



City of Centennial Fiber Master Plan Executive Summary



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Version 1.0

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- The City Centennial and its Associated Departments
- The Fiber Steering Committee; appointed by Centennial City Council
- Centennial City Council
- Arapahoe County
- Arapahoe County Sheriff’s Office
- Arapahoe Library District
- Cherry Creek School District
- Cunningham Fire Protection District
- Littleton Public Schools
- South Metro Fire Rescue Authority
- SPS Innovations, Inc
- Other Centennial Local Businesses



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1. Executive Summary

1.1 Introduction

Forward thinking cities are relying upon municipal fiber-optic (fiber) networks to adapt to the changing digital landscape in their communities. As more municipal functions are carried out online or require interconnectivity, these networks help local governments meet the growing demands of their constituents and the other local public organizations serving them. Municipal fiber networks have also become assets through which municipalities can foster the development of leading edge broadband services in their communities.

The City of Centennial currently owns an existing fiber network that provides connections between traffic signals and City facilities. The network consists of 40 miles of underground fiber-optic cables and conduit that traverse the main corridors of Centennial. Although the network provides a valuable resource to the City today, the opportunities to use this network for other municipal and community purposes are limited by its capacity and reach into much of the area. To pursue any future opportunities, a comprehensive plan to expand Centennial’s foundational fiber network is required.

The City of Centennial has embarked on a multi-year fiber initiative to examine the City’s fiber network to support additional municipal and community needs. Phase 1 of the fiber initiative evaluated the assets and capabilities of the current network and explored potential opportunities for the City to consider using it for a number of additional purposes. Phase 2 (this report) built on the initial work completed in Phase 1 by determining the organizations in Centennial that would utilize the fiber network and creating the network design, cost estimates, financial plan, and roadmap for deployment. The end result of Phase 2’s planning activities is the Fiber Master Plan that the City can consider using to guide expansion of its fiber network using a year-by-year approach.

1.2 Overview of Municipal Fiber Networks

Fiber is the gold standard for municipal communications, broadband services, and Internet access. Fiber is used to transmit large amounts of data securely over long distances with high reliability. It is flexible to support a wide range of applications and scalable to support nearly unlimited capacity and speed. It is considered a capital infrastructure asset similar to water, road, and electric infrastructure and has a lifespan of up to 50 years.

Over 1,000 cities in the US own some form of municipal fiber networks and have used them for decades to support their operations. These networks are becoming increasingly important to cope with the rapid growth in connected devices, from utility assets, to street lights, to traffic signals, to surveillance cameras. Cities that maintain these networks are able to accommodate these “smart city” technologies that make them more efficient, reduce costs, increase the value they deliver to their constituents, and control their own destinies around these key issues.

Within the past 15 years, some cities have expanded the use of these networks to enhance local broadband services in their communities, to support the needs of residents, businesses, and community organizations. As broadband has become a key aspect to support economic development, education, healthcare, and

other community functions, cities have leveraged their networks to foster fiber-based broadband services, either directly or more often, through partnerships with their local broadband providers.

1.3 Opportunity Statement

Centennial's fiber network can become a long-term asset that supports and enhances the communications and technology needs of the City and its community. Centennial already leads the nation with one of the highest rates of Internet adoption and connection, demonstrating the high level of relevance of the Internet to its citizens. Developing a municipal fiber network will foster the opportunity to make Centennial one of the most connected communities in the country; a city where cutting edge technology and communications services are tested and deployed by leading providers. It will also support the goal to ensure Centennial's citizens and businesses are able to take advantage of all opportunities that the Internet has to offer. The fiber network will become a key resource that the City, in partnership with the private sector, will leverage to drive value across a range of municipal and community functions, from economic development, to education, healthcare, and general quality of life.

1.4 Benefits of a Municipal Fiber Network for Centennial

Municipal & Smart City Services

The network will support the City's current operations and be used as an asset to continue to drive efficiencies, reduce cost, and expand capabilities. The network as proposed is robust, redundant, and reliable. It can become a multi-purpose asset of the City that can be used between departments for multiple applications. Most importantly, it will help the City enhance currently provided community services. With an eye towards the future, many applications and services that are collectively referred to as "Smart City" efforts are not possible without a well-designed fiber backbone. This backbone serves as a means of robust data collection and support infrastructure for identifying problems through data analysis.

The City's Innovation Team (i-team) and the City's Public Works provider, CH2M, have undertaken efforts to optimize the City's Intelligent Transportation System (ITS). This optimization initiative focuses on mitigating the effects the I-25 corridor has on operations of Arapahoe Road and improving the systems integration and fiber interconnects necessary to optimize the transportation network. Examples may include "pushing" information out to motorists through Dynamic Messaging Signs (DMS), communicating with vehicles' on-board computers through infrastructure-to-vehicle systems, and improving first responder performance measurements through ITS. Ultimately, the i-team program and the City's potential Smart City efforts are dependent on the establishment and success of Centennial's municipal fiber backbone.

Economic Development

Economic development will become a key beneficiary of the fiber network. The City's asset can be used as a tool to reduce the cost of doing business in the City while enabling high-speed Internet connectivity to attract and retain business. The dark fiber network will be interconnected to at least two key data centers within the City, which provides a gateway to numerous broadband, cloud, and application providers, increasing the choices local businesses have for their communications and technology needs. The City will be able to actively market areas of Centennial as "fiber ready" and provide prospective businesses with a range of available providers. The City will also be able to develop strategic partnerships with current and future broadband providers to market the benefits of Centennial's network and services to businesses.

Education (School Districts and Arapahoe Library District)

The network will provide a platform of advanced connectivity to support educational needs. Educational institutions around the country have become one of the greatest beneficiaries of municipal fiber networks, and Centennial has an opportunity to take a leadership role locally. As schools increase the amount of online learning programs and tools, they need high-speed, reliable connectivity for their students, teachers, and administrators. Littleton Public Schools has already expressed interest in participating in Centennial's municipal fiber network to enhance connectivity to their schools in and around Centennial. The dark fiber network would also provide a platform for future growth, providing long-term cost certainty and easily allowing for future increases in speed at marginal increases in cost. Cherry Creek School District, although unlikely to immediately participate in the network deployment, could easily connect to the network if new needs arise. Many of Cherry Creek's schools (like Littleton Public Schools) will be in close proximity to the City's fiber network and extending it to their facilities in the future would be an option for the City and the school district.

The network will also pass in close proximity to the Arapahoe Library District's facilities within or near Centennial, including the Smoky Hill, Castlewood, Koelbel, and the Southglenn Libraries, as well as the Administration Building, to support their future connectivity needs.

Public Safety (Fire Districts and Arapahoe County Sheriff's Office)

Public safety agencies in Centennial will benefit from additional connectivity to interconnect agencies with one another and provide added redundancy for mission critical applications. South Metro Fire, Cunningham Fire, and Littleton Fire can benefit from the enhanced speeds and reliability that will come from the network and may utilize its capacity to interconnect their organizations to one another. The network will supplement current connectivity in some areas and replace it in other areas, providing significantly higher speeds at similar costs. The connectivity improvements that could be seen from interconnecting the multiple public safety agencies on a single, robust dark fiber backbone include enhanced dispatch abilities, improved communication in the event of an emergency, and preserving opportunities for future enhancement.

Healthcare

Healthcare organizations are carrying out more of their business operations online. With the transition to electronic healthcare, these organizations and the residents they serve require access to high quality, reliable broadband services. As more virtual healthcare and telehealth services are deployed into residents' homes, these organizations will rely on their connectivity to ensure the health of their patients, which requires high quality broadband for healthcare organizations themselves and within patients' homes. The City's network will have future capabilities and capacity to support Centennial's healthcare organizations, enabling them with fiber connectivity to interconnect hospitals, doctor's offices, clinics, and imaging centers, supporting their implementation of digital healthcare programs for Centennial's citizens.

Leading Edge Broadband (Business and Residential)

A municipal backbone network can become a catalyst to accelerate deployment of leading edge broadband services in Centennial. According to a 2014 Governing magazine article¹, Centennial has some of the highest Internet adoption rates in the country, demonstrating that the Internet has a high level of relevance for its citizens. Development of this network presents an opportunity for the City and private providers to work together to bring the latest fiber-to-the-premise technologies to residents and businesses. By lowering cost barriers to deploy fiber-to-the-premise networks, the City can take an active role by developing public-private partnerships with competitive broadband providers. If successful, these partnerships will yield positive economic and social benefits to the Centennial community.

1.5 Fiber Master Plan Roadmap

Today, Centennial's existing fiber network provides connections to traffic signals and City facilities, enabling communications that support the City's IT and public works departments. Expanding the existing network will allow the City to continue these efforts as well as support more of its municipal functions. The Fiber Master Plan proposes extending the network to additional community organizations and businesses that need fiber connectivity in and around Centennial.

During this phase of the fiber-optic initiative, Magellan Advisors and the City conducted significant stakeholder outreach with these stakeholder organizations and found that many of them had needs for fiber connectivity that could be fulfilled through a municipal fiber network. These organizations supplied detailed information that helped the planning team design the network and project its potential costs, including:

- Individual locations for fiber connectivity;
- Technical and operational requirements;
- Timeframe when connectivity was needed; and
- Potential budget for services*

**In many cases, these organizations indicated that they had budgets to support some of the operational or capital costs that Centennial would bear in building and operating the network.*

Through the opportunity assessment, the following organizations were identified as likely near-term users of the proposed network:

- City of Centennial
- Arapahoe County and Arapahoe County Sheriff's Office
- Arapahoe Library District
- Littleton Public Schools
- South Metro Fire & MetCom
- Cunningham Fire District

In addition, City Council participated in a discussion on the design of the proposed network, providing guidance and feedback that directed the Steering Committee in its work on the Fiber Master Plan and

¹ <http://www.governing.com/topics/transportation-infrastructure/gov-most-connected-cities-2013-internet-adoption-report.html>

network design. As a result of this discussion, the Steering Committee developed Resolution 2015-R-72, recommending City goals for the fiber-optic initiative.

On November 9, 2015 City Council unanimously adopted these goals. Broadly, the goal of the fiber-optic initiative is to “develop fiber infrastructure throughout the City that facilitates access to innovative broadband services for Centennial's residents, businesses, and community institutions.” These goals also include:

- Ensuring long-term viability of any infrastructure;
- Enabling the private sector to deliver services; and
- Examining innovative approaches and participation by Centennial.

The core backbone network design and the Fiber Master Plan fulfill these goals while preserving future opportunities. The backbone was designed with three principles in mind:

1. Identify backbone routes that could support connections to community anchor institutions;
2. Identify backbone routes that could support connections for businesses; and
3. Identify backbone routes that could support connections for residences.

Based on the conversations with stakeholders and Council’s direction, a conceptual design was developed for the fiber backbone. The backbone, otherwise known as the “core network,” provides high capacity fiber-optic cables throughout the major corridors of the City. It incorporates the 40 miles of existing City owned conduit and fiber with additional new construction to result in approximately 60 miles of a robust, redundant, and reliable City-wide backbone fiber network. The backbone will be provisioned with high-count fiber-optic cables that supply ample capacity to support current and future needs.

Additional public agencies or private companies may be interested in participating in the development and deployment of a backbone network, although these opportunities were not fully explored. The City should actively pursue and remain open to any additional partners that may wish to participate in the construction, deployment, and use of the proposed backbone network.

The backbone connects to each organization, supplying direct fiber connectivity between their facilities. It has been designed with provisions for high redundancy, ensuring that these organizations maintain reliable connectivity to support their critical business applications. It also provides numerous “access points” that support the attachment of future devices, facilities, and applications that the City and other organizations may utilize in the future. As new smart city technologies are developed in transportation, utilities management, energy management, safety, surveillance, and community development, Centennial’s fiber network will be an asset to support these connected applications and drive innovation for the City.

In addition to the municipal and community functions supported by the network, it may become a platform to expand access to leading edge broadband services for Centennial’s businesses and residents. The network has been designed to pass major business and residential districts with available capacity to support future deployments of fiber-to-the-home (and business) services. Although the City does not intend to directly provide any retail broadband or telecommunications services, the City will seek input from broadband providers, telecom companies, and other parties interested in using the network to deliver services to businesses and residents. A Request for Interest (RFI) was released to solicit potential interest from these entities on how they would utilize the network in partnership with the City. The results of this RFI and additional ongoing outreach may influence future City direction.

Ultimately, the Fiber Master Plan represents the next step for the Fiber-Optic Initiative. The network design and master plan fulfill City goals by developing a viable operational model, bringing fiber-optic infrastructure closer to neighborhoods and business corridors, and potentially lowering the costs and other barriers of deployment for private services. Although there is no guarantee that fiber-to-the-home services will ultimately be deployed in Centennial, the City should work with broadband providers to explore all possibilities to do so.

1.6 Financial Summary and Funding

Figure 1 provides an overview of the capital and operational costs incurred in the next 30 months of the project and a recommended request for funding. Capital construction of the backbone network is projected at approximately \$4.7 million. This includes all outside plant materials, anticipated labor, and a contingency to account for certain variables in the labor and commodity markets. Construction has been broken down by the network segments that are utilized by each organization identified through the stakeholder outreach as a user of the network. As these segments are built, they will contribute to the overall Citywide backbone network that will be used for the range of purposes described in the previous section.

In addition to the capital construction of the network, project management, software, operations, and staffing costs will be required to manage the network as it is built and placed into operation. Project management, software, operations, and operational support staffing costs total roughly \$1.0 million until the end of 2018. These costs are included in the recommended request for funding. After construction is complete, the City may consider assessing future funding and governance structures in light of additional interest. The operational model proposed in this document is sustainable for the foreseeable future, but additional opportunities may present themselves.

Overall, the recommended request for funding for the core network is \$5.7 million in 2016. This money is anticipated to cover capital expenditures and operations and maintenance during a construction period that should be completed at the end of 2018. Specific construction phasing has not been identified and funding will not be utilized at one time or in one specific year. This will be an ongoing capital infrastructure project of the City.

Figure 2 illustrates the current projected Operating Income and Net Proceeds for the proposed network, showing total revenue versus total expense. Network revenues will be generated by leasing access to community organizations identified in the Fiber Master Plan. Revenues were estimated by analyzing each organization's budget for connectivity and using this information to establish reasonable, market-sensitive, leasing rates for the City's fiber. Timing of revenues was also taken into account based on these organizations' existing contracts for service.

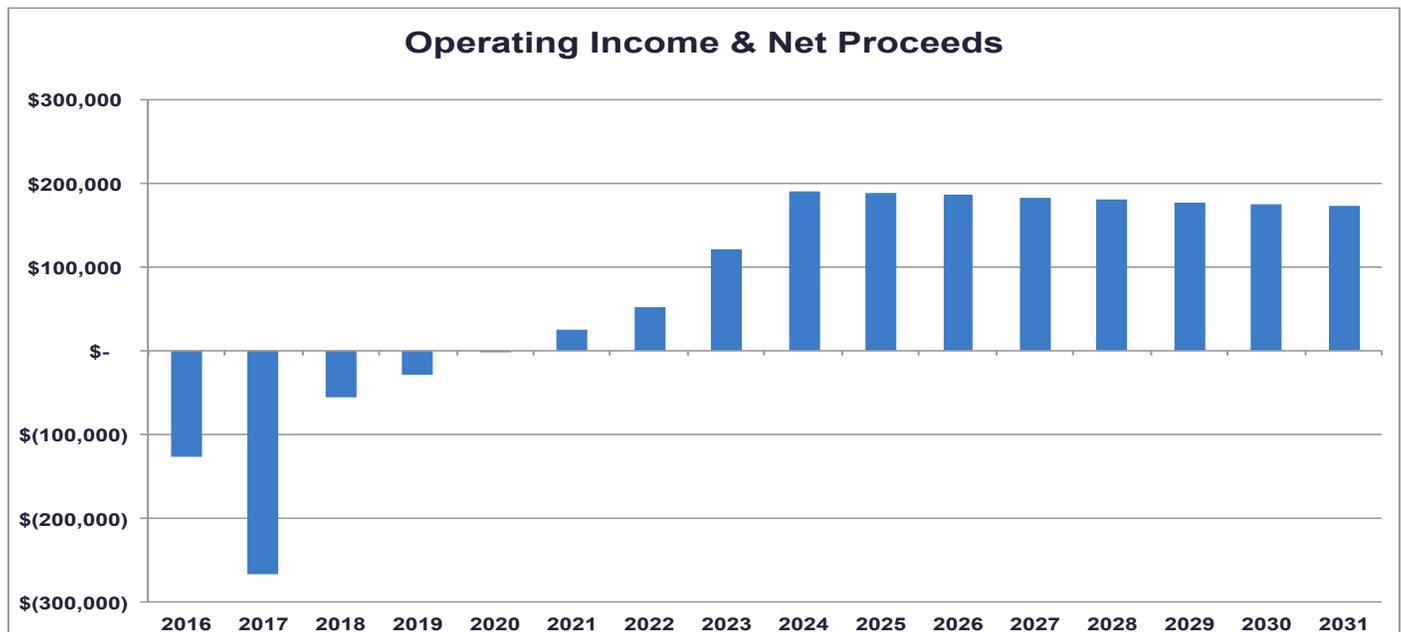
Revenues also include conservative estimates for dark fiber leasing by private broadband providers and other entities that may utilize the City's network. Since the City has not yet determined how broadband providers may partner with the City, this provision allows for some revenue recognition based on the City leasing 20% of the remaining capacity to them over a period of 15 years. These figures are subject to change based on the City's actual negotiation and business model undertaken with broadband providers. Based on the projected revenues, the network is expected to cover its operating costs beginning in year 5 and subsequently thereafter. Based on current analysis, it is unlikely that reduced costs for Centennial and community anchor revenues will solely cover all operating expenses for the network; therefore, subsequent revenues from broadband partnerships or dark fiber leasing are key to achieve positive operating results.

Ultimately, the recommended neutral, open-access, municipal fiber-optic backbone can support additional opportunities, including public-private partnerships, improved service levels and new service models. Without the foundational step of a City-owned backbone, the City cannot begin to consider future possibilities.

Figure 1: Funding Requirements

	2016	2017	2018
Capital Construction Costs²			
West Centennial (west of S. Holly Street)	\$1,389,115		
Central Centennial (S. Holly Street to S. Parker Road)	\$2,150,153		
East Centennial (east of S. Parker Road)	\$1,166,633		
Subtotal: Capital Construction Costs	\$4,705,902		
Operations and Maintenance Costs	\$300,725	\$367,500	\$286,209
Subtotal: Operations and Maintenance Costs	\$340,389	\$367,500	\$286,209
Total Funding Required (2016 – 2018)	\$5,006,627	\$367,500	\$286,209
Recommended Funding Request	\$5,700,000		

Figure 2: Operating Income and Net Proceeds



² As with any capital project, construction may not necessarily occur in the year funding is appropriated. The City should treat the construction of the backbone network as it would any other capital infrastructure project, including the phasing of construction, assessment of alternative options, and constant project management.

1.7 Council Action and Next Steps

Staff is seeking council action to formally accept and adopt the Fiber Master Plan and set aside the funding required for construction and operations of the network. Based on adoption of the plan and availability of funding, Staff will:

1. Seek commitments from community anchor organizations to lease the network from the City;
2. Adjust the network design based on these commitments as necessary;
3. Refine the timeline for construction of the network;
4. Contract for a Fiber General Manager Position; and,
5. Begin procurement for fiber engineering design for the network.