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Preliminary Fiber Network Design and Business Plan Framework

Prepared for the City of Culver City, California
September 2013

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1. Executive Summary

1.1 Background

This report presents a high-level network strategy, design, and business model framework to support Culver City's (City) consideration and planning of a fiber optic backbone and fiber optic connections to key economic development sites. The proposed strategy is designed to further the City's plans to leverage communications infrastructure to promote economic development and to ensure that broadband infrastructure in Culver City evolves over time to meet the needs of its businesses, residents, and public institutions.

As a starting point, this strategy will focus on advancing the availability, affordability, and reliability of connectivity services tailored to the small business market. Further, the strategy focuses on expanding consumer choice. In a perfect market, consumers in Culver City would have access to any connectivity services they desire. Separating the communications infrastructure from the retail service delivery is the first step.

1.2 Methodology

This report was researched and prepared in the summer of 2013 by CTC Technology & Energy (CTC). Over the course of the engagement, CTC performed the following general tasks:

1. Met with key City staff to review economic development objectives.
2. Worked with City staff to identify potential business development areas, which resulted in the identification of five potential "development tracts."
3. Reviewed the potential to leverage existing fiber and conduit assets in serving the identified tracts.
4. Met with business stakeholders and other community representatives selected by the City to review their perceptions regarding availability, reliability, and affordability of connectivity services in each tract.
5. Researched the region's available connectivity services and costs.
6. Prepared a preliminary fiber design (backbone and laterals) to provide redundant connectivity in each identified tract.
7. Held initial discussions with representatives of the City of Santa Monica in regard to their connectivity business model and a potential partnership with Culver City.

8. Initiated conversations with Wilcon and the Los Angeles Department of Water and Power (LADWP) regarding dark fiber leases from Culver City to One Wilshire.

9. Prepared a business model framework for the City's review and consideration.

10. Developed preliminary pro forma financial statements for the City based on initial service pricing and take-rate assumptions.

1.3 Broadband to Businesses Can Create Economic Activity

The literature on broadband and economic development suggests a causal relationship. Broadband is an economic enabler for businesses. From the standpoint of most businesses, broadband has ceased to be a luxury and has become crucial to business functionality.

According to a 2011 survey of building owners and property managers, broadband access is one of the most important decision factors for commercial real estate siting—after price, parking, and location. Similarly, a national survey found that 77 percent of economic development professionals believe that to attract a new business, a community must have broadband of at least 100 Mbps; in other words, they believe that economic development without broadband is essentially inconceivable.

The high speeds that fiber connections provide can facilitate economic development by:

- Enabling job creation and the multiplied economic activity that accompanies it
- Supporting businesses with very high bandwidth needs, such as digital media and software development
- Attracting and retaining businesses of all sizes
- Enabling workforce education
- Enabling telework and distributed work
- Stimulating economic activity
- Promoting major development initiatives such as revitalization zones

A number of studies show that increased broadband speeds have a significant positive effect on economic growth.[1] Data such as these have led to the adoption of new high-level

[1] Press Release: "New study quantifies the impact of broadband speed on GDP," Ericsson, September 27, 2011. (http://www.ericsson.com/news/1550083).

approaches. For example, the U.S. Ignite Partnership grew out of a White House Office of Science and Technology Policy roundtable discussion in January 2011 on how to develop applications that would maximize the benefit of fiber connectivity across the country. The public and private participants in U.S. Ignite are now working "to catalyze approximately 60 advanced, next-gen applications over the next five years in six areas of national priority: education and workforce development, advanced manufacturing, health, transportation, public safety, and clean energy."[2]

1.4 Goals and Objectives

The City's goals and objectives for this project center on the evolution of five identified tracts of buildings—transforming them into areas with the type of robust fiber connectivity options that will attract and retain technology- centric businesses.

For the type of target businesses that the City hopes to attract—small companies, often start-ups, and likely to be in the film and supporting industries because of the proximity to the studios—the availability, affordability, and reliability of high-capacity broadband connectivity is essential.

The identified tracts (see Section 3.2 for maps of each) are:

- Fox Hills
- Hayden
- Jefferson Corridor
- Smiley Blackwelder
- Washington National

The City estimates that more than 80 percent of the buildings in the tracts will have multiple tenants, which indicates that the market for broadband services in the tracts will comprise mostly small businesses. Culver City is considering a fiber deployment in the tracts because, despite the existing service options, there are still connectivity issues in those areas—especially for small technology-centric businesses.

Sharon E. Gillett, Dr. William H. Lehr, et al., "Measuring the Economic Impact of Broadband Deployment," Final Report Prepared for the U.S. Department of Commerce, Economic Development Administration, National Technical Assistance, Training, Research, and Evaluation Project #99-07-13829, February, 2006, (http://cfp.mit.edu/publications/CFP_Papers/Measuring_bb_econ_impact-final.pdf).

Jed Kolko and Davin Reed, "Does Broadband Boost Local Economic Development," Public Policy Institute of California, January 2010, p. 28. (http://www.ppic.org/content/pubs/report/r_110jkr.PDF).

[2] "What is U.S. Ignite?," U.S. Ignite website. http://us-ignite.org/what-is-us-ignite/. One fascinating fact about U.S. Ignite is that it seeks to enable private, commercial development of new, high-bandwidth applications, but most of the network infrastructure it makes available for that development is public—municipal fiber networks that connect many thousands of homes and provide a test-bed for advance application creation.

First, broadband availability is not ubiquitous (e.g., every building, every service). Second, where service is available, the cost of getting a new "drop" connection to an office or other facility is often excessive, even for a large business. And third, the types of available services are not well suited to small businesses. Each tract has a range of available connectivity options, including services such as dark fiber, cable modem, DSL (Digital Subscriber Line), Metro Ethernet, and MPLS (Multiprotocol Label Switching). But most of these services are tailored to either casual users (e.g., cable modem or DSL, which do not meet business performance needs) or large users (e.g., Metro Ethernet or MPLS, which meet business requirements but with unaffordable monthly costs that would represent a substantial portion of many business' ongoing operating costs).

Taken together, these issues drive Culver City's goal to expand its communications infrastructure in these tracts to advance the availability, affordability, and reliability of retail connectivity services tailored to the technology-centric small business market in the identified tracts.

1.5 Fiber Deployment Plan

The City's proposed fiber deployment plan comprises four phases:

1. Implementing a redundant fiber backbone and an access point in each tract as the foundation for future connectivity. The proposed backbone will leverage the City's existing conduit, and was designed so that each tract can be added as needed once the backbone is completed.

2. Deploying fiber laterals in each tract to enable cost-effective connectivity to individual businesses. A key in the lateral design is to ensure that "taps" (where a fiber drop from a building connects to the lateral fiber) are located so that the drop costs are minimized.

3. Extending fiber to community anchor institutions (CAI) such as health care and educational facilities to create additional community benefits.

4. Extending fiber to additional office buildings and multiple dwelling units near the backbone and lateral fiber routes to increase revenue and expand the benefits of the fiber availability.

The estimated cost to create the backbone and build fiber in each of the tracts (i.e., phase 1 and phase 2) is $1.4 million. This cost is just a start, however. The fiber implementation costs include neither the network electronics required to operate the network, nor the fiber drops to connect customers. The total capital costs in the first four years of the plan are $2.45 million ($1.25 million in year 1; $830,000 in year 2; $240,000 in year 3; and $130,000 in year 4).

The complete details of the fiber implementation and network electronics are included in Section 3 and Section 4. Projections regarding phase 1 and phase 2 costs and expenses are included in Section 5. A complete breakdown of the phase 1 and phase 2 capital expenditures by year is presented in Appendix B. (We do not make projections for the deployment costs related to phase 3 or phase 4, because those are long-term concepts that are outside of the scope of this report.)

1.6 Financial Analysis Framework

The City's financial analysis framework is based on the following objectives:

- Leveraging the availability and affordability of enhanced data connectivity as part of an overall business development strategy.
- Ensuring the availability of affordable and reliable data connectivity services tailored to high-tech small businesses in the identified tracts.
- Reducing the time to initiate service and the cost to connect to the customer facility.
- Enabling the City to deploy the fiber infrastructure and related services in phases.
- Enabling Culver City businesses to select among a variety of Internet Service Providers (ISP), performance options, and pricing plans.
- Creating opportunities for new ISPs to enter the Culver City market.
- Leveraging community resources to reduce implementation and operating costs.
- Seeking partnerships and contract services to minimize the City's required staffing allocations and avoid or defer staff additions.

In the process of developing the financial analysis framework and service offerings, we examined the successful model that the City of Santa Monica has developed. However, it is important to understand a fundamental difference between Santa Monica's original objectives as compared to Culver City's.

When Santa Monica initiated its fiber business, there was a gap in the availability of high-end data services. The business market at the time was forced to use expensive, slow, and outdated T1 circuits.[3] The T1 circuit provided a 1.544 Mbps connection and could be "bundled"

[3] A T1 circuit provides an "always-on" 1.544 Mbps symmetrical data circuit (speed of upload and download equal). The T1 circuit was primary used to support voice service, providing support of (24) 64 kbps voice channels.

when greater speed and capacity was required. The cost of each circuit, however, was more than $1,000 per month. Santa Monica was able to offer area businesses a bargain when it first offered 100 Mbps circuits for $5,200 per month. The price for the 100 Mbps circuit provided by Santa Monica has now dropped to about $1,500 to $2,000 per month, depending upon the length of the contract.

1.7 Financial Summary

The financial assumptions we used in our proposed financial analysis framework are presented in Section 5. The initial service offerings and pricing we used in the financial model are as follows:

- 100 Mbps at $300 per month
- 250 Mbps at $500 per month
- 1,000 Mbps (1 Gbps) at $1,100 per month

We recommend that these services and pricing be refined as details of the City's business model are developed. The services, pricing, and performance attributes will be dependent upon negotiations and business relationship developed with ISPs.

The financial projections are based on passing the businesses identified by the City in each of the five tracts—a total of 423 businesses in 279 buildings.[4] We further assumed that the tracts are built out over two years and that 60 percent of these businesses will acquire one of the Culver City-enabled data services within three years. The resulting income and cash flow balances are shown in Table 1.

Table 1: Condensed Income and Cash Flow Statement (Base Assumptions)

	1	2	3	4	5	6	7
Total Revenues	$ 150,850	$ 740,875	$ 1,419,875	$ 1,822,300	$ 1,694,000	$ 1,694,000	$ 1,694,000
Total Cash Expenses	(675,400)	(1,078,400)	(1,343,400)	(1,531,400)	(1,506,400)	(1,506,400)	(1,506,400)
Depreciation (non-cash)	(89,402)	(154,211)	(189,752)	(211,983)	(211,983)	(211,983)	(211,983)
Net Income	$ (613,952)	$ (491,736)	$ (113,277)	$ 78,917	$ (24,383)	$ (24,383)	$ (24,383)
Capital Expenditures	(1,255,160)	(825,600)	(240,240)	(128,300)	-	(30,600)	(96,500)
Funding (net)	1,800,000	1,200,000	-	-	-	-	-
Depreciation (non-cash)	89,402	154,211	189,752	211,983	211,983	211,983	211,983
Net Cash for Year	$ 20,290	$ 36,875	$ (163,765)	$ 162,600	$ 187,600	$ 157,000	$ 91,100
Total Cash Balance	$ 20,290	$ 57,165	$ (106,600)	$ 56,000	$ 243,600	$ 400,600	$ 491,700

The above projection assumes that the City provides $3 million of start-up funding, which will not be recovered with funds generated by the enterprise. If the start-up funding were to be financed instead, the principal and interest payments would be made over 20 years, and the

[4] The complete set of assumptions is listed in Section 5 and Appendix B.

base service pricing would need to increase by approximately 15 percent to maintain a similar cash flow as above if all other assumptions remain unchanged. This impact is shown in Table 2.

Table 2: Condensed Income and Cash Flow Statement (Financed, with Increased Fees)

	1	2	3	4	5	6	7
Total Revenues	$ 164,850	$ 823,875	$ 1,605,875	$ 2,075,300	$ 1,947,000	$ 1,947,000	$ 1,947,000
Total Cash Expenses	(675,400)	(1,078,400)	(1,343,400)	(1,531,400)	(1,506,400)	(1,506,400)	(1,506,400)
Depreciation (non-cash)	(89,402)	(154,211)	(189,752)	(211,983)	(211,983)	(211,983)	(211,983)
Net Income	$ (671,952)	$ (528,736)	$ (47,277)	$ 211,917	$ 111,655	$ 116,841	$ 122,233
Capital Expenditures	(1,255,160)	(825,600)	(240,240)	(128,300)	-	(30,600)	(96,500)
Funding (net)	1,782,000	1,188,000	-	(75,957)	(129,633)	(134,819)	(140,211)
Depreciation (non-cash)	89,402	154,211	189,752	211,983	211,983	211,983	211,983
Net Cash for Year	$ (55,710)	$ (12,125)	$ (97,765)	$ 219,643	$ 194,005	$ 163,405	$ 97,505
Total Cash Balance	$ (55,710)	$ (67,835)	$ (165,600)	$ 54,043	$ 248,048	$ 411,453	$ 508,958

The projected results are directly impacted by key assumptions in the model. The sensitivities to key assumptions are presented in Section 5. In addition, we have separately provided the City with an Excel version of the financial tool that can be used during the refinement of the business model.

1.8 Next Steps and Action Items

As indicated in this report, there are many potential benefits to Culver City pursuing an expansion of fiber infrastructure and data services for local businesses. The plan does have risks, however. The financial model is based on a wide range of assumptions—any one of which might change over time. For example, it is possible that actual costs will exceed the estimates. Further, the projected take rates may be substantially lower than anticipated.

In addition to being aware of these risk factors throughout its partner negotiations and the refinement of the plan, the City will need to make many decisions as the plan moves forward. The City's next steps include:

1. Initiating more detailed discussions with the City of Santa Monica in regard to:
   a. Obtaining a connection into the One Wilshire carrier hotel in Los Angeles
   b. Leveraging Santa Monica's relationships and contracts with retail ISPs
   c. Obtaining network operations center (NOC) monitoring and support
   d. Obtaining a contract for fiber maintenance

2. Continuing discussions with Wilcon on a potential dark fiber lease to One Wilshire (which could be an alternative to a connection via Santa Monica or for redundancy)

3. Conducting focus group or other discussions with potential businesses and property owners in the identified tracts to help refine services (performance and price)

4. Reviewing proposed business models and finance plans with City legal counsel

5. Preparing a detailed fiber and network design that can be used to prepare bid and other procurement documents

6. Exploring potential partnerships, such as with Wilcon, to add value to regional dark fibers services

7. Exploring with building owners the possibility of including a connection services contract with the owners' facility leases

8. Updating the City's financial projections as it refines the project's key assumptions

9. Refining proposed service offerings, pricing, and performance attributes as discussions with potential Internet Service Providers (ISP) unfold. (When introducing pricing, it is better to start at a higher price, then decrease as needed—because it is easier to lower prices than it is to raise them.)

10. Reviewing the contract terms of the pipeline agreement, including the option to renew rights to ensure Culver City's access is available for the next 20 to 30 years

11. Preparing draft access and operating policies for the proposed business

12. Preparing for a marketing campaign in opposition to the City's plan by Time Warner, AT&T, or other existing providers; the City's campaign might position the City not as a competitor but as providing a platform for enhanced competition and opportunities for new businesses

2. Connectivity Market in Culver City

In this section, we discuss the existing connectivity market in Culver City—including both the competitive service offerings and the City's own fiber and conduit assets. We then identify service gaps and strategies the City might take to address them.

As background for this discussion, we define several key aspects of fiber network performance below.

2.1 Understanding Fiber Connectivity Performance

The most common way that consumers compare the performance of a data connection is by evaluating its speed (which is measured in bits per second, and is typically discussed in units of Mbps or 1,000,000 bits per second). However, this measurement can be quite deceptive. For example, a 30 Mbps cable modem connection may cost a residential consumer $50 per month, while a business-grade 10 Mbps Metro Ethernet service can exceed $500 per month.

Why would a service with one-third the speed cost 10 times the price of the "faster" alternative? The answer is that all Mbps are not created equal. Factors such as latency, the availability of the connection speed, and the network's Internet oversubscription rate affect the connection's overall performance. In the example above, the 10 Mbps Metro Ethernet service's total set of performance attributes provides a more robust connection than a 30 Mbps cable modem.

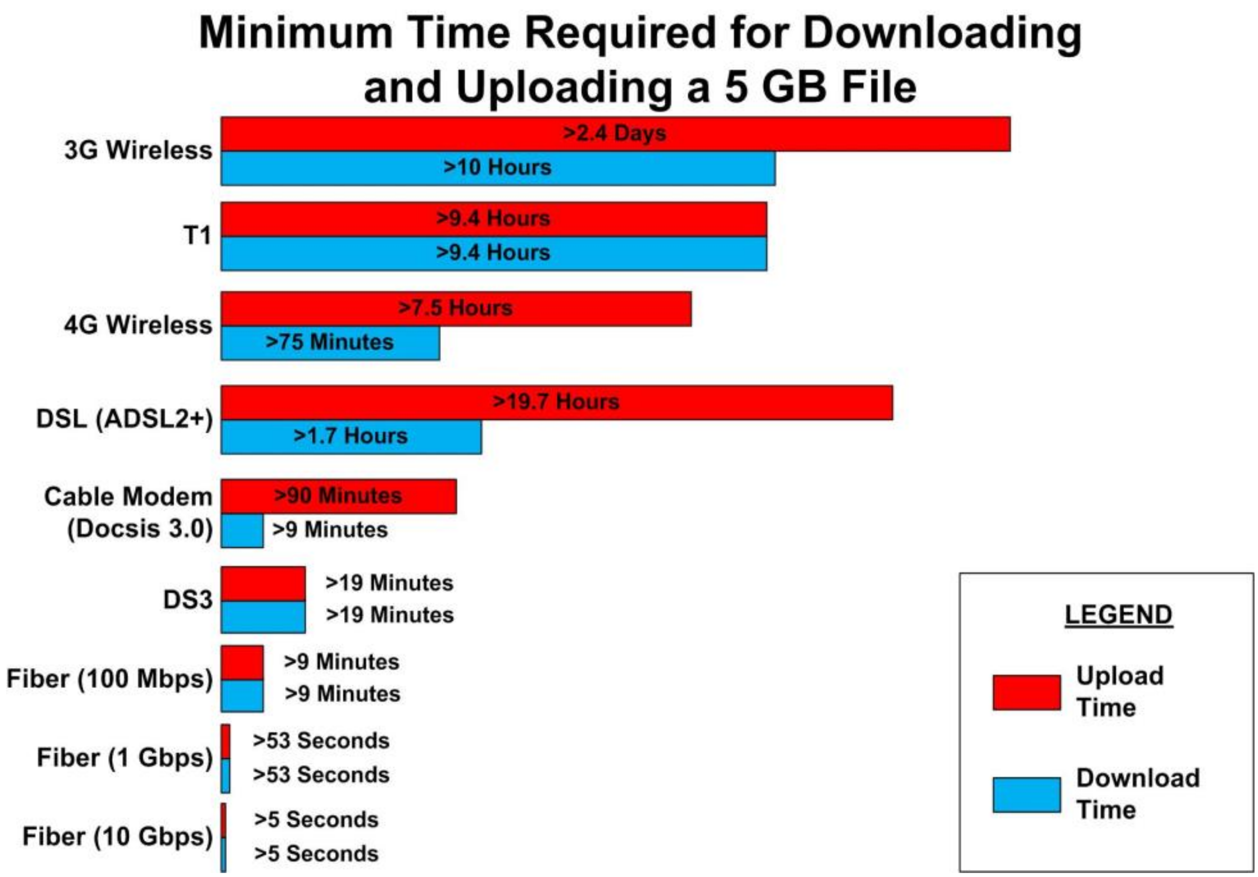
Key attributes that impact performance include:

- *Symmetry:* Cable modem and DSL services are typically "asymmetrical," meaning that their upload[5] and download[6] speeds are different. Typically the download speed is greater than the upload speed by a factor of 10. Metro Ethernet services, on the other hand, are typically "symmetrical," meaning that the upload and download speeds are the same. For businesses that produce and transfer large data or video files, "asymmetrical" services often present a bottleneck to both internal users and external customers.

  An example of the impact of service symmetry is shown in the figure below. A typical cable modem service can download a 5 GB file in less than 10 minutes, but it would take more than 90 minutes to upload—which would not be acceptable to a business creating and distributing large files, such as those seen in production or other studios.

[5] Transfer of data from the users' devices.
[6] Transfer of data to the users' devices.

Figure 1: Illustration of Service Symmetry on Download Times



- *Oversubscription to Internet:* Internet service providers (ISP) recognize that users in a given area do not all access the Internet at the same time; therefore, ISPs only subscribe to a portion of their networks' total potential demand. For example, an ISP that has 1,000 subscribers with 10 Mbps service might contract for a 100 Mbps connection rather than the maximum 10,000 Mbps Internet connection its users might require. The ratio of a network's maximum potential demand to its contracted rates is its oversubscription ratio. In this example, the oversubscription ratio is 100:1.

  Cable modem and DSL providers often have a 100:1 or greater oversubscription ratio for residential users and a 50:1 ratio for business users. If an ISP bundles Internet access with a Metro Ethernet service, the oversubscription ratio is often 10:1 or less. In addition, with a Metro Ethernet service, users often will contract for specified Internet connections, thus defining their own performance. At times, users will not notice the oversubscription, while at other times oversubscription brings the user experience to a crawl—no different than traffic on Interstate 5 on the weekend vs. traffic during a weekday rush hour.

- *Availability*[7] of the Data *Transport Rate:* Metro Ethernet providers will specify a committed interface rate (CIR), which is the guaranteed transport speed of the circuit connecting the users' location(s). Cable modem and DSL services are often "burstable," meaning that users may at times experience the advertised data rates, but that the average speed realized will vary greatly based on the traffic being generated over the provider's distribution network. Performance parameters on a given burstable service are rarely publicized or realized. Often the network operator cannot change this parameter without changing the network physical connections. During heavy use burstable subscribers will experience the same traffic discrepancies as do drivers on Interstate 5 on the weekend vs. the rush hour during the week.

- *Capacity*: The data rate specifies the speed (in bytes) at which data is being transferred, whereas capacity is the measure of how much data was transmitted in a given period. For connections supporting burstable services, capacity limits may defer required network upgrade. For example many data plans for a wireless service will specify the Gigabytes (1,000,000,000 Bytes, or GB) allowed during the month. These plans will carry extra fees for exceeding the limit and will actually slow down your connection speed as you approach your capacity limit. Cable modem and DSL providers have raised the possibility of adding capacity limits on their services (e.g., Comcast has trials of bandwidth limits), but to date implementation of such policies have been limited.

- *Latency*: This is the delay between the instant a message is sent and the instant it is received. Latency occurs on a provider's network and, if a connection is made over the Internet, additional delays are added there. With cable modem and DSL services latency is not an attribute users can specify. For Metro Ethernet and other higher end transport services latency is often a quality-of-service (QoS) feature for which a user can contract (at an added price). At times networks with high latency will prevent users from running certain applications. For example, satellite-based ISP services have an extremely high latency due to propagation delays (i.e., the time it takes for a signal to reach the satellite). These delays will prevent effective use of interactive services such as voice calls or interactive video.

- *Overhead*: This is not typically an option that a user can specify. Each transaction over the network will contain data regarding how to handle the message and where to deliver it (i.e., network control and operation). For cable modem services, overhead is

[7] Availability is often confused with oversubscription to the Internet. Oversubscription applies to the Internet connection, whereas availability applies to the connection or transport between user locations or the access point to the Internet.

typically part of each transaction; for Metro Ethernet, overhead is not part of a user's bandwidth.

- *Connection Type*: This attribute describes how a connection is made with other locations. For example, on a cable modem or DSL service, all connections to other locations are made through the Internet with Internet addressing schemes. This includes any Virtual Private Networks (VPNs) set up between user locations. With higher end data services a user might be able to "route" traffic over the provider's network without connecting to the Internet, set up direct point-to-point connections, or specify which locations will connect among each other (e.g., point-to-point or multipoint-to-multipoint).

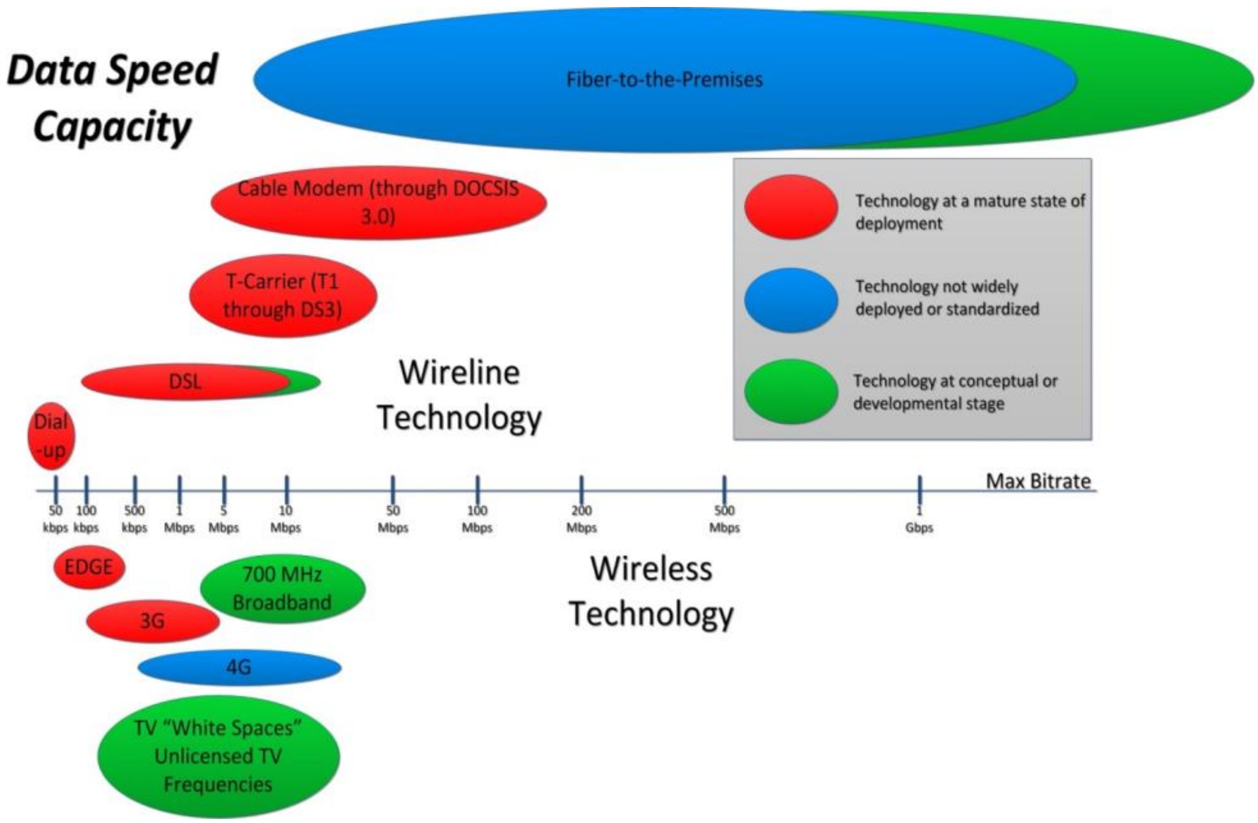
- *Security:* Although security is primarily a function of encryption and other techniques applied by the user or the application sites accessed, traffic over a private network is inherently more secure than traffic on a network that establishes connectivity over the Internet. For example a cable modem or DSL user with multiple sites in Culver City will transmit packets over the Internet to connect between sites. With a higher-end service such as Metro Ethernet connecting user sites, the transport would remain on the provider network. In addition, higher end services often have encryption options at the transport layer.

- *Port Rate:* Not all connections are equal. The network connection, drop, and customer premises equipment (CPE) will define the potential connection speed at the customer site. The port rate is the maximum speed that the demarcation point to the customer can support. For cable modem services this is defined by the incorporated standard[8] for adding data on a cable television system.

An example of the impact of capacity (Bytes) and speed (Mbps) for selected services and network architecture is shown in the figure below. As indicated, fiber-to-the-premises (FTTP) architecture offers far superior performance (capacity and speed) as compared to cable modem or DSL services.

[8] Data over cable service interface specification (DOCIS) is an international standard that defines how broadband data transfer is accomplished over an existing cable television system.

Figure 2: Capacity and Speed of Broadband Technologies



2.2 Competitive Service Providers

This section reviews the availability of connection services tailored to the business market (i.e., services that offer higher performance than cable modem or DSL services). Specifically, this section provides an overview of available dark fiber, Ethernet, and wavelength services with respect to the large business customers Culver City wishes to serve. The assessment does not include a competitive analysis of providers serving residences or small businesses.

A trend that we expect to continue is the consolidation of competitors through mergers and acquisitions. These actions will create opportunities for Culver City because consolidation reduces consumer choice and alternatives for redundant routes. For this analysis, we will refer to dark fiber, lit services (such as Ethernet and wavelengths), and video transport as the three service or product lines.

During the course of our research, we identified 13 service providers in the Culver City area that offer a range of services from dark fiber connectivity to data transport services, with speeds that range from 1 Mbps to 10 Gbps. The data transport services can be broadly classified by the technology used as Ethernet services, Wavelength, Synchronous Optical

Network (SONET) services, and Video Transport. Individual providers tailor these services to a customer's requirements (speed, location of service, etc.). Competitors in each service area are discussed in the following sections. The existing competitors for dark fiber, Ethernet (100 Mbps to 1 Gbps), SONET (OC-1 to OC-192), video, and wavelength (2.5 Gbps and 10 Gbps) services are listed in Table 3. The range of pricing offered by these companies is listed in Table 4. A comparison of the services' speeds is shown in Table 5.

Table 3: Existing Culver City Service Providers

Sr. No.	Carrier	Dark Fiber	Ethernet (Mbps)			Video	Wavelength	SONET
			100	1,000	10,000			
1	AT&T	NO	YES	YES	YES	YES	2.5 Gbps and 10 Gbps	OC-3/OC-12/OC-48/OC-192
2	C2C Cable	Connectivity to Asia-Pacific						
3	Cogent	NO	YES	NO	NO	NO	NO	NO
4	Edison	NO	YES	YES	YES	NO	YES	YES
5	Level(3)	YES	NO	YES	YES	YES	2.5 Gbps and 10 Gbps	DS-1 to OC-48
6	Masergy	NO	YES	NO	NO	NO	NO	NO
7	Windstream	NO	YES	YES	NO	NO	NO	NO
8	CenturyLink	NO	YES	YES	YES	NO	YES	YES
9	Time Warner	NO	YES	YES	YES	NO	YES	YES
10	Verizon	NO	YES	YES	YES	NO	NO	NO
11	Wilshire Connection (Wilcon)	YES	YES	YES	NO	NO	NO	NO
12	Zayo	YES	NO	YES	YES	NO	2.5 Gbps and 10 Gbps	DS-3 to OC-192
13	XO	NO	YES	YES	NO	NO	1G, 2.5G, 10G, 10 GbE LAN PHY	NO

Table 4: Pricing Comparison Table

Service	Bandwidth Range	Pricing		
		Low	High	Unit
Dark Fiber	Variable	$3,000	$5,000	Monthly recurring charge*
Ethernet	1 Mbps to 10000 Mbps	$1,510	$9,500	Monthly recurring charge*
Video	3 Mbps - 1.5 Gbps	$180	$850	Hourly Rate**
Wavelength	1.25 Gbps to 10 Gbps	$7,000	$30,400	Monthly recurring charge*
SONET	155 Mbps to 2.5 Gbps	$500	$61,560	Monthly recurring charge*

* Excludes non-recurring charge

** Data only from one provider

Table 5: Speed Comparison Table

Digital Signal (DS) Hierarchy	Synchronous Optical Network (SONET) Hierarchy	Data Rate (Mbps)
DS1 (T1)	-	1.544
DS2 (T2)	-	6.312
DS3 (T3)	-	44.736
-	OC-1	51.84
-	OC-3	155.52
DS4 (T4)	-	274.176
DS5 (T5)	-	400.352
-	OC-9	466.56
-	OC-12	622.08
-	OC-24	1,244.16
-	OC-48	2,488.32 (2.4 Gbps)
-	OC-192	9,953.28 (10 Gbps)
-	OC-256	13,100 (13.1 Gbps)
-	OC-768	40,000 (40 Gbps)
-	OC-3072	160,000 (160 Gbps)

2.2.1 Dark Fiber Services

Three service providers in the Culver City region offer dark fiber services: Level (3), Zayo, and Wilshire Connection (Wilcon). The fiber is typically priced on case-by-case basis, depending on the requirements of the customer.

Level (3) serves national customers as well as local ones. Its dark fiber services are offered only to certain customers based on application. Dark fiber pricing varies, based on the distance from Level(3)'s fiber ring. A difference in a couple of city blocks can lead to significant differences in the cost of dark fiber connectivity.

Zayo provides dark fiber services over its national network. They claim to have expertise in deploying major dark fiber networks and offer financing options including lease and indefeasible rights of use (IRU). As an example of Zayo's pricing in Culver City, the company quotes a dark fiber connection between on-net locations that are three miles apart at a monthly recurring cost of about $4,000 for a 36-month term, in addition to a $5,000 non-recurring cost. Pricing varies significantly depending on whether the building is on-net to Zayo's fiber, otherwise build/splicing costs would apply.[9]

[9] "Why Dark Fiber?", Zayo Group, http://zayofibersolutions.com/why-dark-fiber accessed September 2013

Wilcon offers customers dark fiber and conduit services in the Los Angeles metro region. It has hundreds of conduits connecting major carrier hotels in the Los Angeles metro region. It also offers colocation services at One Wilshire in downtown Los Angeles and connects to all major collocation facilities from there.[10] While pricing would vary based on location and proximity to existing infrastructure, and would be subject to a site survey, dark fiber from One Wilshire to a location on Washington Boulevard in Culver City was estimated to be a monthly recurring rate of $3,250 for a 36-month term, in addition to a non-recurring fee of $3,250. In contrast, a location on Jefferson Boulevard in Culver City was estimated to be close to triple the amount (with the same terms).

2.2.2 Ethernet Services

Almost all existing service providers offer Ethernet services. The services are typically classified under two categories: Dedicated Internet Access (DIA) and Point-to-Point Ethernet. Bandwidths range from 1 Mbps to 10 Gbps. The carriers that provide these services in the Culver City region are AT&T, Level(3), CenturyLink, Zayo, Time Warner, Verizon, XO Communications, Cogent Communications, Wilcon, Masergy Communications, and Windstream Communications. Prices depend on the bandwidth, location, network configuration and whether the service is protected or unprotected, have a switched or mesh structure.

AT&T has four different types of Ethernet products—GigaMAN, DecaMAN, Opt-E-MAN, and Metro Ethernet. GigaMAN provides a native rate interconnection of 1 Gbps between customer end points. It is a dedicated point-to-point fiber optic based service between customer locations, which includes the supply of the GigE Network Terminating Equipment (NTE) at the customer premises. DecaMAN connects the end points at 10 Gbps and is transmitted in native Ethernet format similar to GigaMAN, only 10 times faster. Opt-E-MAN service provides a switched Ethernet service within a metropolitan area. It supports bandwidths ranging from 1 Mbps to 1,000 Mbps, and configurations such as point-to-point, point-to-multipoint, and multipoint-to-multipoint. Metro Ethernet service provides various transport capabilities ranging from 2 Mbps through 1 Gbps meeting IEEE 802.3 standards.[11]

Cogent Communication's Ethernet services are available at speeds of 1.5 Mbps to 1 Gbps.[12] The 100 Mbps option is popular among the company's customers with the monthly recurring charge being $1,500 for a three-year term. The non-recurring charge would be $500 for installation.

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[10] Wilshire Connection website, http://www.wilshireexchange.com/ accessed September 2013

[11] "Local Ethernet," AT&T, http://www.business.att.com/service_overview.jsp?repoid=Product&repoitem=w_ethernet&serv=w_ethernet&serv_port=w_data&serv_fam=w_local_data&state=California&segment=whole accessed September 2013

[12] "Products and Services," Cogent Communications, http://www.cogentco.com/en/products-and-services accessed September 2013

CenturyLink provides point-to-point inter-city and intra-city configurations for full-duplex data transmission with an Ethernet over SONET service. Speeds of 100 Mbps to 1 Gbps are offered. A 1 Gigabit circuit is priced at a monthly recurring charge of $9,400.[13]

Level (3)'s Ethernet Virtual Private Line (VPL) is offered in speeds ranging from 1 Mbps to 2 Gbps. It is an end-to-end Layer 2 switched Ethernet service delivered via a Multi-Protocol Label Switched (MPLS) backbone. A 1 Gigabit circuit, priced at a monthly recurring charge of $7.10 per MB for a three-year term, would be $7,100. Local access pricing would be an additional cost of about $2,500 depending on location. The non-recurring installation charge would be $500.[14]

Masergy specializes in global MPLS networks for customers seeking high performance for real-time applications such as voice and video and are typically priced higher based on this.[15] QoS is maintained across the Masergy global backbone and customers have three routing options for any service type: Private network, publicly routable network, or both—with the same price for all.

Windstream Communications has a nationwide presence serving major metropolitan areas with speeds up to 1 Gbps.[16]

Time Warner offers Metro Ethernet with the choice of dedicated full-duplex 10 Mbps, 100 Mbps, or 1 Gbps Ethernet service. Protected and unprotected configurations are available.[17]

Verizon offers Ethernet services under three different product categories—Ethernet LAN, Ethernet Private Line, and Ethernet Virtual Private Line. The Ethernet LAN is a multipoint-to-multipoint bridging service at native Local Area Network (LAN) speeds. It is configured by connecting customer User Network Interfaces (UNIs) to one multipoint-to-multipoint Ethernet Virtual Connection or Virtual LAN (VLAN), and provides two class-of-service options—standard and real time. The Ethernet Private Line is a managed, point-to-point transport service for Ethernet frames. It is provisioned as Ethernet over SONET (EoS) and speeds of 10 Mbps to 1 Gbps are available. The Ethernet Virtual Private Line (EVPL) is

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[13] "Ethernet Private Line," CenturyLink, http://www.centurylink.com/business/products/products-and-services/data-networking/private.html accessed September 2013

[14] "Ethernet Virtual Private Line," Level(3), http://www.level3.com/en/products-and-services/data-and-internet/vpn-virtual-private-network/evpl/ accessed September 2013

[15] "Internet Plus," Masergy, http://www.masergy.com/sites/default/files/InternetPlus.pdf accessed September 2013

[16] Windstream, http://www.windstreambusiness.com/ accessed September, 2013

[17] "Ethernet," Time Warner Cable Business Class, http://www.timewarnercable.com/en/business-home/services/network-services/ethernet.html accessed September 2013

an all-fiber optic network service that connects subscriber locations at native LAN speeds; EVPL uses point-to-point Ethernet virtual connections (EVCs) to define site-to-site connections. It can be configured to support multiple EVCs to enable a hub-and-spoke configuration and supports bandwidths from 1 Mbps to 1 Gbps.[18]

Wilcon acts as a carrier's last-mile network. The network connects telecommunications carrier hotels in the Los Angeles metro area. It offers Fast Ethernet and Gigabit Ethernet transport services between major carrier hotels.[19]

XO Communications offers carrier Ethernet services at multiple bandwidth options from 3 Mbps to 100 Gbps over the Tier 1 IP network.[20] DIA service at 1 Gbps and 100 Mbps would be at a monthly recurring charge of $6,030 and $1,765, respectively.

Zayo delivers Ethernet in three service types with bandwidth ranging from 100 Mbps to 10 Gbps with options like QoS and route protection based on customer needs. The different types of services offered are: Ethernet-Line which provides point-to-point and point-to-multipoint configurations with reserved bandwidth availability, Ethernet-LAN with multipoint configurations having a guaranteed service level, and E-PDN (Ethernet Private Dedicated Network) with a completely private, managed network operated by Zayo with dedicated fiber and equipment.[21] Pricing starts at a monthly recurring cost of $1,613 for 1 Gbps point-to-point Ethernet service between on-net sites in Culver City that are three miles apart; pricing varies dependent upon term.

2.2.3 SONET Services

Synchronous Optical Networking (SONET) services are available in speeds ranging from Optical Carrier-1 (OC-1) to OC-192, which is from 51 Mbps to 10 Gbps.

AT&T's SONET product portfolio offers a variety of services that can be grouped into three categories (Ring, point-to-point, and shared service) based on customer requirements. [22],[23]

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[18] "Networking Products," Verizon, http://www.verizonbusiness.com/products/data/ethernet/ accessed September 2013

[19] Wilshire Connection website

[20] "Ethernet Services," XO Communications, http://www.xo.com/carrier/transport/ethernet/ accessed September 2013

[21] "Ethernet," Zayo Group, http://www.zayo.com/ethernet accessed September, 2013

[22] "Synchronous Optical NETwork (SONET)," AT&T, http://www.att.com/gen/isp?pid=2543, accessed September 2013;
"SONET Ring," AT&T, http://www.business.att.com/enterprise/Service/network-services/ring-services/sonet/, accessed September 2013

Edison Carrier Solutions offers SONET services and supports speeds ranging from DS-3 (45 Mbps) to OC-48 (2.4 Gbps), using shared rings. They also offer dedicated OC-48 and OC-192 service over multi-node rings. The SONET service is offered over a diverse, self-healing backbone and collector rings.[24]

The Level (3) Private Line service uses redundant local SONET rings to move data traffic between customer end points. The service supports speeds of OC-3 (55 Mbps), OC-12 (155 Mbps), and OC-48 (2.5 Gbps). The transport can be in a point-to-point, hub, or private dedicated ring (PDR) configuration, depending on the customer's needs.[25] Level (3) offers OC-48 services at a monthly recurring charge of $61,656 and non-recurring charge of $1,760 for a three-year term. The local access component in this price is $29,218 (almost 50 percent of the price) and would vary based on location.

CenturyLink provides speeds ranging from OC-3 to OC-48 on its redundantly routed SONET network. The network runs a four fiber Bidirectional Line Switched Ring (4FBLSR), for path protection. The network includes more than 140 SONET rings incorporating more than 1,400 multiplexers.[26]

Zayo's SONET service offers bandwidth of DS-3, OC3 and OC-12 in Culver City. The Zayo network offers diversity options and routes that are unique from most carrier and ILEC networks.[27] The pricing for the different bandwidths for on-net locations that are three miles apart range from a monthly recurring charge of $503 to $3,520 along with a non-recurring cost of $500 to $3,000.

2.2.4 Video Services

There are three carriers that offer video transport in the Culver City region—AT&T, Level (3), and Time Warner Cable.

AT&T's Global Video Service offers transport of video with two solutions. The 45 Mbps solution is a fiber transmission service that offers connectivity to a switched video network and delivers content to more than 90 cities in the U.S., Canada, and the United Kingdom. Customers who choose occasional service are billed in 15-minute increments. The second solution offered

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[24] Edison Carrier Solutions, http://www.edisonconnect.com/wireline/sonetservice.asp accessed July 12, 2013

[25] "Private Line Services," Level(3), http://www.level3.com/en/products-and-services/data-and-internet/private-line-services/, accessed September 2013

[26] "Synchronous Optical Network Service," CenturyLink Networx Products & Services, Century Link Government website, http://www.centurylink.com/business/networx/products/optical/sonet.html accessed September 2013

[27] "SONET Optical Private Line Point-to-Point Service," Zayo Group, http://www.zayo.com/sonet-optical-private-line-point-point-service accessed September 2013

by AT&T is the MPEG-2 solution, in which MPEG-2 compressed video service is available with bandwidths ranging from 4 Mbps to 22 Mbps and international satellite transmission service from three AT&T-owned earth stations. Service within the U.S. may be booked in one-minute increments with a five-minute minimum. International service is offered in increments of 15-minutes.[28]

Level (3) Vyvx Solutions for video transport include broadcast fiber service, managed video network service, satellite and teleport, and live venue solutions. Level (3)'s Vyvx broadcasting distribution services include fiber video transport in six different formats:

- High-bandwidth digital video with occasional fiber-video transport solution for high-quality transmissions
- Asynchronous Serial Interface (ASI) fiber video for occasional video transmission services from 3 to 213 Mbps/SD/MPEG-2/4
- Hybrid fiber video services from 3 to 22 Mbps
- JPEG 2000 Compressed fiber video services at 80 and 150 Mbps
- Uncompressed fiber video (SD at 270 Mbps and HD at 1.5 Gbps)
- 45 Mbps analog video

Level (3)'s High Definition VenueNet is a service over the Vyvx network for HDTV backhaul primarily for live events. It is offered in two formats: VenueNet+ and VenueNet Lite. The VenueNet+ service is engineered to provide high-quality high-definition (HD) and standard-definition (SD) digital video services for broadcasters along with added HD and SD encoding, high-speed IP (HSIP) and phone support in VenueNet+ venues. VenueNet+ delivers content to various destinations, and connects both professional and college venues across the country, via the global Vyvx network. VenueNet Lite service offers broadcasters and universities a simple, reliable alternative to satellite broadcasting, featuring the high-definition fiber network and central, dedicated locations for easy equipment connectivity, with no need for satellite trucks or extra personnel.[29]

2.2.5 Wavelength Services

[28] "AT&T Global Video Service," Product Brief, AT&T, http://www.business.att.com/content/productbrochures/PB-GVS-16590_v2_6-19-08_3.pdf accessed September 2013

[29] "Video," Level(3), http://www.level3.com/en/products-and-services/video/ accessed September 2013

Seven of the 13 providers offer wavelength services using dedicated wavelengths over either Coarse or Dense Wavelength Multiplexing. Wavelength Division Multiplexing enables several wavelengths to be multiplexed and transported on a single pair of fiber strands, which greatly increases the capacity of fiber.

Wavelength services from AT&T can be purchased under the WaveMAN service, the Metropolitan Optical Ring (MON) Service, or the Ultravailable Network Service. WaveMAN service is a point-to-point data transport service for interconnecting to interLATA, interstate networks. The service uses a Coarse Wave Division Multiplexing (CWDM) signal over fiber, connects intraLATA networks to long-haul services, and provides interconnection handoffs of intraLATA SONET and Interexchange Carrier Optical Wave service at SONET interface levels of 2.5 Gbps and 10 Gbps. The MON Ring Service provides optical transport using Dense Wave Division Multiplexing (DWDM) technology in a dedicated ring configuration. The Ultravailable Network Service (UVN) is a managed, custom Dense Wavelength Division Multiplexing (DWDM) or SONET-based solution. It provides the communication path between a customer's premises and the nodes of AT&T's POP/ AT&T Local Network Services (LNS) or a third-party fiber provider's nodes.[30]

Edison Carrier Solutions offers point-to-point wavelength service in the Southern California region and supports speeds of 1 Gbps, 2.5 Gbps, and 10 Gbps. Off-net and Type 2 services are available on a case-by-case basis. Route diversity and equipment protection options are offered and are independent of protocol.[31]

Level(3) Intercity Wavelength is a point-to-point, unprotected wavelength service at 2.5 Gbps, 10 Gbps, and 40 Gbps waves. Level(3) offers 10 Gbps wavelength DIA service for a monthly recurring charge of $30,430 for a three-year term. A 1 Gbps wavelength service would be priced at $7,183 for the same term. The local access portion would be an additional cost and would vary based on location.

CenturyLink's Optical wavelength service is a managed private point-to-point service delivered over a DWDM network. It provides an end-to-end solution with a wide range of transport bandwidths, including 2.5 Gbps and 10 Gbps.[32]

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[30] "Wavelength, AT&T, http://www.business.att.com/service_overview.jsp?repoid=Product&repoitem=w_wavelength&serv=w_wavelength&serv_port=w_data&serv_fam=w_local_data&state=California&segment=whole accessed September 2013

[31] Edison Carrier Solutions, http://www.edisonconnect.com/wireline/wavelength.asp accessed September 2013

[32] "CenturyLink Optical Wavelength Service," http://www.centurylink.com/business/asset/product-info/optical-wavelength-service-po070135.pdf accessed September 2013

Time Warner Cable offers wavelength transport services under its Dedicated High Capacity service. It offers speeds starting at 10 Gbps in Culver City. This is available in a point-to-point configuration.[33]

XO wavelength services support bandwidths of 1 Gbps Ethernet up to 100 Gbps.[34] Pricing for a point-to-point 10 Gbps connection over three miles would be a monthly recurring charge of about $17,000, while a 1 Gbps connection would be $7,600.

Zayo's wavelength service is available at 1 Gbps, 2.5 Gbps, 10 Gbps, 40 Gbps, and 100 Gbps and exclusive low latency routes. Flexible network topologies and the options for path diversity even for routes procured from a different carrier are available. Zayo's monthly recurring charge for 1 Gbps and 10 Gbps wavelength services between on-net sites that are three miles apart start at $2,130 and $6,910 and vary dependent upon term. The non-recurring cost ranges from $1,500 to $3,000.[35]

2.3 Existing Culver City Fiber and Routes

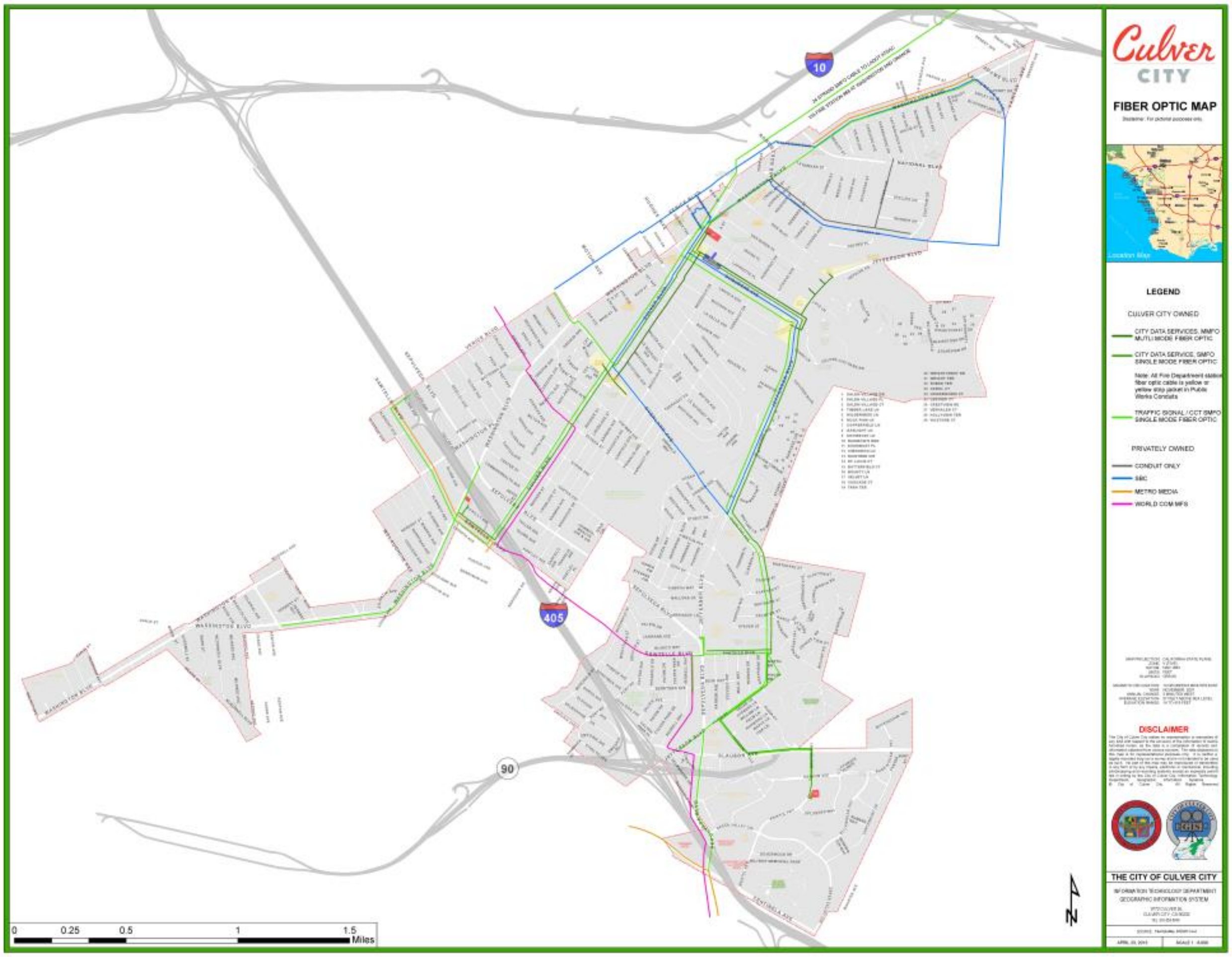
This project takes as its starting point the City's extensive fiber and conduit mapping, and its identification of the five target tracts. Figure 3 is a City map that illustrates existing fiber and conduit; details on the City's existing infrastructure are included in Section 4.

[33] "Carriers and Resellers Solutions," Time Warner Cable Business Class, http://www.timewarnercable.com/en/business-home/solutions/carrier-reseller.html accessed September 2013

[34] "Wavelength," XO Communications, http://www.xo.com/connect/private-line-services/wavelength/ accessed September 2013

[35] "Wavelengths (DWDM): Dedicated Layer 1 Lit Service," Zayo Group, http://www.zayo.com/sites/default/files/Service%20-%20Wavelength%20[2-13-13].pdf accessed September 2013

Figure 3: Culver City Fiber Map



2.4 Service Gaps the City Plans to Address

In Section 2.2 we presented the available services that offer greater performance of cable modem or DSL services. Although cable modem[36] and DSL services are available in Culver City they do not meet the availability, reliability, and affordability needs of small businesses today. This section presents an overview of the services gaps present in Culver City today.

The City identified five target areas or "tracts" of buildings that are the focus of efforts to attract existing and start-up high-tech businesses. For this segment of businesses, the availability, affordability, and reliability of advanced broadband services is crucial in determining whether or not to locate in Culver City.

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[36] For example Time Warner offers business "high-speed" access with up to 15 Mbps download and up to 2 Mbps upload, and business "wideband" services that provides up to 50 Mbps download and up to 5 Mbps upload.

Specific issues that the City's proposed connectivity offerings need to address include:

- The cost of getting the service connected. The initial fees are based on the cost of extending fiber into the building. Due to the network architecture and the spacing of access points with the existing providers' networks, these costs may easily range from $20,000 to more than $50,000. Typically the connection fees are paid by the property owner or the first tenant that signs up for a service.

- The time it takes to activate the service once a contract is signed. During the interviews, participants indicated that the time to activate a Metro Ethernet or other business-class service is often in excess of 90 days.

- The balance of performance and cost of available services, because current services are not tailored to small high-tech businesses:

    - Cable modem and DSL services, although affordable (they start at under $100 per month), are not adequate in terms of oversubscription, committed interface rate (CIR), and other attributes

    - Ethernet services address the performance concerns but are not affordable for many businesses, especially start-ups; a 100 Mbps service starts at $1,500 per month ($18,000 per year) with a three-year commitment

- Increased options for accessing the Internet. Larger businesses, schools, health care providers, and other large data users have limited options to obtain competitive commodity bandwidth (Internet connection) because they are often forced to purchase bandwidth through their access providers.

- Availability of dark fiber within Culver City and dark fiber access to facilities located in the region.

2.5 Potential Leasing and Service Strategies for City Infrastructure

There are four basic leasing and service strategies that the City might pursue to expand connectivity to the identified tracts:

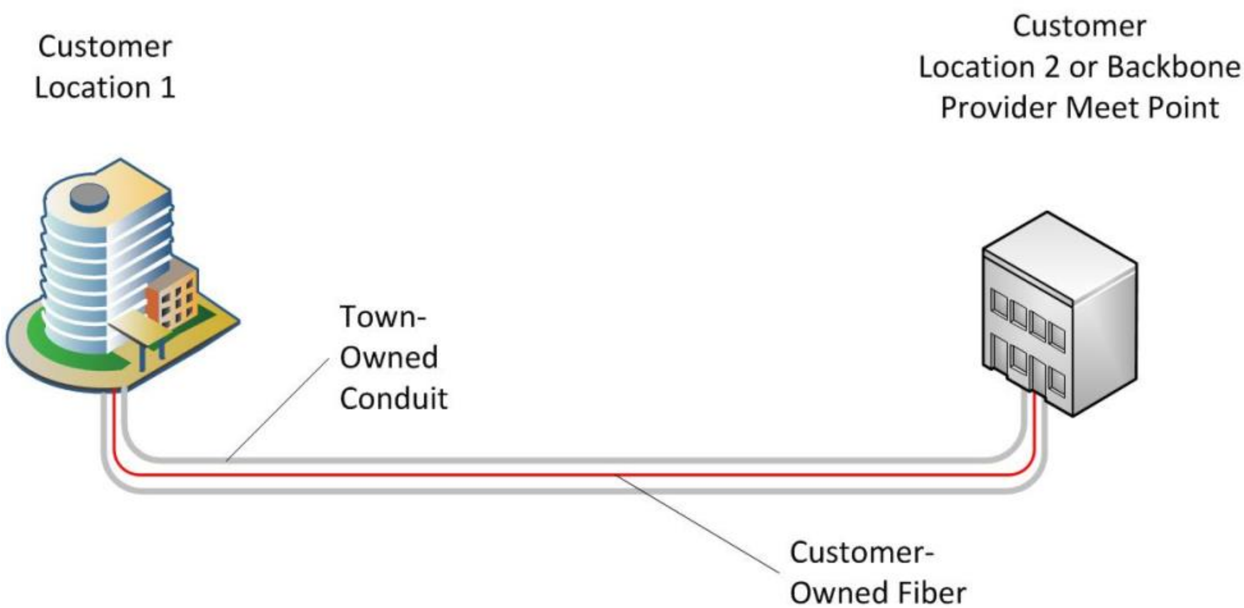
- Conduit or innerduct lease
- Dark fiber lease
- Wholesale or open access services
- Retail services

In most cases municipal offerings will include a combination of the above strategies. For Culver City we recommend a wholesale/open access approach supplemented with dark fiber.

2.5.1 Conduit Lease

Conduit lease simply involves leasing access to empty conduit or inter-duct. This approach has been done in limited cases by municipalities or other providers. In some cases conduit lease is granted in exchange of access to right of ways or other asset. An example of a conduit lease is Culver's City exclusive use of designated inter-ducts the pipeline route. An example of a conduit lease is shown in Figure 4.

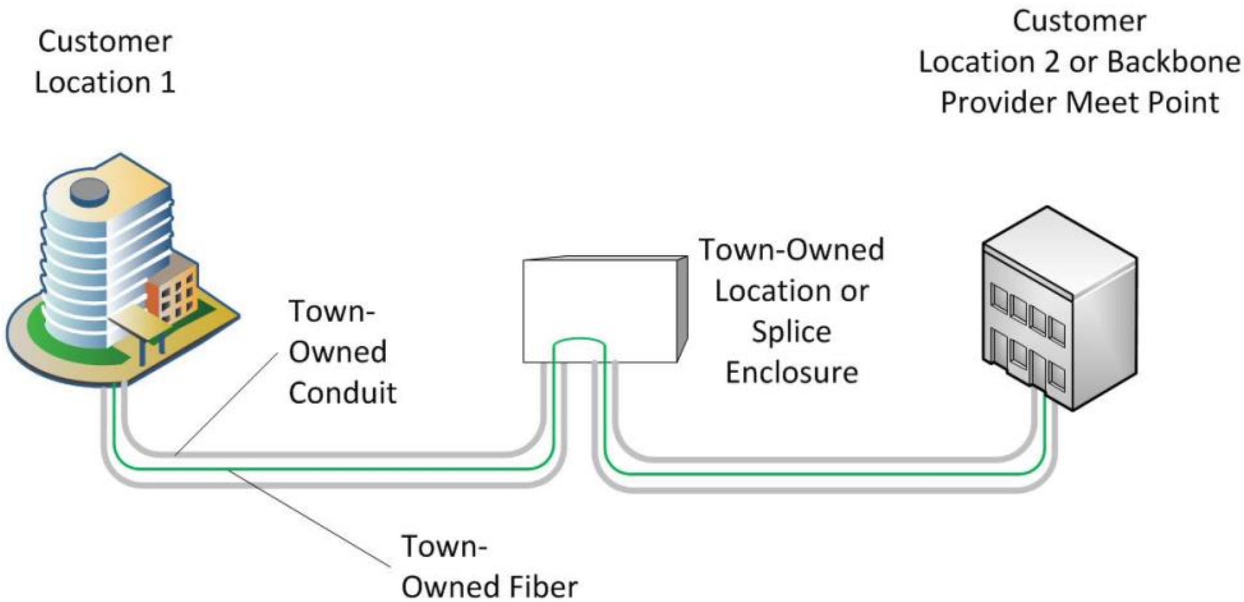
Figure 4: Conduit Lease



2.5.2 Dark Fiber Lease

Dark fiber involves leasing strands of fiber without any electronics—i.e. dark. Most commonly, dark fiber is priced on a per strand per mile basis for a set term. Usually, the lease price is for fibers on the existing fiber network, and the customer is responsible for the incremental cost to connect their facility to the closest access point on the existing fiber route. Colocation, splicing, make-ready, and rack space costs are generally assessed on top of the fiber pricing. Some entities will also charge an up-front fee to cover administrative costs. An example of dark fiber leasing is shown in Figure 5.

Figure 5: Fiber Lease



The following are a range of pricing structures found in both the private and public sectors.

1. Incremental or proportional cost (either of construction or maintenance). In this model, dark fiber is priced at the incremental or proportional cost of building the leased fibers or maintaining them. These structures will result in the lowest pricing possible. In our experience, this model is used only where the provider is under some kind of duress or legal requirement.[37]

2. Up-front payment plus maintenance. Most commonly, dark fiber is leased as a 10- to 20-year (most often 20) Indefeasible Right of Use (IRU). The customer pays up front for the IRU and annually for maintenance.[38] The maintenance cost is calculated on route miles, not strand miles. The annual maintenance charge is the same per mile regardless of whether the lease is for 1 or 10 or 100 strands on the same route. The upfront payment covers the entire term of the fiber lease, but maintenance and co-location contracts typically are renewable and for 5-year or shorter terms, which allow for cost adjustments based on experience and inflation. The benefit of this model is the substantial inflow of funds early in the lease term, funds that can help bridge any

[37] For example, Minnesota Power offers dark fiber at a rate of $13.65 per mile per strand per month under a ruling from the Minnesota Public Utilities Commission on a transaction agreement between Minnesota Power and Enventis Telecom Inc. (a non-regulated subsidiary of Minnesota Power). The ruling bases the lease price of Minnesota Power's unused fiber assets using an incremental cost basis.

[38] One of the benefits of this model for the customer is that the IRU can be treated as a capital expenditure and depreciated on an advantageous schedule.

potential early year cash shortfall while an entity is beginning operations and developing new services. On the other hand, the model will not result in annual revenues over the long-term beyond some of the cost of maintenance.

3. Per annum or per month pricing. This structure has the benefit of delivering to the fiber owner a steady annual income stream over time, but does not deliver a large up-front payment that could serve to bridge a difficult budget year or finance new investment. On the other hand, this model is more achievable if the dark fiber lessee is not able to make a large up-front payment—but can pay for the fiber on a recurring annual or monthly basis. As a result, this model potentially increases the number of potential dark fiber customers. Net pricing over the term of the lease tends to be higher than in the up-front payment model over the same total period of time. This model is often used for short-term leases, and can deliver very high revenues for a short time—a nice bonus, but not necessarily the basis for sustainability of a network.

Dark fiber pricing varies greatly among markets and, even in the same market, among carriers. Pricing is route-specific, location-specific, and sometimes plainly arbitrary. Commercial pricing frequently is based on a mix of factors: market competition in that location; market demand in that location; and the cost of building in that location. Non-profit pricing will frequently take the same factors into account but require less or no margin. Some of the higher education networks around the country, for example, base their fiber pricing on a construction and operations cost recovery model.

Generally, one can divide all fiber in the market into two categories for purposes of pricing, with some sub-categories: first, long-haul fiber and second, metro-area fiber.

Metro-area prices are almost always considerably higher (on a per mile basis) than long-haul fiber, which is less costly to build. Within the metro-area category, more urban routes will be priced significantly higher than routes in suburban and exurban areas, depending on the desirability of the urban market. Occasionally, an urban market will prove to be surprisingly cost-effective, usually because a glut of fiber has had the competitive impact of pushing pricing down.

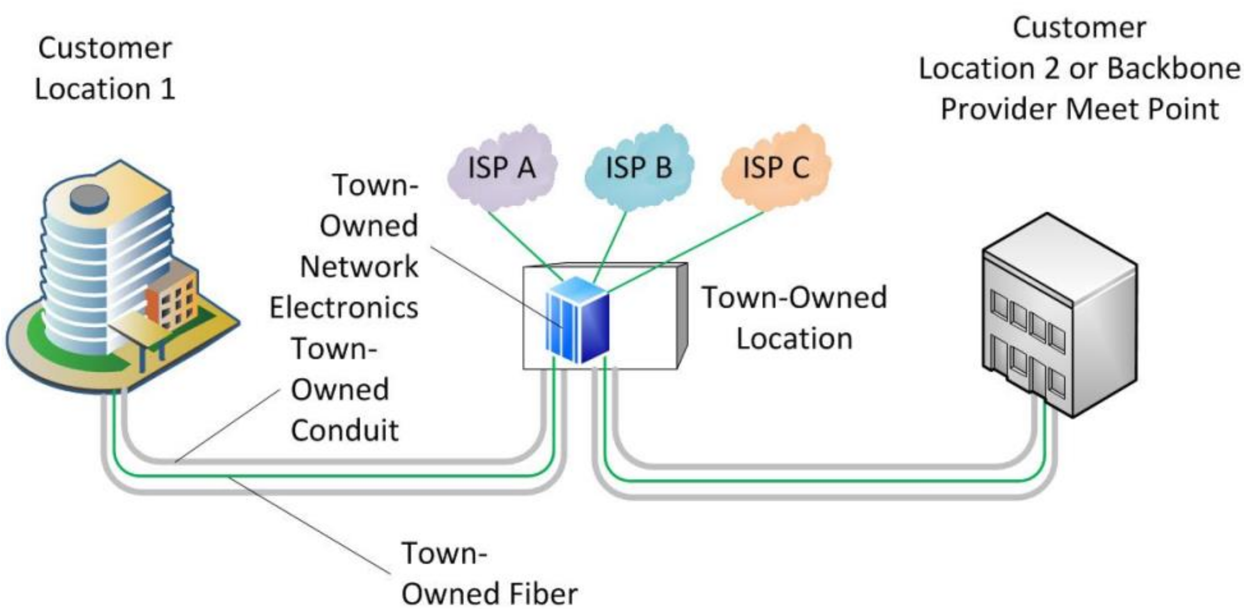
Commercial pricing in major urban areas can range from $2,000 per mile per strand up-front for a 20-year term to $50,000, depending on the provider and whether river crossings or similarly complex routing is necessary. On a per month per mile basis, this equates roughly to $15 to $275. In cases where the full cost for construction is included—as it frequently is in the case of new commercial builds—the cost in our experience ranges from $350 to $6,000 per mile per month per strand—we frequently see bids from commercial providers that include construction costs at 10 to 20 times the cost of the IRU itself, depending on the number of strands required.

2.5.3 Wholesale or Open Access Services

Wholesale or open access separates the "infrastructure" from the "retail" services. In a perfect market, consumers would have access to any service provider they desire. Separating the infrastructure from the service is a step in that direction. As seen in Figure 6 below the providers (ISP) use the City-owned fiber to deliver their service to the consumer. In the case of Culver City, rather than having ISPs access Culver City's fiber in the City, we recommend that Culver City obtain dark fiber access to One Wilshire in Los Angeles. One Wilshire is the region's carrier hotel and most ISPs in the region have a presence there. This connection to One Wilshire further reduces the barriers to entry for ISPs to enter the Culver City market.

As part of the refinement of the business model, the City will need to determine who (the ISP or Culver City) will "sell" the service. In the case of Santa Monica they are the service provider but the consumer has an option of selecting an ISP of their choice. In other open access models, the community has left the selling to the individual ISP. The risk in this model is that the City loses "control" of obtaining desired take rates and other market measurements. Regardless of the approach developed during the business model refinement, Culver City needs to take a proactive approach in promotion and marketing of the available services.

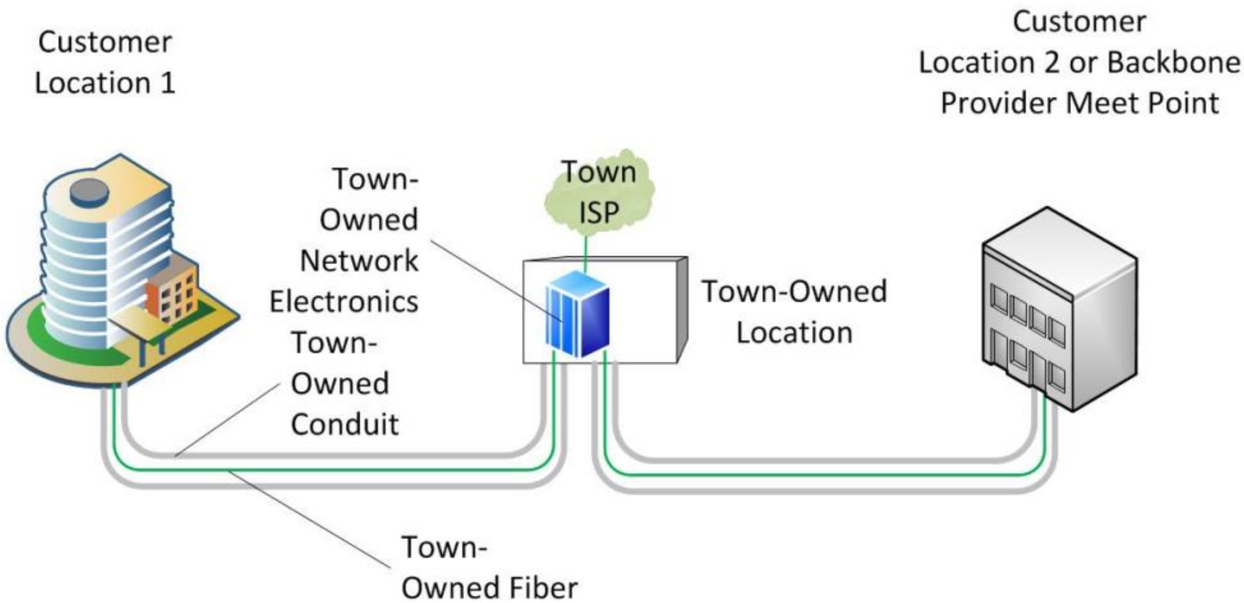
Figure 6: Wholesale or Open Access Services



2.5.4 Retail Service

Many municipalities have used the retail access model across the country. In particular over 100 communities with municipal electric systems have built a fiber-based infrastructure and are offering direct voice, video, and data services to residents and businesses in the community. The retail model is shown in Figure 7.

Figure 7: Retail Services



3. Proposed Fiber Strategy

The City's proposed fiber deployment plan comprises four phases:

1. Implementing a redundant fiber backbone and an access point in each tract as the foundation for future connectivity. The proposed backbone will leverage the City's existing conduit, and was designed so that each tract can be added as needed once the backbone is completed.

2. Deploying fiber laterals in each tract to enable cost-effective connectivity to individual businesses. A key in the lateral design is to ensure that "taps" (where a fiber drop from a building connects to the lateral fiber) are located so that the drop costs are minimized.

3. Extending fiber to community anchor institutions (CAI) such as health care and educational facilities to create additional community benefits.

4. Extending fiber to additional office buildings and multiple dwelling units near the backbone and lateral fiber routes to increase revenue and expand the benefits of the fiber availability.

The maps in the following sections illustrate the fiber deployment phases, starting with the backbone (completing the ring and creating a redundant loop; phase 1), adding laterals to reach each of the tracts (phase 2), and connecting to the individual buildings and businesses in each of the five tracts (phase 2). We then illustrate a sample of the CAIs, non-profits, and larger businesses that might be connected as part of future network expansions (phase 3 and phase 4).

3.1 Redundant Fiber Backbone (Phase 1) and Tract Laterals (Phase 2)

Figure 8 illustrates the fiber backbone—including existing fiber, planned fiber routes, and the pipeline (which is used to complete the redundant path for the backbone network).[39] Most backbone fiber will go through existing conduit; some new construction will be required. This map also shows the location of the City's five tracts.

Figure 9 also illustrates the fiber backbone, with the addition of the planned laterals to each tract for phase 2.

[39] Due to the depth of the pipeline and because any access requires coordination with certified pipeline crews, the preliminary fiber design assumes that no customers will be served from points along the pipeline.

Figure 8: Backbone

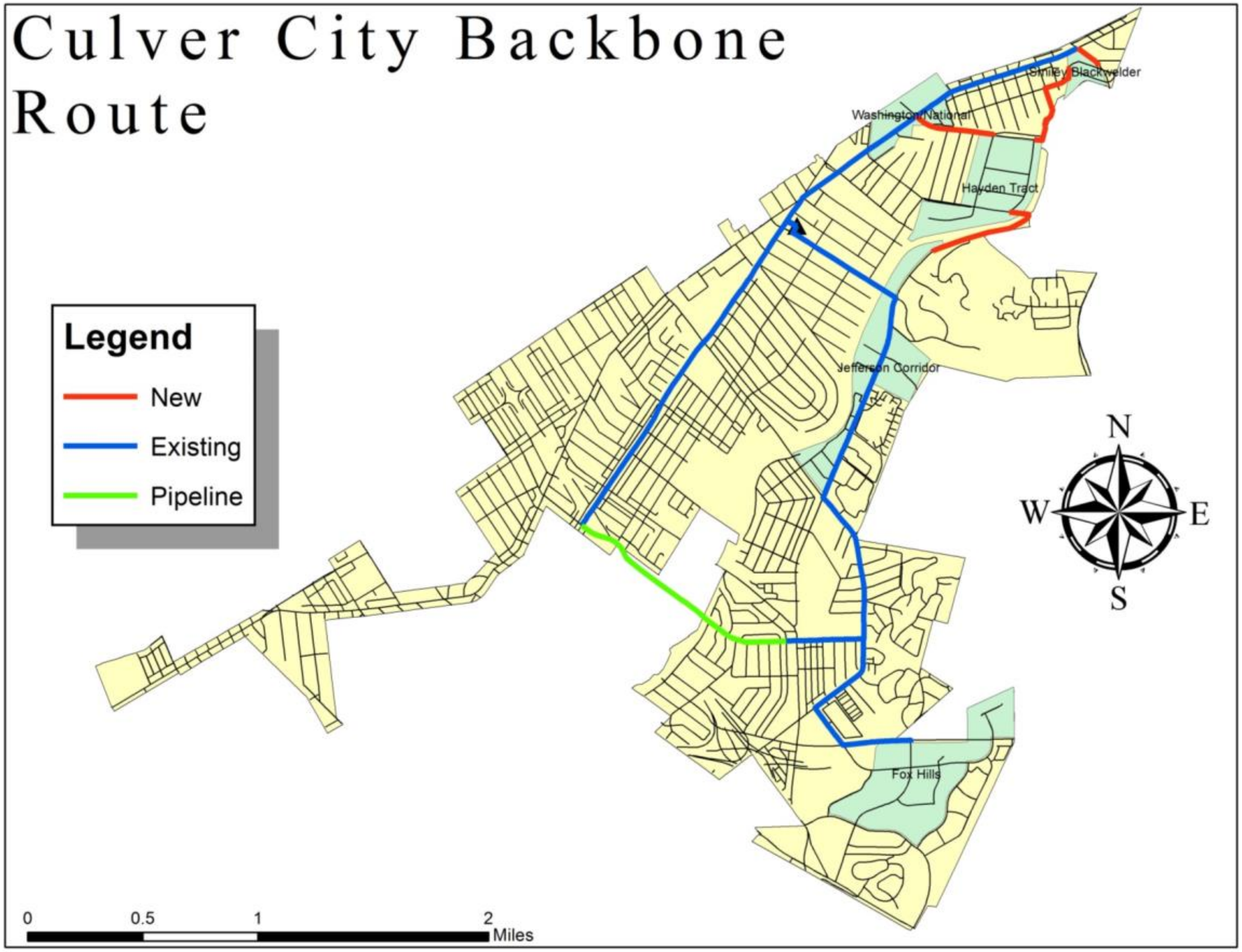
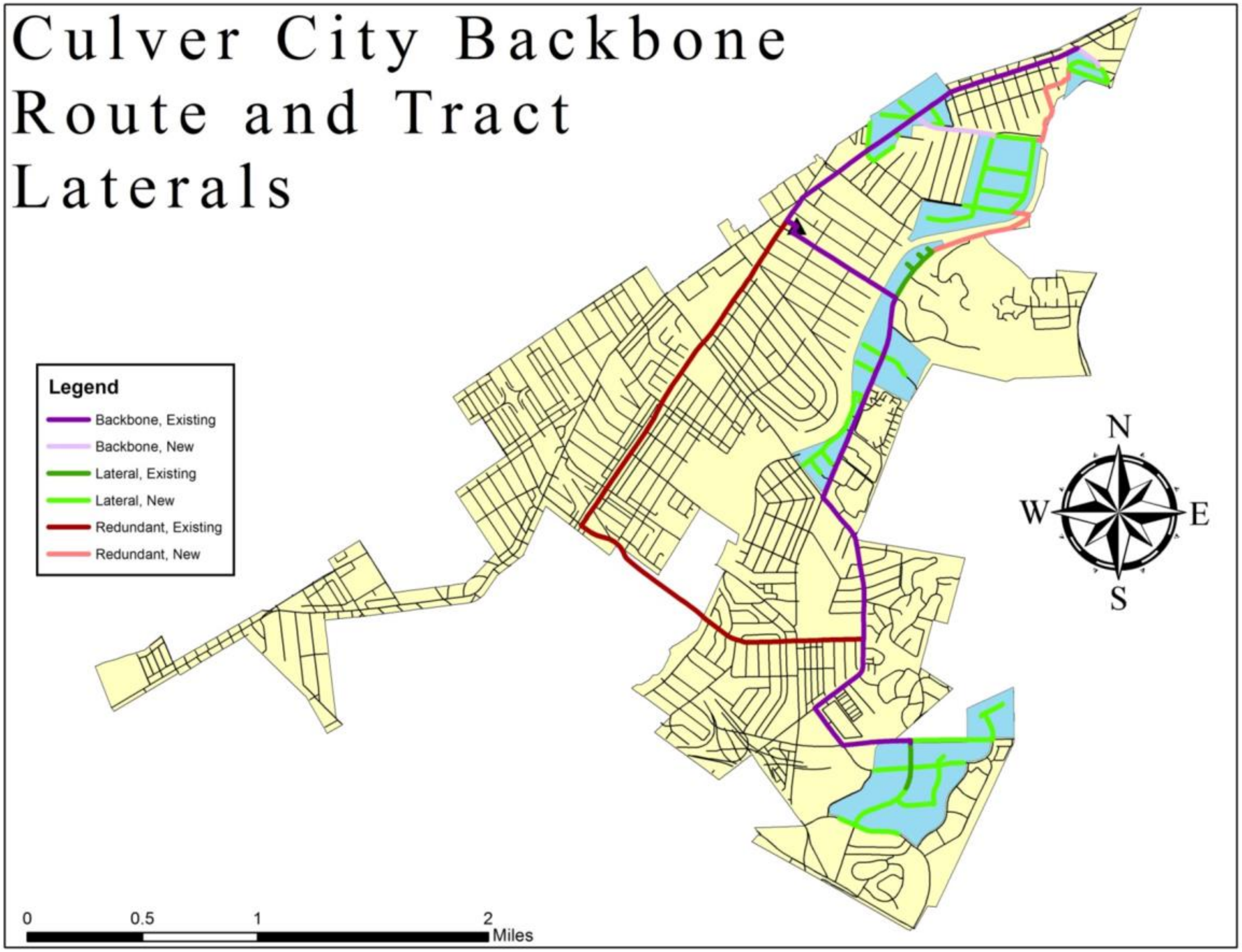


Figure 9: Backbone with Tract Laterals



3.2 Tracts (Phase 2)

The identified “tracts” for the fiber deployment are:

- Fox Hills
- Hayden
- Jefferson Corridor
- Smiley Blackwelder
- Washington National

In each of the tracts the City identified the “targeted” buildings and the estimated number of “Creative Office” and “Studio/Media Production” businesses. These businesses represent the initial market and focus of the City’s proposed service offering. These businesses are summarized in the table below.

Table 6: Number of Business by Tract

Tract	Total Businesses	Total Buildings	Office/Creative Office Buisiness	Studio/Media Production Buisness	Office/Creative Office Buildings	Studio/Media Production Buildings
Fox Hills	210	63	173	37	35	7
Hayden	113	75	42	71	20	19
Jefferson Corridor	51	57	38	13	17	5
Smiley Blackwelder	10	39	5	5	3	4
Washington/National	39	45	17	22	5	5
Total	423	279	275	148	80	40

The maps in the following sections illustrate the individual tracts. The numbers superimposed on the “Creative Office” and “Studio/Media Production” buildings are the City’s tabulation of businesses in those buildings.

Figure 10: Fox Hills Tract

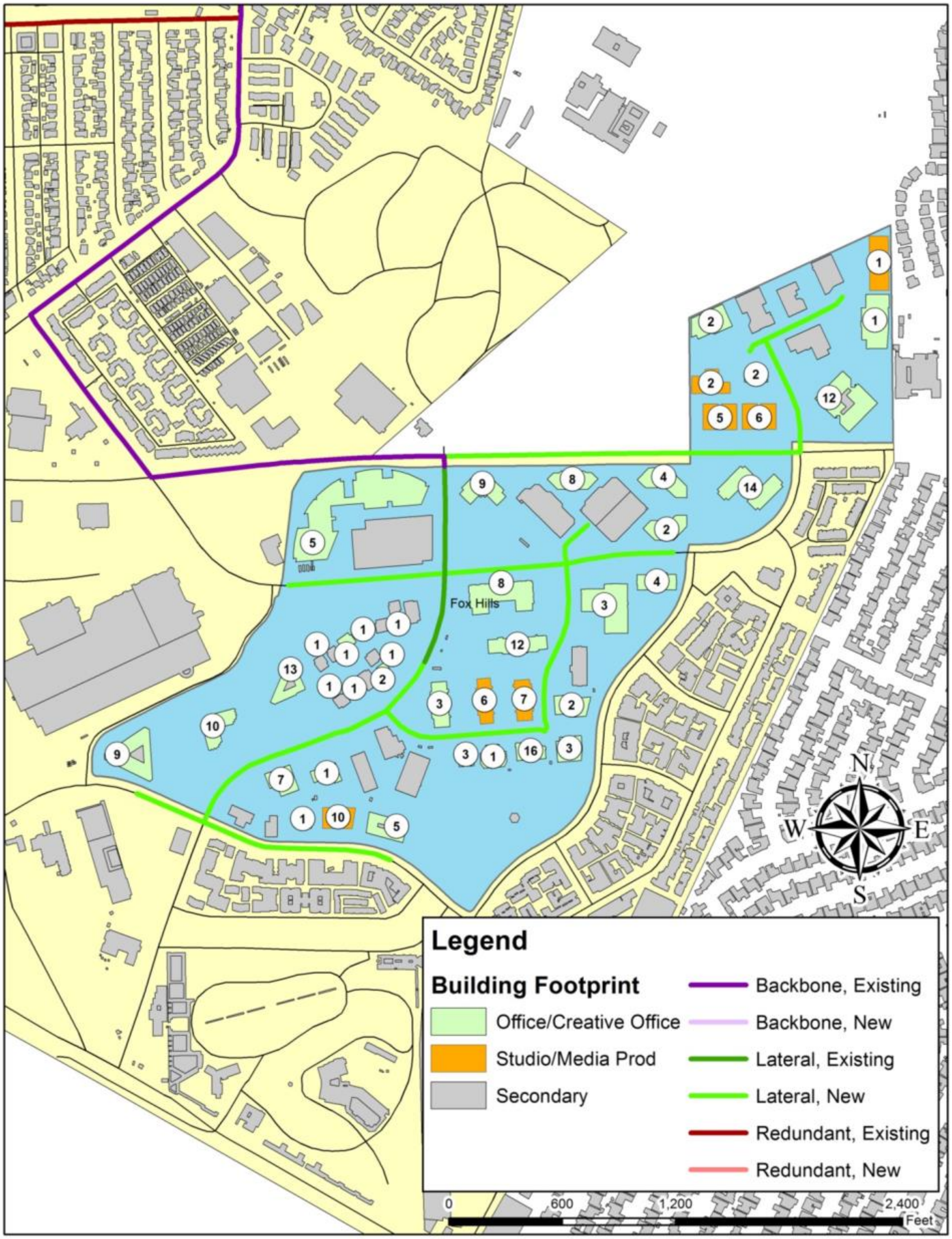


Figure 11: Hayden Tract

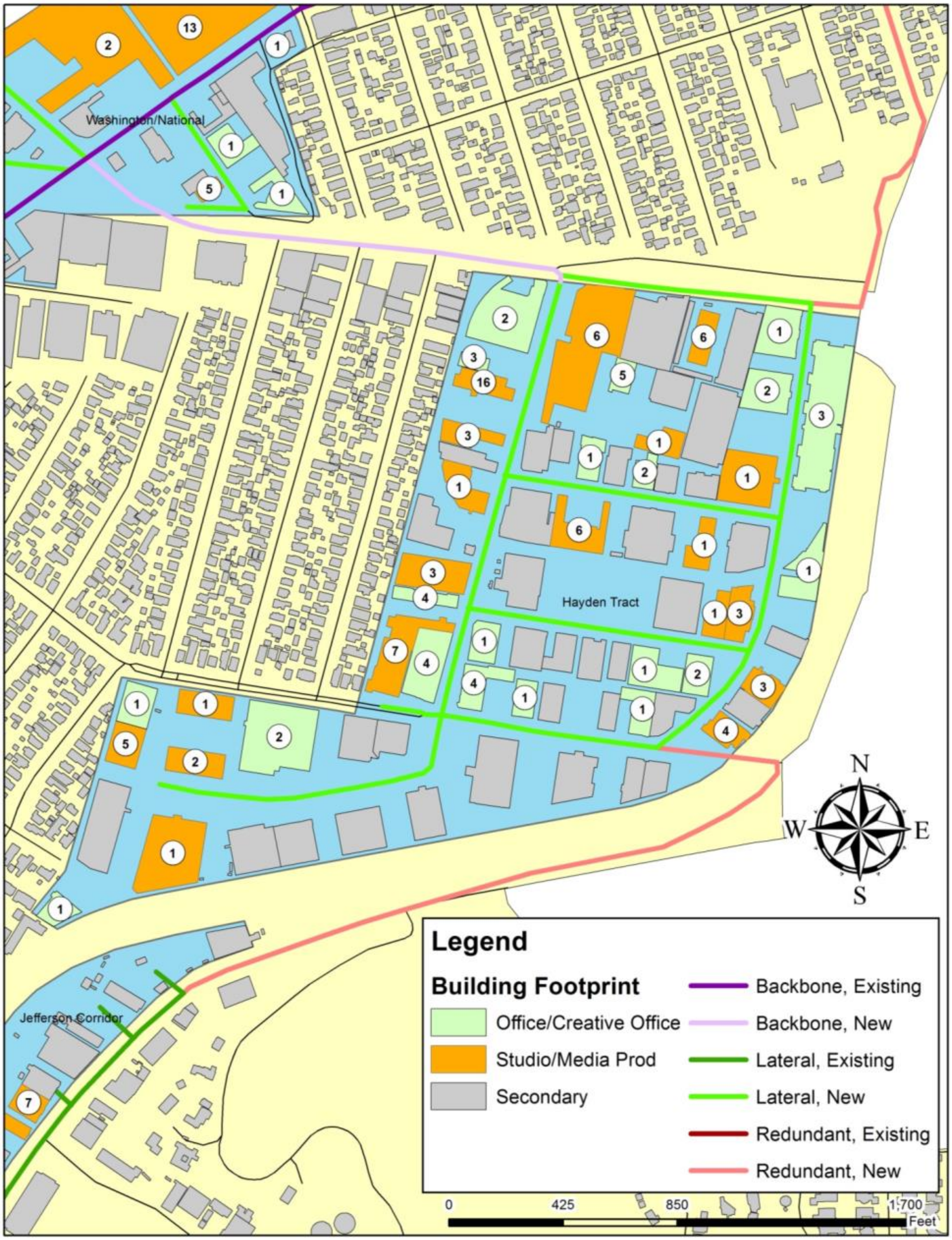


Figure 12: Jefferson Corridor Tract

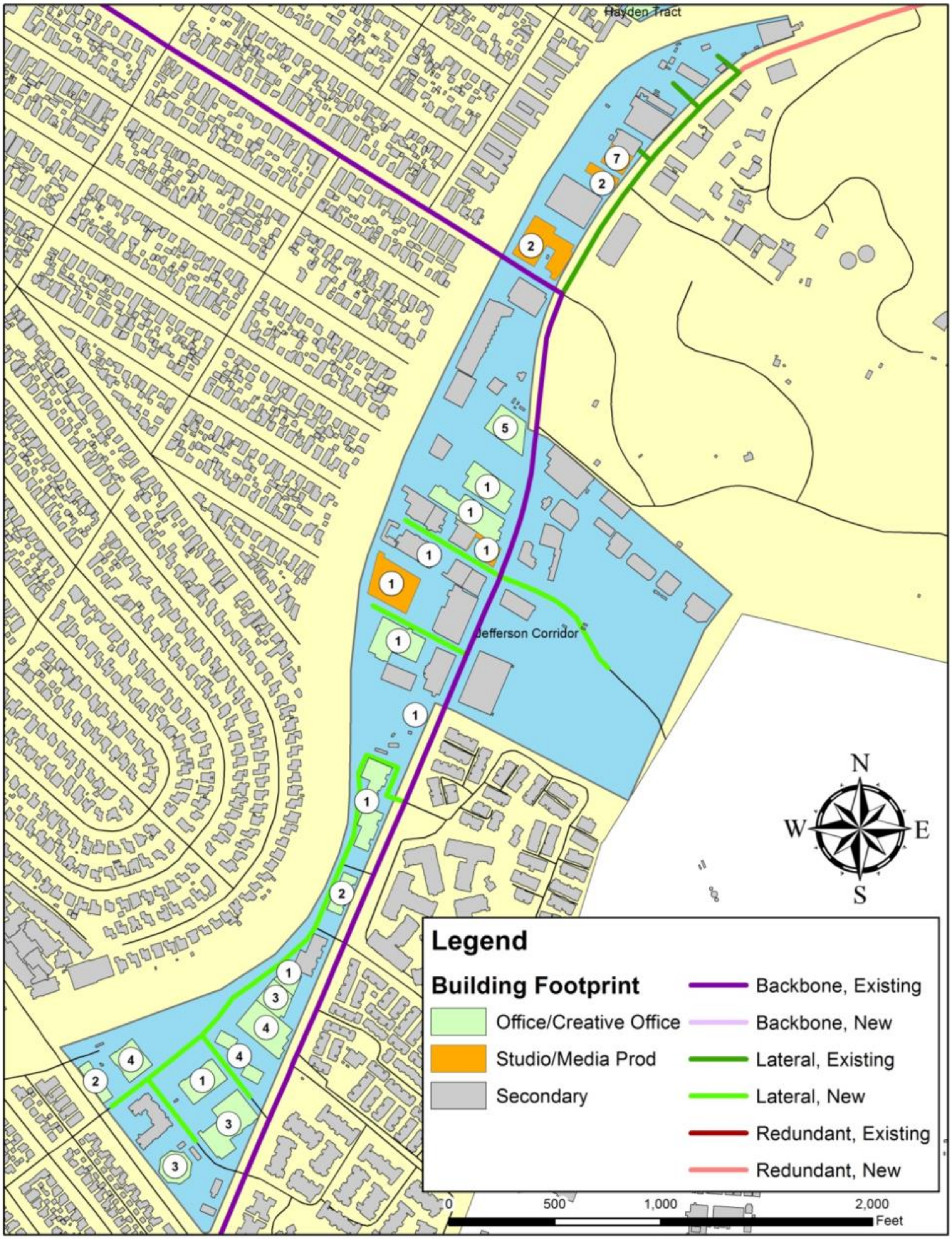


Figure 13: Smiley Blackwelder Tract

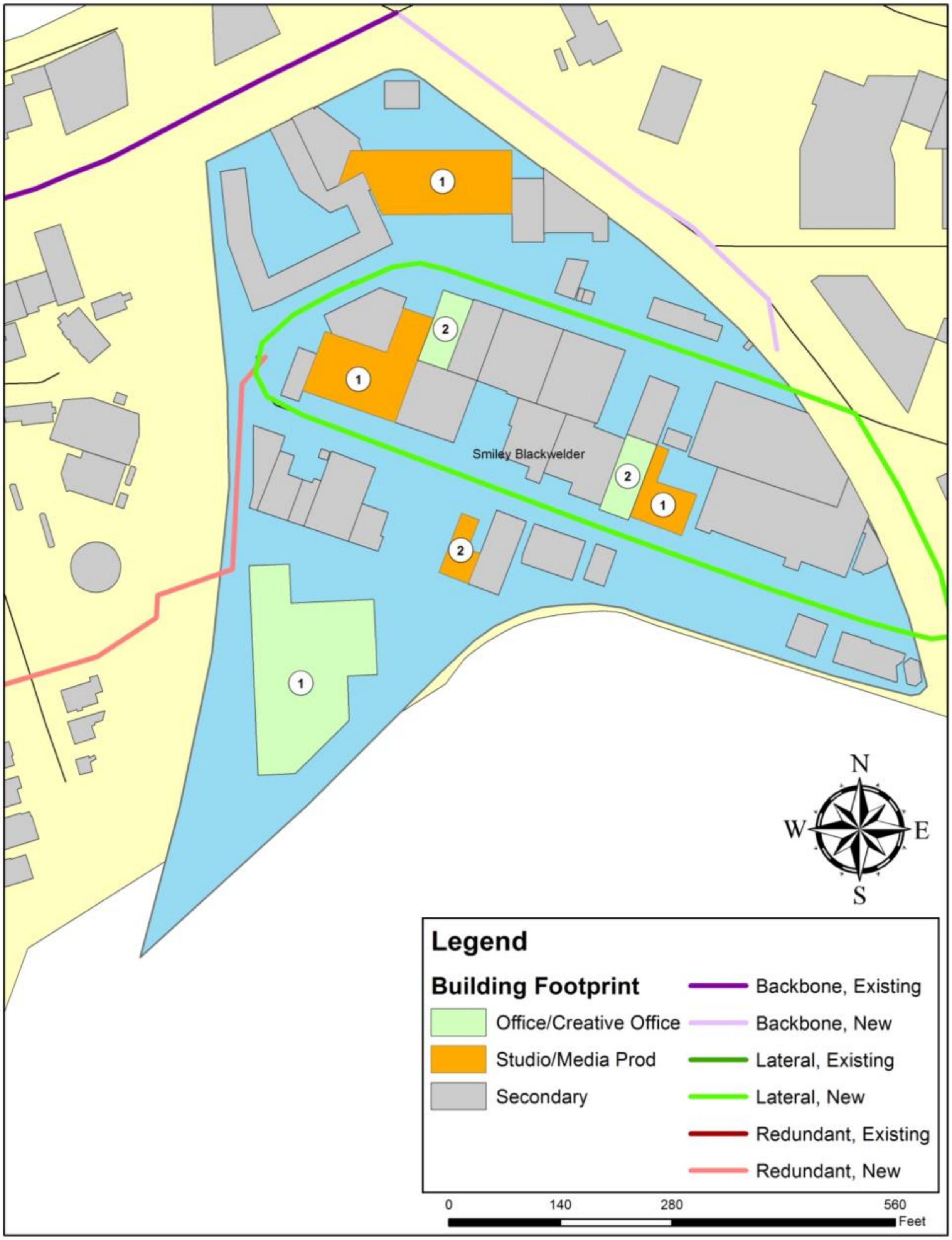
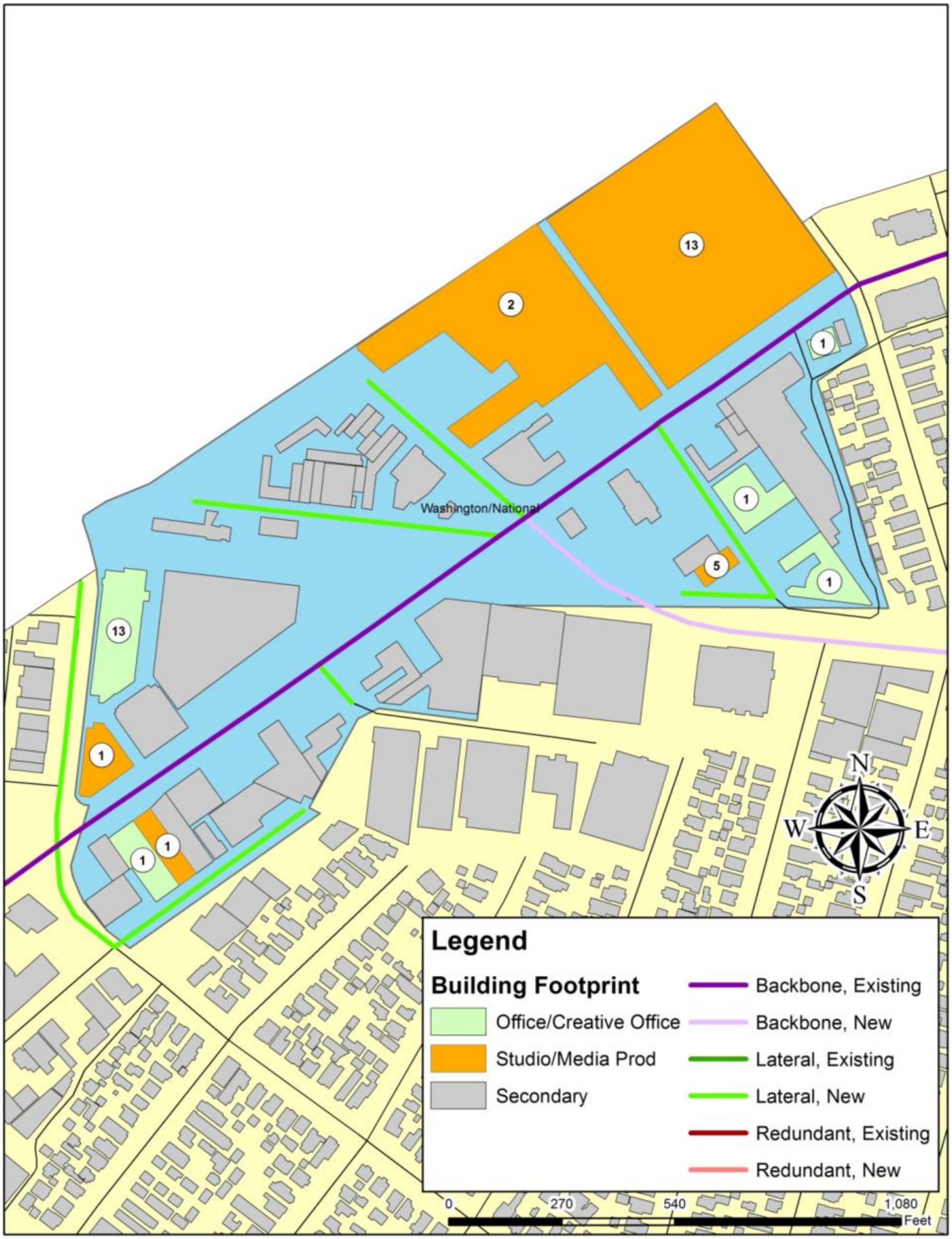


Figure 14: Washington National Tract

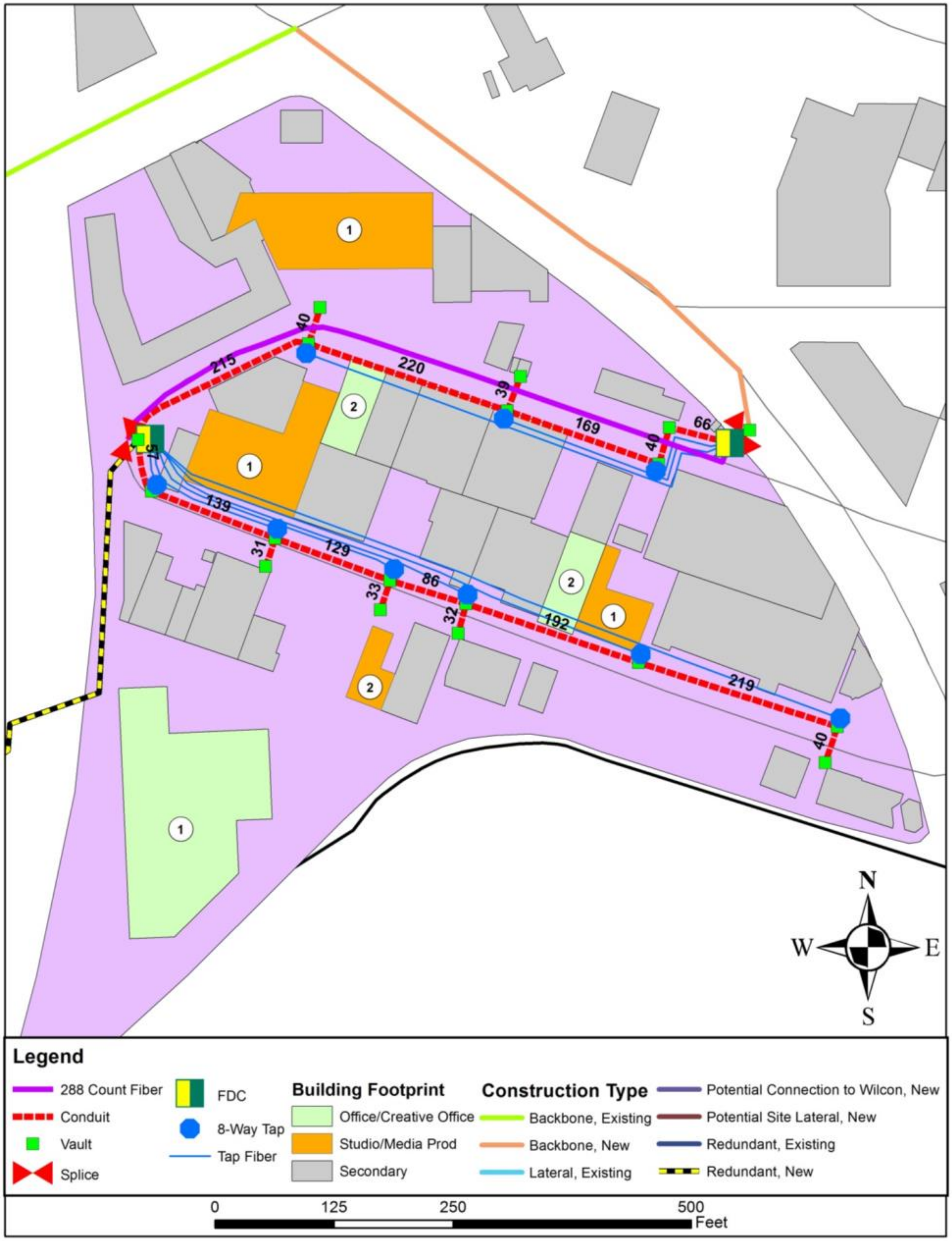


3.3 Connecting Customers in a Tract (Sample Fiber-to-the-Premises Design, Phase 2)

The map of the Smiley Blackwelder tract below includes the essential elements of a fiber-to-the-premises (FTTP) design. This hybrid passive optical network (PON)/Ethernet design includes regularly spaced taps (i.e., the point of connection between lateral fiber and the “drops” to individual customers) to reduce the drop costs for end users. The PON architecture will also allow the City and other ISPs to cost-effectively provide Ethernet transport services to smaller, less bandwidth-intensive customers while also scaling to provide speeds greater than 1 Gbps to larger, high-demand users.

The numbers superimposed over the target buildings represent the number of businesses identified by the City in those buildings. The numbers aligned with the conduit indicate the number of feet of fiber for that portion of the route.

Figure 15: Sample Fiber-to-the-Premises (FTTP) Diagram



3.4 Connecting Community Anchor Institutions (Phase 3) and Businesses (Phase 4)

Looking to the future, after the City has extended fiber to the five tracts, it may create additional community benefits by extending fiber to community anchor institutions (CAI), such as health care and educational facilities. As a fourth phase, the City could extend connections to additional office buildings and multiple dwelling units near the backbone fiber.

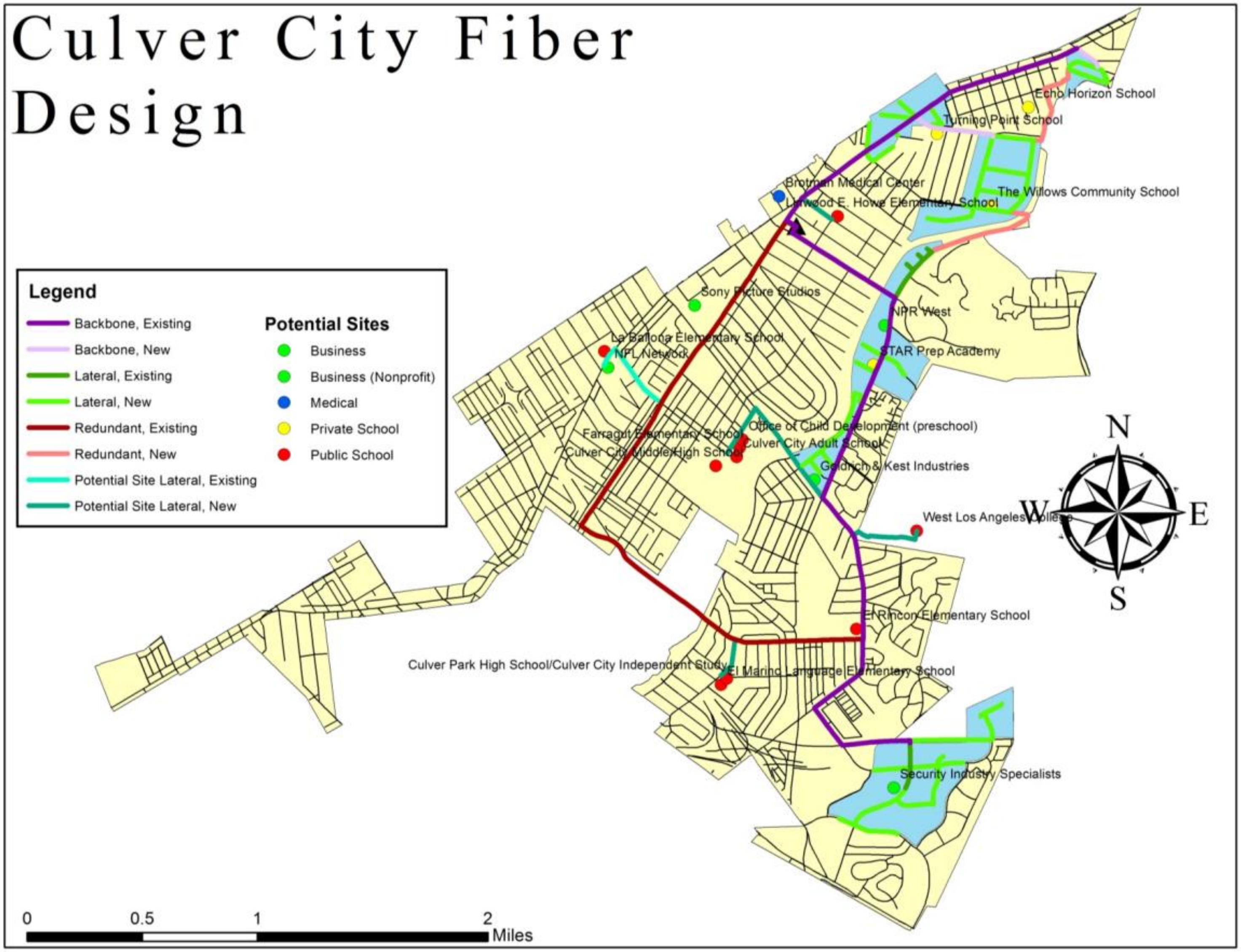
Table 7 identifies potential CAI and business customers near the tracts. Figure 16 illustrates a representative sampling of potential CAIs and larger businesses, and the laterals that would be required to connect them to the backbone.

Table 7: Potential Phase 3 and Phase 4 Customers[40]

Entity	Type
Sony Picture Studios	Business
NFL Network	Business
NPR West	Nonprofit
Brotman Medical Center	Medical
Kaiser Permanente West Los Angeles Medical Center	Medical
West Los Angeles College	Public School
Culver City Adult School	Public School
Farragut Elementary School	Public School
Office of Child Development (preschool)	Public School
El Marino Language Elementary School	Public School
El Rincon Elementary School	Public School
Linwood E. Howe Elementary School	Public School
La Ballona Elementary School	Public School
Culver City Middle/High School	Public School
Culver Park High School/Culver City Independent Study	Public School
STAR Prep Academy	Private School
The Willows Community School	Private School
Turning Point School	Private School
Echo Horizon School	Private School
Goldrich & Kest Industries	Business
Security Industry Specialists	Business

[40] This list is for illustration purposes; it is not vetted or approved. Sources include Chamber of Commerce, business directories, and online research.

Figure 16: Backbone with Connections to Community Anchor Institutions



4. Deployment Overview

This section describes the preliminary network design, including the fiber routes, network architecture, and network electronics. Our assumptions around construction and operating costs, as well as services and revenue, are described in Section 5.

4.1 Fiber

For the City's fiber backbone, we specified a 288-count ribbon fiber optic cable to facilitate serving all of the buildings in each tract. A 288-count fiber comprises 24 ribbons of 12 fibers. The fiber optic cable will be placed underground as opposed to along utility poles (i.e., aerial) to avoid the lengthy pole attachment process. (Should the City have an agreement with the utility pole owner(s), this option can be revisited.)

The fiber will be installed in a conduit, with access available via a handhole approximately every 500 to 800 feet (depending on the curvature of the conduit path). The handholes allow fiber construction workers to pull the fiber through the conduit during installation; the handholes also house the network taps and splice cases, and are storage locations for slack loops (i.e., 100 feet of fiber that can be pulled if the fiber is cut).

Conduit is normally installed in one of two ways—either through directional boring or by trenching (also called plowing). Directional boring, which was chosen for this project, involves locating a handhole site, then drilling underground from that point to the next handhole location on the route. Trenching involves digging down from the surface along the entire fiber route, then burying the conduit. Trenching is usually chosen when there is ample open ground available along the fiber route. In cases where there is a lot of paved surface along the routes, as is the case in Culver City, directional boing is typically the preferred method.

The network was designed to enable the construction of a redundant loop. In this case there would be two rings, one ring in the north (reaching three tracts) and one in the south (reaching two tracts). The primary backbone comprises 24,300 feet of existing conduit and 1,300 feet of new construction. The redundant loops add an additional 16,100 feet of existing conduit and 5,200 feet of new construction. New conduit will require construction in the City's right-of-way green space.

One to two fiber distribution cabinets (FDC) will be placed at each tract. The number of distribution cabinets is dependent upon how many customers are being served and the geography of the tract. Cabinets will be connected back to City Hall via the fiber. Eight-way taps will be placed on the edge of the property line of the buildings to be served, in a handhole. Eight-way taps were chosen, in this case, due to the density of potential customers and to provide the availability to expand the network.

In order to add a customer to the network, an outside plant engineer will need to conduct a site survey. The engineer will decide the best path from the tap to the building and then into the telecommunications closest. If there is existing conduit that is usable and in good condition it may be leveraged to lower the cost of the drop.

4.2 Network Electronics

We recommend that the City pursue implementing a hybrid Passive Optical Networking (PON)/Ethernet transport platform to serve the diverse needs of its customers. We based this recommendation on our examination of the following attributes:

- The types of services the City wishes to provide to customers (Ethernet transport only);
- The locations, size, density, and demographics of the tracts to be served;
- The current state of the art in carrier transport equipment; and
- The fiber optic design and potential hub locations.

Based on these factors, a hybrid PON/Ethernet transport platform will allow the City to cost-effectively provide Ethernet transport services to smaller, less bandwidth-intensive customers while also scaling to provide speeds greater than 1 Gbps to larger, high-demand users.

The section will briefly discuss PON and Ethernet transport technologies before outlining a system-level design for network electronics for the City.

4.2.1 Passive Optical Networking (PON) Overview

Passive optical networking (PON) is an access that provides shared transport services over fiber optic cable. PON technologies are different than cable modem or DSL service in that they require no active electronics in the field. The only electronics that require power are located at the hub site and the customer premises. Because of the bandwidth attainable with fiber optics, PON technologies are capable of providing far more bandwidth than cable modem or DSL services.

PON technologies are a shared transport system as they use optical splitters to split the PON signal to serve up to 64 subscribers from a single fiber connection from the hub. This allows PON service providers to reduce the amount of fiber and number of electronics needed. PON technologies also use time slots to assign transport capacity between individual customers and the hub site—thus enabling PON service providers to assign specific quality of service and bandwidth parameters to each user.

Gigabit PON (GPON) is the most popular PON technology deployed in the United States. GPON has been adopted by Verizon and other fiber-to-the-premises (FTTP) providers. GPON has a capacity of approximately 2.4 Gbps downstream and 1.2 Gbps upstream. GPON is typically deployed with fewer than 32 subscribers per PON port. GPON services provided to the customer can either be symmetrical or asymmetrical in bandwidth.

PON is an optimal technology for aggregating small and medium-sized businesses data demands onto a single optical fiber. However, the technology is a shared data service, and as customers' data demands grow, the subscribers may need to be segmented into smaller optical splits (e.g., 12 or 16 customers per fiber)—or customers requiring higher data capacity will need to be transitioned to a dedicated Ethernet service. As another potential alternative, PON technologies like XG-PON and WDM-PON are being developed and deployed that can provide even greater downstream and upload capacity over the same optical split network.

4.2.2 Ethernet Overview

Ethernet transport service is a popular and widespread commercial service that provides transparent Ethernet connectivity between customer locations. Ethernet transport services can be used to link offices together over a private WAN or can be used to provide a dedicated Ethernet path between a customer and the Internet (i.e., its ISP).

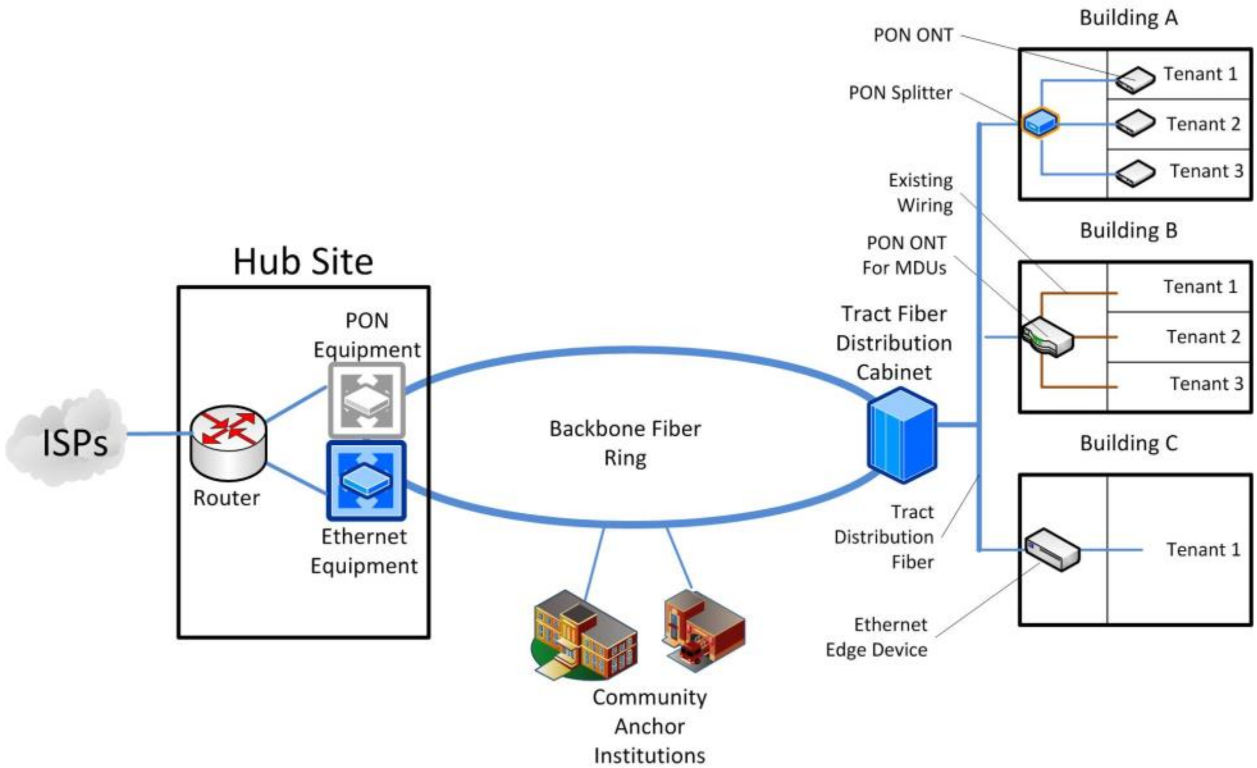
Ethernet transport services can be provided using a variety of protocols; some are proprietary to their equipment manufacturers, and other are standardized (such as Metro Ethernet or pseudowire). Regardless of the standard selected, the Ethernet transport equipment encapsulates the customer's network traffic on one end of the transmission and delivers it at the other end. Because the traffic is encapsulated, the Ethernet transport network does not care what IP addresses or other Layer 3 and high-level protocols are being used by the customer. It simply transports the traffic between the designated locations. For the customer, the Ethernet transport system is completely transparent in the operation of its network.

Ethernet transport services can be provided in a variety of speeds from as low as 10 Mbps to 10 Gbps (or higher). Metro Ethernet has been widely deployed by commercial carriers, whereas MPLS and pseudowire are used more at the enterprise level. Ethernet transport services are more expensive than PON services because they require more electronics and fiber optics. However, Ethernet transport services can provide higher bandwidths and more finely customizable transport services than PON.

4.2.3 Culver City System-Level Network Design

The following figure depicts a system-level network design that would allow the City to serve businesses within the identified tracts, as well as community anchor institutions.

Figure 17: Culver City System-Level Network Diagram



Hub Site

The system-level design assumes that there is only one hub site within the City. The hub site houses the core network electronics for the City's network, as well as routers and other electronics to connect the City electronics to ISPs (so that customers can access the Internet). The hub sites will also house the fiber optic termination panels from the backbone fibers. We estimate that the electronics and fiber termination panels will take four to six racks of space within the hub site.

We assumed that the hub site would be located at an existing City facility. At the facility, we recommend that the area designated for the hub site be modified to reliably support carrier-grade network electronics. This includes ensuring that the space has:

- Adequate commercial power;
- A backup generator with a sufficient fuel supply and automated transfer switch;
- A centralized uninterruptible power supply (UPS) capable of supplying power to the entire hub site until generator power is available;
- Redundant HVAC systems that are connected to backup power;
- A fire-suppression system designed for this application; and

- Security mechanisms.

For the core network electronics, we recommend that the City pursue a multi-service transport platform that is capable of supporting both PON and Ethernet customers. A hybrid platform would simplify management for the City and should provide capacity for future growth and/or migration of customers to higher levels of service. We recommend that the City purchase modular or chassis-based core network electronics. Modular core electronics will allow the City to add capacity as needed on the system by purchasing additional interface cards for the chassis. The core electronics should also support high availability and redundancy. This includes redundant power supplies and control modules, hot-swappable components, and advanced monitoring and control capabilities.

Along with the core electronics, the City needs a comprehensive network management tool to monitor, provision, and maintain the network. A good network management system will minimize the number of truck rolls needed to maintain and operate the network. The system should be able to provision and control both the PON and Ethernet electronics and report the health and availability of each unit.

Field Electronics

The exact field electronics used will vary at each building in a tract. The size of the building, amount and type of internal wiring, number of tenants, and types of tenants will determine the optimal field electronics. We recommend that the City ensure that its network electronics vendor can supply a wide range of field electronics to meet the needs of a specific installation scenario. Regardless of the installation scenario, a fiber optic drop must be installed from the tract distribution fiber to the building, which would be terminated in the building's existing telecommunications room.

4.2.4 Installation Scenarios

The following sections outline several common installation scenarios that the City may experience in providing service to customers in the tracts.

Installation Scenario 1: PON to the Tenant

The ideal scenario for providing PON services to tenants in tract building would be to construct a PON network to each tenant's facility. This would require installing a fiber optic drop to the telecommunications room of the building. PON to the tenant is most cost effective if there is existing conduit within the building from the telecommunications closet to each customer. A fiber optic cable would be installed to each tenant taking the PON service.

The number of tenants in a building will determine how the PON is configured. For example, in a building with many tenants (e.g., 12 or more), the City would likely install an optical splitter in the telecommunications room and connect each customer to the splitter. The PON network would then require one fiber back to the hub site to serve all customers in the building.

In buildings with a smaller number of tenants (e.g., one to 12), the City would likely install a smaller optical splitter at the fiber distribution cabinet that would allow the City to serve multiple small buildings using one fiber back to the hub site. By using varying-sized splitters and placing optical splitters within buildings, the City can cost-effectively serve customers by minimizing the number of core electronics and fibers needed.

At each customer, the City would install a PON optical network terminal (ONT) that would connect to the fiber and provide an Ethernet port to which the customer would connect. PON ONTs are relatively inexpensive compared to traditional Ethernet customer premises equipment (CPE), and are designed for a variety of environmental conditions. PON ONTs can also be purchased with multiple Ethernet ports if the customer purchases multiple services from the City. Unless the City is providing a high-availability PON solution, we do not recommend that the City deploy uninterruptible power supplies (UPS) at each tenant location. UPS can greatly increase the maintenance required by the City at each customer location in the future. That said, we do recommend that the City install the PON CPE on a customer's UPS where possible.

Installation Scenario 2: PON to the Building

The PON to the building scenario constructs fiber to the telecommunications closet in the building and then uses existing wiring within the building to provide services to the individual tenants. This scenario is ideal for older building where existing conduit is not available between the telecommunications closets and the tenants, or where other factors make pulling fiber optics in the building not cost effective.

A variety of existing wire can be used to provide services; these include existing data cables (Category 5 or higher), coaxial cable, and telephone wiring (Category 3). At the telecommunications closet, a PON device designed for multi-unit buildings would be installed with interfaces to utilize the existing wiring. For a multi-unit building PON, we recommend that the City install a UPS to protect the unit from power irregularities and to report the loss of power in a building.

Using the existing wiring in a building may limit the bandwidth and services that the City can offer to customers. For example, if the building has existing data drops, there may be no limitation in the speeds of service. However, providing service over telephone wiring may limit the bandwidth available due to the limitations of the wiring.

Installation Scenario 3: Ethernet Transport

To provide Ethernet transport to customers, the City will need a direct fiber link from the hub site to the customer's facility. The ideal installation scenario would be where the customer occupies the entire building. The City would need to construct a fiber to the telecommunications room, install an Ethernet edge device, and connect to the customer.

In multi-unit buildings, the City will need to install fiber optics or use an existing data cable to reach the customer's facility. For Ethernet transport customers, we recommend that the City install UPS at each customer facility or require that the customer provide UPS power to the unit.

Ethernet transport electronics are typically more expensive than traditional PON ONTs, although they offer higher bandwidth speeds than PON. Redundant connections to the hub site, using a fiber around the backbone ring, can provide higher network availability to premium customers. Ethernet edge devices can also provide either a copper or fiber Gigabit Ethernet handoff to the customer.

5. Financial Analysis Framework

Our financial analysis is based on a range of assumptions, our understanding of the City's objectives, and our industry experience. Further, we developed a financial model that allows us to identify the interplay among the range of inputs.

This section summarizes our estimates of construction costs, and provides the City with our recommended base model for pricing, assuming certain expenses and revenues. The assumptions and pro forma spreadsheets are attached as Appendix B.

We also conducted a sensitivity analysis under a number of scenarios to show how the network's cash balance is affected by changed assumptions. Starting with our base model, we selectively altered the model to illustrate a variety of situations that may evolve as the business model is refined and, later, when the plan is executed. Those scenarios are described in later in this section.

5.1 Summary

The proposed initial service offerings and pricing used in the financial model are as follows:

- 100 Mbps at $300 per month
- 250 Mbps at $500 per month
- 1,000 Mbps (1 Gbps) at $1,100 per month

We set the City's projected pricing below the cost of Metro Ethernet services but higher than cable modem or DSL services—a reflection of both the level of service and the target market. These services would be bundled with Internet access, with an oversubscription negotiated as ISP partners are selected. We recommend that the service performance attributes and pricing be refined as details of the business model are developed. The services, pricing, and performance attributes will be dependent upon negotiations and business relationship developed with ISPs.

The financial projections are also based on passing the 279 buildings and 423 businesses identified by the City in the five tracts.[41] We assume that the tracts will be built out over two years, and that 60 percent of these businesses will acquire one of the Culver City-enabled data services within three years. The deployment order of the tracts in the financial model is just a placeholder; the final order will need to be determined based on readiness and other priorities and objectives.

[41] The complete set of assumptions is listed in Appendix B.

We further assume that $3 million of start-up funding is provided by the City—and is not recovered with funds generated by the enterprise. If the start-up funding is financed, the principal and interest payments would be made over 20 years; the base service pricing would need to increase by approximately 15 percent to maintain a similar cash flow if all other assumptions remain unchanged.

The income and cash flow balances produced by these base assumptions are shown in Table 8. At the end of year seven, the fiber enterprise is projected to have a cash balance of almost $500,000.

Table 8: Condensed Income and Cash Flow Statement (Base Assumptions)

	1	2	3	4	5	6	7
Total Revenues	$ 150,850	$ 740,875	$ 1,419,875	$ 1,822,300	$ 1,694,000	$ 1,694,000	$ 1,694,000
Total Cash Expenses	(675,400)	(1,078,400)	(1,343,400)	(1,531,400)	(1,506,400)	(1,506,400)	(1,506,400)
Depreciation (non-cash)	(89,402)	(154,211)	(189,752)	(211,983)	(211,983)	(211,983)	(211,983)
Net Income	$ (613,952)	$ (491,736)	$ (113,277)	$ 78,917	$ (24,383)	$ (24,383)	$ (24,383)
Capital Expenditures	(1,255,160)	(825,600)	(240,240)	(128,300)	-	(30,600)	(96,500)
Funding (net)	1,800,000	1,200,000	-	-	-	-	-
Depreciation (non-cash)	89,402	154,211	189,752	211,983	211,983	211,983	211,983
Net Cash for Year	$ 20,290	$ 36,875	$ (163,765)	$ 162,600	$ 187,600	$ 157,000	$ 91,100
Total Cash Balance	$ 20,290	$ 57,165	$ (106,600)	$ 56,000	$ 243,600	$ 400,600	$ 491,700

5.2 Construction Cost Assumptions

The backbone (phase 1) and lateral (phase 2) construction will entail costs in three basic categories:

- Fiber costs (backbone, laterals)
- Network electronics costs (hub, headend)
- Customer costs (drops, customer premises equipment)

5.2.1 Fiber Costs

We estimate the total fiber construction costs for the redundant backbone and tracts to be about $1.4 million. If the City were to complete a single-path backbone, without redundancy, the construction cost would be reduced to about $1.1 million.

These costs assume that all new construction in each of the tracts is underground. (Overhead construction, where feasible, could reduce the tract implementation costs by up to 40 percent—but would increase the operating and maintenance costs.) Our projections assume that the City will pull new fiber through existing conduit wherever possible. If the existing conduit is full, the City will need to remove the old fiber before pulling new fiber—an extra step that will marginally increase the construction costs.

The preliminary cost estimate for constructing the single-path backbone is $245,800 (pulling new fiber) to $257,900 (removing old fiber, then pulling new fiber). Making the backbone redundant increases the estimated cost by $223,200 (new fiber) to $231,200 (replacing existing fiber). To connect the City's fiber to one of Wilcon's on-net facilities, which would enable the City to connect to the One Wilshire carrier hotel in Los Angeles, we estimate $29,100 in additional construction costs.

The cost to construct fiber laterals to the tracts varies widely, because each tract presents a unique range of routes and construction factors. The Smiley Blackwelder tract will be the least expensive to connect (an estimated $73,900), while the Fox Hills tract will be the most expensive (an estimated $280,000).

Table 9 lists the estimated fiber construction costs for the backbone, the tracts, the connection to Wilcon, and the redundant backbone routes. Please note that we have provided two estimates. The first estimate assumes that all new fiber is pulled in both new and existing conduit. The second estimate assumes that in existing routes, the existing fiber would need to be removed before the new fiber is pulled. For the financial projections we used the second (higher) estimate.

Table 9: Estimated Fiber Construction Costs

Route / Tract	All New Fiber (Existing and New Conduit)	Replace Existing Fiber in Conduit and Install New Fiber/ Conduit
Backbone	$245,800	$257,900
Make Backbone Redundant	$223,200	$231,200
Wilcon Connection	$29,100	$29,100
Jefferson Corridor	$153,600	$156,400
Smiley Blackwelder	$72,000	$73,900
Fox Hills	$277,600	$280,000
Hayden	$239,300	$241,200
Washington National	$108,300	$110,200
Total	*$1,348,900*	*$1,379,900*

5.2.2 Network Electronics Costs

Network electronics costs include the equipment required for the headend and hub (see Section 4 for a detailed description). This equipment represents one of the primary implementation expenses, estimated at $200,000 in year one. Following the seven-year depreciation cycle, we also estimate that the City will incur a $150,000 replacement cost in year eight.

5.2.3 Customer Costs

Customer costs comprise two general expenses—the cost to connect a facility with a fiber drop, and the cost of the customer premises equipment (CPE).

For both categories of customer costs, we estimate a lower cost in year one than in the subsequent two years. Fewer customers will be connected in the first year because construction will be ramping up; in the second and third years, once the backbone and laterals are in place, we assume that the City will be connecting more customers.

Fiber drops, which have a seven-year depreciation schedule, account for an estimated $37,500 in year one, $97,500 in years two and three, and $60,000 in year four.

CPE costs, which have a five-year depreciation schedule, are estimated to be $30,600 in year one, $96,500 in years two and three, and $68,300 in year four.

5.3 Expense Assumptions

The model includes the following assumptions regarding expenses.

5.3.1 Annual Multipliers

We use a "flat" model because incremental growth assumptions, regardless of being applied evenly to both income and expense, can skew long-term estimates. For example increasing revenue and expense by 3 percent annually also increases operating margins by 3 percent per year. In reality, the network's cost increases will likely be higher than its revenue growth. Margins will likely remain flat—or even shrink—over time.

5.3.2 Operating Expenses

We assume that the City will contract day-to-day operation of the network to a third-party vendor. The operating expenses and assumptions include:

- Annual fiber maintenance (locates, repairs, other) is estimated at 5 percent of the accrued fiber investment. By year 4, the fiber maintenance is estimated at $87,000 per year.

- Network Operations Center (NOC) monitoring and dispatch starts at $50,000 in year 1 and increases to $100,000 per year once all tracts are deployed.

- Community outreach and marketing (material and advertising) is estimated at $12,500 per year. This is in addition to the City staff allocations for marketing, as indicated below.

- Dark fiber lease to One Wilshire is estimated at $146,500 per year. The estimate is based on Los Angeles Department of Water and Power (LADWP) published dark fiber rates and assumes a lease of two fiber strands along two different routes for redundancy. Other alternatives to an LADWP lease include obtaining dark fiber from Wilcon (a quote has been requested) or leveraging the connection that Santa Monica has in place. There are a variety of combinations that can be considered. For example, Culver City may obtain one route through Santa Monica and lease a second, or just start with a non-redundant connection. We also estimated $50,000 for the cost of electronics for the connection between Culver City and One Wilshire.

- Network maintenance agreements are estimated at 15 percent of the accrued electronics investment. By year 4 the network maintenance is estimated at $74,000 per year.

- Incremental insurance is $20,000 in year 1, increasing to $40,000 per year once each of the tracts is connected.

- Legal and consulting fees are $75,000 in year 1, declining to $25,000 per year starting in year 3.

In addition we included a $50,000 per year contingency and a $5,000 per year allocation for utilities. Since the proposed plant is all underground, no pole attachment expenses are projected.

5.3.3 Internal Staffing Allocations

Even with contracting out day-to-day operations, the City will need to devote staff resources to administer and oversee the operation. Project management resources are required during the start-up. We estimate the cost for project management at $50,000 in year 1, $70,000 in year 2, $50,000 in year 3, and $25,000 in year 4.

For operations and administration we estimate $50,000 in year 1 increasing to an annual estimate of $75,000 per year in year 2. For community outreach and marketing support we estimated $37,500 in year 1 declining to $12,500 per year in year 2.

5.3.4 Partner ISP Fees

The ISPs that sell services to end users will receive a portion of each user's service fee (i.e., to cover the cost of customer service support, Internet access fees, and other operating costs).

As an initial estimate, we assumed that ISPs will be paid $7.50 per Mbps per month with an oversubscription ratio of 10. This nets an ISP fee of $75 per month for a 100 Mbps service, $187.50 per month for the 250 Mbps service, and $750 per month for the 1 Gbps service.

5.3.5 Allowance for Bad Debt and Collections

Bad debt and collection costs are estimated at 5 percent of revenues. These costs are estimated at $5,000 in year 1 and increase to $89,000 by year 4. Incorporating pre-payment policies, risk sharing with the ISP partners, and other methods, could substantially reduce this expense.

5.3.6 Business Development and Engineering Support

Costs for the City to refine the business model and cover its contract support needs is estimated at $175,000 in year one and $50,000 in year 2. In addition, the model includes $60,000 for fiber bid development.

5.3.7 Customer Connection Expenses

In addition to the customer premises equipment (CPE) and hub card required for each customer, we assumed an average installation cost of $250. Including installation, the estimated connection cost for 100 Mbps and 250 Mbps customers is $950. For 1 Gbps customers the average cost is estimated at $1,450.

5.3.8 Depreciation Expenses

Depreciation is a non-cash expense, but is used in the income statement to estimate the "use" of the capital equipment to deliver services. In the model, fiber is depreciated over 20 years, hub equipment is depreciated over seven years, and CPEs are depreciated over five years.

5.3.9 Replacement Capital

Because capitalized plant is fully depreciated, costs for replenishments are included in the financial model.

5.4 Revenue Assumptions

We assume that the Hayden and Jefferson Corridor tracts are deployed in year 1, and the remaining tracts are deployed in year 2. This deployment is not a recommendation; rather, the assumption was made to show a phased process. The implementation cost estimate is based on passing the 423 businesses and 279 building in the five identified tracts. We further assume that 60 percent of these businesses will acquire one of the Culver City-enabled data services within three years. The breakdown of the businesses by tract is shown in the table below.

Table 10: Number of Businesses by Tract

Tract	Total Businesses	Total Buildings	Office/Creative Office Buisiness	Studio/Media Production Buisness
Fox Hills	210	63	173	37
Hayden	113	75	42	71
Jefferson Corridor	51	57	38	13
Smiley Blackwelder	10	39	5	5
Washington/National	39	45	17	22
Total	423	279	275	148

The proposed initial service offerings, pricing, and percentage of customers acquiring the service used in the financial model are as follows:

- 100 Mbps at $300 per month
  - 60 percent of creative businesses that obtain a Culver City service will select this option
  - 40 percent of studio/media production businesses that obtain a Culver City service will select this option

- 250 Mbps at $500 per month
  - 20 percent of creative businesses that obtain a Culver City service will select this option
  - 35 percent of studio/media production businesses that obtain a Culver City service will select this option

- 1,000 Mbps (1 Gbps) at $1,100 per month
  - 20 percent of creative businesses that obtain a Culver City service will select this option
  - 25 percent of studio/media production businesses that obtain a Culver City service will select this option

In addition to the monthly service fees we estimate that the customer or building owner will pay for 25 percent of the drop cost and 100 percent of the CPE and installation costs. Dark fiber and other potential revenues are not included in the analysis.

5.5 Sensitivity Analysis

The following presents the financial projections of changing several key assumptions. Please note that in each of the following examples, we assume that $3 million of initial funding provided by the City will not be recovered with funds generated by the enterprise. Paying back this initial funding will reduce the projected cash balances.

5.5.1 Take Rates

The base case assumes that 60 percent of the identified businesses will acquire a Culver City service. The following tables show financial projections for take rates of 45 percent and 30 percent.

Table 11: Take Rate Reduced to 45 Percent

	1	2	3	4	5	6	7
Total Revenues	$ 112,638	$ 566,738	$ 1,088,738	$ 1,379,213	$ 1,285,000	$ 1,285,000	$ 1,285,000
Total Cash Expenses	(649,400)	(981,400)	(1,175,400)	(1,307,400)	(1,282,400)	(1,282,400)	(1,282,400)
Depreciation (non-cash)	(86,800)	(144,440)	(172,812)	(189,806)	(189,806)	(189,806)	(189,806)
Net Income	$ (623,563)	$ (559,103)	$ (259,475)	$ (117,994)	$ (187,206)	$ (187,206)	$ (187,206)
Capital Expenditures	(1,240,010)	(784,400)	(199,040)	(98,900)	-	(22,950)	(74,050)
Funding (net)	1,800,000	1,200,000	-	-	-	-	-
Depreciation (non-cash)	86,800	144,440	172,812	189,806	189,806	189,806	189,806
Net Cash for Year	$ 23,228	$ 938	$ (285,703)	$ (27,088)	$ 2,600	$ (20,350)	$ (71,450)
Total Cash Balance	$ 23,228	$ 24,165	$ (261,538)	$ (288,625)	$ (286,025)	$ (306,375)	$ (377,825)

Table 12: Take Rate Reduced to 35 Percent

	1	2	3	4	5	6	7
Total Revenues	$ 75,425	$ 387,713	$ 749,713	$ 958,288	$ 892,000	$ 892,000	$ 892,000
Total Cash Expenses	(621,400)	(881,400)	(1,005,400)	(1,092,400)	(1,067,400)	(1,067,400)	(1,067,400)
Depreciation (non-cash)	(83,663)	(133,409)	(153,887)	(166,314)	(166,314)	(166,314)	(166,314)
Net Income	$ (629,638)	$ (627,097)	$ (409,575)	$ (300,427)	$ (341,714)	$ (341,714)	$ (341,714)
Capital Expenditures	(1,221,110)	(738,500)	(153,140)	(72,850)	-	(15,300)	(50,650)
Funding (net)	1,800,000	1,200,000	-	-	-	-	-
Depreciation (non-cash)	83,663	133,409	153,887	166,314	166,314	166,314	166,314
Net Cash for Year	$ 32,915	$ (32,188)	$ (408,828)	$ (206,963)	$ (175,400)	$ (190,700)	$ (226,050)
Total Cash Balance	$ 32,915	$ 728	$ (408,100)	$ (615,063)	$ (790,463)	$ (981,163)	$ (1,207,213)

5.5.2 ISP Fees

The base case estimates the ISP is paid $7.50 per Mbps per month with an oversubscription ratio of 10. This nets an ISP fee of $75 per month for a 100 Mbps service, $187.50 per month for the 250 Mbps service, and $750 per month for the 1 Gbps service. The following two tables show the financial projections for increasing and decreasing the ISP fees by 10 percent.

Table 13: ISP Fees Increased by 10 Percent

	1	2	3	4	5	6	7
Total Revenues	$ 150,850	$ 740,875	$ 1,419,875	$ 1,822,300	$ 1,694,000	$ 1,694,000	$ 1,694,000
Total Cash Expenses	(685,400)	(1,117,400)	(1,411,400)	(1,618,400)	(1,593,400)	(1,593,400)	(1,593,400)
Depreciation (non-cash)	(89,402)	(154,211)	(189,752)	(211,983)	(211,983)	(211,983)	(211,983)
Net Income	$ (623,952)	$ (530,736)	$ (181,277)	$ (8,083)	$ (111,383)	$ (111,383)	$ (111,383)
Capital Expenditures	(1,255,160)	(825,600)	(240,240)	(128,300)	-	(30,600)	(96,500)
Funding (net)	1,800,000	1,200,000	-	-	-	-	-
Depreciation (non-cash)	89,402	154,211	189,752	211,983	211,983	211,983	211,983
Net Cash for Year	$ 10,290	$ (2,125)	$ (231,765)	$ 75,600	$ 100,600	$ 70,000	$ 4,100
Total Cash Balance	$ 10,290	$ 8,165	$ (223,600)	$ (148,000)	$ (47,400)	$ 22,600	$ 26,700

Table 14: ISP Fees Decreased by 10 Percent

	1	2	3	4	5	6	7
Total Revenues	$ 150,850	$ 740,875	$ 1,419,875	$ 1,822,300	$ 1,694,000	$ 1,694,000	$ 1,694,000
Total Cash Expenses	(665,400)	(1,039,400)	(1,275,400)	(1,443,400)	(1,418,400)	(1,418,400)	(1,418,400)
Depreciation (non-cash)	(89,402)	(154,211)	(189,752)	(211,983)	(211,983)	(211,983)	(211,983)
Net Income	$ (603,952)	$ (452,736)	$ (45,277)	$ 166,917	$ 63,617	$ 63,617	$ 63,617
Capital Expenditures	(1,255,160)	(825,600)	(240,240)	(128,300)	-	(30,600)	(96,500)
Funding (net)	1,800,000	1,200,000	-	-	-	-	-
Depreciation (non-cash)	89,402	154,211	189,752	211,983	211,983	211,983	211,983
Net Cash for Year	$ 30,290	$ 75,875	$ (95,765)	$ 250,600	$ 275,600	$ 245,000	$ 179,100
Total Cash Balance	$ 30,290	$ 106,165	$ 10,400	$ 261,000	$ 536,600	$ 781,600	$ 960,700

5.5.3 Service Revenues

The base case assumes that 100 Mbps service is $300 per month, 250 Mbps service is $500 per month, and 1 Gbps service is $1,100 per month. The following two tables show the financial projections for increasing and decreasing the service revenues by 10 percent.

Table 15: Service Revenues Increased by 10 Percent

	1	2	3	4	5	6	7
Total Revenues	$ 159,850	$ 796,875	$ 1,542,875	$ 1,991,300	$ 1,863,000	$ 1,863,000	$ 1,863,000
Total Cash Expenses	(675,400)	(1,078,400)	(1,343,400)	(1,531,400)	(1,506,400)	(1,506,400)	(1,506,400)
Depreciation (non-cash)	(89,402)	(154,211)	(189,752)	(211,983)	(211,983)	(211,983)	(211,983)
Net Income	$ (604,952)	$ (435,736)	$ 9,723	$ 247,917	$ 144,617	$ 144,617	$ 144,617
Capital Expenditures	(1,255,160)	(825,600)	(240,240)	(128,300)	-	(30,600)	(96,500)
Funding (net)	1,800,000	1,200,000	-	-	-	-	-
Depreciation (non-cash)	89,402	154,211	189,752	211,983	211,983	211,983	211,983
Net Cash for Year	$ 29,290	$ 92,875	$ (40,765)	$ 331,600	$ 356,600	$ 326,000	$ 260,100
Total Cash Balance	$ 29,290	$ 122,165	$ 81,400	$ 413,000	$ 769,600	$ 1,095,600	$ 1,355,700

Table 16: Service Revenues Decreased by 10 Percent

	1	2	3	4	5	6	7
Total Revenues	$ 141,850	$ 683,875	$ 1,295,875	$ 1,653,300	$ 1,525,000	$ 1,525,000	$ 1,525,000
Total Cash Expenses	(675,400)	(1,078,400)	(1,343,400)	(1,531,400)	(1,506,400)	(1,506,400)	(1,506,400)
Depreciation (non-cash)	(89,402)	(154,211)	(189,752)	(211,983)	(211,983)	(211,983)	(211,983)
Net Income	$ (622,952)	$ (548,736)	$ (237,277)	$ (90,083)	$ (193,383)	$ (193,383)	$ (193,383)
Capital Expenditures	(1,255,160)	(825,600)	(240,240)	(128,300)	-	(30,600)	(96,500)
Funding (net)	1,800,000	1,200,000	-	-	-	-	-
Depreciation (non-cash)	89,402	154,211	189,752	211,983	211,983	211,983	211,983
Net Cash for Year	$ 11,290	$ (20,125)	$ (287,765)	$ (6,400)	$ 18,600	$ (12,000)	$ (77,900)
Total Cash Balance	$ 11,290	$ (8,835)	$ (296,600)	$ (303,000)	$ (284,400)	$ (296,400)	$ (374,300)

Appendix A

Benefit Framework for Government Fiber

1. Local Governments Nationwide Are Pursuing Fiber Initiatives

In addition to the business development goals and objectives driving Culver City's fiber network expansion and potential service offerings, it is important to note that businesses, residents, schools, health care providers, and other institutions can indirectly benefit from an expanded fiber footprint. This appendix provides an overall framework for evaluating the benefits of government-installed and operated fiber networks.

Why Local Government Users Need Fiber

Reliable high-speed networks are critical to the changing needs of local governments, with a specific emphasis on law enforcement and public safety agencies. There are numerous applications for local officials to use in this area. In addition to the many wireless applications that can help emergency personnel cut precious seconds off of their response times, robust wireline networks play a critical role in public safety, due to their speed, bandwidth, and reliability. Criminal arraignments can be conducted using videoconferencing technologies, saving the government thousands and avoiding the dangerous task of transporting prisoners. Traffic systems, including signals wired with fiber optics, can be monitored and adjusted in real-time in response to events. Highway accidents, weather events, and other emergencies can be broadcast to thousands of users simultaneously through public alert systems via e-mail or text message. The improvement to efficiency in public safety created by high-speed network service is hard to overstate.

During large-scale regional emergencies, secure multi-party communications are often required, and wireless facilities may become overwhelmed and unusable. Many local jurisdictions nationwide have taken steps to address these needs. For example, the National Capital Region, comprising Washington, D.C. and the surrounding jurisdictions, built a fiber optic interoperability network known as NCRnet. Built for "security, reliability, and high bandwidth," NCRnet was created specifically to address the needs of first responders and emergency support personnel.[42] The high capacity and redundancy of the fiber network structure lends itself to reliable videoconferencing capacity, ensuring the ability for real-time coordination during a regional emergency.

[42] http://www.broadband.gov/docs/ws_pshs/pshs_afflerbach_reference.pdf

The variety and scale of government applications demands the big bandwidth that fiber provides. As populations grow, institutional broadband needs will grow accordingly; and as data storage and applications move off of conventional hard drives and into the cloud, government institutions will become increasingly bandwidth hungry. These realities point to the need for future-proof institutional network infrastructure, which fiber provides.

Local Governments Have a 15-Year Success Record in Building and Operating Fiber for Government Use

A community's efforts to build fiber and conduit to meet public sector networking needs is part of a broader trend among local governments. Indeed, localities have exercised significant leadership in broadband innovation in the United States. For more than 15 years, a significant minority of localities have chosen to build or purchase fiber for themselves.[43]

In this model, the locality negotiates, purchases, or constructs fiber optics to serve its own needs and those of its local community anchor institutions (CAIs)—connecting over fiber entities such as schools, libraries, public safety departments, and government buildings, and perhaps senior centers, public housing projects, or healthcare institutions.

Many hundreds of communities have implemented, or are considering implementing, cautious fiber strategies. These cities include San Antonio, New York City, Los Angeles, Seattle, San Francisco, Chicago, Washington, D.C., Boston, and hundreds of suburban and rural cities and counties.

We anticipate that this trend, which has continued unabated over the past decade and a half, is likely to continue into the future. The Broadband Technology Opportunities (BTOP) grant program under the federal Recovery Act has, in some parts of the country, accelerated this trend by enabling localities and regional consortia to build more fiber to public sector and other anchor institutions. And American communities are increasingly interested in this type of network to achieve self-reliance in communications.

[43] These internally focused projects contrast to those that are public-facing—networks built by public entities for the purpose of serving residential and business consumers where the private market has failed to deliver adequate service or has failed to deliver competition.

2. Building Fiber Delivers Enormous Government Benefits

The Functional and Technical Benefits of a Community-Owned Network

In almost any community, the local government is one of the largest consumers of broadband bandwidth, which has increasingly become essential to providing a range of public services and governing effectively.

Most local governments' communications networking needs are currently met through leased circuits. This approach has some benefits: For example, it does not require internal staff to operate and maintain the network; its upfront costs are lower than constructing City-owned fiber; and the time to deployment can be shorter. Leasing, however, has critical disadvantages that make it much less desirable than community-owned and operated fiber, particularly with respect to public safety and emergency support services. Specifically:

- The City does not have total control and management over the network
- The City may not be able to evaluate the reliability or availability of a leased circuit because it has no knowledge of the private provider's proprietary network and its physical infrastructure
- Leased services are not independent of the networks used by the public and are therefore less secure and reliable
- The City does not have control over network security between end points

Each of these items is addressed in detail below.

Community-Owned Fiber Facilitates Control and Management

A network built upon leased network services obtained from a service provider cannot provide the control and management that is available in a City-owned and operated network.

Leased network services are in essence a "black box" in terms of control and management. The City is forced to rely on the provider (usually the phone company) to maintain and operate the core equipment of a leased service (these tasks include configuring the equipment, monitoring the hardware and physical infrastructure, and performing routine maintenance).

City internal capacity requirements typically include video, voice, and data communications. Both voice and video services usually require dedicated bandwidth. Two-way voice and video services require dedicated bandwidth and very predictable transmission delay properties.

In other words, linking two-way radio communications systems or supporting videoconferencing over IP or using TDM connections requires the ability to manage bandwidth across the entire network. Although this functionality can be provisioned on the edge device when using a managed service provider for connectivity, if the City owns and operates its own fiber network, it will have control and capability to increase bandwidth based on the City's time frame (which will in turn allow the City to properly plan for integration of new applications without an increase in cost for provisioning of new bandwidth). Further, it offers the ability to implement advanced Quality of Service mechanisms that are enforced on a network-wide, end-to-end basis.

Under the leased model, the City must request (and pay for) the private company to make changes in the core of the network for a new application, increase bandwidth, or to implement new policies for enhanced Quality of Service.

Under the leased model, the City is also not able to control who manages and maintains the core of the network. The knowledge, skill set, and security background of those operating the network is often beyond the control of the City.

With a private fiber optic network, each piece of the communications network is controlled and managed by the City. The City may choose to operate the network on its own with its own staff, or it may outsource the operations to a contractor of its choosing. Either way, choices regarding the management of the network are in the hands of the City—not the phone company.

Community-Owned Fiber Facilitates Availability and Reliability

The availability of a communications link is derived from the probability of a failure within the network between two points. In a leased circuit network, the end user is not aware of all of the potential risks to availability of the network. Several key factors that affect availability and cannot be determined by the City include:

- Physical redundancy in the plant
- Physical redundancy in the building entrances
- Physical redundancy in the networking equipment
- Ensuring network equipment is properly configured and regularly tested to take advantage of hardware and link redundancy
- Redundancy for power and HVAC
- How many facilities the circuit crosses between endpoints
- Whether the plant is located underground or aerial

- Who has access to the core networking equipment and plant
- The core equipment's age and maintenance
- How the system is monitored and maintained
- The single points of failure in the communications link

Many of the factors can be approximated or relative numbers may be obtained from the leased circuit provider; however for critical government services such as public safety, the approximations and availability estimates from leased network services may not meet the availability requirements of a critical traffic network. In the case of physical architecture issues, such as the physical routes of cabling, approximations are not sufficient, and detailed maps are usually considered proprietary and confidential to a commercial provider.

In addition, lessees are subject to the lessor's schedule for repair and maintenance of the circuit. Although it may be possible to include provisions in the service level agreement (SLA) for special priority service restoration, it is possible that SLAs will not be adhered to during major disaster events. Further, there may be no way to ensure that a leased circuit for public safety is the first link to be repaired during a major disaster.

A similar problem can arise in both scheduled and unscheduled maintenance of a leased circuit. The timing of these maintenance downtimes may not correspond to available downtimes in a public safety network. In a City-owned fiber network, maintenance downtimes can be coordinated to minimize downtime and the City can prepare for an outage by adapting operational procedures.

SLAs often guarantee availability and repair time, but typically are not reliable in the event of a major disaster. In addition, service providers usually rely on cash rebates to compensate for network outages to the network—an unacceptable solution in the case of public safety, where cash cannot compensate for lost service.

Community-Owned Fiber Offers Independence from Public Networks

A privately owned communications network does not rely on physical infrastructure, equipment, or other resources that also carry public traffic for residents and businesses. Shared resources are used by a managed network service provider to reduce their cost by taking advantage of the statistical nature of communications traffic. In other words, commercial carriers intentionally oversubscribe their networks to minimize costs (maximize profits), because all of their customers are not likely (statistically speaking) to simultaneously use their services to full capacity all of the time. The advantage of an independent network is that increases in public traffic on the network or public network outages do not affect privately owned networks.

Additionally, the only way to ensure that there is adequate bandwidth is to overbuild a network to support maximum capacity demand, not average utilization (while absorbing the cost even if the bandwidth is not used). Some leased managed services will charge only for the bandwidth that is used—but capacity is limited. Typically, these services are only cost-effective when institutions have a specific understanding of their applications' bandwidth requirements. A City-owned fiber network will provide a more reliable, higher capacity, flexible network infrastructure because it is designed to support a broad range of initiatives and to easily and seamlessly scale to meet new bandwidth requirements.

As is the case in many major public safety incidents, public networks such as the Public Switched Telephone Network (PSTN) and the Internet are often overloaded by the amount of traffic on the network. This can lead to busy signals on the PSTN and a lack of connectivity on the Internet. Privately owned networks typically do not experience the same traffic increases and can be designed to handle any expected traffic increase during a major incident.

Many public networks are in the planning and early implementation stages of providing priority and preemption capabilities for most managed service providers and will not be universally available, however in the event of a crisis, priority and preemption is critical for public safety networks.

A City-owned fiber network can prioritize bandwidth both in the core and at the edge. This capability allows the City to prioritize by location and to preempt all traffic other than public safety traffic, if necessary. More importantly, the City-owned infrastructure can be allocated so that sensitive traffic always has dedicated capacity, because capacity can be readily scaled as needed for other applications.

Community-Owned Fiber Enables Control over Network Security

Implementation of network security on a leased circuit typically occurs at the edge of the network. Many leased networks use end-to-end encryption to securely transmit data over networks that share a core network with public users. Frequently, the provider of a leased circuit may dictate what types of end-to-end security are allowed on a leased circuit (IP managed services, for example).

On a City-owned fiber network, the City can control end-to-end security throughout the network infrastructure. The City can offer layered that makes the network robust and secure.

In addition to data security, a City-owned network allows the City to manage physical security as well as network security. This includes:

- Access to facilities and networking rooms
- Passwords to edge equipment and firewalls

- Network access and authentication
- Monitoring of networking rooms, including security alarms, surveillance cameras, etc.
- Desktop security
- Equipment placement and provisioning

Why Schools Need Fiber

The U.S. Department of Commerce has found that schools require connections of 50 to 100 Mbps per 1,000 students.[44] Education technologists recommend even greater capacity; in an environment where students are bringing up to three devices each to school, some recommend that schools provide 300 to 600 Mbps *per classroom,* which delivers a few megabits per student to support video learning.[45]

The State Educational Technology Directors Association (SETDA) recommends that by the 2014–15 school year, each school have at least 100 Mbps Internet per 1,000 students and staff (service to the public *Internet*) and at least 1 Gbps for each 1,000 students and staff connecting the schools to each other and to their district building (*intranet* service).

These recommendations increase in the 2017–18 school year to 1 Gbps for every 1,000 students and teachers for an external connections and 10 Gbps for internal network connections, "in anticipation of future technologies not yet conceived:"[46]

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[44] Federal Communications Commission, Eighth Broadband Progress Report, In the Matter of Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act, August 14, 2012, GN Docket No. 11-121, at 133.

[45] Tanya Roscorla, "5 Ways to Prepare Schools for Bring Your Own Device," Center for Digital Education, December 10, 2012, http://www.centerdigitaled.com/news/5-Ways-to-Prepare-Schools-for-Bring-Your-Own-Device.html.

[46] Ian Quillen, "Bandwidth Demands Rise as Schools Move to Common Core," Education Week: Digital Directions, October 17, 2012, October 17, 2012, Vol. 6. at 19-20. http://www.edweek.org/dd/articles/2012/10/17/01bandwidth.h06.html.

Fox, *et al.,* 2012, "The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs," Washington D.C.: State Educational Technology Directors Association (SETDA). http://www.setda.org/c/document_library/get_file?folderId=353&name=DLFE-1515.pdf. S*ee also* Center for Digital Education, "Preparing for the Common Core State Standards: School districts face an opportunity to reinvest in network infrastructure," at 5. http://images.erepublic.com/documents/CDE12+STRATEGY+Comcast_V.pdf.

Recommended Bandwidth for Schools

Broadband Access for Teaching, Learning and School Operations	2014-2015	2017-2018
An external Internet connection to the Internet Service Provider (ISP)	At least 100 Mbps per 100 students/ staff	At least 1 Gbps per 100 students/ staff
Internal wide area network (WAN) connections from the district to each school and among schools within the district	At least 1 Gbps per 1,000 students/ staff	At least 10 Gbps per 1,000 students/ staff

Source: State Educational Technology Directors Association

A significant number of the nation's schools suffer from inadequate Internet access. Insufficient bandwidth precludes creative and expansive online learning, such as video conferencing or collaborative work. Such schools are restricting classroom use of broadband applications like streaming video to preserve bandwidth. As the Benton Foundation explains:

> Distance learning over broadband is a distant dream. Online curricula is offline. Teachers are insufficiently trained to use technology in their classrooms, so that whatever technology is available to them languishes. Students are taught the basic 3 Rs, as required by the No Child Left Behind Act, but not the digital skills that will enable them to translate those 3 Rs into success in today's Information Age.[47]

"The content-rich world in which we live requires bandwidth to view it."[48] Yet, according to the 2008 America's Digital Schools report, 37 percent of school districts anticipate a problem obtaining sufficient bandwidth and the majority have already implemented policies to conserve bandwidth by limiting student Internet use.[49] Although a 2010 FCC survey of e-Rate funded schools found the majority of respondents had some level of Internet access, nearly 80 percent

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[47] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 20. http://www.benton.org/initiatives/broadband_benefits/action_plan.

[48] Edwin Wargo, "2008 Digital Schools Report and Bandwidth," *The Brute Thing*, May 16, 2008. http://edtecheconomics.blogspot.com/2008/05/ed-tech-trends-report.html.

[49] Meris Stansbury, "Researchers Identify Key Ed-Tech Trends," *eSchoolNews*, May 15, 2008. http://www.eschoolnews.com/2008/05/15/researchers-identify-key-ed-tech-trends/. (Summarizing Thomas W. Greaves and Jeanne Hayes, "America's Digital Schools Report 2008: The Six Trends to Watch.")

of respondents reported insufficient bandwidth for educational needs.[50] Despite these problems, Internet proficiency is assumed at the college level, leaving many children at an educational disadvantage. These problems will only grow as more schools adopt more bandwidth-intensive practices.

Electronic Textbooks

In no more than a few years more, hard-copy text books will cease to be printed in favor of electronic textbooks. This process is underway in Korea with a fixed deadline. The U.S. Federal Communications Commission (FCC) has challenged the private sector to enable this process by 2015.[51] At a recent conference, FCC Chairman Julius Genachowski urged the nation to "step up [its] efforts to realize the promise of this new technology in the U.S."[52] States around the country are seizing this challenge.

In September 2012, the California state Senate approved SB 1052 and SB 1053, requiring the University of California, the California State University, the California Community Colleges, and other private institutions to find or develop open education resources for students. The legislation is intended to reduce textbook costs for students, saving students at participating universities as much as $1,500 annually. The bills are currently awaiting consideration by the California State Assembly.[53] Such initiatives would not be possible without sufficient bandwidth to support online viewing.

Online Testing

A growing number of states are beginning to administer tests to their students online. SETDA reports that at least 33 states are already delivering at least one test via technology. Moreover, the Department of Education is advocating for a greater use of online testing through the Common Core State Standards initiative, which requires schools in 46 states and

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[50] Fox, *et al.,* 2012, "The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs," Washington D.C.: State Educational Technology Directors Association (SETDA), at 2. http://www.setda.org/c/document_library/get_file?folderId=353&name=DLFE-1515.pdf.

[51] "FCC Chairman Genachowski Joins Secretary of Education Duncan to Unveil New 'Digital Textbook Playbook,' A Roadmap for Educators to Accelerate the Transition to Digital Textbooks," News Release, Federal Communications Commission. http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db0201/DOC-312244A1.pdf.

[52] Katie Ash, March 29, 2012, "U.S. Officials Tackle National Adoption of Digital Textbooks," *Education Week* (Blog), March 29, 2012. http://blogs.edweek.org/edweek/DigitalEducation/2012/03/fcc_lead_and_doe_discuss_digit.html.

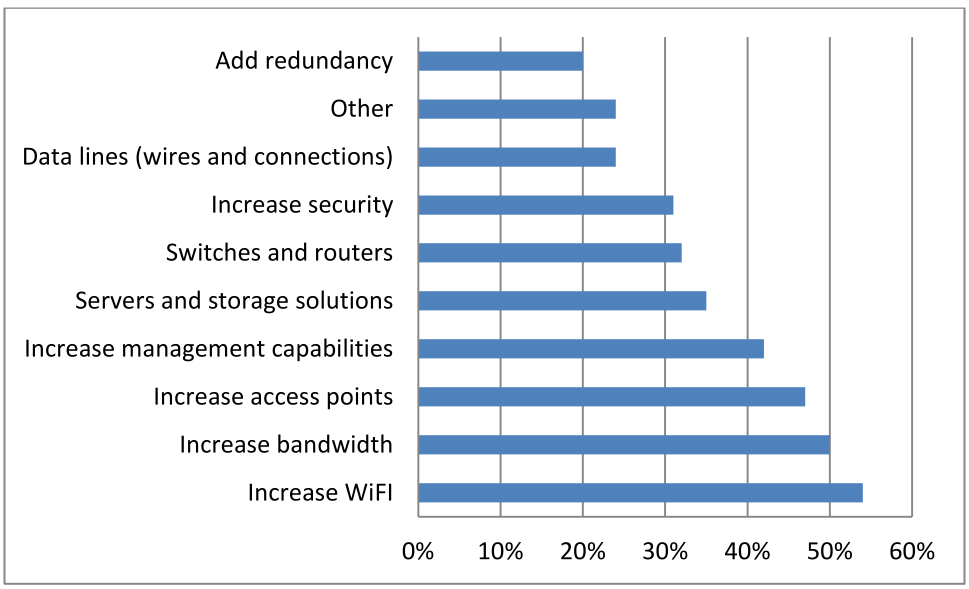
[53] Levon Massian, June 3, 2012, "State Senate Advances Bills that would Create Free Online Textbook Library," *The Daily Californian,* June 1, 2012. http://www.dailycal.org/2012/06/01/state-senate-advances-bills-that-would-create-free-online-textbook-library/.

the District of Columbia to "administer 'next generation' assessments almost exclusively online."[54]

The new assessments for the "Smarter Balanced" and "Partnership for the Assessment of College and Career Readiness" (PARCC) consortia will be conducted electronically by 2014. Moreover, national guidelines require that once such online assessments are implemented, all students in a grade must take the tests (which will include high-definition videos and sound files) simultaneously,[55] leading to greater network traffic during testing.

In fact, the Center for Digital Education explains, "adherence to Common Core guidelines will force school districts across the nation to rethink the way they handle networking and computing in a number of mission-critical areas."[56] (See figure below.) Because digital testing entails large numbers of students working online simultaneously, it is a function that simply cannot be accommodated, even in a small school, over copper-based Internet access.

Networking Upgrades Needed for Online Assessments[57]



[54] Ian Quillen, "Bandwidth Demands Rise as Schools Move to Common Core," Education Week: Digital Directions, October 17, 2012, Vol. 6. at 19-20. http://www.edweek.org/dd/articles/2012/10/17/01bandwidth.h06.html.

[55] Center for Digital Education, "Preparing for the Common Core State Standards: School districts face an opportunity to reinvest in network infrastructure," at 2. http://images.erepublic.com/documents/CDE12+STRATEGY+Comcast_V.pdf

[56] *Id.*

[57] Center for Digital Education, "Preparing for the Common Core State Standards: School districts face an opportunity to reinvest in network infrastructure," at 4 (http://images.erepublic.com/documents/CDE12+STRATEGY+Comcast_V.pdf)

One-to-One Computer Programs

American schools are migrating to one-to-one computer programs (also known as "ubiquitous computing"), whereby each student and teacher has one Internet-connected wireless computing device for use both in the classroom and at home. A 2006 survey found that 31 percent of superintendents are implementing ubiquitous computing in at least one grade, up from an historical average of 4 percent. Moreover, over 75 percent of superintendents recognized the potential benefits of one-to-one computing, agreeing with the statement that "ubiquitous technology can reduce the time, distance, and cost of delivering information directly to students and that teachers can spend substantially more one-on-one time with each student and personalize the education experience to each student's needs."[58]

By 2007, 78.7 percent of U.S. school districts reported moderate to significant improvement in one-to-one computing programs,[59] with potentially significant benefits for student learning. A 2006 report by America's Digital Schools found that one-to-one computing programs correlated with increased student retention and attendance, improved writing skills, and reduced disciplinary problems.[60] As Michael Davino, Superintendent of Schools in Springfield, New Jersey explains, "[a] wireless laptop program provides up-to-date information, access to virtual experiences, instant feedback, individualized attention for all learning styles, student independence, and constant practice. And it's highly adaptable to individual, small group, or whole class instruction."[61] To accommodate such programs, SETDA recommends that a school upgrade its network to a 50 Kbps/ student/staff broadband connection.[62]

Bring Your Own Device (BYOD) Initiatives

Schools are also launching "bring your own device" (BYOD) initiatives. While this leverages limited school infrastructure (by requiring students to provide their own), it raises a number of information technology challenges, including "information security and privacy, support costs, network capacity and bandwidth."[63] Of particular concern, BYOD initiatives are very bandwidth intensive. A recent mobile learning report found that about half of high school students and 40 percent of middle school students have a smartphone or tablet. This represents a 400 percent

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[58] "America's Digital Schools 2006: A Five-Year Forecast," The Greaves Group and The Hayes Connection, at 15, 18. http://www.ads2006.net/ads2006/pdf/ADS2006KF.pdf.

[59] Meris Stansbury, "Researchers Identify Key Ed-Tech Trends," eSchoolNews, May 15, 2008. http://www.eschoolnews.com/2008/05/15/researchers-identify-key-ed-tech-trends/.

[60] "America's Digital Schools 2006: A Five-Year Forecast," The Greaves Group and The Hayes Connection, at 15. http://www.ads2006.net/ads2006/pdf/ADS2006KF.pdf.

[61] *Id.* at 18.

[62] Fox, *et al.,* 2012, "The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs," Washington D.C.: State Educational Technology Directors Association (SETDA), at 4. http://www.setda.org/c/document_library/get_file?folderId=353&name=DLFE-1515.pdf.

[63] Bob Violino, Aug. 21, 2012, Community College Times, "BYOD: Bring your own devices to campus" (http://www.communitycollegetimes.com/Pages/Technology/BYOD-Bring-your-own-devices-to-campus.aspx).

increase from 2007.[64] Assuming similar growth over the next five years, student use of mobile devices will increase the demand on K–12 networks.

Bailey Mitchell, chief technology and information officer of Georgia's Forsyth County Schools, witnessed the impact of such growth on the school's network, explaining that the County did "not have adequate infrastructure to enable an environment where potentially every other or every student has a device." There, the number of devices increased from 10,000 to 19,000 in a single year. The growth exceeded network capacity and "student instruction was interrupted." This failure led to a three-fold expansion of network capacity (1.3 Gbps to the Internet and 2 Gbps to wide area networks). Mitchell explains, "We've been able to justify that expense because when the network blips, it's such an impact on instruction that it's absolutely unacceptable." He cautions that IT directors will need to anticipate such needs when students are allowed to use their devices throughout the day.[65]

Expanded Course Offerings

Many schools are using the Internet to expand course offerings. For instance, in Greenville, South Carolina, students are enrolling in an online Latin course taught by a teacher at another school in the district. Elsewhere, students can use the Internet to take higher level or better-quality courses than those available at their home schools.[66] The Greaves Group has found that many schools are even offering core courses over the Internet, with vocational technology (91 percent) leading, followed by science (78 percent) and social studies (76 percent). Online learning is often used for advanced-placement courses, including art and music (38 percent), math (35 percent), and science (31 percent), which may not have sufficient student enrollment to support a live course.[67] Online education enrollment has grown exponentially. In fact, the Innosight Institute reports that in 2000, roughly 45,000 K–12 students had taken an online course. By 2009, more than 3 million K–12 students had done so. Innosight

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[64] Tanya Roscorla, Dec. 10, 2012, "5 Ways to Prepare Schools for Bring Your Own Device," Center for Digital Education, December 10, 2012. http://www.centerdigitaled.com/news/5-Ways-to-Prepare-Schools-for-Bring-Your-Own-Device.html.

[65] Tanya Roscorla, "Bring Your Own Device Prompts School Infrastructure Investments," Center for Digital Education, March 13, 2012. http://www.centerdigitaled.com/classtech/BYOD-Forsyth-Infrastructure.html.

[66] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 21. http://www.benton.org/initiatives/broadband_benefits/action_plan.

[67] "America's Digital Schools 2006: A Five-Year Forecast," The Greaves Group and The Hayes Connection, at 19. http://www.ads2006.net/ads2006/pdf/ADS2006KF.pdf.

predicts that 50 percent of high school courses will be delivered partially online by 2019.[68] Beyond K–12, online learning is growing in favor because it saves students time and money.[69]

The Internet helps break down the walls of the classroom, allowing students to participate in virtual fieldtrips and better visualize their lessons. Students are going online and "touring the Smithsonian National Air and Space Museum, experiencing a tribal dance in Africa, or scouring the depths of the Pacific Ocean in a submarine." Users are exploring the digital archives at the Library of Congress and collaborating with students, professors and government officials in other states and around the world.[70] The State Educational Technology Directors Association envisions a classroom environment where "Internet-based educational technologies and practices" are fully "integrated into the curriculum." In such a scenario, students "access rich, multimedia-enhanced educational content from the Internet" on personal laptops, post both audio and video content to school learning management systems, access e-textbooks and assignments online, collaborate with other students both at their own school and around the world, participate in fieldtrips to distant locations, and complete online assessments. Such technology-rich experiences require greater bandwidth in the classrooms. In fact, SETDA asserts that this whole-curricula approach requires schools to provide a 100 Kbps per student/staff broadband connection.[71]

Benefits of Broadband Applications in Schools

Research by the International Society for Technology in Education and the Consortium for School Networking confirms that broadband applications in the schools have many benefits. In particular, technology has:

- Led to measurable improvements in school performance (as measured on the Adequate Yearly Progress Tests under the No Child Left Behind Act of 2001).

- Improved attendance, decreased dropout rates, increased graduation rates, and allowed increased parental involvement.

- Improved school efficiency and productivity.

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[68] Michael Horn and Heather Staker, Jan. 2011, "The Rise of K–12 Blended Learning," Innosight Institute, January 27, 2011. http://www.innosightinstitute.org/education-blog/the-rise-of-k-12-blended-learning/

[69] Collette Boothe, "The Need for Data," Center for Digital Education, Jan. 8, 2009. http://www.centerdigitaled.com/edtech/The-Need-for-Data.html.

[70] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 21. http://www.benton.org/initiatives/broadband_benefits/action_plan.

[71] Fox, *et al.,* 2012, "The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs," Washington D.C.: State Educational Technology Directors Association (SETDA), at 4. http://www.setda.org/c/document_library/get_file?folderId=353&name=DLFE-1515.pdf.

- Helped teachers satisfy professional requirements by helping develop lesson plans and providing continuing education opportunities.
- Enhanced students' problem-solving and independent-thinking skills.
- Enabled schools to meet the needs of special education children.
- Increased equity and access in education by creating learning opportunities for geographically isolated students.
- Improved workforce skills.[72]

Case studies bear out these benefits. For instance, elementary school students in the "Enhancing Missouri's Instructional Networked Teaching Strategies" (eMINTS) program consistently scored higher on standardized achievement tests than students who did not have access to the same technology. Participants' classrooms are equipped with a teacher's desktop computer and laptop computer, a scanner, a color printer, a digital camera, an interactive white board, a digital projector, and one computer for every two students. In New York, middle and high school students enrolled in the "Points of View media project" used broadband to access museums and historical collections, streaming video and video conferencing, and primary documents to explore the Theodore Roosevelt era. Seventy-five percent of program participants reported that they learned more than they would have from a traditional class.[73]

Why Libraries Need Fiber

In the libraries sector, TechSoup, a non-profit that provides technical assistance to libraries with the support of the Gates Foundation, notes that the amount of bandwidth required depends on the number of users and computers at a library facility.[74] As a TechSoup/Colorado State Library graphic illustrates (see figure below), a T-1 used by three library patrons simultaneously will enable website loading in five seconds and a book download in 15

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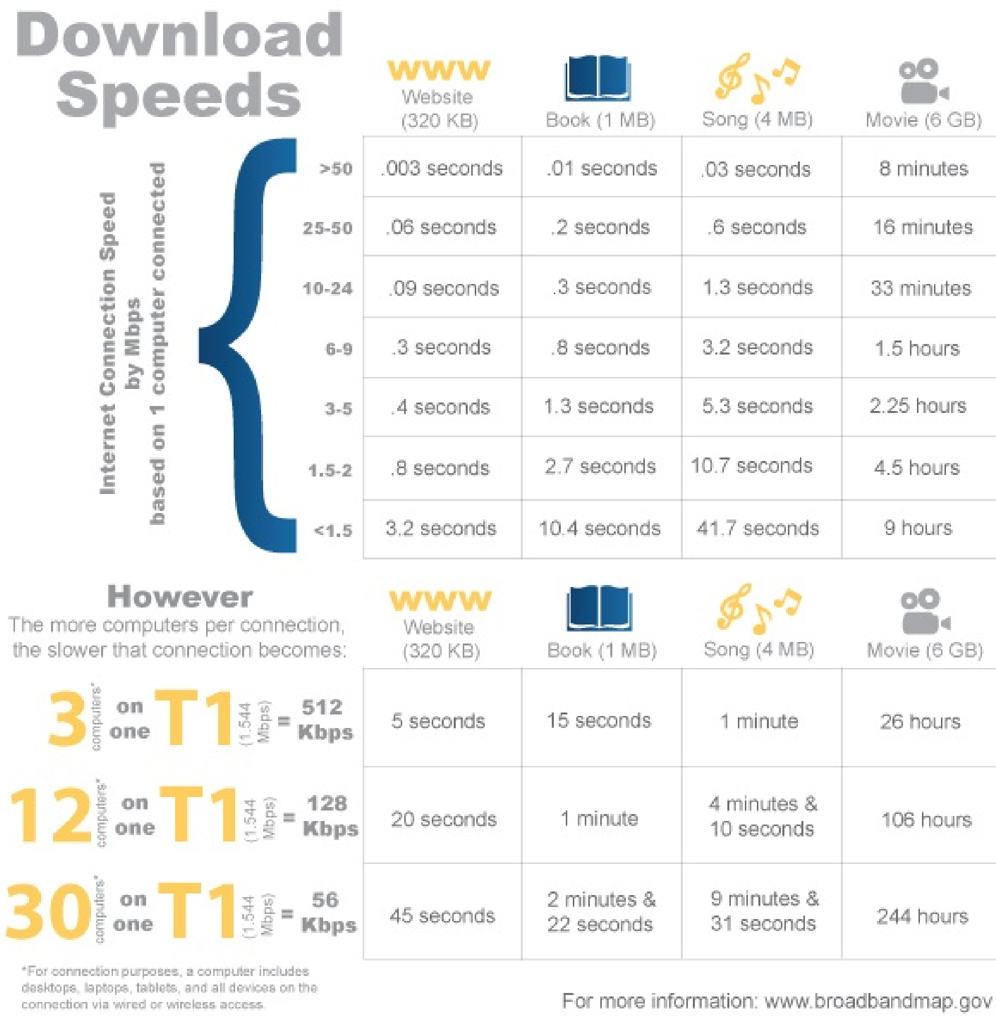
[72] "Why Technology in Schools?" Ed Tech Action Network. http://www.edtechactionnetwork.org/why-technology-in-schools.

[73] "Ed Tech and Student Achievement," Ed Tech Action Network. http://www.edtechactionnetwork.org/student_achieve.html.

[74] "Bandwidth Management," TechSoup for Libraries. http://www.techsoupforlibraries.org/planning-for-success/networking-and-security/bandwidth-management; see also Kieran Hixon, "Broadband Basics for Public Libraries," TechSoup and Colorado State Library, Presentation, January 15, 2013, http://www.techsoupforlibraries.org/blog/broadband-basics-webinar-follow-up; http://ipac.umd.edu/survey/analysis/broadband-public-libaries; http://plinternetsurvey.org/sites/default/files/publications/BroadbandBrief2012.pdf; http://www.webjunction.org/documents/illinois/Broadband_Calculator.html (a broadband bandwidth calculator for libraries that uses speed of website loading as a guide to bandwidth needs).

seconds.[75] While not optimal, these speeds may be acceptable. Times will multiply, however, as the number of simultaneous users multiply. As a result, a library serving 30 simultaneous users would require at least 45 Mbps to enable website loading in five seconds and a book download in 15 seconds. Video applications will require three times that bandwidth.

Download Speeds for Libraries[76]



Download Speeds

Internet Connection Speed by Mbps based on 1 computer connected	Website (320 KB)	Book (1 MB)	Song (4 MB)	Movie (6 GB)
>50	.003 seconds	.01 seconds	.03 seconds	8 minutes
25-50	.06 seconds	.2 seconds	.6 seconds	16 minutes
10-24	.09 seconds	.3 seconds	1.3 seconds	33 minutes
6-9	.3 seconds	.8 seconds	3.2 seconds	1.5 hours
3-5	.4 seconds	1.3 seconds	5.3 seconds	2.25 hours
1.5-2	.8 seconds	2.7 seconds	10.7 seconds	4.5 hours
<1.5	3.2 seconds	10.4 seconds	41.7 seconds	9 hours

However
The more computers per connection, the slower that connection becomes:

	Website (320 KB)	Book (1 MB)	Song (4 MB)	Movie (6 GB)
3 computers* on one T1 (1.544 Mbps) = 512 Kbps	5 seconds	15 seconds	1 minute	26 hours
12 computers* on one T1 (1.544 Mbps) = 128 Kbps	20 seconds	1 minute	4 minutes & 10 seconds	106 hours
30 computers* on one T1 (1.544 Mbps) = 56 Kbps	45 seconds	2 minutes & 22 seconds	9 minutes & 31 seconds	244 hours

*For connection purposes, a computer includes desktops, laptops, tablets, and all devices on the connection via wired or wireless access.

For more information: www.broadbandmap.gov

Source: TechSoup / Colorado State Library

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[75] "Bandwidth Management," TechSoup for Libraries. http://www.techsoupforlibraries.org/planning-for-success/networking-and-security/bandwidth-management.

[76] Kieran Hixon, "Broadband Basics for Public Libraries," TechSoup and Colorado State Library, Presentation, January 15, 2013. http://www.techsoupforlibraries.org/blog/broadband-basics-webinar-follow-up

Libraries have long served as "a premier Internet access provider in the continually evolving online culture."[77] In fact, a 2008 study found public libraries provided the only free Internet access in 72.5 percent of U.S. communities nationwide. This number rose to 82 percent in rural communities.[78] A 2012 study reaffirms the role of libraries as the sole public provider of free Internet access in the majority (64.5 percent) of American communities.[79]

Public libraries serve a variety of functions. They offer desktop workstations for Internet use, technical training, and access to locally relevant content. Public library Internet access is used for an array of reasons—job seeking, educational research, travelers looking to keep in touch with their families, and emergency information. Libraries play a key role in providing access, assistance and training through e-government sites and services. Public libraries also provide a safety net during disasters when Internet access may be limited elsewhere.[80] In light of this wide array of services, "the role of the public library as a stable Internet provider cannot be overestimated."[81]

Public libraries, however, are facing significant capacity constraints. Bandwidth requirements are growing as public use expands and matures, but libraries are unable to keep up. As Bertot, McClure, and Jaeger report:

> Libraries may be struggling to meet demands as a result of a combination of factors such as the limits on physical space in libraries, the increasing complexity of Internet content, the continual costs of Internet access and computer maintenance, the inherent limitations of the telecommunications grid, and the rising demands for bandwidth, processing speed, and numbers of workstations, among other factors.[82]

In recent years, libraries have expanded wireless access to allow for a larger number of users at limited workstations. While this allows more users to get online, it also creates additional traffic on limited bandwidth.[83]

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[77] Marijke Visser and Mary Alice Ball, Dec. 2010, "The Middle-mile: The Role of the Public Library in Ensuring Access to Broadband," Information Technology and Libraries, at 193. http://www.ala.org/lita/ital/sites/ala.org.lita.ital/files/content/29/4/visser.pdf.

[78] *Id.* at 191.

[79] Information Policy and Access Center (IPAC), 2012, "Public Libraries and Broadband." http://www.plinternetsurvey.org/analysis/public-libraries-and-broadband.

[80] John Carlo Bertot, Charles R. McClure, and Paul T. Jaeger, 2008, "The Impacts of Free Public Internet Access on Public Library Patrons and Communities," *Library Quarterly* 78, no. 3, at 286. http://mcclure.ii.fsu.edu/publications/2008/The%20impacts%20of%20free%20public%20Internet%20access%20on%20public%20library%20patrons%20and%20communities.pdf

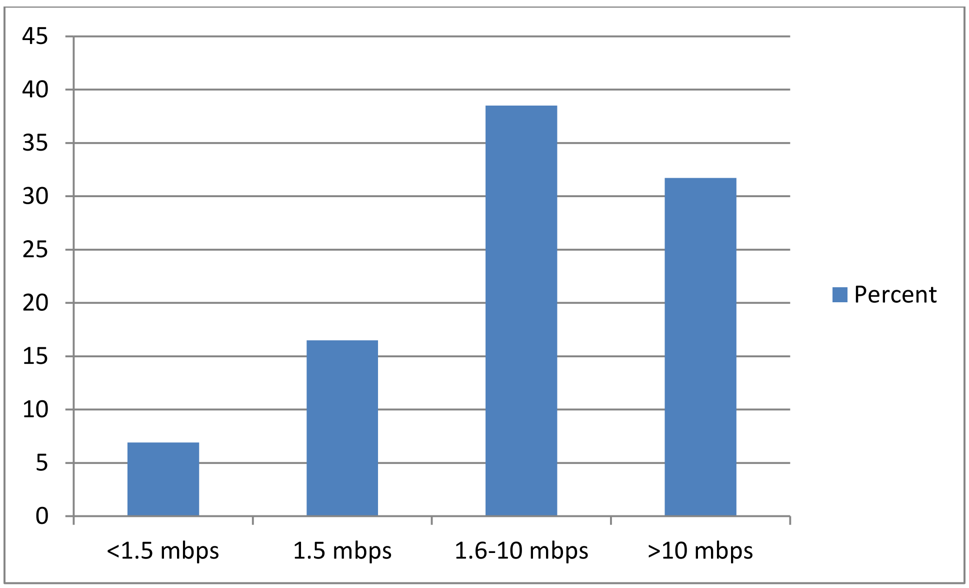
[81] Marijke Visser and Mary Alice Ball, Dec. 2010, "The Middle-mile: The Role of the Public Library in Ensuring Access to Broadband," Information Technology and Libraries, at 192.

[82] John Carlo Bertot, Charles R. McClure, and Paul T. Jaeger, 2008, "The Impacts of Free Public Internet Access on Public Library Patrons and Communities," *Library Quarterly* 78, no. 3, at 297.

[83] *Id.* at 292.

Libraries are seeking ways to add bandwidth as applications become more intensive (e.g., streaming video, online communications, social networking tools), yet this growing need is seldom accompanied by a corresponding increase in budget or capacity. The Information Policy and Access Center (iPAC) reports that libraries have steadily increased their bandwidth capacity in recent years. While only 12.3 percent of public libraries reported speeds greater than 10 mbps in 2008-2009, 31.7 percent of public libraries have reported speeds at this level in 2011-2012 (see figure below).[84] While bandwidth has increased in recent years, however, this growth has been outpaced by the increase in bandwidth-requiring applications. Consequently, despite supposed high-speed connections, users may experience "slow connectivity and near dial-up speeds."[85]

Public Library Internet Connectivity Speeds (2011–2012)[86]



Data from the Public Libraries and the Internet studies reveal a "'disconnect' between what their communities expect and the levels of Internet access that they are able to provide to their communities."[87] In fact, a 2012 study found that 41.1 percent of public libraries report that their connection speeds are insufficient to meet patron needs some or all of the time.[88] While

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[84] "Public Libraries and Broadband," *Public Library Funding and Technology Survey,* Information Policy and Access Center, 2012. http://ipac.umd.edu/sites/default/files/publications/BroadbandBrief2012_0.pdf.

[85] "Broadband and Public Libraries," Information Policy and Access Center (IPAC), 2012. http://www.plinternetsurvey.org/analysis/public-libraries-and-broadband.

[86] "Public Libraries and Broadband," *Public Library Funding and Technology Survey,* Information Policy and Access Center, 2012. http://ipac.umd.edu/sites/default/files/publications/BroadbandBrief2012_0.pdf.

[87] John Carlo Bertot, Charles R. McClure, and Paul T. Jaeger, 2008, "The Impacts of Free Public Internet Access on Public Library Patrons and Communities," *Library Quarterly* 78, no. 3, at 287.

[88] "Broadband and Public Libraries," Information Policy and Access Center (IPAC), 2012. http://www.plinternetsurvey.org/analysis/public-libraries-and-broadband.

this is an improvement from nearly 58 percent reporting inadequate speeds in a similar 2007 survey,[89] it reveals that additional bandwidth is needed. The data suggests that libraries have reached an "infrastructure plateau for provision of and access to Internet services."[90] This problem is only compounded by the economic downturn, as more people depend on libraries for free Internet access. As a consequence, infrastructure limits are being hit precisely at a time when consumer demand for library services is increasing.

While libraries have long served the role of "community guarantor of free public Internet access,"[91] they cannot meet these needs without public support. As Visser and Ball acknowledge, "[o]vercoming the challenges successfully will require support on the local, state, and federal level."[92] Indeed, "[w]hat else can the federal government fund that simultaneously serves so many educational, economic, employment, communication, government, and emergency preparedness functions?"[93]

While slightly more than half (58.3 percent) of public libraries reported in 2010-2011 that their broadband connection meets patron needs, more libraries are expected to report insufficient connections in coming years unless funding to improve broadband infrastructure is increased. Indeed, "[a]s more people rely on public libraries for Internet access, and as more of these people use a greater range of high bandwidth education, government, and entertainment content, the bandwidth capacity of libraries becomes an increasingly significant issue."[94]

Many libraries are seeking to expand their use and meet access demands by establishing Wi-Fi networks. However, the Information Policy and Access Center (iPAC) reports that in the vast majority of libraries with wireless access (82.3 percent), wireless users are sharing the same bandwidth and connection with existing workstations. As a consequence, libraries are increasing "connection capacity at the expense of connection quality." This growth results in more users drawing on limited bandwidth. iPAC explains:

> As an example, take a common scenario: a public library has 15 public access workstations in constant use; it offers Wi-Fi that supports another 10–15 simultaneous connections, typically in use; the library has a T-1 connection (1.5 Mbps or megabits per second leased line broadband service); and the Wi-Fi and public access workstations

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[89] Marijke Visser and Mary Alice Ball, Dec. 2010, "The Middle-mile: The Role of the Public Library in Ensuring Access to Broadband," Information Technology and Libraries, at 191.

[90] John Carlo Bertot, Charles R. McClure, and Paul T. Jaeger, 2008, "The Impacts of Free Public Internet Access on Public Library Patrons and Communities," *Library Quarterly* 78, no. 3, at 297.

[91] *Id.* at 299.

[92] Marijke Visser and Mary Alice Ball, Dec. 2010, "The Middle-mile: The Role of the Public Library in Ensuring Access to Broadband," Information Technology and Libraries, at 191-92.

[93] John Carlo Bertot, Charles R. McClure, and Paul T. Jaeger, 2008, "The Impacts of Free Public Internet Access on Public Library Patrons and Communities," *Library Quarterly* 78, no. 3, at 300.

[94] "Survey: Broadband and Public Libraries," Information Policy and Access Center (IPAC), 2012. http://ipac.umd.edu/survey/analysis/broadband-public-libaries.

> share the same connection. With up to 30 devices sharing the same 1.5 Mbps connection, the connection speed at the device level is the equivalent of dial-up service, severely affecting the quality of the user experience.[95]

It is unsustainable for libraries to increase the number of workstations and use of their Wi-Fi networks without a concomitant increase in connection speed. Yet, this is precisely what is occurring. In fact, though 74.3 percent of libraries reported that they did not increase their connection speed from 2011–2012, 60.1 percent reported an increase in the use of their public access workstations and 74.9 percent reported an increase in the use of their Wi-Fi network. "If these trends continue, we can expect the demands on public library networks to exceed capacity in the near future, especially at urban public libraries."[96]

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[95] *Ibid.*
[96] *Ibid.*

Appendix B

Pro Forma Financial Statements

Contents:

Attached here are the network financial statements, as well as a complete table of the assumptions on which the calculations are based. Staff has also been provided a copy of the working spreadsheet used in creating the statements.

Culver City
Financial Projections Rev 5
September 16, 2013

Initial Projections

The projections used in this analysis were prepared to assist in the assement of the financial feasibility of establishing a enterprise to offer connectivity services in the identified service area. Where appropriate, the analysis includes projected operating revenues, expenses, and cash flows for the life of the system based on estimated construction costs and various market penetration rates. This analysis should not be used for any other purpose. There will be differences between the projected and actual results, because events and circumstances frequently do not occur as expected, and those differences may be material. CTC has no responsibility to update or certify this projection for events and circumstances occurring after the date of this Report.

Culver City
Financial Projections Rev 5
September 16, 2013

Cash Flow Statement

	Year	1	2	3	4	5	6	7	8	9	10
a. Net Income (From Income Statement)		$ (613,952)	$ (491,736)	$ (113,277)	$ 78,917	$ (24,383)	$ (24,383)	$ (24,383)	$ (13,222)	$ (2,775)	$ 7,672
b. Cash Outflows											
Debt Service Reserve		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Reserve		-	-	-	-	-	-	-	-	-	-
Depreciation Operating Reserve		-	-	-	-	-	-	-	-	-	-
Financing		-	-	-	-	-	-	-	-	-	-
Capital Expenditures		(1,255,160)	(825,600)	(240,240)	(128,300)	-	(30,600)	(96,500)	(255,875)	(92,675)	(24,375)
	Total	$ (1,255,160)	$ (825,600)	$ (240,240)	$ (128,300)	$ -	$ (30,600)	$ (96,500)	$ (255,875)	$ (92,675)	$ (24,375)
c. Cash Inflows											
Interest Reserve		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Depreciation Operating Reserve		-	-	-	-	-	-	-	-	-	-
Debt Service Reserve		-	-	-	-	-	-	-	-	-	-
7-Year Term Bond/Loan		-	-	-	-	-	-	-	-	-	-
20-Year Term Bond		-	-	-	-	-	-	-	-	-	-
Internal Loan		-	-	-	-	-	-	-	-	-	-
In-Kind Revenue A		-	-	-	-	-	-	-	-	-	-
In-Kind Revenue B		-	-	-	-	-	-	-	-	-	-
In-Kind Revenue C		-	-	-	-	-	-	-	-	-	-
Matching Grants - A		-	-	-	-	-	-	-	-	-	-
Matching Grants - B		-	-	-	-	-	-	-	-	-	-
Matching Grants - C		-	-	-	-	-	-	-	-	-	-
Internal Startup Funds		1,800,000	1,200,000	-	-	-	-	-	-	-	-
Grants - B		-	-	-	-	-	-	-	-	-	-
Grants - C		-	-	-	-	-	-	-	-	-	-
	Total	$ 1,800,000	$ 1,200,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
d. Total Cash Outflows and Inflows (b+c)		$ 544,840	$ 374,400	$ (240,240)	$ (128,300)	$ -	$ (30,600)	$ (96,500)	$ (255,875)	$ (92,675)	$ (24,375)
e. Non-Cash Expenses - Depreciation		$ 89,402	$ 154,211	$ 189,752	$ 211,983	$ 211,983	$ 211,983	$ 211,983	$ 200,822	$ 190,375	$ 179,928
f. Adjustments (Proceeds from)											
7-Year Term Bond/Loan		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20-Year Term Bond		-	-	-	-	-	-	-	-	-	-
Internal Loan		-	-	-	-	-	-	-	-	-	-
In-Kind Revenue A		-	-	-	-	-	-	-	-	-	-
In-Kind Revenue B		-	-	-	-	-	-	-	-	-	-
In-Kind Revenue C		-	-	-	-	-	-	-	-	-	-
Matching Grants - A		-	-	-	-	-	-	-	-	-	-
Matching Grants - B		-	-	-	-	-	-	-	-	-	-
Matching Grants - C		-	-	-	-	-	-	-	-	-	-
Internal Startup Funds		(1,800,000)	(1,200,000)	-	-	-	-	-	-	-	-
Grants - B		-	-	-	-	-	-	-	-	-	-
Grants - C		-	-	-	-	-	-	-	-	-	-
	Total	$ (1,800,000)	$ (1,200,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
g. Adjusted Available Net Revenue		$ (1,779,710)	$ (1,163,125)	$ (163,765)	$ 162,600	$ 187,600	$ 157,000	$ 91,100	$ (68,275)	$ 94,925	$ 163,225
h. Principal Payments on Debt											
7- Year Bond/Loan Principal		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20- Year Bond Principal		-	-	-	-	-	-	-	-	-	-
5-Year Loan Principal		-	-	-	-	-	-	-	-	-	-
	Total	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

i. Net Cash	$ 20,290	$ 36,875	$ (163,765)	$ 162,600	$ 187,600	$ 157,000	$ 91,100	$ (68,275)	$ 94,925	$ 163,225
Cash Balance (Enterprise)										
Unrestricted Cash Balance	$ 20,290	$ 57,165	$ (106,600)	$ 56,000	$ 243,600	$ 400,600	$ 491,700	$ 423,425	$ 518,350	$ 681,575
Cash Start	-	-	-	-	-	-	-	-	-	-
Depreciation Operating Reserve	-	-	-	-	-	-	-	-	-	-
Debt Service Reserve	-	-	-	-	-	-	-	-	-	-
Total Cash Balance	$ 20,290	$ 57,165	$ (106,600)	$ 56,000	$ 243,600	$ 400,600	$ 491,700	$ 423,425	$ 518,350	$ 681,575
Debt Service Balance (7-Year Bond/Loan)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Service Balance (20-Year Bond)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Service Balance (Internal Loan)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Service (P&I)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Service Coverage Ratio	na	na	na	na	na	na	na	na	na	na

Culver City
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Income Statement

Year	1	2	3	4	5	6	7	8	9	10
a. Revenues										
Dark Fiber or Wavelength Site Access	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Provisioned Service	99,000	589,000	1,304,000	1,783,000	1,783,000	1,783,000	1,783,000	1,783,000	1,783,000	1,783,000
Wholesale Open Access	-	-	-	-	-	-	-	-	-	-
Data Center	-	-	-	-	-	-	-	-	-	-
Dark Fiber or Wavelength Site Discount	-	-	-	-	-	-	-	-	-	-
Provisioned Services Discount	-	-	-	-	-	-	-	-	-	-
Wholesale Access Discount	-	-	-	-	-	-	-	-	-	-
Data Center Discount	-	-	-	-	-	-	-	-	-	-
Dark Fiber IRU Payments	-	-	-	-	-	-	-	-	-	-
Dark Fiber Maintenance and Lease Fees - Plus Lateral Fees	-	-	-	-	-	-	-	-	-	-
Customer Equipment Fee (non-recurring)	30,600	96,500	96,500	68,300	-	-	-	-	-	-
Customer Connection Fee (non-recuring)	26,250	84,375	84,375	60,000	-	-	-	-	-	-
Total	$ 155,850	$ 769,875	$ 1,484,875	$ 1,911,300	$ 1,783,000	$ 1,783,000	$ 1,783,000	$ 1,783,000	$ 1,783,000	$ 1,783,000
b. Operating Expenses - Cash (not including taxes in line h)										
Operating Expenses (Third Party Contracts)	$ 431,900	$ 525,900	$ 521,900	$ 534,900	$ 534,900	$ 534,900	$ 534,900	$ 534,900	$ 534,900	$ 534,900
Operating Expenses - Misc.	111,000	424,000	749,000	973,000	973,000	973,000	973,000	973,000	973,000	973,000
Salaries (Allocations)	137,500	157,500	137,500	112,500	87,500	87,500	87,500	87,500	87,500	87,500
Total	$ 680,400	$ 1,107,400	$ 1,408,400	$ 1,620,400	$ 1,595,400	$ 1,595,400	$ 1,595,400	$ 1,595,400	$ 1,595,400	$ 1,595,400
c. Revenues less Cash Operating Expenses (a-b)	$ (524,550)	$ (337,525)	$ 76,475	$ 290,900	$ 187,600	$ 187,600	$ 187,600	$ 187,600	$ 187,600	$ 187,600
d. Operating Expenses - Non-Cash										
Depreciation	$ 89,402	$ 154,211	$ 189,752	$ 211,983	$ 211,983	$ 211,983	$ 211,983	$ 200,822	$ 190,375	$ 179,928
e. Operating Income (d-c)	$ (613,952)	$ (491,736)	$ (113,277)	$ 78,917	$ (24,383)	$ (24,383)	$ (24,383)	$ (13,222)	$ (2,775)	$ 7,672
f. Non-Operating Income										
Interest Income	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Investment Income	-	-	-	-	-	-	-	-	-	-
Interest Expense (7-Year Bond/Loan)	-	-	-	-	-	-	-	-	-	-
Interest Expense (20-Year Bond)	-	-	-	-	-	-	-	-	-	-
Interest Expense (5-Year Loan)	-	-	-	-	-	-	-	-	-	-
Total	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
g. Net Income	$ (613,952)	$ (491,736)	$ (113,277)	$ 78,917	$ (24,383)	$ (24,383)	$ (24,383)	$ (13,222)	$ (2,775)	$ 7,672
h. Taxes	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
i. Net Income After Fees & In Lieu Taxes	$ (613,952)	$ (491,736)	$ (113,277)	$ 78,917	$ (24,383)	$ (24,383)	$ (24,383)	$ (13,222)	$ (2,775)	$ 7,672

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Expenses

Year	1	2	3	4	5	6	7	8	9	10
Operating Expenses (Third Party Contracts)										
Fiber Maintenance (outside plant)	$ 43,000	$ 77,000	$ 84,000	$ 87,000	$ 87,000	$ 87,000	$ 87,000	$ 87,000	$ 87,000	$ 87,000
Network Extensions (expensed)	-	-	-	-	-	-	-	-	-	-
Network Operations Center	50,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Community Outreach & Marketing (material and contracts)	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500
Dark Fiber Lease to One Wilshire	146,400	146,400	146,400	146,400	146,400	146,400	146,400	146,400	146,400	146,400
Network Maintenance (electronics)	35,000	50,000	64,000	74,000	74,000	74,000	74,000	74,000	74,000	74,000
Insurance	20,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000
Legal	75,000	50,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Consulting	-	-	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000
TBD	-	-	-	-	-	-	-	-	-	-
TBD	-	-	-	-	-	-	-	-	-	-
Contingency	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Total	431,900	525,900	521,900	534,900	534,900	534,900	534,900	534,900	534,900	534,900
Operating Expenses - Misc.										
Attachment Fees	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Education and Training	-	-	-	-	-	-	-	-	-	-
Allowance for Bad Debts	5,000	29,000	65,000	89,000	89,000	89,000	89,000	89,000	89,000	89,000
Internet Connection Fee	101,000	390,000	679,000	879,000	879,000	879,000	879,000	879,000	879,000	879,000
Utilities	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Long Term Lease	-	-	-	-	-	-	-	-	-	-
Total	111,000	424,000	749,000	973,000	973,000	973,000	973,000	973,000	973,000	973,000
Taxes										
Dark Fiber & IRU Taxes	-	-	-	-	-	-	-	-	-	-
Site Services Taxes	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-
Salaries										
Salaries										
Operations & Administration	$ 50,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000
Community Outreach & Marketing	37,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500
Project Management Staff Allocation (construction)	50,000	70,000	50,000	25,000	-	-	-	-	-	-
TBD	-	-	-	-	-	-	-	-	-	-
TBD	-	-	-	-	-	-	-	-	-	-
TBD	-	-	-	-	-	-	-	-	-	-
TBD	-	-	-	-	-	-	-	-	-	-
TBD	-	-	-	-	-	-	-	-	-	-
Total	$ 137,500	$ 157,500	$ 137,500	$ 112,500	$ 87,500	$ 87,500	$ 87,500	$ 87,500	$ 87,500	$ 87,500
Total	**$ 680,400**	**$ 1,107,400**	**$ 1,408,400**	**$ 1,620,400**	**$ 1,595,400**	**$ 1,595,400**	**$ 1,595,400**	**$ 1,595,400**	**$ 1,595,400**	**$ 1,595,400**

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Capital Additions

Year	1	2	3	4	5	6	7	8	9	10
a. Fiber Implementation Costs										
Fiber (20 year depreciation)	$ 812,060	$ 581,600	$ 46,240	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fiber Expansion (20 year depreciation)	-	-	-	-	-	-	-	-	-	-
Headend and Hub Equipment (10 year depreciation)	-	-	-	-	-	-	-	-	-	-
Headend and Hub Equipment (7 year depreciation)	200,000	-	-	-	-	-	-	150,000	-	-
Network Equipment (7 year depreciation)	-	-	-	-	-	-	-	-	-	-
Spare Equipment (7 year depreciation)	-	-	-	-	-	-	-	-	-	-
Total	$ 1,012,060	$ 581,600	$ 46,240	$ -	$ -	$ -	$ -	$ 150,000	$ -	$ -
b. Support Equipment (5 year depreciation unless noted)										
OTDR	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Power Meter Source	-	-	-	-	-	-	-	-	-	-
tbd 1	-	-	-	-	-	-	-	-	-	-
tbd 2	-	-	-	-	-	-	-	-	-	-
tbd 3	-	-	-	-	-	-	-	-	-	-
tbd 4	-	-	-	-	-	-	-	-	-	-
tbd 5	-	-	-	-	-	-	-	-	-	-
Business Development (20 year depreciation)	175,000	50,000	-	-	-	-	-	-	-	-
Administration (7 year depreciation)	-	-	-	-	-	-	-	-	-	-
Operation and Network Equipment (7 year depreciation)	-	-	-	-	-	-	-	-	-	-
Additional Annual Capital Costs	-	-	-	-	-	-	-	-	-	-
Total	$ 175,000	$ 50,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
c. Electronics Costs (5 year depreciation)										
Wavelength	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Wavelength (replacements)	-	-	-	-	-	-	-	-	-	-
Provisioned Service	30,600	96,500	96,500	68,300	-	-	-	-	-	-
Provisioned Service (replacements)	-	-	-	-	-	30,600	96,500	96,500	68,300	-
Wholesale Access	-	-	-	-	-	-	-	-	-	-
Wholesale Access (replacements)	-	-	-	-	-	-	-	-	-	-
Total	$ 30,600	$ 96,500	$ 96,500	$ 68,300	$ -	$ 30,600	$ 96,500	$ 96,500	$ 68,300	$ -
d. Fiber Drop Costs (7 year depreciation)										
Wavelength	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Provisioned Service	37,500	97,500	97,500	60,000	-	-	-	-	-	-
Wholesale Access	-	-	-	-	-	-	-	-	-	-
Wavelength Replacements	-	-	-	-	-	-	-	-	-	-
Provisioned Replacements	-	-	-	-	-	-	-	9,375	24,375	24,375
Wholesale Replacements	-	-	-	-	-	-	-	-	-	-
Total	$ 37,500	$ 97,500	$ 97,500	$ 60,000	$ -	$ -	$ -	$ 9,375	$ 24,375	$ 24,375
e. Real Estate										
Real Estate (20 year)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
h. Long Term Leases										
Long Term Lease (no depreciation)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital (by year)	$ 1,255,160	$ 825,600	$ 240,240	$ 128,300	$ -	$ 30,600	$ 96,500	$ 255,875	$ 92,675	$ 24,375

Project Assumptions

Page Title Information

Organization	Culver City
Plan Name	Financial Projections Rev 5
Date	September 16, 2013

Financial Assumptions

Finance Requirements

Beginning Cash $ -

	Year 1	Year 2	Year 3	Year 4	Year 5					
7-Year Term Bond/Loan	$ -	$ -	$ -	$ -	$ -					
20-Year Term Bond	-	-	-	-	-					
Internal Loan	-	-	-	-	-					
Internal Startup Funds	1,800,000	1,200,000	-	-	-	-	-	-	-	-
Grants - B	-	-	-	-	-	-	-	-	-	-
Grants - C	-	-	-	-	-	-	-	-	-	-
Total	$ 1,800,000	$ 1,200,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

	Year 1	2	3	4	5	6	7	8	9	10
Depreciation Operating Reserve	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

	Year 1	2	3	4	5	6	7	8	9	10
Capital Exp Funded by Depreciation Reserve	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Unrestricted Cash Balance	$ 20,290	$ 57,165	$ (106,600)	$ 56,000	$ 243,600	$ 400,600	$ 491,700	$ 423,425	$ 518,350	$ 681,575
Depreciation Operating Reserve	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Service Reserve	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Cash Balance	$ 20,290	$ 57,165	$ (106,600)	$ 56,000	$ 243,600	$ 400,600	$ 491,700	$ 423,425	$ 518,350	$ 681,575

7-Year Term Bond/Loan

Bonding Finance Rate	6.00%	6.00%	5.00%	6.00%	6.00%	
Period (Years)	7	7	7	7	7	
Principal Repayment Period Start	3	3	2	1	1	
Bond/Loan Issuance Cost	1.00%	1.00%	1.00%	1.00%	1.00%	
Debt Service Reserve	0.00%	0.00%	0.00%	0.00%	0.00%	
Interest Reserve	no	no	no	no	no	
Interest Reserve Year 1 Financing	$ -	$ -				
Interest Reserve Year 2 Financing		$ -	$ -			
Interest Reserve Year 3 Financing			$ -	$ -		
Interest Reserve Year 4 Financing				$ -	$ -	
Interest Reserve Year 5 Financing					$ -	$ -
Total	$ -	$ -	$ -	$ -	$ -	$ -

20-Year Term Bond										
	4.00%	4.00%	4.00%	4.00%	4.00%					
	20	20	20	20	20					
Principal Repayment Period Start	4	4	3	3	3					
Bond Issuance Cost	1.00%	1.00%	1.00%	1.00%	1.00%					
Debt Service Reserve	0.00%	0.00%	0.00%	0.00%	0.00%					
Interest Reserve	no	no	yes	yes	yes					
Interest Reserve Year 1 Financing	$ -	$ -								
Interest Reserve Year 2 Financing		$ -	$ -							
Interest Reserve Year 3 Financing			$ -	$ -						
Interest Reserve Year 4 Financing				$ -	$ -					
Interest Reserve Year 5 Financing					$ -	$ -				
Total	$ -	$ -	$ -	$ -	$ -	$ -				
Internal Loan										
Finance Rate	3.00%	6.00%	5.00%	5.00%	5.00%					
Period (Years)	15	6	5	5	5					
Principal Repayment Period Start	2	2	1	1	1					
Other										
Investment Income	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Earned on Available Cash	0.00%									

Customer Assumptions

Dark Fiber Leases (IRU and Mileage) - to use unhide rows 140 to 263

Dark Fiber or Wavelength (per site)

	Year									
	1	2	3	4	5	6	7	8	9	10
Dark Fiber or Wavelength Site Access	Total Number of Sites Added by Year									
DF TBD 1	-	-	-	-	-	-	-	-	-	-
DF TBD 2	-	-	-	-	-	-	-	-	-	-
DF TBD 3	-	-	-	-	-	-	-	-	-	-
DF TBD 4	-	-	-	-	-	-	-	-	-	-
DF TBD 5	-	-	-	-	-	-	-	-	-	-
DF TBD 6	-	-	-	-	-	-	-	-	-	-
DF TBD 7	-	-	-	-	-	-	-	-	-	-
DF TBD 8	-	-	-	-	-	-	-	-	-	-
DF TBD 9	-	-	-	-	-	-	-	-	-	-
DF TBD 10	-	-	-	-	-	-	-	-	-	-
DF TBD 11	-	-	-	-	-	-	-	-	-	-
DF TBD 12	-	-	-	-	-	-	-	-	-	-
DF TBD 13	-	-	-	-	-	-	-	-	-	-
DF TBD 14	-	-	-	-	-	-	-	-	-	-
DF TBD 15	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-

	Year									
	1	2	3	4	5	6	7	8	9	10
Dark Fiber or Wavelength Site Access	Total Number of Sites (Cumulative)									
DF TBD 1	-	-	-	-	-	-	-	-	-	-
DF TBD 2	-	-	-	-	-	-	-	-	-	-
DF TBD 3	-	-	-	-	-	-	-	-	-	-
DF TBD 4	-	-	-	-	-	-	-	-	-	-
DF TBD 5	-	-	-	-	-	-	-	-	-	-
DF TBD 6	-	-	-	-	-	-	-	-	-	-
DF TBD 7	-	-	-	-	-	-	-	-	-	-
DF TBD 8	-	-	-	-	-	-	-	-	-	-
DF TBD 9	-	-	-	-	-	-	-	-	-	-
DF TBD 10	-	-	-	-	-	-	-	-	-	-
DF TBD 11	-	-	-	-	-	-	-	-	-	-
DF TBD 12	-	-	-	-	-	-	-	-	-	-
DF TBD 13	-	-	-	-	-	-	-	-	-	-
DF TBD 14	-	-	-	-	-	-	-	-	-	-
DF TBD 15	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-

Provisioned Services

	Year									
	1	2	3	4	5	6	7	8	9	10
Provisioned Service	Total Number of Sites Added by Year									
100 Mbps	12	46	46	34	-	-	-	-	-	-
250 Mbps	8	22	22	15	-	-	-	-	-	-
1 Gbps	8	22	22	15	-	-	-	-	-	-
PS TBD 4	-	-	-	-	-	-	-	-	-	-
PS TBD 5	-	-	-	-	-	-	-	-	-	-
PS TBD 6	-	-	-	-	-	-	-	-	-	-
PS TBD 7	-	-	-	-	-	-	-	-	-	-
PS TBD 8	-	-	-	-	-	-	-	-	-	-
PS TBD 9	-	-	-	-	-	-	-	-	-	-
PS TBD 10	-	-	-	-	-	-	-	-	-	-
PS TBD 11	-	-	-	-	-	-	-	-	-	-
PS TBD 12	-	-	-	-	-	-	-	-	-	-
PS TBD 13	-	-	-	-	-	-	-	-	-	-
PS TBD 14	-	-	-	-	-	-	-	-	-	-
PS TBD 15	-	-	-	-	-	-	-	-	-	-
Total	28	90	90	64	-	-	-	-	-	-

Provisioned Service	Year									
	1	2	3	4	5	6	7	8	9	10
	Total Number of Sites (Cumulative)									
100 Mbps	12	58	104	138	138	138	138	138	138	138
250 Mbps	8	30	52	67	67	67	67	67	67	67
1 Gbps	8	30	52	67	67	67	67	67	67	67
PS TBD 4	-	-	-	-	-	-	-	-	-	-
PS TBD 5	-	-	-	-	-	-	-	-	-	-
PS TBD 6	-	-	-	-	-	-	-	-	-	-
PS TBD 7	-	-	-	-	-	-	-	-	-	-
PS TBD 8	-	-	-	-	-	-	-	-	-	-
PS TBD 9	-	-	-	-	-	-	-	-	-	-
PS TBD 10	-	-	-	-	-	-	-	-	-	-
PS TBD 11	-	-	-	-	-	-	-	-	-	-
PS TBD 12	-	-	-	-	-	-	-	-	-	-
PS TBD 13	-	-	-	-	-	-	-	-	-	-
PS TBD 14	-	-	-	-	-	-	-	-	-	-
PS TBD 15	-	-	-	-	-	-	-	-	-	-
Total	28	118	208	272	272	272	272	272	272	272
Total Internet	20	88	156	205	205	205	205	205	205	205

Calculation of Average "Internet" Speed per Site

Enter in speed of each service Internet speed under year one	1	2	3	4	5	6	7	8	9	10
100 Mbps	100	100	100	100	100	100	100	100	100	100
250 Mbps	250	250	250	250	250	250	250	250	250	250
1 Gbps	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
PS TBD 4	-	-	-	-	-	-	-	-	-	-
PS TBD 5	-	-	-	-	-	-	-	-	-	-
PS TBD 6	-	-	-	-	-	-	-	-	-	-
PS TBD 7	-	-	-	-	-	-	-	-	-	-
PS TBD 8	-	-	-	-	-	-	-	-	-	-
PS TBD 9	-	-	-	-	-	-	-	-	-	-
PS TBD 10	-	-	-	-	-	-	-	-	-	-
PS TBD 11	-	-	-	-	-	-	-	-	-	-
PS TBD 12	-	-	-	-	-	-	-	-	-	-
PS TBD 13	-	-	-	-	-	-	-	-	-	-
PS TBD 14	-	-	-	-	-	-	-	-	-	-
PS TBD 15	-	-	-	-	-	-	-	-	-	-
Average Mbps (Direct)	400	367	363	359	359	359	359	359	359	359
Total Mbps (Direct)	11,208	43,330	75,452	97,617	97,617	97,617	97,617	97,617	97,617	97,617
Total Mbps	11,208	43,330	75,452	97,617	97,617	97,617	97,617	97,617	97,617	97,617

Wholesale (Open Access) Customers

	Year									
	1	2	3	4	5	6	7	8	9	10
Wholesale Open Access	Total Number of Sites Added by Year									
OA TBD 1	-	-	-	-	-	-	-	-	-	-
OA TBD 2	-	-	-	-	-	-	-	-	-	-
OA TBD 3	-	-	-	-	-	-	-	-	-	-
OA TBD 4	-	-	-	-	-	-	-	-	-	-
OA TBD 5	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-

	Year									
	1	2	3	4	5	6	7	8	9	10
Wholesale Open Access	Total Number of Sites (cumulative)									
OA TBD 1	-	-	-	-	-	-	-	-	-	-
OA TBD 2	-	-	-	-	-	-	-	-	-	-
OA TBD 3	-	-	-	-	-	-	-	-	-	-
OA TBD 4	-	-	-	-	-	-	-	-	-	-
OA TBD 5	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-
Total for Staffing Calculation	-	-	-	-	-	-	-	-	-	-

Data Center Customers

	Year									
	1	2	3	4	5	6	7	8	9	10
Data Center	8									
DC TBD 1	-	-	-	-	-	-	-	-	-	-
DC TBD 2	-	-	-	-	-	-	-	-	-	-
DC TBD 3	-	-	-	-	-	-	-	-	-	-
DC TBD 4	-	-	-	-	-	-	-	-	-	-
DC TBD 5	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-

	Year									
	1	2	3	4	5	6	7	8	9	10
Data Center	Total Number of Sites (cumulative)									
DC TBD 1	-	-	-	-	-	-	-	-	-	-
DC TBD 2	-	-	-	-	-	-	-	-	-	-
DC TBD 3	-	-	-	-	-	-	-	-	-	-
DC TBD 4	-	-	-	-	-	-	-	-	-	-
DC TBD 5	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-

Revenue Assumptions

Discounts

	1	2	3	4	5	6	7	8	9	10
Average Dark Fiber or Wavelength Site Access Discount	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Average Provisioned Service Discount	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Average Wholesale Access Discount	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Average Data Center Discount	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Dark Fiber or Wavelength (per site)

	Year									
	1	2	3	4	5					
Dark Fiber or Wavelength Site Access	Multiplier (to account for customer ramp-up)									
DF TBD 1	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 2	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 3	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 4	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 5	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 6	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 7	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 8	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 9	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 10	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 11	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 12	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 13	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 14	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DF TBD 15	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	Monthly Fee (per fiber)									
DF TBD 1	-	-	-	-	-	-	-	-	-	-
DF TBD 2	-	-	-	-	-	-	-	-	-	-
DF TBD 3	-	-	-	-	-	-	-	-	-	-
DF TBD 4	-	-	-	-	-	-	-	-	-	-
DF TBD 5	-	-	-	-	-	-	-	-	-	-
DF TBD 6	-	-	-	-	-	-	-	-	-	-
DF TBD 7	-	-	-	-	-	-	-	-	-	-
DF TBD 8	-	-	-	-	-	-	-	-	-	-
DF TBD 9	-	-	-	-	-	-	-	-	-	-
DF TBD 10	-	-	-	-	-	-	-	-	-	-
DF TBD 11	-	-	-	-	-	-	-	-	-	-
DF TBD 12	-	-	-	-	-	-	-	-	-	-
DF TBD 13	-	-	-	-	-	-	-	-	-	-
DF TBD 14	-	-	-	-	-	-	-	-	-	-
DF TBD 15	-	-	-	-	-	-	-	-	-	-
	Weighted Monthly Fee									
DF TBD 1	-	-	-	-	-	-	-	-	-	-
DF TBD 2	-	-	-	-	-	-	-	-	-	-
DF TBD 3	-	-	-	-	-	-	-	-	-	-
DF TBD 4	-	-	-	-	-	-	-	-	-	-
DF TBD 5	-	-	-	-	-	-	-	-	-	-
DF TBD 6	-	-	-	-	-	-	-	-	-	-
DF TBD 7	-	-	-	-	-	-	-	-	-	-
DF TBD 8	-	-	-	-	-	-	-	-	-	-
DF TBD 9	-	-	-	-	-	-	-	-	-	-
DF TBD 10	-	-	-	-	-	-	-	-	-	-
DF TBD 11	-	-	-	-	-	-	-	-	-	-
DF TBD 12	-	-	-	-	-	-	-	-	-	-
DF TBD 13	-	-	-	-	-	-	-	-	-	-
DF TBD 14	-	-	-	-	-	-	-	-	-	-
DF TBD 15	-	-	-	-	-	-	-	-	-	-

Provisioned Services

	Year									
	1	2	3	4	5					
Provisioned Service	Multiplier (to account for customer ramp-up)									
100 Mbps	50.00%	75.00%	95.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
250 Mbps	50.00%	75.00%	95.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
1 Gbps	50.00%	75.00%	95.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 4	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 5	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 6	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 7	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 8	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 9	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 10	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 11	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 12	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 13	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 14	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PS TBD 15	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

	Monthly Fee (per fiber)									
100 Mbps	300	300	300	300	300	300	300	300	300	300
250 Mbps	500	500	500	500	500	500	500	500	500	500
1 Gbps	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
PS TBD 4	-	-	-	-	-	-	-	-	-	-
PS TBD 5	-	-	-	-	-	-	-	-	-	-
PS TBD 6	-	-	-	-	-	-	-	-	-	-
PS TBD 7	-	-	-	-	-	-	-	-	-	-
PS TBD 8	-	-	-	-	-	-	-	-	-	-
PS TBD 9	-	-	-	-	-	-	-	-	-	-
PS TBD 10	-	-	-	-	-	-	-	-	-	-
PS TBD 11	-	-	-	-	-	-	-	-	-	-
PS TBD 12	-	-	-	-	-	-	-	-	-	-
PS TBD 13	-	-	-	-	-	-	-	-	-	-
PS TBD 14	-	-	-	-	-	-	-	-	-	-
PS TBD 15	-	-	-	-	-	-	-	-	-	-

Weighted Monthly Fee

	Year									
	1	2	3	4	5	6	7	8	9	10
Provisioned Service	Monthly Fee per Site									
100 Mbps	150	225	285	300	300	300	300	300	300	300
250 Mbps	250	375	475	500	500	500	500	500	500	500
1 Gbps	550	825	1,045	1,100	1,100	1,100	1,100	1,100	1,100	1,100
PS TBD 4	-	-	-	-	-	-	-	-	-	-
PS TBD 5	-	-	-	-	-	-	-	-	-	-
PS TBD 6	-	-	-	-	-	-	-	-	-	-
PS TBD 7	-	-	-	-	-	-	-	-	-	-
PS TBD 8	-	-	-	-	-	-	-	-	-	-
PS TBD 9	-	-	-	-	-	-	-	-	-	-
PS TBD 10	-	-	-	-	-	-	-	-	-	-
PS TBD 11	-	-	-	-	-	-	-	-	-	-
PS TBD 12	-	-	-	-	-	-	-	-	-	-
PS TBD 13	-	-	-	-	-	-	-	-	-	-
PS TBD 14	-	-	-	-	-	-	-	-	-	-
PS TBD 15	-	-	-	-	-	-	-	-	-	-

Wholesale Open Access Customers

Wholesale Open Access	Year 1	2	3	4	5	6	7	8	9	10
	Monthly Fee per Site									
OA TBD 1	-	-	-	-	-	-	-	-	-	-
OA TBD 2	-	-	-	-	-	-	-	-	-	-
OA TBD 3	-	-	-	-	-	-	-	-	-	-
OA TBD 4	-	-	-	-	-	-	-	-	-	-
OA TBD 5	-	-	-	-	-	-	-	-	-	-

Data Center Customers

Data Center	Year 1	2	3	4	5	6	7	8	9	10
	Monthly Fee per Site									
DC TBD 1	-	-	-	-	-	-	-	-	-	-
DC TBD 2	-	-	-	-	-	-	-	-	-	-
DC TBD 3	-	-	-	-	-	-	-	-	-	-
DC TBD 4	-	-	-	-	-	-	-	-	-	-
DC TBD 5	-	-	-	-	-	-	-	-	-	-

Operation & Maintenance Expense Assumptions

Taxes	
Dark Fiber & IRU Taxes	0.00%
Site Services Taxes	0.00%
Sales tax is a pass through expense	

Operating Expenses (Third Party Contracts)	1	2	3	4	5	6	7	8	9	10
Fiber Maintenance (outside plant)	$ 43,000	$ 77,000	$ 84,000	$ 87,000	$ 87,000	$ 87,000	$ 87,000	$ 87,000	$ 87,000	$ 87,000
Network Extensions (expensed)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Network Operations Center	$ 50,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000
Community Outreach & Marketing (material and contracts)	$ 12,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500
Dark Fiber Lease to One Wilshire	$ 146,400	$ 146,400	$ 146,400	$ 146,400	$ 146,400	$ 146,400	$ 146,400	$ 146,400	$ 146,400	$ 146,400
Network Maintenance (electronics)	$ 35,000	$ 50,000	$ 64,000	$ 74,000	$ 74,000	$ 74,000	$ 74,000	$ 74,000	$ 74,000	$ 74,000
Insurance	$ 20,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000
Legal	$ 75,000	$ 50,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000
Consulting	$ -	$ -	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000
TBD	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TBD	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Contingency	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000
Depreciation (original investment)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

TBD	1	2	3	4	5	6	7	8	9	10
TBD	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TBD	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Operating Expenses - Misc.

Education and Training	0.00%	percent of total labor expense
Allowance for Bad Debts	5.00%	of provisioned and wireless services
Network Electronic Maintenance	15.00%	of accrued electronics investment
Fiber Maintenance	5.00%	of accrued fiber investment

LADWP Lease (two routes)	300	per month per fiber	4	strands	10	miles	12000
	100	per month per locatior	2	locations			200
							12200

	1	2	3	4	5	6	7	8	9	10
Internet Connection Fee	$ 101,000	$ 390,000	$ 679,000	$ 879,000	$ 879,000	$ 879,000	$ 879,000	$ 879,000	$ 879,000	$ 879,000
Incremental Services										
per Mbps per month	$ 7.50	$ 7.50	$ 7.50	$ 7.50	$ 7.50	$ 7.50	$ 7.50	$ 7.50	$ 7.50	$ 7.50
oversubscription ratio	10	10	10	10	10	10	10	10	10	10
Internal Use										
Mbps for Internal (total)	$ -	-	-	-	-	-	-	-	-	-
per Mbps per month	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Cost Annual	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

	1	2	3	4	5	6	7	8	9	10
Total BW used internally (Mbps)	-	-	-	-	-	-	-	-	-	-
Available BW to apply to other users	-	-	-	-	-	-	-	-	-	-
Needed for other users	1,121	4,333	7,545	9,762	9,762	9,762	9,762	9,762	9,762	9,762
Net required for other users	1,121	4,333	7,545	9,762	9,762	9,762	9,762	9,762	9,762	9,762

Attachment Fees	0	poles at	$ -	per year	-	poles	100.00% owned by other

	1	2	3	4	5	6	7	8	9	10
Utilities	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000

Salaries (Allocations)

Annual escalation 0.00% Above what rate increases are (applied to the FTE's only - first two rows of table below)

	1	2	3	4	5	6	7	8	9	10
Operations & Administration	$ 50,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000
Community Outreach & Marketing	$ 37,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500	$ 12,500
Project Management Staff Allocation (construction)	$ 50,000	$ 70,000	$ 50,000	$ 25,000	$ -	$ -	$ -	$ -	$ -	$ -
TBD	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TBD	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TBD	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TBD	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TBD	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ 137,500	$ 157,500	$ 137,500	$ 112,500	$ 87,500	$ 87,500	$ 87,500	$ 87,500	$ 87,500	$ 87,500

Capital Requirement Assumptions

Miscellaneous Costs						
OTDR	$ -	$ -	$ -		100%	year 6
Power Meter Source	$ -	$ -	$ -		100%	year 6
tbd 1	$ -	$ -	$ -		100%	year 6
tbd 2	$ -	$ -	$ -		100%	year 6
tbd 3	$ -	$ -	$ -		100%	year 6
tbd 4	$ -	$ -	$ -		100%	year 6
tbd 5	$ -	$ -	$ -		100%	year 8
Additional Annual Capital Costs	0.00%	Percent of Year 1 to Year 3 fiber implementation costs		Starts in year	4	

Implementation Costs	1	2	3	1	2	Total	Comment
Base Backbone Network							
Fiber (20 year depreciation)	$ 257,900	$ -	$ -	100%	0%	$ 257,900	If able to pull w/o removing existing fiber estimate drops to $245,800
Headend and Hub Equipment (10 year depreciation)	$ -	$ -	$ -	100%	0%	$ -	
Headend and Hub Equipment (7 year depreciation)	$ 150,000	$ -	$ -	100%	0%	$ 150,000	
Network Equipment (7 year depreciation)	$ -	$ -	$ -	100%	0%	$ -	
Spare Equipment (7 year depreciation)	$ -	$ -	$ -	40%	45%	$ -	
Add Redundancy in Backbone							
Fiber (20 year depreciation)	$ 184,960	$ -	$ 46,240	80%	0%	$ 231,200	If able to pull w/o removing existing fiber estimate drops to $223,200
Headend and Hub Equipment (10 year depreciation)	$ -	$ -	$ -	40%	45%	$ -	
Headend and Hub Equipment (7 year depreciation)	$ -	$ -	$ -	40%	45%	$ -	
Network Equipment (7 year depreciation)	$ -	$ -	$ -	40%	45%	$ -	
Spare Equipment (7 year depreciation)	$ -	$ -	$ -	40%	45%	$ -	
Add Connections							
Fiber (20 year depreciation)	$ 29,100	$ -	$ -	$ 29,100			Estimate for Wilcon connection
Headend and Hub Equipment (10 year depreciation)	$ -	$ -	$ -	$ -			
Headend and Hub Equipment (7 year depreciation)	$ 50,000	$ -	$ -	$ 50,000			To light DF connection to One Willshire
Network Equipment (7 year depreciation)	$ -	$ -	$ -	$ -			
Spare Equipment (7 year depreciation)	$ -	$ -	$ -	$ -			

Add Tracts (20 year depreciation)	1	2	3		Year Deployed	Construction & Engineering	Bid Management	
Fox Hills	$ -	$ 295,000	$ -	$ 295,000	2	$ 280,000	$ 15,000	deployed, add at
Hayden	256,200	-	-	$ 256,200	1	$ 241,200	$ 15,000	least $25,000 for
Jefferson Corridor	-	166,400	-	$ 166,400	2	$ 156,400	$ 10,000	combined bid
Smiley Blackwelder	83,900	-	-	$ 83,900	1	$ 73,900	$ 10,000	management in a
Washington/National	-	120,200	-	$ 120,200	2	$ 110,200	$ 10,000	given year
Total Tracts	$ 340,100	$ 581,600	$ -					

Total FTTP				Replacement	
Fiber (20 year depreciation)	$ 812,060	$ 581,600	$ 46,240		
Headend and Hub Equipment (10 year depreciation)	-	-	-	100%	Year 11
Headend and Hub Equipment (7 year depreciation)	200,000	-	-	75%	year 8
Network Equipment (7 year depreciation)	-	-	-	100%	year 8
Spare Equipment (7 year depreciation)	-	-	-	100%	year 8
Business Development & Support Engineering	175,000	50,000	-		
	$ 1,187,060	$ 631,600	$ 46,240		

Other Misc.	1	2	3	4	5	6	7	8	9	10
Administration	$ -	$ -	$ -	na	na	na	na	na	na	na
Operation and Network Equipment	$ -	$ -	$ -	na	na	na	na	na	na	na
Expansion (fiber)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Fiber (Accrued)	$ 812,060	$ 1,393,660	$ 1,439,900
Network Equipment (Accrued)	$ 200,000	$ 200,000	$ 200,000
Business Development & Support (Accrued)	$ 175,000	$ 225,000	$ 225,000
			$ 1,864,900

Real Estate			
Interconnection Sites	$ -	$ -	$ -
	-	-	-
	-	-	-
	-	-	-
Real Estate (20 year depreciation)	$ -	$ -	$ -

Long Term Lease						
	$ -	$ -	$ -	per year		
	-	-	-	per year		
	-	-	-	per year		
	-	-	-	per year		
Long Term Lease	$ -	$ -	$ -		Treat as capital?	yes

Fiber Drop Costs

Wavelength	$ 1,000	50.00%		20.00%		$ 200
Provisioned Service	$ 3,750	25.00%	Replacement Costs	25.00%	Customer Charge	$ 938
Wholesale Access	$ 2,000	60.00%		20.00%		$ 400

Incremental Drops by Year

	1	2	3	4	5	6	7	8	9	10
Wavelength	-	-	-	-	-	-	-	-	-	-
Provisioned Service	10	26	26	16	-	-	-	-	-	-
Wholesale Access	-	-	-	-	-	-	-	-	-	-
Wavelength	-	-	-	-	-	-	-	-	-	-
Provisioned Service	37,500	97,500	97,500	60,000	-	-	-	-	-	-
Wholesale Access	-	-	-	-	-	-	-	-	-	-

Customer Connection Costs

Dark Fiber or Wavelength Site Access	Cost per Customer (Capital)	Total	1	2	3	4	5	6	7
DF TBD 1	$ -	-	-	-	-	-	-	-	-
DF TBD 2	$ -	-	-	-	-	-	-	-	-
DF TBD 3	$ -	-	-	-	-	-	-	-	-
DF TBD 4	$ -	-	-	-	-	-	-	-	-
DF TBD 5	$ -	-	-	-	-	-	-	-	-
DF TBD 6	$ -	-	-	-	-	-	-	-	-
DF TBD 7	$ -	-	-	-	-	-	-	-	-
DF TBD 8	$ -	-	-	-	-	-	-	-	-
DF TBD 9	$ -	-	-	-	-	-	-	-	-
DF TBD 10	$ -	-	-	-	-	-	-	-	-
DF TBD 11	$ -	-	-	-	-	-	-	-	-
DF TBD 12	$ -	-	-	-	-	-	-	-	-
DF TBD 13	$ -	-	-	-	-	-	-	-	-
DF TBD 14	$ -	-	-	-	-	-	-	-	-
DF TBD 15	$ -	-	-	-	-	-	-	-	-
	100.00%	of cost to replace when depreciated	-	-	-	-	-	-	-
	100.00%	recovery of costs with consumer fees							

Provisioned Service	Cost Per Customer (CPE, Card, and Install)	Total	1	2	3	4	5	6	7
100 Mbps	$ 950	138	11,400	43,700	43,700	32,300	-	-	-
250 Mbps	$ 950	67	7,600	20,900	20,900	14,250	-	-	-
1 Gbps	$ 1,450	67	11,600	31,900	31,900	21,750	-	-	-
PS TBD 4	$ -	-	-	-	-	-	-	-	-
PS TBD 5	$ -	-	-	-	-	-	-	-	-
PS TBD 6	$ -	-	-	-	-	-	-	-	-
PS TBD 7	$ -	-	-	-	-	-	-	-	-
PS TBD 8	$ -	-	-	-	-	-	-	-	-
PS TBD 9	$ -	-	-	-	-	-	-	-	-
PS TBD 10	$ -	-	-	-	-	-	-	-	-
PS TBD 11	$ -	-	-	-	-	-	-	-	-
PS TBD 12	$ -	-	-	-	-	-	-	-	-
PS TBD 13	$ -	-	-	-	-	-	-	-	-
PS TBD 14	$ -	-	-	-	-	-	-	-	-
PS TBD 15	$ -	-	-	-	-	-	-	-	-
	100.00%	of cost to replace when depreciated	30,600	96,500	96,500	68,300	-	-	-
	100.00%	recovery of costs with consumer fees							

Wholesale Open Access	Cost Per Customer (CPE, Card, and Install)	Total	1	2	3	4	5	6	7
OA TBD 1	$ -	-	-	-	-	-	-	-	-
OA TBD 2	$ -	-	-	-	-	-	-	-	-
OA TBD 3	$ -	-	-	-	-	-	-	-	-
OA TBD 4	$ -	-	-	-	-	-	-	-	-
OA TBD 5	$ -	-	-	-	-	-	-	-	-
	100.00%	of cost to replace when depreciated	-	-	-	-	-	-	-
	100.00%	recovery of costs with consumer fees							