Fresno Council of Governments

Fresno Climate Resiliency Plan

May 2025

Disclaimer

This report offers information on Fresno County’s transportation assets' climate hazard exposure, vulnerabilities, and risks. Future conditions are inherently uncertain. Climate models, data, and scenarios have limitations, and regional impacts may vary. Forward-looking statements are based on current assessments and interpretations of available information, which may not reflect how actual events unfold over time. The report's information should be interpreted cautiously and with professional judgment.

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American Red Cross
Black Wellness and Prosperity
Community Care Health
Central California Asthma Collaborative
Central California Environmental Justice Network
Central Valley Community Foundation
City of Fresno – Active Transportation Advisory Committee
City of Fresno – Office of Community Affairs
City of Kerman Senior Center
Every Neighborhood Partnership

Familias en Acción
Fresno County League of Women Voters
Fresno County Bicycle Coalition
Fresno Cycling Club
Fresno Interdenominational Refuge Ministries (FIRM)
Fresno Metro Ministry
Highway City Community Development Inc.
Industrial Areas Foundation (IAF) – St. Anthony Mary Claret Catholic Church
Jackson Community Development Corporation
Kings River Conservancy
Linguística Interpretation and Translation Services
Regenerate California Innovation, Inc. (RCI)
Saint Joseph Church
San Joaquin River Conservancy
San Joaquin River Parkway and Conservation Trust
Self-help Enterprise
Sequia Riverland Trust
South Tower Community Land Trust
Stone Soup
The Children's Movement
The LEAP Institute
Tree Fresno
US Green Building Council

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Arup
Urban Diversity Design
Zack Urban Solutions

Key Terms

Adaptation: Adjusting to climate change by taking steps to reduce risks and make communities, economies, and nature more resilient.

Consequence: The costs or impacts of damage to transportation, such as repair costs, delays, or safety risks.

Criticality: How important a transportation system (like a road or bridge) is for keeping things running smoothly.

Downtime: The time when a transportation system (like a road, bridge, or airport) isn't working properly due to a disaster, causing delays and disruptions.

Dry Bulb Temperature: The actual air temperature, measured without considering humidity.

Exposure: The features of a transportation system (like location and materials) that determine how much it is affected by a hazard.

Facility: Any transportation infrastructure, such as a highway, railroad, airport, or public transit system.

Hazard: A possible climate-related event (like a flood, wildfire, or extreme heat) and how likely it is to happen.

Heat Index: A measure of how hot it feels when both temperature and humidity are considered.

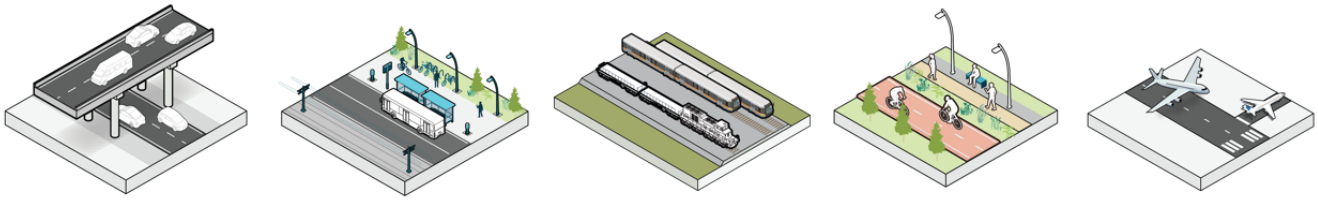
Mitigation: Actions taken to slow down or reduce the effects of climate change by cutting emissions or lessening climate-related damage.

Risk Assessment: A process that looks at the chances of a hazard happening and its possible effects on transportation, giving it a risk level from low to severe.

Vulnerability: How likely a transportation system is to be damaged when exposed to a hazard.

Executive Summary

The Fresno County Climate Resiliency Plan is a roadmap for Fresno County on its journey to become more resilient in the face of a changing climate. The Plan identifies transportation assets in Fresno County that are at risk of various climate-related impacts, including flooding, wildfire, landslides, and extreme heat, and provides a list of projects to help Fresno County adapt to its climate risk while also supporting and reflecting local and regional needs. These projects will become candidates for Fresno Council of Government's (COG) 2026 Regional Transportation Plan/Sustainable Community Strategy. The Plan specifically guides the agency toward five priority projects to advance in the near-term to increase the county's resilience in the face of climate events that are increasing in frequency and severity. The transportation assets included in this Plan are shown in the below figure.



ROADS & BRIDGES | TRANSIT NETWORK | RAIL | BIKE NETWORK | AIRPORTS

Key findings from the transportation risk assessment include:

- Flooding has the greatest impact on the county's transportation assets. The Cities of Fresno and Clovis, and western Fresno County face the highest risk.
- Wildfire primarily impacts rural and mountainous communities, many of which are also isolated.
- Extreme heat is already a major issue across the county and has the largest impact on people walking, bicycling, and taking transit, many of whom are low income.
- The risk of all climate hazards is expected to increase in the county in the future.

How This Plan Was Developed

Fresno COG led the development of this Plan over a 12-month period, with guidance from a Technical Working Group and Community Working Group. These working groups were comprised of Caltrans, Clovis Transit, Fresno Area Express, Fresno City Planning and Development, Fresno County Public Works & Planning, Fresno County Rural Transit Agency, San Joaquin Valley Air Pollution Control District, Selma Airport, Leadership Counsel for

Justice and Accountability, and Fresno County Board of Supervisors. The public also provided input into the Plan at key junctures through a workshop, a public survey, and various pop-up events.

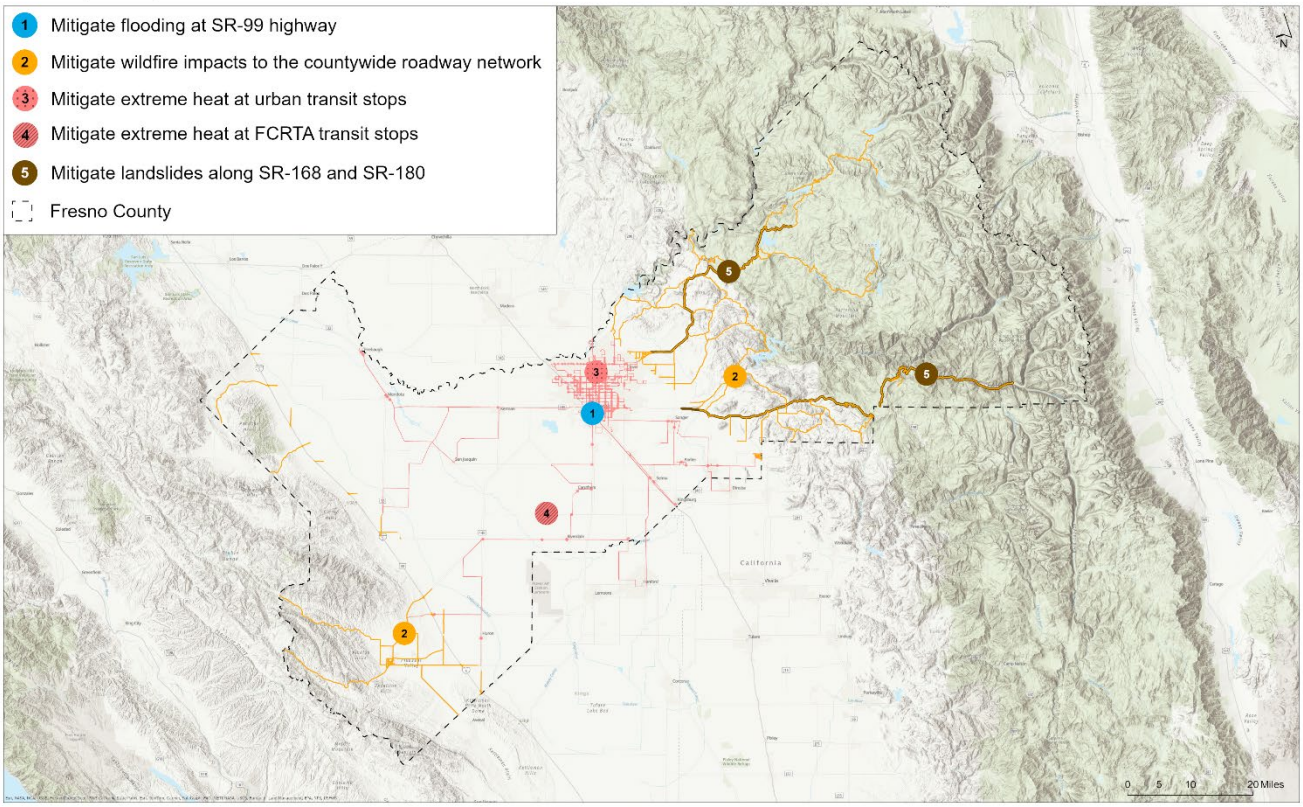
This Plan includes:

- Chapter 1: Why a Climate Resiliency Plan?: The background and context for the Plan.
- Chapter 2: Climate Projections in Fresno County: An overview of how climate is projected to change in the county.
- Chapter 3: Risk Assessment Findings: a summary of the most at risk transportations assets.
- Chapter 4: Project Opportunities: a long list of 31 transportation project opportunities to improve resilience across Fresno County.
- Chapter 5: Priority Projects: a short-list of five priority projects, including a detailed assessment of the risk and potential solutions for each, and planning-level costs.
- Chapter 6: Next steps.

The top five priority projects are included in the table below and shown on the following map. These projects were selected based on several criteria, including level of climate risk, adaptation co-benefits, criticality, and benefits to equity priority communities.

Priority Project	Description
Mitigate flooding along SR-99	Mitigate flooding along SR-99 through stormwater infrastructure improvements and effective flood management to reduce the impacts of stormwater runoff.
Mitigate wildfire impact to Fresno County's mountain road network	Mitigate the impact of countywide wildfires on the county's mountain road network through partnering with other agencies to clear ground fuels from forested areas along the high wildfire risk road network, supporting innovative financing approaches for healthy forest management, and enhancing evacuation planning.
Mitigate extreme heat at urban transit stops	Identify urban bus stops served by FAX, Clovis Transit, and FCRTA throughout Fresno and Clovis that need bus shelters, better shading, and tree canopies to provide critical health benefits to those who are transit dependent.
Mitigate extreme heat at FCRTA transit stops	Identify rural bus stops served by FCRTA transit stops that need bus shelters, better shading, and tree canopies to provide critical health benefits to those who are transit dependent.
Mitigate landslides along SR-168 and SR-180	Mitigate landslide risk along 112 road miles of SR-168 and SR-180 through interventions like landslide retention measures, erosion stabilization, and road realignment if needed. SR-168 is specifically a priority as it serves as a vital FCRTA transit route serving Auberry and other isolated mountain communities.

Priority Projects

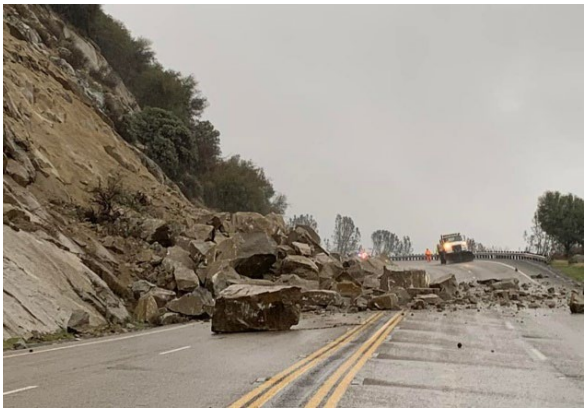


The Plan provides a strategic framework to enhance the county's transportation infrastructure against the current and increasing risks of climate change. By prioritizing key projects and integrating resilience measures, the Plan aims to protect communities, improve mobility, and ensure a more resilient and adaptive transportation network for the future.

1. Why a Climate Resiliency Plan?

The impacts from climate change are already at Fresno County's front door—from the September 2020 Creek Fire to major flooding in 2023, recent climate events have driven discourse at the government level and among the public around the need to prioritize infrastructure investments and develop a tactical strategy for implementation. Projections show that extreme climate events are expected to continue and increase in frequency and severity, elevating the importance of a resilient transportation network and blueprint for the future.

Past events in Fresno County



Rockslide on SR-168 between Prather and Shaver Lake in 2022

A bridge overtopped by floodwaters in January 2023

The Plan identifies transportation assets in the county that are at risk of various climate-related impacts, including flooding, wildfire, landslides, and extreme heat, and provides a list of projects to help the county adapt to its climate risk while also supporting and reflecting local and regional needs. These projects will become candidates for Fresno COG's 2026 Regional Transportation Plan/Sustainable Community Strategy. The Plan specifically guides the agency toward five priority projects to advance in the near-term to increase the county's resilience in the face of climate events that are increasing in frequency and severity.

In 2020, Fresno COG conducted a Regional Transportation Network Vulnerability Assessment (TNVA) using funds from 2018-2019 Caltrans Climate Adaptation Planning Grant. The TNVA included historical weather-related risks, e.g., wildfires, extreme heat, flooding, landslides, etc. and projected future climate changes, and gathered data on the county's multi-modal transportation network. This Plan was informed by a transportation system risk assessment (risk assessment) which built upon the TNVA and other past work, including the following plans, studies, and data sets in Table 1-1 below. Appendix A.5 describes in further detail the past work that was reviewed.

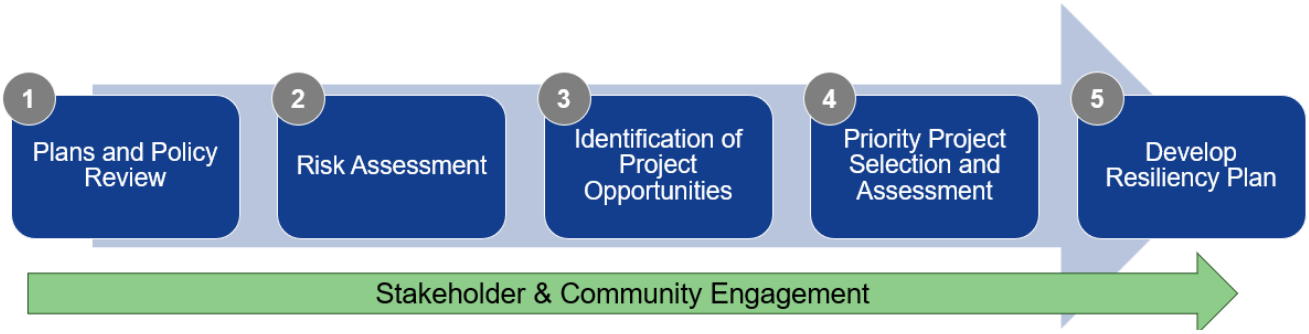
Table 1-1: Plans, studies, and data sets reviewed

Fresno County Regional Transportation Vulnerability Assessment	Blackstone Corridor Transportation + Housing Study
Federal Transportation Improvement Program	Fifth National Climate Assessment
Fresno County Multi-Jurisdictional Hazard Mitigation Plan	California Fifth Climate Assessment
Fresno County Annual Action Plan 2023-24	Cal-Adapt
Fresno County Regional Transportation Plan & Sustainable Communities Strategy	FHWA's Climate Change Adaptation Guide for Transportation Systems
Fresno Priority Climate Action Plan	California Adaptation Planning Guide
Fresno County General Plan Policy Document	U.S. Department of Transportation PROTECT Program
Fresno County Regional Safety Plan	CalEnviroScreen 4.0
Fresno-Madera State Route 41 and Avenue 9 Sustainable Corridors Study	California Public Utilities Commission Disadvantage Communities
Multi-Jurisdictional Pavement Management System	U.S. Department of Transportation Equitable Transportation Community Explorer
Eastside Transportation Corridor Improvement Study	

The risk assessment brought together all the information—mapping the likelihood of the hazards, with the consequences and impacts, to generate a risk rating for all hazards and transportation assets. These risk ratings supported the identification of a long list of project opportunities to improve the resilience of the transportation system and a prioritized a short list of five priority projects based on criteria like equity, transportation asset criticality, and overall risk level. This Plan includes a project-level deep dive for each priority project.

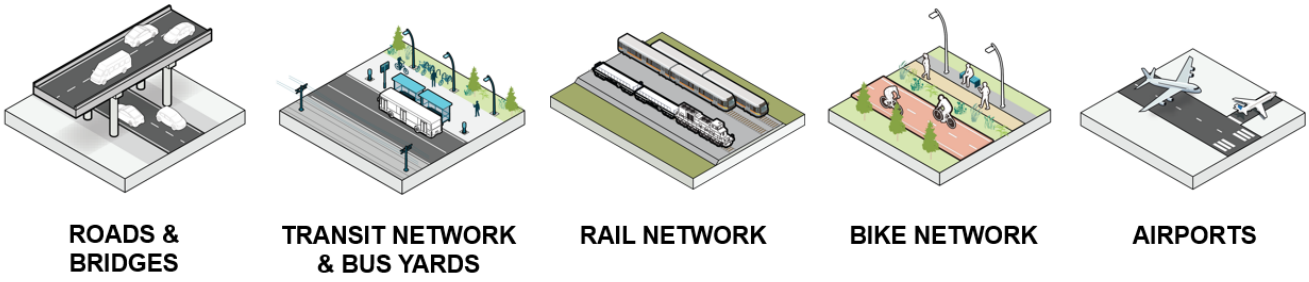
Figure 1-11 illustrates the planning process, from an initial review of existing plans, guidelines, and policies to the priority project selection and final plan development

Figure 1-11: Plan development process



The scope of the risk assessment considers the impacts of multiple climate hazards on the county's regional transportation network and infrastructure. In this risk assessment, the transportation assets detailed in Figure 1-22 were analyzed based on the risk of wildfire, flooding, extreme heat, and landslides:

Figure 1-22: Transportation assets considered in this Plan



Throughout the plan development process, community members provided feedback through a survey, meetings, pop up events, and public review. Community engagement activities and feedback are documented in Appendix A.3 and A.4. Feedback was utilized to deepen understanding of the consequences of hazard impacts, confirm prioritized projects, and provide more nuanced, relevant, and practicable recommendations for mitigating risk.

The Plan serves as a critical step to address the increasing risks posed by extreme climate events to the county's transportation network. By integrating climate hazard assessments, risk evaluations, and strategic project prioritization, the Plan provides a roadmap for enhancing transportation infrastructure resilience. With a focus on equity, asset criticality, and overall risk levels, the five identified priority projects will help safeguard Fresno County's transportation system against future disruptions and impacts to human health and wellness. As climate events continue to intensify, this Plan lays the groundwork for informed decision-making and proactive investments that will strengthen the county's ability to adapt and thrive.

2. Climate Projections in Fresno County

The county is projected to experience significant climatic changes in the coming decades. Average temperatures are expected to rise substantially, with scenarios projecting increases between 1°F and 2.3°F in California over the next few decades. By 2099, temperature increases in higher emissions scenarios could be approximately twice as high as those in lower emissions scenarios. Heat risks are also anticipated to escalate and the region is expected to face hotter, drier, and longer summers, more severe storms, and an 80 percent decline in snowpack. Future climate projections were analyzed to understand the implications of current and future climate scenarios on flooding, extreme heat, and wildfire hazards in the county.

2.1 Key Findings

The following overall trends were identified for the county:

- **Flooding:** Flooding is an issue in multiple locations across the county, though certain areas are more prone to extreme flooding such as the cities of Fresno, Clovis and western Fresno County. In the future, extreme rainfall events are projected to become more frequent.
- **Extreme Heat:** Extreme heat across the county is already a serious concern, and it is expected to get even hotter in the future. The county's heat index is projected to rise on average by 5°F to 11°F by 2050 and 2085, respectively. Similarly, temperatures are anticipated to increase, as well, causing more stress on the county's road network, which may soften and buckle with the heat.
- **Wildfires**: Wildfires predominantly impact rural and mountainous regions in the county due to the availability of wildland fuel (trees, brush, etc.). Climate change is expected to increase the likelihood and severity of wildfire significantly in certain areas. Some projections show that the chance of a wildfire occurring in heavily forested areas of the county will triple by end of century.

2.2 Methodology

Different climate scenarios and timeframes were considered for the climate hazards listed above. These scenarios were created by the United Nations Intergovernmental Panel on Climate Change. They are based on complex calculations that depend on how fast humans reduce greenhouse gas emissions. The calculations also consider changes in population, city growth, education, land use, and wealth. Each scenario is labeled to show the emissions level and the Shared Socioeconomic Pathway (SSP), used in the calculations.

- **2050 and 2085 SSP2-4.5:** This is a "middle of the road" scenario. CO2 emissions stay about the same before starting to decrease around the middle of the century, but they don't reach net-zero by 2100. Socioeconomic factors, like population and income, follow their usual trends without major changes. Progress towards sustainability is slow and uneven. In this scenario, global average temperatures rise by 2.7°C by the end of the century.
- **2050 and 2085 SSP5-8.5:** This is a future to avoid at all costs. CO2 emissions roughly double by 2050. The global economy grows quickly, but this growth relies on using

fossil fuels and energy-intensive lifestyles. By 2100, the global average temperature is 4.4°C higher.

This climate projection analysis employed the best regional public data available for the county. The future climate data was processed to translate climate indicators into specific intensity measures for different hazards like floods and wildfires. The data for extreme heat was directly taken from global climate models. Future landslide hazards were not considered in this Plan.

Present day data was used to understand where transportation assets may be exposed to a particular hazard of concern. Then, climate indicators were used to understand how that hazard may shift over time in its frequency (i.e., how might a flood or wildfire become more likely in the future?). Note there is a limitation in this approach as it does not identify areas that are not currently subjected to flooding or wildfire, that may become subject to these in the future. The following maps show how climate events are projected to change in the county, illustrating the trends described above. More detail is provided in Appendix A.6.

2.2.1 Flooding

The FEMA National Flood Hazard Layer (NFHL) provides a general understanding of the extents of extreme riverine flood events in the county for present-day climate (refer to Figure 2-1). FEMA does not provide projections of how these flood zones may change in the future. As rainfall is the primary driver of riverine flooding, climate model data, in the form of downscaled daily rainfall totals, assisted in estimating how the likelihood of these extreme flood events may change in the future. These projected changes are detailed for mid-century in Figure 2-2a and end of century in Figure 2-2b which show the percentage change in the 100-year rainfall.

Figure 2-1: Present-day FEMA National Flood Hazard Layer overlayed in Fresno County.

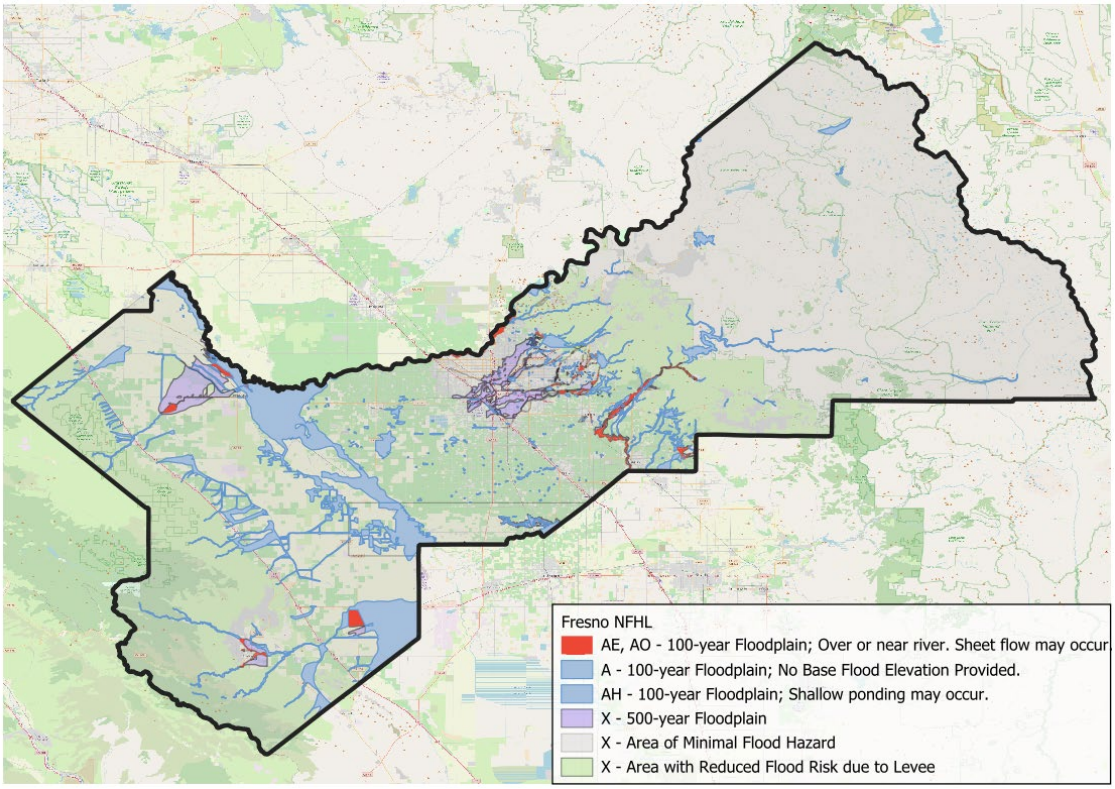
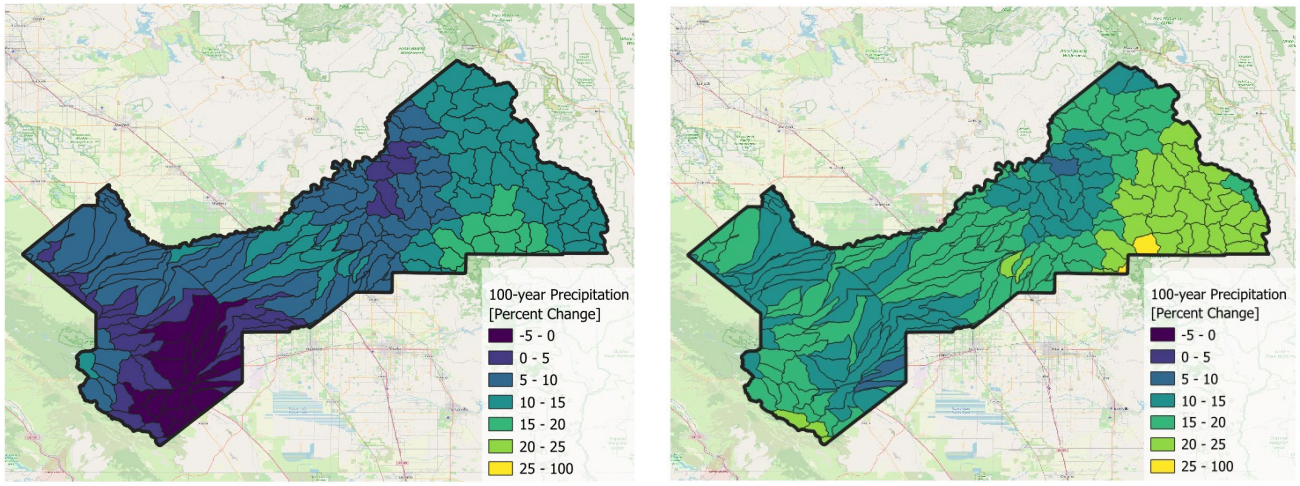


Figure 2-2: Percent change in 100-year precipitation from current climate to future climate scenarios by HUC-12s watershed scale.

(a) SSP5-8.5 2050 **(b) SSP5-8.5 2085**

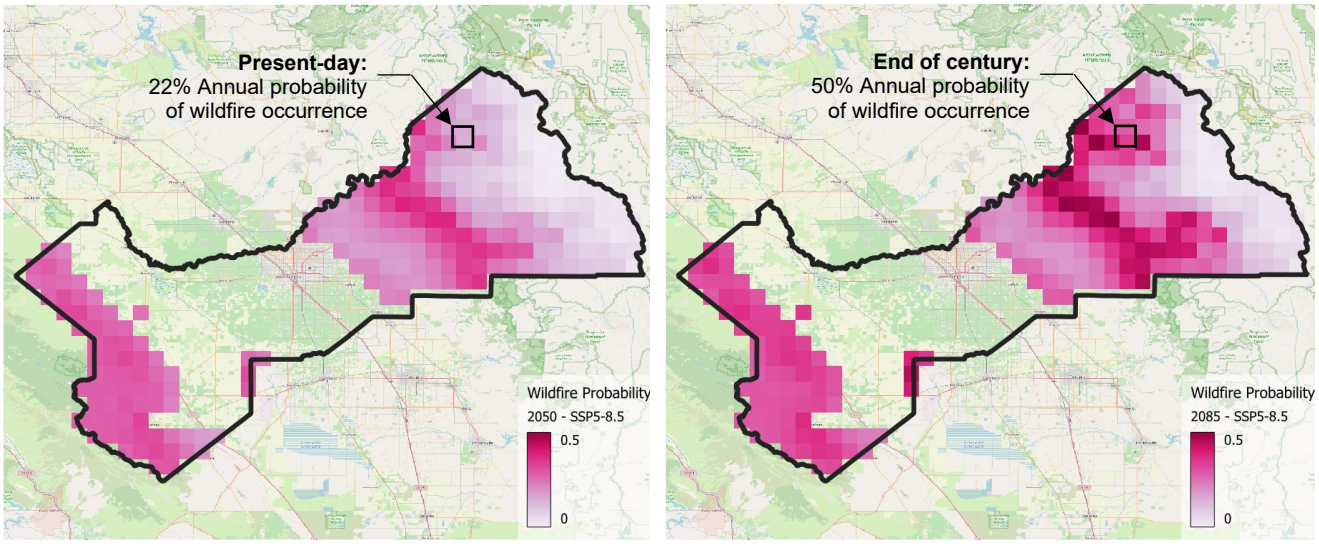


2.2.2 Wildfire

Climate projections provide a metric—the annual probability of a wildfire occurring—for how likely wildfires are to happen each year, looking at past decades (from 1950) and future decades (up to 2100). The metric compares the chance of wildfires in future decades to a baseline, which is the present-day period where climate models are tested using past data.

Figure 2-3. Increase in annual probability of occurrence of a wildfire.

(a) Present-day climate **(b) End of century climate, SSP5-8.5 2085**

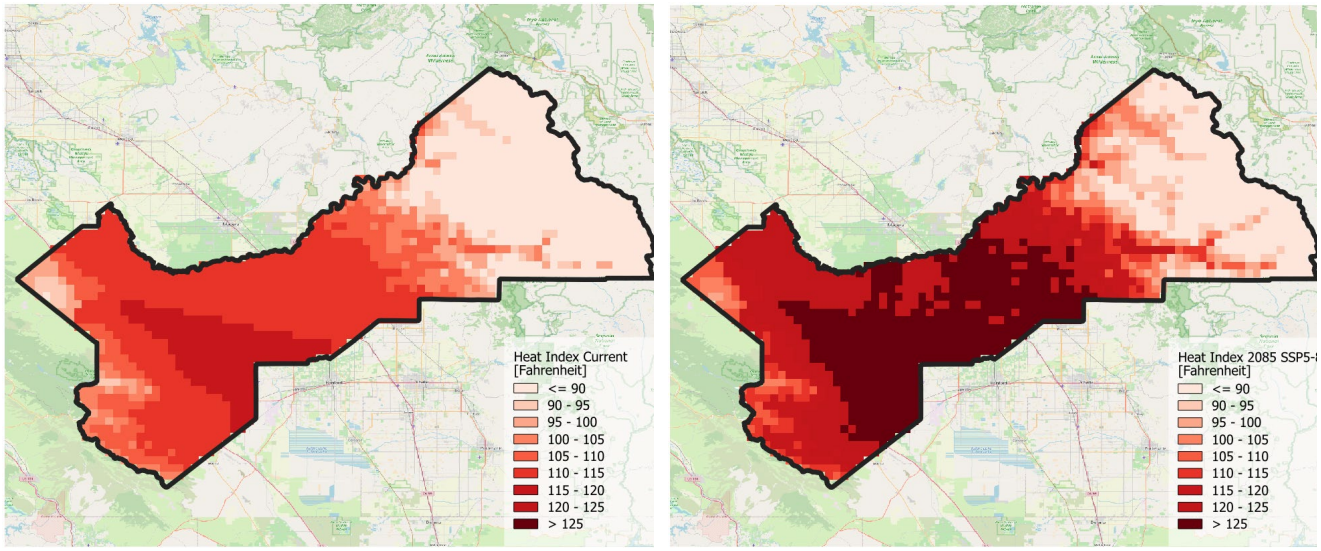


2.2.3 Heat

Heat index is a metric that combines the effects of dry bulb temperature and relative humidity to serve as a proxy for what high temperatures “feel like” on the human body. Heat index is a better reflection of a human’s thermal comfort as opposed to standard outside air temperature (dry bulb temperature).

Figure 2-4. Extreme annual heat index for 1 in 5-year extreme heat event.

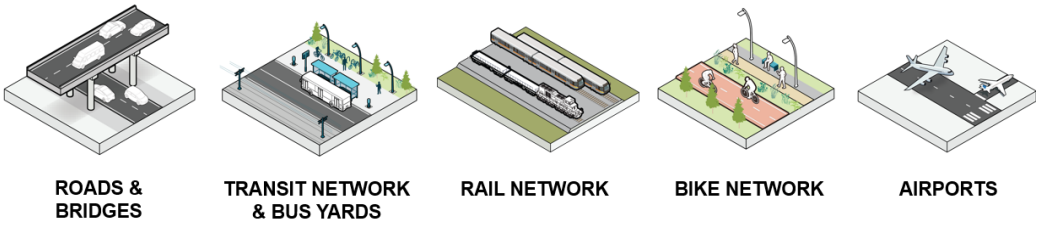
(a) Present-day climate present-day climate **(b) End of century climate, SSP5-8.5 2085**



3. Risk Assessment Findings

The goal of the risk assessment was to identify areas where flood, wildfire, extreme heat, and landslide hazard intersect with vulnerable transportation assets and result in impacts (e.g., downtime due to road closures) for the following transportation assets in the county:

Figure 3-1: Transportation assets considered in this Plan



Understanding the relative risks across these transportation assets for different climate hazards highlights the areas, assets, and hazards of most concern to help guide Fresno COG toward priority projects with the greatest potential benefits. The results from this risk assessment were a key input into the development of projects and programs to enhance the resilience of the county's transportation infrastructure.

3.1 Key Findings

The risk assessment revealed that of all the transportation assets in the county, roads and bridges, transit routes, and bike networks are at the highest risk of either downtime or human health consequences resulting from climate impacts. High level findings are described in the below and detailed findings are in the following table.

- **Roads and bridges:** The impacts of flood and wildfire are similar but impact different regions; wildfire and landslides impact mountainous roads while flooding impacts the inland valley.
- **Transit network:** Flooding primarily impacts urban transit service served by FAX (such as Routes 1, 28, and 38), while rural transit service (such as Coalinga Intercity Transit and Westside Transit Routes) is more susceptible to wildfire risk.
- **Bus yards:** Flooding has the potential to impact about 25 percent of bus yards, with the highest risk at Firebaugh Bus Yard 1, Coalinga Bus Yard, and Orange Cove Bus Yard. Wildfire does not impact any bus yards that were evaluated in this study.
- **Rail network:** Flood impacts are concentrated along the main lines through the City of Fresno and the branch lines in western Fresno County.
- **Airports:** Flooding could impact five of the nine airports in the county included in the study. These include Fresno Yosemite International Fresno Chandler Executive, Selma, William R. Johnston, and Firebaugh Airport. Wildfire does not impact any airports that were considered in this study.

Detailed risk assessment findings are organized by asset and hazard in Table 4, below. Roads and bridges, transit routes, and bike networks in the county face the most extensive risks given both their location and the preponderance of these types of assets when compared to rail, bus yards, and airports. Given this, Table 4 includes further detail only on these asset types.

Table 3-1: Risk assessment key findings by asset and hazard.

	Flooding	Wildfire	Extreme Heat	Landslides
Roads and Bridges	• Roads and highways in Fresno and western Fresno County, such as SR-99 and Belmont Avenue are at the highest risk of flooding • Bridges and road segments over water bodies are of the most pressing concern due to the potential for damage from washout which requires extensive repairs.	• The primary wildfire concern involves rural roads and highways that serve as essential connections between rural mountain communities and the inland valley (e.g. Pittman Hill Road.) • The presence of a bridge can increase a road's vulnerability to wildfire damage because of the potential for structural failure. Consequently, mountain roads that include bridges are of pressing concern.	• Extreme heat most impacts roads in the low-mountain regions. • The effects of climate change have caused portions of the high mountain and western inland valley road network to degrade more rapidly than designed.	• Both SR-168 and SR-180 are located in Fresno County's eastern mountain regions, which are prone to landslides due to slope, soil type, geomorphology, and other factors. • SR-180 has higher landslide risk when compared to SR- 168.
Transit Network	• The transit routes at high flood risk are primarily urban routes operated by FAX, specifically Routes 1, 28, and 38, which also have high weekly ridership. • Rural transit routes, operated by FCRTA, typically serve more isolated communities with smaller overall ridership. Among these routes, the FCRTA Coalinga Intercity Transit and Westside Transit Routes have the most considerable flood risk.	• Transit routes at risk of wildfire impacts include FCRTA's Auberry Transit and Coalinga Intercity Transit Routes.	• Extreme heat is a significant issue today, and it uniformly affects people walking, bicycling, and taking transit in all parts of the county. • Bus stops without shelters or tree canopy exposes transit riders to prolonged direct sunlight while waiting for the bus. Of particular concern is the first and last mile of travel where passengers are exerting themselves by walking to and from a bus stop.	
Countywide Bike network	• Across the countywide bike network, bike paths (off-street paths) are considered especially vulnerable to flood risk due to their	• Portions of the bike network leading into the mountains are particularly vulnerable to wildfire risk. The primary areas of concern	• Extreme heat is a significant issue today, and it uniformly affects people walking and bicycling in all parts of the county.	

	Flooding	Wildfire	Extreme Heat	Landslides
	proximity to bodies of water. The most vulnerable portions of the bike network are in Fresno and Clovis as well near County borders along the San Joaquin River and the Friant-Kern Canal.	are located in the eastern and western mountains of Fresno County, including routes along Auberry Road and Elm Avenue.	• Lack of tree canopy or other shade on portions of the on-street and off-street bicycle network exposes bicyclists to direct sunlight and heat. This exposure creates a health risk, especially during physical exertion.	

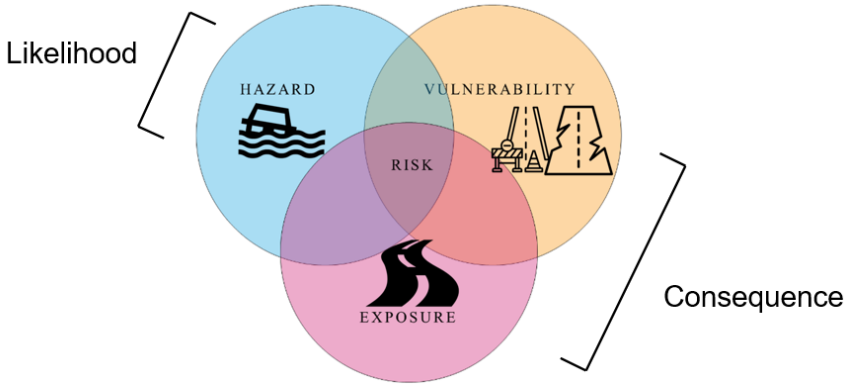
3.2 Methodology

Taking a holistic, consistent, risk-based approach to creating a resilient future required a method that allowed comparison across the potential impacts of multiple hazards, each with different likelihoods and intensities, on several types of infrastructure. For example, wildfires may impact roads much less frequently than flooding does but may impact roads more severely. The risk assessment provides a framework to be able to make these comparisons by considering both the likelihood of an event (e.g., a 100-year flood) in combination with its consequence (e.g. the amount of time the road will be closed).

The risk assessment integrates the following three key components, illustrated in Figure :

- **Hazard:** Hazard is assessed by defining the likelihood and intensity measure for a particular location. For example, in a given year a flood map may give a one percent chance of at least one to three feet of flooding occurring at a given location.
- **Exposure:** Exposure is assessed by identifying the assets in hazard-prone and understanding their characteristics to see if the hazard may impact them. For example, the elevation of a bridge may impact whether the bridge is in fact exposed to flooding. The characteristics considered in this study focused on asset location due to the number of assets and their geographical spread.
- **Vulnerability:** Vulnerability considers how an asset is expected to perform when subjected to a hazard. For example, six inches of flooding on a road can inhibit a car's ability to drive safely on the road and therefore result in road closure. One foot of flooding may damage critical maintenance equipment at a bus yard requiring it to close for a month for repair.

Figure 3-2: Key components of risk assessment



This approach can be used to assess different types of consequences. For flooding, wildfire, and landslide, downtime due to asset closures was assessed. Downtime was also assessed for extreme heat for all assets, except for the transit and bike networks where human health and wellness impacts were assessed. High heat hazards can have significant impacts on health and wellness, particularly for transit riders, and especially for those who are transit dependent. The methodology is described in detail in Appendix A.7.

Health and wellness risks were considered in conjunction with downtime risks to inform further adaptation planning decisions like developing a priority project list. To the extent possible, projects that serve multi-benefits, like reducing downtime and improving public health, or addressing flooding and heat impacts were prioritized.

4. Project Opportunities

Taken together, the climate projections and the system-wide transportation risk assessment focused the Plan on the areas where transportation assets will be most impacted by climate-related hazards either today or into the future. A list of project opportunities was developed to consider as candidates for incorporation into the 2026 Regional Transportation Plan/Sustainable Community Strategy and prioritized for consideration in the longer-term, as well.

4.1 Approach to identifying project opportunities

Project opportunities were identified by aggregating risk and criticality information to develop a long list of 31 project opportunities that can address climate impacts to important transportation assets in the county. The list of project opportunities consists of a climate hazard, and asset class (e.g., road network, bus yards), and a geographical area of high risk. The process to get to the long list was:

Figure 4-1: Approach to identifying project opportunities

Step 1: Identify high risk and critical areas

High risk geographies were identified based on the exposure of transportation assets to existing and future climate hazards, as described in Appendix A.8.

Step 2: Develop project typologies

Next, project typologies were developed that emerged from the risk assessment, to group, characterize, and score projects systematically. The project typologies are shown below.

Flooding

Figure 4-2: Project typologies for flooding

Bridge Infrastructure over major waterways

Airport runways and critical access roads susceptible to flooding

Mainline rail lines susceptible to flooding

Wildfire

Figure 4-3: Project typologies for wildfire

Wildfire-vulnerable mountain passes & bridges

Shared use paths susceptible to wildfire

Extreme Heat

Figure 4-4: Project typologies for extreme heat

Extreme heat impact on pedestrians, bicyclists & transit riders

Heat-vulnerable pavement of roads

Landslides

Figure 4-5: Project typology for landslides

Landslide and slope failure of roads & bridges

Step 3: Score and prioritize project needs locations

To compare the identified locations for prioritization, the previously developed Hazard Risk Score was combined with a Roadway Network Score to develop a final Priority Score. This resulted in a long list of 31 “Priority Need Locations” distributed throughout the county. The three scores are described below with further information in Figure 4-6.

- **Hazard Risk Scores** are a measure of the risk faced by the asset to a specific climate hazard (flood, wildfire, heat, landslide) that were outputs of the risk assessment.
- **Roadway Network Scores** are a measure of criticality, considering the following metrics which were determined in consultation with the Technical Working Group (TWG): traffic volume, presence of a transit route, presence of a bike lane, and whether it serves an equity priority community or isolated or rural populations.
- **Priority Scores** are a combination of the Hazard Risk Score and the Road Network Score and were used to prioritize the long list.

Figure 4-6: Approach to calculating priority scores

Hazard Risk Score (0-8) ✚ **Roadway Network Score (0-5)** 〓 **Priority Score (0-13)**

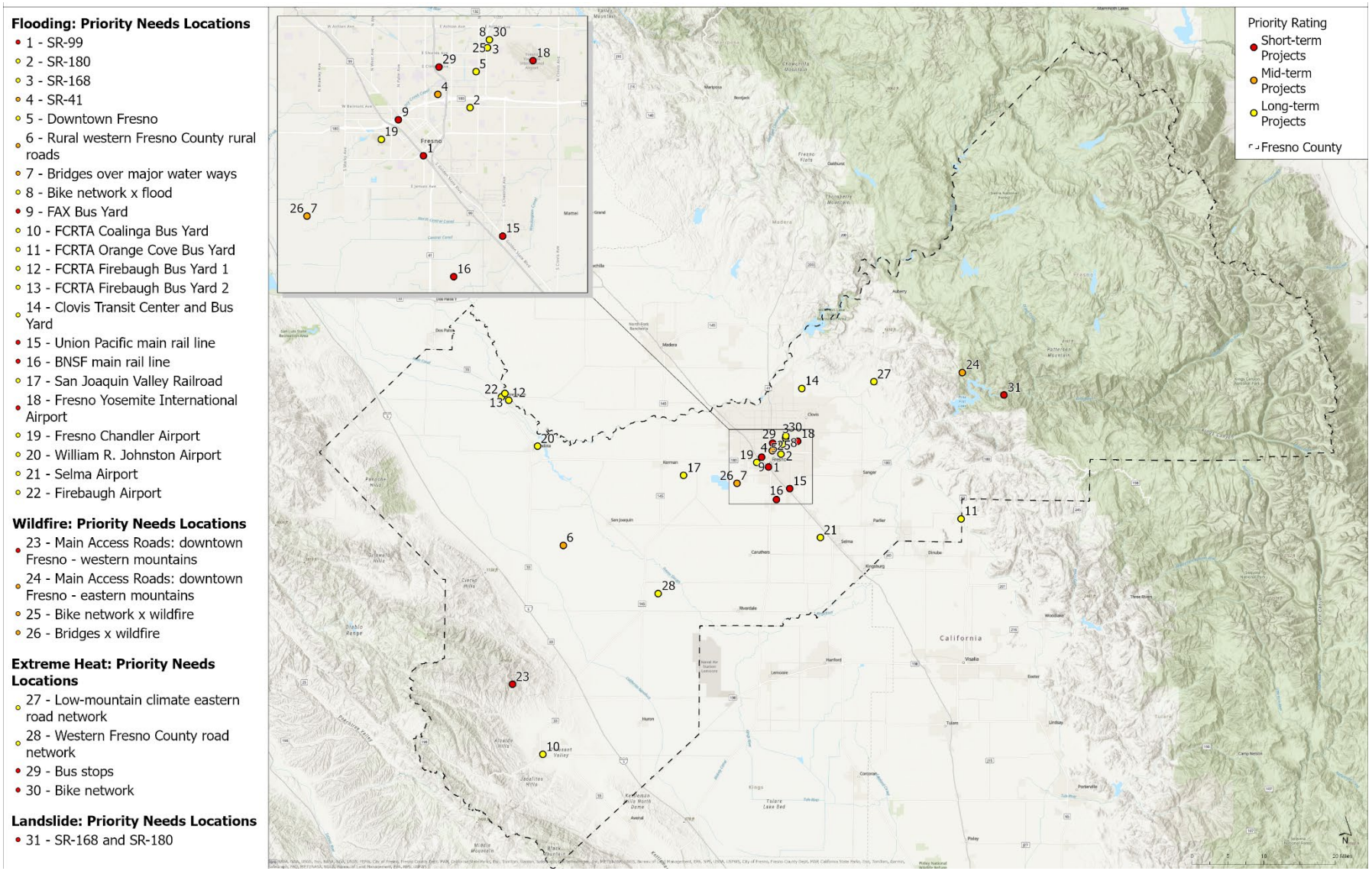
Risk Rating	Number
Negligible	0
Very Low	1
Low	2
Low-Med	3
Med	4
Med-High	5
High	6
Very High	7
Extremely High	8

Metric	Score
Transit route	0 or 1
Bike route	0 or 1
Vehicle volumes	0 to 1
Isolated/rural communities	0 or 1
Equity priority community	0 or 1

Priority Rating	Priority Score
Highest priority	Top third (quantile)
Moderate priority	Middle third
Lower-level priority	Lowest third

Figure 4-7 illustrates the project opportunity locations across the county.

Figure 4-7: Priority needs locations in Fresno County

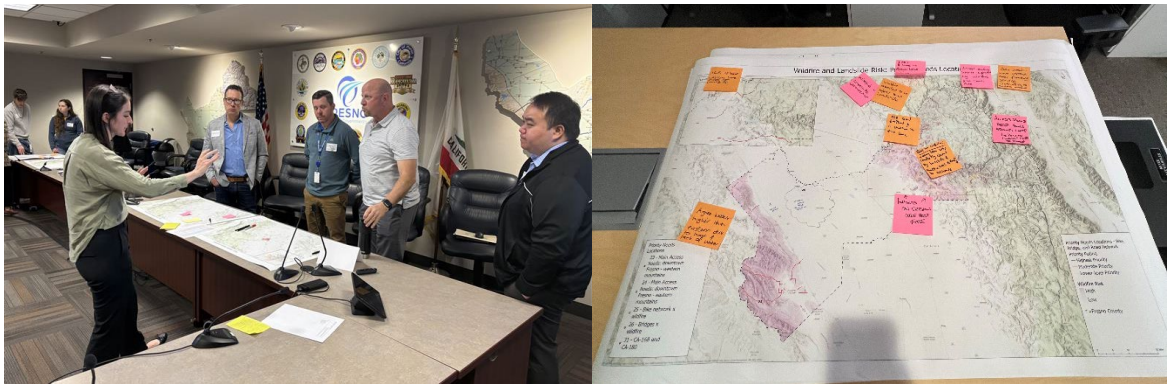


After identifying the list of project opportunities, feedback and guidance was solicited from the Technical Working Group on an approach to select a short list of five priority projects to advance.

Initially, 31 project opportunities were identified. These opportunities were scored and ranked, and then tagged as high, medium, or longer-term priorities. Five project locations scored as a high priority were selected for advancement. The selection process incorporated input from the Technical Working Group, and addressed issues identified by the Community Working Group, and community concerns raised in surveys and meetings.

The selection process also considered organizational capacity to manage the hazard, the geographical distribution of projects, the project's relevance in mitigating disproportionate risks to Equity Priority Communities, and potential co-benefits from project implementation.

Technical Working Group meeting #3 in Fresno

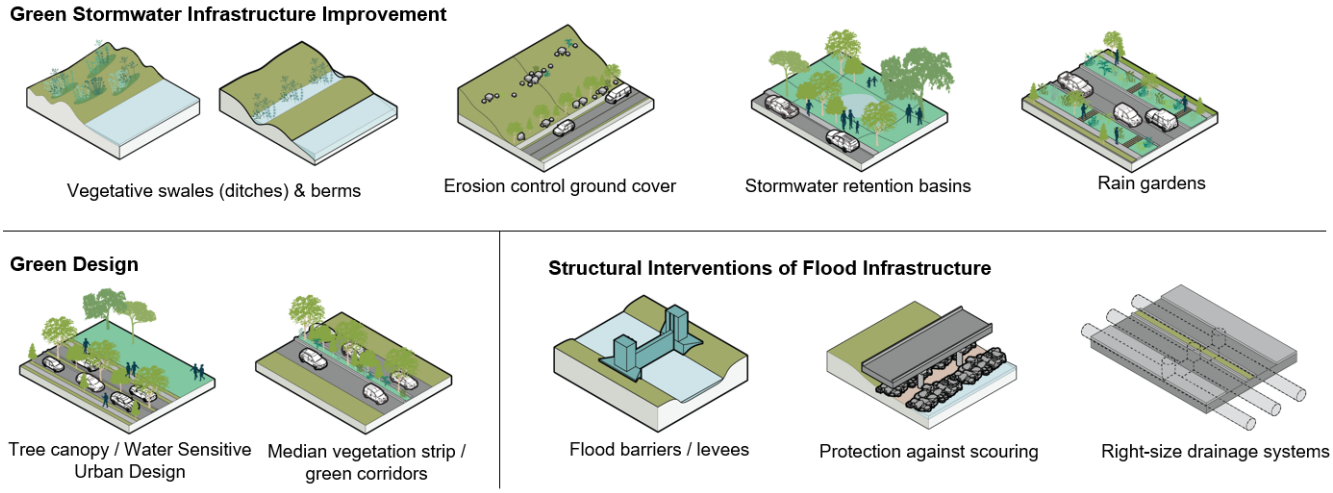


Step 4: Identify solutions for project areas

An Adaptation Solutions Toolkit was developed for each hazard featuring solutions that are suitable for application within the Fresno County context. The Toolkit is intended to provide a list of possible adaptation measures that may effectively mitigate climate impacts. The specific solutions recommended for the priority projects (detailed in Section 5), drew from the Toolkit, which illustrate the solutions' application to mitigating the hazards.

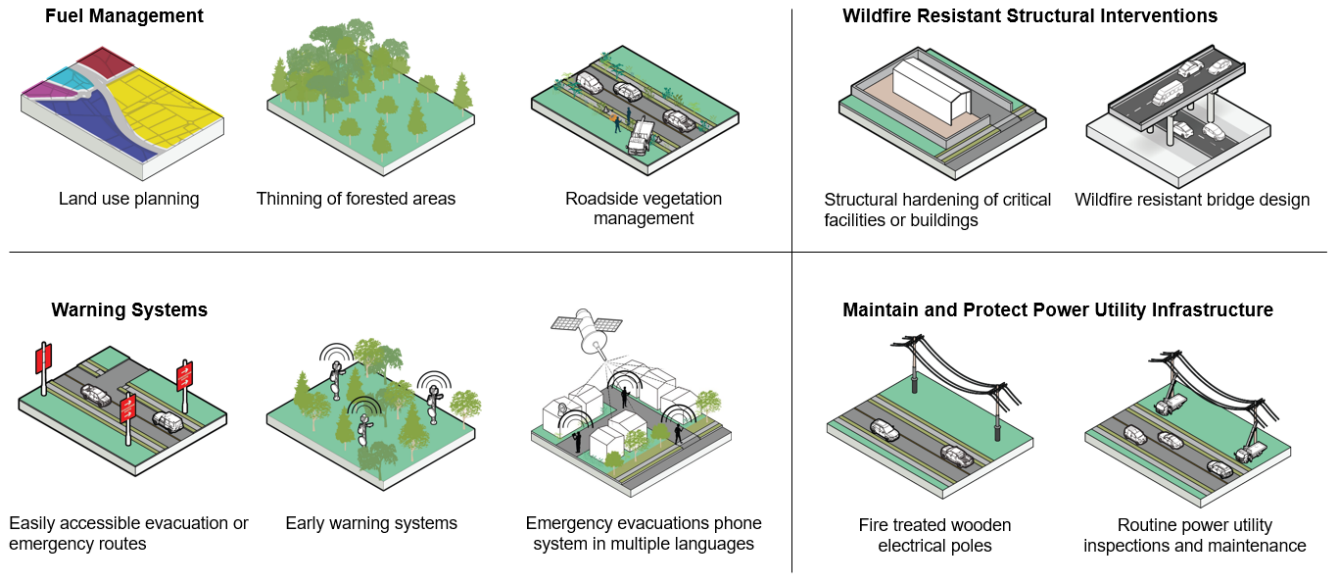
Flooding

Figure 4-88: Adaptation solutions for flooding



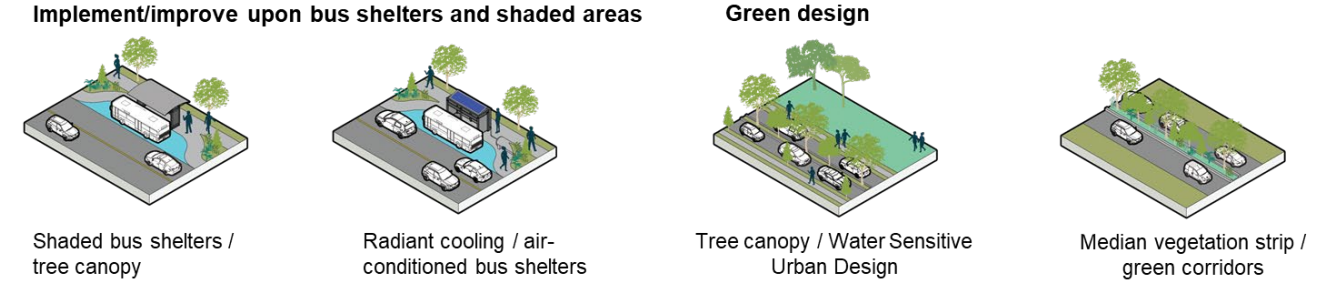
Wildfire

Figure 4-99: Adaptation solutions for wildfire



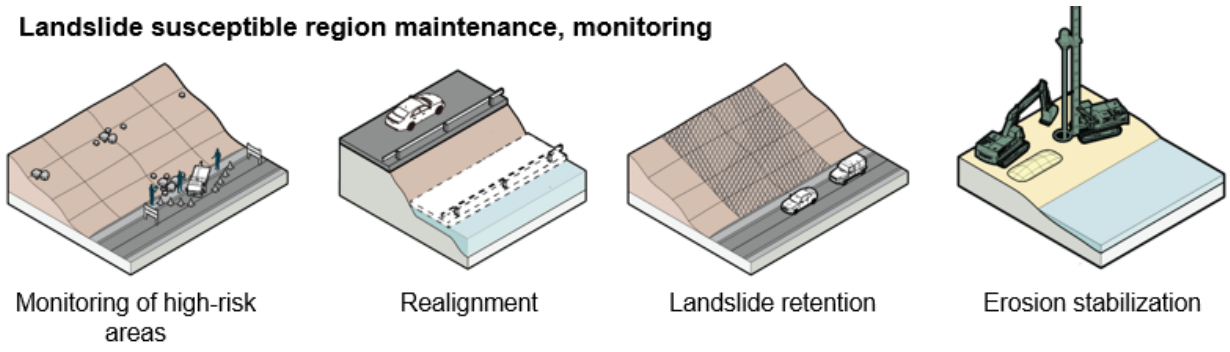
Heat

Figure 4-1010: Adaptation solutions for heat



Landslides

Figure 4-1111: Adaptation solutions for landslide



5. Priority Projects

Building resilience within the county's transportation network requires targeted investments in infrastructure that can withstand and adapt to climate-related hazards. Through a rigorous analysis of climate projections, risk assessments, and transportation asset vulnerabilities, a list of five priority projects were identified, designed to immediately enhance the county's ability to adapt to increasing frequency and severity of climate events. These projects serve as foundational efforts in mitigating risks associated with flooding, wildfires, extreme heat, and landslides.

These five priority projects were identified based on feedback and guidance from the TWG and CWG and the public, as well as the projects' ability to deliver meaningful benefits across multiple criteria, including:

- **Climate Adaptation and Resilience**: Enhancing the durability and adaptability of critical transportation infrastructure.
- **Equity and Community Well-being**: Prioritizing projects that serve equity priority communities and improve access to essential services.
- **Infrastructure Criticality**: Addressing vulnerabilities in transportation assets that are vital for economic activity and emergency response.
- **Multi-Benefit Solutions**: Designing projects that provide additional benefits beyond resilience, such as improving public safety, reducing maintenance costs, and supporting sustainable transportation modes.

The following sections provide a detailed examination of each priority project, outlining the specific vulnerabilities they address, the proposed solutions, and the expected benefits for the county's residents and transportation network. The proposed solutions include both physical infrastructure projects and programs. These adaptation and resilience projects were conceptualized and designed so that they align with – and don't unintentionally conflict with – important local goals such as sustainability, walkability, connectivity, accessibility, and economic development. Cross-agency collaboration and problem-solving can help to foster such a shared and aligned vision during future planning and implementation efforts. Across hazards, improving early warning systems, cross-agency coordination, and culturally-

appropriate communication methods will support emergency response and reduce the impacts of transportation disruptions on the most vulnerable populations. This includes Fresno COG's ongoing coordination with Fresno County's Office of Emergency Services and other response agencies.

Project costs were estimated by considering a typical installation, its appropriate estimated size, and its key components, operations, and maintenance costs. Costs have been provided for physical infrastructure projects, while programs require dedicated agency staff time and have not been costed. Costs incorporate both direct and indirect costs, including General requirements, Overhead and Profits (OH&P) and Design & Construction Contingency. References for costs include Arup benchmark projects and other industry sources.

To develop costs, unit costs were identified for each relevant treatment strategy, according the unit that was most relevant to the installation scale (e.g., mile, each, SF) with a base date of 2025, factored to Fresno County, California. Unit costs were multiplied by an estimated number of units according to assumptions regarding that project's typical installation sizing. Total indirect costs were calculated and added to total direct costs for a total construction cost, which was then applied to a low and high accuracy range -30%/+50%.

In the case of bus shelters, the estimate includes equipment pads and standard shelter units with benches but excludes excavation from the unit cost. For wildfire prevention strategies, only the cost of mechanical thinning is included.

Annual operations and maintenance (O&M) costs are derived from a variety of sources, with referenced links provided in the estimate. These costs may vary depending on the specific methods and services employed.

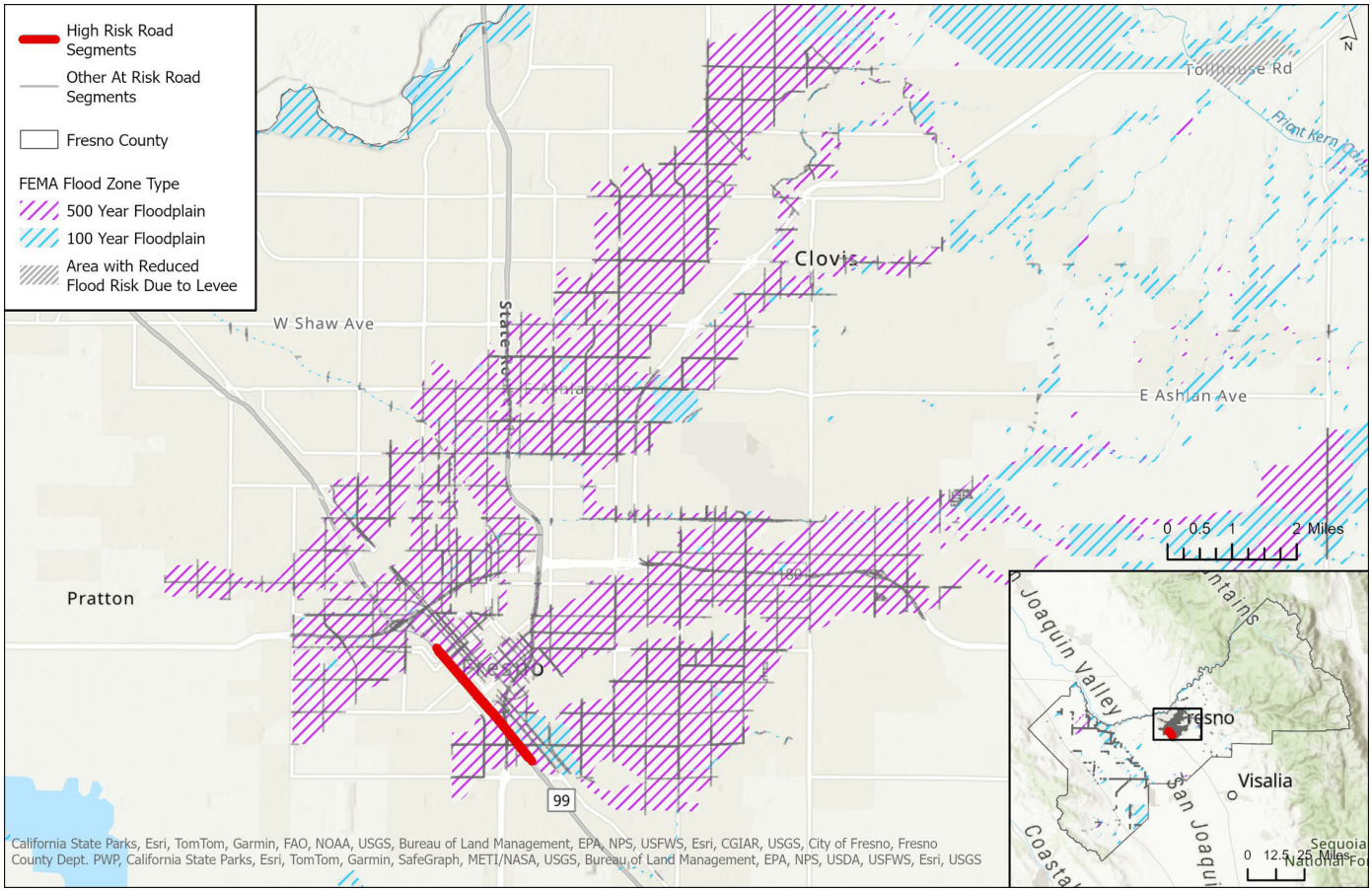
The estimate excludes a number of potential costs and risks, including Owner's soft costs such as permits, fees, and management, and those costs related to latent environmental issues, demolition, utility relocation or installation (unless explicitly stated), risk-based contingency analysis, and external testing or inspections. It also does not account for compensatory costs, regulatory changes, technological advancements, hazardous material mitigation (unless stated), agency administrative expenses, owner-led quality assurance, archaeological discoveries, or local taxes and duties.

PRIORITY PROJECT 1

MITIGATE FLOODING ALONG STATE ROUTE 99

What's At Risk

High flood risk road segment identified for urban Fresno



State Route 99 is a regionally significant north-south corridor through the Central Valley, and a locally important route for Fresno, Clovis, and many Equity Priority Communities.

Flooding along SR-99 in Fresno can cause significant road closures and delays, particularly at the SR-99 / Olive Avenue interchange. Specifically, a 4.5-mile segment (shown in red above) often fails during heavy rainfall due to its low elevation which collects stormwater, leading to hazardous driving conditions and increased accident risk. Priority Project 1 aims to mitigate flooding along SR-99 through stormwater infrastructure improvements and effective flood management to reduce the impacts of stormwater runoff.

Community members noted that the flooding risk along SR-99 extends to South Fresno communities including Calwa and Malaga. Therefore, mitigation planning studies should account for flooding not only at the indicated downtown area but also along connected reaches of SR-99.

Potential Impacts

Asset Criticality

SR-99 serves multiple purposes:

The county's most significant regional route for vehicles, freight, and transit with direct access to Fresno.

Serves Equity Priority Communities.

Potential Consequences

Flooding impacts vary depending on severity, described below:

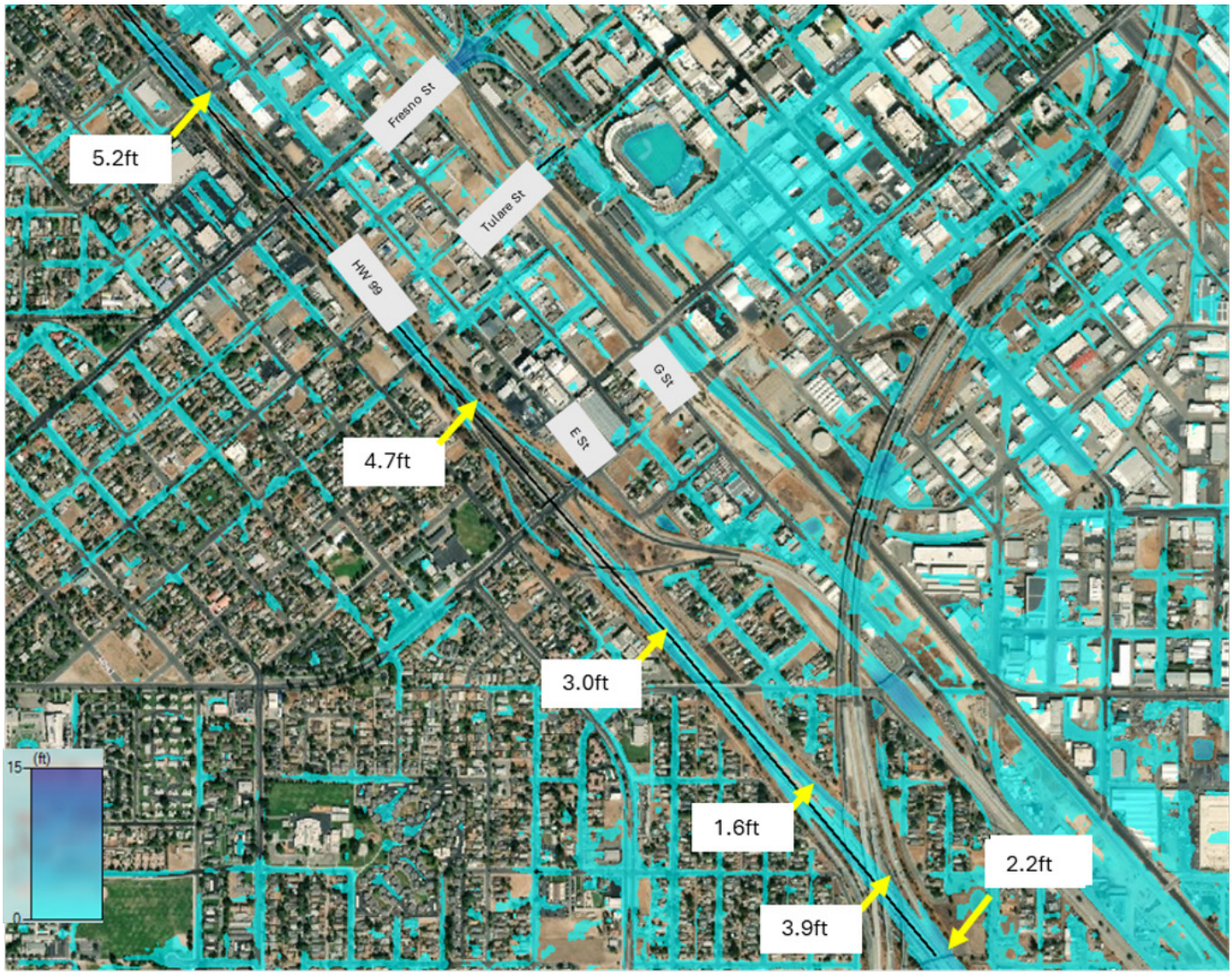
Up to six inches:
Unsafe driving conditions which can result in road closures of a few hours.

Six inches or more:
Exposure to this level of flooding causes clearance issues for vehicles and may result in a range of minor to significant repair needs, depending on the flood velocity. The resulting road damage may lead to closures lasting from several days to several weeks, especially if roads are washed out.

SR-99 underpasses can create hazardous conditions during flooding events, as they are below grade and at lower points in the urban drainage.

Additional Considerations

Projected flood depths



Flood depths of up to five feet can occur along SR-99 during a 100-year storm event, for present-day climate.

Preliminary Hydrologic Engineering Center's River Analysis System (HEC-RAS) modeling* revealed the potential for impactful flooding along this segment of SR-99, with depths reaching up to five feet for a 100-year storm event. This depth could increase to more than seven feet at the end of the century, under a high greenhouse gas emissions scenario.

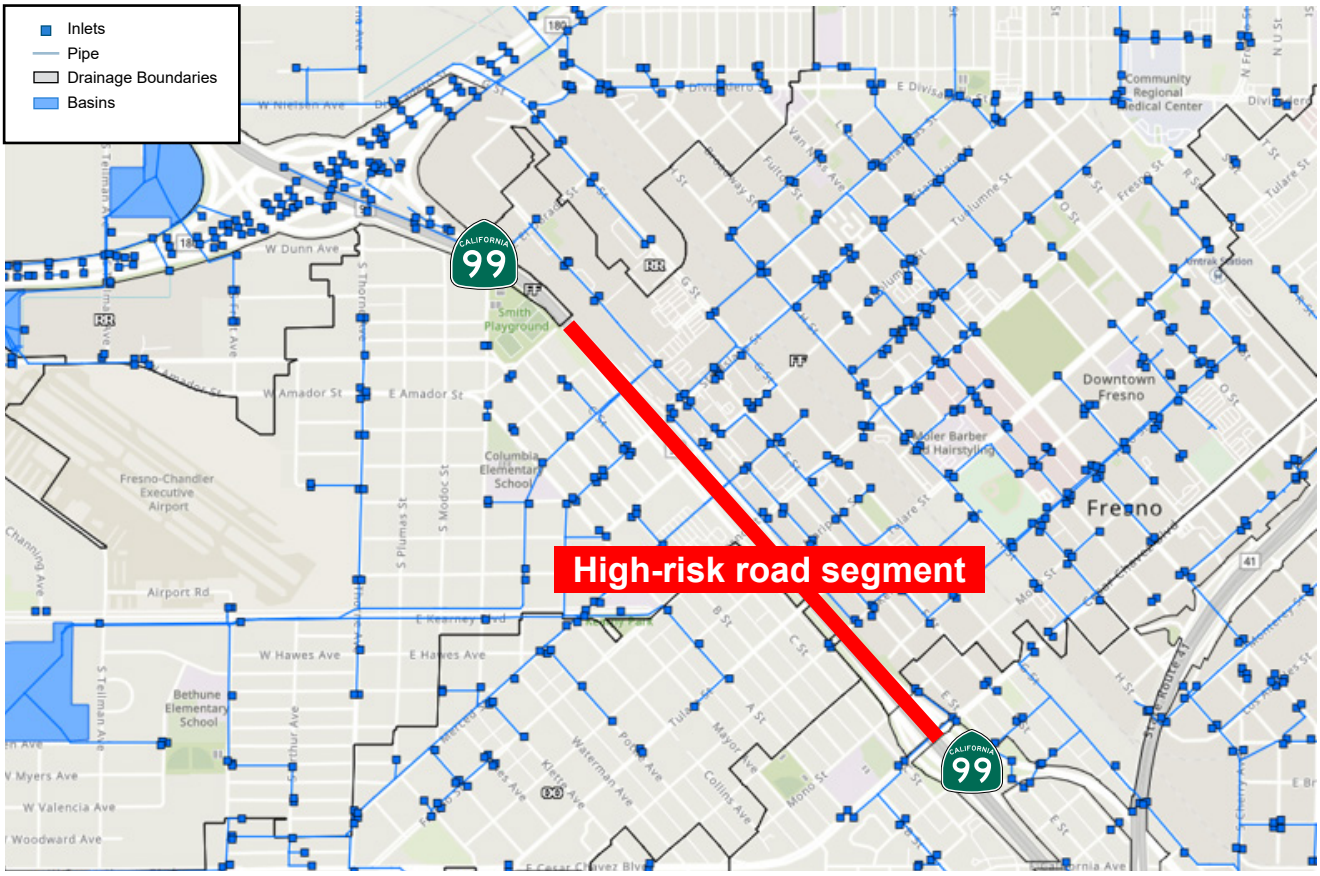
**Fresno COG performed this analysis for conceptual design level planning purposes only. Additional analysis is required for project engineering design.*

Recommended Treatments

Collaborate with the Fresno Metropolitan Flood Control District on two treatments to reduce the volume of stormwater that accumulates during rain events at underpasses and low points along SR-99:

Short Term	Long Term
Implement green stormwater infrastructure features, like bioretention basins, swales, and tree pits throughout the drainage, especially in areas northeast of SR-99.	Integrate climate projections into the storm system master plan sizing to account for more variable (more frequent and intense) storm events.

Currently, stormwater basins are located at the bottom of the drainage surrounding this high-risk segment of SR-99, as water flows northeast towards the southwest end of the drainage (see the drainage boundary in the image below).

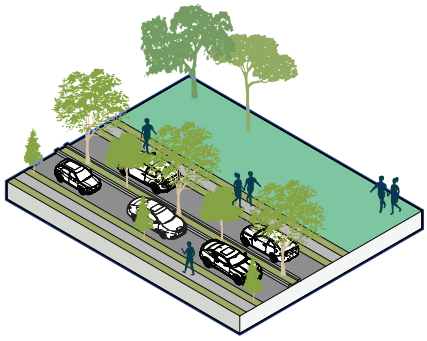


Stormwater management controls placed throughout the drainage, at the northeast end and throughout downtown Fresno, could help to mitigate the volume of runoff that enters the storm system or that flows onto this segment of SR-99. Sizing the storm system to account for larger precipitation events and flooding can help to move stormwater runoff from the street surface and into existing stormwater treatments, such as bioretention basins.

Recommended Treatments

01 | Green Stormwater Infrastructure

Regional stormwater retrofits (e.g., bioretention basins) or other green stormwater treatments could be applied throughout Fresno to reduce the volume of stormwater that collects around SR-99. This could include interventions like pervious pavement and bioretention basins, swales, and tree pits. Bioretention basins alone are not sufficient for larger storm events, but can provide multiple benefits beyond reducing stormwater volume, including supporting cooler, green, and more walkable corridors. If designed holistically, stormwater measures can could enhance connectivity and walkability.



Social / Health

- Maintains accessibility across Fresno County
- Connects communities to services
- Urban heat island reduction/heat relief and cooling
- Health improvement from improved air quality

Environmental

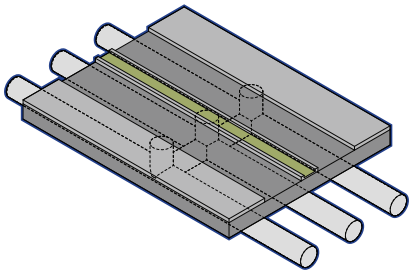
- Enhances biodiversity
- Improves water quality
- Improves air quality

Economic

- Maintains access to high demand roads
- Reduces costs of road maintenance and repairs

02 | Update the Storm System Master Plan

Incorporate climate projections into the Fresno Metropolitan Storm Drainage and Flood Control Master Plan to consider increasing variability of storm events. Collaborate with Fresno Metro Flood Control District to consider storm system sizing for more intense and more frequent storm events.



Social / Health

- Maintains accessibility across Fresno County
- Connects communities to services

Environmental

- Improves water quality

Economic

- Maintains access to high demand roads
- Reduces costs of road maintenance and repairs

Treatment Costs

Typical components of bio retention basins, bio swales, and tree pits include soil amendments, geotextiles, and substrate, vegetation, root protection, drainage and overflow mechanisms, irrigation, and aeration.

Treatment Type	Cost Range	Assumptions
Bio Retention Basin	$35k-$75k per basin	600 ft² @ $50/ft² (direct costs) $33/ft² (indirect costs)
Bio Swale	$59k-$126k per swale	600 ft² @ $85/ft² (direct costs) $55/ft² (indirect costs)
Tree Pits	$18k-$38k per tree pit	600 ft² @ $25/ft² (direct costs) $17/ft² (indirect costs)

Annual O&M

Annual O&M costs ($0.5-$1 / sf) include preventive maintenance costs and operational costs as per stormwater manuals.

Implementation

Implementing bioretention features like basins, swales, and tree pits throughout the urban drainage provides a cost-effective approach to managing stormwater when coupled with stormwater master planning. These features can be applied in rights of way to provide shade and vegetation along streets for more cool, walkable corridors. Stormwater volume improvements are likely to be more impactful with application of bioretention features in approximately 5-10% of the drainage area.

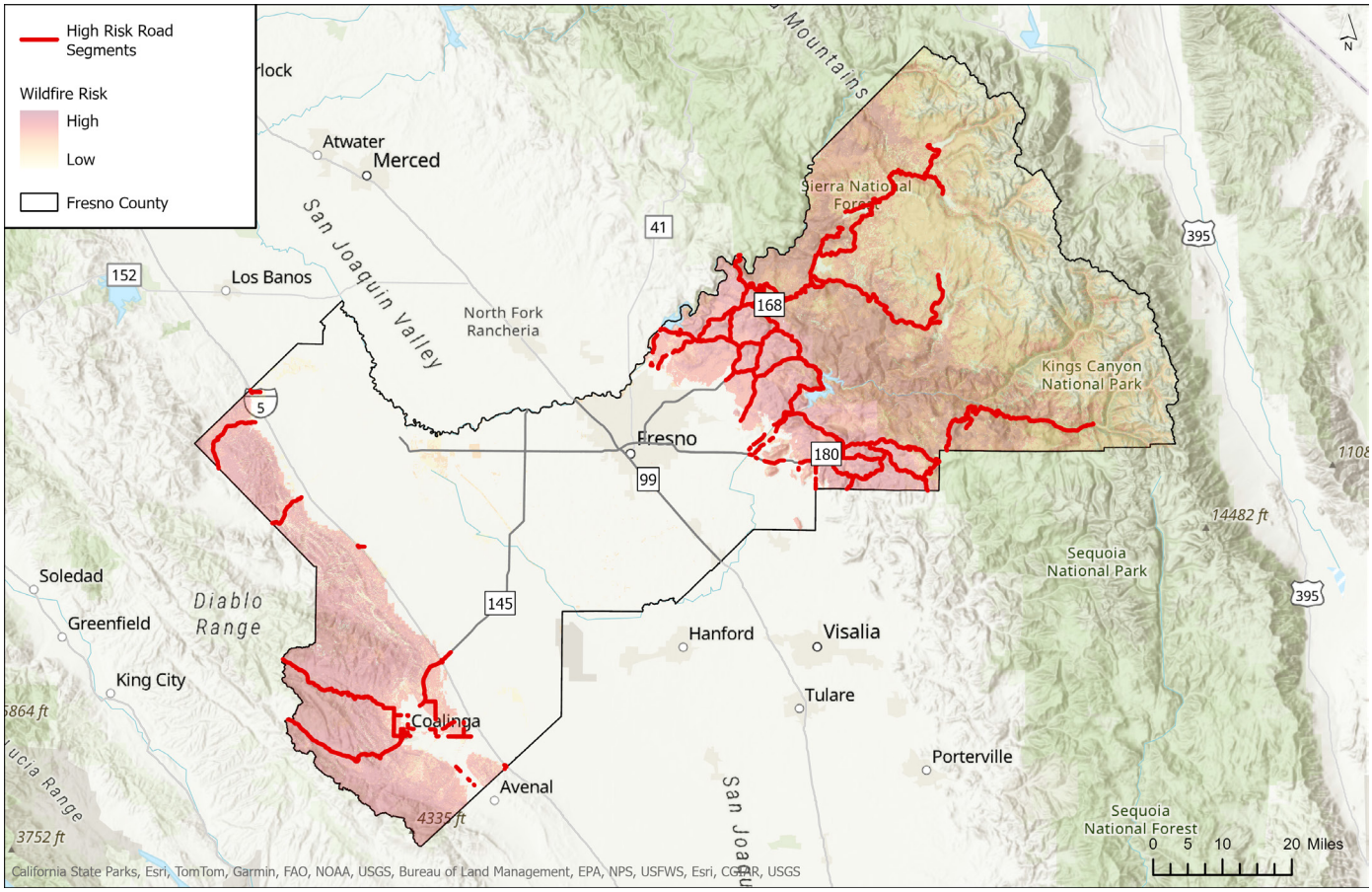
Example of a bioretention trench with trees and vegetation designed to capture, infiltrate, and release stormwater runoff from the sidewalk and a curb cut.

PRIORITY PROJECT 2

MITIGATE WILDFIRE IMPACTS TO THE COUNTYWIDE ROADWAY NETWORK

What's At Risk

High wildfire risk road segments identified in Fresno County



With 483 miles of priority road segments running through wildfire-prone foothill and mountain areas flanking Fresno County's eastern and western reaches, climate projections indicate that the likelihood of wildfires here could triple by the end of the century. These fires, along with landslides, put mountain roads at high risk of closure, isolating residents and cutting off access to essential services and evacuation routes. Additionally, disruptions to these roads impact visitors traveling to Kings Canyon National Park, a vital resource for tourism and the local economy.

Priority Project 2 aims to mitigate the impact of countywide wildfires on the county's mountain road network, ensuring safe, alternative routes for both emergency responders and the communities that depend on these roads for daily life and emergency evacuations.

Potential Impacts

Asset Criticality

The countywide roadway network serves multiple purposes:

Critical emergency access and evacuation routes.

Serves multiple FCRTA routes.

Serves rural, isolated communities and Equity Priority Communities.

Primary access routes to Kings Canyon National Park and Sierra National Forest, and several State facilities.

Potential Consequences

Wildfire impacts vary depending on severity, described below:

Small grass or brush fire near the road: Several days of downtime due to the route being closed from wildfire smoke or evacuation precautions.

Larger, high intensity forest fire near the road: Weeks of downtime due to significant loss of operability from debris or wildfire smoke.

Structural damage to bridges: months of downtime due to closure and repairs.

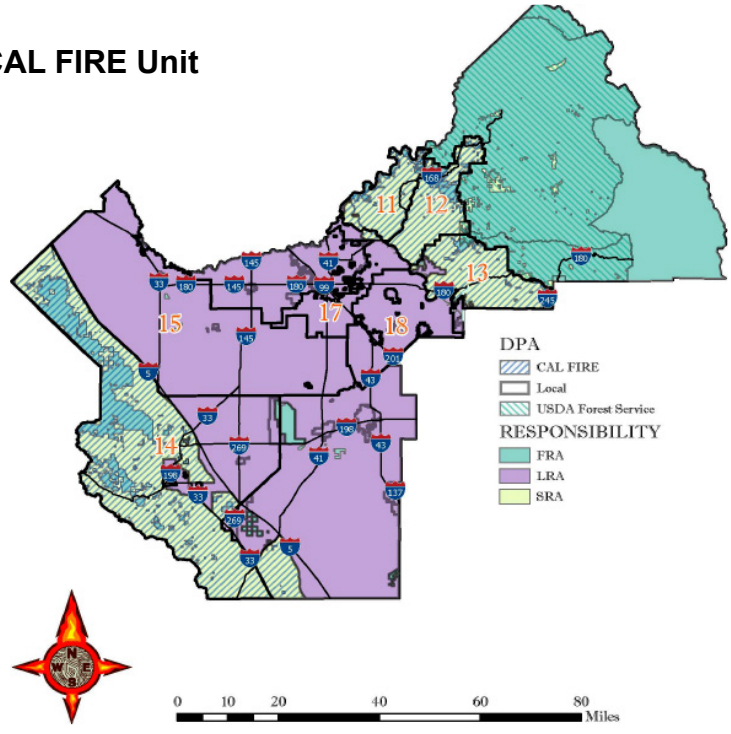
Rural populations may become endangered

if major access routes, such as SR-168 and SR-180 are obstructed during wildfire.

Emergency responders may be unable to perform lifesaving efforts due to road obstructions.

Coordination within the Fresno-Kings CAL FIRE Unit

The roads at highest risk are located within CalFIRE Federal Responsibility Areas (FRAs) and State Responsibility Areas (SRAs) pertaining to Battalions 11, 12, 13, and 14. Fresno COG should complement efforts of the US Forest Service and the Vegetation Management Program projects (VMPs) led by these CalFIRE Battalions in High and Very High Fire Hazard Severity Zones.

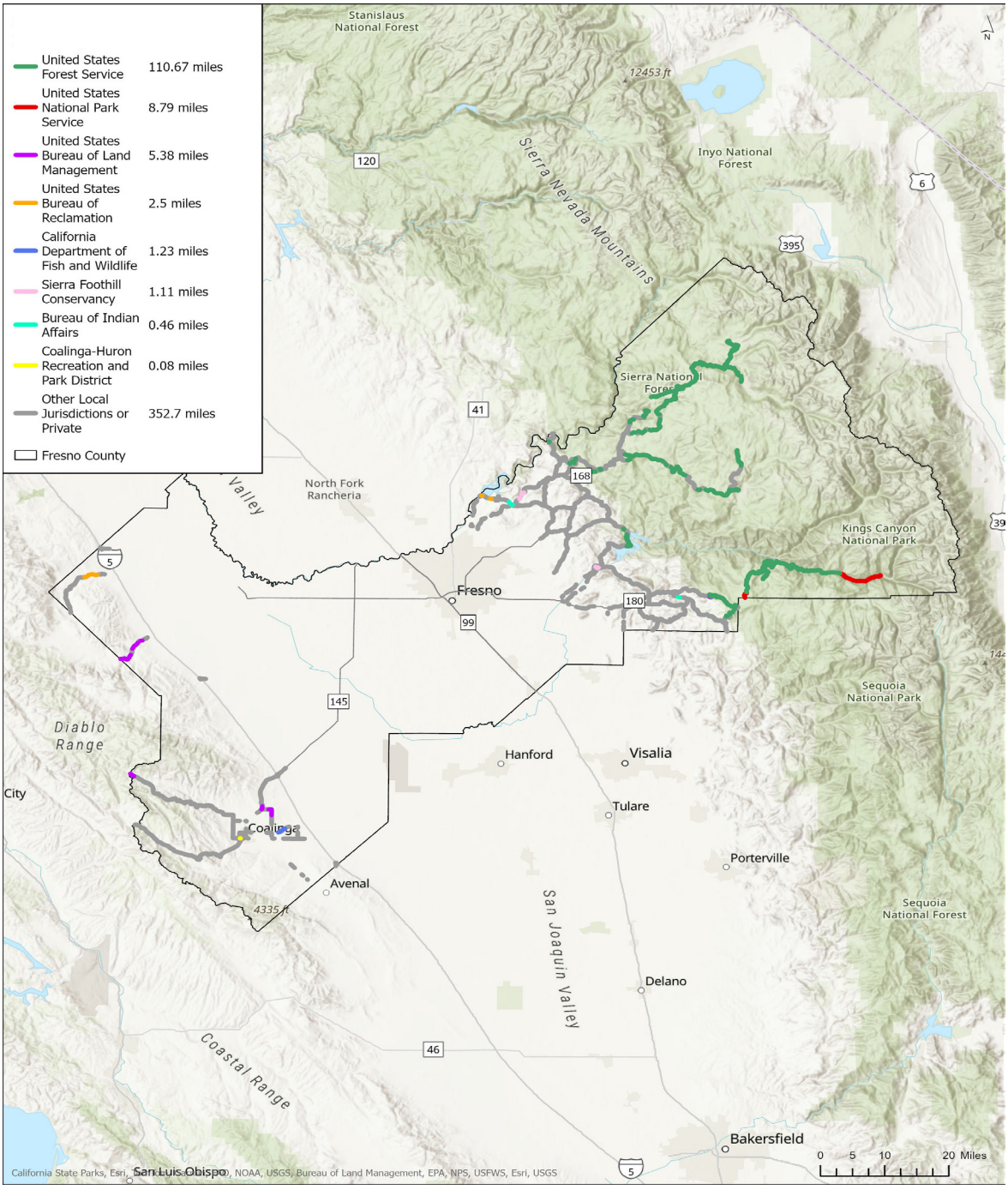


Additional Considerations

Interagency Coordination

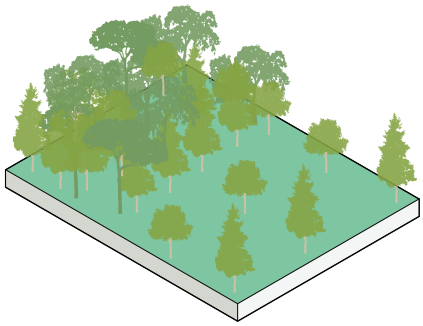
Fresno County requires a coordinated response to address future wildfires given the number of agencies and jurisdictions who manage land in the county. Of a total of 483 high wildfire risk roadway segments, 110 miles are on land managed by the U.S. Forest Service (USFS). Local jurisdictions manage another 352 miles. Working in partnership with land managers to remove deadfall from forested areas and create healthier forests will reduce risks to roadways and maintain evacuation routes during wildfires.

High risk road segments by land manager



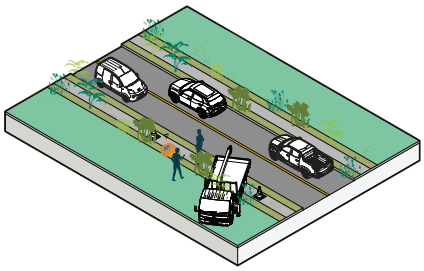
Recommended Treatments

Efforts to reduce wildfire risk should focus on clearing dry, dead vegetation (i.e., ground fuels) and enhancing evacuation plans along high-risk roads. Since the foothills and the mountains have different management needs, fire prevention strategies will vary. Fresno COG should work alongside agencies like CalFIRE, the USFS, the Sierra Resource Conservation District (SRCD), and local fire councils and departments to support ongoing fire prevention projects. For example, the SRCD is working to secure funding for wildfire protection plans along SR-168 and SR-180 in partnership with the SR-168 Fire Safe Council. Communities are working with CalFIRE and conservation districts on Firewise wildfire planning in private land and need support coordinating with Caltrans and other agencies for projects near roads.



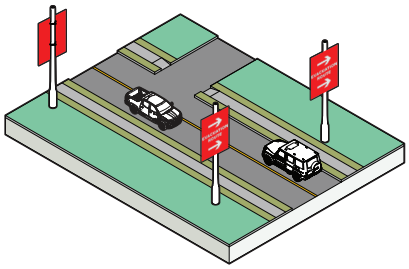
Complement Projects to Clear Ground Fuels

The high wildfire risk road network is located along land managed by the USFS (110 road miles), National Park Service (9 road miles), and the Bureau of Land Management (BLM) (5 road miles) (see map on previous page). Fresno COG should partner with CalFIRE, USFS, and SRCD to clear ground fuels from forested areas along the high wildfire risk road network and create fuel breaks, prioritizing those areas that have been impacted by beetles, including along SR-168. Resources and gaps on private lands present challenges to more comprehensive ground fuel clearance along roadways.



Support Unfunded Priority Areas & Seek Innovative Financing

Fresno COG could explore partnerships with The Nature Conservancy and Blue Forest to identify innovative financing approaches to healthy forest management and fuels reduction. These groups and others explore impact investment models and resilience bonds to reduce upfront capital costs of wildfire mitigation, including forest thinning, clearing ground fuels, reforestation, and healthy forest management.



Evacuation Planning

Enhancing emergency access roads and establishing well-coordinated evacuation plans are essential for wildfire preparedness. Fresno COG should support efforts, like those led by SRCD to improve alternative emergency routes, to mitigate risks along evacuation corridors, strengthen route redundancy, and routinely assess emergency management systems to ensure seamless communication between emergency responders, isolated communities, and road network managers.

Treatment Co-Benefits

Social / Health

- Improves air quality; reduces impacts of fires on respiratory and cardiovascular health
- Connects communities to services
- Emergency Response Preparedness: maintains ingress and evacuation access

Environmental

- Protects air quality
- Reduces greenhouse gas emissions from fires
- Reduces vulnerability to landslide and debris flow, following wildfire

Economic

- Maintains accessible roads of high demand
- Reduces costs of road maintenance and repairs following wildfire
- Avoids loss of life and property

Treatment Costs

Treatment Type	Cost Range	Assumptions
Mechanical Thinning	$38k-$82k per road mile with buffer	1 mile x 400 ft width = 50 acres; $650/acre (direct costs) $420/acre (indirect costs)

Annual O&M

Because brush removal is type of maintenance activity, no O&M costs are considered here. However, thinning and brush removal may be required every few years, depending on the type of vegetation, annual rainfall, degree of beetle damage, and other ecological factors.

Implementation

Mechanical thinning involves selectively removing brush, dead trees, and overgrowth to establish healthier, fire-resistant forests using equipment like chainsaws and precision tree removal machinery. The process may involve marking trees that will be removed for improved accuracy and reduced damage. A typical project may include about 50-100 acres, with a 200 ft buffer on either side of the road.

PRIORITY PROJECT 3

MITIGATE EXTREME HEAT AT URBAN TRANSIT STOPS

What's At Risk

The Central Valley is facing rising temperatures, posing health risks to people when they are outdoors. Today, summer temperatures already reach 116 °F, during heat waves. By 2050, the heat index in Fresno County could increase by 5°F, and by 2085, by 11°F, making heat events even more dangerous. People who walk, bike, and ride transit are particularly vulnerable to these extreme temperatures, facing risks such as heat exhaustion and heat stroke.

Priority Project 3 aims to identify bus stops served by FAX, Clovis Transit, and FCRTA throughout Fresno and Clovis that need bus shelters, better shading, and tree canopies to provide critical health benefits to those who are transit dependent. With over 1,500 bus stops across the city, stop locations and surrounding areas are scored and ranked by ridership and other factors to prioritize improvements that will protect transit riders exposed to heat in the warmer months.

Potential Impacts

Asset Criticality

Fresno's public transit system is an essential component of the countywide transportation network:

It has multiple local and regional transit routes provided by: FAX, Clovis Transit, and FCRTA.

Serves youth, seniors, and others who are unable to drive.

Serves multiple Equity Priority Communities.

Potential Consequences

Heat impacts vary depending on severity:

Increased risk of heat-related illnesses including heat exhaustion (103°F to 124°F), and heat stroke (which becomes a serious threat at 125°F and above), posing a risk of hospitalization or death.

Outdoor workers, pregnant women, and individuals with asthma or cardiovascular disease are most impacted by heat-related illness.

Dependence on public transit can further exacerbate these risks, highlighting the need for effective heat mitigation strategies.

The table below shows that heat indices of 103°F or higher can result in dangerous heat disorders with prolonged exposure or physical activity outdoors. Direct sunlight can increase temperatures by up to 15°F, highlighting the importance of shade in mitigating heat-related health risks.

Classification	Heat Index	Effect on the body
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion with prolonged exposure and/or physical activity
Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely

Source: National Oceanic and Atmospheric Administration

Existing Conditions

Given the uniformly high heat risks throughout Fresno/Clovis, Fresno COG analyzed bus stops and their surrounding areas based on the following criteria:

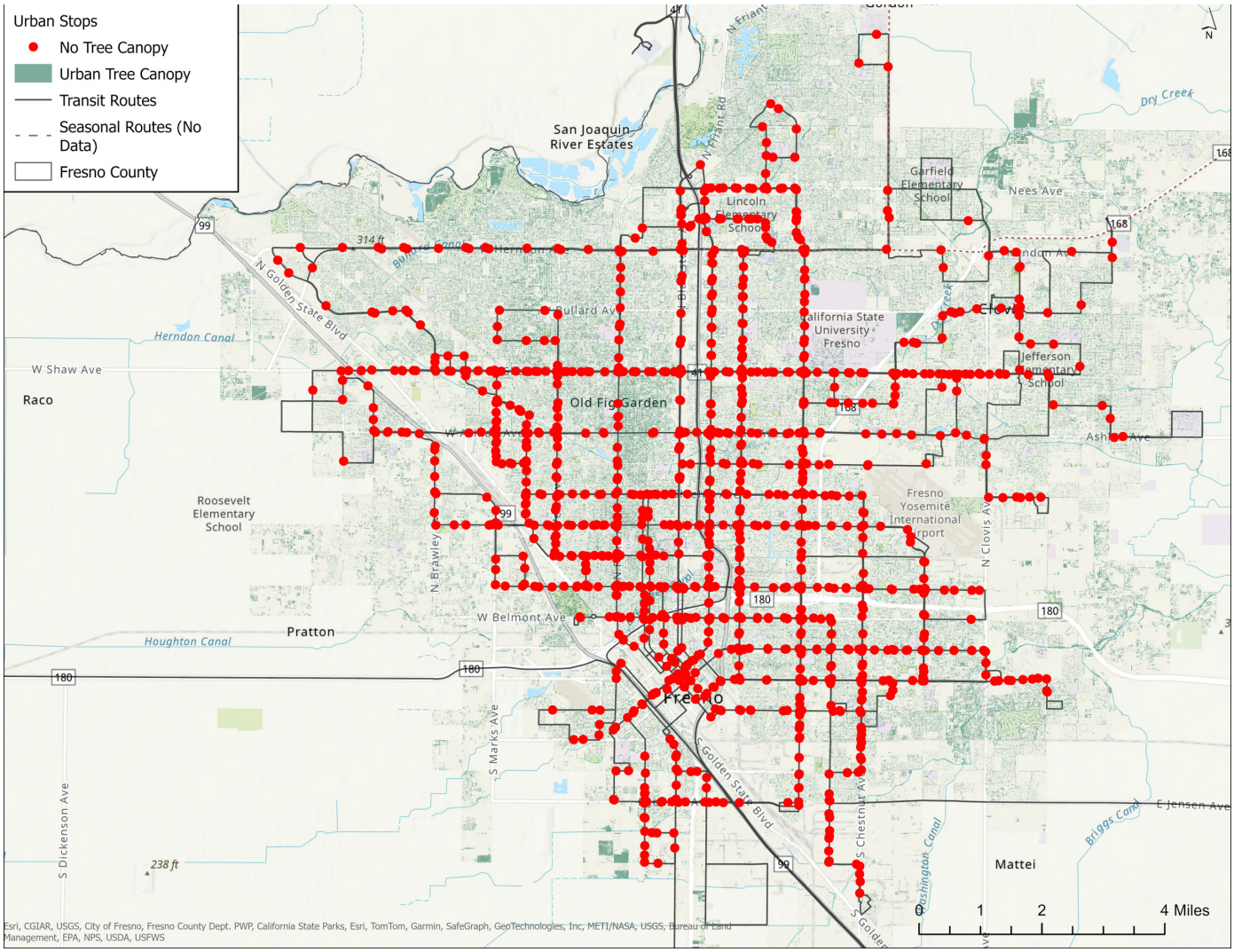
Tree Canopy
Is there adequate tree canopy coverage at this bus stop and surrounding streets?

Bus shelters and seating: Does this bus stop have seating with shade-providing shelter? (This information was not available at the time of writing. An inventory of existing bus shelters is an important next step to determine which stops require shelter installation.)

Ridership
Does this stop have low, medium, or high ridership compared to other transit stops?

Frequency
Does this stop have low, medium, or high frequency of service compared to other transit stops?

Urban Tree Canopy

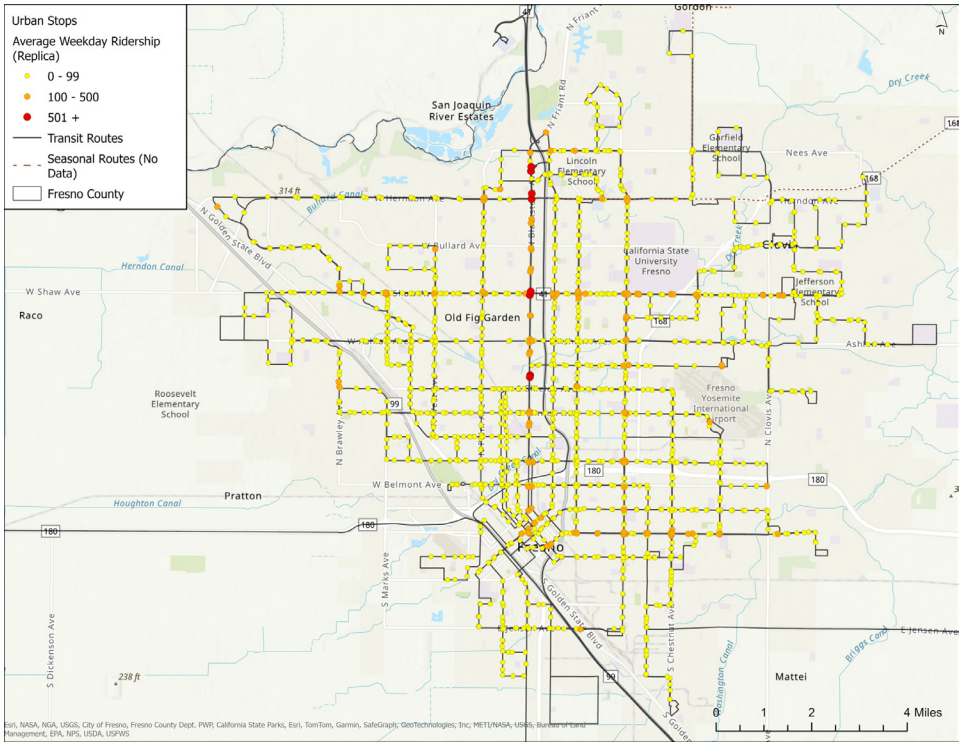


Fresno/Clovis has over 1,500 bus stops served by FAX, Clovis Transit, and FCRTA. Based on data from the USFS, 74 percent of these stops and surrounding areas may be lacking adequate shade from the tree canopy.

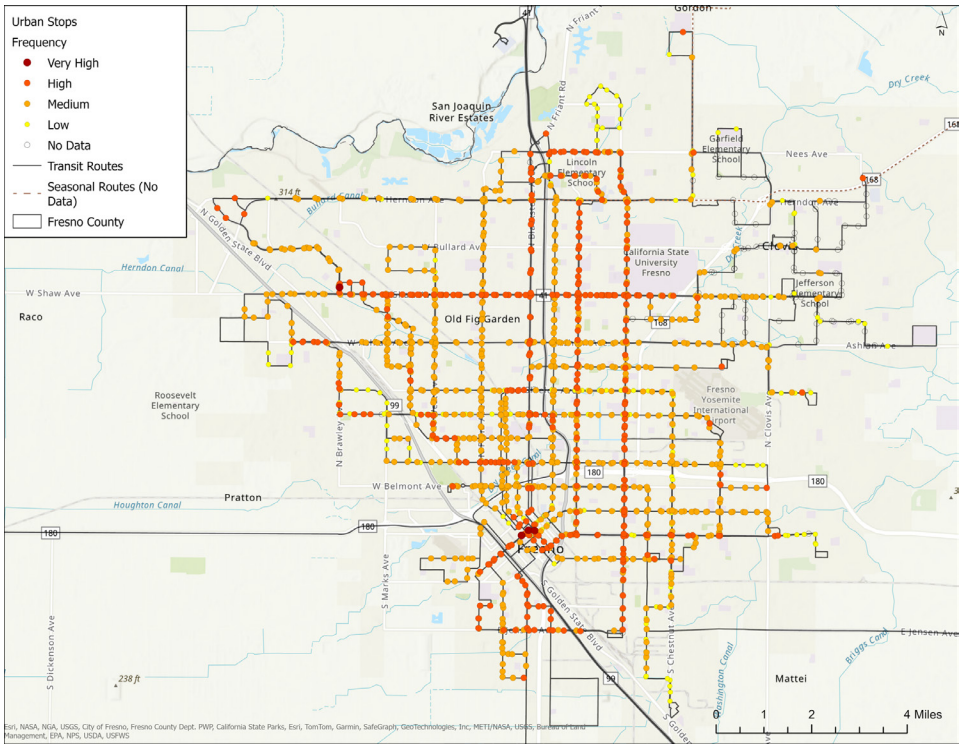
Existing Conditions

The highest ridership lines in Fresno are FAX-01-Q - BRT, FAX-38-Cedar, FAX-09-Shaw, and FAX-34-First Street.

Transit Ridership



Transit Frequency



Recommended Treatments

Recommendations to mitigate extreme heat at transit stops in the City of Fresno fall into high, medium, and longer-term categories. Notably, passive cooling approaches at transit stops can help to maximize thermal comfort. Design solutions include considerations of solar reflectance, albedo, and heat absorption of materials, shade from nearby buildings, solar orientation, mixing and layering shade, and pedestrian routes and connectivity.

High Priority Recommendations

Develop a comprehensive inventory of bus shelters to identify candidate locations for future investment.

Install bus shelters where absent around high frequency/ridership stops.

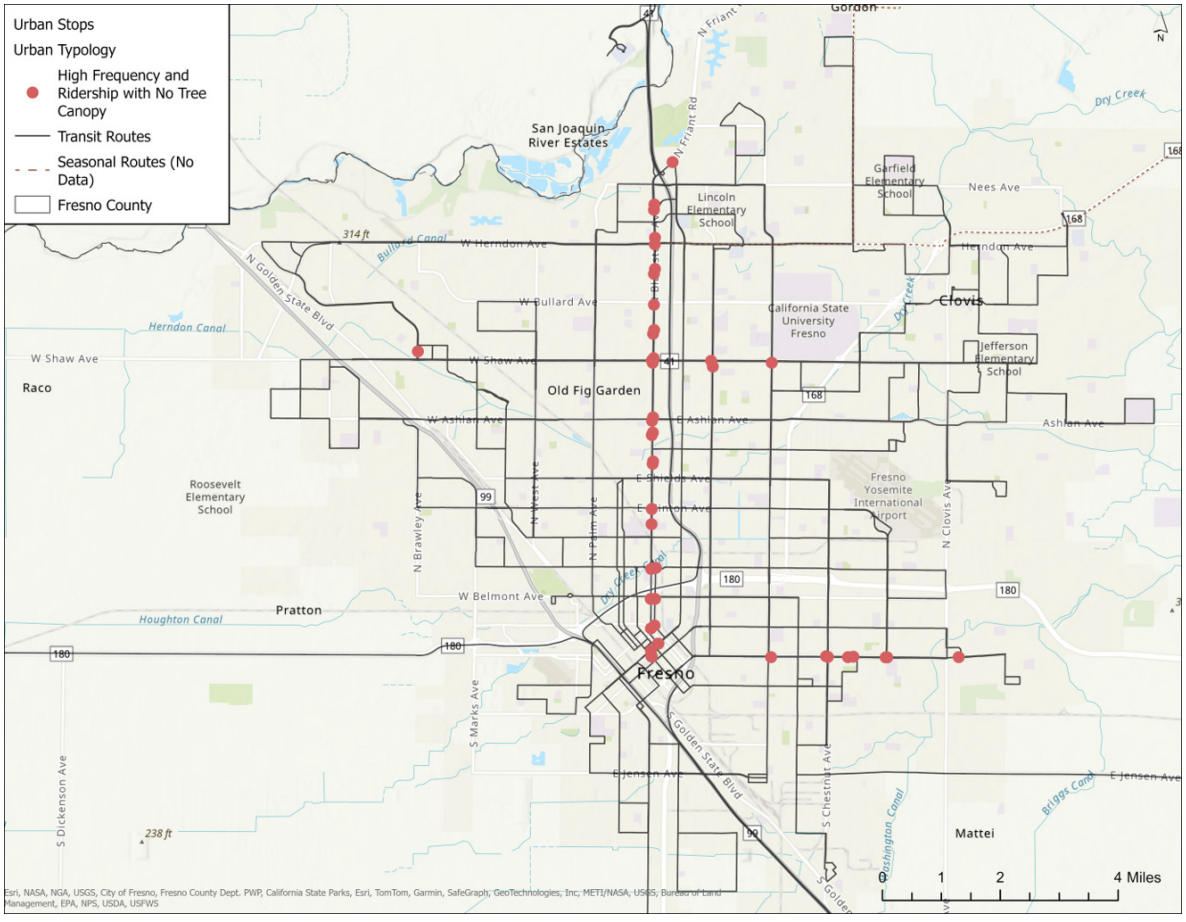
Develop a shade tree and landscaping planting plan for:

- Blackstone Avenue
- Eastern end of the Cesar Chavez/ Kings Canyon Road

Prioritize radiant cooling/air-conditioning at major transit hubs such as:

- Downtown Transit Center
- Manchester Transit Center
- Major stops that serve Cal State Fresno
- Future High Speed Rail Station

High Frequency/Ridership with No Tree Canopy



*Bus stop IDs/locations are available in Appendix 9

Recommended Treatments

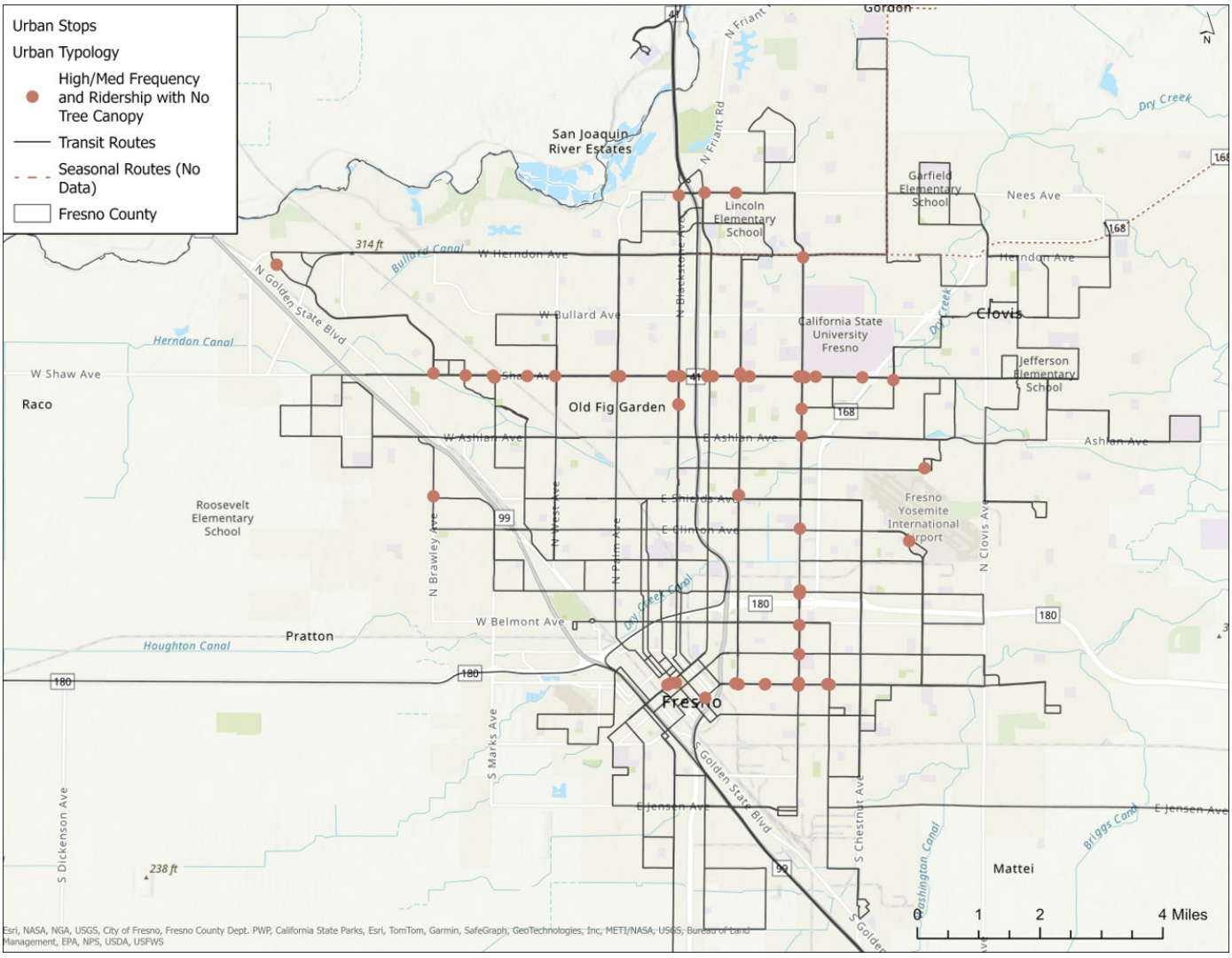
Medium Priority Recommendations

Install bus shelters where absent around medium frequency/ridership stops

Develop a shade tree and landscaping planting plan for:

- Shaw Avenue
- Western end of Cesar Chavez Boulevard
- Cedar Avenue
- Other spot locations as indicated

Medium Frequency/Ridership with No Tree Canopy



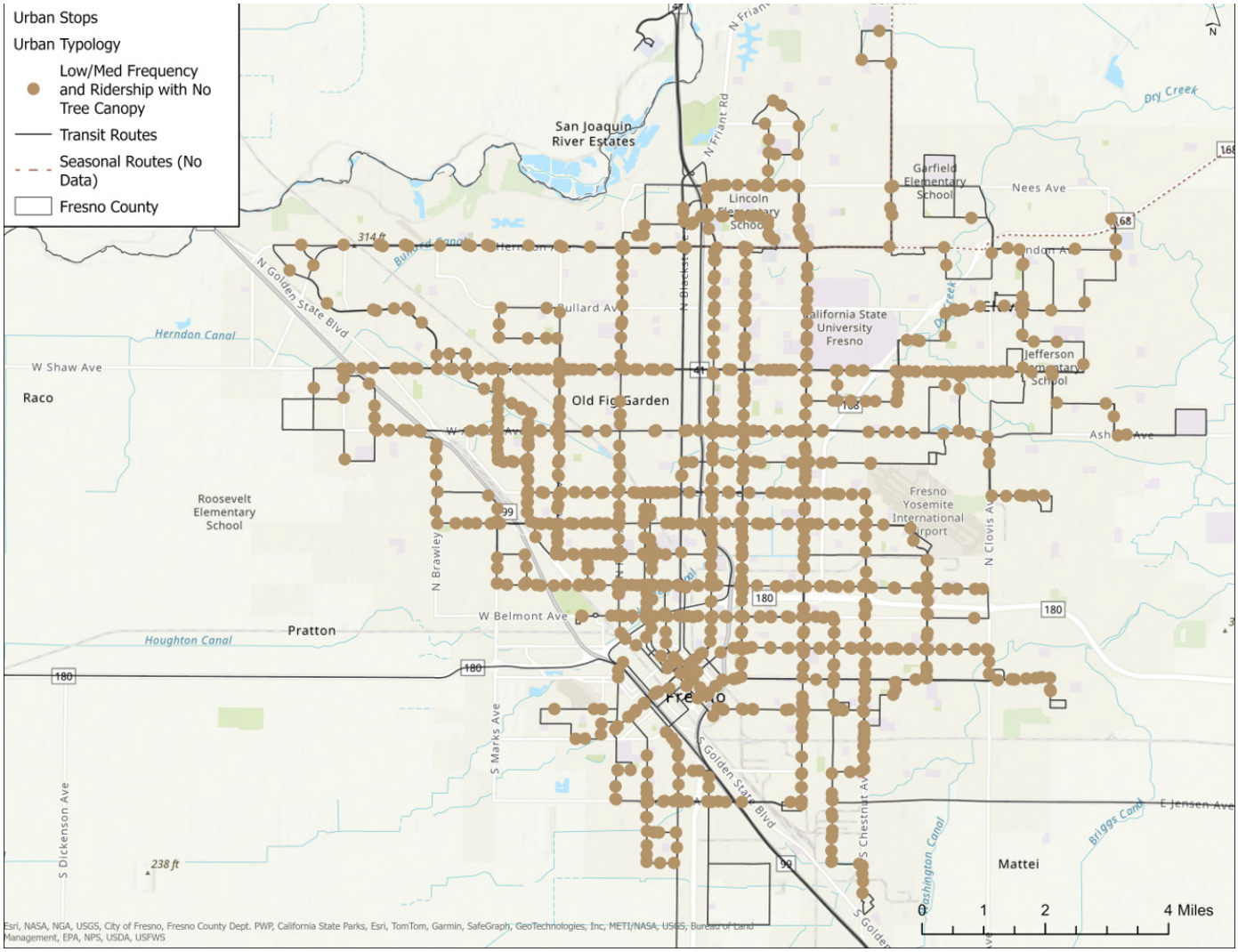
*Bus stop IDs/locations are available in Appendix 9

Recommended Treatments

Opportunistic / Longer Term Recommendations

Install bus shelters where absent around low frequency/ridership stops

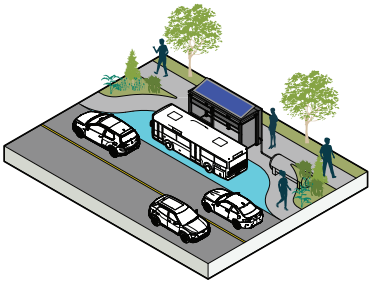
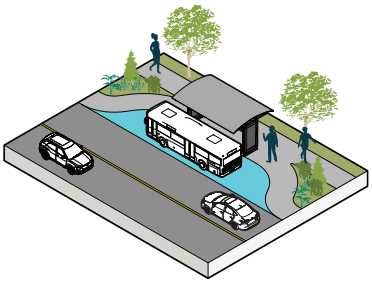
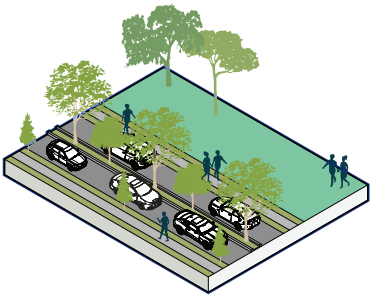
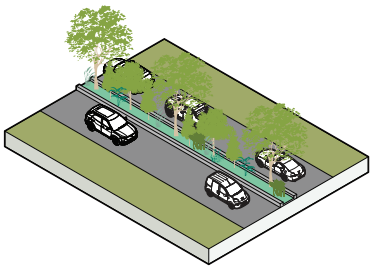
Low Frequency/Ridership with No Tree Canopy



Proposed treatments, including tree and landscaping plans, and radiant cooling/air-conditioning are described further on the next page.

*Bus stop IDs/locations are available in Appendix 9

Recommended Treatments

	Treatment	Description	Application
01	**Radiant cooling / air-conditioned bus shelters** 	Radiant cooling or air-conditioned bus shelters provide the most protection from heat. However, applications should be limited to the highest need locations due to the capital cost, maintenance, and energy requirements.	Major Transit Hubs
02	**Shaded bus shelters / tree canopies** 	Shelters and trees shade passengers waiting for the bus.	Bus stops that lack shelters and/or tree canopy with higher ridership and frequency.
03	**Tree canopies / Water Sensitive Urban Design** 	Planting trees around transit stops and incorporating bioretention basins into the public right-of-way areas.	Bus stops that lack tree canopy with moderate ridership and frequency.
04	**Median Vegetation Strip / Green Corridors** 	Creating shaded, green corridors using a combination of trees, bioretention basins, and vegetation at transit stops, rights of way, and medians along pedestrian routes.	Bus stops that lack tree canopy and areas with high pedestrian activity with low ridership and frequency.

Treatment Co-Benefits

Social / Health

- Provides relief from heat and provides outdoor thermal comfort
- Improves air quality from reduced use of personal vehicles
- Maintains accessibility across Fresno County
- Promotes connectivity

Environmental

- Reduces greenhouse gas from decreased personal vehicle dependence
- Improves air quality from reduced personal vehicle dependence

Economic

- Maintains public transit related jobs and access to jobs

Treatment Costs

Treatment Type	Cost Range	Assumptions*
Radiant Cooling / Air-Conditioned Bus Shelters	$21k-$45k per bus shelter	$18k per bus shelter (direct costs) $12k per bus shelter (indirect costs)
Shaded Bus Shelters / Tree Canopies	$14k-$30k per bus shelter / transit stop	$12k per bus shelter (direct costs) $8k per bus shelter (indirect costs)
Tree Canopies / Water Sensitive Urban Design	$28k-$60k per transit stop	Estimated area is 1000 LF $24k per transit stop (direct costs) $16k per transit stop (indirect costs)
Median Vegetation Strip / Green Corridors	$71k-$151k per transit stop and surrounding median	Includes one bioswale and median vegetation for 600 ft^2 $61k per transit stop/median (direct costs) $40k per transit stop/median (indirect costs)

* All treatment types include equipment pads and standard bus shelters with benches. Excavation costs not included.

Annual O&M

O&M includes weekly cleaning and incidental repairs, electrical maintenance of air conditioner, and tree and vegetation maintenance. O&M costs range from $2k to $4k annually for shade, bioswales, and vegetation at and around transit stops, and between $4k and $8k annually for air-conditioned shelters.

Implementation

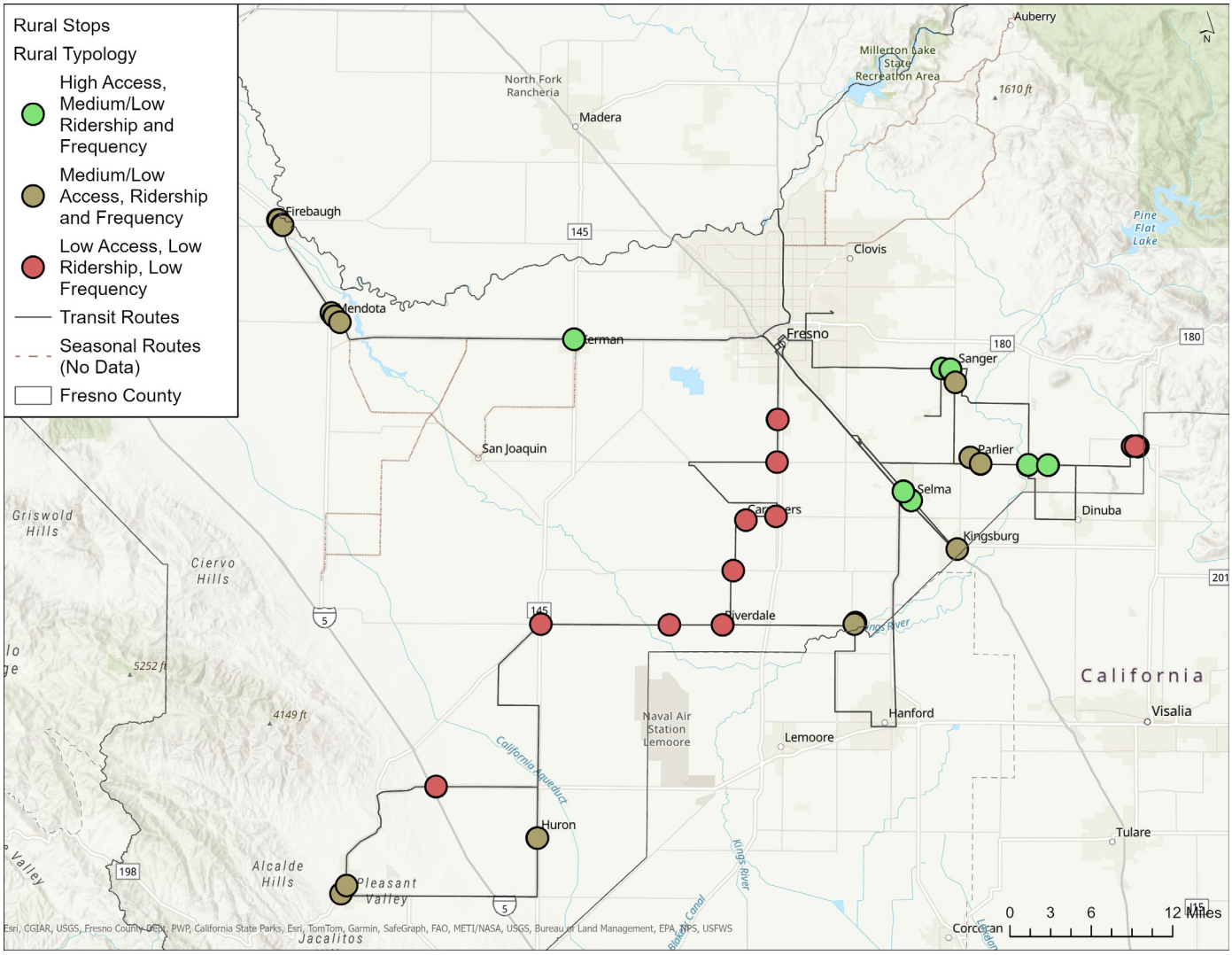
Cost ranges reflect costs for treatment of a single transit stop location. In practice, costs will multiply across prioritized transit stops, phased over time. For 25 high priority stops, implementing shaded bus shelters may cost about $350k to $750k in total.

PRIORITY PROJECT 4

MITIGATE EXTREME HEAT AT FCRTA TRANSIT STOPS

What's At Risk

Rural transit stops based on access, ridership, and frequency



In Fresno County's rural areas, transit riders face long wait times and limited access to essential services, making them especially vulnerable during extreme heat events. Today, summer temperatures can reach up to 116°F during heat waves, and by 2050, the heat index is projected to rise by 5°F, increasing by 11°F by 2085. This means that a 1-in-5-year heat event, which currently averages 99°F, could reach between 104°F and 110°F—dangerous levels for all outdoor travelers.

Priority Project 4 aims to mitigate extreme heat at FCRTA transit stops by adding shelter, shading, and tree canopies to provide relief for transit riders. Investing in these heat-mitigation strategies is essential to protecting the health and safety of those who depend on public transportation in Fresno County's rural communities.

Potential Impacts

Asset Criticality

Fresno's public transit system is an essential component of the countywide transportation network:

It has multiple local and regional transit routes provided by: FAX, Clovis Transit, and FCRTA.

Serves youth, seniors, and others who are unable to drive.

Serves isolated rural communities and multiple Equity Priority Communities.

Potential Consequences

Heat impacts vary depending on severity:

Increased risk of heat-related illnesses including heat exhaustion (103°F to 124°F), and heat stroke (which becomes a serious threat at 125°F and above), posing a risk of hospitalization or death.

Outdoor workers, pregnant women, and individuals with asthma or cardiovascular disease are most impacted by heat-related illness.

Dependence on public transit can further exacerbate these risks, highlighting the need for effective heat mitigation strategies.

Existing Conditions

Given the uniformly high heat risks throughout Fresno/Clovis, Fresno COG analyzed bus stops and their surrounding areas based on the following criteria:

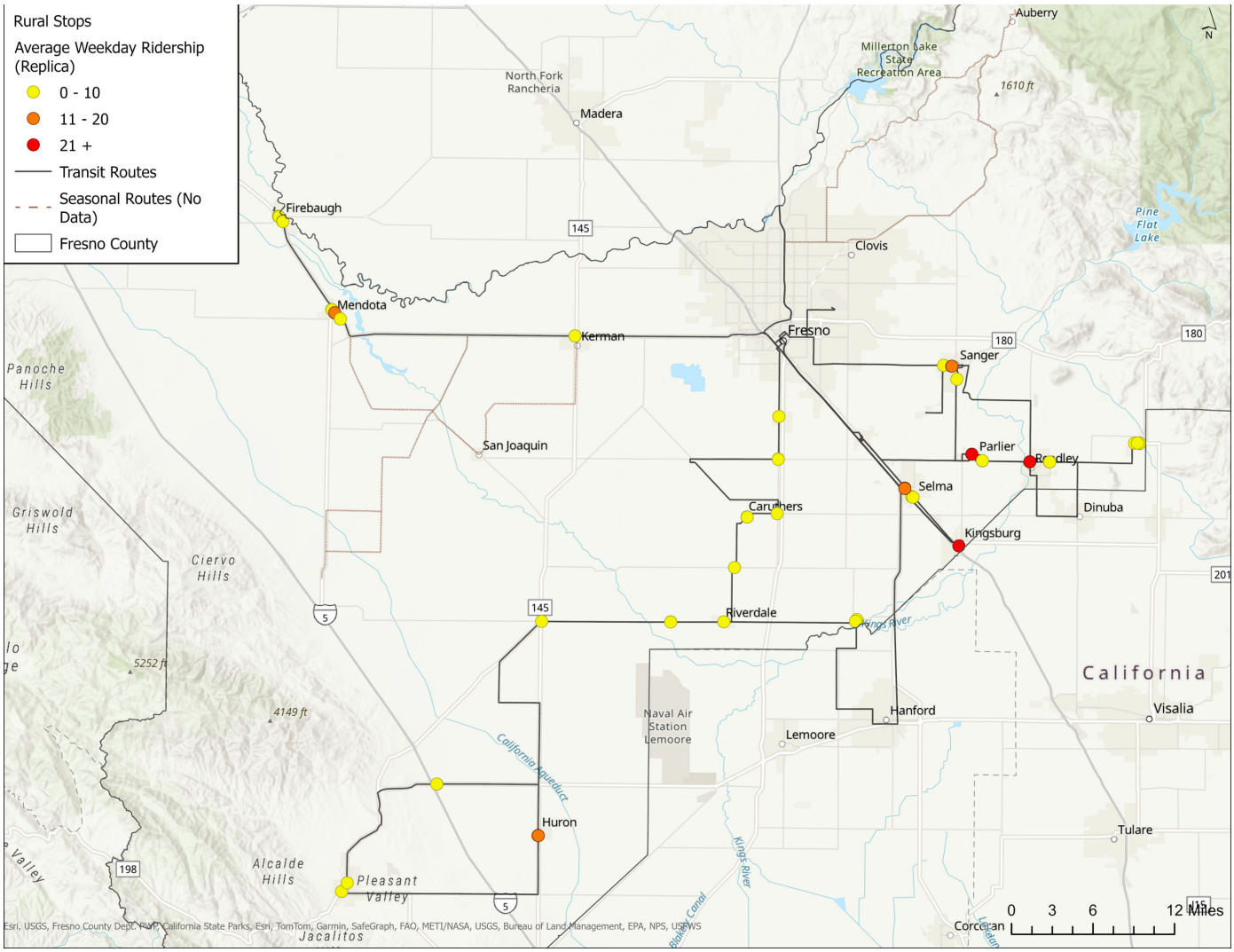
Access to Critical Services: Does this bus stop serve transit routes that provide access to critical services like hospitals, senior centers, and schools? For rural transit riders, transit is essential for accessing critical services.

Ridership
Is this stop along a transit route with low, medium, or high ridership compared to others?

Frequency
Does this stop have low, medium, or high frequency of service compared to other transit stops?

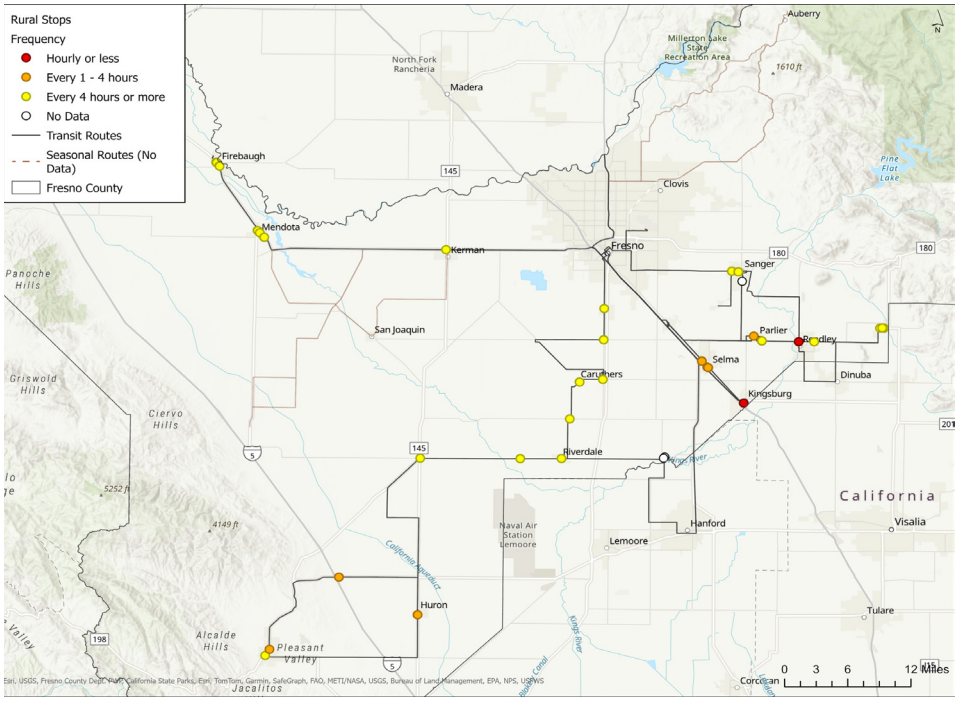
Urban Tree Canopy

Note: Tree canopy data from the USFS is not currently available fo rural areas.

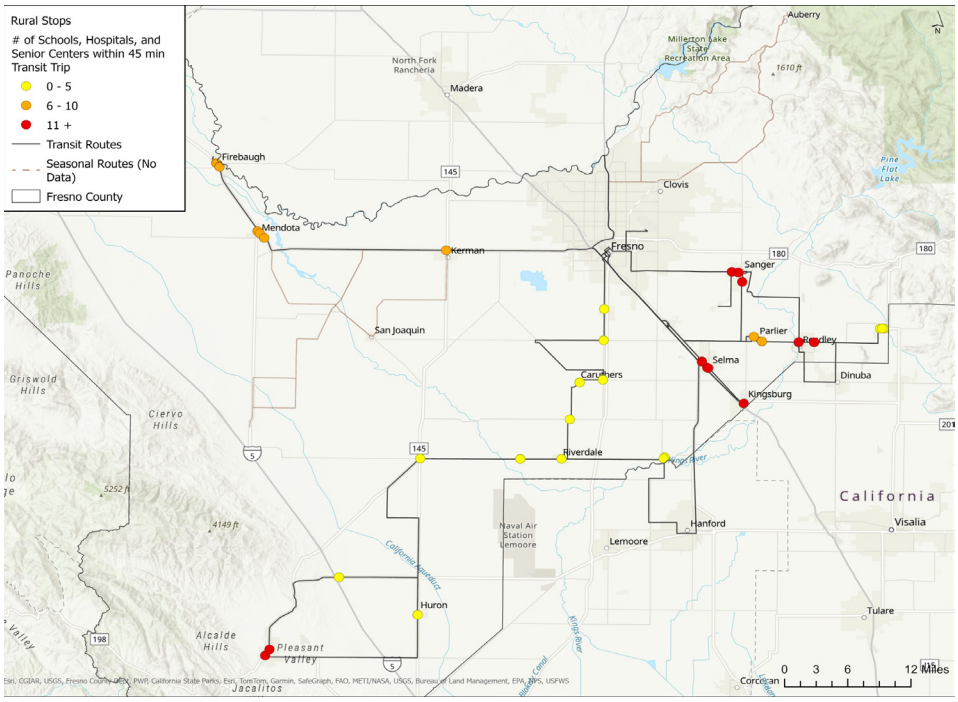


Existing Conditions

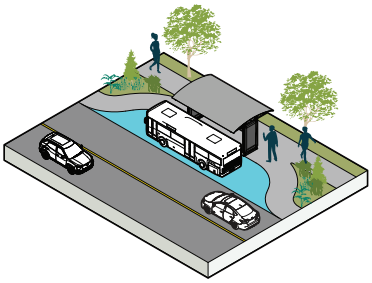
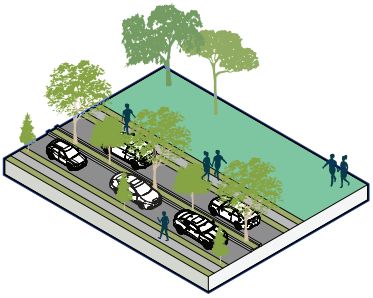
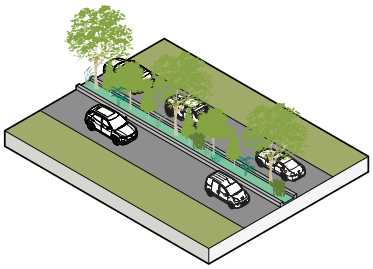
Transit Frequency



Access to Critical Services



Recommended Treatments

	Treatment	Description	Application
01	**Shaded bus shelters / tree canopies** 	Shelters and trees shade passengers waiting for the bus.	Bus stops that lack shelters and/or tree canopy with higher ridership and frequency.
02	**Tree canopies / Water Sensitive Urban Design** 	Planting trees around transit stops and incorporating bioretention basins into the public right-of-way areas.	Bus stops that lack tree canopy with moderate ridership and frequency but provide access to critical services.
03	**Median Vegetation Strip / Green Corridors** 	Creating shaded, green corridors using a combination of trees, bioretention basins, and vegetation at transit stops, rights of way, and medians along pedestrian routes.	Bus stops that lack tree canopy with low ridership and frequency; providing limited access to critical services.

The methodology applied here prioritizes areas of high use and access to services in order to reduce exposure to a greater number of transit riders. However, this is just one framing for prioritization; additional consideration should be given to transit stops that are in more remote locations that may be waiting for long periods of time due to infrequent stops.

Recommended Treatments

Since heat risk is typically uniform across the county, Fresno COG scored and ranked rural transit stops based on level of access to services, ridership, and service frequency. Shelter, shade, and tree canopies are recommended at the following locations, organized by priority.

High Priority Locations

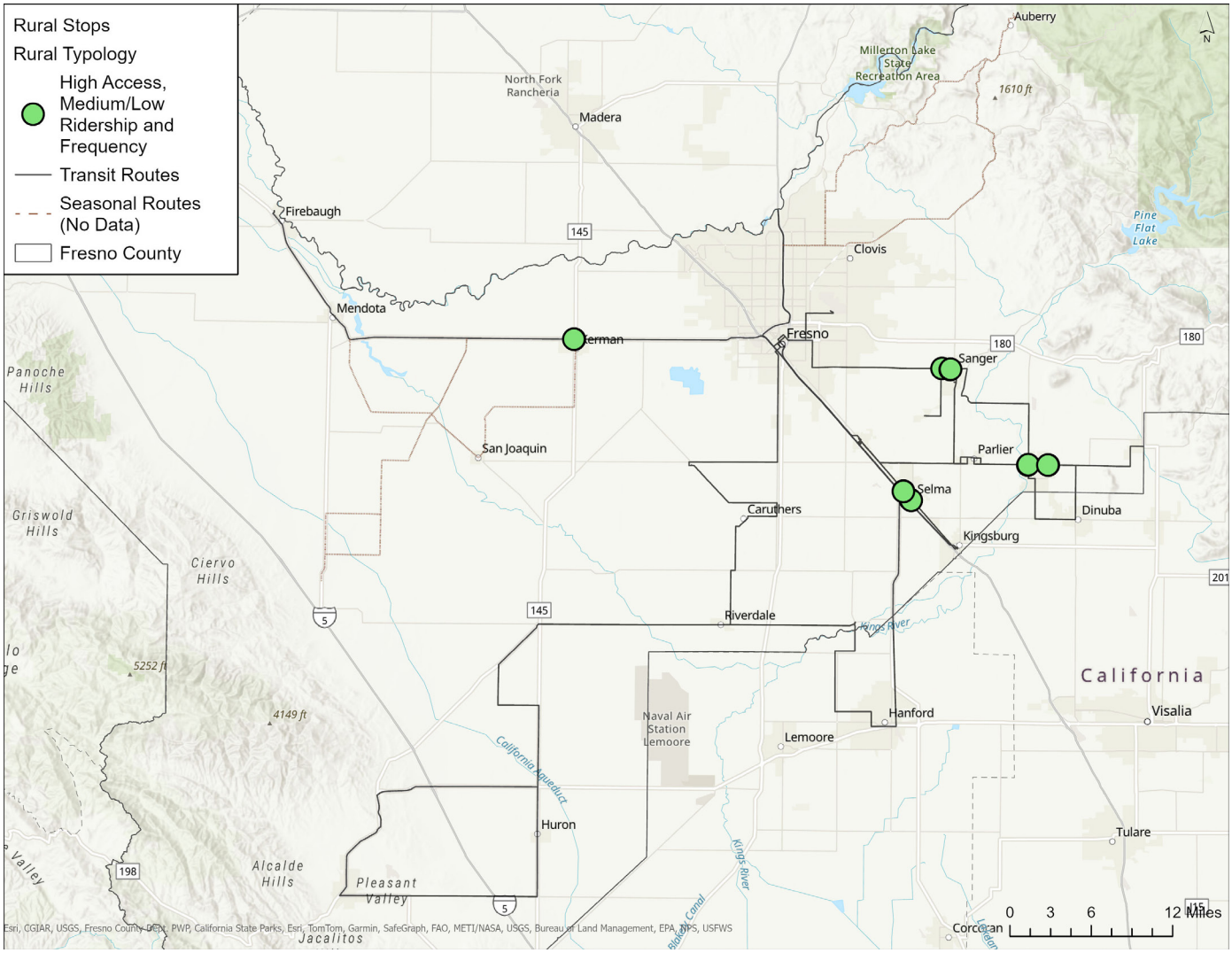
Sanger
- Jensen Ave at S. Bethel Ave
- 7th Street and De Witt Ave

Selma
- Whitson Street

Reedley

Kerman

Routes with the Highest Frequency and Access to Critical Services



*Bus stop IDs/locations are available in Appendix 9

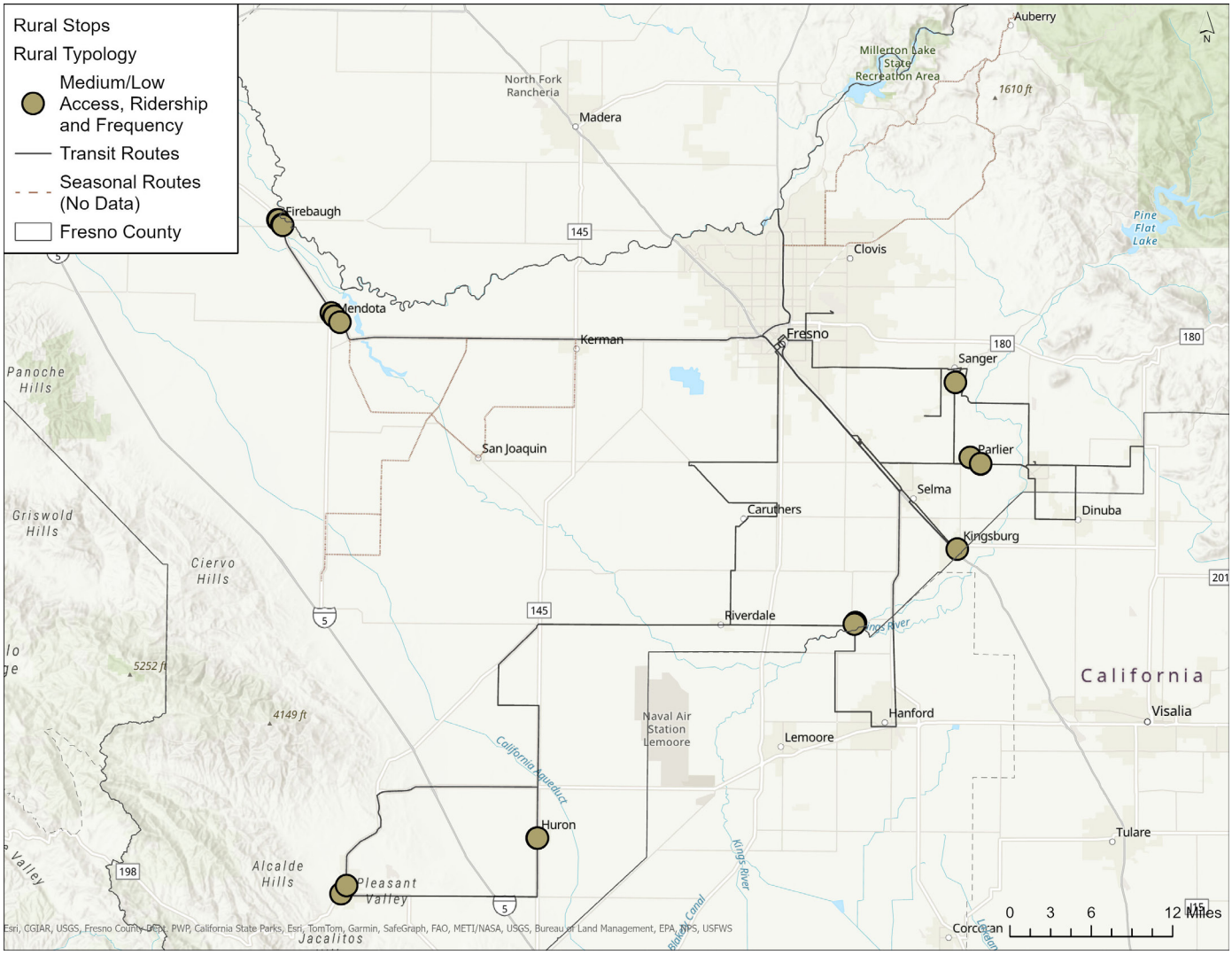
Recommended Treatments

Since heat risk is typically uniform across the county, Fresno COG scored and ranked rural transit stops based on level of access to services, ridership, and service frequency. Shelter, shade, and tree canopies are recommended at the following locations, organized by priority.

Medium Priority Locations

Stops in Firebaugh, Mendota, Kingsburg, Parlier, and Laton

Routes with the Moderate Frequency and Access to Critical Services



*Bus stop IDs/locations are available in Appendix 9

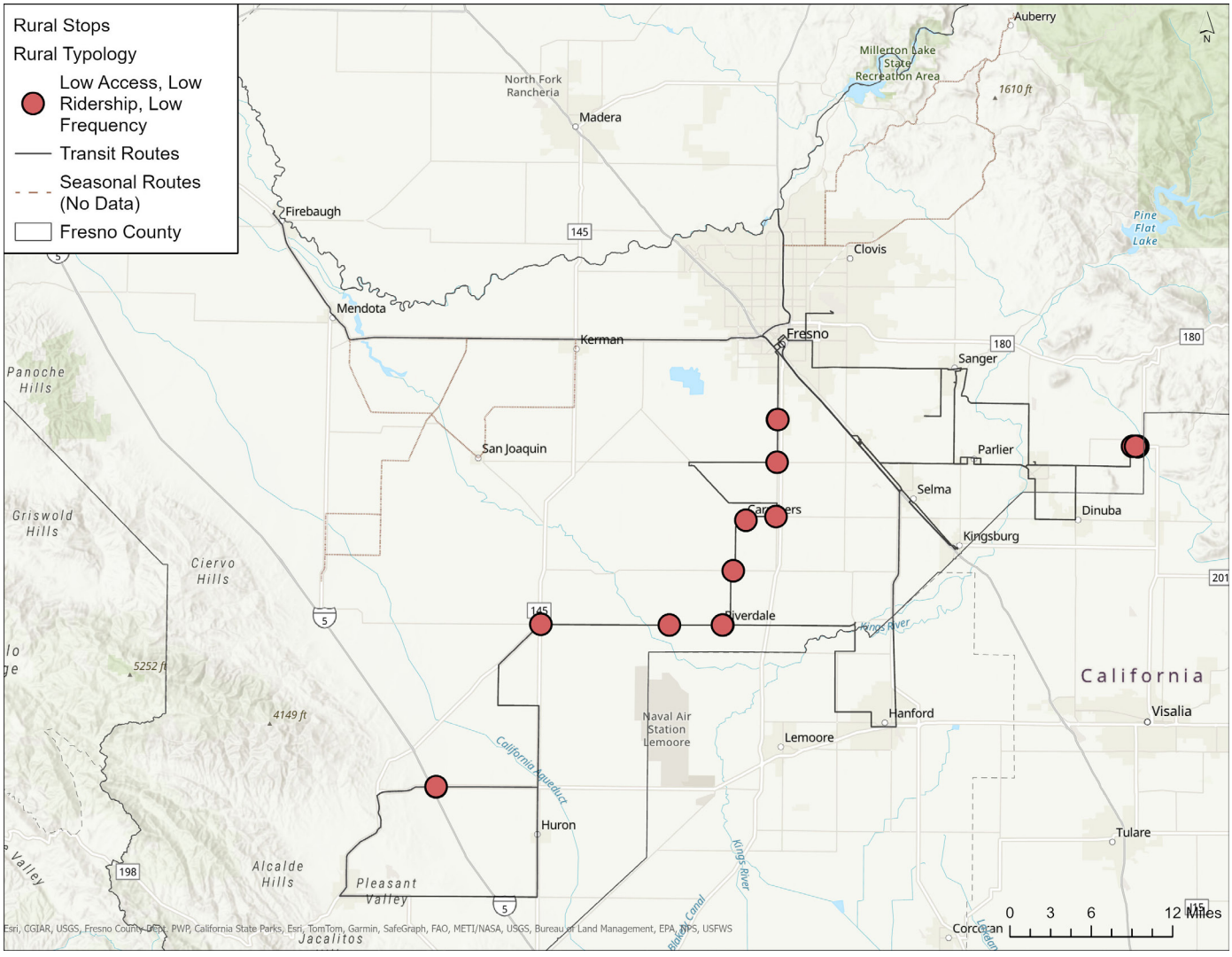
Recommended Treatments

Since heat risk is typically uniform across the county, Fresno COG scored and ranked rural transit stops based on level of access to services, ridership, and service frequency. Shelter, shade, and tree canopies are recommended at the following locations, organized by priority.

Opportunistic/ Longer Term Locations

Stops along Coalinga Intercity Transit

Routes with the Lowest Frequency and Access to Critical Services



Other next steps to support this recommendation include:
Develop a comprehensive inventory of bus shelters to identify candidate locations for future investment.

- Install bus shelters where absent
- Develop a shade tree and landscaping planting plan

*Bus stop IDs/locations are available in Appendix 9

Treatment Co-Benefits

Social / Health

- Provides relief from heat and provides outdoor thermal comfort
- Improves air quality from reduced use of personal vehicles
- Maintains accessibility across Fresno County
- Promotes connectivity
- Serves isolated communities

Environmental

- Reduces greenhouse gas from decreased personal vehicle dependence
- Improves air quality from reduced personal vehicle dependence

Economic

- Maintains public transit related jobs and access to jobs

Treatment Costs

Treatment Type	Cost Range	Assumptions
Shaded Bus Shelters / Tree Canopies	$14k-$30k per bus shelter / transit stop	$12k per bus shelter (direct costs) $8k per bus shelter (indirect costs)
Tree Canopies / Water Sensitive Urban Design	$28k-$60k per transit stop	Estimated area is 1000 LF $24k per transit stop (direct costs) $16k per transit stop (indirect costs)
Median Vegetation Strip / Green Corridors	$71k-$151k per transit stop and surrounding median	Includes one bioswale and median vegetation for 600 ft^2 $61k per transit stop/median (direct costs) $40k per transit stop/median (indirect costs)

* All treatment types include equipment pads and standard bus shelters with benches. Excavation costs not included.

Annual O&M

O&M includes weekly cleaning and incidental repairs, electrical maintenance of air conditioner, and tree and vegetation maintenance. O&M costs range from $2000 to $4000 annually.

Implementation

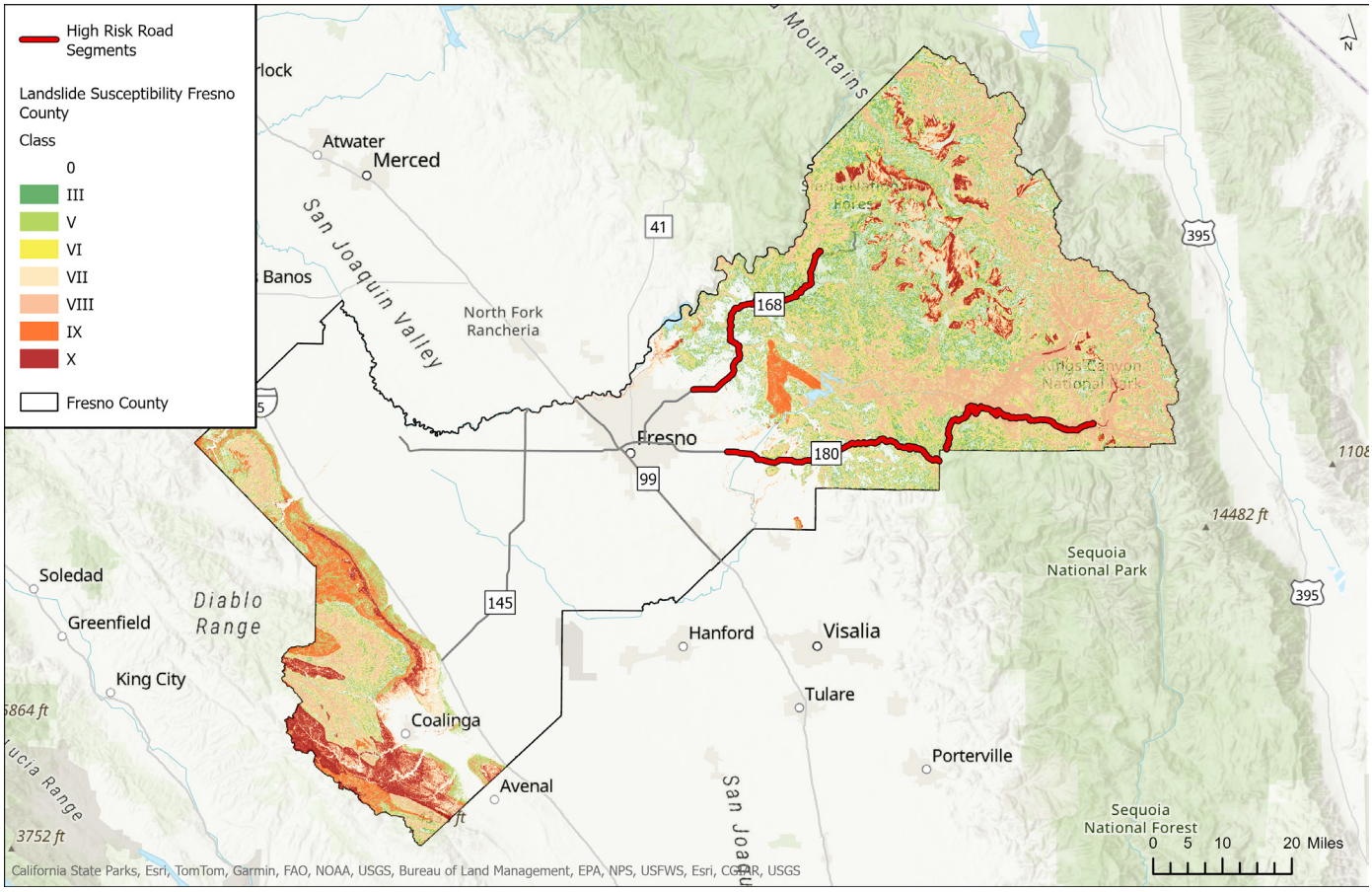
Cost ranges reflect costs for treatment of a single transit stop location. In practice, costs will multiply across prioritized transit stops, phased over time. In the short term, implementing solutions at the 5 high priority transit stops may cost between $70k and $150k for shade and tree canopy improvements. Additional street improvements at all 5 priority stops may cost $140k to $755k in total.

PRIORITY PROJECT 5

MITIGATE LANDSLIDES ALONG STATE ROUTE 169 AND STATE ROUTE 180

What's At Risk

High landslide risk roadside segments identified in Fresno County



Following wildfires, precipitation on burn scars can cause landslides and debris flows. Portions of SR-168 and SR-180 (shown in red) are located in high wildfire risk zones in the mountainous areas that flank the county's east and west side. As a result of combined wildfire risk and slope, these stretches of highway are susceptible to major landslides and slope instability, resulting in road closures and major maintenance needs, cutting off isolated rural communities from basic services. Additionally, disruptions to these roads impact visitors traveling to Kings Canyon National Park, a vital resource for tourism and the local economy.

Priority Project 5 aims to mitigate landslide risk along 112 road miles of SR-168 and SR-180. SR-168 is specifically a priority as it serves as a vital FCRTA transit route serving Auberry and other isolated mountain communities.

ROCK STRENGTH

SLOPE CLASS	1	2	3
1	0	0	0
2	0	V	VII
3	0	V	VII
4	III	VIII	IX
5	VI	IX	X
6	VII	IX	X
7	VIII	IX	X
8	VIII	IX	X

LANDSLIDE SUSCEPTIBILITY CLASSES

(0 III V VI VII VIII IX X → increasing susceptibility)

Potential Impacts

Asset Criticality

SR-169 & SR-180 serve multiple purposes:

Critical emergency access & evacuation routes.

FCRTA Auberry Transit route.

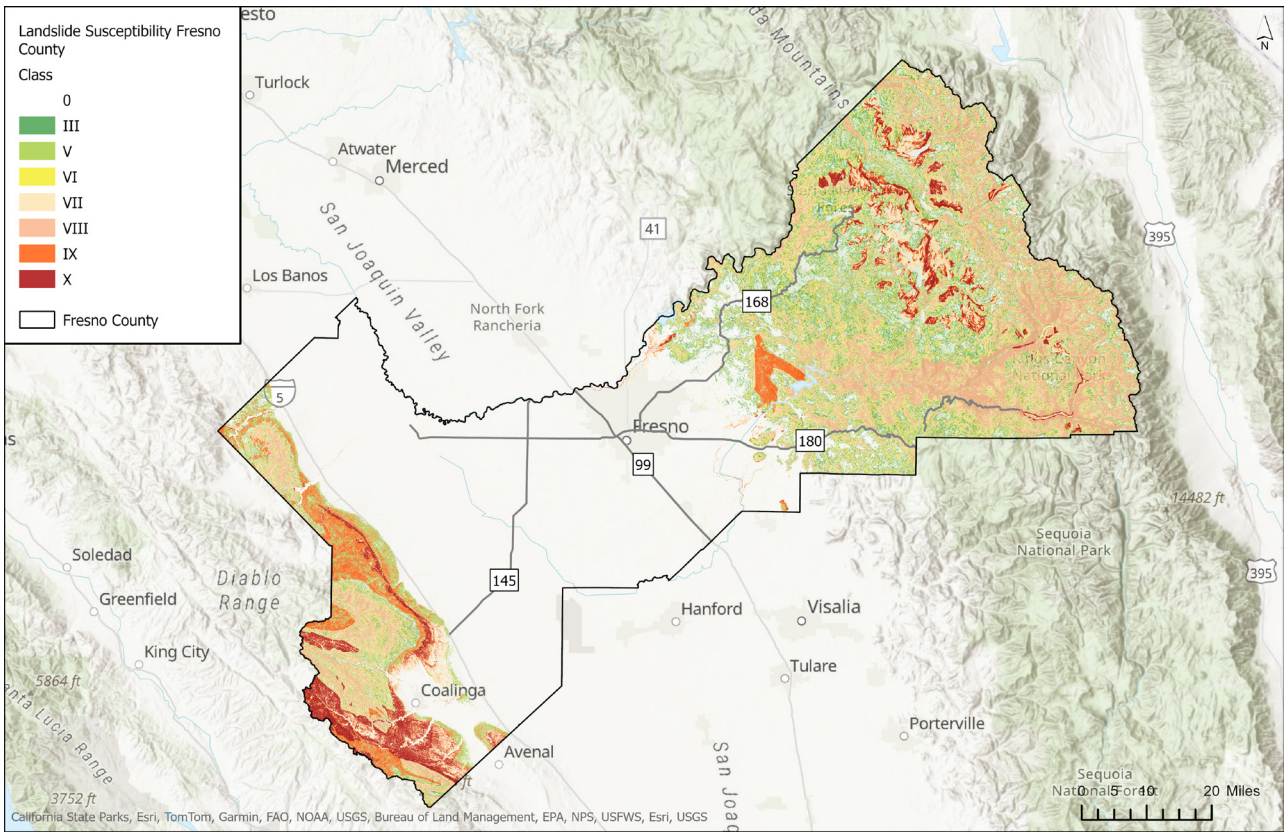
Serves rural, isolated communities and Equity Priority Communities.

Primary access routes to Kings Canyon National Park & Sierra National Forest.

Potential Consequences

Landslide impacts vary depending on severity, described below:

Roads may become inaccessible on the order of weeks to months during repair; past landslide events have led to significant road closures along these routes and even small amounts (e.g., a couple of inches) of soil displacement can cause roads to become impassable.



Fresno County's foothills and mountainous areas have a history of landslides, driven by steep slopes in the Sierra Nevada and erosive soils of the Coast Range. Landslide susceptibility classes can be used as a basis for treatments along high-risk roadway segments. The susceptibility classes indicate areas where landslides are likely to occur based on the locations of past landslides, the location and relative strength of rock units, and the steepness of topographic slope to classify the relative likelihood of deep-seated landsliding (Wilson and Keefer, 1985). Other types of landslides not captured here include events driven by rainfall, earthquakes, and shallow mudslides or debris flows, such as those that follow wildland fires and heavy rain events.

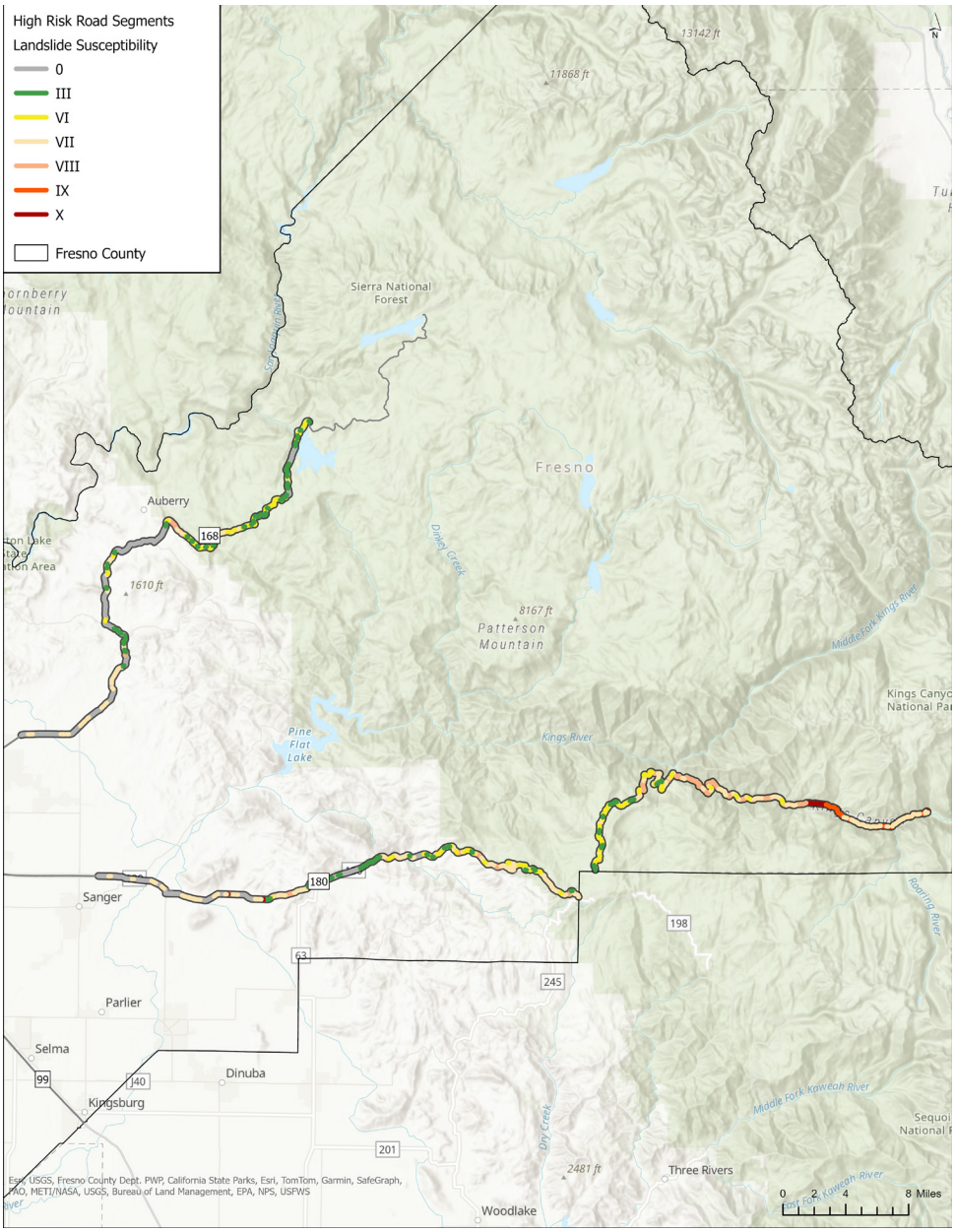
Existing Conditions

Selecting the Appropriate Treatment

Fresno COG identified mountainous segments of SR-168 and SR-180 as high priority due to both landslide susceptibility and other roadway characteristics, including their importance in serving isolated communities. SR-168 serves as a transit route, with Class VIII susceptibility around Auberry. SR-180 includes steep slopes (Class IX and X susceptibility) through Kings Canyon.

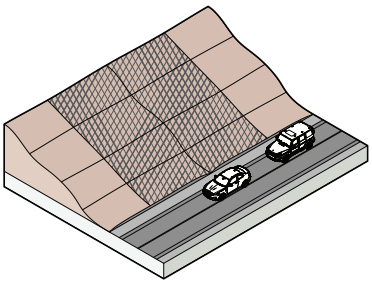
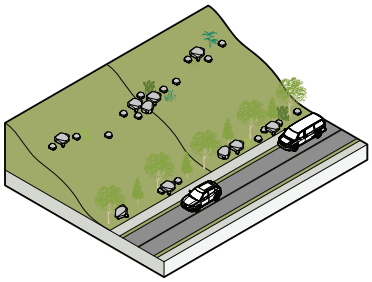
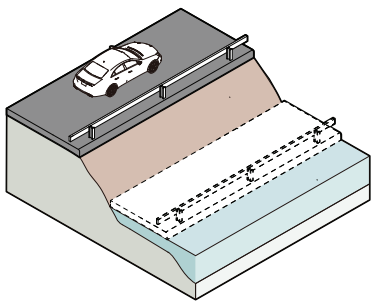
Fresno COG employed the susceptibility classes on the following page to identify the types of suitable mitigation strategies along these priority road segments—for instance, retention measures, like tie backs and rock mesh along steep slopes (especially Classes IX-X) and stabilization measures, like drainage improvements and vegetative controls, along more moderate slopes.

Landslide susceptibility along high landslide risk road segments



Recommended Treatments

Landslide mitigation strategies are based on a variety of factors, including the type of rock present at the slope face, whether the rock has beds (layers) or joints (fractures), the orientation of these features with respect to the slope face, and the position of any road cuts and benches with respect to the slope. The landslide susceptibility categories encompass different types of geology and rock strength that do not map one-to-one with mitigation measures; rather they provide a general framework for assigning appropriate treatments. Fresno COG should apply mitigation strategies in the high landslide susceptibility areas along both of these critical routes. Additionally, Fresno COG can work with Caltrans to monitor high risk landslide areas, including the higher susceptibility segments of the Auberry Transit Line, given its importance for transit-dependent populations.

Treatment	Description	Application
01 **Landalide Retention** 	In-situ stabilization such as rock bolts, rock meshes, and rock catch pits. Taller free-standing rock slopes may be unstable and may require tieback or soil nail walls.	Steep Slopes – Susceptibility Classes VI-X: Landslide susceptibility classes VI-X, such as those along Highway 180 in Kings Canyon.
02 **Erosion Stabilization** 	Vertical/horizontal drains deep within the hill to prevent water buildup in the landslide mass or along the relatively weak failure plane or shear zones; Surficial drainage improvements and vegetation to keep shallow soils in place and prevent formation of slope rills or gullies; or tieback or soil nail walls for taller cut slopes; Appropriate native vegetative cover.	Moderate Slopes – Susceptibility Classes V-X: moderate slopes comprised of soil or weathered rock, such as those along the Highway 168 / Auberry Transit Line.
03 **Realignment** 	Realignment and/or abandonment of current road alignment, with the understanding that the landslide cannot be stopped.	Worst-case scenarios, where maintenance is continuously problematic.

Treatment Co-Benefits

Social / Health

- Promotes connectivity to community services (e.g., healthcare, schools, evacuation)
- Serves isolated communities
- Prioritizes rural areas of Fresno County

Environmental

- Improves water quality from reduced sedimentation
- Enhances or preserves biodiversity

Economic

- Supports continuous access to jobs, tourism, and regional trade routes
- Reduces cost of repair

Treatment Costs

Treatment Type	Cost Range	Assumptions
Landslide Retention	$6.4M-$13.6M per 10,000 ft^2	10,000 ft^2 @ $552/$ft^2$; assumes rock face of 10 ft (direct costs) $350/$ft^2$ (indirect costs)
Erosion Stabilization	$116k-$248k per 10,000 ft^2	10,000 ft^2 @ $10/$ft^2$ (direct costs) $65/$ft^2$ (indirect costs)
Realignment	$15.3M-$33M per mile	$13.3M per mile (direct costs) $8.5M per mile (indirect costs)

Annual O&M

O&M costs for realignment include regular roadway maintenance estimated between $20,000 and $30,000 annually. Erosion stabilization and landslide retention are forms maintenance that may require repeated applications during a 10-15 year design life.

Implementation

In practice, the targeted mitigation areas along 112 road miles will likely vary in size, depending on findings of additional technical studies.

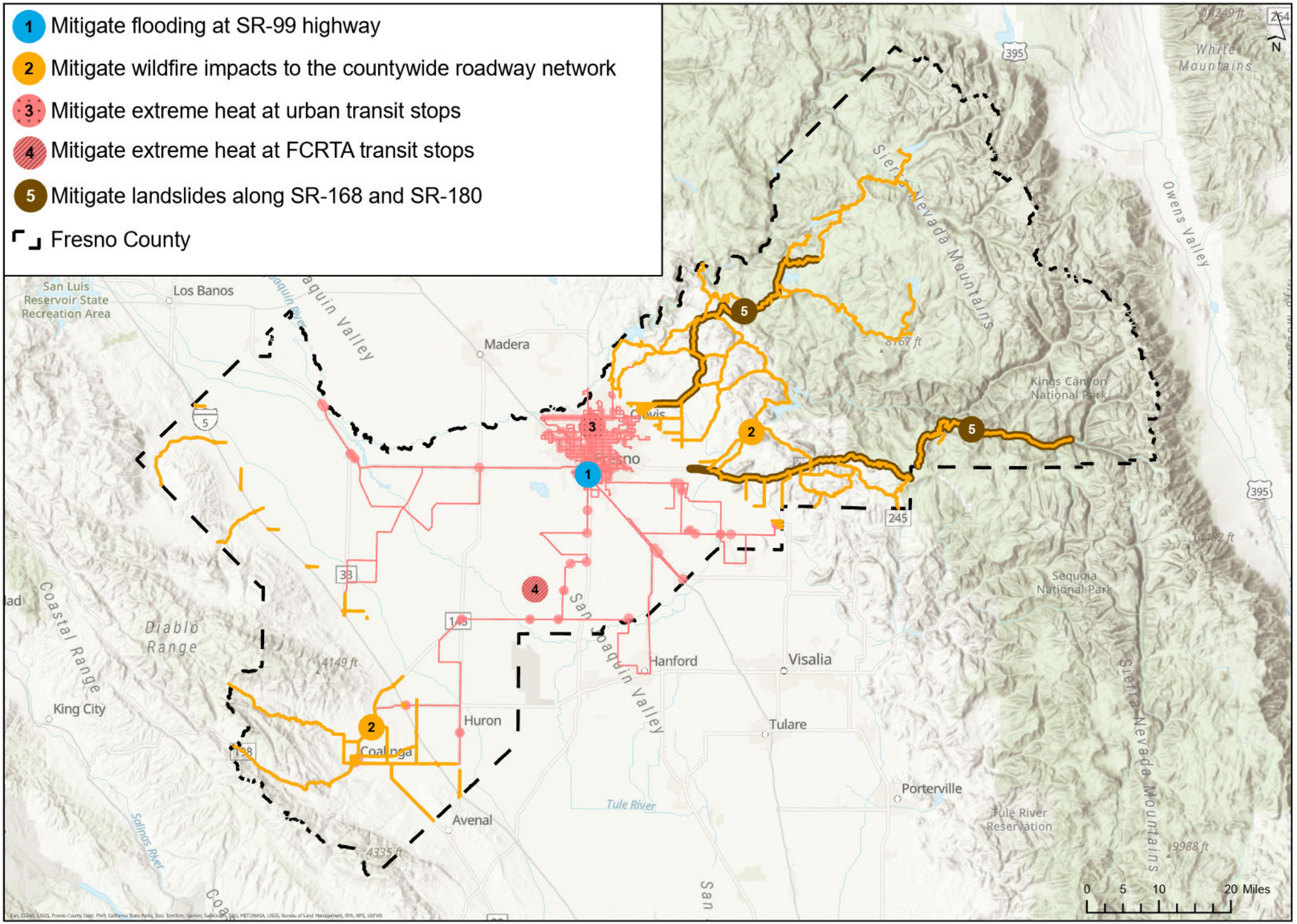
6. Next Steps

The transportation network-wide climate risk assessment and resulting project identification and prioritization marks a significant milestone for Fresno COG, laying the groundwork for a more resilient transportation future. The projects identified here will become candidate projects for the 2026 Regional Transportation Plan/Sustainable Community Strategy. Moving forward, the next steps will focus on securing funding opportunities, fostering partnerships with key stakeholders, and developing detailed implementation strategies for each of the five priority projects. Continued collaboration with local communities, agencies, and policymakers will be essential to ensure these initiatives effectively enhance the county's resilience to climate change. Adaptation and resilience projects should be conceptualized and designed so that they align with – and don't unintentionally conflict with – important local goals such as sustainability, walkability, connectivity, accessibility, and economic development. By advancing these projects, the region takes a critical step toward protecting its natural and built environments while promoting long-term economic and social sustainability.

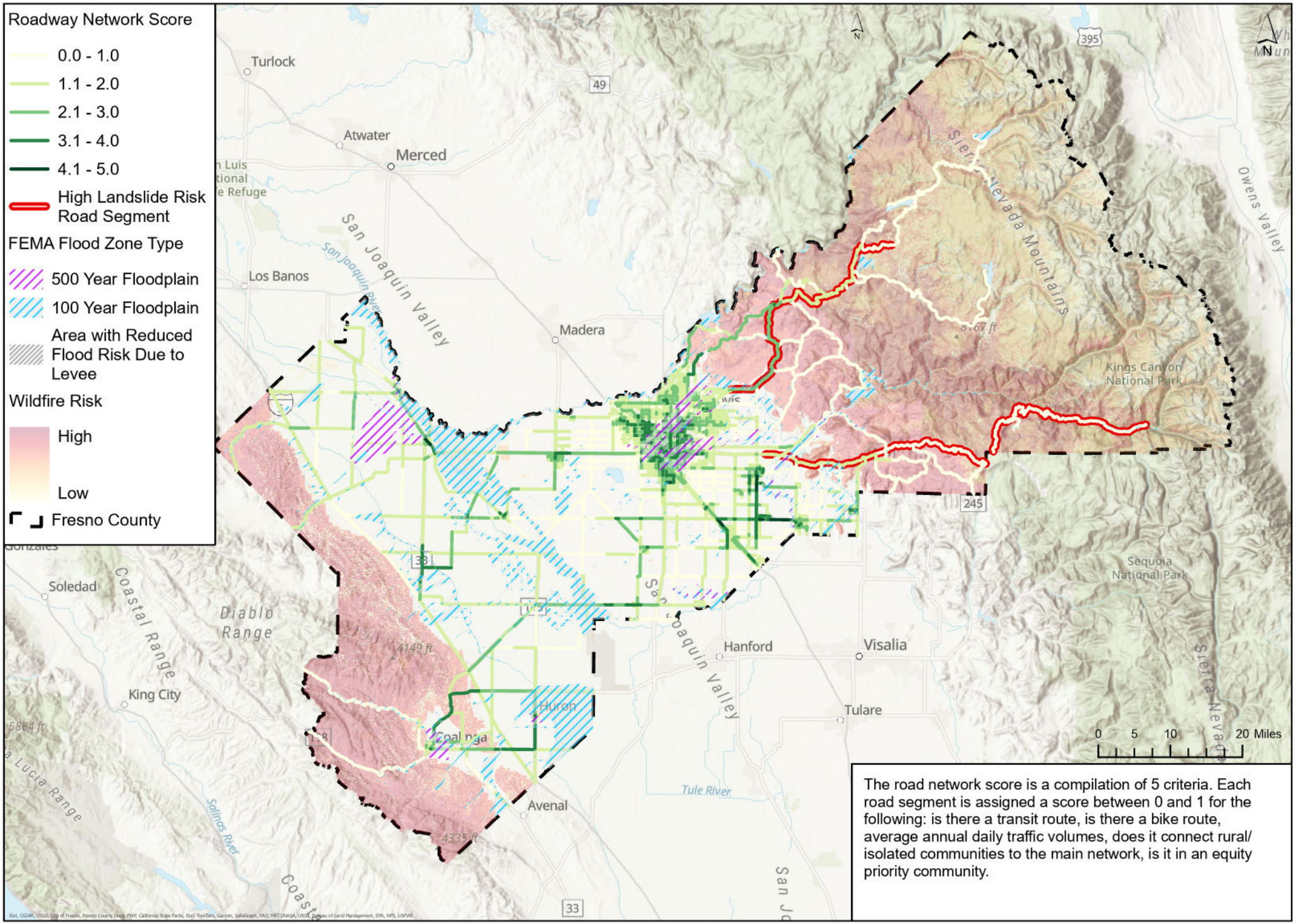
Appendices

A.1 Maps of Priority Projects and Climate Hazards

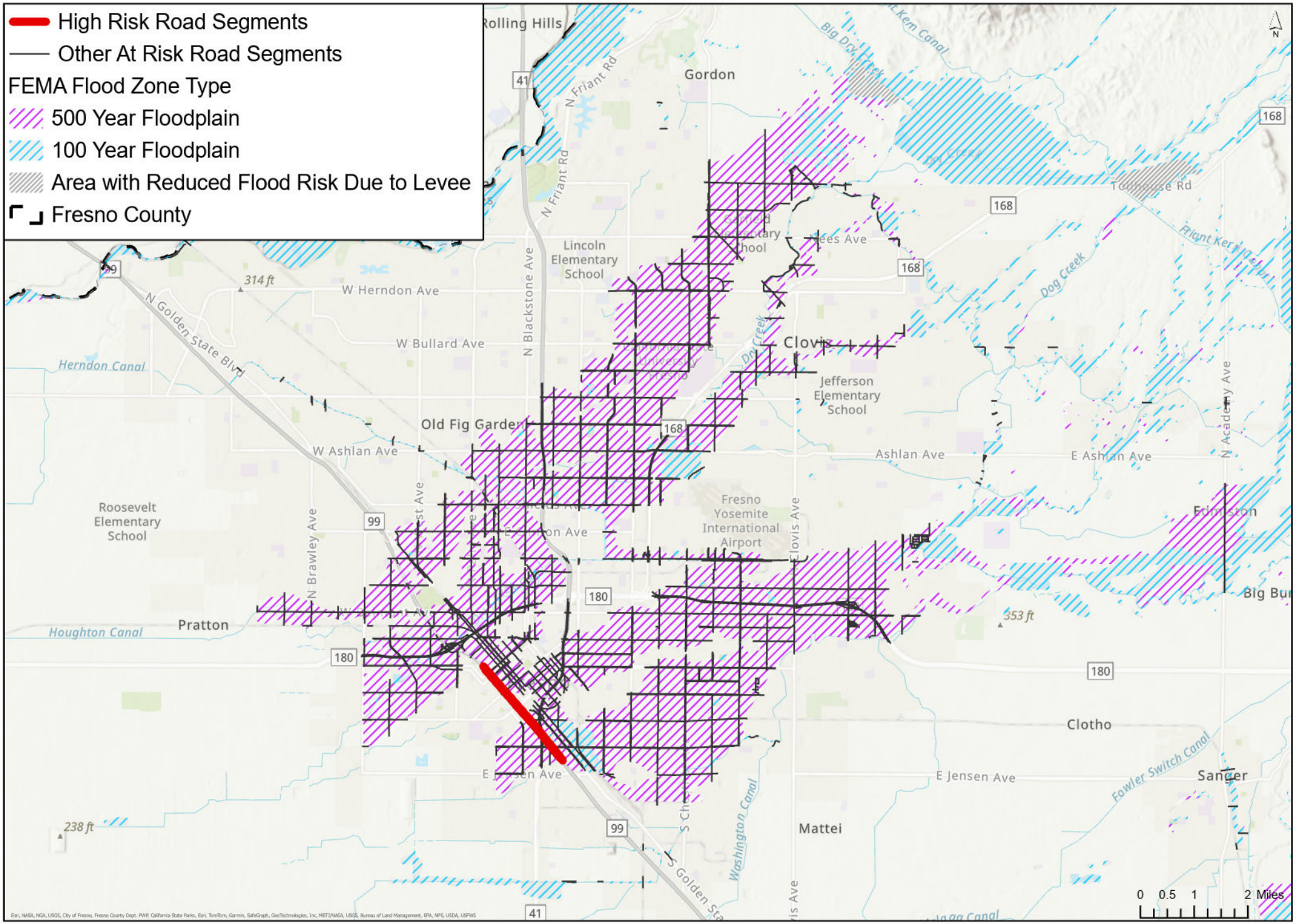
Priority Projects



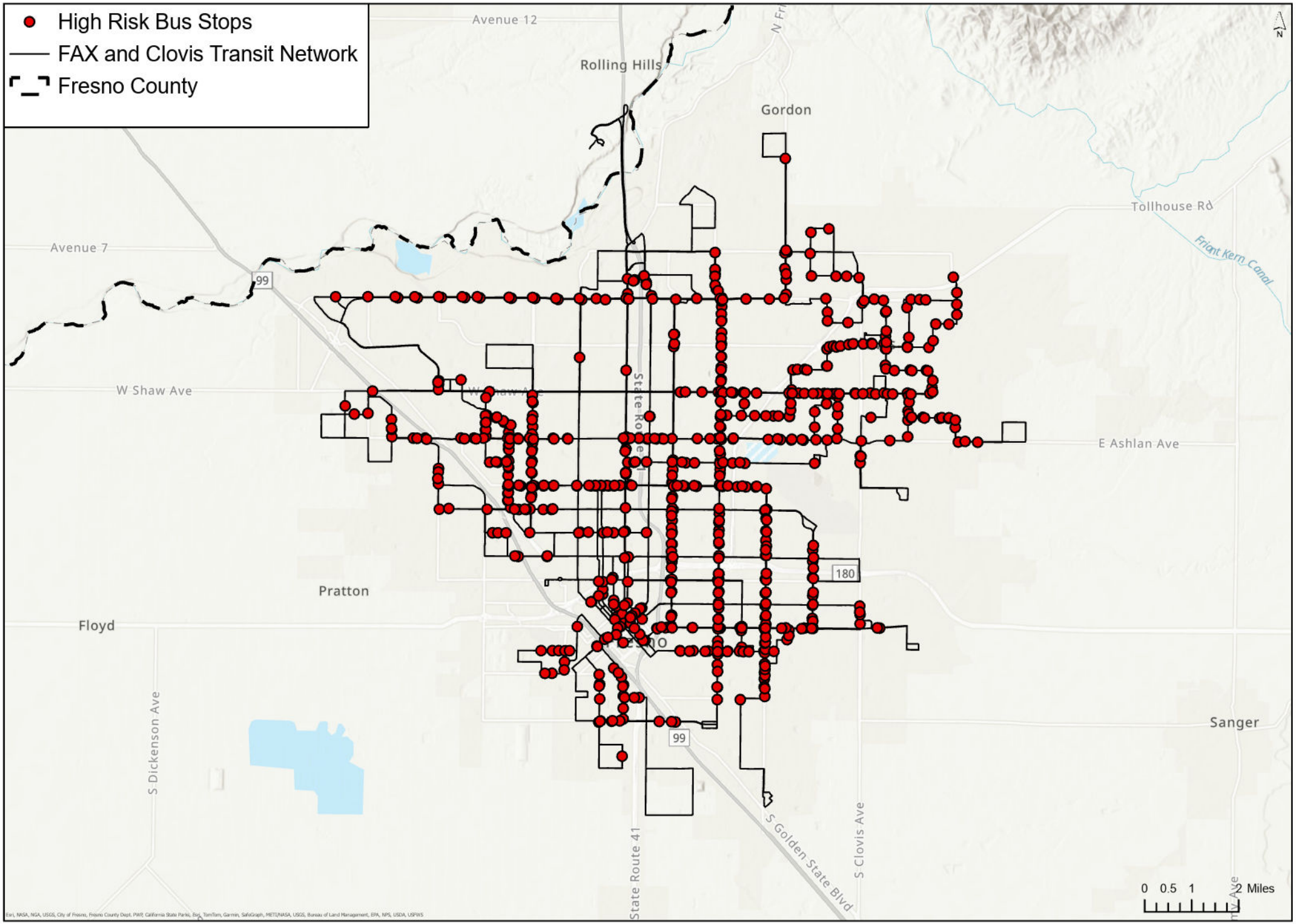
Hazard Impacts to Road Network



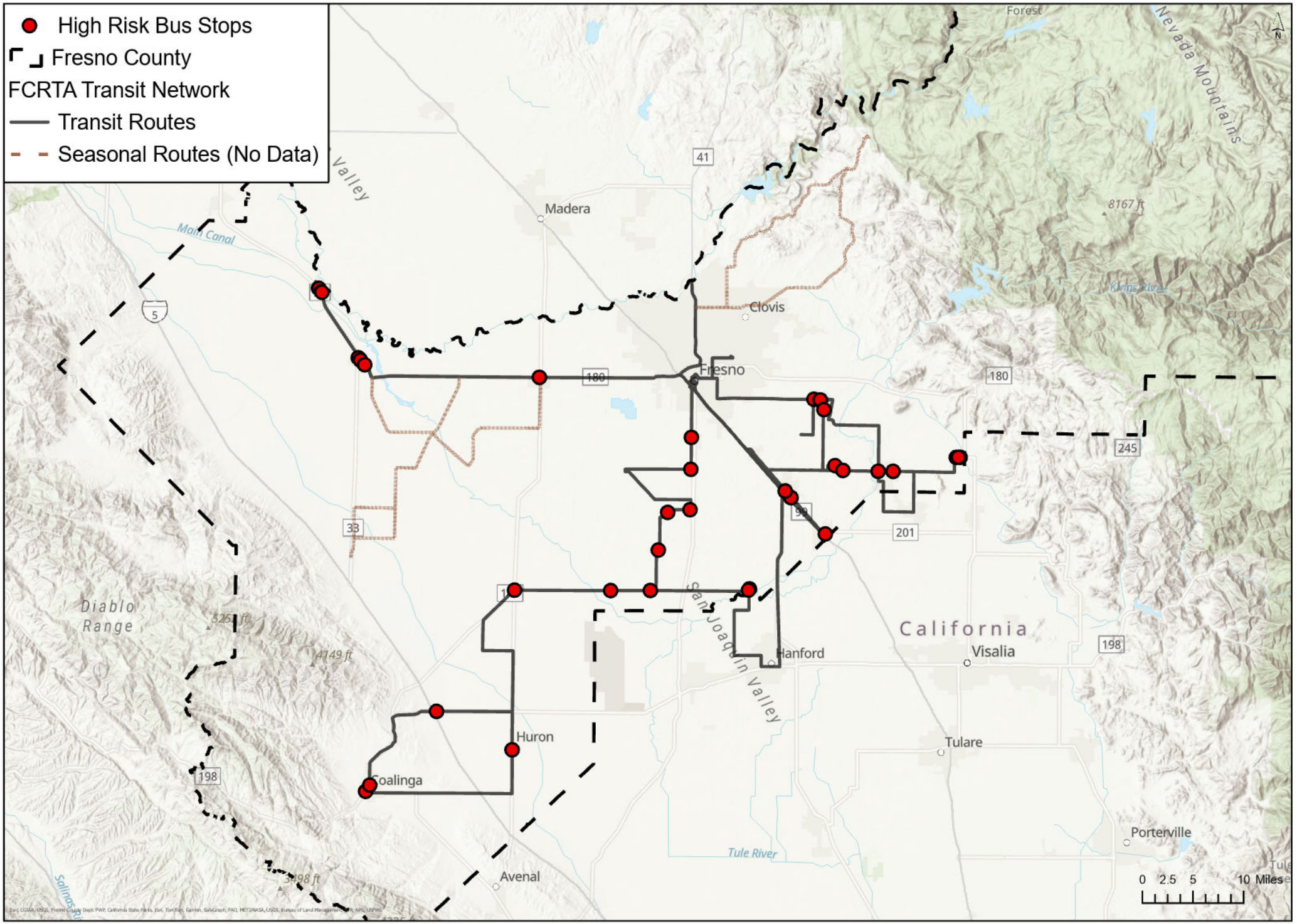
High Risk Urban Flooding in Fresno/Clovis



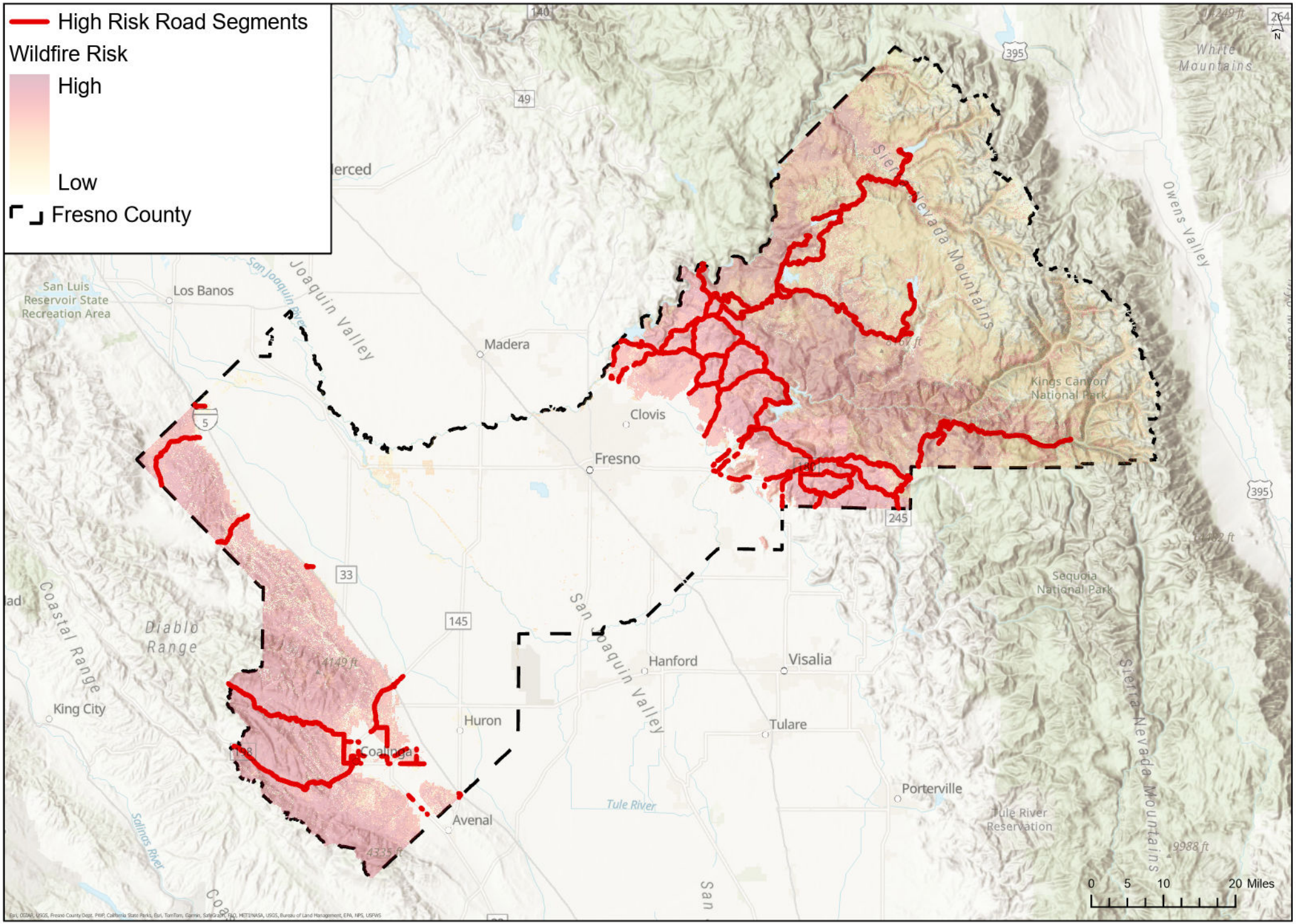
Urban Extreme Heat Impacts to Transit Network



Rural Extreme Heat Impacts to Transit Network



County-wide Wildfire Impacts to Road Network



Landslide Impacts to Road Network