Broadband Strategic Plan

FINAL REPORT

Commerce City, Colorado

March 3, 2026

Contents

Figures

Tables

1. Executive Summary

Broadband refers to high-speed internet connectivity that allows homes, businesses, schools, and public facilities to send and receive large amounts of digital information quickly and reliably. Broadband services support modern activities such as video conferencing, online education, telehealth, cloud computing, and digital commerce. In the United States, the Federal Communications Commission currently defines broadband as internet service providing at least 100 megabits per second (Mbps) download speed and 20 Mbps upload speed.[1] Broadband may be delivered through several technologies, including fiber optic networks, cable systems, fixed wireless services, and modern cellular networks such as 4G and 5G.

It is important to distinguish broadband service from a municipal connectivity network. Broadband service refers to the retail internet access purchased by residents and businesses from private providers. Municipal connectivity networks, by contrast, typically consist of fiber and other communications infrastructure used to connect government facilities, public safety sites, traffic systems, and other public assets. These networks improve operational reliability and support public services, but they do not necessarily provide retail internet service to homes or businesses.

The City of Commerce City engaged ENTRUST Solutions Group (ENTRUST) to complete a Strategic Broadband Plan to evaluate how existing municipal assets, commercial broadband service quality, and wireless performance align with the City's long-term operational, economic, and community-serving goals. This effort included an assessment of City-owned conduit and fiber, a review of commercial broadband offerings, a citywide wireless drive test of the three major mobile carriers, an analysis of community and municipal connectivity needs, and the development of conceptual options for strengthening municipal fiber connectivity and organizing a coordinated wireless infrastructure strategy. Financial modeling examined the feasibility of a City-operated broadband utility and alternative partnership models to support cost-effective, long-term broadband development.

The methodology used to evaluate the City's broadband baseline and overall smart city readiness indicates several foundational steps Commerce City could take to strengthen its position as a strategic municipal partner for future broadband investment. In this context, smart city readiness refers to the underlying digital infrastructure and governance required to support resilient public safety systems, connected facilities, mobility corridors, and data-driven operations. These steps establish a predictable environment for private investment, support technology-driven economic development and improve the City's network resiliency, security, and long-term operational sustainability.

The asset assessment shows that Commerce City has a meaningful foundation of conduit and fiber deployed along major corridors and between key facilities, including more than 30

---

[1] Federal Communications Commission, 2024 Section 706 Broadband Progress Report, establishing 100 Mbps download / 20 Mbps upload as the current benchmark for fixed broadband service.

miles of buried conduit supporting traffic signals and internal operations. These assets provide a strong starting point; however, the network is non-redundant, contains continuity gaps, and leaves several municipal and community anchor facilities unconnected. While it supports core needs, it does not yet function as a cohesive platform capable of supporting expanded municipal connectivity or influencing broader broadband investment.

Analysis of commercial broadband services shows that residents and businesses have multiple provider options, but performance varies significantly across the City. A wireless drive test of AT&T, T-Mobile, and Verizon found that each carrier delivers a different balance of speed, coverage, and reliability. The data indicates that tower siting, backhaul availability (fiber), and overall network design likely drive many of the observed gaps, and suggests that municipal policies affecting this infrastructure can materially influence carrier investment decisions and wireless outcomes.

The conceptual network design component identifies how Commerce City can organize and strengthen its existing assets to improve resiliency and create a scalable foundation for future connectivity. The Fiber Network Conceptual Design outlines a phased approach for improving facility interconnection, reducing single points of failure, and preparing key segments for future expansion as funding and development opportunities arise. Complementing the fiber design, the wireless conceptual plan proposes the creation of a Citywide Master Tower Plan that organizes City-owned sites into a structured platform for municipal wireless equipment, public safety connectivity, fixed-wireless applications, and improved commercial deployments. Rather than creating a City-run mobile service, the strategy treats wireless deployment as a shared, integrated layer that can advance both public service needs and private sector investment.

Financial modeling analyzed whether a municipal retail broadband utility could sustain itself using the existing and proposed conceptual fiber network. Even under favorable assumptions, including a 30 percent take rate and competitive pricing, a City-run retail ISP would generate approximately $760,000 in annual revenue while incurring more than $1.1 million in annual operating losses, before the estimated $3.2 million in start-up capital for customer equipment and installations.[2] This structure does not generate sufficient revenue to sustain operations, service debt, or support expansion. For these reasons, a stand-alone municipal retail broadband utility is not a viable path for Commerce City at this time.

[2] This amount is in addition to an estimated $23 Million in CAPEX to build out a three-phase city backbone design in support of city operations.

For private network providers, successful deployment depends on predictable permitting timelines, clear access to conduit and vertical assets, viable tower locations, and reliable fiber backhaul. These conditions reduce regulatory uncertainty, improve deployment scheduling, and allow capital investments to be planned with greater confidence, ultimately supporting more predictable returns on infrastructure investment. For residents and businesses, the need is consistent performance, competitive service options, and improved reliability across both fixed and mobile networks. For the City, the priority is resilient, secure infrastructure that supports public safety, municipal operations, long-term economic development, and managed growth. The actions outlined below are structured to align these interests by strengthening governance, clarifying asset availability, advancing infrastructure planning, and creating the conditions necessary to attract investment while improving public service resiliency.

Figure 1 Commerce City Broadband Readiness Path

The framework illustrated in *Figure* 1 presents a staged progression of municipal digital infrastructure development, beginning with governance and policy foundations and advancing toward more complex broadband participation models. Based on current conditions and available infrastructure assets, Commerce City is positioned in the early stages of this continuum, where the primary focus is establishing governance structures, creating the technical and policy platform necessary to support future connectivity initiatives, and verifying and organizing existing assets.

The recommendations that follow therefore concentrate on these foundational steps, positioning the City to enable municipal connectivity, attract private-sector deployment, and pursue more advanced broadband opportunities over time as infrastructure, partnerships, and market conditions evolve. They recommendations are presented in logical sequence, beginning with policy review, advancing through asset verification and infrastructure planning, and culminating in financial and partnership structures that create long-term sustainability.

Through this structured approach, the City can then transition from isolated infrastructure assets into a cohesive, resilient broadband platform that jointly strengthens municipal operations, enhances public safety connectivity, improves commercial wireless performance, and supports long-term economic development, without assuming the financial risk of operating a retail broadband utility.

2. Key Recommendations

Commerce City's broadband assessment confirms that while the City possesses a meaningful foundation of conduit, fiber, and strategically located facilities, it lacks the governance and policy clarity, standardized access mechanisms, verified asset inventory, and structured investment framework necessary to translate that foundation into sustained broadband improvement.

2.1 Public Policy Foundational Level Planning

The recommendations in this section focus on establishing the policy and legal framework (master lease agreements, service agreements, Land Development Code updates, etc.) necessary to support coordinated digital infrastructure development across Commerce City. These actions are intended to clarify how existing assets may be used, integrate broadband considerations into capital planning and development activity, and assign clear governance authority for the management and expansion of municipal digital infrastructure systems. Together, these foundational steps create the governance, administrative, and operational structure required to support future infrastructure investments, strengthen interagency coordination, and position the City as a predictable and effective partner for private-sector broadband deployment.

Review and Update Intergovernmental Agreements and Memoranda of Understanding

Commerce City's existing Intergovernmental Agreements (IGAs) with Colorado Department of Transportation (CDOT), Adams County and ADCOM 911 define how portions of the City's joint fiber plant can be used, but the boundaries of these permissions remain unclear. The City should conduct a structured review of these, and other telecom related agreements, to clarify the operational, legal, and technical conditions under which shared fiber or conduit may be used for facility interconnects, broadband expansion, or partnerships with private ISPs. Updating these documents will provide a clear framework for asset utilization, reduce internal uncertainty, and ensure the City is positioned to leverage existing fiber resources without creating conflicts among shared owners.

Implement Utility Coordination Policies & Practices

Commerce City should formalize broadband-supportive policies to ensure that conduit, fiber, and wireless-readiness requirements are integrated into capital projects, street reconstruction, and private development. Establishing predictable standards for dig-once coordination, microtrenching, and other interdepartmental coordination will help reduce repetitive excavation, preserve roadway integrity, and expand the City's underground asset base without relying exclusively on public capital. These policies also provide clear expectations for developers and utilities, allowing the City to capitalize on infill development, annexation activity, and corridor upgrades as opportunities to extend broadband infrastructure incrementally.

Assign Digital Infrastructure Governance Authority to the IT Director

The City should formally assign Digital Infrastructure Governance Authority to the IT Director, or the Director's designee, with approval authority over broadband, conduit, fiber, wireless assets, and related municipal digital systems and smart city projects. The IT Director should review and approve major infrastructure expansions, system integrations, and telecommunications deployments affecting the City's digital backbone and systems.

This authority should ensure that fiber routing, conduit utilization, wireless deployments, and external telecommunications partnerships align with enterprise architecture standards, cybersecurity requirements, interoperability protocols, and long-term municipal technology strategy. No significant digital infrastructure project should proceed without review and approval by the IT Director or designee.

Locating this authority within the IT Department is appropriate because IT traditionally maintains responsibility for network architecture, cybersecurity, systems integration, and technology lifecycle planning. Best practices demonstrate centralized governance reduces fragmentation, strengthens implementation discipline, and ensures that digital infrastructure investments support resilient, secure, and interoperable municipal systems.

Establish a "Digital Technology Fund" to Sustain Long-Term Broadband Investment

While broadband connectivity is a central component of this strategy, the Digital Technology Fund is intended to support the broader category of municipal digital infrastructure. This includes assets and systems that enable modern technology applications across the City, such as fiber networks, conduit infrastructure, wireless systems, smart city sensors, traffic and mobility technologies, public safety communications, and other digital platforms that rely on secure and resilient connectivity. Establishing a fund with this broader scope ensures that revenues generated from digital infrastructure can be reinvested to support the full range of technology systems that underpin municipal operations and service delivery.

A Digital Technology Fund could be established to manage broadband-related revenues and reinvest them into future infrastructure. Revenue sources may include dark-fiber leases, tower or rooftop licensing, MLA agreements, and proceeds from public-private partnerships.[3] A dedicated fund ensures transparency, aligns revenues with broadband priorities, and enables the City to move from ad-hoc, grant-dependent deployments toward a sustainable reinvestment cycle that supports fiber expansion, wireless enhancements, and digital-equity initiatives.

2.2 Infrastructure Platform Development

Once governance authority and policy foundations are established, Commerce City should focus on strengthening the physical and operational platform that supports municipal connectivity and private-sector deployment. This stage centers on verifying and organizing existing conduit and fiber infrastructure, identifying strategic locations for wireless facilities, and creating standardized mechanisms through which private providers can access City-owned assets. These actions transform existing infrastructure from isolated assets into a coordinated platform capable of supporting municipal operations, improving wireless coverage, and enabling future broadband partnerships.

Complete a Comprehensive Audit of City Conduit and Fiber Assets

With more than 30 miles of conduit and fiber assets across the community, the City should conduct a detailed audit to verify condition, continuity, duct availability, strand capacity, and opportunities for reuse. A verified inventory typically is expected to cost between $1.25 to $2.50 per linear foot, and will help the City identify segments requiring rehabilitation, confirm spare duct capacity for fiber expansion, and prioritize routes that can support redundant loops or future facility interconnects. This audit will also strengthen the City’s negotiating posture with private providers by giving staff a precise understanding of what infrastructure is available for joint builds, leases, or public-private partnerships. The resulting GIS-integrated dataset ensures broadband planning becomes a standard part of City operations.

Develop a Citywide Master Tower Plan to Guide Wireless Infrastructure and Attract Carrier Investment

A Master Tower Plan will begin with a parcel-level audit of City-owned land, facilities, and rooftops to identify sites that meet zoning, setback, and height requirements for wireless infrastructure. The Plan should align tower locations with the findings from the wireless performance survey, particularly in areas where tower density is insufficient or coverage gaps persist, to provide a cohesive strategy for improving mobile service. Once priority sites are identified, the Plan functions as a development framework that streamlines permitting, clarifies design standards, and

[3] This reference does not include existing telecommunications franchise agreements that currently support the City’s General Fund.

offers carriers predictable, ready-to-develop locations. This preparation also positions the City to lease vertical space, generating revenue and enabling low-cost deployment of City public safety, IoT, or fixed-wireless equipment. A detailed master tower plan would be anticipated to cost between $24,000 and $33,000.

Adopt a Citywide Master License Agreement (MLA) to Standardize Provider Access

A standardized MLA would create a predictable and legally sound mechanism through which telecommunications providers can lease City-owned conduit, fiber, vertical assets, rooftops, and potential tower sites. Establishing consistent design standards, fee structures, and maintenance obligations will reduce administrative delays, attract private investment, and provide clarity to the private sector regarding how and where they may deploy. An MLA also positions the City to negotiate from a place of strength when considering dark-fiber leases, co-location requests, or public-private partnerships, ensuring that all agreements advance City objectives for coverage, affordability, and long-term sustainability. The MLA governs the use of City-owned telecommunications assets (conduit, fiber, and vertical assets such as poles, rooftops and tower sites) and does not replace right-of-way permitting requirements, which are addressed separately through the City’s utility coordination and construction policies.

2.3 Public Sector Connectivity Recommendations

With governance structures established and infrastructure planning underway, Commerce City can begin implementing targeted projects that strengthen municipal connectivity and support core public services. These initiatives focus on improving interconnection between City facilities, increasing network resiliency, and reducing operational dependence on third-party telecommunications transport. Advancing priority segments of the City’s fiber network will enhance public safety communications, improve reliability for municipal operations, and establish a scalable foundation for future connectivity expansion.

Advance Phase One of the Fiber Network Conceptual Design into Detailed Engineering

Phase One of the Conceptual Design strengthens municipal connectivity, addresses single points of failure, and expands the reliability of public safety operations by adding approximately 9,800 feet of new fiber and creating a looped architecture between key facilities. Advancing this phase into detailed engineering will identify exact routing, splice locations, underground vs. aerial segments, conduit reuse opportunities, and construction requirements needed to achieve a shovel-ready design. Completing engineering also improves the City’s competitiveness for grants, supports capital budgeting, and signals readiness to potential private partners evaluating last-mile or middle-mile extensions. Design engineering of 9,800 linear feet would be anticipated to cost between $15,000 to $23,000.

3. Asset Inventory

The first phase involves conducting a comprehensive asset inventory of the City's current broadband assets including conduit, fiber, antennas, poles, towers, and other infrastructure to determine their usefulness for expanding broadband within the region.

Using GIS datasets, capital improvement schedules, and planning documents, ENTRUST developed a comprehensive broadband asset map. The map integrates layers for conduit, poles, traffic-signal cabinets, and other infrastructure that could support broadband deployment. Capital Improvement Program, General Plan, and Specific Plan data were analyzed to identify strategic and cost-effective opportunities to expand the City's digital infrastructure. Planned projects and right-of-way improvements were reviewed for potential coordination points where conduit or fiber could be installed over the next decade.

3.1 Network Assets

Commerce City has over 30 miles of conduit containing fiber, managed by the Information Technology or Public Works departments (detailed in Table 1), most of which was constructed between 2007 and 2009. Figure 2 illustrates the locations of Commerce City's fiber assets.

Table 1. Conduit owned by Commerce City

Agency/Use	Segments	Feet	Miles
Info Tech	15	63,148	12
Joint	10	63,486	12
Traffic Signal	41	31,835	6
Total	**68**	**158,725**	**30**

Commerce City IT and Public Works each operate fiber segments between Pioneer Park, the Civic Center, and the Municipal Service Center (MSC), using 24-strand and 96-strand cables, respectively. A 96-strand cable jointly owned with ADAMCO911 and Adams County occupies the same conduit in this area. Additional 96-strand traffic-signal fiber is installed along 60th Avenue and 56th Avenue. At Quebec Street and 56th Avenue, Commerce City's traffic fiber physically meets fiber owned by the City of Denver, although the systems are not interconnected.

At the MSC, the IT fiber terminates, while the traffic-signal fiber continues beyond the facility on two separate paths: one route extends south along Hwy 2, and the other extends north along Hwy 2. The jointly owned Adams County/ADAMCO911 cable follows the same Hwy 2 route north to the Bison Ridge Recreation Center. From that joint cable, an IT lateral branches into the recreation center to provide connectivity. Additional traffic fiber runs along 104th Avenue between Hwy 2 and Tower Road, and then south on Tower Road to 81st Avenue. Another IT lateral extends along Chambers Road from 104th Avenue to the Buffalo Run Golf Course on 112th Avenue.

Across the system, conduit is supported by 388 pull boxes, 10 manholes, and 6 splice locations. Some pull boxes are shared with other entities, including the Brighton School District, the Colorado Department of Transportation, and Comcast. Of the six splice locations, three serve as primary trunk or “backbone” splice points that distribute fibers along major segments of the network, while the remaining three establish interconnections with Adams County, including two used for 911 connectivity.

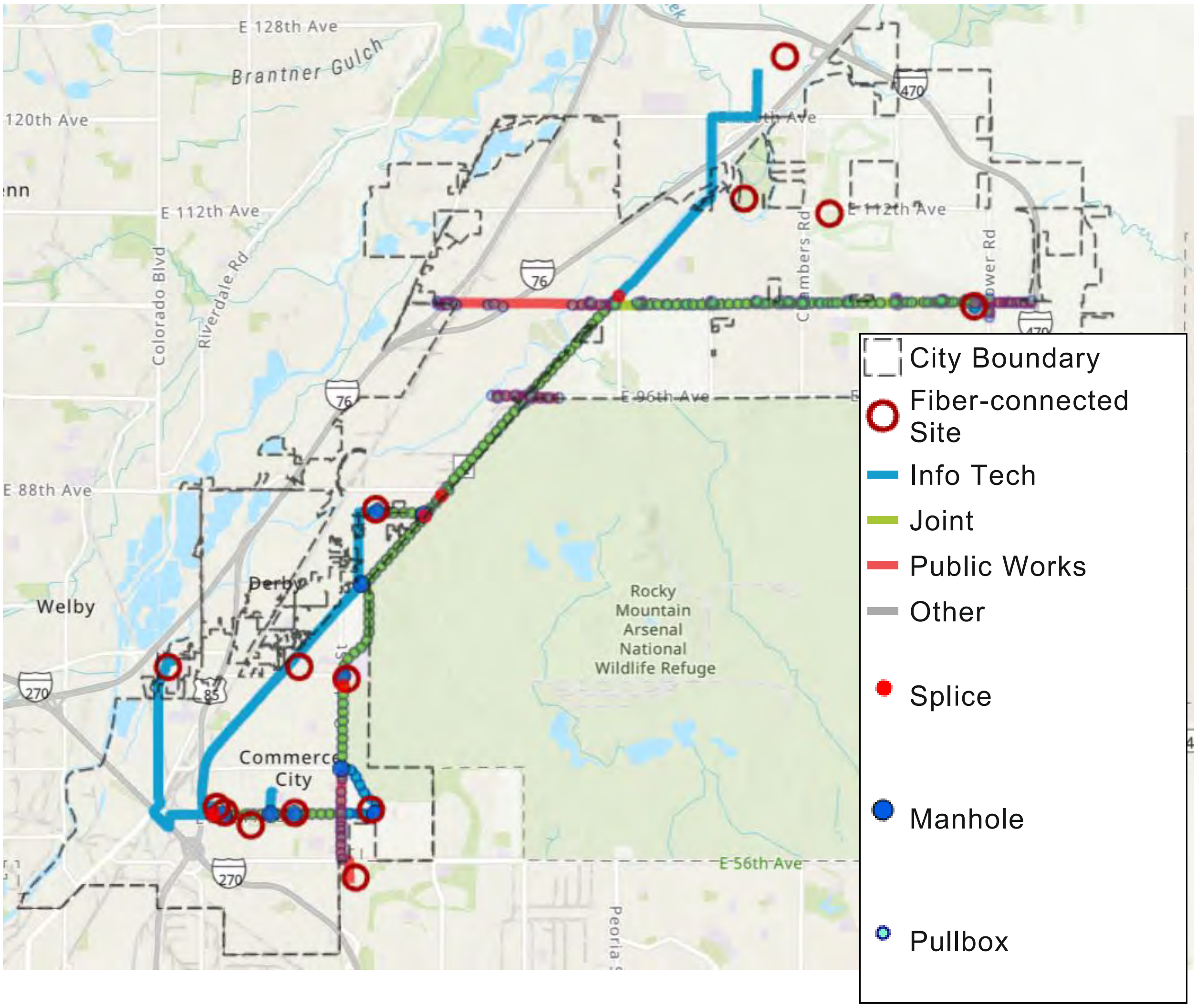

Figure 2. Fiber assets in Commerce City

3.2 Other Assets and Sites

Commerce City’s recently developed 2045 Comprehensive Plan identifies 64 community facilities—including cultural, educational, medical, social services, and utilities—as well as City and county facilities. There are 19 active local government facilities and 27 emergency facilities, most of which are not connected to the fiber, along with 20 emergency sirens. As illustrated in Figure 2 and Figure 3, ten sites are connected via the fiber. All the City’s facilities have Wi-Fi with internal private access and public guest access. The Civic Center is Commerce City’s primary site. Eight other sites are connected to it in a star architecture:

- Adams Tower
- Bison Ridge

- Buffalo Run
- Eagle Pointe Recreation Center
- Municipal Services Center
- Paradise Island/Pioneer Park
- Police Substation – 104th & Hwy 2
- Police Substation – 104th & Tower

The Adams Tower 5th floor and Derby Small Business Resource Center are connected to the Civic Center via Comcast cable (Xfinity) at 500/200 Mbps and 75/15 Mbps respectively. The Civic Center has three Comcast connections, one for Police Investigations (300/100 Mbps), another (2,000/300 Mbps) for non-indicated purpose, and a third (1/1 Gbps) for bulk dedicated internet access (DIA). The City has 1 Gbps DIA connection to Lumen at the Civic Center. The data indicate that the City is connected to the Adams County Communications Center, Adams County Government Center, and Denver Traffic Operations Center via assets owned by other parties.

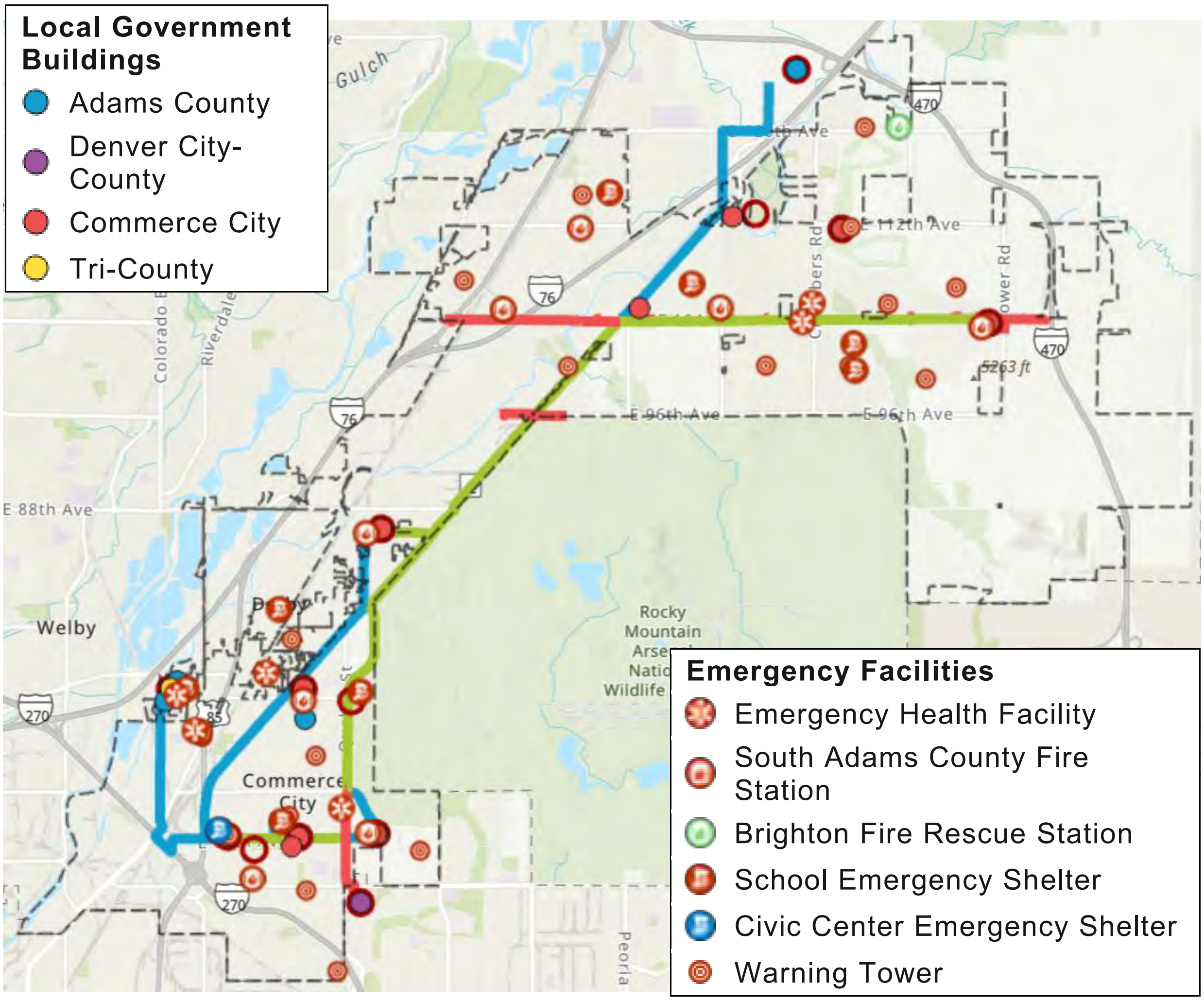

Figure 3. Locations of public facilities in Commerce City

Commerce City has 19 parks, which average over an acre each. The largest is Pioneer Park, located in southwestern Commerce City, north of Interstate 270 and east of US Hwy 6, one mile west of the Civic Center. It has a total of 157 open spaces. Commerce City has an extensive trail network, mapped in Figure 4, totaling over 116 miles, that interconnects most of the city's open spaces and parallels many of its fiber routes. There are also multiple park improvements underway or being planned, including several new facilities.

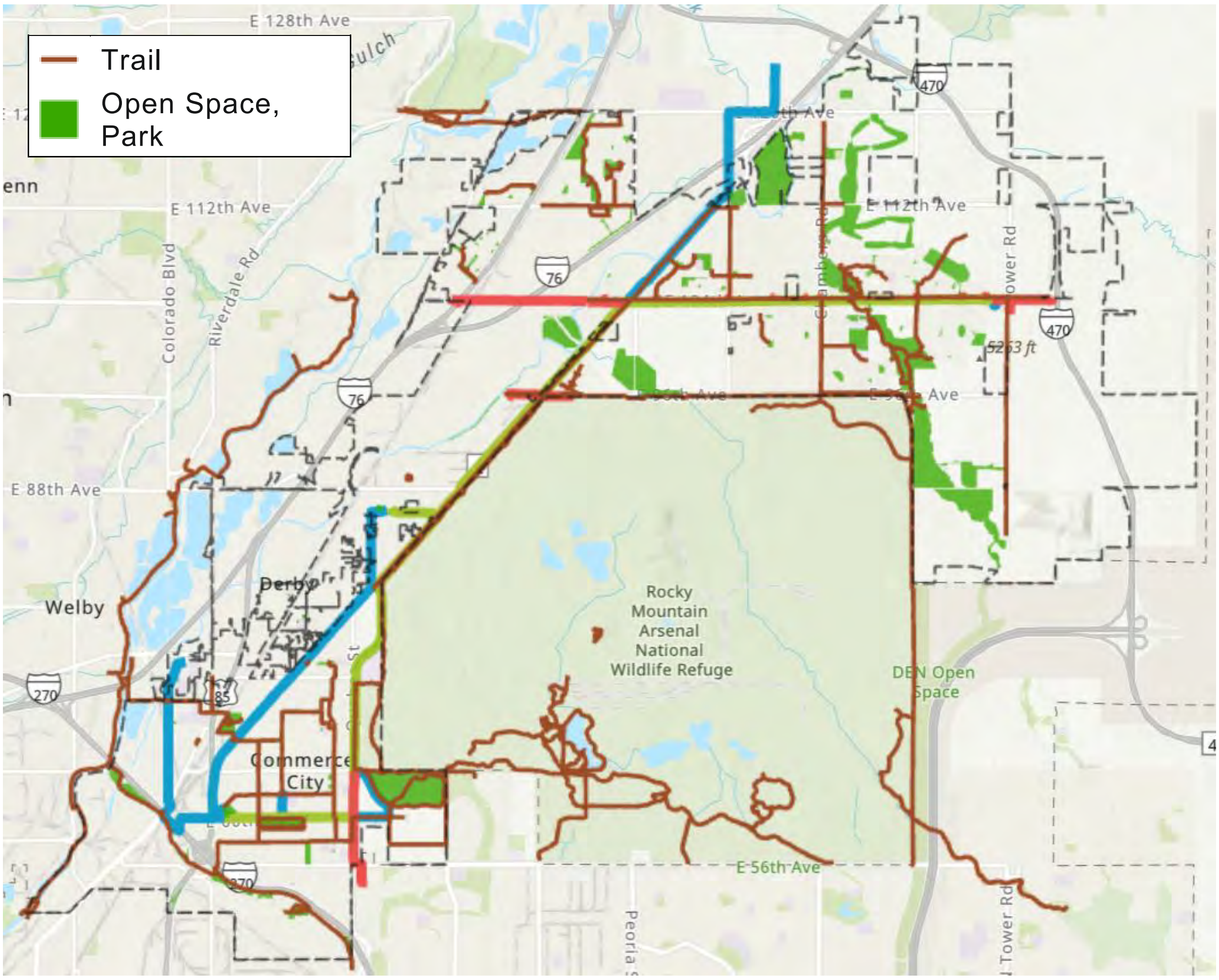

Figure 4. Commerce City's open spaces and trails

Transit for Commerce City is provided by Denver Regional Transportation District (RTD), which operates buses, commuter rail, and light rail services. The latter are available at one station in the southwestern corner of the city, at the western end of East 72 Avenue between Colorado Boulevard and the South Platte River. Over 150 bus stops in the city and 25 adjacent to it are served by a dozen bus routes. There are three park-and-ride locations, the light rail station, Vasquez Boulevard at 60th Avenue, and 104th Avenue at Revere Street. Commerce City maintains 14 parking areas, averaging 142 spaces each, the largest of which are at the Civic Center, Pioneer Park, and Bison Ridge Recreation Center, which is in the north-central area of the city, about 9 miles northeast of the Civic Center.

There are 4,665 streetlights in Commerce City. The 10% of streetlights owned by the City are, as shown in Figure 5, concentrated along Hwy 2 and Tower Road. The City owns no other vertical infrastructure. Adams County Communications Center Authority, known as ADCOM911, which provides public safety communications and dispatch, has two towers in the area and Adams County IT has one.

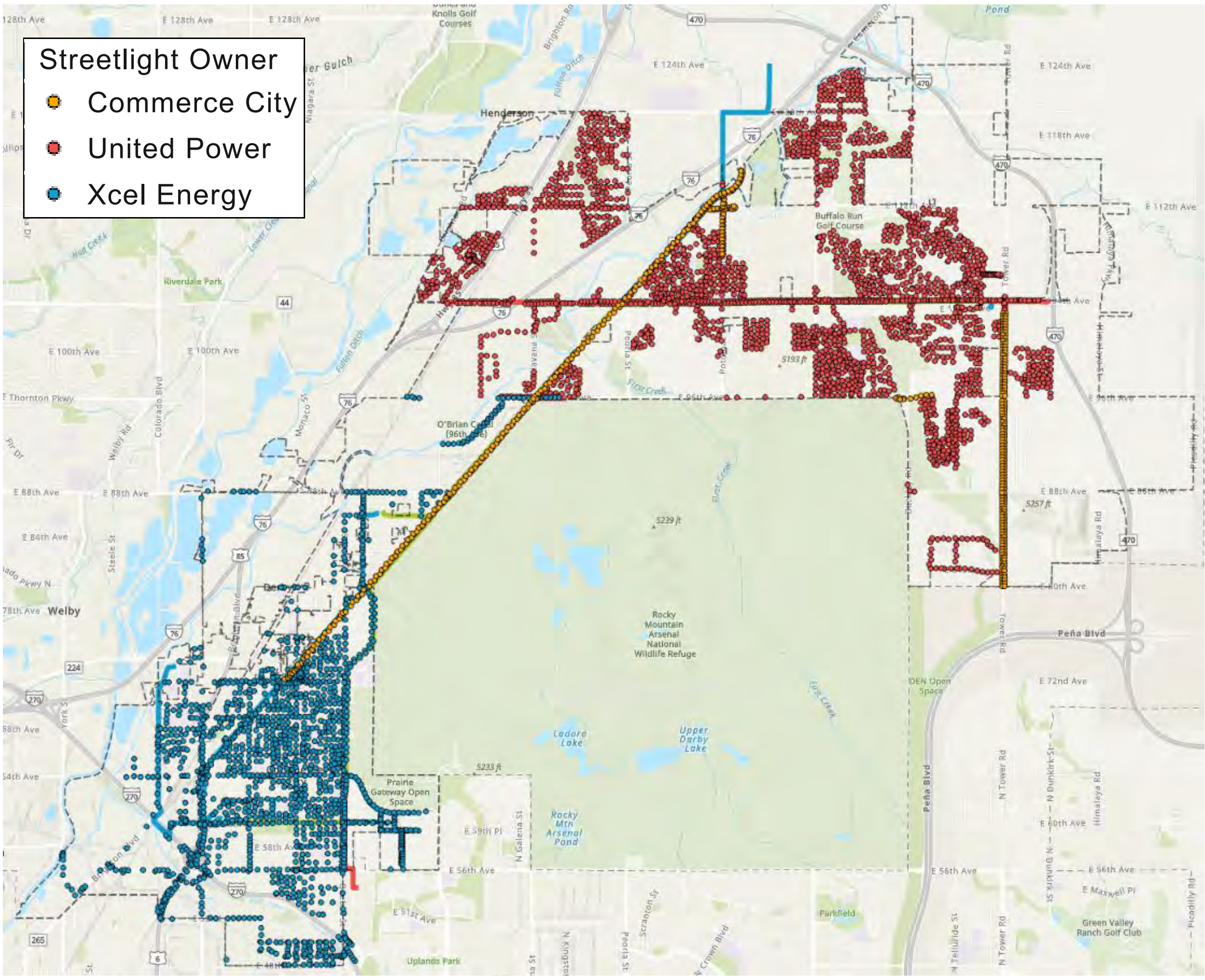

Figure 5. Streetlights in Commerce City

3.3 City Plans and Projects

Commerce City's recently adopted 2045 comprehensive plan envisions the city as:

"… a thriving community: economically strong, environmentally sustainable, and socially equitable." [4]

The plan has multiple goals for:

- Character areas and land use
- Health and environmental sustainability
- Commerce and employment

---

[4] "Community Vision Statement," Commerce City 2045 Comprehensive Plan, Sept. 9, 2023, page 56, https://www.c3gov.com/home/showpublisheddocument/23121/638675386992930000. Generally, information in this subsection was drawn from https://www.c3gov.com/government/city-charter-master-plans/comprehensive-plan and https://www.c3gov.com/government/city-council/strategic-plan.

- Housing and neighborhoods
- Arts, culture, and tourism
- Transportation and mobility
- Parks, open space, and natural environment, and
- Public facilities and infrastructure

There is a chapter focused on "connected corridors" along I-270, US-85, Quebec Parkway, E 72nd Avenue, Hwy 2 South, Hwy 2 North, E 104th Avenue, and Tower Road/High Plains Parkway. The plan mentions "network" 64 times in relation to roads and trails and it mentions "utility" 62 times referencing land used for all/any utility assets. It contains no mentions of "broadband," "cell," "fiber," or "internet." The City's 2024-2028 Strategic Plan does not address technology or network infrastructure, either, but has goals for:

- Infrastructure and Transportation – by "developing and protecting our physical assets, such as roads, trails, sidewalks, and facilities."[5]
- Economic Development – to "promote a balanced, thriving, and inclusive city economy that cultivates, attracts, and retains business."[6]
- Public Health and Safety – to "protect resident health, safety, and education by promoting public safety, environmental health, and sustainability."[7]
- Housing – to "address the full spectrum of housing needs, encourage sustainable development, and protect residents through enhanced oversight and balanced residential growth."[8]
- City Unity and Wellness – to "support our diverse community by encouraging community connectivity, fostering civic pride, and improving resident health and wellness."[9]
- High-Performing Government – to "provide innovative, responsive, and transparent service to the community across all City departments by assessing and meeting service levels and demonstrating efficacy through data and metrics."[10]

Commerce City has more than 60 road capital projects in the works, over two dozen of which were initiated in the last year, including a citywide transportation plan. Major upcoming projects include multimodal improvements along East 64th Ave between Hwy 2 and Quebec Pkwy and along Hwy 2, widening East 88th Ave between I-76 and Hwy 2 and Rosemary St between East 86th Ave and East 81st Pl. The recently completed North Metropolitan Industrial Area Connectivity Study, which includes southwestern portions of Commerce City along with portions of Denver and unincorporated Adams County, identified nine multimodal priority projects to improve connectivity throughout the area.

---

5 https://www.c3gov.com/government/city-council/strategic-plan/infrastructure-and-transportation
6 https://www.c3gov.com/government/city-council/strategic-plan/economic-development
7 https://www.c3gov.com/government/city-council/strategic-plan/public-health-and-safety
8 https://www.c3gov.com/government/city-council/strategic-plan/housing
9 https://www.c3gov.com/government/city-council/strategic-plan/city-unity-and-wellness
10 https://www.c3gov.com/government/city-council/strategic-plan/high-performing-government

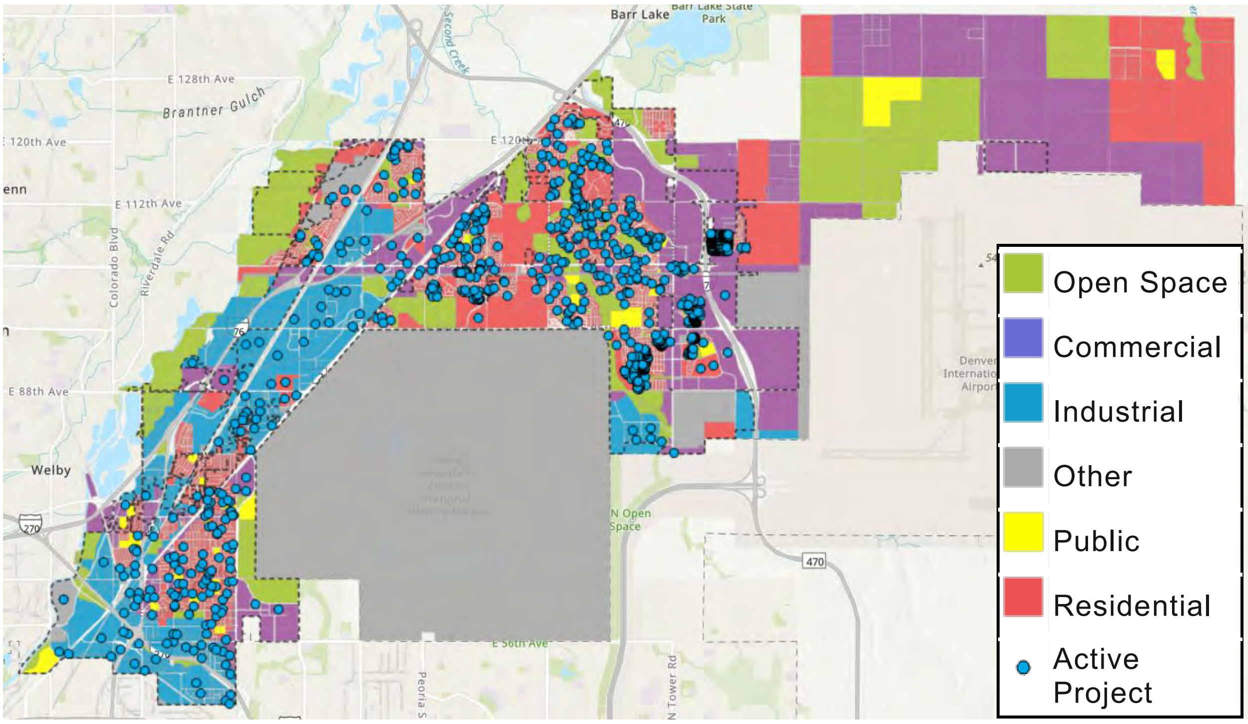

Figure 6. Commerce City active development projects and parcels by zoned use

Commerce City's development plans generally include five urban renewal areas.[11] The largest of which, Victory Crossing, is next to the Civic Center and involves significant mixed-use development. Derby Business District is Commerce City's Downtown, around East 72nd Ave at Hwy 2. Mile High Greyhound Park is between East 62nd and 63rd avenues, just east of Hwy 2. Sand Creek is on the far southwest edge of the city, adjacent to Denver, between 48th and 52nd avenues, south of the Union Pacific railroad. The area around the 72nd and Colorado commuter rail station is the fifth active urban renewal area. All of these are in the core, southwestern portion of the city.

Much of the city's core area, west of the wildlife refuge is zoned for industrial, with commercial along major corridors, and most of the older residential around downtown Commerce City. The area north and east of the wildlife refuge is zoned for residential development. Commerce City's urban growth area extends east into Adams County, north of the airport. Commercial and light industry are planned for this area, particularly along E-470.

Commerce City data includes over 1,200 active development projects, about 300 each are early grading and residential new construction. Twenty-four are new commercial and 20 each are development plans, planned unit developments, and subdivisions.

Development of the area around and including the airport is occurring under the aegis of Colorado Aerotropolis, "a forward-looking model for development that builds on the region's success and creates opportunities for purpose-driven organizations to bring ambitious visions to life."[12] It is a partnership of seven municipalities, including Commerce City, and Denver International Airport, which presents partners with "a unique opportunity to

[11] See https://www.c3gov.com/government/urban-renewal.
[12] See https://coaerotropolis.com/#our-vision.

demonstrate how collaborative, responsible development can benefit the citizens and communities of Colorado—and lead to life-altering global innovations.” While the initiative focuses on the airport, it encompasses over 16,000 acres of available land and many development efforts across the region. The scope includes advanced manufacturing, agricultural innovation, future transport, healthcare innovation, and resource sustainability.

3.4 Summary of Findings

Commerce City has meaningful conduit and fiber in major corridors

That is used for interconnecting its facilities and other municipal assets, particularly traffic signals. The City’s network, which consists of more than 30 miles of buried conduit, does not have redundant connections between sites and has a flat, non-hierarchical structure. Two sites are not on City fiber. All City facilities have public Wi-Fi via the fiber but otherwise have no radio, vertical, or wireless assets. The City’s fiber is over 15 years old. Multiple other areas and assets, including community anchor and key stakeholder sites, may be on fiber but are not connected. The City’s current assets may be of interest to private partners, especially if they were enhanced and expanded via opportunistic broadband development.

The older City core has very different assets and development patterns than the west side industrial area and the North Range

Commerce City’s urban core has multiple renewal efforts that are broadband development opportunities. Infill development, which seems to be prevalent in the center-north, can be conditioned with network assets. Commercial development is pending along E-470. Development conditioning and joint build could result in miles of new fiber. The western and eastern sides of the City are anchored by very different transportation assets-commuter light rail on one side, an international airport on the other-with trails as well as City roads between.

Commerce City has abundant opportunities for economical network infrastructure development

That development can align with and support the City’s general plan and strategy. The City can fully incorporate network assets into its capital improvements process, development conditions, general and strategic plans, and regional partnerships. Commerce City may consider establishing community-based public-private partnerships to expand and more fully utilize its communications assets.

4. Market Analysis

ENTRUST analyzed the broadband environment in Commerce City to assess the existing market conditions, community need, and critical gaps in infrastructure and services. This section describes our approach, findings, and implications for the broadband market in Commerce City. ENTRUST evaluated Commerce City to document service offerings by incumbent internet service providers (ISPs), with a particular focus on facilities-based carriers that own their own physical infrastructure including fiber, copper, coaxial cable, or fixed wireless equipment. The evaluation included pricing, service tiers, access, and market division utilizing public data such as the updated 2025 FCC Broadband Map, previous studies and reports, carriers' websites, and ENTRUST's extensive database and knowledge of the broadband environment. We also contacted the local ISPs and had direct conversations to better understand their strategy in Commerce City.

4.1 Address Testing Validation

ENTRUST analyzed the broadband market within Commerce City to determine the options available to residents and businesses. The analysis also included randomly testing geographically dispersed addresses throughout Commerce City to gain an understanding of the competitive landscape. These are shown in Table 2 and Figure 1.

Table 2. Sites Tested for Providers & Service Tiers

Locations	Zip	Provider						
		Xfinity	Quantum Fiber	Century Link DSL	AT&T	T-Mobile	Verizon	Live Wire Net
Niagara St.	80022	Cable	Fiber			FWA		FWA
Albion St.	80022	Cable	Fiber			FWA		FWA
Brighton Blvd.	80022	Cable		DSL	FWA			FWA
E. 54th Pl.	80022	Cable		DSL				FWA
Rifle St.	80022	Cable		DSL		FWA		
E. 97th St.	80216	Cable	Fiber			FWA	FWA	
E. 116th Ct.	80216			DSL			FWA	
Norfolk Ct.	80216	Cable	Fiber					
E. 104th Ave	80022	Cable		DSL				
Quebec St.	80603	Cable		DSL		FWA		FWA
Syracuse St.	80022	Cable						FWA
E. 89th Pl.	80022	Cable				FWA		
Tower Rd.	80022	Cable		DSL	FWA	FWA		
E. 72nd Ave.	80022	Cable	Fiber					FWA
E 56th Ave.	80022	Cable		DSL	FWA			FWA
Troy St.	80022	Cable		DSL				
E 105th St.	80022	Cable		DSL				
Brighton Rd.	80022	Cable	Fiber		FWA			FWA
Eagle Creek Pkwy.	80022	Cable		DSL	FWA	FWA	FWA	
E. 133rd Pl.	80022			DSL		FWA	FWA	

It is worth noting that when FCC mapping indicates wireless coverage is available, actual service may not be at that time, due to equipment capacity issues from nearby tower locations that are at full capacity at the time-of-service request. As part of this process, some site locations were checked twice randomly, against provider location website detail, with changes in “availability” noted at more than one address for fixed wireless access service.

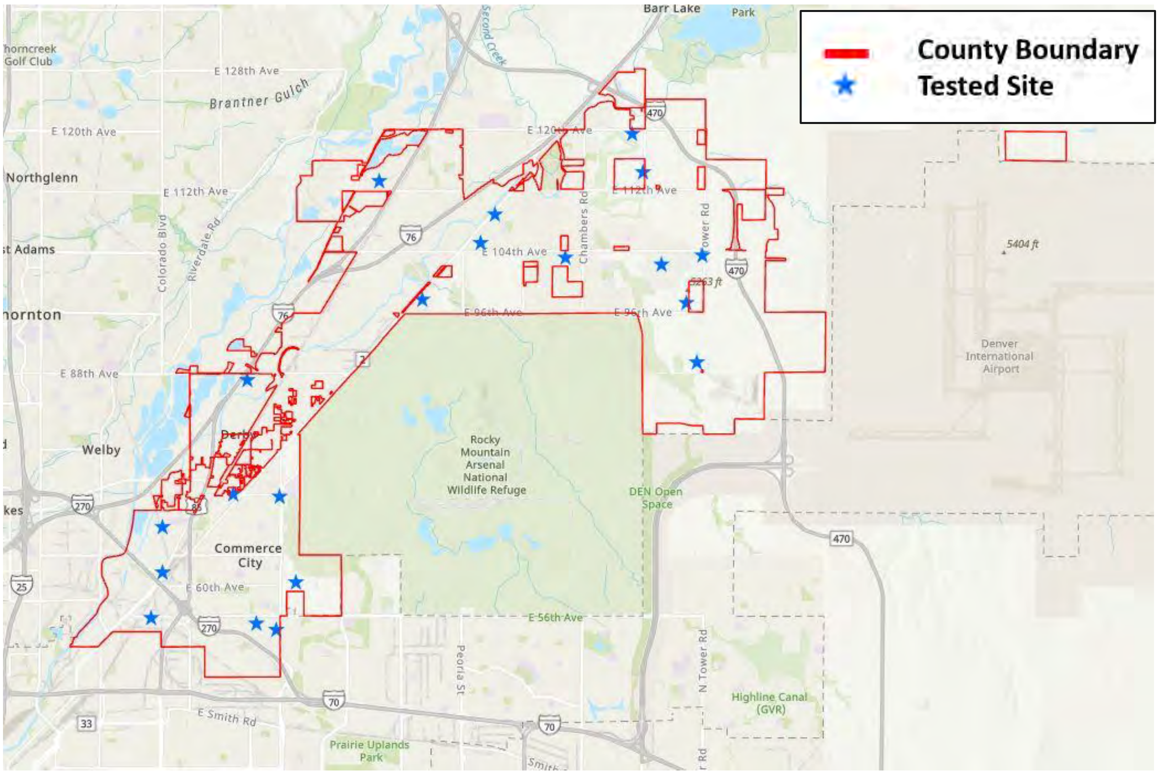

Figure 7. Locations Tested for Broadband Service

4.2 Wireline Providers

Comcast Cable (Xfinity)

Comcast Cable (Xfinity) is one of the largest cable companies in the U.S. Comcast’s network is based on a Hybrid Fiber-Coax (HFC) architecture, which includes a fiber backbone but coax cable for last mile distribution as seen in *Figure 8*.

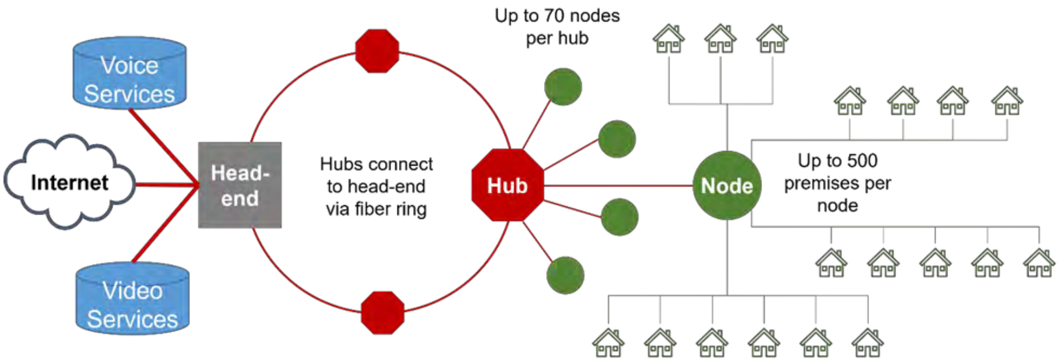

Figure 8. Hybrid Fiber-Coax Network Architecture

These HFC broadband networks are designed to send large amounts of data from the network to the end point such as the home. Smart city applications based on remote devices sending small amounts of data can leverage the consumer-grade broadband from Xfinity. However, while HFC networks can provide download speeds in excess of 1 Gbps, mission critical applications and those requiring higher bandwidth to the network (upstream) require an alternative, as current HFC networks are physically limited to a maximum upload speed of only 35 Mbps.

As the legacy cable company, Xfinity has wide coverage of the residential market through their HFC network, as shown in *Figure 9*.

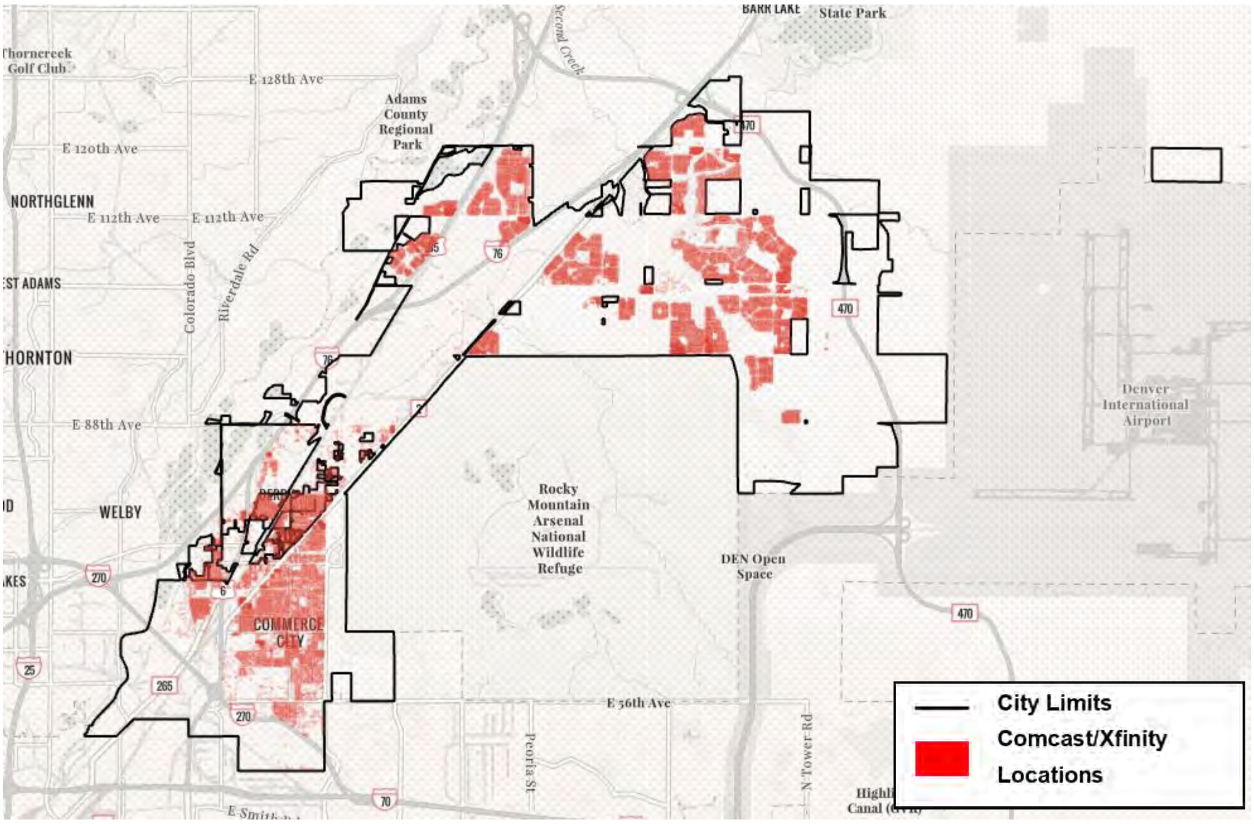

Figure 9. Comcast HFC Network & Coverage[13]

While Xfinity's HFC network is generally capable of delivering gigabit download speeds to its residential and small business market, these speeds, latencies, upload limitations, and service level agreements may not be sufficient for enterprise-level businesses or institutional anchors.

In Commerce City, Xfinity's infrastructure remains largely HFC and based on the DOCSIS 3.1 standard. In many areas, this results in asymmetrical service with download speeds exceeding 1 Gbps and more modest upload capabilities. However, in a growing number of neighborhoods, Xfinity has likely implemented high-split upgrades that expand upstream capacity. These upgraded areas now support upload speeds up to 306 Mbps and download speeds as high as 2.1 Gbps, even while still operating over coaxial connections. These

[13] Source: 2025 FCC Fabric Data

improvements are part of Xfinity's broader evolution toward its 10G platform and anticipated DOCSIS 4.0 rollout nationally, including Colorado.[14]

While the upgraded service tiers now allow for significantly improved upload performance in some parts of Commerce City, other areas remain on legacy configurations and still face traditional limitations. As a result, Xfinity service capabilities vary by neighborhood, and ongoing infrastructure enhancements are gradually expanding the availability of higher-speed, more symmetrical service. Xfinity's offerings remain a strong option for residential and small business use, but the variability in upstream performance, shared bandwidth architecture, and lack of formal service-level guarantees do not fully meet the requirements of enterprise or institutional users.

Xfinity's advertised residential rates (*Table 3*) are asymmetrical (different download and upload speeds) and offered limited-term promotional rates.

Table 3. Comcast (Xfinity) Residential Tiers & Rates

Maximum Download Speed[15]	Typical Upload Speed	Promotional Monthly Rate	Notes[16]
100 Mbps	23 Mbps	$29.95	NA
150 Mbps	114 Mbps	$29.99	12 months
400 Mbps	169 Mbps	$35.00	24 months
600 Mbps	169 Mbps	$ 65.00	12 months
1.1 Gbps	306 Mbps	$ 60.00	12 months
1.3 Gbps	40 Mbps	$ 95.00	12 months
2.1 Gbps	306 Mbps	$ 95.00	12 months

Lumen Technologies (Now Quantum Fiber and CenturyLink DSL)

CenturyLink, a subsidiary of Lumen Technologies, is the Incumbent Local Exchange Carrier (ILEC) for Commerce City. Historically, ILECs have had near-total coverage in their designated service areas, and this remains largely true for CenturyLink in Commerce City. However, this coverage has been primarily delivered through legacy Digital Subscriber Line (DSL) technology, which operates over existing copper telephone lines. DSL, as seen in Figure *10*, is an outdated technology, and no significant new DSL infrastructure is being deployed.

---

[14] Comcast Corporation. "Comcast Delivers Multi-Gig Symmetrical Speeds in the World's First DOCSIS 4.0 Deployment." December 15, 2023. https://corporate.comcast.com/press/releases/comcast-multi-gig-symmetrical-speeds-world-first-docsis-4-deployment

[15] All speeds for Comcast's services – download and upload – are advertised as "up to" maximum speeds, depending on network congestion, time of day, location, etc.

[16] Xfinity Promotional True price tiers jump increase from $24 to $49 per tier per month after promotional period expires.

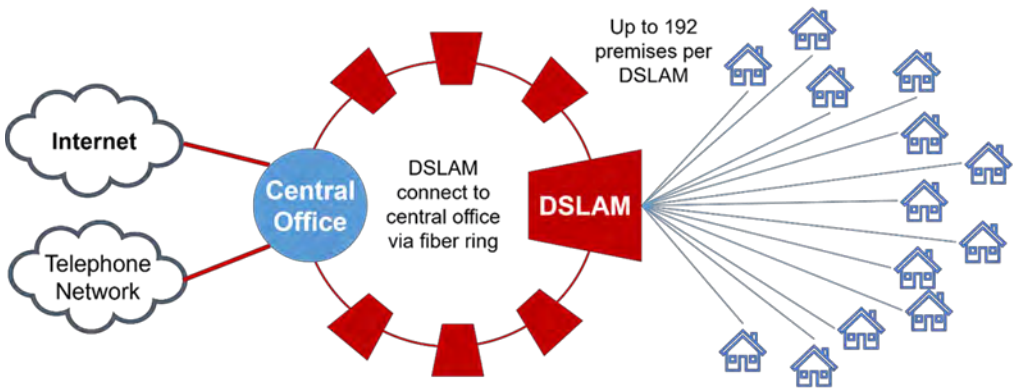

Figure 10. DSL Network Architecture

The speeds achievable with DSL depend on the length and quality of the copper lines, but typically they do not exceed 25–35 Mbps download and 3–5 Mbps upload.[17] These speeds do not meet FCC's current broadband benchmark of 100 Mbps/20 Mbps, as noted in the Broadband Equity, Access, and Deployment (BEAD) program[18], and are insufficient for modern business and residential needs. In addition, its pricing is not competitive, as shown in Table 4. DSL coverage in Commerce City can be seen in Figure *11*.

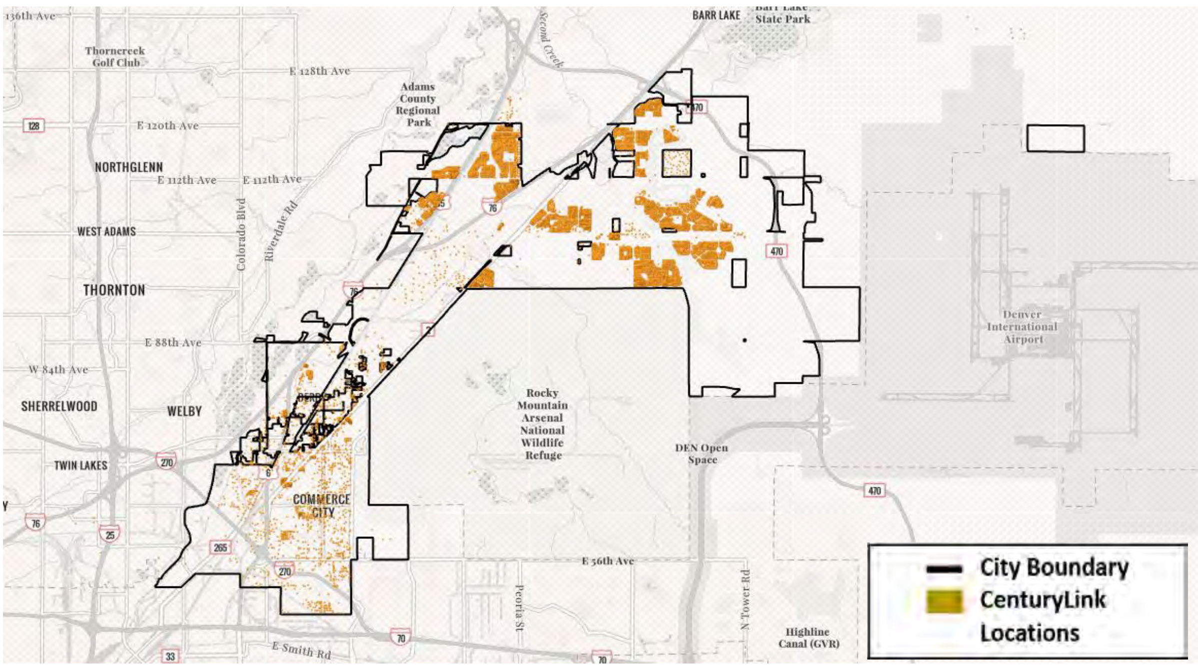

Figure 11. CenturyLink DSL Network & Coverage[19]

[17] While traditional DSL is often associated with speeds of 25–35 Mbps download and 3–5 Mbps upload, advancements in D
SL technology and network configurations have enabled significantly higher speeds in some areas, depending on distance from the node and line quality.

[18] Broadband Equity, Access, And Deployment (BEAD) Program | National Telecommunications and Information Administration

[19] Source: 2025 FCC Broadband Fabric Data

Table 4. CenturyLink DSL Residential Price Tiers

Maximum Download Speed	Maximum Upload Speed	Monthly Rate	Notes[20]
30 Mbps	1.5 Mbps	$55.00	NA
40 Mbps	3.0 Mbps	$55.00	NA
60 Mbps	5.0 Mbps	$55.00	NA
80 Mbps	10.0 Mbps	$55.00	NA
100 Mbps	10.0 Mbps	$55.00	NA

Additionally, Lumen deploys fiber under the Quantum Fiber brand using both Gigabit Passive Optical Network (GPON) and XGS-PON technologies. GPON supports speeds up to 2.5 Gbps downstream and 1.25 Gbps upstream, while XGS-PON supports 10 Gbps symmetric speeds.[21]

Quantum has initiated a fiber-optic network expansion in the City, covering approximately 40.87% of the City while CenturyLink still provides fiber to the premise for another 5.3%.[22] The current Quantum Fiber & CenturyLink fiber to the premise footprint can be seen in Figure 12.

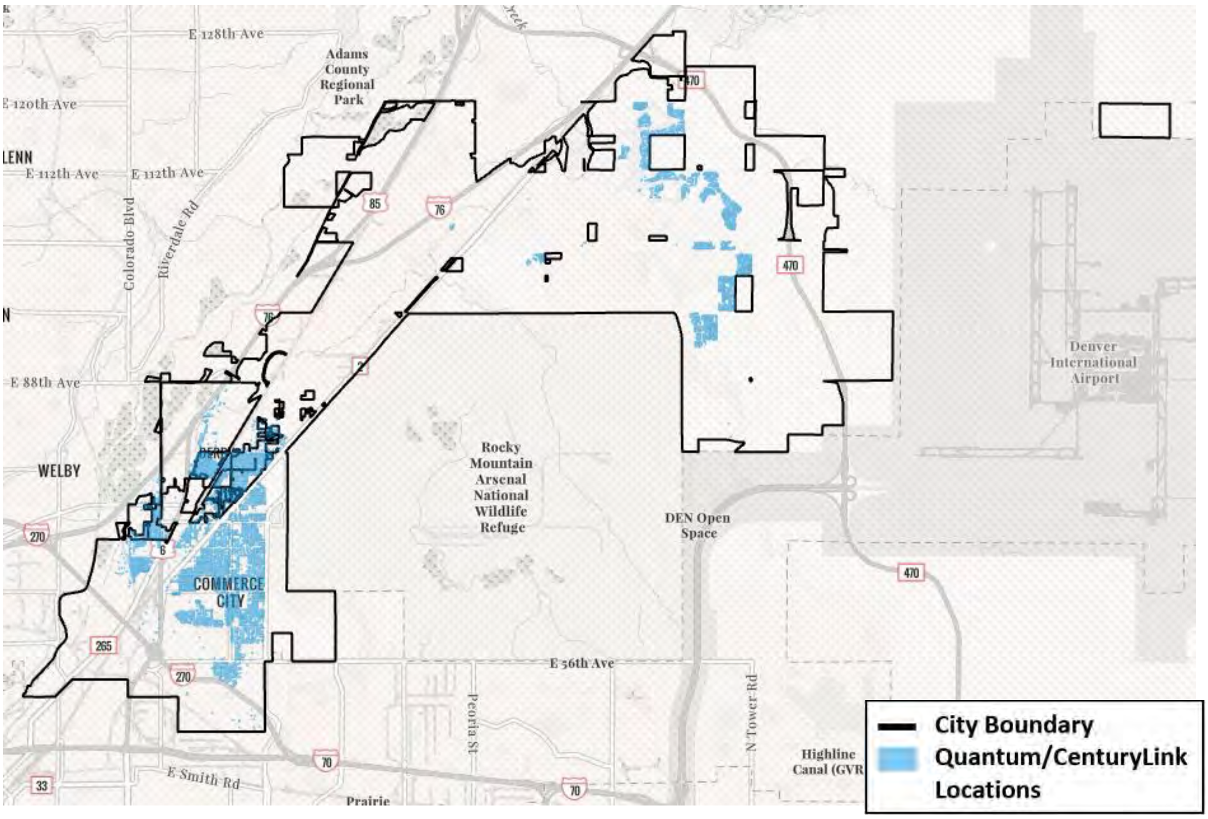

Figure 12. Quantum Fiber & CenturyLink FTTX Network & Coverage

---

20 Monthly pricing does not require a contract.
21 Specification Differences Among GPON, XG-PON and XGS-PON," Tarluz, https://www.tarluz.com/ftth/specification-differences-among-gpon-xg-pon-and-xgs-pon/.
22 Source: 2025 FCC Fabric Data

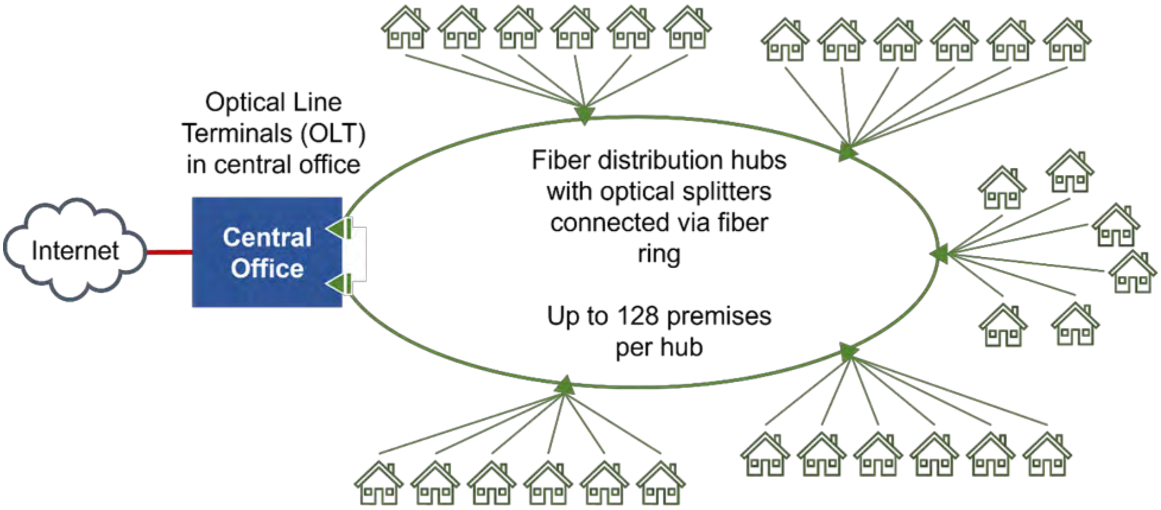

Figure 13. Fiber Optic XGS-PON Network Architecture

The XGX-PON architecture enables ISPs to deliver symmetrical gigabit speeds (equal download and upload speeds) often at 5 or even 10 Gbps. Quantum's advertised pricing tiers for fiber services are listed in Table 5.

Table 5. Quantum Fiber Residential Fiber Tiers & Rates

Maximum Download Speed	Maximum Upload Speed	Monthly Rate	Notes[23]
500 Mbps	500 Mbps	$50.00	NA
940 Mbps	940 Mbps	$50.00	NA
2 Gbps	1 Gbps	$75.00	NA

4.3 Fixed Wireless Providers

Fixed Wireless Access (FWA) provides broadband service using radio signals between antenna sites and user premises, eliminating the need for extensive aerial or underground cabling. While traditionally used in rural settings, FWA is increasingly being deployed in urban and suburban areas like Commerce City as an alternative to fiber or coaxial networks. Performance varies depending on distance from towers, signal interference, and topography. Data rates for wireless broadband will depend on several parameters including distance from the tower, population density, and natural obstacles (geography/hills, trees, foliage).

There are two types of providers deliver FWA. Mobile Network Operators (MNOs) such as T-Mobile, Verizon, and AT&T use their existing 5G and 4G LTE cellular networks to serve homes and small businesses by offering 5G Based Home Internet (Figure 14).

[23] No contract. Requires monthly pre-payment

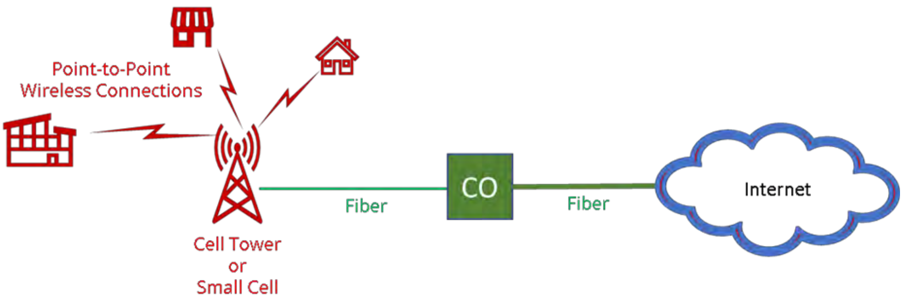

Figure 14. Cellular Wireless Network Architecture

Wireless Internet Service Providers (WISPs) like Rise Broadband, Aerux, and LiveWireNet operate dedicated wireless infrastructure, including air fiber, point-to-point radio links, and CBRS-based networks (Figure 9).

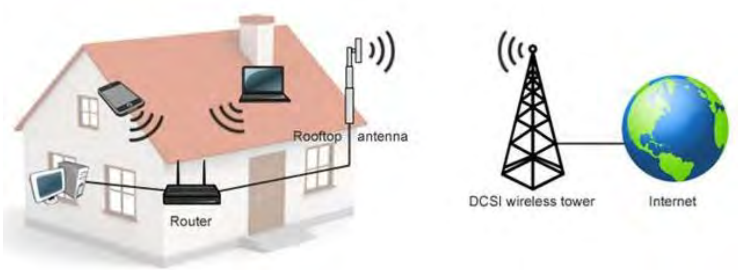

Figure 15. Functionality of a Fixed Wireless Network

T - Mobile

T-Mobile provides 5G and 4G LTE fixed wireless services to households across all 50 states in the U.S. Its residential plans' main features include contract-free services and unlimited data access. The typical download speeds it offers are between 87-415 Mbps and may vary according to location, time of the day, weather, and other factors.

Table 6. T-Mobile Wireless Internet Packages

Package	Max Download Speed	Max Upload Speed	Monthly Rate	Notes
Rely Home Internet	318 Mbps	55Mbps	$50.00	Unlimited data No annual contract
Amplified Home Internet	415Mbps	55Mbps	$60.00	Unlimited data-No annual contract
All in Home Internet	415Mbps	55Mbps	$70.00	Unlimited data-No annual contract

Verizon Wireless

Verizon's 5G Home internet services are an affordable solution with faster speeds than satellite and DSL type of connections. Verizon offers unlimited data and contract-guaranteed pricing, but speeds may vary based on a location's distance to its network towers and real-time network traffic.

Table 7. Verizon Wireless Internet Packages

Package	Max Download Speed	Max Upload Speed	Monthly Rate	Notes
5G Home	100 Mbps	10 Mbps	$ 50	Unlimited data 3-year price guarantee
5G Home Plus	300 Mbps	20 Mbps	$ 70	Unlimited data 4-year price guarantee

AT&T Internet Air

AT&T Internet Air is a newer 5G based fixed wireless service. It is like the 5g services of other providers but offers less variety in pricing. AT&T looks to transition existing customers off DSL as it continues to roll out its fiber plans. It has no data caps, equipment fees, or landline connections. However, it has limited availability based on location and speeds of only up to 300 Mbps. AT&T may reduce data speeds depending on depending on network activity.

Table 8. AT&T Internet Air

Package	Max Download Speed	Max Upload Speed	Monthly Rate	Notes
Internet Air	300 Mbps	30 Mbps	$ 65	No overage Fees 12-month pricing No contracts

Alternate Fixed Wireless Providers

Unlike national mobile carriers, these companies operate purpose-built fixed wireless networks using rooftop antennas, point-to-point radio links, and CBRS spectrum. Rise Broadband does serve a broad national footprint but is limited to a smaller service footprint in Commerce City of a reported 23%, while Aerux focus on regional deployment in the Denver metro area covering a similar 23% of Commerce City. However, the operator with the largest FWA service footprint in the City is LiveWireNet offering coverage to almost 39% of Commerce City. [24]

LiveWireNet

LiveWireNet, established in 1999, is a fixed wireless internet and voice service provider based in Colorado. The company operates as a facilities-based competitive local exchange

[24] Source: bestneighborhood.org https://bestneighborhood.org/tv-and-internet-commerce-city-co/

carrier (CLEC) and is registered with the Colorado Public Utilities Commission.[25] LiveWireNet specializes in delivering broadband connectivity using fixed wireless infrastructure, offering an alternative to traditional wired broadband, most notably in the southwest part of Commerce City (Figure *16*).

LiveWireNet offers residential and business broadband plans without contracts or data caps. Pricing is based on bandwidth, service level, and location and is summarized in Table 9. Performance is dependent on line-of-sight (LoS) between radio endpoints, making coverage difficult in topographically varied or densely built-up parts of the city.

As Commerce City continues to densify, line of site constraints may limit LiveWireNet's ability to match the speeds and reliability of fiber-based providers. However, LiveWireNet remains a viable option in areas with limited service, and the provider has expressed interest in partnering with the City to explore solutions for underserved and unserved neighborhoods.[26]

Table 9. LiveWireNet Internet Service Packages

Package	Max Download Speed	Max Upload Speed	Monthly Rate	Notes[27]
FastLink	25 Mbps	10 Mbps	$25.00	No annual contract No data caps
FastLink+	75 Mbps	15 Mbps	$35.00	No annual contract No data caps
TurbolLink	100 Mbps	20 Mbps	$50.00	No annual contract No data caps
ProLink	200 Mbps	35 Mbps	$80.00	No annual contract No data caps
Valuelink	50 Mbps	10Mbps	$35.00	No annual contract No data caps
Valuelink	75 Mbps	15 Mbps	$55.00	No annual contract No data caps
Valuelink	100 Mbps	25 Mbps	$100.00	No annual contract No data caps
Priority Broadband	50 Mbps	50 Mbps	$125.00	No annual contract No data c
Priority Broadband	75 Mbps	75 Mbps	$150.00	No annual contract No data caps
Priority Broadband	100 Mbps	100 Mbps	$200.00	No annual contract No data caps
Priority Broadband	200 Mbps	100 Mbps	$300.00	No annual contract No data caps
Priority Broadband	250 Mbps	100 Mbps	$500.00	No annual contract

[25] "Company Profile": LiveWireNet, https://www.livewirenet.com/about-us
[26] Information provided during profile interview by ENTRUST Solutions Group with LiveWireNet executive leadership, conducted on April 18, 2025, and subsequent materials made available to ENTRUST.
[27] FastLink, FastLink+, TurboLink and ProLink represent residential broadband plans. ValueLink and Priority Broadband represent broadband plans for business.

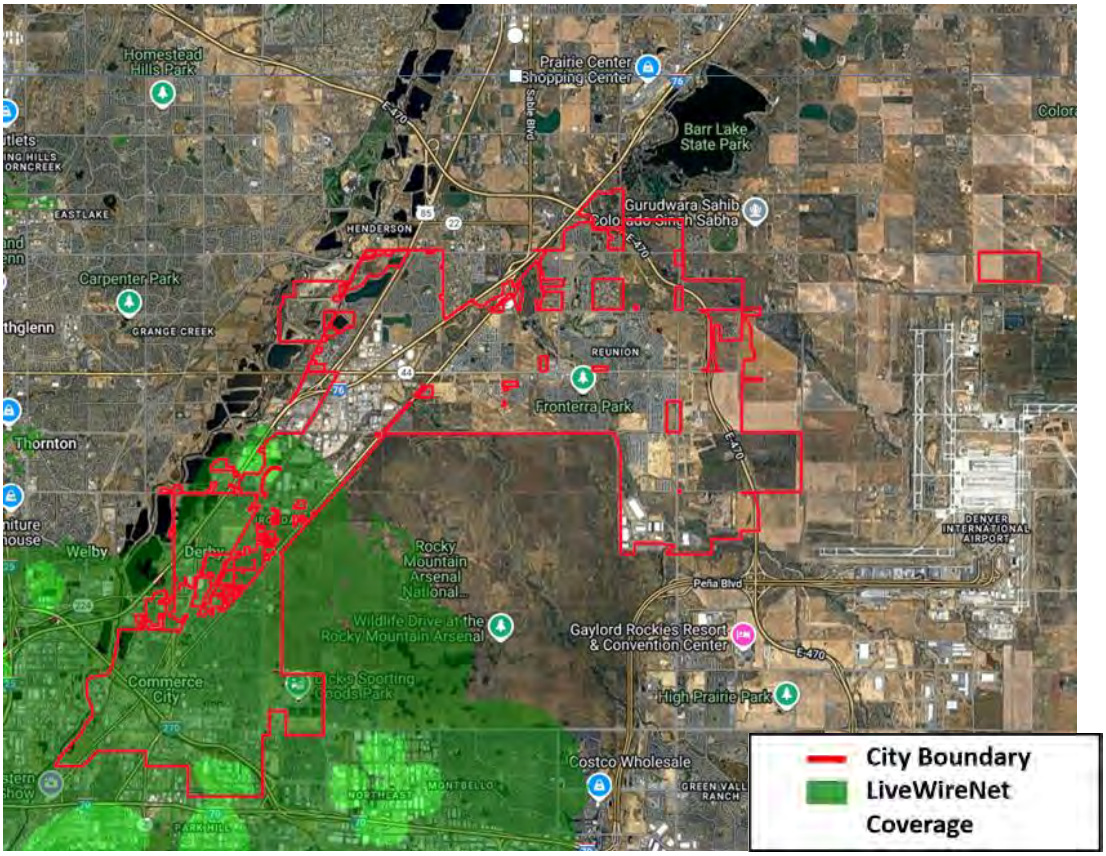

Figure 16. LiveWireNet LBR Fixed Wireless Coverage Area

4.4 GSO and NGSO Satellite Options

Starlink, operated by SpaceX, is a Low Earth Orbit Satellite (LEO) system designed to deliver broadband in areas where terrestrial infrastructure is limited or cost-prohibitive. Starlink satellites orbit at approximately 550 kilometers (342 miles) above Earth[28]—far lower than traditional Geosynchronous Earth Orbit (GEO) satellites, which orbit at around 35,786 kilometers (22,236 miles)[29]. This lower altitude reduces latency significantly, typically to 20–50 milliseconds, making LEO systems more responsive than legacy satellite networks.

Starlink delivers download speeds between 20–200 Mbps and upload speeds of 5–20 Mbps, performance levels comparable to cable-based HFC service. However, it does not provide symmetrical gigabit speeds and comes with a higher price point at $110/month making it less competitive in urban or suburban markets. Traditional GEO providers like HughesNet and Viasat continue to face challenges due to high latency (600–700 milliseconds) and signal degradation. HughesNet plans range from $49.99 to $94.99/month, while Viasat plans

---

[28] SpaceX Starlink. Orbital Altitude Information. https://www.starlink.com/
[29] Federal Communications Commission (FCC). Understanding Satellite Broadband Technologies. https://www.fcc.gov/satellite-broadband

start at approximately $120/month, both placing them at a cost disadvantage compared to wired broadband options.[30]

Due to limitations in speed, latency, and cost, satellite broadband is not considered a viable primary solution in urban and suburban environments. However, LEO and GEO services may offer value as redundant or emergency backup connections for municipal operations, businesses, and households.

4.5 Metropolitan and Long-Haul Networks

Metro networks are designed to interconnect major locations within urban areas, enabling connectivity between business districts, industrial sites, government facilities, and colocation or data center hubs. These networks often serve as the backbone for cloud connectivity, enterprise networking, and smart city deployments. In Commerce City, metro fiber is well-developed and served by a diverse group of providers in older areas of the city like the southwest and central parts of the city, though the market has become increasingly consolidated over the past decade.

Among the metro fiber providers with a presence in Commerce City, several stand out due to network breadth and service capabilities. Zayo Group maintains a strong metro footprint throughout the Denver metro area, including Commerce City, offering dark fiber and lit services to commercial and institutional customers. Crown Castle, another major infrastructure player, also operates in the area, providing metro fiber solutions as part of its national communications infrastructure portfolio.[31] Windstream, now operating under the Uniti Fiber brand following a network spinoff and restructuring, delivers metro and enterprise fiber services across Colorado. WANRack, though more specialized, supports education-focused and custom fiber deployments, contributing to the middle-mile ecosystem.

In addition to these larger players, several other providers have documented fiber presence in the region, including Colorado Communications Transport, Electric Lightwave (formerly Integra), OptK Networks, Segra, and leased assets from SDN and Kansas Fiber Network. While some of these entities operate independently, many are connected through interconnect agreements or rely on infrastructure controlled by larger wholesale providers.

Many of the current metro providers emerged through a series of mergers and acquisitions that reshaped the regional landscape. Electric Lightwave, once a standalone provider, was acquired by Zayo Group, consolidating its assets into Zayo's broader metro and long-haul offering. Windstream's fiber assets were spun out into Uniti Fiber, which now operates both middle-mile and access networks. These shifts have concentrated control of fiber

---

[30] HighSpeedInternet.com. HughesNet and Viasat Pricing Comparison. https://www.highspeedinternet.com
[31] Crown Castle Inc. "Crown Castle Announces Agreement to Sell Fiber Segment to EQT and Zayo for $8.5 Billion." Crown Castle Investor Relations, March 27, 2024. https://investor.crowncastle.com/news-releases/news-release-details/crown-castle-announces-agreement-sell-fiber-segment-eqt-and-zayo

infrastructure among a smaller number of dominant carriers. Figure *17* depicts the variety of Metro Fiber providers in and around Commerce City.

As depicted in Figure *18* , Commerce City also has a significant number of long-haul providers running through it. As in the metro market, long-haul services have also seen considerable consolidation. Hudson Fiber, once independent, is now integrated into ExteNet Systems. Midco acquired assets from Vast Broadband, rebranding the long-haul network as Midpeak. Zayo, was acquired by EQT Infrastructure and Digital Colony in 2020 but continues to operate under its established brand.

Together, these metro and long-haul providers form the foundational infrastructure for Commerce City's digital future. The region benefits from both legacy and modern fiber infrastructure, and ongoing consolidation has allowed larger providers to scale and expand their service offerings. As smart city applications grow in complexity and bandwidth demand, the presence of these robust fiber networks, particularly those with access to regional cloud interconnect points, positions Commerce City well for future connectivity needs.

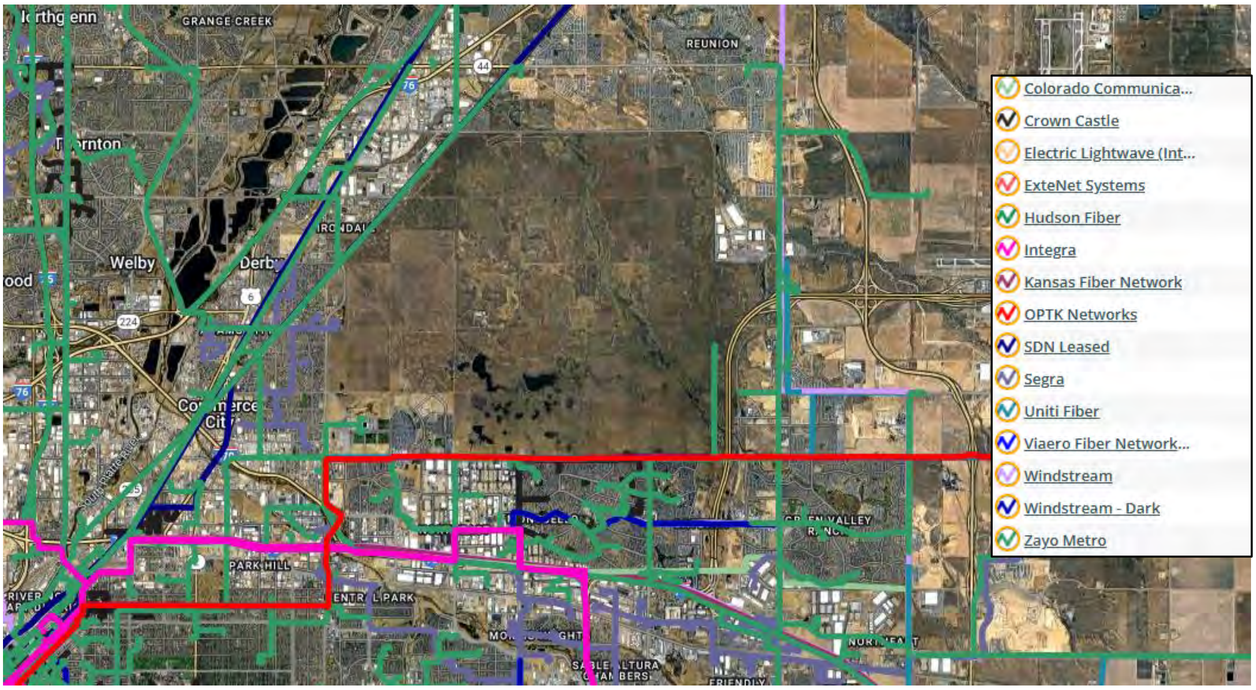

Figure 17. Commerce City Metro Networks

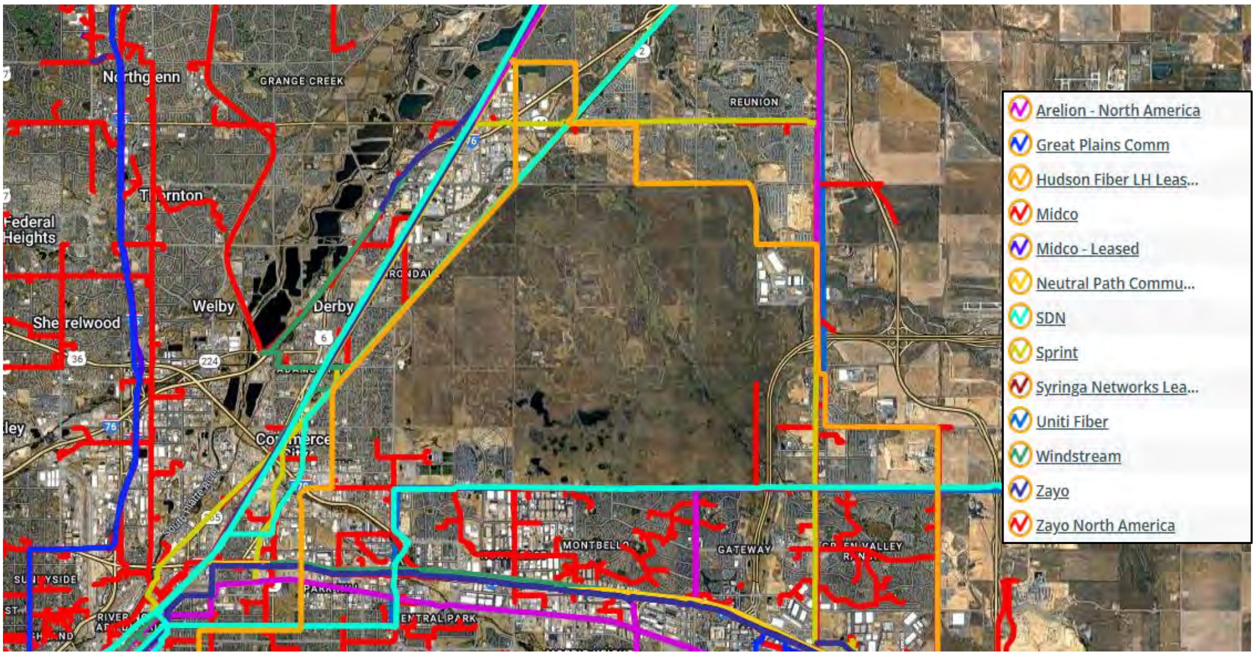

Figure 18. Commerce City Long Haul Networks

4.6 Summary Of Findings

Commerce City is not adequately served with Fiber

According to FCC Broadband Serviceable Location Fabric Data 40.9% of Commerce City's 23,887 service locations (residential and business) have fiber access, placing it in the mid-range among Adams County cities (see *Table 10*).[32] Overall, this is slightly below the countywide average of 42.6%, placing Commerce City roughly in the middle among peer communities in the region.

Table 10. Adams County fiber to the premise (FTTP) percentages

City	FTTP Coverage
Northglenn	87.8%
Brighton	53.8%
Commerce City	***40.9%***
Westminster	34.7%
Thornton	27.2%

[32] The Federal Communications Commission's (FCC) Broadband Serviceable Location (BSL) Fabric is a set of data for all locations in the United States, supplied to the FCC by internet service providers, indicating the services, including nominal speed, available at each location. In this memo it is referred to as "FCC Fabric Data."

Commerce City is subject to a common telecom duopoly

Xfinity Cable and Lumens Technologies dominate broadband in Commerce City, covering 92.3% and 91.0% of serviceable locations, respectively.[33] This duopoly means consumers have a choice of just two wired internet broadband provider options without any competitive pressure to lower costs and/or improve speeds and service to subscribers. The Commerce City market could benefit from greater competition to offer more options to residents and businesses.

The City is ready for a market disruptor

Lumen Technologies, the parent company of both Quantum Fiber and CenturyLink, retains control over the pricing, branding, and availability of 97.6% of the fiber to the premise (FTTP) service locations associated with either brand.[34] Furthermore, with 51.45% of Commerce City's serviceable locations still reliant on DSL, the city's broadband landscape is not just under-competitive—it is underbuilt.[35] This level of dependence on aging infrastructure highlights a clear market opportunity: a new fiber-based provider could bypass legacy networks entirely and deliver modern service where it's needed most. Rather than competing at the margins, a disruptor could directly replace low-performing options, accelerating the shift toward high-speed, future-ready broadband across the city.

Fixed Wireless Access (FWA) is not a true market disruptor in Commerce City

Fixed Wireless Access (FWA) currently plays a secondary role in Commerce City's broadband market, positioned as an alternative in areas with limited fiber or cable deployment.[36] While FWA providers are expanding service nationwide, their ability to compete is constrained by technological limitations that impact reliability and scalability. While fiber and cable offer stable, high-speed connections, FWA performance can be impacted by factors like physical obstructions, line of site transmission, and distance between equipment, making its performance and availability less consistent. Additionally, FWA providers have not demonstrated significant price competition compared to existing wireline broadband options, further limiting their market share. Given these factors, FWA will

---

[33] There are 23,887 BSL service locations within the Commerce City. Xfinity provides cable service to 22,049 service locations. Quantum Fiber and CenturyLink provide fiber to the premise service for a combined 9,440 locations and 12,290 Digital Subscriber Line (DSL) service locations. Lumens Technologies is the parent company for both Quantum Fiber and CenturyLink wireline service providers. Source: FCC Fabric Data Adams County, CO 2025.

[34] Lumen Technologies is the parent company of both Quantum Fiber and CenturyLink. Following its 2020 corporate rebrand from CenturyLink to Lumen, the company now markets fiber services under the Quantum Fiber brand while continuing to operate legacy DSL and voice services under the CenturyLink name.
Source: Lumen Technologies, "Our Brand," https://www.lumen.com/en-us/about/brand.html

[35] Source: 2025 FCC Fabric Data

[36] Fixed Wireless Access (FWA) is a broadband technology that delivers internet to fixed locations using wireless radio links instead of wired connections. Source: Ericsson, "Fixed Wireless Access," https://www.ericsson.com/en/fixed-wireless-access

remain a fallback option in most areas, rather than a primary broadband solution for Commerce City.

Mobile broadband is a supplementary service in Commerce City

Mobile broadband coverage in Commerce City closely follows wireline service availability, with stronger presence in areas where traditional providers operate. However, mobile broadband speeds typically max out at 35/3 Mbps, making it a limited competitor to fixed broadband services. While mobile providers offer an alternative for some consumers, they are not displacing wireline broadband due to lower speeds, network congestion, and data usage limitations. Additionally, no mobile providers are currently marketing service tiers at or above the 100/20 Mbps threshold, limiting their ability to compete in areas where wireline broadband is available.[37] Given these factors, mobile broadband serves a complimentary solution than a direct competitor in the city's broadband market.

There are significant technology driven cost disparities for broadband in Commerce City

Broadband pricing in Commerce City reflects a highly fragmented market where technology type dictates cost-efficiency. DSL, Satellite, and FWA remain the least cost-effective options, offering slower speeds at a higher cost per megabit per second (Mbps). Cable broadband, while generally more reliable, lacks competitive pricing structures that scale efficiently with speed, making it a less attractive option relative to fiber. The pricing breakdown in *Table 11* indicates that fiber provides the best value for consumers, yet its limited availability prevents it from exerting downward price pressure on other broadband technologies. Without increased competition from fiber or alternative high-speed providers, existing DSL and fixed wireless providers continue to compete in the market despite the inferior cost-performance ratio of their services.

Table 11. Average Cost per Technology Type

Technology	Average Monthly Rate	Average Cost per Mbps
DSL	$55.00	$1.07
Satellite	$100.83	$0.90
FWA	$78.53	$0.90
Cable	$39.98	$0.17
Fiber	$58.33	$0.06

[37] The 100 Mbps download and 20 Mbps upload speed threshold is established by the Federal Communications Commission (FCC) as the benchmark for advanced telecommunications capability. This standard reflects the needs of consumers for higher bandwidth applications, such as telehealth, remote work, and online education. Source: FCC, "FCC 24-27: Inquiry Concerning Deployment of Advanced Telecommunications Capability," https://docs.fcc.gov/public/attachments/FCC-24-27A1.pdf.

5. Needs Assessment

The Needs Assessment was developed using a combination of stakeholder engagement, planning document review, and analysis of previously completed technical memos. The findings draw directly from the City's Telecommunications Asset Assessment, and Market Assessment which catalog broadband infrastructure and describe provider landscape, service levels, and market constraints as they pertain to Commerce City.

Structured meetings were held with internal City departments including:

- Information Technology (April 16, 2025)
- Community Development and Economic Development (April 18, 2025)
- Public Works (May 28, 2025)
- Police Department (May 22, 2025)
- Community Development (June 4, 2025)
- Community Well-Being (June 4, 2025).

In parallel, focus group discussions were conducted with key external stakeholders including:

- Business and industry representatives (May 1, 2025)
- Nonprofit and social service organizations (May 2, 2025)
- Land development (May 2, 2025)

Additionally, ENTRUST reviewed data and maps from the American Community Survey (ACS), FCC Fabric Data, Broadband Equity, Access, and Deployment Program (BEAD), and the Colorado Broadband Office website to evaluate the City's access, adoption, barriers, and resources related to broadband. In addition, the Commerce City 2045 Comprehensive Plan was reviewed to identify long-range development patterns, infrastructure priorities, and policy frameworks relevant to broadband planning.[38]

Finally, a community broadband survey was also conducted. The survey consisted of 30 questions covering availability, affordability, performance, and digital literacy, but it yielded only 36 responses with a 53% completion rate. The limited sample size does not support statistically significant findings and is therefore not relied upon in this analysis. However, the lack of engagement itself is informative: it may reflect low public awareness of broadband issues, lack of clarity around the purpose of the survey, or survey fatigue among residents, each of which may indicate the need for improved outreach, clearer messaging, and stronger community engagement strategies in future planning phases.

[38] City of Commerce City, 2045 Comprehensive Plan, adopted October 7, 2024 (Ordinance 2616).

5.1 Indicators of Need

Speed-based availability metrics suggest near universal coverage in Commerce City – but they do not adequately capture variations in reliability and service quality.

According to the Colorado Broadband Office, Commerce City reports 99.9% of locations with access to 100/20 Mbps service, exceeding the statewide average of 94.9%. Speed test data from Ookla shows average download speeds of 223.6 Mbps and upload speeds of 22.0 Mbps in Commerce City, consistent with Adams County averages of 219.2 Mbps download and 22.8 Mbps upload.[39]

However, these benchmarks and averages alone do not capture differences in service quality, reliability, or technology type, meaning speed-based metrics by themselves do not tell the full story of broadband availability in Commerce City.

FCC Fabric Counts

According to the FCC's Broadband Serviceable Location Fabric Data, as shown in Figure *19*, there are 384 unserved or underserved locations within Commerce City's limits, concentrated primarily in three industrial clusters:

- Along 96th Avenue between Highway 2 and I-76.
- South of I-270 and east of US 6.
- North of I-270 and west of US 6.

This relatively low count is due in part to cable broadband availability, which meets or exceeds the FCC's minimum speed threshold and is therefore classified as "served" in federal datasets. When looking forward into the *Growth Boundary Areas* identified by the City, the number of unserved and underserved does not appear to disproportionately increase as the City boundary expands, although some areas of concentration are noted along East 133rd Circle. However, future city growth in the north and east may result in expansion into more dense areas of unserved and underserved locations.

[39] Colorado Broadband Office, Coverage Map & Speed Test Data, https://broadband.colorado.gov

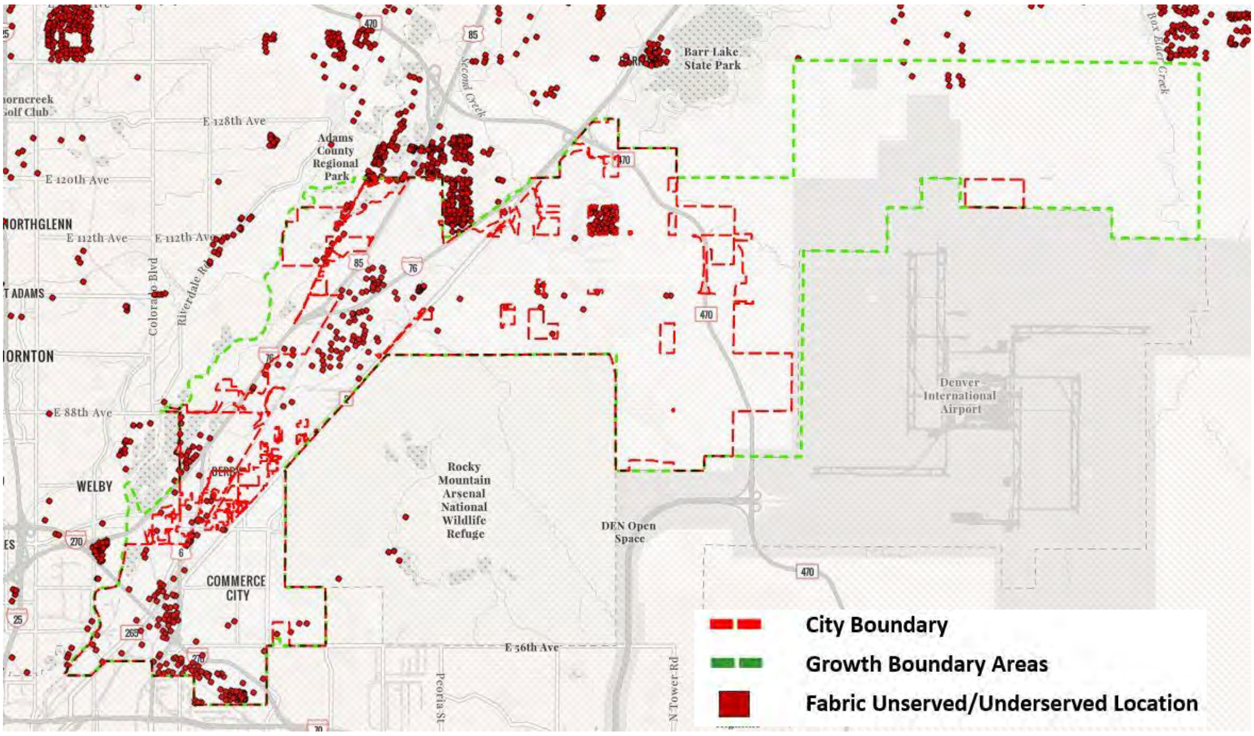

Figure 19. FCC Defined Unserved and Underserved Locations[40]

BEAD-Eligible Counts

The BEAD program, administered by the National Telecommunications and Information Administration (NTIA), uses the same speed thresholds as the FCC but applies additional filters. BEAD focuses primarily on residential and Community Anchor Institution (CAI) locations, excluding most business-only addresses unless they also serve as residences or are CAIs.[41] BEAD also counts locations served by qualifying fixed wireless access (FWA) as "served" if they meet speed and latency requirements, and removes locations already funded under other state or federal broadband programs.

Using the same thresholds but applying additional filters, BEAD identifies 267 eligible locations -188 unserved and 79 underserved. The reduction compared to FCC counts stems from BEAD's exclusion of most business-only addresses, its treatment of qualifying fixed wireless as "served," and its removal of previously funded sites. Under BEAD rules, Commerce City's priority funding target is the 188 unserved locations as shown in Figure *20*. However, In Colorado, the application window for BEAD subgrants administered by the Colorado Broadband Office has now closed, and remaining activities will focus on project implementation by selected subgrantees.

---

[40] Source: FCC Fabric Data – January 2025.

[41] National Telecommunications and Information Administration (NTIA), BEAD Notice of Funding Opportunity, Section I.C: Program Purpose and Overview, 2022.

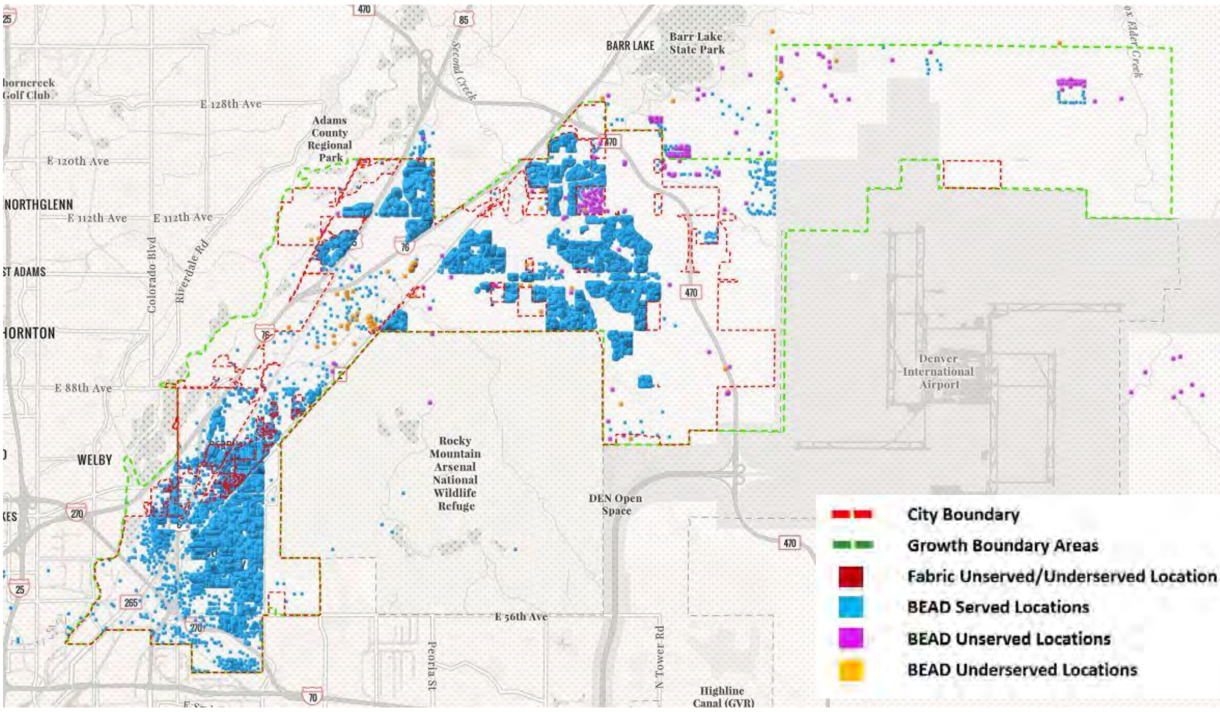

Figure 20. BEAD Unserved-Underserved Locations in Commerce City

Wireless Only Locations

A third dataset, classified under FCC Fabric data designates “Not Wired” locations as highlighted in Figure *21*, identifies 1,317 locations in Commerce City without terrestrial broadband infrastructure such as fiber, cable, or DSL. While many of these are technically “served” by qualifying Fixed Wireless Access (FWA) or satellite service and thus excluded from BEAD, they represent households and businesses relying entirely on technologies that are less reliable and limited in capacity. As such, the “Not Wired” figure is best interpreted as a risk indicator rather than a funding-eligible count. These 1,317 “Not Wired” locations were relatively dispersed throughout the City without any particular concentrations.

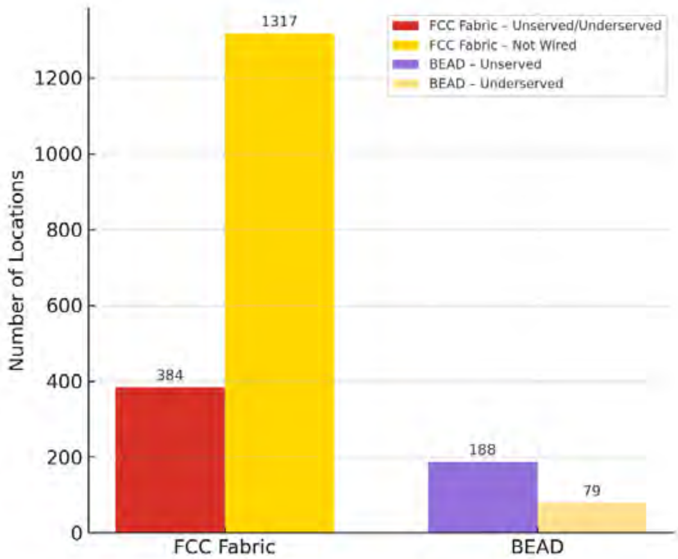

Figure 21. FCC Fabric vs BEAD Data in Commerce City

Fiber vs. Cable: Context for Planning

While unserved and underserved location counts are a core measure in broadband planning, they do not tell the whole story. Current definitions of "served" include locations where cable broadband is the primary technology, even though only fiber can provide symmetrical speed with high upload capabilities, and is widely regarded as the more reliable, resilient, and future-proof option. This means a community can appear fully served under FCC or BEAD criteria while still relying heavily on aging cable infrastructure.

In Commerce City, cable availability covers approximately 92.3% of locations (22,049 out of 23,887), driving the high "served" figures traditionally used by many planning agencies. In contrast, FCC Broadband Serviceable Location Fabric data shows that only 40.9% of locations in Commerce City (9,762 out of 23,887) "can be" served by fiber-to-the-premises (FTTx) as shown in Figure *22*.[42] The key designation as "can be" doesn't mean that there is service at the location, but that service is capable of being provided at the location. [43] These figures may include overlap where some addresses could be served by both fiber and cable. Therefore, the black shaded areas in Figure *22* represent all possible broadband eligible locations, while the blue shading represents where fiber service is available, not necessarily where it has been adopted at every location.

Although cable systems often satisfy the 100/20 Mbps threshold used in coverage assessments, they do not provide the same performance, capacity, upload capabilities, or resilience as fiber networks. This gap between meeting speed metrics and delivering consistent, future-proof broadband service is especially significant in the Northern Range and in planned Growth Boundary Areas, where many neighborhoods remain cable-only. As a result, planning decisions that rely solely on speed-based service counts risk overstating the quality of connectivity and overlooking opportunities to improve network reliability, resiliency, and long-term competitiveness.

---

[42] Federal Communications Commission, Broadband Serviceable Location Fabric Data Dictionary, Version 3.0 (2023), https://www.fcc.gov/BroadbandData/FabricDocumentation

[43] According to the FCC, a broadband serviceable location (BSL) is "a business or residential location in the United States at which mass-market fixed broadband Internet access service is, or can be, installed." Each BSL is represented in the Fabric as a point located within the footprint of a structure; addresses or vacant lots without habitable structures are not considered BSLs. See: Federal Communications Commission, What a Broadband Serviceable Location (BSL) Is and Is Not (BDC Help Center), https://help.bdc.fcc.gov/hc/en-us/articles/16842264428059-About-the-Fabric-What-a-Broadband-Serviceable-Location-BSL-Is-and-Is-Not

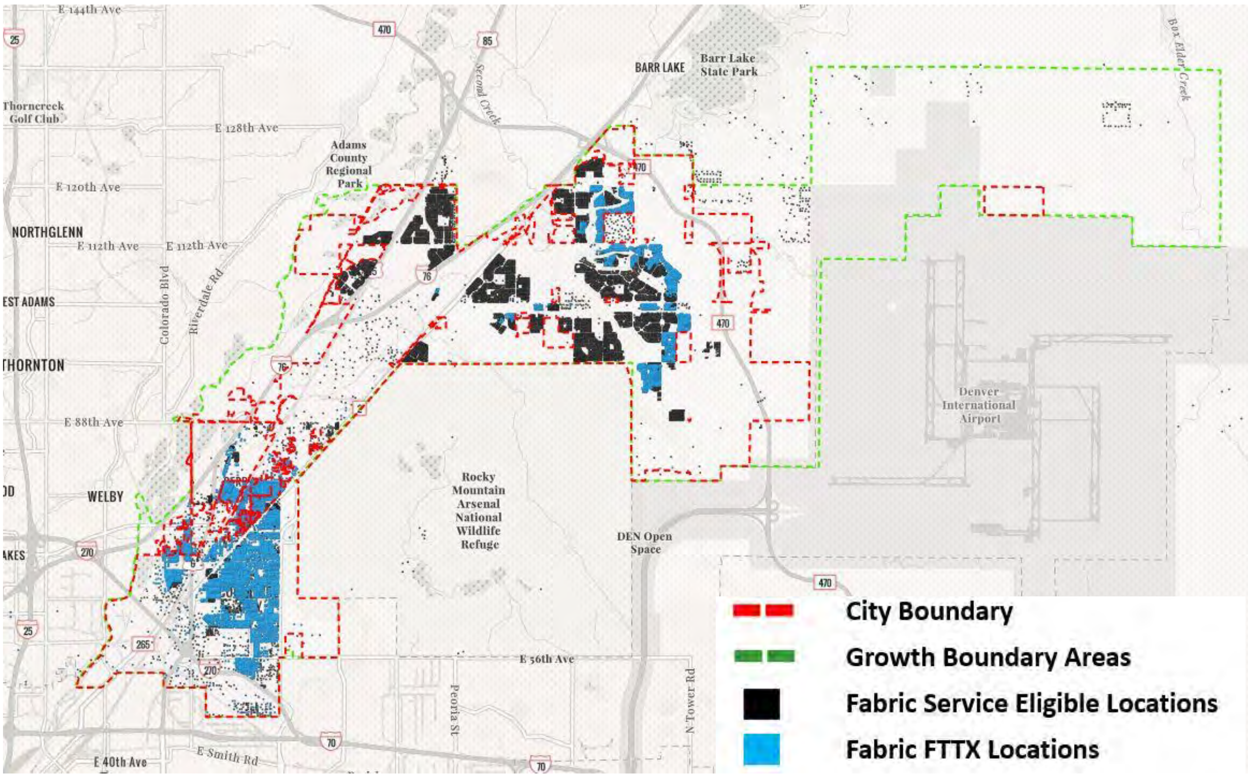

Figure 22. FCC FTTX Eligible Locations vs all "Served" locations

Key Take Aways

Scope differences

The FCC Fabric includes both residential and business addresses, identifying 384 unserved or underserved locations in Commerce City. BEAD removes most business-only locations, reducing the total to 267.[44]

> *Because fiber delivers greater capacity, resiliency, and scalability, speed-based coverage counts that rely on cable alone overstate the quality of service available and mask the long-term risks of relying on cable-only areas.*

[44] According to NTIA's BEAD Final Proposal Guidance v1.2 (pp. 42–45, 90–93), business-only (enterprise) addresses are not eligible as unserved or underserved locations under BEAD. The guidance specifies that "enterprise-only locations do not qualify as unserved or underserved under BEAD" and clarifies that the program's priorities are unserved and underserved residential locations and Community Anchor Institutions (CAIs). The full document is available at: https://www.ntia.gov/sites/default/files/2024-11/bead_final_proposal_guidance_v1.2.pdf

Technology classification changes the picture

The "Not Wired" category contains 1,317 locations without fiber, cable, or DSL, yet many have qualifying fixed wireless or satellite service and are considered served under BEAD rules. However, FWS and satellite are subject to speed and capacity limitations that cannot meet future demand.

Funding eligibility is narrower than need

Only 188 unserved and 79 underserved locations - a total of 267 - would be eligible for BEAD funding. This excludes most business addresses and many wireless-served homes.

Cable vs. fiber is a defining factor

While cable satisfies the 100/20 Mbps threshold, only 40.9% of locations have fiber-to-the-premises, which provides the upload speeds, capacity, reliability, and resiliency required for long-term competitiveness. Commerce City's planning cannot rely on speed metrics alone without addressing the underlying technology divide.

5.2 Broadband Availability and Access

While infrastructure availability is an important planning metric, household adoption rates provide a different perspective on broadband need. Together, these indicators reveal whether a community's connectivity challenges stem from lack of infrastructure, barriers to adoption, or both – commonly referred to as the Digital Divide.

Availability

HUD Low-to-Moderate Income (LMI) census block group data, when layered with 2025 FCC Fabric service availability, shows that fiber deployment patterns in Commerce City do not always align with the areas of greatest socioeconomic need as shown in Figure *23*. The City's core commercial districts display higher concentrations of fiber presence, yet these deployments often track with commercial demand rather than residential income levels and needs.

In the Northern Range area, fiber overbuild of cable is more common in higher-income neighborhoods, while residential areas with LMI designations of 50% or greater - particularly just north of 96th Avenue - remain primarily cable-served only. This reinforces a key planning concern: areas subject to a cable monopoly are responsible for much of the city's "served" designation in official counts, yet only a portion of those locations have fiber-to-the-premises (FTTx) capable of meeting the scalability and resiliency requirements of future demand.

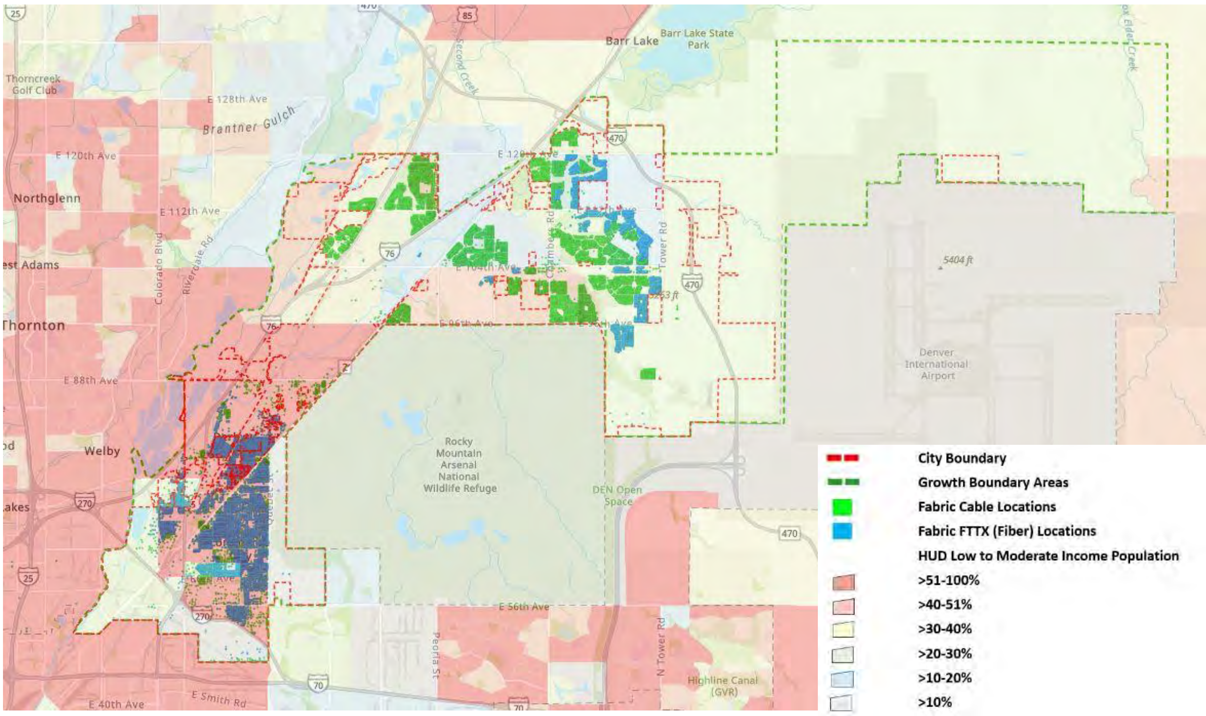

Figure 23. Fiber vs Cable deployment patterns in low-to-moderate income areas

Access

Figure 24 utilizes ACS layers to identify the proportion of households within each census block without internet subscriptions (black circles) and without computers (purple circles). In some areas, households have computers but lack subscriptions, pointing to affordability or adoption challenges (no visible black circle in underlying layer). In others, device access itself is the limiting factor (purple circle larger than underlying black circle). Together, these variables show that broadband gaps are shaped by both equipment availability and subscription decisions.

When ACS Internet Subscription data is overlaid with LMI block group data, distinct adoption gaps emerge. In several neighborhoods, particularly in the south, the data shows both a high proportion of LMI households and a noticeable percentage of residents without an internet subscription, even where both cable and fiber are available. This pattern strongly suggests that affordability, not infrastructure, is the primary barrier to adoption.

In contrast, northern tracts demonstrate a different challenge. These areas show relatively higher incomes, broadband availability, and computers in the home, yet adoption remains impacted. This suggests that in some cases, the barrier is not cost or access but other factors such as digital literacy, awareness, cultural or linguistic barriers, or whether residents see internet service as relevant to their daily lives.

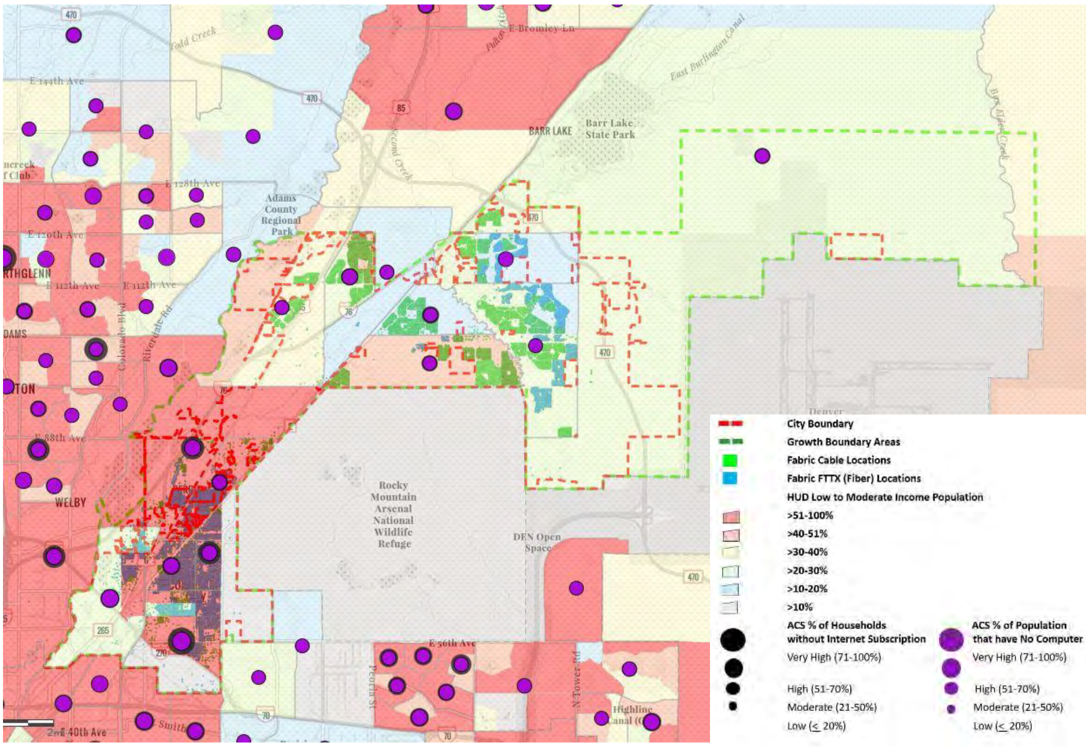

Figure 24. Adoption by Technology by Income and Demographic[45]

Key Takeaways

Infrastructure alone is not enough

Broadband challenges in Commerce City are shaped not only by whether service is available, but by where modern infrastructure is deployed.

Affordability drives adoption

Even in areas with both fiber and cable coverage, adoption lags where household incomes are lower, indicating that cost remains a significant barrier.

> *Closing the Digital Divide requires a complete approach that addresses availability, affordability, reliability, competition, and future-proofing to ensure broadband "service" is both physically present and practically accessible to all residents.*

[45] HUD U.S. Census Bureau. American Community Survey (ACS), 5-Year Estimates: Internet Connectivity Variables, Internet by Income Boundaries, Internet by Age and Race Centroids. Retrieved from https://www.census.gov/programs-surveys/acs , U.S. Department of Housing and Urban Development (HUD). Low to Moderate Income Population by Block Groups. Retrieved from https://hudgis-hud.opendata.arcgis.com, Federal Communications Commission (FCC)., Broadband Serviceable Location Fabric, 2025. Retrieved from https://www.fcc.gov/BroadbandData/Fabric.

Perception and relevance matter

Some households with available broadband may still not subscribe due to lack of awareness, no technology devices, digital skills, or perceived value.

5.3 Stakeholder Perceptions of Need in Commerce City

> *"Getting services to show up (in new development areas) is really the challenge. We can be looking at two different locations to invest in, but if one has a history of delays getting broadband, that's a big deal for our buyers."*
>
> *— Land Development Focus Group*

Stakeholder feedback gathered through focus groups, city department discussions, and review of supplemental materials revealed a set of persistent broadband challenges affecting residents, businesses, and municipal operations. While the specifics varied by sector, five overriding issues emerged consistently across different stakeholder groups. These issues represent the most urgent needs identified for improving connectivity, expanding equitable access, and supporting the city's long-term economic and operational goals. The following is a summary of statements gathered from stakeholders in the community, and do not reflect the opinions of ENTRUST or constitute its formal recommendations.

Key issues flagged during stakeholder interviews include:

- **Service Reliability and Coverage Gaps**. Frequent outages, weak wireless coverage in some areas, and inconsistent speeds across both wired and wireless connections.
- **Limited Provider Choice and Competition**. Lack of multiple providers in many areas, leading to higher costs and slower service improvements.
- **Affordability and Adoption Barriers**. Even in areas with adequate infrastructure - cost, device availability, and digital literacy hinder adoption more than they should.
- **Coordination and Broadband Infrastructure Planning Needs**. There are routine missed opportunities to integrate broadband upgrades with public works or development projects.
- **Economic Development Risks**. Inadequate broadband service as a deterrent to business recruitment, retention, and expansion.

The following sections discuss each of these issues in detail, drawing directly from stakeholder discussions.

Service Reliability and Coverage Gaps

> *"If our internet drops for even ten minutes, our entire scheduling system backs up. It's not just an inconvenience — it costs us money every time."*
>
> *--Business & Industry Focus Group*

Unreliable broadband service was the most frequently reported problem among stakeholders, affecting residents, businesses, and municipal operations. City departments and focus group participants consistently described unstable connections, latency issues, and intermittent service outages as barriers to both daily activities and long-term planning.[46] [47]

Areas in the northern part of Commerce City were repeatedly singled out for having weaker wireless coverage, which limits connectivity for public safety, public works, and residents alike. In these areas, mobile and fixed wireless signals were described as "inconsistent at best," forcing some city departments to rely on alternative communication methods when connections fail.[48]

Operational impacts were cited across multiple settings. City staff noted that during field operations, especially in emergency response, connectivity loss disrupts coordination between dispatch and personnel in the field, slowing response times and creating potential safety risks.[49] Businesses described how dropped video calls or delays in cloud-based applications directly affected productivity and customer service, with some implementing costly backup connections to offset these problems.[50] The issue is not limited to wireless service. Land development stakeholders explained that in certain neighborhoods, wired service is also subject to outages and speed fluctuations, which can delay project work dependent on large data transfers and remote collaboration.[51]

Community organizations reported that residents experience frequent slowdowns during peak evening hours, which can make online classes or telehealth appointments unreliable.[52] These peak-hour slowdowns are consistent with the limitations of cable-based service, which relies on shared neighborhood bandwidth and lacks the capacity and resiliency of fiber-to-the-premises networks.

The persistence of these reliability issues means that even where infrastructure exists, the quality of service does not meet user needs. Stakeholders framed this as both a technical

---

[46] Focus Group – Business & Industry (May 1, 2025).
[47] City Department Discussion.
[48] City Department Discussion.
[49] City Department Discussion.
[50] Focus Group – Business & Industry (May 1, 2025).
[51] Focus Group – Land Development (May 2, 2025).
[52] Focus Group – Non-Profit / Social Services / Churches (May 2, 2025).

problem requiring infrastructure upgrades and a customer service problem, where providers have not adequately addressed chronic performance issues.

Limited Provider Choice and Competition

Stakeholders consistently reported that many areas of Commerce City have only one or two broadband service providers, limiting consumer choice and reducing incentives for service improvement. This lack of competition was tied to higher prices, slower speeds, and limited-service upgrades compared to more competitive markets.[53]

> *"We're trying to make the best user customer experience when they buy a house that they have options or at least an option to be able to get hooked up to broadband."*
>
> *- Land Development Focus Group*

Several focus group participants noted that the lack of provider diversity places both residents and businesses in a take-it-or-leave-it situation, where customers must either accept the available service level or pay significantly more for a higher tier that still may not meet their needs. For organizations reliant on cloud computing, remote collaboration, or high-bandwidth applications, this lack of alternatives can be especially problematic, forcing them to invest in costly redundancy measures.[54] [55]

City departments echoed these concerns, observing that the absence of multiple competing providers reduces the City's leverage when negotiating service expansions or upgrades. They emphasized that without competitive pressure, providers have less motivation to invest in infrastructure improvements in lower-density or underserved areas. [56] In some parts of the city, particularly developing residential neighborhoods and certain commercial corridors, the limited competition is compounded by a complete absence of high-speed service at the time of occupancy. Land development stakeholders explained that even after residents or tenants move in, it can take months before adequate service is available, and when it arrives, there is often only a single provider option.[57]

The convergence of these perspectives shows that the issue is not solely about cost, but about the structural disadvantage created when there is no meaningful choice in the broadband marketplace. Without provider diversity, stakeholders believe both performance and affordability will continue to lag behind regional and national benchmarks.

Affordability and Adoption Barriers

Even in areas where infrastructure and service availability are adequate, stakeholders reported that many households and small businesses cannot fully participate in the digital

[53] Focus Group – Business & Industry (May 1, 2025).
[54] Focus Group – Land Development (May 2, 2025).
[55] Focus Group – Business & Industry (May 1, 2025).
[56] City Department Discussion.
[57] Focus Group – Land Development (May 2, 2025).

economy due to cost, equipment, and digital skills limitations. These barriers are distinct from service reliability and provider competition issues, instead relating to the broader capacity of users to adopt and sustain broadband service. [58]

Multiple focus groups emphasized that monthly service charges remain a challenge for low- and moderate-income households, especially after the Affordable Connectivity Program ended in 2024. [59] Non-profit representatives noted that while some local initiatives provide temporary assistance or device subsidies, these efforts are limited in scope and cannot offset ongoing costs. [60]

"We have clients who live right under a fiber line, but they can't afford the service, or they don't have a computer. It's not just about building the network — it's making sure people can actually use it."

--Non- Profit-Social Services- Focus Group

Stakeholders also identified equipment access as a persistent barrier. Several groups described situations in which households have service available but lack a functioning computer or adequate Wi-Fi equipment to use it effectively.[61] For small businesses, outdated networking hardware was cited as a common issue, particularly in sectors where margins are thin, and technology upgrades are deferred until equipment fails. [62]

In addition to cost and equipment constraints, digital literacy emerged as a critical factor in broadband adoption. Social service representatives and educational stakeholders observed that some residents, particularly seniors and recent immigrants, are hesitant to engage with online services due to limited digital skills or concerns about online security.[63] They noted that without targeted outreach and training, these populations are unlikely to use available connectivity for essential activities such as telehealth, online job applications, and virtual learning.

Several stakeholders linked these adoption barriers to broader economic outcomes. Without affordable, reliable access and the skills to use it, residents are excluded from remote job opportunities and digital upskilling programs. This limits the City's ability to fully leverage broadband as a driver of economic mobility.

Overall, the discussions made clear that improving broadband adoption in Commerce City requires a multi-pronged approach: reducing the cost burden, expanding access to devices, and providing ongoing digital literacy support tailored to specific community needs.

[58] Focus Group – Business & Industry (May 1, 2025).
[59] Focus Group – Non-Profit / Social Services / Churches (May 2, 2025).
[60] Focus Group – Non-Profit / Social Services / Churches (May 2, 2025).
[61] City Department Discussion.
[62] Focus Group – Business & Industry (May 1, 2025).
[63] Focus Group – Non-Profit / Social Services / Churches (May 2, 2025).

Coordination and Broadband Infrastructure Planning Needs

City department interviews suggested that Commerce City requires a more coordinated and strategic approach to managing and expanding its broadband infrastructure. While various broadband-related assets, such as conduit, fiber segments, and wireless facilities exist across multiple departments, there is no centralized system for tracking or integrating this information into planning processes. Individual departments maintain their own records, but these datasets are often incomplete, siloed, or incompatible. [64] Without a unified asset inventory, opportunities for shared use, network expansion, or long-term cost savings can be overlooked.

> *"We replaced sidewalks and rebuilt the streetlights last year, and no conduit went in. Now if we need broadband there, it's a whole new project and a whole new budget."*
>
> *--City Staff Member*

City departments emphasized the need for stronger interdepartmental coordination and earlier integration of broadband considerations into public works and capital improvement projects. Currently, broadband is not consistently addressed during the planning stages of infrastructure projects, which can result in missed opportunities to install conduit or fiber when streets are already being opened for other purposes. [65] The absence of a formal "dig once" or joint trenching policy further limits the City's ability to leverage capital projects for broadband expansion.

From the private sector perspective, focus group participants reported that developers and businesses are often unaware of municipal broadband assets or how to coordinate with the City to support project connectivity needs. [66]This lack of clear communication channels can lead to project delays, increased costs, and missed opportunities to extend service to new areas.

Overall, the discussions underscored the need for a centralized broadband asset management system that is accessible to all relevant departments, the establishment of formal coordination protocols for integrating broadband into capital projects, and proactive outreach to external stakeholders to align public and private infrastructure efforts. Addressing these needs would position the City to deploy broadband infrastructure more efficiently, reduce costs, and improve service coverage in both the short and long term.

[64] City Department Discussion.
[65] City Department Discussion.
[66] Focus Group – Land Development (May 2, 2025).

Economic Development and Regional Competitiveness Needs

> *"Broadband is like roads and utilities now. If it's not there, it changes our decisions on where and how we build."*
>
> *--Land Development Focus Group*

Stakeholder discussions made it clear that broadband is viewed not only as a utility but as a critical driver of economic development in Commerce City. Participants emphasized that the availability of high-quality, affordable broadband can influence business location decisions, support workforce retention, and attract investment in technology-reliant sectors.[67]

Conversely, service gaps and inconsistent performance risk placing the City at a competitive disadvantage compared to neighboring communities with more robust networks. Several focus groups pointed to examples where prospective businesses or developers expressed concern over broadband limitations when evaluating sites within the City. In some cases, slow deployment timelines or a lack of competitive service options deterred projects from moving forward.[68]

These challenges are particularly concerning for industries that depend on high-capacity connectivity, such as logistics, advanced manufacturing, and professional services requiring frequent large file transfers or continuous virtual collaboration. City departments noted that economic development strategies increasingly rely on broadband as a core element of infrastructure planning. Without proactive investment and policy alignment, they warned that the City could miss opportunities to capitalize on regional growth trends, especially in technology-intensive industries.[69]

From the community perspective, non-profit and social service representatives connected broadband access to broader economic mobility, citing its role in enabling remote work, online training, and entrepreneurship. They stressed that improving broadband infrastructure is not solely about attracting outside investment but also about creating pathways for local residents to participate fully in the modern economy.[70]

The collective input from stakeholders indicates a pressing need for the City to integrate broadband considerations into its economic development planning, ensure that commercial and industrial areas have access to high-performance service, and position broadband infrastructure as a competitive advantage in attracting and retaining both employers and a skilled workforce.

---

[67] Focus Group – Business & Industry (May 1, 2025).
[68] Focus Group – Land Development (May 2, 2025).
[69] City Department Discussion.
[70] Focus Group – Non-Profit / Social Services / Churches (May 2, 2025).

5.4 Community Survey Results

The City distributed a 30-question broadband survey to residents and businesses, primarily via the internet, to gather input on current service quality, pricing, and availability. The survey was open for 128 days, beginning on January 23, 2025, and received 36 completed responses. Given the limited response rate (with approximately 53% of those responses actually completed), the results are not statistically significant and detailed conclusions or findings cannot be drawn. However, the lack of participation itself may indicate limited community awareness of broadband initiatives, low perceived value in providing feedback, or possible survey distribution challenges inherent to online-only outreach.

Surveys of this kind are typically an important tool in broadband needs assessments because they provide first-hand information from residents and businesses on service performance, reliability, satisfaction, and pricing. This feedback can help validate and supplement technical coverage data from sources like the FCC Broadband Fabric or state broadband maps. In this case, however, the limited and incomplete response set precludes meaningful analysis, reducing its utility as a verification source.

5.5 Summary of Findings

Commerce City's broadband landscape demonstrates that coverage statistics alone do not reflect the lived experience of residents, businesses, or city departments. While service appears nearly universal on paper, closer analysis and stakeholder feedback reveal persistent reliability issues, affordability barriers, planning gaps, and economic development risks. These findings highlight the importance of treating broadband as essential civic infrastructure requiring coordinated policy, investment, and community engagement.

Coordination and Broadband Infrastructure Planning Needs

Commerce City lacks a centralized and coordinated system for managing broadband assets and integrating broadband into public works planning. Departments maintain their own records of conduit and fiber, but these datasets are siloed and incomplete, resulting in missed opportunities for joint trenching or "dig once" policies. Stakeholders noted that the absence of formal coordination protocols adds cost and delays to projects, while developers often remain unaware of municipal assets that could help serve new neighborhoods or business districts.

Economic Development Risks

Broadband is increasingly viewed as a utility on par with water, roads, and power, and stakeholders made clear that Commerce City's long-term competitiveness depends on it. Businesses and developers cited examples where concerns about limited-service options or deployment delays influenced investment decisions. Without proactive investment and policy alignment, Commerce City risks falling behind neighboring areas that can offer more reliable, future-ready networks, limiting both business attraction and opportunities for local residents to participate fully in the digital economy.

Need for Infrastructure Expansion

Geographic limitations remain in some pockets of the city — especially in lower-density areas and the Northern Range. While the southern part of the city has seen more aggressive fiber overbuild, much of the northern area relies on older cable systems or DSL . Commercial corridors in the core part of the City have strong fiber presence, but nearby residential areas do not always benefit from the same level of investment.

Service Reliability and Coverage Gaps

Despite reporting near-total coverage at the FCC's 100/20 Mbps benchmark, stakeholders consistently described unreliable service as a daily challenge. Outages, fluctuating speeds, and weak wireless coverage in the northern parts of the city hinder public safety coordination, disrupt business operations, and undermine household use during peak hours. This gap between "availability" and dependable, high-quality connectivity underscores the need for infrastructure improvements and stronger performance accountability from providers.

Need for Market Diversity

Broadband service in Commerce City is shaped by a technology duopoly (or in some areas of the City, a cable monopoly), where cable systems provide the dominant baseline and fiber deployment occurs selectively in higher-income neighborhoods or commercial districts. This market pattern leaves many low- to moderate-income areas reliant on cable service alone, limiting both competition and access to future-proof networks. Without deliberate policy and planning interventions, the alignment of fiber investment with income levels risks widening the City's Digital Divide, creating long-term inequities in service quality, affordability, and adoption.

Affordability and Adoption Barriers

Even where broadband infrastructure is available, adoption rates in Commerce City lag due to persistent affordability and capacity challenges. Cost remains a primary barrier, particularly for households in low- and moderate-income areas, where service is present but not within financial reach. In addition to price, adoption is also limited by gaps in digital readiness, as some residents face challenges with equipment, skills, or awareness that prevent them from fully using the connectivity available to them.

6. Gap Analysis & SWOT Matrix

As part of this review, ENTRUST developed a SWOT (strengths, weaknesses, opportunities, and threats) matrix and gap analysis to identify key issues and barriers in meeting the community's broadband needs and to outline possible steps to address any deficiencies.

The analysis synthesized findings from the technical memos to identify recurring themes across infrastructure, market dynamics, community needs, and policy. These themes were organized into a SWOT framework to highlight Commerce City's strengths, weaknesses, opportunities, and threats. From this framework, five key actions were identified to address digital gaps.

6.1 SWOT Matrix

A summary of Commerce City's strengths, weaknesses, opportunities, and threats gathered from the asset inventory, market assessment, and needs assessment is shown in Figure *25* and discussed below.

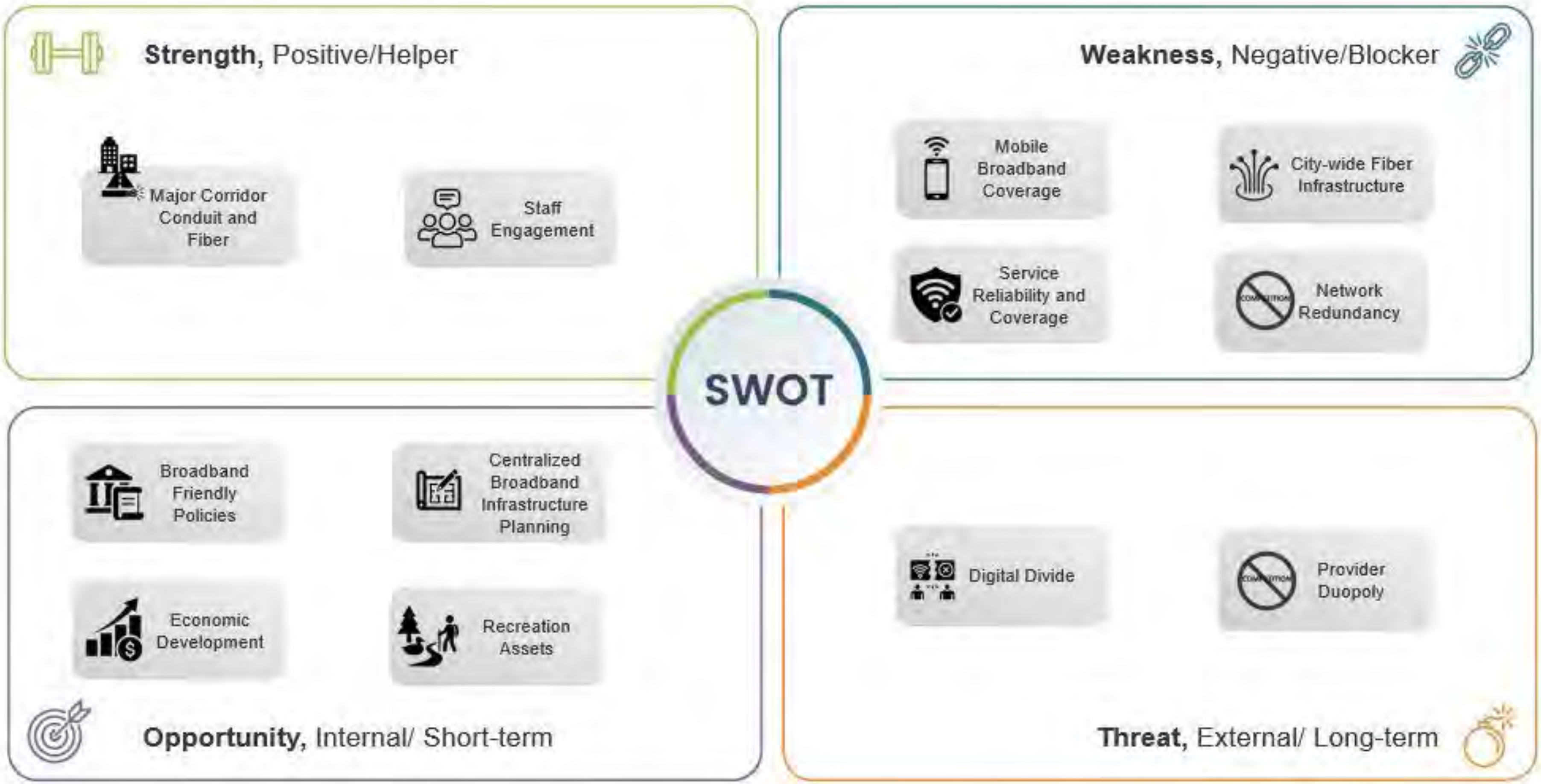

Figure 25. Commerce City Broadband SWOT Matrix

Strengths

Strengths are internal attributes that are beneficial and support achieving objectives. Strengths answer the question: "What do we do well?" For Commerce City, its strengths lie in its public assets, staff, and recreation assets.

- **Major Corridor Conduit and Fiber**: Commerce City has substantial conduit and fiber in major corridors (30+ miles) that are used for interconnecting its facilities and other municipal assets, particularly traffic signals.
- **Staff Engagement**: City staff have shown strong engagement throughout broadband planning and project coordination efforts, demonstrating that communication infrastructure remains a clear organizational priority. Multiple departments have collaborated and assumed expanded roles to advance the vision for a modern, high-performance network. This level of coordination reflects a shared understanding of connectivity's importance to effective city operations, economic growth, and community services.

Weaknesses

Weaknesses are internal attributes that hinder achieving objectives. They answer the questions: "What areas need improvement?" and "What feedback have we received from stakeholders that indicates areas of concern?"

- **Mobile Broadband Coverage:** According to the Federal Communications Commission (FCC), Commerce City is relatively well covered with 4G mobile offerings from the three major U.S. mobile operators: AT&T, Verizon, and T-Mobile. Verified FCC data for 5G service, however, show intermittent and inconsistent coverage, which is typical among mid-sized cities in Colorado. While initial 5G deployments have focused on denser population areas like Commerce City, coverage expansion has lagged behind the City's rapid growth, leaving newer residential and industrial areas underserved as demand continues to rise.
- **City Network Redundancy and Structure:** While the City maintains more than 30 miles of buried conduit that supports municipal and community connectivity, the network lacks redundancy and exhibits a flat, non-hierarchical design. Several facilities are not connected to City-owned fiber, creating single points of failure and limiting opportunities for load balancing or route diversity. This configuration increases vulnerability to outages and constrains future scalability for smart city and broadband initiatives.
- **Broadband Service Reliability and Coverage:** Despite FCC data that shows near-total coverage at the federal 100/20 Mbps benchmark, stakeholders consistently described unreliable service as a daily challenge. Outages, fluctuating speeds, and weak wireless coverage in the northern parts of the City hinder public safety coordination, disrupt business operations, and undermine household use during peak hours. This gap between "availability" and dependable, high-quality connectivity underscores the need for infrastructure improvements and stronger performance accountability from providers.
- **City-wide Fiber Infrastructure:** According to FCC Broadband Serviceable Location Fabric Data, 40.9% of Commerce City's 23,887 service locations (residential and business) have

fiber access, placing it in the mid-range among cities within Adams County, and below the countywide average of 42.6%. [71]

Opportunities

Opportunities are external factors or circumstances that the City can leverage to achieve its objectives and improve its services. Among the questions they answer are: “Are there gaps in the market that we can fill?”, “What unmet needs do our stakeholders have that we could address?” and “What trends can we take advantage of?”

- **Broadband Friendly Policies:** In discussion with City staff, leadership emphasized the need for stronger interdepartmental coordination and earlier integration of broadband considerations into public works and capital improvement projects. Currently, broadband is not consistently addressed during the planning stages of infrastructure projects, which can result in missed opportunities to install conduit or fiber when streets are already being opened for other purposes. Establishing a formal “dig once” or joint trenching policy—applicable to both public works and private development activities that disturb the right-of-way—would further expand the City’s ability to leverage construction efforts for broadband expansion.
- **Centralized Broadband Infrastructure Planning:** Commerce City lacks a centralized and coordinated system for managing broadband assets and integrating broadband into public works planning. Departments maintain their own records of conduit and fiber, but these datasets are siloed and incomplete, resulting in missed opportunities for joint trenching or “dig once” policies. Stakeholders noted that the absence of formal coordination protocols adds cost and delays to projects, while developers often remain unaware of municipal assets that could help serve new neighborhoods or business districts.
- **Economic Development:** Stakeholder discussions confirmed that broadband is seen not just as a utility, but as a key driver of economic development in Commerce City. Participants shared examples of businesses and developers reconsidering projects due to service gaps, slow deployment timelines, or limited provider options. These concerns are especially pronounced in sectors like logistics, advanced manufacturing, and professional services that rely on high-capacity connectivity. City departments emphasized that without strategic investment and policy alignment, the City risks falling behind regional growth trends in technology-intensive industries.
- **Recreation and Growth Corridors**: Commerce City’s extensive network of parks, open spaces, and more than 160 miles of interconnected trails positions the community as a regional destination for outdoor recreation. As growth continues toward the airport and surrounding development areas, these corridors present strategic opportunities to integrate broadband infrastructure. Deploying public Wi-Fi and digital wayfinding systems would enhance visitor engagement and connectivity, transforming recreation assets into active economic development drivers. By combining broadband investment with place-based

---

[71] Federal Communications Commission (FCC), Broadband Serviceable Location Fabric Data, Version 3.0, released 2023, available at https://www.fcc.gov/BroadbandData/FabricDocumentation

amenities, the City can amplify growth, attract tourism, and strengthen the appeal of adjacent residential and commercial districts.

Threats

A threat refers to circumstances that could negatively impact the City's ability to achieve its objectives, maintain the current quality of life for its residents, or retain an atmosphere conducive to business growth and expansion.

- **Provider Duopoly:** Xfinity Cable and Lumen Technologies dominate broadband in Commerce City, covering 92.3% and 91.0% of serviceable locations, respectively. This duopoly means consumers have a choice of just two wired internet broadband provider options without any competitive pressure to lower costs and/or improve speeds and service to subscribers.
- **Digital Divide:** Because service in Commerce City is shaped by a technology duopoly (or in some areas of the City, a cable monopoly), broadband availability occurs selectively in higher-income neighborhoods or commercial districts. This market pattern leaves many low- to moderate-income areas reliant on cable service alone, limiting both competition and access to future-proof networks. Without deliberate policy and planning interventions, the alignment of fiber investment with income levels risks widening the City's Digital Divide, creating long-term inequities in service quality, affordability, and adoption.

6.2 Gap Analysis

Having identified the gaps in the SWOT matrix, ENTRUST identified five policy shifts that could address those gaps. The analysis included findings for addressing each of these gaps, including the deployment of new infrastructure, creating a broadband friendly culture, and streamlining processes that lead to better broadband infrastructure outcomes.

Policy solutions and corresponding gaps that are addressed by implementing the actions are in Figure *26*.

Recommendation \ Gap	Mobile Broadband Coverage	Service Reliability and Coverage	City-wide Fiber Infrastructure	Broadband Friendly Policies	Centralized Broadband Infrastructure Planning	Economic Development	Digital Divide	Provider Duopoly
Policy Recommendations								
1. **Review and update existing intergovernmental agreements** and create a **City Master License Agreement.**	●			●		●	●	●
2. **Establish a Technology Fund** using revenue from leased assets to support future broadband initiatives.				●			●	●
Infrastructure Recommendations								
3. **Conduct a conduit audit** for the existing traffic system to identify usable infrastructure.		●			●			
4. **Create a Master Tower Plan** to guide future wireless infrastructure development and attract carrier partnerships.	●					●	●	
5. **Implement Phase One of the Conceptual Design**, focusing on connecting critical facilities.	●	●	●		●			

Figure 26. Gap Analysis Findings Summary

6.3 Summary of Findings

The City has meaningful Broadband Assets

These assets can be leveraged to expand communications across City and community services but lacks network redundancy and critical site connectivity. The City has already deployed over 30 miles of conduit and fiber in major corridors and continues to demonstrate staff engagement in long-term planning efforts, including inter-agency projects. However, the current network lacks redundancy, leaving it vulnerable to service disruptions, and does not connect all critical City facilities.

The City has Inconsistent mobile/cellular coverage, and many residents and Businesses do not have access to fiber services

A field test of cellular coverage and available speeds documented a number of pockets within the City that lack adequate mobile/cellular coverage, signal strength, or sufficient speeds. Additionally, FCC databases show that approximately 59% of the City currently does not have any fiber services available, leaving many areas subject to a cable monopoly.[72] For comparison the same data shows that approximately 12% of Northglenn and approximately 44% of Brighton are without fiber service.[73]

[72] Federal Communications Commission (FCC), Broadband Serviceable Location Fabric Data, Version 3.0, released 2023, available at https://www.fcc.gov/BroadbandData/FabricDocumentation

[73] FCC data reports an Adams County average fiber availability at 42.6%.

7. Fiber Network Conceptual Design

At this stage of the broadband planning process, a conceptual fiber network design provides the City with a practical framework for evaluating feasibility, phasing, and investment priorities before committing to detailed engineering or construction. The conceptual design translates the City's goals and existing assets into a mappable network structure that allows Commerce City to assess potential expansion paths, understand order-of-magnitude cost and resource implications, and evaluate how different approaches may influence long-term network capacity, resilience, and service capability. This level of design supports informed decision-making related to capital planning, grant positioning, and interdepartmental coordination while preserving flexibility as priorities, funding, and implementation strategies evolve.

The conceptual network design developed by ENTRUST is based on information provided by the City, primarily related to the existing City fiber network and prioritized sites. The design is truly conceptual and is not a full engineering study, and it does not account for specifics such as aerial versus underground deployment, building entry locations, or precise fiber placement within the right-of-way. It is not a full engineering study and does not account for specifics such as aerial vs. underground deployment, building entry locations, which side of the street a particular fiber cable is located, etc. The conceptual design is intended to provide a roadmap for the City, and specific projects undertaken should first complete a full engineering process that will conduct field surveys to verify existing data and assumptions to move the Conceptual Design to a High-Level Design (30% HLD), to a Low-Level Design (60% LLD), and ultimately to a Final Design.

The City Conceptual Design was created using the following factors to determine the route and phasing:

- Existing City fiber network
- City prioritized sites, facilities, and locations
- Network resilience and redundancy
- Fiscal sustainability and strategic investment

The conceptual plan is grounded in a fiscally responsible approach that balances performance, scalability, and cost. While expanding the City's fiber network is a strategic investment in long-term connectivity and service delivery, the plan recognizes the importance of aligning with available budgets and funding opportunities. Deployment strategies prioritize cost-effective routes, leverage existing infrastructure, and phase implementation to spread costs over time. This ensures that the network grows in a sustainable, financially prudent manner while still meeting the City's operational and community goals.

The Conceptual Design can be implemented in a phased approach in order to recognize resource constraints, prioritize critical City facilities, provide flexibility relative to grant availability, and to reflect the City's priorities for growth and connectivity. The phases outlined below can be further broken down into sub-phases or built incrementally and opportunistically through effective Capital Improvement Program (CIP) and utility coordination.

7.1 Background

Commerce City currently manages over 30 miles of conduit containing fiber optic cable, primarily constructed between 2007 and 2009 and overseen by the Information Technology and Public Works departments. Existing City fiber optic cable and the proposed Conceptual Design is shown in Figure 27.

This existing fiber includes a mix of 24- and 96-strand cables, with key connections between City facilities and joint-use segments shared with regional partners such as the Adams County Communication Center Authority (ADAMCO911) and Adams County.

The Conceptual Design only includes fiber assets that have been confirmed and verified by the City. To fully understand what infrastructure is available for future communications needs, a comprehensive audit of all publicly owned / operated communications assets and facilities is recommended. This audit would help identify any undocumented or underutilized assets and ensure the City has a complete picture of its network capabilities. Depending on the results, minor adjustments to the proposed Conceptual Design may be necessary to take advantage of additional resources, reduce the anticipated costs, or to address gaps in connectivity.

Leveraging the existing fiber network reduces deployment costs and accelerates implementation timelines. Understanding the current network layout and use parameters allowed by various agreements ensures that new investments build upon what is already in place.[74]

[74] The City should review the allowable parameters for usage of certain portions of existing City Fiber plant which is a part to an Intergovernmental Agreement (IGA) with the Colorado Department of Transportation (DOT) (2009), and as part of a separate Memorandum of Understanding (MOU) with Adams County and ADCOM 911 (2008).

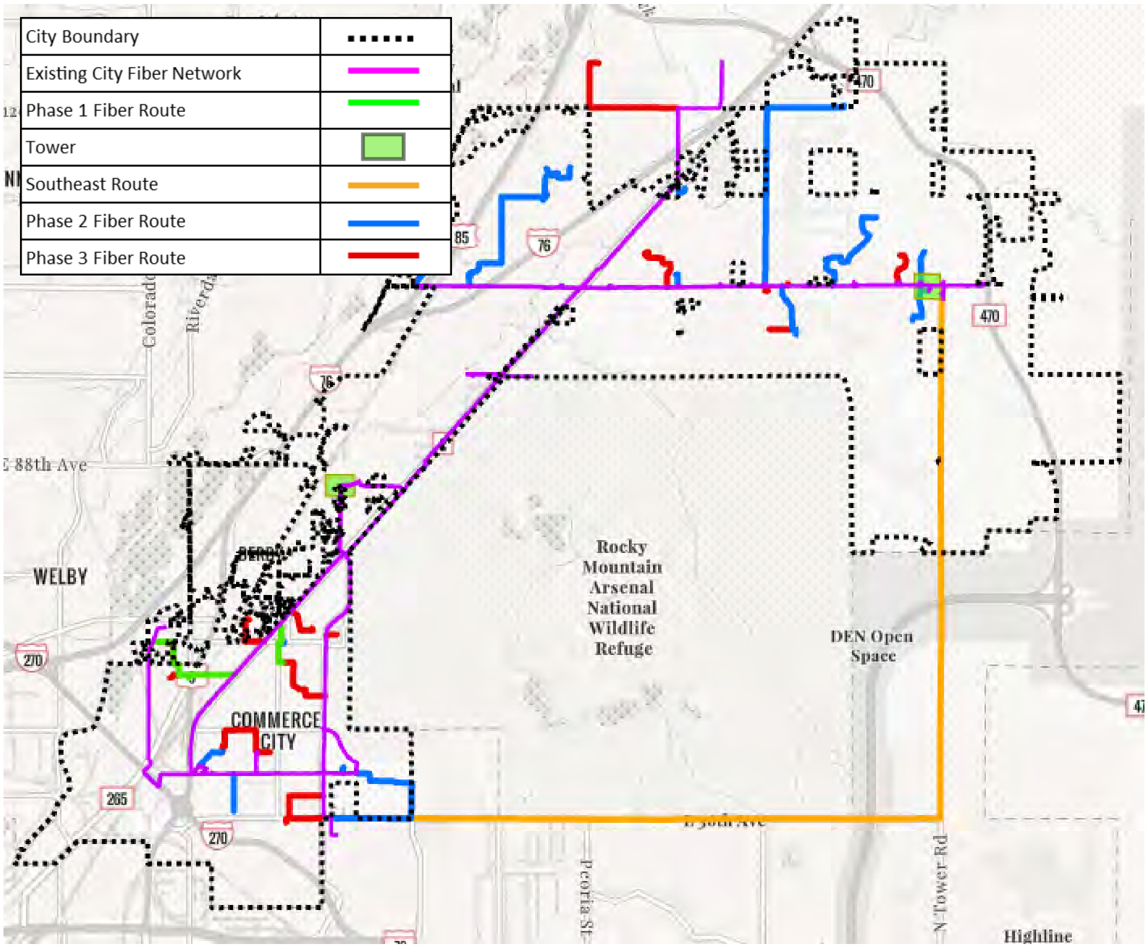

Figure 27. Conceptual Design

7.2 City Prioritized Sites, Facilities, and Locations

Commerce City staff provided a list of 92 prioritized sites, facilities, and locations to guide network expansion. All were assigned a priority level from 1 to 3, reflecting their relative importance to City operations and community services.

Priority 1 sites are the most essential city facilities, such as police headquarters, main fire stations, and key network towers, where connectivity is critical for public safety and core operations. Many of these sites are already on the network but require path redundancy due to their high operational impact.

Priority 2 includes facilities that, while not core-critical, provide strong public service value and have direct City involvement, such as additional fire stations, libraries, and schools with school resource officers (SROs). Priority 3 encompasses remaining community and strategic sites like parks, economic development zones, and schools without SROs. These locations offer long-term value and can be integrated opportunistically, supported by inter-agency or public-private partnerships and Internet Service Provider (ISP) engagement.

Warning towers were integrated into the fiber network when feasible; rather than planning dedicated fiber routes to each tower, the City requested that towers be connected when existing or proposed fiber spans passed within a reasonable proximity.

A breakdown of sites by category and priority is provided in Table 12.

Table 12. Number of Sites by Category and Priority

Category	Priority 1	Priority 2	Priority 3	Total
City Buildings	9	4		**13**
City Facilities	4	4		**8**
Fire Station		10		**10**
School		9	27	**36**
Close Partner		1	1	**2**
Emergency Health Facilities			6	**6**
Economic Development Partner		1	1	**1**
Rec Center			2	**2**
Warning Towers	3	7	3	**13**
Total	**16**	**36**	**40**	**92**

The prioritization framework is used to guide the phasing of the network expansion plan. Sites with higher priority levels (if not already connected to the City's fiber network) were addressed earlier in the implementation process to ensure that critical services and infrastructure are supported first, with path redundant routes. Lower-priority sites were incorporated in later phases, allowing the City to align deployment with operational needs and available resources. This phased approach ensures that the network delivers the greatest value and impact from the outset.

The current City fiber network consists of several radial segments and a single north-south connection along Highway 2, creating single points of failure that reduce reliability and operational resilience. To address this, the conceptual plan emphasizes a transition to a looped network architecture that provides redundant paths between key sites. This design approach ensures that if one segment is disrupted – due to construction, maintenance, or unforeseen events – critical services can remain connected through alternate routes. Enhancing network resilience in this way is essential to supporting public safety, city operations, and other mission critical infrastructure.

7.3 Phased Implementation Plan

Phase 1: Critical Facilities

Phase 1 includes the installation of approximately 9,800 feet of new fiber backbone to connect critical City facilities currently lacking City fiber, two towers to connect northeast and southwest portions of the City, and an optional Phase 1B Southeast Loop of 67,300 feet to establish a new Southeast Loop if the City prefers a wireline redundancy path.

Ten of the 13 Priority 1 sites are already connected to the City's fiber network; however, the lack of network redundancy leaves these critical sites vulnerable to interruptions and outages. The first phase of the network design focuses on creating a redundant loop architecture as well as connecting the three remaining high priority sites and improving overall network reliability.

While new fiber deployments in the southwest portion of the City do not directly connect any new buildings, it significantly enhances the reliability of fiber service for three key City sites: the South Platte Crossing Building, the Paradise Island Pool at Pioneer Park, and the Eagle Pointe Recreation Center. This route was also strategically identified as it can later accommodate unconnected Priority 2 and 3 sites.

There are also new fiber routes proposed along Monaco Street from Highway 2 to East 70th Avenue, which would connect two currently unserved sites – the South Adams County Water and Sanitation District (SACWSD) and the Small Business Resource Center.

Phase 1 also includes a strategic wireless link to ensure network redundancy across the entire City geography (northeast to southwest). A point-to-point wireless connection is planned from the intersection of Highways 470 and 44 on the northeast side of the city to the Municipal Services Center (MSC) in the central area, shown in the green polygons in Figure 28.

In addition to providing critical network redundancy, the new wireless towers offer added long-term value to the City. These structures can be leveraged for future municipal wireless infrastructure needs, such as smart city applications or public safety radio communications. Furthermore, the City may choose to lease space on the towers to commercial cellular carriers to generate revenue and/or improve private wireless service for residents and businesses. Additional details concerning further development of a wireless network development plan will be discussed in a subsequent Technical Memorandum.

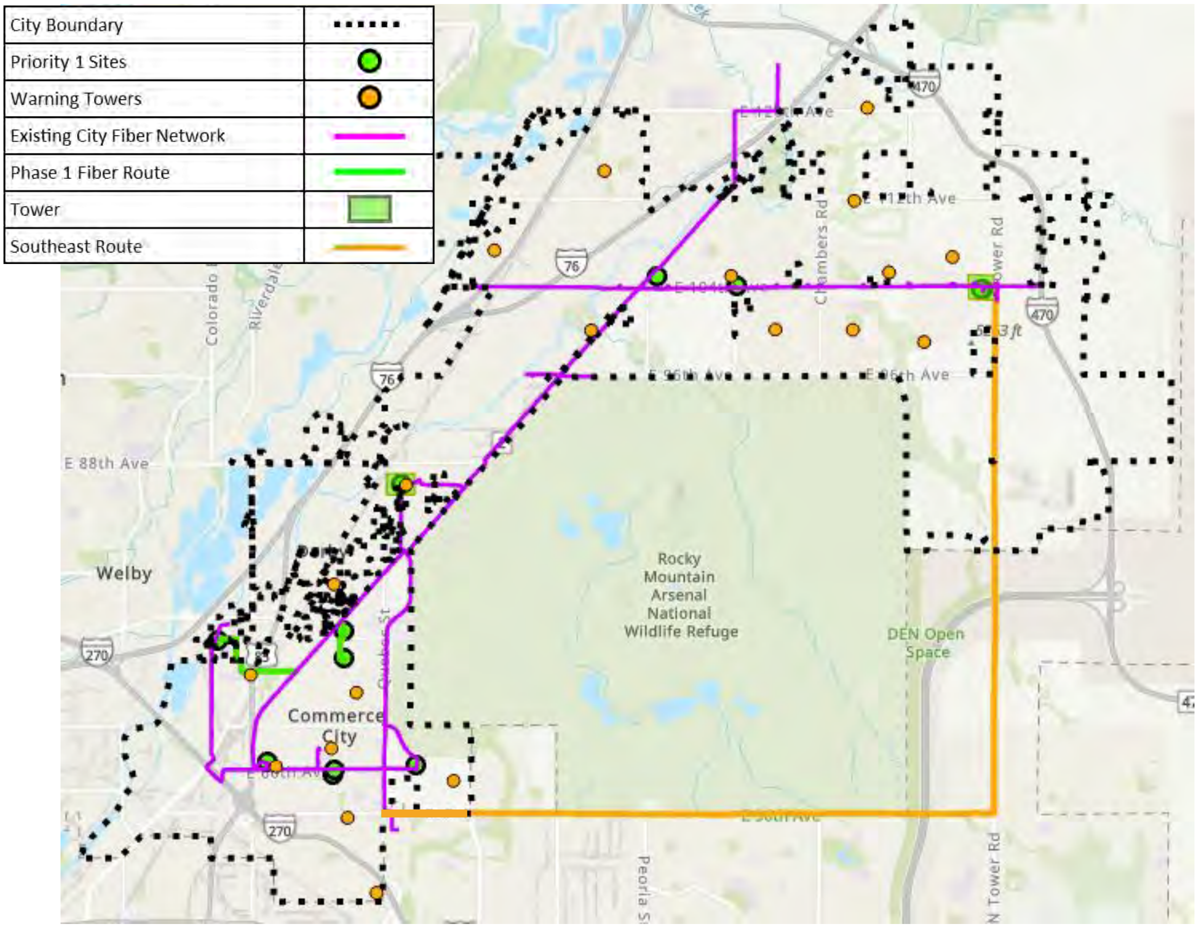

Figure 28. Phase 1 Conceptual Design

Because the City is geographically separated by the Rocky Mountain Arsenal National Wildlife Refuge, a wireless backhaul link was selected as a cost-effective and expedient alternative to a wireline deployment, identified as the Southeast Loop (in orange) in Figure 28, which circumnavigates the Arsenal on the east and southern border. That fiber route, estimated at a construction cost of over $8.7 million, could be funded and deployed over time through partnerships with public agencies and even ISPs. The wireless solution – utilizing two towers at an estimated cost of $815,000 – offers a more economical option while still delivering critical redundancy for police stations and other prioritized sites along Highway 44.

Both the wireless and fiber options serve the same purpose: improving reliability. The wireless link is faster and cheaper to deploy, with an estimated cost of around $815,000. The fiber route offers better long-term performance and reliability but comes with a higher price tag. To help offset the cost, the City could explore partnerships with other public agencies or private companies that may benefit from shared access to the fiber. This approach could reduce the City's financial burden while expanding connectivity for other stakeholders.

Sites that are either currently connected to the fiber network or will be connected to the fiber network with the proposed Phase 1 build are summarized in Table 13.

Table 13. Phase 1 Sites

Site	Currently Connected to City Fiber
Civic Center	Yes
MSC	Yes
Police Department	Yes
SACWSD	No
Police Substation	Yes
South Platte Crossing Building (County & City Services Co-Located)	Yes
Police Substation	Yes
Paradice Island Pool	Yes
Small Business Resource Center	No
Eagle Pointe Recreation Center	Yes
Police Substation	Yes
Paradice Island Pool at Pioneer Park	Yes
Warning Towers 1103, 2103, 2101	No
Police Substation (under development)	No

Phase 2: Priority Sites

There are a total of 29 sites and seven warning towers connected in Phase 2 of the conceptual plan, as shown in Figure 29totaling 65,300 linear feet of new fiber deployment. Because of the dispersed nature of the prioritized sites, most are connected with non-redundant spurs from the existing fiber backbone or the Phase 1 fiber build. An exception is Victory Crossing, where City staff emphasized the strategic importance of having redundant connectivity for future development.

In Phase 2 of the conceptual design, schools with assigned School Resource Officers (SROs) were prioritized for network connectivity due to law enforcement presence and enhanced public safety efforts. Facilities such as Belle Creek Charter and Stuart Middle School, which have dedicated SROs, as well as schools that receive alternating SRO support, such as Landmark Academy, Second Creek Elementary, and others, were connected as part of the Phase 2 design.

Another major focus of the Phase 2 design was the connection of fire stations across the City. A total of ten stations were brought onto the network, requiring long spans of fiber due to their distributed locations. To manage this scale more effectively, the design can be broken into more practical segments by prioritizing key facilities based on operational importance and proximity to existing or proposed fiber routes. Sites served by the Phase 2 fiber build are in

Table 14.

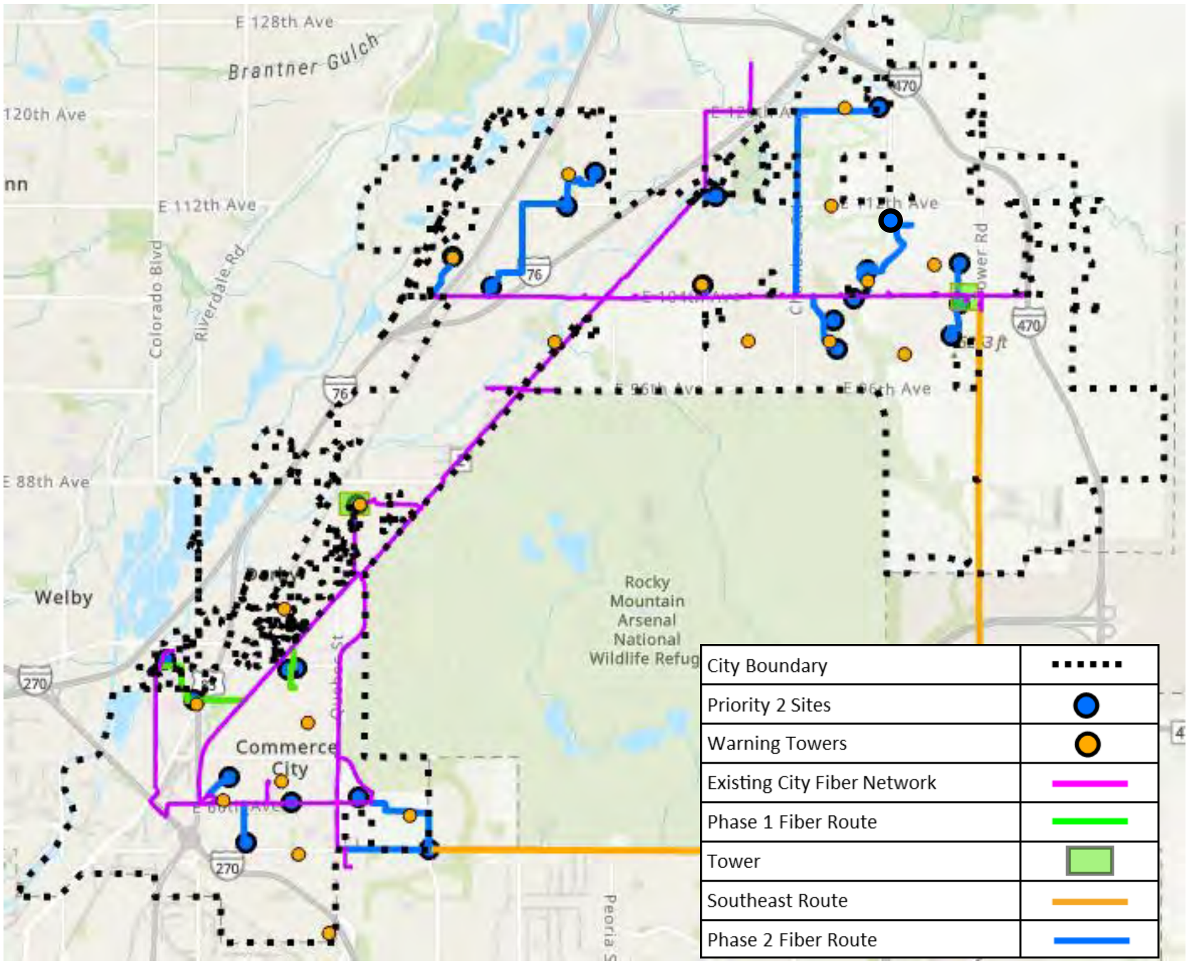

Figure 29. Phase 2 Conceptual Design

Table 14. Phase 2 Sites

Site
Conter Building
Bison Ridge Rec
So. Adams Fire HQ
Adams Service Center
Conter Community Center
Fairfax Park - Maintenance Building
Pioneer Park
Commerce City Housing Authority
Second Creek Elementary
Stuart Middle School
Warning Towers 4201, 4202, 4205, 3203, 3202, 1196, 4207
Brighton Station 53
SACFFA Station 21
Northglenn Ambulance Station 23
Fire Stations 22, 24, 25, 26, 27, 28
Fire Headquarters
Rocky Mountain Lutheran High School
Anythink Library
Reunion Elementary School
Southlawn Elementary School
Thimmig Elementary School
Belle Creek Charter School
Landmark Academy
STEAD School
Victory Crossing (future devo near Civic Center)

Phase 3: Community Anchors

The final phase of the project was designed to extend connectivity to key community anchor institutions and sites - non-SRO schools, six emergency health centers, and two recreation centers. Building off the existing City fiber backbone and segments constructed during Phases 1 and 2, this phase would add approximately 38,000 feet to the design. The Phase 3 Conceptual Design is shown in Figure 30. Sites served by the Phase 3 fiber build are in Table 15.

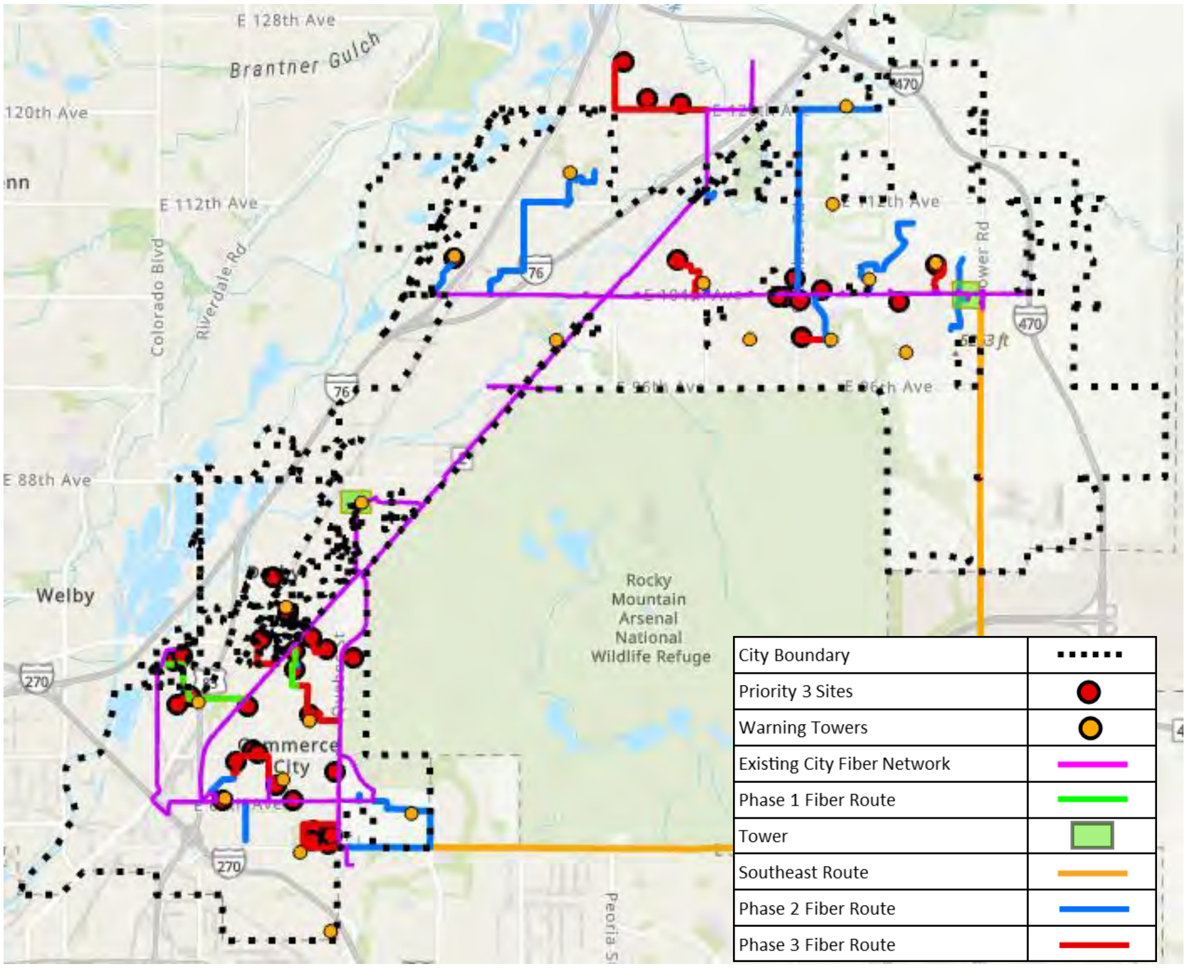

Figure 30. Phase 3 Conceptual Design

Table 15. Phase 3 Sites

Site
Rose Hill Elementary
Monaco Elementary
Dupont Elementary
Kemp Elementary
Alsup Elementary
Central Elementary
Hanson Elementary
Turnberry Elementary
Platte Valley Medical Plaza at Reunion
Community Reach Center
UCHealth Emergency Room
Salud Family Health Centers
Adams Community Mental Health
Kids First Health Care

Warning Towers 1104, 1102, 4203
Sunshine Center Head Start
Little Giants Learning Center
The Children's Courtyard of Reunion
Goddard School of Reunion
Front Range Early Learning Center
Primrose School at Reunion
The Learning Experience at Reunion
Henderson Elementary School
Mildred L. Sanville Preschool
Prairie View Middle
Victory Prep Academy
Community Leadership Academy
Lester Arnold High School
Adams City High School
Adams City Middle School
Educational Support Services Building - Adams 14
STARS Early Learning Center
Kearney Middle School
Prairie View High School
Mile High Greyhound Park
Downtown Derby District
Belle Creek Family Center
Reunion Recreation Center

7.4 Construction Cost Estimates

Cost estimates for the Conceptual Design are only estimates based on existing market conditions and can be further refined upon completing design engineering and putting the project out for a public bid. Construction estimates for conceptual designs need to make assumptions about construction methods (aerial vs. underground), which is not typically determined until the design engineering process. For purposes of this analysis, ENTRUST assumed all fiber construction would be underground, which is the more conservative (expensive) assumption.

The design engineering and field surveying process for future phases would verify and record all existing assets and could uncover additional assets that would reduce the need for some of the new construction, or identify cost-effective strategies, thereby lowering the total overall construction costs.

Construction costs can be even further reduced through effective utility coordination, implementing a dig once/joint trench program, and aligning broadband expansion projects with other major CIP projects, particularly those with excavation in the City right-of-way (ROW). The labor required for underground excavation can account for 40-60% of total construction costs. When work is coordinated between utilities and public agencies, all parties can expand their fiber footprint at a fraction of the cost by taking advantage of synergies with other projects.

The total estimated construction cost by phase is shown in Table 16.

Table 16. Estimated Construction Costs by Phase

Component	Quantity	Units	Unit Cost	Total Cost
Phase 1 Fiber	9,600	LF	$130	$1,248,000
Phase 1 Wireless Point to Point	2	towers	$407,500	$815,000
Phase 1B Southeast Loop Option	67,300	LF	$130	$8,749,000
Phase 2 Fiber	65,300	LF	$130	$8,489,000
Phase 3 Fiber	38,000	LF	$130	$4,940,000
TOTAL	**180,200**	**LF**		**$24,241,000**

7.5 Summary of Findings

Building a redundant and resilient core network is essential for public safety and City operations

The highest priority in Commerce City's broadband plan is connecting and reinforcing critical facilities such as police headquarters, primary fire stations, and other mission critical sites. Ensuring these sites have redundant fiber connections reduces the risk of outages and preserves essential services during emergencies. This phased approach begins with a feasible first-phase investment while laying the foundation for more advanced connectivity in later stages. A resilient core network also serves as the backbone for all subsequent broadband expansion efforts.

Expanding connectivity to key community assets strengthens public service delivery and resident engagement

Tier 2 priorities emphasize facilities that are vital to community life but not necessarily core emergency operations. These include, libraries, recreation centers, maintenance facilities, and schools with School Resource Officers. Extending the network to these sites improves operational efficiency, supports educational initiatives, and expands access to digital resources for residents. By including nearby warning towers and other safety infrastructure in this phase, the City increases the reliability of emergency communications while making efficient use of planned routes. These investments also create opportunities for collaborative use of the network by multiple public agencies.

Strategic long-term planning positions the City for economic development and private sector partnerships

Tier 3 sites, which include economic development zones, additional schools, and community recreation facilities, offer significant long-term benefits for Commerce City's growth and competitiveness. This strategic integration of economic and community goals ensures that the broadband network becomes a key driver of future development.

8. Technical Solutions & Financial Analysis

This section analyzes how the appropriate technical solution fills the needs of the City by considering the different business model approaches to operate such a fiber network as it evaluates the capital and operating costs of the network as proposed in the conceptual design.

The financial analysis is an important and necessary element of broadband master plans. Conceptual Designs for a public network already can be justified on the merits of public benefit through enhanced City communications as it serves the public, controlling and managing traffic, deploying smart city devices and applications, and ensuring public safety and emergency response. However, a business model and financial analysis goes a step further to determine whether that potential new public infrastructure can be leveraged to provide additional community benefits through retail internet services to residents and businesses, and to understand the viability and sustainability of such an enterprise broadband network. This section describes the approach, findings, and implications for building and operating a broadband fiber network in Commerce City

8.1 Estimated Construction Costs - CAPEX

ENTRUST developed a conceptual network design based on a list of 92 prioritized sites, facilities, and locations provided by City staff. The 3-phase plan organized network expansion into stages based on priority and is shown in Figure *31*.

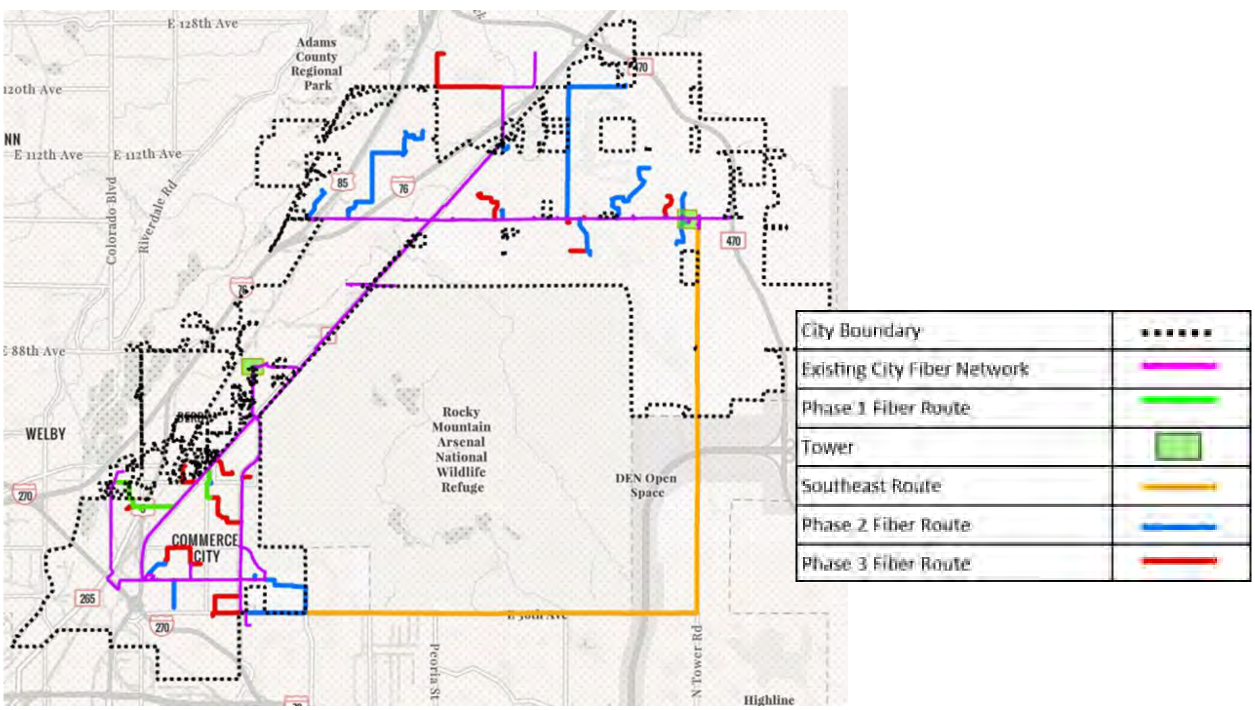

Figure 31. Network Conceptual Design

The conceptual design focuses on a backbone network that connects key corridors and priority locations. A summary of the network construction costs by phase is in Table 17. The backbone totals 182,200 linear feet, with construction costs estimated at $130 per linear foot (assuming all underground construction). The combined estimated backbone construction cost for all phases, including the Phase 1B option, is approximately $23,426,000. Value engineering, done during the design engineering work, could substantially reduce this total estimated cost by identifying optimum routing, additional existing assets, and segments where cable could be placed on existing utility poles (which can run between $60-75/LF, instead of $130/LF for underground).

These conceptual costs provide a planning-level estimate of the investment required to build the backbone network and serve as the basis for the subsequent financial analysis of potential broadband business models and partnership structures in Commerce City.

Table 17 . Conceptual Design Backbone Network Estimated Construction Costs[75]

Phase	Quantity	Units	Unit Cost	Total Cost
Phase 1	9,600	LF	$130	$1,248,000
Phase 1B Southeast Loop Option	67,300	LF	$130	$8,749,000
Phase 2	65,300	LF	$130	$8,489,000
Phase 3	38,000	LF	$130	$4,940,000
TOTAL	**180,200**	**LF**		**$23,426,000**

8.2 Financial Analysis

Estimated Operational Revenues, Expenses & Network Launch CAPEX

The financial analysis evaluates the estimated operational revenues and expenses, as well as the startup capital required, if the City were to monetize its publicly owned fiber network by selling retail broadband services to residents and businesses through a new, stand-alone broadband enterprise. This assessment is intended to give the City a realistic understanding of the financial implications of operating a broadband utility and to illustrate how these findings inform the business model options. The analysis draws from a passings evaluation that uses a 175-foot buffer on either side of the existing and proposed backbone identified in the Conceptual Network Design – a typical buffer that encompasses addresses on the street with existing or future fiber (which can be traversed easily and economically with a standard service drop from the main fiber line). The buffer analysis identified 3,827 serviceable addresses across existing and planned routes.

[75] Does not include the estimated $815,000 for Phase 1 Wireless Point to Point Component of Conceptual Design discussed in ENTRUST's Conceptual Design Draft Technical Memorandum, September 2, 2025.

Table 18. Address Passings (wihin 175 feet) by Phase

Phase	Passings
Existing Fiber	1,563
Phase 1 Fiber	203
Phase 1B Southeast Loop Option	48
Phase 2 Fiber	1,012
Phase 3 Fiber	1,001
TOTAL	**3,827**

New stand-alone broadband enterprises require significant direct costs to deliver services, as well as a minimum level of staffing and industry expertise. Some municipalities may already have some of the support staff and infrastructure in place that can be leveraged for a broadband enterprise, such as billing support and software, fleet vehicles and maintenance, and even field staff. However, this is not the case in Commerce City.

Commerce City may currently have some capabilities to assume control of a stand-alone enterprise; however, examining the anticipated revenues and expenses of such an endeavor can give the City a realistic understanding of the risks and investment needed to transform a public fiber network into a functioning, competitive retail broadband enterprise.

This is not a business plan or feasibility study and is not intended as a definitive financial statement or pro forma. Rather, it is intended as a tool to ensure the City has an overview of the potential revenues and expenses and the impacts of different business model approaches.

Estimated OPEX

The model assumes retail subscriber levels stabilize after 3 years, with 30%[76] of all passings subscribing for retail internet service. That translates to 1,148 customers and results in approximately $760,000 in annual gross revenues based on a monthly rate of $60 for a symmetrical gigabit service.

[76] 30% is an industry standard take rate for markets with two existing incumbent providers, such as Commerce City.

Average Annual Revenue Estimate		
Service Revenues (MRC)	$	757,746
TOTAL	**$**	**757,746**

Average Annual Expenses Estimate		
Direct Cost of Services		
Data Transport	$	60,000
Data Center	$	12,000
Vehicle Maintenance	$	29,250
Network Maintenance	$	507,900
Utilities	$	10,000
Field Tools	$	27,667
Network Software	$	14,235
Revenue Share	$	-
SUBTOTAL	**$**	**661,051**
Administrative Expenses		
Staffing	$	1,147,201
Legal Fees	$	2,000
Marketing	$	15,155
Reporting	$	12,000
Travel & Training	$	9,000
Office Supplies	$	15,223
General Overhead	$	38,058
Bad Debt	$	7,612
SUBTOTAL	**$**	**1,246,248**
TOTAL EXPENSES	**$**	**1,907,300**

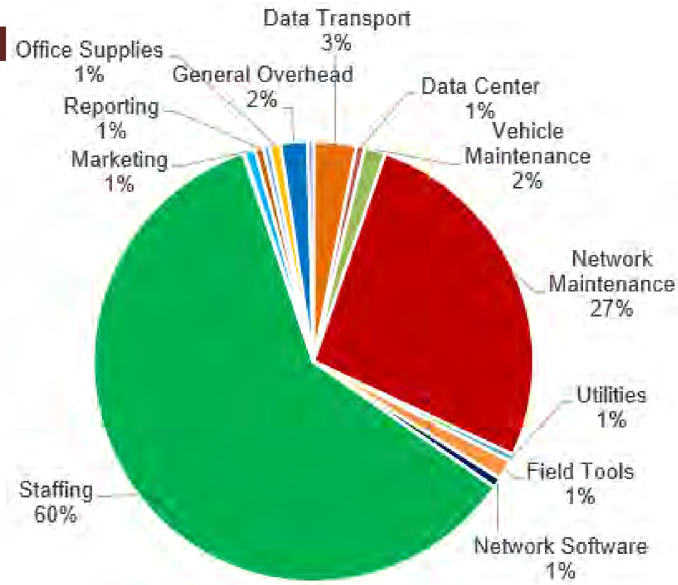

Figure 32 Average Annual Revenue and Operating Expenses Estimate

The estimated earnings before interest, taxes, depreciation, and amortization (EBITDA) are estimated to result in an annual net loss of $1,139,000, which means the network is not viable as a stand-alone enterprise. This is primarily due to the low-density customer base in and around the proposed network, and the sunk costs for minimum new staffing, operational systems, and maintenance functions required to support a municipal retail broadband utility, all of which contribute to the annual deficit.

Start-Up CAPEX

In addition to the $23 million required to construct all three phases of the conceptual network, successful start-up and launch is estimated to require more than $3.2 million in additional capital expenses (CAPEX) to connect 1,148 customers (service drops, equipment, etc.), as shown in Figure 33. The network launch CAPEX required illustrates the need for additional investment in the City's network in order to transform it into a functional, sustainable retail subscriber network. However, even with external funding, the annual operating loss would continue, which reinforces the limited financial feasibility of a new, stand-alone municipal retail model at this time.

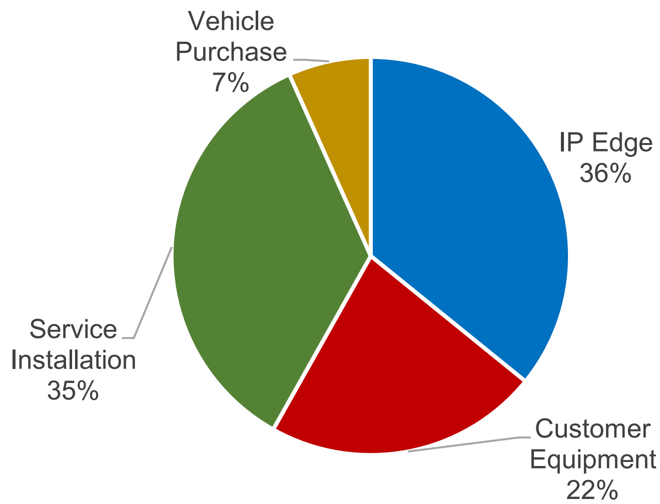

Figure 33 Network Launch CAPEX Estimate $3.2M

Mitigating OPEX & Start-Up

Soliciting a public-private partnership (P3) with a qualified ISP is one approach that can significantly reduce annual expenses by taking advantage of existing ISP operations, staffing, and experience. It is difficult to gauge the level of cost savings that individual ISPs can realize without access to proprietary financial data, but some general assumptions can be made.

ISPs typically already have many of the support staff in place for other neighboring markets (billing, network operations and engineering, etc.), and can share these costs across multiple markets, thus eliminating the need for new hires. An ISP that is already working within the region may be able to reduce the annual staffing costs significantly. ISPs have standard operating procedures and processes and often have many of the technical field staff already in place, which can significantly reduce the costs of ongoing network maintenance by over 50%. Additionally, some of the bigger ISPs often have proprietary operational approaches and favored equipment and material pricing from vendors that allow them to significantly reduce network launch CAPEX. There are many opportunities for additional cost savings, and many of these hinge on the individual ISP and their unique existing markets, equipment, staff, and resources.

8.3 Business & Operational Models

Cities are realizing the importance of next-generation broadband services to support the future of their communities. Evidence demonstrates that broadband services have a net positive economic and social impact to communities by enhancing competitiveness, workforce development, educational capabilities, municipal operations, and smart city deployment.

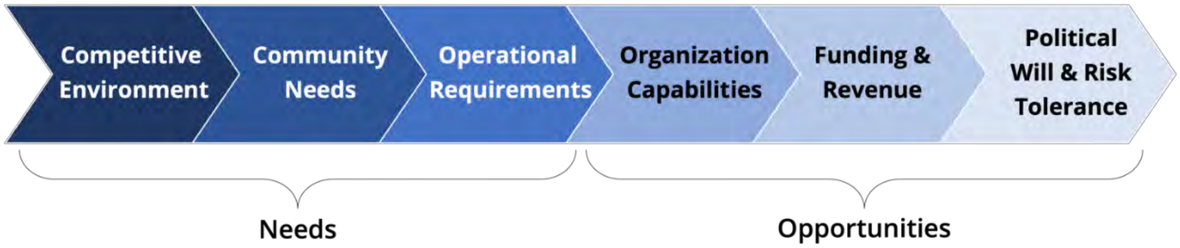

Figure 34 - Factors to Consider when Choosing a Broadband Business Model

To determine which business model for municipal broadband is best, local governments should understand various factors, such as: community needs, competitive market factors that define infrastructure options, and organizational and operational capabilities of the local government itself. The various business models involve different levels of investment and control that come with varying risks and rewards. Commerce City has numerous options – from a laissez-faire, public policy-only approach all the way across the spectrum to a full retail internet business.

The key factors that define a public-private partnership, as opposed to simply a customer-vendor relationship, is that: (a) all parties contribute, (b) each parties' benefits are based on their contributions, and (c) one partner does not pay another; there are few or limited transactions between partners.

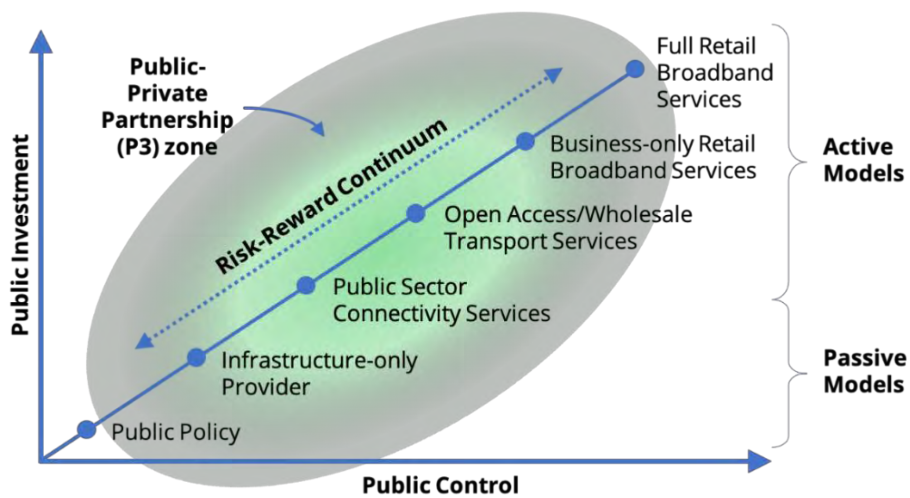

Figure 35 - Broadband Business Models

Public Policy Only

The municipality utilizes its public policy tools to influence how broadband services are likely to develop in its community. Public policies are shaped to streamline the processes of designing, constructing, and managing broadband infrastructure in a local government's jurisdiction. Focus areas include right-of-way access, permitting processes and costs, construction practices and placement methods, franchise agreements, and utility fee assessments. Examples of broadband policies and standards include joint trenching and "dig once" policies, utility relocations, road moratoriums, and funding mechanisms for design, labor, and materials. This option is not considered a true business model but does impact the local broadband environment and is therefore included as one option.

The key to successful policy development and implementation is inter-departmental coordination and communicating the shortcomings in current practices and policies. With a better understanding of interdependent responsibilities, policies can be improved. In addition, changes often come with an associated cost, so municipality will often need to establish a fund to assist in the early adoption of certain policies.

Public Services Provider

Public services providers utilize publicly-owned fiber and broadband resources to interconnect multiple public organizations with fiber or wireless connectivity. These organizations are generally limited to the community anchors within their jurisdiction, including local governments, school districts, higher educational organizations, public safety organizations, utilities, and healthcare providers. The majority of these anchors require substantial connectivity and often, the local government's network can provide higher capacity at lower costs than these organizations are able to obtain in the commercial market.

Infrastructure Provider

Cities that provide conduit and dark fiber services to local organizations are generally considered infrastructure providers. They lease these assets to community organizations, businesses, and broadband providers. These organizations use municipal fiber to connect to one another and to data centers to reach the Internet, cloud services, and other content networks. Many municipal providers who have deployed these services began by building their own fiber networks to serve purely municipal functions. As their networks grew, they realized that these networks could provide access to local organizations needing fiber connectivity.

Dark fiber is the core product of most infrastructure providers and is generally utilized by businesses and community anchor organizations in order to reduce their telecommunication expenses and achieve higher bandwidth speeds. Typically dark fiber strands are leased using a simple mileage-based price calculation to the end user. However, customers may require new construction to reach their facilities, resulting in construction costs to be incurred by the municipality and which will be charged back to customers to allow the municipality to recoup its investment.

Open-Access Provider

Local governments that adopt the open-access model generally own substantial fiber-optic networks in their communities. Open-access allows these local governments to "light" the fiber and equip the network with the electronics necessary to establish a transport circuit to interconnect service providers with the local network.

The concept of open access enables competition among service providers across a network that is owned by the local government. The municipality remains neutral and non-discriminatory and is open equally to any providers that seek to deliver services over the network. Service providers lease access to the network based on the amount of bandwidth required by the end customer and an established standard rate structure and terms of service. Open-access networks generally charge wholesale rates to retail broadband providers. They publish rates for competitive service providers, charging a monthly recurring fee based on bandwidth of the service utilized or a flat fixed fee per month. Services offered may include Internet, telephone, data connectivity (transport), and dark fiber.

Municipal Retail Provider – Business Only

A common goal for municipalities that deploy broadband networks is to support local economic development needs. Local governments equip their business and industrial districts with fiber infrastructure through which they can provide cost effective, high-speed Internet and other data services to local customers.

Municipal business providers offer competitively priced Internet and communication services that are competitive in the small and medium business market against other provider offerings. They compete on both price and quality, generally focused on the following value proposition, all at a lower monthly cost:

- Higher bandwidth, scalable to Gigabit speeds
- Symmetrical service, the same upload and download
- Higher quality fiber connections with less downtime and a stronger service level agreement
- Responsive local customer service

Municipal Retail Provider – Full Residential & Business Services

Municipalities that provide end user services to residential and business customers are considered retail service providers. Most commonly, local governments offer triple-play services consisting of phone, television, and Internet services, essentially becoming an equal competitor to incumbent cable and broadband providers. As a retail provider, the organization is responsible for a significant number of operational functions, including management of retail services, network operations, billing, provisioning, network construction, and general management.

Public-Private Partnerships

Public-private partnerships (P3s) are an emerging business model that provides an innovative solution to an ongoing municipal broadband issue: how does a local government invest in municipal broadband without operating a broadband network? Generally, P3s create a cooperative platform for a local government and one or more private organizations to plan, fund, build, and maintain a broadband network within the municipality's jurisdiction. To make a P3 successful, each organization should align on negotiable agreements, which can include:

- Who has rights to access the network – is it exclusive or non-exclusive?
- What are the public and private partners' goals and how are they incentivized?
- What roles and responsibilities does each partner have?
- What assets are financed through the public?
- What revenue model is used to recoup investment?
- What requirements must the private partner meet, in terms of service availability, speed, price, build locations, and performance schedules?
- How will the partners determine future buildouts and who pays for them?
- What happens if the private assets are sold or acquired?

The business models in the middle of the continuum (Figure *35*) accommodate, but do not necessitate, a P3. The essence of such a partnership is that for-profit and for entities collaborate to achieve complementary, if not common, objectives. The bottom line for private entities is profit, while it is quality of place for public agencies. In concept, private entities can flexibly mobilize resources where there is money to be made, and public agencies can redistribute resources to ensure no one is left out. A P3 can help realize both these outcomes: public involvement reduces risk to private investment, and private involvement enables faster and more extensive execution. Generally, partnerships decrease risks while enabling larger or new forms of rewards.

8.4 Strategic Direction

When evaluated against Commerce City's density, customer base, staffing capacity, financial modeling, and the current maturity of the City's fiber network, only a limited set of business models represent practical, sustainable paths forward. The analysis shows that three approaches best align with the City's goals, existing assets, and operational realities:

Public Policy Leadership

This strengthens the local broadband environment by reducing deployment barriers and improving coordination across permitting, construction practices, and right-of-way management. This approach enables the City to influence network expansion without taking on operational risk and should form the foundation of the City's broadband strategy. Public policy leadership also provides a structured way for the City to shape how, where, and when broadband infrastructure is deployed. By standardizing trenching and restoration requirements, coordinating utility work through shared schedules, and streamlining review processes, the City can lower costs for providers and shorten construction timelines. These actions directly impact broadband availability by making it easier for private ISPs to build in priority corridors, encouraging investment in underserved areas, and improving the long-term quality and consistency of communications infrastructure installed in the rights-of-way.

Public Services Provider

This leverages existing and planned City-owned fiber to interconnect municipal buildings, public safety facilities, and community anchor institutions. This model improves operational reliability, reduces long-term telecommunications costs, and creates a scalable technical foundation for future network expansion. Expanding City-owned connectivity between critical facilities also supports improved service delivery, enhances interdepartmental communication, and provides the resilient backbone necessary for future smart city and public safety applications. As additional sites are connected, the City can incrementally build the network capacity needed for long-term broadband goals without assuming the obligations of a full retail enterprise.

Public–Private Partnership

The P3 approach could be utilized for both a near-term focus on wireless technology and a long-term opportunity for wireline partnerships. Wireless partners, including tower companies, mobile carriers seeking densification, and fixed wireless ISPs, can immediately leverage City assets such as rooftops, towers, poles, and fiber-fed facilities to expand coverage without requiring a full distribution fiber network. In addition, these wireless partnerships support the City's short-term redundancy and resiliency goals by enabling secondary paths and backup connectivity for priority sites as mentioned in previous Technical Memos.[77]

A wireline retail P3 would require significant new capital investment and is not currently supported by the City's network maturity or density profile. This distinction aligns with the City's earlier Wireless Technologies and Options memo, which identified wireless P3 models as the most realistic near-term opportunity.

Together, these three approaches represent the most strategic options available to Commerce City today. They allow the City to meaningfully shape broadband outcomes, improve connectivity for municipal and anchor facilities, and leverage public assets in a fiscally responsible manner—without taking on the operational and financial risk of launching a municipal retail broadband utility.

8.5 Summary of Findings

Public policy and public services provider business models could maximize the benefits of a public network.

By leveraging the City's authority to shape local policies, the City can influence how broadband services develop within the community. Implementing communications-friendly policies, such as streamlined permitting processes, standardized construction and microtrenching practices, and

[77] ENTRUST Solutions, "Wireless Network Conceptual Design" Technical Memorandum, October 30, 2025.

“dig once” initiatives can reduce deployment costs and accelerate infrastructure development – for both publicly-owned networks and privately-funded projects.

The Public Services Provider model does not require the high level of capital investment of a retail enterprise network but could allow the City to utilize its existing and proposed fiber assets to interconnect community anchor institutions, such as public safety agencies, healthcare facilities, and schools. This approach improves connectivity for critical services while laying the groundwork for future expansion without assuming the financial and operational risks of a full retail broadband enterprise. These two models establish the City as a proactive facilitator of broadband growth while maintaining fiscal responsibility and flexibility.

A stand-alone municipal retail broadband enterprise is not financially viable for Commerce City

The financial analysis shows that even with an industry-standard 30% take rate and competitive pricing, the existing and proposed conceptual fiber network would generate approximately $760,000 in annual revenue but still result in an annual operating loss of over $1.1 million. This is primarily due to the low-density customer base and high sunk costs associated with staffing and network maintenance. Additionally, the $3.2 million in start-up capital required for customer connections and equipment further highlights the financial risk of pursuing a stand-alone retail model, as the revenue model does not generate enough to service any debt.

Thus, a municipal retail broadband utility in Commerce City would require not only a significant up-front capital investment, but also a significant ongoing operational subsidy, and is not a sustainable or fiscally responsible option.

A Public Private Partnership could mitigate some of the high operational costs

While a stand-alone new broadband enterprise does not appear viable, bringing in a private internet services provider (ISP) partner may be a strategy to reduce some of the bigger operational cost drivers (staffing and ongoing maintenance). ISPs looking to enter new markets typically already have many of the necessary staff (billing, customer service, maintenance crews) that are shared across multiple markets, which may be enough to lower operational expenses (OPEX) below gross revenues. Leasing City conduit and fiber assets to a private ISP could also attract the private capital required to expand services to more residents and businesses in areas outside of the Conceptual Design.

9. Wireless Field Survey

ENTRUST conducted a wireless field survey in April 2025 to assess the mobile network performance of the big three mobile carriers: T-Mobile, AT&T, and Verizon. The survey focused on evaluating throughput and signal strength along major north-south and east-west roadways to understand the coverage and performance available to residents, businesses, and public safety personnel.[78] The purpose of the Wireless Field Survey was to assess general mobile network coverage and performance by measuring signal strength (Reference Signal Received Power or "RSRP") and throughput (download and upload speeds) along major roadways. This section describes our approach, findings, and implications from a broadband policy review perspective for the City.

9.1 Synopsis of Wireless Carrier Performance

Overall, wireless drive tests indicate that all three major mobile networks, AT&T, T-Mobile, and Verizon, provide extensive coverage in Commerce City, but performance varies in key areas such as speed and consistency as depicted in Table 1.

Table 19. Citywide Test Results

	AT&T	T-Mobile	Verizon
Signal			
5G	35.4%	43.1%	0.0%
4G	63.9%	43.1%	98.2%
NO DATA	0.7%	13.6%	1.8%
Signal Strength LTE			
Excellent	25.0%	39.0%	38.3%
Good	14.4%	19.3%	20.2%
Average	15.0%	12.6%	17.0%
Poor	45.7%	29.1%	24.5%
5G			
Excellent	42.7%	65.1%	NA
Good	35.5%	24.0%	NA
Average	21.8%	11.0%	NA
Poor	0.1%	0.0%	NA

[78] Network performance data was collected and analyzed using RantCell drive testing tools, a mobile-based network testing and monitoring solution designed for measuring signal strength, throughput, and other key performance metrics. https://rantcell.com

	AT&T	T-Mobile	Verizon
Download Speed			
100+ Mbps	18.2%	33.0%	16.8%
2 – 99.99 Mbps	75.8%	53.2%	75.2%
Less than 2 Mbps	6.0%	13.8%	8.0%
Average (Mbps)	53.3	95.5	50.5
Peak (Mbps)	498.7	728.6	363.0
Upload Speed			
20+ Mbps	19.7%	35.8%	21.5%
2- 19.99 Mbps	27.8%	15.8%	41.2%
Less than 2 Mbps	52.5%	48.3%	37.3%
Average (Mbps)	10.7	21.5	10.2
Peak (Mbps)	95.2	122.4	40.2

Survey results show AT&T, T-Mobile, and Verizon, exhibit a different balance of speed, performance, and reliability

AT&T offered adequate 5G availability, but performance was hindered by poor signal strength in many areas, and limited upload capacity, with over half of uploads falling below 2 Mbps and the highest share of weak signal readings.[79] T-Mobile delivered the fastest average and peak download and upload speeds across the test area, but also recorded the highest percentage of low-speed results and zones where no usable data could be collected, highlighting variability in network consistency. Verizon showed no measurable 5G during testing yet maintained a stable LTE experience with moderate speeds and relatively few extreme highs or lows. These results reflect distinct trade-offs: AT&T prioritized delivering high quality service in its available 5G coverage areas despite having moderate overall 5G reach, T-Mobile excelled in raw speed under optimal conditions, and Verizon delivered consistent LTE connectivity but with a higher number of low-speed download instances than AT&T.

AT&T: Moderate 5G Reach, and Mixed LTE Performance

AT&T offers moderate 5G availability across Commerce City, and its signal quality and upload performance lag behind its competitors. While the network delivers 5G coverage in a good portion of test locations, more than 21% of signal readings were average or poor(below -100 dBm), 81% of its download speed tests fell below 100Mbps, and more than 52% of upload samples fell below 2 Mbps, the highest among all carriers (and significantly higher than Verizon's 37.3%). This suggests that while users can often access a 5G signal, real-world

[79] 45.68% of all signal strength was <= -101dBm

performance may be limited by backhaul constraints or low-band deployment strategies that prioritize coverage over capacity. Users relying on LTE fallback may experience further slowdowns, particularly in areas with limited infrastructure.

What AT&T Users Experience

AT&T users in Commerce City often benefit from 5G availability, particularly in well-covered zones in the Core City. In these locations, everyday use, such as voice calls, messaging, and app browsing, generally performs reliably. However, in zones with weak signal or frequent handoffs to LTE, users may encounter slower data speeds, reduced video resolution, and longer load times, especially indoors or in obstructed environments. The transition between network types is especially noticeable in areas along Highway 2, particularly north of 96th Avenue, where LTE coverage remains, but performance limitations affect the overall user experience.

T-Mobile: Fastest Speeds in Commerce City, and highest variability in performance

T-Mobile delivers the fastest overall network performance in Commerce City, with the highest average and peak download speeds among all carriers. This advantage stems from T-Mobile's use of mid-band 5G spectrum (2.5 GHz), which supports faster data rates than AT&T's lower band 5G but offers less range and weaker penetration through buildings and terrain. As a result, T-Mobile users enjoy excellent performance in areas with strong 5G coverage but may encounter slower speeds and reduced signal quality when moving between towers, indoors, or in areas with physical obstructions. T-Mobile also recorded the highest percentage of download speeds under 2 Mbps (13.8%). It also returned the most test samples returning no usable data (13.6%). This figure was over eight times higher than Verizon's score (1.7%) and over 20 times higher than AT&T's (.68%), further magnifying its inconsistencies in performance in comparison. However, T-Mobile may be the best option for users who prioritize high-speed data for streaming, gaming, or downloading in well-covered zones, but a less reliable choice for those who need consistent performance across a broader range of environments.

What T-Mobile Users Experience

T-Mobile users in Commerce City may experience some of the fastest speeds available, especially when located in strong 5G coverage zones. Activities like video streaming, file downloads, and app updates can feel noticeably faster when conditions are optimal. However, performance varies more than with other carriers. In areas where signal quality drops—or where test results returned either poor speeds or no data at all—such as along numerous areas along Highway 2 , along 96th Avenue and around Quebec & 72nd Avenue, or during peak usage times—download speeds can slow significantly. This variability makes the user experience inconsistent, especially for tasks that depend on steady bandwidth like video conferencing, online gaming, or remote work. For users relying on T-Mobile's 5G Home Internet, this can translate to great speeds during off-peak hours but noticeable slowdowns when network congestion rises, making the service feel unreliable even if coverage appears available.

Verizon: Dependable LTE, but no 5G Presence

Verizon's use of a 4G core suggests a limitation from full 5G technology utilization. Despite deploying 5G-capable equipment, all recorded Verizon data samples were labeled as 4G, meaning the network is likely still operating on a 4G core for critical services. However, Verizon does offer steady LTE performance in Commerce City, with signal quality and speed that ranked consistently in the middle range across metrics—stronger than AT&T in some respects, but behind T-Mobile in peak performance. Verizon had 0% of samples registering 5G and more than 98% classified as 4G, confirming the absence of a measurable 5G user experience during testing.

Verizon users are limited to LTE speeds, which averaged 50.5 Mbps for downloads and 10.2 Mbps for uploads—slower than T-Mobile, but still suitable for most routine mobile needs. While the network lacked extremes in either direction, it also did not match the highs reached by its competitors in well-performing zones. A comparative analogy is expanding to a faster, wider freeway while still relying on an outdated toll system and traffic management software, which results in bottlenecking traffic at critical points in the network. While Verizon remains a dependable choice for users who prioritize signal consistency and day-to-day reliability, particularly in LTE-only environments, it is a less competitive option for those seeking fast 5G performance for bandwidth-heavy applications like mobile streaming, cloud gaming, or large file transfers.

What Verizon Users Experience

Verizon users rely entirely on LTE in Commerce City, which provides stable performance for basic tasks like messaging, browsing, and email. The lack of 5G may not be immediately noticeable for users with routine mobile needs, but it does limit performance for applications that require high throughput or low latency. In locations along Highway 85 north of 60th Avenue , along 96th Avenue, and areas along Tower Road users may experience slower speeds or reduced reliability, especially during peak hours. Overall, the experience is consistent but capped, reliable for everyday use, but less suited to data-intensive activities like HD streaming, cloud gaming, or large file transfers.

9.2 Detailed Wireless Coverage Results

The survey collected RSRP and throughput data to assess general coverage and performance, which are the most direct indicators of coverage and user experience in a mobile network. RSRP and throughput provide clear insights into where networks perform well and where coverage gaps exist. RSRP is a measure of the received power level in an LTE/5G cellular network and serves as a key indicator of signal strength. Throughput, measured in bits per second, reflects actual data transfer rates, providing insight into network capacity. The dataset also recorded data type (3G, 4G, or 5G) to distinguish performance variations across network generations.

The survey was designed to provide a broad assessment of mobile network coverage and speed trends. The data analysis did not include Reference Signal Received Quality (RSRQ), Signal-to-Interference-plus-Noise Ratio (SINR), or latency measurements. RSRQ and SINR are most useful for diagnosing interference and congestion issues at a network engineering level but are less relevant for high-level policy and infrastructure planning. As a result, the dataset is limited to signal strength and speed observations, without additional network quality metrics that would provide insights into interference, congestion, or real-time responsiveness.[80] Notably, RSRP and throughput correlate more clearly with real-world user experience, such as video streaming quality, call reliability, and application performance.

To ensure consistency, drive tests were performed using three identical consumer-grade smartphones inside a test vehicle. The collected data was plotted onto street maps, providing a visual representation of network performance across the City. The results were analyzed at both the individual carrier level and in aggregate to assess overall coverage.

AT&T

Table 20. AT&T Survey Summary

AT&T	
% 5G Coverage	35.4%
% 5G Coverage “Good” or “Excellent”	78.1%
% LTE Coverage	63.9%
% LTE “Good” or “Excellent”	39.2%
Average Speed	53.3 Mbps
Peak Speed	498.7 Mbps[81]

AT&T had less recorded 5G coverage than T-Mobile and a lower quality 5G signal overall. Additionally, it had the worst LTE network performance, with 45.7% of LTE signal registering as poor. The average and peak download speeds were also lower than T-Mobile’s. However, AT&T did have strong 5G signal quality where available, with more than 78% of its 5G signal rated as “Excellent or Good.” as seen in Figure *36*. This means that when quality 5G is available, AT&T customers may enjoy reliability comparable to T-Mobile’s 5G customers. AT&T’s LTE network did not perform best in overall signal quality either, with just 25% of coverage considered excellent. This results in a mixed experience for AT&T customers: in strong 5G areas, performance may be acceptable, but in zones without 5G—such as indoors, rural regions, or congested locations—they may not outperform T-Mobile and Verizon users. Since AT&T’s LTE performance is worse than the other two carriers, in-building coverage may be inconsistent, especially given notable signal quality drop-offs. Overall, AT&T performs best in well-covered zones but may show noticeable performance drops for users frequently entering buildings, tunnels, or moving through mixed coverage areas.

---

[80] Reference: https://5gstore.com/blog/2021/04/08/understanding-rssi-rsrp-and-rsrq “Understanding RSSI, RSRP, and RSRQ,” 5Gstore.com, April 8, 2021.
[81] “Speed” refers to measured download speeds, expressed in megabits per second (Mbps).

AT&T did not provide the most consistent network performance. It had a high rate of weak signal areas and slow upload speeds, suggesting performance instability in many zones. Additionally, its download and upload speeds were lower than T-Mobile's, indicating that AT&T may deliver more reliable connectivity than Verizon in some respects, but not necessarily balanced performance across all conditions. Coverage gaps were most noticeable north of 96th Avenue in multiple areas, where large sections where no 5G signal was detected and only negligible (poor) LTE signals were visible (<= 101dBm). Similarly large stretches along Highway 2 and Quebec Street north of 64th Avenue showed the same results indicating minimal signal presence (See Figure 36 and Figure 37).

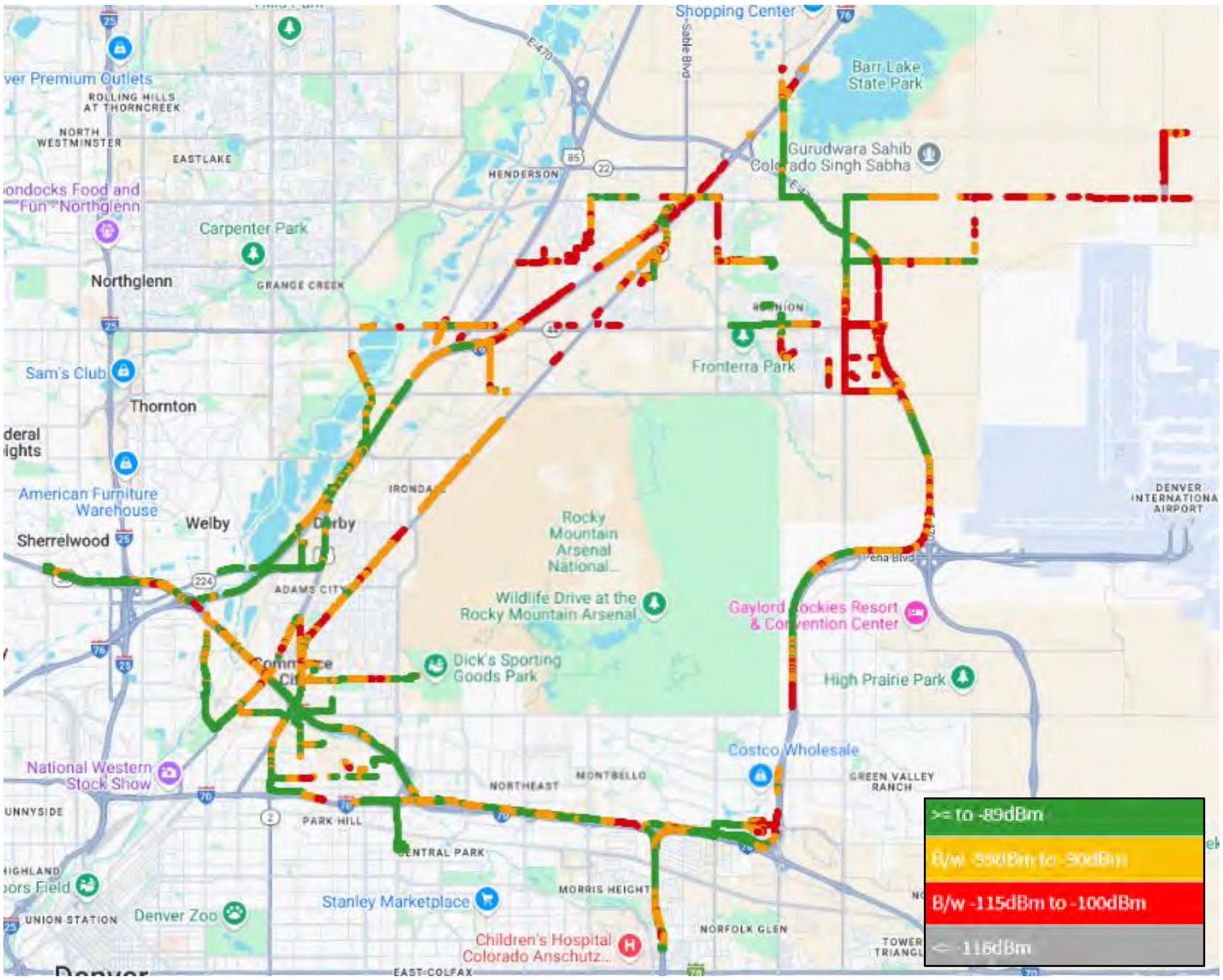

Figure 36. AT&T Signal Strength – NR RSRP[82]

---

82 NRRSRP (New Radio Reference Signal Received Power) is the fundamental measure of 5G NR signal strength, representing the receive power of 5G reference signals at the user device. http://www.4g5gworld.com/blog/5gnr-reference-signals-measurement

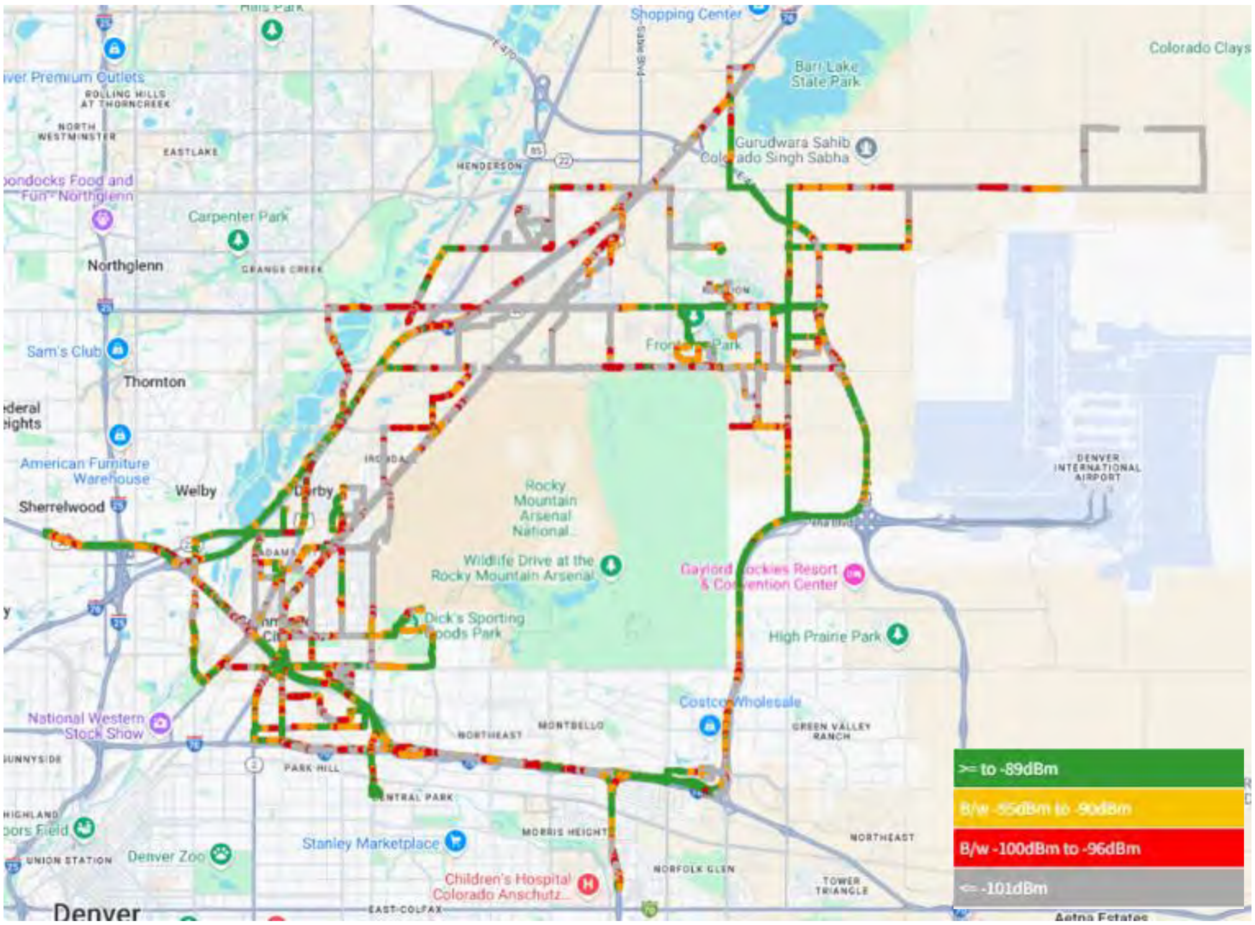

Figure 37. AT&T Signal Strength – RSRP [83]

As shown in Figure *38*, AT&T users experienced the fewest instances of download speeds falling below 2 Mbps (505 occurrences) compared to 691 for Verizon and 838 for T-Mobile. However, having lower peak speeds than T-Mobile, AT&T's results reflect a mid-range

[83] RSRP (Reference Signal Received Power) measures the average received power of LTE reference signals and is the key metric used to assess LTE signal strength and coverage in mobile networks.

performance profile, offering broader 5G availability than Verizon, but with less stability than either competitor in some conditions.

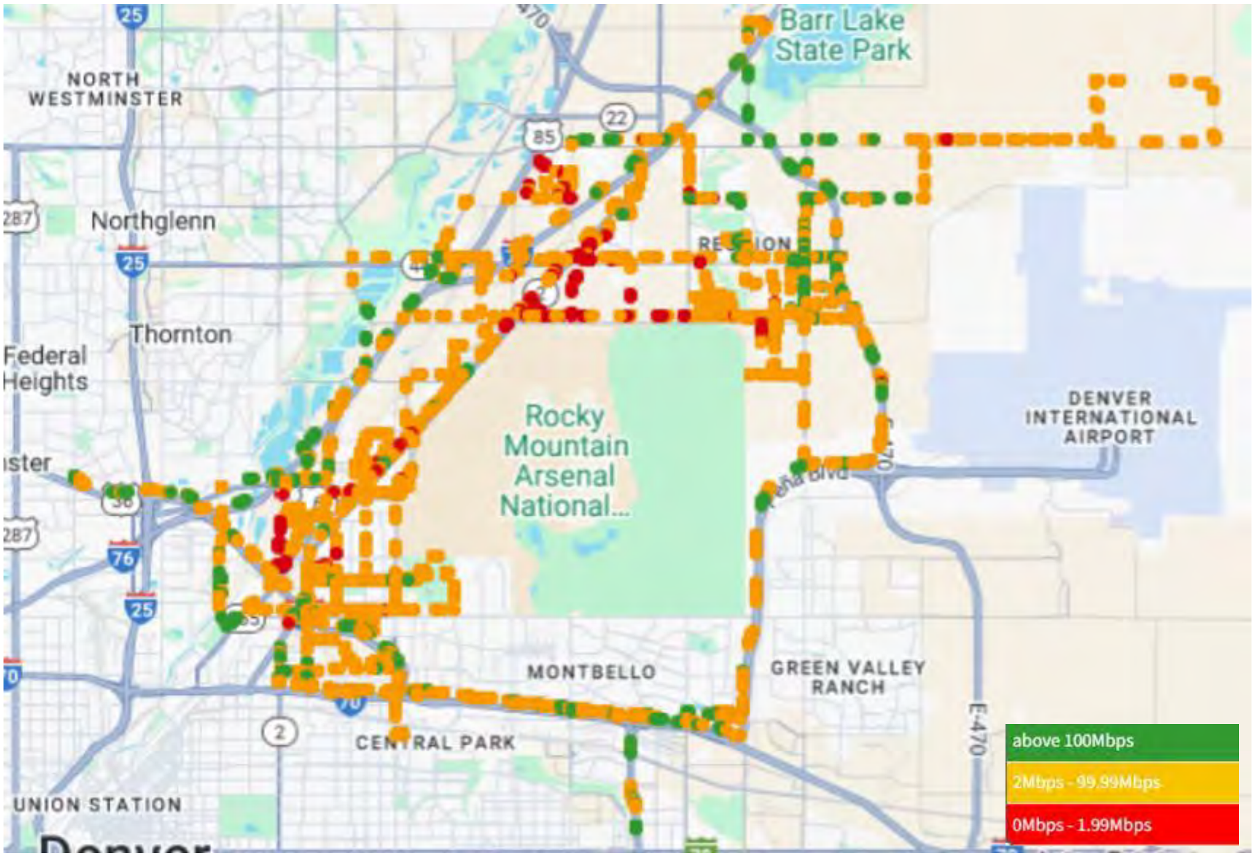

Figure 38. AT&T Download Speed in Mbps

When compared to FCC-reported 5G coverage data, the observed network performance from drive testing does not always align with the reported coverage areas, as seen in Figure *39*.[84] These discrepancies suggest that real-world conditions, such as clutter, congestion, and infrastructure limitations, may impact actual service availability beyond what is reflected in reported coverage maps.

[84] Source: https://map.coveragemap.com *Estimated Coverage Map is created with Coverage data from the FCC.

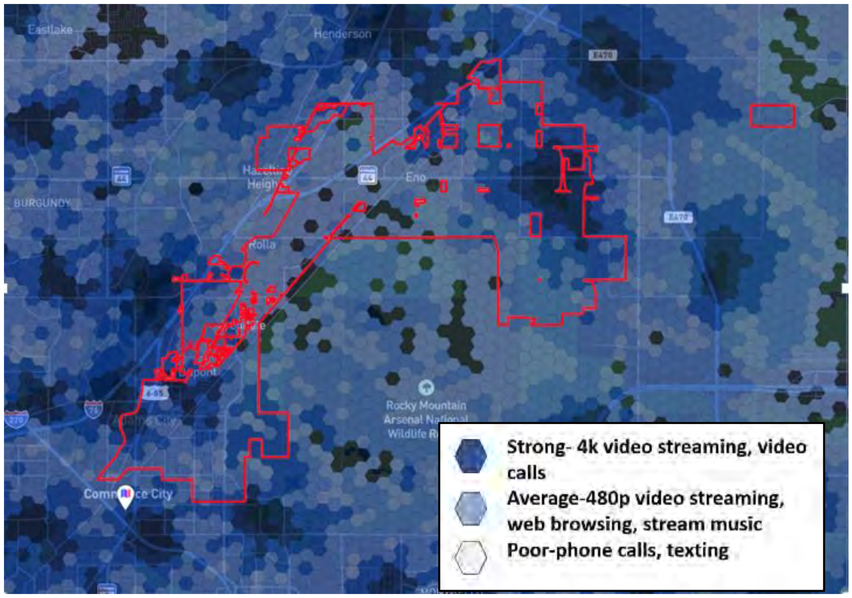

Figure 39. AT&T 5G Estimated Signal Strength as Reported from FCC Data

T-Mobile

Table 21. T-Mobile Survey Summary

T-Mobile	
% 5G Coverage	43.1%
% 5G Coverage “Good” or “Excellent”	89.1%
% LTE Coverage	43.1%
% LTE “Good” or “Excellent”	58.3%
Average Speed	95.5 Mbps
Peak Speed	728.6 Mbps[85]

T-Mobile delivers the fastest speeds overall with an average download speed of 95.5 Mbps. It maintains the highest percentage of 100+ Mbps downloads (33.0%) and offers strong upload performance, making it suitable for streaming, gaming, and large downloads. The vast majority of its 5G coverage exhibits excellent or good signal quality, with only about 11% rated as average and none as poor. This means T-Mobile 5G, where available, generally provides reliable high-speed service. Where 5G is unavailable, T-Mobile’s LTE coverage shows that 58.3% of signal readings are rated good or excellent, indicating moderately strong LTE service in these areas. This suggests that users without 5G access can still expect reasonably reliable connectivity, although LTE speeds and consistency may be lower compared to 5G zones or more reliable LTE networks in Commerce City like Verizon.

Overall T-Mobile showed the most limited coverage and performance along 96th Avenue and 104th Avenue consistently weak signal strength and download speeds frequently falling below 2 Mbps, as shown in Figure 40 and Figure 41. Similar issues were observed along Highway 85 between 60th Avenue and 69th Avenue and in other parts of the Core City. Additional marginal areas with significant drops appeared around the Denver International Trade Center along 120th

85 “Speed” refers to measured download speeds, expressed in megabits per second (Mbps).

Avenue and Trussville Road. T-Mobile exhibited fewer problem areas along major highway areas particularly around the I-470, I-270, I-76 and Highway 2 (south of 96th Avenue) .

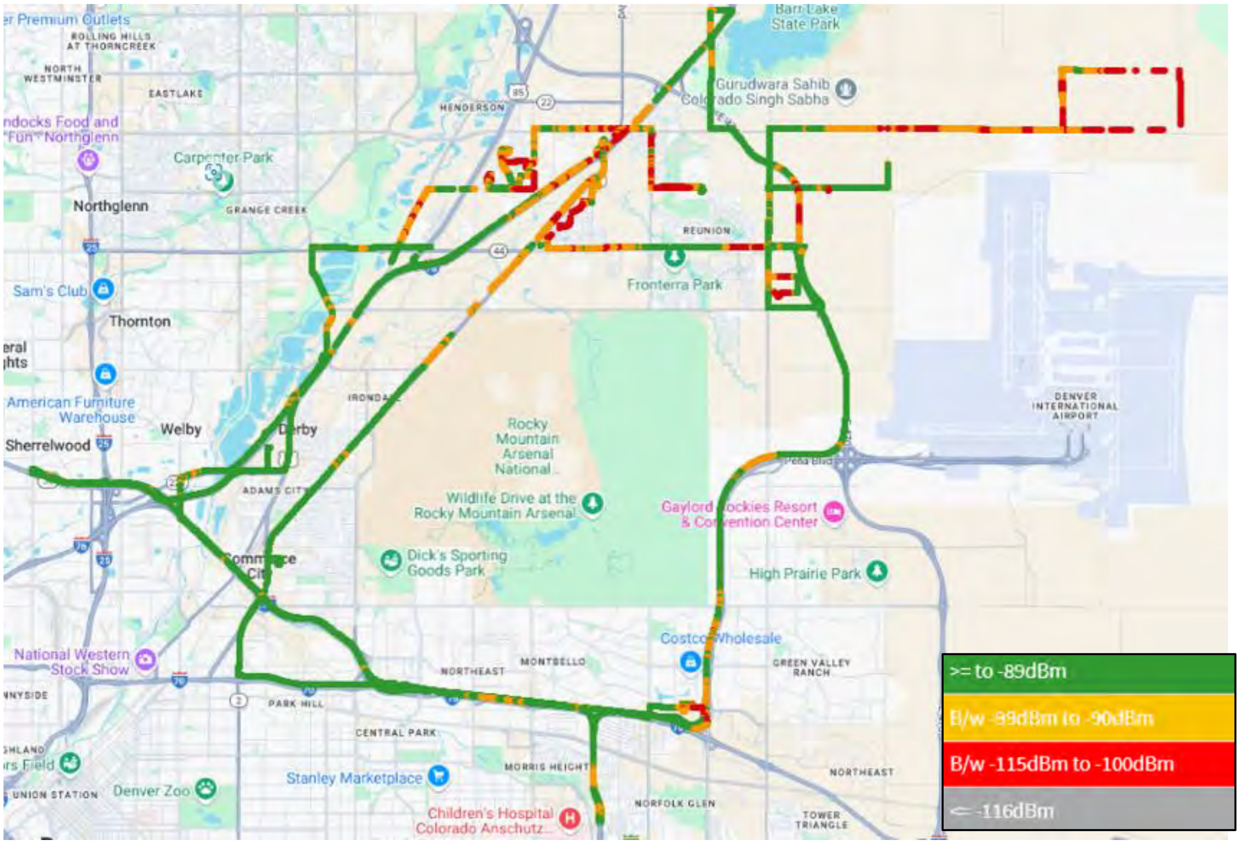

Figure 40. T-Mobile Signal Strength – NR RSRP [86]

Overall network performance was highly variable, with frequent speed fluctuations and the highest number of samples falling below 2 Mbps as seen in Figure *42* (838 recorded instances compared to 505 for AT&T and 691 for Verizon), indicating potential network congestion or de-prioritization issues in high-traffic areas. While T-Mobile's mid-band 5G spectrum provides superior speeds, its network performance was inconsistent, making it ideal for users in low-congestion areas but less dependable in dense or high-usage zones.

[86] NRRSRP (New Radio Reference Signal Received Power) is the fundamental measure of 5G NR signal strength, representing the receive power of 5G reference signals at the user device. http://www.4g5gworld.com/blog/5gnr-reference-signals-measurement

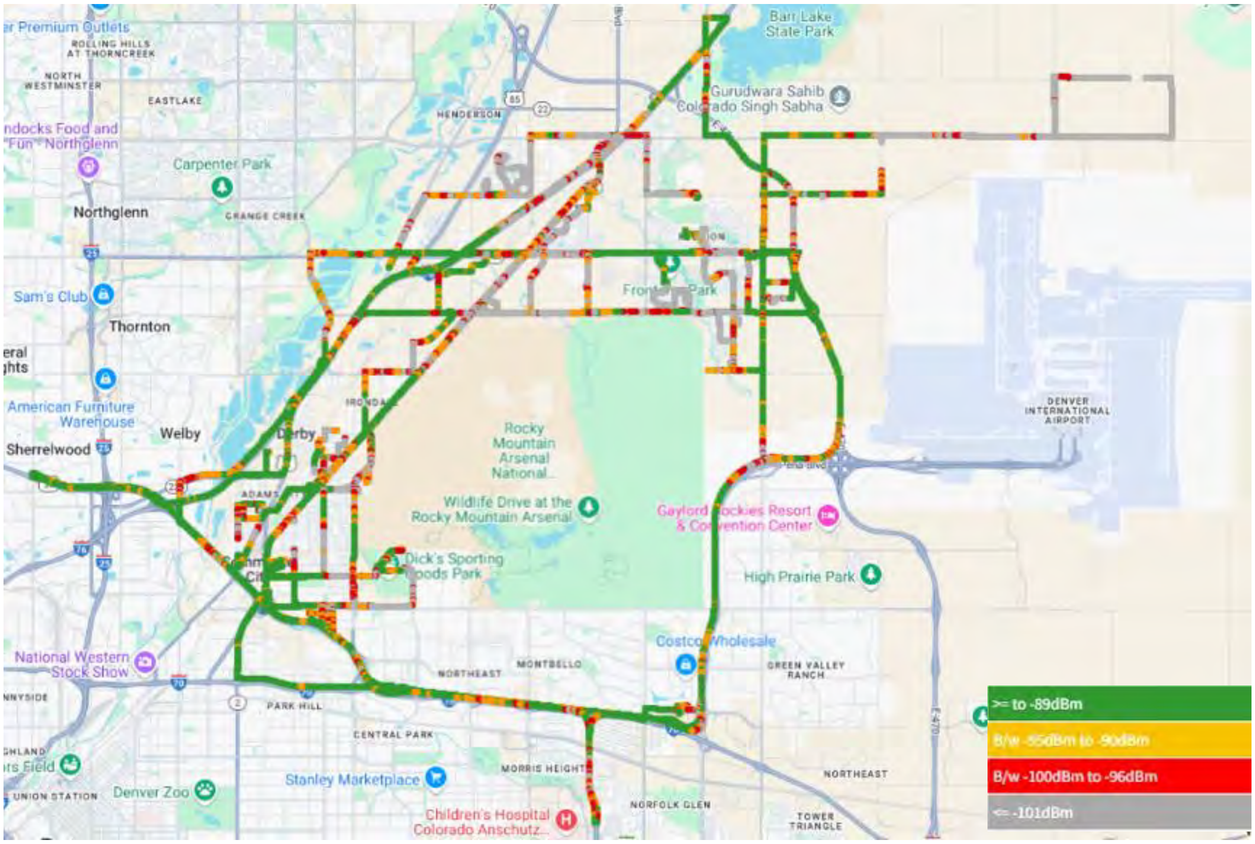

Figure 41. T-Mobile Signal Strength RSRP[87]

[87] RSRP (Reference Signal Received Power) measures the average received power of LTE reference signals and is the key metric used to assess LTE signal strength and coverage in mobile networks.

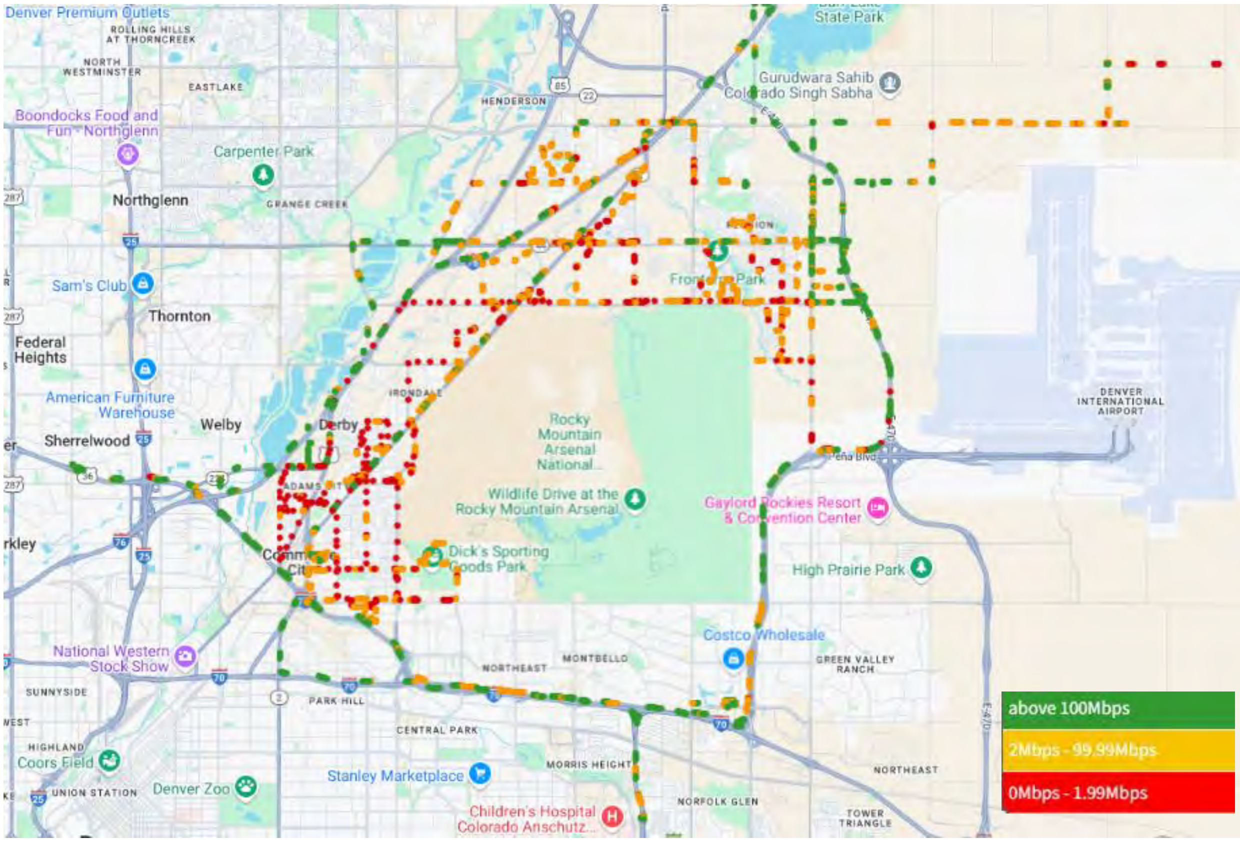

Figure 42. T-Mobile Download Speed in Mbps

When compared to FCC-reported 5G coverage data, the observed network performance from drive testing does not always align with the reported coverage areas. As seen in Figure *43*, discrepancies suggest that real-world conditions, such as clutter, congestion, and infrastructure limitations, may impact actual service availability beyond what is reflected in reported coverage maps.[88]

[88] Source: https://map.coveragemap.com. *Estimated Coverage Map is created with Coverage data from the FCC.

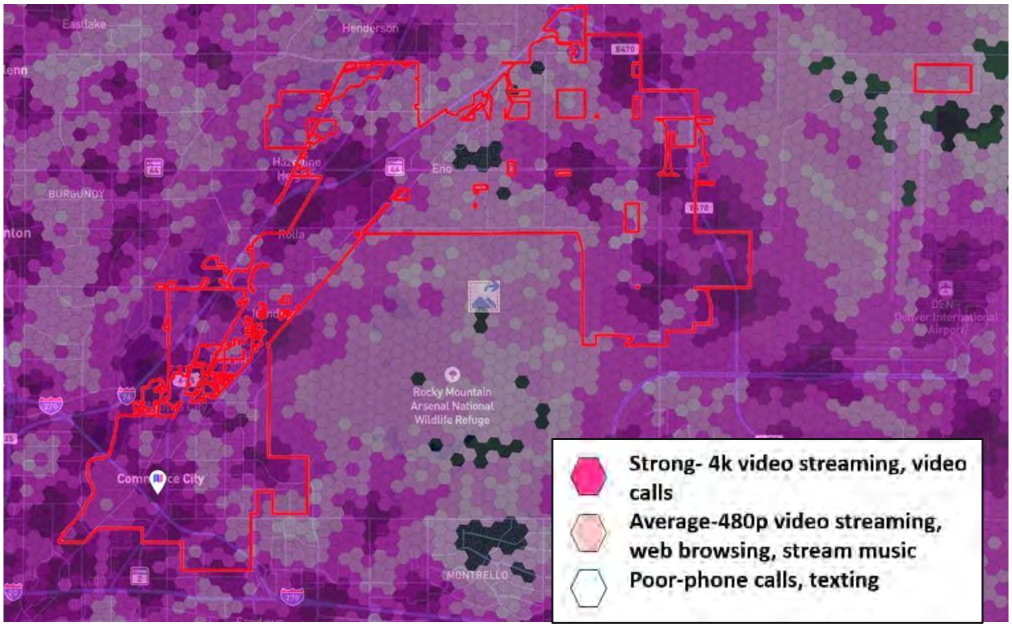

Figure 43. T- Mobile 5G Estimated Signal Strength as Reported from FCC Data

Verizon

Table 22. Verizon Survey Summary

Verizon	
% 5G Coverage	0.0%
% 5G Coverage “Good” or “Excellent”	0.0%
% LTE Coverage	98.2%
% LTE “Good” or “Excellent”	68.5%
Average Speed	50.5 Mbps
Peak Speed	363.1 Mbps[89]

Verizon provides consistent LTE coverage, with 58.5% of its LTE signal classified as good or excellent. Additionally, it has the lowest percentage of poor LTE coverage among all carriers (24.5%). Users will still experience noticeable dropped calls, occasional unreliable texting, and inconsistent data performance in some locations. Additionally, Verizon had no measurable 5G signal in this test, meaning its customers completely miss the ultra-fast speeds and lower latency benefits of 5G. In areas where AT&T and T-Mobile users are enjoying fast 5G, Verizon users will remain on LTE, which is usually slower but more stable. However, in Commerce City Verizon has a higher percentage of upload speeds above 2 Mbps (62.7%) than either T-Mobile or AT&T, possibly indicating a more developed backhaul infrastructure. Typically, this makes Verizon the strongest choice for users who prioritize reliability over cutting-edge speeds, especially for indoor use, vehicle connectivity, and general consistency. However, users looking for high-speed 5G applications like fast mobile gaming, high-definition video streaming, or future 5G-exclusive services will be missing out.

Verizon showed the most significant coverage and performance limitations along Tower Road and the I-476 corridor, and along 120th Avenue heading east towards Trussville Street, showing

[89] “Speed” refers to measured download speeds, expressed in megabits per second (Mbps).

a significant number of drops and unrecordable signal levels in each of those areas, as shown in Figure *44* and Figure *45*. Additional problem areas were observed north of 72nd Avenue in and around Monaco Street and Quebec Street, where service consistency dropped noticeably. However, the signal quality and throughput drops appear more uniformly spread out through the City, indicating more uniform network performance with fewer bottlenecks and more balanced network design.

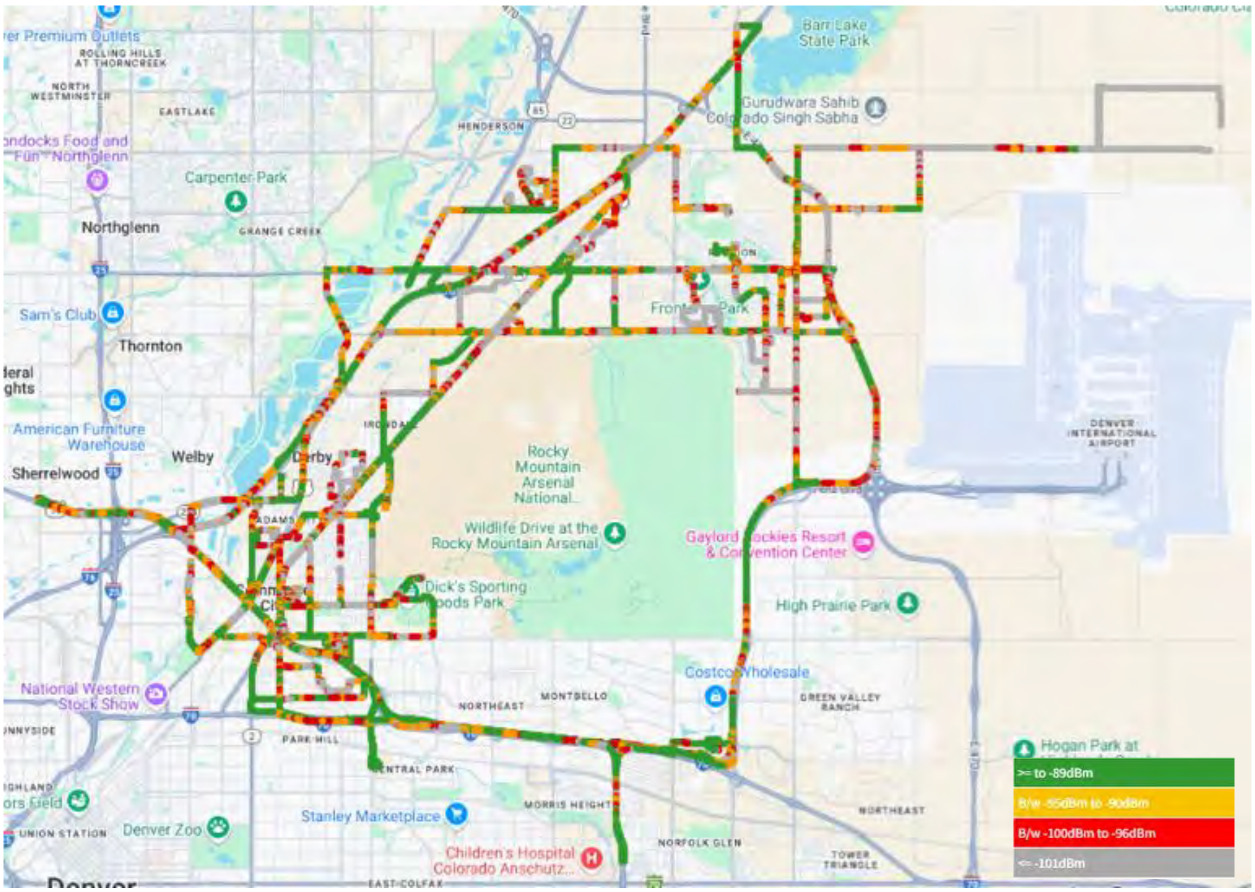

Figure 44. Verizon Signal Strength – RSRP[90]

Unlike its competitors, Verizon's test results showed all recorded data as 4G, suggesting that its network is still operating on a 4G LTE core rather than fully utilizing 5G SA. This may limit future speed improvements and advanced 5G capabilities, such as network slicing and ultra-low latency applications. Verizon maintained steadier speeds than T-Mobile but had more instances of throughput dropping below 2 Mbps than AT&T, as seen in Figure *45*, indicating potential network strain or capacity constraints in certain areas (recording 691 occurrences compared to T-Mobile's 838 and AT&T's 505).

[90] RSRP (Reference Signal Received Power) measures the average received power of LTE reference signals and is the key metric used to assess LTE signal strength and coverage in mobile networks.

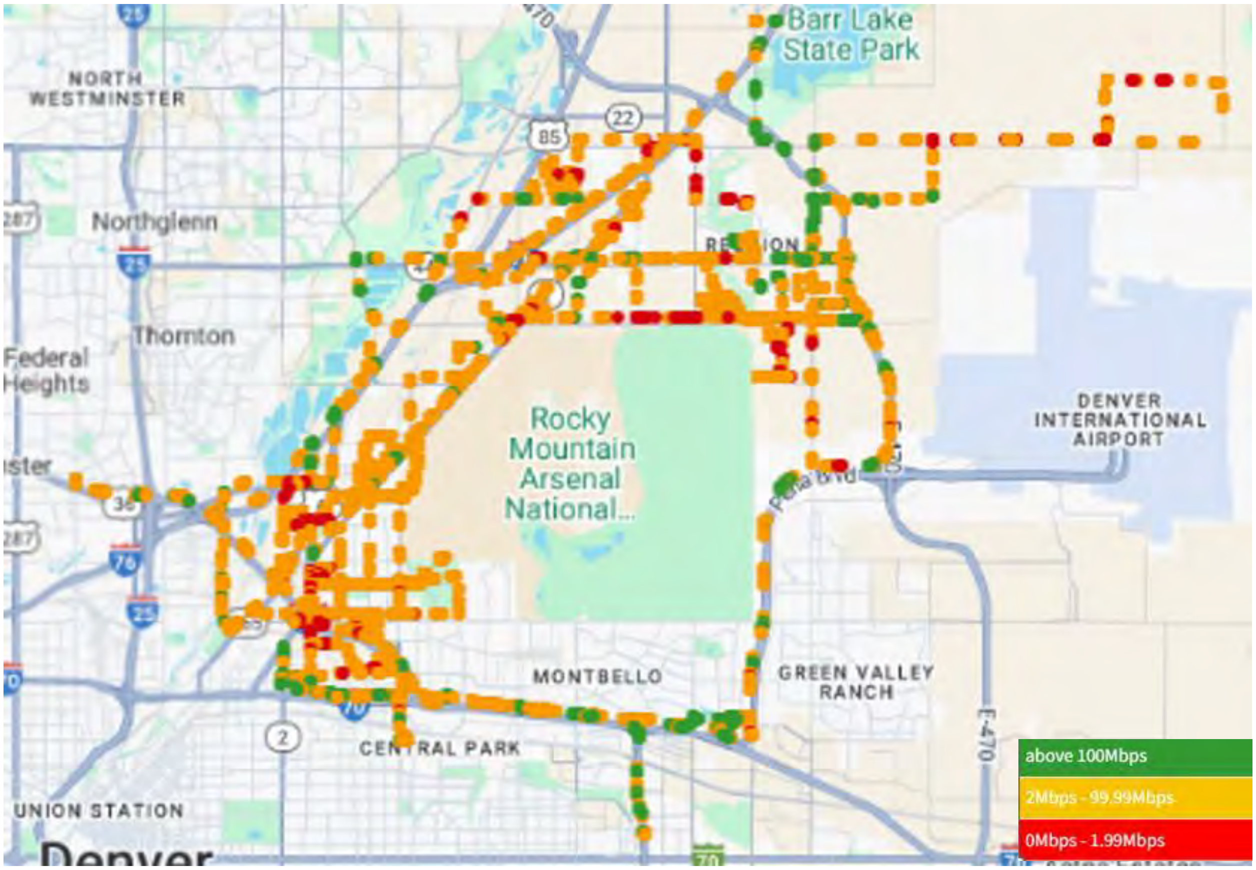

Figure 45. Verizon Download Speed < 2 Mbps

When compared to FCC-reported 5G coverage data, the observed network performance from drive testing does not always align with the reported coverage areas. As seen in Figure *46*, discrepancies suggest that real-world conditions, such as clutter, congestion, and infrastructure limitations, may impact actual service availability beyond what is reflected in reported coverage maps.[91]

[91] Source: https://map.coveragemap.com. *Estimated Coverage Map is created with Coverage data from the FCC.

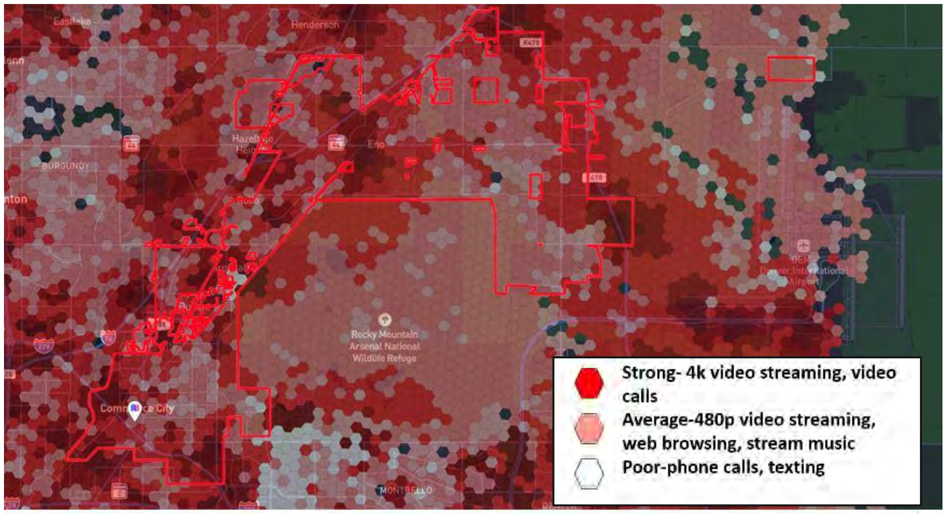

Figure 46. Verizon 5G Estimated Signal Strength as Reported from FCC Data

9.3 Cross Carrier Technical Findings

Coverage and capacity are not the same, and network performance depends on both

Coverage and capacity are often used interchangeably, but they describe two distinct aspects of mobile network performance. Coverage refers to whether a signal is available, while capacity reflects how well the network oversees demand from multiple users and whether it delivers usable speeds to those users. The data from Commerce City illustrates that strong coverage does not automatically translate into strong performance due to insufficient capacity.

Coverage indicates whether a signal is available in a given area—determined largely by geography, antenna height, signal frequency, and transmit power. More towers over a given area, higher mounting locations, and lower-frequency spectrum improve coverage by allowing signals to reach farther and penetrate through obstacles like buildings and terrain. Capacity, on the other hand, denotes the quantity of data the network can manage once a signal is present. Capacity volume depends on the radio equipment at each tower, the amount of available spectrum, the backhaul connection, and the network architecture itself. Think of coverage as the existence of a road and capacity as the number of traffic lanes on that road. A covered area might have a road in place, but if there are only one or two lanes—and too many cars trying to use them, traffic slows, stalls, or backs up. In mobile networks, capacity shortages manifest as slow speeds, buffering, and dropped connections, especially during peak usage times.

In areas where AT&T demonstrated 5G coverage, there is often poor signal strength and low upload performance, suggesting that its network may not always be optimized for throughput or reliability. In contrast, T-Mobile showed more variability in signal quality but achieved consistently the highest speeds, indicating stronger capacity in areas where coverage is available—even if the signal itself is less consistent. Verizon maintained steady LTE coverage and signal quality, but without 5G deployment in the area, its capacity for high-bandwidth performance was limited. These results highlight that strong signal presence alone is not a reliable indicator of real-world performance, and both carrier infrastructure investment and network design choices play a key role in shaping user experience.

Signal strength impacts mobile traffic differently than in-home or in-business connectivity

Users moving through the City, such as those driving along the majority of I-270, I-76 and I-470 or working in commercial areas, depend on strong outdoor signals to maintain reliable connections. Verizon's reliance on a 4G core may support more stable connectivity while on the move, ensuring that users can maintain calls and data sessions without frequent drops, even if speeds are lower than on T-Mobile's network. Meanwhile, T-Mobile's high peak speeds may be better suited for in-home or business use, where stationary users with signal boosters or Wi-Fi offloading can mitigate the impact of variable network performance. AT&T 5G provides moderate availability, but users may experience signal weakness and performance drops—particularly indoors or when transitioning between coverage zones. This can affect real-time applications like navigation, communication, or mobile bookings in certain environments, even if overall coverage is relatively strong.

Network infrastructure- including backhaul capacity and tower density-directly impacts speed and reliability

While spectrum availability is essential to enabling high capacity 5G services, it does not guarantee high performance alone. The number and placement of towers, along with the fiber or microwave backhaul connecting those towers to the core network, can significantly influence both throughput and user experience. Even with abundant spectrum, insufficient backhaul can create data bottlenecks, and widely spaced towers may result in weaker signals, especially in high-traffic or obstructed areas.

In Commerce City, performance patterns suggest that infrastructure may be influencing user experience. T-Mobile's higher speeds but greater variability may indicate strong mid-band spectrum assets but uneven tower density or backhaul limitations at some sites. AT&T's moderate 5G coverage combined with weak signal strength and poor upload speeds may point to constrained infrastructure in certain zones, either from backhaul bottlenecks or underpowered tower sites. Verizon's consistent but moderate LTE performance, coupled with the absence of measurable 5G, could be the result of an infrastructure strategy focused on stability over peak performance, particularly if it continues to rely on 4G core network architecture.

These infrastructure limitations are usually most noticeable in dense or high-traffic areas, such as commercial zones or along major roads, where mobile networks must manage a higher volume of simultaneous connections. In such environments, network upgrades, including small cell deployment, fiber-fed macro towers, and expanded backhaul capacity, can improve user experience more effectively than simply allocating additional spectrum. Without these investments, even high bandwidth 5G deployments may fall short of delivering the speeds and reliability that users expect.

9.4 Summary of Findings

Each carrier demonstrated a different mix of speed, consistency, and signal strength

The three major carriers evaluated—AT&T, T-Mobile, and Verizon—each showed a unique performance profile during field testing. T-Mobile stood out for its highest average and peak speeds but also had the most inconsistent performance, with the highest share of sub-par speed samples (below 2 Mbps). AT&T had widespread 5G coverage but had significant areas with poor signal strength; they had the fewest samples of sub-par download speeds, but conversely also had the highest number of sub-par upload speeds, suggesting some reliability challenges.[92] Verizon, while lacking any measurable 5G coverage, delivered a moderately consistent LTE experience with steady signal strength and modest speed performance. These results indicate that no single provider dominated in all categories, each delivered a different mix of speed, consistency, and signal strength.

Coverage and capacity must be evaluated separately

Field testing showed that having coverage does not guarantee good performance. Several areas in Commerce City had detectable signal but still produced slow speeds or inconsistent results, indicating capacity limitations caused by tower spacing, backhaul constraints, or high user demand. A clear distinction between coverage and capacity is necessary when evaluating real-world performance.

Commerce City can play a strategic role in network improvement

The City has a role to play in advancing connectivity by coordinating with carriers on infrastructure upgrades and facilitating access to public assets. This includes supporting small cell deployment, improving fiber access, and using localized performance data to identify priority zones for enhancement. As Verizon pursues its 5G deployment nationwide and T-Mobile and AT&T continue to densify, public-private collaboration on permitting processes, policies and ordinances, and incentivizing private investment will be essential to closing coverage gaps, supporting digital equity, and future-proofing wireless service across commercial corridors, residential neighborhoods, and transportation routes.

[92] 505 Samples between 0Mbps-1.99Mbps

10. Wireless Network Conceptual Design

In addition to the commercial wireless analysis presented in Section 9, which evaluated the coverage and performance of existing mobile carrier networks, Commerce City engaged ENTRUST to develop a Wireless Network Conceptual Design and Feasibility Assessment as part of its broadband infrastructure and grant planning efforts. This work builds upon prior tasks, including a wireless field survey, GIS-based asset inventory, and preliminary coverage analysis, and focuses on evaluating appropriate wireless technologies, selecting viable deployment strategies, and outlining the technical and business considerations required to support implementation. The design approach emphasizes leveraging the City's existing fiber infrastructure, public facilities, and vertical assets to enable a flexible wireless system that can serve both internal City operations and retail services for the general public. This concept is intended to complement existing commercial cellular networks and is not designed to replicate the nationwide mobile service provided by carriers such as Verizon, AT&T, or T-Mobile. This section presents the resulting conceptual architecture, candidate site assessments, deployment recommendations, and preliminary business model considerations, all grounded in City-provided data and planning priorities.

The conceptual wireless network design presented in this section is primarily informed by desktop propagation modeling using professional Radio Frequency (RF) planning tools to evaluate potential coverage, signal strength, and interference scenarios across Commerce City's geography. These studies guided the selection of preliminary base station sites and shaped the overall architecture.

The design leverages the City's existing municipal fiber backbone and its portfolio of property assets to build a secure and scalable wireless platform. The network will support both public-facing broadband access and a private operational layer to facilitate applications such as public safety communications, command and control links for the Police Department's drone program[93], automated meter infrastructure (AMI), and other City networks. It is worth noting that the tower locations selected are for modeling purposes only; final selection of site locations will require a further detailed design analysis consistent with City asset availability and use regulations.

This analysis outlines the architecture that will form the backbone of the City's wireless strategy. Subsequent smart city technologies can build on this foundation by evaluating detailed technology solutions, developing cost projections, and finalizing implementation approaches.

[93] Drone Command and Control (C2) Link: The secure wireless communications channel between a drone, the operator, and the supporting network. It provides real-time flight control, telemetry, and safety monitoring, distinct from payload data such as video streaming.

10.1 Wireless Concept Design Summary

This wireless network conceptual design outlines a phased, infrastructure-driven strategy centered on the construction of two new fiber-fed antenna towers that will enhance both municipal and commercial wireless connectivity throughout Commerce City.[94]

The approach emphasizes cost-efficiency, rapid deployment, and long-term scalability by leveraging the City's existing fiber network, vertical assets, and right-of-way authority to create a practical, investment-ready solution. This represents a cost-effective path toward advancing four key objectives: strengthening municipal communications, improving network redundancy, promoting private network investment, and expanding broadband access to unserved and underserved residents and businesses.

The first municipal objective is to support critical city network systems through the implementation of a citywide Citizen Broadband Radio Service (CBRS) network. This network can serve multiple purposes, including operational connectivity, future smart city applications, and public safety communications. The second municipal objective is to establish a cost-efficient redundant network path linking the northern and southern parts of the city through an 11 GHz licensed microwave connection between towers, thereby enhancing reliability and resiliency among key city facilities.

The design's community connectivity objectives are also twofold. The first is to provide a fixed wireless access (FWA) alternative for residential and business users, potentially implemented through a public-private partnership (P3) model. The second is to offer ready vertical infrastructure that encourages commercial mobile network providers to co-locate and invest further in the City, resulting in more robust mobile wireless coverage for the community.

Phase 1

Phase 1 includes the construction of two new communications towers focused on supporting the City's municipal and public safety core while being optimized to provide coverage across the full geographic area of Commerce City. It includes costs for establishing a redundant high-capacity microwave path for the northern part of the city network. The network could deliver service to City facilities, households, businesses, and key community anchor sites. When accounting for multi-user households, municipal teams, and approximately 50 public Wi-Fi access points, Phase 1 is expected to support between 2,500 and 5,600 individual users***. With an estimated capital cost of $959,560 and a recurring annual operating cost of $28,980,*** Phase 1 offers a rapid, low-barrier solution—demonstrating proof of concept while establishing the foundation for future expansion and scalability.

[94] Phase 2 later incorporates the addition of a third tower location at the Commerce City Civic Center.

Phase 2

Phase 2 increases the overall capacity of the network to support more end users by adding three additional base stations at the Commerce City Civic Center, which also strengthens connectivity between the City's core facilities. This expansion will extend service reach and improve network resiliency, supporting an additional 650 to 1450 individual users. In total, the system would have the capacity to serve more than 4350 users citywide. The estimated capital cost is $417,450, with an additional annual operating costs of approximately $14,490 beyond the Phase 1 annual operating costs. Phase 2 may be implemented in response to user demand, public safety needs, new anchor-tenant partnerships, or the availability of additional funding to further expand network coverage and capacity.

The combined capital costs for both phases are $1,377,010 and expected annual operating costs would be just over $43,000. The two-phase conceptual plan emphasizes shared-use infrastructure and public-private compatibility, identifying co-locatable sites that can support both public broadband and private mobile deployments.

Future monetization and cost-recovery strategies include revenue-sharing partnerships, third-party tower leasing, and smart city integrations that can offset ongoing municipal operating expenses. Any of these strategies could significantly reduce both the required capital investment, as well as the annual operating costs (as much as 55% for capital contributions). [95] Together, these elements form a sustainable, scalable pathway for Commerce City to meet its near-term digital access needs and long-term smart infrastructure goals.

Design Principles

Leverage the City's Existing Fiber Backbone and Vertical Assets

By using existing fiber routes and vertical infrastructure, such as municipal land (whether developed or undeveloped) streetlights, rooftops, and utility structures, the City can minimize new construction, reduce costs, and accelerate the deployment timeline.

Align Public and Private Infrastructure Needs

The City's wireless design supports both community broadband and commercial carrier expansion by identifying shared-use sites on public property. These locations can not only accommodate City wireless radios/antennas, but, through public-private partnerships (P3), can simultaneously host private wireless infrastructure at reduced costs to expand commercial services. This dual-purpose approach meets public needs while attracting private investment in wireless infrastructure.

---

[95] Purchase and installation of three tower locations could run as high as $750,000 combined covering a large portion of these anticipated capital costs. However, a number of partnership models could completely remove that expenditure for the City.

CBRS Fixed Wireless Layered Architecture

The network architecture follows a functionally layered model, beginning with a fiber-based backhaul that delivers symmetrical gigabit connectivity to each base station site. At the access layer, distributed Citizen Broadband Radio Service (CBRS) base stations provide wide-area radio coverage, with fixed wireless delivery enabled through Customer Premises Equipment (CPE). A complementary Wi-Fi layer could extend connectivity to public users in targeted areas, using access points backhauled through the CPE network (see Figure 47). This structure supports both managed fixed wireless connections and flexible public access, optimizing the network for municipal operations, broadband delivery, and smart city applications.

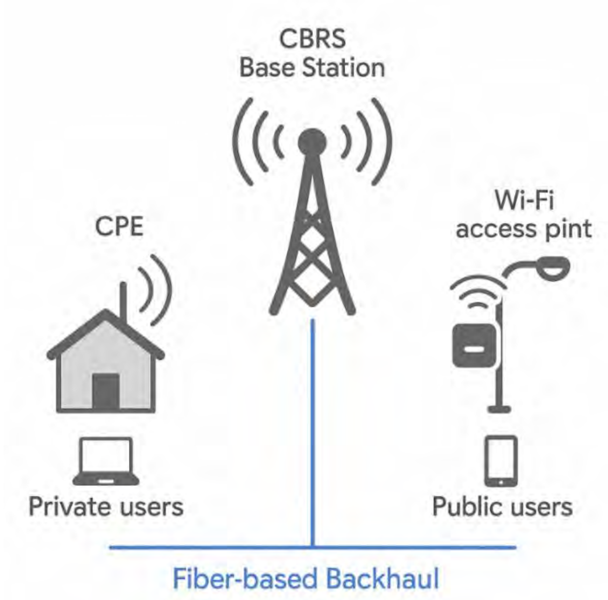

Figure 47. Functionally Layered Architecture for CBRS-Based Fixed Wireless

The deployment strategy prioritizes high-value civic and public safety locations in the initial phase to deliver early benefits while minimizing disruption. By focusing on sites such as the Commerce City Civic Center, Police Substation, and South Adams County Fire Department Station 24 (all locations with existing infrastructure and direct fiber access), the City can accelerate activation, demonstrate early success, and establish a proven deployment model. Phase 2 will then expand coverage in coordination with existing infrastructure and community connectivity objectives, building on the foundation established through the Phase 1 network.

10.2 Existing Conditions and Asset Inventory

The network design is grounded in a detailed understanding of the City's infrastructure assets, which were mapped and analyzed through field survey and GIS-based assessment in earlier project phases.

Commerce City controls only a limited number of existing vertical mounting assets, which typically include City-owned streetlights, signal poles, building rooftops, and water tanks. These assets offer both elevation and power access, and when situated near a city's fiber network, enable cost-effective deployment of backhaul and access-layer infrastructure. Commerce City currently owns and maintains fewer than 500 streetlights, primarily clustered along Highway 2 and Tower Road. Currently, the city owns no other vertical infrastructure.[96]

The municipal fiber network, which provides high-bandwidth, low-latency connectivity throughout key corridors, will serve as the backhaul foundation for the wireless deployment. This backbone is complemented by a number of facilities, such as the Northern Substation (18240 East 104th Avenue), Fire Station 24 (8600 Rosemary Street), and other facilities that are already fiber-connected and centrally located, making them ideal anchor sites as depicted in Figure *48*.

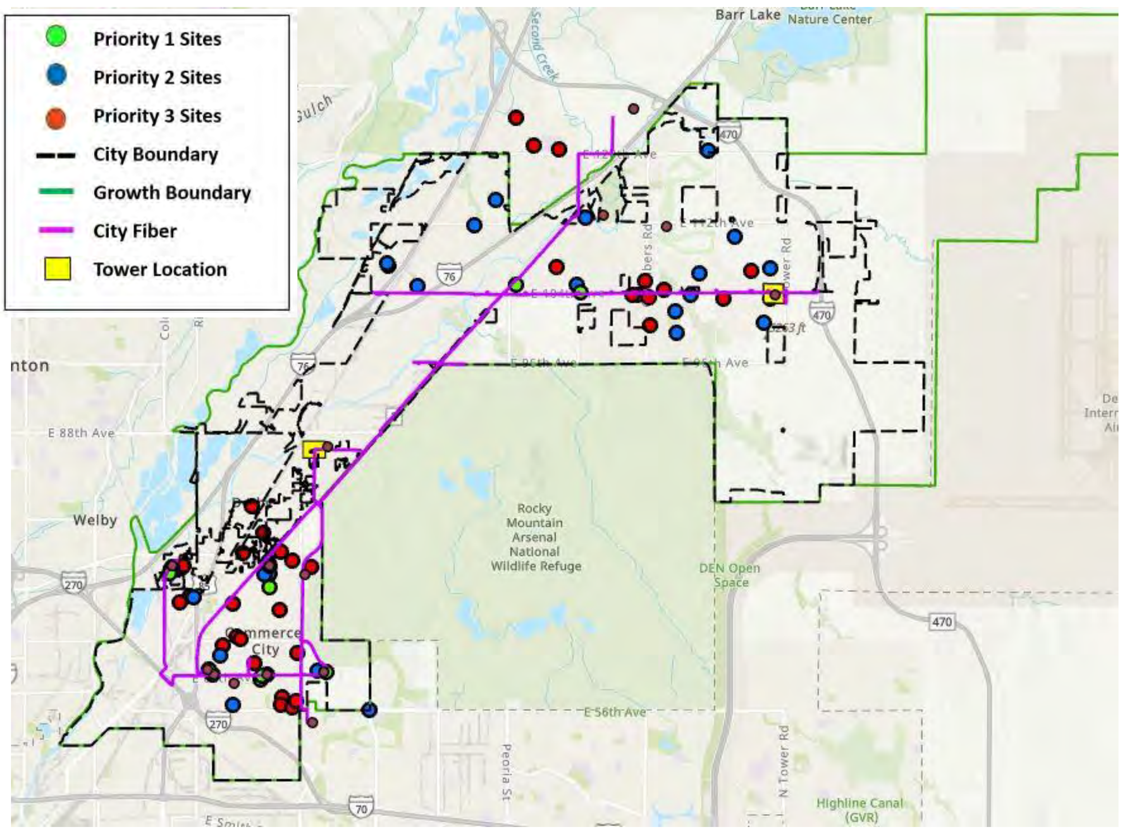

Figure 48. City Fiber Backbone & Key Facilities

A facility prioritization effort was also conducted to classify candidate deployment locations into three tiers, Priorities 1, 2, and 3, based on proximity to fiber, site readiness, and strategic value as defined by the City. Priority 1 sites typically reflect locations of high municipal importance, alignment with current development initiatives, or operational urgency as determined by City

[96] ENTRUST Solutions Group, "Telecommunications Asset Assessment" Technical Memorandum for Commerce City, March 14, 2025.

leadership. Lower-tier sites may still be viable but were ranked lower due to longer deployment timelines, reduced strategic alignment, or infrastructure constraints.

10.3 Technology Considerations

This analysis focused on three leading wireless technologies, Wi-Fi 7 with 60 GHz point-to-multipoint (PTMP), CBRS, and Private Long-Term Evolution (LTE), typically marketed as 4G, as potential foundations for Commerce City's municipal network strategy. Each offers different advantages in cost, performance, and long-term sustainability. A detailed technology profile for each of these can be found in *Appendix A: Comparative Technology Evaluation.* Other microwave backhaul technology options were not analyzed in this assessment, as the 11 GHz licensed spectrum provides the optimal balance of bandwidth, range, and interference protection for the City's intended public safety and operational uses.

Wi-Fi 7 with 60 GHz PTMP

This technology refers to a high-capacity, short-range wireless transmission method using unlicensed 60 GHz spectrum, commonly known as millimeter-wave (mmWave) technology. When paired with Wi-Fi 7, this configuration enables extremely fast data transmission-ideal for line-of-sight environments like city plazas, transit stops, or schoolyards. In this architecture, 60 GHz radios form a backhaul mesh or PTMP network between key distribution points, and Wi-Fi 7 access points deliver service directly to public users. The combination is especially effective for expanding outdoor public Wi-Fi or bridging the digital divide in densely populated neighborhoods without trenching fiber.

CBRS (3.5 GHz shared spectrum)

CBRS operates in the 3.5 GHz band, designated as shared spectrum by the Federal Communications Commission (FCC), and offers a versatile platform for fixed wireless access (FWA) and private LTE/5G networks. CBRS enables cities to deploy their own managed networks using lightly licensed or General Authorized Access (GAA) spectrum, avoiding reliance on commercial carriers. It strikes a balance between coverage and capacity—offering better range and penetration than mmWave solutions while maintaining high throughput for many urban and suburban use cases. CBRS networks support secure and segmented connectivity for both public users and municipal applications, including smart infrastructure, video surveillance, and AMI. Its compatibility with Subscriber Identity Module's (SIM) based authentication also makes it a strong candidate for managed device environments like public safety, logistics, or public Wi-Fi extensions. This flexible model allows municipalities to control quality of service (QoS), prioritize mission-critical traffic, and scale the network as future needs evolve.

Private LTE

Private LTE refers to a dedicated, carrier-grade wireless network that operates independently from commercial cellular providers. Built using 3rd Generation partnership Project (3GPP) standards, this architecture delivers enterprise-level performance with strong mobility, end-to-end encryption, and granular control over quality of service (QoS).[97] Private LTE can operate over licensed, shared (e.g., CBRS), or unlicensed spectrum, depending on regulatory and deployment considerations. Its chief advantage is its ability to support secure, high-priority communications for critical smart city applications, such as public safety, emergency response, transit systems, or SCADA and AMI infrastructure, without competing with general public traffic. However, Private LTE networks require significant capital investment in core network infrastructure and ongoing operational costs for spectrum management, device provisioning, and system integration. They are generally not intended for open public use, which makes them ideal for mission-specific deployments where reliability, security, and operational control outweigh broad accessibility.

Recommendation: CBRS based Fixed Wireless Network

Based on the comprehensive evaluation matrix, weighted scoring methodology and Commerce City's identified priorities as seen in Table 23, the CBRS model demonstrates the strongest alignment with the City's strategic objectives, achieving a total weighted score of 40.07. Further details for that comprehensive analysis can be found here in *Appendix A: Comparative Technology Evaluation*.

A CBRS Network approach offers the best balance of cost, scalability, ease of deployment, and alignment with public funding programs (See Figure *49*). CBRS enables the City to maintain operational control while offering flexible public access and supporting a wide range of smart city applications. Its scalability allows phased deployment that can evolve with community needs and technological advancements.

Table 23. Technology Weighted Score with Commerce City Priorities

Category	Priority Level	Wi-Fi 7 Weighted Score	CBRS Weighted Score	LTE Weighted Score
Deployment Cost	Critical	3.00	3.00	2.00
Operational Cost	Critical	4.00	4.00	3.00
Coverage Efficiency	Critical	3.00	4.00	5.00
Network Management Complexity	Important	2.01	2.01	2.01
Scalability	Secondary	1.50	2.00	2.50
Mobility and Roaming Support	Secondary	1.00	1.50	2.50
Infrastructure Compatibility	Secondary	2.00	2.00	1.00
Municipal Systems Backhaul Readiness	Important	2.68	2.68	1.34
Security and Control	Important	2.68	2.01	3.35
Smart City Readiness	Important	2.68	2.68	2.01
User Experience	Secondary	2.00	1.5	2.00

[97] 3rd Generation Partnership Project (3GPP). About 3GPP. Retrieved from https://www.3gpp.org/about-3gpp

Sustainability and Long-Term Viability	Critical	3.00	4.00	4.00
Grant Funding and Funding Alignment	Important	2.68	2.68	2.68
Monetization Potential	Important	2.01	2.01	2.01
P3 Compatibility	Critical	4.00	.4.00	3.00
TOTAL		**38.24**	**40.07**	**38.40**

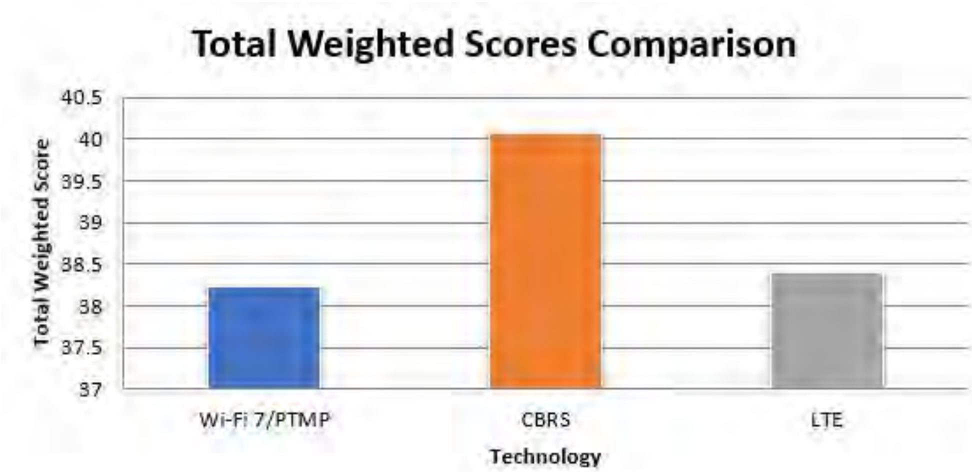

Figure 49. Technology Type Weighted Scoring Comparison

10.4 Conceptual Network Architecture

Conceptual Network Architecture and Design Approach

The conceptual network architecture for Commerce City's wireless overlay was developed to meet several foundational objectives: enable Fixed Wireless Access (FWA) to key municipal facilities, extend connectivity to underserved and unserved areas, and make efficient use of city-owned infrastructure to contain costs. In parallel, the design approach considered how future enhancements could support broader mobility needs and create shared value with commercial wireless carriers. These guiding principles shaped a flexible architecture that balances immediate digital equity goals with long-term scalability and multi-use potential.

The CBRS wireless overlay is designed as a FWA network using the 3.5 GHz (CBRS) band as seen in Figure 5. This shared-spectrum architecture supports residential and public space broadband connectivity, leveraging city-owned assets and existing fiber infrastructure to keep costs low while ensuring coverage and scalability. The system's architecture can also be extended to enable outdoor Wi-Fi to backhaul and, in future phases, mobility support for roaming devices.

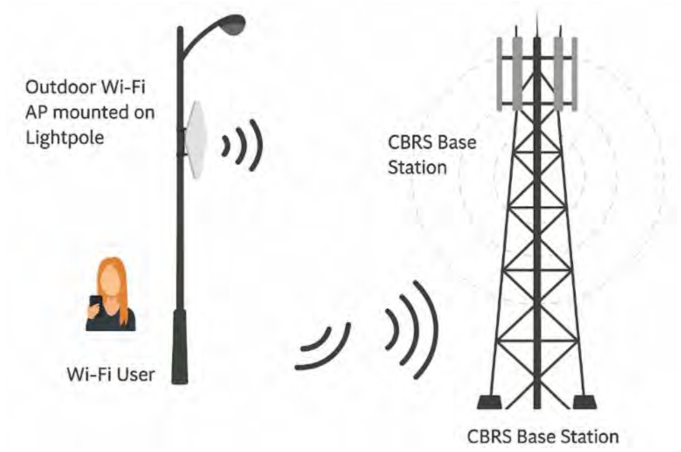

Figure 50. CBRS Wireless Architecture

Multi-Purpose Tower Network and Licensed Microwave Backhaul Integration

To support this design, the City should establish a network of multi-purpose towers that serve both municipal and commercial objectives. These structures will provide reliable connectivity for public safety and operational communications while also creating opportunities for co-location and carrier partnerships that enhance commercial-grade wireless coverage. An 11 GHz licensed microwave system will interconnect the three tower sites to provide high-capacity, redundant backhaul.

Phase 1 includes a point-to-point microwave link between the Police Substation (18240 E 104th Avenue) and Fire Station 24 (8600 Rosemary Street), forming a resilient backbone that supplements the City’s fiber network.

In Phase 2, the Civic Center complex (7887 E 60th Avenue) will be added through an additional licensed microwave hop connecting to the Fire Station 24 tower. This architecture ensures continuous connectivity among critical facilities, improves network resiliency during potential fiber disruptions, and provides scalable capacity to support both municipal services and future commercial deployments.

Network Design Standards and Performance Assumptions

The proposed CBRS wireless network for Commerce City is designed with a primary focus on supporting municipal services, including field operations, smart infrastructure, and public safety applications. Beyond internal use, the system is engineered to support grant-compliant deployment by targeting unserved and underserved areas where extending fiber has not been cost-effective. As a third-tier priority, the network could support outdoor public Wi-Fi access in targeted high-impact areas, such as the downtown civic core.

The architecture is based on a three-sector base station configuration at each deployment site, with each sector operating on a 20 MHz channel under the General Authorized Access (GAA) tier of the CBRS band. GAA offers cost-effective, shared spectrum access through coordination with a SAS, eliminating the need for licensed spectrum while maintaining interference protection standards. Each site is provisioned with a 1 Gbps symmetrical fiber connection, which is shared across all three base stations at the location. Traffic across sectors is dynamically managed to ensure consistent performance for municipal, residential, and public use cases.

Phase 1 includes two deployments of three sectors co-located at two separate municipal towers. Phase 2 expands the system through one additional deployment site, with three sectors, for a total of nine CBRS sectors across three sites. The design includes a combination of Customer Premises Equipment (CPE), supporting indoor or enterprise broadband, and Wi-Fi access points backhauled via CPE, to enable outdoor public connectivity.

Each site could deliver approximately 200–300 Mbps downstream / 30–40 Mbps upstream of aggregated radio throughput. Indoor CPEs typically serve multi-user environments, such as households or small businesses, with an average of 3–4 individual users per location. Public Wi-Fi access points are configured to support 20–50 users per day, depending on factors such as density, placement, and prioritization. Devices with embedded CBRS radios or SIM-based authorization, such as tablets, field units, or IoT sensors, can connect directly to the CBRS network and are counted as individual logical users. Across all three sites, the design could support approximately 1950 to 4350 total users, depending on traffic distribution, spectrum conditions, and device density, as seen in Table 24.

Table 24. CBRS Network User and Equipment Summary

	Phase 1 (Site 1 – Central)	Phase 1 (Site 2)	Phase 2 (Site 3)	TOTAL (All Sites)
# of Base Stations	3	3	3	**9**
# of Sectors (20 MHz each)	3	3	3	**9**
CPE Units (Indoor/Outdoor)	50	50	50	**150**
Wi-Fi Access Points	25	25	25	**150**
Estimated Direct CBRS Devices	10	10	10	**300**
Wi-Fi Users (20-50 per AP)	500-1,250	500-1,250	500-1,250	**1,500-3,750**
CPE Users (3-4 per CPE)	150-200	150-200	150-200	**450-600**
Total Est. Users	650-1,450			**1,950-4,350**

CBRS Base Station Layer

At the heart of the CBRS network are fixed base station sites, each consisting of a three-sector (tri-radio) configuration mounted on a newly constructed monopole (100 ft – 120 ft) at two locations . The radios operate in the mid-band CBRS spectrum (3.5 GHz), offering a blend of propagation range and data throughput. With proper line-of-sight, each base station sector can cover 1 to 1.5 miles, enabling a single base station site to serve hundreds of premises depending on environmental conditions.

The initial Phase 1 deployment centers on tower development at the Police Substation location in the Northern Range area. This location has existing fiber connectivity and sufficient elevation to broadcast signal across a large portion of the city. The base station will be supported by a small outdoor cabinet, power drop, and UPS system. Routes and network permissions may be configured by City IT staff, or a selected network partner to allow secure communication with the broader municipal network.

As the network scales in Phase 2, additional base station sites can be placed at the Commerce City Civic Center. Each site will replicate the three-sector configuration, mounted on a newly constructed Monopole Tower (or possibly rooftop) . Backhaul will be provided through city fiber where possible to minimize cost and latency. The use of City-owned assets avoids leasing costs associated with commercial towers and helps streamline permitting and construction timelines.

CPE and Service Delivery Layer

The service delivery model relies on CPE mounted on individual public facility locations, individual businesses, or residential locations. Each CPE is a fixed wireless radio with a high-gain directional antenna pointed toward the nearest base station. The CPE contains an ethernet handoff that feeds either a standard indoor Wi-Fi router or Ethernet switch to distribute connectivity throughout the home or business.

Typical throughput ranges from 100–150 Mbps download and 10–20 Mbps upload per location under ideal signal conditions. This meets federal broadband performance benchmarks and can support remote work, streaming, virtual learning, and other modern applications.

The design anticipates support for over 300 locations in Phase 1 and up to 900 or more by the end of Phase 2. Each expansion phase aligns with increasing user demand and can be implemented incrementally, keeping capital outlays proportional to actual service growth.

CPEs also serve as the backhaul mechanism for outdoor Wi-Fi deployments, enabling hybrid models where Wi-Fi service areas are fed by the CBRS radio network rather than direct fiber connections.

Outdoor Wi-Fi Integration Layer

To extend connectivity to public spaces and park environments, the CBRS design includes an integrated Wi-Fi access component. In these specific areas, a CBRS CPE is co-mounted with an outdoor-rated Wi-Fi access point on a light pole or utility structure. The CPE connects back to the nearest base station, acting as the wireless backhaul for the access point.

This configuration allows any Wi-Fi-enabled device, such as a phone, laptop, or tablet, to connect to the internet in City parks or on sidewalks using standard Wi-Fi protocols, without requiring the user to interact directly with the CBRS system. Logical segmentation via VLAN or SSID ensures that public-facing traffic remains isolated from City operational data streams.

This model offers a low-cost way to provide public Wi-Fi coverage in areas where trenching or fiber extension is impractical. It also establishes a pathway for future smart city applications, such as camera systems, environmental sensors, or connected lighting, by leveraging the same pole-mounted CBRS backhaul.

10.5 Mobility Readiness Considerations

While the current architecture is optimized for fixed wireless access (FWA), the City’s CBRS network can evolve to support limited mobility in future phases. Achieving mobility requires deliberate planning, including the selection of hardware that supports handoff and seamless connectivity across base stations.

Fixed wireless CPEs typically feature high-gain directional antennas optimized for long-range, high-throughput links, but these are not mobility-friendly. In contrast, mobile-ready CPEs use omnidirectional antennas, which support mobility but require stronger downlink signals to compensate for lower antenna gain. This necessitates a denser base station footprint to ensure overlapping coverage for handoff across the City.

To support true mobility, the network must incorporate a core unit, known as the Evolved Packet Core (EPC), to manage device authentication, traffic prioritization, and handoff coordination between base stations. EPC deployment costs vary widely, ranging from $15,000 for a software-based instance supporting up to 10,000 users to more than $100,000 for carrier-grade solutions. For example, a single-site deployment using Nokia base stations and software configurations integrated with an EPC could exceed $1 million, depending on vendor architecture and licensing requirements.[98]

Hybrid mobile configurations are also possible using Cradlepoint routers configured with both private CBRS SIMs and public LTE SIMs. These devices can default to the City's CBRS network and automatically switch to commercial LTE when signal thresholds fall below a defined level. Session persistence allows the router to maintain connectivity across network transitions, although VPN re-establishment during handoffs may cause brief interruptions. This method avoids direct EPC peering with public carriers, thus reducing peering costs but still requires active SIM subscriptions on the commercial network for fallback functionality.

[98] Nokia. “Private Wireless Solutions.” https://www.nokia.com/networks/private-wireless/

10.6 Site Prioritization Framework

The finalized facility deployment matrix for fiber deployment includes a total of 92 unique public-serving sites, distributed across three deployment priority levels. These include City administration buildings, parks, libraries, public safety buildings, and community centers. The breakdown by priorities are as follows:

- Priority 1: 16 facilities
- Priority 2: 36 facilities
- Priority 3: 40 facilities

To support a cost-effective and strategically sequenced rollout, facilities were grouped into two phases based on factors such as public impact, infrastructure readiness, and geographic distribution. The prioritization strategy balances rapid public benefit with long-term infrastructure growth, ensuring early wins while maintaining flexibility for future use cases. Table 25 includes City-owned coverage objectives such as schools, fire stations, civic buildings, warning towers and similar public-facing facilities. It excludes utility poles, traffic signals, streetlights, or standalone telecommunications towers.

Until the city planning process can establish a clear path to funding and deployment for fiber-based connectivity, many of these identified facilities here will go without connectivity or will require costly connectivity. The implementation of a city wide CBRS based wireless network will provide at least some level of connectivity for those sites until a fiber-based plan can be implemented. Additionally, a CBRS based network can provide redundancy for a variety facilities.

Table 25. City Facilities by Priority

Category	Priority 1	Priority 2	Priority 3	Total
City Buildings	9	4		**13**
City Facilities	4	4		**8**
Fire Station		10		**10**
School		9	27	**36**
Close Partner		1	1	**2**
Emergency Health Facilities			6	**6**
Economic Development Partner		1	1	**1**
Rec Center			2	**2**
Warning Towers	3	7	3	**13**
Total	**16**	**36**	**40**	**92**

10.7 Deployment Phasing Plan

The deployment of Commerce City’s CBRS-based wireless network is organized into multiple phases to maximize early impact, manage capital expenditures, and ensure scalability. This phased approach enables the City to demonstrate the feasibility of a fixed wireless access (FWA) model while aligning network expansion with demand, fiber availability, and public benefit. Phase I also enhances operational resilience by introducing two new CBRS tower sites linked by a point-to-point microwave connection that provides a redundant communication path supporting the City's core fiber network. This integrated design strengthens system reliability for critical public safety and municipal operations while serving as the technical proof of concept for broader expansion in subsequent phases.

Phase 1 – Northern Range Facility to Fire Station 24

Phase I includes the highest-priority civic and public safety facilities, selected for their centrality, operational importance, and proximity to existing fiber. These anchor sites create the backbone for broader connectivity as seen in Figure *51*, covering more than 30 square miles and assuming approximately 100 customer premises equipment (CPE) locations.

The first deployment phase centers around the installation of two new CBRS base stations: one at the Commerce City Police Substation (18240 E 104th Avenue) and another at South Adams County Fire Department Station 24 (8600 Rosemary Street).[99] These locations were selected for their combination of vertical elevation, direct fiber connectivity, and proximity to critical municipal and community operations. Together, they provide complementary coverage across central and northern Commerce City, offering clear line-of-sight to surrounding corridors, public spaces, and neighborhoods that serve as priority zones for initial coverage testing and public safety service delivery.[100]

[99] It is assumed that tower installations at both the Police Substation and South Adams County Fire Department Station 24 will receive approval and site access authorization in support of the overall initiative and its demonstrated public safety and community benefit.

[100] At the time this analysis was completed, the Police substation relocation (18240 E 104th Ave) was not yet completed. Relocation of this Phase 1 Tower location will be addressed in the final report in more detail. An anticipated relocation is not suspected to impact overall effectiveness of the overall system design.

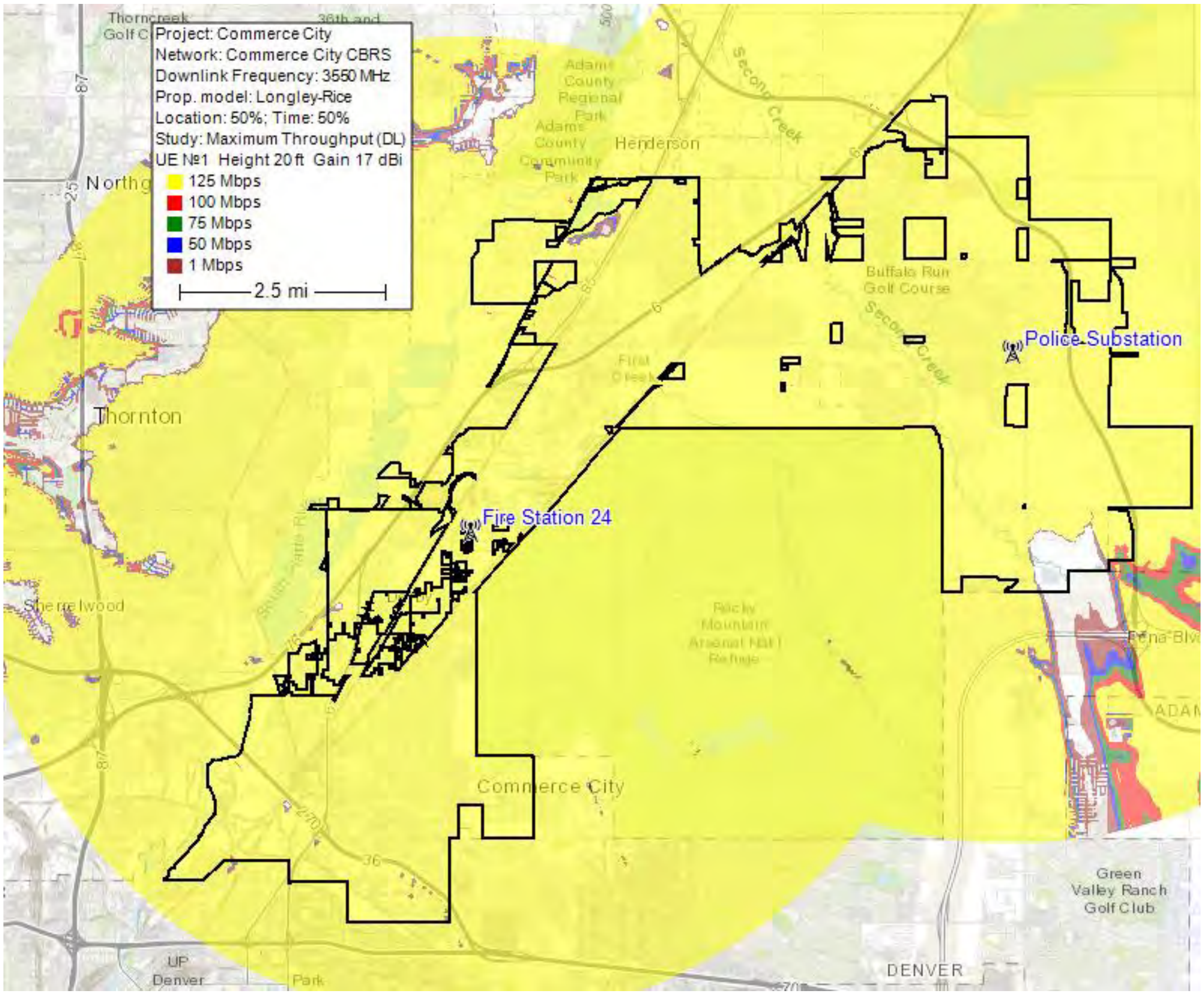

Figure 51. Phase 1 CBRS Network Coverage

The *Phase 1* deployment will focus on establishing a reliable base station supported by a high-capacity backhaul connection. This foundational infrastructure will enable controlled testing of signal propagation, throughput performance, and spectrum behavior in real-world conditions. Initial efforts will also support early-stage municipal use cases and targeted pilot areas to validate service delivery and user experience. Insights gathered during this phase will inform and refine deployment strategies, ensuring that broader geographic expansion in *Phase 2* is approached with tested methods and operational confidence.

Site Selection and Base Station Installation

Three CBRS base stations will be installed at each of the two Phase I tower locations, the Commerce City Police Substation and South Adams County Fire Department Station 24, providing fixed wireless coverage to surrounding civic and residential areas. The vertical elevation and open line-of-sight at both sites enable broad signal footprints with minimal obstruction, supporting reliable coverage across key public safety corridors and community zones. Antenna mounting will be designed for flexibility, allowing directional tuning or sectorization as needed during early propagation modeling. The network design will support a three-sector deployment architecture at each site, enabling directional signal propagation to maximize coverage and spectral efficiency from both base station locations.

Backhaul Integration and Network Resilience

A fiber-fed, point-to-point microwave link between core sites provides network redundancy and enhances overall resiliency by ensuring continuous connectivity in the event of a fiber outage. The CBRS base stations at the Police Substation and Fire Station 24 will connect directly to the City's fiber network, providing high-capacity and low-latency backhaul. Additionally, the overall site design enhances resiliency by including a separate point-to-point wireless backhaul connection between locations, ensuring continued operation if either site experiences damage to its primary fiber link. 11 GHz Licensed Microwave Backhaul

The 11 GHz band is part of the Federal Communications Commission's (FCC) licensed microwave spectrum and is widely used for carrier-grade point-to-point backhaul. Licensed microwave systems in this band provide high-capacity, low-latency connectivity with protected frequency assignments, ensuring interference-free performance and reliability suitable for mission-critical applications. For Commerce City, the 11 GHz microwave network interconnects the Police Substation, Fire Station 24, and the Civic Center, forming a redundant communications backbone that supplements the City's fiber network. This configuration supports symmetrical throughput over long distances, maintains operation during fiber outages, and offers a scalable foundation for future bandwidth growth. The system's licensed nature ensures predictable performance, security, and availability—key attributes for public safety communications and high-reliability municipal networks.

Coverage Focus

Initial signal propagation from both towers will prioritize coverage of civic buildings and administrative offices across the northern portion of Commerce City. This includes adjacent sidewalks, public rights-of-way, and community plazas, as well as potential multi-dwelling units (MDUs) situated near the civic and public safety core. Additionally, service departments operating in close proximity to the Police Substation, Fire Station 24, and other municipal facilities will fall within the early coverage footprint. This targeted approach enables the City to deliver immediate value by activating wireless services for public assets and nearby users through existing infrastructure, while minimizing the need for new construction during the initial deployment phase.

Proof of Concept

Phase 1 is structured to function as a technical and operational proof of concept. During this stage, the City will evaluate overall system performance under live operating conditions and observe how CBRS signals behave within the urban environment, particularly in areas with known physical obstructions. It will also serve to confirm initial coverage assumptions and evaluate the reliability of the wireless backhaul architecture. Just as importantly, Phase 1 will inform the development of deployment protocols that can be replicated and scaled effectively in subsequent phases. Findings from Phase 1 will inform refinements in equipment selection, antenna placement, user provisioning, and asset mounting approaches.

Civic and Pilot Use Cases

In this initial phase, the City's focus will be on testing service delivery for internal municipal needs and evaluating potential public benefit. Target applications may include:

- Department-issued tablets and mobile terminals used by field crews,
- Connectivity for public safety or traffic management equipment,
- Pilot access zones for digital inclusion near civic buildings,
- Support for IoT devices or smart city sensors.

  Starting with internal-facing use cases will allow the City to validate technical configurations, manage data segmentation securely, and assess operational integration without immediate public exposure.

Performance Testing and Optimization

During the first 60–90 days following deployment, the City will undertake an intensive monitoring and tuning process. Activities will include:

- Measuring signal strength, throughput, latency, and noise/interference levels,
- Adjusting antenna azimuth, tilt, and power levels to maximize coverage,
- Validating obstruction impacts (e.g., vegetation, building materials),
- Testing network segmentation policies and device provisioning workflows.

Regulatory Compliance and SAS Integration

The wireless system will be registered with a SAS administrator, as required by federal CBRS rules. This ensures the base station operates within authorized parameters, avoids interference with incumbent users, and maintains compliance with FCC guidelines for shared spectrum access.

Phase 2: Network Expansion and Densification – Fire Station 24 to Commerce City Civic Center

Phase 2 focuses on expanding the network by adding a new tower location that strengthens connectivity between the Commerce City Civic Center (7887 E. 60th Avenue) and Fire Station 24 (8600 Rosemary Street) as seen in Figure 52. This new site will feature a three-sector CBRS base station configuration designed to enhance coverage and increase overall network density. By selecting a city facility with existing fiber access, the deployment minimizes construction costs while providing high-capacity backhaul to the City's core network. The addition of this Phase 2 site expands the service footprint beyond the initial Phase 1 coverage area, improving network reach across civic corridors and enabling reliable connectivity for an estimated 900 CPE locations, including community facilities such as libraries, parks, and recreation centers.

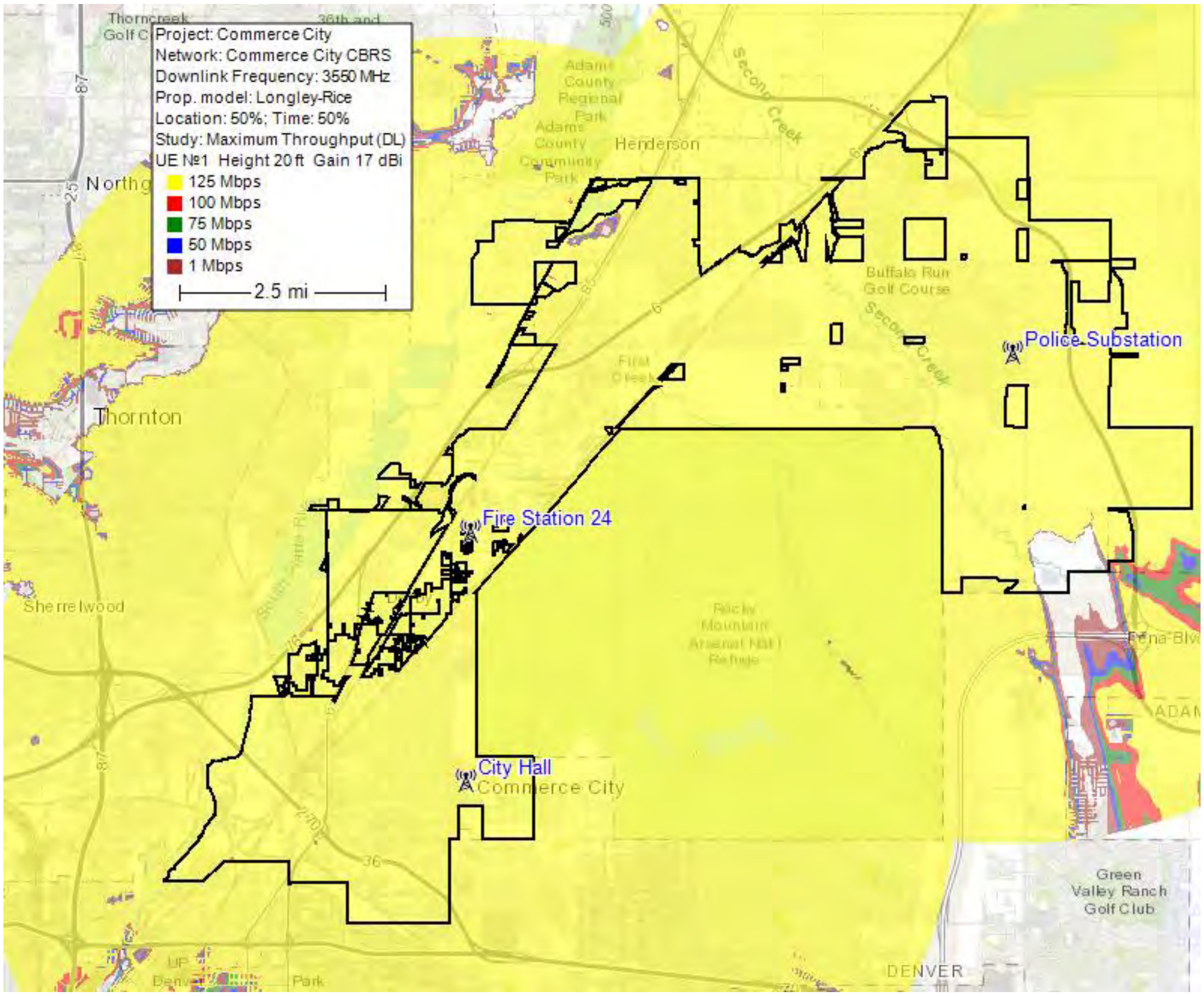

Figure 52. Phase 2 CBRS Network Coverage

Site Selection and Base Station Integration

The three selected tower sites—at the Police Substation, Fire Station 24, and the Commerce City Civic Center—were chosen primarily to enhance the reliability, redundancy, and resiliency of the City's communications network. Together, these fiber-connected facilities form a reinforced public safety backbone linking key operational centers and strengthening municipal connectivity across the northern and central portions of Commerce City. While not located directly within all of the weak-signal corridors identified in the Wireless Survey Technical Memo, their strategic placement supports improved coverage toward adjacent areas where commercial carriers report reduced reliability or slower speeds. These same sites also create new opportunities for commercial co-location by offering existing vertical assets, fiber-fed backhaul, and streamlined permitting—allowing providers to reduce deployment costs and accelerate network improvements using City infrastructure. This integrated approach balances public safety resilience with long-term potential for public-private collaboration and expanded service availability citywide.

Backhaul Integration and Network Resilience

The Phase 2 base station at the Commerce City Civic Center will utilize existing City fiber connections for network integration. This location already provides direct access to the municipal fiber backbone, eliminating the need for wireless backhaul and ensuring high-capacity, low-latency performance with minimal additional construction.

Network Resilience and Scalability

The addition of Phase 2 base stations not only expands capacity but also introduces geographic diversity to improve resilience. By distributing load and avoiding dependence on a single aggregation point, the network becomes better positioned to withstand outages or peak usage conditions. Sectorized base station designs allow directional coverage tuning and future sector additions, enabling a scalable platform for continued growth.

Coverage Focus

This phase focuses on improving connectivity in and around the Commerce City Civic Center, extending service to nearby civic buildings, community facilities, and higher-density residential areas surrounding the complex. Emphasis will be placed on enhancing coverage along adjacent corridors and public spaces with strong community activity and engagement potential. By leveraging existing fiber infrastructure at the Civic Center, this phase strengthens network performance in the city’s administrative core while enabling future expansion to support enterprise, workforce, and IoT applications.

Partnership and Development Alignment

To support broader deployment goals, the City should initiate discussions with potential private partners under a P3 model. Phase 2 presents an opportunity to coordinate new tower or pole development on public land to support both CBRS infrastructure and commercial mobile network expansion. This dual-use approach can address known cellular performance gaps while generating lease revenue and improving service options for residents. Alignment with economic development objectives and digital equity goals will help guide partner selection and investment priorities.

Performance Validation

Following deployment, performance monitoring should focus on measuring increased capacity utilization, service consistency, and redundancy benefits. While Phase 1 emphasized coverage validation, Phase 2 prioritizes load testing, sector balancing, and the demonstration of network performance under multiple concurrent user conditions. Integration with City service applications should be tracked to evaluate operational benefits and inform additional planning.

10.8 Costs and Cost Recovery Strategies

The deployment of a CBRS-based wireless overlay network in Commerce City represents a strategic infrastructure investment with both short-term impact and long-term scalability. The business case balances technical feasibility with cost-effectiveness by leveraging City-owned fiber assets, utility infrastructure, and public facilities. This section outlines the capital and operational expenditures associated with the proposed phased implementation, beginning with an initial core deployment and followed by network densification and geographic expansion. These financial considerations are further informed by deployment priorities, available funding mechanisms, and potential public-private partnership models that could offset costs and accelerate project delivery.

Phase 1 Deployment – Northern Range

Capital Expenditures (CAPEX)

Phase 1 capital costs are estimated at approximately $959,100, covering core infrastructure, base station equipment, customer devices, and outdoor Wi-Fi access points. The design leverages existing City assets to minimize tower and backhaul costs while enabling early-stage service deployment. This includes a 15% allocation for engineering, construction, and project management. Full itemized costs are provided in Table 26.

Operating Expenditures (OPEX)

Ongoing annual operating costs for Phase 1 are projected at $28,980, including internet uplink, utilities, and SAS licensing for CBRS compliance. These recurring costs assume a single base station and support for 100 CPE devices. As the network scales, OPEX is expected to grow incrementally with user volume. A detailed monthly cost breakdown is included in Table 26.

Table 26. Phase 1 CBRS Network Estimated First Year Total Cost

Phase 1 Estimated CBRS Wireless Overlay Cost-CAPEX			
Item	Cost	Units	Total Cost
Cost of Existing City Property Structure	$ --	--	$ --
Tower Cost New	$ 250,000	2	$ 500,000
Utility Pole Set with electric[101]	$ 15,000	--	$ --
Base Station Cost	$ 20,000	6	$ 120,000
Base Station Installation	$ 2,000	6	$ 12,000
Microwave Equipment	$ 25,000	2	$ 50,000
Aggregation Router	$ 5,000	2	$ 10,000
Outdoor Cabinet	$ 1,000	2	$ 2,000
Electric Service (if needed)	$ 5,000	2	$ 10,000
UPS (if needed)	$10,000	2	$ 20,000
10 KW generator (if needed)	$ 5,000	2	$ 10,000
CPE cost ($1000 equipment/350 labor)	$ 1,350	---	$ ---
Outdoor Wi-Fi 1500+500 Labor	$ 2,000	50	$ 100,000
Wi-Fi Router for Home/Office	$ 300	---	$ ---
EPC Access Fee Per CPE	$ 35	--	$ --
Subtotal			$ 834,400
Engineering, Project & Construction Mgmt	15%		$ 125,160
Total Estimated Capex Cost			**$ 959,560**

Phase 1 Estimated CBRS Wireless Overlay Cost-OPEX/Annual			
Item	Cost	Units	Total Cost
Tower Rental for Commercial Towers	$	--	$ --
Utilities	$ 500	2	$ 12,000
Internet Data (if needed)	$ 500	2	$ 12,000
SAS fee per CPE	$ 2	50	$ 1,200
Subtotal	--	--	$ 25,200
Contingency	15%	--	$ 3,780
Total Estimated Cost			**$ 28,980**

Phase 2 Deployment – Core City

Capital Expenditures (CAPEX)

Phase 2 capital costs are projected at approximately $417,450, reflecting the expansion of CBRS coverage through additional base stations, customer devices, and outdoor Wi-Fi equipment. This phase scales the core network by deploying six new base stations mounted on city pole structures, extending coverage to high-priority zones identified in earlier assessments. Costs include expanded Wi-Fi deployments, rooftop or pole-mounted CPE units, and necessary electrical and network support components. A 15% allocation for engineering, project

[101] This cost is eliminated with rooftop mounting.

management, and construction oversight is also included. Full itemized expenditures are shown in Table 27.

Operating Expenditures (OPEX)

Ongoing operating costs for Phase 2 are estimated at $14,496, encompassing utility service, Dedicated Internet Access (DIA), and SAS license fees for 200 active CPEs. These recurring costs reflect the incremental expansion of user coverage and network load, with minimal reliance on commercial tower rental due to the City's use of public assets. A detailed breakdown of estimated monthly operating costs is provided in Table 27.

Table 27. Phase 2 CBRS Network Estimated First Year Total Cost

Phase 2 Estimated CBRS Wireless Overlay Cost-CAPEX			
Item	**Cost**	**Units**	**Total Cost**
Cost of Existing City Property Structure Cost	$ --	--	$ --
Tower Cost New	$ 250,000 [102]	--	$ 250,000
Utility Pole Set with electric	$ 15,000	--	$ --
Base Station Cost	$ 20,000	3	$ 6,000
Base Station Installation	$ 2,000	3	$ 6,000
Microwave Equipment	$ 25,000	1	$ 25,000
Aggregation Router	$ 5,000	1	$ 5,000
Outdoor Cabinet	$ 1,000	1	$ 1,000
Electric Service (if needed)	$ 5,000	1	$ 5,000
UPS (if needed)	$ 10,000	1	$ 10,000
10 KW generator (if needed)	$ 5,000	1	$ 5,000
CPE cost ($1000 equipment, $350 labor)	$ 1,350	--	$ ---
Outdoor Wi-Fi 1500+500 Labor	$ 2,000	25	$ 50,000
Wi-Fi Router for Home/Office	$ 300	--	$
EPC Access Fee Per CPE	$ 35	--	$ --
Subtotal			$ 363,000
Engineering, Project & Construction Mgmt.	15%		$ 54,450
Total Estimated Capex Cost			**$ 417,450**
Phase 2 Estimated CBRS Wireless Overlay Cost-OPEX/Annual			
Item	**Cost**	**Units**	**Total Cost**
Tower Rental for Commercial Towers	$ --	--	$ --
Utilities	$ 500	1	$ 6,000
Internet Data (if needed)	$ 500	1	$ 6,000
SAS fee per CPE	$ 2	25	$ 600
Subtotal			$ 12,600

[102] For planning purposes- the City Center location may allow for placement of CBRS antenna on the roofline rather than constructing a new monopole. This would save the project Phase 2 budget approximately $250,000 but may not be as attractive a collocation site for outside commercial mobile network operators.

Contingency	15%		$ 1,890
Total Estimated Cost			**$ 14,490**

Grant and Public Funding Opportunities

Commerce City's wireless infrastructure initiative, particularly the CBRS-based FWA overlay, aligns closely with the objectives of several federal and state broadband funding programs. These programs prioritize capital investment in scalable, last-mile solutions that can demonstrate long-term viability, digital equity outcomes, and support for critical public service applications.

The U.S. Economic Development Administration (EDA) Public Works and Economic Adjustment Assistance Programs offer competitive grants for infrastructure projects that enhance economic resiliency, workforce development, and industrial access. Broadband deployments, especially those linked to job training sites, industrial corridors, or regional innovation hubs are eligible uses under EDA criteria. Given Commerce City's proximity to regional logistics and manufacturing hubs, a CBRS infrastructure could be positioned not just as a public service, but as an economic development catalyst.[103] EDA grants carry a higher match funding requirement, but existing infrastructure can often be used as an in-kind contribution to cover the match required.

To leverage these programs, the City should prepare for competitive, narrative-driven applications supported by clear engineering schematics, cost models, and community impact projections. Many programs also require local match contributions (often 10–25%) and prioritization of shovel-ready projects with permitting and asset control already established. Commerce City's existing work on site identification and fiber mapping strengthens its positioning for these funds.

Revenue Strategies

In addition to public grants and infrastructure subsidies, Commerce City can explore a diversified set of revenue-generating strategies to offset the capital and operational expenditures associated with the CBRS wireless overlay. These cost recovery methods ensure the network remains financially sustainable while maximizing long-term public benefit.

Subscription-Based Service Models

The City may offer residential and small business broadband through a tiered subscription model. Affordable service tiers (e.g., $15–$30/month) could ensure access for underserved households, while premium tiers could provide higher throughput or device bundling. This model aligns with precedent cases in other cities where municipalities or nonprofit ISPs offer fixed

[103] U.S. Economic Development Administration. "Public Works and Economic Adjustment Assistance Programs." https://www.eda.gov/funding/programs

wireless access under a low-cost service charter, especially in Qualified Census Tracts and disadvantaged areas.[104] Revenue from subscribers could partially offset recurring OPEX such as spectrum licensing, internet uplink, and system maintenance. A full business plan/analysis would be required to determine the scope of potential revenues that might be generated.

Infrastructure Leasing to Third Parties

A CBRS-based network can be designed to accommodate third-party access and leasing. The City can monetize excess tower or backhaul capacity by offering access to commercial mobile carriers or regional ISPs. For example, a mobile network operator needing densification in In Commerce City could lease space on a City-owned pole or backhaul link rather than deploying their own infrastructure, particularly valuable for mid-band 5G deployments.[105] These lease agreements can be structured as flat monthly rates or revenue-share agreements, generating a long-term return on investment.

Offsetting Smart City Operating Costs

The wireless overlay also enables cost avoidance. City departments currently reliant on commercial LTE for IoT devices such as smart meters, cameras, or public safety sensors can migrate those functions to the CBRS network. This reduces monthly SIM costs and improves integration across departments. For instance, a single City-owned CBRS slice could replace dozens of LTE subscriptions currently used by traffic sensors or SCADA systems, eliminating recurring wireless fees while consolidating management under one system.[106]

Public-Private Partnership (P3) Models

To accelerate deployment, reduce municipal financial risk, and support long-term scalability, the Commerce City may consider P3 models as a core component of its wireless infrastructure strategy. These models enable the City to leverage private-sector capital, technical expertise, and operational efficiencies while retaining strategic oversight and advancing public benefit goals such as digital equity, public safety, and broadband availability. Both models reinforce Commerce City's ability to scale its wireless infrastructure sustainably, linking public benefit with private sector capital and creating a viable long-term strategy for funding CBRS growth and operational continuity.

---

[104] Next Century Cities. The Opportunity for Municipal Networks to Deliver Affordable Access. https://nextcenturycities.org
[105] Telecom Infra Project, "Neutral Host Infrastructure Sharing Framework." Neutral Host Infrastructure Sharing Project Group, 2024. https://cdn.mediavalet.com/usva/telecominfraproject/ofHO6Bd0_0eJ9CzmRT83Qg/zKwJK_A0pUC3Wj9m2YyZmg/Original/Neutral%20Host%20Infrastructure%20Sharing%20MC.pdf
[106] U.S. Department of Energy. Communications Requirements of Smart Grid Technologies. https://www.energy.gov

Neutral-Host Infrastructure Model

The neutral-host model allows the City to own or co-own physical infrastructure such as towers, poles, or fiber backhaul, while multiple service providers or private operators lease access to deploy their own wireless equipment. This model promotes infrastructure sharing, reduces visual clutter, and avoids duplicative deployments across neighborhoods. In this arrangement, the City functions as a neutral landlord and may generate recurring lease revenue from mobile carriers, private ISPs, or enterprise customers who use shared assets for commercial service delivery.

Neutral-host designs are particularly well-suited for CBRS networks, where spectrum access is dynamic and device-level authentication can support multiple tenants securely. This approach also aligns with the City's broader goals to expand municipal broadband while allowing private providers to reach additional users at lower infrastructure cost. It creates a competitive, carrier-agnostic environment that enables innovation, encourages service diversity, and increases coverage across underserved areas.

Vendor-Financed Deployments

Alternatively, the City can explore vendor-financed deployment models where private entities fund the construction and management of new wireless infrastructure-typically through a long-term agreement. In this case, the City contributes real estate at reduced or deferred rates, infrastructure availability, or backhaul access in exchange for discounted services, priority coverage zones, or revenue sharing from third-party tenant fees.

As a guiding framework, Commerce City may benefit from establishing a Master Tower Plan-a structured inventory of city-owned and priority real estate, rooftops, and other vertical assets-designated for wireless development. This plan would identify parcel locations suitable for tower builds, rooftop sites, or other attachments (such as water tanks) and include access to backhaul via City fiber. The Master Tower Plan would serve as the foundation for formal partnerships and procurement opportunities, ensuring deployments are aligned with both economic development goals and digital equity outcomes.

Such a plan plays a central role, offering private vendors a ready-made deployment playbook with clearly identified assets, zoning status, and fiber adjacency. This reduces transaction friction and helps the City negotiate stronger terms, such as reserving tower space for public CBRS use or ensuring that revenue from commercial subtenants supports ongoing operations of the citywide wireless system.[107]

[107] National Telecommunications and Information Administration (NTIA), "Public-Private Partnerships: Broadband Infrastructure Deployment," 2022. https://broadbandusa.ntia.gov/funding-programs/broadband-infrastructure-program

Appendix A: Comparative Technology Evaluation

This section presents a comparative assessment of the three technology options using both qualitative and quantitative methods. The evaluation includes a review of relative strengths and weaknesses (pros and cons), followed by a weighted scoring analysis based on the methodology described below. The combined results inform the final technology recommendation.

Methodology

The comparative evaluation of technology options followed a structured, criteria-based scoring process designed to reflect the City's strategic priorities and technical requirements. Each evaluation category (developed and weighted as described previously),was assigned a priority level corresponding to its relative importance for Commerce City. Categories deemed **"Critical"** were given the highest influence on the scoring outcome, while those classified as **"Important," "Secondary," or "Low Priority"** received progressively lower weighting values. This priority designation ensured the evaluation focused on factors most relevant to the City's operational, financial, and public service objectives.

Within each category, the three technology options, ***Wi-Fi 7/PTMP, CBRS, and Private LTE***, were assigned a performance rating on a 1 to 5 scale. A rating of 5 indicated excellent performance or strong alignment with the category's goals, while a rating of one (1) represented poor performance or significant limitations. The weighted score for each category was then calculated by multiplying the technology rating by the corresponding priority multiplier ***(1.0 for Critical, 0.67 for Important, 0.5 for Secondary, and 0.33 for Low Priority).*** The weighted scores across all categories were summed to generate a total weighted score for each technology, providing a transparent, quantitative basis for comparison.

The evaluation framework was designed to be flexible and repeatable. Both the category priority levels, and the technology ratings can be adjusted to reflect evolving City priorities or new technical data. This approach ensures that future assessments can use the same methodology while tailoring the analysis to updated objectives or deployment scenarios.

Evaluation Criteria Rationale and Weighting

The selection of wireless technologies for the Commerce City's municipal network required the careful evaluation of multiple operational, technical, financial, and strategic factors. These factors were grouped into five overarching thematic categories that reflect both technical best practices and practical considerations for long-term sustainability. The following sections describe how each group of criteria was assessed and the underlying rationale that informed the scoring methodology.

Although all 15 criteria were scored numerically on a scale of 1 to 5, with equal weight for the purposes of comparative analysis, several were implicitly weighted more heavily in decision-making and were collectively deemed essential for ensuring both immediate feasibility and long-term operational success. These included:

- *Deployment cost*
- *Operational cost*
- *Sustainability and long-term viability*
- *Grant funding and funding alignment*
- *User experience*
- *P3 compatibility*

Cost and Coverage Efficiency

Deployment cost, ongoing operational cost, and coverage efficiency were grouped together as the most immediate factors influencing both the feasibility and scalability of any wireless solution. These three factors were interdependent. For instance, a solution with low per-node hardware costs could still become expensive overall if a dense deployment of nodes were required to achieve adequate coverage. Therefore, the evaluation placed significant emphasis on total coverage cost per square mile rather than simply assessing individual equipment pricing.[108]

Deployment cost considered the initial capital expenditures required to establish the network, including hardware procurement, site preparation, potential licensing or permitting fees, and any necessary civil works, such as trenching or pole retrofits. Lower deployment costs were favored, particularly where the technology allowed reuse of existing city infrastructure, such as rooftops, light poles, and municipal fiber routes.[109] Technologies that avoided spectrum licensing fees or required minimal site engineering scored more favorably.

Ongoing operational cost reflected the recurring expenses associated with network maintenance, hardware and software support, power consumption, licensing renewals, and any external services such as third-party network management.[110] Systems that minimized vendor lock-in, used open standards, or required fewer personnel for management and support scored higher in this area.

Coverage efficiency was a critical factor influencing both cost and network design complexity. This criterion evaluated the average geographic area that could be served by a single distribution node or access point, considering the radio frequency used, line-of-sight requirements, environmental clutter, and terrain. Technologies offering longer range per node

---

[108] Broadband Communities. “Scaling Wireless Networks for Municipal Use.” 2022. https://bbcmag.com
[109] Federal Communications Commission. “Understanding Wireless Deployment Costs.” https://www.fcc.gov
[110] Gartner Research. “Long-Term Wireless Network Operating Costs.” 2023 https://www.gartner.com

generally reduced overall capital and operational expenses but could introduce trade-offs in bandwidth or latency.[111]

Operational Complexity and Flexibility

This category encompassed network management complexity, scalability, and mobility and roaming support. ***These factors collectively determined how adaptable and manageable the network would be over time.*** These criteria were judged not just on initial capabilities but also on how easily they could accommodate growth and shifting operational needs over a 10 to 15-year planning horizon.

Network Management Complexity assessed the ease of provisioning, monitoring, segmenting, and troubleshooting the network. Solutions that offered centralized, graphical user interfaces (GUIs) with zero-touch provisioning and support for hierarchical access controls were rated more favorably.[112] Technologies requiring specialized RF tuning, SIM provisioning, or proprietary management systems that could increase staff training burdens or vendor dependency were scored lower.

Scalability examined the network's capacity to accommodate increased user demand, geographic expansion, and new applications without requiring a major redesign or disproportionate cost increases. Solutions that could be incrementally scaled by adding nodes, radios, or software features were favored.[113]

Mobility and roaming support were considered in terms of how well the network could accommodate moving devices and users, including field-based municipal staff, inspectors, public safety personnel, and the general public. While this was treated as moderately critical given the largely fixed-use cases anticipated for most municipal requirements, superior mobility capabilities were still recognized as valuable, especially for future smart city applications.[114]

Infrastructure Compatibility and Technical Readiness

Infrastructure compatibility, municipal systems backhaul readiness, security and control, and smart city readiness ***reflected how well each technology aligned with Commerce City's existing assets and future operational objectives.*** These criteria were weighted heavily because the City's network must not only serve current connectivity needs but also function as a long-term platform for innovation and service delivery.

---

[111] Cambium Networks. "Propagation Characteristics of Wireless Technologies." 2023 https://www.cambiumnetworks.com/resource/cambium-wireless-propagation/
[112] Cambium Networks. "Centralized Network Management." https://www.cambiumnetworks.com
[113] Broadband Now. "Wireless Network Scalability Factors." 2023 https://broadbandnow.com/report/fiber-vs-fixed-wireless/
[114] Qualcomm. "Roaming Standards and Mobility Support." https://www.qualcomm.com

Infrastructure compatibility evaluated the extent to which each solution could leverage city-owned vertical assets, including rooftops, streetlights, traffic signal poles, water tanks, and the municipal fiber backbone.[115] Solutions that could minimize new site development or avoid reliance on third-party poles were prioritized.

Municipal systems backhaul readiness assessed the network's ability to carry segmented data streams from SCADA systems, AMI, public safety communications, Internet of Things (IoT) devices, and other smart city telemetry applications. Technologies supporting Virtual Local Area Network (VLAN) segmentation, quality of service (QoS) prioritization, and low-latency delivery were favored[116].

Security and control considered each solution's support for encryption standards, such as WPA3 for Wi-Fi or LTE-standard encryption for cellular networks, as well as the availability of VLAN and Service Set Identifier (SSID) Segmentation and role-based access controls.[117] Systems offering flexible, policy-based management with strong security frameworks scored highest.

Smart City Readiness evaluated how well each technology could support future municipal services, including environmental monitoring, smart lighting, Intelligent Transportation Systems (ITS), and next-generation IoT devices. Solutions that aligned with open standards and supported low-latency, high-capacity operations were considered more future-proof and received higher scores.[118]

User Experience

User experience was treated as a distinct category, reflecting the performance and quality of service delivered to both public users and municipal personnel. This included throughput speeds, latency, concurrency (the number of simultaneous users and devices supported), and seamless roaming between access points. Because user experience directly affects public satisfaction and adoption rates, as well as the reliability of city operations, this criterion was considered critically important, though it stood alone rather than being grouped with infrastructure or cost factors.

[115] IEEE. "Infrastructure Considerations for Municipal Wireless." 2023 https://standards.ieee.org/
[116] Smart Cities Council. "Backhaul Requirements for SCADA and Municipal Systems." 2023 https://smartcitiescouncil.com/
[117] National Institute of Standards and Technology (NIST). "Security Guidelines for Wireless Networks. https://csrc.nist.gov/publications/detail/sp/800-153/final
[118] Smart Cities Dive. "Evaluating Smart City Wireless Infrastructure." https://www.smartcitiesdive.com/

The evaluation favored solutions that could deliver consistent, high-speed connectivity with minimal latency across a range of devices and applications[119]. Emerging standards like Wi-Fi 7 were recognized for offering significant advancements in throughput, multi-link operation (MLO), and latency reduction. Cellular-based solutions were assessed based on their ability to deliver LTE-grade performance or better.

Strategic Value and Funding Alignment

The final category included sustainability and long-term viability, grant and funding alignment, monetization potential, and public-private partnership (P3) compatibility. These strategic factors were considered moderately critical. While not always affecting initial feasibility, they greatly ***influence long-term financial sustainability and the City's ability to maximize the return on its wireless infrastructure investment.***

Sustainability and Long-term Viability assessed the risk of technological obsolescence, vendor lock-in, and support for evolving industry standards. Solutions using open standards with broad industry support were favored, while those relying on proprietary hardware or closed ecosystems were scored lower. [120]

Grant and Funding Alignment evaluated how well each technology met the eligibility requirements of federal and state funding programs, such as Broadband, Equity, Access and Deployment Program (BEAD), Capital Projects Fund (CPF), and American Rescue Plan Act of 2021 (ARPA). Open-access models using unlicensed spectrum and supporting public broadband objectives were generally more aligned with these funding streams.[121]

Monetization Potential considered the ability to generate revenue through ISP partnerships, advertising models, tiered access, or sponsored service tiers. Solutions offering flexible monetization pathways without regulatory, or licensing barriers were rated higher.[122]

P3 compatibility assessed each technology's suitability, including ease of collaboration with ISPs, equipment vendors, and smart city service providers. Open, vendor-neutral solutions were favored because they facilitate a broader range of partnership models.[123]

---

[119] Wi-Fi Alliance. "Wi-Fi 7 Capabilities and User Impact." 2023. https://www.wi-fi.org/discover-wi-fi/wi-fi-7
[120] IEEE 802.11 Working Group. "Wi-Fi Standards Lifecycle." 2023. https://www.ieee802.org/11/
[121] NTIA. "BEAD and CPF Eligibility Requirements." 2023. https://broadbandusa.ntia.doc.gov
[122] Broadband Breakfast. "Monetization Models for Public Wi-Fi." 2022
[123] Brookings Institution. "Public-Private Partnerships in Broadband Deployment." 2022. https://broadbandbreakfast.com/2022/11/monetization-strategies-for-public-wifi-networks/

Table 28. Technology Characteristics Comparative Table

Category	Wi-Fi7/PTMP	CBRS	LTE
Deployment Cost	$1,300–$5000 per node (installed and commissioned).	$8,000–$25,000 per base station (installed and commissioned).	$35,000–$140,000+ per site (macro or small cell).
Operational Cost	$50–$200/month (power, maintenance, backhaul).	$100–$1500/month (power, maintenance, SAS, backhaul).	$500–$3000/month (power, licensing, backhaul, maintenance).
Coverage Efficiency	Coverage: 500–800 ft urban; up to 1,200 ft clear LOS.	Coverage: 1,000–3,000 ft urban; up to 15,000 ft rural.	Coverage: 3,000–15,000 ft (macrocell).
Network Management Complexity	Simple management with standard IT tools.	Moderate complexity; SAS and SIM provisioning required.	High complexity; typically carrier-managed.
Scalability	Modular expansion possible; high flexibility.	Good scalability with fewer nodes than Wi-Fi.	Carrier scalability; requires significant investment.
Mobility and Roaming Support	Limited mobility support; fixed/low-mobility use.	Excellent mobility and roaming (LTE/5G architecture).	Full mobility and roaming supported.
Infrastructure Compatibility	Compatible with rooftops, poles, fiber.	Rooftops, poles, and municipal fiber backhaul.	Integrates with macro towers, small cells, carrier backhaul.
Municipal Systems Backhaul Readiness	Requires fiber/Wi-Fi backhaul integration.	Requires robust fiber backhaul.	Requires carrier fiber or leased backhaul.
Security and Control	WPA3 encryption; VLAN support.	LTE/5G encryption; SIM-based control.	Carrier-grade LTE/5G security protocols.
Smart City Readiness	Supports public Wi-Fi, smart kiosks, basic IoT, video surveillance.	Supports IoT backhaul, workforce mobility, video surveillance, connected vehicles.	Advanced IoT, connected vehicles, public safety, emergency services priority access.
User Experience	Open access; simple onboarding.	SIM provisioning required; moderate onboarding complexity.	Excellent user experience; universal compatibility.
Sustainability and Long-Term Viability	Low OPEX and modular scaling supports sustainability.	Sustainable with managed OPEX; requires skilled operation.	Sustainability depends on carrier partnership terms.

Grant Funding and Funding Alignment	Eligible: BEAD (certain designs), NTIA FFA, USDA ReConnect.[124]	Eligible: BEAD (private networks), NTIA FFA, USDA ReConnect.	Not generally eligible for broadband grants; possible public safety or mobility funding.
Monetization Potential	Potential via tiered services, ads, or ISP partnerships.	Revenue potential through enterprise/carrier leasing.	Monetization controlled by carrier agreements.
P3 Compatibility	Strong potential for city-led P3 or neutral host models.	Compatible with neutral host models and public-private partnerships.	Dependent on carrier P3 interest or site leasing partnerships.

Wi-Fi 7/PTMP Final Analysis

Wi-Fi 7/PTMP represents a flexible, low-cost solution designed for dense urban deployments requiring high throughput and ease of user access. The technology offers low capital and operational expenses, with coverage ranges suitable for street-level and public space connectivity. Wi-Fi 7/PTMP supports scalable deployment through modular node additions and integrates effectively with municipal infrastructure such as light poles, rooftops, and fiber backhaul. While mobility support is limited and performance can be affected by interference in congested areas, the system provides an open-access model with intuitive user onboarding. Its compatibility with a wide range of devices and alignment with public broadband funding programs make it a strong candidate for municipal-managed wireless networks targeting digital inclusion, public Wi-Fi, and smart city applications.

CBRS Final Analysis

CBRS provides a balance between extended coverage, mobility, and enterprise-grade security. Offering longer range than Wi-Fi 7/PTMP and leveraging LTE/5G-grade encryption, CBRS can be suited for both fixed and mobile users in a variety of municipal and commercial use cases. Capital and operational costs are moderate, and the requirement for Spectrum Access System (SAS) coordination and SIM provisioning adds operational complexity but also increases control over user access and quality of service. CBRS supports smart city integrations such as IoT backhaul, workforce mobility, and connected vehicle applications. While grant eligibility is comparable to Wi-Fi-based systems, CBRS can also qualify for certain broadband and smart infrastructure funding programs. Its potential for monetization through enterprise leasing and compatibility with neutral host P3 models provides flexible long-term value.

[124] Eligible programs include the Broadband Equity, Access, and Deployment (BEAD) program, funding broadband expansion nationwide; CPUC Digital Equity programs supporting broadband adoption and inclusion; the NTIA Federal Funding Account (FFA) for middle-mile and broadband infrastructure; and USDA ReConnect, offering grants and loans to deploy broadband in rural areas lacking adequate service.

LTE Final Analysis

LTE offers the most extensive coverage and mobility support, utilizing macro towers and small cell infrastructure to provide city-wide connectivity. It features industry-standard security protocols and excellent user experience with full device compatibility. However, LTE requires significant capital investment and is typically managed in partnership with commercial carriers, resulting in higher operational costs and reduced direct municipal control. Smart city readiness is robust, supporting advanced IoT, emergency services, and connected vehicle applications. Despite limited eligibility for public broadband grants, LTE offers potential for monetization through carrier partnerships or site leasing arrangements. LTE may be best suited for cities prioritizing carrier-driven service expansion, mobility, and advanced connected services over direct municipal management.

Technology Profiles

60 GHz PTMP + Wi-Fi 7

The 60 GHz point-to-multipoint (PTMP) architecture combined with Wi-Fi 7 (IEEE 802.11be) access points ***offers a modular, high-capacity, and flexible wireless network model.*** This design is particularly well suited for cities like Commerce City that possess a substantial inventory of light poles, rooftops, water tanks, and a municipal fiber backbone. The model emphasizes unlicensed spectrum use, segmented public and private traffic, and adaptability for smart city applications.

Cost and Coverage Efficiency

The Capital Cost profile for this architecture reflects the relatively low cost of individual hardware units, including PTMP distribution nodes, subscriber modules, and Wi-Fi 7 access points. These devices are generally more affordable than licensed spectrum solutions, and the use of unlicensed 60 GHz frequencies eliminates spectrum acquisition costs. However, the high frequency's limited range and line-of-sight requirements necessitate a greater number of nodes and access points than longer-range technologies, increasing deployment density and aggregate capital costs.[125]

Ongoing Operational Costs are comparatively low. Unlicensed spectrum use avoids recurring license fees, and modern network management platforms reduce the labor required for monitoring, firmware updates, and troubleshooting. Additionally, the modular nature of this architecture supports incremental deployment, allowing the city to spread capital expenditures over time.[126]

---

[125] Facebook Connectivity (2021). Increasing Capacity with Terragraph: A Scalable 60 GHz, Multi-Hop, Multi-Point Wireless Distribution System. https://terragraph.com/docs/whitepapers
[126] Federal Communications Commission (2021). Technological Advisory Council Report on Cost of Broadband Deployment. https://www.fcc.gov/reports-research/

Coverage Efficiency, while acceptable for urban and suburban areas with dense city assets, is limited by the physics of millimeter wave (mmWave) propagation. Typical PTMP distribution node coverage radii range from 500 to 1,500 feet depending on environmental clutter and line-of-sight availability. This requires higher node density but offers advantages in throughput and interference control.[127]

Operational Complexity and Flexibility

Network Management complexity is moderate and manageable. Centralized platforms such as Cambium's cnMaestro and cloud-based Wi-Fi management tools allow graphical provisioning, policy enforcement, VLAN segmentation, and real-time monitoring without requiring deep RF engineering expertise.[128]

Scalability is a major strength of this model. The modular architecture enables phased expansion, with new PTMP nodes or access points added as needed without disrupting existing services.[129] This flexibility aligns well with municipal budgeting practices and supports growth as community and operational needs evolve.

While the architecture's ***Mobility Support*** is primarily designed for fixed-location use cases (e.g., public access, IoT, smart city telemetry), Wi-Fi 7 introduces fast roaming and multi-link operation that can support municipal staff and light-duty mobile applications.[130] High-speed vehicular roaming, however, is not a primary strength of this solution compared to LTE-based systems.

Infrastructure Compatibility and Technical Readiness

The design's ***Infrastructure Compatibility*** is exceptional. It leverages the City's extensive portfolio of light poles, rooftops, water tanks, and the municipal fiber backbone. These assets provide both mounting locations and power availability, minimizing the need for new site development or leasing of third-party infrastructure. ***Municipal Systems Backhaul*** readiness is considered high. The architecture supports VLAN and SSID segmentation, quality of service (QoS) prioritization, and low-latency delivery of data streams for SCADA, AMI, video surveillance, public safety communications, and IoT devices.[131]

Security and Control features are robust**.** Wi-Fi 7 supports WPA3 encryption, advanced SSID policies, and device onboarding controls. The PTMP distribution layer can enforce VLAN-based

[127] Terragraph Whitepapers: https://terragraph.com/docs/whitepapers
[128] Cambium Networks. "cnMaestro™ Cloud Management Platform." https://www.cambiumnetworks.com/products/management/cnmaestro/
[129] Cambium Networks. "cnMaestro™ Scalable Cloud Management." https://www.cambiumnetworks.com/products/management/cnmaestro/
[130] Celona. CBRS and Wi-Fi: How Does Each Handle Client Mobility? Celona.io, 2022. https://www.celona.io/cbrs/cbrs-and-wi-fi-how-does-each-handle-client-mobility
[131] City of Palo Alto. Wireless Master Plan. https://www.ctcnet.us/wp-content/uploads/2015/09/Palo-Alto-Wireless-Master-Plan-final-for-posting-20150824.pdf

traffic segmentation, isolating public, private, and operational traffic to maintain data security and regulatory compliance. The model also scores highly in ***Smart City Readiness***. The combination of high throughput, low latency, and flexible segmentation supports a wide range of smart city applications, including environmental sensors, traffic management systems, and public safety networks.[132]

User Experience

User experience is a major strength of this architecture. Wi-Fi 7's enhancements, including multi-link operation (MLO), wider 320 MHz channels, and advanced scheduling algorithms, enable realistic peak throughput from 10 Gbps to 15 Gbps with substantially reduced latency. ***This translates into consistent, high-speed public broadband experiences and low-latency performance for city applications such as video surveillance and IoT.*** The architecture supports high device concurrency, accommodating the demands of both public users and municipal services without significant performance degradation in high-density environments.[133]

Strategic Value and Funding Alignment

Sustainability and long-term viability are strong. The model relies on open standards and unlicensed spectrum, minimizing risks of vendor lock-in and ensuring compatibility with a broad range of hardware and management platforms. The evolution of Wi-Fi standards also promotes forward compatibility.[134], while ***Grant and Funding Alignment*** is excellent. The open-access, unlicensed nature of the architecture supports compliance with funding programs such as BEAD and Capital Projects Fund (CPF), which prioritize scalable, publicly accessible broadband solutions that also serve community anchor institutions.[135]

The model offers significant ***Monetization Potential***. The network can support captive portals, tiered service models, advertising platforms, and revenue-sharing agreements with third-party ISPs. ***P3 compatibility*** is high, particularly where P3 Partners can scale at a pace that makes financial sense. The flexibility of the infrastructure and use of unlicensed spectrum enables a

[132] Wi-Fi Alliance. Wi-Fi® for Smart Cities.
https://www.wi-fi.org/discover-wi-fi/wi-fi-for-smart-cities
[133] TP-Link. What is Wi-Fi 7?
https://www.tp-link.com/us/wifi7/
[134] Intel. Wi-Fi 7 Tutorial – Forward-compatible preamble design with universal SIGNAL field (U-SIG). Intel, June 2022.
https://www.intel.com/content/dam/www/central-libraries/us/en/documents/2022-06/wi-fi-tutorial-long.pdf
[135] U.S. Department of the Treasury. Capital Projects Fund Overview.
"Supports broadband infrastructure projects designed to deliver reliable, affordable service to homes and businesses, including those serving community anchor institutions such as schools and libraries."
https://home.treasury.gov/system/files/136/Capital-Projects-Fund-Fact-Sheet.pdf

wide range of public-private partnership models, from shared infrastructure agreements to contracted ISP service provision.[136]

CBRS-Based Network

The Citizens Broadband Radio Service (CBRS) operates in the shared 3.5 GHz spectrum band and offers an appealing balance between range, capacity, and spectrum accessibility. CBRS is designed to support both fixed and mobile broadband services using a spectrum-sharing model authorized by the FCC. ***This architecture provides municipalities the flexibility to deploy private networks or partner with service providers while leveraging LTE or 5G protocols.***

Cost and Coverage Efficiency

Capital Costs- Deployment for CBRS-based networks are generally moderate. The radios and base stations used in CBRS deployments cost more per unit than Wi-Fi or unlicensed millimeter wave (mmWave) solutions, but fewer units are typically required because of the greater coverage range per node, up to 2.5 miles in clear line-of-sight conditions. CBRS deployments often involve additional costs for spectrum access. While General Authorized Access (GAA) is free to use, it can be subject to interference in congested areas. Priority Access Licenses (PALs), which offer protected spectrum use, involve recurring fees or purchase costs.[137]

Ongoing Operational Costs include potential SAS (Spectrum Access System) fees, equipment maintenance, and management platform licensing. Spectrum coordination through the SAS requires both technical management and compliance monitoring, adding some complexity to operations.[138] For CBRS networks, this includes a recurring cost of approximately $2.00 per month for each active Customer Premises Equipment (CPE) device, paid to the SAS provider for dynamic spectrum coordination.

Coverage Efficiency is a huge strength of CBRS. The ability of a single node to cover broad geographic areas reduces the overall node count, lowering cumulative capital expenditures and minimizing the number of pole attachments or building-mounted sites required.[139]

---

[136] International Finance Corporation. Municipal Broadband Networks – Opportunities, Business Models & Public-Private Partnership. https://www.ifc.org/content/dam/ifc/doc/mgrt/em-compass-note-107-municipal-broadband-networks-for-web.pdf

[137] Federated Wireless. What Is CBRS, and How Can It Enhance Service Offerings? https://www.federatedwireless.com/guides/what-is-cbrs/

[138] Mobile Experts & Wireless Innovation Forum. CBRS Overview: Spectrum Sharing and Economics. https://www.wirelessinnovation.org/assets/SSC/mobile%20experts%20cbrs%20overview%20final.pdf

[139] Federated Wireless. Understanding CBRS: Spectrum Sharing and Deployment Advantages. https://www.federatedwireless.com/guides/what-is-cbrs/

Operational Complexity and Flexibility

Network management complexity is moderate. While the core network design aligns with LTE and 5G standards, CBRS introduces additional layers of management for SAS integration and spectrum coordination. These responsibilities often require technical staff or vendor-managed solutions. ***Scalability*** is generally favorable. New coverage areas or capacity increases can be achieved by adding CBRS radios or expanding PAL access. However, scalability can be limited by local spectrum congestion or SAS policies in densely populated areas. ***Mobility and Roaming Support*** is considered strong. CBRS networks, particularly those built to LTE or 5G standards, support seamless mobility like commercial cellular networks. This makes CBRS well-suited for applications involving mobile municipal workers, automated vehicle telemetry, and field staff communications.[140]

Infrastructure Compatibility and Technical Readiness

Infrastructure Compatibility is well suited for Commerce City. CBRS equipment can be mounted on city-owned assets such as rooftops, streetlights, and water tanks. Fewer sites are needed than for Wi-Fi or 60 GHz PTMP networks due to CBRS's superior range, reducing the deployment footprint. ***Municipal Systems Backhaul*** readiness is moderate or better. While CBRS can support VLAN and QoS policies, its LTE-based architecture may require specialized core network integration to achieve the same level of traffic segmentation and latency control as Wi-Fi-based solutions.[141]

Security and Control are robust as CBRS networks inherit LTE and 5G security features, including strong encryption and SIM-based device authentication. However, provisioning SIMs for all devices, especially IoT sensors and municipal assets, can introduce logistical challenges and additional costs. ***Smart City Readiness*** is adequate in that CBRS supports a range of IoT applications and can integrate with smart city platforms. However, variable latency in the shared spectrum and SAS coordination overhead may limit performance for latency-sensitive applications compared to mmWave and Wi-Fi 7 networks.[142]

User Experience

User Experience is comparable to LTE networks. Throughput can reach up to 1 Gbps in ideal conditions, and latency typically ranges from 20 to 50 milliseconds depending on network load and spectrum. On a practical basis, that means from 600 Mbps to 800 Mbps under real world conditions. While this performance is acceptable for most municipal and public access applications, it does not match the ultra-low latency and higher throughput capabilities of Wi-Fi

[140] AHLA. CBRS for Hospitality White Paper. https://www.ahla.com/sites/default/files/CBRS%20for%20Hospitality%20White%20Paper.pdf
[141] Federated Wireless. What Is CBRS, and How Can It Enhance Service Offerings? https://www.federatedwireless.com/guides/what-is-cbrs/
[142] CallMc Networks. CBRS Redefines Communications. https://callmc.com/cbrs-redefines-communications/

7. Moreover, the variable availability of clean spectrum can lead to performance inconsistencies in congested areas.[143]

Strategic Value and Funding Alignment

Sustainability and Long-term Viability are mixed. While the LTE and 5G standards backing CBRS offer longevity and widespread industry support, reliance on spectrum sharing and the evolving policies governing PAL access introduce some long-term uncertainties[144]

Grant and Funding Alignment is moderate as federal and state broadband grants tend to favor open-access and unlicensed spectrum solutions, potentially limiting the competitiveness of CBRS-based projects, especially those requiring PAL access. The ***monetization potential*** exists but is considerably constrained. While municipalities can lease access to service providers or develop sponsored service models, the complexity of spectrum coordination and SIM provisioning limits flexible revenue generation options.[145] Additionally, the ***P3 Compatibility*** has its challenges. While CBRS enables partnerships with mobile network operators and equipment vendors, the technical and regulatory complexity of managing a CBRS network can narrow the pool of willing partners and increase contractual risks.[146]

Private LTE Network

A Private LTE network operates in dedicated spectrum bands such as licensed 700 MHz public safety allocations, leased 900 MHz industrial bands, or shared spectrum like CBRS at 3.5 GHz. Unlike commercial mobile networks, Private LTE gives municipal entities full control over network management, security policies, and device provisioning. This model is often used by utilities, transit agencies, and large enterprises that require highly secure and resilient wireless connectivity.

Cost and Coverage Efficiency

Deployment Costs for Private LTE networks are generally high relative to unlicensed solutions. Capital expenditures include purchasing base station radios, a core network (Evolved Packet Core, or EPC), SIM provisioning infrastructure, and site preparation. Depending on the frequency band and power levels, fewer nodes may be required than with Wi-Fi or 60 GHz PTMP systems because lower-frequency LTE signals cover larger areas and penetrate

[143] CBRS data performance: How it compares to Wi-Fi, LTE, & fiber, Meter Resources, June 2025, https://www.meter.com/resources/cbrs-data
[144] NTIA, Report of Subcommittee on CBRS – Spectrum Access Systems: Lessons Learned, December 2023. https://www.ntia.doc.gov/sites/default/files/2023-12/cbrs_subcommittee_final_report.pdf
[145] Meter. What Is CBRS Private LTE? A clear business guide. https://www.meter.com/resources/cbrs-private-lte
[146] ICMA. Public-Private Partnerships (P3s) White Paper. https://icma.org/sites/default/files/18-109%20Public-Private%20Partnerships-P3s%20White%20Paper_web%20FINAL.pdf

buildings more effectively.[147] Spectrum costs vary considerably. If a municipality or utility partner already holds licensed spectrum, costs may be manageable. Otherwise, acquiring access through lease or purchase can significantly increase capital outlays.

Ongoing Operational Costs are also relatively high. Private LTE networks require specialized staff or third-party managed services to operate and maintain the EPC, ensure regulatory compliance, and manage SIM card provisioning and updates. Power and site leasing costs are typically lower than for small-cell LTE or dense Wi-Fi networks because fewer nodes are needed, but backend operations drive up total cost of ownership (TCO).[148]

Coverage Efficiency Coverage from a Private LTE node can range from 0.5 to 5 miles, depending on terrain, clutter, and antenna height. While lower frequencies generally offer better building penetration and wide-area coverage, access to licensed low-band spectrum is not typically available to cities. For most municipal deployments, CBRS, operating in the mid-band 3.5 GHz range (Band 48), is the most viable option. Cities without Priority Access Licenses (PALs) can still operate in the General Authorized Access (GAA) tier using shared spectrum. CBRS networks can support proprietary protocols or be configured as standards-based private LTE or 5G networks using 3GPP-compliant equipment. However, fully 3GPP-compliant systems, such as those from vendors like Nokia, typically involve higher capital expenditures and ongoing licensing and support costs.[149]

Operational Complexity and Flexibility

Network Management Complexity is high. Municipal operators must manage not only the radio access network but also the EPC or 5G core, device authentication, SIM issuance, and spectrum compliance. These requirements increase IT staffing needs or the cost of managed service providers (MSPs).[150] ***Scalability*** is technically robust. LTE and 5G standards support massive device counts and advanced traffic management. However, scaling often requires significant new capital expenditures, especially for expanding core network capacity.[151]

---

[147] Zebra Technologies. How to Correctly Assess the Value of Private 5G Wireless vs. Wi-Fi, 2023.
https://www.zebra.com/us/en/blog/posts/2023/how-to-correctly-assess-value-of-private-5g-wireless-vs-wifi.html
[148]STL Partners. Total Cost of Ownership: Comparing Private LTE/5G and Wi-Fi Networks, 2022. https://stlpartners.com/articles/private-cellular/private-5g-vs-wi-fi-vs-private-lte/
[149] Celona, "Coverage Metrics for Private 4G" (Help Center)
https://docs.celona.io/en/articles/4113990-coverage-metrics-for-private-4g?utm_source=chatgpt.com
[150] Celona, Private LTE Deployment Guide." The EPC manages mobility, authentication, and subscriber devices, requiring operator expertise or managed services support."
(https://docs.celona.io/en/articles/4113990-coverage-metrics-for-private-4g?utm
[151] Light Reading, "Here's how much a 5G wireless network really costs" Core network requirements for 50,000 subscribers range from $250,000 to $1.2 million, indicating scalable infrastructure comes at a premium. (https://www.lightreading.com/open-ran/here-s-how-much-a-5g-wireless-network-really-costs)

Mobility and Roaming Support is a key strength. Private LTE natively supports seamless mobility and handoff, enabling advanced use cases such as connected vehicles, public safety communications, and city worker mobility. This mobility surpasses what is available in Wi-Fi-based systems.[152]

Infrastructure Compatibility and Technical Readiness

Infrastructure Compatibility is considered satisfactory. Private LTE radios can be installed on city assets such as rooftops, streetlights, or purpose-built poles. Fewer sites are needed than for high-frequency systems, but adequate vertical clearance and power supply remain necessary. ***Municipal Systems Backhaul*** readiness is strong. LTE supports VLAN and QoS standards, though integration with certain SCADA or AMI systems may require additional edge devices or gateways.[153]

As 5G network slicing becomes more widely available, cities may also be able to secure virtualized "private" network partitions on commercial infrastructure, offering many benefits of Private LTE without full ownership startup costs or responsibilities. Network slicing allows operators to create multiple isolated virtual networks on a single physical 5G infrastructure, tailored to specific service needs—such as prioritized, secure connectivity for public safety or municipal applications. Cities can partner with carriers to leverage 5G network slicing—provisioning virtual private network "slices" on shared 5G infrastructure to achieve comparable segmentation, performance guarantees, and security without full private-network hardware deployments. [154]

Security and Control are industry leading. LTE uses SIM-based authentication, strong encryption protocols, and supports advanced traffic segmentation and device whitelisting.[155] However, the complexity of managing SIM cards across thousands of municipal and public devices can be an operational burden. ***Smart City Readiness*** is good. Private LTE supports most smart city applications, including IoT, environmental monitoring, connected vehicles, and public safety video. Its deterministic traffic management and latency controls are suitable for mission-critical use cases.[156]

---

[152] Qualcomm, Private LTE Networks Whitepaper "Private LTE includes intra-network mobility using standard cellular mechanisms and inter-network mobility (roaming) from private LTE to the public RAN." (https://www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/private-lte-networks.pdf)

[153] Sirhan & Martínez-Ramón, "QoS-based Packet Scheduling in LTE," (2022), https://arxiv.org/abs/2208.13053

[154] Viva Solutions : https://www.viavisolutions.com/en-us/5g-network-slicing?utm_source=chatgpt.com

[155] 3GPP TS 33.401 (SAE Security Architecture), specifying LTE SIM-based authentication and encryption. https://www.etsi.org/deliver/etsi_ts/133400_133499/133401/15.07.00_60/ts_133401v150700p.pdf

[156] Nokia, Private Wireless for Smart Cities (2022). https://www.nokia.com/networks/private-wireless/smart-cities/

User Experience

The user experience for municipal operators is strong, offering consistent throughput (typically 20 to 100 Mbps per device) and low latency (20 to 50 milliseconds). However, for public access, the Private LTE model is less suited because devices must be provisioned with SIM cards or eSIMs, limiting flexibility for casual or visitor users. In addition, while coverage and reliability are excellent, throughput and latency generally do not match Wi-Fi 7's performance in high-bandwidth or low-latency use cases like augmented reality or high-resolution video streaming.[157]

Strategic Value and Funding Alignments

Sustainability and Long-term Viability are difficult to predict. LTE and 5G standards will remain in use for at least the next decade, offering a clear upgrade path. However, technology lock-in, dependency on proprietary equipment vendors, and the evolving regulatory environment for spectrum access introduce risks.[158] Many federal and state broadband grant programs prioritize open-access networks and unlicensed spectrum solutions, and the NTIA has recently taken a technology neutral approach, opening up potential grant funding opportunities for wireless solutions.[159]

The overall monetization potential is limited. While Private LTE can reduce operational costs by replacing cellular service for municipal use cases, it is not typically monetized through public access or ISP partnerships because of its closed-access nature. P3 compatibility is moderate, and although partnerships are possible, they generally involve managed services or co-investment models rather than revenue-sharing ISP arrangements.[160]

---

[157] 5Gstore blog: LTE latency ~30–50 ms. 5Gstore: https://5gstore.com/blog/2024/06/17/comparing-lte-to-5g-routers/
[158] Private LTE & 5G Networks (iBwave, 2023), https://info.ibwave.com/ebook-private-lte-5g-networks
[159] Womble Bond Dickinson, "NTIA Makes Substantial Modifications to BEAD Requirements" (June 2025): "NTIA has eliminated the BEAD fiber preference in favor of a technology-neutral approach." https://www.womblebonddickinson.com/us/insights/alerts/ntia-makes-substantial-modifications-bead-requirements
[160] Private vs. Public Wireless Networks: Pros and Cons, TeckNexus. https://www.tecknexus.com/5g-network/private-networks-public-wireless-networks-pros-and-cons/