ctc technology & energy

engineering & business consulting

Broadband Feasibility Study

Prepared for City of Spring Hill, Kansas
February 2018

Columbia Telecommunications Corporation

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1 Executive Summary

Localities throughout the U.S. are increasingly interested in developing broadband infrastructure to address service availability gaps in their communities. More and more, public entities are evaluating ways to deploy new broadband networks, expand existing infrastructure, or collaborate with the private sector. In many cases, public sector entities seek to partner with private industry to offer fiber-to-the-premises (FTTP)—long-lasting fiber optic lines all the way to the home and business with virtually unlimited ability to meet growing needs for connectivity, now and for many decades to come.

1.1 Background Information

The City of Spring Hill (City) has determined that its residents and businesses require access to modern broadband services, and that this need will likely continue to grow. City leadership aims to evaluate the feasibility of deploying a citywide fiber network to address current and future broadband needs. There are several possible approaches to deploying broadband in a community; the City seeks to determine which of these options—if any—is financially and practically feasible for Spring Hill's residents and businesses.

Accordingly, the City engaged CTC Technology & Energy (CTC) to explore the technical and financial implications of deploying a citywide ultra-high-speed fiber-based broadband network. This report, prepared in late 2017 and early 2018, explores the technical and financial feasibility of several potential broadband deployment options.

1.2 Methodology

This report examines the feasibility of the City taking steps to deploy broadband as an infrastructure provider, an open-access provider, or as part of a public–private partnership.

Over the course of the engagement, CTC performed the following tasks:

- Consulted extensively with City staff from several departments, and incorporated feedback from staff and the City's Broadband Task Force[1] into our analysis;
- Researched the region's available broadband services and costs (Section 2);
- Considered the high-level potential impact of broadband in Spring Hill beyond the technical and financial implications (Section 3);
- Evaluated potential public–private partnership business models based on current developments in the broadband industry (Section 4);

[1] See https://springhillks.gov/674/Broadband-Task-Force, accessed December 2017.

- Examined potential alternative approaches to engaging and coordinating with the private sector (Section 5);
- Conducted onsite and desk surveys of City infrastructure, and developed a candidate gigabit FTTP network design and cost estimates (Section 6);
- Developed pro forma financial statements to illustrate the projected potential outcomes of pursuing various business models for FTTP deployment (Section 6.5); and
- Developed "Dig Once" policy recommendations (Appendix A).

1.3 Key Conclusions and Recommendations from this Analysis

CTC's in-depth analysis made clear three conclusions, discussed further in Section 1.8:

1. **Spring Hill faces a challenge of scale**, and like most localities, lacks the economies of scale that a larger provider will have in place to support a ubiquitous standalone FTTP deployment operated by the City;
2. **The City may need to consider funding a dark FTTP deployment** rather than a ubiquitous retail service model; and
3. **A wireless deployment will not cost-effectively provide a ubiquitous connectivity solution for Spring Hill**, but may help provide service to targeted un- or underserved areas.

These findings illuminated three alternate strategies to FTTP that the City can take to position itself to capitalize on its strengths to facilitate eventual delivery of broadband access citywide, discussed further in Section 1.9:

1. **Adopt a dig-once policy or enact changes to current policies to support dig once** to potentially mitigate costs for installing underground network infrastructure;
2. **Focus on actions that will attract private investment in Spring Hill**, including potentially building a middle-mile network, easing and facilitating private access to relevant facility property and assets, and streamlining City processes; and
3. **Participate in a formal solicitation process** once the City has a clear idea of its next steps to engage the private sector, measure potential partners' interest in partnering, and clearly outline the City's plans.

1.4 Goals and Objectives

The City articulated in its 2017 RFP a desire to explore the feasibility of deploying a ubiquitous FTTP network that would serve every home and business in Spring Hill. The City is focused not only on the existing Spring Hill footprint, but on the likelihood of continued growth and development outside current city limits. As described in the RFP, the City seeks to understand three primary FTTP deployment options:

- "Infrastructure Provider – the City provides conduit and dark fiber services for lease to community organizations, businesses and broadband providers, which use the fiber to connect to one another and to data centers to reach the internet, cloud services and other content networks;
- Open-Access Provider – the City owns the fiber optic network and equipment needed to create a broadband network and may operate said network itself or in contract with others on its behalf. Content is typically resold from other providers;
- Public–Private Partnerships – the City and one or more private organizations enter into a partnership to plan, fund, build, operate and maintain a broadband network within the municipality's jurisdiction."[2]

Based on the City's overarching goal of ubiquitous FTTP deployment in Spring Hill and other stated objectives, we evaluated a range of network deployment options to develop our design, cost estimate, and financial analysis:

Dark fiber models

- **A dark FTTP model** in which the City would deploy fiber infrastructure for lease to a private partner, but *would not* deploy the fiber drop cable that connects the customer's premises to the FTTP network. The private partner would be responsible for constructing the fiber drop cables and providing network electronics and customer premises equipment (CPE) to offer retail services. Because this model is based on the agreement between Huntsville (Ala.) Utilities and its private partner, Google Fiber, we refer to it as the **Huntsville model**.
- **A dark FTTP model** in which the City would deploy fiber infrastructure—including the fiber drop cables connecting the customer's premises to the distribution network—for lease to a private provider. The private provider would then add network and consumer electronics to offer retail services. Because this model is based on the agreement between the City of Westminster, Md., and its partner, Ting Internet, we refer to it as the **Westminster model**.

Lit fiber models

[2] "Citywide Fiber Optic Network: RFP for Feasibility Study Report," City of Spring Hill, March 29, 2017.

- **A lit FTTP municipal retail model** in which the City deploys, maintains, and operates a citywide FTTP network (fiber and electronics, including CPE) and offers retail services.

- **A lit FTTP open access model** in which the City deploys, maintains, and operates a citywide FTTP network and relies on retail service providers (RSP) to provide CPE[3] and offer data services directly to homes and businesses. In this model, RSPs would pay the City a per-subscriber fee. This model offers the benefit of the City providing a platform over which RSPs can compete, without the risks and responsibilities of the City becoming a service provider itself.

Consistent with the City's aim to consider becoming an infrastructure provider, we also evaluated the high-level cost to deploy a less-extensive **middle-mile network** that would ensure the availability of fiber optics to government users and key local institutions. This network could effectively lower barriers to market entry for existing and new providers, offering a platform for potential operational relationships between the City and the private sector.

1.5 Constructing a Fiber Network that Passes all Residences and Businesses in Spring Hill Will Cost $4.8 to $5.4 Million[4]

The City's bottom-line cost for a fiber network is variable—heavily dependent on the business model chosen to operate the network, the number of residents and businesses subscribing to the network, and the terms of any partnership the City may negotiate to facilitate construction and service delivery.

To estimate the range of network deployment costs, CTC engineers developed a high-level, conceptual FTTP design that meets the City's goals, is open to a variety of architecture options (see Section 6), and incorporates a combination of aerial and underground construction that reflects the placement of existing utilities.

We developed cost examples for two FTTP approaches:

- **A dark FTTP model,** which shows the cost to deploy *only* the FTTP outside plant (OSP) infrastructure. This is the total capital cost for the City to build a dark FTTP network for lease to a private partner (with or without the fiber drop).

- **A lit model,** which shows the cost to deploy all FTTP infrastructure, electronics, consumer drop cables, and CPE**.** This estimate shows the *total capital costs*[5] to build an FTTP network to support delivery of a ubiquitous Gigabit data service.

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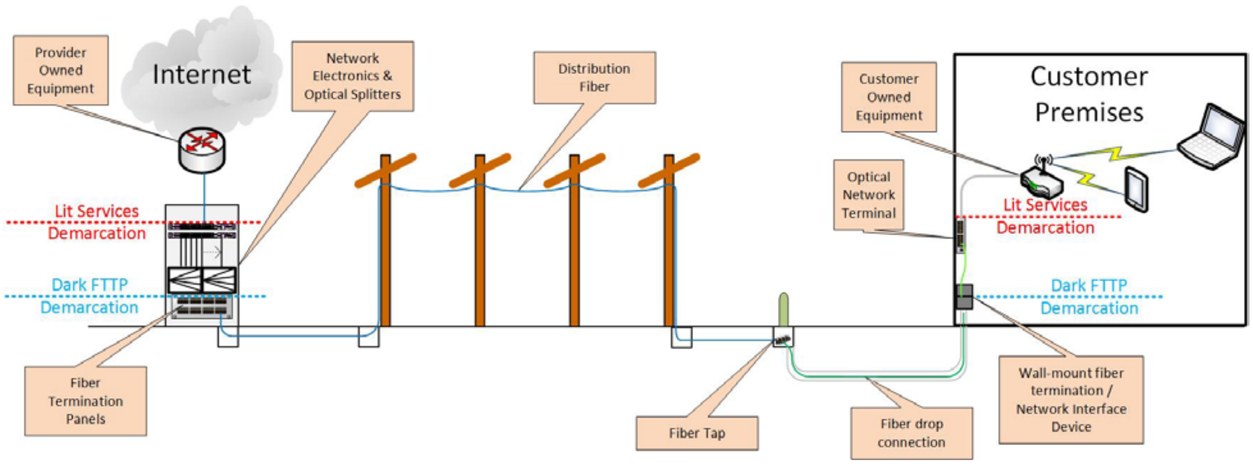
[3] In this model, the City would provision services to the CPE, but the partner would be responsible for the cost of deploying and replenishing these electronics.

[4] Not including fiber drops, core network electronics, or customer premises equipment.

Figure 1 illustrates the differences between these models.

Figure 1: Demarcation Between City and Partner Network Elements in the Lit and Dark Models



It is important to note that actual costs may vary due to factors that cannot be precisely known until the detailed design is completed, or until construction commences. These factors include:

1. Costs of private easements;
2. Utility pole replacement and make-ready costs;
3. Variations in labor and material costs;
4. Subsurface hard rock; and
5. The City's operational and business model.

We have incorporated suitable assumptions to address these items based on our experience in similar markets.

1.5.1 Outside Plant Infrastructure Will Cost $4.8 Million, or $1,700 Per Passing—Which Is Comparable to Per-Passing Costs in Similar Communities

The estimated cost to construct the OSP portion of the proposed FTTP network (excluding drops) is approximately $4.8 million, or $1,700 per passing (potential customer address).[6] This model assumes a mixture of aerial and underground fiber construction, depending on the construction of existing utilities in the area as well as the state of any utility poles, existing infrastructure, and construction within the communication space. Table 1 provides a breakdown of the estimated OSP costs. (Note that the costs have been rounded.) See Section 6 for additional information about how we estimated OSP costs.

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[5] Capital costs are distinct from ongoing operations costs that the City or the City and partners will incur to operate and maintain the fiber enterprise.

[6] The passing count includes individual single-unit buildings and units in small multi-dwelling and multi-business buildings as single passings. It treats larger buildings as single passings.

Table 1: Estimated OSP Costs

Distribution Plant Mileage	Total Cost	Passings	Cost per Passing	Cost Per Plant Mile
39.0	$4,770,000	2,800	$1,700	$120,000

Regardless of the take rate, the cost per passing is $1,700 on average, based on the estimated OSP cost of $4.8 million and an assumed 2,800 residential and commercial passings.

The $1,700 per passing cost for the City of Spring Hill is similar to other communities we have worked with that have a high percentage of underground infrastructure. Figure 19 and Figure 20, below, show the potential range of costs for a variety of communities with which CTC has been engaged.

Figure 2: FTTP Cost per Passing Comparison

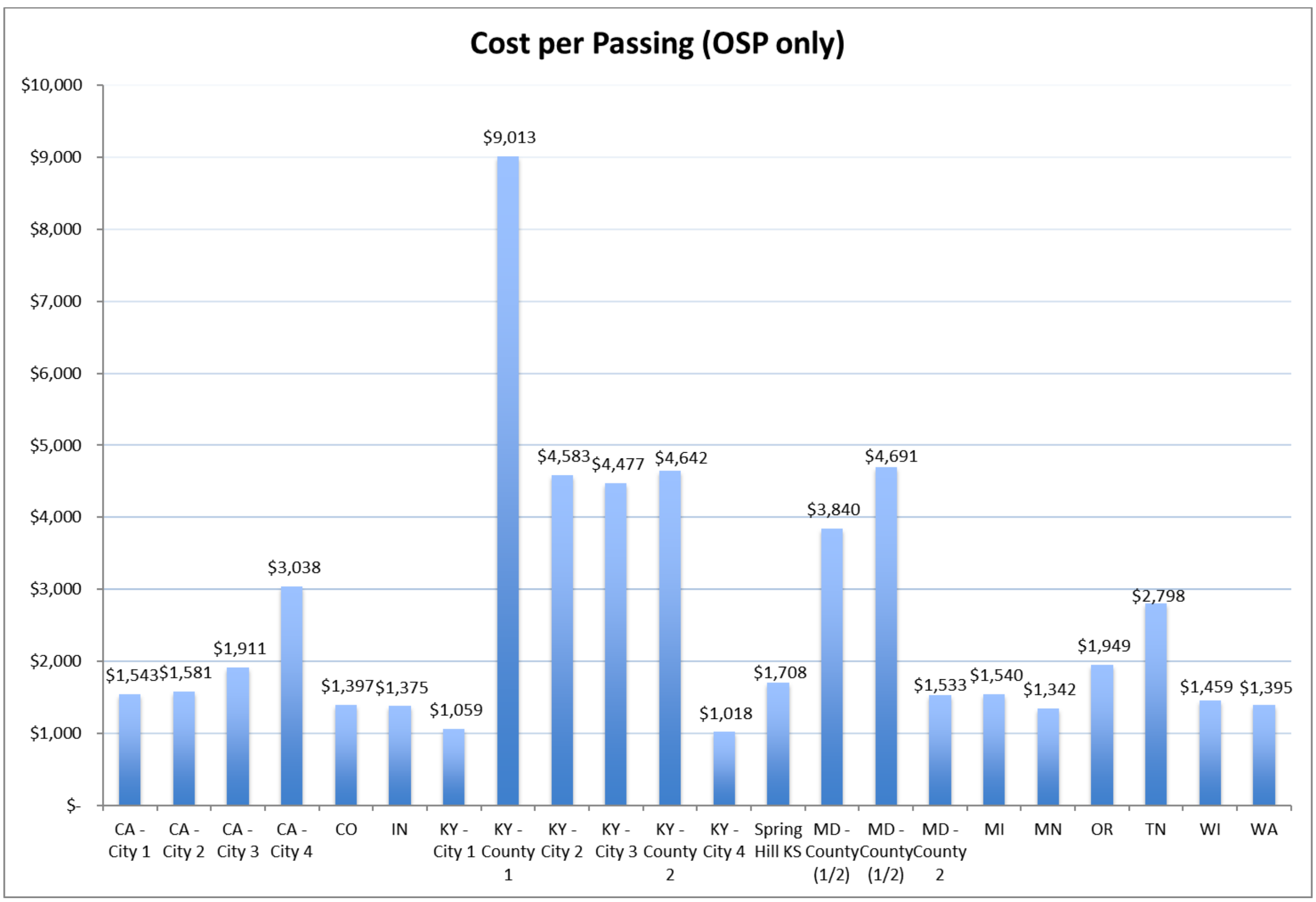
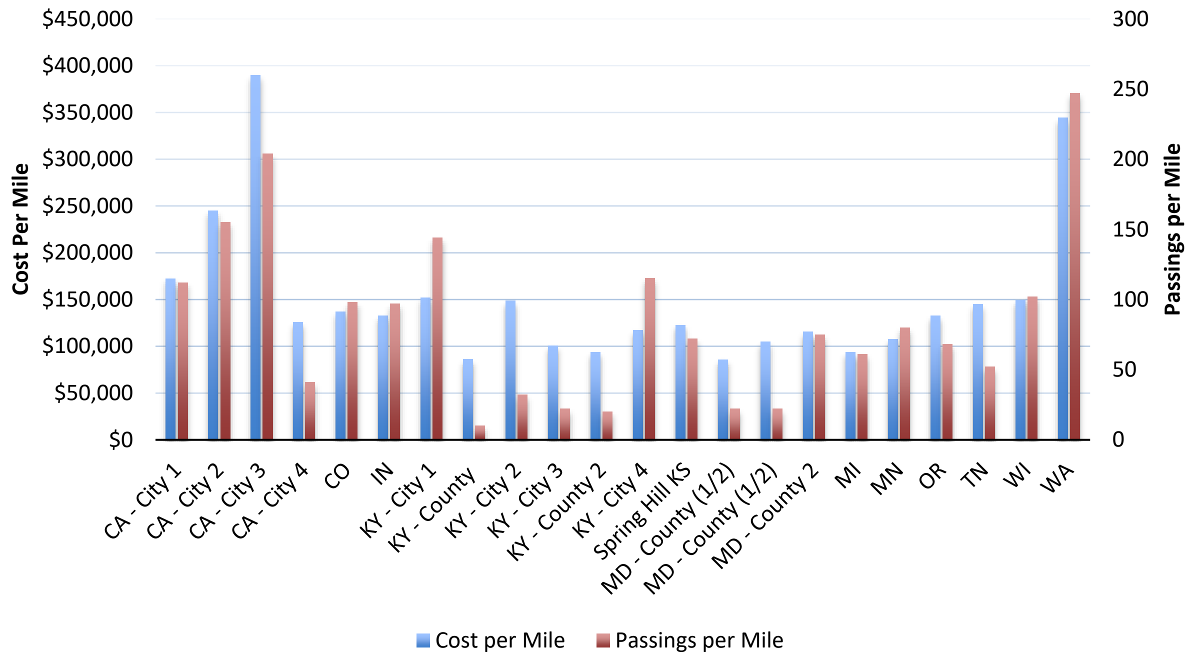


Figure 3: FTTP Key Cost Factors (Density and Construction Cost)



1.5.2 All-Underground Network Deployment Will Significantly Increase Outside Plant Costs

Based on discussions with the City, we understand that it may be challenging for the City to gain access to utility poles. If the City is unable to negotiate pole attachment agreements—or it find that the cost of make-ready is prohibitive—the FTTP network may have to be built entirely underground. An all-underground FTTP network would increase the cost of the OSP construction by $0.6 million, increasing the cost per passing by an average of $230 to $1,930. Table 2 shows the cost of the OSP infrastructure in an all-underground scenario.

Table 2: OSP Costs for an All-Underground FTTP Network

Distribution Plant Mileage	Total Cost	Passings	Cost per Passing	Cost Per Plant Mile
39.0	$5,410,000	2,800	$1,930	$140,000

1.5.3 Central Network Electronics Will Total Roughly $500,000

Central network electronics to “light” the network will cost an estimated $500,000. These costs may increase or decrease depending on take rate, and the costs may be phased in as subscribers are added to the network. The central network electronics consist of the electronics to connect subscribers to the FTTP network at the core and cabinets. We note these costs are only incurred in a Lit FTTP deployment. Table 3, below, lists the estimated costs for these electronics

Table 3: Estimated Central Network Electronics Costs

Network Segment	Subtotal	Passings	Cost per Passing
Core and Distribution Electronics (Sections 6.4.4.1 and 6.4.4.2)	$300,000	2,800	$100
FTTP Access Electronics (Section 6.4.4.1)	$200,000	2,800	$70
Central Network Electronics Total	**$500,000**	**2,800**	**$170**

1.5.4 Per-Subscriber Costs Will Vary, Based on the City's Chosen Model

Beyond OSP, the City may need to deploy CPE and drop cables, based on its chosen operating model.

The drop installation cost is the biggest variable in the total cost of adding a subscriber. A short aerial drop can cost as little as $250 to install, whereas a long underground drop installation can cost upward of $3,000. We estimate an average of $1,590 per drop installation. Additionally, we estimate the City's average CPE cost will total $240 per passing.

The other per-subscriber expenses include the cost of the optical network terminal (ONT) at the premises, a portion of the OLT costs at the hub, the labor to install and configure the electronics, and the incidental materials needed to perform the installation. The numbers provided in Table 4, below, are averages and will vary depending on the type of premises and the internal wiring available at each premises.

Table 4: Per-Subscriber Cost Estimates[7]

Construction and Electronics Required to Activate a Subscriber	Estimated Average Cost
Drop Installation and Materials	$1,590
Subscriber Electronics (ONT and OLT)	240
Electronics Installation	200
Installation Materials	100
Total	**$2,230**

[7] We note that not every network deployment will incur all the per-subscriber costs, because some models shift individual per-subscriber costs to the private partner.

1.6 Deploying a Middle-Mile Network Would Cost Approximately $1.18 Million

Following a presentation of CTC's designs, cost estimates, and financial analysis to City staff in late 2017, we developed a high-level analysis of what it might cost to deploy a middle-mile network. Such a deployment would not directly connect customers, but would support connectivity to key institutions and could lower barriers to market entry for private providers by offering low-cost access to important infrastructure.[8]

Our estimate indicates that a middle-mile fiber network deployment would require a **$1.18 million initial investment, in addition to $12,000 per year in operations and maintenance expenses.** If the City financed the network at a 3 percent interest rate over 20 years, the resulting annual principal and interest payment would be approximately $82,000. That is, **the total annual cost of financing a middle-mile network over 20 years will equal $94,000.** If the City could contribute $1 million over the 20-year span of the model, averaging $60,000 in available capital annually, the City would still face a $34,000 annual shortfall. In order to operate the middle-mile network, this shortfall would need to be supplemented by other revenue sources.

We note that the City would need to be willing to fund this middle-mile asset without expectations of substantial lease revenues. That said, the City can view this investment as a demonstrative step to attract commercial providers by reducing barriers to entry into the broadband market.

For more discussion on this topic, see Section 5.3.

1.7 Potential Fiber-to-the Premises Business Models in Spring Hill

While there are ways to encourage private investment and take other incremental steps toward improving the broadband landscape in Spring Hill, it is our understanding that the City's primary goal is to pursue FTTP deployment. Even if the City determines that FTTP deployment is outside the realm of what is currently feasible, it is important to be aware of the potential business models and options available to the City for such a deployment, and the associated estimated financial implications of those models. Here, we outline potential business models the City may wish to pursue for FTTP deployment, their associated deployment costs, and the financial analysis we developed for each.

[8] We note that this is a key element of successfully partnering with the private sector in this capacity; inexpensive access to infrastructure will likely be an important incentive for private investment in Spring Hill.

We developed cost examples for two FTTP approaches, and four business models that use these estimates:

- **A dark FTTP model,** which shows the cost to deploy *only* the FTTP outside plant (OSP) infrastructure. This is the total capital cost for the City to build a dark FTTP network for lease to a private partner (with or without the fiber drop). The **Huntsville** and **Westminster models** use this cost estimate.

- **A lit model,** which shows the cost to deploy all FTTP infrastructure, electronics, consumer drop cables, and CPE**.** This estimate shows the *total capital costs*[9] to build an FTTP network to support delivery of a ubiquitous Gigabit data service. The **Open Access** and **Municipal Retail models** use this cost estimate.

Table 5 shows the distribution of responsibilities in each model.

Table 5: Responsibility for Network Elements

C = City Responsibility; P = Partner Responsibility; RSP = Retail Service Provider Responsibility						
Business Model	**OSP**	**OSP Maintenance**	**Drops**	**Core Electronics**	**CPE**	**Backhaul**
Huntsville (Dark FTTP)	C	C	P	P	P	P
Westminster (Dark FTTP)	C	C	C	P	P	P
Open Access (Lit)	C	C	C	C	RSP	RSP
Municipal Retail (Lit)	C	C	C	C	C	C

1.7.1 Dark Fiber-to-the-Premises Model and Differences in the Huntsville and Westminster Approaches

As we noted, a Dark FTTP model would entail the City deploying network infrastructure for lease to a third party to "light" the network and deliver services over it. There are two key variations of this model, based on which party is responsible for the drop cable that connects the customer's premises to the FTTP.

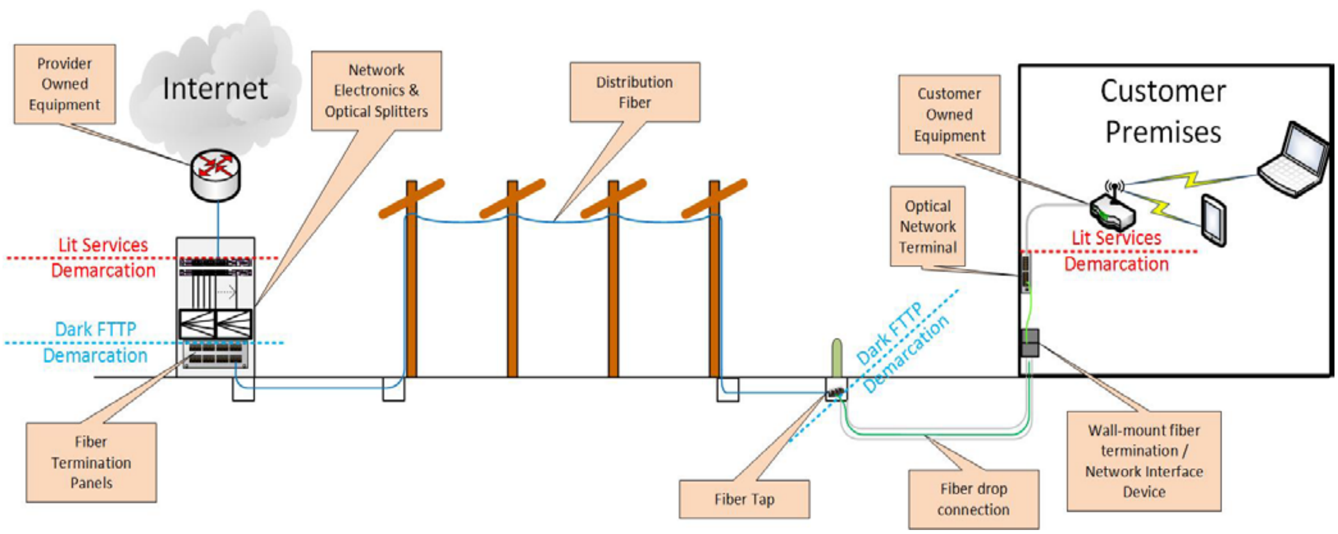
The **Huntsville Model** and the **Westminster Model** are both what we call a Dark FTTP model, in which the public partner constructs, owns, and maintains a fiber network that passes every home and business, and a private partner places electronics to "light" the network. In each, the private partner directly serves the end user. Both models entail a full FTTP network buildout, in which the City would construct and maintain ubiquitous infrastructure that passes every residence and business, and would lease the fiber backbone and distribution fiber to a private partner. In addition to placing all network electronics, the private partner would also be responsible for all CPE and network sales, marketing, and operations.

[9] Capital costs are distinct from ongoing operations costs that the City or the City and partners will incur to operate and maintain the fiber enterprise.

The **Huntsville Model** and the **Westminster Model** differ in their treatment of the fiber drop cable—the cable that connects the customer's premises to the network. In the Huntsville Utilities agreement with Google Fiber, the private entity is responsible for installing, owning, and maintaining fiber drop cables. In the City of Westminster's agreement with Ting, the public entity is responsible for fiber drop cables.

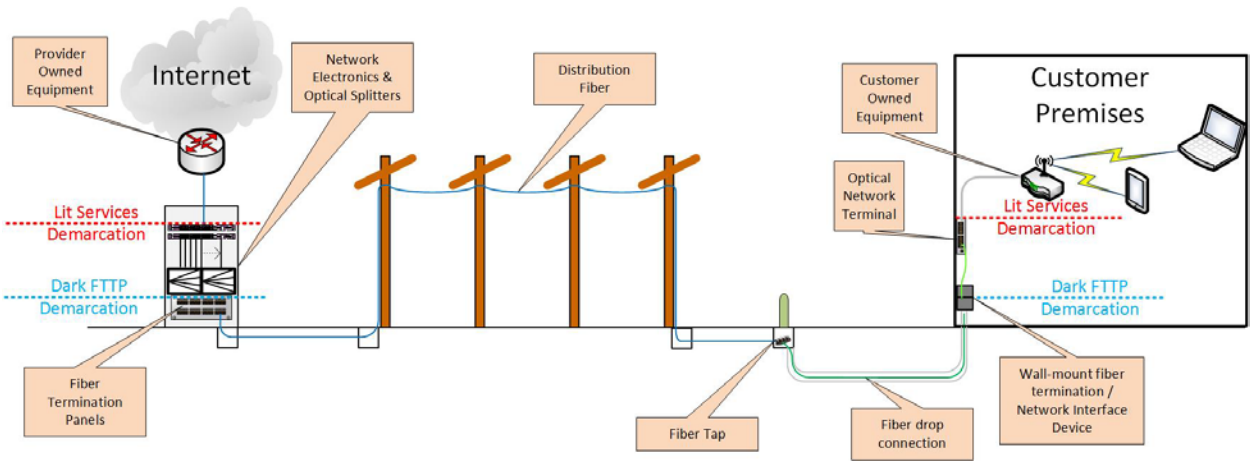
In each of these models, the City is responsible for the FTTP infrastructure up to a demarcation point. In the **Huntsville Model**, the City constructs and owns the network infrastructure throughout the community up to a demarcation point in the public right-of-way (PROW), and the private partner is responsible for connecting drop cables from the PROW into the customer's premises. See Figure 4, below.

Figure 4: Demarcation Point Between City and Partner Network Elements in Huntsville Model



In the **Westminster Model**, the City would be responsible for constructing and maintaining all the fiber infrastructure, including the drop cable that runs from the curb into the customer premises. See Figure 5, below.

Figure 5: Demarcation Point Between City and Partner Network Elements in Westminster Model



1.7.1.1 Per-Passing and Per-Subscriber Fees

Based on the existing agreements in Huntsville and Westminster, we anticipate that in each model, the City would be able to charge its partner a **per-passing fee, which is a fixed fee paid per passing per month from the private partner to the public entity**. Because this fee is based on a known, fixed quantity, the incoming revenue from a per-passing fee would be predictable.

A **per-subscriber fee, which we anticipate the City would assess in a partnership model like the one in Westminster, would be paid to the City by its partner based on the number of subscribers that purchase service from the private partner**. This number, known as the "take rate," would be variable and unpredictable, and would largely depend first on the partner's marketing and advertising efforts, and later on its ability to retain subscribers. One major advantage of this model is that the City would own and control the fiber to each premises, including the drop cable.

In the Huntsville model, there is no per-subscriber fee, because the private partner is responsible for paying for the drop cable to connect to the customer premises. **In its contract with Google Fiber, Huntsville Utilities negotiated a monthly per-passing fee of $7.50.** We note that this number is low, and the City would likely need to obtain significantly higher fees to become and remain cash-flow positive (see Section 1.7.1.2 and Section 7.1.1).

In the city of Westminster's contract with Ting Internet, the locality negotiated a per-passing fee ($6) plus a per-subscriber fee ($17) per month for dark fiber usage. That is, Ting pays the city for every premises the network passes, plus an additional fee for every subscriber receiving service over the network, **totaling $6 per non-subscribed passing and $23 per subscribed passing.** As such, the take rate is vitally important to the feasibility of the project. Again, to become and remain cash-flow positive, the City would need to obtain higher fees from a partner than those agreed upon in Westminster (see Section 1.7.1.3 and Section 7.1.2).

1.7.1.2 Huntsville Model

1.7.1.2.1 Fiber-to-the-Premises Infrastructure to Support the Huntsville Model Will Cost $4.8 Million, Independent of Take Rate

This dark FTTP network deployment will cost approximately $4.8 million, inclusive of OSP construction labor, materials, engineering, and permitting.

Table 6: Estimated Huntsville Model FTTP Costs

Cost Component	Total Estimated Cost
OSP	$4.8 million
Total Estimated Cost:	$4.8 million

This estimate assumes that the City constructs and owns the FTTP infrastructure up to a demarcation point in the PROW, and leases the dark fiber backbone, distribution, and drop fiber to a private partner. The private partner would be responsible for constructing the fiber drop into each home or business, all network electronics and CPE, as well as network sales, marketing, and operations.

1.7.1.2.2 Necessary Partner Fees for the Huntsville Model are 3.7 Times the Fees Agreed Upon in Huntsville

In our base case financial analysis, we present what would be necessary to maintain positive cash flow given the estimated OSP construction and operating costs. The model assumes a straight-line depreciation of assets, and that the OSP and materials will have a 20-year life span while network test equipment will need to be replaced after five years.

To cover network deployment, operating expenses, and maintain a positive cash flow, **the City would need to charge a private partner $27.75 per month per passing, for a total of 2,804 commercial and residential passings. This lease fee is 3.7 times the fee to which Huntsville Utilities and Google Fiber agreed.**

1.7.1.3 Westminster Model

1.7.1.3.1 Fiber-to-the-Premises Infrastructure to Support the Westminster Model, Including Drops, Will Cost $6.4 Million at a 35 Percent Take Rate

This dark FTTP network deployment will cost approximately $6.4 million, inclusive of OSP construction labor, materials, engineering, permitting, lateral drops, and drop materials. This estimate assumes a 35 percent take rate—the percentage of residential and business passings that subscribe to the service. This estimate does not include any electronics or subscriber equipment. (See Section 1.7.3 for more about take rates.)

Table 7: Estimated Dark FTTP and Drop Costs (Assuming a 35 Percent Rate)

Cost Component	Total Estimated Cost
OSP	$4.8 million
FTTP Service Drop and Lateral Installations	1.6 million
Total Estimated Cost:	$6.4 million

This estimate assumes that the City constructs and owns the FTTP infrastructure up to a demarcation point (a network interface device) at each residence and business, and leases the dark fiber backbone, distribution, and drop fiber to a private partner. The private partner would be responsible for all network electronics and CPE—as well as network sales, marketing, and operations.

1.7.1.3.2 Necessary Partner Fees for the Westminster Model are 2.6 Times the Fees Agreed Upon in Westminster

For our base case financial analysis scenario in the Westminster Model, we present what would be necessary to maintain positive cash flow given the estimated OSP construction and operating costs. In this base case model, we assume the private partner can obtain and maintain a 35 percent take rate.[10]

Using our construction cost estimate (see Section 6), we estimate each drop to cost an average of $1,592. If 35 percent of the City's 2,804 passings were to subscribe (roughly 980 subscribers), drop cost construction would total just under $1.6 million.

Though the City will be responsible for funding and constructing the drops, these costs are offset by the per-subscriber lease fees that are the responsibility of the private partner.

To maintain positive cash flow with this model, assuming the private partner can obtain and maintain a 35 percent take rate, **the City would need to charge the partner $15.60 per passing and an additional $44.20 per subscriber. These are 2.6 times the fees the city of Westminster could obtain in its agreement with Ting Internet**.

1.7.2 Municipal Retail, Data-Only Fiber-to-the-Premises (Lit)

In a Municipal Retail Model, the City would construct, own, and operate a citywide FTTP network and provide retail data services to business, institutional, and residential customers. In this model, the City would be responsible for every aspect of network and customer

[10] Most overbuilders typically obtain about a 35 percent take rate when entering a new market.

management, and all business operations—from network maintenance, to sales and marketing, to billing and technical support.

1.7.3 Deploying a Lit Fiber-to-the-Premises Network to Support the Municipal Retail Model Will Cost $7.5 million to $9.9 Million, Depending on Take Rate

The estimated total cost breakdown for a lit FTTP deployment will depend largely on the network's take rate. As stated in Section 1.5.1, **regardless of the take rate, the cost per passing is $1,700 on average, based on the estimated OSP cost of $4.8 million and an assumed 2,800 residential and commercial passings.**

At a 35 percent take rate, deploying a lit FTTP network would cost about $7.5 million; at a 67 percent take rate (i.e., the level needed for positive cash flow), the lit FTTP network would cost $9.9 million.

The key reason for the difference between these estimates is the cost of FTTP service drop and lateral deployment, and the corresponding increase in the number of CPE needed. In a scenario with a 35 percent take rate, only approximately 980 subscribers would be served, whereas a 67 percent take rate would mean that approximately 1,880 subscribers would be served. This nearly doubling of the number of subscribers adds significant capital expenses for network deployment. (The financial analysis in Section 6.5 discusses the impact of take rate in additional detail.)

1.7.3.1 Based On a 35 Percent Take Rate, A "Lit" Network Deployment Will Cost More Than $7.5 Million

Assuming a 35 percent take rate, the full FTTP network deployment will cost more than $7.5 million, inclusive of OSP construction labor, materials, engineering, permitting, network electronics, drop installation, CPE, and testing. See Table 8, below.

Table 8: Estimated Lit FTTP Cost

Cost Component	Total Estimated Cost
OSP	$4.8 million
Central Network Electronics	0.5 million
FTTP Service Drop and Lateral Installations	1.6 million
CPE	0.6 million
Total Estimated Cost:	$7.5 million

1.7.3.2 Based on a 67 Percent Take Rate, A Municipal Retail Network Deployment Will Cost Approximately $9.9 Million

Based on our financial analysis in Section 6.5, we anticipate that a 67 percent take rate will be necessary for the City's fiber enterprise to become and remain cash-flow positive. Based on this take rate, we projected costs for capital additions that are incurred in the first few years during the construction phase of the network. These represent the equipment, materials, and construction labor associated with building, implementing, and lighting a fiber network. Table 9 shows the capital additions costs in years one through four, assuming a 67 percent take rate, or just under 1,880 subscribers.

This analysis projects that capital additions in year one will total roughly $2.6 million. These costs will total almost $3.5 million in year two, roughly $2.8 million in year three, and just over $1 million in year four, for a total of roughly $9.9 million in the first four years.

Table 9: Municipal Retail Model Base Case Capital Additions

Capital Additions	Year 1	Year 2	Year 3	Year 4
Network Equipment				
Core & GPON Equipment	$739,000	$ -	$ -	$ -
Additional Annual Capital	-	-	-	-
Total	$739,000	$ -	$ -	$ -
Outside Plant and Facilities				
Total Backbone and FTTP	$1,436,700	$2,394,500	$957,800	$ -
Additional Annual Capital	-	-	-	-
Total	$1,436,700	$2,394,500	$957,800	$ -
Last Mile and CPE				
CPE (residential and small commercial)	$59,200	$294,200	$528,600	$293,600
CPE (medium commercial)	700	1,400	2,800	1,400
CPE (enterprise)	-	700	1,400	700
Average Drop Cost	151,200	748,200	1,345,200	746,600
Additional Annual Replacement Capital	-	-	-	-
Total	$211,100	$1,044,500	$1,878,000	$1,042,300
Miscellaneous Implementation Costs				
OSS & Portal	$45,000	$-	$ -	$ -
Vehicles	35,000	35,000	-	-
Service Equipment	-	-	-	-
Work Station, Computers, and Software	10,000	1,000	-	-
Fiber OTDR and Other Tools	50,000	-	-	-
Billing Software	30,000	-	-	-
Additional Annual Capital	-	-	-	-
Total	$170,000	$36,000	$-	$-
Total Capital Additions	$2,556,800	$3,475,000	$2,835,800	$1,042,300

The model assumes that subscribership for data services will ramp up over years one through three, and then remain steady.

The financial model is designed to be cash flow positive in year one, which is accomplished through bond financing. Over time, given the cost to construct, maintain, and operate the FTTP network, **the model indicates that a 67 percent take rate[11] of households and businesses passed will be required to maintain positive cash flow.[12]** We note that, in a competitive overbuild market, a typical take rate is usually about 30 to 35 percent, which means that a 67 percent take rate is extremely high.

In this model, we assume the City offers four data services:

- A 1 Gigabit per second (Gbps) residential service at $90 per month
- A 1 Gbps small commercial service at $100 per month
- A 1 Gbps medium commercial service at $200 per month[13]
- A 10 Gbps commercial service at $1,000 per month

These prices reflect what is necessary to generate enough revenue for the City to operate cash-flow positive. We note, however, that these prices are higher than Google Fiber's and Ting Internet's 1 Gbps services, which are $70 and $89 per month, respectively.

We assume that 86 percent of businesses will subscribe to the small commercial service, 10 percent of businesses will purchase medium commercial service, and 4 percent of businesses will purchase 10 Gbps service.

We assume that all data subscribers will be charged a one-time $75 connection fee prior to receiving services.

We have included a financial summary for this model in Table 10.

[11] Indicates take rate in year four.

[12] Based on the cost estimate in Section 6.

[13] Medium commercial service receives a lower oversubscription rate, that is, less members sharing the connection, decreasing the instances of network congestion reducing overall speeds.

Table 10: Municipal Retail Model Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$111,525	$2,094,600	$2,094,600	$2,094,600	$2,094,600
Total Cash Expenses	(694,840)	(1,011,950)	(1,011,950)	(1,011,950)	(1,011,950)
Depreciation	(199,280)	(741,050)	(685,420)	(670,640)	(670,640)
Interest Expense	(99,000)	(308,160)	(226,180)	(132,850)	(22,980)
Taxes	-	-	-	-	-
Net Income	$(881,595)	$33,440	$171,050	$279,160	$389,030

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$25,985	$14,155	$33,065	$107,085	$182,625
Depreciation Reserve	-	545,420	727,660	257,900	379,340
Total Cash Balance	$25,985	$559,575	$760,725	$364,985	$561,965

We discuss this model, and the sensitivity scenarios below, further in Section 7.1.

1.7.3.3 Municipal Retail Model Scenario: "Triple Play" (Add Voice and Video Service)[14]

In this scenario, we expand on the City's network offerings by using the FTTP network to deliver voice and video service to subscribers. Based on the City's articulated goals, our model assumes the City will offer video and data services through a service partner. For video, we assume subscribers will pay an average package price of $60 per month, and that the City will receive $6.00 per subscriber. For telephone, we assume that two services are offered—a residential service at $25 per month and a business line at $35 per month—and that the City will receive $6.25 per month and $8.75 per month, respectively.

This increase in revenue causes two minor changes: the required take rate for the model to cash flow reduces to 65 percent, and the necessary amount financed reduces by $200,000 to over $10.58 million. All other assumptions remain the same as our base case. Table 11 shows a financial summary for this model.

[14] This scenario corresponds to Scenario 2 in Section 7.1.5.1.

Table 11: Municipal Retail Model Scenario Financial Summary – Add Voice and Video Service

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$159,945	$2,459,760	$2,408,760	$2,408,760	$2,408,760
Total Cash Expenses	(742,860)	(1,388,230)	(1,349,720)	(1,349,720)	(1,349,720)
Depreciation	(198,460)	(723,810)	(670,290)	(655,510)	(655,510)
Interest Expense	(99,000)	(302,190)	(221,640)	(130,150)	(22,430)
Taxes	-	-	-	-	-
Net Income	$(880,375)	$45,530	$167,110	$273,380	$381,100

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$35,185	$52,875	$71,275	$136,925	$204,275
Depreciation Reserve	-	532,720	727,900	272,530	408,360
Total Cash Balance	$35,185	$585,595	$799,175	$409,455	$612,635

1.7.3.4 Municipal Retail Model Scenario: Add a Three-Month Operating Reserve Fund[15]

At the City's request, we investigated the implications of adding a three-month operating reserve fund to the model. In this scenario, three months' operating expenses are reserved beginning in year two to protect the City from an unexpected fluctuation in available income. **We note this reserve is to cover unexpected decreases in revenue, and does not provide coverage for a catastrophic infrastructure failure (e.g., natural disaster, etc.).** If all other assumptions remain the same, the necessary take rate increases by one percentage point to 68 percent, and the financed amount must increase to $11.135 million. Table 12 shows a financial summary for this model.

Table 12: Municipal Retail Model Scenario Financial Summary – Add a Three-Month Operating Reserve Fund

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$112,680	$2,128,560	$2,128,560	$2,128,560	$2,128,560
Total Cash Expenses	(694,860)	(1,014,040)	(1,014,040)	(1,014,040)	(1,014,040)
Depreciation	(199,500)	(747,050)	(690,680)	(675,900)	(675,900)
Interest Expense	(99,000)	(317,530)	(232,930)	(136,540)	(23,140)
Taxes	-	-	-	-	-
Net Income	$(880,680)	$49,940	$190,910	$302,080	$415,480

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$24,820	$62,520	$100,800	$194,700	$290,050
Depreciation Reserve	-	549,820	727,560	252,730	369,100
Operating Reserve	-	253,500	253,500	253,500	253,500
Total Cash Balance	$24,820	$865,840	$1,081,860	$700,930	$912,650

[15] This scenario corresponds to Scenario 12 in Section 7.1.5.11.

1.7.3.5 Municipal Retail Model Scenario: Add 700 Residential Passings by Year Five[16]

We note that Spring Hill is one of the fastest-growing cities in Johnson County. To account for this growth, at the City's request, we investigated the implication of the network adding an additional 700 residential passings by year five, to total 3,504 passings. If this were to occur, and the enterprise operates with a three-year operating reserve, provided all other assumptions remain the same, the necessary take rate would decrease to 56 percent, and the financed amount would increase to $11.6 million.

It is important to remember that the required take rate in this scenario does not represent an "apples-to-apples" comparison to the take rate in other scenarios. Because the total number of potential network passings is greater in this scenario, even though the required take rate is lower, a larger number of passings need to subscribe to services.

Table 13 shows a financial summary for this model.

Table 13: Municipal Retail Model Scenario Financial Summary – Add a Three-Month Operating Reserve Fund and Add 700 Passings by Year Five

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$112,680	$2,128,560	$2,128,560	$2,128,560	$2,128,560
Total Cash Expenses	(694,860)	(1,014,040)	(1,014,040)	(1,014,040)	(1,014,040)
Depreciation	(199,500)	(747,050)	(690,680)	(675,900)	(675,900)
Interest Expense	(99,000)	(317,530)	(232,930)	(136,540)	(23,140)
Taxes	-	-	-	-	-
Net Income	$(880,680)	$49,940	$190,910	$302,080	$415,480

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$24,820	$62,520	$100,800	$194,700	$290,050
Depreciation Reserve	-	549,820	727,560	252,730	369,100
Operating Reserve	-	253,500	253,500	253,500	253,500
Total Cash Balance	$24,820	$865,840	$1,081,860	$700,930	$912,650

1.7.4 Open Access, Data-Only Fiber-to-the-Premises (Lit)

Like the Municipal Retail Model, this model assumes the City deploys, owns, and operates a citywide fully FTTP network—including fiber drop cables and core network electronics. Given this, the cost to construct the network will be similar to the Municipal Retail model.

Unlike the Municipal Retail Model, the City **does not provide data services over the network** in the Open Access Model. Rather, RSPs provide CPE, and provide data services directly to homes and businesses in the City. In return, RSPs pay the City a per-subscriber fee. In short, this model offers the benefit of the City providing a platform over which RSPs can compete, without the risks and responsibilities of the City acting directly as an RSP.

[16] This scenario corresponds to Scenario 13 in Section 7.1.5.12.

The financial model is designed to be cash flow positive in year one, which is accomplished through bond financing. Over time, given the cost to construct, maintain, and operate the FTTP network, the model indicates that an RSP take rate of 67 percent[17] of households and businesses passed will be required to maintain positive cash flow.[18] We note that this take rate is extremely high in a competitive overbuild market.

In this model, we assume the City charges RSPs for access to the network based upon the nature of subscriber:

- $69 per residential subscriber per month
- $79 per business subscriber per month

We also assume the City will receive a $75 connection fee for each new subscriber.

We have included a financial summary for this model in Table 14.

Table 14: Open Access Model Base Case Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$86,385	$1,567,092	$1,567,092	$1,567,092	$1,567,092
Total Cash Expenses	(465,530)	(695,930)	(695,930)	(695,930)	(695,930)
Depreciation	(185,380)	(537,730)	(522,770)	(507,990)	(507,990)
Interest Expense	(90,000)	(271,050)	(198,870)	(116,830)	(20,100)
Taxes	-	-	-	-	-
Net Income	$(654,525)	$62,382	$149,522	$246,342	$343,072

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$11,855	$46,299	$250,079	$468,269	$689,389
Depreciation Reserve	-	225,840	478,750	121,670	355,790
Total Cash Balance	$11,855	$272,139	$728,829	$589,939	$1,045,179

We discuss this model, and the scenarios below, further in Section 7.3.

1.8 Findings and Conclusions

The City was clear in its RFP that it aims to deploy or somehow enable citywide FTTP infrastructure to pass, and potentially serve, every home and business in Spring Hill—including residents in multi-dwelling units (MDU) and businesses in shared buildings and complexes. Although this is an admirable goal, there are alternative options that may "move the needle" on broadband in Spring Hill while not placing undue risk and burden on the City or the community. Here we outline several approaches to bolstering broadband service availability in Spring Hill.

Based on the City's goals, this analysis focuses primarily on developing a candidate FTTP infrastructure, and evaluating the financial implications associated with such a network

[17] Indicates take rate in year four.

[18] Based on the cost estimate in Section 6.

deployment. The findings from this analysis are outlined here, and discussed in further detail throughout this report.

1.8.1 Spring Hill Faces a Challenge of Scale

While it may seem that the cost to deploy in a smaller City like Spring Hill would be lower than in a larger city, the opposite tends to be true. This is especially true if the City itself seeks to become the RSP offering service to end users. Typically, a public entity lacks the economies of scale that a larger provider will have in place to support such a deployment. For example, an existing service provider with a footprint in multiple locations can rely on customer service staff to support several markets, whereas a small locality must either contract or provide specialized staff for such functions. Similarly, providers tend to have existing relationships with vendors that enable discounts and other cost reductions that simply are not available to public entities that seek to enter the retail market. Further, a phased deployment will tend to be even more expensive over the long term than a ubiquitous deployment.

One potential middle ground is for the City to consider deploying a middle-mile fiber network and modifying its existing policies and procedures to be more enticing to the private sector. We outline further in Section 1.9.2 ways the City may be able to work with the private sector to mitigate the inherent challenges of being a small municipality.

1.8.2 The City May Need to Consider Funding Dark Fiber-to-the-Premises Deployment

Although the City is interested in a potential retail service model in which it directly deploys FTTP infrastructure throughout Spring Hill and directly serves customers, this model may be financially and practically unrealistic for the City in the near term. An alternative to such an approach is to focus on infrastructure deployment, which will enable the City to capitalize on its own strengths and potentially rely on the private sector to perform functions for which the public sector is not particularly well suited.

Public-sector entities tend to be both familiar and comfortable with infrastructure projects, similar to existing capital improvement and public works projects. Further, the public sector has the ability to make long-term investments to a greater degree than the private sector. That is, the City is likely to be able to seek bond funding for an infrastructure project and not require a short return on investment (ROI), unlike the private sector. Conversely, the private sector tends to have more experience with offering for-choice services like broadband, but often does not have the ability to seek long-term funding for an asset like fiber with a 20-year depreciable lifespan.

In light of this, a less capital-intensive and risky approach than a Municipal Retail Model is for the City to deploy a dark FTTP network in the Huntsville or Westminster model, and seek a private partner to lease the infrastructure and provision service over it. Based on our analysis, and the projected operations and maintenance costs for a Municipal Retail Model, this approach may be more enticing and successful for the City. It will be important to bring in a partner that is willing and able to put its own skin in the game, so to speak, and share the risk as well as the reward with the City. However, we caution that there is no guarantee that the City will recover its capital costs, and no matter which approach the City takes, it should be prepared to make an investment with little to no financial return. Given this, there will likely need to be beyond-the-balance-sheet motivation for deploying network infrastructure, such as the potential to bolster economic development.

1.8.3 Wireless Deployment Considerations

A wireless deployment delivers service to areas that prove cost-prohibitive to a wireline deployment. If the City were to attempt to address specific areas where broadband availability is especially lacking, a wireless network might prove an effective solution.

However, although very effective in addressing a targeted area, ubiquitous wireless deployments entail significant operations, maintenance, and replacement costs to a deployer. Over time, these increased costs frequently translate to a higher cost of ownership than an FTTP deployment. Given this, the financial implications of a wireless solution usually limits deployment to one that augments existing wireline infrastructure by delivering service only to targeted areas.

The key factors to consider in a wireless deployment are the total coverage and capacity of the network. That is, the total number of users the network can reach and the total number of users that can use the network simultaneously, respectively.

To provide ubiquitous coverage, the network would require ever-increasing access points to reach customers who are too far from an existing antenna, or customers whose homes or businesses are obscured from the signal. In turn, these access points will require additional fiber for backhaul. That is, as the total number of network users increases, the total number of access points increases. Similarly, the operating capacity of each wireless access point limits the total number of subscribers it can support. As the total number of network subscribers increases, additional access points will need to be deployed to provide reliable services to all network subscribers.

As the number of network access points increases, the operator's overall operating, maintenance, and equipment replacement costs increase in turn. Additionally, it is vital to remember that wireless antennas require wireline infrastructure, i.e. fiber, from the network core to the antenna. As such, increased access points will require deployment of additional fiber.

Given this, a ubiquitous wireless deployment would not cost-effectively provide ubiquitous coverage to Spring Hill. If the City were to elect a wireless deployment as its chosen connectivity strategy, it would be best-served to engage private wireless internet service providers (WISPs) to better understand the barriers to their market entry in Spring Hill. From there, the City could look to invest in specific strategies to facilitate WISP market entry.

1.9 Recommendations

As a result of our extensive discussions with the City, thorough cost estimation, financial modeling, and analysis, we suggest the City focus on actionable strategies that can attract private investment in Spring Hill. Although these strategies may not immediately provide high-speed internet to every home and business in the City, they position Spring Hill to capitalize on its strengths to facilitate eventual delivery of broadband access citywide.

1.9.1 Adopt a Dig-Once Policy or Enact Changes to Current Policies to Support Dig Once

Based on the condition of the existing poles and other infrastructure in the City, our design and cost estimate assumes that 50 percent of the City's construction in an FTTP deployment will be underground, which entails significant cost to the City.[19] Coordinating efforts for access to its PROW—for example, by encouraging and incentivizing the private sector and other excavators of the City's underground right-of-way space—is an important way the City can potentially mitigate costs for installing underground network infrastructure. Such a “Dig Once” policy can also ensure protection of the City's PROW and may enable additional infrastructure deployment in the future. See Appendix A for our full analysis of Dig Once policy implementation in Spring Hill.[20]

Based on our experience developing similar guidelines, ordinances, and specifications for other municipalities and in accordance with best practices related to Dig Once policies, we encourage the City take the following steps:

1) Develop a procedure to systematically track and manage construction projects in the PROW, and to create a repository of data on existing infrastructure;

2) Prioritize future projects suitable for Dig Once conduit construction, based on a scoring mechanism;

[19] City staff has indicated that it may be challenging and expensive to work with pole owners. Based on our industry experience, the cost to construct on existing, well-maintained poles is lower than the cost to deploy fiber infrastructure in underground conduit. The degree to which this may not be true in Spring Hill will have to be determined on a case-by-case basis during later engineering and deployment phases, when the City begins discussions with pole owners. Additionally, please see Section 1.4.4 for discussion on this topic.

[20] The City is currently in the process of reviewing its existing policies and ordinances to evaluate the potential of implementing Dig Once practices.

3) Estimate incremental costs for Dig Once conduit construction during a project's design stage;
4) Facilitate coordination with excavators;
5) Evaluate Dig Once considerations during new project bids; and
6) Develop a standard engineering specification for Dig Once conduit.

There are often immediate opportunities for Dig Once coordination in the form of ongoing transportation and utility projects. The City can potentially work in parallel to implement coordination with non-City utilities through filing requirements and timely outreach.

It is important to note that, while a robust Dig Once policy promises many benefits to the City, construction is still costly, and the City will want to implement policies in a cost-effective and useful way. Communication between the City and the companies that would potentially use the conduit is vital. The City's information technology (IT) and Geographic Information Systems (GIS) staff play a key role in tracking infrastructure and sharing information.

In short, a Dig Once approach would seek to create opportunities for collaboration among the City, utility operators, and commercial broadband providers with the goals of:

- Maximizing the usable space with the PROW;
- Reducing disruption to the public associated with new construction;
- Reducing the cost of deploying new broadband infrastructure; and
- Extending the lifespan of roadway and sidewalk surfaces.

1.9.2 Focus on Actions that Will Attract Private Investment in Spring Hill

In the event that the City cannot carry out a complete FTTP deployment, but still wants to move the needle for broadband affordability and availability in Spring Hill, the City may wish to look to the private sector for assistance. There are a number of ways the City can potentially engage the private sector, and it may be important for the City to enact modest measures to encourage private investment in Spring Hill to help achieve the community's broadband goals.

1.9.2.1 Potential Private Partners in Spring Hill

The City has been approached by a number of private entities that have indicated a desire to partner with the City on a broadband deployment. None of the potential "partners" that have approached the City appear to have the capability to meet the City's goals for public–private partnership as they are articulated today. Many of the firms that have approached the City are construction companies that would not be able to truly partner with the City in the capacity the City envisions. This is not to say that there is no value in exploring relationships with these firms; on the contrary, if the City opts to directly deploy FTTP infrastructure, it is likely worthwhile to pursue further discussions with these firms.

Additionally, at least one wireless provider has approached the City about an alternative partnership approach. In such an approach, the City would deploy some middle-mile infrastructure and would facilitate access to City facilities for mounting of wireless access points. This approach tends to be especially attractive in rural areas where Digital Subscriber Line (DSL) and cable modem service are either marginally available or entirely unavailable. Again, this option is worth considering further, particularly if the City determines it is unable to directly deploy FTTP infrastructure at this point. Such an approach helps modestly advance the availability of broadband in Spring Hill, but does not achieve the City's goal of ultra-high-speed ubiquitous service.

CTC has had preliminary discussions with some potential partners on behalf of the City, and there has been a generally positive response from those entities with which CTC has interacted. However, **all the entities that we would consider serious, viable partners indicated that—while they are willing to consider working with the City—it is critical for the City to articulate its own goals and what it will bring to a partnership.** That is, before a potential private partner will commit to a serious agreement with the City, even in a non-binding capacity, the City must flesh out its own objectives and be clear on what it can and will provide to a partnership (i.e., infrastructure, financing, etc.). In this vein, we encourage the City to develop a procurement process that will help shape and distill its goals, and will signal to the private sector that the City is serious about pursuing partnership (see Section 1.9.3). Prior to conducting such a procurement, it will be vitally important for the City to establish its goals (which may shift, based on projected costs for infrastructure deployment) and determine what it is able to offer a partnership.

1.9.2.2 Build "Middle-Mile" Network to Incent Private Investment

One option that may attract private investment entails the City building a middle-mile network that runs throughout Spring Hill, but does not connect directly to any homes. In this model, the City addresses its "middle mile" needs by building a less-extensive network that ensures the availability of fiber optics to government users and key local institutions. This network will position these users to meet ever-increasing speed and performance needs.

Although the magnitude of existing City communications expenses is modest today, we anticipate it will increase in the future. If the City were to convert its locations to the middle-mile network, these modest avoided costs could cover a portion of the anticipated operation and maintenance costs of the middle-mile network.

Additionally, such a network may effectively lower barriers to market entry for existing and new incumbents, offering a platform for potential operational relationships between the City and the private sector. This is a proven best practice with two decades of solid empirical data that demonstrates its viability. **We note that low-cost access is likely to be a pivotal component of the City's success in developing this infrastructure.** If the City can incentivize the private sector by providing access to infrastructure, there is a greater likelihood that smaller, private providers will be able to take advantage of the City's network.

We estimate the cost to deploy a middle-mile fiber network is a **$1.18 million** initial investment plus $12,000 per year in operation and maintenance expenses. If the City were to finance the network at a 3 percent interest rate over 20 years, the resulting annual principal and interest payment would total roughly $82,000. That is, **the total annual cost of financing a middle-mile network over 20 years will equal $94,000.** If the City were able to contribute $1 million over the 20-year span of the model, averaging $60,000 in available capital annually, the City would still face a $34,000 annual shortfall. In order to operate the middle-mile network, this shortfall would need to be supplemented by cash from the general fund, tax base, or similar sources.

We note that the City would need to be willing to fund this asset without expectations of substantial lease revenues or cost recovery. The City may prioritize this investment as a demonstrative step to attract commercial providers by the reduced barriers to entry into the broadband market.

For more discussion on this topic, see Section 5.3.

1.9.2.3 Ease Access for Private Providers by Enacting Policy Changes

The cost and complexity of building and maintaining network infrastructure are major barriers to entry for new RSPs that wish to compete in a market. Those factors are also the primary reasons that incumbent providers are typically slow to upgrade or replace aging legacy infrastructure unless the market forces them to compete in this way. Based on discussions with City staff, Spring Hill leadership understands that policy changes to become more provider-friendly and encourage private investment may pay dividends to help the City achieve its connectivity goals.

For example, the City may consider enacting "one-touch make-ready" or "Dig Once" policies as part of its commitment to facilitating broadband infrastructure deployment in Spring Hill. As the name implies, the goal of one-touch make-ready is to use one contractor to prepare utility poles for fiber infrastructure installation. Make-ready is the process of preparing poles for an additional attacher, such as a new provider. Make-ready tasks include moving existing utilities, installing extension arms, and sometimes completely replacing poles. This is significant because OSP make-ready costs are central to overall construction costs.

Ideally, with one-touch make-ready, the contractor—which would be approved by the pole owners—could complete the necessary work in one visit. Because make-ready for utility poles is one of the most significant, time-consuming, and costly barriers to market entry for new service providers, the City may seek to ease this for all qualified private providers.

In a similar vein, the City is already in the process of evaluating how it may adopt a Dig Once Policy, or incorporate Dig Once concepts into its existing ordinances. Like one-touch make-ready, Dig Once can theoretically reduce barriers to market entry for the private sector by providing smooth access to the City PROW and potentially lowering costs.

These types of local policies can be a huge step toward signaling to the private sector that the City is serious about facilitating access and doing what it can to minimize barriers. Any steps that the City can take toward streamlining its permitting process, and other actions it can take to possibly reduce barriers to market entry, might also be meaningful for broadband initiatives and deployment by the private sector. While taking these steps may not directly urge incumbent providers to upgrade their infrastructure or lower their pricing, encouraging private investment through business-friendly policies can energize the marketplace. Further, it is a best practice to implement universal policies that apply equally to any private provider that wants to invest, and to avoid favoring one company over another.[21]

1.9.2.4 Facilitate Private Investment through Streamlined City Processes

One key way the City can encourage private investment in Spring Hill is to minimize barriers for accessing its PROW, and other permitting challenges that are common in the industry. Our experience suggests that there are strategies the City can use to facilitate broadband projects without sacrificing its ability to simultaneously attend to other projects and priorities. Whatever the process for addressing a broadband project, ranging from granting PROW access to permitting to final inspection and approval, we recommend that these processes be formalized and well publicized, and not prohibitively expensive.

In our experience, full transparency about these processes is the single most effective means by which to enable the communications industry to expeditiously plan and deploy networks. Whether the City commits to review permit applications within three days or three weeks, that commitment should be publicized and then consistently met. The provider may wish for a faster process, but at a minimum it will have the benefit of a transparent and open process—with a predictable timeframe under which it can plan its project.

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[21] If the City opts to partner with one or more private entities for FTTP deployment, there will necessarily be some "advantages" specific to the City's relationship with the partner(s). However, the nature of the partnership agreement(s) will ensure that in return for such benefits, the private partner(s) will be required to adhere to certain conditions, likely including financial risk and build-out stipulations.

If one or more providers directly deploys FTTP or other telecommunications infrastructure in Spring Hill, or partners with the City, there will likely be added strain on City staff due to a substantial increase in requests for permits. The City may want to explore options to forego traditional permitting, or create simplified global permitting that streamlines the process for contractors performing work on a broadband deployment—depending on what is possible under state and regional law.

The City's willingness to consider enacting a Dig Once policy illustrates its desire to clear the way for private investment in broadband infrastructure. Streamlining the permitting process is another reasonably modest step the City can take toward enticing the private sector to invest in Spring Hill.

1.9.2.5 Provide Access to City Facilities to Support Wireless and Other Deployment

Although a wireless deployment will not address the City's goal of ubiquitous service delivery, the City may find that reducing barriers to market entry for private-sector wireless providers can advance broadband availability in Spring Hill.

The City can support local wireless providers by offering access to mounting assets, such as City light poles or other desirable locations within the City's PROW or on City-owned facilities (i.e., tall buildings). Additionally, the City may be able to negotiate with local utilities on behalf of local wireless providers for access to existing poles for access points. Or, the City may want to enact or streamline permitting that allows wireless providers to install new poles and/or other infrastructure for mounting wireless access points. Depending on the City's chosen path forward, it may be prudent to engage the private sector directly to establish what, specifically, the City can do from providers' perspectives to support wireless deployment in Spring Hill. Again, such an approach does not address the City's goal of ubiquitous 1 Gbps service delivery, but it can certainly support better access to broadband services citywide.

1.9.3 Participate in a Formal Solicitation Process

If the City moves forward with deploying a network, it will likely be prudent to conduct a formal procurement process like a request for information (RFI) or request for proposal (RFP) process to gauge private sector interest in partnering with Spring Hill. Issuing an RFI or RFP is a direct way for the City to engage the private sector, measure potential partners' interest in partnering, and outline the City's plans.

Even if procurement laws and policies enable the City to directly enter into negotiations with a private partner without going through a formal process, we believe that pursuing a procurement process is in the City's best interest as a next step. Appendix B outlines a potential RFI or RFP shell that the City can use as the basis for its procurement process.[22]

An RFI tends to be a less structured process and is often used to garner information and creative solutions from potential private partners. While this type of procurement can be useful, many firms will opt not to respond to an RFI and will instead wait for a more structured and formal RFP process. It is typically time and labor intensive to respond to an RFI process, and—unlike an RFP—an RFI usually does not guarantee that a locality will move forward with procurement or partnership. An RFP generally goes a step further than an RFI in that it does not only gather information—it actually allows the City to begin the process of negotiating with a potential partner.

The procurement documentation should clearly articulate the City's needs and desires, and invite private companies to respond and outline their unique approaches to meeting the City's connectivity goals. Because the documents will inform the contractual relationship between the City and its partner(s), the operational functions of each party should be clearly articulated. One useful element of developing procurement documentation is that it may help the City to flesh out some areas where its own goals are unclear. Further, the procurement could identify to what degree the City may need to be prepared to invest in infrastructure, based on the degree to which potential partners may be willing to invest.

The procurement process does not have to create strict parameters about how the City expects its objectives to best be met, nor does it have to lock the City into a specific business plan. Rather, the procurement process can lay out the City's goals and any non-negotiable items (e.g., the City must retain ownership of existing fiber) but leave room for a private partner to respond creatively.

It may be prudent to use caution in the degree to which the City specifies its requirements of a private partner. An overly detailed procurement may scare off potential respondents who do not believe they possess all the staff, qualifications, or resources to meet a strict list of City demands. In contrast, a strategically developed procurement can elicit interest from providers that may not have been aware the City was considering FTTP deployment and is willing to make its infrastructure available for use by the private sector. The procurement process can also help the City understand more clearly the real costs associated with its goals. The City may be able to obtain clear industry pricing for various support services like network operations and maintenance that a private provider may offer.

[22] Additionally, CTC has begun conversations with potential private partners on behalf of the City, and has provided City staff with a distribution list of potential interested parties with which the City can share its procurement documents.

An important consideration for a procurement process is that not all potential partner companies will respond in writing to the request. This should not discourage the City from developing and issuing a procurement—such a document is extremely valuable not only for evaluating the written responses, but also for outlining the City's goals and sparking conversation. If the deadline to respond to the procurement passes and the process does not immediately elicit a viable partner, or if for some reason negotiations with a potential partner do not pan out, the City will likely find that the procurement remains useful for attracting and communicating with private companies. It becomes a document that the City can rely on to clearly articulate its objectives—and if an additional means of procurement is ultimately necessary, the existing procurement documents can serve as a basis for that process.

Finally, it is important to be realistic about what a partnership may entail on behalf of both parties.[23] The City must develop and clearly identify its own desires, goals, and requirements for a network. Once it has clearly defined what it hopes to achieve, it can summarize this in its procurement documentation to allow potential private partners to respond based on their own abilities and willingness to help meet the City's needs.

[23] Jon Brodkin, "Skeptics Say LA's Free Fiber Plan As Plausible As Finding a Unicorn," *Ars Technica*, November 8, 2013, http://arstechnica.com/information-technology/2013/11/skeptics-say-las-free-fiber-plan-as-plausible-as-finding-a-unicorn/, accessed November 2017.

2 Overview of Current Broadband Market and Infrastructure

This section provides an overview of competitive providers for services available to residential and small business users in the City. Note that this analysis is based on publicly-available data published by providers, and not every service is available in every neighborhood or at every address within Spring Hill.

2.1 Residential and Small Business Services in the City

Residential and small business customers in Spring Hill have access to a range of services, though individual service options are largely dependent on location. Table 15 lists the service providers and minimum price for each type of service that is available in at least some part of the City.

Table 15: Overview of Residential and Small Business Data Services in the City

Service Type	Provider	Minimum Price (per month)
Cable	SuddenLink	$39.99
	Charter	$49.99
Digital Subscriber Line (DSL)	CenturyLink	$45
Satellite	HughesNet[24]	$49.99
	Exede	$59.99
Mobile/Wireless Internet Service Provider	AT&T	$14.99
	Sprint	$15
	Verizon	$20
	T-Mobile	$20
	Cricket	$30
	Pixius	$86.95
	Kwickcom	$55

2.1.1 Cable

Suddenlink Communications offers residential internet service at 50 Megabits per second (Mbps), 100 Mbps and 150 Mbps download speeds at $49.99 per month and up to $89.99 per month. Discounted prices are available for the first three months ($10 off) or if bundled with another service like voice or TV.[25] On the small business side, multiple options are available starting at 50 Mbps download speeds for $84.95 per month up to 150 Mbps download speeds for $224.95 per month.[26]

[24] Residents and businesses may know HughesNet as DirecTV or DISH Network, depending on how their services are bundled.
[25] https://order.suddenlink.com/Buyflow/Products, accessed November 2017.
[26] https://www.suddenlinkbusiness.com/internet/business, accessed November 2017.

Charter offers services in the area and is reportedly looking to expand in the future. A 60 Mbps service is available at a promotional price of $49.99.

2.1.2 Digital Subscriber Line

CenturyLink offers Digital Subscriber Line (DSL) service for residential customers starting at $45 per month for unbundled or standalone internet service between 1.5 Mbps to 25Mbps. Speeds from 40 Mbps onwards are available at $55 per month.[27]

2.1.3 Satellite

Satellite internet access is available in the City as well. HughesNet[28] has four residential packages available and four geared toward businesses. In addition to slight increases in download and upload speeds, plans are differentiated by their monthly data allowances. Residential offerings include an anytime allowance, plus a larger 50 GB "bonus bytes" allowance which can be used from 1 a.m. to 10 a.m. Business offerings include a "business period" allowance to be used between 8 a.m. and 6 p.m. plus a smaller 10 GB anytime allowance. All packages require a two-year agreement. Details and pricing are listed in Table 16 and Table 17 below. Some promotional discounts are available for the first three months.

Table 16: HughesNet Satellite Residential Plans[29]

Package	Internet Speed	Monthly Data Allowance (Anytime + Bonus Bytes)	Monthly Price
Choice	5 Mbps down/1 Mbps up	5 GB + 50 GB	$49.99
Prime Plus	10 Mbps down/1 Mbps up	10 GB + 50 GB	$59.99
Pro Plus	10 Mbps down/ 2 Mbps up	15 GB + 50 GB	$79.99
Max	15 Mbps down/2 Mbps up	20 GB + 50 GB	$129.99

[27] https://shop.centurylink.com/MasterWebPortal/freeRange/shop/guidedShoppingStart?bones#module=start, accessed November 2017.
[28] Residents and businesses may know HughesNet as DirecTV or DISH Network, depending on how their services are bundled.
[29] http://www.hughesnet.com/plans-and-pricing/internet-service, accessed November 2017.

Table 17: HughesNet Satellite Business Plans[30]

Business Package	Internet Speed	Monthly Data Allowance (Business Period + Anytime)	Monthly Price
Select 100	10 Mbps down/1 Mbps up	20 GB + 10 GB	$79.99
Select 200	10 Mbps down/ 2 Mbps up	30 GB + 10 GB	$99.99
Select 300	10 Mbps down/ 2 Mbps up	40 GB + 10 GB	$129.99
Select 400	15 Mbps down/ 2 Mbps up	50 GB + 10 GB	$159.99

Exede Internet also offers residential and business satellite services in the City. Residential plans provide 12 Mbps download and 3 Mbps upload speeds. They start at $59.99 per month for 10 GB of data and go up to 18 GB for $99.99 or 30 GB for $149.99. After reaching the monthly data cap, download speeds are reduced to 1 Mbps to 5 Mbps. Exede's Business Class product provides 15 Mbps download and 4 Mbps upload speeds. There are two separate 30 GB data caps that run from 8 a.m. to 3 a.m. and 3 a.m. to 8 a.m. providing 60 GB total per month.[31]

2.1.4 Mobile/Wireless Providers[32]

Verizon offers two 4G LTE data packages with multiple choices for data allowances and pricing, depending on the desired mobility and equipment chosen. The data-only plan prices range from $20 for a 2 GB data allowance to $710 for a 100 GB data cap. A connected device can be added for $5 per month.[33] The HomeFusion Broadband Package (LTE-Installed) is a data-only 4G LTE service with Wi-Fi connectivity and wired Ethernet for up to four devices. Available download speeds are 5 Mbps to 12 Mbps and upload speeds are 2 Mbps to 5 Mbps. Monthly prices range from $60 for a 10 GB data allowance to $120 for a 30 GB data cap. Overages are charged at $10 per additional GB. A two-year contract is required, with a $350 early termination fee. Verizon offers a $10 monthly deduction for every month completed in the contract. The Ellipsis JetPack provides a mobile solution, with download speeds of 5 Mbps to 12 Mbps and upload speeds of 2 Mbps to 5 Mbps. Prices for the 12 options of data allowances range from $30 per month for a 4 GB data allowance to $335 per month for 50 GB of data, in addition to a monthly line access charge of $20. The device is $0.99 with a two-year contract. There is a $35 activation fee.[34]

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[30] http://business.hughesnet.com/plans-and-pricing/internet-service, accessed November 2017.

[31] https://www.inmyarea.com/internet/66083, accessed November 2017.

[32] Many view mobile data plans as insufficient substitutes for a dedicated connection in the home or business. We note, however, that due to budget constraints (i.e., an inability to pay for both mobile and fixed service) or the lack of fixed service options, some residents depend on mobile service as their primary connection, especially in unserved and underserved areas.

[33] https://www.verizonwireless.com/plans/data-only-plan/, accessed November 2017

[34] http://www.verizonwireless.com/support/wireless-internet-data-only/, accessed November 2017

AT&T also provides 4G LTE wireless data service in the area, and offers three packages: 250 MB per month download allowance for $14.99 per month, 3 GB per month download allowance for $30 per month, and a 5 GB per month download allowance for $50 per month. There is an overage fee of $10 per 1 GB over the limit. There are also equipment charges with or without a contract, and an activation fee up to $45.[35]

Sprint also offers 4G LTE wireless data in Spring Hill. The three data packages offered are a 100 MB per month data allowance for $15 per month, a 6 GB per month data allowance for $50 per month, and a 30 GB per month data allowance for $110 per month. Each MB over the limit is billed at a cost of $.05. A two-year contract is required, as well as an activation fee of $36 and equipment charges for three different types of devices. There is an early termination fee of $200.

T-Mobile offers a wireless data option for $20 per month with a limit of 2 GB per month. T-Mobile offers additional capabilities and increasing data limits at incremental costs in a total of five packages, up to $80 per month for up to 18 GB of data. Depending upon current promotions, the $35 activation fee is sometimes waived.[36]

Cricket Wireless offers 4G LTE wireless service with a download speed of up to 8 Mbps with five options for data allowance packages. Starting at $30 per month for 1GB of allowed data there are options for up to an unlimited data allowance at $60 per month. There is a $15 activation fee, but no contract or early termination fees.[37]

Pixius wireless offers wireless internet service in the City with four options for speeds. Service starts at the 3 Mbps speed for $86.95 per month up to the 15 Mbps speed for $250 per month.[38]

Kwikcom offers wireless internet service with residential internet speeds from 5 Mbps at $55 per month to 25 Mbps at $105 per month.[39] They also offer business class services with internet speeds from 5 Mbps at $75 per month to 25 Mbps at $125 per month.[40]

[35] https://www.att.com/shop/wireless/plans/planconfigurator.html, accessed November 2017
[36] http://www.t-mobile.com/cell-phone-plans/mobile-internet.html, accessed November 2017.
[37] https://www.cricketwireless.com/support/plans-and-features/cricket-plans-and-features/customer/plans.html, accessed November 2017.
[38] http://www.pixius.com/residential/plans/, accessed November 2017.
[39] https://www.kwikom.com/residential/internet/ accessed November 2017.
[40] https://www.kwikom.com/business/internet/, accessed November 2017.

3 Considerations for Broadband in Spring Hill

There are numerous considerations for broadband deployment and expansion in Spring Hill, ranging from regulatory and legal implications to how the City will pay for infrastructure to understanding and focusing on the City's key objectives. Here, we outline some key considerations the City may want to evaluate as it determines its best path forward.

3.1 Examining Regulatory Considerations with Qualified Legal Counsel Is a Key Next Step

We emphatically note that CTC is not qualified to give legal guidance, and we encourage the City to engage knowledgeable telecommunications attorneys who have specialized experience in examining legal and regulatory nuances within the State of Kansas, and familiarity with other prevailing regulations (regional, local, and federal). Prior to the City moving forward with any plan, however small, we encourage careful examination of these considerations to avoid the City unwittingly violating any regulations or laws to which it may be subject.

There are currently not significant federal regulatory concerns for offering only dark fiber services. However, if the City opts to offer service as an ISP (as in the Municipal Retail Model), there are a variety of regulatory concerns, including reporting requirements to the Federal Communications Commission (FCC) and legal requirements under the Digital Millennium Copyright Act (DMCA), to name only a few.

Additionally, although providing dark fiber does not *currently* trigger requirements associated with becoming a common carrier, this may be changing at the federal level. Particularly if the City becomes involved with offering any service beyond dark fiber, there is a possibility of triggering common carrier requirements at the state or federal level, and this should be researched by the City's telecommunications legal counsel.

3.2 Consider Dig Once and Other Modest Steps to Encourage Private Providers

As we noted, a key step for the City to take is to consider ways it can attract investment by the private sector to bolster service delivery throughout Spring Hill. In this vein, we evaluated the City's existing policies and developed Dig Once recommendations as a starting point for such an approach. While implementing Dig Once, One-Touch Make-Ready, and other policy changes is not a magic solution to the City's broadband challenges, these steps can go a long way toward signaling to the private sector that the City is serious about paving the way for better broadband delivery.

The City may determine that it is able and willing to deploy some network infrastructure, and this could be another important way to work with the private sector to ensure expanded broadband service delivery in Spring Hill. As we noted above, the City may find that it can enact relatively simple policy changes, such as providing access to City PROW and facilities to support expanded wireless deployment. Again, such an approach will not immediately address the City's goal of ubiquity, but it can help move the City in its desired direction, and could be one important step in a patchwork approach to addressing connectivity gaps in Spring Hill.

3.3 Funding and Financing

A key consideration for a retail model is how to fund both capital construction costs and ongoing operational expenses. The importance of factoring in the ongoing cost of operations cannot be overstated—these expenses fluctuate based on the success of the enterprise, and can vary considerably each year, and even month to month.

The City is able to seek bonds (i.e., borrow funds) to enable construction of an FTTP network. We discuss here the two types of bonds that municipalities typically rely on for capital projects, and our recommendations for each.

3.3.1 General Obligation Bonds

General obligation or "GO" bonds are directly tied to the City's credit rating and ability to tax its citizens. This type of bond is *not* tied to any specific revenues from specific projects, but is connected instead to citywide taxes and revenues that can be used to repay this debt. This is what also creates the risk to other public services should the City's broadband enterprise fail to generate enough revenue to be self-sustaining.

GO bonds are typically authorized through a public approval process, or may be approved by the City Council, which can make them easier to pass. However, even if a public approval process is not directly required and bonds can be obtained through Council approval alone, such an approach does not reduce risk. The financial community generally views municipal broadband as a high-risk endeavor, and therefore tends not to accept projected broadband revenues as security. In rare cases where these revenues might be accepted, the bond rates would be extremely high.

If the City seeks municipal bonds, it will likely be prudent to pursue GO bonds or revenue bonds secured with sales tax or other revenues. Use of GO bonds would help reduce the debt services borne by the City's broadband enterprise, but it would also potentially create risk for important City revenue streams that support core public services. If the City's broadband enterprise did not succeed financially, the City would still be obligated to pay debt service on the broadband infrastructure. To make such payments, the City would have to reduce spending on some or all of its other basic functions.

3.3.2 Revenue Bonds

Like the name implies, revenue bonds are directly tied to a specific revenue source to secure the bond and guarantee repayment of the debt. The revenue stream from a municipality's electric, natural gas, or water utility may be used to secure a revenue bond. In fact, in theory, any municipal service that generates some sort of revenue that could be used to pay back the debt might potentially be used to secure a revenue bond—municipally owned public transportation or hospitals, for example. Given this, it stands to reason that revenues from the City's broadband enterprise could be used to guarantee a revenue bond, but this is typically not an accepted practice within the bonding community, particularly with FTTP endeavors.

The bonding community views FTTP overbuilds as a relatively high-risk business venture, and is unlikely to approve revenue bonds tied to an FTTP venture. The risky nature of the endeavor makes these revenues unusable in this context.

3.3.3 Property Tax Funded Utility Model

Instead of borrowing funds, the City could opt to use property tax revenues to support the deployment of an FTTP network. Though this can be politically challenging, one avenue to pursue this funding is to put the request to public vote on a referendum. Passage would require a 60 percent "yes" vote. This enables the City to seek public approval and—if the referendum passes—to minimize the risk to other City services. Note, however, that the financial risk to City residents remains. If the broadband enterprise were to fail, property owners would still be obligated to the tax payments needed to cover the debt on the initial capital investments made to start the system.

3.4 Common Objectives for Broadband

No matter how demographically and geographically different they are, most localities that seek to deploy FTTP networks share certain objectives. Sometimes the primary objectives align, but they also may directly conflict with one another. It is important for localities to consider at the outset their primary, nonnegotiable goals—and to expand to other objectives from that starting point.

This analysis seeks to help the City understand the interplay between common objectives so that it can make decisions about which of its goals are most important, and how to achieve access to broadband in a way that makes sense for residents and business in Spring Hill. It also looks more closely at the goals that underpin a desire for open access, and whether and how those might be achieved through a combination of means.

Instead of considering open access separately, this analysis looks at the objectives that drive the desire for it, and how the City might attain those goals. As over-the-top (OTT) programming like and applications become increasingly prevalent, the need for traditional open access, which relies on access to dark fiber—and all the operational details and costs associated with it—may be waning. The City may find that it can achieve its open access goals, thus promoting competition and consumer choice, through alternative means. If a locality builds a ubiquitous network, and then partners with a private entity to manage operations and provide an unfettered data service, this introduces a new competitor into the market and drives competition at the applications layer.

3.4.1 The Relationship Between Common Broadband Objectives

Many localities share common objectives when considering an investment in a broadband network. In our experience, most communities wish to prioritize some or all of the following goals:

- Ubiquity
- Affordability
- Consumer choice
- Competition in the market
- Ownership and control of assets
- Performance
- Risk aversion
- Positive cash flow

Choosing which goals to prioritize can be challenging, and a locality may determine that its goals necessarily shift as it evaluates the financial and political feasibility of pursuing broadband deployment. We sought to provide the City with information to empower decisions about its connectivity needs that will have ongoing positive outcomes. We used as the basis for our analysis the assumption that the City wants to pursue a universal, or ubiquitous, build-out. Although the City may ultimately decide that a ubiquitous build-out that connects every home and business in its service area is not feasible, this analysis is based on that assumption.

It is important for the City to understand how these objectives interact with each other, how pursuing one objective may mean foregoing another, and how prioritizing objectives can impact the City's decision-making process as it moves forward. Each community must balance its needs so that it can achieve its goals without sacrificing objectives it deems essential. It is important to understand what is behind each of these objectives, and why the City may be compelled to pursue one over another.

As an example, risk aversion is top priority for some localities; it may be politically challenging to build a network, and the only way to complete it is to assure key stakeholders and the public that there is minimal risk involved. As we explain below, however, risk aversion directly conflicts with the goal of building the network throughout an entire community.

We illustrate in Table 18 below the intersection of common objectives. As the key at the top of the table shows, one objective may have no impact on another (NI), objectives may align (A), or they may conflict (C).

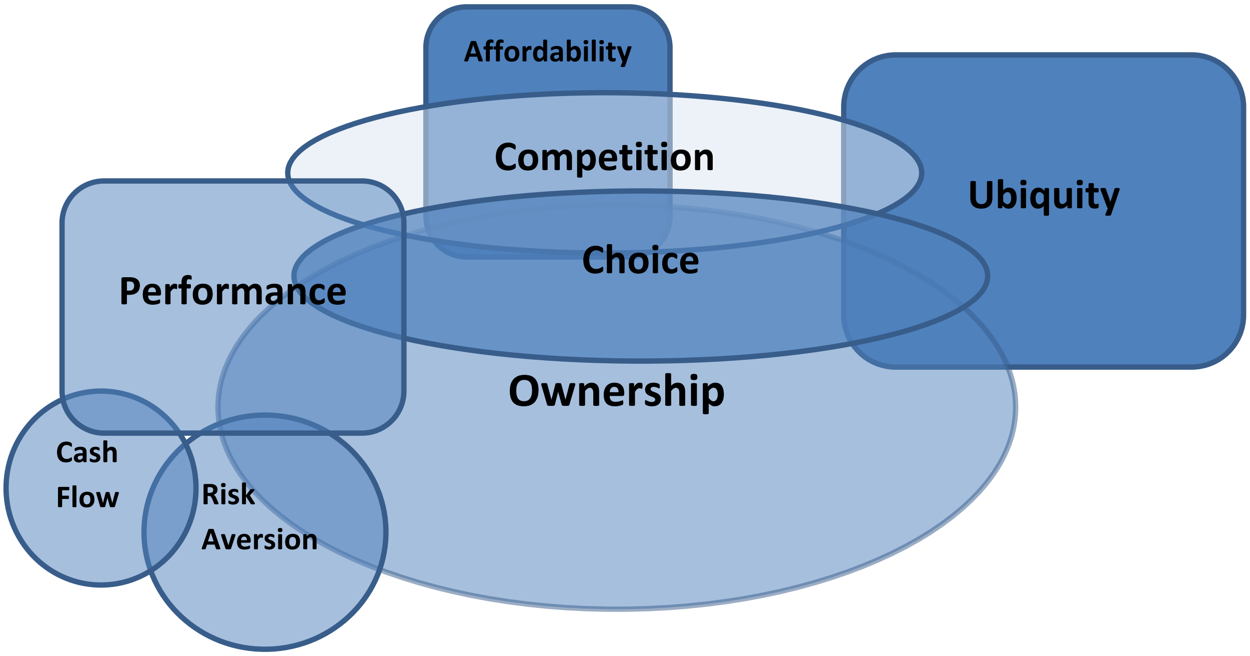
Table 18: Common Goal Alignment

A: Align | C: Conflict | NI: No Impact

	Ubiquity	Choice	Competition	Ownership	Performance	Affordability	Risk Aversion	Cash Flow
Ubiquity		A	A	A	NI	C	C	C
Choice	A		A	A	A	A	C	NI
Competition	A	A		A	A	A	C	NI
Ownership	A	A	A		A	A	A	C
Performance	NI	A	A	A		NI	A	A
Affordability	C	A	A	A	NI		C	C
Risk Aversion	C	C	C	A	A	C		A
Cash Flow	C	NI	NI	C	A	C	A	

In the sections below, we further define these objectives, explain this table, and outline how the objectives listed here interact and overlap with one another. We also describe how prioritizing one objective may impact the City's ability to focus on another. Figure 6, below, shows a visualization of Table 18 to illustrate the relationship between common objectives.

Figure 6: Interplay between Objectives



There are numerous possible outcomes associated with different objectives, and the City must determine what it believes will best serve its unique needs, and have the greatest impact on the community. This analysis does not seek to urge the City in any particular direction, but takes into consideration its potential goals, and attempts to clarify and flesh out what may drive a desire to achieve certain objectives.

As we noted, some objectives may interact favorably with others, overlap, or have no impact. For example, performance either interacts favorably or not at all with other objectives, and prioritizing performance can have a significant positive impact on the FTTP network's viability by setting it apart from incumbent providers. There are no real disadvantages to making performance a top priority for the FTTP network because doing so does not require the exclusion of any other objectives.

3.4.2 Detailed Descriptions of Common Objectives

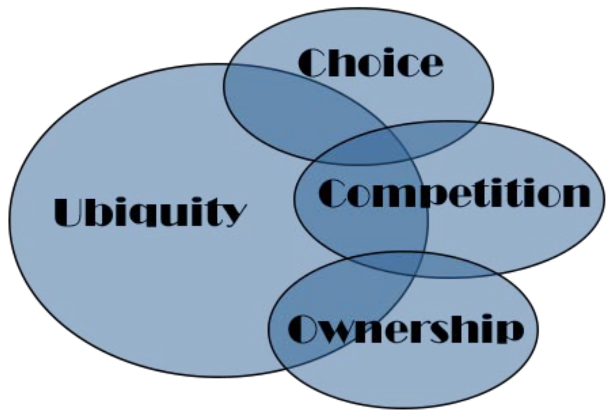
Here we outline an in-depth explanation of what each objective typically means to a locality in its pursuit of broadband deployment. We also describe how these objectives interact with each other, and the potential implications for the City.

3.4.2.1 Ubiquity – Service Is Brought to All Areas of a Community

For most communities that opt to build and operate a network, ubiquity—which refers to designing and building the network so that it connects every residence, business, and institution in the community—is a key objective. Incumbent providers have traditionally often built only to the most affluent areas of a community where they are sure to see a significant

ROI, a practice known as "cherry picking." Many communities are compelled to build a ubiquitous network to safeguard against leaving behind those parts of a community that may not be desirable to private providers. Localities throughout the nation have prioritized ubiquity as a primary goal in their broadband pursuits,[41] and our analysis assumes this as a baseline objective for the City. As illustrated in Figure 7, ubiquity aligns with choice, competition, and ownership.

Figure 7: Ubiquity Aligns with Choice, Competition, and Ownership



This is a reasonable objective for any community; it makes sense that leaders want to bring service to the entire community, and we recognize that the City may aim to deploy a ubiquitous network. However, it is important to note that immediate communitywide build-out often entails significant risk and cost. The financial risk alone is considerable, and in order to make the model sustainable, the service may have to be priced out of some consumers' reach.[42] If the City opts to pursue an FTTP build-out where it retains ownership of the fiber optic network, it may have to seek large bonds to cover the capital costs of building the network. It will then be responsible for making P&I payments, or debt service.

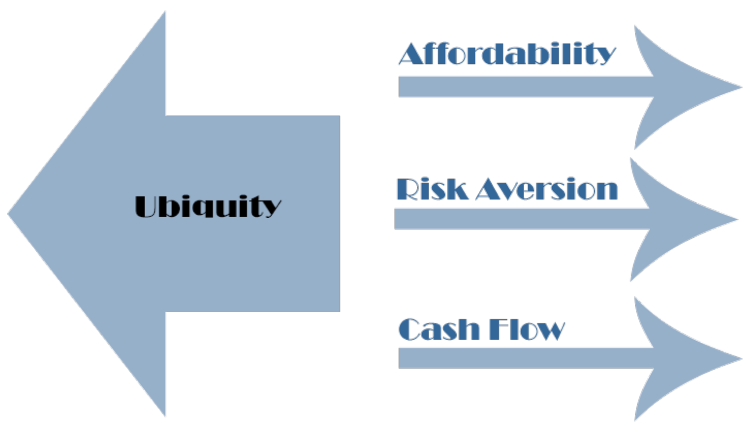
If the City seeks to use revenues from the FTTP network and any retail service offered over it to cover its debt service payments, service fees will have to be calculated with the total cost of P&I in mind. Unless the City can implement a sliding scale fee structure for its most vulnerable populations, those prices may not be affordable to all residents; thus, service prices based on the City's need to pay for a ubiquitous build-out will likely conflict with the goal of ensuring that service is truly *accessible* to all potential customers in Spring Hill.

[41] See, for example: http://www.cnet.com/news/connecticut-communities-join-together-for-gigabit-broadband/, http://broadband.blandinfoundation.org/_uls/resources/Vision_Statement_FINAL_0228.pdf, and https://www.portlandoregon.gov/revenue/article/394185.
[42] This is not to say that pricing cannot be adjusted through various means to absorb additional costs to consumers, but this will likely come with a higher price tag for the City.

A full-scale build-out is typically not compatible with avoiding risk, as localities that seek ubiquity are likely to face stringent deadlines and much higher capital costs than a phased build-out. We note that even a phased build-out can be expensive.

Maintaining positive cash flow is another objective that conflicts with ubiquity. While the City likely does not expect to make a profit on the FTTP network, it is important for the network to be financially sustainable, covering at least any debt service payments and operating costs. This is often referred to as "positive cash flow" or "breakeven." Assuming the City is responsible for the cost of deploying the fiber network, the higher cost to build to every structure in the City means that the point at which the FTTP network can establish positive cash flow will come much later than if the City slowly built out and began generating subscriber revenue earlier in the build-out process. While a partnership may enable the City to reach positive cash flow sooner than a fully-municipal deployment, ubiquity generally conflicts with positive cash flow. Figure 8 illustrates the conflict between ubiquity and affordability, cash flow, and risk aversion.

Figure 8: Ubiquity Conflicts with Affordability, Cash Flow, and Risk Aversion



The City may determine that the advantages of pursuing a ubiquitous network build-out will outweigh any of the potential conflicts with other common objectives. Further, as we noted, the City can take steps to manage some of the potential challenges associated with conflicting objectives (e.g., developing programs to help cover subscriber fees to ensure the service is not priced out of some consumers' reach).

3.4.2.2 Affordability – Service Can Be Purchased by Citizens at All Income Levels

Affordability is important even in communities that may have few low-income areas. While this objective is certainly more important for vulnerable portions of the community, affordability is often a necessary objective for localities. For example, the City may prioritize affordability in an effort to ensure that entrepreneurs and tech startups in its service area can afford the robust connectivity necessary to support their business endeavors.

There are areas in the City where demand is likely low enough that private providers are unlikely to build there. Private providers typically cherry pick based on where they determine they are most likely to recover their cost to build. While the City may not be faced with the choice to potentially offset service costs for a large number of low-income residents, still it may benefit from choosing to invest in infrastructure throughout the community.

Providing affordable service to the entire community would likely create benefits for the City in terms of enhanced quality of life and economic benefits. Further, the City could work with local government and nonprofit agencies to fully leverage benefits that are not monetarily quantifiable. These "benefits beyond the balance sheet" cannot be measured on a financial statement, but their impact communitywide is often profound.

The City may be able to balance ubiquity and affordability by negotiating an agreement with one or more private partners that includes sensitivity to the need for affordable, accessible services in all parts of the community. Similarly, the City may decide to subsidize services for certain portions of the community.

Choice, competition, and ownership all interact favorably with affordability. If the City can reduce pricing to a level that is attainable to all potential subscribers in Spring Hill, the expansion of choice and the likelihood of increased competition will be notable. And if the City retains ownership of its assets, it can make choices about affordability similar to the control it can exert over performance.

If the City decides to subsidize services directly, it may find that prioritizing risk aversion and attaining positive cash flow become more difficult. The more debt and responsibility the City takes on, the higher its risk and the longer it will take for the FTTP network to be cash-flow positive. Similarly, even if the City does not directly subsidize services, prioritizing affordability may mean pricing the product low enough that it is challenging to also prioritize risk aversion and cash flow. It will be important for the City to determine its priorities, and to strike a balance so that one objective is not achieved at the exclusion of another.

3.4.2.3 Consumer Choice – Citizens Can Purchase Service from Various Providers

Localities often pursue open access as a means to increase consumer choice; this is an important consideration and a high priority for many communities. Incumbent cable and internet providers may have little economic incentive to expand to areas of the community where they believe they will not recover significant portions of their cost.

A ubiquitous network that fosters open access, boosts competition, and reaches all parts of the community enhances consumer choice on a number of levels. In addition to gaining access to residential services that may previously have been unavailable, consumers often end up with greater flexibility to access services at various community locations. Ubiquity and competition enable enhanced services at community centers, religious institutions, educational facilities, and other locations that benefit residents.

Affordability of services ties directly with competition and consumer choice—being able to pay for services is often a major barrier for consumers. Having affordable access to services with competitive speeds can significantly improve quality of life, make residential areas more desirable, and spur business growth. Access to premium residential services at affordable prices can also incite home-based businesses, support continued education, and enable access to basic human services like healthcare and education.

Risk aversion could negatively impact consumer choice. If the City decides that it will slowly and organically build out its network and does not take steps to prioritize particularly vulnerable areas, it is possible that only the consumers who have traditionally enjoyed provider choice will be positively affected. The City may find that it can balance risk mitigation with community benefit by deliberately funding service to portions of the community that may be undesirable for a private entity. If the City chooses to seek a partnership, this could be negotiated.[43]

3.4.2.4 Competition in the Market – Enabling Multiple Providers to Compete

Fostering competition in the market is generally the second component of an open access pursuit. That is, communities often seek to develop an open access infrastructure to enable multiple providers to offer service over the network and enhance competition. Like consumer choice, this is generally a major reason localities attempt to pursue a traditional open access infrastructure. Similar to consumer choice, competition in the market can be achieved through open access in the traditional sense as well as through other means.

The key for most objectives is to determine whether they are primary, how they may conflict with others, and how best to pursue whatever a locality deems is its most important goal(s). We believe that competition both upholds and is upheld by other potential primary objectives—it aligns with, does not impact, or is not impacted by other common community objectives. The only potential exception to this is risk aversion, which we explain below.

Choice and competition go hand in hand, and seeking ways to encourage competition will likely only result in greater consumer choice in communities. Similarly, a ubiquitous network build will probably result in greater competition among local providers. This is not only through providers potentially offering services over the City's network, but also in the form of incumbent providers lowering prices and enhancing services in response to improved services

[43] The Urbana-Champaign Big Broadband (UC2B) public network negotiated a similar partnership with a private entity, which will be passed on in the event of any sale or transfer of the network.

by other providers.[44] This also speaks to competition vis-à-vis affordability and network performance: the greater the market competition, the greater the likelihood that other providers will seek to improve their services and lower their prices.

Competition in the market and consumer choice can be prioritized simultaneously with other objectives without negative consequences, and localities often find that focusing on the overall well-being of their communities and citizens has numerous advantages.

It is important to note, however, that there may be some risk involved with creating competition in the market. The service provider industry can be inhospitable, particularly when the perception is that a public entity is attempting to compete with private industry. A major challenge faced by networks built and operated by public institutions is opposition from existing, private-sector providers. There are a number of reasons for this, some of which are related to perception while others relate to the market itself. Criticisms could range from unauthorized use of general or other funds for debt service coverage, to questioning the need or demand for public-based connectivity services.

An important risk that the City should keep in mind is the potential for litigation from objectors ranging from incumbent providers to watchdog groups. Lafayette Utilities System (LUS) was sued by incumbent providers the same year it proposed creation of a separate utility for FTTP,[45] and the Tennessee Cable Telecommunications Association filed a lawsuit against Chattanooga's Electric Power Board (EPB).[46] These are only two examples of the litigation that public sector entrants to the market have faced from incumbent providers and others.

3.4.2.5 Ownership and Control of Assets

Retaining ownership of OSP assets is important to mitigate risk; owning assets is an important way for localities to retain some control of their networks. This includes a scenario in which a locality pursues partnership with a private provider; a good way to balance risk and reward is for the City to maintain ownership and control of the fiber assets while it assigns operational responsibilities to a private partner. This enables both parties to perform functions that highlight their strengths while not having to expend resources and energy attempting to carry out tasks for which they are ill-equipped.

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[44] Marguerite Reardon, "Google's fiber effect: Fuel for a broadband explosion," *CNet*, April 30, 2014, http://www.cnet.com/news/googles-fiber-effect-fuel-for-a-broadband-explosion/, accessed April 2017.

[45] "About LUS Fiber: Timeline," LUS Fiber, *LUS Fiber,* http://lusfiber.com/index.php/about-lus-fiber/historical-timeline, accessed April 2017.

[46] "Cable Group Files Suit To Try To Block EPB Fiber Optic Plan," *The Chattanoogan*, Sept. 21, 2007, http://www.chattanoogan.com/2007/9/21/113785/Cable-Group-Files-Suit-To-Try-To-Block.aspx, accessed April 2017.

Cash flow could potentially conflict with ownership and control of assets, depending on the degree to which the City chooses to exert control. Maintaining a fiber optic network can be costly, particularly if the City opts to be the retail provider for the service. Operational expenses are a sizable and often unpredictable portion of overall network cost, and it can be difficult to get the take rate necessary to reach positive cash flow.

Other objectives either interact favorably or not at all with ownership and control of the assets. If the City retains complete control of the assets, it can make determinations about which provider(s), if any, can offer services over the network. It can regulate which service providers offer services and to what degree, thus allowing for considerable quality control.

The City may choose to oversee and maintain the network—a function with which it is already well accustomed and for which it is already staffed to some degree—and rely on a private partner to deliver retail services. The City may also be able to govern price points to support consumer affordability and service speeds to enhance performance. And because the City would own the network, it would be in control of performance.

3.4.2.6 Performance – Standing Out with a Superior Network

Many communities are already served to some degree by incumbent providers—whether by large national cable or telephone companies, or small local ISPs. Network performance can thus be a powerful differentiator for a community broadband endeavor.

Prioritizing performance in a retail offering is not only advantageous, we believe it is necessary to make a public entity's offering stand out among existing broadband providers. Market entry is generally a major challenge for public sector retail providers, and even a public–private partnership will likely benefit from focusing on one or two highly specialized offerings to allow it to thrive among incumbents.

The City may find that its FTTP endeavor will struggle and be more prone to failure if it attempts to compete with incumbent providers by offering services similar to existing packages. Instead, it is prudent to recognize gaps in the existing broadband market and seek to fill those with a unique service offering that incumbents are not currently able to provide. A 1 Gbps niche service may enable the City and/or a private partner to enter the market and avoid competing with "me too" services.

A 1 Gbps service that is expandable to 10 Gbps and beyond may be the differentiator the City needs to stand out. By focusing on an extremely powerful data-only offering and communicating with potential subscribers about the advantages of a high-performance, unfettered data product, the City may spark the shift in the market it needs to be successful. The goal is to focus on *unbundling* from the traditional triple-play (i.e., focusing on data, not on cable and phone service), and effectively encouraging consumers to leverage the data service to its fullest capacity.[47]

Performance interacts favorably or not at all with other objectives. There are no disadvantages to prioritizing performance as a key objective in a community build, and we believe that this should be a main focus of any fiber enterprise.

If the City retains ownership of its assets, it also has better control over performance. By owning the network over which services are provided and overseeing a private entity that is serving end users, the City can require the level of performance that it deems appropriate to best serve the community's needs.

Risk aversion and cash flow both interact well with performance. We believe that the City minimizes its risk by entering the market with a 1 Gbps high-performance network. The City can set itself apart from other providers by offering a high-speed data product that incumbents cannot.[48] Further, it can differentiate itself by having an always-on, extremely reliable service that customers can use in new and beneficial ways—like to operate a home-based business, telecommute to their job, or pursue an advanced degree.

3.4.2.7 Risk Aversion – Minimizing the City's Exposure and Liability

There are numerous potential risks the City may face as it considers FTTP deployment—financial, legal, and political, for example. While it is necessary to avoid risk to some degree, it is equally important to balance risk and reward. It may take considerably longer to design, build, and deploy a network if risk aversion is the City's top objective. The "slow and steady" approach is not without merits, but it is also unlikely to give a community a competitive edge. Decreased speed to market—or building out slowly—gives competitors more time to respond to the City's approach.

Figure 9 shows a risk and reward matrix that highlights the City's most likely low-risk-low-reward, low-risk-high-reward, high-risk-high-reward, and high-risk-low-reward outcomes. The lowest risk with the highest potential reward lies in building the network in a phased approach, specifically based on the Google Fiber build-to-demand model.[49] In this approach, the company signs up subscribers by neighborhood (known as "fiberhoods" in the Google Fiber model); once

[47] It may be challenging to attract users who are accustomed to triple play services, but it will be a far greater challenge to compete with incumbent providers by offering the same packages.

[48] It is important to note that products like AT&T's GigaPower and Comcast's Gigabit Pro do not set their advertised 1 Gbps and 2 Gbps service as a baseline. Rather, these products offer a 10 Mbps to 100 Mbps baseline with the potential to deliver 1 Gbps to 2 Gbps service as occasional exceptions. The City, on the other hand, may be able to provide service up to 10 Gbps and beyond, with 1 Gbps as its baseline.

[49] Alistair Barr, "Google Fiber Is Fast, but Is It Fair?", *The Wall Street Journal*, August 22, 2014, http://www.wsj.com/articles/google-fuels-internet-access-plus-debate-1408731700, accessed May 2017.

a neighborhood has reached a certain threshold level of committed subscribers, fiber will be built there.

Figure 9: Risk and Reward Matrix

Reward \ Risk	High	Low
High	o Deploy a ubiquitous communitywide FTTP build, partner with a private provider to operate the retail component, City maintains ownership and control of assets	o Prioritize risk aversion to avoid bonding, slowly expand network in a phased approach and engage a private partner for operation and retail services
Low	o Compete with tiered services similar to incumbents – a "me-too" offering.	o Maintain current network and do not pursue expansion of services

If the City chooses this approach, it must recognize that it necessarily sacrifices certain other objectives like affordability and consumer choice. Risk aversion will generally come at the expense of objectives like these, and is especially in conflict with a ubiquitous build-out.

These objectives do not have to be mutually exclusive; instead, the City must decide to what degree it wants to prioritize which objective, and be prepared for possible conflicts and how to mitigate those. For example, if the City chooses a phased approach, it may opt to first expand service to a location that can demonstrate the power of the network. This will support marketing, and can potentially help convince consumers to sign up for service, thereby achieving ubiquity in a lower risk fashion.

Risk aversion conflicts with ubiquity, choice, competition, and affordability. As we previously noted, it will be challenging to obtain a ubiquitous build-out at all, and especially not within a few years if the City prioritizes risk aversion as its key objective. Because the network is unlikely to be built out quickly in this case, it also reduces the likelihood of increased competition and choice.

If the City chooses to prioritize risk aversion, it will align with ownership, cash flow, and performance. Ownership of the assets usually means lower risk for the City because it has greater control and flexibility.

3.4.2.8 Positive Cash Flow – Becoming Financially Sustainable

Becoming cash flow positive is an important goal for any business or entity, and it is also a bit complex to define. Net income is often referred to as "cash flow," though this is technically incorrect because depreciation is a non-cash expense.

Earnings before interest, taxes, depreciation, and amortization (EBITDA) is the difference between operating revenues and operating expenses; it is a key metric in designing a viable financial model, along with net income. In a capital-intensive business such as an FTTP enterprise, EBIDTA must quickly become positive to keep the enterprise afloat. When EBITDA becomes positive, the business can be said to be cash flow positive. Net income then deducts interest, taxes, and depreciation. Revenues are tied to an enterprise's ability to be sustainable or cash flow positive. Collecting revenues to pay off debt and support business operations bolsters the net income and increases the likelihood that it will become positive.

Several objectives may conflict with cash flow, like affordability, ownership, and ubiquity. As we noted, revenue collection directly impacts cash flow so higher revenues mean a greater likelihood of being cash flow positive. If the service is priced affordably, this may mean lower monthly service fees and a longer path to the enterprise becoming cash flow positive, or self-sustaining.

Ownership may also impact cash flow, especially if the City elects to retain ownership of all network electronics, including CPE. Depreciation costs are significant, and it is important to reserve funds for equipment and infrastructure replacement. Typically, last-mile fiber and CPE are replaced after approximately five years, core network equipment is replaced after seven years, and outside fiber and facilities are replaced after 20 to 30 years. Because the useful life of fiber is considered to be 20 years or more, our financial analyses do not account for its replacement. If the City opts to build and own only the dark fiber portion of the network, its risk will be much lower than if it is responsible for core network equipment and CPE replenishments.

Another element of ownership in the context of cash flow is the need for network maintenance and locating costs. Even if a locality has experience with maintaining a fiber optic network, increased costs associated with serving an increased volume of end users may be significant in terms of both locating and replacing equipment at customer homes and businesses.

4 Public-Private Partnership Models

In recent years, three types of partnerships have emerged within the broadband industry, though not every framework has been tested:

- **P3 Framework 1: Private Investment, Public Facilitation**, in which the public entity takes modest measures to encourage private investment in the area; the most prominent example of this model is Google Fiber's deployment in cities like Kansas City and Austin
- **P3 Framework 2: Private Execution, Public Funding,** which entails significant risk for the public entity and relies on the private sector for execution; this model is new in the broadband industry in the U.S., though it has been used in road construction and public transit projects in Europe and, more recently, in the U.S.
- **P3 Framework 3: Shared Investment and Risk,** which takes advantage of the strengths of both the public and private sector partners; this model aims to offset risk by assigning to each entity tasks with which it is familiar and that it is likely to be able to carry out successfully

There are variations within each partnership framework, and even frameworks that have been underway for several years are still fairly new with relatively few data points to provide meaningful insight into what does and does not work with respect to public–private partnerships. What is clear is that most localities are looking for a way to deploy state-of-the-art broadband infrastructure while managing risk, reward, and control. And most private entities are seeking ways to broaden their customer base while being mindful of their own need for significant enough ROI to make investment worth the deployment.

In some cases, control is the driving factor for a locality, and maintaining control means directly deploying infrastructure that the public sector will own. There is significant capital risk involved in developing fiber infrastructure and then seeking a partner. **Localities that go this route must realize that, even if they directly deploy fiber infrastructure, they are not guaranteed a partner**.

Moreover, even if they find a private partner, these localities are not guaranteed a partner who is able and willing to put their own skin in the game and offset the locality's risk entirely. While this approach gives the locality the greatest degree of control, there is also substantial risk in terms of upfront capital costs and ongoing debt service. **Localities that take this route are well-served by strong procurement processes that inform the private sector of the locality's plans.**

The balance of risk and rewards depends greatly on the locality itself, and what constitutes "risk." For example, a locality whose economic vitality relies on access to broadband infrastructure—such as through the ability to attract large businesses—may have reason to invest in a publicly-owned network, knowing that it will likely not recover its capital and operating costs. In this case, the locality may believe that the benefits conferred on the community through increased economic development will be significant enough to offset its financial risk. The key is for localities to understand their vulnerabilities, to take calculated risks, and to ensure that any partnership balances the risk and reward between the public and private entity.

4.1 Private Investment, Public Facilitation

The first partnership framework represents the lowest level of risk to a locality. While not a fully mutually-beneficial partnership, it focuses on modest steps a locality can take to facilitate implementation and delivery of broadband services. For example, the City could benefit by encouraging coordination and incentivizing efforts between the City and the private sector when excavating the PROW and placing conduit. Coordination can enable the City to better protect the PROW, minimize disruptions, and reduce costs of installation of utilities and conduit.

Such joint trenching efforts around the country—usually referred to as "Dig-Once"—have taken many different forms. Dig Once policies reduce the long-term cost of building communications facilities by capitalizing on significant economies of scale through:

1. Coordination of fiber and conduit construction with utility construction and other disruptive activities in the PROW
2. Construction of spare conduit capacity where multiple service providers or entities may require infrastructure

The incentivizing measures range from implementing business processes for improved sharing of information, to facilitating coordination, to adopting legislative measures that enforce standards and specifications for conduits that can be used by the city or leased to other companies.

Transportation and utility projects can provide many opportunities for Dig Once coordination and that taking advantage of those opportunities can start immediately, while the City potentially works in parallel to implement coordination with non-city utilities.

This framework relies on the private sector being willing to invest capital, and design and deploy infrastructure. In addition, the private partner would assume responsibility for asset management, network services, and customer relations. In turn, the locality facilitates construction through economic and procedural incentives, including tax benefits, streamlined permitting, PROW access, and allowing contracted inspectors to accelerate construction project timelines. In a best-case scenario, these processes can reduce the cost of OSP construction by up to an estimated 8 percent.

This partnership framework is ideal for communities wishing to keep public cost as low as possible, and frequently results in increased broadband marketplace competition and incumbent equipment upgrades. However, in an un- or underserved locality, these benefits most likely would not be immediately realized. Further, this framework prevents the locality from obtaining any control over the installed network assets or construction timeline, and can prove to be a public relations risk if something goes wrong on the partner's end.

4.1.1 Case Study: Holly Springs, North Carolina

The Town of Holly Springs is an example of this partnership framework in practice. Based on the Town's design and engineering plans, the Town built a robust fiber backbone capable of a dramatically higher capacity than broadband need deemed necessary at the time of construction. By creating a future-proof, widely distributed infrastructure, the Town possessed a powerful tool to attract potential private partners. Leveraging this fiber asset, the Town sought partners capable of bringing last-mile fiber to each household and business in the area.

In addition to the infrastructure itself, the Town created policies and procedures that clearly demonstrated its interest in facilitating partnership. By streamlining government processes, allowing access to information and facilities, and providing project facilitation and support, the Town demonstrated its desire to be an active partner with the private sector.

In mid-2015, Ting Internet announced that it would partner with Holly Springs to expand network connections throughout the area. Not only did the Town attract Ting with the ability to lease middle-mile fiber, but it also secured its confidence by enacting advantageous policy.

4.2 Private Execution, Public Funding

The second framework is a higher public risk, higher public benefit variation on the traditional municipal ownership model for broadband infrastructure. Like current partnership frameworks used in the U.S. for highways, toll roads, and bridges, this model has proven successful in Europe.

In this framework, the public entity makes a significant investment, while the private partner assumes a combination of engineering, construction, financing, operations, and/or maintenance responsibilities. Depending on the partnership, sources of public capital may come from the local government, or in some frameworks, a fee assessed on local property owners.

This framework benefits the public partner as it capitalizes on the private partner's strengths to provide turnkey network services over an extended period (20-40 years). By removing the logistical barriers to a locality accomplishing such a large project, the partnership provides an effective solution for both parties by enabling private execution and capital.

The solution comes with the highest public risk of our three proposed frameworks. If the private partner is unable to generate enough revenue to recover cost, or even sustainable profit margins, the public partner is still responsible, assuming the role of guarantor for the project. Further, the competitive nature of the broadband marketplace introduces inherent political problems. Were a locality unable to garner enough support for the project, or a significant number of residents choose not to use the infrastructure, progress may be stalled or thwarted entirely.

4.2.1 Case Study: Macquarie Capital

Macquarie Capital pioneered this framework in broadband infrastructure, proposing a scenario for network expansion. By using public funding, it looks to execute a complete FTTP network with potential long-term revenue benefits for the public.

In its proposed framework, Macquarie offers to provide network financing, construction, operations, and service delivery. In return, the locality pays Macquarie on an ongoing basis (using funds collected from a monthly fee on property owners' utility bills). The framework suggests that multiple ISPs will be able to compete to use the network to provide services to local homes and businesses, effectively lowering prices for customers.

Macquarie theorizes that after the construction period, service revenue will grow over time. As this occurs, a portion of the profits will be shared with the locality. **It is important to note that there is no guarantee that the partnership will ever reach a point where there are significant enough profits to share among the entities.** This framework entails a large risk, as the locality stands to shoulder all the capital risk if revenues are not sufficient to cover the debt service for the network. Further, the suggested utility fee may prove too heavy a political lift in some communities.

4.2.2 Case Study: SiFi Networks

SiFi Networks proposes another yet-untested framework to use public funds and private partner contracts to build an FTTP infrastructure. In this option, the ISP providing service offsets the public partner's costs with monthly payments to the partner to use the city's infrastructure.

Compensated by lease payments from the public sector, SiFi Networks provides financing and turnkey network construction and operations. After the initial build-out, SiFi Networks brings the public partner one or more ISPs to provide services. The ISP then contracts with the locality to use the network at a negotiated rate based on the locality's actual cost.

The main benefit of this framework is with an actual cost-negotiated payment from the ISP to offset lease payments to SiFi Networks. The inherent risk hinges on SiFi Networks' chosen ISP(s)' ability to realize significant revenue and profit margins. If the service provider were unwilling or unable to continue under the framework, the city is left to bear the burden of payments to SiFi Networks. **We note that, especially in smaller markets, attracting enough ISPs to make this framework viable and to reduce the locality's risk may be very challenging.**

4.2.3 Case Study: Symmetrical Networks

Symmetrical Networks suggests a partnership like the above frameworks, but with a few important changes, namely giving the public partner choice in the ISP to use, and the potential to negate the public partner's monthly payments.

In Symmetrical Networks' plan, the company and its partners build, finance, and provide turnkey construction of a network operated by a public partner-chosen ISP. The public partner pays Symmetrical Networks a lease payment which will cover the company's debt service, operating costs, and margins. In turn, the ISP pays the public partner an amount equal to the public partner's payment to Symmetrical Networks.

It is important to note that this framework is estimated to be viable with a community take rate of 35 percent. Like SiFi Networks' framework, the viability of the partnership hinges on the ISP's ability to generate sufficient revenue to cover its payment to the locality, its costs, and an acceptable operating margin. Thus, there is significant inherent risk to the public partner. If revenue falls beneath obligatory levels, the locality is still responsible for payments to Symmetrical Networks.

4.3 Shared Investment and Risk

The third framework represents a partnership in the truest sense of the word. In this framework, the unique strengths of both partners are capitalized, and the primary benefit arises from each partner sharing the heavy lifting of the project.

By sharing investment and risk, both partners develop a strategy to work together to realize their common goal in a framework unique to the project and locality itself. The public and private partners both leverage assets as appropriate and negotiate logistics such as service provision, customer service operations, and maintenance to effectively realize their common goal. For greatest success, both must demonstrate willingness and an ability to compromise for the greater success of the project.

This concept manifests in a variety of ways. Frequently, the public partner provides fiber already in use for civil services, and the private partner invests to expand said fiber to develop a robust FTTP infrastructure. The public partner receives multiple "beyond the balance sheet" benefits, including substantial educational, health, and environmental benefits. Additionally, the private partner secures considerable upfront and long-term savings and enormous operational capabilities.

4.3.1 Case Study: Westminster, Maryland

The City of Westminster, Maryland demonstrates one of the most successful instances of this type of partnership. Greatly underserved by incumbent providers, and located in an area with no major highways, the City found itself with little potential for economic development. In 2010, Maryland won a federal award to bring fiber infrastructure to the state, and fiber was constructed within the City.

The City wanted to expand the fiber within City limits, but did not have a municipal utility to help encounter the problem. Further, the City had neither the resources, expertise, nor the political will to build a competitive ISP. The City made a visionary shift in perspective: viewing the fiber assets brought by the state as an asset like water and sewage lines, noting the possibility of using the infrastructure for public good.

The City decided to build, own, and maintain dark fiber. They then sought a partner to light the fiber, provide service, and handle customer relations. This allowed the City to remain independent of network and customer operations, mitigating management risks.

After releasing a request for proposals, the City partnered with Ting Internet, which shared the City's vision of an open-access network facilitated by a strong partnership. While there are elements of risk to both partners, the partnership ensures both sides will be active partners in the deal. The City assumes the risk of funding the dark fiber, while Ting will pay the City a two-tiered lease payment, one portion based on the number of passings in the network, and the second portion based on the number of subscribers on the network. This structure incents Ting to both accrue customers, and continue to provide quality service to those already subscribed.

Further, the partnership secures mutual financial benefit for both partners after the network is deployed and functioning. Any quarter where Ting's lease obligations are less than what the City needs to cover debt service, the provider will pay the City half of the deficit. In any quarter where Ting's obligations are greater, the provider will be reimbursed the equivalent amount. Lastly, once Ting hits certain revenue thresholds, it will share the revenue, awarding the City's risk.

This partnership is a solid example of ideal mutuality in a partnership: capitalizing on strengths, mitigating risk, and reaping shared rewards.

4.3.2 Case Study: Santa Cruz, California

In what we believe is the first of many similar projects to come nationwide, the City of Santa Cruz has adopted a variation on the Westminster model. In December 2015, the City Council in Santa Cruz signed an agreement that potentially delivers tremendous value to local residents while sharing risk between the public and private sector.

The Santa Cruz City Council approved an agreement between the city and a local ISP, Cruzio. The city will build, own, and maintain a fiber network; Cruzio, which is a DSL reseller, will migrate many of its DSL customers over to the city's fiber network—and will actively pursue additional new customers to buy broadband services over the fiber. As in the Westminster agreement, Cruzio will pay the city both a per-passing and a per-subscriber fee for its use of the city's fiber.

Cruzio is a small company, which creates a certain amount of partnership risk for the city. But from the city's standpoint, it is a very attractive partner—a locally based, locally owned company that employs Santa Cruz residents. In fact, the name of the company incorporates the city's name.

For Santa Cruz, identifying a local partner was a key factor in its negotiations. Cruzio's localism was so important to the city that in early 2015, the Council directed city staff to negotiate exclusively with Cruzio.

Cruzio has operated in the city since the early days of the internet when it was a dialup ISP. In the broadband era, it migrated to some wireless service and to reselling phone company DSL. The logical next step is for Cruzio to migrate to fiber—which is what the relationship with the city will enable it to do.

The benefits of the partnership to the city include not only owning a next-generation network—and all the positive externalities that come with such a network—but also supporting and enabling an important local employer and longtime partner in the community.

4.3.3 Case Study: Garrett County, Maryland

Garrett County is a relatively remote community, which struggled to obtain dependable internet service due to its mountainous terrain and remote households. Before construction, the only service available was either the inadequate speed of DSL or mobile wireless broadband, hindered greatly by data caps. For this reason, the county struggled to attract and retain businesses and teleworkers, and enable home-based businesses and schooling.

The County decided to gradually build fiber out to certain institutions, hoping they could eventually leverage the asset to attract a partner help to expand the network to households in the area. In September 2015, Declarations Networks Group (DNG) partnered with the County to deploy a fixed-wireless network to the underserved areas in the County. After an initial County investment of $750,000, matched by the Appalachian Regional Commission (ARC), DNG committed to more than match the County to provide both capital and operational expertise to the project, enabling the County to reduce the number of homes without broadband access options to nearly zero percent.

While this partnership does entail a sizeable County investment, the money comes with enormous economic value for the dollar, enabling home schooling, teleworking, and bringing internet service to roughly 3,000 under- or unserved homes. The County's ability to provide dark fiber, coupled with its willingness to take on some of the risk attracted DNG, and enabled the partnership to bring broadband to nearly every home in the County.

5 Considerations for an Alternative Deployment to Attract Providers

If the deployment of a ubiquitous FTTP network proves infeasible to the City, there are specific steps it can take to help attract providers to deploy and operate connectivity infrastructure in Spring Hill. Although these strategies will not immediately achieve the City's goals, they may help to encourage the private sector to leverage its strengths to address the availability of broadband within the City.

Alternative deployment strategies capitalize on the City's specific objectives, and will help to address a more concentrated and focused issue. We encourage the City to continue to evaluate and re-evaluate its priorities and capabilities in selecting a strategy to help "move the needle" in the broadband market in Spring Hill.

5.1 Spring Hill's Goals, Objectives, and Priorities Must Inform Its Chosen Technological Solution and Deployment Strategy

In evaluating a deployment strategy, a locality must clearly define its goals and objectives. While an effort for a large rural county may aim to provide a basic service ubiquitously to every business and household countywide, a localized urban effort may choose to focus instead on providing affordable service to the majority of a targeted community. A revitalization effort looking to attract new business growth in the technology sector might prioritize a high-speed, dependable solution, while a small city might rather focus on encouraging a competitive broadband market, and lowering barriers to broadband market entry.

Many public deployments strive to achieve an ideal solution that offers affordable, dependable, and ubiquitous broadband through a public deployment for which the locality has the borrowing capacity to support, that can both recover construction costs in the asset's lifetime, and operate cash positive. In practice, however, these goals must be prioritized. Each connectivity technology aligns with certain goals, and thoughtful deployment strategies can further support a locality's primary objectives.

5.2 Wireless Network Deployment

With many localities acutely aware of the high cost of fiber deployment, wireless technologies have garnered much attention recently. Though a wireless deployment may seem to alleviate the high cost of construction, as well as offer a potentially "easier" approach to a complex and specific FTTP design and deployment, the City must thoughtfully consider its goals and priorities, as well as the inherent limitations of wireless technologies before assuming a wireless deployment will offer a "low-cost, low-hassle" solution.

While current wireless technologies will not provide Gigabit service, they do offer a valuable alternative for areas where fiber or cable modem service is not available. Given that the City aims to improve the overall broadband landscape, a well-designed wireless deployment offers one strategy to move the City toward its goals.

5.2.1 A Goal of Ubiquity Compounds the Challenges of a Cost-Effective Wireless Deployment

Localities frequently prioritize a deployment that provides ubiquitous service to all residents and businesses, enabling the entirety of the population to benefit from publicly deployed infrastructure. Although this goal is both understandable and commendable, it is challenging for a wireless deployment to cost-effectively support ubiquitous service. As discussed below, due to the physical and technical limitations of both area coverage and equipment capacity, a ubiquitous wireless approach necessitates increased fiber deployment, increased active components in the field that require constant power, and a resulting increase in operations and maintenance expenses.

If ubiquity is a priority for the City, rather than focusing on deploying the entirety of a wireless network, it should instead look to ways it can facilitate a ubiquitous deployment by a private partner. The primary focus should be on lowering the barriers to a deployment, either for an existing provider in the locality, or for a new market entrant. This may come in the form of deploying sufficient fiber with redundant links to key sites to attract an operator to install access points, offering mounting locations and assets, facilitating access to affordable commodity bandwidth and transport, or even offering tax breaks to the deployer.

We note that if a deployment is aiming for a "good enough" solution, providing access to as many locations as possible without mandating ubiquitous availability, wireless offers a viable solution.

5.2.2 Key Factors to Consider in a Wireless Deployment

In a wireless deployment, the key factors to consider are the total coverage and capacity of the network. That is, the total number of users the network can reach and the total number of users that can use the network simultaneously, respectively. Additionally, it is vital to remember that wireless antennas require wireline infrastructure, i.e. fiber, from the network core to the antenna. As such, increased access points will require deployment of additional fiber.

5.2.2.1 Coverage

The physical coverage of a wireless network—or the overall area that the antennas can reach—is heavily dependent on the height of the antenna (frequently referred to as an access point), as well as the proximity of the receiving antenna on a customer's home or business. Additionally, buildings, trees, and terrain variations can block signals between the broadcasting and receiving equipment.

To address this, the network operator has multiple options. First, it can mount access points higher, enabling the signal to reach more users. In a similar vein, it can choose to deploy equipment at the customer's location that mounts to the outside and/or top of the building to increase its ability to receive the signal. However, in most cases, it must deploy additional access points to reach customers who are too far from an existing antenna, or customers whose homes or businesses are obscured from the signal. In turn, these access points will require additional fiber for backhaul. That is, as the total number of network users increases, the total number of access points, as well as backhaul fiber, increases proportionally.

5.2.2.2 Capacity

The capacity of a wireless network—or the total number of customers the network can serve—is dependent on the technological limitations of each access point. Even if an access point's signal can reach every user in an area, it will only be able to support a maximum number of users simultaneously. Given this, as the total number of network users increases, a locality will need to deploy additional access points, and in turn additional fiber.

5.2.3 Due to Their Short Lifespan, Wireless Network Components Should Not Be Viewed as Infrastructure

Unlike roads, sewers, and fiber, wireless network components frequently need to be replaced within five to seven years of deployment. Given this, it makes little sense for a locality to view wireless network assets as infrastructure, and to make a long-term investment in them as it would its roads, sewers, and fiber. Rather, a locality is best served to use its long-term borrowing capacity to finance infrastructure that supports wireless infrastructure (i.e. fiber assets), and focus on attracting a private operator to deploy, maintain, and replace wireless components.

5.2.4 Spring Hill May Be Well Served by Working with Local WISPs to Determine and Remove Barriers to Market Entry

If a wireless deployment makes sense for the City, it may be in its best interest to lower the barriers of market entry for the private sector. In turn, the private sector can leverage its strengths to provide a solution to the entirety of a locality. We encourage outreach to community and regional WISPs to better understand the hurdles preventing their market entry and/or expansion. These barriers frequently include transport, commodity bandwidth, and facility access, but we encourage dialogue with WISPs to understand the barriers unique to Spring Hill.

5.3 Middle-Mile Fiber Deployment

In this model, the City could address any "middle mile" needs it has by building a less-extensive network that ensures the availability of fiber optics to government users and key local institutions, but do not reach all the way to the home or business. This is a proven best practice with two decades of solid empirical data that demonstrates its viability.

Hundreds of localities have used this strategy, with a range of variations. Austin, Boston, Chicago, Los Angeles, New York City, San Antonio, San Francisco, Seattle, Washington, and hundreds of suburban and rural towns and counties have employed this strategy.

Two decades of public sector experience demonstrate that municipal ownership of a fiber network enables localities to better meet growing demands for communications capacity and functionality, while reducing the risk of private sector price increases for managed communications services. By owning its fiber infrastructure, a locality can both determine how much it will pay for the initial infrastructure and also manage ongoing operating expenses, keeping them relatively constant—even as the network's capabilities increase over time.

Without control over its own network, the City's costs for carrier-provided communications services may increase significantly with time—because aggregate pricing will increase as the community's communications needs continue to grow in coming years to support cloud-based services and Smart Cities initiatives. Additionally, the City may find itself constrained by limited bandwidth at its sites, though the state network can help offset these common challenges. The community may be limited to the offerings that service providers make available in a particular neighborhood, or limited to the offerings that can be purchased under a given year's appropriation.

Additionally, the City may wish to enable a wide range of emerging, high-bandwidth applications, including remote traffic signalization, traffic camera and surveillance camera backhaul, remote sensors, and other devices, as well as a full range of Smart City and Internet of Things deployments. A robust, publicly-owned fiber network makes applications that require backhaul of wireline connectivity far more cost-effective

5.3.1 Deployment and Operating Cost Estimate

We estimate the cost to deploy a middle-mile fiber network is a $1.18 million initial investment plus $12,000 per year in operation and maintenance expenses. If the City were to finance the network at a 3 percent interest rate over 20 years, the resulting annual principal and interest payment would total roughly $82,000. That is, the total annual cost of financing a middle-mile network over 20 years will equal $94,000. If the City could contribute $1 million over the 20-year span of the model, averaging $60,000 in available capital annually, the City would still face a $34,000 annual shortfall. To operate the middle-mile network, this shortfall would need to be supplemented by cash from the general fund, tax base, or similar sources.

5.3.2 Considerations for a Middle-Mile Network

The primary draw of a middle-mile network in Spring Hill would be to attract private providers to enter the broadband market, deploying last-mile infrastructure to homes and businesses in the City. Indeed, maintaining fiber may facilitate competition and delivery of advanced services by competitive service providers. By making spare fiber capacity available for lease, the City may attract commercial providers by the reduced barrier of entry into the broadband market. A well-organized, documented, and maintained fiber network that touches nearly all subdivisions and business districts could potentially provide a backbone for delivery of residential FTTP and/or high-capacity enterprise services.

We note the network must be able to facilitate fiber leasing, to the extent possible, including fiber routes and access points to fiber and communications conduit that target business parks, and spare capacity of fiber and conduit to support the provision of future services to businesses and residents. Leasing fiber on a non-discriminatory basis might enable providers to compete over the fiber and would likely create some modest revenue. There is virtually no risk or cost to lease fiber. Over time, the fiber network may serve as the basis for private investment in world-class broadband to all businesses and residences.

We note that the City would need to be willing to fund this asset without expectations of substantial lease revenues, however, the City can view this investment as a demonstrative step to attract commercial providers by the reduced barrier of entry into the broadband market.

Further, even though a middle-mile network might attract private last-mile investment in the City, it will do little to affect the "overall cost" of an FTTP deployment. Indeed, the middle-mile network represents only a small fraction of the total unit cost to deploy FTTP. That said, an available and robust middle-mile network may solve significant logistical and planning concerns for a private deployer, encouraging FTTP deployment. Most encouragingly, an additional private provider may increase competitive pressure on incumbent providers to offer optimized services and prices.

6 Conceptual Fiber-to-the-Premises Network Design and Cost Estimates

CTC prepared a high-level network design for the City's deployment of a gigabit-capable FTTP network to all homes and businesses in the City. Based on the high-level FTTP design, we developed two cost examples.

The first is the **cost to deploy just the FTTP OSP infrastructure, which we refer to as a "dark FTTP" model.** This is the total capital cost for the City to build a dark FTTP network for lease to a private partner. This dark FTTP model forms the basis for our FTTP financial analysis. The dark FTTP model is presented with two alternatives—one in which the cost for the fiber drop cable is the responsibility of the partner, and one in which the drop costs are the City's responsibility.[50]

The second estimate is the **cost to deploy an FTTP infrastructure, all electronics, consumer drops, and customer premises equipment (CPE), which we refer to as a "lit" model.** This estimate shows the *total capital costs*[51] (by the City or the City and partners) to build an FTTP network to support a ubiquitous Gigabit data service.

The difference between these two cost estimates reflects the general range of costs that a private partner would incur to deploy FTTP within the City. Please note that the partner's costs (electronics) are subject to a seven- to 10-year replacement cycle, as compared to the 20- to 30-year lifespan of a City fiber investment.

The CTC cost estimate provides data relevant to assessing the financial viability of network deployment, and to developing a business model for a potential City construction effort (including the full range of models for public–private partnerships). This estimate also enables financial modeling to determine the approximate revenue levels necessary for the City to service any debt incurred in building the network.

The CTC design and cost estimate are underpinned by data and insight gathered by CTC engineers through discussions with City stakeholders, an extensive desk survey of candidate fiber routes, and a detailed sample design of the City.

Actual costs may vary due to factors that cannot be precisely known until the detailed design is completed, or until construction commences. These factors include:

1. Costs of private easements;
2. Utility pole replacement and make-ready costs;

[50] A fiber drop cable connects the customer's premises to the distribution network.
[51] Capital costs are distinct from ongoing operations costs that the City or the City and partners will incur during ongoing maintenance and operation of the fiber enterprise.

3. Variations in labor and material costs;
4. Subsurface hard rock; and
5. The City's operational and business model.

We have incorporated suitable assumptions to address these items based on our experience in similar markets.

6.1 Survey Methodology for Developing Design and Cost Estimates

To develop estimates of per-mile cost for aerial infrastructure in the communications space and per-mile costs for underground infrastructure where poles are not available, CTC engineers performed a survey of the City via Google Earth Street View.[52] The engineers reviewed available green space, necessary make-ready on poles, and pole replacement—all of which have been factored in to the design and cost estimate.

Table 19, below, summarizes the conditions determined through our desk survey.

Table 19: Field Survey Findings

	High Density
Aerial Construction	50%
Poles per Mile	47
Moves per Pole	2
Poles Requiring Make-Ready	10%
Poles Requiring Replacement	2%
Intermediate Rock	0%
Hard Rock	0%

CTC's OSP engineer noted that the quality of the poles and pole attachments in the City varied, as they do in many cities and counties—but that overall, most of the poles would support an additional cable in the communications space with little make-ready or pole replacement required.

The largest issue with make-ready was tree trimming in the communications space. Make ready is only typically required where both cable and telephone are already located in the communications space.

Figure 10, Figure 11, and Figure 12, below, show examples of poles in various conditions throughout Spring Hill.

[52] Not all areas of the City are available on Google Earth. We surveyed a sample of the City that was available.

Figure 10: Utility Pole Line Showing where Tree Trimming is Needed

Figure 11: Congested Pole Line where Make-Ready will be Required

Figure 12: Example of Low Make-Ready Pole Lines

6.2 Fiber-to-the-Premises Network Design

We developed a conceptual, high-level FTTP design that reflects the City's goals and is open to a variety of architecture options. The design assumes a combination of aerial and underground construction based on the placement of the existing utilities.

Figure 13, below, shows a logical representation of the high-level FTTP network architecture we recommend based on the conceptual design in this report. This design is open to a variety of architecture options.[53] The drawing illustrates the primary functional components in the FTTP network, their relative position to one another, and the flexibility of the architecture to support multiple subscriber models and classes of service.

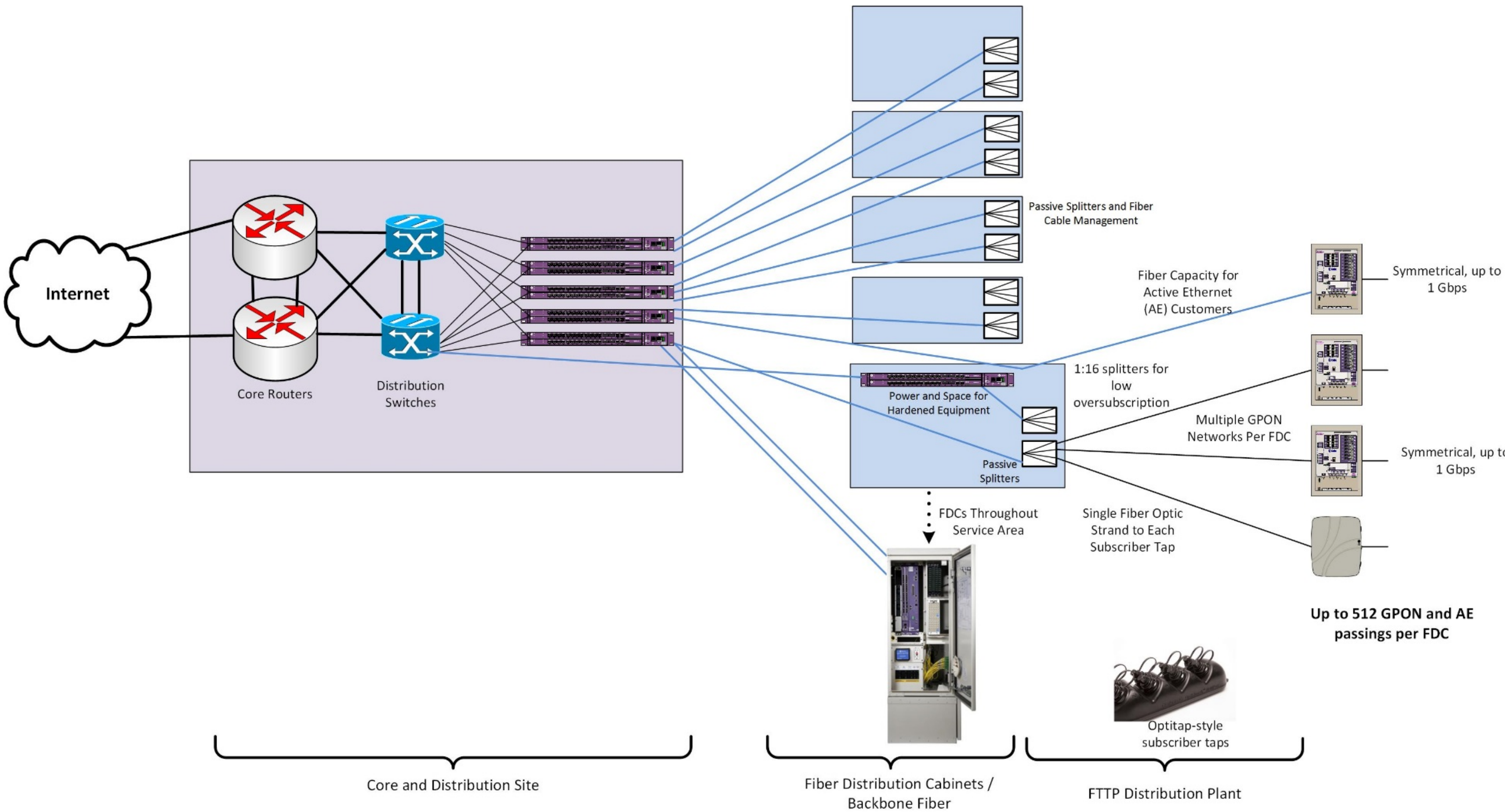
The recommended architecture is a hierarchical data network that provides critical scalability and flexibility, both in terms of initial network deployment and its ability to accommodate the increased demands of future applications and technologies. The characteristics of this hierarchical FTTP data network are:

- **Capacity** – ability to provide efficient transport for subscriber data, even at peak levels

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

- **Availability** – high levels of redundancy, reliability, and resiliency; ability to quickly detect faults and re-route traffic
- **Failsafe operation** – physical path diversity to minimize operational impact resulting from fiber or equipment failure
- **Efficiency** – no traffic bottlenecks; efficient use of resources
- **Scalability** – ability to grow in terms of physical service area and increased data capacity, and to integrate newer technologies
- **Manageability** – simplified provisioning and management of subscribers and services
- **Flexibility** – ability to provide different levels and classes of service to different customer environments; can support an open access network or a single-provider network; can provide separation between service providers on the physical layer (separate fibers) or logical layer (separate Virtual Local Area Network (VLAN) or Virtual Private Network (VPN) providing networks within the network)
- **Security** – controlled physical access to all equipment and facilities, plus network access control to devices

Figure 13: High-Level FTTP Architecture



This architecture offers scalability to meet long-term needs. It is consistent with best practices for an open-access network model that may be required to support multiple network operators, or at least multiple RSPs requiring dedicated connections to certain customers. This design would support a combination of Gigabit Passive Optical Network (GPON) and direct Active Ethernet (AE) services (with the addition of electronics at the fiber distribution cabinets), which would enable the network to scale by migrating to direct connections to each customer, or reducing splitter ratios, on an as-needed basis.

The design assumes placement of manufacturer-terminated fiber tap enclosures within the PROW or easements, providing watertight fiber connectors for customer service drop cables, and eliminating the need for service installers to perform splices in the field. This is an industry-standard approach to reducing both customer activation times and the potential for damage to distribution cables and splices. The model also assumes the termination of standard lateral fiber connections within larger multi-tenant business locations and MDUs.

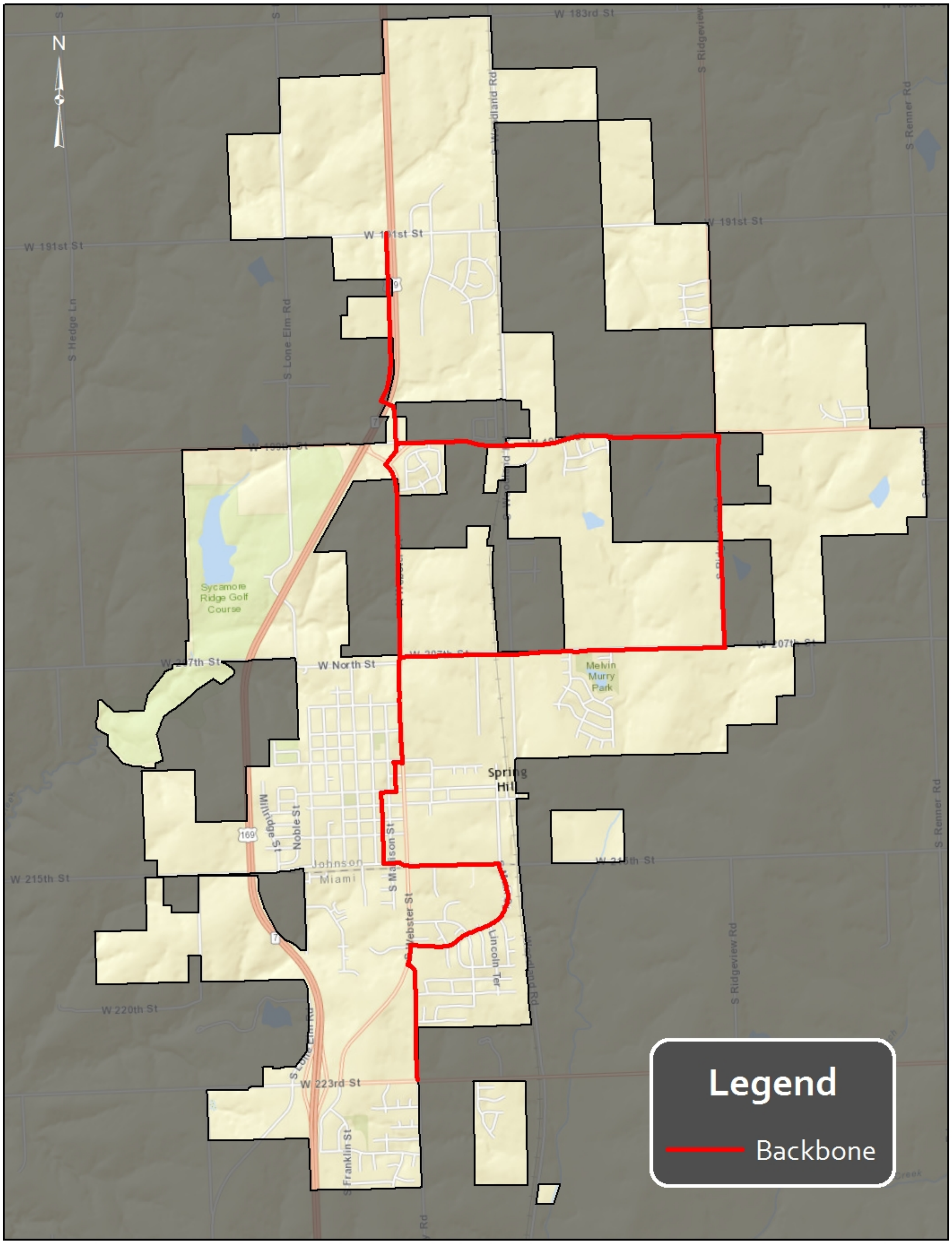
6.2.1 Network Design

The network design and cost estimates assume the City will:

- Use existing City land to locate a core and distribution hub facility. The cost estimate includes the facility costs with adequate environmental and backup power systems to house network electronics, and provide backhaul to the internet
- Construct a robust backbone network to connect to connect the distribution hub to the new fiber distribution cabinets (FDC)
- Construct fiber optics from the FDCs to each residence and business (i.e., from termination panels in the FDC to tap locations in the PROW or on City easements)
- Construct fiber laterals into large, multi-tenant business facilities and MDUs

Spring Hill is rapidly expanding as new subdivisions are added to the City. While the exact location of the new developments cannot be predicted, it is important to construct a robust backbone. The backbone should provide redundancy where possible and extend to the outer edges of the City so that it will be near new subdivisions, which will enable service to be extended to these areas as they are built. Figure 14, below, shows an example backbone design for the City.

Figure 14: FTTP Network Example Backbone Design



The FTTP network and service areas were defined based on the following criteria:

- Fiber will be installed in the communications space of utility poles where present, and in newly constructed conduit in underground areas
- Targeting 288 passings per FDC
- The service area is the entire City, with an emphasis on the expansion that has been occurring on the outer edges of the City
- Multiple FDCs per service area
- FDCs suitable to support hardened network electronics, providing backup power and an active heat exchange[54]
- Avoiding the need for distribution plant to cross major roadways and railways

Coupled with an appropriate network electronics configuration, this design serves to greatly increase the reliability of fiber services provided to the customers compared to that of more traditional cable and telephone networks. The backbone and hub design minimizes the average length of non-diverse distribution plant between the network electronics and each customer, thereby reducing the probability of service outages caused by a fiber break.

The access layer of the network, encompassing the fiber plant from the FDCs to the customers, dedicates a single fiber strand from the FDC to each passing. This traditional FTTP design allows either network electronics or optical splitters in the FDCs. See Figure 15, below, for a sample design.

[54] These hardened FDCs reflect an assumption that the City's operational and business model will require the installation of provider electronics in the FDCs that can support open access among multiple providers. We note that the overall FTTP cost estimate would decrease if the hardened FDCs were replaced with passive FDCs (which would house only optical splitters) and the providers' electronics were housed only at the hub facility.

Figure 15: Sample FTTP Access Layer Design

This architecture offers scalability to meet long-term needs, and is consistent with best practices for an open access network model that may be required to support multiple network operators, or at least multiple RSPs requiring dedicated connections to certain customers.

6.2.2 Network Core and Hub Site

The core site is the bridge that links the FTTP network to the public internet and delivers all services to end users. The proposed network design includes a core location that shares space with the distribution and access electronics; however, if consumer demand dictates, a second internet point of presence (PoP) could be added to increase network redundancy or to decrease distances to customers.

For the cost estimate, we assumed that the core site electronics would be housed in a pre-fabricated telecommunications shelter located near the meet point with the ISP chosen to provide internet access for the FTTP network.

Figure 16: Sample Hub Facility

The core location in this plan will house providers' Operational Support Systems (OSS), such as provisioning platforms, fault and performance management systems, remote access, and other operational support systems for FTTP operations. The core location is also where any business partner or content / service providers will gain access to the subscriber network with their own PoP. This may be via remote connection, but collocation is recommended.

The core location is typically run in a High Availability (HA) configuration, with fully meshed and redundant uplinks to the public internet and/or all other content and service providers. It is imperative that core network locations are physically secure and allow 24x7x365 unencumbered access to authorized engineering and operational staff.

The operational environment of the network core and hub location is like that of a data center. This includes clean power sources, uninterruptable power supply (UPS) batteries, and diesel power generation for survival through sustained commercial outages. The facility must provide strong physical security, limited/controlled access, and environmental controls for humidity and temperature. Fire suppression is highly recommended.

Equipment is to be mounted securely in racks and cabinets, in compliance with national, state, and local codes. Equipment power requirements and specification may include -48-volt DC and/or 120/240 volts AC. All equipment is to be connected to conditioned / protected clean power with uninterrupted cutover to battery and generator.

For the cost estimate, we assumed that the core will be located on existing City land with adequate space for the shelter.

6.2.3 Distribution and Access Network Design

The distribution network is the layer between the core hub and the FDCs, which provide the access links to the taps. The distribution network aggregates traffic from the FDCs to the core. Fiber cuts and equipment failures have progressively greater operational impact as they happen closer to the network core, so it is critical to build in redundancies and physical path diversities in the distribution network, and to seamlessly re-route traffic when necessary.

The distribution and access network design proposed in this report is flexible and scalable enough to support two different architectures:

1. Housing both the distribution and access network electronics at the hub, and using only passive devices (optical splitters and patches) at the FDCs
2. Housing the distribution network electronics at the hub and pushing the access network electronics further into the network by housing them at the FDCs

By housing all electronics at the hub, the network will not require power at the FDCs. Choosing a network design that only supports this architecture may reduce costs by allowing smaller, passive FDCs in the field. However, this architecture will limit the redundancy capability from the FDCs to the hubs.

By pushing the network electronics further into the field, the network gains added redundancy by allowing the access electronics to diversely connect to the hub. In the event of a fiber outage on one link, the subscribers connected to the FDC would still have network access.

A design that supports both models would allow the City to accommodate many different service operators and their network designs. This design would also allow service providers to start with a small deployment (i.e., place electronics only at the hub site, and grow by pushing electronics closer to their subscribers).

6.2.3.1 Access Network Technologies

FDCs can sit on a curb, be mounted on a pole, or reside in a building. The model recommends installing sufficient FDCs to support higher-than-anticipated levels of subscriber penetration. This approach will accommodate future subscriber growth with minimal re-engineering. Passive optical splitters are modular and can be added to an existing FDC as required to support subscriber growth, or to accommodate unanticipated changes to the fiber distribution network with potential future technologies.

Figure 17: Fiber Distribution Cabinet

The FTTP design also includes the placement of indoor FDCs and splitters to support MDUs. This would require obtaining the right to access the equipment for repairs and installation in whatever timeframe is required by the service agreements with the customers. Lack of access would potentially limit the ability to perform repairs after normal business hours, which could be problematic for both commercial and residential services.

In this model, we assume the use of GPON electronics for most subscribers and AE for a very small percentage of subscribers (typically high-end business customers) that request a premium service or require greater bandwidth. GPON is the most commonly provisioned FTTP service—used, for example, by AT&T Fiber, Verizon (in its FiOS systems), Google Fiber, and Chattanooga EPB.

Further, providers of gigabit services typically provide these services on GPON platforms. Even though the GPON platform is limited to 1.2 Gigabits per second (Gbps) upstream and 2.4 Gbps downstream for the subscribers connected to a single PON, operators have found that the variations in actual subscriber usage generally means that all subscribers can obtain 1 Gbps on demand (without provisioned rate-limiting), even if the capacity is aggregated at the PON. Further, many GPON manufacturers have a development roadmap to 10 Gbps and faster speeds as user demand increases.

GPON supports high-speed broadband data, and is easily leveraged by triple-play carriers for voice, video, and data services. The GPON optical line terminal (OLT) uses single-fiber (bidirectional) Small Form-factor Pluggable (SFP) modules to support multiple (most commonly less than 32) subscribers.

GPON uses passive optical splitting, which is performed inside the FDC, to connect fiber from the OLTs to the customer premises. The FDCs house multiple optical splitters, each of which splits the fiber link to the OLT between 16 to 32 customers (in the case of GPON service).

AE provides a symmetrical (up/down) service that is commonly referred to as Symmetrical Gigabit Ethernet. AE can be provisioned to run at sub-gigabit speeds, and—like GPON—easily supports legacy voice, Voice over Internet Protocol (VoIP), and video. AE is typically deployed for customers who require specific service level agreements that are easier to manage and maintain on a dedicated service.

For subscribers receiving AE service, a single dedicated fiber goes directly to the subscriber premises with no splitting. Because AE requires dedicated fiber (also known as "home-run fiber") from the OLT to the CPE, and because each subscriber uses a dedicated SFP on the OLT, there is a significant cost difference in provisioning an AE subscriber versus a GPON subscriber.

The fiber plant is designed to provide AE service or PON service to all passings. The network operator selects electronics based on the mix of services it plans to offer, and can modify or upgrade electronics to change the mix of services.

6.2.3.2 Expanding the Access Network Bandwidth

GPON is currently the most commonly provisioned FTTP technology, due to inherent economies when compared with technologies delivered over home-run fiber,[55] such as AE. The cost differential between constructing an entire network using GPON and AE is 40 to 50 percent.[56] GPON is used to provide services up to 1 Gbps per subscriber and is part of an evolution path to higher-speed technologies that use higher-speed optics and wave-division multiplexing (WDM).

This model provides many options for scaling capacity, which can be done separately or in parallel:

1. Reducing the number of premises in a PON segment by modifying the splitter assignment and adding optics—for example, by reducing the split from 16:1 to 4:1, the per-user capacity in the access portion of the network is quadrupled.

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[55] Home-run fiber is a fiber optic architecture in which individual fiber strands are extended from the distribution sites to the premises. Home-run fiber does not use any intermediary aggregation points in the field.

[56] "Enhanced Communications in San Francisco: Phase II Feasibility Study," CTC report, October 2009, at p. 205.

2. Adding higher-speed PON protocols can be accomplished by adding electronics at the FDC or hub locations; since these use different frequencies than the GPON electronics, none of the other CPE would need to be replaced.

3. Adding WDM-PON electronics as they become widely available, which will enable each user to have the same capacity as an entire PON; again, these use different frequencies than GPON and are not expected to require replacement of legacy CPE.

4. Option 1 could be taken to the maximum, and PON replaced by a 1:1 connection to electronics—an AE configuration.

These upgrades would all require complementary upgrades in the backbone and distribution Ethernet electronics, as well as in the upstream internet connections and peering—but they would not require increased fiber construction.

6.2.3.3 Customer Premises Equipment and Subscriber Services

In the final segment of the FTTP network, fiber runs from the FDC to customers' homes, apartments, and office buildings, where it terminates at the subscriber tap—a fiber optic housing located in the PROW closest to the premises. The service installer uses a pre-connectorized drop cable to connect the tap to the subscriber premises without the need for fiber optic splicing.

The drop cable extends from the subscriber tap (either on the pole or underground) to the building, enters the building, and connects to CPE.

6.3 Dark Fiber-to-the-Premises Cost Estimate

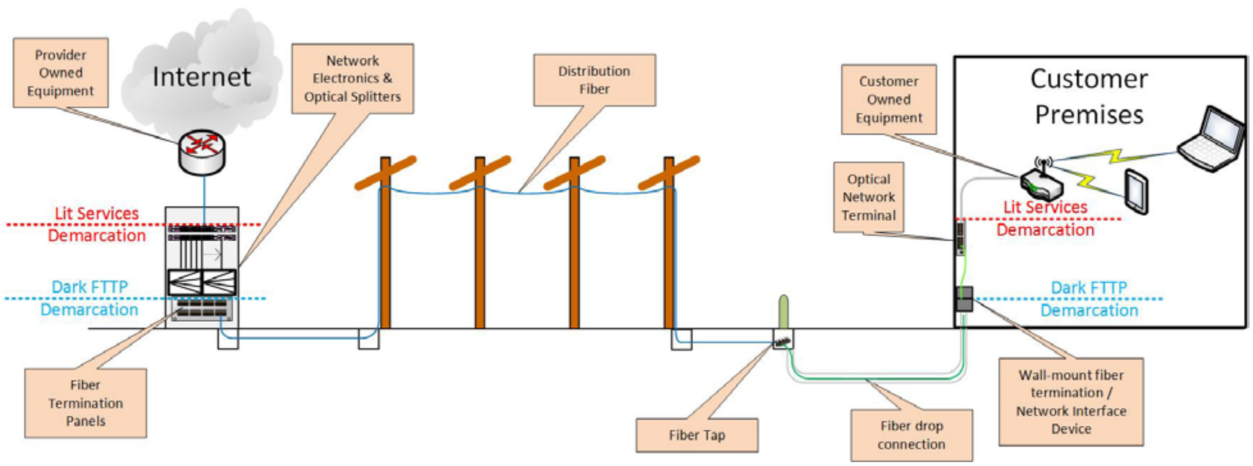
A dark FTTP network deployment will cost approximately $6.4 million, inclusive of OSP construction labor, materials, engineering, permitting, lateral drops, and drop materials. This estimate assumes a 35 percent take rate. This estimate does not include any electronics or subscriber equipment.

Table 20: Estimated Dark FTTP Cost with Drops (Assuming a 35 Percent Take Rate)

Cost Component	Total Estimated Cost
OSP	$4.8 million
FTTP Service Drop and Lateral Installations	1.6 million
Total Estimated Cost:	$6.4 million

This estimate assumes that the City constructs and owns the FTTP infrastructure up to a demarcation point (a network interface device) at each residence and business, and leases the dark fiber backbone, distribution, and drop fiber to a private partner. The private partner would be responsible for all network electronics and CPE—as well as network sales, marketing, and operations.

Figure 18: Demarcation Between City and Partner Network Elements in the Lit and Dark Models



6.4 Lit Fiber-to-the-Premises Cost Estimate

Assuming a take rate (i.e., the percentage of residents and businesses that subscribe to the service) of 35 percent, the full FTTP network deployment will cost more than $7.5 million, inclusive of OSP construction labor, materials, engineering, permitting, network electronics, drop installation, CPE, and testing.

Table 21: Estimated Lit FTTP Cost

Cost Component	Total Estimated Cost
OSP	$4.8 million
Central Network Electronics	0.5 million
FTTP Service Drop and Lateral Installations	1.6 million
CPE	0.6 million
Total Estimated Cost:	$7.5 million

6.4.1 Cost per Passing

On a per-passing basis, the lit FTTP deployment will cost $1,700 on average. The $1,700 per passing cost for the City of Spring Hill is similar to other communities we have worked with that contain a high percentage of underground infrastructure. Figure 19 and Figure 20, below, show the potential range of costs for a variety of communities with which CTC has been engaged.

Figure 19: FTTP Cost per Passing Comparison

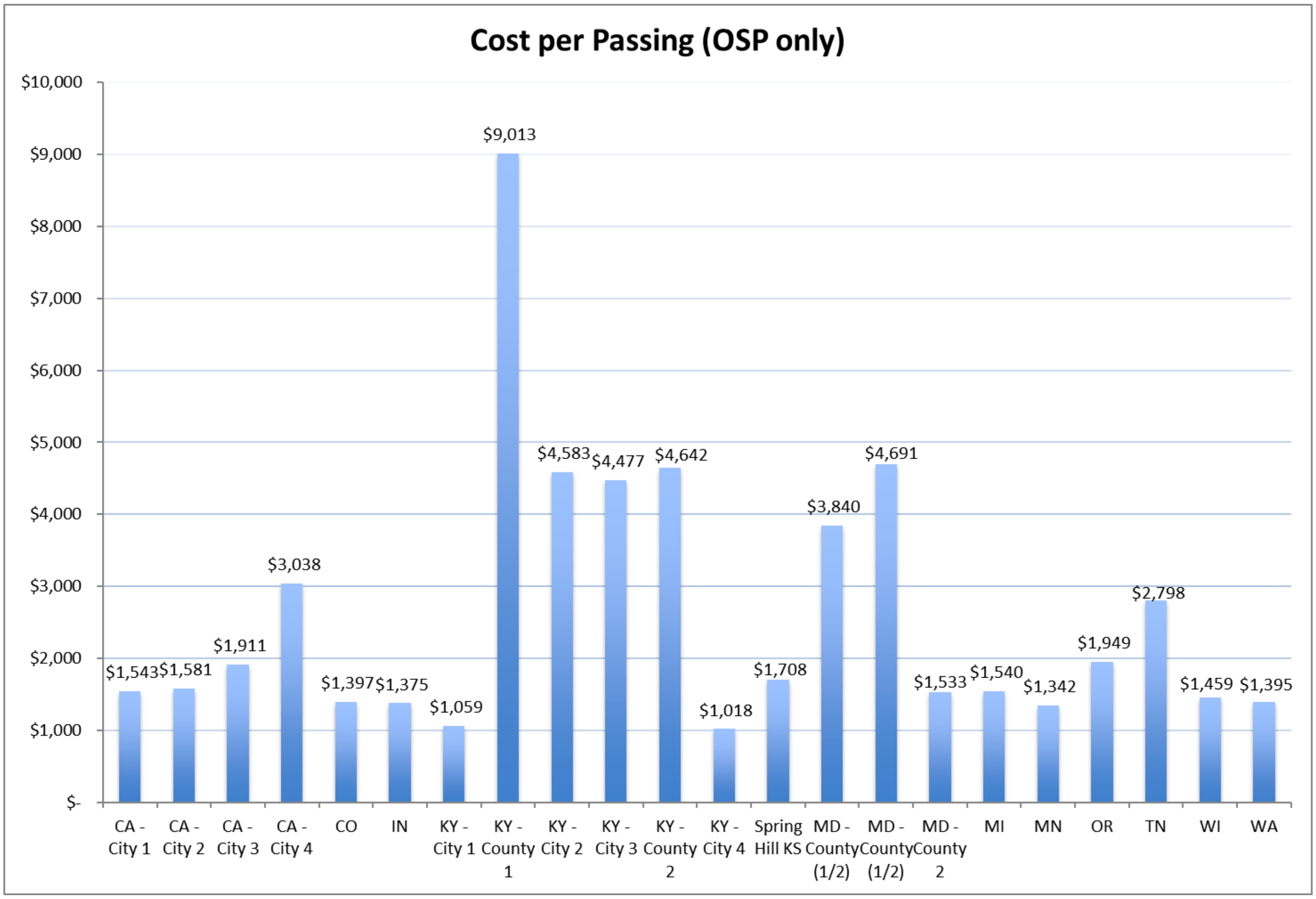
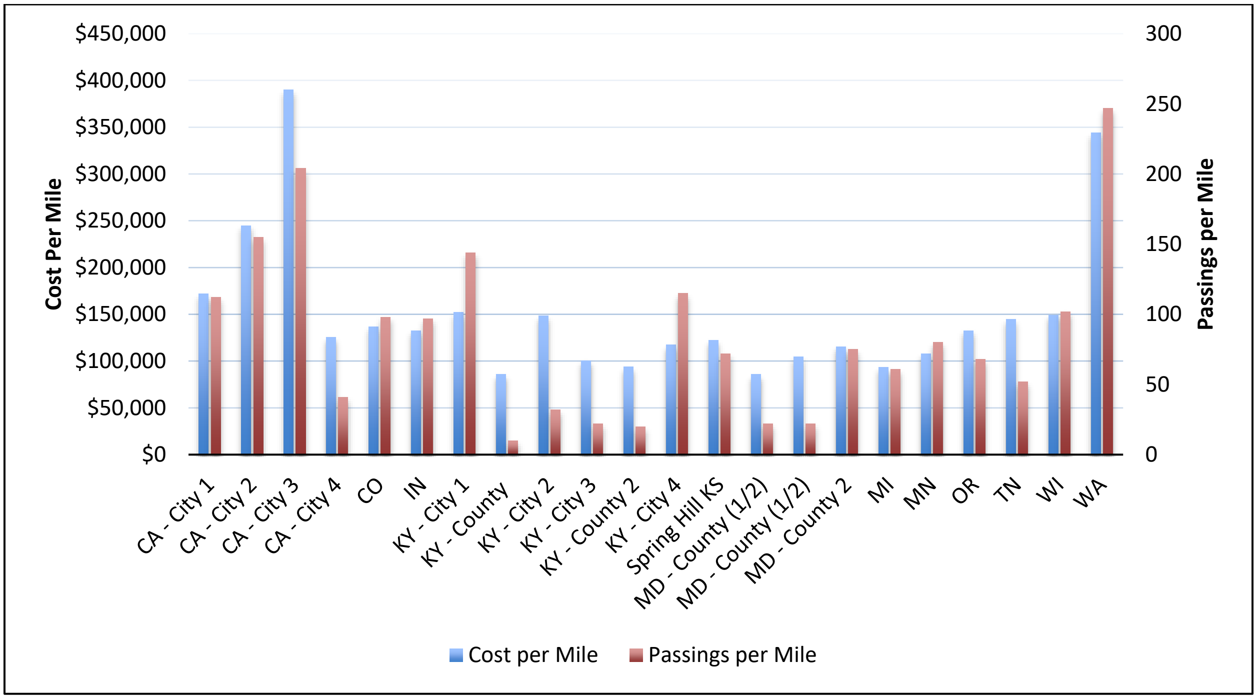


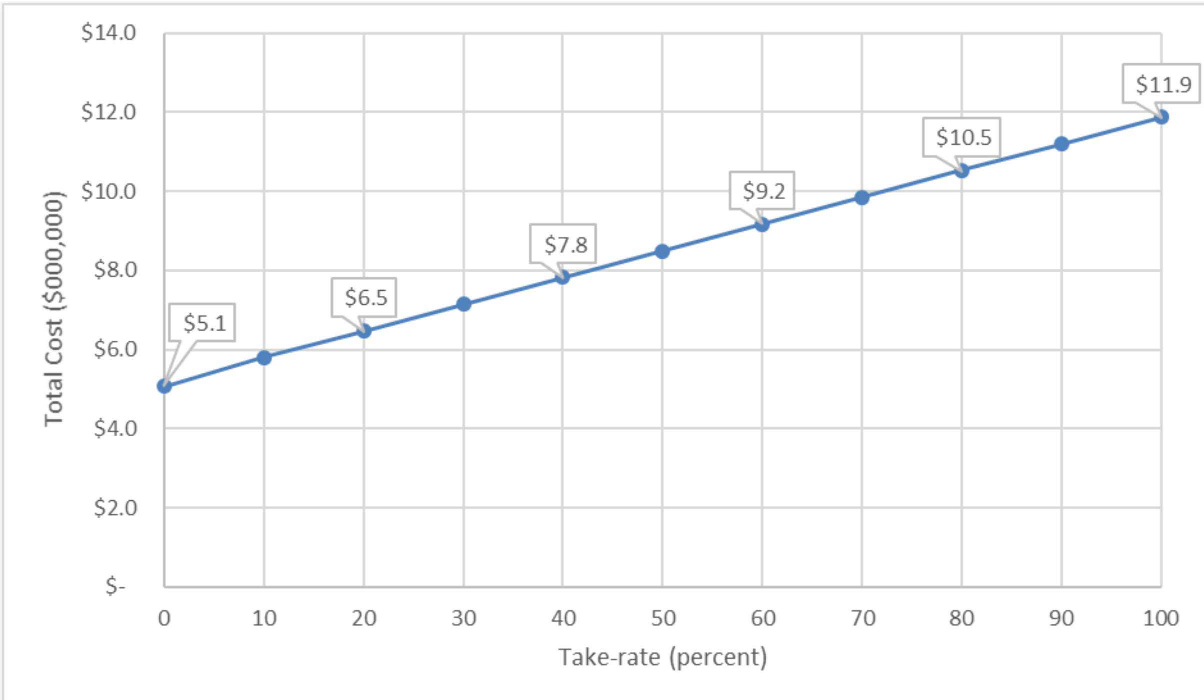
Figure 20: FTTP Key Cost Factors (Density and Construction Cost)



As indicated above, the take rate is the percentage of homes/businesses passed with fiber that will acquire service from the FTTP provider. The estimated 35 percent take rate is within the range that may exist in a market where both the cable and telephone companies also provide broadband service. The financial analysis in Section 6.5 discusses the impact of take rate in additional detail.

Figure 21 shows the total estimated cost by varying the expected take rate. Table 21 assumes a take rate of 35 percent.

Figure 21: Total Estimated Cost versus Take Rate



The cost is roughly linear by take rate, as the cost of adding additional subscribers is a fixed cost.

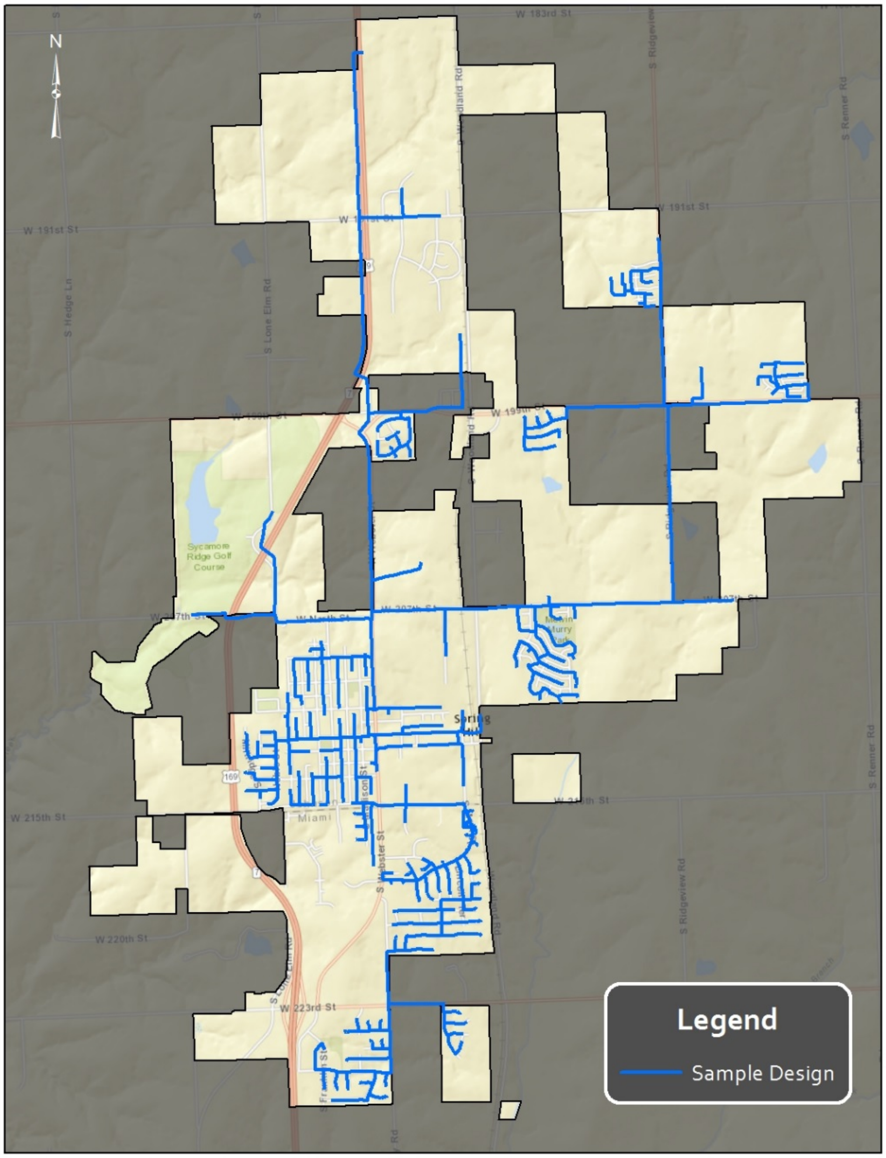
The total cost of operations will also vary with the business model chosen and the level of existing resources that can be leveraged by the City and any potential business partners.

6.4.2 OSP Cost Estimation Methodology

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

To estimate costs, we extrapolated the costs for strategically selected sample designs based on street mileage and passings. Given the size of the City, we were able to develop an extensive sample design.

Figure 22: Map of the Sample Design



Our observations determined that the utilities are primarily aerial in the older portions of the City, and that newer developments are completely underground. We also anticipate that any new subdivisions will likely be constructed underground.

The assumptions, sample designs, and cost estimates were used to extrapolate a cost-per-passing for the OSP infrastructure. This number was then multiplied by the number of passings in each area based on the City's estimation of the population.

The actual cost to construct FTTP to every premises in the City could differ from the estimate due to changes in the assumptions underlying the model. For example, if make-ready and pole replacement costs are too high, the network would have to be constructed underground—which could significantly increase the cost of construction. Alternatively, if the City could partner with a local telecommunications provider and overlash to existing pole attachments, the cost of the build could be significantly lower. Further and more extensive analysis would be required to develop a more accurate cost estimate across the entire City.

6.4.3 OSP Costs

The estimated cost to construct the OSP portion of the proposed FTTP network is approximately $4.8 million, or $1,700 per passing.[57] As discussed above, the model assumes a mixture of aerial and underground fiber construction, depending on the construction of existing utilities in the area as well as the state of any utility poles, existing infrastructure, and construction within the communication space. Table 22 provides a breakdown of the estimated OSP costs. (Note that the costs have been rounded.)

Table 22: Estimated OSP Costs

Distribution Plant Mileage	Total Cost	Passings	Cost per Passing	Cost Per Plant Mile
39.0	$4,770,000	2,800	$1,700	$120,000

6.4.3.1 Aerial and Underground Construction Approach

Costs for aerial and underground placement were estimated using available unit cost data for materials and estimates on the labor costs for placing, pulling, and boring fiber based on construction in comparable markets. The material costs were generally known, with the exception of unknown economies of scale and inflation rates, and barring any sort of phenomenon restricting material availability and costs. The labor costs associated with the placement of fiber were estimated based on similar construction projects.

Aerial construction entails the attachment of fiber infrastructure to existing utility poles, which could offer significant savings compared to all-underground construction, but increases uncertainty around cost and timeline. Costs related to pole remediation and make-ready construction can make aerial construction cost-prohibitive in comparison to underground construction.

[57] The passing count includes individual single-unit buildings and units in small multi-dwelling and multi-business buildings as single passings. It treats larger buildings as single passings.

We assume the installation of strand that the fiber will be lashed to in the communications space on the existing utility poles. Splice cases, subscriber taps, and drops will also be attached to the strand, which facilitates maintenance and customer installation.

While generally allowing for greater control over timelines and more predictable costs, underground construction is subject to uncertainty related to congestion of utilities in the PROW and the prevalence of subsurface hard rock—neither of which can be fully mitigated without physical excavation and/or testing.

While anomalies and unique challenges will arise regardless of the design or construction methodology, the relatively large scale of this project is likely to provide ample opportunity for variations in construction difficulty to yield relatively predictable results on average.

We assume underground construction will consist primarily of horizontal, directional drilling to minimize PROW impact and to provide greater flexibility to navigate around other utilities. The design model assumes a single 2-inch, flexible, High-Density Polyethylene (HDPE) conduit over underground distribution paths, and dual 2-inch conduits over underground backbone paths to provide scalability for future network growth.

6.4.3.2 OSP Cost Components

The cost components for OSP construction include the following tasks:

- ***Engineering*** – includes system level architecture planning, preliminary designs and field walk-outs to determine candidate fiber routing; development of detailed engineering prints and preparation of permit applications; and post-construction "as-built" revisions to engineering design materials. The total cost of OSP engineering is estimated at $600,000.

- ***Quality Control / Quality Assurance*** – includes expert quality assurance field review of final construction for acceptance. The quality control/quality assurance cost is estimated at $330,000.

- ***General OSP Construction*** – consists of all labor and materials related to "typical" underground or aerial OSP construction, including conduit placement, utility pole make-ready construction, aerial strand installation, fiber installation, and surface restoration; includes all work area protection and traffic control measures inherent to all roadway construction activities. General OSP construction is estimated to cost approximately $3.04 million.

- ***Special Crossings*** – consists of specialized engineering, permitting, and incremental construction (material and labor) costs associated with crossings of railroads, bridges, and interstate / controlled access highways. This also includes the necessary costs for levee crossing and encroachments. Special crossings costs are estimated at $70,000.

- ***Backbone and Distribution Plant Splicing*** – includes all labor related to fiber splicing of outdoor fiber optic cables. Backbone and distribution plant splicing is estimated at a cost of approximately $120,000.

- ***Backbone Hub, Termination, and Testing*** – consists of the material and labor costs of placing hub shelters and enclosures, terminating backbone fiber cables within the hubs, and testing backbone cables. The backbone hub, termination, and testing costs are estimated at approximately $600,000.

- ***FTTP Service Drop and Lateral Installations –*** consists of all costs related to fiber service drop installation, including OSP construction on private property, building penetration, and inside plant construction to a typical backbone network service "demarcation" point; also includes all materials and labor related to the termination of fiber cables at the demarcation point. A take-rate of 35 percent was assumed for standard fiber service drops. At a 35 percent take rate, drop costs add approximately $1.58 million to the overall estimated cost.

6.4.4 Central Network Electronics Costs

Central network electronics will cost an estimated $500,000, or $170 per passing, based on an assumed take-rate of 35 percent.[58] (These costs may increase or decrease depending on take rate, and the costs may be phased in as subscribers are added to the network.) The central network electronics consist of the electronics to connect subscribers to the FTTP network at the core and cabinets. Table 23, below, lists the estimated costs for each segment.

Table 23: Estimated Central Network Electronics Costs

Network Segment	Subtotal	Passings	Cost per Passing
Core and Distribution Electronics (Sections 6.4.4.1 and 6.4.4.2)	$300,000	2,800	$100
FTTP Access Electronics (Section 6.4.4.1)	$200,000	2,800	$70
Central Network Electronics Total	**$500,000**	**2,800**	**$170**

[58] The take rate affects the electronics and drop costs, but also may affect other parts of the network, as the City may make different design choices based on the expected take rate. A 35 percent take rate is typical of environments where a new provider joins the telephone and cable provider in a City. In CTC's financial analysis, we will examine how the feasibility of the project depends on a range of take rates.

6.4.4.1 Core Electronics

The core electronics connect the distribution electronics and connect the network to the internet. The core electronics consist of high performance routers, which handle all the routing on both the FTTP network and to the internet. The core routers should have modular chassis to provide high availability in terms of redundant components and the ability to "hot swap" line cards and modular in the event of an outage.[59] Modular routers also provide the ability to expand the routers as demand for additional bandwidth increases.

The cost estimate design envisions running networking protocols, such as hot standby routing protocol (HSRP), to ensure redundancy in the event of a router failure. Additional connections can be added as network bandwidth on the network increases. The core sites would also tie to the distribution electronics using 10 Gbps links. The links to the distribution electronics can also be increased with additional 10 Gbps and 40 Gbps line cards and optics as demand grows on the network. The core networks will also have 10 Gbps to ISPs that connect the FTTP network to the internet.

The cost of the core routing equipment is $225,000. These costs do not include the service provider's OSS, such as provisioning platforms, fault and performance management systems, remote access, and other operational support systems for FTTP operations. The service providers may already have these systems in place.

6.4.4.2 Distribution Electronics

The distribution network electronics aggregate the traffic from the FDCs and send it to the core electronics to access the internet. The distribution electronics consist of high-performance aggregation switches, which consolidate the traffic from the many access electronics and send it to the core for route processing.[60] The distribution switches are typically modular switch chassis that can accommodate line cards for aggregation. The switches should also be modular to provide redundancy in the same manner as the core switches.

The cost estimate assumes that the aggregation switches connect to the access network electronics with 10 Gbps links to each distribution switch. The aggregation switches would then connect to the core switches over single or multiple 10 Gbps links as needed to meet the demand of the FTTP users in each service area.

The cost of the distribution switching equipment is $75,000. These costs do not include any of the service provider's OSS or other management equipment.

[59] A "hot swappable" line card can be removed and reinserted without the entire device being powered down or rebooted. The control cards in the router should maintain all configurations and push them to a replaced line card without the need for reconfirmation.

[60] Given the size of the City, it may be feasible to incorporate the distribution electronics into the core router.

6.4.4.3 Access Electronics

The access network electronics at the FDCs connect the subscribers' CPE to the FTTP network. We recommend deploying access network electronics that can support both GPON and AE subscribers to provide flexibility within the FDC service area. We also recommend deploying modular access network electronics for reliability and the ability to add line cards as more subscribers join in the service area. Modularity also helps reduce initial capital costs while the network is under construction or during the roll out of the network.

The cost of the access network electronics for the network is estimated at approximately $200,000. These costs are based on a take rate of 35 percent and include optical splitters at the FDCs for that take-rate.

6.4.5 Customer Premises Equipment and Service Drop Installation (Per Subscriber Costs)

CPE is the subscriber's interface to the FTTP network. For this cost estimate, we selected CPE that provide only Ethernet data services (however, there are a wide variety of CPE offering other data, voice, and video services). Using the assumed take rate of 35 percent, we estimated the cost for subscriber CPE will be approximately $600,000.

Each activated subscriber would also require a fiber drop cable installation and related electronics, which would cost roughly $2,230 per subscriber, or $15 million total—again, assuming a 35 percent take rate.

The drop installation cost is the biggest variable in the total cost of adding a subscriber. A short aerial drop can cost as little as $250 to install, whereas a long underground drop installation can cost upward of $3,000. We estimate an average of $1,590 per drop installation.

The other per-subscriber expenses include the cost of the optical network terminal (ONT) at the premises, a portion of the OLT costs at the hub, the labor to install and configure the electronics, and the incidental materials needed to perform the installation. The numbers provided in Table 24, below, are averages and will vary depending on the type of premises and the internal wiring available at each premises.

Table 24: Per Subscriber Cost Estimates

Construction and Electronics Required to Activate a Subscriber	Estimated Average Cost
Drop Installation and Materials	$1,590
Subscriber Electronics (ONT and OLT)	240
Electronics Installation	200
Installation Materials	100
Total	**$2,230**

6.5 All Underground Cost Scenario

If the City is unable to negotiate pole attachment agreements or the cost of make ready is prohibitive, the FTTP network may have to be built entirely underground. An all-underground FTTP network increases the cost of the OSP construction and greatly increases the cost to construct drops to each home and business. Table 25 shows the cost of the OSP.

Table 25: OSP Costs for an All-Underground FTTP Network

Distribution Plant Mileage	Total Cost	Passings	Cost per Passing	Cost Per Plant Mile
39.0	$5,410,000	2,800	$1,930	$140,000

The average drop cost of an all-underground FTTP network would be $2,640. This increases the cost of a lit FTTP network to $9.1 million at a take rate of 35 percent.

7 Business Structure and Financial Analysis

This section examines the feasibility of the City operating an FTTP network over a span of 20 years using one of four potential models: Municipal Retail, Open Access, Dark FTTP lease with drops, and Dark FTTP lease without drops. This analysis illuminates necessary pricing—both from customers and potential network operating partners—for the City to operate cash-positive annually.

7.1 Dark Fiber-to-the-Premises Lease Models

In this section, we investigate the feasibility of two potential dark FTTP lease business models. Both are fully FTTP network buildouts, where the City would construct and maintain ubiquitous infrastructure to every residence and business, and lease the fiber backbone and distribution fiber to a private partner. The private partner would be responsible for all network electronics and CPE—as well as network sales, marketing, and operations.

The fundamental difference between the two models concerns drop cables, or the fiber cable which runs from the distribution fiber in the PROW into the member's home or business.

In our first model, presented in Section 7.1.1, the City would be responsible for constructing backbone and distribution fiber up to the PROW, while the private partner would construct the drop cable into the home or business. Because the private partner would fund the last-mile connection, the number of subscribers (and thus the number of drop cables) will not affect the City's financial concerns. As such, fiber lease payments to the City for this model will be based solely on the number of passings in the network.

This model is similar to the agreement between the city of Huntsville, Ala., and Google. We have included reference and comparison to Huntsville's agreement with Google to demonstrate the terms and fees with which another jurisdiction could acquire a private partner.

Our second model, presented in 7.1.2, proposes a scenario where the City would be responsible for constructing and maintaining both distributional fiber and drop cable infrastructure. Because this model presents significant additional costs to the City, the fiber lease fees would have a two-tiered structure—one fee for the number of passings in the network, as well as an additional fee for each subscriber. This subscriber fee helps offset the cost of fiber drops, and only applies to premises where drops have been constructed. Each home and business who wishes to subscribe to the services provided by the partner would need a City-funded drop cable installed, and as such, the financial viability of the model is heavily dependent upon the total subscriber take rate.

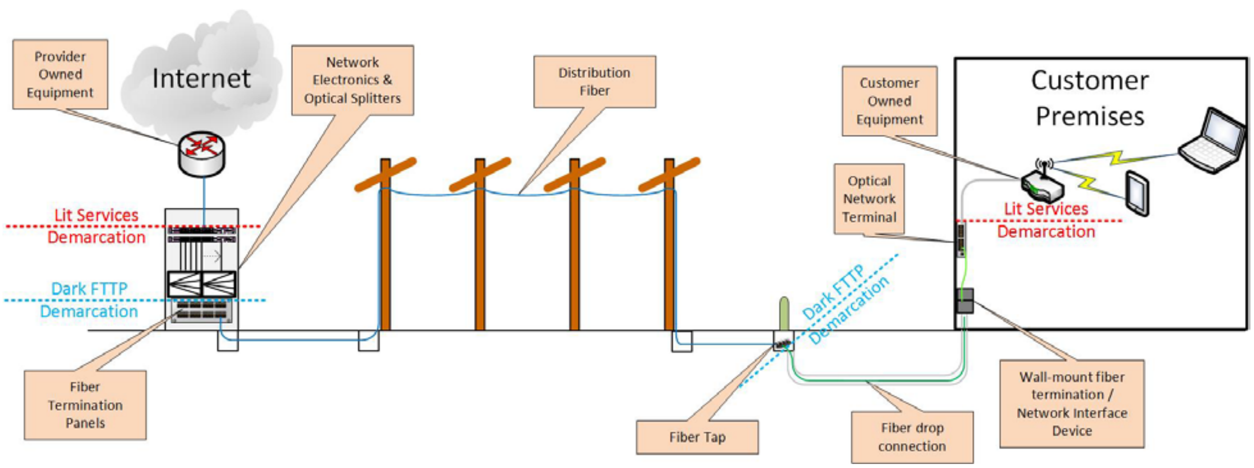
The city of Westminster, Md., and Ting Internet agreed to a similar structure, and we have included discussion of their terms and pricing as an example of the implications of this model.

We have included multiple scenarios for each model to demonstrate potential options the City can consider, as well as illustrate funding and financing concerns. All our models represent the minimum requirements for the City to maintain positive cash flow over the course of 20 years, and in Spring Hill's case, higher partner lease fees than those agreed upon in both Huntsville and Westminster are necessary for the models to cash flow.

7.1.1 Huntsville Model

Our first model assumes that the City constructs and owns network infrastructure throughout the City up to a demarcation point in the PROW, and leases the dark fiber backbone and distribution fiber to a private partner. This demarcation is illustrated in Figure 23.

Figure 23: Demarcation Between City and Partner Network Elements (Huntsville Model)



In this model, the private partner would be responsible for constructing drop cables into each subscriber's home or business; network electronics and CPE; and network sales, marketing, and operations. It should be noted that network electronics and CPE are significant additional expenses for the private partner to consider, and as such, the City should bear them in mind when negotiating pricing with potential partners.

The financial analysis presented here represents a minimum requirement for the City to obtain a break-even cash flow each year. We have provided a complete financial model in Excel format (Appendix C) that can be leveraged to show the impact of changing assumptions. The spreadsheet can be an important tool for the City to use if it negotiates with a private partner.

Please note that we used a "flat model" in the analysis, which means that inflation and operating cost increases (including salaries) are not used because it is assumed that operating cost increases will be offset by increases in operator lease payments over time (and likely passed on to subscribers in the form of increased prices). We anticipate that the City will apply an inflation factor, typically based on a Consumer Price Index (CPI), to the portion of the per-subscriber fee that covers projected operating expenses during negotiations with a private partner.

These financial projections do not include any economic development or other indirect benefits, which are often not easily quantifiable.

In our modeling, we compared a similar FTTP deployment in the city of Huntsville, Ala. In its contract with Google Fiber, Huntsville Utilities negotiated a monthly per-passing fee of $7.50.

We include this reference to demonstrate what pricing is attractive enough to incent partnership, the financial implications of that pricing, as well as what Huntsville pricing would look like in relation to network deployment costs for the City. If the City were to charge similar lease fees as those paid by Google in Huntsville, it will result in cumulative cash deficits of over $12 million after 20 years.

We have included a base case scenario for this model as well as three sensitivity scenarios: the first showing the implications of using Huntsville's pricing, showing the impact of startup funding on both the base case and using Huntsville's pricing.

7.1.1.1 Huntsville Model Base Case

In our base case, we present what would be necessary to maintain positive cash flow given the estimated OSP construction and operating costs. The model assumes a straight-line depreciation of assets, and that the OSP and materials will have a 20-year life span while network test equipment will need to be replaced after five years.

To cover network deployment, operating expenses, and maintain a positive cash flow, the City would need to charge a private partner $27.75 per month per passing, for a total of 2,804 commercial and residential passings. This lease fee is 3.7 times the fee to which Huntsville Utilities and Google Fiber agreed.

As Table 26 shows, though this model will not generate a positive net income until year five, it will operate cash-positive, finishing year one with a cumulative surplus of just under $4,000, year 10 with over $224,000, and almost $357,000 by the end of year 20.

Table 26: Huntsville Model Base Case Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$74,730	$933,730	$933,730	$933,730	$933,730
Total Cash Expenses	(381,540)	(470,190)	(470,190)	(470,190)	(470,190)
Depreciation	(89,840)	(264,550)	(259,530)	(259,530)	(259,530)
Interest Expense	(57,450)	(160,330)	(118,020)	(68,970)	(12,110)
Taxes	-	-	-	-	-
Net Income	$(454,100)	$38,660	$85,990	$135,040	$191,900

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$3,840	$158,920	$224,460	$290,420	$356,660
Depreciation Reserve	-	50,260	73,290	96,190	119,090
Total Cash Balance	$3,840	$209,180	$297,750	$386,610	$475,750

7.1.1.2 Huntsville Model Base Case Financing

This financial analysis assumes that the City will cover its OSP construction costs and additional capital requirements through taking a series of 20-year GO bonds, totaling $5.64 million. After review of the City's recent bonds and outstanding GO debt, we assumed that the City's interest rate would be 3 percent, and that bond issuance costs will be equal to 1.06 percent of the principal borrowed. Principal repayment on the bond will start in the third year after issuance.

Through discussions with the City, we assumed that neither an interest nor debt service reserve will be necessary for the lifetime of the bond. We note that neither dark FTTP models require an operating reserve because we have allocated the equivalent of .25 percent of the total fiber implementation cost for fiber and network maintenance. This is discussed further in Section 7.1.1.4.

The difference between the financed amount and the total capital costs represents the amount needed to maintain positive cash flow in the early years of network deployment. The resulting principal and interest (P&I) payments will be the major factor in determining the City's long-term financial requirements; P&I accounts for roughly 47.5 percent of Spring Hill's annual costs in our base case model after the construction period.

We have included a summarized income statement in Table 27.

Table 27: Huntsville Model Base Case Income Statement

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Revenues					
Per Passing	$74,730	$933,730	$933,730	$933,730	$933,730
Total	$74,730	$933,730	$933,730	$933,730	$933,730
Operating Costs					
Operation Costs	$89,290	$148,190	$148,190	$148,190	$148,190
Labor Costs	292,250	322,000	322,000	322,000	322,000
Total	$381,540	$470,190	$470,190	$470,190	$470,190
EBITDA	$(306,810)	$463,540	$463,540	$463,540	$463,540
Depreciation	89,840	264,550	259,530	259,530	259,530
Operating Income (EBITDA less Depreciation)	$(396,650)	$198,990	$204,010	$204,010	$204,010
Non-Operating Income					
Interest Income	$-	$130	$180	$240	$300
Interest Expense (20-Year Bond)	(57,450)	(160,460)	(118,200)	(69,210)	(12,410)
Total	$(57,450)	$(160,330)	$(118,020)	$(68,970)	$(12,110)
Net Income (before taxes)	$(454,100)	$38,660	$85,990	$135,040	$191,900
Facility Taxes	$ -	$ -	$ -	$ -	$ -
Net Income	$(454,100)	$38,660	$85,990	$135,040	$191,900

This base case results in a negative net income in the network's initial years. By year five, the City's net income will total just over $38,600, growing to just under $86,000 in year 10, and just under $192,000 in year 20.

We have included a summarized cash flow statement in Table 28.

Table 28: Huntsville Model Base Case Cash Flow Statement

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	$(454,100)	$38,660	$85,990	$135,040	$191,900
Cash Outflows					
Debt Service Reserve	$ -	$ -	$ -	$ -	$ -
Interest Reserve	-	-	-	-	-
Depreciation Reserve	-	(25,130)	(24,660)	(24,660)	(24,660)
Financing	(20,200)	-	-	-	-
Capital Expenditures	(1,526,700)	-	-	-	-
Total	$(1,546,900)	$(25,130)	$(24,660)	$(24,660)	$(24,660)
Cash Inflows					
20-Year Bond Proceeds	$1,915,000	$ -	$ -	$ -	$ -
Total	$1,915,000	$ -	$ -	$ -	$ -
Total Cash Outflows and Inflows	$368,100	$(25,130)	$(24,660)	$(24,660)	$(24,660)
Non-Cash Expenses - Depreciation	$89,840	$264,550	$259,530	$259,530	$259,530
Adjustments					
Proceeds from Additional Cash Flows (20-year Bond)	$(1,915,000)	$-	$-	$-	$-
Adjusted Available Net Revenue	$(1,911,160)	$278,080	$320,860	$369,910	$426,770
Principal Payments on Debt					
20 Year Bond Principal	$ -	$265,360	$307,620	$356,610	$413,410
Total	$-	$265,360	$307,620	$356,610	$413,410
Net Cash	$3,840	$12,720	$13,240	$13,300	$13,360
Cash Balance					
Unrestricted Cash Balance	$3,840	$158,920	$224,460	$290,420	$356,660
Depreciation Reserve	-	50,260	73,290	96,190	119,090
Total Cash Balance	$3,840	$209,180	$297,750	$386,610	$475,750

In this base case, the City will finish year one with an unrestricted cumulative cash balance of under $4,000, which will increase to over $224,400 by the end of year 10, and grow to just under $356,700 by the end of year 20.

7.1.1.3 Huntsville Model Base Case Capital Additions

Significant network expenses—known as "capital additions"—are incurred in the first few years during the construction phase of the network. These represent the equipment and labor expenses associated with building a fiber network. Again, because the City's responsibility will be limited to OSP, we have not included any costs for fiber drops, or core network equipment.

This analysis projects that the capital additions (including vehicles and test equipment) in year one will total approximately $1.5 million. These costs will total approximately $2.4 million in year two, and roughly $957,800 in year three. This totals roughly $4.9 million in capital additions for years one through three.

These costs are illustrated in Table 29.

Table 29: Huntsville Model Base Case Capital Additions

Capital Additions	Year 1	Year 2	Year 3
Outside Plant and Facilities			
Total Backbone and FTTP	$1,436,700	$2,394,500	$957,800
Additional Annual Capital	-	-	-
Total	$1,436,700	$2,394,500	$957,800
Miscellaneous Implementation Costs			
Vehicles	$35,000	$35,000	$ -
Work Station, Computers, and Software	5,000	500	-
Fiber OTDR and Other Tools	50,000	-	-
Additional Annual Capital	-	-	-
Total	$90,000	$35,500	$ -
Total Annual Capital Additions	$1,526,700	$2,430,000	$957,800

Please see Appendix C for a complete income statement, cash flow statement, and capital addition statement.

7.1.1.4 Huntsville Model Operating and Maintenance Expenses

The cost to deploy a dark FTTP network goes far beyond fiber implementation. Network deployment requires sales and marketing, network maintenance and technical operations, and other functions. In this model, we assume that the City's partner will be responsible for lighting the fiber and selling service. Given this, Spring Hill's financial requirements are limited to expenses related to OSP infrastructure and network administration.

These expanded responsibilities will require the addition of new staff. We assume the City will add a total of 2.75 full-time-equivalent (FTE) positions within the first two years, and will then maintain that level of staffing. Our assumptions include:

- 0.25 FTE business manager and HR position
- 0.5 FTE GIS & record keeping position

- 1 FTE service technicians/installers and IT support position
- 1 FTE fiber plant operating & maintenance technician

Training new and existing staff is important to fully realize the economies of starting the dark FTTP network. The training will be particularly important in the short-term as the new enterprise establishes itself as a unique entity providing services distinct from City services provided today. We estimate education and training at 2 percent of direct payroll expenses.

Salaries and benefits are based on estimated market wages, and benefits are estimated at 40 percent of base salary. Salaries (including benefits) are summarized in Table 30.

Table 30: Huntsville Model Base Case Labor Expenses

New Employees	Year 1	Year 2	Year 3+	Labor Cost
Business Manager & HR (allocation)	0.25	0.25	0.25	130,000
GIS & Record Keeping	0.25	0.50	0.50	85,000
Service Technicians/Installers & IT Support	1.00	1.00	1.00	75,000
Fiber Plant O&M Technicians	1.00	1.00	1.00	80,000
Total New Staff	2.50	2.75	2.75	

Additional key operating and maintenance assumptions include the following:

- Insurance is estimated to be $25,000 in year one and $50,000 from year two on
- Utilities are estimated to be $600 in year one and $1,200 from year two on
- Office expenses are estimated to be $1,500 in year one and $3,000 from year two on
- Locates and ticket processing are estimated to be $1,800 in year one, increase to $8,800 in year two, and increase further to $17,600 from year three on
- Contingency is estimated to be $7,500 in year one and $15,000 from year two on
- Legal fees are estimated to be $20,000 in year one, and $10,000 from year two on
- Consulting fees are estimated at $20,000 in year one, and $10,000 from year two on
- Pole attachment expenses are estimated at just under $3,500 in year one, roughly $12,600 in year two, almost $20,700 in year three, and just under $23,000 in year four on

Fiber and network maintenance costs are calculated at 0.25 percent of the total construction cost per year. This is estimated based on a typical rate of occurrence in the City's environment, and the cost of individual repairs. These costs will total almost $3,600 in year one, almost $9,600 in year two, and just under $12,000 in year three on. This is in addition to staffing costs to maintain the fiber.

These expenses, as well as principal and interest payments, are shown in Table 31.

Table 31: Huntsville Model Base Case Operating and Maintenance Expenses

Operating Expenses & P&I	Year 1	Year 5	Year 10	Year 15	Year 20
Insurance	$25,000	$50,000	$50,000	$50,000	$50,000
Utilities	600	1,200	1,200	1,200	1,200
Office Expenses	1,500	3,000	3,000	3,000	3,000
Locates & Ticket Processing	1,800	17,600	17,600	17,600	17,600
Contingency	7,500	15,000	15,000	15,000	15,000
Fiber & Network Maintenance	3,590	11,970	11,970	11,970	11,970
Legal	20,000	10,000	10,000	10,000	10,000
Consulting	20,000	10,000	10,000	10,000	10,000
Education and Training	5,850	6,440	6,440	6,440	6,440
Pole Attachment Expense	3,450	22,980	22,980	22,980	22,980
Sub-Total	$89,290	$148,190	$148,190	$148,190	$148,190
Labor Expenses	$292,250	$322,000	$322,000	$322,000	$322,000
Sub-Total	$292,250	$322,000	$322,000	$322,000	$322,000
Total Expenses	$381,540	$470,190	$470,190	$470,190	$470,190
Principal and Interest	$57,450	$425,690	$425,640	$425,580	$425,520
Facility Taxes	-	-	-	-	-
Sub-Total	$57,450	$425,690	$425,690	$425,690	$425,690
Total Expenses, P&I, and Taxes	$438,990	$895,880	$895,830	$895,770	$895,710

The City's total operating and maintenance expenses, including principal and interest payments, will equal almost $439,000 in year one, and grow to roughly $895,800 in years five through 20.

7.1.1.5 Huntsville Model Sensitivity Scenarios

In this section, we look at changing key assumptions from our base case, and show the implications of those changes. In scenario two, we show the deficit that would be generated by the City charging the same fees that Huntsville has agreed upon with Google. In scenario three, we show the impact of adding $5 million in startup funding while using Huntsville fees. Finally, scenario four shows the reduction in necessary partner lease fees if the City could procure $5 million in startup funding.

7.1.1.5.1 Huntsville Model Scenario 2: Use Huntsville Fees

If the City were to charge its partner the same fees agreed upon in Huntsville ($7.50 per passing per month) and all other assumptions were to remain the same, the model would prove unfeasible. The City's net income would remain negative throughout, and the model would generate a cumulative deficit of over $12 million by the end of year 20, as shown in Table 32.

Table 32: Huntsville Model Scenario 2 Financial Summary – Use Huntsville Lease Fees

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$20,200	$252,360	$252,360	$252,360	$252,360
Total Cash Expenses	(381,540)	(470,190)	(470,190)	(470,190)	(470,190)
Depreciation	(89,840)	(264,550)	(259,530)	(259,530)	(259,530)
Interest Expense	(57,450)	(160,330)	(118,020)	(68,970)	(12,110)
Taxes	-	-	-	-	-
Net Income	$(508,630)	$(642,710)	$(595,380)	$(546,330)	$(489,470)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$(50,690)	$(2,053,050)	$(5,394,360)	$(8,735,250)	$(12,075,860)
Depreciation Reserve	-	50,260	73,290	96,190	119,090
Total Cash Balance	$(50,690)	$(2,002,790)	$(5,321,070)	$(8,639,060)	$(11,956,770)

7.1.1.5.2 Huntsville Model Scenario 3: Use Huntsville Fees with $5 Million Grant

If the City were able to procure $5 million in grant or other funding that would not need to be repaid, it would still not be able to charge the same fees as Huntsville. In this case, the increased startup funding lowers the necessary bond to $1 million, while all other assumptions remain the same. Similar to Scenario 2, the City's net income would be negative throughout the life of the model, and would generate a cumulative deficit of well over $5.2 million by the end of year 20. Table 33 shows a financial summary for this model.

Table 33: Huntsville Model Scenario 3 Financial Summary – Use Huntsville Lease Fees with $5 Million Grant

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$20,200	$252,360	$252,360	$252,360	$252,360
Total Cash Expenses	(381,540)	(470,190)	(470,190)	(470,190)	(470,190)
Depreciation	(89,840)	(264,550)	(259,530)	(259,530)	(259,530)
Interest Expense	-	(29,870)	(21,920)	(12,700)	(2,020)
Taxes	-	-	-	-	-
Net Income	$(451,180)	$(512,250)	$(499,280)	$(490,060)	$(479,380)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$3,111,960	$(533,990)	$(2,144,250)	$(3,754,090)	$(5,363,650)
Depreciation Reserve	-	50,260	73,290	96,190	119,090
Total Cash Balance	$3,111,960	$(483,730)	$(2,070,960)	$(3,657,900)	$(5,244,560)

7.1.1.5.3 Huntsville Model Scenario 4: $5 Million Grant

If the City were able to procure $5 million in grant or other funding that would not need to be repaid, provided all other assumptions remain the same, the network could cash flow provided the partner paid the City $16.13 per passing per month. This fee is 2.15 times the fee charged by Huntsville. As shown in Table 34, though the City's net income would remain negative throughout, the enterprise's surplus would total over $3.1 million at the end of year one, almost $50,200 by the end of year 10, and just under $83,200 by the end of year 20.

Table 34: Huntsville Model Scenario 4 Financial Summary – $5 Million Grant

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$43,420	$542,570	$542,570	$542,570	$542,570
Total Cash Expenses	(381,540)	(470,190)	(470,190)	(470,190)	(470,190)
Depreciation	(89,840)	(264,550)	(259,530)	(259,530)	(259,530)
Interest Expense	-	(16,670)	(12,200)	(7,010)	(1,000)
Taxes	-	-	-	-	-
Net Income	$(427,960)	$(208,840)	$(199,350)	$(194,160)	$(188,150)

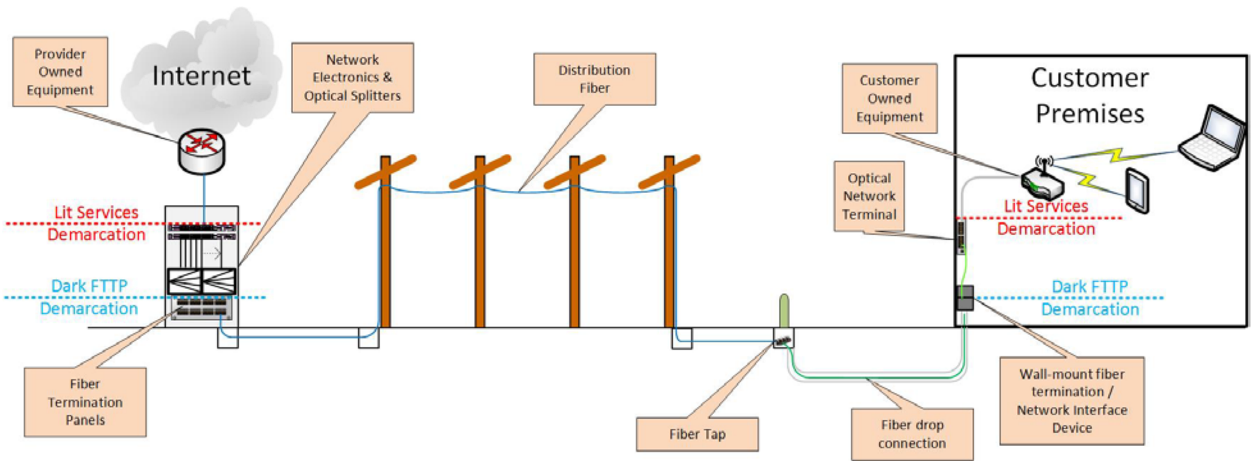
Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$3,135,180	$34,250	$50,190	$66,550	$83,190
Depreciation Reserve	-	50,260	73,290	96,190	119,090
Total Cash Balance	$3,135,180	$84,510	$123,480	$162,740	$202,280

7.1.2 Westminster Model

Our second dark FTTP lease model assumes that the City constructs and owns network infrastructure throughout the entirety of the City up to a demarcation point in the network subscriber's home or business, and leases the dark fiber backbone, distribution fiber, and fiber drops to a private partner. The private partner would be responsible for all network electronics and CPE, as well as network sales, marketing, and operations.

This demarcation is illustrated in Figure 24.

Figure 24: Demarcation Between City and Partner Network Elements (Westminster Model)



Network electronics and CPE are significant additional expenses for the private partner to consider, and as such, the City should bear them in mind when negotiating pricing with potential partners.

The financial analysis presented here represents a minimum requirement for the City to cash flow each year, excluding any potential revenue from other dark fiber lease opportunities that may be available to it. We have provided a complete financial model in Excel format that can be leveraged to show the impact of changing assumptions. The spreadsheet can be an important tool for the City to use if it negotiates with a private partner.

Please note that we used a "flat model" in the analysis, which means that inflation and operating cost increases (including salaries) are not used because it is assumed that operating cost increases will be offset by increases in operator lease payments over time (and likely passed on to subscribers in the form of increased prices). We anticipate that the City will apply an inflation factor, typically based on a Consumer Price Index (CPI), to the portion of the per-subscriber fee that covers projected operating expenses during negotiations with a private partner.

These financial projections do not include any economic development or other indirect benefits, which are often not easily quantifiable.

In our modeling, we compared a similar dark FTTP deployment in the city of Westminster, Maryland. In their contract with Ting Internet, the city negotiated a per-passing fee ($6) plus per-subscriber fee ($17) per month for dark FTTP usage. That is, Ting pays the city for every premises the network passes, plus an additional fee for every subscriber receiving service over the network, totaling $6 per non-subscribed passing and $23 per subscribed passing. As such, the take rate is vitally important to the feasibility of the project.

We include this reference to demonstrate what pricing is attractive enough to incent partnership, the financial implications of that pricing, as well as what Westminster pricing would look like in relation to network deployment costs for the City. In all models, the required per-passing and per-subscriber fees are higher than Westminster's partnership, while charging similar lease fees paid by Ting in Westminster, Maryland will result in a cumulative cash deficit of over $11.5 million after 20 years.

In addition to our base case which projects what fees are necessary to maintain a positive cash flow each year, we have summarized four alternate scenarios, which demonstrates the implications of the City charging the same fees as Westminster, changing the network take rate, and obtaining startup funding that does not need to be repaid.

7.1.2.1 Westminster Model Base Case

For our base case scenario, we present what would be necessary to maintain positive cash flow given the estimated OSP construction and operating costs. In this base case model, we assume the private partner can obtain and maintain a 35 percent take rate.[61]

Using our construction cost estimate from Section 6, we estimate each drop to cost an average of $1,592. If 35 percent of the City's 2,804 passings were to subscribe (roughly 980 subscribers), drop cost construction would total just under $1.6 million.

Though the City will be responsible for funding and constructing the drops, these costs are offset by the per-subscriber lease fees that are the responsibility of the private partner.

To maintain positive cash flow with this model, assuming the private partner can obtain and maintain a 35 percent take rate, the City would need to charge the partner $15.60 per passing and an additional $44.20 per subscriber. These are 2.6 times the fees the city of Westminster could obtain in its agreement with Ting Internet.

We have included a summarized income and cash flow statement for this model in Table 35.

[61] Most overbuilders typically obtain at least a 35 percent take rate when entering a new market.

Table 35: Westminster Model Base Case Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$68,530	$1,045,760	$1,045,760	$1,045,760	$1,045,760
Total Cash Expenses	(381,740)	(474,100)	(474,100)	(474,100)	(474,100)
Depreciation	(93,820)	(342,720)	(337,700)	(337,700)	(337,700)
Interest Expense	(60,300)	(201,350)	(148,220)	(86,630)	(15,250)
Taxes	-	-	-	-	-
Net Income	$(467,330)	$27,590	$85,740	$147,330	$218,710

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$8,990	$12,430	$71,080	$130,170	$189,590
Depreciation Reserve	-	51,400	77,750	104,000	130,250
Total Cash Balance	$8,990	$63,830	$148,830	$234,170	$319,840

While this model will not generate a positive net income in its initial years, by year five, the City's net income will total almost $27,600, and grow to just over $218,700 in year 20. The City's cumulative surplus will total almost $9,000 at the end of year one, growing to just over $71,000 by the end of year 10, and roughly $189,600 by the end of year 20.

7.1.2.2 Westminster Model Base Case Financing

This financial analysis assumes that the City will cover its OSP construction costs and additional capital requirements through taking a series of 20-year GO bonds, totaling just under $7.04 million. After review of the City's recent bonds and outstanding GO debt, we assumed that the City's interest rate would be 3 percent, and that bond issuance costs will be equal to 1.06 percent of the principal borrowed. Principal repayment on the bond will start in the third year after issuance.

Through discussions with the City, we assumed that neither an interest nor debt service reserve will be necessary for the lifetime of the bond. We note that neither dark FTTP models require an operating reserve because we have allocated the equivalent of .25 percent of the total fiber implementation cost for fiber and network maintenance. This is discussed further in Section 7.1.2.4.

The difference between the financed amount and the total capital costs represents the amount needed to maintain positive cash flow in the early years of network deployment. The resulting principal and interest (P&I) payments will be the major factor in determining the City's long-term financial requirements; P&I accounts for roughly 53 percent of Spring Hill's annual costs in our base case model after the construction period.

We have included a summarized income statement in Table 36.

Table 36: Westminster Model Base Case Income Statement

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
a. Revenues					
Per Passing	$42,010	$524,910	$524,910	$524,910	$524,910
Per Subscriber	26,520	520,850	520,850	520,850	520,850
Total	$68,530	$1,045,760	$1,045,760	$1,045,760	$1,045,760
c. Operating Costs					
Operation Costs	$89,490	$152,100	$152,100	$152,100	$152,100
Labor Costs	292,250	322,000	322,000	322,000	322,000
Total	$381,740	$474,100	$474,100	$474,100	$474,100
d. EBITDA	$(313,210)	$571,660	$571,660	$571,660	$571,660
e. Depreciation	93,820	342,720	337,700	337,700	337,700
f. Operating Income (EBITDA less Depreciation)	$(407,030)	$228,940	$233,960	$233,960	$233,960
g. Non-Operating Income					
Interest Income	$-	$130	$190	$260	$330
Interest Expense (20-Year Bond)	(60,300)	(201,480)	(148,410)	(86,890)	(15,580)
Total	$(60,300)	$(201,350)	$(148,220)	$(86,630)	$(15,250)
h. Net Income (before taxes)	$(467,330)	$27,590	$85,740	$147,330	$218,710
i. Facility Taxes	$-	$-	$-	$-	$-
j. Net Income	$(467,330)	$27,590	$85,740	$147,330	$218,710

This base case results in a negative net income of over $467,300 in year one, which will increase to a positive net income of over $85,700 in year 10, and increase further to just over $218,700 in year 20.

We have included a summarized cash flow statement in Table 37.

Table 37: Westminster Model Base Case Cash Flow Statement

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	$(467,330)	$27,590	$85,740	$147,330	$218,710
Cash Outflows					
Depreciation Reserve	$ -	$(25,700)	$(25,330)	$(25,330)	$(25,330)
Financing	(21,200)	-	-	-	-
Capital Expenditures	(1,606,300)	-	-	-	-
Total	$(1,627,500)	$(25,700)	$(25,330)	$(25,330)	$(25,330)
Cash Inflows					
Startup Funds	$2,010,000	$-	$-	$-	$-
Total	$2,010,000	$-	$-	$-	$-
Total Cash Outflows and Inflows	$382,500	$(25,700)	$(25,330)	$(25,330)	$(25,330)
Non-Cash Expenses - Depreciation	$93,820	$342,720	$337,700	$337,700	$337,700
Adjustments					
Proceeds from Additional Cash Flows (20-year Bond)	$(2,010,000)	$ -	$ -	$ -	$ -
Adjusted Available Net Revenue	$(2,001,010)	$344,610	$398,110	$459,700	$531,080
Principal Payments on Debt					
20-Year Bond Principal	$-	$333,180	$386,250	$447,770	$519,080
Total	$-	$333,180	$386,250	$447,770	$519,080
Net Cash	$8,990	$11,430	$11,860	$11,930	$12,000
Cash Balance					
Unrestricted Cash Balance	$8,990	$12,430	$71,080	$130,170	$189,590
Depreciation Reserve	-	51,400	77,750	104,000	130,250
Total Cash Balance	$8,990	$63,830	$148,830	$234,170	$319,840

In this base case, the City will finish year one with a surplus of almost $9,000, which will increase to over $71,000 by the end of year 10, and continue to grow to just under $189,600 by the end of year 20.

7.1.2.3 Westminster Model Base Case Capital Additions

Significant network expenses—known as "capital additions"—are incurred in the first few years during the construction phase of the network. These represent the equipment and labor expenses associated with building a fiber network. (Again, because the City's responsibility will be limited to OSP, we have not included any costs for fiber drops, or core network equipment.)

This analysis projects that the capital additions (including vehicles and test equipment) in year one will total approximately $1.6 million. These costs will total approximately $2.8 million in year two, $1.7 million in year three, and roughly $390,000 in year four. This totals just under $6.5 million in capital additions for years one through four.

These costs are illustrated in Table 38.

Table 38: Westminster Model Base Case Capital Additions

Capital Additions		Year 1	Year 2	Year 3	Year 4
Outside Plant and Facilities					
Total Backbone and FTTP		$1,436,700	$2,394,500	$957,800	$ -
	Total	$1,436,700	$2,394,500	$957,800	$ -
Last Mile and CPE					
Average Drop Cost		$79,600	$390,000	$703,700	$390,000
	Total	$79,600	$390,000	$703,700	$390,000
Miscellaneous Implementation Costs					
Vehicles		$35,000	$35,000	$ -	$ -
Work Station, Computers, and Software		5,000	500	-	-
Fiber OTDR and Other Tools		50,000	-	-	-
Additional Annual Capital		-	-	-	-
	Total	$90,000	$35,500	$-	$-
Total Annual Capital Additions		$1,606,300	$2,820,000	$1,661,500	$390,000

Please see Appendix D for a complete income statement, cash flow statement, and capital addition statement.

7.1.2.4 Westminster Model Base Case Operating and Maintenance Expenses

The cost to deploy a dark FTTP network goes far beyond fiber implementation. Network deployment requires sales and marketing, network maintenance and technical operations, and other functions. In this model, we assume that the City's partner will be responsible for lighting the fiber and selling service. As such, the City's financial requirements are limited to expenses related to OSP infrastructure (including drops) and network administration.

The model assumes a straight-line depreciation of assets, and that the OSP and materials will have a 20-year life span while network test equipment will need to be replaced after five years.

These expanded responsibilities will require the addition of new staff. We assume the City will add a total of 2.75 full-time-equivalent (FTE) positions within the first two years, and will then maintain that level of staffing. Our assumptions include:

- 0.25 FTE business manager & HR position
- 0.5 FTE GIS & record keeping position
- 1 FTE service technicians/installers and support position
- 1 FTE fiber plant operating & maintenance technician

Salaries and benefits are based on estimated market wages, and benefits are estimated at 40 percent of base salary. Salaries (including benefits) are summarized in Table 39.

Table 39: Westminster Model Base Case Labor Expenses

New Employees	Year 1	Year 2	Year 3+	Labor Cost
Business Manager & HR (allocation)	0.25	0.25	0.25	130,000
GIS & Record Keeping	0.25	0.50	0.50	85,000
Customer Service and Sales	1.00	1.00	1.00	75,000
Fiber Plant O&M Technicians	1.00	1.00	1.00	80,000
Total New Staff	2.50	2.75	2.75	

Additional key operating and maintenance assumptions include the following:

- Insurance is estimated to be $25,000 in year one and $50,000 from year two on
- Utilities are estimated to be $600 in year one and $1,200 from year two on
- Office expenses are estimated to be $1,500 in year one and $3,000 from year two on
- Locates and ticket processing are estimated to be $1,800 in year one, increase to $8,800 in year two, and increase further to $17,600 from year three on
- Contingency is estimated to be $7,500 in year one and $15,000 from year two on
- Legal fees are estimated to be $20,000 in year one, and $10,000 from year two on
- Consulting fees are estimated at $20,000 in year one, and $10,000 from year two on
- Pole attachment expenses are estimated at just under $3,500 in year one, roughly $12,600 in year two, almost $20,700 in year three, and just under $23,000 in year four on

Fiber and network maintenance costs are calculated at 0.25 percent of the total construction cost per year. This is estimated based on a typical rate of occurrence in the City's environment, and the cost of individual repairs. These costs will total almost $3,800 in year one, almost $10,800 in year two, and just under $15,000 in year three on. This is in addition to staffing costs to maintain the fiber.

These expenses, as well as principal and interest payments, are shown in Table 40.

Table 40: Westminster Model Base Case Operating and Maintenance Expenses

Operating Expenses & P&I	Year 1	Year 5	Year 10	Year 15	Year 20
Insurance	$25,000	$50,000	$50,000	$50,000	$50,000
Utilities	600	1,200	1,200	1,200	1,200
Office Expenses	1,500	3,000	3,000	3,000	3,000
Locates & Ticket Processing	1,800	17,600	17,600	17,600	17,600
Contingency	7,500	15,000	15,000	15,000	15,000
Fiber & Network Maintenance	3,790	15,880	15,880	15,880	15,880
Legal	20,000	10,000	10,000	10,000	10,000
Consulting	20,000	10,000	10,000	10,000	10,000
Education and Training	5,850	6,440	6,440	6,440	6,440
Pole Attachment Expense	3,450	22,980	22,980	22,980	22,980
Sub-Total	$89,490	$152,100	$152,100	$152,100	$152,100
Labor Expenses	$292,250	$322,000	$322,000	$322,000	$322,000
Sub-Total	$292,250	$322,000	$322,000	$322,000	$322,000
Total Expenses	$381,740	$474,100	$474,100	$474,100	$474,100
Principal and Interest	$60,300	$534,530	$534,470	$534,400	$534,330
Facility Taxes	-	-	-	-	-
Sub-Total	$60,300	$534,530	$534,470	$534,400	$534,330
Total Expenses, P&I, and Taxes	$442,040	$1,008,630	$1,008,570	$1,008,500	$1,008,430

The City's total operating and maintenance expenses, including principal and interest payments, will equal just over $442,000 in year one, and grow to approximately $1 million in years five through 20.

7.1.2.5 Westminster Model Sensitivity Scenarios

In this section, we look at changing key assumptions—including partner fees, take rate, and startup funding—from our base case, and show the implications of those changes.

7.1.2.5.1 Westminster Model Scenario 2: Use Westminster Fees

If the City were to charge its partner the same fees agreed upon in Westminster ($6 per passing per month and an additional $17 per subscriber per month) and all other assumptions were to remain the same, the model would prove unfeasible. The City's net income would remain negative throughout, and the model would generate a cumulative deficit of over $11.5 million by the end of year 20, as shown in Table 41.

Table 41: Westminster Model Scenario 2 Financial Summary – Use Westminster Lease Fees

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$26,360	$402,220	$402,220	$402,220	$402,220
Total Cash Expenses	(381,740)	(474,100)	(474,100)	(474,100)	(474,100)
Depreciation	(93,820)	(342,720)	(337,700)	(337,700)	(337,700)
Interest Expense	(60,300)	(201,350)	(148,220)	(86,630)	(15,250)
Taxes	-	-	-	-	-
Net Income	$(509,500)	$(615,950)	$(557,800)	$(496,210)	$(424,830)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$(33,180)	$(2,030,400)	$(5,189,450)	$(8,348,060)	$(11,506,340)
Depreciation Reserve	-	51,400	77,750	104,000	130,250
Total Cash Balance	$(33,180)	$(1,979,000)	$(5,111,700)	$(8,244,060)	$(11,376,090)

7.1.2.5.2 Westminster Model Scenario 3: Use Westminster Fees and Increase Take Rate to 100 Percent

Even if the entirety of the City's passings were to subscribe to services, the fees agreed upon in Westminster are too low to sustain the network. In this scenario, we have increased the take rate to 100 percent, which necessitates a total bond of just over $10 million, while all other assumptions remain the same. As shown in Table 42, the City's net income would remain negative throughout, and the model will generate a deficit of over $9 million by the end of year 20.

Table 42: Westminster Model Scenario 3 Financial Summary – Use Westminster Lease Fees and Increase Take Rate to 100 Percent

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$44,920	$773,910	$773,910	$773,910	$773,910
Total Cash Expenses	(382,100)	(481,350)	(481,350)	(481,350)	(481,350)
Depreciation	(101,060)	(487,750)	(482,730)	(482,730)	(482,730)
Interest Expense	(63,300)	(290,070)	(214,340)	(125,120)	(21,740)
Taxes	-	-	-	-	-
Net Income	$(501,540)	$(485,260)	$(404,510)	$(315,290)	$(211,910)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$(63,980)	$(1,274,400)	$(3,859,540)	$(6,443,530)	$(9,026,510)
Depreciation Reserve	-	73,160	153,870	234,470	315,070
Total Cash Balance	$(63,980)	$(1,201,240)	$(3,705,670)	$(6,209,060)	$(8,711,440)

7.1.2.5.3 Westminster Model Scenario 4: Use Westminster Fees and Obtain $5 Million Grant

Similar to Scenarios 2 and 3, if the City were to obtain $5 million in startup funding from grants, cash on hand, or another source that does not need to be repaid, the fees agreed upon in Westminster still would not cash flow the network at a 35 percent take rate. The increased startup funding in the scenario would enable the City to bond just over $2 million, while other assumptions remain the same. As shown in Table 43, the City's net income would be negative throughout, and the network would generate a deficit of roughly $4.7 million by the end of year 20.

Table 43: Westminster Model Scenario 4 Financial Summary – Use Westminster Lease Fees and Obtain $5 Million Grant

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$26,360	$402,220	$402,220	$402,220	$402,220
Total Cash Expenses	(381,740)	(474,100)	(474,100)	(474,100)	(474,100)
Depreciation	(93,820)	(342,720)	(337,700)	(337,700)	(337,700)
Interest Expense	-	(59,890)	(44,030)	(25,630)	(4,310)
Taxes	-	-	-	-	-
Net Income	$(449,200)	$(474,490)	$(453,610)	$(435,210)	$(413,890)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$3,038,320	$(809,090)	$(2,091,290)	$(3,373,050)	$(4,654,480)
Depreciation Reserve	-	51,400	77,750	104,000	130,250
Total Cash Balance	$3,038,320	$(757,690)	$(2,013,540)	$(3,269,050)	$(4,524,230)

7.1.2.5.4 Westminster Model Scenario 5: Obtain $5 Million Grant and Increase Lease Fees

If the City were to obtain a $ 5 million grant and charge 1.65 times Westminster fees, or $9.90 per passing and an additional $28.05 per subscriber, the network would cash flow. In this scenario, the City would need to bond just over $2 million, and all other assumptions remain the same as our base case. As shown in Table 44, though the City's net income would remain negative throughout, the City's would finish year one with a surplus just over $3 million, end year 10 with a surplus just over $45,800, and finish year 20 with a surplus just over $97,000.

Table 44: Westminster Model Scenario 5 Financial Summary – Obtain $5 Million Grant and Increase Lease Fees

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$43,490	$663,660	$663,660	$663,660	$663,660
Total Cash Expenses	(381,740)	(474,100)	(474,100)	(474,100)	(474,100)
Depreciation	(93,820)	(342,720)	(337,700)	(337,700)	(337,700)
Interest Expense	-	(59,890)	(44,030)	(25,630)	(4,310)
Taxes	-	-	-	-	-
Net Income	$(432,070)	$(213,050)	$(192,170)	$(173,770)	$(152,450)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$3,055,450	$20,810	$45,810	$71,250	$97,020
Depreciation Reserve	-	51,400	77,750	104,000	130,250
Total Cash Balance	$3,055,450	$72,210	$123,560	$175,250	$227,270

7.1.2.5.5 Westminster Scenario 6: 53 Percent Take Rate

If the network were able to obtain and maintain a 53 percent take rate, the City would need to increase the amount financed to $7.79 million to account for additional fiber drops from our base case. Provided all other assumptions remain the same, the City would need to charge the partner $13.20 per passing per month and $37.40 per subscriber per month. These fees are 2.2 times the fees the city of Westminster agreed upon with Ting.

As shown in Table 45, this model would generate a negative net income in year one that would recover to a net income of just over $28,800 in year five. The City's net income would continue to increase, totaling over $92,400 in year 10 and just over $240,600 in year 20. The model will cash flow, finishing year one with a surplus of just over $8,000. This surplus would grow to over $102,800 by the end of year 10, and almost $220,200 by the end of year 20.

Table 45: Westminster Model Scenario 6 Financial Summary – Obtain 53 Percent Take Rate

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$69,200	$1,111,520	$1,111,520	$1,111,520	$1,111,520
Total Cash Expenses	(381,840)	(476,110)	(476,110)	(476,110)	(476,110)
Depreciation	(95,810)	(382,920)	(377,900)	(377,900)	(377,900)
Interest Expense	(61,500)	(223,650)	(165,080)	(96,450)	(16,890)
Taxes	-	-	-	-	-
Net Income	$(469,950)	$28,840	$92,430	$161,060	$240,620

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$8,060	$45,040	$102,830	$161,250	$220,170
Depreciation Reserve	-	57,440	98,850	140,150	181,450
Total Cash Balance	$8,060	$102,480	$201,680	$301,400	$401,620

7.1.2.5.6 Westminster Model Scenario 7: 67 Percent Take Rate

Following the trend set in Scenario 6, if the network were able to obtain and maintain a 67 percent take rate, the City would need to increase its financed amount to $8.36 million. Provided all other assumptions remain the same, the necessary monthly fees the City would need to charge the partner would decrease to $11.80 per passing and $33.66 per subscriber. These fees are 1.98 times the fees agreed upon in the partnership between Ting and Westminster.

As shown in Table 46, the City would finish year five with a net income of almost $26,500, growing to nearly $253,900 in year 20. The City's surplus at the end of year one would total over $6,100, growing to almost $88,600 by the end of year 10, and roughly $185,600 by the end of year 20.

Table 46: Westminster Model Scenario 7 Financial Summary – Obtain 67 Percent Take Rate

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$70,360	$1,158,710	$1,158,710	$1,158,710	$1,158,710
Total Cash Expenses	(381,920)	(477,670)	(477,670)	(477,670)	(477,670)
Depreciation	(97,400)	(414,110)	(409,090)	(409,090)	(409,090)
Interest Expense	(62,400)	(240,450)	(177,640)	(103,760)	(18,120)
Taxes	-	-	-	-	-
Net Income	$(471,360)	$26,480	$94,310	$168,190	$253,830

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$6,140	$41,200	$88,580	$136,730	$185,550
Depreciation Reserve	-	62,120	115,230	168,230	221,230
Total Cash Balance	$6,140	$103,320	$203,810	$304,960	$406,780

7.2 Municipal Retail Model

The financial analysis in this section assumes the City owns, operates, and provides retail data services to residential and business members via a fully FTTP network citywide. This financial analysis is based on several assumptions (outlined below and further detailed in the spreadsheet in Appendix E).

Please note that we used a "flat" model in the analysis (i.e., we did not include inflation and salary cost increases because we assume that these operating cost increases will be offset and passed on to subscribers in the form of increased prices). Models that add an inflation factor to both revenues and expenses typically greatly overstate future cash flow because net revenues are unlikely to increase as quickly as inflation. At best, the provider will be able to match expenses increases with a dollar-for-dollar rate increase, which is what the flat model represents.

The model assumes that subscribership for data services will ramp up over years one through three, and then remain steady.

7.2.1 Municipal Retail Model Base Case

The financial model is designed to be cash flow positive in year one; which is accomplished through bond financing. **Over time, given the cost to construct, maintain, and operate the FTTP network, the model indicates that a 67 percent take rate[62] of households and businesses passed will be required to maintain positive cash flow.[63]** We note that this take rate is extremely high in a competitive overbuild market.

In this model, we assume the City offers four data services:

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[62] Indicates take rate in year four.

[63] Based on the cost estimate in Section 6.

- A 1 Gbps residential service at $90 per month
- A 1 Gbps small commercial service at $100 per month
- A 1 Gbps medium commercial service at $200 per month[64]
- A 10 Gbps commercial service at $1,000 per month

These prices reflect what is necessary to generate enough revenue to operate cash positive. It should be noted, however, that these prices are higher than Google's and Ting Internet's 1 Gbps services, which are $70 and $89 per month, respectively.

We assume that 86 percent of businesses will subscribe to the small commercial service, 10 percent of businesses will purchase medium commercial service, and 4 percent of businesses will purchase 10 Gbps service.

We assume that all data subscribers will be charged a one-time $75 connection fee prior to receiving services.

We have included a financial summary for this model in Table 47.

Table 47: Municipal Retail Model Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$111,525	$2,094,600	$2,094,600	$2,094,600	$2,094,600
Total Cash Expenses	(694,840)	(1,011,950)	(1,011,950)	(1,011,950)	(1,011,950)
Depreciation	(199,280)	(741,050)	(685,420)	(670,640)	(670,640)
Interest Expense	(99,000)	(308,160)	(226,180)	(132,850)	(22,980)
Taxes	-	-	-	-	-
Net Income	$(881,595)	$33,440	$171,050	$279,160	$389,030

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$25,985	$14,155	$33,065	$107,085	$182,625
Depreciation Reserve	-	545,420	727,660	257,900	379,340
Total Cash Balance	$25,985	$559,575	$760,725	$364,985	$561,965

This base case will not generate a positive net income in its initial years, though by year five, it will generate over $33,400, growing to just over $389,000 in year 20. The model will operate cash-positive, finishing year one with a surplus just under $26,000, which will grow to just over $33,000 by the end of year 10, and over $182,600 by the end of year 20.

7.2.2 Municipal Retail Model Base Case Financing

The initial years of network deployment and operations will be capital-intensive, well beyond what initial subscriber revenues and member passing fees can support. This analysis projects

[64] Medium commercial service receives a lower oversubscription rate, that is, less members sharing the connection, decreasing the instances of network congestion reducing overall speeds.

the City covering these expenses by pursuing a series of 20-year GO bonds, totaling almost $10.79 million.

After review of the City's recent bonds and outstanding GO debt, we assumed that the City's interest rate would be 3 percent, and that bond issuance costs will be equal to 1.06 percent of the principal borrowed. Principal repayment on the bond will start in the third year after issuance.[65]

Through discussions with the City, we assumed that neither an interest nor debt service reserve will be necessary for the lifetime of the bond.

The model assumes a straight-line depreciation of assets, and that the OSP will have a 20-year life span while the network equipment will need to be replaced after 10 years. CPE as well as other miscellaneous implementation costs will need to be replaced every five years. Network equipment, including last mile and CPE will be replaced or upgraded at 80 percent of original cost, miscellaneous implementation costs (test equipment, vehicles, computers) will also be at 80 percent. The model plans for a depreciation reserve account, starting in year four at 36.8 percent, to fund future electronics replacements and upgrades.

Table 48 shows the income statement for years one, five, 10, 15, and 20. The City's net income remains negative in years one through three, totaling roughly negative $881,600 in year one, growing to positive $33,400 in year five. By year 10, net income will equal just over $171,000, growing to $279,100 in year 15 and over $389,000 in year 20.

[65] The scope of work for this report does not include a review of the City's financing capability or review of local or state finance restrictions. A more detailed review and opinion from the City's accountants of financing capability and restrictions is recommended if bonds are pursued.

Table 48: Municipal Retail Model Base Case Income Statement

Income Statement		Year 1	Year 5	Year 10	Year 15	Year 20
Revenues						
Internet - Residential		$97,200	$1,927,800	$1,927,800	$1,927,800	$1,927,800
Internet - Business		7,200	166,800	166,800	166,800	166,800
Connection Fee (net)		7,125	-	-	-	-
	Total	$111,525	$2,094,600	$2,094,600	$2,094,600	$2,094,600
Content Fees						
Internet		$36,000	$99,800	$99,800	$99,800	$99,800
	Total	$36,000	$99,800	$99,800	$99,800	$99,800
Operating Costs						
Operation Costs		$121,590	$306,650	$306,650	$306,650	$306,650
Labor Costs		537,250	605,500	605,500	605,500	605,500
	Total	$658,840	$912,150	$912,150	$912,150	$912,150
EBITDA		$(583,315)	$1,082,650	$1,082,650	$1,082,650	$1,082,650
Depreciation		199,280	741,050	685,420	670,640	670,640
Operating Income (EBITDA less Depreciation)		$(782,595)	$341,600	$397,230	$412,010	$412,010
Non-Operating Income						
Interest Income		$-	$1,360	$1,820	$640	$950
Interest Expense (20-Year Bond)		(99,000)	(309,520)	(228,000)	(133,490)	(23,930)
	Total	$(99,000)	$(308,160)	$(226,180)	$(132,850)	$(22,980)
Net Income (before taxes)		$(881,595)	$33,440	$171,050	$279,160	$389,030
Facility Taxes		$ -	$ -	$ -	$ -	$ -
Net Income		$(881,595)	$33,440	$171,050	$279,160	$389,030

Table 49 shows the cash flow statement for years one, five, 10, 15, and 20. The cumulative unrestricted cash balance is almost $26,000 at the end of year one and just over $33,000 by the end of year 10. By the end of year 15, the unrestricted cash balance is just over $107,000; it is roughly $182,600 by the end of year 20.

Table 49: Municipal Retail Model Base Case Cash Flow Statement

Cash Flow Statement		Year 1	Year 5	Year 10	Year 15	Year 20
Net Income		$(881,595)	$33,440	$171,050	$279,160	$389,030
Cash Outflows						
Depreciation Reserve		$ -	$(272,710)	$(252,230)	$(246,800)	$(246,800)
Financing		(34,900)	-	-	-	-
Capital Expenditures		(2,556,800)	-	-	-	-
	Total	$(2,591,700)	$(272,710)	$(252,230)	$(246,800)	$(246,800)
Cash Inflows						
20-Year Bond Proceeds		$3,300,000	$ -	$ -	$ -	$ -
	Total	$3,300,000	$-	$-	$-	$-
Total Cash Outflows and Inflows		$708,300	$(272,710)	$(252,230)	$(246,800)	$(246,800)
Non-Cash Expenses - Depreciation		$199,280	$741,050	$685,420	$670,640	$670,640
Adjustments						
Proceeds from Additional Cash Flows (20-Year Bond)		$(3,300,000)	$ -	$ -	$ -	$ -
Adjusted Available Net Revenue		$(3,274,015)	$501,780	$604,240	$703,000	$812,870
Principal Payments on Debt						
20 Year Bond Principal		$ -	$511,850	$593,370	$687,880	$797,440
	Total	$ -	$511,850	$593,370	$687,880	$797,440
Net Cash		$25,985	$(10,070)	$10,870	$15,120	$15,430
Cash Balance						
Unrestricted Cash Balance		$25,985	$14,155	$33,065	$107,085	$182,625
Depreciation Reserve		-	545,420	727,660	257,900	379,340
Total Cash Balance		$25,985	$559,575	$760,725	$364,985	$561,965

7.2.3 Municipal Retail Model Base Case Capital Additions

Significant network expenses—known as “capital additions”—are incurred in the first few years during the construction phase of the network. These represent the equipment, material and construction labor associated with building, implementing, and lighting a fiber network. Table 50 shows the capital additions costs in years one through four, assuming a 67 percent take rate, or just under 1,880 subscribers.

This analysis projects that capital additions in year one will total roughly $2.6 million. These costs will total almost $3.5 million in year two, roughly $2.8 million in year three, and just over $1 million in year four, for a total of roughly $9.9 million in the first four years.

Table 50: Municipal Retail Model Base Case Capital Additions

Capital Additions	Year 1	Year 2	Year 3	Year 4
Network Equipment				
Core & GPON Equipment	$739,000	$ -	$ -	$ -
Additional Annual Capital	-	-	-	-
Total	$739,000	$ -	$ -	$ -
Outside Plant and Facilities				
Total Backbone and FTTP	$1,436,700	$2,394,500	$957,800	$ -
Additional Annual Capital	-	-	-	-
Total	$1,436,700	$2,394,500	$957,800	$ -
Last Mile and CPE				
CPE (residential and small commercial)	$59,200	$294,200	$528,600	$293,600
CPE (medium commercial)	700	1,400	2,800	1,400
CPE (enterprise)	-	700	1,400	700
Average Drop Cost	151,200	748,200	1,345,200	746,600
Additional Annual Replacement Capital	-	-	-	-
Total	$211,100	$1,044,500	$1,878,000	$1,042,300
Miscellaneous Implementation Costs				
OSS & Portal	$45,000	$-	$ -	$ -
Vehicles	35,000	35,000	-	-
Service Equipment	-	-	-	-
Work Station, Computers, and Software	10,000	1,000	-	-
Fiber OTDR and Other Tools	50,000	-	-	-
Billing Software	30,000	-	-	-
Additional Annual Capital	-	-	-	-
Total	$170,000	$36,000	$-	$-
Total Capital Additions	$2,556,800	$3,475,000	$2,835,800	$1,042,300

Please see Appendix E for a complete income statement, cash flow statement, and capital addition statement.

7.2.4 Municipal Retail Model Base Case Operating and Maintenance Expenses

The cost to deploy an FTTP network goes far beyond fiber implementation. Network deployment requires additional staffing for sales and marketing, network operations, and other functions new to the City. The addition of new staff will require new office space. Similarly, network inventory requirements will require warehousing space. The City will need to:

- Expand existing office facilities for management, technical, and clerical staff,

- Open a retail "storefront" to facilitate member contact and enhance their experience doing business with the FTTP enterprise,[66]
- Provide warehousing for receipt and storage of cable and hardware for the installation and ongoing maintenance of the broadband infrastructure, and
- Establish a location to house servers, switches, routers, and other core network equipment

Training new and existing staff is important to fully realize the economies of starting the FTTP network. The training will be particularly important in the short-term as the new enterprise establishes itself as a unique entity providing services distinct from City services provided today. We estimate education and training at 2 percent of direct payroll expenses.

Marketing and sales are critical. It is important to be proactive in setting member expectations, addressing security concerns, and educating members on how to initiate services.

Staffing with skills in the following disciplines will be required:

- Sales/Promotion
- Internet and related technologies
- Staff Management
- Strategic Planning
- Finance
- Vendor Negotiations
- Networking (addressing, segmentation)
- Marketing

The expanded business and increased responsibilities will require the addition of new staff. The initial additional positions, staffing levels, and base salaries are shown in Table 51.

These numbers assume one shift of both customer service representative support and subscriber technicians. Changing to full 24x7 staffing will increase costs. Similarly, reducing the support hours will decrease the required staffing. In the model, we added 40 percent overhead to the base (year one) salaries.

[66] Due to the size of the enterprise, we assume the City will use existing City facilities for office space and a "storefront", which will not require lease fees.

Table 51: Municipal Retail Model Base Case Labor Expenses

New Employees	Year 1	Year 2	Year 3+	Year 1 Salary
Business Manager	0.50	0.50	0.50	$130,000
GIS & Recordkeeping	0.25	0.50	0.50	$85,000
Network Engineer	0.25	0.50	0.50	$110,000
Sales & Marketing Representatives	1.00	1.00	1.00	$60,000
Customer Service Representatives	1.00	1.00	1.00	$55,000
Service Technicians/Installers & IT Support	1.00	1.00	1.00	$75,000
Fiber Plant O&M Technicians	1.00	1.00	1.00	$80,000
Total New Staff	5.00	5.50	5.50	

The City's total labor expenses will total roughly $537,300 in year one, and $605,500 in year two on.

Additional key operating and maintenance assumptions include:

- Support services are estimated at almost $5,600 in year one, $3,400 in year two, $8,500 in year three, and $11,300 in year four on
- Insurance is estimated to be $25,000 in year one and $50,000 from year two on
- Utilities are estimated to be $1,200 in year one and $2,400 from year two on
- Office expenses are estimated to be $3,000 in year one and $6,000 from year two on
- Locates and ticket processing are estimated to be $1,800 in year one, $8,800 in year two, and $17,600 from year three on
- Contingency is estimated to be $15,000 in year one and $30,000 from year two on
- Legal fees are estimated to be $30,000 in year one, and $15,000 from year two on
- Consulting fees are estimated at $20,000 in year one, and $10,000 from year two on
- Pole attachment expenses are estimated at roughly $3,500 in year one, $12,600 in year two, $79,400 in year three, and $99,800 in year four on

Vendor maintenance contract fees are expected to start at $74,000 in year two and remain steady from year two on (based upon 10 percent of accrued investment). Annual variable operating expenses not including direct internet access include:

- Education and training are calculated as 2 percent of direct payroll expense (roughly $10,800 in year one, and $12,100 in year two on)

- Allowance for bad debts is computed as 0.5 percent of revenues
- Churn is anticipated to be 6 percent annually, which initiates a $175 per subscriber acquisition cost.

The estimated cost of electronic billing for the new FTTP enterprise is $0.25 per bill, assuming the City's existing billing software will be used.

Fiber and network maintenance costs are calculated at 0.25 percent of the total construction cost per year. This is estimated based on a typical rate of occurrence in the City's environment, and the cost of individual repairs. These costs will total almost $4,000 in year one, just over $11,800 in year two, roughly $17,600 in year three, and nearly $19,500 in year four on. This is in addition to staffing costs to maintain the fiber.

Table 52 shows the City's projected operating expenses for years one, five, 10, 15, and 20. As seen, some expenses will remain constant while others will increase as the network expands and the subscriber base increases.

Table 52: Municipal Retail Model Base Case Operating Expenses and P&I Payments

Operating Expenses	Year 1	Year 5	Year 10	Year 15	Year 20
Support Services	$5,570	$11,270	$11,270	$11,270	$11,270
Insurance	25,000	50,000	50,000	50,000	50,000
Utilities	1,200	2,400	2,400	2,400	2,400
Office Expenses	3,000	6,000	6,000	6,000	6,000
Locates & Ticket Processing	1,800	17,600	17,600	17,600	17,600
Contingency	15,000	30,000	30,000	30,000	30,000
Fiber & Network Maintenance	3,970	19,450	19,450	19,450	19,450
Vendor Maintenance Contracts	-	74,000	74,000	74,000	74,000
Legal	30,000	15,000	15,000	15,000	15,000
Consulting	20,000	10,000	10,000	10,000	10,000
Education and Training	10,750	12,110	12,110	12,110	12,110
Customer Billing (Unit)	290	5,640	5,640	5,640	5,640
Allowance for Bad Debts	560	10,470	10,470	10,470	10,470
Churn (acquisition costs)	1,000	19,730	19,730	19,730	19,730
Pole Attachment Expense	3,450	22,980	22,980	22,980	22,980
Internet	36,000	99,800	99,800	99,800	99,800
Sub-Total	$157,590	$406,450	$406,450	$406,450	$406,450
Labor Expenses	$537,250	$605,500	$605,500	$605,500	$605,500
Sub-Total	$537,250	$605,500	$605,500	$605,500	$605,500
Total Expenses	$694,840	$1,011,950	$1,011,950	$1,011,950	$1,011,950
Principal and Interest	$99,000	$820,010	$819,550	$820,730	$820,420
Facility Taxes	-	-	-	-	-
Sub-Total	$99,000	$820,010	$819,550	$820,730	$820,420
Total Expenses, P&I, and Taxes	$793,840	$1,831,960	$1,831,500	$1,832,680	$1,832,370

The City's operating and maintenance expenses, including principal and interest payments, will total roughly $793,800 in year one, and grow to over $1.8 million in years five through 20.

7.2.5 Municipal Retail Model Sensitivity Scenarios

In this section, we demonstrate how even small fluctuations in our assumptions in the base case can affect the financial modeling (i.e., the take rate required for positive cash flow).

Note that some of these scenarios may not be realistically attainable. They are meant to demonstrate the sensitivity of the financial projections to these assumptions. Some of our assumptions will dramatically impact the feasibility of the model. Further, we note that other than Scenario 2, these models assume the network only delivers data services.

7.2.5.1 Municipal Retail Model Scenario 2: Add Voice and Video Service

In this scenario, we expand on the City's network offerings by using the FTTP network to deliver voice and video service to subscribers. We assume that the City will offer video and data services through a service partner. For video, we assume that subscribers will pay an average package price of $60 per month, and that the City will receive $6.00 per subscriber. For telephone, we assume that two services are offered—a residential service at $25 per month and a business line at $35 per month—and that the City will receive $6.25 per month and $8.75 per month, respectively.

This increase in revenue causes two minor changes: the required take rate for the model to cash flow reduces to 65 percent, and the necessary amount financed reduces by $200,000 to over $10.58 million. All other assumptions remain the same as our base case. As shown in Table 53, this model will generate a negative net income in year one, which will recover to just over $45,500 in year five, growing to $381,100 by year 20. The City's cumulative unrestricted cash balance will total just under $35,200 by the end of year one, growing to almost $71,300 by the end of year 10, and a surplus of just under $204,300 by the end of year 20.

Table 53: Municipal Retail Model Scenario 2 Financial Summary – Add Voice and Video Service

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$159,945	$2,459,760	$2,408,760	$2,408,760	$2,408,760
Total Cash Expenses	(742,860)	(1,388,230)	(1,349,720)	(1,349,720)	(1,349,720)
Depreciation	(198,460)	(723,810)	(670,290)	(655,510)	(655,510)
Interest Expense	(99,000)	(302,190)	(221,640)	(130,150)	(22,430)
Taxes	-	-	-	-	-
Net Income	$(880,375)	$45,530	$167,110	$273,380	$381,100

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$35,185	$52,875	$71,275	$136,925	$204,275
Depreciation Reserve	-	532,720	727,900	272,530	408,360
Total Cash Balance	$35,185	$585,595	$799,175	$409,455	$612,635

7.2.5.2 Municipal Retail Model Scenario 3: Decrease Residential Internet to $70 per Month

If the City were to decrease the monthly price of residential internet by $20 to $70 per month, the decreased revenue would not be able to sustain the fiber enterprise, provided all other assumptions remain the same as our base case.

As shown in Table 54, the City's net income would remain negative throughout the life of the model, and though the City would finish year one with a cumulative unrestricted cash balance of just under $4,500, the model would generate a deficit of $3.4 million by the end of year 10 that would grow to over $7.5 million by the end of year 20.

Table 54: Municipal Retail Model Scenario 3 Financial Summary – Decrease Residential Internet to $70 per Month

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$89,925	$1,666,200	$1,666,200	$1,666,200	$1,666,200
Total Cash Expenses	(694,730)	(1,009,810)	(1,009,810)	(1,009,810)	(1,009,810)
Depreciation	(199,280)	(741,050)	(685,420)	(670,640)	(670,640)
Interest Expense	(99,000)	(308,160)	(226,180)	(132,850)	(22,980)
Taxes	-	-	-	-	-
Net Income	$(903,085)	$(392,820)	$(255,210)	$(147,100)	$(37,230)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$4,495	$(1,307,595)	$(3,419,985)	$(5,477,265)	$(7,533,025)
Depreciation Reserve	-	545,420	727,660	257,900	379,340
Total Cash Balance	$4,495	$(762,175)	$(2,692,325)	$(5,219,365)	$(7,153,685)

7.2.5.3 Municipal Retail Model Scenario 4: Decrease Residential Internet to $85 per Month

Even if the City were to decrease its monthly residential internet prices by just $5 to a total of $85 per month, the enterprise would not be able to operate cash positive at a 67 percent take rate, provided all other assumptions remain the same as our base case.

As shown in Table 55, the enterprise would generate a positive net income of almost $64,500 in year 10, growing to almost $282,500 in year 20. The decreased revenue would result in a cumulative unrestricted cash balance of just over $20,600 at the end of year one, which would become a deficit of over $830,200 by the end of year 10, growing to a deficit of well over $1.7 million by the end of year 20.

Table 55: Municipal Retail Model Scenario 4 Financial Summary – Decrease Residential Internet to $85 per Month

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$106,125	$1,987,500	$1,987,500	$1,987,500	$1,987,500
Total Cash Expenses	(694,810)	(1,011,420)	(1,011,420)	(1,011,420)	(1,011,420)
Depreciation	(199,280)	(741,050)	(685,420)	(670,640)	(670,640)
Interest Expense	(99,000)	(308,160)	(226,180)	(132,850)	(22,980)
Taxes	-	-	-	-	-
Net Income	$(886,965)	$(73,130)	$64,480	$172,590	$282,460

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$20,615	$(316,285)	$(830,225)	$(1,289,055)	$(1,746,365)
Depreciation Reserve	-	545,420	727,660	257,900	379,340
Total Cash Balance	$20,615	$229,135	$(102,565)	$(1,031,155)	$(1,367,025)

7.2.5.4 Municipal Retail Model Scenario 5: Increase Residential Internet to $95 per Month

If the market allowed the City to increase its monthly residential internet prices by $5 to $95 per month, the increased revenue will result in increased surpluses. Provided all other assumptions remain the same, the model will generate a surplus of over $896,300 by the end of year 10, growing to well over $2.1 million by the end of year 20. We have included a financial summary for this model in Table 56.

Table 56: Municipal Retail Model Scenario 5 Financial Summary – Increase Residential Internet to $95 per Month

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$116,925	$2,201,700	$2,201,700	$2,201,700	$2,201,700
Total Cash Expenses	(694,860)	(1,012,490)	(1,012,490)	(1,012,490)	(1,012,490)
Depreciation	(199,280)	(741,050)	(685,420)	(670,640)	(670,640)
Interest Expense	(99,000)	(308,160)	(226,180)	(132,850)	(22,980)
Taxes	-	-	-	-	-
Net Income	$(876,215)	$140,000	$277,610	$385,720	$495,590

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$31,365	$344,605	$896,315	$1,503,135	$2,111,475
Depreciation Reserve	-	545,420	727,660	257,900	379,340
Total Cash Balance	$31,365	$890,025	$1,623,975	$1,761,035	$2,490,815

7.2.5.5 Municipal Retail Model Scenario 6: Operating and Staffing Costs Decrease by 10 Percent

As we describe above, the City's staffing and operating expenses are considerable. If these expenses were to decrease by 10 percent over our base case, provided all other assumptions stay the same as our base case, the increased revenue would have a significant positive impact on cash flow, generating larger surpluses than our base case. As Table 57 shows, the City's unrestricted cash balance would finish year one at roughly $140,200, year 10 at almost $1.5 million, and year 20 with just over $3 million.

Table 57: Municipal Retail Model Scenario 6 Financial Summary – Operating and Staffing Costs Decrease by 10 Percent

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$111,525	$2,094,600	$2,094,600	$2,094,600	$2,094,600
Total Cash Expenses	(580,600)	(866,240)	(866,240)	(866,240)	(866,240)
Depreciation	(199,280)	(741,050)	(685,420)	(670,640)	(670,640)
Interest Expense	(99,000)	(308,160)	(226,180)	(132,850)	(22,980)
Taxes	-	-	-	-	-
Net Income	$(767,355)	$179,150	$316,760	$424,870	$534,740

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$140,225	$703,745	$1,451,205	$2,253,775	$3,057,865
Depreciation Reserve	-	545,420	727,660	257,900	379,340
Total Cash Balance	$140,225	$1,249,165	$2,178,865	$2,511,675	$3,437,205

7.2.5.6 Municipal Retail Model Scenario 7: Operating and Staffing Costs Increase by 10 Percent

On the other side of that equation, if these operating and staffing expenses were to increase by 10 percent over our base case, provided all other assumptions stay the same, the City would face large deficits over time. As Table 58 shows, the City would finish year one with a deficit of almost $99,000, and by year five the enterprise will have a deficit of over $1.5 million, growing to over $2.9 million by the end of year 20.

Table 58: Municipal Retail Model Scenario 7 Financial Summary – Operating and Staffing Costs Increase by 10 Percent

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$111,525	$2,094,600	$2,094,600	$2,094,600	$2,094,600
Total Cash Expenses	(819,820)	(1,169,770)	(1,169,770)	(1,169,770)	(1,169,770)
Depreciation	(199,280)	(741,050)	(685,420)	(670,640)	(670,640)
Interest Expense	(99,000)	(308,160)	(226,180)	(132,850)	(22,980)
Taxes	-	-	-	-	-
Net Income	$(1,006,575)	$(124,380)	$13,230	$121,340	$231,210

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$(98,995)	$(734,615)	$(1,504,805)	$(2,219,885)	$(2,933,445)
Depreciation Reserve	-	545,420	727,660	257,900	379,340
Total Cash Balance	$(98,995)	$(189,195)	$(777,145)	$(1,961,985)	$(2,554,105)

7.2.5.7 Municipal Retail Model Scenario 8: OSP Costs Decrease by 10 Percent

If the FTTP network deployment ends up costing 10 percent less than our estimates, provided all other assumptions remain the same, then the necessary network take rate and total amount financed would reduce to 65 percent, and $10.185 million, respectively.

As shown in Table 59, this scenario would generate a net income of just over $162,000 in year 10, growing to almost $369,000 in year 20. The City would have a deficit of almost $18,600 at the end of year one, but by year 10, it will have recovered to a surplus of almost $32,000, growing to almost $204,900 at the end of year 20.

Table 59: Municipal Retail Model Scenario 8 Financial Summary – OSP Costs Decrease by 10 Percent

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$108,060	$2,033,760	$2,033,760	$2,033,760	$2,033,760
Total Cash Expenses	(694,390)	(1,006,710)	(1,006,710)	(1,006,710)	(1,006,710)
Depreciation	(191,480)	(705,600)	(651,380)	(636,600)	(636,600)
Interest Expense	(93,000)	(291,020)	(213,660)	(125,660)	(21,970)
Taxes	-	-	-	-	-
Net Income	$(870,810)	$30,430	$162,010	$264,790	$368,480

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$(18,560)	$(215)	$31,965	$117,885	$204,875
Depreciation Reserve	-	519,320	666,190	162,020	249,050
Total Cash Balance	$(18,560)	$519,105	$698,155	$279,905	$453,925

7.2.5.8 Municipal Retail Model Scenario 9: OSP Costs Increase by 10 Percent

If the City's total OSP deployment costs increase by 10 percent, provided all other assumptions remain the same as the base case, the necessary take rate to sustain the enterprise increases to 69 percent, and the necessary financed amount would increase to almost $11.3 million. As shown in Table 60, provided the City can obtain and maintain both the increased take rate and financing, the model will eventually operate cash positive—generating a surplus of almost $3,900 by the end of year 10, growing to a surplus over $227,400 by the end of year 20.

Table 60: Municipal Retail Model Scenario 9 Financial Summary – OSP Costs Increase by 10 Percent

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$113,835	$2,157,720	$2,157,720	$2,157,720	$2,157,720
Total Cash Expenses	(695,250)	(1,017,290)	(1,017,290)	(1,017,290)	(1,017,290)
Depreciation	(206,880)	(776,740)	(719,670)	(704,890)	(704,890)
Interest Expense	(102,000)	(322,420)	(236,580)	(138,790)	(23,760)
Taxes	-	-	-	-	-
Net Income	$(890,295)	$41,270	$184,180	$296,750	$411,780

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$(24,285)	$(50,300)	$3,880	$114,680	$227,420
Depreciation Reserve	-	571,680	789,180	353,620	509,260
Total Cash Balance	$(24,285)	$521,380	$793,060	$468,300	$736,680

7.2.5.9 Municipal Retail Model Scenario 10: Obtain $3,000 Connection Fee

If the City were to follow the model implemented by the city of Ammon, ID,[67] and charged each subscribed passing $3,000 upon connection, the network would operate cash-positive, provided the City could obtain and maintain a take rate of 53 percent. Due to the increased revenue, the necessary financed amount would drop to $6.15 million. All other assumptions remain the same as our base case.

In this model, the network would generate a net income of over $18,800 in year 15, growing to over $80,400 in year 20. The City's cumulative unrestricted cash balance would total over $29,800 by the end of year one, growing to almost $393,400 by the end of year 10, and almost $580,000 by the end of year 20. We have included a financial summary for this model in Table 61.

[67] We note the Ammon, ID model is operated using an Open Access network model in which the city receives per-subscriber payments from RSPs. For discussion of the Ammon, ID model in Spring Hill, see Section 1.4.3.1.

Table 61: Municipal Retail Model Scenario 10 Financial Summary – Obtain $3,000 Connection Fee

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$305,280	$1,658,160	$1,658,160	$1,658,160	$1,658,160
Total Cash Expenses	(695,340)	(973,480)	(973,480)	(973,480)	(973,480)
Depreciation	(184,970)	(650,260)	(604,510)	(591,770)	(591,770)
Interest Expense	(88,500)	(171,970)	(125,950)	(74,070)	(12,490)
Taxes	-	-	-	-	-
Net Income	$(663,530)	$(137,550)	$(45,780)	$18,840	$80,420

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$29,840	$344,040	$393,360	$485,700	$579,550
Depreciation Reserve	-	455,180	623,550	234,590	355,230
Total Cash Balance	$29,840	$799,220	$1,016,910	$720,290	$934,780

7.2.5.10 Municipal Retail Model Scenario 11 Financial Summary – Obtain $5 Million in Grants

If the City were able to obtain $5 million in startup funding from grants, cash on hand, or other sources that do not need to be repaid, the necessary take rate would drop to 49 percent, and the total necessary financed amount would drop to $4.55 million. Provided all other assumptions remain the same, the model would operate cash-positive, resulting in a surplus just under $2 million by the end of year one. This surplus would grow to just over $49,800 by the end of year 10, and almost $189,000 by the end of year 20. We have included a financial summary of this model in Table 62.

Table 62: Municipal Retail Model Scenario 11 Financial Summary – Obtain $5 Million in Grants

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$305,280	$1,658,160	$1,658,160	$1,658,160	$1,658,160
Total Cash Expenses	(695,340)	(973,480)	(973,480)	(973,480)	(973,480)
Depreciation	(184,970)	(650,260)	(604,510)	(591,770)	(591,770)
Interest Expense	(88,500)	(171,970)	(125,950)	(74,070)	(12,490)
Taxes	-	-	-	-	-
Net Income	$(663,530)	$(137,550)	$(45,780)	$18,840	$80,420

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$29,840	$344,040	$393,360	$485,700	$579,550
Depreciation Reserve	-	455,180	623,550	234,590	355,230
Total Cash Balance	$29,840	$799,220	$1,016,910	$720,290	$934,780

7.2.5.11 Municipal Retail Model Scenario 12 – Add a Three-Month Operating Reserve Fund

At the request of the City, we investigated the implications of adding a three-month operating reserve fund to the model. In this scenario, three months' operating expenses are reserved beginning in year two to protect the City from any unexpected fluctuation in available income. Provided all other assumptions remain the same, the necessary take rate increases by one percentage point to 68 percent, and the necessary financed amount must increase to $11.135 million.

As shown in Table 63, this model will generate a negative net income in year one, but by year five, the net income will total almost $50,000, growing to almost $191,000 in year 10, and just under $415,500 in year 20. This model will operate cash-positive, resulting in a cumulative surplus of over $24,800 by the end of year one, growing to $100,800 by the end of year 10, and just over $290,000 by the end of year 20.

Table 63: Municipal Retail Model Scenario 12 Financial Summary – Add a Three-Month Operating Reserve Fund

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$112,680	$2,128,560	$2,128,560	$2,128,560	$2,128,560
Total Cash Expenses	(694,860)	(1,014,040)	(1,014,040)	(1,014,040)	(1,014,040)
Depreciation	(199,500)	(747,050)	(690,680)	(675,900)	(675,900)
Interest Expense	(99,000)	(317,530)	(232,930)	(136,540)	(23,140)
Taxes	-	-	-	-	-
Net Income	$(880,680)	$49,940	$190,910	$302,080	$415,480

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$24,820	$62,520	$100,800	$194,700	$290,050
Depreciation Reserve	-	549,820	727,560	252,730	369,100
Operating Reserve	-	253,500	253,500	253,500	253,500
Total Cash Balance	$24,820	$865,840	$1,081,860	$700,930	$912,650

7.2.5.12 Municipal Retail Model Scenario 13: Add 700 Residential Passings by Year Five

We note that Spring Hill is one of the fastest-growing cities in Johnson County. To account for this growth, at the request of the City, we investigated the implication of the network adding an additional 700 residential passings by year five, totaling 3,504. If this were to occur, and the enterprise operates with a three-year operating reserve, provided all other assumptions remain the same, the necessary take rate would decrease to 56 percent, and the necessary financed amount would increase to $11.6 million.

It is important to remember that the necessary take rate in this scenario does not represent an "apples-to-apples" comparison to the take rate in other scenarios. Because the total number of potential network passings is greater in this scenario, even though the necessary take rate is lower, a larger number of total passings need to subscribe to services in this scenario.

As shown in Table 64, the net income in this model will total nearly $71,700 in year five, $209,300 in year 10 and $443,700 in year 20. The City's cumulative unrestricted cash balance will total almost $12,300 by the end of year one, roughly $150,500 by the end of year 10, and almost $299,600 by the end of year 20.

Table 64: Municipal Retail Model Scenario 13 Financial Summary – Add a Three-Month Operating Reserve Fund and Add 700 Passings by Year Five

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$112,680	$2,128,560	$2,128,560	$2,128,560	$2,128,560
Total Cash Expenses	(694,860)	(1,014,040)	(1,014,040)	(1,014,040)	(1,014,040)
Depreciation	(199,500)	(747,050)	(690,680)	(675,900)	(675,900)
Interest Expense	(99,000)	(317,530)	(232,930)	(136,540)	(23,140)
Taxes	-	-	-	-	-
Net Income	$(880,680)	$49,940	$190,910	$302,080	$415,480

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$24,820	$62,520	$100,800	$194,700	$290,050
Depreciation Reserve	-	549,820	727,560	252,730	369,100
Operating Reserve	-	253,500	253,500	253,500	253,500
Total Cash Balance	$24,820	$865,840	$1,081,860	$700,930	$912,650

7.3 Open Access Model

Like the Municipal Retail Model, the financial analysis in this section assumes the City deploys, owns, and operates a citywide fully FTTP network—including fiber drop cables and core network electronics. Unlike the Municipal Retail Model, the City does not provide data services over the network. Rather, RSPs provide CPE, and provide data services directly to homes and businesses in the City. In return, RSPs pay the City a per-subscriber fee. In short, this model offers the benefit of the City providing a platform over which RSPs can compete, without the risks and responsibilities of being a commercial service provider.

This financial analysis is based on a number of assumptions (outlined below and further detailed in the spreadsheet in Appendix F).

Please note that we used a "flat-model" in the analysis (i.e., we did not include inflation and salary cost increases because we assume that these operating cost increases will be offset and passed on to subscribers in the form of increased prices). Models that add an inflation factor to both revenues and expenses typically greatly overstate future cash flow because net revenues are unlikely to increase as quickly as inflation. At best, the provider will be able to match expenses increases with a dollar-for-dollar rate increase, which is what the flat model represents.

The model assumes that subscribership for data services will ramp up over years one through three, and then remain steady.

7.3.1 Open Access Model Base Case

The financial model is designed to be cash flow positive in year one; which is accomplished through bond financing. Over time, given the cost to construct, maintain, and operate the FTTP network, the model indicates that an RSP take rate of 67 percent[68] of households and businesses passed will be required to maintain positive cash flow.[69] We note that this take rate is extremely high in a competitive overbuild market.

In this model, we assume the City charges RSPs for access to the network based upon the nature of subscriber:

- $69 per residential subscriber per month
- $79 per business subscriber per month

We also assume the City will receive a $75 connection fee for each new subscriber.

We have included a financial summary for this model in Table 65.

Table 65: Open Access Model Base Case Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$86,385	$1,567,092	$1,567,092	$1,567,092	$1,567,092
Total Cash Expenses	(465,530)	(695,930)	(695,930)	(695,930)	(695,930)
Depreciation	(185,380)	(537,730)	(522,770)	(507,990)	(507,990)
Interest Expense	(90,000)	(271,050)	(198,870)	(116,830)	(20,100)
Taxes	-	-	-	-	-
Net Income	$(654,525)	$62,382	$149,522	$246,342	$343,072

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$11,855	$46,299	$250,079	$468,269	$689,389
Depreciation Reserve	-	225,840	478,750	121,670	355,790
Total Cash Balance	$11,855	$272,139	$728,829	$589,939	$1,045,179

This base case will not generate a positive net income in its initial years, though by year five, it will generate almost $62,400, growing to just over $343,000 in year 20. The model will operate

[68] Indicates take rate in year four.
[69] Based on the cost estimate in Section 6.

cash-positive, finishing year one with a surplus just under $11,900, which will grow to just over $250,000 by the end of year 10, and almost $689,400 by the end of year 20.

7.3.2 Open Access Model Base Case Financing

The initial years of network deployment and operations will be capital-intensive, well beyond what initial subscriber revenues and member passing fees can support. This analysis projects the City covering these expenses by pursuing a series of 20-year GO bonds, totaling $9.48 million.

After review of the City's recent bonds and outstanding GO debt, we assumed that the City's interest rate would be 3 percent, and that bond issuance costs will be equal to 1.06 percent of the principal borrowed. Principal repayment on the bond will start in the third year after issuance.[70]

Through discussions with the City, we assumed that neither an interest nor debt service reserve will be necessary for the lifetime of the bond.

The model assumes a straight-line depreciation of assets, and that the OSP will have a 20-year life span while the network equipment will need to be replaced after 10 years. Other miscellaneous implementation costs will need to be replaced every five years. Network equipment will be replaced or upgraded at 80 percent of original cost, miscellaneous implementation costs (test equipment, vehicles, computers) will also be at 80 percent. The model plans for a depreciation reserve account, starting in year four at 21 percent, to fund future electronics replacements and upgrades.

Table 66 shows the income statement for years one, five, 10, 15, and 20. The City's net income remains negative in years one through three, totaling roughly negative $654,500 in year one, growing to positive $62,400 in year five. By year 10, net income will equal just over $149,500, growing to $246,300 in year 15 and just over $343,000 in year 20.

[70] The scope of work for this report does not include a review of the City's financing capability or review of local or state finance restrictions. A more detailed review and opinion from the City's accountants of financing capability and restrictions is recommended if bonds are pursued.

Table 66: Open Access Model Base Case Income Statement

Income Statement		Year 1	Year 5	Year 10	Year 15	Year 20
Revenues						
Connection Fee (net)		$7,125	$ -	$ -	$ -	$ -
Provider Fees		79,260	1,567,092	1,567,092	1,567,092	1,567,092
	Total	$86,385	$1,567,092	$1,567,092	$1,567,092	$1,567,092
Operating Costs						
Operation Costs		$115,530	$258,430	$258,430	$258,430	$258,430
Labor Costs		350,000	437,500	437,500	437,500	437,500
	Total	$465,530	$695,930	$695,930	$695,930	$695,930
EBITDA		$(379,145)	$871,162	$871,162	$871,162	$871,162
Depreciation		185,380	537,730	522,770	507,990	507,990
Operating Income (EBITDA less Depreciation)		$(564,525)	$333,432	$348,392	$363,172	$363,172
Non-Operating Income						
Interest Income		$-	$560	$1,200	$300	$890
Interest Expense (20-Year Bond)		(90,000)	(271,610)	(200,070)	(117,130)	(20,990)
	Total	$(90,000)	$(271,050)	$(198,870)	$(116,830)	$(20,100)
Net Income (before taxes)		$(654,525)	$62,382	$149,522	$246,342	$343,072
Facility Taxes		$ -	$ -	$ -	$ -	$ -
Net Income		$(654,525)	$62,382	$149,522	$246,342	$343,072

Table 67 shows the cash flow statement for years one, five, 10, 15, and 20. The cumulative unrestricted cash balance is almost $11,900 at the end of year one and just over $250,000 by the end of year 10. By the end of year 15, the unrestricted cash balance is almost $468,300; it is roughly $689,400 by the end of year 20.

Table 67: Open Access Model Base Case Cash Flow Statement

Cash Flow Statement		Year 1	Year 5	Year 10	Year 15	Year 20
Net Income		$(654,525)	$62,382	$149,522	$246,342	$343,072
Cash Outflows						
Depreciation Reserve		$ -	$(112,920)	$(109,780)	$(106,680)	$(106,680)
Financing		(31,700)	-	-	-	-
Capital Expenditures		(2,487,300)	-	-	-	-
	Total	$(2,519,000)	$(112,920)	$(109,780)	$(106,680)	$(106,680)
Cash Inflows						
20-Year Bond Proceeds		$3,000,000	$ -	$ -	$ -	$ -
	Total	$3,000,000	$-	$-	$-	$-
Total Cash Outflows and Inflows		$481,000	$(112,920)	$(109,780)	$(106,680)	$(106,680)
Non-Cash Expenses - Depreciation		$185,380	$537,730	$522,770	$507,990	$507,990
Adjustments						
Proceeds from Additional Cash Flows (20-Year Bond)		$(3,000,000)	$ -	$ -	$ -	$ -
Adjusted Available Net Revenue		$(2,988,145)	$487,192	$562,512	$647,652	$744,382
Principal Payments on Debt						
20 Year Bond Principal		$ -	$449,160	$520,700	$603,640	$699,780
	Total	$ -	$449,160	$520,700	$603,640	$699,780
Net Cash		$11,855	$38,032	$41,812	$44,012	$44,602
Cash Balance						
Unrestricted Cash Balance		$11,855	$46,299	$250,079	$468,269	$689,389
Depreciation Reserve		-	225,840	478,750	121,670	355,790
Total Cash Balance		$11,855	$272,139	$728,829	$589,939	$1,045,179

7.3.3 Open Access Model Capital Additions

Significant network expenses—known as "capital additions"—are incurred in the first few years during the construction phase of the network. These represent the equipment, material and construction labor associated with building, implementing, and lighting a fiber network. Table 50 shows the capital additions costs in years one through four, assuming a 67 percent take rate, or just under 1,880 subscribers.

This analysis projects that capital additions in year one will total roughly $2.5 million. These costs will total almost $3.2 million in year two, roughly $2.4 million in year three, and just over $793,000 in year four, for a total of roughly $8.9 million in the first four years.

Table 68: Open Access Model Base Case Capital Additions

Capital Additions	Year 1	Year 2	Year 3	Year 4
Network Equipment				
Core & GPON Equipment	$739,000	$ -	$ -	$ -
Additional Annual Capital	-	-	-	-
Total	$739,000	$ -	$ -	$ -
Outside Plant and Facilities				
Total Backbone and FTTP	$1,436,700	$2,394,500	$957,800	$ -
Additional Annual Capital	-	-	-	-
Total	$1,436,700	$2,394,500	$957,800	$ -
Last Mile and CPE				
CPE (residential and small commercial)	$9,400	$46,700	$83,900	$46,600
Average Drop Cost	151,200	748,200	1,345,200	746,600
Additional Annual Replacement Capital	-	-	-	-
Total	$160,600	$794,900	$1,429,100	$793,200
Miscellaneous Implementation Costs				
OSS & Portal	$45,000	$-	$ -	$ -
Vehicles	35,000	35,000	-	-
Service Equipment	-	-	-	-
Work Station, Computers, and Software	6,000	1,000	-	-
Fiber OTDR and Other Tools	50,000	-	-	-
Billing Software	30,000	-	-	-
Additional Annual Capital	-	-	-	-
Total	$151,000	$36,500	$-	$-
Total Capital Additions	$2,487,300	$3,225,900	$2,386,900	$793,200

Please see Appendix F for a complete income statement, cash flow statement, and capital addition statement.

7.3.4 Open Access Model Operating and Maintenance Expenses

The cost to deploy an FTTP network goes far beyond fiber implementation. Network deployment requires additional staffing for sales and marketing, network operations, and other functions new to the City. The addition of new staff will require new office space. Similarly, network inventory requirements will require warehousing space. The City will need to:

- Expand existing office facilities for management, technical, and clerical staff,

- Open a retail "storefront" to facilitate member contact and enhance their experience doing business with the FTTP enterprise,[71]
- Provide warehousing for receipt and storage of cable and hardware for the installation and ongoing maintenance of the broadband infrastructure, and
- Establish a location to house servers, switches, routers, and other core network equipment

Training new and existing staff is important to fully realize the economies of starting the FTTP network. The training will be particularly important in the short-term as the new enterprise establishes itself as a unique entity providing services distinct from City services provided today. We estimate education and training at 2 percent of direct payroll expenses.

Marketing and sales are critical. It is important to be proactive in setting member expectations, addressing security concerns, and educating members on how to initiate services.

Staffing with skills in the following disciplines will be required:

- Promotion
- Internet and related technologies
- Staff Management
- Strategic Planning
- Finance
- Vendor Negotiations
- Networking (addressing, segmentation)

The expanded business and increased responsibilities will require the addition of new staff. The initial additional positions, staffing levels, and base salaries are shown in Table 69.

These numbers assume one shift of both service representative support and subscriber technicians. Changing to full 24x7 staffing will increase costs. Similarly, reducing the support hours will decrease the required staffing. In the model, we added 40 percent overhead to the base (year one) salaries.

[71] Due to the size of the enterprise, we assume the City will use existing City facilities for office space and a "storefront", which will not require lease fees.

Table 69: Open Access Model Base Case Labor Expenses

New Employees	Year 1	Year 2	Year 3+	Year 1 Salary
Business Manager	0.25	0.25	0.25	$130,000
GIS & Recordkeeping	0.25	0.50	0.50	$85,000
Network Engineer	0.25	0.50	0.50	$110,000
Customer Service Representatives	0.25	0.50	0.50	$55,000
Service Technicians/Installers & IT Support	1.00	1.00	1.00	$75,000
Fiber Plant O&M Technicians	1.00	1.00	1.00	$80,000
Total New Staff	3.00	3.75	3.75	

The City's total labor expenses will total roughly $350,000 in year one, and $437,500 in year two on.

Additional key operating and maintenance assumptions include:

- Support services are estimated at roughly $5,100 in year one, just under $700 in year two, almost $1,700 in year three, and just under $2,300 in year four on
- Insurance is estimated to be $25,000 in year one and $50,000 from year two on
- Utilities are estimated to be $1,200 in year one and $2,400 from year two on
- Office expenses are estimated to be $3,000 in year one and $6,000 from year two on
- Locates and ticket processing are estimated to be $1,800 in year one, $8,800 in year two, and $17,600 from year three on
- Contingency is estimated to be $15,000 in year one and $30,000 from year two on
- Legal fees are estimated to be $30,000 in year one, and $15,000 from year two on
- Consulting fees are estimated at $20,000 in year one, and $10,000 from year two on
- Pole attachment expenses are estimated at roughly $3,500 in year one, $12,600 in year two, $20,700 in year three, and almost $23,000 in year four on

Vendor maintenance contract fees are expected to start at $74,000 in year two and remain steady from year two on (based upon 10 percent of accrued investment). Annual variable operating expenses not including direct internet access include:

- Education and training are calculated as 2 percent of direct payroll expense (roughly $7,000 in year one, and $8,800 in year two on)

Fiber and network maintenance costs are calculated at 0.25 percent of the total construction cost per year. This is estimated based on a typical rate of occurrence in the City's environment, and the cost of individual repairs. These costs will total almost $4,000 in year one, just over $11,800 in year two, roughly $17,600 in year three, and nearly $19,500 in year four on. This is in addition to staffing costs to maintain the fiber.

Table 70 shows the City's projected operating expenses for years one, five, 10, 15, and 20. As seen, some expenses will remain constant while others will increase as the network expands and the subscriber base increases.

Table 70: Open Access Model Base Case Operating Expenses and P&I Payments

Operating Expenses	Year 1	Year 5	Year 10	Year 15	Year 20
Support Services	$5,110	$2,250	$2,250	$2,250	$2,250
Insurance	25,000	50,000	50,000	50,000	50,000
Utilities	1,200	2,400	2,400	2,400	2,400
Office Expenses	3,000	6,000	6,000	6,000	6,000
Locates & Ticket Processing	1,800	17,600	17,600	17,600	17,600
Contingency	15,000	30,000	30,000	30,000	30,000
Fiber & Network Maintenance	3,970	19,450	19,450	19,450	19,450
Vendor Maintenance Contracts	-	74,000	74,000	74,000	74,000
Legal	30,000	15,000	15,000	15,000	15,000
Consulting	20,000	10,000	10,000	10,000	10,000
Education and Training	7,000	8,750	8,750	8,750	8,750
Pole Attachment Expense	3,450	22,980	22,980	22,980	22,980
Sub-Total	$115,530	$258,430	$258,430	$258,430	$258,430
Labor Expenses	$350,000	$437,500	$437,500	$437,500	$437,500
Sub-Total	$350,000	$437,500	$437,500	$437,500	$437,500
Total Expenses	$465,530	$695,930	$695,930	$695,930	$695,930
Principal and Interest	$90,000	$720,210	$719,570	$720,470	$719,880
Facility Taxes	-	-	-	-	-
Sub-Total	$90,000	$720,210	$719,570	$720,470	$719,880
Total Expenses, P&I, and Taxes	$555,530	$1,416,140	$1,415,500	$1,416,400	$1,415,810

The City's operating and maintenance expenses, including principal and interest payments, will total roughly $555,500 in year one, and grow to over $1.4 million in years five through 20.

7.3.5 Open Access Model Sensitivity Scenarios

In this section, we demonstrate how even small fluctuations in our assumptions in the base case can affect the financial modeling (i.e., the take rate required for positive cash flow).

Note that some of these scenarios may not be realistically attainable. They are meant to demonstrate the sensitivity of the financial projections to these assumptions. Some of our assumptions will dramatically impact the feasibility of the model.

7.3.5.1 Open Access Model Scenario 2: CPE Is City's Responsibility

If the City were to maintain responsibility for CPE—providing, installing, maintaining, and replacing equipment—it would need to increase the financed amount by $1.1 million, to total $10.58 million.[72] The fees the RSPs pay the City would also need to increase by $9 to total $78 per residential subscriber per month and $88 per business subscriber per month. Provided all other assumptions remain the same, and the network maintains a 67 percent take rate, the fiber enterprise would operate cash positive.

As shown in Table 71, this model will generate a net income of just over $169,000 in year 10, and almost $384,000 in year 20. The City would finish year one with just over $67,600, growing to a surplus of over $330,200 by the end of year 10, and over $524,900 by the end of year 20.

Table 71: Open Access Model Scenario 2 Financial Summary – CPE Is City's Responsibility

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$96,645	$1,770,024	$1,770,024	$1,770,024	$1,770,024
Total Cash Expenses	(465,530)	(695,930)	(695,930)	(695,930)	(695,930)
Depreciation	(195,480)	(737,350)	(682,460)	(667,680)	(667,680)
Interest Expense	(93,000)	(302,710)	(222,480)	(130,600)	(22,460)
Taxes	-	-	-	-	-
Net Income	$(657,365)	$34,034	$169,154	$275,814	$383,954

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$67,615	$289,433	$330,233	$426,733	$524,943
Depreciation Reserve	-	545,640	744,260	290,500	427,940
Total Cash Balance	$67,615	$835,073	$1,074,493	$717,233	$952,883

7.3.5.2 The Ammon, Idaho, Model Is a Variation of the Open Access Model

A variation of the Open Access Model is the "Ammon Model," introduced in Ammon, Idaho, in early 2017. The Ammon Model differs from the Open Access Model in a few key ways:

1. It does not provide ubiquitous coverage. The FTTP in Ammon was deployed *only* in neighborhoods where a sufficient percentage of residents sign up for services, or once a

[72] Based on CPE costs discussed in Section 7.

certain take rate is achieved.[73] The reported required take rate in the Ammon, Idaho model is in the 67 percent to 70 percent range.[74]

2. Each subscriber is required to pay a $3,000 infrastructure fee. This fee can be paid upfront or financed over 20 years through a Local Improvement District (LID).
3. Each subscriber pays the City the monthly infrastructure fee (if financed) and a monthly operations and maintenance fee. As in the case of the Open Access Model, each subscriber chooses its ISP and pays a fee according to the services to which they subscribe.
4. In the Open Access Model, the City is responsible for provisioning services to customers, while the partner is responsible for purchasing, maintaining, and replenishing CPE.

The Ammon Model is not a new concept; it originated in Sweden on the mid 2000s. This model has had success in some communities in Europe, but has not taken hold in the U.S. to date. The most notable attempt was with the Utah Telecommunication Open Infrastructure Agency (UTOPIA) in Utah. The UTOPIA network was developed by an intergovernmental agency (also known as "UTOPIA") consisting of 11 localities in Utah that pledged a percentage of their sales tax revenue to guarantee municipal bonds to finance construction of an FTTP network. The idea was that subscriber revenues from service delivered over the network would be sufficient to avoid having to use tax revenues as a backstop, but those revenues have not been realized.

Although UTOPIA also pursued additional avenues to fund the network, such as grants, it has had difficulty meeting its financial obligations over the years since its inception. UTOPIA has undergone several changes since it started, largely to better meet its bonding requirements and spare its member localities from bearing a huge financial burden. In one of its "reboots," UTOPIA tried boosting its subscriber base in the late 2000s by introducing a variation of the Ammon Model. It found that in the UTOPIA communities, residents were unwilling to commit to the infrastructure payment requirement—either upfront or financed.

Regardless of the model and model variations, they all have common elements:

1. The cost of deploying FTTP infrastructure varies greatly from one community to another.

[73] Known as a demand aggregation model, this approach was popularized by Google Fiber in its Kansas City deployment.

[74] Bruce Patterson, Jeff Christensen, and Robert Peterson. "Ammon Model – City of Ammon Fiber to the Home (FTTH) Financial Model," EntryPoint Networks, December 1, 2016, http://nebula.wsimg.com/99a57bed48ed681cefd00d5d93300073?AccessKeyId=271CF39A6BCEFBB43830&disposition=0&alloworigin=1 (accessed October 30, 2017)

2. The operations and maintenance costs will vary greatly from one organization to another based on buying power, leverage of similar resource requirements, and other factors.
3. The demand for new services will vary greatly based on competition in the market, as well as the demographics in the community (age, income, and education are primary factors).
4. Ultimately, the cost recovery of the **FTTP infrastructure** comes from direct or indirect payments from the residents and businesses in the community.
5. The cost recovery of the **FTTP operations and maintenance** ultimately comes from direct or indirect payments from the residents and businesses in the community.
6. The cost recovery of the **operations and maintenance costs related to delivery of services** ultimately comes from direct or indirect payments from the residents and businesses in the community.

Put simply, the models and their variations are just different ways of slicing and distributing the pie. Costs must be recovered in some way, and, in the end, the implementation and operational cost are distributed among the residents and businesses of the community.

7.3.5.3 Open Access Model Scenario 3: Ammon, ID Model in Spring Hill

If the City were to operate using the same model as Ammon, ID, in which it is responsible for CPE, obtains a $3,000 connection fee from each subscriber, and receives $34 per month per residential subscriber and $44 per month per business subscriber at a 67 percent take rate, the model would generate a deficit of nearly $10.6 million by the end of year 20. We assume the City will bond $6.7 million in this model.

As shown in Table 72, provided all other assumptions remain the same as our base case, the model will not generate a positive net income throughout, and the City's cumulative unrestricted cash balance will only carry a surplus at the end of year one. By year five, the City will have a deficit of over $490,000, growing to almost $10.6 million by the end of year 20.

Table 72: Open Access Model Scenario 3 Financial Summary – Ammon, ID Model

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$324,360	$777,912	$777,912	$777,912	$777,912
Total Cash Expenses	(465,530)	(695,930)	(695,930)	(695,930)	(695,930)
Depreciation	(195,480)	(737,350)	(682,460)	(667,680)	(667,680)
Interest Expense	(84,000)	(188,640)	(138,090)	(81,220)	(13,610)
Taxes	-	-	-	-	-
Net Income	$(420,650)	$(844,008)	$(738,568)	$(666,918)	$(599,308)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$7,430	$(490,416)	$(3,890,276)	$(7,234,436)	$(10,576,886)
Depreciation Reserve	-	545,640	744,260	290,500	427,940
Total Cash Balance	$7,430	$55,224	$(3,146,016)	$(6,943,936)	$(10,148,946)

7.3.5.4 Open Access Model Scenario 4: Ammon, ID Model with $60 Residential RSP Fee

For the Ammon, ID model to work in Spring Hill, the City would need to charge $60 per month per residential passing and $70 per month per business passing for the enterprise to cash flow. We assume the City will bond $5.5 million, and that all other assumptions, including take rate, remain the same as our base case.

Table 73 shows a financial summary for this model. As shown, though the model will not generate a positive net income in 20 years, it will be operable. By the end of year one, the City will have a surplus of just over $37,000, growing to almost $328,000 by the end of year 10, and almost $451,900 by the end of year 20.

Table 73: Open Access Model Scenario 4 Financial Summary – Ammon, ID Model with $60 Residential RSP Fee

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$354,000	$1,364,160	$1,364,160	$1,364,160	$1,364,160
Total Cash Expenses	(465,530)	(695,930)	(695,930)	(695,930)	(695,930)
Depreciation	(195,480)	(737,350)	(682,460)	(667,680)	(667,680)
Interest Expense	(84,000)	(152,910)	(111,780)	(65,810)	(10,850)
Taxes	-	-	-	-	-
Net Income	$(391,010)	$(222,030)	$(126,010)	$(65,260)	$(10,300)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$37,070	$322,610	$327,990	$389,070	$451,860
Depreciation Reserve	-	545,640	744,260	290,500	427,940
Total Cash Balance	$37,070	$868,250	$1,072,250	$679,570	$879,800

Appendix A: Dig-Once Policy

As the City of Spring Hill, Kansas (City) considers options for improving access to broadband throughout the community, one of the primary challenges associated with any scenario it may pursue involves the high cost of installing underground conduit for running fiber.

By encouraging coordination and incentivizing efforts between the City and the private sector when excavating the public right-of-way (PROW), as well as making optimal use of City road and utility projects—an approach referred to as "Dig Once"—the City can protect the PROW, minimize disruptions associated with construction projects, and significantly reduce the costs typically associated with the installation of utilities and conduit. Once the PROW becomes crowded, the options for future construction are reduced, leaving only less desirable methods and more costly locations for construction of additional infrastructure.

A Dig Once approach is also beneficial to the City in greenfield deployments to reduce construction costs associated with future communications facilities. This is a key consideration as the City continues to expand and new developments and roads are constructed.

Benefits of Dig Once

Dig Once policies reduce the long-term cost of building communications facilities by capitalizing on significant economies of scale through:

1. Coordination of fiber and conduit construction with utility construction and other scheduled disruptive activities in the PROW, such as road, sewer, or sidewalk construction
2. Construction of spare conduit capacity where multiple service providers or entities may require infrastructure

These economies of scale exist because fiber optic cables and conduit are relatively inexpensive, often contributing less than one-quarter of the total cost of new construction. While material costs typically fall well below $40,000 per mile (even for large cables containing hundreds of fiber strands), the costs of labor, permitting, and engineering commonly drive the total fiber construction price toward $200,000 per mile for standalone projects.

Dig Once opportunities reduce the cost of a fiber optic build to support connectivity to government facilities and institutions, or last-mile construction to homes and businesses. And, if private sector providers lease space in City infrastructure to deliver high-speed wired or wireless broadband services, the leases create a long-term revenue stream for the City.

Besides reducing overall utility- and telecommunications-related costs of all underground work in the PROW, Dig Once policies facilitate private communications network deployment into underserved or hard-to-reach areas. The incremental placement of conduit through a Dig Once policy will help to create additional options for providers. This can promote connectivity to broadband service in areas that might not otherwise be justifiable from a cost-benefit perspective for private sector providers.

Dig Once Recommendations for the City

Dig Once efforts have taken many different forms around the country (see examples below). Dig Once approaches range from implementing business processes to adopting legislative measures that enforce standards and specifications for additional conduits that can be used by the City or leased to other companies. The business processes might include offering favorable terms in master agreements, such as use of government buildings or properties for hub facilities, or reduced costs for placements on City infrastructure, such as buildings or light poles.

We recommend that the City take the following steps based on our experience developing related ordinances, specifications, and guidelines for other municipalities and in accordance with best practices related to Dig Once policies:

7) Develop a procedure to systematically track and manage construction projects in the PROW, and to create a repository of data on existing infrastructure
8) Prioritize future projects suitable for Dig Once conduit construction, based on a scoring mechanism
9) Estimate incremental costs for Dig Once conduit construction during a project's design stage
10) Facilitate coordination with excavators
11) Evaluate Dig Once considerations during new project bids
12) Develop a standard engineering specification for Dig Once conduit

Transportation and utility projects are immediate opportunities for Dig Once coordination. The City can potentially work in parallel to implement coordination with non-City utilities through filing requirements and timely outreach.

We note, too, that while Dig Once promises many benefits to the City and the public, Dig Once construction is still costly—so the City should strive to implement policies in a cost-effective and useful way. Communication between the City and the companies that would potentially use the conduit is critically important. The City's IT and GIS staff play a key role in tracking infrastructure and sharing information.

In short, a Dig Once approach would seek to create opportunities for collaboration among the City, utility operators, and commercial broadband providers with the goals of:

- Maximizing the usable space with the PROW;
- Reducing disruption to the public associated with new construction;
- Reducing the cost of deploying new broadband infrastructure; and
- Extending the lifespan of roadway and sidewalk surfaces.

Implementing New Policies to Support Infrastructure Development in City Rights-of-Way

The City would benefit from developing a process to track planned, ongoing, and completed excavation in a timely way and for identifying and prioritizing potential projects for City participation through this comprehensive Dig Once policy approach. We also recommend the City develop a way to quickly notify interested parties and to coordinate participation with excavators. The impact on the excavator can be minimized by using a well-defined process that minimizes delays.

Develop a Procedure to Track and Manage Infrastructure

At a high level, we recommend the following type of procedure. First, it is important for the City to be aware of its needs for fiber optics and the needs of other potential users. These can be mapped as potential sites, neighborhoods, or corridors of interest based on reporting from City departments and discussions with service providers.

These areas of interest should feed into a prioritization plan, such as the one described in Section 0. This will enable the City to quickly identify whether a proposed excavation should be part of Dig Once.

The City should make efforts to be aware of excavation as soon as possible. For excavation initiated by the City, opportunities should be reviewed with the departments that initiate them. The City could require that any City project involving excavation (such as road restoration or sewer installation) that is paid for or overseen by the City should include a default installation of conduit, unless the project lead overseeing the project can demonstrate why such a requirement cannot be met.

For those projects initiated by private developers, there should be regular consultations with utilities to discuss and identify projects long before they are designed and permitted (Section 0).

To evaluate the best-fit option available for coordinated construction and installation of Dig Once conduit, it will be important for the City to have a mechanism to identify which projects are planned, which have entered construction, what the target dates are, and which projects are completed.

If the City identifies an area as a likely Dig Once opportunity, it should require that the excavator submit plans and incremental cost estimates to the City prior to permitting; the plans would need to include conduit per the Dig Once specifications. The City should review the plans and cost estimates for consistency with Dig Once requirements (Section 3). If the plans are compliant and the cost estimates reasonable per local costs and industry standards, the project would proceed as proposed; otherwise, the applicant would need to resubmit compliant plans.[75] If the City and the applicant were to reach an agreement, the City could issue an approval; if not, the City could still decline to participate in the project.

After the excavator installs the conduit, the City should inspect the conduit for quality and compliance with the Dig Once requirements. If the conduit were compliant, the excavator would submit as-built information. If the conduit was not compliant, the excavator and the City would negotiate a remedy, and the excavator would perform the negotiated remedy. The City would then re-inspect the conduit; if, upon reinspection, the conduit was compliant, the excavator would submit the as-built information and request reimbursement.

The excavator's as-built information should include scale plans of the completed project, including:

1. Vertical and horizontal position of conduit and vaults
2. GPS coordinates for manholes
3. Edge-of-curb offset measurement every 50 feet
4. Colors, diameters, and materials of conduit

In addition, the excavators responsible for any permitted infrastructure, even if not Dig Once, should be required to submit final design drawings so that the City can maintain an inventory of broadband infrastructure options, whether for City use or for access by the public.

This information can be made accessible through a GIS platform along with details on capital improvement projects. The City would need to address potential concerns of sharing proprietary information with competitors, potentially by requiring a non-disclosure agreement

[75] Based on our experience, a typical benchmark range for incremental labor and materials for adding two additional conduits to a two-conduit trench or bore, in the same bank, is approximately 25 percent to 33 percent of the cost of the original two-conduit project. The percentage is likely to be lower if the original project is a larger-scale project, such as a water or sewer project.

(NDA), and by controlling access (via credentials) to information shared with the City that other registered parties would not be able to see.

Criteria to Prioritize Projects for Building

Because of the costs associated with conduit engineering and installation, even as part of a Dig Once framework, it is necessary to prioritize construction to ensure that 1) priorities are identified when Dig Once opportunities emerge, and 2) resources are not wasted in designing and building conduit that is unlikely to be used.

We observe that the following factors typically result in less useful conduit, based on our experience in a range of Dig Once settings:

- Ability to use utility poles along the same path with a reasonable cost of attachment
- Excavation projects that extend only a short distance, such as for a few blocks
- Excavation projects isolated from other projects and existing fiber and conduit infrastructure
- Excavation projects in parts of low-density residential areas, not in proximity to City facilities, community institutions, or large developments
- Excavation projects that only affect the top layer of the street

We also note that the cost of conduit construction is approximately 50 percent higher in Dig Once opportunities where the excavator is not digging a trench, or where the trench cannot be shared or needs to be widened for placement of the Dig Once conduit.

To ensure that Dig Once projects are both financially feasible and consistent with the City's long-term goals, we recommend prioritization based on the following factors:

1. Ability to place conduit over long, continuous corridors
2. Proximity of the project to government and community anchor facilities requiring service
3. Lack of existing locality communications infrastructure in the vicinity
4. Potential interest in conduit from partners or customers (e.g., government departments, service providers, or developers)
5. Lack of cost-effective alternatives due to physical constraints in the vicinity (e.g., targets of opportunity such as bridges or freeway underpasses)

6. Lack of capacity on utility poles along the route
7. Low risk to Dig Once communications infrastructure (e.g., electrical and communications conduit in Dig Once construction is in closer proximity to the Dig Once conduit than other types of utilities, making the Dig Once conduit more visible to the excavator and therefore easier to avoid in the event the excavator's conduit needs to be repaired)
8. Limited delays to critical infrastructure (i.e., the incremental days for Dig Once coordination must not create a public safety risk)
9. Beneficial project cost (i.e., prioritizing projects with lower-than-average costs)
10. Synergies with opportunistic major projects, such as highway, mass transit, or bridge replacement
11. Plans for major PROW crossings, such as railroad, water, highway, or interstate, which are often difficult for private carriers to facilitate or justify
12. Conduit placement for building fiber into key sites, data centers, or facilities deemed potential targets for redevelopment

As opportunities emerge, or as existing opportunities are reviewed, we recommend they be evaluated, scored using the criteria above, and then ranked.

Estimation of Incremental Costs

The City needs to understand the incremental costs associated with design and construction of the additional infrastructure to determine whether the project is a good opportunity for Dig Once. We recommend providing exceptions or foregoing the excess conduit construction if the cost-benefit analysis does not show a reasonable outcome.

To assess the costs and benefits, we recommend the City examine both the likely public and institutional need for the conduit, and separately reach out to private sector service providers to determine their interest. If the incremental construction and maintenance cost is less than the estimated benefit over a period of 20 years, the conduit, as a long-term asset, is a good value. It is important to also include the benefit in reduced damage and disruption to roads and the PROW, and the placement of conduit in a compact, efficient place in busy PROW that otherwise would become crowded with each uncoordinated conduit placed in the future.

For cost estimation purposes, the incremental cost is the cost of additional materials (conduit, vaults, location tape, building materials) and labor (incremental engineering, incremental design, placement and assembly of incremental conduit, placement of incremental vaults, interconnection, testing, and documentation).

The cost does not have to include roadway or sidewalk restoration or paving (which we assume to be part of the original project) beyond that which is specifically required for the placement of vaults for the City's conduit within paved or concrete surfaces outside of the original project boundaries.

In a trenching project, where trenches are joint, the cost would not include trenching or backfilling. Where the Dig Once trench is separate from the original trench, the incremental cost would include trenching and backfill, but would not include repaving or restoring the road surface (again, assumed to be part of the original project).

Average costs may be derived based on multiple contractor pricing schedules. As the City gains experience by participating in projects, it will develop a more accurate sense of cost.

Coordination with Excavators

Coordinating with excavators—potentially through quarterly outreach or filing requirements—is an important best practice, even if only City excavators are engaged. The earlier opportunities are known, the earlier they can be considered for Dig Once. This enables (but does not guarantee) more coordination among excavators, earlier engineering, and lower costs.

We recommend the City consider notifying excavators as soon as possible of excavation projects where they may be able to take advantage of joint trenching. A formal timeline, such as a 60-day window for excavators to decide whether and how to participate, will allow a reasonable amount of time for decision making.

Greenfield Deployments

During the construction of new neighborhoods, particularly in rural areas (or rural areas that are becoming suburban), conduit may be installed as part of backbone routes as well as connections to each individual building on all new or expanded roads. The main roads could have a bank of three or more two-inch conduit, and two (2) two-inch conduit may be placed along secondary routes. This plan will provide maximum flexibility for future needs. The construction costs will be substantially lower than a build in which construction will disrupt traffic and commerce and damage streets and sidewalks. Additionally, construction in a planned bank will reduce the amount of space used by the conduit, relative to separate builds. The City may wish to have more detailed discussions with potential users of the conduit to optimize the capacity decisions along the various routes.

In greenfield construction, where open ground is available, trenching is probably the most cost-effective choice. We recommend placement under grass parkway (if it exists) between the sidewalk and the road, or under the sidewalk. This will provide greater accessibility in the event of repairs, relative to installation under the road, and will enable the use of more cost-effective manholes.

Updating the City's Engineering Standards and Specifications to Support Dig Once

The City's Technical Specifications for Public Improvement Projects[76] addresses aspects of protecting the PROW but also needs a mechanism for service providers to participate in a joint trench process and place excess conduit capacity for future use. If the City seeks to implement a Dig Once policy that requires construction of additional conduit for fiber optic capacity, we recommend it develop standards and specifications to expedite planning and decision making, to take advantage of opportunities as they emerge. We have provided a sample approach below.

The challenge in developing a standard specification for a Dig Once project is to incorporate the requirements of known and unknown users, and to provide sufficient capacity and capability without excessive costs.

The following factors may be considered in developing a conduit specification:

1. Capacity—sufficient conduit needs to be installed, and that conduit needs to have sufficient internal diameter to accommodate future users' cables and to be segmented to enable conduit to be shared or cables added at a future date.

2. Segmentation—users need to have the appropriate level of separation from each other for commercial, security, or operational reasons.

3. Access—vaults and handholes need to be placed to provide access to conduit and the ability to pull fiber. Vaults need to be spaced to minimize the cost of extending conduit to buildings and other facilities that may be served by fiber.

4. Costs—materials beyond those that are likely to be needed will add cost, as will the incremental labor to construct them. Beyond a certain point, trenches need to be widened or deepened to accommodate conduit.

5. Robustness—the materials, construction standards, and placement need to reasonably protect the users' fiber, and not unduly complicate maintenance and repairs.

[76] http://www.springhillks.com/DocumentCenter/View/247, accessed October 2017.

6. Architecture—sweeps, bend radius, and vault sizes need to be appropriate for all potential sizes of fiber.

We recommend further discussions with private carriers to better develop a specification. It may also be appropriate to have a different specification for different projects. Based on our knowledge of a range of Dig Once efforts, we believe the following sample approach is suitable for major corridors and can be modified as discussions proceed with excavators in the PROW:

- Two 2-inch spare conduit, minimum SDR 11 HDPE, each of a separate color or unique striping to simplify identification of conduits within vaults and between vaults, in the event conduit must be accessed or repaired at intermediate points; of the two 2-inch conduit, one conduit may be reserved for use by a specific City department and the other for the general City use
- Composite vaults sized for the likely number of cables, placed in the sidewalk or available green space within the PROW, as close to the curb or gutter as possible
- Vaults spaced at intervals of 600 feet or less, typically at intersections (in urban and suburban areas)
- Sweeping conduit bends with a minimum radius of 36 inches to allow cable to be pulled without exceeding pull-tension thresholds when placing high-count fiber cables (e.g., 864-count)
- Conduit placed in the same trench directly above the excavator's infrastructure or, where this is not possible, placed with minimum horizontal offset to minimize cost

Typical drawings contain the recommended standards for depth, bend, location, location tape, and vaults/handholes. Figure 25 (below) is a typical diagram showing Dig Once coordination with a communications excavator. Figure 26 (below) is a typical diagram showing Dig Once coordination with a water, power, or sewer excavator, and provides two options—one with Dig Once conduit directly above the utility, and one with Dig Once conduit offset laterally.

Ideally, the Dig Once conduit is placed over the excavator utilities. This reduces or eliminates the need for additional trenching and would incur the lowest incremental cost. With the permission of the utility owner, it may be possible to place the Dig Once conduit directly over the utility conduit (see "Model A" in Figure 26, below). Reducing the clearance between the utility and the Dig Once conduit will reduce or eliminate any incremental excavation to accommodate the Dig Once conduit.

In some scenarios, the conduit may need to be offset horizontally from the utility Infrastructure. This may be the case where the infrastructure is a water pipe that should be offset for ease of maintenance. Offsetting the Dig Once conduit may also reduce the risk of the conduit being damaged by a broken water pipe or by repair to that pipe. “Model B” in Figure 26 depicts a Dig Once scenario in an offset trench.

These scenarios assume that the City has identified a given corridor as suitable for conduit installation, and that it has justified the incremental cost and effort for installation, potentially based on a standard set of criteria.

It is important to note that the above approach is designed to create consistency and predictability in costs and deployment, and is a compromise among the potential users. Some users might prefer larger conduit for consistency with earlier builds. Others might seek a larger count of smaller conduit, to provide more flexibility. If an excavation project has a longer timeline and sufficient budget, it is possible to customize the Dig Once build, potentially adding conduit or adding vaults at certain locations.

The City can express a willingness to work with the excavator on an approach suited to the excavator’s project.

We also recommend the City be open to a wide range of specifications, such as having additional microduct installed at the time of microtrenching by telecommunications providers.[77] In this case, the City can require the provider to install a City microduct and terminate the City microduct in designated handholes.

We suggest that the City require that all handholes have custom covers for easy identification. Labeling the covers with the owner’s name will help reduce problems with locates, repair, and abandonment.

[77] Microtrenching is an increasingly common construction approach in urban and congested areas, especially for installation from the road to premises, or for connection to wireless infrastructure.

Figure 25: Typical Diagram – Dig Once Coordination with a Communications Excavator

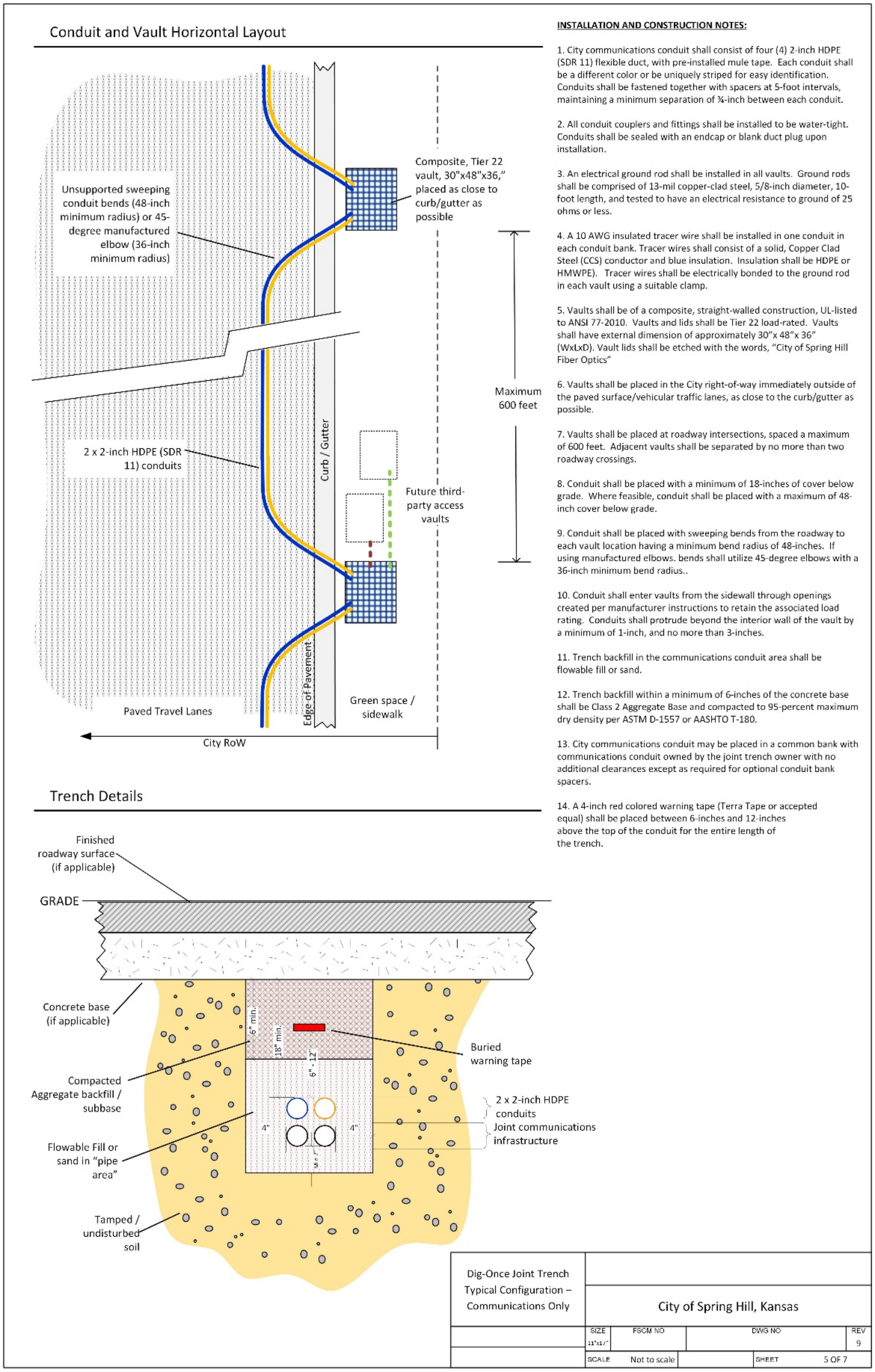
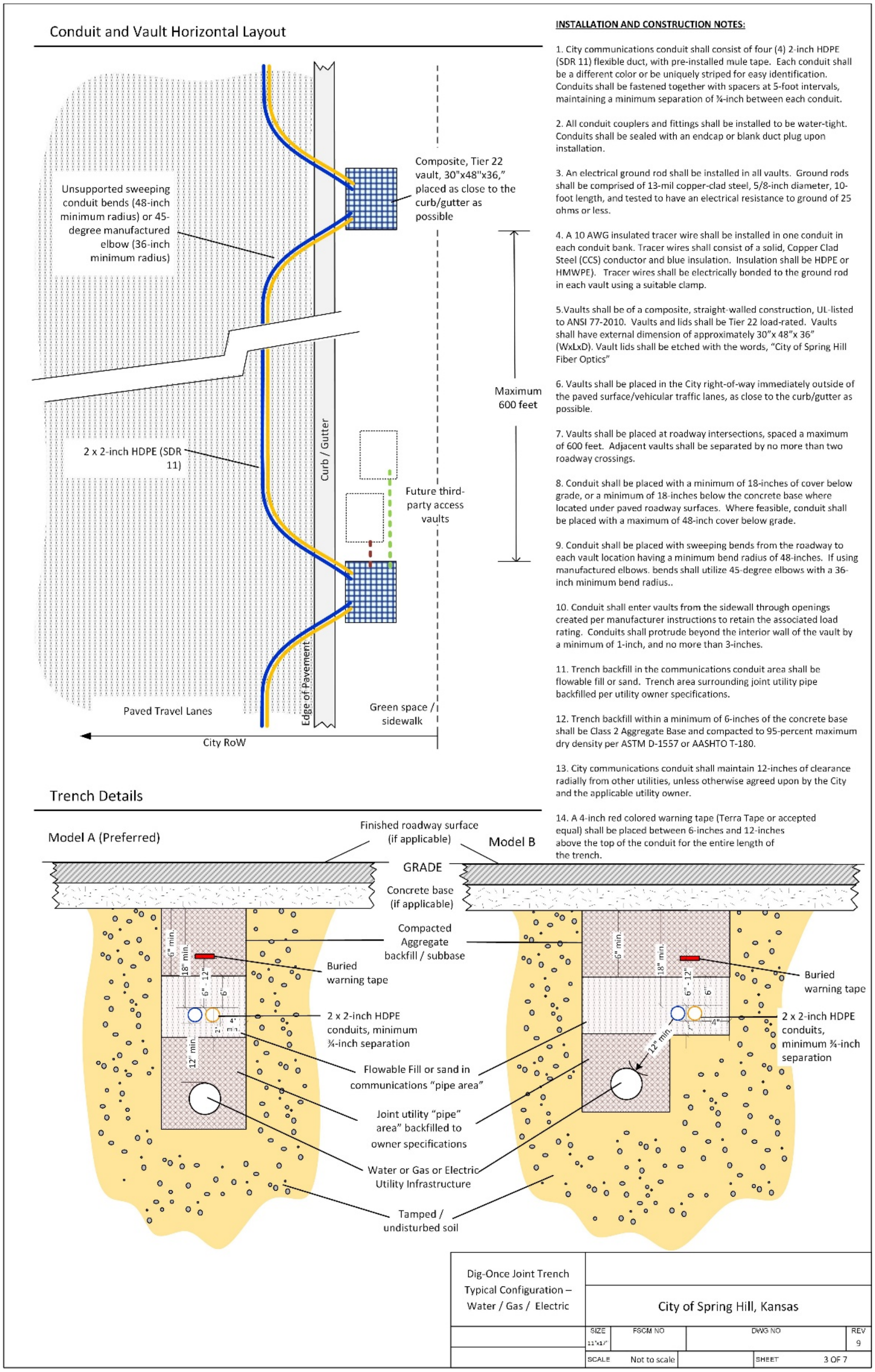


Figure 26: Typical Diagram – Dig Once Coordination with a Water, Power, or Sewer Excavator



Dig Once Policies Across the Country

Cities and counties across the country have developed and implemented Dig Once policies. The primary motivation for municipalities has been to preserve the PROW and improve the telecommunications competition in the market.

The following are a range of policies we have seen. Table 74, below, summarizes the different examples.

a. Boston, Massachusetts was one of the first major cities in the country to implement a Dig Once policy, adopted in 1988. In the first few years of adoption, all excavators in the PROW were required to install a bank of four 1.5-inch conduit during construction. The cost to lease the conduit was a one-time fee of the inflation-adjusted value of the original construction cost of the conduit,[78] plus an annual fee of $5 per foot.

   The quality of the conduit varied greatly across the system, however, and the service attracted few users. The costs associated with leasing were high, and there was no discount to reflect the decreased value of the conduit due to depreciation. Potential users of the conduit often chose to build on parallel streets. Thus, the extent to which this policy became successful depended on factors such as cost and demand for interconnectivity.

   The City is now in the process of conducting a survey to assess the quality of the existing conduit. Over the past year, the policy was modified to require excavators to install 4-inch shadow conduit for the City and other future users. Future users will be required to lease space in the conduit from the shadow builder before being allowed to dig again in that corridor. The lease price is a lump sum of the present value of $200,000 for the right of entry (or equivalent) in addition to an annual fee of $5 per foot. The City also has a five-year moratorium once construction in a particular PROW takes place (i.e., a new excavator in that location would have to conduct restoration from curb to curb).

b. The City of Berkeley, California does not have a Dig Once ordinance but it has municipal policies aimed at reducing the impact of construction in the PROW for telecommunications systems. These policies mandate that any excess capacity in existing or future duct, conduit, manholes, or handholes be made available by the excavator for use by third parties. Also, a prospective excavator would have to coordinate major construction efforts in the PROW with other utility companies through City-sponsored utility coordination meetings. In new developments, a provider would

[78] The user pays for the fraction of the bank used. If the user uses one of the four conduits, it pays one-fourth of the construction cost.

contact the developer to determine whether any surplus conduit exists and whether any joint trenching or boring projects are feasible.

In a new installation that would require excavation, the provider shall install within existing infrastructure whenever sufficient excess capacity is available on reasonable financial terms. Also, the City does not allow a company to excavate if the street has been reconstructed in the preceding five-year period.

c. The City of Bellevue, Washington does not have a Dig Once requirement. However, the City conditions development projects on the excavator providing the City with conduit through the length of the frontage and possible street lighting and/or signal upgrades. Every transportation project that constructs on the sidewalk is required to install conduit.

d. The Central Coast Broadband Consortium (CCBC) is a group of local governments that aims to promote broadband availability, access, and adoption in Monterey, Santa Cruz, and San Benito counties in California. The CCBC has developed a model shadow conduit policy for the local governments that would allow for the installation of additional conduit in the PROW when a construction permit is requested by a telecommunications or utility service provider.

The model policy would allow the jurisdiction to open a 60-day window to notify all other known telecommunications and utility providers to allow coordination with the placement of conduit in the PROW. The permit applicant would be the lead company and the other providers would piggyback on the installation. Under California law, the lead company can charge fees for the installation of communications conduit in the PROW. One of the CCBC's policy goals is to increase competition by reducing the cost of entry for future service providers.

e. The City of Gonzales, California developed a Dig Once policy for public works projects, including construction and maintenance of transportation and utility infrastructure. Excavators in the PROW are required to install communications conduit. An exception is allowed if the City determines there is insufficient cost benefit. The City developed common standards related to the conduit, including:

- Use of PVC Schedule 40 material (color orange)
- Laid to a depth of not less than 18 inches below grade in concrete sidewalk areas, and not less than 30 inches below finished grade in all other areas when feasible, or the maximum feasible depth otherwise

- A minimum 2-inch diameter

The costs associated with the installation of the conduit are covered by the public works budget, and the City owns the conduit.

f. The City of Mesa, Arizona, over the period of several years, built over one hundred miles of communications conduit along widened arterial and new freeway roads and in canal pathways. The conduit was built according to industry standards and with access vaults for ready interconnection. Through coordinating with the road construction and canal maintenance, the conduit construction was completed at the incremental material and labor costs, ranging from 10 percent to 30 percent of the cost of what construction would have cost if it were not coordinated with construction projects. The City has also placed fiber in abandoned water and sewer pipes. The conduit reaches throughout the spread-out community, which has an area comparable to that of Phoenix. Conduit has been used to provide service to an industrial development near the former Williams Air Force Base, which includes the Apple data global command data center, was leased to the cable operator and several telecommunications and service providers, and was used to place fiber for the City's government network.

g. The City of Santa Cruz, California implemented a Dig Once policy with the primary goal of fostering telecommunications market competition and creating a provision for the installation or upgrade of telecommunications cable or conduit for City use. Staff notifies all excavators in the City of the opportunity to join the open trench and helps coordinate efforts for multiple parties to join the dig. City staff works with contractors to identify the most cost-effective approach consistent with City requirements to obtain upgrades in the PROW. The City also enacted a moratorium on standalone construction in the excavation area to protect the PROW after the excavation.

h. The City of San Francisco, California developed a Dig Once ordinance that modifies the City's Department of Public Works (DPW) Code provisions governing utility excavation—specifically, the Code's requirements for coordination.[79] DPW can only approve an application for an excavation permit if the applicant's plans include the installation of communications facilities (e.g., conduit) that meet Department of Technology (DT) specifications, unless DT has opted out of the excavation project.

Excavators (both internal and external) are required to place conduit for the use of DT as well as conduit available for leasing. DT is responsible for the excavator's incremental costs. The City requires the installation of four 1-inch conduit with manholes at regular

[79] "Article 2.4: Excavation in the Public Right-of-Way," Public Works Code, available at: http://tinyurl.com/kqqqop5

intervals. The shadow conduit is required to be placed in a joint trench above the excavator's conduit.

The ordinance was initiated in autumn 2014 and adopted in 2015. The City is now in the process of prioritizing projects (based on a cost-benefit analysis) through a scoring mechanism, because costs are higher with joint build construction. These high costs are typical of urban settings. The City is using its Accela PROW asset management system (formerly Envista), a map-based application, to document and analyze excavator plans, in some cases years ahead of construction, to identify, analyze, and coordinate projects.

i. San Benito County, California has incorporated a Dig Once policy as part of its multi-use streets policy by requiring County roadway construction projects involving more than surface pavement treatment to include underground utility conduit. The County is also a partner in a municipal fiber network and aims to use this policy to expand the network.

j. The City of Sandy, Oregon revised its existing policy to include "broadband infrastructure" to its list of public facilities. In new developments, underground communications conduit became a required improvement to be installed at no expense to the City. The City plans to provide residential internet service via the new conduit through the City-owned ISP SandyNet.

k. The City of Vallejo, California initiated a Dig Once policy to coordinate excavation projects in the PROW and protect the rights of way. As a first step, the City shared documentation of its planned public works projects and shared the information with other potential excavators. Next steps include a process to ascertain and document planned excavation by other carriers, and strengthening enforcement of City moratorium requirements as an incentive for excavators to take advantage of opportunities to coordinate excavation.

l. In Arlington County, Virginia a large electric utility project by Dominion Virginia Power, an investor-owned utility, required construction of underground conduit along many miles of congested urban PROW. As part of the utility permitting and coordination, the County entered into an agreement with the utility to construct fiber optics for the County's use in parallel conduit and manholes. The County, which pursued the project independently of any Dig Once ordinance, received cost estimates for each segment in the design phase and decided to proceed based on the estimates. As part of the agreement, the County provided specifications for the conduit and fiber, including:

- Two 4-inch conduit with tracer wire installed at a minimum of 24 inches from the top of the power line trench
- Splice boxes (24 x 36 x 36 inches) located approximately 600 feet apart
- Installation of one set of three 1.25-inch innerduct in each 4-inch conduit
- Installation of one 144-fiber cable in one innerduct of each 4-inch conduit, leaving a 50-foot coil in each

The installation was accepted only after the County had inspected and tested the conduit and fiber, and payment was made thereafter.

Table 74: Sample Dig Once Summaries

Locality/Network	Summary	Costs
(a) City of Boston, MA	• Shadow conduit installation • Conduit system not standardized • Expensive for potential users of conduit	One-time cost: inflation-adjusted value of construction + $5/foot/year
(b) City of Berkeley, CA	• Excess capacity required to be made available for leasing	Determined by lessor of excess capacity
(c) CCBC	• Consortium of local governments developed a model ordinance • Shadow conduit installation • 60-day notification window when permit application is received	Not determined, possibly shared construction costs or charges by lead company
(d) City of Bellevue, WA	• Additional conduit during some capital improvement and development projects • Transportation projects required to install conduit	Funded from City budget
(e) City of Gonzales, CA	• Shadow conduit installation • Standards developed for conduit • Decision to install conduit only if the cost-benefit analysis is favorable	Public Works budget
(f) City of Santa Cruz, CA	• Joint build based on costs • Optional bids for extra ducts	Joint build costs and/or City budget
(g) City of San Francisco, CA	• Shadow conduit installation and conduit available for leasing • Project prioritization based on scoring mechanism	City pays Incremental per-foot costs: $20.07 (shared trench), $29.14 (offset trench)
(h) San Benito County, CA	• Conduit to be constructed as part of County road projects • Coordination with County fiber build	County capital program funds

Locality/Network	Summary	Costs
(i) Sandy, OR	• Conduit became a required facility in new developments	No cost to the City
(j) Arlington County, VA	• Obtained conduit and fiber as part of an agreement for an electric grid upgrade project • County developed specifications and inspected installation	County funds, $392,082 for 21,700 feet

Appendix B: Sample Procurement Document for Fiber-to-the-Premises Network

This Appendix is attached as a separate PDF file.

Appendix C: Dark Fiber-to-the-Premises (Huntsville) Financial Model

This Appendix is attached as a separate Microsoft Excel workbook.

Appendix D: Dark Fiber-to-the-Premises (Westminster) Financial Model

This Appendix is attached as a separate Microsoft Excel workbook.

Appendix E: Municipal Retail Financial Model

This Appendix is attached as a separate Microsoft Excel workbook.

Appendix F: Open Access, Data-Only Fiber-to-the-Premises Financial Model

This Appendix is attached as a separate Microsoft Excel workbook.