Broadband Strategic Plan

Merced County, CA

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Magellan

An ENTRUST Solutions Group Company

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Executive Summary

Merced County has substantial gaps in broadband infrastructure and services. Costs are relatively high, and options are limited to one or two wireline providers. Few areas have fiber-based service available. Several parts of the County, particularly smaller, more rural communities like Dos Palos and Snelling have no options for broadband that meets California state standards.

Broadband—high-speed, always-on internet access—is almost essential for living in today's digital world. But it is just the tip of the technological iceberg. Ultra-fast, reliable connections are necessary for modern business and industry, particularly the types of industry Merced hopes to attract. The optical fiber infrastructure that is required for delivering broadband (even copper-based access from cable and digital subscriber line (DSL) requires fiber as core feeder network) also enables everything from narrowband utility applications through traffic management systems to next generation 5G wireless. More fundamentally, access to education, healthcare, and job opportunities depend on broadband.

Merced and the entire Central Valley region need a huge investment in network infrastructure to stay competitive, let alone leap ahead. The general reason the county is in this situation is because broadband and other network planning has traditionally been left to the private sector. Consequently, they have invested to maximize profits for giant corporations based far from the Central Valley and to shut out any and all competitors. The big internet service providers (ISPs) do not want competition even in areas they will not provide with advanced services.

To address these issues, the County of Merced, in partnership with the City of Merced, engaged Magellan to develop a countywide broadband master plan. The planning process involved analysis of the full range of network assets, relevant policies, and available services. A community survey that included a built-in internet speed test garnered 465 responses. Representatives of 40 local organizations provided input via focus groups and interviews. Based on these inputs, we developed a conceptual network design to evaluate Merced's readiness for broadband investment and the scale of investment required.

A fiber backbone to fully meet all stakeholders' key goals and needs, particularly the development and operational goals for the County of Merced, would run for 347.7 route miles and cost approximately $66.6M to construct. This capitalizes on the State of California's developing Middle-Mile Broadband Infrastructure (MMBI) and network assets owned by the City of Merced. This infrastructure could directly serve 23.5K of the 71.4K premises in the county. Additional investment of approximately

$3K per premise, or $144M, would be required to extend fiber to all premises. Approximately another $107M would be needed to actually connect and serve all locations. Universal fiber-to-the-premise for all of Merced County would be about a $320M endeavor.

There are numerous tactics the County of Merced and its cities can use to attract investment and reduce build out costs. Incorporate network infrastructure into public capital improvements, planning and permitting. Connect other public infrastructure such as streetlights, which can host radio access network antenna cells for wireless broadband. Condition developments with broadband infrastructure. Capitalize on all existing infrastructure, including fiber owned by special districts. Aggregate demand of community anchor industries and institutions to leverage—and reduce—their telecom spending. If done methodically and opportunistically these tactics can easily cut costs in half. Other tactics such as "Dig Once" ordinances and wireless master license agreements reduce costs further, facilitate broadband development, and attract private investment.

While fiber is the foundation and "gold standard" for broadband, it is not the only option. Indeed, most people access the net via wireless, which costs a fraction of fiber to deploy. There are also numerous business and funding options for developing broadband. The federal and state governments have allocated billions of dollars for broadband development over the next three years. Merced County has joined with other rural counties under the Golden State Connect Authority which is working with open-access fiber network operator UTOPIA to ensure everyone has access. There are a number of local public financing options. And there are multiple private network service companies willing to invest in areas like Merced.

The County of Merced has a prime opportunity to act as a catalyst and guide for broadband development. Magellan recommends the County establish a broadband committee of community anchors, particularly municipalities, school, and special districts, etc., for this purpose. Take a leadership position with GSCA and UTOPIA evolve and implement this plan. Support development of last mile infrastructure. Implement smart policies and programs to encourage broadband development. Capitalize on all relevant capital projects, particularly MMBI. Focus local public investment on connecting government site and economic development areas while reaching into agricultural areas. Target network service providers as economic development prospects with incentives and programs. Directly invest where necessary to achieve public priorities. All of these recommendations are detailed and supported by this plan, which can serve as a roadmap for broadband development across Merced County.

1. Introduction

The County of Merced contracted with Magellan to develop a network infrastructure roadmap. This memo focuses on the County's assets. Many County assets can benefit from being connected to network infrastructure. Buildings and other work sites need connections for people to access the internet and other digital information systems, generally referred to as local area and wide area networks (LAN/WAN), servers, web sites (or just sites), and "the cloud," which is simply processing and storage on many servers across the internet.

In addition, public agencies can utilize private broadband assets through innovative public-private partnerships, which minimizes costs and avoids overbuilding existing infrastructure. These assets include not only fiber optic cable, but also coaxial cable, towers, poles, antennas, and existing retail network and subscriber services. Magellan's preliminary conclusion is that the County has a clear need for additional assets and identify some implications of the findings. Generally, additional assets are needed to integrate existing assets into a network infrastructure capable of providing services to and via other parties.

Additionally, while there appear to be available and relatively affordable retail internet services within some of the metro areas of Merced County, other urban and rural areas of the County have been divided between several carriers, resulting in a disjointed coverage, and varying in pricing, speeds, and services between communities. There is minimal fiber optic cable (privately owned) deployed throughout the county, and only along the Highway 99 corridor.

Although there are 5 different internet service providers that purport to serve the Merced County market, a randomized check of various residential addresses identified numerous locations where none of the 5 ISPs offered service. We find that as evidence of significant areas of un- and under-served populations throughout the County. Their lack of connectivity and insufficient data speeds are likely causing these communities to become increasingly marginalized in the digital economy. Some basic concepts and information about broadband are important for understanding why this is the case and how to move forward.

BROADBAND BASICS

Broadband is essentially a type of network access. It is only one piece of the network infrastructure, illustrated in Figure 1, required to fully connect communities. Networks consists of fiber-optic cable, laid out in rings, interconnected by network service providers' central offices (CO), exchange points,

and similar facilities, connecting cell sites, Wi-Fi access points, and other access infrastructure, and ultimately terminating in commercial, industrial, institutional, and residential premises. Traditionally, this infrastructure is deployed based on profits. Investment focused on relatively affluent, moderately densely populated areas because those areas provided most revenue at the lowest costs. Consequently, disadvantaged people have less access than those with disposable income, stable families and jobs, and other valuable assets.

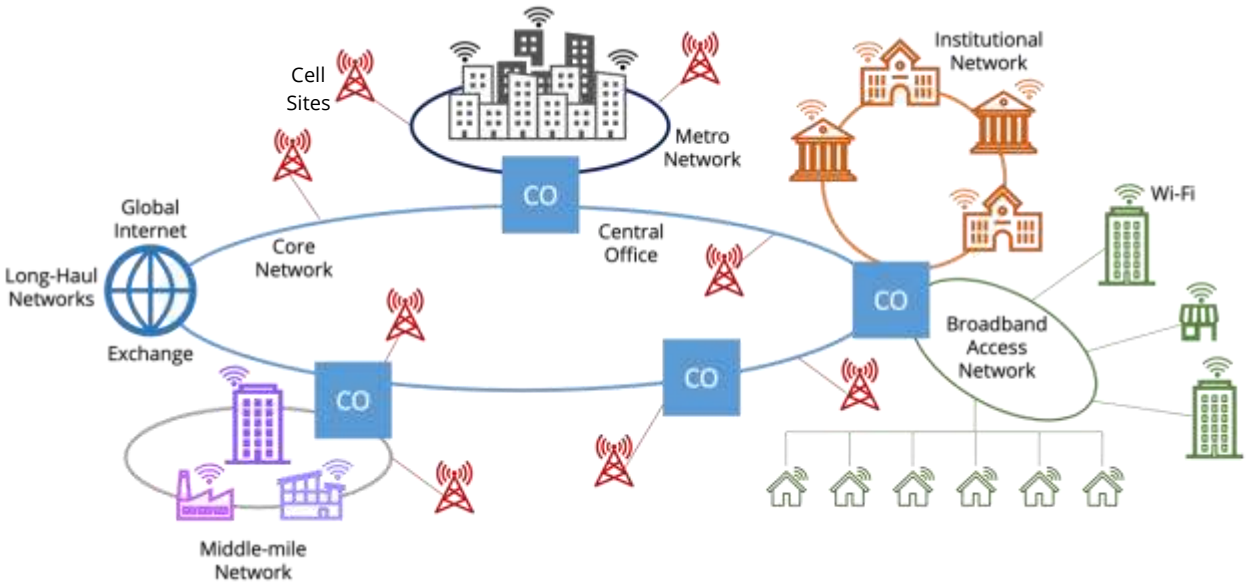

Figure 1. How network infrastructure connects communities

The challenge is to drive network capacity and access infrastructure deeper and more broadly into Merced County. Everyone in the area should have basic access but the overall goal should be to attract investment in next generation infrastructure. This technology is constantly evolving. Current fiber-based "gig-speed" access is the current gold standard but that will soon be surpassed by faster, more flexible network services. How can Merced County get advanced network infrastructure but also continuously refresh it to provide its businesses, institutions, and residents world-class network services? How can it capitalize on those services to develop and maintain an open, inclusive local economy? It starts with a basic understanding of network infrastructure.

Networks as Links and Nodes

Network systems generally consist of links and nodes. Some nodes are internal to the network, owned, operated, and maintained by network service providers to aggregate and route data traffic, manage links and other nodes, and provide

services. Data centers, for example, are nodes, as are providers' central offices and head-end facilities. Most nodes, however, are customer devices and premises—which can have numerous nodes within them—at the network's edge. Typically, all the nodes within a network are represented by a cloud, as in Figure 2. While this diagram is intended to represent physical network assets, it also represents the ties between people and places that networks enable.

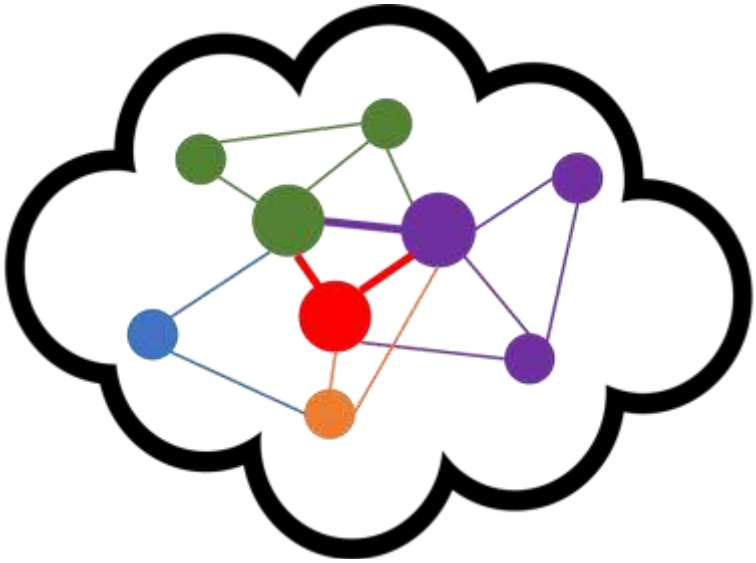

Figure 2. A network "cloud" consists of many nodes and links.

Think of the "cloud" in this diagram as your community. The circles as community members, local businesses, or municipal assets. Today, those social and economic connections are supported by physical network connections between various facilities with specific functions as nodes:

- ***Cells*** are wireless nodes on a radio access network (RAN) that are interconnected to other cells, typically via fiber, to connect end-user devices within a specific geographic area.
- ***Central offices*** (telco) ***and head-ends*** (cable company) are where traffic to and from customers on local network infrastructure is aggregated and routed, as appropriate, to the core network/inter-office backbone.
- ***Collocation facilities*** are interconnection points, housing equipment for multiple network service providers and other information services companies.
- ***Data centers*** house large numbers of computers and other devices for processing and storing data, typically referred to as "hosting" applications and services.

- ***Exchanges or internet exchanges*** are collocation facilities specifically for routing Internet Protocol traffic between major—Tier 1—networks on an equal basis, which is called "peering."
- ***Points-of-presence*** (PoP) are simply where a network can be accessed and/or connects to another network. A PoP can either be in a major node, interconnecting two large providers, or in a small, neighborhood node, connecting multiple subscribers to a providers' fiber-based feeder network.

The important aspects of the network "cloud" for practical purposes are (a) nodes are interconnected (b) in a hierarchy, with some having greater capacity than others, and (c) all of this is invisible to customers. Indeed, many different companies may own nodes and links within a network, as represented by different colors in Figure 2. End users don't see this complexity, they simply get data, images, sound, and text on their devices.

The links that connect nodes—also called "circuits" or just "connections"—can be various media, including copper cable or wire, optical fiber, or radio spectrum. Signals travel across these media at various frequencies or in channels. Generally, the broader the range of frequencies used for a connection, the more information a channel or link can carry. Thus, a link with many channels, each using a broad set of frequencies, has much more capacity than a link with a few or one channel using a narrow set of frequencies. The former is literally "broadband," and the latter defines narrowband, which is widely used for telemetry, monitoring and control.

As shown in Figure 3, this allows for many different types of connections that flexibly interconnect end nodes. All of this is enabled by *protocols* and services. Protocols define how nodes are identified (i.e., addresses and numbering), links established, and data routed across links to nodes. The Internet Protocol, or IP, is possibly the most recognized protocol, but there are many others including 5G and LTE, Ethernet, and passive optical network (PON).

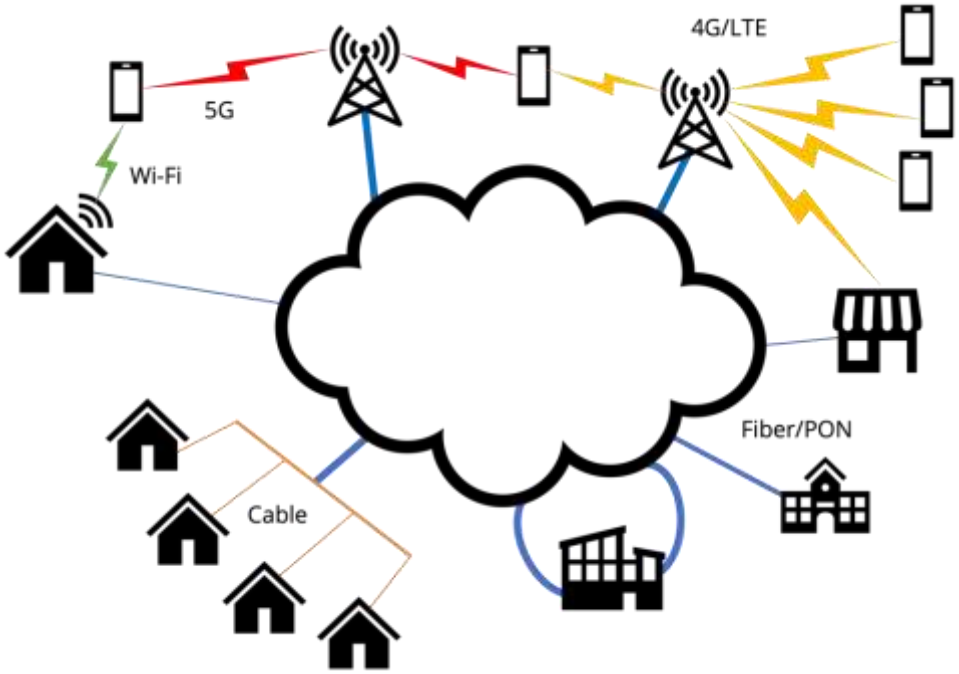

Figure 3. Networks use various access media for services that connect customers.

All of this makes up the infrastructure for network services, which applications for specific purposes—consumer apps like Facebook, TikTok, and Twitter, enterprise information systems, as well as "old-fashioned" telephone calling and cable TV. The key thing to understand is that providers can and do use many different infrastructure components to provide services. Some providers focus on infrastructure, and want to own as much as possible, others prefer to lease infrastructure from others.

BUILDING BETTER BROADBAND

This report is structured as a recipe, starting with available ingredients and issues to address, which can be seen as the gap to close. Solutions can be very low-cost. Changes in policies and procedures can effectively catalyze broadband development. Closing the gap can reduce costs. Core functions of Merced County and government agencies depend on connectivity, which creates substantial costs for them. Direct public investment can enable service improvements and transform operations. State and federal funds are available for this purpose, but private investment is also essential to achieving the vision. Just as the infrastructure is critical to Merced County, it is also valuable to businesses and institutions, which may pay to use it.

Broadband can be an economic development initiative targeting network service providers. Network infrastructure can be developed in the same manner as an

industrial park. Some minor changes in city programs could have significant results. Major results will require additional capacity focused on developing and leveraging network assets for the community. All the ingredients—tactics—specifically prospective fiber routes, are included along with phasing and preparation recommendations and implementation guidelines.

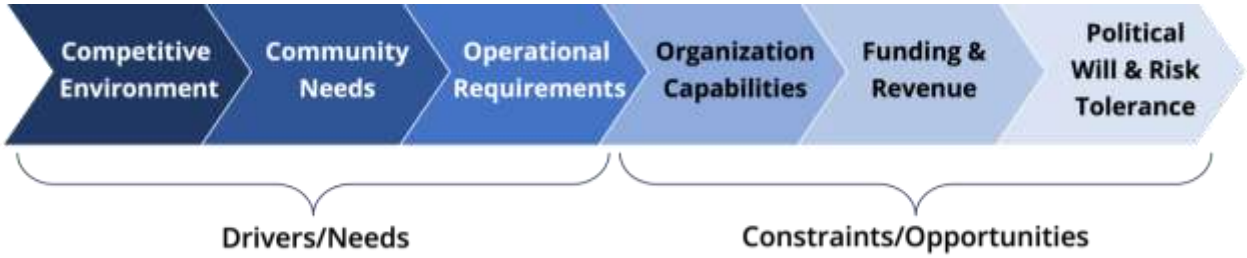

Figure 4. The key factors in broadband development

This report describes the competitive environment, key stakeholders' needs, and operational requirements to identify geographic areas under-served by broadband. We use input from providers to assess capabilities to deliver network services for agribusiness. All of this depends on finances and leadership. Even though the cost of network infrastructure pales in comparison to other infrastructure they can still be substantial.

Public-private collaboration seems necessary to fill in Merced County's broadband gaps. Therefore, an approach to acquiring and governing public broadband investment is also a major component of this report. The goal is to ensure robust, varied options for agribusinesses and their rural neighbors. The content of this report can be used to support grant applications in conjunction with private partners.

2. Asset Inventory

Magellan gathered data from the County of Merced and the City of Merced about its assets. Additional data was acquired or directly generated. Information was captured in geographic information system (GIS), spreadsheets, and other forms. We also researched private infrastructure via providers' websites and third-party sources. The data were analyzed to determine the attributes, geographic location, and quantity of assets.

The asset analysis considered City-owned fiber optic cables that could be utilized through a public-public partnership; underground vaults, handholes, pull boxes, and conduit; and the relative location and possible integration of all County-owned facilities, buildings, and sites for future connectivity.

County or other public-owned assets can be used to enhance broadband connectivity or leveraged to encourage private broadband investment. Buildings, poles, and towers can support antenna; conduit and utility poles can hold fiber-optic cable as it runs along streets and roads. The public easements or rights-of-way (RoW) along those roads may be the most valuable assets, along with other public property. Capital improvement projects are opportunities to economically deploy more broadband assets at a fractional cost.

Other agencies and districts' assets can be coordinated and shared to improve public services through improved broadband access. New California state investments in broadband can be leveraged at the local level by cities, counties, and service districts, and integrated with existing public fiber networks in new public-private partnerships that provide retail internet and data services, helping to close the Digital Divide. Incorporating public assets can make widespread access to broadband more feasible by accommodating new broadband infrastructure and reducing costs.

COUNTY SITES AND FACILITIES

There are 233 sites that were identified by the County for connectivity through a potential county-wide network, largely falling into the categories shown in Table 1. 227 of the sites are County-owned facilities; the six City Halls for each of the County's incorporated cities (Atwater, Dos Palos, Gustine, Livingston, Los Banos, and Merced) are included within the 15 Administration sites. No information was provided as to current connectivity, costs, or speeds.

Table 1. County of Merced facilities to be connected

Use Type	Number
Administration	15
Sheriff	7
Fire	19
Courts	10
Health & Social Services	7
Public Works	5
Warehouse/Storage	2
Airport	105
County Services	3
Library	18
Community Center	21
Event/Entertainment	2
Park	17
Vacant	0
Other	2
Total Sites	**233**

The County-owned sites have a wide geographic dispersal but are generally aggregated along the Highway 99 corridor or within populated cities and/or census-designated places.

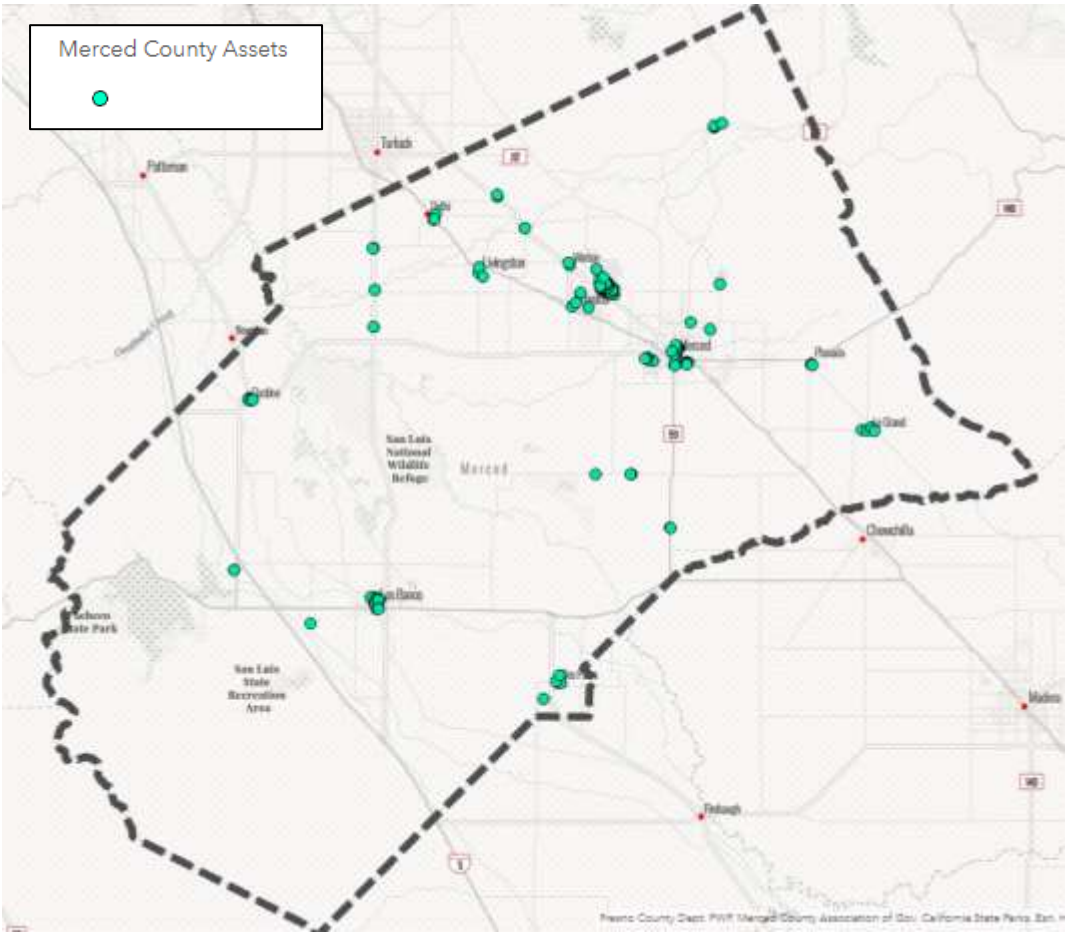

Figure 5. County sites requiring broadband connectivity

Most sites (105) fall within the relatively small geographic area of Castle Airport, comprised of County-owned buildings and assets within the airport grounds. These are anticipated to be sites of future commercial and economic development for rail and air logistics. Having high-speed fiber connectivity will ensure these sites are attractive for businesses looking to relocate or expand operations or other economic development opportunities.

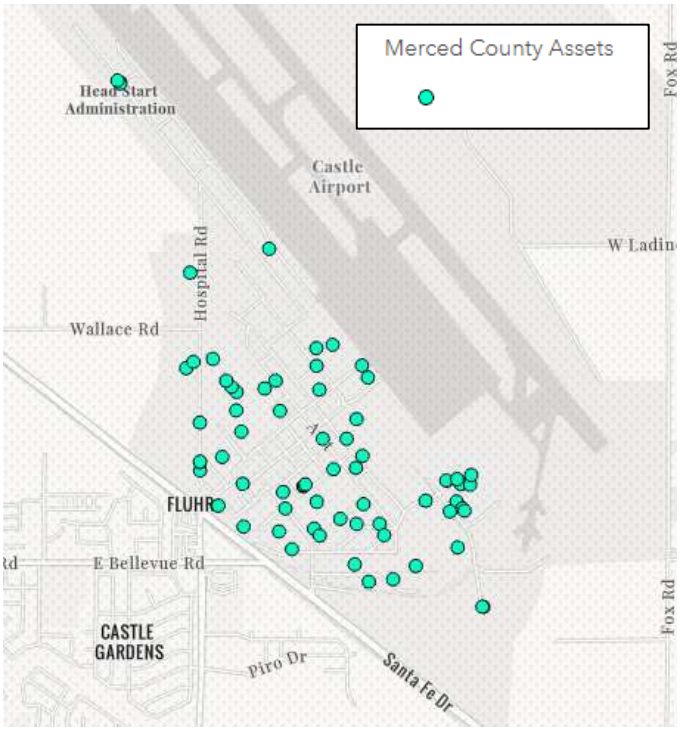

Figure 6. County-owned facilities within the Castle Airport area

FIBER OPTIC CABLE AND CONDUIT

The County of Merced does not own fiber optic cables or conduit networks that can be utilized or leveraged to improve broadband services and technology. The City of Merced does own and manage some fiber and conduit, primarily within City limits and along some corridors that host critical County facilities. A partnership with the City could utilize these fibers through a dark fiber lease and/or conduit occupancy agreement. The City fiber routes have capacity available. Older multi-mode fiber and low-strand-count cables can be removed and replaced at a fraction of the cost to build out new fiber routes.

The City of Merced owns approximately 10.8 miles of fiber optic cable located in five (5) disconnected segments, primarily within Downtown Merced along the Highway 99 corridor. One of those segments, accounting for 14% of the total, is an older multi-mode fiber cable that would need to be pulled out and replaced for future/expanded use through a County-City partnership (at nominal cost). In addition, the City also owns nearly four (4) additional miles of conduit, broken up between five (5) segments. These conduit segments extend to some outlying areas of the City and could be used to install new high-strand count cable for future use at minimal cost.

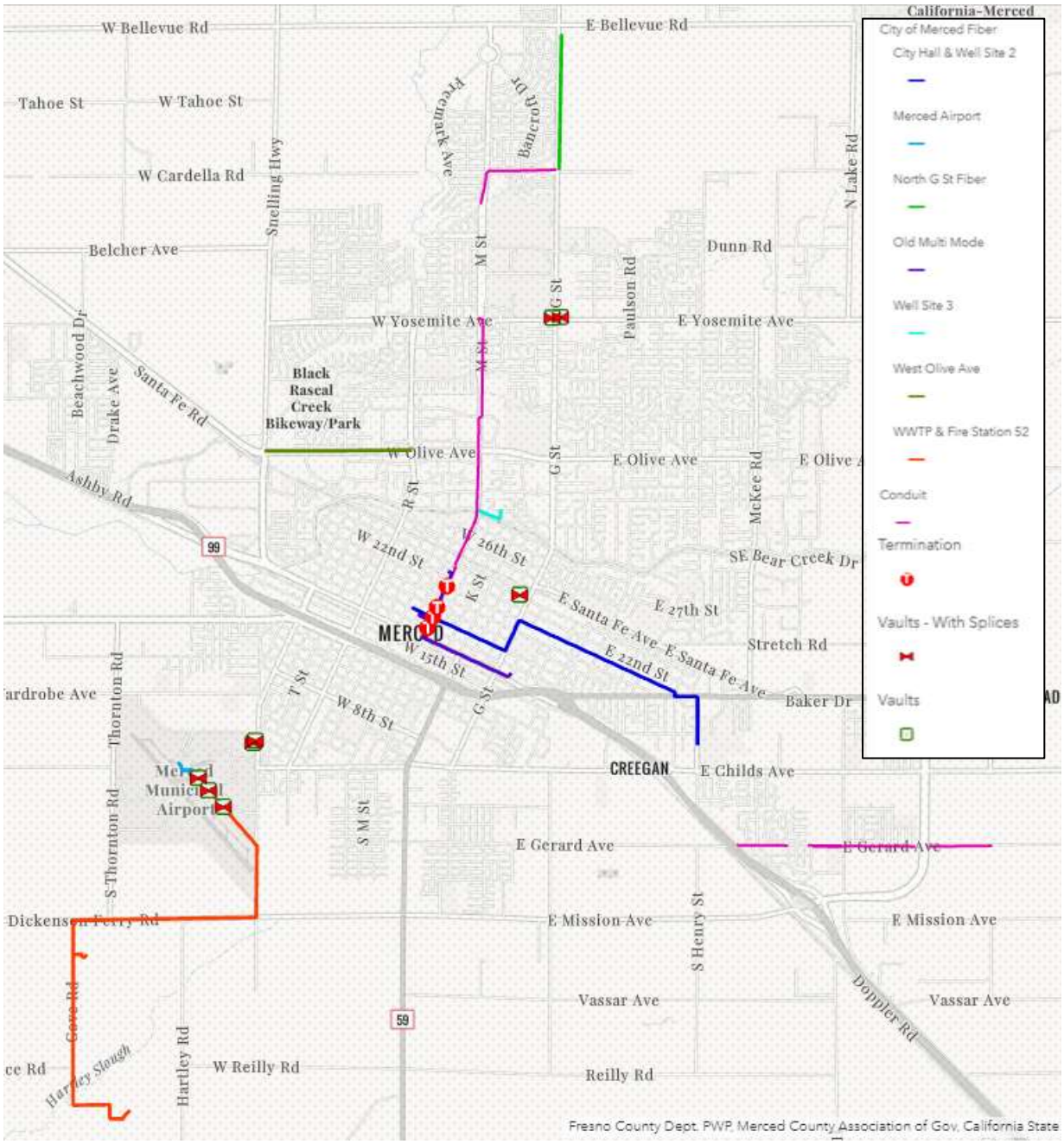

Figure 7. City of Merced fiber cable and conduit

There are at least 13 County buildings/facilities that fall within a 500-foot buffer of existing City fiber and/or conduit routes in Downtown Merced that would be priority sites to be connected in through any County-City partnership. These 13 facilities include some critical public service locations: County administrative offices, the courthouse, the sheriff's administration offices and county jail, the office of environmental health, and the District Attorney's offices.

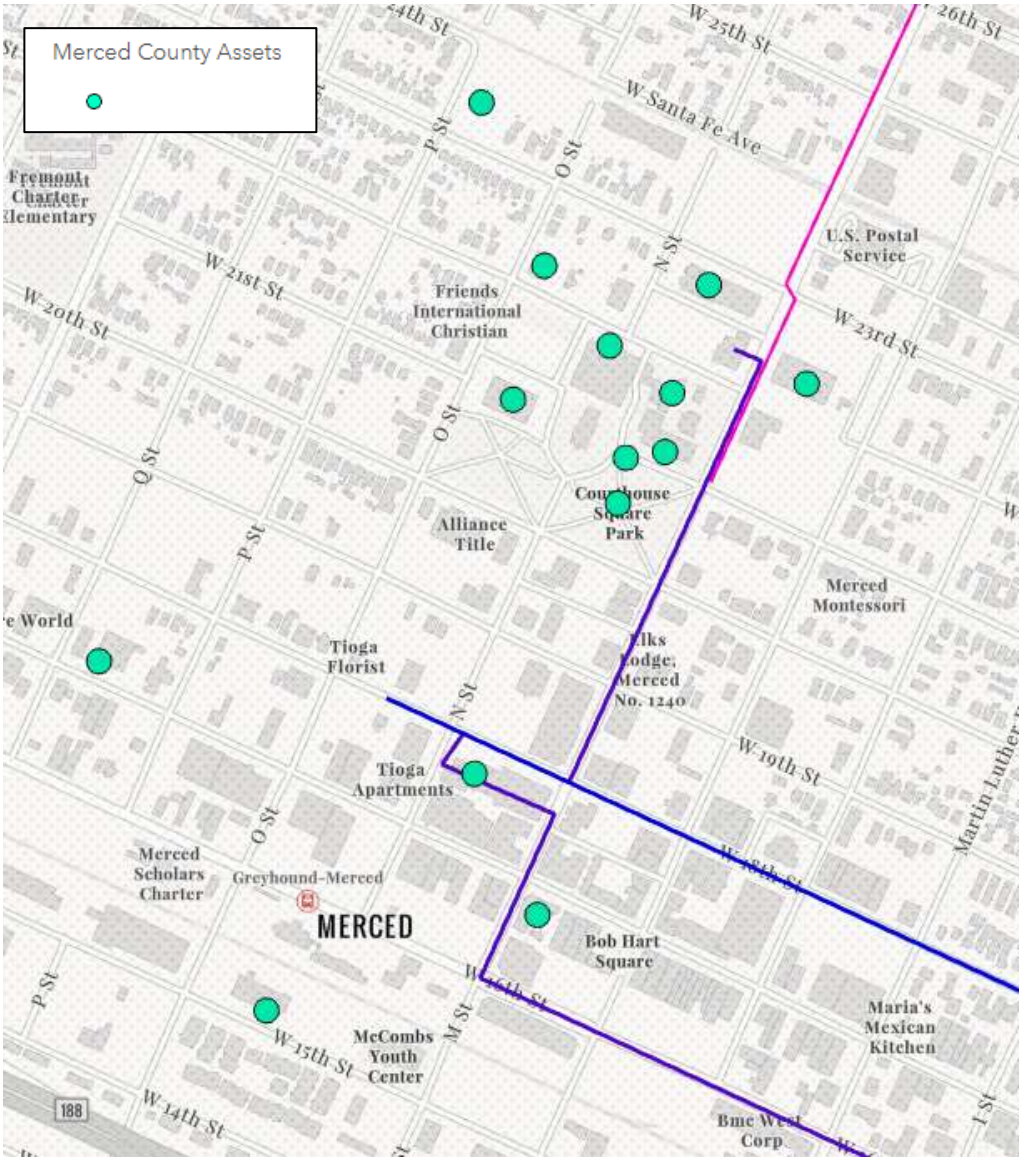

Figure 8. County buildings and facilities within a 500' buffer of existing city fiber

CAPITAL IMPROVEMENT PLANS & OPPORTUNITIES

Utility coordination, or "Dig Once," can be defined as policies and/or practices that foster cooperation among entities (especially utilities) that occupy public rights of way, to minimize the number and scale of excavations when installing infrastructure (especially telecommunications). Dig Once has numerous substantial benefits, including promoting and supporting the placement of broadband infrastructure, minimizing costs by sharing ground excavation work, and reducing the consequences and disruptions of repeated excavations.

Implementation of the utility coordination begins with effective coordination at the local level. County departments should ensure they are coordinating for major

projects. not only on internal County projects, but also coordinating with each of the cities within the County. to include broadband infrastructure where needed by considering at early stages of the projects how can it be used to expand broadband capacity and availability. Planning network assets for major CIP projects that involve excavation will allow the County to cost-effectively install conduit and/or fiber concurrent with other major projects: water main replacements, street paving, sidewalk, curb, and gutter replacements all can be used as opportunities to add in City conduit at a fraction of its typical cost.

There are several County Capital Improvement Projects (CIPs) within Merced County's Fiscal Year 2021-22 CIP list that create the opportunity for the County to plan, integrate, and coordinate the joint placement of fiber optic cable, conduit, or other broadband assets concurrent with other planned excavation work.

Table 2. County of Merced FY 2021-22 CIP projects with broadband implications

Description	Recommended Amount	Detail	Broadband Opportunities
Black Rascal Flood Control	$15,702,312	NA	Unsure
BHRS North County Facility	$5,776,800	New land & facility in Winton	New facility connection
Spring Fair Water System	$1,200,000	New irrigation connections	Dig once opportunities
SB 863 JLCC Improvements	$21,331,139	Facility improvements	Dig once opportunities; new facility connections
JLCC Phase 2 Expansion	$1,350,000	New county jail on Sandy Mush Road	Dig once opportunities; new facility connections
AME-Atwater Expressway	$3,400,000	Hwy 99 to Castle AFB Expressway	Dig once opportunities
New Sheriff Administration		Castle Airport Area	Dig once opportunities; new facility connections
Phase 2 Childs-Yosemite	$14,652,057	Highway 99 to UC Merced Expressway	Dig once opportunities
Structures & Improvements	$3,366,712	Various locations	Dig once opportunities
Structures & Improvements	$21,398,584	Various locations	Dig once opportunities
Structures & Improvements	$4,840,187	Various locations	Dig once opportunities
Measure V Trans. Projects	$4,140,000	Various locations	Dig once opportunities
SB1 Trans. Projects	$6,266,397	Various locations	Dig once opportunities
FAA 21 Castle Runway	$1,853,506	Airport Improvements	Dig once opportunities
Roads Projects	$13,785,524	Road Repair @ multiple locations	Dig once opportunities
	$124,752,999		

The more than $124 million budgeted for the CIP projects listed above represents a significant opportunity to jointly deploy fiber and conduit and exponentially increase the benefits and impacts of these public improvements. There are other potential CIP projects among the various cities within the County that should also be evaluated for broadband deployment. Regular utility coordination meetings with all major utilities, telecom providers, and various public agencies should result in an on-going list of all major projects occurring in the public rights-of-way. Telecommunications conduit and/or cables should be installed as a matter of policy during any major excavation and tracked as an asset afterward.

CALIFORNIA MIDDLE-MILE BROADBAND INFRASTRUCTURE

The State of California plans to spend $3.25 billion from the state's American Rescue Plan funds to build a statewide open access middle-mile network. The Middle-Mile Broadband Infrastructure (MMBI) network will be built by a California Department of Technology in CalTrans rights-of-way and operated by a new organization, GoldenStateNet (GSN), spun out from CENIC, which operates the state's education and research network, CalREN.

The purpose of the statewide Middle Mile Broadband Infrastructure (MMBI) is to provide cost-effective data transport networks for public agencies, cities, counties, and emergency operations, as well as encourage private investment to provide retail internet services in un- and under-served areas. The stated intention of MMBI is to allow very flexible access, placing hand holes and splice cases wherever needed for making full use of the MMBI fiber. The final design for MMBI was still in flux at the time of this research, but most major corridors have been tentatively identified. Figure 5 shows the most current location of its routes in Merced County, which includes major corridors along Highway 99, parts of Interstate 5, and State Routes 33, 140, 152, and 140.

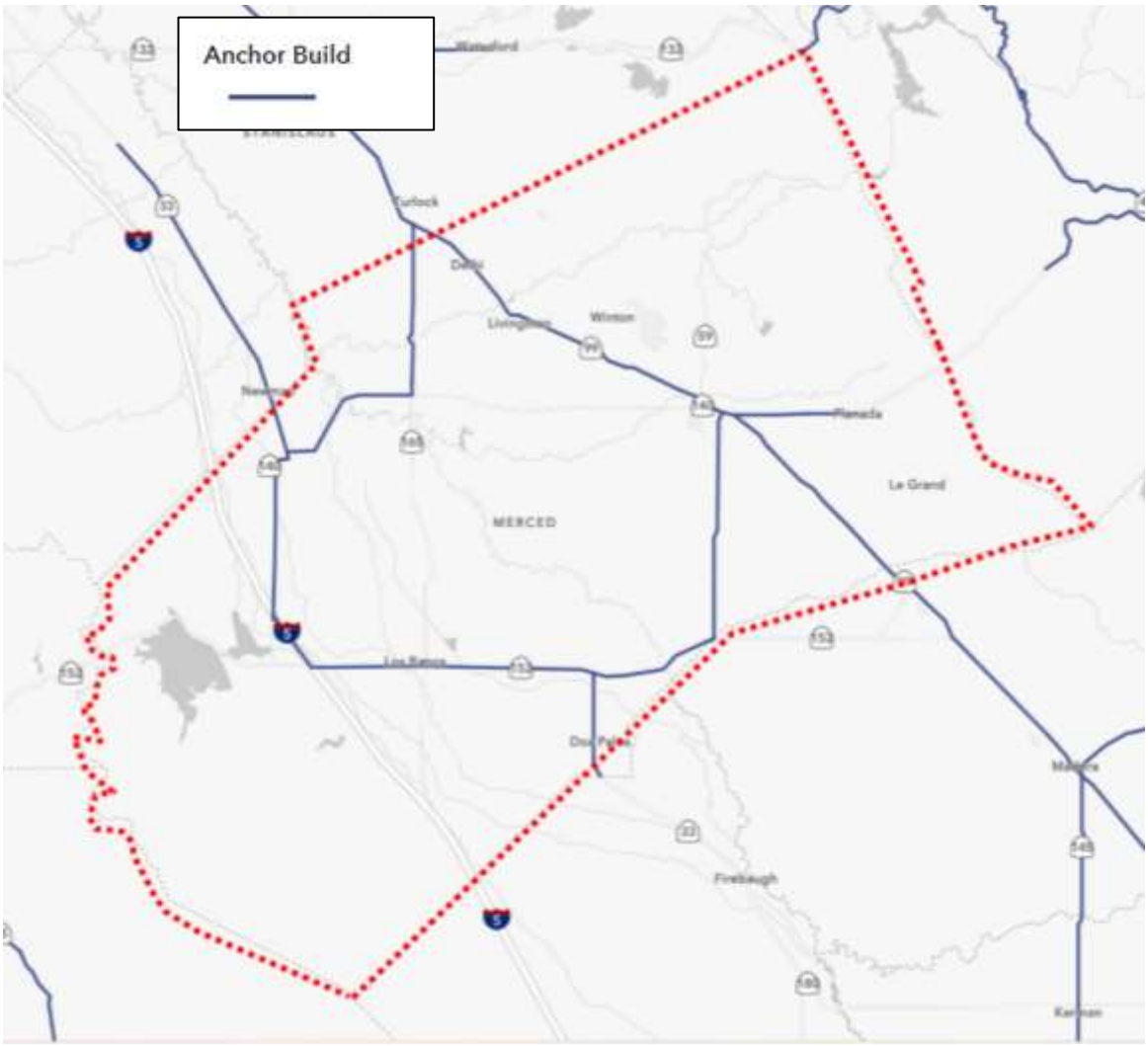

Figure 9. California's planned Middle-Mile Broadband Infrastructure (MMBI)[1]

[1] Source: CENIC. GoldenStateNet https://cenic.org/initiatives/goldenstatenet

3. Market Assessment

The market analysis looked at retail internet and cellular services and the underlying private infrastructure that supports those services, including private coaxial cable, copper, and fiber networks, data centers, cell towers and radio antennas, and the pricing and availability of these networks to subscribers in Merced County.

Nearly all network services are provided by private companies. Generally, in order of capital investment required, these services are retail broadband for commercial and residential customers, enterprise network services and managed services, and radio-based wireless services, including cellular, which is technically mobile, point-to-multi-point, narrowband, and point-to-point.

Retail services require extensive network infrastructure due to the large number of customers involved, as well as operational systems to manage customer accounts and network performance. Enterprise and managed services are more focused, typically on large organizations, which generally means limited infrastructure. Cellular generally involves very large investments to license radio spectrum and establish interconnected cell sites throughout a service area. Other wireless network technologies accommodate more focused investment, even to the level that relatively small businesses can afford to own the infrastructure.

RETAIL BROADBAND SERVICE

Traditional, incumbent cable TV and telephone companies are “facilities-based” service providers—they own wires infrastructure they use to provide services. While originally focused on very different services, companies in both industries evolved into internet service providers (ISPs) provided through different legacy infrastructure and regulations. Telephone service was deemed essential and required to be made available to everyone over twisted copper wire infrastructure. Cable companies, in contrast, developed under local franchise agreements as a non-essential service with limited service areas, and they utilize coaxial cable networks.

While the two services overlapped in urban areas, there was no overlap within the industries; cable companies would not compete head-to-head with each other, and telcos would not overbuild and compete with other telcos. Consequently, today most communities, including Merced County, have a cable-telco duopoly with essentially just two options, at best, for internet services. In areas outside cable service areas, only DSL broadband may be available and that is limited by the

quality of the telco's legacy copper infrastructure. Locations in rural areas far from telco central offices tend to have no wired internet connections available. Several communities within Merced County have been divided up between other service providers that typically don't operate in the central valley region, and thus have limited network capabilities, resulting in a disjointed approach with varying levels of speeds, pricing, and services between communities.

Legacy telephone companies utilizing twisted copper typically now provide internet services over Digital Subscriber Lines (DSL), which can nominally provide only basic broadband speeds of up to 25 Mbps downstream and 3 Mbps upstream. Speeds can be increased modestly by deploying fiber optic backbones within neighborhoods to reduce the distance that data must travel on copper wire. However, in rural and some urban core areas where telcos have not been under competitive pressure to upgrade infrastructure, subscribes are stuck with DSL and, even when upgraded with fiber backbones, still cannot meet the minimum California standard of 100 Mbps download and 25 Mbps upload.

Coaxial cable has relatively higher capacity, so cable companies have been able to deliver faster service by deploying fiber to the node (FTTN) at the neighborhood level, creating a hybrid fiber-coax (HFC) network infrastructure. With their deployment of the latest version of DOCSIS protocol, cable company ISPs can offer "up to" 1 gigabit speeds. Cable broadband has limited capacity to each local node that is shared among all subscribers in that area. Consequently, actual speeds may be much lower than what was offered or advertised, especially when a lot of people are online. This can especially be an issue in dense urban areas where it can be costly and difficult to deploy additional nodes.

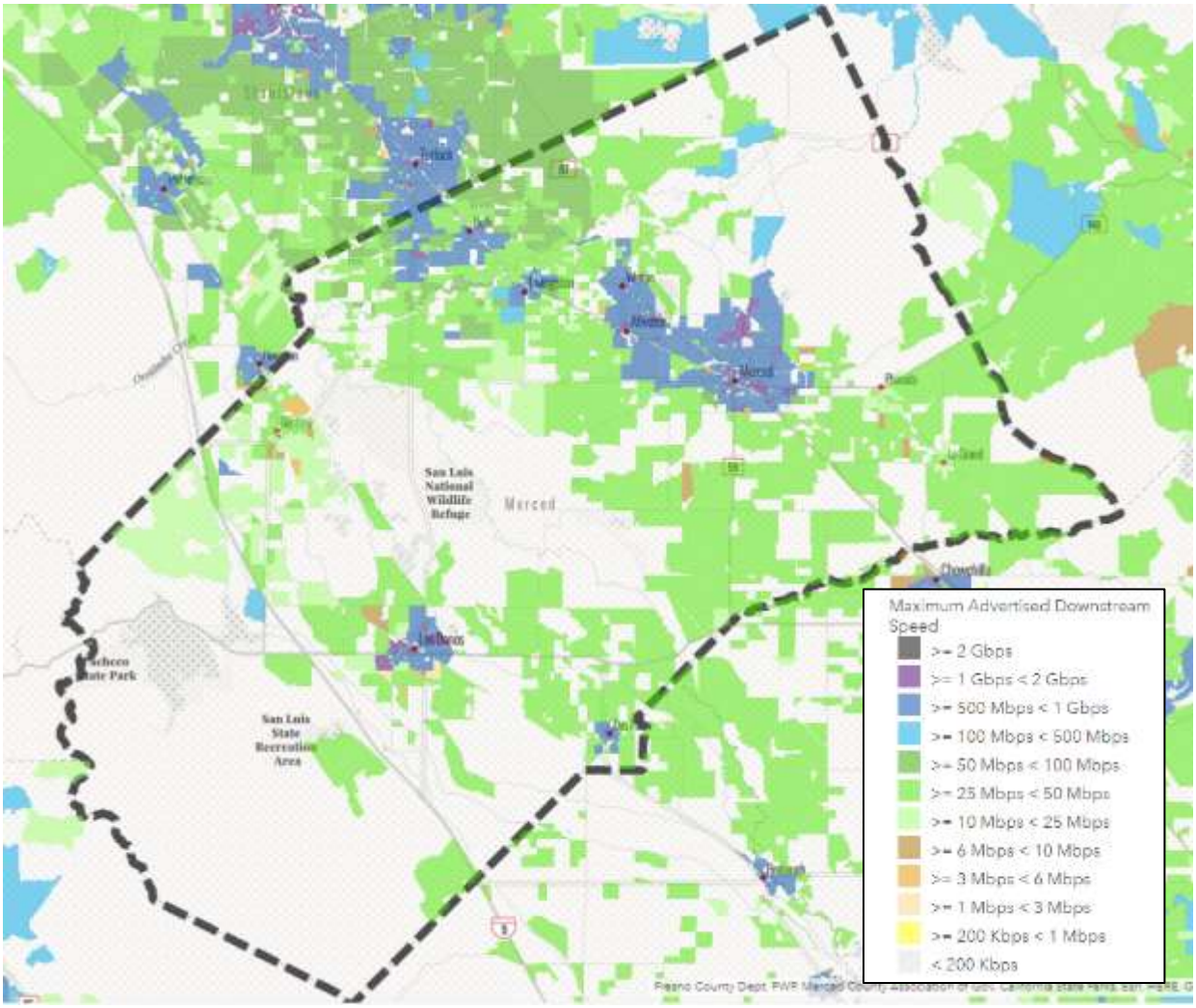

Figure 10. Available Broadband Speeds[2]

Data on broadband services in Merced County—whether through legacy telephone lines, coaxial cable, or fiber optic networks—is limited, and information about retail broadband infrastructure is typically proprietary and not available at the granular level. We used data from the California Public Utility Commission and other sources to assess broadband availability.[3]

[2] Source: California Public Utility Commission (CPUC), https://www.broadbandmap.ca.gov/

[3] The "477" data provided by internet services providers to the FCC is notoriously inaccurate, in part because a zip code area is considered "served" if it has a single address to which a provider can offer a particular service. Therefore, we use other sources to identify gaps. Specifically, the CPUC data, although similarly sourced but is more granular and more thoroughly validated.

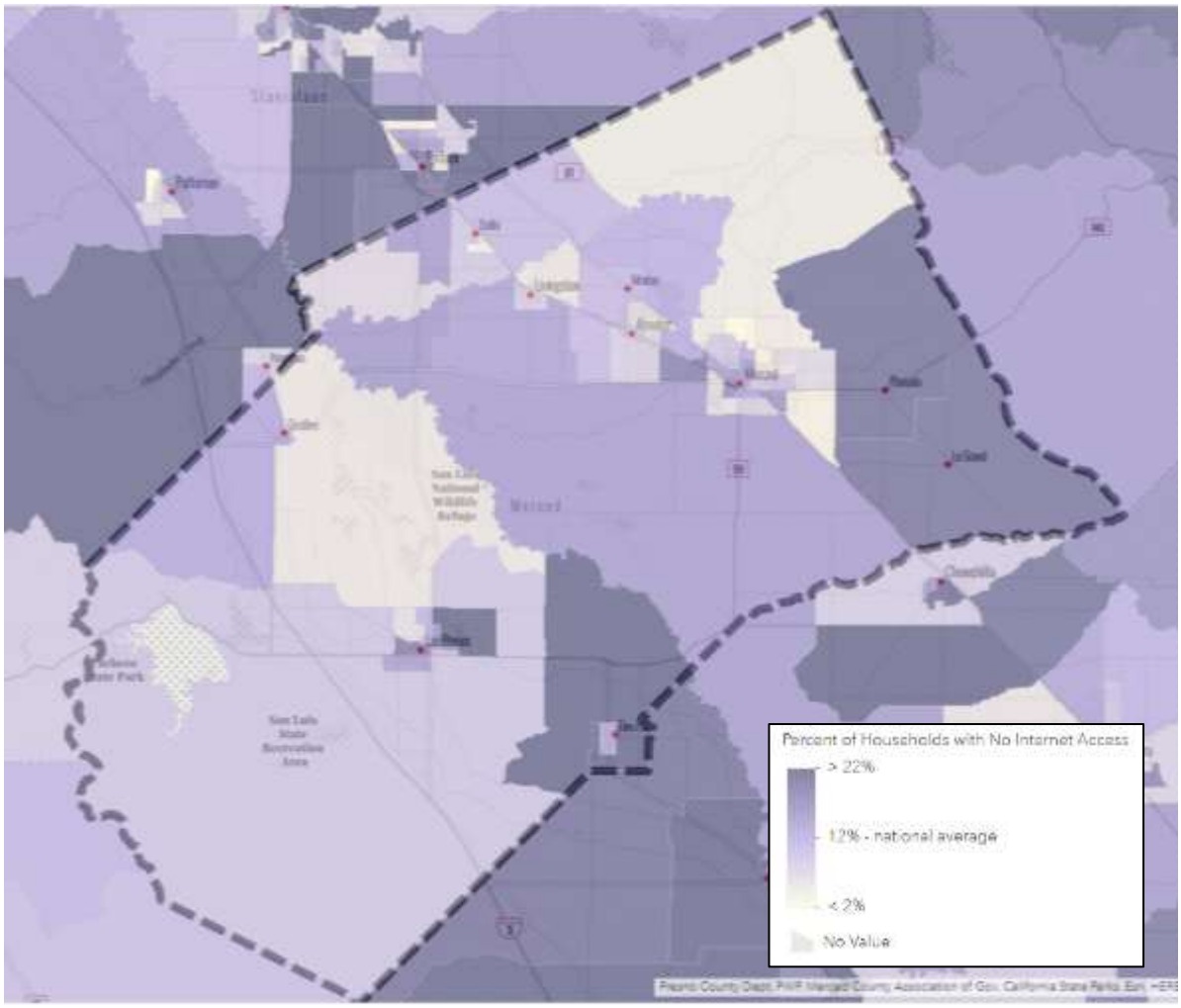

Figure 11. Percent of Households with No Internet Access[4]

Availability of broadband service is limited outside the incorporated cities of Merced, Atwater, and Los Banos, and much of the County currently qualifies as "underserved" (green areas) based on State of California standards which require a minimum download of 100 Mbps and upload of 25 Mbps. Even in the "best case scenario" represented by CPUC data, areas outside the cities have only low-speed broadband available. Moreover, large areas of the County have a higher-than-average number of households without any internet access. either because no retail provider option is physically available, or due to other possible socio-economic factors, including affordability and digital literacy.

Even the incumbent ISPs self-reported data in Figure 7 shows are large unserved portions of Merced County where no internet providers are available, confirming

[4] Source: American Community Survey, 2015-2019, Internet Connectivity Variables

the ACS Survey findings that a significant number of households have no internet availability.

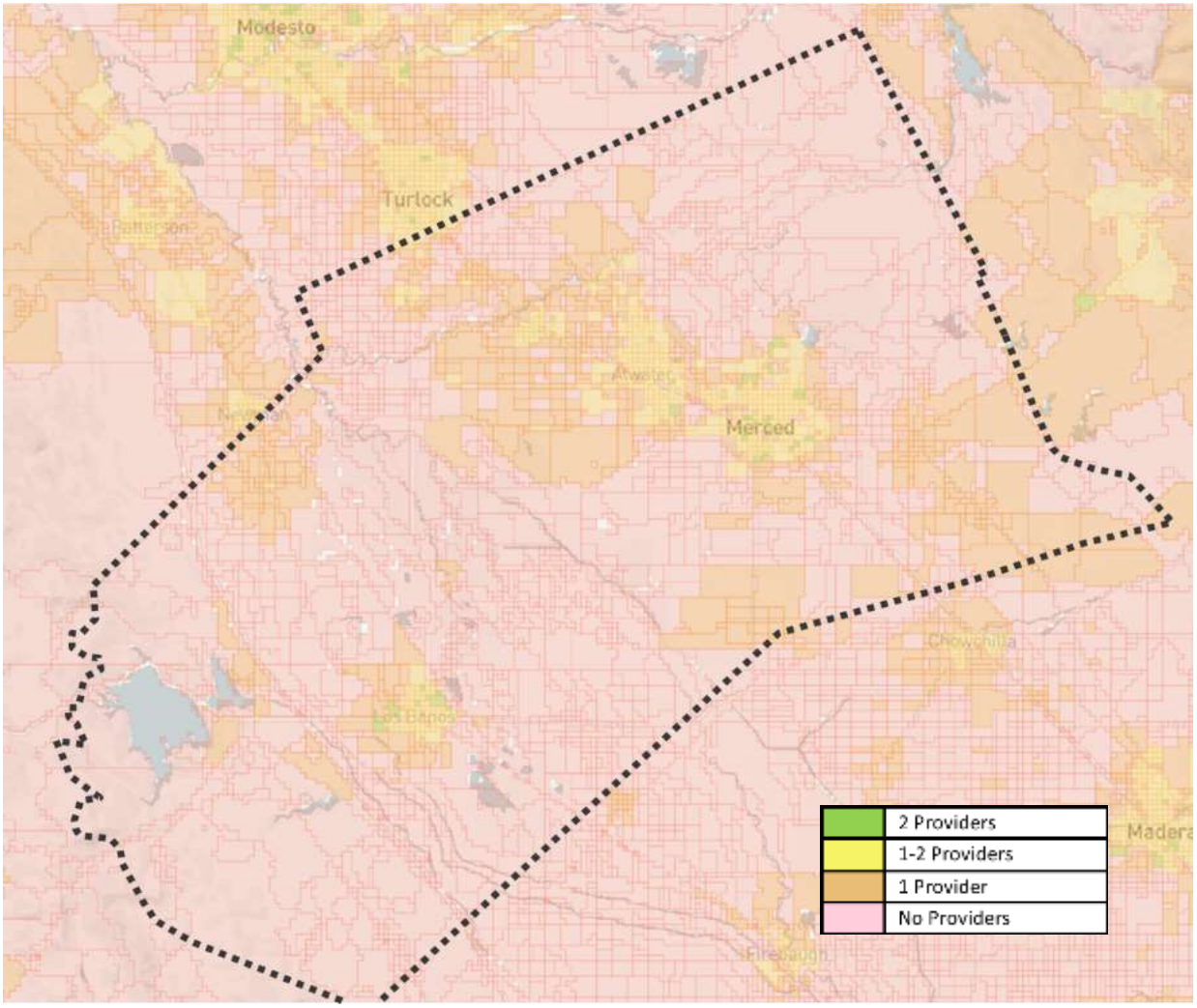

Figure 12. Fixed (Wired) Internet Provider Options in Merced County[5]

AT&T

AT&T is the Incumbent Local Exchange Carrier (ILEC), or the legacy telephone company in Merced County. For broadband internet, they have invested primarily in DSL (Digital Subscriber Lines) technologies which enable data services over their installed base of copper phone wires. The speeds supported by DSL depends on the length of the copper wire and the type of DSL deployed.

[5] Source: Broadbandnow.com

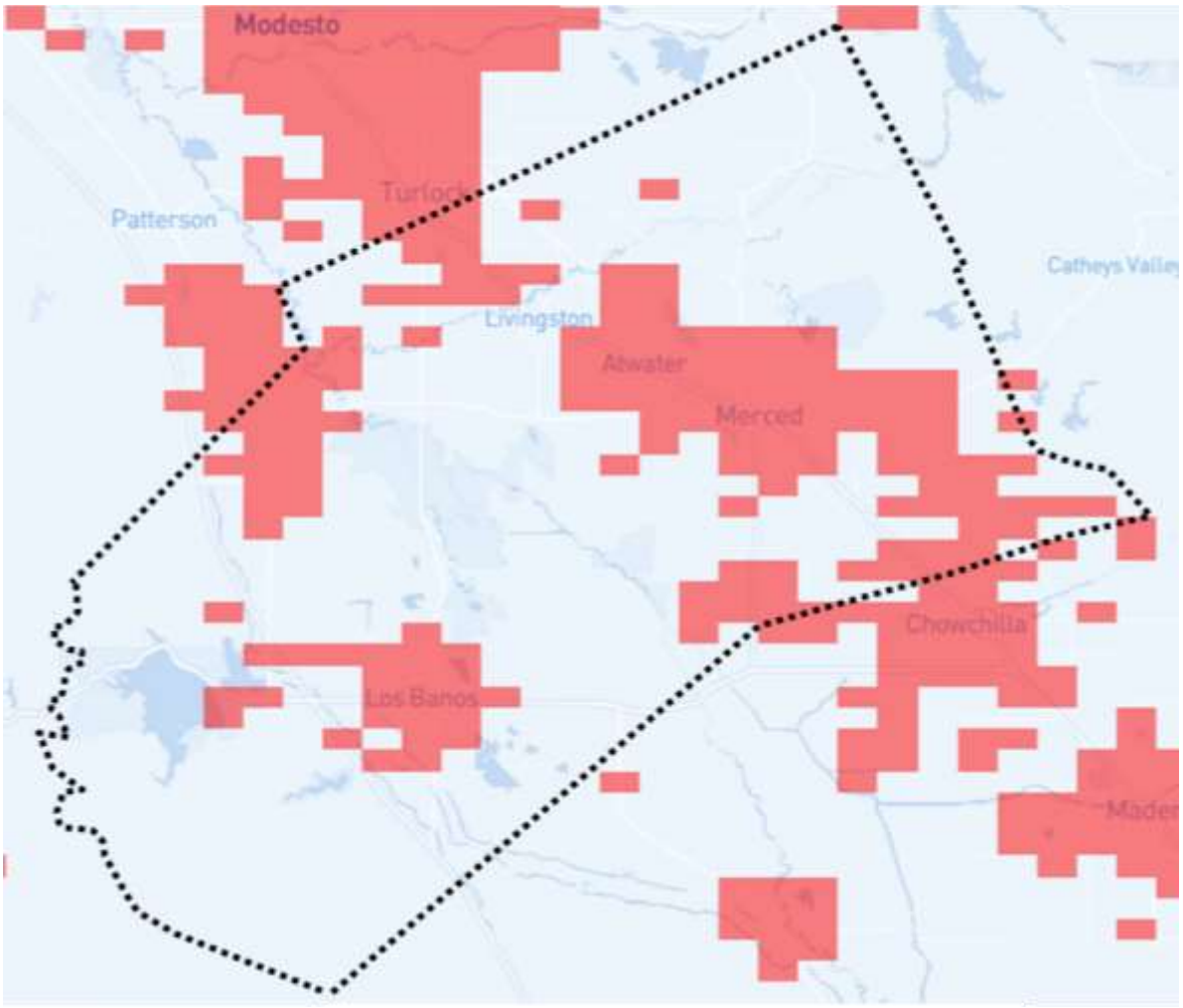

Figure 13. AT&T internet (DSL) coverage in Merced County[6]

AT&T offers DSL services predominantly in urban/populated areas of the county, covering 94% of addresses within the City of Merced, 95% of the City of Los Banos, and 88% of Atwater. Relatively fast DSL speeds of "up to 100 Mbps" imply that AT&T has deployed significant amounts of fiber to neighborhood pedestals and cabinets, relying on copper only locally within neighborhoods for the last few hundred feet to get into the home or business. Existing fiber backbones could reduce the cost and time for them to upgrade more areas to true gigabit fiber networks.

[6] Source: Broadbandnow.com

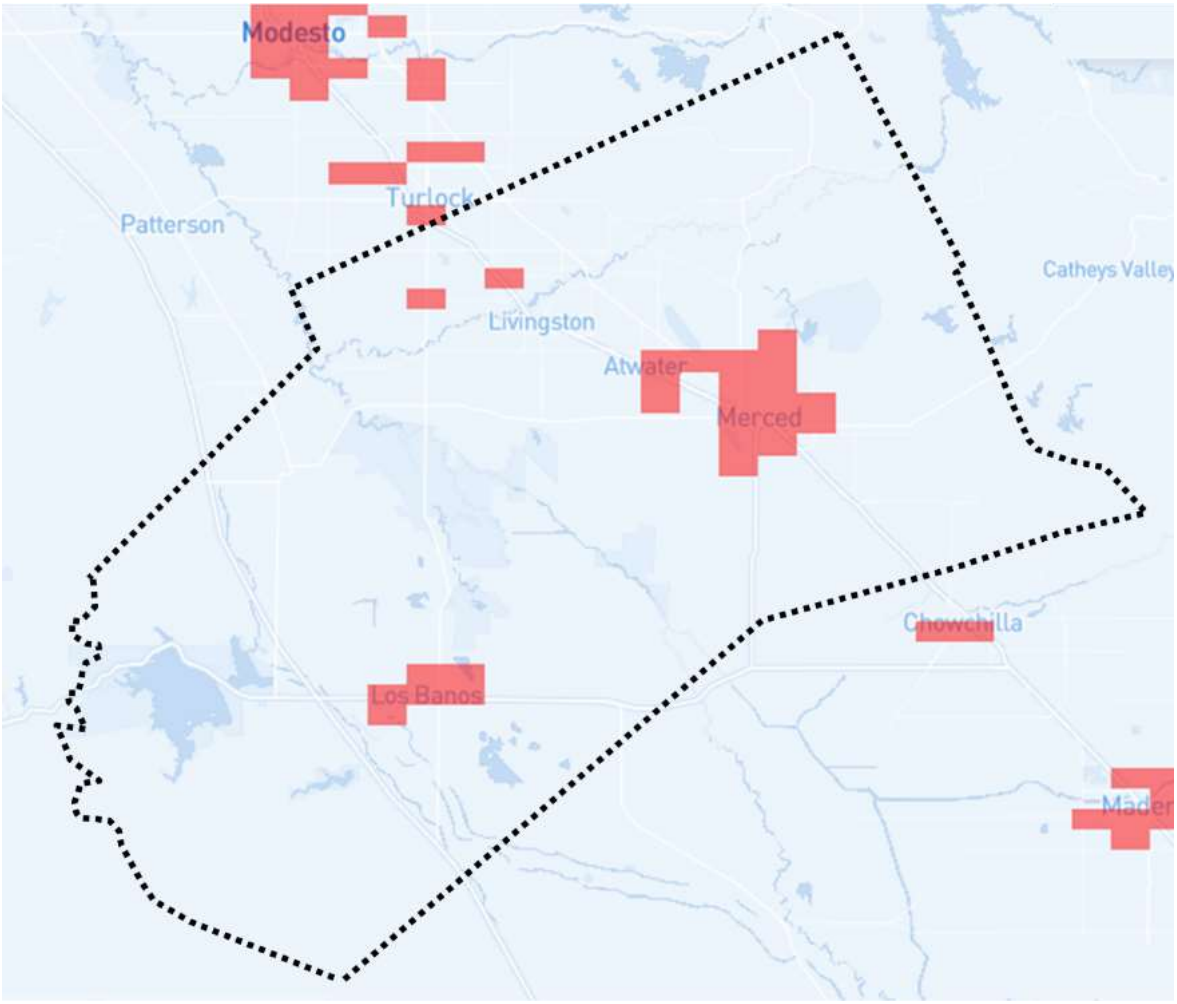

Figure 14. AT&T fiber optic internet coverage in Merced County[7]

AT&T has deployed very limited fiber optic cable within Merced County and offers fiber-to-the-premises services within these small areas shown in Figure 10. AT&T reports fiber optic services available to 17% of the City of Merced, 14% of Los Banos, and 7% of Atwater.

Charter Spectrum

Charter Spectrum is the second largest cable company in the US, but its primary market and presence is in Southern California. It has a limited footprint in Merced County and only provides "up to a gigabit" over its coaxial cable/HFC networks. Spectrum's cable coverage in the County is in the Livingston area in north County, and it does not report any fiber within Merced County.

[7] Source: Broadbandnow.com

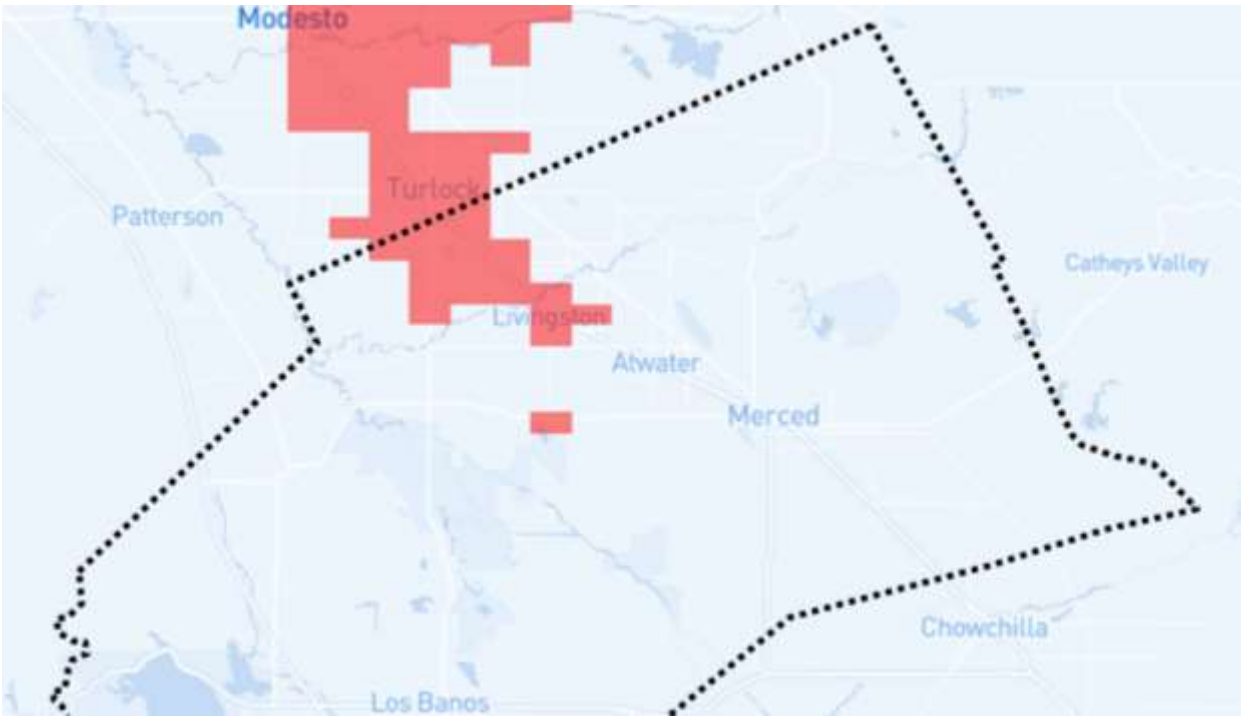

Figure 15. Charter Spectrum cable internet coverage[8]

Comcast Xfinity

Comcast is the largest cable TV company and internet provider in the U.S. As the legacy cable TV provider in Merced County, Comcast reports 100% coverage of serviceable residential addresses. However, as the legacy cable provider, much of Comcast's HFC network is within residential neighborhoods, and businesses or commercial areas cannot always access services without paying a significant, one-time installation fee. Also, there are not "serviceable residential addresses" in portions of the cities. Comcast reports coverage of 97% of the City of Merced, 95% of Los Banos, and 89% of Atwater. The company recently announced it would invest $4.5M to deploy network capable 10 Gbps service in Planada, east of Merced, and donated $100K to the local United Way and San Joaquin Regional Broadband Consortium.[9] Outlying areas, including some residential neighborhoods in unincorporated Merced County, are not served by Comcast.

[8] Source: Broadbandnow.com

[9] See https://california.comcast.com/2023/04/17/comcast-invests-4-5-million-to-expand-its-xfinity-10g-network-to-rural-community-of-planada-in-merced-county-california/ for more information.

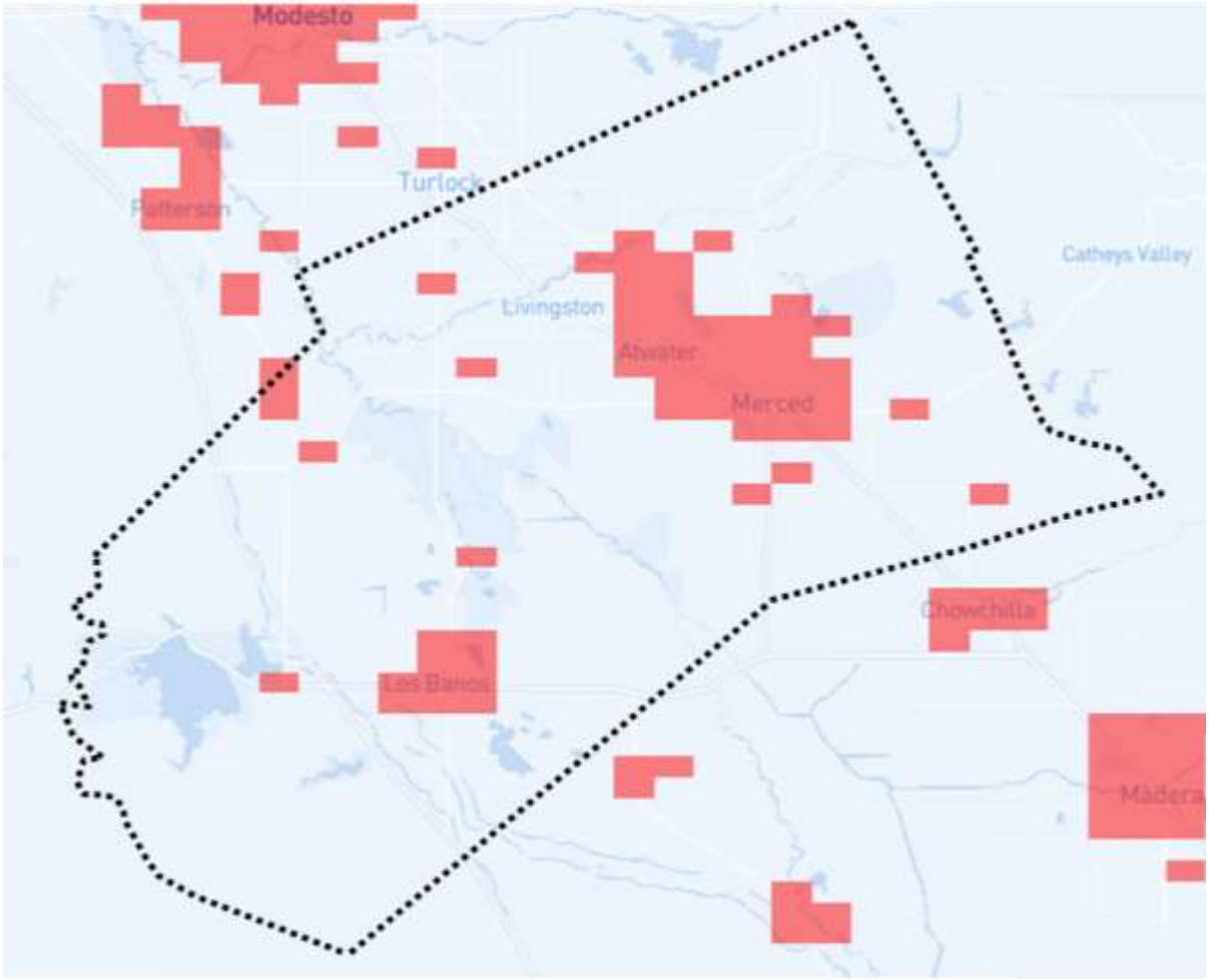

Figure 16. Comcast Xfinity cable internet coverage[10]

Where available, Comcast advertises speeds of "up to 1 Gbps." The upstream rates are not published by Comcast. These tend to be in the 5-20 Mbps range due to inherent limitations in their Hybrid-Fiber-Coax (HFC) network architecture. For Comcast to offer significantly higher upstream rates, outside plant upgrades would be required. These include deploying new fiber deeper into each neighborhood as well as upgrading all existing amplifiers in the field.

Comcast, and the cable industry in general, has a straightforward and comparably inexpensive upgrade path or roadmap to gigabit and 10 gigabit services, including the addition of higher speed symmetrical services. New equipment at the centralized headend and new customer premises equipment are all that's required. The outside plant upgrades and will likely be concentrated initially in the more

[10] Source: Broadbandnow.com

affluent neighborhoods and commercial centers. Comcast does not report offering any fiber-to-the-premises service offerings within Merced County.

Frontier Communications

Frontier is a large US-based telecommunications company that has undergone numerous acquisitions, mergers, and divestitures. It was originally founded in 1935. In the early 1990s, it began acquiring rural telephone lines from providers around the country. Its limited DSL footprint in Merced County is primarily the Atwater-Livingston area. Frontier primarily serves markets in Southern California and has a limited footprint in Merced County. Frontier only provides DSL service within the County and does not report having any fiber cable within the region.

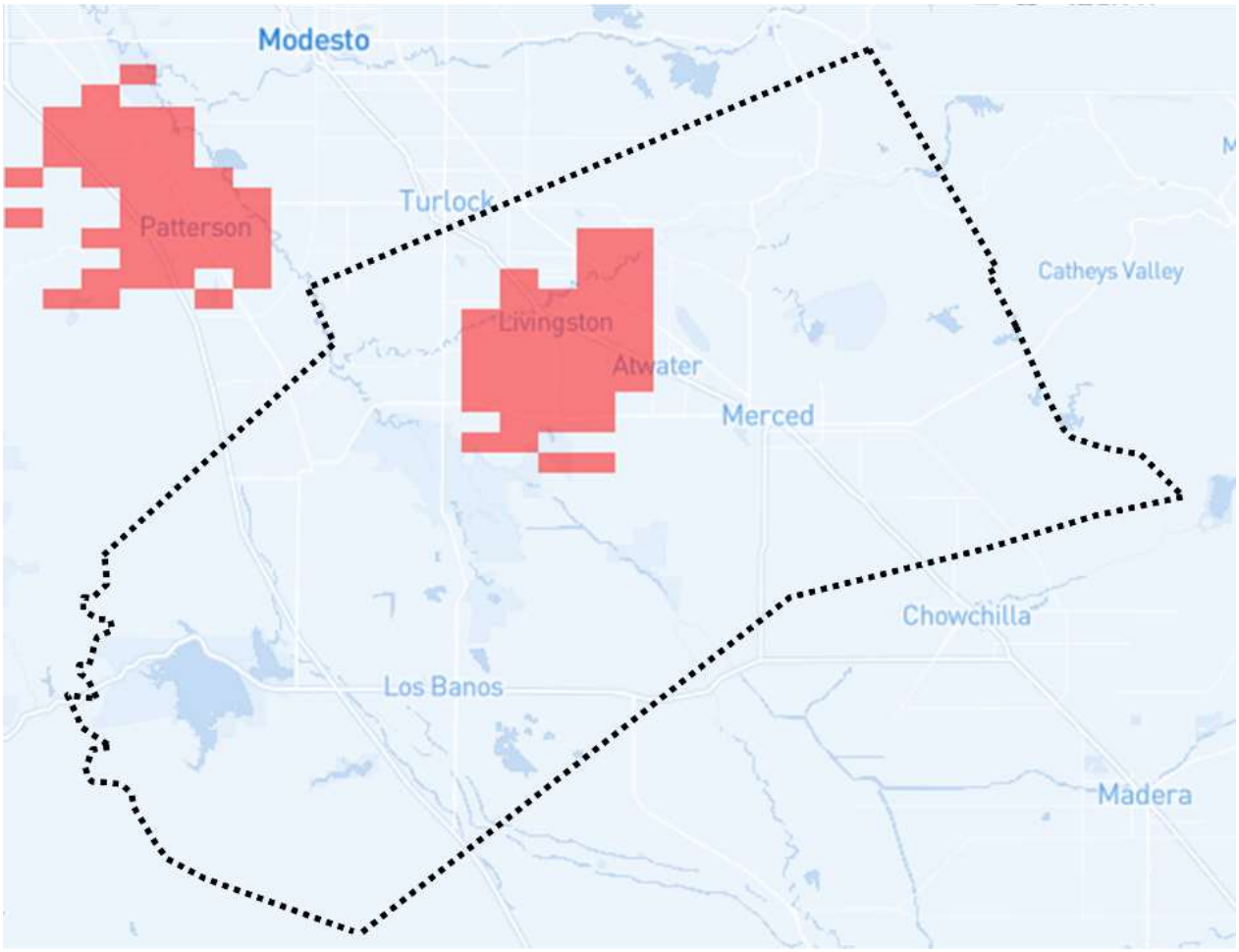

Figure 17. Frontier Communications DSL coverage[11]

[11] Source: Broadbandnow.com

Vast Networks/CVIN

CVIN (Central Valley Independent Network) reports owning and operating fiber optic cables along the northern County Highway 99 corridor. CVIN/Vast does not target the single-family home market; however, they do serve the large multi-dwelling unit (MDU) market as well as providing lit and dark fiber connections for schools and anchor institutions.

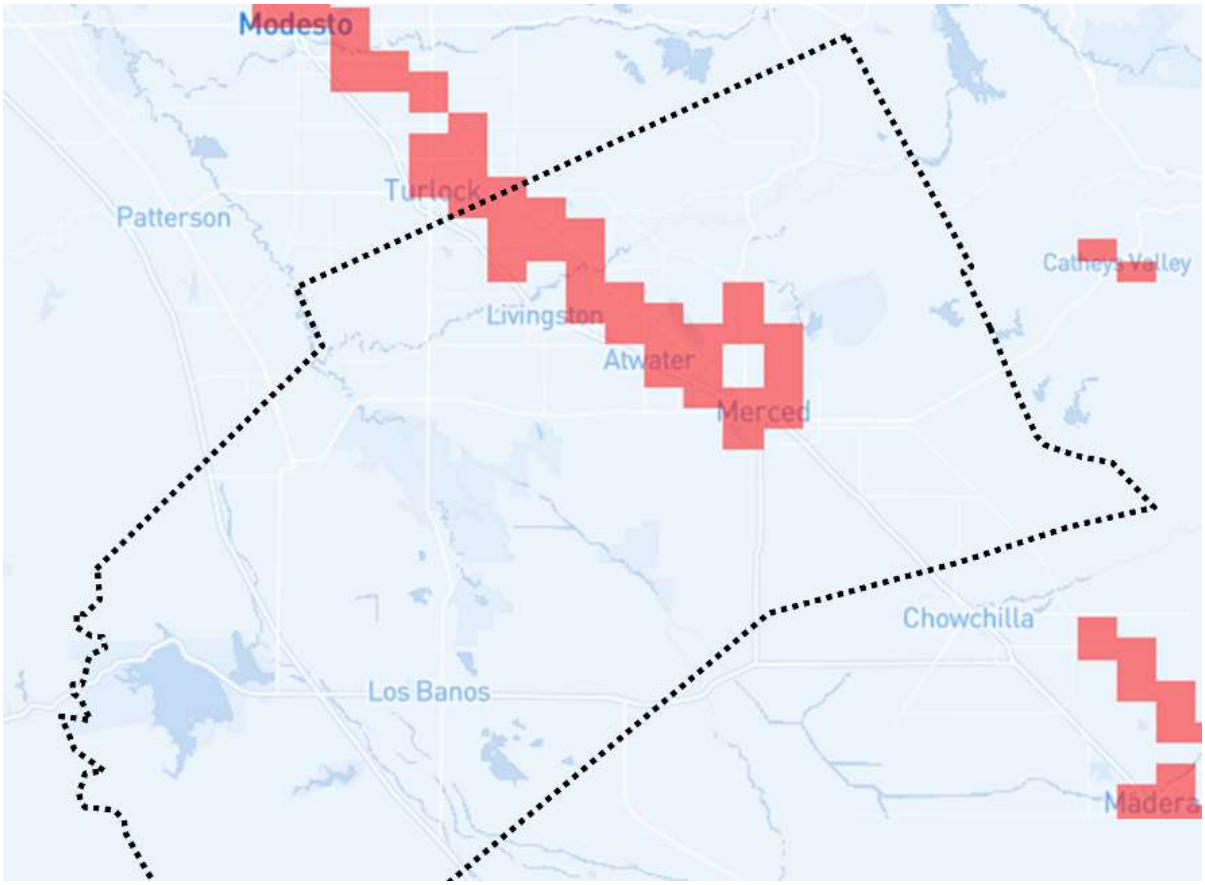

Figure 18. CVIN/Vast Networks Fiber Coverage[12]

Internet Pricing & Speed Tiers

Each of the five ISPs purporting to service areas of Merced County advertise fairly comparable residential internet pricing plans for speed tiers up to 1 Gbps, as shown in Table 3 (notably, Frontier does not state the speed of its $50/month DSL service). Magellan checked random addresses dispersed throughout the County to verify and confirm that these speed tiers are available and priced as advertised.

[12] Source: Broadbandnow.com

Table 3. Residential advertised speeds and pricing tiers[11]

Provider	Media	Speed	MRC[13]	MRC/ Mbps
AT&T	DSL ("IPBB")	100	$65.00	$0.65
	Fiber	300	$55.00	$0.18
		500	$65.00	$0.13
		1,000	$80.00	$0.08
		2,000	$110.00	$0.06
		5,000	$180.00	$0.04
	Fixed Wireless	25	$55.00	$2.20
Comcast Xfinity	Cable	200	$77.00	$0.39
		400	$92.00	$0.23
		800	$97.00	$0.12
		1,000	$102.00	$0.10
		1,000	$107.00	$0.11
	Fiber	6,000	$299.95	$0.05
Charter Spectrum	Cable	300	$49.99	$0.17
		500	$69.99	$0.14
		1,000	$89.99	$0.09
Frontier	Fiber	500	$49.99	$0.10
		1,000	$69.99	$0.07
		2,000	$99.99	$0.05
		5,000	$154.99	$0.03
	DSL	NA	$49.99	NA

However, Magellan's preliminary data shows significant gaps in service. Many addresses in outlying communities (Ballico, Dos Palos, Delhi, etc.) cannot secure internet access from any of the five ISPs and are left only with wireless/cellular options. Early data suggests that although the 5 ISPs collectively report covering populated communities in Merced County as shown in the maps above in Figures 9-14, there are still significant un-served areas of Merced County that have no access availability.

[13] MRC is Monthly Recurring Cost. All prices are for internet-only standard offerings. Some providers have special offers or conditions.

WIRELESS INFRASTRUCTURE AND SERVICES

Wireless communications include any means for establishing links without wires via electromagnetic spectrum between 1 Hz and 3,000 GHz, i.e., radio. This requires an antenna, which sends signals out as radio waves, and a base station, which generates the radio signals from data or other signals. Coverage depends on the height of the antenna, the power of the signal, and the radio spectrum: low frequency signals travel farther and are less susceptible to interference but have greater information carrying capacity.

Radio Communications

Sufficient mobile digital infrastructure, such as cell towers and small cells, is required to provide the necessary coverage and capacity in the County. There are at least 76 licensed "traditional" cell towers located within Merced County. Some of these locations are shared between multiple carriers, or even shared between public safety agencies and private carriers,[14] so it's likely that there are not 76 individual poles; however, with the recent growth in cellular technology and demand, there are likely now more towers and antennas located within the County than the 76 currently listed as licensed. The average height of these towers/poles is 111 feet, and only six currently listed as roof-top towers.

[14] Magellan only identified one County-owned radio communication tower (public safety/sheriff dept) located on Sandy Mush Road adjacent to the correctional facility. No additional data was provided to Magellan confirming publicly-owned towers or County-owned radio communication towers, though undoubtedly there is additional public radio towers, likely strategically located in the more remote eastern and western portions of the county.

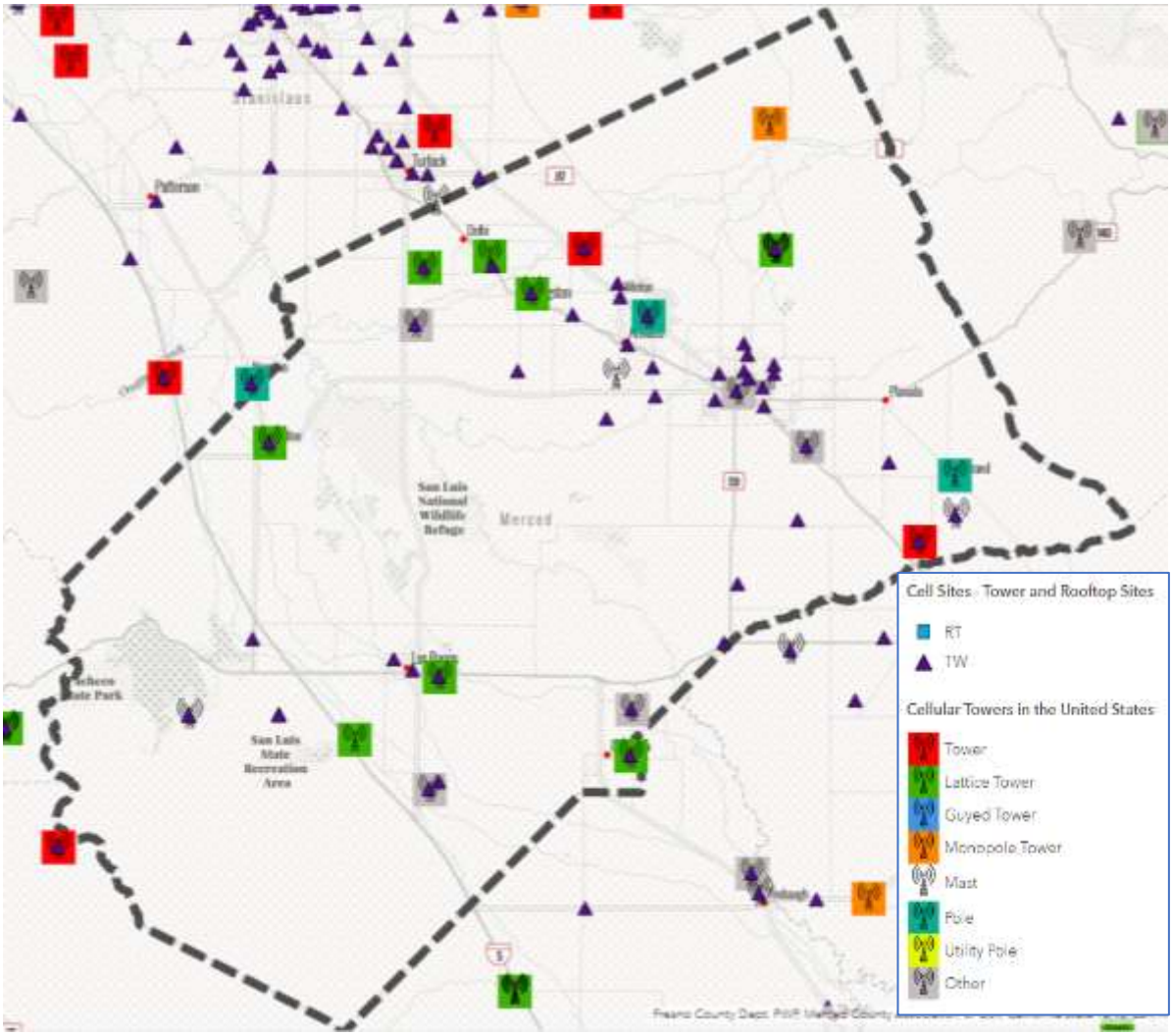

Figure 19. Cell site and towers in Merced County[15]

[15] Source: Homeland Infrastructure Foundation-Level Data (HIFLD)

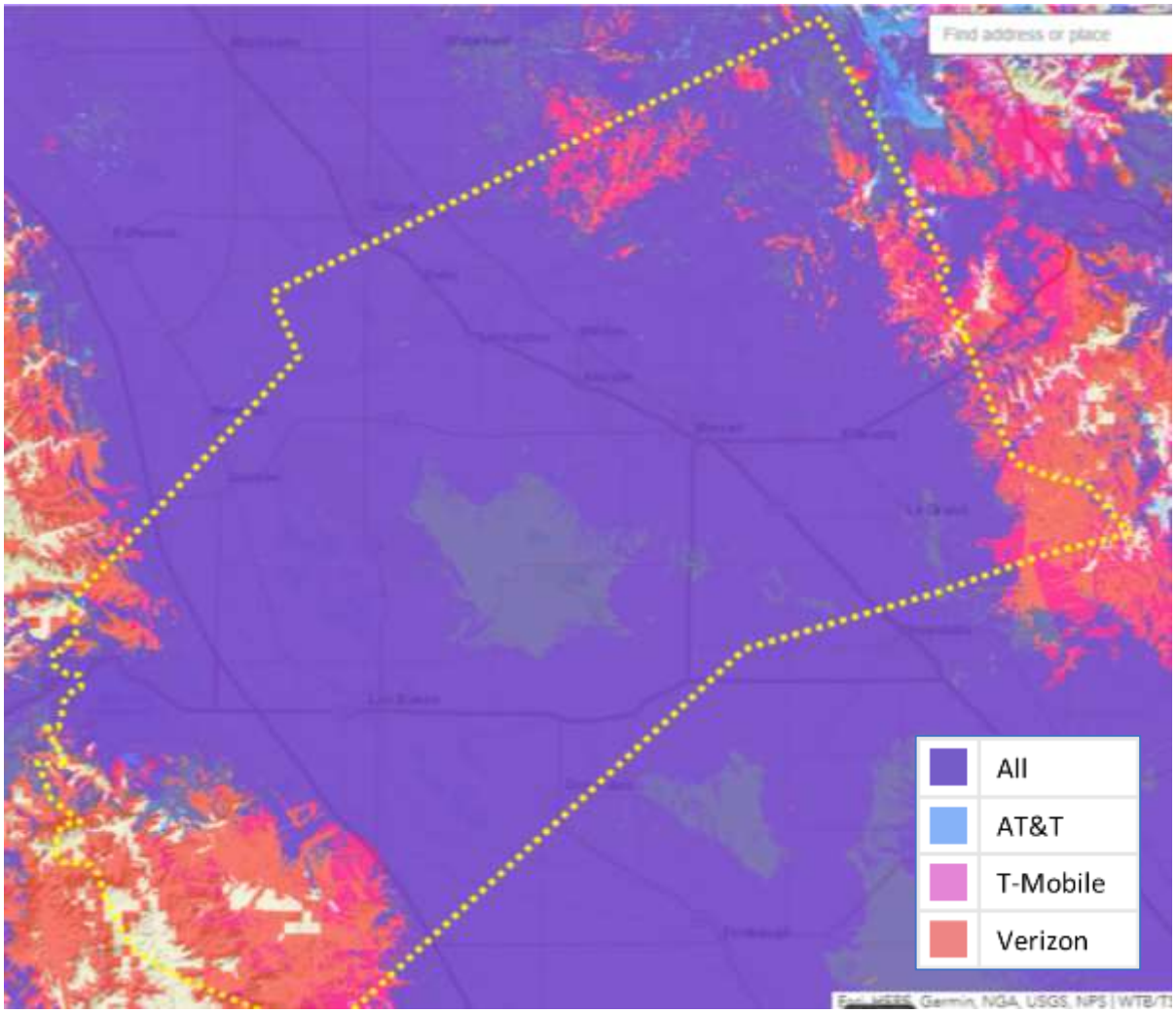

Figure 20. Cellular 4G/LTE coverage in Merced County[16]

Cellular coverage in Merced County is moderate, with most areas nominally covered by the big three cellular carriers (AT&T, T-Mobile, and Verizon), as shown in Figure 19 (purple shading indicates overlap of all 3). However, portions of southwest Merced County and the eastern edge of the County are somewhat limited in carrier coverage. Anecdotal evidence indicates substantial dead zones for all carriers, particularly AT&T's FirstNet service.

Fixed Wireless Internet Services

Often in lower-population or rural areas, service can be provided cost-effectively through fixed wireless options, rather than hard line connections through copper,

[16] Source: Federal Communication Commission (FCC) 4G/LTE Coverage

coax, or fiber cables. Merced County currently has five wireless carriers offering service in various locations throughout the county: Ultra Home Internet, Unwired, Cal.net, Ayera Technologies and AT&T, illustrated in Figure 21.

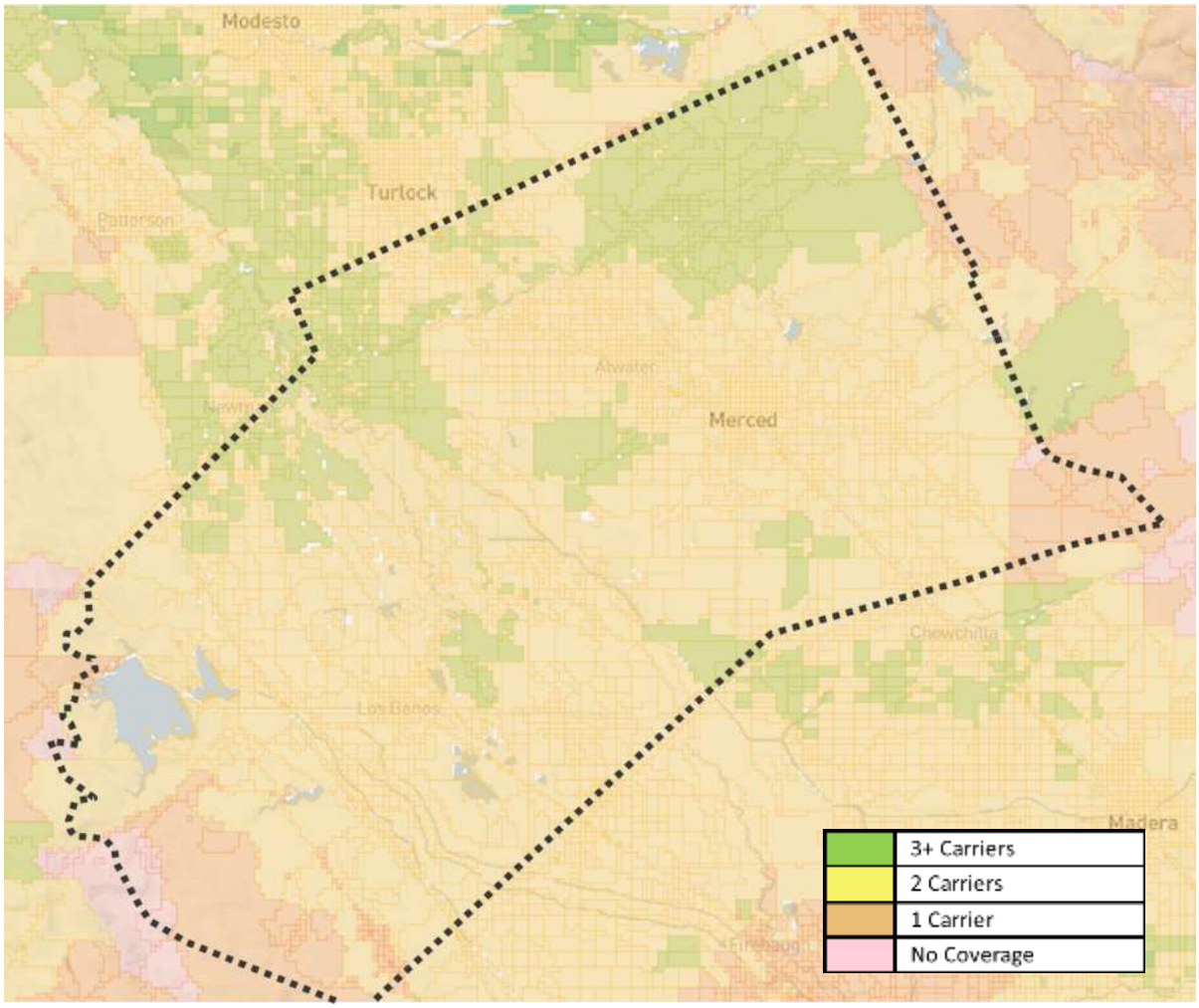

Figure 21. Wireless carrier options in Merced County[17]

AT&T currently reports the broadest coverage area for wireless internet service, as shown in Figure 21. Wireless internet service cannot typically sustain the speeds necessary for today's applications and technologies, and download/upload speeds are far below the California minimum standard of 100 Mbps download and 25 Mbps upload. As shown in Figure 23, wireless connections fall below the standard FCC definition, well short of the new state standard.

[17] Source: Broadbandnow.com

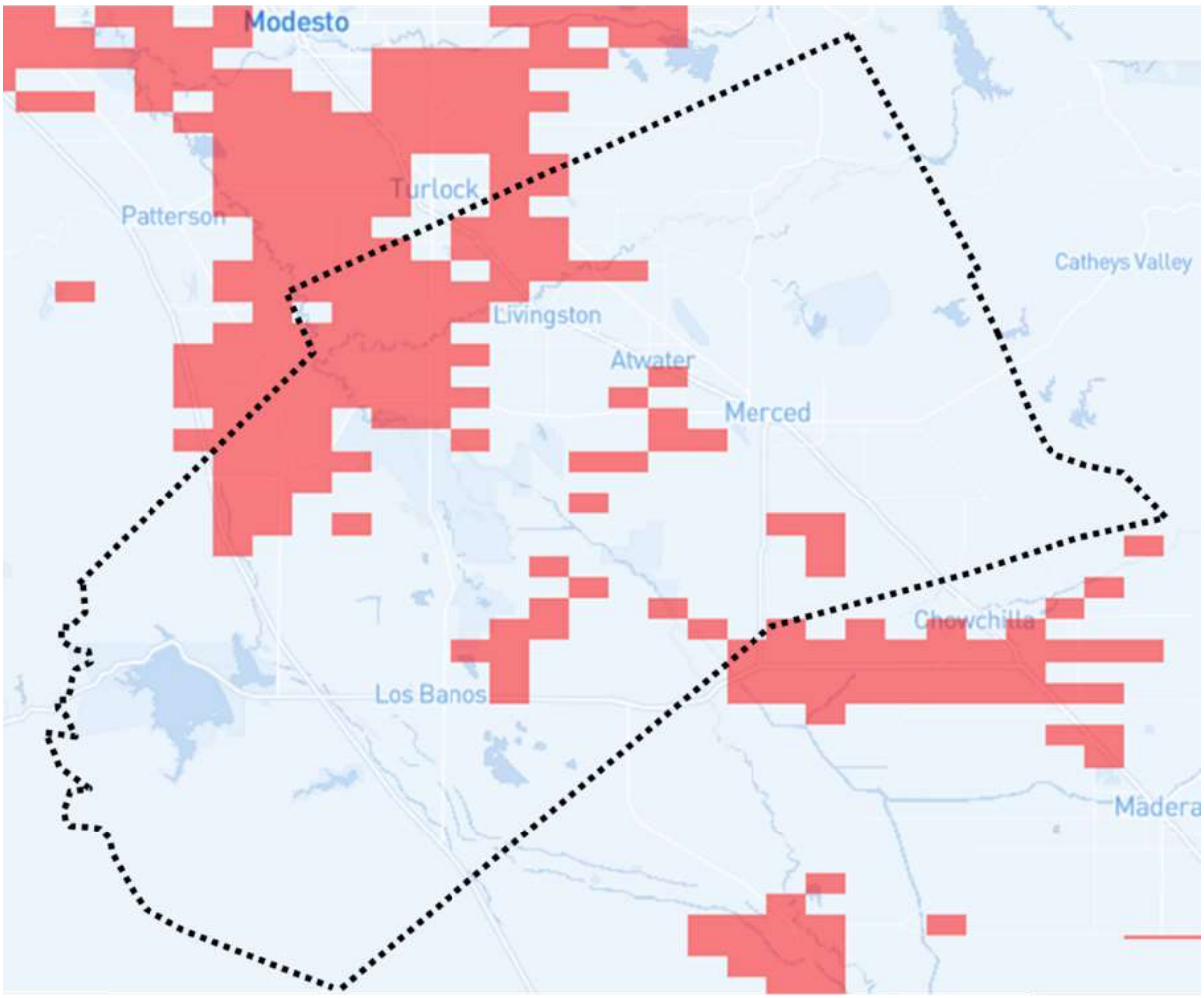

Figure 22. AT&T wireless internet coverage in Merced County[18]

[18] Source: Broadbandnow.com

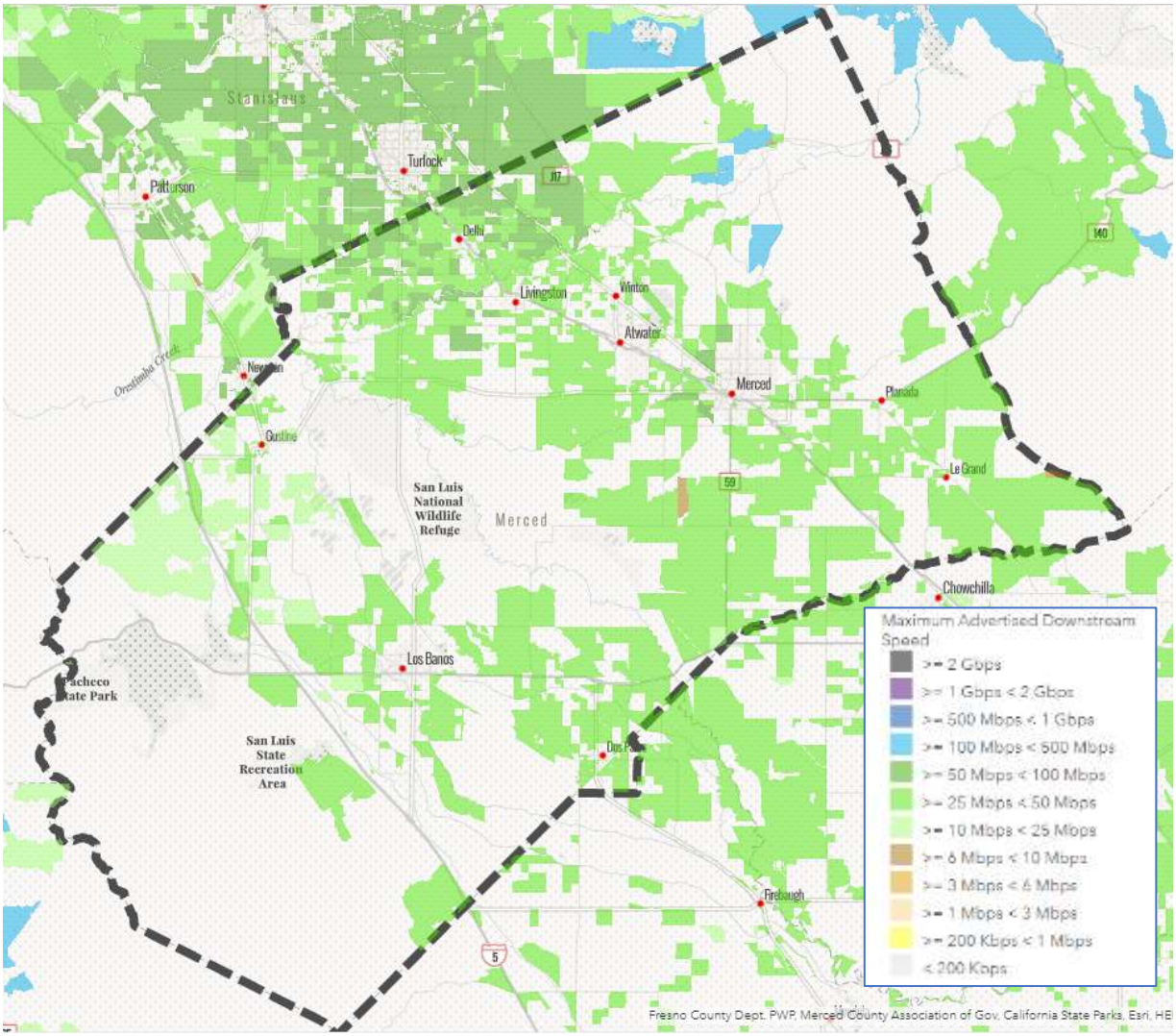

Figure 23. Available wireless download speeds[19]

OTHER PRIVATE NETWORK ASSETS

Long-haul Networks

Fiber optic networks are classified by the types of access they accommodate. Long-haul networks connect major cities and distant facilities to each other, providing bulk/wholesale multi-gigabit circuits to ISPs that are then distributed locally to retail residential and business subscribers. Generally, it is only possible to connect with long-haul fiber at specific points-of-presence in major internet exchange points.

[19] Source: California Public Utility Commission (CPUC), https://www.broadbandmap.ca.gov/

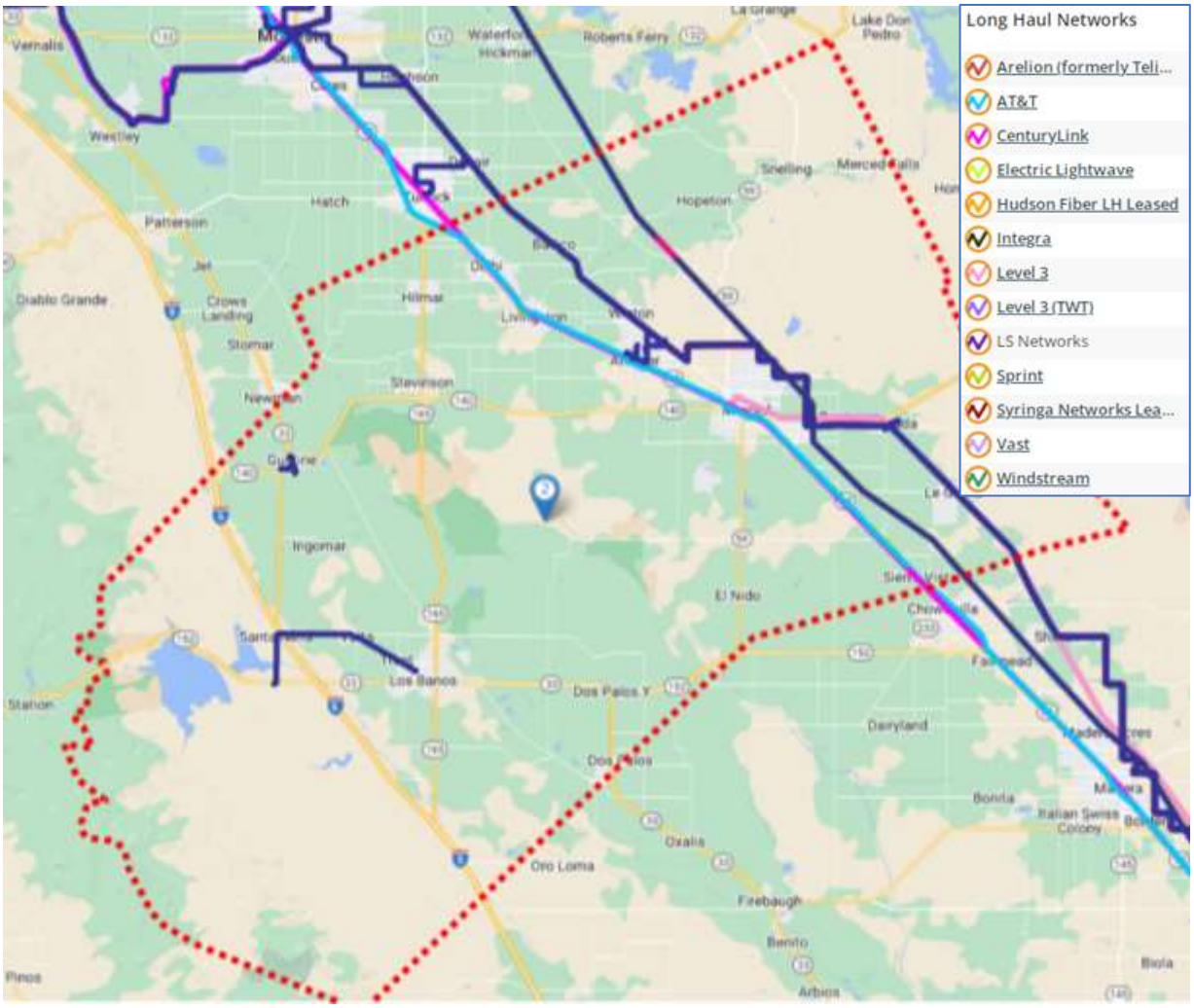

Figure 24. Long-haul fiber networks in Merced County[20]

Most of the long-haul fiber in Merced Count runs north-south along the Highway 99 corridor. These circuits interconnect with all the major carriers in peering data centers in Sacramento, San Jose, San Francisco, and Los Angeles. These long-haul networks could be utilized to secure the bandwidth necessary for the County (or its private ISP partner) to provide retail internet services and add a fiber competitor to the County market.

Metropolitan Networks

Metropolitan networks, as the name implies, are designed to connect major sites to each other, data centers, and other service providers across a metropolitan area, typically via colocation or exchange facilities. Metro networks typically don't provide

[20] Source: Fiberlocator.com

retail-level internet services but provide high-bandwidth services to major commercial enterprises, anchor institutions, schools, hospitals, public agencies, or to other ISPs.

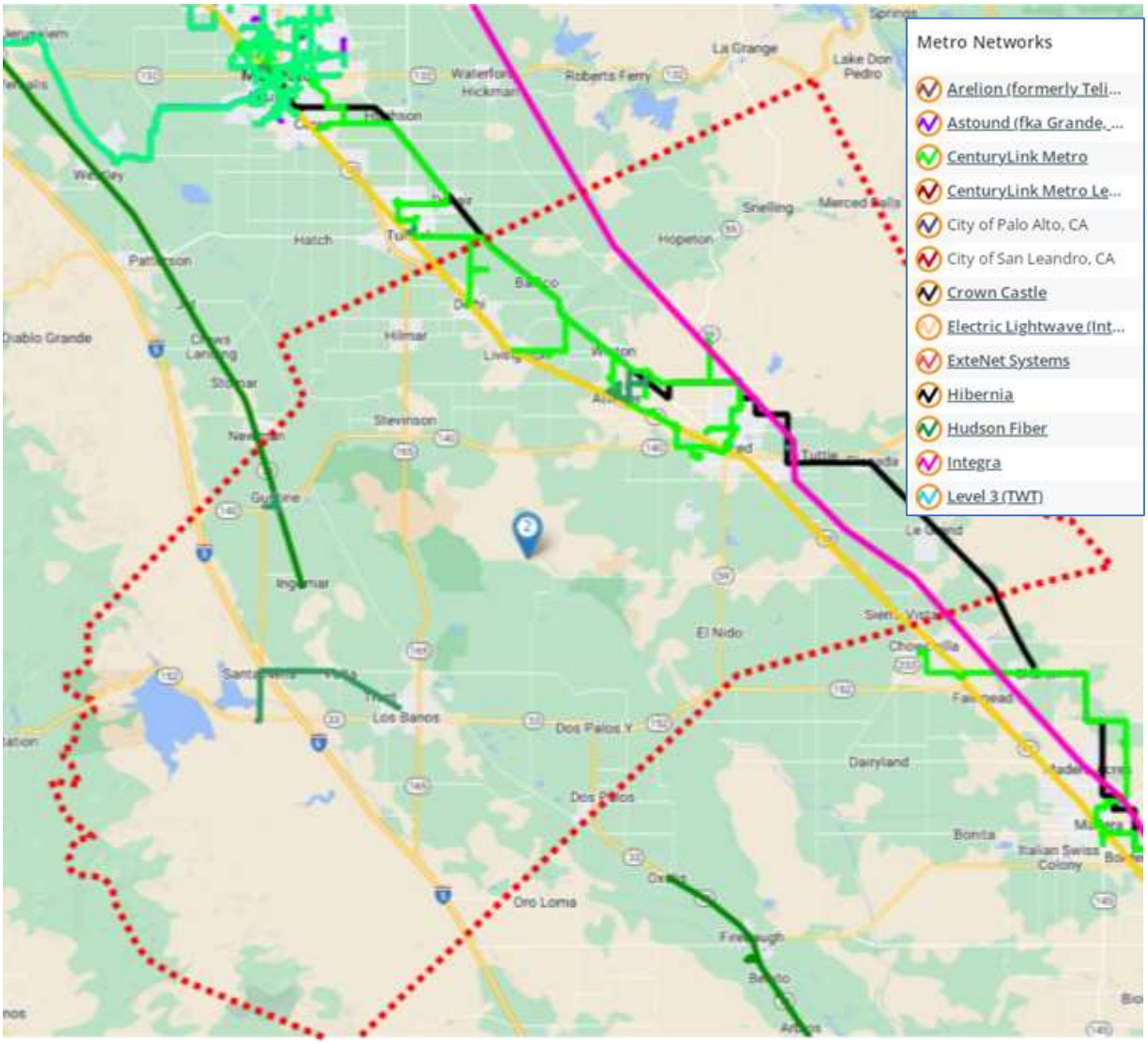

Figure 25. Metro fiber networks in Merced County[21]

As illustrated in **Error! Reference source not found.** 16, CenturyLink operates the m ost extensive metro network in north Merced County, likely serving enterprise customers and cell towers within the Highway 99/Castle Airport area. This existing fiber network could be utilized both for redundancy through circuits back to

[21] Source: Fiberlocator.com

Sacramento and/or San Jose or combined through leases to minimize costs for new County fiber backbone construction.

Data Centers

Colocation facilities, data centers, and other nodes where multiple networks interconnect—also called meet-me rooms—are where service providers interchange network traffic. A major trend in data and software applications is the migration of services to "the cloud." By moving data resources closer to the edge, end users are able to reduce latency and improve application performance. Thus, data centers and peering points are increasingly being established further from the major internet centers to enable better cloud services in areas further from major US cities.

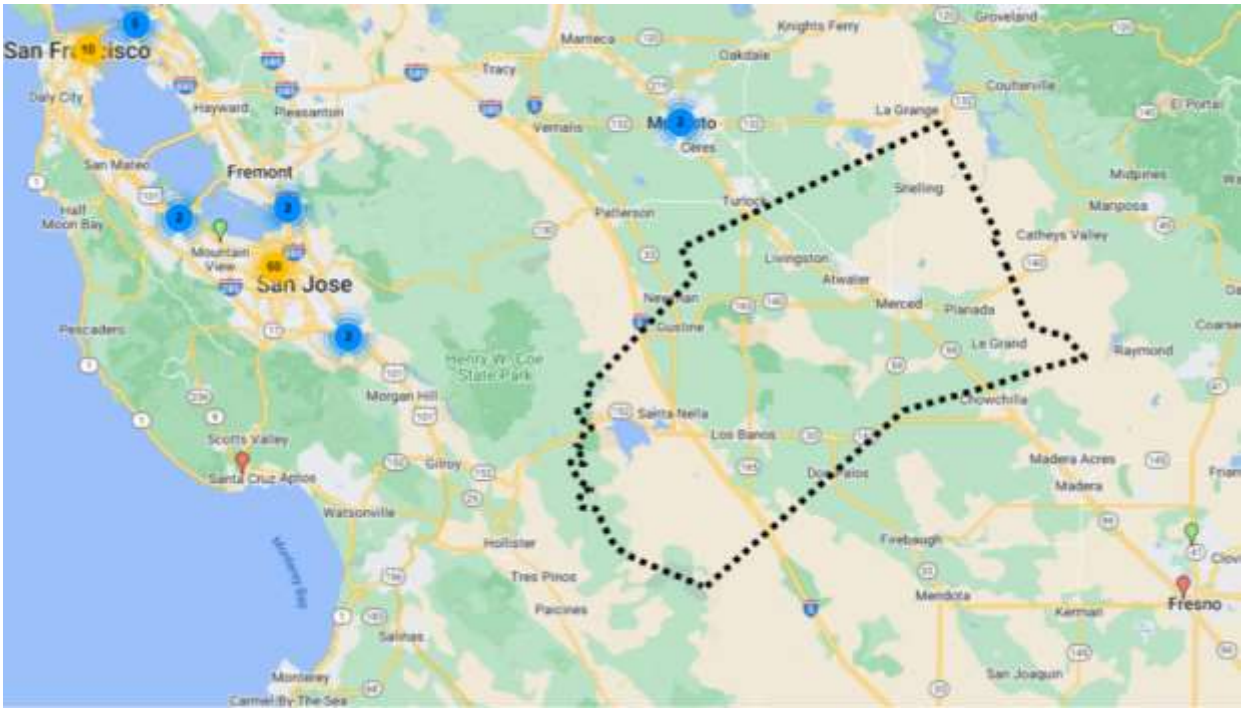

Figure 26. Data centers and colocation facilities near Merced County[22]

Most data centers and interconnect facilities in proximity to Merced County are in San Jose, San Francisco, and Sacramento. There are smaller private interconnect facilities in Fresno County and Modesto, but these do not offer the kind of robust carrier aggregation and redundancy that larger facilities can provide. There is a private interconnect "central office" (a small, localized interconnect facility for one

[22] Source: Datacentermap.com

or more providers) in Merced County located in Fergus along Highway 99, about 3 miles north of Downtown Merced (not pictured/shown in Figure 17). This location could be expanded with a newer, larger facility and could attract more carriers seeking interconnection to ultimately serve as Merced County's data center and colocation point, bring the "edge" within Merced County and enhancing the County's circuit reliability and redundancy.

4. Community Survey Results

The County of Merced contracted with Magellan to develop a countywide broadband strategic plan. A key element of the planning process was to survey residents and businesses to identify current services, test speeds across the community, and identify willingness to support another offering. The online survey instrument included an embedded speed test to determine actual performance and identify location areas with slow speeds limited broadband availability. This memo reports on the results of the survey.

The survey was conducted from October 2022 through January 2023. The County of Merced created a page on its website for broadband planning with a link to the survey. The survey was promoted by the County via regular and special communications including social media. The City of Merced also actively promoted the survey. Stakeholder representatives were asked to promote the survey. Respondents saw only the relevant questions. Only those that indicated broadband service at their locations got the speed tests and questions about their service. Household and organizations got different questions. An abbreviated survey instrument on paper was provided for those with no internet access.

The online survey was opened for 16 weeks and had 556 total responses, 240 complete (i.e., the respondent answered required questions, went through all survey screens, and clicked “Submit”). After clean-up, there were 465 usable responses. Not all respondents answered all questions, so each question is analyzed separately with the number of responses (n) specified. While the total number of responses rises to the level of statistical validity, we use approximate language to emphasize that the results represent the respondents’ understanding and views rather than the overall population.

RESPONSES

Of the 465 total usable responses, 81% had broadband, as shown in Table 4. Half of the responses were complete. Those with low-speed internet (cell/smartphone, dial-up, or satellite) completed the survey at a higher rate than other respondents.

Table 4. Number and percentages of complete and partial survey responses by type of internet service

Responses	All	Broadband internet	Low-speed internet	No internet
Total	465	375	73	17
	100.0%	80.6%	15.7%	3.7%
Complete	234	173	54	7
	50.3%	73.9%	23.1%	3.0%
Partial	231	202	19	10
	49.7%	87.4%	8.2%	4.3%

Ninety percent of responses represent households. Forty-six responses, less than one tenth the useable responses, were from organizations. As shown in Figure 27, the majority of both had broadband. Households were more likely to have slow internet (17%) and only households (4%) had no internet.

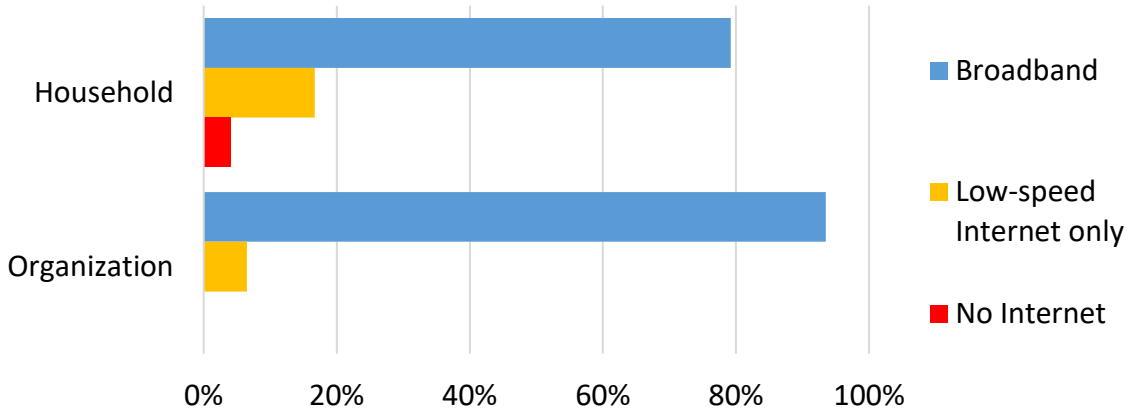

Figure 27. The type of internet service by percentage of households (n = 419) and organizations (n = 46

Nearly two-fifths of responses came from the zip code in the City of Merced. Over 14% came from zip code 95301 in Atwater and 11% from zip code just south of Merced. Other zip codes, listed in Table 5, had less than 10% of responses.

Table 5. Percentage of 465 response per zip code

Zip	Percent of Total (n = 465)
95340	23.0%

Zip	Percent of Total (n = 465)
95348	15.1%
95301	14.0%
95341	10.8%
95365	6.0%
95322	5.6%
95315	5.4%
95334	4.5%
93635	3.4%
93620	3.0%
95388	2.4%
95333	1.7%
95317	1.3%
95369	0.6%
95380	0.4%
95324	0.4%
95312	0.4%
95303	0.4%
93610	0.4%
95323	0.2%
93665	0.2%

Figure 28 overlays the percentage of responses per city with the percentages of responses in each city for various types of internet access. Note that some cities had few responses but indicated no internet—one each from Chowchilla and South Dos Palos and two from Ballico. The few respondents from other cities, specifically Hilmar and Turlock, all had broadband. This does not mean that no one in Ballico, Chowchilla, and South Dos Palos have broadband or that everyone in Hilmar and Turlock do.

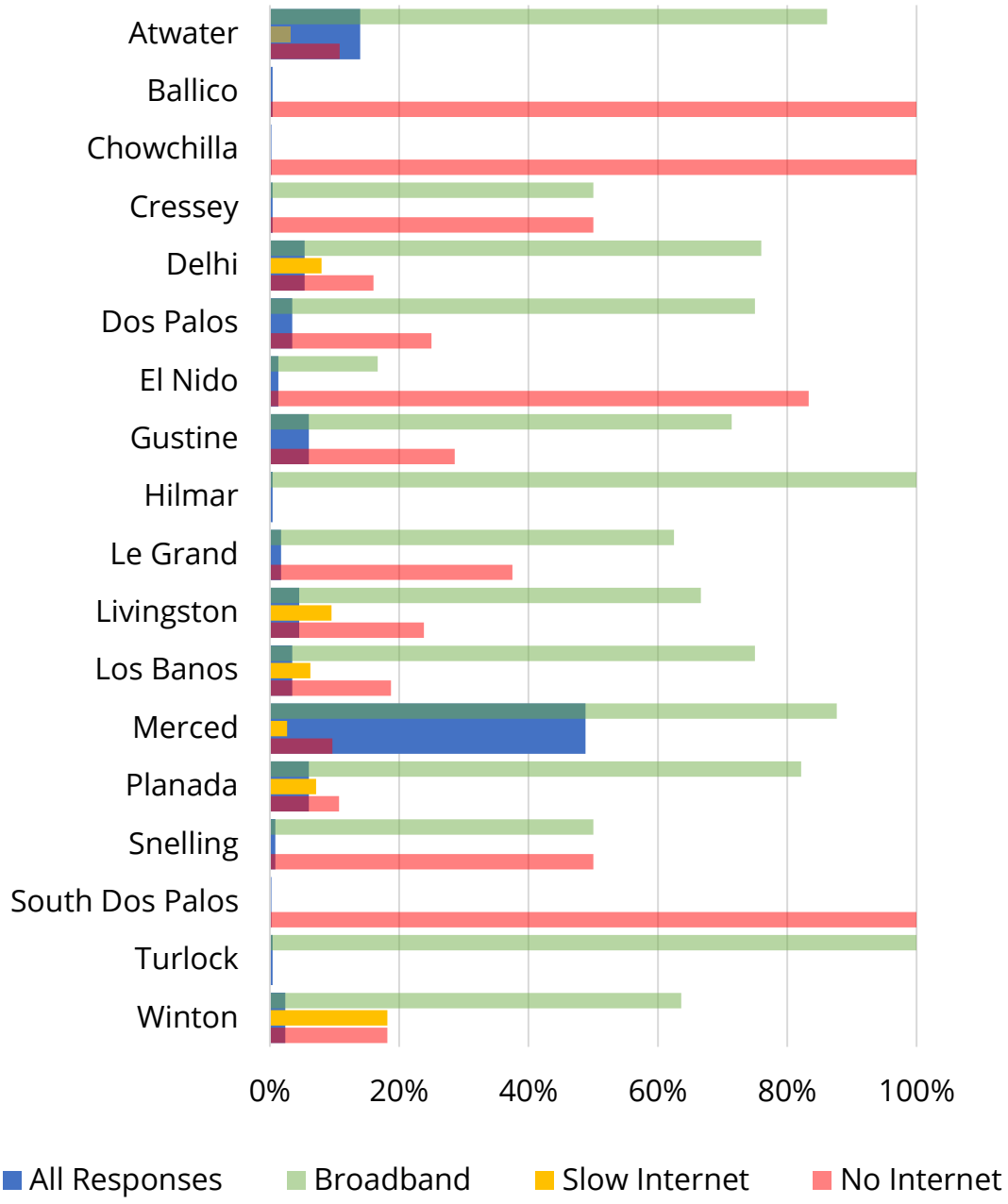

Figure 28. Responses from various cities in Merced County compared (n = 465)

As indicated in Figure 29, responses were more likely to come from those with bachelor's degree or higher than would be expected based on the population. Part of this was due to the nature of the question, which asked for the highest level of educational achievement in the household, which naturally skews the data higher than the overall population. A more substantive result is that the quality of internet access is clearly related to educational level among responses.

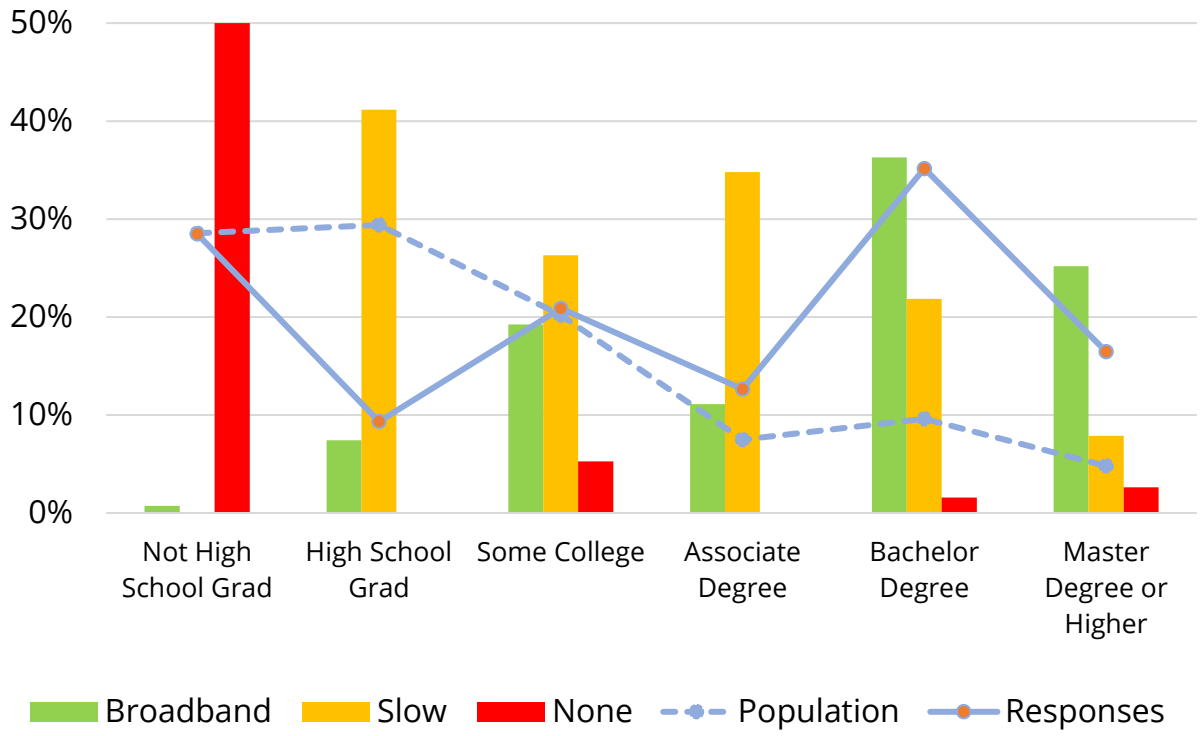

Figure 29. Percentage of county population, total responses, and types of internet service of responses by educational level.

Respondents

As noted above, over 90% of responses were from households. Of the 46 organization responses, ten were complete, and only four provided information about the organization. Given the low number of organization responses, their responses are not analyzed separately. The average household size among respondents is 3.6 persons, and 3.3 for the population of Merced County. The median age of respondents' households was 37 compared to 33.9 for all households in the County.

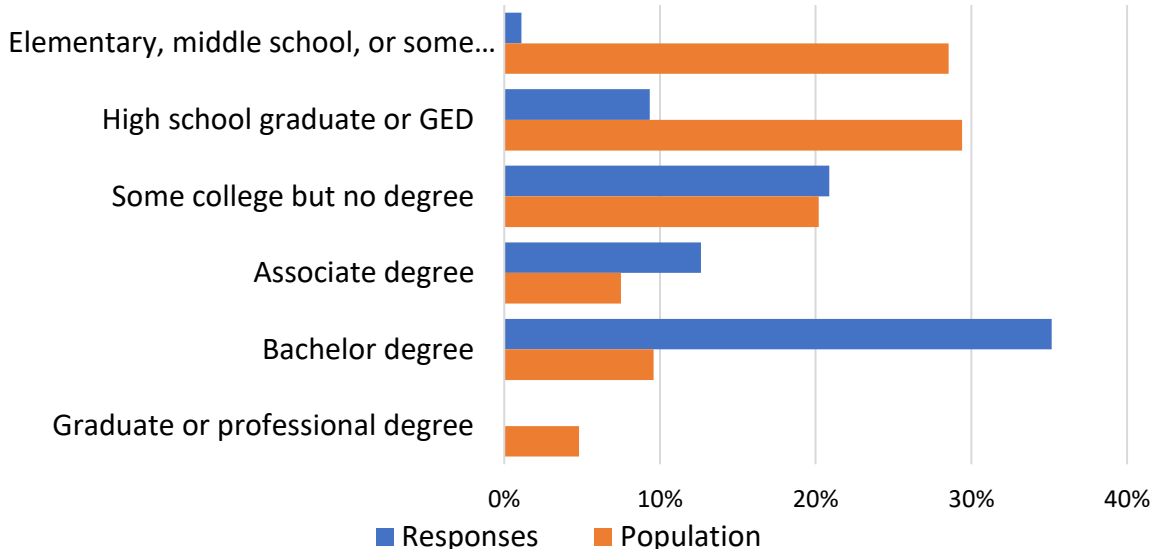

Figure 30. Percentage of 182 responses and overall population by educational levels

Responding households were much more likely to have a bachelor's degree than typical in the County overall, as shown in Figure 30, and more likely to have an associate degree. There were fewer responses indicating with less than high school or high school education than would be expected based on the population. No respondents indicated higher than bachelor's degree. Some of this difference is undoubtedly due to the respondents not necessarily representing the population. Regardless, the results suggest respondents were overall more highly educated

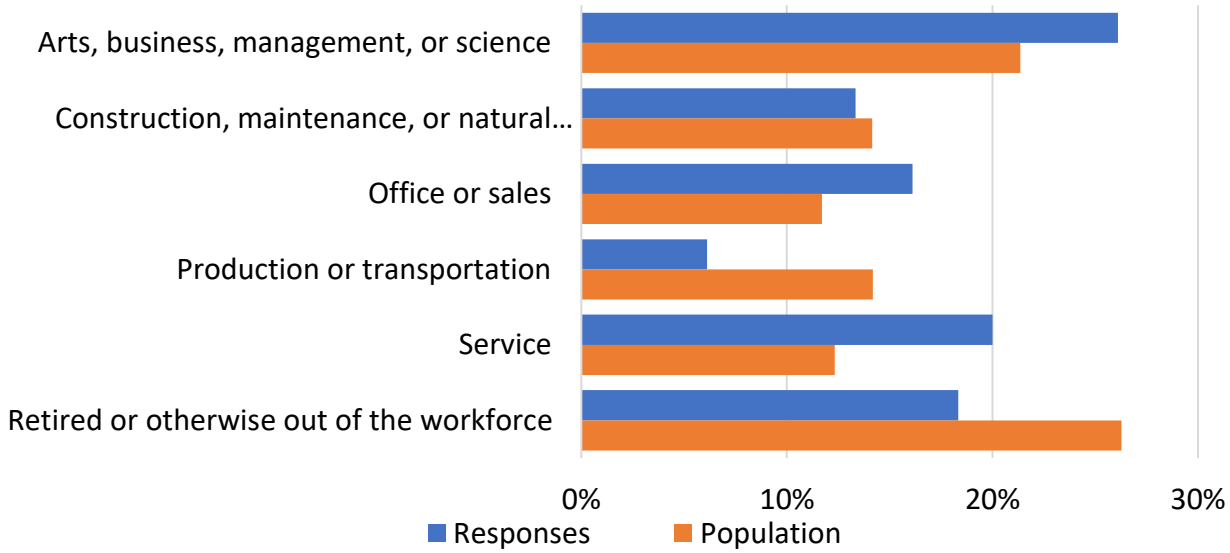

Figure 31. Percentage of 180 responses and overall population by occupational areas

Respondents were much more likely to be in arts or management, office or sales, and service occupations than the overall population, as shown in Figure 31.

Response rates were relatively low for production or transportation occupations and those outside the workforce.[23] The results suggest respondents were generally middle-class families with older children.

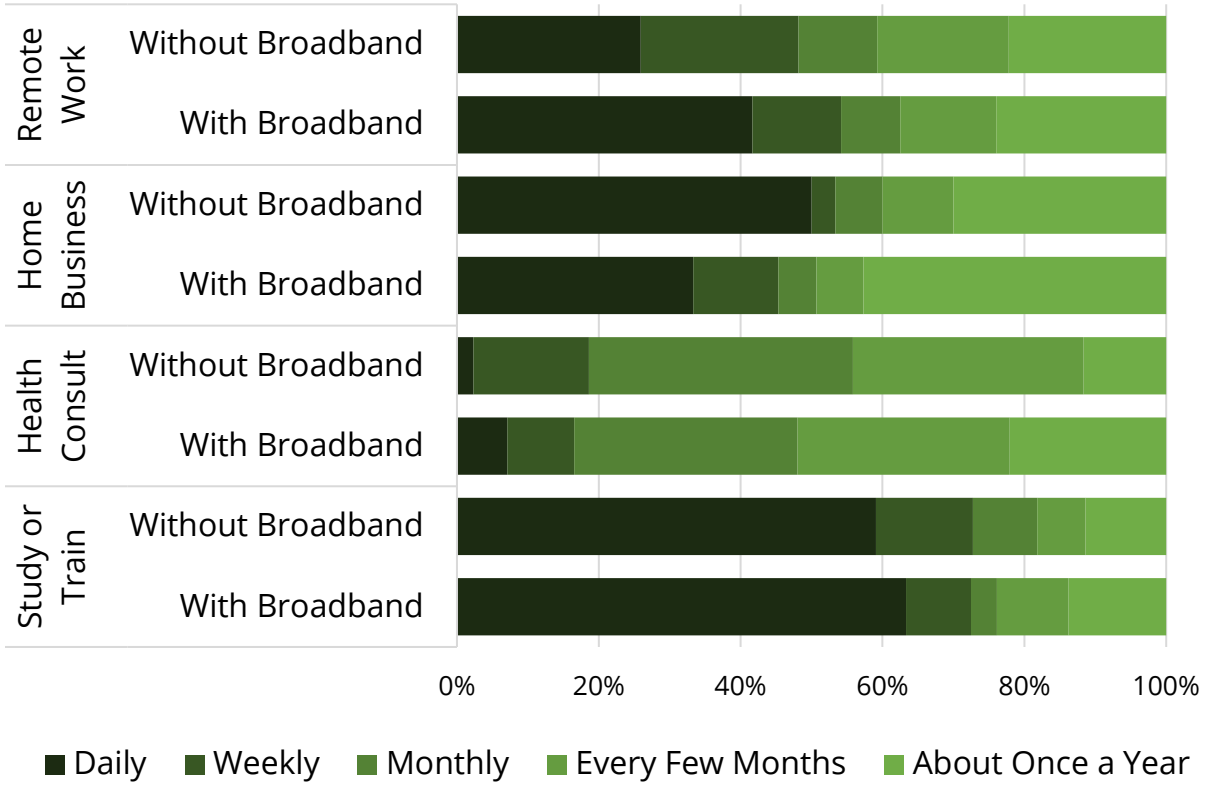

Figure 32. Frequency of broadband-demand indicator activities by percentage of 170 responses comparing households with and without broadband

Certain activities represent demand or reasons for using broadband, so the survey asked about how frequently members of respondents' households engaged in these activities. The most common and frequent activity of these was studying or training at home, followed by working remotely for an employer. As shown in Figure 32, study at home was about the same for households with and without broadband while households with broadband were more likely to have dedicated remote workers. Consulting a healthcare provider was the most common activity but was generally done once a month or less often. Operating a home-based business was the least

[23] Based on households have an estimated 1.74 employed members and on the number of households receiving social security income.

common activity, although nearly half of responding households had a member that did this activity at least once a week. It is notable that households *without* broadband were more likely to have members working on home-based businesses every day.

Table 6. Statitics for number of devices per location comparing all households to those with and without broadband

Respondents	Max	Mean	Median	Mode
All	200	10.3	8	10
With broadband	200	11.5	8	10
Without broadband	21	6.9	5	5

Respondents overall had an average of just over ten devices per household,[24] which can be seen as an indicator of demand for broadband. Those with broadband had substantially more devices than those without broadband as shown in Table 6. The most common number of devices (mode) for broadband households was twice the most common number for non-broadband households, ten compared to five. The most devices for a household without broadband were about a tenth of the maximum number of devices among those with broadband.

BROADBAND SERVICES

Comcast Xfinity is the dominant provider, as over half of the responses indicated have its services. AT&T has effectively over a quarter of the market.

[24] This analysis did not include organization locations.

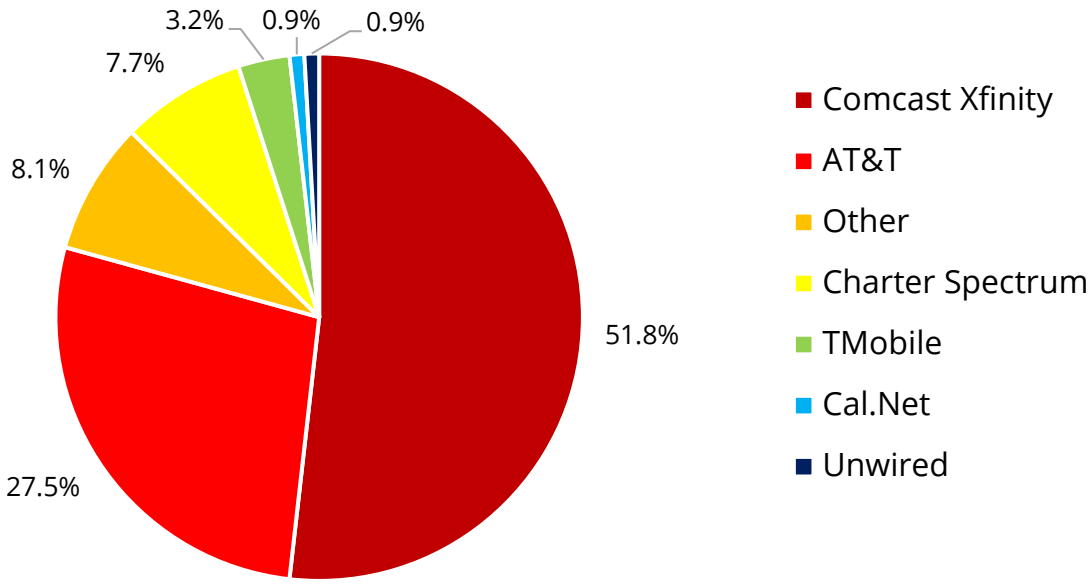

Figure 33. Percentage of 222 responses by internet service provider

Other providers included Charter Spectrum, a legacy cable company like Comcast, and T-Mobile, a cellular company that provides 5G fixed wireless broadband services. Two responses each were for Cal.Net and Unwired, regional wireless internet service providers. Responses indicated other services, which were third as a category, included Earthlink, Fire2Wire, Frontier, RWSI, and Verizon.

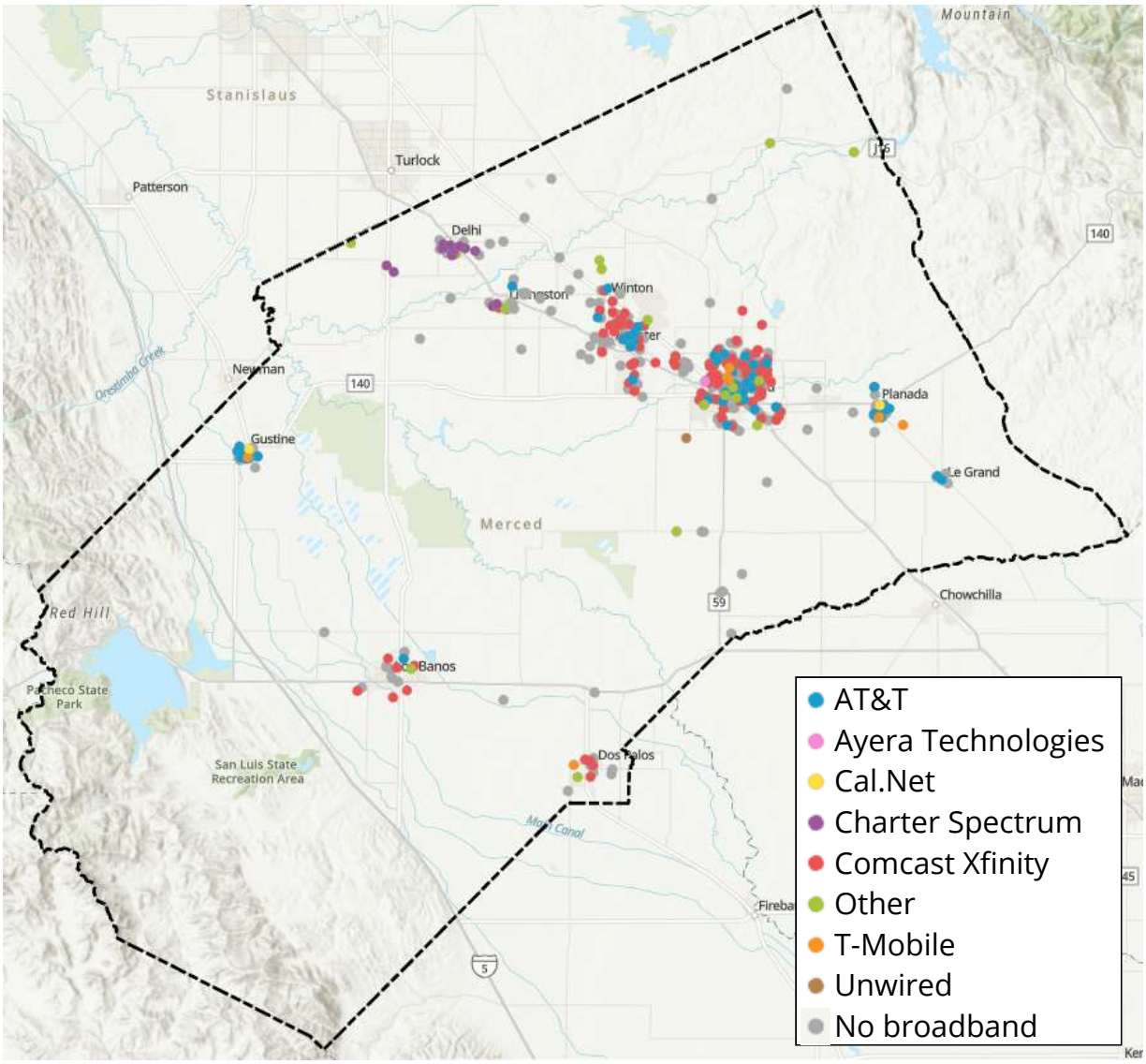

Figure 34. The geographic distribution of 222 responses by service provider, including locations without broadband

The geographic distribution by provider, illustrated in Figure 34, shows cable providers Charter and Comcast in separate areas—Charter in the northern areas and Comcast in the south. AT&T is widely distributed across the County as are locations with other services and no broadband. Many of these were in the northern and southern portions of the County. There were no responses for locations in the center or western portion of the county.

Table 7 provides a comparison of the monthly recurring costs (MRC) and speeds, both actual and contracted. The MRC varies widely but is generally between $45

and $135 per month for internet-only. The MRC per megabit per second (Mbps)[25] of bandwidth varies much more, from less than a dollar to over $16. The average actual (and contracted) speeds for also vary widely. Generally, the more respondents paid, the faster their service but (a) there were substantial discrepancies between what respondents say they were offered—recognizing that retail broadband is "best effort" rather than guaranteed bandwidth—and (b) the costs were generally relatively high and speeds relatively low.

Table 7. Average reported costs and speeds for providers compared

	MRC[26]		Contract Speed		Actual Speed		MRC/
Provider	All	Internet	Down	Up	Down	Up	**Mbps**
AT&T	$129.57	$59.54	190.7	174.5	103.1	58.6	$2.77
Charter Spectrum	$129.44	$70.00	270.7	71.0	182.9	18.9	$0.67
Comcast Xfinity	$700.48	$132.57	523.5	205.9	243.3	39.9	$0.67
T-Mobile	$96.67	$46.67	136.6	36.0	132.0	120.4	$2.23
Unwired	$119.99	$119.99	96.0	15.0	43.5	12.9	$1.23
Other	$144.11	$95.44	41.3	11.5	138.9	126.0	$16.78
All	**$421.26**	**$97.24**	**351.5**	**159.9**	**183.4**	**55.4**	**$2.80**

Some basic descriptive statistics for responses regarding broadband costs and speeds are included in Table 8. While some respondents did have gigabit connection, most speeds were far below that. The fact that the median speeds were far below the mean (average) indicates most respondents' speeds were below average. The same is true for MRC and MRC per Mbps: most respondents paid less than average. But the average MRC per Mbps is much higher than the competitive rate for fiber-based broadband, which is less than $0.30 MRC per Mbps.

[25] Monthly recurring costs per megabit per second (MRC per Mbps) is normalized metric for the cost of broadband.

[26] MRC stands for "monthly recurring costs."

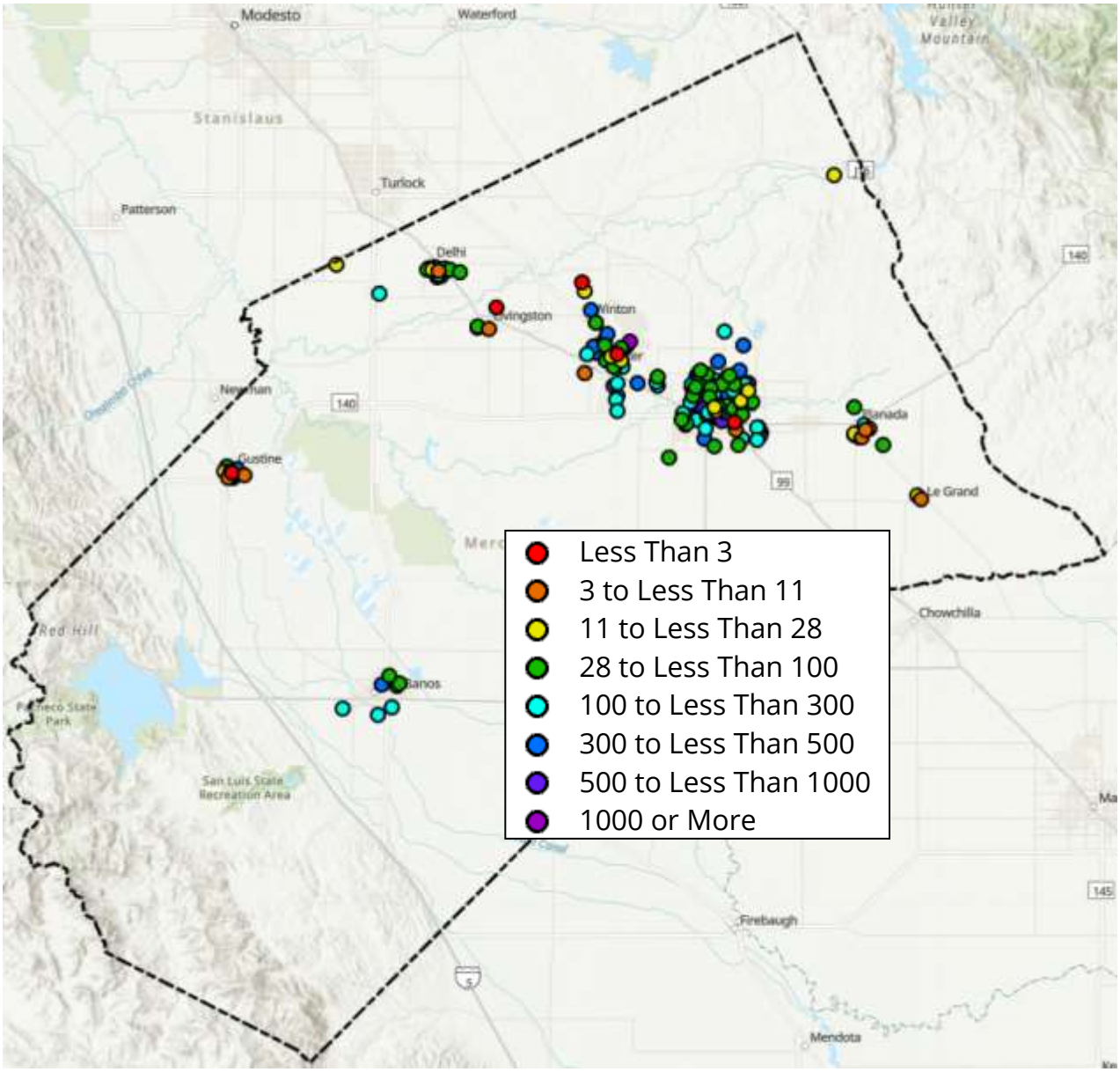

Figure 35. The geographic distribution of 222 responses by aggregate throughput

Table 8. Basic statistics for broadband costs and speeds

Statistic	Down	Up	MRC	MRC per Mbps
Responses	181	180	118	103
Max	934.6 Mbps	913.2 Mbps	$3,000.00	$105.26
Mean	183.4 Mbps	55.4 Mbps	$97.24	$2.80
Median	88.4 Mbps	11.7 Mbps	$70.00	$0.60
Mode	N/A	0.9 Mbps	$50.00	N/A
Min	0.2 Mbps	0.05 Mbps	$9.95	$0.03

The distribution of responses by speed and MRC per Mbps are shown in Figure 36and Figure 37. While over half of respondents had speeds over 120 Mbps total throughput (download plus upload), a fifth of respondents had throughput under 28 Mbps (less than the national standard for broadband). Similarly, while nearly a third of respondents were paying less than $0.30 MRC per Mbps, nearly two-fifths were paying over $1.00 MRC per Mbps.

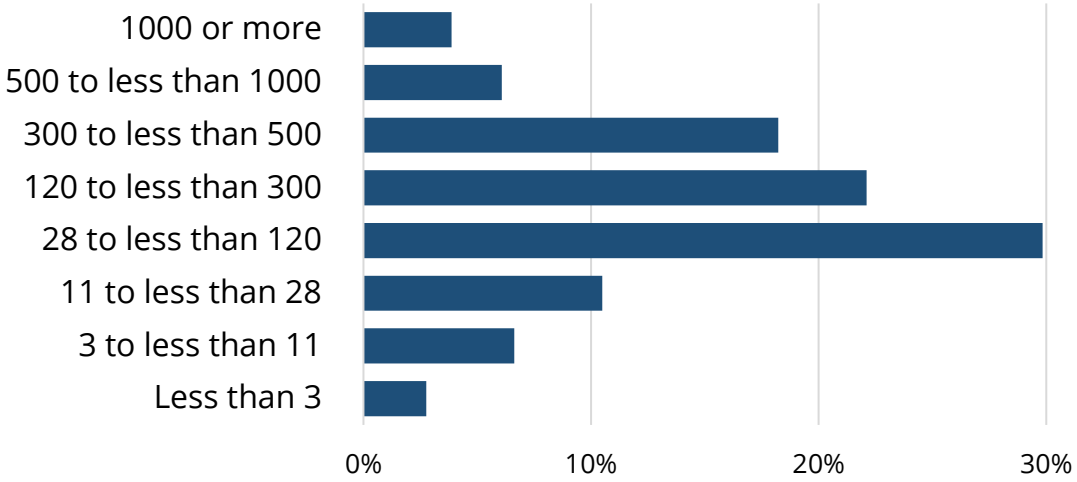

Figure 36. Percentage of 181 responses by tested throughput ranges

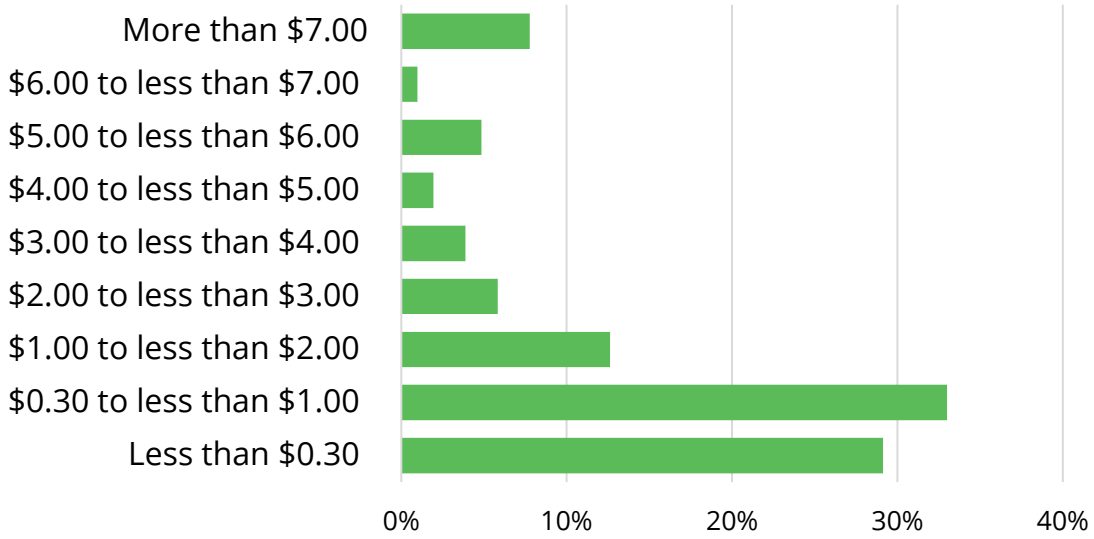

Figure 37. Percentage of 105 responses by MRC per Mbps ranges

Well over half of respondents took only broadband service, as illustrated in Figure 38. Cable television was the most common other service, which a quarter of respondents indicated having. Overall, respondents paid an average of $170 MRC

for all services. Seventeen of 125 respondents paid over $250 per month to their providers.

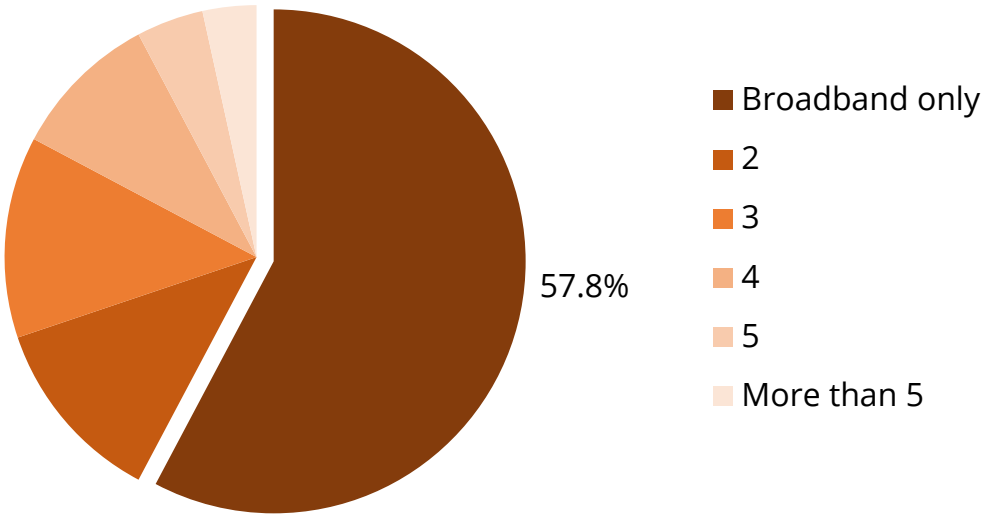

Figure 38. Number of services taken by percentage of 116 responses

The overall reliability reported by respondents was reasonably good, as shown in Figure 39, although over a quarter of respondents experienced outages of at least an hour at least once a month. Most respondents rarely if ever experience an outage over 2 hours.

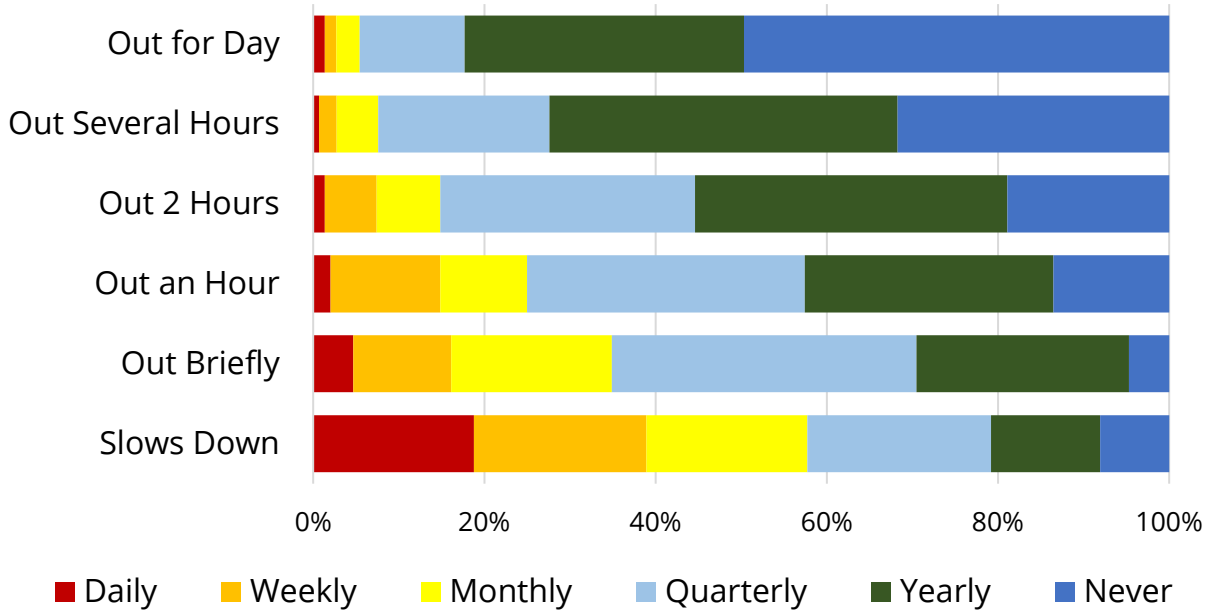

Figure 39. Percentage of 148 responses by frequency and length of performance issues

RESPONDENT SENTIMENTS

The survey asked about the importance of various aspects of broadband service, respondents' level of satisfaction, and their willingness to pay. While the importance and willingness to pay questions were presented to all respondents, the satisfaction question was only asked on those with broadband.

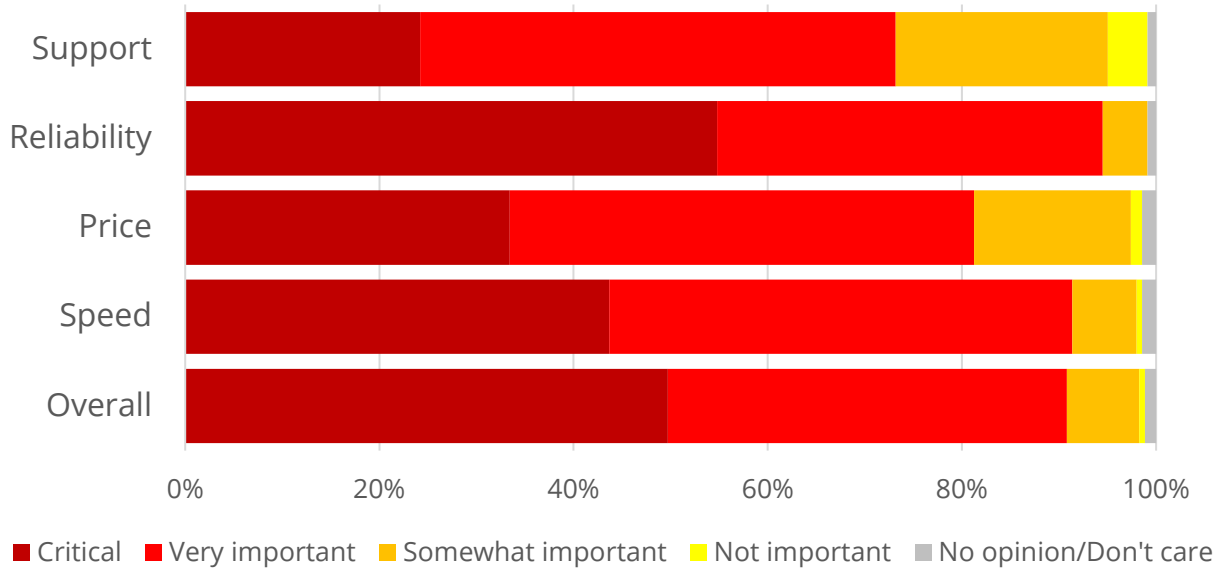

Figure 40. Importance of broadband service factors by percentage of 346 responses

Half of respondents indicated that internet access was critical to them. See Figure 40. Consequently, it's not surprising that a larger percentage indicated that reliability was a critical issue. Overall, reliability was clearly the major issue for respondents. Price and support were also highly rated. Less than 5% of respondents felt speed was unimportant or had no opinion, while about 14% indicated customer support was not important and just over a fifth felt it was only somewhat important.

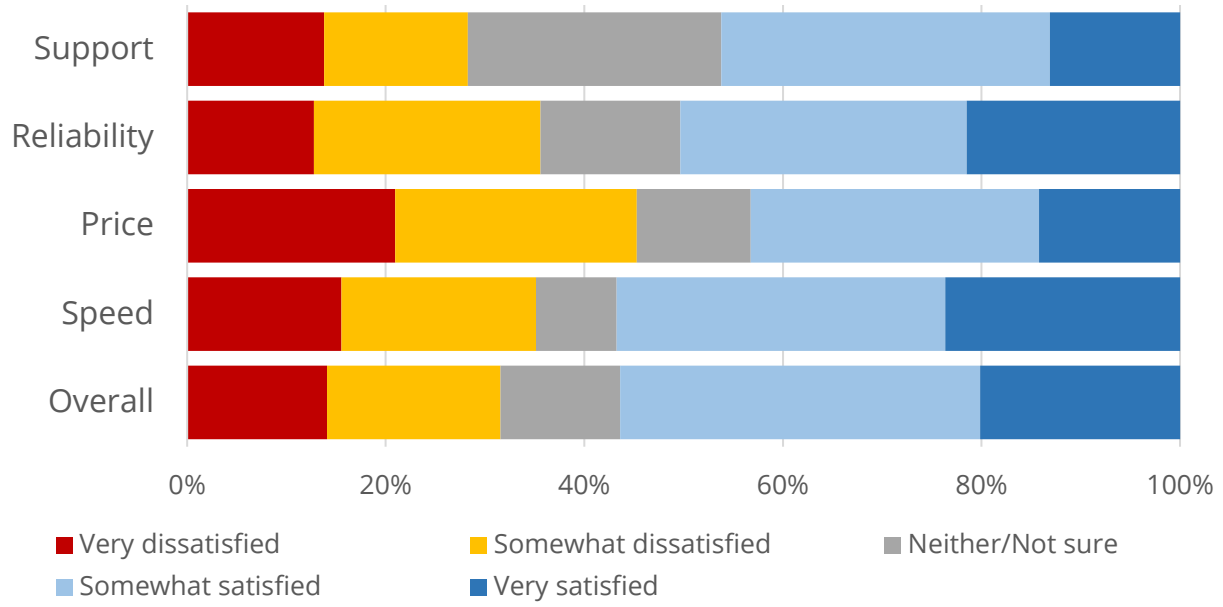

Figure 41. Satisfaction with various aspects of broadband service by percentage of 149 responses

Similarly, as shown in Figure 41, just over half of respondents were at least somewhat satisfied with their broadband service overall and its speed. But, in contrast, just over half were dissatisfied with the cost.

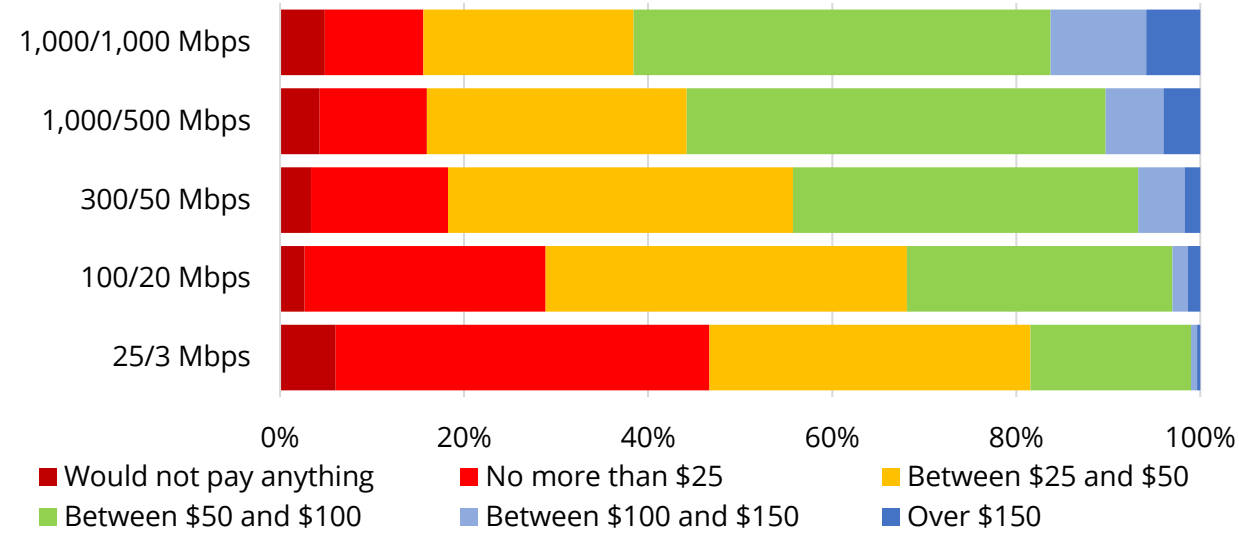

Figure 42. Willingness to pay for various broadband speeds with excellent customer service as a percentage of 301 responses

As noted above in Table 8, the median speed test by survey respondents was 88/12 (88.4 Mbps down and 11.7 Mbps up) for $70.00 a month or around $0.70 per month per Mbps. The actual median MRC/Mbps was $0.60.

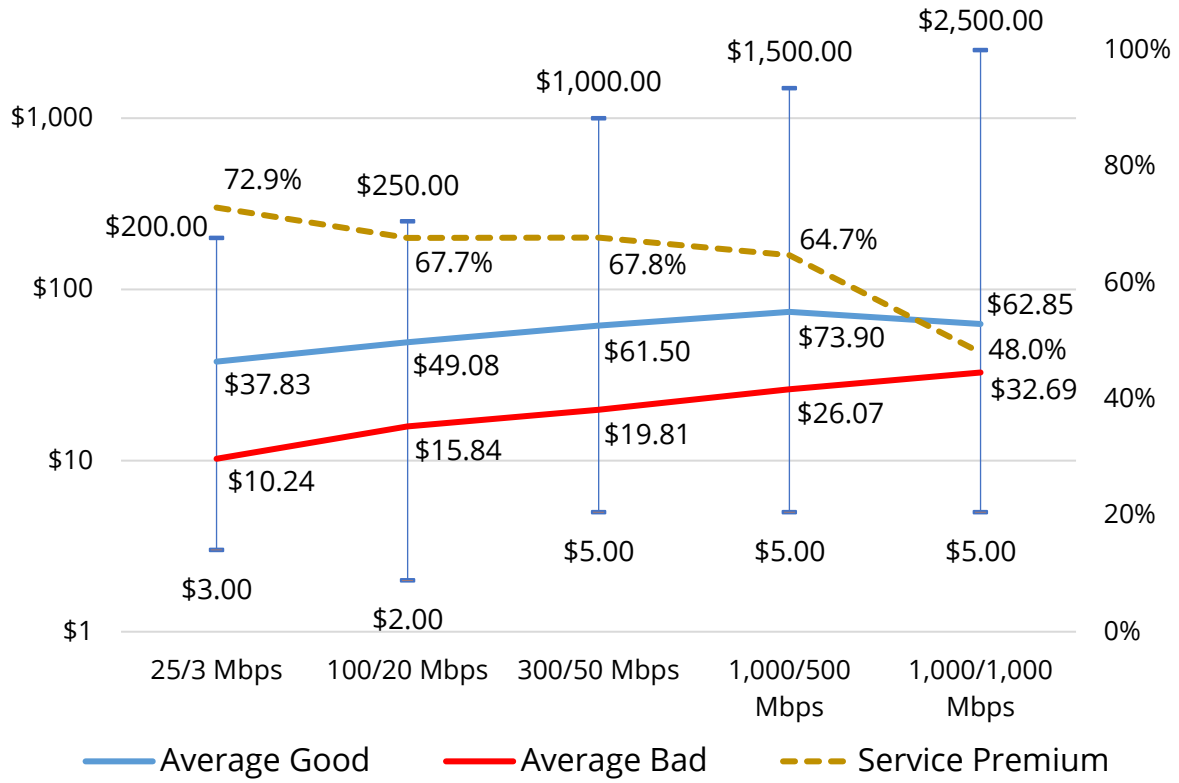

Figure 43. Willingness to pay range for excellent versus terrible customer services based on 364 responses

In contrast, presuming excellent service, 68% of respondents indicated they would not pay $50 per month for 100/20, which is $0.43 MRC per Mbps. Over half did not want to pay $50 for 300/50, which is $0.14. Forty-five percent would pay at least $50 for 300/50 and 10% would pay more than $100 for 1,000/500 service. Some respondents apparently do not want to be connected: Around 5% of respondents would not pay anything for any broadband service.

Customer service and technical support was not as critical for respondents as other issues but, as shown in Figure 40, only 5% of respondents felt it was not important. The survey asked about willingness to pay for "terrible" as well as "excellent" services. Figure 42 compares the two, show the average amount for good and bad service, along with the range of maximum and minimum amounts for good service. As expected, respondents' willingness to pay generally increases with bandwidth provided. The difference between average they were willing to pay for good and bad service as a percentage of the average for good service—the "service premium"—decreased with bandwidth and MRC. This indicates the importance of customer service was highest among those willing to pay for lower bandwidth services.

BROADBAND USES

The most common and frequent use among respondents was general communication—email, etc.—as shown in Figure 44. This was followed by entertainment and general interest research, which were about as common and frequent. Gaming and learning were also equivalent in commonness and frequency, as were online buying and special interest research (hobbies).

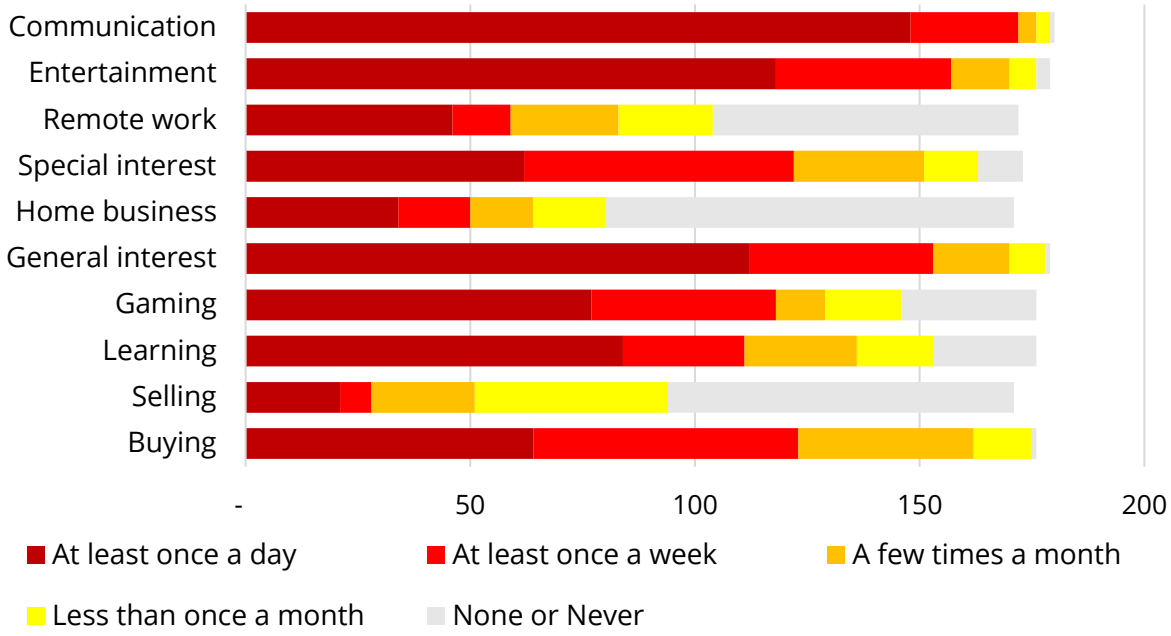

Figure 44. Frequency of various internet uses by number of responses

The least frequent use among respondents' households was online selling, although it was more common than running an online home-based business. Home-based business and remote work were also relatively infrequent and uncommon.

"Cord-cutting"—abandoning cable television in favor of streaming video—is a notable use of broadband that indicates use of broadband over traditional media. Among respondents, over two-fifths of respondents used only streaming video whereas less than a tenth used no streaming video. See Figure 45. Nearly three-quarters of respondents got the majority their video via streaming services.

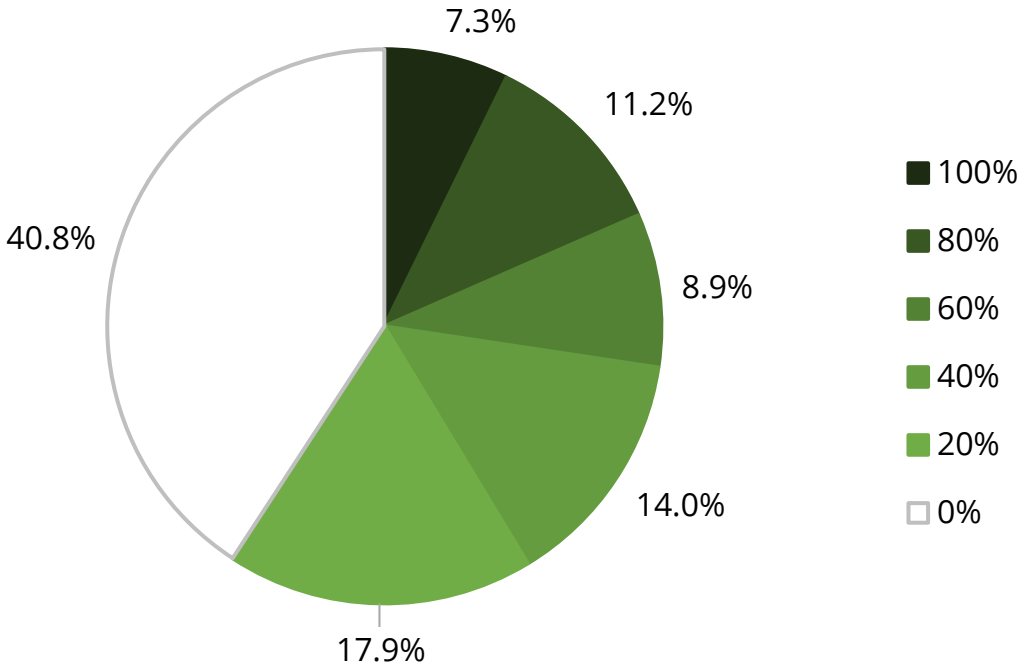

Figure 45. Percent of video from traditional broadcast/cable by percentage of 179 responses

NON-BROADBAND HOUSEHOLDS

A total of 90 responses indicated not having broadband. Eighty-seven of these were from households and 70 of those had low-speed internet. Seventeen said they had no internet. As shown above in Figure 29, responses indicate households without broadband tended to have lower levels of educational achievement. They were also more likely to operate a home-based business.

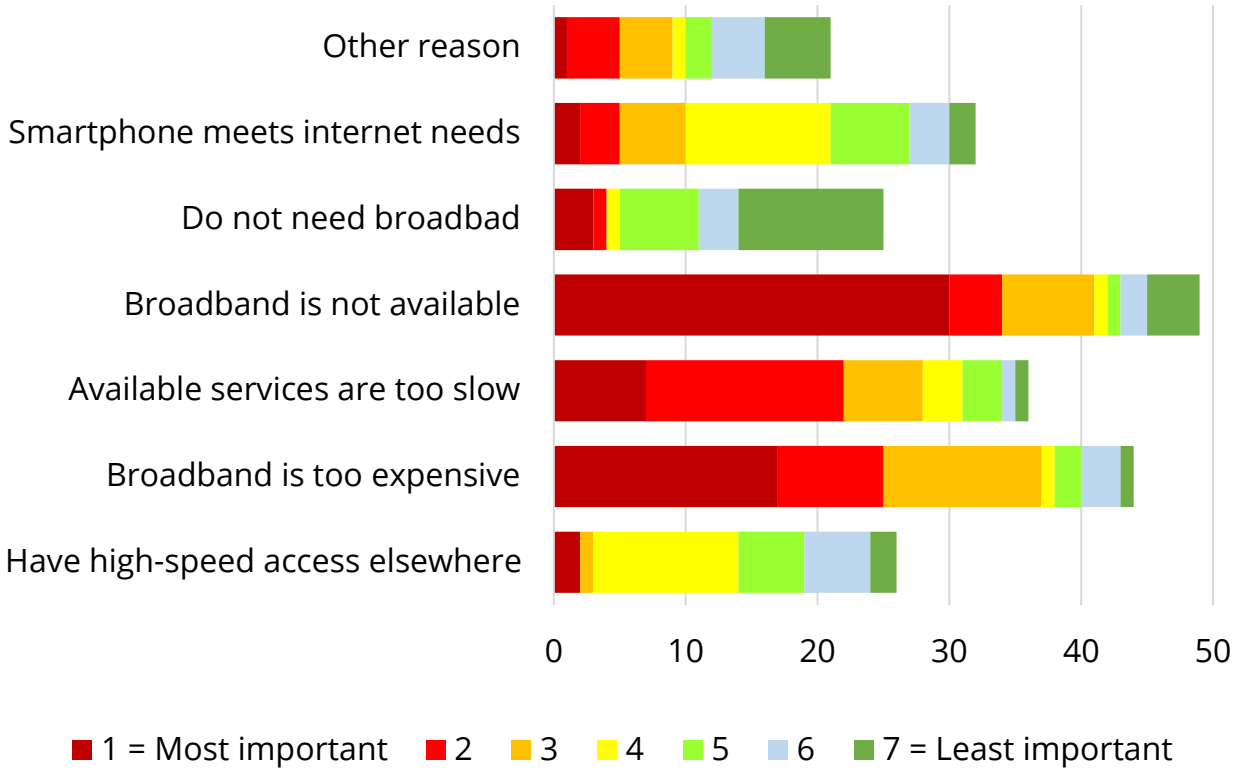

Figure 46. Number of responses per level of importance for reasons for no broadband

The most common and important reason for no broadband among survey respondents, as shown in Figure 46, was unavailability. Costs were a close second. Not needing broadband was the least common reason other than reasons not included as response options. It was the most important reason, though, for more respondents than having high-speed internet access elsewhere or needs met by smartphone. The least common and important reason was having high-speed access elsewhere.

5. Stakeholder Input

The Magellan team worked with the Merced team during late summer and early fall of 2022 to identify the full range of community stakeholders. Generally, stakeholders are anyone who has an interest in the success (or failure) of an initiative, organization, or project. For broadband planning, we consider stakeholders to organizations in an area, particularly those that serve and support local businesses and residents.[27] A list of these types of major organizations, including their representatives' contact information, was developed by the Merced team and supplemented by the Magellan team. For practical purposes, we narrowed these down to nine groups for which we convened online focus groups:

- Agriculture, Major Industry, and Economic Development
- City Administration and IT
- Education
- Health and Wellness
- Land Use and Real Estate Development
- Public Safety
- Small Business and Support Industry
- Social Support Services
- Transportation and Utilities

The focus groups were scheduled six weeks in advance. Stakeholder representatives were contacted via email from the Merced County Chief Administrative Officer to ask for their participation. They were then invited to the relevant focus group via email. Those stakeholder representatives that could not attend were offered the options of (a) attending a different session, (b) having a one-on-one online interview, or (c) sending an associate. Most chose to send an associate, some opted for interviews, and some simply did not respond. Each session generally covered:

- Current connectivity, including any issues or problems
- Connectivity needs of clients, customers, members, and partners
- Goals and plans for the near future, including upgrades, that would impact connectivity needs
- Major issues and trends expected to impact operations and technology requirements

[27] Data on broadband was also gathered directly from local households and organizations via a community survey. Results of that survey are reported elsewhere.

- The County's putative role in increasing broadband availability and improving performance

We also asked participants who else should be asked for input and requested their assistance promoting the survey. We conducted a total of 8 sessions—the small business and support industry session only had one attendee who had already participated in an earlier session. To make up for this, we conducted targeted outreach to small business stakeholders. The information below is directly from stakeholder representatives. By the end of the process, we got input from 70 representatives of 40 organizations, counting the various public safety agencies.

Generally, broadband services are available from two providers—a traditional cable company, Comcast Xfinity or Charter Spectrum, and traditional telco, AT&T—in metropolitan, urban core areas. Connectivity options are more limited in rural portions of Merced County, particularly in the Snelling area. Cellular service, which is used by mobile field workers as well as for internet in areas without broadband, is also inconsistent or nonexistent in rural areas.

Content in the following subsections came directly from focus group participants. This is not information generated directly by Magellan or the view(s) of Magellan personnel. Sentences using present tense are as close to verbatim as possible with minimal edits for clarity and correct grammar. Some past tense sentences are from participants discussing past activities or events. Only sentences in past tense that describe the general tone of the focus group or what occurred during a session were generated by Magellan.

AGRICULTURE, BUSINESS, AND ECONOMIC DEVELOPMENT

Access is a big issue for agriculture in Merced County. The Farm Bureau receives complaints from members about speed. Because services are not fast enough, business activities and information get delayed. Most of the Farm Bureau's members require mobile or other wireless connectivity due to the nature of the business and lack of wired options.

The Ag Commissioner's office stated that their growers need connectivity for most of the equipment they use. A lot of the tractors use GPS, precision spraying and fertilizing, and irrigation systems that require connectivity. The main programs farmers use to operate, such as crop recommendations, are shifting to web-based applications, therefore it is critical their stakeholders have a good connection. Participants from the Ag Commissioners office stated that farming is everywhere, not just where the service is.

All the main programs Ag Commissioner staff use, including permitting programs, are web based. They are typically in the field to connect their tablets through their cell phones. They utilize GPS and GIS programs and download maps constantly. Service is not available everywhere. Generally, the gaps in rural areas, particularly El Nido, La Grande, and areas on the west side of the county. Closing these gaps would enable the Ag Commissioner's office to be more effective and responsive, as well as support ag operations.

Agricultural science is more technologically advanced than most people realize, and according to the Ag Commissioner's office, California is a leader. Profit margins for growers are slim and labor is an immense cost in agriculture, leading to more automation wherever possible. Automation in the ag sector is addressing regulations on labor and pesticides as well as increasing operational efficiency. The Sustainable Groundwater Management Act[28] will impact the amount of land growers can farm, so there will be a critical need to know exactly how much water they are using. Pumps and sensors that control and monitor water usage will need connectivity for real-time data communications. This will be really important for the areas that do not currently have connectivity. A Merced-based company is building automated equipment due to proximity to Silicon Valley. The Ag Commissioner sees an opportunity to bring more ag tech companies into the County of Merced.

These stakeholders were also concerned about affordability for low-income communities in the agricultural areas. There was a sense that carriers do not want to expand into these areas due to the lack of revenue potential. Participants from the City of Merced indicated that low-income neighborhoods with poor broadband adoption rates were likely in qualified CDGB census tracks and opportunity zones, which are based on employment rates, poverty rates, etc. The City's current HUD Consolidated Plan does not include broadband because the need for housing is so great that internet access was not seen as a top priority.

Industrial parks throughout the County need better connectivity. In Los Banos the need arises from outdated infrastructure in the currently developed industrial areas. Participants from the City of Merced said an agricultural technology company near the Merced Airport experiences issues with broadband capacity and availability. There are several other tenants in that location that need connectivity. This lack of connectivity is affecting business operation and expansion in that area.

[28] See https://leginfo.legislature.ca.gov/faces/codes_displayexpandedbranch.xhtml?tocCode=WAT&division=6.&title=&part=2.74.&chapter=&article=.

The City is launching a general plan update, planning to expand the industrial park, and studying high-speed passenger rail. It wants to include broadband in these plans.

The City of Merced sees vertical infrastructure to support fiber for those applications as critical. Participants from the City also stated that all the new data from sensors will feed into planning for traffic, water, and wastewater. They are also thinking about revenue streams from leasing assets to carriers. They have found that it is hard to get new providers to come into a community because of the entrenched services. For these reasons, their planning horizon for where to put the fiber is 10 to 30 years.

The County of Merced identified the Castle Commerce Center—a 1,912-acre multimodal freight transportation hub supported by air, ground, and rail connections—as an area of concern. Plans call for attracting manufacturing, office, and warehousing, including a rail district to improve connections to the BNSF railroad mainline. A couple of companies have permanent locations there with connections that cannot handle the data they are trying to send. There is fiber on the site, but the County-owned fiber is outdated, and fiber-based service is quite expensive.

Transportation Research Center (TRC) is operating TRC California at Castle. It is a 225-acre automotive technology testing and research complex, with a 2.2-mile oval track, city course, two multipurpose vehicle test areas, traffic signals, V2X,[29] and Wi-Fi that can replicate a wide variety of real-world scenarios. The facility can accommodate all types of mobility systems, including conventional and automated cars, trucks, and buses. Major technology companies conduct engineering and testing at the site and need to transfer large amounts to Silicon Valley from Merced.

Stakeholders indicated that the County should take the lead on agriculture and economic development. The County should work with the six cities and members of the agricultural community to have Virginia Smith Trust, UC Merced, and Merced College expand their applied research and development efforts. Demand for technology and broadband is only going to continue to grow. The County of Merced should have a strategy like that of Silicon Valley or the Research Triangle in North Carolina. Having the County involved as an umbrella to help shepherd and foster

[29] V2X stands for "vehicle to everything" communications that is generally referred to as "connected vehicle technology." It uses either cellular or a technology similar to Wi-Fi for connectivity.

tech-led development is essential because most cities are smaller and do not have the capacity.

CITY ADMINISTRATION AND INFORMATION TECHNOLOGY

The City of Merced has the network infrastructure in place to meet its current connectivity requirements, including data, voice, video, SCADA, and radio services for local municipal services. The City will need to expand its fiber network due to growth via annexations and development and for future smart city applications such as automated lighting, enhanced GPS signal light timing, and other IoT smart City applications that will be developed in the future as the City continues to grow. The City believes expanding network infrastructure as a way to enhance local municipal operational efficiencies, while at the same time reducing operational cost to provide those services.

The City of Gustine City Hall has a good fiber connection. Other city facilities are served with point-to-point wireless that have limited capacity. These connections have created challenges when trying to deploy cameras and other applications that use a lot of data. Participants noted a lack of options for internet service in Gustine. They only have AT&T, which provides relatively low-speed DSL, although Comcast Xfinity has active plans to expand in the area.

Several cities outsource their IT function to Mid Valley IT, which has locations in Merced and Stockton. Participants from Mid valley IT said they have cellular or broadband service at most locations they support, although they may need to build out to some sites. They use services from various companies—AT&T, Comcast, Vast, UnWired and Ayera—to connect sites for their customers. The issue is cost rather than availability. That said, they admitted that it can be difficult to get connections in rural areas.

Participants from the City of Livingston indicated they were deploying cameras, traffic signals, and other smart city applications with the help of Mid valley IT. They have also been deploying intersection cameras for the City of Los Banos using point-to-point wireless backhaul to city hall for the cameras in the perimeter of the City. They use a mesh network to connect remote cameras to the camera system and digital video recorders for the City's police department and traffic management.

The cities' major connectivity needs are for internet of things (IoT), according to Mid Valley IT. Their general goal is to replace carrier-provided cellular connections with private radio access networks. They use water towers and radio towers for

antennas and generally don't use fiber due to the cost. Mid Valley IT is hoping to take advantage of grant funding with local stakeholders to develop a private 5G broadband network that covers the entire County. They expect this to provide connectivity for cameras, meter reading, mobile data units in city-owned vehicles, intelligent traffic signals, and other smart city applications. They plan to do this in a 3- to 5-year timeframe and are currently working with their client agencies to adopt policies to enable this to happen.

The City of Merced would like the County to provide an overarching framework for the policies for dig once, assets in the public right-of-way, and encroachments for expansion of fiber optics so when vendors want to come in and dig across the cities there is common set of policies and standards. They would like base-level templates for the cities to build and design from. The County wants to make sure that they are building a good backbone for all the communities in a collaborative effort. They want to understand where they are going to need connectivity in the future and build the backbone to be acceptable to the cities and the unincorporated areas that have broadband challenges like Castle.

EDUCATION

Merced County Office of Education (MCOE) serves 20 school districts—acting as ISP for 19 of the districts—and over 100 schools. The districts all connect into MCOE's two data centers, mostly via Ethernet connections over leased dark fiber. At the district level, schools are connected in a hub and spoke configuration without redundant ring connections. The challenge is to connect two small schools in Snelling, as there is no fiber in that area. Merced River Union Elementary is also not connected via fiber. MCOE uses daisy-chained point-to-point wireless for backhaul to colocation towers, which connect via fiber to the datacenter. This is working but it needs to go faster than 100Mbps. They are in desperate need of fiber in these areas and school sites. MCOE assists schools in applying for E-rate, which would subsidize the cost of these connections, but no carrier has stepped up to provide services faster than T-1s.[30]

[30] "T-1" refers to a leased circuit with 24 channels and 1.544 Mbps aggregate bandwidth. The technically correct term is "DS-1," in which the DS stand for "digital system" and 1 refers to the service hierarchy, which includes 0, 2, and 3, as well.

The backbone between MCOE's two data centers CalREN's[31] two regional nodes sites is provided by K12HSN[32] and CENIC.[33] CENIC has two dual-connected nodes in the Central Valley, one in Fresno and one near Merced in Fergus. MCOE is a CENIC node for the two sites between their 2 datacenters. UC Merced has a separate connection to the node site. They are a hub site off the node site. The data centers are diversly connected via fiber.

Merced Union Highschool district has no issues on campus. Their concern is connectivity for the students at home. Their district covers most of the eastern side of the county, including Livingston, Atwater, and Merced. All their students have devices provided by the school district. During the pandemic schools had to provide connectivity for the estimated 30% to 40% of students without broadband by giving them cellular hotspots. They used carrier maps when deploying the devices, however the maps were inaccurate. When the students got the hardware, they had challenges with connectivity. Merced Union High school district ordered the 10K MiFi units and struggled with large pockets of the County not having good cellular service. They partnered with other school districts to use other carrier to try and get services out to their students. Some school districts had service issues no matter which carrier they used. Merced River, Snelling, and along route 59 had the biggest gaps.

There was a push for CBRS and wireless from the schools but that conflicted with the E-rate regulations. In the Dos Palos area one school moved forward with CBRS, but then everyone returned to site, and they are still in the process of deploying. During the peak of the pandemic there was an overwhelming demand for cellular service and schools scrambled to get staff connected. Another issue is that just because there is fiber in the ground that does not mean the students can get connected. Households represent the biggest connectivity challenge. Even if services are available, affordability can be a barrier, especially when telecom

[31] CalREN is the statewide high-speed, high-bandwidth network for educational instutions. It has more than 8,000 miles of optical fiber 14 Hub Sites and circuits linking to 83 K-12 Node Sites, 11 UC Node Sites, 24 CSU Node Sites, 111 community college Node Sites, as well as 6 Node Sites serving the three participating private universities.

[32] K12HSN (https://www.k12hsn.org/) is a program funded by the California Department of Education to provide educators, students, and staff across the state with reliable high-speed network access.

[33] CENIC (https://cenic.org/) is a non-profit organization that operates CalREN.

providers bundle their services. School districts may be able to help pay for students' internet service but not if it is bundled with other services.

UC Merced does not have issues with connectivity for their students who mostly live in incorporated areas. Their connectivity problems are with remote staff. They have gone to remote work to increase space on campus, and staff are experiencing issues connecting in remote parts of the county. UC Merced experiences connectivity issues with rural remote workers. They also have challenges with diverse fiber pathways and redundancy to upstream network providers and physical locations. They have their main campus, a Castle location, and a location in downtown Merced. They need geo diverse and redundant connections to upstream providers for backup and broader communications. Relying on a single fiber network is a vulnerability for the college.

UC Merced is starting a new recruitment process/program that could possibly impact student connectivity and create more issues. They have a new Merced promise with local schools for automatic admissions and increased local scholarships with a lot of local partnerships with K-12 and transfer exchanges with Merced College including co-housing. This will increase the student population that will be living at home and UC Merced anticipates student connectivity challenges in the future.

UC Merced will be doing a lot more work in Agriculture Tech moving forward. A $65M grant from the USDA for agriculture tech work will spur more regional partnerships, including several community colleges across the Central Valley and Fresno State University. UC Merced currently has a small smart farm on campus and there are discussions of doubling or tripling it. UC Merced also plans to build a medical school/hospital on campus in the next 10 to 15 years. This will require very high-speed and very secure connectivity, which was highlighted in the planning discussions. They are currently mapping out the infrastructure impact. UC Merced just completed doubling the campus infrastructure and plans to double it again in the next 10-15 years.

Bitwise Industries provide software training and apprenticeships as part of their IT services business. Most of the classes Bitwise offers are tech driven mobile design web development so students need access to high-speed internet and devices to program the apps for classes. Their student body is all online. They are not aware of any connectivity issues for their students. They do supply all Wi-Fi hotspots for students who do not have an internet connection. They also provide their students with a computer if they need one. Bitwise offers apprenticeship programs after the completion of their classes.

HEALTH AND WELLNESS

The County of Merced Human Services Agency has six or seven locations for just client services, and do visitation for the elderly, children, etc. Their primary campus is on Wardrobe Ave in Merced. The next largest location is in Castle. They also have locations in Los Banos and Planada. HSA social workers utilize hot spots from their phones or iPads with cellular connectivity. There has been no negative feedback about connectivity thus far. There is a supply chain issue with computer hardware. They have problems getting laptops to replace desktops, which will enable staff to be mobile but also require wireless connectivity, including 4 orders from suppliers falling through.

Broadband options in Delhi are limited and service in that area will occasionally go down for about an hour, however speeds are not an issue. HSA believes it will get more feedback now that people are going out to visit patients more. During the lockdown visits were done remotely and much visitation occurred out in the field. Things are transitioning back into face-to-face interactions. These in person interactions are necessary for social work and to see the living environment of patients.

Dignity Health has large agreements in place with AT&T. They have a circuit going to Phoenix at their office and a circuit going to local sites in Stockton, and Bakersfield. They also have MPLS circuits to clinics, and if the clinic is close enough, they run fiber to them from the datacenter. The circuits are managed through AT&T managed services. Home hospice nurses use iPads as hotspots or rely on internet service at the home of the patient. They do not currently have remote equipment in homes in the Merced market. Dignity Health sees a trend in people wanting to return to in-person visits to make sure their healthcare provider understands what they are feeling. They also see a lot of future in telemedicine and acknowledge that it is good for emergency services.

California Health Collaborative's main office is in Merced. They use Comcast for connectivity at their office. They work from home and in the office. The participant from California Health Collaborative uses Spectrum for internet service at home. They do meet some families out in their homes near Los Banos or areas far away from the City of Merced. They use cellular hotspots through Verizon for client home visits. A shortage of counselors in Merced is driving telehealth to meet the demand. A lot of their mother clients prefer telehealth appointments for counseling rather than arranging childcare and driving to a location.

California Health Collaborative highlighted Delhi as a problem area for their clients and connectivity. The only internet service provider is Spectrum. AT&T and Verizon

will not provide services into houses. In many areas the connectivity is on and off. There are a few satellite options, but the service cost is much higher than Spectrum/Charter. California Health Collaborative clients in Delhi often complain about their services going down/not working. They educate their clients on how to use the digital applications for their healthcare and privacy issues concerning digital communication.

Golden Valley Health Centers has about 11 clinics and administration sites. At the Health Center connectivity is ok and they rely on Comcast for ENS and fiber internet service. They also use AT&T and Frontier for dedicated internet access fiber. GVHC relies on SD1 to mesh their networks together for resiliency. Golden Valley Health Centers is interested in knowing what technologies are available to residents of Merced County because that determines who they provide services to in their homes. They care about what the cell providers can do and if they are expanding their coverage. They would like to see more coverage in the more rural areas like Planada.

Cultiva la Salud spoke about the challenges families face with distance learning. Families drive to community centers to connect for zoom calls because they do not have connectivity at home. They highlighted connectivity issues in the rural communities of Gustine, Santa Nella, and Planada. They also indicated that connectivity in South Dos Palos is challenging and not readily available. Cultiva la Salud also specified affordability as an issue in relation to internet services, as a non-profit organization they pay $300 a month for services. Many of their families use cell phones for connectivity because they do not have a basic computer. They need assistance getting devices, not just internet services.

LAND USE AND REAL ESTATE DEVELOPMENT

The City of Merced foresees growth and annexations causing services to extend farther away from the hubs. There are a lot of developments in the process of being funded for the City of Merced. The housing supply is going to grow all over the community. There is a substantial amount of growth in retail and via annexations. It has eight annexations pending, including UC Merced, which will net about 10K new units in the City. Plans to extend high-speed commuter rail service from Ceres to Merced will also drive growth.

There has recently been an uptick in multifamily development while single family development has stalled. While they expect development to slow down due to interest rates, labor shortages, and supply chain issues, services that the City provides will have to extend out to the annexations. South Merced is a

disadvantaged area with more people who are not connected and do not know about the internet and services available. Many in that area are not able to attend to announcements and resources on the City website, so they get left out of efforts to engage the community.

The City of Los Banos is growing on all sides. The gaps in service are in the downtown areas. They are concerned with how to fund and upgrade that infrastructure. The new developments are not an issue. Another issue or trend in Los Banos is the workforce is leaving the community. There is a high number of out commuters. During covid people moved from Silicon Valley into Los Banos. The City's goal is to provide employment within the community, so people do not have to leave for a living. They like the idea of being able to market having infrastructure and a workforce.

The goal in the County is to preserve the greenfield and agriculture spaces by directing development to the unincorporated urban communities of Franklin Beechwood, Planada, Winton, Helmer, Le Grande, Santa Nella, Delhi, and Winton, per the General Plan. This includes commercial, residential, and industrial development. Most of the new subdivisions coming into the county are concentrated in Delhi and Winton. Santa Nella is where the sales tax is concentrated due to the high traffic interchange west of the Los Banos area. This area is seeing highway oriented commercial development.

There are big commercial development plans in the Castle area by the airport, which has a multiple user autonomous vehicle testing site and is planning for a rail district is in process at Castle, as discussed above. The county will need more housing development to meet the requirements of the state. A major obstacle for development in the County is the public utility infrastructure, which is provided by smaller special districts not the County. The special districts do not have the staff or resources for development.

The City of Merced expects to see some cellular providers pushing 5G and moving away from infrastructure that might be a capital expense for them. City personnel have worked to bring 5G service to the area. The City of Merced has ordinances for providers to attach themselves to public-owned vertical assets in the public right-of way. It was in negotiations with two carriers to establish master license agreements (MLA) for this purpose. Cost recovery fees alone are approximately $270 per streetlight pole. The companies care about their network, not the community, diversity, or socio-economic issues. Having fiber optics in the ground could provide public agencies with greater leverage to get 5G service where the community will benefit. Greater leverage could also allow a public agency to establish an in-kind

contributions like San Jose negotiated from AT&T to provide access for low-income students and libraries.

The City of Livingston is not seeing residential growth, but they do have some commercial growth with a few new businesses coming in, including plans for a few gas stations and a truck stop. In Livingston there is a shift in the workforce as Bay area folks are buying houses in the City. Most of the current workforce is transportation, trucking, or processing, as is exemplified by Foster Farms chicken processing plant. A generational shift will come as younger folks get into technical jobs like software development, help desk, and installations of technical equipment.

Livingston wants to partner with universities for vocational training to prevent people from getting left behind. If the children can catch the tide for economic growth, then maybe the people in Livingston can maintain their lives here and not have to move away to afford housing. The high-speed rail will have a stop in Livingston, and it would be good if people could work on the train. This participant thinks it could go a long way to bringing jobs into the area.

The City of Gustine has seen recent annexations and sees new homes coming into the City. They also have seen interest from two providers regarding bringing fiber to the communities. They received a recent submission from Comcast. Another provider that has been focusing on wireless broadband got some angel funding and is now proposing to bring fiber. Los Banos is also experiencing growth, mostly on the four corners of the city, and has new annexations in the pipeline. Los Banos just updated their general plan and adopted an annexation policy ordinance, which they anticipate will result in more annexations. The City also has a plan for an industrial park/logistics center located close to I-5 and route 152.

A Livingston planning participant identified that it would be useful to hear what infrastructure the City would be responsible for. They also stated that it would be good to know what type of infrastructure would go into already developed areas and what conditions could be included in for broadband in new development agreements. They indicated that it would be helpful to see examples of policies to include in the General Plan to justify and warrant their conditions for approval. They also stated that it would be good to take stock with providers, learn what their plans are, and market Merced County as an area for tech companies to come and invest in.

PUBLIC SAFETY

The EMS dispatch center gets calls from the primary 911 PSAP,[34] for which it dispatches responders based on priority. The EMS Communications Center is run by SEMSA RIGGS[35] employees who dispatch the calls. Each responding crew has a handheld radio and are alerted to the call. Information comes through on the mobile data terminals (MDTs) in their vehicles. The County provides connectivity for 911 dispatch and radio. Any other connectivity is on the company. Panasonic Toughbooks, MDT, and other mobile devices in the ambulances connect via cellular. There are modems and routers in the ambulances. Staff receive a computer-aided dispatch (CAD) push routed to a pager or cell phone.

During transport, workers call the hospital on a dedicated radio channel to let them know what type of patient they are bringing. When there are disasters or anything in the County, EMS works closely with fire and police wherever they are needed. EMS does not have colocations with the fire department. They have 4 physical locations Atwater, Merced, Los Banos, and Dos Palos. There also have hosting areas where 6 to 8 vehicles are positioned as needed based on calls to cover areas. Los Banos and Dos Palos have 24-hour crews to manage those stations. They have 24-hour cars that stay there. Delhi, Atwater, and Merced rotate 12-hour cars due to call volume. There is a computer in the stations and Wi-Fi. They go through a provider, privately served.

The Merced County Fire Department has 19 stations. The department has iPads in each piece of equipment that use CAD incident view. All employees have Verizon cell phones that get CAD texts from the dispatch center. There are a few stations where the internet is slow. There are issues in cellular for some of the stations. The connectivity is adequate to function, but the department would like faster connections. The City of Merced Fire Department falls under City IT and has good connectivity. All the stations have fiber. They have 7 voter sites in the City that are all connected to the radio system. They have iPads in all the engines and CF33 tough books with air cards through Verizon.

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[34] A Public Safety Answering Point (PSAP) is specialized call center responsible for receiving and processing 911 calls.

[35] It is unclear what these acronyms stand for, but SEMSA operates a range of medical transport and related services throughout Central California. See http://calaams.org/semsa.html for more information.

The Sherriff's connectivity is through County IT. They utilize Cradlepoint routers with Verizon in combination with FirstNet[36] for mobile connectivity, and they have FirstNet hotspots as back-up for dispatch throughout the county. They allow personnel to use FirstNet, which is helpful on deployments for fires. They are facing an issue with mobile connectivity in rural areas. The main area with low connectivity is the Sandy Mush area between the cities. It is directly in the middle of the county south of Merced, northeast of Dos Palos, and north of El Nido. There is an 8- to 10-mile stretch of road the is one of the main roads used to travel from the east side to the west side of the county. The City of Livingston Police uses the same connectivity as the Sheriff's office. It is hit-and-miss in certain areas but not as bad as Sandy Mush. The city of Los Banos uses First Net.

The Sherriff's office is looking at next generation 911 systems with Motorola that are cloud-based dispatch services. This is going to fit into their plan to be more mobile. The Sherriff's office is looking at other ways to connect remotely and is talking about using Starlink. Their goal is to be more mobile with consistent service throughout the County. First Net is another service they are looking at. They are also trying to build a new Sherriff's office at Castle. There are two jails in the County. The main jail in downtown Merced is a maximum-security facility. There is a medium to minimum security jail on Sandy Mush Road. Poor connectivity at the Sandy Mush jail has long been an issue. There needs to be a big improvement of infrastructure for that area.

Merced County Office of Emergency Services have run into challenges during emergencies due to infrastructure damaged by the incident and lack of inoperability between systems. They need to make sure people can communicate with each other via cellular or web-based systems, not just first responders. During multijurisdictional response, the city and county department support the first responders out in the field. Public communication is just as important as the response and there can be challenges coordinating that. Everything they do now is in real time with mapping, GIS, and data. Information flows back to the incident command post or emergency operations center. It is then shared horizontally or laterally so everyone knows what is happening, including state and federal partners or anyone else assisting in the response.

City of Merced Police Department is tied to City IT. They have Comcast fiber at their stations and Cradlepoint modems with cellular service to patrol cars. They would

[36] FirstNet is a federal program to provide cellular connectivity to all first responders using dedicated radio spectrum. It is operated by AT&T, using their cellular infrastructure.

love better wireless service. They run a lot of license plate reader (LPR) cameras. They have Cradlepoints on every camera, which are fixed devices, which gets really expensive. The City's Grogan Ave facility is tied in via wireless connections. It works but goes down periodically. They have several backups for redundancy to make sure their PSAP doesn't go down. They use radio signals to give dispatchers the exact GPS location of operators.

The City of Merced Police Department (PD) wants the ability to get video to patrol cars. Next generation 911 allows people to share video but there is no way of getting that out to patrol cars. There is a lot of good information that could be sent to patrol vehicles but there are doubts about whether Verizon has the bandwidth to handle it. The City of Merced Fire Department is considering Cradlepoint routers as they add more mobile devices but there is no decision or plan on that at this point. The Fire Department is adding a new facility in the Airport Industrial Park on Hawk Drive, which has limited connectivity.

The County's public safety communication and information systems are becoming more complex, and the cost of maintenance is rising. The County is considering establishing a public safety communications coordinator to manage these systems more effectively and reduce contracting costs. The state is encouraging public safety agencies to use cloud-based phone systems, but stakeholders are concerned about reliability. Private investment in local communications infrastructure is needed to ensure better, more stable 5G service and meet state goals for migrating systems to the cloud. Mobile cells-on-wheels (COW) are another piece of infrastructure that would reduce risks due to disasters and major events.

SMALL BUSINESS AND SUPPORT INDUSTRY

No stakeholder representatives attended the small business and support industry focus group. Additional outreach to stakeholders has been met with limited success. The Merced Hispanic Chamber of Commerce provided input via a focused interview. The Chamber itself had challenges getting good connectivity at its downtown Merced location but ultimately addressed the issues by switching to Comcast. Downtown used to have free Wi-Fi but that apparently no longer works. Generally, they felt they did not know enough about broadband and related topics to engage their members in a meaningful discussion about the topic.

Their general sense is that the Merced small business community lacks direction on tools for success. Some members have asked about technology to be productive because paper can be hard to track, especially as owners were forced to work from home due to recent floods. Beyond that, the Chamber does not hear much about

technology from members. The Chamber was assessing what assistance members need but does not otherwise know if members were interested in technology or had a website. Generally, “mom & pop” businesses are doing things the way they always have. During the pandemic a lot of kids stepped in to help their parents with social media to stay in business. There needs to be better information about the benefits of technology for small businesses to ease their anxiety about it. Small businesses with low incomes are going to feel helpless and frustrated about technology. If they do not have it, they do not miss it.

The Chamber is focusing on in-person meetings as an educational platform for small businesses. During the pandemic everyone was leery about face-to-face meetings and online meetings had very low engagement. The Chamber’s first seminar in January brought in 40 people from a variety of businesses. Key topics for their members are how to protect businesses and assets, plan for retirement, and access capital. There is also interest in benefits/401k, immigration, and labor laws. The Chamber would be willing to help with outreach but would need financial support for the effort.

Their general suggestion was to focus on south Merced with “boots on the ground” to visit the businesses. It is necessary to go into marginalized communities to ask them directly. These stakeholders do not deal with the County or pay attention to public meetings. Someone must go out and tell them what is happening. The Merced Flea & Farmers Market was identified as a specific location where a lot of businesses show up and hundreds of people come out to shop. If there was broadband access and free Wi-Fi in south Merced, kids could be successful from home and parents could use the internet without having to worry about how to pay for it.

SOCIAL SUPPORT SERVICES

The Merced County Human Services Agency (HSA) locations in Merced, Atwater, Los Banos, and in most of the population centers in the county. They try to meet their clients where they are comfortable so it would be helpful to be able to do case management and assessments online. They use Verizon for mobile connectivity. Inoperability between systems and data integrity are major issues, as well as limited mobile options. During Covid they were forced to go virtual and struggled with logging in, data buffering, and network outages in the HSA office and the field.

HSA would like to have tablets that can support video visits with clients without hotspots. Audio-video, bidirectional connections with healthcare providers are needed to assess health needs and issues and to refer their clients for medical

care. It can be difficult for clients to apply for services effectively. They are looking at electronic form flow and processes including kiosk machines and stations for clients to come in and use. They need to train people who are not familiar with technology. A lot of the population in Merced County are “salt of the Earth” type people with diverse cultural backgrounds and a myriad of languages. The training needs to encompass the different languages of the people in the County.

California Legal Aid identified online hybrid meeting options as important for people with mobility difficulties to participate in outreach programs and get services. Connectivity needs to be addressed for people to access assistance. There needs to be done more in getting information out and getting everyone informed. Broadband should be added to transportation and housing developments. Technology education and training needs to be equitable. Policies and programs should ensure ISPs are being equitable and investing in areas that need access not just the richest areas. It may be necessary for the County to subsidize services in low-income areas.

Faith in the Valley works with a variety of community members as a grass roots community organization focused on leadership training and skills. They typically meet online via Zoom. They are trying to go back to more face-to-face meetings as for the nature of their work, however some people are just more comfortable with Zoom. They are doing hybrid now and plan to continue that approach. Clients in Dos Palos and rural areas have connection difficulties and drop off all the time. They typically connect via cell phone, but even the clients with computers get dropped. The rural communities of El Nido, Dos Palos and the other small rural areas have issues finding internet access. California Legal Aid concurred that connectivity for people at the fringes needs to be addressed. Low income and rural communities experience high cost and low-quality internet more than others.

LifeLine Community Development Corporation (CDC) works with people who do not live in stable environments, and they hold information for those people. It is great to have more access to resources and telehealth, however people need to have a quiet place to talk. This can be an issue for families in under resourced communities, as their homes can be crowded with many family members in one household. Under-resourced communities do not have access to reliable internet and struggled with getting kids to participate in school during lock downs.

LifeLine CDC has two community centers with areas for people to access internet and telehealth, but it is complicated for families to get childcare and deal with other logistics to get to the community center. The Winton Community Center has access to only one service provider and public Wi-Fi in coffee shops that is not usable for the families in these neighborhoods. Working parents with government phones

struggle to keep up to date with school information because the phones are not reliable. When the phones break, the number changes, and they do not get messages. They also have issues with access to electricity.

They see a need for devices and training in technology in under-resourced neighborhoods. Education in technology does not have much value with access to broadband. LifeLine CDC is concerned about public internet, and the government having control of one more aspect of everyone's life. They are also concerned with businesses coming into rural areas, changing the community, and taking over things that used to be owned by the community. They want to be sure there is justice for the communities and not just business coming in. They are also grappling with cyber security issues and were just asked to provide $3M in cybersecurity insurance. Community members are not aware of how easy it is for others to get their information.

TRANSPORTATION AND UTILITIES

Participants for this session mostly represented the irrigation districts and water utilities. The only transportation stakeholder represented was the City of Merced. A Comcast representative also attended. The Merced Irrigation District mainly uses radio for communication and some cellular. They use licensed radio for SCADA to control and monitor operations. The district currently has several thousand growers with accounts and take measurements and read flow meters with crews in trucks.

The Merced Irrigation-Urban Groundwater Sustainability Agency (MIUGSA) consists of 7 members that make up the board: City of Merced, Atwater, Livingston, La Grande CSD, Planada CSD, Winton Water and Sanitary district, and Merced Irrigation district. It covers central Merced County. Areas to the east and west, surrounding MIUGSA, are managed by the Merced Subbasin Groundwater Sustainability Agency. MIUGSA is a collaborative effort to meet the standards of the Irrigation Ground Water Act. It has a handful of sites that use basic 4G cellular connectivity through Verizon. These include monitoring systems with basic telemetry and no control.

MIUGSA has had conversations with a vendor about using low-frequency radio spectrum to connect remote monitoring devices and is considering a pilot for this. In the future they could have monitoring sites on every ground water well in MIUGSA boundaries in eastern Merced, which would be 1,500 to 2,000 sites. When they get to this point there will be a significant need for connectivity. There is potential for an AMI (advanced metering infrastructure) telemetry network possibly

in collaboration with the Irrigation District for facility location and utilization. While there are no plans for this, MIUGSA is young and lacks staff to read flow meters so they will have to come up with a solution.

Due to regulation changes and state Senate bill SB X7-7, water metering will be required on every turn out, and all the deliveries to their several thousand grower accounts will have meters of some sort. There will be a push to reduce truck crews' driving time between sites. Metering of surface water deliveries will need to be integrated with ground water well metering. The water accounting side will become critically important. Growers will have to become extremely aware of how much water they are using and budget accordingly.

The Irrigation district and the GSA do not have dig once or joint build policy efforts currently. They generally do not allow utilities to run in the right-of-way or parallel. Their right-of-way is exclusive. They have various rights-of-way, some owned and some leased. They have concerns about safety and liability as they dig and maintain canals. There are also limitations on what they can do with their easements, building infrastructure/fiber leasing is outside of their core business.

The County of Merced Public Works projects mainly include road overlays and bridges. Due to the specific funding requirements, there is not much spare conduit going in. The City does not currently have a dig once policy. The City of Merced also highlighted the new legislation about air mitigation and technology coming down for outing fiber in the ground, signal light timing, or other tech. The big nexus in the County is to get funding and take advantage of those funds.

The City of Merced Public Works Department maintains streets, streetlights, and traffic signals and provides water and wastewater. The City Engineering Division provides planning and project management for these systems. The Water Division utilizes cellular point-to-point through Cisco Wireless for their SCADA. The City has migrated its water SCADA to IP technologies which require greater connectivity. The City of Merced is constantly growing and expanding its boundaries. They keep growing towards UC Merced and will annex that area before long. They will have to expand water and sewer services moving forward. The annexations and growth will have big impacts on water. It will become necessary to connect lift and well stations to SCADA.

They have smart meters at customers' premises, each of which has a cellular interface. They only have 2 well sites and 1 wastewater treatment facility. They currently do not have fiber. Pumps and lift stations are going to need connectivity. SCADA will need cybersecurity control points. Current connectivity will not meet these requirements. The City of Merced Engineering Division has a project involving

traffic signal interconnect via fiber for synchronization. The next big need for them is signal light timing connectivity, traffic signal interconnection, and intelligent traffic management. They are also in the process of upgrading the Water Division's metering system from 3G cellular to 4G LTE.

Comcast wants to understand who is underserved and where they can upgrade or build out their services. Rural broadband and infill in cities where they have service is a particular interest to Comcast. They are working on building-out to Gustine and Planada. These plans are not public yet and will be made public sometime next year. They want to be good partners and communicators and to dig as minimally as possible with as little impact as possible. They are interested in partnering even with traffic control, garbage control, and other Smart City applications. They stated that if there is an open trench, they want to know about it. The earlier they are aware of any open trench the better, but they can always escalate to leadership to see what is possible.

6. Policy Guidance

The State of California, recognizing the importance of internet access, leveraged federal funds for broadband development through Senate Bill 156. Merced County's participation in Rural County Representatives of California (RCRC) and Golden State Connect Authority (GSCA) gives it substantial leverage to access and benefit from the funding available under SB 156 to further broadband deployment in Merced County under the Broadband Strategic Plan. In particular, the state's middle mile network (under SB 156) is planned for deployment in Merced County.[37] The County can use this network under the Broadband Strategic Plan and in concert with GSCA to serve areas lacking broadband.

The state and federal broadband policy environment strongly supports expansion of the local public broadband infrastructure to achieve Broadband Strategic Plan goals and vision while ensuring the County and the cities within it can maintain their unique aesthetic qualities. State and national policy is squarely focused on eliminating the "digital divide" and making broadband access available to all citizens and communities. Federal and State of California broadband policy developments are explained in further detail in Appendices A and B.

Merced County can most effectively capitalize on the current broadband policy environment through a comprehensive, proactive approach to developing its digital infrastructure, including but not limited to broadband. Traffic and utility infrastructure require and are co-located with network assets in the public right of way. Broadband access infrastructure directly supports economic development, education, essential services, health care, and housing. Abundant state, federal and other resources are now available for broadband development, and they may be used as leverage for other funding. A wide range of complementary investments and impact multipliers are made possible by a comprehensive strategic approach.

[37] See Appendix A, pages 6-7.

Table 9. Summary of broadband-related policies among Merced jurisdictions

Key: NF. None Found, O. in Ordinance, U. Consider Update, Y. Yes, in place

Subject	Merced County	Incorporated Cities					
		Atwater	Dos Palos	Gustine	Livingston	Los Banos	Merced
5G/Small Cell Ordinance	Y	NF	NF	Y	NF	NF	NF/U
5G/Small Cell Standards and Guidelines	O/U	NF	NF	O	NF	NF	NF
5G/Small Cell Master License Agreement	O	NF	NF	O	NF	NF	Y
Radio Frequency Compliance Report	Y/U	NF	NF	Y/U	NF	NF	Y/U
Eligible Facility Requests/5G Upgrades	Y	NF	NF	NF	NF	NF	NF
Utility Coordination/ work in PROW	NF	NF	NF	NF	NF	NF	NF
Wireless Site Facilities Modification	NF/U	NF	NF	NF/U	NF	NF	NF/U
Affordable Connectivity Program	NF	NF	NF	NF	NF	NF	Y
Micro-Trenching	NF	NF	NF	NF	NF	NF	NF
Developer Agreement Conditions	NF	NF	NF	NF	NF	NF	NF

CURRENT POLICIES

Magellan reviewed documents provided by Merced County and the cities, as well as the County's and the cities' websites and ordinances for currency versus recent legislative actions in California (Appendix B) and Federal Communication Commission decisions (Appendix C) in the 5G wireless area. We also reviewed the County's and cities' websites for current policies and procedures relative to best practices for broadband development. Specifically, Magellan reviewed the ordinances and websites in consideration of:

- The FCC's regulations regarding modification of "eligible [wireless] facilities", and radio frequency emissions,
- The FCC's "Small Cell" 5G order,
- The FCC's subsequent orders on wireless site modification and 5G upgrades,
- City and county 5G small cell design standards and guidelines to implement the FCC's wireless regulations,
- Utility coordination and "dig once" practices, and
- Implementation of SB 156 and SB 378 in California.

The table below summarizes our findings for the County of Merced and the cities of Atwater, Dos Palos, Gustine, Livingston, Los Banos, and Merced. There did not appear to be much formal policy on broadband, utility coordination practices, or wireless facilities among the cities. Existing policies may need to be updated. The County had key wireless ordinances, as did the cities of Gustine and, to a lesser extent, Merced. Several of these may need to be updated, as discussed in detail below. Our review did not find any developer agreement conditions for facilitation of broadband, "dig once" coordination of utility work in the public right-of-way, information about Affordable Connectivity Programs, or micro-trenching.

Wireless Ordinances

Merced County

Magellan has reviewed the County's ordinances (particularly Chapter 18.68 Wireless Telecommunications Facilities) and other policy documents pertaining to wireless deployment and broadband. Chapter 18.68 Wireless Telecommunications Facilities was adopted in 2019 in concert with the Zoning Code Update and following the FCC's 2018 "Small Cell Order". The Small Cell Order established requirements for deployment of "5G" small cell antennas. (See Appendix B, FCC Policies.) The Zoning

Code Update added provisions regarding small cell wireless, made revisions for compliance with state law and updated noticing requirements.[38]

The purposes of the new ordinance for small cell wireless are firmly rooted in policy reserved to local authority: "preserve the unique visual character of the County, promote the aesthetic appearance of the County, and to ensure public safety and welfare; pursue additional benefits from the facilities for the public by encouraging the leasing of publicly-owned properties where feasible for the development of communication facilities; and to acknowledge and provide the community benefit associated with the provision of advanced wireless telecommunication services within the County."

The Zoning Code Update establishes wireless telecommunications provisions for:

- locational and developmental standards including height limitations, stealth features, landscaping, undergrounding, and screening of ground mounted equipment consistent with the Small Cell Order.
- stated location preferences which are reasonable given the County's purposes for the ordinance and are like those used by other California cities and counties.
- stated design and development standards are reasonable given the County's purposes for the ordinance and reflect very similar provisions as used in other California cities and counties.
- definitions which compare well with definitions used in other California cities and counties.
- application requirements which are reasonable and compare well with requirements used by other California cities and counties. The County administers well-designed checklist forms on its website for wireless permit applications which align with the ordinance, including a "Telecommunications Facility Companion Page", a "Major Modification Filing Requirements Checklist", and a "Minor Modification Filing Requirements Checklist".
- operating and maintenance standards which are reasonable, and good practice given the County's purposes for the ordinance, using provisions very similar to those used in other California cities and counties.

[38] Zoning Code Update presentation to the Board of Supervisors and Planning Commission Joint Study Session, February 26, 2019, page 17.

The Zoning Code Update includes requirement for execution of a "Master Lease Agreement" or "MLA" for small cell sites in the public right-of-way (Chapter 18.68.040.I.). This is a best practice on the part of the County. It is not clear whether the County created an MLA template agreement or has executed any MLAs at this point.

The Zoning Code Update to create Chapter 18.68 Wireless Telecommunications Facilities also covers the subject of "eligible facilities requests" and "substantial change" in line with FCC regulations on the subject, which impose "shot clock" requirements on applications for modifications to existing towers or base stations. This is an important subject to include in ordinances and the County has appropriately addressed this subject. (See Appendix B, page 17 for further information.)

The County should note that since the adoption of the Wireless Telecommunications Facilities Ordinance in 2019 the FCC has continued to limit local authority and flexibility regarding wireless facility applications. The County may be approached by wireless providers with applications to "upgrade" or "modify" existing wireless locations to accommodate 5G wireless deployment, and the County (and cities) will need to consider the applications based on two more recent FCC orders.

- The FCC's "5G upgrade order" starts the "shot clock" at the first required procedural step (including pre-application meetings) and provides additional interpretation on what constitutes "substantial change" for height increases for towers outside the public right of way, details on equipment cabinets, further explanation regarding "defeat" of concealment elements, and siting approval conditions. (See Appendix B, pages 17-18.)
- The FCC's "Site modification" order expands the definition of what constitutes an "eligible facility request" to include excavation and deployment outside the boundary of the original site, thus expanding the types of wireless application that would be subject to "shot clock" deadlines beyond what cities and counties have accommodated to date. This order was uniformly opposed by cities, counties and other local authorities and is subject to requests for reconsideration. (See Appendix B, page 19.)

The County could consider more detailed Small Cell Design Guidelines and Standards as a document administered by the Public Works Department, beyond the basic requirements contained in the ordinance. This could include further details regarding poles and pole locations, facilities, equipment, wiring and cabling requirements including testing for compliance with FCC RF regulations, power

requirements, signage, undergrounding and stealth designs, and public notice. Regulation of radio frequency emissions is reserved to the Federal Communications Commission, but local authorities may require compliance with FCC RF regulations to be demonstrated by applicants seeking to place wireless antennas. See Appendix B, page 14.

City of Merced

The City of Merced's wireless ordinance (Chapter 20.58 Wireless Communications Facilities) was adopted in 2016 and does not include or address 5G "Small Cell" facilities, or other advances in wireless technologies. The City should consider adoption of an updated wireless ordinance like the County's ordinance. Magellan can provide other city ordinances for reference, and the County's ordinance may also be used for reference, also considering the updating items listed above.

In December 2021 the City adopted a Master License Agreement template for use in permitting wireless providers to use City-owned vertical infrastructure in the public right-of-way for small cell 5G facilities. The MLA template adopted by the city is reasonable and like those in use in other California cities, and consistent with good practice.

Our review of the City's website did not identify any 5G Design Standards and Guidelines, RF compliance certification, "dig once" or utility coordination policies, or developer agreement conditions for facilitation of broadband.

Federal and State Utility Coordination Practices

State and federal policies are establishing coordination of utility work in the public rights of way to foster efficient and cost-effective placement of fiber whenever the public rights-of-way are opened for any project. Substantial federal funding is provided through the Infrastructure Investment and Jobs Act as well as other sources for broadband infrastructure (Appendix C) and transportation projects. The latter category includes roads, bridges, highways, and Intelligent Transportation Systems (ITS). Previous federal policy strictly prohibited non-highway use of federally-funded ITS traffic fiber and related work in the highway rights of way, which impeded efficient deployment of broadband infrastructure.

The Federal Highway Administration implemented a new rule[39] in March 2022 to facilitate installation of broadband infrastructure. To accommodate broadband in

[39] See, 23 CFR Part 645.307(a).

the right of way federal highway projects by rule the state department of transportation is to identify a "broadband utility coordinator" to be responsible for facilitating infrastructure efforts in the rights of way. This is a substantial change of policy direction at the federal level, toward allowing the use of federal highway funding to expand broadband infrastructure and encouraging broadband utility coordination while working on projects involving work in the right-of-way.

Similarly, Caltrans has implemented new policies under state legislation pertaining to wired broadband facilities on state highway right of way on its website. This includes a new resource for "Accommodation of Wired Broadband Facilities within Access-Controlled State Highway Right of Way"[40] dated March 14, 2022, that addresses state legislation and considers the new rule from FWHA. The Caltrans website provides contact information for its Broadband Coordinators, including for the Merced County region (District 10).[41] Inventory and mapping of Caltrans-owned wired data communications assets including broadband conduits is available from the Caltrans district contact.

AB 41 passed in 2021 requires that Caltrans projects funded by the Budget Act of 2021 and located in priority areas as identified by the CPUC under SB 156, include the installation of conduits capable of supporting fiber optic cables. Prioritized locations include those for the state's middle-mile network that will serve locations unserved with last-mile broadband facilities capable of 25/3 Mbps service as well as unserved community anchor institutions (schools, colleges, libraries, healthcare institutions, government entities, etc.) and tribal areas.

Rural County Representatives of California (RCRC) and the Golden State Connect Authority

The Rural County Representatives of California provides an example of the use of Joint Powers Authority to provide broadband services. RCRC is a non-profit entity established as a service organization for 39 rural counties in California, including Merced County. RCRC is organized to advocate on policy issues for rural counties including land use, water and natural resources, housing, transportation, wildfire protection policies, and health and human services.

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[40] https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/encroachmentpermits/attachment-a-wired-bb-accommodation-a11y.pdf

[41] Caltrans Broadband Coordinators, Caltrans. https://dot.ca.gov/programs/design/wired-broadband/poc

Among the initiatives it supports, RCRC has undertaken to push for broadband access for rural California. The objective is to increase access to reliable, affordable high-speed broadband for all rural Californians. As an initial step RCRC has served as the applicant for US Economic Development Administration grants for broadband strategic plans to aid the member counties which do not have one.

Then RCRC formed a joint powers authority. Golden State Connect Authority (GCSA). to deploy infrastructure to achieve this objective. GSCA is a joint powers authority created by RCRC members for the purpose of increasing access to reliable, affordable high-speed internet for all rural Californians. The governance of GSCA is conducted by elected Supervisors from rural counties that elect to join GSCA. Through the collective efforts of its members, GSCA is focused on building and supporting the development of innovative future proof networks that provide the highest level of quality, service, and transparency to rural California.[42]

GSCA capitalizes on the opportunities provided by enactment of SB 156 which include explicit authority for counties to operate broadband internet networks, creation of the state-owned, open-access middle mile network, and significant state and federal funding for deployment of broadband internet infrastructure. GSCA "will assist rural counties in identifying pathways for development of internet infrastructure within their communities, including the construction of municipal-owned and/or operated internet systems, among other options."[43] Golden State Connect's initial areas of focus[44] will be:

- Foundational Readiness: ensure all member counties have broadband strategic plans
- Capacity Building: equip rural counties with information and resources about innovative models and approaches to broadband deployment
- Demonstration Projects: implement open-access municipal broadband projects

[42] https://www.rcrcnet.org/affiliated-entities

[43] https://goldenstateconnect.org/about-us/

[44] Rural County Representatives of California Letter to LAFCO Executive Officers, January 5, 2022.

7. Broadband Feasibility Assessment

Merced County does not have sufficient broadband assets—either publicly or privately owned—to serve its population and economic base adequately, creating significant un- and under-served areas. These gaps will grow as population and utilization grow faster than market response, which will inevitably miss high-cost/low-revenue areas. The lack of connectivity and insufficient data speeds are causing these communities to become increasingly marginalized in the digital economy. The County and its cities cannot afford to be infrastructure limited due to the cost and criticality of network connectivity. The implication is that local governments should anchor long-term infrastructure investment and catalyze private investment to serve their businesses and residents.

TECHNOLOGY OPTIONS

As discussed in the introduction, broadband networks have a hierarchical structure with the core or feeder network as the trunk, distribution infrastructure as branches, access equipment as leaves. Backbone infrastructure interconnects major sites and can either be integrated with or totally separate from infrastructure for broadband services. In fact, a particular fiber route may accommodate multiple backbones for various enterprises, including backbone for interconnecting a broadband provider's central offices to distribution hubs (i.e., it's feeder network). Various technologies or media can be used at each level. For example, feeder network links can be point-to-point microwave and CBRS (discussed in detail below) can be used for wireless distribution. This section provides an overview of the various media, trade-offs between them, and equipment and operational requirements.

Fiber Infrastructure

There are many different construction methods to deploy a fiber optic network, some use existing infrastructure and other methods are new and require substantially more labor, materials, and expertise. There are types of construction that are better to use when a speedy deployment is desired. The baseline cost for fiber construction is approximately $95 per foot.[45] Plan for 20% contingency, which makes total baseline planning costs for fiber about $114 per foot or about $600K

[45] Based on Magellan Advisors' information about current market conditions in the region and state, including local prevailing wages.

per mile. The specific type of construction depends on the built and natural environment and the location of sites to be connected. About 40% of Merced County conceptual design is overhead, which substantially reduces the average per unit cost to less than $90 per foot.

Aerial or Overhead

Overhead deployment can cost 60% less than the baseline cost, assuming the cable can be attached to existing poles.[46] Poles must be inspected and engineered to make sure that a new cable does not "blow" the pole. A blown pole means that the pole is unsafe and has more weight on it than it can safely handle. If the engineering proves the pole can support new cable placement on an existing strand, then placing a new cable on an existing strand can be a desired method. Cost for aerial fiber is between $40 and $60 a foot in favorable circumstances.

Boring/Directional Drilling

Direction drilling aka boring, requires a large, 4'x4'x4', hole to be dug for each 300'-500' segment. Locating the existing utilities is required and anytime the bore path crosses a utility, that utility must be "potholed" and physically located to verify the boring will not contact and damage existing utility facilities. Potholes slow the process of boring down, especially when numerous potholes are necessary. Next to open trench, boring is the most expensive construction method. Costs can range from the baseline amount to as high as $250 per foot in dense, highly developed urban areas.

Microtrenching

Microtrenching is a method of creating a small trench approximately 2" wide and up to 24" deep. It is approximately a quarter of the baseline cost. A machine with a carbide tipped blade cuts through rock, asphalt, concrete, dirt, etc. to make the trench. Then a conduit is placed in the bottom and the trench is then backfilled and compressed. The top 2"-4" is capped with different sealants and substances to protect the trench from accidental damage and prevent moisture from seeping into the ground and causing other serious issues. While cities may be hesitant to use or allow microtrenching due to the shallow depth of the conduit and risk of damage from other excavation efforts including water emergencies as well as the poor

[46] General Order 95 contains the California Public Utilities Commission regulations for attaching to utility poles, which specifies standards that must be adhered to for the safe co-existence of electric and telecom assets.

restoration that can occur, recent State of California legislation[47] requires it to be accommodated.

Open Trench/ Joint Trench

Open trench is when a trench is dug into the ground with shovels, backhoes, skid steers, or mini excavators. The width may vary, but the trench is usually 12" wide by 4' deep. Once the trench is "cut" conduit is placed in the bottom of the trench and backfilled to cover the conduit. In most cases it is the most expensive method for new construction. The high cost is due to cutting through asphalt, concrete, other hardscape, labor cost, and restoration cost. This is a labor-intensive method. Joint trench is the same as open trench except there are many participants from different telecom, power, and cable companies that all share the expense of construction making it more cost-effective. Trenching can easily cost $120 per foot to as much as $150 per foot.

Plowing

Plowing or vibratory plow is a method where a large machine drags a blade ranging between 2'-4' deep in the ground and vibrates up and down to "cut" through the ground. The blade is rounded but sharp on the leading edge and has a slot on the back edge that conduit is fed through as the blade is moved forward. The conduit is routed over the top of the machine into the slot on the backside of the blade and is placed as the machine moves along only leaving a line where the blade had been. The restoration is minimal, and this is a very effective method in open areas with wide easements and minimal utilities in the ground. For these reasons, plowing costs about half to three-quarters of the baseline, depending on existing infrastructure, soil conditions, and other factors.

Rock Drill and Rock Wheel

Rock drills are like giant jack hammers, which make holes as small as 4" in solid stone. Rock wheels use a carbide tipped saw blade that cuts through asphalt, concrete, dirt, rock, etc. just like microtrenching, and cuts a trench that is 6" wide and up to 36" deep. Both rock drill and rock wheel are very expensive—two to three times baseline cost—and slow methods of construction but when needed they are effective methods for placing conduit.

[47] See discussion below in the Utility Coordination and "Dig Once" section.

Traffic Signal Interconnect

Traffic signal interconnect conduit systems are built to utilize copper cables and are usually not able to accommodate fiber optic cables with the needed specifications. Copper cable can be bent in hard 90-degree angles and wrapped very tightly inside of handholes resulting in small handholes and 90-degree elbows. Fiber cables consist of strands of flexible glass that carry light from one end of the cable to the other. If the strands are bent too tight the light cannot reach the other end. To use traffic signals, conduits may need to be upgraded to accommodate fiber. The hard elbows need to be changed to sweeps and handholes must be large enough to allow for the static minimum bend radius of the new fiber. This construction method is more expensive than overhead but cheaper than other underground construction methods.

Backbone fiber can be managed as a physical asset by assigning specific strands to specific users, commonly on a lease basis, and uses. Strands in various cables must be physically spliced together or optically interconnected, including via splitters, to form complete paths so that any light shone (transmitted) down the fiber is seen (received) at the other ends. This approach has relatively low cost because it doesn't require purchasing or operating equipment, but it can also be very inefficient.

For example, if two strands in a 10-mile-long backbone (20 strand-miles total) are used to connect two sites that are a mile apart (2 strand-miles), the other 18 strand-miles become stranded and can only be used on each side of the interconnected sites. This approach also misses the benefit of redundant paths: If the fiber is cut between the two sites, the connection is lost because the information cannot flow in other directions. The key to effectively managing capacity is detailed information about sites to be connected along with additional infrastructure to aggregate traffic onto the network without having to dedicate strands to particular sites or types of sites.

Network Equipment and Services

Beyond leasing dark fiber, use of network infrastructure involves offering services. There are two general classes or types of services that can be provided over modern network infrastructure. ***Access services*** are relatively inexpensive, "best effort" services that do not include any solid performance guarantees. Generally, access services are considered "retail broadband." ***Transport services*** are "dedicated" services that typically come with guaranteed bandwidth and uptime commitments, which are contained in *service level agreements* (SLAs). Transport services are variously referred to as "backhaul," "bulk IP," "carrier-class,"

"enterprise," "long-haul," "managed," "metro," or "middle-mile" services depending on the context. Generally, they are used by large organizations, including providers.

Access and transport services are complementary but involve different components and costs as well as customers. As Those in Merced County is most likely to offer transport as part of public sector connectivity business, we describe transport services infrastructure first, followed by information about co-location, a related service. We include a reasonably comprehensive consideration of access service infrastructure as Those in Merced County may seek partners to offer those services using a portion of the City's network. Improved access services for the community would directly achieve key results for this plan and address one or more of the City's strategic goals.

Transport Services

Transport services involve relatively few, stable but high-performance connections. Users are major businesses and institutions, including network service providers. The service is moving information from one point to another, rather than leasing an asset, so the value comes from ensuring the information keeps moving. This requires equipment that lights the fiber, maintains connections, and transmits data as diagrammed in Figure 47. A form of hand-off to other networks or services, which requires additional equipment, is commonly a part of transport service.

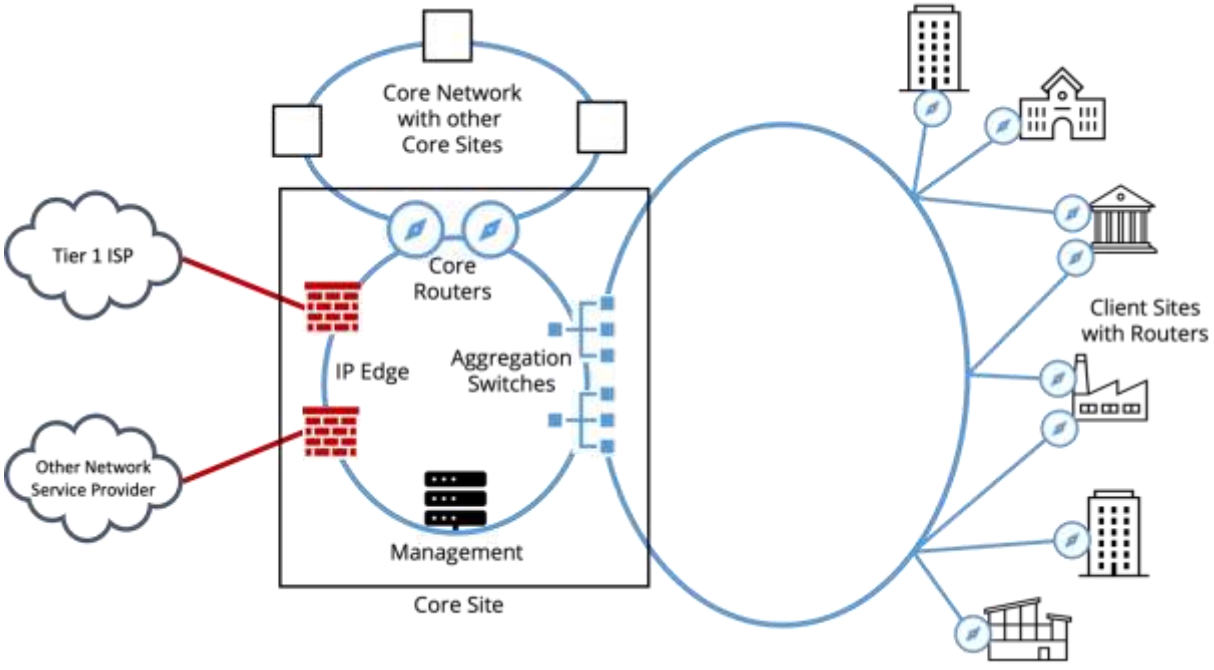

Figure 47. Transport networks interconnect sites and provide access to other networks, which could include access networks

Networks typically have a core network composed of a few centralized core sites—called central offices, data centers, or headends depending on type of ISP—interconnected by fiber in a ring architecture. Core sites contain the most powerful equipment to connect the local network to the global network. They must be secure, with high reliability power, and preferably centrally located. At least one, ideally two, sites must connect to high-capacity dedicated internet services, ideally via different providers with fiber following separate routes, for bulk IP.

Transport customers typically have substantial network operations of their own that incorporate transport services where needed, which requires next generation technologies—specifically software-defined wide-area networks (SD-WAN) and sophisticated management systems. Customers may require dual-homed connections, which connect to the core site via two diverse routes, and redundant connections to cloud services, tier 1 ISPs, and other service providers.

Transport service providers often co-locate in other companies' data centers to reduce costs. Access service providers generally prefer to own their core network sites, known as "central offices" or "headend" facilities, and access infrastructure called "pedestals" or "points of presence" (POP). This is changing somewhat with the emergence of wholesale open access infrastructure. Interconnection sites between different providers range from massive data centers to relatively small huts.

The network equipment required to deliver broadband services to customers is comprised of several functional groups and multiple components. All business models beyond infrastructure-only require core equipment, similar to what most cities currently use for their enterprise WANs. This must be supplemented with additional core capacity and various types of access equipment and infrastructure.

Core Equipment

The core equipment aggregates traffic from all access equipment, connecting customers and routing their data to and from the IP edge equipment or other end-point destinations. Standard network protocols provide link redundancy and dynamic traffic re-routing in the event of an equipment failure or fiber cut. Core equipment can easily support thousands of customers and hundreds of gigabits of traffic throughput at deployment and will accommodate future system growth through the addition of service modules, optical interfaces, and/or software licenses.

Internet Protocol Edge (IP Edge) Equipment

Separate from the core switches, the network must maintain an "internet perimeter." The internet perimeter will include internet routers and internet

firewalls to be used to manage routing throughout the network. Firewalls will be utilized to protect critical back-office systems, including provisioning, network management, data storage, and other information. The two core switches will be interconnected to two internet routers providing redundancy for internet services in the event of a single interface or equipment failure. As mentioned above, bulk IP should be acquired from at least two providers using diverse paths, one of which should be a Tier 1 provider.

Access Services

The major difference between a local transport network and a fiber access network is the addition of access and distribution infrastructure, including hubs and multi-site terminals, illustrated in Figure 48. The core network delivers much the same functionality to broadband distribution hubs—also called points-of-presence (POP)—as to transport service customer sites. The dedicated connections function as feeder lines, which are also typically deployed in rings, between the core sites and distribution hubs. The core and feeder networks and hubs comprise the "transport" network. Access requires additional equipment that supports connections to many customers.

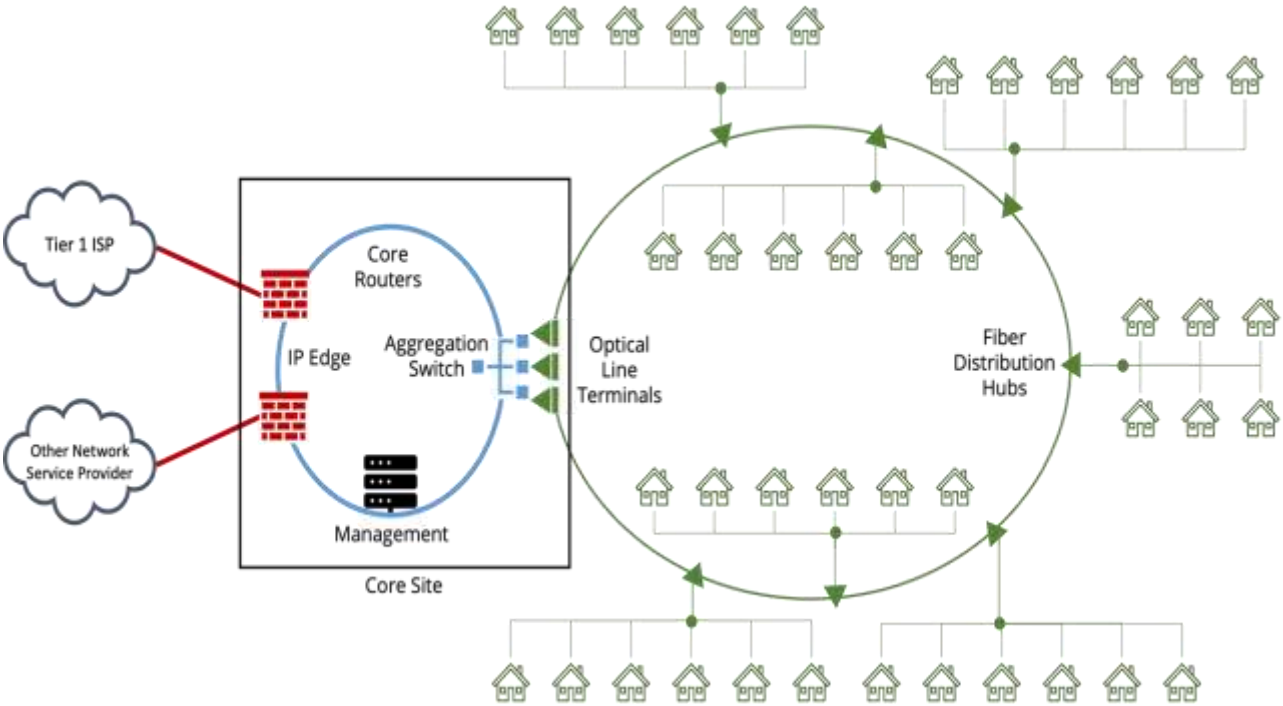

Figure 48. Passive Optical Network (PON) access infrastructure, including hubs and terminals, provides gigabit speed access services

Feeder fiber connects optical line terminators (OLT) in the core sites to passive splitters called fiber distribution hubs (FDHs), typically in outdoor cabinet enclosures placed strategically throughout the service area. Splitters may also be located within the access POP itself. In areas where aerial fiber deployment may be used, FDHs may be placed aerially or transitioned from the aerial pole to a ground mounted FDH. As this plan is limited to assessing major corridors as fiber routes, we assume coverage is limited to customer premises within 500 feet of the backbone. This requires only a single FDH.

The distribution network branches out from the FDHs. Multiple access lines drop off the distribution lines—hence the term “fiber drops”—via drop terminals into customer premises. Major sites can be directly and diversely connected to the core sites via “laterals,” basically putting them on the feeder network. The backbone fiber may be used for a distribution, feeder network, and/or laterals, as well as core network. The particular use of specific fiber strands is a matter of how they are spliced together and where they terminate. Indeed, a single fiber cable can accommodate multiple physically separate networks for purposes such as SCADA or traffic signal interconnection.

Hubs may be powered cabinets, prefabricated shelters, or existing structures with sufficient space for equipment racks and other components. Feeder and Distribution Fiber

Feeder infrastructure that extends from the POPs to neighborhoods and business districts typically requires only a few fibers, at most a single 24-strand buffer tube. The backbone typically consists of 288-strand fiber therefore at least a hundred strands would be available for use as distribution. The estimated costs are based on feeder fibers are sized based on the demand forecast and sizing of each enclosure to ensure that each service area is well equipped for broadband services. These details are addressed in engineering design to get optimal coverage for the least practical costs.

Each OLT serves 512 subscribers at a 1:32 split. The number of POPs and OLTs per POP depends on the number subscribers. The cost includes OLT and backhaul hardware necessary to connect each POP to the core routers. In an actual design/implementation, each OLT would not need backhaul hardware, two line cards, 16 optical interfaces, etc.

Distribution fiber extends from the splitters in the FDHs to network access points (NAPs), or drop terminals, which connect individual fibers entering customers’ premises. NAPs may be attached to aerial strand, located in ground level pedestals or placed in underground vaults or hand holes located near the sidewalk or curb in

residential neighborhoods or business districts. NAPs are costed as an integral component of the distribution infrastructure estimates. Fiber distribution to NAPs will be sized based on the service area density to provide service to between 8-12 premises per NAP.

Fiber Service Drops

Fiber drops connect from each NAP to the customer premise equipment that delivers broadband service. At the customer premise, the drop cable terminates in a protective "clamshell" enclosure attached to a home or building for storage of slack and connection to the home equipment. Drop fiber may be installed aerially or underground, typically for a flat fee. Providers may charge additional drop costs for special circumstances such as burying fiber through difficult landscapes or under driveways. The average cost of a fiber drop in Magellan's experience, including all these components and labor, and recognizing that drops can vary greatly in complexity and distance, is approximately $2,500.

Optical Network Terminal

An Optical Network Unit (ONU), sometimes called an Optical Network Terminal (ONT), serves as the demarcation point between the retail ISP's fiber network and the router or firewall connecting to the customer's local area network (LAN). There are two general methods for installing ONTs. The first method involves mounting an outdoor rated ONT on an exterior wall of the structure and extending service wiring inside the premise. The second method involves extending the fiber into the premise and installing an indoor-rated ONU inside. In either case, the ONT is typically installed somewhere near the fiber entrance and an AC power source. The ONT terminates the fiber-based PON signals and provides customers with access to their services through traditional copper interfaces. XGS-PON ONT's supporting greater than 1 Gbps data service may also support optical small form-factor pluggable (SFP) interfaces for connection to enterprise-class LAN equipment.

Wireless Access Infrastructure

While Merced County would not deploy or operate radio access network or other wireless infrastructure under the model in this study, it is important to consider this infrastructure in the design to accommodate cellular and fixed wireless ISPs and capitalize on the assets. Wireless broadband can operate as mobile or fixed service. Although cellular connections can approach broadband speeds, mobile wireless broadband is still in its infancy, as discussed below. Fixed wireless can be used to connect remote locations or sparsely populated areas, where DSL or cable service

would not be economically feasible, via long-range directional microwave antennas. As discussed below, most of these connections are built on proprietary technologies, although they generally extend Wi-Fi and similar standards.

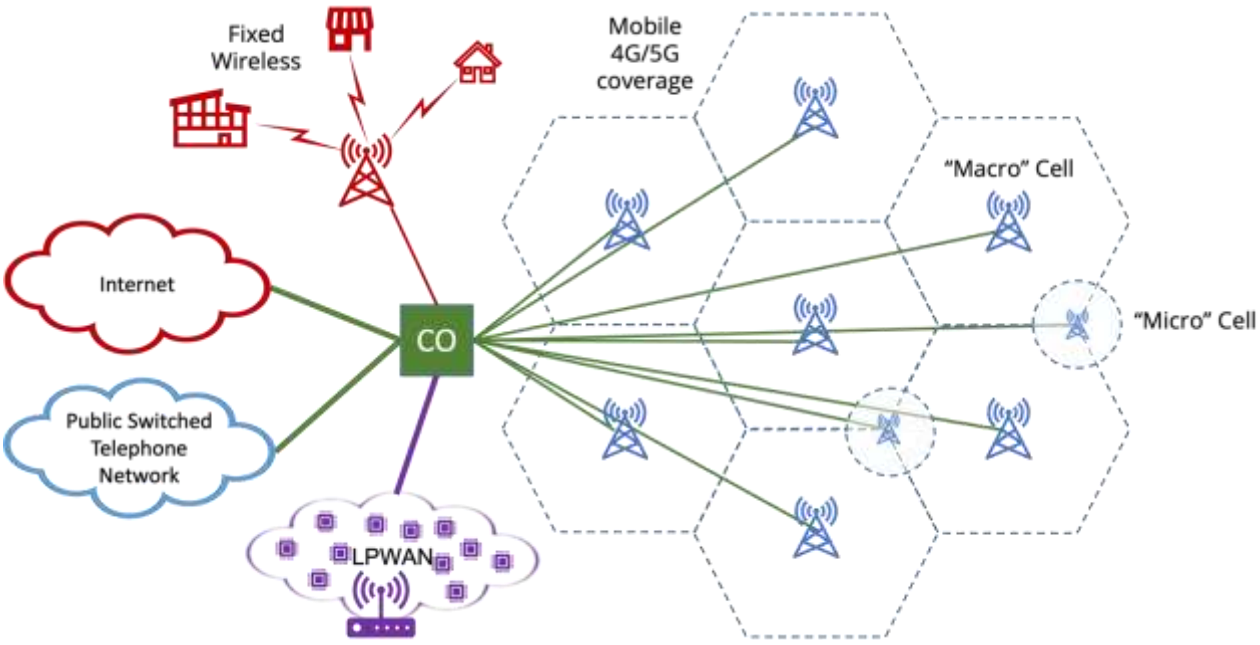

Figure 49. Radio-based wireless services provide flexible connections but have limited capacity and coverage

Coverage and speed are an intrinsic trade-off for wireless technologies. The farther a signal travels, the less information it can carry. High frequency signals, which have inherently high capacity, travel shorter distances than lower frequency signals (at the same power level). Lower frequency signals cover terrain and penetrate physical objects more effectively than high frequency signals. Spectrum in the lower frequency ranges offer better non-line-of-sight solutions, whereas the higher spectrum ranges need a more line-of-sight solution. Line-of-sight requires the transmitting antenna to be able to "see" the receiving antenna with limited trees and buildings in the way to be effective.

Terrain, then, plays an important role in the network design. Radio signals do not get over mountains or hills very well, nor does certain spectrum do very well in penetrating through buildings, foliage, or water, including rain and snow. The farther away the transmitter and the receiver are from each other, the less bandwidth is available. Transmitter sites need a means of connecting to the network, whether via fiber or microwave, to another site where it then transitions to a wireline fiber network. Fiber can be costly to install in remote locations. Electrical power, security and access are also considerations when locating

appropriate tower sites. A propagation analysis to determine appropriate tower locations for Merced County's specific terrain would be part of a wireless high-level design to be conducted in the future.

Cellular Mobile Wireless

Mobile wireless connections operate from antennas on towers that create wireless cells across a geographic area. Connectivity is maintained as devices move from wireless cell to wireless cell. The base of each tower site is connected to other tower sites and the internet, optimally via fiber-optic cables. Today, 4G transmits data at around 12/5 Mbps.[48] With each new generation, more wireless applications become possible as more data can be carried across the airwaves.

5G networks operate multiple frequencies using millimeter wavelengths to offer anticipated download/upload speeds of 1 Gbps. The networks are designed to provide increased efficiencies while decreasing latency and to improve the performance of connected devices that define the Internet of Things (IoT), including autonomous vehicles, healthcare monitoring technologies, ultra-high-definition video, virtual reality, and many more applications ripe for development.

With limits in return on investment and physics, it is unlikely that 5G will be an all-encompassing broadband solution. While the big three cellular providers have nominally launched 5G nationwide, a mature 5G network will take time and continued investment by carriers. The extent of full 5G rollout is to be determined, but if the investments in current infrastructure are any indicator, mid-sized cities like those in Merced County are not the priority. Two keys to full 5G deployment are spectrum—all of which is effectively owned by AT&T, T-Mobile, and Verizon—and vertical assets with fiber connections.

Fixed Wireless

Fixed wireless services allow consumers to access the internet from a fixed point while stationary, and typically requires an external antenna with direct line-of-sight between the distant wireless transmitter and the customer building-mounted receiver. Speeds are generally comparable to DSL and cable modem. These services have been offered using both licensed spectrum and unlicensed devices. There are numerous small ISPs using fixed wireless to serve remote, sparsely populated areas, and several focused on more dense, urban areas.

Fixed wireless can be deployed as point-to-point (PtP) or point-to-multipoint (PtM). PtP involves a one-to-one relationship between antennas at different locations. It is

[48] Several providers have announced they will discontinue 3G services in 2022.

typically used for interconnecting sites, such as headquarters or main buildings, to a remote facility. Fiber has much greater capacity and is more reliable, so internet service providers typically use this approach for connecting to customer locations where they do not have wired infrastructure. End-users typically use it as a backup or secondary connection or for non-critical or remote sites. PtM involves multiple—even hundreds of—users' antennas connecting to a single, central base station. Increasingly, companies are using a cellular PtM for fixed wireless access (FWA).

As illustrated in Figure 49, PtP and PtM are complementary technologies. PtP can be used to interconnect PtM base stations as well as for remote sites (although fiber is preferable due to its capacity and reliability). The networks require Line of Sight (LOS) or near Line of Sight (nLOS) to operate. As implied by the term, fixed wireless does not allow for mobile use. The systems utilize proprietary protocols and specialized devices to achieve the long ranges and high throughputs. Various portions of the radio spectrum, including CBRS (described below), microwave (3 GHz to 30 GHz), and millimeter wave (30 GHz to 300 GHz), are used for these connections. Generally, licensed spectrum offers better performance due to less interference. Different vendors' products may not interoperate with each other.

Citizens' Broadband Radio Service (CBRS) and Private LTE

The FCC set aside the 3550-3700 MHz (3.5 GHz) spectrum in 2015 under a new, shared spectrum approach. There are three tiers of CBRS users, diagrammed in Figure 50. Current, incumbent, tier 1 spectrum users, which include US military, fixed satellite stations, and, for a limited time, wireless internet services providers (WISPs) are protected from interference by other users. Ten Priority Access Licenses (PAL) for 10 MHz channels between 3550 and 3650 MHz in each county was auctioned off by the FCC in July 2020. These licensees are protected from interference by other users but may not interfere with incumbent users. A licensee may aggregate up to 4 PALs. Any portion of the spectrum may be used without a license for General Authorized Access (GAA), but this may not interfere with incumbent or PAL users.

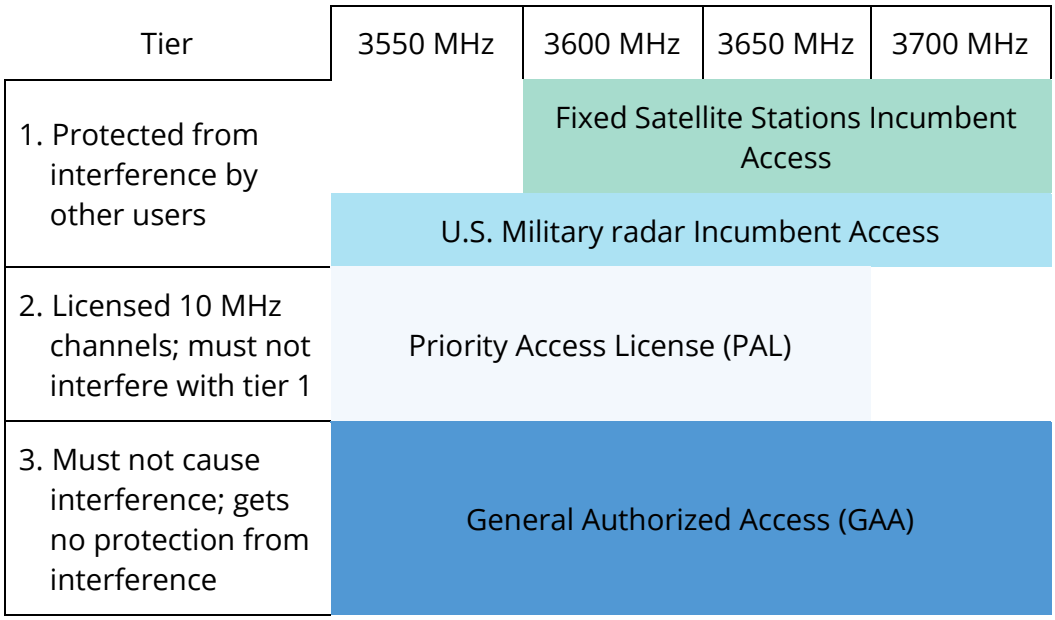

Figure 50 CBRS User Tiers

CBRS use is managed by a Spectrum Access System (SAS) with which all Citizen Broadband Service Device (CBSD) base stations must be registered. There are two classes of CBSD. Class A base stations, which can transmit at 1 watt of power, are meant for smaller-scale indoor, enterprise, or campus use. Class B base stations can transmit at 50 watts, giving them a much greater range. Strategically placed radio signal sensors will ensure that uses do not interfere with each other, particularly military radar.

Another important characteristic of CBRS is the Long-Term Evolution (LTE) protocol is commonly used with the spectrum. LTE is also used for 4G cellular data service, so it is widely implemented in user equipment. CBRS involves different spectrum, but some smartphones have antennas that operate in the CBRS bands. It is reasonably easy and economical to add CBRS/LTE to devices without changing their operating characteristics or systems. Therefore, there are few barriers to end user adoption. This also allows for private networks to be easily established with only a few antennas (which need fiber connections).

The combination of CBRS/LTE in base stations and user equipment is a radio access network (RAN). A RAN has a network core (an Evolved Packet Core or EPC) that authenticates and authorizes user equipment and manages connections to multiple base stations. This allows for mobile roaming from base station to base station without loss of connectivity and makes RANs very secure. The downside of a CBRS/LTE RAN is that some entity must operate EPC and the SAS. These are relatively inexpensive services that can be purchased from vendors or operated on private servers.

Low-Power Wide Area Networks (LPWAN)

Although not broadband, LPWAN technology should be considered in any network infrastructure plans. It is generally used to connect many small devices over a large geographic area. Water meter reading is a prime example of an LPWAN application. These are message-based networks, meaning end devices send small packets of information to an LPWAN gateway that then sends the data via a wired network to monitoring or tracking software. Real-time control of the devices is very limited but other, similar technologies exist that allow for remote control.

There are numerous standards for LPWAN with varying degrees of openness and propriety. The proprietary technologies were first to develop and currently have the largest installed bases. The open standards for LPWAN are still evolving. The major open standards are extensions of other standards, specifically 5G and Wi-Fi. The costs and flexibility of open standard based systems tend to be much better than proprietary technologies, although proprietary technologies may perform better in the short-term.

Wi-Fi

Wi-Fi, which was originally termed "Wireless Fidelity," is an open standard that was developed to connect computers to a local area network (LAN) via unlicensed radio spectrum (the same frequencies used for cordless phones, garage door openers, and other non-network wireless devices). Generally, Wi-Fi is a PtMP technology: Wi-Fi access points connect multiple devices within limited range, typically no more than 150 feet indoors and up to 1,500 feet outdoors. There are multiple standards or versions of Wi-Fi. Some can provide up to 1 Gbps of throughput. Other new Wi-Fi standards are intended to cover large areas with minimal power requirements.

Wi-Fi coverage and speed depends on multiple factors such as buildings, foliage, and other physical barriers, interference from other spectrum users, radio spectrum used, transmission power, type of antenna(s), and weather. New versions of the Wi-Fi protocol operate at greater distances and/or speeds. It can be deployed PtP to interconnect sites and is being adapted for LPWAN applications.

Wi-Fi access points are often integrated into routers that interconnect the Wi-Fi network (also called a service set identifier or "SSID") to other networks, including a broadband connection to the internet. This is typically referred to as a "hotspot" or Wi-Fi zone. Multiple access points can be interconnected to each other as well as a router to cover a larger area. A WiFi network can even be extended over multiple otherwise independent routers via a centralized server to create "community" Wi-Fi. The latest version, Wi-Fi 6, improves these functions, expands the spectrum, and increases speeds for Wi-Fi connections.

Today, many organizations use Wi-Fi to provide wireless connectivity throughout a building or campus. Many cities and counties have deployed public Wi-Fi in zones that extend into parks, other public spaces, and even throughout the community. Wi-Fi hotspots are common at hotels, restaurants, and public buildings for public access, and are widely used in homes and businesses for private access. The conceptual network is designed to accommodate Wi-Fi as well as other wireless technologies but does not include them. While Merced County could potentially offer public Wi-Fi, we assume any such equipment would be provided separately by Merced County or another entity.

Radio Access Network model

The Radio Access Network (RAN) model, diagrammed in Figure 51, accommodates all the above forms of wireless connectivity, and thereby maximizes the number, types, and value of wireless providers as customers. Under this model, Merced County could lease co-location facilities, fiber backbone, poles, towers, and other assets to private companies to deploy and operate RANs. The particular type of RAN would depend on the equipment that providers deploy.

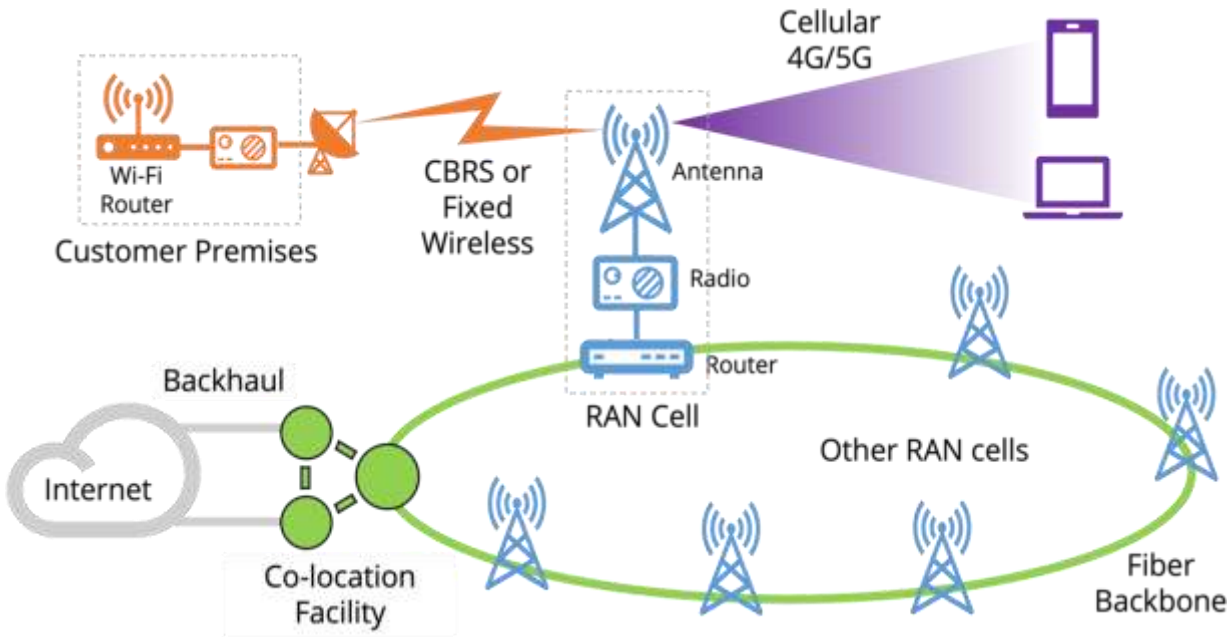

Figure 51 The Radio Access Network (RAN) Model

The key issue for Merced County is how and whether to develop assets and facilities to accommodate RANs. The conceptual network design incorporates poles, but that doesn't mean they can be used for RAN infrastructure. Fiber must be physically accessible at poles and towers to connect cells. Poles would need to be assessed and possibly upgraded to support small cell infrastructure. Tower sites would need secure, multi-tenant huts for providers to deploy their gear (these huts

may also serve as fiber hubs, depending on location). Providers may need the backbone to route to their points-of-presence and will definitely need interconnection to their regional/national networks.

RANs are much less costly than fiber networks.[49] They are more flexible, too, but have much less capacity and lower reliability. Mounting facilities can be the largest cost for RAN because antennas need to be above the surrounding terrain. Aesthetics is also an important issue because, as boxes on poles and towers, cell sites are not particularly attractive. People want connectivity but may object to cell sites in their neighborhood.

CONCEPTUAL NETWORK DESIGN

A conceptual network design is a planning tool to understand the components and scale of a prospective project rather than representing the final result. For Merced County and its stakeholders, the basic concept is to connect all county facilities, key facilities for cities, and major community anchors via infrastructure placed in economic development areas, through low-income neighborhoods, and on public properties. The design should make the most of existing public-owned assets to promote private investment. More fundamentally, the goal was to minimize costs and risks—especially long-term but also short-term—to local government while promoting technology-enabled development.

The design involves 347.7 route miles of fiber, 242.3 of which would be new build, and would cost approximately $66.6M to construct. Most of this (166.4 route miles) is deployed overhead and 76 route miles underground. It consists of a core network ring composed primarily of planned statewide Middle-Mile Broadband Infrastructure (MMBI), and multiple laterals to specific sites. Thirty-nine miles of the ring is newly built and just under five miles of it uses existing fiber owned by the City of Merced. The remaining 88 miles would be leased from the State. About 4 miles of the backbone is PtP wireless.

[49] The active components of a RAN will need refreshed in 5 years at most. Historical trends suggest the costs of those components can be expected to drop substantially in that time.

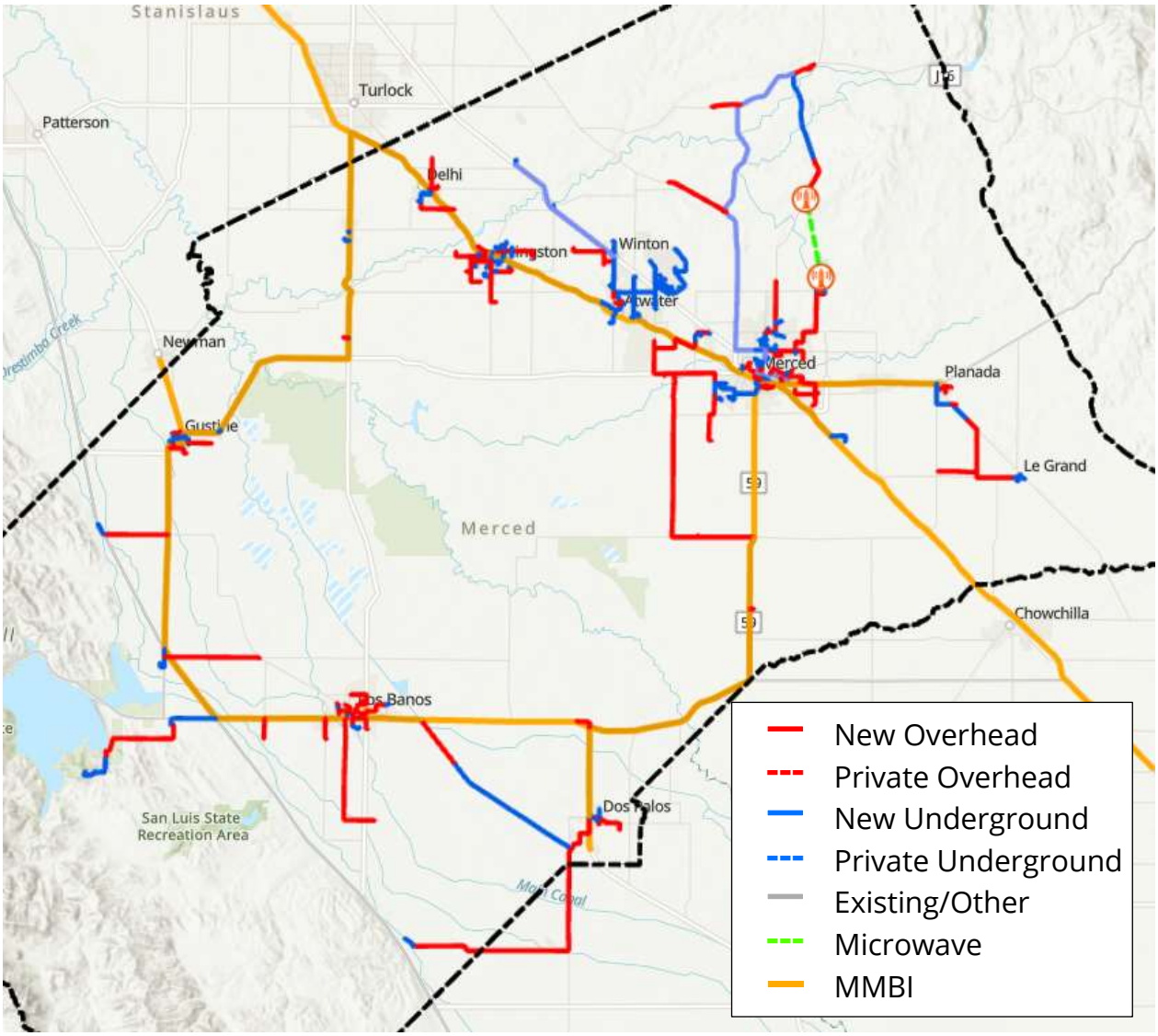

Figure 52. Conceptual network design for a Merced County backbone network

For this design, we assumed that fiber would be deployed overhead in areas with utility poles and underground otherwise. We also assumed the access infrastructure would generally be handled by a third party—i.e., private network service providers—using public assets. A design goal was to make the greatest possible use of existing fiber, including the MMBI, with the caveats that (a) this infrastructure can't be used to connect access equipment and (b) rates to use it are expected to be relatively low but are unknown at this point. There was one network segment for which microwave made more sense than fiber—a redundant route between Snelling and Lake Yosemite Park. It may be more cost-effective to lease existing fiber along SR 59/Snelling Hwy than to construct new along this route but, for the purpose of this analysis, this is assumed to be new build.

Table 10. Backbone distance and cost estitmates by type and supervisorial district

Area	Type	Feet	Cost
District 1	Overhead	154,496	$3,862,400
	MMBI	34,805	TBD
	Underground	75,094	$8,260,340
District 2	Overhead	88,563	$2,214,075
	Existing	20,372	$101,860
	MMBI	31,149	TBD
	Underground	30,760	$3,383,600
District 3	Overhead	36,964	$924,100
	Underground	63,093	$6,940,230
District 4	Overhead	292,213	$7,305,325
	Microwave	20,750	$429,800
	Underground	96,768	$10,644,480
District 5	Overhead	172,110	$4,302,750
	Underground	38,361	$4,219,710
Ring	Overhead	109,350	$2,733,750
	Existing	5,166	$25,830
	MMBI	464,713	TBD
	Underground	96,744	$10,641,840
Totals			
District 1		264,395	$12,122,740
District 2		170,844	$5,597,675
District 3		100,057	$7,864,330
District 4		388,981	$18,379,605
District 5		235,411	$9,145,960
Ring		675,973	$13,375,590
Grand Total		**1,835,661**	**$66,485,900**

Fiber construction rates can fluctuate substantially and vary by locale. For the purposes of this design, we used per foot rates of $25 for overhead and $110 for underground. For existing public-owned fiber, we included $5 per foot to cover the costs of integrating it with new build. Microwave costs in District 4 include two new towers, millimeter wave PtP capable of 10 Gbps, and related equipment. It may be possible to use an existing tower. Rates to lease private fiber and use MMBI fiber are to be determined.

Table 11. Coverage estimates for fiber-to-the-premises using conceptual network design as feeder network and distribution infrastructure

	Supervisorial Districts					
Premise Type	1	2	3	4	5	All/Total
Commercial	213	526	122	203	362	1,426
Farm	87	19	22	62	23	213
Industrial	51	12	5	25	10	103
Multi-Residence	360	656	160	376	298	1,850
Other	28	29	13	23	29	122
Residence	3,728	6,028	1,754	4,590	3,603	19,703
Vacant	17	13	4	2	7	43
Not indicated	0	1	0	0	1	2
Total	**4,484**	**7,284**	**2,080**	**5,281**	**4,333**	**23,462**
Cost per Premise	$3,301	$1,150	$5,070	$3,988	$2,729	$2,839

Portions of the conceptual network design—generally, new build overhead and underground fiber—could be used as core feeder network and distribution infrastructure. As detailed in Table 11, assuming adequate physical access in the form of splice cases and vaults along with equipment and facilities as detailed below, the infrastructure could be used to provide fiber broadband to over 23K premises.

The cost per premise (or "per passing" in industry terms) for just network infrastructure would be $2,839 on average, ranging from a low of $1,150 in district two to over $5K in district four. These amounts are within a reasonable range, considering the mix of rural and urban locations. The costs discussed in the next sub-sections provide some insights into the costs to provide access—including distribution and for both fiber and radio access—and transport services. It is unlikely that Merced County itself will incur these costs, as it is unlikely to offer network services. Rather, this provides some basis for estimating the capital and operating expenses a third-party provider would incur if it used the backbone to serve customers in Merced County.

Access, Distribution, and Transport Costs

Fiber in the routes analyzed above could connect retail ISPs' POPs anywhere in Merced County with backhaul via diverse routes to multiple upstream service providers for maximum fault protection. Additional equipment, infrastructure, and

software will be required to connect homes and businesses to the network. In practice, most access and distribution infrastructure can and should be built in a phased manner in response to consumer demand and/or in conjunction with other capital projects. In concept, it is important to understand the scale of investment required. For cost estimation, we assume:

- 3500 Customer Premises Served per Hub
- 50%[50] Prospective Customer Take Rate
- 1,750 Total Subscribers (Drops) per Hub
- 0 Video Subscribers
- 1 Data Center
- 1:32 Split ratio

The size of the subscriber base impacts the types, quantity, and costs of central office equipment. Core routing and edge routing are assumed to be separated due to increased capacity required. An optical line terminal (OLT), which establishes connections over access infrastructure to subscriber premises, is also required along with equipment for each subscriber site. For estimating costs, we assume that each customer requires a separate broadband/Wi-Fi router, enclosure, and interface (optical network unit or ONU). Required professional services will be approximately 20% of total equipment costs. If additional FDHs were required beyond the central office, plan to spend about $460K per remote hub to serve up to 2,250 subscribers.

Table 12. Capital costs for access services, including central office/core network equipment and customer premises equipment

Item	Unit Cost	Quantity	Total
Central Office and Distribution Equipment			
Edge Routing	$80,000	2	$160,000
Core Routing	$125,000	2	$250,000
Switching	$7,500	2	$15,000
Access Network	$50,000	2	$100,000
Software	$10,000	1	$10,000
Security	$30,000	2	$60,000
Management	$75,000	2	$150,000
IP Services	$15,000	2	$30,000

[50] Take rate in the context is used to estimate costs only, not revenues, and is set to a level intended to result in conservative cost estimates.

Item	Unit Cost	Quantity	Total
Spares	$25,000	1	$25,000
		Subtotal	$800,000
Customer Premises Equipment			
ONU	$275	1,750	$481,250
NID enclosure	$50	1,750	$87,500
Residential Gateway	$159	1,750	$278,250
RG Management	$6,000	1	$6,000
		Subtotal	$853,000
Pro Services	$160,000	1	$160,000
		Subtotal	$1,813,000
Software/Systems			
Billing	$50,000	1	$50,000
Subscriber/Provisioning	$25,000	1	$25,000
		Subtotal	$75,000
		Total Capital Expenses	**$1,888,000**

The estimated one-time capital costs for equipment and services to establish a transport network for the conceptual design, based on vendor-provided pricing, would be about $530K as summarized in Table 13. The core network in this scenario would consist of the City's data center as the "central office" and a secondary, backup site, which we assume would be an existing site. We assume that each site would have a single router combining edge/core functionality, an aggregation switch, cloud service/firewall appliance for security, Internet Protocol services, and management software for server, network elements, and back-office functions.

Table 13. One-time capital costs for equipment to establish a transport network to meet Merced County's internal connectivity requirements

Item	Unit Cost	Quantity	Total
Core/Edge Routing	$80,000	2	$160,000
Switching	$7,500	2	$15,000
Software	$15,000	2	$30,000
Security	$50,000	2	$100,000
Management	$30,000	2	$60,000
IP Services	$5,000	2	$10,000
Spares	$15,000	1	$15,000
		Subtotal	$390,000

Item	Unit Cost	Quantity	Total
CPE	$1,200	51	$61,200
		Subtotal	$451,200
Pro Services	$78,000	1	$78,000
		Total Capital Cost	**$529,200**

Estimated costs for the two core network sites' equipment alone are $390K. Expect professional services at approximately 20% of the total equipment costs to be required. All the City's sites would get 1 Gbps connections, scalable to 10 Gbps. Each site requires customer premise equipment (CPE) that terminates the transport network and provides an interface to the site's local area network (LAN). We assume there is existing LAN equipment capable of 1 Gbps connections. Sites without connections or legacy equipment would involve additional site-specific costs. Budget around $47K annually for maintenance and other recurring equipment costs.

The central office would house core and edge equipment for ISPs serving customers within the area. Other carriers could be co-located in these sites so circuits and traffic could be connected and routed to the rest of the world. Equipment and facilities requirements are reasonably modest—primarily separate, secure cages for providers and major network users to place equipment, along with environmental controls and clean, reliable power. We assume the central office would be the City's data center. Otherwise, plan to spend approximately $500K to build out a data center, not including property acquisition or construction costs.

Wireless Broadband Cost Estimates

For cost purposes, we assume that any wireless solution must qualify as broadband, ideally meeting the State of California's new standard of 100 Mbps download and 20 Mbps upload. CBRS is the best technology for economically meeting these criteria. A CBRS cell with full coverage would have four sectors, each with an antenna and base stations which may come as an integrated unit. Each cell requires a router with fiber interface, power, and an equipment hut, which may be shared with other network infrastructure such as a GPON POP. Cells require up to 24 strands of fiber to connect with centralized switching facility, but GPON can reduce this to as few as four strands. Cells also require a tower, which would typically be a 50 to 150 feet tall monopole, or some other elevated structure suitable for antenna mounting.

Table 14. CBRS Radio Access Network Costs

Component	Unit Cost	Quantity	Cost
Antenna, base station, installation, wiring, and network management software license, per sector[51]	$12,500	4	$50,000
150-foot direct embed monopole, shipping, and installation	$110,000	1	$110,000
Equipment hut, generator/battery backup and AC	$65,000	1	$65,000
Router with fiber interface	$1,000	1	$1,000
Construction, engineering, and project management services		15%	$33,900
Total per CBRS cell[52]			**$259,900**

Each 4-sector cell requires four, 65-degree, 4-port antennas and base stations, which may come as an integrated unit, one per sector. Antennas are mounted on towers and a hut is generally required for other network equipment. A router is required to connect the cell to the fiber network for backhaul. Each customer premise will need equipment that consists of an CBRS LTE antenna and base station with integrated router and Wi-Fi access point. Installation cost is approximately $200 based on Magellan's experience, and each customer initialization involves a $35 fee for EPC. Each customer involves about $750 in capital expenses. There is also a monthly recurring cost of $2.25 per customer.

Such a cell would accommodate 2,000 subscribers—500 subscribers per base station—with 200 Mbps throughput per base station, divided among all users in that sector. Users should generally get 50 Mbps to 100 Mbps throughput, depending on the number of other simultaneous users. A CBRS cell would nominally provide 60 Mbps download at a 10-mile radius in "ideal" circumstances, including no foliage or terrain. The practical range is around 3 miles.

[51] Based on Telrad equipment (see https://telrad.com/products/breezecompact-1000/). There are multiple vendors of CBRS RAN equipment. Magellan/ENTRUST does not endorse or recommend a particular solution or vendor.

[52] Costs do not include land acquisition or site development beyond tower construction.

Operational Requirements

Organizational capacity is needed to deploy, manage, and operate a network. The investment increases with level of control in businesses models including staff and systems for these purposes. At the minimal level of an infrastructure-only business model, Merced County will need at least one network technician and part of a GIS specialist position. It would be best to have a Network Infrastructure Manager responsible for executing and tracking adds, changes, or moves.

Other departments, particularly Public Works, will see marginal increases in workload as they accommodate network assets in other projects and programs. The capacity to promote the network as a useful asset for business will be needed to generate revenue. This function could be part of Economic Development's work and may be shared by staff responsible for tracking revenue from cell site leases. It would be advisable to invest in specialized fiber management software, which may require additional staff capacity.

Any business model beyond leasing a limited amount of dark fiber will require dedicated staff. Merced County would need a Broadband Director with a strong understanding of facilities leasing and maintenance to be responsible for overall organizational performance, focused on finances and governance. If the Merced County broadband entity is actively promoting use of the network, it will also need a Marketing Manager for identifying and managing lessees. The Marketing Manager may also work with wholesale customers to promote their internet services to the community.

At this level, the Merced County's broadband entity will be comprised of a Director, Infrastructure Manager, and Marketing Manager. The broadband entity will need a fiber management system (FMS – potentially contributed by a private partner) and should have a maintenance fund to cover repair costs. Budget approximately $75,000 for one-time software costs with annual fees of 15%. Major maintenance or repair tasks—anything requiring excavation—may be contracted out or may be handled by the Merced County's Public Works. If the Broadband Department offers any service that involves a service level agreement, it will need external contractors on ready and a dedicated full-time Network Engineer.

Table 15. Fully-loaded cost estimates for staffing various jobs in a broadband enterprise

Position	Annual Cost
Broadband Director	$178,200
Accounting Manager	$126,360
OSP/Engineering Supervisor	$157,140

Position	Annual Cost
Sales & Marketing Manager	$129,600
Headend/Network Engineer	$113,400
Customer Support Manager	$105,300
Technical/NOC Support Manager	$129,600
Business/Enterprise Account Manager	$72,900
Network/NOC Technician (Data Center/Inside)	$97,718
Technical Service Rep Level 1	$50,544
Technical Service Rep Level 2	$60,653
Field Services Technician (in-house)	$77,501
Field Locates Technician (in-house)	$72,446

A retail broadband enterprise has substantial overhead and operating costs, as well as a much larger capital investment in infrastructure and equipment. Payroll can account for 90% or more of ongoing costs for a broadband enterprise. For reference purposes, Table 15 lists estimated annual costs to fully staff a broadband enterprise.[53] Equipment licenses, maintenance, refresh, and upgrades create recurring costs and large periodic costs. Limiting operations to a backbone network greatly reduces both up-front and on-going costs while providing critical functionality and setting the stage for private investment.

Metrics and Targets

Targets for broadband development should use standard metrics. Generally, the target should be effectively ubiquitous—to all addresses in the county—availability of 100/20 Mbps broadband service from at least two providers. For fiber-to-the-premises, the target should be symmetrical 1 Gbps service. The targeted costs for retail broadband should be $0.30 per month per Mbps. Targets for commercial broadband depend on numerous factors but should generally be less than 10 milliseconds of latency (end-to-end delay) and no more than 0.001% downtime. Key metrics for broadband development and operations include:

- The amount or number of:
    - Community members connected via high-speed wired and wireless services

[53] These are estimated national average costs. Actual costs for southern California may be substantially higher.

    - Fiber-connected buildings
    - Persons working remotely or in technical jobs
    - Radio access points
- Business utilization of digital technology
- Cost per month per megabit per second for wired and wireless connections
- Investment in network assets by private companies
- Miles of fiber deployed
- Public revenue from network assets and related services
- Service level agreements, down time, and failures

Specific, meaningful targets for investment, performance, revenue, and utilization should be defined as part of detailed planning, based on the business model selected by local leaders. Generally, the County of Merced should consider the following targets:

- High-capacity, redundant connections to all public facilities
- Fiber through all economic development areas, particularly Castle but also commercial corridors and industrial parks, and into all facilities
- Fully capitalizing on all relevant public funding programs
- Network infrastructure included as a consideration in all capital improvement, planning, and permitting processes
- Public assets, including public-owned land parcels and vertical infrastructure made available and prepared for use by network service providers
- Public, open access Wi-Fi with consistent captive portal[54] in all public spaces, including those managed by private parties
- Shared infrastructure for high-cost, low-income areas, particularly those with public facilities
- Special districts, including irrigation, school, and utility districts, actively engaged as partners

[54] A captive portal is a website that loads by default when a devices connects to a Wi-Fi network. Typically, users can access only a limited number of websites or other resources (referred to as a "walled garden") via the captive portal until they agree to terms of service and provide basic information.

8. Conclusions and Recommendations

Merced County has been divided among 5 Internet Service Providers, resulting in a disjointed approach that varies in pricing, speeds, and services between communities. Most broadband assets in the County consist of coaxial cable or outdated twisted copper, which is priced similarly as fiber but limits the speeds achievable for end users. The low bandwidth speeds qualify significant portions of the County as "underserved" under California's minimum standard of 100 Mbps download and 25 Mbps upload. There is y minimal fiber optic cable (privately owned) deployed throughout the county, and only along the Highway 99 corridor.

Initial data has identified a significant number of addresses in the County—even in relatively urban communities—that cannot get service from any of the 5 ISPs, which qualifies these areas as "unserved." This initial data is supported by CPUC and American Census Survey data that shows much of Merced County has a higher-than-average number of households without any internet access. Wireless internet access, while available in some areas of Merced County, is not a viable option for households as speeds typically cannot meet the California standard of 100/20 Mbps.

According to stakeholders, Merced County has numerous gaps in broadband and cellular infrastructure and services. Most are partial gaps due to limited options, but these are still substantial gaps, particularly County facilities, industrial areas, and schools that do not have fiber-based connectivity. Some gaps seem to be total: No service available. Wired broadband in Snelling and cellular services along Sandy Mush are specific examples. These gaps are due to a vicious cycle: Providers do not invest due to lack of profitable market, which undermines adoption and growth that would fuel demand, so providers would not invest due to low demand.

Resilience and growth were key themes in stakeholders' inputs. While the area was recovering from historic floods as of the writing of this memo, there was also an unprecedented period of drought. City administrators and public safety representatives noted issues for resiliency on multiple levels, from cellular outages in disasters to cybersecurity for smart infrastructure. The agriculture and utilities sectors require connectivity to enable resource management. Workforce costs and shortages are driving automation, too. They, along with local governments, need smart technologies to operate in normal circumstances, and they need those technologies to operate in extreme circumstances.

Housing costs and the changing job market have driven a wide range of residents to the area, particularly professionals from the Bay area. There has been strong multi-unit housing growth and there are ample locations for industry. The Castle area is the most prominent growth opportunity due to its size and potential to fuel other commercial and residential growth. That said, there are a range of such growth opportunities. County policies are likely to drive densification and in-fill. Alignment between residential and economic development will cause connectivity requirements to balloon in the next few years, especially as local agriculture adopts new ways of working.

Areas with disadvantaged populations—whether related to age, education, income, race, or just geographic location—were clearly of concern to stakeholders. Some of these areas are urban, such as South Merced, and others, such as Snelling, are quite remote and rural. But it was clear that "exurbs" between suburban are rural areas, including communities in unincorporated areas, were experiencing disparities between available services and connectivity required for commercial, industrial, institutional, and residential purposes.

There are clearly abundant resources in Merced County. The cities, county, schools, including UC Merced, and special districts all have assets that could be leveraged for broadband development. There are abundant agricultural production facilities, particularly farms and other producers, and sites for industry. The area has a wide range of community-based and other organizations that directly improve people's quality of life.

There is a definite tactical awareness among stakeholders of broadband and its implications. Various stakeholders are struggling with aspects of the digital divide and planning to deploy network devices and infrastructure. A common strategy for broadband that aligned with and was integrated into other strategies could (a) drive broadband development, (b) reduce the costs of deploying network infrastructure, and (c) make a wide range of efforts more successful. As examples, development of ag innovations, the Castle area, educational programs, and telehealth services would all benefit increases in network capacity and coverage. The likelihood of such an increase would be greatly increased by a unified approach shared by local stakeholders, including but not limited to those that participated in focus groups and interviews for this project.

The general implication is that stakeholders should actively collaborate on developing network infrastructure, and not just expect the private sector to take care of it. For one thing, the current situation is due to internet service providers not adequately investing in the area to meet requirements. More importantly, this new infrastructure is critical to businesses, institutions, and people's ability to

operate. Active collaboration by stakeholders will inevitably increase investment—public and private—guide that investment to where it is needed most and ensure maximum public benefit with reasonable financial return from the investment.

Merced County does not have any existing fiber or conduit that can be utilized as broadband infrastructure. The City of Merced has some fiber and conduit in and around the center of the City that could be used if expanded and integrated into a larger network. The City conduit and fiber could be the starting point for a countywide backbone infrastructure to reach all government sites, schools, and rural areas. Not only would this allow faster more resilient connections for public purposes, but the backbone infrastructure could also be used by private network service providers to offer retail broadband. Indeed, the infrastructure could support a range of applications and services, including broadband and narrowband radio services.

There are two significant opportunities that the County can leverage to build a county-wide backbone network: 1) Utility and CIP coordination utilizing dig once policies, and 2) integrating into the future California State Middle Mile Network planned along Highways 99, 33, 140, 152, and 140, as well as part of Interstate 5. Capitalizing on County and cities' CIP projects for opportunities to deploy new fiber and conduit assets during otherwise-planned excavation can create new County broadband assets at a fraction of the cost.

Demand or needs for broadband are determined by consumers. As discussed above, the conceptual backbone network design could enable a provider to serve over 23K premises with minimal capital investment. Additional investment in access and distribution infrastructure would greatly increase this reach. The Community Survey Results section of this report provides some insights into consumer demand, their issues and willingness-to-pay for broadband.

Most survey responses came from older, middle-class households in urban areas of the County. Responses in smaller cities and rural areas were more likely to not have broadband, as were households with lower levels of educational achievement. The major reason for not having broadband was the lack of an economical, fast service. While a few respondents indicated not needing or valuing internet, it was clearly very important and useful to an overwhelming majority of respondents.

Reliability was generally good—with notable exceptions—and very important for respondents. While price was relatively less important, it was the major reason for dissatisfaction with broadband service. Evidently, a few respondents have major reliability issues with their internet connections, and many pay too much. There are

limited options for service: Merced has the typical cable-telco duopoly with a few competitive providers.

Actual speeds substantially lower than what providers nominally offer. Nearly a third of respondents were paying rates approaching competitively priced broadband and over two-thirds paid less than $1.00 MRC per Mbps. While customer support was a relatively less important factor, it was relatively more valuable to respondents for lower bandwidth services. Overall, respondents indicated being willing to pay $36 in MRC for excellent customer service. Basic willingness-to-pay was between $50 and $85 MRC for 100/20 Mbps service. Availability and costs seemed to be key issues for those in the northern and southern portions of the County, particularly outside population centers.

Communication, entertainment, and general interest research were the most common and important uses of broadband. Learning, which was a very common household activity, was also a major use along with gaming and online buying. Productive uses, including remote work, operating a home-based business, and selling were the least common and frequent uses among respondents. Given other issues with access, lower income families appear to be excluded from several uses, particularly ones related to generating income, such as operating a home-based business, which they seemed to do at a higher rate than more affluent households.

KEY CONSIDERATIONS FOR BROADBAND STRATEGY

Fiber is the Foundation for Fast Broadband Access

Both wireline and wireless broadband services require fiber optic cable. The Infrastructure Investment and Jobs Act (IIJA) and SB 156 in California have made large amounts of funding available to invest in fiber optic technology, particularly in open-access middle mile networks and last-mile fiber networks for unserved areas lacking access to 100 Mbps upload/100 Mbps download speeds. Additional policy actions by the County and cities can also contribute to expanding the reach of fiber optic connections in Merced County. Generally, it is advisable to incorporate fiber—or at least conduit—into all city and county capital projects and plans. For example, including broadband in HUD plans could allow multi-dwelling units to be retrofitted with fiber. It has become critical to ask the question at the planning stage for each capital project. How can this project support expansion of broadband infrastructure in the city or county?

Affordable Connectivity Program

To the extent they are not doing so already, Merced County and its cities could assist in expanding the penetration of broadband services by making it a practice to regularly publicize and promote the availability of new FCC Affordable Connectivity Program benefits[55] to qualifying County and city residents. The ACP provides a $30 per month subsidy through participating broadband providers to reduce the price for a minimum 100 Mbps download speed broadband connection for eligible households. The Merced County region can benefit from the ACP by increased ACP uptake from additional community awareness of program details as communicated to the County and cities' qualifying residents. Information and awareness need to be built and maintained by program managers responsible for services provided to the low-income communities.

Radio is Essential for Flexible Access

Whether via cellular or Wi-Fi, most people connect to the net via radio access network. Citizens Broadband Radio Service, low-power wide-area network, and millimeter wave, not to mention 5G, are growing more common. Typically, these technologies co-exist, and all rely on fiber for backhaul to core networks. They also require mounting on physical facilities—buildings, poles, tanks, or towers. Merced County states a clear requirement for placing cell sites on public property in Chapter 18.68.070B. Public assets, particularly streetlights, can be used as micro-cell sites, if connected via fiber. Permitting and zoning, including reasonable design and construction standards, can facilitate this. A thorough review of assets and sites will identify what is practical for development. Wi-Fi infrastructure can be inexpensively deployed in most public spaces—community centers, major parks, public buildings, transit centers, etc.—particularly if implemented in a standardized manner.

To the extent not already accomplished, Merced County policies regarding wireless broadband infrastructure should be aligned with the FCC "Small Cell Order" in 2020. Further documentation on small cell should provide common terms and conditions for all wireless providers regarding deployment of small cell facilities on County and city structures and details for installation of small wireless facilities on county and city streetlights.

[55] The FCC's Affordable Connectivity Program is funded by the Infrastructure Investment and Jobs Act.

Each jurisdiction's Public Works and Community Development should be aware of the requirements of subsequent FCC decisions on wireless siting. The "5G Upgrade" decision[56] allows applicants for siting of 5G antennas to start the shot clock with the first procedural step required by a jurisdiction, including a pre-submittal meeting. Once updated, the county wireless telecommunications facilities ordinance can serve as a small cell ordinance template for cities to consider adopting.

For larger wireless infrastructure (e.g., towers), cities should have a telecommunications facilities ordinance to regulate permits for wireless towers and antennas, ideally in line with other California cities. After the Small Cell Order the FCC issued its "Site Modification Order"[57], which expands the definition of an "eligible facilities request" to include ground excavation or deployment of transmission equipment up to 30 feet in any direction outside the boundaries of an existing tower site. Merced County and the cities may see applications for modification of existing tower sites which cite this provision. This should also be considered for inclusion in an updated wireless telecommunications facility ordinance.

Broadband Should be Incorporated into Real Estate Development, Transportation and Utility Projects

All commercial and residential developments require broadband. Transportation and utility infrastructure are getting smart so require connectivity to operate, improving traffic and reducing impact on natural resources. Network assets can be economically incorporated into other infrastructure. Fiber for traffic signal interconnects can include additional fiber and conduit for other applications, including broadband services and cell site backhaul. IIJA provides more funding for traditional infrastructure programs than specifically for broadband. Merced County and its cities can capitalize on that and complement investment specifically for network assets. The key to this is to fully incorporate and include network infrastructure into other capital projects and permits.

Utility Coordination and "Dig Once"

As described above, the Statewide Middle-Mile Broadband Infrastructure (MMBI) is a new public corporation that will build and operate a statewide middle-mile network in Caltrans rights-of-way. Merced County should explore these

[56] See Appendix B at page 14.

[57] See Appendix B at page 16.

opportunities with the representative on broadband utility coordination and MMBI. Deployment of additional broadband infrastructure for other purposes can be planned in conjunction with traffic fiber for Intelligent Transportation Systems (ITS) and the Merced County broadband strategic plan.

Implementation of the utility coordination concept often begins by coordination among county and city departments first, such as Public Works, Utilities, Community Development, and the various transportation improvements at regional and local levels. The concept can then be extended to include projects of private utilities and other occupants of the public right of way using the same cost saving/pavement protecting objectives.

Utility coordination can begin with county and city departments ensuring they are coordinating on major projects to include broadband infrastructure where needed by considering at early stages of the projects how can it be used to expand broadband capacity and availability. Going forward, all significant County and city projects and initiatives should include explicit consideration of broadband implications. Broadband is a critical infrastructure and general plan elements should incorporate actions which support expansion of broadband infrastructure.

Utility maintenance and installation work coordination can avoid damage to the public investment in landscaping and roads, and to avoid disruption to residential neighborhoods. It supports deployment of fiber to streetlights and traffic signals in alignment with this Broadband Strategic Plan, as well as include placement of conduit in economic development corridors, transportation planning and capital improvement projects. In sum design and development processes and documents need to include broadband as a fundamental consideration.

Finally, public works departments will need to plan for compliance with SB 378, which mandates approval of “micro-trenching” applications, which is defined as a narrow open excavation trench that is: (1) no wider than 4 inches; (2) at a depth of 12 to 26 inches; and (3) created for the purpose of installing a subsurface pipe or conduit. The shallower depth often is considered undesirable for long term health of the jurisdiction’s streets as it inevitably requires additional maintenance and reduces lifespan. Requirements for maintenance and restoration should be clearly spelled out in response to this mandate.

Development Standards and Conditions on Development Agreements

Merced County and its cities could consider inclusion of requirements to place fiber/conduit, concurrent with development, in developer agreements to ensure

efficient provision of fiber-optic based next generation broadband services. Examples of approaches to conditioning development include:

- The City of Brentwood California requires developers to place conduits and fiber optic systems for use by the City and its licensed franchisees. [See, Title 16, Subdivisions and Land Development, Chapter 16.120.120, Undergrounding. Electric, communications, street lighting and advanced technology systems.]
- The City of Shafter California conditions approval of developer agreements in part on installation of fiber optic systems to serve each buildable lot and dwelling in the development in concert with its municipal fiber optic network. The City provides detailed fiber optic requirements. See, Developer Agreement Conditions for the City of Shafter CA in Appendix D.
- Sandy, Oregon requires all development sites shall be provided with public water, sanitary sewer, broadband (fiber) and storm drainage, constructed concurrent with development. Work to install public improvement facilities must proceed according to procedures adopted by the City Engineer, to among other things "provide for orderly and efficient land division patterns supported by a connected system of streets, fiber (broadband), water supply, sanitary sewer and stormwater drainage facilities." [Development Code, Chapter 17.84.60]
- Ocala Florida through its Utility Services department establishes fiber conduit rules which contain detailed specifications and procedures for conduit to be installed by the developer, including developer/contractor responsibilities, trench specifications and procedures, requirements for use of joint trench, conduit specifications and procedures, and drawings and exhibits. Ocala Utility Services will install the fiber optic systems using these conduits constructed under its "Fiber Conduit Rules and Regulations". These specifications are similar in nature to the City of Shafter's developer conditions.

Broadband access and internal building wiring can be required for affordable and public housing and CDBG and other HUD funds can be applied to this purpose.

APPROPRIATE MODEL

Merced County has joined the Golden State Connect Authority (GSCA) along with 38 other counties that are member of the Rural County Representatives of California (RCRC). GSCA was established by RCRC to increase access to reliable, affordable high-speed internet for all rural Californians. GSCA is using the "municipal" open-access, public-benefit model that, as illustrated in Figure 53, is the lowest risk active

approach to public-sector broadband development. GSCA contends[58] that the traditional internet service model can limit service options whereas an open-access model allows multiple internet service providers to use the same publicly owned network infrastructure to provide services. The goal is to have increased competition among internet service providers with more options for consumers.

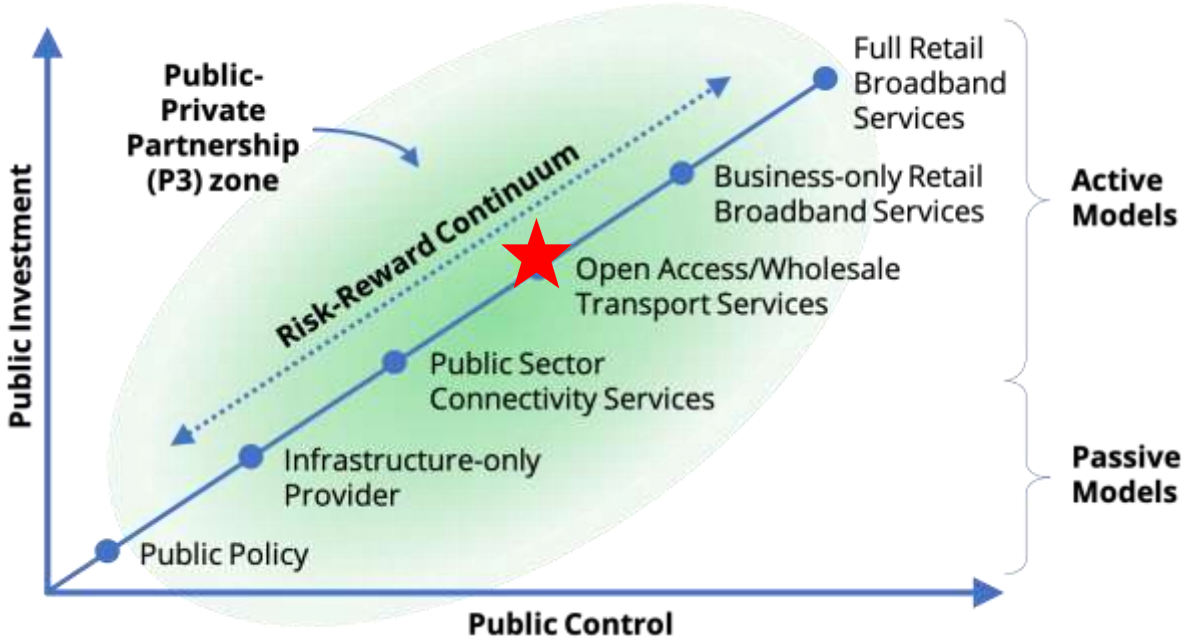

Figure 53. Broadband business models as a continuum of public investment and control

Star (★) indicates GSCA model

GSCA has a memorandum of understanding (MOU) with Utah Telecommunication Open Infrastructure Agency (UTOPIA) Fiber to assist in the development and operation of this infrastructure. UTOPIA will help build and operate the open-access network(s) and provide administrative services for GSCA. GSCA is currently identifying pilot projects with the intent to expand to additional rural member counties. Pilot locations are to be selected based on broadband need and overall viability, including estimated project costs and opportunities for partnership with local government and other agencies. As of the writing of this report, Alpine County and the South Salinas Valley Broadband Authority in Monterey County had been selected as pilot locations. GSCA was evaluating other prospective pilot project areas and working with the local governments to establish local partnerships.

[58] See https://goldenstateconnect.org/projects/.

Merced County is somewhat limited by but not bound to the GSCA model, particularly as other communities have been selected as pilots and it is unclear when or if UTOPIA might start operating in the county. The county is well-positioned for state Last Mile Fund money, but it is likely that funding will go to either GSCA/UTOPIA or existing private service providers. Therefore, it will be impractical for Merced County to play a role more ambitious that public connectivity service provider. That said, several local jurisdictions, including the County itself, and special districts seem to require additional connectivity. The County could play a critical role aligning and capitalizing on investment by cities, irrigation districts, school districts, and others. Incremental, methodical, opportunistic builds by the County and in conjunction with other private and public projects could greatly increase the public-owned network assets. These could then be leveraged to attract private providers and/or utilized by UTOPIA. Therefore, it makes sense for the County to use an infrastructure-only or public-service provider model. Both approaches require modest commitments of staff time that could likely be met as via small increases in existing capacity/functions.

Community Internet Service

There is a long-established precedence for community internet service. Indeed, the earliest ISPs were community internet services and there are numerous such providers operating in California, many of which are operated by school districts. The Dos Palos Community Internet Project is a prime example, in part because the model was borrowed from another school district. Dos Palos-Oro Loma Joint Unified School District used American Rescue Plan Act (ARPA) Elementary and Secondary School Emergency Relief (ESSER) funds to build a radio access network and provide wireless broadband to students' homes. Student access goes through the District's firewall and uses the District's bulk internet connection via statewide non-profit network. Consequently, uses are limited to education related and intended for school purposes. Technically, it would be a simple matter to add another wireless network over this access infrastructure that uses unrestricted backhaul.

The system consists of three towers, two of which pre-existed, with antenna arrays and base stations connected via fiber at school sites. Connections are via CBRS (see above) from the towers to students' homes. Customer premise equipment (CPE) is a small, user-friendly CBRS to Wi-Fi router. The routers are checked out to students by the library after adults submit a request, authorize use, and agree to terms and conditions. All components, including CPE, radio spectrum, and tower maintenance, were required in the proposals. The system connects 300 to 400 students with

speeds of around 20 Mbps at no cost to the families, covering at least 80% of the district's area. It has been a cost-effective solution for the District and the intention is to continuing operating the service for the foreseeable future.

Cost Model

The cost model for Merced County is unclear due to various dependencies that have not been defined. Specifically, it is unclear to what extent GSCA and UTOPIA are going to construct and operate network infrastructure in Merced County and how much Golden State Net is going to charge for use of the MMBI. Information in the "Conceptual Network Design" sub-section provides the basis for a cost model but needs to be narrowed and refined.

A key component of the cost model is current spending. The City and County of Merced are currently operating under an in-kind service arrangement for their institutional wide-area networks (I-NET). Needless to say, the provider would like to change this. Beyond this both governments, other municipalities, and a range of community anchors spend substantially on connectivity and still don't have what they need. It is also important to understand costs to consumers, particularly in under-served areas. See the "Market Assessment" and "Community Survey Results" sections for more information on that.

Lastly, it is important for local leadership to recognize the long, strong levers the County of Merced and other local governments have for moving the costs of broadband development. Broadband-smart policies reduce uncertainty and costs for providers. A comprehensive approach to planning, especially conditioning development with network infrastructure and incorporating it into capital improvements, make broadband development much more economical. Development of shared infrastructure, anchored by public investment, is another powerful tactic for reducing barriers to market entry and cost of doing business for providers. Local public financing, including private activity bonds and special districts can be used for finance network infrastructure.

Funding

Merced County is generally well-positioned for broadband funding. As already noted, the County's position in GSCA will impact how funding flows, but it is unclear at this point exactly how. The State of California has several programs to support broadband development, including MMBI (discussed above in the "California Middle-Mile Broadband Infrastructure" sub-section and below in this sub-section), and the now-closed Local Agency Technical Assistance grants program. The CPUC Federal Funding Account and Broadband Loan Loss Reserve Fund use IIJA funds

(discussed below) for pay for or reduce the risk of broadband development. There are a wide range of other public funding sources—many not directly focused on broadband—that can be leveraged to get more people connected. The State of California provides a comprehensive list of these programs on the "Broadband for All" website at https://broadbandforall.cdt.ca.gov/funding/.

The federal government allocated $1.9T via American Rescue Plan Act (ARPA), to aid public health and economic recovery from the COVID-19 pandemic in spring of 2021. About six percent, or $8.7B, was allocated specifically for broadband and another $10B went to general infrastructure.[59] The State of California received over $43B in combined recovery funds from ARPA, including $27B in state fiscal recovery funds. $2.4B was dedicated to promoting broadband access and affordability and another $7.9B was allocated to economic and health impacts that benefit from broadband.

The County of Merced is receiving $53.9M in ARPA funds and the City of Merced got $27.4M. Initially, rules placed heavy limits on the use of funds for broadband but the final rules for use of ARPA funds were much more flexible. In particular, the final rules give local and state government a great deal of flexibility in defining target areas. While ARPA funding specifically for broadband is limited, funding for other purposes could enable or support broadband development. The same is even more true for IIJA.

The Infrastructure Investment and Jobs Act (IIJA) provides for $1.2T in federal spending over the next five years, including $65B for broadband,[60] $48.2B of which will be administered by the National Telecommunications and Information Administration. $40B is for grants to states to fund deployment. The State of Oregon is establishing a framework for the IIJA state block grants totaling over $100M for broadband and digital equity. IIJA provides funding for complementary infrastructure, too: $111B roads, bridges, and major projects, including $300M to local governments in Oregon, $79B for the power grid, $48B for water infrastructure, and $47B for resiliency. There are other federal funds available, too, particularly for grants and low-interest loans rural broadband development through USDA.

The NTIA programs include for Broadband Equity, Access, and Deployment (BEAD), Digital Equity, and Middle Mile Infrastructure as well as amendments to the Tribal

[59] Source: https://www.ncsl.org/fiscal/arpa-state-fiscal-recovery-fund-allocations

[60] Source: https://www.ey.com/en_us/infrastructure-investment-and-jobs-act

Broadband Connectivity Program. BEAD's objective is to close the availability gap, particularly unserved locations (those without 25/3 Mbps service available), underserved locations (those without 100/20 Mbps), and community anchor institutions without gigabit connections. Other considerations include persistent high-poverty areas, capacity of the proposed network, time to build, and prior compliance with federal laws. The $42.3B of BEAD funds will be distributed through the states, as discussed below. Awardees will be required to offer a low-cost plan to all their subscribers.

The Digital Equity Program provides a total of $2.75B to close the digital divide and promote digital equity and inclusion. Program priorities are low- to moderate-income households, rural areas, seniors, veterans, and individuals who are incarcerated, have disabilities or language barrier, and/or members of racial or ethnic minority. Eligible applicants the state or its political subdivisions, economic development authorities, electric utilities, native entities, nonprofit associations, corporations, foundations, or institutions, regional planning councils, tribal governments, tech companies, telecom companies or cooperatives, and utility cooperatives or public utility districts.

The $1B Middle Mile Infrastructure program is direct competitive grant on technology-neutral basis for similar eligible entities. Its focus is the expansion and extension of middle mile infrastructure to promote broadband resiliency and reduce the cost of connecting unserved and underserved areas. Proposed projects must meet two of five conditions: (1) fiscally sustainable strategies, (2) non-discriminatory interconnection, (3) specific, documented, and sustainable demand for middle mile interconnection, (4) availability of conditions and resources to speed up deployment, and/or (5) demonstrable benefits to national security interests.

ACTION PLAN

Given Merced County's participation in GSCA, there are not many specific actions it should take to develop broadband. It is really on GSCA to move the process forward from this point. It should be undertaking detailed planning for Merced via its contractors and partners. That said, there are a number of general actions the County and its local partners can take. In particular, the County should proactively engage GSCA and basically insist that it use this report as a springboard and aggressively work on broadband development in the area.

1. Establish a broadband committee of community anchors, particularly municipalities, school, and special districts, etc.

Traditionally, telecommunications companies unilaterally planned infrastructure without consideration for, let alone participation by, community anchors. This approach created the digital divide and has impeded digital transformation by many institutions. Local government, community-based organizations, and special district wield a great deal of resources that could direct and drive broadband development. The result can and should be better, more equitable use of technology, lower costs for everyone, more options for consumers, and more profits for competitive providers. These results can only be achieved via collective action. A broadband committee (task force, team, working group, etc.) can be a very effective means of ensuring all voices are heard, all needs met, and all resources fully utilized. It will undoubtedly be critical to the success of GSCA's efforts.

2. Take a leadership position with GSCA and UTOPIA evolve and implement this plan

Merced County is well ahead of most other members of the GSCA due to its work to-date, exemplified by this plan. It is not clear that the Authority is aware of this position or appreciates it. Consequently, Merced may be overlooked and not given its due in the process. Brief the GSCA leadership on this plan and ask them to make Merced a priority, in part to enable and guide other GSCA communities. Capitalize on GSCA but avoid relying on it as a total solution. It can be a vital part of getting and using broadband but there are many other resources and tactics available to Merced. This plan provides a starting point, but it will necessarily evolve as it gains details and gets implemented. Actively involve GSCA and other stakeholders, including State of California agencies in the evolutionary process.

3. Support development of last mile infrastructure

The County of Merced may not play a direct role in building out the last mile of broadband—the access and distribution infrastructure. Indeed, there seems to be little desire or need for the County to play such a role. There are many different players, including innovative initiatives like the Dos Palos Community Internet Project, who are focused on ensuring access for all. The County and other local governments can directly invest public resources and guide private investment to support those initiatives. For example, the County could buy IRUs from UTOPIA to remote sites to ensure fiber is deployed in rural areas. That fiber could then be

used by community-based organizations, entrepreneurs, and established network service providers to cost-effectively provide services.

4. Implement broadband-smart policies and programs

As discussed in detail above (specifically, the "Policy Guidance" section, dig once, joint build, integrated planning and permitting, development conditioning, wireless master license agreement, and various other policies and programs can make broadband development much more economical and guide it to where it is most needed. The County should work with the City of Merced and other municipalities to implement clear, consistent policies. Work with community-based organizations, special districts, and other stakeholders on programs to provide devices and digital literacy training, as well as support broadband development. The broadband committee, discussed above, should be a vehicle for these activities.

5. Capitalize on relevant capital projects, particularly MMBI

This action has been described in detail in other parts of the plan. The key to success is to be comprehensive yet focused in these efforts. Ensure the full range of capital projects, including those by irrigation and school districts, ACE Rail, and, of course, MMBI. The County should also engage with neighboring counties and regional entities to align efforts and ensure they are also capitalizing on large-scale projects. The County and other local governments should consider establishing enterprise funds specifically for broadband, network infrastructure, or technology in general to ensure they have resources for these purposes.

6. Focus on assets for government site interconnection and economic development areas reaching into agricultural areas

To the extent that the County and cities invest in network assets, focus that investment on economic development areas and government sites, including parks and public housing. The key consideration should be community value: How does this investment help achieve strategic goals or reduce operating costs. Given the importance, dynamism, and challenges of the agriculture sector, it is particularly important for the County to look for every opportunity for public investment to benefit firms and workers in that sector.

7. Target network service providers as economic development prospects with incentives and programs

This may be one of the most important roles for the County in support of GSCA and UTOPIA. It is also likely to have some of the biggest benefits to consumers and anchor industries, particularly agriculture. As discussed above, public investment or spending can provide a catalyst for private investment. Network service providers can be targeted for attraction with incentives and other programs just like any other type of company. In fact, attracting a range of network service providers and related companies to Merced can increase the area's attractiveness to other industries. The autonomous vehicle and value-added processing sub-sectors are two prime examples that are especially relevant to Merced.

8. Invest where necessary to achieve public priorities

Direct public investment may make financial sense. The County and other local governments should review the full range of financing options, including community service and facilities districts (i.e., Mello-Roos), enterprise funds, private activity bonds, and revenue bonds. Remember that connectivity is essential to achieve many public priorities. For example, investments in streetlighting can facilitate development of radio access networks as well as improve public safety. Hybrid fiber-radio networks are the new infrastructure and broadband is the new utility. Just as public investment was necessary to build out traditional infrastructure and availability of power and water, so broadband is unlikely to develop in key areas without public investment. While federal and state resources, along with private investment, can accomplish most of this, local leadership and direct investment may be the most effective way to ensure all residents, institutions, and businesses in Merced County have the connectivity they require to prosper in today's digital world.

Appendix A: Stakeholder Participants

- Nathan Ahle, Comcast
- Vern Alvarado, Merced County Office of Education
- Adam Amaral, Merced County Office of Emergency Services
- Gaby Araiza, American Cancer Society
- Maribel Arevalo, City of Livingston PD
- Happy Bains, City of Livingston
- Matthew Beaman, Merced Irrigation Urban Groundwater Sustainability Agency
- Jeff Bennyhoff, City of Merced
- Cullen Byrne, MidValley IT
- Dennise Carrera, Dignity Health
- Frank Castro, Comcast Xfinity
- Claudia Corchado, Cultiva la Salud
- Michael Courtney, Westside Ambulance
- John Cox, County of Merced
- Marvin Dillsaver, City of Merced Police Department
- Ken Elwin, Merced Public Works
- Khamla Emanivong, County of Merced
- Danielle Flake, Farm Bureau
- Wayne Fox, Environmental Health
- Mike Friedburg, Merced County Office of Education
- Sarah Frey, University of California Merced
- Miguel Galvez, Livingston Planning
- Cari Gansberger, Merced County Agricultural Commissioner
- Miguel Garcia, Merced High School District
- Sheryl Garman, Merced Union High School District
- Michael Garrett, Merced County Emergency Medical Services
- Brenda Geary, City of Merced Police Department
- Monika Grasley, Lifeline CDC
- Joe Guilian, County of Merced
- Chuck Hale, City of Livingston
- Yang Her, County of Merced
- Tiffany Ho, County of Merced
- Derrik Hunger, Merced County Agricultural Commissioner
- Nicholas Jensen, California Legal Aid

- Latisha Jimenez, California Health Collaborative
- Cyndi Lang, Dignity Health
- Scott McBride, City of Merced
- Christy McCammon, County of Merced
- Angellica Medina-Boersma, DHHSC Merced Outreach
- Maria Mendoza, City of Merced
- Mark Mimms, County of Merced
- Wunna Mine, Golden Valley Health Centers
- Blanca Ojeda, Faith in the Valley
- Greg Padilla, Merced County Fire Department
- Jennifer Prandini, Comcast
- Teddy Purganan, County of Merced
- Jovan Pulido, Bitwise Industries
- Frank Quintero, City of Merced
- Aaron Rosenberg, Merced County Sheriff's Office
- Alexxis Rudich, Farm Bureau
- Sean Runyon, Merced County Agricultural Commissioner
- Corri Silveira, MidValley IT
- Deanna Soria, City of Livingston PD
- Stacy Souza, City of Los Banos
- Nanette Waggoner, Merced County Office of Education
- Scott Weimer, Merced Union High School District
- Jami Westervelt, City of Gustine
- Tim Williams, Merced County Emergency Medical Services
- Casey Wilson, City of Merced
- Lindsey Wine, Mercy Medical

Appendix B: California's Broadband Policy

GOVERNOR NEWSOM'S EXECUTIVE ORDER

Governor Newsom issued **Executive Order N-73-20**[61] on **August 14, 2020**, which found:

- Over 2 million Californians do not have access to broadband at benchmark speeds of 100 Mbps (download) including 50 percent of rural housing units.
- 23 percent of California housing units, housing 8.4 million residents, do not have broadband subscriptions (as of December 2018).
- 34 percent of adults over age 60 do not currently use the Internet.
- "The COVID-19 pandemic has amplified the extent to which broadband is essential for public safety, public health, and economic resilience".
- "The COVID-19 pandemic has caused schools to shift to distance learning".

The Executive Order directed state agencies to bridge the Digital Divide and ordered:

1. California state agencies to pursue a minimum broadband speed goal of 100 Mbps download speed to guide infrastructure investments and program implementations; and,
2. The California Broadband Council to create a new State Broadband Action Plan[62] for a roadmap accelerating state agency deployments and supporting local government deployments, providing information on federal and state funding, and maximize inclusion of tribal lands.

The Executive Order also directed state agencies to collaborate regarding broadband mapping and data, funding, deployment, and adoption:

1. Undertake regular research with private sector companies to understand and predict current and future demand for broadband to better manage

[61] *See*, https://www.gov.ca.gov/2020/08/14/38666/.

[62] *See*, https://broadbandcouncil.ca.gov/wp-content/uploads/sites/68/2020/12/BB4All-Action-Plan-Final.pdf

policies, programs, and resources for continued leadership in broadband innovation (mapping and data).

2. Office of Business and Economic Development is to identify funding opportunities for broadband deployment and adoption (funding).
3. Department of Technology is to seek leveraging opportunities for state contracting authorities to further broadband access and adoption (funding).
4. Transportation agencies to include placement of fiber and conduit in all appropriate and feasible state transportation projects along strategic corridors (deployment).
5. Provision of an inventory of state property for use in broadband infrastructure by the Department of General Services (deployment).
6. Coordination by the Office of Emergency Services to expand broadband infrastructure when implementing Next Generation 9-1-1 (deployment).
7. Identification and support for new broadband projects that support precision agriculture by the Department of Food and Agriculture (deployment).
8. Housing agencies are to provide recommendations to the CPUC for increased free or low-cost broadband connectivity serving subsidized housing units (deployment).
9. Office of Business and Economic Development to coordinate outreach informing residents of affordable internet service, including tools developed by CPUC for easy identification and subscription to affordable broadband plans, promotion of affordable home internet service to recipients of School Lunch program benefits by California Emerging Technologies Fund, and promotion of affordable home internet services by the California State Library (adoption).
10. Department of Education to lead statewide effort to ensure students have computers and connectivity necessary for distance learning (adoption).
11. Department of Aging to analyze needs of people over 60 for access to broadband and opportunities to close the digital divide among older Californians (adoption).

The Executive Order directed the **California Public Utilities Commission** (CPUC) to take specific actions regarding broadband mapping and data, and deployment:

1. Lead mapping and data gathering efforts to provide information on locations without broadband access, private and public broadband network

infrastructure, state owned infrastructure and rights of way, costs of middle mile and last mile deployments (mapping and data).

2. Provide information supporting development of local broadband infrastructure deployment and digital equity plans (mapping and data).
3. Use programs under its jurisdiction to accelerate broadband deployment and leverage utility infrastructure (deployment).

RULEMAKING REGARDING BROADBAND INFRASTRUCTURE DEPLOYMENT AND TO SUPPORT SERVICE PROVIDERS IN THE STATE OF CALIFORNIA

The CPUC opened a rulemaking proceeding[63] to begin implementation of the **Executive Order**. Both the Governor's Executive Order and the CPUC rulemaking were written prior to availability of COVID-19 vaccines, amid pandemic-related shut-down requirements. The CPUC Order states:

> Communities across California face a multitude of barriers for the deployment of resilient and accessible networks. Broadband internet access service in urban communities varies by neighborhood, with great discrepancies in infrastructure technology. Communities in rural areas often lack sufficient wireline and wireless broadband internet access service, as well as the backhaul infrastructure to provide broadband services.
>
> The COVID-19 pandemic has highlighted the extent to which broadband access is essential for public safety, public health and welfare, education, and economic resilience. The pandemic adds greater urgency to develop new strategies and expand on existing successful measures to deploy reliable networks with affordable service. Universal connection to the internet at reliable speeds is crucial to California's economic recovery from the impact of COVID-19. More Californians are telecommuting from their places of residence and millions of children are attending classes remotely. Additionally, with unprecedented growth in unemployment caused by COVID-19 and the need to participate in society from home, the demand for low-

[63] Order Instituting Rulemaking Regarding Broadband Infrastructure Deployment and to Support Service Providers in the State of California; R.20-09-001; September 18, 2020.

> cost broadband internet access service will increase as millions of additional Californians need affordable plans to get through the pandemic and recover.[64]

The CPUC Rulemaking is to "identify strategies and tactics to facilitate expeditious deployment of reliable, fast, and affordable broadband infrastructure as well as services to connect all Californians." The issues included are "infrastructure deployment models and strategies, economic vitality and recovery strategies, and strategies to support specific communities, public safety, and other critical uses."[65]

Senate Bill 156, Funding for a State-Operated Open-Access Middle-Mile Network, Last-Mile Facilities, and a Broadband Loan Loss Reserve Fund

The State of California built on the Executive Order's direction to eliminate the Digital Divide when **Senate Bill 156** was signed into law on July 20, 2021. This bill implements significant broadband provisions for the 2021-22 budget, including creation of a Federal Funding Account to use American Rescue Plan Act (ARPA) funds. The major elements of the broadband budget are:

1. $3.25 billion in funding (all from ARPA) for construction of a state-owned open-access middle mile network designed to provide connectivity for rural and urban areas to achieve the greatest reductions in the number of households unserved by broadband service under state and federal standards.
2. $2 billion in funding ($1.072 billion from ARPA) for "last mile" projects, funded through the Broadband Infrastructure Grant Account program, divided between rural and urban counties.
3. $750 million (general funds) to assist local governments and non-profit organizations in financing broadband projects.

Other major provisions of SB 156 include:

1. Establishment of the Office of Broadband and Digital Literacy at the Department of Technology, with duties including oversight of the acquisition and management of the statewide open-access middle-mile network.

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[64] *Id*., at page 6.

[65] *Id*., at page 9.

2. Requirement for CPUC to identify and prioritize statewide open-access middle-mile locations according to specified priorities, including:
    a. Locations where there is no known open-access affordable middle-mile networking, that would enable last mile connections.
    b. Areas unserved or unserved by open-access middle-mile networks where such networking can be built expeditiously.
    c. Locations that would enable last mile connections to unserved residences and community anchor institutions and tribal lands.
3. Requirement for CPUC to prioritize state highway rights-of-way for open-access middle mile network construction.
4. Stipulation that the open-access middle-mile network if for a public purpose, can be leased for less than fair market value.
5. Exempts certain broadband projects from CEQA requirements.
6. Removes limitations on local governments receiving grant funding.

The CPUC added SB 156 issues to the scope of Rulemaking 20-09-001 regarding broadband infrastructure deployment on August 2, 2021. The added issues address the implementation of SB 156 and the historic funding for middle-mile and last-mile broadband deployment contained in the American Rescue Plan Act.[66]

State Operated Open-Access Middle-Mile Network

"Middle-mile refers to the high-capacity fiber-optic cables that traverse long distances (i.e., 10s. 100s of miles) to connect communities to the Internet backbone."[67] Middle Mile networking connects the "last mile" distribution facilities connecting households and businesses to the network, with the backbone long haul facilities that comprise the Internet backbone between large cities such as San Francisco and New York.

Development of open-access middle-mile networking is crucial for unserved households in both rural and urban areas. "Lack of Middle Mile is a barrier to

[66] Assigned Commissioner's Second Amended Scoping Memo and Ruling, R.20-09-001; August 2, 2021.

[67] "Middle Mile Locations Outreach Briefing" presented to California State Association of Counties, California Public Utilities Commission, August 20, 2021.

deployment and affordability"[68] of broadband services. The CPUC indicates middle mile networking is expensive to build for smaller providers, and either expensive to lease or unavailable from existing providers due to competitive position and proprietary networks.[69]

SB 156 prioritizes middle mile construction for a "geographically diverse group of projects in rural and urban areas of the state to achieve the greatest reductions in the number of households unserved by broadband internet access service meeting federal and state standards".[70] Under SB 156, the State of California plans to spend $3.25B from the state's American Rescue Plan funds to build a statewide open access middle-mile network. See the "California Middle-Mile Broadband Infrastructure" subsection on page 21 for more information about this network.

RM 20-09-001 Decision Adopting Federal Funding Account Rules

California's new Federal Funding Account establishes a two-billion-dollar grant program "focused on building broadband internet infrastructure to communities without access to Internet service at sufficient and reliable speeds."[71] The Rules and Guidelines contained in the Commission's Decision address:

- Eligible areas: CPUC will publish priority areas.
- Funding criteria and CPUC evaluation of applications, which will consider proposed matching funds, project technology choice, type of partnership, inclusion of Lifeline service, pricing commitments, low-cost broadband plans, coverage of existing broadband needs, applicant capacity and performance, project plan and budget, and leveraging of state middle-mile network.
- Entities eligible to receive funding include those possessing CPUC certification, other facilities based broadband providers, local government agencies, electric utilities, non-profits, cooperatives, and California tribes.
- Middle-mile infrastructure may be funded if it is needed to achieve proposed last-mile connections, but use of the state middle-mile network is expected.

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[68] *Id*.

[69] *Id*.

[70] SB 156 Senate Floor Analysis, July 11, 2021.

[71] Decision Adopting Federal Funding Account Rules; Rulemaking Regarding Broadband Infrastructure Deployment and to Support Service Providers in the State of California; R.20-09-001; D. 22-04-055 dated April 21, 2022. ("Federal Funding Account Decision")

CPUC will verify if state middle-mile network could be used. In any event, open access, interconnection, and just, reasonable and non-discriminatory pricing is required.

- Performance criteria include project completion deadlines, minimum speeds and maximum latency, data caps are disfavored, commitment to "serve all" customers at specified prices, and participation in affordability programs.
- Required information from applicants, including description of applicant's current broadband infrastructure, project location data, deployment schedule, proposed expenditures, economic life of assets, letters of credit/funding sources and financial qualifications, five-year business plan demonstrating project viability, pricing commitments, marketing and outreach plan, and government and community support.
- Application submission, timelines, and objections process.
- Reporting requirements consistent with US Treasury rules on compliance and reporting guidance for state and local ARPA funds and other identified information.
- Payments based on submittal of progress reports.
- Execution and performance including commencement of project at agreed time and following the project plan.
- Provisions for sale or transfer of assets during the construction and post-construction phases.
- Penalties.

The decision addresses "**affordability**" requirements where affordability is defined as "the impact of essential utility service charges on a household's ability to pay for non-discretionary expenses".[72] The Decision requires Federal Funds Account grantees to participate in the FCC's Affordable Connectivity Program[73] (which provides a discount of up to $30 per month on broadband service) or other broad based affordability program. The Decision also encourages applicants to provide a low-cost broadband plan which is less than $40 per month, without data caps, 50/20 Mbps speeds, no charge for installation, no minimum term and includes a free modem or router.

The Loan Loss Reserve

SB 156 establishes the Broadband Loan Loss Reserve Fund in the State Treasury to fund costs of financing the deployment of broadband infrastructure by local

[72] Federal Funding Account Decision, at page 66.

[73] https://www.fcc.gov/acp

agencies or non-profits, including payment of costs of debt issuance, obtaining credit enhancement, and establishing and funding reserves for payment of interest and principal. Revenue bonds issued by joint power authorities can be supported by the Broadband Loan Loss Reserve.

SB 156 provides that the CPUC may establish eligibility requirements, financing terms and conditions, and allocation criteria, for infrastructure projects deployed in whole or in part using financing supported by the reserve fund. It also authorizes the CPUC to require information from the local agency or non-profit demonstrating the ability to reasonably finance and implement the broadband project using financing supported by the reserve fund.

It is anticipated that CPUC staff will provide a proposal for implementing the Loan Loss Reserve Fund in Fall 2022.[74]

VIDEO FRANCHISING AND BROADBAND DEPLOYMENT

The Digital Infrastructure and Video Competition Act of 2006 (DIVCA) "fundamentally changed video franchising within California by transferring the authority for issuing video franchises from municipalities and counties to the State" (CPUC).[75] The franchise period is ten years subject to franchise renewal. "Due to consolidations, mergers and business closures, there were 28 active [state video franchise] holders at the end of 2019"[76] which is the current number of franchisees.[77] DIVCA limits the authority of the CPUC and local authorities in video franchising. The CPUC is limited to approving franchise applications, enforcing anti-discrimination and build out rules, preventing cross subsidization of video

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[74] https://www.cpuc.ca.gov/industries-and-topics/internet-and-phone/broadband-implementation-for-california

[75] First Annual Report to the Governor and the Legislature, Video Franchising and Broadband Deployment: The Digital Infrastructure and Video Competition Act of 2006 (DIVCA), submitted March 12, 2009, California Public Utilities Commission, Communications Division, page i. https://files.cpuc.ca.gov/videofranchisetemplate/DIVCA_2008_Annual_Report.pdf

[76] 2020 Annual Report to the Governor and the Legislature, Digital Infrastructure and Video Competition Act (DIVCA) & State Video Franchise Holder Employment, California Public Utilities Commission, at page 3. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/communications-division/documents/video-franchising-and-broadband-analysis/video-franchising-main/annual-reports/divca-annual-report-20191231.pdf

[77] The list of current California state-issued video franchise holders can be found at https://www.cpuc.ca.gov/regulatory-services/licensing/video-franchising

infrastructure from residential basic service telephone revenues, and handling complaints from local authorities regarding anti-discrimination or build out rule violations. Local authorities are limited to regulating PEG (public, education, and government) programming requirements, FCC emergency alert system requirements, and federal and state customer protection standards. Cable TV rates are deregulated.

Notably, under DIVCA local authorities no longer may require the franchisee to provide Institution Network (I-Net) facilities.

JOINT POWERS AUTHORITIES

Joint Powers Authorities (JPA) are authorized under Section 6500 of the California Government Code and allow public agencies to join to exercise their powers or to form a new separate legal entity by agreement among the public agencies.[78] Either form of JPA requires an agreement addressing specific topics. Formation of a JPA as a separate entity sets it up with a legal identity separate from each of the public agencies that formed it, and therefore the public agencies are insulated from debts, liabilities, and obligations of the JPA while the JPA is authorized to enter into contracts and hold and operate assets including infrastructure. Use of a JPA is a creative approach to providing public services on a scale beyond which any of the individual public agencies can afford or justify.

SB 156 has expanded the value of using a JPA to provide broadband services by allowing use of revenue bonds for broadband infrastructure deployment, supported by the new Broadband Loan Loss Reserve Fund. The Fund covers costs of debt issuance, obtaining credit enhancement, and establishment and funding of reserves for payment of principal and interest on the debt.

Joint Powers Authorities can be used to increase access to reliable, affordable high-speed internet services. For example, the 39 Rural County Representatives of California (RCRC) have formed the Golden State Connect Authority as a JPA. GSCA capitalizes on the opportunities provided by enactment of SB 156 which include explicit authority for counties to operate broadband internet networks, creation of the state-owned, open-access middle mile network, and significant funding for

[78] The Governance and Policy discussions do not constitute a legal opinion and should not be construed as such. Questions about interpretation or applicability of these or other provisions of federal or California law should be referred to legal counsel.

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deployment of broadband internet infrastructure. GSCA "will assist rural counties in identifying pathways for development of internet infrastructure within their communities, including the construction of municipal-owned and/or operated internet systems, among other options."[79]

Key Points of the Golden State Connect Authority JPA Agreement

The JPA Agreement states the purposes of the Authority, which is "to make reliable and adequate communications services and connectivity available for the benefit of rural communities, businesses, and residents, including without limitation establishing and operating programs and projects to facilitate provision and expansion of broadband internet access service and related telecommunications services in rural communities, and directly providing such services in substantially the same manner as a municipal utility."

Public agencies seeking to become a member can do so by presenting resolution or evidence of formal action adopting this JPA agreement. "Participating entities" include public agencies or other JPAs that are authorized to provide broadband internet access service upon adoption of a participation agreement as prescribed by the Authority.

Each member appoints a delegate to the Governing Board. An Executive Committee is drawn from the Governing Board and composed of the Chair and Vice Chair (elected from the delegates) and additional members serving on the Executive Committee of RCRC with additional members appointed by the Board if necessary to reach the minimum number of Executive Committee members. The Executive Committee has the power to approve projects and programs, upon two-thirds vote of the full membership.

The JPA agreement is not exclusive, and members retain the right to carry out improvements on their own. The debts and liabilities of the JPA are not obligations for any of the members. Specific powers for the Authority include establishing and operating programs and projects to facilitate provision and expansion of broadband internet access service and related telecommunications services. This includes acquisition, construction, operation, and maintenance of broadband infrastructure for broadband internet access service. Obtaining federal or state support and participation in any federal program whereby federal funds are

[79] https://goldenstateconnect.org/about-us/

granted for financing the construction, acquisition, improvement, preservation, and rehabilitation of real property and infrastructure are allowed.

Amounts received under bond purchase agreement, bonds issued by any of its members, issuing bonds or other indebtedness and pledge any of its property or revenues as security are under resolution of the Board or Executive Committee. Issuing other forms of indebtedness including industrial development bonds, imposition, levy, collection, receipt and use of sales taxes, parcel taxes, Mello-Roos taxes, property taxes, special taxes, or any other type of tax or assessment, application for, and receipt of all permits, grants, loans, or other aids from any federal, state, tribal or other local public agency, promulgation, adoption and enforcement of any ordinances, policies, rules and regulations may be necessary to implement and effectuate the JPA agreement, and exercise the common powers of the members and any additional powers available under the laws of the State of California.

Specific actions permitted for the Authority include those necessary to operate a business such as executing contracts, employing staff, acquiring, constructing, and operating plant, incurring debts and obligations, receiving grants and contributions, investing funds, suing and being sued, setting and collecting fees, assessing members as needed, cooperating and contracting with other public agencies, and doing any and all things necessary to accomplish the purpose of the JPA.

Appendix C: Federal Communications Commission Policies

WIRELESS SERVICES POLICIES

The placement of wireless facilities is governed by an interrelated legal framework characterized by shared jurisdiction between state (e.g., cities and counties, and the California Public Utilities Commission) and federal authorities (the Federal Communications Commission or FCC, and Congress).[80] However from time to time, the Federal Communications Commission (and Congress) has preempted or sought to preempt the authority of state and local jurisdictions over wireless matters.

Federal law provides the basis for federal preemption where it allows local authorities to regulate the "placement, construction, and modification" of wireless communications facilities but subject to certain limitations.[81] Those limitations include:

- City regulations may not "prohibit or have the effect of prohibiting the provision of personal wireless services"[82];
- City regulations may not "unreasonably discriminate among providers of functionally equivalent services"[83];
- Any denial of an application to place, construct, or modify a personal wireless facility must be based on "substantial evidence contained in a written record"[84]; and,
- City regulations may not "regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such

[80] The following discussion does not constitute a legal opinion and should not be construed as such. Questions about interpretation or applicability of these or other provisions of federal or California law should be referred to legal counsel.

[81] 47 U.S.C. § 332(c)(7)(A).

[82] 47 U.S.C. § 332(c)(7)(B)(i)(I).

[83] 47 U.S.C. § 332(c)(7)(B)(i)(II).

[84] 47 U.S.C. § 332(c)(7)(B)(iii).

> facilities comply with the Commission's regulations concerning such emissions.[85]"

With the emergence of 5G, the large national wireless service providers pushed the Federal Communications Commission to preempt the authority of state and local jurisdictions regarding siting of wireless facilities, while pressing state legislatures for legislation to limit local authority over matters pertaining to small cell deployment. Such legislation has been considered in California in 2017 but ultimately did not become law due to Governor Brown's veto.

FCC Regulation of Radio Frequency Emissions

In one specific area. radio frequency (RF) emissions. The Federal Communications Commission (FCC) has been assigned complete regulatory jurisdiction, under the 1996 Telecommunications Act. TA96 preempted local regulation of RF safety standards in favor of a uniform national RF safety standard under FCC jurisdiction.[86] Local authorities can require compliance with these national FCC RF standards be demonstrated in evaluating 5G siting applications. Applicants often make this demonstration part of the application package, and many cities have ordinance or standards and guidelines provisions that require RF compliance to be demonstrated by applicants. Local authorities may not however deny wireless communications facilities siting applications based on RF emissions. Congress has preempted local authority on this subject and placed jurisdiction in the hands of the FCC.

The FCC determined in 2019 that no update to its guidelines for exposure to RF emissions was required for 5G equipment.[87] This decision was appealed, and the Court of Appeals for the District of Columbia remanded that decision back to the FCC to provide "a reasoned explanation for its determination that its guidelines adequately protect against harmful effects of exposure to radiofrequency radiation unrelated to cancer."[88] The FCC has not yet made any decisions and findings on 5G RF emissions so there is a potential for change to the RF emission standards.

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[85] 47 U.S.C. § 332(c)(7)(B)(iv).

[86] 47 U.S.C. § 332(c)(7).

[87] *Resolution of Notice of Inquiry, Second Report and Order, Notice of Proposed Rulemaking, and Memorandum Opinion and Order*, FCC 19-26, released December 4, 2019.

[88] Environmental Health Trust, et al. v. Federal Communications Commission and United States of America, No. 20-1025, Decided August 13, 2021 (DC Cir.), at page 30.

See the FCC's A Local Government Official's Guide to Transmitting Antenna RF Emission Safety for further information on the FCC's current RF emission rules.[89]

The FCC Small Cell Order

One of the most recent examples of FCC preemption is the FCC's 2018 "Small Cell Order".[90] There the FCC sought to limit and preempt local authority over placement of small cell facilities. It broadly interpreted the "effective prohibition" provisions of the Telecommunications Act Sections 253(a) and 332(c)(7) to find that a state or local government need only "materially inhibit" placement of "small wireless facilities" to have an effect of prohibiting the provision of wireless service. The Small Cell Order:

- permits fees only to the extent they are non-discriminatory ("no higher than the fees charged to similarly-situated competitors in similar situations") and are a "reasonably approximation" the government entity's "objectively reasonable costs" specifically related to the deployment.[91]
- sets out "safe harbor" fee levels which are "presumptively reasonable". $270 per small wireless facility per year, $500 application fee for up to five facilities, plus $100 for each facility beyond five.[92] Higher fees can be charged if the state or local government entity can show the higher fees are a reasonable approximation of cost and the costs themselves are reasonable and being assessed in a non-discriminatory manner.[93]
- appears in a footnote to preclude "in-kind" services or contributions stating such services or contributions "are not cost-based" and "they inherently have 'the effect of prohibiting' service".[94]

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[89] A Local Government Official's Guide to Transmitting Antenna RF Emission Safety: Rules, Procedures, and Practical Guidance; Local and State Government Advisory Committee, Federal Communications Commission, June 2, 2000. https://wireless.fcc.gov/siting/FCC_LSGAC_RF_Guide.pdf

[90] Declaratory Ruling and Third Report and Order; In the Matter of Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment; WT Docket No. 17-79; In the Matter of Accelerating Wireline Broadband Deployment by Removing Barriers to infrastructure Investment; WC Docket No. 17-84; Released by the Federal Communications Commission, September 27, 2018. ("Small Cell Order" or "Order".)

[91] Small Cell Order, at paragraph 50.

[92] *Id*., at paragraphs 78-79.

[93] *Id*., at paragraph 80.

[94] *Id*., at footnote 252. The footnote cites no evidence beyond comments of service providers.

- States aesthetic requirements must be reasonable, objective, non-discriminatory and published in advance, or they are subject to possible preemption.[95] Undergrounding requirements are subject to similar criteria.[96]

Additional provisions of the Small Cell Order include:

- Shortened shot clocks pertaining to small wireless facilities:
    - 60 days for siting on preexisting structures;
    - 90 days for siting requests the involve construction of a new qualifying structure;
- Shot clocks are applied to all authorizations, e.g., zoning permits, building permits, electrical permits, road closure permits, and engineering permits;[97]
- Permits fees paid to consultants and third-party contractors to be passed through as long as they are reasonable.[98]
- Conflicting provisions of state small cell laws would evidently be preempted by the FCC; [99] and,
- Conflicting provisions of preexisting contracts could be preempted by the FCC, depending on facts and circumstances.[100]

The Small Cell Order was appealed to the Ninth Circuit Court of Appeals, which issued its Opinion[101] largely upholding the FCC's Small Cell Order but with one exception, where it upheld local authority over aesthetic regulations:

> The exception is the Small Cell Order provision, dealing with the authority of local governments around aesthetic regulations. We hold that to the extent that provision requires small cell facilities to be treated in the same manner as other types of communications services, the regulation is contrary to the congressional directive that

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[95] Id., at paragraphs 84-89.

[96] Id., at paragraph 90.

[97] *Id*., at paragraph 144.

[98] Id., at paragraph 70.

[99] *Id.*, at paragraph 6.

[100] *Id*., at paragraph 66.

[101] City of Portland v. United States, 969 F.3d 1020, 1049-1053 (9th Cir., 2020).

> allows different regulatory treatment among types of providers, so long as such treatment does not "unreasonably discriminate among providers of functionally equivalent services." 47 U.S.C § 332(c)(7)(B)(i)(I). We also hold that the FCC's requirement that all aesthetic criteria must be "objective" lacks a reasoned explanation.

And:

> In sum, the requirement that aesthetic regulations be "no more burdensome" than those imposed on other technologies is not consistent with the more lenient statutory standard that regulations not "unreasonably discriminate." The requirement that local aesthetic regulations be "objective" is neither adequately defined nor its purpose adequately explained. On its face, it preempts too broadly. We therefore hold those provisions of Paragraph 86 of the Small Cell Order must be vacated.

The Spectrum Act and "Eligible Facilities Requests"

Prior to the Small Cell Order, the "Spectrum Act" enacted by Congress in 2012[102] added new requirements and directives to the Federal Communications Commission (FCC) for processing and approval of wireless deployments. Following the Spectrum Act, the FCC issued new regulations to interpret and implement the Section 6409(a) requirements and directives of the Act related to local authorities processing of applications for wireless communications facilities. In brief, the Act tightens the application of "shot clock" timelines and requires local jurisdictions to approve certain collocations and modifications to existing wireless communications facilities under shortened explicit deadlines, if it is an "eligible facilities request". any request for modification of an existing tower or base station that does not *substantially change* the physical dimensions of such tower or base station, involving (1) collocation of new transmission equipment; (2) removal of transmission equipment; or (3) replacement of transmission equipment. The new FCC regulations established defined standards for "substantial change" and implemented the statutory changes to "shot clock" regulations. In short, under these rules, a State or local government shall approve within 60 days any request for modification of an existing wireless tower or base station that does not substantially change the physical dimensions of such tower or base station. The

[102] *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, 126 Stat. 156, § 6409(a) (2012) ("Spectrum Act"), *codified at* 47 U.S.C. § 1455(a).

Rules adopted by the FCC are preemptive and apply to cities and other local authorities.

The FCC's "5G Upgrade" Declaratory Ruling

After the Small Cell Order, the FCC made a Declaratory Ruling which expands preemption of local authority regarding placement of wireless facilities. The Declaratory Ruling[103] was issued on June 10, 2020, and "clarifies" existing FCC rules originally adopted in 2014 to implement the "eligible facilities requests" defined in the Spectrum Act.

> Specifically, our Declaratory Ruling clarifies our rules regarding when the 60-day shot clock for State or local government review of modifications of existing structures commences.[8] We also clarify what constitutes a "substantial change" in the physical dimensions of wireless infrastructure under our rules, and the extent to which certain elements of a proposed modification to existing infrastructure affect the eligibility of that proposed modification for streamlined State or local government review under section 6409(a).[104]

Under the Declaratory Ruling, applicants can now start the shot clock with the first procedural step required by the City (e.g., a pre-application meeting) and submission of documentation demonstrating the proposed modification is an eligible facilities request.[105] The Declaratory Ruling also provides additional interpretation on what constitutes "substantial change" for height increases for

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[103] *In the Matter of Implementation of State and Local Governments' Obligation to Approve Certain Wireless Facility Modification Requests Under Section 6409(a) of the Spectrum Act of 2012*, WT Docket No. 19-250 and RM-11849, FCC 20-75 (released Jun. 10, 2020)

[104] Id., at paragraph 4.

[105] If a city does not have a Section 6409 process in place, the applicant can start the shot clock by filing documents that are typically required for a zoning or siting review.

towers outside the public right of way[106], details on equipment cabinets[107], further explanation regarding "defeat" of concealment elements[108], and siting approval conditions[109].

Assembly Bill 537

Assembly Bill 537 amends state law to reflect FCC shot clock requirements and clarify that small wireless facility applications must be processed and approved in accordance with applicable FCC shot clock rules, effective January 1, 2022. AB 537 places the start of the shot clock in line with FCC rules with the primary clarification being that the shot clock starts if or when an agency requires a pre-application meeting, communication, or similar step before submission. AB 537 clarifies that an agency must notify an applicant of an incomplete application within the time periods established by FCC rules.

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[106] Section 6409 defines substantial change pertaining to modification of a tower located outside of public rights-of-way as one which "increases the height of the tower by more than 10% or by the height of one additional antenna array with separation from the nearest existing antenna not to exceed twenty feet, whichever is greater." The Declaratory Ruling clarifies that "separation from the nearest existing antenna" means the distance from the top of the highest existing antenna on the tower to the bottom of the proposed new antenna to be deployed above it.

[107] The Declaratory Ruling clarified that small pieces of equipment such as remote radio heads/remote radio units, amplifiers, transceivers mounted behind antennas and similar devices are not "equipment cabinets" if they are not used as physical containers for smaller, distinct devices. Also, the maximum number of additional equipment cabinets that can be added under the rules is measured for each separate eligible facilities request, rather than the cumulative number of equipment cabinets on the site.

[108] The Declaratory Ruling stated to "defeat concealment," the proposed modification must cause a "reasonable person" to view the structure's intended stealth design as no longer effective after the modification.

[109] The Declaratory Ruling clarifies a municipality may not impose and enforce conditions on approvals for wireless facilities that then prevent future modifications or upgrades that are otherwise eligible facilities requests.

The FCC's Site Modification Report and Order[110]

Based on petitions from the wireless industry, in November 2020 the FCC revised the definition of "substantial change" for modifications of existing towers outside the public right of way. An eligible facilities request may now include a modification of an existing tower outside the public rights-of-way that entails ground excavation or deployment of transmission equipment up to 30 feet in any direction outside the boundaries of a site. Other eligible support structures besides towers outside the public right of way are not affected by this revised definition. This change by the FCC is intended to facilitate the addition of equipment to existing towers to expand 5G capacity. It is expected this rule change will allow additional providers to collocate on towers and allow additional equipment (fiber terminations, cabinets and power supply, backup power, etc.) to be placed to expand 5G services.

The FCC also expanded on the definition of a "site" such that it "refers to the boundary of the leased or owned property surrounding a tower and any access or utility easements currently related to the site as of the date that the tower or base station was last reviewed and approved by a state or local government".[111]

This decision was uniformly opposed by cities, counties and other local authorities and is subject to requests for reconsideration.

BROADBAND MAPPING

The FCC has administered a broadband mapping process for a decade that is known to be inaccurate in that it overreports broadband availability due to its data and methodology. The data is self-reported by broadband providers and is not verified by the FCC. But the bigger issue is that if one home in a census block can get broadband service, the whole census block is considered to be "served". Thus, a consumer is not able to tell from the FCC's broadband map with any certainty whether broadband is actually available or not at a particular address.

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[110] *In the Matter of Implementation of State and Local Governments' Obligation to Approve Certain Wireless Facility Modification Requests Under Section 6409(a) of the Spectrum Act of 2012*, WT Docket No. 19-250, Report and Order, FCC 20-75 (Rel. Nov. 3, 2020) ("Site Modification Report and Order").

[111] "Small Entity Compliance Guide", Implementation of State and Local Governments" Obligation to Approve Certain Wireless Facility Modification Requests Under Section 6409(a) of the Spectrum Act of 2012, Report and Order, FCC 20-153, WT Docket No. 19-250, Released November 3, 2020, dated January 4, 2021.

Congress recognized the problematic nature of existing FCC broadband maps, which becomes an even more urgent issue when policymakers desire to identify areas without broadband availability to fund deployment of broadband infrastructure. Thus, the Broadband Deployment Accuracy and Technological Availability (S. 1822), or "Broadband DATA act" was passed in 2020. Among other things the Broadband DATA Act directs the FCC to collect granular service availability data from wired, fixed wireless and satellite broadband providers, set parameters for service availability data collected from mobile wireless broadband providers, permits the FCC to collect verification data, requires the FCC to establish a crowdsourcing process for data collection, and requires the use of these new maps for new awards of broadband funding. The FCC implemented a Broadband Data Collection program to improve the accuracy of broadband maps and create the "broadband serviceable location fabric" for the maps.[112]

The first public version of the FCC's National Broadband Map was released on November 18, 2022.[113] It is intended to show where internet services are and are not available across the country. It is also intended that the map will be improved in a continuous iterative process of data collection including data submitted by providers, challenges with additional data from the public, and verifications and audits by the FCC. The map displays the "Broadband Serviceable Location Fabric" for the US. locations of individual buildings or structures where internet access service is or could be available. This data is the foundation of broadband availability displayed on the National Broadband Map.

The FCC is currently seeking to update the broadband availability data in its second broadband data collection window[114], as part of the iterative process for data collection and improvement of the accuracy of the National Broadband Map.

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[112] Broadband Data Collection, Federal Communications Commission. https://www.fcc.gov/BroadbandData

[113] "FCC Releases Broadband Map, Opens Public Challenge Process"; Nicole Ferraro, Light Reading, November 18, 2022. https://www.lightreading.com/digital-divide/fcc-releases-broadband-map-opens-public-challenge-process/d/d-id/781847

[114] "Broadband Data Task Force Announces Opening of the Second Broadband Data Collection Filing Window", Public Notice, Released December 27, 2022, Federal Communications Commission. https://www.fcc.gov/document/broadband-data-collection-window-opens-january-3-2023

AFFORDABLE CONNECTIVITY PROGRAM

The Infrastructure Investment and Jobs Act (IIJA) extends the Emergency Broadband Benefit to provide $30 per month discounts for broadband service to eligible households which enroll in the Affordable Connectivity Program[115]. "Eligible households" are defined as those with incomes at or below 200% of the poverty level or meets other stated criteria.[116] The minimum speed to be offered by participating providers has been increased to 100 Mbps download.[117]

The ACP is intended to ensure that low-income households have broadband connections for work, school, healthcare, and other needs. In addition, under the ACP there is a one-time discount available up to $100 to purchase a laptop, desktop, or tablet device.

Various wireless and landline broadband internet providers participate in the ACP. The participating providers will be different in each area.

The ACP is a new program and so far, it "flies under the radar". The FCC is seeking ways to expand community and marketing outreach so that those who will benefit are aware of the program and sign up.[118] Cities can benefit from the ACP by gaining awareness of program details and communicating them to their low-income residents and program managers for services provided to the low-income communities.

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[115] "Affordable Connectivity Program", A Guidebook to the Bipartisan Infrastructure Law for State, Local, Tribal, and Territorial Governments, and Other Partners. The White House, at page 392. Available at https://www.whitehouse.gov/wp-content/uploads/2022/01/BUILDING-A-BETTER-AMERICA_FINAL.pdf

[116] These criteria include participation in other assistance programs such as SNAP, Medicaid, Federal Public Housing Assistance, WIC, Supplemental Security Income, Veterans Pension or Survivor Benefits, or the FCC's Lifeline program; benefiting from the free and reduced-price school lunch program or school breakfast program; federal Pell Grant participation; or meets the criteria of the participating broadband provider's program. See, "Affordable Connectivity Program", Federal Communications Commission, https://www.fcc.gov/acp

[117] "Get Internet", The White House. https://www.whitehouse.gov/getinternet/?utm_source=getinternet.gov However, the FCC has so far declined to set a specific minimum speed requirement for the ACP program.

[118] "Broadband Subsidies Fly Under the Radar", The Wall Street Journal. May 9, 2022. Page A6.

Appendix D: Infrastructure Investment and Jobs Act (IIJA) Broadband Infrastructure Grants

Provisions regarding state broadband infrastructure grants ($42.45 billion):

- Funds will be disbursed based on a competitive grant process administered by each state under rules promulgated by the National Telecommunications and Information Administration (NTIA).
- New FCC mapping of broadband availability must be completed before proposals will be accepted. FCC maps are expected early to mid-2022.
- Priorities and specific allowed uses of funds:
  - First, infrastructure for areas without 25/3 Mbps service.
  - Then infrastructure for areas without 100/20 Mbps service. Then eligible community anchor institutions.
  - Multi-Dwelling Units (MDUs): Installing internet and Wi-Fi infrastructure or providing reduced-cost broadband within a multi-family residential building, prioritizing those with a substantial share of qualified low-income households.
  - Programs for broadband adoption including provision of affordable internet-capable devices.
  - Broadband data collection, broadband mapping and planning.
- Project requirements for funding:
  - Speeds of at least 100/20 Mbps with low latency. Higher speeds will receive priority.
  - 25% match required from non-federal sources, such as in-kind contributions, unspent COVID relief funds or provider investment.
  - Projects prioritized based on higher speed, greater scalability, faster buildout and service coverage for high poverty areas.
  - Projects must be completed within four years.
  - Projects must offer at least one low-cost broadband option (rates are not regulated, but determined by state, approved by NTIA).

- Additional requirements included regarding service quality, reliability, cyber rules, prohibition on using gear manufactured in China, required technical and operational capacity for the subgrantees.

Appendix E: Developer Agreement Conditions Example (City of Shafter, CA)

BUILDING DEPARTMENT CONDITIONS:

1. Fiber Optic Installation for Dwelling Units: Owner agrees to install in each dwelling unit the following fiber optic requirements:
    a. Install a dedicated City Fiber Enclosure adjacent to the other utility enclosures or a Common Communication Enclosure (collectively "Utility Enclosure") for the proposed communications utilities (phone, cable, fiber, etc.). The enclosure type shall be Benner-Nawman 14326W-UL or as approved by the City. The Utility Enclosure may face the garage exterior or interior and shall include one 120-volt, 15-amp convenience receptacle mounted inside the enclosure on either side wall with the outlets facing horizontally. The receptable power shall be protected by a ground fault circuit interrupter (GFCI).
    b. Install a wireless-transparent 28-30 inch or 42-inch Structured Media Enclosure ("Media Enclosure") of type Legrand 30" ENP3050 or 42" ENP4250, Leviton 30" 49605-30W, Primex Verge 30" P3000 or 42" P4200 or as approved by the city in a master bedroom closet wall or a laundry room wall furthest from the water supply and maintain a minimum 48-inch horizontal clearance between and 24-inch clearance above any metallic appliances or accessories. The enclosure shall include one 120-volt, 15-amp convenience receptacle located inside the enclosure.
    c. Install a conduit pathway from the Utility Enclosure to the Media Enclosure with a minimum of one (1) 1-inch diameter non-metallic, flexible conduit which shall maintain a minimum 36-inch bend radius and protrude a minimum of 6-inches into the enclosures. The conduit shall be marked with orange Tyvek or plastic tags, labeled "City Fiber Use Only" and "661-746-5000", tie wrapped to the conduit in plain view within the enclosures.
    d. Install a continuous conduit without breaks or couplings from the existing City Fiber Distribution Enclosure located in the right-of-way ("Distribution Enclosure") to the bottom side of the Utility Enclosure. The conduit shall be installed a minimum of 36-inches below grade,

protrude a minimum of 12-inches into the Utility Enclosure, be orange in color, and be factory labeled “City of Shafter 661-746-5000.” If the conduit does not have an integrated tracer wire, a continuous external #12 AWG solid conductor tracer wire with high-density polyethylene insulation rated for direct burial shall be installed along with the conduit leaving a minimum 15-feet of slack coiled in the Distribution Enclosure and 3-feet of slack coiled in the Utility Enclosure. The conduit and tracer wire shall be inspected by a City of Shafter Public Works Department representative before shading and backfilling.

i. After backfilling, the conduit shall be mandrel tested between the Distribution Enclosure and the Utility Enclosure. All conduits 1/2-inch or larger shall require mule tape or equivalent installed. Mule tape shall be slack (no tension) and fastened to the plug or cap. Innerducts and Microducts shall have the pull string completely removed before being tested with a ball bearing. The testing process shall be witnessed by a City of Shafter Public Works Department representative.

ii. Couplings shall be used to repair damaged or short conduit only if approved by the City. Conduit couplings shall be an air-tight, water-tight, push-on compression fitting approved by the City. Tracer wire couplings shall be an airtight, water-tight, twist or compression connector approved by the City. Coupling integrity shall be inspected by a City of Shafter Public Works Department representative.

e. Category 6 Unshielded Twisted Pair (CAT 6 UTP) cable (or as approved by the City) shall be installed according to industry standards and the requirements below and shall not be pinched, stapled, bent sharply, or crossing any sharp, unprotected edges:

i. Install minimum of three (3) cables from the Utility Enclosure to the Media Enclosure.

ii. Install the following connection points terminated to a CAT 6-rated 8P8C (RJ-45) jack within a single-gang low voltage wall box, using the ANSI/TIA-568 T568A termination standard:

1. Minimum of two (2) connection points to every entertainment center, kitchen, master bedroom, kitchenette, office, den, etc.

i. Install one (1) or more Wi-Fi Access Point (WAP) ceiling mounting locations (as approved by the City) on each floor such that no exterior wall is more than 30- feet from any WAP mounting location. Each WAP mounting

location shall include a single-gang, low voltage wall box through which a single CAT 6 UTP cable with a minimum three (3) feet of slack shall be terminated with a CAT 6-rated 8P8C (RJ-45) plug for connecting to a WAP.

ENGINEERING DEPARTMENT CONDITIONS:

1. Developer shall design and install a system of conduits, terminal enclosures, distribution enclosures, splice enclosures, connection points, and hand holes for a fiber optic network to each buildable lot within the development. Design and material specifications are available from the City of Shafter. Plans shall be submitted and approved by the City of Shafter, prior to recordation of the final map, showing the proposed utility trench and all appurtenant hardware. The design shall include the following minimum specifications:
   a. A combination of fiber optic conduits shall minimally include 4" SDR-11 HDPE, 2" SDR-11 HDPE, 7-Way bundled HPDE innerduct with attached tracer wire, and direct-bury HDPE Microduct with attached tracer wire. Fiber optic conduits may be joint trenched with other utility company pipes and/or conduits.
   b. All underground fiber optic conduits, innerduct bundles, Microducts, etc. shall be factory-labeled "City of Shafter 661-746-5000." Conduits shall be identified by a permanent marking, with the address number of the residence they serve, within the distribution enclosures.
   c. All underground fiber optic conduit paths shall have tracer wire. If the conduit does not have an integrated tracer wire, a continuous external #12 AWG solid-conductor tracer wire with high-density polyethylene insulation rated for direct burial shall be installed along with the conduit leaving a minimum 15-feet of slack coiled in the endpoint enclosures.
   d. The ends of all fiber optic conduits, innerducts, and Microducts shall be plugged or capped to prevent dirt, debris, or foreign objects from entering.
   e. After backfill and compaction, all conduits shall be checked for obstructions, and re-excavated and repaired or replaced as required. Conduits 1/2-inch or larger shall require mule tape or equivalent installed. Mule tape shall have a minimum 2' slack at each end which shall be fastened to a tie-off loop on the inside of the plug or cap. Mule tape tie-off and tension check to be witnessed shall be witnessed by a City of Shafter Public Works Department representative. Innerducts

and Microducts shall be mandrel tested while being witnessed by a City of Shafter Public Works Department representative.

f. A combination of underground utility enclosures shall minimally include 36”W x 60”L x 36”D polymer concrete enclosures with dual torsion covers, 36”W x 36”L x 24-36”D and 24”W x 36”L x 24-36”D High Density Polyethylene (HDPE) enclosures.

g. All underground utility enclosures shall be factory-stamped “City Fiber.”

TRACT MAP CONDITIONS (NOT FULLY MODIFIED TO ALIGN WITH THE MORE RECENT DEV. AGREEMENT CONDITIONS ABOVE):

1. Minimum 24-inch bending radius on all service drop conduits.
2. Minimum 48-inch bending radius on all 2-inch hdpe conduits and future path.
3. Minimum 96-inch bending radius on all 4-inch hdpe conduits.
4. All couplings and caps shall be approved by the city.
5. Couplings shall be eliminated for all future path and service drop conduits (except to join the r.o.w. segment to the p.u.e. segment).
6. Any couplings used in the fiber optic conduit shall be installed in accordance with city direction. Detection wires at couplings shall be wired together in an approved manner. Detection wires shall not carry tension.
7. All coupling locations shall be documented as length (ft) of conduit from nearest vault.
8. Ends of all conduits shall be capped to prevent dirt, foreign objects, or debris from entering the conduit. ½” and larger shall have a cap or plug with a ring for fastening the mule tape so that it does not retract into the conduit. Innerducts and microducts shall be capped with …
9. Microducts shall have a minimum of 50' of rolled up conduit at the property line of each home for future connection to homes.
10. All conduits 2" or greater shall be capped and have mule tape or equivalent installed. Mule tape shall be slack (no tension) and secured to the cap to prevent loss of the mule tape within the conduit.
11. All 2" hdpe conduit shall be accompanied by 12 gauge insulated solid copper tracer wire (or copper-clad stainless steel), to be approved by city. All end points including box locations will have 25' minimum of rolled up tracer wire.
12. Make & model of all vaults and boxes shall be approved by the city prior to use or installation.

13. All fiber optic vaults and boxes shall be located outside sidewalk and a minimum of 12 inches clearance from water mains and wall foundations. Clearance from other utility boxes shall be 36" minimum.
14. All vault and box locations shall be backfilled and well compacted with vibratory or equivalent prior to placing the box.
15. All 36x60 boxes shall be set on a minimum of 10 inches of gravel. All 36x36 and 24x36 boxes shall be set on 8 inches of gravel.
16. Conduits shall come into each box from below and shall terminate as close to the top of the box as possible while still allowing the lid to close. Conduits shall be cut to their final length by others just before fiber is placed.
17. Fiber optic conduits coming from the same direction shall be bundled closely to each other within the vault or box. Where possible, bundled conduits shall occupy the portion of the box or vault that identifies the direction from which the conduits came. For instance, conduits coming in from the south shall be bundled and placed within the south side of the box. Same for all other directions.
18. Microducts within the distribution box shall be tagged to identify the address of the residence they serve. Tag shall be permanently fixed to the microduct within the box. Tag shall be waterproof and corrosion resistant. Product shall be approved by the city.
19. Backfill around box perimeter shall be well compacted with vibratory.
20. All microduct and future path shall be mandrel tested. Microduct shall be tested with a 5-millimeter bb. Futurepath shall be tested with a 7-millimeter bb.
21. All microduct and futurepath shall have a detection wire factory-bundled external to the microduct(s).

FTTH INSTALLATION PROCESS RECENTLY CHANGED TO MOVE AWAY FROM MICRODUCT BUT NOT PLACED IN DEV. AGREEMENTS OR MAP CONDITIONS:

New Tracts. Service Drops from Distribution boxes to home Utility boxes:

a. Install Orange 1-1/4" SDR-11 conduit.
    a. NOTE: If this conduit specification cannot be obtained for the start of a new tract, the “Sleeve” conduit used on the “Active Tracts” may be used for the full tract or until the specified conduit arrives and the Sleeve conduit is exhausted (e.g., Tract 7388).
    b. Standard factory labeling (not branded for any provider)

   c. No tracer wire is required for the service drop conduit paths
   d. May terminate conduit at the edge of PUE to the homes covered with a box or capped conduit to protect all communications utilities' conduits until later extension to the homes.
   e. Couple with non-metallic push-on, compression fit, translucent-center connectors rated airtight to 250 psi, watertight, 700# pull-out, and direct burial.

1. Call for City inspection before any shading
   a. Shade with minimum 6" of sand. 12” preferred
   b. Backfill and compact
   c. Install 1/2" 1200+ Lb polyester mule tape. Tape must be slack and tied to the inside of conduit caps in the Distribution box and tied to or screwed down with in the Utility box.
   d. Call to coordinate mule tape tie-off and tension check to be witnessed by City inspector.