State of New Mexico

Broadband Strategic Plan

and Rural Broadband Assessment

Prepared for the New Mexico Department of Information Technology
Office of Broadband

by CTC Technology & Energy

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1 Executive Summary

The criticality of broadband to the life of Americans has never been more apparent. Even before the Covid-19 pandemic, broadband internet access had become foundational to economic activity, political and civic engagement, education, health care, and delivery of public services.

The State of New Mexico recognized this urgency and criticality more than a decade ago and has taken steps since then to improve broadband in all areas of the State; to support and facilitate private-sector investment in broadband; to ensure that schools and public safety facilities have world class access to broadband; and to lay the groundwork for solving New Mexico's rural broadband challenges comprehensively over time.

Through a series of initiatives, the State has substantially narrowed the broadband gap within its borders. A few examples: New Mexico dramatically improved connectivity to public schools throughout the State in a short period of time through the efforts of the Public Schools Facilities Authority (PSFA) of the Public School Capital Outlay Council (PSCOC) and local school districts. The Department of Information Technology (DoIT) effectively leveraged federal public safety broadband funding to pioneer new statewide public safety wireless capabilities. Similarly, New Mexico companies have successfully competed for extensive federal broadband funding, both through recent programs such as the U.S. Department of Agriculture's ReConnect grants and through the American Reinvestment and Recovery Act programs a decade ago. That flow of federal dollars has substantially improved broadband infrastructure in many parts of New Mexico.

This Broadband Strategic Plan and Rural Broadband Assessment (Plan) builds on that decade of work by many state agencies and their private partners and provides a framework for the coming years' effort to comprehensively eliminate the broadband gap in New Mexico, including as a means of combatting the economic impact of Covid-19.

This Plan was commissioned by DoIT's Office of Broadband in 2019 and developed over the course of late 2019 and early 2020. In the spring of 2020, the Plan was refined in light of the Covid-19 pandemic and its demonstration of the urgency and importance of broadband.

1.1 Summary of findings

The research, analysis, and engineering conducted in preparation of this Plan suggest the following about broadband[1] in New Mexico:

[1] For purposes of this project, DoIT adopted the following definitions of these key terms:
Served: An area or address is **served** by broadband if it can receive fixed, terrestrial internet access with transmission speeds that, at a minimum, provide twenty-five megabits per second (25 Mbps) download and three megabits per second (3 Mbps) upload. Neither satellite nor mobile service can be considered broadband for purposes of this

1.1.1 Between 13 and 20 percent of New Mexico locations do not have broadband available

A conservative analysis of State, ISP, and federal data identifies an estimated **196,000 locations in New Mexico that are unserved by broadband, or 20 percent** of the State's approximately 940,000 homes and businesses (referred to herein as Unserved Model 1).[2] This model does not count within the definition of broadband fixed wireless and copper phone line DSL technologies because of their inherent technical limitations.[3]

An analysis that uses broader, best-case assumptions about which locations are served includes fixed wireless and DSL despite their technical challenges (this model is referred to herein as Unserved Model 2). This best-case model suggests a lower number of unserved locations: **126,000 unserved locations, or 13 percent** of the State's approximately 940,000 homes and businesses.

The methodology for developing these models to determine unserved areas is described in detail in Section 2 below.

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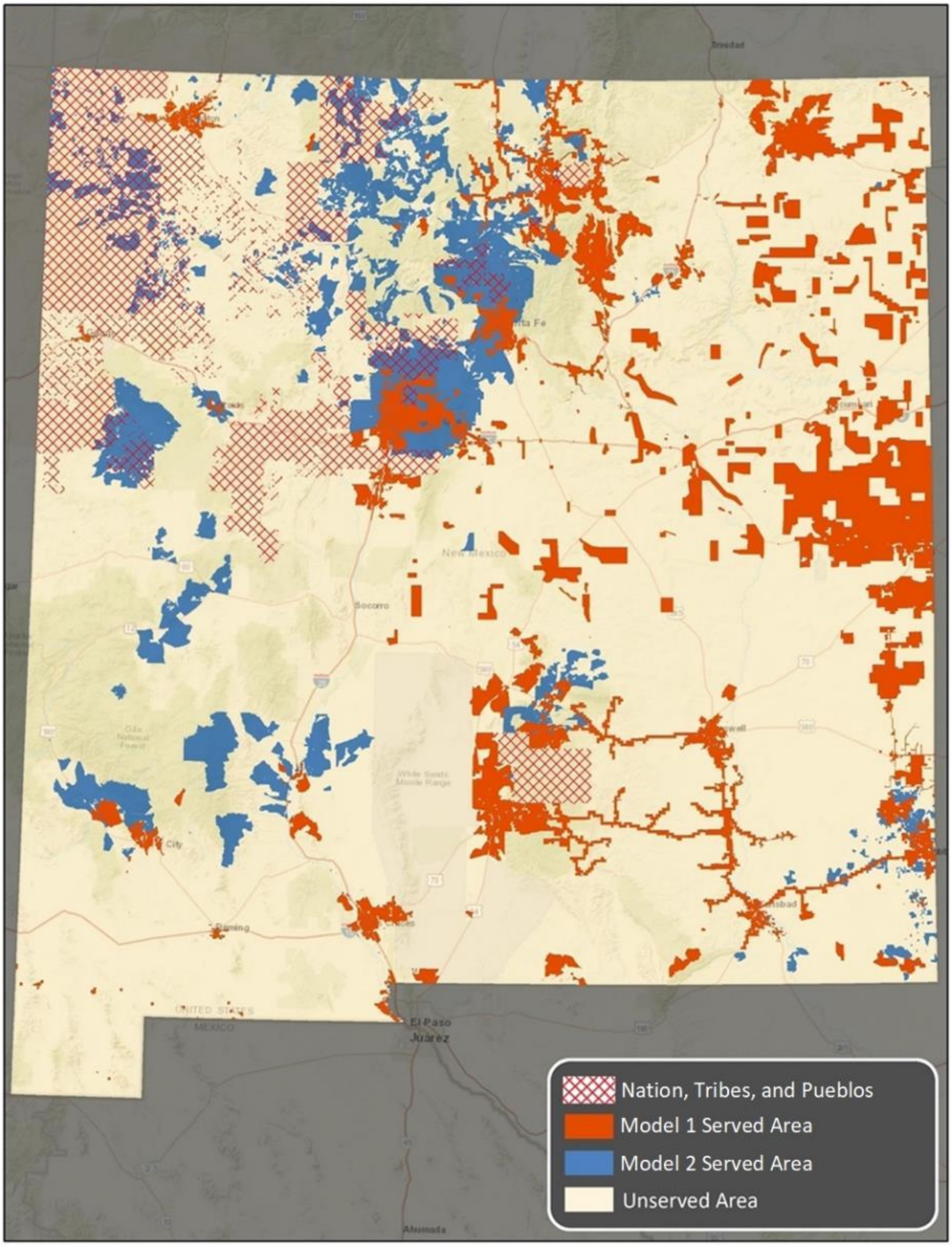
definition. This definition generally aligns with federal rules. *See* "2018 Broadband Deployment Report," Federal Communications Commission, Feb. 2, 2018, https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2018-broadband-deployment-report (accessed September 17, 2019).

Unserved: An area or address is **unserved** by broadband if it cannot receive fixed, terrestrial internet access with transmission speeds that, at a minimum, provide twenty-five megabits per second (25 Mbps) download and three megabits per second (3 Mbps) upload. Neither satellite nor mobile service can be considered broadband for purposes of this definition. This definition generally aligns with federal rules. *Ibid*. The sources consulted in developing these definitions are described and quoted in Appendix C.

[2] To identify the relative magnitude of an initiative in which broadband service would be made available to every home and business in the State, this Plan estimates the total number of unserved premises—then uses those numbers to develop cost estimates for deploying fiber optics, fixed wireless, or a hybrid of the two technologies to deliver broadband. Because there are no perfect maps or datasets of addresses that are served and unserved by broadband, these estimates required analysis of a variety of data sources. The methodology for this analysis is discussed in detail in Section 2 below.

[3] Based on our experience, wireless and DSL networks frequently do not serve all premises in a claimed area and, even if designed to provide 25 Mbps download and 3 Mbps upload service, do not always do so consistently for all customers. These technology limitations are described in detail in Section 3.3 below.

Figure 1: Served and Unserved Areas of New Mexico



1.1.2 Rural broadband requires public funding

Unserved portions of New Mexico face the same challenges as other rural communities to attract broadband infrastructure investment. Because of the high capital costs per user, such areas, which are largely rural, struggle to attract private investment capital in infrastructure.

Nationwide, even in the most affluent rural and semi-rural areas—from the horse farms around Lexington, Kentucky, to the ski communities outside of Aspen and Telluride, Colorado, to the resort areas on the Chesapeake Bay—the economics simply do not exist for rural broadband deployment absent substantial government funding. The private sector will not build costly infrastructure to reach all homes and businesses in low-density areas simply because the potential return on investment is insufficient to justify the investment. This is not surprising. Nor is it a value judgment. It is simply how private investment works.

The same dynamics apply to virtually all areas of rural infrastructure development, including roads, highways, water, electricity, and other utilities. In the case of broadband, the issues are starker because broadband in the United States is traditionally thought of as an area of private rather than public investment. The challenging economics result from the lack of density of potential customers—and, in many cases, the fact that homes are located far from arterial roads or on large parcels of land; long driveways or setbacks from the road greatly increase the cost to deploy infrastructure to those locations.

To solve this, state, local, and federal governments can take steps to improve the economics of broadband deployment in areas where investment has been insufficient by investing to make broadband in those areas economically viable.

This need for broadband capital subsidy as a critical part of addressing the rural broadband gap is increasingly understood in Washington, D.C., and it forms the basis for many of the recommendations in this Plan.

1.1.3 Federal funding programs have a mixed record of success in New Mexico because of flaws in some programs

Despite the emerging bipartisan consensus in Washington regarding the need for greater support for rural broadband, the federal government's track record in deploying funds effectively is mixed—and this has been apparent in New Mexico. Some federal programs have had great impact in comprehensively addressing identified needs: The E-rate program, for example, has greatly narrowed the gap in broadband to New Mexico schools, thus successfully using federal Universal Service Fees to meet a critical need. Similarly, the American Reinvestment and Recovery Act grant awards made substantial inroads with respect to deployment of fiber optics in rural New Mexico by entities such as ENMR Plateau and Kit Carson Electric Cooperative.

Other programs have had low impact relative to the enormous amount of funding allocated. This is the case in part because some federal programs have significant flaws with respect to performance metrics and associated enforcement. For example, the FCC's Connect America Fund Phase II awards to "price cap" carriers such as CenturyLink in New Mexico have had remarkable limitations:

1. The funds have been awarded to support low performance networks. Through the CAF II, the FCC provided six years of funding for services of 10 Mbps download/1 Mbps upload—*speeds that did not meet the FCC's own definition of broadband*.[4]
2. The requirements have been limited to some but not all locations in an area. As the FCC has itself described it, "the deployment schedule is determined by the service provider, not the FCC. Moreover, not every household that is located in an area where the service provider is eligible for the support is guaranteed access. While service providers must offer voice and broadband services to a required number of locations within the covered areas, they have the flexibility to choose which locations will be offered service."[5]
3. Funding was accepted and received by companies that have failed to meet their commensurate obligations. CenturyLink, for example, admits to missing its 2019 commitments for deployment under the Connect America Fund II awards it received in 2015, both in New Mexico and in many other states, and now also admits it will not meet those commitments in 2020, purportedly because of the Covid-19 pandemic.[6]

1.1.4 New Mexico faces greater rural broadband challenges than its neighboring states

New Mexico lags behind its neighbor states with respect to broadband options available to residents, in part because fewer providers serve tribal and rural areas. By one set of measurements,[7] New Mexico ranks behind its neighboring states at 42nd in the nation for broadband coverage, with as much as 22 percent of the population unserved.

[4] https://www.fcc.gov/consumers/guides/connect-america-fund-phase-ii-faqs
[5] https://www.fcc.gov/consumers/guides/connect-america-fund-phase-ii-faqs
[6] https://arstechnica.com/tech-policy/2020/05/centurylinks-slow-broadband-deployment-gets-even-slower-in-pandemic/
[7] https://broadbandnow.com/

Table 1: New Mexico's Broadband Coverage and National Ranking According to Broadband Now

	Broadband Coverage	Population Unserved	Average Statewide Speed (Mbps)	National Connectivity Ranking
New Mexico	83 percent	22 percent	35	42
Arizona	89 percent	18 percent	56	34
Colorado	92 percent	10 percent	63.5	22
Texas	90 percent	14 percent	56	30
Utah	96 percent	8 percent	50	10

1.1.5 Rural broadband is particularly important in New Mexico given the agriculture and oil and gas industries

For New Mexico, with its extensive rural areas and important rural industries, broadband is particularly important. Quality broadband connections allow the oil and gas industry to operate more safely and efficiently than ever before, and enhanced broadband can enable cost-saving measures without compromising safety.

Similarly, large ranches and farms require broadband for high end uses such as precision agriculture applications and robotic harvesters. Smaller ranches and farms need quality broadband connections for many of the same reasons as other small business owners, including direct sales; marketing and logistical management; professional training; and to provide their families with health care, educational, and social opportunities.

The importance of broadband for farms' sales and marketing efforts has never been as clearly demonstrated as during the Covid-19 crisis. As sales to restaurants have plummeted, demand for local produce has exploded, and farms have used broadband to develop new markets by connecting directly to consumers.[8]

1.1.6 New Mexico's state broadband programs have sometimes suffered from lack of consistent funding and clear mandates

The State of New Mexico was an early actor in addressing broadband challenges, with DoIT beginning its earliest statewide broadband efforts in 2009 and 2010 using federal funds awarded under the American Reinvestment and Recovery Act. DoIT, however, has struggled to sustain efforts initiated by the Office of Broadband (and its predecessor entities within DoIT) largely because of lack of resources. Even with these challenges, the successes have been significant,

[8] https://growingsmallfarms.ces.ncsu.edu/2020/04/register-now-for-april-webinar-on-creating-a-free-online-store-for-your-farm/

and New Mexico has been a recipient of substantial federal funds to both public and private entities.

Still, individual State initiatives have been hobbled by lack of ongoing resources and support. The clearest major exception is the effort by the Public School Facilities Authority (PSFA) to improve broadband to New Mexico schools, an effort over the past five years that is universally acclaimed and that has increased bandwidth to almost every public school in the State while reducing per-unit costs.

It is no coincidence that PSFA's efforts were well-funded through appropriation, well-defined through specific statutory charge, and driven by an urgent need—the requirement to prepare schools for online testing associated with new federal education policy. The twin drivers of adequate funding and imminent need—combined with purposeful planning and execution—resulted in an exemplary outcome.

Solving New Mexico's other broadband challenges will require similar sustained support in the form of funding, as well as clear mandates and driving needs. The need to mitigate—and recover from—the economic and public health ravages of Covid-19 may provide some of the impetus required, even as it puts a strain on resources.

1.1.7 Permanently filling rural broadband gaps with fiber optics would cost between $2 billion and $5 billion, while a mixed approach of both fiber and wireless would cost less than $1 billion

An engineering model that builds on the analysis of how many premises are served results in a conclusion that bringing future-proof, fiber-based broadband to all of rural New Mexico will cost between $2 billion (under best-case assumptions) and $5 billion (under less optimistic assumptions), as illustrated in Table 2.

The best-case cost assumptions assume a buildout led by incumbent providers using existing space on utility poles and other cable pathways and resources in place. The less optimistic cost assumptions are based on providers who are not already located in the area that would construct new infrastructure.

Of the State's unserved premises, approximately half are relatively closely clustered. These can be connected over state-of-the-art fiber optics at a cost between $300 million (using best-case assumptions) and $800 million, or an average of $3,800 to $9,300 per location.

Serving the full unserved population will require serving not only those clustered premises but also other locations that are widely spread-out. For the most widely spread-out homes and businesses in New Mexico (i.e., in areas where there are no existing towers for mounting fixed wireless antennas), density is often so low that a fixed tower might only serve one or a few premises with broadband speeds—meaning that the cost of fixed wireless would then approach the usually higher cost of fiber.

The cost of extending fiber optics or fixed wireless technology (where the latter is appropriate from an engineering standpoint) to the widely spread-out areas is between $1.6 billion (best-case assumptions) and $4.3 billion, or between $15,000 and $40,000 on average per location.

Table 2: Summary of Estimated Costs to Deploy Broadband to Unserved Locations

Unserved Model	Density of Locations	Number of Locations	Total Cost by Density	Total Cost
Model 1 (196,000 unserved)	Fiber to clustered premises	87,000	$332 million – $806 million	$1.9 billion – $5.1 billion
	Fiber or fixed wireless to widely spread-out premises	109,000	$1.6 billion – $4.3 billion	
Model 2 (126,000 unserved)	Fiber to clustered premises	50,000	$236 million – $576 million	$1.7 billion – $4.3 billion
	Fiber or fixed wireless to widely spread-out premises	76,000	$1.5 billion – $3.7 billion	

Fixed wireless technology is an option for delivery of services and, as discussed in Section 3.3 below, may be well-suited to less dense areas. Fixed wireless, however, comes with substantial limitations in performance and also has higher operational and equipment replacement costs than do fiber networks. A shorter-term interim solution that is focused on fixed wireless service and that uses existing wireless towers could cover approximately two-thirds of the unserved locations for an initial expenditure of approximately $500 million; however, this option would require replacement of most of the equipment every five to seven years, increasing the total cost considerably over time.

We recommend considering a hybrid approach of (1) fiber to the premises in the relatively closely clustered areas, (2) fixed wireless outside those clusters on existing towers that can serve five or more premises, and (3) addressing the most widely spread-out areas in a future stage, potentially using satellite or other emerging methods of broadband delivery. This latter category's cost currently is so high ($15,000 to $40,000 per location on average), whether with fixed wireless or fiber infrastructure, that to be viable those locations will require enormous federal funding or the emergence of a new technology innovation.

This recommended hybrid approach will cost between $3,200 and $8,200 per premises on average for the served addresses and will serve approximately 50,000 to 87,000 premises with fiber and 67,000 to 85,000 premises with fixed wireless (Table 3). It will reach approximately 61 percent to 68 percent of the unserved premises in New Mexico. Following implementation of the hybrid approach, all but 31,000 to 42,000 premises (i.e., all but 3 percent to 4.5 percent of New Mexico premises) would have access to 25/3 Mbps service.

Table 3: Summary of Estimated Costs for Hybrid Approach to Deploy Broadband to Unserved Locations

Unserved Model	Technology Approach	Number of Locations	Total Cost by Technology	Total Cost
Model 1 (196,000 unserved)	Fiber to clustered premises	87,000	$330 million – $800 million	$490 million – $1 billion
	Fixed wireless to areas outside clusters with towers	67,000	$155 million – $185 million	
	Future technology	42,000	TBD	
Model 2 (126,000 unserved)	Fiber to clustered premises	50,000	$240 million – $580 million	$400 million – $780 million
	Fixed wireless to areas outside clusters with towers	45,000	$165 million – $200 million	
	Future technology	31,000	TBD	

The full engineering analysis and methodology are described in detail in Section 3 below.

1.2 Summary of recommendations

In brief summary, the Plan recommends the following:

1.2.1 Use a grant program to expand rural broadband and leverage federal funds

The State should continue to fund a New Mexico broadband infrastructure grant program, akin to those that have enabled DoIT and PSFA to effectively target funding to meet key goals, even if this funding amount is modest in the near future given the financial challenges caused by the Covid-19 pandemic. These funds can provide much-needed leverage for accessing federal broadband and other grant funding, enabling New Mexico to compete with other states for a limited pot of federal funding.

In accordance with best practices, the grant program should:

- Fund future-proof infrastructure that is scalable to meet future bandwidth needs;
- Require collaborations between local officials and the full range of potential providers, including electric utilities and non-profits;
- Allow local authorities to leverage access to state funds in negotiations with existing and potential new service providers;
- Position state programs to work synergistically with federal funding opportunities so as to leverage state funds to attract federal grants;
- Support local and regional efforts to put projects and applications together for state and federal broadband funding opportunities;
- Engage small and medium providers so as to encourage and broaden participation; and
- Create a predictable flow of funding and develop a pipeline of potential applicants.

This grant program is not intended to replace or overlap with the existing universal service program administered by the Public Regulation Commission (PRC) but instead to complement and support it. The PRC program holds a particular statutory mandate and is targeted toward a select group of entities regulated by the PRC. The grant program recommended here would be more broadly available to a wide range of entities, including companies, localities, and electric utilities. In addition, this program would be designed to serve as leverage to attract federal grants (for example, by fulfilling match requirements)—a strategy that New Mexico has very successfully used in the past, including to attract federal E-rate funds to service New Mexico schools.[9]

[9] As an illustration of this strategy, we understand that there is a pending effort for the State to use an existing appropriation for the Navajo Nation to provide five percent of a project cost to build hundreds of miles of fiber to Navajo schools. If this pending plan comes to fruition, the State contribution of five percent will serve as leverage to secure 95 percent funding from the E-rate program.

Importantly, given the challenges with adequate standards and enforcement of federally-supported broadband networks (described above), the State should take a different, more rigorous approach with respect to all State funding for broadband: first, it should clearly establish robust metrics for performance and customer support for all networks, regardless of technology; and, second, it should require and verify that awardees have met those grant performance metrics.

Detailed recommendations regarding a State broadband grant program, and alignment with federal funding, are included in Section 7.

1.2.2 Prioritize fiber-based rural solutions for longevity, impact, and long-term value for money

To the extent feasible, the State should prioritize investment in fiber optic networks as a means of ensuring the long-term benefits of the public investment. Fiber represents an infrastructure asset with a lifetime of decades that is almost endlessly upgradeable and capable of supporting any number of public or private sector communications initiatives—and fiber is a critical underlying platform for wireless networks.

For a given expenditure in communications hardware, fiber optics can reliably carry many times more capacity over many times greater distances than any other communications medium. Indeed, fiber is one of the few technologies that can legitimately be referred to as "future-proof," meaning that, for the foreseeable future, it will accommodate growing demand and provide customers with larger, better, and faster service offerings.

While construction of fiber is costly relative to wireless alternatives, the cost advantages of wireless are reduced over time by high maintenance costs and the need for frequent equipment replacement.[10]

The limitations of fixed wireless networks also arise from the need for line of sight between a network antenna and the equipment at the customer's location. Given the technical challenges (and cost) of connecting some customer locations, many fixed wireless companies throughout the country simply decline to serve customers who have challenging terrain or foliage, resulting in a network that purports to be available to all but that still leaves a substantial percentage of

[10] The capital costs for fiber are dominated primarily by construction labor and secondarily by outside plant materials, with network electronics making up a relatively small portion. As a result, much of the cost is incurred at the beginning of the project—with electronics, with a replacement cycle of five to 10 years, representing a small cost. By comparison, most of the wireless capital cost is in electronics and software, with some construction or improvement of towers or antenna masts. Electronics have a lifetime of five to 10 years. What this means is that, by comparison with fiber, capital costs are incurred over the lifetime of the project, and that comparable initial capital cost of fiber and wireless will likely over time lead to a higher total cost of operations for the wireless network. Section 3 describes the relative capital costs of fiber and wireless deployments.

locations without the prospect of service. This is a rational and reasonable decision by fixed wireless companies, but it reduces the impact and reach of a public investment.

One key metric in determining the cost-effectiveness of fiber construction is the density of the area under consideration. The number of homes and businesses per mile of roadway is typically the most important factor in determining cost. For that reason, one approach in technology choice is to set density thresholds for fiber deployment. Somewhat higher density areas could be prioritized for fiber deployment with wireless filling some gaps in the least dense areas based on certain cost and density measures (see Section 3.1.4).

1.2.3 Prioritize construction of new fiber and wireless networks over ongoing support for legacy copper networks

The State should deprioritize funding for options that are centered around copper line DSL technology. Copper cable is ubiquitous throughout New Mexico, but it is limited in bandwidth capacity and future growth by (1) the underlying physical properties of the medium and (2) the age and condition of the majority of the existing installed copper cable.

CenturyLink's very-high-bit-rate digital subscriber line (VDSL) services can deliver 25 Mbps over a single pair of copper. However, these services are, for the most part, limited to portions of the metropolitan areas of Albuquerque and Santa Fe with fiber to the node—i.e., fiber that comes within 3,000 feet of the customer's location. Most of New Mexico's locations outside the cities will be served over copper cables that are 10,000 to 20,000 feet long. Given those distances, the average available DSL download speed will be 1.5 Mbps to 6 Mbps—a small fraction of the federal definition of broadband. DSL technology will not be able to increase capacity far beyond those speeds or consistently provide service across typical copper lines without substantial upgrades, such as constructing fiber-to-the-curb or other costly re-engineering and construction. Furthermore, DSL technologies are more difficult and costly to maintain than new networks.

Given the high costs and low capabilities of these copper-based technologies, State funding should be prioritized for more future-looking technologies wherever possible.

1.2.4 Include broadband considerations in all Covid-19 recovery planning

New Mexico should prioritize broadband in every element of its strategy and planning for Covid-19 recovery, in light of the critical role broadband has played in mitigating the impact of Covid-19 shutdowns and quarantines, as well as the essential continued role broadband will play in enabling economic activity, learning, health care, and community support during the challenging months and years to come.

Much as broadband has proven critical to continued economic and educational life in the early months of the pandemic—through work from home, home-based business, and distance learning—it is likely to be a necessary element of Covid-19 recovery. Many workplaces and schools will not function the way they did before the pandemic, and shifts that stagger in-person and remote attendance will likely be the norm for some time to come. As a result, significant amounts of economic and educational activity will continue to occur over the broadband internet as economic and health recovery expands.

Given this continuing elevated role of broadband, the issue should be prioritized and included in every recovery-oriented program for the foreseeable future. Further, there should be accelerated procurement around broadband projects and broadband grants in light of the urgency of the needs identified, including to get connectivity to students and to enable economic recovery. In the Covid-19 era, accelerated procurement has become the norm at both the state and federal levels, reflecting the criticality of broadband to stabilization and recovery.

1.2.5 Support companies and communities with technical assistance

The State should provide support and technical assistance to qualified companies, non-profits, and communities who are interested in broadband planning, public-private collaboration, and seeking federal broadband grant funds. Research done during the preparation of this Plan identified that there exist many qualified companies, tribal and local governments, and non-profits who do not work together on broadband planning because they do not have time or resources to do so—and who do not apply for federal grants because the burden is too great. Through the DoIT Office of Broadband, the State can address this challenge by enabling qualified applicants who lack resources or sophistication with planning and federal grant processes to compete for federal funds.

Given the Covid-19 crisis, the critical necessity of broadband to support telework, economic activity, education, and health care has never been more apparent. Further, broadband will be a critical enabler of economic recovery in New Mexico in coming months and years.

For nearly a decade, DoIT has engaged in extensive efforts to improve the availability of broadband services for as many New Mexico residents and businesses as possible. These efforts can be directed to simultaneously increase the amount of federal funding entering the State to build new broadband networks—and to create broadband-enabled employment opportunities.

Specifically, the Office of Broadband should be empowered to provide technical assistance to qualified companies, non-profits, and communities who are seeking federal broadband grant funds.

Office of Broadband involvement in the process can help assure that the State's strategic objectives are prioritized. For example, New Mexico will benefit most if federal funds flow to New Mexico companies—rather than to companies headquartered out of state—and are used for construction here in New Mexico, helping with the economic recovery that will be necessary following the pandemic. Further, DoIT involvement will ensure that grant applications are targeted towards sustainable, high speed broadband solutions that cover as many New Mexicans as possible that are currently unserved by broadband, with technologies that can grow with increased future needs in broadband speed.

1.2.6 Prepare now to leverage existing and future federal broadband funding

When it was funded in 2019, the U.S. Department of Agriculture's (USDA) ReConnect grant and loan program represented Congress' largest allocation to support broadband infrastructure deployment in a decade. ReConnect reflected a bipartisan understanding that the rural broadband gap should be recognized as a national priority. In our view, that bipartisan agreement has only grown since the Covid-19 pandemic shifted much of American life to the internet, and that bipartisan approach may result in very substantial new broadband funding—potentially measured in the tens of millions of dollars—in the next few years.

While we do not know what form (or multiple forms) federal funding is likely to take, New Mexico should prepare now for that opportunity. As a result of the Covid-19 crisis, there is widespread expectation in Washington, D.C. that federal funds will be made available in multiple ways to address a range of broadband needs, potentially including:

- Funding to create broadband construction jobs in the short term and an engine for job growth (i.e., enabled by the new broadband services) in the long term;
- Funding to promote economic recovery, which might include infrastructure and end-user funding targeted to particularly distressed communities; such funding would likely seek to ensure that infrastructure is robust and expansive and can support connectivity to businesses and homes for the sake of business continuity;
- Funding to close the "homework gap" —the struggle of some students to learn effectively when they do not have internet at home—which might be funneled through the existing E-rate program that subsidizes connectivity to schools and libraries, directly to schools, or in expanded ways to get broadband access closer to where students live; and
- Funding to governments that develop infrastructure projects or other models to quickly and efficiently enable broadband access or promote broadband adoption, particularly among families with school-aged children, elderly residents who may benefit from access to telehealth, and other vulnerable populations who would benefit from broadband-enabled services.

For one-time stimulus-type programs, the emphasis will likely be on projects with strong potential employment impact (and, potentially large footprints) and the ability to ramp up quickly with ready-to-go projects. Since the emphasis is on invigorating local communities whose resources are depleted, we expect matching requirements for funding that is funneled through existing grant programs to be either relaxed or absent. For example, the $1.5 billion in CARES Act funding Congress added to the Economic Development Administration program for Covid-19 mitigation was implemented through and existing program, but the match requirements were reduced from 50 percent in the pre-existing program to 20 percent for the CARES Act funds.

To fully take advantage of such opportunities, we recommend that the DoIT Office of Broadband prepare in a range of ways:

- Encourage companies and communities to develop broadband plans that include specific project concepts;
- Develop tools and strategies for public-private collaboration; and
- Develop middle-mile concepts at a regional or State level that can be leveraged for such funds.

Appendix A summarizes the existing federal grant programs that may represent opportunities for addressing the State's rural broadband needs. In particular, the Federal Communications Commission's Rural Digital Opportunity Fund (RDOF) is the federal government's current primary vehicle for delivering broadband funding to rural areas.

1.2.7 Support anchor institutions, including libraries and health care facilities, to plan collaboratively and aggregate demand

As part of its effort to connect all New Mexico businesses, institutions, and residences to the internet with robust bandwidth, we recommend that the State consider funding planning grants for anchor institutions, including library systems and health care entities, that are still struggling to connect one or more of their locations. This program would reflect the reality that these two anchor segments—libraries and health care—unfortunately lag behind the education segment with respect to connectivity.

New Mexico's efforts to connect schools over fiber optics have been enormously successful. The goal now is to achieve the same results for rural health care facilities, libraries, and other anchors. The purpose of the grants would be to enable broader strategic planning than is feasible from a single entity's perspective alone. The grants would support hospitals' and libraries' efforts to coordinate with other users of bandwidth—including higher education—to aggregate demand and plan competitive processes designed to maximize existing infrastructure and increase carrier investment in infrastructure to support all stakeholder needs, including those of the unconnected libraries and rural health care facilities.

Another equally critical focus of the recommended grant effort is to enable libraries and hospitals to coordinate with other local and regional stakeholders and to plan for how they will use connectivity and technology to support their users.

1.2.8 Elevate and fund the Office of Broadband

In keeping with best practices nationally, including in many of New Mexico's neighboring states, the Office of Broadband should be elevated in status and consistently funded on an ongoing basis through appropriations, with appropriate statutory authority and responsibility for broadband matters, and with commensurate accountability requirements.

The Office of Broadband should be specifically charged and empowered to serve as a single coordinating entity for broadband throughout New Mexico, monitoring and reporting on private investment, services, and infrastructure, and managing many of the public investment programs that are specifically focused on broadband. This change would reduce the inefficiencies of many different State agencies undertaking uncoordinated and overlapping efforts.

Consistent with best practices, the Office of Broadband should be able to sustain ongoing efforts for geospatial data collection, technical assistance, engagement with other departments of New Mexico government as well as local and tribal governments, and coordination of state programs and federal grant applications. Resources of at least $1 million per year are required to support appropriate staffing and programs given the scale of New Mexico's broadband challenge, as well as the urgency of broadband in the current economic and public health crisis.

The Office of Broadband already serves many of the relevant functions to a limited degree but is constrained by lack of resources and stature. Ideally, given sufficient resources, it can expand and enhance its current efforts in the following ways:

1. Coordinate public and private broadband efforts across the State, including to reduce silos among stakeholders, realize improved communications, and reduce inefficiencies among effort, enabling steering of funds (both State and federal) to the areas with the most need and highest potential impact;

2. Provide planning and guidance to companies and localities, including regarding how to compete for federal grant funds;

3. Provide input and insight to other departments of New Mexico government regarding the role of broadband in economic development, long-term economic recovery following the Covid-19 pandemic, health care policies related to telehealth services, and educational policies related to distance learning;

4. Act as a clearinghouse for broadband mapping and geospatial resources (an area in which New Mexico has been considered a national leader for more than a decade) and serve as a means to provide accurate, critical data regarding broadband availability to federal policy-makers so as to ensure New Mexico's interests are fully represented in future funding programs[11];

5. Facilitate partnerships with other relevant departments and agencies associated with broadband infrastructure initiatives, including the PRC, the Department of Transportation (DOT), and the Economic Development Department (EDD);

6. Provide expert guidance regarding permitting and other regulatory matters to private and public entities at all levels (including federal permitting authorities) to the extent those matters impact broadband deployment; and, relatedly, serve an ombudsman role within State government to assist internet service providers to efficiently interact with the appropriate authorities as necessary; and

7. Provide expert analysis and insight to State authorities about issues that impact New Mexico at the federal level. This could include analysis of how upcoming FCC changes to its broadband data collection processes would impact funding to New Mexico.

1.2.9 Develop a digital equity plan to complement this infrastructure Plan

Solving the broadband challenge in New Mexico will require attention to issues of digital literacy and device access in addition to the broadband access and infrastructure considerations that clearly loom so large and that are the subject of this Plan.

As the Covid-19 crisis has laid bare, access to broadband service itself may not be sufficient to fully bridge the digital divide. The remarkably high number of families who lack broadband at home—even where service is ostensibly available—demonstrates that other factors preclude the participation of some New Mexico families (most of them very low income) in the digital economy, distance learning, and telehealth.

Digital inclusion research is a new and emerging field, but most researchers agree that broadband use disparities tend to result from a combination of three factors:

1. Lack of access to affordable broadband service;
2. Lack of access to usable, broadband-enabled devices; and

[11] As is discussed in some detail in Sections 2 and 3 below, universally-derided federal data collection methodologies have resulted in large parts of New Mexico being regarded as "served" by broadband even though the great majority of locations in those areas are entirely unserved.

3. Lack of knowledge (or "literacy") of how to use the internet in ways that are meaningful or valuable to the user.

Indeed, given the scale of dis-connectedness in New Mexico, a critical set of questions arises: What level of service and equipment fees would be a barrier to those New Mexicans' adoption of broadband services? Are there affordability, credit, or other financial issues that reduce use of broadband? Is lack of ease with computers and the internet interfering with the ability of families to use broadband for basic life functions? And does the cost and complexity of owning a broadband-enabled device, such as a laptop or tablet, reduce use of the internet?

Given the importance of these and other questions for strategic planning to enable a robust broadband future, the State should direct the Office of Broadband to undertake research of the full set of barriers and how they impact internet use among low-income and other New Mexicans, preferably by use of a methodology that will enable statistically significant conclusions about the nature and scale of the problem.

Ideally, the following types of data would be collected to enable New Mexico to understand digital challenges so as to develop an actionable plan to address those challenges:

1. Broadband adoption rates and patterns;
2. Means by which community members access the internet (e.g., wireline and/or mobile) and the reasons for that choice or outcome;
3. Use of broadband subsidy programs such as AT&T's Access program, Comcast's Internet Essentials, and the FCC's Lifeline program;
4. Access to broadband-enabled devices, knowledge of how to use those devices, and challenges with use (for example, viruses, maintenance costs, etc.);
5. Broadband "literacy," or challenges with knowledge of how to use the internet in ways that the user finds meaningful, useful, and safe; and
6. Need for training to develop knowledge of how to use the internet.

2 Understanding Where in Rural New Mexico Lacks Broadband

To identify the relative magnitude of an initiative in which broadband service would be made available to every home and business in the State, we first estimated the total number of unserved premises.

There are no perfect maps or datasets when it comes to identifying areas that are served and unserved by broadband.[12] To get a handle on how many addresses are unserved requires drawing boundaries around existing broadband infrastructure, which in turn requires accurate and complete knowledge of that infrastructure. Internet service providers (ISP), however, are not required to provide accurate network and infrastructure maps to the government, and the data they provide to the Federal Communications Commission is notorious for representing vastly exaggerated served areas.

Even when network maps are available, an accurate assessment of how many addresses are unserved requires:

- Verification of those maps;
- An understanding of what those maps mean (because not all broadband infrastructure can be used to provide service drops to nearby addresses);
- Knowledge of what expansions are underway or planned; and
- Accurate address-level data identifying locations for potential connectivity.

An accurate picture of how many addresses are unserved, therefore, requires analysis of a variety of data sources to triangulate estimates and a determination of the strengths, weaknesses, currency, authoritativeness, and accuracy of each data source. These numbers and locations are in turn used to generate cost estimates for extending connectivity.

In order to determine a reasonable upper and lower range of unserved premises in the State, we adopted two different sets of assumptions regarding unserved areas (the complete methodology is described in Section 2.2.) In the more conservative approach to mapping unserved areas, we eliminated technologies where there is less certainty that they deliver 25/3 Mbps speeds and full coverage; in the less conservative approach to mapping, we tightened the mapping conditions by including those less-certain technologies—and, further, assumed that areas where ISPs have

[12] The State has adopted a standard of 25 Mbps download and 3 Mbps upload (i.e., 25/3), which is in line with the federal minimum speed benchmark for broadband.

been awarded grants to build infrastructure under the federal Connect America Fund [13](CAF II) program will soon have at least 25/3 Mbps service.

These lower and upper unserved mapping assumptions were then used to estimate the costs to construct fiber-to-the-premises (FTTP) infrastructure to deliver service to those premises (Section 3). These cost approaches focused on contiguous, relatively dense areas that would provide attractive targets for potential partners and could cost-effectively reach a large number of unserved residents. To enable more granular comparisons, we analyzed two different construction approaches and further distinguished between construction to homes that are relatively clustered together and construction to reach more isolated premises in low-density areas.

In addition, we used the same models to estimate the cost of deploying fixed wireless broadband service to the State's unserved premises (Section 3.2).

2.1 Summary of analysis: Number of unserved premises

An analysis of State, ISP, and federal data identified an **estimated 196,000 unserved[14] premises in New Mexico, or 20 percent of the State's approximately 940,000 homes and businesses**. This analysis, which we refer to as Unserved Model 1, considers a home or business served if it is capable of getting 25 Mbps downstream and 3 Mbps upstream from a wireline fiber or coaxial cable connection. We eliminated fixed wireless providers and copper phone line DSL from this model.[15]

When we adopted the broader assumptions about which premises are considered unserved, including fixed wireless and DSL, that total dropped to 126,000 or 13 percent of the State's approximately 940,000 homes and businesses (Unserved Model 2). In the stricter model, we assumed that areas funded under CAF II will fully serve all addresses in their grant-awarded awarded areas, and that fixed wireless and DSL service speeds reported on Form 477 are

[13] The Federal Communications Commission awarded funding through an auction in 2018; winning bidders have six years to fully complete construction. See: "Connect America Fund Phase II Auction (Auction 903)," FCC, https://www.fcc.gov/auction/903.

[14] For purposes of this plan, an area or address is unserved with broadband if it cannot receive fixed, terrestrial internet access with transmission speeds that, at a minimum, provide twenty-five megabits per second (25 Mbps) download and three megabits per second (3 Mbps) upload. Neither satellite nor mobile service can be considered broadband for purposes of this definition. We defined "served" as 25/3 in the memorandum to DOIT, "Proposed Definitions of Broadband (Served, Unserved, and Underserved), October 4, 2019 (see appendix). This definition generally aligns with federal rules. See: "2018 Broadband Deployment Report," Federal Communications Commission, Feb. 2, 2108, https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2018-broadband-deployment-report (accessed September 17, 2019).

[15] Based on our experience, wireless and DSL networks frequently do not serve all premises in a claimed area and, even if designed to provide 25 Mbps download and 3 Mbps upload service, do not always do so consistently for all customers.

accurate. As such, Unserved Model 2 provides a more “generous” set of assumptions regarding serviced areas, leading to a lower number of unserved premises.

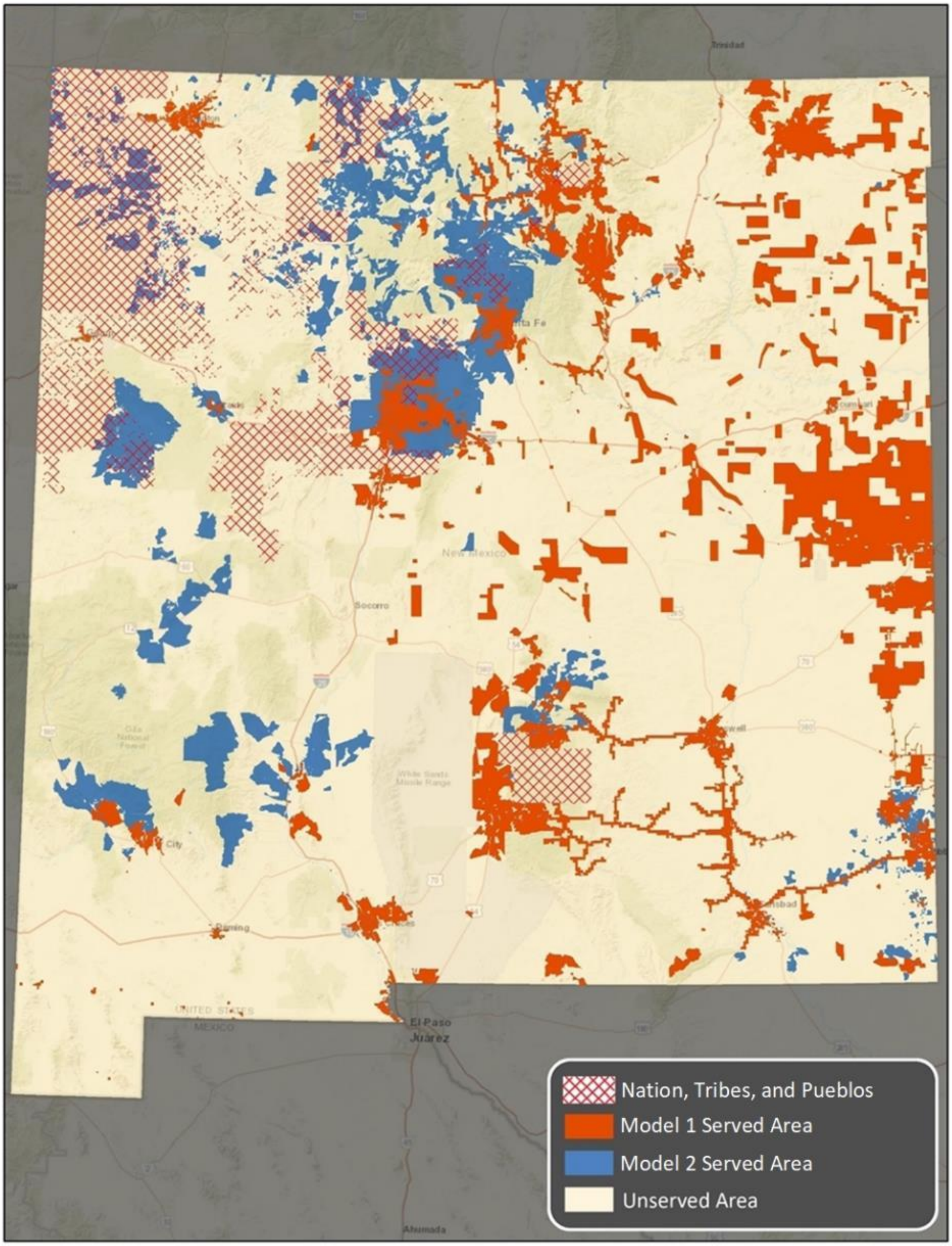
Within each model, we further distinguished among unserved premises that are clustered (and thus relatively more cost-effective to serve) and premises in lower-density areas that would require more extensive construction (Table 4).

Examples of unserved areas in clusters include West Zuni to Black Rock, Southeast Chama to Tierra Amarilla, and South Greater Tucumcari. Low-density areas are those outside the clusters where premises lack the per-mile density to be grouped into clusters. Typically, the State’s ranches fall into the low-density areas. The low-density areas are described in more detail in Section 2.2 and shown in Figure 2.

Table 4: Numbers of Unserved Premises (Unserved Model 1 and Unserved Model 2)

Unserved Model	Clustered Premises	Low-Density Premises	Total Unserved
1	87,000	109,000	196,000
2	50,000	76,000	126,000

Figure 2: Served and Unserved Areas (Unserved Model 1 and Unserved Model 2)



2.2 Mapping unserved premises

At the direction of DOIT, CTC worked extensively with the Earth Data Analysis Center (EDAC) at the University of New Mexico to capture and map multiple sources of data to determine how many homes and businesses were unserved. The central source of information for determining service was an analysis performed by EDAC primarily using service information provided by the service providers. In addition, a variety of State and federal data sources, were leveraged, along with CTC analysis of technologies, their patterns of expansion, and likely speed ranges. To create usable upper and lower bounds for a cost range, mapping was further refined with a set of different assumptions for Unserved Model 1 and Unserved Model 2.

2.2.1 Methodology for identifying unserved premises

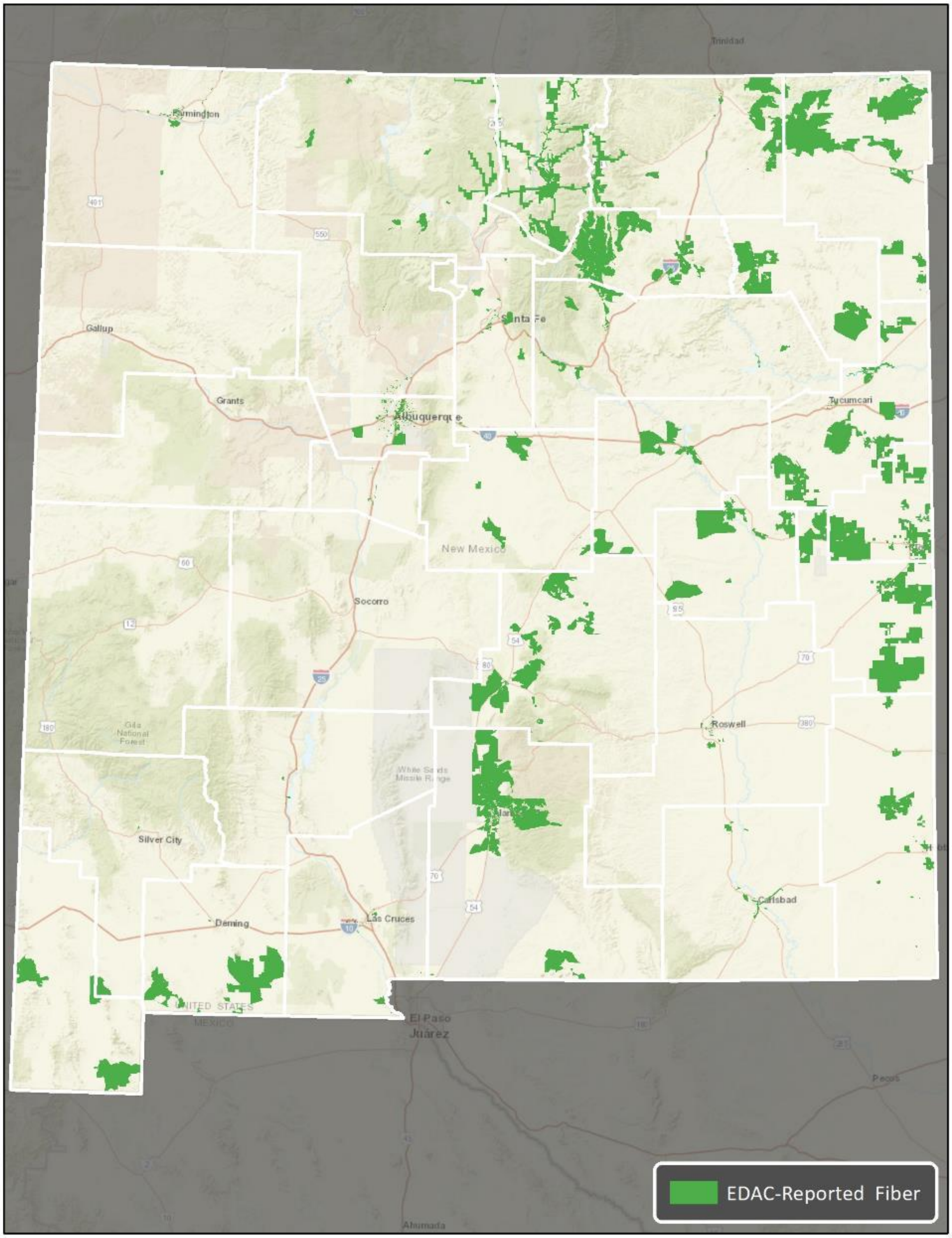
Identifying unserved premises requires knowing where there are address points,[16] and where there is broadband infrastructure adjoining the address. Our methodology included extensive analysis of multiple data sources and a desk and field surveys of areas to confirm assumptions about service availability and assumptions about construction costs for new infrastructure.

DOIT provided a database of address points, including premises on Navajo Nation, Pueblos, and Tribal lands. For almost all areas, DOIT had current address points from local wireless Enhanced 911 (E911) reporting.[17] DOIT provided address data separately for the Navajo Nation at a later stage of our analysis.

To analyze existing broadband infrastructure, we first evaluated the database of coverage areas provided by EDAC. The database includes data reported by most ISPs operating in the State. The EDAC database is updated bi-annually[18] and includes service areas and broad categories of technology, such as fiber (see Figure 3), cable, and DSL, but not service speeds.

[16] Address points are latitude and longitude of residential and business premises.
[17] "911 and E911 Services," Federal Communications Commission, https://www.fcc.gov/general/9-1-1-and-e9-1-1-services (accessed June 3, 2020).
[18] https://edac.unm.edu/nmbb/ (accessed June 3, 2020).

Figure 3: Example EDAC Map: Areas Served by Fiber Optic Broadband Services



We used EDAC's most recent data available for each ISP to map served and unserved areas. (Appendix D contains the table of data used for each ISP.) EDAC's 2019 dataset had fewer providers reporting data than the 2018-reported data, so we worked with the State to request that ISPs update their 2019 data.

As an added check, we compared EDAC data to data collected by the Federal Communications Commission (FCC). The FCC collects data from ISPs nationwide on their service territories by census block, including not just coverage (like EDAC) but also speed and sub-technology, such as advanced DSL that can provide 25/3 Mbps service. The data are self-reported on Form 477[19] (see Figure 4, below).

The main limitation of the Form 477 data is that it typically exaggerates actual coverage—because if one subscriber can be served in a census block, the service provider can declare the entire block is served. (And that is the case even if the service provider does not actually deliver service to that subscriber.) To seek to ameliorate this overreporting, we merged Form 477 and EDAC data to identify areas for further analysis, including locations where coverage data appeared suspect or wildly inconsistent (see Figure 5, below).

We also overlaid these maps on population density heatmaps (see Figure 6, below), using the address data supplied. Looking at existing infrastructure and technology allowed our engineers to predict where expansions would be likely, and therefore where more recent service coverage claims could be realistic or require further inquiry.

[19] For mapping of unserved/served, we focused on 25/3 to reflect the State and FCC adopted lower benchmark for broadband speed Other mapping was produced for grant eligibility which adopts a variety of restrictions, including maximal speeds allowable for grant eligibility. For example, USDA's ReConnect grant and loan program uses 10/1 as its lower eligibility requirement, while still mandating that applicants offer at least 25/3 for their proposed service areas.

Figure 4: Form 477 Data Showing Greater Than 25/3 Broadband Service

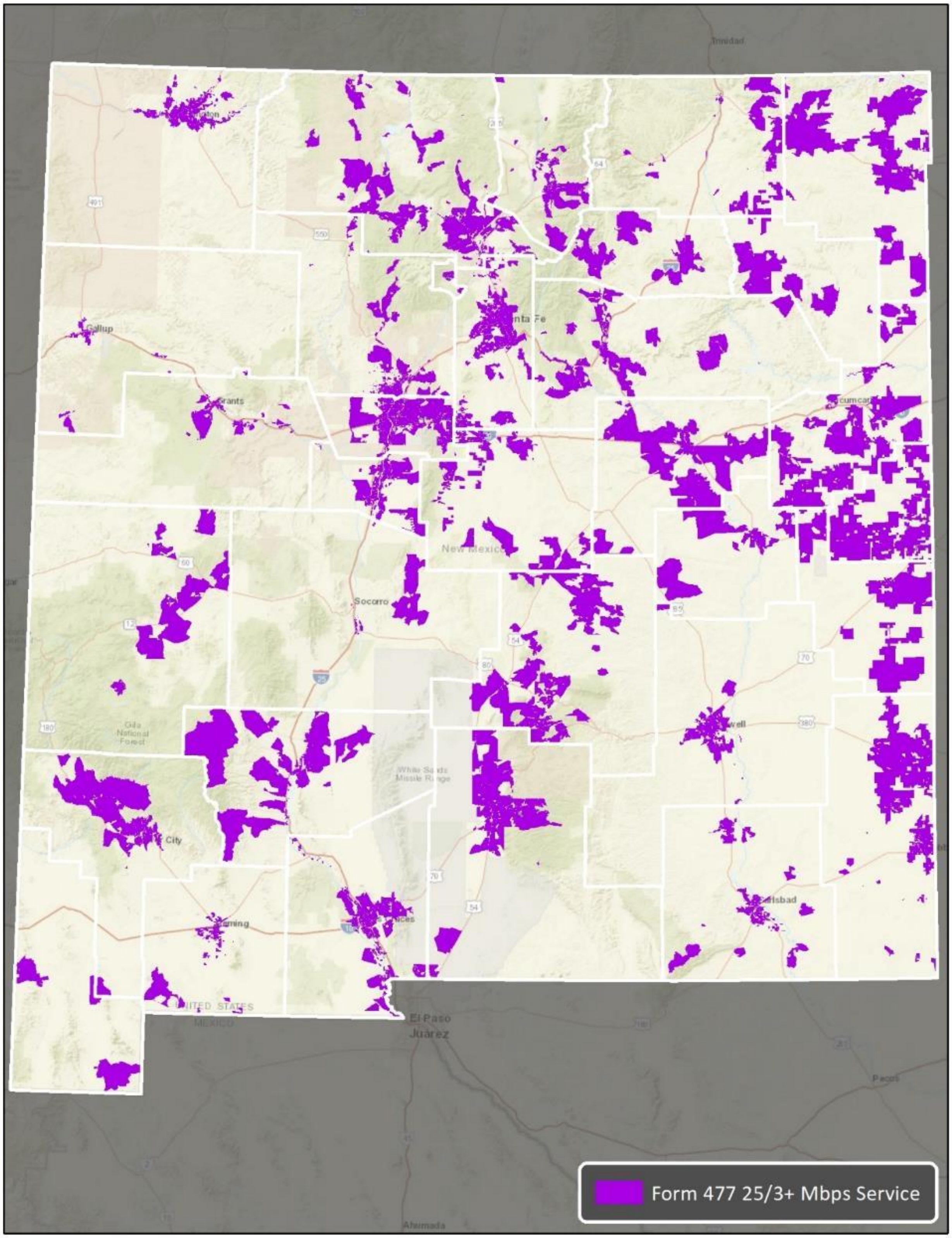


Figure 5: Example Overlay Map Analysis: Comparing Form 477 Coverage Claims Against EDAC Data

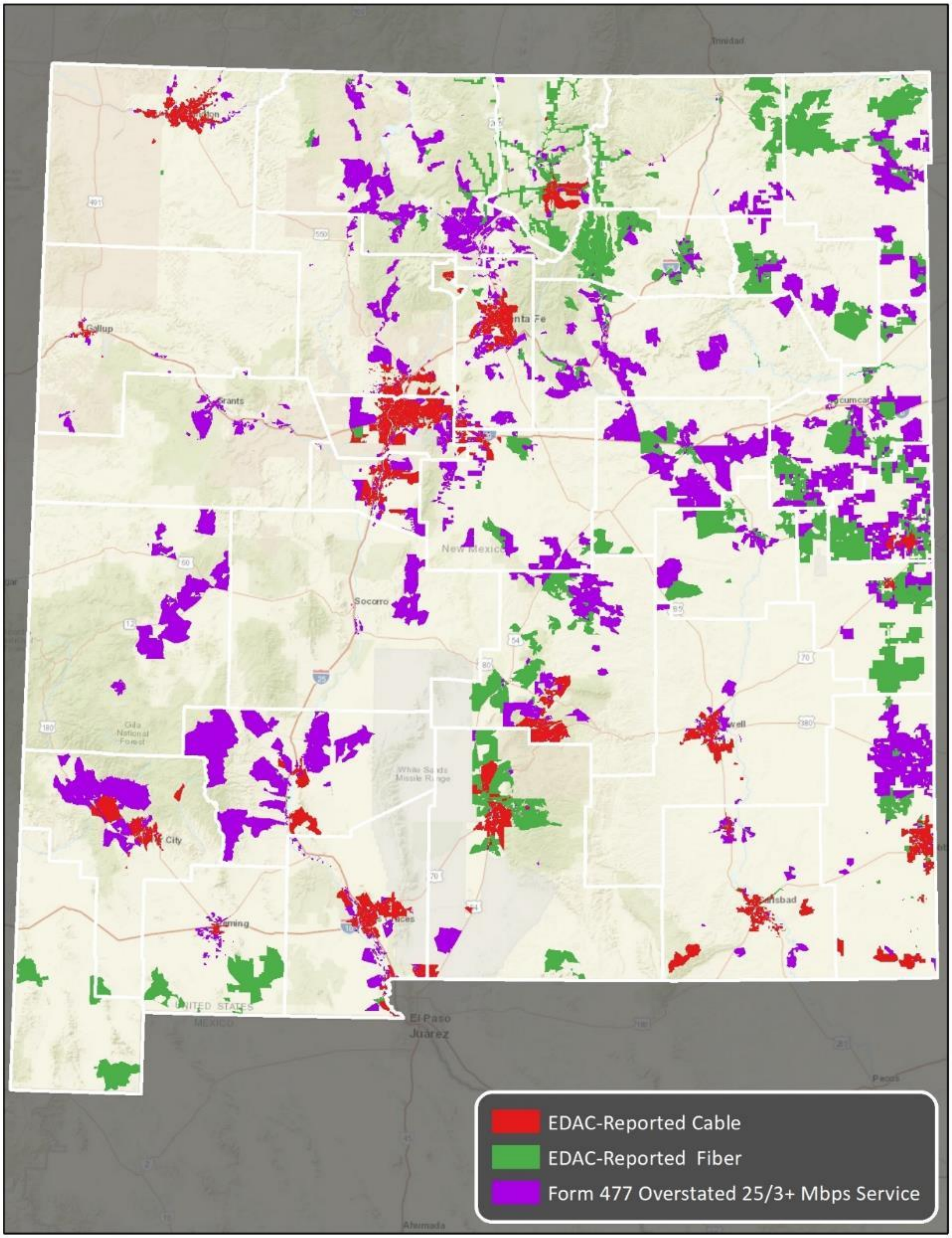
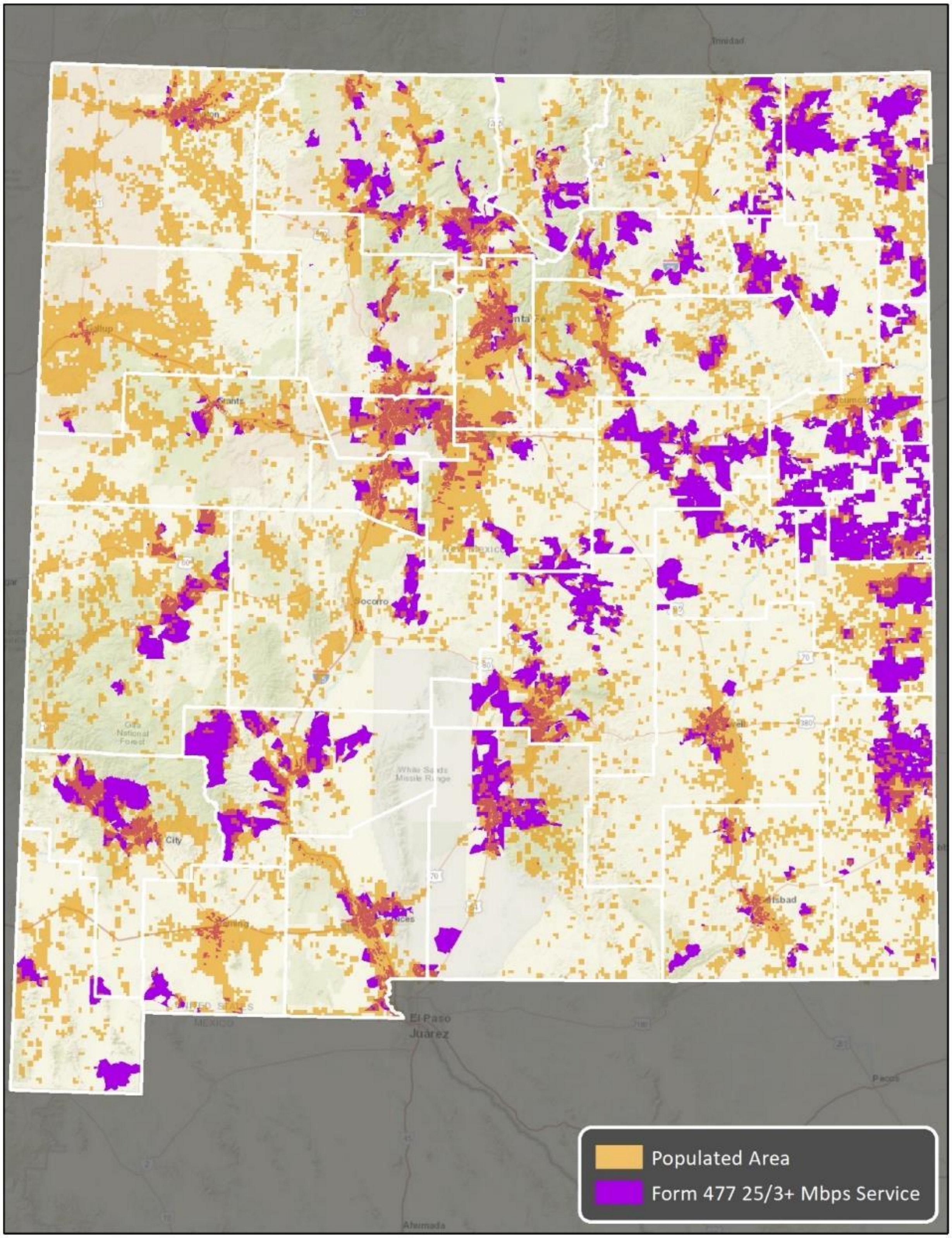


Figure 6: Overlay Map Analysis: Comparing Form 477 Coverage Claims, EDAC Data, and Density



Lastly, we examined other federal databases that showed either eligibility under different grant programs (i.e., areas deemed to be unserved for purposes of those programs) or locations where recent funding has been awarded (i.e., areas deemed to be unserved, and that the federal government has awarded funding to an entity that proposes to construct new infrastructure over some period of time). For example, the U.S. Department of Agriculture (USDA) and the FCC provide data on which entities have requested funding under CAF II (and with what technology), while USDA provides similar data on recent ReConnect awards. The FCC also provides data on provisionally eligible areas for the Rural Digital Opportunity Fund (RDOF) program.[20] (We discuss the federal grant programs in detail later in this report.)

The recent award information was used to ascertain locations where future expansion has been funded, while the eligibility data were used mostly to map any inconsistencies with the Form 477 data. Where inconsistencies were found, we performed further analysis.

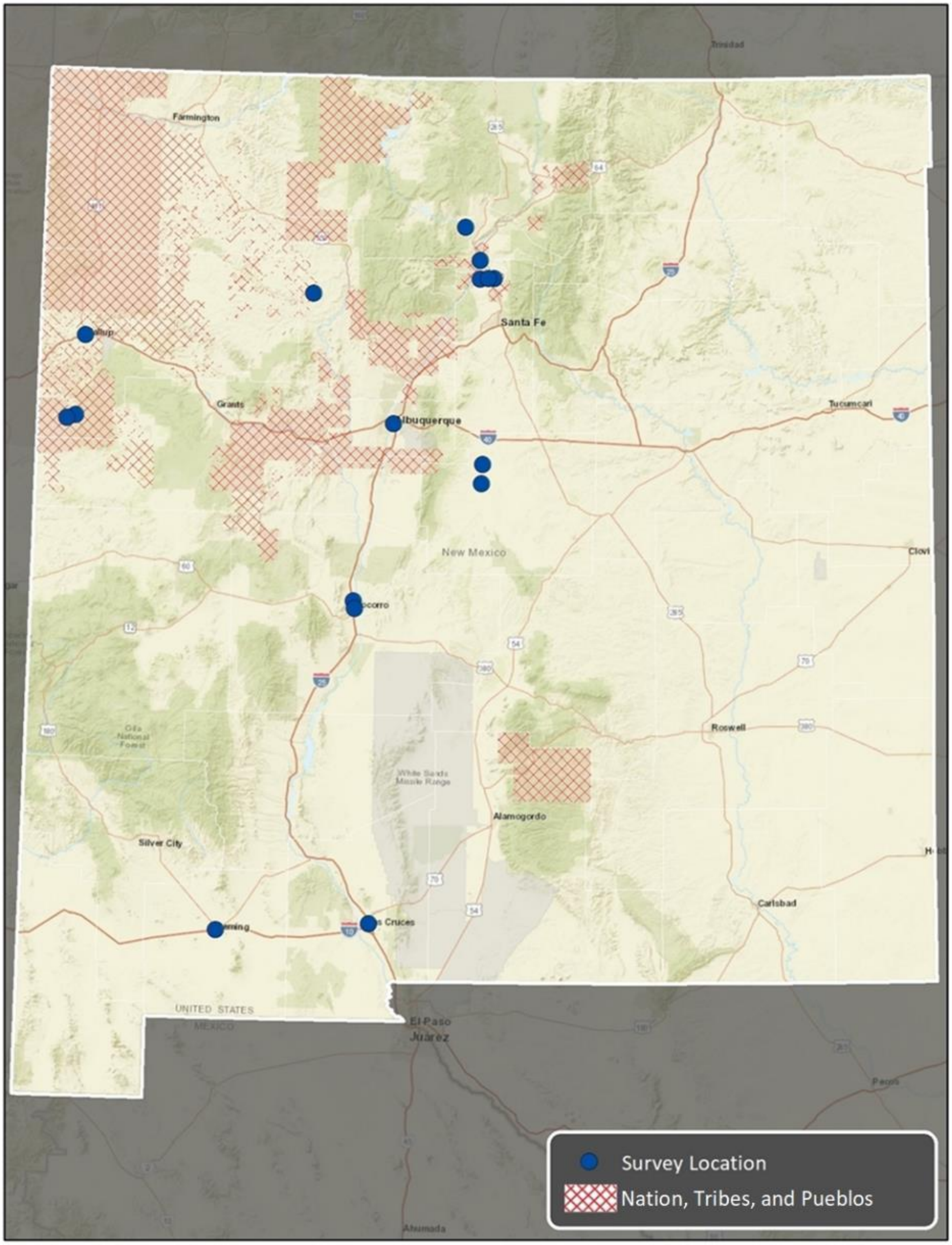
Fixed wireless service areas were analyzed separately. Fixed wireline deployments depend on cables, which can be seen. Identifying fixed wireless service availability is more complex. ISPs will often report best-case scenarios that are highly unrealistic. Without a granular understanding of topology, tower locations, antenna mounting heights, and the fixed wireless technology used by an ISP, verification can best be achieved with in-field and in-home testing. While it is certainly possible to make some reasonable assumptions based on known deployment dates and grant information regarding promised speeds (which will allow engineers to make certain inferences regarding the available technology of the time and likelihood that it would meet the 25/3 threshold), we instead adopted two models in which fixed wireless claimed at 25/3 would be included for one model and excluded for another.

Engineering analysis of the mapped layer revealed areas of interest to be pursued through an extensive desk survey (i.e., an analysis of available infrastructure identified in publicly available databases of street-level and aerial photography). In particular, we were told anecdotally that there were coaxial cables in areas that EDAC and the FCC claimed were unserved. Based on further research, we believe this discrepancy is likely due to those providers only delivering cable television over their coaxial cables, and not broadband.

As a final step in our analysis, we identified areas for a field survey based on analysis of the desk survey data. The field survey (see Section 3.1.1) was intended as a way to spot-check and confirm that mapping of existing infrastructure was consistent with field evidence, and to develop assumptions regarding the general state of poles, soil, and other parameters used to generate cost estimates.

[20] "Auction 904 Initial Eligible Areas," FCC, https://www.fcc.gov/reports-research/maps/auction-904-preliminary-eligible-areas/ (accessed June 3, 2020).

Figure 7: Field Survey/Sampling Map



2.2.2 Mapping the two models for unserved: Lower and upper bounds for unserved premises

For the more expansive Unserved Model 1 assumptions, we consider a home or business served if it is capable of getting 25 Mbps downstream and 3 Mbps upstream service from a wireline fiber or coaxial cable connection. We eliminated fixed wireless providers and DSL from this model. This model results in the higher estimate of unserved homes and businesses in the State—and therefore the higher cost estimate for filling the gaps.

The map for Unserved Model 1 is illustrated in Figure 8 (below). We counted approximately 196,000 unserved homes and businesses for Unserved Model 1. This is approximately 20 percent of the homes and businesses in the State.

The second model reduces the number of unserved, modifying Unserved Model 1 by including

- CAF II auction winners' service areas as being served (see Section 2.1)
- Areas identified by EDAC as having fixed wireless service that are identified in Form 477 as being 25/3 Mbps or faster
- Areas with DSL service that are identified in Form 477 or in other sources as having 25/3 Mbps speeds

The CAF II areas would then be assumed to be served. And reliance on Form 477 generated a more generous acceptance of coverage claims than EDAC's data. As such, Unserved Model 2 provides a more conservative assumption of areas that qualify as unserved, leading to a lower number of unserved premises—and a lower build cost for filling the gaps. In other words, Unserved Model 2 adds in areas where providers have committed to build, and are in the process of deploying in their grant-awarded areas, but have not necessarily completed building, and includes provider-claimed coverage of fixed wireless and DSL services.

A map showing the unserved areas under Unserved Model 2 is illustrated in Figure 9 (below). There are approximately 126,000 unserved homes and businesses in Unserved Model 2, or 13 percent of the homes and businesses in the State.

Figure 10 (below) shows how Unserved Model 2 expands the number of homes and businesses that are served. With a smaller unserved area, Unserved Model 2 will have a lower cost for constructing FTTP.

Figure 8: Unserved Model 1 Areas

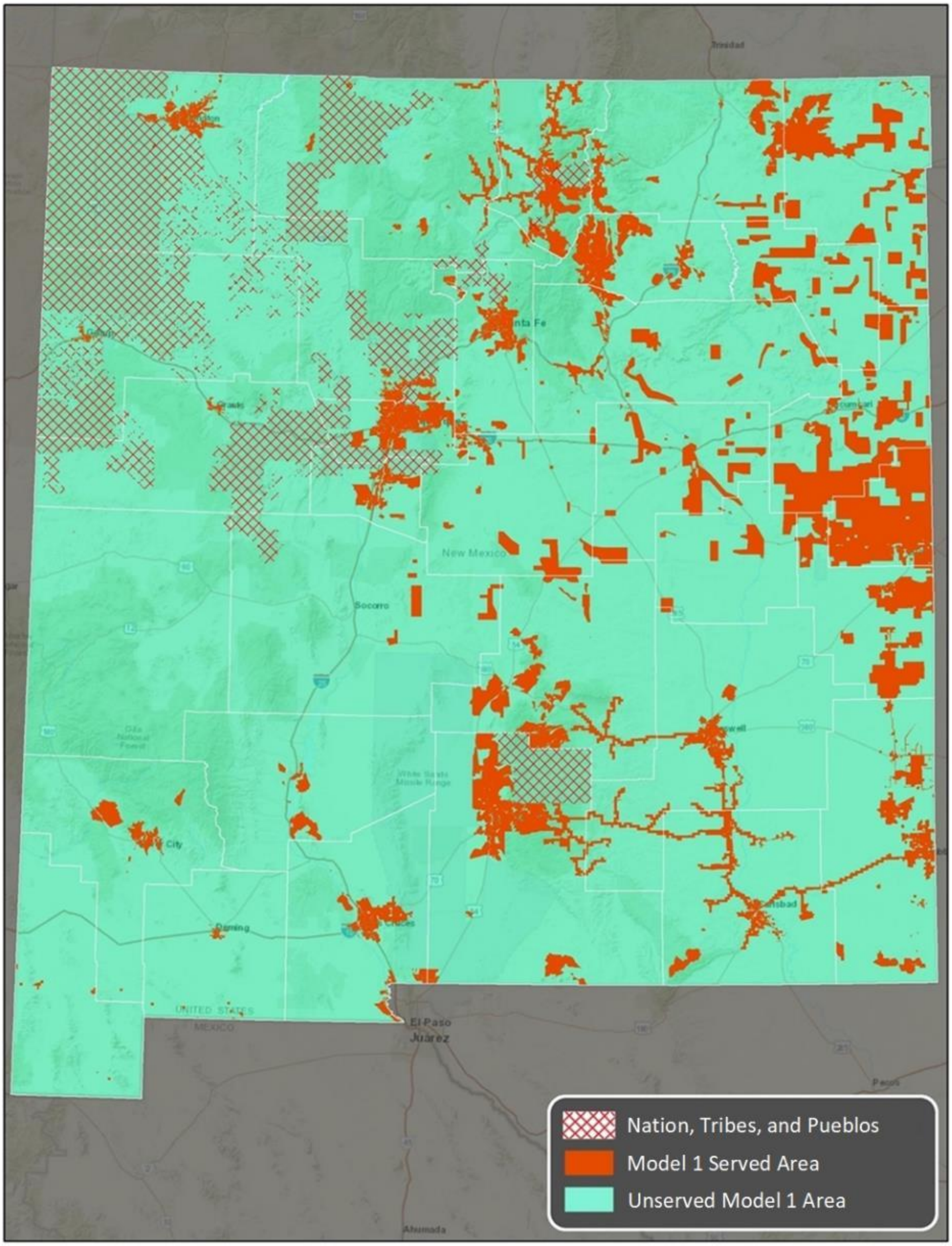


Figure 9: Unserved Model 2 Areas

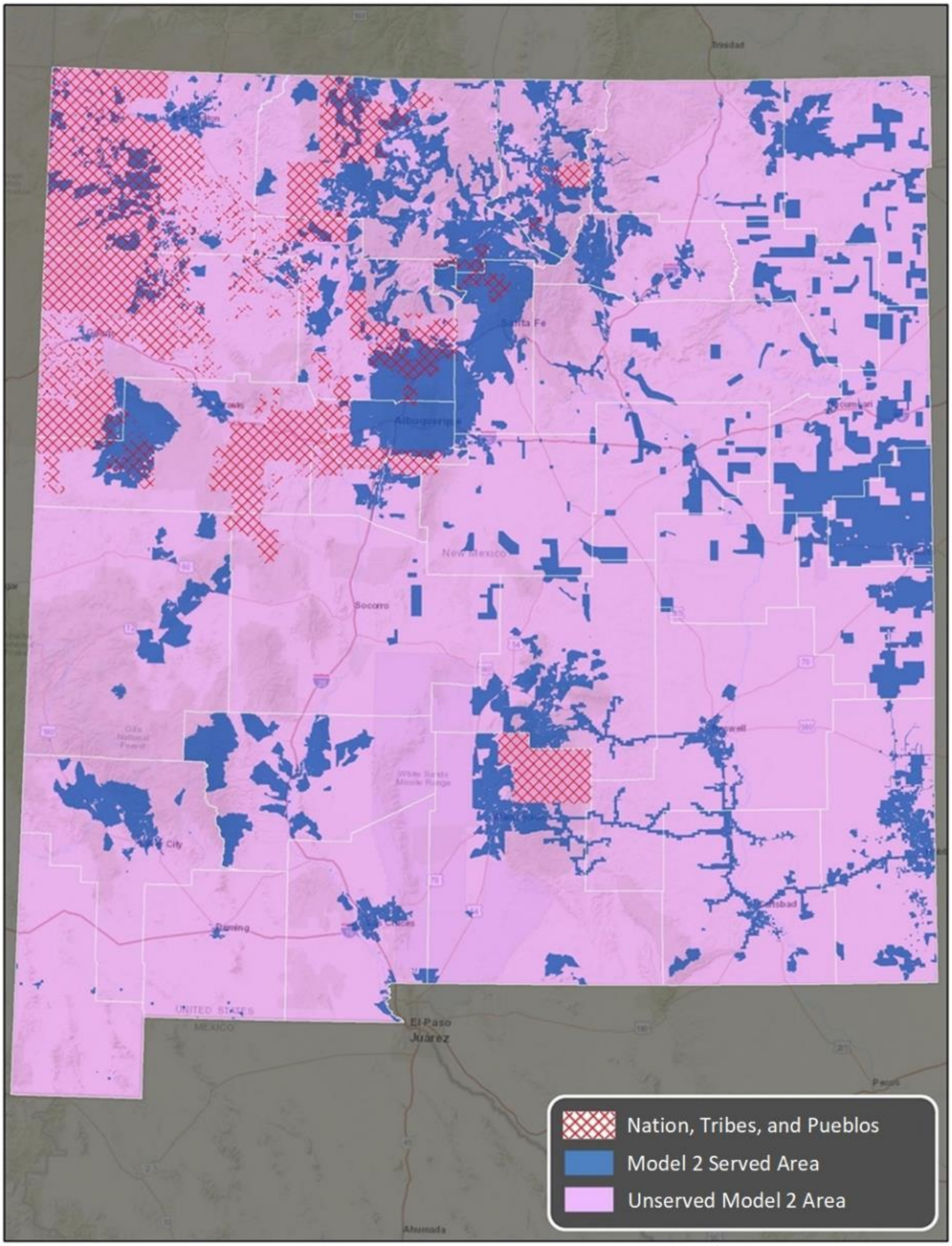
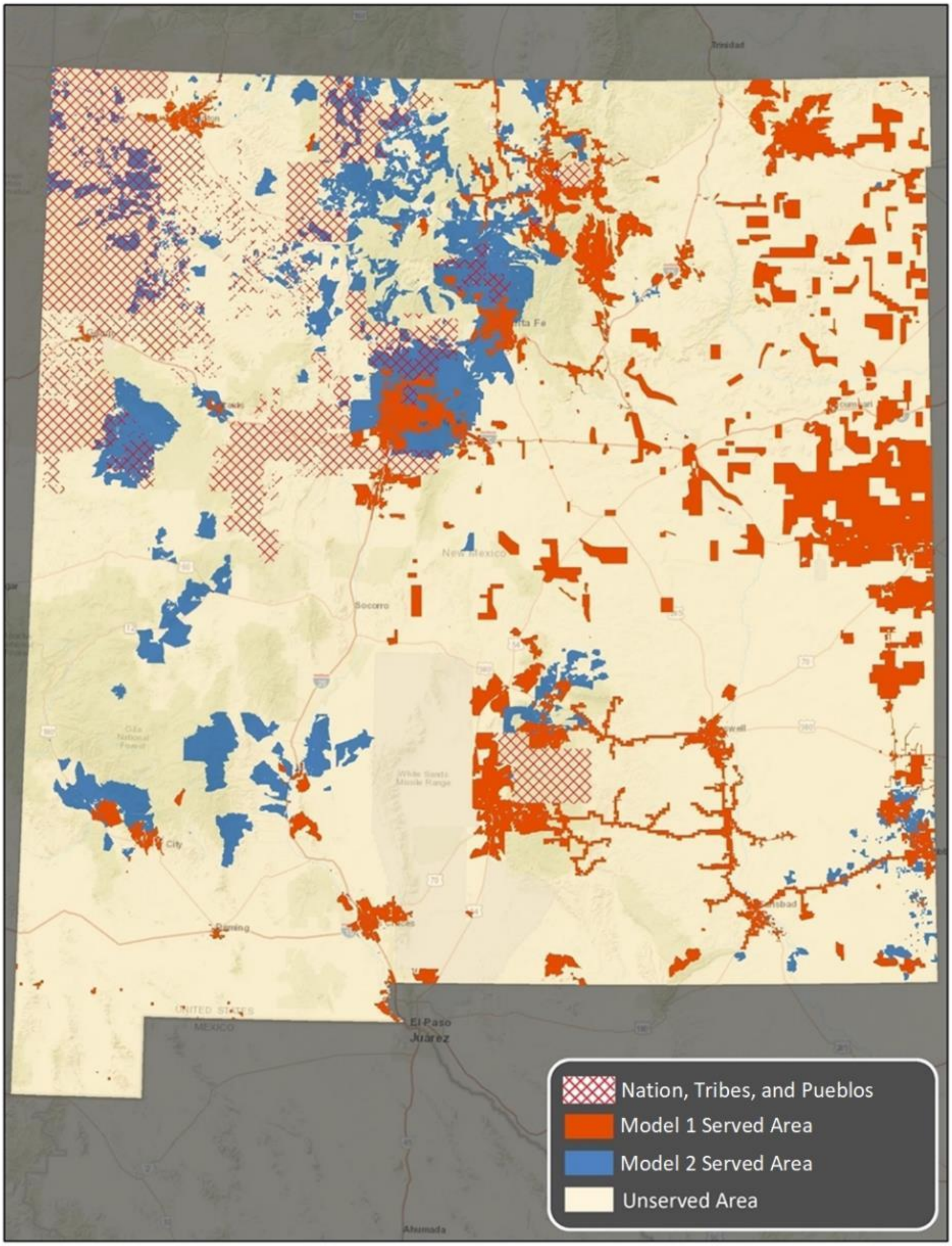


Figure 10: Unserved Model 2 Has a Greater Served Area Than Unserved Model 1



2.2.3 Mapping priority unserved areas: Areas primed for fiber-to-the-premises

We then analyzed GIS data to develop a density map (see Figure 11, below) to determine where groups of unserved homes and businesses are clustered together. Given the wide geographic distribution of unserved New Mexicans, the purpose of seeking clusters of premises was to identify areas that could be most cost-effectively addressed. Taken together, the cluster ed areas comprise close to half of the State's unserved premises in each model.

Clustered groups of homes are the most attractive and cost-effective areas for providers to offer new or expanded service. These areas are often outside cities and towns that have service (and thus where existing providers might expand their existing infrastructure).

In Unserved Model 1, we identified 86 clustered areas that contain 87,000, or 44 percent of that model's 196,000 unserved homes and businesses (see Figure 12, below).

Unserved Model 2 has 60 clustered areas that contain 50,000, or 40 percent of that model's 126,000 unserved premises (see Figure 13, below).

Figure 11: Address Point Density Heatmap

Figure 12: Clustered Premises in Unserved Model 1

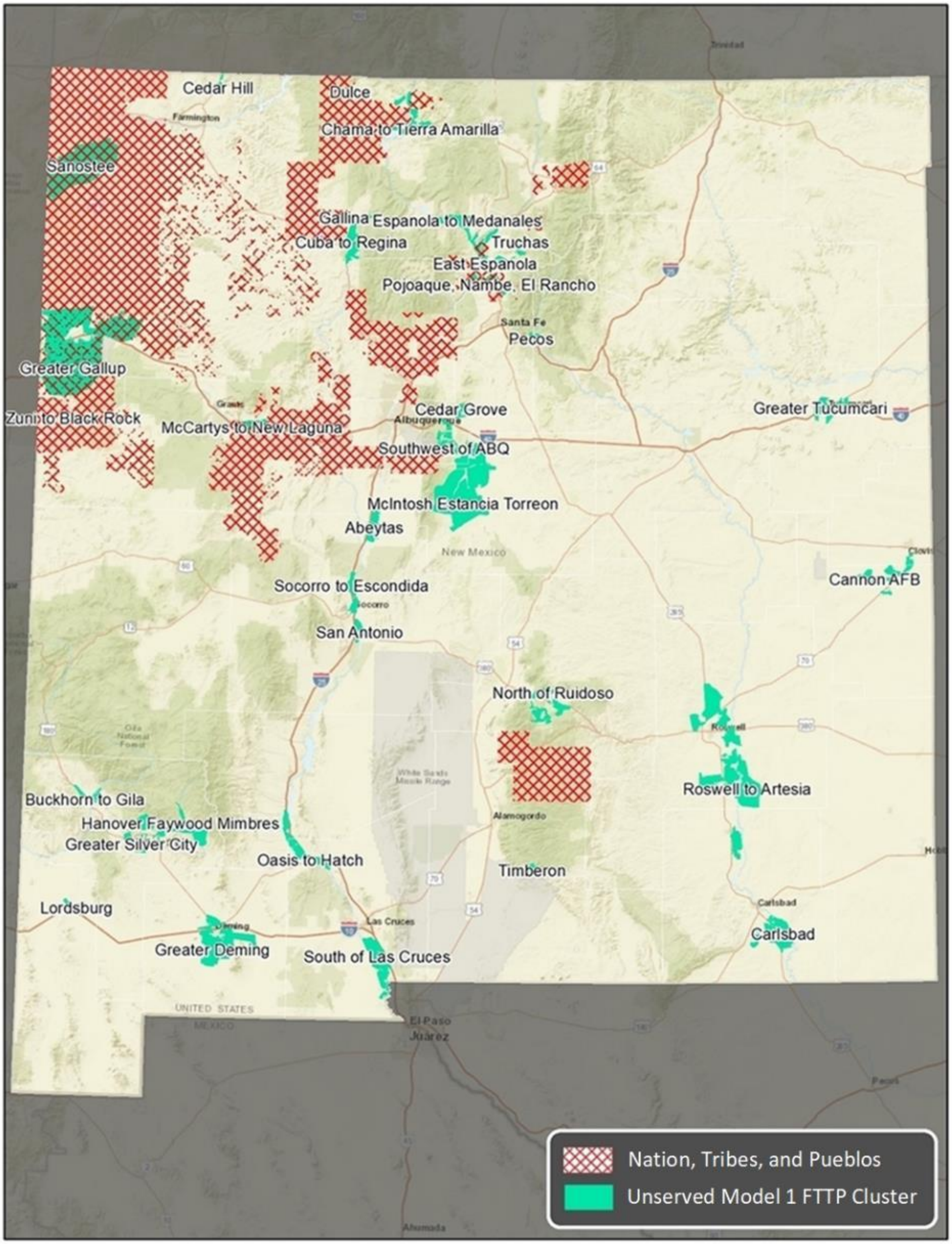
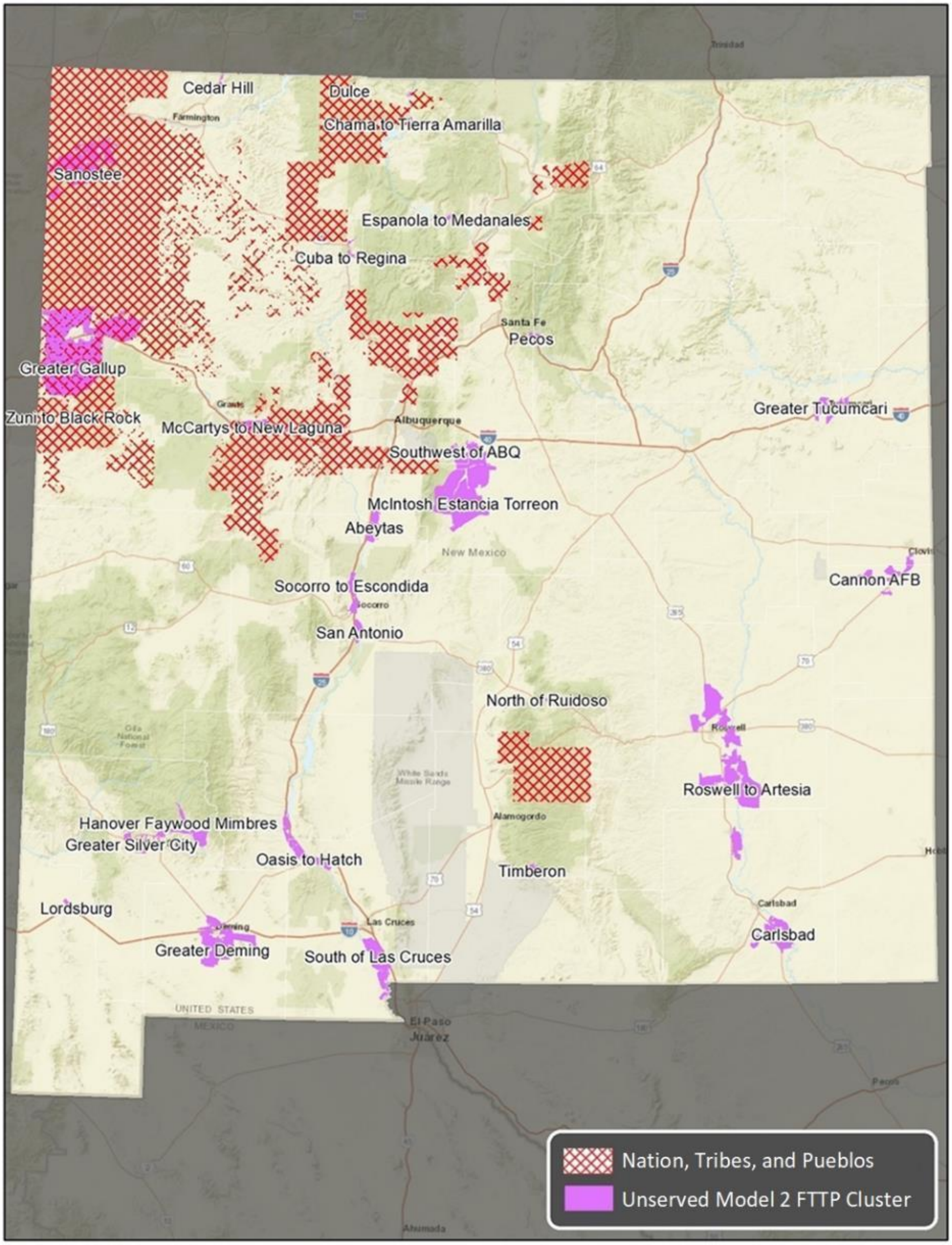


Figure 13: Clustered Premises in Unserved Model 2



3 Cost Estimate for Expanding Access to Broadband in Unserved New Mexico

We created two models for estimating the cost to construct fiber-to-the-premises (FTTP) to serve[21] the State's currently unserved premises, representing the low and high estimates of cost:

- The high-cost model assumes an entity, most likely a new provider, constructs a wholly new FTTP network entirely underground.
- The low-cost model assumes an incumbent provider constructs FTTP—leveraging its existing assets such as fiber, conduit, and aerial pole attachments to reduce the amount of new construction required.

In Unserved Model 1, building FTTP to serve the 87,000 unserved homes and businesses that are clustered would cost $332 million to $806 million, or $3,820 to $9,270 per passing. Serving the 109,000 unserved homes and businesses outside of those clusters would cost $1.6 billion to $4.3 billion, or $15,520 to $39,260 per passing.

In Unserved Model 2, building FTTP to serve the 50,000 unserved homes and businesses that are clustered would cost an estimated $236 million to $576 million, or $4,750 to $11,600 per premises.[22] Serving the 76,000 premises outside the clusters would cost $1.5 billion to $3.7 billion, or $19,780 to $48,790 per passing. (See Table 5.)

[21] For purposes of this plan, an area or address is served with broadband if it can receive fixed, terrestrial internet access with transmission speeds that, at a minimum, provide twenty-five megabits per second (25 Mbps) download and three megabits per second (3 Mbps) upload. Neither satellite nor mobile service can be considered broadband for purposes of this definition. This exclusion is consistent with the FCC definition and is because of limitations of those technologies, including the likelihood that the service limits the data that can be used by the subscriber each month or meters the data amount.

[22] The cost estimates in this report assume that 60 percent of the homes and businesses subscribe to the service, which is also known as take-rate. A 60 percent take-rate is possible in environments where a new provider delivers service in a previously unserved area. Market research would be required to estimate a more accurate take-rate at assumed service costs.

Table 5: Estimated Costs to Construct Fiber to Unserved Premises

Unserved Model	Density of Premises	Number of Passings	Total Cost by Density	Cost per Passing	Total Cost
1	Clustered	87,000	$332 million – $806 million	$3,820 – $9,270	$1.9 billion – $5.1 billion
	Low-Density	109,000	$1.6 billion – $4.3 billion	$15,520 – $39,260	
2	Clustered	50,000	$236 million – $576 million	$4,750 – $11,600	$1.7 billion – $4.3 billion
	Low-Density	76,000	$1.5 billion – $3.7 billion	$20,300 – $50,000	

Broadband can also be delivered using fixed wireless technology. In Section 3.2 we provide a model where we use existing wireless sites to deliver fixed wireless service. Costs are summarized in Table 6.

Table 6: Estimated Fixed Wireless Coverage and Cost Estimates

Unserved Model	Number of Towers	Passings Served	Percent of Passings Served[23]	Capital Cost Assuming 60% Penetration	Average Distribution Network Cost per Wireless Passing	Installation and Electronics per Customer
Wireless Unserved Model 1	966	134,121	69	$282,100,000	$1,030	$1,800
Wireless Unserved Model 2	780	84,655	67	$202,300,000	$1,300	$1,800

As stated, there are often technical limitations relative to a fully fiber optic network. These include difficulty or inability to serve customers obstructed by terrain or foliage and limitations in available wireless spectrum. As a result, fixed wireless providers have typically adopted a business model where they expect to serve a lower percentage of the potential customers (e.g.

[23] For Wireless Unserved Model 1 and Wireless Unserved Model 2, this figure represents the percentage of total unserved premises. For the two hybrid models, this figure represents the percentage of unserved premises in low-density areas (i.e., outside of clusters).

lower "penetration") and focus their efforts on subscribers who can most optimally be served from available antenna sites.

It is critical to note that the costs and engineering assumptions in this model assume that the fixed wireless provider is instead pursuing a model where it must be the primary provider in a service area and has approximately 60 percent of passed homes and businesses on the network (a typical number in an otherwise unserved area).

Because of the technical advantages of fiber but the clear need to seek an alternative in less dense areas, we also present a hybrid approach, in which the denser unserved areas have fiber service—and low-density areas have fixed wireless (see Section 3.2). Costs are summarized in Table 4.

Table 7 Estimated Hybrid Fixed Wireless Coverage and Cost Estimates

Unserved Model	Number of Towers	Passings Served	Percent of Passings Served[24]	Capital Cost Assuming 60% Penetration	Average Distribution Network Cost per Wireless Passing	Installation and Electronics per Customer
Wireless Unserved Model 1 (Hybrid)	788	67,007	61	$184,400,000	$1,700	$1,800
Wireless Unserved Model 2 (Hybrid)	638	44,447	59	$139,000,000	$2,100	$1,800

That said, many parts of New Mexico, especially low-density areas, may be better suited to fixed wireless because of the high cost of building wireline infrastructure. We developed a hybrid model that demonstrates how fiber and wireless technologies can work in complementary way, but unfortunately much of the State's premises outside of clustered areas (76,000 to 109,000 premises, or 8 percent to 12 percent of the State's homes and businesses) are very expensive to serve either with current fiber or wireless technologies. The cost of serving those areas with fiber technology is $1.5 billion to $3.7 billion, or $20,300 to $50,000 per passing in Unserved Model 2.

[24] For Wireless Unserved Model 1 and Wireless Unserved Model 2, this figure represents the percentage of total unserved premises. For the two hybrid models, this figure represents the percentage of unserved premises in low-density areas (i.e., outside of clusters).

3.1 Estimated costs for constructing fiber-to-the-premises to serve homes and businesses

We created two cost models. The high-cost estimate is a "worst-case," where a new provider enters the market and constructs FTTP entirely underground. In the low-cost estimate an incumbent provider constructs FTTP by leveraging their existing assets such a fiber, conduit, and aerial pole attachments. Within each model, we further distinguished among premises that are clustered (and thus relatively more cost-effective to serve) and premises in lower-density areas that would require more extensive construction.

In Unserved Model 1, building FTTP to 87,000 unserved homes and businesses in clusters (out of a total 196,000 unserved premises) would cost $332 million to $806 million, which is $3,820 to $9,270 per home or business. In Unserved Model 2, which has 50,000 unserved premises in clusters (out of that model's total of 126,000 unserved), the cost range is $236 million to $576 million, which is $4,750 to $11,600 per passing. The following tables itemize the cost for each model by component. (See Section 3.1.5 for details.)

Table 8: Unserved Model 1 Cost Estimate for Clustered Premises by Component

	Low Estimate	High Estimate
Outside Plant Construction	$252,000,000	$629,000,000
Core Electronics	$26,000,000	$26,000,000
Subscriber Costs (CPE and Drop)	$55,000,000	$151,000,000
Total	**$332,000,000**	**$806,000,000**
Homes and Businesses	87,000	87,000
Cost Per Home and Business	$3,820	$9,270

Table 9: Unserved Model 2 Cost Estimate for Clustered Premises by Component

	Low Estimate	High Estimate
Outside Plant Construction	$190,000,000	$475,000,000
Core Electronics	$15,000,000	$15,000,000
Subscriber Costs (CPE and Drop)	$31,000,000	$86,000,000
Total	**$236,000,000**	**$576,000,000**
Homes and Businesses	50,000	50,000
Cost Per Home and Business	$4,750	$11,600

For the remaining homes and businesses in the State that are not in clusters, low density creates a challenge from a cost perspective to construct FTTP to every home. We created a high-level cost estimate to construct to these homes and businesses.

In Unserved Model 1, there are 109,000 unserved homes and businesses in low-density areas outside the clusters. The cost range to construct FTTP to them is $1.6 billion to $4.3 billion, or $15,520 to $39,260 per passing. [25] Unserved Model 2, with 76,000 unserved homes and businesses outside the clusters, would cost $1.5 to $3.7 billion, or $20,300 to $50,000 per passing. (See Section 3.1.6 for details.)

3.1.1 Desk and field survey of outside plant

3.1.1.1 Desk survey methodology

CTC engineers first performed desk surveys of the State using Google Earth Street View. Areas were sampled from around the State, and particular target areas were selected based on analysis of our mapping data—especially areas of divergence between EDAC and Form 477 data on served areas, as well as areas where anecdotal information contradicted either dataset.

The engineers reviewed available right-of-way space available for underground conduit construction and estimated the modifications that would be necessary to existing infrastructure on utility poles for aerial construction. To develop the parameters for cost estimation, the desk survey methodology focused on:

1) Confirming the lack of visible high-speed broadband technologies

2) Identifying where cable TV plant is in place (with the intent to follow up with cable providers to determine whether those areas have cable TV but no broadband service)

3) Examining the condition and capacity of utility poles to confirm or refine assumptions about make-ready and pole replacement requirements

4) Examining the size and condition of the right-of-way

5) Identifying cabinets and pedestals that signify the presence of underground plant (for example, to identify where backbone or middle-mile fiber transitions to copper)

3.1.1.2 Field survey methodology

A CTC outside plant engineer then performed field surveys of select locations across the State to verify served and unserved areas, and confirm and refine our analysis. We also selected target areas to survey across the State.

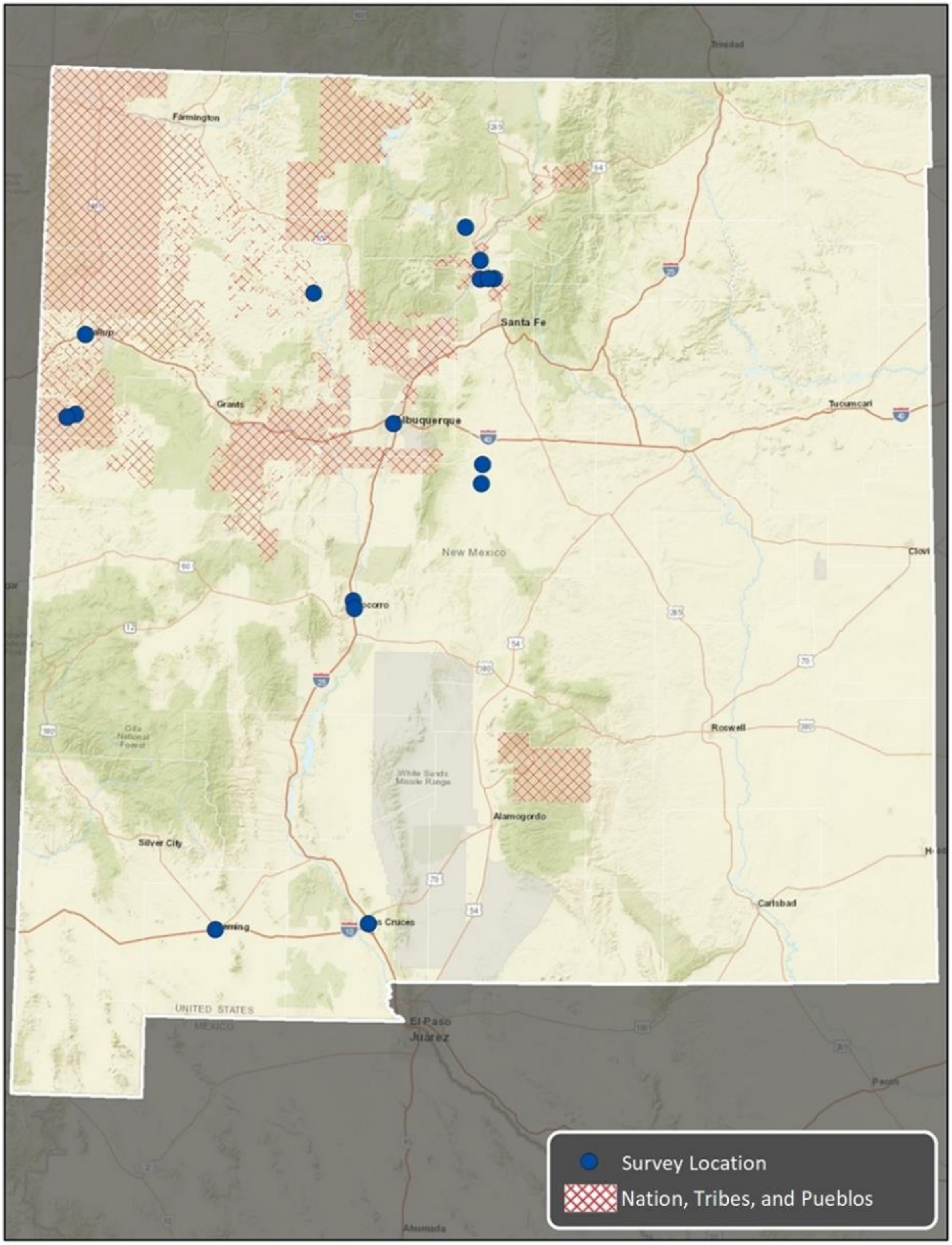
The engineer conducted the assessment over five days. The map in Figure 14 shows the areas where we conducted field surveys:

[25] Costs are detailed in Section 3.1.3.

- Pojoaque, Nambe, El Rancho
- East Espanola
- Espanola to Medanales
- Southwest Albuquerque
- McIntosh Estancia Torreon
- Socorro to Escondida
- South of Las Cruces
- Greater Deming
- Greater Gallup
- Zuni to Black Rock

This analysis contributed to the customized estimates of per-mile costs we developed for 1) construction on utility poles and 2) underground construction where poles are not available. We developed a high-cost estimate assuming 100 percent new underground construction and a low-cost estimate assuming expanded construction by an incumbent provider using existing conduit, fiber, and aerial attachments. (See Section 3.1.5 for more details.)

Figure 14: Field Survey Locations



3.1.1.3 Sample infrastructure conditions from the field

Below are sample photos of unserved areas identified based on a combination of EDAC data and field surveys. In general, delivering broadband to these areas would require upgrading existing infrastructure or construction of new infrastructure as described in Section 3.1.3. In general, in between towns, there is substantial space in the right-of-way—and, where utility poles exist, there is space on utility poles.

In small communities the utility poles typically are short and thin, with many needing replacement to support a new fiber attachment. Therefore, the lowest cost for fiber construction would be available to the existing telephone company (or the cable company, where present), which could upgrade its system by replacing cables or overlashing fiber to existing cable. Existing telecommunications providers also have access to their own poles and conduit, which yields relatively low costs for adding cable attachments. Newer entrants, however, would need to place new cables underground or on a new attachment on the utility pole, and therefore would face significantly higher costs.

The following photographs were taken as part of our outside plant survey to depict the state of communications infrastructure in the areas we reviewed. In the unserved East Espanola area (Figure 15), for example, we identified copper lines for telephone and/or low-speed DSL, as well as and cable-TV (without internet). Space is available on the poles for new infrastructure.

In the Espanola area (Figure 16), we identified a repeater for copper phone service and/or low-speed DSL.

Figure 15: East Espanola Area – Copper and Cable TV (No Internet)

Figure 16: Espanola Area – Repeater for Copper Phone Service and/or DSL

Near Deming, we identified the transition point from fiber to copper service (Figure 17). Copper lines only support DSL and dial-up; the fiber is for backbone and middle mile services only.

Figure 17: Deming Area – Transition From Fiber to Copper for Phone and/or DSL

In the Mcintosh area of Torrance County we identified a repeater and cabinet for DSL and/or dial-up services (Figure 18).

Figure 18: Mcintosh Area – Repeater and Cabinet for DSL and Dial-Up Services

In the Socorro area we identified relatively crowded poles but no broadband infrastructure (Figure 19). (Based on EDAC data, there is low-speed DSL and cable-TV in the area; broadband would require an upgrade of the cable system and/or placement of fiber.)

Figure 19: Socorro Area – Relatively Crowded Poles But No Broadband

Near Espanola, we identified copper for DSL and dial-up on the poles, and middle-mile or backbone fiber underground (Figure 20).

Figure 20: Near Espanola – Copper on Pole, Middle-Mile or Backbone Fiber Underground

3.1.2 Fiber-to-the-premises network design

We developed a conceptual, high-level fiber-to-the-premises outside plant network design that is aligned with best practices in the industry and is open to a variety of electronic architecture options.[26]

Figure 21, below, shows a logical representation of the fiber-to-the-premises network architecture we recommend based on the conceptual outside plant design. The drawing illustrates the primary functional components in the fiber-to-the-premises network, their relative position to one another, and the flexibility of the architecture to support multiple subscriber models and classes of service.

The recommended architecture is a hierarchical data network that provides scalability and flexibility, both in terms of initial network deployment and its ability to accommodate the increased demands of future applications and technologies without requiring expensive new construction. The characteristics of this hierarchical fiber-to-the-premises data network are:

- **Capacity** – ability to provide efficient transport for subscriber data, even at peak levels
- **Availability** – high levels of redundancy, reliability, and resiliency; ability to quickly detect faults and re-route traffic
- **Resilient operation** – physical path diversity in the network backbone to minimize operational impact resulting from fiber or equipment failure
- **Efficiency** – no traffic bottlenecks; efficient use of resources
- **Scalability** – ability to grow in terms of physical service area and increased data capacity, and to integrate newer technologies without new construction
- **Manageability** – simplified provisioning and management of subscribers and services
- **Flexibility** – ability to provide different levels and classes of service to different customer environments; can support an open access network or a single-provider network; can provide separation between service providers on the physical layer (separate fibers) or logical layer (separate Virtual Local Area Network (VLAN) or Virtual Private Network (VPN) providing networks within the network)

[26] The network's outside plant is both the most expensive and the longest-lasting portion. The architecture of the physical plant determines the network's scalability for future uses and how the plant will need to be operated and maintained; the architecture is also the main determinant of the total cost of the deployment.

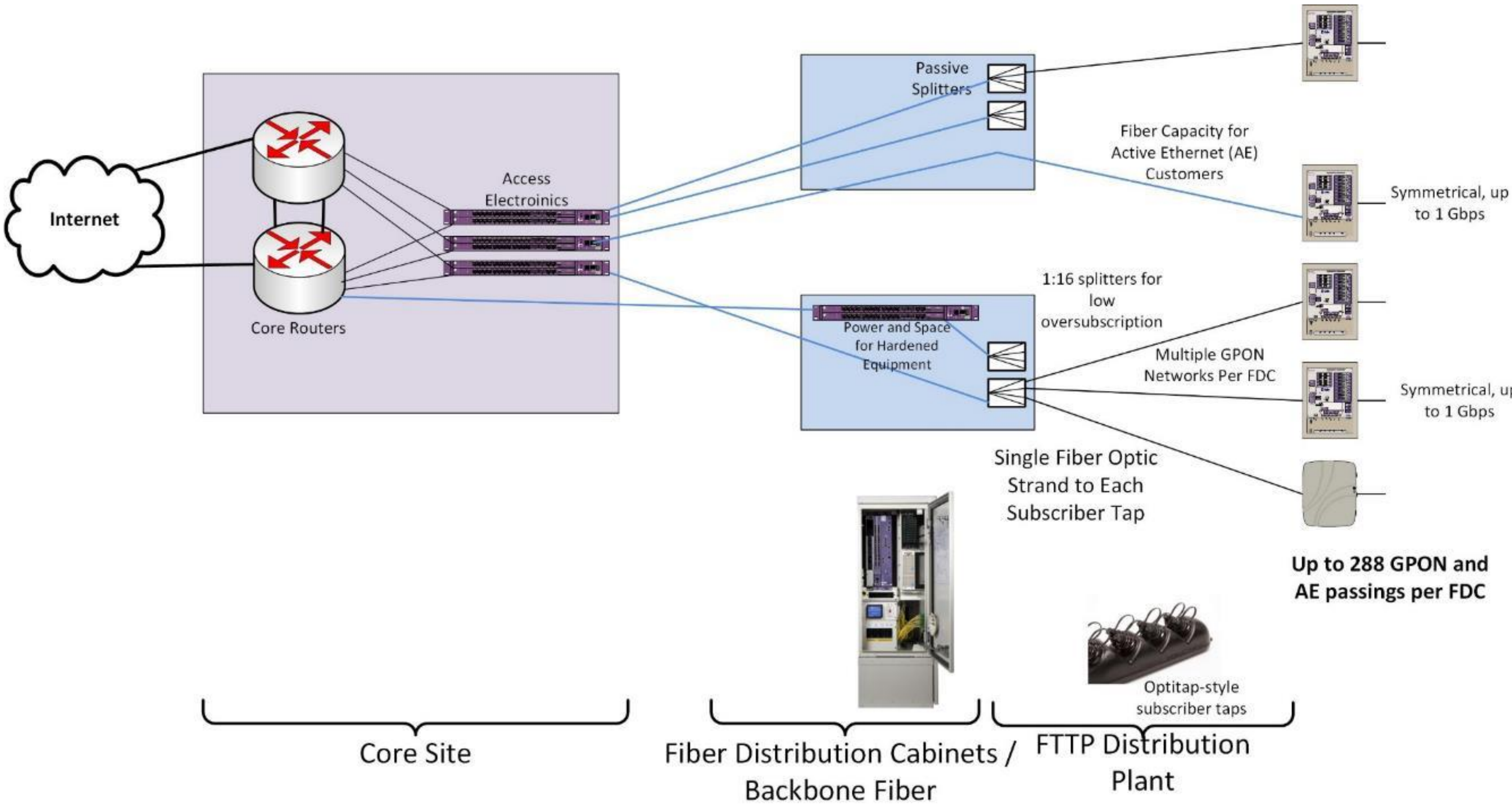
- **Security** – controlled physical access to all equipment and facilities, plus network access control to devices

This architecture offers scalability to meet long-term needs. It is consistent with best practices for either a standard or an open-access network model to provide customers with the option of multiple network service providers. This design would support the current industry standard gigabit passive optical network technology. It could also provide the option of direct Active Ethernet services.[27]

The design assumes placement of manufacturer-terminated fiber tap enclosures within the public right-of-way or easements, providing watertight fiber connectors for customer service drop cables, and eliminating the need for service installers to perform splices in the field. This is an industry-standard approach to reducing both customer activation times and the potential for damage to distribution cables and splices. The model also assumes that the service provider obtains easements or access rights to Navajo Nation, Pueblos, and Tribal lands, or private drives within communities to access homes.

[27] The architecture enables the network to provide direct unshared Ethernet connections to 5 percent of customers, which is appropriate for a select group of high-security or high capacity commercial users (banks, wireless small cell connections). In extreme cases, the network can provide more customers with Active Ethernet with the addition of electronics at the fiber distribution cabinets on an as-needed basis.

Figure 21: High-Level Fiber-to-the-Premises Architecture



3.1.3 Construction cost variables

As with any utility, the design and associated costs for construction vary with the unique physical layout of the service area—no two streets are likely to have the exact same configuration of fiber optic cables, communications conduit, underground vaults, and utility pole attachments. Costs also vary by soil conditions, such as the prevalence of subsurface hard rock; the condition of utility poles and feasibility of aerial construction involving the attachment of fiber infrastructure to utility poles; and crossings of bridges, railways, and highways.

Make-ready is the work required to create space on an existing utility pole for an additional attachment. Existing attachments often have to be moved or adjusted to create the minimum clearance required by code to add an additional attachment. Each move on the pole has an associated cost (i.e., for contractors going out to perform the move). When a utility pole is not tall enough to support another attachment or the pole is not structurally capable of supporting the attachment, a pole replacement is required. The pole replacement cost is then charged to the new attacher. For a best-case, low-cost estimate, we assumed that no make-ready would be needed. We also assumed that existing conduits would be usable where needed.

One of the challenging variables with underground construction is the prevalence of rock. Softer stones and boulders (intermediate rock) require the use of a specialized boring missile that is more expensive than traditional boring. Where hard rock, such a granite is present, specialized rock boring machinery is required to directional bore new conduit. The cost of boring through rock is added to the cost of traditional boring. For a high-cost estimate, we assumed underground construction for all areas. The prevalence of extensive rock could increase the cost of construction higher.

3.1.3.1 Estimated cost per foot for high-cost estimate: New provider builds new underground fiber-to-the-premises system

The high-cost estimate assumes that a new provider will come into an area and serve homes and businesses with a new FTTP network that will be constructed entirely underground. Underground conditions for constructing fiber in the unserved portions of the State are better than in built-up downtown areas where surface restoration costs are high, and the right-of-way is congested. We used a blended cost estimate of $7.05 per foot based on the table and costs below.

Table 10: Underground Construction Blended Average Cost

Type of Construction	Cost per Foot	% of Construction	Subtotal
Boring	$12.00	15%	$1.80
Street Cut	$25.00	5%	$1.25
Plow	$5.00	80%	$4.00
		Total	**$7.05**

The cost estimate assumes a 60 percent take-rate of homes and businesses purchasing services. When someone subscribes, the cost estimate assumes that a new fiber drop is installed within a new conduit.

3.1.3.2 Estimated cost per foot for low-cost estimate: Incumbent provider extends fiber to the unserved areas

The low-end estimate assumes that an incumbent provider, such as the local telephone company, upgrades its network with fiber to support unserved homes and businesses. We assumed that the incumbent provider will use their existing conduit and aerial pole attachments to pull fiber through conduit and to overlash fiber to the poles. For the low end we assumed that the incumbent will have no make ready to overlash to the existing aerial attachments. We assumed a cost of $2 per foot to either pull fiber through conduit or overlash to the existing aerial plant. New fiber drops to each subscriber will be from the existing pole outside the premises or using existing underground conduit.

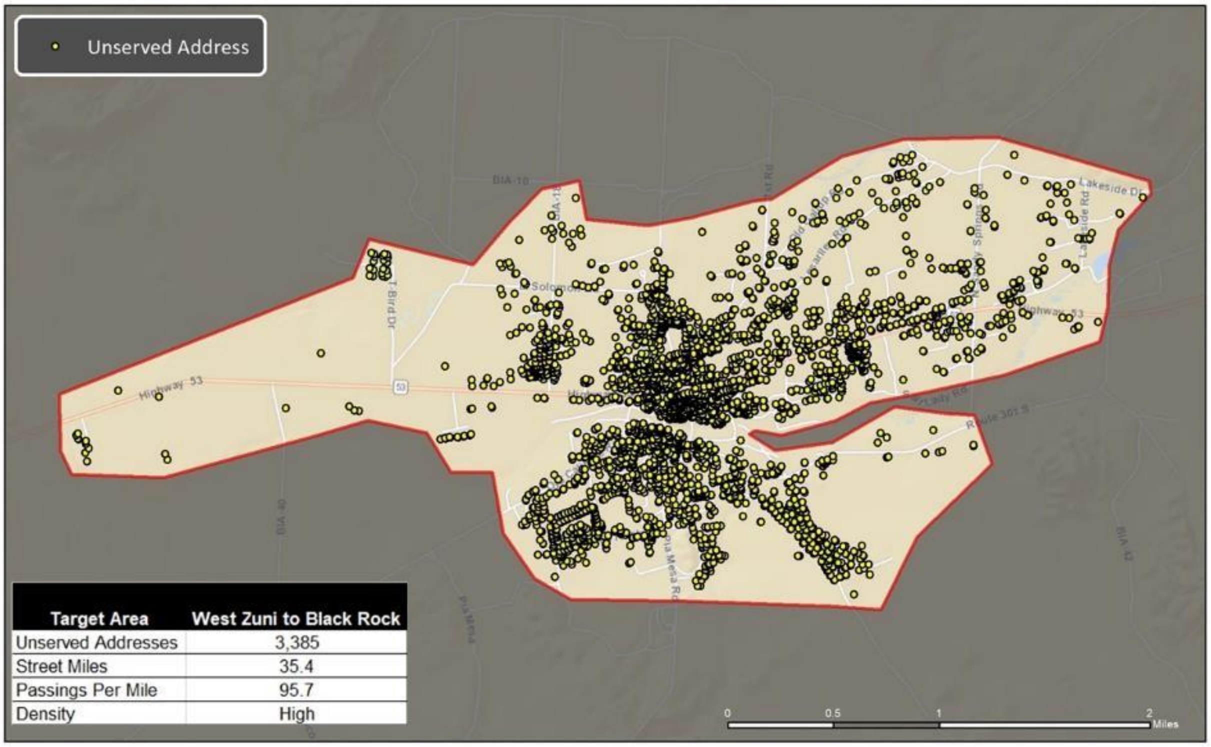
The cost estimate assumes a 60 percent take-rate of homes and businesses purchasing services, which we believe is typical of an environment where a fiber provider activates service in a previously unserved area. When someone subscribes, the cost estimate assumes that a new fiber drop is installed within a new conduit.

3.1.4 Estimating density of premises in clustered areas

To determine the cost for constructing each clustered area we calculated the number of homes and businesses per mile, or passings per mile (PPM), to determine density. The clustered areas were then organized into groups of high, medium, and low density. We then took the weighted average of the PPMs for each category weighted against the total number of home and business per area. In the high-density areas, the weighted average was 39 and the medium density areas were 13. The low density was 6.

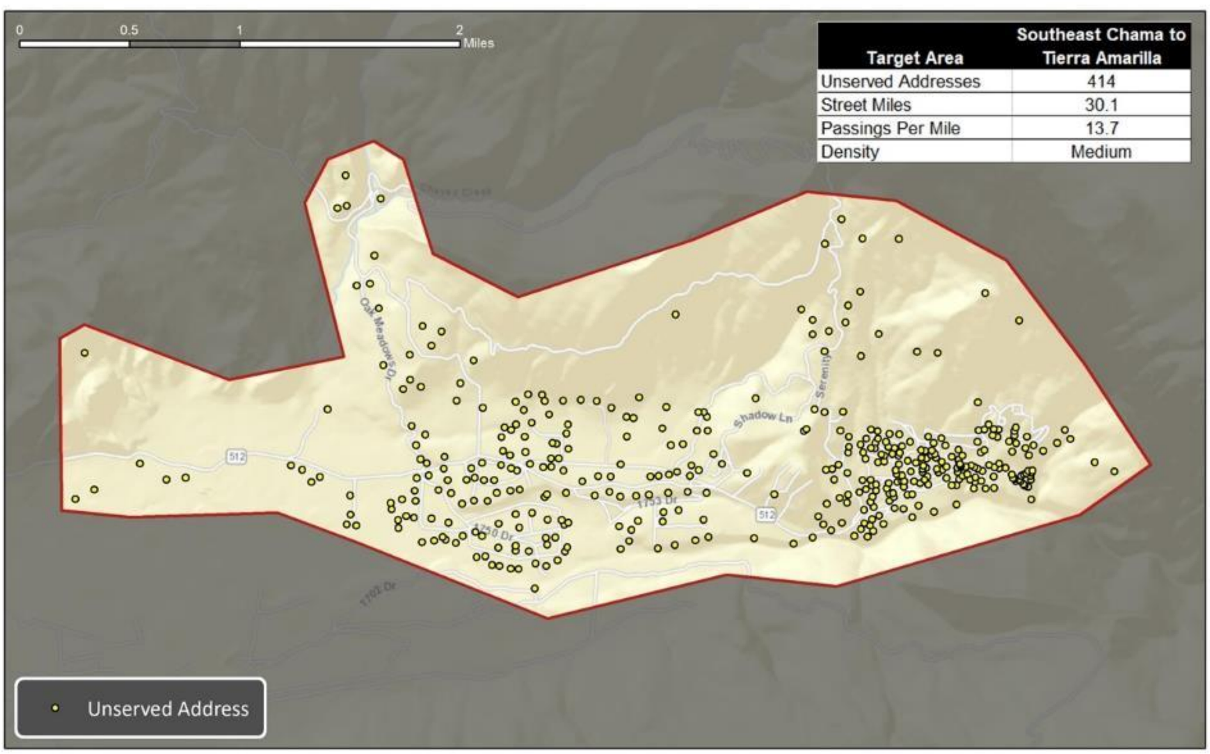
To develop the cost model, for the highest-density areas we used models from our industry experience to estimate construction costs based on the average density of the given area. We then modified these models using the cost assumptions outlined in this section. We used the average costs generated from these FTTP cost models to develop costs for the areas. We used the same FTTP cost models for the high-end cost estimate and the low-end cost estimate by modifying the construction cost assumptions. For example, in West Central Greater Silver City, there is an average density of 14 homes per mile. Based on our models, we derive an average cost of $2,800 to $7,000 per passing.

Figure 22: Example of a High-Density Unserved Model 1 Area—West Zuni to Black Rock



Target Area	West Zuni to Black Rock
Unserved Addresses	3,385
Street Miles	35.4
Passings Per Mile	95.7
Density	High

Figure 23: Example of a Medium-Density Unserved Model 1 Area—Southeast Chama to Tierra Amarilla

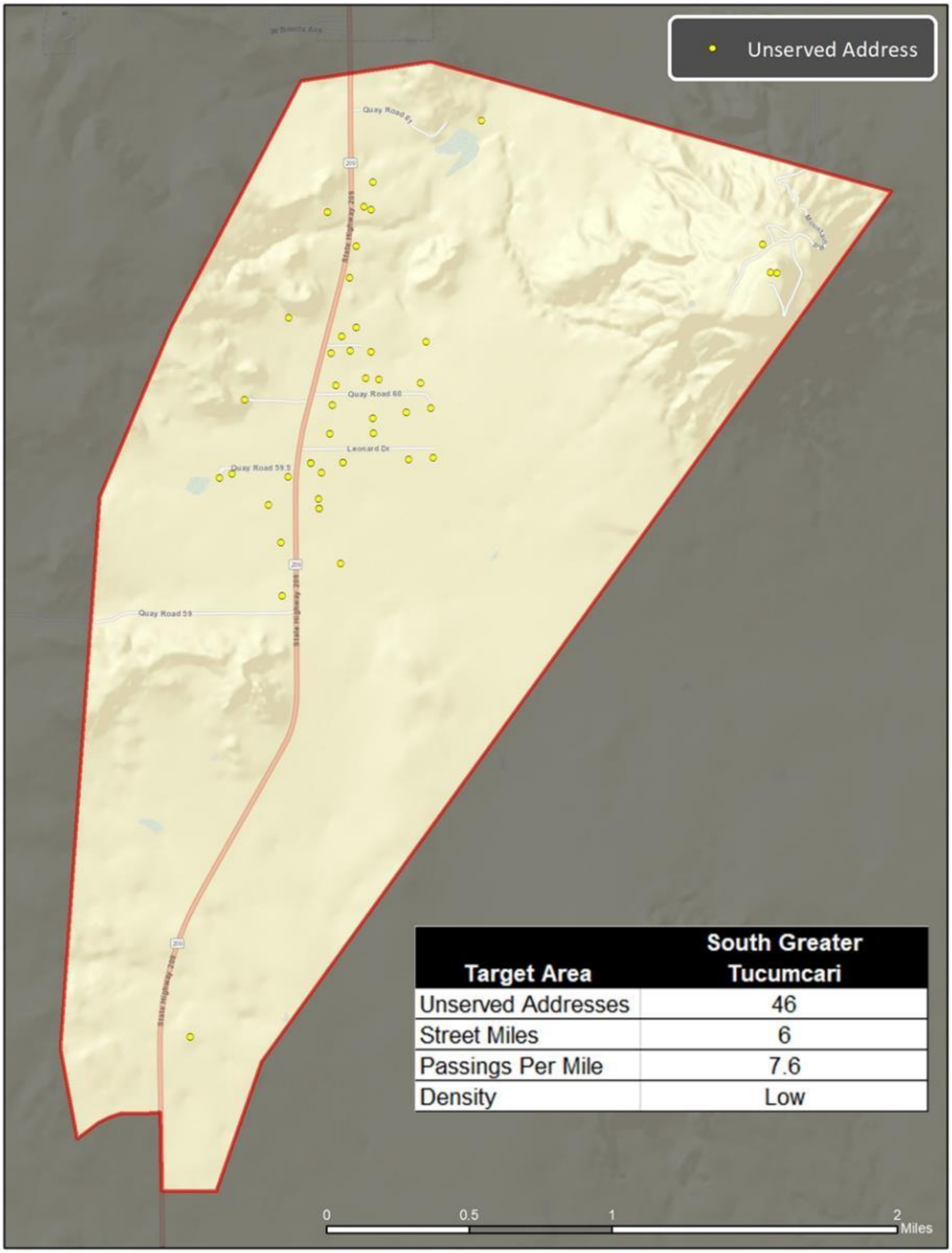


Target Area	Southeast Chama to Tierra Amarilla
Unserved Addresses	414
Street Miles	30.1
Passings Per Mile	13.7
Density	Medium

For the low-density areas, we determined that the cost to construct to every home is the equivalent of constructing fiber down every street in an area and adding a connection as homes and businesses are passed—all using the average construction costs per mile developed in the high and medium FTTP costs models.

This methodology is also the same used for the other rural areas of the State with extremely low density, and therefore not incorporated in a target area (Section 3.1.6).

Figure 24: Example of a Low-Density Unserved Model 1 Area—South Greater Tucumcari



The following table summarizes our cost estimate assumptions for the high and low cost estimates.

Table 11: Fiber Cost Estimate Assumptions

Description	High Estimate	Low Estimate
Fiber Construction Cost Per Mile	$100,000	$40,000
Core Network Electronics Per Passing	$300	$300
Customer Premise Device and Installation	$500	$500
Fiber Drop Installation	$2,400	$500

The fiber construction cost assumes a turnkey fiber construction by a third-party vendors. ISPs may be able to reduce costs if they have the capacity to do some of the work internally. The cost components for outside plant construction include the following tasks:

- ***Engineering*** – includes system level architecture planning, preliminary designs and field walk-outs to determine candidate fiber routing; development of detailed engineering prints and preparation of permit applications; and post-construction "as-built" revisions to engineering design materials.
- ***Quality Control / Quality Assurance*** – includes expert quality assurance field review of final construction for acceptance.
- ***General Outside Plant Construction*** – consists of all labor and materials related to "typical" underground or aerial outside plant construction, including conduit placement, utility pole make-ready construction, aerial strand installation, fiber installation, and surface restoration; includes all work area protection and traffic control measures inherent to all roadway construction activities.
- ***Special Crossings*** – consists of specialized engineering, permitting, and incremental construction (material and labor) costs associated with crossings of railroads, bridges, and interstate / controlled access highways.
- ***Backbone and Distribution Plant Splicing*** – includes all labor related to fiber splicing of outdoor fiber optic cables.
- ***Backbone Hub, Termination, and Testing*** – consists of the material and labor costs of placing hub shelters and enclosures, terminating backbone fiber cables within the hubs, and testing backbone cables.
- ***Fiber-to-the-Premises Service Drop and Lateral Installations*** – consists of all costs related to fiber service drop installation, including outside plant construction on private property,

building penetration, and inside plant construction to a typical backbone network service “demarcation” point; also includes all materials and labor related to the termination of fiber cables at the demarcation point. The model only includes drop costs for the estimated 60 percent of customers taking the service.

Using the GIS information for each area and the cost estimates we developed a cost per passing for each area. Costs for core network electronics, customer premises equipment, and drop installation were added to the OSP costs based on the 60 percent take-rate for each model.

3.1.5 Cost estimate for clustered areas

We created two cost models. The high-cost estimate assumes a new provider enters the market and constructs FTTP entirely underground. The low-cost estimate assumes an incumbent provider constructs FTTP by leveraging their existing assets such a fiber, conduit, and aerial pole attachments.

For Unserved Model 1, which has 87,000 clustered unserved homes and businesses out of the State’s 196,000 unserved premises, the cost range is $332 million to $806 million, which is $3,820 to $9,270 per home or business. In Unserved Model 2, with 50,000 unserved out of the total 126,000 unserved premises in that model, the cost range is $236 million to $576 million, which is $4,750 to $11,600. The following tables itemize the cost for each model by component.

Table 12: Unserved Model 1 Cost Estimate for Clustered Premises by Component

	Low Estimate	High Estimate
Outside Plant Construction	$252,000,000	$629,000,000
Core Electronics	$26,000,000	$26,000,000
Subscriber Costs (CPE and Drop)	$55,000,000	$151,000,000
Total	**$332,000,000**	**$806,000,000**
Homes and Businesses	87,000	87,000
Cost Per Home and Business	$3,820	$9,270

Table 13: Unserved Model 2 Cost Estimate for Clustered Premises by Component

	Low Estimate	High Estimate
Outside Plant Construction	$190,000,000	$475,000,000
Core Electronics	$15,000,000	$15,000,000
Subscriber Costs (CPE and Drop)	$31,000,000	$86,000,000
Total	**$236,000,000**	**$576,000,000**
Homes and Businesses	50,000	50,000
Cost Per Home and Business	$4,750	$11,600

The tables below itemize the costs for individual fiber segments; shaded rows indicate areas that include Navajo Nation, Pueblos, or Tribal lands; more details on the costs to serve those areas are in Section 3.1.7.

Table 14: Unserved Model 1 Costs for Clustered Premises

Target Area	Passings	Street Miles	Passings Per Mile	Low-Cost Estimate	High-Cost Estimate
West Zuni to Black Rock	3,385	35.4	96	$4,562,000	$10,441,000
East Zuni to Black Rock	783	11.4	69	$1,185,000	$2,739,000
Central East Espanola	4,065	65.3	62	$6,391,000	$14,819,000
South Central Espanola to Medanales	1,926	37.6	51	$3,296,000	$7,692,000
East Espanola	2,940	69.6	42	$5,518,000	$12,956,000
Cordova	209	5.3	39	$407,000	$957,000
South Socorro to Escondida	4,016	103.1	39	$7,859,000	$18,503,000
South Espanola to Medanales	792	20.6	39	$1,559,000	$3,672,000
South East Espanola	2,756	73.7	37	$5,510,000	$12,990,000
East Pecos	1,561	42.7	37	$3,158,000	$7,451,000
Central Dulce	765	21.7	35	$1,580,000	$3,733,000
North East Espanola	2,769	78.9	35	$5,732,000	$13,540,000
Central Espanola to Medanales	1,901	55.1	35	$3,971,000	$9,386,000
South Pojoaque, Nambe, El Rancho	714	23.2	31	$1,590,000	$3,772,000
West Sedillo	757	25.7	29	$1,731,000	$4,112,000
East Pojoaque, Nambe, El Rancho	1,593	54.4	29	$3,659,000	$8,694,000
Truchas	414	14.7	28	$973,000	$2,315,000
Chupadero, Rio En Medio	412	14.8	28	$974,000	$2,318,000
South Sedillo	709	26.1	27	$1,702,000	$4,054,000
Lordsburg	1,733	65.4	27	$4,227,000	$10,073,000
Cedar Hill North	195	7.6	26	$486,000	$1,159,000
West Southwest of ABQ	1,911	77.3	25	$4,868,000	$11,624,000
East Southwest of ABQ	1,033	42.6	24	$2,665,000	$6,368,000
West Pecos	811	34.6	23	$2,139,000	$5,116,000
West Pojoaque, Nambe, El Rancho	954	41.3	23	$2,541,000	$6,080,000
North Southwest of ABQ	1,003	44.1	23	$2,696,000	$6,455,000
North Chama to Tierra Amarilla	1,084	49.2	22	$2,975,000	$7,128,000
North South of Las Cruces	4,826	219.0	22	$13,249,000	$31,746,000
South of Las Cruces	1,572	72.6	22	$4,367,000	$10,470,000
Gallina	257	12.4	21	$734,000	$1,761,000
Cedar Hill South	561	28.5	20	$1,663,000	$3,996,000
Southeast Dulce	369	20.1	18	$1,149,000	$2,768,000
South Oasis to Hatch	1,889	105.1	18	$5,962,000	$14,367,000

Target Area	Passings	Street Miles	Passings Per Mile	Low-Cost Estimate	High-Cost Estimate
East Greater Silver City	268	15.4	17	$867,000	$2,090,000
East Central Greater Silver City	80	4.9	16	$271,000	$655,000
North McCartys to New Laguna	1,312	80.7	16	$4,446,000	$10,742,000
Cedar Grove	951	61.4	15	$3,340,000	$8,079,000
Abeytas	1,840	123.4	15	$6,647,000	$16,092,000
West Central Greater Silver City	142	9.9	14	$529,000	$1,282,000
South Cannon AFB	283	19.9	14	$1,061,000	$2,571,000
South Buckhorn to Gila	376	26.9	14	$1,424,000	$3,453,000
South McCartys to New Laguna	1,089	78.4	14	$4,150,000	$10,064,000
Southeast Chama to Tierra Amarilla	414	30.1	14	$1,591,000	$3,859,000
North Espanola to Medanales	1,646	120.4	14	$6,346,000	$15,395,000
East Dulce	118	8.9	13	$464,000	$1,127,000
South Cuba to Regina	689	52.4	13	$2,736,000	$6,642,000
North Hanover Faywood Mimbres	963	74.6	13	$3,879,000	$9,423,000
South Central Chama to Tierra Amarilla	742	58.9	13	$3,045,000	$7,402,000
North Greater Deming	951	79.2	12	$4,053,000	$9,862,000
San Antonio	599	50.9	12	$2,594,000	$6,313,000
Southwest Chama to Tierra Amarilla	227	19.8	11	$1,003,000	$2,443,000
North Oasis to Hatch	1,005	94.5	11	$4,713,000	$11,495,000
North Greater Gallup	2,989	285.0	10	$14,179,000	$34,596,000
South Greater Gallup	2,683	256.8	10	$12,766,000	$31,150,000
North Greater Silver City	558	54.6	10	$2,704,000	$6,602,000
North Socorro to Escondida	854	84.9	10	$4,192,000	$10,236,000
North Buckhorn to Gila	357	36.4	10	$1,790,000	$4,373,000
South North of Ruidoso	807	85.3	9	$4,162,000	$10,175,000
West Greater Tucumcari	357	40.1	9	$1,935,000	$4,735,000
Southwest Cannon AFB	545	61.9	9	$2,983,000	$7,303,000
North McIntosh Estancia Torreon	1,414	164.4	9	$7,892,000	$19,326,000
Southwest Greater Silver City	344	43.6	8	$2,065,000	$5,064,000
South Hanover Faywood Mimbres	180	23.5	8	$1,108,000	$2,719,000
South Greater Tucumcari	46	6.0	8	$284,000	$696,000
Central McIntosh Estancia Torreon	1,055	138.5	8	$6,520,000	$15,999,000
Northwest Roswell to Artesia	288	40.0	7	$1,867,000	$4,586,000
Timberon	764	119.3	6	$5,482,000	$13,486,000
South Roswell to Artesia	324	50.8	6	$2,331,000	$5,736,000
North Cuba to Regina	354	58.0	6	$2,648,000	$6,520,000
Central Cannon AFB	285	48.2	6	$2,192,000	$5,399,000
North of Ruidoso	270	46.7	6	$2,117,000	$5,216,000
Southeast Carlsbad	604	110.4	5	$4,978,000	$12,274,000

Target Area	Passings	Street Miles	Passings Per Mile	Low-Cost Estimate	High-Cost Estimate
East Greater Tucumcari	257	47.1	5	$2,124,000	$5,236,000
Central Chama to Tierra Amarilla	196	37.5	5	$1,684,000	$4,153,000
South Greater Deming	2,042	392.7	5	$17,606,000	$43,433,000
West McIntosh Estancia Torreon	740	154.4	5	$6,862,000	$16,945,000
South McIntosh Estancia Torreon	895	190.2	5	$8,441,000	$20,848,000
North Roswell to Artesia	410	99.1	4	$4,347,000	$10,750,000
Northwest Chama to Tierra Amarilla	83	20.1	4	$880,000	$2,177,000
Northeast Roswell to Artesia	179	43.4	4	$1,901,000	$4,701,000
East Greater Deming	1,095	284.1	4	$12,381,000	$30,640,000
Central Roswell to Artesia	383	106.0	4	$4,597,000	$11,382,000
Southwest Carlsbad	45	16.8	3	$715,000	$1,776,000
East Central Roswell to Artesia	330	123.5	3	$5,246,000	$13,022,000
Navajo Nation Sanostee	797	388	2	$16,265,00	$40,434,000
West Central Roswell to Artesia	34	23.0	1.5	$952,000	$2,371,000

Table 15: Unserved Model 2 Costs for Clustered Premises

Target Area	Passings	Street Miles	Passings Per Mile	Low-Cost Estimate	High-Cost Estimate
West Zuni to Black Rock	3,150	33.3	95	$4,261,000	$9,754,000
East Zuni to Black Rock	783	11.4	69	$1,185,000	$2,739,000
West Southwest of ABQ	122	3.0	41	$233,000	$547,000
South Socorro to Escondida	4,007	102.9	39	$7,843,000	$18,465,000
North Chama to Tierra Amarilla	608	16.7	36	$1,232,000	$2,906,000
East Pecos	1,455	41.0	36	$2,992,000	$7,064,000
Gallina	42	1.3	33	$90,000	$213,000
Cedar Hill North	172	5.5	31	$380,000	$901,000
Lordsburg	1,733	65.4	27	$4,227,000	$10,073,000
West Pecos	803	34.3	23	$2,120,000	$5,071,000
South of Las Cruces	1,469	68.6	21	$4,108,000	$9,852,000
North South of Las Cruces	4,448	210.9	21	$12,571,000	$30,160,000
East Southwest of ABQ	452	22.6	20	$1,326,000	$3,187,000
Cedar Hill South	523	27.6	19	$1,589,000	$3,823,000
East Greater Silver City	268	15.4	17	$867,000	$2,090,000
South Oasis to Hatch	1,770	103.2	17	$5,775,000	$13,934,000
East Central Greater Silver City	80	4.9	16	$269,000	$651,000
North McCartys to New Laguna	1,254	79.8	16	$4,359,000	$10,541,000

Target Area	Passings	Street Miles	Passings Per Mile	Low-Cost Estimate	High-Cost Estimate
South Central Chama to Tierra Amarilla	159	10.4	15	$563,000	$1,363,000
Abeytas	1,794	121.2	15	$6,518,000	$15,784,000
West Central Greater Silver City	139	9.7	14	$515,000	$1,249,000
South Cannon AFB	283	19.9	14	$1,061,000	$2,571,000
South McCartys to New Laguna	1,088	78.4	14	$4,147,000	$10,057,000
North Espanola to Medanales	264	19.2	14	$1,013,000	$2,458,000
North Hanover Faywood Mimbres	923	72.7	13	$3,767,000	$9,154,000
North Greater Deming	917	77.4	12	$3,951,000	$9,615,000
Southeast Dulce	31	2.6	12	$134,000	$327,000
San Antonio	583	50.4	12	$2,557,000	$6,226,000
South Cuba to Regina	163	14.9	11	$746,000	$1,818,000
North Greater Gallup	2,988	284.9	10	$14,174,000	$34,584,000
South Greater Gallup	2,676	256.7	10	$12,755,000	$31,125,000
North Socorro to Escondida	854	84.9	10	$4,192,000	$10,236,000
West Greater Tucumcari	357	40.1	9	$1,935,000	$4,735,000
Southwest Cannon AFB	545	61.9	9	$2,983,000	$7,303,000
North Oasis to Hatch	745	85.2	9	$4,102,000	$10,043,000
North McIntosh Estancia Torreon	1,289	160.9	8	$7,637,000	$18,724,000
South Hanover Faywood Mimbres	180	23.5	8	$1,108,000	$2,719,000
South Greater Tucumcari	46	6.0	8	$284,000	$696,000
Central McIntosh Estancia Torreon	1,047	138.2	8	$6,502,000	$15,956,000
North Cuba to Regina	39	5.2	8	$242,000	$595,000
North of Ruidoso	28	3.7	8	$174,000	$428,000
Southwest Greater Silver City	309	41.6	7	$1,950,000	$4,788,000
Northwest Roswell to Artesia	288	40.0	7	$1,867,000	$4,586,000
Southeast Chama to Tierra Amarilla	79	11.5	7	$533,000	$1,310,000
Timberon	764	119.3	6	$5,482,000	$13,486,000
South Roswell to Artesia	321	50.6	6	$2,322,000	$5,714,000
Central Cannon AFB	283	48.0	6	$2,182,000	$5,374,000
East Greater Tucumcari	257	47.1	5	$2,124,000	$5,236,000
South Greater Deming	1,918	386.6	5	$17,248,000	$42,573,000
Southeast Carlsbad	507	104.1	5	$4,636,000	$11,446,000
South McIntosh Estancia Torreon	895	190.2	5	$8,441,000	$20,848,000
West McIntosh Estancia Torreon	646	151.8	4	$6,672,000	$16,495,000
Northeast Roswell to Artesia	179	43.3	4	$1,899,000	$4,695,000
East Greater Deming	1,077	282.9	4	$12,317,000	$30,484,000
North Roswell to Artesia	363	98.2	4	$4,266,000	$10,561,000
Central Roswell to Artesia	383	106.0	4	$4,597,000	$11,382,000
Southwest Carlsbad	45	16.8	3	$715,000	$1,776,000

Target Area	Passings	Street Miles	Passings Per Mile	Low-Cost Estimate	High-Cost Estimate
East Central Roswell to Artesia	330	123.5	3	$5,246,000	$13,022,000
Navajo Nation Sanostee	715	388	2	$16,188,000	$40,267,000
West Central Roswell to Artesia	34	23.0	1	$952,000	$2,371,000

3.1.6 Cost estimate for low-density unserved areas

For the remaining homes and businesses in the State that are not in clusters, density creates a challenge from a cost perspective to construct FTTP to every home. We created a high-level cost estimate to construct to these homes and businesses. We determined that the cost to construct to every home is the equivalent of constructing fiber down every street in the areas and adding a connection as homes and businesses are passed; we applied the average construction costs per mile developed earlier, which were $100,000 per mile for the high-cost estimate and $40,000 per mile for the low-cost estimate.

In Unserved Model 1, there are 107,000 unserved homes and businesses outside the clusters. The cost range to construct FTTP to these low-density areas is $1.7 billion to $4.3 billion, or $15,500 to $39,300 per passing. The Unserved Model 2 cost range with 74,000 unserved homes and businesses outside the clusters is $1.5 billion to $3.7 billion, or $19,800 to $48,800 per passing.

Table 16: Costs for Unserved Passings in Low-Density Areas (Unserved Model 1 and Unserved Model 2)

County	Unserved Passings Outside Target Areas	Street Miles	Passings Per Mile	High Estimate	Low Estimate
Bernalillo	4,491	931.5	4.8	$102,316,467	$41,438,561
Catron	5,298	2,760.2	1.9	$286,827,000	$115,335,000
Chaves	577	1,485.1	0.4	$149,683,000	$59,939,000
Cibola	5,135	2,540.1	2.0	$264,489,000	$106,381,000
Colfax	6,045	931.5	4.8	$132,375,000	$53,639,000
Curry	375	2760.2	1.9	$19,569,000	$7,870,000
De Baca	393	1485.1	0.4	$88,779,000	$35,557,000
Doña Ana	8,031	2540.1	2.0	$140,485,000	$57,110,000
Eddy	1,555	1200.4	5.0	$117,278,000	$47,089,000
Grant	1,762	188.0	2.0	$96,984,000	$38,994,000
Guadalupe	658	879.8	0.4	$95,136,000	$38,129,000
Harding	190	1241.0	6.5	$46,272,000	$18,530,000

County	Unserved Passings Outside Target Areas	Street Miles	Passings Per Mile	High Estimate	Low Estimate
Hidalgo	1,185	1141.1	1.4	$102,975,000	$41,325,000
Lea	2,061	933.9	1.9	$153,712,000	$61,720,000
Lincoln	1,789	937.9	0.7	$105,641,000	$42,460,000
Los Alamos	388	458.8	0.4	$9,354,000	$3,786,000
Luna	1,895	1005.6	1.2	$181,240,000	$72,712,000
McKinley	4,458	1495.1	1.4	$150,241,000	$60,605,000
Mora	741	1019.9	1.8	$38,551,000	$15,505,000
Otero	3,075	85.6	4.5	$225,883,000	$90,704,000
Quay	555	1773.7	1.1	$51,274,000	$20,573,000
Rio Arriba	2,795	1411.5	3.2	$161,174,000	$64,788,000
Roosevelt	763	370.4	2.0	$104,704,000	$41,969,000
San Juan	9,009	2196.1	1.4	$156,867,000	$63,774,000
San Miguel	9,945	501.4	1.1	$152,265,000	$62,040,000
Sandoval	11,440	1554.7	1.8	$311,600,000	$125,944,000
Santa Fe	11,490	1031.5	0.7	$161,240,000	$65,806,000
Sierra	2,990	1384.9	6.5	$119,695,000	$48,219,000
Socorro	2,861	1319.8	7.5	$224,828,000	$90,258,000
Taos	514	2882.6	4.0	$41,018,000	$16,466,000
Torrance	1,833	1378.0	8.3	$103,326,000	$41,540,000
Union	961	1136.0	2.6	$112,475,000	$45,100,000
Valencia	4,269	2189.9	1.3	$99,678,000	$40,358,000

3.1.7 Unserved areas within Navajo Nation, Pueblos, and Tribal lands

People living on Navajo Nation, Pueblos, and Tribal lands represent a significant portion of the State's unserved population. In Unserved Model 1, of the 196,000 unserved addresses, 37,000 or 18 percent of the unserved homes and businesses are on Navajo Nation, Pueblos, and Tribal lands (Figure 25). Of the 86 clusters in Unserved Model 1 where we create fiber optic network models, 26 contain unserved homes on Navajo Nation, Pueblos, and Tribal lands. These clusters are shaded in Table 14 (see Section 3.1.5).

In Unserved Model 2, of the 126,000 unserved addresses, 21,000 or 16 percent are on Navajo Nation, Pueblos, and Tribal lands (Figure 26). Of the 60 clusters in Unserved Model 2 where we create fiber optic network models, 10 contain homes and businesses on Navajo Nation, Pueblos, and Tribal lands. These clusters are shaded in Table 15 (see Section 3.1.5).

Figure 25: Unserved Premises on Navajo Nation, Pueblos, and Tribal Lands (Unserved Model 1)

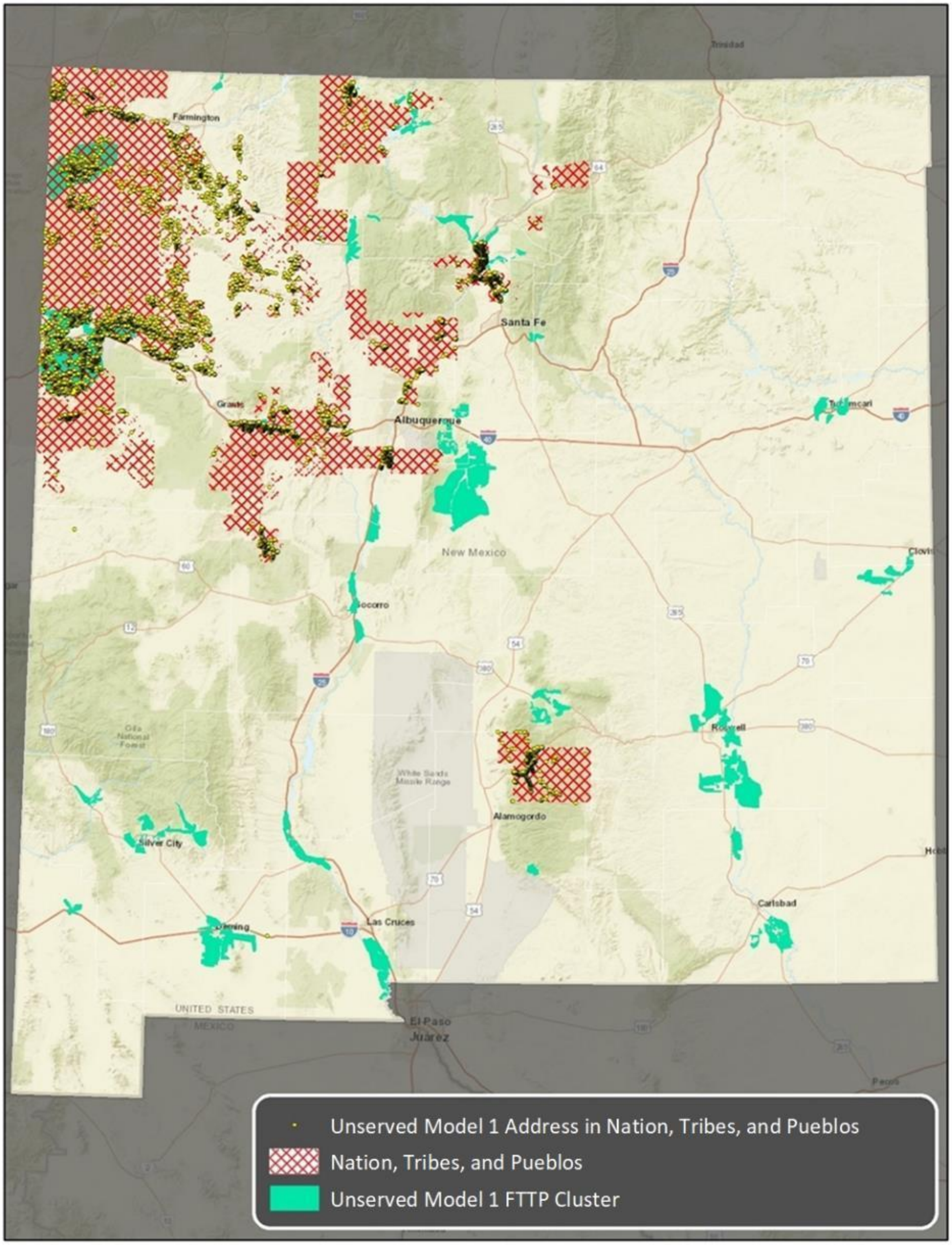
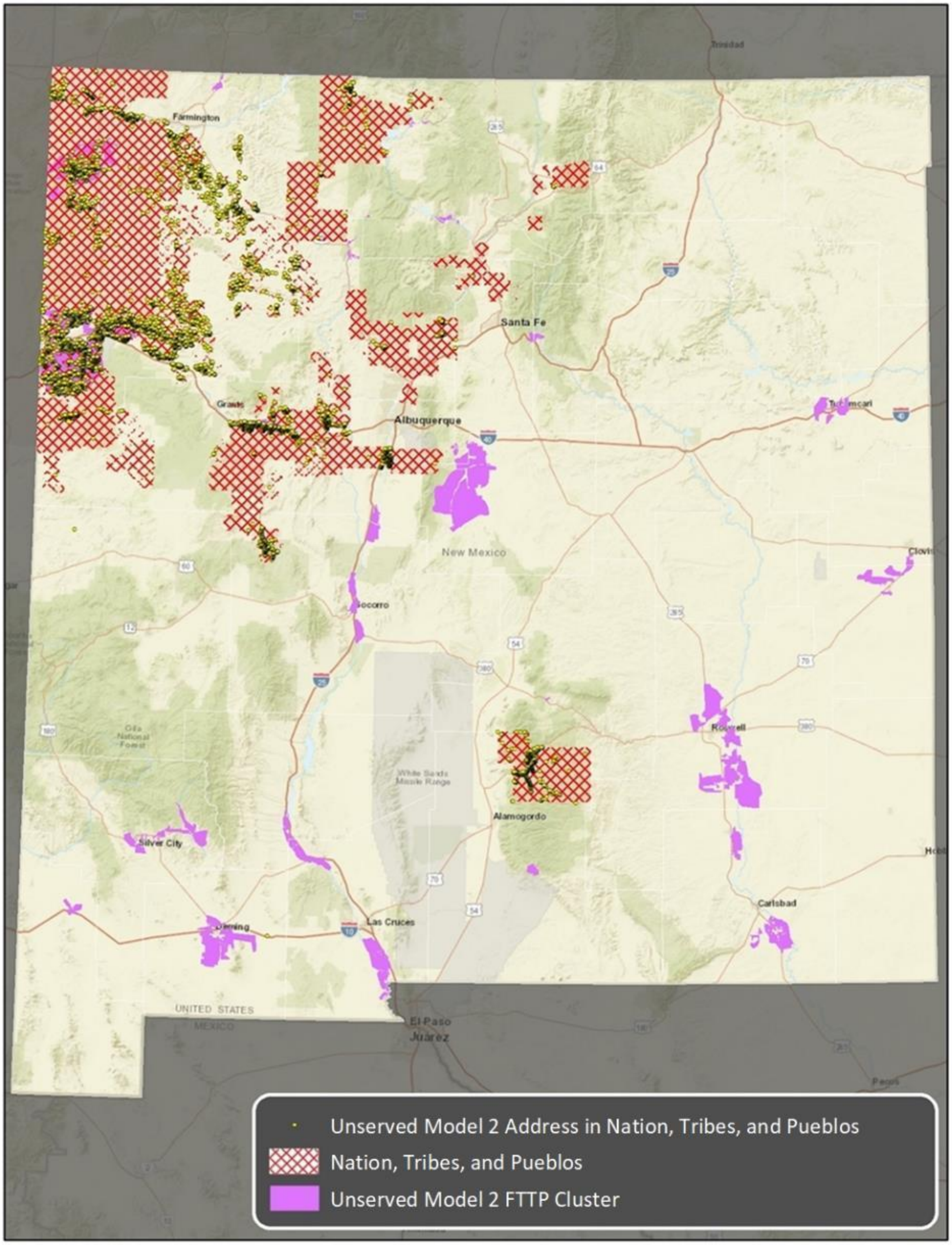


Figure 26: Unserved Premises on Navajo Nation, Pueblos, and Tribal Lands (Unserved Model 2)



A more detailed engineering analysis would be needed to generate costs for individual Navajo Nation, Pueblos, and Tribal lands, but individual cluster costs can be seen in Table 14 and Table 15.

We estimated the cost to serve unserved homes and businesses on Navajo Nation, Pueblos, and Tribal lands by multiplying the total costs for constructing FTTP in Unserved Model 1 and Unserved Model 2 by the percentages above (Table 17). On average, these costs are higher than the construction in the clustered areas (Table 12 and Table 13), because many of the unserved locations on Navajo Nation, Pueblos, and Tribal lands are outside the clusters and spread out.

As with the unserved addresses statewide, serving Navajo Nation, Pueblos, and Tribal lands can be done with different approaches depending on the specific situation, with a focus on fiber in denser areas and wireless in less dense areas.

Table 17: Cost Estimate for Unserved Navajo Nation, Pueblos, and Tribal Lands

	Unserved Addresses on Navajo Nation, Pueblos, and Tribal Lands	Total Cost to Construct FTTP	Cost per Passing
Unserved Model 1	37,000	$342 million – $918 million	$9250 – 24,800
Unserved Model 2	21,000	$272 million – $688 million	$12,950 – $32,750

3.2 Estimated costs for constructing fixed wireless infrastructure to serve homes and businesses

This section describes CTC's analysis of the use of State-owned and commercial towers and other suitable structures to provide fixed wireless broadband access to unserved homes and businesses in New Mexico. We found that a fixed wireless network alone could serve up to about 68 percent of the State's unserved premises—compared to 100 percent using fiber in the cluster areas—although, as discussed in Section 3.3, it would have clear technical limitations relative to a fiber optic network.

This analysis demonstrates that fixed wireless technology can be a technically feasible approach to providing broadband to unserved addresses. Although there are technological limitations relative to a fiber optic service (as well as higher operational costs and a shorter technology lifetime), wireless technology has benefits in terms of lower capital costs and reduced time to deploy. Furthermore, as discussed below, new developments in wireless technology are improving the reliability and speed of wireless broadband, and therefore these technologies are a better option now than they were in the recent past.

3.2.1 Overview of analysis

Considering the location of unserved premises identified in Unserved Model 1 and Unserved Model 2 above (see Section 2.2), we developed variations on fixed wireless network models that use antennas mounted on existing structures (which we refer to here, for convenience, under the catchall term "towers") to deliver service to New Mexico's unserved addresses:

1) Wireless Unserved Model 1: Serving all unserved addresses in Unserved Model 1
2) Wireless Unserved Model 1 (Hybrid): Serving unserved addresses in low-density areas of Unserved Model 1 (as an addition to constructing FTTP to clusters of premises)
3) Wireless Unserved Model 2: Serving all unserved addresses in Unserved Model 2
4) Wireless Unserved Model 2 (Hybrid): Serving unserved addresses in low-density areas of Unserved Model 2 (as an addition to constructing FTTP to clusters of premises)

As a starting point for our analysis, Figure 27 (below) shows the unserved addresses in New Mexico, based on the analysis described in Section 2.2.

In Wireless Unserved Model 1, equipment mounted on 966 existing towers could deliver service to an estimated 68 percent of the State's 197,000 unserved premises (see Figure 28, below). The yellow areas illustrate the higher-speed coverage with wireless technologies. The green shading indicates the remaining unserved areas.

Figure 27: Unserved Areas and Addresses in New Mexico

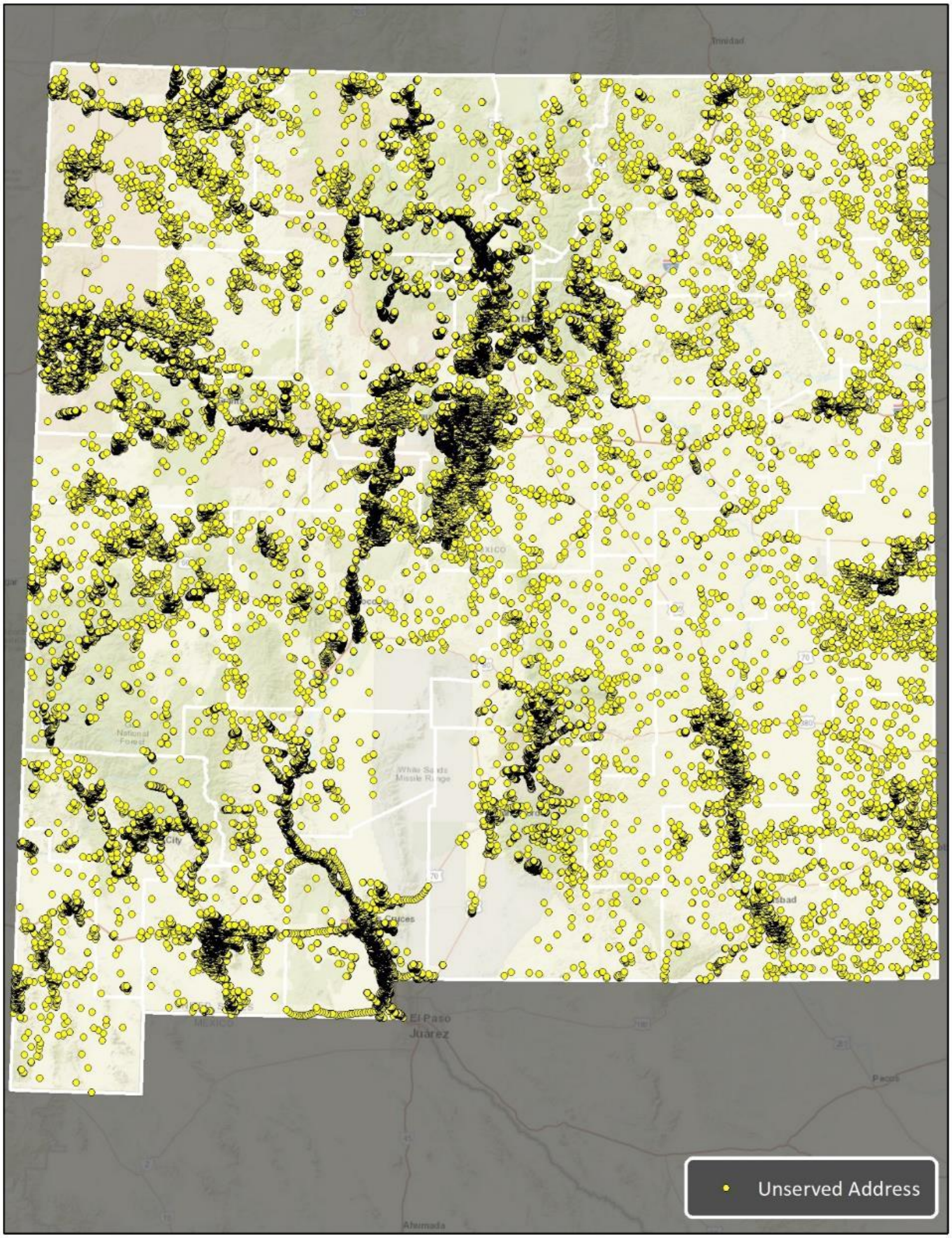
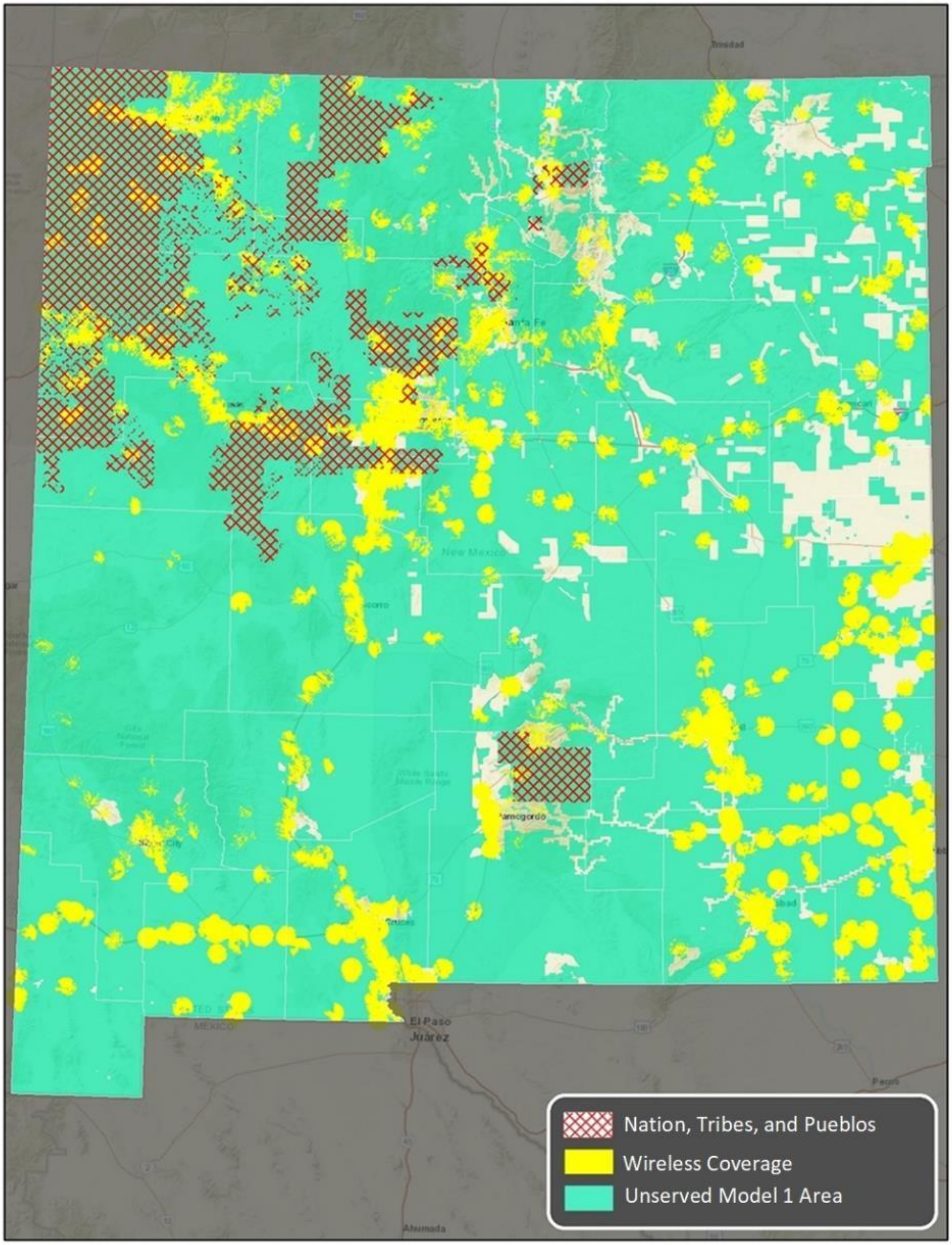


Figure 28: Coverage Enabled by Equipment on Existing Towers for Wireless Unserved Model 1



In Wireless Unserved Model 2, where we have a tighter definition of "unserved" and fewer premises fall into that category, equipment mounted on 780 existing towers could deliver service to an estimated 67 percent out of the total 126,000 unserved premises in that model.

Table 18 summarizes the cost and scope of the wireless unserved models.

Table 18: Fixed Wireless Coverage and Cost Estimates

Option	Number of Towers	Passings Served	Percent of Passings Served[28]	Capital Cost Assuming 60% Penetration	Average Distribution Network Cost Per Wireless Passing	Installation and Electronics Per Customer
Wireless Unserved Model 1	966	134,121	69	$282,100,000	$1,030	$1,800
Wireless Unserved Model 1 (Hybrid)	788	67,007	61	$184,400,000	$1,700	$1,800
Wireless Unserved Model 2	780	84,655	67	$202,300,000	$1,300	$1,800
Wireless Unserved Model 2 (Hybrid)	638	44,447	59	$139,000,000	$2,100	$1,800

In Wireless Unserved Model 1, we found that an average of more than 139 addresses were served by each of the existing 966 towers. In Wireless Unserved Model 1 (Hybrid), we found that an average of more than 85 addresses would be served wirelessly by each of the existing 788 towers. In Wireless Unserved Model 2, we found that an average of more than 109 addresses would be served by each of the existing 780 towers. In Wireless Unserved Model 2 (Hybrid), the average was more than 70 addresses served wirelessly by each of the existing 638 towers.

The following sections:

[28] For Wireless Unserved Model 1 and Wireless Unserved Model 2, this figure represents the percentage of total unserved premises. For the two hybrid models, this figure represents the percentage of unserved premises in low-density areas (i.e., outside of clusters).

- Provide a high-level introduction to fixed wireless connectivity (including technologies, basic architecture, spectrum, and elements of costs)
- Describe the use of the existing structures within the State in a fixed wireless solution for the unserved homes and businesses of New Mexico for Wireless Unserved Model 1, Wireless Unserved Model 1 (Hybrid), Wireless Unserved Model 2, and Wireless Unserved Model 2 (Hybrid).

3.2.2 Introduction to fixed wireless network connectivity

Broadband speeds in compliance with the FCC's definition (i.e., 25 Mbps download, 3 Mbps upload—which is also the definition of "served" approved by New Mexico for this project) are more readily available from fixed wireless networks than in the past, owing to the recent introduction of the Citizens Broadband Radio Service (CBRS) spectrum into the market and new wireless technologies. While wireless internet service providers (WISP) are typically not able to offer connection speeds on a market-wide basis comparable to cable or fiber networks built to each premises, a fixed wireless connection may be a desirable solution if cable or fiber is not cost-effective. This is especially true in low-density rural areas where there are few homes and businesses per mile, and therefore the cost of building wired networks is often high.

As opposed to an underground or aerial cable, wireless broadband is provided from access point antennas on towers or rooftops. The customer antenna may be on the home or business or on a mast on the customer premises (Figure 29).

Figure 29: Example Fixed Wireless Network with Access Point Antennas on a Monopole and Various Customer Antenna Configurations

3.2.2.1 Fixed Wireless Spectrum and Architecture

Fixed wireless networks typically use the following spectrum:

• TV White Space (TVWS)	500 MHz
• Unlicensed	900 MHz, 2.4 GHz, 5 GHz
• Citizens Broadband Radio Service (CBRS)	3.5 GHz

It is useful to determine which band may be most effective to use in different areas. Each band will need its own set of equipment; if one or more band can be eliminated from specific sites, then the overall cost of deployment and operations will be reduced.

Of these bands, only CBRS and 5 GHz technology have channel widths capable of delivering 25 Mbps down and 3 Mbps up—so those are the two primary bands we considered. The CBRS band is predicted to connect the most addresses. (In addition to the spectrum properties, the ability to connect is due to the antennas being allowed to be mounted higher than the TVWS antennas under the licensing rules of the FCC, and CBRS being allowed to have the greatest broadcast power of the three technologies.)

That said, we also considered TVWS—which delivers service over unused television frequencies (known as white space). TVWS bands have much better non-line-of-sight transmission qualities than the other bands; however, due to its narrower bandwidth, TVWS is not capable of delivering 25 Mbps down, and therefore should only be considered in cases where other connectivity is not available or feasible. Also, because white space technology is still in an early phase of development, compatible equipment is far more expensive than other off-the-shelf wireless equipment.

Most fixed wireless network solutions require the antenna at the subscriber location to be in or near the line of sight of the base station antenna. This can be especially challenging in mountainous regions. It is also a problem in areas with dense vegetation or multiple tall buildings. WISPs often need to lease space at or near the tops of radio towers; even then, some customers may be unreachable without the use of additional repeaters. And because the signal is being sent through the air, climate conditions like rain and fog can impact the quality of service. In our model, we assumed that the top of any existing tower is already utilized, and that any new equipment would be placed at 80 percent of the current tower height.

In addition, there is a tradeoff in these bands between capacity and the ability to penetrate obstructions such as foliage and terrain. The higher frequencies have wider channels and therefore the capability to provide the highest capacity. However, the highest frequencies are those most easily blocked by obstructions.

Wireless equipment vendors offer a variety of point-to-multipoint and point-to-point solutions.

The models in this document assume point-to-multipoint equipment, which is typical for a residential or small business connection. Point-to-point service would typically be chosen by a medium-sized business, because it would enable dedicated bandwidth (at a higher cost than a point-to-multipoint service); that said, point-to-point networks may have limited network capacity, particularly in the upstream, making the service inadequate for applications that require high-bandwidth connections.

3.2.2.2 Fixed Wireless Network Deployment Costs

The following factors will determine the costs associated with a fixed wireless network:

- **Wireless equipment used:** Different wireless equipment has different aggregate bandwidth capacity and use a range of different spectrum bands, each with its own unique transmission capabilities.

- **Backhaul connection**: Although the bottleneck tends to be in the last-mile connection, if a WISP cannot get an adequate connection back to the internet from its tower, equipment upgrades will not be able to increase available speeds beyond a certain point.

- **Future capacity and lifespan of investment:** Wireless equipment generally requires replacement every five to 10 years, both because exposure to the elements causes deterioration, and because the technology continues to advance at a rapid pace, making decade-old equipment mostly obsolete. The cost of deploying a wireless network is generally much lower than deploying a wireline network, but the wireless network will require more regular investment.

- **Availability of unobstructed line of sight:** Most wireless networking equipment requires a clear, or nearly clear, line of sight between antennas for optimum performance. WISPs often lease space near the tops of radio towers, to cover the maximum number of premises with each base station.

3.2.3 Analyzing radio frequency coverage in the State

We conducted a wireless analysis to determine how the State's unserved addresses could be served via fixed wireless. The high-level model is for planning purposes only. The RF coverage analysis was modeled using CloudRF, which is an online service available for modelling the Radio frequency propagations. The software was chosen because of its ability to output coverage maps in a GIS layer than can be overlaid on the unserved address points, and therefore identify which of the address would be covered by the wireless model.

There are various propagation models used for RF analysis. Widely used models are the line of sight (LOS) model, cost 231 model, Okumura Hata model, and Longley-Rice model (also called the Irregular Terrain Model, or ITM). For our analysis we used ITM, which is the most conservative and takes into consideration the atmospheric conditions, the ground elevation, the deployment environment, the obstacles between the base and mobile stations, and the ground clutter.

3.2.4 Tower selection methodology

To examine the potential of existing "towers" (which, for purposes of this analysis, included poles, buildings, and other tall mounting structures) to provide service to the State's unserved addresses, we analyzed multiple commercial and government databases (e.g., GeoTel) and identified approximately 9,213 total existing tower locations in New Mexico.

We narrowed down the list of tower sites that could potentially be used as part of a fixed wireless solution based on factors such as height and ownership. We filtered further to exclude such non-feasible "structures" as billboards and trees. Sites were then filtered by latitude/longitude in order to remove any duplicate sites.

Next, a 500-foot buffer was placed around all government-owned towers—and all non-government towers within that buffer area were removed. Finally, all towers within 500 feet of one another were clustered and all but the tallest tower were removed. This list was further reduced by eliminating all the towers which had no structure height and structure type listed.

After all filtering, we selected to 3,876 towers as potential siting options for fixed wireless equipment. We then conducted an RF analysis for each of the towers. Each tower's coverage footprint was analyzed to determine how many unserved addresses could be served with wireless equipment mounted on the site.

CTC assessed the coverage provided by each of the selected tower sites using the three fixed wireless frequency band options (CBRS, 5 GHz, and TVWS) to determine how many of the unserved address would be within each spectrum's predicted coverage area. We based our analysis on the following assumptions:

- Antenna heights on the towers are placed at 80 percent of the tower for all structures except buildings, hotels, gas stations and roof mounts in which antenna placement was not possible at lower heights
- For a tower with structure height as 0 feet in the list, the height was changed to 100 feet
- For a pole with structure height as 0 feet in the list, the height was changed to 30 feet
- For a building with structure height as 0 feet in the list, the height was changed to 100 feet
- All the structures with height greater than 450 feet were changed to 150 feet for conservative analysis

- Broadcast power is at the maximum FCC limit for CBRS band
- Channel bandwidth is 20 MHz for 5 GHz, 10 MHz for CBRS, and 6 MHz for TVWS
- Subscriber equipment antenna is 4.57 meters (15 feet) above the ground
- Ground elevation and clutter resolution is 30 meters

As a final step, we then applied an algorithm to the tower list to select the fewest towers that covered the most addresses in each model. As a baseline, we eliminated any tower that could cover fewer than five addresses.

In sum, we identified 966, 788, 780, and 638 towers for Wireless Unserved Model 1, Wireless Unserved Model 1 (Hybrid), Wireless Unserved Model 2, and Wireless Unserved Model 2 (Hybrid), respectively.

3.2.5 High-level coverage and cost estimate: Wireless Unserved Model 1

Of the 3,876 towers analyzed, we identified 966 that could serve more than five Unserved Model 1 unserved addresses. Figure 30 (below) shows the government sites in yellow and commercial towers in dark blue.

Equipment mounted on 966 existing towers could deliver service to an estimated 68 percent of the State's unserved premises (see Figure 31, below). The yellow areas illustrate coverage with wireless technologies. The green shading indicates the remaining unserved areas.

Figure 30: Existing Towers in New Mexico

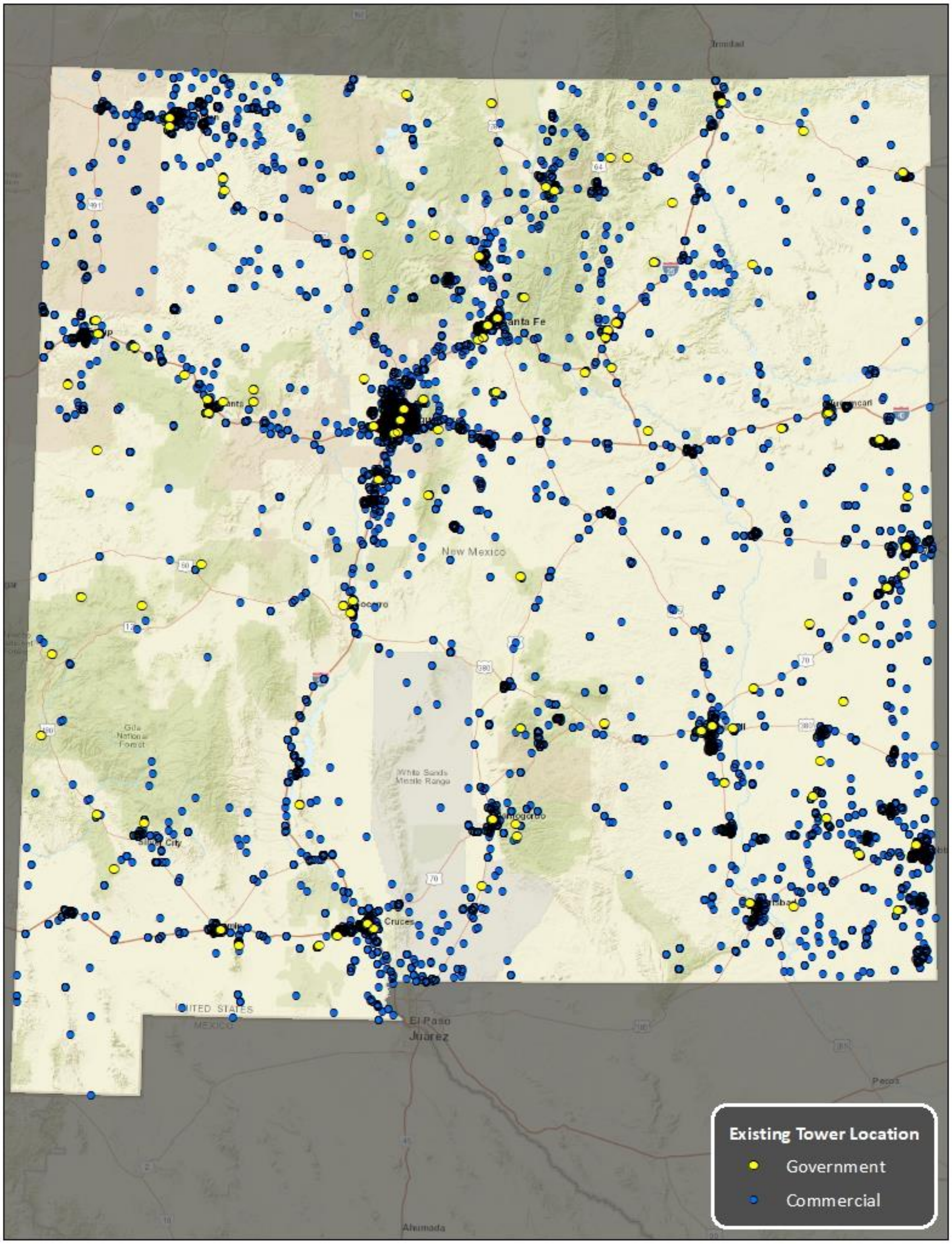
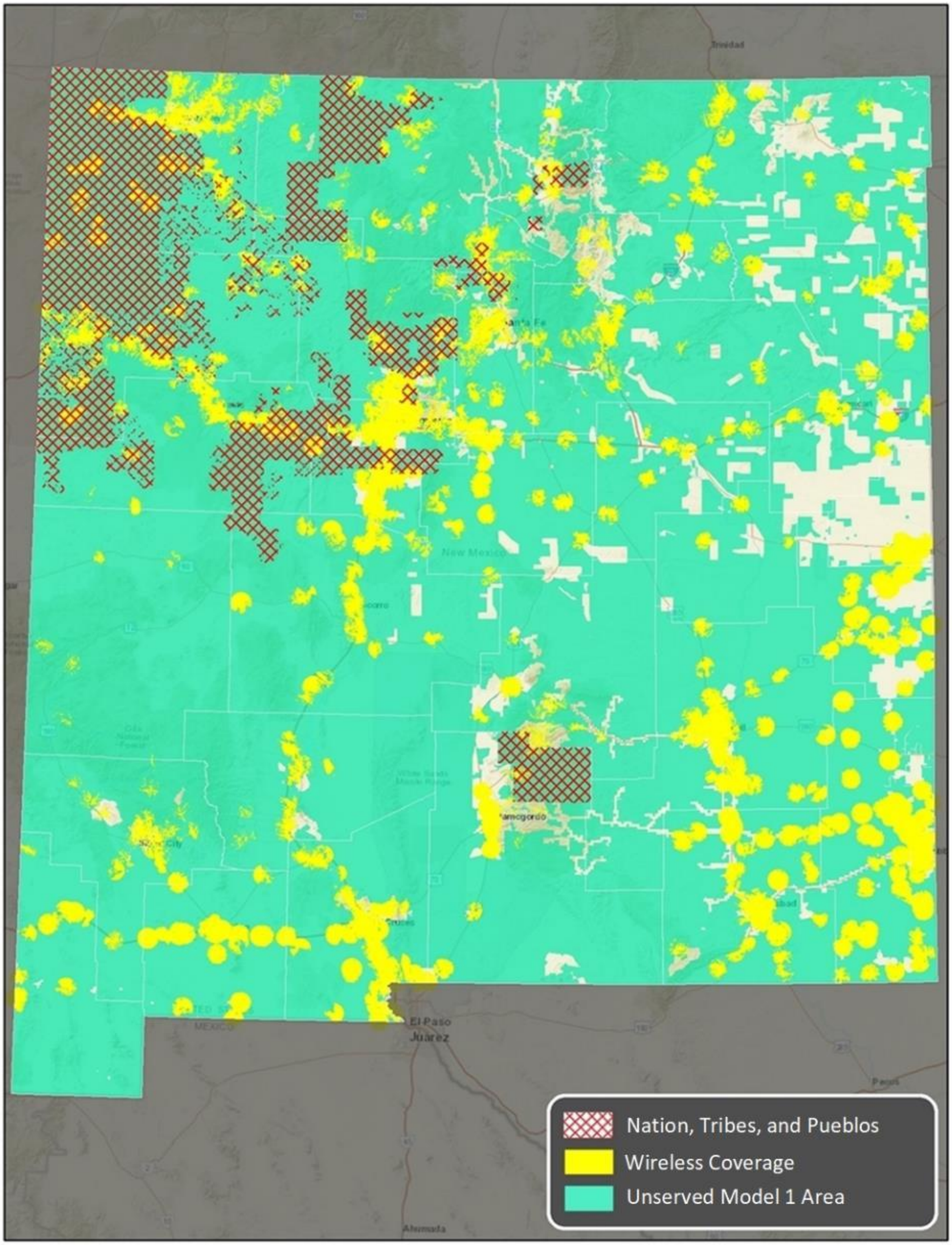


Figure 31: Coverage Enabled by Equipment on Existing Towers for Wireless Unserved Model 1



The tables below show our cost breakdown for using the existing towers for a fixed wireless solution. Our assumptions are as follows:

- All served addresses will require subscriber equipment installed (60 percent take-rate)
- Towers will be configured with three sectors for each frequency used
- All selected towers will have CBRS deployed
- 25 percent of the towers will also have 5 GHz deployed
- 25 percent of the towers will also have TVWS deployed
- Towers will be connected to backhaul using microwave links; 10 percent of the sites will require an additional hop
- Engineering and design includes propagation studies, RF path analysis for point to point connections, structural analysis, construction plans, permits
- Site acquisition costs include the costs of the preliminary equipment dimensioning, power needs, shelter requirements, RF suitability, escorts, and lease negotiations
- There is room within the shelter at the tower location for additional equipment
- To support a fixed wireless network, it is necessary to set up a core network to manage functions such as authentication, billing, security, and connection to the internet; in each of the cases outlined below, CTC assumes $200,000 for equipment and setup of a core
- The costs outlined below are capital costs only and do not include operational costs

Table 19: Capital Cost Estimate for Wireless Unserved Model 1

	Cost/Number
Network Core	$200,000
Access Point Equipment	$16,300,000
Backhaul	$14,500,000
Installation, Engineering, and Design	$67,600,000
Site Acquisition	$38,700,000
Total Distribution Network Costs	$137,000,000
Total Addresses	134,121
Cost per Address (Distribution Network Only)	$1,030

Table 20: Total Cost Estimate for Wireless Unserved Model 1 at Different Penetration Rates

Item	Cost
Total Incremental Cost (Distribution Only)	$137,000,000
Total Incremental Cost (35% Penetration)	$222,000,000
Total Incremental Cost (60% Penetration)	$282,100,000
Incremental Cost per Address (Distribution Only)	$2,830
Incremental Cost per Customer (35% Penetration)	$4,700
Incremental Cost per Customer (60% Penetration)	$3,500

Almost all addresses that have 5 GHz coverage also have CBRS coverage. Although no more addresses are reached by adding 5 GHz than by simply deploying CBRS, there may be some cases where the CBRS capacity is at a maximum and 5 GHz could be deployed to offload some of the traffic.

Because CBRS covers the most addresses, and delivers 25 Mbps, we recommend it be deployed at all the towers. 5 GHz can be used selectively to add capacity at sites, and TVWS can be used selectively to pick up additional addresses at select locations.

Our propagation analysis predicts there would still be 62,346 addresses, or 31.4 percent, in the unserved areas that would not be covered by the CBRS frequency band from the all selected existing towers. The following table breaks down the results.

Table 4: Predicted Coverage for Wireless Unserved Model 1

Addresses	Number
Total addresses in unserved area	196,467
Addresses served by wireless	134,121
Addresses not served by wireless	62,346
Percent of addresses served	68%

3.2.6 High-level coverage and cost estimate: Wireless Unserved Model 1 (Hybrid)

In this model, out of the 3,876 towers analyzed, we identified 788 that could serve more than five addresses in low-density areas of Unserved Model 1. The number of addresses served in this model is 67,007.

Figure 32 provides a statewide map of the hybrid model, in which the unserved portions of the State are divided into 1) cluster areas served by fiber, 2) areas that are well-suited to fixed wireless using existing towers, and 3) low-density areas outside the clusters that are not capable of being served by existing towers.

Figure 32: Coverage Enabled by Equipment on Existing Towers for Wireless Unserved Model 1 (Hybrid)

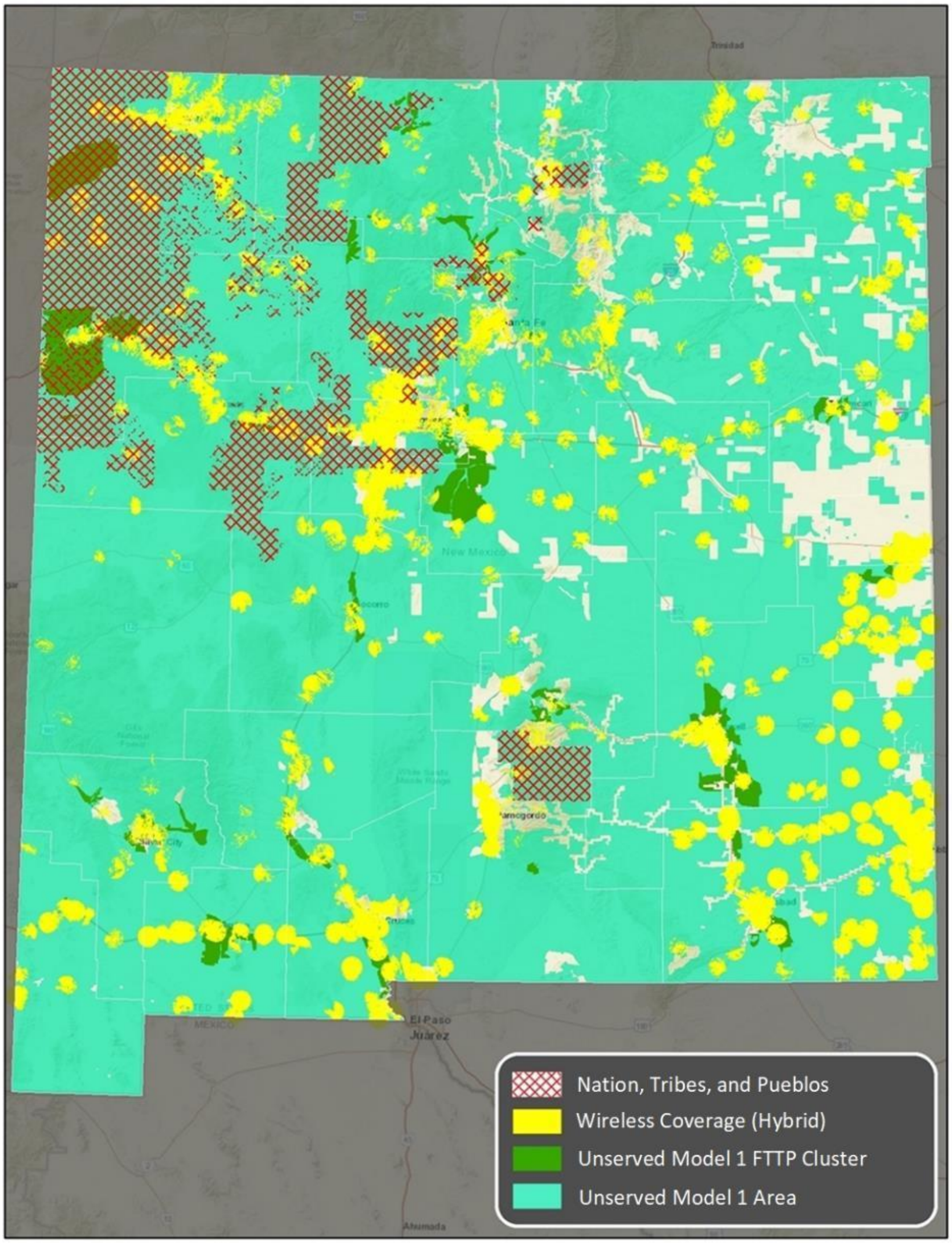
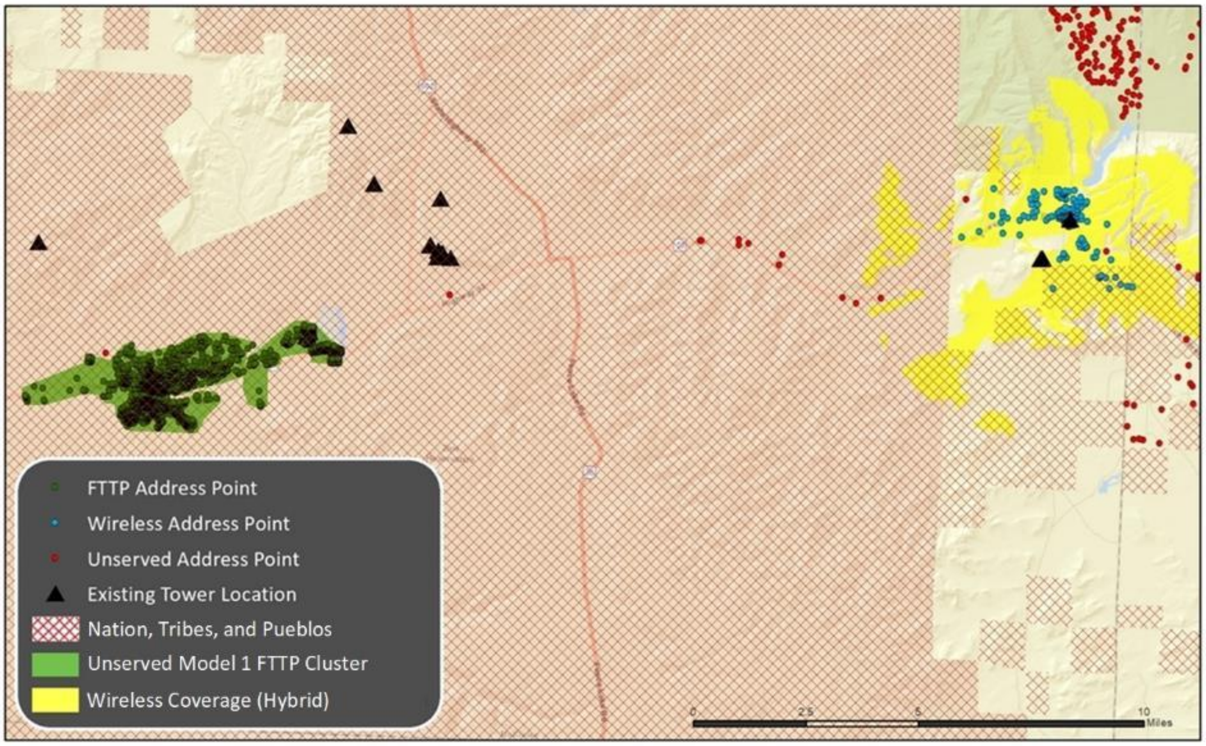


Figure 33 provides a closeup of the Zuni and Black Rock areas in the hybrid model, providing an example of a fiber-served cluster and a nearby fixed wireless service area, with the surrounding low-density areas.

Figure 33: Hybrid Model for Wireless Unserved Model 1 (Hybrid) – Zuni to Black Rock



The following table shows the costs for using the 788 existing towers. The assumptions are the same as those used in Unserved Model 1.

Table5: Capital Cost Estimate for Wireless Portion in Unserved Model 1 (Hybrid)

	Cost/Number
Network Core	$200,000
Access Point Equipment	$13,300,000
Backhaul	$11,800,000
Installation, Engineering, and Design	$55,200,000
Site Acquisition	$31,500,000
Total Distribution Network Costs	$112,000,000
Total Addresses	67,007
Cost per Address (Distribution Network Only)	$1,700

Table6: Total Cost Estimate for Wireless Portion in Unserved Model 1 (Hybrid) at Different Penetration Rates

Item	Cost
Total Cost (Distribution Only)	$112,000,000
Total Cost (35% Penetration)	$154,200,000
Total Cost (60% Penetration)	$184,400,000
Incremental Cost per Address (Distribution Only)	$3,500
Per Customer (35% Penetration)	$6,600
Per Customer (60% Penetration)	$4,600

Our propagation analysis predicts there would still be 42,520 addresses, or 39 percent, in the unserved areas that would not be covered by wireless from the selected existing towers. The following table breaks down the results.

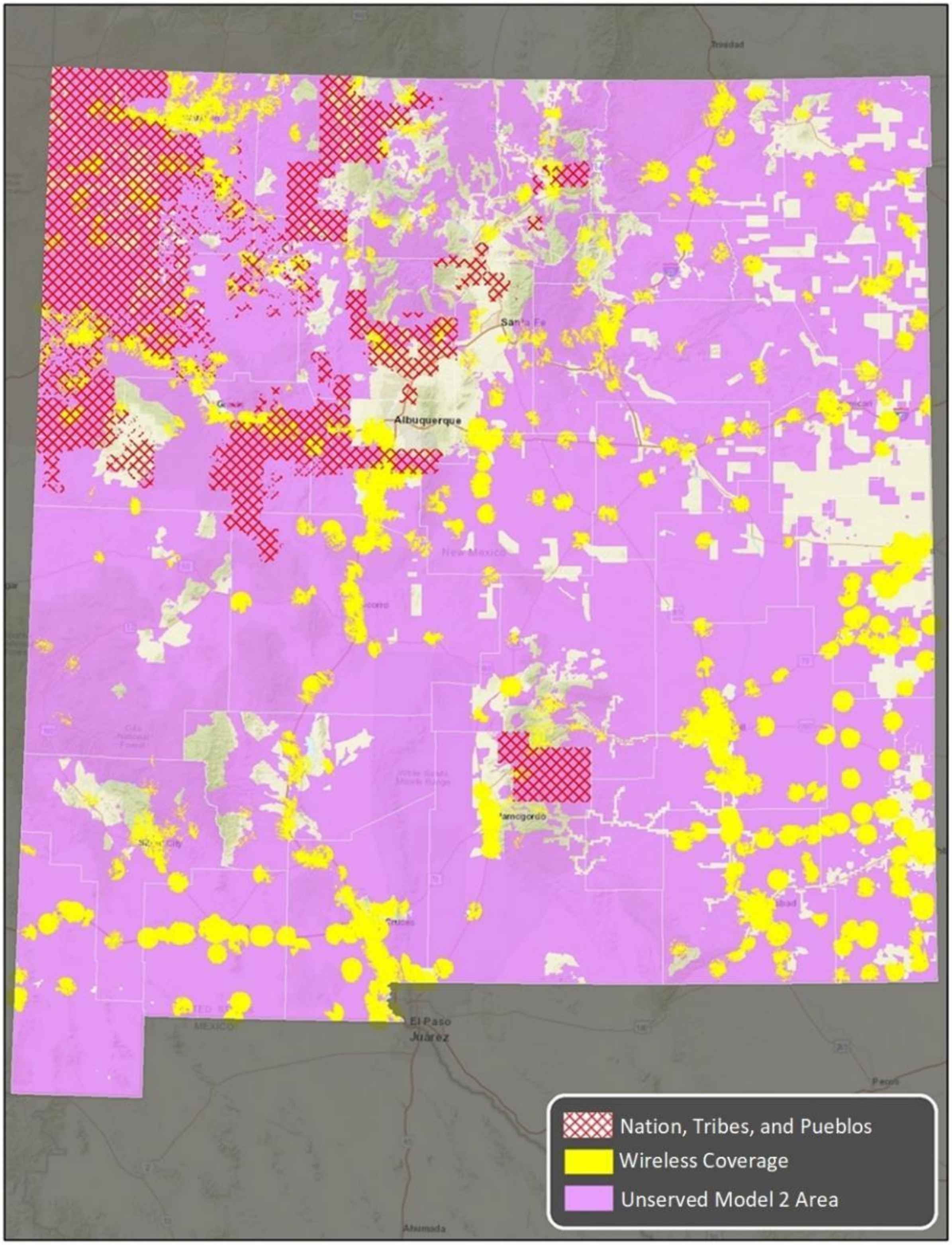
Table 7: Predicted Coverage for Wireless Unserved Model 1 (Hybrid)

Addresses	Number
Total addresses in unserved area	109,527
Addresses served by wireless	67,007
Addresses not served by wireless	42,520
Percent of addresses served	61%

3.2.7 High-level coverage and cost estimate: Wireless Unserved Model 2

In this model, out of the 3,876 towers analyzed, we identified 780 towers that could serve more than five of the Unserved Model 2 unserved addresses. Figure 34 shows the resulting overall coverage using the 780 existing towers. The number of addresses served in this model is 84,655.

Figure 34: Total Coverage Using Existing Towers for Wireless Unserved Model 2



The following table shows the costs for using the 780 existing towers. The assumptions are the same as those used in Unserved Model 1.

Table 21: Capital Cost Estimate for Wireless Unserved Model 2

	Cost/Number
Network Core	$200,000
Access Point Equipment	$13,200,000
Backhaul	$11,700,000
Installation, Engineering, and Design	$54,600,000
Site Acquisition	$31,200,000
Total Distribution Network Costs	$111,000,000
Total Addresses	84,655
Cost per Address (Distribution Network Only)	$1,300

Table 22: Total Cost Estimate for Wireless Unserved Model 2 at Different Penetration Rates

Item	Cost
Total Cost (Distribution Only)	$111,000,000
Total Cost (35% Penetration)	$164,200,000
Total Cost (60% Penetration)	$202,300,000
Incremental Cost per Address (Distribution Only)	$3,100
Per Customer (35% Penetration)	$5,600
Per Customer (60% Penetration)	$4,000

Our propagation analysis predicts there would still be 40,865 addresses, or 33 percent, in the unserved areas that would not be covered by the CBRS frequency band from the all selected existing towers. The following table breaks down the results.

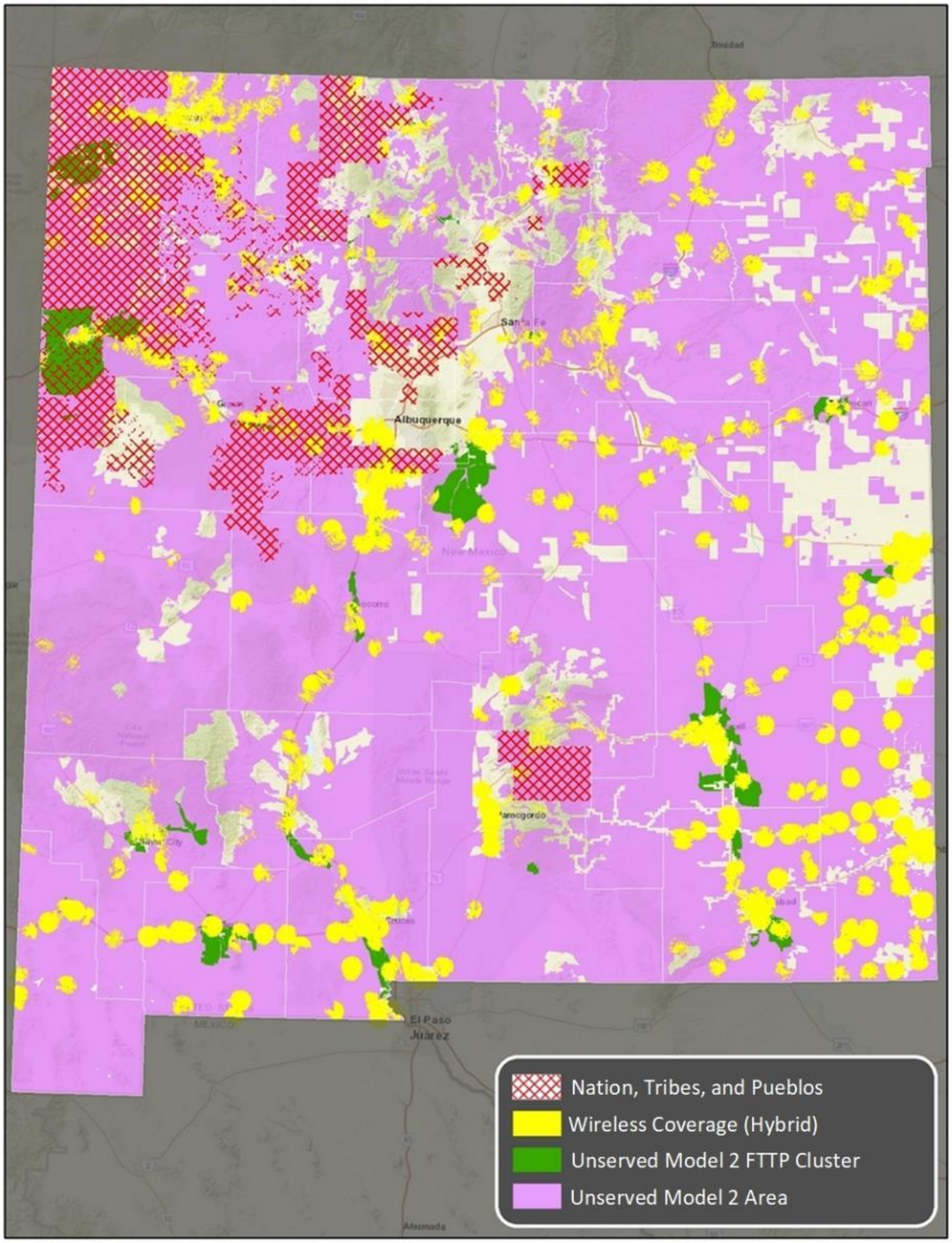
Table 10: Predicted Coverage for Wireless Unserved Model

Addresses	Number
Total addresses in unserved area	125,520
Addresses served by CBRS band	84,655
Addresses not served by the CBRS band	40,865
Percent of addresses served	67%

3.2.8 High-level coverage and cost estimate: Wireless Unserved Model 2 (Hybrid)

In this model, out of the 3,876 towers selected, we identified 638 optimum towers that could serve more than five addresses. Figure 35 shows the resulting overall coverage. The number of addresses served in this model is 44,447.

Figure 35: Total Coverage Using Existing Towers for Wireless Unserved Model 2 (Hybrid)



The following table shows the costs for using the 638 existing towers. The assumptions are the same as those used in Unserved Model 1.

Table11: Capital Cost Estimate for Wireless Portion in Unserved Model 2 (Hybrid)

	Cost/Number
Network Core	$200,000
Access Point Equipment	$10,800,000
Backhaul	$9,600,000
Installation, Engineering, and Design	$44,700,000
Site Acquisition	$25,600,000
Total Distribution Network Costs	$90,600,000
Total Addresses	44,447
Cost per Address (Distribution Network Only)	$2,100

Table12: Total Cost Estimate for Wireless Portion in Unserved Model 2 (Hybrid) at Different Penetration Rates

Item	Cost
Total Cost (Distribution Only)	$90,600,000
Total Cost (35% Penetration)	$119,000,000
Total Cost (60% Penetration)	$139,000,000
Per Address (Distribution Only)	$3,900
Per Customer (35% Penetration)	$7,600
Per Customer (60% Penetration)	$5,200

Our propagation analysis predicts there would still be 31,387 addresses, or 41 percent, in the unserved areas that would not be covered by the CBRS frequency band from the all selected existing towers. The following table breaks down the results.

Table 13: Predicted Coverage for Wireless Portion in Unserved Model 2 (Hybrid)

Addresses	Number
Total addresses in unserved area	75,834
Addresses served by wireless	44,447
Addresses not served by wireless	31,387
Percent of addresses served	59%

3.3 Functional and cost comparison of technologies

3.3.1 Performance advantage of fiber

Both coaxial (cable-TV and cable broadband) and twisted-pair (telephone) copper cables were originally designed to provide video and voice services, respectively, and were sufficient in the early years of data communications when usage was low relative to current expectations. However, as demand for data capacity increased, networks built with these media became less capable to support demand relative to their high-speed counterparts. On an increasingly large scale, communications carriers and cable operators are deploying fiber to replace large portions of their networks—because for a given expenditure in communications hardware, fiber optics can reliably carry many times more capacity over many times greater distances than any other communications medium.

Fiber is one of the few technologies that can legitimately be referred to as “future-proof,” meaning that it will be able to provide customers with larger, better, and faster service offerings to accommodate growing demand.

The biggest advantage that fiber holds is bandwidth. A strand of standard single-mode fiber optic cable has a theoretical physical capacity in excess of 10,000 GHz, and capacity can be symmetrically allocated fully symmetrically between upstream and downstream data flows using off-the-shelf technology. Fiber optics are not subject to outside signal interference and do not require amplifiers to boost signals in a metropolitan area broadband network.

Within a fiber optic strand, an optical communications signal (essentially a ray of light) behaves according to a principle referred to as “Total Internal Reflection” that guides it through the optical cable. Optical cables do not use electrical conduction, and thus do not require a metallic conductor, such as copper, as their propagation medium. Unlike electrical signals over copper cables, optical communications signals also do not experience the significantly increased losses as a function of higher higher-frequency transmission experienced by electrical signals over copper cables.

Further, technological innovations in the development of fiber optics have enabled the manufacture of very high quality, low impurity glass; these optics that can provide extremely low losses within a wide range of frequencies, or wavelengths, of transmitted optical signals, enabling long-range transmissions. Compared to a signal loss on the order of tens of decibels (dB) over hundreds of feet of coaxial cable, a fiber optic cable can carry a signal of equivalent capacity over several miles with only a few tenths of a dB in signal loss.

Moreover, weather and environmental conditions do not cause fiber optic cables to corrode in the way that metallic components can over time as a result of weather and environmental conditions, which means that fiber has further reduced maintenance costs.

One criticism often directed at fiber networks is the cost involved in constructing and deploying the network. However, while optical fiber is often more expensive per foot than many types of copper wire, the costs including construction have become almost comparable over the last decade. Despite the higher material cost of the fiber, new outside plant construction for copper and optical fiber is generally equivalent, because the vast majority of plant construction cost is due to the labor required.

3.3.2 Cost-effectiveness of fiber where density is sufficient

One key metric in determining the cost-effectiveness of fiber construction is the density of the area under consideration. The number of homes and businesses per mile of roadway is typically the most important factor—often more important than the condition of the right-of-way, the availability of utility poles, or unit costs of labor and materials.

One approach in technology choice is to set thresholds in density for fiber. Section 3.1.4 indicates the number of homes per mile and the estimated cost to build to the clusters. Taking into account the benefits of fiber, a grant or bid process would ideally preference fiber, but allow use of wireless technologies below certain cost and density thresholds.

3.3.3 Wireless cost considerations

Section 3 provides capital costs for fiber and Section 3.2 provides those costs for wireless networks and finds that costs are comparable on an apples-to-apples comparison. The capital costs for fiber are dominated primarily by construction labor and secondarily by outside plant materials, with network electronics making up a relatively small portion. As a result, much of the cost is incurred at the beginning of the project—with electronics, with a replacement cycle of five to 10 years, representing a small cost.

By comparison, most of the wireless capital cost is in electronics and software, with some construction or improvement of towers or antenna masts. Electronics have a lifetime of five to 10 years. What this means is that, by comparison with fiber, capital costs are incurred over the lifetime of the project, and that comparable initial capital cost of fiber and wireless will likely over time lead to a higher total cost of operations for the wireless network.

Moreover, most of the wireless electronics cost is at the user premises. As a result, the cost to build and operate a wireless network increases dramatically with growth in the number of customers. It is therefore important that, where the State considers supporting a fixed wireless model, it adequately takes into account the provider’s ability to serve enough of the target population and that it designs its network to accommodate both the target population and provide sufficient capacity to give all of them the performance they need in peak conditions.

Fixed wireless providers face significant technical challenges in achieving line of sight to all potential customers and in obtaining sufficient spectrum to deliver sufficient capacity. If the provider is a small start-up (as many fixed wireless providers are), it may also have difficulty with customer support, installation and maintenance for large numbers of customers. What many fixed wireless providers have done in the past is decide not to serve customers who have challenging terrain or foliage, and potentially also target a smaller percentage of the customers, so that they can more easily manage customer support and not overload their networks.

Therefore we recommend the State clearly establish metrics for performance and customer support for all networks (fiber, cable and fixed wireless) and require potential partners to demonstrate technical capabilities (line of sight, spectrum, ability to load network, reliability of design) as well as ability and willingness to support the customers in the service area.

3.3.4 Technical unsuitability of DSL

Copper cable is ubiquitous throughout New Mexico, but its bandwidth limitations (which are directly related to the underlying physical properties of the medium) and the age and condition of most of the copper cable limit its scalability. This is especially true as average user demand for broadband communications increases to hundreds of Mbps and, eventually, Gbps of capacity.

CenturyLink's very-high-bit-rate digital subscriber line VDSL services can deliver 25 Mbps over a single pair of copper. However, these services are for the most part limited to portions of the metropolitan areas of Albuquerque and Santa Fe with fiber to the node—to within 3,000 feet of the customer. Most of the State has copper lines 10,000 feet to 20,000 feet for small ones. Given those distances, the average available DSL download speeds 6 Mbps for the shorter lengths and less than 1.5 Mbps for the long ones. DSL technology will not be able to increase capacity far beyond those speeds or consistently provide service across typical copper lines without substantial upgrades, such as fiber-to-the-curb or other costly re-engineering and construction.

Bandwidth limits on copper cables are directly related to the underlying physical properties of the medium. Higher data rates require a broader frequency range of operation—wider channels. Twisted-pair wire is limited to a few tens of megahertz in usable bandwidth (at most), with dramatic signal loss increasing with distance at higher frequencies. This physical limitation is why DSL service is only available within a close proximity to the telephone central office.

For these reasons, we recommend that the State deprioritize funding for options that are centered around copper line DSL technology. In contrast to fiber, hybrid fiber-coaxial (cable-TV) or even fixed wireless, the technology just barely supports 25/3 Mbps service, and funds spent on building it will not have the long-term value of funds spent on other technologies. Furthermore, DSL technologies are more difficult and costly to maintain. Because of the age of the physical cables, more maintenance is needed. Also, because higher speeds need optimal frequency response, many of the copper pairs in a given cable are not in adequate condition, and therefore DSL operators have in many cases declined to add or maintain service.

4 How New Mexico Compares with Neighboring States

CTC performed research to see how New Mexico compares to three neighboring states, Arizona, Colorado and Texas, with respect to access to broadband. We added Utah to this analysis given that Utah in many respects has model policies for promoting broadband expansion. We reviewed state broadband policies, FCC Form 477 data, and rankings made by third parties.

4.1 New Mexico lags neighboring states in terms of broadband options available to residents

The FCC collects data through a required filing called Form 477, in which broadband providers state whether service is available in census blocks. In spite of the data's shortcomings,[29] the metric of number of providers providing broadband service can be considered a rough, if exaggerated, proxy for how well a state is served. In all five states, the FCC says that there are at least two broadband providers reaching all residents with 25 Mbps download, 3 Mbps upload (or 25/3) service. However, New Mexico lags the other four states with respect to what percentage three providers. Table 23 shows these data for both 25/3 service and 10/1 service.

Table 23: Percent of Population with Three or More Broadband Providers According to FCC Form 477 Data

State	**25/3 Service** ***Percent of Population with Three or More Providers***	**10/1 Service** ***Percent of Population with Three or More Providers***
New Mexico	85	95
Arizona	88	97
Colorado	95	98
Texas	94	97
Utah	97	97

4.1.1 New Mexico Lags Colorado, Texas, and Utah in numbers of providers serving tribal areas, but is ahead of Arizona

Breaking this data down by category, it becomes apparent that the New Mexico disparity is mostly the result of fewer providers serving tribal and rural areas. With respect to these areas,

[29] Although the reporting is mandatory, the data overstate actual availability because the FCC considers a census block served if only a single location within the block is served.

New Mexico trails Colorado and Texas in both categories but is ahead of Arizona. Table 24 shows these data.

Table 24: Percent of Populations (by Category) Having Three or More Providers of 25/3 Broadband According to FCC Form 477 Data

State	Entire State Population	Urban Population	Rural Population	Non-Tribal Population	Tribal Population
New Mexico	85	95	***50***	89	***35***
Colorado	95	98	***76***	95	***69***
Arizona	88	94	***43***	90	***12***
Texas	94	98	***75***	94	***63***
Utah	97	99	***68***	95	***49***

4.1.2 One measure suggests that New Mexico ranks 42nd in the nation in broadband coverage, behind neighbors

By one set of measurements, New Mexico ranks behind the other three states in terms broadband coverage and is the 42nd-most connected state in the nation, with 22 percent of the population considered unserved. This is according to Broadband Now, a website supported in part by the broadband industry which pulls data from the FCC and U.S. Census Bureau, then merges the data with private data acquired directly from broadband providers, resellers, customers, and other sources.

Table 25: New Mexico's Broadband Coverage and National Ranking According to Broadband Now[30]

State	Broadband Coverage	Population Unserved	Average Statewide Speed (Mbps)	National Connectivity Ranking
New Mexico	83 percent	22 percent	35	42nd
Arizona	89 percent	18 percent	56	34th
Colorado	92 percent	10 percent	63.5	22nd
Texas	90 percent	14 percent	56	30th
Utah	96 percent	8 percent	50	10th

[30] https://broadbandnow.com/

5 Broadband's Role in New Mexico's Rural Economy

5.1 Importance of connectivity to the oil and gas industry

Quality broadband connections allow the oil and gas industry to operate more safely and efficiently than ever before. Already the industry has begun to realize the benefits of smart sensors, machine-to-machine connections and big data analytics. Each year, more sensors and gages installed in remote wells are brought online, increasing the amount of data drilling managers and oil field services companies can access from centralized locations. Rapid data analysis allows management to adjust drilling speeds as necessary to achieve maximum efficiency, and artificial intelligence can help predict equipment failure before it happens. [31] High quality video streams enhance safety and security in remote facilities, and in the event of an irregularity, allows more personnel to visually monitor the situation and participate in decision making. Increasingly, the industry is using remote operated vehicles (ROVs) equipped with high definition cameras to assist in routine maintenance tasks, and to help troubleshoot problems in remote locations.[32]

Better broadband will allow oil and gas companies to enact cost-saving measures without compromising safety. With faster, more affordable connectivity at well sites and along pipelines, engineers and management will have greater opportunities to monitor and interact with equipment and instruments in remote locations. The industry is working towards a future in which engineers can use virtual models and augmented reality to assist in equipment repair from centralized locations.[33] Adequate broadband shrinks the distance between remote facilities and company headquarters, giving management greater control over operations and allowing qualified personnel to monitor and participate in critical decision making processes in distant locations. In the event of stricter regulations, robust broadband enables lower-cost ways for companies to comply with regulation and provide adequate safety assurances, helping ensure the industry earns sufficient profits to continue operations.

Better connectivity is also important for the quality of life of staff working from remote areas. In response to growing demand for broadband for personal use, Shell has begun allowing employees in remote locations to use facilities' broadband connections during non-business

[31] Andrew Slaughter, et al. "Connected barrels: Transforming oil and gas strategies with the Internet of Things," *Deloitte*, August 14, 2015, https://www2.deloitte.com/us/en/insights/focus/internet-of-things/iot-in-oil-and-gas-industry.html (accessed November 2019).
[32] Steve Hamlen, "Video in an Offshore Environment: Fueling Bandwidth Demands," *Satellite Today*, November 1, 2012, https://www.satellitetoday.com/telecom/2012/11/01/video-in-an-offshore-environment-fuelling-bandwidth-demands/ (accessed November 2019).
[33] Todd Rigby, "The Oilfield of the future will include a mobile wireless network," *Oil and Gas Engineering*, January 28, 2019, https://www.oilandgaseng.com/articles/the-oilfield-of-the-future-will-include-a-mobile-wireless-network/ (accessed November 2019).

hours.[34] Broadband allows staff to stay connected to family, access telehealth and telepsychiatry services, and pursue professional development and other educational opportunities.

Another important aspect is the ability to quickly contact public safety either via voice communication or IoT at the start of a disaster. Public safety can even be monitoring operations (video, sensors, etc.) and can be on alert if data shows a potential disaster. There are certain situations that can cause fires.[35]

5.2 Importance of connectivity to agriculture

In order to produce food for a growing population in a time of regular, severe weather emergencies, farmers are looking to digital technologies to help them farm more efficiently. The USDA recently estimated that the gross economic benefit of ubiquitous broadband infrastructure and next generation precision agriculture adoption in row crops, specialty crops and livestock together could be as much as $18-23 billion.[36]

Already, many innovative farmers have begun incorporating Internet of Things (IoT) sensors, GPS and GIS applications, robotics and wearable technologies into their operations, allowing them to farm in ways that are both economically and ecologically more sustainable, but a lack of robust broadband are preventing wider-spread adoption of these technologies. A recent study by the United Soybean Board found that 60 percent of farmers and ranchers reported that they do not believe they have adequate internet connectivity to run their businesses, and 50 percent want to incorporate more technology into their operation but are held back by limited connectivity.[37]

For row and specialty crop producers, better connectivity promises to provide farmers with a more detailed understanding of the land they have under cultivation, with all of its variations. Dense network of sensors embedded throughout cropland and drones equipped with multispectral cameras will allow farmers to apply inputs more precisely, based on the needs of plants in specific location. Variable rate applications can increase overall yield, reduce runoff and save farmers money on water, soil amendments, herbicides, fungicides and insecticides.[38] As machine learning and robotic technologies continue to improve, even complex tasks, like picking

[34] Steve Hamlen, "Video in an Offshore Environment: Fueling Bandwidth Demands," *Satellite Today*, November 1, 2012, https://www.satellitetoday.com/telecom/2012/11/01/video-in-an-offshore-environment-fuelling-bandwidth-demands/ (accessed November 2019).

[35] https://www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2015/March-April-2015/Features/Fracking

[36] "A Case for Rural Broadband," *United States Department of Agriculture*, April 2019, https://www.usda.gov/sites/default/files/documents/case-for-rural-broadband.pdf (accessed November 2019).

[37] "Rural Broadband and the American Farmer," *United Soybean Board*, October 9, 2019, https://api.unitedsoybean.org/uploads/documents/58546-1-ruralbroadband-whitepages-final.pdf (accessed November 2019).

[38] "A Case for Rural Broadband," *United States Department of Agriculture*, April 2019, https://www.usda.gov/sites/default/files/documents/case-for-rural-broadband.pdf (accessed November 2019).

fruit at precisely the right level of ripeness, can be automated if farmers are not able to secure a reliable source of labor.[39]

For livestock and dairy producers, robust broadband enhances farmers and ranchers' ability to monitor their herd remotely and detect health problems before they necessitate costly interventions. Audio and visual monitoring and artificial intelligence can reduce labor time and flag signs of illness sooner than even the most watchful farm worker.

Connectivity also plays an important role in marketing efforts today, especially for those small farms that aim to cut out the middleman and connect directly with their customers.

Many farming families need at least one member of their household to earn off-farm income, and having quality broadband on the farm provides opportunities to telecommute or operate a home-based business.[40] High-speed broadband also allows farmers to continue their education, participate in research studies and develop new competencies from their home. Without broadband, farmers are forced to ask their families to sacrifice educational opportunities in order to stay on the farm. As the current crop of farmers moves towards retirement, the next generation of farmers will be drawn to areas where they can farm and raise a family without forgoing all of the benefits associated with high speed broadband.

5.3 Importance of connectivity for small farms

Small and medium sized farms in New Mexico are a vital part of the State's economy and food security efforts. Although these small and medium sized operations may not have the resources or incentives to invest in data-intensive technologies in use on large corporate farms, like precision agriculture applications and robotic harvesters, smaller farms need quality broadband connections for many of the same reasons as other small business owners. Specifically, small and medium sized farms need broadband to:

- Access direct sales, marketing and logistical management opportunities
- Continue professional training from the farm
- Conduct high-quality video consultations with experts
- Earn supplemental income from home
- Provide their families with health care, educational, and social opportunities

5.3.1 Enabling direct sales, marketing and logistical management opportunities

Small farms have long used the internet to connect with customers, but the importance of broadband for farm's sales and marketing efforts has never been as clear as during the Covid-19

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[39] John Seabrook, "The Age of Robot Farmers," *The New Yorker*, April 8, 2019, https://www.newyorker.com/magazine/2019/04/15/the-age-of-robot-farmers (accessed November 2019).
[40] Virginia Gewin, "Can Rural Broadband Help Save Farm Country?" *Civil Eats*, October 7, 2019, https://civileats.com/2019/10/07/can-rural-broadband-help-save-farm-country/ (accessed November 2019).

crisis. As sales to restaurants have plummeted, demand for local produce has exploded and farms have been forced to pivot and focus on connecting directly with quarantined families who want to avoid crowded markets and grocery stores. To adapt to these challenges, many farms are setting up online store where customers can find out what is available, make purchases and arrange pickup. In some states, extension agents have provided farms with training and resources to help them quickly create a virtual storefront.[41]

Even when people can congregate in markets and stores again, online sales will continue to be an important revenue source for smaller farming operations. Farms located in areas with inadequate broadband will have a harder time connecting with customers, collaborators and wholesalers. Getting perishable farm products to customers will always be a logistical challenge, but a little less challenging for farmers who can use broadband-enabled applications on their farm, like e-commerce, inventory and customer relationship management solutions. As more commerce and logistical management moves online each year, farms without broadband will increasingly be at an economic disadvantage.

Broadband is also key to marketing efforts today, with many farms turning to Instagram and other social media platforms to find and engage with customers. Regularly uploading images and videos helps farms build customer loyalty and reach consumers who may not otherwise shop at a farmer's market or sign up for a CSA. Engaging with social media is especially important for farms wanting to attract local families for events and agritourism opportunities.

Many farmers turn their harvests into value added products, and often do the design and branding work themselves. However, design professionals tend not to work from home in rural areas for good reason: slow internet connections make image editing a nightmare. Simple tasks that take minutes in places with robust broadband, like uploading a high-resolution image of a product label, can take several days on a farm with painfully slow DSL or satellite service.

Like the rest of society, farmers do more of their input sourcing and purchasing online each year. Online vendors often have more specialized products than local stores, sometimes at a more competitive price. Without robust broadband, farmers are either forced to accept what their local vendor has available or spend time they may not have at a library or coffee shop to research products and make purchasing decisions.

5.3.2 Continuing professional training

No farmer can ever learn all there is to know about farming, and that is even more true in the era of climate change, when insects and pathogens spread rapidly around a globalized planet. State agricultural extension officers provide opportunities for farmers at every stage of their career to

[41] https://growingsmallfarms.ces.ncsu.edu/2020/04/register-now-for-april-webinar-on-creating-a-free-online-store-for-your-farm/

continue to learn and adapt to changing markets and climatic conditions. However, farmers rarely have lots of extra hours in their workday to commute to off-farm classes and trainings. Extension officers are increasingly offering trainings online through webinars, and other online formats. Many of the land-grant universities offer courses online as well. With a robust broadband connection, farmers can stay at the cutting edge of agronomic research at times of the day that work for them, without ever having to leave the farm.

Many successful farmers end up becoming jacks of all trades, as managing the day-to-day operations for a farm can force farmers to learn about small engine repair, plumbing, carpentry, engineering, etc. With a quality broadband connection, farmers can attend online courses in related subjects, or find a YouTube instructor with a teaching style that fits their specific learning needs.

5.3.3 Consulting experts

In the past, farmers have needed to travel to population centers or land grant universities to consult agricultural professionals and scientists. With adequate bandwidth, farmers can provide a far-away veterinarian with a high definition video interview with a sick animal, potentially saving both the farmer and the animal from making an uncomfortable drive. Farmers can send high quality images to plant pathologists and entomologists, enabling quicker detection of pathogens or infestations.

5.3.4 Earning supplemental income from the farm

Only some small American farms are principle occupation farms. Even some of the farmers who farm as their principal occupation can only do so because a spouse supplements farm income with an off-farm job. Very few couples can earn enough from farming to pay a mortgage and support a family, but the labor involved in tending to plants, animals and kids can make leaving the farm for work a challenge. In places with robust broadband, farming families can supplement farm income from home through telework or home-based internet businesses.

Telecommuting has been a growing trend for years, and the Covid-19 crisis has pushed many more business processes online. Many jobs that previously required a daily commute to the office may remain at least partially remote when the crisis is over. Working from home is particularly attractive to farming families, where leaving the farm means one less set of eyes to watch the crops, flocks, herds and family members.

5.3.5 Health care, educational, and social opportunities for farming families

The Covid-19 crisis has accelerated existing trends in telemedicine. Broadband is being used for doctor visits and therapy sessions. Innovations in biometric monitoring are allowing elderly family members to age from home more safely. These tools are especially important for families living outside of population centers, for whom traveling to a doctor or specialist's office necessitates a long commute through traffic.

Having a home broadband connection was vital part of ensuring equitable educational opportunities before the Covid-19 crisis. Now, a lack of home broadband can lock kids out of their classes all together. Farming outside of population centers already causes farming families to be somewhat isolated, and a lack of access to broadband intensifies that isolation.

6 Framework for Broadband Public-Private Collaboration

There exist a range of models for New Mexico localities to consider as they seek broadband expansion and, in some cases, competition. The models are designed to enhance the chances of New Mexico's communities meeting the goals they expressed during preparation of this Plan:

First, to secure **future-proof infrastructure –** broadband services that will meet the community's long-term needs for residential and business broadband, as well as emerging 5G wireless technologies, Internet of Things, Smart City, autonomous and connected vehicles, and other innovations as they develop in the future.

Second, to **attract private broadband investment** to the community that will not only deliver on broadband's promise but also create new forms of economic activity.

And third, to achieve these goals through **a competitive marketplace**—a solution that will facilitate a local broadband marketplace that is as competitive as reasonably possible, so as to secure the benefits that flow from competition, such as lower consumer costs and higher quality services.

The models are described in more detail, with case studies, in Appendix B.

The following are a range of models that are briefly summarized below as potential means to support these goals:

Option 1: Public-Private Collaboration: Under this option, a community would work with a private company that would develop a broadband network and provide high speed internet service. As part of this model, the community would lease to the private entity communications-enabling assets such as conduit or tower space or might provide a grant or other support to the private entity to make the collaboration opportunity more attractive.

Option 2: Community Infrastructure and Outsourced ISP Operations: Under this option, the community would finance and build a broadband network all the way to homes and businesses, and then lease the network to one or more internet service providers and entities to utilize the infrastructure.

Option 3: Community Infrastructure and ISP Operations: Under this option, which is usually known as "municipal broadband," the community would finance and build a fiber broadband network to homes and businesses, and itself provide retail internet service through a new operation within government.

Table 26 summarizes the potential alignment of these options with community goals as they were expressed during the data collection and interviews for this Plan.

Table 26: Summary of Alignment of Community Goals and Options

Goal / Scale	Option 1: Assets Leased to ISP	Option 2: Community-wide Network Leased to ISP	Option 3: Municipal Broadband
Goal: Future-looking infrastructure	**Good:** Assets such as conduit and fiber backbone could support a range of technologies, including a fiber-to-the-premises or a wireless last-mile, depending on partner's willingness to invest and deployment model.	**Excellent:** A community-wide network can serve as a platform for ultra-high-speed services, as well as next generation wireless services.	**Excellent:** A community-wide network can serve as a platform for ultra-high-speed services, as well as next generation wireless services.
Goal: Attract private investment and stimulate economic activity	**Good:** Assets are a means by which communities can differentiate themselves and attract private capital, both for purposes of building/operating broadband and to use the new broadband capabilities. There exists universal understanding that broadband impacts economic activity positively, as has been demonstrated by the degree of work from home during the Covid-19 pandemic.	**Excellent:** A community-wide would serve as a clear differentiator for attracting private capital, both for purposes of building/operating broadband and to use the new broadband capabilities. There exists universal understanding that broadband impacts economic activity positively, as has been demonstrated by the degree of work from home during the Covid-19 pandemic.	**Excellent:** A community-wide would serve as a clear differentiator for attracting private capital, both for purposes of building/operating broadband and to use the new broadband capabilities. There exists universal understanding that broadband impacts economic activity positively, as has been demonstrated by the degree of work from home during the Covid-19 pandemic.

Goal / Scale	Option 1: Assets Leased to ISP	Option 2: Community-wide Network Leased to ISP	Option 3: Municipal Broadband
Goal: A competitive marketplace	**Promising**: Assets facilitate last-mile deployment but requires significant partner investment.	**Excellent**: Likely to be one or two entities interested in/capable of leasing communitywide network; dynamic competitive market potential with at least one new provider.	**Excellent**: The community will be bringing competition into the market and its entry into the broadband market will almost certainly result in incumbent efforts to compete, particularly with lower per until internet prices and cable television promotions.
Scale of community's cost and risk	**Modest:** If existing assets can be maximized, the community would be leveraging current assets rather than making new investments.	**High:** Higher capital investment required, with limited likelihood of dark fiber leases covering all Community debt service and O&M costs.	**Very high:** Community will bear the full cost of the network and will be obligated to cover shortfalls if revenues are insufficient.

7 Recommended Structure for State Broadband Grant Program

As this Plan documents, the challenging economics of rural broadband preclude substantial private sector investment without public funding to make the investment opportunity more attractive. The Plan thus recommends that New Mexico fund an ongoing rural broadband grant program, even if of modest size, as a tool for chipping away at the rural broadband deficit—and as a means of attracting federal grant funds and private investment.

7.1 Use State rural broadband funding as seed money to leverage federal funds

The State should use its fund not only to deploy new broadband infrastructure but also, where possible, as a match to improve the competitiveness of applications for federal grant and other funding programs. The State should therefore require grant applicants to develop plans and commit to seek additional funding from federal programs that can be used for broadband infrastructure (other than applicants who plan to build broadband only in areas that are not eligible for federal grant programs.)[42]

To meet this requirement, grant applications could include two potential plans for new facilities: (1) a baseline footprint that the applicant plans to build with the State funding and, (2) and an expanded footprint of a larger unserved geographic areas that the applicant plans to apply to the federal government to fund under an existing or emerging federal program.

An unsuccessful effort to secure the federal grant should not impact the award of the State funds, though the viability of the planned federal grant strategy and application should be a criterion in awarding of State funds for those applicants whose proposed footprints include areas that are eligible for federal funding.

7.2 Require public-private collaboration at the local level

CTC recommends that the State open eligibility for the funding program as broadly as possible, in order to spur participation, planning, and creativity. We recommend this breadth of eligibility in part because many communities may choose to partner with private for-profit or non-profit entities, and their grant applications may be stronger as a result.

One very successful strategy in other states has been to require public sector participation. Maryland and Virginia, for example, have required county applications and support for private networks, thus ensuring local buy-in and company responsiveness to local requirements. We thus encourage the State to require local government participation in any grant application, but also

[42] For example, the terms of the federal ReConnect program create a "protected" status for some census blocks based on previous federal funding received for services in those census blocks. Though these census blocks are not eligible for ReConnect, many should qualify for the State of New Mexico's funding program because the federally-funded services do not meet the State's definition of broadband.

to allow consortia (including a full range of other entities as well) to be part of the grant application.

Based on our interviews in preparing this Plan, there exist a considerable number of potential private sector partners who will eagerly seek partnerships with localities in this regard.

A decade of experience demonstrates the value of a breadth of potential applicants and beneficiaries. The Recovery Act funding programs, for example, were open to all applicants and funded substantial and successful programs led by state governments, local governments, and research and education non-profit networks. Well-regarded state funding programs such as that in Minnesota are open to all applicants, and the state of California recently expanded eligibility to include public entities despite the earlier iterations of its program that were limited to a certain class of telecommunications companies. California discovered that the broader eligibility served better to facilitate the goals of competition, efficient use of resources, and expansion of broadband services to all Californians.

Based on these best practices, we therefore recommend that local governments be a required participant in a grant application, and that the State encourage partnership applications that can include telephone companies, cable companies, competitive Internet service providers (ISP), electric utilities, non-profits, and a full range of other potential stakeholders.

7.3 Emphasize impact and sustainability in scoring

We recommend a scored grant mechanism that in our experience has been the most successful way of distributing modest broadband funding, both at the federal and state levels. In a scored program, as distinguished from some kind of auction mechanism, funding is awarded based on key selection criteria that flow from policy goals and risk containment strategies. Scored grants are a tested model that have been used by the U.S. Department of Commerce, the U.S. Department of Agriculture, and most of the states that have thus far awarded broadband funding.

A grant program of this sort has significant advantages in light of the State's goals. Among other things, it allows quantitative and qualitative evaluation of key criteria, including not only cost but also such matters as the track record of the applying entity, community support, the likely pricing for services under the program, commitment to customer service, likelihood of service to community anchor institutions, and likely impact on advancing digital inclusion and digital equity goals. In other words, this kind of process and program would allow the State to award funding based on more factors than just cost—unlike most FCC Universal Service funding programs, where awards are based primarily on cost, usually through a reverse auction process.

Administering a grant program can be quite labor intensive. But it allows for custom analysis and, ideally, maximization of State resources. The states of Maryland and Minnesota have had tremendous success in administering scored grant programs that enable the states to give targeted awards to entities that present the strongest business case and best use of state funding. Those programs are discussed in more detail below.

CTC recommends that the State entity or team charged with establishing the grant program and making awards consider the following criteria, among others, in scoring awards. These criteria are based on experience and best practices, both at the federal and state levels, over nearly a decade of broadband grant program experience. (There will be other criteria for award, of course, but in our experience, these are the principal ones that bear consideration from the very beginning.) Other states' experience with these and other factors is described below.

7.3.1 Financial viability

For obvious reasons, the first criterion we recommend is the financial viability of the project. We note that many projects will be in the planning stage rather than ready for execution, but we encourage the State to require a showing of financial viability as a means of determining how extensive the planning has been, and how far along the project is. A more sophisticated and extended planning process is likely evidence of long-term effort, extensive local input, and working through some of the pragmatic challenges likely to arise. Among other things, the State can require detailed description of the business model, and potentially business plan as well as financial projections and an explanation of the assumptions underlying them.

While it is never possible to remove all risk from a broadband project, as the economics of a broadband project are inherently challenging and risky, vetting a business model for viability and sufficiency is one means by which to identify high-quality applications.

Related to this requirement, we note that the State should also require that the entities partnering with the localities that apply for the funding are indeed themselves financially viable. The states of Illinois and Wisconsin, among others, encountered challenging situations when private sector grant awardees turned out not to have sufficient experience, depth of resources, or capability to overcome challenges.

The FCC overcomes this concern by requiring private sector applicants for federal funding to provide documentation of their financial viability in the form of letters of credit and multiple years of audited financials. Such documentation or other means of determining viability represent a best practice for protecting public funding.

7.3.2 Additional funding commitments

Depending on the size of the financial commitment the State makes, some level of additional funding—and indeed, possibly considerable additional funding—will be necessary. Among the potential sources of that funding could be investment by private partners, the local government applicants, potential commercial users of the network, and other parties that stand to benefit.

A showing of commitments for additional funding, whether by public or private sectors, should be a necessary requirement of the grant scoring process, as an additional means of assessing the viability of the application and the likelihood of success. The showing can be made in a range of ways, from letters of interest to lease fiber, to commitments to invest, to local government documentation of pledged resources, proposed bonding, or budget allocations. Both the federal Recovery Act programs and most state grant programs have required commitments of this sort.

7.3.3 Technical viability and sufficiency

As with financial viability, we recommend that the State require a strong showing of technical capacity by the applicant or consortium of applicants. This capacity can be demonstrated through partnerships that a locality develops with other entities if the locality itself does not have experience building or operating communications networks. The technical viability can be shown in the form of discussion of experience, both with regard to construction and operations, including provision of service to the public.

While the requirement of this kind of experience may have the impact of reducing the participation of start-up companies, it will at the same time provide protection for the public funds involved. In our experience, one way to enable newer companies to participate is to take into account the depth of experience of the management team in the broadband industry—which can be an indication of technical capacity, if it is supported by the business and financial viability discussed above.

7.3.4 Breadth of community support

One critical criterion for assessing the viability and likely success of the grant application is demonstration of local community need and support. In our experience, this broad support usually exists in any community that applies for broadband funding. But it is advisable to request a showing of that support as means of ensuring that the community has been consulted and engaged, and a broad range of stakeholders has been part of the planning process and has demonstrated their interest and need—not only to support execution for the program, but to be users and customers of the broadband program that will emerge from the effort.

Both federal and state grant makers have found that letters of support—including, by way of example, organizations as diverse as business improvement districts, Boys & Girls Clubs, and religious organizations—serve as indicators of need and local commitments.

7.3.5 Digital inclusion benefits

Among other criteria, we recommend that the State include a showing that the program will benefit those in the community who have the least access to broadband services—whether that lack of access is because services are not available or not affordable. This is an area in which applicants should be encouraged to develop creative solutions and build them into their business and technical models, so they can meet the unique needs of their own communities.

Based on our discussions with a range of New Mexico localities over the past few years, it is our conclusion that digital equity and digital inclusion goals are driving the broadband efforts in many of those communities—as is a clear understanding that lack of access to affordable broadband puts Americans who lack that access at a huge disadvantage relative to education, health care services, access to government services, and many of the other benefits conferred by broadband access.

As the State develops its planned broadband grant program, it is critical to think strategically about how to maximize federal funding opportunities. This is not to say that the State's approach should be guided by federal priorities or goals; rather, it is a recognition that existing federal broadband grant and loan programs—particularly given the multi-billion-dollar allocations created by the Coronavirus Aid, Relief, and Economic Security (CARES) Act—could have a significant multiplier effect on the State's funds if eligibility requirements are aligned.

For example, many local jurisdictions would be hard-pressed to take advantage of federal grant opportunities that require matching funds—but State funds awarded to those communities could be a solution. In one potential scenario, State funding of 20 percent of a project's cost could unlock federal grants worth the remaining 80 percent.

That said, it is important that the State not design its grant program solely to dovetail with specific federal grant programs. Rather, the guidance presented here recommends taking a strategic approach to prioritizing the unserved areas of the State that have the greatest need, then seeking to take advantage of federal grant funding opportunities that can quickly leverage local and State-level planning for broadband solutions in those areas (without requiring any costly and time-consuming additional planning).

7.4 Provide essential strategic guidance and support through the DoIT Office of Broadband

As important as the State's grants will be to enabling local-level projects in purely financial terms, the State's strategic planning and guidance will also be essential to those applicants. Many local communities need guidance to take advantage of federal opportunities. Because current federal grant funding opportunities come in many forms (as will future opportunities), it is difficult for jurisdictions to plan in a strategic fashion that is grant-neutral and can be effectively and flexibly leveraged for a variety of grant opportunities. In addition, some federal funding may be passed through the State.

As this strategic plan illustrates, too, the State is uniquely positioned to see the broader picture—including in terms of overall economic development, long-term economic recovery following the Covid-19 pandemic, and educational policies related to distance learning.[43] And the State government is logically best-suited to act as a clearinghouse for mapping resources and future federal performance reporting when it comes to identifying residents and regions that are unserved by broadband.

For all these reasons, it is important for the State government to have a technically and strategically savvy broadband planning office that can help steer funds (both State and federal) to the areas with the most need and the areas where funds can have the most impact.

The State broadband office can also track projects underway in different localities and regions to help steer future funds in the right direction. And the State's office can play a key role in facilitating partnerships with the Department of Transportation (DOT), the Economic Development Department,[44] and other relevant departments and agencies to lead or encourage infrastructure initiatives that can help improve the broadband environment at both the State and local levels.

Indeed, some broadband infrastructure initiatives may require the State to take the lead, or at least would strongly benefit from that sort of top-level project oversight. As with transportation construction and other critical infrastructure initiatives, a State-level department can identify and balance State-level and local requirements, aligning both with overall State policies and goals.

Like a major DOT project, broadband infrastructure should be seen as a long-term investment that will yield continuous benefits over a long lifecycle. Within that framework, a State-level broadband office might even find itself guiding and incentivizing local entities away from unsustainable solutions such as satellite or fixed wireless internet access in favor of future-proof (but admittedly more costly) solutions like fiber optics where those make the most sense.

7.5 Plan State-level strategy around federal funding

When it was funded in 2019, the U.S. Department of Agriculture's (USDA) ReConnect grant and loan program represented Congress' largest allocation to support broadband infrastructure deployment in a decade. ReConnect reflected a bipartisan understanding that the rural broadband gap should be recognized as a national priority; as we discuss below, the State may be well-positioned to apply for any future rounds of ReConnect funding or similar federal grant programs.

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[43] At the time of this writing, distance learning is an essential approach for continuation of the school year. Given the uncertainty around the pandemic's spread and the timing of a possible vaccine, online classrooms may also be required for some period of time because of public-health concerns.

[44] New Mexico Economic Development Department, https://gonm.biz/.

Prior to ReConnect, the federal government's last comparable broadband funding initiative was launched by the American Recovery and Reinvestment Act of 2009—a response to the global economic crisis. We are in a similar moment today, in terms of the federal government's inclusion of broadband funding in its economic stimulus efforts. Just like in 2009, we can expect federal broadband funding to be made available in multiple ways to address a range of broadband needs.

These may include:

- Funding to create construction jobs in the short term and an engine for job growth (i.e., enabled by the new broadband services) in the long term
- Funding to promote economic recovery, which might include Infrastructure and end-user funding targeted to particularly distressed communities; such funding would likely seek to ensure that infrastructure is robust and expansive and can support connectivity to businesses and homes for the sake of business continuity
- Funding to close the homework gap, which might be funneled through the existing E-rate program (i.e., the universal services fund for service to schools and libraries) directly to schools or in expanded ways to get broadband access closer to where students live
- Funding to local governments that develop infrastructure projects or other models to quickly and efficiently enable broadband access or promote broadband adoption, particularly among families with school-aged children, elderly residents who may benefit from access to telehealth, and other vulnerable populations who would benefit from broadband-enabled services

For one-time stimulus-type programs, the emphasis will likely be on projects with large impacts (and, potentially large footprints) and the ability to ramp up quickly with ready-to-go projects. Since the emphasis is on invigorating local communities whose resources are depleted, we expect matching requirements for funding that is funneled through existing grant programs to be either relaxed or absent. For example, the $1.6 billion in funding congress added to the EDA program for Covid-19 related economic development funding (EDA CARES Act Recovery Assistance) was implemented through its existing Economic Adjustment Assistance (EAA) program—but unlike the traditional EAA program, which has a number of stringent requirements and requires at least a 50 percent match, the emergency assistance grants only require a 20 percent match.

A special type of stimulus funding are block grants provided directly to states with a wide degree of latitude in letting states determine what qualifies for funding. If a recent round of such funds is any indication, emphasis will be on applications that can be quickly reviewed for projects that can be completed in a relatively short time. (Broadband could be one of the types of eligible requests on a competitive basis.) To fully take advantage of such opportunities we recommend the State's broadband office:

- Encourage counties and local jurisdictions to consider developing broadband plans that include specific project concepts that can be implemented in the $1 million to $5 million range
- Work with the Governor's office to ensure that the broadband staff is involved in evaluation of broadband projects
- Consider developing middle-mile concepts at a regional or State level that can be leveraged for such funds

While it is impossible to know what form such projects will take, the funding they might be awarded could lower costs overall for interested ISPs to enter a market with high-speed solutions at competitive pricing—something most federal broadband programs are not designed to accomplish.

In Appendix A we outline the federal grant programs that may represent opportunities for addressing the State's rural broadband needs. For example, the Federal Communications Commission's Rural Digital Opportunity Fund (RDOF) and the USDA's ReConnect grant and loan program are the federal government's primary vehicles for delivering broadband funding to rural areas.

To the extent these programs require or favor public-private partnerships, we note that some private providers will not participate in federal grant applications as a matter of policy, so the State and its local jurisdictions will need to craft strategies that reflect the willingness of its potential partners.

7.6 Leverage federal broadband programs

The ReConnect program represents the most significant congressional appropriation of broadband funding since the Recovery Act in 2009—with $600 million allocated in 2019 and $550 million (with an added $100 million as part of the CARES Covid-19 response package) made available in 2020. The program awards loans, grants, or a combination of the two for last-mile connections in rural areas—with priority given to private-sector applications and public-private partnerships. It is overseen by the Rural Utilities Service (RUS). The most recent round of grant applications opened on January 31, 2020, and closed April 16, 2020. However, the program is well regarded in Congress and future rounds are considered likely.

Congress created a significant barrier to ReConnect funding when it wrote the legislation: It made ineligible any areas for which another grantee or loan recipient has received a previous broadband award. This is relevant for the State's consideration of appropriate partners for

ReConnect applications: A fixed wireless provider receiving an award from this program would be protected from any other subsequent applicant for the entire originally funded service area for up to 10 years.

Our models for fixed wireless, however, have not found a way to serve all unserved premises in the State, so the State might therefore risk having no remedy for some unserved premises in a claimed service area for the entire, long protection period. And the actual network performance within a fixed wireless service area varies widely from customer to customer. We therefore recommend the State prioritize applications to ReConnect for wireline solutions, or write in robust remedies as conditions of support with the partner to manage risks.

The recent round of the ReConnect program comprised three separate funding categories: 100 percent grants (covering up to 75 percent of eligible project costs, with a 25 percent match), 50 percent grants with a 50 percent loan or other form of match, and 100 percent loans. Funds will go to rural areas where 90 percent or more of the households lack access to broadband speeds of at least 10 Mbps download and 1 Mbps upload. (In Round 1, 100 percent of the households in the PFSA had to lack access to 10/1 Mbps broadband for 100 percent grant awards. [45])

Applicants had to propose networks capable of providing access to every premises in the PFSA at minimum speeds of 25 Mbps downstream and 3 Mbps upstream.

Matching funds are a point of distinction. Awarded applicants for 100 percent grant awards will need to provide matching funds equivalent to 25 percent of the project's total cost—and that matching contribution must be expended first, followed by grant funds. For 50 percent grants with a 50 percent loan or other form of match, applicants could propose a cash alternative to the loan at the time of application. (For an awarded project in this scenario, all cash proposed must be expended first, followed by loan funds and then by grant funds.)

Generally, we anticipate that USDA will continue to prioritize private-sector applications and public-private partnerships, so it will be important for local governments to build a public-private partnership strategy for future rounds of this program. RUS will consider public networks that lack extensive experience to be startups and may disfavor their applications. Should the State decide to take the lead, it should partner only with entities with extensive experience as an ISP to compete for these funds. Any experienced ISP, whether public or private, will require the strong collaboration and support of its local and state governments to present a compelling case for funding.

[45] The FCC had a similar criterion for eligibility in its Connect America Fund II auction, but raised its threshold of eligibility to 25/3 as well in its current RDOF auction. It is possible that USDA will follow the FCC's lead in adopting a similar threshold of eligibility in its next ReConnect round (or it may be mandated by Congress).

Applications to this program will require a detailed business plan and pro forma. RUS will grant application review points based on those plans, as well as many other factors. The rurality of the PFSA can earn almost 25 points alone. RUS will also award points to applications proposing to build networks capable of at least 100/100 Mbps. Additional points can be scored if the proposed area includes a health care center, education facility, or critical community facility. Furthermore, points will be awarded for projects in states with an updated broadband plan in the past five years.

We anticipate RUS will make grant/loan combinations in the $3 million to $10 million range. This is quite a bit more than RUS's Community Connect grants—and, because the program's funding is considerably larger in total dollars, we anticipate that ReConnect will make more awards. Further, ReConnect does not have the low-income requirements of Community Connect, making it a more flexible program.

7.7 Maximize the FCC's Rural Digital Opportunity Fund

The FCC's Rural Digital Opportunity Fund (RDOF) is a different vehicle for providing broadband expansion assistance. Traditional federal funding programs, such as ReConnect, provide grants and loans in order to incentivize buildout of broadband infrastructure. Payout may be phased in tandem with buildout progress or be based on eligible cost reimbursements, and are essentially capital subsidies. Capital grants and loans assume that the barrier to broadband expansion is chiefly in access to and high barrier of sufficient capital funding. In contrast, RDOF is a direct descendant of the Connect America Fund which itself is based on high cost areas subsidies to telephone companies to ensure rural and remote subscriber has access to phone service. This arrangement recognized that large telecom providers do not have a problem accessing capital funds, but simply cannot justify a ROI for getting minimal revenue in return for a high infrastructure maintenance cost. The result was the universal service fee and lifeline programs. These are designed to offer operational subsidies to make the long-term ROI work. RDOF provides operational support over 10 years.

The other aspect that distinguishes RDOF is its reverse auction format. While rare in other contexts, it is the primary method by which FCC auctions off frequency licenses. (We describe RDOF in greater detail in a federal funding guide prepared as a companion to this report.)

The eligible entity participating in the auction can be the State, or a local government or tribe, but if so, would need strong partner with operational experience. We do not expect many governments to bid in such auctions. Governments are often reluctant to compete directly with private entities as they can open themselves to political (and sometimes economic) liabilities. Conversely, unlike ReConnect, there is no matching requirement (or mechanism). Only the interested internet and voice service provider would participate in the auction. Without a matching requirement or required interfacing with local communities, and in fact any agreement could reveal one's bid strategy and distort the auction, the format does not lend itself well to public-private partnerships—although RDOF does allow for such.

In contrast, ReConnect is designed for such partnerships: apart from the various requirements regarding support from local government or tribe, the scoring for connecting a wide range of community institutions, need to conduct detailed analysis of eligible areas y delineating existing served and unserved areas, and matching requirements foster a mutual dependency and support. The local government's active participation in this process brings down what would otherwise be a substantial barrier to entry. Large incumbents do not have such barriers and can easily afford feasibility studies. But they often do not like the strings that come with federal funding or local constraints. Some will not participate in such programs, while others are happy to but prefer to do it without local government assistance and subsidies.

Because of the lower barrier of entry (the short form is very simple to complete), in RDOF, the auction format itself likely favors large providers with nearby infrastructure that can bid over large territories, and switch or shift to different areas tactically to focus on those with highest chance of award as the bid clock winds down. But smaller operators too can be well positioned if they have small nearby pockets where there are no nearby larger incumbents, and/or large players do not consider the areas to be worth entering an auction to serve.

Telecoms and electric utilities are likely the primary entities that benefit from such auctions. They are ideally suited to bid on areas and operate the infrastructure. Telecoms already have pole access (in fact, often own the poles) and may already have existing fiber optic assets already that can be overlashed on. And they are just about everywhere already, and already provide these services in a variety of places. There are no new offices, organizations, service catalogs, business processes, or resources that need to be built from scratch. Electric utilities, especially rural electric coops, are also very well suited for RDOF. They also own their own poles and have often deployed fiber assets for their own purposes already, and just need to scale existing capabilities. To local communities they are particularly welcome entrants as they reflect community values and extend infrastructure to their entire service area without cherry-picking high return customers.

While the large telecoms will bid or not based on their own interests and will not need or even want government partners, electric coops may need some planning and/or capital assistance to develop a sustainable business model.

As mentioned earlier, a potential bidder will not have the high barrier in terms of effort and time to prepare an application for RDOF. In fact, the short form, due July 15, announcing intent to and demonstrate qualification for participation in the auction is truly short. A more extensive long form is only due after assignments of areas to winning bidders. However, if a potential bidder provider does not already know the areas of interest well and need an extensive study to understand if it should engage in the auction and/or need jurisdictional or other partner support, the current RDOF round may be too late to apply. The same is true for local jurisdictions who want to find partners and see if they can convince them to participate in the auction with the right support.

There is, however, at least one more round coming and likely additional funding as well. The first round of RDOF, which will take place October 27, 2020, will be for $16 Billion. If no additional funds are added to the remaining pool, that means there will still be at least $4,6 Billion for the second round.

That being said, there could be opportunity costs for the State/local jurisdictions not encouraging the right providers to bid. As Figure 36 below shows, there is some overlap between clusters where it would make most sense to bring FTTP solutions as the most sustainable, future-proof, and speedy technology. These proposed FTTP clusters are attractive targets from a market perspective with the right incentives exactly because of the relative density which brings down both capital and operational costs. But if fixed wireless providers bid on these overlapping areas without competition from a cable or fiber provider, they could win these areas in the coming RDOF round, and the clusters may not be eligible for federal grant funding for the next 10 years in the worst-case scenario.

From a policy perspective, it is therefore in the State's (and the local communities') interest to encourage RDOF participation by high-speed wireline operators. There are a variety of conditions under which RDOF can be an attractive vehicle for high speed wireline providers:

- The providers operate nearby so expansion is low cost
- Telecoms or electric utilities that have pole access/ownership can leverage those assets even If their closest broadband infrastructure is a bit farther away
- Entrepreneurial smaller operators can find a way to affordably lease a backhaul connection from their existing home network farther away to "parachute" in to the target market
    - If they have sufficient access to capital, even the higher buildout costs can pay for itself over time
    - But they may need assistance on the capital side from state or local entities
- Access to a consortium of interested bidders would allow such providers to split costs on consulting, bid strategies, and business planning

While it is too late for the upcoming round of RDOF, the logic of potential opportunity costs (which results in a poor fit between implemented and desired technology) holds for more traditional grant programs as well, and will be relevant for subsequent rounds of RDOF. We recommend the State develop an RFI (or help localities, Pueblos, Tribes, or Nations develop RFIs) to identify interest among providers in expanding their networks with funding support. Such RFIs can gauge what kind of support is necessary and develop RDOF as one among several paths for partnerships targeting areas with appropriate technology.

The State can also encourage or facilitate the creation of consortia for smaller operators in distributed markets or clusters with a condition for participation that such operators commit to FTTP in those areas. This would enable the consortia members to cost share on planning, consulting, business modeling, and bid strategy.

7.8 Support unconnected libraries and health care facilities to plan collaboratively and aggregate demand

As part of its effort to connect all New Mexico businesses, institutions, and residences to the internet with robust bandwidth, we recommend that the State consider funding planning grants for library systems and health care facilities that are still struggling to connect one or more of their locations. This program would reflect the reality that these two anchor segments—libraries and health care—unfortunately lag the education segment with respect to connectivity.

New Mexico's efforts to connect schools over fiber optics have been enormously successful. The goal now is to achieve the same results for rural health care facilities and libraries. The purpose of the grants would be to enable broader strategic planning than is feasible from a single entity's perspective alone. The grants would support hospitals' and libraries' efforts to coordinate with other users of bandwidth to aggregate demand and plan competitive processes designed to maximize the chances of carrier deployment of infrastructure to support all stakeholder needs—including those of the unconnected libraries and rural health care facilities.

Another equally critical focus of the grant effort is to enable libraries and hospitals to coordinate with other local and regional stakeholders and to plan for how they will use connectivity and technology to support their users. The program would also help libraries and hospitals make the case for the criticality of this effort with local decision-makers—including elected officials, who are likely to be essential to providing adequate funding to meet libraries' and hospitals' technology needs over time.

To support this effort, the State should consider funding a specialist/coordinator within the Office of Broadband that can help libraries and health care facilities to leverage the E-rate and Health Care Connect funds, which are federal funding sources dedicated for this purpose. This coordinated support could help to reduce the inevitable silo of working solely from a library or health care perspective, which reduces the strength of community demand aggregation—which is a proven way to leverage resources, particularly in remote areas where adequate communications infrastructure does not exist.

It is extremely helpful for institutions such as libraries, K-12 schools, community colleges, local governments, public safety agencies, and economic development entities to coordinate broadband planning. Even if they are not able to undertake a single competitive bidding process seeking private sector infrastructure deployment or services, the coordinated effort can enable them to plan together with regard to timing, routing, services, long-term commitments, and other factors. Taken together on behalf of multiple entities, these efforts have the potential to attract private sector investment in ways that a single institution's connectivity needs are unlikely to justify.

Particularly because most carriers will require a payback on infrastructure investments that is measured in a handful of years rather than in decades, aggregating a range of different users helps to make the business case more viable for that commercial investor. And coordination around the E-rate process, which under some circumstances will fund some communications infrastructure construction, will help to further accelerate capital return on investment for the bidder.

Ideally, this local or regional coordination planning and acceleration of the business case would even lead to a competitive bidding environment to the benefit of all of the public and non-profit entities involved. This kind of planning happens in certain jurisdictions around the country and has proven quite successful in some of them. That said, many remote and rural jurisdictions struggle to access the resources or hire staff to undertake this kind of coordinated planning.

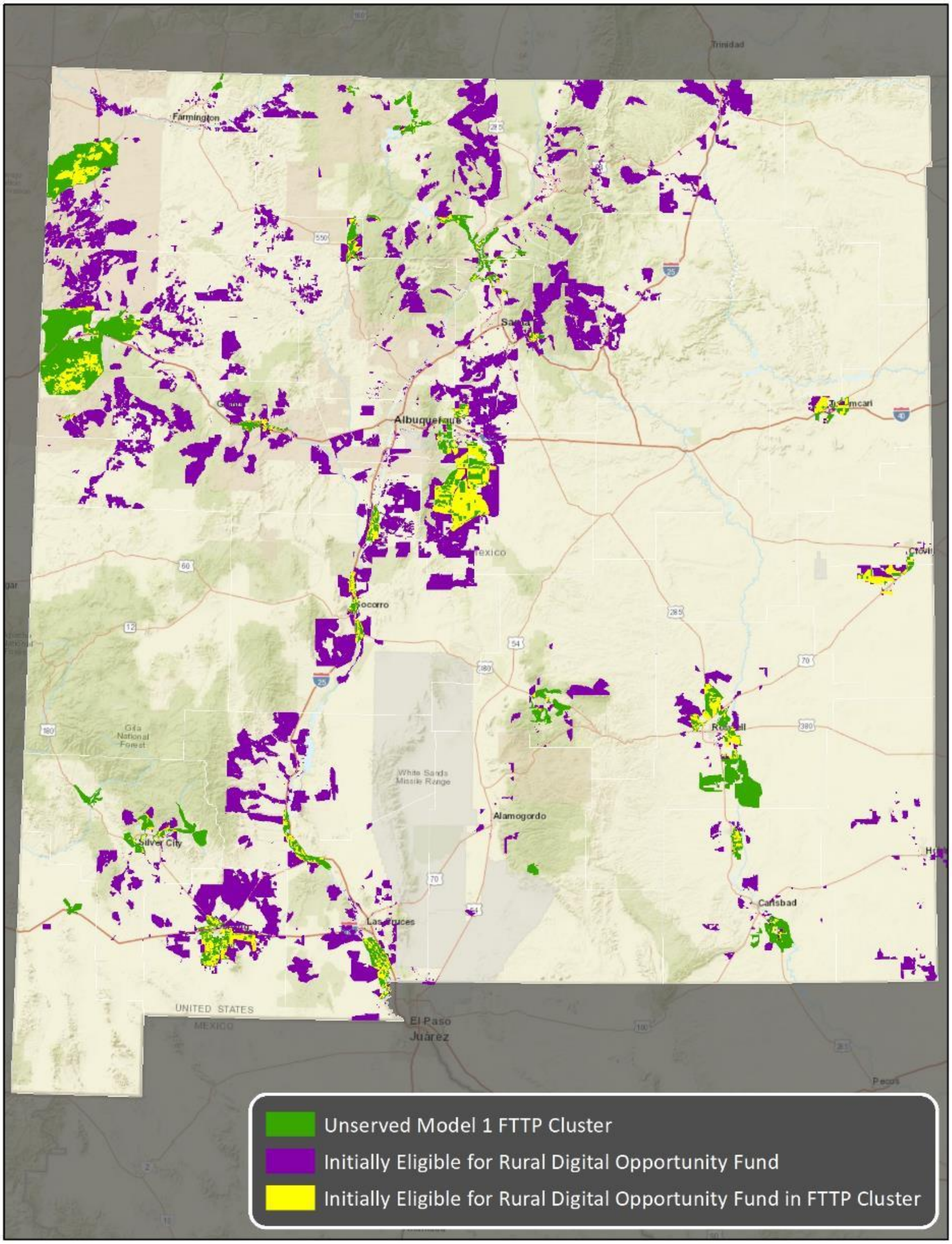
A State competitive grant program to be awarded to library jurisdictions or public health entities facing particular connectivity challenges and that are willing to take on leadership within their local communities could be an enormous help in bridging the resource gap. Planning grants can be relatively modest, perhaps measured in the range of $70,000 to $150,000. That funding would enable a concentrated six-month planning process, followed by a six-month execution process, involving a part-time effort by a skilled technology and financial planner.

Libraries in particular today and in the future are increasingly the locus of internet connectivity in remote and rural communities. A remarkable number of rural and low-income Americans access the internet in libraries, and many of them gain access to internet-enabled devices like laptops and tablets in libraries. With every day that passes, technology becomes a more critical part of libraries' mission.

Many of the best resourced and most sophisticated libraries in the United States have, for 15 years, been thinking strategically through their roles as technology hubs in the internet era, and the ways in which their focus will continue to migrate from words on a page to words on a screen, while fulfilling their traditional mission of providing access to information and educational resources to Americans. This kind of planning has been an unimaginable luxury for remote libraries or those without scale or resources, and for which day-to-day service to library patrons absorbs all available time and resources.

For these reasons, we recommend that the State fund such strategic planning efforts for the less-resourced libraries in recognition of the fact that this planning is no more a luxury than the internet is, and that this kind of planning is critical to the library—and the health care facility—of the future.

Figure 36: RDOF-Eligible Areas



7.9 Best practices and lessons learned from other state grant programs

The following are summaries of some of the innovative grant funding programs that have emerged in other states, along with lessons learned from those states' experiences.

7.9.1 Minnesota Border-to-Border Broadband Development Grant Program

Minnesota has been working to bring better broadband access to its non-metropolitan areas for over a decade, and its Border-to-Border Broadband Development Grant Program has been used as a model for other state broadband infrastructure programs. In 2010, Minnesota adopted the goal that no later than 2015, all state residents and businesses would have access to broadband service that provides a minimum download speed of 10 Mbps to 20 Mbps and a minimum upload speed of 5 Mbps to 10 Mbps. It has continued to move its benchmark as demand for bandwidth has surged, now targeting ubiquitous access to 25 Mbps download/3 Mbps upload by 2022, and 100 Mbps download/20 Mbps upload by 2026.

In 2013, legislation created the Office of Broadband Development (OBD), and in 2014, the Governor created a $20 million program called the Border-to-Border Broadband Infrastructure grant program.[46] The goal of the program is to provide state resources that help make the financial case for new and existing providers to invest in building broadband infrastructure into unserved and underserved areas of the state. The state defines an unserved area as one in which households or businesses lack access to wireline broadband service that meets the FCC threshold of 25 Mbps download and 3 Mbps upload. An underserved area is one in which households or businesses receive service above the FCC's broadband service threshold, but lack access to service that meets the State goals of 100 Mbps download and 20 Mbps upload.[47]

The Minnesota Border-to-Border Broadband Development Grant Program funds the acquisition and installation of middle-mile and last-mile infrastructure that supports symmetrical broadband service scalable to at least 100 Mbps.

Funding for the program is based on ongoing appropriations from the legislator, and as a result, funding has been inconsistent and difficult to predict. Between 2014 and 2017, the program invested $85 million, leveraging an additional $110 million in matching funds to connect more than 40,000 household, businesses and community anchor institutions. Legislators failed to fund the program in 2018, but Governor Tim Walz was elected later that year with a promise for additional funding. Although appropriations have fallen short of his proposed budget target, the legislator passed a bill giving the program a $40 million budget for the next two years. $23 million

[46] Wells, Diane, "State Broadband Infrastructure Programs," *Minnesota Office of Broadband Development*, February, 2015.

[47] "2020 Provider Broadband Service Inventory," *Minnesota Office of Broadband Development,* April 2020, https://mn.gov/deed/assets/infrastructure-grant_tcm1045-134198.pdf (accessed May 31, 2020).

in grants was awarded in the 2019 cycle, which will connect an additional 10,900 locations.[48] The Covid-19 crisis has brought more urgency to the problem, with legislators are currently debating adding an additional $10 million to the program for the 2020 cycle.[49]

7.9.1.1 Projects Eligible for Funding

The program pays up to 50 percent of the infrastructure deployment costs for a qualifying project, including project planning, the cost of obtaining permits, facilities construction, construction of middle-mile and last-mile infrastructure, equipment, and installation and testing of the broadband service. The maximum grant amount is $5 million, and applicants must provide matching funds. Matching funds can come from public, private, federal, or a combination of sources.

Applicants are only obligated to provide speeds in excess of 25 Mbps download/3 Mbps upload, but all grant-funded infrastructure must be capable of delivering a symmetrical 100 Mbps connection without requiring new construction. Grant applicants are asked to have a manufacturer or engineer certify that the installed infrastructure is scalable to speeds of at least 100 Mbps in both directions.

In 2016, the legislator changed the challenge process to allow any provider that operates near the proposed project area to stop a project from receiving a grant if they commit to providing speeds in excess of 25 Mbps download/3 Mbps upload within eighteen months. While the stated purpose was to avoid duplicative infrastructure investment, critics argue incumbents are using the process to prevent competition, without incentivizing anyone to invest in infrastructure capable of delivering an 100 Mbps connection.[50]

7.9.1.2 Applicants Eligible for Funding

Groups eligible to apply included: Incorporated businesses or partnerships, political subdivisions, American Indian tribes, Minnesota nonprofits, Minnesota cooperative associations, and Minnesota LLCs organized for the expressed purpose of expanding broadband access.[51]

The State made funding available to invest in broadband infrastructure with the goal of continuing to create more partnerships and supporting providers working to implement next-

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[48] "Gov. Walz Announces New Broadband Grants; Funding Championed in Minn. House by Rep. Ecklund," *Minnesota House of Representatives,* January 21,2020, https://www.house.leg.state.mn.us/members/profile/news/15452/26458 (accessed May 31, 2020).

[49] "MN Rural Broadband Coalition: Legislature Adjourns, No Deal on Additional Broadband Funding – May 18, 2020," *Blandin Foundation,* May 18, 2020, https://blandinonbroadband.org/2020/05/18/mn-rural-broadband-coalition-legislature-adjourns-no-deal-on-additional-broadband-funding-may-18-2020/ (accessed May 31, 2020).

[50] "End-of-Session Update," *Greater Minnesota Partnership,* May 26, 2016, http://gmnp.org/2016/05/end-of-session-update/ (accessed May 31, 2020).

[51] "Broadband Grant Program: Overview," *Minnesota DEED*, http://mn.gov/deed/programs-services/broadband/grant-program/ (accessed May 31, 2020).

generation gigabit service. Applicants have proposed a wide range of different partnership models, with private and public entities sharing costs and risks in a variety of ways. Local governments can demonstrate community buy-in by committing funds to the project using money from their general fund, loans, grants, or other funds allocated by the State.[52] The scoring criteria gives preference to applications that demonstrate strong community support.

7.9.1.3 Lessons Learned

The leadership of the OBD emphasized the importance of developing strong relationships with smaller providers who are interested and willing to participate. States should try to build them into the process, consult with them, and get their thoughts about how to structure and execute the program. Their buy-in and participation are essential to the success of the program. Cable provider opposition can potentially hurt formation of a program. However, demonstrating to the cable companies early on that a rural grant program will not impact the primarily metropolitan territories they serve can win their trust and cooperation. Charter even participated and was awarded grants in the latest funding cycle to extend its network into unserved and unserved areas of two counties.

OBD leadership also advised keeping up relationships with grantees in order to identify issues before they become problems that threaten the success of the project. If possible, states should develop a pre-established pipeline of applicants, and require robust feasibility studies from vendors in order to increase the chances of funding successful projects. Since applicants often develop applications over multiple years, interruptions in regular funding cycles can cause a project to stall and fall apart.

Developing a strategy to integrate with, and leverage federal funding sources to maximize the benefit to the state is also essential. The state changed its challenge process in 2016 in part to account for the added presence of Connect America Fund (CAF) II investments. In order to issue a challenge, providers must share build plans with the OBD, and lose their ability to issue subsequent challenges if they fail to deliver on commitments. However, existing providers can block grants by committing to delivering 25 Mbps/3 Mbps service to the proposed project area within eighteen months, without certifying that the technology used can scale to a symmetrical 100 Mbps connection, as required for all state funded projects. Critics argue incumbents are using the challenge process to prevent investment in next generation networking technology and protect outdated network from competition.

The Office of Broadband Development is housed within the Minnesota Department of Employment and Economic Development (DEED), rather than a regulatory agency, which has helped foster buy-in from service providers. Building the program within an agency that has

[52] Ibid.

experience and expertise giving and overseeing competitive grants also contributes to the success of the program.[53]

Restricting grants from paying for infrastructure that cannot deliver a symmetrical 100 Mbps connection has helped the state avoid paying for infrastructure that is already, or will quickly become obsolete. Since grant recipients have been forced to install infrastructure that can scale to a symmetrical 100 Mbps connection, their networks are well-built to handle the surge in demand for faster home broadband speeds that the Covid-19 crisis has caused.[54]

7.9.2 Maryland Broadband Infrastructure Grant Program

Governor Hogan created the Office for Rural Broadband (ORB) in 2017 to expand broadband capabilities in underserved, rural areas of Maryland. In its first two years, the ORB awarded grants of up to $100,000 to eleven small pilot projects, as well as up to $60,000 to six counties for broadband feasibility studies. In 2019, the governor announced a five-year, $100 million plan to bring broadband to 225,000 unserved and underserved rural households.[55]

In May 2020, the ORB announced it would award $7.3 million to four projects in the first round of the Maryland Broadband Infrastructure Grant Program, which, upon completion, will bring broadband access to an estimated 3,700 homes and businesses. The ORB also announced an additional $2.3 million in smaller grants through the Maryland Broadband Pilot Funding Program to eight local jurisdictions, which will connect an estimated additional 1,300 households and approximately 70 businesses. Additionally, the ORB has made grants available to assist with broadband infrastructure funding applications. This program covers as much as 100 percent of the cost of market studies, engineering, legal, financial and other approved services provided by outside consultants. These grants helped communities organize themselves and prepare to submit applications for the state infrastructure grant program, as well as federal infrastructure funding opportunities.

7.9.2.1 Entities eligible for funding

The only entities eligible to apply for the infrastructure grant program are local jurisdictions or any other legal entity, including a cooperative, private corporation, or limited liability company organized on a for-profit or not-for-profit basis that is recognized as a partner by the local

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[53] Based on interview by CTC President, Joanne Hovis, of Executive Director of Minnesota Office of Broadband Development, Danna MacKenzie, November 11, 2015.

[54] A recent OpenVault report found average consumption at the end of 1Q20 jumped to 402.5 GB, an increase of 47 percent over the 1Q19 average of 273.5 GB and a 17 percent rise over the 344.0 GB in 4Q19, and that increased usage is moving subscribers towards faster speed tiers:
"OpenVault Broadband Industry Report: Q1 2020," *Open Vault*, May 4, 2020, http://openvault.com/complimentary-report-Q120/ (accessed May 31, 2020).

[55] "Hogan Administration Announces Nearly $10 Million Rural Broadband Expansion," *Maryland Department of Housing and Community Development,* August 19, 2019, https://news.maryland.gov/dhcd/2019/08/19/hogan-administration-announces-nearly-10-million-rural-broadband-expansion/ (accessed May 31, 2020).

jurisdiction. Local jurisdictional partners must submit a letter acknowledging and documenting the extent of the partnership. This effectively transformed local authorities into the gatekeepers of state funds, placing them in a strong position to negotiate with existing and potential new providers. This allowed the ORB to leverage local authorities' comprehensive knowledge of the problem in their communities. The local jurisdictions complete their own vetting of potential providers, ensuring anyone who submits a valid application has already demonstrated their competence, and willingness to fairly share risks.

7.9.2.2 Projects eligible for funding

The ORB defines unserved as locations lacking service of at least 25 Mbps download/3 Mbps upload. The Office works with applicants to establish that a proposed funded service area (PFSA) meets the criteria of unserved ahead of time, and encourages applicants to do their own field research.

The applicant must agree to provide service of at least 25 Mbps download/3 Mbps upload to the entire PFSA. The applicant must commit a minimum of a 50 percent match, except in Priority Funding Areas where the match requirement may be reduced to 25 percent.[56]

In May 2020, the ORB offered $2.3 million in Broadband Expansion Pilot grants to eight local jurisdictions in western and southern Maryland and on the Eastern Shore. These are grants of up to $200,000 that extend existing networks to incorporate underserved or unserved household. The ORB also offered nearly $7.3 million in Broadband Infrastructure Network Buildout grants to four large scale infrastructure projects. These are grants of between $1 million and $3 million, intended to fund substantial new buildouts in unserved areas. Once completed, the ORB expects the projects to bring broadband to an estimated 5000 locations.[57]

7.9.2.3 Lessons learned

The program is only in its first year, but already results look promising. The structure of the program encourages collaborations between local jurisdictions and service providers and invites new forms of public private partnerships. The ORB shared the burden of selecting qualified applicants with the local officials who often have the clearest sense of the problem. Forcing providers to gain the support of the jurisdictions they wish to serve in order to be eligible for state grant money puts local leaders in a good position to negotiate with existing and potential new providers. Virginia's broadband grant programs also force applicants to form public private

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[56] "Maryland Broadband Infrastructure Grant Program," *Maryland Governor's Office of Rural Broadband,"* November 27, 2019, https://dhcd.maryland.gov/RuralBroadband/Documents/FY2020-Broadband-Infrastructure-Program-Grant-Application-Guide.pdf (accessed May 31, 2020).

[57] "Hogan Administration Announces Funding for Rural Internet Connectivity," *Maryland Department of Housing and Community Development,* https://news.maryland.gov/dhcd/2020/05/22/hogan-administration-announces-funding-for-rural-internet-connectivity/ (accessed May 31, 2020).

partnerships, and stakeholders say incentivizing public and private sector has been key to their programs success.[58]

The ORB also created a pipeline of potential applicants by funding feasibility studies and supporting communities as they prepare broadband infrastructure applications. This helps local leaders define the problem and look for potential partners willing to fairly share risks and rewards. It also helps ensure local officials are prepared to take advantage of any federal funding source as soon as it becomes available.

7.9.3 New NY Broadband Program

In 2015, New York allocated $500 million for the New NY Broadband Program. The New York State Broadband Office (BPO) administers the program with the purpose of incentivizing the expansion of high-speed broadband access in unserved and underserved areas. The program allocated the funds using a similar reverse auction mechanism that the FCC used in its Connect America Fund (CAF) II auction, and the FCC allowed the state to award the additional $170 million CAF support that it would otherwise have allocated in its own reverse auction.

Initially the goal was to get every New Yorker access to at least 25 Mbps download/3 Mbps upload service by 2018 at a cost of no more than $60 per month, with a prohibition on data caps. The state made significant progress towards this goal over the course of three years. The BPO allocated the $670 million in a three-stage reverse auction, funding projects that will connect roughly 256,000 locations upon completion.

Still, the initial goal proved unachievable within the timeframe and budget. Some funded projects will not be completed until 2022, and 75,628 of the most remote locations in the state will only be connected via satellite, which was available prior to the auction. HughesNet received $28.3 million in exchange for offering the 75,628 locations $60 broadband service for five years, a discounted installation fee, and a throttling limit rather than a firm data cap.[59] While the technology HughesNet uses is capable of delivering speeds in excess of 25/3 Mbps in optimum conditions, high latency makes telework, remote education and telemedicine applications frustrating, if not impossible. The speed of the service can slow in rain and snow, or during periods of congestion, or if the southern sky is partially obstructed by trees or mountains. Even the most expensive plan will have a data limit of 50 GB, less than one eight the average monthly broadband data use in the United States and Europe in the first quarter of 2020.[60] Once a

[58] Anne Stauffer, et al. "How States Are Expanding Broadband Access," *The Pew Charitable Trust,* March 20, 2020, https://www.pewtrusts.org/-/media/assets/2020/03/broadband_report0320_final.pdf (accessed May 31, 2020).
[59] Marie J. French, "Cuomo's broadband coverage program will miss 2018 deadline," *Politico,* December 12, 2020, https://www.politico.com/states/new-york/albany/story/2018/12/20/cuomos-broadband-coverage-program-will-miss-2018-deadline-756108
[60] "OpenVault Broadband Industry Report: Q1 2020," Open Vault, May 4, 2020, http://openvault.com/complimentary-report-Q120/ (accessed May 31, 2020).

household hits the limit, HughesNet will throttle the connection to 1-3 Mbps for the remainder of the month.[61]

The BPO claims that when round three commitments are completed, 99.9 percent of the state will have access to 25 Mbps/3 Mbps service, but this number is based on FCC Form 477 broadband availability data, which considers entire census blocks served if a single location has 25 Mbps/3 Mbps service. In a recent Legislative Committee on Rural Resources hearing, local broadband advocates in rural counties stressed that significant portions of their communities remain unserved, though they live in an area the FCC maps consider “served.” A member of a Broadband Committee in Duanesburg, a small town within commuting distance of Albany, explained how her committee checked utility poles and surveyed the community to make their own maps of unserved areas. They found a third of the community lacked access to a 25 Mbps/3 Mbps connection, but more than half of those unserved homes had no BPO award because they were incorrectly marked as “served” on the FCC maps.[62]

7.9.3.1 Areas eligible for funding

The program awarded funds to projects to bring service to unserved and underserved areas of the state. The BPO defined unserved as census blocks lacking 25 Mbps download/3 Mbps upload and underserved if it lacked a service that offered 100 Mbps download.

To determine what census blocks were eligible for funding, it used a combination of the FCC’s Form 477 data and a map that Charter submitted of the network expansion it has planned to satisfy merger requirements on its acquisition of Time Warner Cable. However, the Charter maps are not public, and Charter’s build out has missed multiple deadlines, with the final deadline now pushed back to September 2021. The state has already fined the company for trying to submit already served locations as part of its build-out numbers. Local officials and broadband advocates complain of being in the dark as to what locations will ultimately gain Charter service, and what locations will remain unserved.[63]

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[61] Bernie Arnason, “HughesNet Begins Offering Satellite Broadband Through CAF, NY Broadband Program,” *Telecompetitor*, April 18, 2019, https://www.telecompetitor.com/hughesnet-begins-offering-satellite-broadband-through-caf-ny-broadband-program/ (accessed May 31, 2020)

[62] Testimony of Annabel V. Felton, “Public Hearing on Rural Broadband,” *Joint Legislative Commission on Rural Resources, New York State Assembly,* September 17, 2019, https://nystateassembly.granicus.com/DocumentViewer.php?file=nystateassembly_ae073b036d5c0b320840d503fac0fc02.pdf&view=1 (accessed May 31, 2020).

[63] Panel 6, “Public Hearing on Rural Broadband,” Joint Legislative Commission on Rural Resources, New York State Assembly, September 17, 2019, https://nystateassembly.granicus.com/DocumentViewer.php?file=nystateassembly_ae073b036d5c0b320840d503fac0fc02.pdf&view=1 (accessed May 31, 2020).

7.9.3.2 Entities eligible for funding

Entities eligible to participate in the reverse auction included incorporated organizations, Native American tribes or tribal organizations, local units of government or a group of multiple units of government, cooperatives, private corporations, LLCs and groups of public and/or private sector partners.[64]

In order to participate, applicants must provide a co-investment of at least half of the total project cost. The auction rules gave preference to providers that could deliver speeds of at least 100 Mbps download, but the speed requirement dropped to 25 Mbps if no commercially reasonable bid came in for 100 Mbps service. Award recipients are obligated to provide 25/4 Mbps service for no more than $60 per month.

Any entity willing to meet these requirements could submit an application including the proposed service area, total project costs and the state investment that the applicant is seeking on a dollar-per-unit-served basis. Using the reverse auction methodology, the BPO selected the proposal which sought the lowest amount of state investment per unit served.

7.9.3.3 Lessons learned

The reverse auction method of allocating funds has some clear advantages. The administrative burden of distributing $670 million in three years through a traditional grant making process would have been significant. In a reverse auction, award decisions come down to which provider is willing to commit to meeting the service and pricing requirements at the lowest cost to the state per unit served.

One problem with awarding funds through a reverse auction is there is little room for local officials to participate in the process. At a recent Legislative Committee on Rural Resources hearing, the Supervisor of the Town of Windsor, and President of the Upstate New York Towns Association recommended that in future grant programs companies should be required to describe how municipalities were involved, and require the chief municipal office signoff on the application. She explained that in her town, the BPO awarded funds to extend fiber to numerous households that already had cable service, but failed to award funds to connect the corner of the town that is stuck on satellite service.[65]

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[64] "New NY Broadband Grant Program; Request for Proposal Guidelines," *New York State Broadband Program Office*, 2016, https://nysbroadband.ny.gov/sites/default/files/documents/new-ny-broadband/New%20NY%20Broadband%20Program%20RFP%20Guidelines-%20FINAL.PDF (accessed May 31, 2020).

[65] Testimony of Carolyn Price, "Public Hearing on Rural Broadband," Joint Legislative Commission on Rural Resources, New York State Assembly, September 17, 2019, https://nystateassembly.granicus.com/DocumentViewer.php?file=nystateassembly_ae073b036d5c0b320840d503fac0fc02.pdf&view=1 (accessed May 31, 2020).

Local officials have a far more granular understanding of the problem than state grant administrators. Forcing companies to demonstrate they are working with local leadership increases the likelihood that state funds go to companies that demonstrate a willingness to commit to working towards universal service, rather than to companies with a history of failing to deliver advertised speeds or cherry-picking the most profitable areas and preventing other providers from entering their service territory. Most municipal governments are actively working to address the digital divide in their community, and the BPO failed to tap this knowledge base, or give local officials a chance to negotiate directly with the provider that will receive state funds to connect unserved households.

BPO leadership has acknowledged that the inaccuracy and lack of granularity of the FCC's broadband availability maps has been a thorn in their side throughout this process. They have tried to reduce the problem of partially served census blocks going forward by forcing state grant recipients to serve every household in the census block, but acknowledge that this does not help underserved and unserved locations in census blocks shown to have 100 Mbps service available in the FCC's Form 477 database. [66]

The program has also received criticism for allocating funds to satellite service for the hardest to reach 75,628 households, rather than wait until enough funds were available to incentivize last-mile network construction to these locations. HughesNet received $28.3 million from the BPO in exchange for offering the eligible locations discounted installation and service for five years, and a throttling limit rather than a firm data cap. Some rural broadband advocates argue this technology was already available, and these funds would have been better used paying for incremental infrastructure expansions that could have laid the groundwork for better service options in the future.[67]

7.9.4 Maine's ConnectMaine Authority

The State of Maine created the ConnectMaine Authority in /2006 with the goal of stimulating investment in communications technology infrastructure in unserved. Since that time, the Authority has conducted fourteen grant rounds.[68] From 2007 through 2019, the Authority awarded 150 grants totaling $12.97 million through a process that solicited, scored, and awarded bids from public–private partnerships. The grants have generated an additional $12 million from

[66] Testimony of Jeffrey Norhaus, "Public Hearing on Rural Broadband," Joint Legislative Commission on Rural Resources, New York State Assembly, September 17, 2019, https://nystateassembly.granicus.com/DocumentViewer.php?file=nystateassembly_ae073b036d5c0b320840d503fac0fc02.pdf&view=1 (accessed May 31, 2020).
[67] Tim Fenster, "Broadband Delays Prompt Frustration in Rural New York," *Government Technology*, April 2, 2018, https://www.govtech.com/network/Broadband-Delays-Prompt-Frustration-in-Rural-New-York.html (accessed May 31, 2020).
[68] "Award Recipients; ConnectMaine Authority Grant Program," *ConnectMaine,* https://www.maine.gov/connectme/grants/award-recipients (accessed May 31, 2020).

private and local funding sources, and have helped bring wired broadband to more than 40,000 households across the state.[69]

7.9.4.1 Areas eligible for funding

The ConnectMaine Authority focuses on unserved areas of the state and the Authority included defining the terms as part of its mission. In line with the current federal standard, it defines unserved locations as addresses lacking access to 25 Mbps download/3 Mbps upload service. However, it uses a symmetrical 10 Mbps as its own standard for broadband, and grant recipients are forced to build to this standard. It explains its reasoning as follows:

> "Upload speeds are particularly important for businesses and telecommuters, which use real time video-conferencing or cloud-based services. The new standard of 10 Mbps symmetric (both up and down) is fast enough to allow customers to do these activities and many others—services that customers in many parts of the country take for granted. Adopting a symmetric standard is especially important for Maine, where many businesses are small businesses for whom upload speeds are as important as download speeds." [70]

Recognizing the inadequacy of the FCC's broadband availability data, Maine forces private providers to attend town meetings in areas they serve in order to allow citizens to dispute companies' service availability data in person.[71] The Authority works to create its own comprehensive database of unserved location, and recently submitted its data to the FCC to demonstrate the enormous number of unserved locations in Maine that will be ineligible for funding in the first phase of the Rural Digital Opportunity Fund because of inaccurate maps.[72]

The funded projects are mostly small FTTP or wireless last-mile networks, often built off the backbone of the Three-Ring Binder fiber project, a Recovery Act-funded project of over $25 million that built three rings of fiber running along the eastern and southern sides of the state, connecting the northernmost tip to the southernmost tip. The Three-Ring Binder is an open-access, middle-mile network completed in 2012. Although the network sold to a private, Albany-

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[69] "ConnectMaine Authority Annual Report to the Maine State Legislature," *ConnectMaine*, January 15, 2020, https://www.maine.gov/ConnectMaine/sites/maine.gov.ConnectMaine/files/inline-files/ConnectMaine%20Authority%20Annual%20Report%202020.pdf (accessed May 31, 2020).

[70] "Maine Overhauls Broadband Policy," *Ratewatcher Guide*, Summer 2015, https://www.maine.gov/meopa/sites/maine.gov.meopa/files/inline-files/Ratewatcher-2015.pdf (accessed May 31, 2020).

[71] Ryan Johnston, "In States, Concern with Fairness of FCC's Rural Digital Opportunity Fund," *StateScoop*, February 12, 2020, https://statescoop.com/states-fcc-rural-digital-opportunity-fund-fairness-mapping/ (accessed May 31, 2020).

[72] "Comments of the State of Maine ConnectME Authority and the Maine Broadband Coalition," *FCC WC Docket No. 19-126*, https://prodnet.www.neca.org/publicationsdocs/wwpdf/92319maine.pdf (accessed May 31, 2020).

based ISP in 2019, the new owner is required to continue making dark fiber available on an open-access basis.[73]

7.9.4.2 Entities eligible for funding

The communities applying for grants are required to partner with one of the telecommunications providers already serving customers in Maine. Each grant applicant was required to show a partnership between a municipality, county, or regional authority, and an established ISP.[74]

The ConnectMaine Authority's funds come from a 0.25 percent surcharge on all communications, video, and Internet service bills in Maine, as well as a onetime $2.5 million cash contribution from Verizon, per its agreement with the Maine Public Utilities Commission as a condition of the sale of its local telephone lines. The surcharge generates approximately $1.1 million per year.[75] With a declining number of video subscribers, the authority faced declining revenue over the last few years, so the legislator added an additional 10 cent per line charge on landline phone service beginning in 2020.[76]

The Authority has set a goal of bringing high-speed broadband to 95 percent of the state by 2025, but acknowledges the legislator will need to allocate a great deal more funding to make this happen. In its' 2020 Broadband Action Plan, the ConnectMaine Authority estimated it will take $600 million to bring high speed broadband connections to 95 percent of the state, and recommended the state allocate $200 million over the next five years in order to leverage federal and private funding sources.[77] In 2019, legislators narrowly voted against issuing a $15 million broadband bond to expand the infrastructure grant program, but in response to the Covid-19 crisis, legislators have once again introduced multiple bills to provide additional appropriations to the ConnectMaine Authority.[78]

7.9.4.3 Lessons learned

The ConnectMaine infrastructure grant program has successfully forced community broadband champions and local service providers to work together to tackle the unique challenge of deploying broadband infrastructure throughout sparsely populated communities. The grant program supplies a maximum of half of the total project funds, with the other funds coming from a combination of the private provider and the community partner. Many of the funded projects

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[73] *https://www.pressherald.com/2019/05/17/despite-conflict-new-3-ring-binder-overseer-promises-to-play-fair/#*

[74] "Infrastructure Grants," *ConnectME Authority*, https://www.maine.gov/connectme/grants/infrastructure-grants (accessed May 31, 2020).

[75] Ibid.

[76] "State of Maine Broadband Action Plan," *ConnectME Authority*, January 2020, http://www.peninsulautility4broadband.org/uploads/1/5/1/9/15195878/state_of_maine_-_statewide_broadband_action_plan_2020.pdf (accessed May 31, 2020).

[77] Ibid.

[78] Dan Neumann, "As Mainers shift their lives online, not everyone is connected," *Maine Beacon*, March 27, 2020, https://mainebeacon.com/as-mainers-shift-their-lives-online-not-everyone-is-connected/

have built on the success of the federally funded "Three Ring Binder" middle-mile fiber project, which provides dark fiber on an open-access basis to ISPs in many remote regions of the state.

In the beginning, the ConnectMaine Authority allowed incumbent ISPs to challenge grant applications if they already had infrastructure or plans to construct it soon. Over the course of the ConnectMaine project, incumbents made roughly half a dozen challenges, most of them successful. The intent was to allow the private sector to take care of areas they were already covering or planning to cover, thus reserving public funds for unserved areas. However, a challenge was overturned in one case, when local citizens acted collectively to prove the incumbent's services provided speeds below the "served" definition. The challenge option has since been removed for that and other reasons.[79]

Since 2016, the Authority also provides planning grants to help communities develop plans or prepare to apply for state or federal broadband infrastructure grants. After three years of planning grants, the Authority saw that many communities had trouble maintaining momentum as they move from the planning stage to implementation. In response, in 2019 the Authority broke the planning grant into two separate phases. An initial planning grant helps community leaders understand the scope of the problem and build support for a solution, and then a second phase helps fund a thorough feasibility study and engineering analysis.[80] Completing the two phases of the planning grants improves communities' ability to apply for both state and federal broadband infrastructure grants.

The ConnectMaine Authority works synergistically with local non-profits that provide additional support for the planning and engineering phase of projects, as well as with federal infrastructure grant opportunities. Keeping with the FCC's standard of "unserved" to mean a household lacking 25 Mbps download/3 Mbps upload ensures proposed project areas are also eligible for federal funding sources, but the Authority forces state grant recipients to build to its symmetrical 10 Mbps standard. Forcing providers to build networks with greater upload capacity helps ensure funded projects can support business applications in rural communities for years to come. Symmetrical connections enable high quality video-conferencing applications that have become fundamental to telework, remote education and telemedicine during the Covid-19 crisis.

7.9.5 The California Advanced Services Fund

The California Advanced Service Fund (CASF) was created in 2007 to provide grants to bridge the digital divide in unserved and underserved parts of the state. The CASF is administered by the California Public Utilities Commission (CPUC) and contains multiple accounts it uses to pursue

[79] Based on interview by CTC staff of Executive Director of the ConnectMaine Authority of Phil Lindley, November 25, 2015.
[80] "Planning Grants," ConnectME Authority, https://www.maine.gov/connectme/grants/planning-grants (accessed May 31, 2020).

this goal, including an account to directly fund broadband infrastructure, an account to assist infrastructure grant applicants in the project development and grant application process, and an account to address barriers to adoptions. The CASF is funded through a small assessment on telephone and VoIP services.

The Broadband Infrastructure Grant Account is by far the largest. It began with a $100 million allocation, and has expanded to $300 million, though the whole program can only collect $66 million per year, and the infrastructure grant account gives out grants for a fraction of available funds on a rolling basis. The State provides grants for up to 70 percent of construction costs for projects in unserved areas and up to 60 percent of construction costs for projects in underserved areas. Since 2008, the account has awarded a total of $270.7 million to 77 last-mile, middle-mile and hybrid projects. Of these, 40 have been completed and 37 report to be ongoing. Upon completion, they will bring a service of at least 6 Mbps download/1 Mbps upload to 320,734 estimated households.[81]

The grant program has gone through different phases as the governing legislation has tweaked eligibility and grant requirement. In its early years, internet service providers that were not registered telephone companies were barred from participating. During this period, incumbents used much of the available funds on middle mile infrastructure, without building last mile connections to unserved and underserved households. After legislation opened the fund to non-telephone corporations, independent service providers were able to successfully access funds to build new fiber and fixed wireless infrastructure to reach unserved and underserved homes. However, later legislation strengthened incumbents' right of first refusal, excluded areas where incumbent providers claim they plan to provide service, and lowered the threshold that qualified a household as "served" so low that telecom companies could meet the service threshold without substantial new investment in their aging copper plant. As a result, the number of households eligible for CASF support shrank from 300,000 to about 20,000.[82]

As a result of these changes, new applications slowed to a trickle until this year when the Covid-19 crisis brought the digital divide into the headlines. This year, grants submitted ask for almost

[81] "2019 Annual Report," *California Advanced Service Fund,* April 2020, https://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Communications_-_Telecommunications_and_Broadband/2019%20Annual%20Report%20California%20Advanced%20Services%20Fund%202.pdf (accessed May 31, 2020).

[82] "Analysis of AB 1665," *Senate Committee on Energy, Utilities and Communication,* July 3, 2017, https://www.tellusventure.com/downloads/policy/ab1665/senate_euc_analysis_ab1665_10jul2017.pdf (accessed May 31, 2020).

double the total available funds in the account,[83] and the crisis has lawmakers once again discussing the fund's future. Broadband advocates have backed a bill that would increase the threshold of "served" to households that have a symmetrical 25 Mbps connection, and gives priority to applicants proposing to use future-proof infrastructure that can deliver a symmetrical 100 Mbps connection without new construction.[84] The California Senate's Energy, Utilities and Communications Committee recently approved the bill, and it is now headed to the Senate Appropriations Committee.[85]

7.9.5.1 Projects eligible for funding

The goal of the CPUC's Broadband Infrastructure Grant Account is to approve funding for infrastructure projects that will provide broadband access to no less than 98 percent of California households, however the legislator continues to debate what should constitute as "served." The CASF originally provided grants to assist in the building and/or upgrading of middle-mile and last-mile broadband infrastructure in areas that are unserved or are underserved by existing broadband providers, but subsequent legislation prioritized last-mile projects. The funded projects use a range of technologies including DSL, fixed wireless, and FTTP.

Originally, underserved was defined as no wireline or wireless carrier offering service at advertised speeds of at least 6 Mbps download and 1.5 Mbps upload. Assembly Bill No. 1665 changed the definition of unserved to locations lacking service with advertised speeds of at least 6 Mbps download and 1 Mbps upload. Lowering the minimum upload speed by 0.5 Mbps has allowed the incumbent telecommunication companies to meet the minimum service requirement without substantial upgrades to their existing copper plant, and the expanded right of first refusal has made it easier for incumbent providers to block new applicants from receiving grants that would allow them to enter the incumbents' existing service territory, even when the service they offer falls dramatically short of the federal definition of "broadband." Organizations looking to build infrastructure in served areas are not permitted to apply, unless the organization can prove that speeds in that area are not as high as incumbent providers claim.[86]

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[83] Steve Blum, "Total California broadband grant ask grows to $528 million, twice what's available," *Steve Blum's Blog*, May 6, 2020, https://www.tellusventure.com/blog/total-california-broadband-grant-ask-grows-to-528-million-twice-whats-available/ (accessed May 31, 2020).

[84] Ernesto Falcon, "California Legislator Introduces Fiber Broadband for All Bill," *Electronic Frontier Foundation*, April 6, 2020, https://www.eff.org/deeplinks/2020/04/california-legislator-introduces-fiber-broadband-all-bill (accessed May 31, 2020).

[85] Iridian Casarez, "Bill to Fund Broadband Infrastructure Moves Forward" *North Coast Journal,* May 26, 2020, https://www.northcoastjournal.com/NewsBlog/archives/2020/05/26/bill-to-fund-broadband-infrastructure-moves-forward (accessed May 31, 2020).

[86] "California Advanced Services Fund (CASF) Application FAQs," California Public Utilities Commission, https://www.cpuc.ca.gov/General.aspx?id=1076#PQ11 (accessed May 31, 2020).

7.9.5.2 Applicants eligible for funding

In the original legislation, CASF funding was only available to entities with a Certificate of Public Convenience and Necessity (CPCN) that qualify as a "telephone corporation" or wireless carriers that are registered with the CPUC. Subsequent legislation allowed all facilities-based broadband service providers to apply for CASF funds, prioritizing projects that offer last-mile broadband access to unserved or underserved households. The program now prohibits applicants from applying to serve areas where incumbents have announced plans to improve service, and provides incumbents in underserved areas a right of first refusal for funding support if they make a commitment to upgrade their facilities in the proposed project area.[87]

7.9.5.3 Lessons learned

CASF has gone through multiple phases, as the legislation governing the fund has tweaked eligibility and grant requirements. It provides an instructive example of how seemingly small changes to eligibility requirements and service thresholds can have major impact on how the funds are used.

Initially eligibility requirements for grant applications were overly restrictive, resulting in too few applications and too large a surplus of funding—the CPUC received only five applications in the October 2012 application period, even though it still offered more than $40 million of the second $100 million allocated in 2010. Based on letters from private companies and the California public, the CPUC realized that requiring applicants to possess a CPCN or a Wireless Identification Registration (WIR) was the aggravating factor, because it cut out the 28 wireless ISPs (WISP) already operating cost-effectively in rural areas, as well as American Indian tribes trying to build infrastructure on their tribal lands.

Additionally, the large telecommunications companies were using their grant money to focus almost exclusively on middle-mile infrastructure instead of building new last-mile connections to unserved homes and businesses. A great deal of public money was used without getting much closer to the goal of having 98 percent of California households' access to the minimum service threshold. To remedy the situation, the CPUC lobbied the state legislature to prioritize last mile projects and remove the restrictions on eligibility, which the legislature did at the end of 2013 with SB 750. The legislature initially rejected the idea of loosening eligibility requirements because organizations not holding CPCNs or WIRs are subject to less direct regulatory control, which raised concerns about the potential for waste, fraud, and abuse. However, the CPUC has

[87] Kevin Fitzgerald, "Connected at a Cost: Is the 'Internet for All Now Act' a Lifeline for Rural Communities—or a Big Giveaway to the Telecom Industry?" *CV Independent,* September 20, 2017, https://www.cvindependent.com/index.php/en-US/news/local-issues/item/4078-connected-at-a-cost-is-the-internet-for-all-now-act-a-lifeline-for-rural-communities-or-a-big-giveaway-to-the-telecom-industry (accessed May 31, 2020).

been able to make use of previous grant-allocation models to develop pathways to oversee and regulate the work of the grantees, satisfying the legislature.

For a few years, both incumbents and competitive providers successfully used funds to build new last-mile infrastructure in unserved and underserved communities. Then in late 2017, AB 1665 changed the threshold of “served” households from locations lacking 6 Mbps download and 1.5 Mbps upload service to 6 Mbps download and 1 Mbps upload service, and made it easy for incumbent telecom and cable companies to prevent competitors from applying for support to serve areas near incumbent’s existing service territory. Since then, new applicants slowed (until the onset of Covid-19) and much of the money has gone to pushing aging DSL networks to their technological limit. While AT&T and Frontier would have needed to make substantial investment in network upgrades to deliver uploads speeds of 1.5 Mbps, the 1 Mbps upload threshold was largely achievable over aging copper lines. Somewhat ironically, around the time the legislator lowered the upload threshold, the CPUC published a report detailing AT&T and Frontier’s pattern of persistently disinvesting in infrastructure in rural and low-income areas between 2012 and 2017.[88]

While lowering the threshold of “served” to a point where existing copper infrastructure can deliver minimum service effectively shrank the number of “underserved” households, it failed to encourage new investment in last-mile networks that are capable of the symmetrical connections needed to support the telework, remote learning and telemedicine applications that have proven critical during the Covid-19 crisis. Much of the state money went to upgrading infrastructure that is incapable of meeting the bandwidth demands of today, to say nothing of tomorrow. AB 1655 provides an example of how broadband grant programs can become ineffective when incumbent service providers have too much say in crafting the governing legislation.

Despite its flaws, CASF has been an important tool that the CPUC continues to use to narrow California’s digital divide. In addition to providing grants to extend broadband infrastructure in unserved and underserved areas, it helps support broadband adoption efforts and the planning and grant writing efforts of local broadband advocates. The Covid-19 crisis will inevitably push the fund into its next phase of evolution, and the CPUC will continue to work within the limits of the governing legislation to use the fund to narrow California’s digital divide.

[88] “Examination of the local telecommunications networks and related policies and practices of AT&T California and Frontier California; Study conducted pursuant to the California PUC Service Quality Rulemaking 11-12-001, Decision 13-02-023, and Decision 15-08-041,” *Economics and Technology*, April 2019, https://www.tellusventure.com/downloads/cpuc/quality/cpuc_network_examination_2010_2017_executive_summary_redacted_22jul2019.pdf (accessed May 31, 2020).

8 The Challenges with Collecting Accurate and Complete Broadband Data

This Section of the Plan discusses the challenges with broadband data. It summarizes what New Mexico can expect from the FCC's new Digital Opportunity Data Collection (DODC) program, which should result in more accurate maps, but the timeline for the new maps remains uncertain at this time. For that reason, we follow with a discussion of how different state broadband grant programs are overcoming the lack of good data and conclude with some observed best practices in light of New Mexico's commitment to addressing rural broadband challenges and its history of successful broadband mapping.

New Mexico has, for more than a decade, maintained extensive maps of the types of broadband services available in different parts of the State. The work has been undertaken within DoIT by the Office of Broadband and Office of Geospatial Initiatives.

We recommend continuing this important effort. DoIT's methodology represents an efficient, low-risk approach to developing the data, maps, and insights the State and its companies need because it collects and aggregates the best and most extensive data available regarding the presence of broadband in New Mexico. DoIT uses a wide range of diverse datasets in order to achieve the most comprehensive and insightful possible combination of data. This approach enables the State to conservatively and realistically assess the usefulness (and weaknesses) of different datasets, expand on existing data, and build a reasonable, defensible methodology for broadband mapping.

In the meantime, the federal Broadband DATA Act has become law, though it is not yet funded. Given that state of mapping uncertainty and the potential for appropriation of significant mapping funds by Congress in the near future, we recommend against costly State mapping efforts in the near-term that could prove to be moot once federal direction and federal funding are made available.

It is difficult to address a problem you cannot clearly understand, but unfortunately there is no way to see a fully accurate picture of what parts of the country lack broadband access. By the FCC's own admission, its current maps of broadband availability in the United States are inadequate. They are based on Form 477, which collects data by census block. Whole census blocks are considered "served" if a service provider could provide service to a single address in the block, even if providing such service necessitates new network construction, and there is currently no way for states, municipalities or citizens to challenge the data. There are no consequences when a company admits an error, as AT&T recently did about nearly 3,600 census blocks.[89] BroadbandNow Research recently completed a study that suggested the actual number of unserved households to be closer to 42 million, double the 21.3 million that the FCC estimated in its 2019 Broadband Deployment Report.[90]

The FCC announced a new data collection program that will create more accurate maps, and Congress has asked it to publish details by late September. However, Congress neglected to appropriate the funds needed to build the underlying location fabric and submission portal. Once funds are appropriated, it will still likely take almost two years before the FCC can publish rules, receive submissions, address inconsistencies and make the data available in a useful form. We are unlikely to have more granular, accurate maps of broadband availability before 2022.

The gap between the FCC's map and the reality of broadband access leave millions of Americans ineligible for federal universal service subsidies. Each state with a broadband grant program for is forced to come up with its own strategy to overcome a lack of accurate maps. States like Minnesota, California and North Carolina have invested millions of dollars in creating their own, more accurate maps of broadband availability. Other states, including Alabama, Tennessee, Virginia and Wisconsin use the Form 477 maps as the starting point for their grant programs, but establish protocols for how applicants can challenge the maps and demonstrate that the proposed project area is unserved. Most states also offer incumbent operators a chance to challenge a grant if they can show that they already serve, or commit to serving, part of the proposed project area within a given timeframe.

8.1 The Digital Opportunity Data Collection Program and the Broadband DATA Act

In August, the FCC took the first step towards improving its map of where broadband services are available with the announcement of the Digital Opportunity Data Collection (DODC) program. By its own admission, the maps that the FCC currently uses grossly overstates broadbands availability. These maps are based on Form 477 reporting, which asks ISPs to list every census block where they could provide broadband service. The inaccuracy of these maps make unserved areas in census blocks where an ISP could provide service to one address ineligible for universal service subsidies, including the Connect America Fund and soon, the first phase of the Rural Digital Opportunity Fund (RDOF), which will distribute 78 percent of the available $20.4 billion. While the timing of DODC implementation remains unknown at this time, the data collection program will go into effect in time for the second phase of RDOF to distribute the remaining 22 percent of the funds.

[89] https://ecfsapi.fcc.gov/file/104101431124557/RDOF%20Challenge%20Process%20WC%20Docket%20No.%2019-126.pdf

[90] https://broadbandnow.com/research/fcc-underestimates-unserved-by-50-percent

The Report and Order (RO) that the FCC adopted in August establishes new reporting requirements for fixed broadband providers in order to generate more accurate maps. The DODC will require wired and fixed wireless broadband providers to submit coverage polygons that show where each tier of their broadband services is available. They must submit different polygons for every combination of maximum upload and download speed, differentiate between business and residential service offerings, and report what networking technology is used to deliver the service.[91]

The RO also closes a loophole that previously allowed ISPs to claim that a location is served even if establishing that service requires substantial new network construction or exorbitant service activation fees. ISPs will only be able to report a location as served if it, “has a current broadband connection or it could provide such a connection within 10 business days of a customer request, without an extraordinary commitment of resources, and without construction charges or fees exceeding an ordinary service activation fee.” Wired service providers are expected to already have fiber, cable or copper passing a location and fixed wireless providers are expected to already have base stations installed.[92]

The RO includes a Second Further Notice of Proposed Rule Making in which the FCC seeks comments on a process by which state and local governments and citizens will be able to challenge the accuracy of ISPs coverage polygon. At this time, it is unclear what the challenge process will look like, and what kind of consequences an ISP will face if the map they submit proves to be inaccurate. The Second Further Notice of Proposed Rule Making also seeks public comment on how to improve the FCC’s maps of where mobile data and voice services are available.[93]

In March, Congress passed bipartisan legislation known as the Broadband DATA Act to mandate that the FCC improve its map of broadband availability. The legislation provides more specificity about what the FCC should consider for its technical reporting requirements, but mostly just reaffirms what the FCC already proposed to do in the DODC RO. However, the Act establishes a deadline for the new data collection process, providing the FCC one hundred and eighty days to issue final rules for the new data collection procedure.

The Broadband DATA Act and the DODC Report and Order diverge most significantly over the role of the universal service fund and the Universal Service Administrative Company (USAC). The DODC Report and Order directed USAC to create the submission portal and oversee the new data collection process. The Broadband DATA Act explicitly prohibits the FCC from delegating

[91] https://docs.fcc.gov/public/attachments/FCC-19-79A1.pdf
[92] Ibid.
[93] Ibid.

responsibility to USAC, and from using any funds from the universal service program to cover any of the costs associated with the new data collection process.

Although the Broadband DATA Act intended to expedite the process of getting better broadband availability maps, it may end up having the opposite effect unless Congress appropriates funds to implement the act. Creating the location fabric that will underly the new maps will cost tens of millions of dollars on its own, and the FCC also needs to establish technical standards for wireless providers and create a submission portal that complies with the Federal Information Security Management Act (FISMA). The FCC could begin collecting and publishing shapefiles before it builds the underlying location fabric, but it would be difficult to say what locations are covered in each shapefile, making the data unsuitable for funding decisions. Without additional congressional appropriation, it is unlikely that the FCC will meet the one hundred eighty-day deadline Congress has set for it.

Even if Congress appropriates money for this effort tomorrow, we are unlikely to see new maps before 2022. It will take the FCC at least six months to publish the final rules, and then providers will have at least six months before they must make their first submission. It will then take a few more months for the FCC to sort through the data, correct any errors, and compile the coverage maps so that they can be published and used to determine what parts of the country are eligible for universal service subsidies, and for state broadband grant programs that rely on the FCC's dataset.

Despite recognition that the current maps are inaccurate, the FCC still plans to move forward with the first phase of its RDOF using its existing maps to establish what locations are "unserved," and therefore eligible for the $16 billion in available funds. The FCC plans to make these funds available through a reverse auction starting early next year. A second phase will distribute an additional $4.4 billion in funding using the new maps that the DODC generate to begin to address the problem of unserved locations in census blocks that the current maps consider having broadband services available.[94]

8.2 Best practices in establishing eligible areas and handling disputes

Since better broadband availability maps are still years away, we reviewed what other states are doing to allow both grant applicants and existing providers to weigh in on whether or not a proposed project area meets their state's definition of "unserved." Detailed descriptions of a few different states' approach to the problem follows, but first we offer a few best practices that seem to simplify and expedite the process of establishing eligible areas and handling disputes.

[94] https://www.benton.org/blog/what-rural-digital-opportunity-fund

8.2.1 Hold providers to the DODC reporting standards

First, while the FCC has not yet published detailed submission instructions for its DODC program, it has shared the type of data it will soon require and asserted stricter parameters to reduce providers ability to overreport the area they serve. Since broadband providers need to start preparing for the additional reporting requirements anyway, states can now hold providers to a higher reporting standard without causing an undue burden.

Specifically, a state can now request that both grant applicants and challengers submit detailed shape files showing what service tiers they have, or propose to have, available in what locations, as they will be forced to do when the DODC program goes into effect. Challengers can no longer claim that this level of detail will expose proprietary information since Congress has already mandated that they share this data publicly. Until the FCC shares its underlying location fabric, it may still be difficult to determine whether a given address is or is not included in a polygon, but the added granularity of the shapefiles should help resolve some disputes regarding the eligibility of certain proposed project areas.

Some disputes over eligibility stem from the fact that an existing provider has infrastructure nearby to a proposed project area, even if providing service to the area would require additional network construction. New Mexico can follow the FCC in tightening the definition of “served” to only refer to those locations that a provider can establish service within 10 business days of a customer request, without an extraordinary commitment of resources, and without construction charges or fees exceeding an ordinary service activation fee. Providers wishing to challenge the eligibility of a proposed project area can be asked to provide evidence that existing infrastructure can be used to extend service to locations in the disputed area within 10 business days, and for a binding commitment not pass construction charges on to the customers in these areas.

8.2.2 Provide guidance and transparency on how to make the case for eligibility

States can also reduce conflicts over eligibility by making explicit what kinds of data it will accept, and what kind of data it prefers, when trying to determine whether a proposed project area meets its definition of “unserved.” North Carolina does this well, informing applicants that it will accept scrubbed survey data with speed tests, or sworn affidavits from citizens detailing their current service offerings, in order to determine whether a proposed project area is eligible for funding. This removes uncertainty for applicants and makes it easier for grant administrators to explain why a grant is denied if the data it submitted to establish eligibility does not meet the state’s standard.

Similarly, states can reduce the incidence of disputes by providing challengers with clear guidelines about what data they need to submit as part of a grant challenge, and what types of data is most preferable. Virginia strongly encourages challengers to submit third-partied verified speed tests for technologies that can have variable speeds. The more guidance and transparency a state can offer about what it looks for in data to establish eligibility, the easier it is for the grant administrator to dismiss grants and challenges that fail to submit an acceptable dataset, or to settle disputes between varying datasets.

8.2.3 Establish protocols for resolving disputes

When applicants and challengers disagree on whether an area meets the state's definition of "served," it falls on grant administrators to mediate. Establishing a protocol for resolving disputes helps ensure all parties feel they were treated fairly by the process. The North Carolina legislator recently added a section to the legislation governing its broadband grant program explaining how Broadband Infrastructure Office will use a speed test, with a preestablished methodology, to resolve disputes. If a grant applicant and challenger dispute one another's claims in Tennessee, the state Department of Economic and Community Development sends a contractor to the disputed area to evaluate the capabilities of available infrastructure.

8.2.4 Encourage direct communication between applicants and existing providers

Grant applicants and existing providers will likely be in direct competition with one another in some parts of their territory and may be justifiably wary of sharing any information beyond what is publicly available with one another. Still, existing providers will eventually learn about a grant application for areas near their service footprint, and the grant applicant will eventually learn whether the existing provider can demonstrate the ability to provide the state's minimum definition of broadband service. Virginia forces applicants to document their correspondence with existing providers in the area, informing them of their intention to apply for a grant and asking for maps of what services they have available in the area nearby. In Minnesota, grant applicants must ask existing providers for plans to extend of upgrade service in the proposed project area. Existing providers will not necessarily respond, but sometimes they will let the applicant know of their intent to challenge specific locations in the proposed project area. The applicant can then amend the application to exclude those areas, reducing the administrative burden on the grant administrators.

8.2.5 Decouple eligibility decisions from the grant award process

Decisions about what parts of the state are eligible for grant funding do not necessarily have to happen in conjunction with the grant award process. Minnesota has put a lot of resources into creating its own map of broadband availability in its state, but still admits that the map is a work in progress. The grant application invites applicants to challenge the map at any time, ideally before the application deadline. This gives administrators time to work with the applicant to collect satisfactory data to establish that the proposed project area is eligible before the administrators are under time pressure to announce grant recipients.

8.2.6 Encourage local governments to put their unserved areas on the map

Local officials are often all too aware of where the unserved areas of their community are located. In states like Minnesota and North Carolina, local officials were encouraged to participate in mapping efforts and challenge the maps reliability if it failed to reflect the reality on the ground.

Creating a clear mechanism for local officials to submit sufficient evidence to designate an area as "unserved" on the state map will help potential grant applicants understand where there is enough money on the table to make investment in a grant-supported network expansion worthwhile. This will also help put local officials in a better position to challenge the new DODC maps when they come out, potentially helping make their unserved areas eligible for federal support through the Rural Digital Opportunity Fund, or other universal service fund programs.

8.2.6.1 North Carolina

North Carolina makes explicit that its Growing Rural Economies with Access to Technology (GREAT) Grant Program is available to portions of rural census blocks that lack 10/1 Mbps. To create the base map for their grant program, the Department of Information Technology adds overlays multiple data layers to the Form 477 maps to create a more accurate picture of eligible areas. The state's Director of the Broadband Infrastructure Office explains their strategy:

> "First, we are aggregating data from various sources to create a more comprehensive and accurate map. We do this by taking the FCC data and overlaying it with additional data, including locations where telephone companies have received federal funding to provide service. We then use satellite imagery and state parcel data to identify locations not served through the ISP's federally funded expansions. We partner with other state agencies, such as the Department of Transportation, to map key infrastructure. And we maintain a database of all vertical assets (water towers and towers) in the state.
>
> Second, we subscribe to commercial services that help identify the location of fiber optic cables and cell phone towers and other infrastructure. These tools help our technical assistance advisors locate communications equipment and infrastructure when developing solutions for communities and internet service providers working to connect unserved areas.
>
> Third, we have created an online speed reporting map. Any North Carolinian can visit our map, enter their address, and take a speed test. We receive the data and plot it on the map. If there is no service at the respondent's household or business, they can simply click a box, enter their address from work, a library or mobile device and we'll plot that location.
>
> Fourth, we are working with smaller providers and middle-mile providers, such as MCNC, to map their infrastructure and locations served.

> Fifth, we've entered into a partnership with the National Telecommunications and Information Administration (NTIA), a division of the U.S. Department of Commerce, to locate additional data sources and identify means of analysis to create a more accurate map.
>
> Finally, our office was recently tasked to administer the Growing Rural Economies with Access to Technology (GREAT) rural broadband grant program. Internet service providers requesting grants will be required to provide specific location information for the homes and business they plan to serve. This data in turn informs our map."[95]

The state uses its map as the starting point to determine eligibility for its grant program, but still invites applicants to submit its own data that demonstrates an area meets the criteria of an unserved area. The application provides clear instructions for types of data it will accept:

"To demonstrate that the proposed funding area is unserved and eligible for funding an applicant may submit the following information, including but not limited to:

- Scrubbed data (no raw data) from citizen survey results or demand aggregation results with speed tests, if applicable. This data must identify the areas that have less than 10:1 service."
- Affidavits from citizens or other individuals certifying one or more of the following:
    a. they are not able to receive broadband service
    b. the only available service is cellular or satellite
    c. the only broadband service available by the existing providers is less than 10:1 service.

Data included should be relevant to the proposed service area. Data points should be tied to specific locations and be geocoded for consideration as part of the Application."[96]

The GREAT grant program distributed $10 million in funds in 2019 and will distribute an additional $15 million this coming year.[97] The original legislation granted a thirty day period after the awards are published for existing service providers to challenge an application. As a result of difficulties that arose from the protest period during the first year pilot, the legislator revised the legislation to make the challenge process more transparent, and establish acceptable methods of resolving disputes (added text in italics):

[95] https://www.wraltechwire.com/2019/02/01/the-problem-and-the-solution-with-mapping-broadband-in-north-carolina/
[96] https://www.ncbroadband.gov/greatgrant/guidelines/
[97] https://www.ncbroadband.gov/2019/12/16/news-release-applications-period-opens-for-15m-in-great-grants-to-expand-broadband-access-in-rural-nc-communities/

"Applications shall be made publicly available by posting on the Web site of the Department of Information Technology for a period of at least 30 days prior to award. During the 30-day period, any interested party may submit comments to the Secretary concerning any pending application. A provider of broadband services may submit a protest of any application on the grounds the proposed project covers an area that is not an eligible area under this section. Protests shall be submitted in writing, accompanied by all relevant supporting documentation, and shall be considered by the Office in connection with the review of the application. *Upon submission of evidence satisfactory to the Office that the proposed project area includes prospective broadband recipients that are served, as measured using a methodology satisfactory to the Office, the Office may work with an applicant to amend an application to reduce the number of unserved prospective broadband recipients in the project area to reflect an accurate level of current broadband service.* The Office may revise application scores in accordance with amended applications. For applications with filed protests, the Secretary shall issue a written decision to the protesting party at least 15 days prior to the approval of that application. *Following a protest that is granted for a portion of the application, the Office may release to an applicant the locations or areas declared ineligible. The information released to the applicant is not a public record, as that term is defined under G.S.132-1, and shall remain confidential. Any provider submitting a protest shall verify that the information in the protest is accurate and that the protest is submitted in good faith. The Office may deny any protest or application that contains inaccurate information.*

As a means of resolving a protest, the Office may utilize speed tests to determine if the protested area or individual households or businesses currently have access to broadband service as defined in this section. The Department shall publish the speed test methodology it uses to assess speed levels pursuant to this section. All decisions regarding the speed test to be utilized and the manner by which the speed tests are applied shall be made by the Secretary or the Secretary's designee."[98]

8.2.6.2 Tennessee

Tennessee began its Tennessee Broadband Accessibility Grant Program in 2017 with $10 million, and the legislator has expanded the program by $5 million each year since. Tennessee uses the Form 477 data as a starting point but allows applicants to submit additional evidence to demonstrate that an area is unserved. Their application guidelines advise:

"While we're using the FCC Form 477 data as our starting point in determining eligibility, we will allow applicants to apply for areas deemed served in the data if they include additional evidence to prove the area's lack of service. This can include a statistically

[98] https://www.ncleg.gov/EnactedLegislation/SessionLaws/PDF/2019-2020/SL2019-230.pdf

> significant survey of the residents in the proposed area, the location of infrastructure assets, or other information. Additionally, a screenshot from a provider's website demonstrating the lack of service availability at a specific address is an example of evidence that can be provided to prove that service is not available at that location, however, final determinations will be based on all the evidence submitted in the application and the public comment period."[99]

In response to questions about what kinds of surveys they will accept as valid, they advise:

> "There is not a magic number of people that need to be surveyed. What we recommend is that applicants ensure that their data is statistically significant. Factors that affect this include the number of people in a given location as well as the response rate. The question is whether the data provided can be relied on to determine that an area is in fact unserved."[100]

Once the applications are published, the state Department of Economic and Community Development (TNECD) accepts public comments for three weeks. Existing providers can submit documentation showing that the proposed area is already served, in which the area will be disqualified from receiving funds, or that the proposed area is part of future expansion plans, which will factor into the grant scoring. Applicants have a chance to respond to the comments and can amend their applications to remove ineligible areas.[101] In situations where two parties dispute one another's claims, the state sends a contractor to the site to investigate available infrastructure.[102]

8.2.6.3 Virginia

In response to overwhelming demand for funding, the Virginia Telecommunication Initiative (VATI) has grown from $1 million in 2017 and 2018, to $4 million in 2019, to $19 million appropriated in 2020. To try and reduce the number of challenges to grants, the grant application forces applicants to submit evidence that they have reached out to local service providers asking for maps of where their service is available, and to make them aware of the grant's proposed service area.

The application also encourages challengers to work directly with applicants to resolve conflicts over proposed service areas. Incumbent providers that decide to move forward with a formal challenge must submit an affidavit that includes street level data of actual customers receiving service within the proposed service area. Challengers are strongly encouraged to submit third-

[99] https://www.tn.gov/content/dam/tn/ecd/documents/broadband/FAQs.pdf
[100] Ibid.
[101] Ibid.
[102] https://www.pewtrusts.org/-/media/assets/2020/03/broadband_report0320_final.pdf

partied verified speed tests for technologies that can have variable speeds. Once a provider submits a formal challenge, applicants have a chance to respond or amend their application accordingly.[103]

8.2.6.4 Minnesota

Minnesota's Border-to-Border Broadband Development Grant Program has been one of the most ambitious and successful state broadband grant programs in the country. Since the program began in 2014, the state has invested $85.2 million and leveraged $110.6 million in matching funds to extend service to 34,000 households, 5,200 businesses and 300 community anchor intuitions (CAIs).[104] The program offers grants for both unserved (no access to 25Mbps/3Mbps) and underserved (without access to 100Mbps/20Mbps) areas.

The state has invested considerable resources into creating its own map of what level of service is available in every corner of the state, but readily admits that its map is a work in progress. The grant program invites applicants to challenge the accuracy of the maps at any time, ideally prior to applying to serve the disputed area. Although the website does not provide specific information about the documentation necessary to dispute the state's map, asking applicants to dispute the map prior to the application deadline allows Office of Broadband Development (OBD) staff to handle challenges as they come, rather than having to evaluate claims in the bounded period between the deadline and the announcement of recipients.

Since 2016, the state offers service providers two opportunities to rebut an 'unserved' or 'underserved' designation. Six weeks prior to submitting an application, grant applicants must contact all broadband providers in the proposed project area and ask them for their plans to upgrade service in the proposed project area. Whether or not the incumbent provider responds, applicants must include documentation of its correspondence as part of the applications.[105] After applications are submitted, the OBD publishes the proposed project area on its websites, and existing providers have 30 days to submit a challenge. A challenge must demonstrate that the provider already provides service to the proposed project area at speeds equal or greater than the state's speed goal or contain a commitment to offer such a service within 18 months of the grant awards. If a challenger states that construction plans are under way, it must demonstrate that the project has executive sign off and an adequate budget assigned. If the OBD finds a challenge credible, no funding will be awarded for the relevant portion of the proposed project.[106]

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[103] https://www.dhcd.virginia.gov/sites/default/files/Docx/vati/2020-finalized-guidelines-rfp-questions-foia-062119.pdf
[104] https://www.pewtrusts.org/-/media/assets/2020/02/broadband_report_final.pdf
[105] https://mn.gov/deed/assets/b2b-faqs_tcm1045-391862.pdf
[106] https://mn.gov/deed/assets/challenge-process_tcm1045-390920.pdf

Appendix A: Summary of Existing Federal Funding Opportunities

This guide offers an overview of federal funding options that could provide financial support to local governments, Indian tribes, utilities, and internet service providers in their efforts to construct and operate broadband networks in New Mexico.

Federal funding is an important element of many large-scale broadband deployments. Varying dramatically in size, funding opportunities target a wide variety of deployment scenarios and end users. This guide provides information on a range of federal programs available in 2020. Additional opportunities may emerge in any given year—examples of the always-changing landscape of broadband funding and financing.

Among the most promising sources of potential funding at the moment are the Commerce Department's Economic Development Assistance (EDA) grants, the FCC's upcoming Rural Digital Opportunity Fund (RDOF) auction, and the USDA's ReConnect grant and loan program. E-rate funds can help local schools and libraries pay for advanced telecommunications services, but service providers need to win a competitive bidding process to be awarded these funds. The application window for the Bureau of Indian Affairs' National Tribal Broadband Grant program closes very soon, but represents a promising opportunity if additional funding is allocated in the future.

U.S. Department of Agriculture

Rural Broadband Program

The Rural Broadband Program (formerly the Rural Broadband Access Loan & Loan Guarantee Program) has historically been the RUS program with the greatest promise for competitive broadband. The application process is not onerous and there is some flexibility in what awards can cover.

In March 2020, the Department of Agriculture published interim final rules that proposed changes to the program, including updating the program name and adding a grant component. At the time of writing, these rules are not yet final.

<u>Program Mission</u>: The Rural Broadband Program has a broad mission. It is designed "[t]o provide loans for funding, on a technology neutral basis, for the costs of construction, improvement, and acquisition of facilities and equipment to provide broadband service to eligible rural communities."

<u>Nature of Award</u>: Awards are in the form of Treasury-rate loans, four-percent loans, and loan guarantees. Loans are for the term of the life of the facility (thus, 18-20 years for standard-wire

broadband). Money is dispersed as construction is completed, with monthly advances against the following month's contract. Once awarded, funding covers capital costs and can retroactively cover pre-application expenses (e.g., project design); however, applicants must take a "leap of faith" in preparing these details during the application process. The interim final rules published in March proposed a new loan/grant combination award, though that change is not yet final.

Eligible Entities: Entities eligible to receive loans include corporations, limited liability companies, cooperative or mutual organizations, Indian tribes, and state or local government. Individuals or partnerships are not eligible.

Eligible Areas: Loans are limited to eligible rural communities (i.e., an area with less than 20,000 inhabitants and not adjacent to an urbanized area with more than 50,000 inhabitants). An eligible service area must be completely contained within a rural area, at least 15 percent of the households in the area must be underserved (unless the current borrower applies to upgrade existing facilities in an existing service area, in which case they are exempt from this requirement), no part of the service area can have more than three incumbent service providers (note that an area may have two competing broadband service providers), and no part of the funded service area can overlap with the service area of current RUS borrowers and grantees or be included in a pending application before RUS. It is likely that portions of a service territory would qualify, although the service territory may not qualify in its entirety. Incumbent service providers are broadband providers that RUS identifies as directly providing broadband service to at least five percent of the households within a service area.

Eligible Costs: The program funds costs of construction, improvement, and acquisition of facilities and equipment to provide broadband service to eligible rural areas. Thus, loans are not limited by anticipated end uses.

FY 2020 Resources: Appropriations have not been made for 2020, as the program is currently undergoing rule changes.

Typical Award: Congress approves an annual appropriation (loan subsidy) and a specific loan level (lending authority) for the program. Minimum and maximum award amounts will be published in the Federal Register, but have historically been $100,000 (minimum) to $100 million (maximum).

Cost-Share Requirement: For loans, there is no cost-share requirement, however, applicants must carry fidelity bond coverage for 15 percent of the loan or loan/grant combination award amount. Grants may cover between 25-75 percent of project costs, dependent on the population density of the proposed funded service area.

Applicable Deadlines: The program is not currently open. We anticipate that new program rules will be finalized in June 2020 and that a funding round will open shortly afterwards.

Other Requirements: Applicants must complete build-out within three years (proposed new rules would adjust this to five years if adopted), demonstrate ability to provide the service at the Agency's "broadband lending speed" (25/3 Mbps), and demonstrate an equity position of at least 10 percent of the loan amount (though the proposed rules would eliminate the equity position requirement). Note that awards are only partially based on project design, but pay particular attention to the business plan and pro forma. Thus, applicants must invest resources preparing these supporting documents. Loans are given to those projects that demonstrate the greatest likelihood of repayment (as demonstrated by the business plan). RUS will give greatest priority to applicants that propose to offer broadband to the greatest proportion of households that have no incumbent service provider.

Key Links:

- Fact Sheet: https://www.rd.usda.gov/sites/default/files/fact-sheet/508_RD_FS_RUS_FarmBillBroadbandLoans.pdf
- Application Guide: https://www.rd.usda.gov/files/FB_AppGuide_Revised_18_19.pdf
- Federal Register Notice (proposed rule changes): https://www.govinfo.gov/content/pkg/FR-2020-03-12/pdf/2020-04086.pdf

Agency Contact:

Ken Kuchno (202-690-4673); Kenneth.kuchno@wdc.usda.gov

ReConnect Program

Program Mission: The ReConnect program offers financing to facilitate broadband deployment in rural areas of the country that lack access to at least 10/1 Mbps.

Nature of Award: There are three types of opportunities offered through this program: 100 percent grant, 50/50 grant/loan, and 100 percent loan.

Eligible Entities: Awards can be given to both public and private entities. Eligible applicants for broadband grants include incorporated organizations, Indian tribes or tribal organizations,[107]

[107] Applications for projects on tribal lands are eligible for additional points in the scoring process. See: "ReConnect Loan and Grant Program: Evaluation Criteria," U.S. Department of Agriculture, https://www.usda.gov/reconnect/evaluation-criteria (accessed June 5, 2020).

state or local units of government, or cooperatives, private corporations, and limited-liability companies organized on a for profit or not-for-profit basis. Individuals or partnerships are not eligible.

Eligible Areas: To be eligible for ReConnect, service areas must be rural, and 90 percent of households must lack access to fixed, terrestrial service of at least 10/1 Mbps. RUS will not fund a project proposing to serve an area that has already received financial assistance for broadband service from RUS broadband loans, the Community Connect program, CAF II Auction 903, state-funded areas, or previous rounds of ReConnect.

Eligible Costs: Award funds can be used to fund the construction or improvement of broadband facilities, the acquisition of an existing system (up to 40 percent of the total requested award), and reasonable pre-application expenses (up to five percent of the total requested award). Operating costs are not eligible costs.

FY 2020 Resources: Round one of the program has awarded over $621 million. Round two closed on April 15, 2020, and will distribute $550 million plus an additional $100 million from the stimulus act. The details of a third round are unknown, but it is generally anticipated that there will be more rounds in the future.

Typical Award Size: Awards range considerably in size. One hundred percent grants are limited to $25 million, and 50/50 awards are limited to $25 million for each the grant and the loan. One hundred percent loans are limited to $50 million.

Cost-Share Requirement: Applicants receiving a 100 percent grant must provide a match equal to 25 percent of the overall project cost.

Applicable Deadlines: The application deadline for the second round of program funding was April 15, 2020. Updates on application deadlines are available through USDA Rural Development Updates.[108]

Projects Funded: Eligible projects must propose to provide at least 25/3 Mbps broadband service to all premises in the proposed service area that do not have sufficient access to broadband, and must demonstrate that they can be completely built out within five years of funding being made available.

Key Links:

- Program overview: https://www.usda.gov/reconnect/program-overview

[108] https://public.govdelivery.com/accounts/USDARD/subscriber/new?email=&commit=Sign+Up.

- Second funding round Funding Opportunity Announcement: https://www.govinfo.gov/content/pkg/FR-2019-12-12/pdf/2019-26522.pdf

Program Contact:

General contact: https://www.usda.gov/reconnect/contact-us

Community Connect Program

Priority for Community Connect grants is given to areas demonstrating "economic necessity." The application process is rigorous and competitive (with awards given to only 10 percent of applicants) and once awarded, program requirements are demanding (e.g., requiring last-mile service for all households in the service area). Awards are fairly modest.

Program Mission: Community Connect has a broad program mission of helping "rural residents tap into the enormous potential of the internet."

Nature of Award: Grant with modest (15 percent) match requirement.

Eligible Entities: Awards can be given to both public and private entities. Eligible applicants for broadband grants include incorporated organizations, Indian tribes or tribal organizations, state or local units of government, or cooperatives, private corporations, and limited-liability companies organized on a for profit or not-for-profit basis. Individuals or partnerships are not eligible.

Eligible Areas: Funding is geographically limited to a contiguous area with a population less than 20,000 that does not currently have Broadband Transmission Service (defined as 10/1 Mbps).

Eligible Costs: Eligible projects must offer basic broadband transmission service to both residential and business customers within the proposed service area. Examples of eligible projects include deploying broadband transmission service to critical community facilities, rural residents, and rural businesses; constructing, acquiring or expanding a community center (but only five percent of grant or $100,000 can be used for this purpose); or building broadband infrastructure and establishing a community center with at least 10 computer access points, which offer free public access to broadband for two years.

FY 2020 Resources: For FY 2020, $35 million was available for Community Connect Grants. Funding is provided through annual appropriations in the Distance Learning and Telemedicine account within the Department of Agriculture appropriations bill.

Typical Grant Award: Awards range considerably in size, from $100,000 to $3 million.

Cost-Share Requirement: Applicants must make a matching contribution of at least 15 percent of the total award. This match can be made with "in kind" contributions, but cannot be made with federal funds.

Applicable Deadlines: Applications for the Community Connect program are typically opened around March or April, and conversations with program staff confirm that there is a about a 45 to 60-day application window with awards given in September. As of May 2020, a Funding Opportunity Announcement had not yet been announced for this year. Updates on application deadlines are available through www.grants.gov.

Notes: The grant process is very selective, with awards given to only 10 percent of applicants. Community Connect funds approximately 15 projects annually (from an application pool of 150). Priority is given to areas that demonstrate "economic necessity."

Other Requirements: Grant requirements are fairly onerous, as recipients must agree to provide last-mile services throughout the entire service area (i.e., "basic transmission service to residential and business customers").

Key Links:

- Basic background: http://www.rurdev.usda.gov/utp_commconnect.html
- Application Guide: https://www.rd.usda.gov/files/CC_Application_Guide_FY2019_final.pdf
- 2019 Funding Opportunity Announcement: https://www.rd.usda.gov/files/2019_CC_FOAfinal.pdf

Agency Contact:

Long Chen and Janet Malaki (202-690-4673) (community.connect@wdc.usda.gov)

Kenneth Kuchno (202-690-4673)

Distance Learning and Telemedicine (DLT)

Grants for this program are given for equipment, rather than broadband service; however, this may provide a good way for a utility to leverage a new broadband network (e.g., by helping finance video conferencing systems and home medical units). As such, this could be a good supplement to other funding options. Applicants have a fairly high likelihood (70 percent) of receiving an award.

Program Mission: Grants are available for projects that "meet the educational and health care needs of rural America."

Nature of Award: Grant

Eligible Entities: Funds can be awarded to both public and private entities (including corporations or partnerships, Indian tribes, state or local units of government, consortia, and private for-profit or not-for-profit corporations), assuming they provide the requisite services. Individuals are not eligible. Grantees must provide education and medical care via telecommunications. Eligible entities must either directly operate a rural community facility or deliver distance learning or telemedicine services to entities that operate a rural community facility or to residents of rural areas.

Eligible Areas: Rural areas with populations of 20,000 or less.

Eligible Costs: Grants can be used for equipment, but not broadband service. Eligible projects vary and can include capital assets (e.g., interactive video equipment, data terminal equipment, inside wiring, etc.), instructional programming that is a capital asset, technical assistance and instruction. Grants can provide operating costs for the first two years of a program, and are made for projects where the benefit is primarily delivered to end users that are not at the same location as the source of the education or health care service.

FY 2020 Resources: The second funding round will distribute $47 million, in addition to any leftover funds from the first round window and a special Covid-19 allocation of $25 million.

Typical Grant Award: Grant awards range from $50,000 (minimum) to $1 million (maximum). Roughly 70 percent of applicants are awarded grants.

Cost-Share Requirement: The grant program requires a 15 percent match. Such matches may be made through "in kind" contributions, but cannot be made with federal funds. Applications that provide a greater contribution may be scored more favorably.

Applicable Deadlines: The deadline for the second funding round is July 13, 2020.

Restrictions: RUS borrowers are not eligible for DLT loans. Demonstration projects are not eligible for DLT funds. Projects must be in a rural area as defined by 7 CFR 1703.126(a)(2).

Key Links:

- Program page: https://www.rd.usda.gov/programs-services/distance-learning-telemedicine-grants

- Funding Opportunity Announcement: https://www.rd.usda.gov/sites/default/files/USDARUS2020_DLT_FOAR2CARESActFunding_04142020.pdf
- Application Guide: https://www.rd.usda.gov/sites/default/files/FY2020_DLT_App_Guide_Final.pdf

Agency Contact:

General information (202-720-1051 or dltinfo@wdc.usda.gov).

Sam Morgan (202-205-3733 or sam.morgan@wdc.usda.gov)

Telecommunications Infrastructure Loans

USDA provides loans to support broadband in rural communities. Loans are limited to telephone companies serving rural areas within cities of fewer than 5,000 inhabitants. Other, more generous grants and subsidies may be available.

Program Mission: The Telecommunications Infrastructure program makes "long-term direct and guaranteed loans to … finance[e] the improvement, expansion, construction, acquisition, and operation of telephone lines, facilities, or systems to furnish and improve Telecommunications service in rural areas." The loans are intended to provide advanced telecommunications networks for rural areas, especially broadband networks designed to accommodate distance learning, telework and telemedicine.

Nature of Award: All awards are in the form of low-interest loans and include: cost-of-money loans (3.15 percent for a 20-year term beginning June 2014), guaranteed loans (interest rates are Treasury rate plus 1/8 percent; historically between .15 and 4.2 percent), and hardship loans (5 percent interest).

Eligible Entities: The Department of Agriculture provides Telecommunications Infrastructure Loans to entities providing telephone service in rural areas; public bodies providing telephone service in rural areas as of 1949; cooperative, nonprofit, limited dividend or mutual associations. All borrowers must be incorporated or a limited liability company.

Eligible Areas: Rural areas, defined for this program as an area not included within the boundaries of any city, village, or borough (incorporated or unincorporated) with a population greater than 5,000.

Eligible Costs: Loans can be used to finance telecommunications in rural areas for improvements, expansions, construction, acquisitions and refinancing.

FY 2020 Resources: $690 million is budgeted for FY 2020.

Typical Award: $50,000 is the minimum loan award. The maximum is unclear, though as of June 2011, Triangle Telecom has received $136 million over the course of a decade.

Cost-Share Requirement: N/A (loan)

Applicable Deadlines: Applications can be submitted year-round.

Restrictions: Loans are limited to rural areas, narrowly defined as areas within a city of fewer than 5,000 inhabitants.

Key Links:

- General information: http://www.rurdev.usda.gov/utp_infrastructure.html
- Brochure: http://www.rurdev.usda.gov/supportdocuments/telecomloansflyerfactsheet.pdf
- Regulations: http://www.rurdev.usda.gov/supportdocuments/7_cfr_part_1735.pdf

U.S. Department of Commerce

Economic Development Administration Public Works and Economic Adjustment Assistance Program

This program is a rebrand of the previous Economic Development Administration (EDA) Program and is designed to address needs in economically distressed areas. While the agency does not receive many broadband applications, this can actually be a strategic advantage for communities that can show broadband is needed as an element of their economic development plan. While the program focuses on distressed communities, especially those that have experienced plant or base closures, an addendum to EDA's notice of funding opportunity was added on May 7, 2020 to announce additional funding through the CARES Act to support recovery of communities adversely affected by Covid-19. Funding requests that target recovery from Covid-19 distress are intended to be flexible and spent quickly and not subject to the regular economic distress requirements.

Nature of Award: Grants and cooperative agreements

Eligible Entities: Eligible entities include city, township, county, or special district governments;

state governments; federally recognized tribal governments (or "a consortium of Indian Tribes"); nonprofits, aside from institutions of higher education; private institutions of higher education; and public and state-controlled institutions of higher education.

Eligible Areas: For the regular program (not the special Covid-19 addendum), the community must qualify as distressed to be eligible. Criteria for eligibility is established by providing "third-party data that clearly indicate that the region is subject to one (or more) of the following economic distress criteria: (i) an unemployment rate that is, for the most recent 24-month period for which data are available, at least one percentage point greater than the national average unemployment rate; (ii) per capita income that is, for the most recent period for which data are available, 80 percent or less of the national average per capita income; or (iii) a "Special Need," as determined by EDA."

Note that the EDA has determined that the economic impact of the Covid-19 pandemic constitutes a "special need," and has extended eligibility to all communities if applying for Covid-19 related funding. Applicants must still explain in their applications how their project would "prevent, prepare for, and respond to" to Covid-19, or respond to "economic injury as a result of the coronavirus." Working early in the application process with the regional EDA representative is highly recommended.

Eligible Costs: Building, designing, or engineering infrastructure and facilities to advance economic development strategies, or planning efforts to implement such solutions.

Funding availability: In 2019 around $200 million was awarded in public works, economic adjustment grants and planning grants. On May 7, 2020, $1.467 billion was added to the program in Covid-19 related funding.

Typical Grant Award: Grant awards vary with a minimum of $100,000, and a maximum of $30 million. For broadband programs $3 million to $5 million is likely the sweet spot.

Match: Grant typically covers up to 50 percent of project costs, but the maximum allowable investment rate can increase if other economic factors are met. For projects that constitute a special need (such as to ameliorate the effects of the coronavirus on the community), the EDA will determine the maximum award percentage, generally not to exceed 80 percent of project costs. The addendum to the EDA's notice of funding opportunity notes that "EDA's regulations provide discretion to establish a maximum EDA investment rate of up to 100 percent for projects of Indian Tribes."[109] Funds from other federal financial assistance awards may be considered

[109] Notice of Funding Opportunity: Public Works and Economic Adjustment Assistance Programs," U.S. Department of Commerce, May 7, 2020, at p. 13, https://www.grants.gov/web/grants/view-opportunity.html?oppId=321695 (accessed June 5, 2020).

matching only if authorized by statute.
Requirements: Community Economic Development Strategy (CEDS) must be in place for the intended project area & must discuss the need for broadband. The applicant must demonstrate support of the project by the business community.

Application deadline and process: Rolling applications. Requires engaging an EDA Regional representative at start of process.

Key Links:

- Program Fact Sheet: https://www.eda.gov/pdf/about/Economic-Adjustment-Assistance-Program-1-Pager.pdf
- Notice of Funding Opportunity, including CARES Act allocation: https://www.grants.gov/web/grants/view-opportunity.html?oppId=321695
- Frequently Asked Questions: https://www.eda.gov/coronavirus/faq/index.htm

Agency Contact: Find the Economic Development Representative for your community here: https://www.eda.gov/contact/

Federal Communications Commission

Rural Digital Opportunity Fund (RDOF)

Program Mission: RDOF is a reverse auction program that will target funds to rural America for the buildout of broadband infrastructure.

Nature of Award: Reverse auction for operational subsidies of eligible areas for next ten years.

Eligible Entities: Open to those with an Eligible Telecommunications Carrier (ETC) designation (or who will get one, if awarded funding—you do not have to already have designation in order to apply).

Eligible Areas: The Phase I auction will target census blocks that are entirely unserved by 25/3 Mbps broadband. Phase II will include census blocks that are partially served, as well as locations that are not funded in Phase I. Eligibility is determined using Form 477 data and the Connect America Cost Model (CAM). Areas lacking 10/1 Mbps and Tribal areas are given priority. The minimum performance tier is 25/3 Mbps and the baseline performance tier is 50/5 Mbps. Additional performance tiers exist for 100/20 Mbps and 1 Gbps/500 Mbps service.

Eligible Costs: As long as the buildout meets buildout targets, location metrics, and performance standards, support is in the form of monthly subsidies, and not reimbursement for any actual expenses.

FY 2020 Resources: The total RDOF program budget is $20.4 billion over ten years; the Phase I auction has a budget of $16 billion and Phase II will distribute the remainder (at least $4.4 billion).

Typical Award: Depends on number of locations pre-defined in a particular auctioned area and the percentage of the "reserve price" represented by the final bid. (Tribal lands have higher reserve prices "[t]o account for the unique challenges of deploying broadband to rural Tribal communities".)[110] In the auction, bidders who propose to provide service with the smallest subsidy (after applying other evaluation weights) will be awarded the bid.

Cost-Share Requirement: None

Applicable Deadlines: The Phase I auction is scheduled to begin October 29, 2020. Short form applications are due July 15. The short form is required to be able to participate in the October auction, but it is not binding.

Restrictions: Must provide both voice and broadband service. Recipients are also required to offer standalone voice service, and to ensure that voice and broadband services are offered at costs comparable to rates in urban areas.

Key Links:

- General information: https://www.fcc.gov/implementing-rural-digital-opportunity-fund-rdof-auction
- Report and Order: https://docs.fcc.gov/public/attachments/FCC-20-5A1.pdf

Program Contact: Auction related questions can be directed to auction904@fcc.gov.

Emergency Covid-19 Telehealth Program

Program Mission: This program was developed as an expedited version of the Connected Care Program in order to quickly enable telehealth applications that allow health care providers to connect to patients or their devices over digital connections in response to Covid-19.

[110] "Rural Digital Opportunity Fund, Connect America Fund," Final Rule, at 14. Federal Communications Commission, March 10, ,2020, https://www.federalregister.gov/documents/2020/03/10/2020-03135/rural-digital-opportunity-fund-connect-america-fund (accessed June 5, 2020).

Nature of Award: Reimbursement

Eligible Entities: Nonprofit or public health care providers, or a consortium of such. Eligibility is established using FCC Form 460—this form can be accessed via the Universal Service Administrative Company (USAC) portal, here: https://www.usac.org/rural-health-care/resources/my-portal/.

Eligible Areas: All areas area eligible; the program is open to eligible health care providers that serve urban or rural areas.

Eligible Costs: Eligible projects provide connectivity or devices required to reach patients, and must be based on a need related to Covid-19. Telehealth services may be provided from a provider permanent premise (such as a hospital or clinic) or from a temporary or mobile location.

FY 2020 Resources: $200 million has been made available through the CARES Act.

Typical Award Size: There is a formal limit of $1 million and no floor for awards.

Cost-Share Requirement: None

Applicable Deadlines: The application opened on April 13, 2020 and will remain open until funds are expended.

Restrictions: Applicants are not permitted to “double dip” with other federal or state funds.

Key Links:

- General information: https://www.fcc.gov/covid-19-telehealth-program

Universal Service Fund – Schools and Libraries Program (“E-Rate”)

Program Mission: The E-rate program provides support to schools and libraries by partially funding the cost of broadband services (and, in some cases, the cost of construction of fiber laterals), representing an important revenue source for communications providers such as utilities.

Nature of Award: Funding is provided through the Universal Service Fund in the form of a subsidy on the eligible facility’s telecommunications expenses. The size of the subsidy varies, as elaborated below and may cover both internet service and infrastructure.

Eligible Entities: Funding is provided to eligible schools, school districts and libraries (either individually or as part of a consortium). Funds are distributed to both public and private schools, as long as they provide primary or secondary education, operate as a non-profit business, and do not have an endowment exceeding $50 million. Eligible libraries must be eligible for assistance from a state library administrative agency under the 1996 Library Services and Technology Act. Generally, libraries are eligible if their budget is separate from a school and they do not operate as a for-profit business. Applicants can determine whether a school or library has filed a Form 470 to initiate the application process by searching submitted forms.[111]

Eligible Areas: Any eligible entity can apply for E-Rate funding. Subsidy sizes vary based on rurality and poverty level.

Eligible Costs: The Schools and Libraries Program is designed to support connectivity—the conduit or pipeline for communications using telecommunications services and/or the internet. Funding is requested from providers under four categories of service: telecommunications services, internet access, internal connections, and basic maintenance of internal connections. Eligible services include both equipment (fiber) and access.[112] The E-rate helpline notes that eligible applicants are virtually assured funding to assist with Priority 1 projects (i.e., telecommunications, telecommunications services and internet access services).

FY 2020 Resources: Funding is stable as resources are not subject to appropriations. E-rate program funding is based on demand up to an annual cap of about $4.15 billion (modified annually to account for inflation). Note that the E-rate program is a distinct program from the Connect America Fund; as such, resources are unaffected by the CAF. Resources for any given school or library are determined based on levels of rurality and poverty in the relevant district.

Typical Grant Award: E-Rate provides a discount on eligible services, with the size of the discount (ranging from 20 to 90 percent) dependent on the level of poverty and the urban/rural status of the population served. The funding level can be determined from the matrix available on the E-rate website at http://www.usac.org/_res/documents/sl/pdf/samples/Discount-Matrix.pdf. The primary measure for determining Schools and Libraries support discounts is the percentage of students eligible for free and reduced lunches under the National School Lunch Program (NSLP), calculated by individual school. For instance, if 70 percent of the students at the relevant school are eligible for NSLP, E-rate will reimburse 80 percent of the costs for eligible services.

Cost-Share Requirement: E-rate discounts range from 20 to 90 percent, with higher discounts for higher poverty and more rural schools and libraries. Schools and libraries are always responsible for paying at least some part of the cost of service.

[111] Forms can be searched by year and zip code at http://www.slforms.universalservice.org/Form470Expert/Search_FundYear_Select.aspx.
[112] USAC maintains a complete description of eligible services at http://www.usac.org/_res/documents/sl/pdf/ESL_archive/EligibleServicesList-2014.pdf

Applicable Deadlines: The application process typically begins in July (Form 470) and continues throughout the year. A flowchart depicting the general process (without dates) is available online (https://www.usac.org/wp-content/uploads/e-rate/documents/Handouts/application-process-flow-chart.pdf).

Restrictions: Facilities need not be located in rural areas, though funding levels will increase based on poverty and rural status.

Key Links:

- To submit questions: http://www.usac.org/about/tools/contact-us.aspx
- General background: http://www.usac.org/sl/
- Eligible service list: http://www.usac.org/_res/documents/sl/pdf/ESL_archive/EligibleServicesList-2014.pdf
- Training sessions are provided to potential applications in the fall (http://www.usac.org/sl/about/outreach/default.aspx for schedule and links)

Agency Contact:

The E-rate helpline is extremely helpful. Contact 1-888-203-8100 with questions.

Rural Health Care Program

The Rural Health Care Program (RHC) provides funding to eligible health care providers (HCPs) for telecommunications and broadband services necessary for the provision of health care. RHC is comprised of two programs: the Telecommunications Program and the Healthcare Connect Fund.

"Health care provider" is defined by statute as hospitals, rural health clinics, local health departments, community health centers or health centers providing health care to migrant workers and post-secondary educational institutions offering heath care instruction, teaching hospitals, and medical schools. Individual providers can determine whether they are located in a rural area through a look-up tool on USAC's website.[113] *Note that non-rural HCPs may still apply for funding through the Healthcare Connect Fund if they are a member of a majority rural consortium.*

While none of these programs support comprehensive broadband deployment, they may provide useful resources to support eligible health care providers.

[113] http://www.usac.org/rhc/telecommunications/tools/Rural/search/search.asp

Program Mission: The Rural Health Care Program is intended to reduce the disparity in cost between rural and urban telecommunications and internet services used for the provision of health care at eligible facilities.

Nature of Award: Subsidy

FY 2020 Resources: Funding is through the Universal Service Fund (i.e., surcharges on telephone bills), rather than Congressional appropriations. In June of 2018, the FCC issued an order that increased the annual RHC Program funding cap to $571 million, to annually adjust the cap for inflation, and to establish a process to carry-forward unused funds from past years for use in future years. For FY 2020, the program cap was $604,759,306.

Applicable Deadlines: The Rural Health Care Program funding year runs from July 1 through June 30 of the following year. Although funding requests may be submitted through the last day of the funding year, applicants are encouraged to submit funding requests during the initial funding request filing period, which runs from March 1 through May 30. All funding requests filed within the initial "filing period" will be treated as though simultaneously filed. Funding requests filed after the initial filing period will be treated on a rolling, first-come, first-served basis, and may be filed until the end of the funding year. Prior to submitting a funding request, applicants are required to allow 28 days for competitive bidding before selecting a service provider.

Key Links:

- General background: http://www.usac.org/rhc/
- Fact Sheet Comparing the Telecommunications Program and the Healthcare Connect Fund Program: http://www.usac.org/_res/documents/rhc/pdf/handouts/RHC-Program-Comparison.pdf

Agency Contact: Paloma Costa, Manager of Outreach for Rural Health Care Program, Universal Service Administrative Company (pcosta@usac.org or 202-772-6274)

Telecommunications Program

Eligible Entities: Rural, public or not-for-profit health care providers (HCPs) are eligible. Consortia of HCPs with at least one eligible entity as a member can also apply. To determine if the HCP facility is located in a rural area, see the Eligible Rural Areas Search Tool on the Rural Health Care Program website.[114]

[114] http://www.usac.org/rhc/telecommunications/tools/Rural/search/search.asp

Eligible Costs: Telecommunications services

Typical Award: The subsidy amount is determined by the urban/rural differential of cost of service.

Healthcare Connect Fund

Eligible Entities: Rural, public or not-for profit health care providers (HCPs) and consortia of such are eligible. Non-rural HCPs are also eligible if they are a member of a consortium that is made up of majority rural HCPs. To determine if the HCP facility is located in a rural area, see the Eligible Rural Areas Search Tool on the Rural Health Care Program website.[115]

Eligible Costs: Eligible costs include telecommunications and broadband services and network equipment. Consortium applicants can also apply for funding for constructed and owned network facilities, and for support for upfront charges associated with service provider deployment of new or upgraded facilities to provide requested services, dark or lit fiber leases or IRUs, and self-construction where demonstrated to be the most cost-effective option.

Typical Award: The Healthcare Connect Fund offers a 65 percent flat-rate discount on eligible expenses.

Connected Care Pilot Program

Program Mission: This program is intended as a three-year pilot to help understand the future of Universal Service Fund use and how the fund can support connected care and telehealth over the long term. The program defrays costs for health care providers to provide connected care services, especially for low-income and veteran patients.

Nature of Award: Grant

Eligible Entities: Eligible nonprofit and public health care providers (HCP)

Eligible Areas: Eligible HCPs can apply regardless of whether they are in a rural or urban area

Eligible Costs: Broadband connectivity, network equipment, and information services necessary to provide connected care services to the intended patient population.

FY 2020 Resources: $100 million will be made available over three years.

Typical Award: There is no floor or ceiling for the requested grant amount. Awards are given for a three-year duration, plus up to six months for project set-up and six months for project close-out.

[115] http://www.usac.org/rhc/telecommunications/tools/Rural/search/search.asp

Cost-Share Requirement: A 15 percent match is required from awardees. The match can be from participating patients, health care providers, or government or non-profit grants, but cannot be from vendors. Awardees cannot also receive grants for broadband from the Healthcare Connect program for the same purpose.

Applicable Deadlines: The application has not yet been released.

Restrictions: The program does not provide support for health care providers' administrative costs associated with participating in the pilot program, doctor or staff time spent on the pilot program, or other miscellaneous costs.

Notes: One goal of the program is to use funded projects as datasets to understand impacts, so the program will likely favor projects that target a sufficiently large amount of patients to be able to analyze and aggregate data.

Key Links:

- Report and Order: https://docs.fcc.gov/public/attachments/FCC-20-44A1.pdf

U.S. Department of the Interior, Bureau of Indian Affairs

National Tribal Broadband Grant

Program Mission: This program provides grant funding to hire consultants to perform feasibility studies for broadband deployment, with the goal of supporting informed decisions about broadband planning and ultimately improving quality of life by encouraging the availability of broadband services.

Nature of Award: Grant

Eligible Entities: Federally recognized tribes

Eligible Areas: Awards can be used to conduct a feasibility study for any federally recognized tribe.

Eligible Costs:

Eligible costs include:

- Assessment of current broadband services
- Engineering assessment of new broadband services
- Cost estimate for building new or expanding existing services
- Identification of potential funding or financing for a network

- Risk assessment
- Determination of transmission mediums to be deployed

Applicants may work with a variety of entities, including but not limited to universities and colleges, private consulting firms, and non-profits, to perform eligible services.

Awards may not be used for indirect or administrative costs, creation of new jobs, equipment, training, legal fees, or any other activities not authorized by the grant award letter.

FY 2020 Resources: Total program funding for the FY 2020 funding opportunity was estimated to be $1,200,000.

Typical Award: Awards range from $40,000 to $50,000. The Office of Indian Energy and Economic Development anticipates awarding between 25 and 30 grants for FY 2020.

Cost-Share Requirement: None.

Applicable Deadlines: Applications are due by June 15, 2020 at 9 p.m. Eastern.

Other Requirements: Each application should address one project; applicants may submit more than one application in order to seek funding for various studies.

Key Links:

- Grant opportunity on Grants.gov: https://www.grants.gov/web/grants/search-grants.html?keywords=National%20Broadband

Agency Contact: James R. West, NTBG Manager, Office of Indian Energy and Economic Development (jamesr.west@bia.govor 202-595-4766)

Appendix B: Framework of Collaborative Broadband Options for New Mexico Communities

The following is an overview of strategies for New Mexico localities to consider as they seek broadband expansion and, in some cases, competition. The models are designed to enhance the chances of New Mexico's communities meeting the goals they expressed during preparation of this Plan:

First, to secure **future-proof infrastructure**—broadband services that will meet the community's long-term needs for residential and business broadband, as well as emerging 5G wireless technologies, Internet of Things, Smart City, autonomous and connected vehicles, and other innovations as they develop in the future.

And second, to achieve this goal through **a competitive marketplace**—a solution that will facilitate a local broadband marketplace that is as competitive as reasonably possible, so as to secure the benefits that flow from competition, such as lower consumer costs and higher quality services.

The following models that are summarized below as potential means to support these goals:

Option 1: Public-Private Collaboration: Under this option, a community would work with a private company that would develop a broadband network and provide high speed internet service. As part of this model, the community would lease to the private entity communications-enabling assets such as conduit or tower space or might provide a grant or other support to the private entity to make the collaboration opportunity more attractive.

Option 2: Community Infrastructure Fiber and Outsourced ISP Operations: Under this option, the community would finance and build a broadband network all the way to homes and businesses, and then lease the network to one or more internet service providers and entities to utilize the infrastructure.

Option 3: Community Infrastructure and ISP Operations: Under this option, which is usually known as "municipal broadband," the community would finance and build a fiber broadband network to homes and businesses, and itself provide retail internet service through a new operation within government.

Table 27 summarizes the potential alignment of these options with community goals as they were expressed during the data collection and interviews for this Plan.

Table 27: Summary of Alignment of Community Goals and Options

Goal / Scale	Option 1: Assets Leased to ISP	Option 2: Community-wide Network Leased to ISP	Option 3: Municipal Broadband
Goal: Future-looking infrastructure	**Good:** Assets such as conduit and fiber backbone could support a range of technologies, including a fiber-to-the-premises or a wireless last-mile, depending on partner's willingness to invest and deployment model.	**Excellent:** A community-wide network can serve as a platform for ultra-high-speed services, as well as next generation wireless services.	**Excellent:** A community-wide network can serve as a platform for ultra-high-speed services, as well as next generation wireless services.
Goal: Attract private investment and stimulate economic activity	**Good:** Assets are a means by which communities can differentiate themselves and attract private capital, both for purposes of building/operating broadband and to use the new broadband capabilities. There exists universal understanding that broadband impacts economic activity positively, as has been demonstrated by the degree of work from home during the Covid-19 pandemic.	**Excellent:** A community-wide would serve as a clear differentiator for attracting private capital, both for purposes of building/operating broadband and to use the new broadband capabilities. There exists universal understanding that broadband impacts economic activity positively, as has been demonstrated by the degree of work from home during the Covid-19 pandemic.	**Excellent:** A community-wide would serve as a clear differentiator for attracting private capital, both for purposes of building/operating broadband and to use the new broadband capabilities. There exists universal understanding that broadband impacts economic activity positively, as has been demonstrated by the degree of work from home during the Covid-19 pandemic.

Goal / Scale	Option 1: Assets Leased to ISP	Option 2: Community-wide Network Leased to ISP	Option 3: Municipal Broadband
Goal: A competitive marketplace	**Promising**: Assets facilitate last-mile deployment but requires significant partner investment.	**Excellent**: Likely to be one or two entities interested in/capable of leasing communitywide network; dynamic competitive market potential with at least one new provider.	**Excellent**: The Community will be bringing competition into the market and its entry into the broadband market will almost certainly result in incumbent efforts to compete, particularly with lower per until internet prices and cable television promotions.
Scale of community's cost and risk	**Modest:** If existing assets can be maximized, the community would be leveraging current assets rather than making new investments.	**High:** Higher capital investment required, with limited likelihood of dark fiber leases covering all Community debt service and O&M costs.	**Very high:** Community will bear the full cost of the network and will be obligated to cover shortfalls if revenues are insufficient.

Option 1: Public-private collaboration, with leased access to excess community assets

Under the Public-Private Collaboration model, the community would work with a private company that would lease excess communications-enabling assets such as conduit, fiber, or tower space and then invest itself to expand to homes and businesses to which to provide high speed internet service. In this model, the community would be the sole owner of the existing assets and the private provider would be the community's lessee for those assets and the owner of the portions of the network built solely with private capital. The availability of the excess assets would significantly reduce the partner's deployment expense.

This business model represents a low-risk, modest-cost approach to broadband, so long as the assets are robust and sufficient to attract a private partner that sees the value of the assets.

In another variation on this model, the private provider would construct and operate the network with private capital, but the community would subsidize a portion of the construction, potentially to connect parts of the community for which the private party felt it did not have sufficient business case to fund itself. This is a requirement that can be tested in a competitive process or evaluated during negotiations.

Description

In this approach, localities endeavor to attract private sector fiber-to-the-premises investment, much as they might try to attract investment in other areas of economic development. This approach entails relatively modest public cost (though it could entail considerable staff time and effort) and less public risk than other models, but it also gives the private sector partner nearly complete control over the deployment of the infrastructure.

Among the areas of decision-making left to the private sector are such policy issues as net neutrality and data privacy. community subsidy could be leveraged to realize certain types of policy goals (such as deployment to low income areas that might not meet private sector return expectations because of low adoption).

The potential for cities to work with private investors to realize the benefits of new, competitive broadband networks became evident to many communities in 2010, when Google stated that it would build gigabit fiber-to-the-premises networks. In 2011, the company selected Kansas City, Kansas, as the first Google Fiber city.[116] Over the next five years, Google Fiber worked with at least 34 cities,[117] all of which had attracted the company's interest, in part, by explaining what they were willing to do to make the construction "quicker, more efficient, and less disruptive."[118] Google Fiber went live in 10 cities, and the company periodically announced plans to construct networks in additional cities.[119]

In October 2016, though, Google Fiber announced that it was putting its expansion plans on "pause."[120] Industry analysts cited a range of potential reasons for Google Fiber's retreat, including the high cost of broadband deployment and lower-than-expected demand.[121] A year ago, Google Fiber's "pause" became more of a hard stop.[122] It appears that the company will not

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[116] Erin Kim, "Google brings faster Internet to Kansas City," *CNNMoney*, July 26, 2012. http://money.cnn.com/2012/07/26/technology/google-fiber/. See also: https://www.youtube.com/watch?v=6uZVqPuq81c.
[117] "Exploring new cities for Google Fiber," Google Fiber Blog, Feb. 19, 2014, https://fiber.googleblog.com/2014/02/exploring-new-cities-for-google-fiber.html
[118] "Google Fiber City Checklist," https://fiber.storage.googleapis.com/legal/googlefibercitychecklist2-24-14.pdf.
[119] "Cities," Google Fiber, https://fiber.google.com/newcities/#viewcities.
[120] "Advancing our amazing bet," Google Fiber Blog, Oct. 25, 2016, https://fiber.googleblog.com/2016/10/advancing-our-amazing-bet.html.
[121] Brian Fung, "Why Google Fiber is no longer rolling out to new cities," *Washington Post*, Oct. 26, 2016, https://www.washingtonpost.com/news/the-switch/wp/2016/10/26/why-google-fiber-is-no-longer-rolling-out-to-new-cities/?utm_term=.bfcfe3c21805.
[122] Klint Finley, "Google Fiber Sheds Workers as It Looks to a Wireless Future," *Wired*, Feb. 15, 2017, https://www.wired.com/2017/02/google-fiber-restructure/

build in the "potential" cities—and even in some cities where Google Fiber is active, the company has started pulling back; for example, it reportedly notified some customers that had earlier signed up for service in Kansas City that they will not be activated.[123]

But even with its recent withdrawal from deployment of fiber-to-the-premises, Google Fiber has had considerable impact on the market. As of this writing, it is still not clear to what extent Google Fiber's retreat from fiber-to-the-premises construction has chilled this dynamic.

Though Google Fiber was, until recently, the most prominent example, there is also significant interest among smaller companies—which have fewer resources than Google but can deliver next-generation broadband to smaller cities or to particular areas of a larger city on a targeted basis. In Virginia, for example, competitor Ting Internet operates a competitive fiber-to-the-premises network in Charlottesville and Shentel, a rural telephone company, has expanded its footprint with competitive fiber-to-the-premises or fixed wireless in many areas. In Indiana and Illinois, MetroNet, an Indiana-based ISP, has built fiber-to-the-premises in several dozen small towns and is now expanding to Kentucky, Florida, and elsewhere. In Nebraska, Allo has deployed similarly in Lincoln and many smaller communities and is targeting larger cities in surrounding states. In Mississippi and Alabama, C-Spire has deployed fiber-to-the-premises in communities that support its deployment while in the San Francisco Bay Area, Sonic has done the same.

Factors that can accelerate private investment—or slow it

Every company obviously makes unique decisions about deployment based on its technology choices, available capital, business plan, and return on investment (ROI) requirements. In an environment where the private sector has complete control over that dynamic, there exists a wide range of factors that will determine deployment patterns. In our experience, most of these factors are outside the control of a city, but some factors—such as requirements for underground infrastructure—can be addressed by a city under certain circumstances.

Among these are **proximity to existing backbone fiber plant**. In some markets, for example, CenturyLink offers gigabit services to multi-dwelling units (MDU) and single-family homes that are located in close proximity to its existing fiber optics.

Another factor is **proximity to areas with significant potential enterprise business**. As with the former factor, many companies will have invested in fiber infrastructure to areas where large enterprise customers that make big monthly purchases of services are located. As a result, neighborhoods with some proximity to these enterprise customers tend to offer better economics for new residential deployment.

[123] Jacob Kastrenakes, "Google Fiber reportedly cancels hundreds of installations in Kansas City," *The Verge*, March 21, 2017, http://www.theverge.com/2017/3/21/15009694/google-fiber-kansas-city-cancellations.

The **availability of aerial utility pole space** is a further critical factor, so long as utility poles are in reasonably good condition and do not require costly replacement or extensive "make ready" to prepare them for a new attachment. This is not an area in which the community can have influence, given that the utility poles in the community are not owned or controlled by the community in most areas, unless the community has a municipal electric utility.

Closely related to whether aerial utilities are available or not is the cost factor associated with **density**. The higher the density in a neighborhood, the lower the per-customer construction or upgrade costs (all other things being equal); obviously the savings associated with density can be negated by the potential higher costs of expensive pole replacement and make ready or costly underground construction.

Another related factor is the **type of housing** in the neighborhood, and whether it is single family or multi-dwelling units (MDU). Construction to MDUs can be more cost-effective, assuming that the inside wiring in the building is usable for new broadband purposes, and that the service provider has access to the market in the MDU. (This is frequently not the case. Often, MDU building owners will have exclusive marketing contracts with a single service provider, thus enabling an effectively exclusive business opportunity for that provider.)

Finally, **demographics** play a significant role in private sector investment calculus around broadband upgrades or expansion. Again, all other things being equal, families with higher levels of education, multiple breadwinners, multiple children of internet-use age, and so on tend to be high-revenue customers for broadband internet service. Neighborhoods and cities in which these potential customers are concentrated are of particular interest to private investors.

Case studies

Lexington, KY

Lexington Mayor Jim Gray announced at the end of 2017 that the City secured significant new fiber broadband investment and will soon be one of the country's largest gigabit cities—with the potential for even faster speeds in the future. Over the several years preceding the announcement, the City endeavored to attract private capital to Lexington so as to create competition for the barely competitive internet market dominated by Time Warner Cable (now Charter/Spectrum) and Windstream.

The City agreed to a cable franchise agreement with MetroNet, an Indiana-based cable and internet provider. MetroNet committed to spend between $70 and $100 million building a new fiber-to-the-premises network in Lexington.

Significantly, the agreement includes a robust build-out provision, ensuring that no part of the Lexington community is left out of the gigabit era. MetroNet has agreed to build out to 70 percent of the City in the first four years, with the remaining 30 percent to be added as the company achieves certain subscriber benchmarks. This outstanding agreement is testament to the City's commitment to digital equity and to MetroNet's willingness to bring fiber to everyone, rather than exclusively to the neighborhoods that offer the highest return on investment.

Once MetroNet's network is built, Lexington's residents and businesses will enjoy more choice and dramatically better services, all offered over a robust fiber-to-the-premises infrastructure.

Lexington is a demographically-desirable market, home to the premiere public university in Kentucky. Its population was 318,000 as of 2016. The Lexington market is served adequately at best by a cable company (Charter) and with low-end services by a phone company (Windstream). The lack of robust competition presents a significant market opportunity, one that MetroNet recognized and sought access to through a collaboration with the city of Lexington.

In our view, Lexington has achieved a number of the key goals that have been articulated to us in our conversations with New Mexico communities, including future-oriented infrastructure and all the benefits of a competitive market.

Lincoln, NE

The collaboration and subsidy model is not extensively established and represents a new strategy for engagement between public and private sectors. In perhaps the most interesting case study we know of, the city of Lincoln, Nebraska entered into a partnership with Allo Communications, a locally-owned, experienced fiber-to-the-premises competitor. Among other elements of the collaboration between the city and the company, the city pledged an ongoing subsidy of a certain amount per month (from cable franchise fees) to support service to low-income members of the community. In return, Allo pledged to match that subsidy amount for the same purpose. The collaboration also involves the company's leasing of existing city assets such as conduit, as well as ongoing collaborative efforts to smooth and streamline processes so as to expedite construction.

Lincoln is a sophisticated university city and home to a premiere public research university. Its demographics are highly conducive to the high-end internet market. The deployment of the Allo network in Lincoln has preceded quite expeditiously, with full deployment citywide accomplished in less than three years. As Allo is a private entity, we do not have access to its take rate or cost data, but CTC's analysis is that take rate has been substantial and certainly sufficient to encourage Allo and its parent company, Nelnet, to seek other markets, particularly those with strong demographics (Allo has recently announced projects in Tallahassee and Breckenridge).

Through the collaboration with Allo, the city of Lincoln has succeeded in achieving some substantial policy goals, including citywide access, affordability for low-income residents, a robust competitive marketplace, and future-oriented infrastructure throughout the community.

Holly Springs, NC

The town of Holly Springs, North Carolina, represents a successful implementation of this approach. Beginning in 2010, this town of 20,000 in the outer suburbs of Raleigh built a robust fiber backbone capable of a dramatically higher capacity than what the town needed at the time to meet its internal broadband requirements. By building a future-proof, widely distributed middle-mile infrastructure, the town created a powerful tool to attract a potential private fiber lessee and investor.

Leveraging this fiber asset, the town sought a lessee willing to bring last-mile fiber to each household and business in the area. In mid-2015, Ting Internet announced it would lease the middle-mile fiber and bring “crazy fast internet” to homes and businesses throughout Holly Springs.

Holly Springs’ elected officials chose to build a fiber network with dramatically higher capabilities than the need apparent at the time, in the knowledge that a robust fiber backbone would attract interest from private ISPs that recognize the potential to leverage that backbone to build their own fiber-to-the premises infrastructure more efficiently.

A key factor in Ting’s decision to invest in Holly Springs was the fact that the Town not only was willing to lease excess fiber in its backbone, but also brought best practices to bear in its willingness to work with and facilitate Ting’s efforts. Among other things, the Town offered efficient government processes, access to information and facilities, and facilitation and support—all of which boosted Ting’s confidence about this community as an investment opportunity.

Ting Internet offered a proven track record of quality infrastructure, an excellent end product, and top-notch customer service to communities. Over the past two years, Ting built fiber to connect most homes and businesses in Holly Springs and offers symmetrical gigabit internet access to homes and businesses. Through this collaboration, Holly Springs achieved the benefits of forward-looking infrastructure and competition, which were its primary goals. Though these were not terms of the agreement, the community also benefits from Ting’s low-cost product for lower-income consumers and its ongoing commitments to net neutrality and privacy.

Centennial, CO

Incorporated just two decades ago, in 2001, the city of Centennial, Colorado, has about 107,000 residents spread out over its roughly 28 square miles. The city sits about 14 miles south of Denver—and a few miles from the Denver Tech Center—on the I-25 corridor.

Just as they did when they voted to incorporate, Centennial’s residents came out in force to approve a 2013 ballot question posed by City Council. In summary, the ballot initiative asked residents to allow the city to "indirectly provide high-speed internet… through competitive and non-exclusive partnerships…."[124]

In the almost five years since that vote, the city has moved methodically toward achieving that goal—starting in 2014 with a preliminary study, then the approval, in 2015, of a plan to develop a fiber backbone design.[125]

In 2016, the City Council committed $5.7 million to deploying "a neutral, carrier-grade fiber optic backbone utilizing both existing city infrastructure as well as new infrastructure."[126] To date, the city reports having completed 33 miles of underground construction; the stated plans are to complete the backbone in phases over a 24-month period, with the end result being a citywide backbone that "will enable both existing and new broadband providers to tie into the new infrastructure with the goal of providing better and more competitive choices and services for consumers."[127]

With that result in mind, and the fiber and conduit under construction, the city made its infrastructure available for lease by a private entity. In fall 2016, Ting Internet announced that it would lease backbone fiber from the city and build fiber-to-the-premises.[128]

While the city has publicized Ting's pre-order status, it has made clear that "[t]he decision of where Ting would invest and build to offer internet services is entirely theirs, as Ting is an entirely independent entity from the City."[129] In other words, the city did not negotiate any buildout obligations in its lease agreement with Ting.

We understand that the city also did not require any other policy obligations—though we suspect that Ting may have been open to additional policy requirements. That said, the city's efforts seem poised to secure next-generation fiber-to-the-premises infrastructure for most of its residents and businesses, and Ting's standard policies include net neutrality and a commitment to user privacy.

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[124] "Council approves ballot question for November election," News Release, City of Centennial, August 20, 2013, http://www.centennialco.gov/uploads/FileLinks/dba2744ae15e4b65a9e3caefa4b5bb35/8.20.13.pdf.
[125] "Green light for Phase II of the City's Fiber Initiative," News Release, City of Centennial, May 20, 2015, http://www.centennialco.gov/uploads/FileLinks/dba2744ae15e4b65a9e3caefa4b5bb35/5.20.15.pdf.
[126] "Centennial City Council Adopts Fiber Master Plan," News Release, City of Centennial, March 9, 2016, http://www.centennialco.gov/uploads/FileLinks/dba2744ae15e4b65a9e3caefa4b5bb35/3.9.16.pdf.
[127] "FiberWorks," City of Centennial, http://www.centennialco.gov/Business-Services/fiber-initiative.aspx.
[128] "Ting names Centennial, CO as the next gigabit Internet Ting town," News Release, Ting Internet, September 21, 2016, https://ting.com/wp-content/uploads/Ting-names-Centennial-CO-as-the-next-gigabit-Internet-Ting-town.pdf.
[129] "FiberWorks."

Urbana-Champaign, IL

The University of Illinois and the cities of Urbana and Champaign, Illinois, have worked together over many years to expand their broadband infrastructure through development of the Urbana-Champaign Big Broadband (UC2B) network, which is managed by a not-for-profit corporation created by the cities and university.[130] In 2013 to 2015, UC2B built fiber rings specifically engineered to enable fiber-to-the-premises deployment in the most cost-effective manner. It also built fiber-to-the-premises in neighborhoods with the lowest broadband adoption rates, on the theory that those would be the last places that the private sector would deploy.

UC2B's existing investment and willingness to share future risk in 2013 attracted a private partner, iTV-3, an Illinois company with fiber-to-the-premises experience. The two partners entered into an agreement that gave iTV-3 access to UC2B fiber on a lease basis at no cost in return for meeting the community's goals of deploying additional fiber-to-the-premises with the following requirements:[131]

1. Gigabit service speeds
2. Wholesale access on the network to competing companies
3. No cherry picking—all neighborhoods have equal opportunity to get services

Through the agreement, the cities also negotiated that the terms of the agreement would survive transfer of iTV-3's interests to another party (and that the cities have a right of first refusal to buy the network in the event that iTV-3 attempted to sell it). When iTV-3's parent company ran into financial trouble and sought to sell the network, the cities were able to secure from a new private partner, i3 Broadband, similarly robust commitments to meet the cities' policy goals of performance/gigabit speeds, competition/wholesale access, and ubiquitous buildout in return for access to the infrastructure

Under the agreements with both iTV-3 and the successor partner, the community effectively receives 100 percent of the economic development, competition, and digital inclusion benefits it seeks in return for the investment it has already made in the existing fiber. The model also means the community can focus on driving demand and adoption, while relying on an experienced private partner to handle customer service, marketing, and operations.

Urbana and Champaign are university towns that are home to a major research university and substantial federal research. The combined population of the twin cities is 125,000 and the incumbent providers are Comcast and AT&T. Urbana and Champaign identified, when they began

[130] "About," Urbana-Champaign Big Broadband Not-for-Profit. http://uc2b.net/about/.

[131] "Urbana-Champaign Big Broadband Not-for-Profit (UC2B NFP) to Hold Expansion News Conferences," News Release, UC2B NFP (May 29, 2014) http://uc2b.net/wordpress/wp-content/uploads/2014/05/UC2B-NFP-News-Advisory-05.29.2014.pdf

this effort, a substantial lack in the communities of both future-proof infrastructure and robust competition. Through the UC2B effort, they have managed to address the needs of many low-income residents, secure private investment in forward-looking infrastructure, and realize the massive benefits of competition (both by setting in place a new competitor and by negotiating with that competitor that it will sell wholesale service to other entities—effectively, open access.

The buildout obligations of the partnership are not as strong as the cities would have liked, and i3's deployment obligations are triggered only by certain levels of demand. That said, demand appears to be materializing (take rate data are not public) as is evidenced by the strong pace of i3's deployment.

Option 2: Community fiber and private lessee operations

In this model, the community would finance and build a fiber broadband network, and then lease the network to one or more ISPs to utilize the infrastructure.

Description

A number of projects have emerged over the past few years that utilize a hybrid arrangement in which a locality and private partner find a creative way to share the capital, operating, and maintenance costs of a broadband network. These projects have tended to focus on public investment in infrastructure that is utilized to attract at-risk private capital. These alternative approaches are in their early days. Localities that undertake this approach are breaking relatively new ground.

In this scenario, the community would finance, build, and maintain extensive wireless or fiber capabilities **reaching all or most of its residents and businesses**, and then partner with a company that is willing to pay for access to that fiber and to those potential customers. The community's risk is limited to the fiber—a long-term, future-proof asset—while the private company can enter the market quickly and without incurring the construction risk and capital expense of building the fiber network itself.

Among other enormous benefits to this model is an institutional or public network of the future—more extensive than any network that served city or county needs in the past, because the fiber would go everywhere in the community. It will have the potential to serve every conceivable application, from traffic signal control to air quality monitoring, from robust and secure public safety communications to high-end videoconferencing between universities and schools.

We note, however, that while this model offers an extraordinary opportunity for innovation, it is in no way a sure thing. At the moment, early actors are developing new and exciting partnerships to bring next-generation broadband to their communities. We describe some of those projects in the brief examples below.

Case studies

Westminster, MD

The city of Westminster, Maryland a decade ago identified fiber infrastructure as the focus for the city's broadband efforts. Beginning with an approach that includes fiber in the category of durable assets with long lifespans, such as roads, water and sewer lines, and other infrastructure, the city then determined what part of the network implementation and operations the private sector partner would handle and what part could be the city's responsibility.

The hybrid model that made the most sense required the city to build, own, and maintain dark fiber, and to look to partners that would light the fiber, deliver service, and handle the customer relationships with residents and businesses. The model would keep the city out of network operations, where a considerable amount of the risk lies in terms of managing technological and customer service aspects of the network.

The city solicited responses from potential private partners through a request for proposals (RFP). Its goal was to determine which potential partners were both interested in the project and shared the city's vision.

The city eventually selected Ting Internet, then an upstart ISP with a strong track record of customer service as a mobile operator. Ting shared Westminster's vision of a true public–private partnership and of maintaining an open access network. Ting has committed that it will shortly open its operations up to competitors and make available wholesale services that other ISPs can then resell to consumers.

Under the terms of the partnership, the city is building and financing all of the fiber (including drops to customers' premises) through a bond offering. Ting is leasing fiber with a two-tiered lease payment. One monthly fee is based on the number of premises the fiber passes; the second fee is based on the number of subscribers Ting enrolls.

Based on very preliminary information, given that this is a market in development as we write, we believe this is a highly replicable model.

What is so innovative about the Westminster model is how the risk profile is shared between the city and Ting. The city will bond and take on the risk around the outside plant infrastructure, but the payment mechanism negotiated is such that Ting is truly invested in the network's success.

Because Ting will pay Westminster a small monthly fee for every home and business passed, Ting is financially obligated to the city from day one, even if it has no customers. This structure gives the city confidence that Ting will not be a passive partner because Ting is highly incented to sell services to cover its costs.

Ting will also pay the city based on how many customers it serves. Initially, this payment will be a flat fee—but in later years, when Ting's revenue hits certain thresholds, Ting will pay the city a small fraction of its revenue per user. That mechanism is designed to allow the city to share in some of the upside of the network's success.

Perhaps most significantly, there is also a mechanism built into the contract that ensures that the two parties are truly sharing risk related to financing the outside plant infrastructure. In any quarter in which Ting's financial obligations to the city are insufficient to meet the city's debt service, Ting will pay the city a portion percent of the shortfall. In subsequent quarters, if Ting's fees to the city exceed the debt service requirements, Ting will be reimbursed an equivalent amount. This element of the financial relationship made the deal much more attractive to the city because it is a clear demonstration of the fact that its private partner is invested with it.

Westminster is a community of only 20,000 residents, located an hour from Baltimore and 90 minutes from Washington, DC. It houses a community college as well as a small liberal arts university. Before Ting's entry into the market, the only extensive service was provided by Comcast and Verizon, but Verizon's infrastructure in Westminster has not been upgraded and its DSL services are barely competitive with Comcast's cable modem offerings. Ting's entry has meant increased competition and far better service offerings and customer service than was available in this market previously.

The deployment period was approximately three years, with all construction conducted by city contractors under the direction of the city. Neighborhoods have been activated in a serial fashion as construction has completed, and the average take rate across all the neighborhoods (some of which were very recently activated, others some time ago) exceeds 30 percent. The small business areas, in particular, have seen robust take rate, likely because they were entirely unserved by Comcast and served by Verizon only over DSL.

With its investment in dark fiber-to-the-premises, Westminster has secured the benefits of a long-term, future proof broadband infrastructure, as well as the considerable benefits of competition. At the same time, though its negotiations with Ting as lessee of the city's fiber, it has ensured provision of a low-cost internet product and a commitment to open access.

Huntsville, AL

In February 2016, the city of Huntsville, Alabama, the state's northern technology hub, announced that its municipal electric utility will build a fiber network throughout its city limits (presumably, to pass all or most businesses and homes), and that Google Fiber entered into a series of agreements with the utility to lease fiber throughout that footprint and to provide gigabit services to residences and small businesses wherever the utility has built fiber within the city of Huntsville.

The arrangement between Huntsville and Google Fiber is a variation on the model pioneered in Westminster, though the payment terms are different and provide a key contrast. Google Fiber leases fiber from Huntsville based on a rate sheet that provides for various levels of pricing based on amounts and volume. In contrast, Ting's obligations to Westminster are based in part on how much fiber it uses and in part on how many customers it secures and revenues it generates. As a result, Westminster will have less predictability and certainty about its revenues from Ting but has the potential to share in upside in the event that Ting is very successful in that market.

As in Westminster, the Huntsville model puts the city in the business of building infrastructure, a business it knows well after a century of building roads, bridges, and utilities. The model leaves to the private sector (in this case, Google Fiber and any other provider that chooses to lease Huntsville fiber) all aspects of network operations, equipment provisioning, and service delivery.

Interestingly, the Huntsville model holds the potential for competition among providers, as Google Fiber will not be the exclusive user of the fiber and other entities can also choose to lease fiber based on Huntsville Utilities' established rates. We anticipate that there may over time be other ISP users of the city's fiber, particularly to serve larger businesses and institutions, but we question whether the economics exist for another provider to compete against Google Fiber in the residential market, as least in the short-term. Over the long term, however, market demand and structures may change and new opportunities for competition may arise. By building and owning its own fiber assets, the city of Huntsville has ensured it will be able to react to those changes and maximize its benefits.

Huntsville is a community of 194,000 residents, and the home to extensive federal facilities, including NASA, and a large federal contracting base. The incumbent providers are Comcast and AT&T, but the city identified competition and robust infrastructure as key gaps in the existing broadband market.

Deployment has been underway for a number of years, with all construction conducted by Huntsville Utilities contractors under the direction of the utility. Google has been activating customers for at least two years, pursuant to its contractual obligations to quickly install service.

Google Fiber does not share its take rates, and we have no basis for projecting take rates.

With its investment in dark fiber-to-the-premises, Huntsville has secured the benefits of a long-term, future proof broadband infrastructure, as well as the considerable benefits of competition from a robust competitor like Google. Google's lease of fiber is not exclusive, but the likelihood is slim that another entity would choose to lease fiber to compete with Google, AT&T, and Comcast; the economics of that endeavor would be challenging.

Option 3: Municipal broadband—community network and ISP operations

Under the fully-municipal option, the community would finance and build a broadband network, likely a fiber optic network, and begin to provide retail internet service through a new operation within government.

Description

In this model, localities build, own, and operate broadband networks themselves. This is a high-risk and high-reward proposition, with a respectable track record in communities across the country. In our observation, however, this is a difficult model to replicate, particularly for communities that do not own their own municipal electric utilities (as we describe below). The risks and challenges involved in this model suggests that it will be adopted infrequently. Aggressive anti-municipal efforts by incumbent phone and cable companies make this model even more risky. At the same time, the model offers substantial reward, in that the community owns and controls the network and can use it to meet its policy goals.

Background regarding municipal broadband networks

Despite the risks, more than 100 local communities have built hybrid fiber-coaxial networks (the architecture used by cable companies) or fiber-to-the-premises networks to comprehensively serve residential and business markets.

Some of these networks date back almost two decades; the great majority were deployed in the first decade of the 21st century. In almost every case, these networks have been deployed in towns located in largely rural areas. Some, but not all, of these towns already had cable modem service, but many of them were unserved or close to unserved by broadband service.

Track record of municipal investments in fiber-to-the-premises

The economics of fiber-to-the-premises are extremely challenging given the very high capital costs and the modest revenues possible, particularly in light of competition from lesser broadband technologies. Unlike other public utilities such as water and sewer, city communications networks do not operate in a monopoly environment, and a number of competitor technologies, however inferior, do exist. These include far-lower-bandwidth options such as DSL, cable modem service, and wireless service. (In contrast, some of the municipal fiber-to-the-premises networks were built a decade or more ago at a time when there may not have been much or any competition in those rural towns.) These alternative technologies do not offer the same future-proof scalability and speeds as fiber—but they can certainly offer robust competition with respect to price and other factors.

Notable successes have been achieved by public fiber-to-the-premises networks such in Lafayette, Louisiana; Chattanooga, Tennessee; and Wilson, North Carolina—all of which are municipal electric utilities that achieved substantial efficiencies.[132]

The most dramatic successes of these networks are in the benefits that do not necessarily show up on financial statements—such as enhanced productivity, innovation, education, health care, company recruitment, and related benefits that are among the reasons for the communications investment in the first place. Thus, even those public entities that have found it challenging to make fiber-to-the-premises networks self-sustaining on a balance sheet basis can still claim significant success based on these other benefits—which some call positive externalities or ancillary benefits, but that are more central to the purpose of the network than any other factor.

We note, frankly, that a modest subset of the municipal fiber-to-the-premises and hybrid fiber-coaxial networks have struggled financially for a range of reasons, including the challenges created by incumbent opposition to municipal networks (which in some states has restricted municipal options; for example, in Utah, municipalities are statutorily prohibited from offering retail services—a law that was passed at the behest of the incumbent providers, and that has created significant economic challenges for municipal networks) but also ongoing litigation, anti-municipal PR campaigns, and related efforts to delay, obstruct, and increase the costs of municipal efforts.

The significant challenging economics of competitive broadband have also played a factor in creating real financial challenges for a subset of the municipal networks. In some communities, some of the functions required to operate a competitive broadband cable and phone enterprise have proven challenging for public sector entities—in particular, such critical elements as superior customer service in a competitive market is challenging even for private companies and has proven so for some public entities as well. Further, in many but not all municipal broadband communities, the municipal provider is operating in a somewhat competitive market, offering services in competition with one or more companies (though it's critical to note that the services offered over municipal fiber are generally far superior in speed, latency, and reliability than those offered by competitors over legacy infrastructure). Unlike in regulated utility areas such as power, water, and sewer, broadband does not represent a regulated monopoly with no competitive pressures, and as a result, municipal internet service providers face far different challenges than do municipal electric and water utilities.

[132] In 2012, the Benton Foundation and the Institute for Local Self-Reliance published a study about the utilities' fiber-to-the-premises networks in these cities. Mitchell, Christopher. "Broadband at the Speed of Light: How Three Communities Built Next-Generation Networks," Institute for Local Self-Reliance. (April 2012) http://www.ilsr.org/wp-content/uploads/2012/04/muni-bb-speed-light.pdf. *See also*: Kendrick, Julie. "The Broadband Challenge." *The Line*. (July 18, 2012) http://www.thelinemedia.com/features/broadband071812.aspx.

Benefits of municipal networks

While it comes at considerable cost, municipal broadband offers demonstrable and important benefits, including municipal decision-making and control with regard to critical factors such as insuring that the network is made universally accessible to all members of the community rather than building only to areas with a higher return on investment.

Municipal ownership also delivers considerable flexibility and opportunity to expand, change business models, and otherwise innovate as necessary to meet the needs of the community. For example, the first fiber-to-the-premises networks to offer gigabit consumer offerings were actually public networks that led the way with industry-defining innovation such as symmetrical products and gigabit level services. For example, a decade before Google Fiber announced its first fiber-to-the-premises project, in the Kansas City region, the city of North Kansas City had done so. Similarly, the first widely available gigabit consumer offering was that of Chattanooga's EPB, a product that was made available before Google's symmetrical gigabit product reached the market.

This flexibility and opportunity to innovate can have remarkable potential for economic activity and entrepreneurship. In markets like Chattanooga and Lafayette, Louisiana, entrepreneurial ecosystems and facilities catering to technology entrepreneurs have sprung up. In these cases, in cities that were not previously identified with either technology innovation or technology entrepreneurship.

An additional and critical area of benefit is in regard to pricing and the affordability that is created by a competitive dynamic. The municipal fiber-to-the-premises and hybrid fiber-coaxial networks to date have tended to be in markets where the likelihood of a third private competitor emerging was slim to nonexistent. In fact, some of these networks have developed in markets where only one or no broadband competitors existed. As a result, these municipal networks have almost universally delivered a level of competition that was inconceivable otherwise—and competition creates a dynamic in which pricing increases are constrained, prices frequently decrease, and services frequently improve and increase.

In fact, we have found that even in markets where municipal network has been contemplated but not emerged, the potential for competition can change incumbent pricing and behavior. In cities such as Santa Cruz, CA for example, where a municipal fiber network has been under consideration for the past several years, Comcast appears to have significantly stepped up marketing and field efforts, including offering special pricing and has significantly increased bandwidth in certain service tiers without increasing pricing, thus effectively bringing down per megabit pricing quite substantially.

Challenges of municipal networks

At the same time, municipal networks present considerable challenges. In addition to the financial risk entailed in building and operating a venture that competes with private sector service offerings in some cases, a number of other challenges present themselves. Municipal networks are generally only possible when a city is in a position to issue bonds to raise capital to build the network. In many cases, even cities with outstanding credit ratings are unable to bond to support a communications network because of other critical priorities. And bonding capacity is limited in any city, no matter how good its credit rating or how prosperous its economy.

Competing needs for capital are thus a considerable challenge around municipal efforts. At the same time, additional challenges can be created in multiple functional areas associated with construction, operations, and maintenance of a communications enterprise. The challenges can range from the considerable difficulty of hiring network engineers, where network engineers are in such demand and command very high private sector salaries that are difficult for the public sector to match.

Case studies

Longmont, CO

Longmont, CO is a city of around 90,000. With a number of high-tech companies located in the area, the city recognized the need for better communications infrastructure. The city already had a 17-mile fiber optic loop, installed in 1997 at a cost of $1.1 million by the Platte River Power Authority.[133] While the local school district and hospital system benefited from the fiber loop, it did little to improve the availability of advanced broadband services for residential and business customers. Longmont's municipal electric utility, Longmont Power & Communications, first sought to extend the fiber network to residential and business customers in 2009, but the ballot measure that would have given it the authority to start the expansion failed to gain voter approval after the cable industry poured hundreds of thousands of dollars into the campaign to defeat the measure.[134]

In 2013, Longmont voters approved a measure giving the city authority to issue a $45.3 million bond to extend the fiber network, known as NextLight, to every home and business within city limits in three years. With a capital budget of just over $20 million, Longmont Power & Communications took a phased approach to construction, building first in areas where demand was highest.

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[133] http://www.timescall.com/news/elections/ci_24462881/longmonts-fiber-optic-wastewater-bond-issues-pass?IADID=Search-www.timescall.com-www.timescall.com

[134] https://www.washingtonpost.com/news/the-switch/wp/2013/11/06/big-cable-helped-defeat-seattles-mayor-mcginn-but-they-couldnt-stop-this-colorado-project/?utm_term=.d3825bb977ca

NextLight originally aimed for a 38 percent take rate in the first five years but experienced far greater demand than expected. In many areas, the network achieved take rates in excess of 40 percent as soon as service became available.[135]

One of the reasons for NextLight's high take rate is its creative "charter membership" offer, which allows homeowners to lock in 1 Gbps symmetrical service for $50/month if they sign up within three months of NextLight service becoming available in their area.[136] NextLight originally offered only voice and data service, with speeds ranging from 25 Mbps to 1 Gbps. It also partnered with Layer3 TV to add video service offerings.[137]

Wilson, NC

Wilson, NC is a city of just under 50,000, located an hour east of Raleigh. Once known as "the World's Greatest Tobacco Market," the city's economy took a major hit when tobacco began to decline in the 1990s. City leadership hoped that improving communication infrastructure would help retain and attract new businesses to the area.

The city has a long history of public investment in critical infrastructure. The city formed a water and power utility in 1890 and added natural gas in 1912. In 2006, after the incumbent cable and telecommunication providers made clear that they had no interest in upgrading their private networks in Wilson, the City Council unanimously voted to borrow $28 million to build a fiber-to-the-premises system.[138]

The network, named Greenlight, passes all of the homes and businesses within the city of Wilson, as well as all of the public schools in the County. The city began offering service in mid-2008, and by early 2009, service was available citywide, a year ahead of schedule. Greenlight immediately saw demand far exceed what it had predicted in its business plan. In order to keep up with the cost of connecting new customers, the city borrowed an additional $4.75 million in 2010, bringing the total cost of the project up to $33 million. In 2012, Greenlight began expanding service to households and businesses in the surrounding county.[139] Greenlight offers voice, video and data service, with speeds ranging from 50 Mbps to 1 Gbps. Despite aggressive pricing practices from one of the incumbent providers, at the end of 2012, Greenlight had 6,050 customers, giving it a

[135] https://muninetworks.org/content/transcript-community-broadband-bits-episode-161
[136] https://muninetworks.org/content/transcript-community-broadband-bits-episode-161
[137] https://www.longmontcolorado.gov/departments/departments-e-m/longmont-power-communications/nextlight-broadband/rates-and-services-gig-promo
[138] https://muninetworks.org/reports/wilsons-greenlight-leads-north-carolina-fast-internet
[139] Ibid.

30 percent market share.[140] By mid-2017, the network had roughly 9,000 customers, giving it a 40 percent market share.[141]

Salisbury, NC

Located just 37 miles northwest of Charlotte and 33 miles southeast of Winston-Salem, Salisbury has a population of just under 34,000. As the mills and furniture factories that served as the backbone of Salisbury's economy in the 20th century shut down, city leadership began searching for a way to differentiate itself and attract new businesses to the area.[142] Frustrated with the incumbent cable and telecommunication providers, the city approved $33.56 million in bonds in 2008 to build a fiber-to-the-premises network to all residents and businesses in the Salisbury service area. Fibrant, the name of the city's fiber enterprise, began offering service to customers in December 2010. Unlike Wilson and Longmont, the city did not have an existing public utility.

Although Fibrant did help the city achieve some public policy goals such as increased competition and support for economic development, Fibrant offers a cautionary tale about market challenges. The city hoped to reach 4,800 subscribers by 2015, but by mid-2017, Fibrant still only had 2,800 residential and 430 commercial subscribers.[143] In spite of offering below market rates of $45 monthly for 50 Mbps speeds,[144] take rate remained at or below 21 percent. Fibrant was not earning enough revenue to cover its operating costs and debt service. Fibrant was costing the city approximately $3 million annually, which the city was forced to cover from its general fund.

In 2017, the city issued an RFP to find a third-party operating partner to reduce the city's financial burden. None of the respondents offered to fully cover the city's costs and debt service. The City Council in 2018 approved a network lease with a private entity, Hotwire Communications, that has the potential to reduce the city's annual financial losses by half or more. The city of Salisbury has achieved an enviable level of competition and has secured for the community the benefits of future-proof infrastructure, but at great cost.

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[140] Ibid.

[141] https://www.salisburypost.com/2017/07/27/fibrant-in-focus-story-of-wilsons-salisburys-fiber-optic-networks-a-tale-of-two-cities/

[142] https://www.salisburypost.com/2017/07/23/fibrant-in-focus-salisburys-fiber-optic-network-started-as-response-to-business-closings/

[143] Ibid.

[144] http://fibrant.com/residential/packages

Appendix C: Sources Consulted in Development of Project Definitions

For purposes of this Plan, DoIT adopted the following definitions of "served" and unserved" broadband.

1. **Served:** An area or address is **served** with broadband if it can receive fixed, terrestrial internet access with transmission speeds that, at a minimum, provide twenty-five megabits per second (25 Mbps) download and three megabits per second (3 Mbps) upload. Neither satellite nor mobile service can be considered broadband for purposes of this definition. This definition generally aligns with federal rules.[145]

2. **Unserved:** An area or address is **unserved** with broadband if it cannot receive fixed, terrestrial internet access with transmission speeds that, at a minimum, provide twenty-five megabits per second (25 Mbps) download and three megabits per second (3 Mbps) upload. Neither satellite nor mobile service can be considered broadband for purposes of this definition. This definition generally aligns with federal rules.[146]

The following is a list and quotations from the sources consulted in development of those definitions.

1. **Congressional Research Service**[147]

"One way broadband can be defined is by setting a minimum threshold speed for what constitutes 'broadband service.' Section 706 of the Telecommunications Act of 1996 requires the Federal Communications Commission (FCC) to regularly initiate an inquiry concerning the availability of broadband to all Americans and to determine whether broadband is 'being deployed to all Americans in a reasonable and timely fashion…. In 2015 the FCC, citing changing broadband usage patterns and multiple devices using broadband within single households, raised its minimum fixed broadband benchmark speed from 4 Mbps (download)/1 Mbps (upload) to 25 Mbps/3 Mbps."

[145] "2018 Broadband Deployment Report," Federal Communications Commission, Feb. 2, 2108, https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2018-broadband-deployment-report (accessed September 17, 2019).

[146] "2018 Broadband Deployment Report," Federal Communications Commission, Feb. 2, 2108, https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2018-broadband-deployment-report (accessed September 17, 2019).

[147] Lennard G. Kruger, "Defining Broadband: Minimum Threshold Speeds and Broadband Policy," Report, Congressional Research Service, Dec. 4, 2017, https://fas.org/sgp/crs/misc/R45039.pdf (accessed May 17, 2019).

2. Federal Communications Commission[148]

"The FCC retains the existing speed benchmark of 25 Mbps download/3 Mbps upload (25 Mbps/3 Mbps) for fixed services…"

"Consequently, we rely upon [Form 477] data to identify areas with access to services with maximum advertised speeds meeting our 25 Mbps/3 Mbps speed benchmark for fixed advanced telecommunications capability, as well as identifying areas with LTE coverage at minimum advertised (or in the case of SBI data, maximum advertised) or expected speeds of 5 Mbps/1 Mbps. We note that the Form 477 and SBI data only report service at the census block level, and not the household level. A whole census block is classified as served if the Form 477 or SBI data indicate that service is being provided anywhere in the block. Therefore, it is not necessarily the case that every person will have access to a service in a block that this Report indicates is served."

"Certain mobile services provide 'high-speed, switched, broadband telecommunications capability that enables users to originate and receive high-quality voice, data, graphics and video telecommunications using any technology.' In this Report, we evaluate mobile deployment holistically and use various data points to assess the extent to which American consumers have access to advanced telecommunications capability under section 706. While we acknowledge the potential benefits of a single speed benchmark for mobile service, we find—as was the case in the last report—that adoption of a single mobile benchmark is currently unworkable given the inherent variability of actual mobile speeds and our available data. Instead, we will use 4G LTE as our starting point and will present LTE coverage data based on the Form 477 minimum advertised speeds of 5 Mbps/1 Mbps. However we are not asserting that 5 Mbps/1 Mbps is a mobile advanced telecommunications capability benchmark."

3. U.S. Code Authorizing RUS Rural Broadband Access Loan and Loan Guarantee Program[149]

"The term 'broadband service' means any technology identified by the Secretary as having the capacity to transmit data to enable a subscriber to the service to originate and receive high-quality voice, data, graphics, and video."

[148] "2018 Broadband Deployment Report," Federal Communications Commission, Feb. 2, 2108, https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2018-broadband-deployment-report (accessed May 17, 2019).
[149] 7 USC 950bb(b)(1), https://www.law.cornell.edu/uscode/text/7/950bb (accessed September 17, 2019).

4. U.S. Code Defining "Substantially Underserved Trust Area"[150]

"*Underserved* means an area or community lacking an adequate level or quality of service in an eligible program, including areas of duplication of service provided by an existing provider where such provider has not provided or will not provide adequate level or quality of service."

5. USDA RUS ReConnect Program[151]

"*Sufficient access to broadband* means any rural area that has fixed, terrestrial broadband service delivering at least 10 Mbps downstream and 1 Mbps upstream."

6. Broadband Technology Opportunities Program (BTOP)[152]

"Broadband means providing two-way data transmission with advertised speeds of at least 768 kilobits per second (kbps) downstream and at least 200 kbps upstream to end users, or providing sufficient capacity in a Middle Mile project to support the provision of broadband service to end users."

"*Underserved area* means a Last Mile or Middle Mile service area, where at least one of the following factors is met: (i) No more than 50 percent of the households in the Last Mile or Middle Mile service area have **access** to facilities-based, terrestrial broadband service at greater than the minimum broadband transmission speed (set forth in the definition of broadband above); (ii) no fixed or mobile terrestrial broadband service provider advertises to residential end users broadband transmission speeds of at least three megabits per second (''Mbps'') downstream in the Last Mile or Middle Mile service area; or (iii) the rate of terrestrial broadband **subscribership** for the Last Mile or Middle Mile service area is 40 percent of households or less. An underserved area may include individual Census block groups or tracts that on their own would not be considered underserved. The availability of or subscribership rates for satellite broadband service is not considered for the purpose of determining whether an area is underserved.

"*Unserved area* means a Last Mile or Middle Mile service area where at least 90 percent of the households lack access to facilities-based, terrestrial broadband service, either fixed or mobile, at the minimum broadband transmission speed (set forth in the definition of broadband above). An unserved area may include individual Census block groups or tracts that on their own would

[150] 7 USC 1700.101, https://www.law.cornell.edu/cfr/text/7/1700.101 (accessed September 14, 2019).

[151] "Broadband Pilot Program Funding Opportunity Announcement (FOA) and solicitation of applications," Rural Utilities Service, U.S. Department of Agriculture, Federal Register, Dec. 14, 2018, https://www.federalregister.gov/documents/2018/12/14/2018-27038/broadband-pilot-program (accessed September 17, 2019).

[152] "Broadband Technology Opportunities Program Notice of Funds Availability (NOFA) and solicitation of applications," U.S. Department of Commerce, National Telecommunications and Information Administration Second, Jan. 22, 2010, https://www.ntia.doc.gov/files/ntia/publications/fr_btopnofa_100115_0.pdf (accessed September 17, 2019).

not be considered unserved. A household has access to broadband service if the household readily can subscribe to that service upon request. The availability of or subscribership rates for satellite broadband service is not considered for the purpose of determining whether an area is unserved."

7. Pew Center on Internet and Society[153]

Pew's research depends on self-reporting (i.e., Pew asks survey respondents if they have "broadband"). Pew also collects data on adoption patterns and notes that "as is true of internet adoption more broadly, home broadband adoption varies across demographic groups. Racial minorities, older adults, rural residents, and those with lower levels of education and income are less likely to have broadband service at home."

[153] Kathryn Zickhur, "How Pew Research calculates broadband adoption," Pew Research Center, Aug. 29, 2013, https://www.pewresearch.org/fact-tank/2013/08/29/how-pew-research-calculates-broadband-adoption/ (accessed September 17, 2019); "Internet Fact Sheet," Pew Research Center, Feb. 5, 2018, https://www.pewinternet.org/fact-sheet/internet-broadband/ (accessed September 15, 2019).

Appendix D: ISP Data on Served and Unserved Premises

Provider Name	Technology	ISP-Provided EDAC Data Date	Provider Submitted 2019 477 Data	Source of Unserved Data Used
Cable One, Inc.	Cable	2018	YES	EDAC 2018
Charter Communications, Inc.	Cable	2018	YES	EDAC 2018
COMCAST CABLE COMMUNICATIONS, LLC	Cable	2018	YES	EDAC 2018
EarthLink Business, LLC	Cable	2018	YES	EDAC 2018
PVT Networks, Inc.	Cable	2019	YES	EDAC 2019
Spectrotel, Inc.	Cable	2018	YES	EDAC 2018
Suddenlink Communications	Cable	2018	YES	EDAC 2018
TDS BROADBAND SERVICE LLC	Cable	2018	YES	EDAC 2018
APXNET	Cable	2018	NO	EDAC 2018
Chaparral CableVision	Cable	2018	NO	EDAC 2018
63	DSL (Asymmetric)	–	YES	FCC Form 477
Bulls Eye Telecom	DSL	2018	NO	EDAC 2018
Birch Communications Inc.	DSL	2018	NO	EDAC 2018
Baca Valley Telephone Company, Inc.	DSL (Asymmetric)	2018	YES	EDAC 2018
CenturyLink, Inc.	DSL (Asymmetric)	Custom	YES	CenturyLink Provided
Copper Valley Telephone, Inc.	DSL (Asymmetric)	–	YES	FCC Form 477
Cyber Mesa Computer Systems Incorporated	DSL (Asymmetric)	2018	YES	EDAC 2018
Delcom, Inc.	DSL (Asymmetric)	2018	YES	EDAC 2018
E.N.M.R. Telephone Cooperative	DSL (Asymmetric)	2019	YES	EDAC 2019
EarthLink Business, LLC	DSL (Asymmetric)	2018	YES	EDAC 2018
Frontier Communications Corporation	DSL (Asymmetric)	2018	YES	EDAC 2018
Global Capacity LLC	DSL	2018	NO	EDAC 2018
La Jicarita Rural Telephone Cooperative	DSL (Asymmetric)	2018	YES	EDAC 2018
Leaco Rural Telephone Cooperative	DSL (Asymmetric)	2019	YES	EDAC 2019
Lobo Internet	DSL (Asymmetric)	2018	YES	EDAC 2018
McLeodUSA Telecommunications Services, L.L.C.	DSL (Asymmetric)	2018	YES	EDAC 2018

Provider Name	Technology	ISP-Provided EDAC Data Date	Provider Submitted 2019 477 Data	Source of Unserved Data Used
Mescalero Apache Telecom, Inc.	DSL (Asymmetric)	2018	YES	EDAC 2018
NetFortris	DSL	2018	NO	EDAC 2018
Penasco Valley Telephone Coop	DSL (Asymmetric)	2019	YES	EDAC 2019
Roosevelt County Rural Telephone Cooperative, Inc.	DSL (Asymmetric)	–	YES	FCC Form 477
Sacred Wind Communications Inc.	DSL (Asymmetric)	2019	YES	EDAC 2019
Spectrotel, Inc.	DSL (Asymmetric)	2018	YES	EDAC 2018
Tularosa Communications, Inc	DSL (Asymmetric)	2018	YES	EDAC 2018
Valley Telephone Cooperative, Inc.	DSL (Asymmetric)	2019	YES	EDAC 2019
Valor Telecommunications of Texas, LLC	DSL (Asymmetric)	–	YES	FCC Form 477
Windstream	DSL	2018	NO	EDAC 2018
Yucca Telecom	DSL	2018	NO	EDAC 2018
WNM Communications	DSL (Asymmetric)	2018	YES	EDAC 2018
CenturyLink, Inc.	Fiber	Custom	YES	CenturyLink Provided
Affiniti, LLC	Fiber	2018	YES	EDAC 2018
Baca Valley Telephone Company, Inc.	Fiber	2018	YES	EDAC 2018
Charter Communications, Inc.	Fiber	2018	YES	EDAC 2018
Cogent Communications Group	Fiber	2018	YES	EDAC 2018
Cyber Mesa Computer Systems Incorporated	Fiber	2018	YES	EDAC 2018
Delcom, Inc.	Fiber	2018	YES	EDAC 2018
Kit Carson Electric Cooperative	Fiber	2018	NO	EDAC 2018
La Jicarita Rural Telephone Cooperative	Fiber	2018	YES	EDAC 2018
Level 3 Communications, LLC	Fiber	2018	YES	EDAC 2018
Mammoth Networks	Fiber	2018	NO	EDAC 2018
MCI Communications Corporation	Fiber	2018	YES	EDAC 2018
McLeodUSA Telecommunications Services, L.L.C.	Fiber	2018	YES	EDAC 2018
Panhandle Telecommunications Services LLC	Fiber	2018	NO	EDAC 2018
TDS BROADBAND SERVICE LLC	Fiber	2018	YES	EDAC 2018

Provider Name	Technology	ISP-Provided EDAC Data Date	Provider Submitted 2019 477 Data	Source of Unserved Data Used
Tularosa Communications, Inc.	Fiber	2018	YES	EDAC 2018
Yucca Telecommunications Systems	Fiber	2018	YES	EDAC 2018
Zayo Group, LLC	Fiber	2018	YES	EDAC 2018
Windstream	Fiber	2018	NO	EDAC 2018
Continental Divide Electric Cooperative, Inc.	Fiber	2019	YES	EDAC 2019
E.N.M.R. Telephone Cooperative	Fiber	2019	YES	EDAC 2019
FastTrack Communications, Inc.	Fiber	2019	YES	EDAC 2019
Leaco Rural Telephone Cooperative	Fiber	2019	YES	EDAC 2019
PVT Networks, Inc.	Fiber	2019	YES	EDAC 2019
Unite Private Networks, L.L.C.	Fiber	2019	YES	EDAC 2019
NMSURF	Fiber	2019	NO	EDAC 2019
Kit Carson	Fiber	2019	NO	EDAC 2019
Valley Telephone Cooperative, Inc.	Fiber	2019	YES	EDAC 2019
63	Fiber	–	YES	FCC Form 477
Black Mesa Wireless LLC	Fiber	–	YES	FCC Form 477
Call One, Inc.	Fiber	–	YES	FCC Form 477
COMCAST CABLE COMMUNICATIONS, LLC	Fiber	–	YES	FCC Form 477
DPAccess, LLC	Fiber	–	YES	FCC Form 477
Futurum Communications Corp.	Fiber	–	YES	FCC Form 477
Plateau Telecommunications, Inc.	Fiber	–	YES	FCC Form 477
Roosevelt County Rural Telephone Cooperative, Inc.	Fiber	–	YES	FCC Form 477
Sierra Communications	Fiber	–	YES	FCC Form 477
Transtelco, Inc.	Fiber	–	YES	FCC Form 477
U.S. TelePacific Corp.	Fiber	–	YES	FCC Form 477
Valor Telecommunications of Texas, LLC	Fiber	–	YES	FCC Form 477
Visionary Communications, Inc	Fiber	–	YES	FCC Form 477