STUDY SESSION MEMORANDUM

TO: Mayor and Members of City Council

FROM: Nuria Rivera-Vandermyde, City Manager
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DATE: August 24, 2023

SUBJECT: Community Broadband Analysis

The purpose of this study session is to share outcomes of research and analysis conducted at the request of Council, answer questions related to that research and analysis, and ask Council what additional information it needs to decide on a path forward for Community Broadband at a future public hearing. Staff and other subject matter experts have prepared analysis for discussion related to:

- the community's perspective of the city's role in the local broadband market;
- the financial implications of a municipalized internet utility; and
- the market interest from broadband operators /investors in partnering with the city to fulfill Community Broadband objectives.

Pending the outcome of the August 24th study session, a public hearing will be held at a future date for Council to formally decide on the path forward.

EXECUTIVE SUMMARY

The urgency of fulfilling the objectives of Community Broadband[1], originally defined in 2018 and reaffirmed in January 2023, has never been more relevant. Emboldened by the national conversation on the broadening of the digital divide and anecdotal evidence suggesting community dissatisfaction with the current internet landscape in Boulder, staff has listened to community members representative of diverse socioeconomic statuses, races, ages, living situations, and occupations. They have spoken loudly and with remarkable conviction affirming that affordable and reliable internet access is essential for personal and professional life. Most notably, community members expressed

[1] As defined by Council in 2018 and updated in January 2023, objectives for Community Broadband are citywide access, equitable & inclusive, future-oriented, net neutrality, competitive marketplace, and consumer privacy

frustration at the cost, customer service, reliability, and lack of choice[2] in the current internet landscape[3]. 90.3% of Boulder residents desire action from Council to mitigate these challenges[4].

The research presented here is lengthy and the issue before Council is both technically complex and philosophically thought-provoking. However, the crux of this matter can be boiled down to two questions: (a) can the city leverage existing owned telecommunications assets to serve a role in creating citywide and affordable access to fiber-based broadband internet services that achieves the objectives defined by Council; and, if so, (b) should a certain model be employed (i.e., which model is the most viable way to achieve the objectives while balancing other factors of risk, cost, time-to-market, and control)?

Staff and external experts have summarized three potential models below. All three are used widely throughout the nation, are validated by the City Attorney's Office as legally feasible, and achieve our Community Broadband objectives, except where noted. Additional details on each are provided in the Matrix of Options section towards the end of this memo.

1. ***Municipalized Internet Utility:*** An entirely city-owned and city-operated internet service. The city has the benefit of controlling everything from construction through operations and the benefit of realizing all revenues/service fees, but it has the obligation to cover all expenses necessary to build and operate the infrastructure. The city would also bear all risks associated with network failures, lower than projected take rates[5], and competition.

   Can we? It would be challenging.
   - ○ There is a lot of precedence, thus many cities to model, especially regionally. However, the favorable conditions present for other cities (e.g., ownership of electric utility, large amounts of existing owned conduit, and more affordable cost of capital due to lower cost of goods and services) are not the reality Boulder faces.
   - ○ While potentially possible, this is the most expensive model for the city and would require voter-authorized General Obligation debt secured by the General Fund.
   - X Additionally, assuming a 40% take rate, Boulder taxpayers would bear the burden of nearly $10M to $22M a year subsidy (depending on the specific year's broadband cashflows) to cover a shortfall between internet utility revenues and the year's operating expenses + debt service. While this is potentially viable, it would require significant community conversation

[2] Per FCC data, ~64% of Boulder residences have no choice of provider for wired internet service.
[3] Attachment 1 – 2023 Boulder Internet Demand Study
[4] Attachment 1 – 2023 Boulder Internet Demand Study
[5] Take rate is defined as the percentage of potential subscribers who are offered the service that do subscribe.

and entail tough funding trade-off discussions and decisions as other current General Fund services would have to be reduced.

Why should / shouldn't we?

- ✓ This model puts the city in full control from design and construction methods to operational decisions such as price, service area, customer service, and service offerings.
- X This model creates an innate conflict between achieving a Community Broadband objective of a competitive marketplace and the financial viability of the city-owned internet service. The entrance of a city internet utility into the market would, theoretically, increase competition. However, it is possible that competition from incumbent providers and/or entrance of another provider could make an already challenging financial situation impossible for the internet utility.
- X The financial risk to the taxpayer cannot be overstated as Boulder would enter a market with two national internet companies. For the first time in its history, the city would enter a competitive for-profit utility marketplace. The two incumbent providers have significant existing capital investments that they would seek to protect, national marketing and customer service apparatus to appeal to customers, and decades of overall experience in this space. Because of their national customer base, they also, we assume, have more flexibility to lower prices locally to "beat" prices the city could offer and retain market share while maintaining financial solvency. Without additional General Fund subsidy, the city would not have this same flexibility.
- X Time-to-market is critical to serve the needs of constituents and this model will take, conceptually, the longest time to implement.

2. ***Public-Private Partnership (Partially or Fully City-Owned Internet Infrastructure that is Partner Operated):*** This is a balanced approach, with the city realizing the benefit of having a partner address costs and risks to which they are best suited/have expertise, while preserving some level of control (and responsibility) to the city and placing on the city some level of risk.

   Can we? Maybe.

   - ✓ Some market interest from operator and/or capital partners exists.
   - X Similar financial constraints exist as with the creation of a municipalized internet utility.

   Why should / shouldn't we?

   - ✓ Some direct control remains with the city.

- ○ Assuming partial partner ownership in middle- and last- mile infrastructure, the city would likely need to change its Design and Construction Standards[6] to allow shallow trenching[7].
- X The financial risk to the city remains with level of exposure dependent on ownership stake.
- X Time-to-market is likely quicker than with municipalized internet utility, but it remains long.

3. ***Backbone Lease & Right-Of-Way Agreement (Negotiate Community Broadband Objectives with an Internet Provider who owns middle- and last-mile infrastructure and operates network):*** This is the city's most feasible and lowest risk approach. The city leases backbone assets to a third-party service provider. The service provider would fund, construct, and own the middle- and last-mile infrastructure and operate the network consistent with their regular business, subject to the terms of the lease – which would include terms that further the city's Community Broadband objectives either directly or indirectly.

   Can we? Yes.
   - ✓ Strong market interest from capital + operator partners exists.
   - ✓ The cost to the city, relative to the other models, is minimal and would not require the city to issue debt.

   Why should / shouldn't we?
   - ✓ The city has a valuable backbone asset as negotiation leverage.
   - ✓ Additional financial investment and risk is low for the city.
   - ✓ Private capital and partners with extensive market knowledge and construction partnership mean the fastest time to serve customers.
   - ○ The city would likely need to change its Design and Construction Standards to allow shallow trenching.
   - X The city will have less control without an ownership stake in the middle- and last- mile infrastructure or network operations.

Ultimately, Council must decide which one of these models does the best to answer the questions of "can we?" and "should we?". Doing so requires careful consideration of the balance between achieving Community Broadband objectives, cost, control, and risk.

Based on the research presented in this memo, staff will, at a future public hearing, recommend the third option, that the Council authorize the City Manager to negotiate our Community Broadband objectives into a backbone lease and right-of-way agreement with a partner who fully owns the middle- and last- mile infrastructure and operates the internet service in exchange for rights to use existing city-owned fiber assets.

[6] https://bouldercolorado.gov/media/969/download?inline=

[7] Shallow trenching is the practice of laying conduit with infrastructure such as fiber in a narrow and shallow trench cut into roads and other surfaces – typically up to 16 inches deep, above existing utilities in the right-of-way.

QUESTION FOR COUNCIL

1. What, if any, additional information does Council need before deciding between:
    a. authorizing the City Manager to negotiate an agreement with a partner to deliver on the Community Broadband objectives (staff recommendation); or,
    b. instructing the City Manager and staff to continue exploring financing options for a city-owned or partially city-owned network.

BACKGROUND

Boulder City Council approved an investment in fiber backbone infrastructure in 2018 as the first of multiple steps to bring high-quality internet services to Boulder. The approach in 2018 was to construct the backbone and, initially, use it to improve connectivity with city sites, traffic signals, and public safety assets. Ultimately, the vision was to either leverage the backbone with a private partner or use it to create a municipal internet utility. A detailed history of Boulder's Community Broadband efforts can be found in the January 12, 2023, City Council memo. An update of construction on the city-owned fiber backbone, set for completion by the end of 2023, is included in Appendix 1.

At the January 12th City Council Study Session, staff was asked to prepare additional analysis related to the financial feasibility, market interest, and community desire for a municipal internet utility or a public-private partnership. Based on Council feedback, staff executed a six-month analysis project with the following priorities:

- Assess the quality and market interest of private partners through a Request for Information to understand current partnership strategies, industry experience, and level of interest from the private sector in partnering with the city;
- Update cost assumptions and financial modeling for potential revenue and expenses to be generated with a municipal internet utility and understand the city's opportunities to finance a new utility;
- Conduct a statistically valid resident survey, business community focus groups, and interviews with other stakeholders including manufactured home communities, Community Connectors in Residence, peer cities, and incumbent internet providers to assess current sentiments about internet service in Boulder;
- Understand the current internet landscape including who is underserved, and why.

ANALYSIS

Analysis of Wired-Internet Accessibility

The Colorado Broadband Office (CBO) was established in 2016 with the vision that all Coloradans should have equal access to affordable, fast, and reliable broadband service. As the authority on coordinating activity and funding across the state, the CBO has defined acceptable "broadband service" to be speeds of at least 100 megabits per second (Mbps) download and 20 Mbps upload (100/20 Mbps) via wired internet. CBO's definition of broadband-level service is a step further than the Federal Communications Commission (FCC), who defines "broadband" as 25/3 Mbps. For the purposes of the

analysis of broadband accessibility in the City of Boulder, staff have gone a step further than the CBO and used a 250/25 Mbps threshold provided only via wired connection – the gold standard.

Using FCC data[8] from December 31, 2022, staff concludes that 99.5% of residential premises in the City of Boulder have access to the internet via wired connection at 250/25 Mbps. Of these residential premises:

- 99+% have access to cable internet, owned and operated by Comcast, under the brand name "Xfinity".
- 36% of residential premises also have access to a fiber-based option offered by Lumen, under the brand name "CenturyLink".
- Approximately 64% of households therefore have no choice when selecting a wired internet solution for their home.
- Further analysis of the 0.5% (approximately 250 premises) who, according to the FCC data, do not have access to wired internet revealed that all are located on a single manufactured home community parcel. Through discussions with ownership of that manufactured home community, it was revealed that residents typically receive internet through a wireless provider such as Live Wire Networks or T-Mobile.

Community Engagement

The purpose of this phase of community engagement was to (1) inform the community about the status of the Community Broadband project, (2) to understand community and stakeholder priorities for internet quality, price and access, and (3) to assess community perspective on the city's role in providing internet service. This project's engagement plan was supported by a project-based Racial Equity Instrument. It included a discussion with City of Boulder Community Connectors-in-Residence, a statistically valid community survey, business community focus groups, input received via BeHeard Boulder, discussions with owners, property managers, and resident representatives from the city's five manufactured/mobile home communities, and discussions with the city's two incumbent residential wired internet providers, Comcast and Lumen.

Community Connectors

Staff met with the Community Connectors-in-Residence (CC-in-Rs) in May 2023 to seek their feedback early in the community engagement process. Staff asked questions about how CC-in-Rs prioritize attributes of internet service (quality, price, access) and if they believed the city should play a role in Boulder's broadband market.

In general, the CC-in-Rs expressed support for a city-operated service. They suggested that bundling services (phone, internet, tv) would likely be needed to replace offerings from incumbent providers. They shared concerns about how the city would approach equitable access and pricing. CC-in-Rs also expressed value in the Affordable Connectivity Program and believe any city-operated or partnered service must be a program participant.

[8] https://broadbandmap.fcc.gov/home?version=dec2022

The Affordable Connectivity Program (ACP) is a Federal Communications Commission (FCC) program to help low-income households pay for internet service and connected devices like a laptop or tablet. Eligibility is based on household income below 200% of the Federal Poverty Line, or if someone in the household currently participates in certain public assistance programs like SNAP, Medicaid, SSI, WIC, Pell Grant, or Free and Reduced-Price Lunch. If eligible, the household receives up to a $30/month discount on internet service.

This program is used by an estimated 2,500 households (5.3%) in the city today[9].

Funding for the ACP was initially established through Infrastructure Investment and Jobs Act of 2021 but long-term funding for the ACP is currently unknown and, according to some experts, current funding could run out as soon as 2024[10].

Resident Survey and Business Focus Groups

Via a Request for Proposals (RFP) process, the city contracted with an independent research firm, BBC Research & Consulting, to conduct a statistically valid survey of Boulder residents. Statistically valid indicates that the survey responses are from a representative sample of the Boulder population (per 2020 census figures) and promise representative findings with 95% confidence. Additional details on survey methodology can be found in Attachment 1.

BBC Research & Consulting also conducted a series of four focus groups of 8-10 small/medium sized business representatives each to better understand their internet service needs and how they may differ from the residential consumers. The city solicited focus group participation through an invitation to businesses who remit sales tax to the city and to members of the Latino Chamber of Commerce of Boulder County. The Boulder Chamber also included information in a member newsletter.

Key findings from the community survey responses include:

- Most households indicated a desire and demand for city-provided or -partnered services.
- Most households currently pay between $50 and $75 for internet services (inclusive of equipment rental but not including taxes and fees).
- Most households are willing to pay between $60 and $80 per month for city-provided internet services.
- Households make internet provider decisions based on reliability, speed, and cost.
- Households identified various barriers to switching to city services including concerns about cost, quality, and a lack of trust in government-operated services.
- Households not satisfied with their current services are more likely to switch to City-provided internet services than households satisfied with their current

[9] https://www.usac.org/about/affordable-connectivity-program/acp-enrollment-and-claims-tracker/#enrollment-and-claims-by-zipcode-and-county

[10] https://www.brookings.edu/articles/washington-may-be-about-to-take-a-giant-step-backward-in-closing-the-digital-divide/

services (ratings of 4 or 5; not satisfied = 85%; satisfied = 69%).
- Households indicated that current services are expensive, can be unreliable, and lack effective customer support. However, most households remain relatively satisfied with the current Internet services.

Key findings from the business focus groups include:

- Most businesses indicated a desire and demand for city-provided internet services but not necessarily for city-operated. Several businesses expressed skepticism about the city's ability to operate an internet utility without consultation or partnership with an existing provider.
- Businesses, like households, indicated that current services are expensive, can be unreliable, and lack effective customer support.
- A lack of competition for internet services in Boulder was repeatedly cited as a major challenge for small businesses.
- There is often a disparity between upload and download speeds on internet provided via cable to small businesses.
- Businesses make internet provider decisions based on reliability, speed, and cost.

The full research report including details on each question can be found in Attachment 1.

BeHeard Boulder

The Community Broadband project page on BeHeard Boulder aimed to update the community on project status while gathering preferences from constituents on the issue before Council. Engagement was low and may not reflect the opinions of the broader community. Feedback indicated that some people prefer emulating the Longmont and Fort Collins model (municipal internet utility) while others expressed support for a public private partnership model. Affordable and competitive pricing was a priority for many respondents, and some expressed doubt about the city's ability to provide the service.

Manufactured Home Community Discussions

In July and August 2023, city staff met with representatives of all five of the city's mobile/manufactured home communities (Boulder Meadows, Mapleton, Orchard Grove, Ponderosa, and Vista Village). Representatives included owners, property managers, and current residents. Direct outreach was conducted after analysis demonstrated the only non-wired internet access for residential service in the city was in a mobile home community. These properties, ranging in size from approximately 60 to 650, presented various challenges with the current internet landscape. Four of the five properties are 100% served by Comcast and/or Lumen while one is mostly served by wireless providers. The approximately 250 residences not served by Comcast and/or Lumen are in one community and are the only residences in the city unserved by wire-internet at 250/25 Mbps. Property owner permission is required for Comcast and/or Lumen to bring internet service to residences within a manufactured home community.

Affordability is the main challenge for every community with annual price fluctuations highlighted as a major issue for those living on a fixed income. While many residents qualify for the ACP due to household income, many do not. Poor customer service and

convoluted marketing were also major complaints of residents, particularly from elderly community members. Additionally, multiple communities expressed concern over increased physical security threats and how the presence of security cameras with appropriate data connection not currently available could act as a deterrence (notes: staff did not validate claims of increased crime in these areas; it is widely accepted that the presence of security cameras does act as a deterrent to some types of crime).

All the communities expressed a willingness to, in theory, bring additional infrastructure on site to serve their residents, provided it was at no cost to home- or land- owners.

Incumbent Internet Service Provider Discussions
Incumbent small-business and residential wired-internet providers operating in the city, Comcast and Lumen, are critical partners in the pursuit of our Community Broadband objectives. Strong relationships with both providers are and will continue to be a cornerstone of Community Broadband. In August 2023, staff met with representatives from both companies to share additional information related to the goals of creating citywide fiber-based and affordable internet for all.

Comcast, the provider with the most customers in the city as of August 2023, continues to invest in its already robust cable-based internet network in the city. Comcast's investments are focused on improving the ways their existing infrastructure can handle the demands of more data transfer. They also continue to provide bundled services for wired phone, cable TV, and home security services. Furthermore, Comcast's Internet Essentials program, now in its 12th year, provides low-cost internet to income qualified customers – in many cases, customers can leverage ACP funding to receive service at no cost.

Lumen, or "CenturyLink", has constructed a fiber network that is available to approximately a third of Boulder residents and small businesses. They have documented plans to invest in an expansion of this network to serve additional premises, but those plans are currently unfunded. Lumen, too, participates in the ACP program and delivers a service to income qualified customers that is effectively free of charge when the customer leverages the ACP.

Financial Analysis

Via amendment to a contract originally awarded in 2014, in the summer of 2023 the city worked with an independent consulting firm, CTC Energy and Technology, to provide updated capital estimates and analysis of expected revenues and expenses for a municipal internet utility. While the city provided inputs to some of the assumptions below, the "market-based" assumptions and the financial modeling are the sole work of CTC based on their broad expertise in the global fiber-based broadband market. The resulting forecasts that this analysis is based on are, of course, forecasts and may be influenced by unforeseen changes in the market. A summary of CTC's modeling is in Attachment 2.

The assumptions in the analysis are based on current industry practice and include:

- 43,634 "passings" (homes and businesses), with 8% qualifying for a low-income

federal subsidy;

- 40% “take-rate" (percentage of total serviced premises that pay for the service) 6-years after construction is complete;
- Construction costs based on current Boulder costs for the backbone and industry standards, escalated for construction in 2024 – 2026 and assuming 10% contingency;
    - Assumes 100% underground conduit construction and uses city conduit where existing.
- Operational costs based on similarly sized municipal operations and a combination of city staff and contracted services;
- Interest rate of 5% for debt service on 25-year term bond;
- Average revenue generated per month from for residential and business customers at $70, $30/month for income qualified customers, and a $50 one-time connection fee;
- Price assumptions are aligned with the current market and with the Boulder resident survey that is summarized in the Resident Survey and Business Focus Groups section of this memo.

Capital Investment Estimate

There are significant capital expenses to connect homes and businesses to the existing city-owned fiber backbone. In addition to the backbone capital costs that City Council approved in 2018, the capital investment to bring fiber to premises is currently estimated to be $217.7M in 2023 dollars.

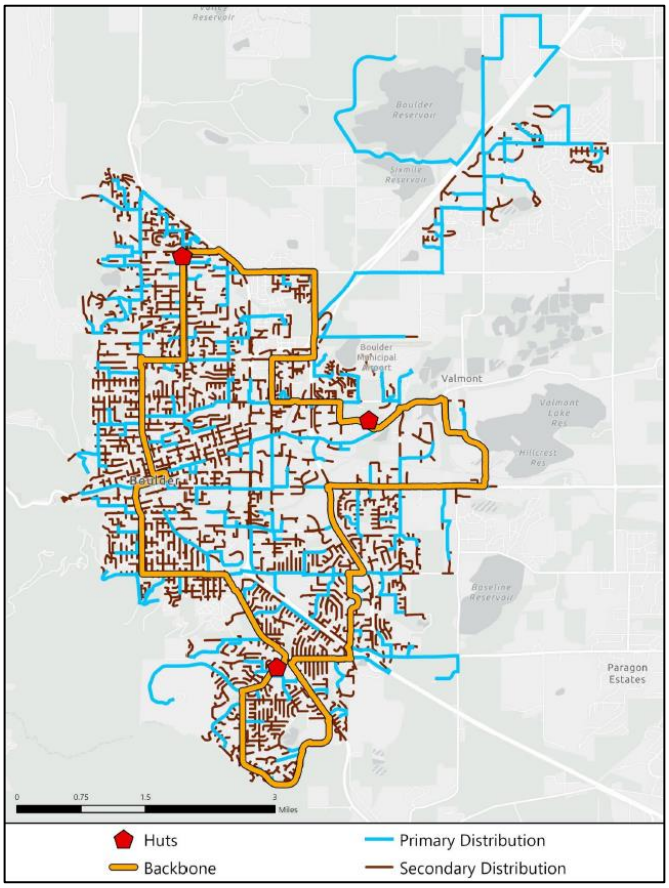


Figure 1

$217.7M would construct approximately 325 miles of underground conduit to homes and businesses. Figure 1 illustrates a notional core design that would enable the passing of 100% of premises in the city, enabling accessibility for all. The $217.7M capital estimate assumes 40% of these premises take service and drops are constructed. If 100% of homes take service additional capital costs would be incurred for the additional drops raising the total cost to $274.0M in 2023 dollars. Details regarding the assumptions and construction rates used to calculate the capital estimates are provided in Attachment 2. While the capital cost estimate is $217.7M, considering inflation over 5 years of construction, cashflow shortfalls during construction, financing fees, and required reserves, the total amout of debt the city

would need to issue is estimated at $295.2M. For the purposes of this memo's analysis when referring to the capital required, $295.2M will be used.

Capital Financing Options
Considering the capital need, staff consulted with the city's financial advisors at Hilltop Securities, and bond counsel, Kutak Rock, in outlining the capital financing options.

As of December 31, 2022, the city has a total of $256.21M in outstanding debt including the following:

- $6.57M General Obligation Bonds ($10M initially issued)
- $48.35M Certificates of Participation ($61M initially issued)
- $43.39M other debt supported by base rentals ($61.23M initially issued)
- $18.66M other debt liabilities
- $139.24M Revenue Bonds supported by water and sewer revenue ($178.89 initially issued)

The voters have also authorized the city to issue an additional $192.7M for the following purposes:

- Climate Initiatives - $59.2M in authorized Par
- Capital investments including facilities through the Community, Culture, Resilience and Safety Tax (CCRS) - $110M in authorized Par
- Open Space and Mountain Parks (OSMP) - $23.5M in authorized Par

There are two potentially viable financing option for the $295.2M capital required:

- **Issue General obligation bond secured by current General Fund revenue sources.** While this is potentially viable, it would require significant community conversation and entail tough funding trade-off discussions and decisions as other current general fund services would have to be reduced.
- **Securing voter approval for a general obligation bond supported by a new increment of tax.** This option would require both a tax increase to be approved by Boulder voters and the municipal internet utility to be identified by Council as the highest priority for a new tax initiative.

Several other financing paths were explored and determined not to be viable, including:

- **Utilizing the existing water / wastewater utility enterprise fund and pledging water / wastewater utility rates.** This path is not viable due to existing bond covenants and the level of outstanding debt, including planned debt issuance in late 2023 and 2024. Advisors also noted that while communities have leveraged a municipal electric utility for an internet utility, they were not aware of an instance where a water utility was used.
- **Issuing voter approved general obligation debt to fund construction and when the internet utility is sufficiently operational creating a broadband enterprise fund and issuing enterprise bonds to retire the general obligation debt.** The city has enterprise funds, like water and wastewater utilities, that

operate under different municipal finance rules based on the fund being self-supporting through service fees and, importantly, having less than 10 percent tax support. This option is dependent on the internet utility qualifying as an enterprise and, according to the modeling, it would not because it would require significant tax support. Thus, this option is not viable.

- **Issuing Certificates of Participation**. This is the method used to fund the broadband backbone and is a financing mechanism based on pledging existing city assets, typically buildings. However, with the significant capital costs expected with a municipal internet utility, there are not enough city assets to create the size loan that the city would need.

If the city determines it wants to own part or all the middle- and last-mile fiber infrastructure, then the city's Finance Team, City Attorney's Office, and bond counsel will need further study on the viable financing options.

Operational Revenue and Expense Analysis

To estimate revenue for a municipal internet utility, take rate and pricing are the two most important factors. An optimistic take rate of 40% was used as the base case for this analysis given the factor of two incumbent providers.

CTC also used industry-standard pricing to create revenue projections:

- $70/month for homes and businesses
- $30/month for low-income households
- $50 one-time connection fee

The statistically valid resident survey that was completed as part of this analysis supports residential rates of $60-80/month[11].

Revenue projections reflect a multi-year build of the full network and acquiring customers as the build is completed in their neighborhoods. It is estimated that it would take six years to reach the assumed 40% take rate. At the six-year maturity mark, revenues are estimated at $18M. Revenue growth then stabilizes assuming a flat take rate of 40% and only increases reflecting an annual inflation factor of 3%. Revenues are reflected in Figure 2 below.

[11] See Attachment 1 for more details on price sensitivity.

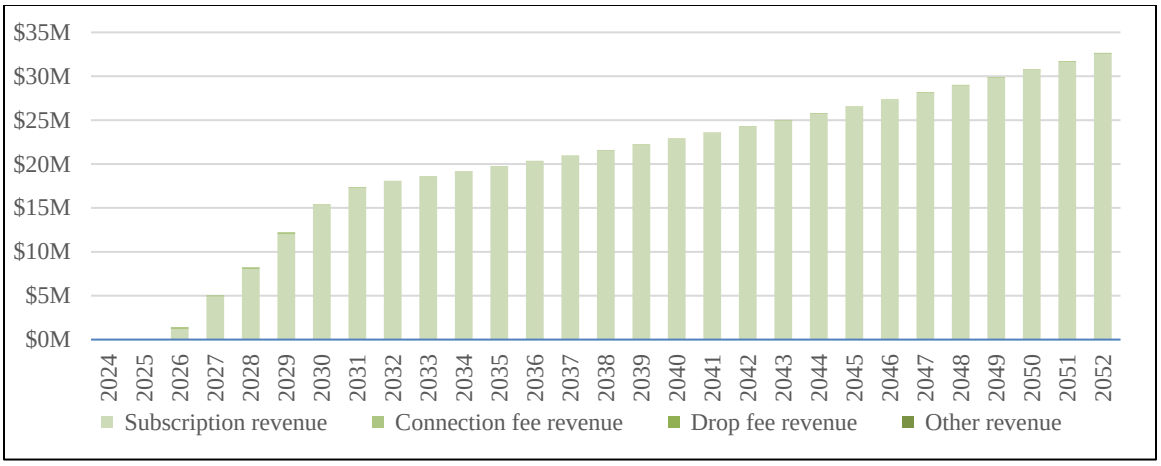


Figure 2

Operational expenses include all the costs to run the internet utility: staff, contractor costs, equipment, maintenance of the network, insurance, and more. At year 6 (when take rate is assumed to reach 40%) operational costs, not including debt service, are approximately $8M/year and then increase over time reflecting inflation. Expenses are modeled in Figure 3 below.

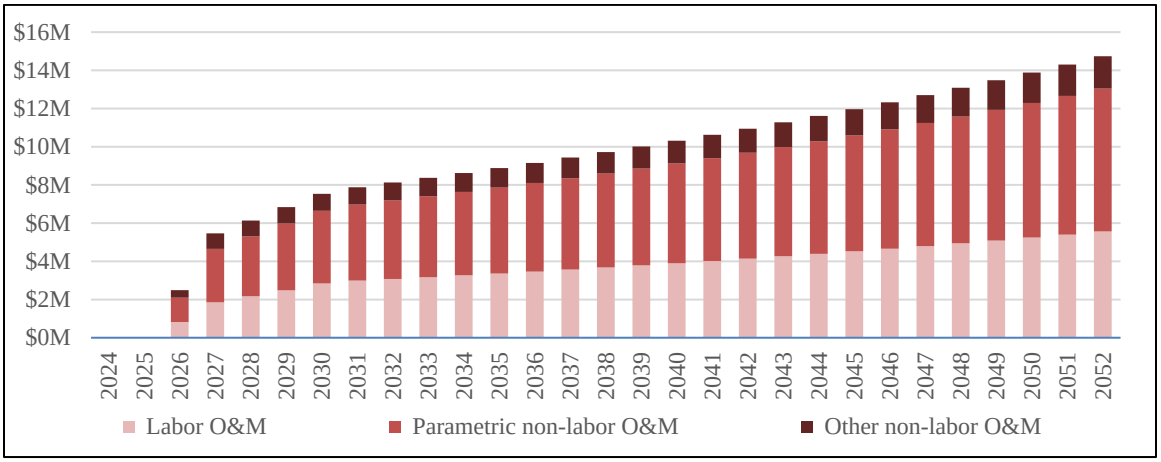


Figure 3

Additionally, debt payments must be made over the term of the debt. The average annual debt payment is $23.9M. This, in addition to the operating expenses detailed in Figure 3, are combined in Figure 4, below, to illustrate the total cash outlay annually.

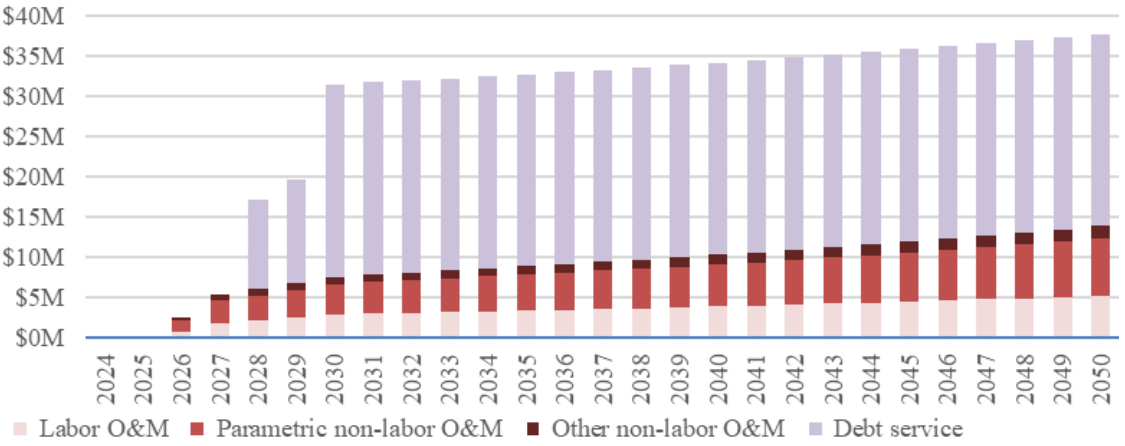


Figure 4

Combining the operational expenses ($8M/year) and debt service ($23.9M/year) there is a total of $32.5M expenses per year. With revenues generating $18M annually, a shortfall is observed. This shortfall remains throughout the term of the debt and only at its full payment does the city recognize a surplus. During the term of the debt the shortfall averages $16.5M annually and ranges from $10M - $22M depending on revenue and operating expense assumptions. These shortfalls are shown in Figure 5 below.

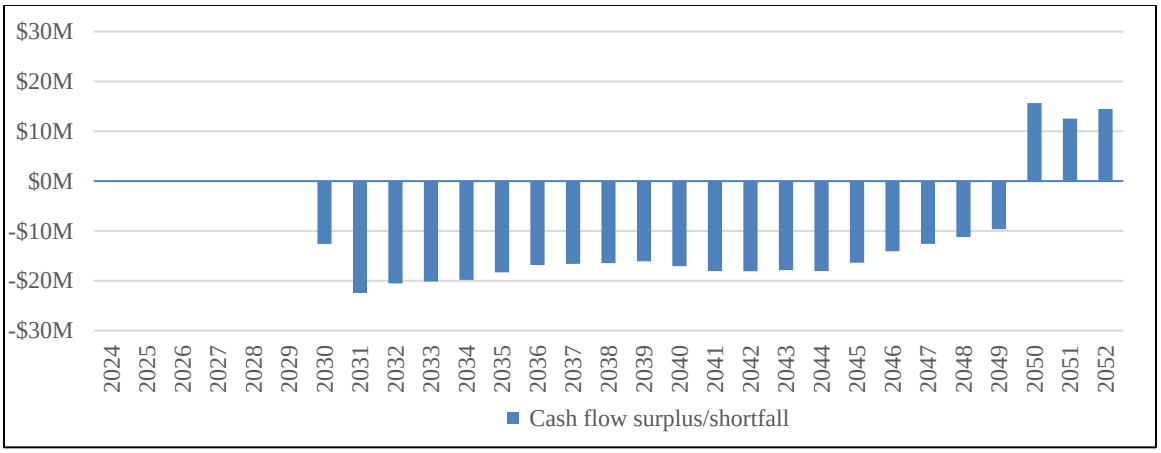


Figure 5

The amount of revenue that could reasonably be generated by a municipal internet utility in Boulder is not enough to cover all the operational costs and the entire debt service. Thus, Boulder taxpayers would bear the burden of nearly $10M to $22M a year subsidy (depending on annual broadband cashflows) in addition to paying market-rate prices for a municipal internet service.

This is not viable for the city for several reasons including the high costs to boring underground conduit in Boulder, lack of economies of scale for construction materials and human resources, and the number of homes and businesses available to generate revenue for the utility. If the city is willing to employ shallow trenching construction (detailed in the Construction Analysis below) for the secondary distribution routes and drop access to premises, it is estimated the capital burden would be $18M less. However, for the purposes of this financial analysis, that reduction in capital burden would not eliminate the annual cashflow shortfall during the term of the debt.

Partnership Interest Analysis

The city issued a Request for Information (RFI) to the broadband community to gauge the interest of for-profit and nonprofit entities in forming a partnership with the city to make Gigabit-class bandwidth available to all Boulder homes and businesses.

The city received eight RFI responses from a variety of internet service providers, investors, and open-access technology providers. Staff interviewed a subset of the respondents, based on the quality and relevance of their proposal, to understand their intent more fully.

There were three main approaches proposed by the industry:

A. City-owned, partner-operated: This model leverages the industry's expertise in operating internet service organizations, though all the capital financing is generated by the city. City ownership of the entire network has benefits, including more leverage in negotiating expected outcomes for the internet service's quality, price, and access. It also provides the control for the city to build to every premise ensuring fiber access to all.
B. Shared ownership, partner-operated: This model utilizes the low cost of government financing to create shared ownership via the city and partner. Both contribute financially to the network construction and then the partner operates the internet service, leveraging its expertise.
C. Partner-owned, partner-operated: This is a common approach as the private market looks for ways to enter new markets. The partner finances the capital costs and owns all the infrastructure (aside from the backbone, which the city will continue to own) and only seeks city assistance in right-of-way permitting. The city has some negotiation leverage to ensure Community Broadband objectives are achieved by offering lease-based access to the city-owned fiber assets. These include but are not limited to the newly constructed 432-strand dark fiber backbone and the adjacent empty conduit capable of fitting an additional 432-strand backbone.

The matrix of options in the next section further summarizes the attributes, benefits, and weaknesses to each of the models.

Construction Analysis

Section 9.21 of the city's Design and Construction Standard outlines telecommunication construction standards. It dictates that the minimum depth of cover of telecommunications conduit shall be 30 inches. While the city's backbone conduit was bored at a minimum depth 30 inches, compliant with this standard, all the potential partners offering to bring private capital would seek a different construction method for them to realize the return on investment required. This alternative construction method is known as shallow- or micro- trenching. While staff is not requesting Council action on this item at this time, it is important to know that given the opportunity to negotiate a backbone lease & right-of-way agreement with a partner, staff would consider the partner's desired construction methods and balance those with the high standards for construction in our right-of-way. Any proposed changes to the Design and Construction Standard would be brought forward to Council for ultimate approval.

A whitepaper by the Fiber Broadband Association dated March 2023[12] provides an overview of shallow trenching as it relates to other conduit construction methods and how it is a key ingredient in achieving 100% broadband access in the United States. Additional staff research into the viability of shallow trenching in Boulder is required.

[12] https://fiberbroadband.org/wp-content/uploads/2023/06/Microtrenching-Accelerates-Fiber.pdf

MATRIX OF OPTIONS

As detailed in the Executive Summary, three models are presented:

		Municipalized Internet Utility	Public-Private Partnership	Backbone Lease & Right-Of-Way Agreement
Description of Approach	Backbone Infrastructure Owner	City	City	City
	Middle- and Last- Mile Infrastructure Owner	City	Shared	Partner
	Service Provider	City	Partner	Partner
	Partner Relationship	N/A	Revenue sharing; Policy objectives negotiated	Policy objectives and/or fees negotiated for use of existing city-owned assets.
Likelihood of Achieving Objectives	Citywide Access	Very High	Very High	Very High
	Equitable & Inclusive	Very High	Very High	Very High
	Net Neutrality	Very High	Very High	Very High
	Future-Oriented	High	High	Very High
	Competitive Marketplace	High	High	Very High
	Consumer Privacy	Very High	Very High	High
Cost to the City[13]	Capital (2023 Dollars)	$218M - $274 M[14]	$0 M - $274 M[15]	$0
	Debt Required[16]	$295M - $370M	$0M - $370M	$0
	Operating	$2M - 14 M[17]	$1M[18]	$1M[17]
Time-to-Market Estimates	First Customer	3 years	2.5 years	18 months
	Full Build	7 years	6 years	4 years
Level of Control in Retail Strategy (Price, Speed, Customer Service, Mix of Service Offerings)		Very High	Moderate (Negotiable w/ Partner)	Low (Negotiable w/ Partner)
Middle- and Last- Mile Construction		City Determined	Shallow Trenching	Shallow Trenching
Partnership Market Interest		N/A	High	Very High
Major Risks		• Financial • Reputational • Start-Up • Network security	• Partner management • Financial	• Partner management
Other Communities with this Approach		Longmont, CO Ft. Collins, CO Loveland, CO	West Des Moines, IA Fountain, CO Fort Morgan, CO	San Antonio, TX Salt Lake City, UT Lincoln, NE

[13] Unless otherwise noted, all cost estimates derived from Attachment 3.
[14] Range represents the construction of drops to 40% of homes passed to 100%.
[15] Range represents a value from zero to full ownership for the city pending negotiation.
[16] This is the total debt required inclusive of base capital cost in 2023 Dollars, inflation considering 5 years of construction, cashflow shortfalls during construction financing fees, and required reserves.
[17] The operating cost range represents costs from early build years to full build.
[18] City-generated estimate for ongoing city owned asset maintenance, partnership management, and community engagement

Ultimately, Council must decide which one of these models does the best of answering the core questions of can we? And should we? Doing so requires careful consideration of the balance between achieving Community Broadband objectives, cost, control, and risk. Based on the research presented in this memo, staff will, at a future meeting, recommend that the Council authorize the City Manager to negotiate a backbone lease and right-of-way agreement with a partner who fully owns the middle- and last- mile infrastructure and operates the internet service and pays lease payments in exchange for rights to use existing city-owned fiber assets.

NEXT STEPS

Pending Council's feedback, additional data needs, and general alignment with staff's recommendation:

- Staff to complete additional data requests, as needed;
- Schedule a Public Hearing for Council to vote on a proposed motion to authorize the City Manager to negotiate an agreement with a partner to deliver on the Community Broadband objectives.

ATTACHMENTS

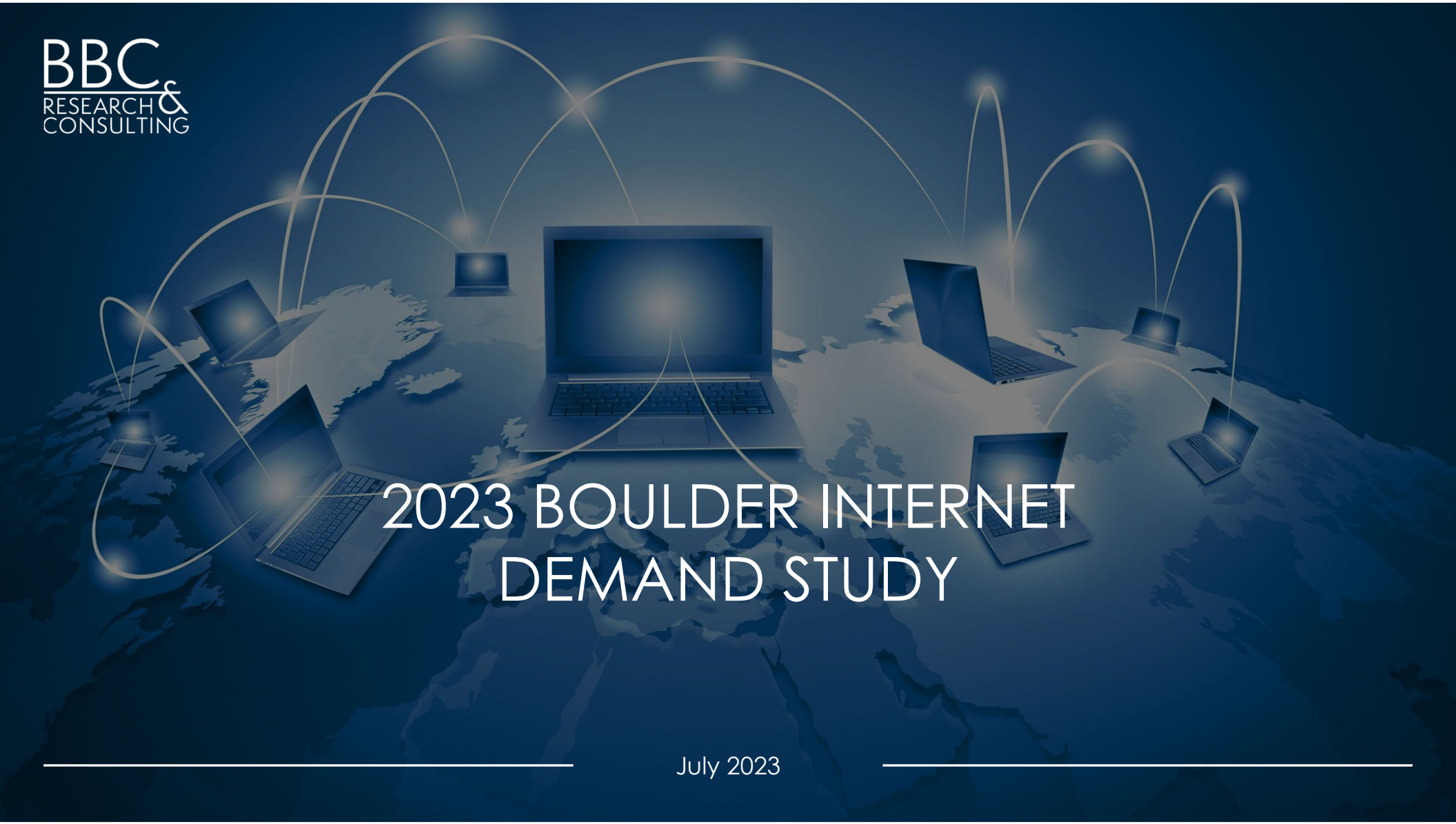
Attachment 1 – 2023 Boulder Internet Demand Study, *BBC Research & Consulting*
Attachment 2 – Summary Report: FTTP Cost Estimate and Financial Model, *CTC Energy & Technology*

APPENDIX 1 – BACKBONE CONSTRUCTION UPDATE

In 2023, even with challenging winter and spring weather impacting daily production in the field, progress on the city's fiber backbone was positive. At the end of 2022, production of the total project was at 74%. Since then, it has moved up to 86% with progress in our very rock-prone areas of phases 5 and 6 (Canyon and Table Mesa rings). Our goal remains to complete all backbone construction by late Fall 2023 and current production rates put us on track to achieve that. Approximately 33,000 ft of backbone bore work and conduit placement remain.

In addition to backbone construction, we have completed lateral construction to eleven new sites where all fiber work has also been completed and include city facilities, public safety, and community partner sites. With some previously connected radio tower sites and buildings, the project supports live circuits (or connectivity) to nine locations with several more coming onboard in the summer months.

All fiber work, deployment, splicing and testing related to phases 1-4 and 7 (North Broadway, Iris, Downtown, Arapahoe, and Diagonal rings) have been completed and the city's traffic signal connections will be terminated and tested during August and September. Once complete, the fiber backbone will connect to a total of 112 traffic signals.


BBC
RESEARCH &
CONSULTING
2023 BOULDER INTERNET
DEMAND STUDY
July 2023

BBC RESEARCH & CONSULTING

- Objectives and approach
- Business focus groups
- Resident surveys
- Key findings

OBJECTIVES AND APPROACH

OBJECTIVES

- Gather perceptions of current Internet service options
- Identify Internet needs and any existing service gaps
- Assess the value of various Internet service qualities
- Evaluate demand for City-provided Internet services

APPROACH

FOCUS GROUPS

Internet perceptions among Boulder-based **small businesses** of different types

SURVEYS

Internet perceptions among demographically-representative Boulder **households**

BUSINESS FOCUS GROUPS

METHODOLOGY

- Four focus groups (one in-person and three virtual) with small businesses of different types
- 5 – 7 participants in each group
- Discussion topics included choosing Internet providers, service needs and gaps, perceptions of current providers, and demand for City-provided services (see Appendix A)

VALUE OF SERVICE QUALITIES

- Most participants indicated that reliability is their highest priority for Internet service.
- Speed and cost were commonly cited as the second and third highest priorities.
- Customer service was consistently cited as the lowest priority when choosing a provider.

CHOOSING A SERVICES PROVIDER

- Business representatives typically make provider decisions based on reliability, convenience, speed, and cost.

"We chose Comcast for its reliability and speed for the money."

"Comcast was really the only one that could do what we needed it to do."

"[Century Link] just sent a mailing that they were new in the neighborhood and the price seemed right and the service has been fine."

- Participants frequently mentioned the lack of competition for Internet services in Boulder.

"The primary problem is a lack of competition."

"It's really annoying to have to rely on whatever service is available to you in your area, which does make it … a monopoly for them, and you are at their mercy."

"It was kind of a default to go with Comcast. … There's no other option, really."

INTERNET NEEDS

- Fast, reliable, and affordable access is critical to small businesses in Boulder.
- Many businesses require the ability to:
  - Participate in video conferences;
  - Upload and download large files;
  - Access remote software and cloud storage; and
  - Have many individual connections to the Internet.

"We're frequently leading Zoom meetings with between two and a 100 participants."

"We upload and download lots of large […] files on a daily basis, if not hourly."

"Our database is stored remotely, so in order to get the necessary information throughout the day and provide information, everything is stored remotely. … It's critical."

"We often have 200 or more people needing to use the Internet at the same time."

GAPS IN SERVICES

- Service options are expensive, with much higher pricing for businesses.

"I know a lot of people have trouble affording anything in Boulder, just being able to get some reliably good service."

- Connectivity can be unreliable, especially in certain areas of the city.

"Service quality has gotten a lot more inconsistent. There [are] definitely periods of time where we've lost service altogether. It can be as much as one or two times a day that we lose it for a few minutes here and there, so I also now have an additional hotspot service as backup."

"We have one to two, if not three daily outages."

- There is often a disparity between upload and download speeds.

"We use more upstream bandwidth than we do downstream, and that's very typical for many business types, and it is beyond infuriating. …We can't get a faster upstream at the location that we're at."

- Customer service is lacking.

"There are maybe 10 people in the company that know what they're doing, but otherwise, until you can get to them, it's ridiculous."

"If there's an outage with Comcast or [Lumen], good luck. It may be an hour or two before you found out, even if you happen to even find out what's going on."

DESIRABILITY OF CITY SERVICES

- Almost all business representatives supported the concept of City-*provided* Internet services but not necessarily City-*operated* Internet services.

"Municipal broadband [would] drive the incumbent carriers to be much, much better … . You won't see Comcast and Lumen leave the area, because they hate to see that as a success story for community broadband. So, they'll improve their service levels, they'll become more competitive in price."

- Boulder businesses are eager to have additional service options as long as they are reliable.

"I like competition, but competition also has to be comparable competition. So we can't just say that we have five Internet service providers, but only one of those providers is doing an adequate job of meeting our needs."

- Internet service is crucial to both residents and businesses, making the success of the project paramount.

"[The City] can't mess this up because if [they do], not only are people's lives going to be impacted because people rely on the internet, but as residents, we going forward won't be able to trust [the City] with some of the bigger asks that [they're] asking for in terms of municipalization."

CONCERNS ABOUT CITY SERVICES

- Although almost all participants supported a City-provided option, several businesses indicated that they do not trust the City to effectively operate an Internet utility itself.

"I just don't think the City is in a position to pull that off or run any kind of … Internet kind of company. The City is barely keeping it together with all the stuff that a city is supposed to provide."

"The City really needs to get their act together and make sure that this is something that they can pull off and do. They have competent people in charge, [but] they don't turn it into another Boulder Building Department."

"I just have absolutely zero faith in the City being able to pull this off."

- Some participants cited the City's past attempt to municipalize an electric utility as a reason for their skepticism.

"[Boulder] hasn't demonstrated a lot of competency with some of their municipal services."

"I hope this thing goes better than the electric utility that Boulder thought they were going to put together."

PUBLIC PRIVATE PARTNERSHIPS

- Some business representatives are also skeptical of the City entering into a partnership with a third party. Various reasons include:
  - A perception that existing problems with existing providers would not be solved;
  - Skepticism around profit incentives for private partners (although some see such incentives as a good thing); and
  - The City's loss of control over pricing and service quality

"I would be concerned about partnering … it would be too easy to invite all the problems that the Internet currently has."

"I don't see any great benefit to going to the people that [they're] going to compete against, ask them to come in so they can make more money. I would rather not do it than line the pockets of a Lumen or a Comcast."

"I think the incentives are better aligned when it's a private company that's managing it. They have a financial incentive. They have a, 'We're going to lose customers,' incentive in a way that the government just doesn't."

"If the City has made the major capital investment, I'm not sure that the solution now is to turn it over to some third party to implement it."

"That loss of control can be pretty significant to the end user, in terms of the accountability, the level of service, … and what the actual government is going to be able to hold people accountable to."

PUBLIC PRIVATE PARTNERSHIPS

- Some business representatives think the City does not have the expertise to operate an Internet utility without the assistance of a third-party partner.

"I think it should be left with entities that have a history, and they know how to do it and there's a little bit of competition perhaps. Yeah, I would be concerned about the level of service, honestly, having worked with the City on other things."

"[We need] a larger business who's done this multiple times and has that scale capacity and can bring in savings as a result of that scale."

- Some business representatives suggested that the City enter into an impermanent partnership with an existing provider, eventually taking full control of Internet operations itself.

"You could get a company, but just on a, 'Okay, make us great, make us a wonderful system, give us the knowledge, and we're paying you to come and service and help us through.' And then that should be dropping off."

"I would be open to a tiered approach of giving the City parameters that they must meet by a certain deadline. So if they haven't met those parameters then the fallback is we have a third party come in and take it over."

LONGMONT INTERNET

- Unprompted, participants in each focus group cited Longmont's municipal Internet as an exemplary way to operate services.

"I would say that Longmont might prove the case that it's possible to run a utility scale internet service in a good way."

"We've got some clients in Longmont that use Longmont's fiber, and it's been great. They do a great job."

"We have an example of[an Internet utility] being well run and well managed nine miles away. I really think that we should look to our neighbors to see how it has worked for them."

"We've got a sister city in Longmont that's doing it, let's go talk to them"

- Business representatives suggest consulting with or partnering with the City of Longmont.

"Let's go to Longmont, and say, 'Can you double your staff, or triple your staff? And can you run our broadband facility?' It doesn't have to be the City of Boulder."

EQUITY IN INTERNET SERVICES

- Unprompted, several businesses indicated that equity in Internet access across Boulder is a priority for them.

"I would be interested in the City putting its money, my money, into universal access on a sliding scale. I don't need my rate to come down, but it does bother me that there are families and individuals in my town who can't afford Internet access … .

"It needs to be something that everybody can afford. And it shouldn't be something that's a privileged offering."

"The social component is huge, and I just mention it as a marketing tool or a messaging tool for how to get this across. I think that this group is likely willing to pay the same, if not more, slightly more, for similar services if it were accessible to all. So as far as getting this by voters or getting people behind this thing, I would really, really look at the social component as a necessary piece of the communication."

- Many business representatives think *the City* is best positioned to advocate for equity in providing Internet services in Boulder.

"I think that the only way we can get to some of our stated goals of equity is if the City runs it. We don't have any power to tell Comcast or Lumen to make broadband accessible to our low-income residents."

DEMAND FOR CITY SERVICES

- Most business representatives indicated they would switch to City-provided services.

"I would definitely be an early adopter if the City decided to run their own broadband right now."

"We'd probably try it right away."

- Some participants would want redundancy with their current providers in the early stages of getting City-provided services.

"I like the idea of … redundancy. I think that … would make me feel safe, while I'm still supporting this very much needed infrastructure."

" … were we to make the transition, we would need to … have both services [Comcast and City-provided] available for a period of time, because I also talk a mean game about my mistrust of both contractors and Boulder government's ability to do something well."

- The City's choice to operate Internet services itself or with a third-party partner does not seem to have a substantial effect on demand.

PUBLIC FUNDING OPTION

- Participant support for additional public funding options is mixed and largely contingent on the structure of the funding mechanism.

"Sure, raise taxes on the businesses that are going to benefit from it. I can look at the cost of one single four-hour outage every three months, which is about typical for our Boulder location. … I think that the financial burden … businesses could shoulder a lot of that burden and it would benefit everybody."

"I want [a public funding mechanism] to be based more on people living here versus the companies. … And I think with the prevalence of working from home and the lifestyle in Boulder … this is more for serving the people than the businesses, per se."

- Some business representatives do not think additional public funding is necessary.

"I would question if you don't have to have a profit, if the infrastructure is already there, why would the City not be able to run this [without additional public funding?"

"It shouldn't be a broader taxpayer charge, unless you choose to do things like equitably allow minimum levels of service for reduced or $0 … ."

RESIDENT SURVEYS

METHODOLOGY

- Online surveys with households across Boulder
- 417 demographically representative participants, per U.S. Census data
- Survey topics included current Internet services, service usage, service needs and gaps, perceptions of current providers, demand for City-provided services, and price sensitivity (see Appendix B)
- Results shown overall and separately by satisfaction with current services (select questions)
- Results weighted by participant age*

* BBC used a weight of 0.60 for participants 35 years of age and older and a weight of 0.40 for participants between the ages of 18 and 34. We based those weights on United States Census data after accounting for the number of college students in Boulder.

PARTICIPANT CHARACTERISTICS

Hispanic	% of sample
Yes	8%
No	92%

Race	% of sample
White	87%
Latino/a	2%
Asian	2%
Black or African American	1%
American Indian/Alaska Native	0%
Native Hawaiian/Other Pacific Islander	1%
Two/More races	7%
Other	1%

Income	% of sample
Less than $25,000 a year	6%
$25,000 to $49,999 a year	14%
$50,000 to $99,999 a year	25%
$100,000 to $149,999 a year	19%
$150,000 a year or more	36%

Education	% of sample
No 4-year college degree	16%
4-year college degree	84%

Gender	% of sample
Woman/Female	51%
Man/Male	47%
Gender nonconforming	1%
Self-describe	1%

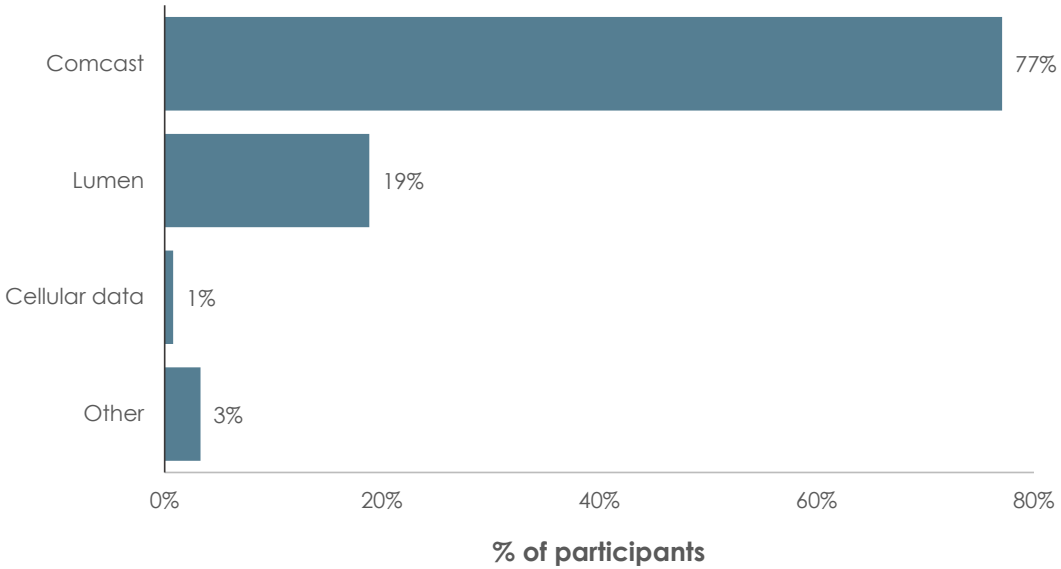
Age	% of sample
18 - 24 years old	6%
25 - 34 years old	17%
35-44 years old	18%
45-54 years old	17%
55-64 year old	21%
65 years old or older	22%

Home ownership	% of sample
Own	68%
Rent	31%
Other	2%

*Q1; Q25 – Q28**

* Responses for demographic questions were not weighted.

CURRENT INTERNET SERVICES



Which provider do you use to access the Internet? [Q6]

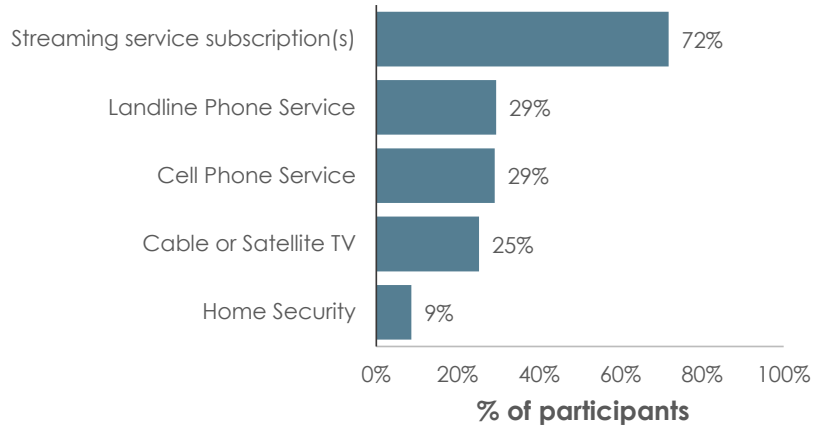
- Most households get Internet services from Comcast (77%).
- Outside of Comcast and Lumen, very few households get services from other providers (4%).
- Only 5 participants indicated they don't have Internet access at home (did not continue survey).

BUNDLED SERVICES

71%

do not bundle services

Do you pay for Internet services as part of a bundled package that includes other services? [Q7]

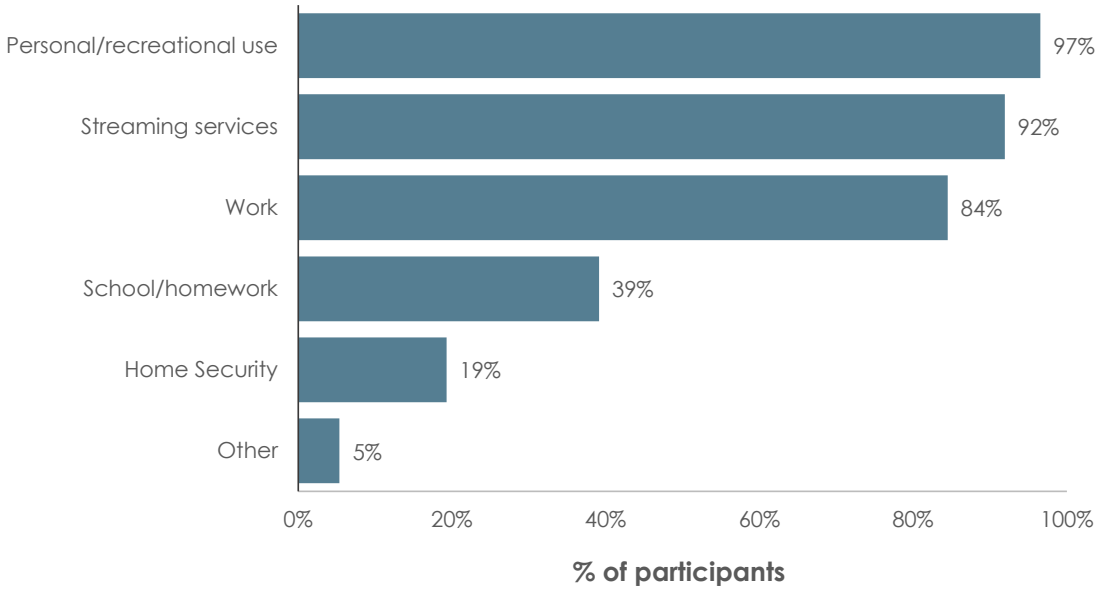


*What services, other than Internet, are included in your bundle? [Q8]**

- Most households do not bundle additional services with their Internet (71%).
- The households that do so tend to bundle Internet with streaming services (72%).

* Participants could select multiple items for Q8.

INTERNET USE

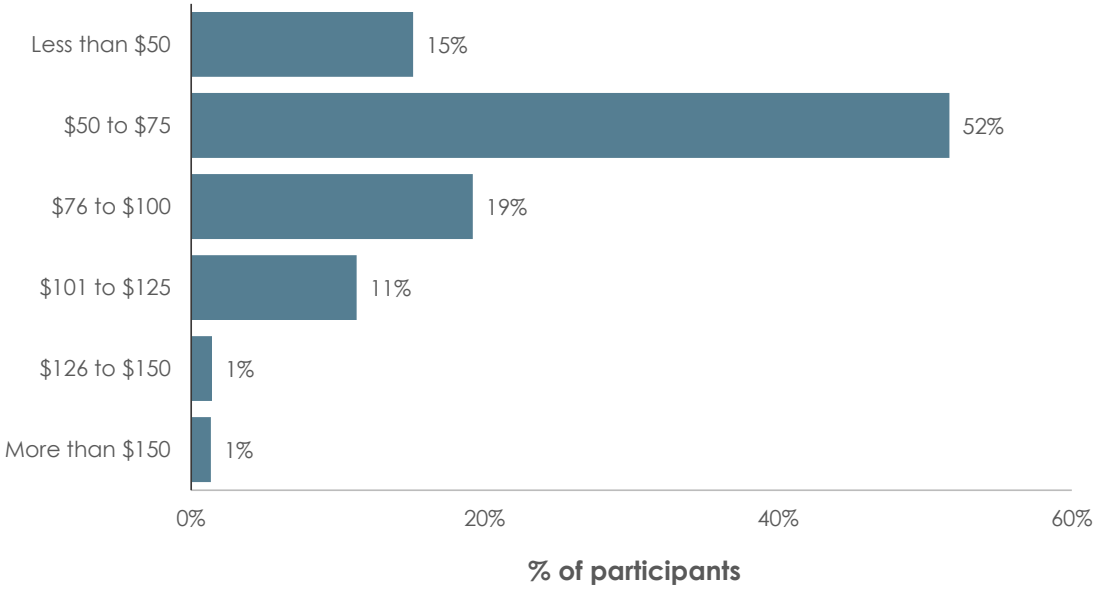


*What are the ways in which you use home Internet services? [Q11]**

- Nearly all households use Internet for personal use (97%) and streaming services (92%).
- Smaller—but still substantial—percentages of households use Internet for work (84%) or school (39%).

* Participants could select multiple items.

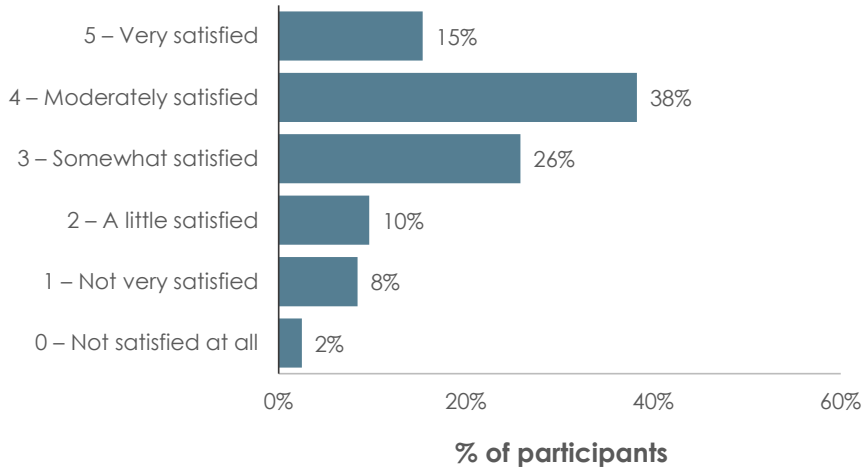
PRICING OF CURRENT SERVICES



How much do you pay for home Internet services (not bundled services)? [Q10]

- Most households pay between $50 and $75 for Internet services per month (52%; including equipment rental but not taxes.)
- Relatively few households pay less than $50 per month for Internet services (15%).

SATISFACTION WITH CURRENT SERVICES



Rate how satisfied you are overall with your current Internet services. [Q13]

Poor customer service

Unreliable service

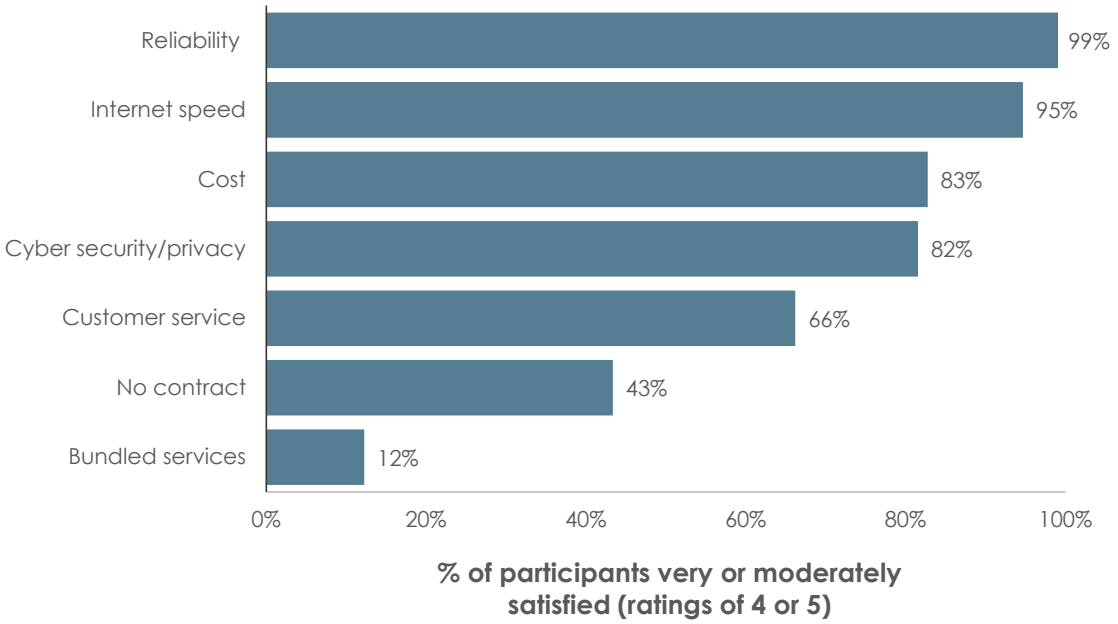
Costs too much

Slow speeds

Tell us a little about why you're not satisfied with your current Internet services (if unsatisfied). [Q14]

- Most households are satisfied with their current services (ratings of 4 or 5; 53%)
- Those households not particularly satisfied with their services cite poor customer service, unreliable service, high costs, and slow speeds as reasons for their dissatisfaction.

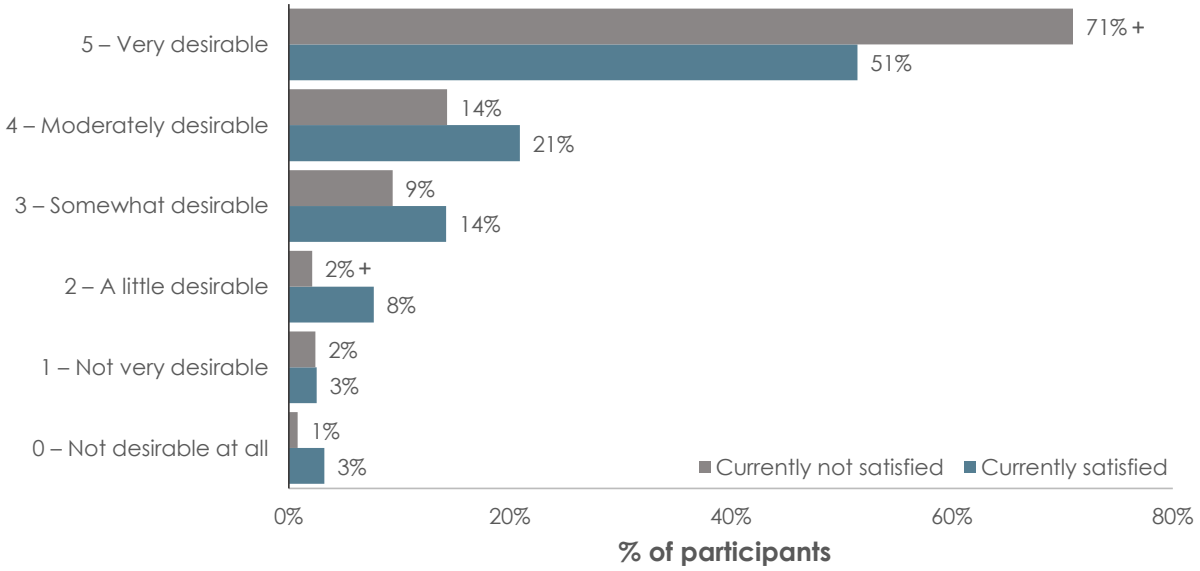
CHOOSING SERVICES PROVIDER



Rate how important each of the following factors are to you in choosing an Internet services provider. [Q12]

- Factors most important to households in selecting a services provider include service reliability (99%), Internet speed (95%), cost (83%), and cyber security (82%).
- Relatively few households find bundled services to be particularly important in selecting a services provider (12%).

DESIRABILITY OF CITY SERVICES



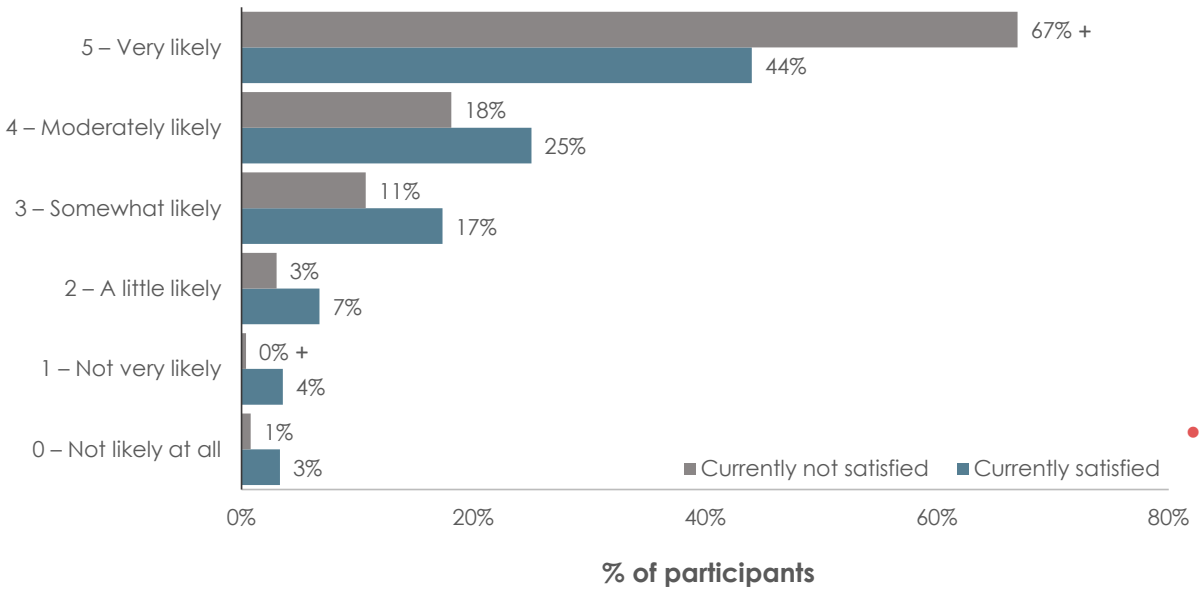
How desirable would it be to you for the City to begin providing Internet services? [Q15] *

- Households **not satisfied** with their current services find the idea of City-provided Internet services more desirable than households **satisfied** with their current services (ratings of 4 or 5; not satisfied = 85%; satisfied = 72%).
- Very few households, regardless of their level of satisfaction with their current services, find the idea of City-provided services as undesirable (ratings of 0 or 1; not satisfied = 3%; satisfied = 6%).

+ indicates statistically significant difference between groups

** **Currently satisfied** defined as participants who gave overall satisfaction ratings of 4 or 5 to Q14; **Currently not satisfied** defined as participants who gave satisfaction ratings of 0, 1, 2, or 3 to Q14.*

LIKELIHOOD TO SWITCH



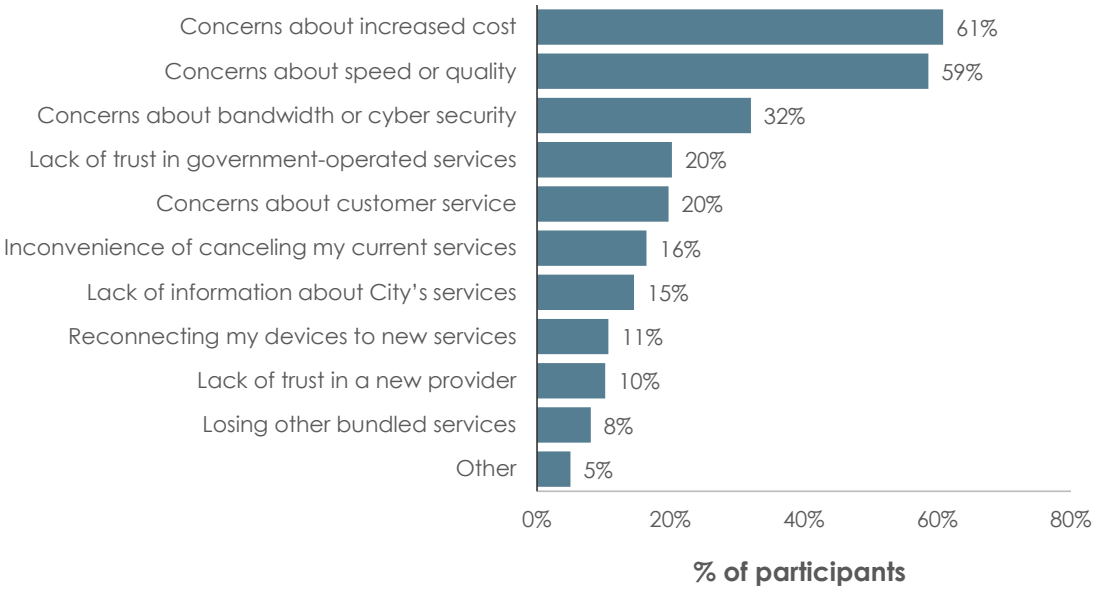
How likely would it be that you would switch from your current services to fiber-based Internet services that the City would provide? *

+ indicates statistically significant difference between groups

* ***Currently satisfied*** *defined as participants who gave overall satisfaction ratings of 4 or 5 to Q14;* ***Currently not satisfied*** *defined as participants who gave satisfaction ratings of 0, 1, 2, or 3 to Q14.*

- Households **not satisfied** with their current services are more likely to switch to City-provided Internet services than households **satisfied** with their current services(ratings of 4 or 5; not satisfied = 85%; satisfied = 69%).
- Very few households, regardless of their level of satisfaction with their current services, are unlikely to switch to City-provided services (ratings of 0 or 1; not satisfied = 1%; satisfied = 7%).

BARRIERS TO SWITCHING

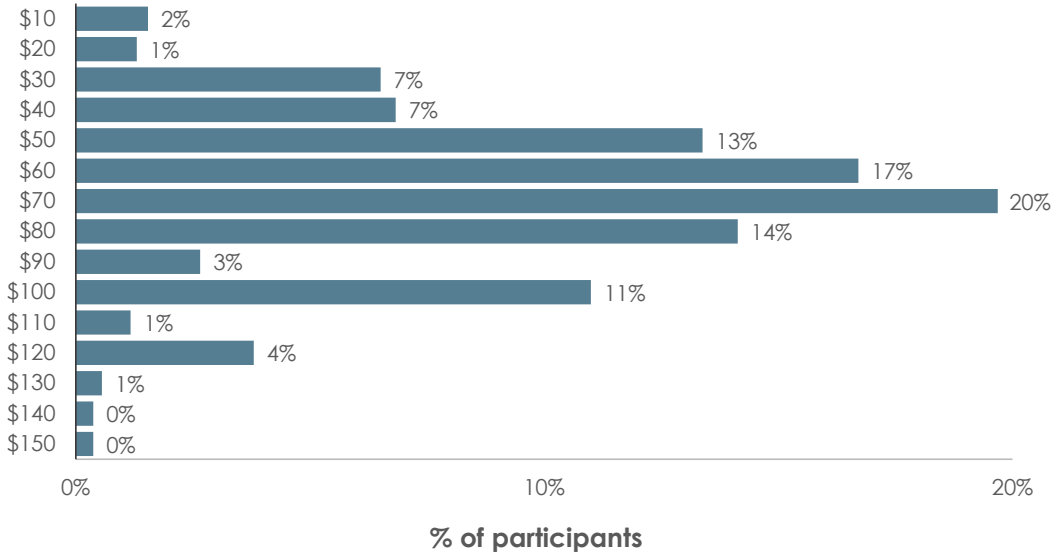


*What would be the biggest barriers for you to switch from your current services to the City's fiber-based Internet services?**

- Households **most often** cite concerns about increased cost (61%) and speed or quality (59%) as barriers to switching to City-provided services.
- Households **least often** cite lack of trust in a new provider (10%) and losing bundled services (8%) as barriers to switching to City-provided services.

* Participants could select multiple items.

PRICE FOR CITY SERVICES



How much would you be willing to pay each month for fiber-based Internet services that the City would provide? [Q18]

- Most households would be willing to pay between $60 and $80 per month for City-provided services (51%; including equipment rental but not taxes).
- The price point households most often indicate for City-provided services is $70 per month (20%; including equipment rental but not taxes).

KEY FINDINGS

- Most businesses indicated **desire and demand for City-*provided* Internet** services but not necessarily for City-*operated* services. Several businesses expressed skepticism around the City's ability to operate an Internet utility without consultation or partnership with an existing provider.
- Most households indicated a **desire and demand for City-provided** services.
- Most households currently pay between **$50 and $75 for Internet services**, which is approximately what they are willing to pay for City services (inclusive of equipment rental but not including taxes and fees).
- Businesses and households make Internet provider decisions based on **reliability, speed, and cost**.

- Households identified various barriers to switching to City services including **concerns about cost, quality, and a lack of trust in government-operated services**.
- Businesses and households indicated that **current services are expensive, can be unreliable, and lack effective customer support**. However, most households remain relatively satisfied with the current Internet services.

APPENDIX A:
FOCUS GROUP DISCUSSION GUIDE

Introduction

Welcome everyone! My name is Stephanie Ayers – I am a Senior Project Manager with BBC Research & Consulting. BBC is a 53-year-old research firm located in Denver. We specialize in leading discussions like this one about different issues related to consumer and business insights.

BBC is working with the City of Boulder to explore options for delivering broadband Internet access across Boulder. The City is considering the possibility of partnering with a third-party or establishing a City-operated Internet utility—to provide high-quality, affordable Internet service to Boulder residents and businesses.
The City of Boulder has been constructing the foundational infrastructure for fiber internet service, called a "dark fiber backbone", which will be completed this year. With the backbone in place, Boulder can either partner with a third-party to finish construction of the fiber infrastructure and provide internet service, or Boulder can do so on its own as a new municipal internet utility. Boulder is currently in the process of assessing these options, and your input today is valuable to their assessment.

You were invited to participate in this focus group because you represent businesses that work in the marketplace, and we want to hear your perspectives and thoughts regarding Internet services in the City of Boulder as well as your needs and priorities as they relate to broadband Internet access, cost, and quality. Our goal is to engage you in a free-flowing discussion about those topics. We want you to be respectful of one another's ideas, but please feel free to share whatever is on your mind.
Today's discussion will last about 90 minutes, and we're committed to ending on time. We will record this session to accurately capture your thoughts. Unless anyone has any questions, let's get started!

Warm Up (5 minutes)

Let's go around and introduce ourselves. Please briefly tell us:

- Your name and the business you represent; and
- A little about your business: what type of work you do and how your business currently uses the Internet.

Factors for Choosing an Internet Provider (10 minutes)

Let's begin by discussing the Internet options that exist in Boulder, primarily Comcast/Xfinity and Century Link, which is now known as Lumen, and what factors influenced your business' decisions regarding your Internet provider.

- What Internet service provider does your business currently use? Does your Internet package also include other services, such as phone service or cable TV?
  - If your Internet package does include other services, are these other services valuable to your business? Did bundling these services ultimately reduce the cost of these services to your business?
- What factors led your business to choose the Internet provider that it did?
- Did Internet access or service options factor into determining where to locate your business? If so, how?

Internet Service Needs and Gaps in Service Delivery (15 minutes)

Let's talk more specifically about what your business' needs are as they relate to Internet service, and where you may see gaps in service with your current provider.

- How much does your business use the Internet on an average workday? How important is quality Internet service to the success of your business? Does your business have remote employees? If so, do they connect to a company server from their location?
- How well does your current service provider meet your businesses' needs? Are there any gaps between your business' Internet needs and your current service?
  - Does your business use the Internet for anything that requires certain speeds or bandwidth, such as video conferencing?
  - Does your business deal with sensitive information that requires advanced server security?
  - Are there any challenges specific to your industry as it relates to Internet access?

Perceptions of Current Internet Options (15 minutes)

- How well does your current service provider meet your businesses' needs? Are there any gaps between your business' Internet needs and your current service?
- Would you characterize the predominant Internet providers available in Boulder, meaning Comcast/Xfinity and CenturyLink/Lumen, as generally positive, neutral, or negative? Why?
- Are you satisfied with the service you receive from your current Internet service provider?

  - Speed?

  - Price?

  - Reliability?

  - Customer service/support?

  - Other factors?

- Do you think there is a need for additional Internet providers in the City of Boulder?

Priorities in Internet Service Qualities (15 minutes)

Now let's discuss where your priorities fall when considering Internet service qualities. Considering cost, Internet speed or bandwidth, reliability, cybersecurity, and customer service/support, I'd like you to rank these qualities of Internet service in terms of highest to lowest priorities for your business' Internet service. Please share how you ranked these qualities and why.

City-operated Internet Utility (25 minutes)

We've talked a lot about how your businesses use the Internet and what your needs and priorities are when it comes to choosing an Internet provider. Now we'd like to talk about the possibility of the city creating its own municipal Internet utility. Creating a municipal Internet utility would mean that it operates like Boulder's water utilities and the City would carry all the capital and operational expenses associated with constructing the infrastructure and delivering Internet service. This likely means the City would have to raise taxes to pay for it.

[Fiber optic internet is a type of Broadband transmitted over fiber-optic cables, offering fast, reliable service.]

- First, what are your overall perceptions of fiberoptic Internet services? Do you think fiberoptic Internet would better meet your business' needs? Why or why not?
- What are your thoughts about the City of Boulder establishing its own City-operated Internet utility?

  - What do you think the benefits would be?
  - What do you think the disadvantages would be? What are your concerns?
- Do you think the City of Boulder is qualified to operate its own Internet utility? Why or why not? What might it take to make you feel more comfortable with it?
- What are your thoughts about the City partnering with an existing Internet provider to offer Internet service? How valuable would it be for the City to work with an existing provider that already has the expertise to conduct Internet service operations?

  - What do you think the benefits would be?
  - What do you think the disadvantages would be? What are your concerns?

- If the City launched a City-operated Internet utility option, how likely would you be to switch from your current provider to the City-operated option?
  - What factors would influence your decision?
  - What would be the barriers to switching providers?
  - Would the City's decision on whether to partner with an existing Internet provider factor into your decision in any way?
- If you reside within the city of Boulder, would you vote for a public funding option, such as an increase in sales tax, property tax bond that would include an increase in sales tax to help fund a City-operated Internet utility option? Why or why not?

Concluding Questions (5 minutes)

- Do you have any other thoughts on Internet service options in Boulder?
- Do you have any other insights or comments pertaining to the City of Boulder's decision on whether to operate the utility independently or whether to partner with a third-party organization?
- What can the City of Boulder do to address any concerns that businesses have regarding a City-operated Internet utility?

APPENDIX B: SURVEY INSTRUMENT

2023 BOULDER INTERNET DEMAND SURVEY

Thank you for agreeing to participate in the City of Boulder's (the City's) Community Broadband Internet Survey. The City is conducting this survey to understand your Internet needs and priorities. Information from the survey will help inform how the City might ensure access to high-quality, fiber-based Internet services for Boulder residents. The survey will take about 10-12 minutes to complete, and your responses will be kept anonymous. As a way to thank you for your participation, we will collect your contact information at the end of the survey to send you a $10 Visa gift card.

If you have any questions after completing the survey, please contact the City's Department of Innovation and Technology by e-mailing giansantiM@bouldercolorado.gov

We need to ask you a few questions to confirm your eligibility for the survey.

1. Please select your age from the drop down menu below.

   [TERMINATE IF YOUNGER THAN 18]

2. Do you live in Boulder, Colorado, either on a full-time or part-time basis?

   Yes

   No [TERMINATE]

3. Does your household have Internet service?

   Yes [SKIP TO 4]

   No

3a. What are the reasons your household does not have Internet service? (*Select all that apply.)*

Household members don't use the Internet enough to subscribe.
Internet service is too expensive.
Household members have access to Internet elsewhere (*for example, at work or the public library)*.
Other (please specify): _____

[TERMINATE]

4. Does your household pay for Internet services yourselves?

Yes
No [TERMINATE]

5. Are you involved with making decisions about the Internet services to which your household subscribes?

Yes
No [TERMINATE]

TERMINATE SCRIPT

Thank you for your willingness to participate in the survey. However, we are only surveying Boulder residents who are 18 years of age or older, whose households subscribe to Internet services, and who are involved in making decisions about those services. Have a good day!

6. Which Internet service provider does your household use to access the Internet at home?

   Lumen (formerly Century Link)
   Comcast/Xfinity
   Cellular data plan on a smartphone/tablet [SKIP TO Q10]
   Other (please specify) _____

7. Do you pay for Internet services as part of a bundled package that includes other services, such as television, security, or phone services?

   Yes
   No [SKIP TO Q10]

8. What services, other than Internet, are included in your bundle? *Select all that apply.*

   Cell Phone Service
   Landline Phone Service
   Cable or Satellite TV
   Streaming service subscription(s)
   Home Security
   Other (please specify) _____

9. About how much do you pay for your bundled services each month, including equipment rental **but not** including taxes or other fees?

Less than $50
$50 to $75
$76 to $100
$101 to $125
$126 to $150
$151 to $175
$176 to $200
More than $200
Don't know
Refused

[SKIP TO Q11]

10. About how much do you pay for home Internet services, including equipment rental but not including taxes or other fees?

Less than $50
$50 to $75
$76 to $100
$101 to $125
$126 to $150
More than $150
Don't know
Refused

11. What are the ways in which you use your home Internet services? *Select all that apply.*

Personal/recreational use (other than streaming)
Work
Home Security
School/homework
Streaming services
Other (please specify) _____

12. Please rate **how important** each of the following factors are to you in choosing an Internet services provider on a scale from 0 (*not important at all*) to 5 (*very important*).

a. Bundled packages with other services (for example, television, home security, or phone)
b. Internet speed
c. No contract
d. Cyber security/privacy
e. Cost
f. Reliability
g. Customer service

0 – Not important at all
1 – Not very important
2 – A little important
3 – Somewhat important
4 – Moderately important
5 – Very important

13. Please rate **how satisfied** you are overall with your current Internet services on a scale from 0 (*not satisfied at all*) to 5 (*very satisfied*).

    0 – Not satisfied at all
    1 – Not very satisfied
    2 – A little satisfied [SKIP TO Q15]
    3 – Somewhat satisfied [SKIP TO Q15]
    4 – Moderately satisfied [SKIP TO Q15]
    5 – Very satisfied [SKIP TO Q15]

14. Please use the space provided to tell us a little about why you're not particularly satisfied with your current Internet services.

    _____

    _____

    _____

15. On a scale from 0 to 5, where 0 indicates *not desirable at all* and 5 indicates *very desirable*, **how desirable** would it be to you for a government agency like the City to begin providing Internet services to homes or businesses in Boulder, either by itself or in partnership with existing providers?

    0 – Not desirable at all
    1 – Not very desirable
    2 – A little desirable
    3 – Somewhat desirable
    4 – Moderately desirable
    5 – Very desirable

16. On a scale from 0 to 5, where 0 indicates *not likely at all* and 5 indicates *very likely*, **how likely** would it be that you would potentially switch from your current Internet services to fiber-based Internet services that the City would provide, either by itself or in partnership with existing providers?

    0 – Not likely at all
    1 – Not very likely
    2 – A little likely
    3 – Somewhat likely
    4 – Moderately likely
    5 – Very likely

17. What would potentially be the biggest barrier(s) for your household to switch from your current Internet services to the City's fiber-based Internet services? *Select up to three.*

Concerns about speed or quality issues
Losing other bundled services
Reconnecting my devices to new services
Lack of trust in a new provider
Inconvenience of canceling my current services
Concerns about increased cost
Concerns about lack of information about the City's services
Concerns about customer service
Concerns about bandwidth or cyber security concerns
Lack of trust in government-operated Internet services
Other (please specify) _____

I can't think of any barriers. [MAKE EXCLUSIVE]

Existing Internet service providers currently offer traditional high-speed broadband Internet services (speeds up to 1,000 megabits per second) to Boulder residents for approximately $70 - $75 per month, including equipment rental but <u>not</u> including taxes or other fees.

18. Assuming comparable or even higher speeds and quality than what existing providers offer, and considering how much existing providers charge each month, please use the slider scale below to indicate **how much you would be willing to pay each month** for fiber-based Internet services that the City would provide, either by itself or in partnership with existing providers. Please include the price of equipment rental but do not include taxes or other fees as part of your response.

    [INCLUDE SLIDER SCALE from $10 - $150 in increments of $10]

19. At what monthly price, including equipment rental but not including taxes or other fees, would you consider the City's fiber-based Internet services to be **too expensive** that you would not consider buying it?

    [INCLUDE SLIDER SCALE from $10 - $150 in increments of $10]

20. At what monthly price, including equipment rental but not including taxes or other fees, would you consider the City's fiber-based Internet services to be **too cheap**, and because of it, you would feel that the quality of the services would be poor?

    [INCLUDE SLIDER SCALE from $10 - $150 in increments of $10]

21. At what monthly price, including equipment rental but not including taxes or other fees, would you consider the City's fiber-based Internet services **starting to become too expensive**—that is, it would not be out of the question, but you would have to give some thought to buying it?

    [INCLUDE SLIDER SCALE from $10 - $150 in increments of $10]

22. At what monthly price, including equipment rental but not including taxes or other fees, would you consider the City's fiber-based Internet services to be a **bargain**—that is, a great buy for the money?

    [INCLUDE SLIDER SCALE from $10 - $150 in increments of $10]

23. If you subscribed to fiber-based Internet services through the City, would you want to bundle Internet services with other services, such as television or phone services?

    Yes
    No [SKIP TO Q25]
    Don't know [SKIP TO Q25]
    Refused [SKIP TO Q25]

24. What other services would you want to bundle Internet services with? *Select all that apply.*

    Cell Phone Service
    Landline Phone Service
    Cable or Satellite TV
    Streaming service subscription(s)
    Home Security
    Other (please specify) _____

25. What is your gender?

    Woman
    Man
    Gender nonconforming
    Prefer to self-describe: _____

26. What is your annual household income range?

    Less than $25,000 a year
    $25,000 to $49,999 a year
    $50,000 to $99,999 a year
    $100,000 to $149,999 a year
    $150,000 a year or more
    Prefer not to answer

27. Which race or ethnicity do you identify with most?

White
Hispanic or Latino/a
Asian
Black or African-American
American Indian or Alaska Native
Native Hawaiian or other Pacific Islander
Two or more races
Other (please specify) _____
Prefer not to answer

28. What is your highest level of educational attainment? *Select one.*

No schooling completed
Elementary/primary school through 8th grade
Some high school, no diploma
High school graduate, diploma or equivalent (GED)
Some college credit, no degree
Trade/technical/vocational training
Associate degree
Bachelor degree
Some graduate school, no graduate degree
Post-graduate degree
Professional degree
Doctorate degree
Prefer not to answer

29. Do you own or rent your home?

    Own
    Rent
    Other
    I do not have stable housing right now
    Prefer not to answer

Thank you for your participation in the survey! As we mentioned during the introduction, we would like to send you a $10 Visa gift card, which you can use anywhere that accepts Visa. What e-mail address should we send it to?

E-mail address: _____
Prefer not to receive a gift card.

ctc technology & energy

engineering & business consulting

Summary Report: FTTP Cost Estimate and Financial Model

Prepared for the City of Boulder, CO

August 11, 2023

Columbia Telecommunications Corporation

10613 Concord Street • Kensington, MD 20895 • Tel: 301-933-1488 • Fax: 301-933-3340 • www.ctcnet.us

Contents

Figures

Tables

1 Introduction

This report provides summary findings of an updated cost estimate for a fiber-to-the-premises (FTTP) buildout in Boulder, CO, and summarizes outputs of a custom financial model built to evaluate the financial implications of the City entering the municipal FTTP business itself.

The estimate in this report is a fresh cost estimate reflecting market and cost conditions in 2023, as well as updated information provided by the City. The financial analysis was done anew, using an updated financial model incorporating new data points and following City direction during the engagement.

In addition to this report summary, the complete deliverable from CTC and its consulting partner, Rebel, includes the following:

- Cost estimation details provided as a separate slide deck by CTC
- A financial model provided separately as an Excel workbook by Rebel

2 Constructing an underground FTTP network to reach all residences and businesses in Boulder would cost ~$218 million in 2023 dollars

An underground fiber-to-the-premises (FTTP) distribution network passing 43,634 residences and businesses in Boulder—comprised of 324.8 route miles and using existing City conduit where feasible (approximately 58.4 miles)—would cost an estimated $218 million in 2023 dollars (or $242 million in nominal/year-of-expenditure dollars[1]), which includes a 10 percent contingency. This estimate assumes that the network assets already built by the City are made available.

This estimate assumes underground construction only, as requested by the City, as well as a 40 percent take-rate (that is, the percentage of households or businesses choosing to take service). It is necessary to choose a take-rate to develop a capital cost estimate because capital costs include installing connections (also known as drops) from the street to the premises and activating service. The total figure therefore varies by the number of subscribers. If the City were to build drops to all premises, the total cost would rise to $274 million in 2023 dollars (or $308 million in nominal/year-of-expenditure dollars). The table below summarizes the cost estimate described above, using 2023 dollars.

Table 1: Components of capital cost estimate (2023 dollars)

Cost Component	Estimated Costs @40% Take-Rate	Estimated Costs @100% Take-Rate
Project management	$6.15 million	$6.15 million
Engineering	$18.7 million	$18.7 million
Conduit infrastructure construction	$106.25 million	$106.25 million
Fiber optic cables and components	$11.75 million	$11.75 million
Fiber splicing, testing & documentation	$2.60 million	$2.60 million
Hub facilities	$2.25 million	$2.25 million
MDU laterals and cabling	$1.75 million	$1.75 million
City construction oversight	$6.15 million	$6.15 million
Core network electronics	$6.55 million	$6.55 million
Total fixed cost	**$162.15 million**	**$162.15 million**
Fixed cost per passing	**$3,716**	**$3,716**
Distribution electronics cost	$3.55 million	$6.55 million
Subscriber drop cables	$21.15 million	$52.85 million
Customer activation cost (includes CPE)	$11.05 million	$27.60 million
Total cost	**$197.9 million**	**$249.10 million**
Total cost per customer	**$11,339**	**$5,709**
Total cost with 10% contingency	**$217.69 million**	**$274.01 million**
Total cost per customer with 10% contingency	**$12,473**	**$6,280**

[1] Assumes 3% annual inflation

Further details about the cost estimate are provided in the separate slide deck. Operating expenses are a function of time and are included in the financial model, which was also provided as a separate deliverable. Operating expenditure assumptions—such as staffing levels, salaries, and non-labor operating expenses—are also provided in Section 3 of this report.

2.1 Comparison to an earlier estimate

Between 2016 and 2018, CTC developed several FTTP cost estimates and analyses for the City of Boulder under a variety of assumptions and scenarios. One of those efforts, provided in a report dated April 2018, produced an estimate of $117 million to $140 million for constructing a 100 percent underground lit network using a 35 percent take-rate. (The upper end of this range reflects a 20 percent contingency.) The table below reflects that estimate. This is provided here as a frame of reference for the new cost estimate.

Table 2: FTTP cost estimate provided in 2018 report with 100% underground and 35% take-rate

Cost Component	Total Estimated Cost
Dark FTTP OSP	$69 million – $83 million
Central Network Electronics	$7 million – $8 million
FTTP Service Drop and Lateral Installations	$30 million – $36 million
Customer Premise Equipment	$11 million – $13 million
Total Estimated Cost	**$117 million – $140 million**

The difference between the two cost estimates can be attributed to several factors including the following:

Inflation: Since 2017, according to the Bureau of Labor Statistics consumer price index, inflation has driven prices up by nearly 25 percent. This obviously impacts materials and labor costs. As an additional consideration, significant public funding of broadband has increased demand for relevant labor and materials nationwide. These programs include:

- Coronavirus Aid, Relief, and Economic Security (CARES) Act broadband funding
- American Rescue Plan Act funding for broadband (specifically, Treasury State and Local Fiscal Recovery Funds and the Capital Projects Fund)
- Deployments resulting from the Federal Communications Commission (FCC) Rural Digital Opportunity Fund (RDOF)
- NTIA's Broadband Infrastructure Program, Tribal Broadband Connectivity Program, and Enabling Middle Mile Grant Program

Hard rock: In the earlier estimate the City directed that it would appropriate to assume that 5 percent of the construction would encounter hard rock, driving up construction costs. The 5 percent figure was used in producing the estimate provided in 2018. In the new estimate, the consulting team used 45 percent, based on numbers provided to CTC in recent weeks by the City. The new percentage reflects the City's actual experience encountering hard rock in the backbone buildout in Boulder.

Take-rate: The new estimate uses a 40 percent take-rate, which entails additional costs for drops and customer premises equipment. (The estimate in the 2018 report used a 35 percent take-rate.) The 40 percent figure was used because it is in line with what has been achieved elsewhere in the United States, and thus forms an element of our "base case" described below.

Permit issuance, reviews, and inspections: The City will need permitting and inspection staffing that can provide oversight for a multi-year buildout of more than 300 miles of fiber. The current estimate includes a $5.2 million line-item for City construction oversight, an internal City cost not included in the prior estimate.

3 A citywide FTTP network would likely require a significant subsidy to be financially feasible

For the City to establish a financially feasible FTTP business, a significant subsidy by the City would be required. This subsidy could be structured either as an upfront or ongoing contribution. The remainder of this section assumes that the City will issue debt to finance the project and analyzes how much annual operational subsidy would be required on average during the debt repayment period to absorb any cash flow shortfalls. To do so, we first analyze the cash flow shortfalls (and therefore the required subsidy) under a "base case" scenario (explained in Section 3.1). Next, we review how the cash flow shortfall would change in other scenarios.

Determining financial feasibility involves evaluating numerous variables including the capital costs described above, ongoing operating costs, take-rates (that is, the percentage of potential customers who actually choose to take service), pricing, project term, and interest rates. This section summarizes several scenarios and how they would impact the required subsidy. Given the uncertainty underlying each of the inputs, the calculated average cash flow shortfalls and subsidy amounts should be considered order-of-magnitude estimates, which can be used to help understand relative differences between scenarios.

3.1 Under the base case using relatively conservative assumptions, chiefly that 40% of premises subscribe and that subscribers pay an average of $70 per month, the project would require an annual subsidy of ~$16.5 million over a 20-year period

If the project achieves a take-rate of 40 percent (which has been met in successful comparable projects across the United States) and using the capital expenditure estimates above, there would on average be a $16.5 million annual cash flow shortfall between 2030 and 2049. This shortfall would need to be funded from other sources of revenue to make the project financially feasible. In this report, this scenario is called the base case. The base case includes the following major assumptions.

- The cost to construct, inclusive of a 10 percent contingency, is $242 million in nominal/year-of-expenditure dollars as per the cost summary described above.
- The average revenue per user (ARPU) is $70 per month for the 90 percent of subscribers who are paying market rates and $30 per month for 10 percent of residential subscribers who are low-income, with prices increasing by 3 percent per year.[2]

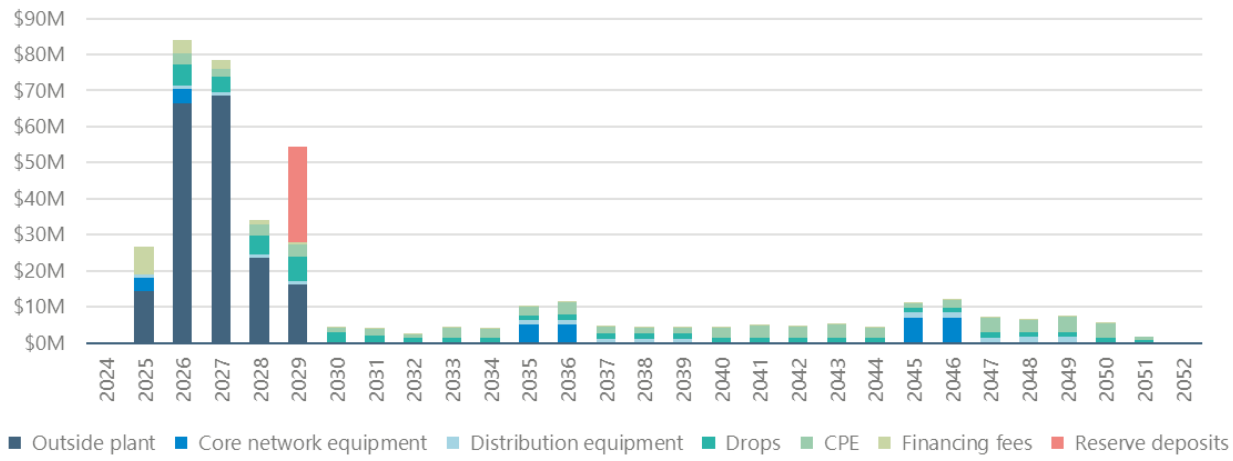
[2] The range of services could vary over time. As a frame of reference, $70 is in line with the current monthly cost of 1 Gigabit fiber services in other U.S. cities.

- Operating costs (described in the model and later in this report) are also assumed to increase by 3 percent annually.
- The project achieves a take-rate of 40 percent after a five-year ramp-up period from the start of operations in mid-2026.
- The City uses debt financing to cover the project's capital expenditure at a 5 percent interest rate, interest capitalization through end of 2027, and an annuity-style repayment from 2030 through 2050.
- The project time horizon includes a five-year construction period and 25 years of operations.

Using the above base case assumptions, the following charts show the cash flow implications for the City if it were to operate the project itself.

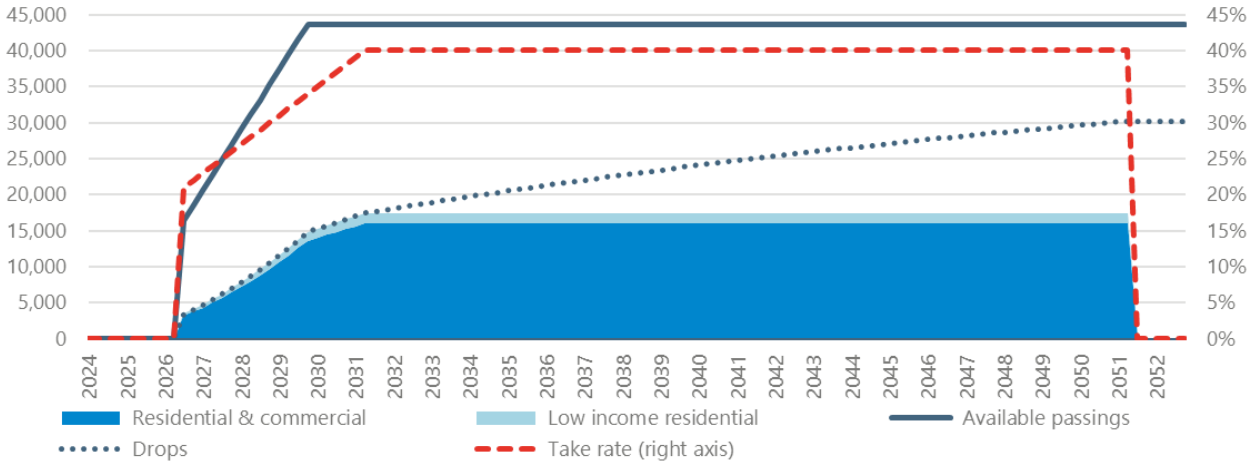
The first chart shows a sample capital expenditure and capital renewal profile, assuming a 40 percent take-rate and 10-year renewal cycle for core network and distribution equipment.

Figure 1: Sample capital expenditure and renewal profile



The next chart shows a sample build out and adoption profile, assuming a five-year ramp up and a 40 percent long-term steady state take-rate. Furthermore, the base case assumes a 5 percent churn ("churn" refers to the percentage of customers who cancel service each year) which means that to maintain a constant steady state take-rate, new customers need to be added as other cancel service, which explains the continued growth in drops over time.

Figure 2: Sample build out and adoption profile



Using the build out and adoption profile as well as a $70 per month ARPU for residential and business users and $30 per month for low-income users, the next chart shows a sample revenue profile for a 40 percent take-rate.

Figure 3: Sample revenue profile

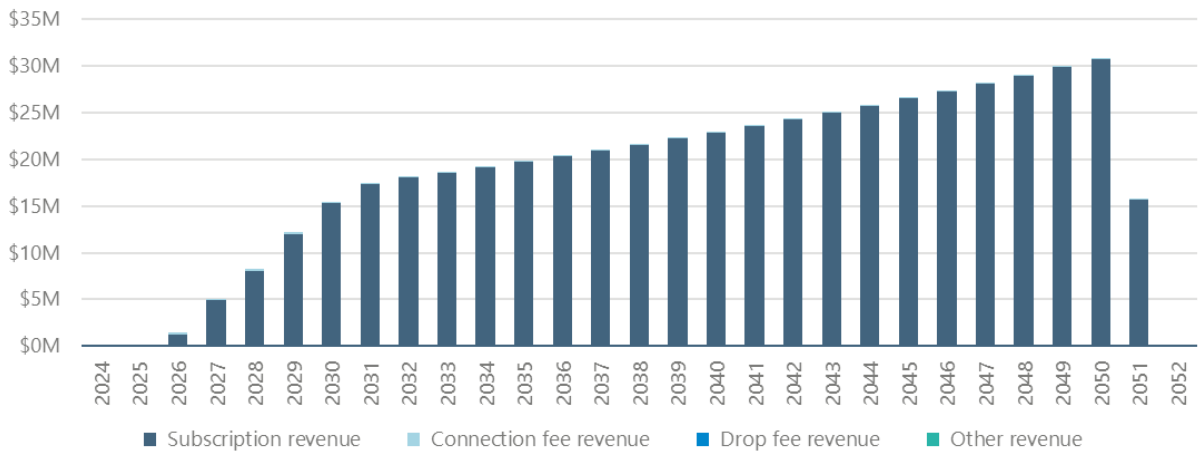
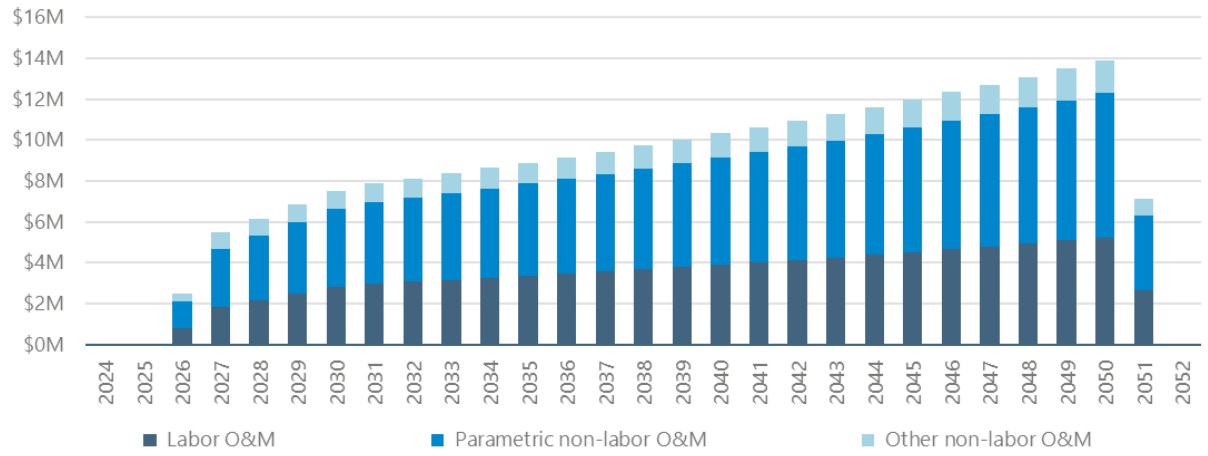


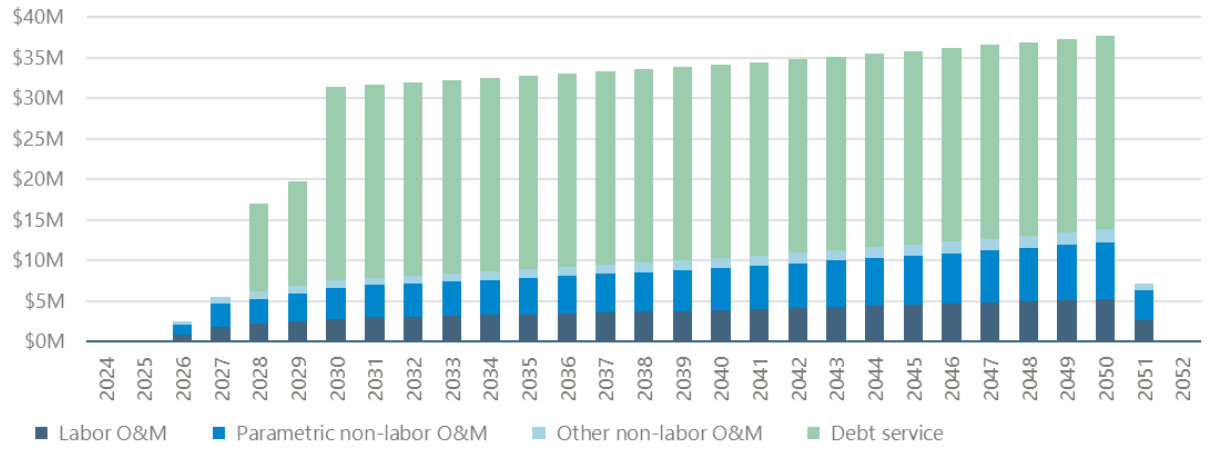
Figure 4 shows a sample O&M profile, which is calculated using three distinct O&M categories, as described in Section 3.

Figure 4: Sample O&M profile



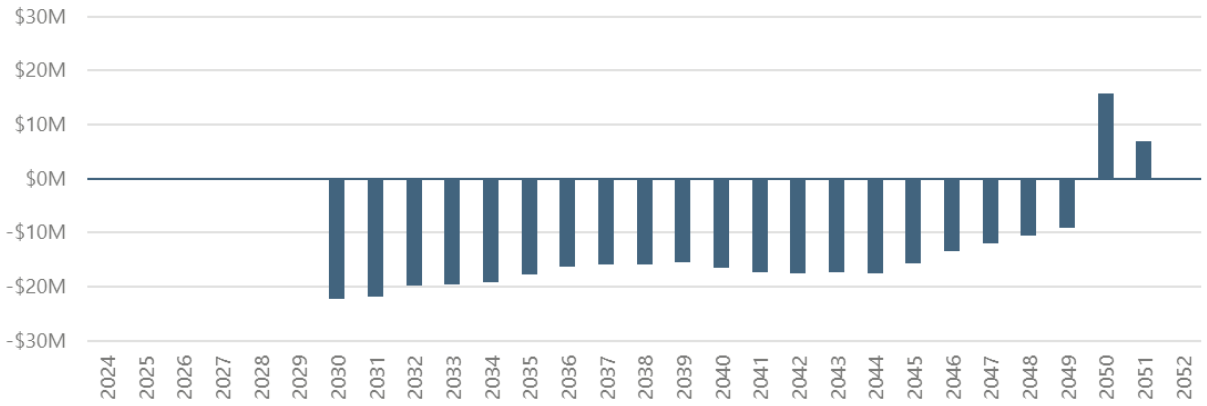
The next chart combines the sample O&M profile with debt service on the full project capex, assuming a 5% interest rate, interest capitalization through end of 2027, and an annuity-style repayment from 2030 through 2050. Annual debt service is about $24 million.

Figure 5: Sample O&M and debt service profile



The final chart shows the net cash flow over the full project period. As can be seen from the chart, the base case scenario requires substantial ongoing subsidies from 2023 through 2049.

Figure 6: Sample net cash flows



The positive net cash flow in 2050 is largely caused by the release of the debt service reserve account. The positive net cash flow in 2051 can be explained by the fact that the debt is structured to be fully repaid by the end of 2050, so no debt service is due in that year. Both 2050 and 2051 are not considered in the calculation of average cash flow shortfall. If 2050's positive cash flow value was to be included in the average annual cash flow shortfall calculation, the average shortfall would drop from $16.5 million to $15.0 million.

The fluctuations seen in the net cash flows chart are mostly driven by fluctuations in capital renewal and associated reserve deposits and releases.

3.2 The magnitude of the cash flow shortfalls is highly sensitive to changes in construction costs, average revenue per user, and take-rate

Because pricing and take-rate determine revenue, estimates of the required subsidy are highly sensitive to these factors. Changes in capex also significantly affect the required subsidy. Each of these factors will be evaluated in this section.

The City has conducted a separate residential survey. It may wish to use the financial model to explore how survey findings—on matters such as willingness to subscribe to a new fiber provider at various price points, and willingness to pay a temporary construction fee (which could provide a source of subsidy funds)—would affect the required subsidy if statements made on a survey were to be realized in the form of future purchasing decisions and fee payments.

3.2.1 Sensitivity to variations in construction cost

If costs prove to be 10 percent lower than CTC's updated base case cost estimate (i.e., no contingency was required), the average annual cash flow shortfalls drop from $16.5 million to $13.5 million. If costs are 10 percent higher than the updated cost estimate provided by CTC (meaning that a 20 percent contingency was required), this would increase the average cash flow

shortfalls to $19.6 million per year. A 30 percent contingency would lead to an average annual shortfall of $22.6 million.

Table 3: Capex sensitivity

Capital expenditure sensitivity	Average shortfall
Capex + 0% contingency ($198 million in 2023 dollars)	$13.5 million
Capex + 10% contingency ($218 million in 2023 dollars) – base case	$16.5 million
Capex + 20% contingency ($237 million in 2023 dollars)	$19.6 million
Capex + 30% contingency ($257 million in 2023 dollars)	$22.6 million

Another way to look at the impact of capital expenditure on financial feasibility is to focus on the project's fixed cost per passing. Under the base case, the pre-contingency cost per passing is $3,716 (or $4,088 with 10 percent contingency) in 2023 dollars. The table below shows the level of average annual cash flow shortfall for different fixed costs per passings.

In this analysis, the fixed cost per passing does not include the drop cost (estimated at $1,250 per drop in 2023 dollars) nor any customer premise equipment (estimated at $633 per drop in 2023 dollars).

Table 4: Cost per passing sensitivity

Cost per passing sensitivity	Average shortfall
$2,500 per passing ($2,750 with 10% contingency)	$10.1 million
$3,000 per passing ($3,300 with 10% contingency)	$12.7 million
$3,500 per passing ($3,850 with 10% contingency)	$15.4 million
$3,716 per passing ($4,088 with 10% contingency) – base case	$16.5 million
$4,000 per passing ($4,400 with 10% contingency)	$18.1 million

3.2.2 Sensitivity to variations in pricing

If pricing (average revenue per user, or ARPU) is lowered by $10 for all subscribers, the average annual cash flow shortfall would increase to about $20.3 million. Conversely, if ARPU is increased by $10 for all subscribers, the average annual subsidy would fall to approximately $12.8 million. Increasing the ARPU by $20 further reduces the average cash flow shortfall to $9.3 million.

Table 5: Pricing sensitivity

Pricing sensitivity	Average shortfall
ARPU of $60 (normal) / $20 (low income)	$20.3 million
ARPU of $70 (normal) / $30 (low income) – base case	$16.5 million
ARPU of $80 (normal) / $40 (low income)	$12.8 million
ARPU of $90 (normal) / $50 (low income)	$9.3 million

3.2.3 Sensitivity to variations in take-rate

A more aggressive take-rate assumption of 50 percent would reduce the average annual cash flow shortfall to approximately $13 million, while reducing it to 30 percent would increase the average shortfall to about $20 million.

Table 6: Take-rate sensitivity

Take-rate sensitivity	Average shortfall
30% steady state take-rate	$20.0 million
35% steady state take-rate	$18.4 million
40% steady state take-rate – base case	$16.5 million
45% steady state take-rate	$14.6 million
50% steady state take-rate	$12.9 million

3.2.4 Sensitivity analysis summary

The table below summarizes how changes in pricing, capex contingency, and take-rates affect the required upfront subsidy.

Table 7: Capex contingency, pricing and take-rate scenarios and their impacts on required subsidy

Scenario/sensitivity	Average shortfall
Baseline analysis	$16.5 million
Baseline analysis with 0% capex contingency	$13.5 million
Baseline analysis with 20% capex contingency	$19.6 million
Baseline analysis with 30% capex contingency	$22.6 million
Baseline analysis with $10 lower pricing	$20.3 million
Baseline analysis with $10 higher pricing	$12.7 million
Baseline analysis with $20 higher pricing	$9.3 million
Baseline analysis with 30% steady state take-rate	$20.0 million
Baseline analysis with 50% steady state take-rate	$12.9 million

Variations in operating cost assumptions, the length of the operating period, and the interest rate would also influence the upfront subsidy. The model allows the City of Boulder to explore these and other variables and their impact on the financial feasibility of the project.

4 Forecasted operating expenditures

The opex forecast included in the financial feasibility analysis was developed through a combination of industry benchmarks and experience from past projects. This section breaks down the inputs, assumptions and calculations used in the development of the opex forecast.

Opex in the financial model consists of three categories, broken down further below into discrete line items: 1) Labor costs, 2) parametric non-labor costs, and 3) other non-labor costs.

4.1 Labor costs

Labor costs consist of seven fixed staffing categories and three variable staffing categories. The inputs for the fixed and variable staffing levels are based on the project team's industry expertise and comparable projects. Fixed staffing levels remain the same from the start of operations in Year 2026 onwards whereas variable staffing levels ramp up until Year 2031 and remain steady thereafter.

Table 8: Fixed staff FTEs

Fixed Staff Category	Number of FTEs (Year 2026 Onward)
Integrity Manager	1
GIS Analyst	1
Senior IT Specialist	1
IT Specialist	3
Customer Account Rep I	3
Account Clerk I	1
Field Services Technician	1
Total Fixed Staff	12

Table 9: Variable staff FTEs, ramping up through 2031

Variable Staff Category	Number of FTEs (Year 2031 Onward)	Notes on Variability
Customer Account Rep I	10	Based on # subscribers
Customer Account Rep II	4	Based on # subscribers
Account Clerk II	5	Based on # subscribers
Total Variable Staff (Y2031)	*19*	

The number of FTEs for each staff category is multiplied by the salary cost for each category to arrive at total labor costs. In addition to the salary costs, it is assumed that there is an additional 40% labor cost for staff benefits. The table below shows the salary costs for each staffing category with and without the 40% additional benefits.

Table 10: Salary costs

Staff Category	Salary ($2023) per Year Without Benefits	Labor Cost ($2023) per Year Inclusive of Benefits
Integrity Manager	$135,000	$189,000
GIS Analyst	$85,000	$119,000
Senior IT Specialist	$105,000	$147,000
IT Specialist	$90,000	$126,000
Customer Account Rep I	$50,000	$70,000
Customer Account Rep II	$60,000	$84,000
Field Services Technician	$90,000	$126,000
Account Clerk I	$50,000	$70,000
Account Clerk II	$60,000	$84,000

All salaries are projected to grow at an annual rate of 3 percent.

4.2 Parametric non-labor costs

Parametric non-labor costs are opex items that are calculated based on specific network parameters. The parametric input values are based on the project team's industry expertise and comparable projects. The table below summarizes these opex line items.

Table 11: Parametric non-labor opex costs

Parametric Non-Labor Opex Category	Opex per Unit ($2023)
Locates & ticket processing	$250 / month / mile outside plant
Network equipment maintenance	15% of network equipment cost / year
CPE maintenance	1% of CPE cost / year
Education & training	2% total labor cost / year
Customer billing	$0.20 / month / subscriber
Bad debt allowance	0.50% of total revenue
Commodity internet/bandwidth	$250 / Gbps / month

All parametric non-labor opex categories are projected to grow at an annual rate of 3 percent.

4.3 Other non-labor costs

Other non-labor costs are annual fixed costs and include all remaining opex items. These estimates are also based on the project team's industry expertise and comparable projects but have been modified where appropriate to meet the specific circumstances of the City.

Table 12: Other non-labor opex costs

Other Non-Labor Opex Category	Opex per Year ($2023)
Insurance	$200,000
Utilities	$100,000
Office expense	$50,000
Contingency	$100,000
Legal	$50,000
Consulting	$75,000
Marketing	$150,000

All other non-labor opex categories are projected to grow at an annual rate of 3 percent.

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CITY OF BOULDER FIBER TO THE PREMISES (FTTP) FEASIBILITY ANALYSIS

Capital Cost Estimates

Revised August 9, 2023

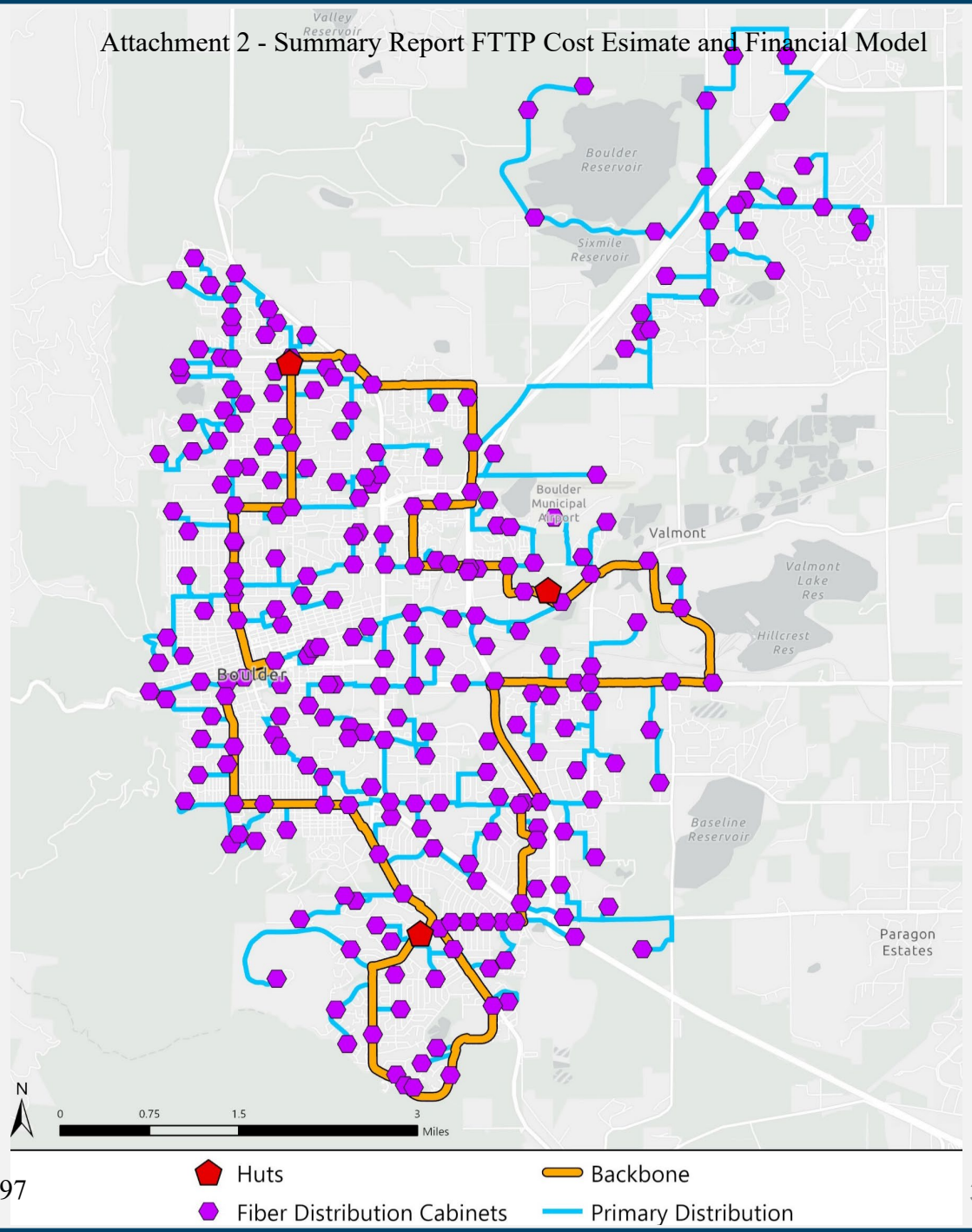
CONCEPTUAL DESIGN OVERVIEW

- Citywide Fiber-to-the-Premises (FTTP)
  - Reaches approximately 43,600 residential and business addresses
  - 100% underground conduit construction
  - Comprised of 324.8 route miles of new and existing fiber optic cable and conduit
  - Includes use of existing City conduit where feasible (approximately 58.4 miles)
- Capable of delivering cutting edge service levels and future scalability
  - Standard services of up to 10 Gbps leveraging XGS-PON electronics
  - Enterprise services up to 100 Gbps over dedicated Ethernet connections
  - End-to-end fiber to every customer for scalable capacity through many generations of network electronics upgrades

DESIGN OVERVIEW

Backbone and Primary Distribution Layer

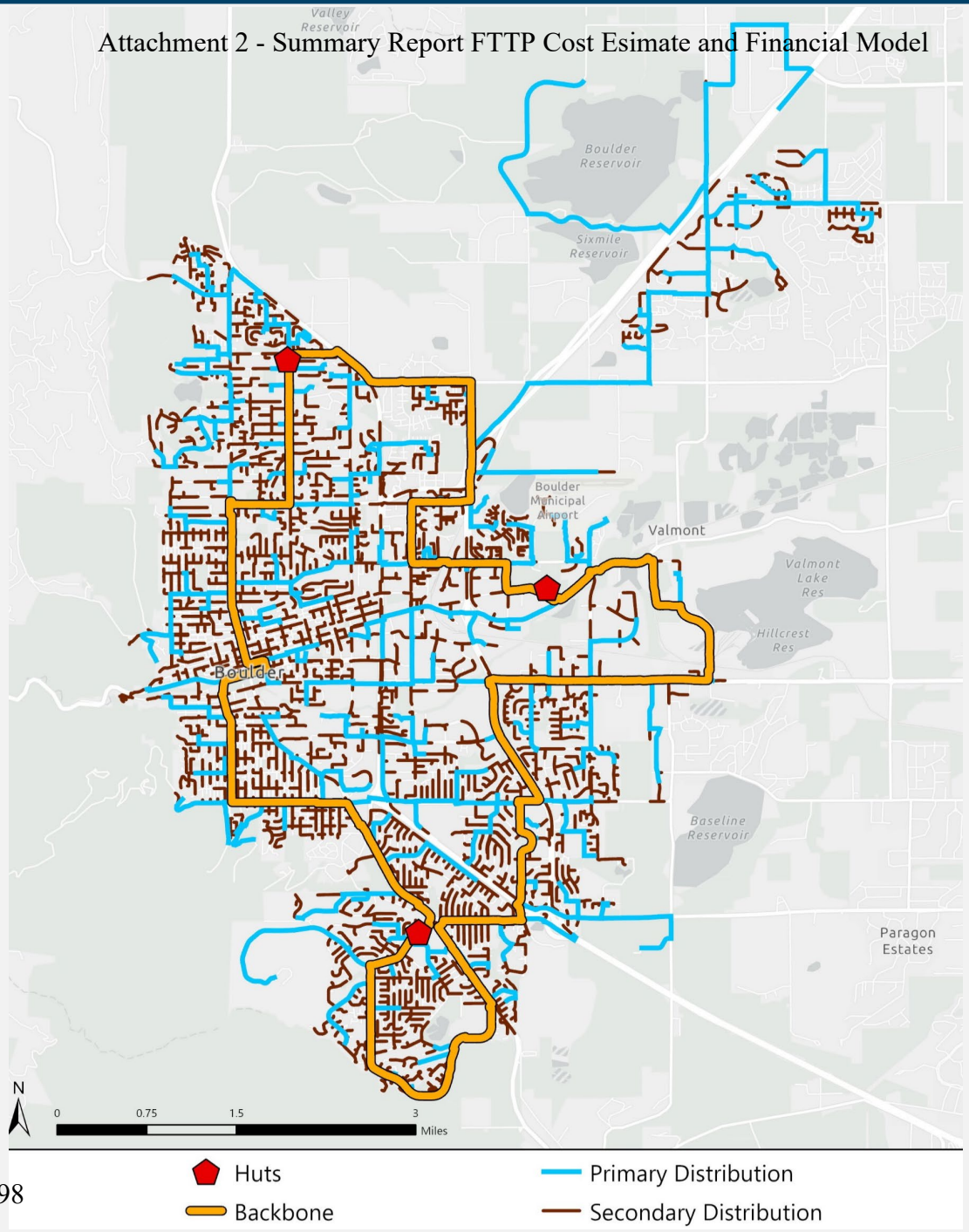
- Three redundant core hub sites interconnected over fully diverse backbone rings
  - House network electronics in resilient, hardened shelter environment
- Primary distribution cables extend from hubs to Fiber Distribution Closures (FDCs) in each neighborhood
  - 265 passive fiber distribution points to house fiber optic splitters
  - Underground placement in vaults to limit aboveground visual impact compared to cabinets mounted on utility poles or concrete pads



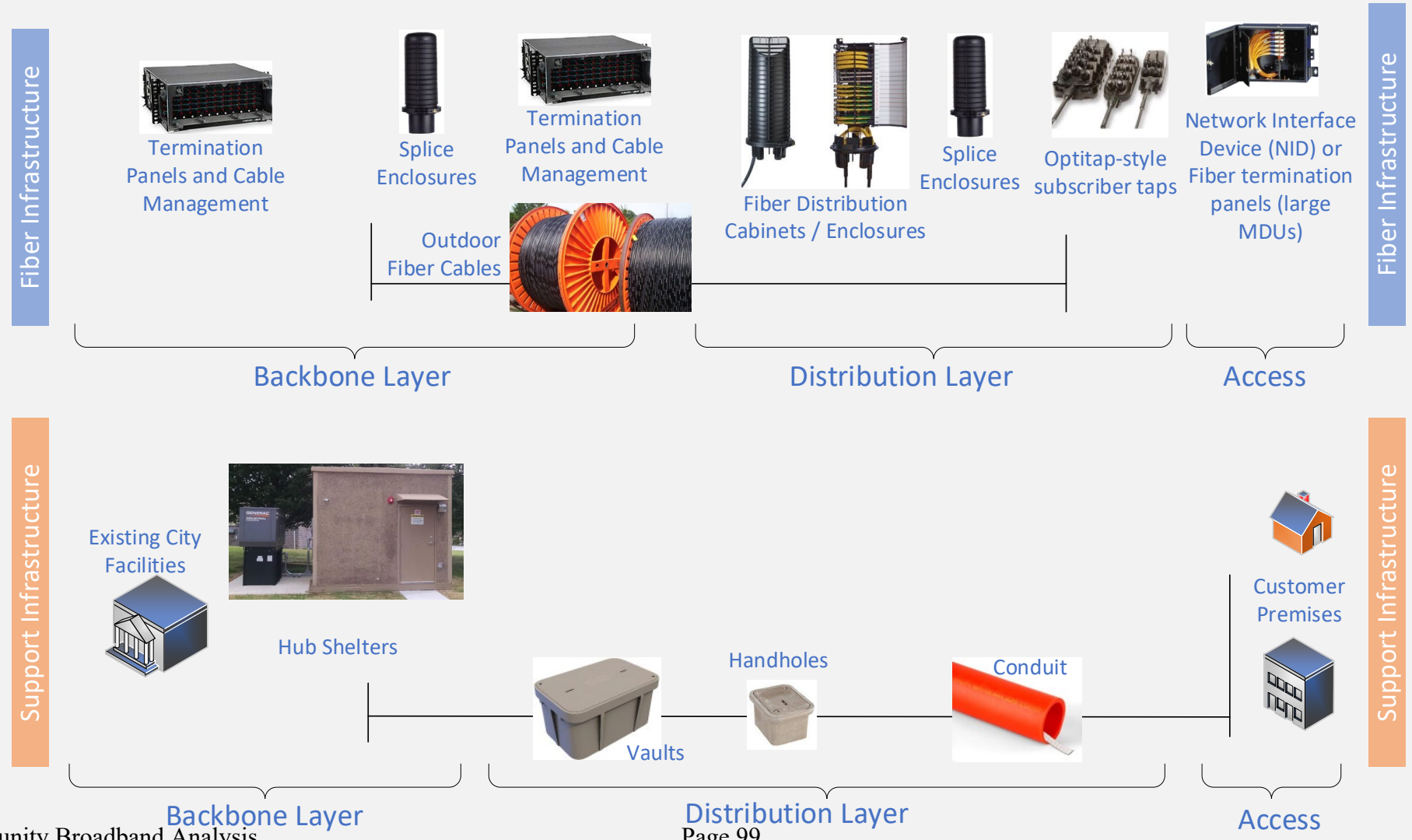
DESIGN OVERVIEW

Backbone, Primary Distribution, and Secondary Distribution Layers

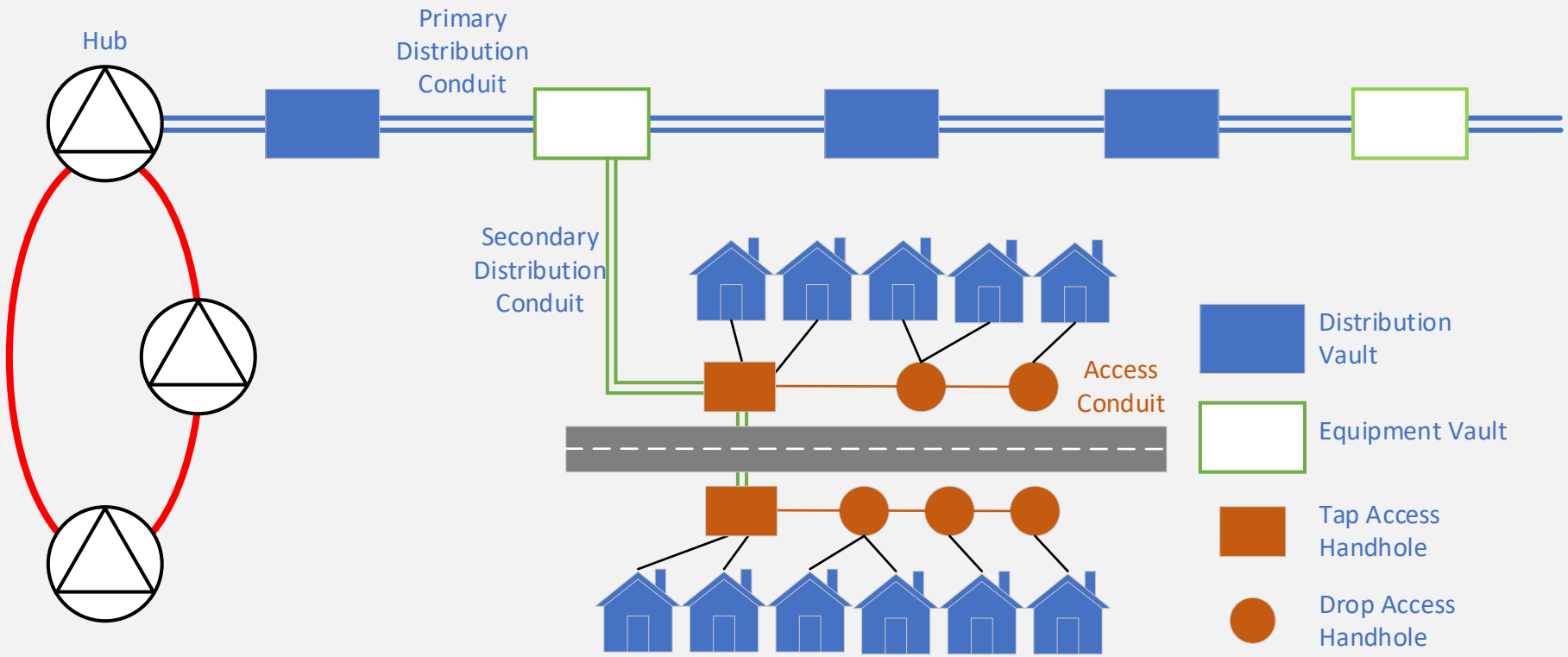
- Secondary distribution layer extends from the FDCs to fiber tap terminals
  - Provide connection points for connecting service drop cables in the public ROW
  - Tap terminals located within 300 feet of every home and business
- Drop access conduits (not shown) extend from tap terminals to small handholes at the parcel edge of each serviceable passing to facilitate efficient service drop installation with minimal disruption to the ROW



FIBER INFRASTRUCTURE KIT OF PARTS



“LAYER 0” CONCEPTUAL CONDUIT DESIGN



Conduit infrastructure – "Layer 0"

Hub

- Hardened facility for network electronics
- Approx. 15,000 to 20,000 passings per hub
- Fiber termination for distribution plant

Distribution Vault

- Large underground vaults along distribution routes
- 750-foot spacing for cable pulling & direction changes
- Supports cable slack loops

Equipment vaults

- Large underground vault dedicated for fiber equipment (splice enclosures, splitters, etc.)

Tap access handholes

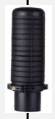
- Medium-sized underground vault
- Contains FTTP tap terminals for 6 to 12 passings (typical);
- <300 feet from each premises

Drop access handholes

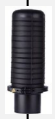
- Small underground vault
- Provides access point to drop conduit
- Placed in ROW adjacent to customer premises
- Supports 1 to 2 passings
- No more than 3 in any service drop path

Fiber cable & components – "Layer 1"

Termination panels



Fiber splice enclosures

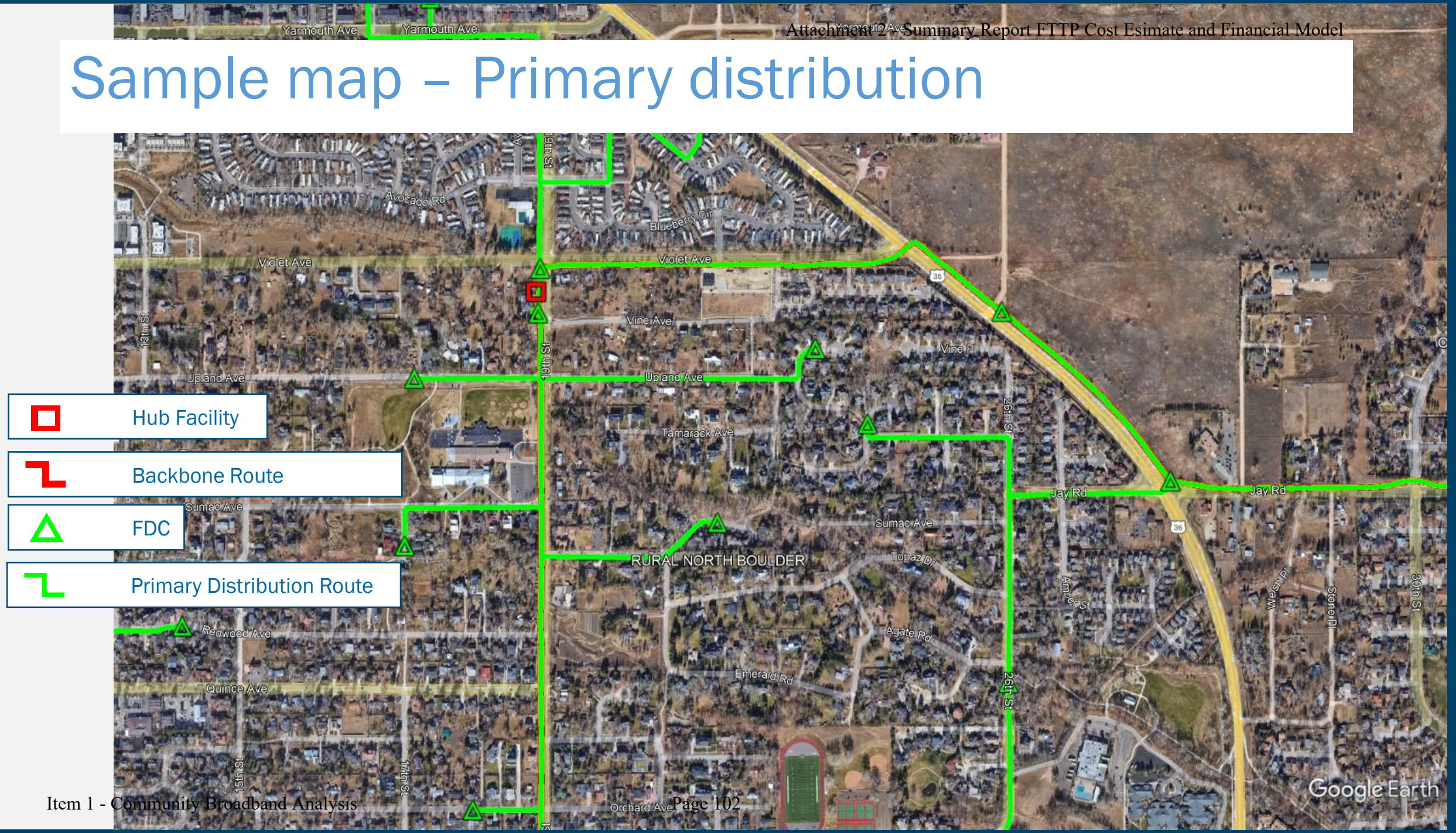


Fiber distribution closures / splitters

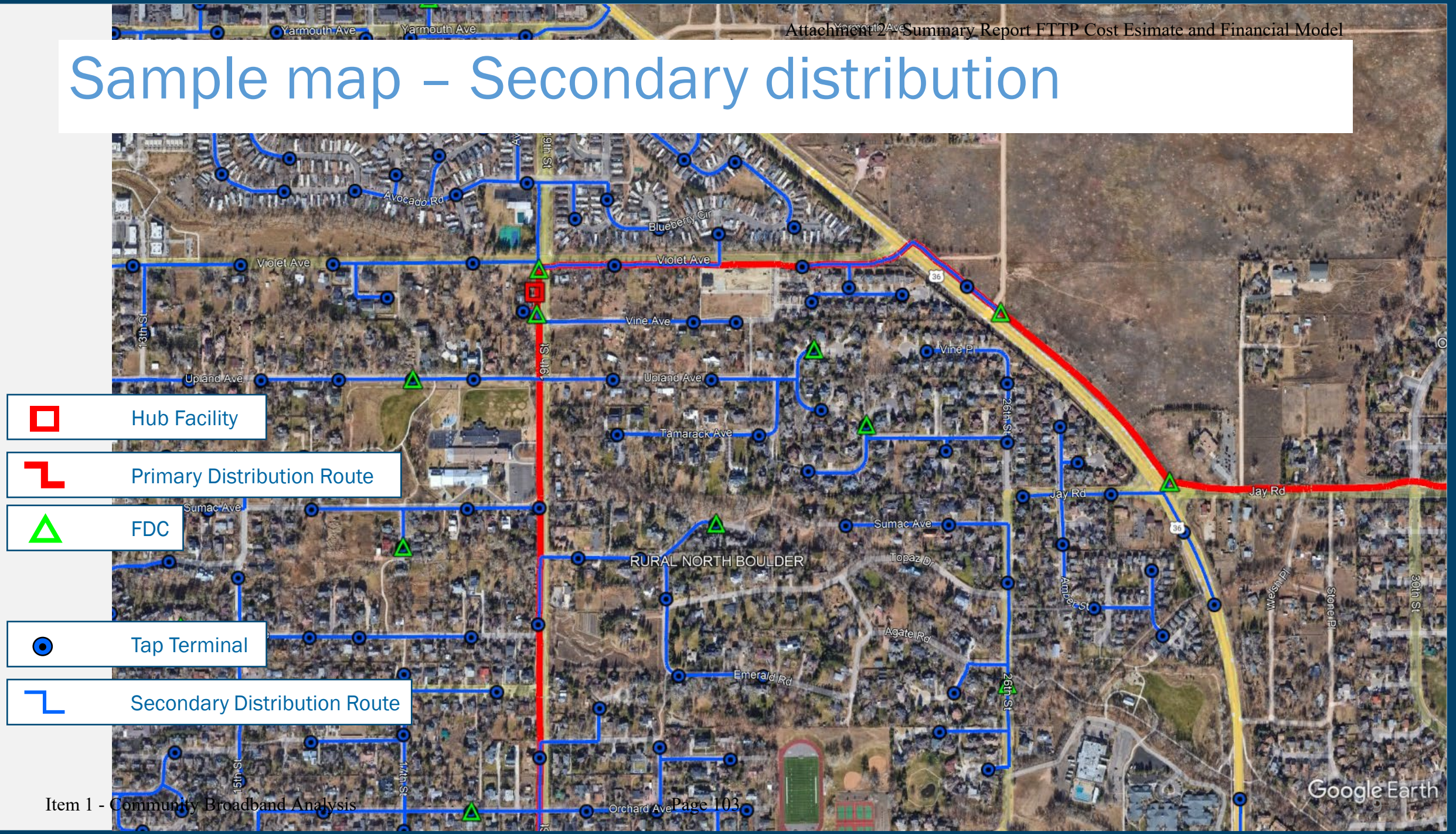
Subscriber taps

Network interface device ("NID")

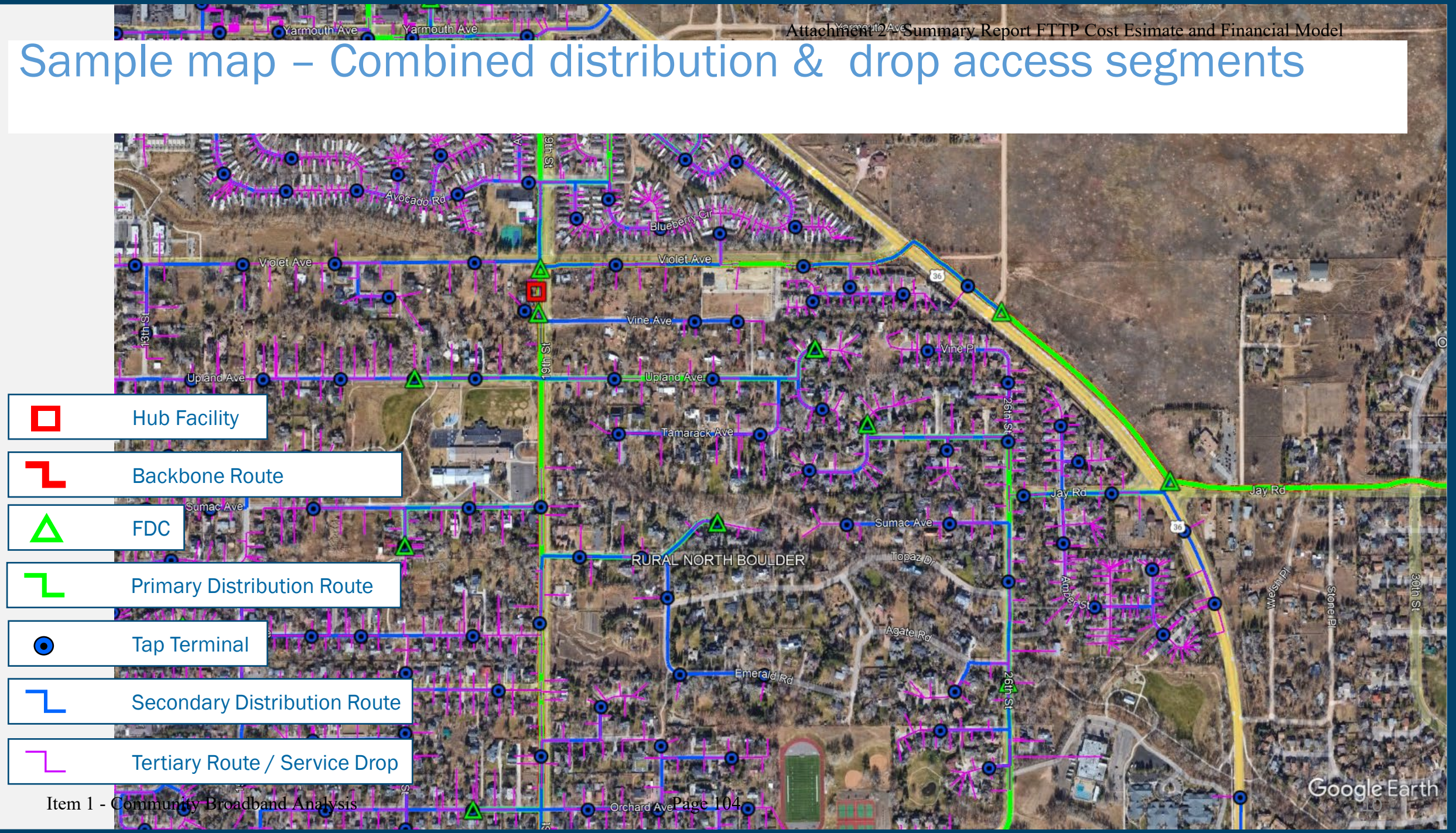
Sample map – Primary distribution



Sample map – Secondary distribution



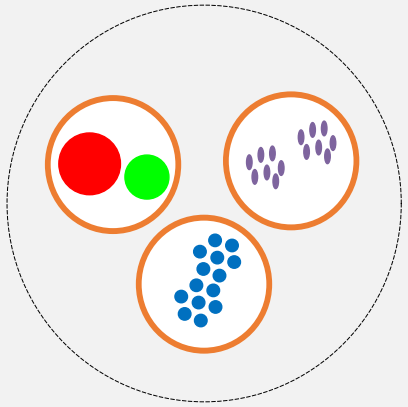
Sample map – Combined distribution & drop access segments



PRIMARY CONDUIT CONFIGURATION TYPES AND ESTIMATED AVERAGE INSTALLATION UNIT COSTS

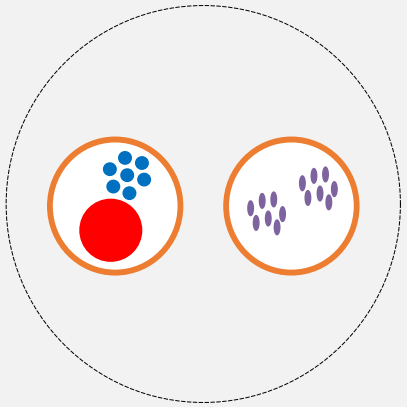
Conduit configurations vary with overlap of different network layers

Backbone, Primary & Secondary Distribution, Drop Access (3 x 2-inch)



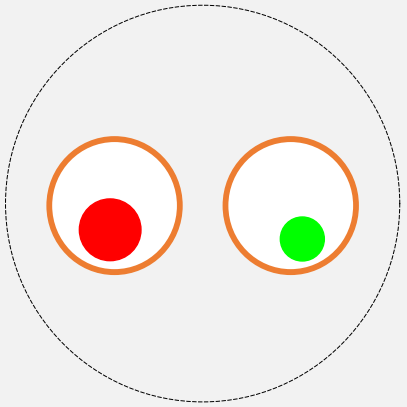
$40.25 per foot
~59.1 miles

Backbone, Secondary Distribution, and Drop Access (2 x -inch)



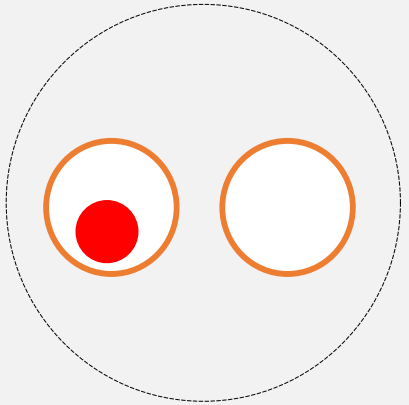
$33.25 per foot
~168.9 miles

Backbone, Primary Distribution (2 x 2-inch)



$33.25 per foot
~35.5 miles

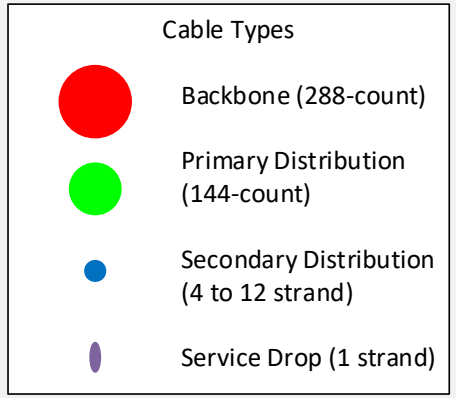
Backbone only (with spare conduit) 2 x 2-inch)



$33.25 per foot
~0.3 miles

Drop Access (1 x 1.25-inch)

$23.50 per foot
~349.9 miles



Costs includes all labor and material costs for conduit installation, including tracer wire and estimated hard rock excavation. Pricing does not include vaults or fiber-related labor and material. Conduit mileage exceed total stated route mileage due to the requirement for drop access conduit pathways on both sides of the street along applicable routes.

PRIMARY VAULT CONFIGURATION TYPES AND UNIT COST ESTIMATES

Equipment Vault (48”x48”x48”)

$4,795 each
Qty. 265

Distribution Vault (30”x48”x36”)

$2,295 each
Qty. 2,022

Tap Access Handhole (24”x36”x36)”

$1,970 each
Qty. 2,906

Drop Access Handhole (12”x12”x12”)

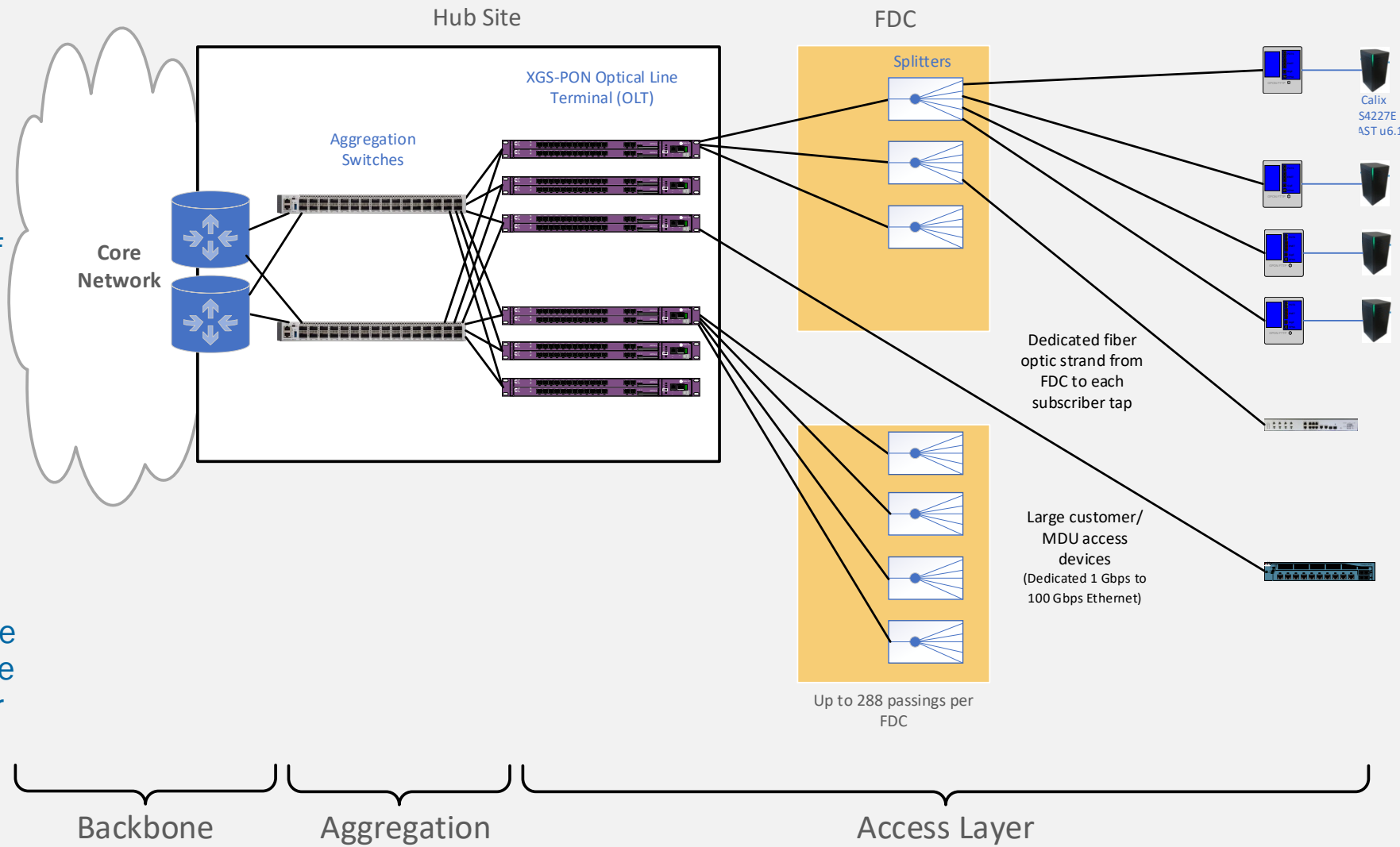
$695 each
Qty. 18,177

Estimated cost includes all labor and material costs for vault / handhole installation, including ground rods. Pricing does not include conduit or fiber-related labor and material.

NETWORK ELECTRONICS REFERENCE DESIGN

Flexible architecture capable of supporting multiple electronics architectures and/or multiple providers with differing approaches

- Cutting edge XGS-PON and low split ratio (1:32) for up to 10 Gbps symmetrical services
- Large strand counts and flexible hardware architecture to enable dedicated Ethernet services for large business and enterprise customers

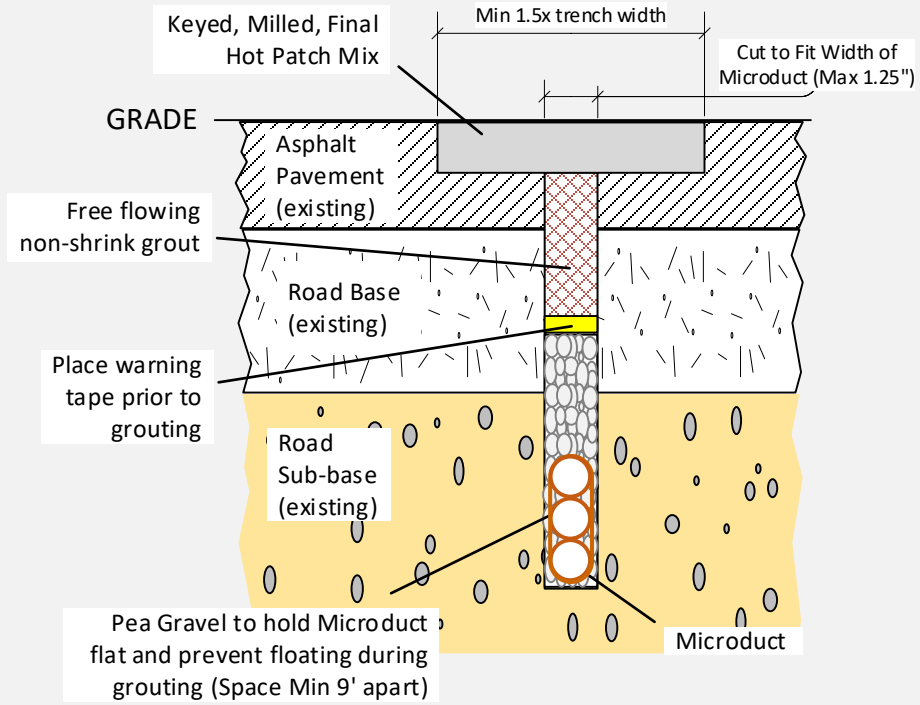


BOULDER FTTP CAPEX ESTIMATES SUMMARY

Cost Component	Estimated Costs @ 40% Take-Rate	Estimated Costs @ 100% Take-Rate
Project management	$6.15 million	$6.15 million
Engineering	$18.7 million	$18.7 million
Conduit infrastructure construction (labor & materials)	$106.25 million	$106.25 million
Fiber optic cables and components	$11.75 million	$11.75 million
Fiber splicing, testing & documentation	$2.60 million	$2.60 million
Hub facilities	$2.25 million	$2.25 million
MDU laterals and cabling	$1.75 million	$1.75 million
City construction oversight	$6.15 million	$6.15 million
Core network electronics	$6.55 million	$6.55 million
Total fixed cost	**$162.15 million**	**$162.15 million**
Fixed cost per passing	**$3,716**	**$3,716**
Distribution electronics cost	$3.55 million	$6.55 million
Subscriber drop cables	$21.15 million	$52.85 million
Customer activation cost (includes customer premises equipment or CPE)	$11.05 million	$27.60 million
Total cost (without contingency)	**$197.9 million**	**$249.10 million**
Total cost per customer	**$11,339**	**$5,709**
Contingency (10%)		
Total cost (with contingency)	**$217.69 million**	**$274.01 million**
Total cost per customer	**$12,473**	**$6,280**

POTENTIAL COST SAVINGS FROM MICROTRENCHING

- Potential reduction of conduit installation costs of up to $18 million, or approximately 12% of the total fixed deployment costs, primarily due to:
  - Shallow conduit placement (8” to 16” deep) in the existing road base, sub-base, or other disturbed right-of-way avoid hard rock and utilities
  - Specialized “microduct” conduit and fiber cable products reduce installation timeframes
- Not recommended for backbone and primary distribution routes
  - More likely to be damaged by subsequent excavation
  - Smaller conduit is less scalable for future needs along more critical routes
  - Estimated cost savings is based on the use of microtrenching along secondary distribution and drop access routes only
- Cost savings may depend on City requirements around conduit depth and surface restoration



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APPENDICES

CAPEX ESTIMATE DETAILS AND KEY ASSUMPTIONS

Cost Component		Description / Key Assumptions
Fixed Costs	Project management	Consists of a full-time, two-person project management team and support staff for the 5-year deployment timeframe.
	Engineering	Consists of all contract engineering services for design, permitting, and as-built documentation, based on 15% of the total fixed costs (not including City construction oversight or core network electronics)
	Conduit infrastructure construction (labor & materials)	Consists of all contract labor and material costs for conduit infrastructure construction, including vaults and handholes (see detailed BOMs).
	Fiber optic cables and components	Consists of all contract labor and material costs for fiber optic cable installation and related components, including fiber termination panels, multi-port tap terminals, fiber splice enclosures, and fiber distribution closures (see detailed BOMs).
	Fiber splicing, testing & documentation	Consists of all contract labor for fiber cable splicing, testing, and documentation. Testing consists of bi-directional OTDR traces and optical power meter tests for all terminated fiber strands.
	Hub facilities	Consists of the labor and material costs for installation of pre-fabricated concrete equipment shelters, inclusive of backup power generator, redundant HVAC, fire suppression, and physical security systems.
	MDU laterals and cabling	Consists of constructing fiber distribution within larger (~16+ units), multi-tenant / multi-dwelling structures and developments. Includes lateral cable construction, riser cables (medium-rise and high-rise buildings), and horizontal fiber runs to each unit. Costs are assumed to be fixed, rather than take-rate dependent, as with standard service drops.
	City construction oversight	Consists of contractor and/or internal staffing support for construction oversight and inspection by the City's permitting authorities. Based on 10% of related construction costs.
	Core network electronics	Consists of equipment and installation costs for core network routers, switches, network management systems, and related support infrastructure. Costs are estimated based on an average per passing cost and assumed to be mostly fixed, rather than take-rate dependent.
Take-rate-dependent Costs	Distribution electronics cost	Consists of equipment and installation costs for distribution network switches and access electronics, including the optical line terminal (OLT) hardware. Based on the use of XGS-PON at a 1:32 split ratio. Costs are estimated specific equipment BOM at a given take-rate.
	Subscriber drop cables	Consists of the contract labor and materials for the installation of underground service drops from Drop Access Handholes in the ROW to the customer premises. Based on an estimated average drop cable length of 254 feet, including 106 feet of new conduit pathway on private property per customer. Costs are take-rate dependent.
	Customer activation cost (includes customer premises equipment or CPE)	Consists of the contract labor and equipment for customer activations (not including service drop cable installation). Includes the supply and installation of customer premises equipment (CPE), consisting of an XGS-PON ONU and Wi-Fi router supporting service speeds of up to 10 Gbps.

CONSTRUCTION LABOR AND MATERIAL BOMS

Labor

Description	Unit	Estimated Quantity	Price	Extended Price
UNDERGROUND CONDUIT AND CABLE INSTALLATION				
Installation of Ground Rod	EA	23,370	$40.00	$934,800.00
Installation of HDPE conduit, Directional Boring, 2 x 2-inch	FT	887,171	$22.00	$19,517,762.30
Installation of HDPE conduit, Directional Boring, 3 x 2-inch	FT	256,180	$27.25	$6,980,912.63
Installation of HDPE conduit, Directional Boring or trench, 1x 1.25-inch	FT	1,789,849	$15.00	$26,847,737.40
Installation of Drop Access Handhole – 12" x 12" x 12"	EA	18,177	$300.00	$5,453,100.00
Installation of Tap Access Handhole – 24" x 36″ x 36″	EA	2,906	$575.00	$1,670,950.00
Installation of Distribution Vault – 30″ x 48″ x 36″	EA	2,022	$700.00	$1,415,400.00
Installation of Equipment Vault – 48″ x 48″ x 48″	EA	265	$1,200.00	$318,000.00
Installation of cable in conduit	FT	2,933,200	$2.00	$5,866,400.91
FIBER SPLICING AND TESTING				
Installation of New or Re-entry of Existing Splice Enclosure	EA	542	$550.00	$298,100.00
Splicing of Fiber (per splice)	EA	43,484	$35.00	$1,521,929.06
Splicing of Fiber (per Ribbon)	EA	122	$140.00	$17,053.02
Final Acceptance testing of Terminated Cable (per strand)	EA	48,574	$15.00	$728,605.31
FIBER TERMINATION AND INSIDE PLANT WORK				
Installation of Backbone Termination Panel	EA	22	$550.00	$12,100.00
Hub Building Entry	EA	3	$2,500.00	$7,500.00
Fiber Tap Housing (any size, not including tap tail cable or splicing)	EA	3,866	$50.00	$193,300.00
Installation of Fiber Distribution Cabinet, 288-Strand, Passive, vault or pad-mount (not including splicing)	EA	265	$5,000.00	$1,325,000.00
ADDITIONAL ITEMS				
Intermediate Rock Adder	FT	1,319,941	$15.00	$19,799,115.00
Solid Rock Adder	FT	29,333	$60.00	$1,759,980.00

Materials

Description	Unit	Estimated Quantity	Price	Extended Price
CONDUIT				
1.25-inch, SDR 11, HDPE Conduit	FT	1,789,849	$0.75	$1,342,386.87
2-inch, SDR 11, HDPE Conduit	FT	2,542,883	$1.75	$4,450,045.02
HANDHOLES				
Drop Access Handhole – Tier 22, 12" x 12" x 12"	EA	18,177	$300.00	$5,453,100.00
Tap Access Handhole – Tier 22, 24" x 36" x 24"	EA	2,906	$1,300.00	$3,777,800.00
Distribution Vault – Tier 22, 30″ x 48″ x 36″	EA	2,022	$1,500.00	$3,033,000.00
Equipment Vault – Tier 22, 48″ x 48″ x 48″	EA	265	$3,500.00	$927,500.00
SPLICE ENCLOSURES				
Backbone/Distribution Splice Enclosure and Accessories (6 cable, 576 mass fusion and 72 single splices)	EA	542	$500.00	$271,000.00
CONSTRUCTION HARDWARE				
Ground rod, 8 ft.	EA	23,370	$55.00	$1,285,350.00
#10 copper tracer/ground wire, green insulation	FT	3,240,602	$0.40	$1,296,240.84
Wrap-Around Cable Marker Labels	EA	8,792	$2.50	$21,980.00
FIBER DISTRIBUTION CLOSURES AND TERMINATION				
Hub Termination Panel, 144-strands	EA	22	$5,500.00	$121,000.00
Fiber Tap Assembly, 12-port (not including stub cable)	EA	3,866	$200.00	$773,200.00
Fiber distribution cabinet (288 passings, including splitters)	EA	265	$5,000.00	$1,325,000.00
FIBER OPTIC CABLE				
Fiber Tap Tail (6-12 strands)	FT	2,888,624	$0.25	$722,155.96
72- to 144-strand feeder cable, ribbon, outdoor cable	FT	549,731	$1.50	$824,596.03
288-strand backbone cable, ribbon, outdoor cable	FT	124,921	$2.50	$312,301.44