REGIONAL ARTERIALS CONCEPT INVENTORY

August 2019

CAMPO
CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

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Foreword

The Capital Area Region is expected to see at least double the number of current residents to over 4 million by 2045. This means that today's transportation system will not be able to support the myriad of future expected uses. The Regional Arterials Concept Inventory was conceived by staff at the Capital Area Metropolitan Planning Organization (CAMPO) as a way to analyze potential strategies on mostly existing roadways that could improve future mobility for people and goods. The Regional Arterials Concept Inventory is a technical analysis of high-level concepts centered on improvements to the arterial roadway network.

Per Transportation Policy Board (TPB) direction, staff initiated an analysis in partnership with local entities to identify relevant concepts for improving the regional arterial network. Regional planning is a moving target and the study was coordinated while many other local agencies were in the process of finalizing or updating the own planning effots. While the this study presents the best information available at the time, it may or may not present certain details the same as approved local plans. Some of those concepts come from locally adopted plans, while others have been identified through the process of this study. Given that transportation needs vary across the region, the results of this study may mean something different to and be used differently by each of CAMPO's regional partners.

To lay a foundation for local and regional long-range planning, the study took an unconstrained look at needs like many other local and regional transportation plans. In particular, the Regional Arterials Concept Inventory is intended to:

- Serve as a forum for local-governments and implementing entities to coordinate and collaborate regional arterial planning via the development of a regionally connected network based on local plans and needs
- Provide the TPB with a data-driven analysis on potential impacts of creating a better connected arterial network
- Be used as a resource document for local governments, especially smaller or underresourced communities
- Provide insight into the potential regional significance of new and improved corridors.
- Document and test best practices in corridor design to accommodate multiple modes and improve aesthetic quality.

The Regional Arterials Concept Inventory does not supersede any planning work done by any local government. All arterial concepts in this document not part of an official locally adopted plan, are merely concepts developed for illustrative and modeling purposes. A local government or implementing entity must decide to sponsor a concept for it to move forward into project development, and construction. The local government or a transportation entity like the Texas Department of Transportation (TxDOT) or the Central Texas Regional Mobility Authority (CTRMA) would also have to agree to be the financial sponsor for it to be included in the fiscally constrained 2045 Long-Range Plan. Any concepts or ideas resulting from this study will have to have written sponsorship from the relevant local entities and/or transportation agencies to be included in the fiscally unconstrained illustrative portion of the 2045 Long-Range Plan. In addition to local project sponsorship, any concept in the study beyond projects in a locally adopted plan, would need to be vetted by the public before moving forward to the implementation process. The TPB would need to approve any concept/idea for inclusion in the 2045 Long-Range Plan or the short-range Transportation Improvement Program.

Although no long-range planning process expects to be a completely accurate prediction of the future, what it can do is present concepts and ideas that policymakers today, tomorrow, and far into the future can use to inform decisions on transportation infrastructure investments.

Acknowledgments

CAMPO Transportation Policy Board

Capital Area Metropolitan Planning Organization (CAMPO) is governed by a 20-member Transportation Policy Board, made up of 18 elected officials and one representative from both the Texas Department of Transportation (TxDOT) and the Capital Metropolitan Transportation Authority (Capital Metro). The 2018 Transportation Policy Board members are listed below and acknowledged for their project support.

Steve Adler
Chair, City of Austin Mayor
Cynthia Long
Vice Chair, Williamson County Commissioner Precinct 2
Alison Alter
City of Austin Council Member District 10
Clara Beckett
Bastrop County Commissioner Precinct 2
Gerald Daugherty
Travis County Commissioner Precinct 3
Sarah Eckhardt
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Jimmy Flannigan
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Hays County Commissioner Precinct 2
Ann Kitchen
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Edward Theriot
Caldwell County Commissioner Precinct 3
Jane Hughson
City of San Marcos Mayor
Jeff Travillion
Travis County Commissioner Precinct 1
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City of Cedar Park Mayor

CAMPO Project Team

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Doise Miers
Community Outreach Manager
Kimberly Petty
Executive Assistant
Ryan Collins
Short Range Planning Manager
Theresa Hernandez
Finance and Administration Manager
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Administrative Associate

Regional Arterials Steering Committee

The study is overseen by a Steering Committee of representatives from local governments and implementing agencies from around the region. Steering Committee Members represented the following communities and entities:

Amy Miller
Director of Community Development

Robert Daigh
Senior Director of Infrastructure

Cheryl McOsker
Transportation Staff Liaison

Cole Kitten
Transportation Systems Development Division manager

Lyle Nelson
Chief of Staff

Ray Miller
City of Georgetown Project Manager

Gary Hudder
Director of Transportation

Ed Theriot, AICP
County Commissioner

Jacob Calhoun
Long Range Transportation Planner/Project Controls

Jerry Borcherding
Transportation Director

Mike Hodge
City Manager

Morgan Cotten
Public Works Division Director

Julie Oakley
Assistant City Manager

Tom Gdala
Senior Engineering Associate

Marisabel Ramthun
Director of Transportation Planning & Development

Megan Will
Principal Plannerr

Trey Fletcher
Assistant City Manager

Justin Word
Director of Engineering

Laurie Moyer
Director of Engineering & Capital Improvements Projects

Leon Barba
City Engineer

Regional Arterials Steering Committee

The role of the Steering Committee is to provide direction and feedback regarding the process and deliverables. This committee reports to the CAMPO Technical Advisory Committee, which reports to the CAMPO Transportation Policy Board. The findings and reports produced for this study will be presented to all these bodies for approval.

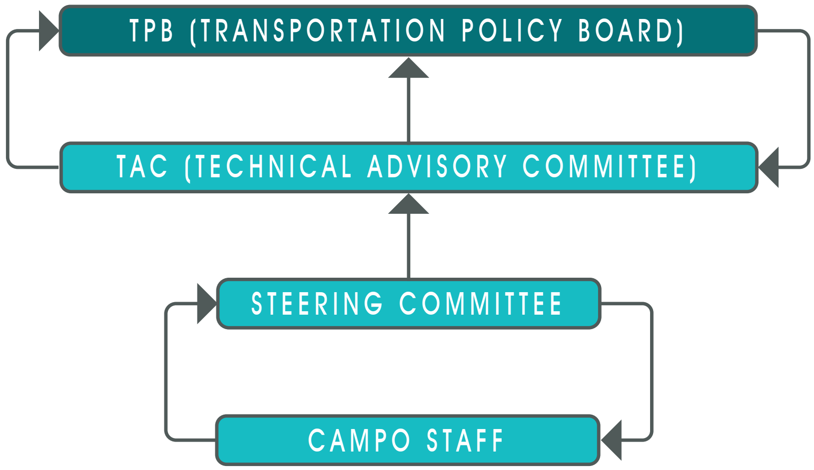


Figure 1.1 CAMPO Organizational Structure

Executive Summary

What is the Regional Arterials Concept Inventory

As our region continues growing over the next 25 years, transportation system efficiency is integral to a sustainable future. As a part of the Capital Area MPO Platinum Planning Program, the Regional Arterials Concept Inventory lays a pathway for developing a comprehensive arterial network to support future growth within the Capital Area region. The Regional Arterials Concept Inventory:

- Provides a hierarchy of roads that support options for different travel needs.
- Establishes a well-connected variety of roads that work together within the hierarchy that promotes flexible movement of people and goods.
- Establishes a proper road spacing within the hierarchy and provides a menu of street cross sections.
- Identifies policy tools that empower local entities within the region to work towards achievement of regional connectivity goals.

The intent of the Regional Arterials Concept Inventory is to identify mobility choices that are safe, convenient, reliable, efficient, and flexible. To achieve this intent, the project team approached the development of the Regional Arterials Concept Inventory by creating an outreach program, collecting data, evaluating the existing, planned, committed and desired network, and developing a Pattern Book with framework for understanding and improving the integration of land use and transportation that includes cross-sections and typologies for future application, all of which is summarized into a final report for member municipalities.

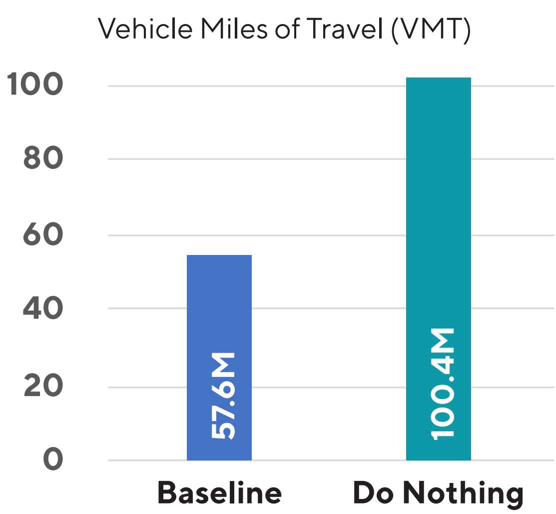
The RACI includes information that can be used to support the development and decision-making process on arterial roads in the Capital Area region. Considerations that promote and enhance travel for the next 25-years are:

- Improved safety
- Efficient mobility

- Multi-modal travel
- Economic, equity and health benefits
- Effective management of future growth
- Environmental protection and preservation.

The Need
Results from the Arterials Study indicate that our population will double over the next 25 years. That growth will increase the current demand for roadways by almost 75%. This equates to a 130% increase in the amount of time a household will spend traveling each day – from 48 minutes a day today to 1 hour and 50 minutes a day.

Key Finding:
Travel demand across the Capital Area region is expected to nearly double by 2045. The Capital Area MPO Platinum Planning Program lays a pathway to a sustainable future by envisioning a region where multiple transportation options are viable and accessible. A comprehensive arterial network provides the foundation to achieve this vision as the region grows.



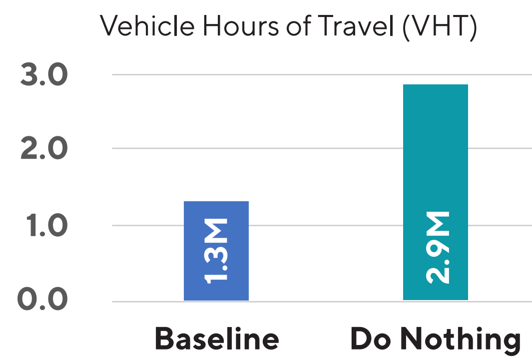


Figure 1.2 VMT & VHT Projections

How to Address the Need
This vision cannot be achieved in a vacuum. Often local transportation plans are developed and implemented independently of adjacent jurisdictions. The Arterials Study is the first time that transportation plans from around the Capital Area region have been collected and consolidated into one comprehensive regional arterial network and evaluated at the regional level. Scenario planning was used to uncover the potential of stitching together a comprehensive arterial network and to provide operational and design options that serve local as well as regional goals and objectives. The results from each of the scenarios indicate that either independently or in combination, they can have meaningful impact on improving and advancing a comprehensive arterial system within our region.

The overarching purpose of the Arterials Study is to provide local transportation planners a planning tool to advance projects that meet their needs, yet also advances the development of a comprehensive regional arterial network. Because this is a regional arterial study, locations of proposed improvements do not represent actual alignments but were developed for travel demand modeling purposes to support the evaluation of each Scenario. The recommended improvements contained in the Arterial Concept List are starting points for each jurisdiction within the Capital Area region. The Arterial Concept List developed through scenario planning could be considered a “menu.” Scenario planning helped ensure that as a region we are planning “off the same menu." When combined with the Pattern Book, local planners have a starting point from which to begin the development of projects that benefit both the local and regional community.

The Arterials Study process led to the development of a potential comprehensive regional arterial roadway system. This process also lays out a methodology on choosing cross-sections for the arterial system based on access, land use, and functional classification. The steps are as follows:

- Step One: Creation of Vision and Goals, Outreach, and Existing Conditions Analysis
- Step Two: Development of a Pattern Book and Case Study Corridor Analysis
- Step Three: Building the Existing Network
- Step Four: Creating a Planned, Desired, and CAMPO Gaps Network
- Step Five: Forming the Concept Plan
- Step Six: Establishing Regional Corridors
- Step Seven: Scenario Analysis

Key Finding:
A key finding was a missing functional class of roadway - somewhere between a Limited Access Route (i.e., IH-35, Loop 1, US-183) and a Major Arterial (i.e., Loop 360, Congress Avenue). The missing functional class might allow for the same amount of throughput but has generally less access to adjacent driveways and lower-functioning roadways.

Functional Class Hiearchy Example

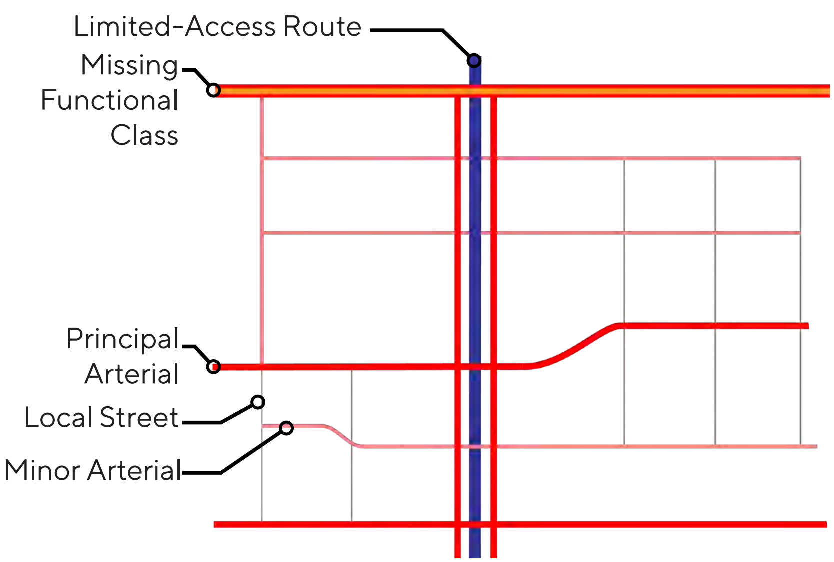


Figure 1.3

Regional Arterials Concept Inventory Process Summary

A summary of the planning steps and key takeaways are provided below.

Step One: Creation of Vision and Goals, Outreach, and Existing Conditions Analysis Steering Committee meetings were conducted to develop an adopt the vision and goals of the plan. Meetings with

Figure 1.4

local governments were held to better understand local needs. Public open houses were also conducted throughout the CAMPO region.

Step Two: Development of a Pattern Book and Case Study Corridor Analysis
Case studies of peer-regions and best-practice corridors were developed to better identify the missing elements of the CAMPO arterial network, provide insight into common arterial grid spacing in peer regions, and discover potential solutions to incorporating multimodal uses within the arterial network. The case study corridors provided insight into unique and instructive design, operation, safety features, and the corridor's mechanisms for balancing access and mobility needs. The case studies of peer-regions and corridors served as the basis for the development of best practices in grid spacing, connectivity, roadway hierarchy, and planning for context sensitive arterials, as well as street design. These findings form the basis of the Pattern Book, along with a presentation of recommended arterial cross-sections. The regional and corridor case studies were offered in full in the Pattern Book report.

In the Pattern Book chapter of the plan, we have identified five context zones that range from high-rise downtown districts to rural areas with a very scattered built form. This means that the functional classification of the roadway can change as it moves through the region due to this change in context. Similarly, context can also impact the design choices for a roadway since changes in built form often mirror changes in population densities and activity. A full menu of possible treatments is found in the Pattern Book and is organized by context zone.

CAMPO Context Zones

Z1	Z2	Z3	Z4	Z5

Downtown Austin, Texas (2013)	Downtown Taylor, Texas (2010)	Parmer Ln. & Metric Blvd. Austin, Texas (2018)	Austin, Texas (2018)	Taylor, Texas (2018)
Urban 1	**Urban 2**	**Suburban 1**	**Suburban 2**	**Rural**
High-rise Downtown	Main Street/ Small Town	Mixed Use/ Activity Center	Conventional	

Figure 1.6

Step Three: Building the Existing Network

CAMPO Counties/Cities	TxDOT	CAMPO Functional Classification
Toll	Toll	Limited Access (Non-tolled/tolled)
Freeway Interstate Highway Limited Access State Controlled Access	Interstate Freeway / Expressway	
Principal Arterial Major Arterial Parkway	Principal Arterial	Principal Arterial Major Arterial Regional Connector
Minor Arterial	Minor Arterial	Minor Arterial
Major Collector Minor Collector	Major Collector Minor Collector	Collector
Local	Local	Local

Figure 1.5 CAMPO grouping up of functional classes

An initial task for the plan was to create an inventory of the existing arterial network. Recognizing that most jurisdictions use their own functional classification definitions that don't always line up across jurisdictional lines, CAMPO staff worked to standardize, or group up, each jurisdiction's functional roadway classes into standard categories in keeping with FHWA and TxDOT standards. This provided an "apples to apples" framing of the network at the regional scale. This step was also taken so that the draft final set of recommendations yield potential projects that meet FHWA and TxDOT funding eligibility criteria.

The map below displays the arterial network, along with limited access facilities and collector roads. This gives us a sense of the existing supply of arterials, their location within the region, and how they serve the limited access network. This map was presented to the Steering Committee originally at the September 2018 meeting.

Existing Arterial Network

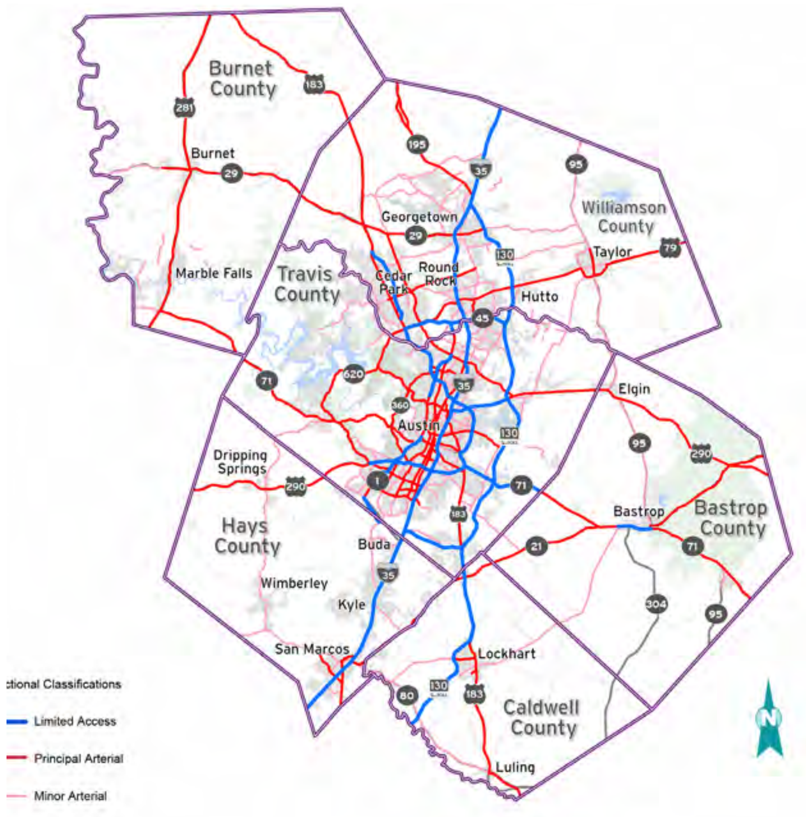


Figure 1.7

Step Four: Creating a Planned, Desired, and Regional Gaps Network
Once the existing network was assembled, the network of planned improvements and new facilities was added. CAMPO received locally-adopted plans from partner regional partner jurisdictions that contained new and/or improved arterials as approved by their boards/councils/commissioners' courts. These individual plans were combined to display the full regional network of planned and existing facilities.

With locally planned and locally desired facilities mapped, CAMPO staff undertook a regional "gap" analysis to determine where missing connections between planned and existing facilities may be or where demographic forecasts show a lack in the supply of arterial roadways. The result of this analysis was the identification of gaps that recommend additional roadway improvements or new facilities to enhance connectivity. A map depicting these three types of new or improved facilities, along with the existing arterial network is shown below. This map was presented to local governments in the second round of meetings.

Figure 1.8

Step Five: Forming the Concept Plan
The next step in the planning process involved the building of the Combined Concept Plan for the 2045 arterial network. The Combined Concept Plan is the culmination of the existing, planned, desired, and regional gaps network presented above, and detailed recommendations for four test case corridors. The Combined Concept Plan began in earnest with the process described above to combine all locally-planned networks. This allowed us to better understand where there may be gaps between new or upgraded facilities.

To assess the proper design and capacity for the facilities in the Combined Concept network, CAMPO created longer distance Regional Corridors from the existing, planned, desired, and regional gaps network facilities. This provided the planning team with all the information to develop an inventory of improvements and new facilities and begin scenario planning work to better understand the potential impact of the Combined Concept network. CAMPO has also set out to provide additional analysis for four test case corridors, SH 21, FM 734, RM 1431, and RM 12. For each, specific treatments and cross sections, as featured in the Pattern Book, were applied to the test case corridors and provide additional analysis on improvements or policies that can help these corridors better meet with the goals and objectives stated in the plan.

Step Six: Establishing Regional Corridors
With a full map in place of planned, desired, and gap facilities, CAMPO identified areas where these individual pieces (typically on the same roadway) could create longer distance, strategically connected "Regional Corridors." This was done, in part, to help illustrate the impact that individual improvements may have on the mobility demands along a given corridor, and to provide truly regional connections to a wider variety of communities.

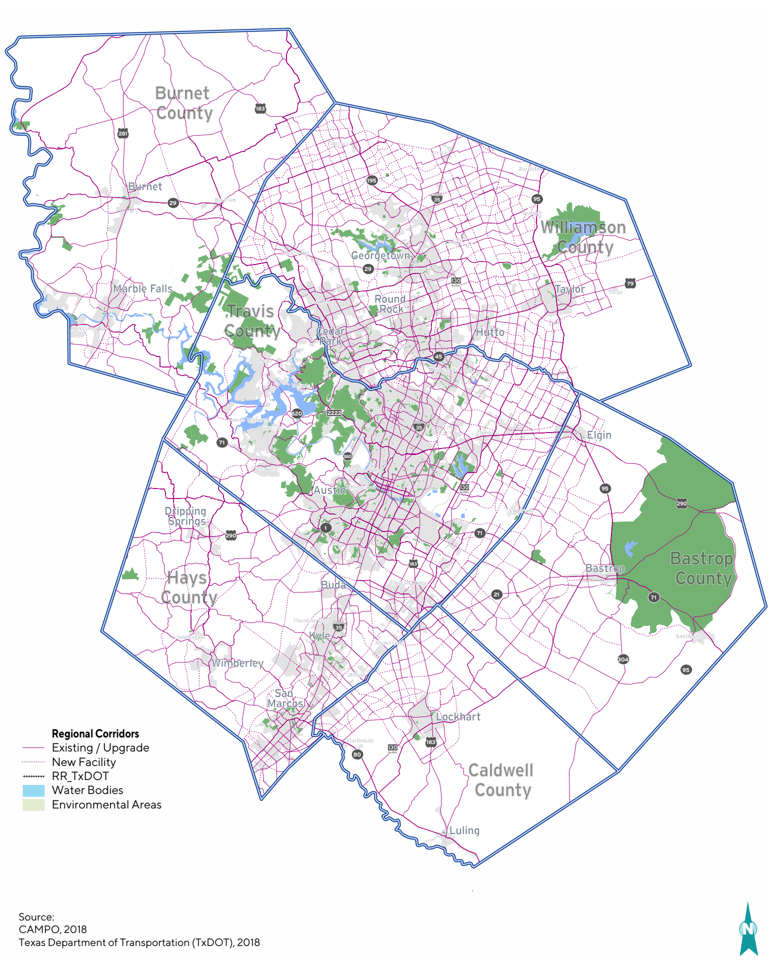


Figure 1.9 Regional corridors

CAMPO combined individual improvements, as shown below, to form each Regional Corridor. Most of the Regional Corridors were comprised of multiple segments with improvements or new facilities planned by a local entity or identified through this planning process. The Regional Corridor below follows RM 1431 going east through the region, then following University Boulevard, Chandler Road, and a planned extension of that corridor to the eastern extent of the region. These corridors cross multiple jurisdictions from Kingsland to just north of Taylor.

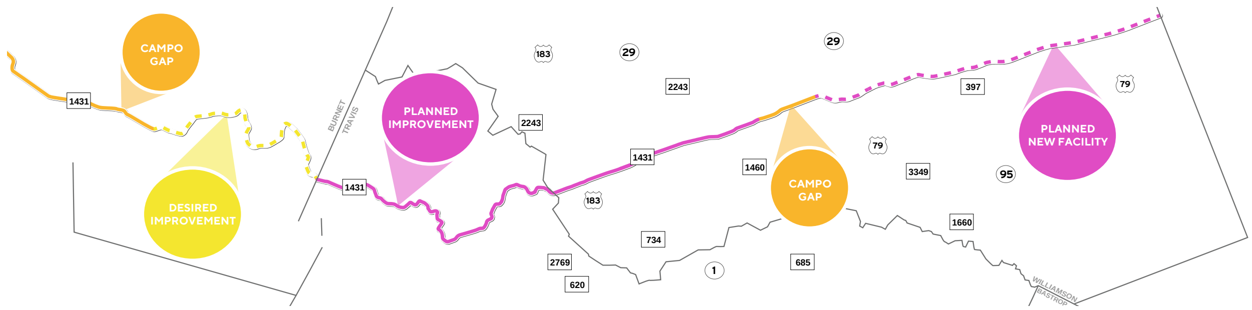


Figure 1.10 Example of corridor segmentation

The Regional Corridors were inventoried in a table to organize all the information previously collected regarding the improvements or proposed new facilities that form each one of them. The process of building the inventory followed the procedure illustrated below, with segments generally determined by a break in the source of the planned improvement or new facility.

1	**Regional Corridor - AF**	
1.1	Segment From A to B	Planned Improvement
1.2	Segment From B to C	Planned New Facility
1.3	Segment From C to D	Desired
1.4	Segment From D to E	Existing
1.5	Segment From E to F	CAMPO Gap

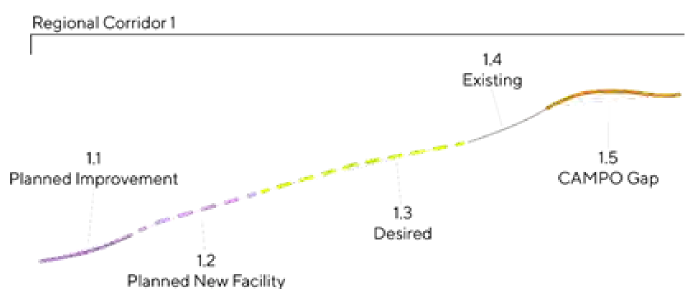


Figure 1.11 Example of corridor segmentation

Step Seven: Scenario Analysis

To better understand the impact of the improved and new facilities that make up the Combined Concept network, a series of five scenarios were developed. Four of the scenarios will be assessed through the CAMPO Transportation Demand Model, while an additional scenario was analyzed outside of the model. Scenario descriptions are as follows:

Scenario Z: Future No Build

Scenario Z is based on the 2040 adopted demographic forecast found in the currently approved Transportation Demand Model. This scenario assumes a doubling of our current population and no roadway improvements beyond those contained in the Transportation Improvement Program (TIP). This type of scenario is often referred to as a “Do-nothing” scenario and is used to compare the impacts of improvements in other scenarios.

Scenario A1/2: Interim Reversible
Scenario A ½ evaluates the potential of an interim operational design change within the no-build roadway network. This option looked at the potential benefits of reversing the directionality of roadway lanes during the AM and PM peak periods. This option is referred to as the Interim Reversible Option. During peak periods, there are roadways in which the direction of travel is significantly higher in one direction than the other. Essentially, there is unused capacity in the lower traveled direction. The interim reversible lane option “borrows” a lane from the other direction so that capacity in the heavily traveled direction receives an additional lane of capacity during either the AM or PM peak periods.

The Interim Reversible Option was evaluated for a few selected roadways with heavy directional flows in the AM and PM peak periods. The table below illustrates the increase in carrying capacity with a reversible lane option. Although this option takes advantage of unused capacity without having to construct new lanes, there will be significant operational challenges to convert existing facilities into this type of usage.

Facility (location)	Existing Trips	Peak-period Reversible Lane Trips
EB FM 969 (@ Springdale)	2,768 (PM)	3,123 (PM)
WB RM 2222 (@ MoPac)	5,689 (PM)	7,210 (PM)
EB RM 2244 (@ Redbud Trail)	2,887 (AM)	4,283 (AM)

Figure 1.12 Reversible lane options

Scenario A: Regional Connectors
Scenario A is a scenario where only the regions' major arterials are improved, and new major arterials are added to eliminate gaps within our regional connections. These types of roadways are the highest functioning roadways within our region and support most of our travel. Within Scenario A, these roadways are our region's top tier roadways. Top tier roadways include all limited access and higher functioning principal arterials in the Capital Area MPO region.

A significant improvement was seen of several regional arterials. Vehicle hours of travel was reduced for all but one regional arterial while average speed increased on all the regional arterials.

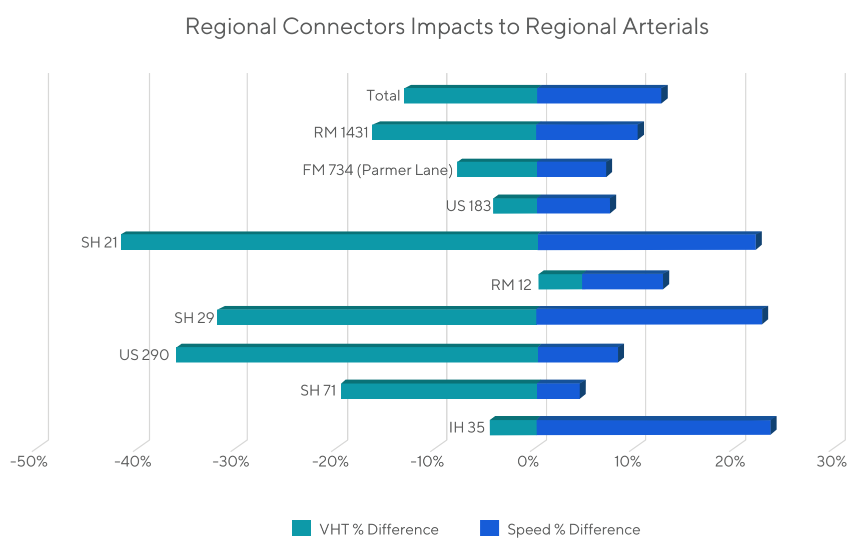


Figure 1.13

Scenario B: HOV (High Occupancy Vehicle)
Scenario B was developed to qualitatively illustrate how facilities could increase person throughput by utilizing lane management techniques. This scenario includes the addition of a flexible lane type for a select number of the top tier roadways identified in Scenario A. Flexible lanes can be special use lanes that are managed – often referred to as "diamond" lanes. Their uses could change throughout the day. These flexible lanes or diamond lanes could be used for transit, high-occupancy vehicles and motorcycles, be limited to parking during off-peak times, be used to support reversible lanes, or be used as variable priced facilities. The flexible uses on arterials in the study would be assumed in the right lane in each direction or using shoulders. Shoulder use would require additional legislation at the state level.

Similar to the Reversible Lane Option in Scenario A 1/2, a few selected roadways were chosen as a test case for evaluation. CAMPO worked with Capital Area Rural Transportation System (CARTS) and Capital Metro Transit Authority (CMTA) to develop transit assumptions for the year 2040. These assumptions were used to determine the potential change in person throughput. These assumptions can be found within the Appendix. The table below provides the results for the HOV option. Under the HOV option, person throughput could be significantly increased on major regional arterials.

Facility	% Change in Vehicle Trips	% Change in Person Trips
RM 12	37%	83%
FM 1826	28%	63%
US 290 W	14%	35%
US 290 E	15%	37%
SH 71 E	18%	45%
SH 71 W	29%	65%
FM 734	17%	42%
RM 1431	21%	49%
US 183 N	7%	21%
US 183 S	17%	42%

Figure 1.14 Potential change in person trips

Scenario C: Combined Concept
This scenario combines the transportation plans from individual jurisdictions within the Capital Area MPO region. Scenario C builds upon the arterial network developed in Scenario A with more emphasis placed on increasing the number and connectivity of minor arterials throughout the region. This increase in minor arterials provides support to the region's high capacity arterials and will help distribute trips more efficiently throughout the roadway network. This scenario provides redundancy to critical arterials in the event of an evacuation, hazardous spills, or major crashes which shut down portions of an arterial for an extended time. The network includes planned projects from the region's municipalities' and counties' transportation plans. It also includes improvements identified by CAMPO that would improve connectivity in areas where roadway gaps were found to exist due to jurisdictional boundaries – gaps in planning jurisdictions.

Capital Area Region
Scenario C: Combined Concept

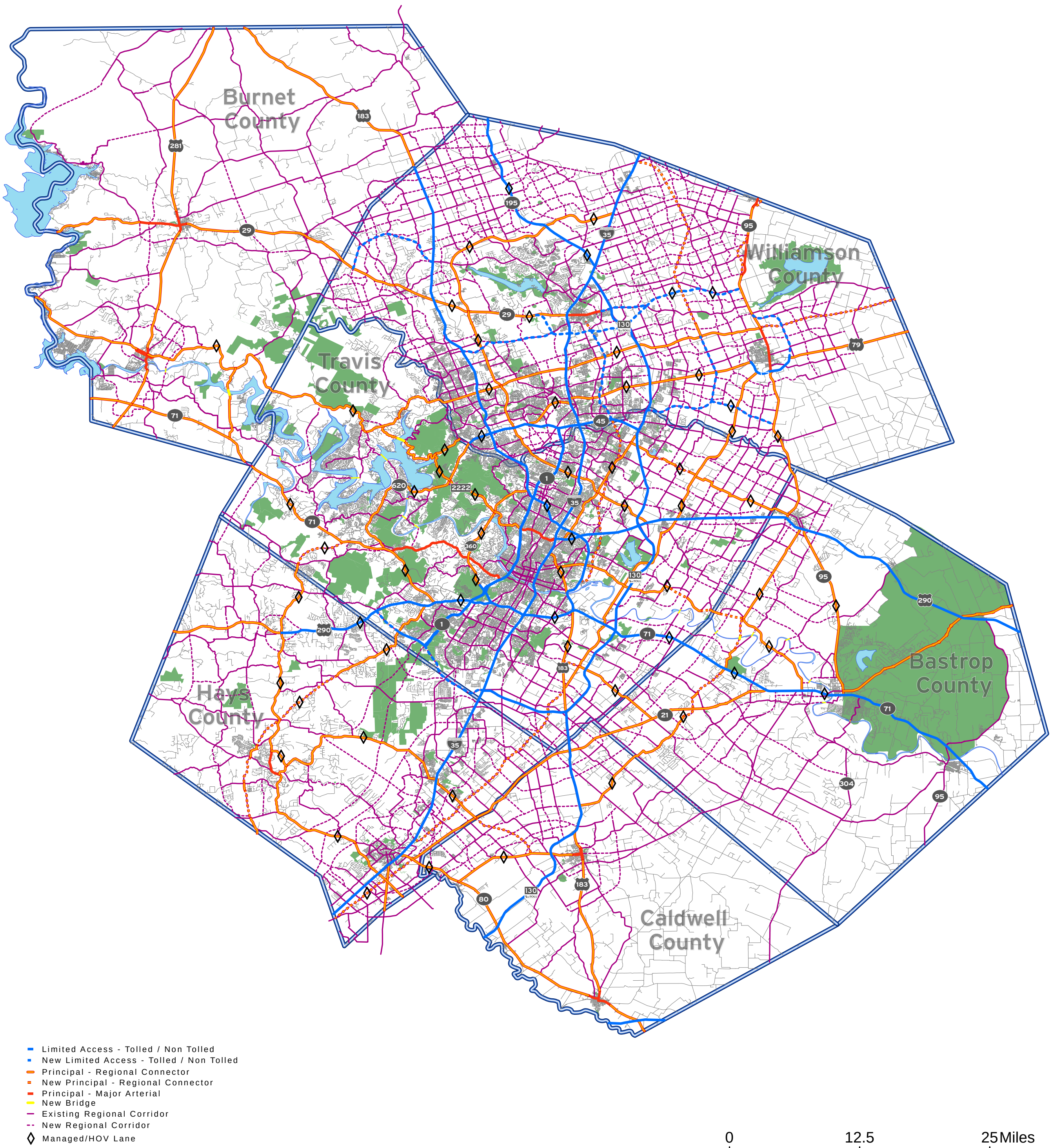


Figure 1.15

Scenario D: Regional and Supporting Connections
The objective of Scenario D is to identify supporting minor arterial improvements from Scenario C that provide the greatest contribution to the top tier roadways identified in Scenario A. Selection criteria include safety, redundancy, volume to capacity ratios (V/C ratio), and input from the public. This scenario establishes the optimal blend of regional connectors from Scenario A and key supporting minor arterial connections from Scenario C.

The results for Scenario D show that roadway performance gained by Scenario A can be further increased with this expanded network as well. With this network which increases the lane miles by only 26% over Scenario 1, we see that VMT is reduced by 3% and VHT is reduced by 22%. Moreover, when comparing Scenario D with Scenario A, we see a 1.5% reduction in vehicle miles traveled (VMT) and a 10% reduction in vehicle hours traveled (VHT) with an 8% increase in lane miles. These results show that with strategic improvements we have the potential to improve safety, connectivity, and congestion while also reducing the miles and time driven.

Capital Area Region
Scenario D: Regional and Supporting Connections

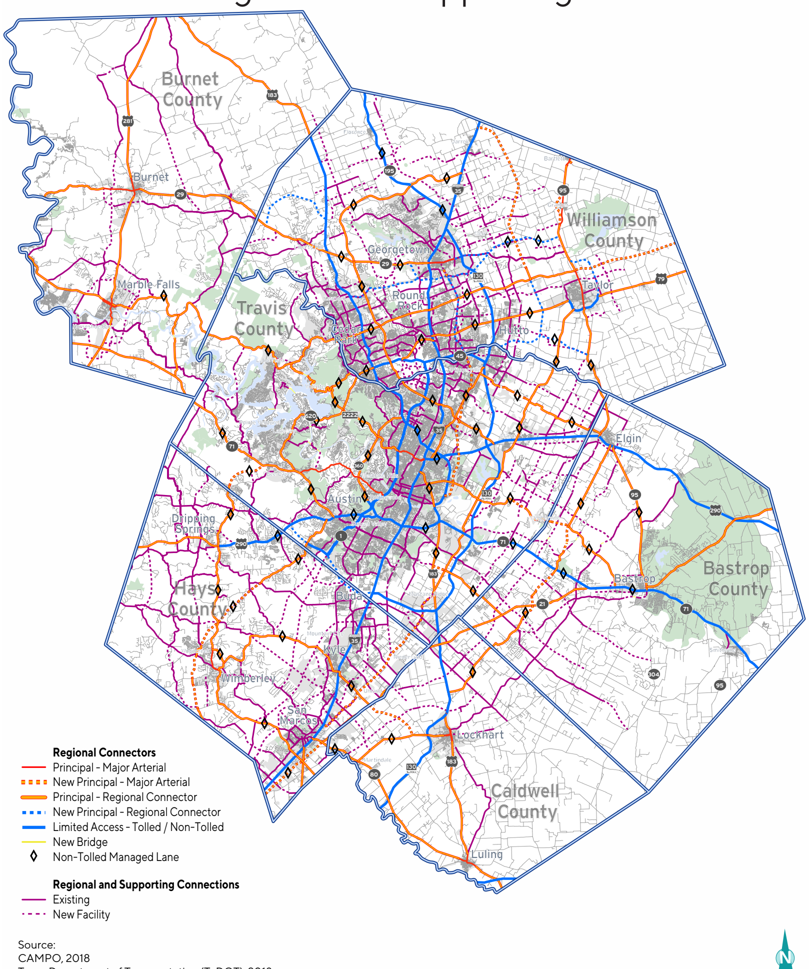


Figure 1.16

A summary of model results for the associated scenarios are shown below.

The final output of the Combined Concept network is an inventory of arterial improvements including their descriptions, source, and costs. These improvements are contained in the Arterial Concept List.

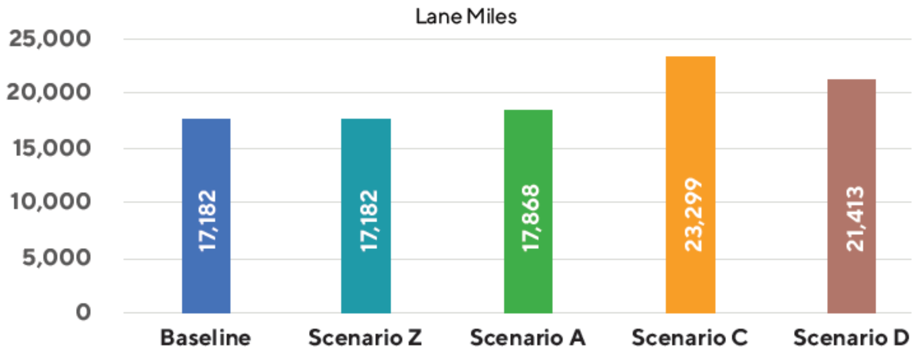


Figure 4.10

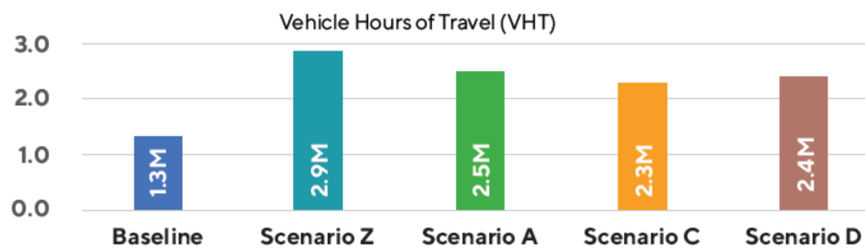


Figure 4.11

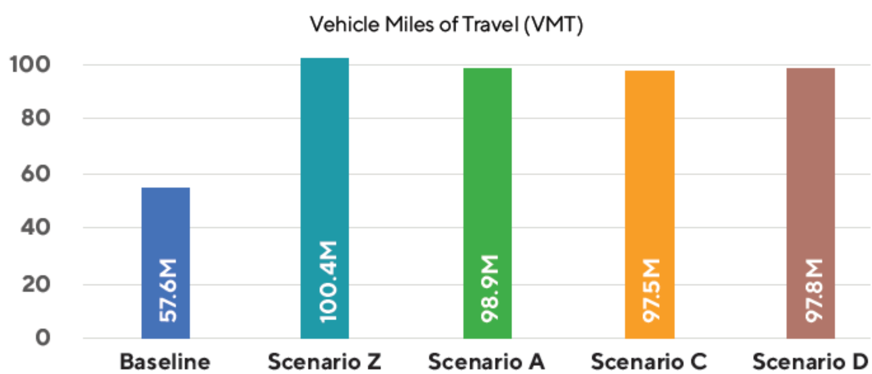


Figure 1.17 Model results summary

How Does a Project on the Arterials Concept List Advance?

As with any project, there are several challenges and hurdles to overcome before a project ever gets constructed. Improvements contained in the Arterial Concept List must have a project sponsor. The project sponsor is the lead agency or jurisdiction responsible for the promotion, development, and funding of the project. No project can advance without a project sponsor. These improvements would also have to be adopted into the CAMPO 2045 Long Range Transportation Plan. Funding would also have to be available for project development. Project development is the planning phase where roadway alignments and the design begin to take shape. Prior to construction, environmental clearance and approval following the National Environmental Policy Act (NEPA) would have to occur. Finally, the project will need construction dollars and will need to be contained in the Statewide Transportation Improvement Program (STIP).

Contents

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Appendices

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REGIONAL ARTERIALS CONCEPT INVENTORY

CHAPTER 1

PROCESS

CAMPO

CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

Introduction

This chapter provides a summary of the Regional Arterials Concept Inventory (RACI) methodology/process and outcomes, and CAMPO's platinum planning process.

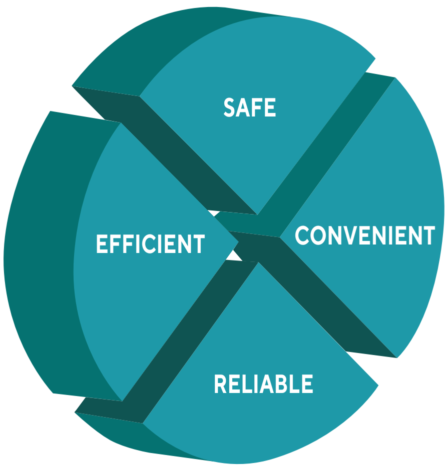
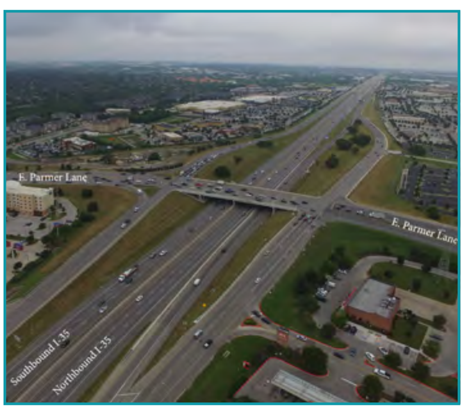


Figure 1.18 Study purpose diagram

Study Purpose

CAMPO is developing a regional arterials study to provide mobility choices that are safe, convenient, reliable, and efficient. The Capital Area MPO 2045 Regional Arterials Concept Inventory is also a planning effort that is part of the 2045 Regional Transportation Plan. The purpose of the RACI is to:

- Create a hierarchy of roads that provide options for different travel-needs.
- Establish a well-connected variety of roads that work together within the hierarchy that can exist flexibility to move people and good.
- Establish a proper road spacing within the hierarchy and provide a menu of street cross sections.
- Identify policy tools that empower local entities within the region to work to achieve regional connectivity goals.



Source: Parmer Lane at IH-35, 2016. HNTB

Source: SH 21 at SH 71, 2018. Google Streetview. https://bit.ly/2F7YB6x

Source: FM 969 at SH 130, 2016. Google Streetview. https://bit.ly/2VO9pMo

Figure 1.19 Regional arterials

Study Process

CAMPO worked closely with the Regional Arterials Steering Committee to guide the study process through regular meetings and presentations. Extensive outreach was conducted with local government officials and the public through a series of meetings. Analysis was conducted and deliverables were developed throughout the process.

Approach

The project team approached the development of the RACI by starting with the creation of an outreach program, collecting data, evaluating the existing, planned, committed and desired network, developing a Pattern Book with framework for understanding and improving the integration of land use and transportation that includes cross-sections and typologies for future application, all of which is summarized into a final report for member municipalities.

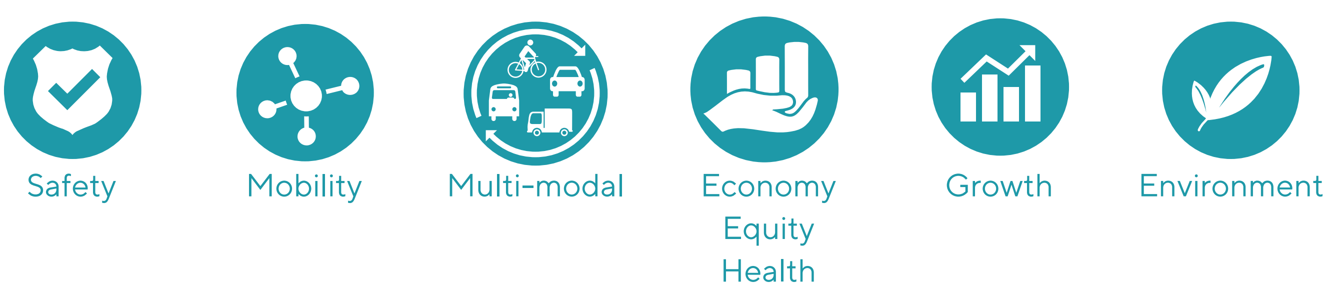
Platinum Planning Program

Platinum Planning is the locally-driven approach for CAMPO's Long-Range Planning Work Recommendations from plans completed through the Platinum Planning Program may be used in CAMPO's 2045 Regional Transportation Plan and certain projects may be eligible for future CAMPO-allocated Federal funding.

Figure 1.20 Platinum Planning diagram

What is in the Study?

The RACI includes information on how the transportation model can be used to support the development and decision-making process on arterial roads in the Capital Area. Considerations that promote and enhance travel for the next 25-years are: (1) Improved safety, (2) Efficient mobility, (3) Multi-modal travel, (4) Economic, equity and health benefits, (5) Effective management of future growth, and (6) Environmental protection and preservation.



About CAMPO

The Capital Area Metropolitan Planning Organization (CAMPO) is the Metropolitan Planning Organization (MPO) encompassing Bastrop, Burnet, Caldwell, Hays, Travis, and Williamson Counties.

CAMPO coordinates regional transportation planning with counties, cities, Capital Metropolitan Transportation Authority, Capital Area Rural Transportation System, Central Texas Regional Mobility Authority, and Texas Department of Transportation.

Figure 1.21 Map of CAMPO's six county region

Process and Timeline

There are five major components of the RACI. Public Outreach is a continuous effort from initiation through to completion . Existing conditions, Pattern Book, and Concept Plan comprise the overall study. Implementation of the study begins when stakeholders apply the RACI to the Capital Area MPO Region.

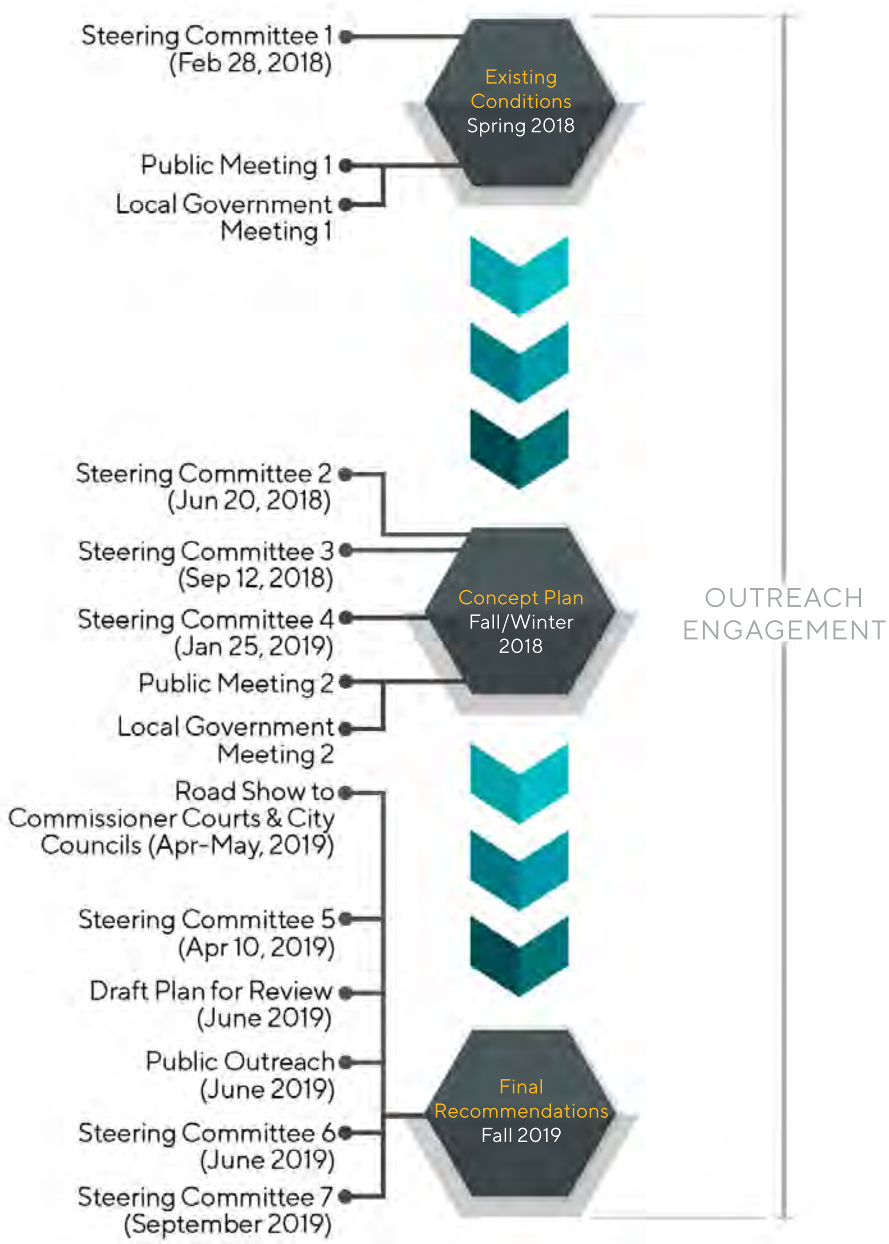


Figure 1.22 Study timeline

Vision, Goals, and Objectives

Success comes from having a clear vision. The steering committee refined the vision statement to include the improvement of multimodal mobility as well as intermodal mobility and the promotion of economic development.

As defined by the Steering Committee, the 2045 Regional Arterials Concept Inventory sets a vision and describes a series of goals and objectives for the region's arterial roadway network.

Vision

The Capital Area's world-class Regional arterial network provides a broad set of transportation choices that improves multi-modal and inter-modal mobility, that are safe, convenient, reliable, resilient, and efficient. They will also promote equitable prosperity, region-wide connectivity, economic development, and healthy communities.

The goals and objectives provide a framework for planning for a better arterial network. They serve as guideposts for the study and the impetus for recommendations.

Goal 1: Safety

Improve safety for arterial road users.

- **Objective:** Reduce severity and number of crashes for all modes to assist local governments and other transportation agencies reach vision zero metrics.
- **Objective:** Reduce emergency response times.
- **Objective:** Enhance evacuation routes.

Goal 2: Mobility

Improve network efficiency and flexibility to reduce travel times and distance.

- **Objective:** Expand the network to reduce congestion and increase capacity.
- **Objective:** Decrease network gaps to add connectivity, reduce bottlenecks and remove barriers.
- **Objective:** Improve network redundancy to reduce reliance on the limited access roadway network for short trips.
- **Objective:** Unlock economic development/redevelopment potential by allowing for opportunities to live, work, and play in close proximity.
- **Objective:** Utilize improved technology to increase efficiency of travel.

Goal 3: Growth

Plan for growth more effectively.

- **Objective:** Plan for and leverage growth through a more comprehensive network to accommodate different development types.
- **Objective:** Prepare for future land use and development opportunities.
- **Objective:** Identify right of way (ROW) for preservation, and reservation for future or redeveloping corridors.
- **Objective:** Use available policy tools creatively to achieve community objectives.
- **Objective:** Promote a network that supports a wide range of housing choice near employment.

[1] Vision, Goals, and Objectives approved by the Steering Committee at the June 20, 2018 meeting.

Goal 4: Multi-modal

Design Multi-modally to provide more transportation choices to move people and goods.

- **Objective:** Design the roadway network for all modes.
- **Objective:** Design arterials for all ages and abilities.
- **Objective:** Design roadway network with flexibility for all modes.
- **Objective:** Design arterials that are freight and transit supportive.

Goal 5: Environment

Protect and preserve the environment.

- **Objective:** Develop roadway design that limits negative impacts to water and air quality.
- **Objective:** Consider design elements and aesthetic treatments that are context appropriate.
- **Objective:** Consider environmental factors and the impacts of materials on the environment and roadway life-cycle costs.

Goal 6: Economy, Equity, and Health

Foster a system that promotes prosperity and vitality for our region.

- **Objective:** Align road functionality with evolving road character and design to community and environmental standards.
- **Objective:** Consider freight and delivery needs.
- **Objective:** Provide equitable access to support economic development.
- **Objective:** Improve public health outcomes through air quality, active mobility and enhance quality of life.

Figure 1.23 Public outreach wordcloud

Public Outreach

Community Outreach Summary

An integral component of developing the RACI was a robust community engagement program to gather input from a diverse range of residents throughout the region. An overarching goal of the community engagement process was to be inclusive and equitable, reaching the general public to include vulnerable populations such as Environmental Justice, Limited English Proficiency, seniors, school aged children, and people with disabilities.

Opportunities for Participation

The first phase of outreach for the RACI began in spring 2018 and included several meetings with planning partners, local government officials, and the public. The purpose of this phase of outreach was to share background information on the study and gather input on existing conditions, needs, and priorities as they relate to the regional arterial network.

The second phase of outreach began in winter 2019 to share an overview of public input and technical data collected during the first phase of the project, along with improvement concepts and best practices identified through regional and national case studies. The purpose of this phase of outreach was to update the community on the progress of the study and gather feedback on potential improvements to the regional arterial network. The third and final phase of outreach began in summer 2019 to share the draft RACI report and potential design types, planning scenarios, and next steps for projects to be implemented. The purpose of this round of outreach was to gather public feedback on the draft study prior to presenting the study to the Transportation Policy Board for adoption.

Opportunities to provide input online or in person were provided during all phases of outreach, along with opportunities to learn more at community centers and events.

Steering Committee

A Steering Committee, made up of 22 representatives from local government agencies and regional transportation entities, was assembled to provide guidance on the project. The Steering Committee held four meetings to provide their insight into project challenges and opportunities. The Steering Committee supported the project in an oversight role, provided their input on project outputs, assisted with the promotion of open houses and provided feedback on the development of the vision, goals, and objectives.

Local Government Meetings – Over 200 Local Government and Agency Participants

Two rounds of local government meetings were held in conjunction with public outreach periods to share detailed information about the planning process and gather input from staff of local planning agencies through mapping exercises and workshops. Local and regional entities were invited such as cities, counties, ISDs, TxDOT, and CTRMA.

Meeting details, including meeting locations, attendance, and participating entities, are included in the appendix.

Figure 1.24Public meeting diagram

- **Round 1** (April 2 – 16, 2018) – Shared study background information and planning considerations, gathered input on existing conditions and collected mapped input on existing facilities, and identified local transportation plans and arterial needs
- **Round 2** (November 2 – 9, 2018) - Shared study updates, summarized input and data gathered during the first round of outreach and gathered input from local planning partners on existing condition findings, the draft pattern book, test case corridors, and CAMPO identified gaps in the arterial network

Figure 1.25 Meeting location maps

Public Meetings – Over 250 Reached

Three rounds of public meetings were held throughout the planning process to gather community feedback and provide updates on the study. Meetings were conducted in an open house format in the evenings, with one daytime option during each round for convenience. To make public participation more convenient, meetings were held in various locations across the region and were combined with meetings for other CAMPO initiatives where possible to provide information about several planning processes in one place. Detailed descriptions of meeting locations and times, attendance, and materials are included in the appendix.

Figure 1.26 Public meeting diagram

- **Round 1** (April 2 – 17, 2018) –Shared study background information and planning considerations, gathered input on existing conditions, and identified local transportation needs and priorities
- **Round 2** (November 26 – December 7, 2018) - Shared study updates, summarized input and data gathered to date, and collected input on draft concepts and CAMPO identified gaps in the arterial network
- **Round 3** (June 11- 20, 2019) – Shared the draft study for community feedback

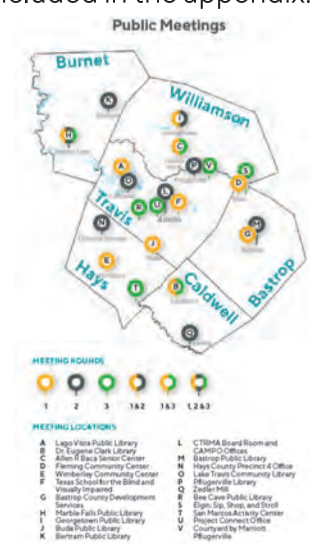


Figure 1.27 Public meeting maps

Intercept Surveys – Over 200 Reached

To reach the public where they were already gathered, the project team visited several community locations during the survey period to administer surveys on iPads and share printed copies of the survey for distribution. Areas with low participation or high concentrations of vulnerable populations were chosen for this activity in an effort to engage underrepresented groups.

Online Engagement

All meeting materials and input opportunities were available on the project webpage. Those that could not attend in meetings in person were offered the opportunity to view meeting materials through an Online Open House, provide their input via email, and take the survey online or provide comments via email.

What We Heard

A survey was available in both English and Spanish during the first round of outreach to gather input from community members on arterial needs and priorities throughout the region. Over 1,995 surveys were received, and participants were dispersed among various income levels, ages, ethnicities, and zip codes (as shown in Figure 1.28).

Input was collected during the second round of outreach through written comment forms and emails. Over 160 comments were received during this round of outreach and generally discussed the need for safety improvements to SH 71, improving congestion by providing additional network connectivity, environmentally sensitive growth, and suggestions for specific treatments for local roadways and intersections.

Throughout the region, input received from the community generally emphasized a need to address congestion and improve connectivity to the existing transportation network. Many participants throughout the region also noted a need for improved multimodal options and connectivity for alternate modes of transportation. Summaries of input received from each county are included below.

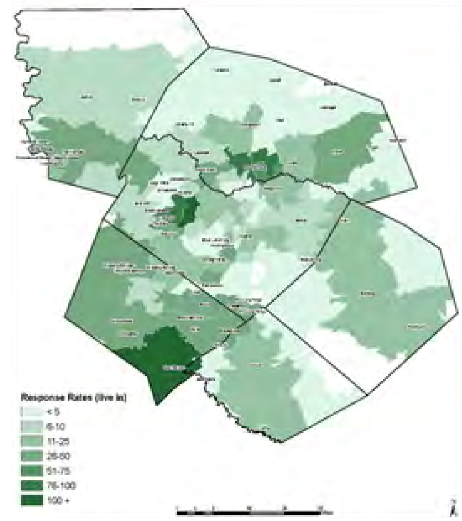


Figure 1.28 Public outreach map

Bastrop County

In general, Bastrop County participants and local government representatives agreed with the purpose of the plan and that there is a critical need to address congestion and bottlenecks in the network, specifically on roadways connecting to Travis County. Additionally, the public noted a desire for improved pedestrian and public transit options, including improved CARTS service and potential rail options.

Burnet County

Many participants from Burnet County noted a need to improve connectivity to the existing network and surrounding areas, as well as a desire for additional river crossings and low water crossings. Several survey responses discussed the need for improved roadway safety features, including turn lanes, dividers, and bicycle and pedestrian facilities.

Caldwell County

Residents of Caldwell County noted a need to address congestion and traffic volume, as well as improve roadway conditions through maintenance. Residents also expressed a preference to improve multimodal facilities, such as transit and bicycle accommodations, and noted the need to consider environmental features and potential impacts.

Hays County

In general, participants from Hays County emphasized the need to consider sustainable growth and environmental conditions and impacts. Hays County residents also noted a desire for reliable multimodal transportation options with connections to major destinations and improved safety on US 290.

Travis County

It should be noted that the majority of input in Travis County came from residents of the Steiner Ranch area, who strongly emphasized concerns for congestion and safety conditions on RM 620, and from the Safer 71 Coalition, who emphasized the need to improve safety along US 71 in the western portion of the county. Other topics addressed in comments from Travis County residents include suggestions to identify improved safety evacuation routes and the need for reliable, convenient, and safe multimodal transportation options.

Williamson County

Input received from Williamson County frequently identified a need for multimodal facilities, including improved bicycle and pedestrian facilities and more reliable and convenient transit options. Williamson County residents also noted a need for improved signal timing on existing roadways.

REGIONAL ARTERIALS CONCEPT INVENTORY

CHAPTER 2

EXISTING CONDITIONS

CAMPO

CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

Introduction

This Chapter provides the "big picture" and how the transportation system in the Capital Area region operates today within a local, State, and Federal framework. Overall, this Chapter will highlight how people are interconnected in the region – CAMPO residents live, work, and play in different cities and counties than they reside. For example, design of the roadway network in Williamson County impacts a resident living in Bastrop and vice-versa. Ease to which users of the transportation network can connect from their local community to the regional community is a current and predicted demand trend. This chapter provides the "where are we now" to providing the needed connectivity so that residents in all counties have access to their desired job markets, services, and recreation.

What is an Arterial Road?

The U.S. Department of Transportation (USDOT) and Federal Highway Administration (FHWA) support state and local governments in the design, construction, and maintenance of the nation's highway system. "On-System" is used to categorize roads that are inclusive of the National Highway System (NHS) and "Off-System" is used for roads that are not. TxDOT defines Off-System roadways as any roadway not designated on the State Highway System and not maintained by TxDOT. Conversely, On-System roadways are designated on the State Highway System and maintained by TxDOT. Maintenance of off-system roadways is the responsibility of the local jurisdiction in which the road is located. CAMPO may partner to fund improvements to many of the On-System arterials and high functioning off-system roads with local governments. On-System and Off-System roads can be further classified by functional classification which groups roadways into classes based on traffic characteristics and the types of service they provide.

Based on the most recent TxDOT Roadway Inventory in 2016

On-System Roadway miles within the Capital Area region just under 2,500 miles[2]

Off-System Roadway miles within the Capital Area region just over 10,500 miles[2]

This study will use TxDOT and FHWA definitions of functional roadway classifications as a starting point for further discussions. Figure 2.1 illustrates the accepted roadway classification system and FHWA's definition of several functional classifications are included below.

[2] Texas Department of Transportation (TxDOT); 5RDGZD\,QYHQWRU\$QQXDO Reports 2016; Roadway Inventory. Assessed at https://bit.ly/2Ykd71Q

FHWA Classification Table	
Interstate	Interstates are the highest level of roadway and designed for long-distance travel offering limited access.
Freeway	These roads have directional travel lanes and are separated by some type of physical barriers. Access is purely controlled by interchanges and on- and off-ramps to maximize their mobility function.
Tollroad	Roadways (either public or private) where passengers pay a usage fee to use the roadway.
Expressway	Roadways with directional travel lanes that are typically separated with controlled access to maximize mobility.
Principal Arterials	Roads serve major centers and provide a high level of mobility, but abutting land uses can be served directly.
Minor Arterials	Provide service for trips of moderate length and offer connectivity to the higher arterial system.
Collector	Gather traffic from local roads and funnel users to the arterial network.
Local	Classified by default of all used roads other than arterials and collectors. Designed to minimize through traffic and are often used at the very beginning or end of a trip.

Figure 2.1

FHWA Classification Tree

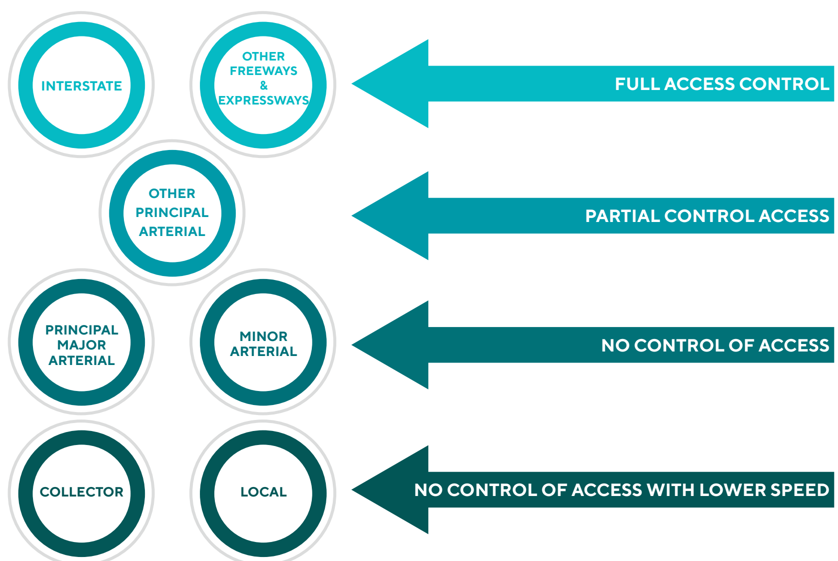


Figure 2.2 FHWA Classification Tree

Grouping-up process - Deferred to TxDOT Classification Table

CAMPO Counties / Cities	TxDOT	CAMPO Functional Classification
Toll	Toll	Limited Access (Non-tolled/tolled)
Freeway Limited Access Interstate State Highway Controlled Access	Interstate Freeway / Expressway	
Principal Arterial Major Arterial Parkway	Principal Arterial	Principal Arterial Major Arterial Regional Connector
Minor Arterial	Minor Arterial	Minor Arterial
Major Collector Minor Collector	Major collector Minor Collector	Collector
Local	Local	Local

Figure 2.3 CAMPO grouping up graphic

CAMPO used FHWA's definitions as a starting point and reclassified the transportation network into the below classifications. For the purposes of this plan, CAMPO defined an arterial as a road that connects to limited access roadways (freeways), local streets, and destinations. Arterials are smaller than a major access controlled roadway such as IH-35, but larger than a local neighborhood street. Within the Capital Area region, arterials are used frequently to commute between home, work, and school.

FHWA Classification Table	
Limited Access Route	This classification includes interstates, and freeways that are designed for long-distance travel. These roads have directional travel lanes and are separated by some type of physical barriers. Access is purely controlled by interchanges and on- and off ramps to maximize their mobility function. These roadways are typically used for trips throughout the region that are more than five miles in length.
Tolled Limited Access Route	These roadways (either public or private) are similar to Limited Access Routes, but passengers are required to pay a usage fee to use the roadway. Trip type for these roadways is similar to Limited Access Routes as they are typically used for longer trips, more than five miles in length.
* Expressway/ Regional Connector	Although a major arterial, this roadway functional class is recognized as a missing type in the Capital Area region. These roadways have directional travel lanes that are typically separated with controlled access to maximize mobility. When access is not controlled, they aim to achieve higher mobility over access. Typical trip types that use this classification are in five mile segments.
* Major Arterials	Roads serve major centers and provide a high level of mobility, but abutting land uses can be served directly. Trip type for principal and major arterials typically serve trips between three and five miles.
Minor Arterial	Minor arterials serve trips of moderate length and offer connectivity to the higher arterial system (including principal or major arterials and connectors). Typical trip type on minor arterials are one to three miles in length.
Collector	These roadways are used to gather traffic from local roads and funnel users to the arterial network. Typical trip distance on collectors is around one mile.
Local	Local roads are designed to minimize through traffic and are often used at the very beginning or end of a trip. Local road are typically used for shorter trips within a community that are less than one mile.

*** Expressways and Major Arterials are both types of princicpal Arterials.**

Figure 2.4

Arterials exist in large cities and small communities. In rural areas without limited-access facilities, arterials connect communities and provide a way for longer distance travel. Arterials play an important role by providing for trips inappropriate for freeways or local streets and reserving long distance travel for the freeway functional classification roadway which supports long distance high speed travel.

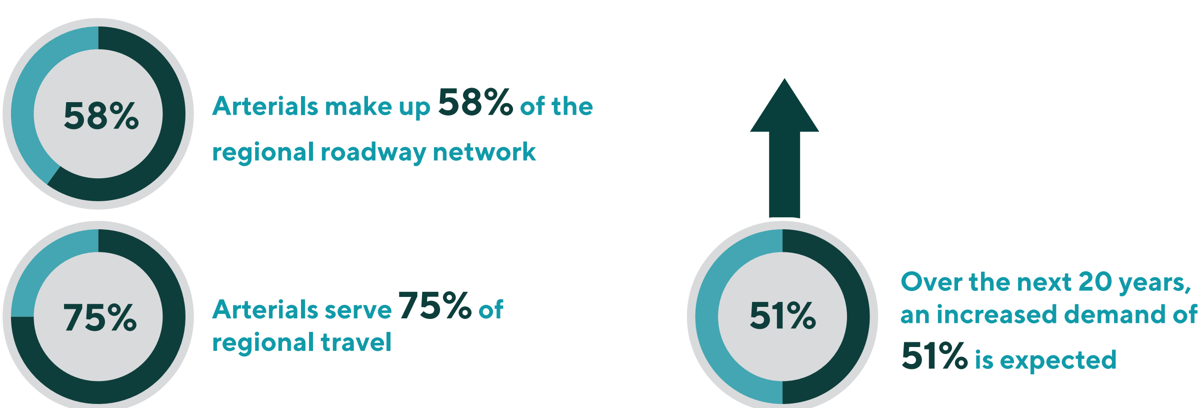


Figure 2.5 (Existing Arterial Network) highlights the arterials that have been redefined for the purposes of this study by CAMPO, which include existing limited access, principal and minor arterials.

Existing Arterial Network

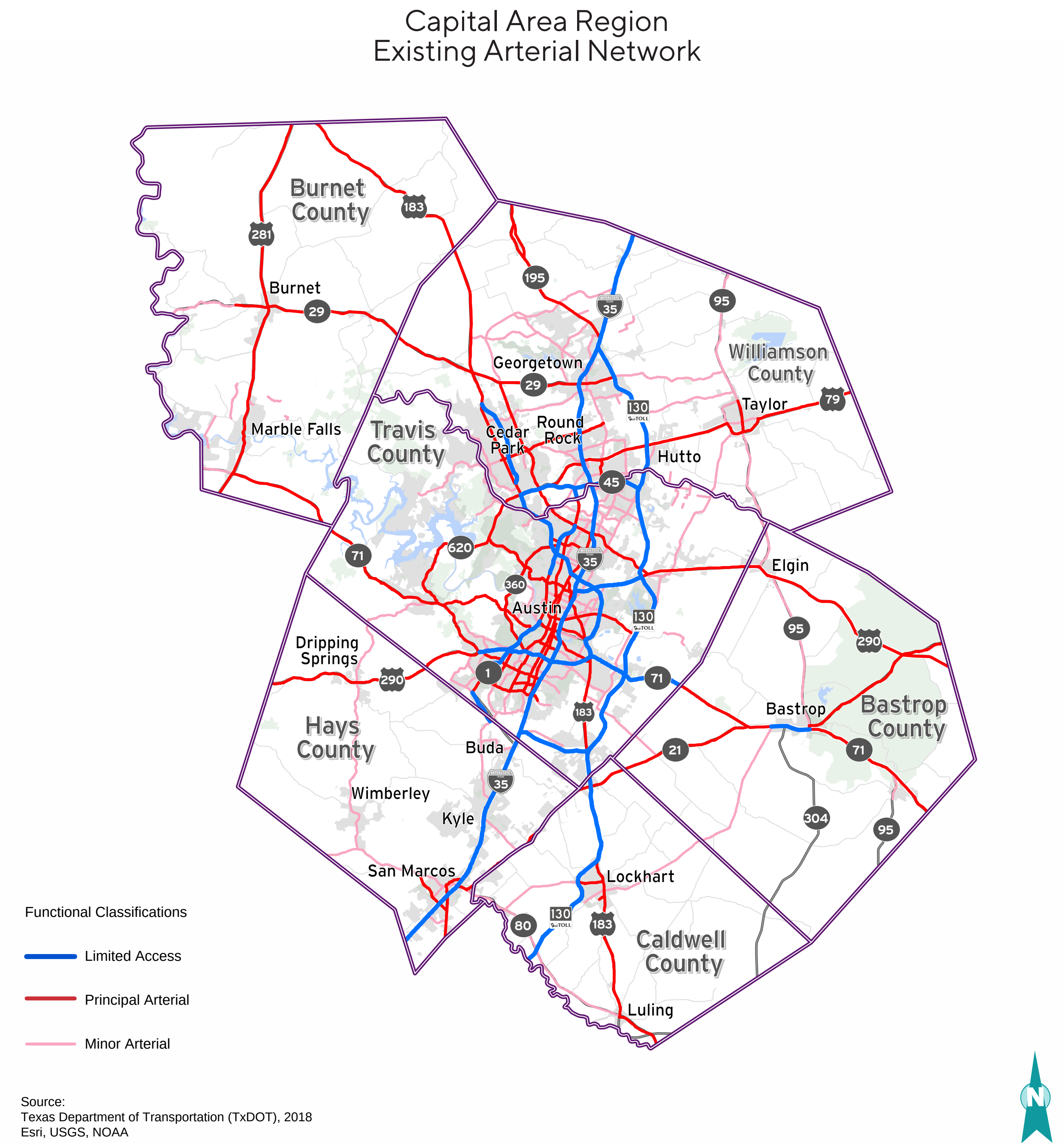


Figure 2.5

CAMPO Network

The Capital Area region contains several of Texas' top 100 most congested roadways. Several of the counties within the Capital Area Region are lacking the appropriate mix of roadway types – limited access facilities and regional connectors. The results of our current network lead to high congestion indices.

The 2018 ranking of Texas' most congested roadways illustrates a familiar theme: growth-induced traffic gridlock is getting worse every year. The Capital Area region contains 14 of the 100 most congested roadways within the region and IH-35 from US 290 to SH 71 ranked #3 of the top #100.

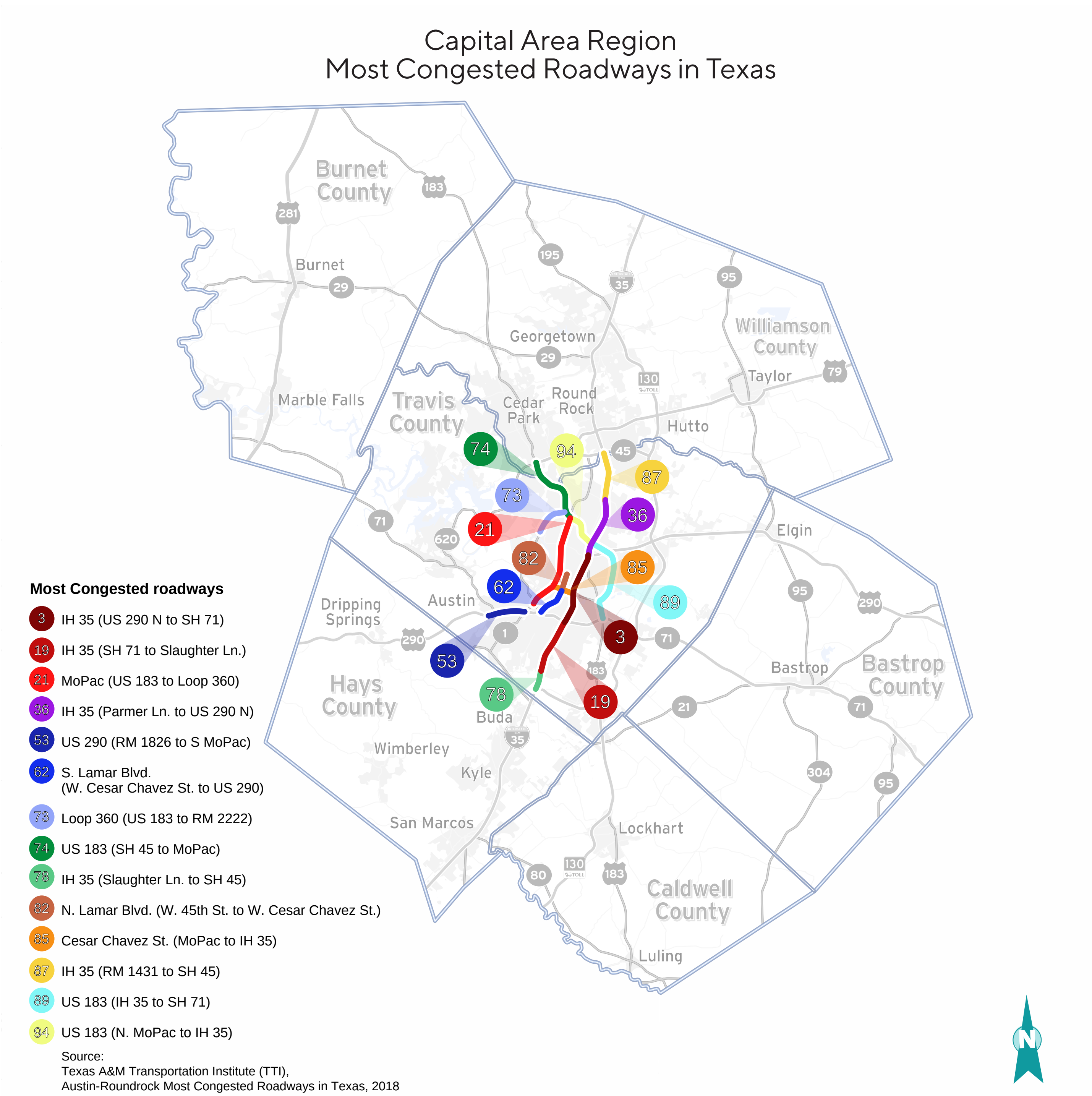


Figure 2.6

The existing network and its performance is directly related to the interaction between the available supply (roadway) and demand (people). Demand can be described as the number of roadway users, their origins and destinations, and how they traverse the roadway (car, bike, transit). Supply can be described as the amount of roadway and the type of roadway i.e. lane miles of bike lanes and lane miles of roadways for single-occupancy vehicles. Performance is a measure of the relationship between the supply and the demand. Roadway performance can suffer when demand is greater than supply. The root cause is often due to the fact that the supply is not appropriate for the demand, there is a lack of additional choices in the wider network, or the function of the road conflicts with how the design of the road has balanced access and mobility concerns.

Ultimately, the more travel time it takes a person to get to their destination or origin, the poorer the performance. Travel times of people are impacted by both supply and the access to facilities whether it be roadway, bicycle lanes, or pedestrian facilities. In Figure 2.7 summarizes the network performance and how supply of different facilities impacts overall mobility in the region.

[3]

	Percent of Road Miles by CAMPO Classification Type						
Type	Bastrop	Burnet	Caldwell	Hays	Travis	Williamson	CAMPO
Limited Access Route	3%	0%	1%	6%	10%	4%	6%
Tolled Limited Access Route	0%	0%	8%	0%	7%	5%	5%
Expressway/Regional Connector	21%	12%	17%	17%	29%	25%	23%
Minor Arterial	20%	8%	26%	25%	17%	29%	21%
Collector	14%	30%	11%	14%	2%	2%	8%
Local	42%	50%	37%	38%	35%	35%	37%
Total Network Miles	497	386	433	649	1,979	1,502	5.446

Figure 2.7

Observations from the analysis:

- Travis and Hays Counties have the highest share of Limited Access Routes (also referred to as Interstates by FHWA) at 10% and 6% respectively
- Caldwell County has the highest share of Tolled Limited Access Routes (8%)
- Travis County has the highest share of Expressway/Regional Connectors (29%)
- Williamson County has the highest share of Minor Arterials (29%)
- Burnet County has the highest share of Collectors (30%) and Local (50%)

[3] Scenario 0; 2020 baseline represents the current transportation network performance

Vehicle miles of travel represent the demand on the regional roadway network. Today, over 57 million vehicle miles are traveled each day in our region. Over half the regional demand occurs in Travis County. Today Travis county has the highest population, the most network mileage, and contains most of the employment/shopping opportunities.

Vehicle Miles Traveled by County[3]		
County	VMT	% VMT
Bastrop	2,301,370	4%
Burnet	2,257,861	4%
Caldwell	1,676,381	3%
Hays	7,250,661	12%
Travis	30,273,157	53%
Williamson	13,733,065	24%
Total	57,492,495	100%

Figure 2.8

Almost half of the total regional demand is served by our regions arterial system and over a quarter of that demand is served by IH-35. The regional arterial system is the backbone of the region's network.

Vehicle Miles Traveled by Functional Class[3]		
Functional Class	VMT	% VMT
Interstate/Freeway	16,097,110	28%
Regional Arterial	27,539,858	48%
Minior Arterial	6,336,552	11%
Collector	1,334,993	3%
Local	662,452	1%
Toll Facilities	4,286,771	7%
Other	1,234,756	2%
Total	57,492,492	100%

Figure 2.9

Vehicle hours of travel represent the time spent on the network each day. Our region spends almost 1.4 million hours a day traveling through the region. Over half the time spent traveling is on the arterial network.

Vehicle Hours Traveled by County[3]		
County	VHT	% VHT
Bastrop	44,874	3%
Burnet	51,332	4%
Caldwell	31,543	2%
Hays	161,106	12%
Travis	795,703	58%
Williamson	295,745	21%
Total	1,380,303	100%

Figure 2.10

Most of our region's travel time is spent in Travis County. Similar to the VMT in Travis county, Travis county has the highest population, the most network mileage, and contains most of the employment/shopping opportunities.

Vehicle Hours Traveled by Functional Class[3]		
Functional Class	VMT	% VMT
Interstate/Freeway	323,903	23%
Regional Arterial	727,112	53%
Minior Arterial	171,827	12%
Collector	35,980	3%
Local	24,359	2%
Toll Facilities	63,263	5%
Other	33,857	2%
Total	1,380,301	100%

Figure 2.11

[3] Scenario 0; 2020 baseline represents the current transportation network performance

Today, our interstate facilities and regional arterials are already under performing. These facilities are not able to meet the demand under the existing conditions. Travel on IH-35 can take 40% longer than a trip under free flow conditions, a 1.4 travel time index. Travel on our regional arterials can take 20% longer than a trip under free flow conditions, a 1.2 travel time index.

[3]

Functional Class	Freeflow VHT	Congested VHT	Congestion Index
Interstate/Freeway	238,595	323,903	1.4
Regional Arterial	585,099	727,112	1.2
Minior Arterial	150,615	171,827	1.1
Collector	33,991	35,980	1.1
Local	21,388	24,359	1.1
Toll Facilities	60,650	63,263	1.0
Other	32,370	33,857	1.0
Total	1,122,708	1,380,301	1.2

Figure 2.12 Functional classification performance metrics

Roadways that are over capacity reduce travel time reliability forcing those using the transportation system to spend more time in traffic. Almost half of our roadways are operating at or over capacity in either the AM, Midday, or PM peak periods. As described above, almost half the demand and travel time occurs on our regional arterials. These are the roadways that are operating at or above capacity. Arterials can experience congestion when a network is poorly connected meaning there are limited alternative route options. Arterial congestion can also occur due to limited mode choices, drive-way spacing that is too dense, poor signal timing, or poor intersection design.

Today, on average, a household spends an hour and half a day traveling and drives approximately 65 miles a day. As our region's population grows, the regional arterial system will only continue to degrade. Improving our region's arterial network should be the focus. Solutions to improve our arterial network include; roadway re-design, adding capacity, making new connections with new arterials to existing arterials, utilizing technological solutions, and increasing opportunities for transit and other uses within arterials.

[3] Scenario 0; 2020 baseline represents the current transportation network performance

As part of the needs analysis, a holistic review of transportation network was completed with a focus on the region's arterials. Residents in Bastrop, Burnet, Caldwell, Hays, Travis, and Williamson Counties make 1,588,646 work-related trips daily and represent 17% total traffic volume daily. Trips for recreation, appointments, school, shopping or other non-work related activities make up 6,834,615 number of trips and 74% of total trips. Trips that are entering the region make up 9% or 835,412 of total daily trips. Many of these trips, if not most, use an existing arterial road.

Figure 2.13 Trip types

Network Connectivity

The roadway network plays an important role in determining the effectiveness of travel, as well as, the form and function of communities. Ideally, and in congruence with the goals and vision of the RACI, arterials should contribute to a well-connected efficient network that provides safe, direct, ideally redundant, and convenient access for multiple modes of transportation (including motorized and non-motorized). Arterials can and should provide a wide range of travel opportunities with varying speeds, using a broad set of cross-sections, for different travel purposes not appropriate for freeways or local streets and various transects (urban, rural, suburban) that arterials serve. Today the region's arterials are under-performing and lack the necessary connectivity and redundancy. Due to current constraints, additional demand is put on the limited access roadways. As the arterial network is improved, volume can be shifted to the arterial network to take the additional load off the limited access corridors.

This plan aims to evaluate the existing arterial network and assess the existing policies in use to achieve these goals. Building upon a solid understanding of current conditions, the Concept Plan will act as a guide and the Pattern Book provide a tool for municipalities to reach the CAMPO vision for the arterial network.

Connectivity is key as no single roadway can provide utility without the addition of connecting roadways. Today, limited access roadways do not have sufficient arterial support as they carry the brunt of the volume and demand in the Capital Area region. A better connected road network reduces VMT by providing more direct routes between origins and destinations. Lack of connectivity causes circuitous and indirect trip routes.

A better connected road network reduces VMT by providing more direct routes between origins and destinations

Lack of connectivity causes circuitous , indirect trip routes

With a better connected arterial network, traffic will more evenly distribute across the network allowing all roadways to operate at a higher level of service and more efficiently.

Municipalities have several policy tools to promote access and connectivity to new or existing infrastructure. Tools include connectivity goals, block dimensions guidance, access management tools including the use of medians and signal spacing, backage, access authority, through-traffic policies, intersection spacing guidelines, and others. The following descriptions give a brief overview of these policy tools and they are explained in greater depth in this section.

- Connectivity Ratio/Index – Identifies a connectivity ratio/index definition based on some measure of streets or nodes per block or area and encourages use of ratio/index in planning and assessment of existing and future development.
- Intersection Spacing – Regulations or guidelines for intersection spacing based on functional classification or typology of roadways.
- Block Length Guidelines – Recommended block length (enforced by block length minimums and maximums) based on community character, land use, and roadway classification.
- Backage, Frontage or Offsetting Access – Guidelines that don't allow individual residential driveways onto arterial streets.
- Access Points – Requiring multiple access points for new development ensures network redundancy.
- Through Traffic – Guidelines to discourage through traffic on local streets through neighborhoods and instead encourage through traffic on nearby arterials.

Avoiding policies that make it more challenging for people to travel from home to work or commercial activity centers is a vital part of achieving improved connectivity and ultimately regional mobility. Figure 2.14 demonstrates the continued mobility challenges that start at the neighborhood level with ordinances that limit much needed connectivity. The table indicates existing policies in place within CAMPO communities. Encouraging policies at all levels that encourage connectivity across roadway types will ensure the region develops a robust and resilient regional network.

Network Connectivity Policies			
	Policy	Number of Communities' Codes/Ordinances with Related Policy	Existing Policy Summary
1	Promotes Using Connectivity Ratio or Index	3 of 24	Minimum *connectivity ratios range from 1.2 to 1.6.
2	Recommends Intersection Spacing Requirements	13 of 24	Not included in all communities. Arterial spacing requirements range from 1,000 - 5,000 ft.
3	Recommends Maximum Block Lengths	20 of 24	Most have some variation of block length/size policies, though requirements vary from general parameters with a 400-ft. minimum to a maximum of 2,000 ft. block length in commercial or industrial districts. Traditional, mixed use, or form districts are generally limited to a block length between 600 – 800 ft. Some include block perimeter limits from 2,000 - 5,000 ft.
4	Recommends Backage (Reverse or Double Frontage Requirements)	13 of 24	Most have policies allowing or requiring backage, reverse frontage, or offsetting access points for residential lots backing up to an arterial or major road.
5	Promotes Connectivity with New Streets	22 of 24	Almost all require connectivity between new roadways to existing and/or future development on adjacent tracts.
6	Requires More Than One Subdivision Access Point	13 of 24	Most require subdivisions to have more than one access point (with exceptions for those with fewer lots). Some do not specify the number of access points required for subdivisions.
7	Discourages "Through Traffic"	17 of 24	Most have specific language to eliminate, avoid, or discourage continuous streets through neighborhoods, particularly those directly connecting arterials

Figure 2.14

*A simplistic measure of connectivity is the connectivity ratio which is calculated by: Counting all nonarterial intersections and cul-de-sacs (nodes) in the study area; Counting all nonarterial roadway segments (links) between the nodes in the study area, and dividing the number of links by the number of nodes.

Municipalities have various planning tools at their disposal to guide development in a way that supports the vision outlined by the community. However, counties do not have the same land use planning authority as city municipalities. Network connectivity, redundancy, and supply can be impacted by land use policy and ultimate build-out. Integration of land use and transportation planning in a concerted effort to reduce high VC ratios but still provide residents access to jobs, school, recreation, and healthcare is vital to ensure the most efficient use of public resources and economic competitiveness. Tools and requirements between developers and municipalities to ensure coordination of roadway development and land use development is cohesive may be stifled due to the limitations on land use planning counties have. Due to law changes in Texas, it is now more difficult for municipalities to annex other areas. Cities often have more tools and policies available to help ensure connectivity and redundancy adjacent to developments that can meet the needs of growing regions.

Network Redundancy

Network redundancy is an important feature of a connected network because it manages mobility by providing alternative routing to a destination. Network redundancy allows drivers to take an alternative route due to construction, extreme congestion, or roadway incidents and avoid daily bottlenecks. Redundancy is extremely important to emergency response services, but it is often overlooked in network planning and design that tends to focus on corridor improvements. There are very few communities in the Capital Area region that specifically reference network redundancy or include alternative routing, except when requiring a minimum of two access points to new subdivisions. This is a holdover of traditional subdivision planning that has occurred in the past 50 years.

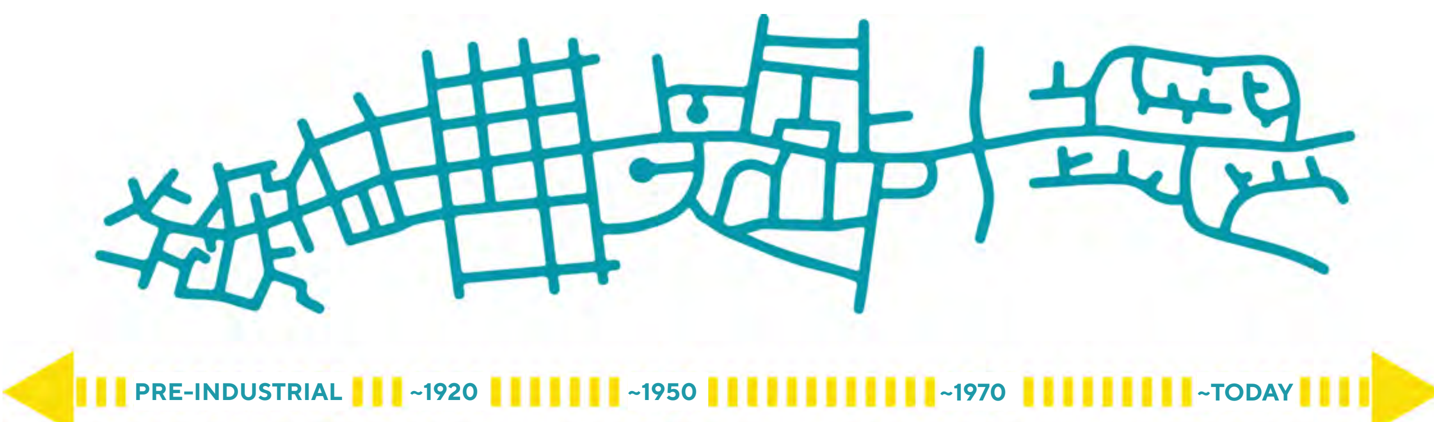


Figure 2.15 Street network patterns over time

A well-connected network has many links, numerous nodes, and minimal dead-ends. In Figure 2.16 illustrates the difference between a disconnected network within arterial blocks and a connected block with more intersections and therefore increased grid density.

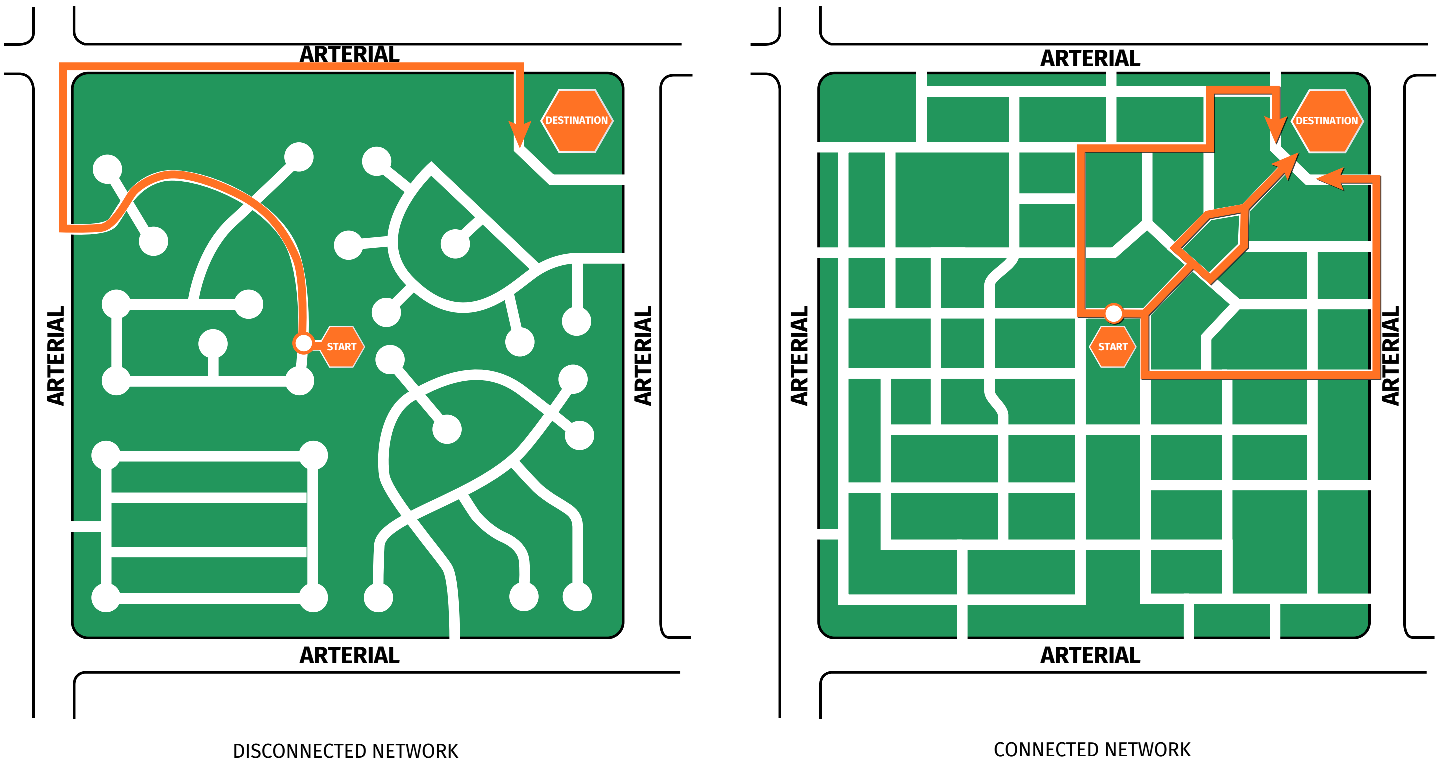


Figure 2.16 Neighborhood connectivity graphic

There are many ways to measure network connectivity and redundancy including block dimensions (block length, face, or size), intersection density, street density, connected node ratios, the connectivity index (CI), grid pattern, and pedestrian route directness.[4] Intersection density is a common measure of vehicle connectivity and is simply the total number of intersections per land area (square mile). Although some guidelines recommend a preferred measure of 160 intersections per square mile with a 100-intersection minimum, that measurement does not account for all of the various roadway types nor need to vary intersection density accordingly.[5] For example, in mixed-use and/or urban activity areas, a denser, highly-connected multi-modal network with lower traffic speeds and comfortable and interesting pedestrian areas would be more appropriate than a lower-density network designed to move large volumes of traffic through the area as quickly as possible. In rural areas, a lower-density network with longer block lengths, protected open spaces, and low-moderate speeds is more appropriate. In transitional areas between rural and suburban communities and employment centers, a mix of low- and high-density networks may be needed to serve both local traffic and commuter traffic requiring higher-volume, higher-speed roadways.

[4] Victoria Transportation Institute Online Encyclopedia. Roadway Connectivity, 2010. Accessed at https://bit.ly/23p81Si

[5] Metro (2004), Street Connectivity: An Evaluation of Case Studies in the Portland Region.

Capital Area Region
Intersection Density

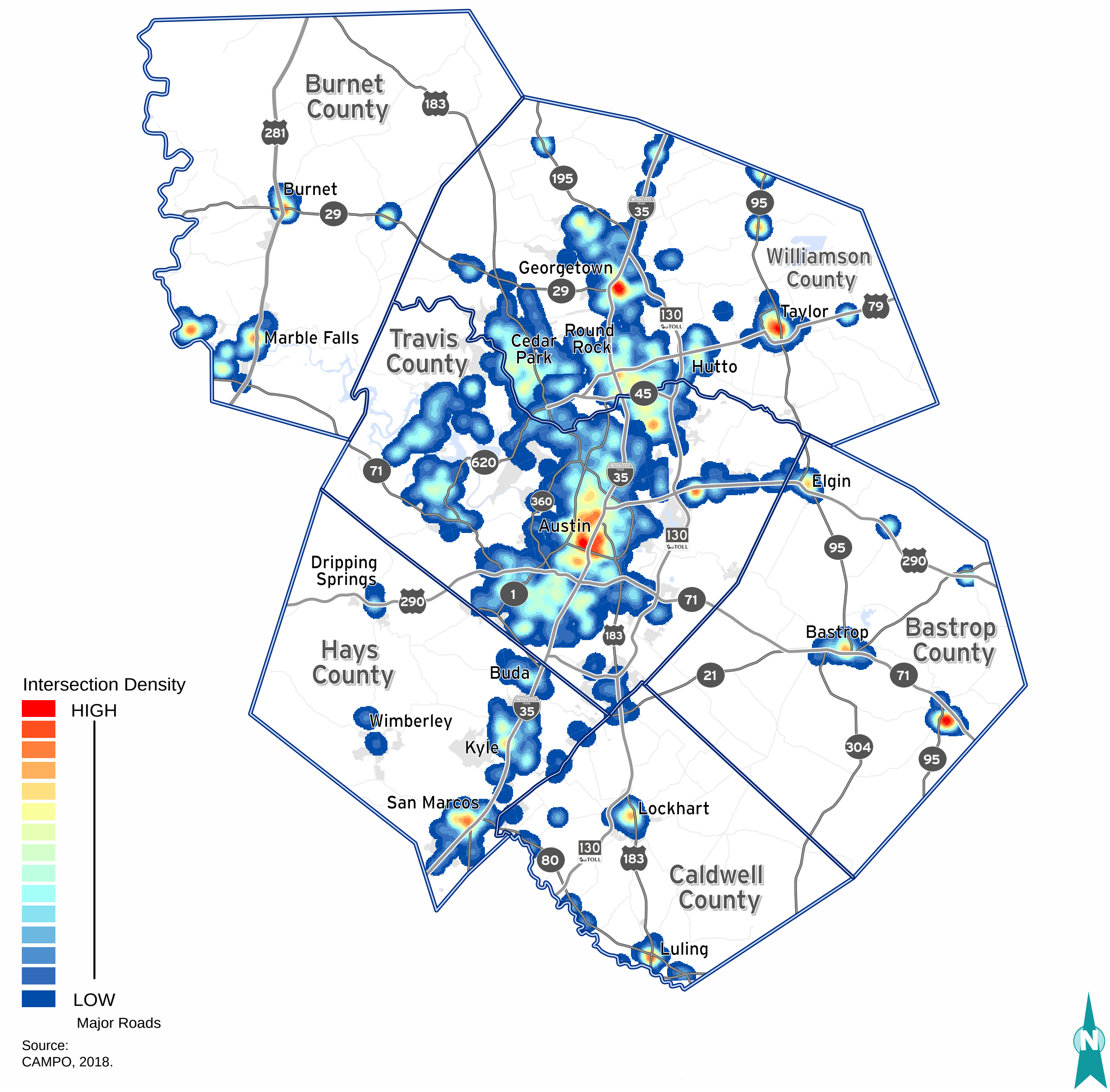


Figure 2.17

Intersection Density

A sample policy analysis noted that several plans in the region recommend that connectivity ratios be implemented, however, few if any have been adopted into codes and ordinances of Capital Area region jurisdictions likely due to the challenges associated with applying one intersection density ratio across a community with a wide variety of densities and roadway types that are rapidly evolving. CAMPO mapped the current intersection densities, and as expected the highest concentration of intersections occurs in the urban core and town centers of the region providing access to services, while fewer intersections are located in the rural communities that are focused on mobility.

In addition to connectivity ratios and measures, most communities do not include specific block length policies or signal spacing requirements. However, communities with form-based codes do generally stay within Complete Streets guidelines (typically 600 feet or less, and ideally within 350 to 550 feet). Figure 2.18 below provides a local/corridor example of network redundancy.

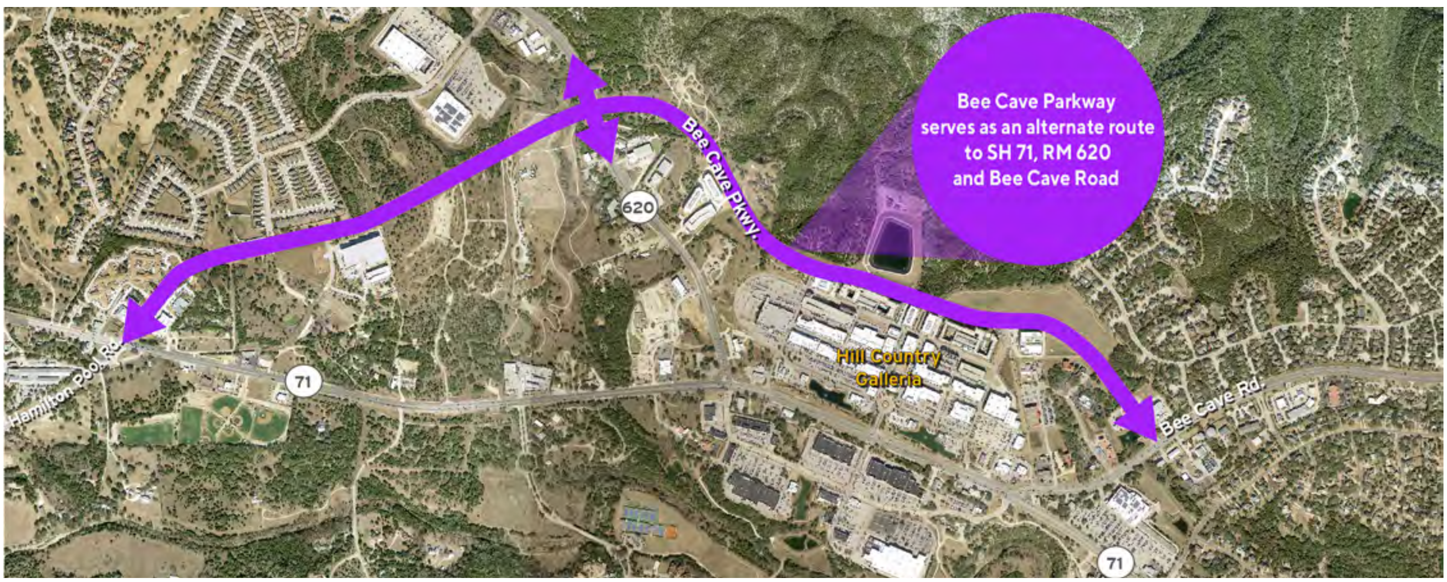


Figure 2.18 Arterial support roadway graphic

Source: COA Aerials, August 2018.

[6] TND Design Rating Standards, Version 2.2. U.S. Environmental Protection Agency, 2005. Accessed at https://bit.ly/2XfB6CS

Block Dimensions

Block dimensions are important because they relate directly to intersection density and signal spacing. As roads move out of the urban areas that are focused on access, there are fewer intersections as the roadways become more focused on mobility. The block dimensions follow this pattern of increasing in size as the road's functionality changes. We see this typically in suburban areas with commercial nodes that have shopping centers with large square footage shopping retailers like HEB, Target and the like. The challenge with these large lot commercial centers and their associated distances between intersections, is that they often diminish connectivity with the creation of super blocks, which are the combination of several small blocks into one large block. Super blocks are areas bounded by arterial roads that are the size of many typically-sized city blocks combined with roads only designed to serve local, internal circulation needs.

The grid is often disconnected when the super blocks are developed to serve large commercial, retail or even entertainment uses such as stadiums. Although some large super blocks such as those with museums are appropriately scaled to serve unique destinations, too many of them in a suburban setting can result in a disconnected grid. Figure 2.19 illustrates how block dimensions can scale with the transportation network and setting.

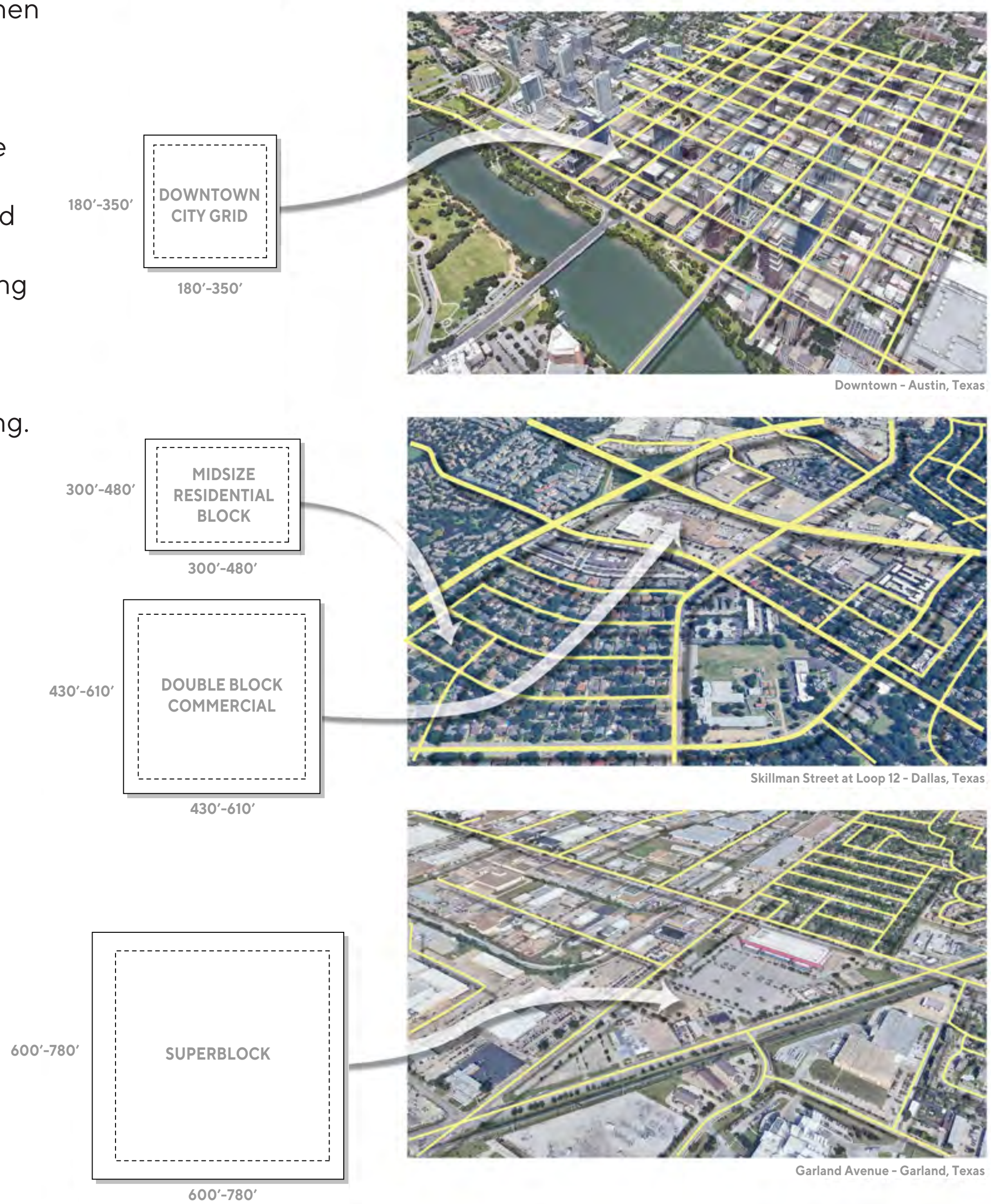


Figure 2.19 Block sizes graphic

Driveway Spacing

Frequent driveways and access points along short segments of roadway, particularly mobility focused roadways, can create many conflict points. Take for example, North Mays Street, an important connector between Williamson and Travis Counties.

Population growth and demand between the two counties has driven this corridor to be a mobility-focused corridor. However, original design, per-existing conditions, and lack of policy tools has allowed frequent driveways and curb cuts along the corridor.

Driveways also create conflict as traffic turning into and out of driveways moves slower and results in speed differences that may lead to crashes. Some communities within the Capital Area region have driveway spacing guidelines and requirements; some do not. There are a handful of communities that promote joint access and shared use of driveways.

Figure 2.20 Image of driveway spacing

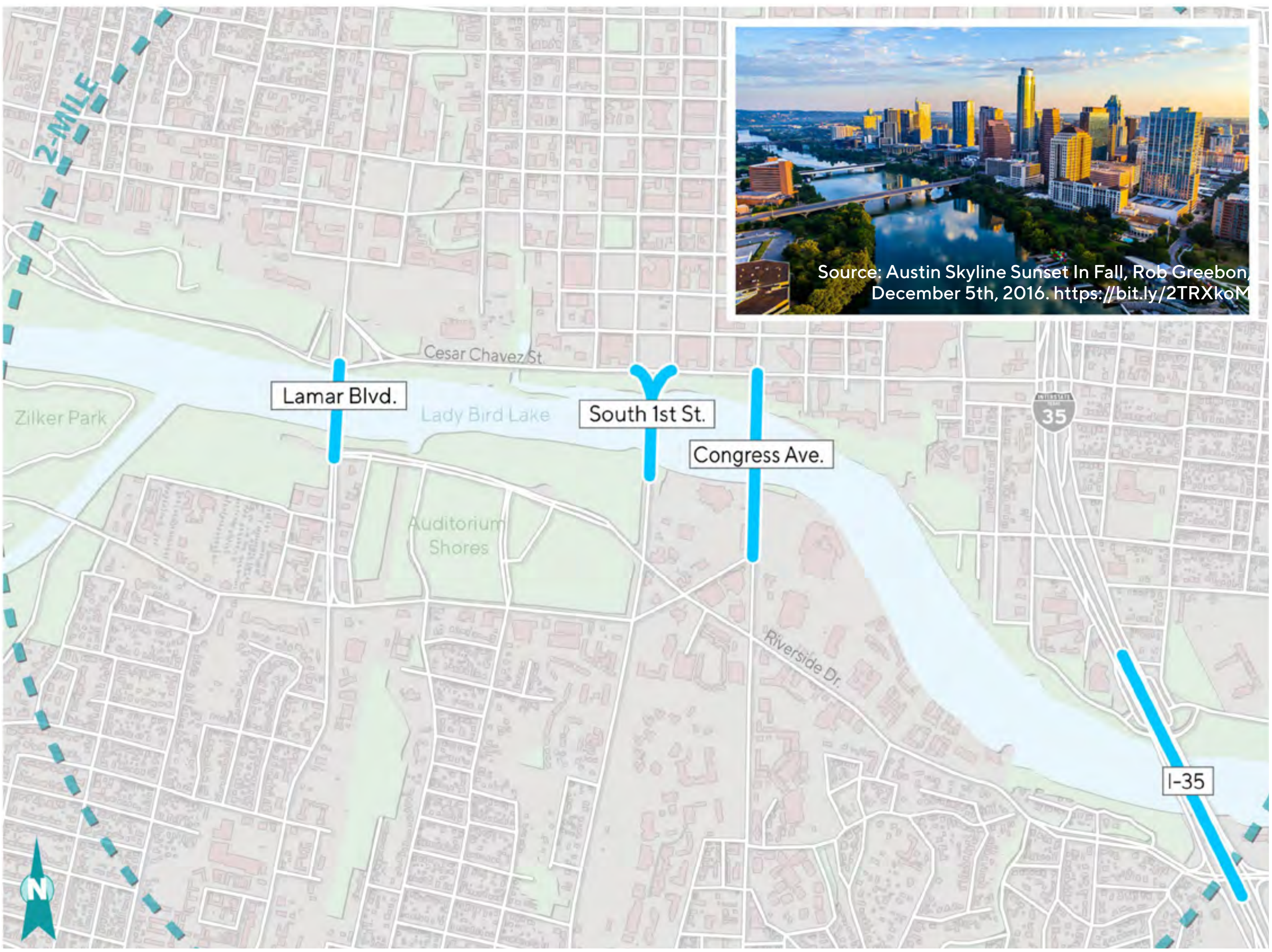
Source: Google Maps; http://bit.ly/2XwnWhe

Driveway spacing requirements are important for safety reasons; however, the often-unintended consequence is numerous closely space drive-ways due to a need to access parking and uses on the roadway.. This land use pattern may not be reflective of the desired roadway functionality or the alignment with the land use plans. This highlights the importance of cooperation and coordination between agencies planning mobility improvements and those with land use planning authority to ensure our desired development patterns are aligning with the appropriate roadway functionality and transit service. Of the 24 communities whose policies were reviewed, 63% of the communities had general policies that promote or recommend joint access or use of driveways. More than 90% of communities whose policies were reviewed, include driveway spacing guidelines, but most reference state guidelines and none provide specific spacing requirements.

Factors Limiting Connectivity

Geographic Barriers

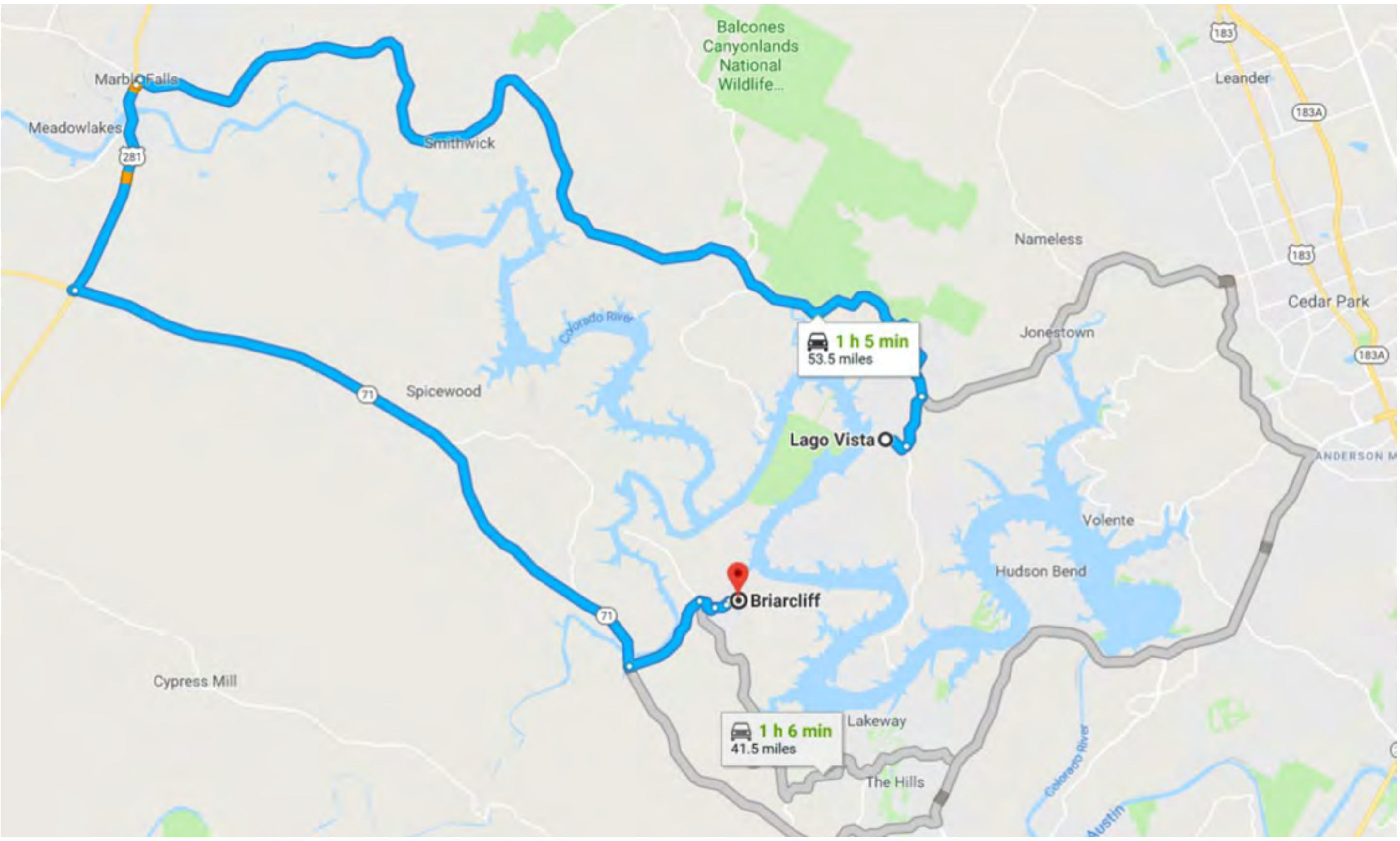
Various physical barriers in the region greatly influence the layout of roadways and system design and often lead to gaps and obstacles in the transportation network. There are several geographic barriers in the Capital Area region including rivers, lakes, and nature preserves. For example, Lady Bird Lake (a reservoir on the Colorado River) cuts through the center of downtown Austin, CAMPO's largest urbanized area. Due to physical and financial constraints, there are only four river crossings in a two-mile radius. Three of the four of the river crossing are arterials that serve downtown am and pm peak traffic as well as significant event traffic throughout the year. Other communities outside of the urban core experience similar constraints along the Colorado River, particularly in Travis County in communities such as Lago Vista.



Source: Base Network - ESRI, Building footprint City of Austin, 2005

Figure 2.21 Barriers map

Another barrier that often impacts roadway design is topography. While gentle topography with small slopes can be overcome, extreme slopes quickly add cost to roadway design and construction with additional costs associated with cut and fill. Roadway supports can be designed to traverse even the steepest grades, but extreme measures often push projects over budget and may make the project financially infeasible.



Source: Briarcliff, Texas to Lago Vistra, Texas.
Google Driving Directions. https://bit.ly/2F87rBf

Figure 2.22 Lack of water crossings

Man Made Barriers

Man-made barriers also cause problems in network connectivity and sometimes roadways themselves become barriers. For example, there is a one and a half mile stretch along US 183 between Anderson Mill Road and McNeil Road where no roadways connect across (or under) US 183. This condition can create bottenecks at the intersections that provide access across US 183. When constructing new arterials, ensuring connectivity (through tools including proper block lengths and number of access points) becomes extremely important. This will help to ensure that communities are not cut in half and left divided due to the construction of a new road.

Figure 2.23 Man-made barrier between Anderson Mill Rd. and McNeil Dr. along US 183 (1.54 miles)

Source: Nase network - ESRI

In addition to this planning effort, CAMPO is working diligently to address connectivity challenges through initiatives such as the Near Northwest Study of the US 183 corridor. The study assessed enhanced pedestrian, bicycle, and transit connections to help ensure community cohesion as growth in the area is accommodated.

As our region grows and once rural areas become suburban, additional connectivity between arterials and across limited access facilities or other barriers will need to increase.

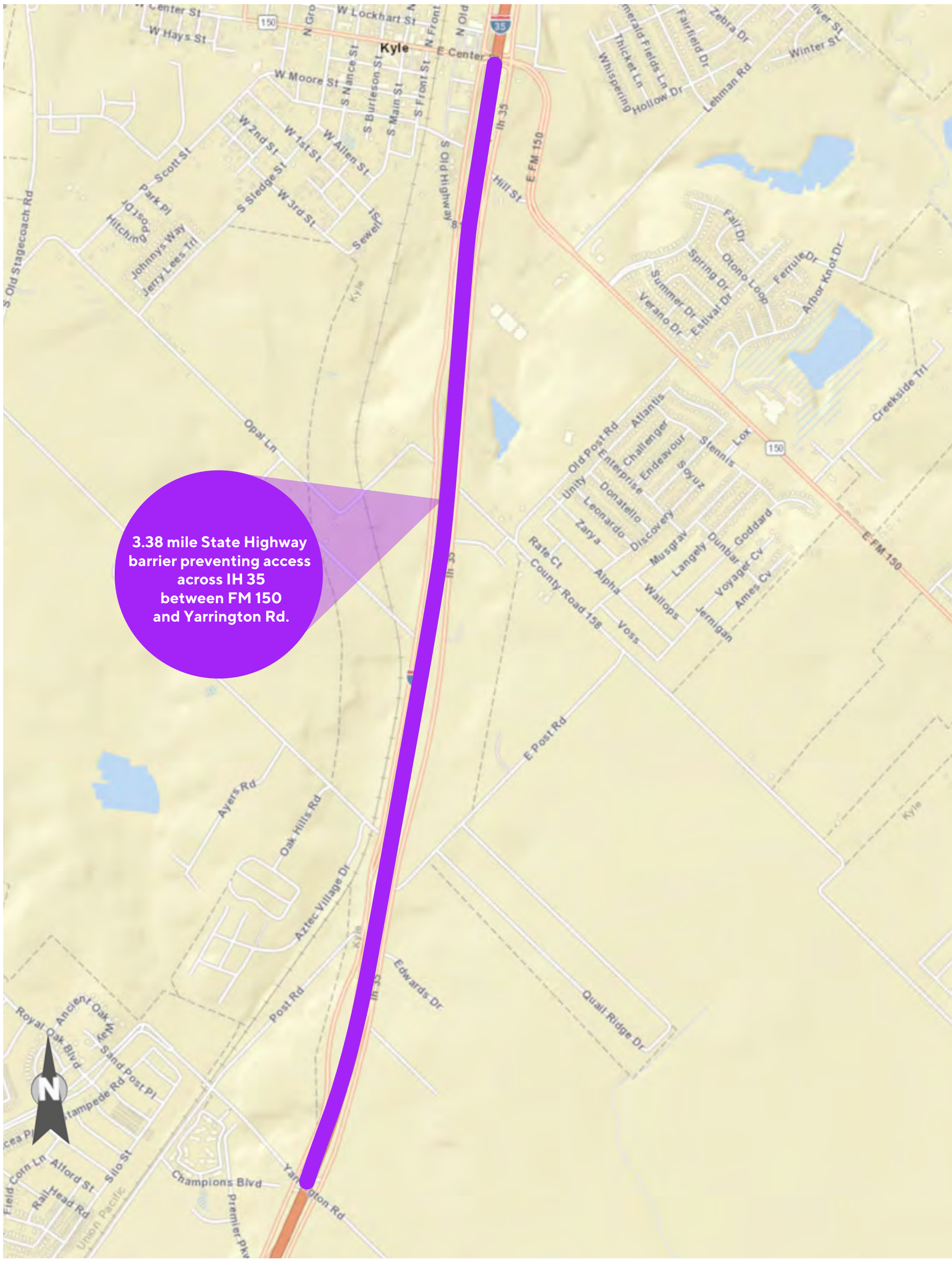


Figure 2.24 IH 35 as a barrier between FM 150 and Yarrington Rd in Hays County (3.4 miles)

Source: Nase network - ESRI

Right of Way (ROW) Constraint

ROW is necessary to construct new roadways and expand existing roadways. ROW is the legal right granted or reserved over the land for transportation purposes. Where ROW does not already exist, it must be acquired before a new roadway can be constructed. Areas within the Capital Area region that are rapidly growing will soon be struggling with development encroaching on existing ROW boundaries and developing land in areas that could be used for new roadway connections. Additionally, with development pressure, the ROW costs increase rapidly, raising the total costs of infrastructure projects substantially. An example is Eastern Travis County, where the opportunity to preserve ROW is quickly evaporating with enormous growth as previously discussed.

Source: Gattis School Road, Google Maps

Source: RM 2222, Google Maps

Figure 2.25 Images of right of way constraints

Safety

Improving the safety of all mobility users and modes is a primary goal for CAMPO and one of the guiding goals of the RACI. An analysis comparing the three-year average crash rates per 100 million VMT against the statewide average for similar roadways helps identify problem areas and roadway segments of concern. Figure 2.26 identifies in red the segments that are more than two times the statewide average crash rate for the same period (years 2014 – 2016) as defined by TxDOT's statewide crash statistics reports.

Segments with greater than two times the statewide average crash rate span both urban and rural communities in the Capital Area MPO. In addition to many dispersed segments, this includes multiple segments of both the mainlane and Frontage Roads along IH-35, US 183 and 183A, FM 812, and various roads in Caldwell and Bastrop Counties. Notably long segments with a higher than average crash rate include FM 973, SH 195, FM 150, Decker Ln, FM 2336, FM 672, FM 86, and FM 2984.

[7] Texas Motor Vehicle Crash Statistics. TxDOT, 2016. Accessed at https://bit.ly/2YZ6CCj

In addition to the segment analysis, CAMPO worked with municipalities and residents as part of the outreach process for the Active Transportation Plan to identify intersections that are perceived to be dangerous; particularly related to pedestrian and bicycle concerns. These intersections are also indicated in Figure 2.26 as dangerous intersections.

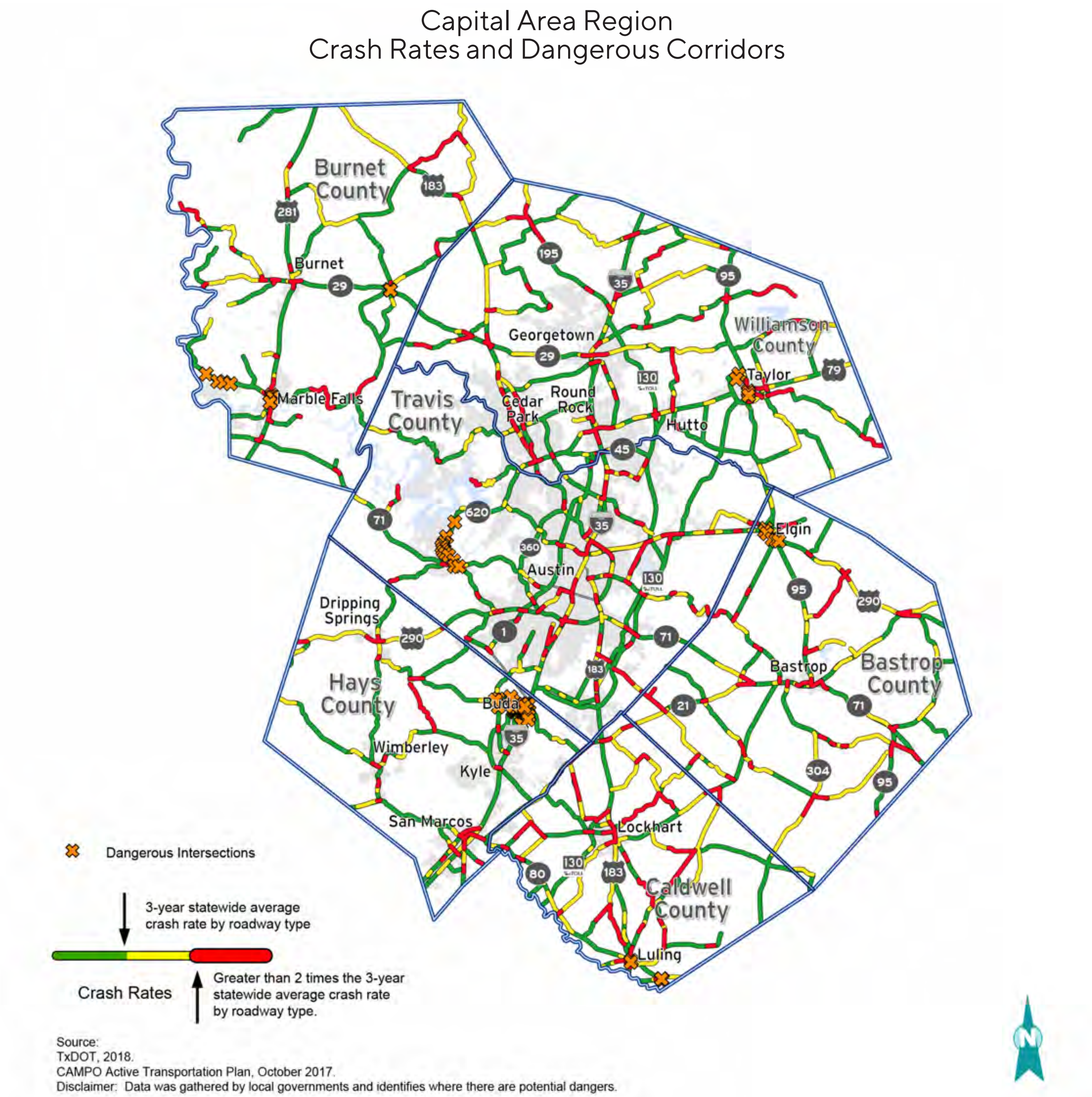


Figure 2.26

Traffic Generators

Job Centers Methodology

In order to refine the cartography of the resulting weighted overlay map (seen on the next page), the Focal Statistics tool was used which calculates a statistic for the values within a specified "neighborhood" around it for each input cell location.

- Convert employment, population, and intersection density feature layers to raster layers

- Reclassified the raster layers into 6 classes

- Performed Weighted Overlay using the three raster layers
  - With equal weights (% influence) – there were no real concentrations
  - With employment at 50%, population at 25%, and intersection density at 25% influence – concentrations began to show.

-

The weights were chosen because centers tend to exist where there are high concentrations of jobs (i.e. downtowns) even if there is not a correlative amount of population. Moreover, when population was weighted equal to employment the gradient became much larger and reduced the concentrations. Street intersection density was also not weighted as highly as employment because there are often many jobs in areas without high intersection densities (i.e. US 183 NW of MoPac). These reasons contributed to the weights that were chosen.

Activity and Street Connectivity Density Index

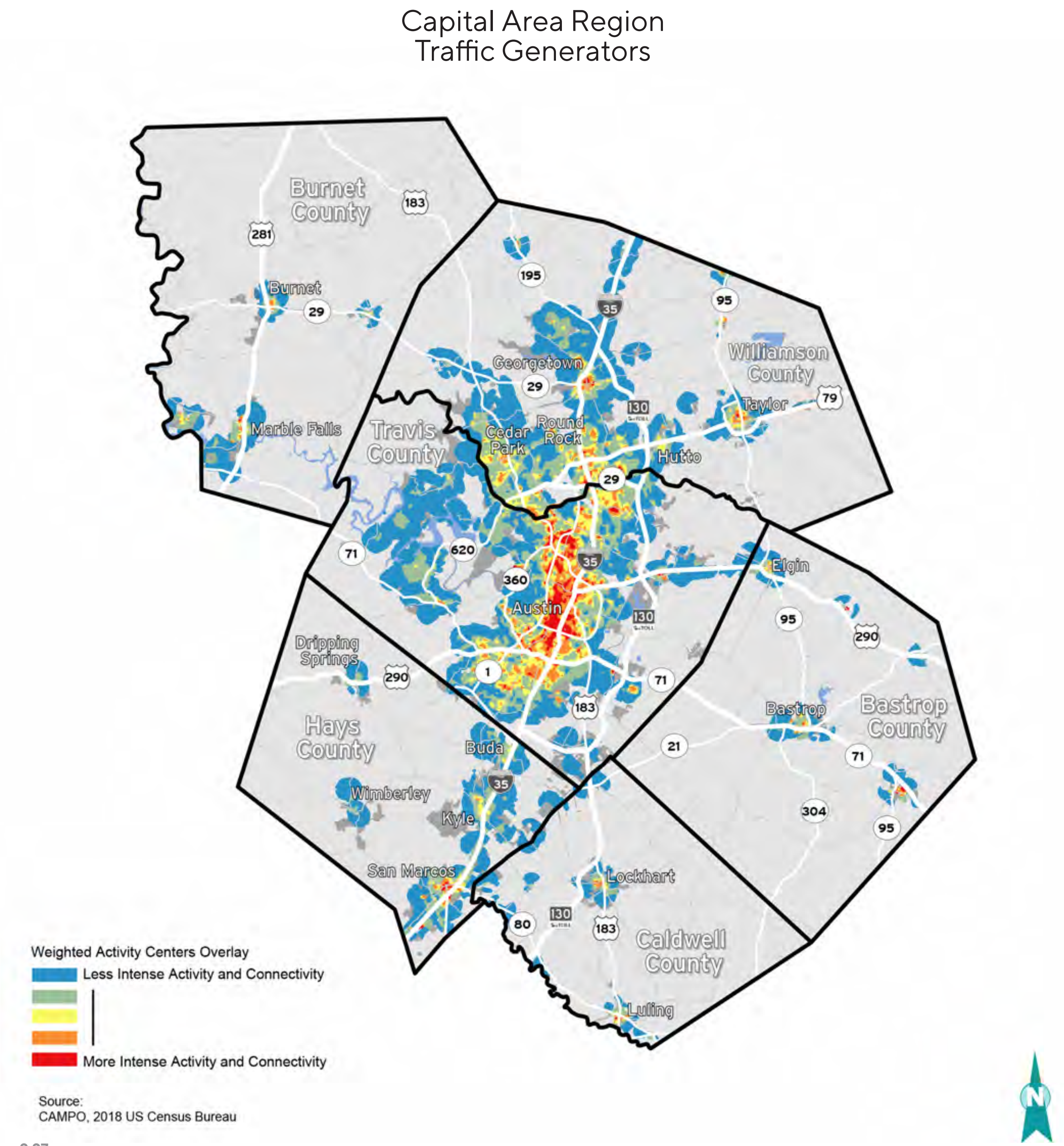
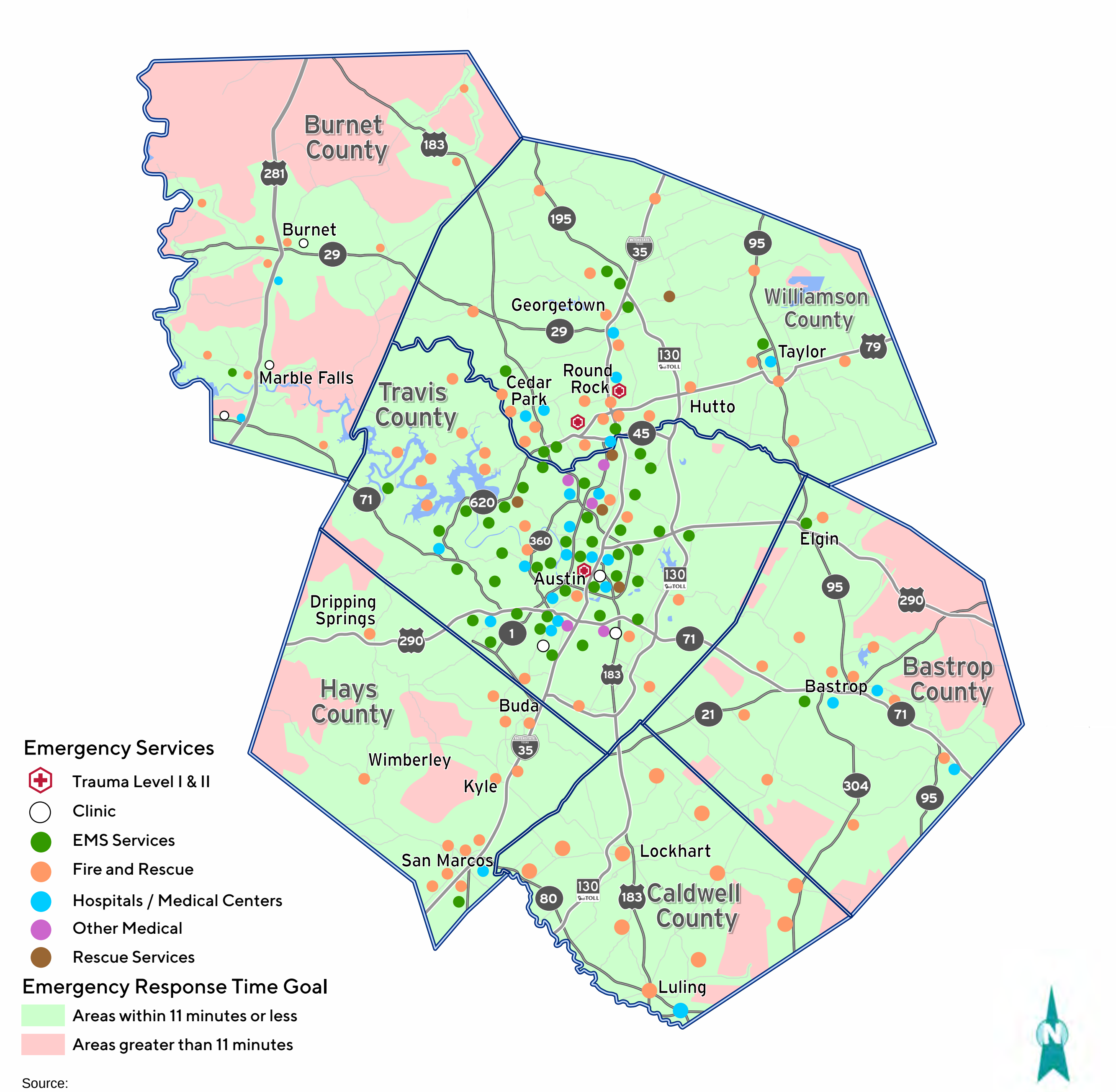


Figure 2.27

Emergency Response

Emergency response is also vital to the safety and well being of area residents. In addition to safety, adequate emergency response access relies upon another primary goal of the RACI, to improve mobility through improved network efficiency and reduced travel times. Travel time is a key performance indicator for emergency response.

Capital Area Region
Average Emergency Response Time Service Goal



Source:
Travis County, 2018.
CAPCOG - Homeland Infrastructure Foundation - Level Data, 2018.

Figure 2.28

The "Capital Area Region Average Emergency Response Time Service Goal" map shows the Emergency Medical Services (EMS) response time goal of 11 minutes without traffic delays. As indicated by the map, there are several areas in the outer region of the Capital Area region where response times are greater than the identified goal. These areas in the outer region may also have limited ways of accessing large properties in rural communities, river crossings or other physical barriers, and two-lane roadways subject to fire or flooding. Any place with limited redundancy delays EMS from providing emergency services and can negatively impact response times.

Congested arterials and peak-hour travel characteristics add travel time for all users, including emergency responders, therefore expanding the challenge areas noted in the map. These geographies are problematic as many of the region's most vulnerable populations live in the outer areas of the Capital Area region and have limited access to health and emergency facilities. Improved and enhanced network connectivity can improve travel times and reduce the size of the emergency response challenge zones. However, new arterials and increased capacity may not be the most effective way to serve these zones. For example, additional emergency response station infrastructure could also help close the gaps. In addition to new corridors and emergency response stations, local codes and ordinances can help create a more connected and redundant network, thus improving emergency management.

Redundancy/Emergency Management Policy Summary		
Policy		Number of Communities' Codes/Ordinances with Related Policy
1	Requires More Than One Subdivision Access Point	13 of 24
2	Has Evacuation Route Policy	5 of 24

Figure 2.29

[8] Overall On-Time Rate – Travis County Only. City of Austin, 2014. Accessed at https://bit.ly/2X5gNmY

The region has a history of significant events requiring substantial response from first responders. The images below provide a history of some of those recent events.

Source: marble-falls-bridge-implosion
https://bit.ly/2UDC6zp

Source: Google Streetview (November 2018)
https://bit.ly/2v8Crew

Source: Texas Floods.
https://nbcnews.to/2S5J8qu

Source: More Texas Wildfires.
https://bit.ly/2GMgIFK

A policy review in the six-county area related to health and safety demonstrates that most communities within the Capital Area region include safety-related planning topics in existing policies and plans. For example:

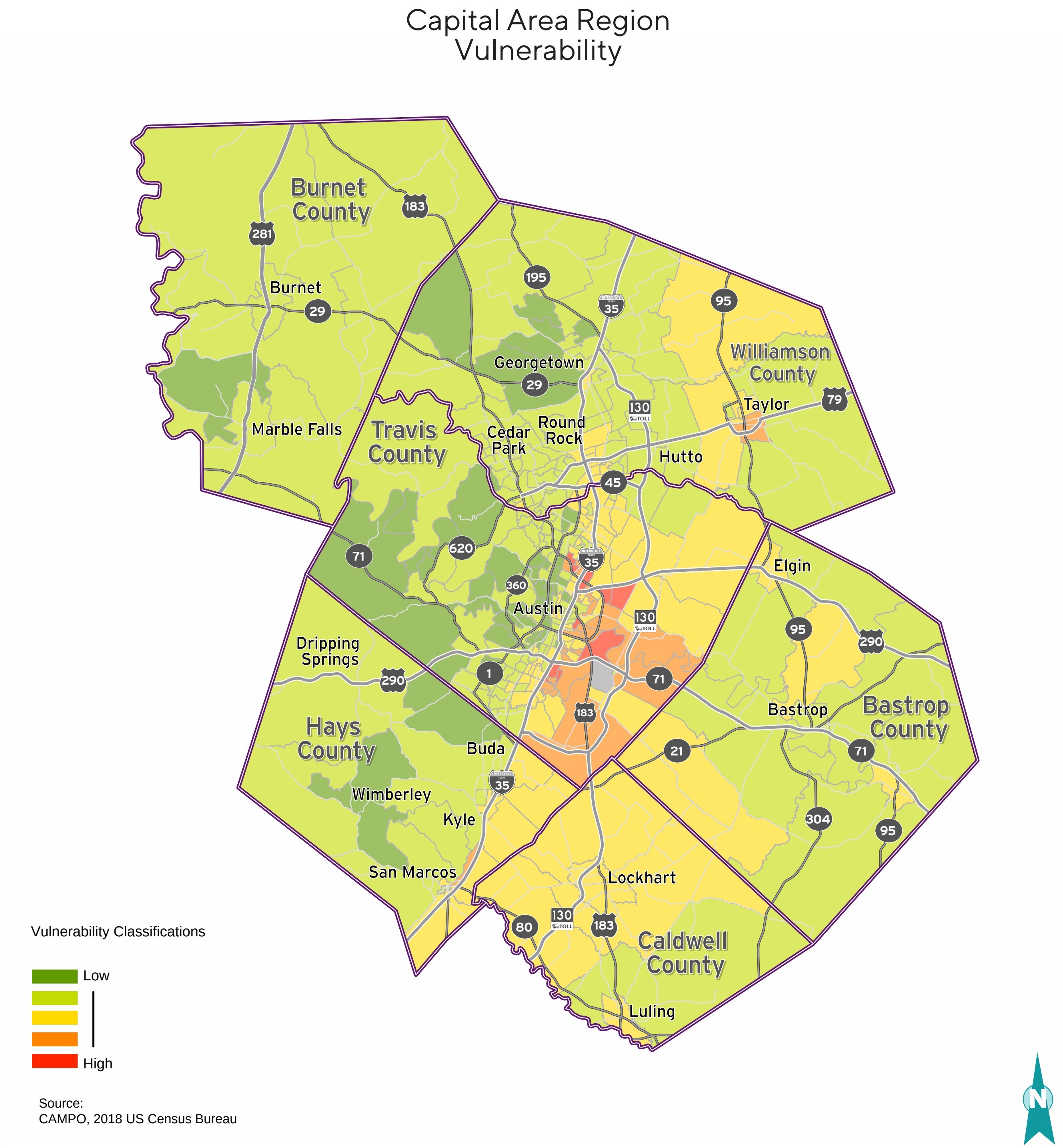
- Flood Control – Most jurisdictions require identification of flood plans and most have general flood control and storm water management policies.
- Historical/Cultural Resources – Almost all communities have protection policies or historical district overlays.
- Urban Trees/Forest Protection – Many communities have urban forest and tree protection policies as part of protecting the environment and community character.
- Natural Habitat – Most are lacking or absent in community planning and policies. Such policies can serve as both a quality of life component but also a flood control and erosion control measure.

Vulnerability

A portion of the Capital Area region population is considered vulnerable. Vulnerability is a subset of Title VI/ Environmental Justice established per FHWA. Federal agencies make efforts to integrate Environmental Justice into programs, policies, and activities to protect environment and public health in minority, low-income, tribal, and other vulnerable populations. Vulnerable populations include those who are made especially vulnerable by their financial circumstances, place of residence, health, age, personal characteristics, functional or developmental status, ability to communicate effectively, and presence of chronic illness or disability. Examples include the elderly, people with disabilities, and young children. Figure 2.30 identifies the locations and intensity of the Capital Area regions' vulnerable populations. These populations continue to grow as the total population of the region grows. People considered vulnerable can require special consideration with regards to transportation. Whether it's transportation to and from medical appointments, shopping, work, and evacuations, many of these people in urban areas rely on public transportation systems. Many may use transportation provided by non-profit organizations, senior services, or city agencies. Seniors with disabilities who are low income represent a particularly vulnerable group.

Those who may require transportation assistance include:
- Individuals who can independently get to a pick-up point,
- Individuals who live independently and require transportation from their location,
- Individuals who live in a group setting (e.g., group home, assisted living center) that require transportation directly from their location,
- Individuals in acute care/in-patient facilities,
- Individuals with disabilities, and
- Individuals with limited English proficiency.

A well-connected multimodal network which facilitates intermodal activities can make a significant difference in the quality of the lives of our vulnerable populations.



Capital Area Region
Vulnerability
Burnet County
Williamson County
Travis County
Hays County
Bastrop County
Caldwell County
Burnet
Marble Falls
Georgetown
Round Rock
Cedar Park
Hutto
Taylor
Austin
Elgin
Dripping Springs
Bastrop
Buda
Kyle
Wimberley
San Marcos
Lockhart
Luling
281
183
29
195
35
95
79
130
45
620
71
360
1
290
183
21
304
80
Vulnerability Classifications
Low
High
Source:
CAMPO, 2018 US Census Bureau
N

Figure 2.30

Environmental Considerations

Careful and thoughtful consideration should be given to sensitive and/or limited environmental resources within our region. The following series of maps present our regions' aquifers and floodplains (and other water features), prime farmland, soil plasticity, and preserved lands. If new or improved roadways are to be constructed within these areas, additional consideration for elevating facilities and applying relevant context sensitive solutions will be critical in these areas.

Figure 2.31 maps wetlands, aquifer outcrop (water-bearing rock exposed at the land surface) and sub-crop (water-bearing rock below the surface), and streams in the region.

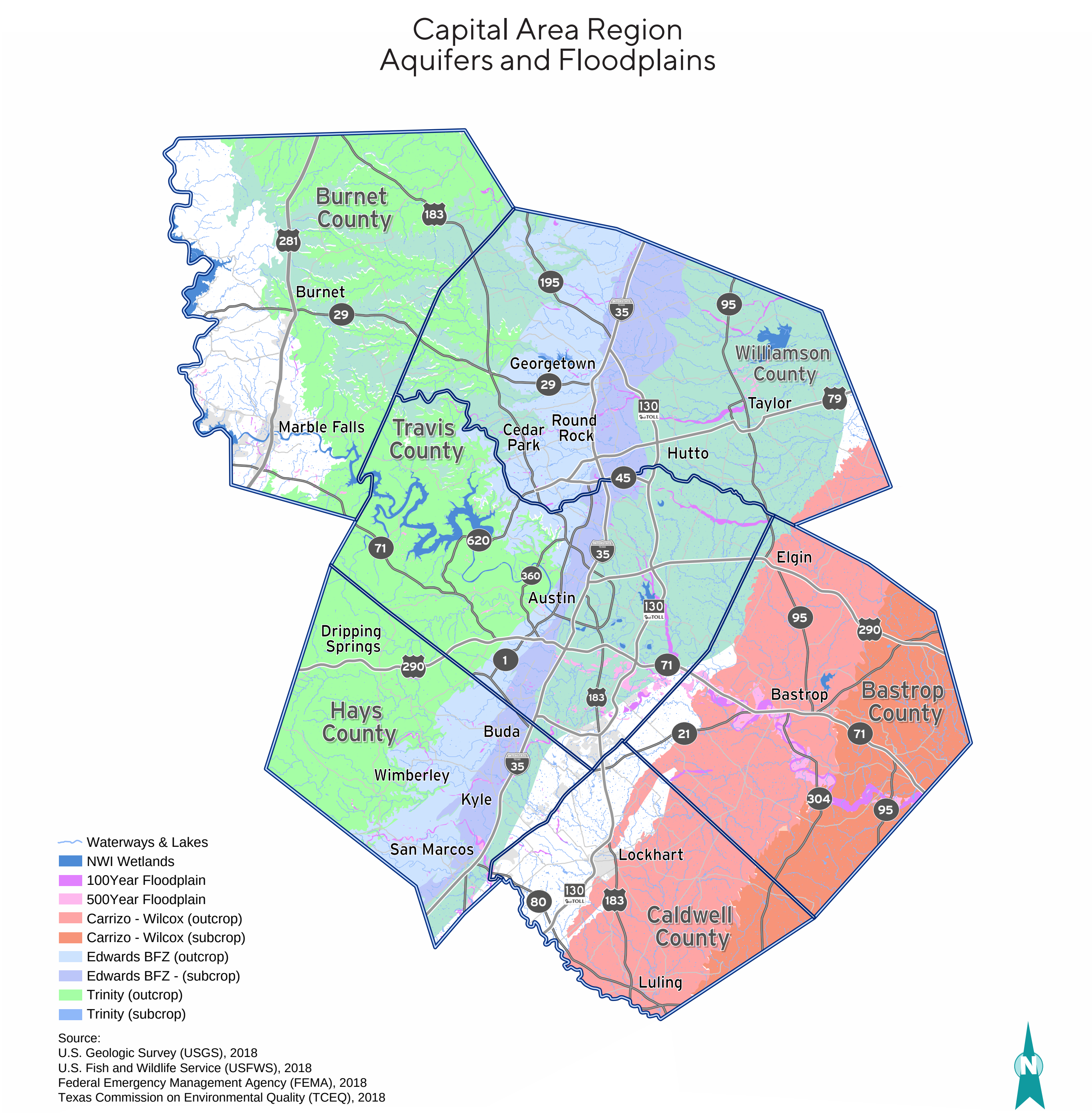


Figure 2.31

Inclusive of health and human safety is protecting air quality, habitat, cultural resources, forests, and waterways that provide places to live for CAMPO's residents. Protecting and preserving the environment is one of the six identified goals of the RACI. Of the communities surveyed, most have ordinances with supportive environmental policies in place, the exception being ordinances focused on the protection of prime farmland. Although many communities may not have farmland in their jurisdictional boundaries, prime farmland if irrigated is prevalent across the Capital Area region. Many communities may require additional measures to ensure the farmland is adequately protected as development pressures increase.

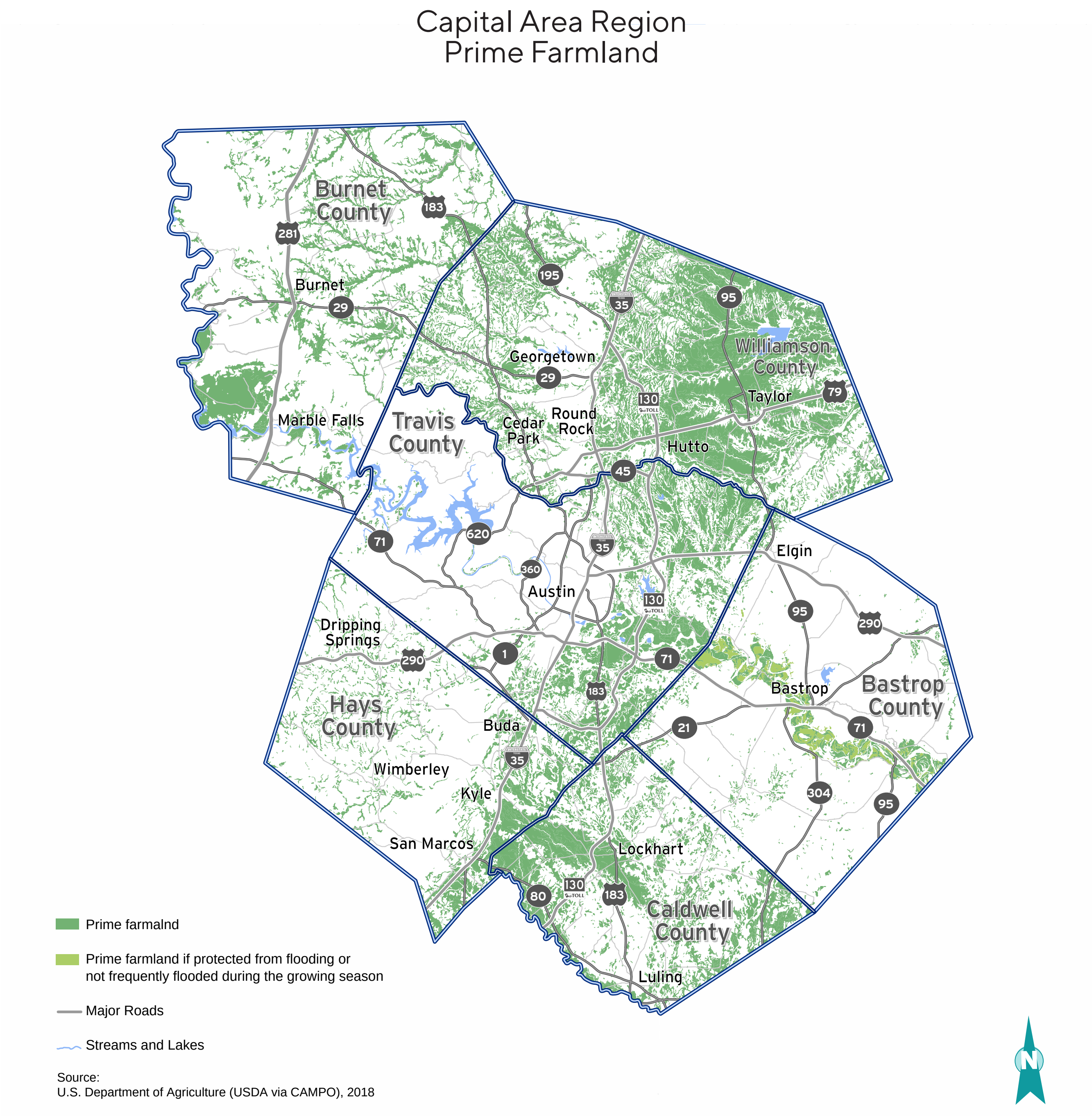
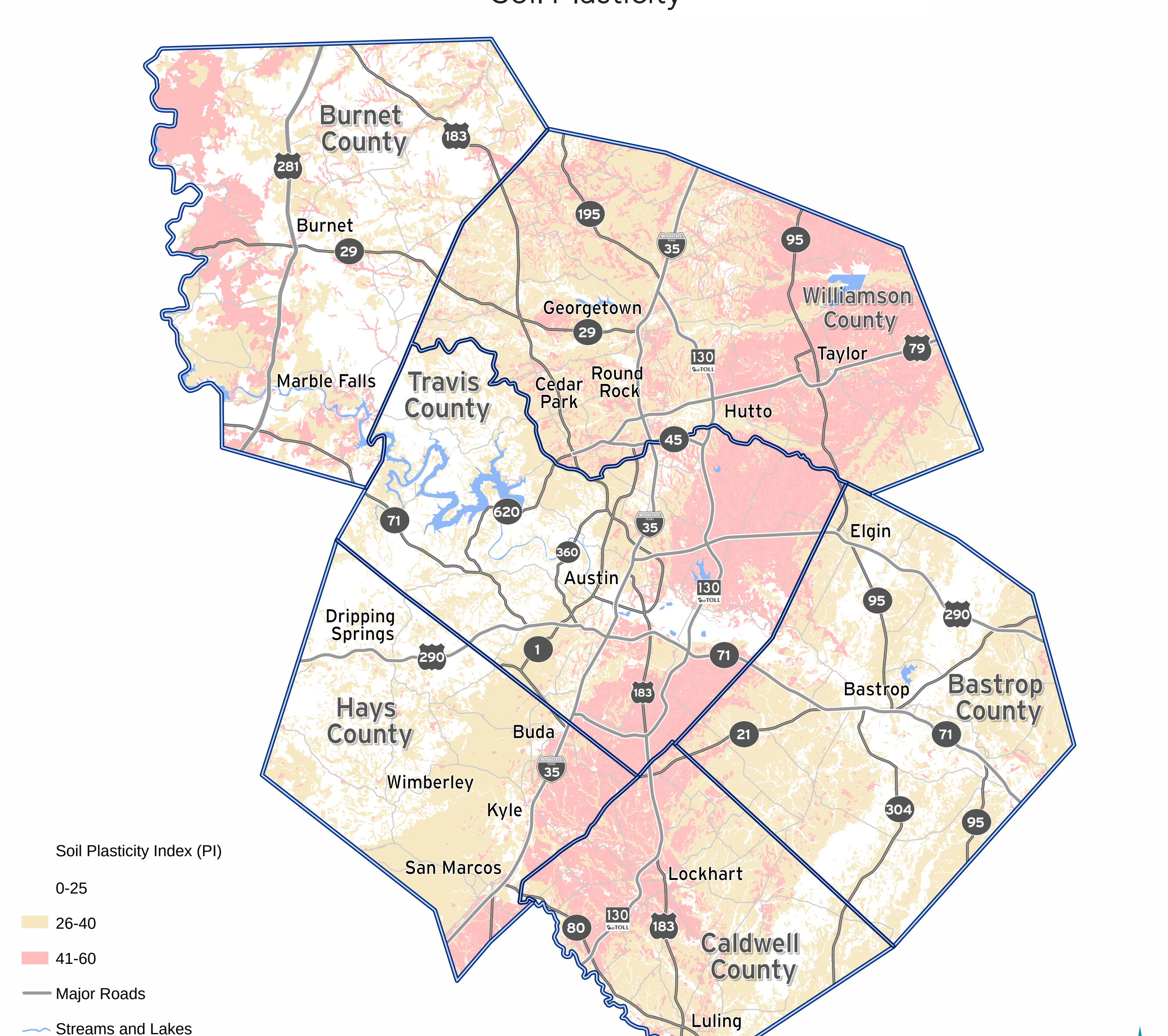


Figure 2.32

Also important to understand when planning and maintaining infrastructure, is soil plasticity. As shown in the map, large portions of the Capital Area region have a soil Plasticity Index (PI) greater than 40 or less than 25. Soil plasticity is particularly important relating to infrastructure as it contributes to the overall life-cycle cost. Soils (particularly clay soils) shrink and swell (contract and expand) causing damage to infrastructure like road beds. However, additional costs are also incurred when working in extremely hard material such as hard rock or granite (soils with a PI of less than 25). However, the transportation network is not the only infrastructure affected. Any extreme may add life-cycle cost or require additional engineering techniques.

Capital Area Region
Soil Plasticity



Source:
USGS National Hydrology Data set Plus, 2018
TPWD, various cities and counties parks departments
USDA, Soil Surveys for Texas
* The Plasticity index is a range of moisture in which a soil remains in a plastic state while passing from a semisolid state to a liquid state.

Figure 2.33

Other factors that act as constraints to new roadways or an enhanced network include preserved lands. While difficult, environmental stewardship and protection is a guiding goal of the RACI. For example, the Houston Toad is a protected species that is a vital part of the ecosystem and its nesting areas are protected. Understanding where and how the species lives in Bastrop County will substantially aid in defining the most effective transportation network achievable.

Other projected lands include state parks, the National Wildlife Refuge, Balcones Canyon Conservation land, water resource conservation land and wildlife management areas as shown in the map in addition to the active critical habitat for the Houston Toad.

Capital Area Region
Preserved Lands

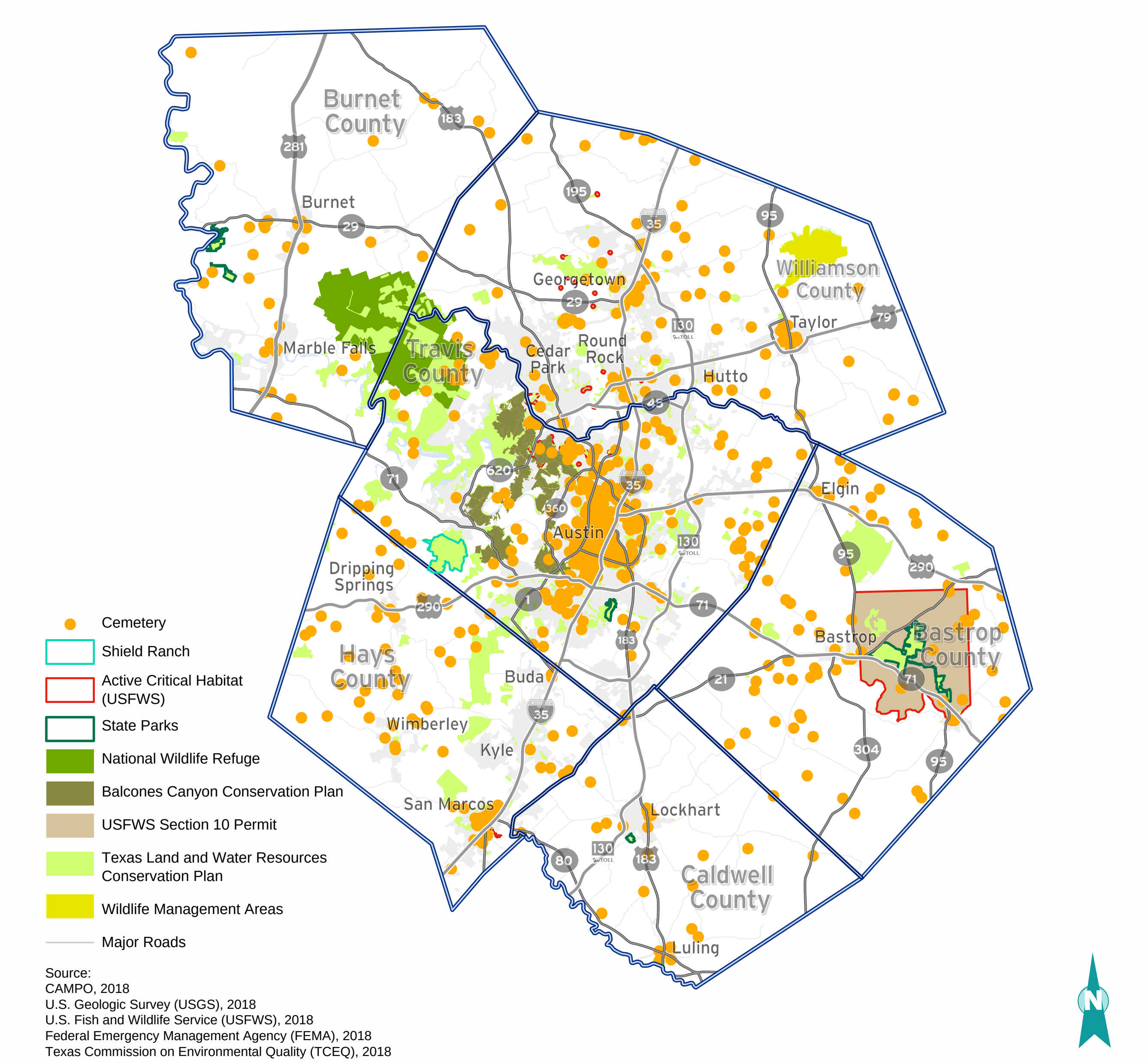
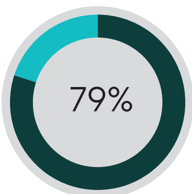


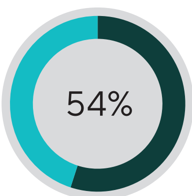
Figure 2.34

Context Sensitive Design

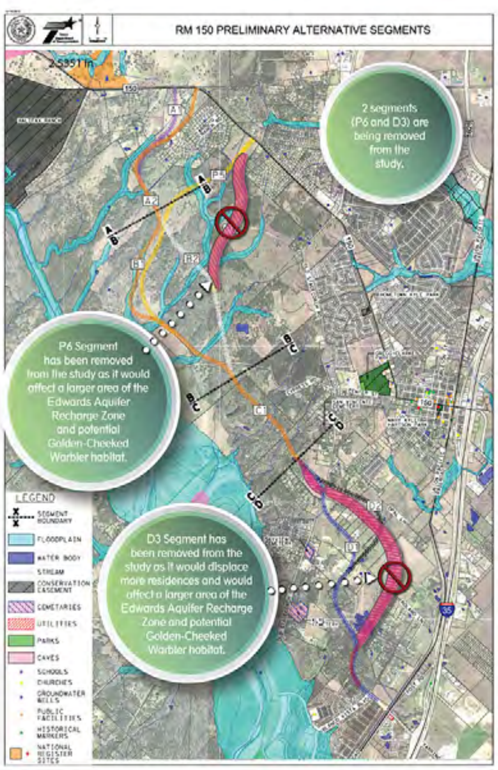
Context Sensitive Design (CSD) incorporates stakeholder input and local environmental characteristics into the design and development of roadway or transit corridors. CSD tools can be used to help CAMPO achieve its goal of fostering a system that promotes prosperity and vitality for all communities across the region. CSD solutions go beyond a traditional "one size fits all" roadway design approach, and instead are tailored to meet the needs and desires of affected stakeholders and fit the specific environment in which they are being constructed. CSD was intended to ensure that roads more effectively aligned with their context, particularly for multi-lane highways, however, a context sensitive approach is relevant at the arterial level as well, understanding that there may be more evolution of the roadway over time to accommodate growth and that may impact roadway functionality. CAMPO understands that each community is unique and CSD helps CAMPO align road functionality with evolving road and community character.



19 of the 24 counties, municipalities, and regional entities for which planning documents were reviewed included policies promoting the use of context sensitive design in the development of transportation projects

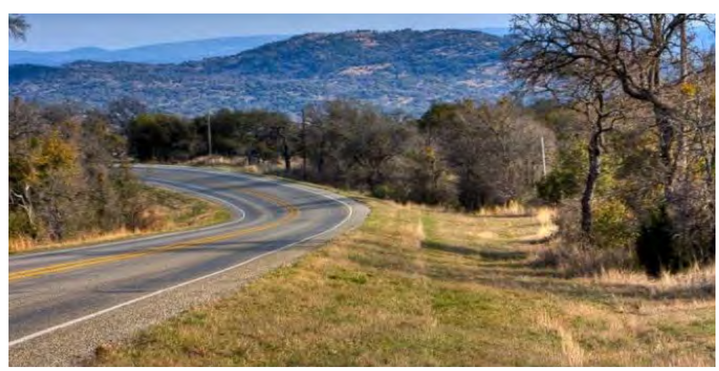


13 of 24 counties and municipalities incorporated context sensitive design into their codes and ordinances.



Source: RM 150 Alignment Project; https://bit.ly/2YVWrhw

Source: Chapter 6 Pattern Book; Austin, Texas (HNTB 2018)



Source: Chapter 6 Pattern Book; Daniel Ray https://bit.ly/2FFLyJT

Market Accessibility

The County to County trips or desire lines demonstrates where people are generally traveling in the region. This includes the movement of both people and goods within and through the Capital Area region. Dependency on only one facility for these county to county trips makes markets less accessible. Creating redundancy can have the benefit of opening up markets to more residents and businesses.

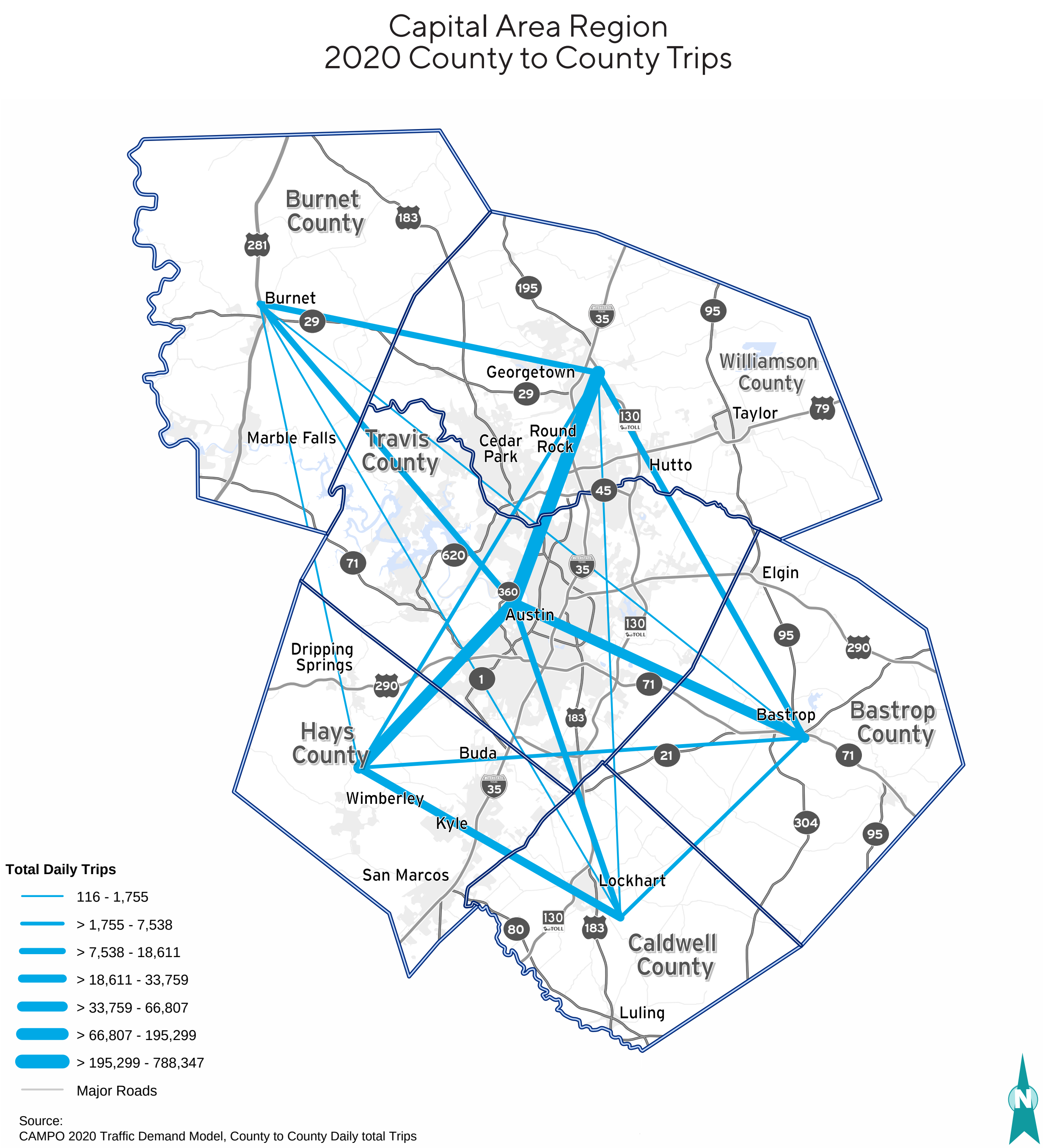


Figure 2.35

The City of Austin and Travis County account for approximately 60% of the population and employment in the six-county Capital Area region. This large portion of activity and employment in Travis County places stress on the arterial network, particularly in high-density areas. In general, job centers with clusters of employers in the Capital Area region are in relatively dense population areas except for a handful of employers. Most all areas with high job densities are urbanized, as indicated in the mapping of Job Centers.

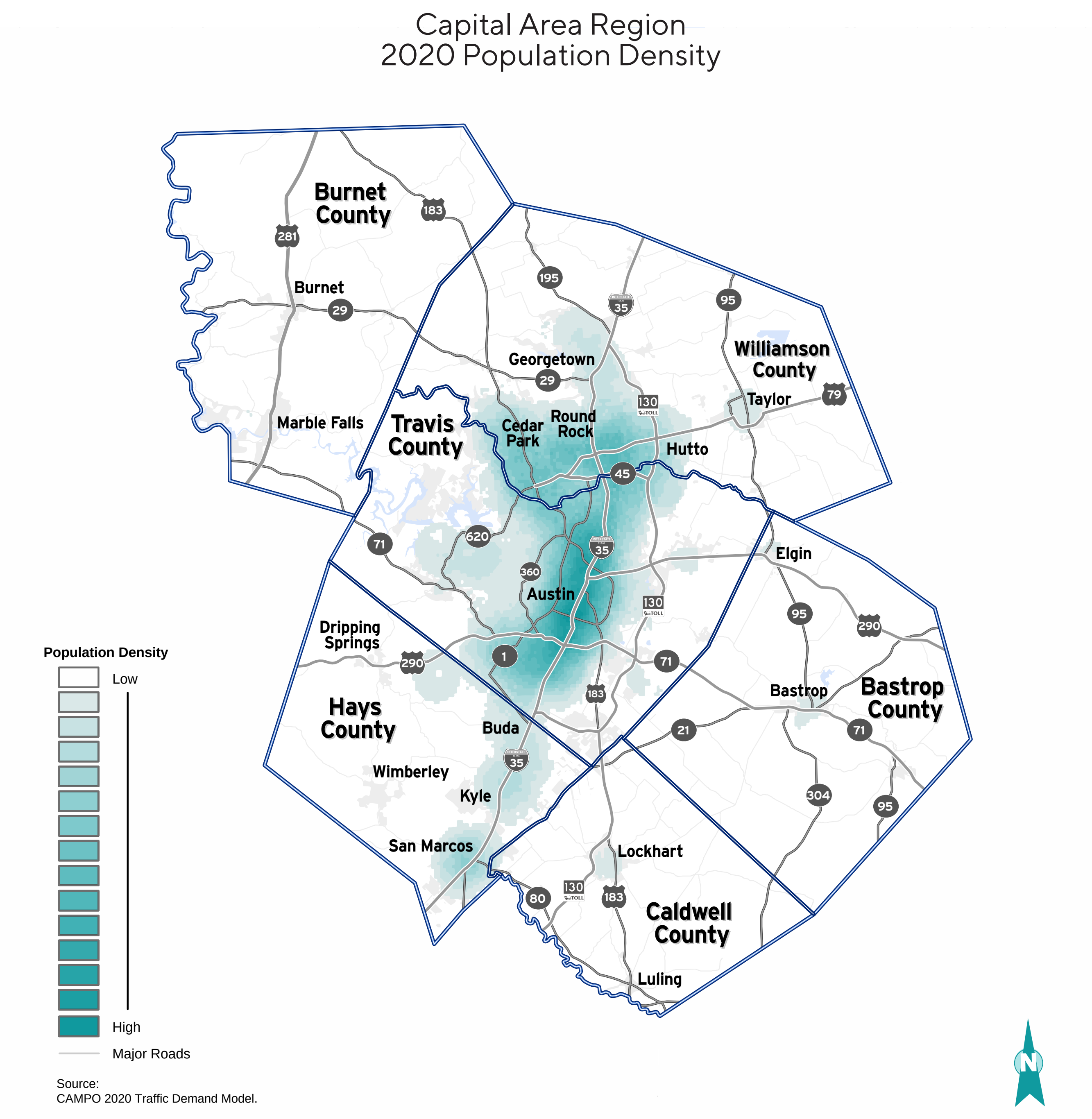


Figure 2.36

Capital Area Region
2040 Population Density

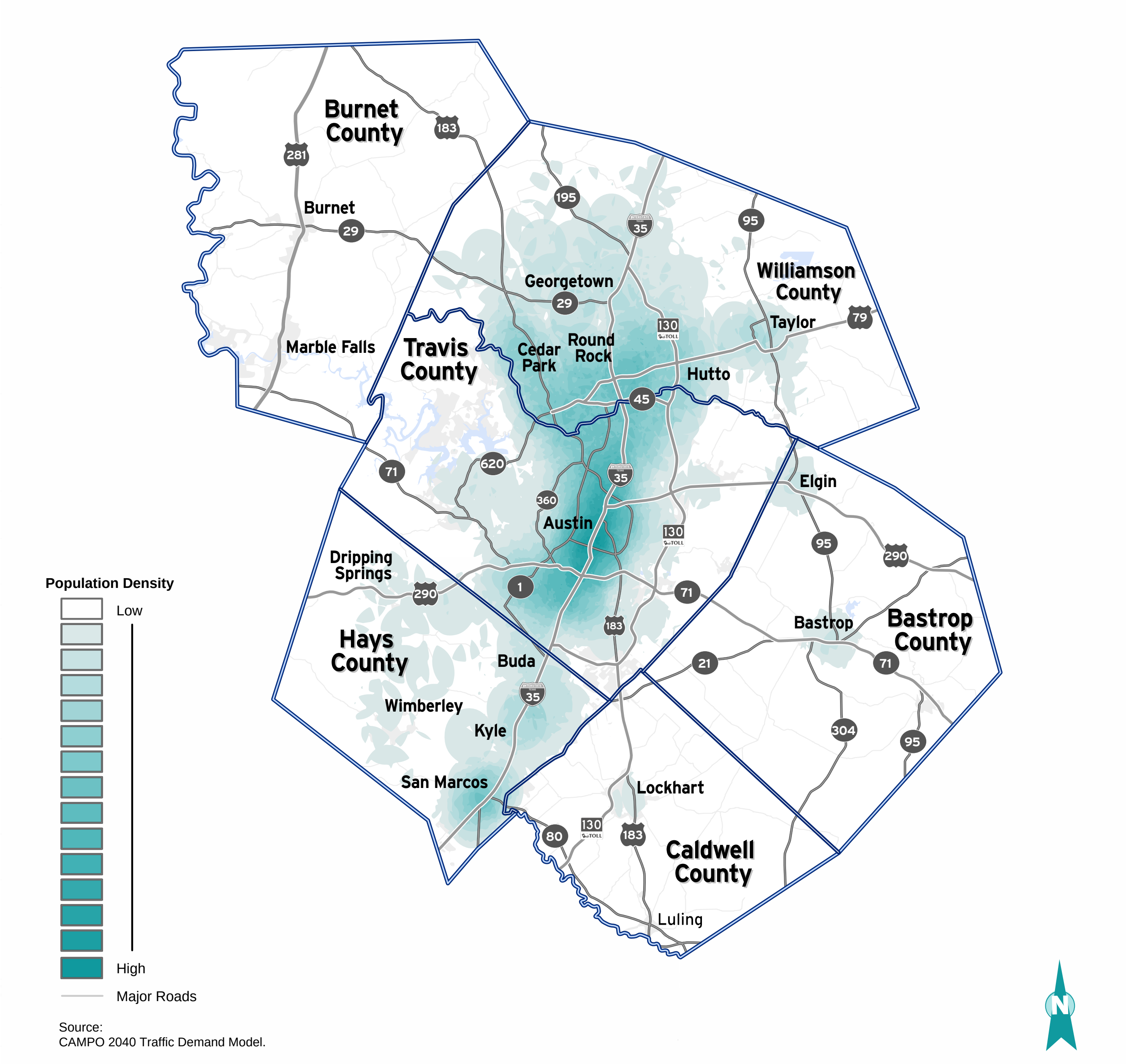


Figure 2.37

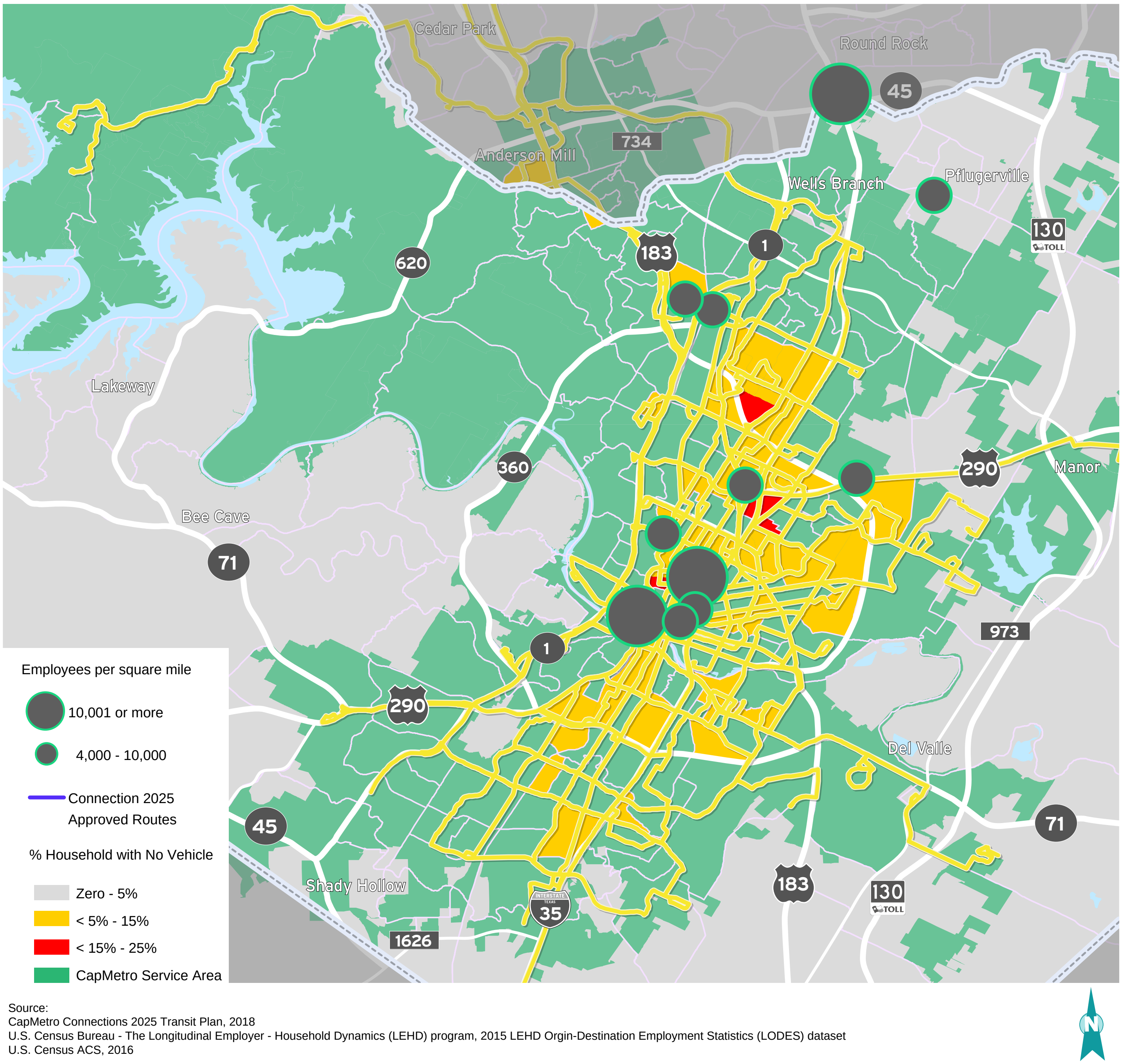
Mobility allows an individual to transcend their existing conditions and reach new opportunities. While there is high correlation between the supply of the labor force (Capital Area region residents and population density) and employment (employment density and large employment centers), vulnerable populations (low income and minority populations, zero car households, seniors, persons with disabilities, and others) do not always have adequate access to employment as they've been pushed out of the urban areas due to unaffordable housing costs. These populations have relocated outside of the city-center, but the City of Austin and Travis County account for 60% of jobs in the Capital Area region and it can be difficult to access major employers from outside the urban areas due to limited transit accessibility, particularly in the outer areas of the Capital Area region.

Figure 2.38 show transit proximity to job centers as it relates to zero car households. There are a handful of areas with high percentages of zero car households (up to 25%) near employment centers in Downtown Austin. This area is well served by transit and is the heart of the Capital Metro service area. The higher percentages of zero car households may indicate need, however, it also likely includes households who have chosen to not own a car as mobility options in the urban core are sufficient (including transit, bicycle, and pedestrian options).

The greater areas of concern are those zero car households outside the transit service area. Residents in the outer areas of the Capital Area region, without access to a car or transit have virtually no autonomous mobility. Most of these residents cannot independently make a trip further than they are willing to walk or bike. Furthermore, many of the communities do not have proper and safe pedestrian and bicycle facilities. This mobility barrier arguably limits the quality of life of residents in these areas without access to a car, and limits their potential employment opportunities.

For example, the city of Manor has a high percentage of housing stock that is considered affordable. However, the city has few transit connections to downtown Austin and is served by MetroExpress service which only operates in the peak hours. As people locate in areas that are considered affordable, often outside of the City of Austin, there are fewer mobility options. One potential solution to increase mobility options for people locating in areas considered affordable but outside of the City of Austin would be to provide a dedicated high occupancy vehicle (HOV) facility. Linking underserved locations to downtown Austin via dedicated HOV facility, would provide opportunities for bus rapid transit and ridesharing, for example.

Capital Area Region
Urban Transit Proximity to Job Centers



Source:
CapMetro Connections 2025 Transit Plan, 2018
U.S. Census Bureau - The Longitudinal Employer - Household Dynamics (LEHD) program, 2015 LEHD Orgin-Destination Employment Statistics (LODES) dataset
U.S. Census ACS, 2016

Figure 2.38

We're All Connected

To more clearly delineate the arterial network in the Capital Area region, arterials have been further broken out into road typologies: rural ranchland, urban center, suburban connector, town center, commuter focus, evolving commercial corridor and industrial connector. These arterial types are included as arterials in the following trip pattern assessment.

Since Arterials are a broad classification of roadways, they are a major supporter of regional travel. As previously illustrated in the County-to-County trips analysis and map, a large number of CAMPO residents commute from surrounding counties into Travis County daily. These types of commutes contribute to a long average trip length which is supported in Figure 2.39 for 2015 Home to Work Average Trip Length by County that shows an average trip length of greater than 24 miles accounts for 39% of commute trips in Bastrop County, 56% in Burnet County, and 54% in Caldwell County. Of course, many of these trips are taking place on the mainlanes of IH-35, SH71 or other highway, but many of these trips are using key arterials (likely industrial connectors, commuter focused, and rural ranchland arterials) as key connectors to their destination.

2015 Home to Work Average Trip Length by County			
County	0 to 10 Miles	10 to 24 Miles	Greater than 24 Miles
Bastrop	34%	27%	39%
Burnet	27%	17%	56%
Caldwell	20%	26%	54%
Hays	24%	39%	37%
Travis	56%	24%	20%
Williamson	36%	38%	26%

Figure 2.39

Source: LEHD 2015

A regional perspective shows the high dependence on arterials for regional travel. Almost 50% of trips in the Capital Area region are ten miles or less which are very likely using some form of arterial, and approximately 35% of trips are between 10 and 24 miles on average. Local system should be well-connected for appropriated trip lengths to support the longer arterials. Long commutes in Bastrop, Burnet, and Caldwell counties likely utilize major arterials, but short, internal trips are expected to be between 25 and 60 minutes (dependent upon congestion levels) and are even more likely to depend on the region's minor arterials (urban center, suburban connector, and town center arterials).

Due to the region's high dependence on arterials, many are over capacity resulting in congestion and delays for residents. Figure 2.40 shows the top three existing arterials in the network that are over capacity; many of which support county-to-county movement.

Travel times can be an indicator to assess individual trip impacts. CAMPO has previously used a travel time comparison in the CAMPO 2040 Regional Transportation Plan (RTP) to assess equity in the transportation network. Using the same travel demand model that was used for this plan, CAMPO analyzed travel times to and from Environmental Justice (EJ) zones and similar non-EJ zones pairs. The results of the travel time analysis for 2010, 2020, and 2040 concluded that there were no significant differences in travel times between EJ and non-EJ zones.

CAMPO's expanded definition for vulnerable populations includes other groups, such as elderly and school aged children that are not traditionally included in Environmental Justice communities. Impacts to travel times are included for the various psychographic profiles developed for this study, which are representative of several vulnerable groups.

Top Three Arterials Over Capacity by County	
County	Major Arterials
Bastrop	FM 1100 SH 71 US 290
Burnet	FM 2147 FM 1431 CR 116
Caldwell	SH 21 SH 80 US 183
Hays	Loop 82/Aquarena Springs Drrive McCarty Lane RM 12
Travis	Loop 360 US 183N US 183S
Williamson	US 183 N McNeil Road Southwest Bypass

Figure 2.40

Arterial Capacity

Of the roughly 6,500 miles of roadway in the Capital Area region, arterials account for 60% of the roadway network and serve the majority of regional travel. Of the total 6,500 miles of roadway in the area, 1,000 miles (15%) currently operate at capacity, near capacity, or over capacity. The limited capacity and congestion threaten the crucial purpose of arterials and the larger network of moving the region's residents and employees in an efficient manner.

A majority of commute trips are to and from Travis County as the county accounts for 60% of employment and population in the region. This aligns with the fact that every county except for Travis County has more out-bound commuters than in-bound commuters, putting extreme pressure on arterials within Travis County. Importantly, most of the arterials connecting Travis County to other counties are under-performing. Furthering the pressure on Travis County is the high number of Travis County residents that commute and work within the county (more than 60% of total residents). Figure 2.41 shows that Travis County also accounts for 60% of the VMT in the Capital Area region. The region's arterials serve well over half of the region's VMT.

Additional pressure is placed on arterials within the Capital Area region due to inbound commuters from outside the Capital Area region and outbound commuters making their way out of the Capital Area region. Of the approximately 1.1 million commuters in the Capital Are region, approximately 20% are inbound commuters who live outside the Capital Area region. Another 17% are Capital Area region residents who commute through and outside the Capital Area region for work.

At a higher level, the Greater Central Texas region which includes the Killeen-Temple MPO (KTMPO) and Alamo Area MPO (AAMPO) area, also has more people commuting in, than out of the region. Of the approximately 2.1 million commuters in the Greater Central Texas region, approximately 14% are inbound commuters who live outside the Greater Central Texas region. Another 13% are Greater Central Texas region residents who commute through and outside the Greater Central Texas region for work. As the Central Texas economy continues to grow, the out-of-region proportion of travelers on our roads may also increase. Sizing our infrastructure to consider those trips that in part use the arterial system is an important future planning component.

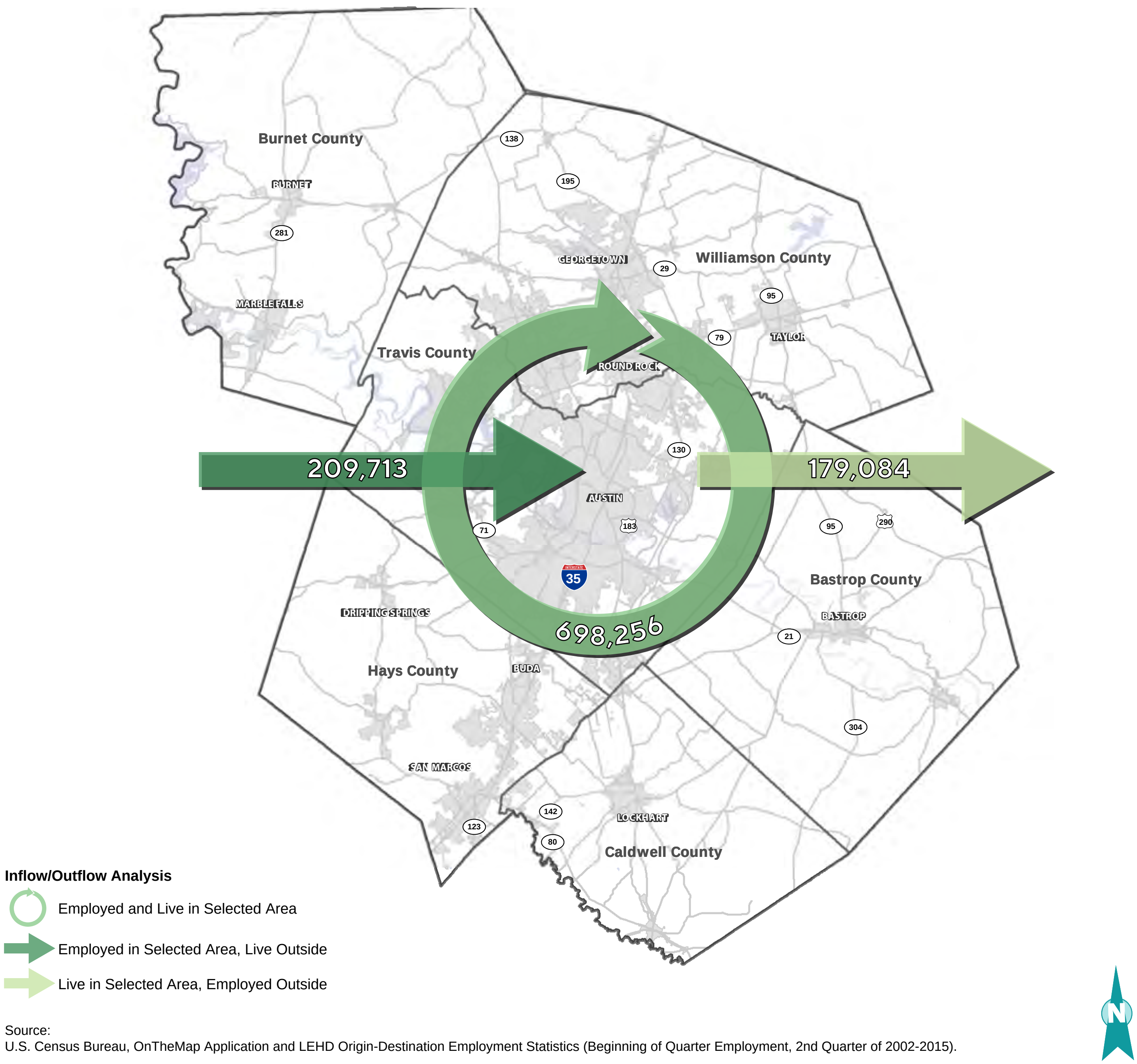
County	VMT	Percent
Bastrop	2,617,292	4.7%
Burnet	2,441,214	4.4%
Caldwell	1,818,860	3.3%
Hays	788,192	1.4%
Travis	32,866,516	59.0%
Williamson	15,204,655	27.3%

Figure 2.41 Capacity table

While it is clear that Travis County is attracting the majority of commute trips, a significant number of trips are leaving Travis County to Williamson and Hays Counties. Additionally, Bastrop County has a considerable number of jobs leaving the Capital Area region and going towards Lee and Fayette Counties.

Outside of Travis County, employment centers are dispersed and the highest employment densities are not always in the city center. The arterial network is critical to serving these outlying employment areas in the Capital Area region.

Capital Area Region
Inflow/Outflow Analysis



Source:
U.S. Census Bureau, OnTheMap Application and LEHD Origin-Destination Employment Statistics (Beginning of Quarter Employment, 2nd Quarter of 2002-2015).

Figure 2.42

CAMPO – KTMPO – AAMPO REGION
Inflow/Outflow Analysis

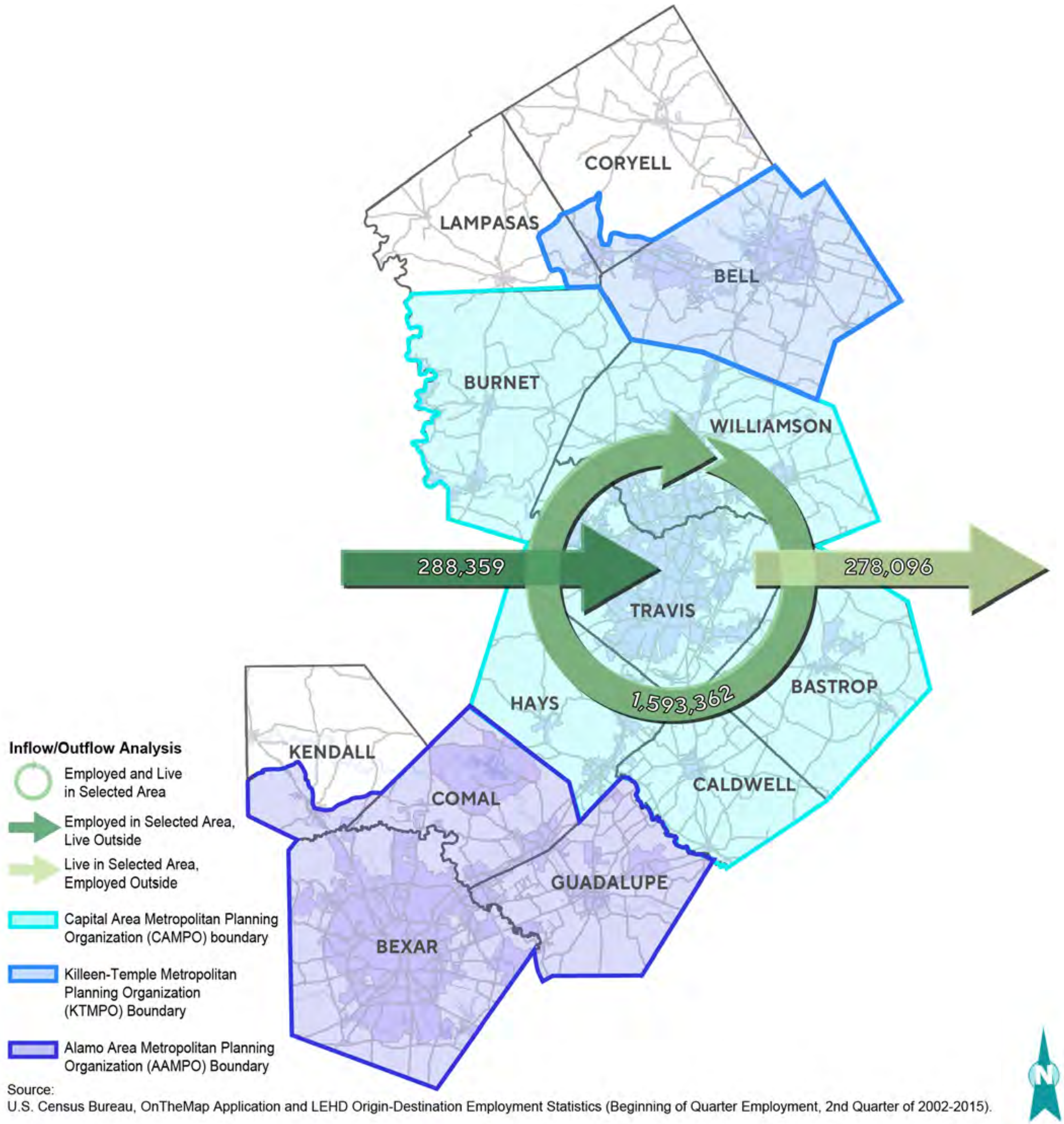


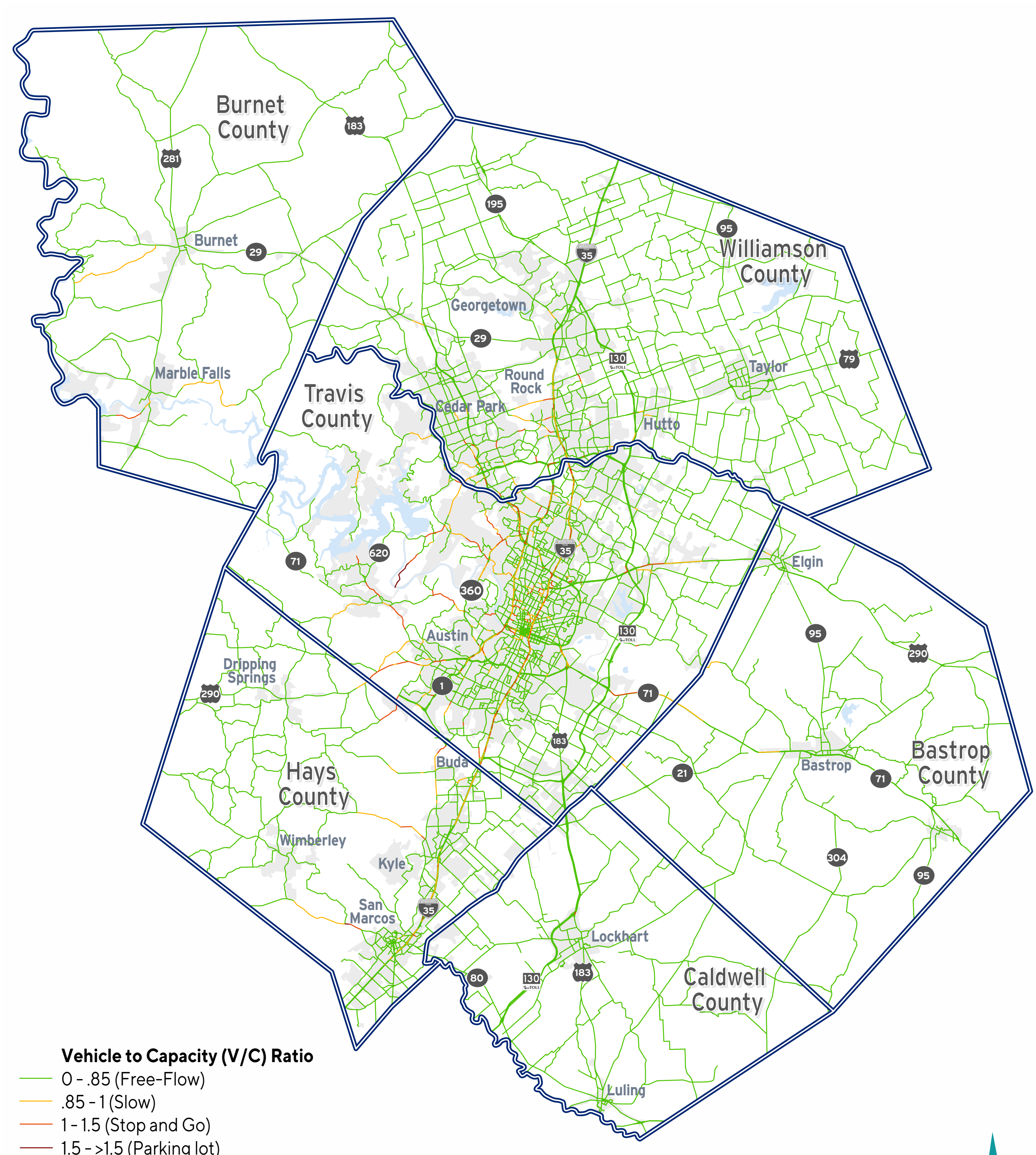
Figure 2.43

The following figures depict existing congestion levels for the AM and PM peak periods. A significant portion of the existing network is performing at or above roadway capacity. Congestion is measured by dividing the number of vehicles (volume) on a roadway by the roadway's vehicle capacity. This measure is called the volume to capacity ratio (V/C ratio). The closer to 1.0 or greater than 1.0 indicates a roadway is operating at or above its designed capacity.

Roadways shown in yellow, orange, or red are currently operating just below capacity, at capacity, or above capacity. Roadways operating in these conditions experience more traffic demand than the roadway can efficiently handle. Congested corridors and hot spots are due to the lack of roadway connectivity, insufficient roadway capacity, man-made barriers, natural barriers, and poor or outdated roadway design. For additional detail on congested corridors and hot spots for specific counties, please refer to Appendix - A.

Baseline Scenario:
AM Peak Period (6am to 9am)
Existing Congestion Levels

AM

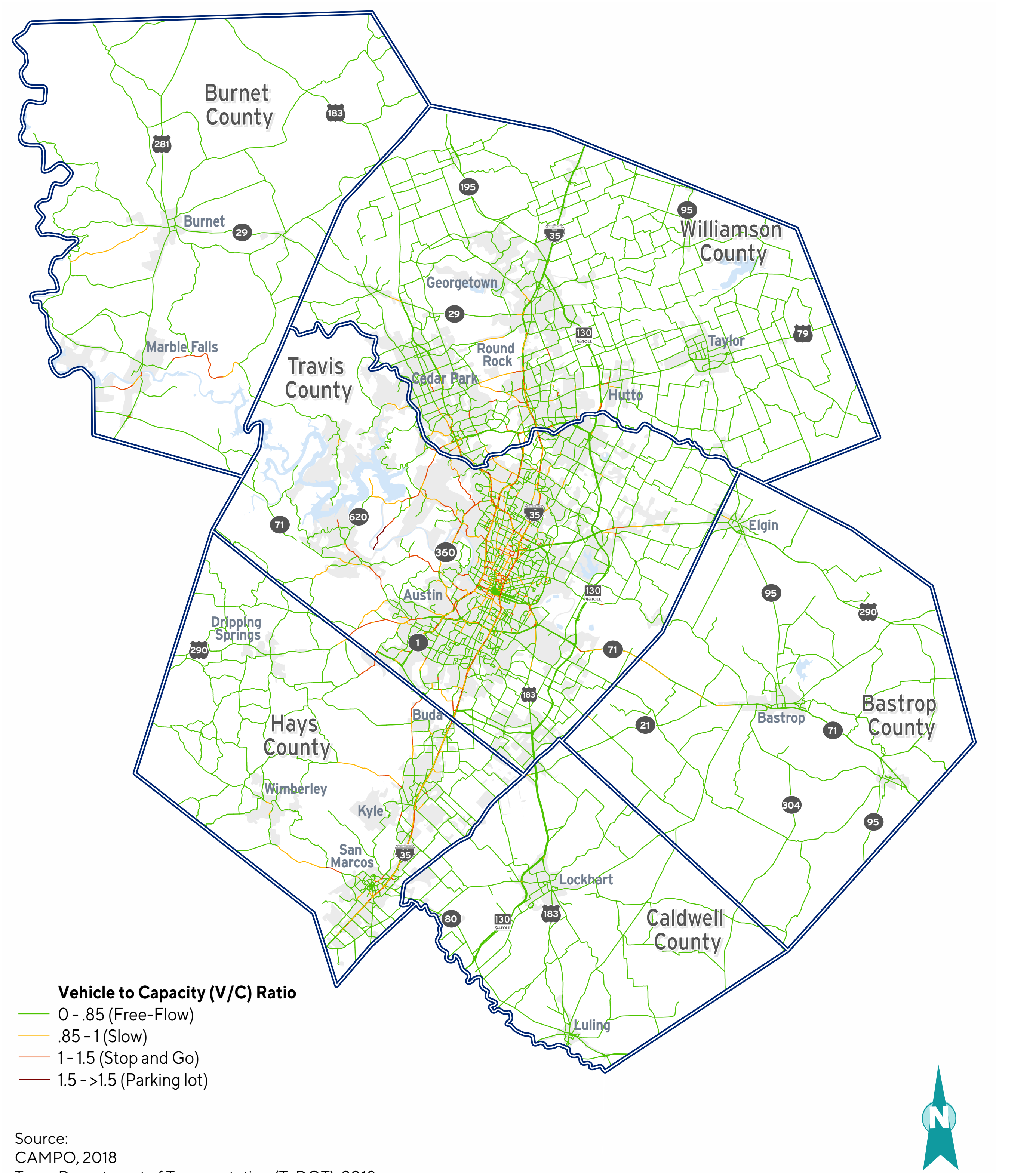


N

Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 2.44

Baseline Scenario:
PM Peak Period (3:30pm to 6:30pm)
Existing Congestion Levels



Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 2.45

Freight

The freight industry and the movement of goods play a vital role in the economy of Central Texas and the State of Texas. The Capital Area is part of the Texas Triangle mega region, a large interdependent region linked by infrastructure, economic ties, shared culture and history, and multiple metropolitan areas, whose vitality is greatly reliant upon freight and successful mega regional planning. The Texas Freight Mobility Plan, published in 2017, provides a blueprint for meeting freight transportation needs.

Efficient freight movement helps support livable and complete communities while minimizing environmental impact and maximizing transportation infrastructure investment. An efficient Multi-modal freight network is essential for continued economic stability and growth as the freight network provides access to markets and jobs as well as the delivery of raw materials and finished goods. Freight also includes services such as garbage collection and mail distribution, which occur primarily on local arterial roads. Basic economic and daily services rely on the arterial network. Fostering a system that promotes prosperity can be achieved through a sound and efficient arterial network, and regional vitality is a goal of the RACI.

The Texas Freight Mobility Plan analyzed potential 2045 freight demand and identified IH-35 from Dallas-Fort Worth to Laredo as one of the major highway corridors with significant anticipated congestion in 2045. Today, IH-35 through Austin is already classified as one of the top 100 freight bottlenecks in the nation by the American Transportation Research Institute. Modeling as part of the Texas Freight Mobility Plan used the Texas Statewide Analysis Model to determine how future freight movements will impact the Texas transportation network. Overall state-wide tonnage is expected to nearly double between 2016 and 2045 and several additional highways in the Capital Area region are shown to experience a Level of Service (LOS) F (forced flow) in existing conditions (2016) as well as 2045.

In addition to the limited access network, and the focus of this study, trucks rely on arterial roadways to access origins and destinations. Similar to demand on the region's highways, freight demand on arterial and connector roads is also anticipated to increase. Several factors are anticipated to grow demand for freight (and the share of freight in the overall vehicle mix) including continued growth in online sales and technological developments in automated and connected vehicles.

Locally, the region is also experiencing increased goods movement travel as the result of manufacturing locating in the Capital Area region. The 855,000-square foot San Marcos Amazon Distribution center, developed in 2016, serves the Central Texas region by moving over 1-million packages per day, which means a truck leaves the facility every six minutes. The scale of these types of developments places tremendous pressure on both the transportation network and the supportive land use patterns near the facility.

[9] American Transportation Research Institute. 2017 Top 100 Freight Bottlenecks in the U.S., September 4, 2017. Accessed at https://bit.ly/2jSx9x1

[10] San Marcos Mercury, July 15, 2015. Accessed at https://bit.ly/2X4L3y9

As development continues to locate on the outer edges of the Capital Area region, freight will more heavily rely on arterials to reach destinations within the six-county area. Specifically, there is a large amount of freight tonnage moving between Williamson and Travis Counties.

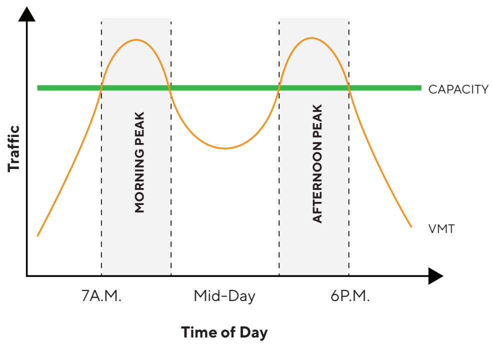
Increased freight demand is a concern for communities, particularly because of the greater impact of trucks on roadways than smaller vehicles. "Just-in-time" delivery and growing demand for online products has forced freight and trucking companies to carry heavier and heavier loads. The future of freight delivery includes the increasing likelihood of freight platooning and the potential for Long-Combination Vehicles (LCVs) as seen in other states and in Canada. The wear and tear from heavier loads is beginning to take a toll on the region's roadways. Furthering the problem is the soil in the area. Due to the high clay content, particularly in the outer areas of Capital Area region, infrastructure including roads are crumbling; often in areas with the region's most vulnerable population base, leading to high life cycle costs.

[11] Ontario Ministry of Transportation, February 2017. Accessed at https://bit.ly/2FECnZH

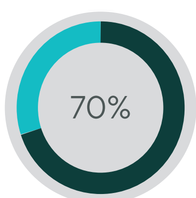
Network Performance

Based on the inventory and assessment of the Capital Area region's arterials, the region could benefit from the development of a planning framework to better support the integration of arterial roadways and land use. Extreme population growth is putting strain on the network, and the region must work proactively to improve arterials and manage demand. Constraints and barriers in the network have caused problems over time that have been exacerbated by recent growth.

Based on the network analysis, three key performance observations were made:



1. Almost half of the daily VMT on the network is traveling on facilities that are currently operating near, at, or above capacity between the peak hour travel, 7 a.m. and 6 p.m., Monday through Friday; a typical work day.



2. Arterials within the region serve approximately 70% of the total traffic, yet not all arterials are designed for mobility and high levels of throughput as previously discussed.

Source: CAMPO, RM 1431 Test Case Corridors

3. Many long-distance corridors that could provide better regional connectivity are less able to improve mobility due to access management issues such as too many driveways and other conflict points that inhibit safety and mobility. Some arterials are focused on access.

[12] CAMPO Travel Demand Model, 2010 Base Network Analysis, 2018.

Growth in Central Texas

Where did all these people come from?

The Capital Area prides itself on being one of the youngest, smartest, safest, and fastest growing regions in the United States. Three of the six counties in the region have experienced fast paced and dynamic growth in industries like advanced manufacturing, clean energy, data management, life sciences, and multimedia technology that pull professionals and families from around the state, nation, and globe to locate in the Capital Area region.

In 2015 the Austin MSA ranked first among the 50 largest U.S. metropolitan areas on net migration as a percent of total population. Additionally, 6.4% of Austin Metropolitan Statistical Area (MSA) residents lived elsewhere one year prior; the fourth largest rate among the top 50 U.S. metropolitan areas. More than 50% of this growth is attributable to domestic migration; roughly one-third is from natural increase and the remaining is due to international migration.[13] The largest sources of new migrants to the area are other parts of Texas, followed by California, Florida, Illinois, and Michigan.

It's not just the City of Austin that's growing, growth in Hays County contributed significantly to the growth of the Austin MSA, growing by almost 5.1% from 2015 to 2016.[14] During the same period Hays County gained almost 10,000 residents. Other counties in the CAMPO region saw strong growth as well. Williamson County and Bastrop County were ranked the 14th and 42nd fastest growing counties in the country respectively.

[13] Austin Population Migration Insights. Austin Chamber, February 17, 2016. Accessed at https://bit.ly/2XbvNiV

[14] Austin's booming population growth blows past the rest of Texas. Culturemap Austin, March 2017. Accessed at https://bit.ly/2ZVcBb0

Capital Area MPO Region Historic Growth 2005 to 2015
Population Percentage Growth from 2005 to 2015

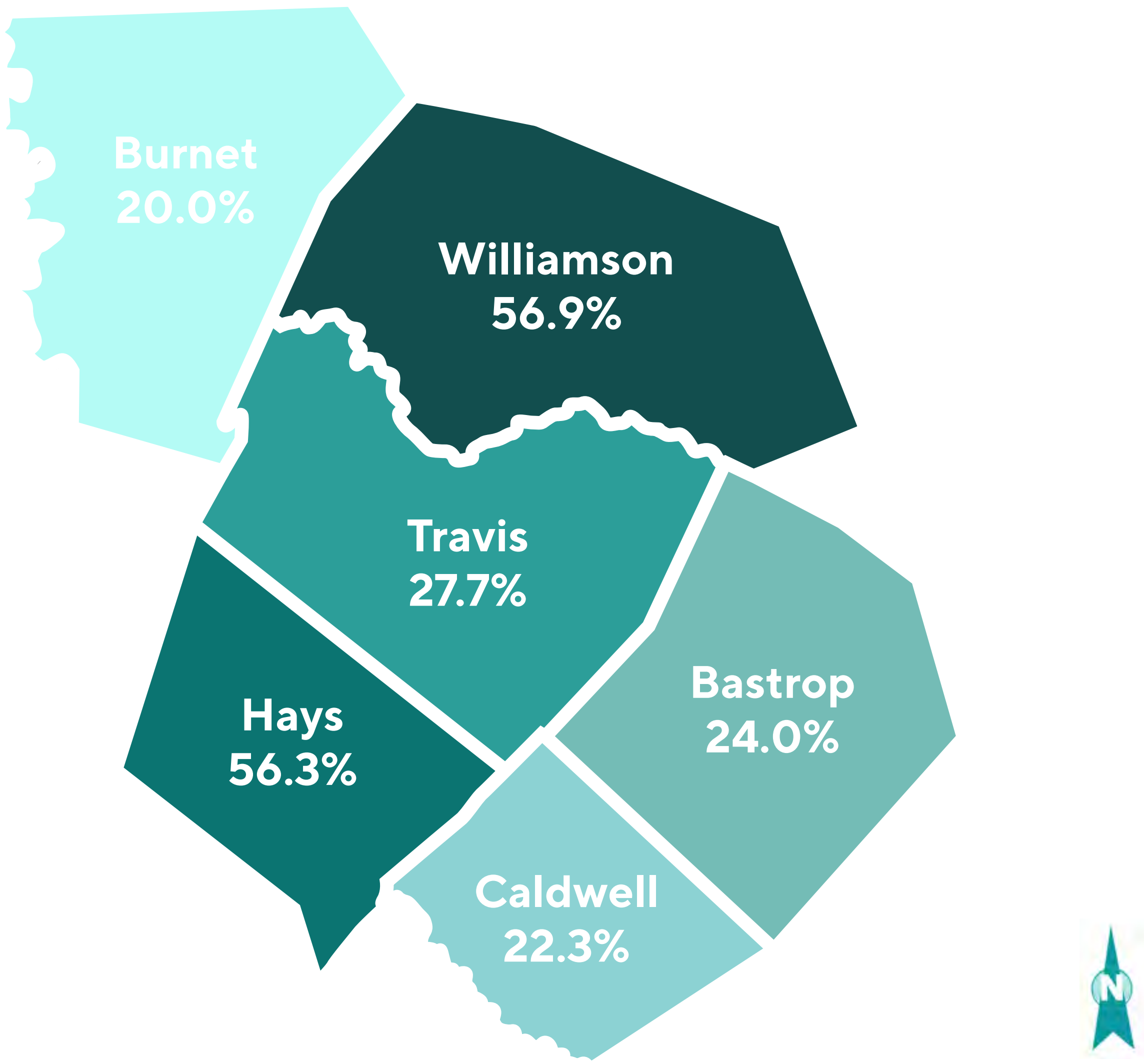


Figure 2.46

County	2005 Population	2010 Population	2015 Population
Williamson	330,740	422,679	518,775
Hays	126,206	157,107	197,298
Travis	896,753	1,024,266	1,144,887
Bastrop	69,516	74,171	86,175
Caldwell	35,426	38,066	43,322
Burnett	39,489	42,750	47,386
Total	1,498,130	1,759,039	2,037,843

[15]

[15] Texas Department of State Health Services, 2018.

While growth in the suburban fringe and in unincorporated areas of the county is apparent, the population within the cities has continued to grow as well through increased density. The difference is striking when comparing an aerial from 2003 to an aerial image taken in 2017. The growth patterns in the six-county region are both that of intensification and increased infill development in city centers, but also continued development of greenfields in areas that lack land use control, presenting new challenges in preserving our environment while accommodating growth.

Figure 2.47 Images of increases in development

Source: Bee Cave, Texas, Google Earth 2003.
https://bit.ly/2TINUw5

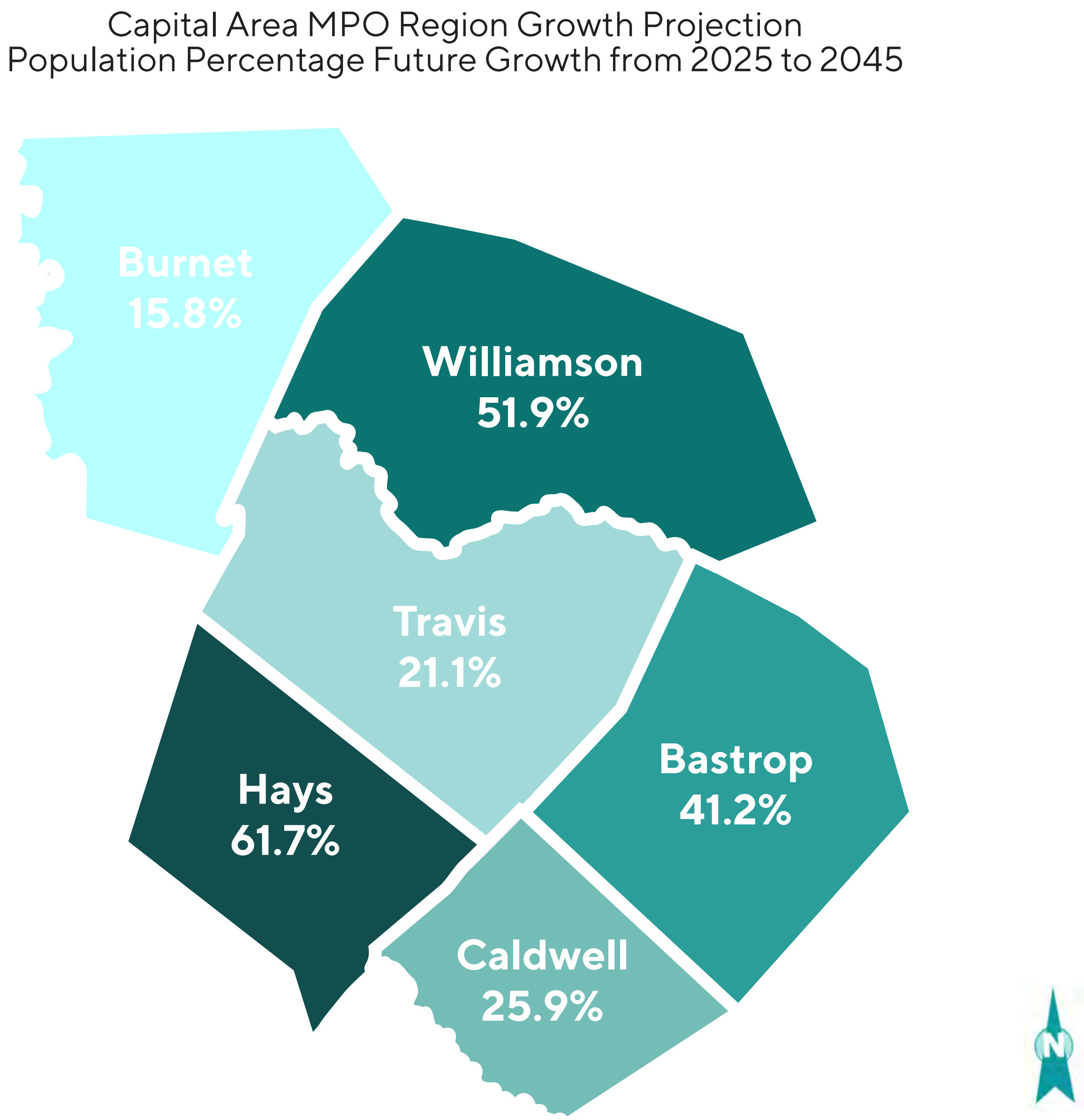
Source: Bee Cave, Texas, Google Earth 2017.
https://bit.ly/2TINUw5

Source: Georgetown, Texas, Google Earth 2001.
https://bit.ly/2SylSpz

Source: Georgetown, Texas, Google Earth 2017.
https://bit.ly/2SylSpz

The Capital Area's growth is expected to continue. Travis County is projected to grow by more than 250,000 residents between 2014 and 2024. While substantial, the proportional growth is even more extreme in Williamson County and Hays County.

Where will all these people live?



County	2025 Population	2035 Population	2045 Population
Hays	329,000	481,000	633,000
Williamson	775,000	1,076,000	1,377,000
Bastrop	140,000	203,000	266,000
Caldwell	61,000	82,000	104,000
Travis	1,480,000	1,839,000	2,197,000
Burnett	61,000	78,000	94,400
Total	2,846,000	3,759,000	4,671,400

[16]

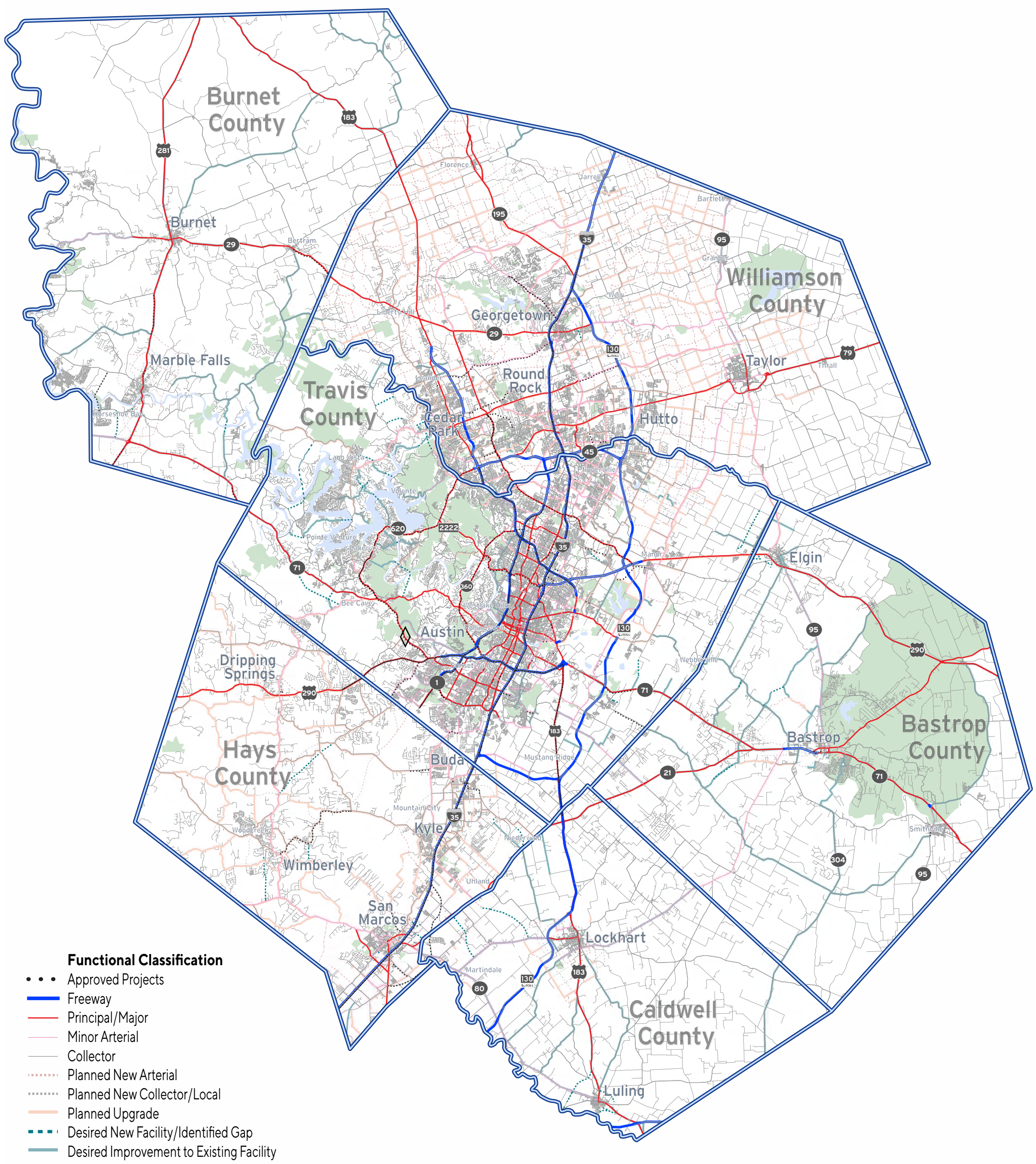
[16] Texas Demographic Center, 2018.

Gaps and Needs

One of the primary intents of the Regional Arterial Study is to identify gaps in the transportation system and additional roadway needs beyond those already planned. CAMPO conducted several workshops with local governments with the intent of obtaining their planned roadways. In addition to obtaining roadway plans from each local government, mapping exercises were conducted where participants in the workshops were encouraged to draw additional roadways that they felt would eliminate gaps in their respective networks or increase capacity or connectivity – these potential projects are termed "Desired". Coupled with the local planned roadway projects and local desired roadway projects, CAMPO developed a subset of the regional arterial network based on Locally Identified Needs. Another portion of the regional arterial network includes roadway projects contained in the Transportation Improvement Program or often called the "TIP." The TIP contains roadway projects that are funded and construction is scheduled within the next 3 to 5 years. TIP projects could include widening projects, new location projects, or interchange improvements. TIP projects are commonly referred to as "committed" are often included with the "existing" network as they will likely be constructed with the next few years. The last set of roadway projects included in the regional arterial network are those roadway projects for which CAMPO identified gaps and needs above those obtained from local governments, TxDOT, and the TIP.

The result of this process was the identification of gaps and additional roadway improvements or new facilities to enhance regional connectivity. A map depicting the culmination of the existing, committed, local planned and desired, and CAMPO proposed roadway improvements is shown in Figure 2.48. This regional arterial network will be referred to as the "Vision Network" in subsequent chapters and is explained in detail. This map was presented to local governments in the second round of outreach meetings.

Existing and Planned Network with Locally-Identified Needs



Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 2.48

Conclusion

In summary, the Capital Area arterial network exhibits a lack of connectivity causing users to travel longer distances and spend additional time getting to their destinations. This has impacts to economic development and productivity, as well as to the quality of life of residents. Reducing the total time and distances traveled can enhance economic competitiveness, reduce the stress of commuting, and have positive impacts to environmental and air quality.

The factors leading to this lack of connectivity include:
- Natural Barriers,
- A post-war development pattern, and
- An insufficiently connected network.

Noted earlier in the functional classification discussion, a missing roadway class was identified – Regional Connectors. These types of facilities place mobility over access and provide for high volume, high speed travel. This type of facility limits driveways and cross street access which improves operations and improves safety by limiting the frequency of conflict points.

The tools identified in this study can empower local entities to better meet with these challenges and push users of the arterial network to facilities that are better matched with their intended trip purpose or length. Currently, residents might use limited access facilities, such as IH 35, to travel only a few miles to the grocery store instead of using a minor arterial. As the Pattern Book chapter makes clear, the Capital Area region is over reliant on higher-functioning arterials for the region's mobility needs. Thereby, our regional arterial network is less efficient than those found in the peer regions presented in this study. A better developed hierarchy of roads can provide options for travelers.

Improvements to the network will require close coordination and support to ensure that the region's arterial roads further the intents of this study. This will become even more critical as the region continues to add thousands of residents, new businesses, and jobs. The remainder of the report puts forward best practices, analysis, concepts, and recommendations for improving the arterial network as a whole.

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REGIONAL ARTERIALS CONCEPT INVENTORY

CHAPTER 3

PROFILES OF NETWORK USERS

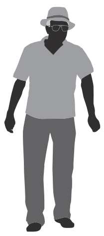
CAMPO

CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

Introduction

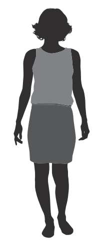
The Capital Area region is diverse and so are its residents. These user profiles help put into context how residents in the region use the transportation network and highlight the current challenges.

Profiles of Typical Arterial Road Users



Craig is a retiree living in rural Caldwell County.

Carla lives in South Austin and is a student at the Texas School for the Blind and Visually Impaired.

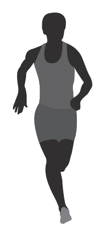


Lauren is a young professional who lives in Williamson County and works in downtown Austin in the Technology industry.

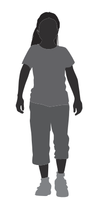
Eric is a father of two living in Bastrop County.

Thomas lives in Burnet County and manages several offices that require access to warehousing space around the region.

Miles is the owner of a start-up delivery company in Williamson County.



Billie lives in southeast Austin and uses car share for commuting to a nearby corporate campus and her daily errands.

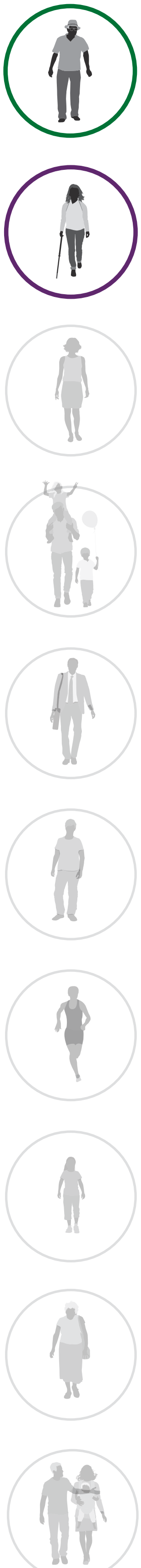


Sarah is a fifth grader in Round Rock whose school is a few streets away from her house.

Rosa is a senior citizen living in Hays County.

Alex and Leah are a young couple living in suburban Travis County.

User Profiles

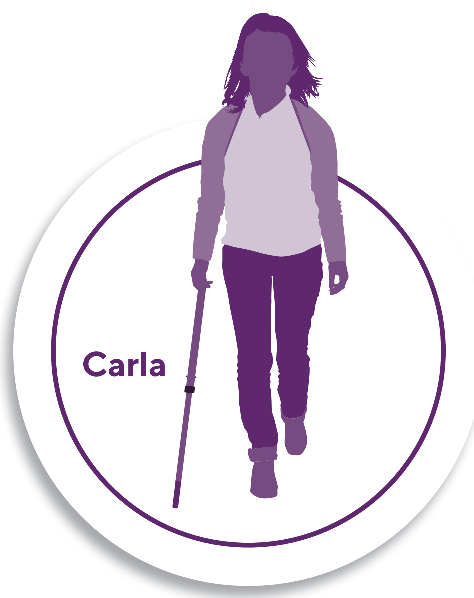


Craig is a retiree living in rural Caldwell County. Once a week he needs to run errands and attend appointments in Lockhart. Craig uses a rural road with low water crossings and a state route to travel into Lockhart's town center. Normally he has no problem getting into town, but when extreme flooding occurs he has limited alternative routes to access food and medical care in Lockhart. In addition, Craig needs to check-in on his elderly mother that lives in Victoria, and there have been numerous times he has been delayed by the train in Luling. On one occasion, he was delayed for over an hour. A train was stopped and blocked all roads crossing town.

Trip Length: 10 + miles

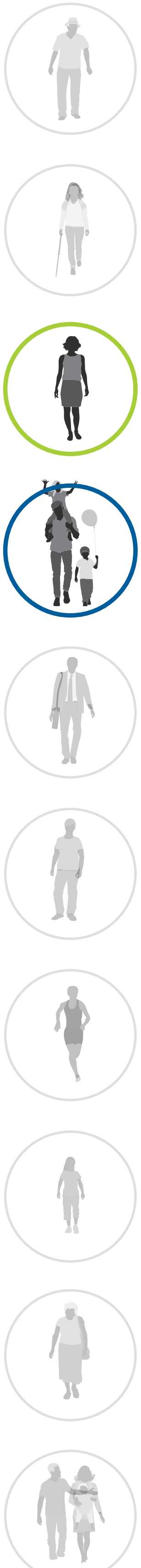
Trip Travel Time: Craig's trip into Lockhart for errands typically takes between 12 – 16 minutes if he leaves in the morning. He tries to get home before the PM commute period, otherwise his trip home can take as long as 22 minutes.

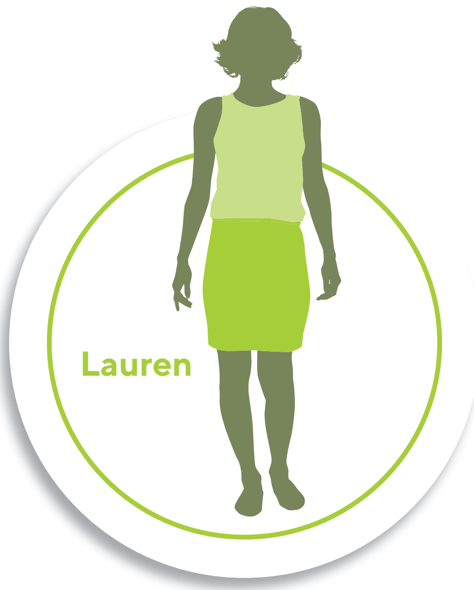
Carla lives in South Austin and is a student at the Texas School for the Blind and Visually Impaired. She relies on public transit that operates on congested roadways to get to school in the morning and her job after class. Her commute times vary drastically due to the heavy traffic along her bus route. She also has a difficult time getting from the bus stop to her job 3 blocks away as she walks along a major arterial.



Trip Length: 5 – 7 miles

Trip Travel Time: Her commute on transit in the morning typically takes around 45 minutes. Her trip after school to work takes about the same.





Lauren is a young professional who lives in Williamson County and works in downtown Austin in the Technology industry. She drives her car to the Tech Ridge Park and Ride and catches a carpool or takes the bus, both of which drop her off at Capital Metro's Downtown Station. Since she doesn't drive most of the trip, she's able to work on her laptop, but the ride often takes over an hour and thirty minutes.

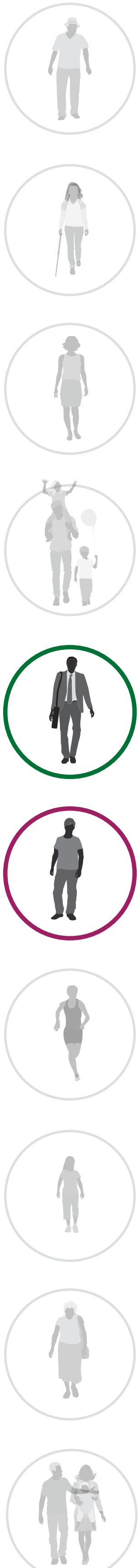
Trip Length: 10 + miles

Trip Travel Time: Lauren's commute typically takes between 2 hours during peak travel times and 1.5 hours during off-peak travel times.

Eric is a father of two living in Bastrop County. He lives near his parents' house, where he drops off his kids on the way to work. Traveling into the City of Bastrop, he relies on one of the two bridges to cross the Colorado River. However, if there is an incident on one or both bridges, Eric has to sit in traffic or drive miles in the opposite direction to get across the river.

Trip Length: 5 – 7 miles

Trip Travel Time: Eric's typical commute is between 10 and 12 minutes.

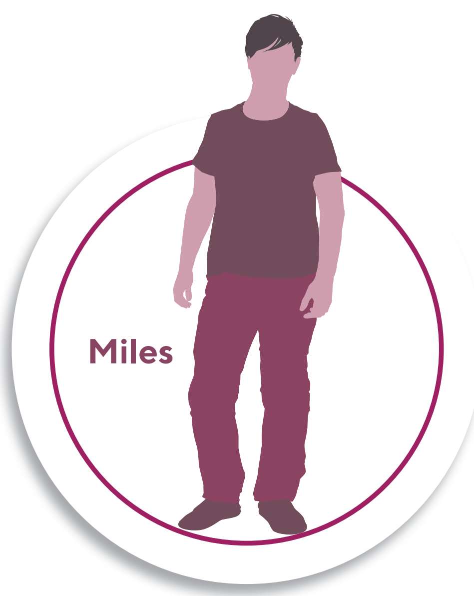


Thomas lives in Burnet County and manages several offices that require access to warehousing space around the region. He's on the road much of the day as he makes frequent trips between offices. Thomas has to allow for extra time in his schedule as the rural road system leaves him with very few direct routes to get around the county, and even fewer ways to cross the river. Thomas is also slowed down by the lack of passing lanes on some of the facilities. He has also witnessed several near accidents on many of his trips.

Trip Length: 10 + miles

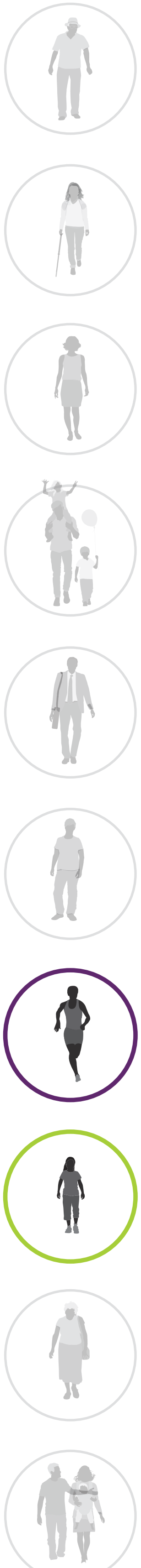
Trip Travel Time: Thomas typically drives a minimum of 20 minutes between each of his offices.

Miles is the owner of a start-up delivery company in Williamson County. The company services the entire region. The time it takes to make pick-ups and deliveries is critical to the company profits and driver commissions. In many cases, the delivery trucks are parked illegally by blocking travel lanes or on-street parking spaces to quickly service a customer. This has resulted in numerous costly parking citations and mean looks by motorists that were delayed.



Trip Length: 10 + miles

Trip Travel Time: The company's trips typically range between 10 and 50 minutes.



Billie lives in southeast Austin and uses car share for commuting to a nearby corporate campus and her daily errands. However, her apartment complex, as well all other complexes on her street have their sole access point on a major arterial. There is very little connectivity in her local area network, providing few alternatives. This causes Billie to deal with congested traffic during the morning and evening rush hours which also increases the costs of her trips.

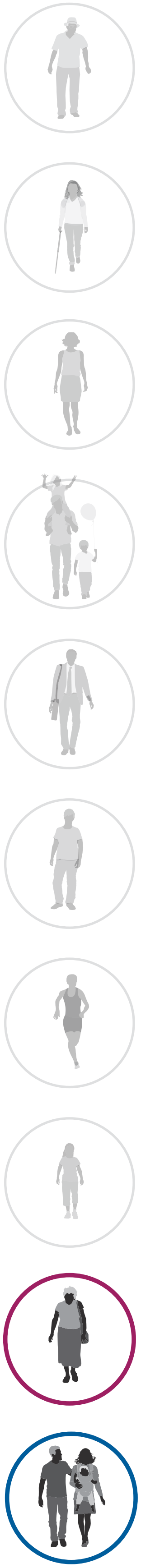
Trip Length: 1 – 3 miles

Trip Travel Time: During peak commute times, her trip can take longer than 10 minutes where it would normally be less than a 5-minute drive.

Sarah is a fifth grader in Round Rock whose school is a few streets away from her house. She would like to walk or bike to school, but her parents are concerned about safety due to her school being sited on a major roadway with relatively high speeds. Therefore, her parents drive her to and from school each day.

Trip Length: Less than 1 mile.

Trip Travel Time: What is currently a less than 5-minute drive to school would be about a 10-minute walk or a 3-minute bicycle ride for Sarah.



Rosa is a senior citizen living in Hays County. She does not drive and lives far from any public transportation options. She relies on her family and neighbors to help her run errands downtown in San Marcos and to access medical care. When there was a wildfire near her residence last year, emergency workers and her family had a difficult time reaching her due to severe congestion along the single rural road that connects her to the regional roadway network.

Trip Length: 5 – 7 miles

Trip Travel Time: Rosa's family and friends normally take her to run errands during off-peak times and their trip normally takes about 10 minutes.

Alex and Leah are a young couple living in suburban Travis County. They share one car and take turns taking their toddler to day care on the way to work. Alex works in a hotel in downtown Austin, while Leah works in retail at Lakeline Mall. The lack of synchronized traffic lights, limited connectivity, and bottlenecks of the arterial network means that they use limited access routes to travel to their jobs. The lack of reliable routes between their home and jobs has often made them late to pick up their daughter from daycare.

Trip Length: 10 + miles

Trip Travel Time: The company's trips typically range between 10- and 50-minute drives.

Conclusion

While challenges vary between users of the regional transportation network, CAMPO has heard the number one priority of community members is to reliably and safely access their home and destinations.

The profiles represent perspectives from the daily life of residents using the transportation network in the Capital Area region. The purpose of these profiles is to highlight what aspects of the transportation network "work well" and "work poorly" based on user experience. Additionally, they highlight residents' competing demands, interests, and fiscal priorities for the transportation network. CAMPO's Regional Arterials Concept Inventory is focused on finding a balance between users' competing demands while improving the reliability and safety of the network.

REGIONAL ARTERIALS CONCEPT INVENTORY

CHAPTER 4
ARTERIALS CONCEPT

CAMPO
CAPITAL AREA METROPOLITAN
PLANNING ORGANIZATION

Introduction

As our region continues growing over the next 25 years, transportation system efficiency is integral to a sustainable future. As discussed at the start of this document, the Capital Area MPO Platinum Planning Program lays a pathway to this future by envisioning a region where multiple transportation options are viable and accessible, coordinated with land and housing development, sensitive to the environment and equitable for all people, and promotes strong economic development opportunities. A comprehensive arterial network provides a foundation to support each of these ideas and helps them scale up as the region grows.

Our existing conditions analysis shows that our region's arterial network is not well proportioned and lacks connectivity. The network of roadways lacks in providing an optimal mix of facility types to allow users to reach destinations via a variety of routes, and is overdependent on our limited-access network and major arterials, such as motorists using IH 35 to go a mile or two versus a parallel arterial. To remedy these issues, this concept plan seeks to advance a connected arterial network with multiple types of roadways that are designed to serve particular types of trips.

The concept plan includes an analysis of a more substantial network of minor arterials for shorter trips and a missing functional class of high-capacity arterial roadways that was identified in 3 of the 4 peer region's case studied in the pattern book. This missing functional class in our region has been addressed by the identifying of a system of mostly existing and some new routes being upgraded to "regional connectors," which are a higher-capacity arterial that can move people and goods more efficiently throughout the region. This better-connected network, with managed access and operational improvements, will improve overall efficiency and make other modes more competitive for regional travel. Moreover, it will also improve safety with context sensitive design treatments that will reduce the number and severity of crashes. These improvements are detailed in chapter 3 of the Pattern Book and have the potential to demonstrably increase the seamless movement of people and goods throughout our region and keep us competitive with other regions.

Best practice improvements were developed based on an analysis of case study regions with post-war development patterns, similar populations (currently or in 2040), similar economies, and significant natural or human-made barriers. This analysis helped determine benchmarks for arterial spacing, connectivity, and trip purposes, which were then used in the development of a transportation package of regional and supporting roadway connections. Upon identifying the missing functional class, a gap analysis was conducted to recognize how the arterial network should progress in the future. Special consideration was given to locally planned improvements and locally identified needs and desires. Regional Connectors and minor arterials were identified and developed to integrate regional connections, improvements to existing arterials and limited-access facilities, as well as new arterials. The combination of regional connectors and their supporting minor arterials provides a high capacity roadway network while again leveraging the local planning work already done.

Once roadway improvements were identified and inventoried, scenario modeling was used to evaluate improvement options. To understand which options best meet the goals of the study, six scenarios were developed and evaluated. Two of the scenarios included a Baseline and a No-build condition. The Baseline scenario establishes the existing condition, while the No-build scenario establishes the future condition if no transportation improvements were to happen. The remaining four scenarios include the implementation of various safety measures, operational improvements, increased capacity, and new routes. The explanation of the scenarios and an analysis of their performance shows how different interventions will ultimately impact our region over the next 25 years.

Forming the Concept Plan

The Concept Plan is a re-imagining of the existing, planned, desired, and gaps network (seen in Figure 4.1). The Concept Plan began in earnest with the process described above to combine all locally-planned networks. Combining all planned networks helps identify gaps between planned upgrades and new planned roadways.

CAMPO created longer-distance Regional Corridors from the existing, planned, desired, and gaps network facilities to assess the proper design and capacity. This assessment provided the information needed to develop an inventory of improvements and new facilities and to begin scenario planning to better understand the potential impacts. CAMPO has also set out to provide additional analysis for four test case corridors: SH 21, FM 734, FR 1431, and RM 12 included in the Pattern Book. For each, we will look at specific treatments and cross sections, as featured in the Pattern Book, to apply to the corridors and provide additional analysis on improvements or policies that can help these corridors better meet the goals and objectives stated in the study.

Creating a Planned, Desired, and CAMPO Gaps Network

Once the existing network was assembled, the network of planned improvements and new facilities was added. CAMPO received locally-adopted plans from regional partners that set out new and improved arterials. These individual plans were combined to display the full regional network of planned and existing facilities.

CAMPO received partner plans from the following local entities:

- Austin
- Bastrop
- Buda
- Cedar Park
- CTRMA
- Georgetown
- Hays County
- Hutto
- Kyle
- Leander
- Lockhart
- Marble Falls
- Round Rock
- San Marcos
- Travis County
- TxDOT
- Williamson County

In addition to adopted local plans, as part of the local government meetings, CAMPO staff asked local government representatives to vet their plan data displayed on the locally identified needs maps shown within the existing conditions. Local governments were asked to provide insight on additional needs beyond the plan shown on the planned, desired, and CAMPO gaps network map. This allowed the needs assessment to reflect need of the communities that may not have locally adopted plans and additional needs beyond adopted plans.

The first round of local government outreach meetings also produced locally-identified needs, which were generally new connections or improvements - "Desired Improvements." These new or improved facilities were further refined in the second round of local government outreach meetings.

With locally planned and locally desired facilities mapped, CAMPO staff undertook a "gap" analysis to determine where missing connections between planned and existing facilities may be or where demographic forecasts show a lack in the capacity of arterial roadways. The result of this analysis was the identification of gaps that recommend additional roadway improvements or new facilities to enhance connectivity.

A map depicting these three types of new and improved facilities, along with the existing arterial network is shown on the next page. This map was presented to local governments in the second round of outreach meetings.

Planned, Desired, and CAMPO Gaps Network

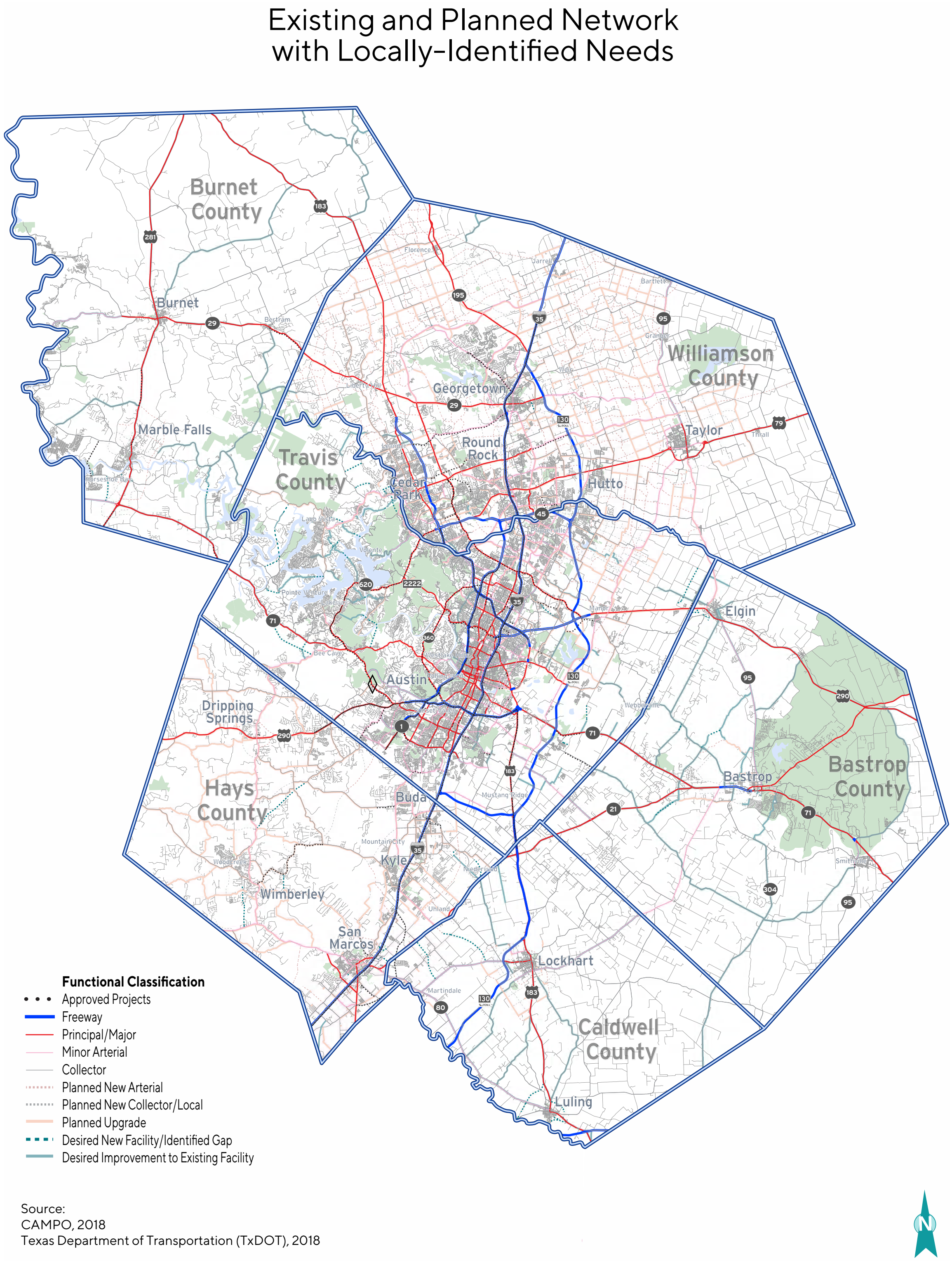


Figure 4.1

Regional Corridors

With a full map of planned, desired, and gap facilities, CAMPO identified areas where individual pieces (typically on the same roadway) could create longer distance, strategically connected "Regional Corridors." This was done, in part, to help illustrate the impact that individual improvements may have on the mobility demands along a given corridor, and to provide truly regional connections to a wider variety of communities.

CAMPO combined individual improvements, as shown in Figure 4.2, to form each Regional Corridor. Most of the Regional Corridors were comprised of multiple segments with improvements or new facilities planned by a local entity or identified through the gap analysis process. The Regional Corridor follows RM 1431 going east through the region, then following University Blvd, Chandler Rd, and a planned extension of that corridor to the eastern extent of the region. These corridors cross multiple jurisdictions from Kingsland to just north of Taylor, Texas.

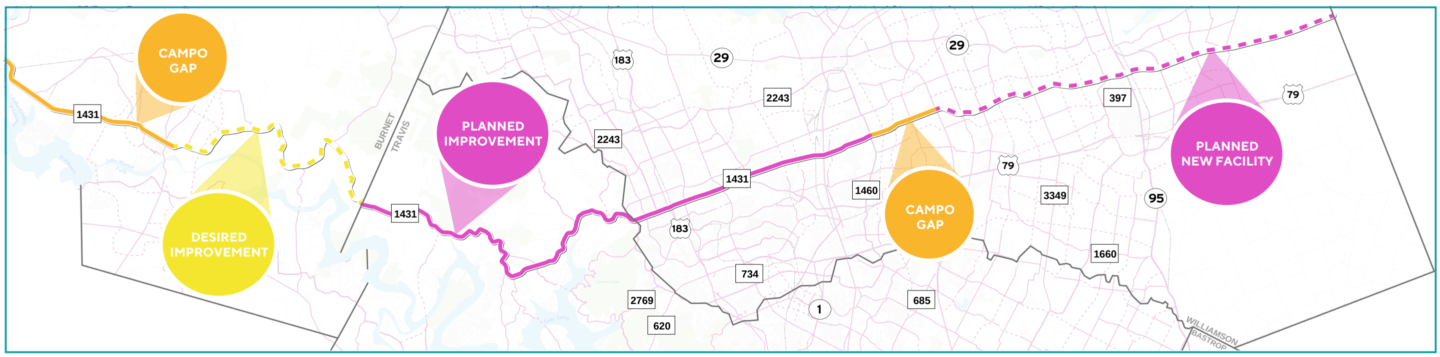
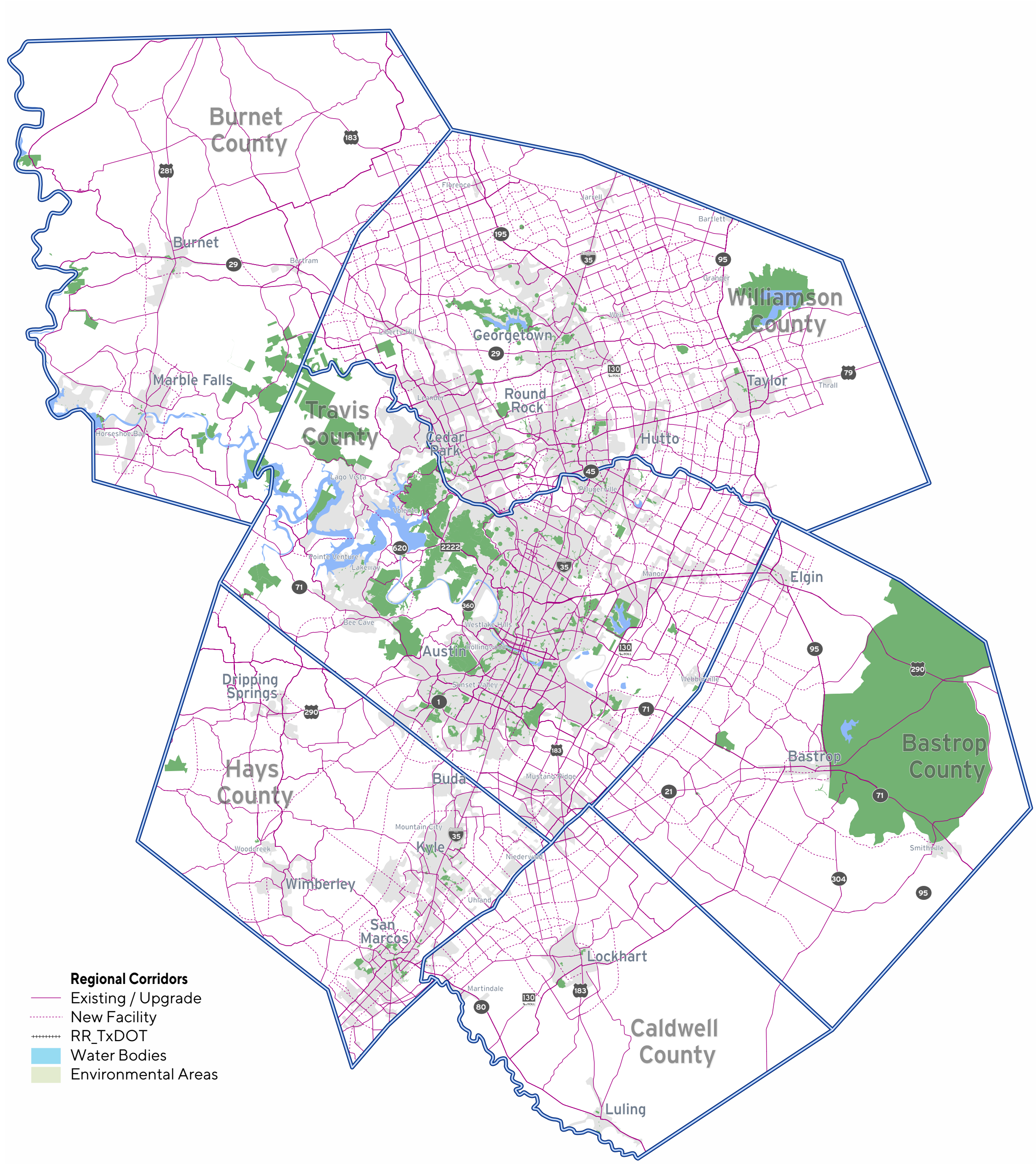


Figure 4.2 Shows the RM 1431 corridor gap analysis through multiple jurisdictions

After the initial Regional Corridors were formed, a sample of them were mapped and presented to the Steering Committee in January 2019. Displayed as a single color, Figure 4.3 allows for a better understanding of the full potential arterial network for 2045.

Complete Potential Arterial Network



Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 4.3

Developing the Regional Corridor Inventory

The Regional Corridors were inventoried in a table to organize all the information previously collected regarding the improvements or proposed new facilities that form each one of them. The process of building the inventory followed the procedure illustrated in Figure 4.4, with segments generally determined by a break in the source of the planned improvement or new facility.

Each Regional Corridor was assigned a number. In Figure 4.4, an illustrative Regional Corridor connecting US 183 to US-90 has been given a project number of 1. The project is further broken out into project sub-segments and given its own project ID based on the Regional Corridor assigned number. Segment were generally created by the break in the source or type of improvement.

Regional Corridor US 183 to US 90		
Regional Corridor Number	Project sub-segment	Source
1		
1.1	SH 130 to Flores St.	Planned Improvement
1.2	Flores St. to S. Commerce St.	Planned New Facility
1.3	S. Commerce St. to FM 213	Desired
1.4	FM 213 to SH 80	Existing
1.5	SH 80 to US 90	CAMPO Gap

Figure 4.4

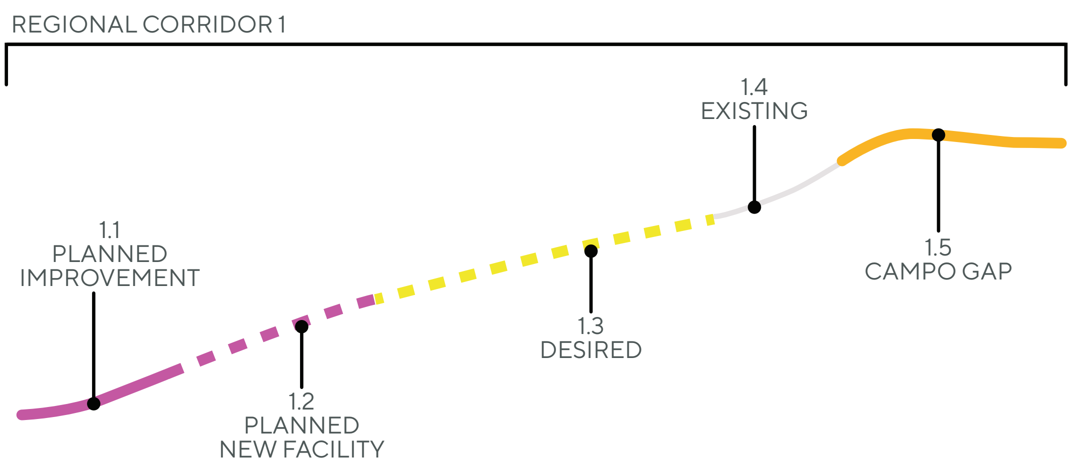


Figure 4.5 Example of corridor segmentation

The Combined Concepts (Unconstrained Arterial Network)

The Regional Arterial network is the full network of locally planned facilities, locally identified needs, and CAMPO-identified gaps for 2045. This is done to provide a better sense of how the network functions. This analysis was completed by integrating each of the local transportation plans and locally identified needs. Given that these local plans include the entirety of local transportation improvements, the spectrum of projects were vast and included many projects that do not impact regional travel. For this reason, these projects were removed from the vision network. Specifically, CAMPO removed all facilities below the major collector functional class, as any lower functional classes would most likely not meet the minor arterial functional class by 2045. These reductions provided the appropriate base of facilities needed for the arterial analysis. From there, another analysis was undertaken using the 2040 model which yielded the results of a few additional corridors that would have a proportional increase in average daily traffic (ADT) that would need to be examined for improvements and potential upgrades to the minor arterial functional class.

The vision network was not only mapped but coded in terms of the number of lanes and the design type of the roadways. CAMPO followed local plans to determine the coding, but many plans either did not extend to 2045 or did not make determinations according to lanes or design types. In the case that local entities did not decide on these elements in their plans, CAMPO based coding choices on local demand (based on the demographic forecast), projected and current Volume/Capacity (V/C) ratios, and arterial spacing guidelines gleaned from the findings of the case study analysis of the Pattern Book.

Modeling Scenarios

Modeling scenarios were developed to evaluate different suites of transportation improvement packages. Modeling output from each scenario can be compared to each other and help inform transportation investments for the region. The first scenario represents our regions current roadway with our current population. The second scenario represents our regions current roadway and a doubling of our population by 2040. This scenario provides a look into our future roadway performance if we were to make no improvements to our transportation network despite our population growth over the next 20 years. The other scenarios provide options for improving roadway performance as we grow over the next 20 years.

The transportation improvements associated with several scenarios were coded into the CAMPO 2040 Regional Travel Demand Model (TDM). The TDM is used to forecast regional demand for roadways. For any given year, the TDM quantifies the vehicular demand for a roadway or set of roadways and provides a resulting travel time based on that demand. There are limitations to the TDM. This model is a demand model and not an operational model; it is sensitive to capacity changes and the addition of new roadways. Capacity changes include widening a road or upgrading its functional classification. The TDM is considered a “macroscopic” model and is not suitable for operational analysis. Operational analysis is typically conducted using mesoscopic and microscopic models. The TDM does not account for intersection/interchange geometry, signalization, queuing, delay, merge/weave and other operational interactions between intersecting roadways. For this reason, detailed intersections, overpasses, special intersection designs, and interchanges were not modeled. Furthermore, at this level of study, any recommended interchange/intersection treatments would be speculative.

Modeling Scenarios

Coding improvements include digitizing the existing, planned, and desired roadway connections into the regional model network and assigning attributes such as number of lanes and functional class based on the proposed improvement. The Travel Demand Model provides performance metrics which are then used to evaluate and compare scenarios to each other. Performance metrics used to evaluate each scenario are described below:

Centerline mileage – is the sum of the length of each roadway in the region. Increasing centerline mileage is equivalent to adding new roadways to the region's current network.

Network Lane mileage – is the sum of the length of each roadway multiplied by the number of lanes within each segment of roadway. Increasing lane mileage is equivalent to adding new roadways and/or widening existing roadways. Adding lane mileage increases roadway capacity.

Vehicle Miles of Travel (VMT) – represents vehicular demand. VMT is calculated by multiplying the number of vehicles on a roadway segment by the length of that segment. VMT can be calculated for individual roadways or for the entire regional roadway network.

Vehicle to Capacity Ratio (V/C) – represents how "full" a roadway is. By dividing demand (VMT) by the capacity (Lane miles) the result is the V/C ratio. A V/C ratio of .85 to 1 means that a roadway segment is operating near or at full capacity. A V/C ratio above 1 means the roadway segment is operating over capacity. A V/C under .85 means the roadway is operating at or near free-flow conditions.

Vehicle Hours of Travel (VHT) – measures how long vehicles are on the roadway network or a roadway segment. VHT is calculated by multiplying the number of vehicles on a roadway segment or regional network by the travel time of the roadway segment or regional network. VHT typically decreases when improvements are made to a roadway or regional network. When VHT is decreased, travel time or network speed is increased.

AM and PM Peak – time period during the morning (6:00am - 9:00am) and afternoon (3:30pm - 6:30pm) commute to and from work. The AM and PM peak are periods of the day where traffic demand is at its highest point.

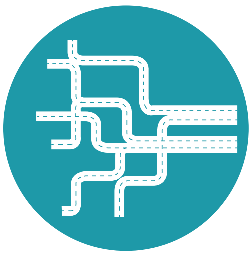
V/C ratio Ranges	
V/C Ratio	Description
0.0 - 0.85	Roadway operating at 85% of its capacity or less; free-flow traffic to slow traffic
0.85 - 1.0	Roadway operating between 85% and 100% of its capacity; stop and go
1.0 - 1.5	Roadway operating between 100% and 150% over capacity; congested
1.5 - >1.5	Roadway operating at over 150% of its capacity; "parking-lot" traffic

Figure 4.6

Baseline Scenario

The *Baseline Scenario* includes the current (2020) roadway performance. This scenario depicts current congestion levels from which to compare the performance of all other scenarios. This scenario includes the existing roadways plus roadway improvements contained in the Transportation Improvement Plan (TIP).[1] Projects in the TIP are funded and expected to go to construction within the very near future. The current TIP was adopted in May 2018.

Baseline Scenario performance measures



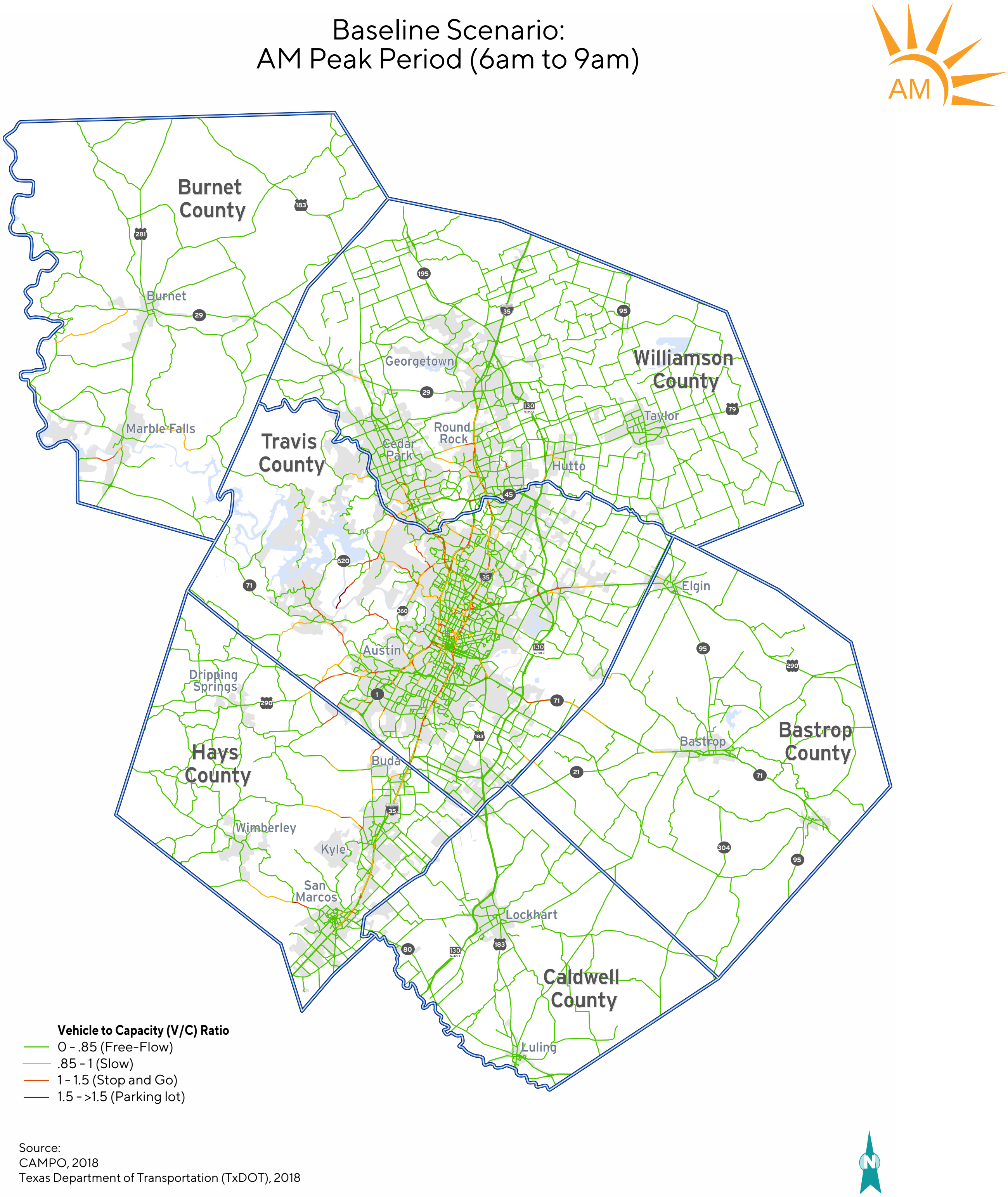
Network Lane Mileage 17,182

VMT 57.6 Million

VHT 1.3 Million

[1] CAMPO Transportation Improvement Program. Accessed at https://www.campotexas.org/tip/

Baseline Scenario:
AM Peak Period (6am to 9am)

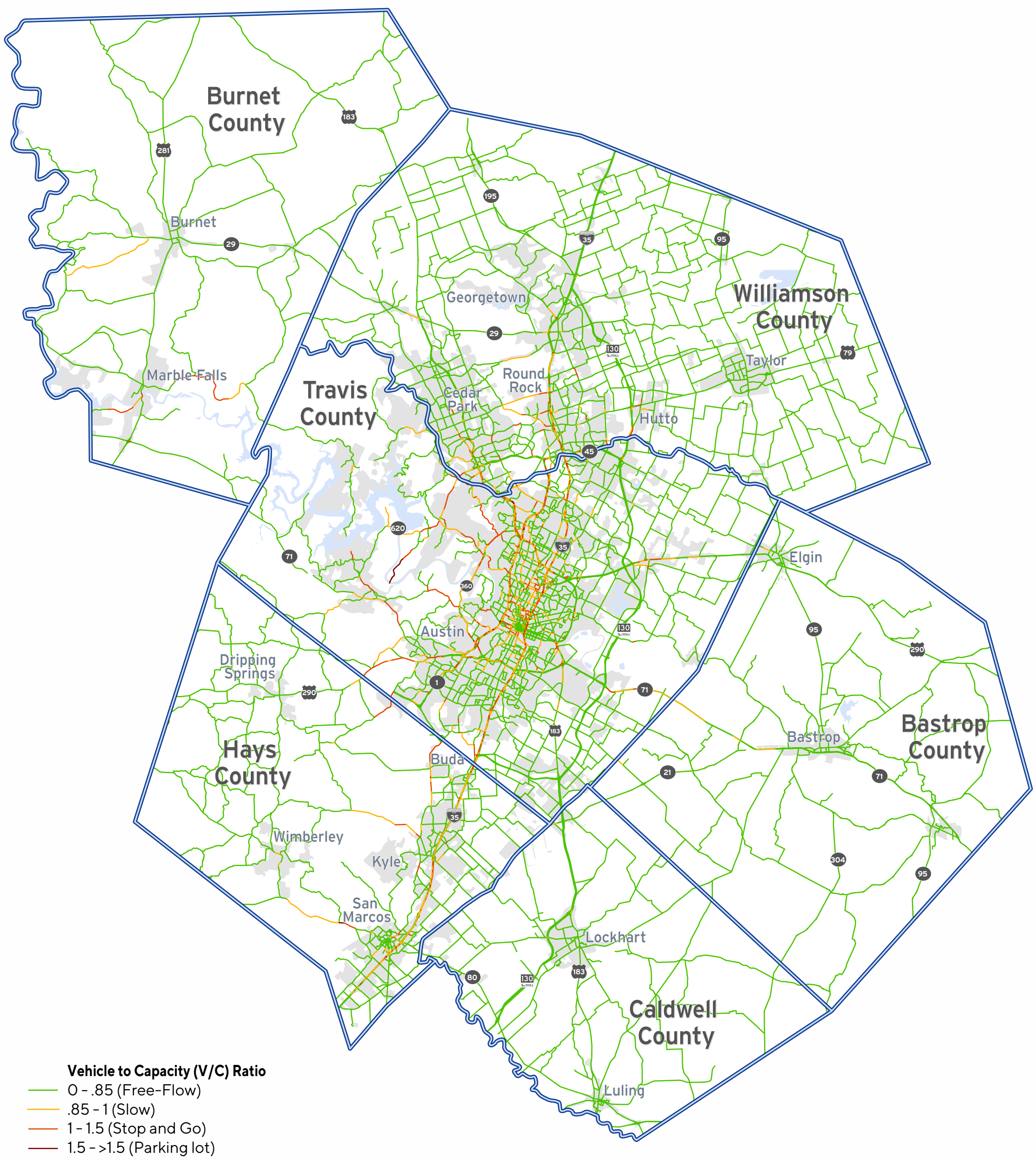


Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 4.7

Baseline Scenario:
PM Peak Period (3:30pm to 6:30pm)

PM



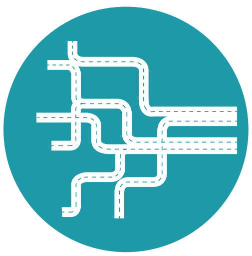
Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 4.8

Scenario Z: Future No Build

Scenario Z differs from Baseline Scenario in that the population and employment is based on the 2040 adopted demographic forecast found in the currently approved Transportation Demand Model. This scenario assumes a doubling of our current population and no roadway improvements beyond those contained in the Baseline scenario. This type of scenario is often referred to as a "Do-nothing" scenario and is used to compare the impacts of improvements made in other scenarios.

Scenario Z: Future No Build performance measures



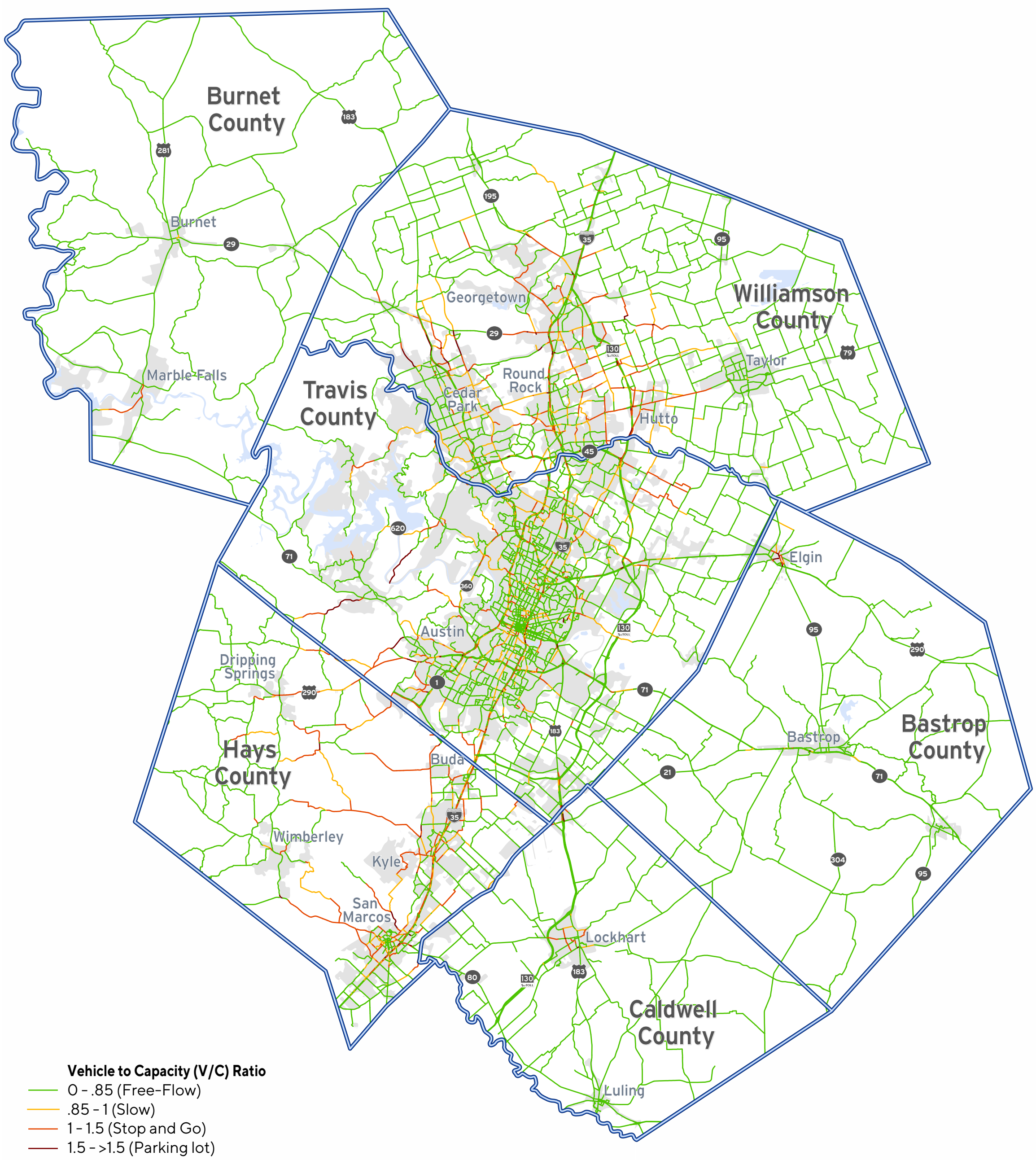
Network Lane Mileage 17,182

VMT 100.4 Million

VHT 2.9 Million

Scenario Z: Future No Build
AM Peak Period (6am to 9am) Congestion Levels

AM



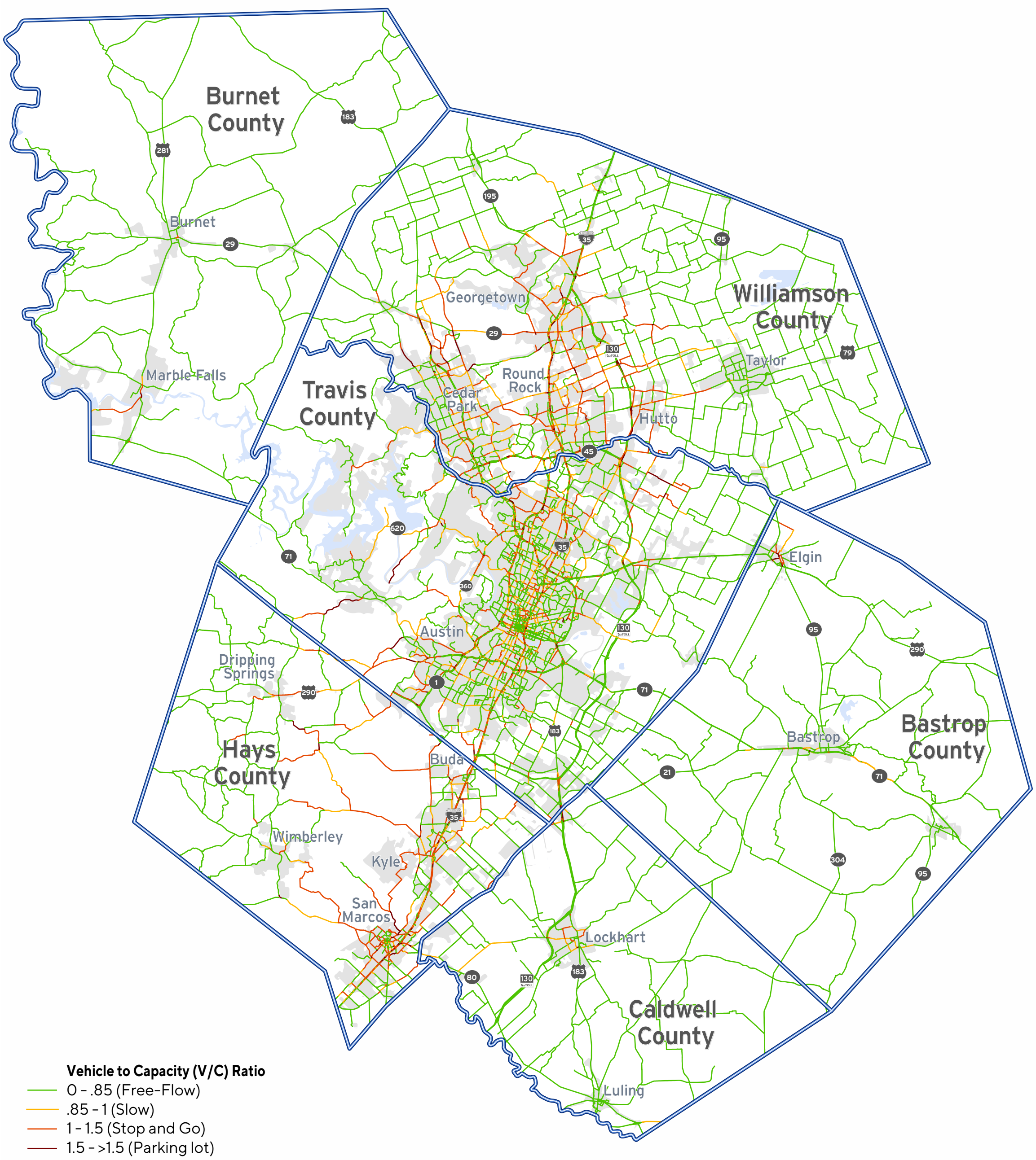
Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

N

Figure 4.9

PM

Scenario Z: Future No Build
PM Peak Period (3:30pm to 6:30pm) Congestion Levels



Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 4.10

Scenario A1/2: Interim Reversible

Scenario A ½ evaluates interim operational improvement concepts to the 2020 no-build (Scenario Z) roadway network. This technical analysis looked at the potential impact of reversing the directionality of roadway lanes during the AM and PM peak periods. This interim reversible lane concept is presented merely to illustrate these potential benefits and do not reflect specific recommendations or plans for the facilities or locations chosen for this analysis.

During peak periods, there are roadways, like the three featured below, in which the direction of travel is significantly higher in one direction than the other. Essentially, there is unused capacity in the less traveled direction. The interim reversible lane concept "borrows" a lane from the other direction so that capacity in the heavily traveled direction receives an additional lane of capacity during either the AM or PM peak periods.

The interim reversible concept was evaluated for a few selected roadways with heavy directional flows in the AM and PM peak periods. Figure 4.11 illustrates the increase in carrying capacity when applying this concept in the travel demand model. Although this concept takes advantage of unused capacity without having to construct new lanes, there would be significant operational challenges to convert existing facilities into this type of usage. Like many of the other concepts presented in this study, implementing agencies can study this concept further and vet it with their community members to see if it can benefit peak-period trips (especially where ROW is limited) or to enhance mobility during special events.

Facility (location)	Existing Trips	Peak-period Reversible Lane Trips
EB FM 969 (@ Springdale)	2,768 (PM)	3,123 (PM)
WB RM 2222 (@ MoPac)	5,689 (PM)	7,210 (PM)
EB RM 2244 (@ Redbud Trail)	2,887 (AM)	4,283 (AM)

Figure 4.11 Example of capacity increase due to Peak-period Reversible Lane Trips

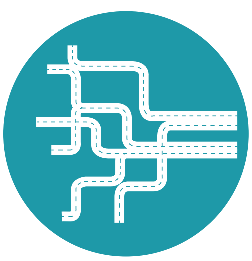
Scenario A: Regional Connectors

As previous analysis has made clear, it is apparent that not all arterial roadways within the network function the same or are used the same by residents and visitors to the Capital Area MPO region. For example, I-35 and Congress Avenue are both considered major arterials, however they are designed and used differently. *Scenario A* is a scenario where only the regions' major arterials are improved, and new major arterials are added to eliminate gaps within our regional connections. These types of roadways are the highest functioning roadways within our region and support most of our travel. Within *Scenario A*, these roadways are our region's top tier roadways. Top tier roadways include all limited access and higher functioning principal arterials in the Capital Area MPO region.

This also includes a missing functional class, as identified in the initial phases of the study, that have been identified as Regional Connectors. These facilities provide long-distance connections and allow for greater mobility due to tighter access controls. Along with the limited access facilities and a few strategically located major arterials, the Regional Connectors form an integrated system of multi-lane high-capacity principal arterials. More specifically, they feature:

- Tight Access Management
  - Right turns in/out only
  - Left turns at signalize intersections only
- Intersections typically spaced no less than ½ mile apart (all signaled)
- Raised medians or traffic barriers
- Grade separated intersections with all other regional connectors and limited access roads
- Timed/Synchronized lights
- Dedicated separated ped/bike facilities
- Bus pullouts

Scenario A: Regional Connectors performance measures



Network Lane Mileage 17,868

VMT 98.9 Million

VHT 2.5 Million

The results from the model show that in *Scenario A* lane miles were only increased by 16% but the improvements had a 1.4% reduction on regional VMT and a 13% reduction on regional VHT as compared to *Scenario Z*. This is understandable due to the capacity improvements to the top tier roadways. Several major arterials were also selected throughout our region to identify the performance impacts of *Scenario A* on those arterials. All the arterials selected experienced an increase in their average speed by 7% to 24% which is consistent to the improved V/C ratios. All the arterials selected experienced a decrease in VHT with the exception of RR 12. Although VHT did increase slightly on RR 12, this is attributed to its increase in VMT and lane miles which is also closely correlated with the increase in population and jobs in Hays County by 2040. Still, the improvements on RR 12 provide more capacity and increase the average speed, even while moving more vehicles. Overall, the results from *Scenario A* illustrate that we can realize tangible benefits in the efficiency of our arterial system by making strategic improvements to a relatively modest number of roadways.

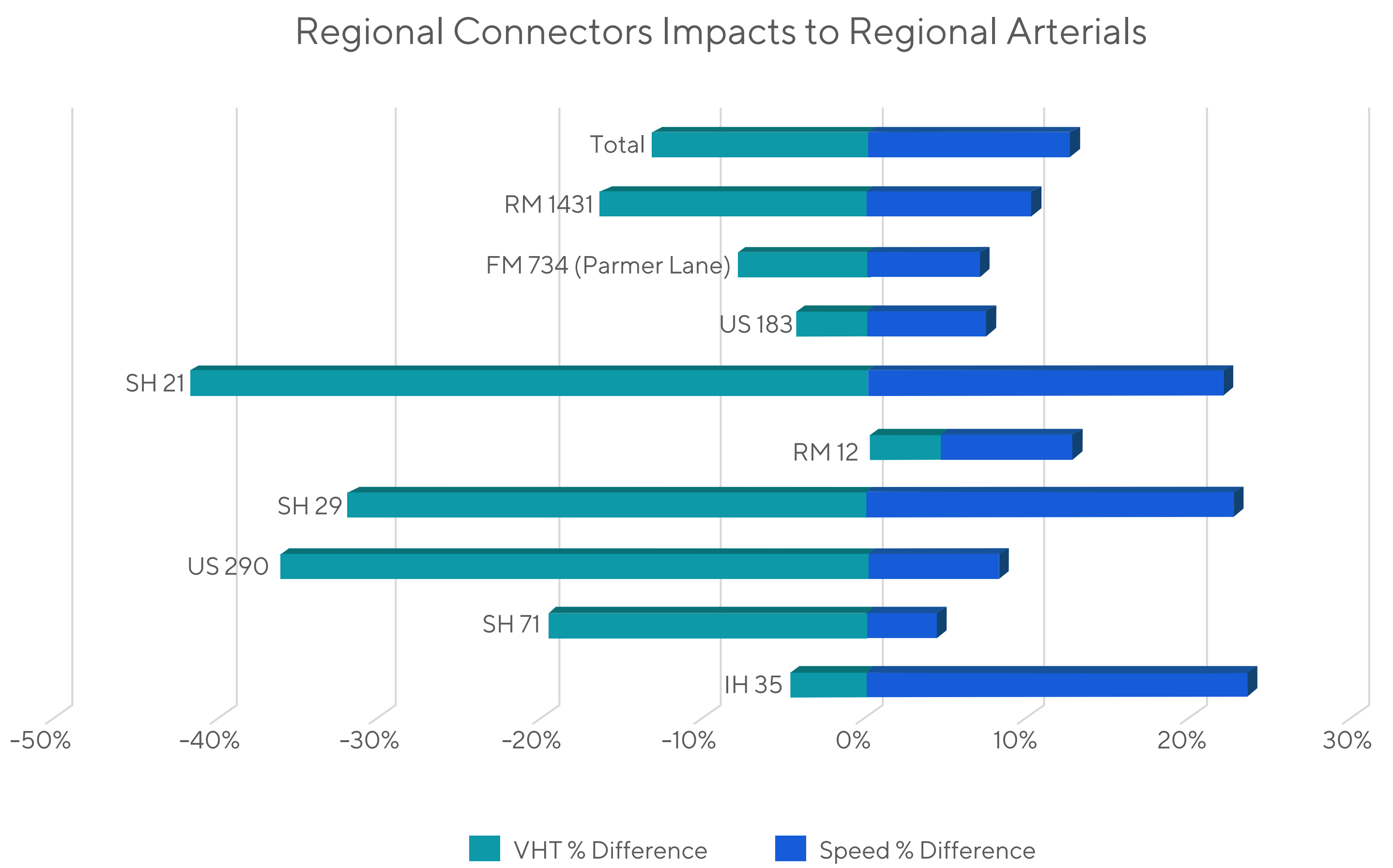


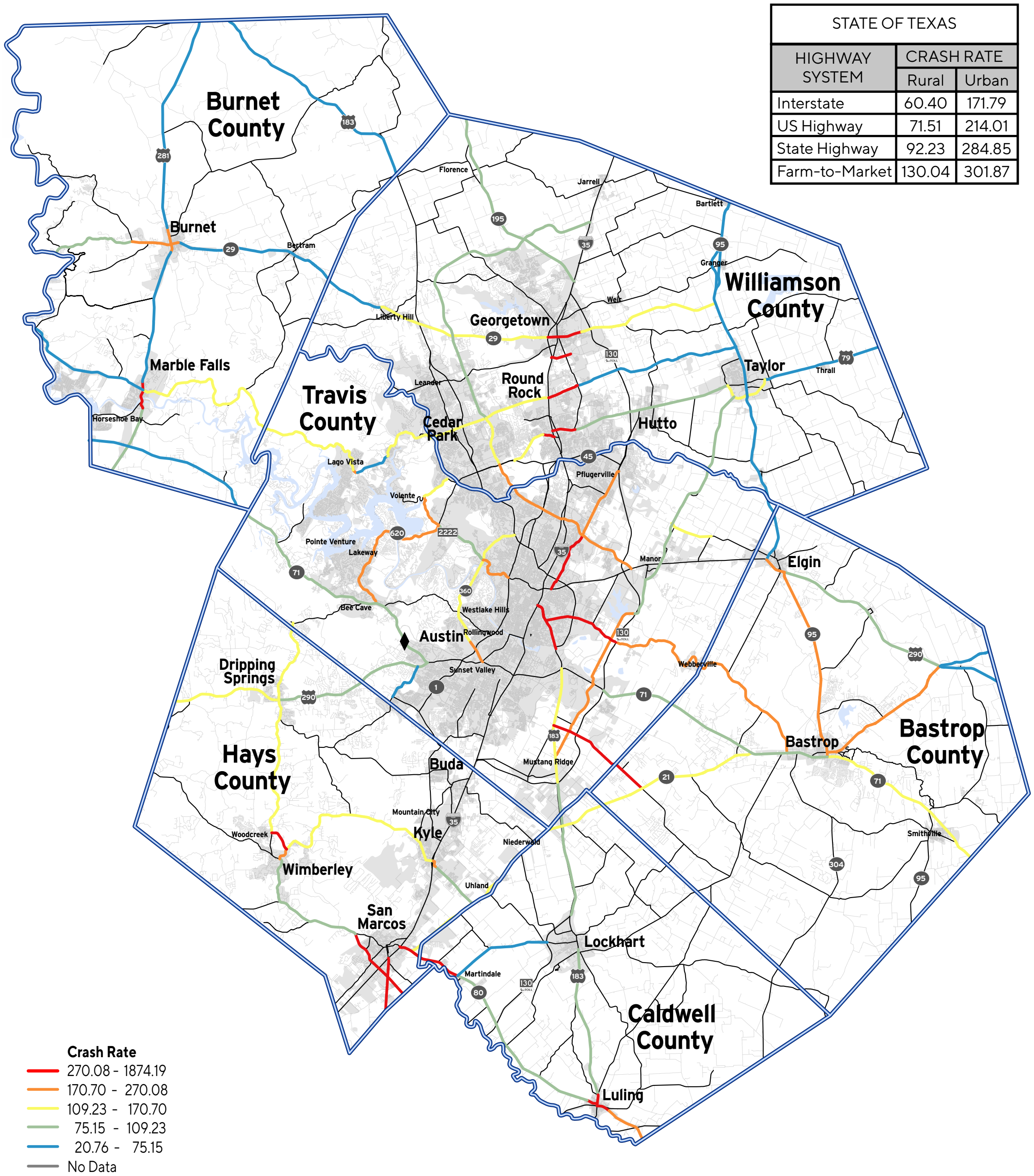
Figure 4.12

The network is spaced appropriately for higher functional class roadways (3 to 5 miles or more). This was based on best practices developed by the case study regions examined in the Pattern Book. Additionally, this network connects multiple centers and many generally provide mobility around the core. Figure 4.19 displays the Regional Connector network, along with additional treatments or peak period uses that may be recommended to help improve mobility. *Scenario A* corridors will be added to the current 2030 model network used in *Scenario Z: Future No Build.*

Figure 4.13 Example of a Regional Connector

Source: Google Maps; http://bit.ly/2WtJazG

Capital Area Region
Regional Connectors - Crash Rates



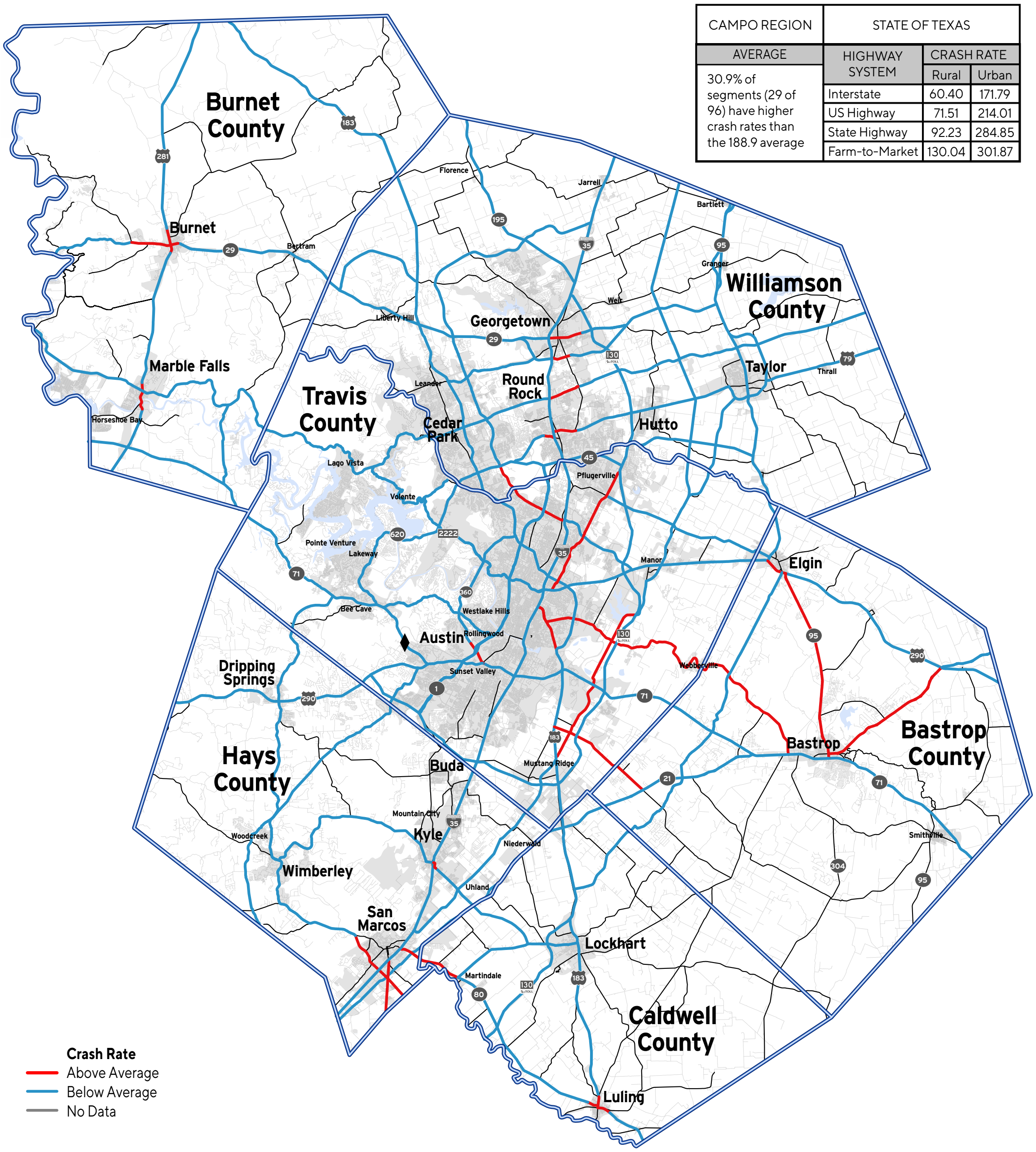
STATE OF TEXAS		
HIGHWAY SYSTEM	CRASH RATE	
	Rural	Urban
Interstate	60.40	171.79
US Highway	71.51	214.01
State Highway	92.23	284.85
Farm-to-Market	130.04	301.87

Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 4.14

Capital Area Region
Regional Connectors - Crash Rates (Average)

CAMPO REGION	STATE OF TEXAS		
AVERAGE	HIGHWAY SYSTEM	CRASH RATE	
		Rural	Urban
30.9% of segments (29 of 96) have higher crash rates than the 188.9 average	Interstate	60.40	171.79
	US Highway	71.51	214.01
	State Highway	92.23	284.85
	Farm-to-Market	130.04	301.87

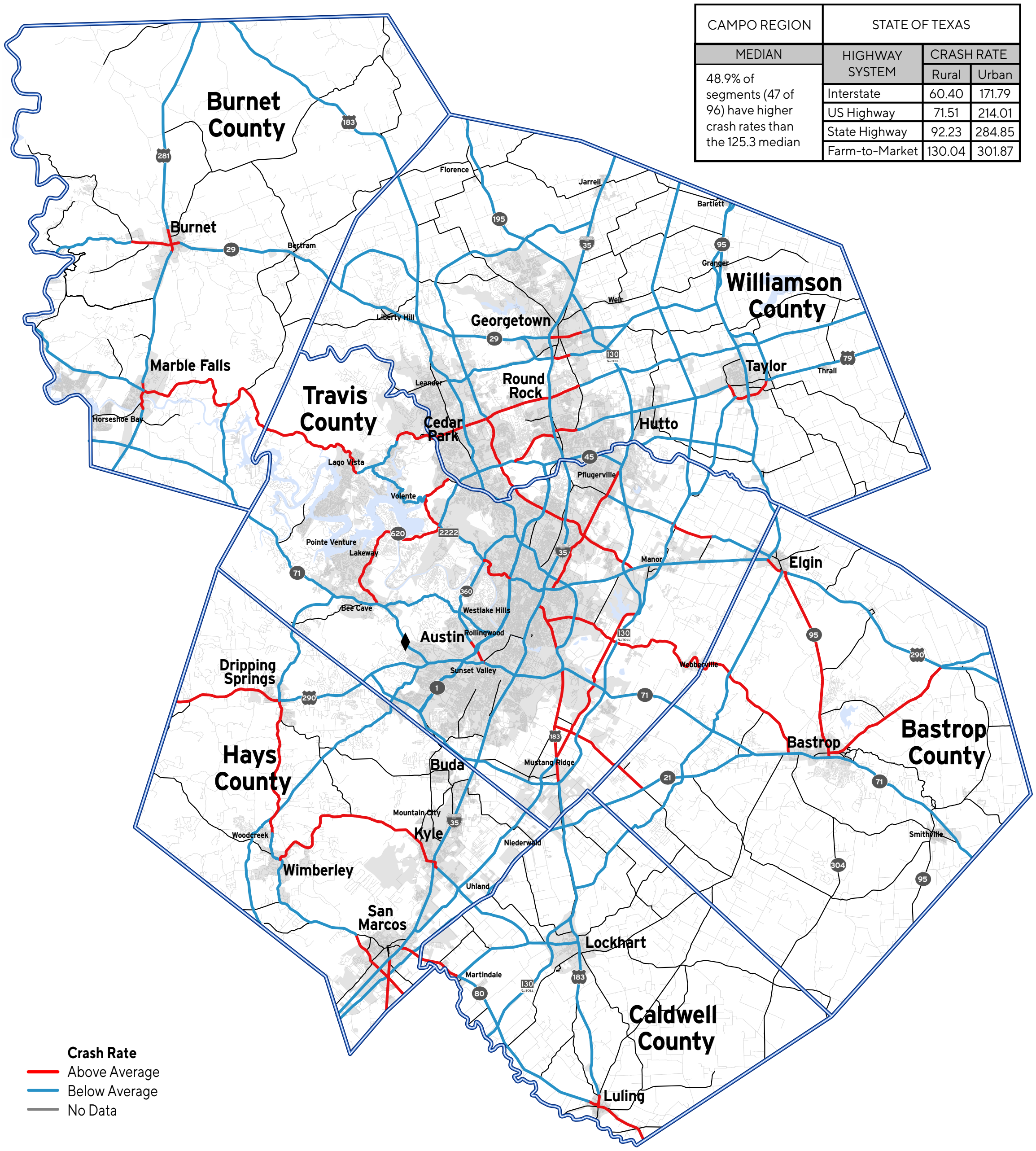


Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 4.15

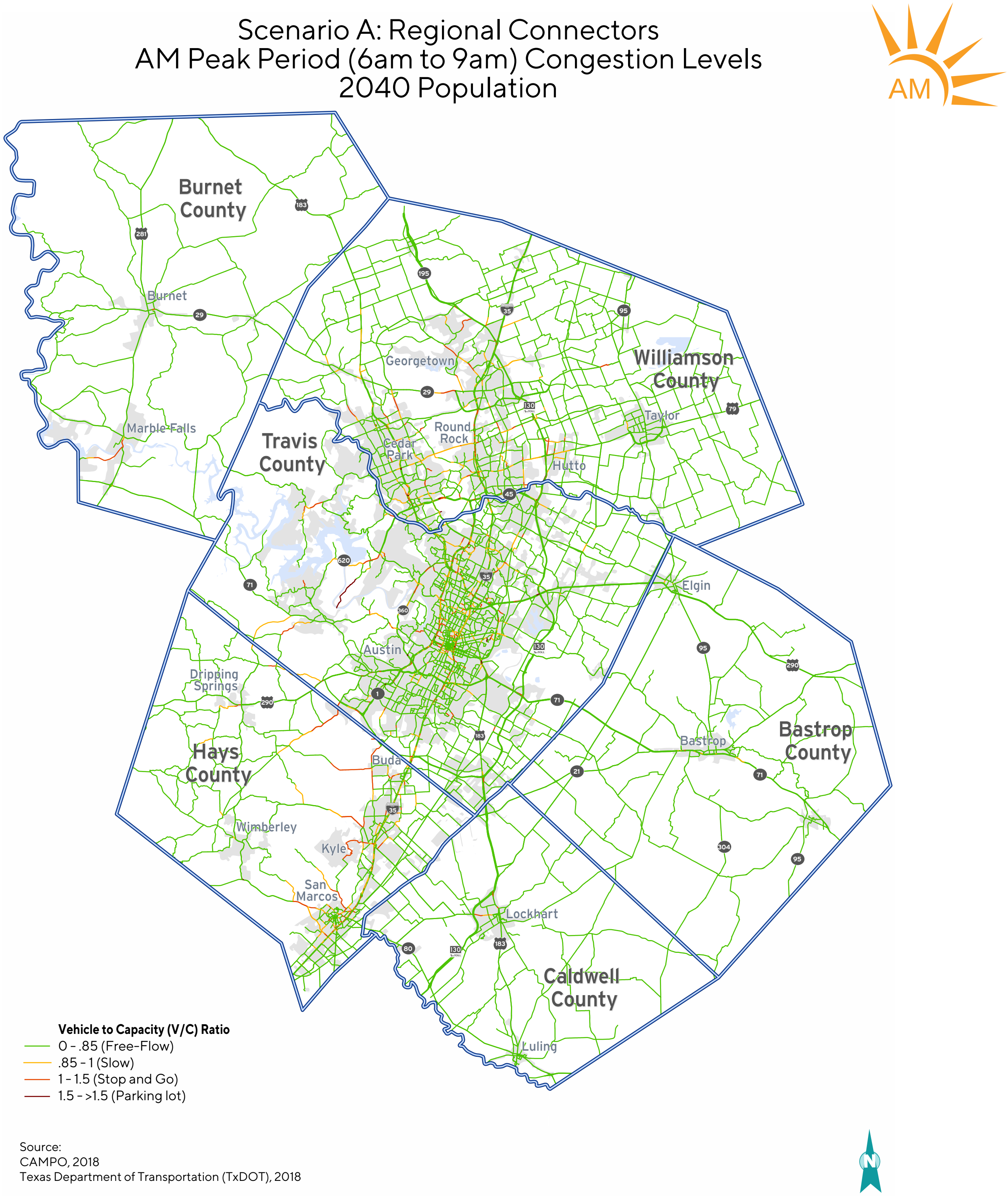
Capital Area Region
Regional Connectors – Crash Rates (Median)

CAMPO REGION	STATE OF TEXAS		
MEDIAN	HIGHWAY SYSTEM	CRASH RATE	
		Rural	Urban
48.9% of segments (47 of 96) have higher crash rates than the 125.3 median	Interstate	60.40	171.79
	US Highway	71.51	214.01
	State Highway	92.23	284.85
	Farm-to-Market	130.04	301.87



Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 4.16



Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 4.17

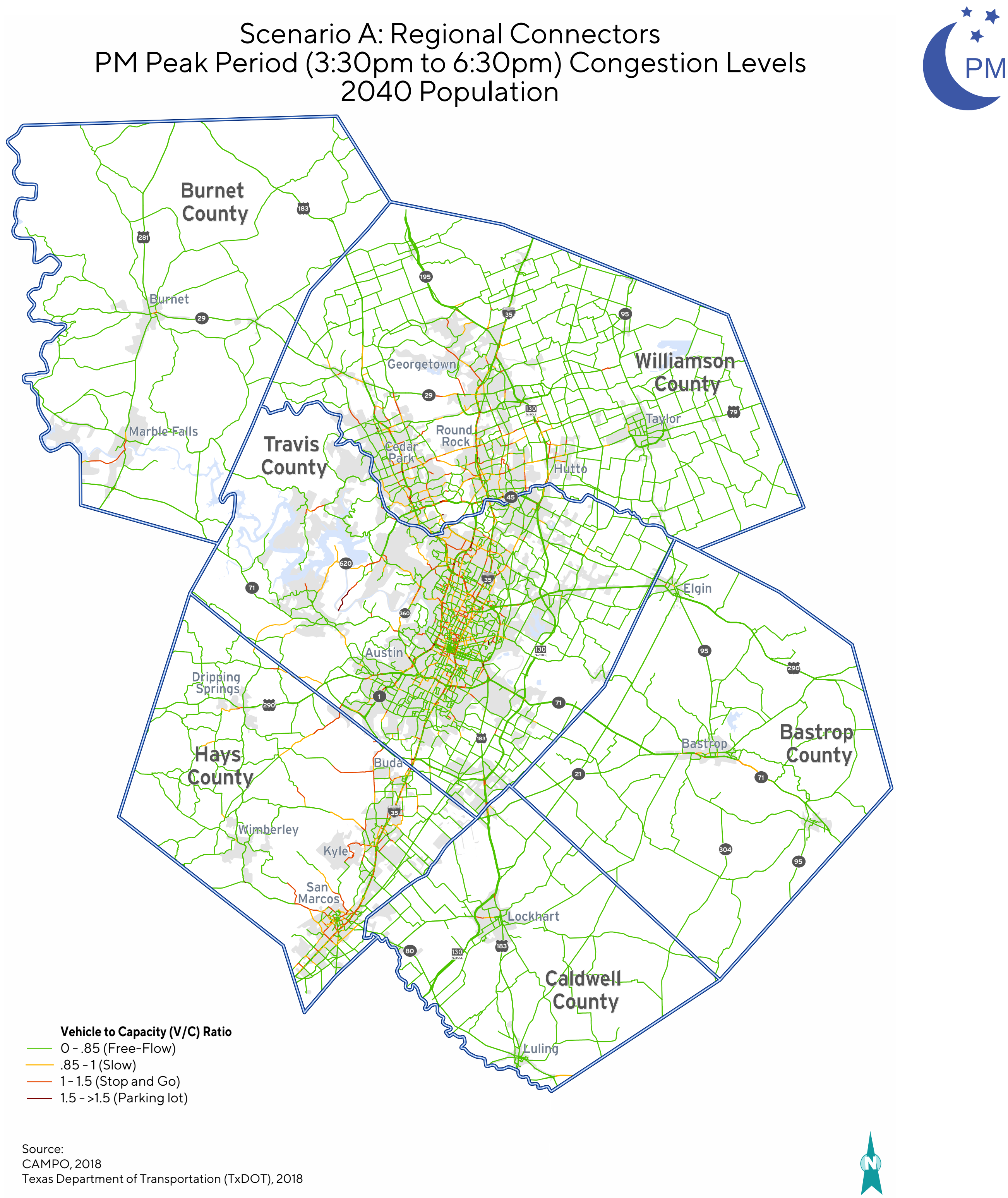
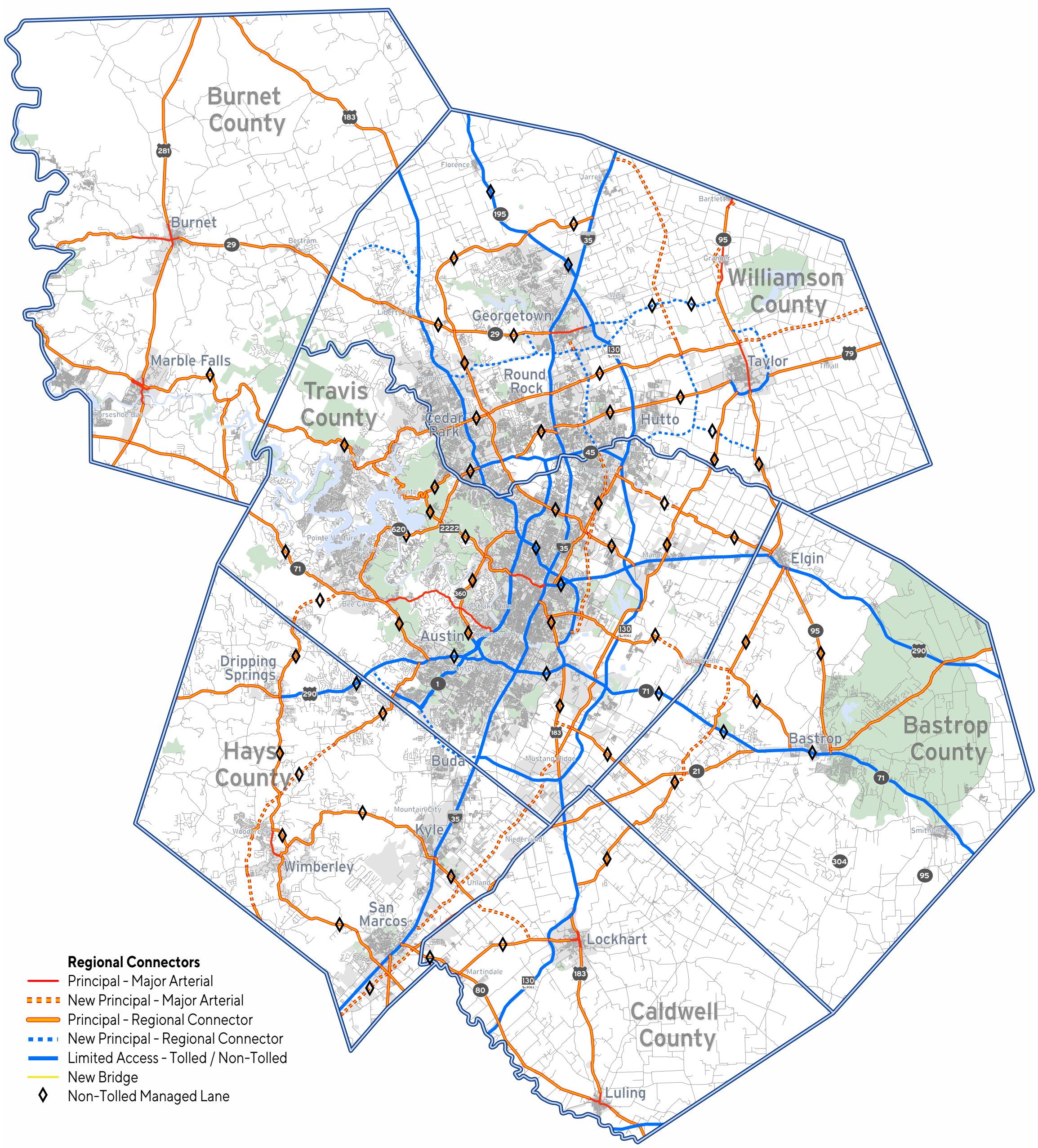

Scenario A: Regional Connectors
PM Peak Period (3:30pm to 6:30pm) Congestion Levels
2040 Population
PM
Burnet County
Burnet
Marble Falls
Williamson County
Georgetown
Round Rock
Cedar Park
Hutto
Taylor
Travis County
Austin
Elgin
Bastrop County
Bastrop
Hays County
Dripping Springs
Buda
Wimberley
Kyle
San Marcos
Caldwell County
Lockhart
Luling
Vehicle to Capacity (V/C) Ratio
0 - .85 (Free-Flow)
.85 - 1 (Slow)
1 - 1.5 (Stop and Go)
1.5 - >1.5 (Parking lot)
Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018
N

Figure 4.18

Capital Area Region
Scenario A: Regional Connectors



Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 4.19

Scenario B: HOV

Scenario B was developed to qualitatively illustrate how facilities could increase person throughput by utilizing lane management techniques. This scenario includes the addition of a flexible lane type for a select number of the top tier roadways identified in Scenario A. Flexible lanes can be special use lanes that are managed – often referred to as "diamond" lanes. Their uses could change throughout the day. These flexible lanes or diamond lanes could be used for transit, high-occupancy vehicles (HOV) and motorcycles, be limited to parking during off-peak times, be used to support reversible lanes, or be used as variable priced facilities. The flexible uses on arterials in the study would be assumed in the right lane in each direction or using shoulders. Shoulder use would require additional legislation at the state level.

Diamond lanes are thought to be an alternative that may increase mode shift; i.e. from single occupancy vehicles (SOV) to HOV or to transit. Shifting drivers from their single occupant vehicle to bus or other HOV vehicles can increase person throughput with less vehicles. Evidence of mode shift has been found in our region since the implementation of the MoPac Express Lanes. The MoPac express lanes enable drivers to travel up to 21 mph faster than those on the non-tolled lanes which equates to roughly 25 minutes of travel time savings on the route.[2] Transit is also able to take advantage of the free flow without paying the toll which has bolstered an increase in Express Bus ridership of 73% year-over-year on MoPac.[3] Although pricing is the management tool of these lanes, they do show that increasing the amount of person-trips is attainable with a more creative approach to roadway design, operation, and management.

Lane management can come in many forms depending upon the objective. HOV lanes or High Occupancy vehicle lanes, require a minimum number of occupants to be in a vehicle. This objective achieves to move as many people but with fewer vehicles. Managing the type of vehicle that is allowed to use the lane can be an objective. For example, not allowing large commercial vehicles or allowing transit only vehicles. Tolling is also a common lane management tool. By tolling a lane, the users help fund its construction, but tolling can also control the demand within the lane so that an acceptable speed is maintained. Flexible lanes may be a viable option for Scenario A project improvements. Analyzing the impacts of a HOV flex lane was accomplished by post processing model results from the Scenario A model run. The primary assumptions for the impacts of the HOV Scenario include:

- Vehicle occupancy rates for SOV, HOV, and transit bus,
- Travel demand by time of day,
- Vehicle capacity of a NML,
- Bus frequency,
- Bus Passenger Car Equivalent (PCE), and
- Mode shift from SOVs to HOV vehicles.

The scenario assumes that 50% of vehicles with two or more passangers would shift to the HOV lane. Along with the assumptions regarding bus frequency and capacity, it was assumed that these routes would be at 80% occupancy.

[2] https://bit.ly/2HAK4QE

[3] https://bit.ly/2XnXoTe

Similar to the Reversible Lane Option in *Scenario A 1/2*, a few selected roadways were chosen as a test case for evaluation. CAMPO worked with Capital Area Rural Transportation System (CARTS) and Capital Metro Transit Authority (CMTA) to develop transit assumptions for the year 2040. These assumptions were used to determine the potential change in person throughput. These assumptions can be found within the Appendix. Figure 4.20 provides the results for the HOV option. Under the HOV option, person throughput could be significantly increased on major regional arterials.

Facility	% Change in Vehicle Trips	% Change in Person Trips
RM 12	37%	83%
FM 1826	28%	63%
US 290 W	14%	35%
US 290 E	15%	37%
SH 71 E	18%	45%
SH 71 W	29%	65%
FM 734	17%	42%
RM 1431	21%	49%
US 183 N	7%	21%
US 183 S	17%	42%

Figure 4.20 Example of potential change in person throughput with the HOV option

Figure 4.21 provides an illustration of a selection of the potential HOV routes that were analyzed under Scenario B: HOV. If fully built out, this network of HOV lanes (combined with similar facilites currently found in the region) could total over 1,300 lanes miles. This network would be more extensive that what is projected for the Houston-Galveston MPO region (about 850 in 2035) or the San Jose region (nearly 600 by 2045).

Capital Area Region
Scenario B: HOV Lanes (not modeled)*

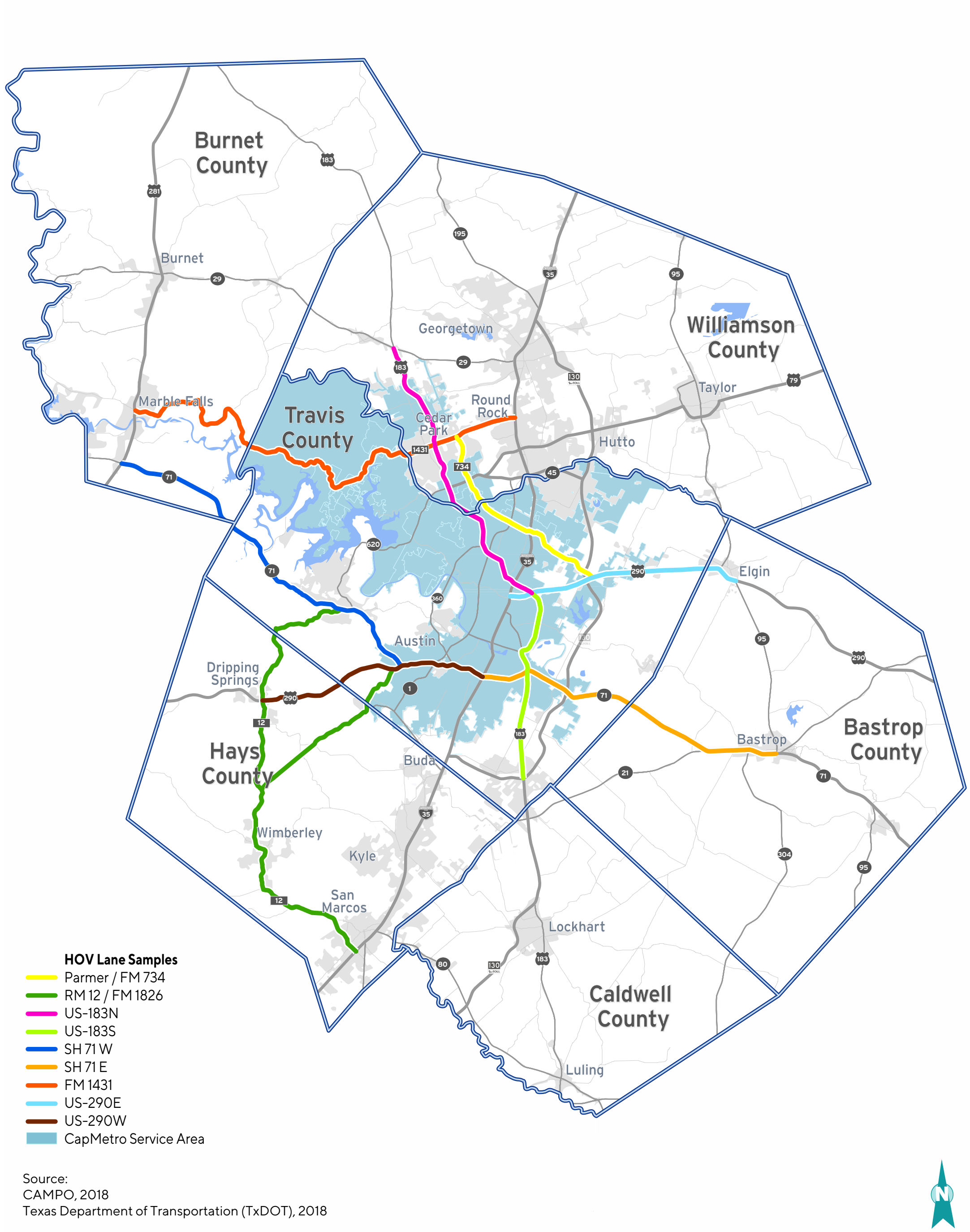


Figure 4.21

*Map shows a sample of HOV Lanes

The figure below provides an illustration of where current transit routes exist within the corridors under Scenario B: HOV.

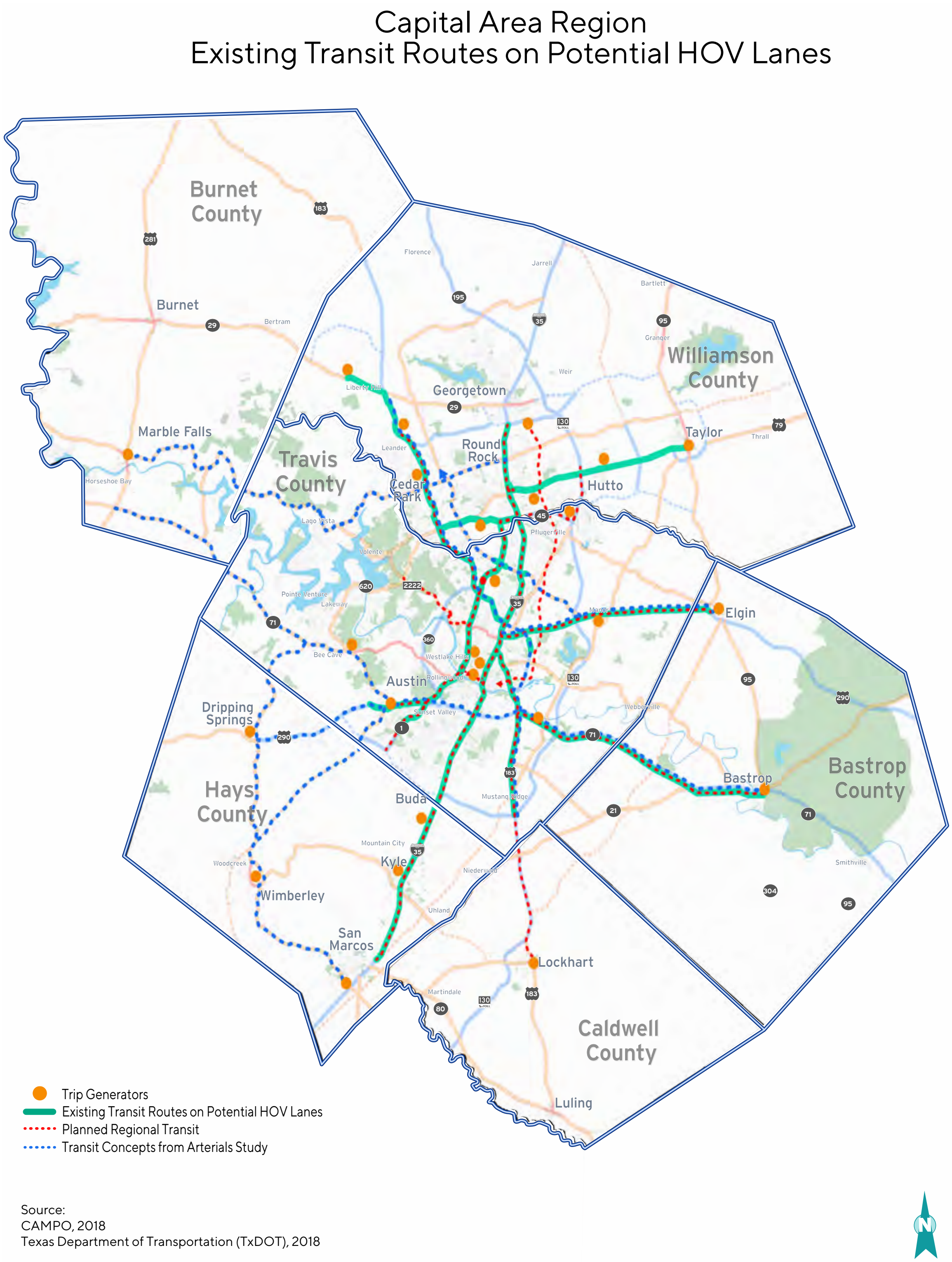


Figure 4.22

Figure 4.23 provides an illustration of where current and planned transit routes exist within the corridors under Scenario B: HOV. In addition, trip generators, jobs and population clusters are also shown. Opportunities exist to help make this Scenario a viable one.

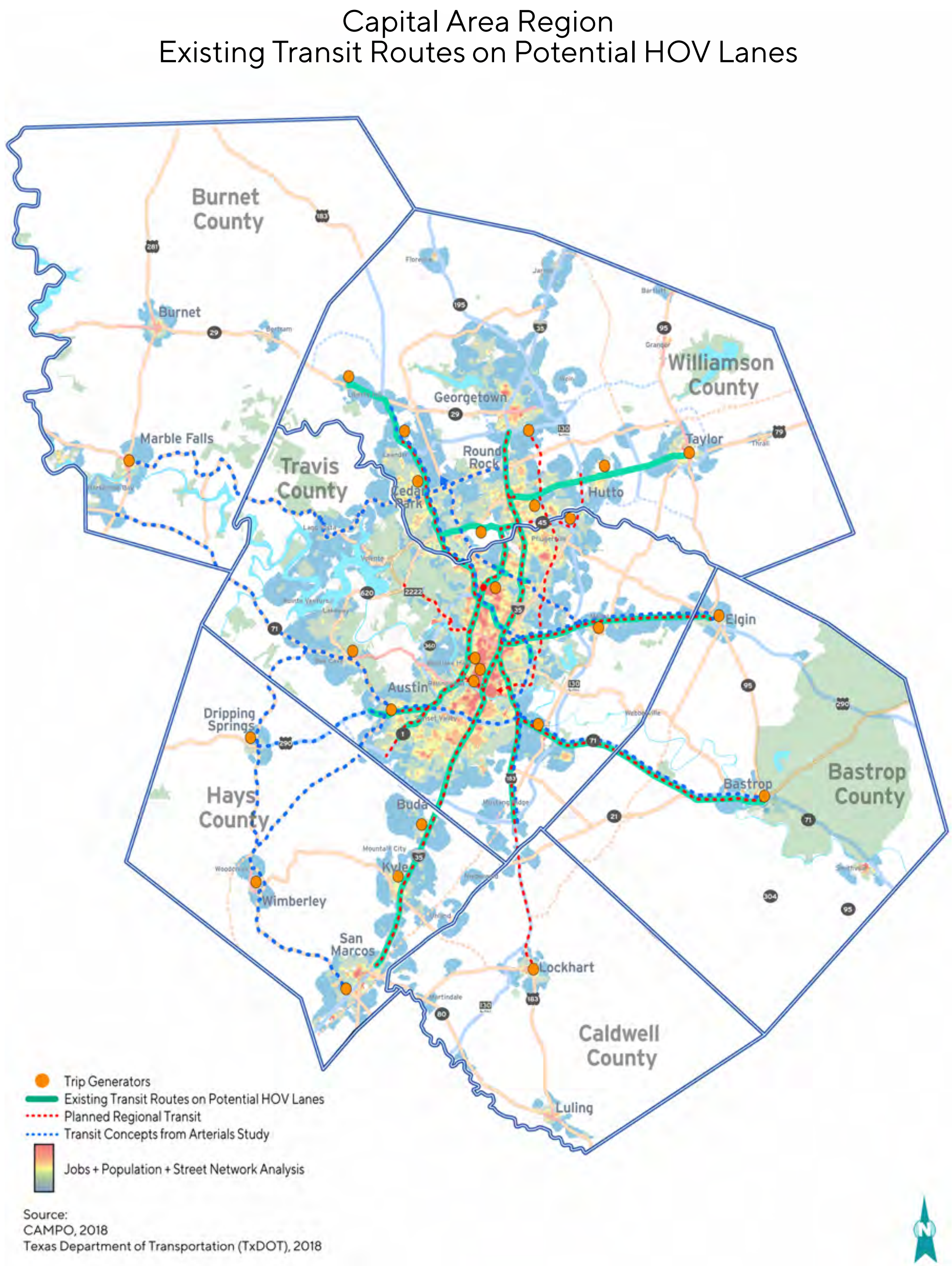


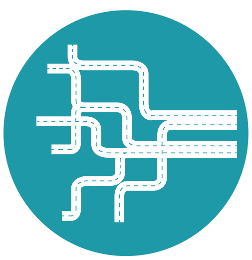
Figure 4.23

Scenario C: Combined Concept

This scenario combines the transportation plans from individual jurisdictions within the Capital Area MPO region. *Scenario C* builds upon the arterial network developed in *Scenario A* with more emphasis placed on increasing the number and connectivity of minor arterials throughout the region. This increase in minor arterials provides support to the region's high capacity arterials and will help distribute trips more efficiently throughout the roadway network. This scenario provides redundancy to critical arterials in the event of an evacuation, hazardous spills, or major crashes which shut down portions of an arterial for an extended time. The network includes planned projects from the region's municipalities' and counties' transportation plans. It also includes improvements identified by CAMPO that would improve connectivity in areas where roadway gaps were found to exist due to jurisdictional boundaries – gaps in planning jurisdictions.

Scenario C also improved the performance of the network as compared to *Scenario Z*. Regional VMT is reduced due to more direct routes associated with a more connected network of roadways. Short trips that might otherwise be relegated to limited access roads or principal arterials would then be shifted to minor arterials. This enables the network to work more efficiently by distributing different trip types to more appropriate functional classes. While this scenario does elicit a reduction in VMT and VHT, it does also include a significant increase in lane miles (37%). Consequently, this increase in lane miles is another factor contributing to the reductions in VMT and VHT by enabling more direct, shorter trips. The 37% increase in lane miles correlates to a 3% reduction in VMT and a 20% reduction in VHT.

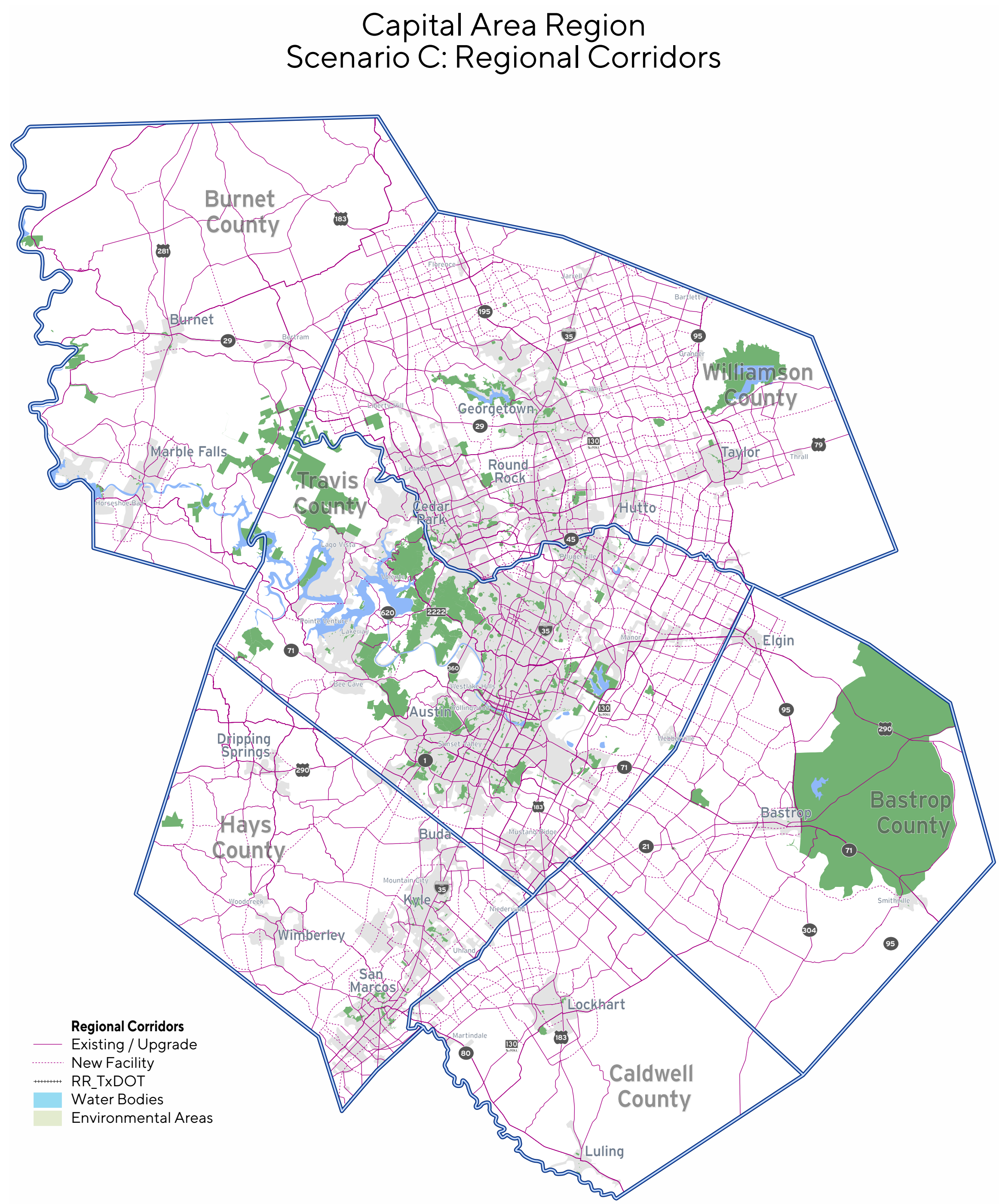
Scenario C: Combined Concept performance measures



Network Lane Mileage 23,299

VMT 97.5 Million

VHT 2.3 Million



Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 4.24

Capital Area Region
Scenario C: Combined Concept

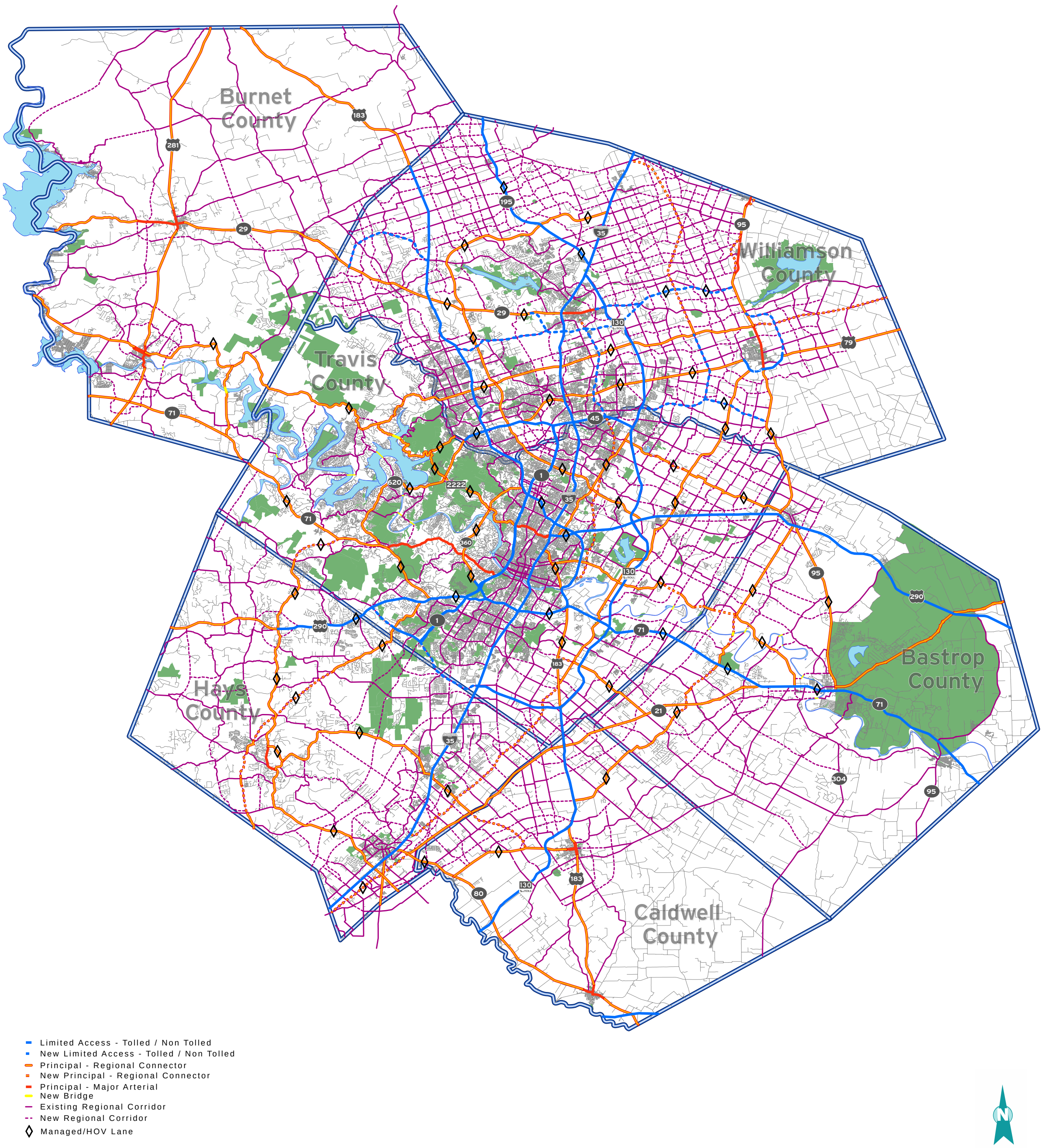


Figure 4.25

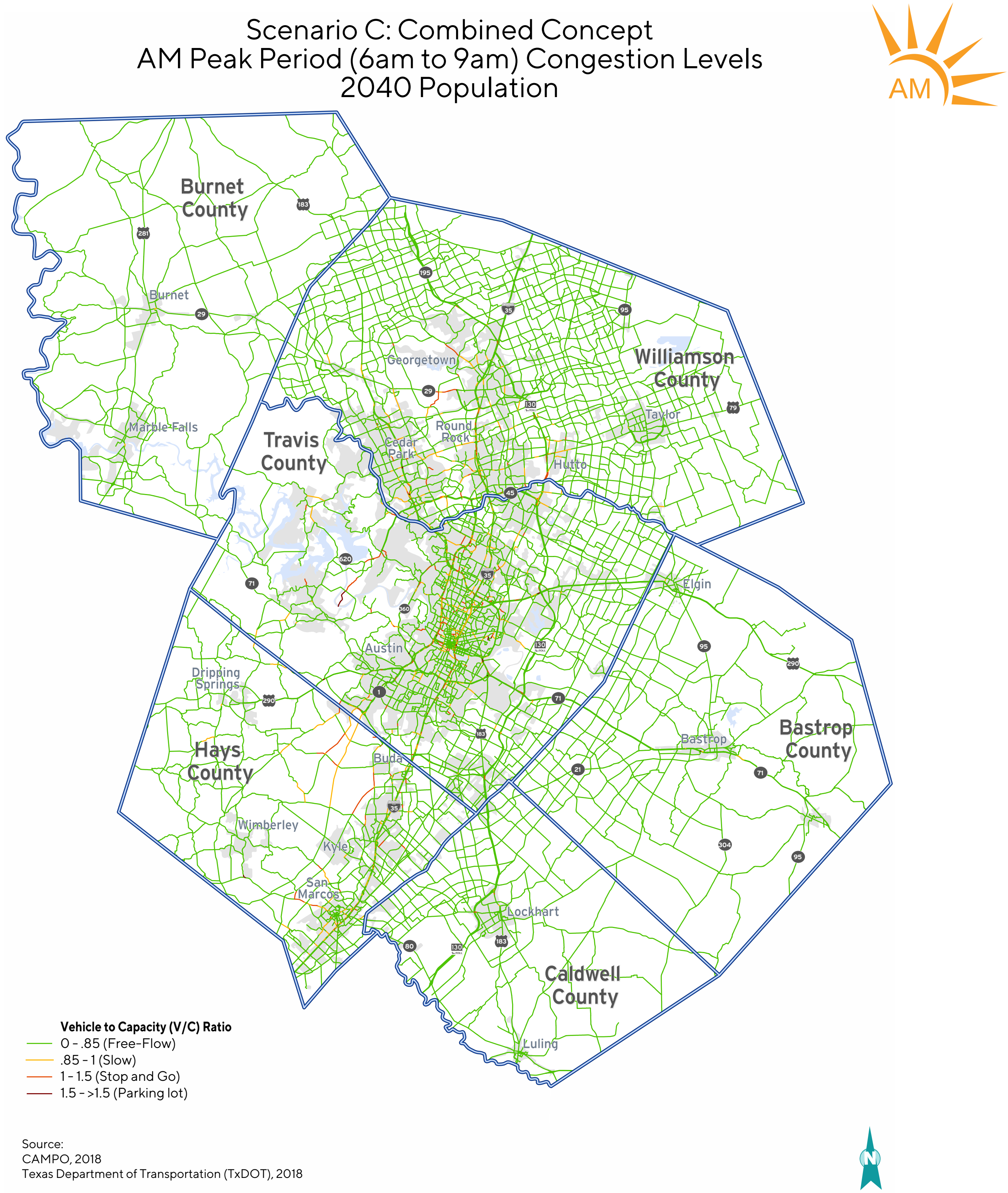

Scenario C: Combined Concept
AM Peak Period (6am to 9am) Congestion Levels
2040 Population
AM
Burnet County
Williamson County
Travis County
Hays County
Bastrop County
Caldwell County
Burnet
Marble Falls
Georgetown
Round Rock
Cedar Park
Taylor
Hutto
Elgin
Austin
Dripping Springs
Buda
Bastrop
Wimberley
Kyle
San Marcos
Lockhart
Luling
Vehicle to Capacity (V/C) Ratio
0 - .85 (Free-Flow)
.85 - 1 (Slow)
1 - 1.5 (Stop and Go)
1.5 - >1.5 (Parking lot)
Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018
N

Figure 4.26

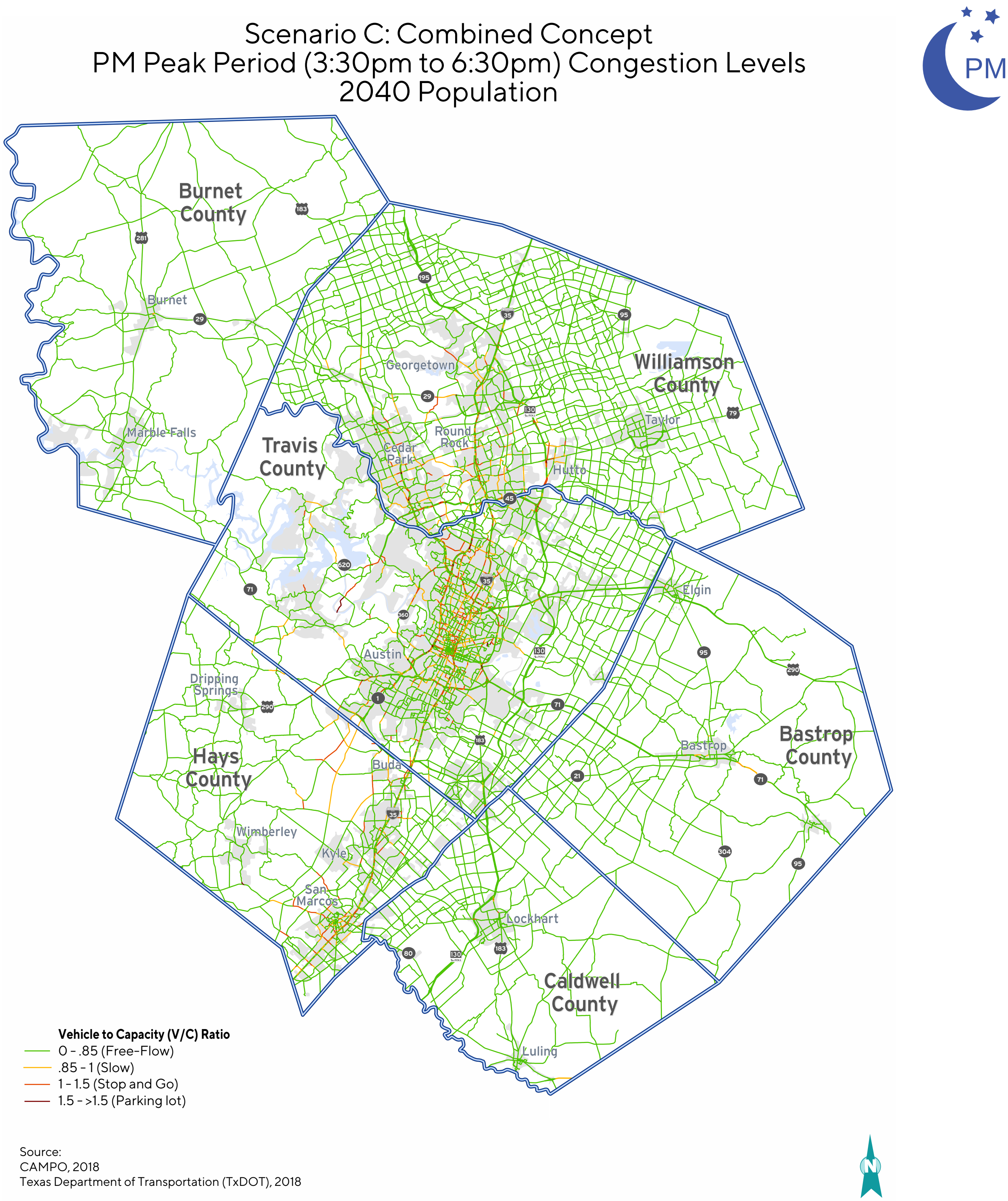

PM
Scenario C: Combined Concept
PM Peak Period (3:30pm to 6:30pm) Congestion Levels
2040 Population
Burnet County
Burnet
Marble Falls
Williamson County
Georgetown
Round Rock
Cedar Park
Hutto
Taylor
Travis County
Austin
Elgin
Bastrop County
Bastrop
Hays County
Dripping Springs
Buda
Wimberley
Kyle
San Marcos
Caldwell County
Lockhart
Luling
Vehicle to Capacity (V/C) Ratio
0 - .85 (Free-Flow)
.85 - 1 (Slow)
1 - 1.5 (Stop and Go)
1.5 - >1.5 (Parking lot)
Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

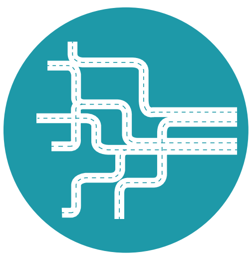
Figure 4.27

Scenario D: Regional and Supporting Connections

The objective of *Scenario D* is to identify supporting minor arterial improvements from *Scenario C* that provide the greatest contribution to the top tier roadways identified in *Scenario A*. Selection criteria included safety, redundancy, V/C ratios, and input from the public. This scenario establishes the optimal blend of regional connectors from *Scenario A* and key supporting minor arterial connections from *Scenario C*.

The results for *Scenario D* show that roadway performance gained by *Scenario A* can be further increased with this expanded network as well. With this network which increases the lane miles by only 26% over *Scenario Z*, we see that VMT is reduced by 3% and VHT is reduced by 22%. Moreover, when comparing *Scenario D* with *Scenario A*, we see a 1.5% reduction in VMT and a 10% reduction in VHT with a 8% increase in lane miles. These results show that with strategic improvements we have the potential to improve safety, connectivity, and congestion while also reducing the miles and amount of time driven.

Scenario D: Regional and Supporting Connections performance measures



Network Lane Mileage 21,413

VMT 97.8 Million

VHT 2.4 Million

Capital Area Region
Scenario D: Regional and Supporting Connections

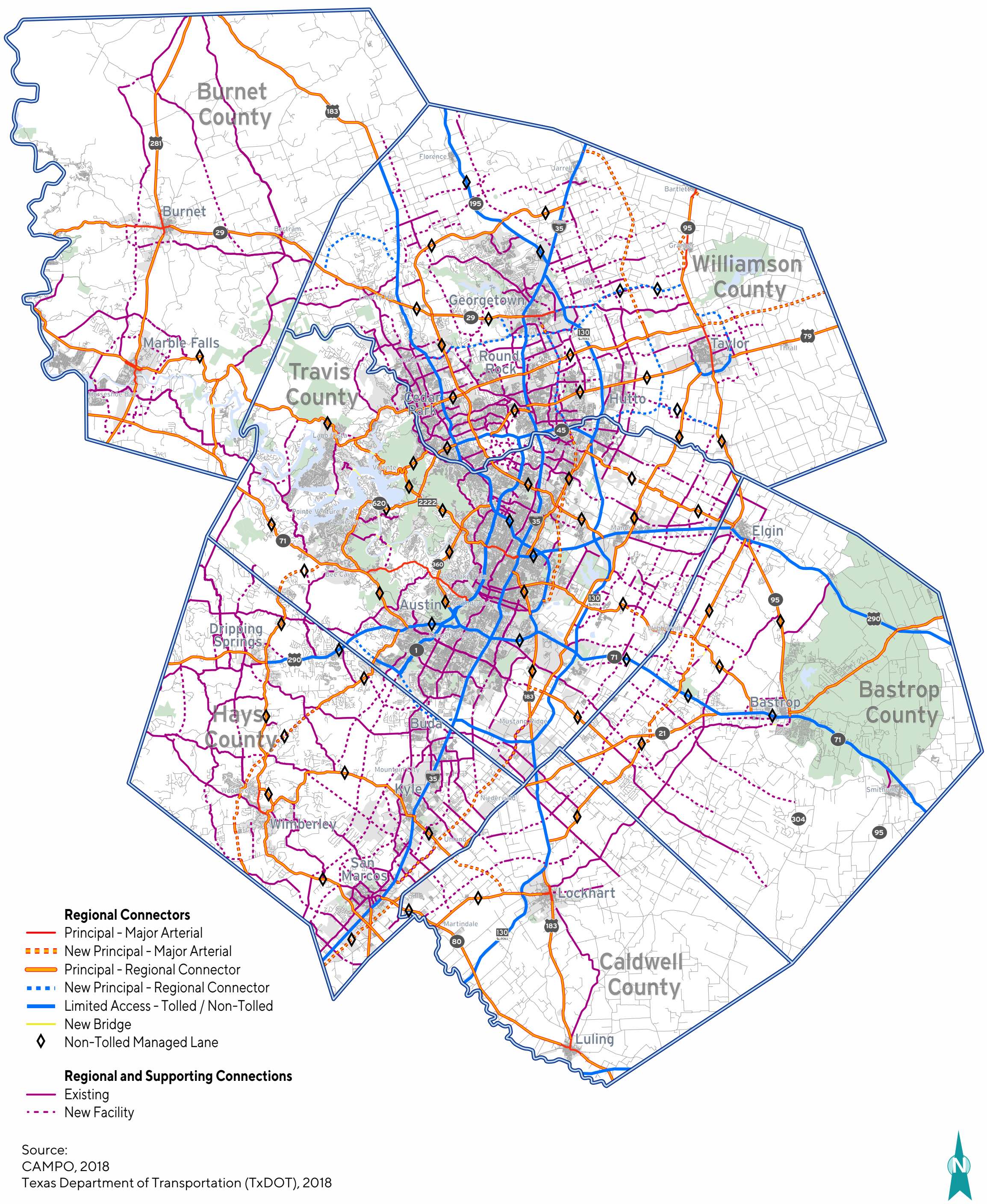
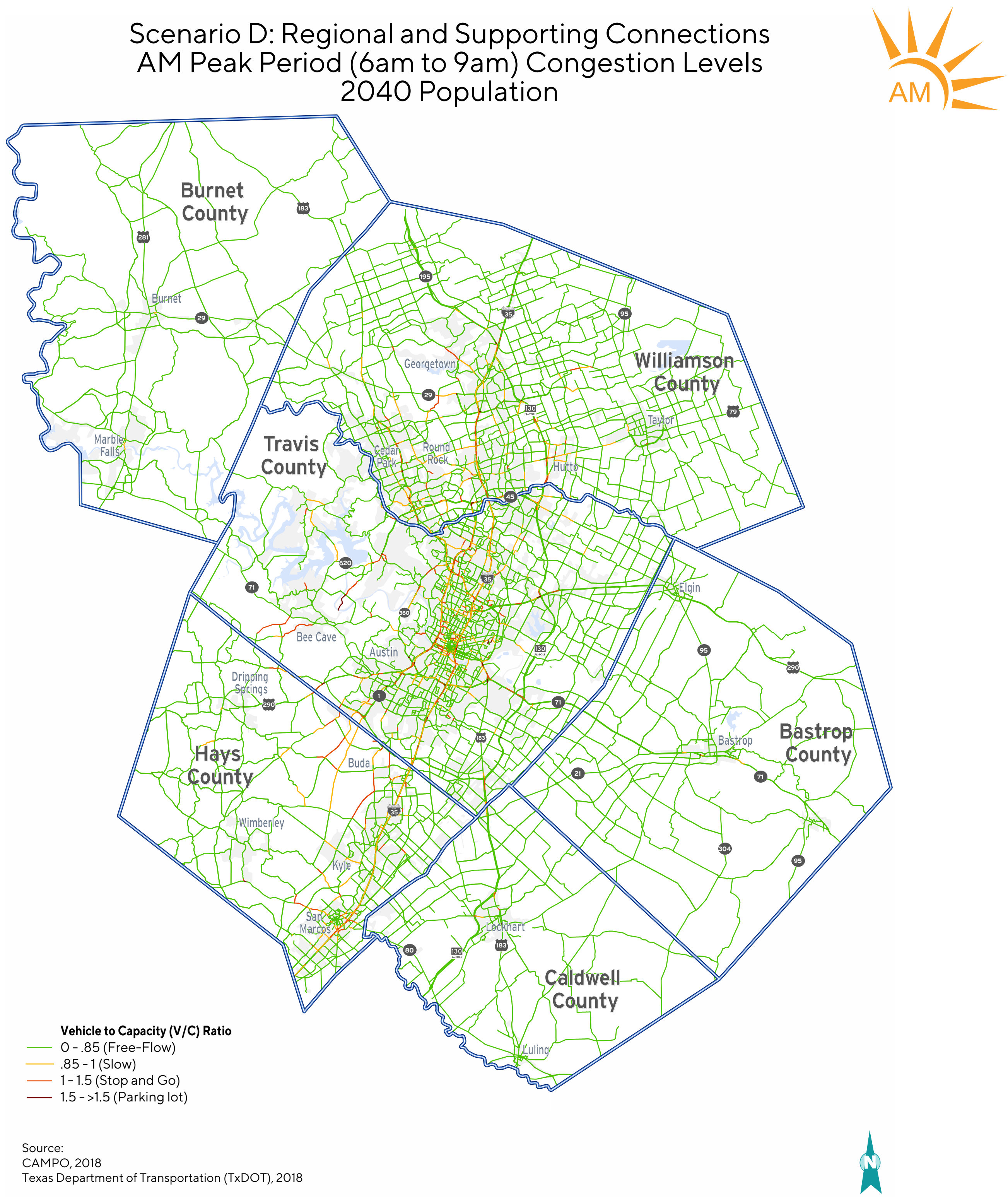


Figure 4.28

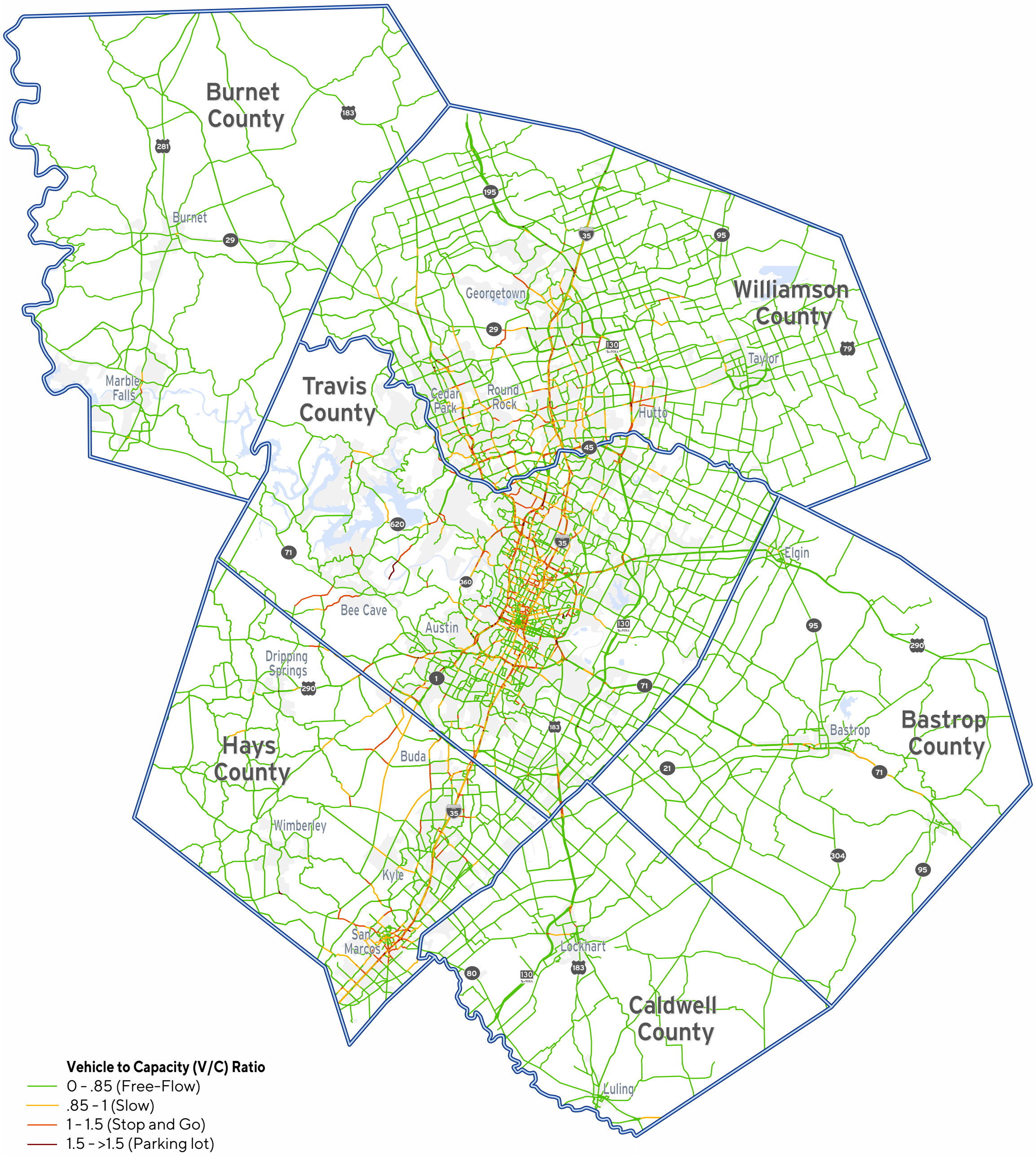


Scenario D: Regional and Supporting Connections
AM Peak Period (6am to 9am) Congestion Levels
2040 Population
AM
Burnet County
Williamson County
Travis County
Hays County
Bastrop County
Caldwell County
Burnet
Marble Falls
Georgetown
Taylor
Cedar Park
Round Rock
Hutto
Elgin
Bee Cave
Austin
Dripping Springs
Buda
Bastrop
Wimberley
Kyle
San Marcos
Lockhart
Luling
Vehicle to Capacity (V/C) Ratio
0 - .85 (Free-Flow)
.85 - 1 (Slow)
1 - 1.5 (Stop and Go)
1.5 - >1.5 (Parking lot)
Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018
N

Figure 4.29

PM

Scenario D: Regional and Supporting Connections
PM Peak Period (3:30pm to 6:30pm) Congestion Levels
2040 Population



Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Figure 4.30

Scenario Comparison

The overall results of the scenario planning illustrate how the improvements assumed in each Scenario benefit the transportation network as a whole. It is clear that network performance will worsen as the Capital Area region grows; however, the results show that strategic improvements can have substantial improvements to the regional network. The modeled scenarios with system improvements (*Scenarios A, C,* and *D*) each include positive changes associated with them. Figure 4.31, Figure 4.32 , and Figure 4.33 offer a comparison of each.

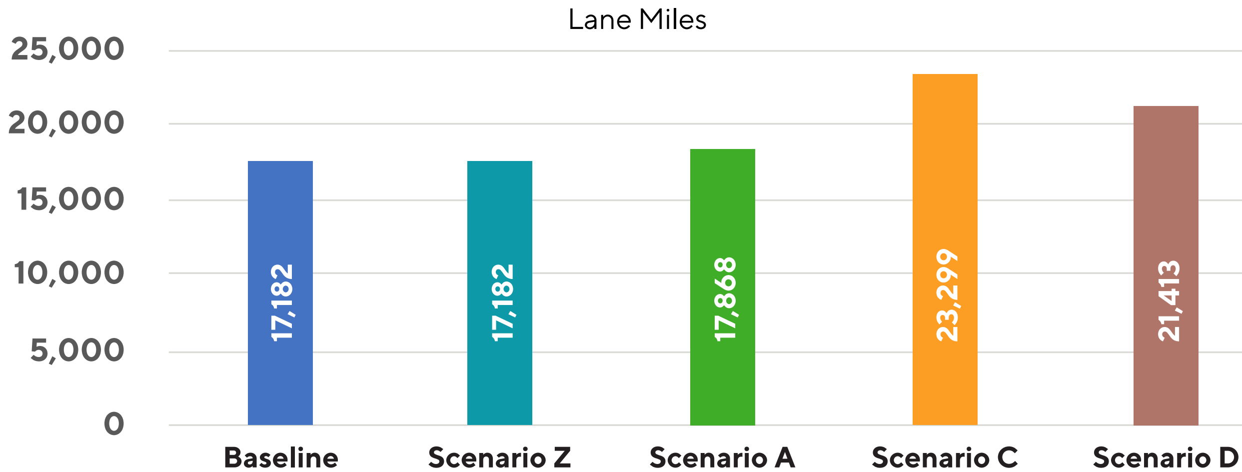


Figure 4.31

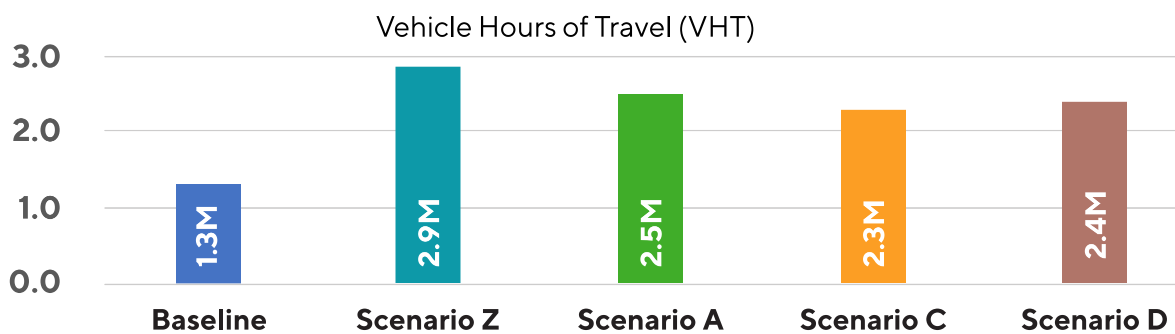


Figure 4.32

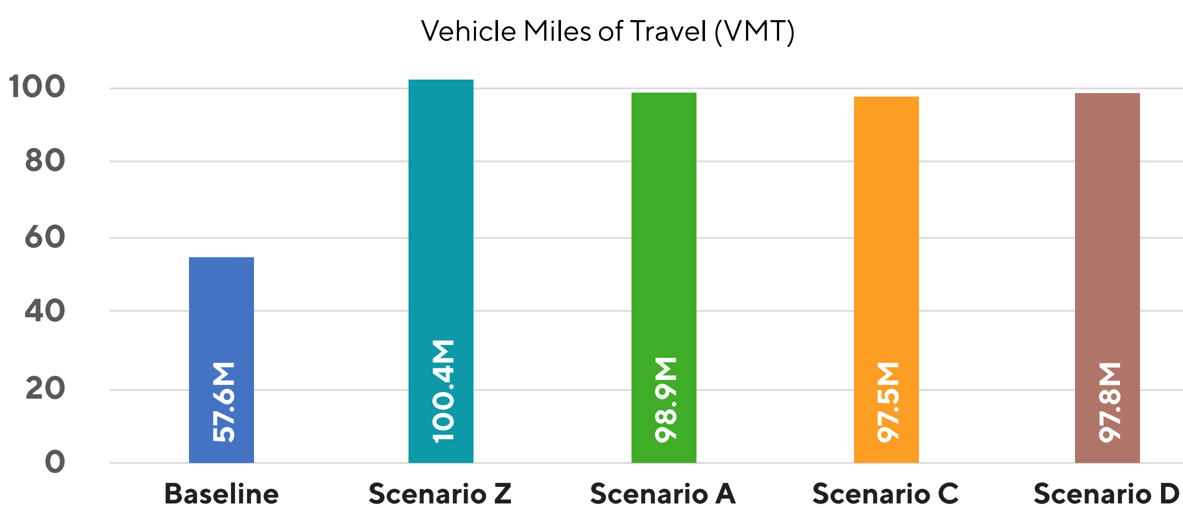


Figure 4.33

	Baseline Scenario: Existing on 2020	**Scenario Z**: Future No Build	**Scenario A**: Regional Connectors	**Scenario C**: Combined Concept	**Scenario D**: Regional and Supporting Connections
Network Lane Mileage	17,182	17,182	17,868	23,299	21,413
VMT	57.6M	100.4M	98.9M	97.5M	97.8M
VHT	1.3M	2.9M	2.5M	2.3M	2.4M
V/C	0.21	0.37	0.28	0.25	0.27
Network MPH	45.5	34.3	39.7	42.1	41.5

Figure 4.34 Scenario comparisons

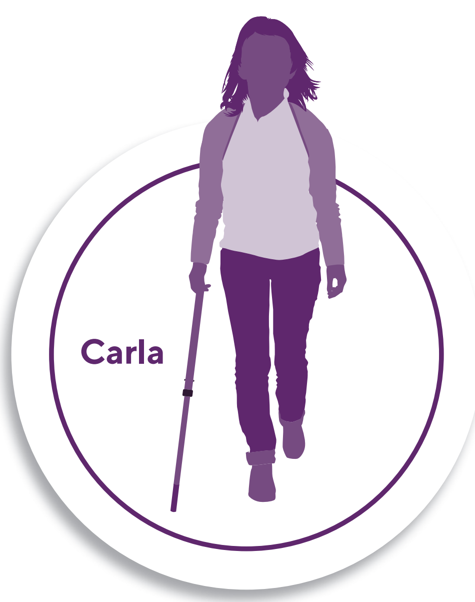
Impacts to Network Users

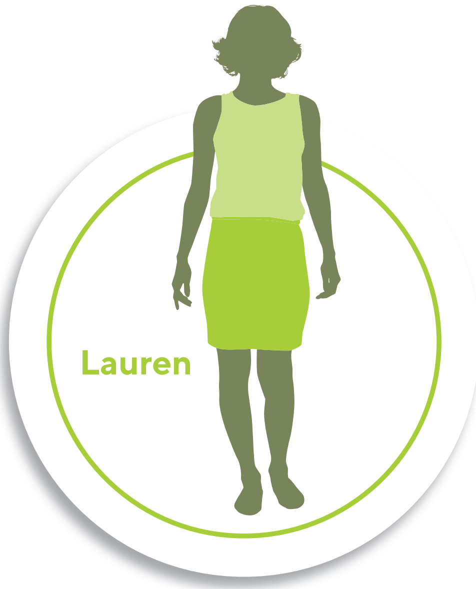
The CAMPO planning processes aim to address the needs of millions of individuals living across six-counties. Just like the local jurisdictions within the Capital Area region vary greatly in terms of urbanization and development, the needs of its residents vary greatly based on factors such as income level, age, abilities, access to various modes of transportation, and daily commuting patterns. With such a diverse region, there is no singular solution that will meet the needs of every resident and traveler. Each scenario developed as part of this study has benefits and challenges that would affect individuals differently.

The user profiles discussed in the Existing Conditions section of this report illustrated examples of different needs of residents throughout the Capital Area region. Below is a description of how various planning scenarios included in this study might impact each network user if implemented.

Craig
Under Scenario C, Craig would have several new options to travel to his destinations in Lockhart, as well as improved access to major arterials and controlled access facilities that support long-distance trips. These options would be especially helpful when traffic is heavy during peak periods or when his normal route is flooded. Instead of rushing back home to avoid traffic or weather delays, Craig could take his time running errands and at appointments. With more convenient travel options, Craig could also spend more time with his mother in Victoria and take more recreational trips to surrounding areas in Central Texas.

Carla
Scenario C would provide several alternatives to the roadways used by Carla's bus service, as well as additional options for Carla's trip from the bus stop to her job. Several new connections could be added in the area surrounding her school and job, allowing her to walk along facilities with less traffic. Having safer and more convenient traveling options would give Carla the flexibility to choose when and how she wants to travel, expanding her independence and providing better access to recreational, educational, and professional opportunities.





Lauren

Lauren's commute is greatly impacted by Scenario B, which would provide HOV options for her carpool and bus routes to bypass personal vehicle traffic that slows down her commute during peak periods. By choosing routes that take advantage of these lanes, she could save a significant amount of time spent commuting each day – that means more time in the mornings and evenings to take care of personal errands or to relax outside of her fast-paced career.

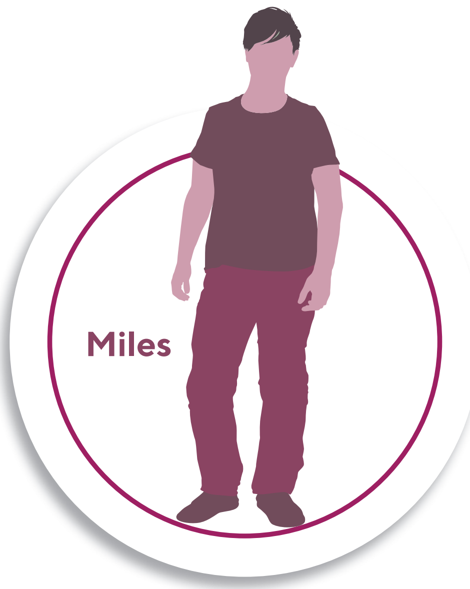
Eric

Once Eric drops off his children in the morning, he prefers to travel to work on higher speed regional arterials, like those included in Scenario D. Aside from having multiple options to reach his office, Eric would benefit from the additional connections to cross the Colorado River. Access to more reliable river crossings would help Eric avoid long detours around backups on the existing bridges, which is especially important when he needs to rush home to take care of sick kids or a household emergency.

Thomas

Scenario C would provide Thomas with direct connections between several of his office locations, which would reduce a significant amount of time spent making midday trips. Not only would he be able to take shorter routes to many of his destinations, but Thomas could also avoid roadways that feel unsafe or where safety and mobility features, such as passing lanes, are lacking. By gaining back some of the time spent traveling between offices, Eric would be able to spend more time at each office location and improve operations for his business.

Miles
With additional regional connections included in Scenario D, Miles' delivery company would have more support for the higher speed, long-distance trips that make up the bulk of their business. By reducing travel times between pick-up and drop-off locations, Miles' employees could take on more jobs each day to increase the profitability of the business and commissions taken home by each driver. Shorter drive times would also give Miles and his employees more flexibility during delivery windows, reducing pressure to park illegally to speed up operations and eliminating some frustration for delivery drivers and their fellow motorists.



Billie
Since Billie's commute is relatively short, she prefers traveling on minor arterials to avoid the stress and added expense of carpooling on congested roadways. With the additional local connections included in Scenario C, Billie and her carpool partners would have several options to avoid roadways with heavy traffic during their commute. Not only would this reduce the amount of time Billie spends commuting each day, but it would allow her to budget less money for travel costs each month and spend more on recreation.

Sarah is a fifth grader in Round Rock whose school is a few streets away from her house. She would like to walk or bike to school, but her parents are concerned about safety due to her school being sited on a major roadway with relatively high speeds. Therefore, her parents drive her to and from school each day.

Rosa

Scenario C would provide additional alternatives to access the arterial network that takes Rosa and her family from her house to downtown San Marcos. While some of these new routes could have slower speeds than the major arterials serving more urban parts of the county, having more options to access the regional roadway network would reduce how much Rosa relies on a single rural connection that exists today. In addition to making day-to-day travel simpler for Rosa and her caregivers, knowing that emergency service providers have reliable access to her home would greatly increase peace of mind for Rosa and her family.

Alex and Leah

The additional regional connections included in Scenario D would give Alex and Leah alternatives to avoid using limited access routes while still getting around the bottlenecks and mobility issues on the existing transportation network. These new connections would provide several reliable alternatives for Alex and Leah to get their daughter's day care center and their respective workplaces, regardless of whether they are using a personal vehicle or alternate modes of transportation. In addition to the benefits of alternate routes, interim improvements like adding HOV lanes on key routes would help make commuting easier and faster for each of them when it is their turn to carpool or take transit to work. Reduced commute times would eliminate the stress of being late to pick up their daughter and give them more time to spend together as a family.

Conclusion

As our region continues growing over the next 25 years, transportation system efficiency is integral to a sustainable future. Results from the Baseline Scenario and Scenario Z indicate that by 2040, vehicle hours of travel within the Capital Area region will increase by 123% if no improvements are made to our existing roadway network. That increase in vehicle hours of travel for the region equates to a 130% increase in the amount of time a household spends traveling each day – from 48 minutes a day today to 1 hour and 50 minutes a day by 2040. As discussed at the start of this document, the Capital Area MPO Platinum Planning Program lays a pathway to a sustainable future by envisioning a region where multiple transportation options are viable and accessible. A comprehensive arterial network provides the foundation to achieve this vision as the region grows.

This vision cannot be achieved in a vacuum. Often transportation plans of local jurisdictions are developed and implemented independently of adjacent jurisdictions. Since roadways do not end at geopolitical boundaries, transportation planning as if they do can create connectivity “gaps.” When this happens, regional connections to locations outside a jurisdiction may get overlooked and, thereby, have impacts on local transportation users. In this way providing for regional solutions can benefit local transportation needs. Utilizing the Pattern Book along with the Arterials Concept List, local planners can plan and develop a transportation network with greater regional coordination. This can allow for a better connected network that promotes local development and desires, while supporting regional transportation needs.

REGIONAL ARTERIALS STUDY

CHAPTER 5

RECOMMENDATIONS

CAMPO

CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

Recommendations

In developing the Regional Arterials Study the focus has been to provide a blueprint to a transportation network that provides greater mobility that is safe, reliable and efficient. The purpose of the study is to:

- Create a hierarchy of roads that address different travel needs in the region
- Establish a well-connected system of roads throughout the region that provides flexibility and greater mobility choices
- Establish a program for road spacing and provide a menu of appropriate street cross sections to support a hierarchy of roads
- Identify policy tools that empower local entities within the region to work to achieve regional connectivity goals.

This Chapter summarizes the preliminary analysis and findings of the study and proposes recommendations to implement a regional arterial network. It has been determined that the region's arterial network lacked connectivity and was not well proportioned to effectively serve the needs of the community. The previous chapter included a concept plan and identified scenarios for redefining the existing, planned, desired and gap arterial network. As stated previously, the region is continuing to grow and each of the six counties will experience a boom in population in the next 25 years, particularly in Travis, Williamson, and Hays Counties. Scenarios A - D provide improvements that more effectively establish an integrated regional arterial network and address the gaps and identified needs of the roadway network. Scenario D identifies the network improvements as Scenarios A and C, but slightly amplifies the minor arterial improvements that reduce Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT), but with a smaller increase in new lane miles than identified in Scenario D.

This chapter highlights key considerations in recommending and implementing a multi-hierarchical arterial network based on a series of design elements.

Arterial Hierarchy

CAMPO developed area specific arterial hierarchy based on the functional classifications defined by the Federal Highway Administration (FHWA). Recognizing the unique nature of the six county region, the roadway classifications were modified to reflect the connectivity and mobility options. These classifications include:

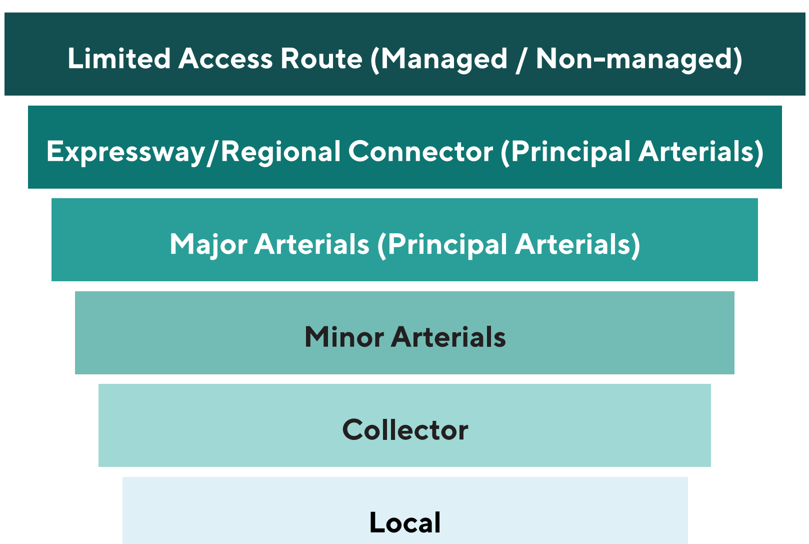


Figure 5.1Early Phase Example of Backage and Interparcel Connectivity

Implementing this arterial hierarchy is critical in developing the regional arterial study as every road plays a role in connectivity. The various arterial classifications work together to most effectively move people and goods in, around and through the Region. An integrated arterial hierarchy enhances mobility and effectively creates greater capacity.

Local roads primarily serve a localized area and are used for shorter trips (less than a mile) within a community. Local roads are often the roads used for the first mile and last mile of a trip and are designed to minimize through traffic. Spacing of the local roadways provides capacity and flexibility within the community. The local roads form the foundation of the arterial hierarchy. These roads support local development and provide connectivity to other arterials for longer trip making purposes. As communities continue to develop, the spacing of the local roadways should be designed to provide easy access, connectivity and efficient short trip travel.

Collector roads, are low to moderate in capacity and designed for shorter trips. These roads collect traffic from local roads to the arterial network. In communities, such as Sun City and Blackhawk, the connector roads funnel the traffic from lower speed local roads to the higher speed, greater capacity arterials. To more effectively connect communities to regional destinations, connector roads can provide improved access and greater connectivity and not require excessive travel through the neighborhood.

Minor arterials are still local in nature, but are critical to enhancing mobility within a region; supporting longer trips within the community, connecting to major arterials and more efficiently distributing traffic volumes.

Regional Connectors / Expressways and Major arterials are the critical roadways connecting major activity centers and designed for longer trips. These roads are not limited in access, but do operate at higher speeds and provide access to major developments that are more regional.

Limited access roadways are designed to serve inter/intraregional trips that are longer distances and provide connectivity to major activity nodes across the region. These roadways operate at higher speeds and have greater capacity. These arterials could be considered for multimodal uses, such as transit lanes, express truck lanes, and future autonomous or connected vehicles.

An effective arterial hierarchy is more than a network of varying capacity roadways, but also an integrated transportation system that is sensitive to the local environments, zoning requirements, multiple government and agency standards, traveling characteristics of the region (both urban and rural: traveling characteristics include one's trip lengths, trip purpose, trip mode, and time of travel), multimodal operations, future demand, and maximization of capacity working with defined resources. While efficient travel and enhanced mobility are the goal of the arterial plan, a careful balance must be drawn between competing demands.

Implementation Considerations

In order to effectively implement the findings of the study, there are a number of considerations that must be addressed and incorporated in future planning efforts. The following is a brief summary of the implementation recommendations.

A. An integrated thoroughfare plan can minimize gaps in connectivity amongst communities. In developing the Regional Arterial Study, it is important to understand the individual plans of each community and/or jurisdiction. Many cities and counties have approved major thoroughfare networks. All of these plans have been reviewed and this study presents a Combined Concept developed primarily from new and improved corridors found in local plans. Gaps, inconsistencies, and conflicting policies have been identified and analyzed. Implementation requires a consensus in the process for funding and programming the improvements based on the arterial hierarchy.

Figure 5.2 Thoroughfare Plans from the Capital Area region

B. Increase efficiency of facilities through operational changes across the region. To maximize existing capacity and improve travel time reliability, consideration should be given to the flexible use of shoulders on arterial roads, reversible lanes, time of day allowances, designated freight lanes, and other alternative roadway applications. These operational considerations cross jurisdictional lines and are policy driven. The next step is to determine where operational changes would be most effective and the process for implementation, beginning with establishing the appropriate policies or legislation to advance these changes.

C. Support operational changes through planning, education, and enforcement. In conjunction with establishing appropriate policies, operations and enforcement planning is required to ensure the arterials operate as designed, safely and efficiently. Time of day operations, road use limitations and access/egress process must all be clearly communicated and displayed and enforcement penalties defined. There are many tools, such as traffic cameras and law enforcement patrols, and it's important that each facility leverage the most appropriate solution given its regional context. An aggressive public information campaign must also accompany the planned changes.

D. Promoting transportation improvements through public/private partnerships. Addressing future Right of Way (ROW) needs and the best way to maximize available rights of way is inherent in the regional arterial study. In outlining the defined arterial hierarchy, the ROW needs and opportunities for expansion are critical. The ultimate buildout of the network should identify the right of way requirements. This is a public/private endeavor with land owners and developers' working with jurisdictions to plan for future expansion and connectivity needs. Area developers participation is essential to furthering the concepts presented in the Regional Arterials Study, and the developers can play an active role in implementation by building or improving roadways to plan standard that are adjacent to their development. Another option is for the developer to donate ROW for needed improvements or share the costs of constructing improvements. In many communities, developers play an active role in promoting transportation improvements that enhance their developments and contribute financially to implementing these improvements.

E. Included in the consideration of right of way needs should also be an analysis of expansion of the roadway, whether expansion should occur from the inside or the outside. The right of way limitations may dictate the opportunity for roadway expansion from one side or another. Also, there may be standards or policies that impact roadway expansion.

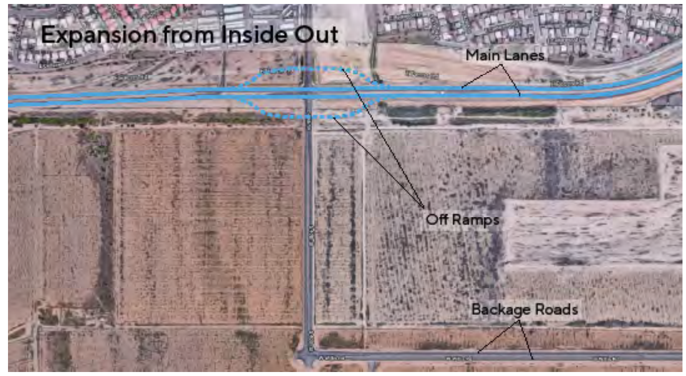


Figure 5.3 Expansions from the inside out and outside in

F. Managed lanes can improve throughput. Use of managed lanes are an option to provide arterial capacity and flexibility. Managed lanes are special use lanes and have limited applications. These lanes can be used for transit, high occupancy vehicles (HOV), and motorcycles and can be restricted by time of day and operation. The plan should accommodate flexible uses on arterials, which as stated above will also require policy and possible legislative action. Managed lanes are frequently a tool to promote high occupancy vehicle and transit travel. The preferential treatment of managed lanes, such as diamond lanes, provide an alternative from single occupancy vehicles (SOV) to transit or HOV resulting in travel time savings for the commuter. Managed Lanes increase mode shift to HOV and can increase person throughput on the arterials with less vehicles. Managed Lanes provide an opportunity to reduce vehicle miles traveled and maximize capacity. In Chapter 3, Concept Plan, managed lanes are discussed and the impacts of implementation of managed lanes are identified.

Figure 5.4 Illustration of roadway with HOV lane

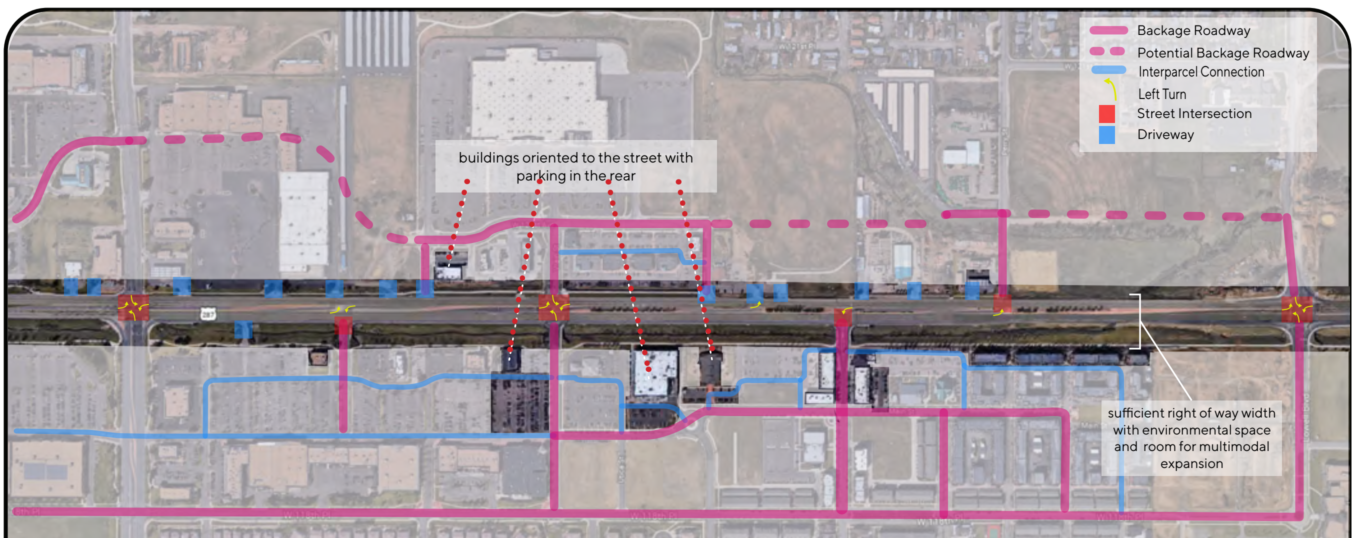
G. Managed lanes can support future mobility technology. The inclusion of managed lanes in the arterial network may also allow for the future development operation of autonomous and connected vehicles (AV/CV) in these special use lanes. With the regional growth and projected significant increase in traffic volumes, managed lanes offer a flexible option to respond to the demand. Managed lanes can provide opportunities to implement new technologies and transportation alternatives that will decrease travel time and help reduce congestion.

H. A traffic management plan can help reduce congestion and increase safety. Another consideration in establishing the regional arterial study is a regionally approved traffic/incident management plan.

Congestion and travel delays are frequently caused by obstructions and incidents on the arterial network. A plan to address roadway obstructions and to clear accidents/incidents should complement the arterial study. In Harris County, the Tow and Go program has been implemented which quickly clears vehicle breakdowns and stalls from the area freeways with a free tow. This program has not only helped relieve congestion on the freeways, but also has had a major impact on reducing accidents.

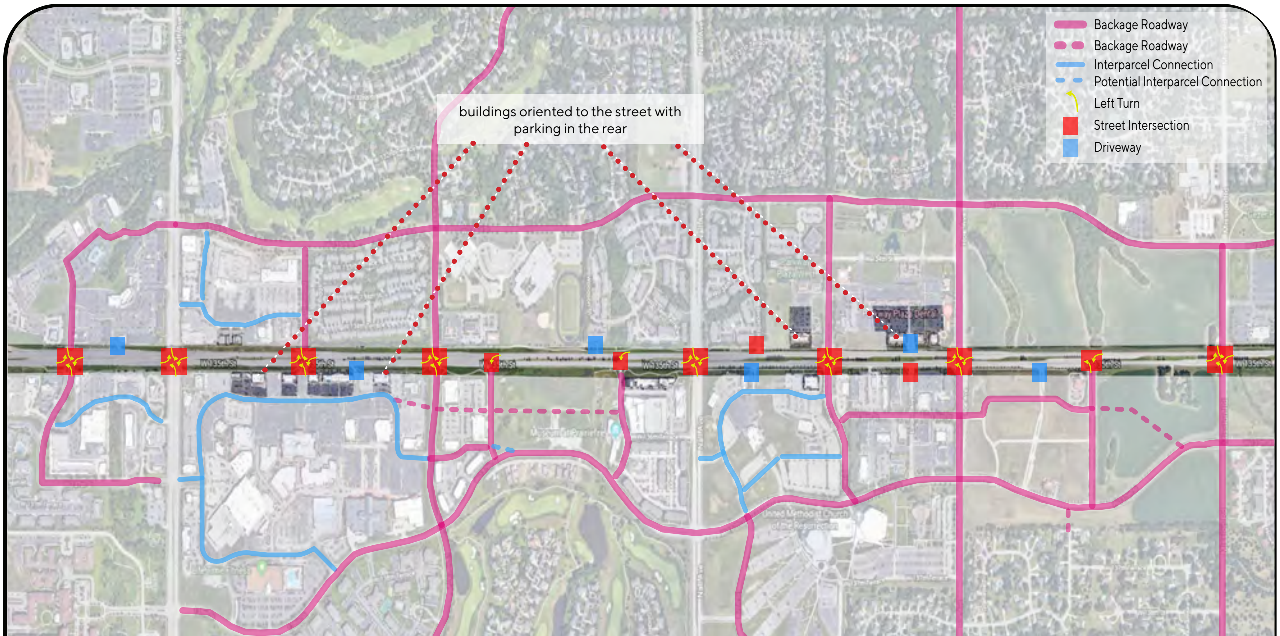
I. The importance of Right of Way (ROW) and land-use planning relationships. The Regional Arterial Study outlines a process and attention must be focused on the urban form and zoning restrictions (where applicable). The various jurisdictions, the counties and CAMPO must engage area planners and the development community to ensure compatible operation and connectivity. As new developments are planned, roadways should complement the development and avoid creating greater congestion. Right of way may need to be reserved to provide connectivity and sufficient accessibility from multiple approaches. Zoning ordinances could also require building setback requirements to ensure that sufficient ROW is reserved for future transportation needs. The Pattern Book described in Chapter 6 provides a number of case studies of arterials and the relationship between land use, mobility and connectivity. This is a multi-jurisdictional effort and coordination across jurisdictions and between agencies is key to implementation.

J. Zoning, development and parking ordinances/regulations have a major impact on the design and operation of roadways and arterials. The type and intensity of land use, and the physical manner in which land is developed affect the character and volume of traffic and the operating efficiency of the roadway system. Zoning plays a role in developing roadway design standards and capacity requirements. The intensity and composition of land uses have a direct relationship to street hierarchy. Uses that generate high traffic volumes require proximity to minor and major arterials. Low density uses are generally along collectors and local streets and have different capacity needs. Appropriate zoning helps ensure the desired intensity and type of uses and compatibility of permitted uses with the intensity of surrounding streets. In a heavily industrial or manufacturing area, the arterial should be designed for freight traffic and the movement of larger vehicles. In residential areas and near schools, the adjacent roadways are local and accommodate shorter trips and slower moving traffic. The right of way of local streets in neighborhoods and surrounding local attractions should accommodate bicycles and pedestrians.



The suburban Denver (Westminster) example takes advantage of local zoning policies that encourage development toward regional connectors with necessary setbacks for future corridor expansion. Prescribing appropriate zoning and managing access is paramount for all users that move through the area. This area utilizes setback requirements, strategically located parking (in the rear), and an ample backage network. The corridor design in Denver also considers the entire right-of-way, environmental swells, and multimodal transportation users. Backage routes are even created specifically for freight deliveries with special access points in the back of stores, away from the main roadway.

Figure 5.5Early Phase Example of Backage and Interparcel Connectivity



Suburban Kansas City (Overland Park) is an example of carefully planned backage roads with access points to/from development along West 135th Street. Developments are only accessible through main intersections or a select few minor streets/driveways. Reducing the amount of entrances and exits allows the critical opportunity for creating a subdivision street network that is well-coordinated with the local and regional street network while being able to serve pedestrian safety concerns. The Kansas City example also shows how developments can coordinate and minimize the amount of parking needed by using shared parking spaces.

Figure 5.7Early Phase Example of Backage and Interparcel Connectivity

This last image highlights the symbiotic relationship between transportation and land-use in suburban Oakland (Emeryville). Emeryville utilizes an integrated system of hierarchal streets, buildings that orientate to the street, parking in the rear, and carefully planned access points for the developments along 40th Street. Orienting development toward the corridor allows for direct and efficient transportation access, improves the visibility of business and commercial units, and enhances the vibrancy of the street by encouraging people to walk and bike.

Figure 5.6Advanced Phase Example of Backage and Interparcel Connectivity

K. Development plans play a similar role as zoning ordinances. Development plans generally include a traffic plan and address access to and from the development, the number, size and location of driveways and access points, and an assessment of traffic flow and volume. Development standards require that adequate screening, accessibility and buffering are applied for uses along highly travelled streets. These ordinances can specify standards for property setbacks and can include requirements for setbacks that allow for future ROW needs and roadway expansion.
Thoroughfare plans are also transportation planning tools that provide developers with specifications for the adjacent roadway design. As a development and/or redevelopment projects move through the platting and permitting stages, the developer will be responsible for preserving and dedicating the ROW per the requirements outlined in a thoroughfare plan.

L. Parking ordinances are also key considerations that impact the arterial study. Parking ordinances and parking lot requirements specifically address driveway widths and spacing, which impact turning movements, travel speeds, through traffic, and connectivity. The decision to allow on-street parking and loading zones, whether all day or at limited times, is another ordinance that directly impacts roadway operations, functionality and capacity. Time of day parking or pick-up/drop-off restrictions may be implemented to provide for greater capacity and reduce congestion during peak hours or times of greatest congestion or conflict. Parking ordinances also provide an element of safety in specifying sight obstruction/visibility triangle standards based on the arterial hierarchy at intersections and driveways.

M. Modifications and additions to subdivision regulations and requirements can be implemented to help achieve regional arterial network goals. Requiring subdivisions to provide sufficient access in and out of the area with more connectors will help streamline mobility and better serve local traffic and through traffic. Driveway spacing and alleyway access also support local road movements and collector roads access. Subdivision regulations should include geometric standards, street cross-sections, and other design criteria to accommodate turning movements, intersections operations, speed and connectivity.

N. Changes to infrastructure design criteria in response to roadway operation and capacity needs. In areas of high density and faster traveling speeds, raised medians may be required to enhance safety and efficient operations. Design criteria should also address the transition from a more rural road to an urban road. Design criteria and design requirements should be developed to effectively address the transitions within the arterial hierarchy. Infrastructure requirements standards, such as open cut drainage versus curb and gutter, or at-grade crossing versus grade separated, or thresholds for when and how to grade separate an arterial, can be modified to best provide connectivity, safety and operation efficiencies.

O. Another and very important consideration to implementation is understanding who is the owner of the facility. TxDOT classifies the statewide roadway system as either On-system or Off-system:

- Off-system roadways are not designated on the State Highway System and are not maintained by TxDOT (i.e. city street, county road).
- On-system roadways are designated as on the State Highway System and maintained by TxDOT.

This is an important to note during implementation of on-system roadways. TxDOT serves the entire state, so what may be a regional priority for our area may not necessarily be a statewide priority. The following figure provides the current On-system roadway for our region as well as potential candidates for removal or addition to the On-system roadway inventory.

Finally, infrastructure criteria must also be edited and updated to respond to changing technologies. The regional arterial study should recognize the advent of AV/CV and also future vehicle to vehicle and vehicle to infrastructure communications. Infrastructure requirements and ROW standards should be flexible to accommodate alternative arterial operations and movements.

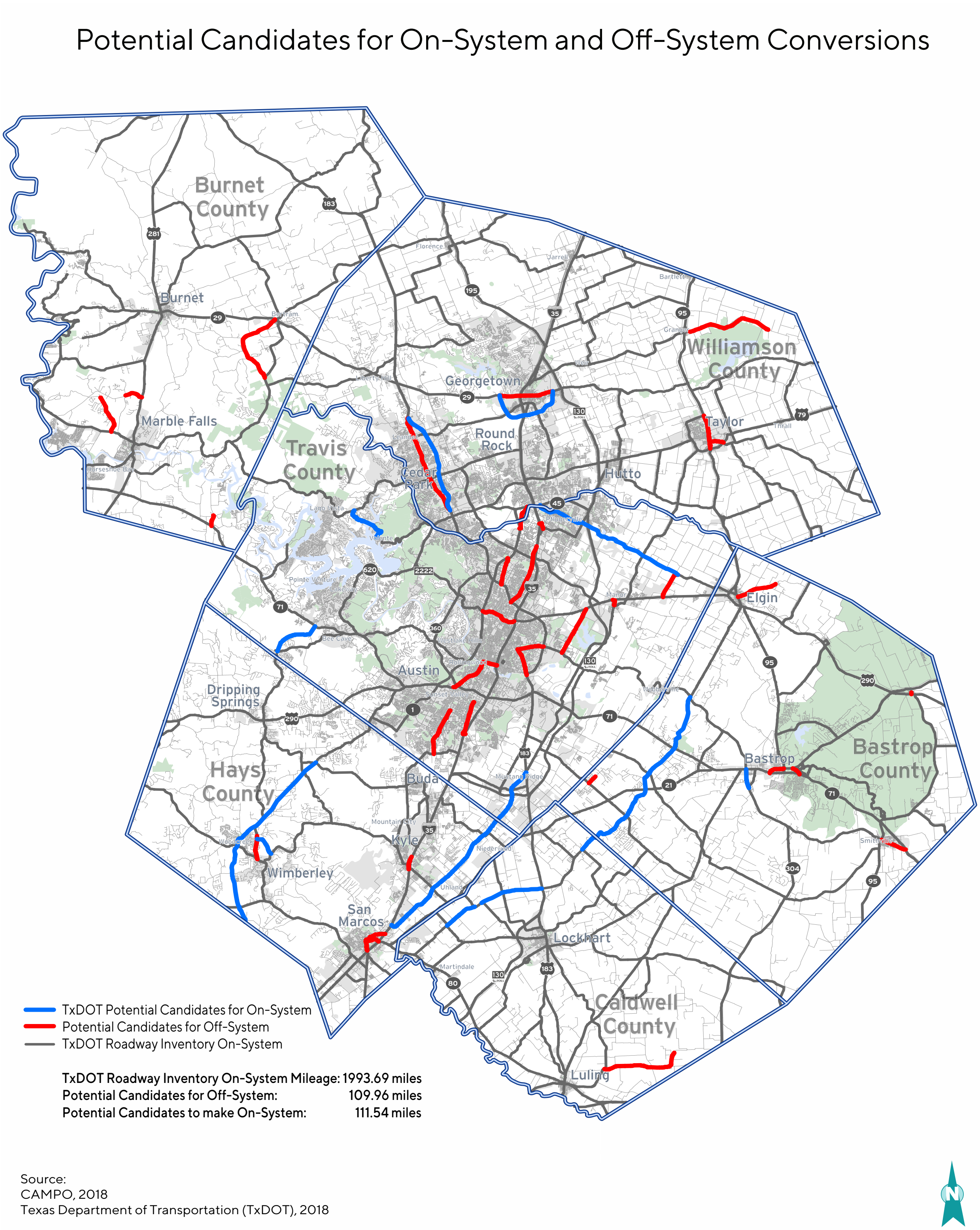


Figure 5.8 Potential candidates for on-system and off-system conversions

Coordination with Developers

Thoroughfare plans can be used as transportation planning tools that provide developers with specifications for adjacent roadway design. The multiple area thoroughfare plans that are consolidated in this study identify the arterial alignment and ROW requirements and define the future capacity and operation of roadways. As development and redevelopment projects move through the platting and permitting stages, the developer will be responsible for preserving and dedicating ROW based on the requirements outlined in a thoroughfare plan. The images below are two such examples where developers considered the future capacity and operation of the surrounding roadways of their developments.

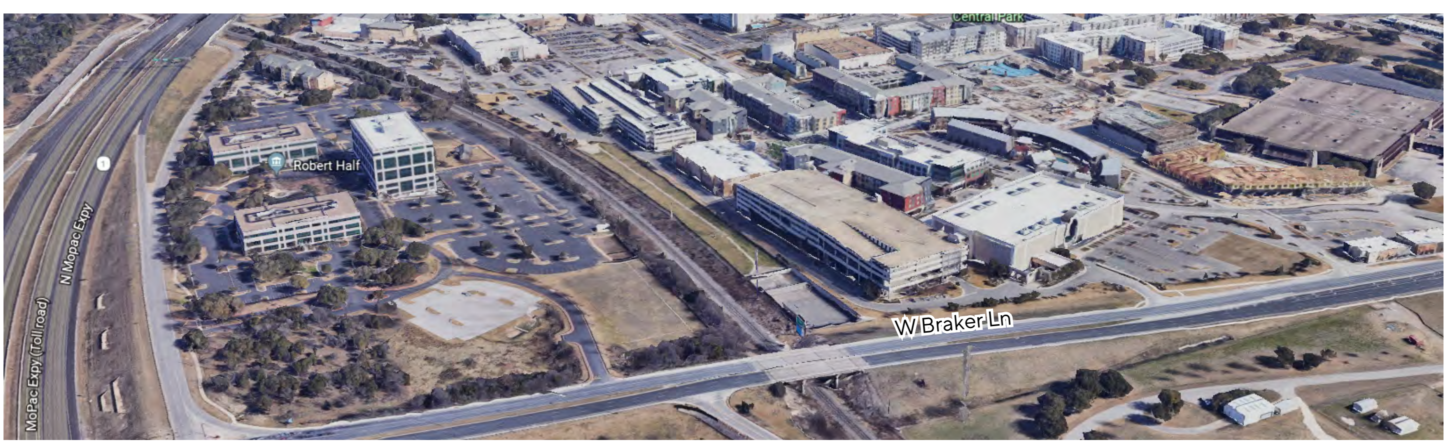
Figure 5.9 Example of developer coordination

New IKEA in San Antonio
Source: San Antonio Express-News

PSV Unveils Austin Stadium Rendering
Source: www.sportsbusinessdaily.com

There are also a number of other opportunities for developers to contribute to the efficient operation of the arterial network. In particular, roadway conflicts can be reduced by limiting the number of driveways and controlling the corner clearances and spacing of the driveways. Parking capacity should be planned for more thoughtfully and in a context-sensitive manner by limiting curbside parking on Principal Arterials and by promoting the sharing of parking between developments. The developer may also assist in maintaining traffic flow and preserving roadway capacity by designing developments that allow for increased traffic circulation within the development and reduce conflict points on roadways. Traffic Impact Studies can identify areas of conflict and assist developers in positioning high volume pedestrian traffic generating establishments away from the major roadway corridors and access points. Before building The Domain, developers leveraged Traffic Impact Studies to designate parking that allows for safe pedestrian access and reduced conflict points.

Figure 5.10 Example of developer coordination



The Domain in Austin, TX
Source: Google Maps

Funding/Financing

There are multiple funding sources and opportunities that may be applied to finance transportation improvements. CAMPO receives state and federal dollars through TxDOT's Statewide Transportation Improvement Program (STIP), which is a four-year capital improvement program. The Unified Transportation Plan (UTP) is TxDOT's planning document for proposed transportation projects that are projected to be constructed over the next ten years. The UTP authorizes projects for construction, development and planning activities and includes projects involving highways, aviation, public transportation, and state and coastal waterways. There are a number of TxDOT funding categories that are funding sources for CAMPO projects. In FY 2018, the TxDOT Austin District and CAMPO received UTP funding that totaled over $2.5 billion dollars. Figure 5.11 identifies the TxDOT funding allocation by category to CAMPO in 2018.

2018 TxDOT UTP Funding Allocation – Austin District and CAMPO		
Category 2	METRO and Urban Area Corridor Projects	$ 1,232,460,000
Category 3	Non Traditionally Funded Transportation Projects (Local)	$ 52,238,810
Category 4	Statewide Connectivity Corridor Projects	$ 314,397,650
Category 7	Metropolitan Mobility and Rehabilitation	$ 345,890,000
Category 9	Transportation Alternatives Program	$ 24,600,000
Category 10	Supplemental Transportation Projects	$ 140,000
Category 12	Strategic Priority Funding Summary/TX Clear lanes	$ 637,512,678
TOTAL		$ 1,604,730,000

Figure 5.11

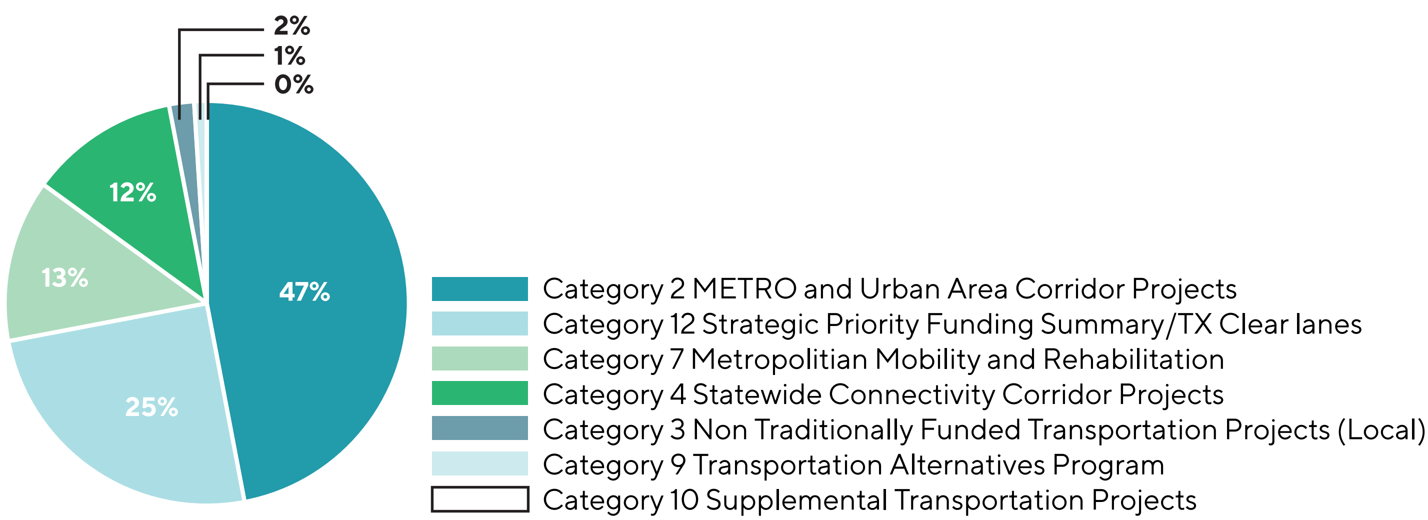


Figure 5.12 - 2018 UTP Funding Forecast for Austin District and CAMPO – 10 years ($millions)

Figure 5.13 provides the breakdown of the UTP funding allocation categories and funds which were exclusively allocated for roadways within the Capital area. These numbers provide a sense of dedicated funding available for roadway improvements and enhancements already in the pipeline.

2018 TxDOT UTP Funding Allocation - CAMPO			
Category 2	METRO and Urban Area Corridor Projects	CAMPO	$ 1,232,460,000
Category 7	Metropolitan Mobility and Rehabilitation	CAMPO	$ 345,890,000
Category 9	Transportation Alternatives Program	CAMPO	$ 24,600,000
Category 12	Strategic Priority Funding Summary	CAMPO	$ 1,780,000
TOTAL			$ 1,604,730,000

Figure 5.13

Projects identified for advancement need to have a project sponsor and be included in the RTP, which is a financially constrained plan. Although federal programs provide the majority of funding for transportation projects, local municipalities are responsible for remaining project costs not covered through these sources. The local funding sources include property and sales taxes, Impact/Developer fees, and bond programs issued by counties/cities in the Capital Area region.

The following Figure 5.14 provides a breakdown of current funding by project sponsor in the Capital Area region and includes the counties, cities, and transit agencies.

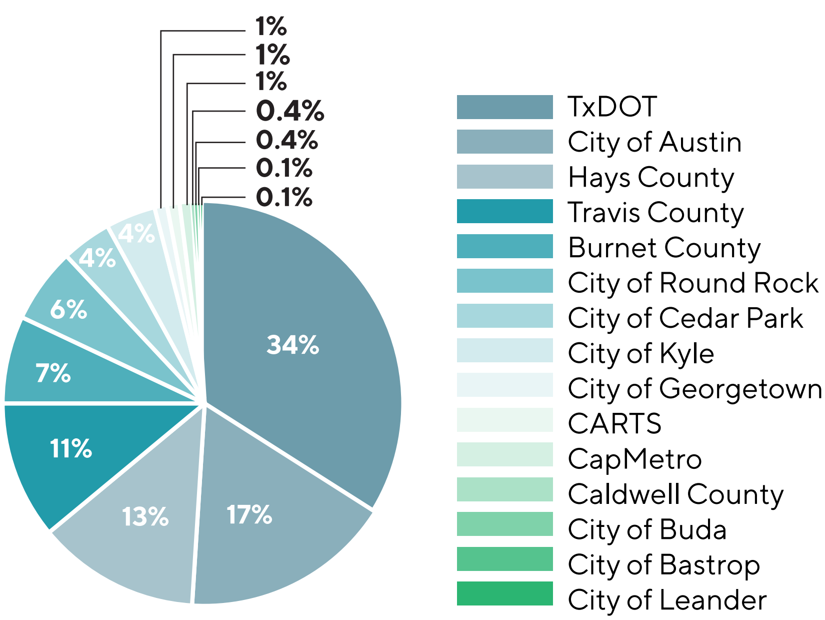


Figure 5.14 - Funding by Sponsor (Source: CAMPO 2019-22 TIP)

Figure 5.15 illustrates the current breakdown by the counties in the Capital Area region.

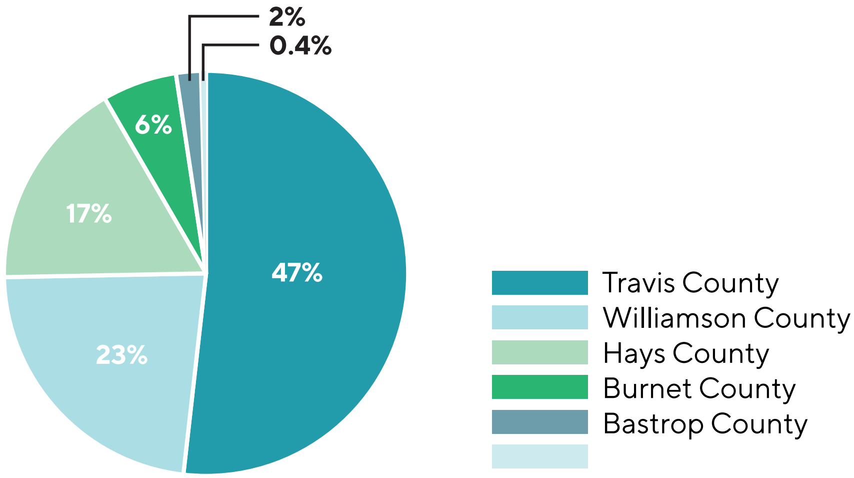


Figure 5.15 - Funding by County (Source: CAMPO 2019-22 TIP)

Other Funding Opportunities

- TxDOT provides grant programs through the Texas Traffic Safety Program. The goal of this fund is to identify traffic safety problem areas in order to implement improvements that will help reduce the number and severity of vehicular crashes. These grants are separate from the categories discussed above and are eligible to organizations (state and local government agencies, educational institutions, and non-profit agencies)
- Funding for some arterials in the Capital Area region may also be tapped to support freight mobility. Arterials listed by the MPO as Critical Rural or Critical Urban freight corridors that provide connectivity on the National Highway Freight Network (NHFN) may be eligible for strategically directed resources to improve performance of portions of the US freight transportation network.
- The US Department of Transportation (DOT) also provides transportation funding as part of the Infrastructure For Rebuilding America (INFRA) Grant program to address critical issues facing our nation's highways and bridges. These grants are discretionary funds and are competitively awarded. The program is designed to incentivize project sponsors to pursue innovative strategies to repairing and maintaining roadways and bridges.
- The US DOT has also established a funding opportunity through the Better Utilizing Investments to Leverage Development (BUILD) Transportation Discretionary Grants program. These grants are for investments in surface transportation infrastructure and are awarded on a competitive basis that will have significant local or regional impact.
- In addition, US DOT offers credit assistance through the Transportation Infrastructure Finance and Innovation Act (TIFIA) program. The program offers direct loans, loan guarantees, and standby lines of credit to finance surface transportation projects of national and regional significance.

- TxDOT is authorized to make low interest loans through the State Infrastructure Bank (SIB) which is part of the National Highway Designation Act. The loans are designed to help accelerate needed mobility improvements through a variety of financial assistance options made to local entities through the state's transportation departments.
- Finally, there may be limited funding opportunities to support the advancement of innovative technologies. The Signal Phase and Timing (SPaT) Challenge has been issued by the National Operations Center of Excellence (NOCoE) to state and local public sector transportation infrastructure owners and operators to work together to achieve deployment of dedicated short range communication (DSRC) infrastructure with SPaT broadcasts. SPaT messages define the current intersection phases. The SPaT message can be obtained from a traffic signal controller and is broadcast by the DSRC roadside devices as a standardized data message. Through the deployment of both the SPaT intersection message system with the DSRC communication broadcast, the system supports vehicle to infrastructure communication and enhances traffic operations. The goal is to deploy DSCR infrastructure with SPaT broadcasts in at least one corridor or network (approximately 20 signalized intersections) in each of the 50 states by January 2020 through agency cooperation and coordination. While Austin is already in the process of deploying the equipment at two intersections, there may be opportunities and additional resources to expand the pilot program and increase deployment in the corridor or in other locations in the region.

Advancing Improvements

The Concept Plan is the first time that transportation plans from around the Capital Area region have been compiled into one comprehensive arterial network and evaluated at the regional level. Scenario planning was used to uncover the potential of stitching together a comprehensive arterial network and to provide operational and design options that serve local as well as regional goals and objectives. The results from each of the scenarios indicate that either independently or in combination, they can have meaningful impact in improving and advancing a comprehensive arterial system within our region.

The overarching purpose of the Concept Plan is to provide local transportation planners a planning tool to advance projects that meet their needs, yet also advances the development of a comprehensive regional arterial network. Because this is a regional arterial *Study*, the roadway maps depicted throughout this document do not represent actual alignments but were developed for travel demand modeling purposes to support the evaluation of each scenario. The recommended improvements contained in the Arterial Concept List are starting points for each jurisdiction within the Capital Area region. The Arterial Concept List developed through scenario planning could be considered a "Menu". Scenario planning helped ensure that as a region we are planning "off the same menu". When combined with the Pattern Book, local planners have a starting point from which to begin development of projects that benefit both the local and regional community.

How Does a Project on the Arterial Concept List Advance?

As with any project, there are several challenges and hurdles to overcome before a project ever gets constructed. Improvements in the Arterial Concept List must have a project sponsor. The project sponsor is the lead agency or jurisdiction responsible for the promotion, development, and funding of the project. No project can advance without a project sponsor. These improvements would also have to be adopted into the CAMPO 2045 Long Range Transportation Plan, he Transportation Policy Board would need to approve the project to be included into the TIP, and funding would have to be available for project development. Project development is the planning phase where roadway alignments and the design begin to take shape. Prior to construction, environmental clearance and approval following the National Environmental Policy Act (NEPA) would have to occur. Finally, the project will need construction dollars and will need to be contained in the Statewide Transportation Improvement Program (STIP).

Recommendations Time Line

Funding availability will certainly dictate when and which projects can advance to development and construction phases. Short-term improvements include operational improvements and the improvements in the Transportation Improvement Plan (TIP). The TIP provides needed structure to transportation decision-making. The TIP is a four-year strategic planning document that assembles, organizes, and prioritizes transportation projects from adopted transportation plans. The purpose of the TIP is to serve as a tool in the decision-making process regarding which projects should be advanced given limited staff and funding resources. By design, the TIP framework is flexible. Due to many factors, including introduction of new projects, shifting priorities, and funding source dynamics, the TIP will regularly change in response to the changing civic environment.

Many of these improvements are also contained within local jurisdictions, transportation plans. Although these improvements may be categorized as long-term improvements, they may advance at any time based on local funding and desires.

Traffic Management Coordination Strategies, Policies, and Best Practices

As cities and communities grow, and new organizations and agencies take shape, regional transportation operations tend to become more siloed as transportation management system development becomes more complex and individual communities face mounting pressure to focus on resolving local challenges. However, opportunities exist to bring cross-jurisdictional and comprehensive solutions to maintain a common goal and seamless network operations. Due in part as system users do not typically equate jurisdictional/agency boundaries into their mode or route choice.

A high-level case study of three regional model traffic management programs was conducted which highlighted coordination strategies, policies, and best practices. The results are made available for the Capital Area region to learn, adopt and enhance for potential application. Details of case studies and traffic management can be found in the Appendices.

The three regional programs include:

- Las Vegas, NV - Freeway and Arterial System and Transportation (FAST)
- Houston, TX - Houston TranStar
- Denver, CO - Denver Regional Council of Government (DRCOG) Traffic Operations Program

Each the three regional programs were selected in part due to the similarities in regional growth characteristics, mobility challenges, infrastructure need, regional agency/organization functionalities, and the unique approach each program offers for managing arterial mobility, with some solutions having potential applicability to the Capital Area region.

The results of these case studies offer insight as to how the Capital Area region can implement a framework for a multi-lateral regional transportation operations program. Planning for the establishment of a regional operations program would provide the necessary connection and backbone to support the development of active transportation management strategies for the arterial systems. The planning of this effort is in line with state priorities, as outlined in TxDOT's Transportation Systems Management and Operations (TSMO) plan for the Austin District,[1] and CAMPO's regional arterial goals. The end result would provide an improved traffic management coordination and regional operations, providing seamless delivery of services to all transportation users that improves travel for all on the region's arterial systems.

[1] Source: https://bit.ly/2JBH3k8

Need for Transportation Management

The Capital Area region is experiencing challenges of corralling transportation system operations to provide seamless travel and efficient mobility experience that users demand while reducing congestion. In response to this, the region is operating a multitude of solutions and strategies on the arterial systems, some of which are as follows:

- Highway Emergency Response Operators (HERO) Program
- Local/Agency Traffic Signal Coordination Timing Program (TxDOT, County, City)
- Transit Rail/Bus/Bus Rapid Transit (CapMetro)
- Managed Express Lanes (CTRMA)
- Regional Toll Facilities (CTRMA, TOD)
- ITS (Intelligent Transportation System)
- Smart Work Zone Management (TxDOT, Cities)
- Ridesharing Program
- Demand Management Programs (Private Flex Work Programs)
- Parking Management
- Combined Transportation, Emergency & Communications Center (CTECC)

A common theme among this list is that these programs provide targeted solutions with specific local or regional functions. Although some programs have inter-jurisdictional agreements for regional operation, such as CTECC and Capital Metro Bus Rapid Transit, each of these strategies are independently managed through specific guidelines amongst partner agencies and organizations that have a stake in the operations of each program.

It is also important to note that the agencies and organizations that develop and operate strategies on the region's arterial networks have varying organizational structure, missions, goals, objectives, and priorities. Although good faith efforts are practiced to ensure success of projects, opportunities are sometimes missed to provide better operations for many reasons, including varying degrees of resources and priorities between agencies.

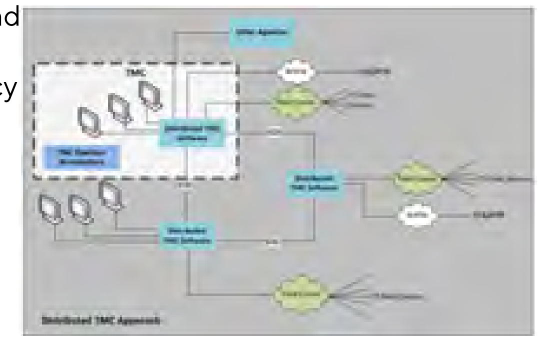
The adoption of Transportation Systems Management and Operations (TSMO) philosophies among agency organizations across the country, including the Texas Department of Transportation, provides an opportunity for the Austin region to re-visit current practices for project/strategy development and operations. TSMO is defined as "An integrated set of strategies to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal, cross-jurisdictional systems, services, and projects designed to preserve capacity and improve security, safety, and reliability of the transportation system."[2] Creation and adoption of new philosophies and process would improve data sharing, resources management, and facilitate active traffic management strategies on arterials. Efficient and seamless deployment of these strategies would promote better service for all users across boundary lines.

[2] TSMO MAP-21 Definition: https://bit.ly/2xHWMZk

Recommendations of Enhanced Management and Coordination

The organizational structure for a regional arterials program will greatly influence how the region's stakeholders work together to develop regional strategies and programs, especially at the arterial level. Today, most of the arterial facility operators manage each of their facilities separately, but support regional strategy deployments using inter-agency operational agreements for specific portions of corridor segments. The agreements are often passive from an operational perspective, which sometimes leave gaps in cross-jurisdictional active management of the system. For example, the hours of operation of the respective municipal/agency TMC operates at varying time periods of the day. This limits the ability of the municipalities to provide continuous management and operations, specifically during the time periods when the TMCs are closed. This gap in TMC hours of operations and passive agreements present opportunities to improve arterial transportation operations. The Capital Area region could facilitate better regional operations through either of the following:

- Decentralized System Model – leverages existing ITS systems and network, build out communications gap, and develop a central software open to stakeholders requiring data and control; agency partners will require multiple agreements on framework, roles,

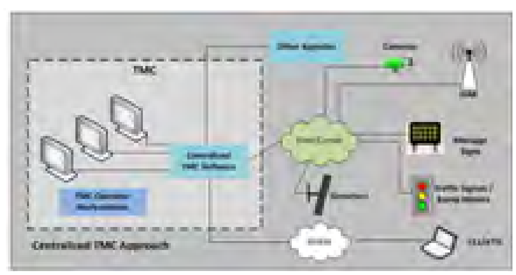


Source: FHWA

  Advantages: Partner agencies retain control of their systems, reducing single point network failure. Strategy capabilities are shared between various TMCs. In the short-term, agencies could maximize resources, provide better efficiency, and share costs.

  Disadvantages: System requires more complex agreements. The network may not be as secure due to wider access and remote operations. In addition, it may potentially cost more in the long-term due to additional hardware/software requirements and maintenance for each TMC site. Competing missions may also slow down strategy implementation.

- Centralized System Model – requires development of a consortium and will typically require a dedicated facility with dedicated staff for regional transportation operations that would



Source: FHWA

  Advantages: This system provides a single point of authority that has a unified mission, goals, and objectives. In addition, the infrastructure provides enhanced security, reduced complexity, neutral system management, in-house staff, one regional program. Potential operational cost benefits in the long-term.

  Disadvantages: Complex implementation (cost sharing agreement), regional philosophy change, required communication build-out to reduce wide area network (WAN) failure of partner connections.

A combination of either decentralized and centralized operations may also be explored, including potential virtual TMC to further regional operations. It may be prudent to begin this process through development of a technical or working committee to explore the appropriate model for regional adoption. The committee could focus on developing leadership requirements, framework and organizational structure, staff and strategy deployments.

Guidelines for Transportation Systems Management and Operations

Establish a Regional Framework to Facilitate Traffic Operations and Management

Establishing an organizational framework to facilitate traffic operations is a key factor for successful deployment, operations and maintenance of traffic operations capabilities.

- Establish a multi-disciplinary ITS Steering Committee, including Incident/Emergency Management, Special Event Traffic, and Traffic Signal Subcommittees
- Develop organizational policies and procedures
- Develop regional standards and practices for traffic operations

Lay Groundwork & Formalize a Stand-Alone Committee or Consortium

Bring all potential parties to the table to discuss partnering to fund or create a stand-alone agency, focused on transportation operations and management for the region.

- Define operating and maintenance purview
- Estimate necessary technology, resources, staff needs, etc.
- Determine preferred organizational chart
- Set necessary contractual and inter-local agreements necessary to allocate funding and initiate partnership

Identify Short- and Long-Term Strategies, Technologies, and Policies

Coordinate applicable TSMO strategies, technologies, and policies throughout the Capital Area region. Several of the strategies listed below may be appropriate for the Capital Area region to prioritize.

- Transit Service and Model Enhancement Strategies – Transit Signal Priority (TSP), bus-on-shoulder opportunities, and bus-only lanes help to prioritize transit on congested corridors.
- Traffic Signal Program Management and Operations – The planning, maintenance and operation of signalized intersections and traffic signal systems.
- Freeway Access Management – Ramp metering or congestion pricing on the freeway and interstate system.
- Capacity management – Dynamic lane control (reversible lanes, active lane management, dynamic speed control, and queue detection) using ITS technologies to expand capacity during peak travel times. Could also include reversible lanes or shoulder running.
- Traffic Incident Management (TIM) Strategies – May include back of queue protection vehicles, crash investigation sites, emergency pull-outs, incentives/disincentives for heavy wrecker operations and clearance, etc.
- Enhanced Public Information Strategies – Real-time displays can warn drivers of upcoming queues or significant slow-downs ahead, thus reducing rear-end crashes or resulting in motorists choosing to take a different route. Dynamic signs can also alter motorists on arterials on roadway hazards.
- Curb Management and Pricing – Can be used to help manage congested downtown streets where lots of drop-off and pick-ups occur.
- Emergency Response – Coordinate a regional approach to expanding emergency response services to the greater Capital Area region and arterial facilities.
- Emergency Management – Coordinate existing emergency management procedures.
- Communications – Coordinate regional policies and strategies to accommodate connected and autonomous vehicles.

Prioritize Strategies and Implement

It is essential that each individual strategy or program be coordinated with the broader transportation magement program, and that overall network performance be considered.

- Identify Stakeholders – Identify all relevant stakeholders and representatives/contact personnel. Develop coordination process through standing committees or a special task force that meets periodically to guide and enhance the program.
- Define the Problem – Define the problem before identifying or selecting a solution, through data collection, data compilation, brainstorming, and constructive critiques of existing practices
- Set Goals and Objectives – Establish the guiding principles of the strategy or program. Goals and objectives need to be multi-agency in scope; not merely the goals and objectives of individual agencies. Goals reflect long-term aspirations and objectives typically define the specific, often measurable, level of performance that would be required to progress toward a given goal.
- Develop & Select Strategies – Based on the goals and objectives, the group can develop alternatives to combine available tools and techniques into program packages for evaluation. Evaluate alternatives, prioritize, and select preferred short- and long-term strategies.
- Implement Strategies – Resolve issues (funding sources, jurisdictional boundaries, operational responsibilities, joint training, field communications, etc.) and formalize understandings among agencies and jurisdictions.
- Re-evaluate Strategies – Management and operations is an ongoing process. Successful programs continually re-assess and refine the system. Regular data collection allows program managers to assess the effectiveness of efforts, identify areas for improvement, and demonstrate the benefits provided by the program.

Conclusion

In conclusion, this study is designed to address future growth by providing an effective regional, multimodal transportation network. The key element to implementing the study is continued flexible coordination at all levels of government and a thorough understanding of local systems and policies. It should be adjustable and nimble enough to facilitate future innovations. This is a blueprint for the future and must address not only projected growth in the region, but also on going, technical advancements in the implementation of a regional arterial network, such as accommodation for AV/CV through development of vehicle to infrastructure communication networks, virtual messaging, adaptive system controls, and other innovations.

Arterial Concept and Investment

Introduction

The connections studied in the Concept Plan are a collection of ideas, vetted by local governments, for regional corridor improvements. The Arterial Concept list describes 325 regional connections and assigns a high level planning cost.

The preliminary programmatic cost analysis of the connections in the Regional Arterials Study are based upon comparable, planned project cost improvements in 2019 dollars. To develop costs for the study, costs previously developed for the Williamson County Corridor Study, Mobility35, and published programming cost comparisons were analyzed to develop a cost per lane mile for each classification in the roadway network. Programmatic costs evaluated range from roughly $1 million to $7 million per lane mile depending on project complexity. Based upon these numbers, a cost per lane mile was developed for each roadway classification. All comparable costs include only construction costs. As this is a high level, programmatic cost analysis, a 30% contingency, and 20% for planning, environmental, design and construction oversight were added to each connection added to the model network.

These programmatic costs are based upon additional lane miles in each functional classification beyond what is in the existing and committed network. The lengths utilized represent general corridor locations. These high level planning costs do not include right-of-way acquisition costs or utility relocation costs as these are highly variable by corridor and can't be advanced without a corridor alignment. Additionally, it is important to see these costs as an indication of the investment needed, which may be made from public or private sector sources. That exact proportion of public and private sources would be determined on the context and jurisdiction of the arterial. In order to advance the study of an identified corridor connection to an actual alignment, each connection will need sponsorship to pursue additional study that would result a preferred alignment and better inform project costs.

Preliminary Programming Cost Methodology

In association with the Regional Arterial Study, Preliminary Programming Costs were developed for each of the projects identified in the Study across the six-county region. In order to develop a Preliminary Programming Cost for projects at this level of development, a methodology was established to bring consistency to the corridors and account for the potential improvements on the corridors based upon the information that is available at this stage of development.

Projects identified at this level of study are intended to show the typical section and linkage between points. This level of development is not refined enough to apply typical unit cost estimating methodology. To develop a Preliminary Programming Cost, research was conducted to collect costs from similar projects on a cost per lane mile basis. The Williamson County Corridor Program, TxDOT's Mobility35 program, and various national publications from DOT's (Arkansas DOT, Utah DOT, Oklahoma DOT) were reviewed and used to develop costs per additional lane mile for each of our three major categories: Regional Connector, Major Arterial, and Minor Arterial. The Williamson County Corridor and Mobility35 Programs were utilized to create the base case per category and used the national publications to verify the numbers that were developed. Programmatic costs evaluated ranged from roughly $1 million to $7 million per lane mile depending on project complexity. Based upon these numbers a cost per lane mile was developed for each roadway classification. All comparable costs include only construction costs. The per additional lane mile cost developed for the three categories is: Limited Access Facilities - $2,500,000/lane mile, other Regional Connectors and Major Arterials - $2,000,000/lane mile, and Minor Arterials - $1,900,000/lane mile. Additionally, for major projects for which there are published costs (Mobility35, 183N, MoPac South, etc.), the published costs were used to be consistent with these programs.

These per lane mile costs represent an average across the total study. In general, these costs include standard improvements including pavement and base materials, drainage improvements, basic pedestrian accommodations, basic vegetation and stabilization, basic retaining walls, safety treatments (guardrail, barrier, etc.), and other ancillary improvements.

Several interchange/intersection improvements were identified as part of the Regional Arterial Study. Major interchange/intersection improvements would not be accounted for within the per lane mile cost. Standard costs were added for intersection/interchange improvements specifically identified in the study for grade separated intersections, additions of direct connectors, and major intersection/interchange reconfiguration. Due to the high-level nature of these costs, an additional 30% contingency was added to each segment. This contingency accounts for unforeseen project costs as well as additional project costs such as Traffic Management Systems (digital message signs, traffic counters, communications cables, etc.), aesthetic treatments, and more robust bicycle and pedestrian improvements. An additional 20% was added to the total cost to account for project development, engineering, and construction engineering and inspection costs. These costs were applied to each identified roadway segment in the Regional Arterial Study based upon the additional lanes and length of each segment. Certain assumptions were required to develop an accurate cost for the program. These assumptions include:

- Addition of shoulders for potential future shoulder running counted as additional lanes on the roadway
- Conversion from an undivided section to a divided section required reconstruction of one half of the existing roadway and the addition of any new lanes
- Additional lanes on existing roadways are assumed to follow same basic alignment of existing roadway

At this level of project development, there is not enough information to tie down all of the costs related to the projects. Since the projects are identifying roadway cross section and beginning and ending points only, reasonable costs for right-of-way acquisition and utility relocation cannot be developed at this stage. Right-of-way acquisition and utility relocation costs will need to be added to these Preliminary Programming Costs as the project continues through project development. Once general alignments of the roadway segments are developed, the local municipality will be able to produce a programming level estimate for these costs.

Arterial Concept List

The Arterial Concept List is a summary of over 2,000 individual segment concepts that roll up to the 325 connections as described below. The list provides a reference number to each facility, the facility or facilities associated with the concept, the plans referenced in developing the concepts, the counties traversed, from/to location, a summary description of the concept, and finally, a high-level cost. In addition, there are several conceptual intersection and interchange improvements. Details on the intersection and interchange improvements are mapped and shown in a similar tabular format following the Arterial Concept List. Any intersection or interchange costs are subsidiary to the overall facility cost identified in the 325 Arterial Concepts.

Each of the 325 arterial concepts range from point-to-point connections to regional connections that span multiple counties. As such, their recommended cross-sections and improvements may not be identical across their entire length. This makes it challenging to describe in a few sentences, a 10-mile-long arterial concept with many differing subsegments. Therefore, the summary descriptions try to capture the minimum and maximum change one could see anywhere on each arterial. For example, arterial concept 63 is presented as an improvment to a corridor extending southward from Travis County into Hays County. The summarized improvement concept is representative of varying local priorities and regionally identified gaps, derived from multiple jurisdictions and planning efforts. As such, portions of the improvement concept along the regional corridor were derived from the 2019 Austin Strategic Mobility Plan (ASMP) process, while others were identified as regional gaps through this planning effort. Regional planning is always a moving target and during the course of developing this study many local planning efforts were in the works or being updated, such as the 2019

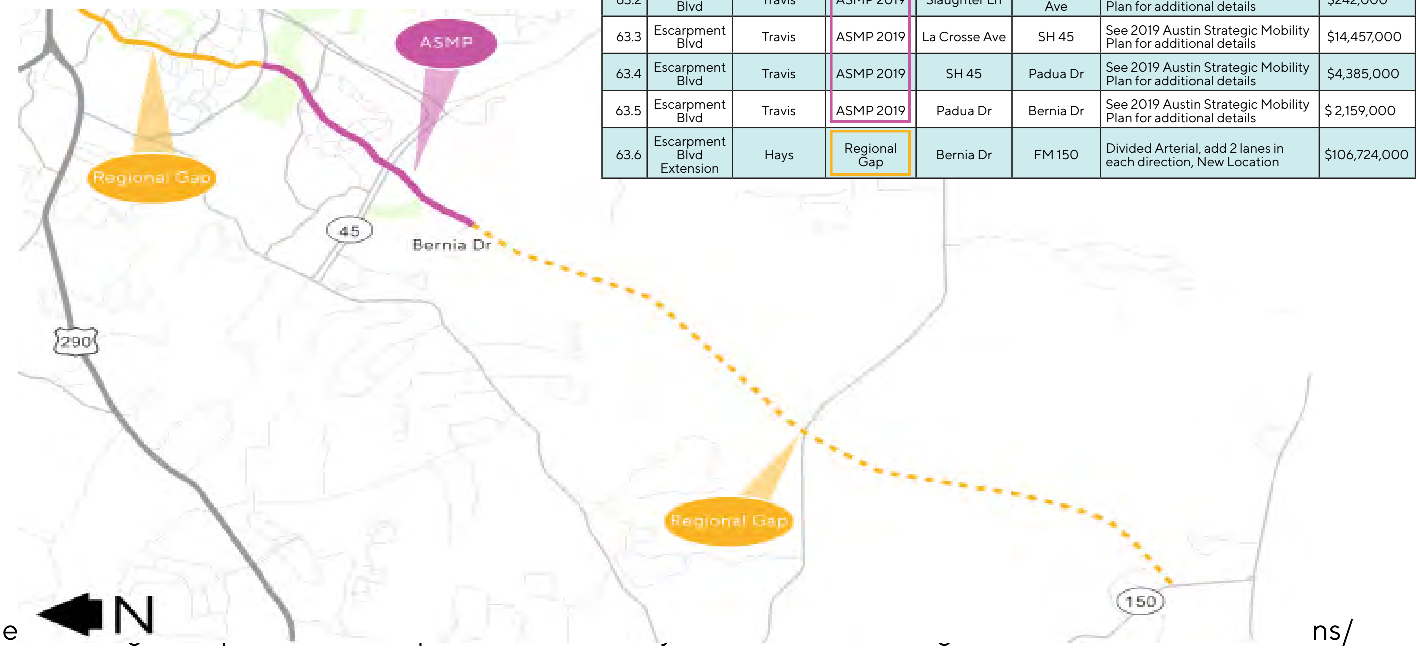
ASMP. Collaboration at various stages of the process enabled the study to rely on the best available data, but the concepts presented may not always reflect what is presented in a final plan.

GROUPED

ARTERIAL	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	SUMMARY DESCRIPTION	COST
63	Escarpment Blvd	Hays, Travis	ASMP 2019, Regional Gap	William Cannon	FM 150	Upgrade to Divided/Undivided Arterial, add 0 to 1 lane in each direction, some new location	$128,842,000

SEGMENTS

#	Facility	County	Plans Refenced	From	To	Arterials Concept Summary Description	Cost
63	Escarpment Blvd						
63.1	Escarpment Blvd	Travis	Regional Gap	William Cannon	Slaughter Ln	Upgrade to Divided Arterial, include safety and operational improvements	$875,000
63.2	Escarpment Blvd	Travis	ASMP 2019	Slaughter Ln	La Crosse Ave	See 2019 Austin Strategic Mobility Plan for additional details	$242,000
63.3	Escarpment Blvd	Travis	ASMP 2019	La Crosse Ave	SH 45	See 2019 Austin Strategic Mobility Plan for additional details	$14,457,000
63.4	Escarpment Blvd	Travis	ASMP 2019	SH 45	Padua Dr	See 2019 Austin Strategic Mobility Plan for additional details	$4,385,000
63.5	Escarpment Blvd	Travis	ASMP 2019	Padua Dr	Bernia Dr	See 2019 Austin Strategic Mobility Plan for additional details	$ 2,159,000
63.6	Escarpment Blvd Extension	Hays	Regional Gap	Bernia Dr	FM 150	Divided Arterial, add 2 lanes in each direction, New Location	$106,724,000



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Arterials Concept List Glossary		
CD	Collector/ Distributor	A collector-distributor road is a type of road that parallels and connects the main travel lanes of a highway and frontage roads or entrance ramps. Collector-distributor roads are found at intersections and, in the case of an intersection with a traffic signal, allow motorists to bypass the signal by driving under the intersecting road, much like an underpass.
CLT	Continous Left Turn Lane	A continuous left turn lane is a street configuration that provides a center lane exclusively for left turning vehicles coming from either direction.
DC	Direct Connector	A direct connector connects two or more high volume, high speed facilities with a single high speed ramp.
DDI	Diverging Diamond Intersection	A diverging diamond interchange should be considered for any interchange where signal lights can be expected on the cross road. The DDI works best if one of the left turning movements is high and/or if thru movements are unbalanced during peak hours. The DDI can solve many other issues such as queuing, synchronization, bottlenecks, lane balancing, weaving, pedestrians, special event needs, and widening needs.
GP	General Purpose Lanes	General purpose lanes are lanes that are not managed by policy or tolls and are not limited to any specific use.
HOV	High Occupancy Vehicle lanes	High occupancy vehicle lanes are generally managed by policy or tolls and are typically limited to specific users (transit vehicles, emergency vehicles, passenger vehicles with more than 1 occupant).
SPUI	Single Point Urban Interchange	A single point urban interchange enhances safety, mobility and connectivity by reducing potential crash points at intersections and by allowing more cars to move through an intersection. This means a reduction in both delay and travel time.

Figure 5.16

ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
1	US 281	Burnet	TxDOT, TIP, Regional Gap	Lampasas County Line	Blanco County Line	Upgrade to Regional Connector and Divided Arterial, add 0 to 1 lane in each direction	$464,221,000
2	US 183	Burnet, Caldwell, Travis, Williamson	TxDOT, Burnet County Plan, Williamson County Plan 2045, CAMPO, Caldwell County Transportation Plan, Regional Gap	Lampasas County Line	Gonzales County Line	Upgrade to Regional Connector and Limited Access, add 1 to 2 lanes in each direction (potential HOV use), frontage/ backage segment 4 to 6	$979,050,000
3	SH 71	Bastrop, Burnet, Travis	TxDOT, TIP, Regional Gap, CAMPO	Llano County Line	Fayette County Line	Upgrade to Regional Connector and Limited Access, add 0 to 3 lanes in each direction (potential HOV use), frontage/ backage segments 2+2	$3,536,088,000
4	US 290 W	Hays, Travis	TxDOT, Regional Gap	Blanco County Line	IH 35	Upgrade to Regional Connector and Limited Access, add 0 to 2 lanes in each direction (potential HOV use), frontage/ backage 4 to 6	$2,541,750,000

Figure 5.17Arterials Concept List

** Details on each subsegment can be found in the comprehensive Arterials Concept List with Subsegments shown in the Appendices. The following table provides descriptions of the acronyms used in describing the arterials and intersections/interchange improvements.

*ML = Managed Lane, FR = Frontage, GP = General Purpose, HOV = High-Occupancy Vehicle

ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
5	US 290 E	Travis, Bastrop	TxDOT, TIP, Regional Gap	IH 35	Lee County Line	Upgrade to Limited Access, add 1 lane in each direction, frontage/ backage 4 to 6	$ 1,454,847,000
6	SH 195	Williamson	KTMPO, Regional Gap, Williamson County Plan 2045	Bell County Line	Regional Corridor 151	Upgrade to Limited Access, add 1 to 3 lanes in each direction (potential HOV use), frontage/ backage 4 to 6, some new location	$438,539,000
7	SH 21	Bastrop, Hays	TxDOT, TIP, Regional Gap, CAMPO, San Marcos Plan 2035	Lee County Line	Guadalupe County Line	Upgrade Regional Connector, add 0 to 2 lanes in each direction, some new location	$ 1,113,187,000
8	SH 79 / Sam Bass Rd	Williamson	TxDOT, Regional Gap	FM 2243	Milam County Line	Upgrade to Regional Connector and Limited Access, add 0 to 1 lane each direction (potential HOV use), frontage segment 2+2	$638,100,000
9	SH 29 / PR 4 Spur	Burnet, Williamson	TxDOT, TIP, Regional Gap, Williamson County Plan 2045	CR 116	SH 95	Upgrade to Regional Connector and improved arterial, add 0 to 2 lanes in each direction (potential HOV use), some new location	$1,357,728,000

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ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
10	FM 734/ Parmer / Ronald Reagan connector	Travis, Williamson	TxDOT, TIP, Regional Gap	Blue Bluff Rd	Williamson County Line	Upgrade to Regional Connector, add 1 to 2 lanes in each direction (potential for HOV & shoulder usage)	$ 1,222,588,000
11	RM 1431 / University Blvd / Chandler Rd	Burnet, Travis, Williamson	TxDOT, TIP, Williamson County Plan 2045, Regional Gap	Milam County Line	Llano County Line	Upgrade to Regional Connector, add 1 to 2 lanes in each direction (potential for HOV)	$ 1,483,231,000
12	FM 973 extension	Travis, Williamson	TxDOT, Regional Gap	SH 79 Bypass	IH 35	Upgrade to Regional Connector, add 1 to 2 lanes in each direction (potential HOV use), some new location	$ 852,808,000
13	RR 12 / Wonder World	Guadalupe, Hays	TxDOT, San Marcos Plan 2035, Regional Gap, Local Govt Need	FM 1339	Regional Corridor 62	Upgrade to Regional Connector, add 1 to 2 lanes each direction	$ 532,440,000
14	SH 80 / Hunter / Hopkins	Caldwell, Comal, Hays	TxDOT, TIP, San Marcos Plan 2035, Regional Gap	Watson Ln	US 183	Upgrade to Regional Connector and Divided Arterial, add 0 to 2 lanes in each direction	$ 341,396,000
15	FM 969 / FM 304	Bastrop, Travis	TxDOT, TIP, ASMP 2019, Bastrop Comp Plan (2016-2036), Regional Gap	Lamar Blvd	SH 95	Upgrade to Regional Connector, add 0 to 1 lane in each direction (potential interim reversible lane segment and long-term HOV use)	$ 571,232,000

** Details on each subsegment can be found in the comprehensive Arterials Concept List with Subsegments shown in the Appendices. The following table provides descriptions of the acronyms used in describing the arterials and intersections/interchange improvements.

*ML = Managed Lane, FR = Frontage, GP = General Purpose, HOV = High-Occupancy Vehicle

ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
16	SH 304	Bastrop, Caldwell	TxDOT, Regional Gap	SH 71	Gonzales County Line	Upgrade to Undivided Arterial, include safety and operational improvements	$ 22,922,000
17	Archeleta / Hugo connector	Hays	Regional Gap	SH 45 / SL 1	Purgatory Rd	Divided Arterial, add 1 to 2 lanes in each direction, some new location	$126,531,000
18	FM 1704/ Southern Connection	Bastrop, Caldwell	Regional Gap	SH 80	US 290	Upgrade to Regional Connector, add 2 lanes in each direction (potential HOV use), some new location	1,198,452,000
19	Pflugerville Pkwy	Bastrop, Travis	Regional Gap	SH 45	SH 95	Upgrade to Regional Connector, 2 to 3 lanes in each direction, (potential HOV use), some new location	$ 269,502,000
20	SH 95	Williamson, Bastrop	TxDOT, KTMPO, Williamson County Plan 2045, Regional Gap	Bell County Line	Griesenbeck Ranch Rd	Upgrade to Regional Connector, 0 to 3 lanes in each direction (potential HOV use), some new location, include corridor wide safety and operational improvements	$ 667,371,000
21	RM 2341 / CR 107	Burnet	Regional Gap	SH 29	Lampasas County Line	Upgrade to Undivided Arterial, include safety and operational improvements	$9,000,000
22	SH 29 alternate	Burnet	Regional Gap	SH 29	RM 2341 @ SH 29	Divided Arterial, 2 lanes in each direction, New Location	$225,723,000

** Details on each subsegment can be found in the comprehensive Arterials Concept List with Subsegments shown in the Appendices. The following table provides descriptions of the acronyms used in describing the arterials and intersections/interchange improvements.

*ML = Managed Lane, FR = Frontage, GP = General Purpose, HOV = High-Occupancy Vehicle

ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
23	Saratoga Farms	Bastrop	Regional Gap	US 290	Caldwell Rd at TX 21	Divided Arterial, 2 lanes in each direction, New Location	$299,137,000
24	FM 1174 extension	Burnet	TxDOT, Regional Gap	SH 71	Lampasas County Line	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$12,232,000
25	FM 2104 / FM 153 / SH 95 / FM 535	Bastrop	TxDOT, Regional Gap	SH 290	FM 973	Upgrade to Undivided Arterial, include safety and operational improvements	$ 21,447,000
26	RM 2222 / Western Connection	Travis	TxDOT, ASMP 2019, Regional Gap	RM 1431	IH 35	Upgrade to Regional Connector and Divided Arterial, add 1 to 2 lanes in each direction (potential HOV use), some new location (potential interim reversible lane segments)	$203,538,000
27	FM 20	Bastrop, Caldwell	TxDOT, Regional Gap	SH 71	US 183	Upgrade to Undivided Arterial, add 1 lane in each direction	$445,719,000
28	RM 243 / SH 138	Burnet, Williamson	TxDOT, Regional Gap	SH 29 @ FM 1174	Bell County Line	Upgrade to Undivided Arterial, include safety and operational improvements	$ 11,095,000
29	RM 963	Burnet	TxDOT, Regional Gap	US 281	FM 2657	Upgrade to Divided Arterial, include safety and operational improvements	$ 10,357,000

** Details on each subsegment can be found in the comprehensive Arterials Concept List with Subsegments shown in the Appendices. The following table provides descriptions of the acronyms used in describing the arterials and intersections/interchange improvements.

*ML = Managed Lane, FR = Frontage, GP = General Purpose, HOV = High-Occupancy Vehicle

ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
30	CR 200 / CR 210	Burnet	KTMP, Regional Gap	FM 963	Lampasas County Line	Upgrade to Undivided Arterial, include safety and operational improvements	$ 12,598,000
31	RM 2340 connector	Burnet	Regional Gap	FM 1174	RM 2341	Upgrade to Undivided Arterial, include safety and operational improvements	$ 13,500,000
32	FM 963 / RM 1431 connector	Burnet, Williamson	TxDOT, Regional Gap	FM 963	RM 1431	Divided/ Undivided Arterial, add 1 to 2 lanes in each direction, some new location	$154,624,000
33	RM 1431 / SH 29 West connector	Burnet	Regional Gap	RM 1431	SH 29	Upgrade to Undivided Arterial, include safety and operational improvements	$ 5,138,000
34	CR 122 / CR 121 connector	Burnet	Regional Gap	RM 1431	CR 107	Undivided Arterial, add 1 to 2 lanes in each direction, & some new location	$248,522,000
35	RM 1855 / CR 120	Burnet	Regional Gap	RM 1431	RM 1431	Upgrade to Undivided Arterial, add 0 to1 lane in each direction, some new location	$58,508,000
36	SH 71 / Jacobs Well connector	Hays, Travis	Regional Gap	Travis County Line	CR 220 @ Jacobs Well Rd	Upgrade to Undivided Arterial, add 0 to1 lane in each direction, some new location	$45,905,000

** Details on each subsegment can be found in the comprehensive Arterials Concept List with Subsegments shown in the Appendices. The following table provides descriptions of the acronyms used in describing the arterials and intersections/interchange improvements.

*ML = Managed Lane, FR = Frontage, GP = General Purpose, HOV = High-Occupancy Vehicle

ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
37	US 290 / Comal connector	Hays, Travis	Regional Gap	US 290	Comal County Line	Upgrade to Regional Connector , add 1 to 3 lanes in each direction (potential HOV use), some new location	$515,027,000
38	US 290 West / IH 35 South connector	Hays	TxDOT, San Marcos Plan 2035, Regional Gap	W US 290	IH 35 @ San Marcos	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction, some new location	$183,829,000
39	Blanco County / SH 142 connector	Caldwell, Hays	TxDOT, Regional Gap	Blanco County Line	SH 142	Upgrade to Regional Connector, add 0 to 3 lanes in each direction (potential HOV Use), some new location	$382,407,000
40	Fitzhugh / Circle / FM 2244 connector	Hays, Travis	Regional Gap	Blanco County Line	Thomas Springs Rd	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction, some new location	$2,338,000
41	SH 71 / US 290 W connector	Hays, Travis	Regional Gap	SH 71	CR 190 - Creek Rd	Upgrade to Undivided Arterial, add 0 to1 lane in each direction, some new location	$16,781,000
42	RM 165 / CR 244	Hays	Regional Gap	Blanco County Line	FM 32	Upgrade to Undivided Arterial, add 0 to1 lane in each direction, some new location	$12,623,000
43	US 290 West / Caldwell connector	Caldwell, Hays, Travis	TxDOT, Regional Gap	US 290	FM 672	Upgrade to Undivided Arterial, add 0 to1 lane in each direction, some new location	$376,252,000

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ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
44	William Cannon extension / FM 812	Travis, Bastrop	TxDOT, ASMP 2019, Regional Gap	Southwest Pkwy	FM 304 (CR 289 - St. Mary's Rd)	Upgrade to Regional Connector and Divided Arterial, add 0 to 3 lanes in each direction (potential HOV use), some new location	$ 425,114,000
45	SH 95 connector	Bastrop	Regional Gap	SH 95	US 183	Upgrade to Divided Arterial, add 0 to 1 lane in each direction, some new location	$58,077,000
46	RM 620 / SH 45	Bastrop, Travis, Williamson	TxDOT, TIP, Regional Gap	SH 71	CR 97 - Blisard Rd	Upgrade to Regional Connector, Limited Access, and Divided Arterial, add 0 to 3 lanes in each direction, some new location	$498,247,000
47	Manda Carlson / Dunlap connector	Travis, Williamson	Williamson County Plan 2045, Regional Gap	Williamson County Line	Regional Corridor 275	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$156,983,000
48	Regional Corridor 112 / FM 1625 connector	Hays, Travis	Draft Travis County Plan, Regional Gap	Regional Corridor 112	FM 1625 / Williamson Rd extension	Upgrade to Divided/ Undivided Arterial , add 0 to 2 lanes in each direction, some new location (potential reversible lane segment)	$159,039,000

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49	US 281 / SH 71 / RM 620 connector	Burnet, Travis	Regional Gap	Llano County Line	SH 71	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$48,015,000
50	Slaughter Ln extension	Bastrop, Travis	TIP, ASMP 2019, Regional Gap	FM 1826	CR 250 - The Forest Rd	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$268,984,000
51	FM 1660 / Hunters Bend connector	Travis	Regional Gap	FM 1660	Regional Corridor 68	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction, some new location	$91,776,000
52	FM 3000 / SH 71 connector	Bastrop	Regional Gap	FM 3000	FM 1774 Extension	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$140,308,000
53	McNeil Rd / Old Kimbro	Travis, Williamson	ASMP 2019, Draft Travis County Plan, Regional Gap	Round Rock Ave	Lund Rd	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$262,793,000
54	Howard Ln extension	Travis	ASMP 2019, Regional Gap	McNeil Rd	FM 973	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction, some new location	$21,674,000
55	Pecan St extension	Travis	Regional Gap	Wells Branch	Sayers Rd	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction, some new location	$177,201,000

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56	RM 1431 / FM 2243 Loop connector	Travis, Williamson	TxDOT, TIP, ASMP 2019, Williamson County Plan 2045, Regional Gap	RM 1431	RM 1431	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction, frontage 3+3, some new location	$604,784,000
57	Loyola-Dessau	Travis	ASMP 2019	Cesar Chavez	FM 969	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction, some new location	$65,274,000
58	SH 45 connector	Travis	Regional Gap	FM 1826	US 290 West	Upgrade to Divided Arterial, add 0 to 1 lane in each direction, some new location	$32,846,000
59	Quinlan Park to Murfin	Travis	ASMP 2019, Local Govt Need	RM 620	Quinlan Park Rd	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$206,333,000
60	SH 45 connector	Travis	Regional Gap	IH 35	RM 1626	Divided Arterial, 3 lanes in each direction, New Location	$333,505,000
61	Hamilton Pool extension	Hays	Regional Gap	Blanco County Line	SH 71	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$25,733,000
62	CR 185 / Lakeway Blvd connector	Hays	Regional Gap	US 290	Hamilton Pool Rd	Upgrade to Undivided Arterial, include safety and operational improvements	$ 2,733,000

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63	Escarpment Blvd	Hays, Travis	ASMP 2019, Regional Gap	William Cannon	FM 150	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction, some new location	$128,842,000
64	Evelyn Rd / FM 20 connector	Caldwell, Travis	Regional Gap	IH 35	FM 20	Upgrade to Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$88,355,000
65	Central Hays connector	Hays	Regional Gap	Comal County Line	FM 2001	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$245,537,000
66	Pleasant Valley extension	Travis, Hays	ASMP 2019, Regional Gap	E 7th St	Regional Corridor 12	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction, some new location	$155,057,000
67	Central Travis / Bastrop connector	Bastrop, Travis	Regional Gap	FM 973	SH 95	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$165,266,000
68	Travis North-South connector	Travis, Williamson	Regional Gap	Rio Grande St	Westall / Hunters Bend	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$71,987,000
69	Bluff Springs Rd extension	Bastrop, Travis	ASMP 2019, Regional Gap	William Cannon Dr	FM 20	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction, some new location	$139,094,000

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70	CR 141 / Cameron Rd	Travis, Williamson	TxDOT, ASMP 2019, Williamson County Plan 2045, Regional Gap	FM 972	51st St	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction, some new location	$237,736,000
71	Anderson / Spicewood Springs	Travis	ASMP 2019	Lamar Blvd	Old Lampasas Trail	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction	$41,344,000
72	University Dr	Hays	San Marcos Plan 2035	Aquarena Springs Dr	IH 35	Upgrade to Divided/ Undivided Arterial, include safety and operational improvements	$ 442,000
73	Pace Bend Rd	Travis	Local Govt Need	SH 71	Lohman Ford Rd	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$42,997,000
74	Thurman Bend / Flying J Blvd extension	Travis	Regional Gap	FM 2322	RM 1431	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction, some new location	$48,047,000
75	Destination Way / Hudson Bend	Travis	Regional Gap	RM 1431	RM 620	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$5,700,000
76	Boggy Ford / Destination Way	Travis	Regional Gap	Highland Lake Dr	Regional Corridor 26	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$5,587,000

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77	Corridor E	Williamson	Williamson County Plan 2045	IH 35	FM 1660	Upgrade to Regional Connector, 1 to 3 lanes in each direction, some new location	$291,178,000
78	SH 142	Caldwell	Regional Gap	SH 80	SH 130	Upgrade to Regional Connector, add 1 lane in each direction	$147,577,000
79	Yarrington Rd / Hays-Caldwell Connector	Hays	Regional Gap	FM 3237@ Lone Man Mountain	SH 142	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$85,549,000
80	FM 3237 - Old Kyle Rd	Hays	TxDOT, Regional Gap	RM 12	FM 150	Upgrade to Regional Connector, add 2 lanes in each direction	$109,582,000
81	FM 150 / CR 170	Hays	TxDOT, Regional Gap	RM 12	FM 3237 - Old Kyle Rd	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction	$36,480,000
82	FM 1626 / FM 2720 connector	Caldwell, Hays, Travis	TIP, Regional Gap	IH 35	SH 130	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$93,608,000
83	Brodie Ln extension	Hays, Travis	TxDOT, ASMP 2019, Regional Gap	US 290 W	IH 35	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$96,359,000
84	Hays 84	Hays	Regional Gap	FM 1626 @ Lakewood Dr	Regional Corridor 37	Undivided Arterial, 1 lane in each direction, New Location	$35,097,000

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85	Corridor A	Williamson	TIP, Williamson County Plan 2045	IH 35	SH 95	Upgrade to Regional Connector, 2 to 3 lanes in each direction, frontage segment 4 to 6, some new location	$240,575,000
86	FM 3405 / SH 29 connector	Williamson	Williamson County Plan 2045, Regional Gap	Williams Dr	SH 29	Upgrade to Undivided Arterial, 0 to 3 lanes in each direction, some new location	$179,579,000
87	Brizendine Rd	Williamson	Williamson County Plan 2045	Burnet County Line	Regional Corridor 28	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$38,077,000
88	CR 131 / Westinghouse Rd / New Hope Drive connector	Travis, Williamson	TIP, Williamson County Plan 2045, Cedar Park Transportation Plan Update 2015	FM 1660	RM 1431	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$160,701,000
89	CR 255	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	Regional Corridor 136	Regional Corridor 9	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction, some new location	$199,156,000
90	Bee Cave / Barton Springs / Riverside connection	Travis	TxDOT, ASMP 2019, Regional Gap	SH 71	US 183	Upgrade to Divided/ Undivided Arterial, add 1 to 3 lanes in each direction	$166,369,000
91	MoKan	Travis, Williamson	Regional Gap	SH 29	US 290	Upgrade to Regional Connector, 1 to 3 lanes in each direction, 2 non toll managed lanes (peak shoulder use)	$369,920,000

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92	SE Inner Loop / Booty's Crossing	Williamson	Williamson County Plan 2045	Sam Houston Ave	SH 29	Upgrade to Limited Access 2 to 3 lanes in each direction, frontage segment 3+3, some new location	$334,804,000
93	Decker Ln / FM 1660	Travis, Williamson	TxDOT, ASMP 2019, Draft Travis County Transportation Plan, Williamson County Plan 2045	FM 969	CR 314	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$185,052,000
94	Rundberg / Longhorn Blvd	Travis	TIP, ASMP 2019, Regional Gap	Arterial A	MoPac Frontage Rd	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$27,708,000
95	RM 2338 / Williams Dr	Burnet, Williamson	TxDOT, TIP, Williamson County Plan 2045, Regional Gap	FM 2657	IH 35	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$164,020,000
96	D B Wood Rd / CR 318	Williamson	Williamson County Plan 2045, Regional Gap	SH 29	CR 384	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$27,501,000
97	CR 150 / CR 342	Williamson	Williamson County Plan 2045	IH 35	SH 95	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$41,337,000
98	Rowe Ln / CR 139	Travis	Draft Travis County Plan, Pflugerville Plan 2030, Regional Gap	SH 45 / Wilke Ln	SH 95	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction, some new location	$93,386,000

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99	CR 341 / US 281 Loop connector	Burnet	Marble Falls Comp Plan 2016, Burnet County Plan	CR 341	US 281	Undivided Arterial, 1 lane in each direction, New location	$53,948,000
100	Resource Parkway extension	Burnet	Burnet County Plan	RM 1431	Slaughter Mountain Rd	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$25,290,000
101	Lakeline extension / Bertram connector	Burnet, Williamson	TIP, Burnet County Plan, Williamson County Plan 2045, Regional Gap	Old Hwy 29	SH 45	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$292,332,000
102	CR 249 / CR 216	Williamson	Williamson County Plan 2045	US 183	CR 305 Extension	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$79,834,000
103	Williamson 103	Williamson	Williamson County Plan 2045, Regional Gap	SH 130 (.75Mi North Of University Blvd)	Milam County Line	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction, some new location	$85,835,000
104	CR 226 / CR 245	Williamson	TxDOT, Williamson County Plan 2045, Regional Gap	Burnet County Line	RM 2338	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$40,088,000
105	CR 147 / CR 302	Williamson	Williamson County Plan 2045, Regional Gap	CR 241	CR 343	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction, some new location	$125,437,000
106	CR 236 / CR 244	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	CR 274	FM 487	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$31,584,000

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107	Spur 191	Burnet	Regional Gap	SH 71	RM 1431	Upgrade to Regional Connector, 1 lane in each direction, some new location	$47,193,000
108	SH 95 connector / Giese Ln	Travis, Williamson	Williamson County Plan 2045, Regional Gap	SH 95	US 290	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$32,951,000
109	Littig Rd / Webberville Rd	Travis	Regional Gap	Albert Voelker Rd	Webberville Rd	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$42,285,000
110	Parmer-Blake connector / CR 55	Bastrop, Travis	Regional Gap	Blake Manor Rd	CR 49 @ CR 157	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$35,419,000
111	Lindell Ln / Mesquite St	Bastrop, Travis	Draft Travis County Transportation Plan, Local Govt Need, Regional Gap"	Decker Ln	SH 95	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$176,130,000
112	Burleson / Elroy Rd / CR 219	Bastrop, Travis	ASMP 2019, Regional Gap	Ben White Blvd	Regional Corridor 25	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$169,659,000
113	CR 240 / CR 182	Caldwell	Regional Gap	SH 80	CR 179	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$76,724,000

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114	CR 158 / FM 1966	Caldwell, Hays	Regional Gap	IH 35	FM 20	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$40,297,000
115	Caldwell 115	Caldwell	Regional Gap	SH 142	Regional Corridor 113	Undivided Arterial, 1 lane in each direction, New Location	$42,640,000
116	Bebee Rd / High Rd	Hays, Caldwell	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan, Regional Gap	Jack C Hays Trail	Regional Corridor 18	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$179,487,000
117	Lockhart Loop	Caldwell	Lockhart 2020 Thoroughfare Plan, Regional Gap	SH 130	Regional Corridor 113	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$106,429,000
118	SL 360	Travis	TxDOT, Regional Gap	US 183	US 290	Upgrade to Regional Connector and Limited Access, add 1 to 3 lanes in each direction, frontage/ backage segment 3+3	$ 685,127,000
119	Burnet Rd	Travis	ASMP 2019, Regional Gap	Duval Rd	45th St	Upgrade to Divided/ Undivided Arterial, add 1 to 3 lanes in each direction	$24,083,000
120	N Lamar / Guadalupe / S 1st	Travis	TxDOT, ASMP 2019	IH 35 SBFR	FM 1626	"Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction & some one-way pair"	$34,785,000

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121	CR 182 - CR 182 extension	Caldwell	Regional Gap	Regional Corridor 113	FM 672	Upgrade to Undivided Arterial, include safety and operational improvements	$678,000
122	East Austin ETJ	Travis	Regional Gap	Webberville Rd	FM 812	Divided Arterial, 2 lanes in each direction, New Location	$87,199,000
123	Shadow Creek Blvd / CR 157	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan, Regional Gap	CR 123	CR 159 - Yarrington Rd	Upgrade to Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$66,194,000
124	Hays 124	Hays	TxDOT, TIP, Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan, Regional Gap	Regional Corridor 65	Charles Austin St	Upgrade to Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$16,028,000
125	FM 1625 / CR 221	Caldwell, Hays, Travis	Local Govt Need, Regional Gap	US 183	SH 130	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$62,283,000
126	Congress Ave	Travis	ASMP 2019	11th St	Slaughter Ln	Upgrade to Divided/ Undivided Arterial	$39,014,000
127	Montopolis / Stassney / West Gate	Travis	ASMP 2019	US 183 / Airport	US 290	Upgrade to Divided/ Undivided Arterial, add 1 to 3 lanes in each direction	$65,607,000
128	Lamar / Manchaca	Travis	TxDOT, ASMP 2019, Regional Gap	Guadalupe St	US 290	Upgrade to Divided/ Undivided Arterial, add 1 to 3 lanes in each direction	$135,265,000

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129	FM 2001 / Buck Ln	Bastrop, Caldwell, Hays, Travis	TIP, Local Govt Need, Regional Gap	IH 35	End Of Buck Lane	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$115,525,000
130	CR 179	Caldwell, Travis	Draft Travis County Plan, Regional Gap	Regional Corridor 43	FM 20	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$84,469,000
131	Edmondson / McDonald Ln	Bastrop	Regional Gap	Regional Corridor 23	SH 304	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$34,379,000
132	Shiloh Rd	Bastrop	Regional Gap	Regional Corridor 44	SH 304	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$44,647,000
133	Von Quintas Gap	Bastrop, Travis	Regional Gap	FM 973	Regional Corridor 18	Upgrade to Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$122,671,000
134	Holz Rd Gap	Caldwell, Hays	Regional Gap	Regional Corridor 12	CR 303 / FM 2001 Intersection	Upgrade to Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$66,309,000
135	McKinney Falls Pkwy / McAngus Rd	Travis	ASMP 2019, Regional Gap	US 183	COTA	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction	$52,859,000

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136	Williamson 136	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	SH 195	US 183	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$38,295,000
137	Williamson 137	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	SH 195	CR 210	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$26,747,000
138	Williamson 138	Williamson	Williamson County Plan 2045	SH 195	CR 223	Undivided Arterial, 1 lane in each direction, New Location	$27,134,000
139	Williamson 139	Burnet, Williamson	KTMPO, Regional Gap, Williamson County Plan 2045	Bell County Line	CR 243	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$82,090,000
140	Williamson 140	Williamson	Williamson County Plan 2045	FM 970	Regional Corridor 253	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$44,809,000
141	Williamson 141	Williamson	Williamson County Plan 2045	Regional Corridor 28	Regional Corridor 86	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$57,808,000
142	Williamson 142	Williamson	Williamson County Plan 2045	RM 2338	CR 258	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$88,514,000
143	Williamson 143	Williamson	Williamson County Plan 2045, Regional Gap	CR 302	CR 245	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$82,084,000

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144	Williamson 144	Williamson	Williamson County Plan 2045	Bell County Line	CR 305 / Regional Corridor 28	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$9,926,000
145	Williamson 145	Williamson	Williamson County Plan 2045	Regional Corridor 89	US 183	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$6,400,000
146	Williamson 146	Williamson	Williamson County Plan 2045	SH 95 / Regional Corridor 20	Regional Corridor 70	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$26,657,000
147	Williamson 147	Williamson	Williamson County Plan 2045	SH 95	Regional Corridor 77	Undivided Arterial, 1 lane in each direction, New Location	$28,231,000
148	Williamson 148	Travis, Williamson	ASMP 2019, Williamson County Plan 2045, Regional Gap	Carlos G. Parker Blvd	FM 734	Upgrade to Divided/ Undivided Arterial, add 1 to 3 lanes in each direction, some new location	$208,107,000
149	Williamson 149	Williamson	Williamson County Plan 2045, Regional Gap	W 2nd St	Regional Corridor 10	Upgrade to Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$46,168,000
150	Williamson 150	Williamson	Williamson County Plan 2045	Regional Corridor 85	Regional Corridor 267	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$73,699,000
151	Williamson 151	Williamson	Williamson County Plan 2045	3/4 Mi S. Of CR 327	Bell County Line	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$26,265,000

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152	Williamson 152	Williamson	Georgetown Overall Transportation Plan Update 2015	SH 130	Patriot	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$66,089,000
153	Old Settlers Blvd / extension	Williamson	Williamson County Plan 2045	SH 130	Sam Bass Rd	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$53,142,000
154	Windy Hill to SH 130	Caldwell, Hays	Regional Gap	Windy Hill Rd	SH 130	Undivided Arterial, 2 lanes in each direction, New Location	$188,575,000
155	Cesar Chavez / Red Bud / Westlake Dr	Travis	ASMP 2019, Regional Gap	US 183 / Airport Blvd	Bee Cave Rd	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction	$44,926,000
156	W 7th St	Travis	ASMP 2019	Guadalupe St	Airport Blvd	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction	$20,628,000
157	Enfield / 15th St	Travis	ASMP 2019	Lake Austin	IH 35	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction	$22,253,000
158	Bertram couplet	Burnet	Regional Gap	North Street	Hopewell Rd	Arterial, 1-Way Couplet, add 0 to 1 lane in each direction	$ 250,000
159	Marble Falls couplet	Burnet	Regional Gap	Via Viejo	Industrial Blvd	Arterial, 1-Way Couplet, add 0 to 3 lanes in each direction	$ 980,000
160	SH 71 E backage roads	Travis	ASMP 2019	Ross	Pearce	Undivided Arterial, 1 lane in each direction, New Location	$48,787,000

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161	Lockhart couplet	Caldwell	Regional Gap	Frio St	FM 20	Upgrade to Undivided Arterial, & 1-Way Couplet, add 0 to 2 lanes in each direction, some new location	$ 469,000
162	183A	Williamson	Regional Gap	SH 45	Burnet County Line	Upgrade to Divided Arterial, add 1 to 2 tolled lanes plus 4 to 6 frontage	$703,236,000
163	FM 1063	Williamson	TxDOT	FM 1331	US 79	Upgrade to Undivided Arterial, include safety and operational improvements	$34,008,000
164	FM 110	Caldwell, Hays	TxDOT	SH 123	SH 21	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$60,559,000
165	FM 1325	Travis, Williamson	Regional Gap	SH 45	Merrilltown Dr	Upgrade to Divided Arterial, include safety and operational improvements	$ 830,000
166	FM 1466	Williamson	TxDOT	0.52 Miles East Of SH 95	FM 619	Upgrade to Undivided Arterial, include safety and operational improvements	$37,849,000
167	FM 1625	Travis	TxDOT	US 183	SH 130	Upgrade to Undivided Arterial, include safety and operational improvements	$ 1,059,000
168	FM 1660	Williamson	TxDOT, Regional Gap	CR 101 North Of Hutto	SH 95	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$100,287,000

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169	FM 1980	Burnet	Regional Gap	RM 1431	Fairland Rd	Upgrade to Undivided Arterial, include safety and operational improvements	$ 2,285,000
170	FM 2984	Caldwell	TxDOT	FM 671	0.463 Miles West Of US 183	Upgrade to Undivided Arterial, include safety and operational improvements	$ 2,437,000
171	IH 10	Caldwell	TxDOT	Guadalupe County Line	Gonzalez County Line	Limited Access, 2 lanes in each direction	$ 95,000
172	FM 619	Williamson	TxDOT, Regional Gap	At Little Dry Brushy Creek	US 79	Upgrade to Undivided Arterial, include safety and operational improvements	$15,000,000
173	FM 86	Caldwell	TxDOT	At FM 713	At FM 713	Intersection and Safety improvements	$100,000
174	CR 211 / Ronald Reagan Blvd connector	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	CR 211	Ronald Reagan Blvd	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$32,989,000
175	FM 971	Williamson	TxDOT	SH 95	Austin Ave	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction	$ 5,715,000
176	FM 972	Williamson	TxDOT	IH 35	SH 95	Upgrade to Undivided Arterial, include safety and operational improvements	$ 5,970,000
177	CR 223	Burnet	Local Govt Need	FM 963	Lampasas County Line	Upgrade to Undivided Arterial, include safety and operational improvements	$ 1,648,000

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178	CR 221	Burnet	KTMPO	FM 2657	Bell County Line	Upgrade to Undivided Arterial, include safety and operational improvements	$ 598,000
179	North Burnet connector	Burnet	Regional Gap	FM 2340	CR 108	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$11,735,000
180	CR 208	Burnet	Regional Gap	US 183	CR 207	Upgrade to Undivided Arterial, include safety and operational improvements	$ 2,539,000
181	CR 202 / CR 204	Burnet	Regional Gap	CR 207	FM 2340	Upgrade to Undivided Arterial, include safety and operational improvements	$ 1,469,000
182	Park Road 4	Burnet	Regional Gap	US 281	FM 2342	Upgrade to Undivided Arterial, include safety and operational improvements	$ 3,169,000
183	West Marble Falls connector	Burnet	Marble Falls Comp Plan 2016	US 281	RM 1431	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$16,702,000
184	CR 401	Burnet	Regional Gap	US 281	Blanco County Line	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$4,392,000

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185	South Marble Falls connector	Burnet	Marble Falls Comp Plan 2016, Local Govt Need, Regional Gap	CR 404	RM 1431	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$77,852,000
186	US 281 / FM 2147 connector	Burnet	Marble Falls Comp Plan 2016	US 281	FM 2147	Undivided Arterial, 1 lane in each direction, New Location	$9,510,000
187	Mormon Mill Rd	Burnet	Regional Gap	CR 341	US 281	Upgrade to Undivided Arterial, include safety and operational improvements	$ 1,480,000
188	Northeast Marble Falls connector	Burnet	Regional Gap	CR 341	RM 1431	Upgrade to Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$9,688,000
189	Hays 189	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	Regional Corridor 41	Blanco County Line	Undivided Arterial, 1 lane in each direction, New Location	$4,533,000
190	North Dripping Springs connector	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	US 290	CR 169	Undivided Arterial, 2 lanes in each direction, New Location	$49,850,000
191	Southeast Dripping Springs connector	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	US 290	RM 12	Undivided Arterial, 2 lanes in each direction, New Location	$16,758,000

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192	CR 190	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	US 290	FM 165	Divided Arterial, 2 lanes in each direction, New Location	$99,295,000
193	Western Hays connector	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	RM 12	Blanco County Line	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$14,729,000
194	Regional Corridor 36 / Regional Corridor 42 connector	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	Regional Corridor 36	Regional Corridor 42	Undivided Arterial, 1 lane in each direction, New Location	$15,700,000
195	Fischer Store Rd	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	FM 2325	Comal County Line	Upgrade to Undivided Arterial, include safety and operational improvements	$ 2,167,000
196	Southwest Wimberley connector	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	RM 12	Regional Corridor 42	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$1,939,000
197	RM 32 / CR 179 connector	Hays	Local Govt Need	FM 32	CR 179	Undivided Arterial, 1 lane in each direction, New Location	$49,955,000
198	Hays 198	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan, Local Govt Need"	FM 3237	RM 12	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$89,447,000

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199	RM 32	Hays	Regional Gap	RM 12	Comal County Line	Upgrade to Divided Arterial, add 1 lane in each direction	$22,128,000
200	Nutty Brown Rd	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	US 290	FM 1826	Upgrade to Divided Arterial, add 2 lanes in each direction	$40,984,000
201	Sawyer Ranch Rd	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	US 290	FM 150	Upgrade to Divided Arterial, add 1 lane in each direction	$43,006,000
202	Dacy Ln	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	Hillside Terrace	Bunton Creek Rd	Upgrade to Divided Arterial, add 1 lane in each direction	$26,995,000
203	Main St	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan, Regional Gap"	Regional Corridor 130	Dacy Ln	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction, some new location	$145,532,000
204	Jack C Hays Trail	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	FM 967	CR 140	Upgrade to Divided Arterial, add 1 lane in each direction	$34,808,000
205	Hays 205	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan, Regional Gap"	At IH 35	Regional Corridor 65	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$99,989,000

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206	Jacobs Well Rd	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	RM 12	Regional Corridor 37	Upgrade to Undivided Arterial, include safety and operational improvements	$ 568,000
207	RM 150	Hays	Hays County Transportation Plan Amended 2016 - Major Thoroughfare Plan"	FM 1826	Elder Hill Rd	Upgrade to Divided Arterial, add 1 lane in each direction	$3,550,000
208	Goforth Rd	Caldwell, Hays	Local Govt Need	FM 2001	FM 2720	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$67,275,000
209	Lockhart 209	Caldwell	Lockhart 2020 Thoroughfare Plan, Local Govt Need, Regional Gap	SH 142	US 183	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$33,958,000
210	Lockhart 210	Caldwell	Lockhart 2020 Thoroughfare Plan, Local Govt Need, Regional Gap	US 183	Westfork Rd	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$30,460,000
211	FM 1322	Caldwell	Regional Gap	E Martin Luther King Jr Industrial Blvd	US 183	Upgrade to Undivided Arterial, include safety and operational improvements	$ 5,288,000
212	FM 671	Caldwell	Local Govt Need	US 183	SH 80	Upgrade to Undivided Arterial, include safety and operational improvements	$ 2,923,000
213	FM 1966	Caldwell	Regional Gap	SH 142	SH 21	Upgrade to Undivided Arterial, include safety and operational improvements	$ 1,545,000

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214	South Central Bastrop connector	Bastrop	Local Govt Need, Regional Gap	SH 71	CR 238	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$4,001,000
215	Bastrop 215	Bastrop	Bastrop Comp Plan (2016-2036), Local Govt Need, Regional Gap	SH 21	Regional Corridor 112	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$36,931,000
216	Childers Dr	Bastrop	Bastrop Transportation Master Plan	SH 21	Regional Corridor 215	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$47,911,000
217	Bastrop 217	Bastrop	Bastrop Comp Plan (2016-2036)	CR 157	FM 1209	Undivided Arterial, 2 lanes in each direction, New Location	$86,465,000
218	Monkey Rd / Swenson Blvd connector	Bastrop	Regional Gap	Swenson Blvd	Monkey Rd	Undivided Arterial, 1 lane in each direction, New Location	$11,863,000
219	Littig Rd	Bastrop, Travis	Regional Gap	Upper Elgin River Rd	FM 973	Upgrade to Divided Arterial, add 1 lane in each direction	$57,875,000
220	Travis 220	Bastrop, Travis	Draft Travis County Transportation Plan, Regional Gap"	Regional Corridor 52	Manda Carlson Rd	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$60,462,000
221	CR 84	Bastrop	Regional Gap	Roemer Rd	Upper Elgin River Rd	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$20,529,000

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222	FM 3000	Bastrop	Regional Gap	Pleasant Grove Rd	US 290	Upgrade to Undivided Arterial, include safety and operational improvements	$ 1,117,000
223	County Line Rd	Bastrop, Travis	Draft Travis County Transportation Plan, Regional Gap"	CR 461	Blake Manor Rd	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$95,546,000
224	Blake Manor Rd	Travis	Regional Gap	Regional Corridor 111	FM 969	Upgrade to Divided Arterial, add 1 lane in each direction	$10,260,000
225	Northeast Travis / SH 95 connector	Travis, Williamson	Williamson County Plan 2045, Draft Travis County Transportation Plan, Regional Gap	SH 95	Harry Lind Rd	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$30,117,000
226	Engelmann Ln	Travis	Pflugerville Plan 2030, Draft Travis County Transportation Plan, Regional Gap	Williamson County Line	US 290	Upgrade to Divided Arterial, add 1 lane in each direction	$73,107,000
227	E Williamson / Pflugerville connector	Travis, Williamson	Williamson County Plan 2045, Pflugerville Plan 2030	CR 101	Cameron Rd	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$239,559,000
228	Yager Ln	Travis	ASMP 2019, Regional Gap	FM 734	E Cesar Chavez St	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$49,857,000
229	Braker Ln	Travis	ASMP 2019	Harris Branch Pkwy	Dessau Rd	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$35,764,000

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230	Braker Ln	Travis	ASMP 2019	Dessau Rd	US 183	Upgrade to Divided Arterial, include safety and operational improvements	$ 2,014,000
231	Mesa Dr	Travis	ASMP 2019, Local Govt Need	Jollyville Rd	Lake Austin Blvd	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction	$4,350,000
232	CR 137	Travis, Williamson	Pflugerville Plan 2030, Regional Gap	FM 1660	E Pflugerville Pkwy	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$46,725,000
233	SH 45 - McNeil Road connector	Travis, Williamson	ASMP 2019	McNeil Dr	Avery Ranch Blvd	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$41,065,000
234	O'Connor Dr	Williamson	ASMP 2019, Regional Gap	Great Oaks Dr	US 183	Upgrade to Divided Arterial, include safety and operational improvements	$ 2,414,000
235	Round Rock 235	Williamson	Round Rock Transportation Master Plan Update 2017	O'Connor Dr	Deep Wood Dr	Divided Arterial, 2 lanes in each direction, New Location	$53,964,000
236	Hairy Man Rd	Williamson	Round Rock Transportation Master Plan Update 2017, Cedar Park Transportation Plan Update 2015	Sam Bass Rd	Anderson Mill Rd	Upgrade to Divided Arterial, include safety and operational improvements	$26,611,000
237	E Park St	Williamson	Cedar Park Transportation Plan Update 2015	S Vista Ridge Blvd	Anderson Mill Rd	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$29,693,000

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238	RM 620 / SH 29 connector	Williamson	Round Rock Transportation Master Plan Update 2017, Williamson County Plan 2045, Cedar Park Transportation Plan Update 2015	D B Wood Rd	RM 620	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$173,718,000
239	CR 166	Williamson	Williamson County Plan 2045, Cedar Park Transportation Plan Update 2015	FM 1460	Regional Corridor 238	Divided Arterial, 2 to 3 lanes in each direction, New Location	$76,453,000
240	Leander 240	Williamson	Leander Transportation Plan 2017	Ronald Reagan Blvd	RM 2243	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$62,949,000
241	North Leander connector	Williamson	Williamson County Plan 2045, Leander Transportation Plan 2017	CR 279	San Gabriel Pkwy	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$66,170,000
242	Collaborative Way	Travis, Williamson	Leander Transportation Plan 2017, Regional Gap	Halsey Dr	RM 2243	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction, some new location	$31,208,000
243	CR 177	Travis, Williamson	Leander Transportation Plan 2017, Regional Gap	CR 175	RM 1431	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$50,876,000
244	CR 284	Williamson	Williamson County Plan 2045	CR 282	RM 1869	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$13,477,000

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245	Williamson 245	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	US 183	FM 1174	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$6,269,000
246	Williamson 246	Williamson	Williamson County Plan 2045, Regional Gap	Regional Corridor 142	SH 29	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$15,655,000
247	SH 29 Loop	Williamson	Williamson County Plan 2045	SH 29	SH 29	Divided Arterial, 3 lanes in each direction, New Location	$176,760,000
248	Williamson 248	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	CR 243	Regional Corridor 101	Undivided Arterial, 1 lane in each direction, New Location	$57,542,000
249	Williamson 249	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	CR 243	CR 281	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$65,859,000
250	Williamson 250	Williamson	Williamson County Plan 2045	Regional Corridor 248	CR 288	Undivided Arterial, 1 lane in each direction, New Location	$15,619,000
251	Thousand Oaks Trail	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	Regional Corridor 248	CR 323	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$15,595,000
252	Williamson 252	Williamson	Williamson County Plan 2045	SH 29	Travis County Line	Undivided Arterial, 1 lane in each direction, New Location	$73,500,000
253	Corridor I	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	Regional Corridor 139	CR 201	Upgrade to Regional Connector, 1 lane in each direction, some new location	$49,309,000

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254	CR 284 / CR 207	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	CR 243	US 183	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$3,223,000
255	Williamson 255	Williamson	Williamson County Plan 2045	Regional Corridor 102	FM 3405	Divided Arterial, 1 lane in each direction, New Location	$17,057,000
256	Williamson 256	Burnet, Williamson	Williamson County Plan 2045, Regional Gap	Regional Corridor 136	Ronald Reagan Blvd	Undivided Arterial, 1 lane in each direction, New Location	$63,960,000
257	SH 195 Bus / Bell County Connector	Williamson	Williamson County Plan 2045, Regional Gap	Bell County Line	SH 195	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$21,059,000
258	Ramms Dr	Williamson	Williamson County Plan 2045, Regional Gap	Bell County Line	US 79	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction, some new location	$288,003,000
259	Williamson 259	Williamson	Williamson County Plan 2045	FM 487	Regional Corridor 143	Undivided Arterial, 1 lane in each direction, New Location	$31,850,000
260	Williamson 260	Williamson	Williamson County Plan 2045	Regional Corridor 106	Ronald Reagan Blvd	Undivided Arterial, 1 lane in each direction, New Location	$32,548,000
261	FM 487	Williamson	Williamson County Plan 2045, Regional Gap	Regional Corridor 28	SH 195	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$81,057,000

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ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
262	CR 305	Williamson	Williamson County Plan 2045, Regional Gap	Regional Corridor 28	FM 1660	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction, some new location	$125,345,000
263	Williamson 263	Williamson	Williamson County Plan 2045	FM 1105	Regional Corridor 10	Undivided Arterial, 1 lane in each direction, New Location	$5,564,000
264	Williamson 264	Williamson	Williamson County Plan 2045	Bell County Line	FM 972	Undivided Arterial, 1 lane in each direction, New Location	$18,125,000
265	CR 343	Williamson	Williamson County Plan 2045	Bell County Line	Regional Corridor 97	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$28,887,000
266	Williamson 266	Williamson	Williamson County Plan 2045	Regional Corridor 265	Regional Corridor 263	Undivided Arterial, 1 lane in each direction, New Location	$12,313,000
267	Williamson 267	Williamson	Williamson County Plan 2045	Regional Corridor 151	Regional Corridor 77	Undivided Arterial, 1 lane in each direction, New Location	$21,538,000
268	Williamson 268	Williamson	Williamson County Plan 2045	Regional Corridor 10	Regional Corridor 146	Undivided Arterial, 1 lane in each direction, New Location	$18,288,000
269	Williamson 269	Williamson	Williamson County Plan 2045	Regional Corridor 20	CR 339	Undivided Arterial, 1 lane in each direction, New Location	$14,710,000
270	CR 418	Williamson	Williamson County Plan 2045	FM 1331	Regional Corridor 11	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$22,550,000
271	CR 419	Williamson	Williamson County Plan 2045	FM 1331	FM 112	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$11,002,000

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ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
272	CR 414	Williamson	Williamson County Plan 2045	CR 419	Regional Corridor 20	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$16,608,000
273	CR 420	Williamson	Williamson County Plan 2045, Regional Gap	CR 424	N Main St	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$28,311,000
274	FM 112	Williamson	Williamson County Plan 2045, Regional Gap	CR 424	S Main St	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$2,540,000
275	CR 433	Williamson	Williamson County Plan 2045	CR 424	Regional Corridor 151	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$35,510,000
276	CR 416	Williamson	Williamson County Plan 2045	FM 1331	CR 445	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$23,396,000
277	Williamson 277	Williamson	Williamson County Plan 2045, Regional Gap	FM 1331	CR 445	Undivided Arterial, 1 lane in each direction, New Location	$45,005,000
278	Williamson 278	Williamson	Williamson County Plan 2045	SH 95	FM 3349	Undivided Arterial, 1 lane in each direction, New Location	$32,189,000
279	CR 407	Williamson	Williamson County Plan 2045	SH 95	Regional Corridor 93	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction, some new location	$54,930,000
280	Williamson 280	Williamson	Williamson County Plan 2045	Regional Corridor 151	Carl Stern Dr	Divided Arterial, 1 to 3 lanes in each direction, New Location	$59,640,000

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ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
281	Georgetown 281	Williamson	Georgetown Overall Transportation Plan Update 2015, Regional Gap	SH 195	Lawhon Ln	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$96,804,000
282	Williamson 282	Williamson	Williamson County Plan 2045	FM 487	SH 195	Undivided Arterial, 1 lane in each direction, New Location	$25,260,000
283	Ronald Reagan / RM 2243 connector	Williamson	Leander Transportation Plan 2017, Williamson County Plan 2045	Regional Corridor 238	Ronald Reagan Blvd	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$70,363,000
284	N Mays St	Williamson	Round Rock Transportation Master Plan Update 2017	Westinghouse Rd	Dell Way	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$20,644,000
285	Williamson 285	Williamson	Williamson County Plan 2045	Southwest Bypass	IH 35	Divided Arterial, 3 lanes in each direction, New Location	$62,533,000
286	Rockride Ln	Williamson	Williamson County Plan 2045, Regional Gap	Sam Houston Ave	Red Bud Ln	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction, some new location	$127,855,000
287	Lime Creek Rd	Travis	Local Govt Need	Anderson Mill Rd	Anderson Mill Rd	Upgrade to Undivided Arterial, include safety and operational improvements	$ 5,632,000
288	San Marcos 288	Hays	San Marcos Plan 2035	Regional Corridor 79	RM 12	Divided Arterial, 2 lanes in each direction, New Location	$119,532,000

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ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
289	McCarty Ln	Hays	San Marcos Plan 2035, Regional Gap	SH 123	CR 214	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$34,763,000
290	Rattler Rd	Hays	San Marcos Plan 2035, Regional Gap	IH 35	Guadalupe County Line	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$7,285,000
291	N LBJ Dr	Hays	San Marcos Plan 2035	Regional Corridor 288	Sessom Drive	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction, some new location	$7,573,000
292	Sessom Dr	Hays	San Marcos Plan 2035	Academy St	Post Rd	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction	$ 662,000
293	Post Rd	Hays	San Marcos Plan 2035, Regional Gap	CR 158	Aquarena Springs Dr	Upgrade to Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$68,640,000
294	S Guadalupe St	Hays, Guadalupe	San Marcos Plan 2035	W Woods St	FM 1101	Upgrade to Regional Connector, 1 to 3 lanes in each direction, & 1-Way Couplet	$ 203,465,000
295	FM 621	Hays, Guadalupe	San Marcos Plan 2035	SH 123	FM 1339	Upgrade to Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$65,283,000
296	Old Bastrop Hwy	Hays	San Marcos Plan 2035	SH 21	IH 35	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction	$28,309,000

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ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
297	Riverway Ave / SH 142 Connector	Hays	San Marcos Plan 2035	Regional Corridor 78	Post Rd	Divided Arterial, 2 lanes in each direction, New Location	$158,882,000
298	San Marcos 298	Hays, Guadalupe	San Marcos Plan 2035	SH 80	End Of Quail Run	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$92,088,000
299	Center Point Rd	Hays, Guadalupe	San Marcos Plan 2035	Hunter Rd	Francis Harris Ln	Upgrade to Divided/ Undivided Arterial, add 0 to 1 lane in each direction	$41,564,000
300	Old Bastrop Hwy	Hays	San Marcos Plan 2035	Old Bastrop Hwy	Center Point Rd	Upgrade to Undivided Arterial, include safety and operational improvements	$ 1,080,000
301	San Marcos 301	Hays, Comal, Guadalupe	San Marcos Plan 2035	Regional Corridor 288	Center Point Rd	Uprade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction, some new location	$55,814,000
302	Old Zorn Rd	Guadalupe	San Marcos Plan 2035	Center Point Rd	FM 1979	Upgrade to Undivided Arterial, include safety and operational improvements	$ 4,003,000
303	Old Bastrop Hwy	Hays	San Marcos Plan 2035	SH 123	IH 35	Upgrade to Undivided Arterial, add 1 lane in each direction	$36,994,000
304	Uhland Rd	Hays	San Marcos Plan 2035	IH 35	E Hopkins St	Upgrade to Divided Arterial, add 0 to 1 lane in each direction	$16,995,000

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ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
305	Craddock / Bishop	Hays	San Marcos Plan 2035	Wonder World	Hopkins	Upgrade to Divided Arterial, add 0 to 1 lane in each direction	$58,882,000
306	Franklin / Holland	Hays	San Marcos Plan 2035	Bishop	LBJ	Upgrade to Undivided Arterial, add 0 to 1 lane in each direction	$ 588,000
307	The Domain Network arterial support	Travis	ASMP 2019	Research Blvd	Research Blvd	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction	$73,246,000
308	Near NW Case Study Interventions	Travis	Near Northwest Corridor Connections Case Study 2017, ASMP 2019	Pond Springs	SL 360	Upgrade to Divided/ Undivided Arterial, add 0 to 2 lanes in each direction	$108,632,000
309	Robinson Ranch / Apple Campus Streets	Travis, Williamson	ASMP 2019	SH 45	Parmer Ln	Upgrade to Divided Arterial, add 0 to 3 lanes in each direction	$189,269,000
310	IH 35	Hays, Travis, Williamson	TxDOT	SH 195	Comal County	Limited Access, 6 to 8 GP lanes, 0 to 4 MLs and Frontage 3+3	$10,908,375,000
311	SL 1 / MoPac	Travis, Williamson	TxDOT	FM 734 ————— Cesar Chavez	US 183; then ————— SH 45 S	Limited Access, 6 to 8 GP, 0 to 4 Managed Lanes, Frontage 4 to 6	$655,739,000
312	RM 620 / RM 2222 support	Travis	Local Govt Need	RM 2222	Sitio Del Rio	Undivided Arterial, 1 lane in each direction, New Location	$14,953,000
313	SH 130	Caldwell, Travis, Williamson	TIP, Regional Gap	IH 35	Guadalupe County Line	Limited Access, add up to 1 lane in each direction	$1,223,825,000
314	Creek Bend Blvd / Brightwater Bend extension	Williamson	Round Rock Transportation Master Plan Update 2017	Regional Corridor 88	Great Oaks Dr	Upgrade to Divided Arterial, add 0 to 2 lanes in each direction	$58,747,000

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ARTERIAL CONCEPT NUMBER	FACILITY	COUNTY	PLANS REFERENCED	FROM	TO	ARTERIAL CONCEPT SUMMARY DESCRIPTION	COST
315	CR 112 / CR 118 / N Taylor connector	Williamson	Williamson County Plan 2045	CR 421	N AW Grimes Blvd	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction	$262,838,000
316	CR 313 / Regional Corridor 146 connector	Williamson	Williamson County Plan 2045	CR 313	Regional Corridor 146	Undivided Arterial, 1 lane in each direction, New Location	$42,833,000
317	FM 487 / Regional Corridor 97 connector	Williamson	Williamson County Plan 2045	Bell County Line	Regional Corridor 97	Undivided Arterial, 1 lane in each direction, New Location	$9,733,000
318	FM 1105-US 79 connector	Williamson	Williamson County Plan 2045	Bell County Line	W. 2nd St	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction	$177,203,000
319	CR 124	Williamson	Williamson County Plan 2045	SH 95	SH 130	Upgrade to Divided/ Undivided Arterial, add 0 to 3 lanes in each direction	$89,636,000
320	Airport Blvd / SL 111	Travis	ASMP 2019, Regional Gap	US 183	IH 35	Upgrade to Regional Connector, 2 lanes in each direction, plus 1 flex lane segment in each direction	$61,229,000
321	SH 71 New Facilities	Travis	ASMP 2019	SH 71	Fagerquist Rd	Undivided Arterial, 1 lane in each direction, New Location	$54,000,000
322	5th St	Travis	ASMP 2019	MoPac	Guadalupe St	1-Way couplet	$516,000
323	6th St	Travis	ASMP 2019	MoPac	Guadalupe St	1-Way couplet	$596,000
324	US 290 Support	Travis	Regional Gap	County Line Rd	Regional Corridor 47	Divided Arterial, 2 lanes in each direction, New Location	$50,880,000
325	SH 95	Bastrop	Local Govt Need	SH 71	Bastrop County Line	Upgrade to Undivided Arterial, include safety and operational improvements	$3,645,000

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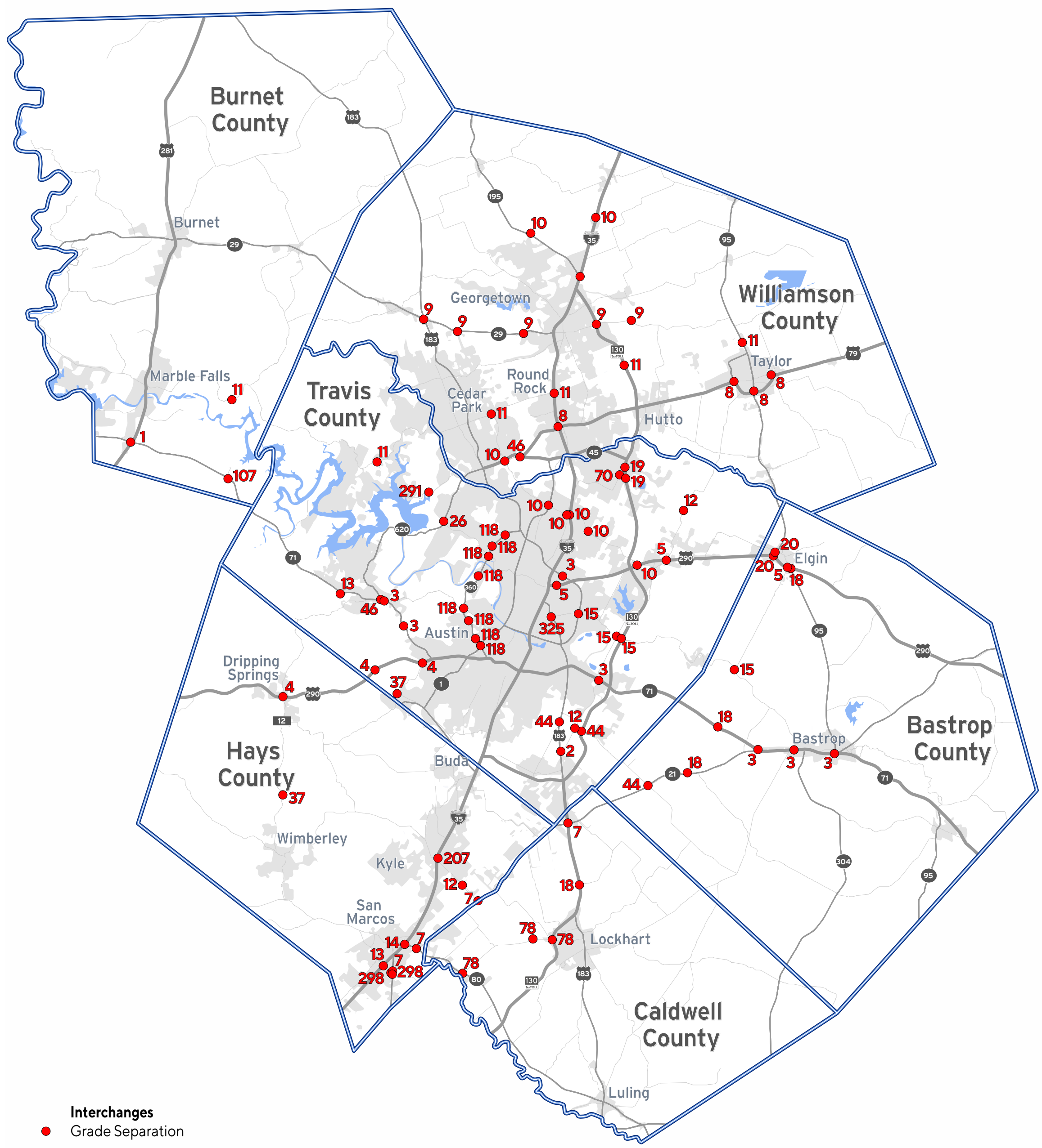
Interchanges



Source:
CAMPO, 2018
Texas Department of Transportation (TxDOT), 2018

Regional Corridor Inventory Interchange Concept Summary

ARTERIAL CONCEPT NUMBER	FACILITY	AT	COUNTY	INTERCHANGE CONCEPT SUMMARY	COST
1	US 281	SH 71	Burnet	Modified Cloverleaf w/CD	$82,500,000
2	FM 685/ Cameron/ Dessau	US 183	Travis	3 level Diamond	$75,000,000
2	US 183	FM 973	Travis	3-level Diamond	$75,000,000
3	SH 21	SH 71 (West Bastrop)	Bastrop	Diamond with direct connectors 71 west to 21 south	$120,000,000
3	SH 21	SH 71/95 (East Bastrop)	Bastrop	Single Point Urban Interchange	$45,000,000
3	SH 71	Cross Town Pkwy	Travis	Diamond	$45,000,000
3	SH 71	Southwest Parkway	Travis	Diamond	$45,000,000
3	FM 969	SH 71	Bastrop	3-level Diamond	$75,000,000
3	FM 973 - Ext	SH 71	Travis	3-level Diamond	$75,000,000
4	RM 12/North Extension	US 290	Hays	3-level Diamond	$75,000,000
4	US 290	45 SW	Travis	3-leg Directional	$45,000,000
4	US 290	RM 1826	Travis	Diamond	$45,000,000
5	SH 95	US 290 (East Elgin)	Bastrop	add direct connectors from US 290 east/95 south to	$112,500,000
5	FM 685/ Cameron/ Dessau	US 290	Travis	3-level Diamond	$75,000,000
5	FM 973 - Ext	US 290	Travis	3-level Diamond	$75,000,000
7	SH 21	RM 12	Hays	3-level Diamond	$75,000,000
7	SH 21	SH 80	Hays	3-level Diamond	$75,000,000
7	SH 21	FM 150	Hays	Diamond	$45,000,000
7	SH 21	SH 130/US 183	Caldwell	3-level Diamond	$75,000,000
8	US 79	IH 35	Williamson	Add direct connectors from IH 35 north to 79 north	$75,000,000
8	US 79	Bus 79 W	Williamson	Complete 3/4 cloverleaf add direct connector for 7	$37,500,000
8	US 79	Bus 79 E	Williamson	Complete 3/4 cloverleaf add direct connector for 7	$37,500,000
8	SH 95	US 79	Williamson	Finish Cloverleaf	$37,500,000
9	SH 29	US 183	Williamson	3-level Diamond	$75,000,000
9	SH 29	SW Inner Loop	Williamson	Partial Cloverleaf	$45,000,000

ARTERIAL CONCEPT NUMBER	FACILITY	AT	COUNTY	INTERCHANGE CONCEPT SUMMARY	COST
9	SH 29	SE Inner Loop	Williamson	Diamond with 29 grade separation	$45,000,000
9	SH 29	SH 130	Williamson	3-level Diamond	$75,000,000
9	FM 734/ Ronald Reagan	SH 29	Williamson	3-level Diamond	$75,000,000
10	FM 685/ Cameron/ Dessau	FM 734	Travis	3-level Diamond	$75,000,000
10	FM 734/ Ronald Reagan	US 290	Travis	3-level Diamond	$75,000,000
10	FM 734/ Ronald Reagan	IH 35	Travis	3-level Diamond with 35 Frontage by-passes	$75,000,000
10	FM 734/ Ronald Reagan	SL 275	Travis	Diamond	$45,000,000
10	FM 734/ Ronald Reagan	SL 1	Travis	3-level Diamond with SL 1 Frontage by-passes	$75,000,000
10	FM 734/ Ronald Reagan	SH 45/RM 620	Williamson	3-level Diamond	$75,000,000
10	FM 734/ Ronald Reagan	SH 195	Williamson	3-level Diamond	$75,000,000
10	FM 734/ Ronald Reagan	IH 35 N	Williamson	3-level Diamond	$75,000,000
11	FM 734/ Ronald Reagan	RM 1431	Williamson	3-level Diamond	$75,000,000
11	RM 1431/ University/ Chandler	Spur 191/New Facility	Burnet	Diamond	$45,000,000
11	RM 1431/ University/ Chandler	New Connection to Volente	Travis	Diamond	$45,000,000
11	RM 1431/ University/ Chandler	IH 35	Williamson	3-level Diamond with frontage C/D	$75,000,000
11	RM 1431/ University/ Chandler	SH 130	Williamson	3-level Diamond	$75,000,000
11	RM 1431/ University/ Chandler	SH 95	Williamson	3-level Diamond	$75,000,000

ARTERIAL CONCEPT NUMBER	FACILITY	AT	COUNTY	INTERCHANGE CONCEPT SUMMARY	COST
12	FM 150	FM 973 - Ext	Hays	3-level Diamond	$75,000,000
12	FM 973 - Ext	FM 812	Travis	3-level Diamond	$75,000,000
12	FM 973 - Ext	Pflugerville Parkway/FM 1100	Travis	3-level Diamond	$75,000,000
13	SH 71	RM 12-Ext	Travis	Diamond	$45,000,000
13	RM 12/North Extension	IH 35	Hays	3-level Diamond	$75,000,000
14	SH 80	IH 35	Hays	3-level Diamond	$75,000,000
15	FM 969	US 183	Travis	3-level Diamond	$75,000,000
15	FM 969	FM 973	Travis	At-Grade signal	$750,000
15	FM 969	SH 130	Travis	3-level Diamond	$75,000,000
15	FM 1704	FM 969	Bastrop	3-level Diamond	$75,000,000
18	SH 21	FM 1704	Bastrop	3-level Diamond	$75,000,000
18	FM 1704	SH 130	Caldwell	Cloverleaf	$45,000,000
18	FM 1704	SH 71	Bastrop	3-level Diamond	$75,000,000
18	FM 1704	US 290	Bastrop	Diamond	$45,000,000
19	FM 685/ Cameron/ Dessau	Pflugerville Parkway	Travis	3 level Diamond	$75,000,000
19	FM 1100/ Pflugerville Pkwy	SH 130	Travis	3-level Diamond	$75,000,000
20	SH 95	US 290 (West Elgin)	Bastrop	3-level Diamond, add direct connector 290 east to	$112,500,000
20	FM 1100/ Pflugerville Pkwy	SH 95	Travis	3-level Diamond	$75,000,000
26	RM 2222/ Bullick Hollow	RM 620	Travis	3-level Diamond	$75,000,000
37	RM 12/North Extension	RM 1826/Alamo Connection	Hays	3-level Diamond	$75,000,000
37	RM 1826/ Alamo Connector	45 SW	Hays	3-level diamond with direct connectors for 1826 no	$150,000,000
44	US 183	FM 812	Travis	3-level Diamond	$75,000,000
44	SH 21	FM 812	Bastrop	3-level Diamond	$75,000,000
44	FM 812	SH 130	Travis	3-level Diamond	$75,000,000
46	SH 71	FM 620	Travis	Diamond with 2 Direct Connect from 620 south to 7	$120,000,000
46	RM 620	SH 45	Travis	Add direct connectors from 45 east to 620 east and	$75,000,000

ARTERIAL CONCEPT NUMBER	FACILITY	AT	COUNTY	INTERCHANGE CONCEPT SUMMARY	COST
70	FM 685/ Cameron/ Dessau	SH 130 S	Travis	Diamond with DC	$37,500,000
78	SH 80	SH 142	Caldwell	At-grade signal	$750,000
78	SH 142	SH 130	Caldwell	Diamond	$45,000,000
78	FM 150	SH 130	Caldwell	Diamond	$45,000,000
107	SH 71	Spur 191	Burnet	Diamond	$45,000,000
118	Loop 360	Spicewood Springs Rd	Travis	Diamond	$45,000,000
118	Loop 360	Lakewood Dr	Travis	Diamond	$45,000,000
118	Loop 360	RM 2222 / Courtyard Dr	Travis	3-level Diamond	$75,000,000
118	Loop 360	Westlake Dr	Travis	Diamond	$45,000,000
118	Loop 360	RM 2244	Travis	DDI	$45,000,000
118	Loop 360	Lost Creek Blvd / Westbank Dr	Travis	Diamond	$45,000,000
118	Loop 360	Walsh Tarlton Ln	Travis	Diamond	$45,000,000
118	Loop 360	Loop 1	Travis	Partial stack and Diamond	$75,000,000
207	FM 150	IH 35	Hays	3-level Diamond	$75,000,000
291	RM 2222/ Bullick Hollow	FM 2769	Travis	Add turn lanes (right and left)	$750,000
298	SH 21	SH 123	Hays	3-level Diamond	$75,000,000
298	RM 12/North Extension	SH 123	Hays	3-level Diamond	$75,000,000
325	Loop 111	FM 969	Travis	Diamond with Signal	$45,000,000

REGIONAL ARTERIALS CONCEPT INVENTORY

CHAPTER 6

PATTERN BOOK

CAMPO

CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

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SECTION 1

REGIONAL ARTERIAL NETWORK CASE STUDIES

Introduction

To better understand the CAMPO Region facilities network, the arterials of four peer regions have been studied and are detailed below. The peer regions of San Jose, Oklahoma City, Las Vegas, and Phoenix each exhibit post-war development patterns like the CAMPO Region and are seeing relatively high rates of population growth. For Oklahoma City, Phoenix, and Las Vegas the MPO areas were used as study area boundaries; for San Jose the Metropolitan Statistical Area (MSA) area was used.

- San Jose, Metropolitan Statistical Area (San Jose Region)
- Oklahoma City, Metropolitan Planning Area (Oklahoma City Region)
- Las Vegas, Metropolitan Planning Area (Las Vegas Region)
- Phoenix, Metropolitan Planning Area (Phoenix Region)

Each case study evaluated a region's:

1. Socioeconomic context.
2. Arterial network and local definitions for functional classification.
3. Key performance metrics related to mobility.
4. Spacing of arterial roadways.
5. Identification of barriers to network connectivity.

An investigation of corridor-level best practices follows the regional case studies, which highlights the roles that these corridors serve, key design and operational features, and typical cross sections. Ten corridors are presented to show the ways in which arterial roadways can be designed to accommodate various modes of transportation like car, freight, transit, biking, and walking. The examples span from arterials serving interregional movement, those providing for longer distance travel within the region, to arterials that function as key sub-regional corridors.

Additionally, CAMPO evaluated and identified 'Best Practices' and 'Lessons Learned' that may be applicable to the CAMPO Region's facility network.

Key Takeaways from Peer Region Study

The findings of these case studies offer insight into the design and operation of regional arterial networks and corridors . Some of the key insights point out that:

Las Vegas, Oklahoma City, and Phoenix Regions all have extensive gridded networks of arterial roads and Collectors. In particular, these regions have more lane miles per person of Minor Arterials, which often serve to support Major Arterials and Limited-Access facilities (See FHWA-Based Classification and Descriptions below).

Due to the uniformity and connectivity of the gridded networks of Las Vegas, Oklahoma City, and Phoenix, these regions have a greater number of lane miles per person of Minor Arterials than the Capital Area Region.

The San Jose Region has a network of Regional Connectors, which are a system of Principal Arterials, to support longer distance regional movement. Wurzbach Parkway in San Antonio serves a similar purpose but highlights how Principal Arterials that also limit access to supplement existing Freeways.

The Capital Area Region has the second lowest weighted population density per square mile at the block group level.[1]

[1] Source: Weighted population density was calculated as the average of each resident's census block group density.

Case Study Metrics

The following descriptions highlight why each evaluated metric is pertinent for arterial comparison. Comparing regions with similar or dissimilar development patterns provides opportunities to evaluate `Best Practices' or `Lessons Learned' that may be applicable to the CAMPO Region's arterial network.

Metric	Description
Vulnerable Populations	The two major data points for this metric are number of residents in a region below the poverty level according to the U.S. Census and number of minority residents. CAMPO's definition of Vulnerable Population also considers seniors, persons with a disability, and youth.
Crude Density vs Weighted Density	Crude density' is the overall population density of a geographical area (i.e. County). Weighted density illustrates the specific areas where the least or most people live in that geographical area. For example, the overall U.S. population density in 2010 was 87 people per square mile, but weighted density illustrates that in 2010 U.S. Populations actually lived at an average of 5,369 people per square mile. Additionally, weighted density better accounts for open space or un-developable land.
Vehicle Miles Traveled	The total number of miles vehicles in a Region drive, typically an annual total. Provides an 'order of magnitude' idea of the miles the arterial network is supporting in each region. Can illustrates how decision making on arterial networks can impact travel trip time. This information can be useful when designing streets in communities with high-rates of either low-income or minority populations that can benefit from multi-modal solutions. Particularly, if any of these communities have higher than the regional average of transit dependent households.
Mode Split	Indicates the percentage of residents that use single-occupancy vehicle, carpool, transit, and walk or bike to their destinations. This information is typically available for peak AM and PM commute times. This statistic does not currently include trips using private micro-transit i.e. Chariot. Mode split is most influenced by density. Typically, the higher the density the greater the transit mode share.
Grid Spacing	This is the distance between parallel arterials going the same geographical direction – North, South, East and West. As expected the highest concentration of parallel corridors being in close proximity is in the urban core whereas in rural communities the proximity of parallel corridors can be in the tens of miles. We also see large grid spacings between intersections in the suburbs with commercial nodes that have shopping centers with large square footage shopping retailers like HEB, Target and the like. Planning the grid spacing will help to drive density and manage growth.
Lane Miles Per Capita	This metric establishes a value for the quantity of lane miles by population and cam be expressed as ratio. This value indicates the quantity of roads available to users in comparison with other cities or communities. It is primarily used to indicate roads available for single occupancy vehicular use but can also be used to infer multimodal dependence. It can also be used to compare the lane miles available by functional class to ensure your transportation network is appropriately balanced.

Other census metrics were evaluated as part of a detailed review for the regions previously discussed. Other metrics, such as population, vehicles hours, percent change of population (net increase or decrease), and mean travel time to work, help better understand how the land use and built form influence regional transportation.

[2] Source: Smart Cities Drive, The Census Bureau embraces weighted density. https://bit.ly/2XAQ467

FHWA-Based Classification and Descriptions

There are multiple types of municipal functional classification groupings, so for these case studies, we elected to build the CAMPO functional classification system based on FHWA system principles to provide a unified classification measure. [3, 4]

Freeways or Expressways are controlled access facilities with grade-separated interchanges.

Principal/Major Arterials serve major traffic movements within urbanized areas, connecting central business districts, outlying residential area, major intercity communities, and major suburban centers.

Super Arterials are characterized by speed limits up to 55 miles per hour (mph), grade-separated of 1-mile-spaced signalized intersections, a concrete median barrier between opposing traffic and pedestrian areas, and consolidated, right-turn-only curb cuts and driveways to adjacent property.

Minor Arterials are roadways for which mobility and access to abutting land uses are important functions. They are connected to principal arterials to provide a free flow for trips of moderate lengths within relatively small geographical areas.

[3] Source: California Department of Transportation. Functional Classification. https://bit.ly/2XGmDiL

[4] Source: FHWA Highway Functional Classification Concepts, Criteria and Procedures. https://bit.ly/2DKhQ2y

Case Study Regions

San Jose Region

Oklahoma City Region

Las Vegas Region

Phoenix Region

San Jose Region Case Study

While there are many similarities between the CAMPO Region and the San Jose Region (Santa Clara and San Benito Counties), the table below highlights key differences.

Census Comparison of San Jose Region and CAMPO Region[5]

Facility Type	San Jose Region	CAMPO Region
Total Population Estimates (July 1, 2017)	1,998,463	2,162,631
Population growth (2010 to 2017)	8.8%	22.9%
Mean travel time to work (minutes)	29.0	28.6
Persons in poverty, percent	9.4%	10.9%
Population per square mile	745.7	414.8
Land area in square miles	2,679.9	5,214.2
Weighted Density Per sq. mi (Block Group)	10,448.9	3,998.3
Vehicle miles traveled (VMT)	37.7 million	44.2 million

Figure 4.1

The CAMPO Region is roughly double the land area of the San Jose Region and considerably less dense. Even though both economies share key economic drivers that typically feature large low-density corporate campuses, the San Jose Region has been able to develop a more compact arterial network that is concentrated, well-connected, and supportive of both short and long-distance travel. The regional network has also grown in an organic pattern similar to that of the CAMPO Region which makes its approach more feasible, scalable, and appropriate. This case study explores these ideas and seeks to uncover concepts that have been successfully put into practice.

Economy

Much like the CAMPO Region, the San Jose Region is often thought of as a predominant technology economy, although the San Jose Region has a more diverse economy. According to the Bureau of Labor Statistics' May 2018 count, Professional & Business Services is the portion of the economy that employs the greatest number of people with 232,500 jobs (21%), followed by Education & Health Services with 176,800 jobs (16%), and Manufacturing with 172,600 jobs (15%). By contrast, Information totals 90,200 jobs[6], or 8% of total jobs. Each of these segments of the economy generate demand for the arterial network, and this is especially true with Manufacturing which necessitates a robust roadway network for goods distribution.

[5] Source: US Census Bureau. Census Population Estimates, 2017. https://bit.ly/2XmSKol

[6] Source: U.S. Bureau of Labor Statistics . https://bit.ly/2XIEBkT

San Jose Region Arterial Network

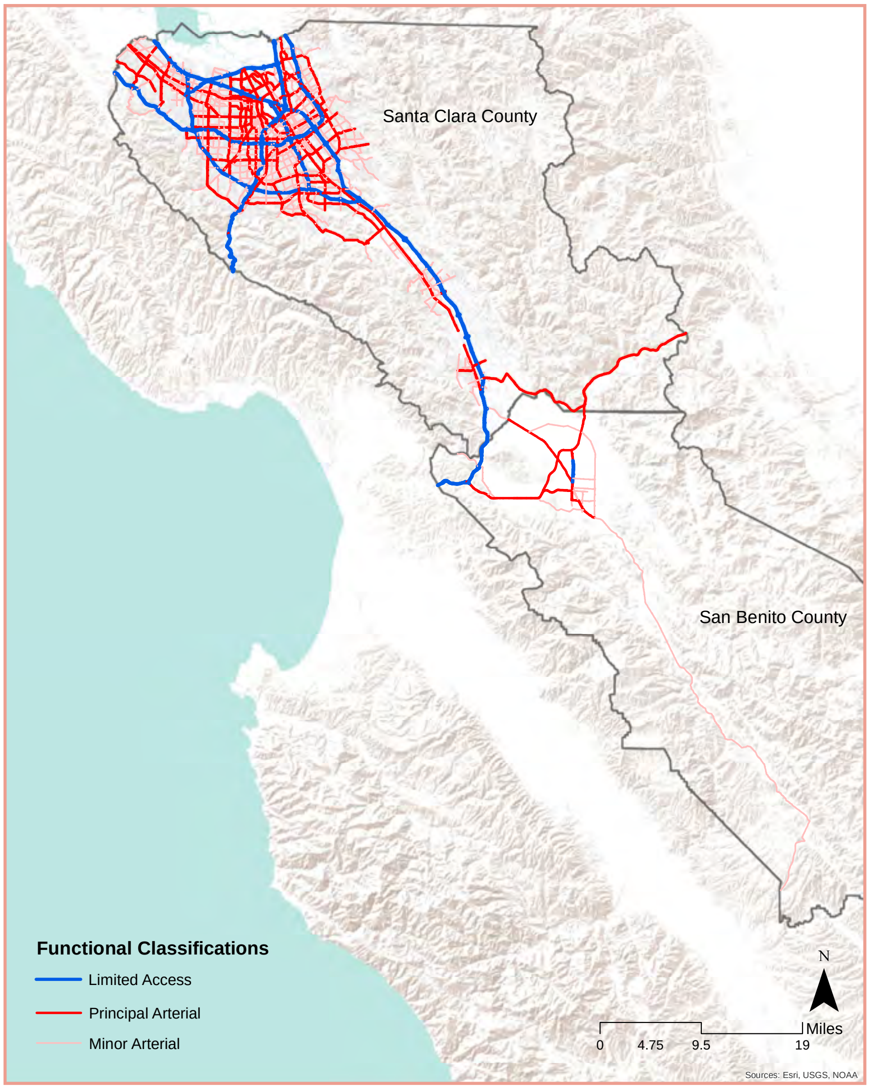


Figure 4.2

The table below is the mileage by CAMPO's functional classification grouping.

San Jose Region Metro[7,8]

Facility Type	San Jose Lane Miles	Lane Mile Per 10,000 People	CAMPO Lane Miles	Lane Mile Per 10,000 People
Limited-Access	340.9	1.7	1,332.8	6.2
Principal/Major Arterial	2,148.3	10.7	2,543.5	11.8
Minor Arterial	1,227.4	6.1	1,644.6	7.6
Collector	1,831.1	9.2	5,248.7	24.3

Figure 4.3 Lane mile table

Vehicle Miles Traveled

San Jose Metro area also has about **37,676,760 Daily Vehicle Miles Traveled.**[9]

[7] Source: 2016 PRD Table 3
[8] Source: FHWA classified CA 85 as a Principal Arterial from IH-280 to Meridian Avenue. CAMPO classified this segment as a Regional Connector. FHWA also classified the Capital Expressway as a freeway/expressway but CAMPO classified it as a Principal Arterial.
[9] Source: 2016 PRD Table 4

San Jose Region Network Spacing

The San Jose Metro area has a consistent albeit asymmetrical network of arterials in the urbanized area. Minor Arterials are spaced roughly 1/4 to 1/2 mile apart whereas Major Arterials are spaced roughly 1 to 2 miles apart. When these roadways are integrated they are spaced approximately 1/4 miles apart. Moving away from the core city, the integrated arterials become less dense at roughly 1/2 to 1 mile apart. Supporting the arterial network is the system of Freeways which are spaced 3-5 miles apart.

Central San Jose Region Arterial Network Spacing

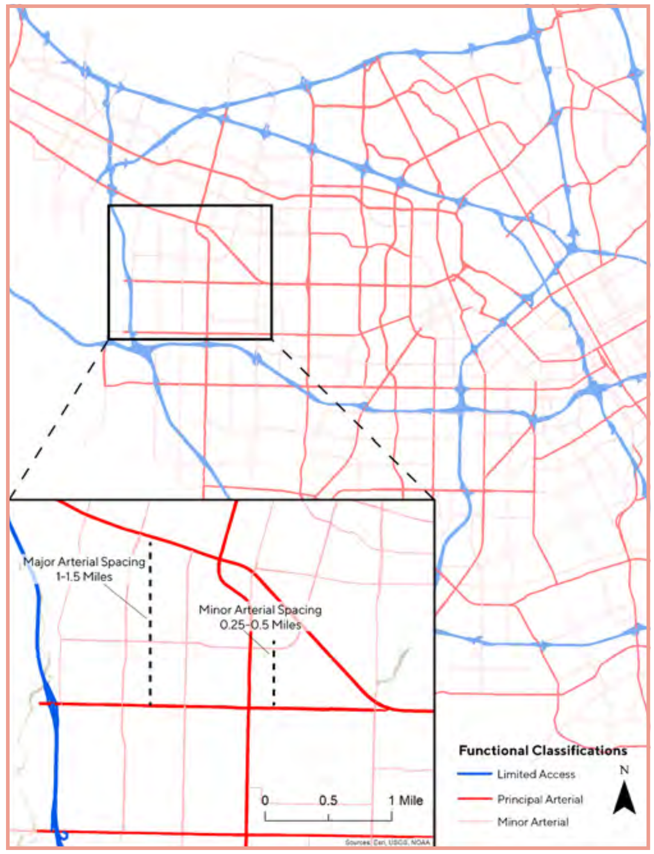


Figure 4.4

Network Barriers

Despite being in a valley surrounded by mountains and the Bay, the Metro area has relatively few natural barriers—most of its barriers are human made. The primary hurdle for the arterial network is the San Jose International Airport, which creates a break in the network. Conversely, the natural barriers in the area (i.e. creeks and topographical undulations) are overcome using bridges or by building roadways around them. Below are the prominent network barriers in the area.

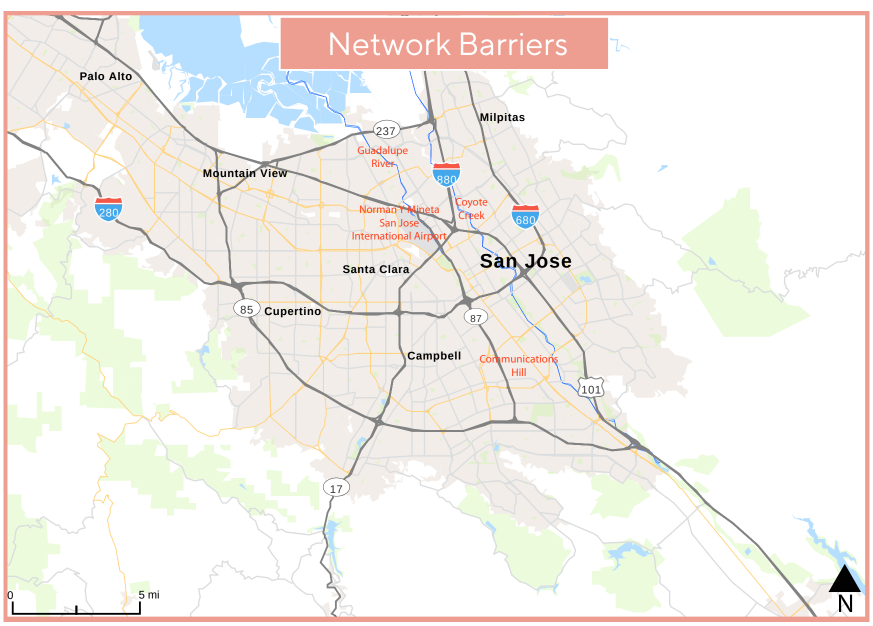


Figure 4.5

- Norman Y. Mineta San Jose International Airport
- Coyote Creek
- Area Freeways (e.g. IH-280, US 101, etc.)
- Communication Hill

Multi-modal Design Features

The Metropolitan Transportation Commission (MTC) is the Bay Area's MPO and operates managed access infrastructure and the Express Lane projects which will be expanded in the near future. Express Lanes are carpool lanes that act as transit ways during the morning and evening rush hours and are reserved specifically for transit, carpool vehicles, clean air vehicles, and motorcycles using a flex pass to access the Express-Lanes for free. If traveling alone, a flex pass is needed to use the express lane as a tolled facility.[10] A unique feature of the San Jose Region's arterial network would be its system of Expressways that are surface arterials that on many stretches include peak-period bus/motorcycle/carpool restrictions in the right-lanes or shoulders.

Source: High-occupancy vehicle (HOV) lane, HNTB 2018

Figure 4.6

Source: VTA Transit Stop, Wikipedia. https://bit.ly/2MaiDz7

Figure 4.7

In addition, there are also 81 directional route miles of light rail in the Region, most of which runs in the median of divided arterials while local buses operate mostly in mixed traffic with occasional bus pull outs.[11] The San Jose Region currently has 8.6 miles of existing managed access lane miles on Freeways (which Caltrans considers Principal Arterials) and 256.5 programmed-proposed managed access lane miles.[12] The arterial network also includes active transportation accommodations with bike lanes on some arterials and sidewalks on most arterials.

[10] Source: Santa Clara Valley Transportation Authority. How to Use Silicon Valley Express Lanes. https://bit.ly/2LEdosW

[11] Source: Federal Transit Administration. 2016 Service, Federal Transit Administration. https://bit.ly/2LCNfuV

[12] Source: Caltrans - California Department of Transportation. Express Lane Inventory List. https://bit.ly/2L1rCoD

Oklahoma City Region Case Study

The Oklahoma City Metro Area is the largest region in the state of Oklahoma and the state capital.

Census Comparison of Oklahoma City Region and CAMPO Region[13]

	Oklahoma City Region	CAMPO Region
Total Population Estimates (July 1, 2017)	1,373,211	2,162,631
Population growth (2010 to 2017)	9.2%	22.9%
Mean travel time to work (minutes)	22.5	28.6
Persons in poverty, percent	14.7%	10.9%
Population per square mile	249.1	414.8
Land area in square miles	5,511.6	5,214.2
Weighted Density Per sq. mi (Block Group)	3,655.8	3,998.3
Vehicle miles traveled (VMT)	30.3 million	44.2 million

Figure 4.8

Over the course of its history, the Oklahoma City Region has served as a regional crossroads for trade and energy production. Much like other sunbelt cities, like the CAMPO Region, its dynamic growth occurred in the 20th Century which has resulted in a post-war development pattern oriented around the automobile. The Oklahoma City metro area has planned an extensive arterial network to serve its current population and future growth.

Economy

Like the CAMPO Region, the Oklahoma City Region is home to the state capital which is why government jobs are the largest proportion of the local economy with 132,100 jobs (20%). *Trade, Transportation, and Utilities* makes up the second largest share with 111,200 jobs (17%). Following these are *Education and Health* Services 92,700 jobs (14%), *Professional and Business Services* 85,300 jobs (13%), and *Leisure and Hospitality* 75,100 jobs (12%). Particularly relevant to the arterial network is the fact that nearly one fifth of the economy is directly employed by *Trade, Transportation, and Utilities.*

[14]

20%	Government
17%	Trade,Transportation & Utilities
14%	Educational & Health Services
13%	Professional & Business Services
12%	Leisure & Hospitality
5%	Construction
5%	Manufacturing
5%	Financial Activities
5%	Other Services
3%	Mining and Logging
1%	Information

[13] Source: US Census Bureau. Census Population Estimates, 2017. https://bit.ly/2LziaYI
[14] Source: U.S. Bureau of Labor Statistics. https://bit.ly/2Yubgrk

Oklahoma City Region Arterial Network

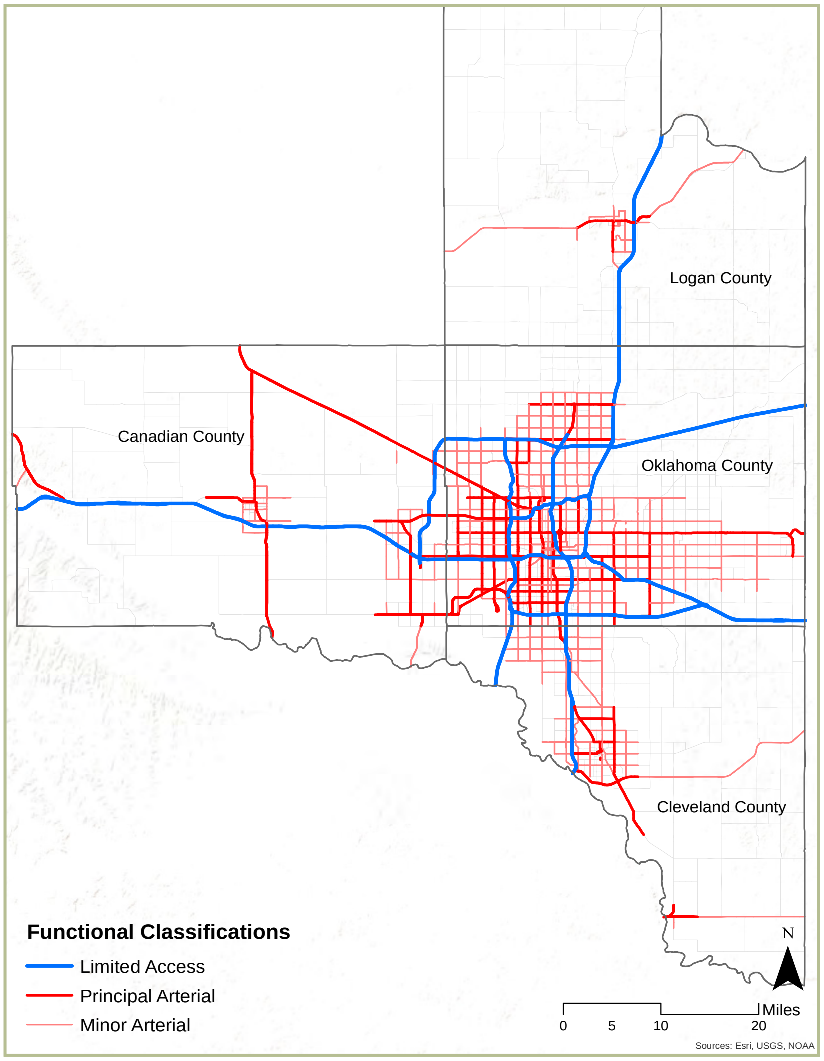


Figure 4.9

The table below is the mileage by CAMPO's functional classification grouping.

Oklahoma City Region Metro[15]

Facility Type	Oklahoma City Lane Miles	Lane Mile Per 10,000 People	CAMPO Lane Miles	Lane Mile Per 10,000 People
Limited-Access	2,248.2	16.8	1,332.8	6.2
Principal/Major Arterial	2,840.9	20.7	2,543.5	11.8
Minor Arterial	2,424.2	17.7	1,644.6	7.6
Collector	3,794.2	27.6	5,248.7	24.3

Figure 4.10 Lane mile table

Vehicle Miles Traveled

In 2010, Oklahoma City Metro area also had about 30,266,000 Daily Vehicle Miles Traveled.[16]

[15] Source: FHWA classified the John Kilpatrick Turnpike as a Principal Arterial from W Britton Road to E Wagner Road and from N County Line Road to NW 122nd Street. CAMPO classified these segments as Regional Connector.

[16] Source: Page 5. John G. Johnson, Executive Director of ACOG, Encompass 2040 presentation. https://bit.ly/2XkpYjs

Oklahoma City Region Network Spacing

The Oklahoma City Metro area has an integrated network of arterials spaced exactly one mile apart. The Downtown Oklahoma City area includes irregular Minor Arterials that connect to other regional roadways. Throughout the network, Minor Arterials are spaced one mile apart whereas Major Arterials are spaced roughly 2 to 3 miles apart. Moving out of the Downtown area, the arterial network consistently connects to a system of Freeways spaced every 3 to 5 miles apart.

Central Oklahoma City Region Arterial Network Spacing

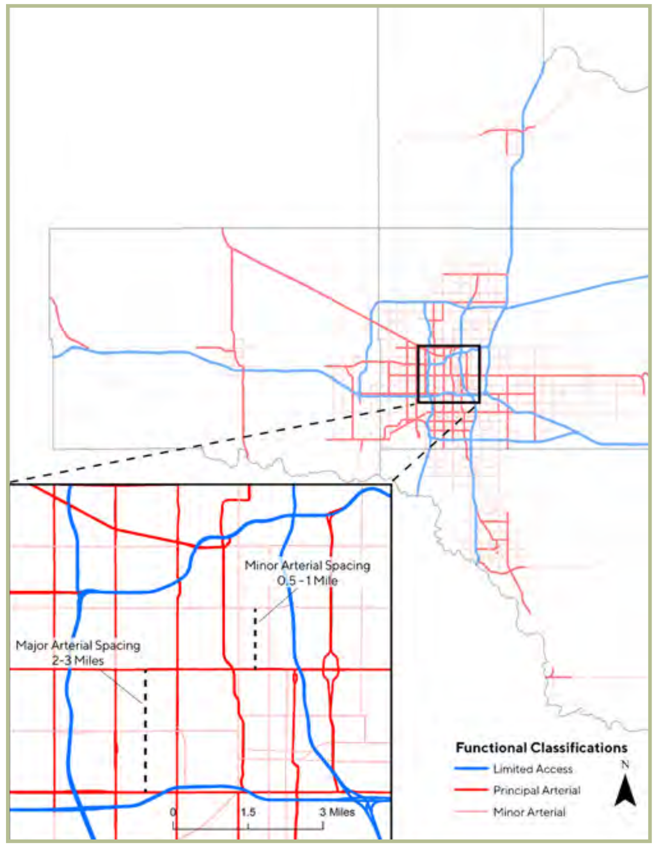


Figure 4.11

Network Barriers

The Oklahoma City Region has quite a few barriers, from natural to human built, that the arterial network navigates. Some of the barriers are difficult to traverse (i.e. lakes and airports) and therefore require the network to contort around them, while others can be overcome with bridges or underpasses (i.e. viaducts and rivers). Below are the prominent network barriers in the area.

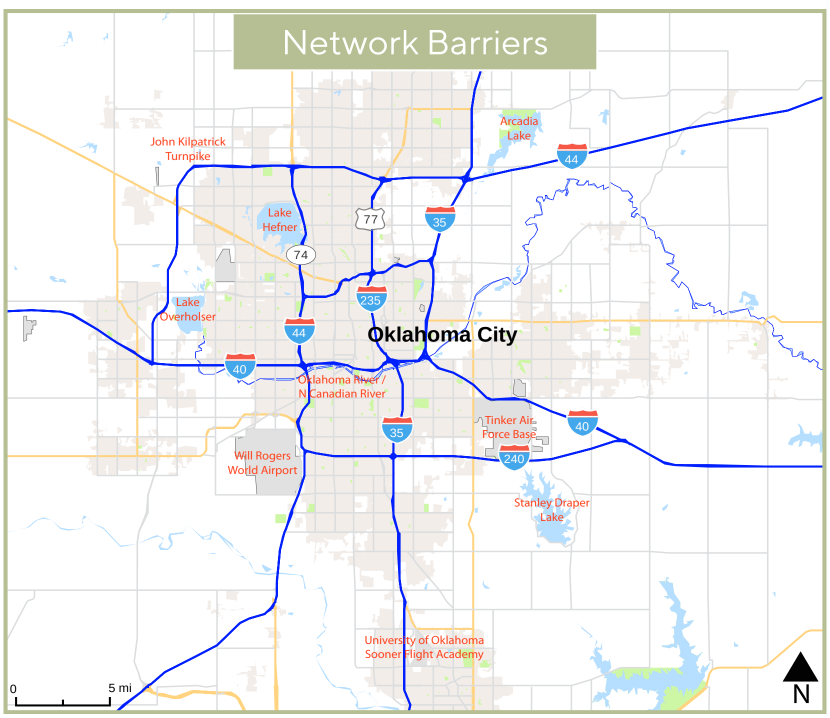


Figure 4.12

- Lake Hefner
- Lake Overholser
- Stanley Draper Lake
- Oklahoma River/North Canadian River

- Will Rogers World Airport
- Tinker Air Force Base
- University of Oklahoma Sooner Flight Academy
- Limited-Access facilities (e.g. IH-35, US 77, etc.)

Multi-modal Design Features

Currently, the Oklahoma City Region does not have any bus only lanes or transit/HOV lanes within arterials in the Downtown area. However, a modern streetcar is being constructed and will be operational by 2019. The streetcar will extend 4.6 miles through the business district and the historic Bricktown and Midtown neighborhoods. Portions of the streetcar route run on Major and Minor Arterials in the urban core. Most of the region's transit is local bus service which includes occasional features like bus pull outs and bus stations. The arterial network also includes active transportation accommodations with bike lanes on some arterials and sidewalks on most arterials in the urban core. The network gradually has less active transportation infrastructure further from the Downtown core.

Oklahoma City Streetcar[17]

Figure 4.13

[17] Oklahoma City Streetcar (open house 2018). https://bit.ly/2Bw2i4e

Las Vegas Region Case Study

The Regional Transportation Commission of Southern Nevada (RTC) is the Metropolitan Planning Organization (MPO) and also the transit authority for the region. Las Vegas is principally known as a destination for tourists, but in recent decades the regional economy has seen some diversification. Tourism as a primary base of economic activity puts a unique strain on the roadway network that many urban places only face during certain seasons or within districts. This case study looks at how the RTC has planned for their growing region and used their arterial roadway system to support mobility.

Census Comparison of Las Vegas Region and CAMPO Region[18]

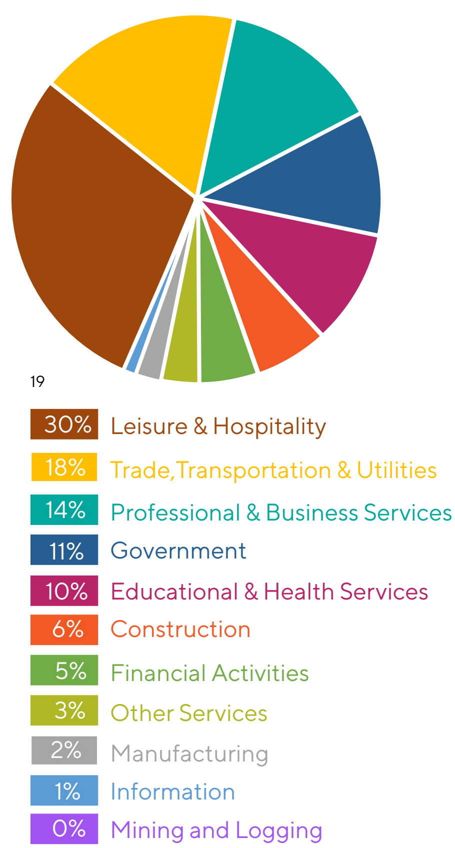
	Las Vegas Region	CAMPO Region
Total Population Estimates (July 1, 2017)	2,204,079	2,162,631
Population growth (2010 to 2017)	12.9%	22.9%
Population Density	279 persons per square mile	415 persons per square mile
Weighted Population Density (census block group)	7,640 persons per square mile	3,998 persons per square mile
Total Land Area (square miles)	7,891	5,214
Vehicle miles traveled (VMT)	36.2 million	44.2 million

Figure 4.14

The weighted density of the Las Vegas Region (Clark County) is 7,640 persons per square mile. The block group with the highest density has 55,298 persons per square mile.

Economy

The Region's economy is centered around the tourism and hospitality sector, with the most significant nodes being along the Las Vegas Strip (Las Vegas Boulevard) and in Downtown. The core area of Las Vegas attracts over 41 million visitors annually. The regional transportation network must meet a high level of demand from users that may be unfamiliar with the ways in which to best get around. In an effort to manage impacts of regional congestion, RTC has attempted to develop a robust Intelligent Transportation System (ITS) called the Freeway & Arterial System of Transportation (FAST).



[18] Source: US Census Bureau. Census Population Estimates, 2017. https://bit.ly/2FPyv83
[19] Source: U.S. Bureau of Labor Statistics. https://bit.ly/2FMaKO4

Las Vegas Region Arterial Network

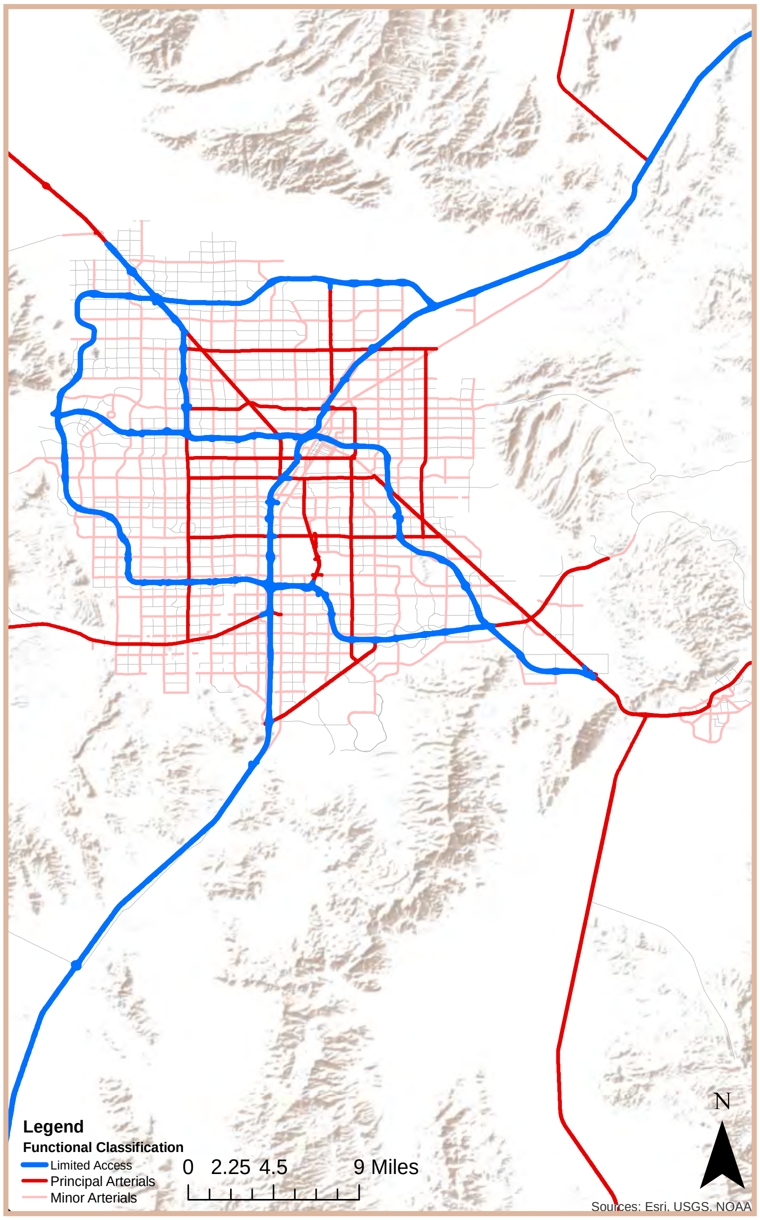


Figure 4.15

Below is the mileage by CAMPO's functional classification grouping.

Las Vegas Region Metro

Facility Type	Las Vegas Lane Miles	Lane Mile Per 10,000 People	CAMPO Lane Miles	Lane Mile Per 10,000 People
Limited-Access	1,349.0	6.1	1,332.8	6.2
Principal/Major Arterial	1,373.0	6.2	2,543.5	11.8
Minor Arterial	2,515.0	11.4	1,644.6	7.6
Collector	2,546.0	11.6	5,248.7	24.3

Figure 4.16 Lane mile table

Vehicle Miles Traveled

The table below presents vehicle miles traveled, along with a few other measures of transportation demand as modeled by the RTC. Projections for 2040, as detailed in the long-range plan, are included as well and are reflective of improvements identified in the RTC's Active 2040 Regional Transportation Plan.

Las Vegas Region	2015	2040 (Projected)
Daily Trips	8.4 million	11.1 million
Daily VHT	877,000	1.3 million
Daily VMT	36.2 million	53.6 million
Per Capita Daily VMT	17.4 miles	19.2 miles
Daily Trips	8.4 million	11.1 million

Figure 4.17 Transportation metrics table

Las Vegas Region Network Spacing

The regional network is supported by one primary interstate highway, IH-15, and two auxiliary interstate highways, IH-215 and IH-515. There is an extensive arterial network with robust operational systems to manage the flow of traffic and to reduce congestion. According to the 2011 Clark County Area Access Management Report, the roadway network has been developed in a one-mile grid of six-lane roadways, a half-mile grid of four-lane roadways, and a quarter to one-eighth mile grid of two-lane roadways.

More than half of total lane miles are classified as arterial. Similarly, over 56% of total hours per day traveled in the region are on Major or Minor Arterials. Within the Southern Nevada Region there are only 22 miles of HOV lanes available on Freeways.

Central Las Vegas Region Arterial Network Spacing

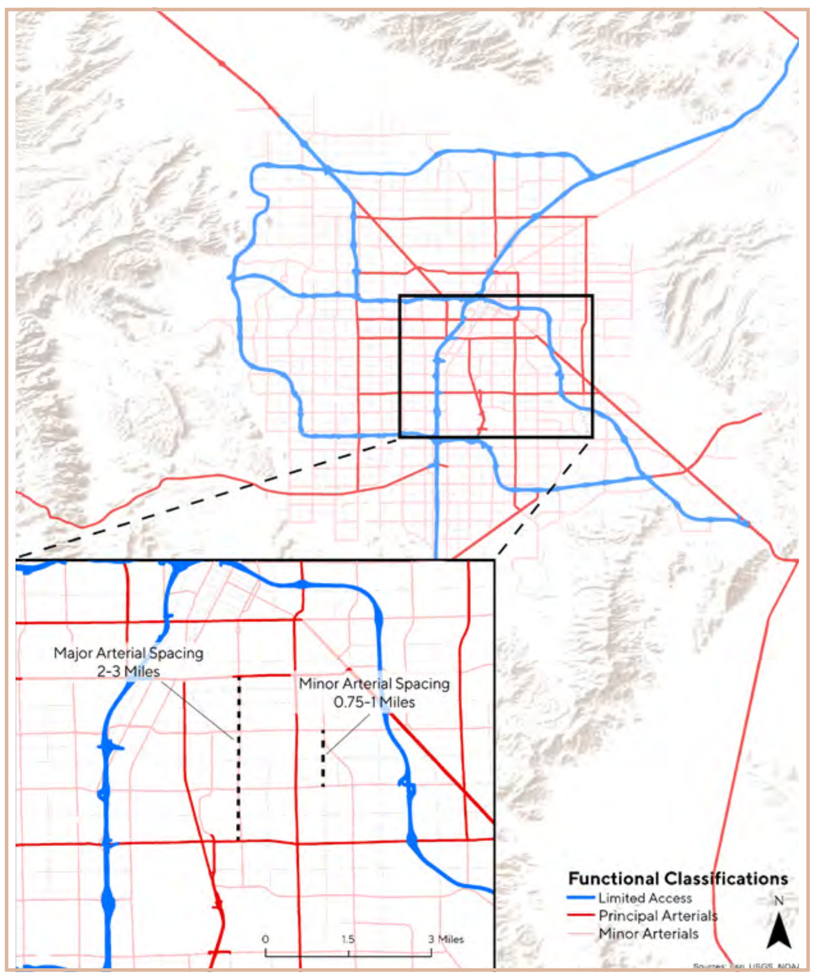


Figure 4.18

Network Barriers

There are only a few barriers that impede development within the Las Vegas Region. Those include McCarran International Airport and Nellis Air Force Base. The Las Vegas Strip, IH-15, and a railroad/logistics corridor that supports businesses along the Las Vega Strip also constitute a barrier for the arterial network. Nevertheless, in many instances, grade-separated intersections and operational tools have been used to make these barriers less obstructive.

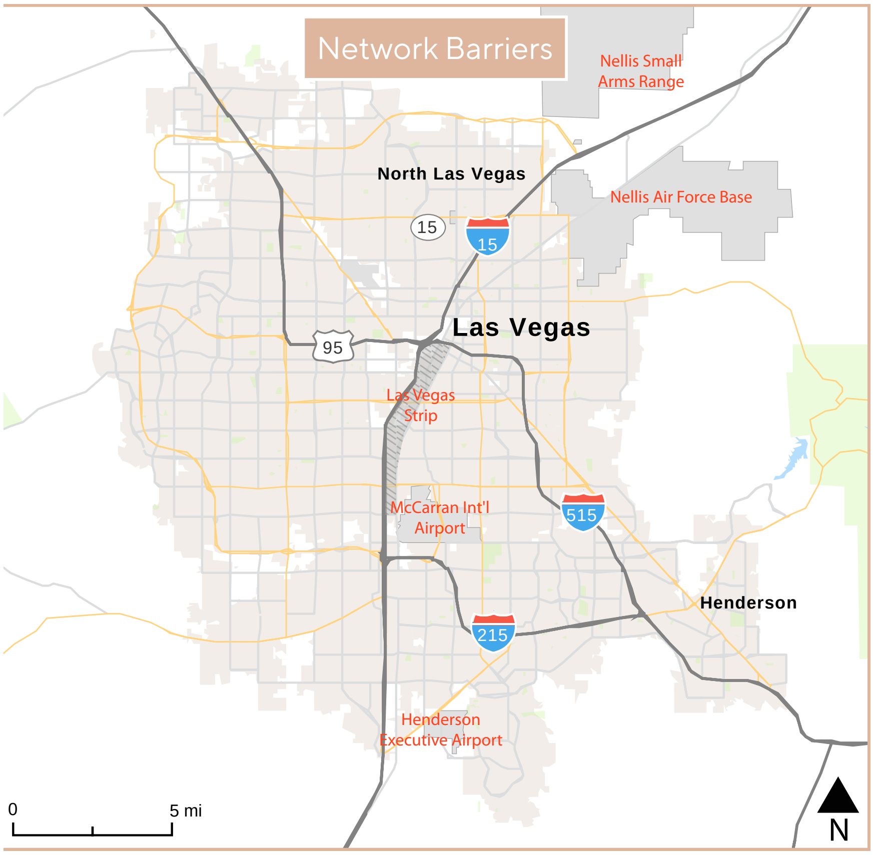


Figure 4.19

Multi-modal Design Features

The RTC, which serves as the public transit authority for the Las Vegas Region, ensure Downtown residential (local), express, and frequent transit service along the Las Vegas Strip and in Downtown. While there are few dedicated lanes for transit along arterials, the Sahara Avenue Corridor (as detailed in the Case Study Corridors section) provides an outside lane for bus, bike, and right-turns. This corridor is a major east-west arterial and moves many users from the eastern and western edge of the central portion of the region to the Las Vegas Strip and the IH-15 corridor.

With the Regional Complete Streets Study, the RTC identified the need for multi-modal solutions to address capacity issues. The RTC's Complete Streets Study served several purposes including providing guidance to cities and counties on multi-modal design via illustrations of typical cross-sections and treatments of new and improved roadways. Additionally, as a result of this effort, the RTC produced a Complete Streets Design Manual and improvements to the Sahara Avenue Corridor were made.

Phoenix Region Case Study

The Maricopa Association of Governments (MAG) is a Council of Governments (COG) that serves as the MPO for the Phoenix Metropolitan Area, this includes the Phoenix area and the neighboring urbanized area in Pinal County. The Phoenix Region has been attracting major service and high-tech industry that has resulted in growth of population and economic diversity.

The region is in the middle of the Arizona Sun Corridor, where there is a significant amount of freight traffic due to the movement of goods in and out of Mexico. Business, Retail, and Consumer services are at the top of the economy and the region and several important freight hubs are in the region.
This case study looks at how the MAG has managed increasing population growth and freight traffic through an arterial roadway grid system that enhances both access and mobility for the region.

Census Comparison of Phoenix Region and CAMPO Region[20]

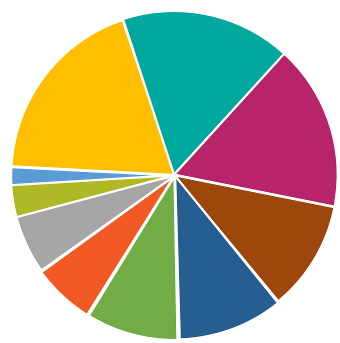
	Phoenix Region	CAMPO Area Region
Total Population Estimates (July 1, 2017)	4,737,270	2,162,631
Population growth - (April 1, 2010 to 2017)	12.9%	22.9%
Mean travel time to work (minutes)	26.0	28.6
Population per square mile, 2010	444.6	414.8
Land area in square miles, 2010	10,655.1	5,214.2
Weighted Density Per sq. mi (Block Group)	5,669.5	3,998.3
Vehicle miles traveled (VMT)	109.8 million	44.2 million

Figure 4.20

*Environmental Justice Metrics available in the Appendix

Economy

Currently, the largest industries are Trade, Transportation, and Utility jobs (19%), Professional and Business Services jobs (17%), and Education and Health Services jobs (16%). Several Fortune 500 and Fortune 1000 companies in diverse industries have their international headquarters in the area, including industries such as manufacturing, aviation, education, and technology. The Phoenix Region ranks 5th in the nation in economic growth. Compared to the National unemployment rate (6.3%), the unemployment rate of the area is lower (5.3%). The Region has significantly higher sales tax rates at 8.4% compared to the national average of 6%. Although, income tax rates are lower at 3.4% compared to the national average (4.7%).[21]



[22]

[20] Source: FactFinder. Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2017. https://bit.ly/2hGmt3H
[21] Source: City-Data. Phoenix Economy. https://bit.ly/1R8uAE5
[22] Source: U.S. Bureau of Labor Statistics. https://bit.ly/2uuhk5k

Phoenix Region Arterial Network

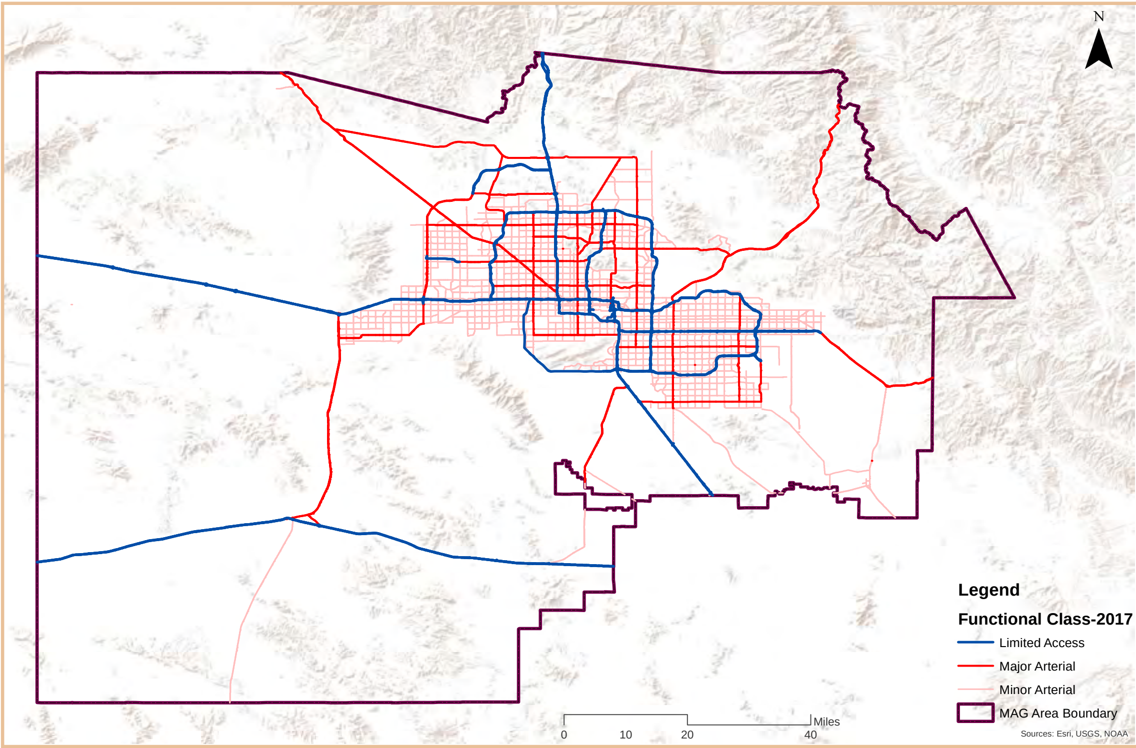


Figure 4.21

Below is the mileage by CAMPO's functional classification grouping.

Phoenix Region Metro:[23]

Facility Type	Phoenix Region Lane Miles	Lane Mile Per 10,000 People	CAMPO Lane Miles	Lane Mile Per 10,000 People
Limited-Access	7,416.1	15.7	1,332.8	6.2
Principal/Major Arterial	7,155.5	15.1	2,543.5	11.8
Minor Arterial	11,975.6	25.3	1,644.6	7.6
Collector	16,778.8	35.4	5,248.7	24.3

Figure 4.22 Lane mile table

Vehicle Miles Traveled

According to 2015 data, the daily VMT for the Region is 109,762,231 per day (Freeways and Arterials). By 2040, daily VMT is projected to grow to about 165 million.

According to the Texas Transportation Institute, the Phoenix urban area ranked 17th in the nation for annual hours of delay per traveler. Arizona drivers each spend about 51 hours a year in traffic.[24]

[23] Source: HPMS Public Release GIS Data Arizona 2016. https://bit.ly/2XJsKmv
[24] Source: MAG Regional Fast Facts (October 2017). https://bit.ly/31YhAJU

Phoenix Region Network Spacing

The arterial street system is a critical element of the regional transportation network and consists primarily of roadways with four or more lanes on a 1-mile grid. In addition to the Freeway and arterial network, the Region is served by non-arterial streets, which include Local and Collector streets. The development and density of Local and Collector street mileage is closely associated with the growth in population and employment over the years.

Central Phoenix Region Arterial Network Spacing

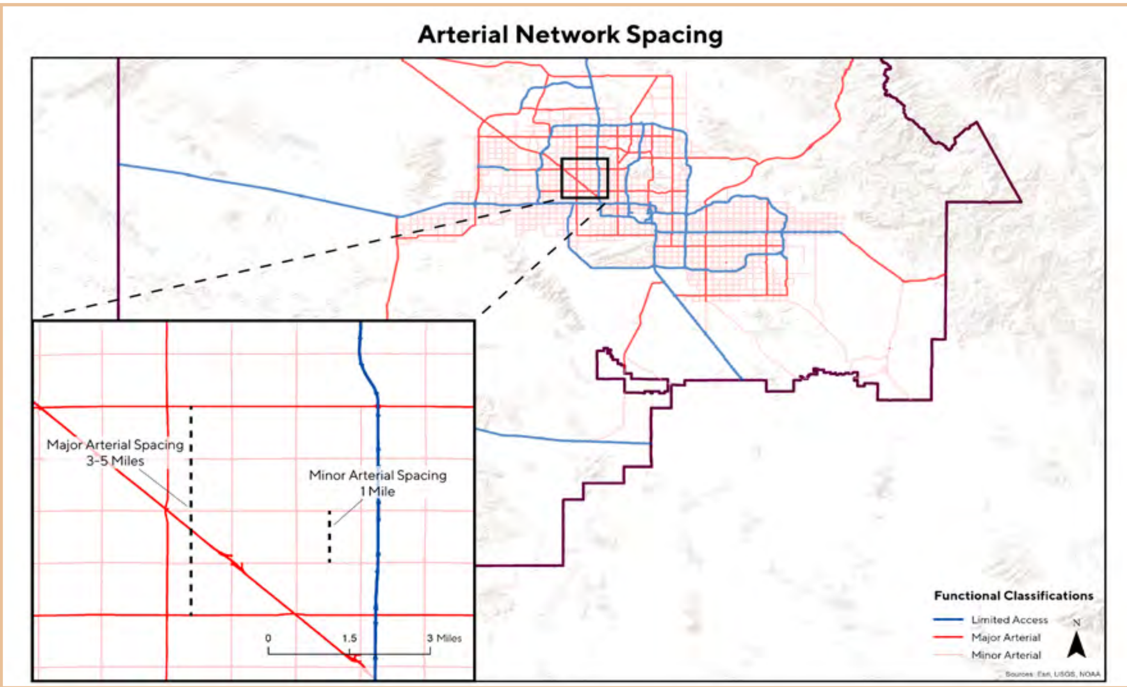


Figure 4.23

Network Barriers

The Phoenix Region has several geographical barriers such as rivers, canals and mountains. Some of the major regional geographical barriers are the Agua Fria River, Salt River, the Gila River, the Arizona Canal, Camelback Mountain, the Phoenix Mountains Preserve, and Estrella Mountain among others. The region is also located inside of the Sunbelt Freight Corridor and there are several heavy railroad tracks that act as a barrier for the roadway system at specific points of the region especially along US 60/ Grand Avenue where there is an intermodal freight station, carrying heavy truck and rail freight traffic. The centrally located Sky Harbor International Airport creates a unique barrier for connectivity and because of its size, development restrictions, and location within the city network.

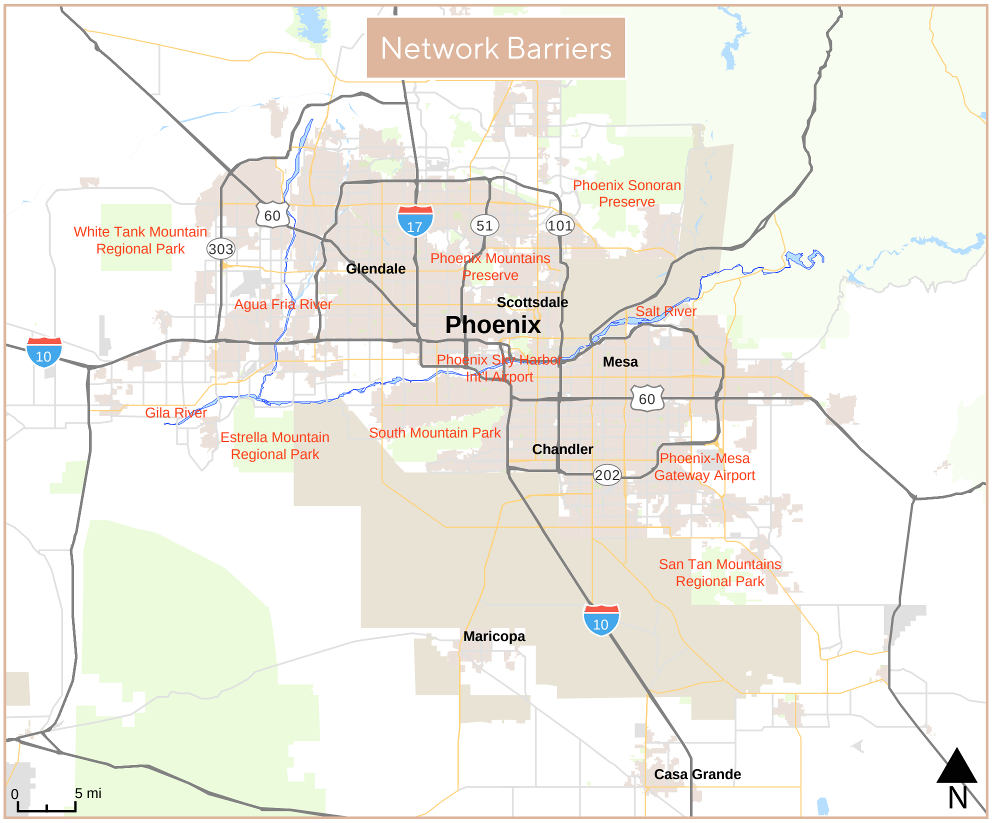


Figure 4.24

Multi-modal Design Features

Valley Metro is the public transportation provider for the Phoenix Region. The Phoenix Region has identified transit needs, deficiencies, opportunities, and constraints to develop solutions for future transit markets but there are currently no dedicated bus lanes or transit/HOV lanes on the arterial network inside the Phoenix Region to better serve these markets. However, there is a 25-mile light rail line which will be expanding to 61 miles in the next 15 years. Segments of the light rail line operate on arterials.

Moreover, Valley Metro is the first public transportation system in the country to create a partnership with an autonomous vehicle and technology company (Waymo/Google). The project started on August 1, 2018 and is operating as a 2-year pilot. The intent is that it will support first and last-mile connections to transit stops, transit centers and park-and-rides in the future, this pilot could result in helping some of Valley Metro's on-demand services. Test groups will also have the opportunity to travel using autonomous vehicles to local destinations to support the collection of additional travel data. [25]

The Phoenix Region has developed a multitude of plans to facilitate the construction of active transportation projects including crafting multimodal corridors plans, bicycle and pedestrian design guidelines, and design assistance programs for those entities pursing multimodal solutions.

[25] Source: Wired. Can WAYMO self-driving cars help fix Phoenix's public transit? July 2018. https://bit.ly/2NY0aVY

CAMPO Comparisons

After studying the four regions, overall comparisons communicate how varying profile and economic metrics are similar and dissimilar to the CAMPO Region.

Overall Regional Profile Comparison:

Metric	San Jose Region	Oklahoma City Region	Las Vegas Region	Phoenix Region	CAMPO Region
Total Population (2017)[26]	1,998,463	1,373,211	2,204,079	4,737,270	2,162,631
Population growth (2010 to 2017)	8.8%	9.2%	12.9%	12.9%	22.9%
Population per square mile (2010)	746	249	279	445	415
Land area in square miles (2010)	2,680	5,512	7,891	10,655	5,214
Weighted density per square mile (block group)	10,449	3,656	7,640	5,670	3,998
Mean travel time to work (minutes)	29.0	22.5	24.4	26.0	28.6
Total arterial lane miles per 10,000 persons	18.6	54.7	23.8	56.0	25.5

Figure 4.25

Overall Regional Economy Comparison:

[27]

Metric	San Jose Region	Oklahoma City Region	Las Vegas Region	Phoenix Region	CAMPO Region
Trade, Transportation & Utilities	12%	17%	18%	19%	18%
Government	9%	20%	11%	11%	17%
Professional & Business Services	21%	13%	14%	17%	17%
Educational & Health Services	16%	14%	10%	16%	12%
Leisure & Hospitality	9%	12%	30%	11%	12%
Construction	4%	5%	6%	6%	6%
Financial Services	3%	5%	5%	9%	6%
Manufacturing	15%	5%	2%	6%	5%
Other Services	3%	5%	3%	3%	4%
Information	8%	1%	1%	2%	3%
Mining and Logging	0%	3%	0%	0%	0%

Figure 4.26

[26] Source: US Census Bureau. Census Population Estimates, 2017. https://bit.ly/2XkAH2d
[27] Source: U.S. Bureau of Labor Statistics. https://bit.ly/2Jj58MI

CAMPO Regional Arterial Study - Existing Conditions

The CAMPO Region mapped below illustrates approved projects in the Transportation Improvement Plan, existing arterial corridors, planned new facilities, planned upgrades to existing facilities, locally identified needs and Capital Area Council of Governments (CAPCOG) roads. Geographically, impacts to the arterial grid and connectivity are evident at lakes and protected lands.

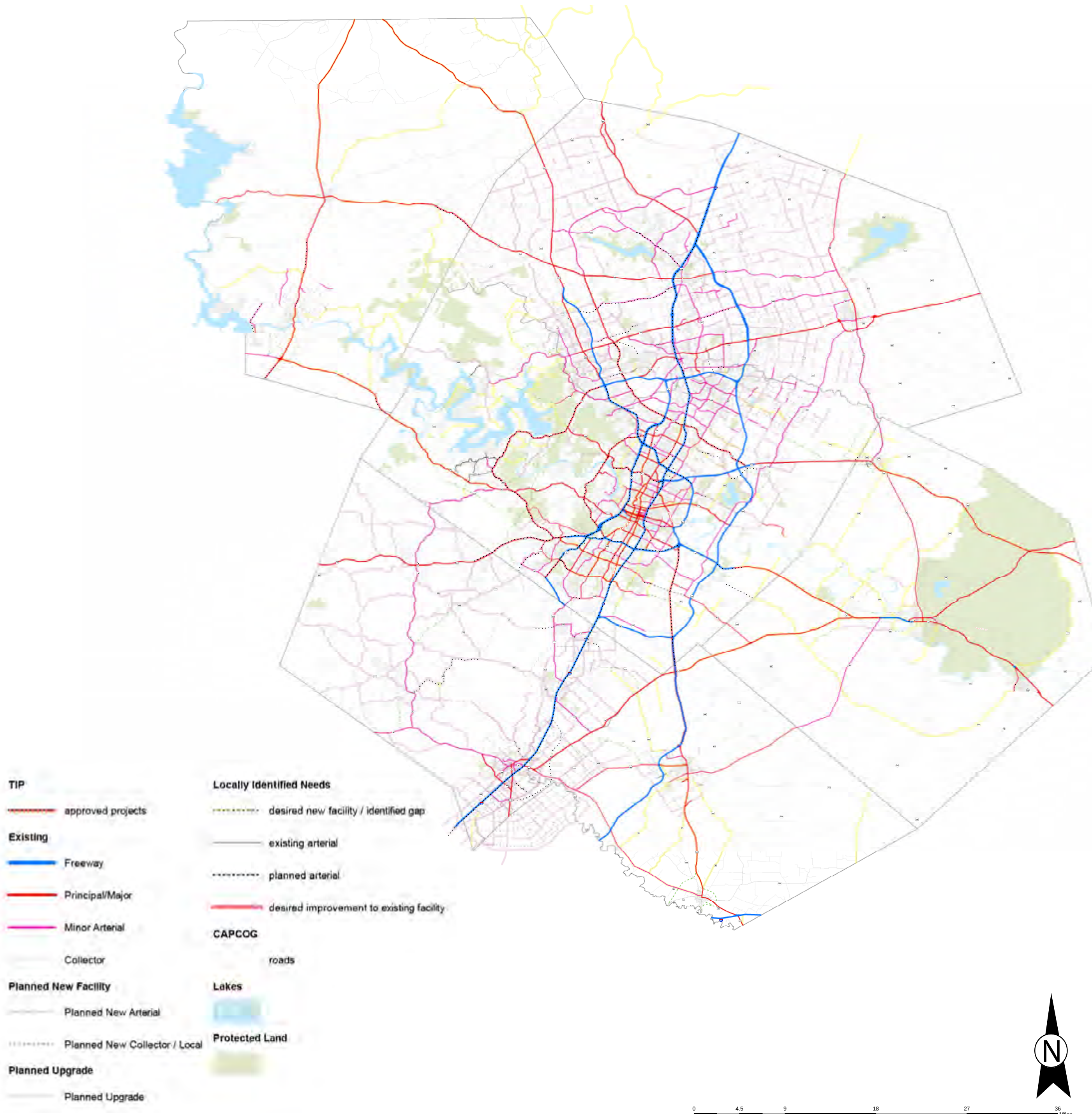


Figure 4.27

Conclusion

When comparing lane miles by functional class in each region, most have fewer lane miles per 10,000 people for Principal Arterials compared to the CAMPO Region. This is likely due to the fact that the CAMPO Region is both less dense, meaning that commuters must travel greater distances to job centers, and the Region lacks a gridded network.

Additionally, the San Jose's Expressway system offers a unique arterial functional classification that is not found in the CAMPO Region. These facilities serve long distances, have Limited-Access facilities, but, on occasion, meet at-grade with other Principal Arterials in the regional network. Where appropriate, these Expressways or Regional Connectors also provide access to Minor Collectors that service residential neighborhoods.

Regional Best Practices

These case studies offer insight into how regional arterial networks can serve the transportation needs of a variety of users and economies. They point to best practices in:

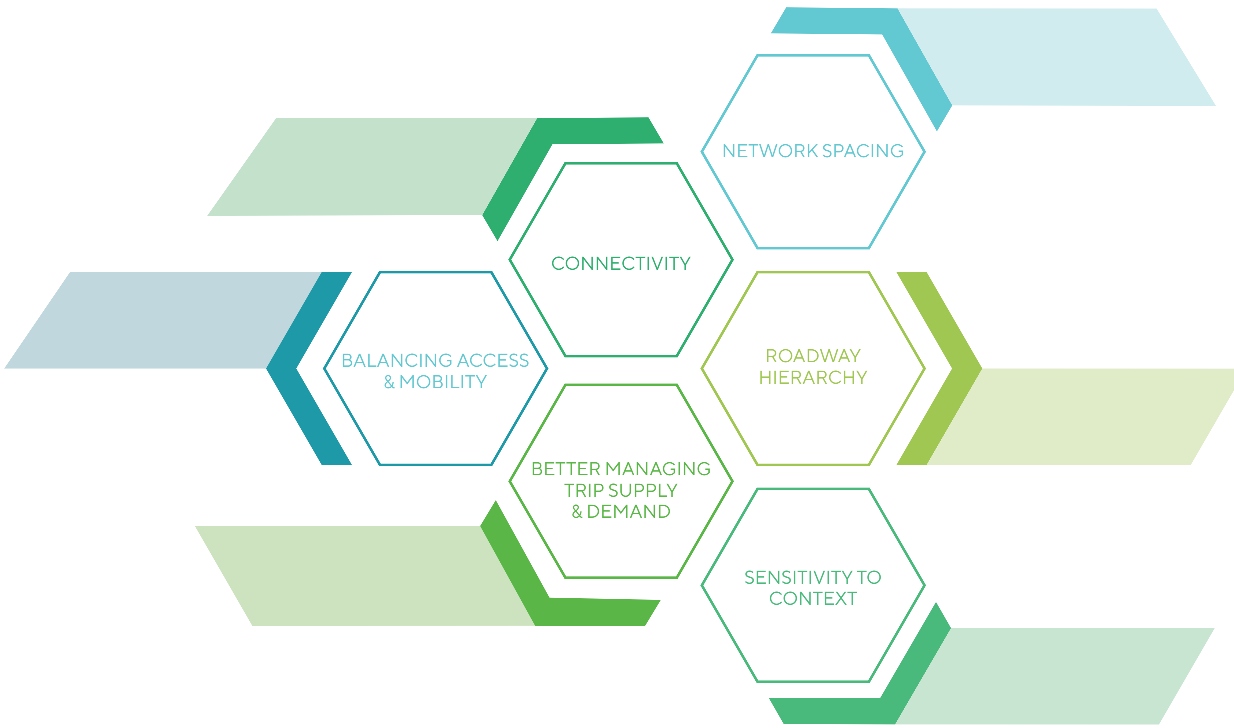


Figure 4.28

Regional arterial networks, as we have detailed in the case studies of San Jose, Oklahoma City, Las Vegas, and Phoenix, are the sum of individual facilities that support movements within the region. Yet, how they function is in many ways dependent on the lowest functional class of roadways: Local Streets. All of the region studied saw significant growth in the post-war era, in which the predominant pattern of urban design featured larger and less connected suburban developments. The Local Streets that service these kinds of developments typically have fewer connections to Collector or arterials and are more likely to end in a cul-de-sac. This design of Local Streets put greater a greater burden on arterials as more users are made to rely on them for short trips.

Since the CAMPO Region largely follows this post-war era pattern of development, much of the arterial network lacks connectivity. Thus, many trips are often served by facilities that are built to serve trips of longer distances. There are many best practices of arterial network design, inspired by certain elements of the case study regions, that the CAMPO Region can apply to increase connectivity and thereby, allow the region's arterials to better manage growth and increase safety.

Grid Spacing/Connectivity

Gridded street networks provide for greater connectivity along with a grid of Minor Arterials and Collectors that can support Principal Arterials. This allows for a greater dispersion of traffic compared to non-gridded networks. Gridded networks may feature not only square or rectangle blocks, but also irregular block shapes.

In general, the Case Studies found arterials are ideally spaced in the following manner:

- Limited-Access facilities are spaced 5 to 10 miles apart;
- Principal Arterials spaced 3 to 5 miles apart;
- Minor Arterials spaced 1 to 3 miles apart; and
- Collectors spaced 1/2 mile intervals.

Context can change these general parameters for grid spacing, as more dense areas may need arterials closer together than less dense areas. Rural areas may likely be served by only one Principal Arterial or Minor Arterials and, thereby, may see wider spacing between facilities of the same functional class.

Example Arterial Spacing

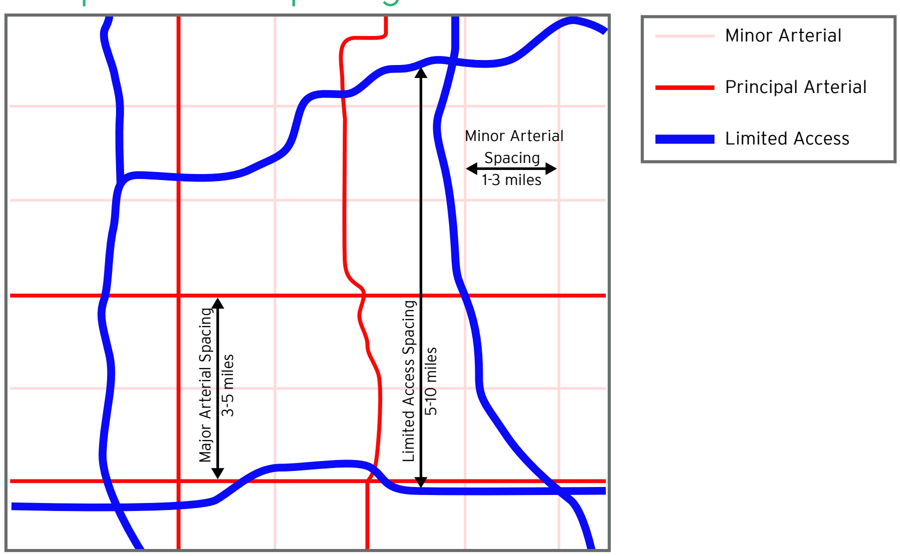


Figure 4.29

One of the biggest takeaways from the regional case studies is that the CAMPO Region lacks the gridded network of arterials that are most prominent in Las Vegas, Oklahoma City, Phoenix, and, to a lesser degree, San Jose Regions. These regions, due to their historical development within the Public Land Survey System, have a considerable portion of area that exhibits square or rectangular grids. While portions of the San Jose Region follow a regular grid pattern, much of the arterial network is an irregular grid pattern.

The Land Survey System of development has led to, in some cases, very regimented grid systems. In the Phoenix and Oklahoma City Regions Principal Arterials are generally spaced 2 to 3 miles apart, while Minor Arterials are spaced about 1 mile apart. Las Vegas' arterial network, encourages 4 lane arterials spaced approximately ½ mile apart. For the higher functional class roadways these guidelines are not rigid, as context will play a key role in determining the specific distance appropriate for a given functional class.

Hierarchy

Functional class can be determined, in part, by trip purpose. Each of the functional classifications determined by CAMPO (**Limited-Access, Principal Arterial, Minor Arterial, Collector, and Local**) serve trips associated with their general spacing guidelines.

Higher Functional Classes are designed to move higher volumes of users due to prioritization of mobility over access. This makes these roadways better able to serve modes such as high-capacity transit, long-distance bicycle trips, and interregional coaches.

Lower Functional Classes are roadways, which allow for greater access to intersecting facilities and adjacent properties, are designed for lower speeds and, thereby, may provide a higher level of comfort for pedestrians and cyclists.

This is one example of a new functional class that could serve regional trips on CAMPO Region.

Limited-Access facilities are designed to serve trips over 5 miles and connect a significant number of employment nodes and activity centers within a region. They are generally the primary facilities providing for interregional trips.

Principal/Major Arterials are the primary connections between employment nodes and activity centers. They typically serve trips from 3 to 5 miles and provide for intraregional trips, but many Principal Arterials serve longer distance interregional travel. Additionally, CAMPO's designated Regional Connectors or Expressways category, are considered a Principal Arterial and provide for longer distance movement, but generally, don't restrict access in the same manner as Limited- Access arterials.

Minor Arterials primarily support trips within a subregion, generally trips about 1 to 3 miles. They provide support for the Principal Arterial network and connect Collector and Local roadways to higher functional classes. occasion, meet at-grade with other arterials in the regional network. Where appropriate, these expressways also provide access to minor collectors that service residential neighborhoods.

Collector roads serve local traffic with low-to-moderate-capacity.

Local roads primarily serve local residential areas.

Functional Class Hiearchy Example

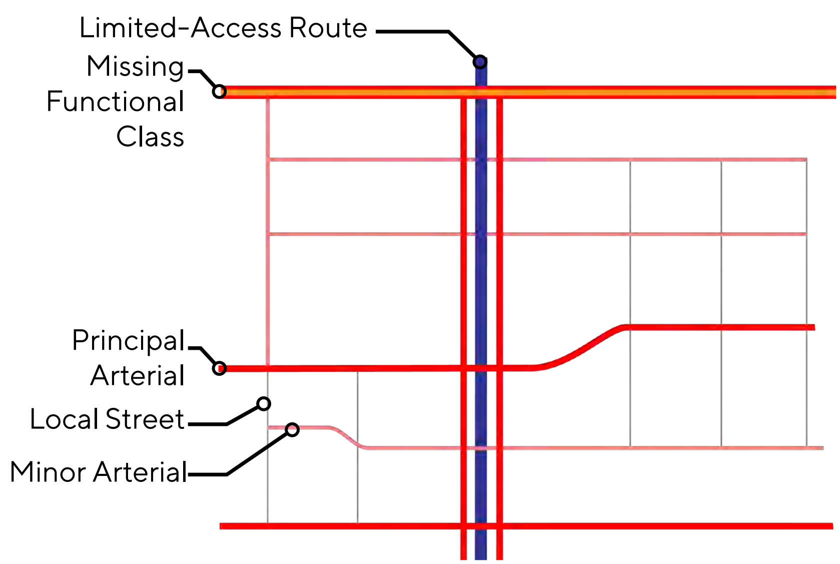


Figure 4.30

Connectivity

In many ways, the functional classifications of a region's arterial network are very closely related to connectivity, as a system that has more connections can better disperse traffic on a wider variety of facilities. The better connected a network is, the better travelers are able to access arterials that are appropriate for their trip purpose. This allows traffic to move at more reliable speeds and can shorten trips and travel times. Connectivity may also make modes other than vehicular traffic more feasible for a wider variety of trips.

Since the CAMPO Region arterial network largely follows an irregular pattern, it is more difficult to make connections. Coordinated planning efforts such as this study are vital to helping the CAMPO Region meet its goals to improve network connectivity.

Context

Arterials should also be context sensitive. The design of a regional network can be determined by topography, and also densities of development. Grid spacing can change based on the Context Zone through which an arterial passes, but context can also change for how an arterial should account for multiple modes and economic activity. Lastly, in denser areas arterials may need to also account for deliveries made to adjacent properties.

CAMPO Context Zones

Z1

Downtown Austin, Texas
Austin Relocation Guide
https://bit.ly/2T3SCnq

Z2

Downtown Taylor, Texas
https://bit.ly/2RNwIHT

Z3

Parmer Lane & Metric Boulevard Austin, Texas
https://bit.ly/2VX2zF7

Z4

Urban vs. Suburban: Austin, TX
https://bit.ly/2ClsiOF

Z5

Taylor, Texas
Google Streetview, 2018
https://bit.ly/2TRhT4A

Urban 1	Urban 2	Suburban 1	Suburban 2	Rural
High-rise Downtown	Main Street/ Small Town	Mixed Use/ Activity Center	Conventional	

Figure 4.31

Balancing Access and Mobility

Put simply, arterials serve both through movements and entrances, or exits, to and from other facilities and adjacent properties. How the roadway balances these needs is in part what underlies the distinction between Principal Arterials and Minor Arterials, as Minor Arterials are designed for greater access to adjacent properties and feature a higher frequency of intersections.

Principal Arterials, given the greater focus on mobility, can support higher speeds for through traffic. Thus, it becomes more important to manage access through divided roadways and limiting left turns or other conflict points. The key point to consider during network design is understanding what kinds of movements the roadway is currently serving or is predicted to serve in the planning window.

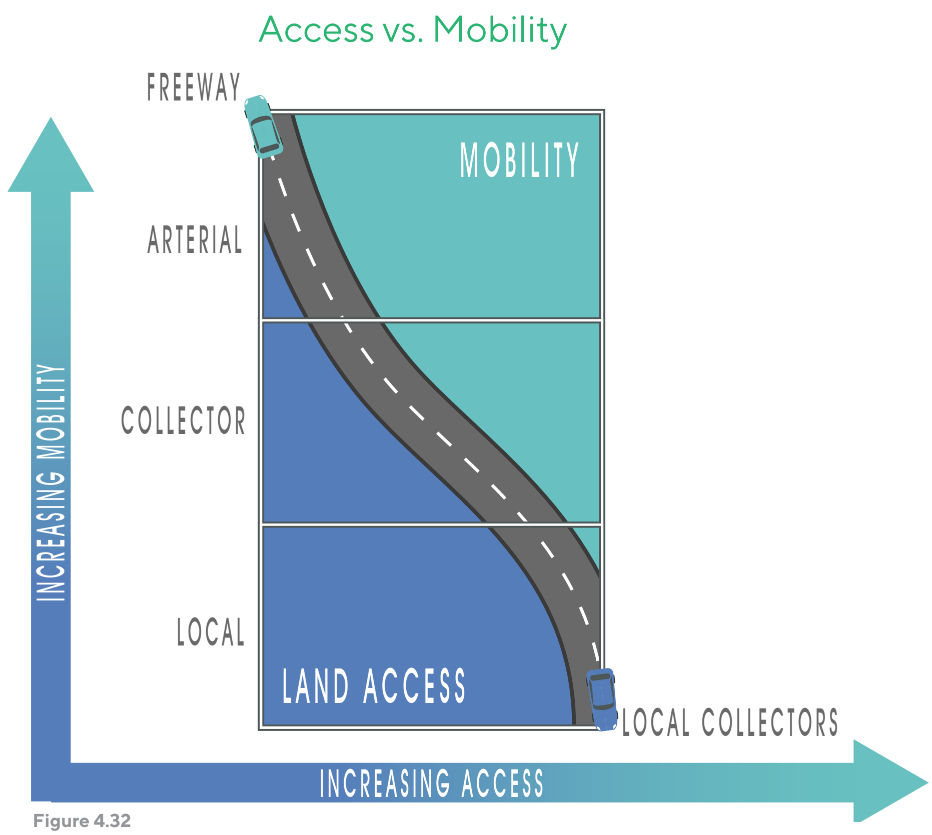


Figure 4.32

Supply and Demand

As summarized in the regional Case Studies sections, the CAMPO Region does not necessarily lack arterial roadways, but lacks the connectivity and supporting network that is developed in a well-planned gridded system. Managing supply and demand through the design of the arterial network can allow for greater safety and can make it easier to balance the needs of mobility and access.

Economic Development

Arterial network design can play a key role in economic development. A more viable site to locate a business can be an area with a good arterial network.

A good arterial network can open job markets for local businesses by reducing congestion and providing the connectivity between worker's homes and job centers. A better connected network can also produce more corner lots, that can be ideal for spurring successful commercial development. Shorter travel times and distances to developments and those job centers, lower the cost of commuting for workers, making employment opportunities more feasible. Because of this, workers may find it attractive to look for employment opportunities in the added economic opportunity areas.

Examples of Arterials & Economic Development

Source: Austin City Guide
https://bit.ly/2CmyB4r

Source: Austin City Guide
https://bit.ly/2CmyB4r

Source: Wimberley, Texas. Google Streetview, 2016
https://bit.ly/2RtBn29

Figure 4.33

SECTION 2

ARTERIAL CORRIDOR CASE STUDIES

CAMPO
CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

Introduction

The case study corridors reviewed include arterials that serve interregional, regional, and subregional movements.

- Interregional routes are long distance routes that tend to be either Limited-Access or divided arterials which connect multiple communities in separate regions;
- regional routes are routes that travel throughout a region;
- subregional routes are ones that facilitate travel within a portion of a region.

Corridors operate differently at various segments and within different built forms, therefore the functional classifications of each of the corridors were attributed to each Context Zone to identify features included in the rights-of-way of each corridor. Now, changes can occur to the adjacent corridor. For example, a Rural Context Zone can transform into a Suburban 1 or Suburban 2 Context Zone. Additionally, some areas in the great region may seem to meet one or more Context Zones. Context Zones are a tool to help stakeholders to evaluate relevant best practices and to contextualize corridor treatments ensuring they are appropriate for given locations.

Each of the corridors reviewed best illustrate design and/or operational features that meet the needs of the users they serve and address safety, mobility, access, and multi-modal needs. Moreover, corridor characteristics are detailed regarding multi-modal service, safety features, access, as well as the surrounding built form and land use. Street sections for several key segments and intersections are included below, along with images that highlight the key design features and highlight a connected arterial network.

Key Takeaways: Corridor Case Studies

The findings of these case studies corridors offer insight into the design and operation of regional arterial networks and corridors. Some of the key insights point out that:

North 1st Street, San Jose, California, links a wide variety of land uses and facilitates a variety of multimodal options that provide access to the greater metro area. Within its right-of-way, this corridor accommodates light rail, bus, bicycle, pedestrian, and cars providing subregional, regional, and interregional connectivity.

Euclid Avenue, Cleveland, Ohio, traverses through a variety of Context Zones, illustrates how an arterial can be designed to serve a variety of modes. It is also a transit way, and connects to adjacent arterials that provide additional corridor capacity for multi-modal movements.

CA 111, Palm Desert, Riverside County, California, provides interregional connectivity but shows how the use of Local Arterials can help arterials better balance mobility and access on a commercial corridor.

Key Takeaways: Corridor Case Studies (continued.)

San Tomás Expressway, San Jose, California is a Controlled Access arterial that connects several area arterials and freeways. The corridor features HOV lanes for bus and carpool use during peak periods. This expressway combines right-hand slip turn lanes at every four-way intersection with pedestrian refuge islands for safer pedestrian crossing.

Sea to Sky Highway, British Columbia, Canada, travels from Horseshoe Bay north of Vancouver along the coast into the Pacific Ranges of southwestern British Columbia, is an example of how long-distance travel in rural areas can be safely accommodated despite unforgiving terrain.

Keystone Parkway, Carmel, Indiana is a Limited-Access arterial that connects two regional freeways with non-signalized, grade-separated intersections. While there aren't multimodal elements along the length of the corridor, bike lane and sidewalk crossings for suburban connectivity are accommodated at intersections.

Sahara Avenue, Las Vegas, Nevada traverses residential and commercial land uses while connecting several highways and Las Vegas Boulevard. Signalized intersections occur every 1/2 mile and are at grade. This roadway supports and is supported by the adjacent network of arterials and collectors which serve the high density of residential, tourism, medical, and commercial developments.

Wurzbach Parkway/PA-1502, San Antonio, Texas connects two interstate highways and intersects major city roads. It is a mostly controlled-access corridor without continuous frontage roads or an adjacent supporting arterial network. No transit routes operate along the corridor and the multimodal elements are limited to bike lanes and hike/bike trails situated on portions of the corridor.

Camelback Road, Scottsdale, Arizona has continuous pedestrian facilities and several bus routes operating along the corridor, with covered bus stop amenities. The road is supported by a one-mile grid system of roadways and collectors. Situated along and nearby the corridor are major employment centers, business, retail, recreational, tourism, and military land uses.

US60/Grand Avenue, Phoenix, Arizona has the widest right-of-way amongst the other case studies. While this corridor has just one limited-stop bus route, there are more than 15 bus routes that intersect the corridor. The Burlington Northern Santa Fe (BNSF) Railroad runs parallel to the north of the corridor, limiting access between developments. The railroad and its nearby intermodal facility increase freight trucks that travel along the corridor. US-60 is not an arterial per FHWA guidelines, the corridor intersects more than 20 Major Arterials, promoting regional connection.

CAMPO Context Zones

Z1	Z2	Z3	Z4	Z5

Downtown Austin, Texas (2013)	Downtown Taylor, Texas (2010)	Parmer Ln. and Metric Blvd. Austin, Texas (2018)	Austin, Texas (2018)	Taylor, Texas (2018)
Urban 1	**Urban 2**	**Suburban 1**	**Suburban 2**	**Rural**
High-rise Downtown	Main Street/ Small Town	Mixed Use/ Activity Center	Conventional	

Figure 4.34

The following descriptions for Context Zones.

Zone	Description
Z1 – Urban 1, Highrise Downtown	**Land Use:** Generally, mixed-use and high-rise development facing the street with many activity centers at corner lots. **Distinguisher:** Major regional activity center, with multiple national or global companies or commercial interests located here. i.e. Multi-story national hotel chain. **Transportation:** Freeways and Major Arterials typically with the highest VC (Volume-to-Capacity) ratios in a region transect this area.
Z2 – Urban 2, Main Street/ Small Town	**Land Use:** Generally, an activity center surrounded by lands with single family houses. Commercial buildings facing the street that are typically no taller than six stories. **Distinguisher:** 'Main Street' feel and roadway right-of-way may be constrained due to the historic nature of buildings. **Transportation:** Major Arterials may transect the area, however, VC ratios other than during regular peak commute hours and special community events remain relatively similar compared to surrounding areas.
Z3 – Suburban 1, Mixed Use Activity Center	**Land Use:** Generally, an activity center surrounded by single family housing and commercial. Buildings do not typically face the street. **Distinguisher:** The activity center is typically multiple 'big box stores' or sprawling medical, education, and/or warehouses. **Transportation:** VC ratios heavily dependent on site specific businesses. VC ratios can be heavy during weekends for 'big box stores' or low during peak commute times for warehouses. Major and Minor Arterials may serve adjoining development.
Z4 – Suburban 2, Conventional	**Land Use:** Generally, lack of large activity centers (as described above). Mostly housing typically with small 'strip malls' or a single grocery store/convenience store. **Distinguisher:** Linkage between housing communities whether roadway, bike, or pedestrian between is limited. **Transportation:** VC ratios along one corridor will likely be high during peak commute times as cul-de-sacs and dead-end streets prevent residents from accessing multiple arterials or freeways.arterials or Freeways.
Z5 - Rural	**Land Use:** Generally, free from large developments with scattered single-family housing or the occasionally large facility. **Distinguisher:** Significant amount of land use dedicated to farmland, protected habitat, and open lands. **Transportation:** VC ratios remain low compared to the region unless there is a special community event that attracts local, regional, or national/international tourism. Farm-to-Market roads are more prevalent in these areas.

Corridor Characteristics

The following descriptions highlight the importance of evaluated arterial corridor characteristics.

Characteristic	Description
Multimodal	**Definition:** Served by diverse transportation options, such as walking, cycling, public transit, and automobile. **Importance:** Arterials connect adjacent developments, land use types, and other transit corridors and connections. Multimodal options provide more travel options for a greater range of users along the corridor and allow for increased carrying capacity.
Safety	**Definition:** The means and methods used to prevent harm to users of the transportation facility. Safety is implemented through improvements such as lighting, landscaping, buffers between vehicular road and pedestrian facilities, raised median islands, traffic barriers, reflective surfaces, street lights, appropriate sight distances, and grade-separated pedestrian/bicycle routes. **Importance:** Arterials often accommodate multimodal travelers; the more vulnerable of them are pedestrians and cyclists. Implementing safety elements to the transportation corridor will enhance the protection of all its users.
Access	**Definition:** The way by which users access the transportation facility from adjacent land parcels. Access types can include driveways, safe turning lanes, medians, and right-of-way management. **Importance:** Access management is a means of improving and maintaining efficient and safe mobility.
Urban Form	**Definition:** The geometry, density, and configuration of buildings, setbacks, landscaping, lighting, and undeveloped land adjacent to the right-of-way. **Importance:** The relationship between a transportation corridor and its adjacent urban form is symbiotic. Just as the qualities of existing and future surrounding developments influence the arterial road, the arterial road will also influence the
Land Use	**Definition:** A built environment that has a dedicated function(s). Some land uses include recreational, agricultural, residential, commercial, and industrial. **Importance:** Existing and future land use types along the corridor impact the planning for and success of multimodal transportation, safety, and access management.

First North 1st Street, San Jose, California

North 1st Street is a Principal Arterial thoroughfare stretching roughly 8 miles from Downtown San Jose, California to the San Francisco Bay. It is a primary route for transit and vehicular traffic that connects a variety of employment centers and regional roadways.

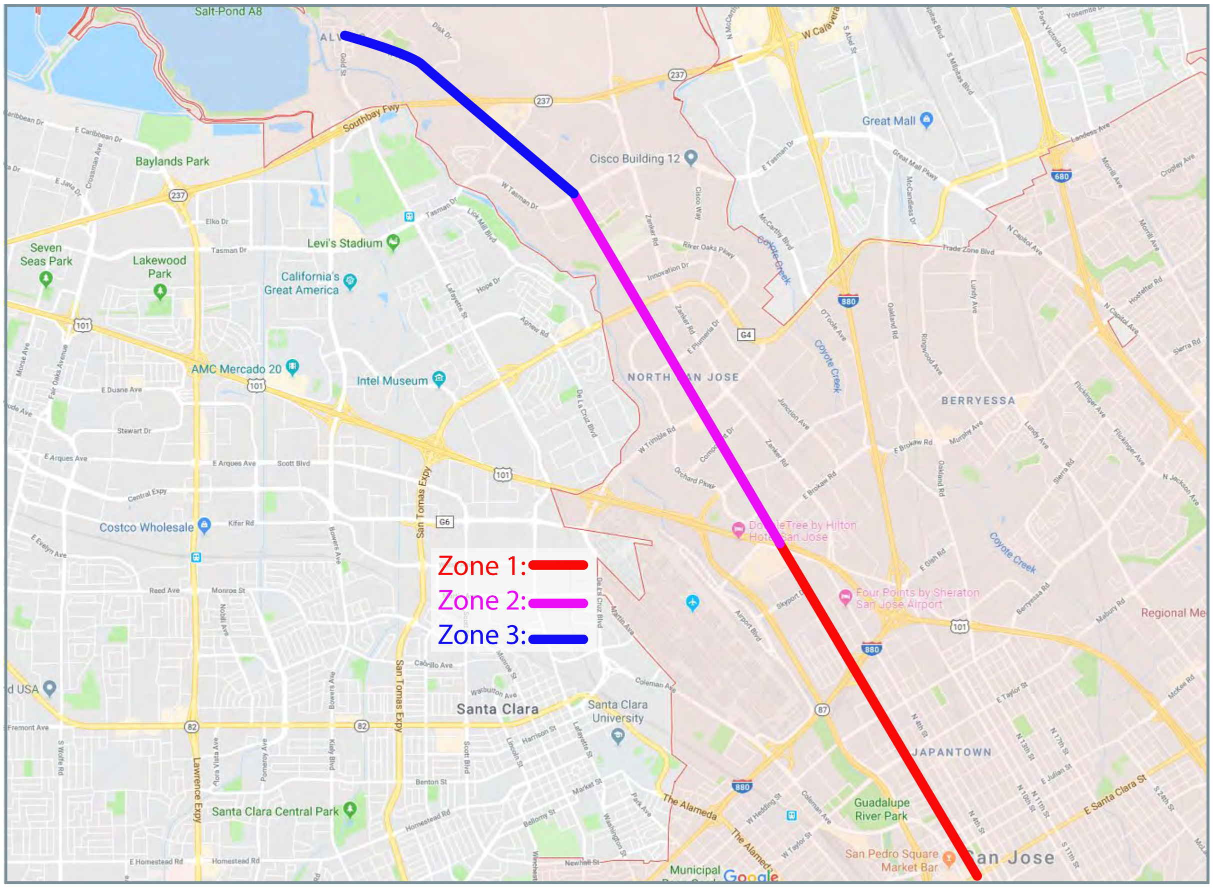


Figure 4.35

Source: Google Maps 2018, https://bit.ly/2CjuF4o

North 1st Street is a subregional route that connects Downtown San Jose with the northern part of the city. It also provides access to subregional, regional, and interregional routes as it intersects IH-880, US 101, the Montague Expressway, CA 237, and Tasman Drive. Light rail and bus routes operate along one corridor that provide regional access within the metro area.

Functional Classification	Principal Arterial
Context Zone	Transitions between Zones 1-3
Total Length	8 miles (E Santa Clara St to Liberty St)
Right-of-Way Width	95′ to 135′ feet
Safety Features	Medians, Street Trees, Pedestrian Refuge Islands
Multi-modal Features	Light rail, bus route, bike lanes, and sidewalks along corridor
Speeds	20 to 45 mph
Lighting	Throughout corridor

Characteristics

MULTIMODAL

- Pedestrian sidewalks 8'-10' feet wide along most of the corridor.
- The corridor accommodates a variety of alternative transportation options, including light rail, bus, bikes/pedestrians, and bike share stations.
- Light rail stations are in the median while the bus stops that are located in right lane of traffic often include pull-outs.

SAFETY

- Many of the train stations also operate as pedestrian refuge islands within the surrounding grade separation providing refuge in a relatively wide right-of-way.
- Lighting is present throughout the route, with various types of light fixtures. applications. In the core city area, there are ornamental street lamps spaced roughly every 75' feet, whereas, the areas outside the core have lights spaced roughly every 100'-120' feet.
- The corridor features raised medians along most of its length.

ACCESS

- The corridor is connected to a consistent street network for much of the length but its connectivity is limited to north of W Tasman Drive. There are multiple parallel streets for accessibility but only 4th Street/Zanker Road (Minor Arterial) extend the entire 8 miles. The other primary roadway nearby is the CA 87 freeway which extends about half the length of the N First Street corridor.
- In the downtown portion of the route, driveways are irregular with roughly 1 or 2 per city block. Driveway spacing becomes denser on the north end as the built form along the corridor is more auto-oriented with approximately 270'-330' feet between each driveways.
- All segments with bidirectional traffic have a left turn lane at intersections except at Bassett Street in Downtown which is a four-way stop sign treatment.
- In the more suburban segments toward the north end of the route, there are a few right turn lanes, and in most of the areas where a right turn lane is present, there are pedestrian refuge islands to reduce the length of the pedestrian crossing.

URBAN FORM

- Much of the right-of-way is lined with mid-rise buildings, especially downtown; however, the segments north of Bassett Street begin to have the buildings setback off the street (5'-15' feet).
- Most of the corridor includes landscaping and trees situated along the perimeter of the sidewalks and interspersed in the medians. Both types of landscaping provide shade along the corridor and within the median trees act as a barrier between the train stations, railway, and traffic on the street.

LAND USE

- The nearby land uses adjacent to the downtown segment of the corridor include healthcare, education, and government with a smaller proportion being professional services and retail/hospitality services.
- The land uses surrounding the northern segment of the route include professional services and manufacturing and logistics.

Downtown Adjacent Network & Access

Figure 4.36 Source: San Jose, California, Google Earth 2018. https://bit.ly/2CjuF4o

N 1st Street and Southbay Freeway Adjacent Network & Access

Figure 4.37 Source: San Jose, California, Google Earth 2018. https://bit.ly/2VV0c5N

Annual Average Daily Traffic (AADT) Numbers:[28]

North 1st Street				
Location	2007 AADT	2011 AADT	2014 AADT	2015 AADT
@ Component	25,206	-	-	-
@ IH 280 (S First)	-	20,800	-	-
@ Santa Clara	-	-	3,549	-
@ San Salvador	-	-	-	3,360

Figure 4.38

[28] Source: Kaggle: Your Home for Data Science. https://bit.ly/2JkOITE

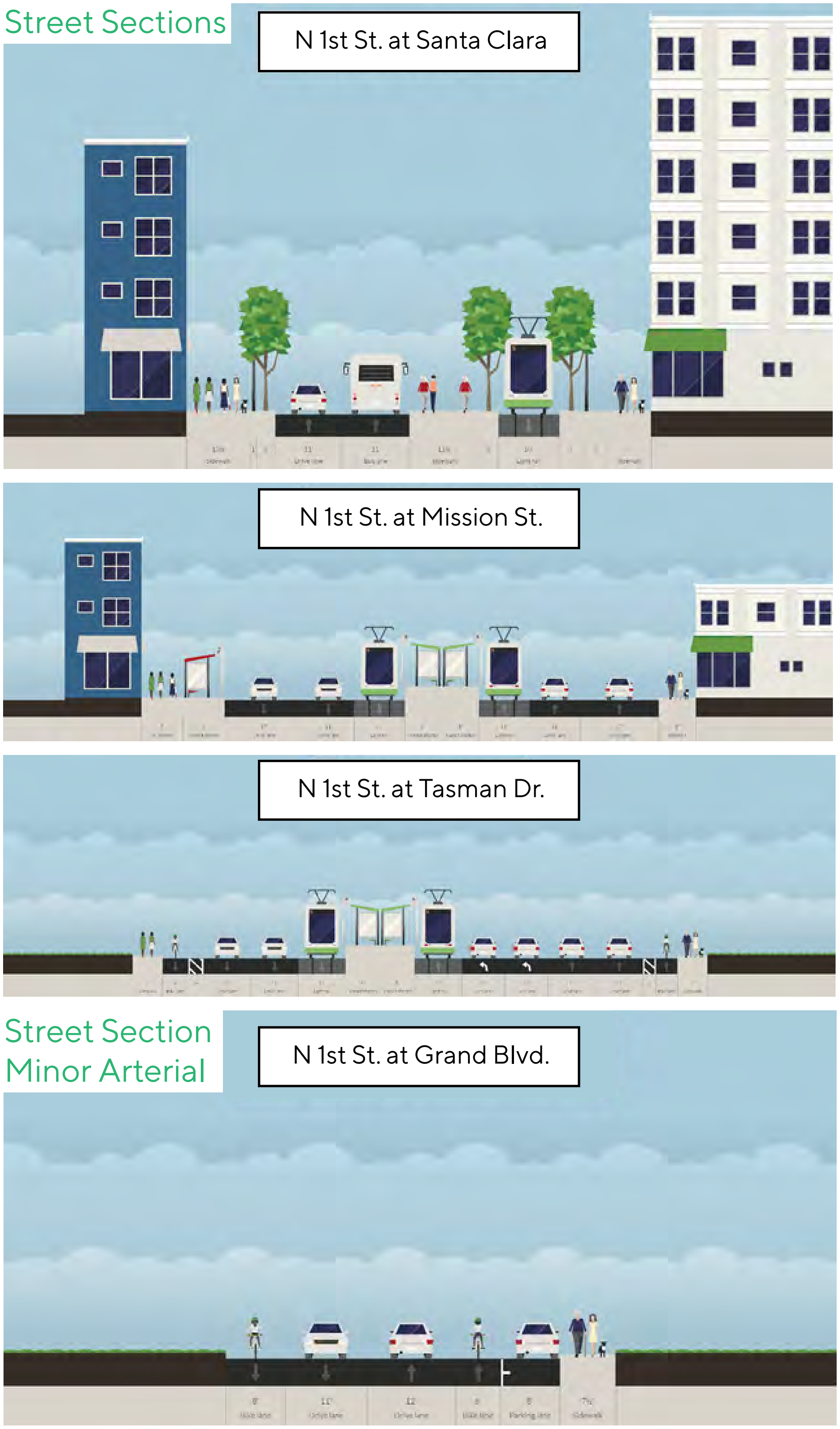

Street Sections
N 1st St. at Santa Clara
N 1st St. at Mission St.
N 1st St. at Tasman Dr.
Street Section
Minor Arterial
N 1st St. at Grand Blvd.

Figure 4.39

Euclid Avenue, Cleveland, Ohio

Euclid Avenue is an urban thoroughfare extending from the City's central square northwest to the suburban community of Willoughby. The four mile segment of corridor in the core of Cleveland is a multi-modal Minor Arterial with Bus Rapid Transit (BRT). The segment outside the core of the corridor is a Principal Arterial roadway to its terminus in Willoughby.

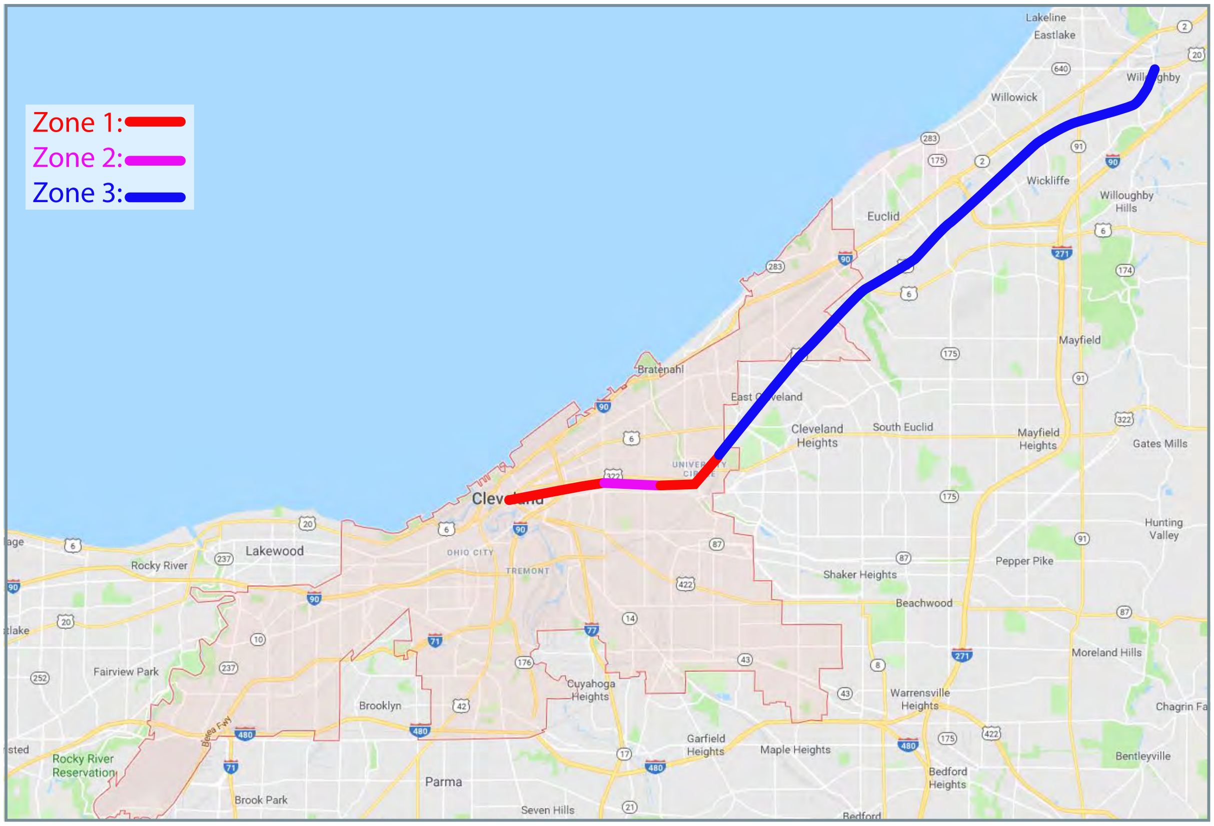


Figure 4.40

Source: Google Maps 2018, https://bit.ly/2Rurly4

At different points Euclid Avenue serves as a local route or subregional route that ties into a regional roadway (US 20). The portion between Downtown Cleveland and US 322 is a local urban corridor intersecting IH-90 and multiple local streets. From US 322 to OH 640, the corridor serves as a subregional route connecting IH-90, US 6, OH 91, and OH 174.

Functional Classification	Minor Arterial / Principal Arterial
Context Zone	Transitions between Zones 1-3
Total Length	18.5 miles
Right-of-Way Width	85′ to 110′ feet
Safety Features	Medians, Street Trees, Pedestrian Refuge Islands
Multi-modal Features	Bus Rapid Transit, local bus, bike lane in some areas, sidewalks throughout corridor
Speeds	25 to 35 mph
Lighting	Present throughout corridor

Figure 4.41

Characteristics

MULTIMODAL

- The BRT line is in the center of a varying width of right-of-way, which means the space on either side of the BRT line can change from 1-3 lanes at any given point. Relevant signage at each intersection is used to guide drivers on the appropriate lane to use.
- Moreover, the BRT platforms are often split with a street intersection in between them.
- The entirety of the BRT line is accompanied by pedestrian facilities between 8′-10′ feet wide to serve pedestrians and transit riders.

Source: Cleveland, Ohio Google Streetview, 2017
https://bit.ly/2AQfDmW

Figure 4.42

SAFETY

- The medians at the BRT stations also operate as pedestrian refuge islands with surrounding grade separation to reduce the crossing distance.
- Some segments of the corridor have trees planted between the sidewalk and the street, while other segments have trees planted in the area outside the sidewalk. Both types of tree planting design provide shade for pedestrians and bicyclists and provide pedestrians with protection from moving vehicles.
- Lighting is present throughout the corridor with the downtown area having both street lamps as well as overhead cobra lights at each intersection and within the median. The street lamps are generally spaced between 30′-75′ feet. The segment without the BRT line, has cobra head lighting spaced roughly every 150′ feet.

ACCESS

- Euclid Avenue is surrounded by a consistent street network throughout its length, including a variety of Principal and Minor Arterials, and Collectors. The network is well-connected between Downtown Cleveland and University Circle; however, beyond University Circle most of the network intersects Euclid perpendicularly. The main alternative routes for Euclid Avenue are Principal (Cedar and Chester Avenues) and Minor (Prospect Avenue) arterials, and a Collector (Hough Avenue).
- Driveways are spaced roughly one per city block along the corridor within the downtown area. As the route becomes more suburban, driveways are located on varying blocks in a clustered fashion for strip malls (2-3 per block). There's not a demonstrable, consistent increase in the number of driveways in suburban versus urban areas. In the areas outside of downtown Cleveland, driveway spacing is roughly 150′-200′ feet.
- Left turns are restricted on much of the corridor Downtown, because of the only one general purpose lane. However, on segments with more than one general purpose lane in each direction, left turns and U-turns are permitted on the corridor. These left turn lanes are Grade-Separated by a curb barrier or simply by street paint.

URBAN FORM

- Most of the right-of-way is lined with buildings, especially in Downtown, at Cleveland State University, and near Case Western Reserve University. In these areas many buildings lack setbacks. The large buildings that do, have setbacks of roughly 15'-30' feet.
- In various sections of the median, landscaping is present to benefit the streetscape.

LAND USE

- The land use in the downtown core of Cleveland adjacent to Euclid Avenue is heavily focused on retail & general commercial services. The area near the intersection of Euclid Avenue & IH90 is dominated by land use for education; Cleveland State University campus is situated to adjoining retail services. When the corridor turns northeast at the intersection of Martin Luther King Jr. Drive, land use dedicated to education is again prominent; Case Western Reserve University situated on Euclid Avenue.

Downtown Adjacent Network & Access

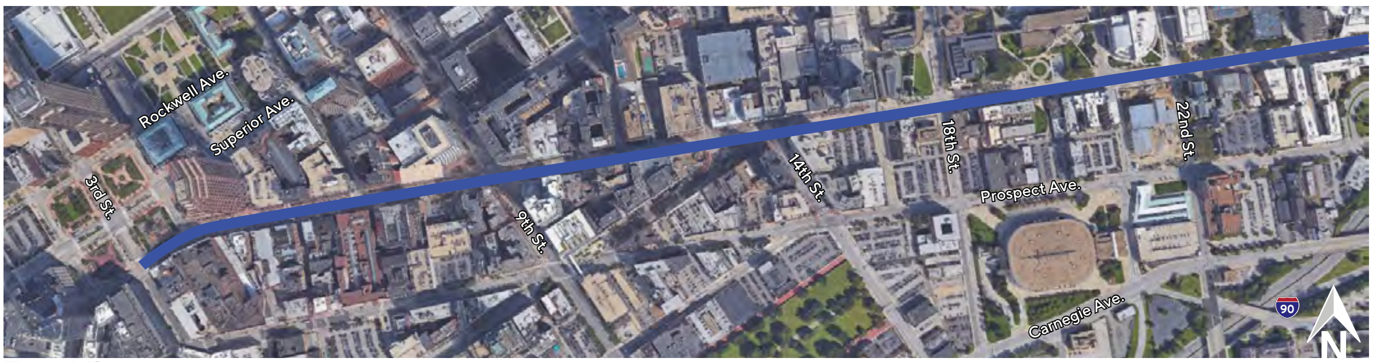


Figure 4.43

Source: Cleveland, Ohio, Google Earth 2014. https://bit.ly/2CpnesA

Euclid Avenue at London Road Adjacent Network & Access

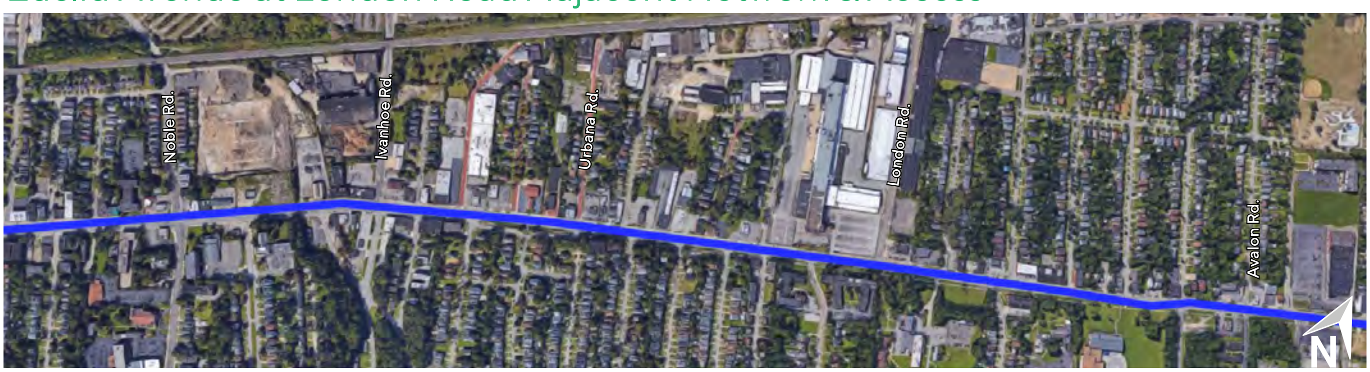


Figure 4.44

Source: Cleveland, Ohio, Google Earth 2018. https://bit.ly/2RQxUdp

Annual Average Daily Traffic (AADT) Numbers:[29]

Euclid Ave					
Location	2013 AADT	2014 AADT	2015 AADT	2016 AADT	2017 AADT
@ E 73rd St	7,610	7,420	7,499	5,917	6,077
@ Adelbert Rd	20,180	20,321	20,699	25,826	25,826
@ Highland Rd	22,250	22,406	22,823	24,376	24,376
@ E 286th St	-	9,718	9,822	10,235	10,511

Figure 4.45

[29] Northeast Ohio Areawide Coordinating Agency GIS Portal, traffic layer, traffic counts. https://bit.ly/32fZXWi

Street Sections

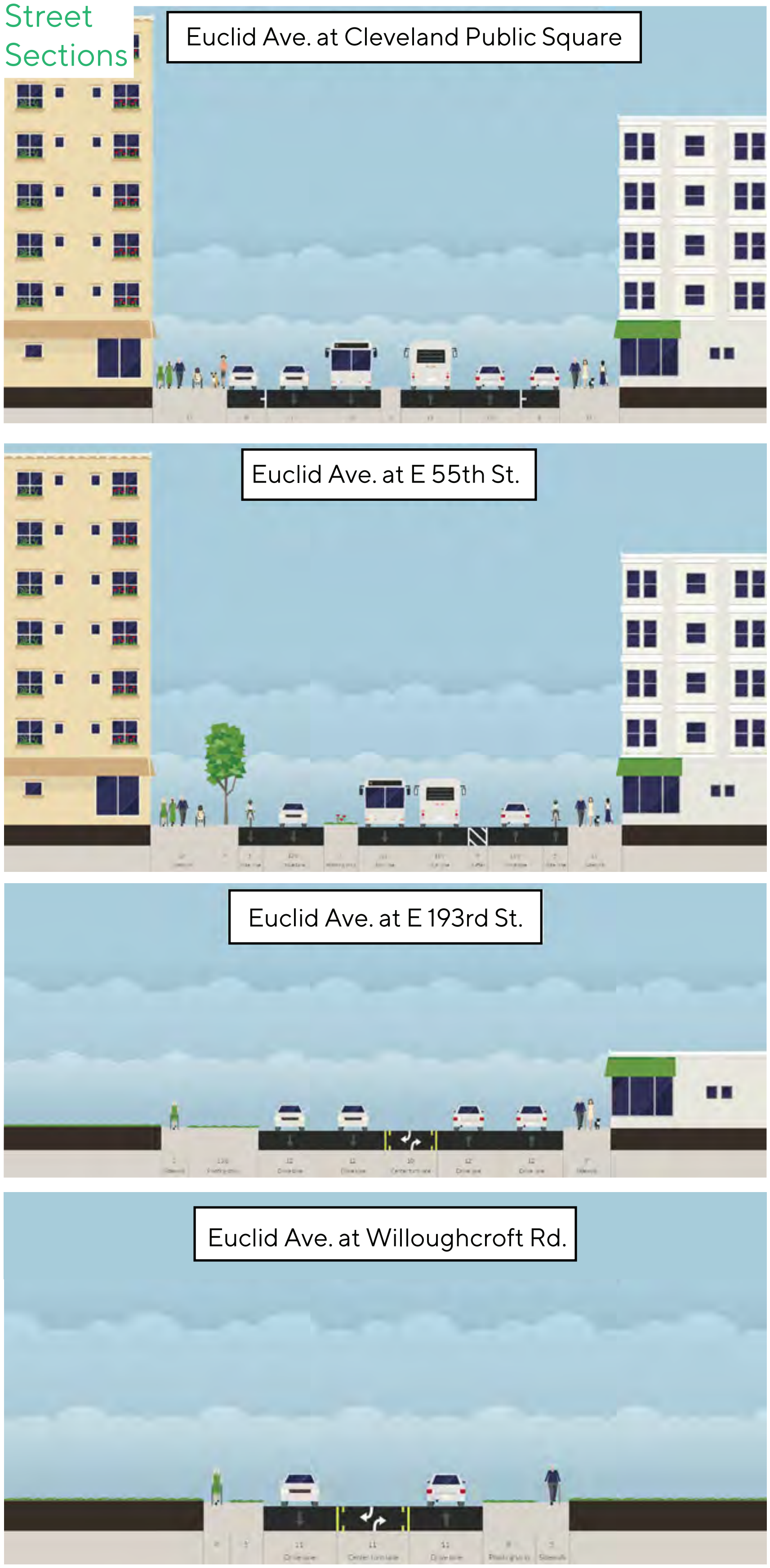


Figure 4.46

CA 111, Palm Desert, Riverside County, California

CA 111 is a state highway extending from IH-10 near Whitewater down to the Mexican border. This case study focuses on the 1.5-mile segment passing through Palm Desert. Along this stretch, CA 111 is a Major Arterial.

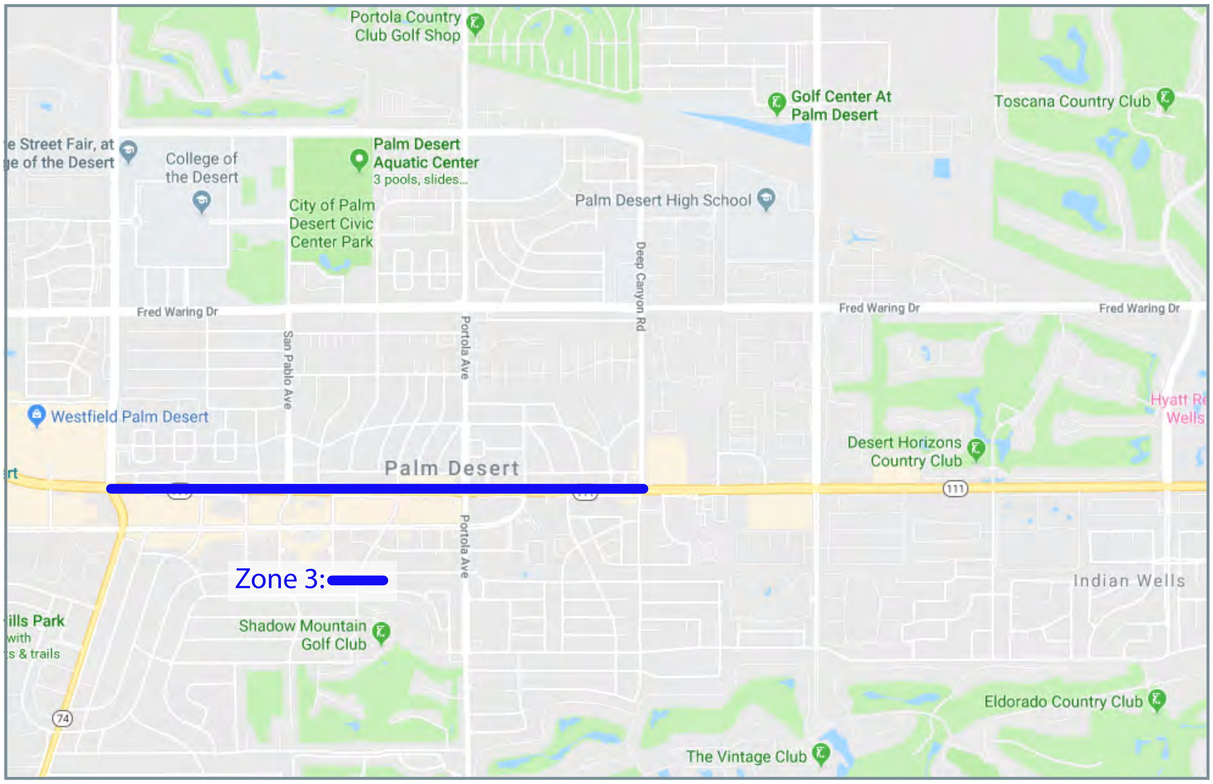


Figure 4.47 Source: Google Maps 2018, https://bit.ly/2DbBN4y

In its entirety, CA 111 is an interregional route running from IH-10 near Whitewater, CA south of the United States and Mexico border. The regional segment of CA 111 is from IH-10 to Indio, CA and handles much of the non-interstate traffic in the region. This segment in Palm Desert is a regional corridor as well as a main commercial street and primary transport corridor through the city and its Downtown. CA 111 connects to the regional route CA 74 (Pines to Palms).

Functional Classification	Major Arterial
Context Zone	Zone 3
Total Length	1.5 miles (Monterey Ave to Deep Canyon Rd)
Right-of-Way Width	120' to 205' feet
Safety Features	Medians and street trees
Multi-modal Features	Bus route and sidewalks throughout
Speeds	45 mph on central roadway and 15 mph on slip streets
Lighting	Occasionally found at intersections

Figure 4.48

Characteristics

MULTIMODAL

- Transit operates along the corridor, and center with bus stops and bus pull-outs located in the right general purpose lane.
- The pedestrian realm is mostly lacking from the central lane but there are sidewalks on the outside of the local lanes providing access to the storefronts.

SAFETY

- The medians between the slip streets and main general-purpose lanes provide pedestrian refuge islands; most of the corridor is a narrow one or two lane design.
- The intersections utilize pedestrian signals for improved safety.
- Lighting is absent from the corridor except at intersections where the traffic lights share the same poles as the overhead cobra lighting.

ACCESS

- The corridor is surrounded by an inconsistent street network but does include backage serving the CA 111 roadway. There are also a few parallel streets for accessibility including one Principal Arterial (Fred Waring Drive) and one major Collector (El Paseo) that parallel a portion of the length of CA 111 through Palm Desert.
- Complete four-way street intersections are spaced very far apart (more or less 2,500 feet). This spacing permits better access by the regularly-spaced local lane entrances to the commercial areas adjacent to the roadway.
- For most of the corridor, local lanes facilitate local traffic on both sides of the central thru travel lanes. However, there are sections without local lanes. Intersection types vary with some local lanes passing through intersections parallel to the thru travel lanes and others merging with thru travel lanes before and after intersections.
- Each intersection allowing for left-hand turns includes dedicated left turn lanes. Some intersections have left-hand turn lanes in each direction.

CA 111 at San Pablo Avenue Adjacent Network & Access

Figure 4.49

Source: Palm Desert, California, Google Earth 2018. https://bit.ly/2Fwe4hW

Annual Average Daily Traffic (AADT) Numbers: [30]

CA 111					
Location	2010 AADT	2011 AADT	2012 AADT	2013 AADT	2014 AADT
@ Monterey	30,656	30,827	30,174	30,005	33,218
@ Portola	36,054	35,439	38,233	37,594	41,299

Figure 4.50

[30] Source: City of Palm Deser, Coachella Valley Association of Governments 2017 Traffic Census Report. https://bit.ly/305yvIO

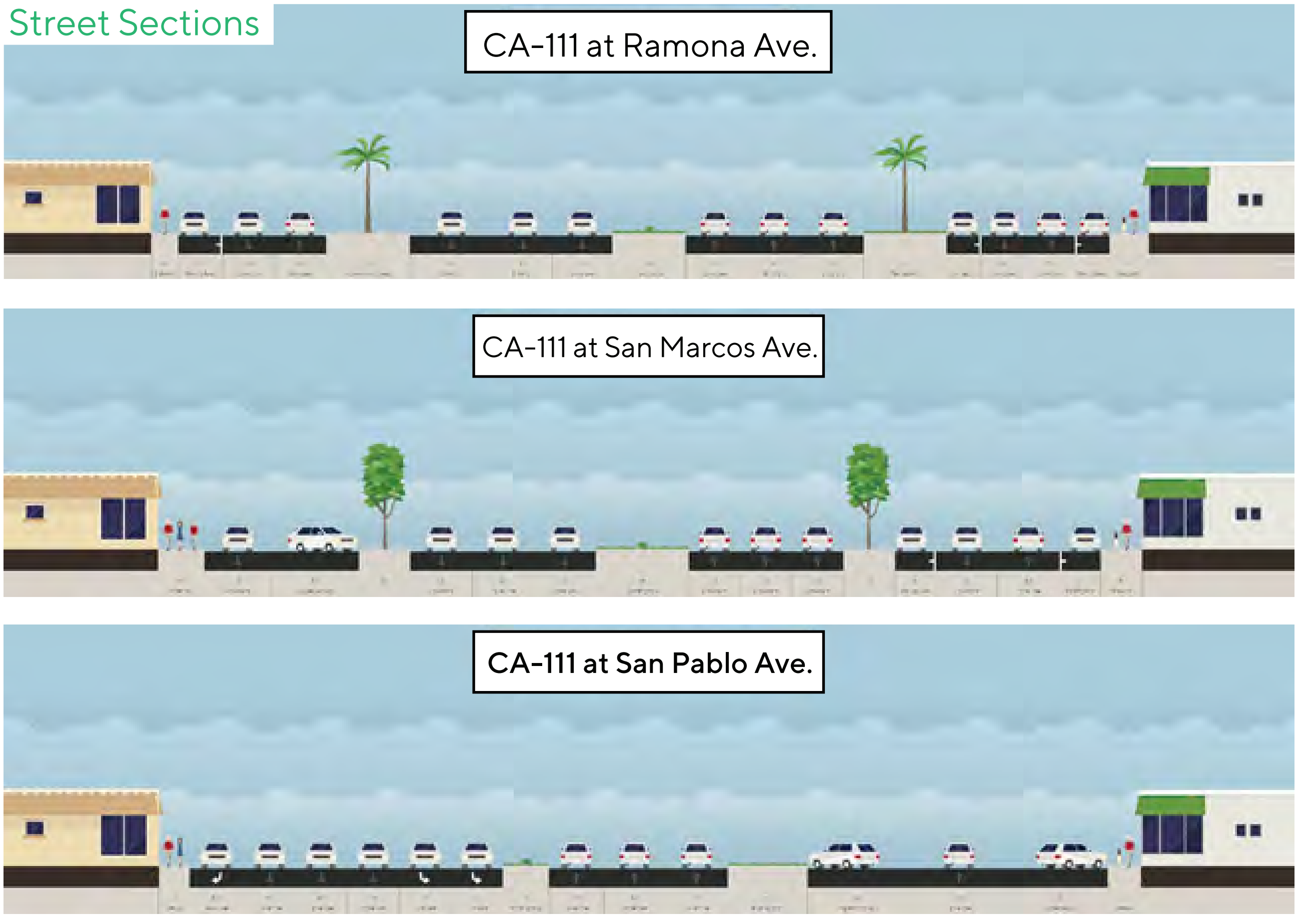

Street Sections
CA-111 at Ramona Ave.
CA-111 at San Marcos Ave.
CA-111 at San Pablo Ave.

Figure 4.51

San Tomás Expressway, San Jose, California

The San Tomás Expressway is an 8.2-mile controlled access Principal Arterial roadway passing through multiple communities in the San Jose metropolitan area. It is a major Regional Connector with access to multiple arterial roadways and Freeways.

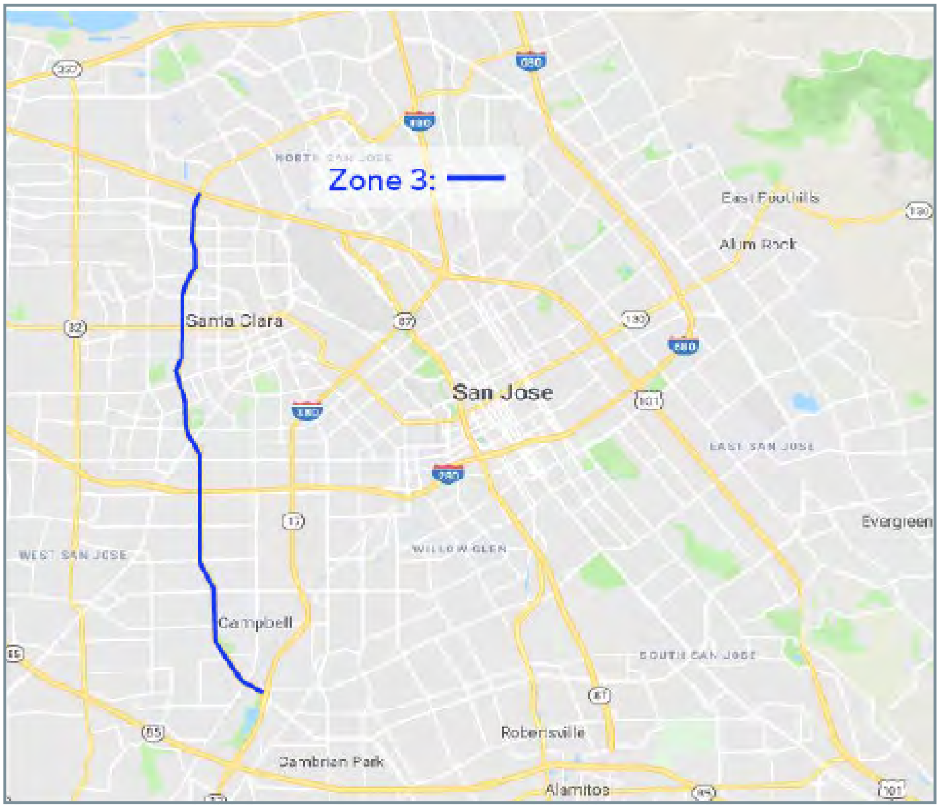


Figure 4.52 Map of San Tomás Expressway

Source: Google Maps 2018, https://bit.ly/2Ddovo5

The San Tomás Expressway is a subregional route that connects the Montague Expressway with Camden Avenue/Hillsdale Avenue, and the Capital Expressway to create a beltway around San Jose. It also connects multiple subregional, regional and interregional routes such as Saratoga Avenue, Homestead Road, the Central Expressway, CA 17, IH-280, CA 82, and US 101.

Functional Classification	Principal Arterial
Context Zone	Zone 3
Total Length	8.2 miles (CA-17 to Bayshore Freeway)
Right-of-Way Width	120′ to 155′ feet
Safety Features	Medians and jersey barriers
Multi-modal Features	HOV/transit way, some sidewalks at intersections
Speeds	45 mph
Lighting	Occasionally found at intersections

Figure 4.53

Characteristics

MULTIMODAL

- Transit operates along the corridor with bus stops at intersections and diamond-marked transit lanes on this corridor. The diamond-marked lanes are for bus and carpool use Monday through Friday during peak periods.
- Although, the corridor does not allow for pedestrian access along its entirety, sidewalks extend a few hundred feet to allow for pedestrian access to the bus stop.
- There is a short section near the southern end of the corridor with an adjacent shared-use path.

SAFETY

- Most of the route includes greenery and trees on the periphery of the right-of-way acting as a sound and safety barrier between the expressway and adjacent land uses. Many sections implement fences and walls for separation.
- Grade-separated pedestrian crossings are present at certain points along the corridor. The right-of-way is wide (150′-200′ feet at intersections), however the pedestrian refuge islands between the slip streets split the right-of-way, creating shorter crossing distances.
- Roadway lighting is typically only found at intersections.

ACCESS

- San Tomás expressway is surrounded by a consistent street network for much of its length, however the expressway provides limited-access to the street network. There are a few parallel Major Arterials (Westchester Boulevard, Saratoga Avenue, and the Lawrence Expressway) that provide greater access to these networks but none of them extend the entire length of the 8.2-mile corridor.
- The corridor has right-hand slip turn lanes at every four-way intersection. At each intersection where a slip turn lane is present, there are pedestrian refuge islands for safer pedestrian crossings.
- The 8.2 mile corridor has managed access with 18 at-grade intersections (roughly one intersection every half mile).
- Four grade-separated interchanges providing access to other arterials and Freeways along the corridor.
- Every four-way at-grade intersection is signalized and includes 1-2 left hand turn lanes.

URBAN FORM

- The entirety of the corridor is divided with either a grass median or a curb.
- Lighting is clustered at intersections where the traffic lights share poles with overhead cobra lighting. There are also other segments north of the Monroe Street intersection where cobra street lights are along the roadway spaced roughly 200 feet apart.

LAND USE

- San Tomás Expressway is a Limited-Access facilities without much connectivity to the adjacent land uses. The route is highly populated with adjacent residential subdivisions and retail land uses at certain nodes and includes pockets of manufacturing and logistics at the intersection of CA17 and US101.

San Tomás Expressway at Saratoga Avenue Adjacent Network & Access

Figure 4.54

Source: San Jose, California, Google Earth 2018. https://bit.ly/2CrbmXb

Average Daily Traffic (ADT)* Numbers:[31]

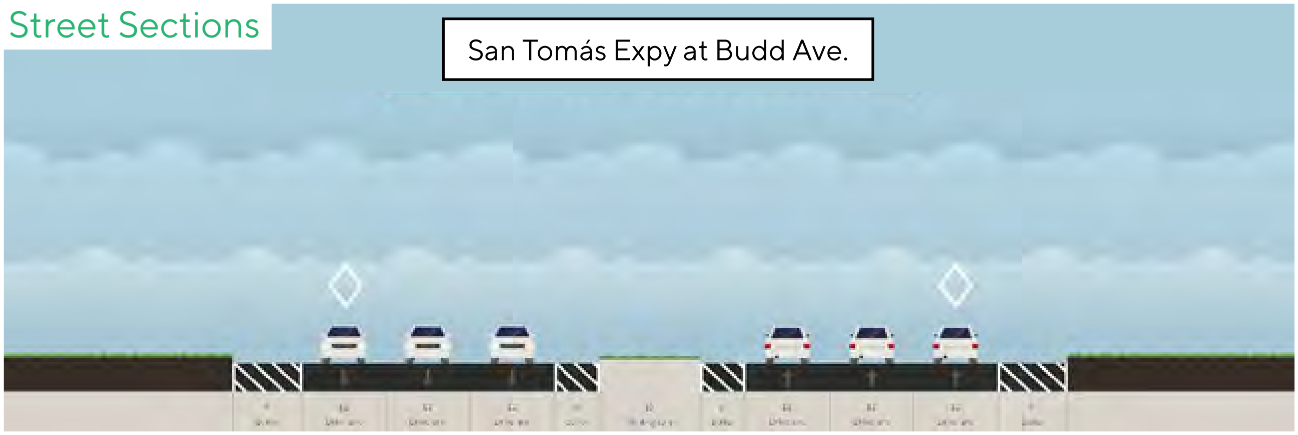
San Tomás		
Location	2013 AADT	2016 AADT
@ Hwy 17	62,140	57,480
@ Hamilton	-	45,750
@ E. Ret. WT Oaks	-	57,480
@ Stevens Creek	-	39,500
@ Bayshore	-	74,920
@ El Camino	-	67,920

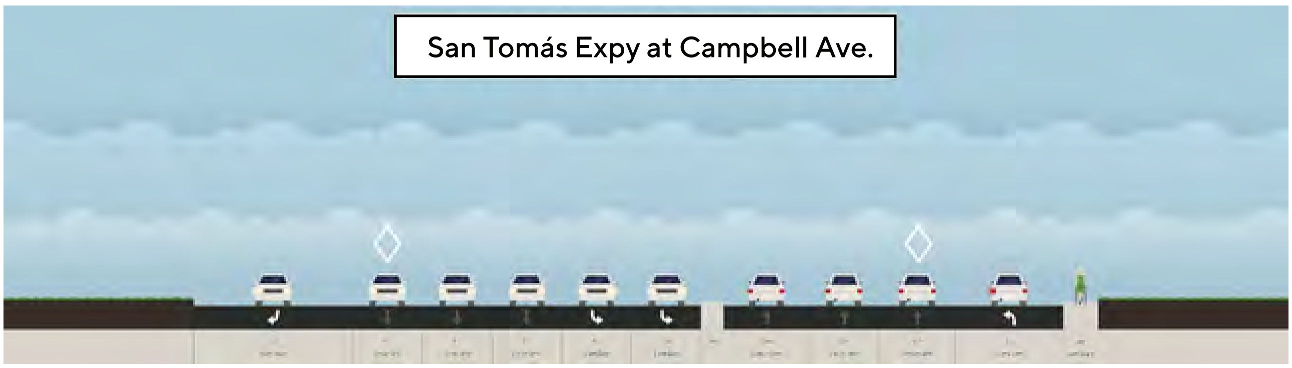
Figure 4.55

*ADT was used as a proxy for AADT due to accessibility of data.

[31] Source: Welcome To The County Of Santa Clara. Official County Road Book 2017. Https://Bit.ly/2Ntgfte

Street Sections





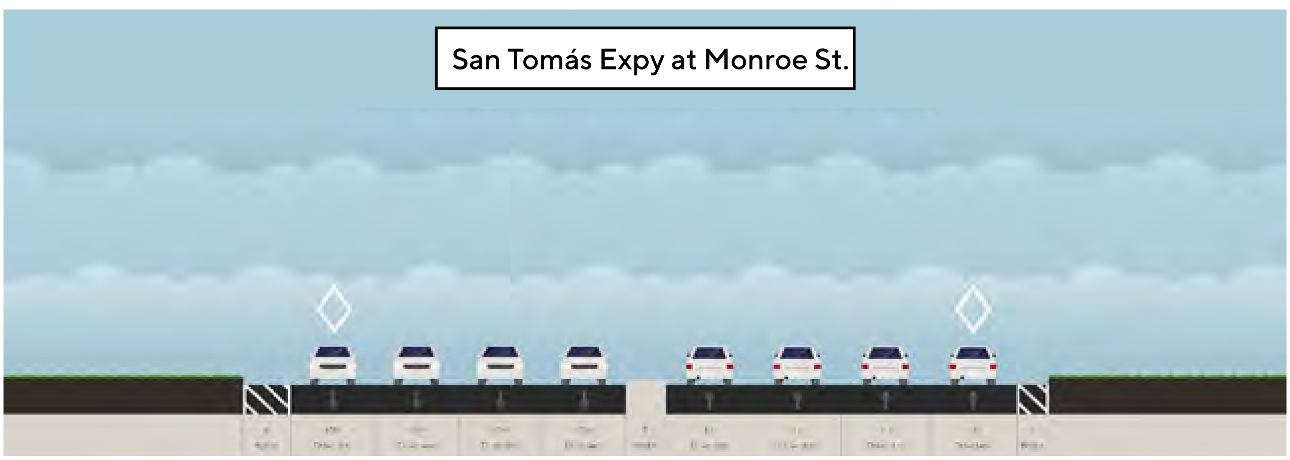


Figure 4.56

Sea to Sky Highway, British Columbia, Canada

Sea to Sky Highway, or British Columbia Highway 99, is considered as a Primary Highway (with northern extent functioning as a Secondary Highway) according to British Columbia's Ministry of Transportation. As a rural arterial, Sea to Sky Highway is designed to serve long-distance trips and interregional connectivity. It is likely that it would be considered a Freeway or a Principal Arterial according to FHWA guidelines.

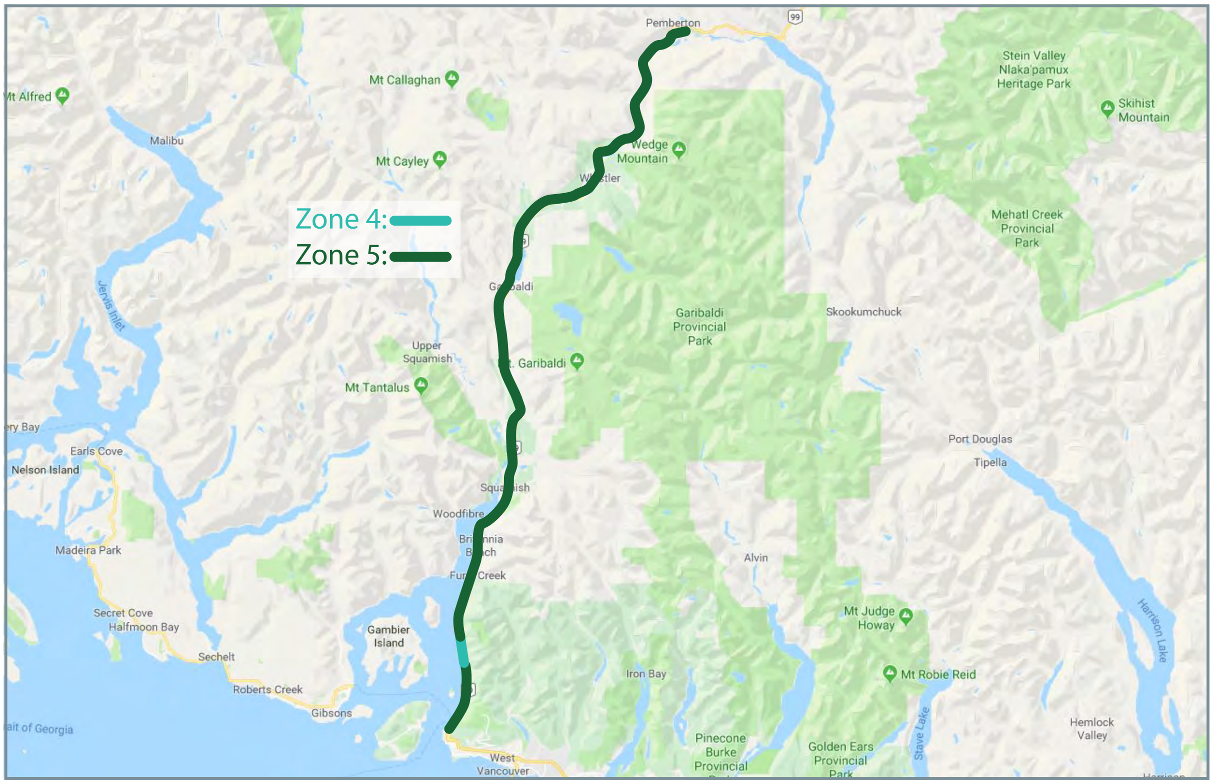


Figure 4.57

Source: Google Maps 2018, https://bit.ly/2QQjo0Z

Sea to Sky Highway runs through rural and a few traditional suburban areas. It connects to the Trans-Canada Highway at, BC-99 and BC-97.

Functional Classification	Principal Arterial
Context Zone	Typically zone 5, but occasionally passes through zone 4
Total Length	82 miles
Right-of-Way Width	65' to 75' feet
Safety Features	Jersey barriers
Multi-modal Features	Designated bike lane in shoulder in some areas
Speeds	37 to 60 mph
Lighting	Occasionally found at intersections

Figure 4.58

Characteristics

MULTIMODAL

- There is a marked bike lane in a few sections of the corridor, mostly the southern section, and shoulders wide enough to accommodate cyclists throughout.

SAFETY

- Safety features include jersey barriers, which are located in medians and in the shoulder in long segments of the roadway.
- Some areas, particularly in the southern section near Howe Sound, have jersey barriers in both shoulders and in the median.

ACCESS

- The highway is generally limited-access, as it is designed to serve long-distance trips through primarily rural areas.
- At-grade intersections are found only in urbanized areas. "Jug handles" for left-turning traffic or U-turns are occasionally located at grade-separated intersections.
- As the highway serves primarily long-distance travel and traverses through valleys between mountain ranges, there is not a true supporting network beyond the Minor Arterials and Collectors that serve towns along the corridor.

URBAN FORM

- The highway passes through mostly rural areas north of Vancouver heading into the nearby mountain ranges. As such, there is little development directly adjacent to the corridor, apart from the suburban communities closest to Vancouver and the low-lying retail and commercial developments in the towns that the Sea to Sky Highway serves.

LAND USE

- Most of the corridor passes through protected wilderness and rural to suburban residential communities. However, through the towns of Whistler and Squamish commercial uses are situated adjacent to the corridor.

Jug handle and Bike Lane – Sea to Sky Highway at Kelvins Grove Way

Sea to Sky Highway at Kelvins Grove Way

Figure 4.59

Sources: Lions Bay, British Columbia, Canada. Google, 2018 and Google Streetview, 2018. https://bit.ly/2AR7PkT

Bike lane on Sea to Sky Highway at Cleveland Avenue

Figure 4.60

Source: Squamish, British Columbia, Canada. Google Streetview, 2018. https://bit.ly/2QSTgIY

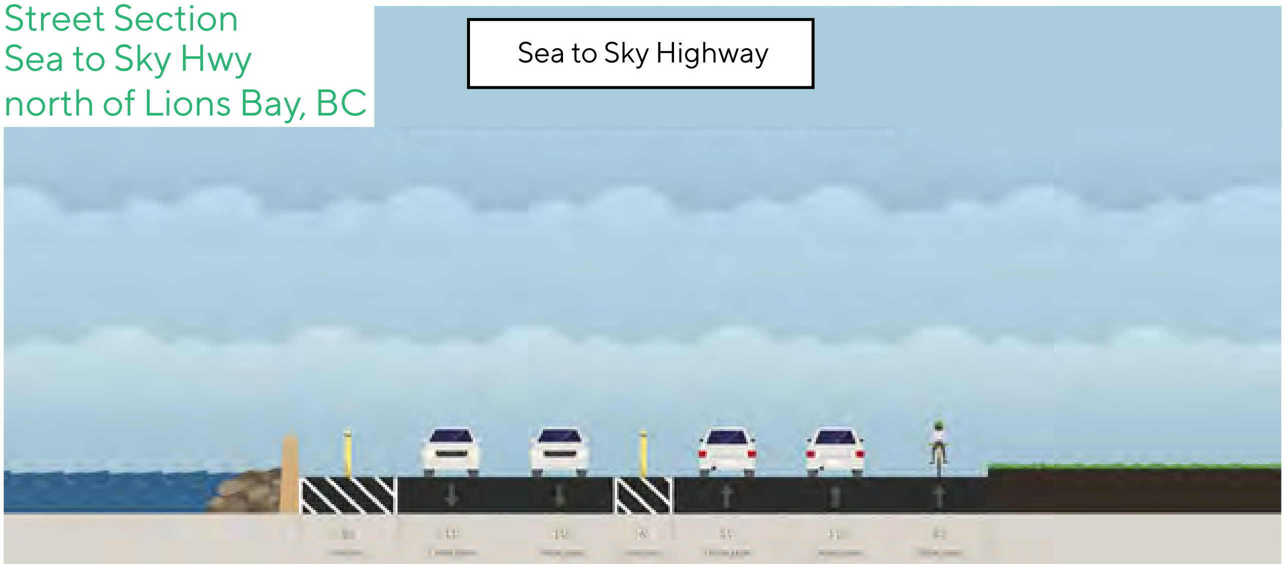
Annual Average Daily Traffic (AADT) Numbers:[32]

Sea to Sky Highway					
Location	2012 AADT	2013 AADT	2014 AADT	2015 AADT	2016 AADT
Horseshoe Bay Drive	16,330	17,052	17,733	18,985	19,890
Cheekye River Bridge	9,192	9,350	9,766	10,463	11,225
Alpine Way	3,686	3,789	3,941	4,284	4,977

Figure 4.61

[32] Source: Traffic Data Program. Welcome to the Traffic Data Program GIS Application. https://bit.ly/2xwyMII

Street Section
Sea to Sky Hwy
north of Lions Bay, BC



Street Section
Sea to Sky Hwy
at Tunnel Point

Figure 4.62

INDIANA 431 Keystone Parkway, Carmel, Indiana

Keystone Parkway serves as a Principal Arterial through the suburban community of Carmel, IN. It connects IH-465 to US-31, as such, serves as an important supporting facility for the regional freeway system. Despite being a Limited-Access facilities, grade-separated intersections with the local grid network allow for easy movement crossing the corridor.

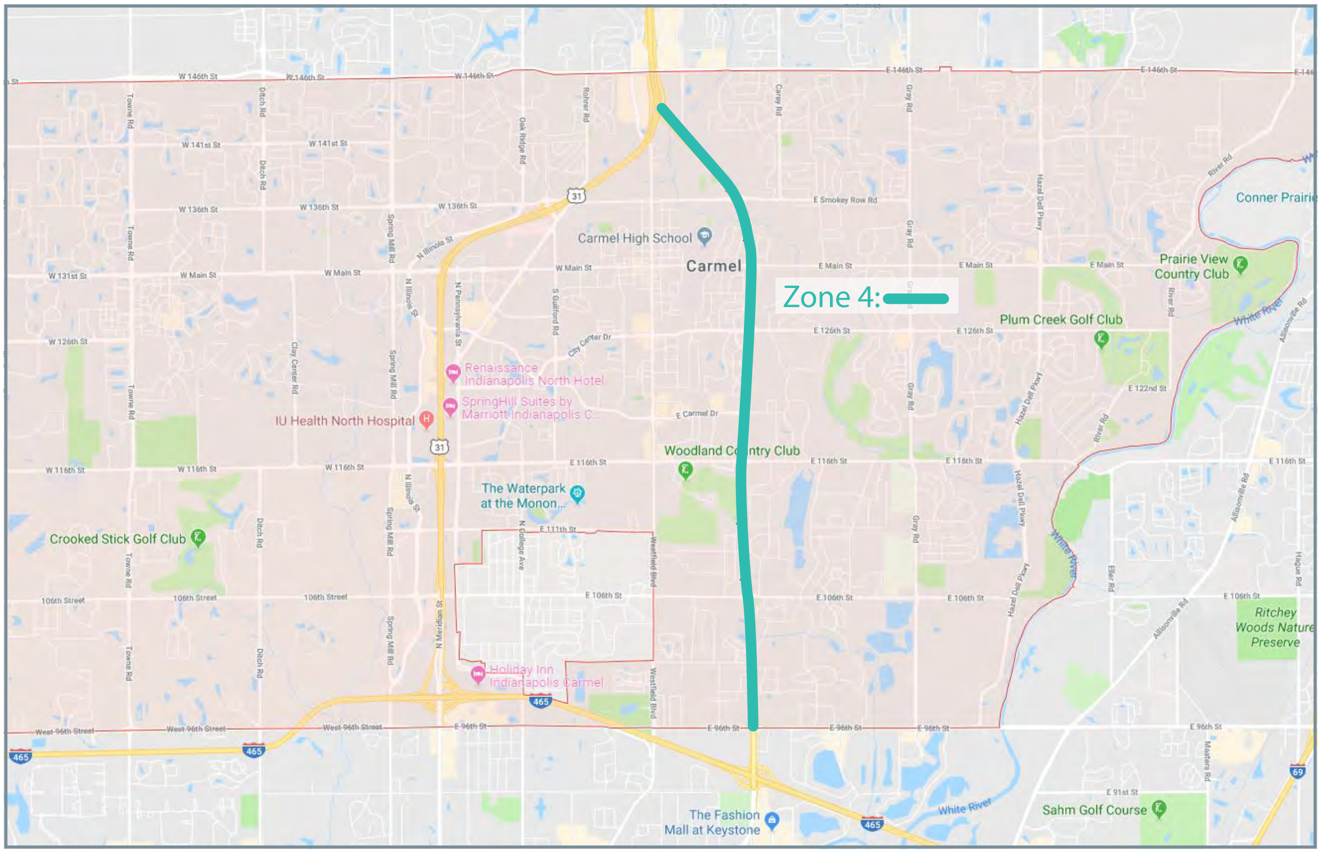


Figure 4.63 Keystone Parkway map

Source: Google Maps 2018, https://bit.ly/2ANZ3UB

The very southern end of the Keystone Parkway is within the City of Indianapolis, but most of the corridor is within the City of Carmel. The corridor passes through Context Zone 4 for its entirety.

Functional Classification	Principal Arterial
Context Zone	Zone 4
Total Length	5.5 miles
Right-of-Way Width	110’ to 120’ feet
Safety Features	Wide shoulders and medians
Multi-modal Features	Bike lane and sidewalks on cross streets
Speeds	50 mph
Lighting	Along outside edge

Figure 4.64

Characteristics

MULTIMODAL

- While the Keystone Parkway does not feature specific multi-modal design elements, cross streets have bike lanes and sidewalks in many places that transect the corridor above grade.

SAFETY

- Wide shoulders and raised medians are common throughout the length of the corridor. In some places there are traffic barriers in the shoulder.

ACCESS

- Intersections with a network of cross streets are Grade-Separated and feature "dog bone" style roundabouts every 1/2 to 1 mile. The only signalized intersection is at the southern endpoint of the Keystone Parkway at 96th Street.
- Auxiliary lanes for ingress and egress are a feature.
- Keystone Parkway provides network redundancy for US-31 (located approx. 2 miles west of the corridor). About 2 miles east of the corridor is Hazel Dell Parkway, which features the same number of lanes as Keystone Parkway.

URBAN FORM

- The corridor passes through primarily traditional suburban and mixed-use suburban areas, with single-family houses and commercial strip development being most common.

LAND USE

- The corridor traverses residential and some commercial developments near central portions of Carmel.

Keystone Parkway at E 116th Street Adjacent Network & Access

Figure 4.65

Source: Carmel, Indiana. Google Earth 2018. https://bit.ly/2ANZ3UB

Dog bone intersection, Keystone Parkway at E 126th Street

Source: Carmel, Indiana. Google Earth 2015. https://bit.ly/2QTAxXk

Dog bone intersection, Keystone Parkway at E 106th Street

Figure 4.66

Source: Carmel, Indiana. Google Streetview, 2013. https://bit.ly/2RQ0Oud

Annual Average Daily Traffic (AADT) Numbers:[33]

Keystone Parkway					
Location	2013 AADT	2014 AADT	2015 AADT	2016 AADT	2017 AADT
96th Street	33,335	33,668	35,183	35,289	35,007
106th Street	37,496	37,871	39,575	39,694	39,376
126th Street	17,376	17,550	18,340	18,395	18,248

Figure 4.67

[33] Indiana Department of Transportation. https://bit.ly/29ih1yV

Street Section

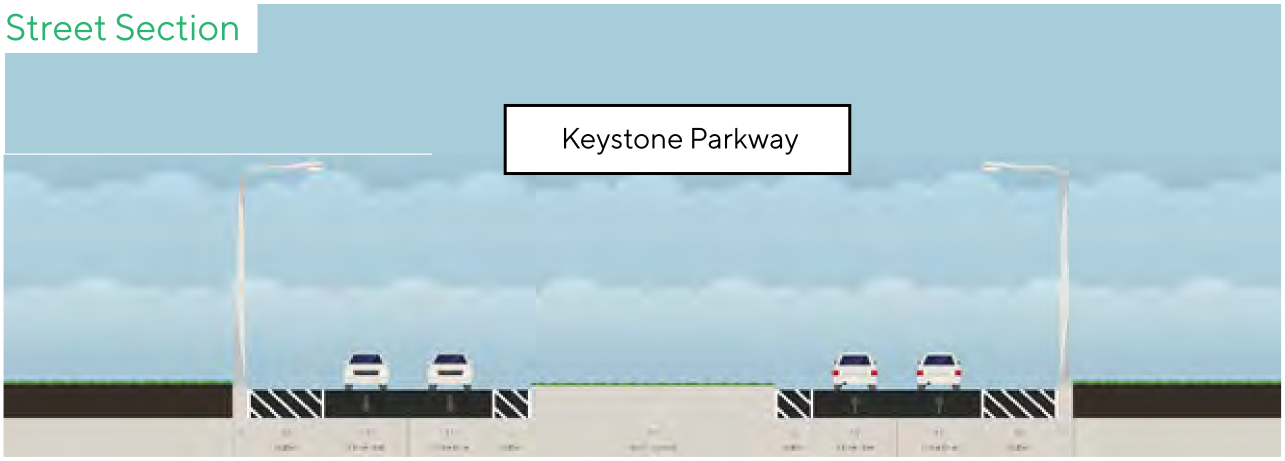


Figure 4.68

Sahara Avenue, Las Vegas, Nevada

Sahara Avenue or State Route 589, serves central Las Vegas as a Principal Arterial between South Rainbow Boulevard to Fremont Street. The corridor serves a wide variety of land uses, from suburban residential communities in the east and west, retailers and denser housing developments in the central portion of the corridor, to workers and travelers accessing the northern portion of the Las Vegas Strip.

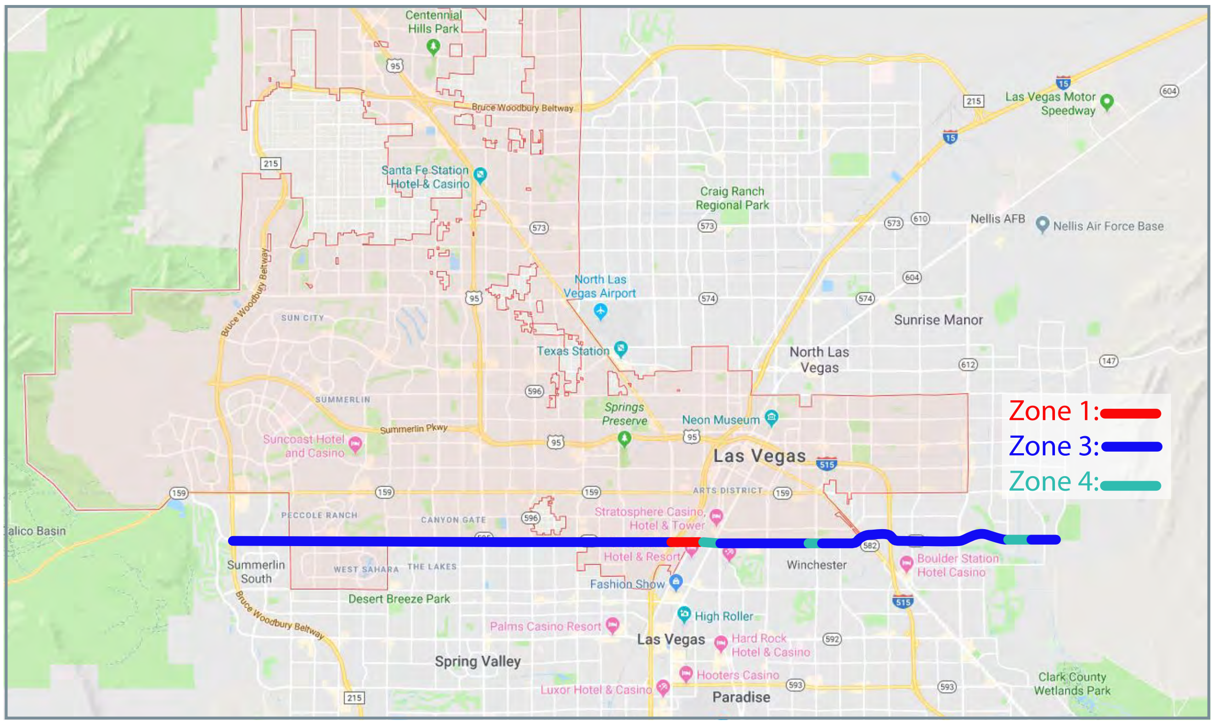


Figure 4.69 Sahara Avenue map

Source: Google Maps 2018, https://bit.ly/2DeO5Ju

The corridor passes through the suburban communities of Spring Valley and Summerlin South on the western end and through the City of Las Vegas and unincorporated Clark County to the east. It connects to IH-15, the Bruce Woodbury Beltway (IH-215), Las Vegas Boulevard, and IH-11. It provides regional connectivity for the Las Vegas Region.

Functional Classification	Principal Arterial
Context Zone	Passes through zones 3 and 4, but also zone 1 at the intersection with Las Vegas Blvd.
Total Length	18 miles
Right-of-Way Width	100' to 140' feet
Safety Features	Wide medians and access management throughout
Multi-modal Features	Bus/bike/right-turn only lanes
Speeds	45 mph
Lighting	In median

Figure 4.70

Characteristics

MULTIMODAL

- The corridor features a right turn/bus/bike only lane. This lane starts to change to a standard vehicular lane approaching IH-15, but becomes a multi-modal lane again at Paradise Road.
- Wide sidewalks are common and help support the bus route along the corridor.

SAFETY

- There is some managed access to driveways along the corridor for adjacent commercial developments and a raised median throughout corridor to limit conflict points.

ACCESS

- Signalized, at grade intersections are featured at every 1/2 mile. Typically, there are two left turn lanes at intersections with other arterial roads and some collectors.
- There is a dense supporting network of arterials and Major Collectors throughout central Las Vegas. Minor Collectors are found a 1/2 mile north and south of Sahara Avenue. One mile to the south is Desert Inn Rd, a Minor Arterial. One mile to the north is State Route 159, or Charleston Boulevard, which also functions as a Principal Arterial within central Las Vegas.

URBAN FORM

- Land uses served by the corridor generally consists of suburban residential developments with commercial strip development within the central portions of the metro area.
- A high number of hotels, restaurants, warehousing, and office space for suppliers and service providers to the hospitality industry are adjacently located to the intersection of Las Vegas Boulevard and Sahara Avenue.

LAND USE

- Residential uses are prominent along the eastern and western ends of the corridor, while commercial uses are prominent in central segment where Sahara Avenue functions as a Principal Arterial.

Sahara Avenue at Durango Drive Adjacent Network & Access

Figure 4.71 Source: Las Vegas, Nevada. Google Earth 2018. https://bit.ly/2AQroKe

Sahara Avenue at Potosi Street, with right turn/bus/bike-only lanes

Figure 4.72 Source: Las Vegas, Nevada. Google Earth 2018. https://bit.ly/2AQWt0b

Sahara Avenue at Lindell Road

Figure 4.73 Source: Las Vegas, Nevada. Google Streetview, 2018. https://bit.ly/2Ry1dIE

Annual Average Daily Traffic (AADT) Numbers: [34]

Sahara Avenue					
Location	2013 AADT	2014 AADT	2015 AADT	2016 AADT	2017 AADT
Ft. Apache Rd	28,500	28,500	32,000	33,000	34,000
Las Vegas Blvd	56,000	61,000	66,500	69,000	69,000
Maryland Pkwy	41,000	43,500	43,500	46,000	50,000

Figure 4.74

[34] Source: Nevada Department of Transportation. Annual Traffic Reports. https://bit.ly/3078fxA

Barrier crossing at Sahara Avenue and Interstate 15 / railroad tracks

Figure 4.75

Source: Las Vegas, Nevada. Google Earth 2018. https://bit.ly/2TT4hpb

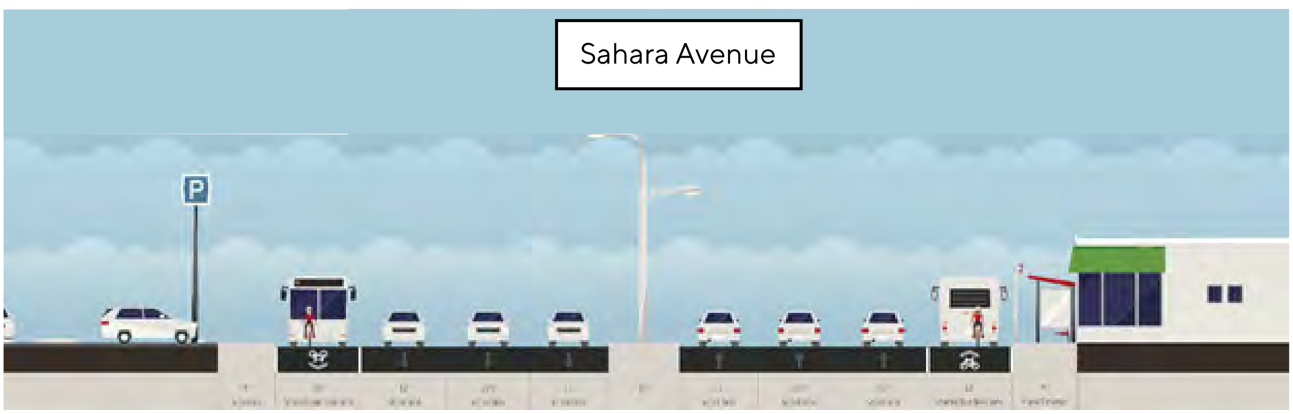


Figure 4.76

1502 PA Wurzbach Parkway/PA-1502 – San Antonio, Texas

Wurzbach Parkway features four and six lanes divided and serves as a connection between IH-10 and IH-35 on San Antonio's Northside. It also serves as an alternative east-west connection between Loops 1604 and 410, reducing some demand on those facilities. This corridor study area passes through many commercial areas, light industrial, and residential uses. There are parks along the corridor including a soccer complex home to a professional team, and an active quarry. There is undeveloped land near the airport adjacent to a segment of the corridor.

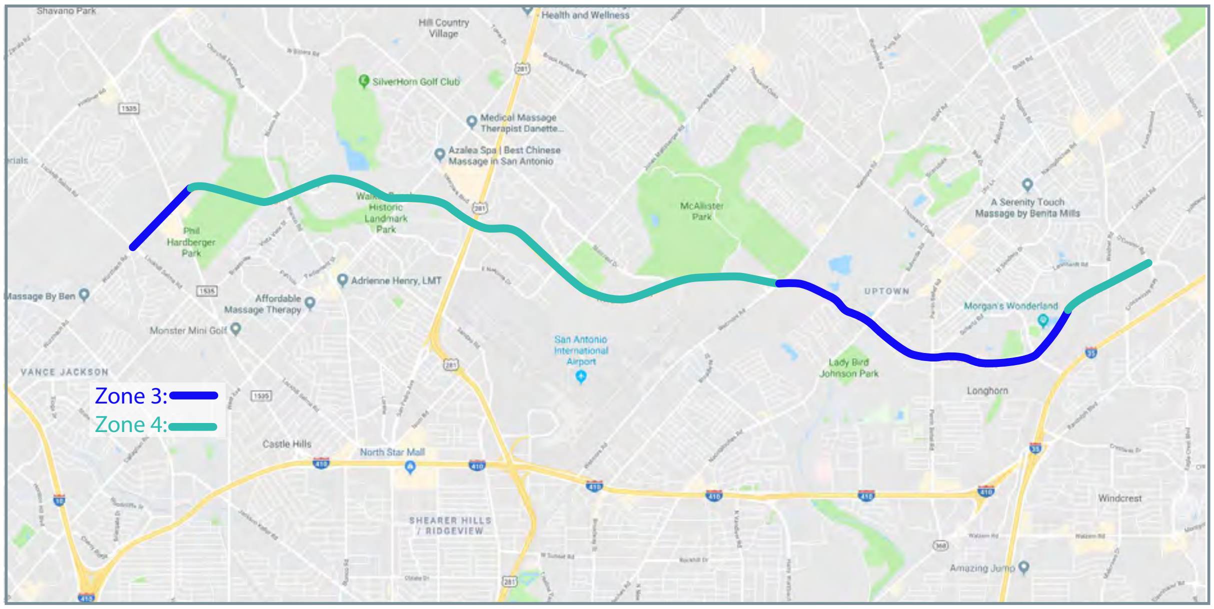


Figure 4.77 Wurzbach Parkway map

Source: Google Maps 2018, https://bit.ly/2RP0oo8

Wurzbach Parkway serves cross region trips, connecting two interstate highways (IH-10 and IH-35), and key destinations such as the international airport, major parks, recreational areas, several office and retail centers. The entire corridor is located inside San Antonio city limits and it intersects major roads such as US 281, NW Military Highway, Blanco Road, Lockhill-Selma Road, Wetmore Road, Nacogdoches Road, and Thousand Oaks among others.

Functional Classification	Principal Arterial. "Super Arterial"
Context Zone	Transitions between zone 3 and zone 4
Total Length	12 miles. (West end: Lockhill-Selma. East end: O'Connor Rd)
Right-of-Way Width	110' to 220' feet
Safety Features	Signaled crosswalks, Raised median, Jersey Barrier, noise abatement walls
Multi-modal Features	Bike Lane along most of the segment in each direction.
Speeds	45 to 60 mph
Lighting	Human scale at west end. Street lighting constant along the corridor

Figure 4.78

Characteristics

MULTIMODAL

- Bike lanes are present west from Perrin-Beitel Road to Jones-Maltsberger Road and from West Avenue to Lockhill-Selma Road, and to the east from Lockhill-Selma Road to Blanco Road, from Vista Del Norte to West Avenue., and from Starcrest Drive to Perrin-Beitel Road.
- A segment of the Salado Creek Greenway (hike/bike trail) passes under or alongside the corridor between US 281 and Starcre Street.
- There is a walking trail in the wide raised median between Lockhill-Selma and NW Military Highway.
- There are no transit routes that operate along the corridor within the highway study area.

SAFETY

- The segment between Lockhill-Selma Road and NW Military has a landscaped and lighted pedestrian trail in the median.
- The corridor within the study area has four and six lane divided roadway with a raised island and/or a Jersey Barrier.
- Street lights are present along the whole corridor study area.

ACCESS

- There are no continuous frontage roads along most of the route, and connections to local streets and driveways are limited and with right hand turn only lanes.
- The corridor study area has Grade-Separated overpasses and interchanges at Blanco, West Avenue, US 281, Jones-Maltsberger, Starcrest Drive, Wetmore Road, Nacogdoches Road, Perrin-Beitel Road, and Thousand Oaks.
- The intersection at Wetmore Road has a partial cloverleaf; all other intersections are diamonds.
- Most of the corridor study area is controlled-access. The eastern and western ends each have two at-grade, signalized intersections to provide a controlled transition from expressway to the signalized surface roadways that the parkway connects to on either end.
- Wurzbach Parkway does not have supporting arterials/connectors roads to distribute the east-west demand on San Antonio's Northside. Supporting roads are limited to Highways (Loop 1604 and 410) located 2 to 3 miles North and South of the corridor, respectively.

URBAN FORM

- At both ends of the corridor study area, there are suburban activity centers in a typical shopping center form.
- The corridor study area runs through a very auto-oriented suburban area. Very little vegetation inside the right-of-way, limited shade, except for a few short walking paths that rung along the corridor.
- The corridor segment between Lockhill-Selma Road and NW Military Highway has a landscaped and lighted pedestrian trail in the wide raised median.

LAND USE

- A great majority of the corridor study area passes by residential single-family use.
- There are several parks and recreation areas situated along the corridor including a semi-professional soccer stadium.
- The nearby land uses in close proximity to both ends of the corridor are mainly light industrial and retail commercial.
- There is undeveloped land near the airport adjacent to a segment of the corridor.

Wurzbach Parkway at US 281 Adjacent Network and Access

Figure 4.79 Source: San Antonio, Texas. Google Earth 2018. https://bit.ly/2QTHCqS

Street Sections

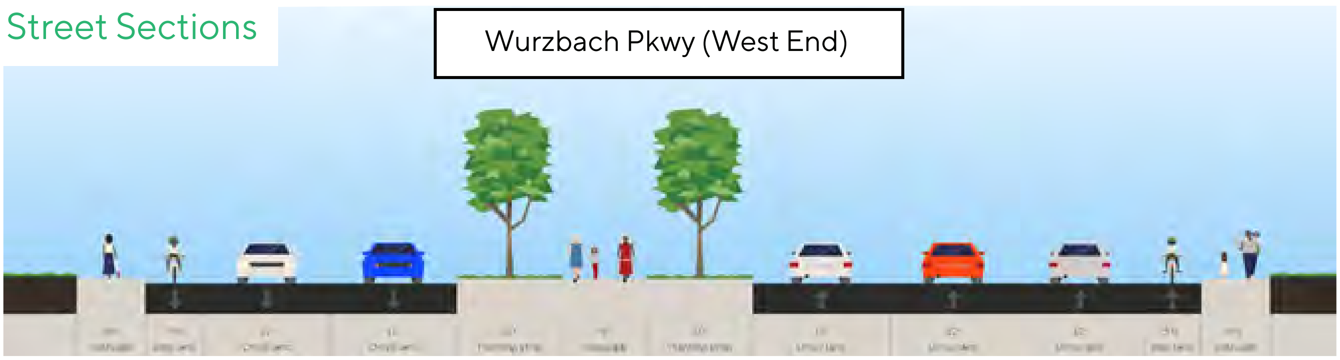


Figure 4.80 Wurzbach Parkway between Lockhill-Selma and NW Military

The west end cross-section is a transition between conventional suburban and suburban activity center zones. It has the widest median within the corridor study area and was modified to a walking path with trees for shade and pedestrian scale street lighting. Going west there are only two lanes since the road transitions into a Minor Arterial.

Street Sections

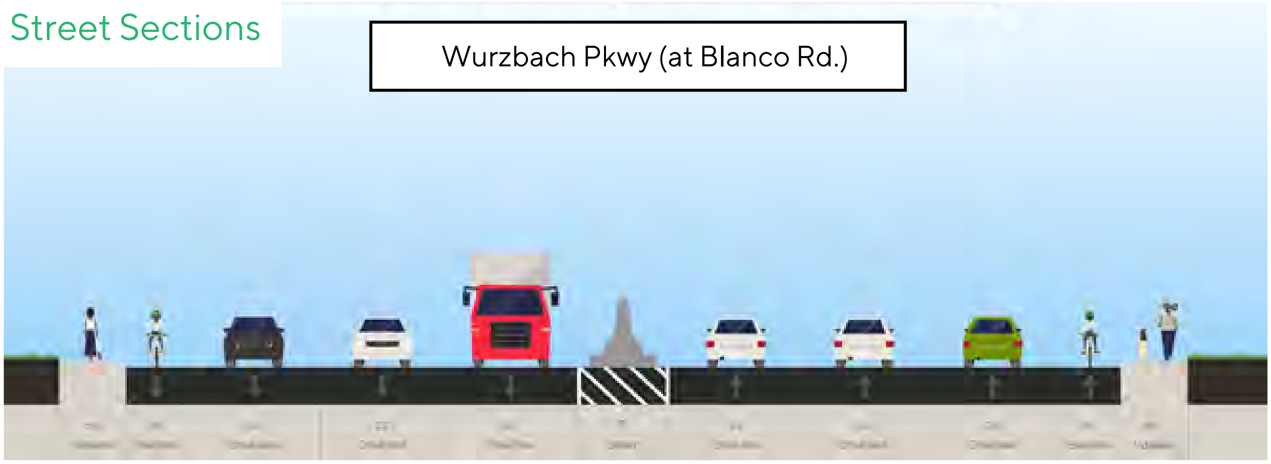


Figure 4.81 Wurzbach Parkway between Lockhill-Selma and NW Military

The second cross-section is located between NW Military Highway and Blanco Road. Due to Hardberger Park bisecting the corridor, the roadway is mainly a parkway design, with adjoining suburban land uses. In this segment, the design is similar to the west end cross-section, but with more emphasis on vehicle mobility than pedestrian activity. There is no pedestrian or bike connectivity between both sections of the corridor. This segment has more limited access and the speed limit increases from 50 to 60 mph, with a Jersey barrier as a safety provision.

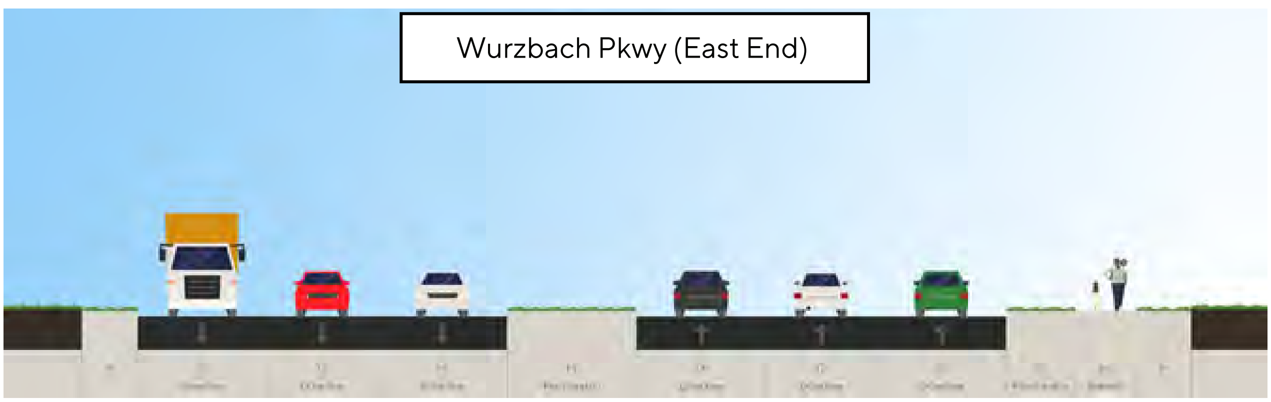


Figure 4.82 Wurzbach Parkway between Weidner Road and O'Connor Road

The east end of the corridor study area is a transition to O'Connor Road, a Minor Arterial roadway that connects to IH-35. This segment it is also a transition between conventional suburban (Z4) and Mixed-use suburban (Z3) zones with emphasis to retail and office uses due to its proximity to IH-35. The closets intersection has left turning lanes in both directions and signaled crosswalks.

Camelback Rd Camelback Road - Scottsdale, Arizona

Camelback Road runs east-west through the north central area of the Phoenix region, connecting to several major destinations. The west end of the corridor is one of Phoenix's primary business districts (sometimes called the Camelback Corridor). Camelback Road is part of the arterial one-mile grid system which provides a high level of accessibility and mobility, providing network connectivity and redundancy to the freeway system.

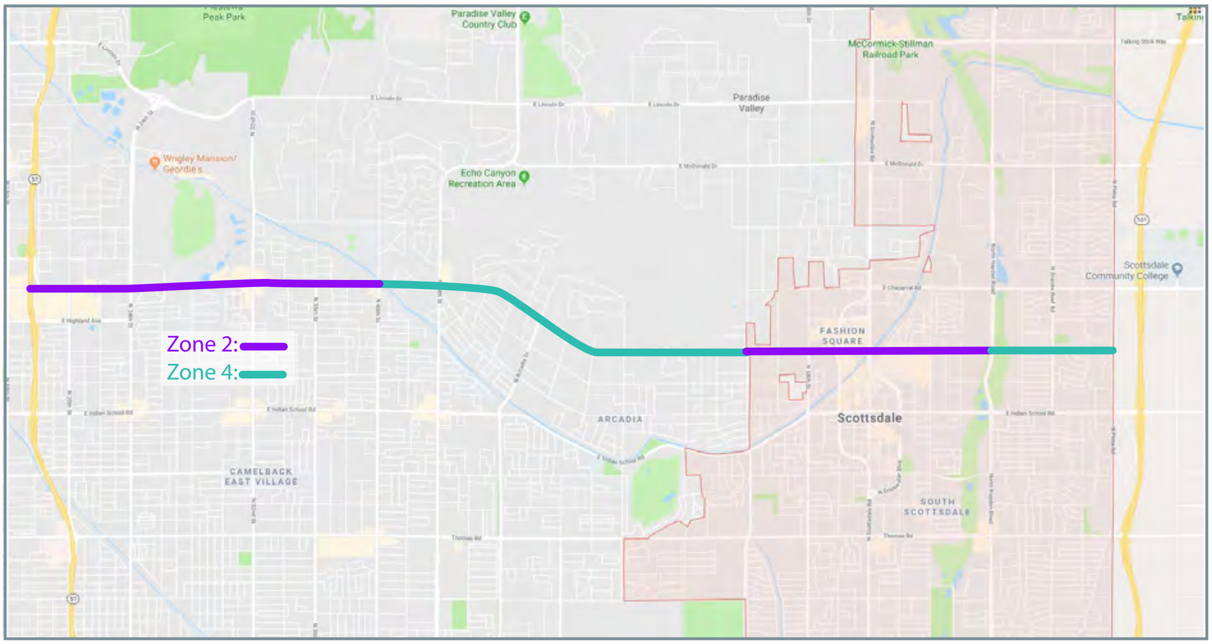


Figure 4.83 Camelback Road map

Source: Google Maps 2018, https://bit.ly/2QRH2Kw

Camelback Road is a regional route traversing several jurisdictions including the communities of Goodyear, Litchfield Park, Glendale, Phoenix, and Scottsdale. East of SR 101, Camelback Road connects to Salt River-Pima Maricopa Indian Community. At this junction, the corridor becomes an unpaved local road and ends on the east end of SR 87. The segment selected as the corridor study area has a subregional context. It connects the activity centers between Phoenix and Scottsdale between SR 51 to SR 101. The corridor intersects with major roads such as N 24th Street, N 32nd Street, N 44th Street, N Scottsdale Road, and N Hayden Road among others.

Functional Classification	Principal Arterial / Minor Arterial / Major Collector
Context Zone	Transitions between zone 2 and zone 4
Total Length	9 miles. (West end: SR 51. East end: N 87th Terrace)
Right-of-Way Width	57' to 115' feet
Safety Features	Raised median, signalized crosswalks, center turn lane
Multi-modal Features	Local Bus routes, covered bus stops, pedestrian facilities
Speeds	25 to 40 mph
Lighting	Not constant. At activity centers only

Characteristics

MULTIMODAL

- Several local bus routes operate along the corridor area and passenger facilities include covered bus stops with benches.
- Sidewalks and pedestrian amenities are consistently placed along the corridor providing pedestrian connectivity to the various activity/commercial centers along the corridor.
- No bicycle facilities are present along the corridor.

URBAN FORM

- Present along most of the corridor is landscaping and trees that compliment the various context zones and land uses that align the corridor.
- The alignment of the corridor is challenged by the geography of the area (Camelback Mountain and Arizona Canal).
- The east end of the corridor has a more constrained right-of-way along with deeper building setbacks giving a suburban feeling to this part of the corridor. The functional classification of the corridor on the east end is a Major Collector.

ACCESS

- The east end does not connect to SR 101 (0.2 miles) it ends at N 87th Terrace, and the corridor continues to the east of SR 101 as an unpaved local road.
- The west end of the corridor intersects with SR 51 but does not have direct connection with it.
- The corridor is undivided on both of its ends, with a center turning lane only at specific commercial access points.
- The raised median divided segment of the corridor has several left-turn access points, between 2 or 3 depending on the number of commercial driveways per block.
- Camelback Road is part of the arterial one-mile grid system. It provides connectivity to Indian School Road on the South and Lincoln Drive, McDonald Drive, and Chaparral Road on the north. The corridor is also supported by a strong grid of Collector and Local roads on the south. Camelback Mountain does not have the same connectivity to a grid network on the north side.

LAND USE

- Camelback Road runs directly south of Phoenix's Camelback Mountain, also adjacent to several major resorts and a major shopping mall. Major retail and entertainment activity centers along the corridor provide a great number of jobs to the residents making this area a major employment center for the region.
- The "Camelback Corridor" is one of Phoenix's primary business districts (located between SR 51 and N Arcadia Drive)
- On the west end of the corridor, Camelback Road skirts the southern boundary of Luke Air Force Base.

Camelback Road at Goldwater Boulevard Adjacent Network and Access

Figure 4.84

Source: Scottsdale, Arizona. Google Earth 2018. https://bit.ly/2RAUM1z

Street Sections

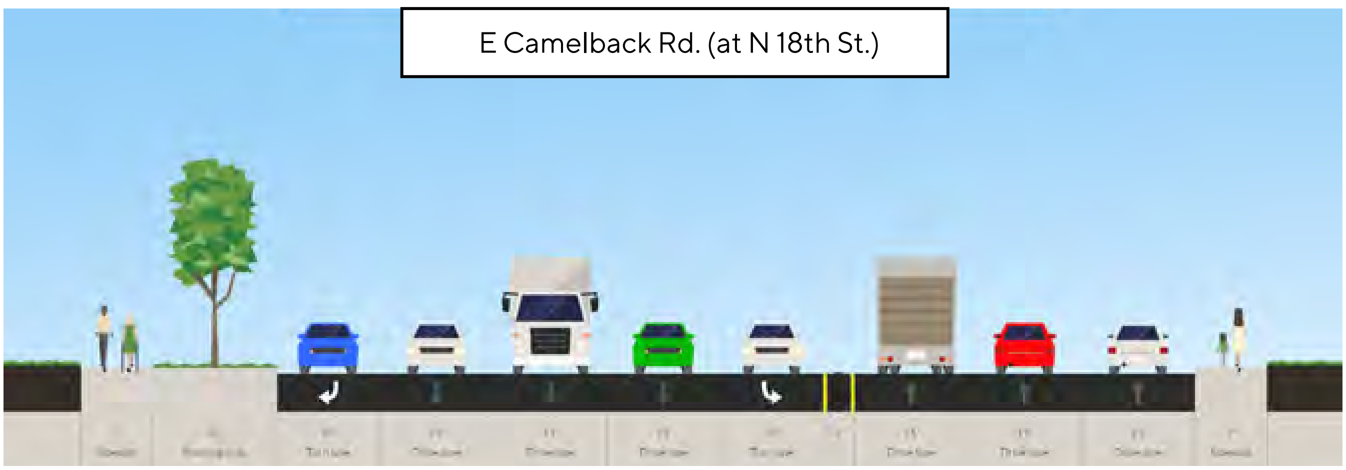


Figure 4.85 E Camelback Road at N 18th Street

The west end of the corridor is one light east of the overpass intersection at SR 51. The intersection has turning lanes in both directions to maintain continuous traffic flow. Although the corridor has wide and buffered sidewalks, these pedestrian facilities only connect the office and retail commercial uses in the segments of Camelback Road. There is a lack of pedestrian and bicycle infrastructure in many segments of Camelback Road. This cross-section highlighted above is in the middle of a suburban activity center zone.

Street Sections

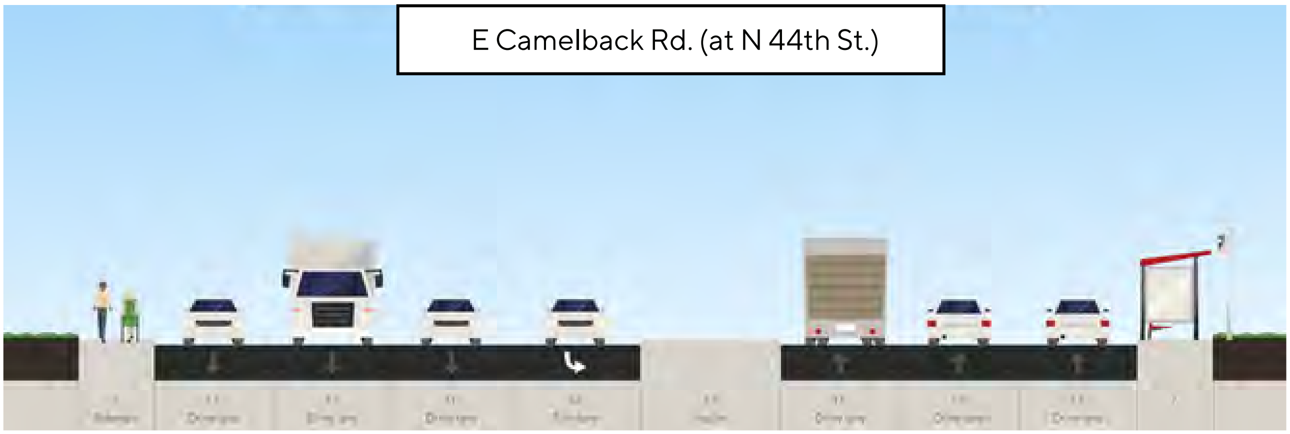


Figure 4.86 E Camelback Road at N 44th Street

Camelback Road at N 44th Street is the start of a transition between a suburban activity center and main street urban area. The surrounding land use in the main street area mostly consists of retail and office and a few multifamily complexes. There is no bike infrastructure available on the corridor, but the Arizona Canal Trail works as a semi-parallel alternative for cyclists. The pedestrian realm is limited to the commercial spaces available in the area but there is no external connectivity. A bus stop is located on the far side of the traffic light to reduce traffic flow conflicts between buses and other vehicles.

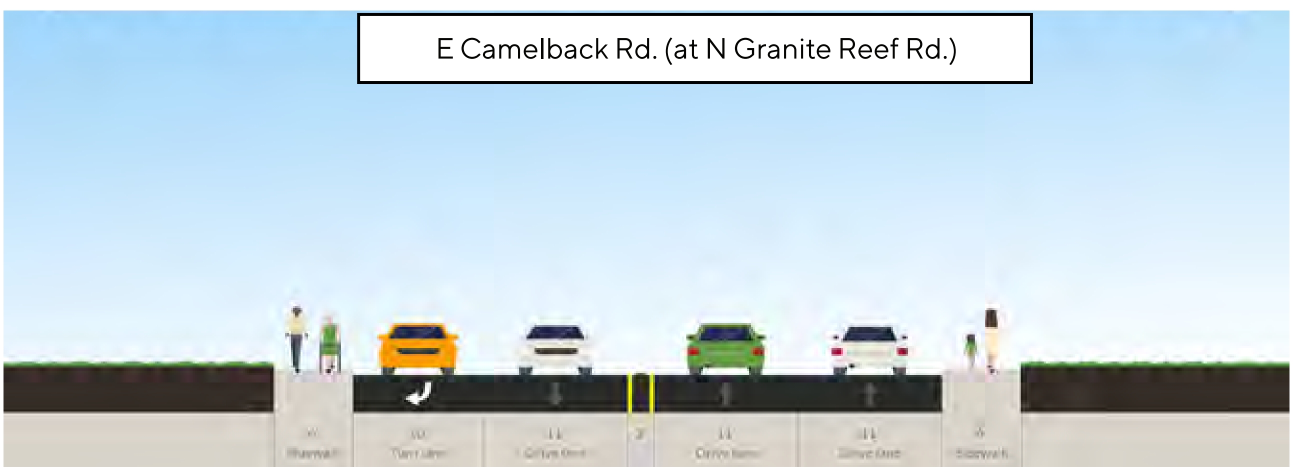


Figure 4.87 E Camelback Road at N Granite Reed Rd

This segment of Camelback Road is in a conventional suburban area where residential single-family units are predominantly used. The right-of-way is reduced to about 60′ and the functional class of the road changes to Major Collector. There are more driveways and parking is allowed in the right lane; on intersections, this lane works as a right turn lane.

60 US60 / Grand Avenue – Phoenix, Arizona

US-60 (Grand Avenue) is a major urban thoroughfare that extends diagonally (45-degree angle) from the core of the urban area to the northwest corner of the Maricopa Associations of Government (MAG) region, providing a direct connection to Phoenix's Northwest suburbs. It provides important connectivity to a regional freeway system, including Loop 303, Loop 101, IH-17 and IH-10.

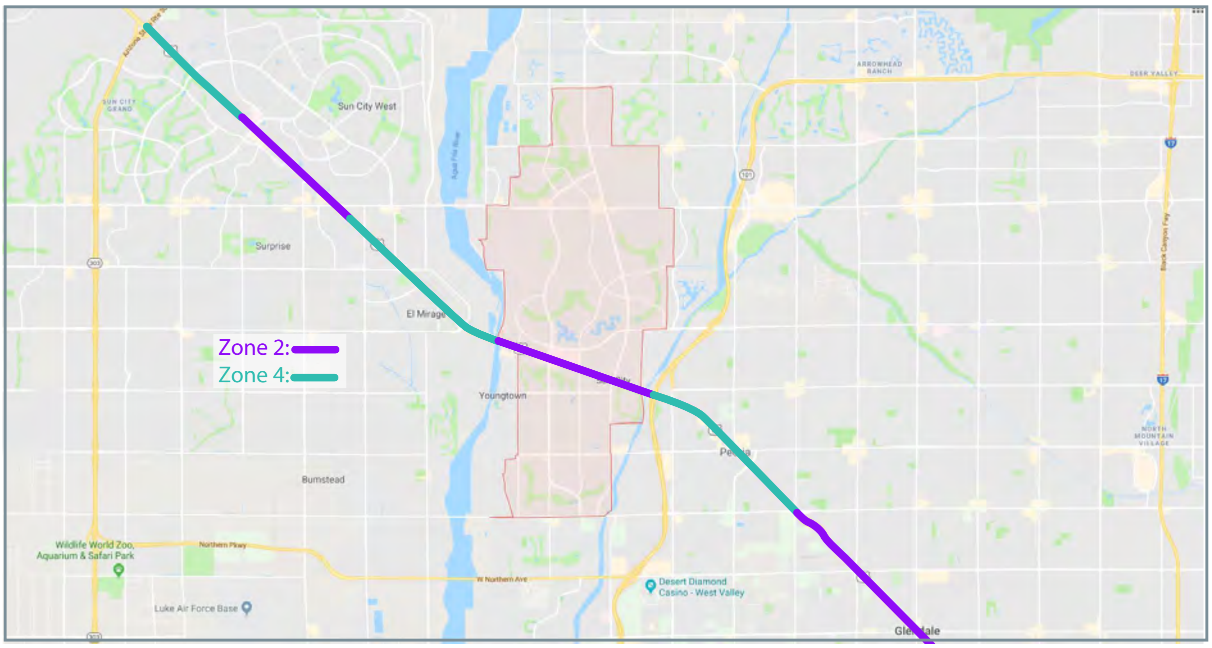


Figure 4.88 Grand Avenue map

Source: Google Maps 2018, https://bit.ly/2RQrPh5

US-60 is apart of the National Highway system traveling 2,670 miles from Brenda Junction, Arizona to Virginia Beach, Virginia. As a whole, US-60 has an inter-regional context for this study, the Downtown Phoenix to Loop 303 in the northwest suburbs was evaluated. The corridor study area runs through several communities including Surprise, El Mirage, Youngtown, Peoria, Glendale, and Phoenix. It intersects more than 20 Major Arterials because of a regional grid system. Major roads such as W Bell Road, N 107th Avenue, N 99th Avenue, SR 101, W Peoria Avenue, 83rd Avenue, W Northern Avenue, W Glendale Avenue, W Camelback Road, W Indian School Road, IH-17, and IH-10 all connect to the corridor.

In 2017, Maricopa Associations of Government (MAG) along Arizona Department of Transportation (ADOT) developed a concept plan known as the Corridor Optimization, Access Management Plan, and System Study (COMPASS) for US-60. The study consists of consolidating approximately 430 driveways along the corridor to only 230 driveway access points. The recommendations are only concepts at this point, and design and environmental clearance(s) are the next steps with required local, state and federal agency approvals.

Characteristics

MULTIMODAL

- Most of the truck freight traffic in the region travel along US-60. Several railroad tracks are also adjacent to US-60.
- Sidewalks and multi-use paths are limited along Grand Avenue. Along most of Grand Avenue, development is typically limited to the west side, opposite the BNSF railroad tracks, and west side development lacks continuous sidewalk that provides linkage between developments, Major Arterials, and the communities along Grand Avenue.
- No bicycle lanes are provided on Grand Avenue within the study area, however, bicycles are permitted to use the shoulder.
- One limited stop service bus route, called the Grand Avenue Limited, operates along the corridor. More than 15 local, express, and circulator bus routes intersect the corridor.

ACCESS

- The BNSF railroad parallels Grand Avenue along the north side limiting development and access points between parallel running facilities.
- Drainage ditches parallel Grand Avenue between the roadway and railroad right-of-way on the north side, and between the roadway and the frontage road on the south side limit access to driveways.
- Left and right-turn lanes are located at major intersections and access points.
- Within the corridor study area, Grand Avenue crosses three water bodies that represented a regional challenge to connectivity: the Agua Fria River, the New River and, the Grand Canal, from west to east respectively.
- Grand Avenue is a unique Major Arterial in the system, intersecting more than 20 north-south and east-west Major Arterials.

LAND USE

- One BNSF intermodal facility is located north of Camelback Road and south of Grand Avenue. Large amounts of freight are transferred between trucks and trains. As the freight has destinations across the Phoenix metropolitan area, it is likely a majority of the truck traffic either travel along Grand Avenue or crosses it.
- The west end of the corridor is a suburban conventional zone (Z4) with a higher presence of single-family residential land use.
- Inside the city of surprise is a medical center area within the corridor. Clustered with the medical center is a small activity center with office and light retail.
- As the corridor enters the city center, more land is dedicated to industrial and transportation uses.

Functional Classification	Principal Arterial
Context Zone	Transitions between zone 2 and zone 4
Total Length	22 miles. (West end: ST 303. East end: IH-17)
Right-of-Way Width	125′ to 300′ feet
Safety Features	Median, Noise abatement walls, signaled crosswalks
Multi-modal Features	Grand Avenue Limited stop bus route
Speeds	45 to 55 mph
Lighting	Continuous along the corridor with some segments with longer spacing

Grand Avenue at Maryland Avenue Adjacent Network and Access

Figure 4.89

Source: Glendale, Arizona. Google Earth 2018. https://bit.ly/2VWFvGy

Street Sections

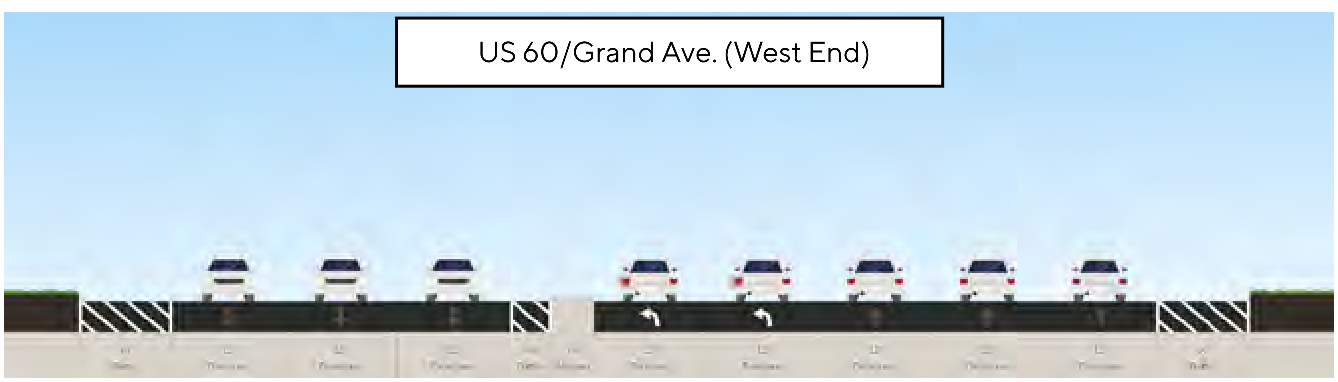


Figure 4.90 Grand Avenue at N Sunrise Blvd

This segment of the corridor is in a conventional suburban area, where residential single family is the only land use present in the area. The area is in the suburban community of Surprise, Arizona. Pedestrian and bicycle facilities, as well as transit are not present along this segment.

Street Sections

Figure 4.91 Grand Avenue at N 91st Avenue

This segment of the corridor is located just east of the overpass intersection of SR 101. This is a suburban activity center zone primarily consisting of office and retail uses. Pedestrian facilities are within the adjacent private developments, for example, within the shopping centers and small office complexes. Development is located on the south side of the road because of the access limitations created by the BNSF railroad tracks. Public pedestrian infrastructure is available at intersections with signalized crosswalks.

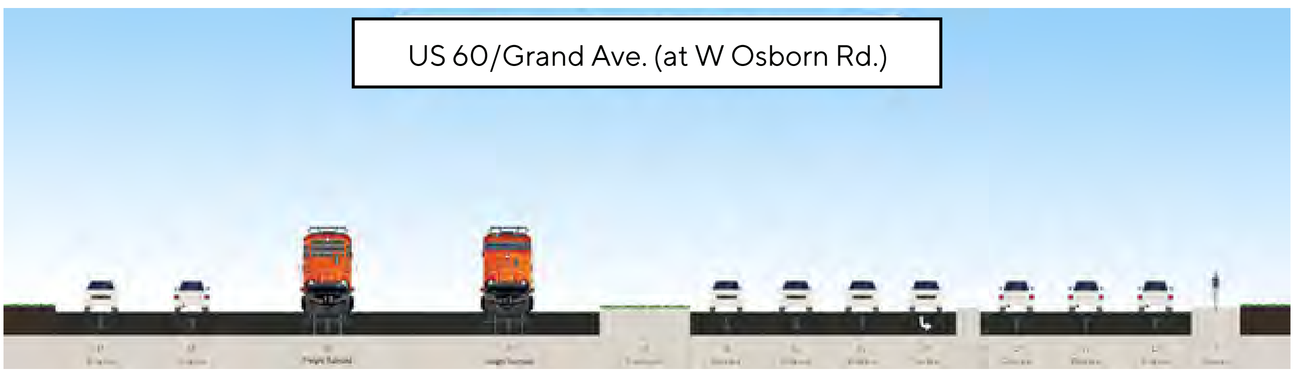


Figure 4.92 Grand Avenue at W Osborn Road

The east end segment of the corridor study area is located just west of the 6-leg intersection of Grand Avenue, N 27th Avenue, and Thomas Road. This segment is in the middle of a light industrial and commercial area, although it is close proximity to the city center, existing land use and Limited-Access facilities create the conditions of a suburban activity center zone. Also, in this segment, the alignment of the BNSF railroad tracks changes from the north to the south side of the road.

Conclusion

The case study corridors presented bring to the forefront best practices in arterial design and treatments. Their street sections are a key input into the pattern book presented in this Concept Plan. The design and treatments featured can be applied to existing and planned transportation facilities in order to address needs and challenges identified in the CAMPO Regions transportation network. Additionally, a key finding from this study is that there are examples of arterial roadways that can efficiently move users of the transportation network to their destinations while implementing Platinum Planning elements that are critical to addressing the needs of where CAMPO's communities.

SECTION 3

ARTERIAL CLASSIFICATIONS, TYPES, AND PATTERNS

Introduction

The arterial cross-sections are organized by the previously defined functional classification system used for this study and by context zones. As the corridor case studies section mentions, CAMPO has defined five Context Zones for the purposes of this study. Zone 1, or the High-Rise Downtown, is the most intensely developed land in comparison to the other zones. It is typical for this zone to have buildings with more than 10 stories. Zone 2, or the Main Street/Small Town, is active with buildings that fill the street and incorporate a mixture of uses like seen in Zone 1.

Zones 3 and 4 both feature suburban development patterns, with sizeable setbacks and lower densities. However, Zone 3, the Mixed-Use Suburban, generally incorporates nodes of commercial development throughout residential neighborhoods and has a greater density of housing units than Zone 4, the Conventional Suburban, which equates to zoning separated by use. Rural areas are represented by Zone 5, which features the lowest density of development of all the zones and sparser street network.

Cross-sections for each class of roadway not only vary based on CAMPO'S Context Zone but by design type. CAMPO has developed four design types: Undivided, Divided, Boulevard, and One-Way. In the section below, we detail traits for each functional class and highlight the differences for each design type where applicable.

CAMPO Context Zones

Z1

Downtown Austin, Texas (2013)

Z2

Downtown Taylor, Texas (2010)

Z3

Parmer Ln. & Metric Blvd. Austin, Texas (2018)

Z4

Austin, Texas (2018)

Z5

Taylor, Texas (2018)

Urban 1	Urban 2	Suburban 1	Suburban 2	Rural
High-rise Downtown	Main Street/ Small Town	Mixed Use/ Activity Center	Conventional	
• Downtown Austin, TX • The Domain, Austin, TX	• Downtown Taylor, TX • South Congress Avenue, Austin, TX • Main Street Bastrop, TX	• Parmer Lane (N. Lamar Boulevard to MoPac), Austin, TX • Burnet Road (Koenig Lane to US 183), Austin, TX • Williams Drive (IH-35 to Serenada Drive), Georgetown, TX	• RM 1431 (IH-35 to A.W. Grimes Boulevard), Round Rock, TX • SH 21 (FM 969 to the Colorado River)	• FM 1660 (FM 973 to SH 95) • SH 95 (City of Taylor to City of Coupland)

Figure 4.93

Limited-Access

Divided (All Context Zones):
Limited-Access facilities are high-speed facilities whose intent is to move a high volume of users. They are divided roadways with grade-separated interchanges and prioritize mobility, with access to adjacent development provided on backage or frontage roads. Express or commuter transit services can operate on these roadways, along with inter-regional coaches.

Principal Arterials

> Regional Connector/Expressway

Regional Connectors or Expressways, are high-speed facilities that provide for longer distance movement, but generally, don't restrict access in the same manner as
Limited- Access arterials. Signalized intersections may occur, but generally less frequently for Major Arterials.

Divided (Context Zones Z3, Z4, Z5):

Divided Regional Connectors Expressways are designed for high volumes of traffic and with a focus on mobility. As such, these roadways have limited left turns. In context Zone 3, they can feature Diamond Lanes, which can help move a higher volume of users. In context Zones 3 and 4, they can provide a flex lane, which can be used for transit or right-turns. Trails for pedestrians and cyclists are found in context Zones 3 and 4 where appropriate.

Boulevard (Context Zones Z1, Z2, Z3):

Regional Connectors can also be designed as Boulevards to allow for a better balance between access and mobility. These roadways feature higher speed, divided general purpose lanes, or slip roads, that provide not only driveway access, but local transit service access. Express or commuter transit service all operate on the general purpose lanes.

One-Way (Context Zones Z1, Z2 Z3):

One-Way Regional Connectors Expressways are designed to allow for fluid traffic flow when there is a potential Right-of-Way constraint in denser areas, such as Context Zones 1, 2, and 3. These One-Way roadways are often paired with parallel facilities. Though the focus of the roadway is generally to enhance mobility, flex lanes can allow for parking, loading, or for transit service.

> Major Arterial

Major Arterials, unlike Regional Connectors, are designed to provide access to adjacent development while still allowing for higher speeds to support longer trips.

Undivided (Context Zones Z1, Z2, Z3, Z4):

Undivided Major Arterials allow for a considerable amount of access to adjacent development and to supporting collector roadways. They can feature a center lane that is reversible to accommodate directional peak period travel. Sidewalks and trails in less dense Context Zones support pedestrian movements. To increase capacity, outside lanes can be used as a flex lane for transit and right-turns.

Divided (Context Zones Z1, Z2, Z3, Z4):

Divided Major Arterials, which are designed with a raised median, can improve roadway safety by limiting conflict points. They often operate local bus service. These arterials are generally designed for higher speeds, therefore, pedestrian and cyclists may be better accommodated on parallel facilities.

One-Way (Context Zones Z1, Z2):

Major Arterials can also be One-Way facilities that can accommodate high traffic volumes of traffic in areas with limited right-of-way. As with One-Way Regional Connectors Expressways, these roadways can be designed to function in pairs and/or offer a flex lane for transit vehicles in an outside lane.

> Minor Arterial

Compared to Principal Arterials, Minor Arterials prioritize access over mobility. They provide support for the Principal Arterial network and connect Collector and Local roadways to higher functional classes.

Undivided (Context Zones Z1, Z2, Z3, Z4, Z5):

Undivided Minor Arterials serve a wide variety of context zones and, since they are undivided roadways, allow for a greater amount of access than other Minor Arterials. As such, speeds are generally lower and, in Context Zone Zone 5, may include only one general purpose lane. However, in other contexts they can feature either a center turn lane to accommodate left turns or a reversible lane to better support directional peak period travel.

Divided (Context Zone Z1, Z2, Z3, Z4):

Minor Arterials with a divided roadway allow for moderate speeds since the presence of a raised median limits conflict points. They are often good routes for cyclists as they feature dedicated bike lanes and provide sidewalks or trails to facilitate pedestrian movements between neighborhoods or commercial nodes.

One-Way (Context Zone Z1):

One-Way Minor Arterials, like other roadways designed for one-way traffic, function in pairs to help support large volumes of traffic. As a Minor Arterial, however, One-Way roadways are most appropriate for Context Zone 1, as they are generally used to support One-Way Major Arterials. A flex lane can provide a dedicated lane for transit, better facilitate right-turns, or be used for parking or loading.

General Observations

- Design speed and ADT should be considered for all cross sections and applicable lane widths.
- Raised Median and sidewalk widths are established according to Type II Curb and Gutter standard.
- These width ranges are required if federal funds are requested for a specific project with some exceptions due to limited Right-of-Way.
- If local funds are used to finance a specific project, lane width ranges can be applied as desired by the local jurisdiction.

Definition Matrix[35]

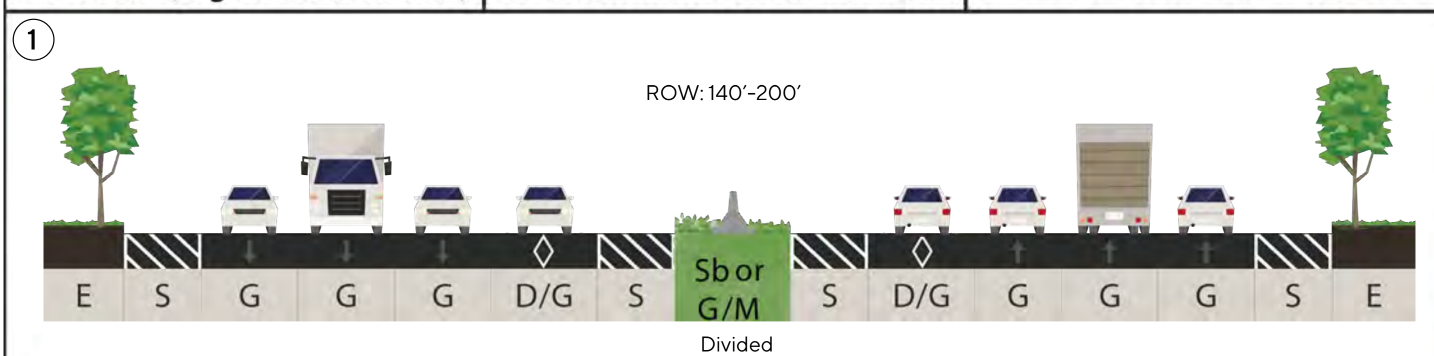
The definition matrix below provides a key to the illustrative cross-section.

Description	Lane Type	Width Range	Preferred Width
General Purpose	G	10′-12′	- - -
Diamond (Transit/HOV-Peak Period)	D	13′-14′	- - -
Parking/Loading/Bulbout	P	10′	- - -
Center Turn Lane	C	11′-16′	- - -
Flex Lane (Diamond/General/Shoulder/ Parking/Loading/Right-Turn)	F	13′-14′	- - -
Reversible Lane (General/Transit/Center Turn)	R	11′-16′	- - -
Shoulder	S	3′-12′	- - -
Slip Road	Sl	10′-12′	- - -
Raised Median	R/M	4′-12′	- - -
Safety Barrier	Sb	3′-7′	- - -
Grass Median/Swale	G/M	5′-12′	- - -
Bike Lane	B	5′	- - -
Trail (Shared Use Path)	T	10′-14′	- - -
Sidewalk	Sw	6′-8′	- - -
Expansion/Environmental Space	E	Needs Based	- - -
* To calculate right-of-way, border width should be 20 ft desirable			

Figure 4.94

* Ranges for lane width are based on recommended widths by FHWA and AASHTO.

Z1- Urban (Highrise Downtown)	Z2- Urban (Main Street/Small Town)	Z3- Suburban (Mixed Use/Activity Center)



8 lane divided with 6 general purpose lanes general, 2 diamond lanes, and shoulders.
Diamond lane could be used for Express and limited bus service.

[35] Source: Federal Highway Administration, Safety, Geometric Design, Publications, Mitigation Strategies For Design Exceptions. Lane Width: https://bit.ly/2wpkxV6
Source: Federal Highway Administration, Safety, Pedestrian & Bicycle, Tools to Diagnose and Solve the Problem, Toolbox of Pedestrian Countermeasures: https://bit.ly/2Np3rSO
Source: AASHTO Guide for the Development of Bicycle Facilities. https://bit.ly/2KUZp2I

Z4- Suburban Conventional	Z5- Rural

2

ROW: 120′-175′

Divided

6 lane divided with 6 general purpose lanes and shoulders

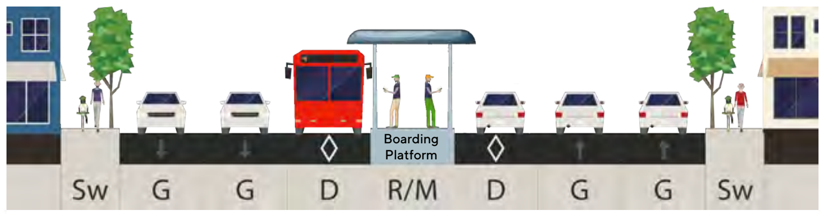
LIMITED-ACCESS*

* Cross-sections for Limited Access roads do not take into account the presence of frontage roads. For frontage road cross-sections, please refer to one-way alignments.

PRINCIPAL ARTERIALS: Expressway/Regional Connector

Z1- Urban (Highrise Downtown)	Z2- Urban (Main Street/Small Town)

3

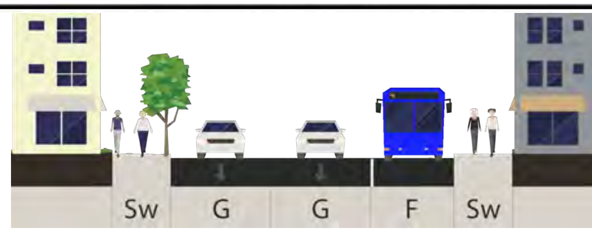


ROW: 105′ - 175′

Divided

6 lane divided with 4 general purpose lanes and 2 diamond lanes.
Diamond lane for Express and limited bus service (Non TxDOT facilities).

4

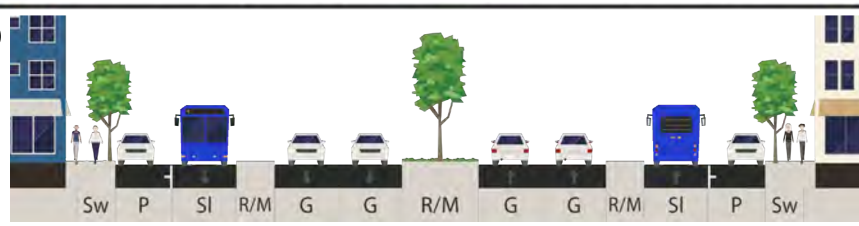


ROW: 105′ - 175′

One-Way

3 lanes one-way with 2 general purpose lanes and one flex lane.

5

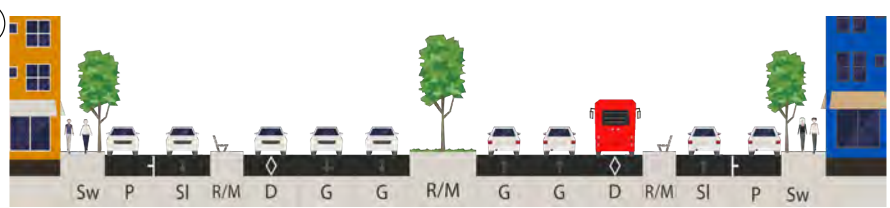


ROW: 125′ - 185′

Boulevard

8 lane divided with 4 general purpose lanes, 2 slip roads, and 2 parking lanes.
Local bus service uses slip road.

6



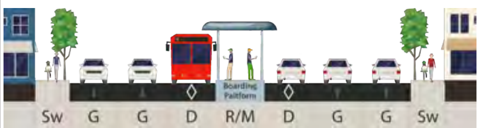
ROW: 145′ - 210′

Boulevard

10 lane divided with 4 general purpose lanes, 2 diamond lanes, 2 slip roads, and 2 parking lanes.
Diamond lane could be used for Express and limited bus service.

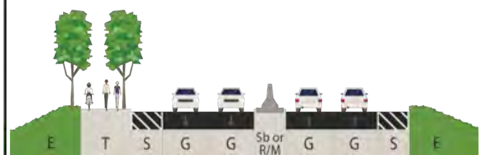
Z3- Suburban (Mixed Use/Activity Center)	Z4- Suburban Conventional	Z5- Rural

3



ROW: 105′ - 175′
Divided
6 lane divided with 4 general purpose lanes and 2 diamond lanes. Diamond lane for Express and Limited bus service (Non TXDOT facilities)

10

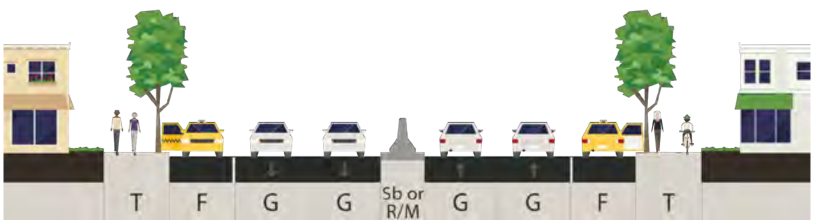


ROW: 85′ - 140′
Divided
4 lane divided with 4 general purpose lanes and shoulders

11

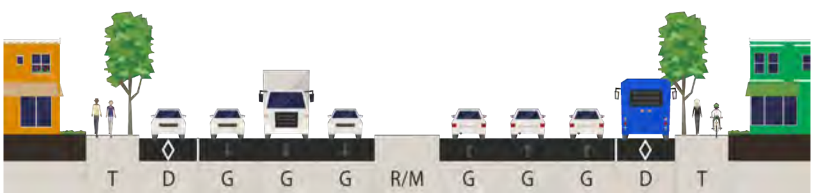
ROW: 90′ - 150′
Divided
4 lane divided with 4 general purpose lanes and shoulders

7



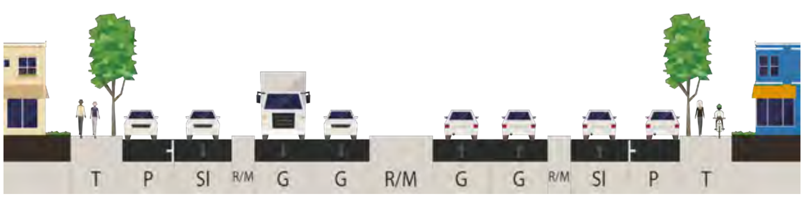
ROW: 105′ - 155′
Divided
6 lane divided with 4 general purpose lanes and 2 flex lanes

8



ROW: 125′ - 180′
Divided
8 lane divided with 6 general purpose lanes and 2 diamond lanes

9

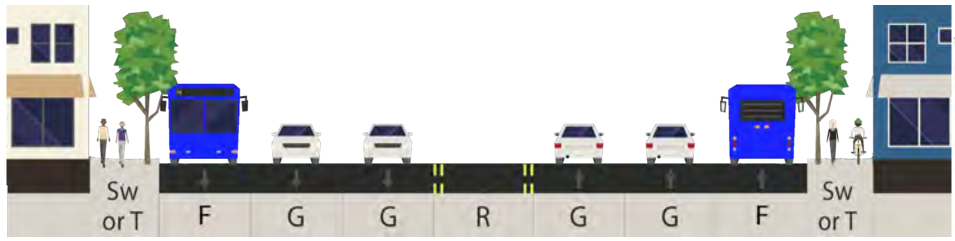


ROW: 125′ - 185′
Boulevard
8 lane divided with 4 general purpose lanes, 2 slip roads, and 2 parking lanes

PRINCIPAL ARTERIALS: Major

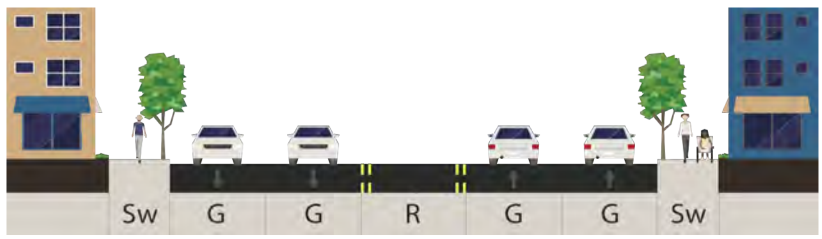
Z1- Urban (Highrise Downtown)	Z2- Urban (Main Street/Small Town)

(12)



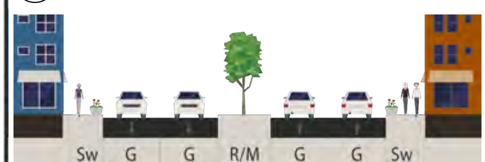
ROW: 110′ - 155′
Undivided
7 lane undivided with 4 general purpose lanes, 2 flex lanes, and a reversible lane*

(13)



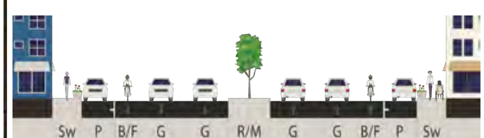
ROW: 90′ - 120′
Undivided
5 lane undivided with 4 general purpose lanes and a reversible lane*

(14)



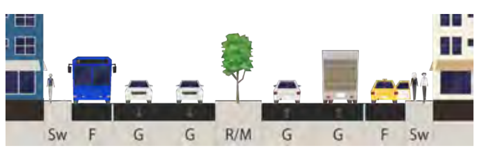
ROW: 75′ - 120′
Divided
4 lane divided with 4 general purpose lanes

(16)



ROW: 100′ - 135′
Divided
8 lane divided with 4 general purpose lanes, 2 parking lanes, and 2 bike lanes

(15)

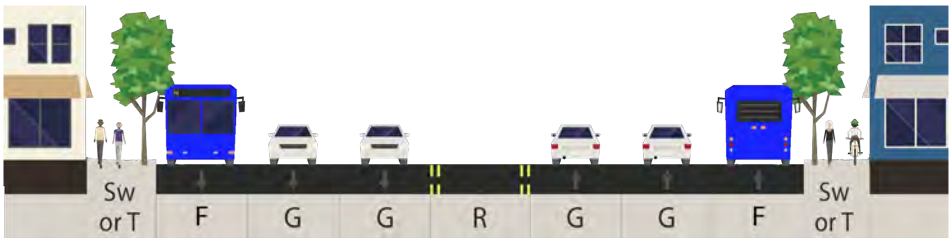


ROW: 95′ - 140′
Divided
6 lane divided with 4 general purpose lanes and 2 flex lanes

* Local governments may determine that reversible lane is appropriate for dedicated transit use to increase capacity of non-TxDOT facilities. .

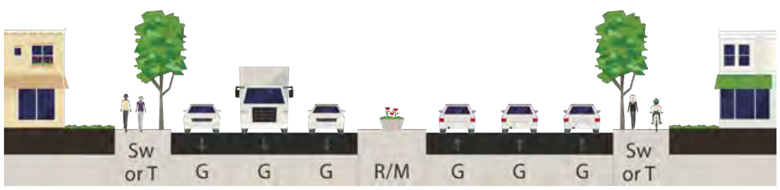
Z3- Suburban (Mixed Use/Activity Center)	Z4- Suburban Conventional	Z5- Rural

(12)



ROW: 110′ - 155′
Undivided
7 lane undivided with 4 general purpose lanes, 2 flex lanes, and a reversible lane*

(17)

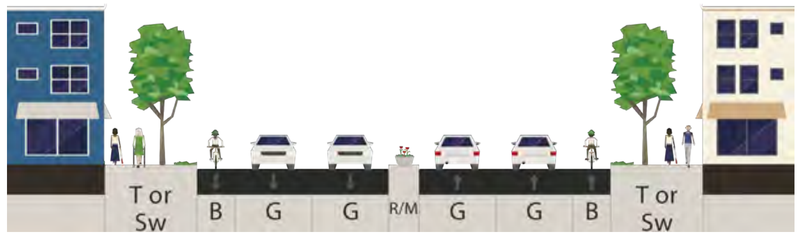


ROW: 95′ - 155′
Divided
6 lane divided with 6 general purpose lanes

PRINCIPAL ARTERIALS: Minor

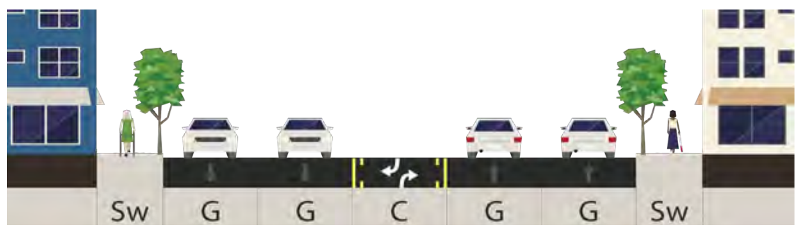
Z1- Urban (Highrise Downtown)	Z2- Urban (Main Street/Small Town)

18



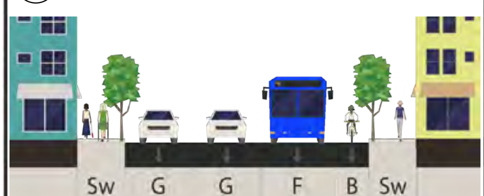
ROW: 85' - 140'
Divided
6 lane divided with 4 general purpose lanes and 2 bike lanes

19



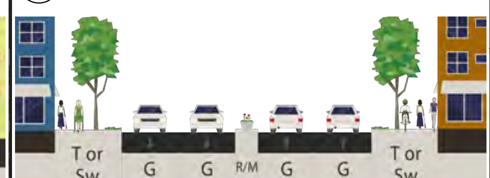
ROW: 95' - 120'
Undivided
5 lane undivided with 4 general purpose lanes and a center turn lane

20



ROW: 65' - 100'
One Way
4 lane one way with 2 general purpose lanes, a flex lane, and a bike lane

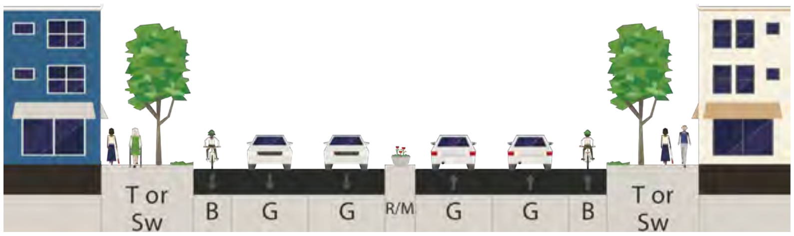
21



ROW: 75' - 130'
Divided
4 lane divided with 4 general purpose lanes

Z3- Suburban (Mixed Use/Activity Center)	Z4- Suburban Conventional	Z5- Rural

18

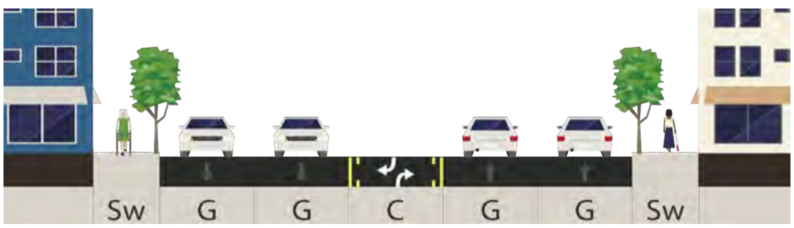


ROW: 85′ - 140′
Divided
6 lane divided with 4 general purpose lanes and 2 bike lanes

23

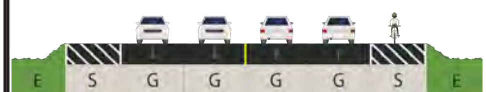
ROW: 80′ - 100′
Undivided
2 lane undivided with 2 general purpose lanes and shoulders

19



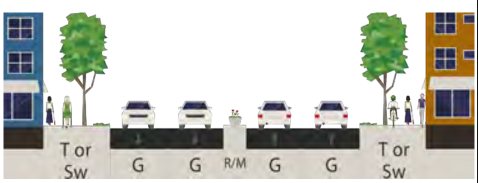
ROW: 95′ - 120′
Undivided
5 lane undivided with 4 general purpose lanes and a center turn lane

24



ROW: 80′ - 120′
Undivided
4 lane undivided with 4 general purpose lanes and shoulders

21

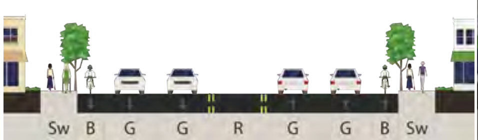


ROW: 75′ - 130′
Divided
4 lane divided with 4 general purpose lanes

25

ROW: 80′ - 100′
Undivided
3 lane undivided with 3 general purpose lanes and shoulders

22



ROW: 105′ - 130′
Undivided
7 lane undivided with 4 general purpose lanes, 2 bike lanes, and a reversible lane

Design Enhancements

To support recommended arterial cross sections, a range of intersection, interchange, safety, operational, access, aesthetic and sustainability improvements can be designed and constructed. These design enhancements can be reflective of a Context Zone and sensitive to adjacent land use.

Intersections

The intersection treatments below have a shared effect of reducing conflict points of a conventional, at-grade intersection, while improving safety and mobility.

> Michigan Left Turn

U-turns are provided beyond the intersection for left-turning motorists. This increases efficiency for through-traffic and reduces pedestrian/motorist conflicts.

Figure 4.95

Bloomfield Township, Michigan, Google Earth 2018. https://bit.ly/2DdcLSK

> Jughandle

Motorists making all turns at the intersection depart from the main roadway on a right-exit dedicated lane prior to arriving at the intersection. The dedicated lane places the motorists beyond the intersection at the cross street to make their desired turn. This increases efficiency for through-traffic and reduces pedestrian/motorist conflicts.

Figure 4.96

Mansfield, Texas, Google Earth 2018. https://bit.ly/2ANbzE8

Interchanges

The interchange configurations below have a shared effect of reducing conflict points of a conventional, grade-separated interchange, while improving safety and mobility.

> Full and Partial Cloverleaf

Left turns are facilitated by dedicated ramps. A full cloverleaf uses a total of four ramps, one for each direction of traffic. A partial cloverleaf uses one to three ramps. While this increases efficiency for through-traffic and somewhat reduces pedestrian/motorist conflicts, the conflict remains by motorists exiting the ramp and merging into traffic.

Full Cloverleaf

Figure 4.97 Cutlerville, Michigan, Google Earth 2018

Partial Cloverleaf

Figure 4.98 Milton, Ontario, Canada Google Earth 2018

> Diamond

Motorists navigating to the minor road exit the major road on dedicated ramps prior to the road crossing.

Figure 4.99 Jeffersonville, Ohio, Google Earth 2018. https://bit.ly/2su7PCL

> Diverging Diamond

Prior to the road crossing, through- and left-turning motorists on the minor road crossover to the left side of the road. Right-turning traffic uses a free right turn prior to the crossover. A free left turn to access the major road occurs after the crossover. Beyond the road crossing and free left turn, through motorists on the minor road crossover to the right side of the road.

Figure 4.100

Round Rock, Texas, Google Earth 2018. https://bit.ly/2AQ9EPb

> Continuous Flow

Left-turning motorist on the minor road crossover to the left side of oncoming traffic in a dedicated lane prior to the road crossing. After the road crossing, left-turning motorist complete the free left onto the major road.

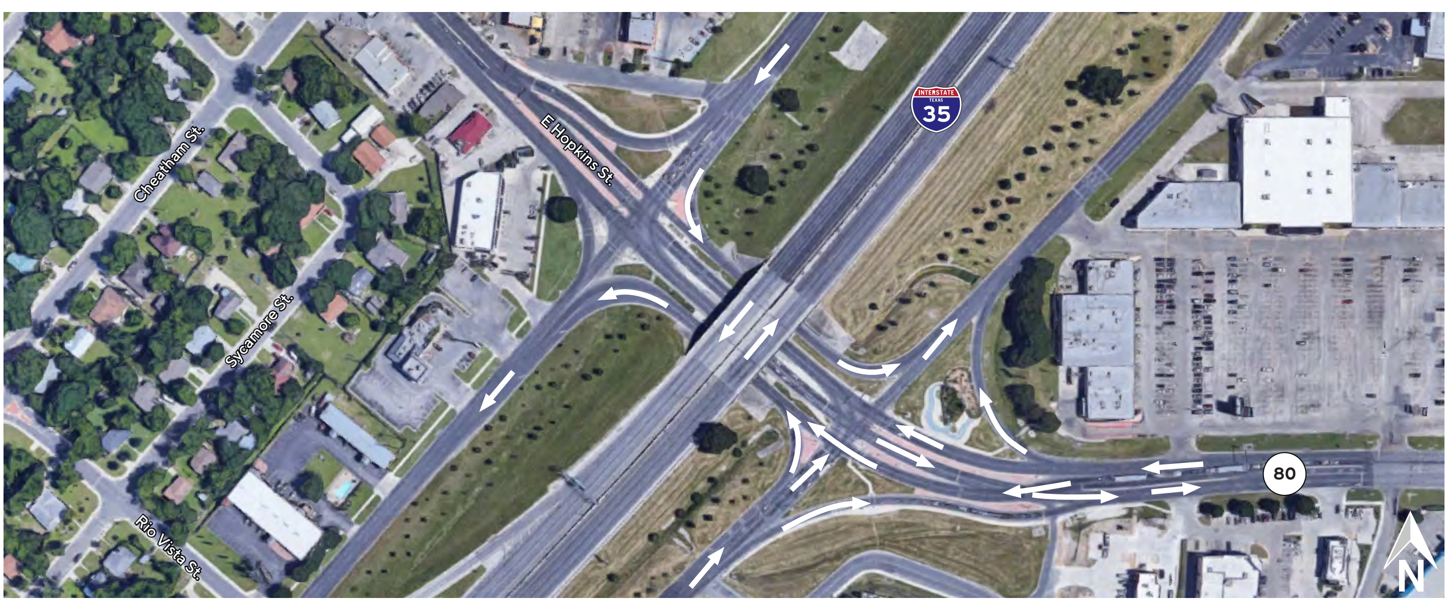


Figure 4.101

San Marcos, Texas, Google Earth 2018. https://bit.ly/2CpqcOf

> Trumpet

Occurs where one road ends at a second road. The ending road is split into ingress/egress ramps that facilitate movement to/from the second road.

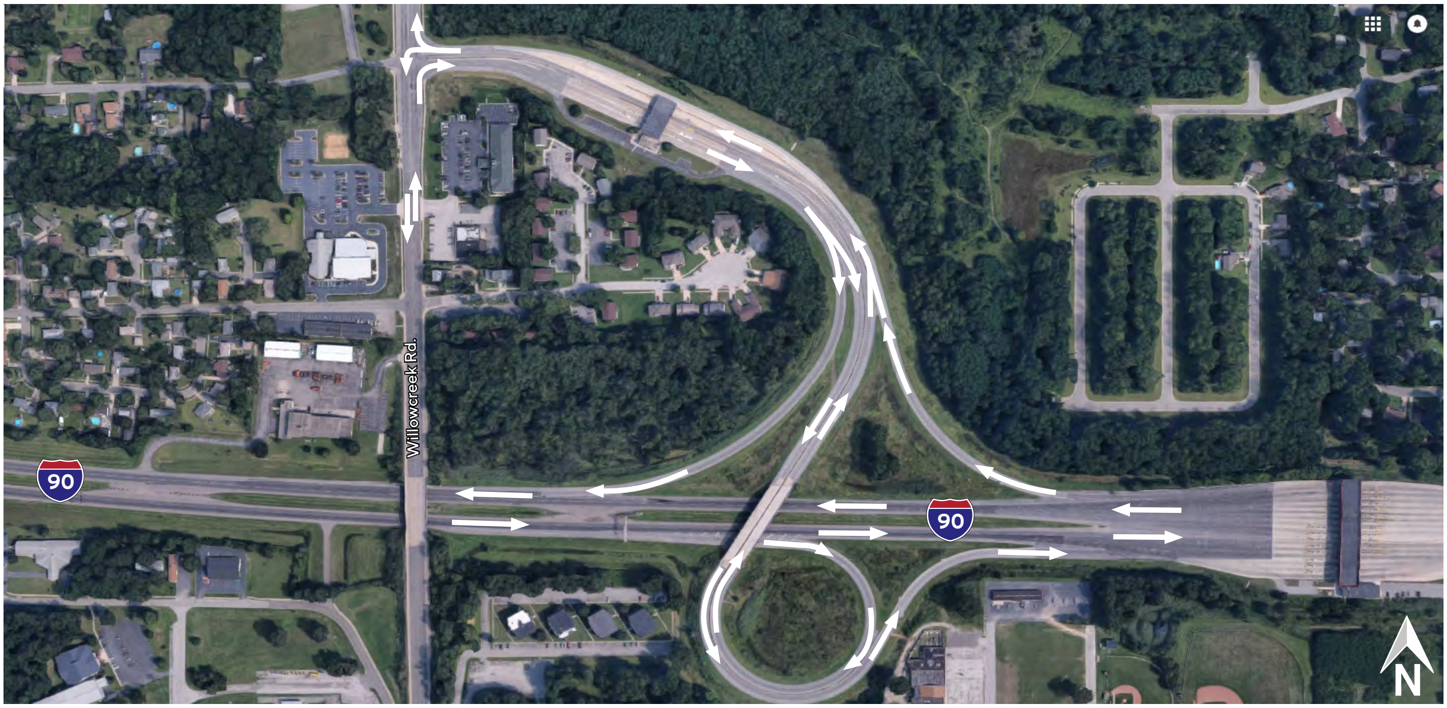


Figure 4.102

Portage, Indiana, Google Earth 2018. https://bit.ly/2RN8w8F

> Three-Way Directional Stack Interchange

This interchange provides ingress/egress on dedicated ramps for motorists traveling to/from three different roadways.

Figure 4.103

Maple Grove, Minnesota, Google Earth 2018. https://bit.ly/2HhulJv

Safety and Operations

Safety and operations of a roadway corridor have a symbiotic relationship. Safety can be influenced by the operational characteristics such as congestion, construction zones, traffic signal timing, and other travel conflicts. Operations can be impacted when safety isn't prioritized and crashes occur on the facility.

Safety

> Barriers and Rumble Strips

A roadside barrier is a longitudinal barrier used to shield motorists from natural and man-made obstacles located along either side of a traveled way.[36] They are usually categorized as rigid, semi-rigid or flexible depending on their deflection characteristics when impacted.

Metal beam guard fence (MBGF)

Figure 4.104 Source: TxDOT Landscape and Aesthetics Design Manual. November 2017. https://bit.ly/2FK8zvB

Metal beam guard fence (MBGF) is comprised of a corrugated metal horizontal member that is mounted to treated wooden or metal posts. This guard fence a semi-rigid barrier system.

Tension Cable Barrier

Figure 4.105 Source: Firehouse. University of Extrication: Cable Median Barriers – Part 1. Ron Moore. January 2011. https://bit.ly/2CuA09a

Tension cable barriers consist of steel wire ropes mounted to weak posts. Their primary purpose is to prevent a vehicle from leaving the travel lane and striking an obstruction. The errant vehicle is contained and redirected at impact. Tension cable barriers are a flexible barrier system.

Jersey Barrier

Figure 4.106 Source: Smith-Midland Corporation: Precast Concrete Products. https://bit.ly/2AS7JJU

Jersey barriers, also known as concrete road barriers or concrete traffic barriers, are modular concrete barriers placed in a linear fashion along the path of travel to delineate vehicular lanes and roadway uses. These barriers are a rigid barrier system.

Rumble Strips

Figure 4.107 Source: Phil Riggan. https://bit.ly/2sxPg0I

Rumble strips are modifications to the surface of the roadway paving, such as applied divots or raised/fastened units, placed on the periphery of a roadway. The rumble strip alerts inattentive drivers through vibration and sound that their vehicle has left the travel lane.

[36] Source: AASHTO Roadside Design Guide. 4th Edition 2011. Page 10-17.

> Pavement Markings

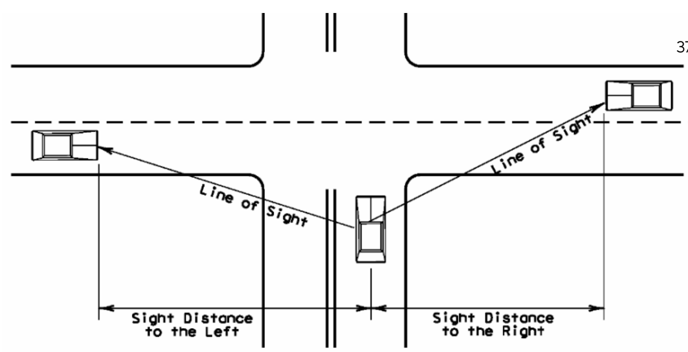
Pavement markings are applied uniformly to delineate the roadway path and lane assignments which communicate information to road users. They provide continuous information to road users related to the roadway alignment, vehicle positioning, and other important driving-related tasks.

Source: NACTO. https://bit.ly/2stRFt6

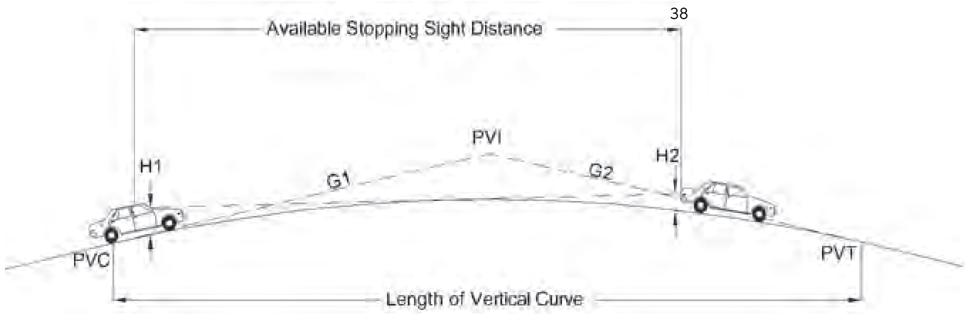
Source: Aquarena Springs Drive, San Marcos, Texas, Google Street View 2018. https://bit.ly/2FCLdrA

> Sight Lines

Sight lines are the arrangement of geometric elements so that there is adequate sight distance for safe and efficient traffic operation assuming adequate light, clear atmospheric conditions, and drivers' visual acuity.



[37]



[38]

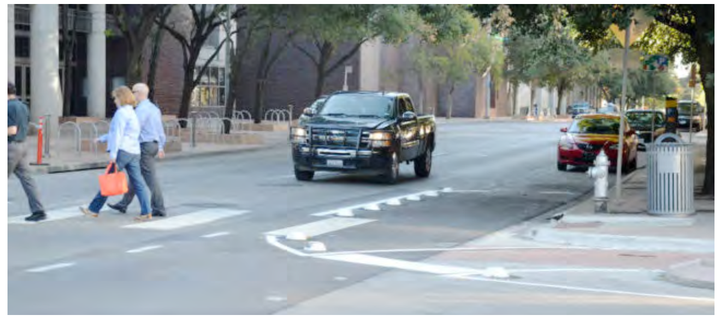
[37] Source: TxDOT. https://bit.ly/2Jq7f0O

[38] Source: FHWA Speed Concepts Informational Guide. Page 13 Figure 2. Effect of crest vertical curves on sight distance. https://bit.ly/2JjFOWG

> Bike Lane Delineators

Bike lane delineators provide improved safety to cyclist from motorists by creating visual and/or physical separation.

Source: Tactical Urbanism Materials and Design Guide.
https://bit.ly/2TPRgga



Source: Tactical Urbanism Materials and Design Guide.
https://bit.ly/1eFGViE

Source: Tactical Urbanism Materials and Design Guide.
https://bit.ly/2AOSlhc

Source: Alta Planning + Design.
https://bit.ly/2TYEw7b

Operations

> Dynamic Message Signs

Source: Walsh Tarlton Lane and Bee Cave Road, Austin, Texas.
HNTB 2018

Dynamic Message Signs (DMSs), also called Variable Message Signs, are large, electronic signs placed within the roadway corridor to inform drivers of changing or temporary traffic management situations.

> Flexible Pylons

Source: Kevin Tanaka/Pioneer Press
https://trib.in/2Fwf3ij

Flexible pylons are devices placed on the roadway for lane delineation and separation. In arterial roadways, they are placed for access management. These pylons are less rigid (as compared to concrete barriers) enabling easier access for emergency vehicles and provide more positive control than pavement markings for channelizing traffic.

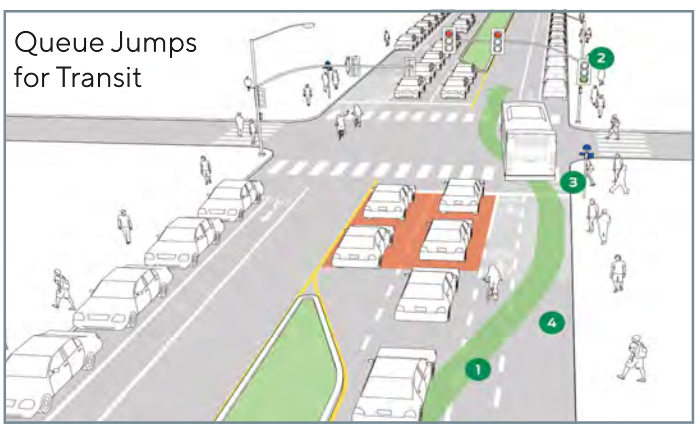
> Lane Management

Source: Salt Lake Tribune.
https://bit.ly/2RA0JLO

Reversible lanes add peak-direction capacity to a two-way road and decrease congestion by borrowing available lane capacity from the other (off-peak) direction. Reversing lanes reduces congestion for handling special event traffic, during morning and evening commutes when an incident blocks a lane, or when construction or maintenance activity is present on the road.

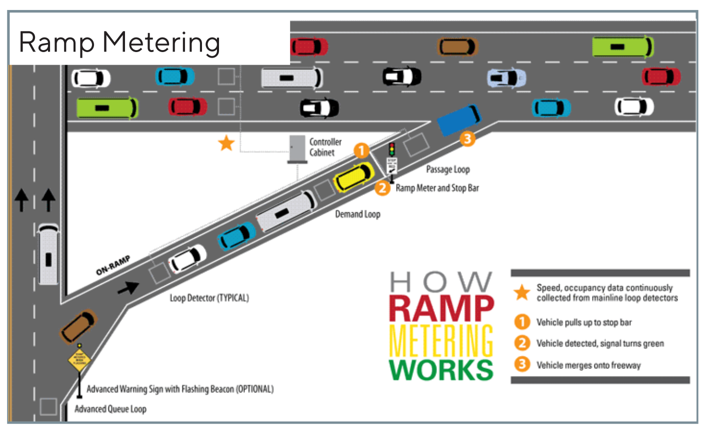
Source: oksana.perkins / Shutterstock.com.
https://bit.ly/2FFHPfn

High-occupancy vehicle lane, or HOV Lane, is a restricted traffic lane reserved for the exclusive use of vehicles with a driver and one or more passengers, including carpools, vanpools, and transit buses. They are usually located next to the regular, or unrestricted, lanes. HOV lanes enable those who carpool or ride the bus to bypass the traffic in the adjacent, unrestricted ("general purpose") lanes.



Source: NACTO.
https://bit.ly/2MeiZVr

Queue jumps for transit combine short dedicated transit facilities with either a leading bus interval or active signal priority to allow buses to easily enter traffic flow in a priority position. Applied thoughtfully, queue jump treatments can reduce delay considerably, resulting in run-time savings and increased travel reliability.



Source: FHWA
https://ops.fhwa.dot.gov/publications/fhwahop14020/sec1.htm

A ramp meter or ramp signal, usually a basic traffic light or a two-section signal light together with a signal controller, that regulates the flow of traffic frequency entering freeways.

> Bus Bulbs

Source: Austin, Texas. Google Streetview, 2019.
https://urlzs.com/uE9Vp

A bus bulb is a dedicated area defined by a curb extension within the parking lane. The extended space contains the bus stop and its amenities so that passenger boarding is facilitated while the bus remains in the travel lane. Bus bulbs increase efficiency of passenger boarding by reducing the bus's time spent merging in and out of traffic.

Access

Source: Kyle, Texas. Google Streetview, 2018.
https://bit.ly/2T0ryWm

Managing how and when access to the facility occurs will impact the efficiency and safety of the corridor.

Aesthetics and Sustainability

> Public Art

Public art can take various forms and use a range of mediums. Employing public art in a space can improve economics, provide culture, and create community engagement.

Austin, Texas (Source: HNTB 2018)

Berlin, Germany (Source: Wolfgang Rieger)

> Barrier Aesthetics

Traffic barriers can be treated as large canvases to carry out desired aesthetic upgrades.

Bronx, New York (Source: New York City Department of Transportation)

(Source: C&W Construction Specialties) https://bit.ly/2SYaP63

> Sound Walls

A physical obstruction that is constructed between the roadway noise source and the noise receptor(s) that lowers the noise level, including stand alone noise walls, noise berms (earth or other material), and combination berm/wall systems.[39]

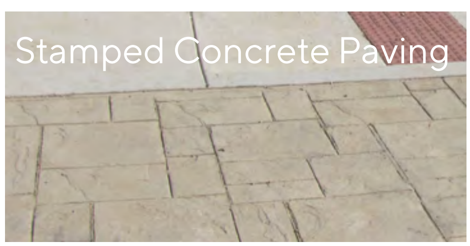
Source: Smith-Midland Corporation: Precast Concrete Products. https://bit.ly/2FurYkR

Source: Missouri Department of Transportation https://bit.ly/2RUXxtQ

> Decorative Paving

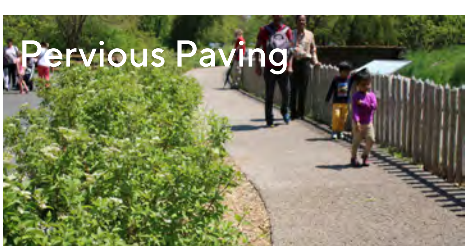
By using a range of paving materials, decorative paving enhances aesthetics and can improve stormwater management and safety.

Austin, Texas (Source: HNTB 2018)

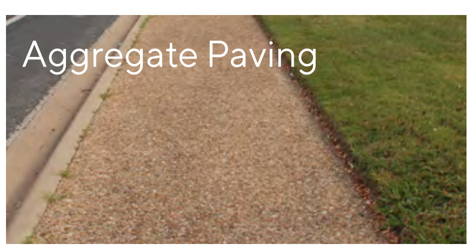


Austin, Texas (Source: HNTB 2015)

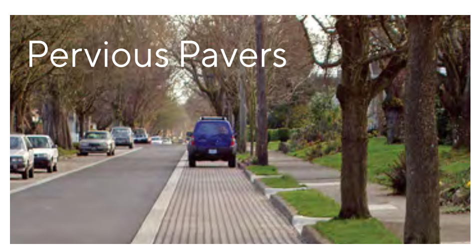
Austin, Texas (Source: HNTB 2015)



Detroit, Michigan (Source: Detroit Zooilogical Society)



Austin, Texas (Source: HNTB 2018)



Warrenville, Illinois (Source: unknown)

[39] Source: FHWA Highway Traffic Noise: Analysis and Abatement Guidance. December 2011. https://bit.ly/2LzDAVG

> Low Impact Development

Low Impact Development (LID) maximizes site functions to manage stormwater runoff. The methods used for LID are meant to create environmental sustainability and can enhance aesthetics.


Austin, Texas (Source: HNTB 2018)

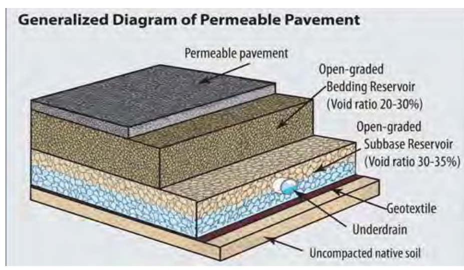

Austin, Texas (Source: HNTB 2018)


Austin, Texas (Source: HNTB 2018)

> Permeable Paving

Permeable paving is a method of paving vehicle surfaces that allows water to pass through voids in the paving material while providing a stable, load-bearing surface.

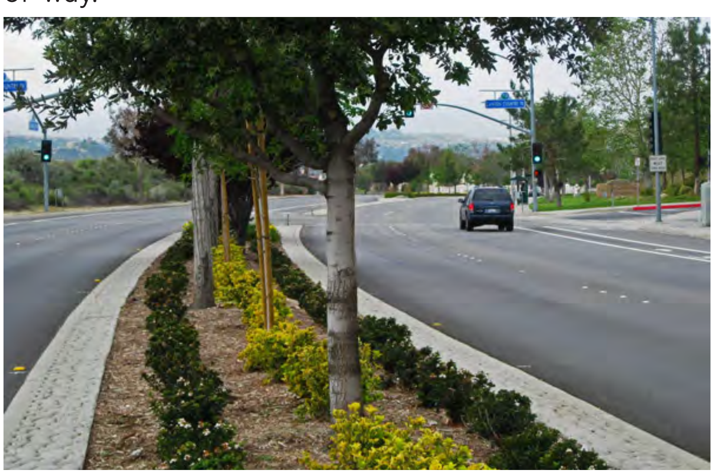

Source: Porous Pavement for Powerful Stormwater Management https://bit.ly/2AOyD5b



Source: Typical cross section with permeable pavement https://bit.ly/2RwMTKh

> Landscape Enhancements

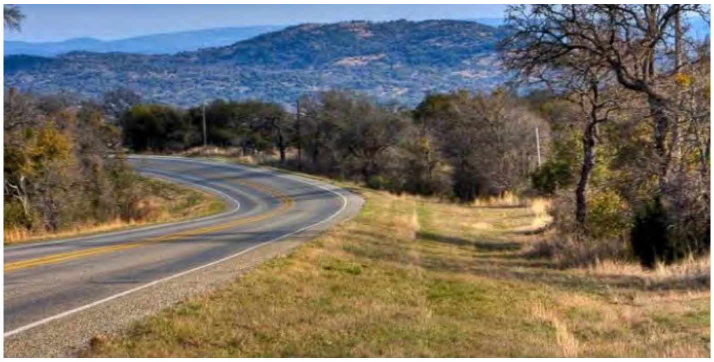
Landscape enhancements on the roadway corridor normally occur in the parkways and, at times, the medians within the right-of-way. The scale, density, and design complexity of the landscape vary depending on the Context Zone (urban, suburban, or rural), design speed of the road, and size of the landscape areas in the right-of-way.


Source: City of Santa Clarita. https://bit.ly/2AOW9Pw

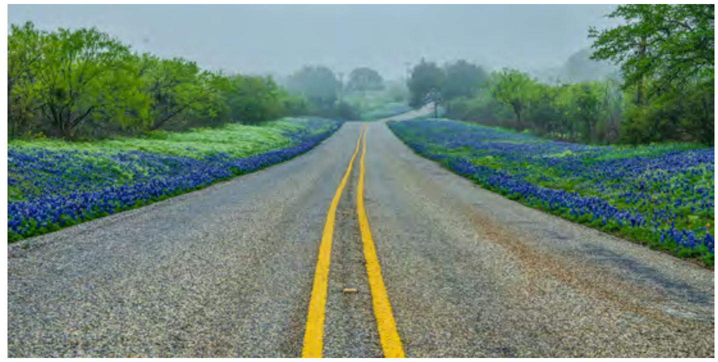

Source: Bronx, New York (Source: New York City Department of Transportation)

> Scenic Views

Scenic views along a road way range from tourism-attracting, breathtaking vistas, to unpleasant eyesores that are eagerly forgotten. Placement of a new roadway can harness the aesthetics of existing environments, such as the native landscape, architecture, or geological formations, to produce scenic views for the user. These improved views can demonstrate community character while attracting potential economic development.



Source: Daniel Ray
https://bit.ly/2FFLyJT



Source: Jeffrey W. Spencer.
https://bit.ly/2AOXENO

Medians

Due to their placement in the right-of-way and range of sizes, medians provide opportunities to support elements that contribute to safety, operations, access, and aesthetics and environmental enhancements.

Source: NACTO. Median Refuge Island.
https://bit.ly/2FwGJ6x

Source: NACTO. Median Refuge Island.
https://bit.ly/2FwGJ6x

Bronx, New York (Source: New York City Department of Transportation)

Source: Rain Community Solutions.
https://bit.ly/2RAqr32

> Creative Sidewalks

Creative Crosswalks use colors, textures, and patterns to enliven city streets as engaging and safe places for people. They can be designed to reflect the special character of a neighborhood, mark the gateway to a district, or otherwise create local identity and pride.

Source: AustinTexas.gov; Streets as places.
https://bit.ly/2VX9QEZ

Source: Streets Blog; Check Out Austin's New Polka-Dotted Intersection Neckdowns
https://bit.ly/2Hiw6px

Source: Streets Blog; It Just Works:
Davis Quietly Debuts America's First Protected Intersection.
https://bit.ly/2Hiw6px

Conclusion

To initiate an arterial corridor's development, or improve an existing corridor. Context Zones 1-5 and the recommended cross sections help regional planners understand how it can best plan arterials that meet regional transportation goals. The sampling of design enhancements provided help to promote efficiency, mobility, wellbeing, and sense of place for the community. As a region evolves, more creativity, innovation, and technology will strengthen arterials in the CAMPO Region for a smarter, more connected, overall transportation system.

SECTION 4

ARTERIAL TEST CASE CORRIDORS

Introduction

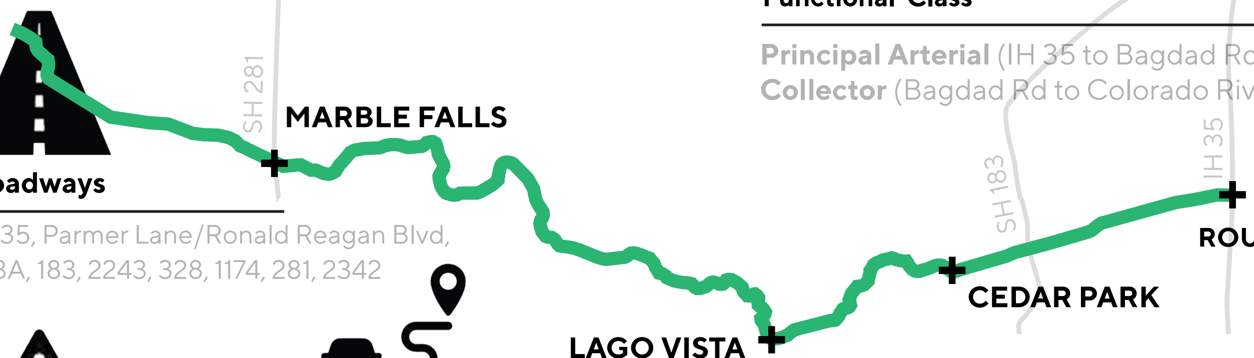
Four test case corridors were selected to demonstrate the application of this Pattern Book to identify proposed cross-sections for a particular roadway. These corridors were chosen because they serve as significant cross-county routes connecting multiple jurisdictions and traversing a multitude of physical barriers. Corridors selected include: RM 1431, FM 734 (Parmer Lane), RM 12, and SH 21. These four corridors are identified as a part of this study for functional class upgrading. The concept promotes them to the missing functional class in the Capital Area region defined as a regional connector.

Existing conditions were evaluated at the corridor-level to characterize and identify overarching needs for each corridor as a whole. One-mile segments within these corridors were subsequently selected and assessed in greater detail. CAMPO context zones were assigned to these one-mile segments in order to identify and recommend appropriate cross-sections.

RM 1431 Ranch to Market Road 1431

RM 1431 was chosen as a test case corridor because it is one of the most significant cross-county routes connecting multiple jurisdictions in Burnet, Travis, and Williamson Counties to the regional network. This principal arterial links up with IH 35, a trunk line for multi-modal terminals nationwide. This corridor will be upgraded to a Regional Connector classification, which demands increased capacity, as well as improved safety, access management, and operations. Growth along the corridor and the presence of physical barriers, such as the steep topography adjacent to the Colorado River, assert the need for enhancements required to upgrade RM 1431 to a functional Regional Connector.[1]

58
TOTAL MILES
1.15 MILES DIVIDED
56.85 MILES UNDIVIDED



Intersections

186 **TOTAL**
97 EASTBOUND /Every 0.60 mi.
89 WESTBOUND /Every 0.65 mi.

Functional Class

Principal Arterial (IH 35 to Bagdad Rd)
Collector (Bagdad Rd to Colorado River)

Roadways

IH 35, Parmer Lane/Ronald Reagan Blvd, 183A, 183, 2243, 328, 1174, 281, 2342

Destinations

Retail node(s): ✚

Safety Concerns

Total Crashes Across the Corridor in 2016

418
TOTAL

Barriers Crossed

Colorado River, Balcones Canyonlands National Wildlife Refuge

Driveways

527 **TOTAL**
279 EASTBOUND /Every 0.21 mi.
248 WESTBOUND /Every 0.23 mi.

[1] *Source: CAMPO, 2018*

Currently, only 2% of the 58-mile corridor is divided by a turn lane or median.[2] Undivided portions of the corridor and driveways present a greater number of conflict points, increasing safety hazards, especially where line-of-site is constrained by the terrain. The intersection at US 281 experienced the highest number of crashes, accounting for nearly one-third of all crashes along the corridor in 2016.

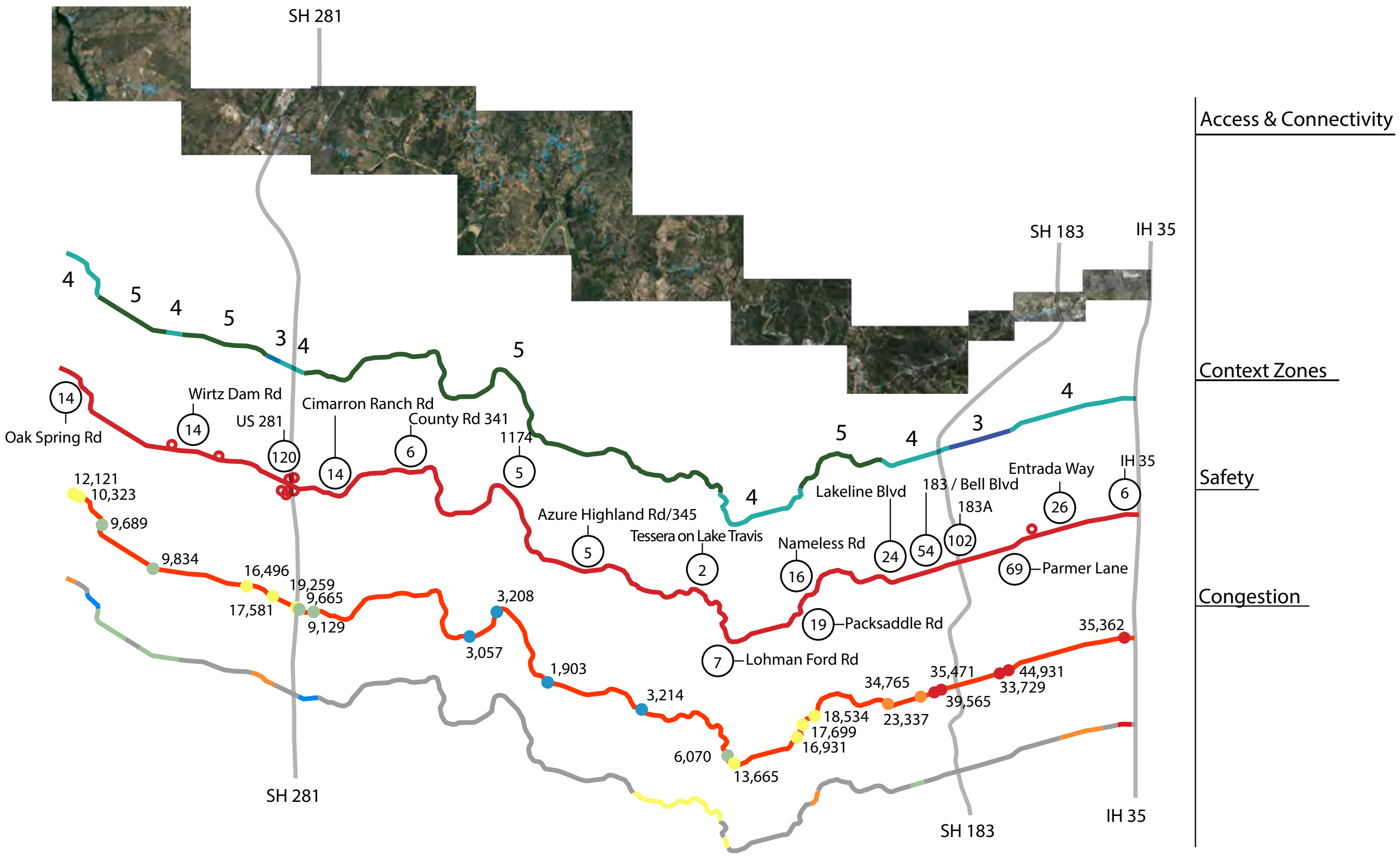
Traffic congestion is highest near IH 35. The highest average annual traffic counts are around 35,000 between Lakeline Boulevard.[3] Increasing the number of lanes and expanding the roadway would increase capacity of the corridor and alleviate this congestion.

There are more than 9 driveways per mile and 3 intersections per mile.[4] Reducing access points with grade separations and other intersection enhancements would improve operations by alleviating congestion at key intersections. Operational needs will vary where transit is made available.

By the year 2045, the entire length of the corridor will be divided with 4 - 6 lanes. Three-level diamond interchanges are proposed at IH 35, SH 130, SH 95, Spur 191 (new facility), and a new connection to Volente. A boulevard concept is proposed between Main Street in the City of Marble Falls to Deer Canyon Road in the city of Jonestown and from Destination Way to Bar-K Ranch Road in the city of Lago Vista.[5]

[2]Source: CAMPO, 2018
[3]Source: CAMPO 2040 Regional Transportation Plan, Travel Demand Model, Adopted May 11, 2015.
[4]Source: CAMPO, 2018
[5]Source: HNTB, 2019

Test Case Corridor Diagram: RM 1431



Access & Connectivity

- Driveway
- Street Intersection

Context Zones

- Zone 1 — Highrise Downtown
- Zone 2 — Main Street/Small Town
- Zone 3 — Mixed Use Suburban
- Zone 4 — Conventional Suburban
- Zone 5 — Rural

Congestion

Average Annual Daily Traffic

- 0 - 5,000
- 5,001 - 10,000
- 10,001 - 20,000
- 20,001 - 32,500
- 32,501 - 105,000

Volume / Capacity Ratio

- 0.0 - 0.09
- 0.10 - 0.21
- 0.22 - 0.29
- 0.30 - 0.35
- 0.35 - 0.59
- 0.60 - 0.69
- 0.70 - 2.0

RM 1431

Source: CAMPO, 2018

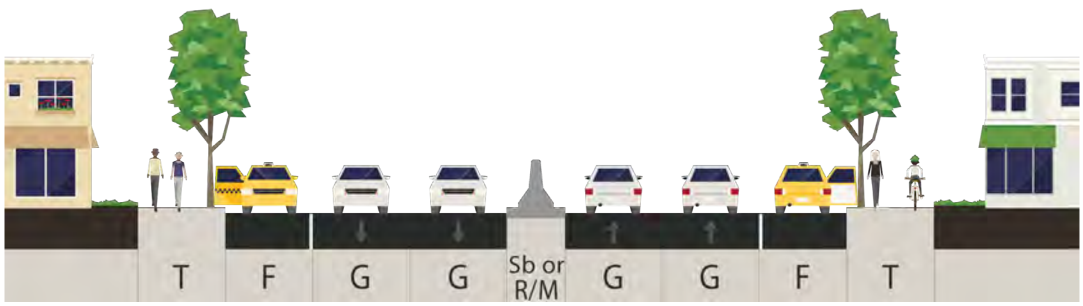
RM 1431 from Lake Crest Drive to Deer Canyon Road

Proposed Improvement

RM 1431 from Lake Crest Drive to Deer Canyon Road in Jonestown will be upgraded from a 4-lane Undivided to a Boulevard - 4GP + 2 local. As shown on the Test Case Corridor diagram, this section of the corridor carries an annual average of approximately 18,000 vehicles per day. Volume to capacity ratios in this area range between 0.35 - 0.59.[6]

Recommended Pattern Book Cross Section

Based on the Section, this segment of RM 1431 falls into the Zone 4 Suburban Conventional context. The forecasted growth in employment and population are expected to increase slightly in this small town. Traffic volumes are forecasted to increase by approximately 88*% to almost 34,000 vehicles per day by 2040.[7] This traffic growth is attributed to through trips. The roadway is considered a principal arterial and is recommended to be improved from its current 4-lane undivided cross section to a 6-lane divided cross section. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #7 from the Pattern Book chapter is recommended.



ROW: 105' - 155'
Divided
6 lane divided with 4 general purpose lanes and 2 flex lanes

This cross-section option would improve safety by reducing the possibility of head-on collisions caused by out-of-control vehicles crossing the median or failure to yield during a left turn. The addition of sidewalks would improve walkability in the area by providing a safe route for pedestrians where there are currently none. Future development within the central business district could employ Oak St and 1st St as backage routes while accessibility is reduced along the corridor to eliminate hazardous conflict points at existing driveways.

Proposed Cross Section Example - Wurzbach Parkway @ Starcrest, San Antonio, Texas

[6]Source: CAMPO, 2018
[7]Source: CAMPO 2040 Regional Transportation Plan, Travel Demand Model, Adopted May 11, 2015.

To address changing needs in the area, the addition of flex lanes would improve congestion and operational performance.

Context

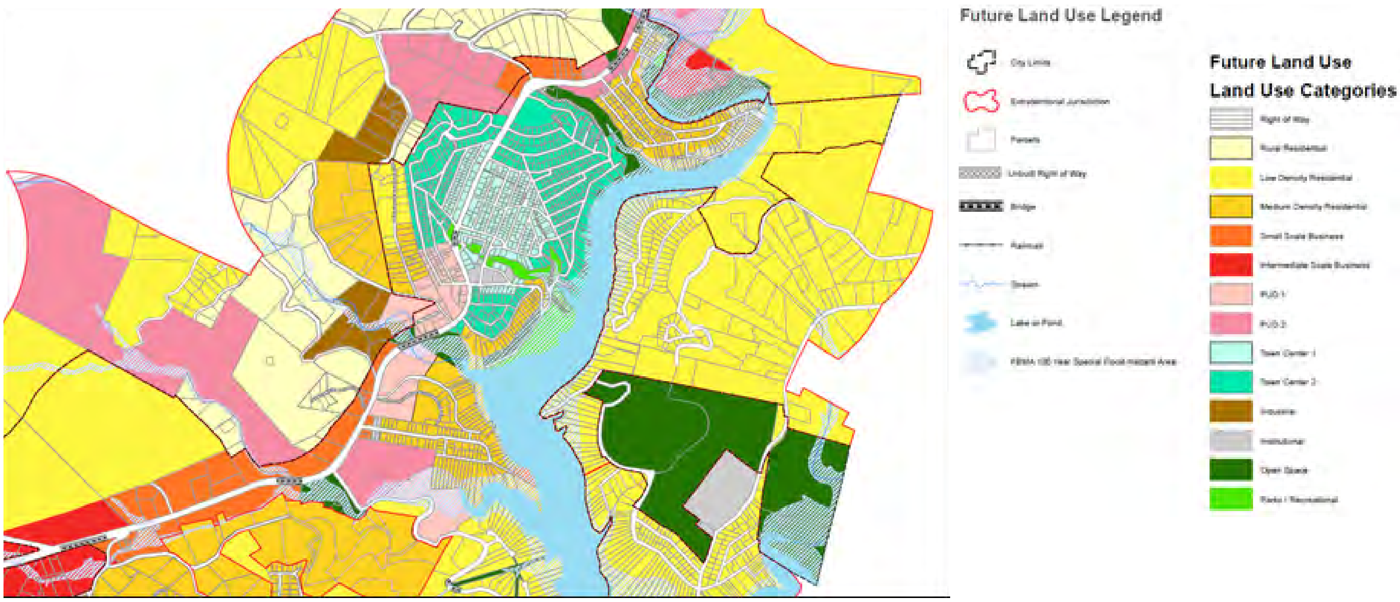
Located on the northern end of Lake Travis, the City of Jonestown is a community of 2,000 residents. RM 1431 serves as the commercial corridor through the City's central business district.

Text Case Corridor: RM 1431 (from Lake Crest Dr to Deer Canyon Rd)

Like many rapidly developing rural regions in the Capital Area, citizens are trying to preserve a specific way of life and attract compatible economic and community development projects. The majority of parcels along the RM 1431 segment are defined as commercial real property and vacant lots. The lots tend to be small in size with the majority less than half an acre.

A major concern in the community is the volume of traffic along RM 1431. The combination of topography, traffic counts, and lack of dedicated turn lanes make this segment difficult to navigate. The challenge going forward is to improve safety along this corridor to help facilitate the town center concept the community envisions along RM 1431.

Zoning/ Future Land Use (2016)



Source: Travis CAD

Opportunities

Jonestown's future land use plan depicts the RM 1431 segment as a town center. This area would be comprised of mixed-use single-family residential units, small square footage commercial businesses (that may be combined with residential use on the same property or in same building), professional office, government, institutional. Buildings along this corridor would likely be 2 or 3 stories tall. Development opportunities are currently limited in Jonestown due to challenging topography and a lack of a centralized wastewater system. As described in the land use plan, a main barrier the town center concept faces in terms of development is adequate wastewater facility connections. Therefore, the roadway improvements impact on the community might be constrained based on other infrastructure issues.

Roadway infrastructure improvements recommended in this section could accelerate development in the area. If the approximately 30 acres of undeveloped and underdeveloped property is built out as a mixed-use town center over the next 20 years, this could translate into 700,000 square feet of new commercial and residential space, 500 new jobs, and $100.0 million in new taxable value.

The separation of opposing traffic with a median turn-lane or a median barrier would drastically improve safety where line-of-sight distances are constrained by curves and steep terrain. These constraints are especially prevalent at the northern end where the slope is greatest and the roadway rises 63 feet in elevation in over an 1100-foot distance. Limiting left-turn lanes will become an important safety measure as more residential units within the central town center are converted to commercial and mixed-use. Limiting left turns will also provide corridor access management and improve traffic flow.

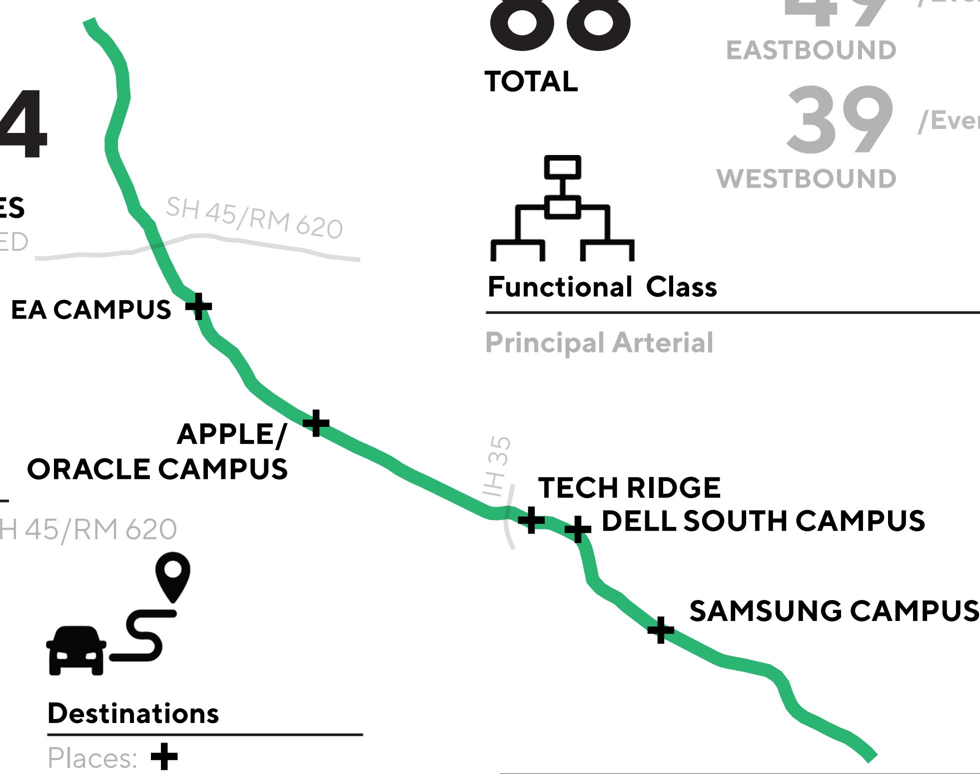
FM 734 Parmer Lane (FM 734)

In comparison to the other test case corridors, Parmer Lane (FM 734) passes through highly developed areas and connects major job centers within Travis and Williamson Counties. This principal arterial provides connections to IH 35, MoPac Expressway, and SH 45. As a Regional Connector, this corridor will be upgraded to meet growing mobility demands, while offering greater safety, access management, and potential operational improvements. Many firms have chosen in recent years to locate along or near the corridor and making these improvements will be key to supporting regional mobility.

Currently, the entire 19.4-mile corridor is divided by a turn lane or median.[8] The intersection at IH 35 experienced the highest number of crashes, accounting for nearly one-quarter of all crashes along the corridor in 2016. Construction of a median barrier, where there are currently none, would reduce safety hazards.

19.4

TOTAL MILES
19.4 MILES DIVIDED



Intersections

88 TOTAL

49 EASTBOUND /Every 0.40 mi.

39 WESTBOUND /Every 0.50 mi.

Functional Class

Principal Arterial

Roadways

SH 130, IH 35, Mopac, SH 45/RM 620

Destinations

Places: +

Safety Concerns

Total Crashes Across the Corridor in 2016

466 TOTAL

Barriers Crossed

N/A

Driveways

138 TOTAL

81 EASTBOUND /Every 0.24 mi.

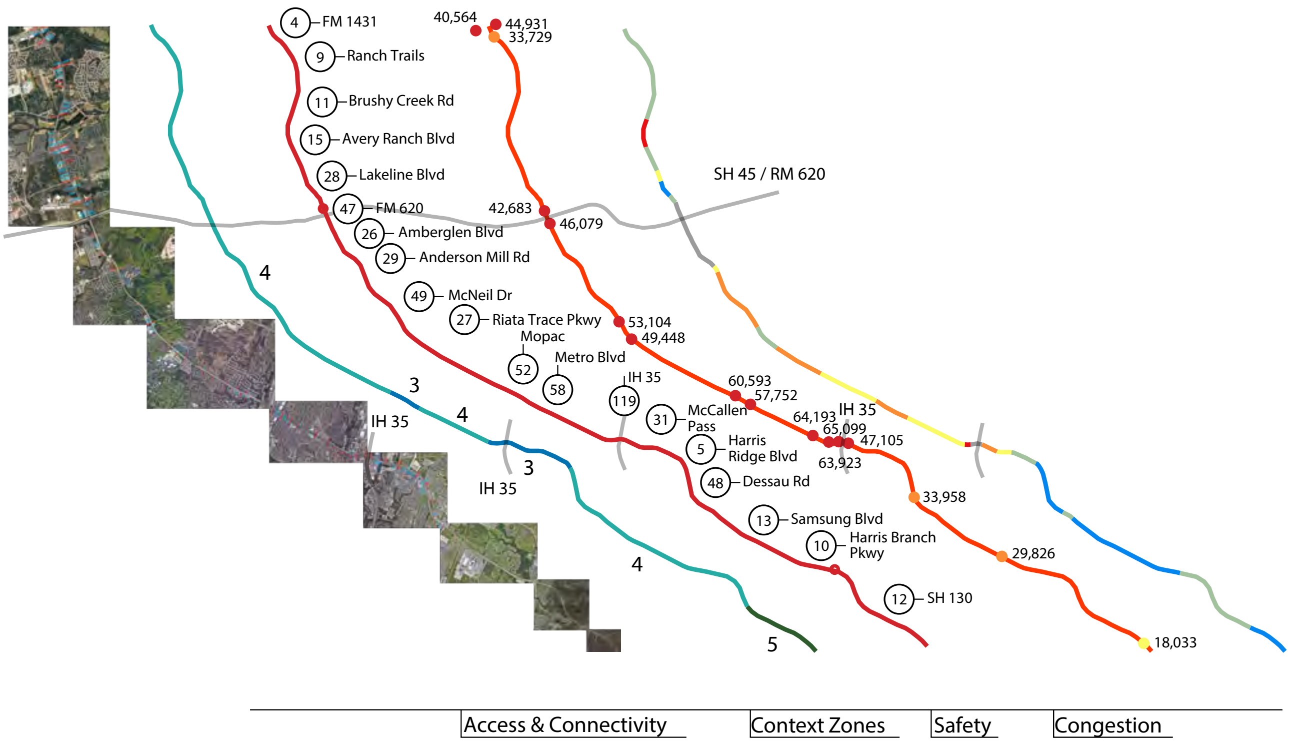
57 WESTBOUND /Every 0.34 mi.

[8]Source: CAMPO, 2018

Traffic congestion is highest near Avery Ranch Boulevard and between IH 35 and McNeil Drive in the City of Austin. Increasing the number of lanes and expanding the roadway would increase capacity of the corridor and alleviate this congestion.

There are more than 7 driveways per mile and 5 intersections per mile. Reducing access points with grade separations and other intersection enhancements would improve operations by alleviating congestion at key intersections. Operational needs will vary where transit is made available.[9] By the year 2045, the entire length of the corridor is proposed to be 4-8 lanes. Three-level diamond interchanges are proposed at IH 35, US 290, SH 45, SH 29, SH 195, SL 1, SL 275, and RM 1431.

Test Case Corridor Diagram: Parmer Lane (FM 734)



Access & Connectivity

- Driveway
- Street Intersection

Context Zones

- Zone 1 — Highrise Downtown
- Zone 2 — Main Street/Small Town
- Zone 3 — Mixed Use Suburban
- Zone 4 — Conventional Suburban
- Zone 5 — Rural

Congestion

Average Annual Daily Traffic

- 0 - 5,000
- 5,001 - 10,000
- 10,001 - 20,000
- 20,001 - 32,500
- 32,501 - 105,000

Volume / Capacity Ratio

- 0.0 - 0.09
- 0.10 - 0.21
- 0.22 - 0.29
- 0.30 - 0.35
- 0.35 - 0.59
- 0.60 - 0.69
- 0.70 - 2.0

FM 734

[9]Source: CAMPO, 2018

Parmer Lane from SH 130 to US 290E

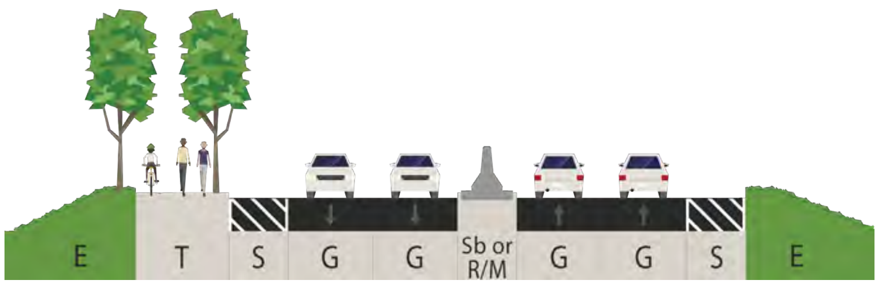
Proposed Improvement

Parmer Lane between SH 130 and US 290 is proposed to be upgraded from a 4-lane Divided to 6-lane Divided. As shown on the Test Case Corridor diagram, this section of the corridor carries an annual average of 18,000 vehicles per day near. Volume to capacity ratios in this area range between 0.10 and 0.29.[10]

Recommended Pattern Book Cross Section

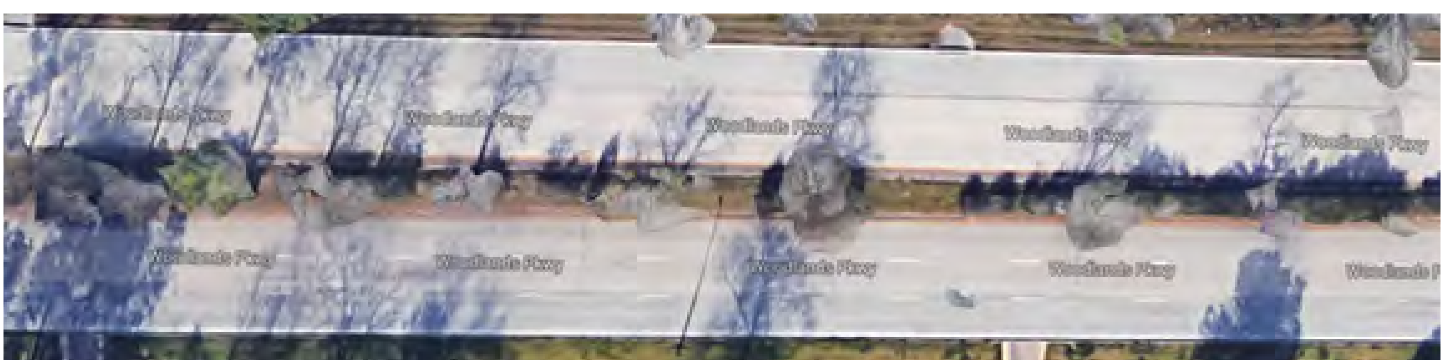
Based on the Pattern Book chapter, this segment of Parmer Lane falls into the Zone 4, Suburban Conventional context. The forecasted growth in employment and population are expected to triple. Resulting traffic volumes are forecasted to increase by 75% to almost 31,500 vehicles per day by 2040.[11] The roadway is considered a principal arterial and is recommended to be improved from its current 4-lane divided cross section to a 4-lane divided cross section with shoulders. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #10 from the Pattern Book chapter is recommended.

Proposed Cross Section: #10



ROW: 85' - 140'
Divided
4 lane divided with 4 general purpose lanes and shoulders

This cross-section option would improve safety and operational performance by allowing for pedestrian or transit facilities where there are currently none. The addition of sidewalks would improve walkability in the area by providing a safe route for pedestrians where there are currently none. Future development sprawling should limit accessibility and employ backage routes to eliminate hazardous conflict points along the corridor. Additional transit-dedicated lanes would improve congestion and operational performance by reducing the number of cars on the road. A median barrier would provide for strategic access management and improve traffic flow.



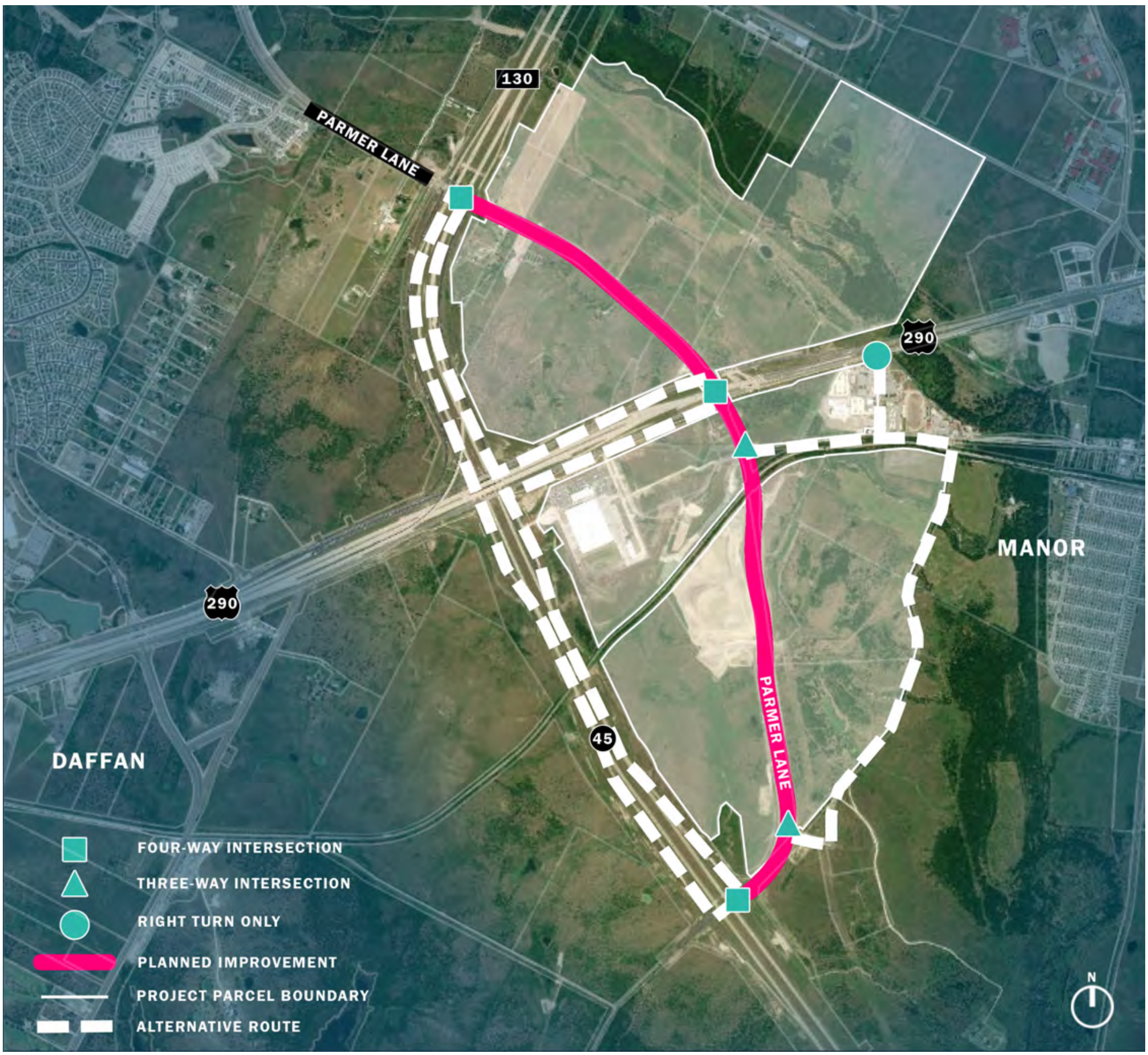
Proposed Cross Section Example - RM 1431 near Discovery, Cedar Park, Texas

[10]Source: CAMPO, 2018
[11]Source: CAMPO 2040 Regional Transportation Plan, Travel Demand Model, Adopted May 11, 2015.

Context

Located in eastern Travis County in the extraterritorial jurisdiction of Austin, this segment of Parmer Lane is a major roadway that connects SH 45 to SH 130. The land use in this area is largely vacant/rural, with some single-family. The expectation is that eastern Travis County, long a bystander in the overall growth in the Capital Area, is primed for extensive development. A number of factors are in the mix. First is the cost and availability of land; while prices are rising, the cost per acre remains far less expensive than elsewhere in the immediate Capital Area, and the ability to assemble/acquire fairly large tracts of land is unmatched locally. Second are environmental considerations, as most of eastern Travis County is less sensitive environmentally than other parts of the Austin region, and so is a preferred area for development. Planning by the City of Austin and other local jurisdictions reflect this desire, and most regional plans target this area for significant growth.

Test Case Corridor: Parmer Lane (FM 734)



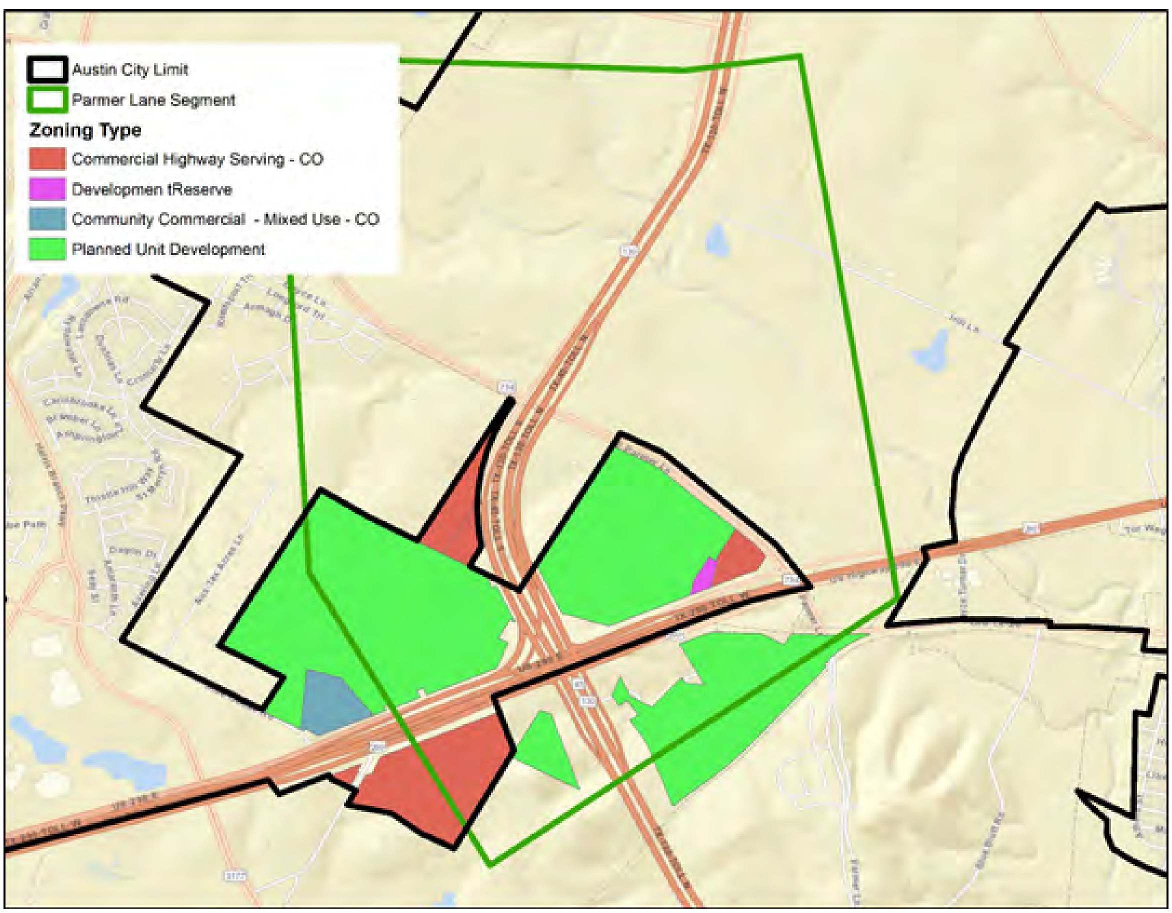
Meanwhile, changing laws on annexation and the perception that self-governance creates opportunity has led to at least one Municipal Management District (MMD) and a number of Municipal Utility Districts (MUDs) in the area being approved in the most recent legislative session. Substantial existing transportation infrastructure investments by both the public and private sector round out the picture of an area primed for growth.

Opportunities

Over the next 25 years, based on TAZ forecast data, population and employment are expected to approximately triple. These forecasts may well be too conservative, especially regarding employment, improved access near the intersection of two major highways should stimulate the concentration of significant commercial development. This is especially true if residential development occurs at a pace consistent with the development plans of several major landowners in the area, which also include a large volume of mixed-use development. Most of these plans also includes a high volume of amenities such as parks and other recreational facilities, which are typically only feasible in large, master-planned environments. If thousands more people will live and play in the area, the improvements should facilitate both movement within the area and better connection to Austin and communities to the east, north, and south.

Investments in roadway infrastructure in this area may accelerate planned development. Once improved, this roadway may serve as an important backage route for developments on the east side of SH 130. In turn, Blue Bluff Road could potentially be used as a backage route for developments in Manor extending west and development around the interchange of SH 130 extending east toward Parmer Lane. If implemented, dedicated transit lanes could provide a mobility connection for residents in the City of Manor to the Austin Bergstrom Airport among many other parts of the region.

Zoning/ Future Land Use (2016)



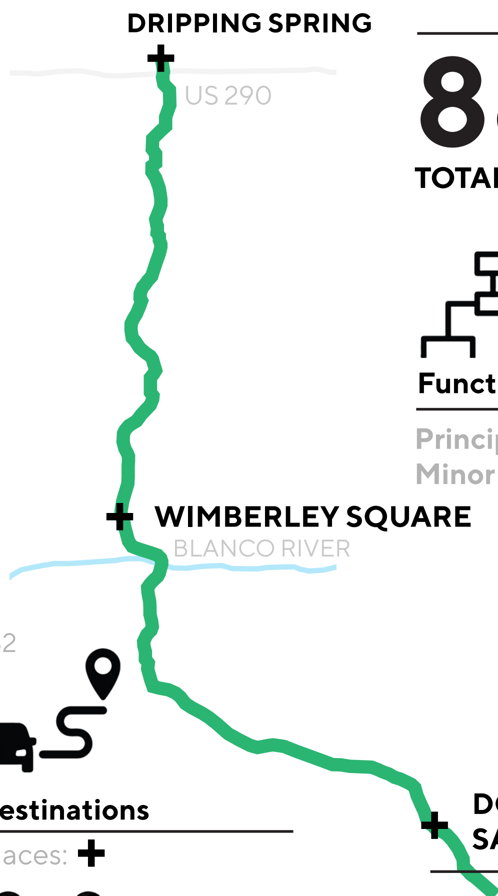
Source: Travis CAD

RM 12 Ranch to Market Road 12

RM 12 serves as a principal arterial for connecting urban and rural areas, as well as small towns in Hays County. It offers access to IH 35 and US 290. As growth in Hays County increases the demand for mobility, it will be particularly important to ensure that improvements help to manage access and improve safety, while supporting environmental sustainability. As the roadway serves a variety of land uses and development intensities, it will be key to tailor its design to those individual communities.

27.1

TOTAL MILES
1.94 MILES DIVIDED
25.16 MILES UNDIVIDED



Intersections

88 TOTAL

47 EASTBOUND /Every 0.58 mi.

41 WESTBOUND /Every 0.66 mi.

Functional Class

Principal Arterial (IH 35 to Old Ranch Rd 12)
Minor Arterial (Old Ranch Road 12 to US 290)

Roadways

US 290, RM 150, FM 2325, FM 32

Safety Concerns

Total Crashes Across the Corridor in 2016

152 TOTAL

Destinations

Places: +

Barriers Crossed

Blanco River

Driveways

308 TOTAL

166 EASTBOUND /Every 0.16 mi.

142 WESTBOUND /Every 0.19 mi.

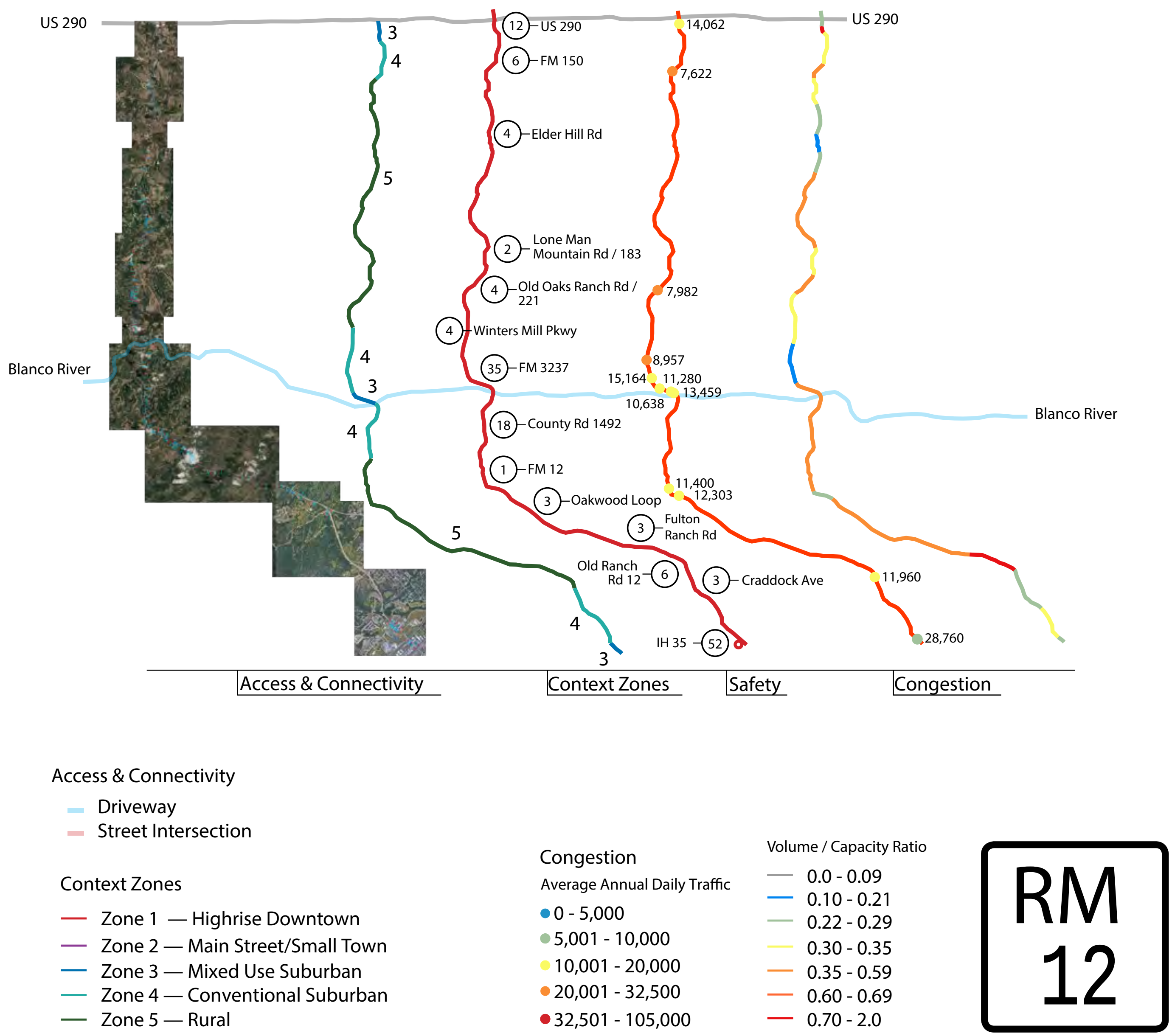
Currently, only 7% of the 27.1-mile corridor is divided by a turn lane or median. Undivided portions of the corridor and driveways present a greater number of conflict points, increasing safety hazards, especially where line-of-site is constrained by the terrain. The intersection at IH 35 experienced the highest number of crashes, accounting for approximately one-third of all crashes along the corridor in 2016.[12]

Traffic congestion is above capacity along most of the corridor south of the Blanco River and is highest between Fulton Ranch Road and Old Ranch Road 12. Increasing the number of lanes and expanding the roadway would increase capacity of the corridor and alleviate this congestion. [13]

There are more than 11 driveways per mile and 3 intersections per mile. Reducing access points with grade separations and other intersection enhancements would improve operations by alleviating congestion at key intersections. Operational needs will vary where transit is made available.[14] By the year 2045, the entire length of the corridor is proposed to be divided with 4 - 6 lanes. Three-level diamond interchanges are proposed at IH 35, US 290, SH 123, and RM 1826/ Alamo Connection. [15]

[12]Source: CAMPO, 2018
[13]Source: CAMPO 2040 Regional Transportation Plan, Travel Demand Model, Adopted May 11, 2015.
[14]Source: CAMPO, 2018
[15]Source: HNTB, 2019

Test Case Corridor Diagram: Ranch Road 12



Source: CAMPO, 2018

Wonder World Drive (RM 12) from Hunter Road to IH 35

Proposed Improvement

Wonder World Drive from Hunter Road to IH 35 is proposed to be upgraded from 4-lane Undivided to 6-lane Divided. As shown on the Test Case Corridor diagram, this section of the corridor carries an annual average of approximately 29,000 vehicles per day. Volume to capacity ratios in this area range between 0.22 and 0.69.[16] The intersection at IH 35 experienced the highest number of crashes in 2016 when compared to other major intesections along the RM 12 corridor, making this Wonder World Drive section of RM 12 a high priority for

[16]Source: CAMPO, 2018

safety improvements. Future development in the area will be primarily industrial and commercial, with potential to increase truck traffic and the need to limit access.

Recommended Pattern Book Cross Section

Based on the Pattern Book chapter, this segment of Wonder World drive is a Zone 4, Suburban Conventional context. The forecasted growth in employment and population are expected to triple. Resulting traffic volumes are forecasted to grow by nearly 193% to almost 82,000 vehicles per day by 2040.[17]

The roadway is considered a principal arterial and is recommended to be improved from its current 6-lane undivided cross section to a 6-lane divided cross section. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #17 from the Pattern Book chapter is recommended.

This cross-section option would improve safety by reducing the possibility of head-on collisions caused by out-of-control vehicles crossing the median or failure to yield during a left turn. The addition of sidewalks

Proposed Cross Section: #17

ROW: 95' - 155'
Divided
6 lane divided with 6 general purpose lanes

Source: CAMPO Pattern Book, 2019

would improve walkability in the area by providing a safe route for pedestrians where there are currently none. Additional transit-dedicated lanes would improve congestion and operational performance by reducing the number of cars on the road. Stagecoach Trl and Dutton Dr could serve as backage routes so that access along the corridor may be reduced, eliminating hazardous conflict points at existing driveways.

Proposed Cross Section Example - CO 121- Wadsworth @ Interlocken Loop, Broomfield, Colorado

[17] Source: CAMPO 2040 Regional Transportation Plan, Travel Demand Model, Adopted May 11, 2015.

Context

Located on the southern side of San Marcos, this segment of Wonder World Drive runs northwest from IH 35. Current land use is oriented toward industrial and warehouse-based commercial, with a modest volume of multi-family residential as well. There is also a significant volume of undeveloped land in this corridor, with just over 70 acres of vacant lots and/or qualified open space.

The current zoning along Wonder World Drive is primarily commercial and industrial. Future land patterns will be driven by the size of economic development projects in the area. The active railroad that crosses Wonder World Drive will impact some parcels more than future road upgrades and improvements. Stagecoach Trail will likely serve as the dividing line between small commercial and retail businesses and larger industrial users to the southwest.

Test Case Corridor: Wonder World (from IH 35 to Hunter Rd)

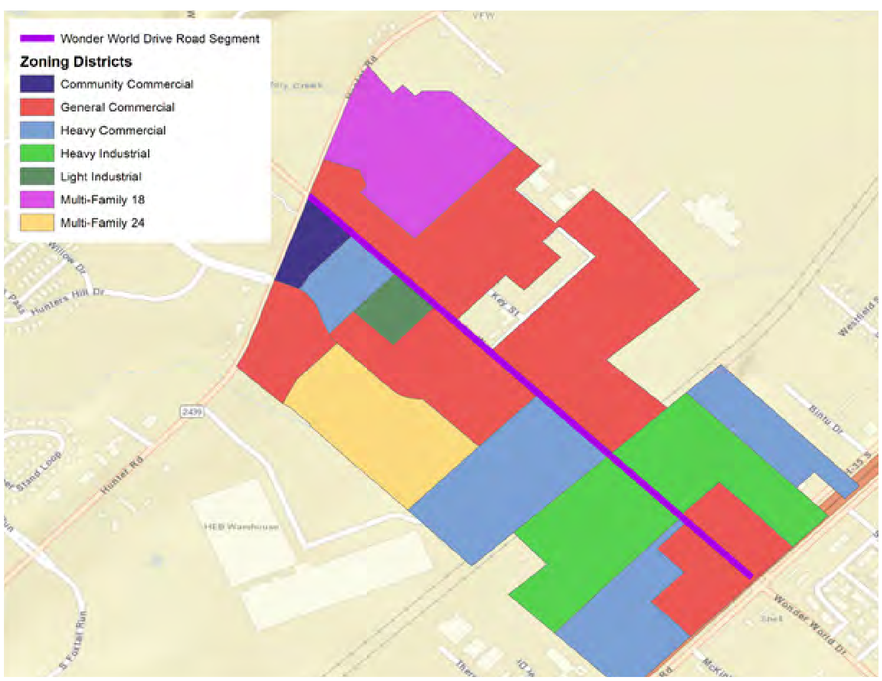
Opportunities

San Marcos is one of the fastest growing communities in the nation and for several years in a row, led the nation in the rate of population growth. Service providers are rapidly moving in to meet the needs of the multitude of new residents. East of IH 35, this pattern is evident along Wonder World Drive, as a number of retail, medical, entertainment, and hospitality uses are clustered across the highway, along with large multi-family developments. On the western side of the segment, there are also a number of commercial outlets, including senior living and some financial services.

Over the next 25 years and based on TAZ forecast data, both population and employment in the area are projected to approximately triple, reflecting continued rapid growth along the IH 35 Corridor in general and the San Marcos/Hays County in particular. The pattern of development likely will remain fairly consistent with what has occurred to date, with light industrial/commercial remaining along the artery and multi-family residential being developed in the out-parcels. The improvements should facilitate the infill along the segment, as well as better enabling connectivity within the area and to the region as a whole.

This roadway is located in the center of the South End development zone that is envisioned to serve as a new connection to Downtown San Marcos. An increase in vehicle capacity would have the potential to accelerate commercial investments in the area as well as accommodate projected growth. If the approximately 70 acres of undeveloped property is developed consistently with the future land use plan and zoning, this could translate into over 1.0 million square feet of new commercial and industrial space, 1,500 new jobs, and $100.0 million in new taxable value. Pedestrian safety improvements along this corridor would provide a safe pedestrian connection for zero-car and elderly households nearby. Dedicated transit lanes would connect the greater region to current and future commercial services and employment. Dividing the roadway with a median or barrier would reduce left-turn and head-on-collision conflict points as trucks serving the commercial and industrial developments would increase.

Zoning / Future Land Use (2016)



Source: City of San Marcos

[18]Source: CAMPO, 2018
[19]Source: CAMPO 2040 Regional Transportation Plan, Travel Demand Model, Adopted May 11, 2015.

RM 12 from US 290 to Butler Ranch Road

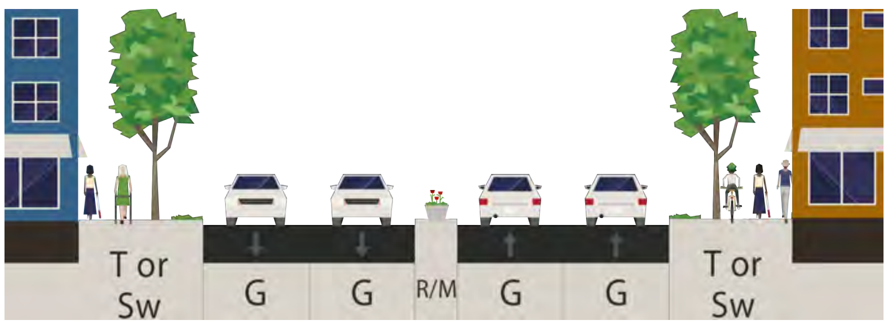
Proposed Improvement

RM 12 from US 290 to Butler Ranch Road is proposed to be upgraded from 2-lane Undivided to 4-lane Divided. As shown on the Test Case Corridor diagram, this section of the corridor carries an annual average of approximately 14,000 vehicles per day. Volume to capacity ratios in this area range between 0.30 and 0.69.[20] Curves along this section of roadway present safety hazards associated with sight-distance constraints between Butler Ranch Road and US 290.

Recommended Pattern Book Cross Section

Based on the Pattern Book chapter, this segment of Ranch Road 12 falls into the Zone 3 Suburban context. The forecasted growth in employment and population are expected to increase by a factor of 5. Resulting traffic volumes are forecasted to increase by 135% to nearly 33,000 vehicles per day by 2040.[21] The roadway is considered a principal arterial and is recommended to be improved from its current 2-lane undivided cross section to a 4-lane divided cross section. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #21 from the Pattern Book chapter is recommended.

Proposed Cross Section: #21



ROW: 75′ - 130′
Divided
4 lane divided with 4 general purpose lanes

This cross section option would improve safety by reducing the possibility of head-on collisions caused by out-of-control vehicles crossing the median or failure to yield during a left turn. The addition of sidewalks would improve walkability in the area by providing a safe route for pedestrians where there are currently none.

Proposed Cross Section Example - S. Lakeline Boulevard near Old Mill Road, Cedar Park, Texas

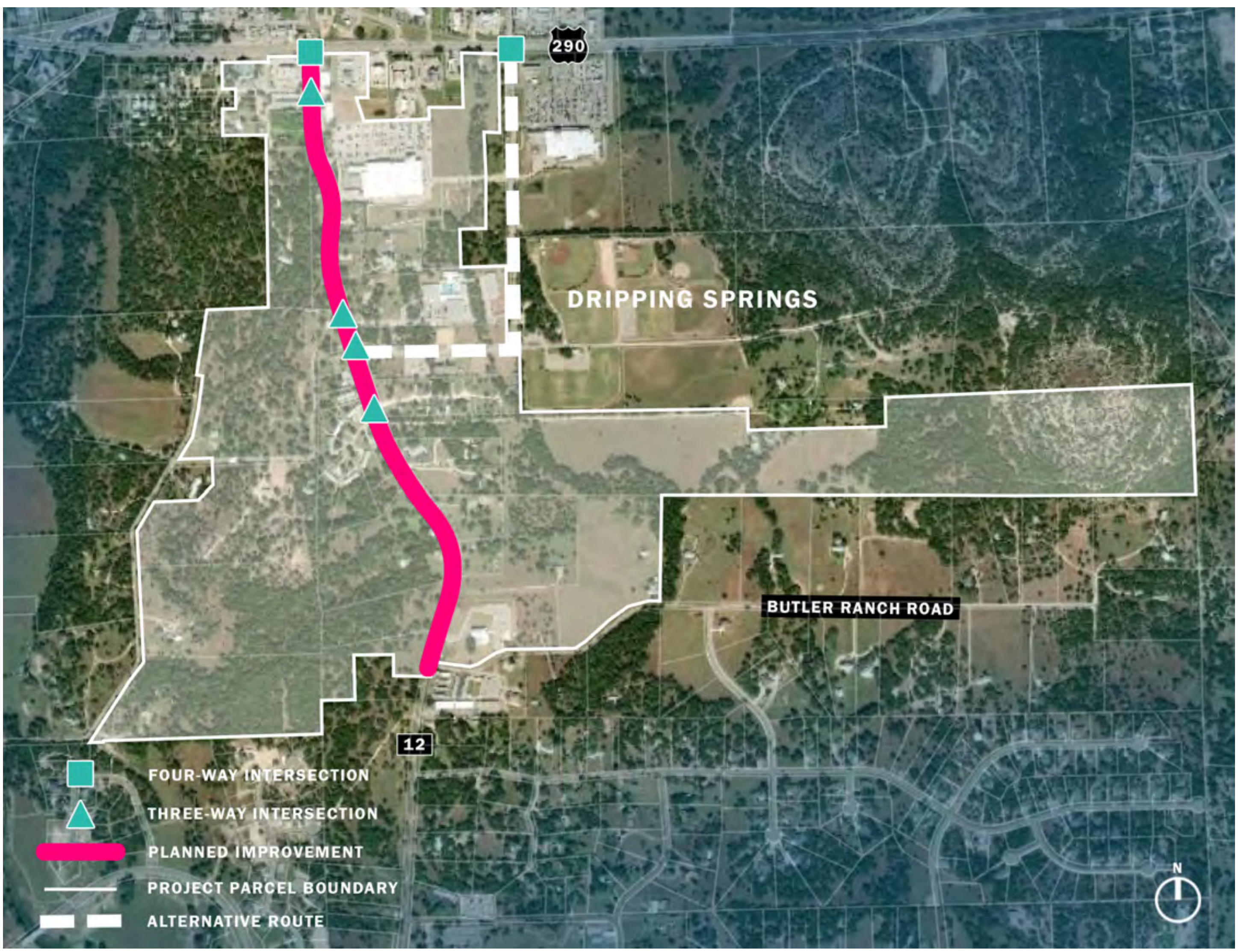
[20]Source: CAMPO, 2018
[21]Source: CAMPO 2040 Regional Transportation Plan, Travel Demand Model, Adopted May 11, 2015.

Additonal general purpose lanes would increase capacity, improve congestion and operational performance. Future developments in the area should employ backage routes so that access along the corridor may be reduced, eliminating hazardous conflict points at existing driveways.

Context

Located on the northern end of Hays County, this segment of RM 12 is beginning to see spillover from the rapid growth of Dripping Springs. While the land use in this area is still largely vacant/rural, there has been significant commercial development at the corner where RM 12 joins US 290, anchored by Home Depot. Dripping Springs and RM 12 have become a popular location for breweries and distilleries, with producers such as Deep Eddy Vodka, Bell Springs Winery, Treaty Oak Distillery, San Luis Spirits Revolution Spirits, Goodnight Loving Vodka, and Twisted X Brewing all either in the city or nearby. When attractions such as Hamilton Pool, live music and antiques, and a burgeoning restaurant scene are factored into the equation, it is clear that this area will be highly attractive to both visitors and future residents. Boasting over 35 wedding venues within a 15-mile radius, Dripping Springs has also become the "official wedding capital of Texas."

Test Case Corridor: RM 12 (from US 290 to Butler Ranch)



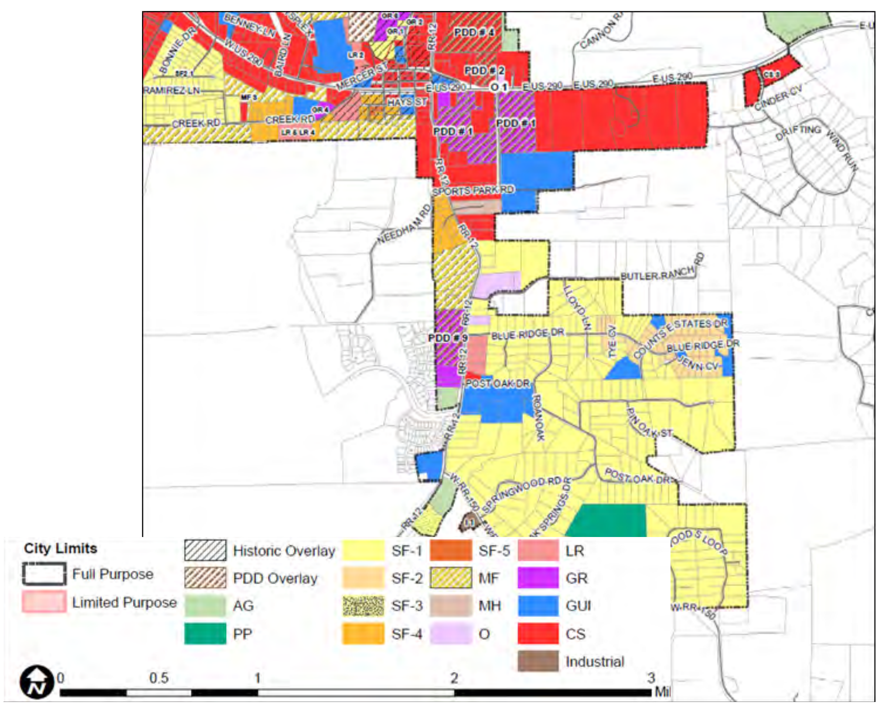
The current land use and zoning along RM 12 focus on commercial and residential uses. The northern and western portions of the RM 12 segment imagine more commercial and retail activity. The majority of the eastern side of RM 12 should be single-family homes.

Opportunities

Dripping Springs has exploded in recent years, reflecting both the overall growth of the Capital Area, the amenities described above, and the particular geographic beauty and appeal of northern Hays and southwestern Travis Counties. The proposed improvements will facilitate growth spreading to the south, where there is ample room for new development. Meanwhile, the demographics of the area are likely to change, as people with more disposable income and higher education are likely to be drawn to the area. This, in turn, will stimulate demand for higher end retail, additional entertainment, more upscale housing (perhaps including higher-end multi-family at some point) and eventually perhaps small-scale office.

Over the next 25 years and based on TAZ forecast data, population and employment are expected to grow by a factor of 5. This forecast is plausible; the factors above suggest that the development and growth that occurs will be higher-end than the historical pattern. An increase in vehicle capacity would have the potential to accelerate development in the area as well as accommodate projected growth. If the roughly 100 acres of the undeveloped property transitions to commercial and residential lots in comparable size to the surrounding neighborhoods over the next 20 years, this could result in over $25.0 million in new taxable value.

Traffic is expected to increase in tandem with population and employment growth. Separating opposing traffic flows with a median turn-lane or barrier would improve safety by reducing left-turn conflict points and potential head-on collisions, especially where line-of-site constraints exist due to curves in the road. Sidewalks would provide safer connections for pedestrians from the low-density residential developments to commercial and community services to the north, including a church (Church of the Springs) and recreational facility (YMCA).



Source: City of Dripping Springs

21 TEXAS SH 21

SH 21 was chosen as a test case corridor because it is one of the most significant routes connecting multiple jurisdictions within Bastrop, Caldwell, and Hays County to the regional network. This principal arterial will be upgraded to a Regional Connector classification, which demands increased capacity, as well as improved safety, access management, and operations. Forecasted growth in the area, a history of increasing traffic volumes, and physical barriers such as the Colorado River and steep topography assert the need for enhancements. These enhancements will be required to upgrade SH 21 to a functional Regional Connector.

53.9

TOTAL MILES
12 MILES DIVIDED
41.90 MILES UNDIVIDED

Intersections

134 TOTAL

61 EASTBOUND /Every 0.88 mi.

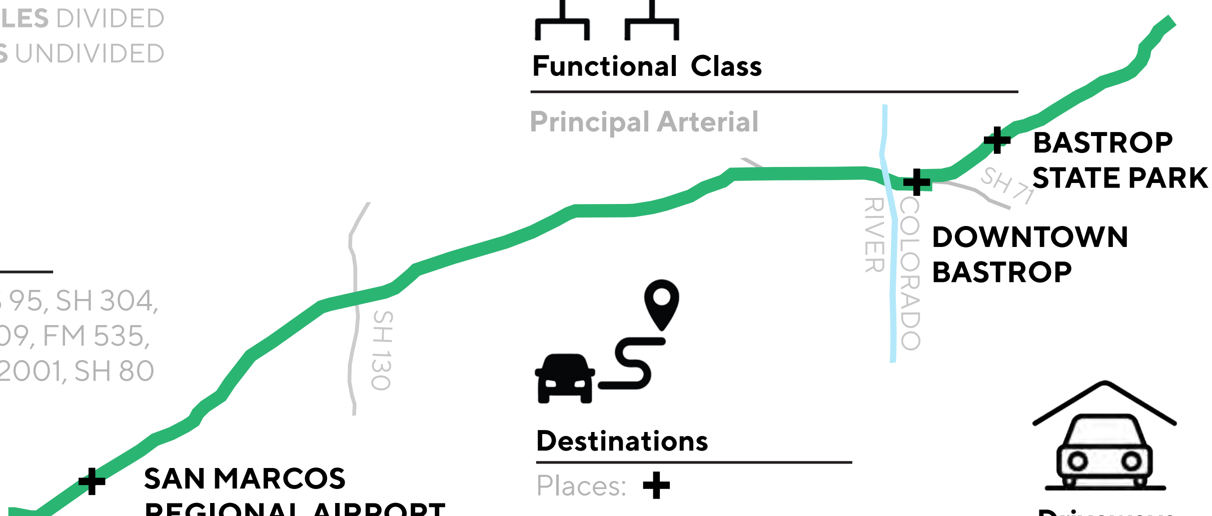
73 WESTBOUND /Every 0.74 mi.

Functional Class

Principal Arterial

Roadways

US 290, FM 1441, US 95, SH 304, FM 20, SH 71, FM 1209, FM 535, FM 812, SH 130, FM 2001, SH 80



Destinations

Places: +

Safety Concerns

Total Crashes Across the Corridor in 2016

404 TOTAL

Barriers Crossed

Colorado River

Driveways

502 TOTAL

227 EASTBOUND /Every 0.24 mi.

275 WESTBOUND /Every 0.20 mi.

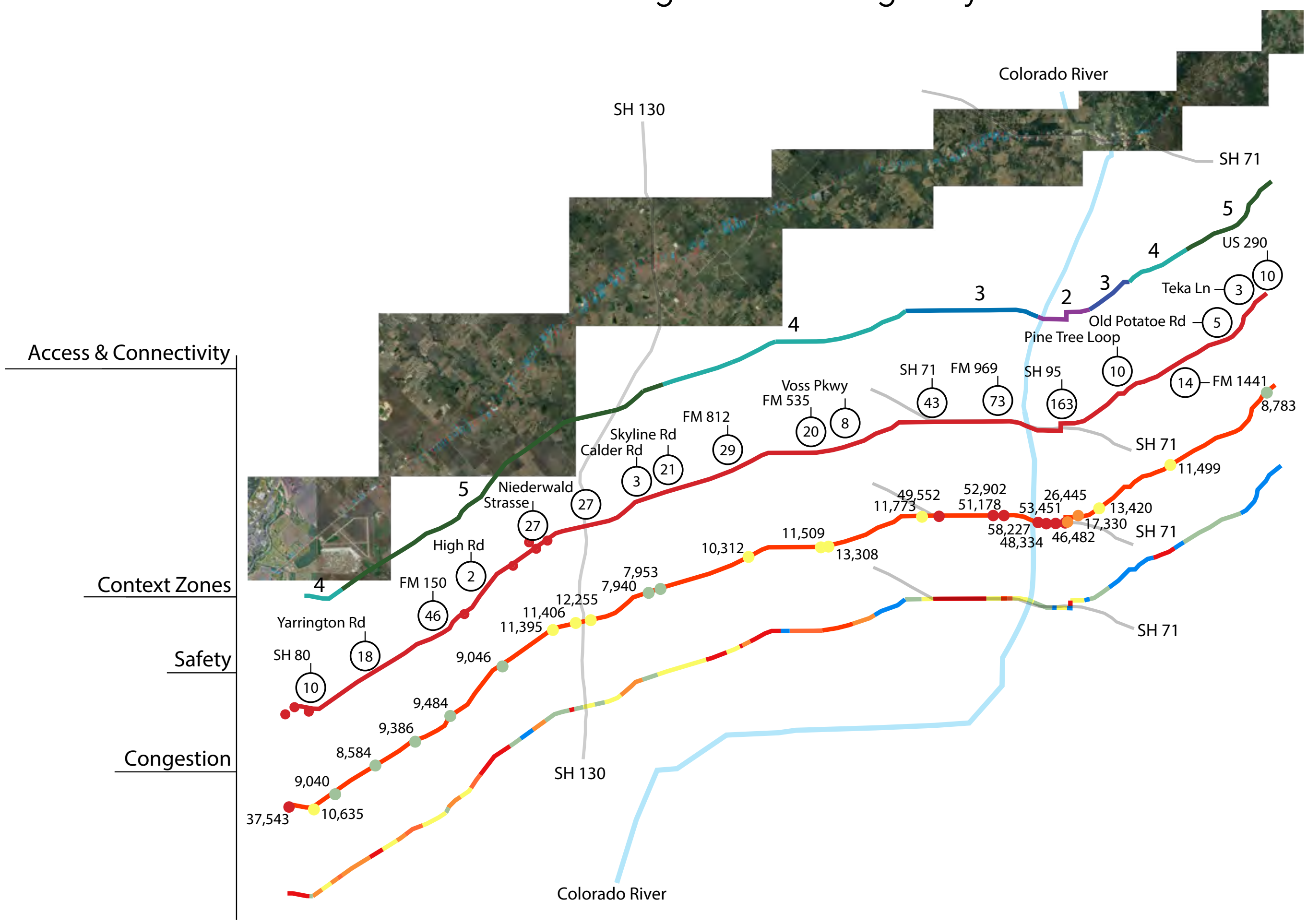
Currently, only 22% of the 53.9-mile corridor is divided by a turn lane or median. Undivided portions of the corridor and driveways present a greater number of conflict points, increasing safety hazards, especially where line-of-site is constrained by the terrain. The intersections at SH 71 and RM 150 experienced the highest number of crashes, accounting for approximately 10% of all crashes along the corridor at each location in 2016. Medians, improved guard rail designs, turn-lanes, and grade-separations would improve these safety hazards.[22]

Traffic congestion is above capacity along most of the corridor and is highest at the intersection with SH 71. Increasing the number of lanes and expanding the roadway would increase capacity of the corridor and alleviate this congestion.[23]

There are more than 2 driveways per mile and 2 intersections per mile. Reducing access points with grade separations and other intersection enhancements would improve operations by alleviating congestion at key intersections. Operational needs will vary where transit is made available.[24] By the year 2040, the entire length of the corridor is proposed to be divided with 4 - 6 lanes. Three-level diamond interchanges are proposed at SH 130/ US 183, SH 71 , SH 80, SH 123, RM 150, FM 812, FM 1704 and RM 12.[25]

[22]Source: CAMPO, 2018
[23]Source: CAMPO 2040 Regional Transportation Plan, Travel Demand Model, Adopted May 11, 2015.
[24]Source: CAMPO, 2018
[25]Source: HNTB, 2019

Test Case Corridor Diagram: State Highway 21



Access & Connectivity

- Driveway
- Street Intersection

Context Zones

- Zone 1 — Highrise Downtown
- Zone 2 — Main Street/Small Town
- Zone 3 — Mixed Use Suburban
- Zone 4 — Conventional Suburban
- Zone 5 — Rural

Congestion

Average Annual Daily Traffic

- 0 - 5,000
- 5,001 - 10,000
- 10,001 - 20,000
- 20,001 - 32,500
- 32,501 - 105,000

Volume / Capacity Ratio

- 0.0 - 0.09
- 0.10 - 0.21
- 0.22 - 0.29
- 0.30 - 0.35
- 0.35 - 0.59
- 0.60 - 0.69
- 0.70 - 2.0

21
TEXAS

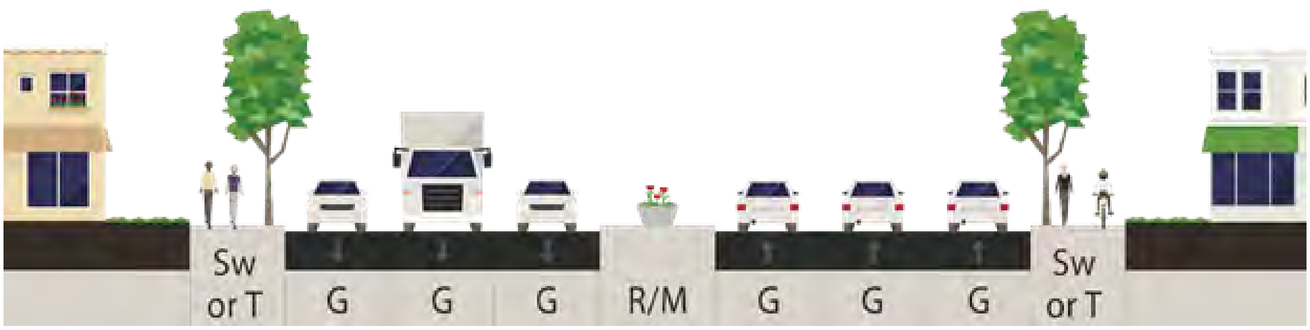
Source: CAMPO, 2018

Camino Road (SH 21) from SH 80 to Arnold Avenue

Proposed Improvement
SH 21 from SH 80 to Arnold Avenue is proposed to be upgraded from 4-lane Undivided to 6-lane Divided. As shown on the Test Case Corridor diagram, this section of the corridor carries an annual average of approximately 37,500 vehicles per day. Volume to capacity ratios in this area range between 0.70 and 2.0.[26]

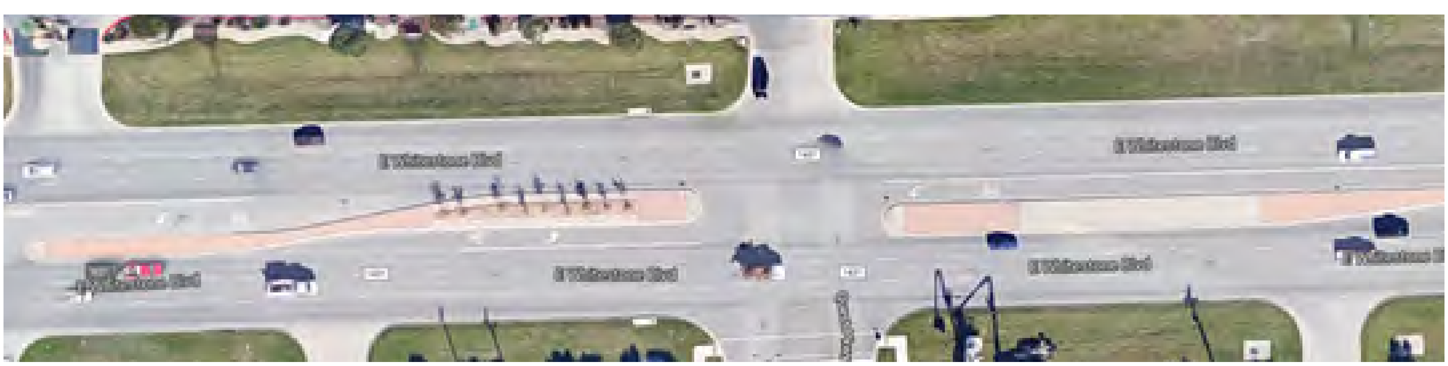
Recommended Pattern Book Cross Section
Based on the Pattern Book chapter, this segment of SH 21 falls into the Zone 4 Suburban 1 context. The forecasted growth in employment and population are expected to increase by a factor of 4. Resulting traffic volumes are forecasted to increase by 20% to 45,000 vehicles per day by 2040.[27] The roadway is considered a principal arterial and is recommended to be improved from its current 4-lane undivided cross section to a 6-lane divided cross section. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #17 from the Pattern Book chapter is recommended.

Proposed Cross Section: #17



ROW: 95′ - 155′
Divided
6 lane divided with 6 general purpose lanes

This cross-section option would improve safety by reducing the possibility of head-on collisions caused by out-of-control vehicles crossing the median or failure to yield during a left turn. The addition of sidewalks would improve walkability in the area by providing a safe route for pedestrians where there are currently none.



Proposed Cross Section Example - RM 1431 near Discovery, Cedar Park, Texas

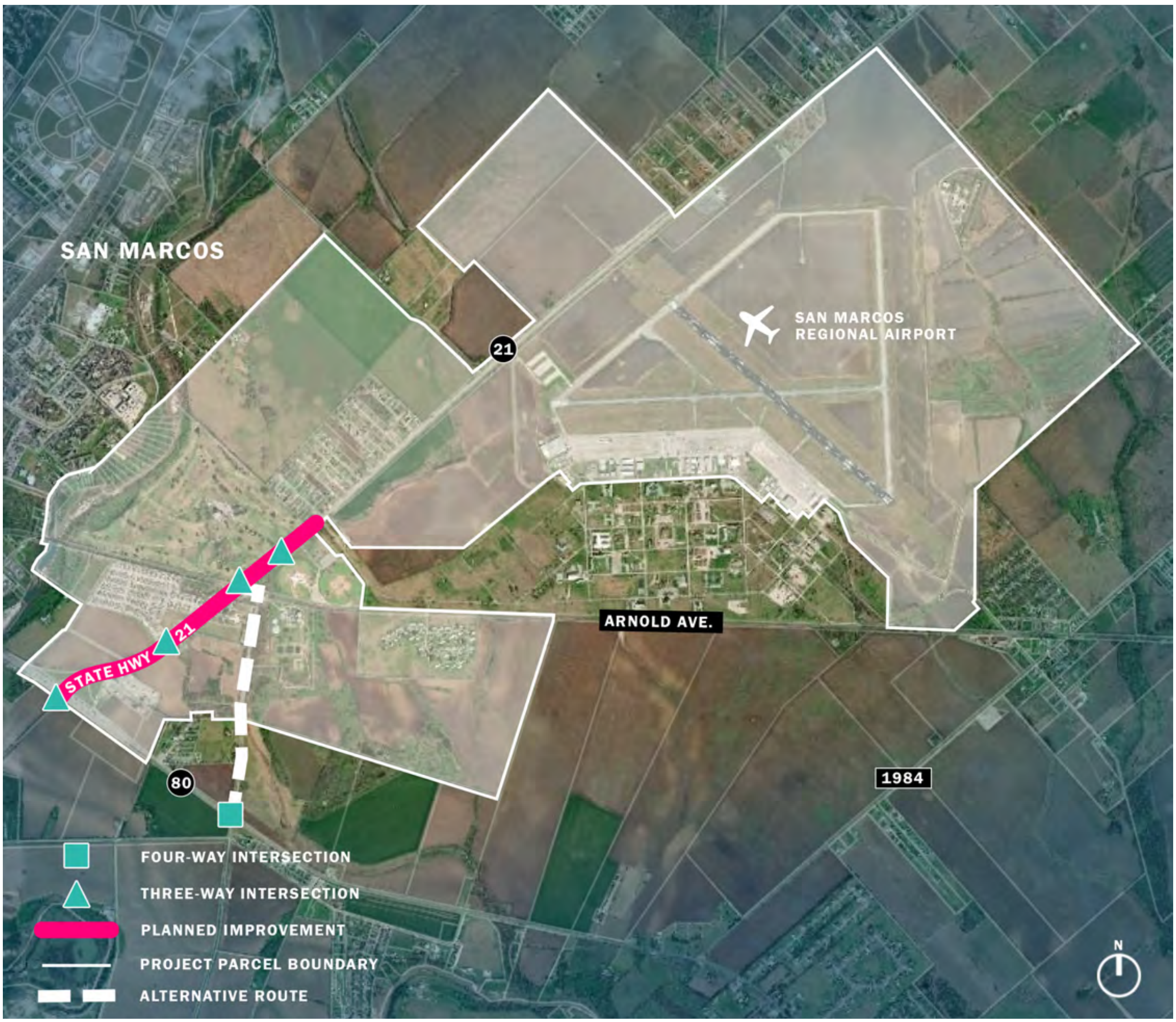
[26]Source: CAMPO, 2018
[27]Source: CAMPO 2040 Regional Transportation Plan, Travel Demand Model, Adopted May 11, 2015.

Additional transit-dedicated lanes would improve congestion and operational performance, by reducing the number of cars on the road. Newberry Drive currently serves as a backage route to the Blanco River Village neighborhood. Future developments should also limit access to SH 21 and utilize backage routes to minimize hazardous conflict points.

Context

Located on the eastern side of San Marcos, this segment of SH 21 connects to the San Marcos Regional Airport. The land use in this area is largely vacant/rural, with Quail Creek Golf Course accounting for the limited commercial property. There is a significant volume of undeveloped land in this corridor, with just over 250 acres of vacant lots and/or qualified open space. Not all of the property is within the City of San Marcos city limits. The combination of the San Marcos Regional Airport, Quail Creek Golf Course, and Gary Sports Complex limits development opportunities on the northern end of this segment. Over the long term, the construction of FM 110 (San Marcos Loop) will enhance connectivity of the road segment.

Test Case Corridor: State Highway 21 (from SH 80 to Arnold Ave)



Based on current zoning and land use, the northern side of SH 21 within the San Marcos city limits should develop as residential. The development pattern on the southern side of SH 21 will likely be residential but is currently being used for agricultural purposes. TxDOT also controls nearly 7 acres near the intersection of SH 21 and SH 80 which is currently being used as maintenance facility.

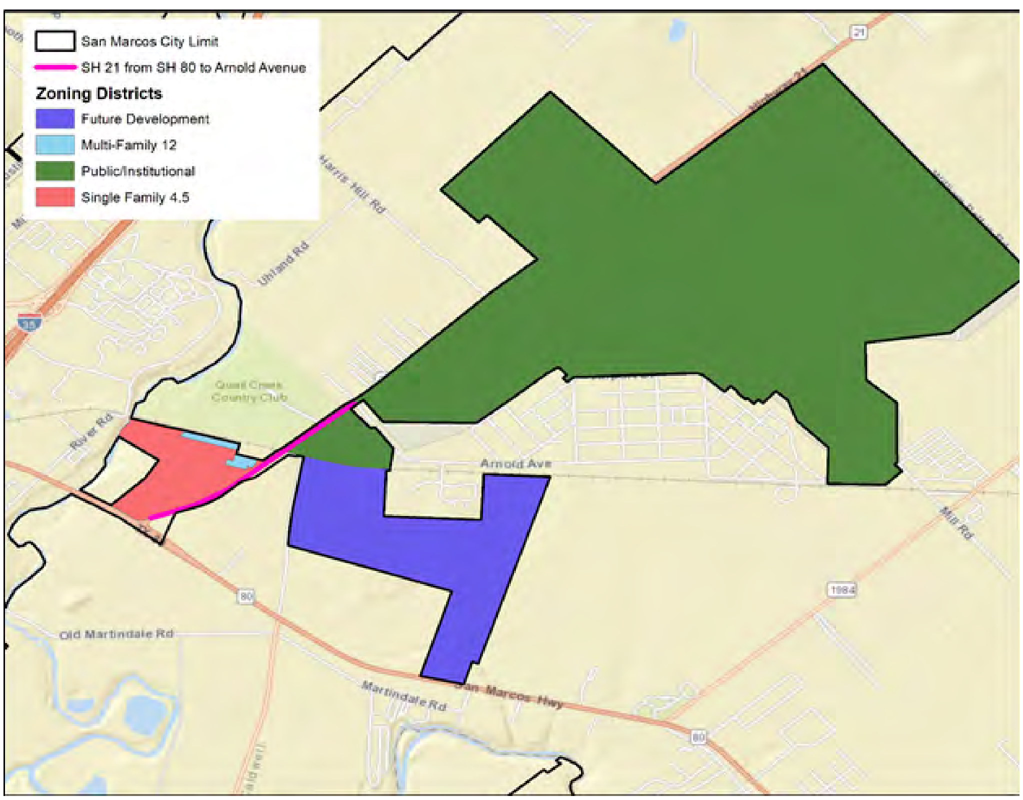
Opportunities

The proposed improvements will facilitate Goal 6 of the City of San Marcos's Comprehensive Plan, to "promote and support the maximum potential of the San Marcos Municipal Airport by enhancing roads and transit infrastructure." Since there is a substantial volume of vacant land, it is expected that growth will naturally gravitate toward this area, much as it has done to the east along US 79 toward SH 130 and in the area near SH 130 and TX 290.

Over the next 25 years and based on TAZ forecast data, population is anticipated to grow by a factor of 4 (although only from about 300 to 1,200 people), while employment in the area is projected to hold constant. This forecast is likely too conservative, especially regarding employment, as the intersection of the proposed improvement will be ripe for significant commercial development. This is especially true if residential development occurs at a pace more consistent with the analogous areas in the region cited above; if several thousand residents end up in this area, commercial inevitably will follow. The improvements should facilitate both happening over the forecast horizon.

Safety and mobility enhancements along this corridor could potentially accelerate planned residential developments along the corridor by enhancing access to SH 80 and IH 35. If the 122 acres of the undeveloped property transitions to residential lots comparable in size to the surrounding neighborhoods over the next 20 years, this could result in over 650 new residential units and exceed $150.0 million in new taxable value.

Zoning/ Future Land Use (2016)



Source: City of San Marcos

SH 21 from Gaines Road to SH 71

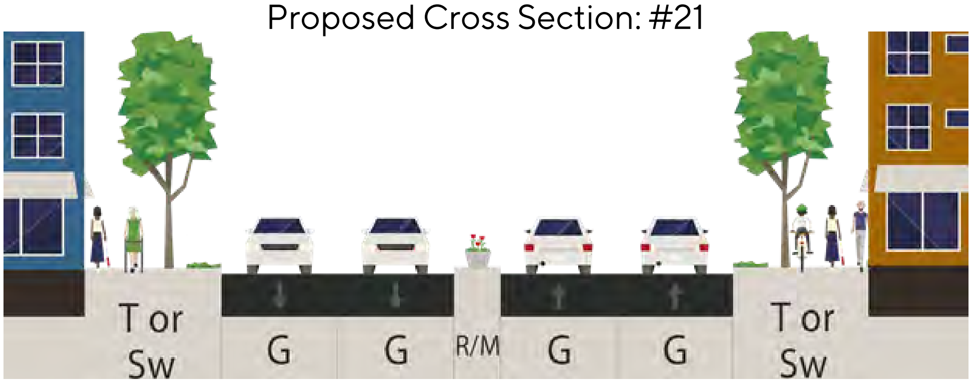
Proposed Improvement

SH 21 from Gaines Road to SH 71 is proposed to be upgraded from a 2-lane Undivided to 4-lane Divided. As shown on the Test Case Corridor diagram, this section of the corridor carries an annual average of approximately 12,000 vehicles per day. Volume to capacity ratios in this area range between 0.30 and 2.0.[28]

Recommended Pattern Book Cross Section

Based on the Pattern Book chapter, this segment of SH 21 falls into the Zone 2 Urban (Main Street/Small Town) context. The forecasted growth in employment and population are expected to triple. Resulting traffic volumes are forecasted to increase by 25% to almost 15,000 vehicles per day by 2040.[29] The roadway is considered a principal arterial and is recommended to be improved from its current 2-lane undivided cross section to a 4-lane divided cross section. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #21 from the Pattern Book chapter is recommended.

Proposed Cross Section: #21



ROW: 75′ - 130′
Divided
4 lane divided with 4 general purpose lanes

This cross-section option would improve safety by reducing the possibility of head-on collisions caused by out-of-control vehicles crossing the median or failure to yield during a left turn. The addition of sidewalks would improve walkability in the area by providing a safe route for pedestrians where there are currently none. Additional transit-dedicated lanes would improve congestion and operational performance by reducing the number of cars on the road. Future developments should limit access to SH 21 and utilize backage routes to minimize hazardous conflict points.

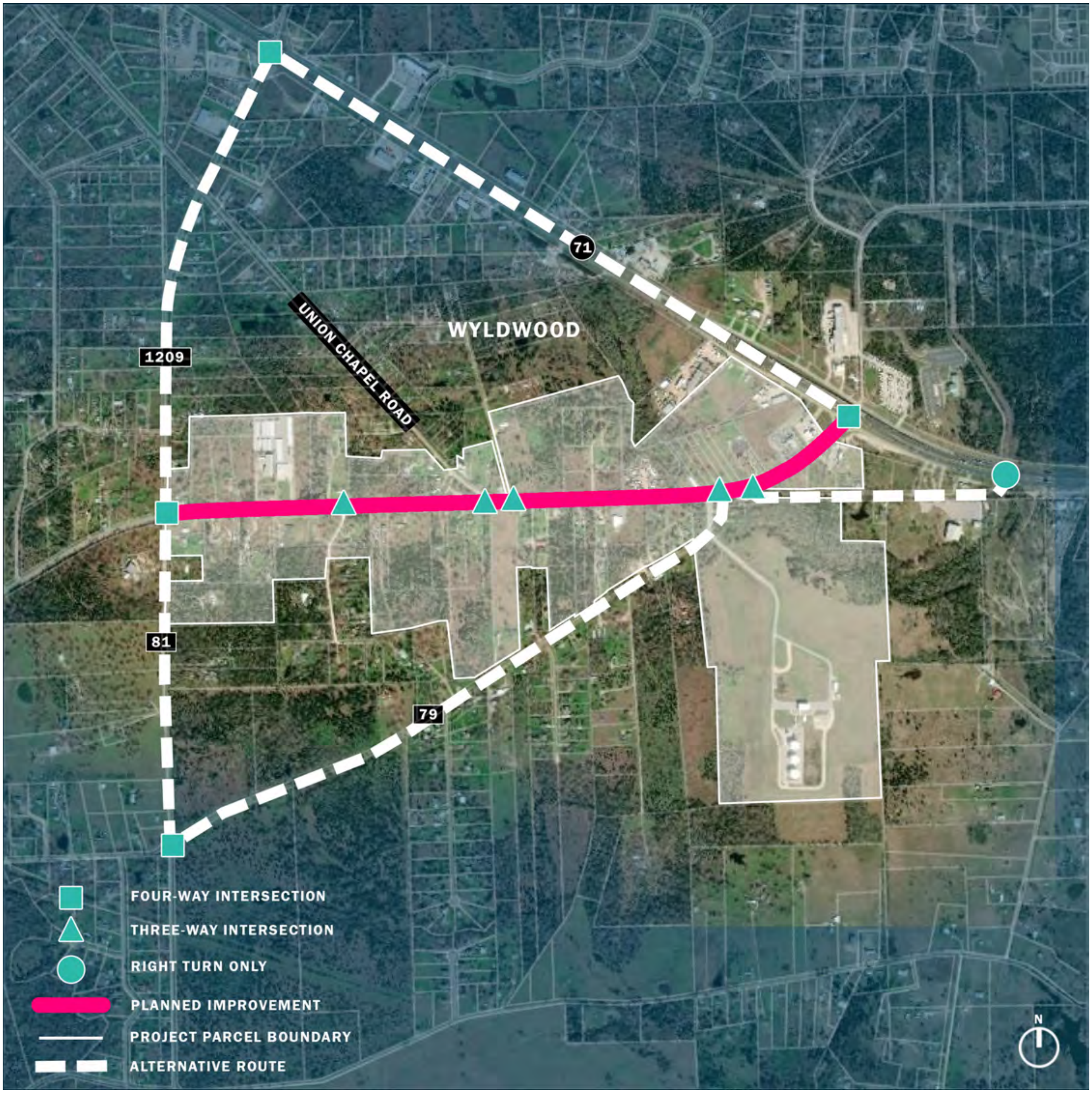
Proposed Cross Section Example - Colesville Road (US 29) near N. Noyes Drive, Silver Spring, Maryland

[28]Source: CAMPO, 2018
[29]Source: CAMPO 2040 Regional Transportation Plan, Travel Demand Model, Adopted May 11, 2015.

Context

Located to the west of the City of Bastrop, this segment of SH 21 connects to SH 71. The land use in this area is largely rural, large lot residential, with only a few small retail and commercial establishments located at the intersection of SH 21 and SH 71. The largest parcel in the area is a 108-acre fuel terminal owned by Flint Hills Resources. The roughly 20 acres closer to the intersection of SH 21 and SH 71 are zoned commercial.

Test case Corridor: State Highway 21 (Gaines to SH 71)



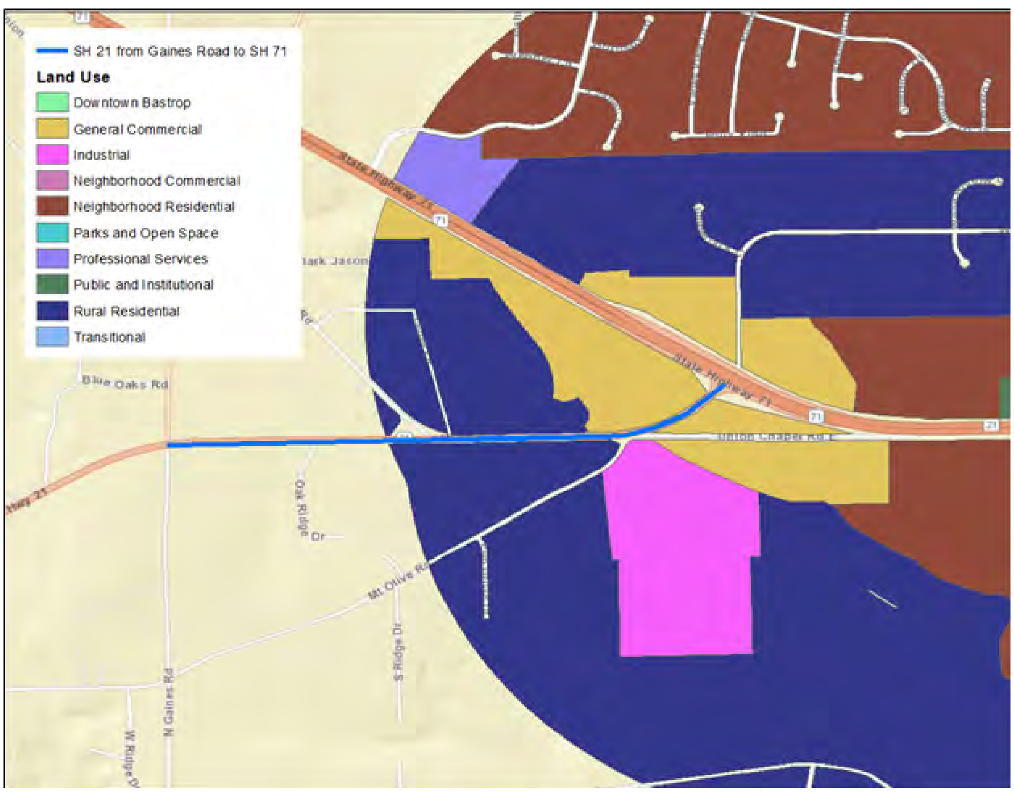
The balance of the property toward the west is projected to be rural residential. The preliminary approved Los Milagros subdivision, a 410-lot development on 195 acres located near SH 21 and FM 812 is the type of residential development likely to happen in this region of Bastrop County. Lot sizes for this development will range from a third of an acre to 1 acre. This is consistent with rural residential land use.

Opportunities

Over the next 25 years and based on TAZ forecast data, population and employment levels are anticipated to triple. What is not captured in the dataset is the number of residential developments that will likely occur further south along SH 21. The majority of people living in this area commute to Austin or Bastrop for work each day, with the expectation that there may be some future commuting patterns toward San Marcos as well. SH 21 should experience a noticeable increase in traffic in the coming years. Transportation improvements along this corridor will not only increase safety, but also impact the character of future commercial and residential developments.

If 70 acres of the undeveloped property transition to rural residential lots over the next 20 years, this could result in over 100 new residential units and exceed $15.0 million in new taxable value. In addition, commercial land uses could add an additional $7.5 million in taxable value on the remaining undeveloped acreage.

Future Land Use



Source: City of Bastrop

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SECTION 5

TRAFFIC MANAGEMENT

Traffic Management Coordination Strategies

The cross sections and the operational improvements and strategies described within this chapter can make significant improvements to the performance and character of our transportation network. That improved performance can be increased exponentially with a coordinated regional traffic management system. The backbone of the transportation network is in the processes and operations made by many actors and stakeholders within the region. While arterial facilities are typically a second-tier mode for moving people and goods, they are key to providing access to the many opportunities that a region provides. As such, the management of the arterial network's transportation infrastructure is extremely important to advancing the region's mobility goals.

As cities and communities grow, and new organizations and agencies take shape, regional transportation operations tend to become more siloed as system development becomes more complex and individual communities face mounting pressure to focus on resolving local challenges. However, opportunities exist to bring cross-jurisdictional and comprehensive solutions to maintain a common intent and seamless network operations. Due in part as system users does not typically equate jurisdictional/agency boundaries into their mode or route choice.

This section provides guidance and recommendations for developing a regional arterial traffic management program.

Establish a Regional Framework to Facilitate Traffic Operations and Management

Establishing an organizational framework to facilitate traffic operations is a key factor for successful deployment, operations and maintenance of traffic operations capabilities.

- Establish a multi-disciplinary ITS Steering Committee, including Incident/Emergency Management, Special Event Traffic, and Traffic Signal Subcommittees
- Develop organizational policies and procedures
- Develop regional standards and practices for traffic operations

Lay Groundwork & Formalize a Stand-Alone Committee or Consortium
Bring all potential parties to the table to discuss partnering to fund or create a stand-alone agency, focused on transportation operations and management for the region.

- Define operating and maintenance purview
- Estimate necessary technology, resources, staff needs, etc.
- Determine preferred organizational chart
- Set necessary contractual and inter-local agreements necessary to allocate funding and initiate partnership

Identify Short- and Long-Term Strategies, Technologies, and Policies

Coordinate applicable TSMO strategies, technologies, and policies throughout the CAMPO region. Several of the strategies listed below may be appropriate for the CAMPO region to prioritize.

- Transit Service and Model Enhancement Strategies – Transit Signal Priority (TSP), bus-on-shoulder opportunities, and bus-only lanes help to prioritize transit on congested corridors.
- Traffic Signal Program Management and Operations – The planning, maintenance and operation of signalized intersections and traffic signal systems.

- Freeway Access Management – Ramping metering or congestion pricing on the freeway and interstate system.
- Capacity management – Dynamic lane control (reversible lanes, active lane management, dynamic speed control, and queue detection) using ITS technologies to expand capacity during peak travel times. Could also include reversible lanes or shoulder running.
- Traffic Incident Management (TIM) Strategies – May include back of queue protection vehicles, crash investigation sites, emergency pull-outs, incentives/disincentives for heavy wrecker operations and clearance, etc.
- Enhanced Public Information Strategies – Real-time displays can warn drivers of upcoming queues or significant slow-downs ahead, thus reducing rear-end crashes or resulting in motorists choosing to take a different route. Dynamic signs can also alter motorists on arterials on roadway hazards.
- Curb Management and Pricing – Can be used to help manage congested downtown streets where lots of drop-off and pick-ups occur.
- Emergency Response – Coordinate a regional approach to expanding emergency response services to the greater CAMPO region and arterial facilities.
- Emergency Management – Coordinate existing emergency management procedures.
- Communications – Coordinate regional policies and strategies to accommodate connected and autonomous vehicles.

Prioritize Strategies and Implement

It is essential that each individual strategy or program be coordinated with the broader transportation management program, and that overall network performance be considered.

- Identify Stakeholders – Identify all relevant stakeholders and representatives/contact personnel. Develop coordination process through standing committees or a special task force that meets periodically to guide and enhance the program.
- Define the Problem – Define the problem before identifying or selecting a solution, through data collection, data compilation, brainstorming, and constructive critiques of existing practices
- Set Goals and Objectives – Establish the guiding principles of the strategy or program. Goals and objectives need to be multi-agency in scope; not merely the goals and objectives of individual agencies. Goals reflect long-term aspirations and objectives typically define the specific, often measurable, level of performance that would be required to progress toward a given goal.
- Develop & Select Strategies – Based on the goals and objectives, the group can develop alternatives to combine available tools and techniques into program packages for evaluation. Evaluate alternatives, prioritize, and select preferred short- and long-term strategies.
- Implement Strategies – Resolve issues (funding sources, jurisdictional boundaries, operational responsibilities, joint training, field communications, etc.) and formalize understandings among agencies and jurisdictions.

Re-evaluate Strategies – Management and operations is an ongoing process. Successful programs continually re-assess and refine the system. Regular data collection allows program managers to assess the effectiveness of efforts, identify areas for improvement, and demonstrate the benefits provided by the program.

Lane management can come in many forms depending upon the objective. HOV lanes or High Occupancy vehicle lanes, require a minimum number of occupants to be in a vehicle. This objective achieves to move as many people but with fewer vehicles. Managing the type of vehicle that is allowed to use the lane can be an objective. For example, not allowing large commercial vehicles or allowing transit only vehicles. Tolling is also a common lane management tool.

By tolling a lane, the users help fund its construction, but tolling can also control the demand within the lane so that an acceptable speed is maintained. Flexible lanes may be a viable option for Scenario A project improvements. **Key to the effective functionality of these flexible lane uses is enforcement. There are many types of tools, such as traffic cameras and law enforcement patrols, and it's important that each facility leverage the most appropriate solution given its regional context.** Analyzing the impacts of an HOV flex lane was accomplished by postprocessing model results from the scenario A model run.

The primary assumptions for the impacts of the HOV Scenario include:

- Vehicle occupancy rates for SOV, HOV, and transit bus,
- Travel demand by time of day,
- Vehicle capacity of an NML,
- Bus frequency,
- Bus Passenger Car Equivalent (PCE), and
- Mode shift from SOVs to HOV vehicles.

REGIONAL ARTERIALS CONCEPT INVENTORY

APPENDICES

CAMPO

CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

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REGIONAL ARTERIALS CONCEPT INVENTORY

APPENDIX - A

EXISTING CONDITIONS

CAMPO

CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

County Plans

Arterial Capacity

The upcoming figures show the large number of congested arterials in the Capital Area region, the majority being within Travis County and access points to Travis County from other counties.

The red dots represent bottlenecks identified by stakeholders at CAMPO meetings. However, not all of the identified bottlenecks directly align with the congestion data from the CAMPO travel demand model. These congested arterials, shown in red, are arterials where the demand on the roadway segment nears the available capacity at some point during the day. This is calculated using a volume to capacity (V/C) ratio. Segments with a V/C ratio greater than .75 at any time between 6:00 am and 7:00 pm are shown in red.

Bastrop County

In 2015 Bastrop County had just over 33,300 jobs with the largest industry being retail trade. The majority of Bastrop County residents commute northwest to the City of Austin and more than half (54%) commute more than 25 miles to work. As anticipated, one of the highest congested corridors in Bastrop County is SH 71 which serves as a connector between Bastrop County and the City of Austin. This aligns with findings in the Bastrop County Transportation Plan, as SH 71 through the City of Bastrop and to the west was seen to have a LOS of F and was identified as a deficiently operating corridor. Identified and prioritized projects in the transportation plan include improvements to a future connector at Shiloh Road, a corridor paralleling SH 71 to south.

Though much fewer, Bastrop County also has a number of jobs leaving the Capital Area region and going towards Lee and Fayette Counties. While smaller in population and employment than other counties in the region, Bastrop County continues to experience growth as the urbanized area expands eastward. In total Bastrop County accounts for just under 5% of VMT in the Capital Area region.

Capital Area Region
Congested Arterials and Bottlenecks
Bastrop County

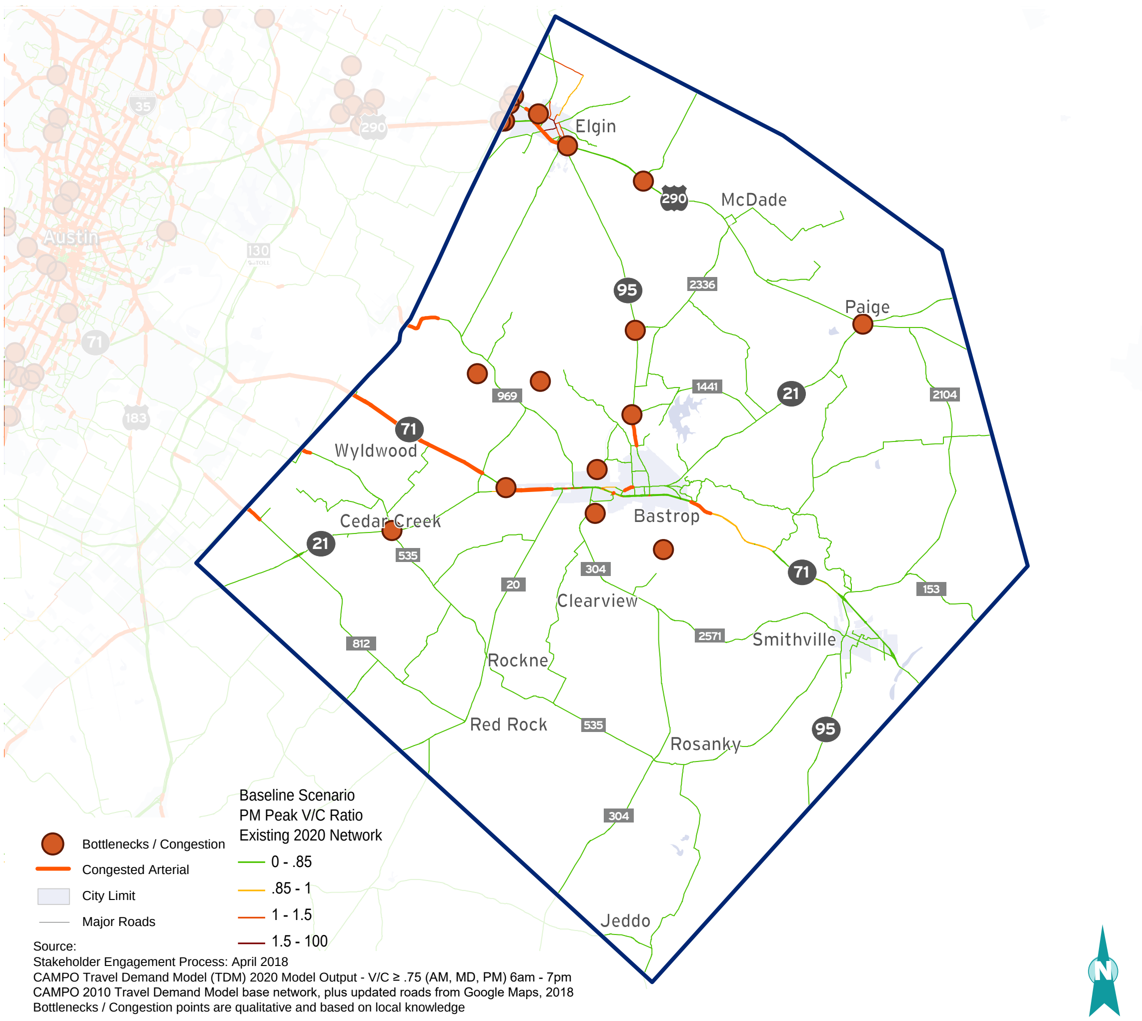


Figure A.1

Burnet County

Most Burnet County residents commute southeast to the cities of Marble Falls and the City of Austin (roughly 16% of the workers employed travel to each city). More than half (56%) commute more than 25 miles to work. Burnet County has a number of physical barriers including the Colorado River and several lakes which have limited the existing network connectivity and arterial efficiency. Input from local government representatives in Burnet County supports the plan's intent to improve network efficiency by filling network gaps and overcoming physical barriers. Representatives identified the need for an additional river crossing as well as the need for grade separations to bypass the railroad.

As Burnet County continues to grow the network will continue to strain with few reasonable alternatives to disperse traffic demand. Today, Burnet's most congested corridors are FM 1431, RM 2147, FM 2342, Hoover's Valley Road, and SH 71. However, SH 71 likely carries people traveling through Burnet County rather than those originating from or destined to Burnet County. The most recent Burnet County Comprehensive Transportation Plan identified several of these most congested corridors (FM 1431, FM 2342, and SH 71) for priority improvements.

Capital Area Region
Congested Arterials and Bottlenecks
Burnet County

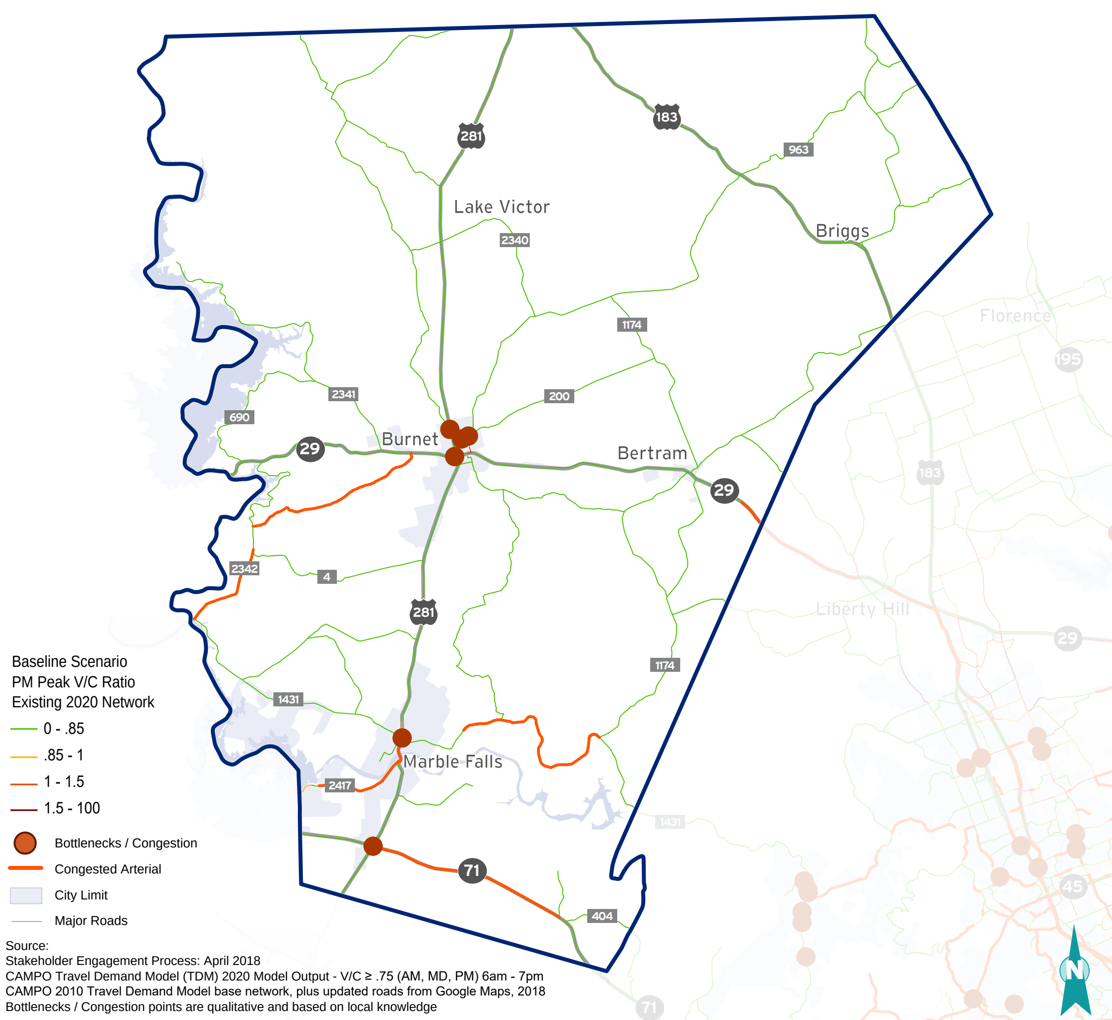


Figure A.2

Caldwell County

Caldwell County had just over 16,700 jobs in 2015 that were dispersed throughout the county with the largest industry sector being health care and social assistance. While dispersed, most of the jobs are in Lockhart and Luling. Most Caldwell County residents leave the county for work driving north to the cities of Austin, Lockhart, and San Marcos. Nearly 40% of Caldwell County residents work in the City of Austin or Lockhart. The segments that are most congested in Caldwell County are in the direction of Travis and Hays Counties which aligns with the commuter patterns shown in the data. Stakeholders identified a number of bottlenecks in the County, though all bottlenecks identified are within the cities of Lockhart and Luling. Input from local government representatives suggested the need for intersection and signal enhancements. Local feedback also identified the need for grade separations to bypass the railroad.

Depending on where users are traveling to and from within Caldwell County, users may encounter two to three railroad crossings in a single trip heading to or coming from Travis County.

Capital Area Region
Congested Arterials and Bottlenecks
Caldwell County

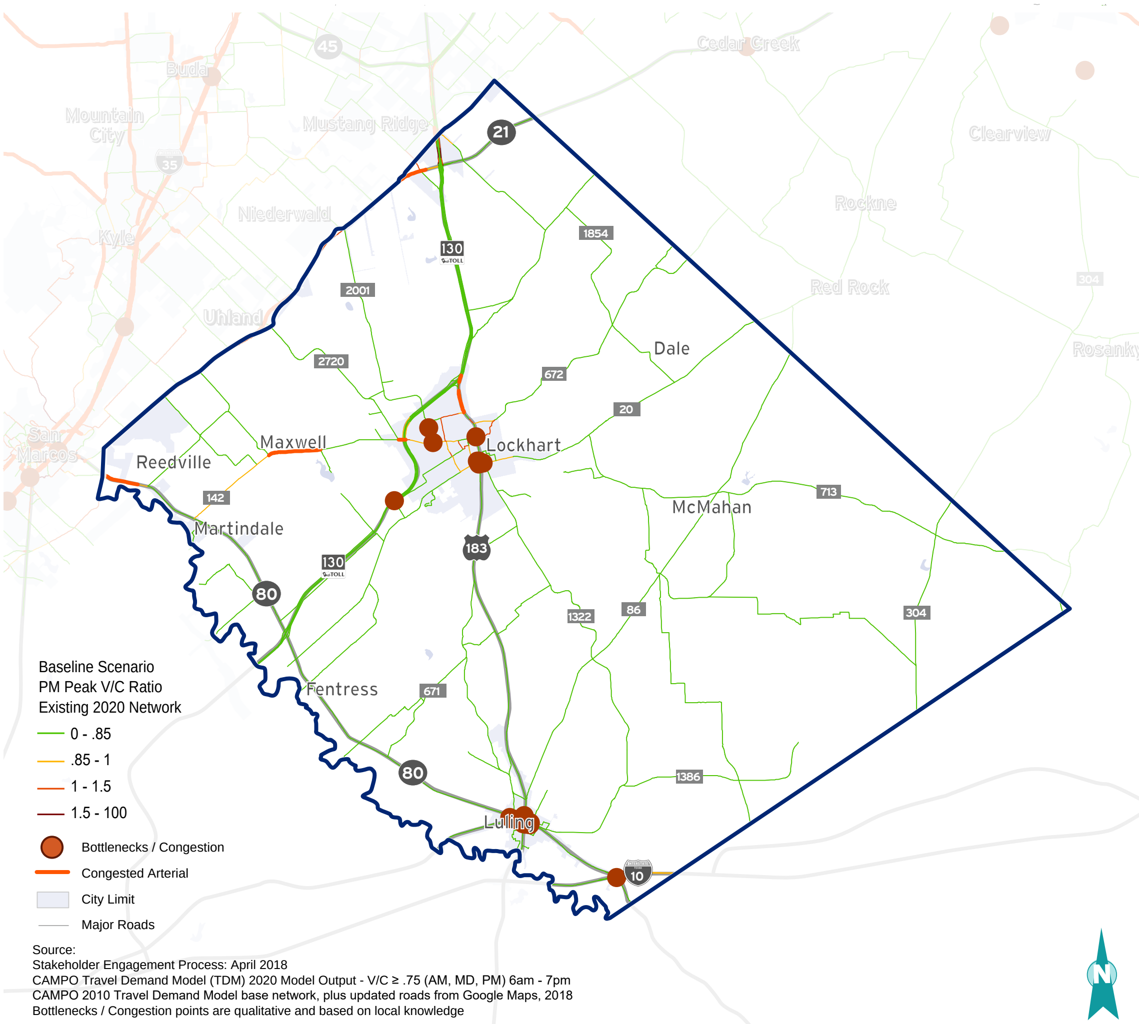


Figure A.3

Hays County

In 2015 Hays County had just over 85,500 jobs dispersed throughout the county with the largest industry being educational services. The majority of Hays County residents commute north and northeast to places in Travis County for work and about 36% of workers in the county drive 25 miles or more for work. While today Hays County only accounts for just over one percent of VMT in the Capital Area region, the county population is growing rapidly. From 2000 to 2017, Hays County had the highest growth rate of any county in the Capital Area region and from 2010 to 2015, Hays County was the fastest growing county in the State of Texas.

As shown in Figure A.4, Hays County has a number of congested arterials. This congestion will worsen as population and employment continue to grow in the County. As anticipated from stakeholder feedback, the data shows congested arterials include the frontage roads along the IH-35 corridor. Congested arterials also include those that connect to the city of Wimberley. Also, the stakeholder-identified bottleneck locations closely align with the congested arterials throughout the corridor. In addition to arterials paralleling IH-35 (IH-35 frontage roads), RM 12, FM 150, FM 967, and FM 1826 all have significant segments of roadway that are congested. Local government representatives understand the need for network redundancy in order to disperse traffic and demand. Network redundancy to relieve traffic to and along the IH-35 was identified as a need in Hays County and several planning efforts, specifically along FM-150, are underway to address mobility while maintaining character.

Input from local government representatives closely aligns with the plan's first goal: to improve safety for arterial users. Representatives identified several blind curves that need safety enhancements and noted that safety improvements for pedestrians are needed in the City of San Marcos. Approximately 45% of workers in Hays County live in San Marcos. In addition to safety concerns, representatives also identified the need to address flooding and drainage concerns.

These needs and congested arterials align with the existing Hays County Thoroughfare plan. Added capacity on several arterials providing access to the IH-35 corridors are shown on RM 12, FM 150, and FM 967 as future improvements which will enhance the county's and region's arterial network.

Capital Area Region
Congested Arterials and Bottlenecks
Hays County

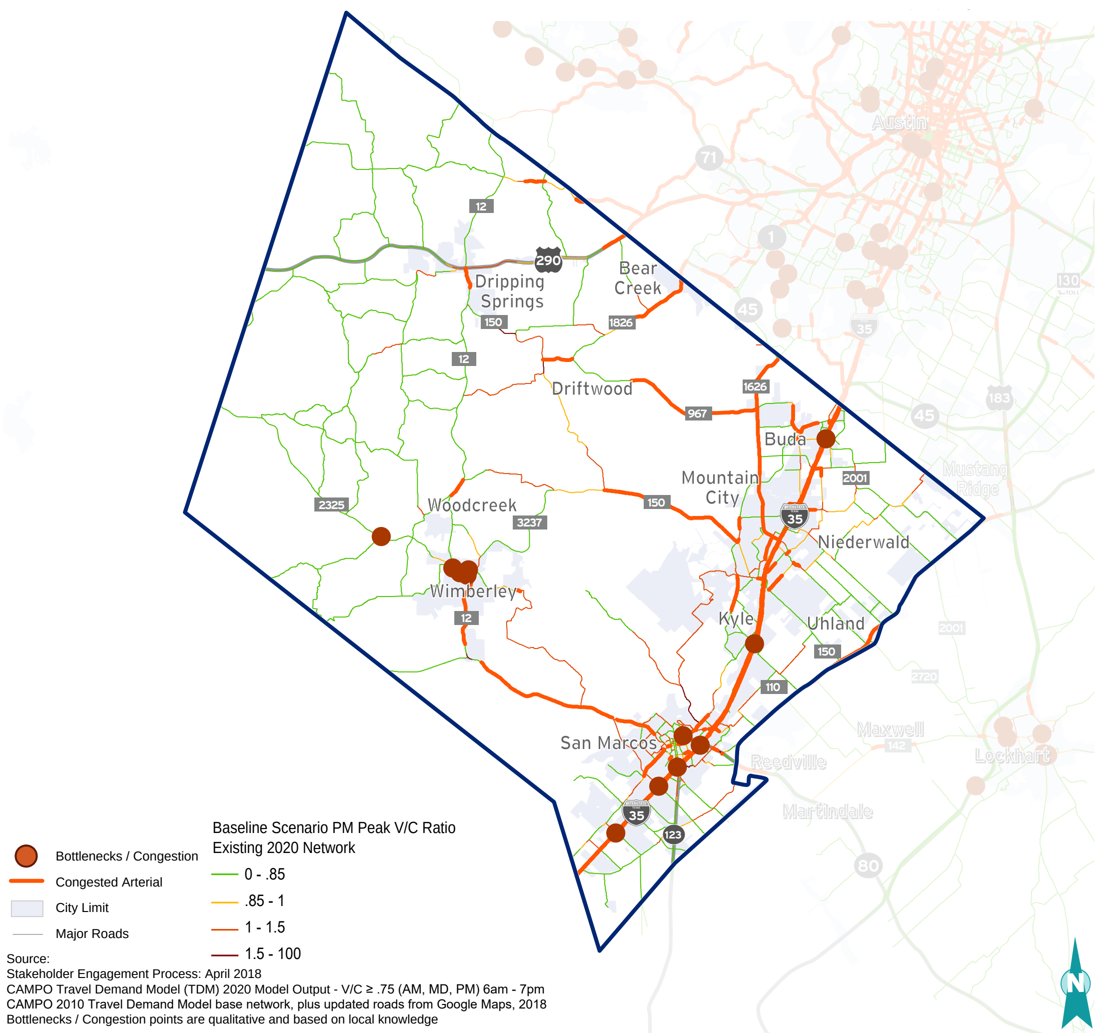


Figure A.4

Travis County

A majority of commute trips are to and from Travis County as the county accounts for 60% of employment and population in the region. Travis County has the most jobs in the CAMPO area and in 2015, the county had just over 547,000 jobs. The largest industry sectors include health care and social assistance; professional, scientific, and technical services; educational services; and accommodation and food services. Jobs in Travis County are dispersed throughout the urbanized area. More than 60% of workers live and work within the county, the highest in the Capital Area region.

Due to the high employment numbers, Travis County has more out-bound commuters than in-bound commuters, putting extreme pressure on arterials connecting to Travis County and highlighting the imbalance between job and hosting locations. Importantly, and as shown in Figure A.5, most of the arterials connecting Travis County to other counties are underperforming. This presents opportunities for future transit along key corridors and operational improvements as the majority of traffic is to and from Travis County during the commute periods.

Capital Area Region
Congested Arterials and Bottlenecks
Travis County

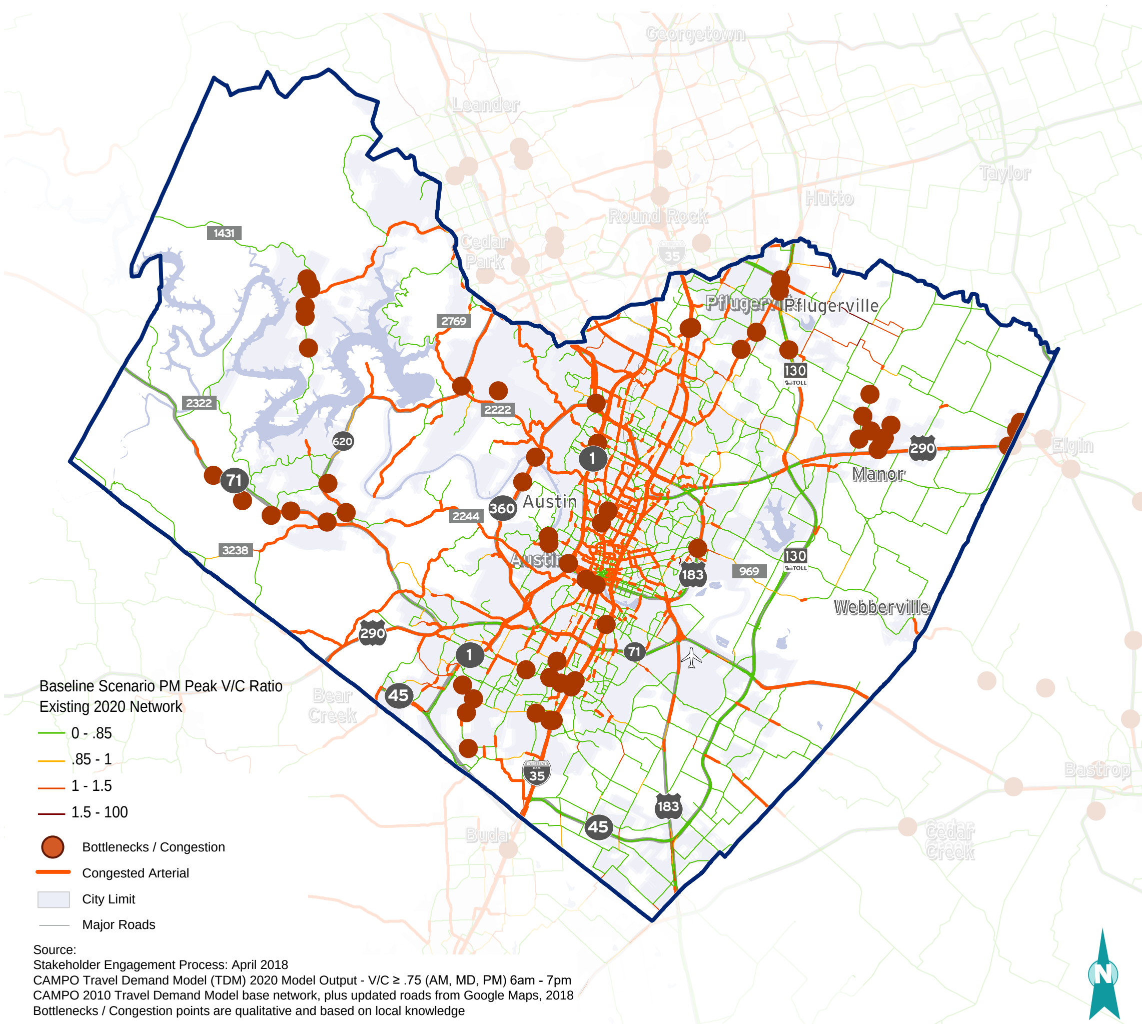


Figure A.5

Furthering the pressure on Travis County is the high number of Travis County residents that commute and work within the county, again more than 60% of total residents. As shown on the previous page, Travis County is experiencing congestion on many of its arterials. Travis County also accounts for 60% of the VMT in the Capital Area region. The region's arterials serve well over half of the region's VMT.

The community feedback and local government input reiterated the need to invest in Travis County's arterials. Local government representatives noted that added capacity is needed in addition to new connections and investment in existing connections to emerging developments and future schools in South Travis County. This aligns with the plan's goal to plan more effectively for future growth. Representatives also noted the need for additional river crossings in west Travis County and voiced concerns about flooding in South Travis County.

Williamson County

In 2015 Williamson County had more than 240,300 jobs in the county with the largest industry being health care and social assistance. The majority of Williamson County residents commute south to Travis County, however many Travis County residents also commute north to work in Williamson County. Approximately 85% of the workers in Williamson County live in the City of Austin highlighting significant demand on roadways between the two counties. In total Williamson County accounts for just over one-quarter of VMT in the Capital Area region, the second highest after Travis County.

As shown in Figure A.6, Williamson County has a number of congested arterials. Particularly on major arterials connecting to Travis County as anticipated with the commuting patterns in the area. Several arterials connecting Williamson County and Travis County are congested, including those that connect to the interstate system. Examples include RM 620, McNeil Road, and West Parmer Lane.

Williamson County is also experiencing significant growth and is the second fastest growing county (after Hays County) in the Capital Area region from 2000 to 2017. The county population and employment is expected to continue growing and this will put further demand on the county's arterials. Williamson County local government representatives identified the need to invest in existing arterials, as well as, invest in arterials providing access to emerging developments. The stakeholder-identified bottlenecks are dispersed throughout the urbanized area of the county and follow congested arterials as shown by the data. Representatives also identified the need for better east-west and north-south network connectivity in Georgetown.

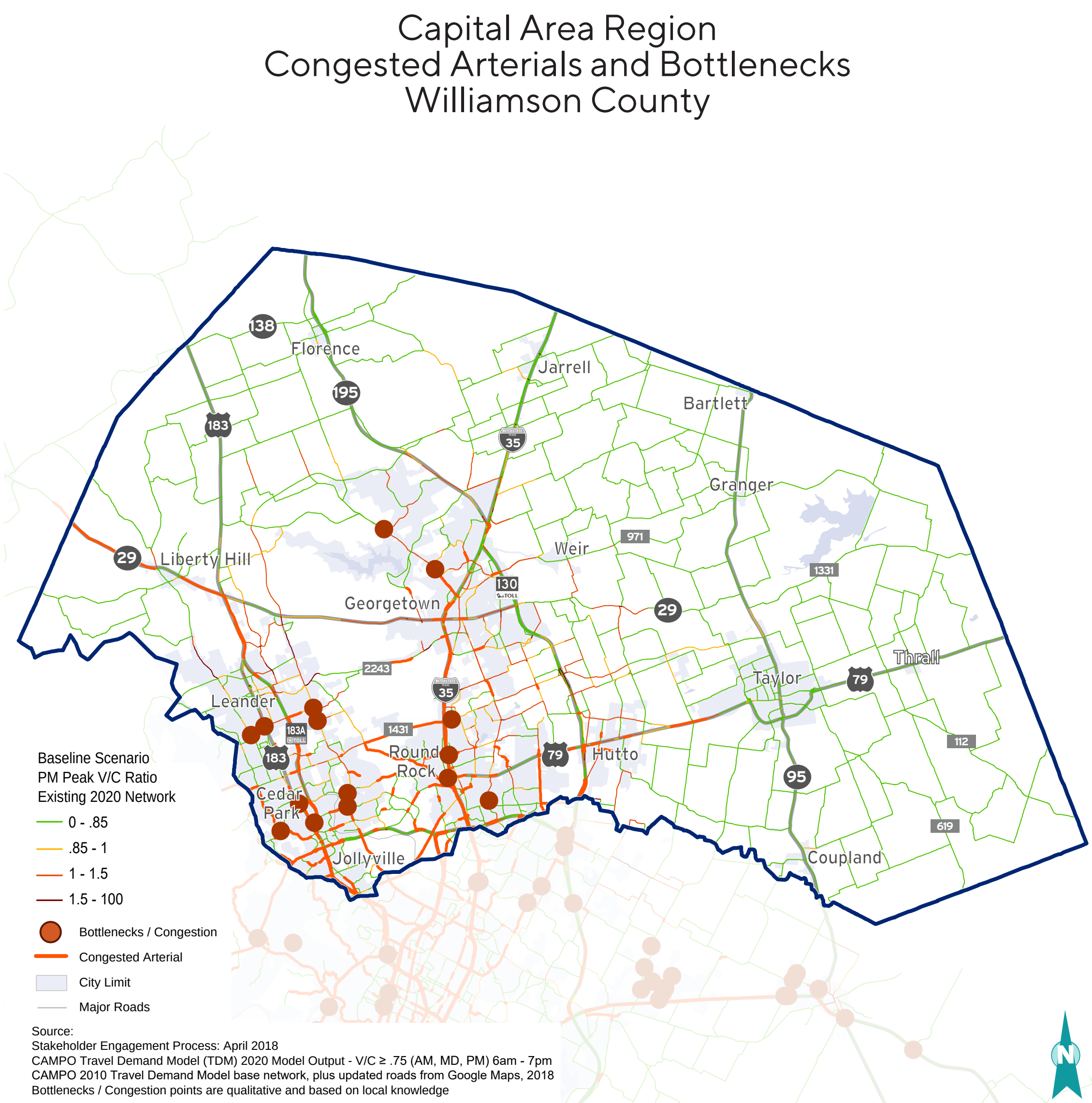

Capital Area Region
Congested Arterials and Bottlenecks
Williamson County
Florence
Jarrell
Bartlett
Granger
Weir
Liberty Hill
Georgetown
Leander
Round Rock
Cedar Park
Jollyville
Hutto
Taylor
Thrall
Coupland
Baseline Scenario
PM Peak V/C Ratio
Existing 2020 Network
0 - .85
.85 - 1
1 - 1.5
1.5 - 100
Bottlenecks / Congestion
Congested Arterial
City Limit
Major Roads
Source:
Stakeholder Engagement Process: April 2018
CAMPO Travel Demand Model (TDM) 2020 Model Output - V/C ≥ .75 (AM, MD, PM) 6am - 7pm
CAMPO 2010 Travel Demand Model base network, plus updated roads from Google Maps, 2018
Bottlenecks / Congestion points are qualitative and based on local knowledge

Figure A.6

Growth in Central Texas

Gaps and Needs

As part of an early outreach, the following county connectivity "Gaps and Needs" figures were identified back in April 2018. Through the study's iterative planning process, a more comprehensive network was developed.

Gaps and Needs – Bastrop County

Bastrop County serves a commuter population to job centers outside the county that travel primarily on SH71. The areas for future investigation will look at the non-controlled access portions of SH71, but will also evaluate the highlighted connectivity opportunities in the City of Bastrop.

Bastrop County Gap Analysis

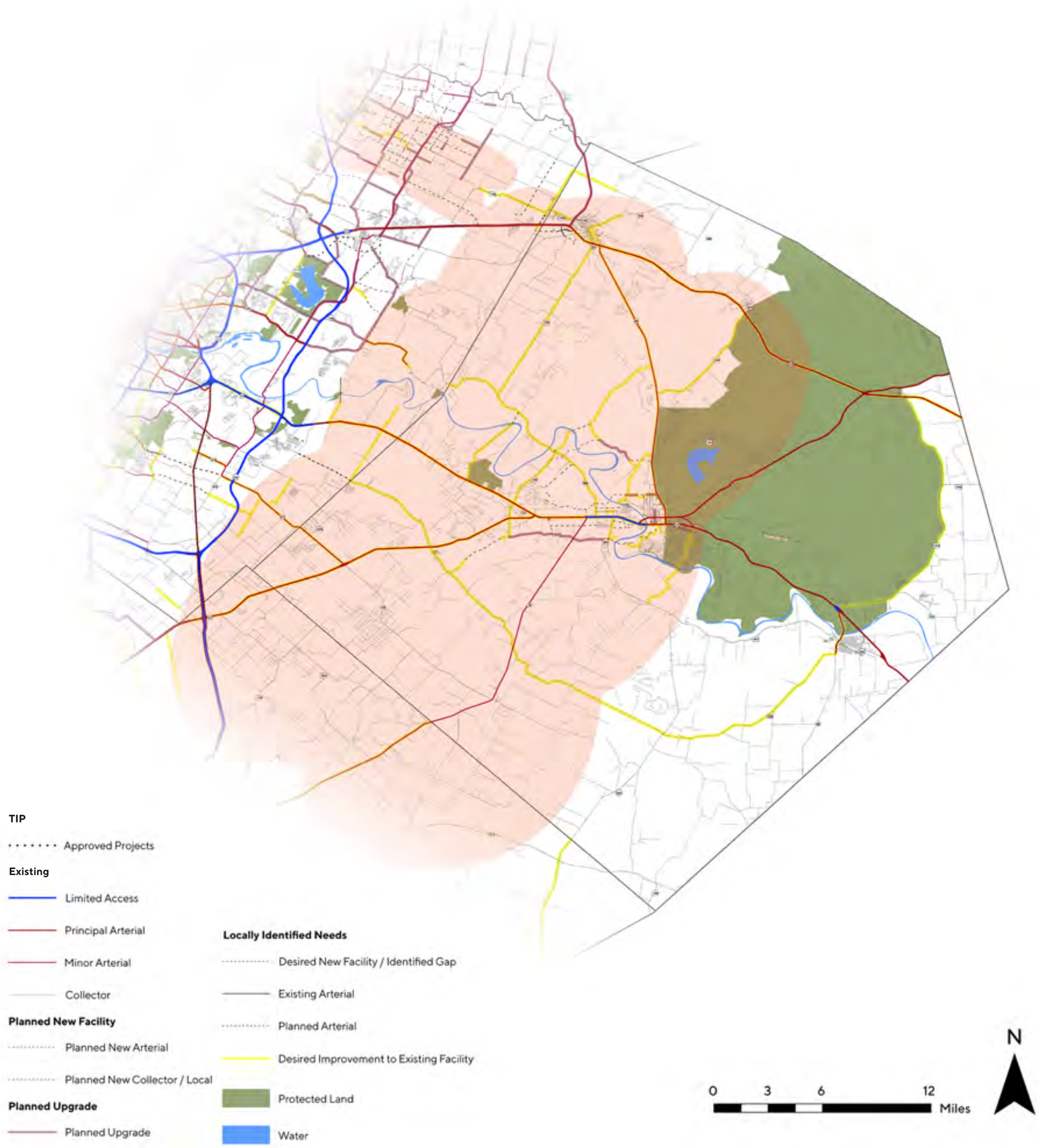


Figure A.7

Gaps and Needs – Burnet County

The majority of demand for connectivity is focused in the community of Marble Falls with limited demand outside of the populated area that serves both residents and visitors. The polygons placed on the map highlight those high areas of demand. The northern boundary that connects with Lampasas and the Killeen-Temple MPO will be evaluated as part of the Concept Plan as well.

Burnet County Gap Analysis

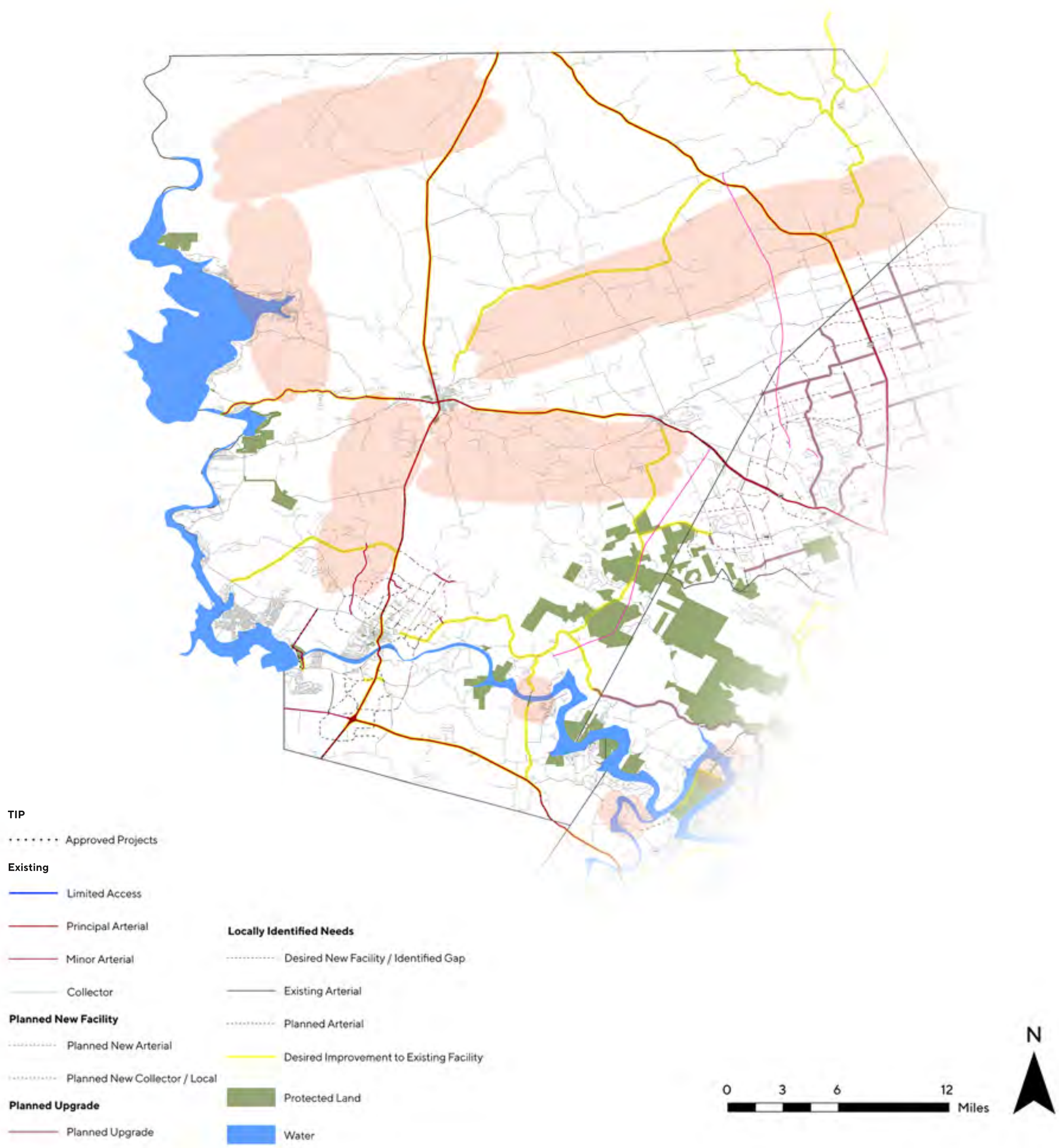


Figure A.8

Gaps and Needs – Caldwell County

Caldwell County recently completed a thoroughfare plan and added considerable connectivity to the existing network. This forward thinking leaves a limited number of areas for further investigation given their environmental constraints, such as the extensive floodplains to the west. However, that being said a few areas were highlighted through the engagement process that the team will investigate further as part of the Concept Plan.

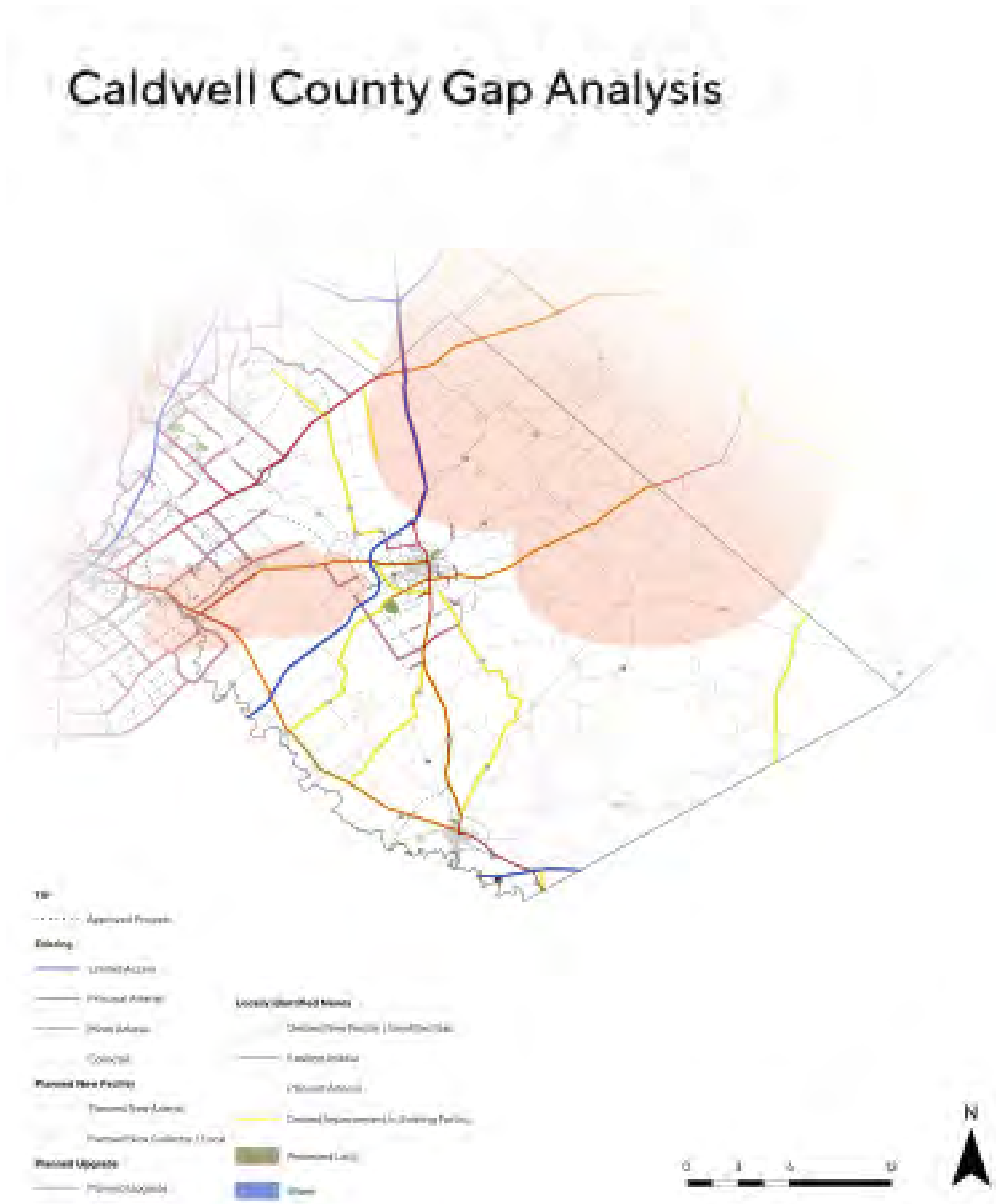


Figure A.9

Gaps and Needs – Hays County

The tremendous growth in Hays County has spurred a number of planning efforts, the outcome of which is considerable planned network to accommodate growth. Given this, the identification of new connectivity opportunities was limited to highly sensitive areas to the west and northeast. Additionally, this community has expressed a strong interest in corridor preservation and network redundancy which will also be evaluated in the Concept Plan as well.

Hays County Gap Analysis

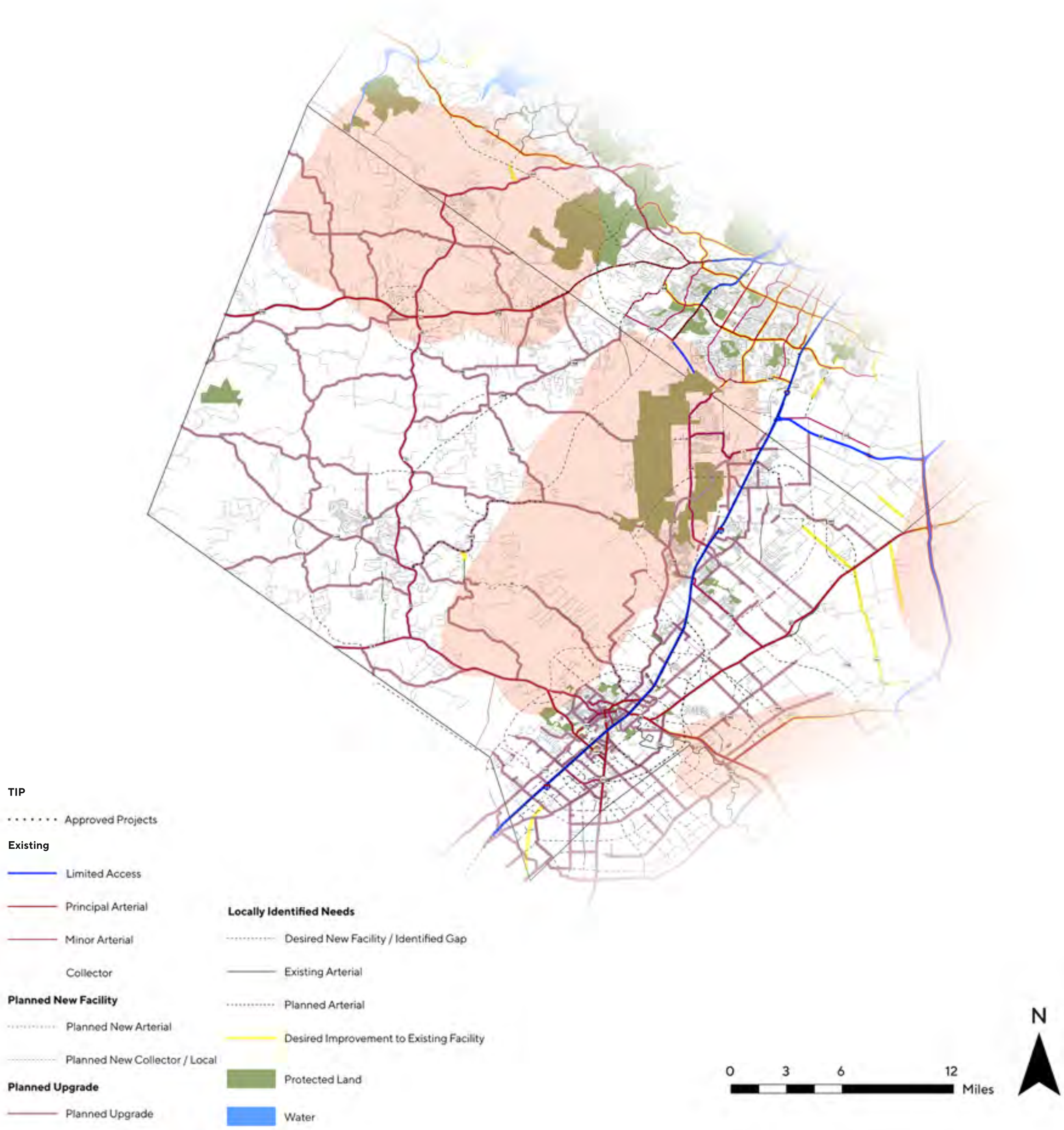


Figure A.10

Gaps and Needs – Travis County

Travis County has nearly full build out in the urban core, making it challenging to add new connectivity or identify gaps. The highlighted areas in both the eastern and western portions of the county are experiencing high growth that could benefit from additional network, however the hilly topography and preserved areas in the west and the clay soils in the east that add to life-cycle costs will limit opportunities for new connections. The Concept Plan will include those areas as well as opportunities for continued long-distance connectivity on existing arterials to the south and connections across the county line to the north.

Travis County Gap Analysis

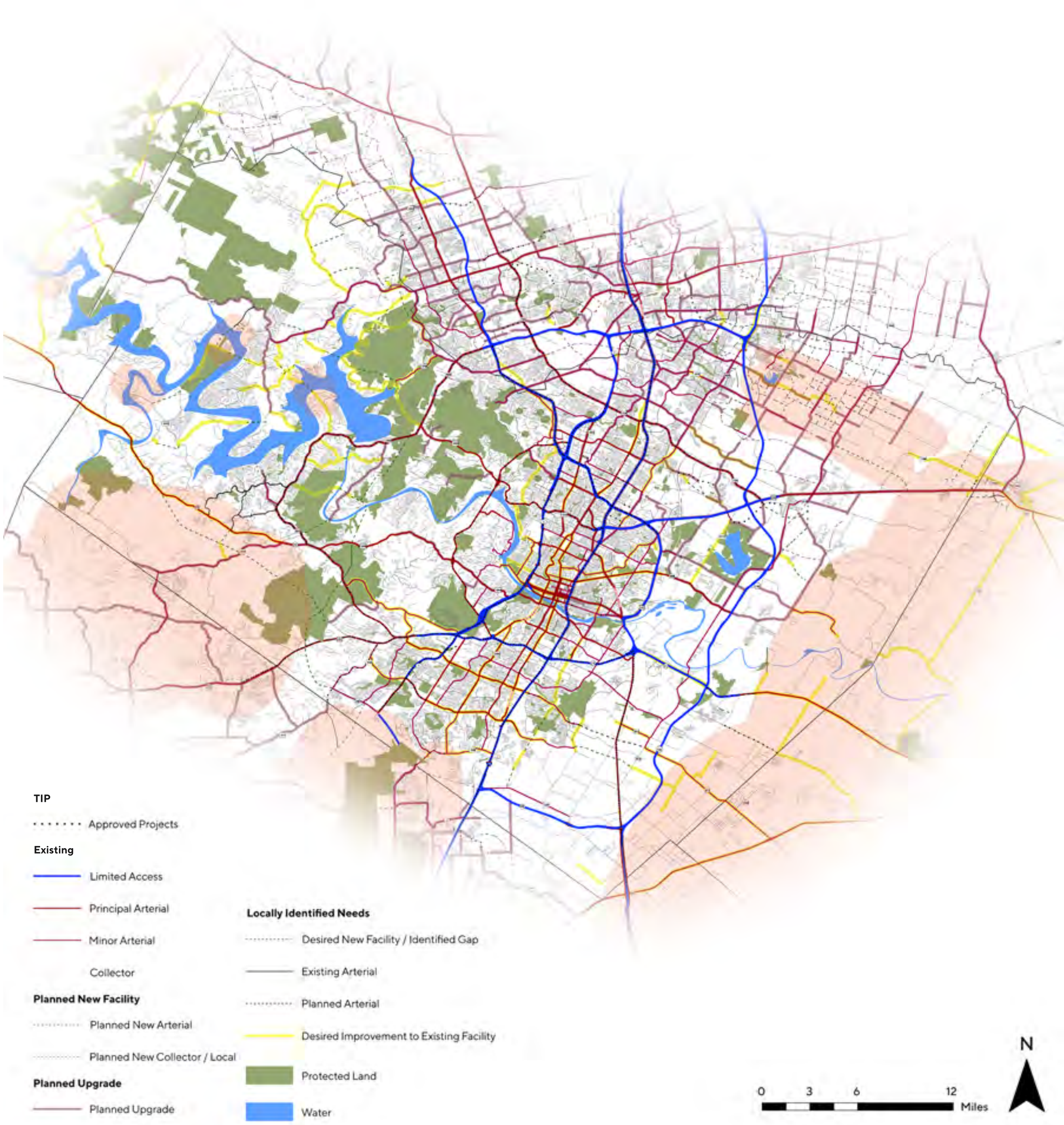


Figure A.11

Gaps and Needs – Williamson County

Williamson County has taken on a concerted effort through their long-range planning and history of bond programs to add extensive connectivity to the network. Although the entire new planned network as part of the long-range plan is not programmed, the county is actively delivering individual projects as funding for project development becomes available. In the Concept Plan, the evaluation will focus on small pockets of new connectivity highlighted in Figure A.12. Of course, continuing the planned network across county boundaries will be evaluated where beneficial and feasible.

Williamson County Gap Analysis

Figure A.12

Natural and Built Environment

Multi-Modal: Complete Streets Arterial Road Design

Arterials provide connectivity for a variety of users and multiple modes. Freight and vehicle access are often the focus of arterial conversations; however, transit, cyclist and pedestrian connectivity are also important to creating sustainable and livable places and using all available tools to move people. Increasing mobility for all users is a primary goal of the RACI.

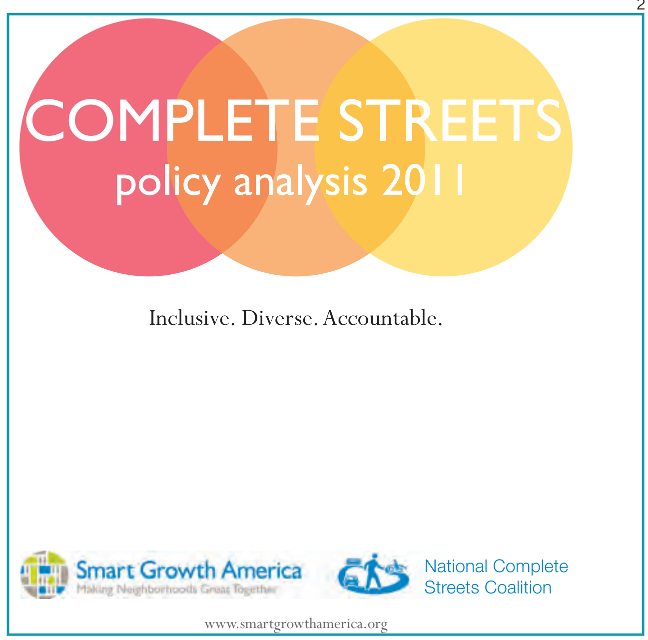
The region continues to be challenged by a desire to implement connected and walkable environments with a high degree of connectivity; it is promising that so many of the six-county region's communities have already received policy support for such approaches, but more work needs to be done to move from vision to practice. Of the 24 counties, municipalities, and regional entities for which planning documents were reviewed, 19 (79%) had policies to encourage or promote walkable design or new urbanism strategies, but only 13 of 24 cities and counties put policy into practice with ordinances that implement these designs.

Of the counties and municipalities surveyed, only the City of Austin and San Marcos appears to have officially adopted a Complete Streets Policy. The cities of Buda and Georgetown have incorporated statements and requirements that reflect Complete Street concepts, and others touch on the need for multi-modal options and connectivity in their codes and ordinances. However, having a codified policy that is clearly reflected in communities' ordinances and regulations would not only re-enforce the importance of offering multi-modal choices, but would also help ensure that these choices are incorporated into future development.

Using the existing arterials network to maximize transit facilities, can also relieve traffic congestion, and maximize resources. There are several examples around the region of facilities along arterials that were upgraded for transit users, including Guadalupe Street in the City of Austin.

[1]

[2]



[1] Complete Streets And Protected Bike Lanes For San Marcos, Texas, 2014. Accessed At https://bit.ly/2J3Oqlp

[2] Smart Growth America; Complete Streets Policy analysis, inclusive. Diverse. Accountable, 2011. Accessed at https://bit.ly/2Xjkx4t

Other Multi-Modal Efforts in the Capital Area region

Other multi-modal efforts completed, currently underway, or planned for the Capital Area Region include CAMPO's recently completed Active Transportation Plan, and CAMPO's Transit Plan which will begin later this year. In addition Capital Metro's Project Connect is a plan designed to create a system of high capacity transit (HCT) options that will connect people, places and opportunities in an affordable, efficient, and sustainable way. Recently constructed MoPac managed lanes project also provide new opportunities for HCT.

Extreme Weather

CAMPO, in partnership with the City of Austin, produced the Central Texas Extreme Weather and Climate Change Vulnerability Assessment of Regional Transportation Infrastructure.[3] The assessment was one of 19 Federally-sponsored projects nationwide to evaluate extreme weather vulnerability of transportation infrastructure. The project team lead the pilot in partnership with municipalities and other state and local entities. Nine critical assets were identified in the area as shown in Figure A.13.

Assets for Evaluation					
Asset	County	Mode	Vulnerabilities	Soil Plasticity	Evacuation Route
SH 71E at SH 21	Bastrop	Road, Airport Access	Flooding, drought, extreme heat	High	Yes
IH-35 at Onion Creek Parkway (Area includes Old San Antonio Road low water crossing)	Travis	Road	Flooding, extreme heat	Low	No
US 290W/ SH 71-Y at Oak Hill	Travis	Road	Flooding, drought, wildfire, extreme heat	Moderate	No
Loop 360/RM 2222	Travis	Road	Flooding, drought, wildfire, extreme heat	Moderate	No
FM 1431 at Brushy Creek/Spanish Oak Creek	Williamson	Road	Flooding, drought, extreme heat	Moderate	No
US 281 and SH 29 Intersection	Burnet	Road	Flooding, extreme heat	N/A	No
US 183 north of Lockhart	Caldwell	Road	Flooding, drought, extreme heat	Moderate	Yes
SH 80 (San Marcos Highway) at the Blanco River	Hays	Road, Airport Access	Flooding, extreme heat	N/A	No

Figure A.13

The majority of the critical assets identified are on the arterial network. These assets were evaluated on their vulnerability from flooding, drought, extreme heat, wildfire, and extreme cold on a scale from none to severe. Furthermore, some of these critical assets are identified as an evacuation corridor. Each of these evaluations can be used when setting project priorities and helping to identify strategies to help reduce vulnerabilities in the arterial network.

[3] Central Texas Extreme Weather and Climate Change Vulnerability Assessment of Regional Transportation Infrastructure. CAMPO. 2015. Accessed at https://bit.ly/2LC1sla

Risk Rating Summary					
Asset	Flooding	Drought	Heat	Wildfire	Extreme Cold
SH 71E at SH 21	High	Moderate-High	Low-Moderate	Moderate-High	Low-Moderate
IH-35 at Onion Creek Parkway (Area includes Old San Antonio Road low water crossing)	Low	None	None	Moderate-High	Low-Moderate
US 290W/ SH 71-Y at Oak Hill	Moderate	Moderate	None	High	Low
Loop 360/RM 2222	Moderate	Moderate	None	High	Low-Moderate
FM 1431 at Brushy Creek/Spanish Oak Creek	None	Moderate	Low	Moderate-High	Low
US 281 and SH 29 Intersection	Moderate-High	Low	Low	Moderate	Low
US 183 north of Lockhart	Low-Moderate	High	Low-Moderate	Moderate-High	Low-Moderate
SH 80 (San Marcos Highway) at the Blanco River	Moderate	Low	Low	Moderate	Low

Figure A.14

Environmental Considerations

Environmental requirements are one of the few tools that allow counties to influence development outside city limits. This includes water quality and flood protections that can be used to minimize the intensity and impacts of new development. Conservation subdivisions offer opportunities to influence how the subdivision is laid out (i.e. cluster development) by identifying protected resources. Historic and cultural resource policies also help communities protect their character, which is indicated as important in long-term policy statements. Tree protections are also noted as important for maintaining the community character.

Environmental Policy Summary		
	Policy	Number of Communities' Codes/Ordinances with Related Policy
1	Impervious Cover Recommendations or Restrictions	19 of 24
2	Watershed Protection Measures	20 of 24
3	Aquifer/Stream/River Protection Measures	17 of 27
4	Surface Groundwater/Springs Protection Measures	18 of 27
5	Habitat Protection Measures	12 of 27
6	Flood Control Policies	24 of 24
7	Prime Farm/Agricultural Land Protection Measures	5 of 24
8	Promotes Preservation of Historic and Cultural Resources	18 of 24
9	Promotes Conservation Subdivisions or Easements (Related to Farm Land Preservation)	11 of 24
10	Tree Preservation Measures	19 of 24

Figure A.15

When evaluating expanded roadway capacity or network extensions, jurisdictions consider environmental factors which may limit solutions that allow for added connectivity. While protection of environmental resources can be a challenge, environmental stewardship is a primary goal of the RACI.

Growth in Central Texas

The Capital Area is expected to continue growing at a high rate and many local and regional initiatives aim to address and absorb the massive economic growth without compromising quality of life as seen in previous map figures. Capital Area residents value and appreciate their quality of life to such a degree that it has become a cultural moment to comment on growth challenges.

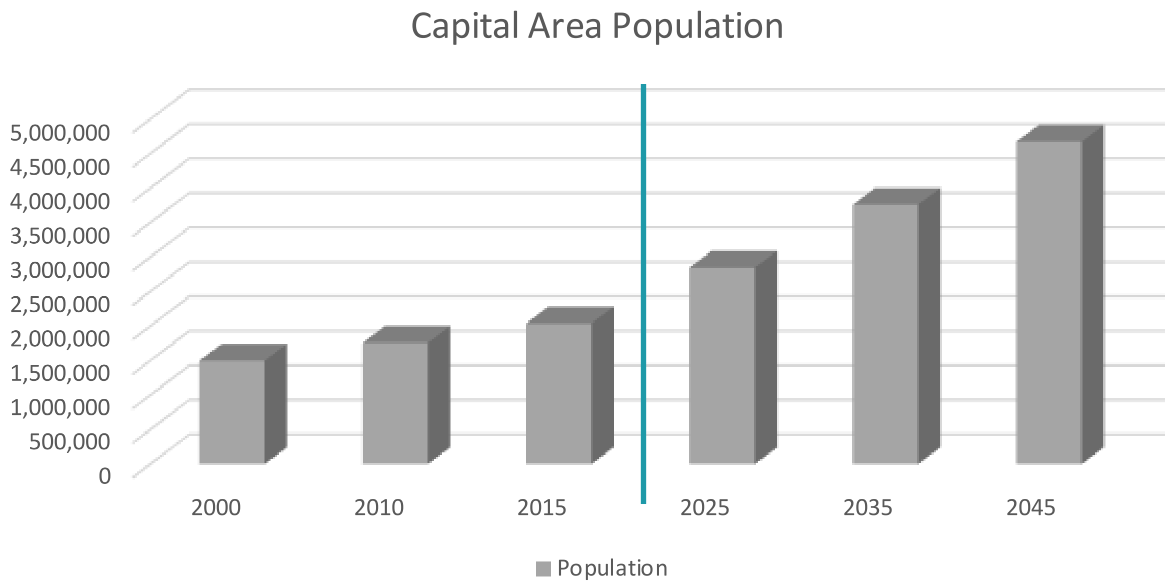


Figure A.16

Capital Area Rate of Population Change

36% 2000-2015 | **129%** 2015-2045

This extreme growth puts considerable pressure on the transportation network, specifically the arterial roadways, which are the workhorses of the transportation network.

Providing mobility and connections among the various areas of growth within the region is vitally important. A major facilitator for this movement is the network's arterials. They are key lifelines for many in the region, facilitating 75% of regional travel.

While the City of Capital Area continues to attract new jobs and residents, much of the growth has located in the surrounding communities like Georgetown, Cedar Park, Round Rock, Pflugerville, San Marcos, Buda, and Kyle. The unprecedented growth and increasing costs of housing in the region resulted in expanding lower-density development through-out the Capital Area region where housing is more affordable. This dispersed land use pattern and automobile-centric development creates difficult markets to serve via transit, and results in long commutes for travelers, putting even more pressure and demand on the mobility network and Regional Arterials.

Policy

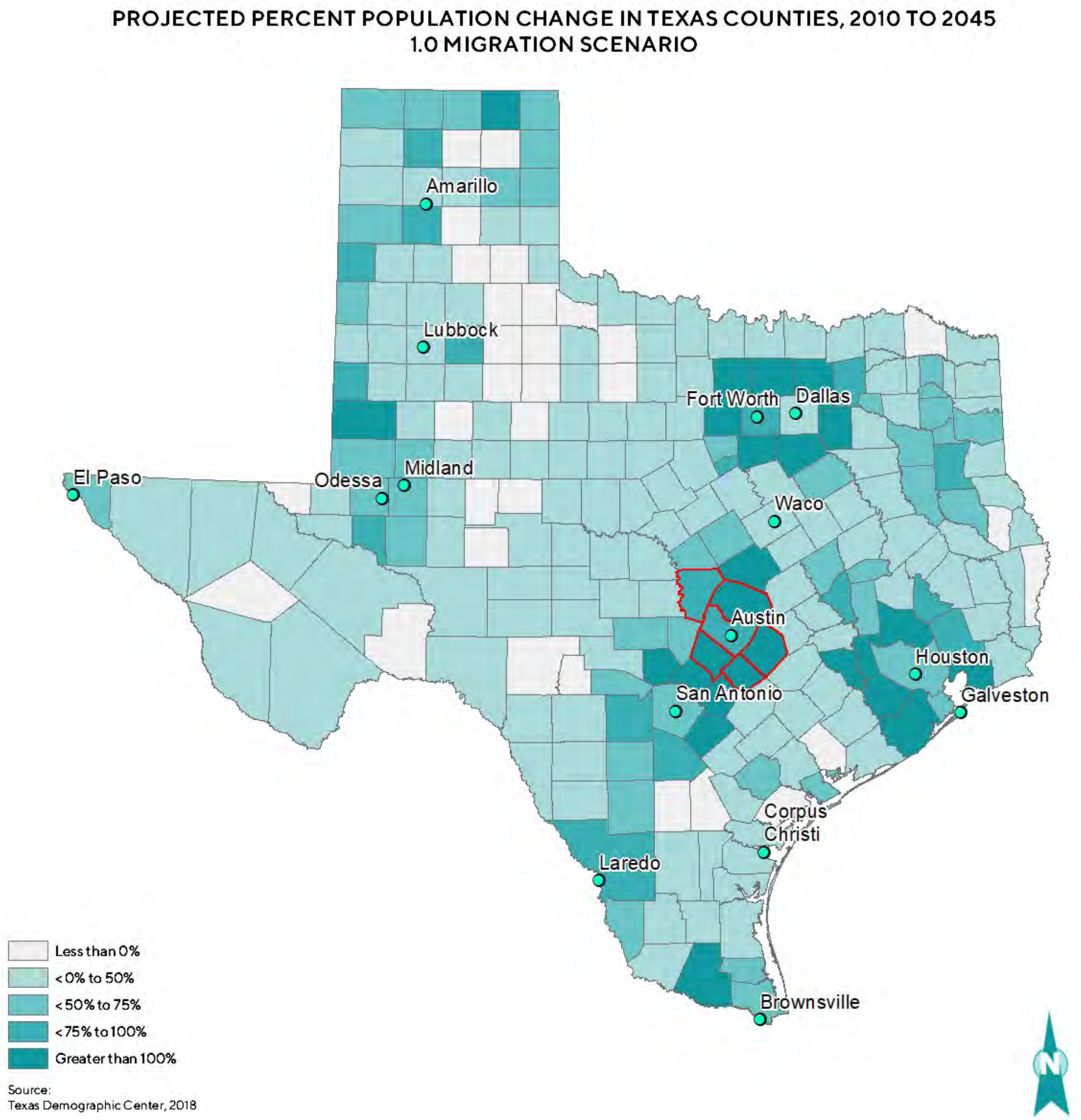


Figure A.17

Migration in the Capital Area region is significant and doesn't appear to be slowing any time soon. Our efforts to plan for growth are that much more critical to maintain our economic competitiveness as a region and high quality of life. In addition, the Capital Area's growth can't be looked at in isolation as the state's other major metropolitan area's continue to grown at a rapid pace. By 2045 the Dallas-Fort Worth area will grown to over 11 million, Houston Metro will be over 10 million, our neighbors to the south in San Antonio will be around 4 million people. Population estimates for the Capital Area put our region between 4.2 - 4.7 million. This means the corridor from Killeen-Temple to the Capital Area to San Antonio may have a population of over 8 million people.[4]

[4] Gone To Texas. Texas Comptroller, October 2017. Accessed at https://bit.ly/2KR6gtJ

Policy to Pattern: What's the impact of our planning policies on our land use patterns?

For the RACI, the team undertook a policy analysis of current planning related guiding documents in the region including comprehensive plans, subdivision ordinances and thoroughfare plans. This policy survey helped identify the similarities and differences of existing policies and uncover inconsistencies or opportunities for to improve our mobility as part of improved integration between land use and transportation.

Vision Statements

As the metropolitan area's population and job growth has increased rapidly over the last few decades, individual jurisdictions within the region have experienced a wide range of development pressures, and each have responded by using their policy tools differently. Some jurisdictions have expressed long-term visions and goals that reflect a desire for mobility, connectivity, walkability, economic growth, diverse housing options, strong community character, affordability, environmental sustainability, and other characteristics related to quality of life for their residents, not all have adopted corresponding implementation tools to help them achieve this future. The word cloud below highlights the various vision statements a policy analysis revealed. The larger the word, the more frequently it was used across the six-county region as part of planning guiding documents. As you can see, transportation was the most popular term.

Figure A.18

County Growth Planning

Counties in Texas have limited land use planning authority greatly preventing their ability to direct growth. Our policy analysis revealed that most counties are limited to subdivision platting authority with the exception of Travis County.

However, despite this some counties are using these tools to the greatest degree possible to guide growth in a way that maintains health and safety, guides infrastructure investments to be sustainable, preserves sensitive lands and discourages sprawl.

A summary of the limited land use controls within county unincorporated areas include:

- Review and approval of the subdivision of land – This allows counties to require that new subdivisions meet specific standards to protect public "health, safety, welfare, and orderly development," based on Section 232 of the Texas Local Government Code. These standards may include requirements for water supply and quality, infrastructure (including utilities and transportation rights of way, setbacks, driveway widths, etc.), drainage and flood control, 911 emergency response, and various other environmental protections. They can also include requirements for parkland dedications or fees in lieu from developers, as well as conservation easements to protect particularly sensitive environmental resources.

- Establishing some housing standards, such as transportation and environmental requirements in manufactured housing rental communities, and offering incentives for development of affordable housing (See Chapter 48 of the Travis County Code).

- Requiring new development to meet specific standards for water, wastewater, stormwater, and sewage facilities (see Section 366 of the Texas Health and Safety Code and Travis County's Onsite Sewage Facility requirements – Chapter 48).

- Requiring conservation efforts under the Texas Parks and Wildlife Code, Title 5, which allows for the protection of Wildlife Management Areas, Sanctuaries, and Preserves. This allows counties to require regional habitat or habitat conservation plans. Bastrop County has used this to protect the Houston Toad and Lost Pines Habitat.[5]

- Regulating certain land uses or "nuisances", including sexually-oriented businesses, businesses that sell alcohol, junk yards/salvage yards (Section 396.041 of the Texas Transportation Code), and the disposal of solid waste (Section 361 of the Health and Safety Code).

Although some counties are working to creatively but defensibly use their authority to guide sustainable planning that accommodates growth these efforts are not a substitute for the full array of land use planning authorities held by the municipalities.

[5] Lost Pines Habitat Conservation Plan for Bastrop County. Bastrop County, December 1, 2007. Accessed at https://bit.ly/31YVlhH

Municipal Growth Planning

In some jurisdictions or communities within them, development patterns have been driven primarily by market demand for available and affordable land. This is most common in areas that were once considered "rural," but are now experiencing encroachment from urban and suburban areas because they offer substantial greenfield opportunities. Often these areas are or were previously outside city limit boundaries, where land use regulation tools are severely limited. Residential development in these areas is typically characterized by low-density single-family, large-lot subdivisions built on previously undeveloped or agricultural land. Commercial development is usually focused around intersections with highways and arterials, with an emphasis on accessibility. This often results in development that is heavily reliant on and centered around automobile travel, with few other mode choice options.

Other jurisdictions have attempted to direct new growth using traditional "Euclidian" zoning to designate specific areas for specific land use types. This is generally seen in smaller established towns that were once physically separate and distinct from other communities, but are now experiencing significant development pressure. While these communities have more control over the location, diversity, and compatibility of land use and associated roadway types, the clear separation of uses often results in a "sprawling," low-density, auto-dependent development pattern. This pattern emphasizes mobility in most cases, while limiting the ability of the community to adapt over time. A greater focus on built form, in addition to mobility, can support more flexible uses that promote quality of life and resiliency. Other mode choices may be available, but the disconnect between where people live, work, and conduct other activities limits the viability of these options. Planners have since learned that the Euclidian zoning approach from the early days of planning does not accommodate growth as successfully as other models that allow greater flexibility in uses over time.

Still other jurisdictions, generally in urban and suburban areas that are experiencing a rapid increase in population, have moved towards higher densities and a mixture of traditional and mixed-use zoning and form-based codes that offer flexibility and focus more on a built form that offers economic resilience and includes quality of life objectives in the design versus the separation of land uses. These types of policy tools allow communities to more effectively address specific needs and goals. Often most importantly, these goals include long term economic sustainability that also happens to be more walkable and pedestrian-friendly with vibrant commercial and activity areas that support alternative transportation modes, job growth and connectivity, diverse housing options, and other goals that are not achievable by separating developments with traditional planning strategies.

For the six-county region most of the communities have come to recognize the broad benefits of these more effective land use models and their associated strategies. Although counties have limited mechanisms to ensure growth and connectivity.

Housing Growth Policies

Regarding land use patterns related to equity, a Platinum Planning element, although only 16% of the communities surveyed promote affordable housing through their policies, 42% offer affordable housing incentives, such as impact fee waivers and density bonuses, for developers who provide affordable housing. Although the larger vision statements that support affordable housing may be limited, the increased number of communities by comparison seeking new affordable housing options is promising if we are to continue to maintain affordable communities in the region.

- The standard development pattern in the region has focused heavily on the growth of low-density, single family homes on the periphery of urban and suburban areas. This dispersed residential pattern can spark a cycle of sprawl, housing diversity and affordability issues, and limits opportunities for economic development and alternative transportation opportunities: Employment and economic growth follows a similar dispersed development pattern.

- Residents are often forced to commute long distances to their jobs or activities in more concentrated employment areas such as downtown Austin, increasing their transportation costs and time in traffic.

- The dispersed development pattern and housing/employment densities in outlying areas do not support transit, increasing reliance on the automobile and the financial means to use it, as well as the congestion on our roadways.

- Demand for housing closer to the urban core increases as new residents seek more convenient access to jobs and activities. This subsequently increases home prices beyond the means of many residents, including low-income residents who have traditionally lived in central and core neighborhoods.

- Many residents, including those with limited incomes who may not have access to a vehicle and are dependent on public transit services for mobility, are being forced to move to the more affordable, low-density housing in suburban or rural areas where transit options are limited or unavailable.

- As more people move to the region, development continues to move outward, focusing primarily on low-density, single-family homes.

Housing Growth Policies

This phenomenon creates a negative feedback loop where residents increasingly face very long commute times to and from employment centers, but have very few alternative housing and transportation options.

Several communities in the region are recognizing this trend and taking positive steps to address it through policies that increase densities in targeted areas; promote mixed uses; generate attractive places through urban design; and offer diverse housing, employment, and transportation options to make development more convenient, desirable, and affordable for all residents, though there is still work to be done:

- Of the city, county, and regional jurisdictions for which housing policies were reviewed, 84% promoted offering and/or expanding diverse housing options to residents. However, only 38% of these entities' codes and ordinances reflected specific policies promoting housing diversity.
- Maximum standard residential district density requirements ranged from as low as 0.5 dwelling units per acre to as high as 53 dwelling units per acre. One city allowed densities of up to 75 dwelling units per acre with the use of density bonuses.
- Approximately 42% offer affordable housing incentives, which include impact fee waivers and density bonus incentives for developers who provide affordable housing.
- Approximately 54% of the cities allow accessory dwelling units, sometimes known as "Granny Flats" as an option in their zoning districts.

The continuation of these policies will support regional mobility to the greatest degree possible using the policy tools at our disposal.

Other Planning and Urban Design Growth Strategies

Urban design brings together the key elements that make up a city or town: buildings, streetscapes, public spaces, environmental features, and transportation systems. The interaction between these elements can influence an area's mobility, connectivity, safety, economic development, walkability, and overall character and aesthetics. Several urban design concepts and tools are being explored and used to varying degrees within the region to influence how our communities are developing and the resulting built form:

New Urbanism is a movement that began in the 1980s as an effort to reign in sprawl. Its intent is to create (or recreate) communities where walking is the primary form of transportation - harkening back to traditional urban designs that defined cities for centuries, prior to the rise of the automobile and low-density suburban housing. The concept incorporates designs that promote walkability, mixed uses, housing diversity, social diversity, context-appropriate neighborhood structure (with higher densities in central locations, surrounded by progressively lower densities), multi-modal transportation, environmental sustainability, and high-quality urban design. Transit-Oriented Development, discussed next, often incorporates a "new urbanist" approach to development.

Approximately 63% of the sample planning, code, and ordinance documents reviewed for the region included policies promoting walkability and new urbanist concepts.

Form based codes are regulatory tools that help communities implement their desired urban design. Unlike traditional zoning ordinances that segregate residential, commercial, and industrial land uses and encourage sprawl and auto-dependence, Form-Based Codes (FBC) focus on creating walkable urban spaces where urban design takes precedent over building use. FBC involves extensive public input on what people want their communities to look like, and provides standards for the function and design of buildings and transportation elements – including vehicle travel lanes, sidewalks, parking, and landscaping – in targeted areas.

- Some cities in the region are adopting stand-alone or overlay form based codes, while others use character or overlay zones and Planned Unit Developments (PUDs) within their zoning ordinances simply to have more influence on urban design or protect certain unique areas. Of the policy documents reviewed:
- 39% have adopted form based codes.
- 83% include overlay zones in their zoning ordinance to apply urban design standards to certain "character" areas.
- 100% allow PUDs, which can either be used as "floating" overlay districts that simply allow more flexibility than the existing zoning requirements, or to apply more specific urban design standards, such as for conservation areas.
- As more people move to the region, development continues to move outward, focusing primarily on low-density, single-family homes.

Form based codes (continued)

Although there are promising policy developments, some of the land use policies surveyed show an inconsistency between policy and supporting ordinances as shown in the table below. The percent of plans that include supportive language for density that discourages sprawl and supports transit is reasonably high, however the realization of those policies as ordinances drops considerably.

Land Use Policy Summary			
	Policy	% of Plans	% of Ordinances
1	Promotes or Allows Mixed Use Districts	82%	54%
2	Promotes or Allows Overlay/Character Areas	68%	63%
3	Promotes or Allows Planned Unit Developments	64%	88%
4	Promotes or Allows Form-Based Codes	23%	29%
5	Promotes Land Use Compatibility	77%	75%
6	Encourages Higher Densities	73%	25%

Figure A.19

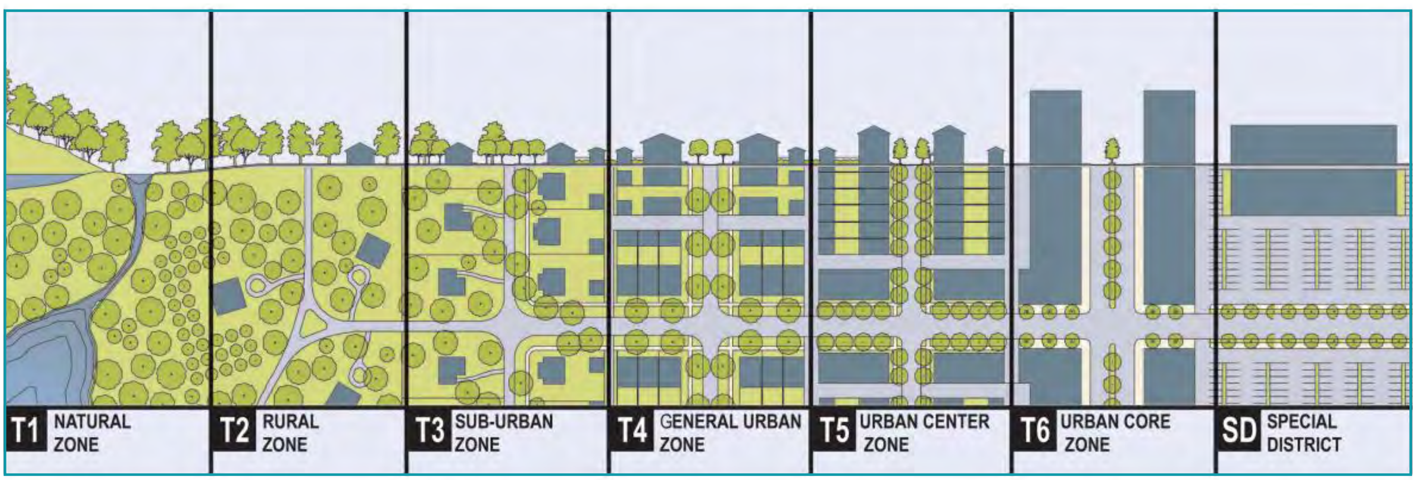


Figure A.20

Source: Transform Place, https://bit.ly/2MTHRSE

Transit-Oriented Development

Transit-Oriented Development (TOD) emphasizes the placement of transit stations and facilities at the heart of where people live and want to go. Effective TOD places transit facilities in the center of neighborhoods, within approximately a five-minute walk to major destinations such as retail, office, and high-density residential developments. TODs and surrounding transit-supportive areas are developed with walkability and community design at the forefront to encourage transit usage, connectivity and mobility, economic development, and overall community character and quality of life.

Approximately 40% of the planning documents reviewed had policies promoting or requiring transit facilities to be located in close proximity to housing and/or other transportation modes.

17% of the jurisdictions in which documents were reviewed have Transit Oriented Districts.

Transit Policy Planning Opportunities

There are several transit development plans and practices influencing the past and future arterials network. Looking at the system past and present, it appears there is a disconnect between the policies and ordinances in place. 88% of policy documents encourage transit improvements, but only 25% of ordinances provide direction to developers to include transit improvements. Hence, as communities develop, many may not be transit supportive in their design.

Transit Planning		
Policy	% of Plans	% of Ordinances
Encourages Transit and Other Multi-Modal Links to Undeserved Populations	40%	17%
Encourages Transit-Oriented Development	40%	13%
Recommends Park and Ride Policies	32%	4%
Recommends Transit Site Selection Policies	52%	29%
Encourages Transit Improvements	88%	25%

Figure A.21

This is increasingly important as plans such as Project Connect are developed. Project Connect is the region's potential future system plan and is aiming to provide increased mobility, by connecting people, places and opportunities through a complete, congestion-proof system of reliable and frequent high-capacity transit services running in dedicated lanes or on tracks. For instance, Figure A.22 celebrates the proposed TOD concept at Leander Station.

6

CAPITAL METRO CONNECTS PEOPLE, JOBS, AND COMMUNITIES BY PROVIDING QUALITY TRANSPORTATION CHOICES. WE COVER A SERVICE AREA OF 522 SQUARE MILES, SERVE A POPULATION OF 936,363, AND AVERAGE 2.6 MILLION MONTHLY BOARDINGS. METRO

SERVICES

- MetroBus: 2700 stops. 400 buses. 83 routes. Night Owls, E-Bus, UT Shuttles.
- MetroRail: 32 miles between Leander and Downtown Austin. 9 stations.
- Vanpools & Carpools: 141
- MetroAccess Vehicles: 139
- MetroExpress
- MetroBike
- RideShare
- FreightRail

CAPITAL METRO TOD

Transit-oriented development (TOD) creates transit-friendly walkable communities with a mix of people, jobs, and services. Capital Metro partners with its constituent communities to establish TODs in transit-rich locations. Implementing the CAMPO 2035 Activity Centers plan depends on focusing growth in walkable urban places served by transit.

Capital Metro considers TOD opportunities at several transit facilities. TOD provides increased ridership, increased revenues from development, and more choices for the community.

TOD supports affordable living. The two largest expenditures for most households are housing and transportation. Capital Metro works with the community to create more affordable living options by providing more transit and by supporting development in transit-rich locations.

CAPITAL METRO'S STRATEGIC PLAN FY 2012 GOALS

1 | Provide a great customer experience.
2 | Improve business practices.
3 | Demonstrate the value of public transportation to an active community.
4 | Be a regional leader.

LEANDER STATION IS THE NORTHERNMOST STOP OF THE METRORAIL RED LINE, A 32-MILE COMMUTER ROUTE CONNECTING THE RAPIDLY-GROWING NORTHWEST SECTOR OF THE REGION TO CENTRAL AUSTIN.

This property has an approved Form Base Code and Regulating Plan. Transit Village Investments, Ltd. (Leander Transit Development, Ltd.) has worked closely with Capital Metro, and owns the property north and south of Capital Metro's, however the developments remain independent. The ACC property is within 1/4 mile from the station.

The City, with Williamson County and area land owners (including Capital Metro), has created a supportive street grid for optimizing regional access to Leander Station and the development from nearby suburban and rural areas. Built or under construction is Hero Way (RM 269) and San Gabriel Parkway (RM274).

Entitlements approved (ultimate build-out):

COMBINED PLAN	CAPITAL METRO SITE ONLY
• 414,000 sq ft retail	• 120,000 sq ft retail
• 700,000 sq ft	• 250,000 sq ft office not listed separately
• 54,000 flex	• 200-973 DU (residential)
• 600-2521 DU (residential)	• 2 public areas
• 4 public areas	• 1500-2000 parking spaces
• 3,200 parking spaces (+80% in structures)	• 2-8 story building heights w/ 1 tower
• 2-8 story building heights w/ 4 towers	
• Transit ridership from Leander, nearby towns including Liberty Hill, Bertram, Georgetown, Round Rock, & Cedar Park	

LEANDER

800 US183 AT METRO DRIVE

CAPITAL METRO owns approximately 14 acres on US183 and Metro Drive in Leander, Texas. It is located less than ½ mile from downtown Leander, and is the center of the planned Leander TOD. Leander has a population of 15,705, a 107% increase since 2000. Located in the high growth corridor of the NW Austin MSA, with excellent public schools, Leander continues to attract new commerce and new residents.

Leander Station hosts both a MetroRail and MetroExpress service. Beautiful native landscaping and a gazebo plaza serve the transit area.

The City of Leander adopted a Smart Code in 2005 to encourage denser, walkable development. A TIRZ for the TOD was set up in 2006. Capital Metro and Leander Transit Development obtained full approval for a dense, mixed use development on the Capital Metro tract and adjacent 50 acres. Transit service and the planned TOD were principal considerations for the 100 acre purchase by Austin Community College (ACC) for a future campus in the TOD.

Capital Metro has partnered with area jurisdictions and property owners to build the primary roadways serving this area: CR 269, CR274, and CR273. Engineering work includes an exemption to detention requirements for new development.

SITE/ ADJACENT CHARACTER
- 14 acres, includes Leander Rail Station and Park & Ride; available for redevelopment that incorporates transit.
- 100 acre future ACC Campus adjacent, CR269 complete 2012, CR274 complete 2012, CR273 complete 2014, 183A Toll.

TRANSIT CONNECTIONS
- MetroRail Red Line: 8 trains weekdays, 6am peak/2pm peak; +6 Friday evenings March-September
- Express Bus: 53 connections weekdays
- Vanpool connections

RIDERSHIP
- Rail Ridership: 850 weekly
- Express Bus ridership: 290 weekly

MAJOR EMPLOYERS
HEB, City of Leander, Construction Trades, Manufacturing

ATTRACTIONS
Crystal Falls Golf Club, Hill Country, Leander ISD rated excellent

Figure A.22

[6] Transit-Oriented Development Leander Accessed at https://bit.ly/3095ImN

Transit Policy Planning Opportunities

Additionally, as transit becomes more viable in the communities that can support it, affordable housing will need to be an element considered as part of the build out of a transit system plan. Currently only 13% of communities surveyed require affordable housing near transit or pedestrian options. Ensuring that residents can locate near transit with access to job centers will encourage a mode shift to address mobility concerns and continue to support the CAMPO goal of equity as it relates to housing accessibility.

Housing and Equity Policy Summary		
Policy	**% of Policy**	**Notes**
Encourages/Allows Accessory Dwelling Units ("Granny Flats")	54%	In some jurisdictions, accessory dwelling units are restricted solely to family member or caretaker occupancy.
Promotes Affordable Housing Requirements	4%	The City of Austin has special affordable housing requirements to comply with the multifamily residence highest density district.
Promotes Consideration of Multi-Modal Connections for Undeserved Populations	13%	These policies include requirements to locate affordable housing near transit and pedestrian options.

Figure A.23

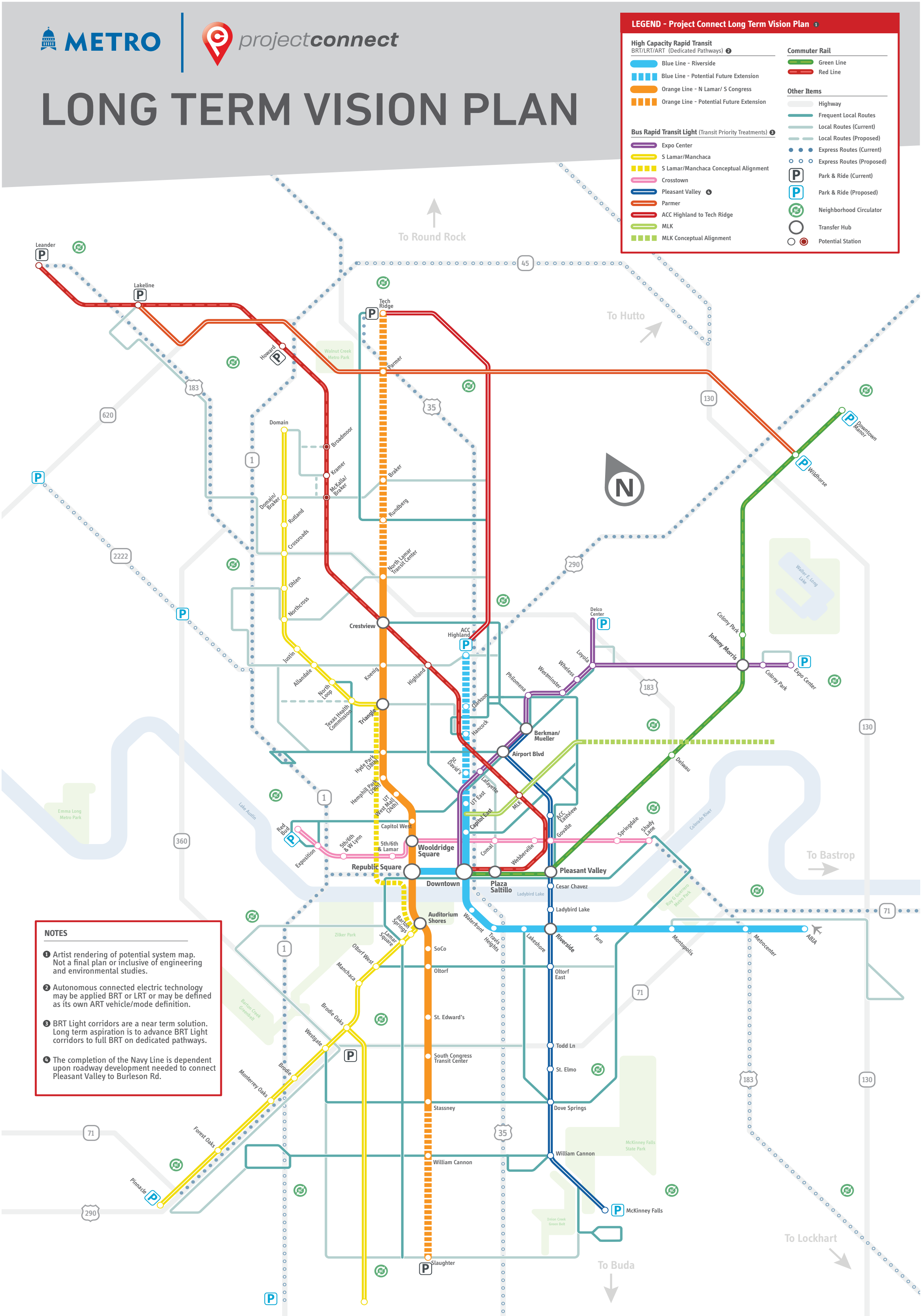
Existing, Committed, Planned and Desired Networks

To manage and direct growth in the region, municipalities, CAMPO, the counties, TxDOT, and the transit agency all have significant infrastructure plans. The project team mapped these plans along with desires recorded as part of the public engagement process and identified areas for further study by county as a starting point to identify gaps and needs. Gaps and needs to be identified in the Concept Plan will likely include:

- Closing gaps left between two projects
- Identifying intersection bottlenecks
- Locating possible new arterial connectors
- Highlighting projects that have strong Multi-modal synergies as part of the project development process

The following image provides Capital Metro's Project Connect Long Term Vision Plan.

[7]



02/15/19

7 CapMetro-ProjectConnect; Project Connect Long Term Vision Plan. Accessed at https://bit.ly/2XgJeTT

Economic Development Policy Findings

- Improve mobility on heavily-used arterials and surrounding roadways.
- Enhance the character/urban form, business growth opportunities, and safety along arterials that serve as the social and/or economic backbone of communities.
- Promote multi-modal options and connections along arterials that improve overall network mobility, better meet the housing and transportation needs of under-served populations, and offer opportunities for healthier lifestyles, lower costs of living, and diversity in urban form.
- Protect sensitive areas from development that may degrade environmental quality or diminish community character.

Economic Development Policies Summary				
Policy	No. of Entities w/ Related Policies	Notes	No.of Entities w/ Related Codes/ Ordinances	Notes
Encourages Tax Increment Financing	16 of 25	Some entities listed TIFs as a general development tool available, while others noted a specific area or district - such as downtown or along a redevelopment corridor - to which they should apply.	5 of 24	All specific areas noted were tax reinvestment zones.
Encourage Special Assessment District	13 of 25	PIDS were the most prevalent tool noted, though Enterprise Zones and County Assistant Districts were also mentioned as potential economic development tools.	6 of 24	The special assessment districts noted included PIDs specifically, and public utility or "other assessment" districts more generally.
Encourages Impact Fees	13 of 25	While many entities mentioned using impact fees to pay for costs of new development, others recommended waiving these fees as a development incentive.	15 of 24	Most entities required impact fees for water and wastewater services.
Encourages Public-Private Partnerships	16 of 25	Many plans made a general reference to partnering with private entities to develop or redevelop in certain areas, while some offered specific recommendations such as matching current investments in free parking for cars and working with rails-to-trails on railroad realignments.	0 of 24	No codes/ordinances included specific requirements related to public/private partnerships.
Encourages Tax Abatements or Fee Waivers	7 of 25	In some cases, tax abatements/fee waivers were specifically noted as incentives for developing in airport areas and for green development.	6 of 24	More than half of these were related to fee waivers for historic preservation efforts, while the other were related to economic development more generally or in a very specific targeted zone.
Encourages and/or Offers Incentives to Guide Economic Development	21 of 25	Most plans noted the desire to focus economic development in specific areas, including along commercial corridors, in activity/mixed-use areas, in infill/redevelopment locations, and away from environmentally-sensitive areas. Incentives noted included using sales taxes for economic development, establishing density bonuses for targeted areas, and fast-tracking the permitting process.	9 of 24	Incentives focused on projects that would help manage the flow or demand for travel to a particular area, increase the tax value jobs, redevelopment, or aesthetic/ community benefits within the area, or promote conservation efforts in sensitive locations.

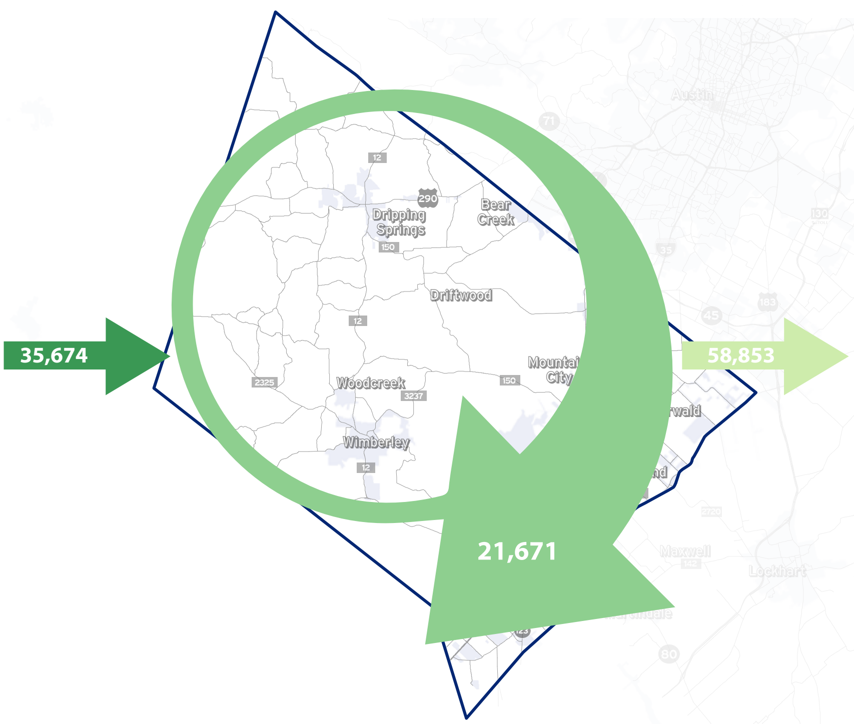
Figure A.24

Market Accessibility

In general, Americans are moving around, chasing jobs and financial opportunities, and in-migration has become an indicator of economic vitality. As such, the relationship between transportation and a successful economy is clear. As regional vitality relies upon the success of individual businesses and households, the transportation network must meet the needs of the employer, as well as the employee. Improved transportation and connections enhance the labor market for both workers and employers.

An efficient transportation network is essential in bringing together the production of goods and services with the demand and needs of consumers, we think of this as market accessibility. Transportation, movement, and the exchange of goods and services are obligatory features today. An efficient network not only influences business productivity, but also the economic competitiveness of the region and the arterial roads in the region play an important role in our future economic vitality. A high-quality transportation network with good connectivity improves economic output, reduces trip times and trip costs, and makes the Capital Area region more economically attractive and viable.

Traffic congestion can be directly tied to the state of the local economy. A growing economy often means more jobs and people and an increase in trips taken (Vehicle Miles Traveled), resulting in increased congestion levels. Therefore, with economic opportunities, comes the need to discuss performance of local roadways to address the increasing demands for mobility and ensure growth, job centers and infrastructure improvements are aligned.



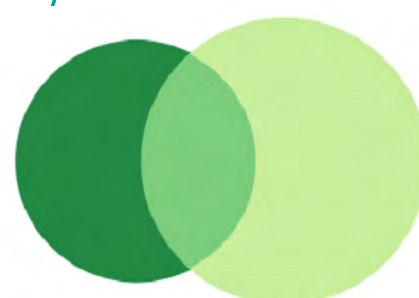
Note: Overlay arrows do no indicate directionality of worker flow between home and employment locations.

Employed in Hays and live outside

Employed and live in Hays

Live in Hays and employed outside

Inflow/Outflow Job Counts in 2015



35,674 - Employed in Hays and live outside

21,671 - Employed and live in Hays

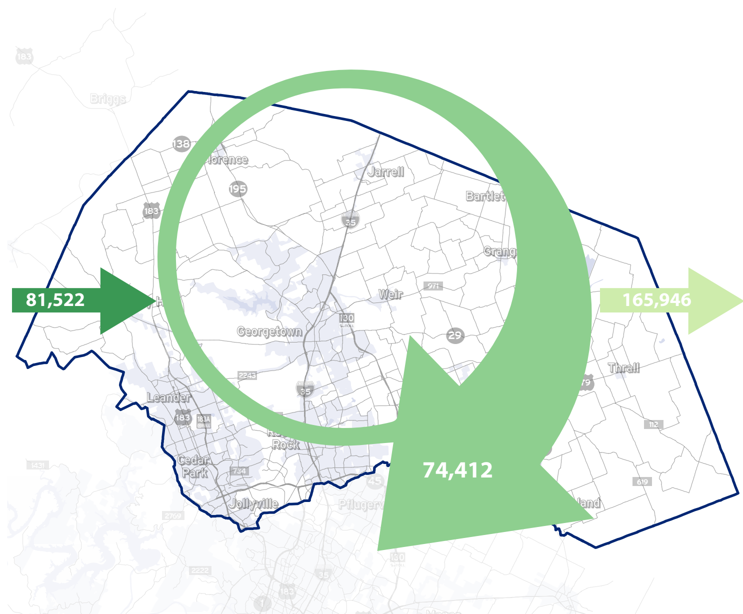
58,853 - Live in Hays and employed outside

Inflow/Outflow Job Counts (All Jobs) 2015[8]

	Count	Share
Employed in Hays	57,345	100.0%
Employed in Hays but living outside	35,674	62.2%
Employed and living in Hays	21,671	37.8%
Living in Hays	80,524	100.0%
Living in Hays but employed outside	58,853	73.1%
Living and employed in Hays	21,671	26.9%

8 Source: Longitudinal Employer-Household Dynamics; https://lehd.ces.census.gov/

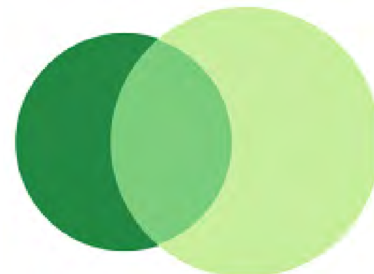
Williamson County Inflow and Outflow



Note: Overlay arrows do no indicate directionality of worker flow between home and employment locations.

Employed in Williamson and live outside — Employed and live in Williamson — Live in Williamson and employed outside

Inflow/Outflow Job Counts in 2015

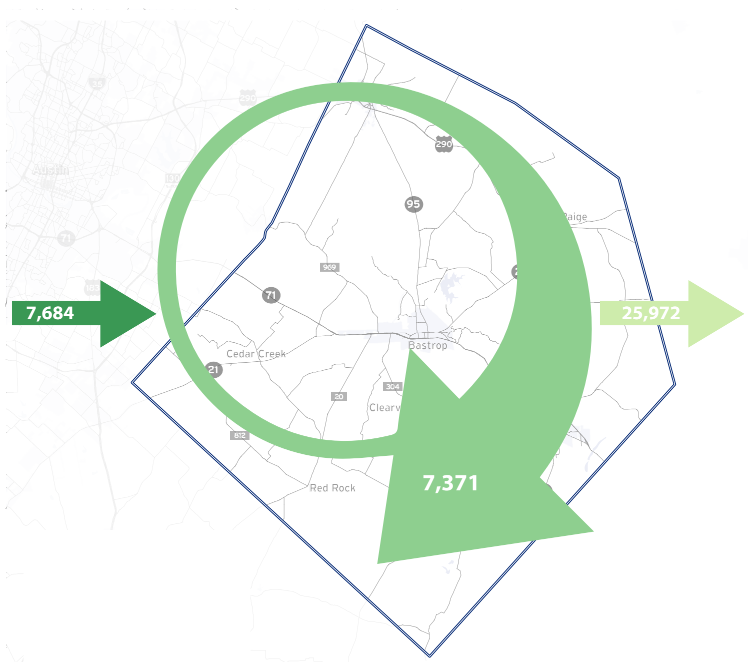


81,522 - Employed in Williamson and live outside
74,412 - Employed and live in Williamson
165,946 - Live in Williamson and employed outside

Inflow/Outflow Job Counts (All Jobs) 2015

	Count	Share
Employed in Williamson	155,934	100.0%
Employed in Williamson but living outside	81,522	52.3%
Employed and living in Williamson	74,415	47.7%
Living in Williamson	240,358	100.0%
Living in Williamson but employed outside	165,946	69.0%
Living and employed in Williamson	74,412	31.0%

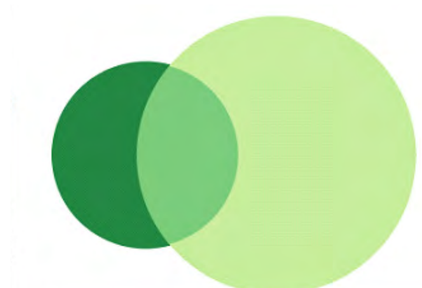
Bastrop County Inflow and Outflow



Note: Overlay arrows do no indicate directionality of worker flow between home and employment locations.

Employed in Bastrop and live outside — Employed and live in Bastrop — Live in Bastrop and employed outside

Inflow/Outflow Job Counts in 2015

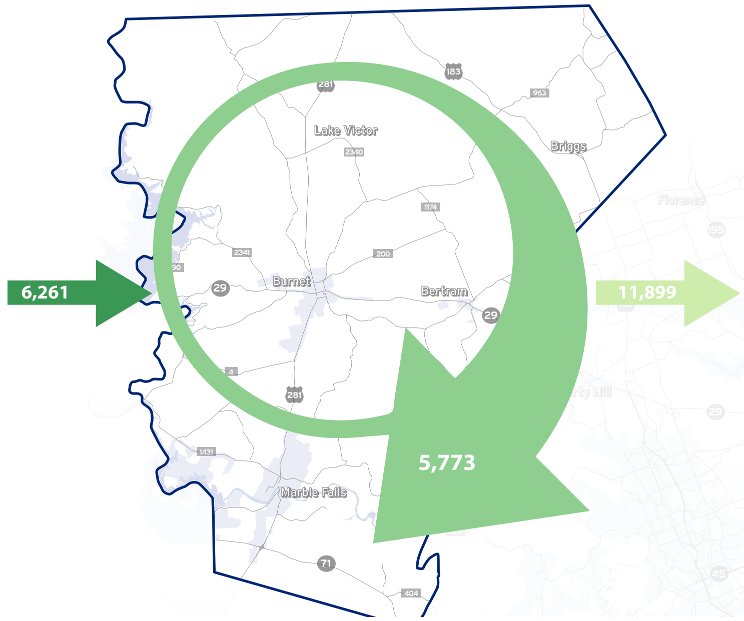


7,684 - Employed in Bastrop and live outside
7,371 - Employed and live in Bastrop
25,972 - Live in Bastrop and employed outside

Inflow/Outflow Job Counts (All Jobs) 2015

	Count	Share
Employed in Bastrop	15,055	100.0%
Employed in Bastrop but living outside	7,684	51.0%
Employed and living in Bastrop	7,371	49.0%
Living in Bastrop	33,343	100.0%
Living in Bastrop but employed outside	25,972	77.9%
Living and employed in Bastrop	7,371	22.0%

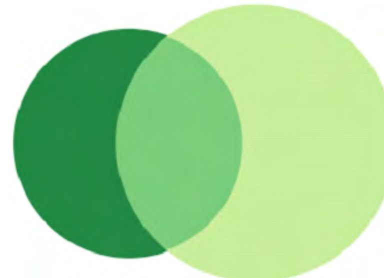
Burnet County Inflow and Outflow



Note: Overlay arrows do no indicate directionality of worker flow between home and employment locations.

Employed in Burnet and live outside | Employed and live in Burnet | Live in Burnet and employed outside

Inflow/Outflow Job Counts in 2015

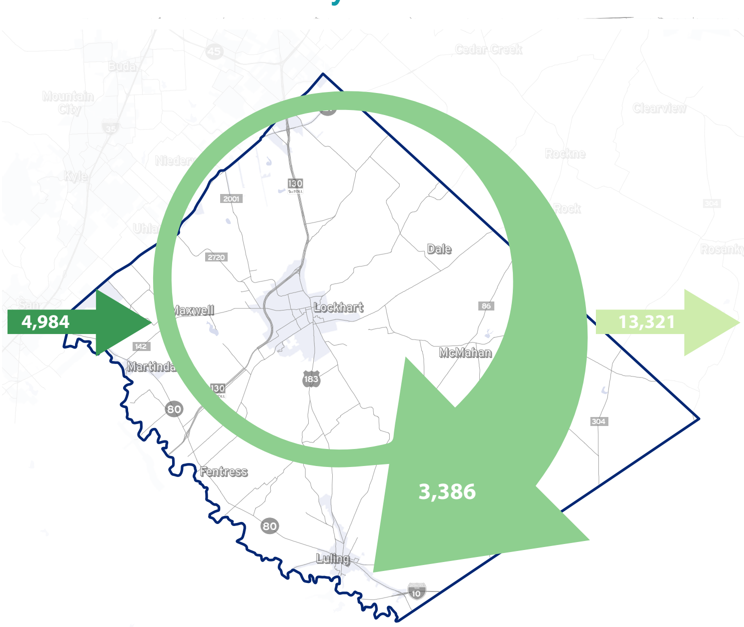


- 6,261 - Employed in Burnet and live outside
- 5,773 - Employed and live in Burnet
- 11,899 - Live in Burnet and employed outside

Inflow/Outflow Job Counts (All Jobs) 2015

	Count	Share
Employed in Burnet	12,034	100.0%
Employed in Burnet but living outside	6,261	52.0%
Employed and living in Burnet	5,773	48.0%
Living in Burnet	17,672	100.0%
Living in Burnet but employed outside	11,899	67.3%
Living and employed in Burnet	5,773	32.7%

Caldwell County Inflow and Outflow



Note: Overlay arrows do no indicate directionality of worker flow between home and employment locations.

Employed in Caldwell and live outside | Employed and live in Caldwell | Live in Caldwell and employed outside

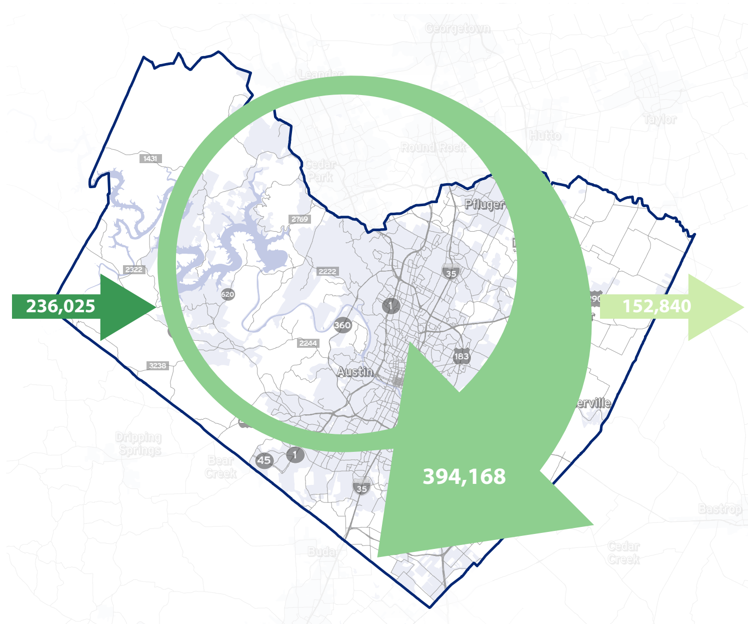
Inflow/Outflow Job Counts in 2015

- 4,984 - Employed in Caldwell and live outside
- 3,386 - Employed and live in Caldwell
- 13,321 - Live in Caldwell and employed outside

Inflow/Outflow Job Counts (All Jobs) 2015

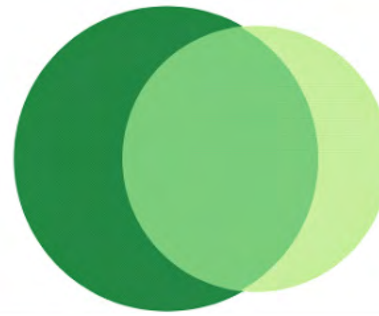
	Count	Share
Employed in Caldwell	8,370	100.0%
Employed in Caldwell but living outside	4,984	59.5%
Employed and living in Caldwell	3,386	40.5%
Living in Caldwell	16,707	100.0%
Living in Caldwell but employed outside	13,321	79.7%
Living and employed in Caldwell	3,386	20.3%

Travis County Inflow and Outflow



Note: Overlay arrows do no indicate directionality of worker flow between home and employment locations.

Inflow/Outflow Job Counts in 2015



326,025 - Employed in Travis and live outside

394,168 - Employed and live in Travis

152,840 - Live in Travis and employed outside

Inflow/Outflow Job Counts (All Jobs) 2015

	Count	Share
Employed in Travis	720,193	100.0%
Employed in Travis but living outside	326,025	45.3%
Employed and living in Travis	394,168	54.7%
Living in Travis	547,008	100.0%
Living in Travis but employed outside	152,840	27.9%
Living and employed in Travis	394,168	72.1%

The Rural Transit Proximity to Job Centers exhibit shows the larger CAMPO region and the existing Capital Area Rural Transportation System (CARTS) routes. While CARTS provides service to the outer areas of the Capital Area region, the network does not capture all of the areas with low vehicle ownership. In articular, the area east of Marble Falls and the large area near Dripping Springs in Hays County.

Capital Area Region
Rural Transit Proximity to Job Centers

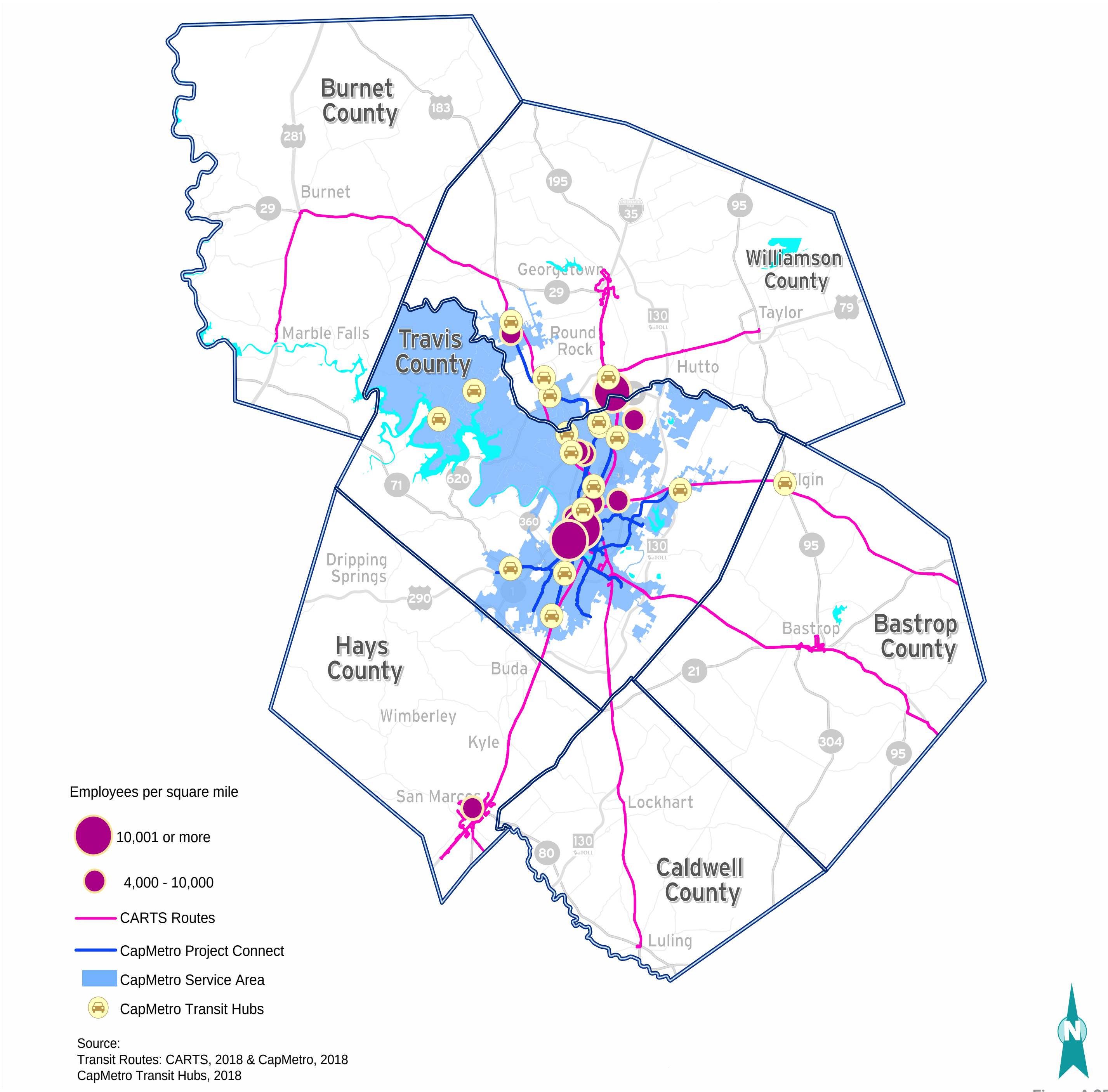


Figure A.25

While downtown Austin does account for some of the areas with high zero car ownership, the majority of areas with high percentages of households with no vehicles lie in the outer areas of counties where there are few job clusters and limited access to employment.

Capital Area Region
Household with No Vehicles to Job Centers

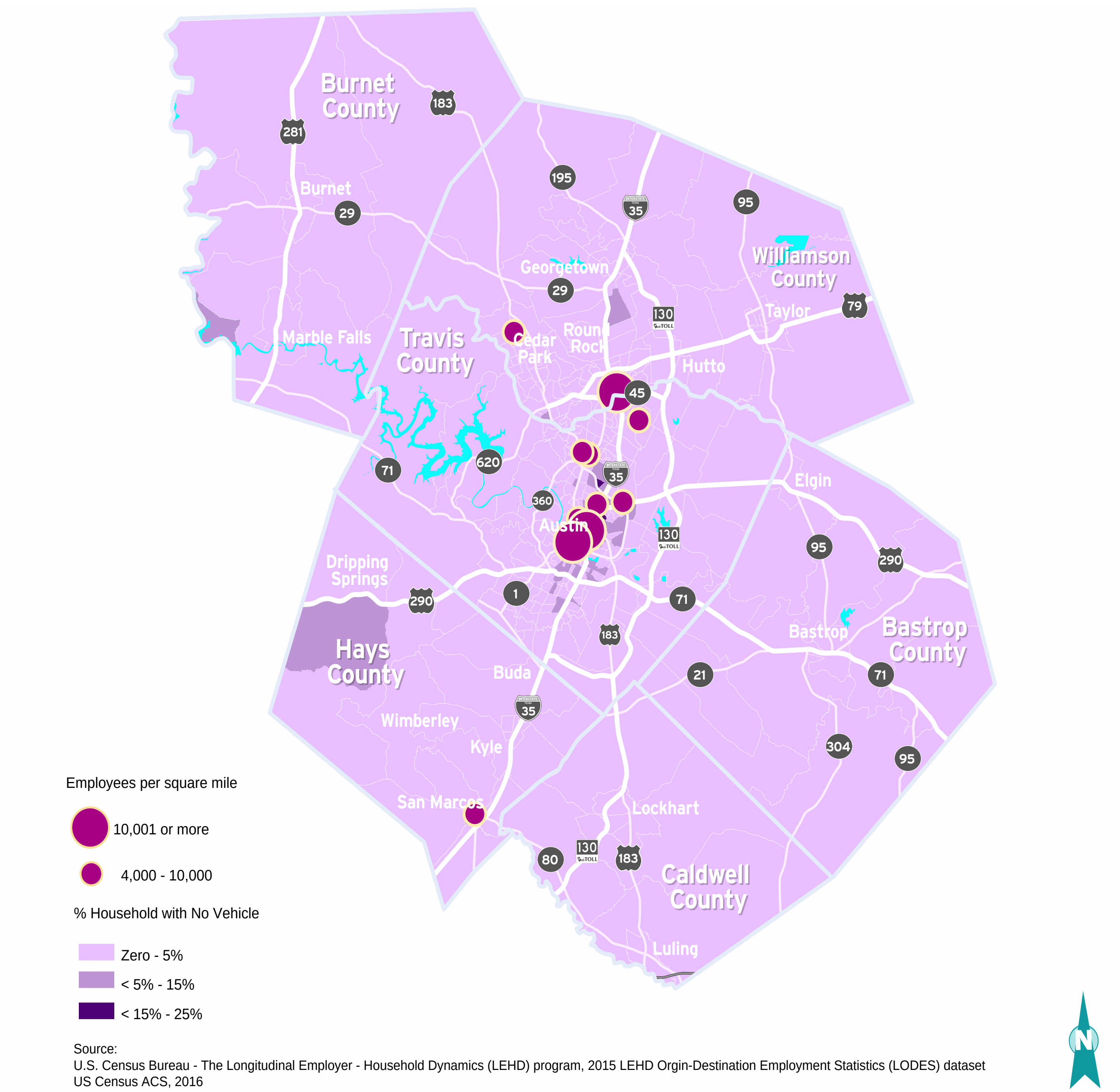
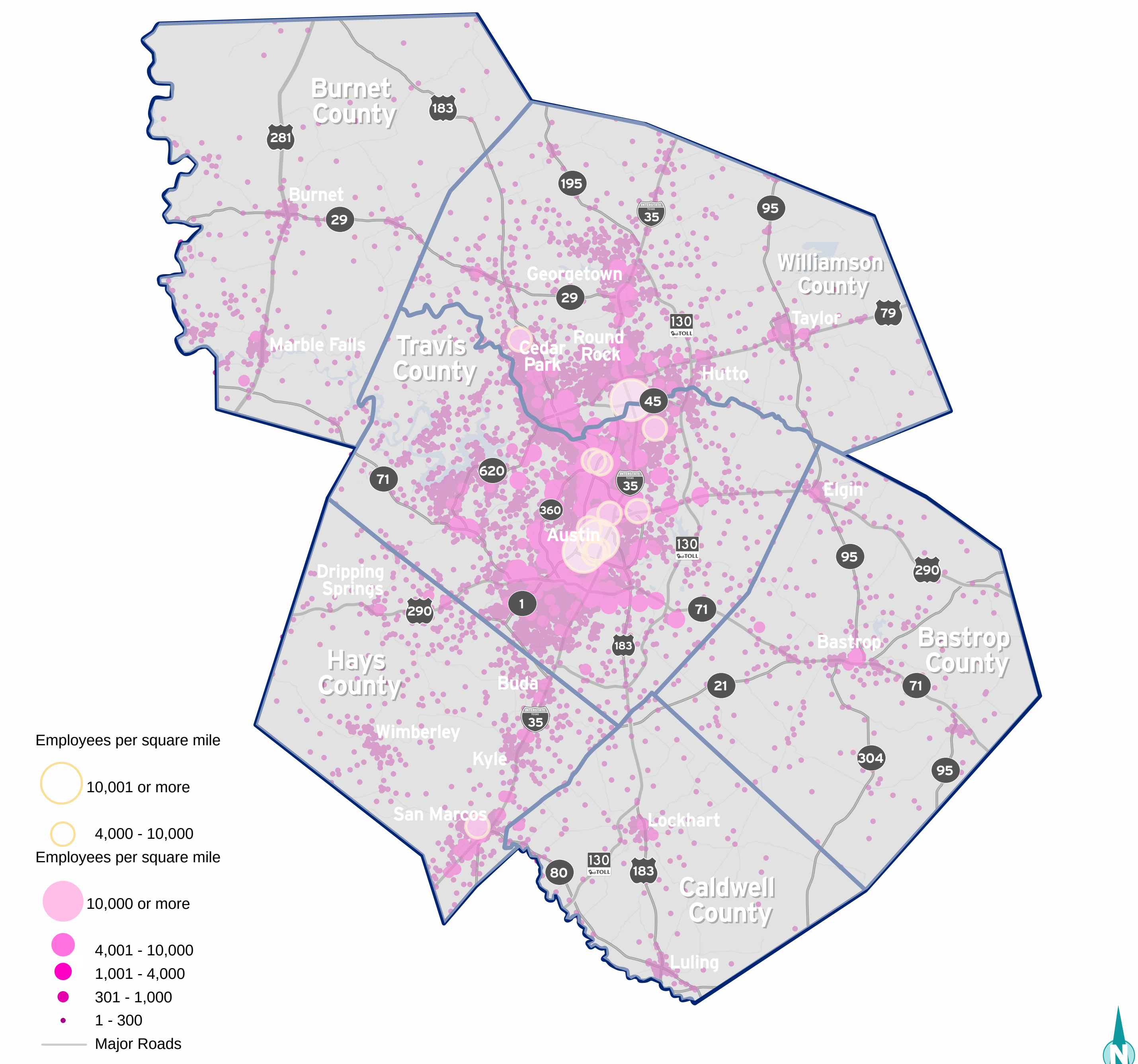


Figure A.26

Assessing performance and investing in the arterial network allows new markets, activity centers, and employment clusters to emerge as demand is dispersed across the network. As population continues to grow, development will occur throughout the six counties. This development will occur in areas that are connected via a reliable and safe transportation network. Historically, the urbanized area surrounding IH-35 was the magnet for this development. The City of Austin will likely continue to be a strong employment cluster, but new job clusters will continue to form outside of Austin and in the outer areas of the Capital Area region.

Capital Area Region
Job Density and Job Clusters



Source:
CAMPO 2040 Regional Arterial Study
U.S. Census Bureau - The Longitudinal Employer - Household Dynamics (LEHD) program, 2015 LEHD Orgin-Destination Employment Statistics (LODES) dataset.

Figure A.27

Public Outreach

Input We Received - Spring 2018

Outreach began in spring 2018 with a Steering Committee Kick-off meeting, followed by local government meetings, public open houses and a public comment period, which included a survey asking about needs and concerns on the Regional Arterials network. The purpose of the first round of outreach was to introduce the project and gather input on existing conditions and needs.

The team worked diligently to make public participation more convenient by providing information about CAMPO initiatives in one place. The team utilized joint open houses with CAMPO's 2019-2022 Transportation Improvement Program (TIP) update, in an effort to maximize the opportunity for public comment on more than one program simultaneously. For the first round of public meetings, the brochure advertised both the RACI and TIP open houses to optimize attendance and input.

8 local government meetings were held throughout the region during the first round of outreach which included a presentation with project background information and an interactive workshop session. Attendees were asked to share location-specific input on existing conditions. The purpose of the local government meetings was to:

- Share project information
- Provide background information on the project
- Gather input on existing conditions and collect mapped input on existing facilities
- Identify local transportation plans and arterial needs.

This section summarizes what was heard across the region through meetings with local government officials, open houses, and on-line survey responses that informed the outcomes. A more thorough description of stakeholder engagement efforts can be found in the Appendix.

Local Government Meetings

Capital Area Region
Local Government Meetings

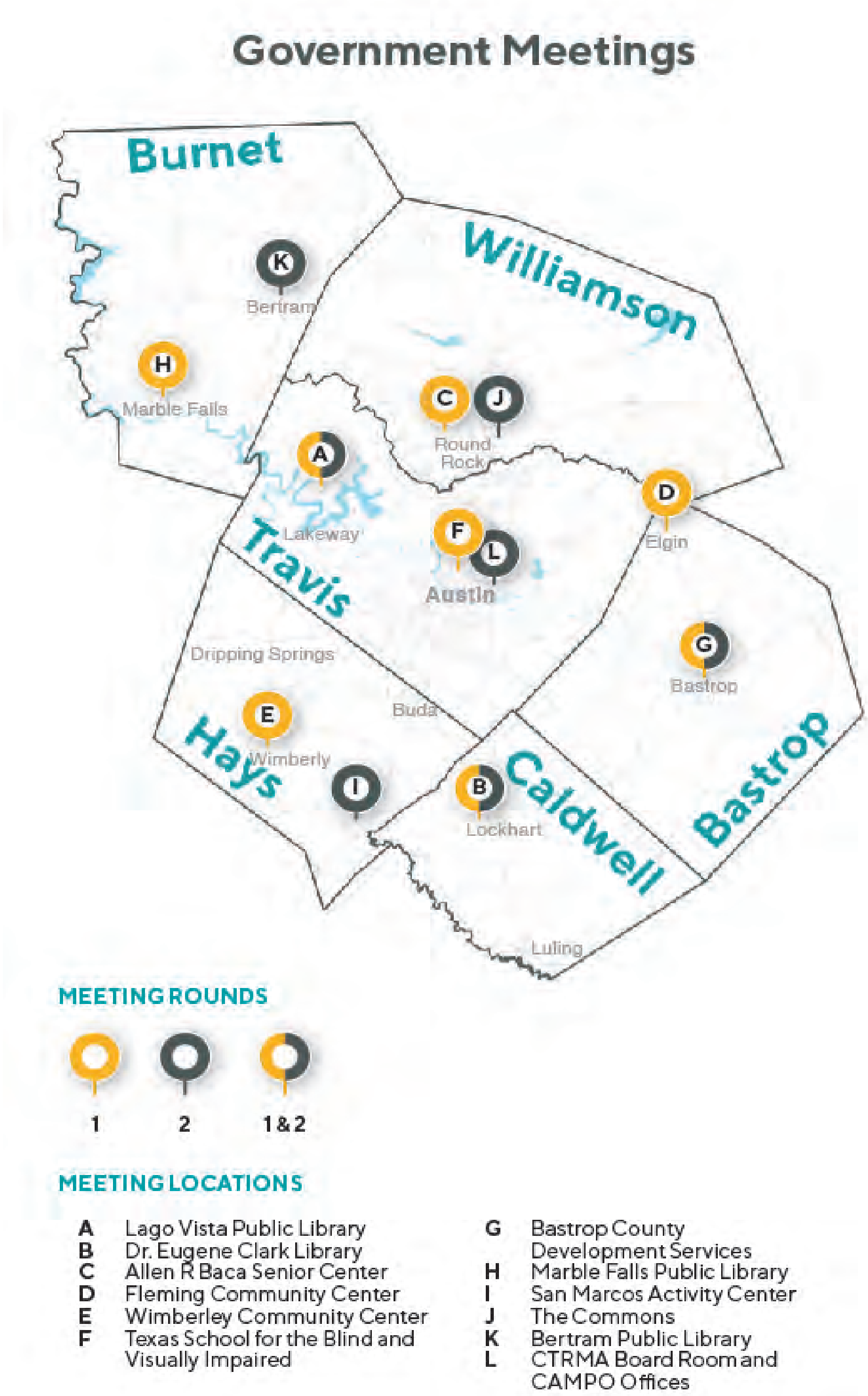


Figure A.28

Public Meetings

A survey was available in both English and Spanish from April 2 to May 28, 2018 to gather input from community members on arterial needs and priorities throughout the region. Participants were dispersed among various income levels, ages, ethnicities, and zip codes (full demographic information included in the summary below). CAMPO received 1979 responses to the English survey and 16 responses to the Spanish survey. 573 participants signed up for project updates by providing their email address on the survey.

However, it should be noted that survey results from this round of outreach were heavily influenced by residents in the Steiner Ranch area on RM 620 who were concerned with the development of the TIP and participated in high numbers.

What zip code do you live?

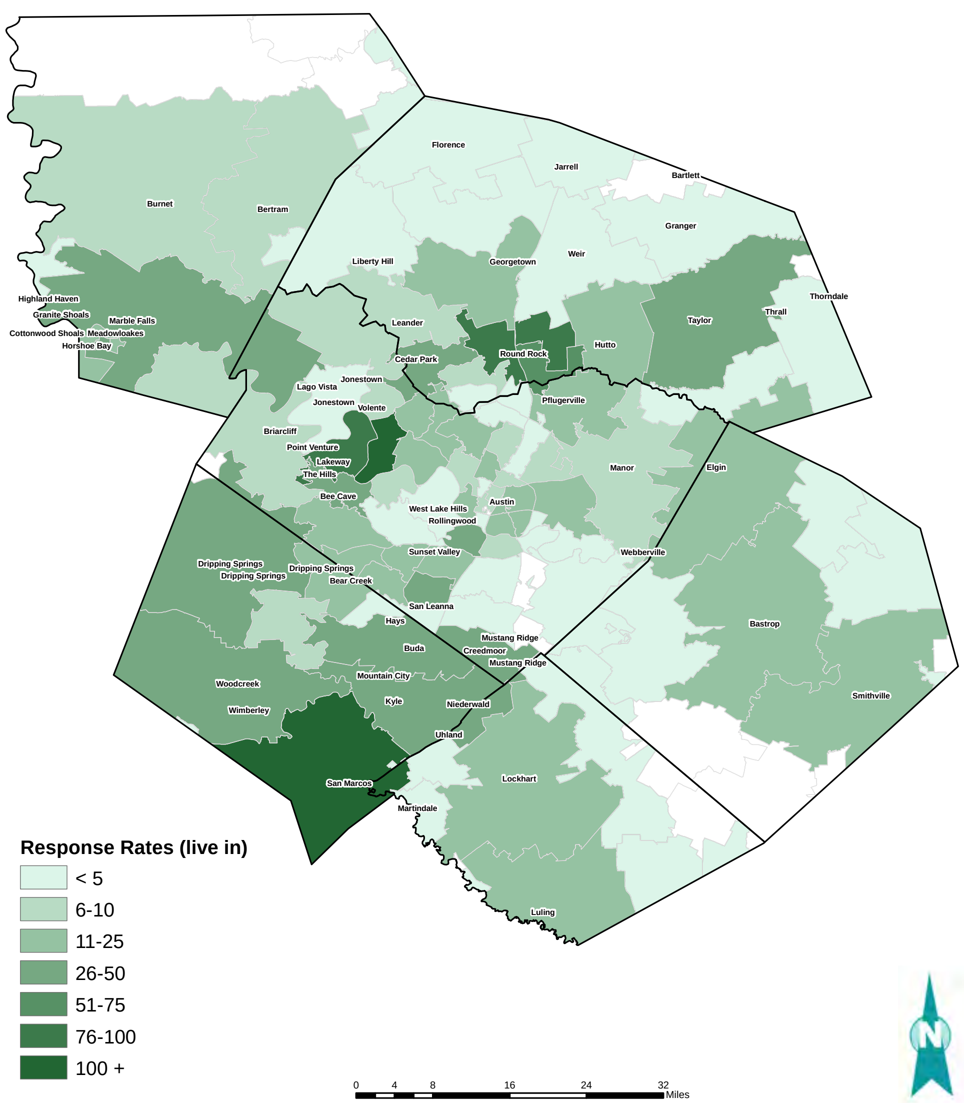


Figure A.29

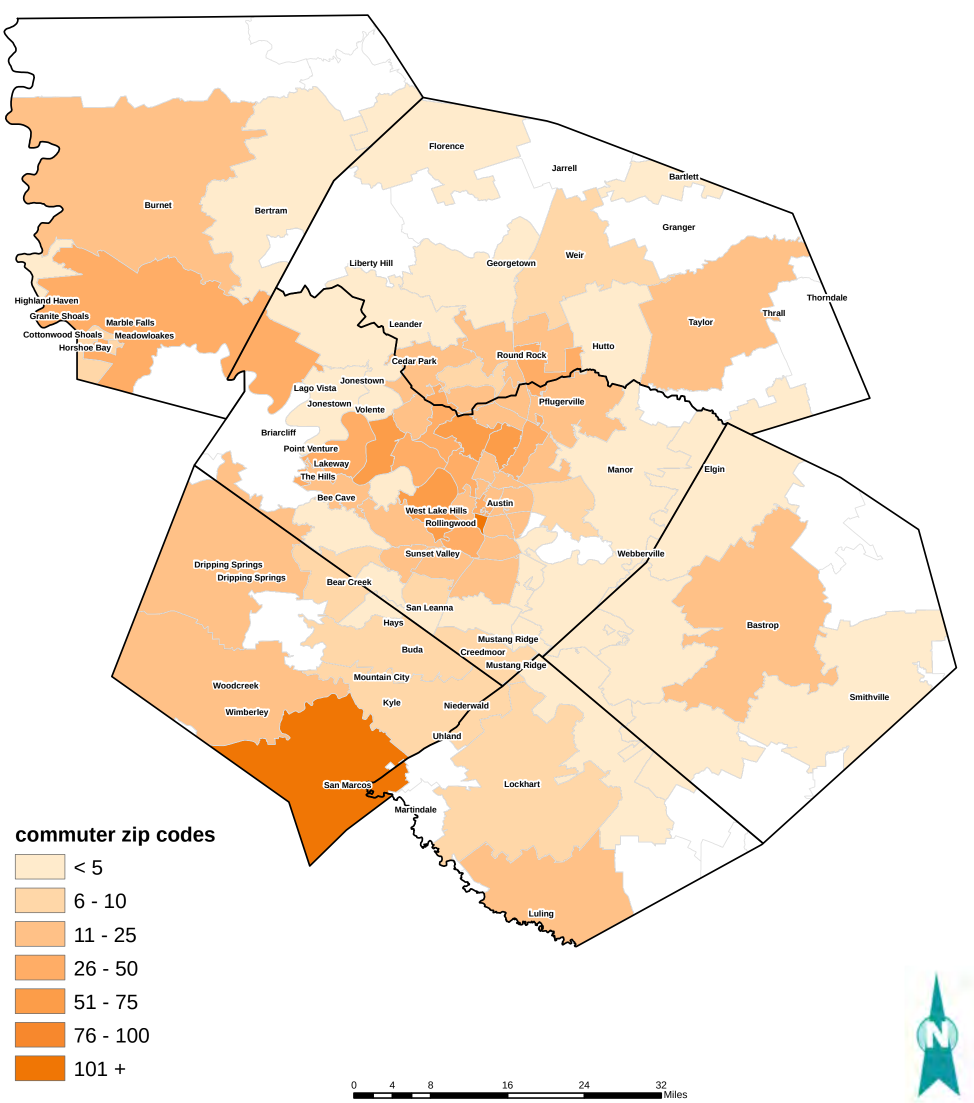
1,995
Surveys Collected

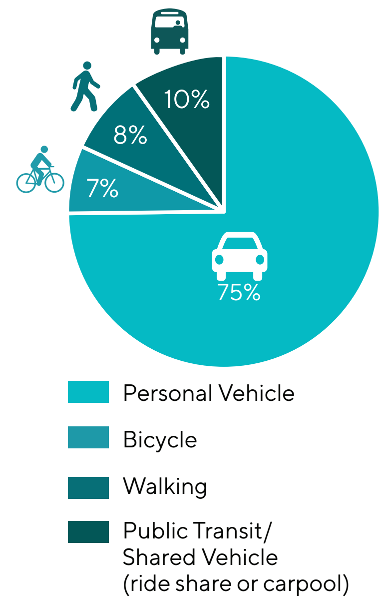
County	Number of Responses
Bastrop	70
Burnet	50
Caldwell	36
Hays	298
Williamson	383
Travis	1,063
Outside Capital Area Region	95

Public Meetings

Survey Responses by Location		
County	English	Spanish
Bastrop	70	–
Burnet	50	–
Caldwell	36	–
Hays	596	–
Williamson	380	3
Travis	1,050	13
Full Region	2,182	16

What zip code do you work in or commute to often?





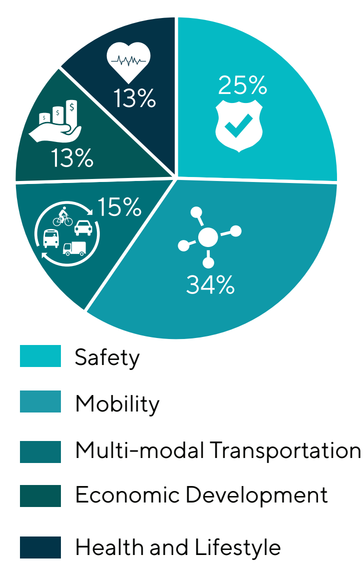


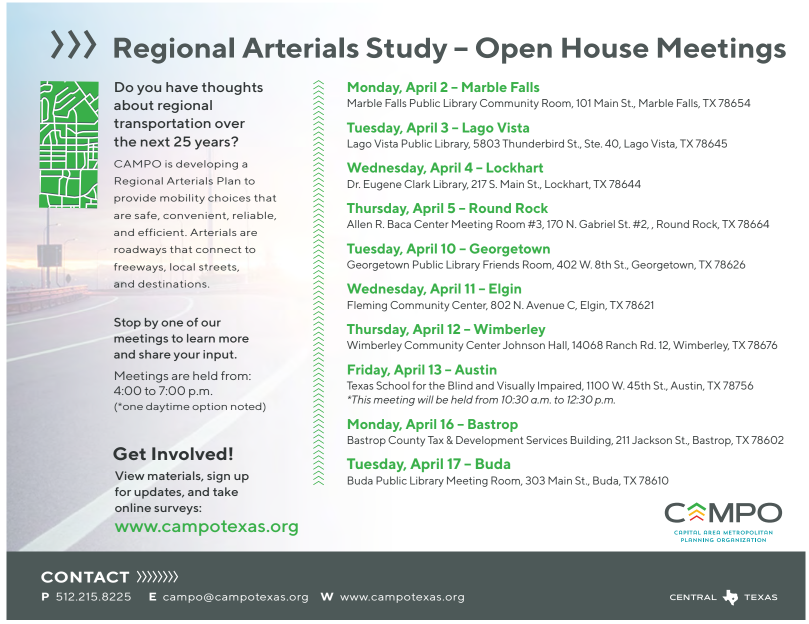
Figure A.30

Public Meetings

10 public meetings with a total of

145 attendees

During the first round of outreach, ten public meetings were held throughout the region to give stakeholders a convenient opportunity to attend and provide feedback. Public meetings were held in an open house format in the evenings, with one daytime option for convenience. To make public participation more convenient by providing information about CAMPO initiatives in one place, the RAP meetings were conducted alongside meetings for the Transportation Improvement Program (TIP) where possible.



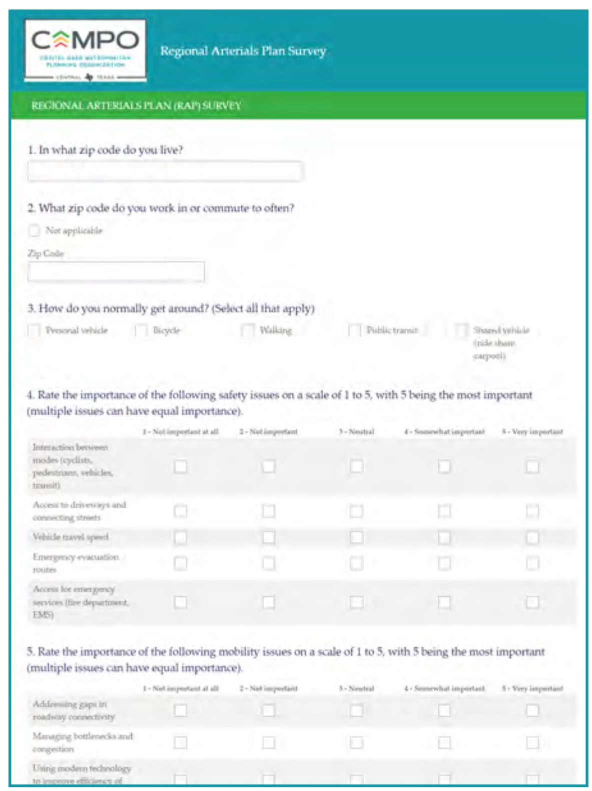
Intercept Surveys

200 Reached

To reach the public where they were already gathered, the project team visited several community locations during the comment period to administer surveys on iPads and share printed copies of the survey for distribution. Areas with low participation or high concentrations of vulnerable populations were chosen for this activity in an effort to engage underrepresented groups.

Online Engagement

All meeting materials and input opportunities were available on the project webpage. Those that could not attend in meetings in person were offered the opportunity to view meeting materials through an Online Open House, provide their input via email, and take the survey online.



CAMPO

Regional Arterials Plan Survey

REGIONAL ARTERIALS PLAN (RAP) SURVEY

1. In what zip code do you live?

2. What zip code do you work in or commute to often?

Not applicable

Zip Code

3. How do you normally get around? (Select all that apply)

Personal vehicle | Bicycle | Walking | Public transit | Shared vehicle (ride share, carpool)

4. Rate the importance of the following safety issues on a scale of 1 to 5, with 5 being the most important (multiple issues can have equal importance).

	1 - Not important at all	2 - Not important	3 - Neutral	4 - Somewhat important	5 - Very important
Interaction between modes (cyclists, pedestrians, vehicles, transit)					
Access to driveways and connecting streets					
Vehicle travel speed					
Emergency evacuation routes					
Access for emergency services (fire department, EMS)					

5. Rate the importance of the following mobility issues on a scale of 1 to 5, with 5 being the most important (multiple issues can have equal importance).

	1 - Not important at all	2 - Not important	3 - Neutral	4 - Somewhat important	5 - Very important
Addressing gaps in roadway connectivity					
Managing bottlenecks and congestion					
Using modern technology to improve efficiency of					

Outreach and Open House Meetings

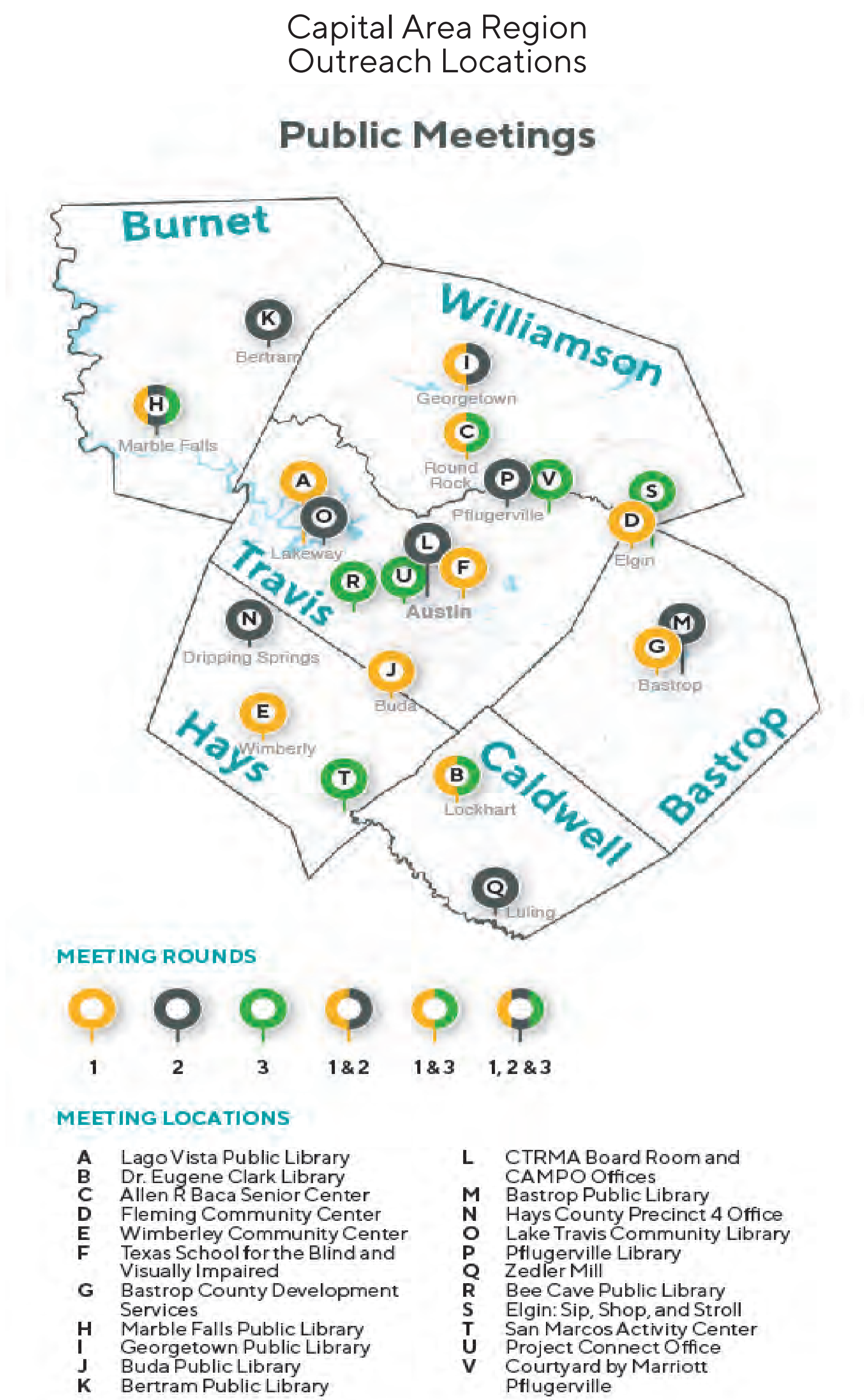
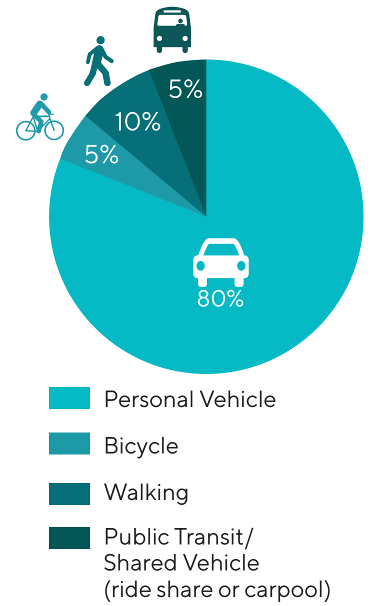


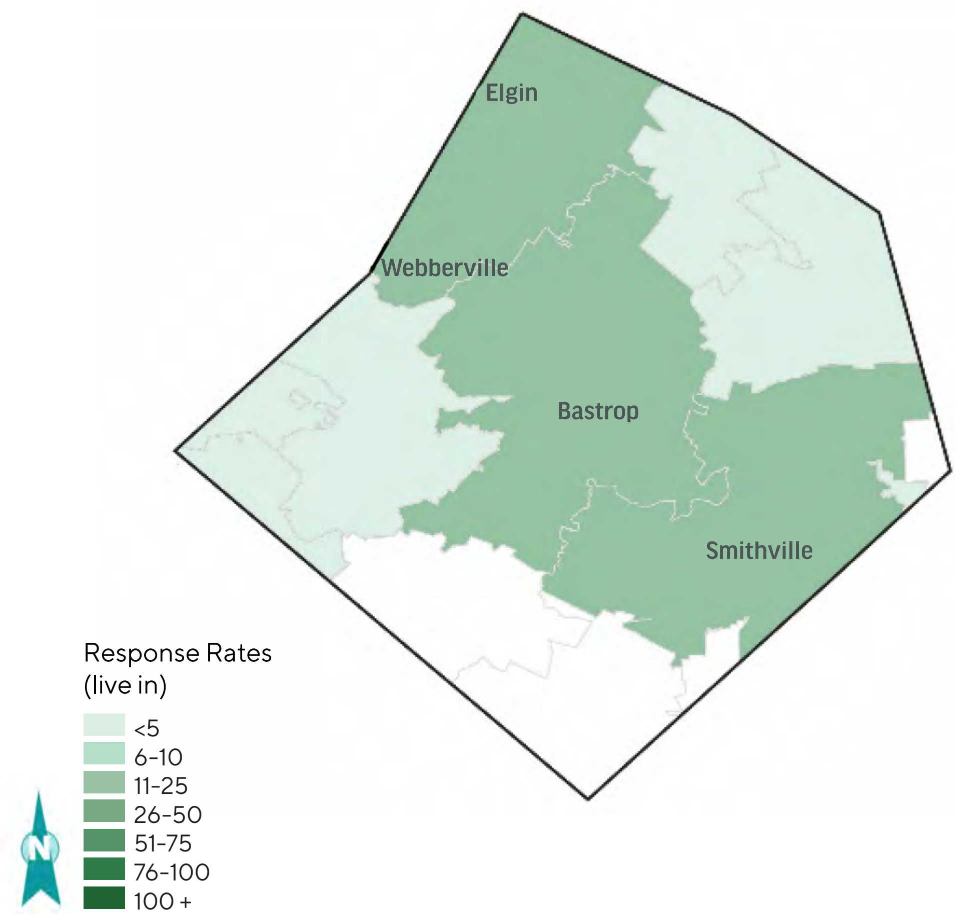
Figure A.31

Public Meetings: Bastrop County

Several key themes were identified by local government representatives at in-person meetings. These included the following identified needs:

- Grade separations to bypass railroad crossings
- Additional river crossings
- Connections to north and east Travis County
- Improvements to existing arterials





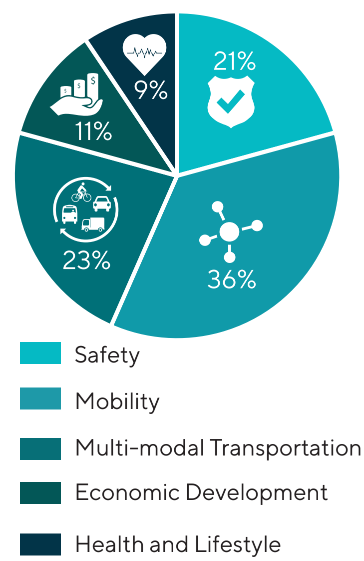


Figure A.32

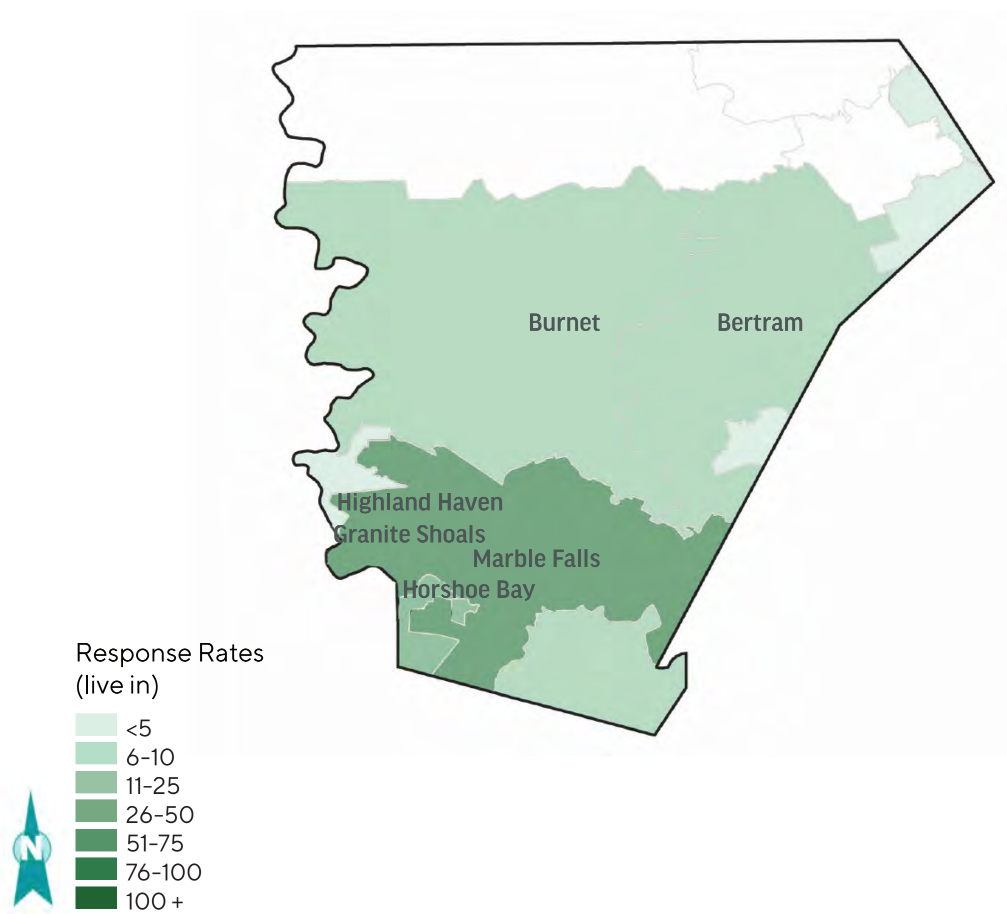
While the survey was available in both English and Spanish versions, only English responses were received from Bastrop County residents. In total, 70 Bastrop County responses were collected that spanned six of the eight county zip codes. When asked about residents' commute destination, the majority of respondents stayed within the county while the next most popular destination was the City of Austin.

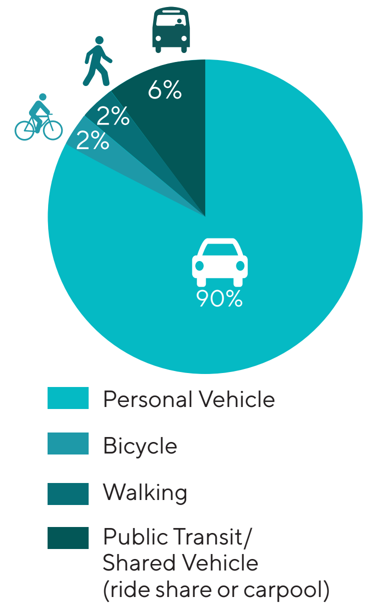
In general, Bastrop County survey participants and local government representatives agreed with the purpose of the plan and that there is a critical need to address congestion and bottlenecks in the network, specifically on roadways connecting to Travis County. Additionally, the public noted a desire for improved pedestrian and public transit options, including improved CARTS service and potential rail options.

Public Meetings: Burnet County

Several key themes were identified by local government representatives at in-person meetings. These included the following identified needs:

- Expansion needed on US 281
- Additional river crossings
- Connections to existing arterials (SH 71, FM 1431, US 281)
- Limited visibility and lack of shoulders in Southeast Burnet County
- Support for commuter and freight traffic





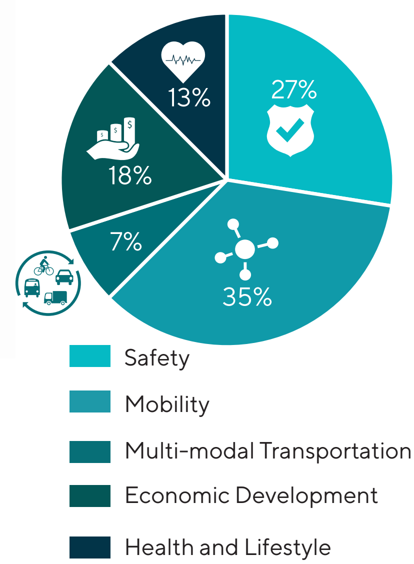


Figure A.33

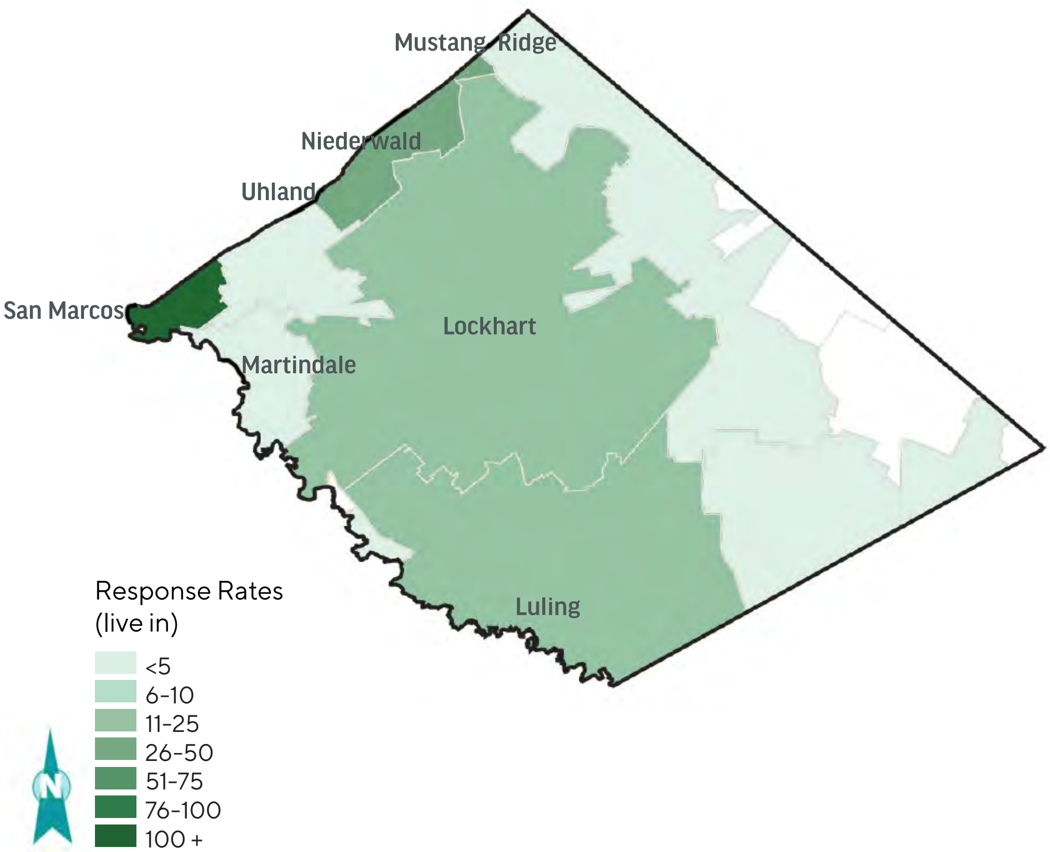
Only English responses were received from Burnet County residents. In total, 50 Burnet County responses were collected from residents living in three of the seven county zip codes. When asked about residents' commute destination, most respondents commuted to Marble Falls and Bertram, and almost all stayed within Burnet County.

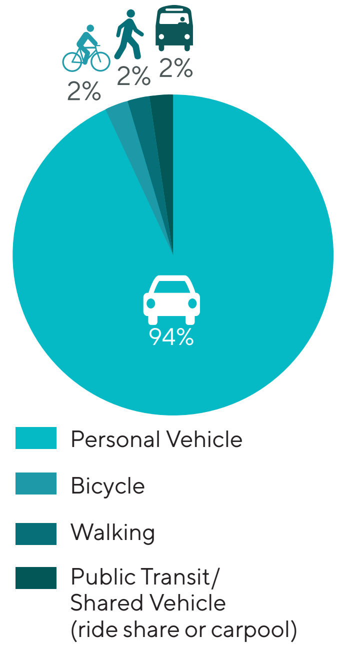
Several respondents from Burnet County noted a need to improve connectivity to the existing network and surrounding areas, as well as a desire for additional river crossings and low water crossings. Many responses discussed the need for improved roadway safety features, including turn lanes, dividers, and bicycle and pedestrian facilities.

Public Meetings: Caldwell County

Several key themes were identified by local government representatives at in-person meetings. These included the following identified needs:

- Grade separations to bypass railroad crossings
- Intersection and signal enhancements
- Flooding and drainage concerns
- Coordinate with neighboring counties (Guadalupe and Gonzales) and MPOs improvements in South Caldwell County





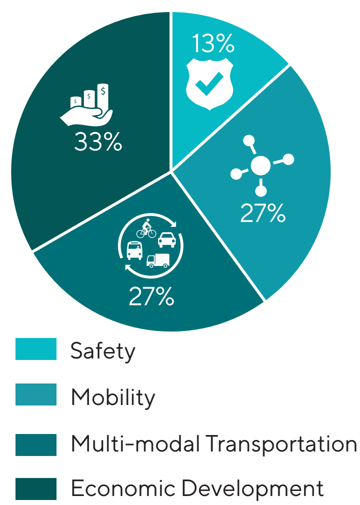


Figure A.34

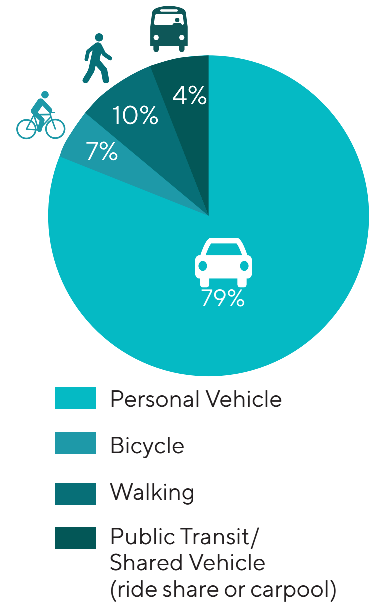
Caldwell County residents submitted a total of 36 English surveys, while no Spanish surveys were received. Surveys were submitted from residents living in six of the seven Caldwell County zip codes. When asked about residents' commute destination, the most popular destination was Luling, followed by San Marcos.

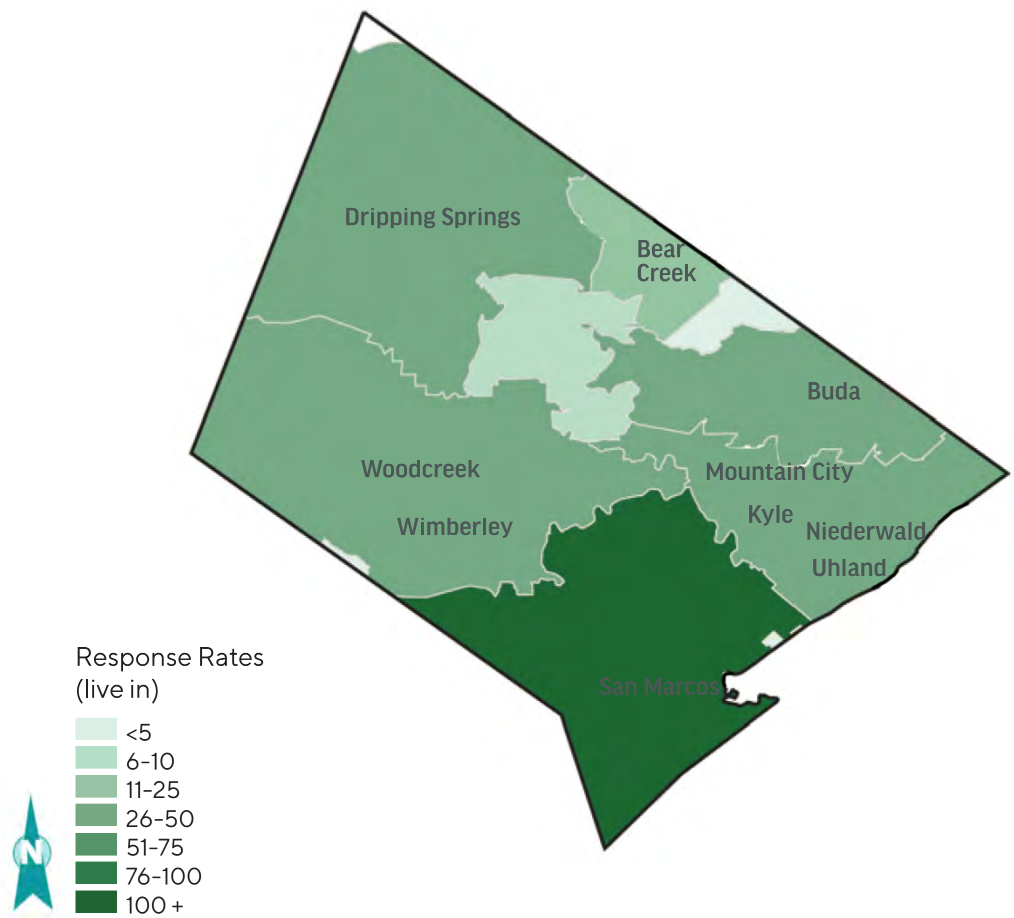
Residents of Caldwell County noted a need to address congestion and traffic volume, as well as improve roadway conditions through maintenance. Residents also expressed a preference to improve Multi-modal facilities, such as transit and bicycle accommodations, and noted the need to consider environmental features and potential impacts.

Public Meetings: Hays County

Several key themes were identified by local government representatives at in-person meetings. These included the following identified needs:

- Pedestrian safety in San Marcos
- Relieve congestion around IH-35
- Flooding and drainage concerns
- Blind curves need safety improvements





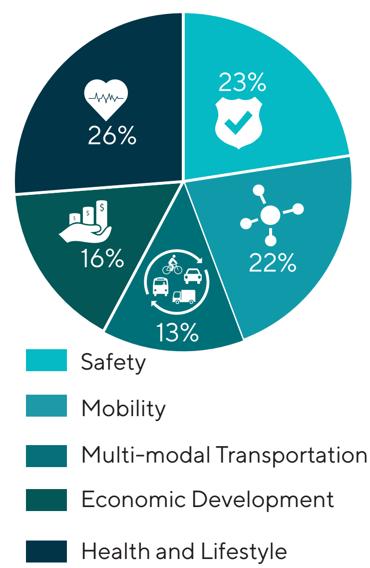


Figure A.35

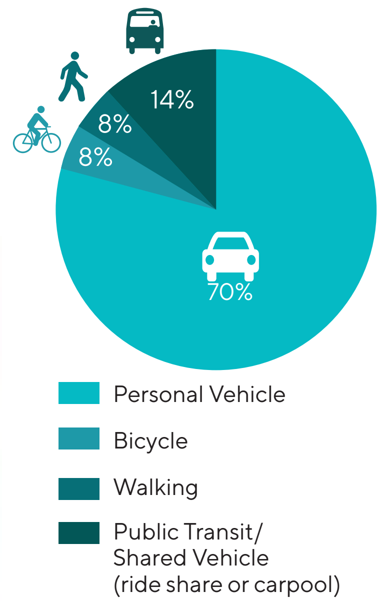
A total of 596 English responses were collected from Hays County residents. All seven residential zip codes in Hays County were represented in responses received. The most common commute destination for respondents from Hays County was San Marcos.

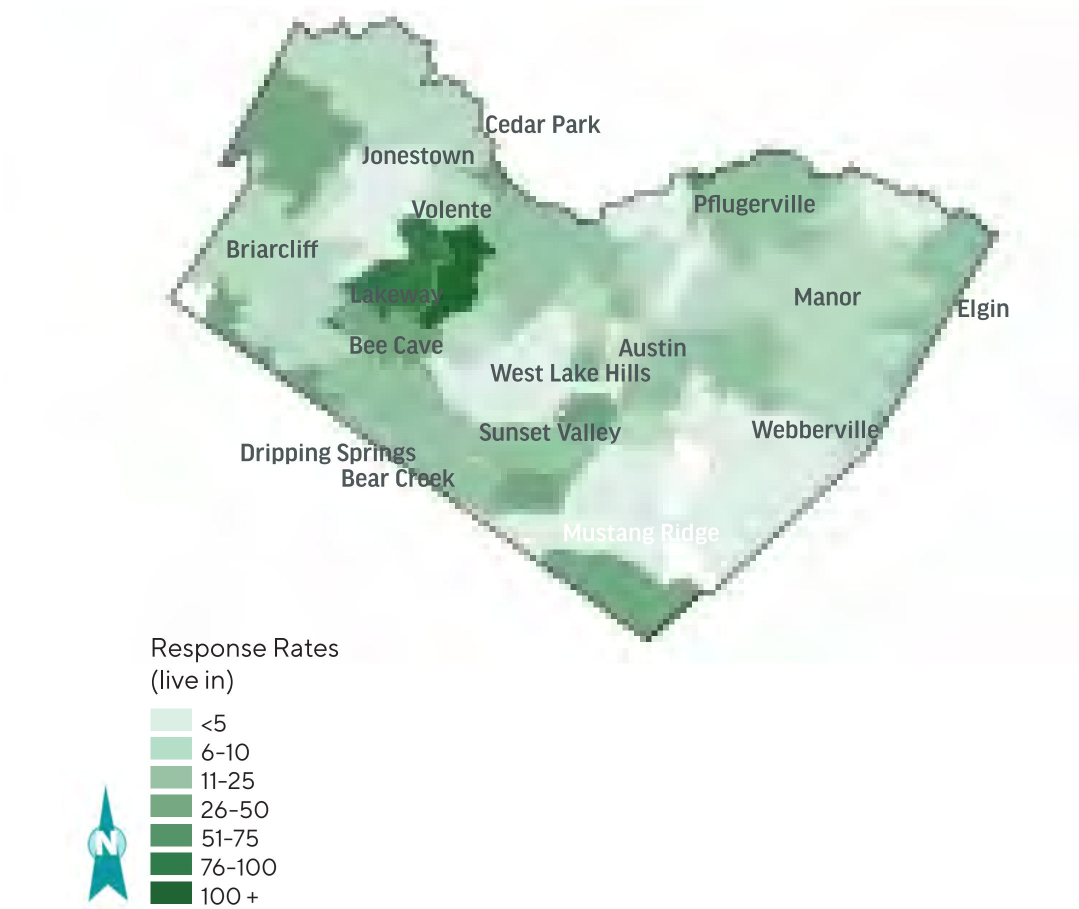
In general, respondents from Hays County emphasized the need to consider sustainable growth and environmental conditions and impacts. Hays County residents also noted a desire for reliable multi-modal transportation options with connections to major destinations and improved safety on US 290.

Public Meetings: Travis County

Several key themes were identified by local government representatives at in-person meetings. These included the following identified needs:

- Flooding and drainage concerns in South Travis County
- connections to emerging developments and future school sites
- Additional river crossings in West Travis County
- Added capacity on existing arterials





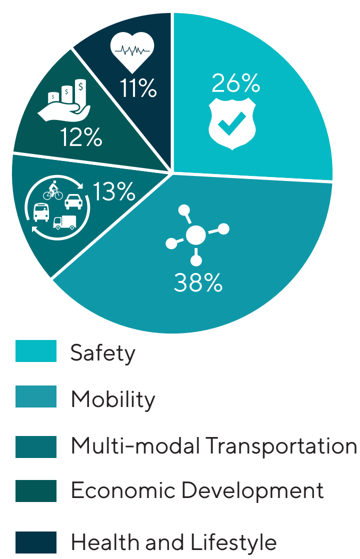


Figure A.36

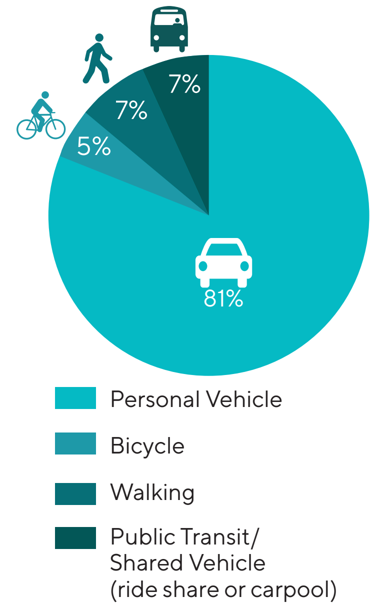
Travis County residents submitted 1,050 English survey responses and 13 Spanish responses, with residents living in 23 out of 86 Travis County zip codes. When asked about residents' commute destination, the majority of respondents commuted to Austin.

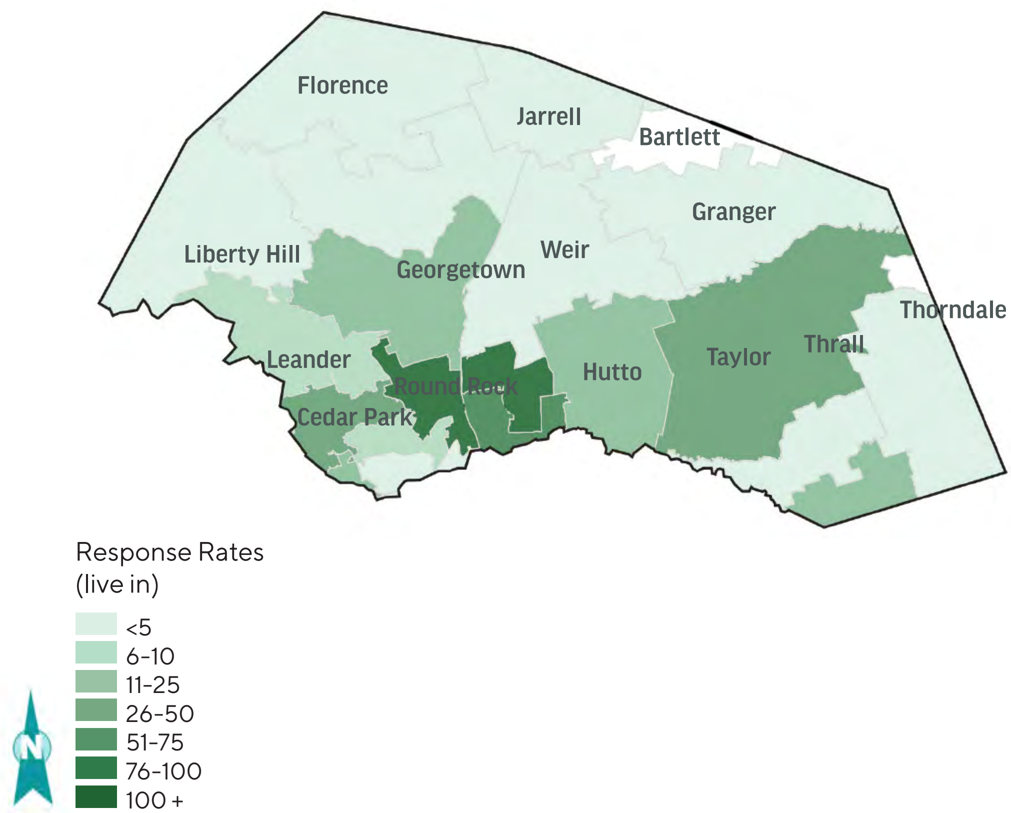
It should be noted that the majority of responses came from residents of the Steiner Ranch area, who strongly emphasized concerns for congestion and safety conditions on RM 620. Other topics addressed in comments from Travis County residents include suggestions to identify improved safety evacuation routes and the need for reliable, convenient, and safe Multi-modal transportation options.

Public Meetings: Williamson County

Several key themes were identified by local government representatives at in-person meetings. These included the following identified needs:

- Impact of emerging developments will increase traffic volume
- Added capacity and connections for existing arterials
- Improved connectivity throughout county, including within cities
- Additional support for school traffic, including improved routes for school buses and bottleneck relief for pickup zones





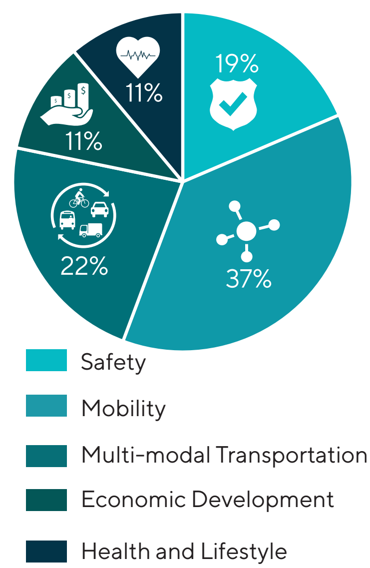


Figure A.37

380 English and 3 Spanish survey responses were received from residents of Williamson County, living in 19 of the 27 county zip codes. Of the 41 respondents who provided their commute destinations, the majority travel to Taylor, Round Rock, or Austin.

Responses from Williamson County frequently suggest a need for Multi-modal facilities, including improved bicycle and pedestrian facilities and more reliable and convenient transit options. Williamson County residents also noted a need for improved signal timing on existing roadways.

Figure A.38

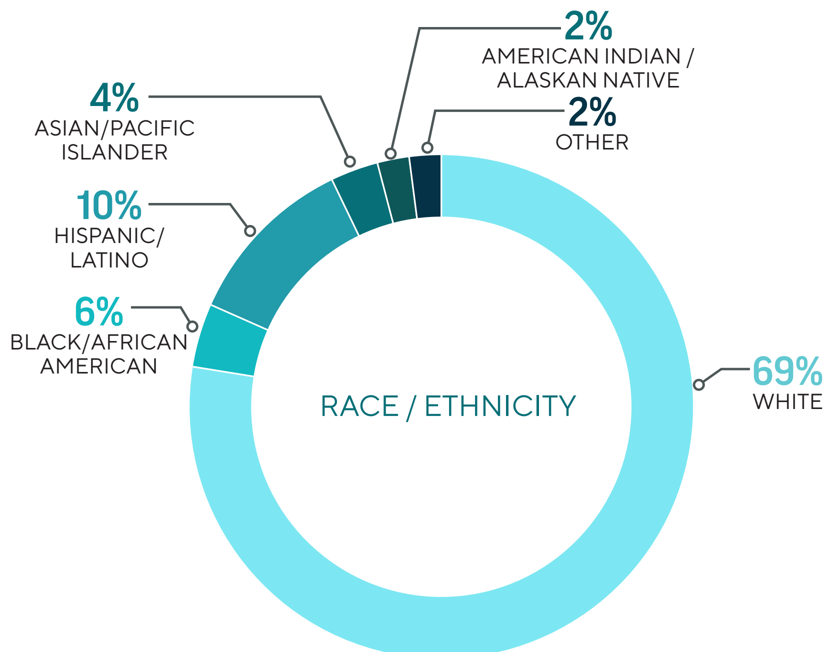


Figure A.39

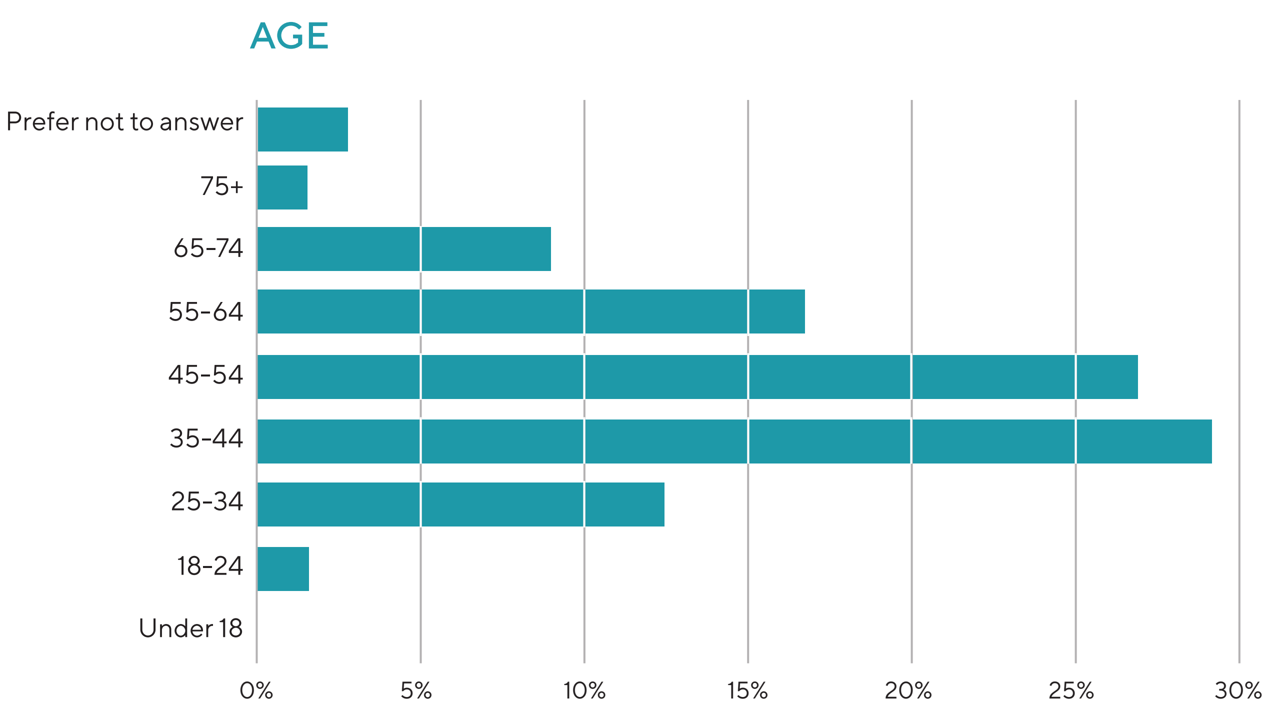


Figure A.40

INCOME

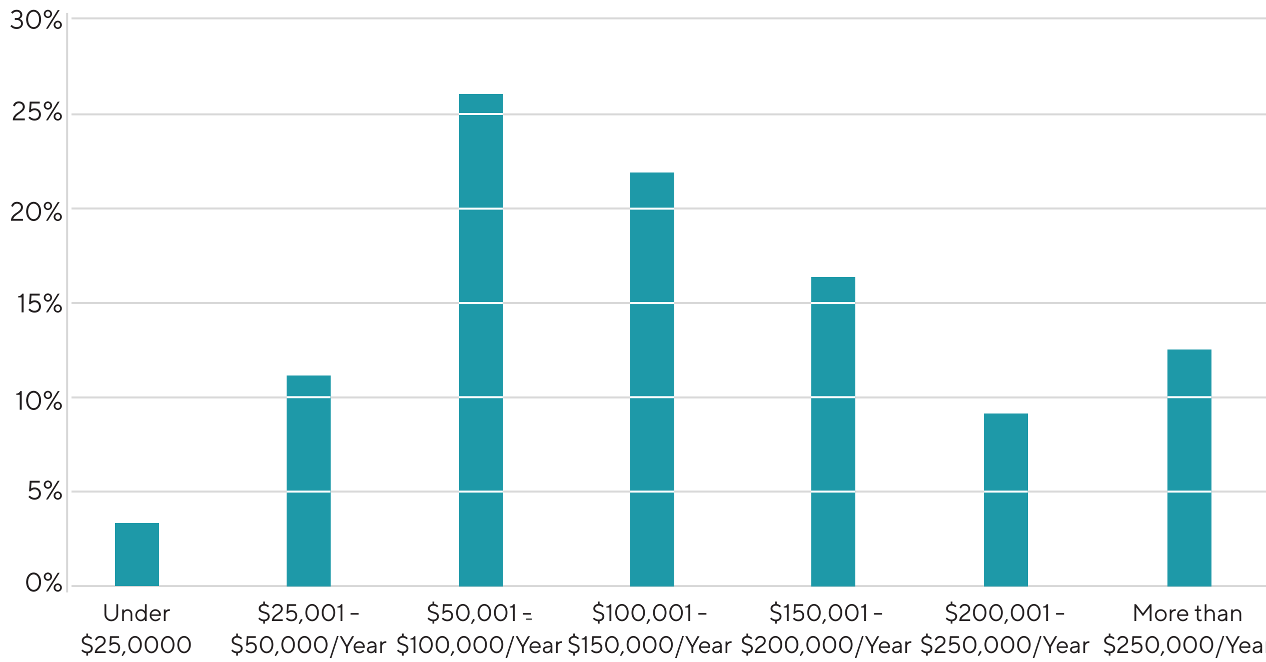


Figure A.41

Comment Form Responses - Summer 2019

Question 1: How do you think the findings in the RACI will affect your commute?
- Positively – 95
- Negatively – 84
- No effect/unclear – 59

Question 2: Will improving the region's arterial network improve your quality of life? Why or why not?
- Positive impact – 126
- Negative impact – 154

Question 3: Which network do you think will most benefit the region?
- A – 7
- B – 18
- C – 10
- None of these - 9

Additional Comment Topics

- Access and impacts to Steiner Ranch neighborhood
    - Mixed and polarized response about expanding road network nearby
    - Strong opposition to bringing through traffic to area
    - Would like a second exit in back of neighborhood in case of emergencies and to relieve congestion within neighborhood
    - Impacts to lifestyle, crime, property values were cited in opposition to development
- Bridge crossings over Lake Austin – mixed response, but many noted that additional crossings would be very beneficial
- Impacts to Quinlan Park Rd
    - Safety for children and pedestrians
    - Do not want it to become an arterial, high speed will make it dangerous to bike/walk
    - Concern about current and future congestion
- Safety and emergency access
    - Lack of alternate evacuation routes and congestion cause dangerous conditions in case of fire or other emergencies
    - Concern about high travel speeds
- School zones – concerned about higher speed travel through school zones and near sidewalks that children use
- Support for flex lanes
- Confusion about purpose and outcomes of Study, and purpose of maps
- Multimodal and public transit options
    - Some expressed desire for public transit options instead of expanding roads
    - Bus, light rail and underground subways were proposed as options
    - Park & ride lots and bicycle accommodations desired
- Congestion and extremely long commute times were major topics, with various suggestions for solutions
    - Some expressed concern that plans would only shift congestion to a new area and not relieve it
    - Congestion especially bad on RM 620, RM 2222, SL 360, Anderson Mill
    - Desire for improvements along RM 620 and RM 2222

- Environmental impacts
    - Concern about development in environmentally sensitive areas
    - Opposition to expanding network due to increased emissions
    - Do not want to destroy scenic areas
- Desire to increase access to Lakeway and Bee Cave
- Desire improvement to US 290
- Overall improvements to regional network and connectivity
- Concern about cost and sources of funding
- Strong opposition to implementing reversible lane on Bee Cave Road, especially if new turn lane is converted

Promotion of Opportunities for Participation

Several methods were used to promote the public open houses and local government meetings, along with the online surveys and virtual open house.

Phone Outreach - Phone calls were made to more than 120 city and county government officials, ISD contacts, higher education representatives, other transportation entities, and community groups from all six counties. Contacts reached were asked to participate and to help distribute information to their communities and contacts.

Meeting Fliers - Were distributed through social media, email, and in-person to community groups, local businesses, and planning partners who could share with their contacts.

Media Coordination - A media release was sent to 70 media contacts on March 29, 2018. Contacts included media outlets throughout CAMPO's six-county region from local radio, television, and print publications.

Social Media - Posts were shared on CAMPO's social media accounts and reposted by stakeholders and community partners, including local governments, advocacy groups, and transportation entities. Social media advertisements were developed in both English and Spanish to encourage survey participation and extend our reach in the region.

Email Campaigns - Email notifications with public meeting details and survey links were sent to the CAMPO database on March 29 to 6,044 emails and May 4 to 6,606 emails.

120 Personal Phone Calls made to government officials

70 media contacts sent media packets

+6,000 e-mails sent for e-mail campaign

Vision, Goals, and Objectives

Input was collected on the Goals and Objectives through a dot exercise in the public meetings. Attendees were given two dots and asked to place them by their top two goals. The table below shows the number of responses for this exercise by county.

		Goals and Responses					
		Safety	Mobility	Multi-modal	Economy, Equity, and Health	Growth	Environment
County Name	Bastrop	2	15	11	5	10	2
	Burnet	13	17	2	1	10	2
	Caldwell	2	2	1	2	2	1
	Hays	5	16	8	6	7	17
	Travis	4	3	4	2	3	0
	Williamson	6	16	7	1	12	0
	Total	32	69	33	17	44	22

Figure A.42

The existing network and its performance is directly related to the interaction between the available supply (roadway) and demand (people). Demand can be described as the number of roadway users, their origins and destinations, and how they traverse the roadway (car, bike, transit). Supply can be described as the amount of roadway and the type of roadway. Performance is a measure of the relationship between the supply and demand. Performance can suffer when demand is greater than supply – lack of network or route choice or the supply is not appropriate for the demand – focused on access versus mobility.

REGIONAL ARTERIALS CONCEPT INVENTORY

APPENDIX - B

ARTERIALS CONCEPT

CAMPO
CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

Arterial Test Case Corridors

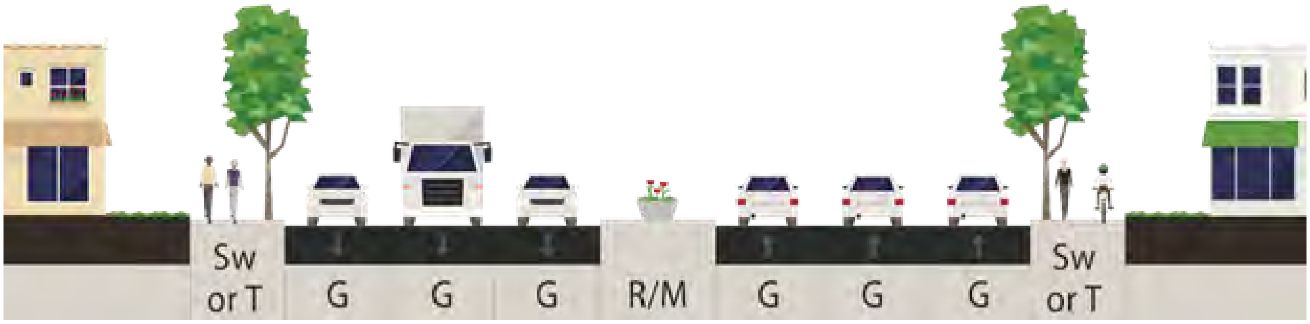
Wonder World Drive from Hunter Road to IH-35

Proposed Improvement

Wonder World Drive from Hunter Road to IH-35 is proposed to be upgraded from a 4-lane Undivided to 6-lane Divided.

Recommended Pattern Book Cross Section

Based on the Pattern Book chapter, this segment of Wonder World drive is a Zone 3, Suburban 1 context. The forecasted growth in employment and population are expected to triple. Resulting traffic volumes are forecasted to grow from approximately 28,000 vehicles per day to almost 82,000 vehicles per day by 2040. The roadway is considered a principal arterial and is recommended to be improved from its current 4-lane undivided cross section to a 6-lane divided cross section. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #17 from the Pattern Book chapter



ROW: 95′ - 155′
Divided
6 lane divided with 6 general purpose lanes

Context

Context: Located on the southern side of San Marcos, this segment of wonder World Drive runs northwest from IH-35. Current land use is oriented toward industrial and warehouse-based commercial, with a modest volume of multi-family residential as well. There is also a significant volume of undeveloped land in this corridor, with just over 70 acres of vacant lots and/or qualified open-space.

The current zoning along Wonder World Drive is primarily commercial and industrial. Future land patterns will be driven by the size of economic development projects in the area. The active railroad that crosses Wonder World Drive will impact some parcels more than future road upgrades and improvements. Stagecoach Trail will likely serve as the dividing line between small commercial and retail businesses and larger industrial users to the southwest.

Opportunities

San Marcos is one of the fastest growing communities in the nation, (having recently led the country for several years in a row in the rate of population growth) and consumer services are being rapidly developed to meet the needs of the multitude of new residents. East of IH-35 this pattern is evident along Wonder World Drive, as a number of retail, medical, entertainment, and hospitality uses are clustered across the highway, along with several large multi-family developments. On the western side of the segment, there are also a number of commercial outlets, including senior living and some financial services.

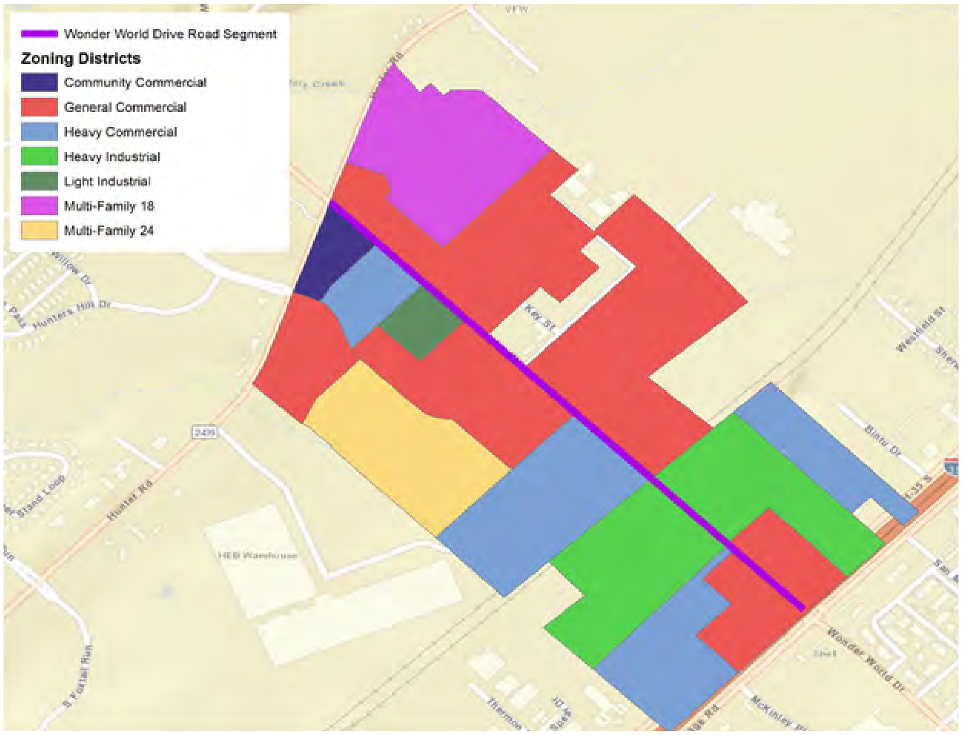
Over the next 25 years and based on TAZ forecast data, both population and employment in the area are projected to approximately triple, reflecting continued rapid growth along the IH-35 Corridor in general and the

San Marcos/Hays County in particular. The pattern of development likely will remain fairly consistent with what has occurred to date, with light industrial/commercial remaining along the artery and multi-family residential being developed in the out-parcels. The improvements should facilitate the infill along the segment, as well as better enabling connectivity within the area and to the region as a whole.

If the approximately 70 acres of undeveloped property is developed consistent with the future land use plan and zoning, this could translate into over 1.0 million square feet of new commercial and industrial space, 1,500 new jobs, and $100.0 million in new taxable value.

Figure 1 – Wonder World Drive from Hunter Rd to IH-35

Figure 2 – Wonder World Drive Zoning



Source: City of San Marcos

Figure 3 – Wonder World Drive Segment Traffic Serial Zones (TAZ)

Source: CAMPO

Table 1: Wonder World Drive Segment TAZ Demographics

TAZ	Population (2015)	Employment (2015)	Population (2040)	Employment (2040)
1817	5	2,958	5	5,101
783	680	1,599	964	5,702
914	338	1,071	3,478	2,172
915	2	190	10	1,222
800	736	364	452	2,817
Total	1,761	6,182	4,909	17,014

Source: CAMPO

Figure 4 – Wonder World Drive Segment Land Use and Parcels

Source: Hays CAD

Table 2: Wonder World Drive Segment Real Land Use Breakdown (2019)

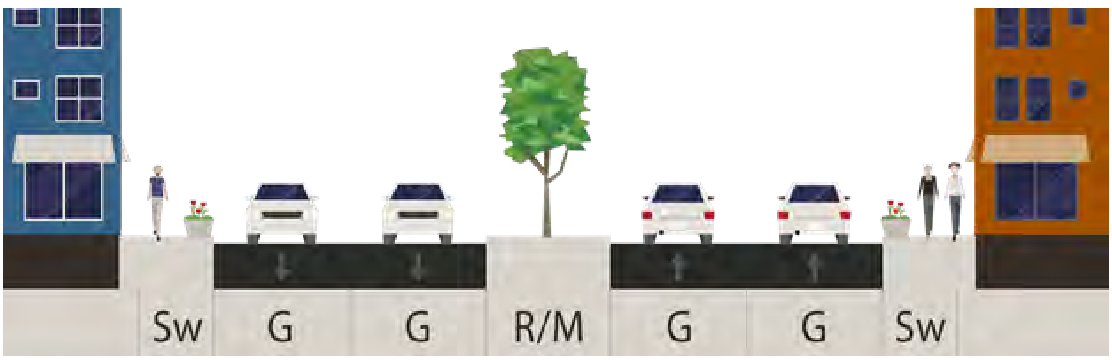
Land Use Category	Acres	Assessed Values	Value Per Acre
Single Family Residence	0.4	$157,500	$430,680
Multifamily Residence	22.5	$40,267,690	$1,791,619
Vacant Lots And Land Trac	37.1	$9,855,660	$265,864
Qualified Open-Space Land	33.7	$5,850	$173
Commercial Real Property	29.3	$36,582,692.0	$1,248,625
Industrial And Manufacture	28.5	$7,060,820	$247,585
Totally Exempt Property	2.6	$182,430	$69,777
Total	154.1	$94,112,642	$610,782

Source: Hays CAD, TXP

RM 12 from US 290 to Butler Ranch Road

Proposed Improvement
RM 12 from US 290 to Butler Ranch Road is proposed to be upgraded from 2-lane Undivided to 4-lane Divided.

Recommended Pattern Book Cross Section
Based on the Pattern Book chapter, this segment of Ranch Road 12 falls into the Zone 3 Suburban 1 context. The forecasted growth in employment and population are expected to increase by a factor of 5. Resulting traffic volumes are forecasted to grow from approximately 13,000 vehicles per day to almost 33,000 vehicles per day by 2040. The roadway is considered a principal arterial and is recommended to be improved from its current 2-lane undivided cross section to a 4-lane divided cross section. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #14 from the Pattern Book chapter is recommended.



ROW: 75' - 120'
Divided
4 lane divided with 4 general purpose lanes

Context
Located on the northern end of Hays County, this segment of RM 12 is beginning to see spillover from the rapid growth of Dripping Springs. While the land use in this area is still largely vacant/rural, there has been significant commercial development at the corner where RM 12 joins US 290, anchored by Home Depot. Dripping Springs and RM 12 have become a popular location for breweries and distilleries, with producers such as Deep Eddy Vodka, Bell Springs Winery, Treaty Oak Distillery, San Luis Spirits Revolution Spirits, Goodnight Loving Vodka, and Twisted X Brewing all either in the city or nearby. When attractions such as Hamilton Pool, live music and antiques, and a burgeoning restaurant scene are factored into the equation, it is clear that this area will be highly attractive to both visitors and future residents. Boasting over 35 wedding venues within a 15-mile radius, Dripping Springs has also become the "official wedding capital of Texas."

The current land use and zoning along RM 12 focus on commercial and residential uses. The northern and western portions of the RM 12 segment imagines more commercial and retail activity. The majority of the eastern side of RM 12 should be single-family homes.

Opportunities
Dripping Springs has exploded in recent years, reflecting both the overall growth of the Capital Area, the amenities described above, and the particular geographic beauty and appeal of northern Hays and southwestern Travis Counties. The improvements will facilitate growth spreading to the south, where there is ample room for new development. Meanwhile, the demographics of the area are likely to change, as people with more disposable income and higher education are likely to be drawn to the area. This in turn will stimulate

demand for higher end retail, additional entertainment, more upscale housing (perhaps including higher-end multi-family at some point) and eventually perhaps small-scale office.

Over the next 25 years and based on TAZ forecast data, population and employment are expected to grow by a factor of 5. This forecast is plausible; the factors above suggest that the development and growth that occurs will be higher-end than the historical pattern. The improvements should play an important role in making that happen. If the roughly 100 acres of the undeveloped property transitions to commercial and residential lots in comparable size to the surrounding neighborhoods over the next 20 years, this could result in over $25.0 million in new taxable value.

Figure 1 – RM12 from US 290 to Butler Ranch Road

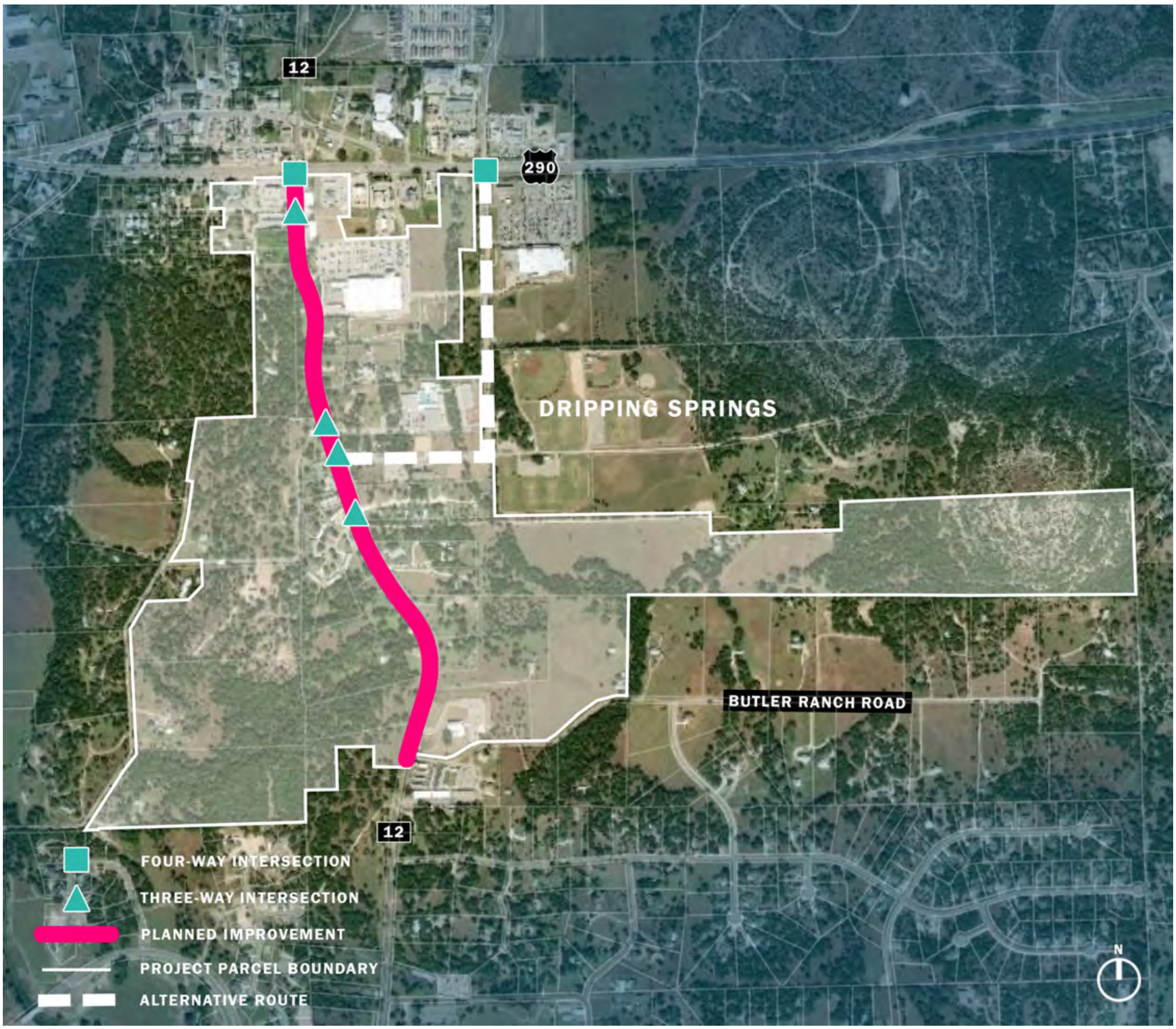
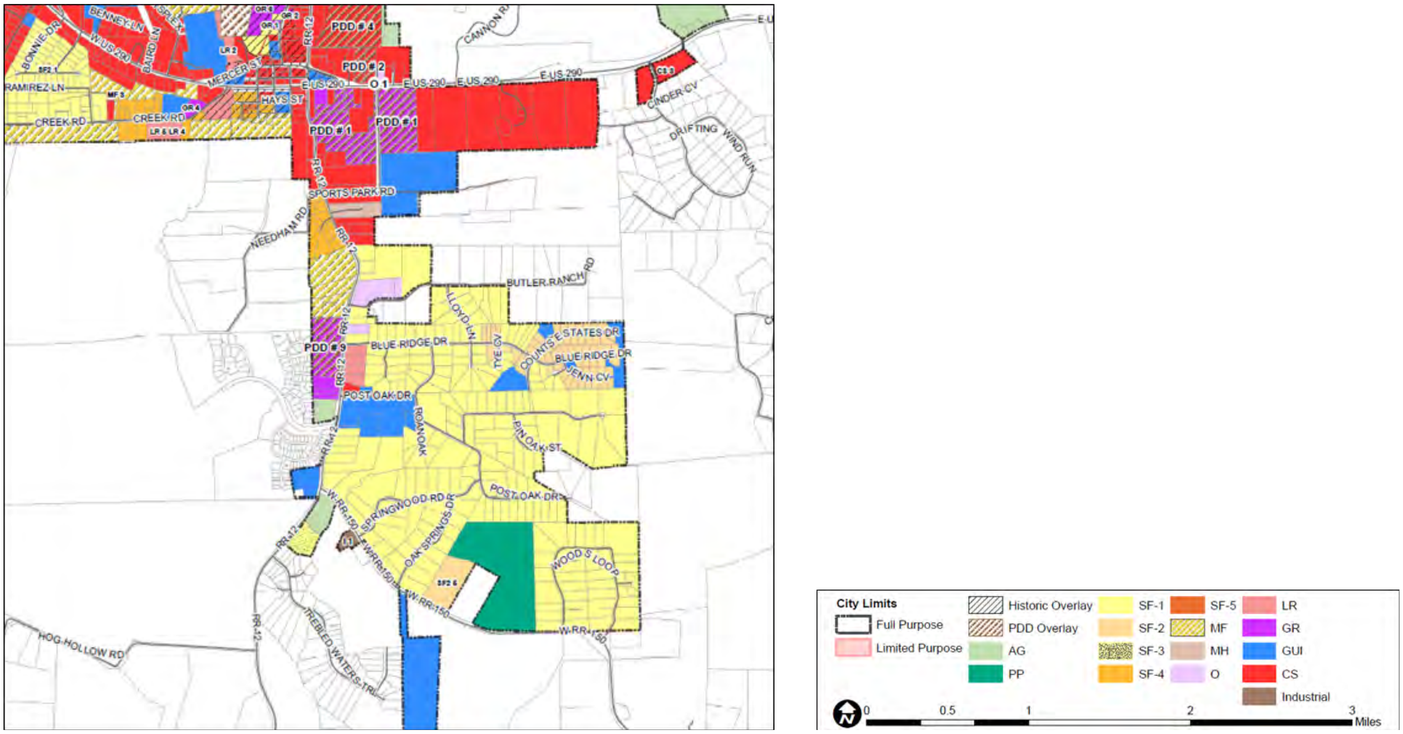
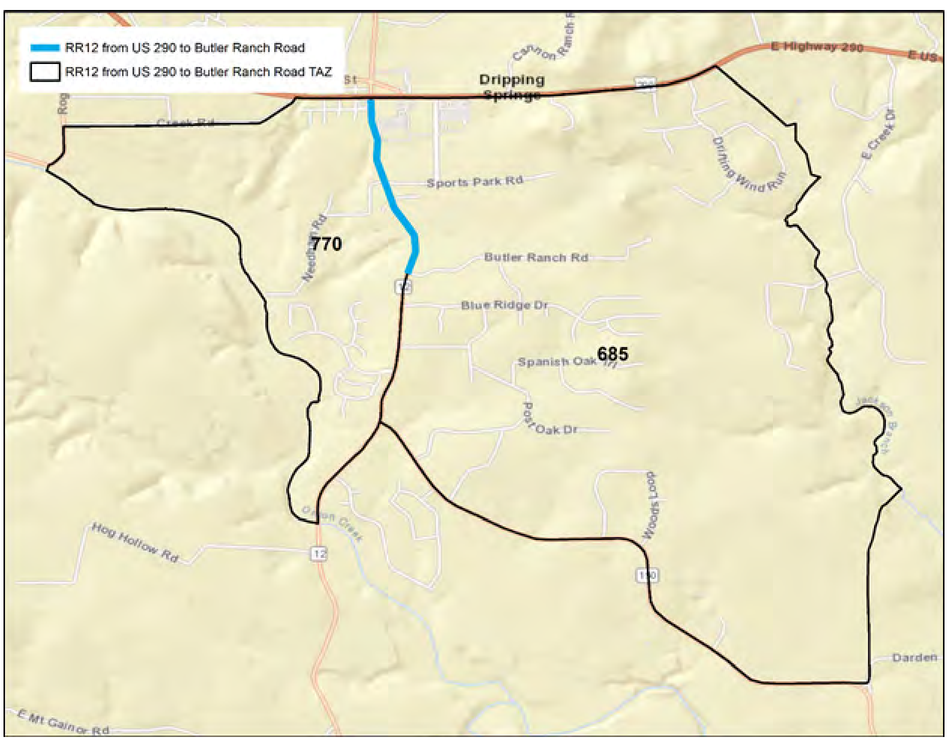


Figure 2 – RM12 from US 290 to Butler Ranch Road Zoning



Source: City of Dripping Springs

Figure 3 – RM12 from US 290 to Butler Ranch Road Traffic Analysis Zones (TAZ)



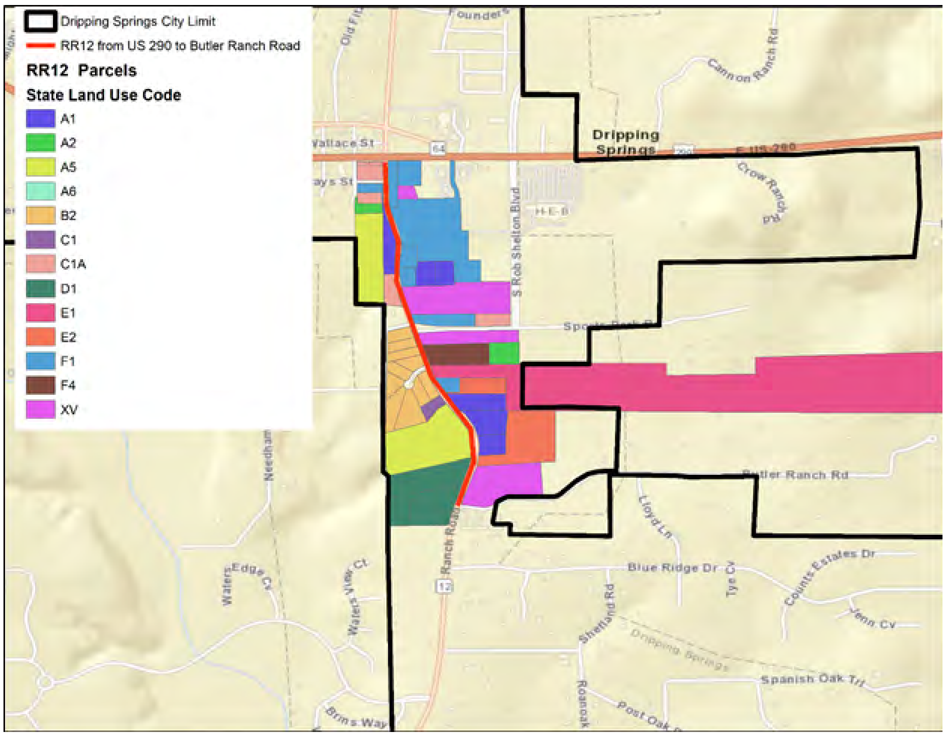
Source: CAMPO

Table 1: RM12 from US 290 to Butler Ranch Road TAZ Demographics

TAZ	Population (2015)	Employment (2015)	Population (2040)	Employment (2040)
770	159	123	351	1,856
685	1,001	722	5,638	2,074
Total	1,160	845	5,989	3,930

Source: CAMPO

Figure 4 – RR12 from US 290 to Butler Ranch Road Segment Land Use and Parcels



Source: Hays CAD

Table 2: RM12 from US 290 to Butler Ranch Road Segment Real Land Use Breakdown (2019)

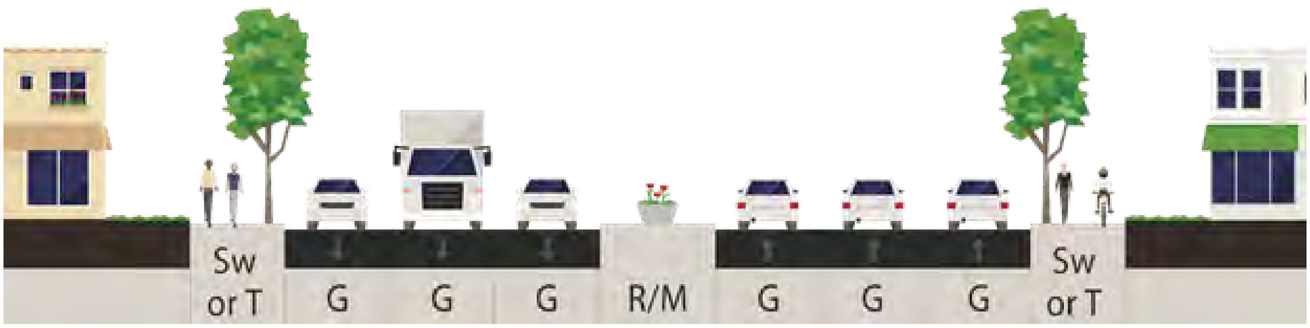
Land Use Category	Acres	Assessed Values	Value Per Acre
Single Family Residence	53.2	$3,952,912	$74,349
Multifamily Residence	12.8	$2,753,430	$215,215
Vacant Lots And Land Trac	6.7	$734,910	$109,007
Qualified Open-Space Land	95.7	$92,680	$969
Rural Land, Non Qualified	15.6	$879,000	$56,173
Commercial Real Property	31.6	$10,483,398	$332,213
Totally Exempt Property	26.0	$4,453,720	$171,106
Unidentified	7.0	$0	$0
Total	248.6	$23,350,050	$93,913

Source: Hays CAD

SH 21 from SH 80 to Arnold Avenue

Proposed Improvement
SH 21 from SH 80 to Arnold Avenue is proposed to be upgraded from 4-lane Undivided to 6-lane Divided

Recommended Pattern Book Cross Section
Based on the Pattern Book chapter, this segment of SH 21 falls into the Zone 4 Suburban 1 context. The forecasted growth in employment and population are expected to increase by a factor of 4. Resulting traffic volumes are forecasted to grow from approximately 10,000 vehicles per day to almost 45,000 vehicles per day by 2040. The roadway is considered a principal arterial and is recommended to be improved from its current 4-lane undivided cross section to a 6-lane divided cross section. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #17 from the Pattern Book chapter is recommended.



ROW: 95' - 155'
Divided
6 lane divided with 6 general purpose lanes

Context
Located on the eastern side of San Marcos, this segment of SH 21 connects to the San Marcos Regional Airport. The land use in this area is largely vacant/rural, with Quail Creek Golf Course accounting for the limited commercial property. There is a significant volume of undeveloped land in this corridor, with just over 250 acres of vacant lots and/or qualified open-space. Not all of the property is within the City of San Marcos city limits. The combination of the San Marcos Regional Airport, Quail Creek Golf Course, and Gary Sports Complex limits development opportunities on the northern end of this segment. Over the long-term, the construction of FM 110 (San Marcos Loop) will enhance connectivity of the road segment.

Based on current zoning and land use, the northern side of SH 21 within the San Marcos city limits should develop as residential. The development pattern on the southern side of SH 21 will likely be residential but is currently being used for agricultural purposes. TxDOT also controls nearly 7 acres near the intersection of SH 21 and SH 80 which is currently being used as maintenance facility.

Opportunities
San Marcos is one of the fastest growing communities in the nation, (having recently led the country for several years in a row in the rate of population growth) and consumer services are being rapidly developed to meet the needs of the multitude of new residents. The improvements will facilitate more rapid connection to activity centers to the west in San Marcos, as well as better enabling any airport related development. Since there is a substantial volume of vacant land, growth will naturally gravitate toward this area, much as it has done to the east along TX 79 toward SH 130 and in the area near SH 130 and TX 290.

Over the next 25 years and based on TAZ forecast data, population is anticipated to grow by a factor of 4 (although only from about 300 to 1,200 people), while employment in the area is projected to hold constant. This forecast is likely too conservative, especially regarding employment, as the intersection of the proposed improvement will be ripe for significant commercial development. This is especially true if residential development occurs at pace more consistent with the analogous areas in the region cited above; if several thousand residents end up in this area, commercial inevitably will follow. The improvements should facilitate both happening over the forecast horizon.

If the 122 acres of the undeveloped property transitions to residential lots in comparable size to the surrounding neighborhoods over the next 20 years, this could result in over 650 new residential units and exceed $150.0 million in new taxable value.

Figure 1 – SH 21 from SH 80 to Arnold Avenue

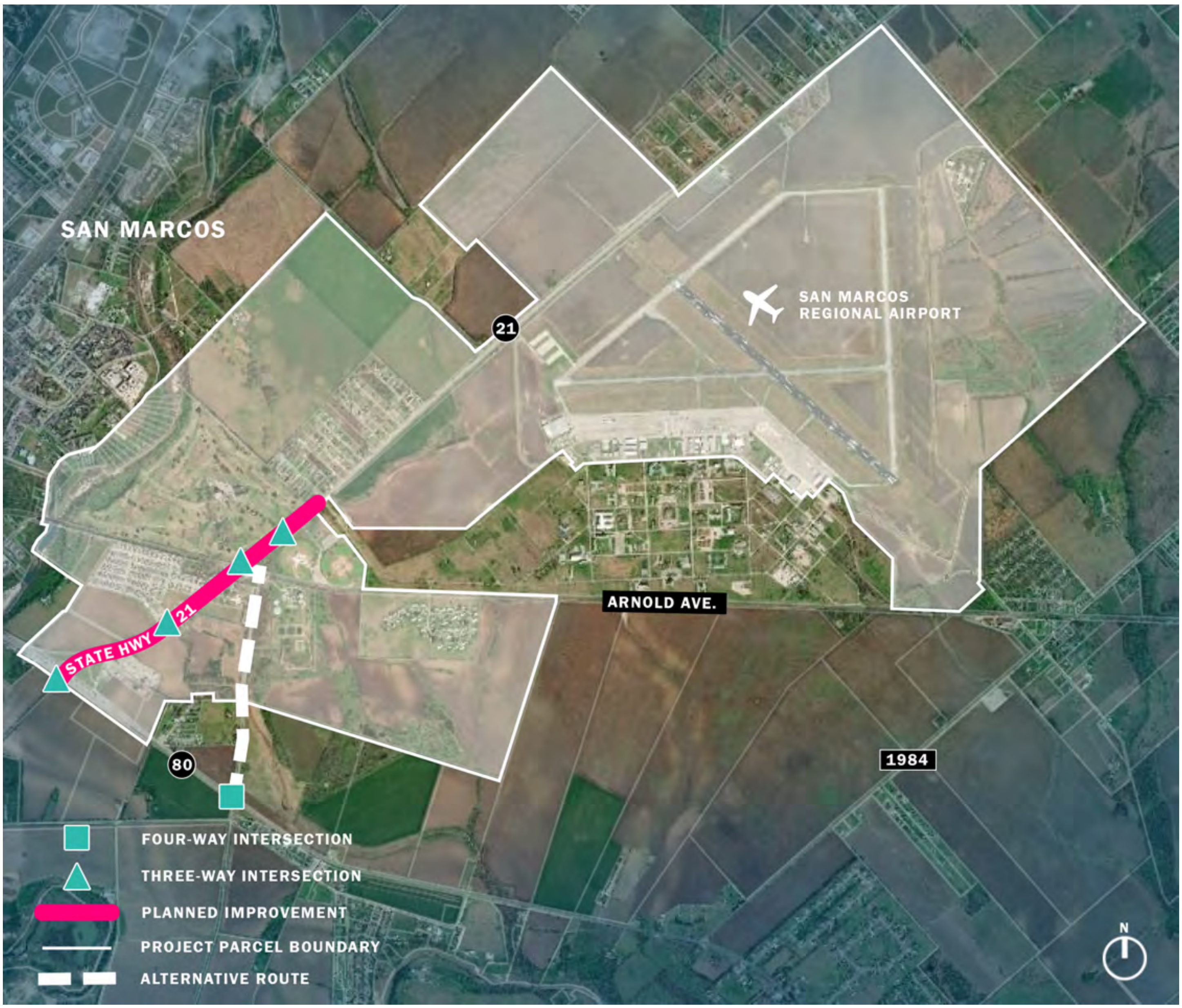
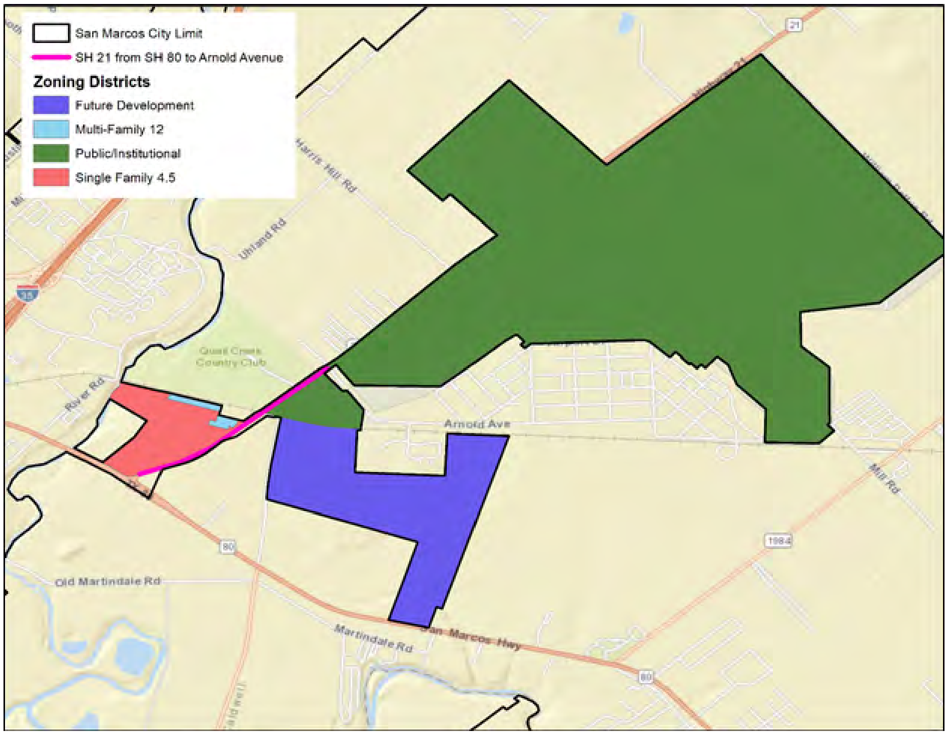
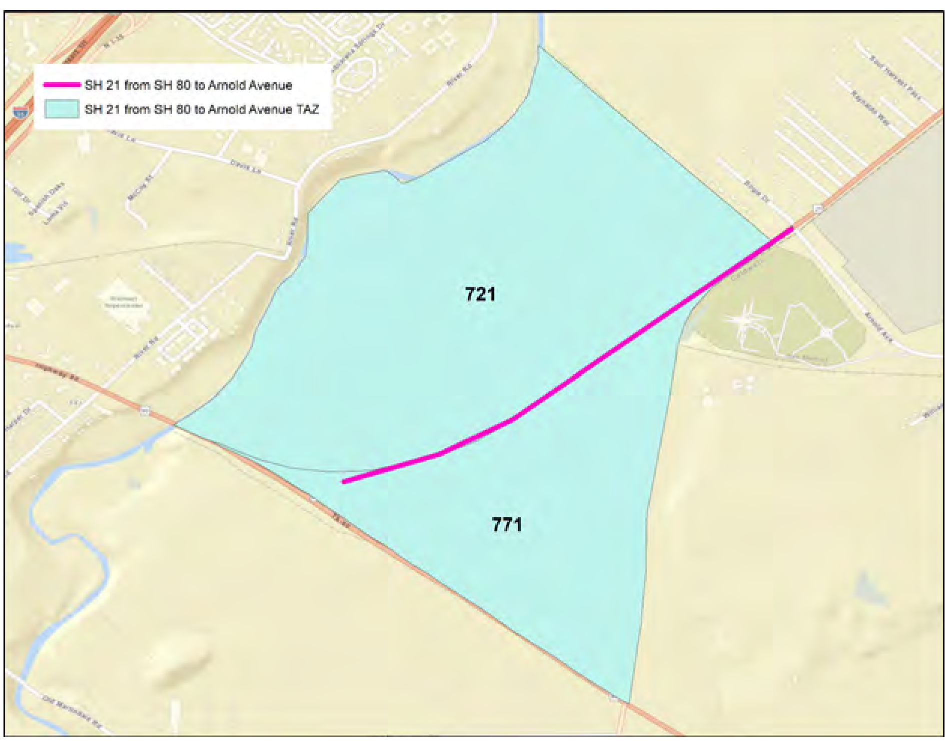


Figure 2 – SH 21 from SH 80 to Arnold Avenue Zoning



Source: City of San Marcos

Figure 3 – SH 21 from SH 80 to Arnold Avenue Segment Traffic Serial Zones (TAZ)



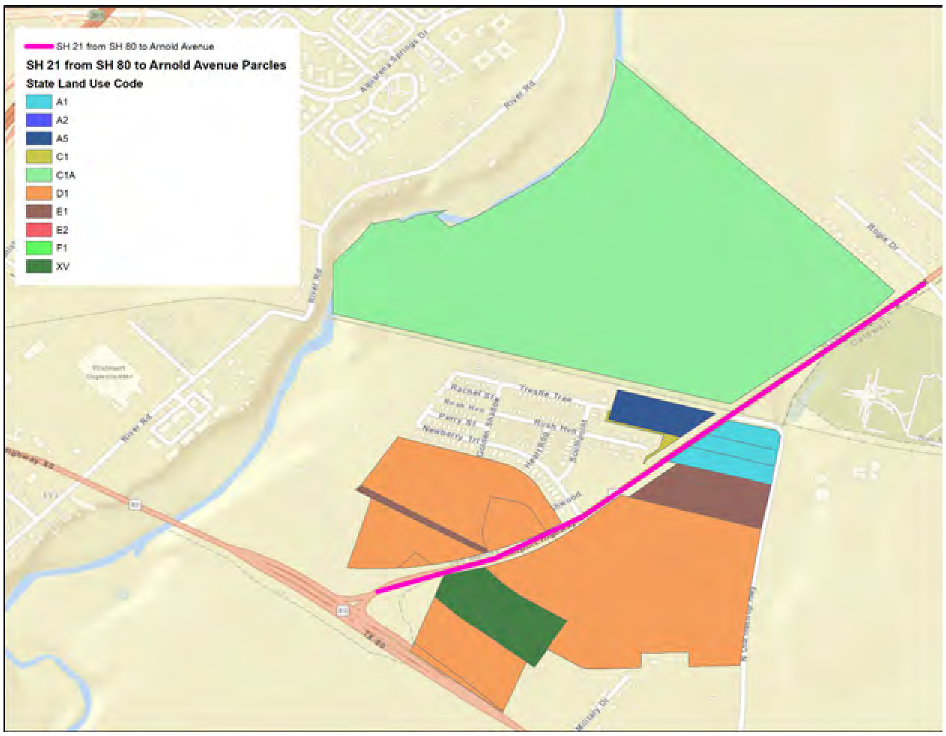
Source: CAMPO

Table 1: SH 21 from SH 80 to Arnold Avenue TAZ Demographics

TAZ	Population (2015)	Employment (2015)	Population (2040)	Employment (2040)
721	242	137	642	148
771	86	28	559	16
Total	328	165	1,201	164

Source: CAMPO

Figure 4 – SH 21 from SH 80 to Arnold Avenue Segment Land Use and Parcels



Source: Hays CAD

Table 2: SH 21 from SH 80 to Arnold Avenue Segment Real Land Use Breakdown (2019)

Land Use Category	Acres	Assessed Values	Value Per Acre
Single Family Residence	15.1	$905,010	$59,976
Vacant Lots And Land Trac	0.7	$697,950	$1,047,238
Qualified Open-Space Land	44.2	$19,150	$434
Rural Land, Non Qualified	78.8	$814,710	$10,343
Commercial Real Property	175.7	$1,040,850	$5,925
Totally Exempt Property	11.5	$860	$74
Unidentified	4.7	$0	$0
Total	330.6	$3,478,530	$10,522

Source: Hays CAD

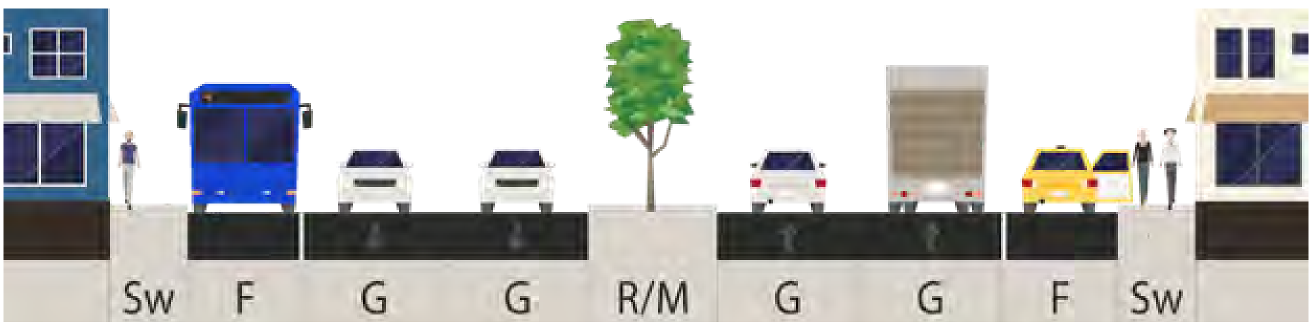
RM 1431 from Lake Crest Drive to Deer Canyon Road

Proposed Improvement

RM 1431 from Lake Crest Drive to Deer Canyon Road is proposed to be upgraded from a 4-lane Undivided to a Boulevard - 4GP + 2 local.

Recommended Pattern Book Cross Section

Based on the Pattern Book chapter, this segment of SH 21 falls into the Zone 4 Urban 2 context. The forecasted growth in employment and population are expected to increase slightly in this small town. Traffic volumes are forecasted to grow from approximately 18,000 vehicles per day to almost 34,000 vehicles per day by 2040 – traffic growth attributed to through trips. The roadway is considered a principal arterial and is recommended to be improved from its current 4-lane undivided cross section to a 6-lane divided cross section. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #15 from the Pattern Book chapter is recommended.



ROW: 95' - 140'
Divided
6 lane divided with 4 general purpose lanes and 2 flex lanes

Context

Located on the northern end of Lake Travis, the City of Jonestown is a community of 2,000 residents. RM 1431 serves as the commercial corridor of the City. Like many rapidly developing rural regions in the Capital Area, citizens are trying to preserve a specific way of life and attract compatible economic and community development projects. The majority of parcels along the RM 1431 segment are defined as commercial real property and vacant lots. The lots tend to be small in size with the majority less than half an acre.

A major concern in the community is the volume of traffic along RM 1431. The combination of topography, traffic counts, and lack of dedicated turn lanes make this segment difficult to navigate. The challenge going forward is to improve safety along this corridor to help facilitate the town center concept the community envisions along RM 1431.

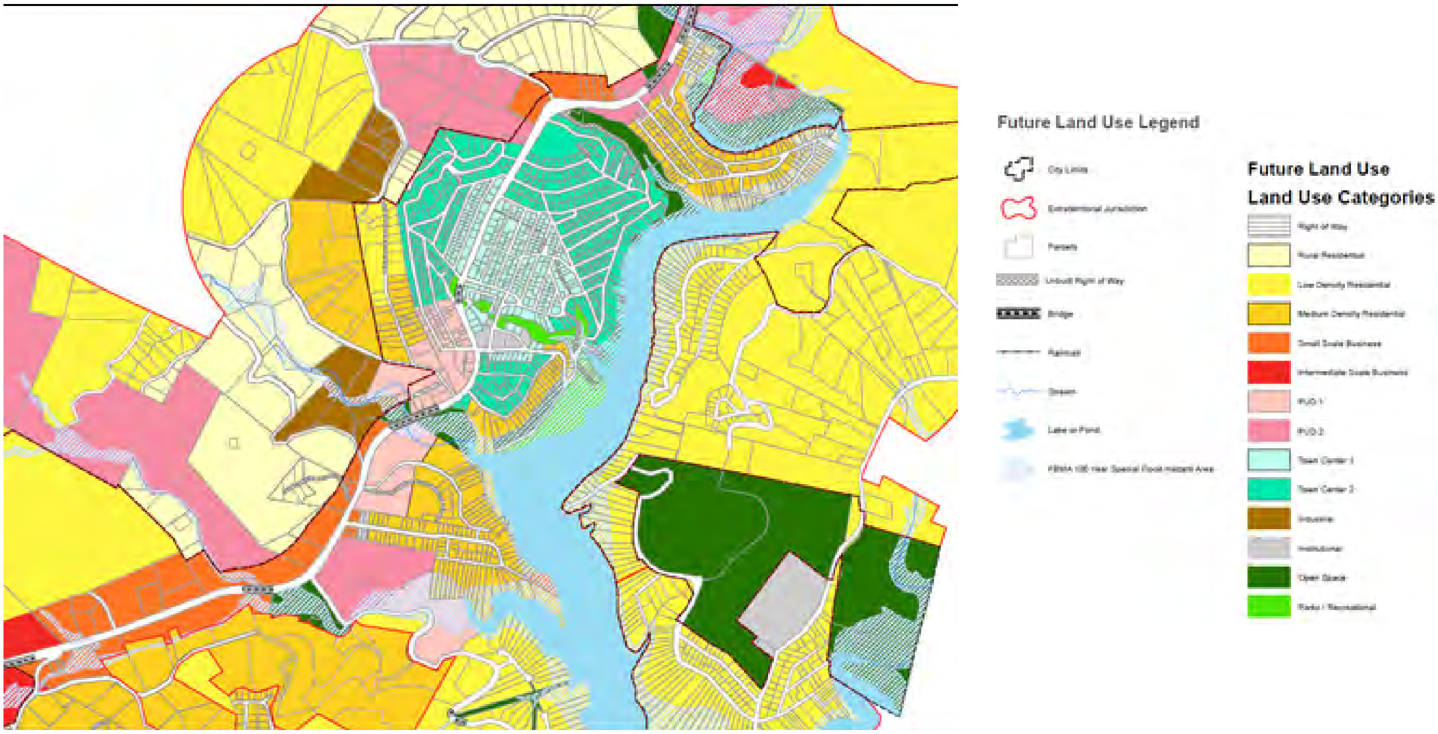
Opportunities

Jonestown's future land use plan depicts the RM 1431 segment as a town center. This area would be comprised of mixed-use single-family residential units, small square footage commercial businesses (that may be combined with residential use on the same property or in same building), professional office, government, institutional. Buildings along this corridor would likely be 2 or 3 stories tall. Development opportunities are currently limited in Jonestown due to challenging topography and a lack of a centralized wastewater system. As described in the land use plan, a main barrier the town center concept faces in terms of development is adequate wastewater facility connections. Therefore, the roadway improvements impact on the community might be constrained based on other infrastructure issues.

If the approximately 30 acres of undeveloped and underdeveloped property is built out as a mixed-use town center over the next 20 years, this could translate into 700,000 square feet of new commercial and residential space, 500 new jobs, and $100.0 million in new taxable value.

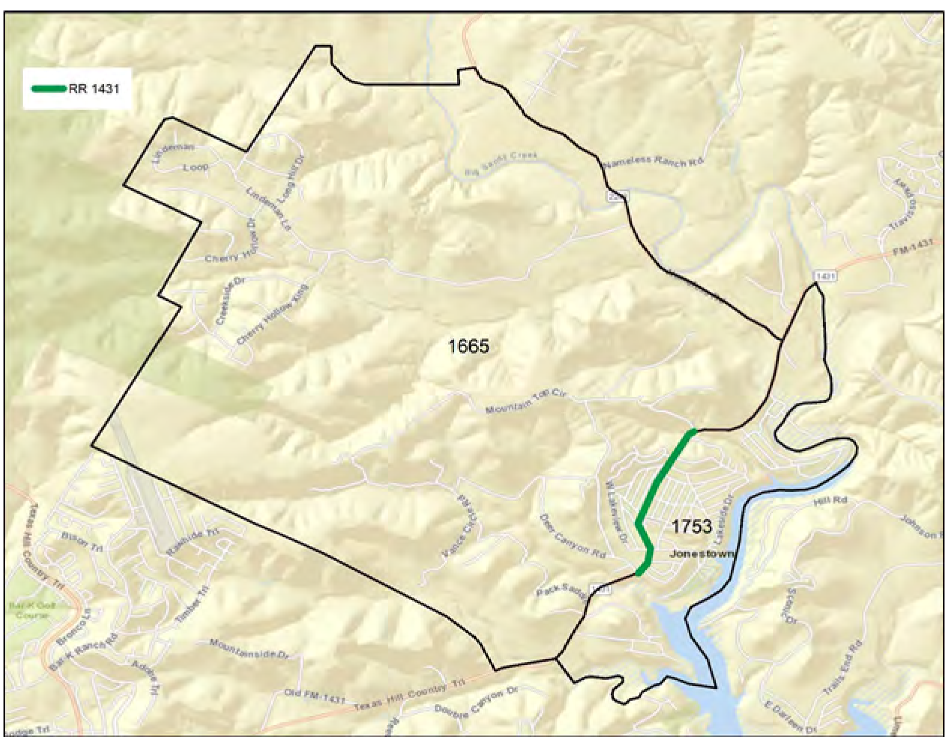
Figure 1 – RM 1431 from Lake Crest Drive to Deer Canyon Road

Figure 2 – RM 1431 from Lake Crest Drive to Deer Canyon Road Zoning



Source: City of Jonestown

Figure 3 – RM 1431 from Lake Crest Drive to Deer Canyon Road Traffic Analysis Zones (TAZ)



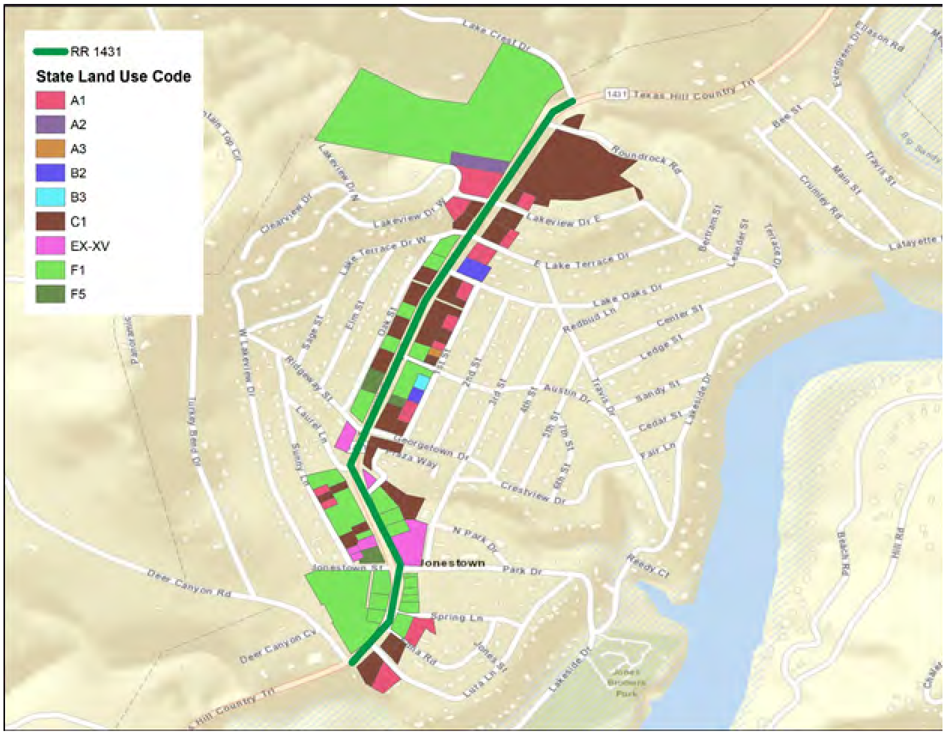
Source: CAMPO

Table 1: RM 1431 from Lake Crest Drive to Deer Canyon Road TAZ Demographics

TAZ	Population (2015)	Employment (2015)	Population (2040)	Employment (2040)
1665	1,630	191	3,587	196
1753	939	276	959	136
TOTAL	2,569	467	4,546	332

Source: CAMPO

Figure 4 – RM 1431 from Lake Crest Drive to Deer Canyon Road Land Use and Parcels



Source: Travis CAD

Table 2: RM 1431 from Lake Crest Drive to Deer Canyon Road Land Use Breakdown (2018)

Land Use Category	Acres	Assessed Values	Value Per Acre
Single Family Residence	6.6	$2,682,528	$408,160
Multifamily Residence	1.0	$163,194	$163,399
Qualified Open-Space Land	18.2	$1,815,035	$99,604
Commercial Real Property	36.8	$9,050,306	$246,242
Totally Exempt Property	2.8	$0	$0
Total	65.3	$13,711,063	$209,952

Source: Travis CAD

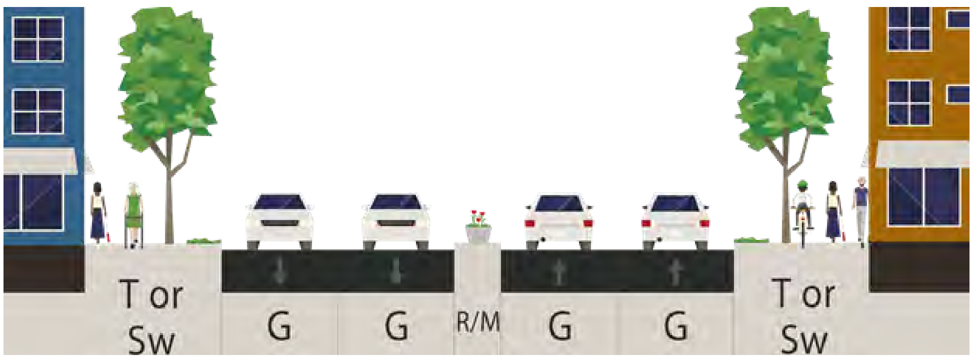
SH 21 from Gaines Road to SH 71

Proposed Improvement

SH 21 from Gaines Road to SH 71 is to be upgraded from a 2-lane Undivided to 4-lane Divided.

Recommended Pattern Book Cross Section

Based on the Pattern Book chapter, this segment of SH 21 falls into the Zone 5 Suburban 2 context. The forecasted growth in employment and population are expected to triple. Resulting traffic volumes are forecasted to grow from approximately 12,000 vehicles per day to almost 15,000 vehicles per day by 2040. The roadway is considered a principal arterial and is recommended to be improved from its current 2-lane undivided cross section to a 4-lane divided cross section. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #21 from the Pattern Book chapter is recommended.



ROW: 75' - 130'
Divided
4 lane divided with 4 general purpose lanes

Context

Located to the west of the City of Bastrop, this segment of SH 21 connects to SH 71. The land use in this area is largely rural, large lot residential, with only a few small retail and commercial establishments located at the intersection of SH 21 and SH 71. The largest parcel in the area is a 108-acre fuel terminal owned by Flint Hills Resources. The roughly 20 acres closer to the intersection of SH 21 and SH 71 has commercial land uses. The balance of the property toward the west is projected to be rural residential. The preliminary approved Los Milagros subdivision, a 410-lot development on 195 acres located near Texas 21 and FM 812 is the type of residential development likely to happen in this region of Bastrop County. Lots sizes for this development will range from a third of an acre to 1 acre. This is consistent with rural residential land use.

Opportunities

Over the next 25 years and based on TAZ forecast data, population and employment levels are anticipated to triple. What is not captured in the dataset is the number of residential developments that will likely occur further south along SH 21. The majority of people living in this area commute to Austin or Bastrop for work each day, with the expectation that there may be some future commuting patterns toward San Marcos as well. SH 21 should experience a noticeable increase in traffic in the coming years. Transportation improvements along this corridor will not only increase safety, but also impact the character of future commercial and residential developments.

If 70 acres of the undeveloped property transitions to rural residential lots over the next 20 years, this could result in over 100 new residential units and exceed $15.0 million in new taxable value. In addition, commercial land uses could add an additional $7.5 million in taxable value on the remaining undeveloped acreage.

Figure 1 – SH 21 from Gaines Road to SH 71

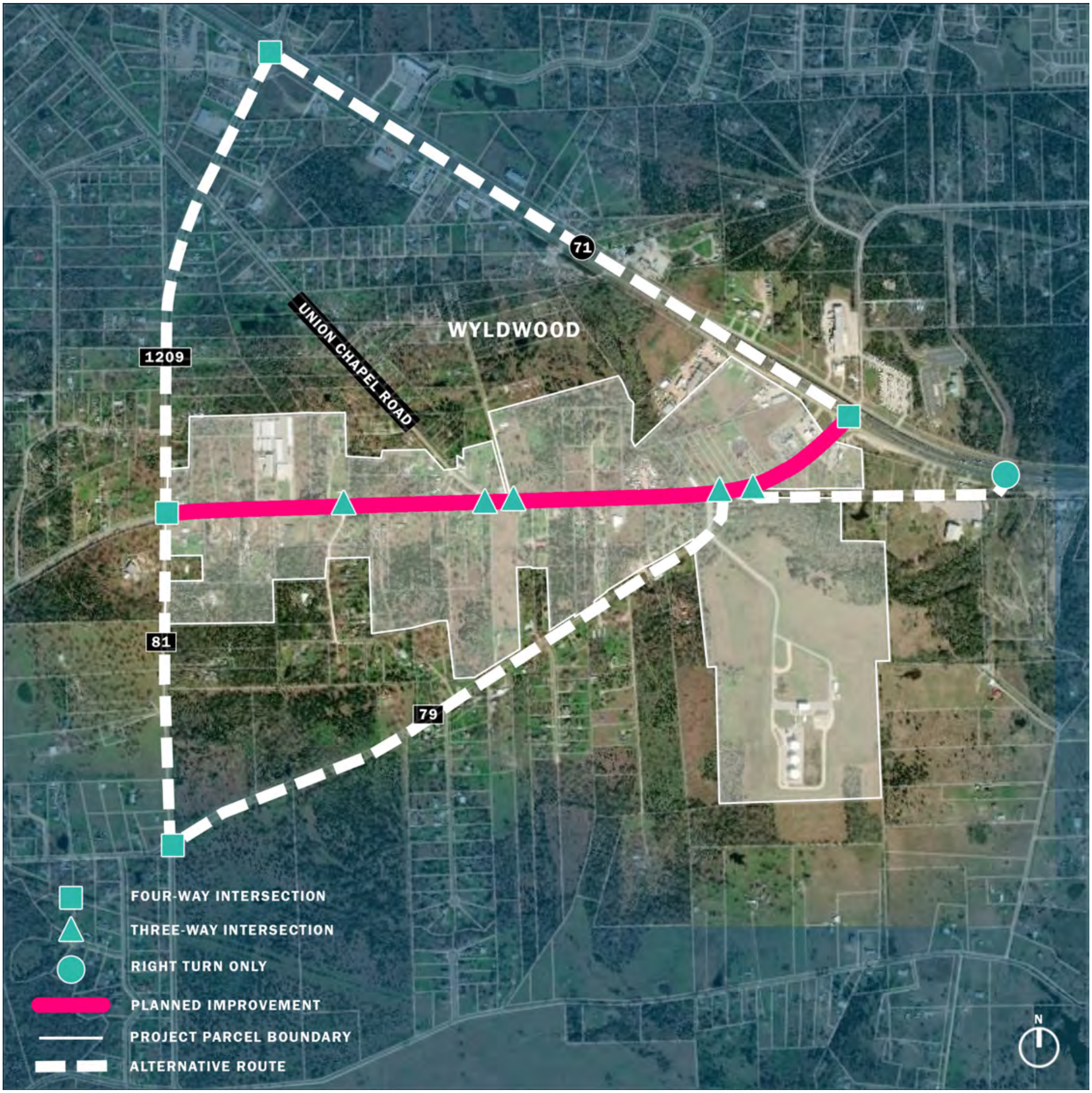
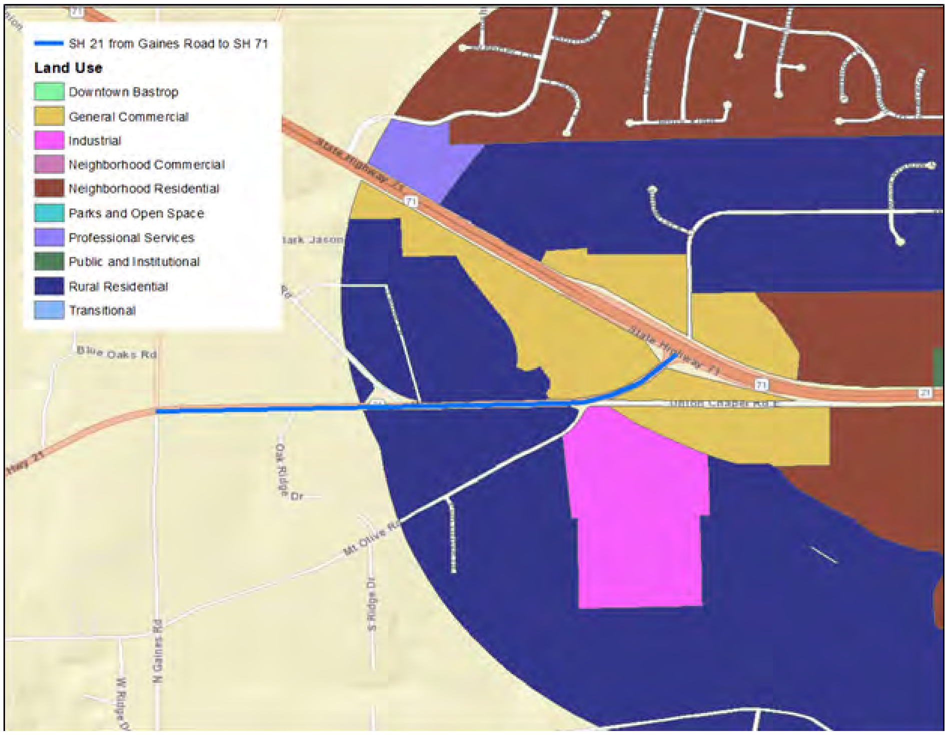
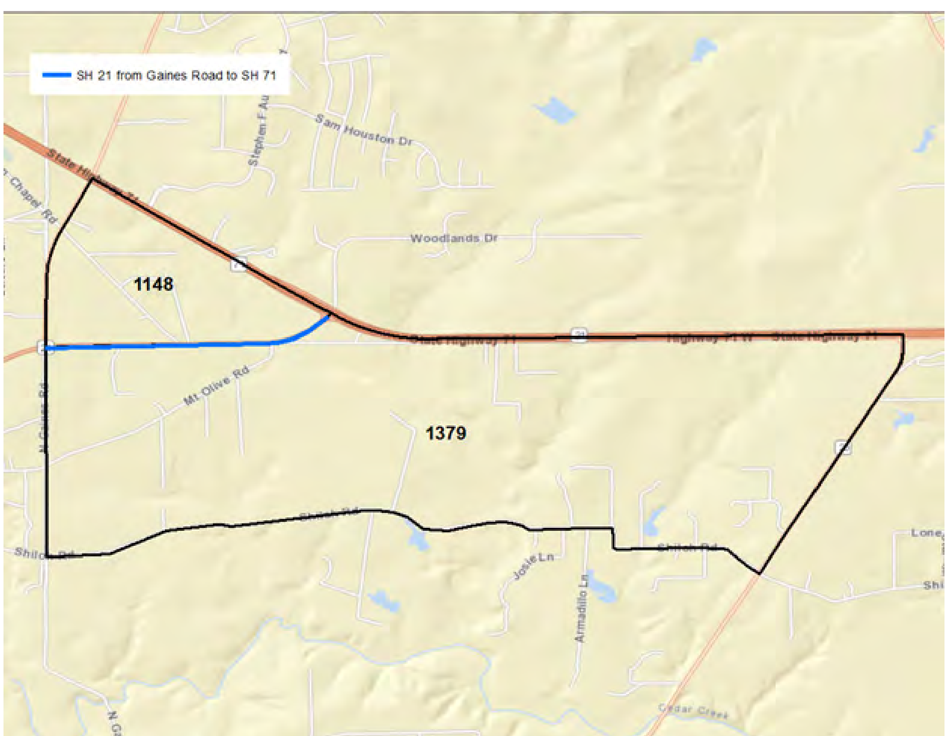


Figure 2 – SH 21 from Gaines Road to SH 71



Source: City of Bastrop

Figure 3 – SH 21 from Gaines Road to SH 71 Traffic Serial Zones (TAZ)



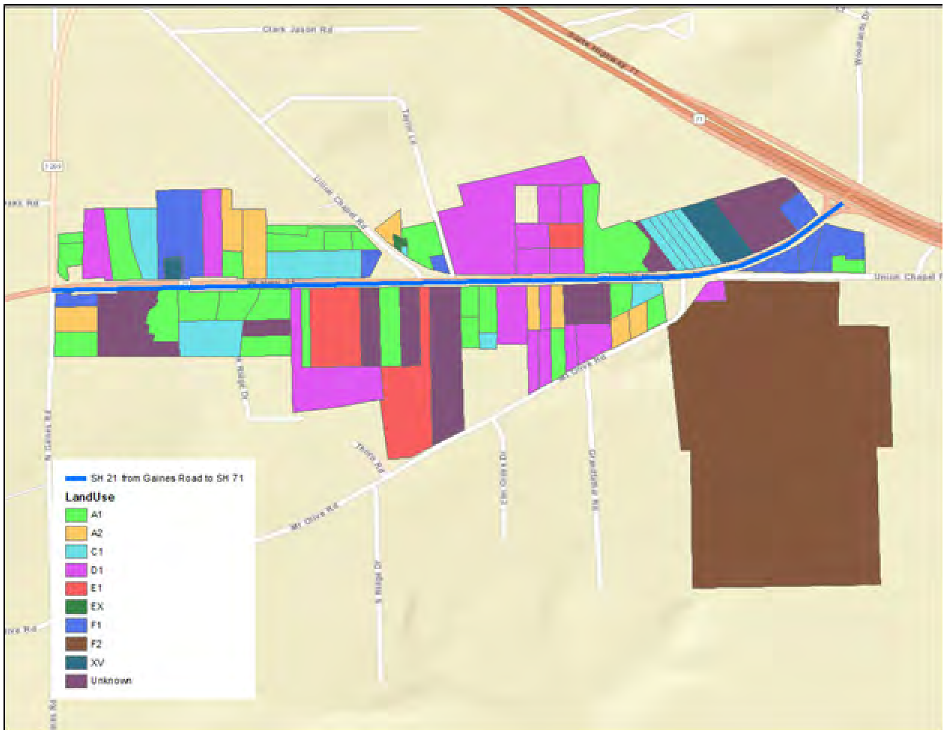
Source: CAMPO

Table 1: SH 21 from Gaines Road to SH 71 TAZ Demographics

TAZ	Population (2015)	Employment (2015)	Population (2040)	Employment (2040)
1379	546	256	2,088	936
1148	337	240	408	817
Total	883	496	2,496	1,753

Source: CAMPO

Figure 4 – SH 21 from Gaines Road to SH 71 Land Use and Parcels



Source: Travis CAD, TXP

Table 2: SH 21 from Gaines Road to SH 71 Real Land Use Breakdown (2018)

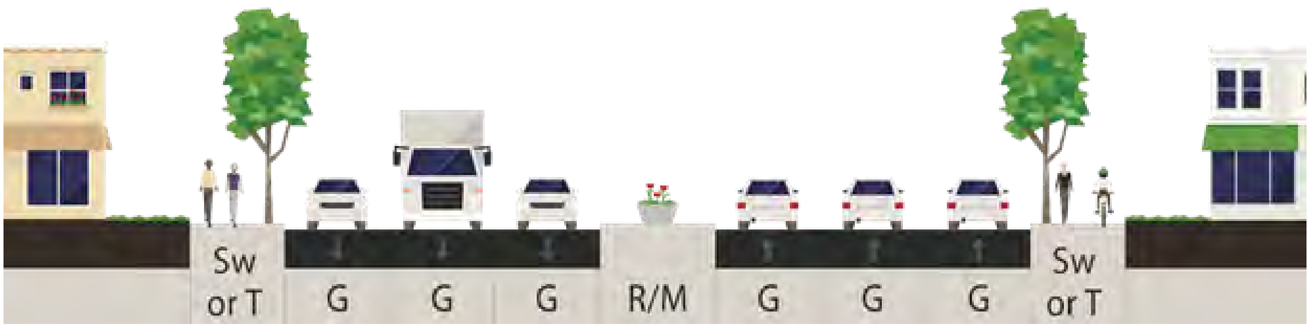
Land Use Category	Acres	Assessed Values	Value Per Acre
Single Family Residence	44.8	$3,771,191	$84,091
Single Family Residence MH	11.8	$798,570	$67,641
Vacant Lot	18.9	$426,462	$22,599
Acreage (AG)	48.6	$529,505	$10,901
Farm and Ranch IMPR	17.8	$551,914	$31,038
Commercial	15.9	$5,724,269	$360,266
Industrial	108.5	$4,880,124	$44,990
Exempt	4.7	$0	$0
Unknown	35.2	N.A.	N.A.
Total	306.4	$16,682,035	$54,438

Source: Bastrop CAD, TXP

Parmer Lane (SH130/45)

Proposed Improvement
Parmer Lane between SH 130 and US 290 is proposed to be upgraded from a 4-lane Divided to 6-lane Divided.

Recommended Pattern Book Cross Section
Based on the Pattern Book chapter, this segment of Parmer Lane falls into the Zone 5, Suburban 1 context. The forecasted growth in employment and population are expected to triple. Resulting traffic volumes are forecasted to grow from approximately 18,000 vehicles per day to almost 31,500 vehicles per day by 2040. The roadway is considered a principal arterial and is recommended to be improved from its current 4-lane divided cross section to a 6-lane divided cross section. Based on the land use, functional classification, and demand characteristics described in the Pattern Book chapter, cross section #17 from the Pattern Book chapter is recommended.



ROW: 95' - 155'
Divided

Context
Located in the eastern Travis County on the outskirts of Austin, this segment of Parmer Lane is a major roadway that connects SH 45 to SH 130. The land use in this area is largely vacant/rural, with some single-family. The expectation is that eastern Travis County, long a bystander in the overall growth in the Capital Area, is primed for extensive development. A number of factors are in the mix. First is the cost and availability of land; while prices are rising, the cost per acre remains far less expensive than elsewhere in the immediate Austin area, and the ability to assemble/acquire fairly large tracts of land is unmatched locally. Second are environmental considerations, as most of eastern Travis County is less sensitive environmentally than other parts of the Austin region, and so is a preferred area for development. Planning by the City of Austin and other local jurisdictions reflect this desire, and most regional plans target this area for significant growth. Meanwhile, changing laws on annexation and the perception that self-governance creates opportunity has led to at least one Municipal Management District (MMD) and a number of Municipal Utility Districts (MUDs) in the area being approved in the most recent legislative session. Substantial existing transportation infrastructure investments by both the public and private sector round out the picture of an area primed for growth.

Opportunities
Over the next 25 years and based on TAZ forecast data, population and employment are expected to approximately triple. These forecasts may well be too conservative, especially regarding employment, improved access near the intersection of two major highways should stimulate the concentration of significant commercial development. This is especially true if residential development occurs at a pace consistent with the development plans of several major landowners in the area, which also include a large volume of mixed-use

development. Most of these plans also includes a high volume of amenities such as parks and other recreational facilities, which are typically only feasible in large, master-planned environments. If thousands more people will live and play in the area, the improvements should facilitate both movement within the area and better connection to Austin and communities to the east, north, and south.

Figure 1 – Parmer Lane (SH130/45)

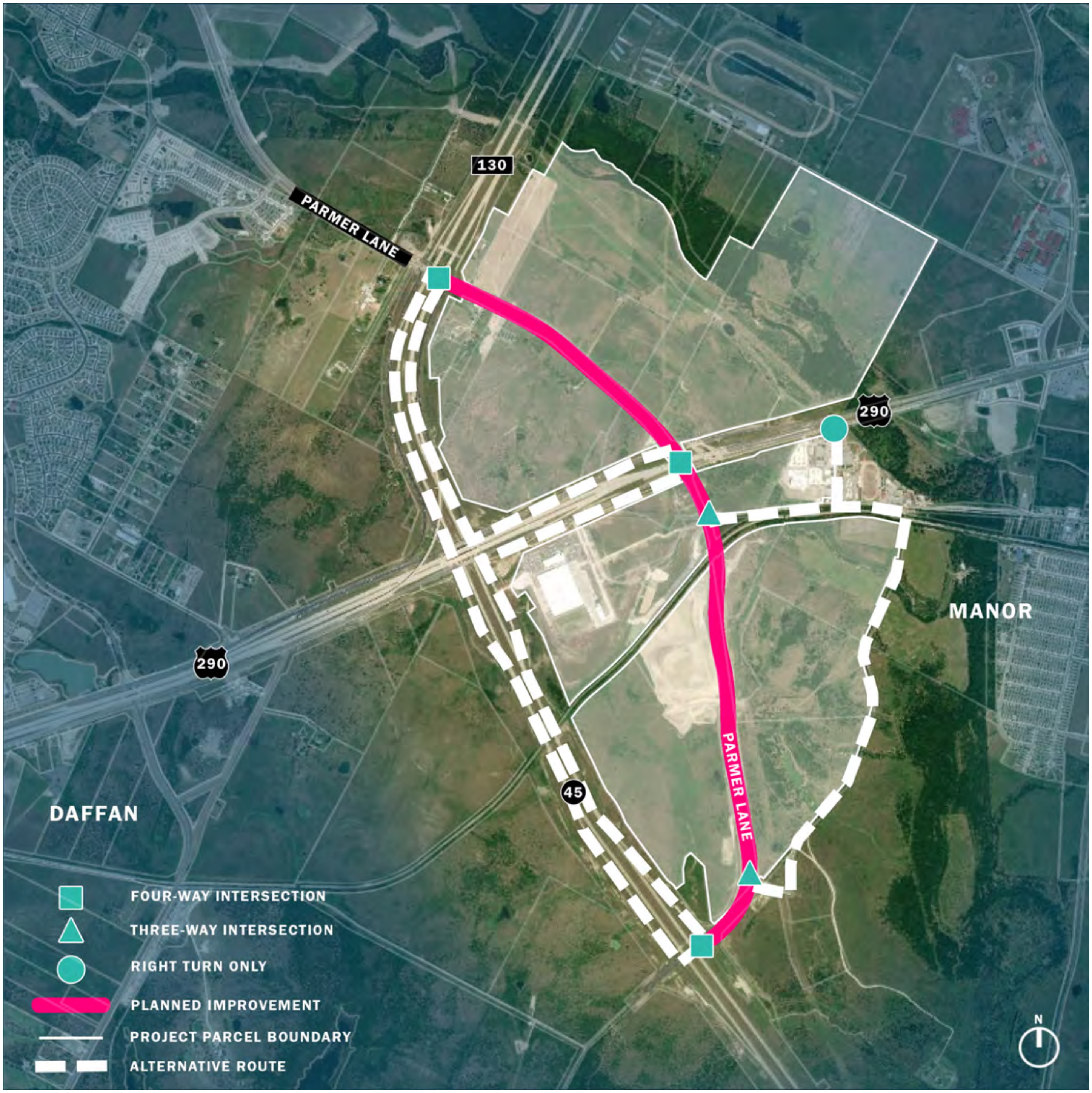
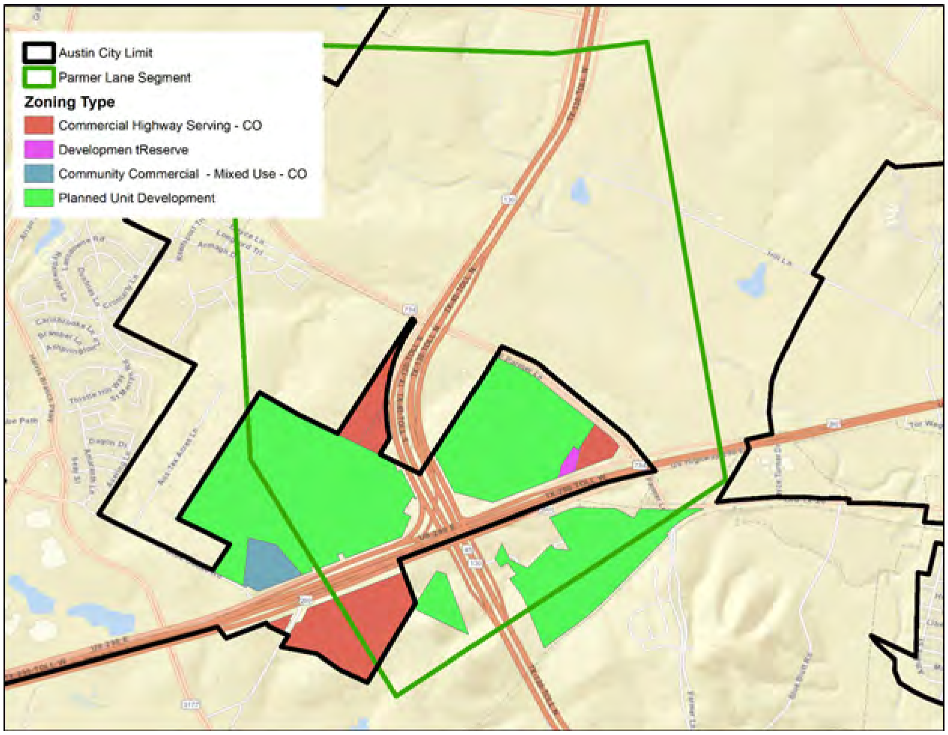
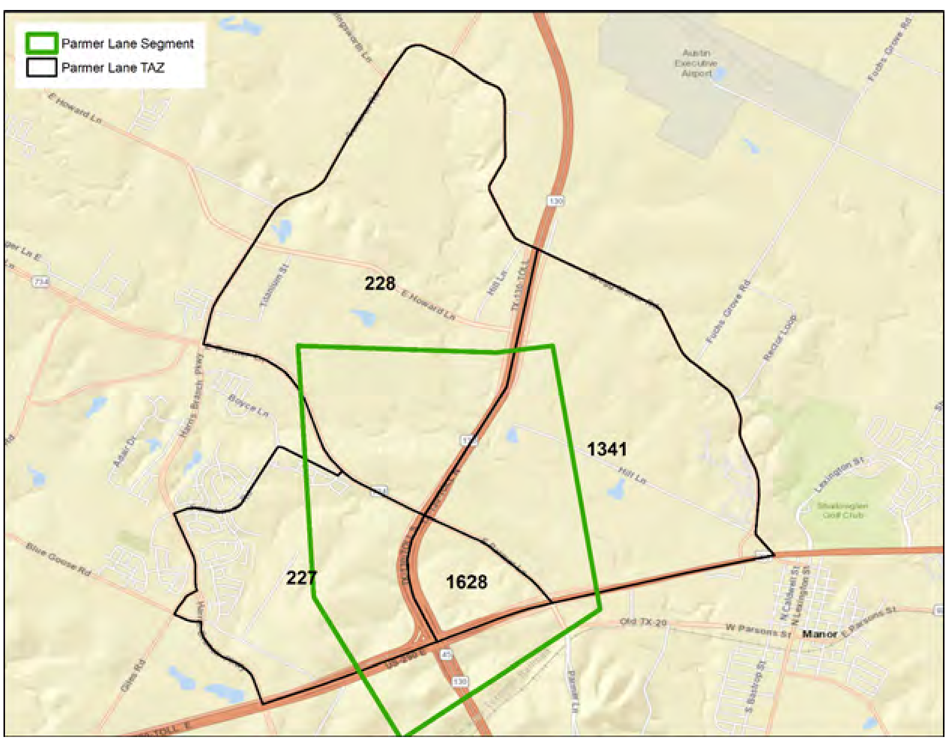


Figure 2 – Parmer Lane (SH130/45) Zoning



Source: Travis CAD

Figure 3 – Parmer Lane (SH130/45) Traffic Serial Zones (TAZ)



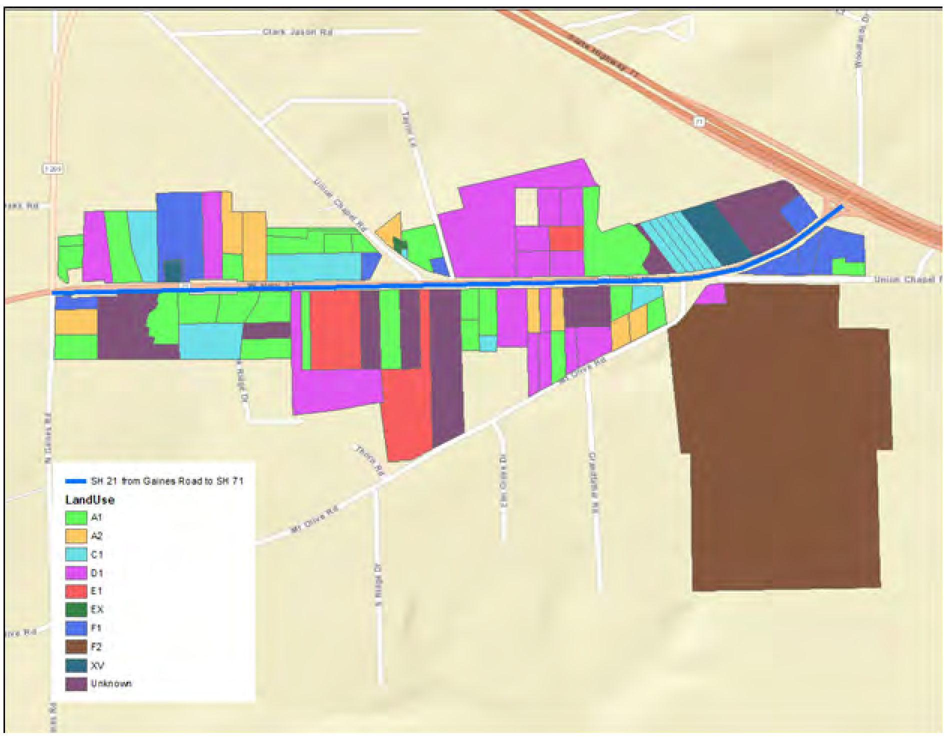
Source: CAMPO

Table 1: Parmer Lane (SH130/45) Segment TAZ Demographics

TAZ	Population (2015)	Employment (2015)	Population (2040)	Employment (2040)
228	1,826	90	2,690	37
1628	10	0	79	0
1341	10	234	1,075	273
227	36	110	1,999	807
Total	1,882	434	5,843	1,117

Source: CAMPO, TXP

Figure 4 – Parmer Lane (SH130/45) Segment Land Use and Parcels



Source: Travis CAD

Table 2: Parmer Lane (SH130/45) Segment Land Use Breakdown (2018)

Land Use Category	Acres	Values	Value Per Acre
Single Family Residence	75.24	$2,556,930	$33,984
Vacant Lot and Land Trac	19.92	$595,999	$29,918
Qualified Open-Space Land	735.60	$365,594	$497
Rural Land, Non Qualified	83.75	$2,649,594	$31,638
Total	914.51	$6,168,117	$6,745

Source: Travis CAD, TXP

Scenario B: HOV Assumptions

Sample HOV Lane Methodology

HOV Modal Shift to NTM	50%
24-Hr Demand	157,000
Time of Day Distribution	
AM	14%
MD	39%
PM	22%
NT	25%
% SOV	72%
SOV Vehicle Occupancy	1
%HOV	28%
HOV Vehicle Occupancy	2.6
Source: CAMPO 2040 Travel Demand Model	
Peak NTM Assumptions	
HOV/Variable Priced Vehicles Per Hour	1800
Number of Lanes	2
Off Peak NTM Assumptions	
HOV/Variable Priced Vehicles Per Hour	1000
Number of Lanes	2
Peak Bus Transit Assumptions	
People per bus	32
Frequency - # bus per hour	4
Person trips per hour	128
Off Peak Bus Transit Assumptions	
People per bus	32
Frequency - # bus per hour	2
Person trips per hour	64
Bus Passenger Car Equivalent	3
CapMetro Bus Seating Capacity	
Metro Bus - 35ft	29
Metro Bus - 40ft	36
Metro Express - 40ft	39
Metro Express - 45ft	57
Metro Rapid - 60ft	30
Metro Rapid - 134ft	46
Average	39.5
80% occupancy	31.6
Source: CAPMetro	

Transit Service Assumptions

Facility	Agency	Count Point	Peak	Off-Peak	Bus Type	People/Vehicle	Concept Route
RM 12	CARTS CARTS	Winter Mill Winter Mill	30 30	60 60	30 to 45 ft 30 to 45 ft	37	Bee Cave to San Marcos Oak Hill to San Marcos
FM 1826			30	60	30 to 45 ft	37	
US 290 W US 290 E	CARTS Cap Metro	Monterey Oaks	20 10	60 20	30 to 45 ft Rapid	55	Dripping Springs to Downtown Oak Hill to Downtown
SH 71 E	CARTS Cap Metro	Spirit of Texas	20 10	60 20	30 to 45 ft Metro Bus	50	Bastrop to Downtown Airport to Downtown
SH 71 W	CARTS	Bee Cave Rd	30	60	30 to 45 ft	37	Marble Falls to Downtown
FM 734	CARTS Cap Metro	Burnet Rd	15 10	60 20	30 to 45 ft Rapid	55	Elgin to Robson Ranch/Domain Manor to Robson Ranch/Domain
FM 1431	CARTS Cap Metro	Nameless Rd	30 30	60 60	30 to 45 ft Express	55	Marble Falls to Domain Lago Vista to Lakeline
US 183 N	CARTS Cap Metro	SL 360	30 10	60 30	30 to 45 ft Express	55	Marble Falls to Downtown Leander to Downtown
US 183 S	CARTS	Montopolis Dr	30	60	30 to 45 ft	55	Lockhart to Downtown

REGIONAL ARTERIALS CONCEPT INVENTORY

APPENDIX - C

RECOMMENDATIONS

CAMPO

CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

Traffic Management Coordination Strategies, Policies, and Best Practices

The backbone of the transportation network is in the processes and operations made by many actors and stakeholders within the region. While arterial facilities are typically a second-tier mode for moving people and goods, they are key to providing access to the many opportunities that a region provides. As such, the management of the arterial network's transportation infrastructure is extremely important to advancing the region's mobility goals.

As cities and communities grow, and new organizations and agencies take shape, regional transportation operations tend to become more siloed as system development becomes more complex and individual communities face mounting pressure to focus on resolving local challenges. However, opportunities exist to bring cross-jurisdictional and comprehensive solutions to maintain a common goal and seamless network operations. Due in part as system users does not typically equate jurisdictional/agency boundaries into their mode or route choice.

This section provides an overview of the current CAMPO region's transportation operations management. It also includes a high-level case study of three regional model programs and highlights **coordination strategies, policies, and best practices** available for the CAMPO region to learn, adopt and enhance for potential application in the Austin region.

The three regional programs include:

Las Vegas, NV - Freeway and Arterial System and Transportation (FAST)
Houston, TX - Houston TranStar,
Denver, CO - Denver Regional Council of Government (DRCOG) Traffic Operations Program

As noted, the results of these case studies offer insight as to how the CAMPO region can implement a framework for a multi-lateral regional operations program. Planning for the establishment of a regional operations program would provide the necessary connection and backbone to support the development of active transportation management strategies for the arterial systems. The planning of this effort is in line with state priorities and TxDOT's Transportation Systems Management and Operations (TSMO) plan for the Austin District.[1]

Need for Transportation Management

The Austin region is experiencing similar challenges of corralling transportation system operations to provide seamless travel and efficient mobility experience that users demand while reducing congestion. In response to this, the region is operating a multitude of solutions and strategies on the arterial systems, some of which are as follows:

Highway Emergency Response Operators (HERO) Program
Local/Agency Traffic Signal Coordination Timing Program (TxDOT, County, City)
Transit Rail/Bus/Bus Rapid Transit (CapMetro)
Manage Express Lanes (CTRMA)
Regional Toll Facilities (CTRMA, TOD)

[1] http://ftp.dot.state.tx.us/pub/txdot-info/trf/tsmo/aus-tsmo-program-plan.pdf

ITS (Intelligent Transportation System)
Smart Work Zone Management (TxDOT, Cities)
Ridesharing Program (B-Cycle)
Demand Management Programs (Private Flex Work Programs)
Parking Management
Combined Transportation, Emergency & Communications Center (CTECC)

A common theme among this list is that these programs provide targeted solutions with specific local or regional functions. Although some programs have inter-jurisdictional agreements for regional operation, such as CTECC and Capital Metro Bus Rapid Transit, each of these strategies are independently managed through specific guidelines amongst partner agencies and organizations that have a stake in the operations of each program.

It is also important to note that the agencies and organizations that develop and operate strategies on the region's arterial networks have varying organizational structure, missions, goals, objectives, and priorities. Although good faith efforts are practiced to ensure success of projects, opportunities are sometimes missed to provide better operations for many reasons, including varying degrees of resources and priorities between agencies.

The adoption of Transportation Systems Management and Operations (TSMO) philosophies among agency organizations across the country, including the Texas Department of Transportation, provides an opportunity for the Austin region to re-visit current practices for project/strategy development and operations. TSMO is defined as "An integrated set of strategies to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal, cross-jurisdictional systems, services, and projects designed to preserve capacity and improve security, safety, and reliability of the transportation system." [2] Creation and adoption of new philosophies and process would improve data sharing, resources management, and facilitate active traffic management strategies on arterials to provide efficient and seamless deployment of strategies that provides better service for all users across boundary lines.

Model Program Overviews

Development of a multi-jurisdiction, multi-agency regional operations program is not an easy feat. Breaking the current trend and bringing new ideas to a consensus is a delicate balance and navigation to find common mission, vision, goals, and objectives. Although the idea of active regional operations is not new to the Austin region, it has never been implemented on at the arterial network level.

One of the premier multi-agency programs in the Austin area is the Combined Transportation, Emergency & Communications Center (CTECC) program. Commissioned in 2003. CTECC provides emergency, and freeway-arterial state facility incident/traffic management, and transit dispatch within the Austin Metro area. CTECC houses TxDOT, City of Austin, Travis County, and Capital Metro programs to facilitate the sharing or exchange of select data and facility resources for:

dispatching of Law Enforcement, Fire and Emergency Management Services;
providing TxDOT on-system facilities transportation management services;
providing Capital Metro fixed route dispatch services;
providing emergency management services for the City of Austin and Travis County.

[2] TSMO MAP-21 Definition: https://ops.fhwa.dot.gov/tsmo/index.htm

CTECC does not provide arterial management services within the City of Austin or neighboring municipalities. The owning (municipal) agency primarily performs management and operations of strategies on arterials such as traffic signal timing, ITS surveillance, and incident coordination with local first responders. Regional operations are primarily handled by larger agencies through development of corridor/strategy specific agreements with the municipalities. This model provides municipalities the ability to control and own transportation systems within their jurisdiction. However, the process to develop the solutions often require longer lead times to develop. Moreover, the municipal specific strategies, such as traffic signal timing coordination, typically ends at the jurisdictional limit line, which impact delivery of services to users.

There are several model regional operations program across the country that can be used to glean potential best practices for policy development and governance structure and arterial strategies to improve interagency coordination. The Las Vegas FAST Program, Houston TranStar program, DRCOG Traffic Operations Program were specifically selected for evaluation and comparison to provide insight into each of their respective histories, operations, and framework benefits.

Case Study 1: Las Vegas, NV - Regional Transportation Commission (RTC) of Southern Nevada

The Regional Transportation Commission of Southern Nevada (RTC) is the acting MPO in the Las Vegas, Nevada region; a region of approximately two million people. The metropolitan area is comprised of four major local jurisdictions: Clark County, City of Las Vegas, City of Henderson, and City of North Las Vegas (in addition to other outlying cities). RTC has several service branches including operations of the Freeway and Arterial System and Transportation (FAST) program in addition to transit operations (fixed route and paratransit services), funding transportation infrastructure, and traditional MPO planning responsibilities.

History and Background

In the 1980s three of the local entities in the region (Clark County, City of Las Vegas, and North Las Vegas) came together to consolidate signal operations to gain efficiencies on arterial operation. At the time, the region's population was just under 500,000.[3] With congestion beginning to appear, and financial and infrastructure resources limited, the region made a bold move to develop an inter-agency program that would manage and operate the region's arterial traffic systems.

It was agreed that each of the three municipalities would pay a proportionate amount of funding based on the number of signals that would be adopted by the program within each of their respective jurisdictions. The City of Las Vegas took on administrative duties for the program and the organization was named Las Vegas Area Computerized Traffic System (LVACTS). As rapid growth occurred in the region, several other municipalities joined the program. The adoption of municipal traffic signal systems into LVACTS was performed through inter-local agreements that included formal approvals from the local governmental agencies.

LVACTS was considered successful, and in the early 2000s, the Nevada Department of Transportation (NDOT) and the existing LVACTS program worked collaboratively to add the freeway ITS component to

[3] Clark County Population - http://www.clarkcountynv.gov/comprehensive-planning/demographics/Documents/Clark%20County%20Demographics%201960-2012.pdf

the regional organizational structure. This resulted in the formation of a new program that is now known as the Freeway and Arterial System and Transportation (FAST) under the RTC. It was agreed that NDOT would fund some of the staff as well as the operations and maintenances of the freeway ITS system, while RTC took on the responsibility of funding arterial operations.

In support of the program, a new Traffic Management Center (TMC) was completed in 2005, with additional space being dedicated to FAST partners that includes the Nevada State Highway Patrol, and NDOT District 1. The building is owned by NDOT and each of the respective agency programs and partners have a lease agreement to use a portion of the building space.

Organizational Structure

FAST is under direct authority of the RTC, but also answers to NDOT and local municipalities. FAST has a total staff of approximately 40 people. One third of the staff are NDOT funded and the other two-thirds are RTC funded. FAST is comprised of one program director, a few managers and supervisors, and other staff including operators, field technicians, engineers, IT, and administrative staff.

In general, the organization is comprised heavily of technicians supported by a few engineers. The program director position requires both technical competency and be politically astute to navigate the demand of the various partner agencies.

To keep up with daily challenges and trends, the FAST program organized an Operations Management Committee (OMC) to meet every two months, which follows typical public agenda and minutes notification procedures. The meetings are organized and managed by FAST/RTC personnel that report back to local government entities and NDOT. This formal process provides a place for FAST staff to exchange information, and build relationships with local entities to create a successful program.

Current Responsibilities

FAST is responsible for all signal coordination for local entities in the area. While FAST is responsible for operations of the signal system, FAST/RTC does not own any infrastructure (signals, controllers, hardware, etc.). Their focus is on the operations and signal coordination to minimize delays and improve travel time and network progression. There is some ambiguity between where FAST responsibilities end, and municipal responsibilities pick up.

FAST deploys several traffic management strategies and ITS technologies on the arterial network including transit signal priority, emergency vehicle preemption, traffic incident management, and cameras among others. Adaptive traffic signals are under investigation by FAST. FAST also operates and maintains all freeway ITS devices including ramp meters, cameras, electronic signs, and flow detectors, on behalf of NDOT. FAST has a much larger role in terms of operating NDOT's freeway ITS, which includes maintenance responsibilities in addition to operations. Overall, FAST has maintenance jurisdiction over the region's ITS fiber-optic communication network whether it's an arterial or freeway corridor.

FAST understands the importance of tracking data over time and using data for performance monitoring. FAST has developed an in-house performance dashboard, but the data is highly aggregated. They are working on using new innovative methods through pilot projects that utilize sensors, in-vehicle data, and algorithms to monitor and manage the system.

Program development and planning is currently driven by other entities (local municipalities or NDOT). Even within RTC, there is room for further development with regards to improving collaboration between

FAST and the planning function of the RTC. This collaboration could be, and should be, conducted more proactively. Much of the work the FAST performs cut across multiple departments within the RTC and the local municipalities. This includes operations, IT, maintenance, and planning. FAST mitigates the potential risk of misunderstanding through better preparation, coordination, and sometimes special or innovative ways of discussing projects or implementation processes. This ensures team understanding of the project which leads to successfully achieving the regional mission and goals.

Case Study 2: Houston, TX - TranStar

Houston TranStar is a unique partnership between the City of Houston, Harris County, METRO, and TxDOT. TranStar's primary purpose is to manage the region's transportation system and coordinate emergency management throughout the Houston metro, which has a population of almost 6.5 million people. The program's mission is "to provide the best transportation and emergency management services through the use of collective resources to maximize safety and mobility to the public."

TranStar allows the four major agency organizations in the Houston metro to manage and operate their respective transportation systems and strategies independently but facilitates regional coordination by providing the infrastructure and technology for each stakeholder to work in a team environment to manage recurring and non-recurring events, including large major emergencies. The program serves as the primary point of coordination for state, county, and local agencies when responding to incidents and emergencies.

History and Background

Houston TranStar was created through an Interlocal Agreement in 1993 among four governmental entities engaged in various functions of transportation management: The City of Houston (COH), Harris County, the Texas Department of Transportation (TxDOT) and the Metropolitan Transit Authority of Harris County (METRO). The effort was initiated by the City of Houston Mayor, who at the time, was also a Texas Highway Commission Chairman and Chairman of the METRO Board. The City made a convincing argument for a TMC focused in providing intelligent transportation systems (ITS) services. This was in response to the anticipated population growth and collective understanding that it would be beneficial to proactively create a transportation management entity to better manage traffic growth impact. TranStar was founded after receiving a federal grant to fund and build Houston TranStar.

Organizational Structure

Houston TranStar has three levels in the organization: The Executive Committee, the Leadership Team, and Agency Managers. The Executive Committee, comprising the heads (or representatives) of each of the four agencies: Houston Transportation Director, Harris County Judge, TxDOT-Houston District Engineer, and METRO President and CEO meets monthly to set the direction of the agency. The Leadership Team meets on a bi-monthly basis to prepare items for the Executive Committee and are generally more focused on operational items. The Agency Managers are located within TranStar and are leaders and representatives of the different entities and divisions within TranStar's purview.

The Executive Committee hires an Executive Director to manage the functions within the Center. The Executive Director acts as an administrative position and spokesperson rather than a transportation engineer. The Director has a staff that includes a budget manager, purchasing manager and assistant, building manager, facility security manager, public information officer, GIS specialist and receptionist. The salaries of these employees are paid by the four agencies.

TranStar funding for staff positions is split evenly amongst each of the four partnering entities. However, TxDOT's contribution is made through in-kind support worth one-quarter of the budget.

While not one of the four primary partnering entities, the MPO is heavily involved with TranStar. An MPO representative is invited to Executive Committee meetings and a recent Regional Incident Manager position was created within the MPO. While the position is funded by the MPO, the Regional Incident Manager reports jointly to the MPO and TranStar Executive Committee and is housed at TranStar.

Current Responsibilities

Houston TranStar host a variety of programs that are actively managed and operated by each of the four governmental entities as follows:

Texas Department of Transportation (TxDOT)

- Freeway Operations
- Intelligent Transportation Systems (ITS) Design and Special Projects
- Media Contractors
- SH 288 Tolling Support Operations
- Transportation Management Systems

Metropolitan Transit Authority of Harris County (METRO)

- Regional Bus System
- Light Rail System
- METRO Police
- Office of Emergency Management

Harris County (HC)

- Traffic & Transportation Group
- Sheriff's Office
- Office of Homeland Security & Emergency Management

The City of Houston (COH)

- ITS & Safety
- ITS Plan Review
- Mobility and Traffic

The TMC processes data made available from a multitude of ITS surveillance, detection, and broadcasting systems to monitor the corridors, detect events, manage event responses, and provide the real-time traveler information to reduce delay, improve safety and reduce congestion. The TMC houses a variety of central software packages that connects with various roadside devices through various forms of wireless, wired, and fiber-optic communication lines, including Closed-Circuit Television Cameras (CCTVs), Dynamic Message Signs (DMS), Ramp Meters, Signals, and Flood Detectors.

TranStar also operates two roadside service programs for Traffic Incident Management (TIM). The two TIM service programs are SAFEClear and the HC Motorist Assistance Program (MAP). The SAFEClear Program is in charge with dispatching tow trucks to freeways stalls and crashes within the COH. The MAP is dispatch by the HC Sheriff's Office Incident Management Unit (IMU), and roadside assistance, including provide remote authorization of towing disabled vehicles through the SAFEClear Program.

Moreover, the City of Houston's (COH) Traffic Signal Timing and Operations Section (TSTOS) and the Harris County Infrastructure Department's Traffic Maintenance Group (HC-TMG) also operate in TranStar. Both of TSTOS and HC-TMG manages signalized intersections and arterial corridors within their respective jurisdiction. The two agencies combined manages a over 3,445 signalized intersections. Both groups perform traffic signal re-timing programs, data collection, equipment management, technology implementation, and performance metric tracking.

TranStar was the first center in the nation to combine transportation management and emergency management to improve public safety during natural and man-made disasters. When emergency conditions arise (hurricanes, floods, industrial explosions, etc.) the Emergency Operations Center (EOC) is activated and representatives from all four collaborating agencies, in addition to other local and national entities, come together to quickly coordinate responses. The Automated Flood Warning System, Doppler Radar Imagery, Satellite Weather Maps, Road Flood Warning Systems and the Regional Incident Management System (RIMS) comprise some of the tools used to address the emergency.

Case Study 3: Denver, CO - DRCOG Traffic Operations Program

Denver Regional Council Of Government (DRCOG) is the designated MPO for local governments in the Denver region; a region of approximately over 3 million people. DRCOG is comprised of representatives from fifty local goverments within Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Gilpin and Jefferson counties and southwest portion of Weld County. DRCOG primarily develops partnerships to sustain the management of the region's transportation, mobility, growth, and aging disability resources through development of guidelines, policy, and funding allocation.

The agency is the platform for the region's agency partners to develop and promote initiatives that improves mobility and reduces congestion. Since 1955, the DRCOG has supported the development of the region's freeway system, travel demand programs (e.g. vanpools, schoolpools, telework, and carpools), multi-modal transportation plan, transit, and Denver International Airport. From an arterial management perspective, the DRCOG was instrumental in developing the Traffic Operations Program. This program provides opportunities for inter-agency coordination within the region's defined Transportation Management Area (TMA).

History and Background

Prior to the development of the Traffic Operations Program in 1989, local agencies primarily were charged with managing and maintaining their respective traffic and ITS. With the population continuing to grow and traffic congestion increasing, the DRCOG adopted the *Regional Traffic Signal System Improvement Program*[4] (TSSIP) in 1994. DRCOG administers the TSSIP using federally-funded "pool" projects under the region's Transportation Improvement Program (TIP). This program facilitates projects across jurisdictional lines and is updated every three to four years. Major program activities include: signal system capital improvements, systems engineering, special projects, equipment purchase, and traffic signal timing and coordination.

Although the Traffic Operations Program facilitates inter-agency projects, the thirty-seven agencies that manage signals and ITS within the Transportation Management Area (TMA) continue to own the technology and infrastructure within their jurisdictional boundaries. As such, these agencies are required with ensuring management and maintenance of their respective infrastructure to support regional operations and strategies. The region currently has several TMCs that manages arterial and operate specific strategies for this effort. Some of TMCs in operation includes the: Colorado Transportation

[4] Regional Traffic Signal System Improvement Program: https://drcog.org/sites/drcog/files/resources/2013%20TSSIP%20Update-Adopted%2009-18-13.pdf

Management Center (CTMC), City and County of Denver (CCD), Lakewood, Douglas County, Commerce City, RTD Transit Operations Center. In addition, smaller agencies have banded together and procured third party services for system monitoring and management to support continuous operations and maintenance.

The DRCOG also adopted the *Denver Regional Intelligent Transportation Systems Strategic Plan*[5] and the *Regional Concept of Transportation Operations*[6]. These plans support the Traffic Operations Program by providing additional guidance for allocating the TSSIP and ITS pool funds. The Strategic Plan provides the regional policy and framework for applying ITS in the region; while the Concept of Transportation Operations provides the framework for regional operations.

Organizational Structure

DRCOG is comprised of fifty-eight local elected official from the region's municipalities, including three non-voting members from CDOT, RTD, and the State of Colorado. The DRCOG Board employs an executive comprised of an Executive Director that is supported by five directors for Regional Planning and Development, Transportation Planning and Operations, Area Agency on Aging, Administration and Finance, and Communications and Marketing

The Transportation Planning and Operations serves as the liaison for a variety of committees and programs including: Transportation Advisory Committee, Regional Transportation Committee, Metropolitan Planning Organization, Transportation Improvement Program, Intelligent Transportation System, Traffic Operations, Transportation Demand Management, and Regional Travel Demand Forecasting.

DRCOG's Traffic Operation's staff administers the funding for both the TSSIP and ITS pool fund to partner agencies. Each operating agency coordinates with DRCOG Traffic Operations Program to develop and deploy projects. The local agencies follow a typical municipal structure with local representatives and experts that coordinate with DRCOG Traffic Operations Program staff to facilitate the administration of the arterial related programs.

Current Responsibilities

Each operating agency that participate in the Traffic Operations Program are responsible for maintaining each of their specific traffic signals and infrastructure systems within their jurisdiction. However, regional and cross-jurisdictional operation improvements are handled with agreements as part of capital projects developed and deployed through the Traffic Operations Program, including TSSIP or ITS programs. Each program outlines key requirements and funding application limitations.

To ensure that the projects perform as intended across jurisdictional boundaries, the DRCOG provides staff with technical expertise to work with local agencies with implementation and fine-tuning during project deployment. Once the projects are completed, the maintenance and operations are handed over to the agencies to maintain specific performance metrics, which are continuously evaluated by DRCOG staff.

[5] Denver Regional ITS Strategic Plan:
https://drcog.org/sites/drcog/files/resources/ITS%20Strategic%20Plan%20Update%20Oct%202010.pdf

[6] DRCOG Regional Concept of Operations:
https://drcog.org/sites/drcog/files/resources/Regional%20Concept%20of%20Tranp%20Operations%2008-15-12_0.pdf

Relevance to CAMPO Region

The CAMPO region may be able to draw applicable programs and strategy elements from the Las Vegas RTC-FAST, Houston TranStar, and DRCOG Traffic Operations Program for use in the CAMPO region. Each of the three programs have varying degrees of capabilities in providing regional arterial management system operations and development:

- The FAST program appears to provide heavy emphasis on centralized arterial operations with a controlled role on managing the NDOT's freeway system.
- TranStar program appears to focus on managing the freeway network and directly coordinates with emergency services programs, while creating partnerships with local municipalities and agencies to enhance arterial strategy, operations, and management systems within their respective jurisdiction.
- DRCOG provides regional arterial operations by extending programs that allow partner agencies to participate in multi-jurisdictional operations.

Each of the three case study programs are predicated and influenced by the jurisdictional footprint, economic factors, and growth challenges affecting the region at the time of adoption. Each of these factors appear to also drive the development of short- and long-term solutions for each case, which impact the formation of partnerships and transportation system characteristics over time, becoming more complex as new solutions are adopted.

In all cases, each region has found success through an appropriate balance of leadership, managerial talents, and technical competence to extract the most from each of the region's resources. Each program understands the importance of placing neutral leadership that can provide the necessary balance for finding common ground and applying regional strategies to manage congestion. The leadership may come in the form of creating a consortiums or committees that can rally political support and communicate the necessary priorities with the many stakeholders in the region. In addition, the top levels of leadership are heavily supported by a team comprised of engineers, planners, and technicians. **Table 1** shows a comparison of existing arterial management programs between the CAMPO region and each of the case studies.

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Table 1: Case Study Arterial Management Strategies/Programs and Operational Policy Type				
Strategies/Programs	Austin Region	Las Vegas Region	Houston Region	Denver Region
	Arterial Operations Policy Type			
Traffic Management				
Signal Operations/Management	L	R/L	L	R/L
ITS Surveillance	L/R	R	L/R	L/R
Traffic Incident Management - Roadside Service - Aggressive Tow/Clearance	R-Frwy Only	R-Frwy Only	R-Frwy Only	R-Frwy Only
Traveler Information System - Dynamic Message Signs - Website - 3rd Party Partnerships - 511 or Mode Specific Web or App	L/R	L/R	L/R	L/R
Special Event Management	R/L	R/L	R/L	R/L
Reversible Lanes	None	R-Frwy	L/R-Frwy	R-Frwy
Manage Lanes [HOT/HOV/Variable Price]	L-Frwy	L-Frwy	L-Frwy	L-Frwy
Traffic Management Centers - Municipalities Traffic Management - Freeway and Incident Management - Toll Systems Management	L/R	L/R	L/R	L/R
Travel Options				
Bicycle & Pedestrian Facilities	L	R	L	L
Carpool and Vanpool Programs	L	R	L	L
Telecommute Programs/Initiatives	L	R	L	R
Active Traffic Management				
Dynamic Lane Management	R-Frwy*	R-Frwy	L-Frwy	L-Frwy
Variable Speed	None	R-Frwy	None	L-Frwy
Temporary Shoulder Use	None	None	None	None
Queue Warning	None	R-Frwy	L-Frwy	None
Ramp Meters	None	None	L-Frwy	L-Frwy
Transit System				
Park and Ride	L	R	L	L
Bus Service	L	R	L	L
Bus Rapid Transit - Shared Lane (Mix Traffic Flow) - Dedicated Parkways	L	R	L	L
Light Rail Transit	L	None	L	L
Transit Operations/Dispatch Center	L	R	L	L
L - Local Agency/Municipality/Private Vendors Operations with select partner agreements				
R - Regional Operations thru a consortium or/with select partner agreements				
* - Indicates System is Turned Off				

While the organizational structure of each program is different, there are many similarities. These include:

A high level of support and coordination with the state DOT;

Formal agreements with all coordinating partner agencies;

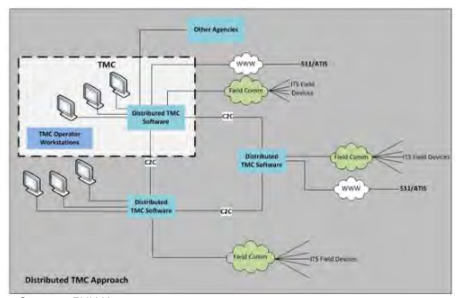
Sharing of resources and funding among agencies.

The CAMPO region's transportation system morphology would greatly benefit by leveraging both arterial and freeway network to meet mobility needs and connect the planned arterial cross sections.

Implementation of Enhanced Management and Coordination

The organizational structure for a regional arterials program will greatly influence how the region's stakeholders work together on developing regional strategies and programs, especially at the arterial level. Today, most of the arterial facility operators manage each of their facilities separately, but supports regional strategy deployments using inter-agency operational agreements for specific portions of corridor segments. The agreements are often passive from an operational perspective, which sometimes leaves gap in providing cross-jurisdictional active management of the system. For example, the hours of operation of the respective municipal/agency TMC operates at varying time periods of the day. This limits the ability of the municipalities to provide continuous management and operations, specifically during the time periods when the TMCs are closed. This gap in TMC hours of operations, passive agreements among stakeholder's present opportunities to improve arterial and effectively regional transportation operations. The CAMPO region could facilitate regional operations through either:

Decentralized System Model – leverages existing ITS systems and network, build out communications gap, and develop a central software open to stakeholders requiring data and control; agency partners will require multiple agreements on framework, roles, policies, business rules, funding, and asset sharing.

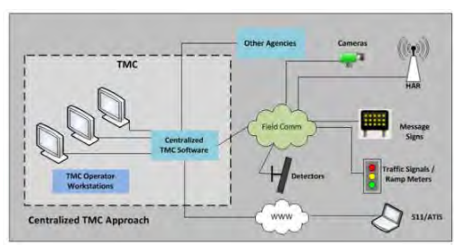


Source: FHWA

Advantages: Partner agencies retains control of their systems, reducing single point network failure. Strategy capabilities are shared between various TMCs. In the short-term, agencies could maximize resources, provide better efficiency, and share costs.

Disadvantages:
System requires more complex agreements. The network may not be as secure due to wider access and remote operations. In addition, it may potentially cost more in the long-term due to additional hardware/software requirements and maintenance for each TMC site. Competing missions may also slow down strategy implementation.

Centralized System Model – requires development of a consortium and will typically require a dedicated facility with dedicated staff for regional transportations operations that would create connections with partner agencies.



Source: FHWA

Advantages: This system provides a single point of authority that has a unified mission, goals, and objectives. In addition, the infrastructure provides enhanced security, reduced complexity, neutral system management, in-house staff, one regional program. Potential operational cost benefits in the long-term.

Disadvantages:
Complex implementation (cost sharing agreement), regional philosophy change, required communication build-out to reduce WAN failure of partner connections.

A combination of either decentralized and centralized operations may also be explored, including potential virtual TMC to further regional operations. It may be prudent to begin this process through development of a technical or working committee to explore the appropriate model for adoption for the region. The committee could focus on developing leadership requirements, framework and organizational structure, staff and strategy deployments.

Conclusions and Recommendations for CAMPO Region

Establish a Regional Framework to Facilitate Traffic Operations and Management
Establishing an organizational framework to facilitate traffic operations is a key factor for successful deployment, operations and maintenance of traffic operations capabilities.

- Establish a multi-disciplinary ITS Steering Committee, including Incident/Emergency Management, Special Event Traffic, and Traffic Signal Subcommittees
- Develop organizational policies and procedures
- Develop regional standards and practices for traffic operations

Lay Groundwork & Formalize a Stand-Alone Committee or Consortium
Bring all potential parties to the table to discuss partnering to fund or create a stand-alone agency, focused on transportation operations and management for the region.

- Define operating and maintenance purview
- Estimate necessary technology, resources, staff needs, etc.
- Determine preferred organizational chart
- Set necessary contractual and inter-local agreements necessary to allocate funding and initiate partnership

Identify Short- and Long-Term Strategies, Technologies, and Policies
Coordinate applicable TSMO strategies, technologies, and policies throughout the CAMPO region. Several of the strategies listed below may be appropriate for the CAMPO region to prioritize.

- Transit Service and Model Enhancement Strategies – Transit Signal Priority (TSP), bus-on-shoulder opportunities, and bus-only lanes help to prioritize transit on congested corridors.
- Traffic Signal Program Management and Operations – The planning, maintenance and operation of signalized intersections and traffic signal systems.
- Freeway Access Management – Ramping metering or congestion pricing on the freeway and interstate system.
- Capacity management – Dynamic lane control (reversible lanes, active lane management, dynamic speed control, and queue detection) using ITS technologies to expand capacity during peak travel times. Could also include reversible lanes or shoulder running.
- Traffic Incident Management (TIM) Strategies – May include back of queue protection vehicles, crash investigation sites, emergency pull-outs, incentives/disincentives for heavy wrecker operations and clearance, etc.
- Enhanced Public Information Strategies – Real-time displays can warn drivers of upcoming queues or significant slow-downs ahead, thus reducing rear-end crashes or resulting in

motorists choosing to take a different route. Dynamic signs can also alter motorists on arterials on roadway hazards.

Curb Management and Pricing – Can be used to help manage congested downtown streets where lots of drop-off and pick-ups occur.

Emergency Response – Coordinate a regional approach to expanding emergency response services to the greater CAMPO region and arterial facilities.

Emergency Management – Coordinate existing emergency management procedures.

Communications – Coordinate regional policies and strategies to accommodate connected and autonomous vehicles.

Prioritize Strategies and Implement

It is essential that each individual strategy or program be coordinated with the broader transportation management program, and that overall network performance be considered.

Identify Stakeholders – Identify all relevant stakeholders and representatives/contact personnel. Develop coordination process through standing committees or a special task force that meets periodically to guide and enhance the program.

Define the Problem – Define the problem before identifying or selecting a solution, through data collection, data compilation, brainstorming, and constructive critiques of existing practices

Set Goals and Objectives – Establish the guiding principles of the strategy or program. Goals and objectives need to be multi-agency in scope; not merely the goals and objectives of individual agencies. Goals reflect long-term aspirations and objectives typically define the specific, often measurable, level of performance that would be required to progress toward a given goal.

Develop & Select Strategies – Based on the goals and objectives, the group can develop alternatives to combine available tools and techniques into program packages for evaluation. Evaluate alternatives, prioritize, and select preferred short- and long-term strategies.

Implement Strategies – Resolve issues (funding sources, jurisdictional boundaries, operational responsibilities, joint training, field communications, etc.) and formalize understandings among agencies and jurisdictions.

Re-evaluate Strategies – Management and operations is an ongoing process. Successful programs continually re-assess and refine the system. Regular data collection allows program managers to assess the effectiveness of efforts, identify areas for improvement, and demonstrate the benefits provided by the program.

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REGIONAL ARTERIALS CONCEPT INVENTORY

APPENDIX - D

PATTERN BOOK

CAMPO
CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION

Data Definitions and Formulas:

Population and Land Use Definitions and Formulas

Data Point	Definition
Population estimates	U.S. Census Bureau for X year. Data table X.
Population, percent change – 2010	(U.S. Census Bureau for X year. Data table X. U.S. Census Bureau for X year. Data table X) / 2010 U.S. Census Bureau
Mean travel time to work (minutes)	
Persons in poverty, percent	U.S. Census Bureau for X year. Data table X.
Population per square mile	U.S. Census Bureau for X year. Data table X.
Land area in square miles	XXX Formula
Weighted Density Per sq. mi (Block Group)	X Input + X Input + X Input – X Input (X input – X input)
Vehicle miles traveled (VMT)	Sum of the number of miles traveled by each vehicle traveled for year X.

Regional Descriptions

Data Point	Definition
CAMPO Region	Metropolitan Planning Area encompassing Bastrop, Burnet, Caldwell, Hays, Travis, and Williamson Counties in State of Texas.
San Jose Region	San Jose-Sunnyvale-Santa Clara MS encompassing Santa Clara and San Benito Counties in Metropolitan Statistical Area in State of California.
Oklahoma City Region	Oklahoma City, OK Metro Area encompassing seven counties make up the Oklahoma City Metropolitan Area: Canadian, Cleveland, Grady, Lincoln, Logan, McClain, and Oklahoma in State of Oklahoma.
Las Vegas Region	Las Vegas-Henderson-Paradise, NV Metropolitan Statistical Area in State of Nevada.
Phoenix Region	Phoenix-Mesa-Glendale MSA encompassing Maricopa and Pinal Counties in State of Arizona.

Background

> San Jose Region Data & Maps
> 2014 San Jose Region Crash Data

In 2014, the San Jose Region had 6,875 crashes and a rate of .00344 crashes per capita. Of these crashes, there were 47 people killed (per capita 0.0000235) and 2,996 injured (per capita .00145).

Santa Clara County (top) and San Benito County (bottom)

Statewide Travel / Accident Summary
FOR 2014 PREPARED 03/06/17

TRAVEL AND ACCIDENT SUMMARY FOR SCL COUNTY [40]

LANE TYPE	ROAD MILES	TRAVEL (MVM)	ACCIDENTS TOTAL	PDO	INJURY	FATAL	VICTIMS KILLED	INJURED
COUNTYWIDE								
2 AND 3 LN	64.5	182.1	195	101	89	5	6	144
4+ UND	1.0	10.9	10	6	4	0	0	5
4+ DIV	26.1	439.2	580	317	260	3	3	349
SUBTOTAL	91.6	632.2	785	424	353	8	9	498
2 AND 3 LN EXP	0.2	2.2	1	1	0	0	0	0
4+ DIV EXP	22.2	356.1	209	135	74	0	0	107
NON FWY	114.0	990.6	995	560	427	8	9	605
FREEWAY	137.8	7,198.7	5,695	3,958	1,706	31	33	2,263
TOTAL	251.8	8,189.3	6,690	4,518	2,133	39	42	2,868
COUNTYWIDE [41]								
2 AND 3 LN	67.4	122.7	73	41	30	2	2	50
4+ UND	0.0	0.0	0	0	0	0	0	0
4+ DIV	2.5	11.6	15	6	9	0	0	17
SUBTOTAL	69.9	134.3	88	47	39	2	2	67
2 AND 3 LN EXP	11.9	48.3	17	11	6	0	0	10
4+ DIV EXP	5.5	57.7	33	19	14	0	0	23
NON FWY	87.3	240.3	138	77	59	2	2	100
FREEWAY	5.1	83.8	47	28	17	2	3	28
TOTAL	92.4	324.1	185	105	76	4	5	128

Crash Data
> Bicycle

SANTA CLARA COUNTY [42]

Highway Type		Total	Fatality	Injury
Expressway		1	0	1
Freeway		26	0	26
Conventional Highway		47	0	47
One-Way City Street		0	0	0
COUNTY TOTAL		74	0	74

SAN BENITO COUNTY [43]

Highway Type		Total	Fatality	Injury
Expressway		0	0	0
Freeway		0	0	0
Conventional Highway		1	0	1
One-Way City Street		0	0	0
COUNTY TOTAL		1	0	1

Crash Data
> Pedestrian

SANTA CLARA COUNTY [44]

Highway Type		Total	Fatality	Injury
Expressway		1	0	1
Freeway		28	9	19
Conventional Highway		13	0	13
One-Way City Street		0	0	0
COUNTY TOTAL		42	9	33

SAN BENITO COUNTY [45]

Highway Type		Total	Fatality	Injury
Expressway		1	0	1
Freeway		0	0	0
Conventional Highway		2	0	2
One-Way City Street		0	0	0
COUNTY TOTAL		3	0	3

40 Pg. 62 2014 Collision Data on California State Highways. https://bit.ly/2Xo87gr

41 Pg. 61 2014 Collision Data on California State Highways. https://bit.ly/2Xo87gr

42 Pg. 108 2014 Collision Data on California State Highways. https://bit.ly/2Xo87gr

43 Pg. 106 2014 Collision Data on California State Highways. https://bit.ly/2Xo87gr

44 Pg. 98 2014 Collision Data on California State Highways. https://bit.ly/2Xo87gr

45 Pg. 96 2014 Collision Data on California State Highways. https://bit.ly/2Xo87gr

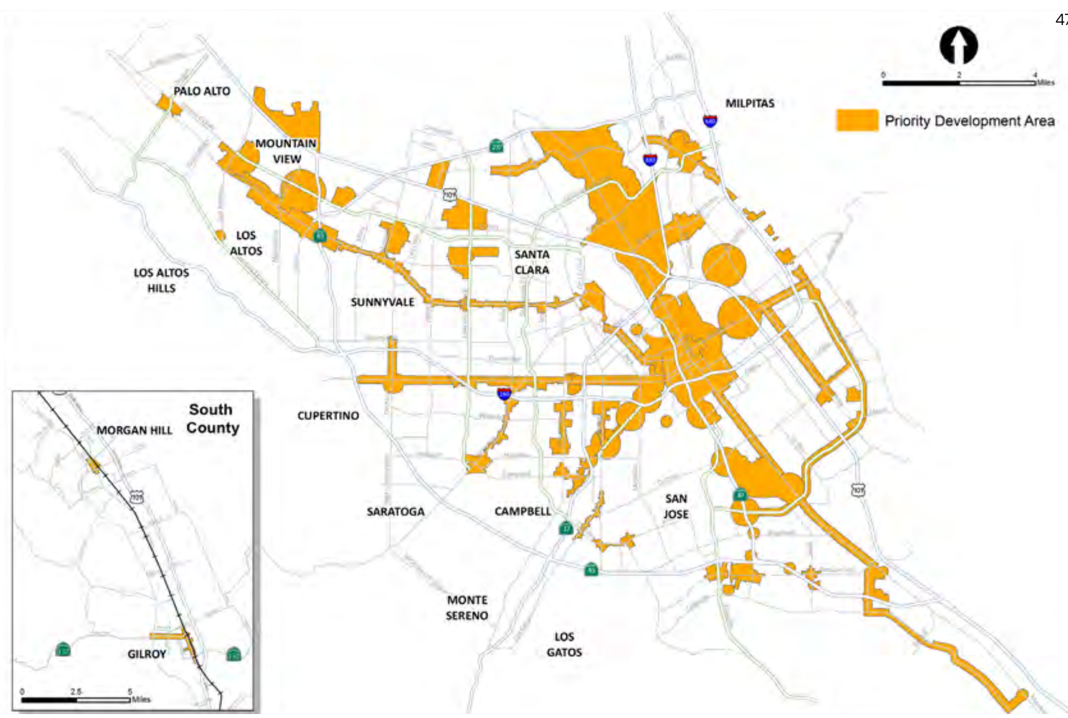
Emergency Response

Finally, the region had experienced some issues with emergency response due to the growing population and increasing congestion. As a proxy for the region, we'll look at San Jose's proportion of on-time responses:

City of San Jose [46]
911-Code 3 Emergency Medical Services
Percent of On-time Responses by Month

Month	Percent On-time	Month	Percent On-time
July 2012	90.11%	May 2013	87.32%
August 2012	91.67%	June 2013	86.84%
September 2012	88.74%	July 2013	89.19%
October 2012	88.01%	August 2013	88.37%
November 2012	87.41%	September 2013	86.32%
December 2012	87.44%	October 2013	86.89%
January 2013	88.14%	November 2013	83.87%
February 2013	88.60%	December 2013	83.87%
March 2013	89.39%	January 2014	88.06%
April 2013	89.52%	February 2014	87.66%

Santa Clara County is seeking to change travel patterns and land uses to focus growth near transit and to develop dynamic communities. This desire has resulted in a prioritization of areas which are shown in the map below.



[47]

46 Pg. 2, Limited Scope Management Audit Emergency Medical Services Response Time, Fire Department of the City of San Jose. https://bit.ly/305n8AC

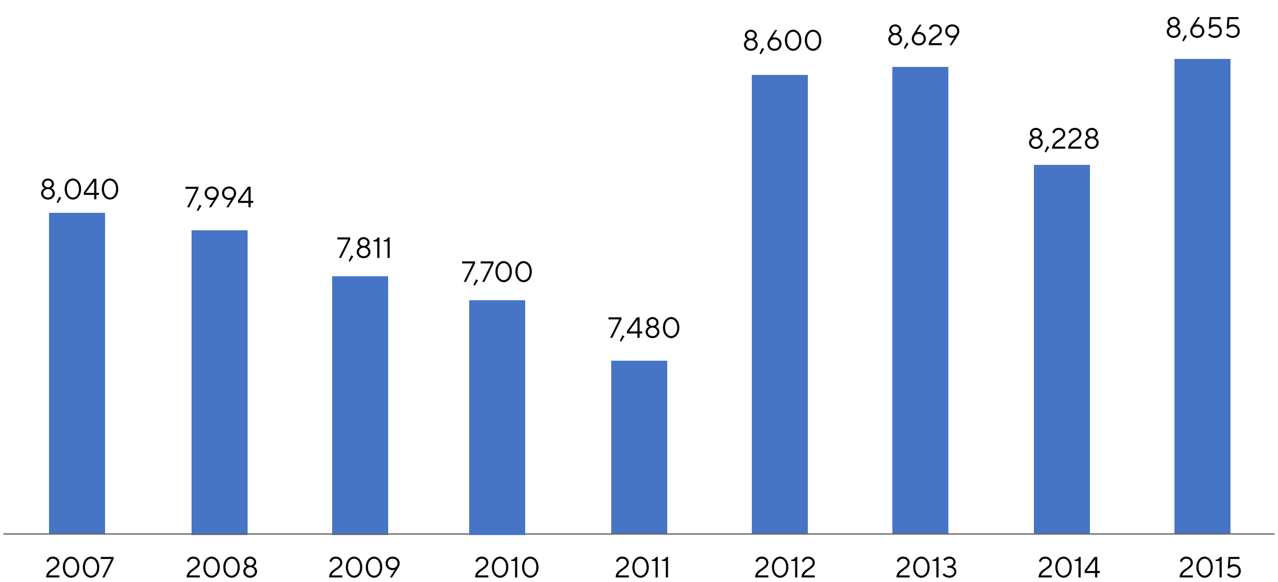
47 Pg. 19, VTP2040 The Long-Range Transportation Plan for Santa Clara County. https://bit.ly/2KRlb7j

Oklahoma City MSA Data & Maps[48]

From 2007 to 2015, the OCARTS area had 73,137 crashes at intersections. Below the crash data and maps (page 110 & 111) show dangerous areas of the region.

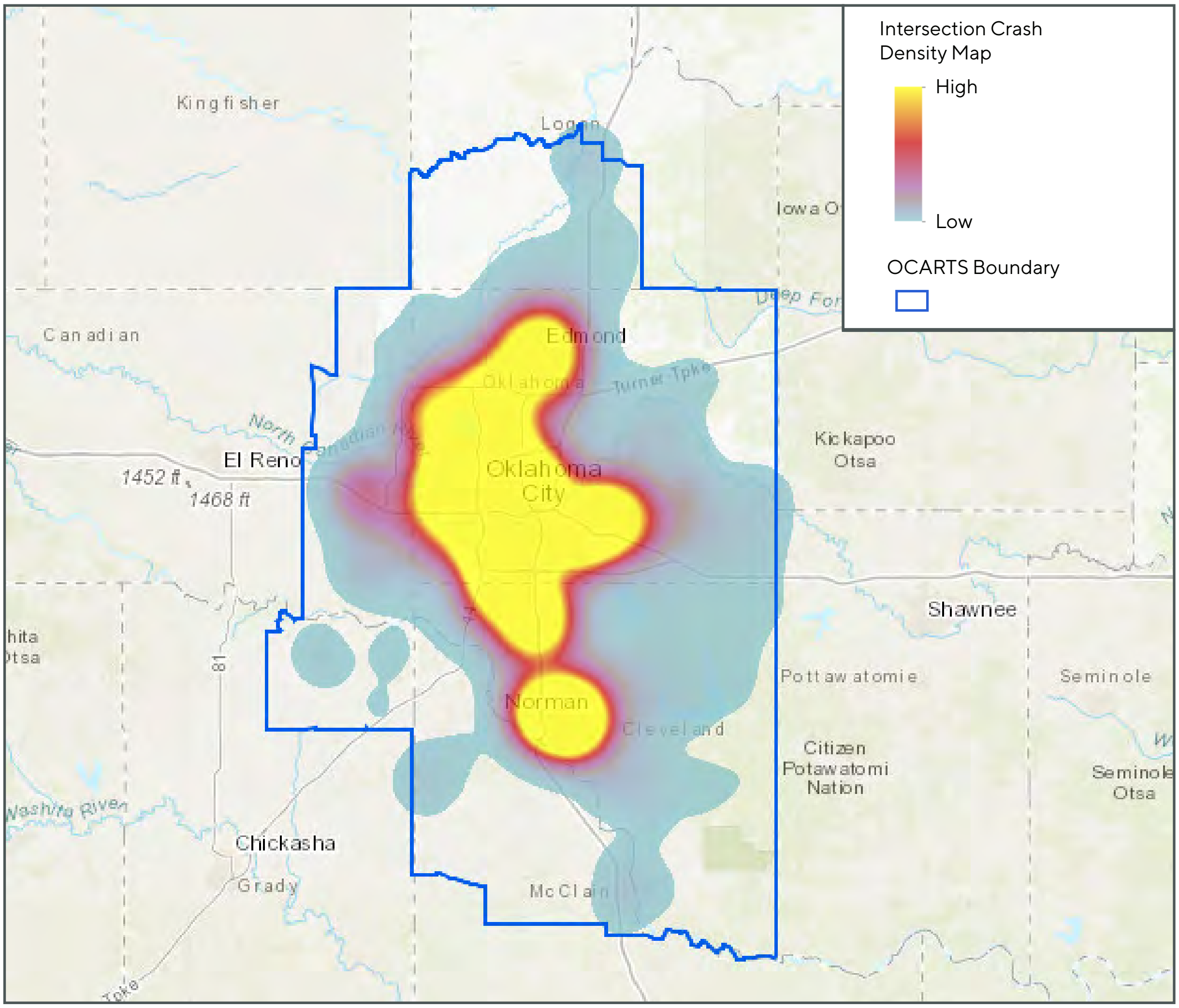
Year	Fatal	Serious and Incapacitating Injury	Property Damage Only
2007	20	1,400	5,104
2008	18	1,269	5,095
2009	16	1,130	5,128
2010	15	1,150	4,996
2011	19	1,046	4,844
2012	25	1,164	5,554
2013	20	1,151	5,676
2014	19	1,087	5,419
2015	19	1,110	5,695

Chart 1: Intersection Crashes Per Year in Study Area

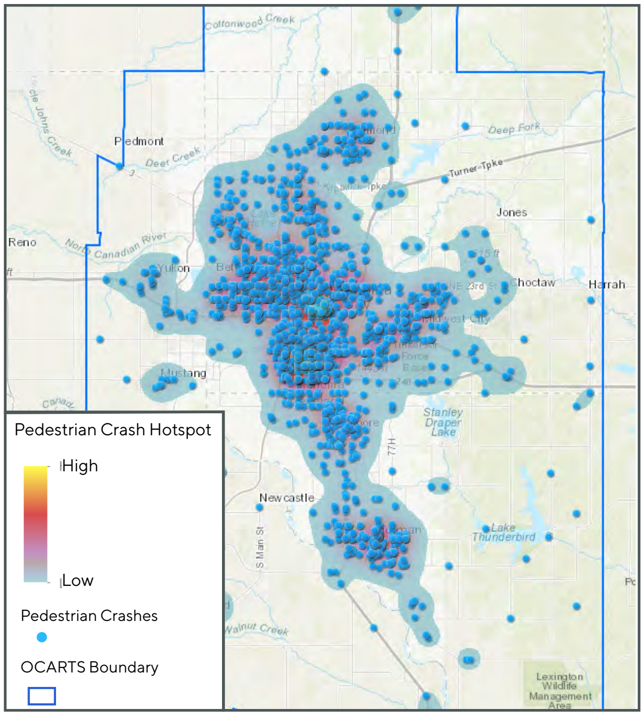


48 Source: https://bit.ly/2RPFEKc, accessed 11.28.2018

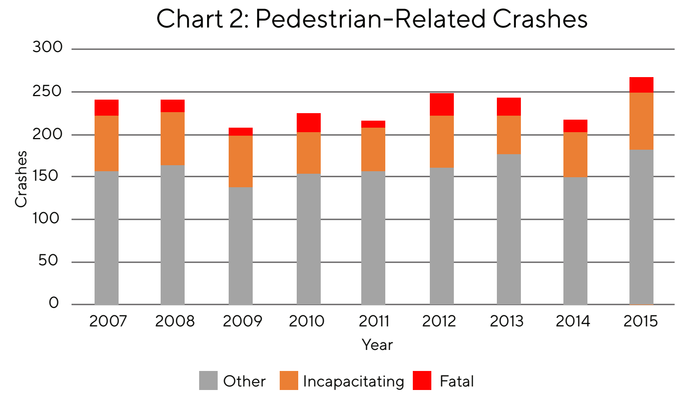
Automobile Crashes



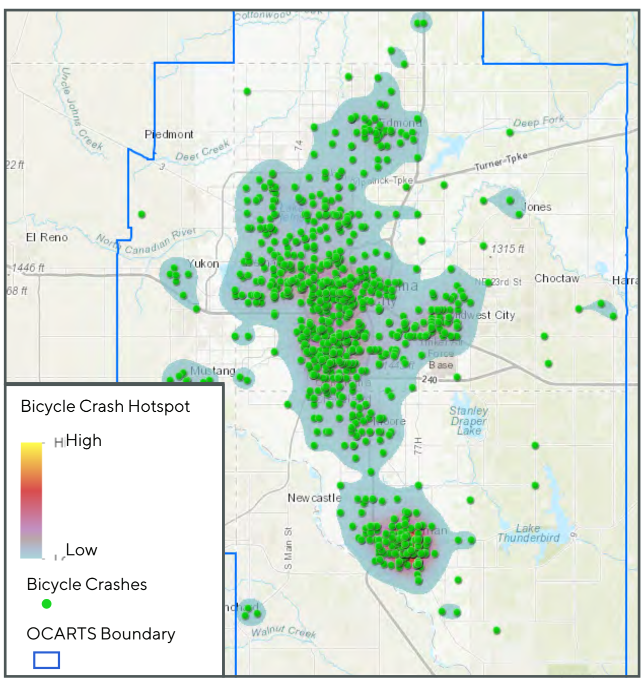
Pedestrian Crashes



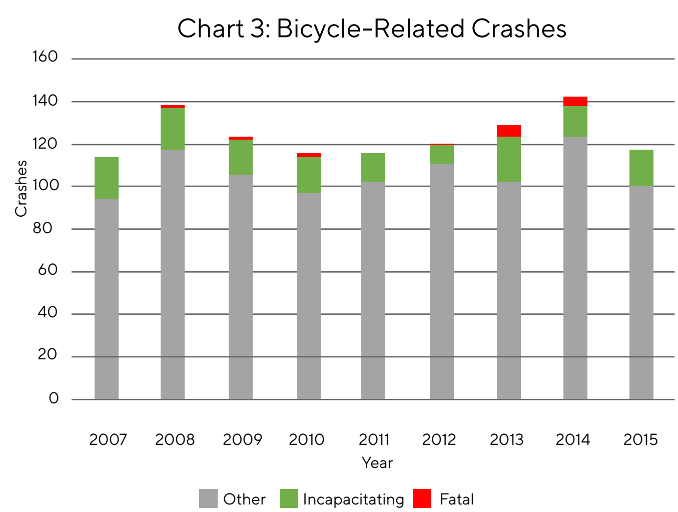
From 2007 to 2015, the OCARTS area had 2,091 crashes involving pedestrians, resulting in 147 deaths. On average, there are 232 crashes per year that involve a pedestrian.



Bicycle Related Crashes



From 2007 to 2015, the OCARTS area had 1,114 crashes involving cyclists, resulting in 15 deaths. While 15 is a relatively low number, 6 of those fatal crashes occurred in 2013. On average, there are 124 crashes per year involving a cyclist.



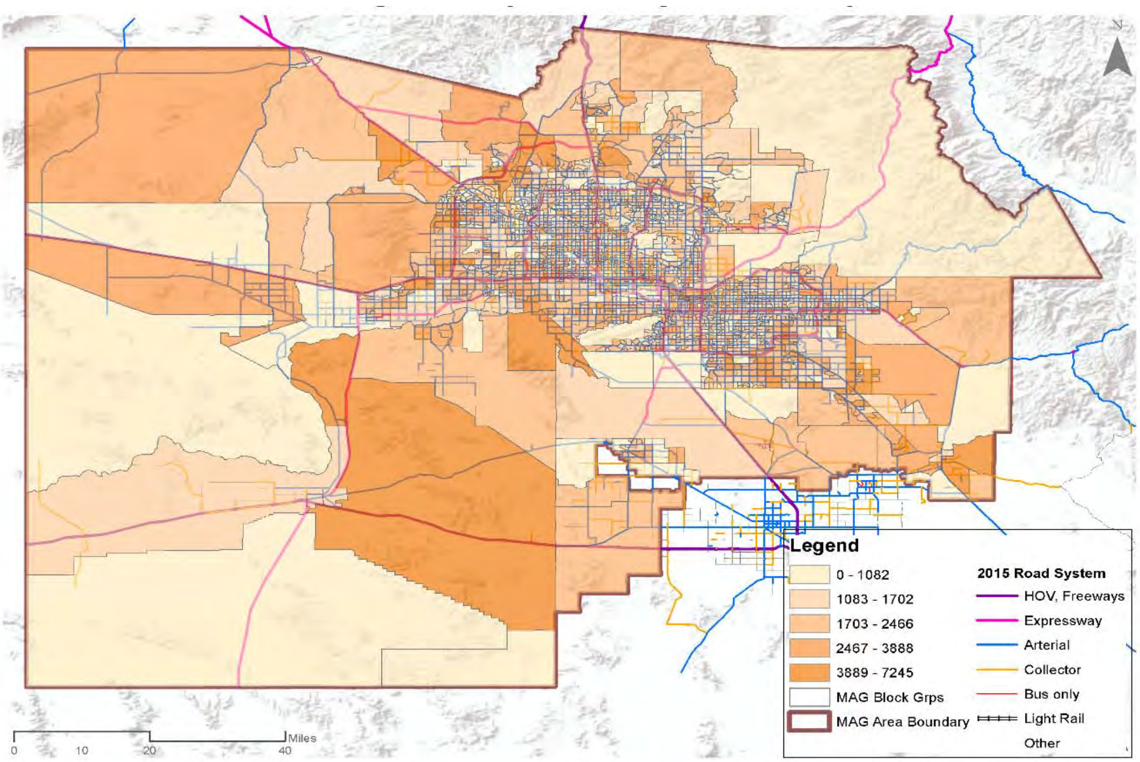
Arizona COG/MPO Employer Database

Industry Cluster	# of Businesses	# of Jobs	Share
Business Services	6,954	200,190	12.37%
Construction	4,928	121,710	7.52%
Consumer Goods Manufacturing	546	22,070	1.36%
Consumer Services	10,453	180,650	11.16%
Education	2,583	128,870	7.96%
Finance, Insurance & Real Estate	4,720	147,560	9.12%
Government, Social & Advocacy Services	3,712	124,750	7.71%
Healthcare	6,292	173,840	10.74%
High Tech Manufacturing & Development	972	70,800	4.37%
Hospitality, Tourism & Recreation	1,760	65,980	4.08%
Media, Publishing & Entertainment	652	13,750	0.85%
Metal Inputs & Trans.-Related Manufacturing	684	21,890	1.35%
Non-Metallic Manufacturing	653	18,670	1.15%
Resource Dependent Activities	435	18,010	1.11%
Retail	7,166	188,820	11.66%
Telecommunication	623	18,470	1.14%
Transportation & Distribution	3,166	102,770	6.35%
TOTAL	**56,299**	**1,618,800**	**100%**

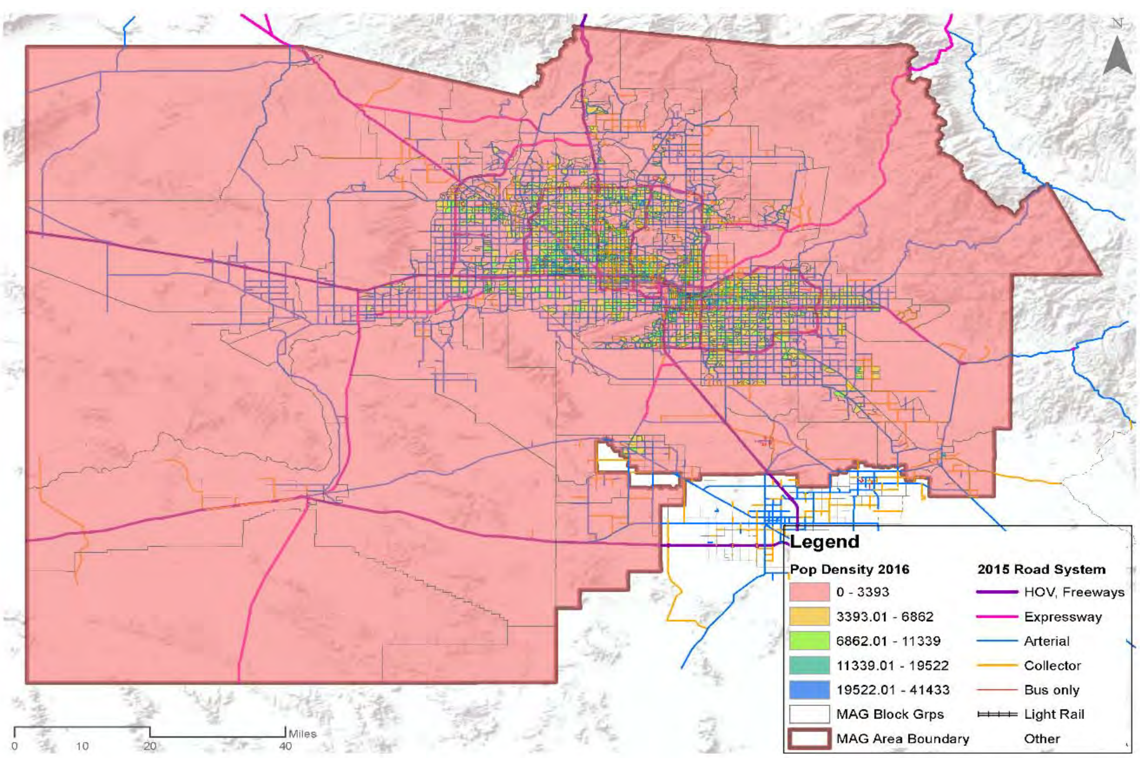
Source: Arizona COG/MPO Employer Database, employers with 5 or more employees.

Population and Population Density

Phoenix Region - Population by Block Groups



Phoenix Region - Population Density by Block Groups



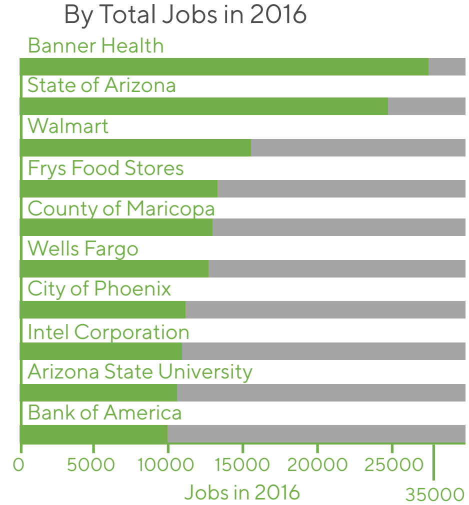
	Year							
Facility Types	2015	%	2020	%	2030	%	2040	%
Freeway (1)	38.3	36.9	43.4	37.8	52.6	37.7	61.3	37.1
HOV (2)	4.7	4.5	5.2	4.6	6.4	4.6	6.9	4.2
Expressway	3.1	3.0	3.4	3.0	4.5	3.2	5.6	3.4
Arterial/Local (3)	57.7	55.6	62.8	54.7	76.2	54.6	91.4	55.3
Total	103.8	100.0	114.9	100.0	139.6	100.0	165.2	100.0
Auto VMT	97.0	93.5	107.2	93.3	130.3	93.3	153.8	93.1
Truck VMT	6.8	6.5	7.7	6.7	9.3	6.7	11.4	6.9

(1) Includes: General purpose (GP) lanes, ramps, and collector-distributor roads.
(2) Includes: HOV lanes and HOV-GP connectors.
(3) Includes: Arterials, collectors, G-leg arterials, unpaved roads and centroid connectors.

Jurisdiction	MCDOT Functional Classification Categories			
	Principal Arterial	Minor Arterial	Major Collector	Minor Collector
Avondale	Arterial; RRS	Major Collector	N/A	N/A
Buckeye	Arterial	N/A	N/A	N/A
Carefree	Arterial	N/A	Collector	Minor Collector
Cave Creek	Principal Arterial	N/A	Major Collector	Minor Collector
Chandler	Major Arterial	Minor Arterial	N/A	N/A
Fountain Hills	Principal Arterial	Minor Arterial	Major Collector	Limited Collector; Minor Collector
Gila Bend	Principal Arterial	Minor Arterial	Collector	N/A
Gilbert	Major Arterial; RRS	Minor Arterial	Major Collector	Minor Collector
Glendale	Major Arterial; Superstreet	Arterial	Collector	N/A
Goodyear	Scenic Arterial; Major Arterial; Arterial	City Center Arterial	N/A	N/A
Litchfield Park	Arterial	N/A	Collector	N/A
Mesa	Arterial (6 lanes); Parkway	Arterial (4 lanes)	N/A	N/A
Paradise Valley	Major Arterial	N/A	Minor Arterial	Collector
Peoria	Principal Arterial; Major Arterail	Minor Arterial	Major Collector	Collector
Phoenix	Major Arterial;	Arterial	Collector	Minor Collector
Queen Creek	Principal Arterial	Arterial	Collector	N/A
Scottsdale	Major Arterial	Minor Arterial	Major Collector	Minor Collector
Surprise	Major Arterial	Minor Arterial	N/A	N/A
Tempe	Arterial	N/A	N/A	N/A
Tolleson	Major Street	N/A	N/A	N/A

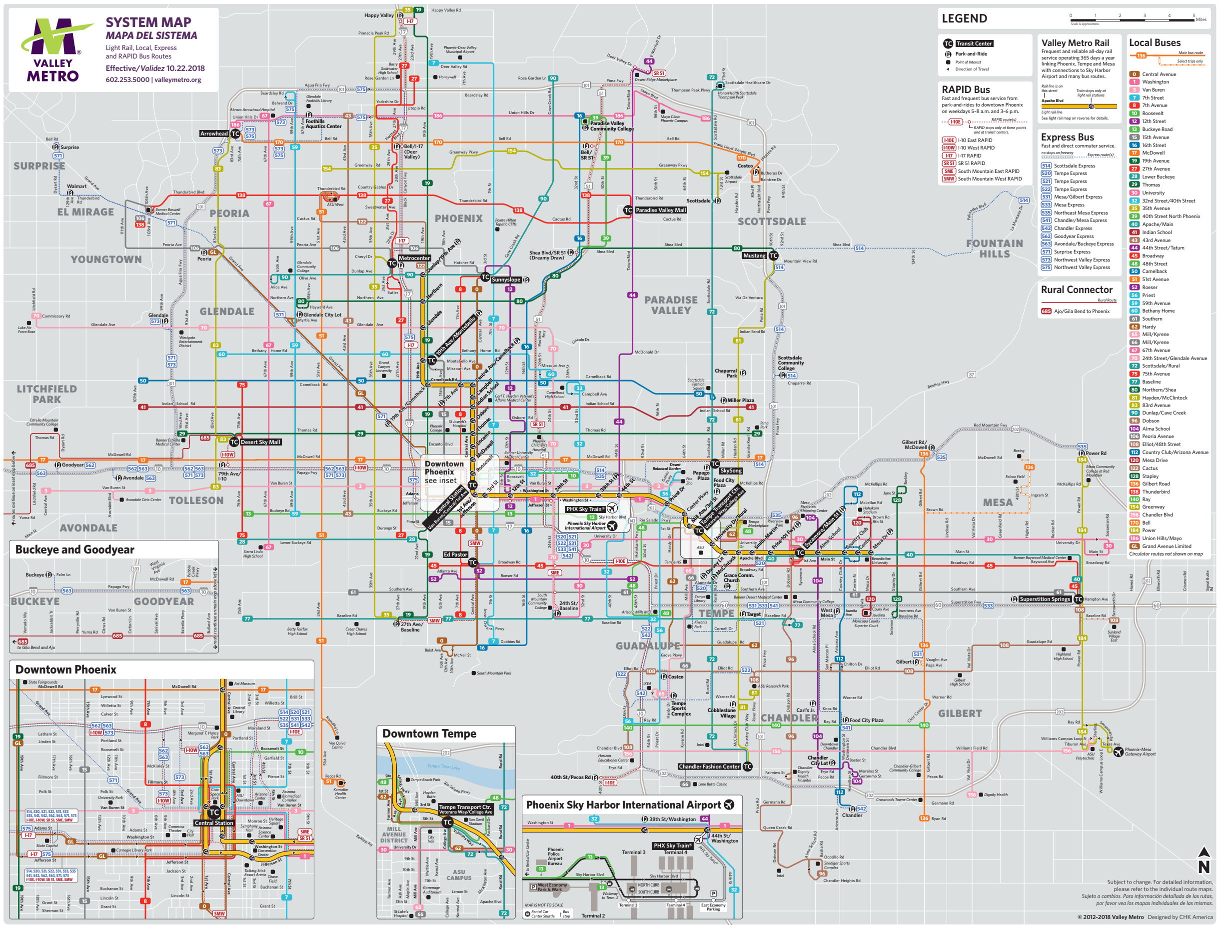
Jobs - Top 10 Employers

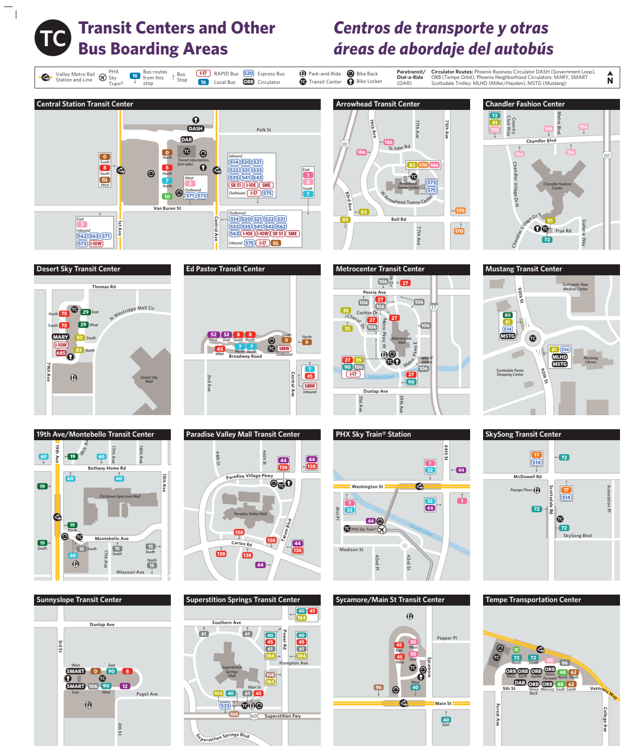
By Total Jobs in 2016

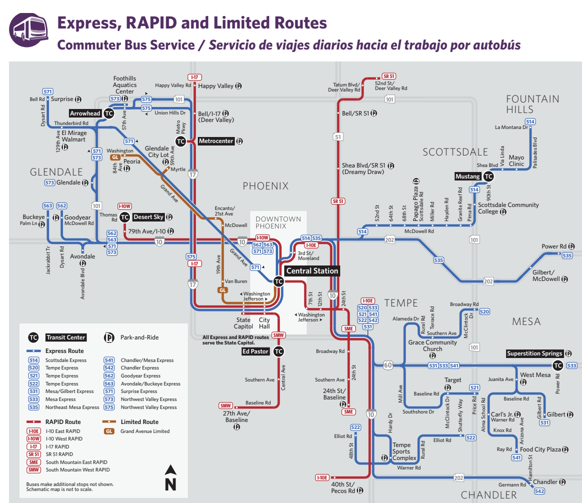


Source: 2016 COG/MPO Employer Database

Transit System Full Map - Metro Valley[49]

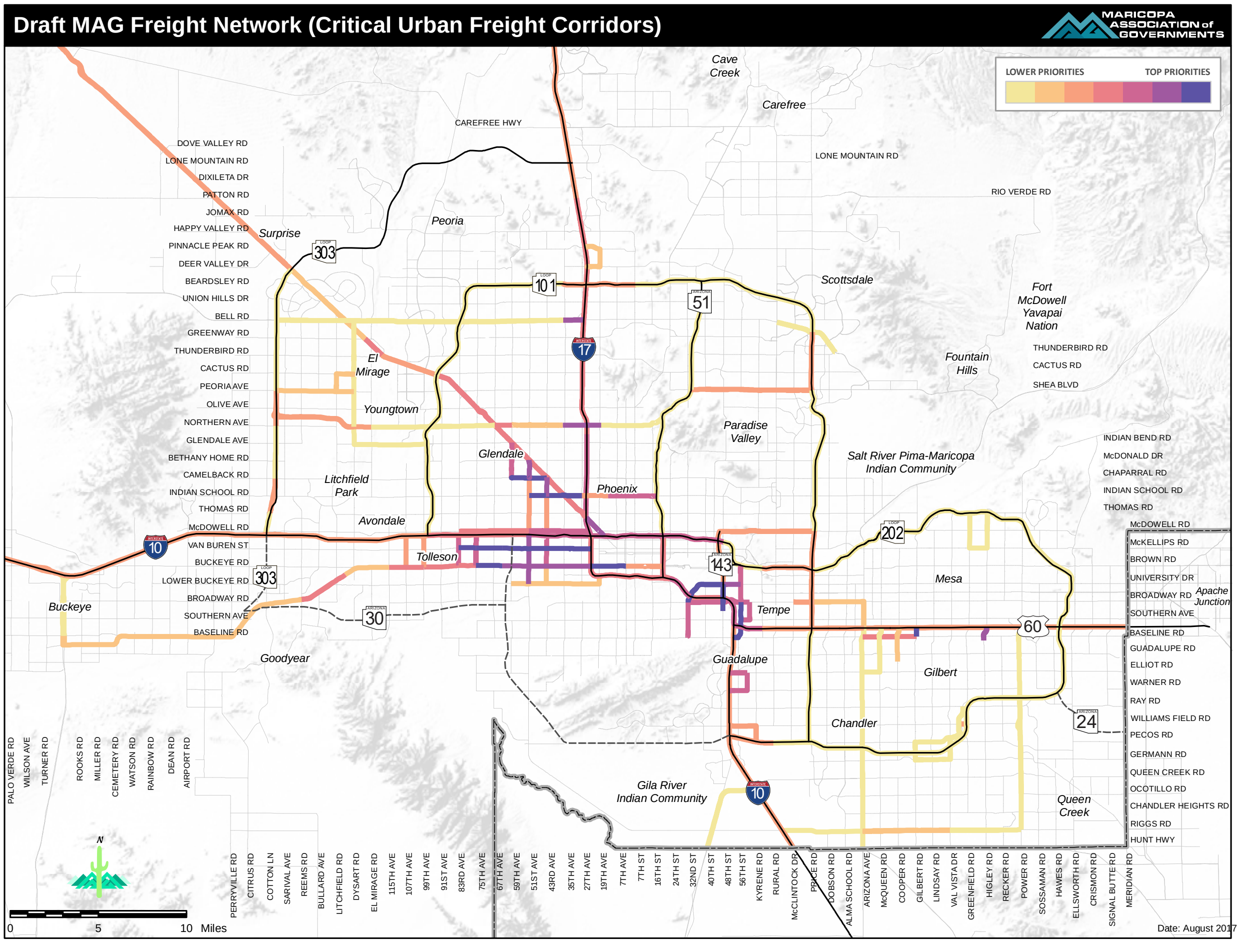






49 Source: https://bit.ly/2JXgBoq

Critical Urban Freight Corridor Map - July 2017 [50]



50 Source: https://bit.ly/2J5ollS

Freight

A study by the American Transportation Research Institute (ATRI) in cooperation with the Federal Highway Administration (FHWA) Office of Freight Management and Operations shows that three Sun Corridor interchanges ranked among the 100 worst in the nation specifically for goods movement.[51] These include the IH-10 and IH-17 interchange, in Phoenix (ranked 36), IH-10 and IH-19 interchange in Tucson (ranked 78) and the IH-10,
SR-51 and SR-202 interchange, in Phoenix (ranked 86). Results of the 2007 MAG Travel Time and Travel Speed Study reiterate the ATRI study findings by highlighting the duration of congestion at bottleneck location within the Phoenix metropolitan area. Various locations along IH-10 and IH-17, in particular, present challenges for reliable goods movement to, from and through Maricopa

Managed Access

MAG, in cooperation with the Arizona Department of Transportation (ADOT), Federal Highway Administration (FHWA), Valley Metro, and member agencies, explored a regional managed lanes system in the Phoenix Metro area. This effort was in part a response to Arizona House Bill 2396, which enables ADOT to consider Public-Private-Partnerships (P3) as a tool for financing transportation infrastructure in Arizona. The study entails determining future needs for High Occupancy Vehicle (HOV) and evaluating the potential introduction of High-Occupancy Toll (HOT) lanes, and active traffic management strategies. However, Maricopa County and Pinal County do not currently own or operate any Regional Connectors.

Occupancy Toll (HOT) lanes, and active traffic management strategies. However, Maricopa County and Pinal County do not currently own or operate any Regional Connectors.

Phoenix Region Crash Data[52]

County	Number of crashes						
	Total	Per Capita	Fatal	Injury	PDO	Killed	Injured
Maricopa	93,596	0.022	435	26,852	66,309	463	39,131
Pinal	3,977	0.010	64	1,191	2,722	71	1,802

County	Cost of Traffic Crashes			
	Fatalities	Injuries	PDO	Total
Maricopa	$2,685,400,000	$3,115,590,000	$265,236,000	$6,066,226,000

Freight Performance Measures, 2009 Bottleneck Analysis of 100 Freight Significant Highway Locations. American Transportation Research Institute (ATRI) and the Federal Highway Administration (FHWA) Office of Freight Management and Operations

52 AZDOT data - https://bit.ly/2RTFeTs

Case Study Corridor Data

WURZBACH PARKWAY/PA-1502 – SAN ANTONIO, TX
AADT Traffic Counts

Location	2006	2010	2014	2015	2016	2006-2016 % Change
@Weidner Road	11,000	15,800	14,334	16,337	24,153	+119.57%
@Perrin-Beitel Road	18,000	29,000	16,926	19,293	39,036	+116.87%
@Nacogdoches Road	32,000	31,000	18,507	21,086	39,829	+24.47%

US60 / GRAND AVENUE – PHOENIX, AZ
AADT Traffic Counts

Location	2015	2016	2017
@SR 303	20,997	20,405	21,139
@SR 101	25,807	31,264	32,358
@83rd Avenue / Peoria Avenue	29,664	30,317	31,378
@43rd Avenue / Camelback Road	41,550	37,946	39,274
@31st Avenue / Osborn Road	36,058	36,851	38,141

E CAMELBACK ROAD – SCOTTSDALE, AZ
AADT Traffic Counts

Location	2015	2016	2017
@SR 51	48,464	49,530	51,264
@N. 31st Street	40,434	41,324	42,770
@N. 40th Street / N. 44th Street	35,787	36,574	37,854
@N. 66th Street	27,207	27,806	28,779
@N. 78th Street / N. Hayden Road	18,822	19,236	19,909

CAMPO EJ Demographics

CAMPO ACS 2012-2016 ACS 5-Year Estimates		
Topic	**Estimate**	**Percent**
Gender and Age		
Total Population	***1,987,199***	-
Senior Population (65+)		
65 years and over	194,447	9.78%
Race and Ethnicity		
Total Population	***1,987,199***	-
Hispanic	630,102	31.71%
Non-Hispanic		
White, Non-Hispanic	1,069,603	53.82%
Black, Non-Hispanic	136,909	6.89%
Native American, Non-Hispanic	3,724	0.19%
Asian, Non-Hispanic	101,883	5.13%
Pacific Islander, Non-Hispanic	878	0.04%
Other, Non-Hispanic	3,374	0.17%
Two or More, Non-Hispanic	40,726	2.05%
Ability to Speak English		
Population 5 years and over	***1,987,199***	-
Speak Only English	3,002,527	74.1%
Speak Other Languages	1,046,846	25.9%
Speak English "very well"	680,267	-
Persons with Limited English Proficiency (LEP)	365,442	-
Speak English "well"	151,859	-
Speak English "not well"	128,956	-
Speak English "not at all"	82,234	-
Poverty Status in the Past 12 Months		
Persons for whom poverty status is determined	***1,987,199***	-
Persons with income below poverty level	700,375	16.4%
Persons with income below 150% of poverty level	1,102,610	25.8%
Persons with income below 200% of poverty level	1,510,974	35.4%
Vehicles Available		
Occupied Housing Units		-
No vehicle available	97,959	6.3%

County	Total Population	65+ Population	Hispanic Population
Bastrop	78,286	10,497	27,528
Burnet	44,584	9,473	9,589
Caldwell	39,848	5,288	19,853
Hays	185,686	18,642	68,832
Travis	1,148,176	97,083	387,357
Williamson	490,619	53,464	116,943

Maricopa Assoc. of Governments ACS 2012-2016 ACS 5-Year Estimates [53]		
Topic	**Estimate**	**Percent**
Gender and Age		
Total Population	***4,341,854***	-
Gender		
Male	2,153,712	49.6%
Female	2,187,887	50.4%
Age		
Median Age	-	-
Under 5 years	291,566	6.7%
5 to 9 years	307,496	7.1%
10 to 14 years	304,227	7.0%
15 to 19 years	293,347	6.8%
20 to 24 years	297,920	6.9%
25 to 34 years	615,066	14.2%
35 to 44 years	578,496	13.3%
45 to 54 years	556,962	12.8%
55 to 59 years	250,422	5.8%
60 to 64 years	231,059	5.3%
65 to 74 years	353,918	8.2%
75 to 84 years	180,944	4.2%
85 years and over	71,287	1.6%
Select Age Groups		
18 years and over	3,256,024	75.0%
21 years and over	3,080,293	70.9%
62 years and over	745,974	17.2%
65 years and over	609,004	14.0%
Race and Ethnicity		
Total Population	***4,341,854***	-
Hispanic	1,292,434	29.8%
Non-Hispanic		
White, Non-Hispanic	2,490,209	57.4%
Black, Non-Hispanic	216,163	5.0%
Native American, Non-Hispanic	74,282	1.7%
Asian, Non-Hispanic	157,465	3.6%
Pacific Islander, Non-Hispanic	8,261	0.2%
Other, Non-Hispanic	5,105	0.1%
Two or More, Non-Hispanic	92,466	2.1%
Minority (1)	1,851,314	42.6%
Educational Attainment		
Population 25 years and over	***2,843,967***	-
Less than 9th Grade	171,228	6.0%
9th to 12th Grade, No Diploma	197,856	7.0%
High School Graduate (includes equivalency)	663,127	23.3%
Some College, No Degree	706,496	24.8%
Associate Degree	241,723	8.5%
Bachelor's Degree	549,139	19.3%
Graduate or Professional Degree	310,064	10.9%

[53] Source: U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates

Maricopa Assoc. of Governments ACS 2012-2016 ACS 5-Year Estimates [53]		
Topic	**Estimate**	**Percent**
Ability to Speak English		
Population 5 years and over	***4,049,652***	**-**
Speak Only English	3,002,527	74.1%
Speak Other Languages	1,046,846	25.9%
Speak English "very well"	680,267	-
Persons with Limited English Proficiency (LEP)	365,442	-
Speak English "well"	151,859	-
Speak English "not well"	128,956	-
Speak English "not at all"	82,234	-
Veterans Status		
Civilian Population 18 years and over	***3,251,640***	**-**
Civilian veterans	281,757	8.7%
Veterans by Gender		
Male	258,344	-
Female	21,446	-
Veterans by Age		
18 to 34 years	23,287	-
35 to 54 years	67,030	-
55 to 64 years	49,844	-
65 to 74 years	68,529	-
75 years and over	65,144	-
Households		
Total Households	***1,548,415***	**-**
Average Household Size	-	-
Family Households (Families)	1,018,618	65.8%
Married-couple family	737,631	-
Female Householder, no husband present	192,945	-
with own children under 18 years	109,497	-
Nonfamily Households	529,725	34.2%
Householder living alone	414,997	-
Household Income (in 2016 inflation-adjusted dollars)		
Total Households	***1,548,415***	**-**
Median Household Income (dollars)	$ -	-
Less than $10,000	103,178	6.7%
$10,000 to $14,999	65,636	4.2%
$15,000 to $24,999	146,245	9.4%
$25,000 to $34,999	154,873	10.0%
$35,000 to 49,999	218,346	14.1%
$50,000 to $74,999	287,950	18.6%
$75,000 to $99,999	193,942	12.5%
$100,000 to $149,999	211,167	13.6%
$150,000 to $199,999	78,713	5.1%
$200,000 or more	77,010	5.0%

[53] Source: U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates

Maricopa Assoc. of Governments ACS 2012-2016 ACS 5-Year Estimates [53]		
Topic	**Estimate**	**Percent**
Poverty Status in the Past 12 Months		
Persons for whom poverty status is determined	***4,272,979***	***-***
Persons with income below poverty level	700,375	16.4%
Persons with income below 150% of poverty level	1,102,610	25.8%
Persons with income below 200% of poverty level	1,510,974	35.4%
Poverty Status for Families in the Past 12 Months		
Total Families	***1,018,618***	***-***
Families with income below poverty level	120,418	11.8%
Married-couple family	49,197	-
with related children under 18 years	33,287	-
Female householder, no husband present	54,206	-
with related children under 18 years	46,885	-
Male householder, no wife present	14,273	-
with related children under 18 years	10,879	-
Commuting to Work		
Workers 16 years and over	***1,935,484***	***-***
Car or Truck - drive alone	1,484,809	76.7%
Car or Truck - carpool	210,236	10.9%
Public Transportation	40,780	2.1%
Bicycle	15,329	0.8%
Walked	27,818	1.4%
Other means (taxicab, motorcycle, etc.)	32,645	1.7%
Work at home	116,783	6.0%
Occupation		
Civilian employed population 16 years and over	***1,963,836***	***-***
Management, business, science, and arts occupatior	721,346	36.7%
Management, business, and financial occupations	307,464	-
Management occupations	197,964	-
Business and financial operations occupations	108,227	-
Computer, engineering, and science occupations	111,693	-
Computer and mathematical occupations	61,408	-
Architecture and engineering occupations	38,224	-
Life, physical, and social science occupations	9,326	-
Education, legal, community service, arts, and mec	189,964	-
Community and social service occupations	30,914	-
Legal occupations	19,687	-
Education, training, and library occupations	100,369	-
Arts, design, entertainment, sports, and media o	33,992	-
Healthcare practitioners and technical occupations	108,271	-
Health diagnosing and treating practitioners and	74,531	-
Health technologists and technicians	32,029	-
Service occupations	362,316	18.4%
Healthcare support occupations	36,926	-
Protective service occupations	44,181	-
Firefighting and prevention, and other protective	26,301	-
Law enforcement workers including supervisors	16,539	-

[53] Source: U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates

[53]

Maricopa Assoc. of Governments ACS 2012-2016 ACS 5-Year Estimates		
Topic	**Estimate**	**Percent**
Housing		
Total Housing Units	***1,786,861***	-
Units in Structure		
1, detached	1,163,504	65.1%
1, attached	89,269	5.0%
2 to 9	177,203	9.9%
10 or more	245,636	13.7%
Mobile Home	105,271	5.9%
Boat, RV, van, etc.	2,668	0.1%
Occupancy, Tenure, Value, and Rent		
Occupied Housing Units	***1,548,415***	-
Average Household Size	-	-
Owner Occupied Housing Units	945,894	61.1%
Average Household size of Owner Occupied Hous	-	-
Median Value (dollars)	$ -	-
Renter Occupied Housing Units	602,446	38.9%
Average Household size of Renter Occupied Hous	-	-
Median Rent (dollars)	$ -	-
Vacant Housing Units	238,112	13.3%
For seasonal, recreational, or occasional use	95,305	-
All other vacant	141,616	-
Vehicles Available		
Occupied Housing Units	***1,548,415***	-
No vehicle available	97,959	6.3%
1 vehicle available	580,151	37.5%
2 vehicles available	602,789	38.9%
3 or more vehicles available	264,488	17.1%
Area		
Total Area in Acres	6,819,240	-
Total Area in Square Miles	10,655.1	-
Source: United States Census Bureau, American Community Survey 2012-2016 5yr Estimates		

Source: U.S. Census Bureau, 2012-2016 American Community Survey (ACS) 5-Year Estimates. ACS data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate is represented through the use of a margin of error (MOE). In addition to sampling variability, the ACS estimates are subject to nonsampling error. The MOE and effect of nonsampling error is not represented in these tables. Supporting documentation on subject definitions, data accuracy, and statistical testing can be found on the American Community Survey website (www.census.gov/acs) in the Data and Documentation section. Sample size and data quality measures (including coverage rates, allocation rates, and response rates) can be found on the American Community Survey website (www.census.gov/acs) in the Methodology section. The MOE for individual data elements can be found on the American FactFinder website (factfinder2.census.gov). Note: Although the ACS produces population, demographic and housing unit estimates, the 2010 Census provides the official counts of the population and housing units for the nation, states, counties, cities and towns. Prepared by: Maricopa Association of Governments, www.azmag.gov, (602) 254-6300

People with Disabilities					
	Maricopa	Pinal	Total	Total Population	% share
Estimate	40,434	53,230	491,661	4,433,845	11.09%

Senior population (65+)					
	Maricopa	Pinal	Total	Total Population	% share
Estimate	564,220	72,364	636,584	4,433,845	14.36%

[53] Source: U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates

Limited-Access:
Cross-section #1

US 67 near Hampton Road, Dallas, Texas

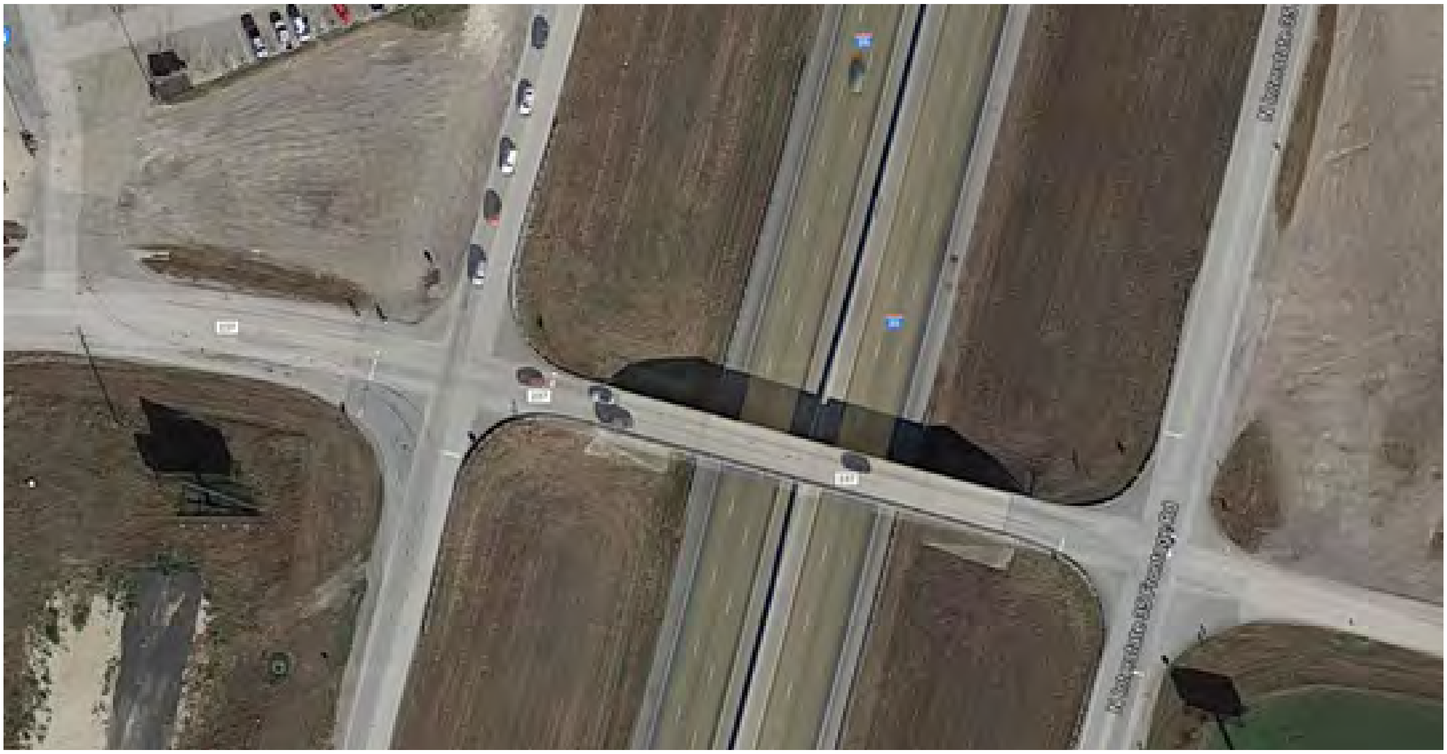
AZ Loop 202 near Power Road, Phoenix, Arizona

I-65 near Forest Hills Drive, Nashville, Tennessee

* Existing Aerial Arterial Cross-section Corridor Examples: Google 2018 (pages 126-155)

Limited-Access: Cross-section #2

I-35 at Ronald Reagan Boulevard, Austin, Texas



I-10 @ Clint-San Elizario Road, Clint, Texas

Principal Arterial (Expressway/Regional Connector and Major) Cross-section #3

Av de los Insurgentes Sur near Loreto, Mexico City, Mexico

Principal Arterial (Expressway/Regional Connector and Major) Cross-section #4

N. St Mary Street @ Houston, San Antonio, Texas

East Commerce Street.@ St. Mary, San Antonio, Texas

Principal Arterial (Expressway/Regional Connector and Major) Cross-section #7

FM 1187 near McCart, Crowley, Texas

Wurzbach Parkway @ Starcrest, San Antonio, Texas

Principal Arterial (Expressway/Regional Connector and Major) Cross-section #8

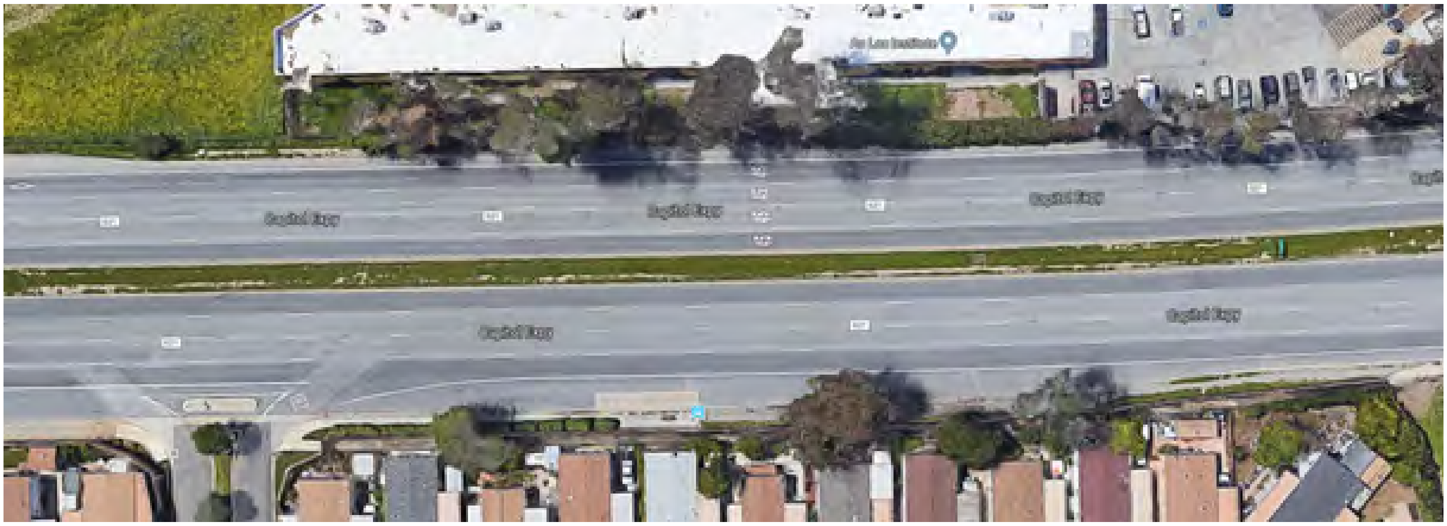
San Tomás Expressway near El Camino Real, San Jose, California

Plan View:

Principal Arterial (Expressway/Regional Connector and Major) Cross-section #8 (continued)

Capital Expressway near Aborn Road, San Jose, California

Plan View:



Principal Arterial (Expressway/Regional Connector and Major) Cross-section #8 (continued)

Lawrence Expressway near Moorpark, San Jose, California

Plan View:

Principal Arterial (Expressway/Regional Connector and Major) Cross-section #9

Bothell Way near NE 186th Street, Bothell, Washington

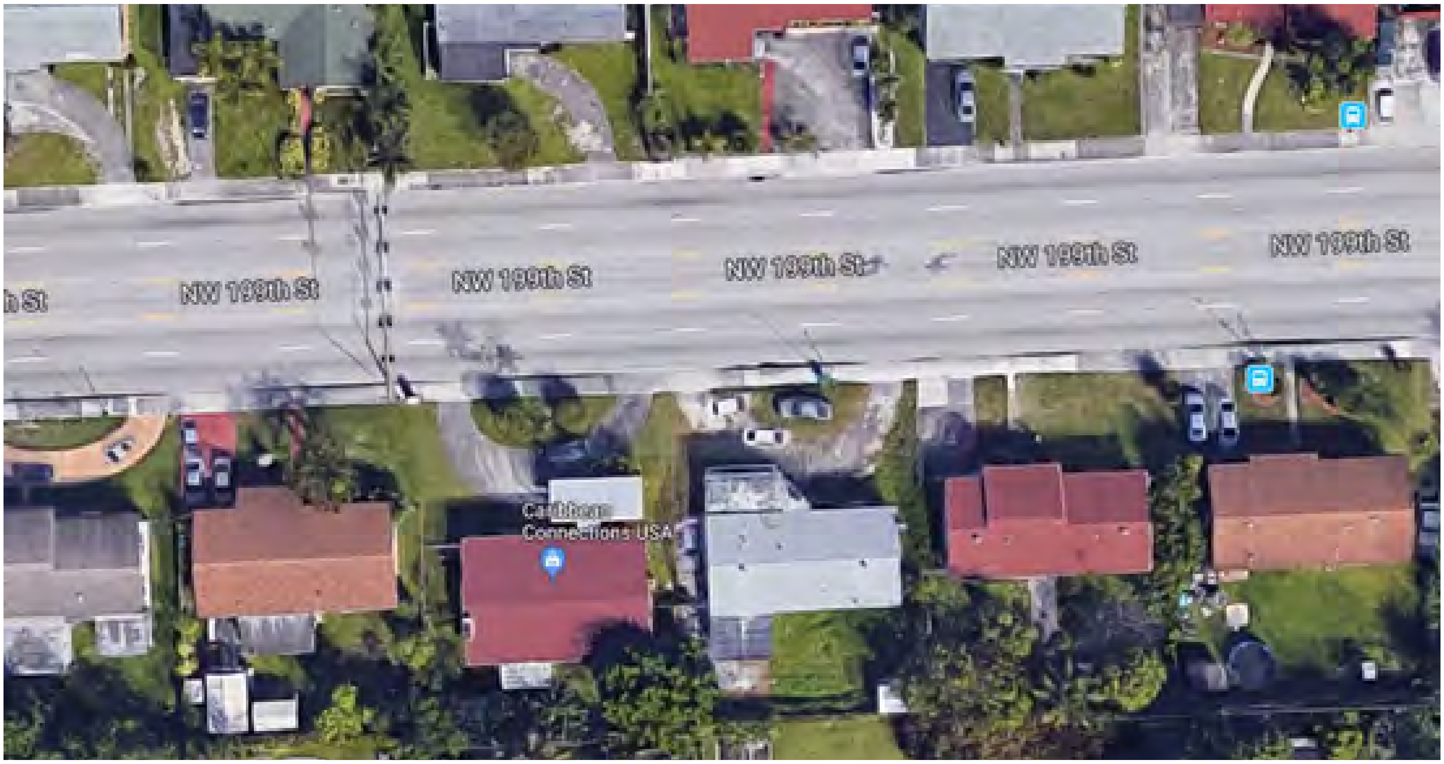
Principal Arterial (Expressway/Regional Connector and Major) Cross-section #10

Lawrence Expressway near Moorpark, San Jose, California

Plan View:

Major Arterial
Cross-section #13

NW 199th Street, Miami, Florida



7th Avenue, Phoenix, Arizona

Major Arterial
Cross-section #14

Cesar Chavez Boulevard @ Aubrey Street, San Antonio, Texas

Major Arterial
Cross-section #15

Bicentennial Boulevard @ Jackson Avenue, McAllen, Texas

Rosedale near Henderson, Fort Worth, Texas

Major Arterial
Cross-section #15 (continued)

Lancaster Avenue @ Houston Street, Fort Worth, Texas

Plan View:

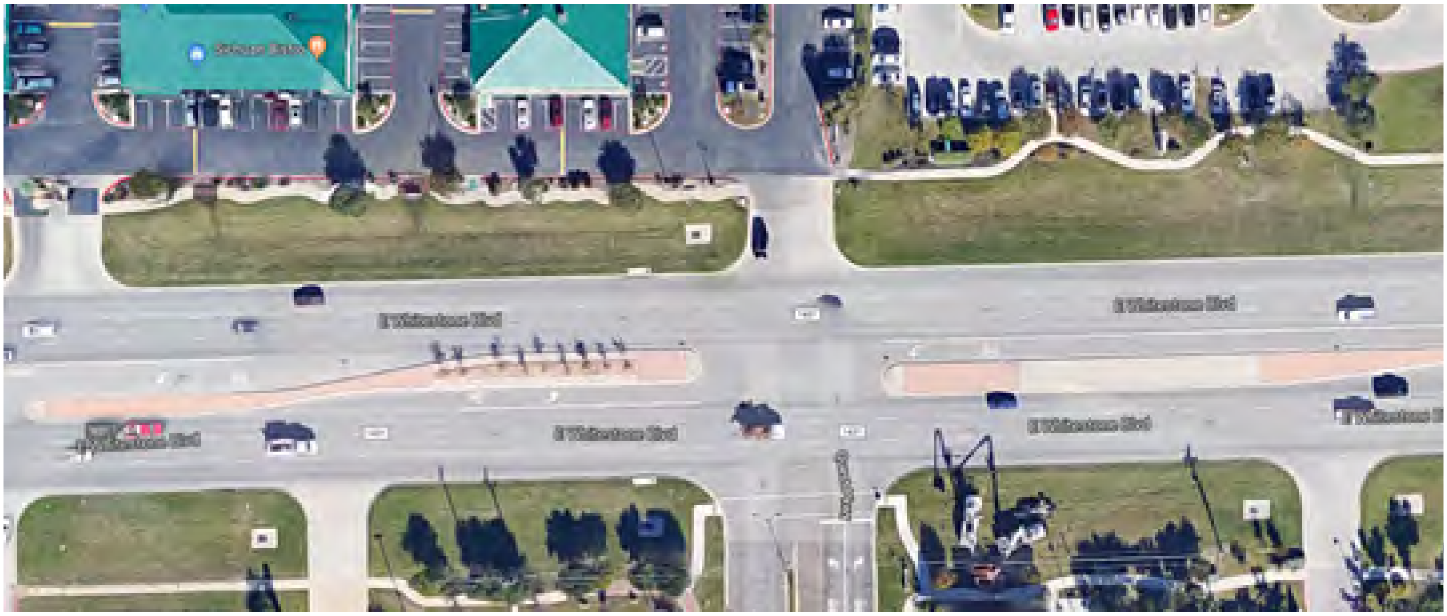
Major Arterial
Cross-section #16

Santa Monica near La Cienega Boulevard, West Hollywood, California

Plan View:

Major Arterial
Cross-section #17

RM 1431 near Discovery, Cedar Park, Texas



CO 121- Wadsworth @ Interlocken Loop, Broomfield, Colorado

Minor Arterials:
Cross-section #18

N Park Street @ Spring Street, Madison, Wisconsin

Basin Street @ St. Peter Street, New Orleans, Louisiana

Major Arterial
Cross-section #18 (continued)

N. First Street @ CA237, San Jose, California

Rio Rd (VA-631) @ John Warner Parkway Charlottesville, Virginia

Plan View:

Minor Arterials:
Cross-section #19

Jollyville Road @ Pavilion Boulevard, Austin, Texas

Plan View:

Major Arterial
Cross-section #20

N Broom Street @ W Washington Avenue, Madison, Wisconsin

W Johnson Street @ Henry Street, Madison, Wisconsin

Minor Arterials:
Cross-section #21

S. Lakeline Boulevard near Old Mill Road, Cedar Park, Texas

Minor Arterials:
Cross-section #22

Colesville Road (US 29) near N. Noyes Drive, Silver Spring, Maryland

Major Arterial
Cross-section #23

Sea to Sky, British Columbia, Canada

Examples of Flexible Lanes

Commerce Street. @ Griffin Street., Dallas, Texas

Houston Street @ W. 1st Street., Fort Worth, Texas

Examples of Flexible Lanes (continued)

Louisiana Street @ Elgin Street, Houston, Texas

SH-161 near W. Walnut Hill Lane, Irving, Texas

Intersections

Michigan Left Turn

How. Also known as a median u-turn crossover. In this intersection design, left turn/u-turn crossovers eliminate left turns at the intersection and moves them to median crossovers beyond the intersection. For median u-turn crossovers located on the major roadway, motorists turn left off the major roadway by passing through the intersection, making a u-turn at the crossover, and turning right at the cross-street. Motorists wishing to turn left onto the major road from the cross street turn right onto the major road and make a u-turn at the crossover. U-turn movements can be signalized and coordinated with the main intersection. U-turn movements can be applied to all four quadrants of an intersection. Medians must be wide to accommodate this configuration.

Why. This intersection type reduces signal phasing to a two-phase signal configuration, increasing intersection efficiency. The number of pedestrian and vehicle conflict points in this type of intersection are reduced because the traditional left turn lane is eliminated. Pedestrians crossing either street will only encounter through-traffic and vehicles making right turns. The left-turning movement, having been eliminated, removes one source of[53]

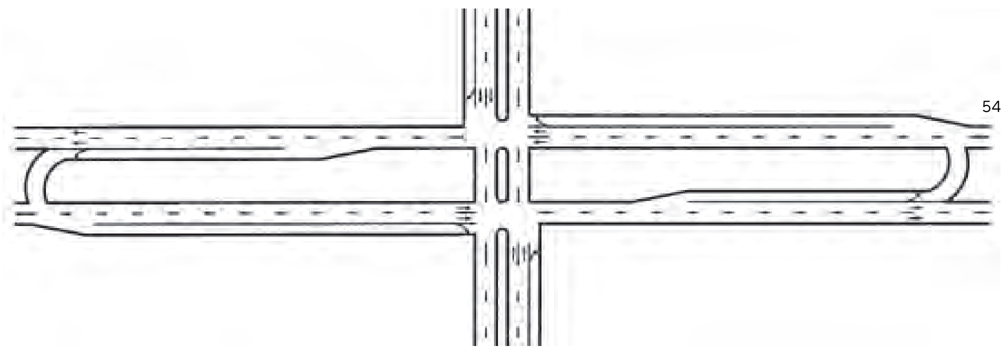
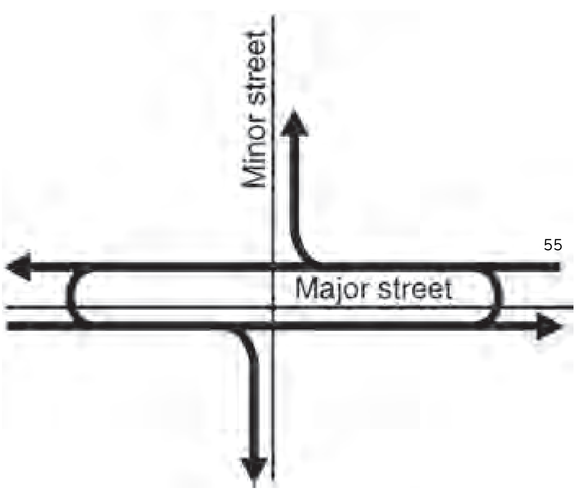
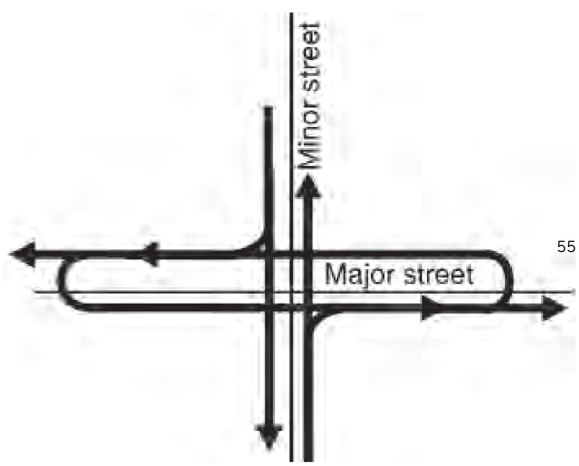


Diagram of a median U-turn crossover from the main line.[54]



Major Street Movement[55]



Minor Street Movement[55]

[53] FHWA Signalized Intersections: Informational Guide. FHWA-HRT-04-091. August 2004. Chapter 10 – Alternative Intersection Treatments. https://bit.ly/2JiPVLb

[54] Source: FHWA Chapter 10 – Alternative Intersection Treatments. 10.2.2 Median U-Turn Crossover, Figure 85. Diagram of a median U-turn crossover

[55] Source: FHWA Chapter 10 – Alternative Intersection Treatments. 10.2.2 Median U-Turn Crossover, Figure 86. Vehicular movements at a median U-turn intersection.

Jughandle

How. This intersection employs an indirect left turn configuration. It uses one-way roadways in two quadrants of the intersection that allow for removal of left-turning traffic from the through stream without providing left turn lanes. All turns, right, left, and u-turns, are made from the right side of the roadway. Motorists turning left exit the major roadway at a ramp on the right and turn left onto the minor roadway at a terminus separated from the main intersection.

Why. The number of pedestrian and vehicle conflict points in this type of intersection are reduced because the traditional left and right turn lanes are eliminated. Jughandles remove left- and right-turning vehicles from the through lanes and thus are likely to reduce crashes if sufficient signing is provided to help eliminate driver [56]

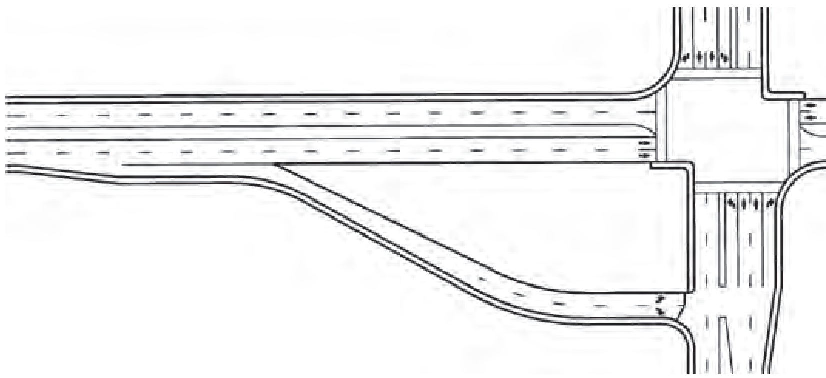
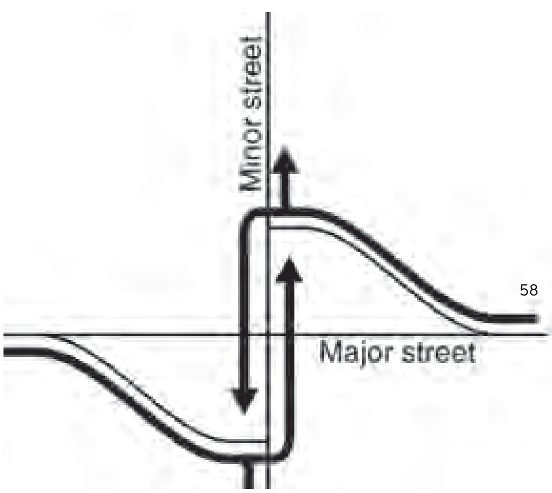
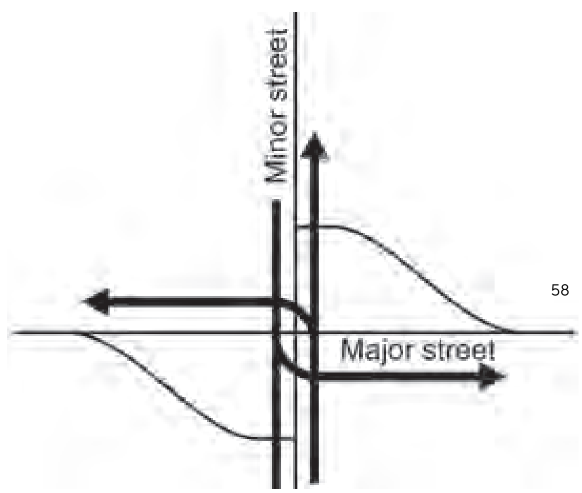

[57]

Diagram of a jughandle intersection.



[58]

Major Street Movement



[58]

Minor Street Movement

[56] FHWA Signalized Intersections: Informational Guide. FHWA-HRT-04-091. August 2004. Chapter 10 – Alternative Intersection Treatments. https://bit.ly/2JiPVLb

[57] Source: FHWA Chapter 10 – Alternative Intersection Treatments. 10.2.1 Median U-Turn Crossover, Figure 76. Diagram of a jughandle intersection

[58] Source: FHWA Chapter 10 – Alternative Intersection Treatments. 10.2.1 Median U-Turn Crossover, Figure 77. Vehicular movements at a jughandle intersection.

Interchanges

Full and Partial Cloverleaf

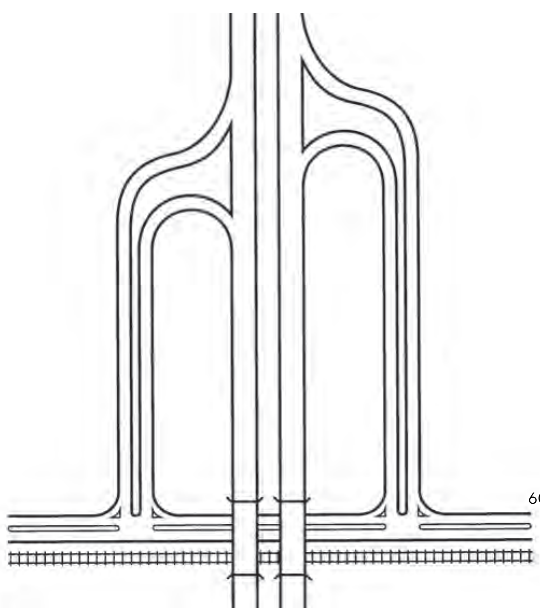
How. A cloverleaf is an interchange in which left turns are facilitated by ramp roads. These interchanges may be appropriate when interchanging a roadway with a non-controlled access facility in a location away from an urban area.

The four-quadrant, full cloverleaf interchange eliminates all left turn conflicts through construction of a two-level interchange.

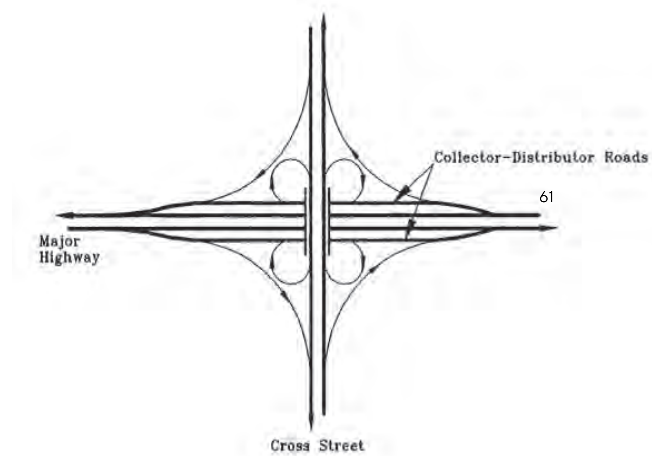
A partial cloverleaf does not have ramps in all four quadrants. It is sometimes used when site controls (such as railroads or streams running parallel to the crossroad) limit the number of loops and/or the traffic pattern is such that the left turn conflicts caused by the absence of one or more loops are within tolerable limits.

Why. This interchange type can be a good solution for intersections with heavy left turn movements because those vehicles utilize ramps dedicated for left turns. Potential conflict between left-turning vehicles and vehicles traveling through the intersection is eliminated.

Disadvantages worth noting include large right-of-way requirements, capacity restrictions of single-lane loops, short weaving length between loops, and weave and acceleration difficulty for large trucks. Cloverleafs should not be used where left turn volumes are high since loop ramps are limited to one lane of operation and have[59]


[60]

Partial Cloverleaf Interchange



[61]

Full Cloverleaf Interchange

Source: TxDOT Roadway Design Manual. Section 6: Freeways. April 26, 2018. https://bit.ly/2xpoVnN

Source: TxDOT Roadway Design Manual. Section 6: Freeways. April 26, 2018. 3-25. Full Cloverleaf Interchange.

Source: TxDOT Roadway Design Manual. Section 6: Freeways. April 26, 2018. Figure 3-26. Partial Cloverleaf Interchange.

Diamond

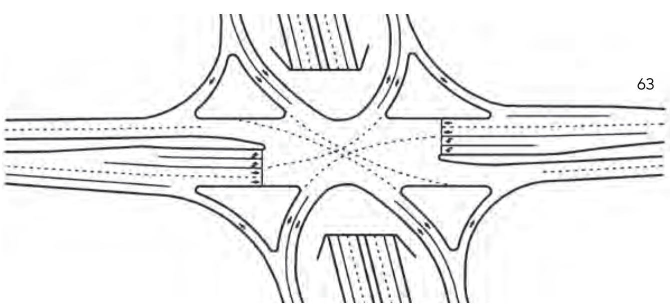
How. A diamond interchange is a facility where the through movements on the major roadway are physically separated from the other turning movements, which are typically served by one or two intersections (ramp terminals) on the minor roadway. On- and off-ramps connect the major roadways to these ramp terminals, forming the shape of a diamond. Diamond interchanges have a variety of forms, and their function depends on the separation between the two ramp terminals and the associated traffic control strategy. Two of the more common types of diamond interchanges used in constrained urban environments are the single-point diamond (SDI) and compressed diamond (CDI).

A SDI operates as a single signalized intersection. Left turns from the ramps and on the cross-street are aligned such that they oppose each other, eliminating a potential source of conflict. Because of the layout of the interchange, at-grade movements are served by a three-phase signal, although relatively long cycle lengths are typical. This is in part because longer clearance intervals are required for a single-point interchange to allow vehicles to depart the intersection.

A CDI operates as two closely spaced intersections, typically controlled by four-phase overlap signal phasing system for the two intersections. Layout of the left turns on the cross-street are back to back, resulting in an increased cross section across/under the bridge relative to a SDI. Even with this increased cross section, there is less open pavement area at a CDI relative to a SDI, which allows for shorter clearance intervals.

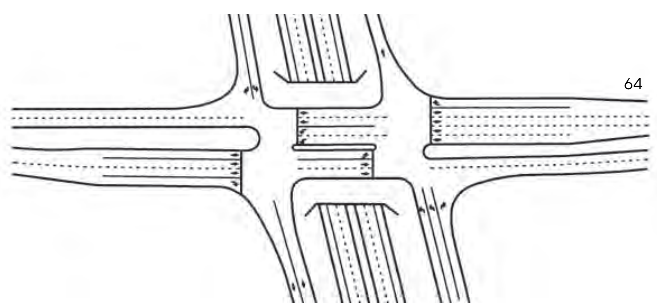
Why. A SDI and a CDI each offer the potential for a significant decrease in midblock collisions and in collisions involving major street through-traffic. However, a SDI also offers the potential for a major decrease in angle collisions. Also, left-turn movements can take place at higher speeds and at higher saturation flow rates relative to a CDI.

A CDI can be constructed in a relatively confined Right-of-Way while serving high traffic demand volumes. In addition, the CDI design can serve pedestrians effectively and work in combination with frontage roads without a substantial decrease in the efficiency of the interchange. A SDI combined with a frontage road would also decrease the overall efficiency of the interchange, as additional phases are required at the signal to serve traffic movements and two additional phases plus an adequate refuge area to serve pedestrians crossing the roadway.[62]



[63]

Single-point Interchange



[64]

Compressed Diamond Interchange

[62] Source: FHWA Signalized Intersections: Informational Guide. FHWA-HRT-04-091. August 2004. Chapter 10 – Alternative Intersection Treatments. https://bit.ly/2JiPVLb

[63] Source: FHWA Chapter 10 – Alternative Intersection Treatments. 10.3.2 Diamond Interchange, Figure 107. Diagram of a single-point interchange.

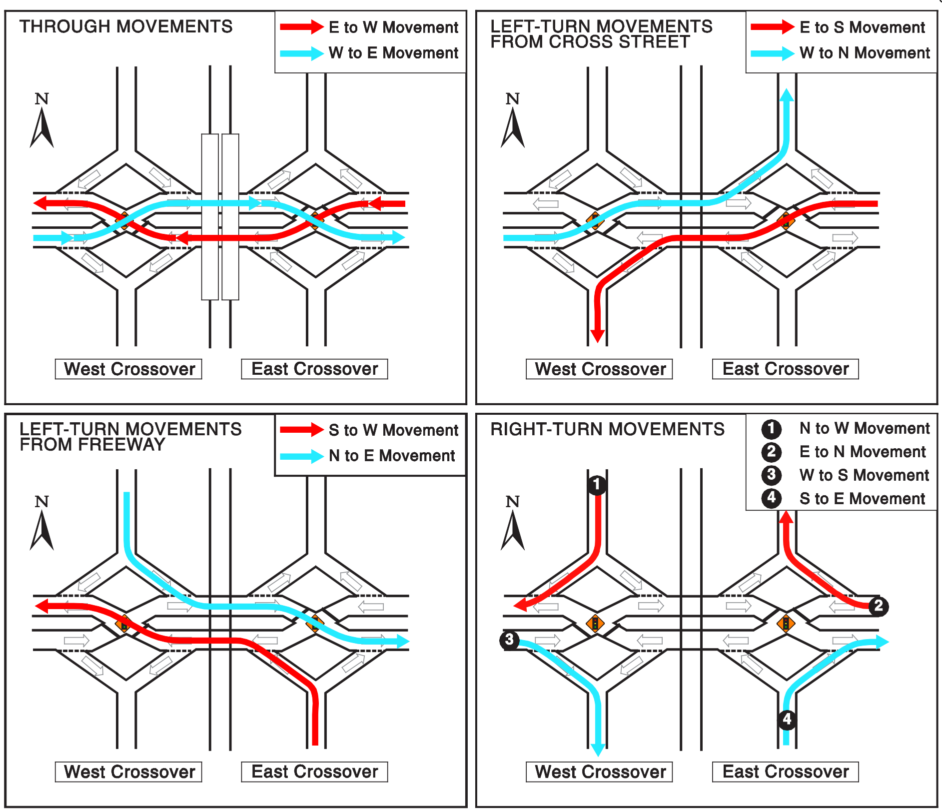
[64] Source: FHWA Chapter 10 – Alternative Intersection Treatments. 10.3.2 Diamond Interchange, Figure 108. Diagram of a compressed diamond interchange.

Diverging Diamond

How. A diverging diamond intersection (DDI) is an alternative to the conventional diamond interchange. Directional crossovers on either side of the interchange shifts motorists to the left side of the roadway, allowing through-traffic and left-turning traffic to proceed through the intersection simultaneously and without crossing the paths of approaching through-traffic. The directional crossover for through movements functions as a two-phase signal. Right turns from the arterial to the Limited-Access facility typically yield to left-turning motorists of oncoming traffic. Left turns from the Limited-Access facility onto the arterial yield or are signal-controlled. After arterial through-traffic moves beyond the intersection, it crosses back over to the right side of the roadway. Limited-Access motorists aren't provided with a through-traffic route.

Why. A DDI increases traffic flow by improving the operations of turning movements to and from the intersecting roadway facilities and significantly reduces the number of vehicle-to-vehicle conflict points. The severity of conflicts is reduced as the conflicts between left-turning movements and the opposing through movements are eliminated. The remaining conflicts are reduced to merging for turning movements, and the reduced-speed crossover conflict of the two through movements. The interchange design will be directly affected by whether the arterial passes over or under the Limited-Access facility. In most cases, DDIs designed with a cross-street as an overpass offer the most design flexibility in serving pedestrians.[65]

[66]



Diverging Diamond Interchange Movement

[65] Source: FHWA Diverging Diamond Interchange Informational Guide. FHWA-SA-14-067. August 2014. https://bit.ly/327Hknm

[66] Source: FHWA Diverging Diamond Interchange Informational Guide. Page 71 Exhibit 5-2. Naming convention of movements at a DDI. FHWA-SA-14-067. August 2014. https://bit.ly/327Hknm

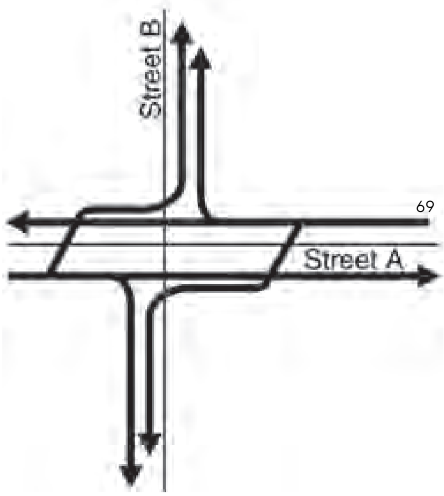
Continuous Flow

How. Continuous flow intersections (CFI) are also sometimes referred to as crossover-displaced left turn (XDL) intersections. A CFI removes the conflict between left-turning vehicles and oncoming traffic by introducing a left turn bay placed to the left of oncoming traffic. Motorists access the left turn bay at a midblock signalized intersection on the approach where continuous flow is desired. The left turns potentially stop three times: once at the midblock signal on approach, once at the main intersection, and once at the midblock signal on departure. However, careful signal coordination can minimize the number of stops.

Why. Safety improvements may be experienced by the left-turn movement due to the relocation of the turn lane; rear-end crashes with through vehicles may be reduced. Congestion-related collisions (mainly rear ends) may also decrease if stop-and-go conditions occur less often.

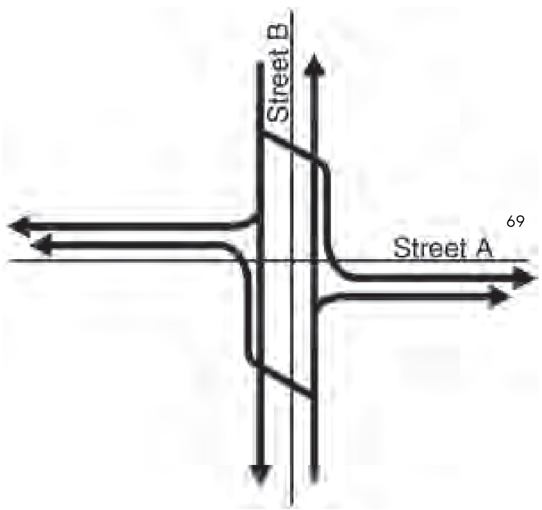
While U-turns are restricted with this design, through traffic benefits greatly.[67]


[68]



[69]

Turning Movements from Street A



[69]

Turning Movements from Street B

[67] Source: FHWA Signalized Intersections: Informational Guide. FHWA-HRT-04-091. August 2004. Chapter 10 – Alternative Intersection Treatments. https://bit.ly/2JiPVLb

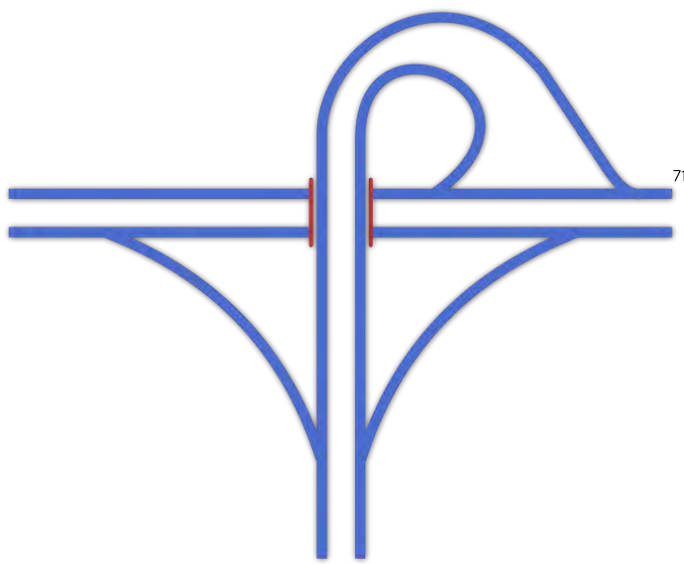
[68] Source: FHWA 6.3.6 Parallel Flow Intersection, Figure 151. Illustration. Typical geometry of a parallel flow intersection. https://bit.ly/2YswWEv

[69] Source: FHWA Chapter 10 – Alternative Intersection Treatments. 10.2.3 Continuous Flow Intersection, Figure 92. Vehicular movements at a continuous flow intersection.

Trumpet

How. This three-leg interchange allows one facility to end into a second facility. Preference should be given to the major turning movements so that the directional roadway handles higher traffic volume and the loop manages the lower traffic volume.

Why. This interchange is suitable for the connection of a major facility and a minor facility. Three-leg interchanges should be used only after careful consideration because expansion to include a fourth leg is usually very difficult. If the potential exists that a fourth leg will ultimately be included, another type of interchange may be appropriate.[70]


[71]

Trumpet Interchange

Three-Way Directional Stack Interchange

How. Also called a Y stack, this interchange arranges three left- or right-turning roadways so that they bridge over or under one another.

Why. This interchange allows three different roadways to intersect each other while providing free flowing

[72]


Three-Way Stack Interchange

Source: TxDOT Roadway Design Manual. Section 6: Freeways. April 26, 2018. https://bit.ly/2xpoVnN

Source: Wikiwand. Interchange (road). https://bit.ly/2Xg1I1L (road)

Source: Steam Community. Advanced Interchange Geometry. https://bit.ly/2LyByW3

Safety and Operations

Safety and operations of a roadway corridor have a symbiotic relationship. Safety can be influenced by the operational characteristics such as congestion, construction zones, traffic signal timing, and other travel conflicts. Operations can be impacted when safety isn't prioritized, and collisions can occur on the facility.

Safety

Barriers and Rumble Strips

The area adjacent to the traveled way plays an important role in the safe operation of a high speed facility. Accident statistics show that a significant portion of accidents on rural roads are the single vehicle, run-off-the-road type. It should be remembered that a barrier can also be a hazard and should only be used where the results of leaving the roadway and overturning or striking a fixed object would be more severe than the consequences of striking the barrier.

Metal beam guard fence (MBGF)

MBGF is comprised of a corrugated metal horizontal member that is mounted to treated wooden or metal posts. This guard fence a semi-rigid barrier system. Its placement is susceptible to slope limitations and should not be used with a curb installation on high speed roads without additional installation measures.[73]

Tension cable barriers

Tension cable barriers work as a retrofit on existing, wide, relatively flat median areas and are also effective on sloped terrain. They generally cost less to install than other barrier systems and repair and maintenance costs are easily offset by their life saving and injury-reducing benefits. State transportation departments across the nation that have installed cable median barriers report a decrease in fatalities and in the severity of this type of crash.[74, 75]

Jersey barriers

These barriers are made in a variety of shapes with the purpose of redirecting a crash using a car's momentum to absorb the impact and slide the vehicle up along the side of the barrier to prevent a rollover. Their designs have been well-tested and modified to ensure driver safety on both sides of the road in the event of a crash.[76]

Source: TxDOT Roadside Safety Field Guide 2014. August 2014, updated February 2017. https://bit.ly/2XkrIhr

Source: https://bit.ly/2RTmW4K

Source: AASHTO Innovation Initiative. Cable Median Barrier. https://bit.ly/2xsZFwQ

Source: Mental Floss Why are Road Partitions Called Jersey Barriers? Sean Hutchinson. July 2013. https://bit.ly/2FZPSmX

Rumble strips

Shoulder rumble strips are typically installed along the shoulder near the travel lane. On divided roadways, rumble strips are sometimes installed on the median side (left-hand side) shoulder as well as on the outside (right-hand side) shoulder. On two-way roadways, rumble strips are sometimes installed along the center line.[77]

Pavement markings

Pavement markings indicate which part of the road to use, provide information about conditions ahead, and indicate where passing is allowed. Yellow lines separate traffic flowing in opposite directions. Drivers should stay to the right of yellow lines. A solid yellow line indicates that passing is prohibited. A dashed yellow line indicates that passing is allowed. White lines separate lanes for which travel is in the same direction. A double white line indicates that lane changes are prohibited. A single white line indicates that lane changes are discouraged. A dashed white line indicates that lane changes are allowed.

Symbols are used to indicate permitted lane usages. A diamond indicates a lane reserved for use by high-occupancy vehicles. A bicycle indicates a lane reserved for bicyclists. Arrows show required or permitted movements at intersections. A row of solid triangles indicates that the road user must yield.

Pavement markings are also used to alert users to potentially hazardous conditions ahead. A letter X with a letter R on each side indicates a highway-rail grade crossing ahead. A hollow triangle indicates a yield ahead. A series of progressively wider lines across a lane indicates a speed hump ahead.

Standards for the design and application of pavement markings can be found in the Manual on Uniform Traffic Control Devices (MUTCD). Design specifications for pavement markings are in the Standard Highway Signs Book.[78, 79]

77 Source: FHWA Manual on Uniform Traffic Control Devices (MUTCD). 2009 Edition. https://bit.ly/2XDbHTe

78 Source: FHWA The Benefits of Pavement Markings: A Renewed Perspective Based on Recent and Ongoing Research. Paper No. 09-0488. August 2008. https://bit.ly/2XGvkJV

79 Source: FHWA United States Pavement Markings. 2002. https://bit.ly/2YoWhPw

Sight lines or sight distance

Four types of sight distance are considered; stopping sight distance, decision sight distance, passing sight distance, and intersection sight distance. Stopping sight distance is the sum of two distances: first, the distance traversed by the vehicle from the instant the driver sights an object necessitating a stop to the instant the brakes are applied; and, second, the distance needed to stop the vehicle from the instant brake application begins. Decision sight distance is the distance required for a driver to detect an unexpected or otherwise difficult-to-perceive information source, recognize the source, select an appropriate speed and path, and initiate and complete the required maneuver safely and efficiently. Passing sight distance is the length of highway required by a driver to make a passing maneuver without cutting off the passed vehicle and before meeting an opposing vehicle. Therefore, passing sight distance is applicable to two-lane roadways only (including two-way frontage roads). Regarding intersection sight distances, the operator of a vehicle approaching an intersection should have an unobstructed view of the entire intersection and an adequate view of the intersecting highway to permit control of the vehicle to avoid a collision.

Sight distance on horizontal and vertical curves are also considered. Where an object off the pavement, such as a bridge pier, bridge railing, median barrier, retaining wall, building, cut slope or natural growth restricts sight distance, the minimum radius of curvature is determined by the stopping sight distance.[80]

[80] Source: TxDOT Roadway Design Manual. April 26, 2018. https://bit.ly/2FNtFZb

Bike Lane Delineators

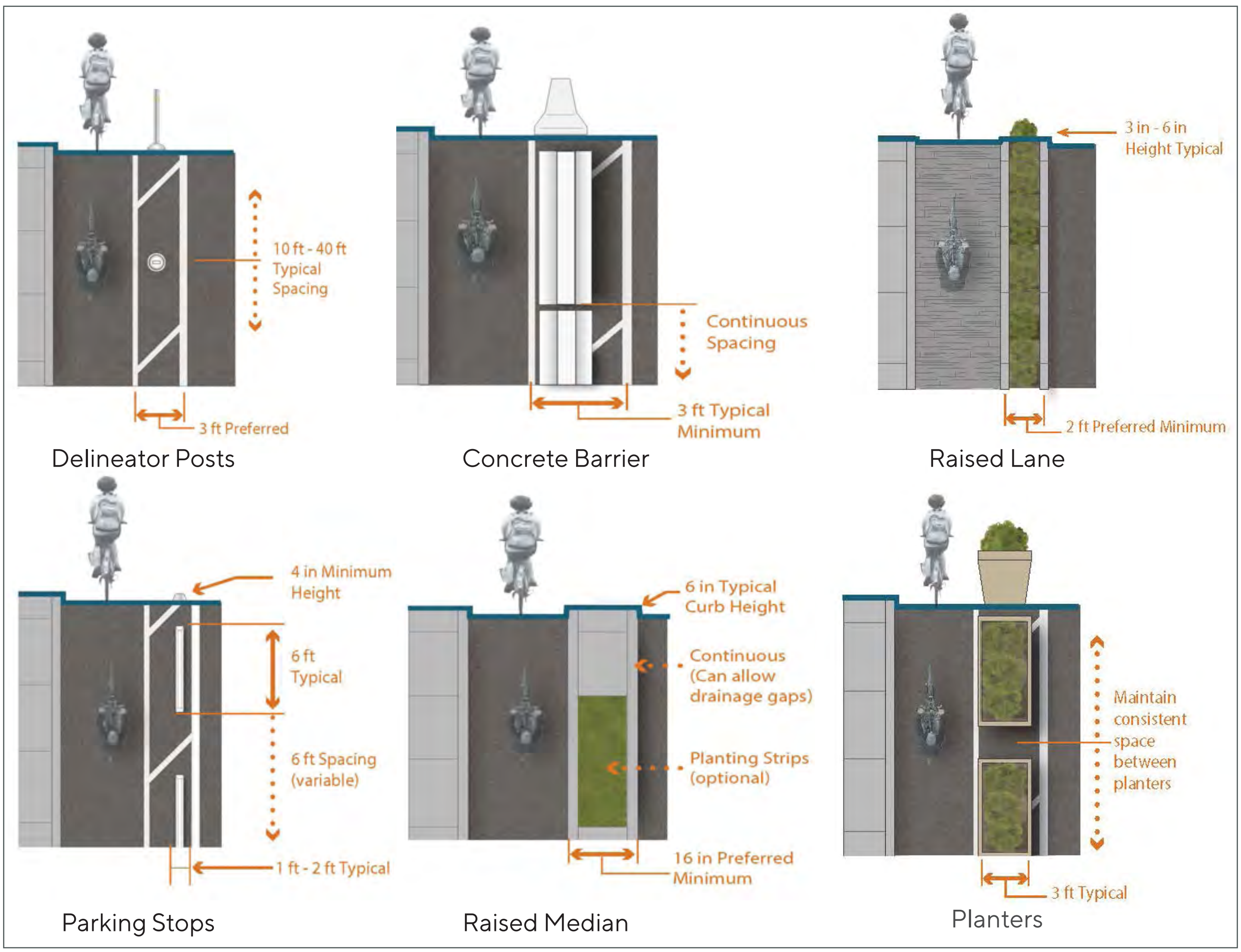
How. Used Individually or in combination, bike lane delineators include flexible delineator posts, bollards, concrete barriers, raised medians, raised lanes, planters, parking stops, paint, and parked cars.

The selection of separation type(s) should be based on the presence of on-street parking, overall street and buffer width, cost, durability, aesthetics, traffic speeds, emergency vehicle and service access, and maintenance. In certain circumstances, emergency vehicle access may need to be provided through low or mountable curbs or non-rigid means.

Why. Safety: Cyclists enjoy the greatest level of comfort when buffers provide greater levels of physical separation.

Aesthetics: There are opportunities to incorporate color, texture, visual art, and plant material within this type of infrastructure.[81]

[82]



81

82 Source: FHWA Separated Bike Lane Planning and Design Guide. May 2015. Chapter 5: Menu of Design Recommendations. Forms of Separation. https://bit.ly/2LyByW3

Operations

Dynamic Message Signs

Message content typically communicated on these signs include information about traffic conditions, travel times, construction, special events, and roadway or safety incidents. Agencies, like TxDOT, have guidance such as the Dynamic Message Sign Message Design and Display Manual that establishes protocol for the operations of the DMSs. For example, the manual provides instruction on visibility considerations for DMS placement and message development for message length reductions for vertical and horizontal curves, and rain and fog, and effects for large trucks on DMS legibility.[83]

Flexible pylons

If pylons are hit by a vehicle, an unsafe condition for motorists could result as debris from broken pylons and/or curbs leave exposed nails or broken curbs. The use of pylons can result in increased long-term maintenance costs even though the initial deployment costs are typically much less than traditional concrete median barriers (or Jersey barriers). Other names for these devices are delineator posts, candle sticks, tubular markers, and channelizing posts.[84, 85]

[83] Source: TxDOT Sign Guidelines and Applications Manual. May 2017. https://bit.ly/2NHIvXB

[84] Source: FHWA Guidance For Effective Use Of Pylons For Lane Separation On Preferential Lanes And Freeway Ramps. FHWA/TX-13/0-6643-1. May 2013. https://bit.ly/2J700Mx

[85] Source: Texas A&M Transportation Institute 0-6643: Guidelines for the Effective Use of Flexible Pylons for Congestion Mitigation, Access Management, and Safety Improvement. August 2012. https://bit.ly/2JhWD4j

Lane Management

Reversible lanes/contraflow

The ways in which roadways can be adjusted are becoming a one-way street or having one middle lane operate in the peak direction. These adjustments, indicated by changeable message signs and/or arrows.

The decision to consider reversible lanes is usually based on the need to mitigate recurrent congestion. Its use is most applicable on multilane roadways with a directional imbalance in excess of 65/35 percent with a predominance of through traffic and predictable congestion patterns.

Researchers have noted that the American Association of State Highway and Transportation Officials (AASHTO) Green Book does not provide specific design criteria for installation of a reversible lane. It suggests that reversible lanes on arterial roadways should be designed as a normal travel lane. This lack of information has led several transportation agencies to develop their own design guidelines to address design issues, particularly for retrofitting existing facilities.

Proper communication and public participation are crucial to ensuring the strategy's success. Local agencies should identify the best locations for implementation and ensure the public and agencies understand the concept and operation. The terminus treatment requires care and attention—common treatments extend across an intersection, requiring complex signals and signal timing strategies. Locating a safe mid-block left turn across the favored travel direction can also be difficult. Impacted businesses may complain of denial to traffic, and there is an increased potential for crashes depending on left turn demand, mid-block geometric conditions, and platooning of the favored traffic[86] direction.

[86] Source: Texas A&M Transportation Institute Reversible Traffic Lanes. June 2012. https://bit.ly/2FN6HBp

Lane Management (continued)

High-occupancy vehicle lane, or HOV Lane

These restrictions may be only imposed during at peak travel times or may apply at all times. The normal minimum occupancy level is two or three occupants. Because most drivers, especially during rush hours, are driving alone, the HOV lane is seldom congested. Many jurisdictions exempt other vehicles, including motorcycles, charter buses, emergency and law enforcement vehicles, low-emission and other green vehicles, and/or single-occupancy vehicles paying a toll. HOV lanes are normally created to increase average vehicle occupancy and persons traveling with the intent of reducing traffic congestion.

HOV lanes look like any other street or highway lane, except that it is typically delineated with signs and diamonds painted on the pavement. While the most common type of HOV facility is a carpool lane, other types of HOV facilities include exclusive HOV ramps, bypass ramps at ramp meters, toll plazas, bus lanes, and commuter parking lots with direct connections to HOV lanes.

For the most part, HOV lanes look like any other street or highway lane, except that it is typically delineated with signs and diamonds painted on the pavement. But there is a great deal of variety in the design and operation of HOV lanes. Some, called concurrent flow lanes, lie adjacent to, and operate in the same direction as general purpose lanes. Others, called contraflow lanes, operate in the opposite direction of adjacent lanes, enabling HOVs to drive on the “wrong” side of the roadway with barriers separating them from oncoming traffic. Reversible lanes, usually placed in the roadway median, run in one direction in the morning, then in the opposite direction in the afternoon. Busways are usually physically separated from adjacent lanes, and are reserved for bus use only. HOV lanes are delineated by several methods, including barriers, medians rumble strips, buffer areas, and pavement markings. [87]

[87] Source: FHWA Freeway Management Program. HOV Facilities FAQ. February 2017. https://bit.ly/2NrPofc

Lane Management (continued)

Queue jumps for transit

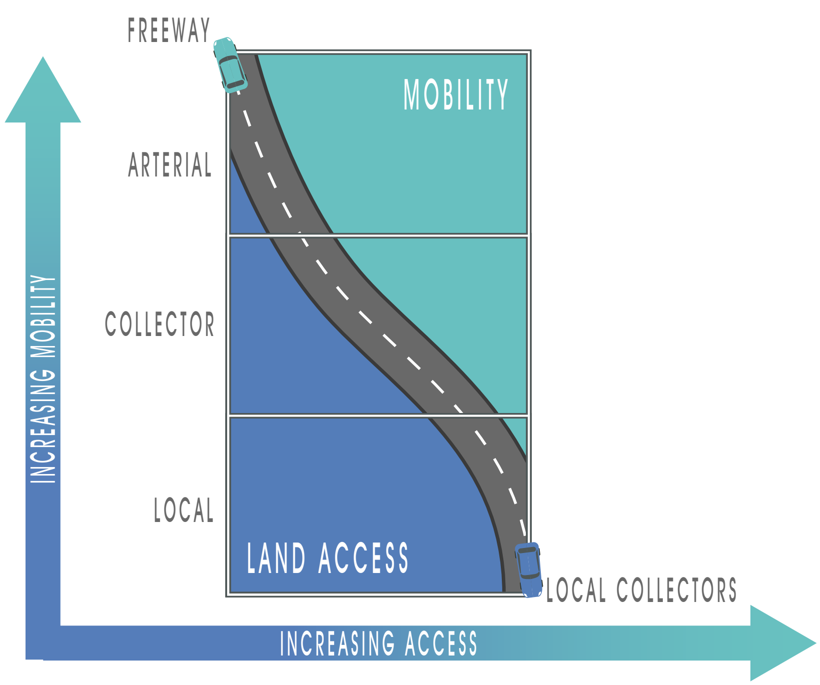
The application of queue jumps are typically on signalized streets with low or moderately frequent bus routes, especially where transit operates in a right lane with high peak hour volumes but relatively low right turns. Buses must have access to a lane and the ability to reach the front of the queue at the beginning of the signal cycle. Buses receive a head start with an advance green. Separate signals must be used to indicate when transit proceeds and when general traffic proceeds. Transit signals can be either be a transit specific signal head or a louvered or visibility-limited green indication, making it visible only to the right-most lane. Where stops are located far-side, a signal phase progresses right-turning vehicles together with through-traveling buses. The queue jump lane must be long enough so buses can effectively bypass the expected length of congestion at the intersection at peak. Where stops are located near-side, right turns are prohibited from happening curbside. The bus pulls into the stop, completes boarding, and then pulls forward onto a loop detector to receive the advance green. The length of a shared head start/right-turn pocket should be long enough to allow storage of right-turning vehicles and allow buses to reach the queue jump during each signal cycle. If provided as a shared right-turn/queue jump, a protected right-turn signal may be used with a sign indicating "right turn signal" and "except buses". [88]

[88] Source: NACTO Transit Street Design Guide. 2016. https://bit.ly/2DRp8EG

Access

How. Access on a facility occur in different ways. Access spacing, driveway spacing, safe turning lanes, median treatments, and right-of-way management are considerations that are made when designing a facility. Access spacing is the distance between traffic signals. Similarly, driveway spacing is the distance between driveways along the facility. Safe turning lanes include dedicated left and right turns, indirect left turn, u-turn lanes, and roundabouts. Median treatments include two-way left turn lanes and nontraversible, raised medians. Right-of-way management includes right-of-way reservation.

Why. For access spacing, increasing this distance between traffic signals improves the flow of traffic on Major Arterials, reduces congestion, and improves air quality for heavily traveled corridors. Fewer driveways spaced further apart allows for more orderly merging of traffic and presents fewer conflicts to drivers. Dedicated turning lanes and roundabouts keep through-traffic flowing. Roundabouts represent an opportunity to reduce an intersection with many conflict points or a severe crash history (T-bone crashes) to one that operates with fewer conflict points and less severe crashes (sideswipes) if they occur. The aforementioned median treatments are examples of some of the most effective means to regulate access and reduce crashes. Reserving right-of-way facilitates future widenings, good sight distance, access locations, and other access-related issues. Managing access provides an important means of maintaining mobility. It calls for effective ingress and egress to a facility, efficient spacing and design to preserve the functional integrity, and overall operational viability of street and roadway systems. [89]



[89] Source: FHWA What is Access Management. February 2017. https://bit.ly/2RMKbNM

Aesthetics and Sustainability

Public Art

How. Public art is any work of art that is designed for and placed in a location accessible to the public and often paid for with public funds. Types of art include sculpture, architecture, painting, mosaics, topographical/landform design, graffiti, monuments, fence panel and wall design, and light installations.

Why. Public art has shown to further economic development, tourism, and place-making by enhancing the quality of public spaces, reflecting local culture, and providing a venue for community engagement in project planning and design decisions.[90]

Barrier Aesthetics

How. Traffic barriers can be enhanced aesthetically with paint and stain. Colors selected for barriers can create aesthetic effects that range from blending into the environment to highly contrasting with the surroundings.

Why. Enhancing traffic barriers can provide visual integration into the fabric of the area. Applying color to this component of the roadway supports the importance or significance of the area.

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Aesthetics and Sustainability (continued)

Sound Walls

How. Also known as Noise Barriers, sound walls are normally solid wall-like structures built between the noise source (highway) and the impacted activity area to reduce noise levels. Although they are usually constructed of concrete or masonry, other materials such as wood, stucco and metal can also be used. Barriers can also be formed from earth piled into a large mound or berm. Though natural in appearance, berms require a large area of right-of-way to reach the height required to be effective.

The sound wall design considerations include:

- appearance and ability to blend in with the surrounding environment
- roadway features and distances between the road and impacted activity areas
- number and category of impacted activity areas
- access to activity areas from the roadway for routine and emergency traffic
- adequate visibility around noise barriers to ensure motorist and pedestrian safety
- ability of the noise barrier (height, length and material) to effectively reduce noise level
- reasonable cost of construction and maintenance
- avoidance of utilities and easements
- desires of the public

Why. Sound walls are a noise abatement measure used to reduce the impact of noise from roadway traffic on an activity area.

The use and extent of sound wall placement adjacent to a roadway can be determined by a noise study. The purpose of the noise study is to learn whether roadway traffic sounds will have an impact on nearby outdoor areas frequently used by people.[91]

[91] TxDOT Building Barriers to...Traffic Noise. Environmental Affairs Division. June 2011. https://bit.ly/2LwaeaN

Aesthetics and Sustainability (continued)

Decorative Paving

How. Used individually or in combination, decorative paving can include pavers of various materials (pervious and impervious), textured and colored concrete, stamped asphalt, pervious asphalt, and concrete with exposed or special aggregate. These paving types can be used on sidewalks, however, other locations that benefit from decorative paving are:

- Transit stop areas, including transit curb extensions and medians
- Pedestrian crossings, especially at important civic locations, neighborhood commercial areas, and other special districts
- Pedestrian refuge areas within medians
- Flexible space in parking lanes
- Curb extensions
- The furnishings zone of sidewalks
- Driveways
- Gateways and other special places

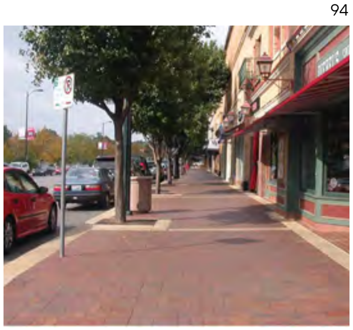
Why. Aesthetics: Decorative paving can enhance the aesthetics of public spaces, give circulation areas a stronger sense of place, and enhance the hierarchy of public spaces.

Environment: Pervious paving may be built as a standalone feature, or in coordination with other streetscape and stormwater management features, such as street trees, bioretention/rain garden planters, or sidewalk landscaping.[92, 93]

Safety: Decorative pavement placed at key locations such as transit stop areas, pedestrian crossings, pedestrian refuge areas, or intersections provides additional spatial delineation for motorists, cyclists, and pedestrians. This spatial delineation provides these facility users with a heightened awareness of each other's presence. For example, decorative paving at crosswalks alerts motorists to expect crossing pedestrians and directs pedestrians to desirable crossing locations.

Pervious pavers and pervious asphalt draw water away from the surface of the paving. This can eliminate or greatly reduce the formation of ice during freezing weather conditions.

[94]



Special paving in the sidewalk

[94]

Special paving at pedestrian refuges crossings

[94]

Special paving define the transit waiting area for pedestrians

[92] Source: San Francisco Better Streets Special Sidewalk Paving. 2015. https://bit.ly/309f9Cr

[93] Source: City of San Antonio Downtown Streetscape Design Manual. April 2014. https://bit.ly/2FKqvW4

[94] Source: San Francisco Better Streets. Special Sidewalk Paving. https://bit.ly/309f9Cr

Aesthetics and Sustainability (continued)

Low Impact Development

How. Low impact development (LID) is a land planning and engineering design approach that maximizes site functions to manage stormwater runoff. Ways in which LID are implemented into transportation facilities are rain gardens, bio-swales, pervious pavement, subsurface retention, and tree box filters (typically in-line with storm drain inlets).

Why. Environmental benefits of LID include on-site water quality improvement, reduced water conservation, and in some cases, a reduction of necessary water quality ponds.

Aesthetics are improved with the implementation of the various LID infrastructure by providing more green space and decorative paving.

Landscape Enhancements

How. Landscape enhancements must consider corridor qualities to be effective, safe, and aesthetically complementary. Considerations for assessing the corridor's needs include identifying the Context Zone, views to be preserved, areas to be screened, sound wall locations, maintenance methods, key off-site relationships and interactions, user visibility, and sites requiring environmental mitigation or protection.

Rural Context Zones are characterized by their natural landscape which tends to be visually dominant. Landscape improvements should be designed to supplement or enhance the existing conditions. Nodes along the rural corridor are fewer and farther between. This means the areas where landscape can make the biggest impact are at transition points such as intersections.

Urban Context Zones are characterized by the visually distinct nature of various abutting land uses and the limited area likely to be occupied by a single land use. Also, the visual character of a corridor in and urban setting changes more rapidly compared to changes in a rural one. Landscape improvements should consider social and cultural influences, the impact of adjacent land uses, visual complexity for the viewer, views and visibility, non-vehicular access, and environmental mitigation.

Why. The general public is increasingly demanding aesthetic enhancements to existing and proposed transportation facilities. The greatest pressure for aesthetic enhancements tends to be in major urban centers and in rural areas having high scenic quality. Apart from aesthetic enhancements, adding landscape to the medians and parkways of a corridor provide traffics calming, wildlife habitat, heat island cooling, comfort for cyclists and pedestrians, and visual screening. [95]

[95] TxDOT Landscape and Aesthetics Design Manual November 2017. https://bit.ly/2XgI3Pd

Aesthetics and Sustainability (continued)

Scenic Views

How. Scenic views should be considered and identified during the planning stages of corridor design. Placement of nodes and alignment orientation can utilize area views, landforms, or architecture.

Why. Scenic views communicate cultural significance, sense of place, and wayfinding. Pleasant views are traffic calming, add value to the region, and can influence economic development.

Medians

How. Medians provide a place within the right-of-way for a variety of components that provide safety, aesthetic, and environmental enhancements. Components can include decorative paving, pedestrian/cyclist refuge, aesthetic barriers, low impact development, landscape planting, and public art. It is important to maintain clear sight visibility to adhere to local safety requirements.

Why. Medians vary in length, width, shape, and function. They are highly visible to motorists, cyclists, and pedestrians. Because of their high-visibility, they are an ideal place to incorporate aesthetics. Their placement creates an opportunity for low impact develop in the center of the corridor, instead of or in addition to the outer edges of the right-of-way. Medians provide a natural location for safer cyclist and pedestrian refuge during crossing movements in an intersection.