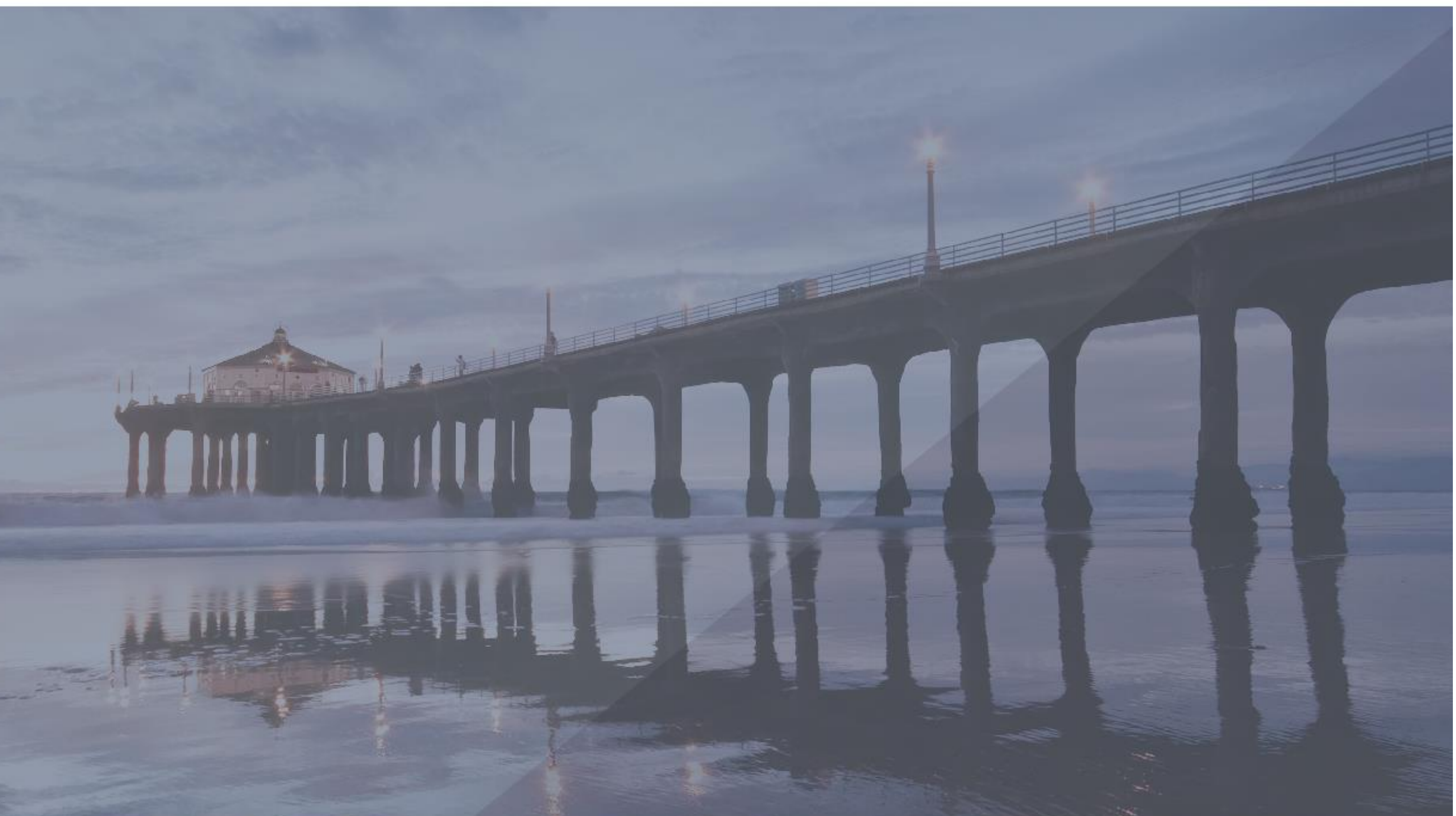
Magellan ADVISORS

www.magellan-advisors.com

April 2018

Final



FIBER MASTER PLAN

CITY OF MANHATTAN BEACH

ACKNOWLEDGEMENTS

Magellan Advisors wishes to thank the City of Manhattan Beach for the opportunity to assist with this important work. We would like to thank City leadership and staff for the vision, time, and thoughtful input they invested in providing the development of this Fiber Master Plan. We especially want to thank Sandy Taylor, Stephanie Katsouleas and their staffs for their time and effort on this project. Also, we want to recognize Bruce Moe for his contributions and insights.

Many other organizations within the City provided important information including the GIS team, the police and fire departments, finance, libraries, business development, and other stakeholder organizations and individuals. The contributions they have made have been incorporated into the project plan and have provided a representative voice of interested parties in Manhattan Beach.

The valuable input for this study would not have been possible without local leaders and residents sharing information and contributing to discussions around their internet connectivity challenges and ambitions.

We would like to thank the people of Manhattan Beach who took the time to share their experiences and opinions through the surveys and group discussions. The insights derived through public meetings, interviews and surveys were central to the development of this study.

The cooperative spirit from Manhattan Beach staff and community encourages confidence that a bright fiber-optic future is within reach for the residents, businesses and organizations across the city.

Municipal and Community Anchors

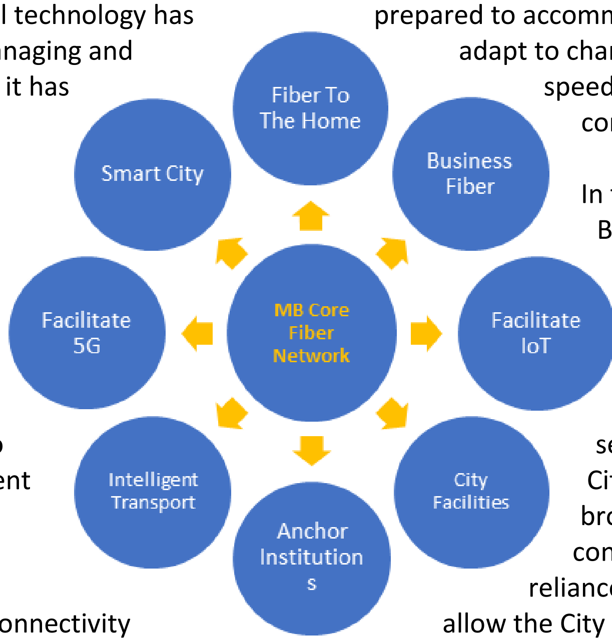
City of Manhattan Beach | City of Manhattan Beach GIS Team | City of Manhattan Beach Department of Finance | Manhattan Beach Police Department | City of Manhattan Beach Business Development| Manhattan Beach Fire Department | City of Manhattan Beach Public Libraries

TABLE OF CONTENTS

Table of Figures

1. Executive Summary

The future of cities is as much in bits and bytes, "smart" systems and software applications as it is physical infrastructure. Cities are increasingly recognizing and acting upon the fact that "broadband"[1] is another utility, just like water, sewer, gas and power. All digital technology depends on bandwidth and connectivity—the ability to move information quickly and flexibly from and to most anywhere. Indeed, digital technology has become the key to effectively managing and using traditional systems even as it has opened new possibilities for business, commerce, education, healthcare, governance, public safety, and recreation.



As a City replete with well educated, forward-thinking residents, the vast array of devices that permeates Manhattan Beach is only going to increase. Nearly ninety-five percent (95%) of the City of Manhattan Beach is comprised of residents, while businesses account for five percent (5%). Devices and their connectivity enable this vast proportion of residents to greatly improve and transform how they live, work and play.

For Manhattan Beach, building a multi-purpose fiber network is an investment in the City's future. The City has the opportunity to own an asset that can accommodate smart and connected technologies for municipal, personal, and business-related functions. Smart City Technologies and the Internet of Things (IoT)[2] are growing trends that will change the way cities carry out their missions as electronic government ("e-government") expands across many municipal functions, as well as enhance automated capabilities within homes and across all sectors of commerce. More devices, sensors and people will be connected than ever before. By establishing a fiber network, Manhattan Beach will be prepared to accommodate these emerging trends, adapt to changing needs, and support high-speed communications throughout the community.

In this spirit, the City of Manhattan Beach commissioned Magellan Advisors to develop a Fiber Master Plan to examine existing broadband offerings within the community and offer solutions on how best to improve broadband services. This Plan will help guide the City and its stakeholders into a broadband future in which they control their own destiny, downplaying reliance on commercial providers. It will allow the City to make investments based on long-term needs and take a comprehensive approach in investing in and deploying fiber assets. Fiber master planning will also allow the City to define standards and specifications for the buildout of other fiber-based assets and provide an expanded framework for all departments working together in collaboration.

[1] The term "broadband" refers to high-speed internet services, which provide online content—websites, television shows, videoconferencing, cloud services, or voice conversations—to be accessed and shared via computers, smartphones, and other devices. The Federal Communications Commission (FCC) has defined broadband as a specific speed (subject to change) of 25Mbps down and 3Mbps up (25/3Mbps) and indicated latency requirements. However, broadband is more regularly being defined as the speed necessary to facilitate the features and function that one uses every day. While some may find that a 25/3Mbps connection meets their current usage habits, others view 25/3Mbps as insufficient and struggle to call it broadband.

[2] Smart Cities is a term referring to the use of the growing Internet of Things (IoT) to help improve city services such as intelligent parking, public Wi-Fi, intelligent traffic and transportation, smart metering and community cameras. The ecosystem for this burgeoning market will be a combination of fixed broadband (fiber) for backhaul and delivery, wireless and cellular services such as the new 5G products being introduced, as well as all the connected devices require this foundational network.

1.1 Guiding Broadband Principles

The entire process of planning the City of Manhattan Beach's information infrastructure may be most effective if it is guided upon some fundamental, measurable principles:

1. **MEET STAKEHOLDER NEEDS AND DEMANDS**. Local governments can provide citizens with affordable and high-quality internet access and digital network services that have direct value to residents and businesses while also being used to improve local government performance.

2. **ENHANCE QUALITY OF PLACE WITH INFRASTRUCTURE.** The City should invest in technological infrastructure and work closely with the public, private, non-profit, and for-profit entities that make Manhattan Beach unique to fully capitalize on those investments.

3. **ENABLE QUALITY OF LIFE WITH APPLICATIONS AND CONTENT.** The City can focus on applications that deliver content and generate information that enables economic, environmental, personal, and social improvement. This will allow the City to enhance the implementation of IoT applications and services for residents, secure its position in the digital economy, enable attraction, growth and retention of businesses, and support anchor institutions[3] and essential services to the entire community.

1.2 Needs Assessment

To begin our study, Magellan employed a methodical approach to understand the current and future broadband needs of Manhattan Beach. We used a combination of internal and external stakeholder interviews, online surveys, and community focus groups for residents, anchor institutions and business entities. Throughout the fall of 2017, internal interviews were conducted with representatives from all City departments as well as other anchors and stakeholders. Each group provided crucial feedback on its current and future broadband needs, and all were in favor of having additional and reliable broadband resources available to them to improve their workflow and delivery of services to the community. The residential stakeholders provided valuable insights into their broadband experiences, indicating that they need better broadband choices at home and would overwhelmingly support the City offering an alternative solution. However, low turnout among the business and anchor communities did not allow the study to obtain significant feedback from this stakeholder group.

Online surveys were also conducted and the residential community, once again, provided valuable feedback about the current state of broadband and their related experiences with current providers. The surveys garnered 643 responses from Manhattan Beach households and 121 responses from businesses. The survey findings indicate that across the board, residents are unhappy with the cost and speed of internet services offered by incumbent internet service providers (ISPs). Residents expressed a strong desire for an alternative solution to be provided by the City.

I hope you implement this and do it soon. It is true that internet access should be provided as electricity and water are in this modern age we live in.

-City of Manhattan Beach Household Broadband Survey Response

[3] Anchor institutions are entities such as schools, libraries, health care centers, and other agencies that provide crucial community services.

1.3 Market Assessment

Magellan assessed the current broadband services available in Manhattan Beach through online research, discussions with current providers, and with the results of input provided via the online survey, focus groups and stakeholder interviews. The goal of the market assessment was to determine if the current products and services are meeting the needs and demands of the City's communities, and if Manhattan Beach is ahead or behind other cities in broadband availability. It also provides a snapshot of current providers' offerings to residents, business, and government agencies, including costs, speeds, and products available, and helps the City understand how it might help address those needs.

There are two primary incumbent providers serving Manhattan Beach: Spectrum (Charter) Cable and Frontier Communications. Although other entities may provide services to some businesses and limited services to residents, these two providers deliver the vast majority of services within the City. Spectrum offers broadband via a cable (or coaxial) medium and Frontier offers DSL and fiber-based services to many locations. Of the end users that responded to our surveys and focus group discussions, many (nearly half) felt that these providers do not meet their current needs in terms of either speed or price and have additional concerns about their improvement plans for the future (or lack of them).

> At many times of the day the internet speeds are much slower; cost for increasing speed is very high; my price is part of a bundle that I have had for years; any changes would result in MUCH higher costs
>
> *-City of Manhattan Beach Household Broadband Survey Response*

Additionally, current service providers have not invested heavily in their networks over the past few years in Manhattan Beach. 1Gbps broadband is fast becoming the norm. While Frontier does not currently provide this level of service, in June 2018, Spectrum announced it would be providing 1Gbps internet services to all Southbay residents for an introductory price of $104.99, and $124.99 after the introductory rate expires. Spectrum does not indicate whether the 1Gbps speed is dedicated.

Cellular service, while not technically broadband, was also discussed, and it was stated that there are several parts of the City that are not adequately covered by cellular providers, especially along the beach. Stakeholders expressed hope that any City broadband initiative would help improve availability of cellular service through offers of backhaul or through policies that help improve cellular services within the community.

Lack of choice, high prices, limited speeds, contract constraints and potential throttling of providers (revocation of Net Neutrality) were all concerns expressed by the community.

1.4 Network Design Considerations

Before designing any network, Magellan Advisors set out to first define what the network needs to deliver both for the short and long term. Magellan Advisors, along with City staff and community input, determined that this fiber-optic network must support multiple uses and provide features including:

- Affordability
- Fiber-to-the-Home (FTTH) broadband with support for minimum 1Gbps service
- Business users with 1 Gbps or greater dedicated service
- City Facilities with 1-10 Gbps service
- Anchor institutions
- Smart City applications and services
- Wireless/cellular backhaul (ie 5G)
- Future growth and expansion of services
- Redundancy and reliability

Magellan Advisors' engineering team has proposed a fiber-optic network taking into consideration Manhattan Beach's terrain, topography and existing assets in the public right-of-way. The network follows the main traffic corridors and extends out to residential neighborhoods, business and commercial areas, city facilities and anchor institutions. The City was divided into seven (7) zones to

Figure 1: Seven Zones of the City of Manhattan Beach Fiber Network

simplify the build and deployment process (Figure 1). The design team looked at several construction and fiber deployment techniques including all underground (micro-trenching), all aerial, and a combination of these methods. While each deployment method has advantages and disadvantages, the team ultimately focused on an all underground approach for Manhattan Beach because it is the best long-term option and the most streamlined approach to implement.

Once the network design was agreed upon with City staff, we applied costs to the network. Costs include labor and materials for undergrounding, handholes, central office considerations, network electronics, management solutions and connection to a Point-of-Presence (POP) for internet access.

1.5 Network Business Models

Building the network is only part of the initiative. Significant consideration was also given to network management, deployment models, future upgrades, sales and marketing, and the options available to the City for day-to-day operations.

Each city that contemplates providing broadband service to its community has a choice of solutions for how best to manage, fund and operate its network. These solutions range from low-cost, low-risk, low-reward options to high-cost, high-risk, high-reward alternatives. Low cost/risk broadband options include implementation of broadband friendly policies and procedures imposed on private carriers to aid in the ease of their deployment. At the high-cost/risk end of the spectrum, many cities have chosen to be a full-service retail broadband provider to residential and business customers. Some in the "middle" opt to adopt the broadband friendly policies and to deploy fiber for city facilities' use only; others have elected to offer broadband to businesses along main traffic corridors but not offer fiber-to-the-home (FTTH) services; and still others elect to build opportunistically in conjunction with other construction projects.

The financial model presented in this Master Plan focuses on the City offering a Full Retail Solution to residents (FTTH), businesses, city facilities, anchor institutions, and for backhaul from vertical assets such as light and power poles in support of the upcoming 5G network solutions. This model also provides the City with the most control over its broadband solutions, while at the same time providing a potential revenue stream that can be used to continue buildout and management of the network.

Once built, many of the resources needed for managing the network can be done with the assistance of contractors, limiting the need for the City to hire full-time employees. Network support, including customer support, billing and accounting, network installations and upgrades, can all be done by experienced vendors under contracts with the City.

1.6 Financial Overview

The City can build a locally owned and controlled fiber backbone network capable of connecting residents, community anchors, and businesses. As outlined in this Plan, the City could invest as much as $73,020,755 million to fund a fiber buildout that would be available to every parcel in the City, ensuring that the network reaches all homes and neighborhoods as well as business and commercial corridors. The estimated payback on the system would be 20 years at a 40% take rate.

The network's capital costs are grouped into several categories, including:

- Core Network
- Laterals for residential homes & businesses
- Cost to connect to the POP

Ongoing maintenance and support costs are identified as operational costs rather than capital expenditures.

1.6.1 Residential Fiber-To-The-Home (FTTH)

The financial analysis for the fiber-to-the-premises (FTTP) scenario represents a conservative estimate based on requirements for the City of Manhattan Beach to deploy and operate an FTTP network, excluding any potential revenue from dark fiber lease opportunities that may be available to the City. The model also provides revenue projections from offering enhanced services to businesses and by leasing vertical assets and backhaul to cellular providers.

We looked at several "like" cities to determine how each model might be applied to the City of Manhattan Beach. Locally, cities reviewed included Beverly Hills, Rancho Cucamonga and Santa Monica. Nationally, staff also looked at Chattanooga, TN, Ammon, ID, Longmont, CO, and several others. Some offer full retail FTTH services, while others have chosen to be wholesale network providers.

This FTTH analysis for Manhattan Beach assumes that the City would construct, own, and maintain a fiber network over which the City would provide full retail services to end users. For this "all in" FTTH model, financial and logistical responsibilities for deploying fiber throughout the City would include construction costs, core electronics to operate the network, outside plant components, customer premise equipment, installation of fiber drops, and maintenance and replenishments for electronics. To support the delivery of services, one or more data centers would need to be established/built, along with core equipment necessary to manage the network.

This Plan proposes a network designed reach homes in phases over a 4-year period until every Manhattan Beach parcel has access to fiber-based broadband. The phases would be aligned with the seven sections of the City as illustrated in Figure 1, creating an incremental process that would put the least amount of stress on the City's budget.

As each segment is built and connected, revenue generating users would be added in a ramped-up fashion over a 3-year period. The model anticipates a 40% take rate for FTTH services, which is a conservative representation of industry norms (Figure 2). With roughly

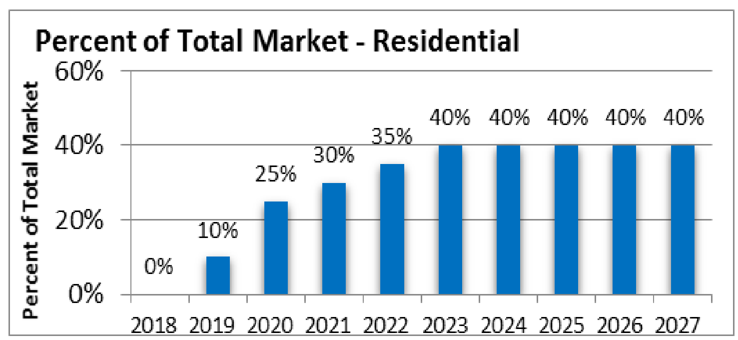


Figure 2: Percent of Total Market – Residential Subscribers

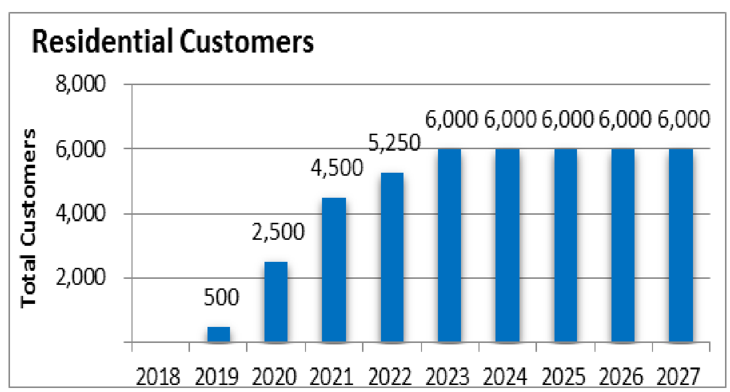


Figure 3: Total Number of Residential Customers Projected to Sign Up for Service

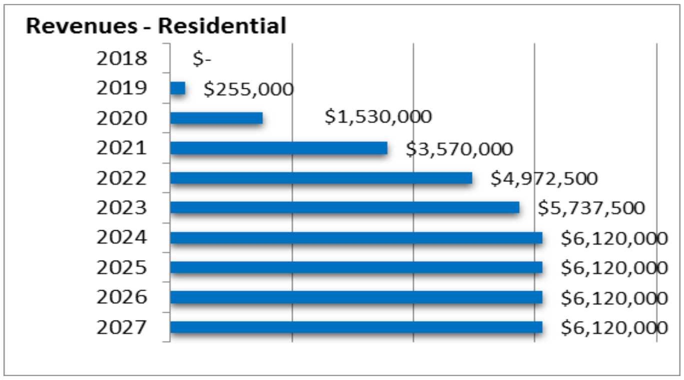


Figure 4: Revenues – Residential

15,000 homes in Manhattan Beach, the expected capture rate is 6,000 of those homes for broadband (Figure 3). Using a phased approach that assumes a 4-year build, this number will be achieved by 2023. A 40% take rate for FTTH can generate $6.12M per year in annual revenue for the City by 2024 (Figure 4). These generated revenues will continue to help pay the cost of building the network while providing all residents of Manhattan Beach with superior broadband service.

1.6.2 Business and Anchor Fiber

Business and anchor institutions will also be offered fiber-based broadband and services. As demonstrated in Figure 5 below, these models assume 250 existing area businesses will subscribe to the City's services. The take rate for business users is expected to be 25%, also ramped over a 4-year period (Figure 6).

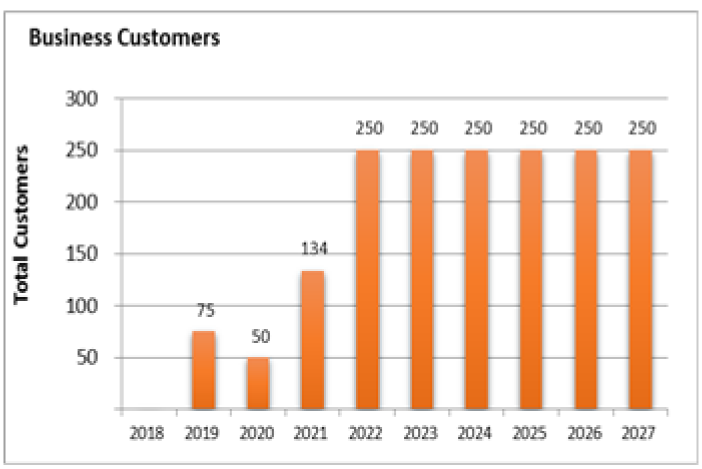


Figure 5: Number of Business Customers

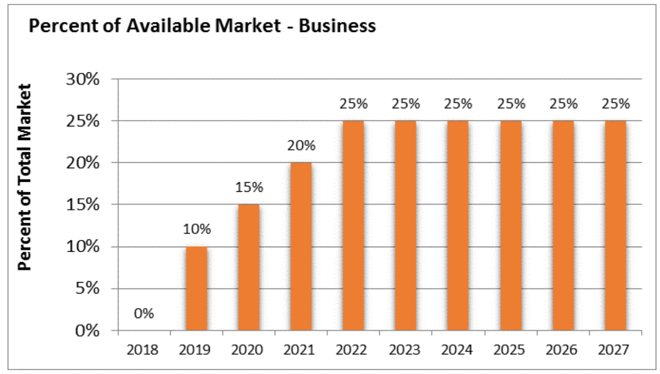


Figure 6: Percent of Available Market - Business

Using the model's stated assumptions, Figures 7 and 8 below illustrate annual revenues of $866,700 for businesses and $1,368,000 for anchor and dedicated institutions by 2022. In addition to earlier shown revenues from FTTH, these revenues can assist the City in offsetting

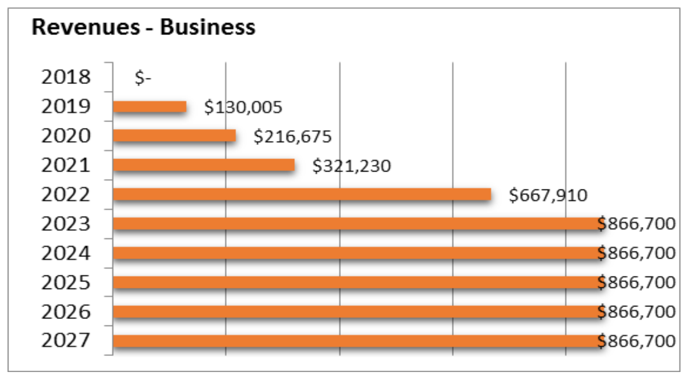


Figure 7: Revenue – Business

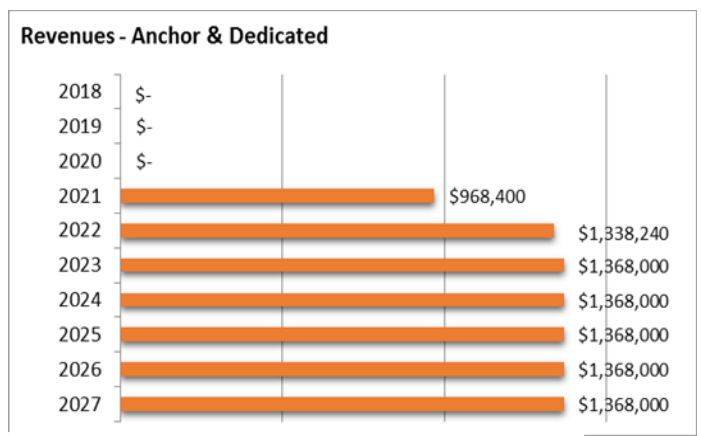


Figure 8: Revenue – Anchor & Dedicated

the cost of construction of the network.
As outlined in Chapter 6 of this Fiber Master Plan, the project will require up to $73,020,755 million in funding over the 4-year build period. The Financial Dashboard below (Figure 9) provides a snapshot of these figures.

$	FUNDING REQUIRED **$73,020,755**
	NORMAL PAYBACK PERIOD **20+ YEARS**
	PAYBACK PERIOD USING FREE CASH FLOW **20+ YEARS**
$	CUMMULATIVE FREE CASH FLOW OVER 20 YEARS **$6,938,135**

Figure 9: *Manhattan Beach Financial Dashboard*

The revenue model covers all operating and capital requirements, debt service, and funding of necessary reserve balances. The model projects Cumulative Free Cash Flow of nearly $6.9 million over the initial 20 years. This is telecommunications revenue that today leaves the City in the form of monthly recurring fees paid to commercial service providers. All financing instruments have been assumed at 20-year using a 2.5% interest rate (Figure 10). These financial models are sensitive and can be used to provide various levels of analysis around the model's variable points – service rates, uptake, costs and operating structures. This model should be refined as the project progresses, taking regular opportunities to validate and update the model's cost estimates, actual rates for service, and real market uptake as each phase is constructed.

It is worth noting that this model does not reflect potential construction costs savings that could be derived by the use of grant funds, such as are available for traffic signal improvements, nor does it include any savings from the use of Dig Once or Joint Trench opportunities. The costs reflected in the model are based on our experience with other "like" construction projects. The next phase of decision-making should include a more detailed network design and construction estimate, which will provide increased granularity of actual local construction costs. We anticipate those costs to be lower than represented,

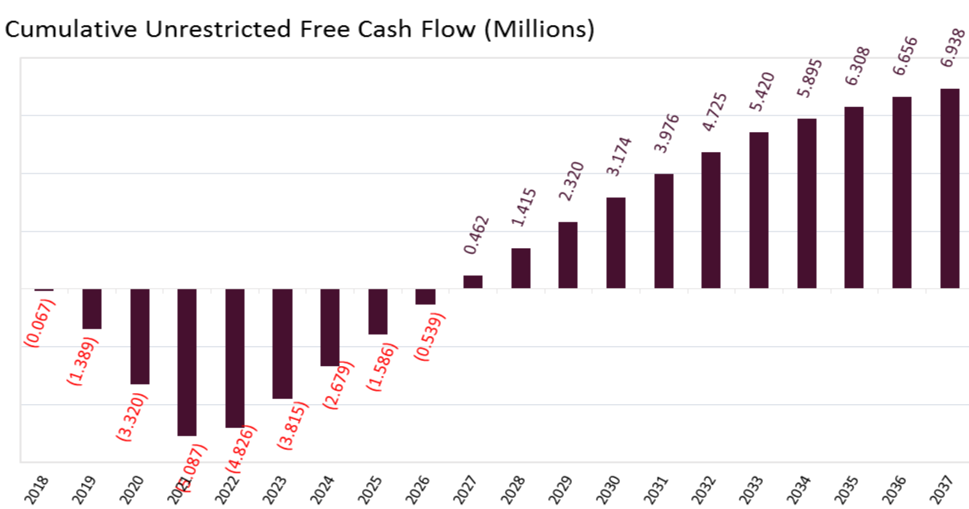


Figure 10: *Cumulative Unrestricted Free Cash Flow (Millions)*

but we elected to keep the numbers presented conservative for modeling purposes.

1.7 Recommendations and Next Steps

The City of Manhattan Beach should evaluate this Fiber Master Plan and the recommended actions to ensure alignment with the City's goals and vision. This Plan outlines a core piece of community infrastructure which will enable Manhattan Beach to permanently reduce network communications costs for the City and its communities while offering world class broadband access to homes, businesses, anchor institutions and the the greater Manhattan Beach community.

Through smart public policy and investment in local infrastructure, the City can capture some of the dollars lost to commercial service providers and save money for residents while providing a new fiber-based community owned network that is faster, more robust and more reliable.

THE CITY OF MANHATTAN BEACH'S NEXT STEPS INCLUDE:

1. **Review and adopt the City of Manhattan Beach Fiber Master Plan to begin the steps toward implementation.** City Management and elected leaders should review, comment, and provide direction on this Fiber Master Plan. The roadmap outlined in this document requires initial funding and resources. The City should designate this broadband effort as a City program, and it should be funded and structured just like any other City enterprise.

2. **In addition to Dig Once, approve and implement broadband policies including a Wireless Ordinance and a Master License Agreement to control costs and create communication standards centered on common goals.** As an important part of acknowledging City participation and support for improved broadband service to the community, public policies should be enacted as soon as possible to realize the most effective results.

3. **Develop a Pilot Program designed to test assumptions**. This program should test assumptions within the City using a Pilot FTTH Design Engineering Plan based on the recommendations of this document. The City should plan for the staging, budget, timelines, and implementation of a pilot design and issue an RFP for design and preparation of construction documents. Those plans should be put out to bid to determine actual market costs of construction.

4. **Based on the results of the Pilot FTTH Design Engineering Plan, the City should refine this Fiber Master Plan and financial assumptions.** The outcomes of the Pilot Program will serve as indicators of expected results for the City of Manhattan Beach, and may reveal additional adjustments to be made to the Fiber Master Plan.

5. **Report back findings of the Pilot Program to City Council for examination and input**. Council will be able to use insights from the Pilot Program to discuss and approve the next stages of implementation of the Fiber Master Plan, including potential construction based on the bids received.

6. **Use the Fiber Master Plan and indications from the Pilot Program to develop an Implementation Plan for citywide broadband deployment and network management.** If moving forward with phased deployment, this Implementation Plan should ensure that Smart Cities Initiatives are considered in the short and long-term, including future use of surveillance cameras, sensor networks, traffic cabinets, smart light poles, and other connectable devices contained within the Internet of Things and Smart City applications.

7. **Agree whether to move forward with the proposed Business Plan citywide**. The plan laid out in this document proposes that the City offer a full retail

solution to residents (FTTH), businesses, city facilities, anchor institutions and for backhaul from vertical assets. It provides a potential revenue stream to supplement the cost of building and managing the network and endows the City with the highest level of control over broadband solutions.

8. **Issue a Request for Proposals and select a firm to begin design and construction of the entire network.** The selected proposer should have relevant previous experience with designing this kind of FTTH network, and the contracted firm must be well-aware of Manhattan Beach's needs and goals before beginning the design and build efforts.

9. **Establish operating support systems to provide documentation, inventory tracking, processes, and management of network assets throughout the system.** The City should consider investing in a telecom-centric facility management system that provides documentation, inventory, work orders, and other relevant information about the network's physical plant assets. Availability of this information is crucial for both managing the existing network and future system expansion, as well as for tracking and depreciating assets with a long economic life, such as conduit, fiber, towers, and facilities. The cost for such a system has been included in the proposed capital budget.

10. **Issue an RFP for a multi-year O&M (Operations & Maintenance) contract, for a construction firm that would provide emergency restoration of the fiber infrastructure, and would be available to expand the network as needed.** The selected proposer should have the necessary expertise and equipment available to maintain the City's fiber-optic infrastructure. This contractor will respond to emergency fiber cuts and service outages within an agreed upon service level, as well as being responsible for all aspects of OSP operations and maintenance. The responsibility would include adds, moves, and changes associated with the network as well as standard fiber maintenance.

2. Broadband Today and Tomorrow

As our governments, economies and daily lives become increasingly reliant on the intake and output of vast amounts of information, connection to the internet is a necessary daily occurrence. Technologies are constantly evolving, and as new trends emerge, the efficiency of our everyday functions depends upon our understanding what is current, embracing what is new, and anticipating what is on the horizon.

2.1 Current Broadband Delivery Options

There are multiple broadband delivery systems that connect devices to the internet, the most common of which are cable, DSL, fiber, and wireless. Fiber is ideal for supporting broadband and is essential for fast, reliable connections. A fiber-optic cable — or just "fiber"— is a strand of glass the diameter of a human hair that carries waves of light. Using photons across glass, as opposed to traditional electrons across copper wire, fiber has the capacity to carry nearly unlimited amounts of data across long distances, literally at the speed of light. The term "broadband" refers to the high-speed service that enables devices to access online content.

Broadband is generally divided into business and consumer services, each of which have multiple tiers of performance and cost. Broadband is just one of many telecommunications services that also include other types of offerings such as voice. The variety of services and technologies are increasing—exemplified by the explosion in smartphone apps[4]—but the networks themselves are converging, so that anything can potentially connect with anything else.

Broadband is deployed throughout communities as wires that carry digital signals to and from end users. The content comes into the local community from around the world via global, national and regional networks. Local infrastructure was historically built, connected and operated by internet and telecommunications companies that own the physical wires to each household. This started with telephone companies, which deployed twisted-pair copper telephone lines. The second wire came from television companies in the form of coaxial cable. Later satellite and wireless phone companies provided video and voice, with more flexibility to mobile and remote devices using radio waves. Beginning in the mid-1990s, all of these companies repurposed their infrastructures to connect to the internet and carry digital content.

Infrastructure that is aging and built on the older technologies described above results in slower, less reliable access to content. Due to the limited capacity of this infrastructure, telecom companies can't reliably provide high speeds and often limit the amount of data consumers can use. Fiber provides the robust network that connects telephone and cable infrastructure between communities and around the world. It was originally used by telecommunications for their core infrastructure to connect their major switching centers, and was only available to large corporate and institutional customers. Today, fiber-optic is in homes and businesses throughout the world, providing telephone and television as well as internet access services. The next section describes internet access technologies in more detail.

[4] "App" is a shortened form of "application" and refers to software packages that give devices certain functions.

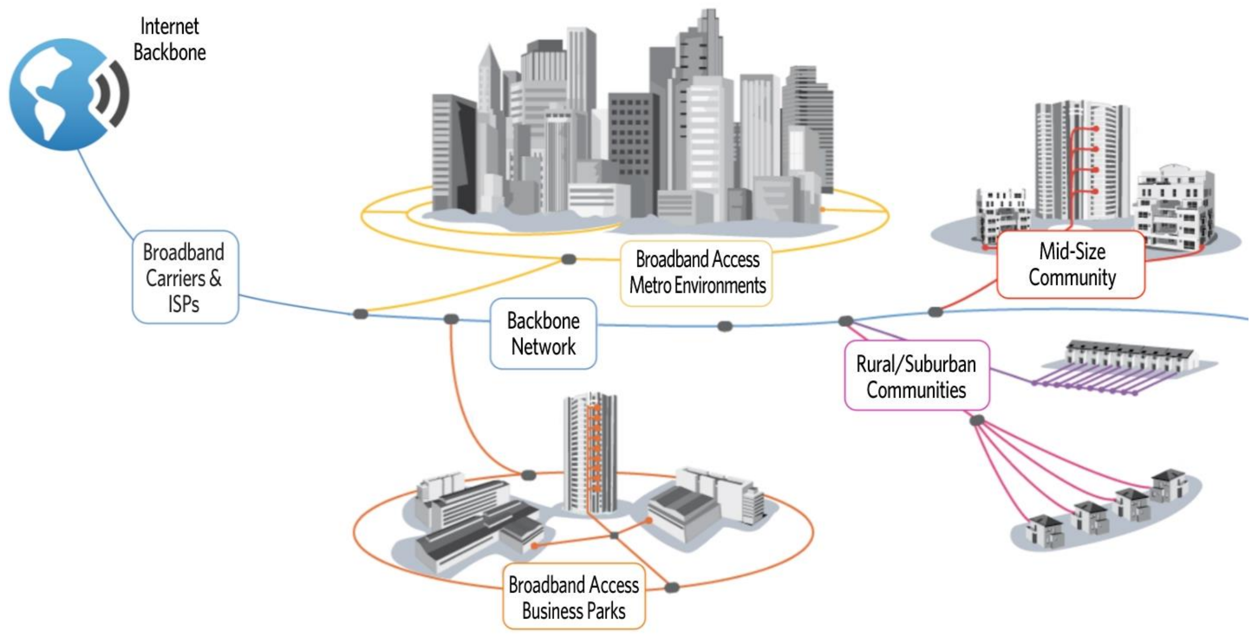


***Figure 11:** How Fiber-Optic Networks Connect Our Communities*

Dial-Up Access

Though not defined as a broadband technology due to speed and bandwidth[5] limitations, dial-up access still exists. Dial-up internet access uses the public switched telephone network (PSTN) to establish an analog connection from a computer to an internet service provider (ISP). The computer connects via a modem by dialing a telephone number on a conventional telephone line and translating digital data into an analog signal.

Digital Subscriber Line (DSL)

DSL is a wireline technology that uses high frequencies, which are not used by analog voice calls, to transmit digital data over traditional copper telephone lines faster than modems. DSL-based broadband provides transmission speeds ranging from several thousand bits per second (Kbps) to millions of bits per second (Mbps), generally ranging from 1.5 Kbps to 10 Mbps. DSL operates over the phone line—in parallel with voice traffic so calls are not affected—which plugs directly into a computer or router at the customer's site. The other end of the phone line connects to a DSL line card in the telephone company's central office or remote cabinet. Each user's data is multiplexed with their neighbors' over high-capacity fiber, transported to internet interconnection points, then routed over internet backbones to their online destinations. There are different types of DSL:

- Asymmetrical Digital Subscriber Line (ADSL/ADSL2/ADSL2+) provides faster speed in the downstream direction than the upstream direction. This is fine for most customers who receive a lot of data but do not send much.
- Symmetrical Digital Subscriber Line (SDSL) – SDSL has the same up- and downstream speeds. Used typically by businesses that generate online content or for services such as video conferencing, which need significant bandwidth both to and from the internet.
- Very-high-bit-rate Digital Subscriber Line (VDSL) – is a new generation of technology that provides up to

[5] "Bandwidth" is technically the range of electromagnetic frequencies that a piece of broadband infrastructure accommodates. In general use, "bandwidth" relates to how much information capacity is available for connections on a portion of a network.

52/16 Mbps. It is more sensitive to line quality and requires a more expensive line card.

The availability and speed of DSL service depends on the distance from the customer to the closest telephone facility known as a central office. Telephone lines were optimized for voice communications and conditioned to eliminate high frequency noise. Consequently, some telephone lines cannot handle DSL, and others must be modified to support the service. Multiple DSL lines can be bonded to provide higher speeds, but the cost multiplies too.

Digital Carrier Systems

Most commonly known as T-1s, this is the digital telephone standard in the US and has been the mainstay of corporate telecom for years. This service uses a four-wire interface to deliver 1.5 Mbps, which can be subdivided into 24 channels when bonded together. This is the way many companies get internet access and connect their various facilities. T-1s are universally available from local service providers, although they may charge for mileage and other aspects that make the service rather expensive. The digital services hierarchy extends to multi-megabit services and fits with the even higher bandwidth optical carrier services.

Cable Modem

Cable operators provide broadband to subscribers using the same coaxial cable that has historically delivered content to televisions through a cable modem across the same "tree and branch" network used to distribute channelized broadcast television. Technically termed DOCSIS (Data Over Cable Service Interface Specification), cable broadband literally allocates channels for carrying data to and from customers instead of television. Most cable modems are external devices that have two connections: one to the cable wall outlet via coaxial cable that goes out to the internet, the other to a computer or router via Ethernet cable.

On the cable network, where the coaxial physically ends, a DOCSIS interface strips out the data and routes them all to their destinations via fiber optic cable. DOCSIS uses a "multiple access" approach to network in which every user's data is intermingled with others on the wire from the house to the router. Transmission speeds vary depending on the type of cable modem, cable network, and traffic load.

In response to growing consumer demand for bandwidth, DSL and cable network operators upgrade outdated or underperforming equipment following their revenue models and capital budget limitations to attempt to make the infrastructure faster and more reliable. However, several fundamental issues pose long-term challenges to meeting the growing bandwidth demand through copper infrastructure:

- Broadband signals degrade significantly over copper as distances increase.
- Broadband signals over copper are susceptible to electrical interference and signal degradation, particularly as they age.
- The amount of bandwidth available on portions of broadband networks is often shared among multiple users, which can result in an uneven distribution of speed to users, and slower speeds to all as facilities become congested.

Fiber-Optics

As previously noted, fiber-optic network technology converts electrical signals carrying data into light and sends the light through transparent glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding copper, typically by hundreds of megabits per second. With fiber-optic broadband networks, speeds in the billions of bits per second range are possible. The fiber-optic network today operates at nearly 300 Terabits per second, which is so fast that a single fiber could carry all of the traffic on the internet.

More commonly, fiber-optic networks provide between 100 Mbps and 10 Gbps to users. Fiber-optic networks can be designed to be highly reliable as well as extremely fast. Fiber-optics are used extensively by major corporations and institutions and are at the core of every telecom company's network. There are numerous standards for *fiber-optic networks. The two most common for* broadband applications are Active Ethernet (AE) and Gigabit Passive Optical Network (GPON).

The actual speed the customer experiences will vary depending on a variety of factors, such as how the network is structured, the hardware attached to the fiber-optics, and how the service provider configures the service. The same fiber that provides broadband internet can also simultaneously deliver voice (VoIP) and video services, including video on demand. Fiber operates synchronously, meaning the service is just as fast to download as to upload, which is increasingly important for households and businesses.

Dark fiber is a fiber-optic strand with no hardware attached to generate laser light signals across the fibers. From the business perspective, dark fibers are facilities—real estate—that are leased to customers. As with any real estate, the value of dark fiber depends on location: namely, the locations of its end points and route. Dark fiber customers are large enterprises, including internet service providers (ISPs), that need to interconnect local area networks or "last mile" access network infrastructure.

The dark fiber must be "lit" in order to carry data across the fiber to provide bandwidth, connectivity, and other network services. Equipment must be placed on each end of the fiber, the equipment must be powered and connected to other network infrastructure, and it must be securely housed in a building or field cabinet.

Fiber to the Node (FTTN) brings high-capacity fiber-optic cables to communities and then connects to existing DSL and coaxial equipment. This is not an "all fiber" approach. Rather than bringing fiber-optic cables to every home or business, the fiber is connected to the existing copper network near the end to increase its capacity. The copper-based "last mile" network that connects homes and businesses to the local nodes is still a bottleneck and results in subscribers not accessing the true speeds of fiber-optic connections. Fiber to the Premise (FTTP) provides internet access by running fiber-optic cable directly from an ISP to a customer's home or business. This approach is "all fiber" all the way to the customer. Fiber facilitates much faster speeds than copper wire, generally needs to be serviced less, and is "future proof" because technology can increase the bandwidth of fiber-optic cables. AE and GPON are both FTTP technologies.

Figure 12 illustrates the relative difference between common internet connection methods, comparing access technologies from basic dial-up service through DSL, cable, and fiber. Whereas traditional broadband

Dial-Up – 56Kbps
- *Legacy Technology*
- *Shared Technology*

ADSL – 10Mbps
- *First Generation of DSL*
- *Shared Technology*

ADSL2 – 24Mbps

Second Generation DSL
- *Shared Technology*

Cable – 150Mbps
- *Data Over Cable (DOCSIS 3.0)*
- *Shared Technology*

Next Generation Fiber – 1Gbps
- *Passive Optical, Active Ethernet*
- *Shared and Dedicated Technology*

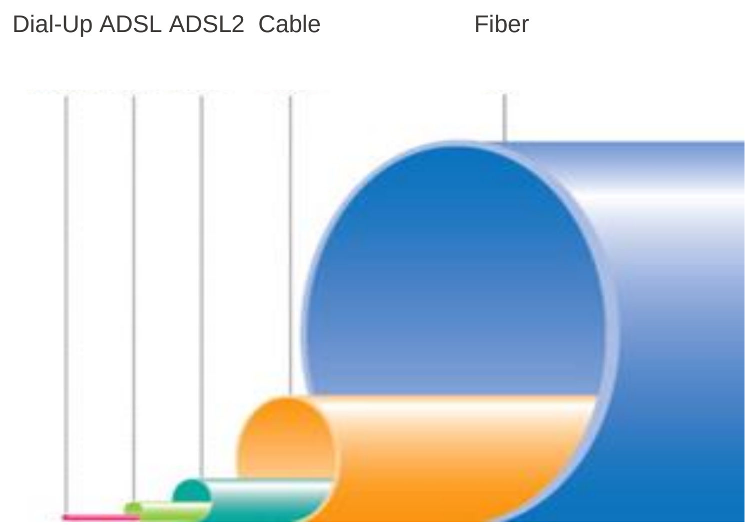


Figure 12: Physical Bandwidth Capacity Comparisons

technologies have an upper limit of 300 Mbps, next-generation broadband that utilizes fiber-optic connections surpasses these limitations and can provide data throughputs of 1 Gbps and greater.

Wireless

Wireless broadband can operate as mobile, hotspot, or fixed. Wireless can also be used as "backhaul" to connect remote locations or sparsely populated areas where DSL or cable modem service would not be economically feasible via long-range directional antenna. Fixed wireless services allow consumers to access the internet from a fixed point while stationary, and often require an external antenna with direct line-of-sight between the wireless transmitter and receiver. Speeds are generally comparable to DSL and cable modem. These services have been offered using both licensed spectrum and unlicensed devices.

Hotspot wireless uses the Wi-Fi standard to provide connectivity for digital devices in a particular area via physical access points and a router, which interconnects wireless devices to the internet. Hotspots typically operate at 54 Mbps, but the actual bandwidth depends on the quality of the wireless signal and speed of backhaul to the internet. Wi-Fi is a multiple access technology, so bandwidth is shared with other users. While users can move around in the hotspot, they can't drive away. Wi-Fi does not provide a mobile connection. Wi-Fi is fast and robust, although limited in distance and susceptible to interference because it operates in open, unlicensed spectrum. Wi-Fi hotspots are common at hotels, restaurants, and public buildings for public access. It is used in many homes and businesses for private access. Many ISPs use Wi-Fi, and it is increasingly available from traditional telecoms (AT&T and Comcast have many branded hotspots). Wi-Fi complements cellular data via mobile wireless and users often use it to avoid cellular data caps and slow speeds, and is used in conjunction with wired broadband services—most hotspots connect to the internet via broadband.

Wireless cellular data services, which borders on broadband speeds, are widely available from mobile phone companies. Typically referred to as either 3G or 4G (G for "generation"), mobile connections operate within cells that hand off signals from antenna to antenna as the device moves. 4G can move data at 12/5 Mbps, but speeds in the Kbps range are more common. Cellular data connections are most commonly used with smartphones, or with computers via cellular network interface card. Many smartphones can act as Wi-Fi hotspots or tether to computers via Bluetooth.

The next generation of wireless networks, 5G, is being designed and developed with forecasted commercial availability in 2020 and an increased maturity of the network in approximately 2035.[6] 5G networks operate multiple frequencies (i.e., 5-GHz, 60-GHz, 0.47-0.71 GHz) and utilize millimeter wavelengths. They will also operate on the IEEE 802.11ac, 802.11ad, and 802.11af standards[7], also known as Gigabit Wi-Fi[8] and are expected to provide download/upload speeds up to 1 Gbps, which depends on the number of connections[9]. The networks are designed to provide increased efficiencies while decreasing latency, and are designed for improving the performance of connected devices, or the Internet of Things (IoT).

In particular, 5G networks are designed to support high bandwidth and low latency applications such as autonomous vehicles, healthcare technologies (such as blood glucose monitoring), ultra-high-definition video, virtual reality, and many more emergent network design architectures and applications.

[6] Kinney, Sean. Qualcomm SCP: New spectrum 'cucial to 5G success, RCR Wireless News, July 24, 2017. https://www.rcrwireless.com/201/0/24/5g/qualcomm-new-spectrum-5g-sucess-tago17, accessed December 5, 2017. https://www.rcrwireless.com/201/0/24/5g/qualcomm-new-spectrum-5g-sucess-tago17, accessed December 5, 2017.

[7] http://ieeexplore.ieee.org/document/7169508/?part=1, accessed December 5, 2017.

[8] "802.11ac)Gigabit Wi-Fi). http://whatis.techtarget.com/definition/80211ac

[9] Rouse, Margaret. 5G. WhatIs, March 2015. http://whatis.techtarget.com/definition/5G, accessed December 5, 2017http://whatis.techtarget.com/definition/5G, accessed December 5, 2017

Satellite

Satellite internet uses licensed radio spectrum to send data from and to anywhere on Earth. The signals go on a 46,000-mile roundtrip from earth-bound devices through the atmosphere via the satellite and back to earth to another computing device. These radio signals have limited capacity and thus the connections tend to be slow. Because of the distance the signal must travel, satellite transmissions are susceptible to weather. Satellite should be considered a last resort for all but the most rural and remote areas. Areas with a high adoption of satellite generally indicates a need for better service. Today, the federal government finds that no satellite broadband service meets the 25/3 Mbps threshold of broadband.

2.2 The Smart City and the Internet of Things

Cities are on the cusp of rapid change, precipitated by technology that is being integrated into municipal operations for a variety of functions and applications. A "Smart City" is one which "has developed some technological infrastructure that enables it to collect, aggregate, and analyze real-time data and has made a concerted effort to use that data to improve the lives of its residents."[10] Advancing technologies place cities at the center of innovation in a variety of mediums, as shown in Figure 13 below.

Smart Cities are enabled generally by the "Internet of Things" (IoT). The IoT is being driven by the increased sophistication and reduced costs associated with wireless, Bluetooth and sensor technologies, coupled with the advent of cloud computing, which places storage and computing power in the cloud. Devices around us are undergoing technological re-imagination to incorporate technology to make them "smart." Increasingly simpler and cheaper devices can be employed by cities to connect municipal assets and functions to generate more and

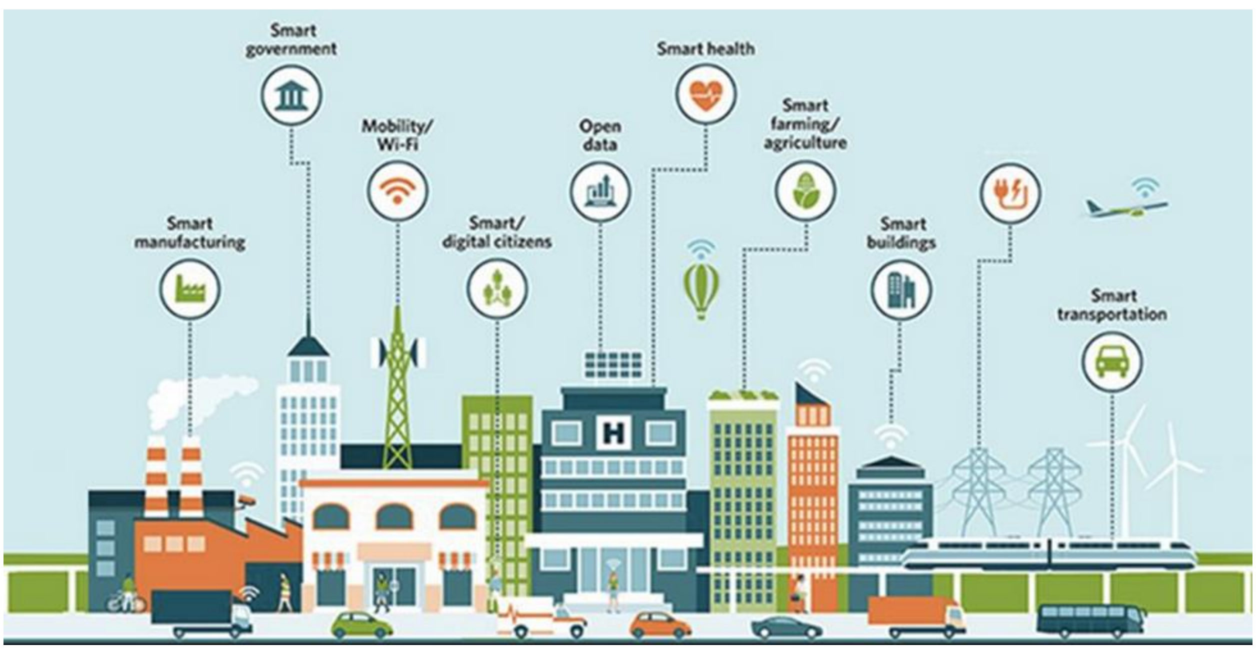


Figure 13. The Smart City

[10] "Trends in Smart City Development: Case Studies and Recommendations", National League of Cities, 2016. http://www.nlc.org/sites/default/files/2017-01/Trends%20in%20Smart%20City%20Development.pdf ("NLC Smart City Report")

more data – enabling more efficient and effective management of services and programs.

However, Smart City initiatives require high bandwidth network connectivity for transmission of large and growing amounts of data. Area service providers will sell high bandwidth (broadband) to cities as a service on their own infrastructure, but this is priced as a retail service from relatively few providers and is unaffordable to cities in both the short and long run. The alternative is to use and expand city assets in public rights-of-way, on a planned and strategic basis, to provide Smart City connectivity. Municipal broadband networks provide affordable means for implementing Smart City initiatives for health, education, public safety, mobility, livability and economic growth. Therefore, as communities invest in fiber infrastructure, they are constructing foundational communications networking useful to support a multitude of technology-based initiatives that require connectivity.

Smart Cities is a specific application of broader IoT efforts, but it needs and warrants its own unique approach because of the size of the opportunity and its ability to dramatically improve lives. Public engagement needs to focus on the direct and tangible benefits to residents' daily lives, like the ability to reduce traffic congestion or direct people to available parking spaces, or a reduction in cost or delivery of services with immediately evidential benefits.

As utilities and communities invest in fiber-optics, they are provided the baseline infrastructure required to support a multitude of technology-based initiatives that require connectivity. These initiatives can include:

Broadband Services

- Common network for all anchors
- City and County
- Schools and libraries
- Hospitals and clinics
- Public Safety
- Interconnection with service providers
- Wi-Fi in public centers
- Internet of Things

IT Collaboration

- E-Government applications
- Bulk internet purchasing
- Application sharing
- Disaster recovery
- EOC communications

Public Safety Applications

- Video monitoring
- First responder support
- Collaboration with state and federal agencies
- FirstNet preparedness

Future Energy and Utility Management

- Smart Grid and Demand Response
- Automated Meter Reading
- Advanced Metering Infrastructure
- SCADA communications and control

It is important to note that Smart Cities are not exclusively technological. Organizational and human factors must be provided for to foster the necessary collaborations and investment in human capital. Ultimately Smart Cities initiatives are layered, involving network facilities infrastructure, with connected devices (cameras, sensors, Wi-Fi, etc.), and the data from these devices which allows capabilities to be embedded in daily practices based on collaboration among organizations and departments.

2.2.1 The Internet of Things in the Public Sector

In public-sector environments, IoT has exploded with perhaps more devices and applications than other sectors to drive efficiencies and citizen services. Sensors enable the optimization of vehicle parking availability and traffic flow, environmental sensors help better manage rainwater runoff or detect subtle changes to air quality, utilities can manage peak energy load balancing and usage through smart infrastructure applications and can detect leakages or contaminations to water supplies.

Citizen engagement applications drive the promise of the Smart City movement through the marriage of consumer and industrial IoT technologies. Such devices, scattered by the thousands throughout communities, are networked seamlessly and generate an enormous amount of data.

For example, IoT can ease commute pains for individuals while the macro cost savings will be tremendous for a municipal government. The biggest impact for IoT could be for small businesses, not big ones. The simple but very useful information that these applications generate can make a difference.

The IoT is gaining momentum and communities must equip their IT architecture to capitalize on this Smart City connectivity to create value for residents and enjoy sustainable financial and operational benefits. City-owned fiber can provide a public infrastructure that can be used for public benefits, including enhanced municipal utilities, government applications, technology collaboration, and infrastructure sharing programs.

Magellan has kept future IoT and Smart City applications in mind throughout the creation of this plan and the resultant recommendations include strategies for Smart City readiness. Appendix A – Smart Cities includes further information about Smart City trends and technologies and an explanation of best practices to support its emergence.

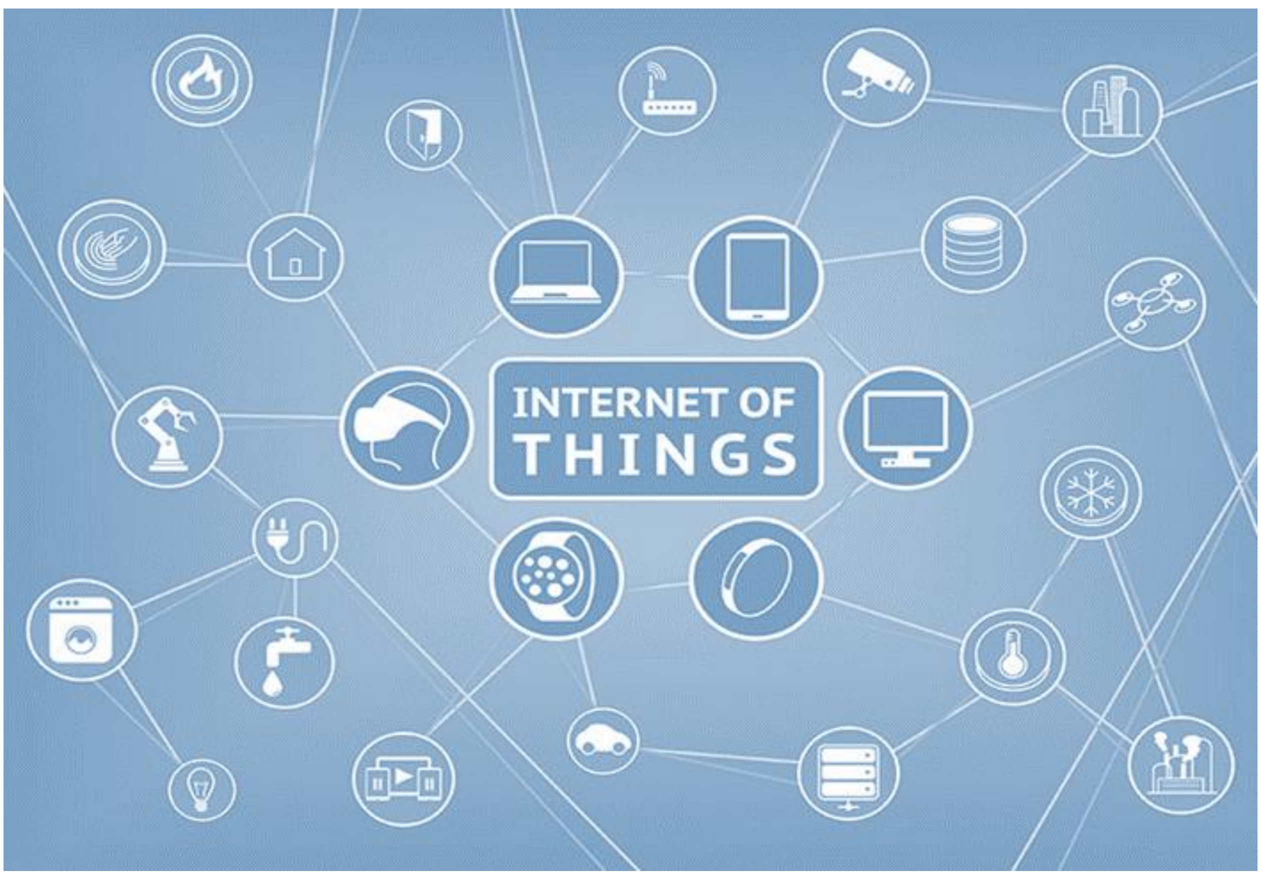


Figure 14. The Internet of Things

3. The City of Manhattan Beach

Manhattan Beach is a city within the South Bay district of Los Angeles County that covers just under four square miles (see Figure 15). Positioned on the Pacific coast south and west of Los Angeles, the City of Manhattan Beach is nearly 95% residential and its household incomes are well above averages of Los Angeles County, the state of California, and the entire US.

Manhattan Beach is very well educated, overall, and its population is primarily well-established. Young adults are a relatively smaller proportion, likely due to higher housing costs. Household incomes skew to the higher end, and discretionary income is likely to be available in many cases, allowing for procurement of higher-speed broadband.

As Manhattan Beach's direction is to focus on providing broadband services via fiber to its residents, the following demographics section focuses primarily on households, including ages, median incomes, levels of education, and by implication, levels of discretionary spending. This information is instrumental in determining pricing for offered broadband services.

3.1 Manhattan Beach Population Demographics

In 2016, the City had an estimated population of 35,500 (+/-34) that was a majority white (80.6%) and split male/female (48.8 / 51.2%). As shown in Figure 16, Manhattan Beach has a relatively less prevalent young adult population (under 35) than the rest of Los Angeles

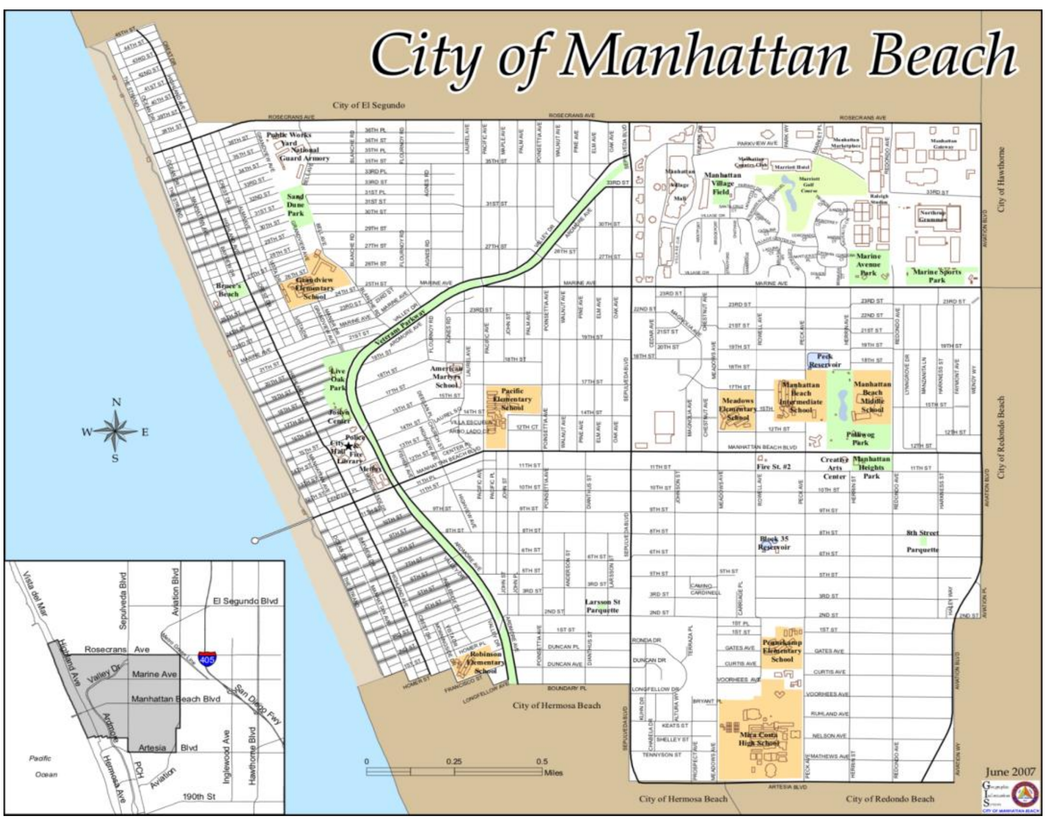


***Figure 15**: Map of the City of Manhattan Beach*

County, the state of California, and the rest of the country. Manhattan Beach's median age in 2016 was 43.6, compared to 37.7 for the US, 36.0 for California, and 35.8 for Los Angeles County, CA.

Manhattan Beach is very well educated. US Census data indicates that Manhattan Beach holds the ranking of second most educated city in Los Angeles County and the fifth most educated city in the state of California (see Figure 17). Median incomes are consistently higher for all educational levels in Manhattan Beach than in the county, state, and nation, as shown in Figure 18. In fact, median incomes in Manhattan Beach rose almost 50% from 2000-2016. The differences in income become even more apparent when considering families. Manhattan Beach has a much higher portion of families at high and very high-income levels than the county, state, and nation. It also has a much smaller percentage of families at low- to mid-income levels, as shown in Figure 19 below.

Age Distribution	US	California	LA County	Manhattan Beach
Under 5 years	6.2%	6.5%	6.3%	6.0%
5 to 9 years	6.4%	6.6%	6.2%	6.7%
10 to 14 years	6.5%	6.6%	6.3%	7.5%
15 to 19 years	6.7%	6.8%	6.8%	5.7%
20 to 24 years	7.1%	7.5%	7.7%	2.8%
25 to 34 years	13.6%	14.7%	15.6%	9.3%
35 to 44 years	12.7%	13.3%	13.9%	14.6%
45 to 54 years	13.6%	13.5%	13.7%	17.6%
55 to 59 years	6.7%	6.3%	6.2%	7.0%
60 to 64 years	5.9%	5.4%	5.2%	6.8%
65 to 74 years	8.3%	7.3%	6.8%	9.4%
75 to 84 years	4.3%	3.8%	3.7%	4.5%
85 years and over	1.9%	1.8%	1.7%	2.1%
Median age	37.7	36.0	35.8	43.6

Figure 16: *Manhattan Beach Population in Various Age Ranges*

Education	US	California	Manhattan Beach
High School or higher	88.9%	79.8%	96.8%
Bachelor's or higher	31.5%	31.4%	67.6%
Graduate or Professional Degree	11.4%	11.6%	28.6%

Figure 17: *Manhattan Beach Educational Attainment*

Income (2016)	US	California	Manhattan Beach
Median household income (2016)	$57,617	$67,739	$153,332
Median per capita income (2016)	$31,128	$33,389	$91,739

Figure 18: *Manhattan Beach Median Income*

Household Income	US	California	Manhattan Beach
Income < $10K	20.8%	5.4%	1.9%
$10K - $20K		8.6%	2.7%
$20K - $30K		8.3%	3.4%
$30K - $40K	22.2%	8.0%	3.6%
$40K - $50K		7.5%	3.4%
$50K - $60K	17.0%	6.9%	3.5%
$60K - $75K		9.4%	6.0%
$75K - $100K	12.3%	12.2%	8.8%
$100K - $125K	14.1%	9.5%	8.4%
$125K - $150K		6.2%	7.1%
$150K - $200K	6.6%	7.9%	13.0%
> $200K	7.0%	10.1%	38.1%
Median Income	$59,039	$67,739	$153,332

Figure 19: *Manhattan Beach Household Income*

3.2 Manhattan Beach Broadband Needs Assessment

The broadband needs assessment focuses on the supply and demand sides of broadband by examining service providers that serve customers in the City of Manhattan Beach. The assessment also examines how Manhattan Beach households and businesses use the internet today and how they will use it in the near future. This chapter explores topics of broadband availability, adoption and utilization from the perspective of residents and businesses.

The assessment determines local indicators of broadband importance and identifies barriers that discourage or prevent local broadband service adoption. It also indicates opportunities for future increased broadband adoption and socioeconomic benefit. Through the benefit of in-person meetings and online and printed surveys of Manhattan Beach households and businesses, the broadband needs assessment explores how the internet currently benefits local households and facilitates the operations of local businesses and organizations.

3.3 Community Engagement

As part of the needs assessment research process, Magellan Advisors and City of Manhattan Beach staff visited with community and business leaders throughout the City during the fall of 2017. The goal of each meeting was to understand the connectivity challenges from the people who live and work in the City and understand how the internet impacts the things they do.

These community stakeholder meetings provided the opportunity for candid and open discussions with key employers, government and community organizations, business and community leaders, educators and first responders, as well as service providers and others. The meetings allowed stakeholders to share how they use the internet today and how they envision using the internet and broader applications and technology tools in the future. As provided in this report, residents and businesses in Manhattan Beach have shared their needs for internet connectivity and better broadband services.

3.4 Residential and Business Survey

Knowing that it is impossible to speak with every resident and business owner in the city, an online survey of Manhattan Beach households and businesses was conducted. The surveys were promoted in large part with the help of Manhattan Beach project staff. In sum, 640 Manhattan Beach households and 121 businesses responded to the survey.

The survey responses were entered into the survey platform and evaluated using Magellan's established data analysis techniques. No answer weighting or bias tools were applied to the data, and statistically significant differences between response categories are highlighted and discussed where relevant in the Residential and Business Needs Assessment narratives.

The high household response rate lends to a high statistical relevancy of data. With approximately 15,000 households in Manhattan Beach, the 643 residential survey responses yield a 95% confidence level with a ±3.8% margin of error, exceeding industry research standards of 95% confidence level and a ±5% margin of error. The response rate from the businesses was somewhat lower, with 121 responses and a 64% completion rate. With just over 12,600 businesses in the City, the total responses yield a statistically relevant 95% confidence level with a ±8% margin of error.

The survey captured information about residential and business internet services, satisfaction with those services, and desire for improved services. The survey results provide Manhattan Beach a broad understanding of broadband needs of the City. Aggregate results of the survey will be distributed throughout the report.

3.5 Residential Needs Assessment

To gain an understanding of the broadband-related issues faced by Manhattan Beach households, an online survey was conducted that included questions about current broadband access and how the internet was used in the home. In addition, a well-attended Residential Broadband Focus Group meeting provided feedback on the residential user experience.

In Manhattan Beach, where internet providers have expanded the availability of their service offerings, adoption and use of the internet have also grown. Manhattan Beach residents appear to be using the internet every day, and survey responses show that the internet is imperative to everyday life.

Of the 643 households that completed the survey, 99.38% reported subscribing to internet services (Figure 20). The adoption of the internet and use of internet-enabled devices is strong, indicating that it has clearly become ingrained in the lives of Manhattan Beach residents. This suggests strong demand for residential broadband services as a core utility.

3.5.1 Barriers to Household Internet Subscribership

From all surveys collected, only four (4) households, or less than 1%, reported they do not subscribe to residential internet services, while 3 respondents skipped

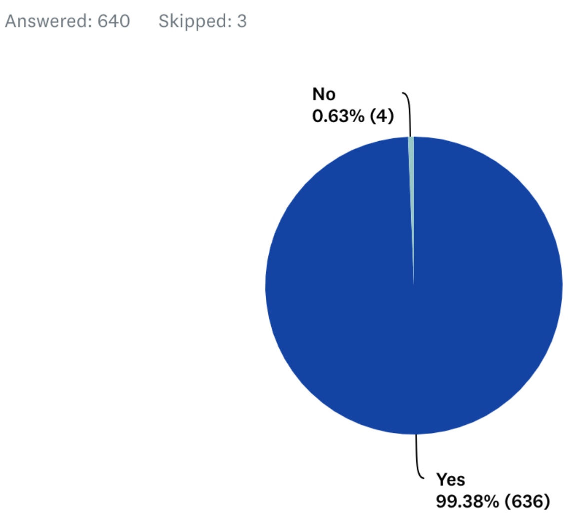


Figure 20: Percentage of households reporting that they have internet service at home.

the question. Notably, across all surveyed households, there were no households that reported choosing not to subscribe because they do not need the internet.

Of the 4 non-subscribers, respondents report they believe services are too expensive, suggesting that affordability is the primary inhibitor to subscription. They also report concerns that internet access is too slow and too unreliable. The non-subscribers rely on access through public community anchors, such as libraries or schools, or locations with free Wi-Fi. Alternatively, they rely on mobile phone data plans for access, which can be a very expensive way to consume data, given limited data plans and slower speeds.

3.5.2 Current Household Broadband Subscribers – Technologies

Over 500 respondents named their primary subscribed broadband technology, with 14 unsure of their choice (Figure 21). Of those who specified their technology, over 60% currently subscribe to the internet via fiber optics, which is provided by Frontier FIOS, and one third access the internet via cable services provided by Spectrum. Only a handful of subscribers used DSL, mobile wireless or cellular as their primary source to access the internet.

3.5.3 Current Household Broadband Subscribers – Satisfaction

Generally, 60% or more of subscribers report they are "somewhat satisfied" to "completely satisfied" with broadband service reliability, speeds, customer support, and offered services. However, over 50% of subscribers report the price-to-value proposition as unsatisfactory. Subscription costs are expensive relative to perceived

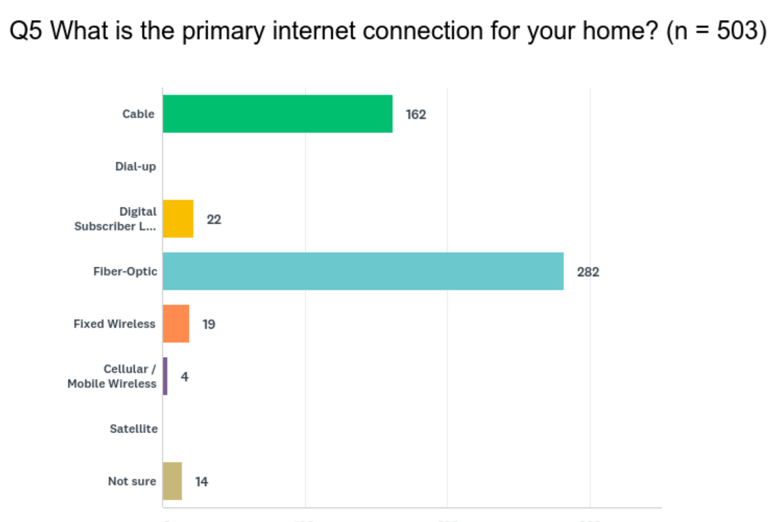


***Figure 21:** Household Subscribers - by Technology*

value received (See Figure 22). Among subscribers, reliability is not reported as a significant impediment, with over 80% reporting 8 hours or less of service interruption per month. Naturally, the effects of service reliability depend on the time of the outage and the task being performed (Figure 23).

3.5.4 Current Household Broadband Subscribers – Bandwidth

With over 60% of household subscribers using fiber, expectations of Manhattan Beach residents for bandwidth are high. Survey results indicate that download and upload speeds are generally high, though unsurprisingly,

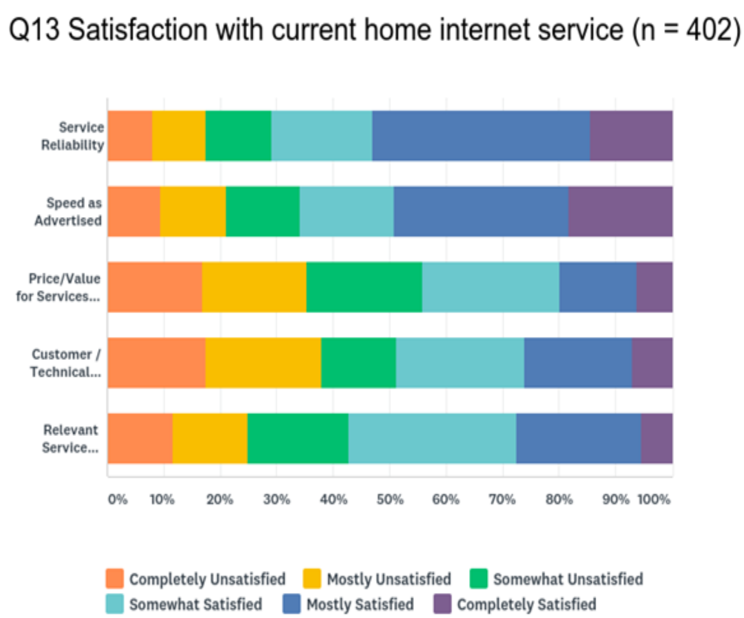


Figure 22: *Manhattan Beach Household Subscribers - Satisfaction*

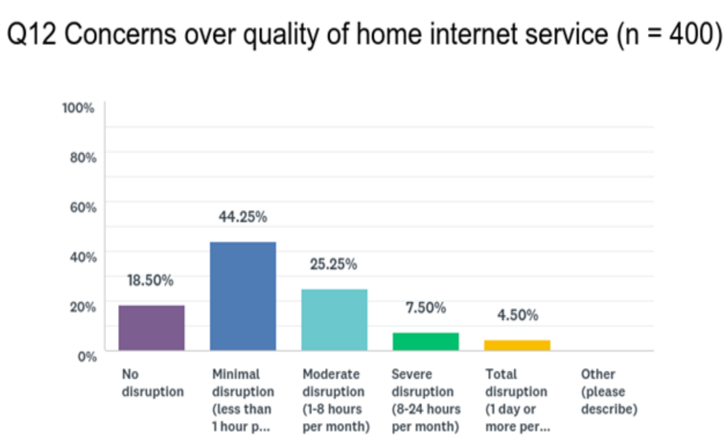


Figure 23: *Household Subscribers – Reliability Concerns*

actual measured speeds for uploads (via Ookla speed test) are lower than advertised speeds.

Over 400 respondents reported that, on average, the download and upload speeds advertised by their internet services provider (ISP) are 89 Mbps and 97 Mbps, respectively (see Figure 24). This is anomalous, as download speeds are typically higher than upload speeds; more granularity would be required to determine distribution of speeds. Most of this unusual result is likely explained by the service providers overstating the speeds offered for internet plans.

However, when measuring actual download and upload speeds, the results are more expected. Average measured download speeds are 114 Mbps and 81 Mbps, using respondent-reported Ookla results (see Figure 25). We observed that the actual upload speeds are less than the advertised upload speeds. In addition, we speculate that the actual measured download speeds exceeding the advertised speeds are attributable to the large proportion of fiber subscribers.

Despite the relatively favorable bandwidth measures, however, expectations of internet service are much higher. Of over 400 respondents to the question, more than half feel that their internet services do not meet their current needs or are not sure (see Figure 26). Specifically identifying these deficiencies in the survey, over 60% felt prices were too high for the offered services; over 60% felt bandwidth speeds were insufficient for their current needs; and over half felt the services were too unreliable. These three main concerns were repeatedly identified. In addition, over one-third of respondents felt customer service and technical support

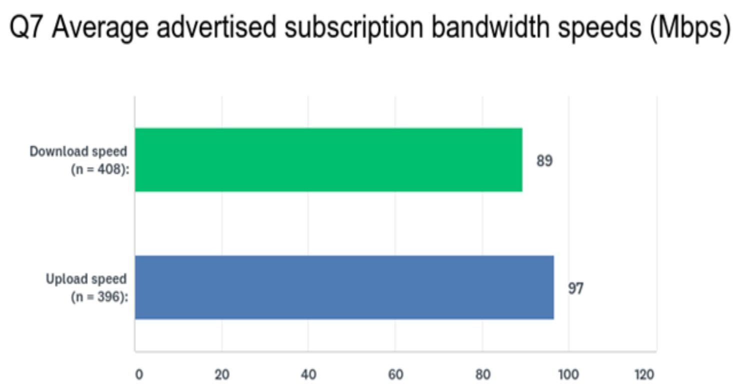


Figure 24: Household Subscribers – Bandwidth (as Advertised)

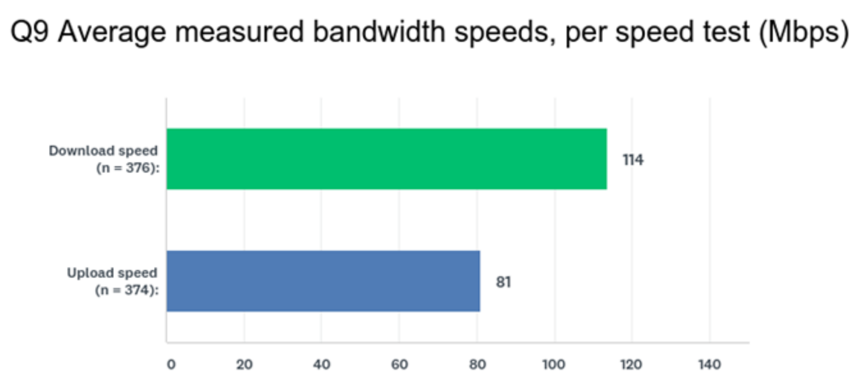


Figure 25: Household Subscribers – Bandwidth (as Measured)

could use improvement. Only one in five felt that they had insufficient options, however (see Figure 27).

- Video Entertainment – watching movies, videos, or TV

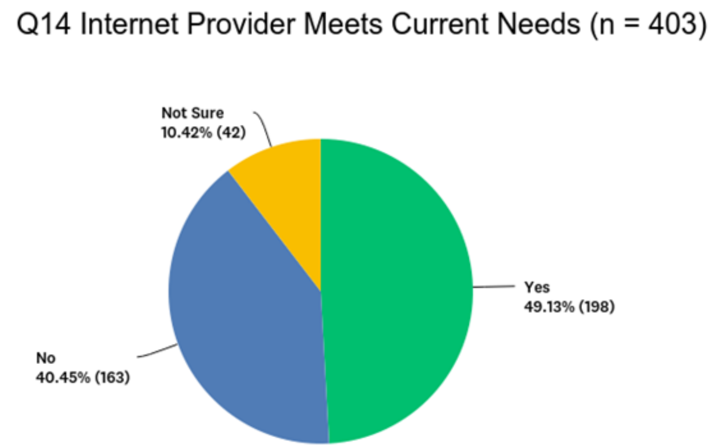


Figure 26: *Household Subscribers – Sufficiency of Current Services*

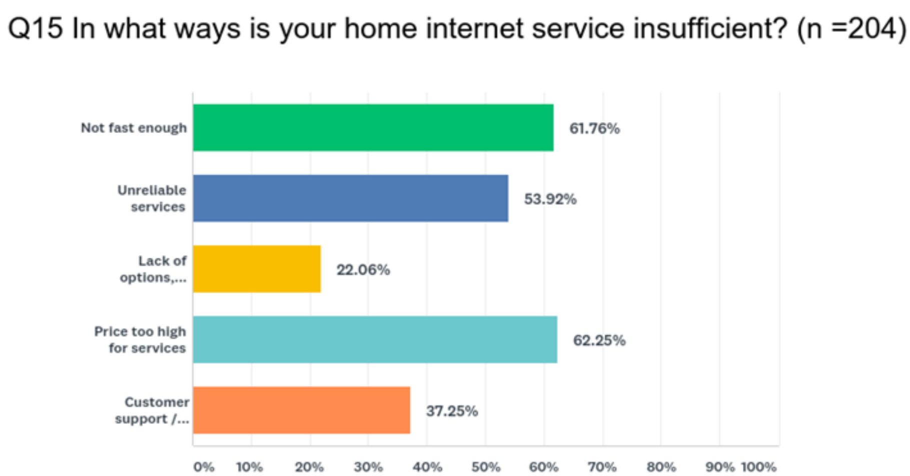


Figure 27: *Household Subscribers – Concerns Regarding Current Services*

3.5.5 What are Households Doing On the Internet?

The study conducted also explored why households are dissatisfied with current services by examining what the respondents themselves are doing on the internet today. An overwhelming majority (greater than 80%) of current subscribers report that they "occasionally" or "frequently" use the internet for:

- Shopping online
- Audio Entertainment – downloading or streaming music
- Email – personal and business
- Accessing educational websites or material
- Making video calls
- Accessing local government services
- Researching or browsing online
- Social media
- Accessing healthcare

Manhattan Beach residents have clearly integrated internet access into their daily lives for personal, education, entertainment, and informational needs. Smaller proportions run small businesses, sell products or services, use internet-based security systems, or participate in online gaming (Figure 28).

3.5.6 Less Traditional Things are Households Doing on Internet

On average, Manhattan Beach household subscribers reported the following:

- Over 94% consider broadband internet as an essential utility, alongside water and electricity;
- Over 95% state that the internet is “important” to their household;
- An average of 11 devices are connected to the internet in every household today, either directly or via Wi-Fi hotspot;
- Over 50% have someone in the household using the internet to work while at home;
- Over 60% have someone who regularly telecommutes or works from home for an outside employer;

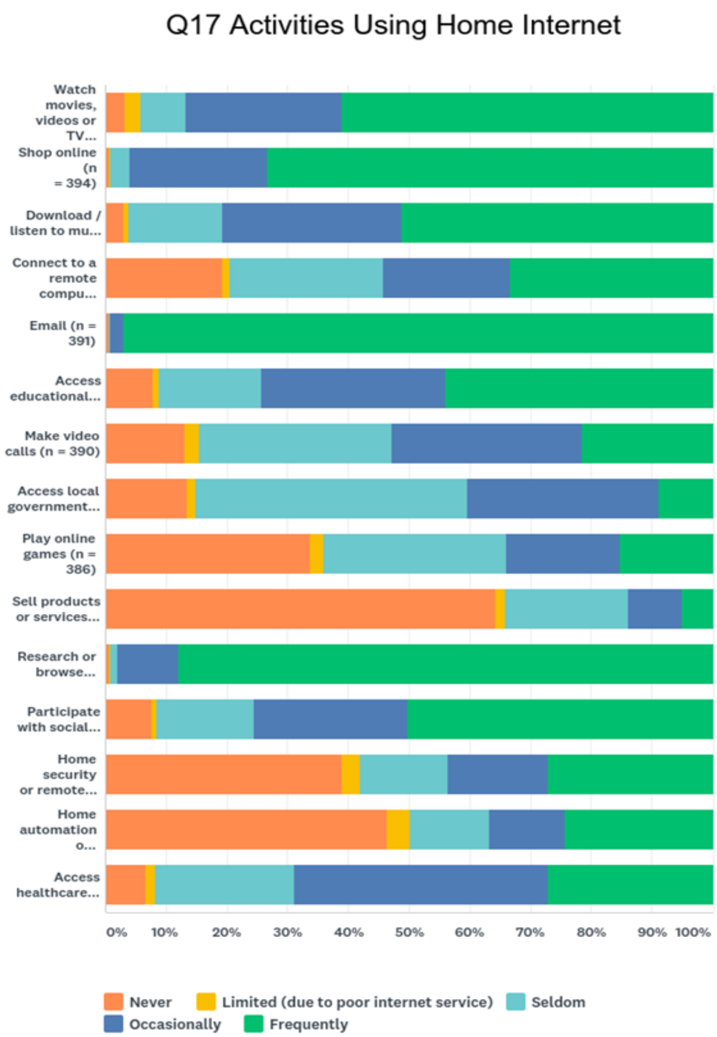


Figure 28: Household Subscribers – What Are They Doing?

- Over 55% have someone in the household who does schoolwork or takes training from home.

In addition to traditional internet services, more and more households are using the internet for complementary phone and TV services. In many cases, these are the result of "bundles" offered by internet providers. These bundles typically include telephone and television services, alongside internet service.

Telephony*:* Of 391 respondents, almost 25% report using telephone services over the internet, utilizing Voice-Over-IP. [Note, multiple phone services, including mobile and cellular, are reported by most households; See Figure 29.]

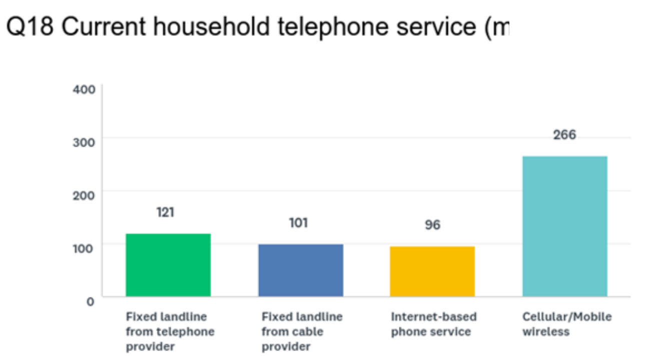


***Figure 29**: Household Subscribers – Internet Telephone Use*

Television: Increasingly, television is being consumed on-demand, streamed, and accessed away from traditional scheduled broadcast programming. Services such as Netflix, Sling, Hulu, Roku, YouTube TV, Amazon and others increasingly deliver their content via the internet for a small monthly access fee. Even traditional broadcasters, such as CBS or ABC, or sports networks, such as ESPN have introduced subscription services, where content can be accessed directly. All of these services deliver their content via broadband internet, where they can be consumed on smart TVs, smart phones, or any internet-connected device.

How are Manhattan Beach residents behaving? Of 331 respondents, on average, they indicate only 55% of their television viewing is through traditional distribution channels; the remaining 45% is consumed via internet.

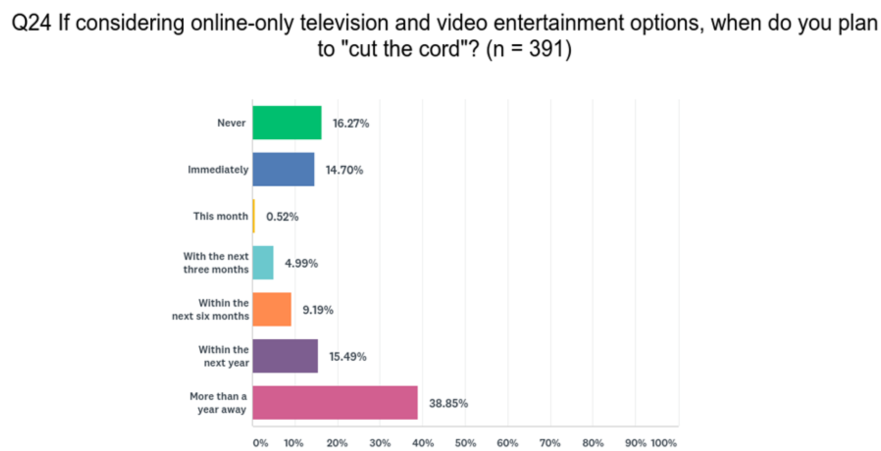


Figure 30: Internet Television and Cutting the Cord

The internet subscription model can be expected to grow in the coming years, thereby increasing demand for unlimited, high speed broadband.

This trend is accelerating at such a pace that many household subscribers are considering "cutting the cord" completely and utilizing internet-only TV services. Of 391 respondents, almost 50% are strongly considering fully cutting the cord within the next year. However more than 16% saying they will never cut the cord. As internet TV becomes more widely embraced, one can reasonably expect the number of people who will never cut the cord to continue declining (see Figure 30).

Other Devices: Demand is strong in Manhattan Beach, with connected devices set to climb as more services and 5G devices come to market. While the survey did not ask for specific devices inside the home that connect to the internet, the most current U.S. research[11] finds that devices related to security lead the way, with devices that help manage utilities and energy consumption next, followed by smart appliances, health monitoring, and entertainment and gaming systems.

As another example, for the first time ever, 53% of U.S. households have smart TVs that are capable of connecting to the internet.[12] Many multimedia entertainment systems, thermostats, irrigation systems, food storage and preparation areas, and security and monitoring systems are now connected to the internet, consuming even more home broadband bandwidth. In the coming years, the explosion of internet-connected devices in and around the "smart home" will lead to increased use of always-on residential broadband connections.

Gartner Research says there were 174 million smart homes in 2015, and that number nearly doubled in 2016 to 339 million. Consumer applications fueling the growth of smart homes are smart TVs, smart lighting , smart thermostats, home security systems, kitchen appliances and more. Overall, the total number of connected devices is expected to hit 1.6 billion, up from 1.2 billion in 2016.[13]

Enabling smart homes is the ability to wirelessly connect all the various devices around the house quickly and conveniently. This wireless connection is most commonly made through Wi-Fi technology, which is often done through the use of a router with wireless functionality. In Manhattan Beach, 98.1% of surveyed households that have a broadband connection also have a Wi-Fi router installed in the home.

With the ease of Wi-Fi connectivity, homes are consuming more video and streaming applications, which require significant bandwidth and reliability from their broadband connections. A typical home might have one television set connected to broadband over a wired connection, while other devices on which video is viewed — such as tablets and Smart TVs — are connected over Wi-Fi.

Today, average monthly broadband usage in U.S. homes is 190 gigabytes per month according to a report from iGR Research.[14] More than 95% of this traffic is video, as TV watching has moved from a group activity where the whole family might watch the same show, to now being a personal activity. This means that not only are homes watching video over the internet, but also that if four people live in a household, four times the data is likely being consumed.

3.5.7 Does Residential Demand for Municipal Broadband Exist in Manhattan Beach?

The Manhattan Beach Residential Survey was designed to assess residents' current usage, perceptions of service, and expectations based on the respondents' knowledge. The survey did not report analysts' expectations that internet content will be more video intensive; that more devices (especially in smart homes, for TV, security, and the Internet of Things) will continue to proliferate; or that higher bandwidth demand will continue to grow, for education, for health care, and for entertainment.

Even without those valid expectations, we asked respondents a simple question: "If competitively priced, how likely would you be to subscribe to internet services directly from the City of Manhattan Beach?" *The demand was overwhelmingly positive, with **over 80%** indicating they would consider an offering by the City*

3.6 Manhattan Beach Business Needs Assessment

To help research the broadband-related issues experienced by Manhattan Beach businesses, several techniques were used. Outreach sessions to businesses were scheduled, including a meeting with the Downtown Business Improvement District; a meeting with the head of the Chamber of Commerce; and a workshop with

[11] Delivering on the Promise of Connected Homes: www.mckinsey.com/spContent/connected_homes
[12]http://www.broadcastingcable.com/sites/default/files/public/pdf/MagidTubeMogulPressReleaseFINAL.pdf
[13] http://www.gartner.com/newsroom/id/3175418
[14] http://igr-inc.com/advisory-subscription-services/wireless-mobile-landscape

representatives of a medical center, a local mall, and a credit union. An online survey was also conducted that included questions about current broadband access and how the internet is used today. Of the 121 businesses that completed the survey, 95.8% reported subscribing to internet services.

3.6.1 Business Workshop Summary

At the business workshop, representatives of the three local businesses listeed above shared their experiences and thoughts. They all currently use broadband and internet, and those services are critical to their operations.

Although each tenant of the shopping mall is required to make its own arrangement for service, the mall does provide free public Wi-Fi, with an email registration required, and target marketing suggestions delivered on subsequent visits. Point-of-sale support for kiosks is also a requirement, as is variable message signs for parking.

For the medical center, the increasing dependence on electronic medical records and telemedicine is placing tremendous demands on supporting growth of bandwidth, with security of personal health records remaining a significant concern.

For the credit union, more and more transactions are being performed by members online, so access to records is critical to the credit union's growth and marketing.

All three entities reinforce the three primary concerns of subscribing to internet services offered by commercial service providers: the price for services; the limitations on bandwidth; and the relative unreliability of assured service operation.

3.6.2 Barriers to Manhattan Beach Business Internet Subscribership

From all surveys collected, only five (5) businesses reported they do not subscribe to internet services, of which three (3) businesses stated that they access the internet elsewhere, either at home, at school, or at a library. Of the 5 non-subscribers, affordability and price-to-value are the primary inhibitor to subscription. The non-subscribers rely on access through public community anchors, such as libraries or schools, or locations with free Wi-Fi.

3.6.3 Current Business Broadband Subscribers – Technologies

Of the 121 business respondents, over 85 named their primary subscribed broadband technology, with 4 unsure of their technology choice. Of those that specified their technology, over 53% currently subscribe to the internet via fiber optics, and one quarter of the subscribers access via cable services. DSL and T1 services, along with mobile wireless and cellular, were only used as the primary technology by a handful of subscribers.

3.6.4 Current Business Broadband Subscribers – Bandwidth

With over 50% of subscribers using fiber, expectations of Manhattan Beach businesses for bandwidth are high. Survey results indicate that download and upload speeds are generally high, though unsurprisingly, actual measured speeds for uploads are lower than advertised speeds.

55 respondents reported that their download and upload speeds, as advertised by their internet services provider (ISP), are 90 Mbps and 82 Mbps, respectively. However, when measuring actual download and upload speeds, the results are much less than advertised. Average measured download speeds are 58 Mbps and 55 Mbps using respondent-reported Ookla results.

3.6.5 Sufficiency of Current Subscription Service

Despite the relatively favorable bandwidth measures, expectations of internet service are much higher. Among 75 respondents, less than half (43%) feel that their internet services meet their current needs.

3.6.6 Expectations of Growth of Business Broadband Needs

Over 80% of businesses expect their internet and broadband needs to grow over the next three years, with 43% anticipating significant growth in usage.

3.7 Service Providers in Manhattan Beach

This market analysis of the supply side of broadband includes information about the providers that serve the homes and businesses of Manhattan Beach. It focuses on residential broadband internet services and considers telephone and television services that are often bundled with broadband. Manhattan Beach presently has six internet service providers for residential services; four of these are terrestrial providers and two are satellite providers. Figures 31 and 32 on the following pages show offerings among these four ISPs.

AT&T and Windstream offer DSL service to less than 5% of Manhattan Beach parcels, and thus they are not significant providers of internet access to Manhattan Beach communities.

- **Frontier's** fiber offerings are a better value, with 30 Mbps symmetrical service for two-year promotional rate of $25/mo, including a modem with Wi-Fi hotspot. Higher speed offerings are available, with 100 Mbps symmetrical service for two-year promo rate of $30/mo; 150 Mbps symmetrical service with two-year promo monthly rate of $40; both of these carry a $5 modem fee.

- **Spectrum** offers speeds up to 300 Mbps for a one-year promotional rate of $45/mo. After the promotional period, the rate increases to $65/mo.

Two satellite providers provide coverage to the entire City. However, both satellite providers carriers' best offerings just meet, and do not exceed, the FCC's definition for downloads at 25 Mbps. Each carrier also imposes surprisingly small monthly data caps, impairing residents' usage for high-bandwidth demands like video streaming.

- **HughesNet** offers a basic plan that provides the FCC broadband minimum of 25 Mbps down / 3 Mbps up with 10 GB data cap for a two-year promotional price of $50/mo. Setup is free, and a modem is an additional $15/mo. However, once the data cap is exceeded, data speeds will be reduced to less than 3 Mbps down for the remainder of the billing period. Additional plan offerings provide larger monthly data caps at higher rates, but offer no improvements in speed.

- **Exede** offers a basic plan that provides FCC minimum of 12 Mbps symmetrical with 12 GB data cap for a three-month price of $30/mo, and a two-year contract commitment at $50/mo. Setup is free, and a modem is either an additional $10/mo, or $300 one-time. However, once the data cap is exceeded, data speeds are reduced to less than 5 Mbps down for the remainder of the billing period, or even slower for evening usage. Additional plan offerings provide larger monthly data caps at higher rates, but offer no improvements in speed.

Provider	Monthly Recurring Cost	Installation Fee	Speeds
Charter/Spectrum Cable	$45 for first year; $65 regularly	None	Up to 300 Mbps
Frontier Fiber	$40 for two year promo	$5 Modem Fee	150 Mbps
Frontier Fiber	$30 for two year promo	$5 Modem Fee	100 Mbps
Frontier Fiber	$25 for two year promo	None	30 Mbps
Frontier DSL	$50 for two year promo	None	50 Mbps Symmetrical
AT&T	$40 for first year; $70 regularly	$99 with modem and Wi-Fi	50 Mbps w/ 1000 G Monthly Data Cap
Windstream	$60 plus $10 monthly for modem	$85 for professional; $50 for self-install	25 Mbps Symmetrical
Windstream	$70	None	50 Mbps Symmetrical

Figure 31. *Terrestrial Service Provider Offerings to Residents*

FINAL	Technology	Pct Area Covered	Offered Speed (Mbps) (down / up)	Promo Price (MRC)	Promo Term (mos)	Regular Price (MRC)	Data Cap (Gb)	Other One-time Costs	Other Recurring Costs (MRC)	Comments
Terrestrial										
Spectrum	Cable	100	100 / 10	44.99	12	64.99	N/A	49.99	5.00	Modem included Router provided by Customer, or $5 MRC
Frontier	DSL	96	12 / 1.5	25.00	24		N/A	N/A	5.00	Modem w/ WiFi MRC; Includes one year Amazon Prime.
Frontier	DSL	96	18 / 1.5	30.00	24	35.00	N/A	N/A	5.00	Modem w/ WiFi MRC; Includes one year Amazon Prime.
Frontier	Frontier FiOS (Verizon)	< 60	30 / 30	24.99	24	30.00	N/A	75.00	N/A	$50 Amazon Gift Card; Modem w WiFi included
Frontier	Frontier FiOS (Verizon)	Varies	100 / 100	30.00	24	35.00	N/A	75.00	N/A	One year of Amazon Prime; Modem w WiFi included; Installation paid over three months
Frontier	Frontier FiOS (Verizon)	Varies	150 / 150	40.00	24	45.00	N/A	75.00	N/A	One year of Amazon Prime; Modem w WiFi included; Installation paid over three months
ATT	Fiber	< 5	50 / 50	40.00	12	70.00	1000	99.00	N/A	One-year term w/ $180 early termination fee; Modem w WiFi included
ATT	Fiber	< 5	100 / 100	60.00	12	80.00	1000	99.00	N/A	One-year term w/ $180 early termination fee; Modem w WiFi included
ATT	Fiber	Varies	1000 / 1000	80.00	12	90.00	N/A	N/A	N/A	One-year term w/ $180 early termination fee; Modem w WiFi included
Windstream	DSL	< 5	25 / 25	60.00	12	80.00	N/A	50.00	9.99	"Free" self-installation; Professional installation additionl $35; $100 bill credit offered;
Windstream	DSL	< 5	50 / 50	70.00	12	90.00	N/A	N/A	9.99	"Free" self-installation; Professional installation additionl $35; $100 bill credit offered;

Notes:

1. Pricing data based on current offerings. Subject to change and modification without notice.
2. Availability at specific service addresses may vary. Subject to change and modification without notice.
3. All prices exclude taxes, surcharges, other fees.

Bundled Services	Technology	Pct Area Covered	Offered Speed (Mbps) (down / up)	Promo Price (MRC)	Promo Term (mos)	Regular Price (MRC)	Data Cap (Gb)	Other One-time Costs	Other Recurring Costs (MRC)	Comments
Spectrum Triple Play	Cable	Varies	100 / 100	89.97	12	149.97	N/A	N/A	N/A	Internet; Spectrum TV Select; Phone service; Modem included
Spectrum Triple Play	Cable	Varies	100 / 100	79.98	12	119.98	N/A	34.99	N/A	Internet; Spectrum TV Select; no phone Modem included
Frontier Triple Play	Fronter FIOS (Verizon)	Varies	75 / 75	70.00	12	114.99	N/A	N/A	N/A	Internet; FIOS TV Prime; FIOS Digital Voice; Modem included
Frontier TV / Internet	Fronter FIOS (Verizon)	Varies	75 / 75	65.00	12	114.99	N/A	N/A	N/A	Internet; FIOS TV Prime; FIOS Digital Voice; One year of Amazon Prime; Modem included
ATT TV and Internet	U-Verse TV	Varies	50 / 50	65.00	12	109.00	N/A	N/A	N/A	Internet; ATT U-verse TV; 2-year term; $180 early termination fee; $250 reward card for online orders; Modem w WiFi included.
ATT TV and Internet	DirecTV	Varies	50 / 50	65.00	12	106.00	N/A	N/A	N/A	Internet; DirecTV; 2-year term; $180 early termination fee; $250 reward card for online orders; Modem w WiFi included.

***Figure 32.** Commercial Offerings*

Satellite										
HughesNet	Satellite	100	25 / 3	49.99	24	59.99	10	N/A	14.99	Contract term 2 years; 50 GB data free (2AM - 8AM); Once data cap hit, speeds of 3 Mbps or lower
HughesNet	Satellite	100	25 / 3	59.99	24	69.99	20	N/A	14.99	Contract term 2 years; 50 GB data free (2AM - 8AM); Once data cap hit, speeds of 3 Mbps or lower
HughesNet	Satellite	100	25 / 3	79.99	24	99.99	30	N/A	14.99	Contract term 2 years; 50 GB data free (2AM - 8AM); Once data cap hit, speeds of 3 Mbps or lower
HughesNet	Satellite	100	25 / 3	99.99	24	129.99	50	N/A	19.99	Contract term 2 years; 50 GB data free (2AM - 8AM); Once data cap hit, speeds of 3 Mbps or lower
HughesNet	Satellite	100	25 / 3	69.99	24	99.99	35	N/A	19.99	Contract term 2 years; 25 GB daytime data included; 10 GB data anytime; Once data cap hit, speeds of 3 Mbps or lower
ViaSat / Exede	Satellite	100	12 / 12	30.00	3	50.00	12	N/A	9.99	Contract term 2 years; Once data cap hit, speeds of 5 Mbps or lower; Modem $9.99 MRC, or $299.99 one-time
ViaSat / Exede	Satellite	100	12 / 12	50.00	3	75.00	25	N/A	9.99	Contract term 2 years; Once data cap hit, speeds of 5 Mbps or lower; Modem $9.99 MRC, or $299.99 one-time
ViaSat / Exede	Satellite	100	12 / 12	75.00	3	100.00	50	N/A	9.99	Contract term 2 years; Once data cap hit, speeds of 5 Mbps or lower; Unlimited data from 3AM - 6AM; Modem $9.99 MRC, or $299.99 one-time
ViaSat / Exede	Satellite	100	25 / 25	100.00	3	150.00	N/A	N/A	9.99	Contract term 2 years; Once 150GB data, data prioritized behind other customers during congested periods; Modem $9.99 MRC, or $299.99 one-time
ViaSat / Exede	Satellite	100	15 / 4	99.99	3	75.00	20	299.99	N/A	Contract term 2 years; Modem included.

***Figure 32 Continued**. Commercial Offerings*

3.8 Community Anchor Institutions

Local governments and public organizations like schools, hospitals, libraries, responders, civic organizations - all considered "community anchor institutions" - must strive to work smarter and more efficiently through technology. To succeed and grow, community and social support organizations must thrive as well. These types of community institutions, whether volunteer, faith- or cause-based, must be the reliable go-to organizations for the needs and interests of the community to be represented and served.

Broadband plays a vital role in helping anchor institutions fulfill their missions, allowing them to communicate and access local information. Broadband equips these organizations with the tools necessary to ensure they operate efficiently, helping to organize and enable staff and leadership of budget-conscious organizations to be successful in the execution of their important roles in the community.

3.8.1 Economic and Community Development

Overall, the technology needs Manhattan Beach faces are similar to basic community and economic development challenges present in many other cities: maintain and enhance attractive and viable neighborhoods, retain existing companies, attract new companies, and create more jobs.

The technology needs of the community anchors are growing. While broadband is available, many institutions are concerned about the price of services, the bandwidth speeds available, and the reliability of the technology offered by commercial providers. More recently, they are also concerned about net neutrality rulings. Throughout this study, these stakeholders expressed a shared commitment to support Manhattan Beach in efforts to bring abundant, affordable bandwidth to the city.

Broadband is also a powerful economic enabler. The City seeks to understand frameworks for network infrastructure investment, within current local, state and federal policy to ensure optimal return on investments. A master technology plan for how new technologies change development, maintenance, and permitting processes for cities should consider various broadband solutions for communities. Tremendous benefits could result for citizens from improving government and service provider partnerships.

3.8.2 Healthcare and Social Services

Broadband is expected to transform healthcare through the use of electronic health records to securely share personal health information while improving access to medical professionals and specialists by eliminating the need to visit specialist facilities. Broadband will simultaneously enable better outcomes and lower costs for internal operations of the practice, more efficient diagnostics, and the patient care side through telehealth. The National Broadband Plan says that Electronic Health Records and Remote Monitoring technology alone could save over $700B over 15-25 years.[15]

Beyond the cost aspects, using telehealth is a viable way to revolutionize patient care. The American Medical Association (AMA) believes that the appropriate use of telehealth applications to deliver care to patients could greatly improve access and quality of care while maintaining patient safety and eliminating logistics regarding geography and transportation.

In 2014, the AMA created guiding principles[16] for ensuring the appropriate coverage of telehealth services that state:

- Telehealth provided over robust broadband networks can facilitate immediate diagnoses and care to prevent lasting damage to stroke victims, prevent premature births, and deliver psychiatric treatment for patients in underserved rural areas.

---

[15] http://www.broadband.gov/issues/healthcare.html

[16] https://download.ama-assn.org/resources/doc/hod/x-pub/a14-cms-report-7.pdf

- Telehealth is viewed as a cost-effective alternative to the more traditional face-to-face consultations or examinations between provider and patient.
- Similar to regular small businesses, rural clinics and small physician's offices have the same price sensitivity to broadband, which is often priced beyond their means or altogether insufficient to support their health IT needs.

For patients, remote access to healthcare offers major advantages over traditional methods of delivery. Obviously, broadband to the patient's home is the enabler of all telehealth benefits. At the top of this list is making certain types of care more accessible for those who struggle to get to distant medical facilities, especially the elderly and the poor, for whom services offered by commercial service providers are too expensive.

3.8.3 Government and Public Services

Fiber-optic networks provide a public infrastructure that can be used for an assortment of public benefits, including enhanced municipal management and service offerings, as well as new e-government applications that support interdepartmental collaboration, increasing efficiency while reducing costs. In addition, fiber provides a platform for long-term adoption and smart community innovation, ranging from applications for energy management to enabling a community-scale platform for the Internet of Things (IoT).

City departments need access to information to serve the needs of the public as efficiently and effectively as possible. These organizations need access to networks that let them share streaming real-time video, detailed maps and blueprints, high resolution photographs and other files. Mobile technology capable of sending and receiving bandwidth-intensive information can help all local departments, specifically coordinating the central roles of police, fire, and emergency medical services during emergency response. Consider how much more effective fire services would be if maps and floor plans of the target destination were delivered to emergency vehicles en route, and available prior to arrival on scene.

Demands on the City's network are growing consistently. As these new systems make governmental services more effective and efficient, city government needs more bandwidth and greater connectivity to better serve citizens and visitors. The City of Manhattan Beach is interested in stakeholders' needs and opportunities in part because it needs to grow and continually improve its internal information infrastructure.

4. Manhattan Beach Fiber Opportunities Assessment

This section begins by providing information about the current federal and state regulatory environment and the policies that have shaped the state of broadband in Manhattan Beach. An important objective of Manhattan Beach in deploying a municipal fiber-optic network is to address many of the important broadband deficiencies detailed in the needs assessment. Building off both those findings, this section establishes a framework for assessing broader opportunities regarding fiber infrastructure investments.

Because the mission of the City is different than that of any competitive ISP that would serve households and businesses in Manhattan Beach, the actions of the City can have a tremendous social and economic impact. The "off balance sheet" benefits of the improved connectivity are far reaching.

- **Increase Broadband Adoption and Utilization**
  Broadband adoption is influenced by two key factors: relevancy and affordability. Manhattan Beach can improve both affordability and relevancy for residents and businesses by making measured investments in infrastructure. Affordability and adoption of broadband services are positively correlated – as adoption increases, so does affordability.

- **Enhance Economic Development**
  Increasing the availability of fiber-based services into business corridors and parks will allow the City to enhance its economic development message regarding broadband capabilities. Through the deployment of fiber distribution technology, communities and business parks in Manhattan Beach can designate these areas as being a "Gigabit Community," allowing any business moving to Manhattan Beach to recognize that fiber services are readily available at very competitive rates. This, partnered with data center facilities, would provide the message that a business can locate anywhere in Manhattan Beach and have broadband as good as anywhere in the world.

- **Improve Public Efficiency and Effectiveness**
  Leveraging new fiber assets to connect public institutions throughout the City creates opportunities to establish collaborative technology programs across multiple organizations. Establishing institutional access to the City's conduit and dark fiber networks would create an inter-governmental backbone through which public organizations across the City and county can collaborate on projects and initiatives. Connecting schools, libraries, local governments, public safety agencies, and community organizations to one another will facilitate the sharing of technology resources among the organizations. Some of the benefits include cost reductions through joint volume purchasing agreements, file and application sharing, reduction in duplication of effort, efficiency in handling multi-departmental approval or permitting processes, and improvements to emergency response and communications.

- **Improved Government Efficiency**
  Improving public efficiency and effectiveness helps reduce government expenses. The Manhattan Beach broadband initiative can become a tool that facilitates cost reductions, not only for the City itself but also for schools, libraries, and community organizations. The network can also "future proof" the connectivity needs of these agencies and protect them from cost increases as they grow and require additional bandwidth. Plus, the money that residents and business save can be spent elsewhere in the City and monthly revenue for operating the network will stay local, rather than being paid to existing providers.

- **Support Reliability and Performance**
  Prospective new businesses are negatively impacted by lead-times that delay activation of their new services. The time to activate new customer broadband services is significantly determined by the

availability of existing infrastructure in the area around the new customer. Having more fiber infrastructure throughout the City close to any potential new customer premise supplements broadband service provider infrastructure to reduce lead times to become connected.

Joint Trenching and Dig Once

A primary element of this broadband initiative is installation of conduit. Installation of fiber-optic conduit during all projects involving roads, sidewalks, trails, or lighting projects where the ground is to be opened for any other purposes would be less costly than installing conduit through standalone broadband projects. Additionally, the City could work with companies deploying infrastructure to install additional conduit, inner duct, or fiber with those projects for use by the City. Some cities acquire ownership to fiber strands within providers' fiber cables in lieu of permit fees.

Joint trenching and Dig Once policies can facilitate more opportunities to install conduit, fiber, and other infrastructure due to lower costs. Standardization of these agreements across all potential owners of underground infrastructure can be established to ensure all parties are aware of the joint trenching opportunities as they become available. Installations should be coordinated between all relevant parties as a basic element within the projects.

The City of Manhattan Beach has already adopted broadband-friendly policies including Dig Once to ease the capital and resource expenditures in expanding its fiber assets. These policies will help as the City determines projects in which the opportunities can be seized to lay conduit and fiber.

The City also requires conduit in private developments and buildings. Basic conduit infrastructure can be added to development projects, again, for a minimal cost, and will allow those buildings and properties to be considered "fiber-ready."

Engineering Standards

Engineering standards support and simplify management and operations. They ensure that infrastructure deployed at different times, in different locations, and by different entities is consistent and functional. Generally, the City should adopt standards based on input from knowledgeable stakeholders, and then operations staff should assure the standards are met.

Standards include contracts and operating procedures, as well as details around specific network facilities, and even specify the order of the spatial placement of underground cables. The number of standards increases with service offerings, and there is no shortage of issues and resources that should be standardized. This policy should also be coordinated with utilities operating in the region, broadband providers, and underground utility organizations.

GIS and Infrastructure Record Keeping

As part of the implementation of broadband-friendly policies, Manhattan Beach already requires that Geographic Information System (GIS) documentation of all broadband infrastructure installations, upgrades, and other items be maintained and updated.

This allows the City and agencies that may collaborate to maintain a clear understanding of locations of the broadband infrastructure such as conduit, vaults, pull boxes, transitions, fiber-optic cable, and other outside plant resources. Magellan recommends that the City continue to follow these procedures to allow for continued efficiency of asset management.

Manhattan Beach has already acted upon implementing public policies to enhance its autonomy in the future of broadband. Further information on best practices in public policy can be located in Appendix B.

5. Conceptual Network Design and Deployment

Based on our Market and Needs Assessment analysis, Manhattan Beach could benefit greatly from the adoption of a City-owned fiber-optic network. This network would support City services, as well as residential, business and anchor broadband, and it would be the foundation for Smart City initiatives and IoT devices of the future.

In contemplating a network design, we start with a set of “requirements” that are based on the market needs assessments and desires of City stakeholders. This set of requirements dictates what the network design and build will ultimately achieve incuding:

1. Provide FTTH solutions delivering multi-gigabit, affordable broadband services to every home within the City.
2. Provide a fiber-based network to support the business and anchor institutions with robust broadband solutions.
3. Provide a network for connecting all City facilities thus enabling more efficient and cost effective delivery of City services.
4. Provide a network that supports Smart City, 5G vertical attachments and the Internet of Things.

It is important to understand the various physical network components and their functions that, together, create a fiber-optic network and municipal broadband utility. This section provides a high-level overview of the functional requirements used to prepare the conceptual FTTH design and cost estimate for the Manhattan Beach financial model. Please note, all fiber is proposed to be underground based on the assets available to the City and the difficult challenges with entering into use agreements with utilities for pole space.

5.1 Network Architecture Overview

The proposed fiber network consists of three separate groupings of technology that must be negotiated with various vendors and service providers before they can be deployed into the community. As shown in Figure 33, these groups include the central office, the feeder/distribution network, and the fiber drops that connect the network to subscriber homes and businesses.

Hub Sites

The entire Manhattan Beach network would be connected to the internet through what is known as a hub, or "headend." The hub contains networking equipment securely housed and maintained in a physical data center environment. As the name suggests, the physical location of the central office is usually along two or more routes of the internet backbone into and out of

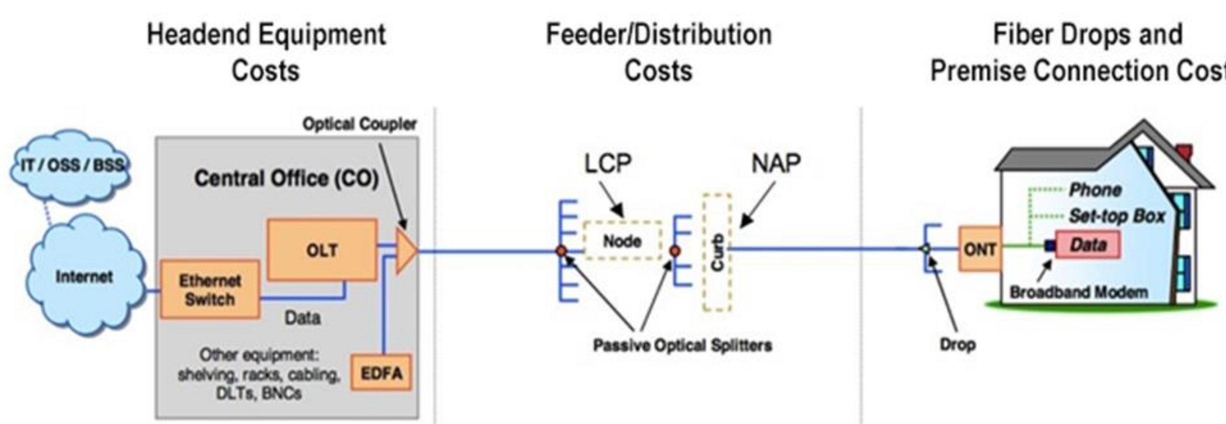


Figure 33: Network Architecture

the service area to act as the convergence points of inbound network traffic. The headend functions through a collection of network switches, routers and electronic devices to send and receive data between the internet and customers across the network. The facility needs to be clean, secure, air conditioned, have appropriate rack space and power. Back-up systems should also be implemented as this network will provide critical communications for the entire community.

Backbone Node(s) Data Center/Equipment Shelter

The highest level of physical network resiliency for the City's network will require diverse fiber paths into the City's data center. This requirement for fiber diversity has been incorporated in the OSP backbone design. A visual is provided in Figure 34.

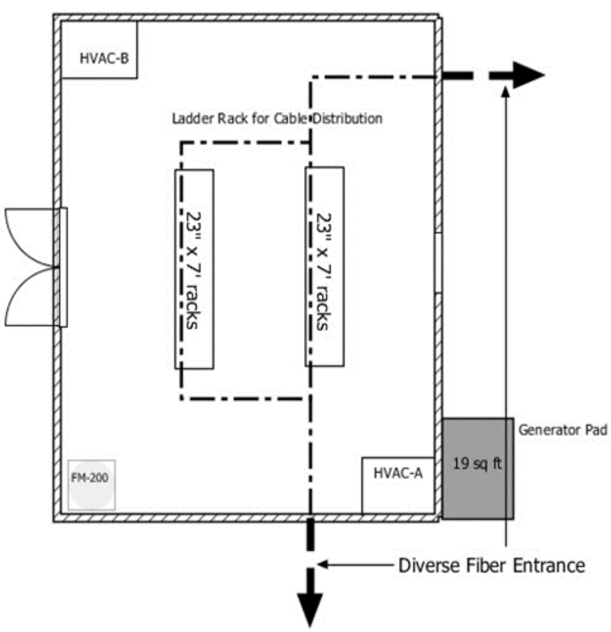


Figure 34: *Data Center Design Layout*

Backbone fiber will enter the data center facility through multiple entrances and route to enclosures, which will allow breakout of individual fiber strands to a distribution panel mounted in a 7'h x 23"w rack assembly. Additional racks will contain carrier Ethernet equipment, power distribution, environmental monitoring, and cable management equipment. The backbone cables that terminate within the City's data center will be high-count (at least 288 count), and will transport various network connections back to the core network. The data center, and any future nodes, will contain appropriate cooling, humidity control, and clean agent fire suppression equipment (in addition to the carrier Ethernet equipment). A generator of appropriate capacity should be available to maintain backup power for a minimum of four (4) hours in the event of a power outage.

Based on final network architecture specs, and final design engineering, the City may decide to deploy additional backbone node facilities. These additional facilities would be 10x10 prefabricated shelters, and would house additional carrier Ethernet equipment that would extend lit transport services deeper into the community, and most importantly, provide new levels of active electronic resiliency. Each node would form a core node that is interconnected to the City's backbone. These locations would also function as aggregation points for local network connections. These locations would be capable of functioning as network access locations for future residential FTTH services.

Network Management

The City should deploy a software system to provide comprehensive fault, configuration, accounting, performance, and security (FCAPS) management of the network elements and operation. The selected equipment vendor should provide a compatible FCAPS system that integrates transparently with their hardware and software. An integrated network management platform has been included in the project's design and capital budget.

Feeder/Distribution Network

To reach customers, data moves out of the data center across fiber-optic cables as waves of light and into the community across a network of fiber-optic cables that are buried underground. The network of fiber-optic cables that spread throughout the community is known collectively as the Feeder and Distribution network.

As the name suggests, this portion of the network feeds the waves of light from the data center into neighborhoods throughout the City. With the Manhattan Beach conceptual design, City facilities act as network nodes throughout the City. As the fiber-optic cable passes through a neighborhood, the fiber-optic cable connects to the Local Convergence Point (LCP), which can be either located inside a facility or inside a cabinet in the field. From this node, the optical signal is split and distributed into up to 32 different connections from the Network Access Point (NAP). It is from the NAP that the final connection is made into customer premises.

5.2 Outside Plant Build Specifications

Most of the network in Manhattan Beach will be deployed using underground facilities. Aerial facilities were not considered because they are highly dependent on pole segments owned by other utilities. The long-term leasing costs for space and the pole load assessments and/or replacement that may be required were not desirable. With underground placement, the specifications are more defined and standardized, as summarized in Figure 35.

Fiber Drops

To reach the individual customer, connections are made via "fiber drops," which refers to the collective equipment and processes to physically connect customer premises to the NAP via fiber-optic service lines. At the home or business, the fiber enters the home at the Optical Network Terminal (ONT), typically mounted near or with the utility meter on the side of a building. From there, the customer may connect their own wired or wireless networking equipment for sharing the connection with computers, phones, and appliances.

5.3 Conceptual Network Design

The network architecture described in the previous section summarizes to the conceptual design for Manhattan Beach's central office and the fiber routes for the feeder and distribution network. A conceptual network design for Manhattan Beach would include the high-level outside plant design for the feeder and distribution network to connect the headend backbone throughout the service area to the NAP.

The conceptual design includes all fiber-optic components from integration with the backbone network through fiber distribution hubs and out to pedestals within the service area. Components of the design include:

- Underground placement requirements;
- Fiber-optic routes in established ROW with distance and slack;
- Location of vaults, hand-holes and pedestals, along with their sizes and quantities;
- Placement of fiber distribution hubs, sizes and quantities;

Basic Fiber Specifications	Basic Conduit Specifications
• Backbone cable size – 288 count fiber • Lateral cable size – 12/24 count fiber • Single mode, loose-tube cable • Jacketed central member • Outer polyethylene jacket • Sequential markings in meters • All dielectric • Gel-free/dry buffer tubes • 12 fibers per buffer tube • Color coded buffer tubes based on ANSI/TIA/EIA 598-B Standard Color	• 36” minimum acceptable depth • 2” HDPE smooth wall reel-mounted pipe depending on application • Warning tape installed at 12” or 18” • Maximum fill ratio of 50% • Maxcell or smaller innerduct • Vault placement at intersections, every 500ft in commercial corridors • Vaults sized appropriately to house underground lid-mounted pedestals and splice enclosures

- Splitter configuration and density within fiber distribution hubs;
- Fiber-optic splice points, splice cases, and splicing;
- Fiber-optic termination locations, sizes, and quantities; and
- Equipment locations and requirements.

5.4 Fiber to the Premise Conceptual Network Design

The network architecture for the City of Manhattan Beach divides the City into seven zones (Figure 36). Each zone will have a detailed design, construction and conceptual build out plan outlined. [Note: This is still a conceptual design; for a detailed design, a more in-depth plan will have to be completed.]

Figure 36: *Fiber-to-the-Premises Conceptual Network Design*

6. Manhattan Beach Fiber Business Models

Manhattan Beach is now ready to consider feasible broadband deployment and operations strategies. As such, the City seeks to gain an understanding of its business options by building knowledge of prevailing broadband concepts and business models. These models draw from a spectrum of broadband programs that have been implemented by cities over the past 20 years.

In considering models for Manhattan Beach, Magellan analyzed several proven business models that are available to with the City. Figure 37 below illustrates the prevailing roles that municipalities typically play in fiber infrastructure deployments in the U.S. The analysis in this chapter and through the remainder of this report will discuss the opportunities for Manhattan Beach fiber network deployment and operation.

As shown in the table, the City of Manhattan Beach has a range of options for investing in, owning, and utilizing fiber-optic infrastructure. It is the desire of the City to consider a Full Retail Provider model by building and owning a network that can deliver 21st century services to all residential, business, anchor and City facilities. This next section explores some of the decisions that feed into the determination of the business model that would best fit Manhattan Beach.

	Policy Only	Infrastructure Only	Public Services Provider	Open Access Provider	Business Provider	Full Retail Provider
		THESE INVOLVE SOME FORM OF PARTNERSHIP WITH A PUBLIC OR PRIVATE ENTITY				
Services Provided	None	Dark Fiber Only	Dark Fiber, Data Transport, Internet, Phone	Dark Fiber, Data Transport	Internet, Phone, Value-Added Services	Internet, TV, Phone, Value-Added Services
Customers	None	Broadband Providers	Public Entities Only	Broadband Providers	Businesses & Anchors	Households, Businesses & Anchors
Funding Required	Low	Moderate	Moderate	Moderate	High	High
Complete with Private Sector	None	No	No	No	Yes	Yes
Operational Requirements	Low	Low	Low	Moderate	High	Very High
Regulatory Requirements	Low	Low	Low	Moderate	High	Very High
Revenue Generation	Low	Low	Low	Moderate	High	Very High
Operational Costs	Low	Low	Low	Moderate	HIGH	Very High
Financial Risk	Low	Low	Low	Moderate	High	Very High
Execution Risk	Low	Low	Low to Moderate	Moderate	High	Very High

Figure 37: *Potential Manhattan Beach Fiber Business Models*

The scale of financial investment required for fiber-optic infrastructure is comparable to other public infrastructure projects, such as roads, water and sewer. The longevity of fiber as an investable infrastructure asset is also comparable, with a life-cycle that extends well over 30-50 years.

Fiber is "future proof" - its value as an asset will only increase along with its economic importance. As such, fiber can serve many uses for every person and organization in Manhattan Beach. Without question, investing in fiber infrastructure today positions the City to offer an array of broadband services now and well into the future.

The Full Retail Provider model affords the provider full control of the network. It also allows the City to become competitive in the retail broadband market, offering a wide array of services and opportunities. Other options, such as Public Services Provider, Open Access Provider, and Business Provider models all require the City to enter some form of public or private partnership to fulfill a determined role in the operation of the network. They also limit total control of the network and/or cost structure and profit.

A Model Built Around Need

Based on analysis of the existing broadband telecommunications market in Manhattan Beach, much of the broadband infrastructure owned and operated by incumbent providers is based on technologies that deliver services over copper-based/coax networks with some growing fiber solutions. For many areas of Manhattan Beach, service providers simply have not been able to justify the capital investments necessary to upgrade their infrastructure. Although the strategy must be unique to Manhattan Beach, certain truths are consistent across most initiatives.

In consideration of the outcomes of the Needs Assessment portion of this study in the context of possible business models, there are a number of ways the City can participate in the broadband ecosystem. These possible roles are detailed in Appendix C and are listed in order of complexity, starting with the continuation of simply being a broadband consumer of available services, all the way to Manhattan Beach becoming a provider of full retail services to households and businesses. Many of these options are not exclusive of each other, meaning that the City could take on multiple roles as applicable.

6.1 Potential Business Models for Manhattan Beach

Given the current economic and competitive broadband environment, Magellan has narrowed the exploration of business models to three fiber business models: Fiber-to-the-Premises, Public Services Provider, and a Joint Ownership Model around a Public-Private and/or Public-Public Partnership.

The broadband team has determined the full retail model may be the best option for Manhattan Beach and has focused on this model in its assumptions. In discussions with City staff and the broadband team, and based on the community feedback received, there is support for Manhattan Beach to consider the full retail model by offering services directly to the end users for both retail and businesses. The City can outsource much of the day-to-day operations, including customer support, installations and network maintenance.

A Word About Open Access Models

During the development of this Fiber Master Plan, much discussion was shared regarding Open Access, and those considerations should be acknowledged here. A paramount vision of true Open Access is for an entity, like a municipality or a utility, to own and maintain the entire fiber network while allowing all service providers to connect to the municipal network and compete for customers on an even playing field. While many cities have tried the Open Access business model, it has been met with mixed results.

There are several reasons why Open Access is a challenge, and many of those reasons also apply to Manhattan Beach. For one, a lot of fiber needs to be built in Manhattan Beach, and while the City's tolerance for debt is more long-term than most service providers, the City needs to look at its total financial picture to determine if it wants to rely on service providers to help with the payback, with limited profit.

While there is a possibility that additional retail service providers may enter the market because of the dense customer base, it is unlikely the market will be able to support all of the entrants over the long term. It is more likely that one or two providers will gain market share and eventually dominate the market, and in a true open network marketplace, service providers compete on service levels and customer service, with high price sensitivity.

Is Open Access really an attractive long-term arrangement? Why not just form a partnership with two or more service providers from the start? While Open Access can be an eventual goal, the need for shorter-term ROI makes Open Access unattractive for retail providers because sharing revenue is difficult or unsustainable for both the private partner and the City.

Public Services Provider Model

More and more cities are exploring the option of becoming a partial retail provider of broadband services. Moreover, they view fiber-based services as no longer something provided by the private sector, but rather as a required public-owned utility, just like water, sewer and power. Under this model, the City would look to meet its own needs through direct fiber connectivity to all local government sites and community anchors, and then leverage its investment by leasing dark fiber connectivity to retail service providers who would sell retail broadband services to residents and business.

The City would likely seek a retail partner or partners to build the final "last mile" connections of fiber from community anchors and community network nodes to homes and business.

Public Services Provider	Joint Ownership	Fiber To The Premises
Manhattan Beach owns network and provides fiber to community anchors and sells dark fiber to retail service providers.	Manhattan Beach jointly owns the network with retail partner or partners. City provides fiber services to community anchors.	Manhattan Beach fully owns network and provides fiber services to every home and business and community anchor in the city.
As an Open Access IRU network, the fiber infrastructure would be owned by City and open and available to retail providers for use under an "*Indefeasible* Right of Use" to increase competition and help broadband services become widely available.	A Public-Private or Public-Public Partnership supported by shared revenue. All partners would jointly build, own, and maintain the network. Partner would own from the node to the customer premise and would be the retail broadband service provider.	City builds, maintains, and owns a fiber network through entire city and provides a full offering of retail broadband services, including gigabit internet access, voice service, with potential for television to every household, business, and community anchor institution.
Pros: Shared financial responsibility. ISP owns customer relationship including billing, customer support and marketing Cons: Many ISPs do not like this arrangement, so often results in limited competition. Control over marketing, pricing and competition is limited. See Open Acccess Models below.	Pros: Shared financial liability; partner generally expert in these networks Cons: Shared control results in potential loss of flexibility of network options Partnerships are often difficult	**Recommended** Pros: Complete network control over costs, marketing and services provided Cons: Expensive. Sometimes outside of City expertise

Figure 38: *Three Discussed Business Models for Manhattan Beach*

Once deployed, the City can use some of its dark fiber to provision bandwidth for public Wi-Fi for its citizens and visitors. Under the Public Service Provider model, the City would be in a position to offer retail broadband services in the event the private providers do no take advantage of the City's favorable lease rate. However, discussions with local service providers have shown a strong willingness to work with the City and investment funds that could be allocated to expand fiber in locations where it makes sense.

Joint-Ownership Model

The Joint Ownership Model allows the potential pooling of capital and risk, sharing of expertise and resources, and leverages new network builds to do more at a lower cost. Using long-term lease agreements allows for individual ownership (not shared ownership) of strands of fiber in the cable by the strategic partners on their own behalf.

Local governments and service providers can have "joint ownership" of network assets through Indefeasible Right of Use (IRU) and "co-location" agreements. For example, if the City is not happy with a service provider partner's network management for some reason, it can bring another operator on board, or even decide to manage the network on its own without affecting the other partners.

Fiber strands can be swapped under IRUs as well, or there can be an upfront payment or even recurring payments of the term. The IRU is flexible in that it can be customized to specific situations as agreed upon by the partners. An IRU is an actual capital lease booked as an asset on the balance sheet and amortized over the term of the agreement.

California cities may lease conduit or fiber in their existing or planned fiber-optic networks in the same way that service providers do, and they may coordinate new deployment plans to meet their mutual interests. In this way, cities and service providers can pool existing and planned fiber and duct to fill their own infrastructure gaps at low cost and intelligently plan new infrastructure in a synergistic way to accelerate broadband expansion for themselves and the greater community.

"Pre-construction" IRUs can sometimes represent the lowest possible cost of new deployment. For example, if a city plans to build a new route to a remote site, and a strategic service provider partner wishes to connect to sites reasonably close by, the route design could be altered to allow for fiber leasing to the service provider to expand service into a larger area.

Conversely, if the service provider intends to build fiber to expand service into a new area, and the City has a planned site in the general area (such as an economic development site), the route can be tailored to allow the City to lease fiber from the service provider for the City's use. The dollars contributed for pre-construction IRUs lower the cost of deployment for both parties and accelerate broadband expansion to a larger area.

Another way that cities and service providers can co-invest is through Dig Once policies, whereby a service provider must allow co-location when trenching in City rights-of-way, and the City installs duct at its own expense, or vice-versa, such as when a City is expanding a road and a service provider installs duct. In this way, both the City and the service provider have invested dollars to meet their own needs as well as the needs of the community.

There are other ways that the City and a service provider partner can accelerate broadband infrastructure by sharing assets, resources, buying power, contacts, and expertise. Cities may issue bonds or levy special taxes to pay for city-owned fiber, and leverage a provider's ownership of electronics, facilities and maintenance, and restoration personnel by granting a right of use to a portion of the fibers to the service provider to provision services to the local government and the community. The parties are investing in their own needs and the needs of the community, but not in a public-private venture jointly owned and controlled by both.

To that end, similar to the Public Services Provider model, the City would need to increase revenue opportunities to meet annual bond payments. Lost in the Joint Ownership model is the broader opportunity for dark fiber revenue, as the City would be competing with its private sector partner for dark fiber customers. As such, dark fiber revenue opportunities are more limited.

6.1.1 Fiber to the Premises (FTTP) Model

The financial analysis for the Fiber-to-the-Premises scenario represents a conservative estimate based on requirements for the City of Manhattan Beach to deploy and operate an FTTP network, excluding any potential revenue from dark fiber lease opportunities that may be available to the City. The model also provides revenue projects from offering services to businesses and by leasing vertical assets and backhaul to cellular providers.

We looked at several "like" cities to determine how each model might be applied to the City of Manhattan Beach. Cities that were looked at include Beverly Hills; Santa Monica; Rancho Cucamonga; Chattanooga, TN; Ammon, ID; Longmont, CO; and many others. Some are offering retail FTTH services, while others have elected to be wholesale network providers.

This FTTH analysis for Manhattan Beach assumes that the City would construct, own and maintain the fiber network over which the City would provide retail services to end users. For this "all in" FTTH model, the City would be responsible for the finances and logistics of deploying fiber throughout the City along with core electronics to operate the network. It would also be responsible for outside plant components, customer premise equipment and installation of fiber drops, as well as maintenance and replenishments for electronics. To support the delivery of services, a data center would need to be built, along with core equipment necessary to manage the network.

The revenue portions of the model also assume full retail offerings of internet access; triple play services, such as internet, voice and TV/video are beyond the scope of this project. However, there are 3rd parties that provide these types of services (wholesale) should Manhattan Beach decide they want to offer them. Agreements are available to make this happen. From a financial perspective, it has been our experience that TV service offerings are a break-even business at best. End users are changing the way they get and consume TV content and many are using "over-the-top" services like Netflix in lieu of traditional TV subscription packages, so it may not be prudent to invest in offering typical TV services.

Financial Plan

This comprehensive financial plan provides an outlook for the City Manhattan Beach based on developed forecasts, projected revenues, capital and operational costs, loan funding and debt service for the program. This financial plan provides a model that determines the network's financial performance under a particular set of conditions and assumptions. As Manhattan Beach's business environment and conditions change, the outcomes produced in the model will also change. Therefore, it is important for the City to periodically update the forecast and financial model as business requirements change.

Magellan recommends a quarterly review of the forecast and financial plan for the first 12-month period and during the trial phase to ensure that the assumptions made throughout this project remain valid and the City is meeting its financial obligations.[17]

Assumptions

Each financial figure is based on a set of assumptions as inputs into the model. We have elected to use what we consider to be very conservative estimates for the model and to let the outcomes of those assumptions speak for themselves. All too often, companies try to use unrealistic figures that will support their desired outcome. We have not chosen to do so.

The assumptions that are used are based on best-known-methods from other like projects, with some conservative

[17] As the forecasts and financial models are subject to change, Magellan provides no guarantees that financial outcomes will match those determined in the model. No representation, warranty, or undertaking (express or implied) is made and no responsibility is taken by Magellan Advisors for the merchantability, adequacy, accuracy, or completeness for the model or its assumptions (inherent or explicit). Users of this financial model and its output do so entirely at their own risk and are responsible for performing their own due diligence. The model is a tool that should be utilized to forecast potential financial outcomes at the end users' discretion.

judgement for Manhattan Beach. The model, as built, can be used to test certain sensitivities that help identify risk. For instance, different percentages of take-rate (subscribers) can be tested to see the effect on revenue and net profit. Potential grants that reduce the overall cost to the City could also be modeled.

The assumptions for the model that have been used include:

- **Total Households: 15,000**
  - Take Rate: 40% (6,000) ramped over a 4 year period
  - Price: $85 per month, internet only
- **Total Businesses: 1,000**
  - Take Rate 25% (250) ramped over a 4 year period
  - Prices: $1,295 1Gbps dedicated (10%); $399 1Gbps best effort (90%)
- **Total Anchors and Vertical Assets: 2,000**
  - Take Rate 8% (152)
  - Price: $750 month lease backhaul
- **Network Build:**
  - 3-4 year phased build
  - $52M estimated for for core build
- **Subscriber Connections:**
  - Phased over a 4-5 year period
  - $3,300 per subscriber for last mile and equipment
  - 40% take rate is $20.5M
  - The model does not account for homes that are already underground ready, which would reduce costs

Operation Costs (OpEx)

- All operations could be outsourced with the exception of a broadband manager, sales and marketing, accounting and billing, and field technicians
- Operations including customer support, billing, network montioring and maitenance, installations, network backhaul, upgrades: ~ $1.8M per year for outsourcing

Funding Assumptions

- 20 year term
- 2.5% Iinterest rate
- All funds borrowed. Model does not include any potential grant funds, dig once opportunties, or other funding sources that would reduce costs.

6.1.2 Capital Plan

	Year #	
Feeder & Distribution Fiber Design & Construction		**Totals**
Total Costs		
Year 1 FTTH Buildout	Labor	$ 17,046,347
Year 1 FTTH Buildout	Materials	$ 4,119,549
Year 1 FTTH Buildout (10% Labor and Material)	Materials	
Prep existing RCMU Total		$ 21,165,896
Year 2 FTTH Buildout	Labor	$ 15,713,569
Year 2 FTTH Buildout	Materials	$ 4,602,649
Year 2 FTTH Buildout (10% Labor and Material)	Materials	
Year 2 Backbone Total		$ 20,316,218
Year 3 FTTH Buildout	Labor	$ 6,461,259
Year 3 FTTH Buildout	Materials	$ 1,975,982
Year 3 FTTH Buildout (10% Labor and Material)	Materials	
Year 3 Backbone Total		$ 8,437,241
FTTH Network Design/Engineering (10% Labor and Material)	Materials	$ 500,000
Network Design/Engineering Total		$ 500,000
X	Labor	
X	Materials	
x (10% Labor and Material)	Materials	
Total		
OVERALL TOTAL		**$ 50,419,355**
Premises Connected		
Materials Cost		
Connectorized Drop Fiber Cost Per Passing	Materials	$ 19,206,000
Premise Inside Wiring Per Passing	Equipment	
Other Materials	Equipment	
-		
Equipment Cost		
Optical Network Terminal + Power Supply	Equipment	$ 1,280,400
Residential Gateway	Equipment	
Settop Boxes - 2.5 Per Subscriber @ 245 ea.	Equipment	
-		
Labor Cost		
Drop Fiber Installation, Splicing and Termination Per Passing	Materials	
Premise Equipment Installation Per Passing (2 Hours)	Materials	
Premise Inside Wiring Per Passing	Equipment	

Headend Equipment / PM		-
Core switch routers	Equipment	$ 500,000
Encoders/Transcoders	Equipment	
Fiber termination panels	Equipment	$ 25,000
Firewalls	Equipment	$ 40,000
Internet routers	Equipment	$ 150,000
Intra-facility cabling	Equipment	$ 20,000
Ladder/raceway	Equipment	$ 10,000
OLTs	Equipment	$ 200,000
Racks/cabinets	Equipment	$ 10,000
Switches, servers, storage	Equipment	$ 100,000
IP TV Middleware	Equipment	
Video On Demand	Equipment	
Network Management Systems	Equipment	$ 35,000
Provisioning Systems	Equipment	
Billing Systems	Equipment	
Installation & Project Management	Labor	$ 1,025,000
Subtotal Categories Annual		**Totals**
Feeder & Distribution Fiber Design & Construction		**$ 50,419,355**
Premises Connected		**$ 20,486,400**
Headend Equipment / PM		**$ 2,115,000**
Building Improvements		**$ -**
General Equipment		**$ -**
Wireless Equipment		**$ -**
Cumulative by Year Categories		**Totals**
Feeder & Distribution Fiber Design & Construction		**$ 50,419,355**
Premises Connected		**$ 20,486,400**
Headend Equipment / PM		**$ 2,115,000**
Building Improvements		**$ -**
General Equipment		**$ -**
Wireless Equipment		**$ -**
Subtotal Type Annual		**Totals**
20 Year Lifetime (Materials / Labor)		**$ 70,650,355**
10 Year Lifetime (Equipment)		**$ 2,370,400**
Subtotal Type Cumulative		
20 Year Lifetime (Materials / Labor)		**$ 70,650,355**
10 Year Lifetime (Equipment)		**$ 2,370,400**
Total Annual Capital		**$ 73,020,755**
Total Cumulative Capital		**$ 73,020,755**

6.1.3 Staffing

Manhattan Beach will need to consider staffing requirements for the network. At a minimum, the City will require an internal Network Manager or Telecom Supervisor to oversee and manage the network operation and the greater Broadband Infrastructure Program. In addition, the City should identify an outsourced Network Operator, a partner that would manage all network electronics, service levels, and planned or unplanned maintenance (Figure 39).

All OSP components would be managed from a Fiber Operations and Maintenance (O&M) contract as outlined in this Plan.

Internal and exernal staffing costs have been included in this Plan's financial model. Based on the conservative assumptions below (Figure 41), Manhattan Beach would have cumulative free cash flow at 20 years of $6.9M and over $5M in cash reserves with a gross profit margin of 71% and a net profit margin of 29% (Figure 42).

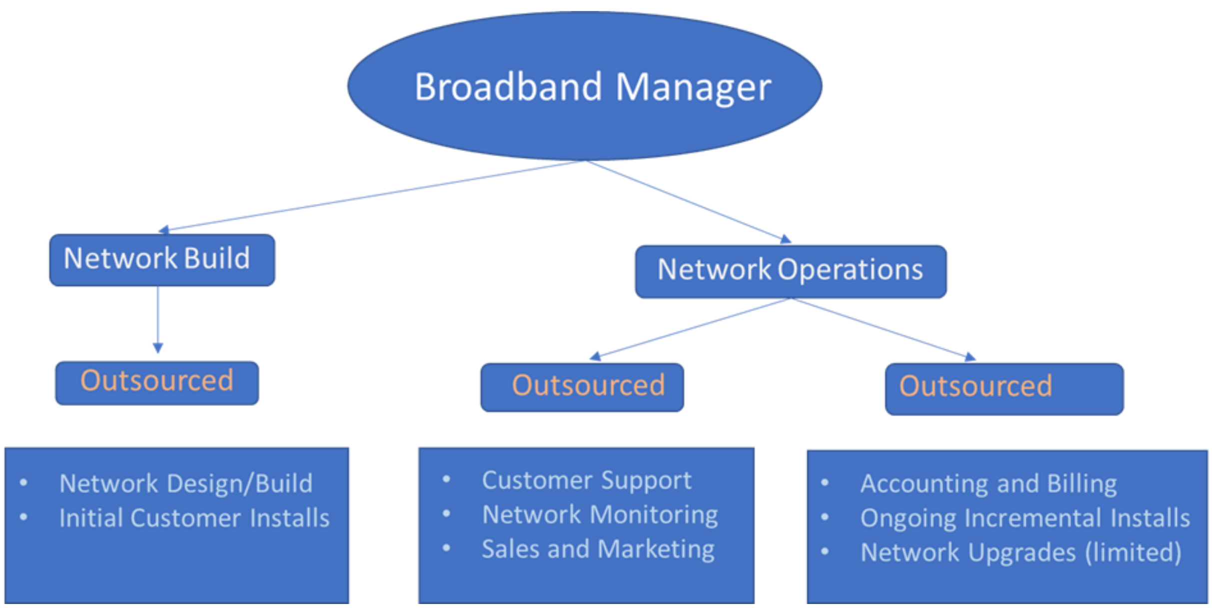


Figure 39: *Full Retail Fiber-to-the-Premise Model*

Core Data Center/Network Equipment	Estimate
Carrier Ethernet Transport	$700,000
Core Routing/Firewalls	$190,000
Network Management/Misc. Equipment	$135,000
Total:	$1,025,000

Figure 40*: Data Center/Network Equipment Cost Estimate*

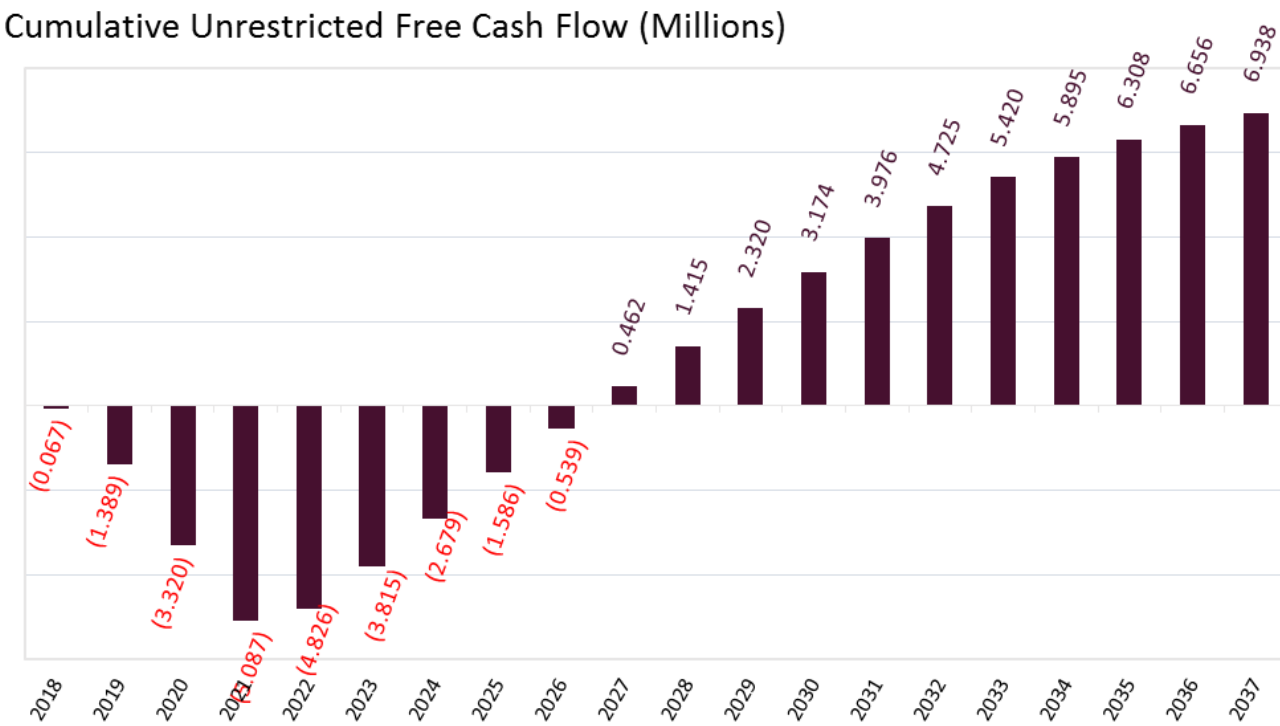


Figure 41: *Cumulative Unrestricted Free Cash Flow*

6.1.4. Reserve Requirements

This Plan identifies three reserve funds for the City's broadband enterprise and calculates the reserves required for each fund on an annual basis. These funds include the following:

- Operating Reserve Fund
- Renewal Reserve Fund
- Capital Expansion Fund

Reserve funding will be required once the network is fully operational and begins to serve customers. The first full year of reserves are scheduled for Year 4. Reserve funding levels were calculated as follows:

- Operating Reserve Fund – .5% of total operating expenses
- Renewal Reserve Fund – .2% of total invested capital
- Capital Expansion Fund –.2% of gross revenue

These initial levels will need to be reviewed and revised periodically but provide a starting point for the City to ensure reserve funding is maintained by the organization. Figure 42 below illustrates reserve fund growth over the 20-year period, accumulating $2 million in Year 10 and nearly $5 million by 2036. Figure 43 represents the Profit Margins over the same period. The capital expansion fund grows significantly over time, as it is tied to revenue growth.

The City should evaluate its long-term capital expansion plans to ensure that there is adequate coverage on an annual basis for the capital expansion fund. If the capital expansion fund is excessive for the capital needs of the program, Magellan recommends it be restructured to be more in line with network's capital expansion plans. The capital expansion fund is utilized here as a set-aside for future capital spending to ensure the network's revenues and future financing will provide coverage for potential capital expansion into more areas throughout the City of Manhattan Beach.

Additional network connections and incremental revenue or cost savings from municipal and community use, including surveillance, Wi-Fi, traffic management and other Smart City initiatives have not been factored into this model.

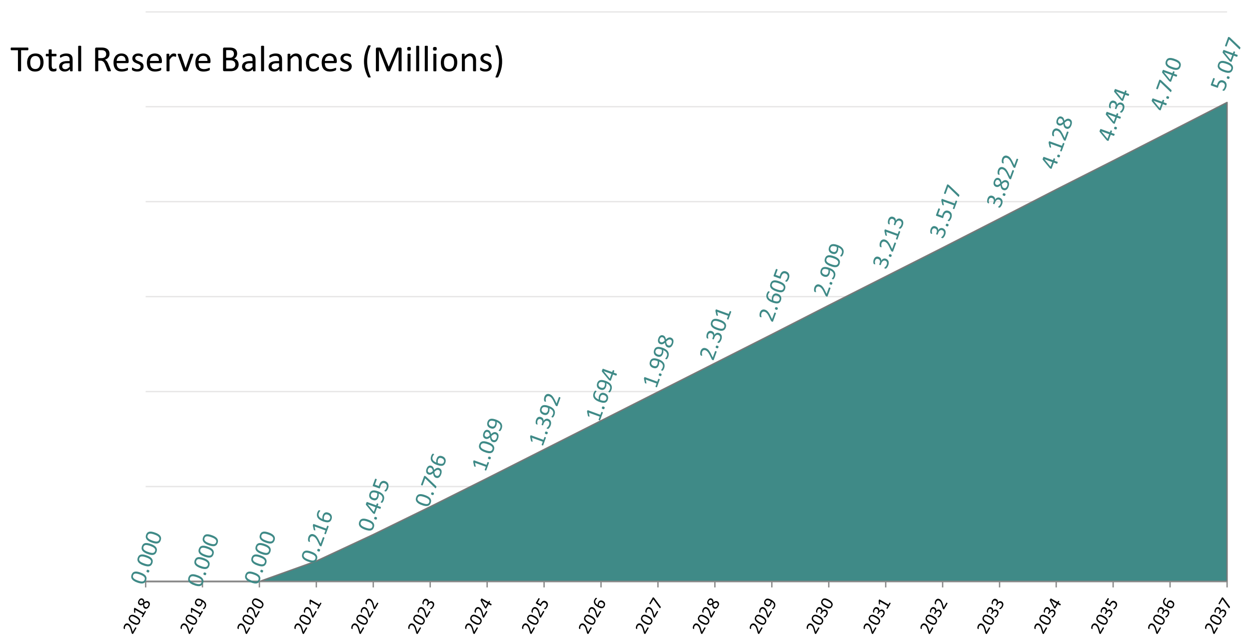


Figure 42: *Total Reserve Balances*

Profit Margins

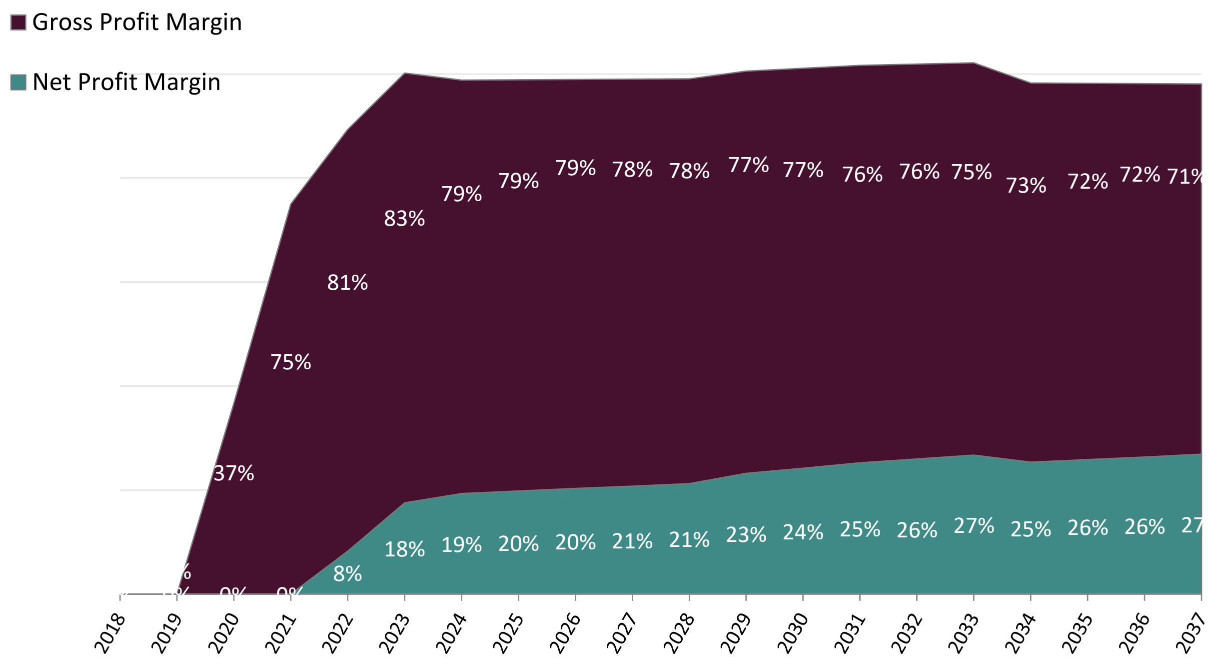


Figure 43: *Profit Margins*

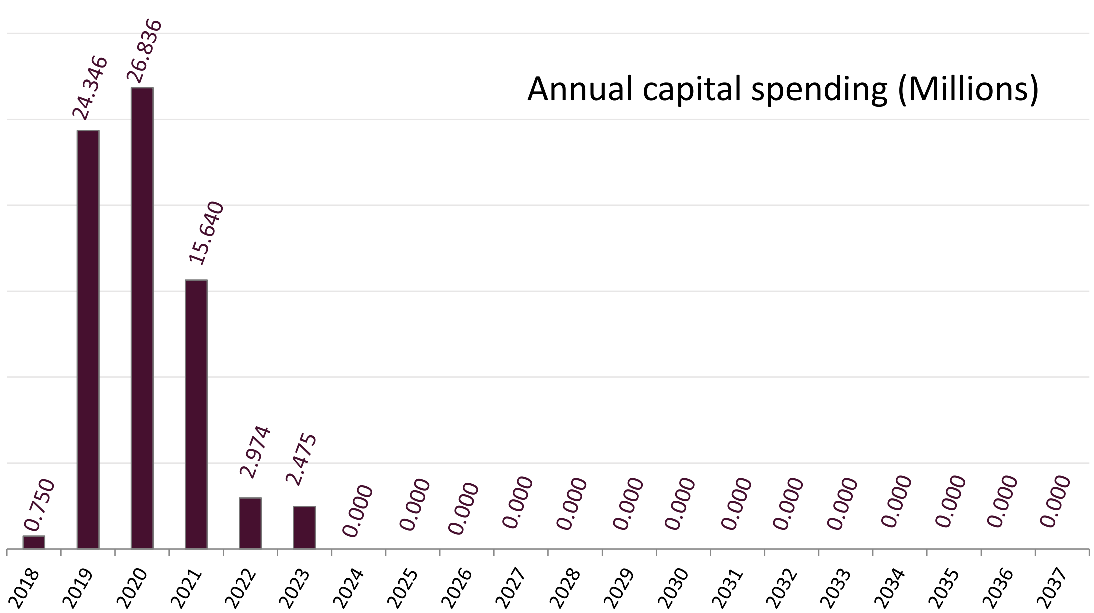
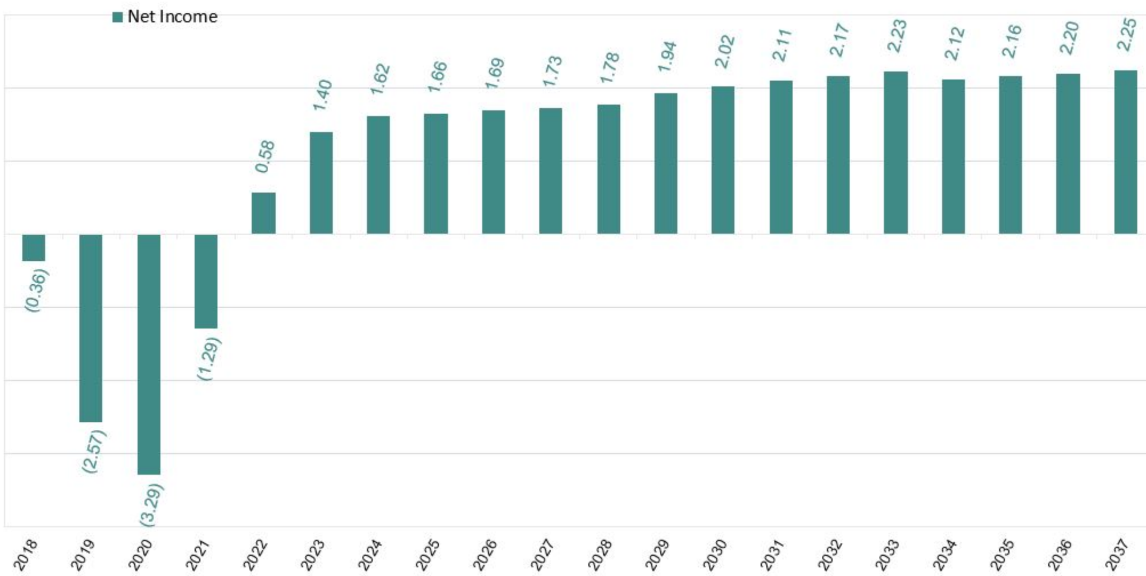


Figure 44: *Annual Capital Spending*

Net Income

Net Income (Millions)



7. Recommendations and Next Steps

Manhattan Beach recognizes fiber-optic infrastructure as an important and necessary part of the community. The City understands that in today's world, connectivity affects every aspect of and part of a community – whether in municipal operations, education, healthcare, or public safety.

Through the development of this Fiber Master Plan, the greater community has also shown overwhelming support for Manhattan Beach pursuing fiber-optic broadband goals. From the survey results and feedback received during community meetings, households and businesses conveyed their appreciation for the effort being put forth to improve the quality and affordability of broadband in Manhattan Beach.

The recommendations in this Plan signify the beginning of important work ahead for the City of Manhattan Beach. The roadmap proposed in the Plan aims to build a network that reaches every single resident and business, anchor institution, and City facility. It is also the foundation for future Smart City applications. The Needs Assessment portion of this study demonstrates there is an unmet need for better broadband connectivity in the City.

Key Next Steps:

1. Review and Adopt Fiber Master Plan
2. Approve Broadband Policies
3. Develop a Pilot Implementation Program and Bid Project
4. Refine the Model
5. Develop Citywide Plan
6. Design the Citywide Fiber Project
7. Construct Citywide Fiber Project
8. Establish Support Systems for Operations

As the City continues to make progress in bringing this initative to fruition, there are a number of key tasks to consider that will validate the project's cost structures and will assist the City in planning for how these assets will be constructed and utilized.

7.1 Detailed Next Steps

1. Review and Adopt the City of Manhattan Beach Fiber Master Plan

City Management and elected leaders should have the opportunity to review, comment, and provide direction on this Fiber Master Plan. The roadmap outlined in this document requires funding; and the resources needed and should be vetted in this manner. The City should designate this broadband effort as a City program, and it should be funded and structured just like any other City enterprise.

2. Approve and Implement Broadband Friendly Policies

The City staff has already begun the process of adoption broadband friendly policies including Dig Once, Wireless Ordinances and an updated Master License Agreement. The City should continue to refine, adopt and publish these policies.

3. Develop A Pilot Implementation Plan and Bid the Project

The City should consider and approve a trial program for delivering FTTH services to a discrete segment of the City. The goal of this trial is to test the assumptions of the proposed network, including network construction and operational costs, as well as take rate.

The City should determine a representative neighborhood section for trial design, construction and deployment. A mini Business and Implementation Plan can be developed outlining the pilot area, goals and expected outcomes of the network build, staging, budget, timeline, and implementation strategy. This plan should include issuing an RFP for Design and Engineering services to develop construction douments that can be bid out to validate and refine current cost estimates.

Costs for Design and Engineering services for the Pilot Program are anticipated to be between $200,000-$300,000. The design engineering timeline for the initial project should be completed within three (3) to four (4) months. Assuming construction estimates are at or below current estimates and the trial moves forward, careful review of the actual results versus assumptions should be refined in the financial model for all fiber-related costs.

4. Review and Refine Business Plan Based on Pilot Results

Based on the bid results of the Pilot FTTH Design Engineering Plan program, the City should refine this Fiber Master Plan and financial assumptions. The pilot bid results will provide valuable information that will allow the further refinement of the Broadband Implementation Plan, from preparation to adoption and execution of the full plan.

5. Develp a Business Plan Inclusive of Staging, Budgets, Timelines, and Implementation

Before developing a timeline for implemetion, City leadership must decide how and when this program will be incorporated into the City's overall plan and budget.

- Review funding requirements and identify funding source(s);
- Develop budget and funding strategy and timeline; and
- Develop full implementation plan, including all procurement timelines and tasks.

The Fiber Master Plan can help provide the framework for developing a Business Plan for full broadband deployment and network management, including Smart Cities initiatives.

6. Undertake a Citywide Fiber Design Plan: Establish Timeline for Design and Engineering, Construction and Operations

Once existing assets have been identified and inventoried, the City should move forward with phased deployment for design and engineering of the entire network, including traffic conduits and all backbone routes and facilities. During the design and engineering process, actual routes will be solidified, engineers' estimates will be developed, and project costs can be refined.

This stage includes issuing a Request for Proposals and selecting a firm to begin design work, ultimately followed by bidding and construction of the entire network. The design engineering process allows the City to "value engineer" the network, taking into account any newly identified assets (e.g., abandoned pipes) or existing dark fiber, and allows the routes to be optimized based on true ROW conditions. It is worth noting that the conceptual route designs presented in this Plan are meant to provide capital cost ranges and estimates based on potential routes. An actual design will provide construction-ready design documents with supporting levels of detail to move the project directly into Year 1 construction. With these new estimates, the City will be able to update the financial model that has been developed through this Plan, and continually refine the strategic goals and direction of the project.

7. Select Construction Firm to Begin Construction of the Remaining Network

Upon completion of OSP design-engineering, the City would call for bids for the multi-year proposed network infrastructure construction. The bid would include all specifications and requirements of the OSP design-engineering deliverable; maps including all fiber routes and other network facilities; compliance and bonding requirements of the selected contractor; previous experience and references for similar OSP construction projects; and detailed requirements on the OSP documentation and modeling in the City's GIS or selected fiber management system.

The bid should be released per California Procurement guidelines, with a 30-day response window to allow for scheduled site visits and thorough responses. A respondent should be selected based on predetermined weighting criteria, and a contract awarded to follow the City's 4-year construction schedule. A Project Manager should be assigned to oversee the project and report status updates to the City. The Project Manager would be responsible for coordinating with the selected contractor on the project schedule, lateral facility managers for building access, and with relevant City departments for traffic control and right-of-way access.

The City's Fiber Master Plan and its accompanying financials should be updated and revised regularly as major bidding, construction and take rate stages occur, thereby allowing the City to continue to capture true costs and refine the model as needed.

8. Establish Operating Support Systems

The City should consider investing in a telecom-centric facility management system that provides documentation, inventory, work orders, and other relevant information about the network's physical plant assets.[18] These assets include outside plant, equipment, contracts and other relevant assets. This system will provide documentation, inventory tracking, processes, and management of network assets throughout the system. The system is particularly important in management of the outside plant fiber-optic network to ensure the City has valid documentation and control of as-built documents, assignments, splice plans, work orders, changes, and other information pertaining to the outside plant network. Availability of this information is crucial for both managing the existing network and future system expansion. These systems are also important for tracking and depreciating assets with a long economic life, such as conduit, fiber, towers, and facilities. The cost for such a system has been included in the proposed capital budget.

The City should also secure a multi-year, on-call operations and maintenance contract with a construction firm that would provide emergency restoration of the fiber infrastructure and would be available to expand the network as needed. Through this contract, all incremental construction, splicing, and other tasks would be performed, ensuring the fiber and supporting passive components are functioning at optimal levels at all times. Any CAI or wholesale carrier will require the City to offer industry standard Service Level

[18] Established providers of telecom facility management systems include:

- ETI Software - http://etisoftware.com/
- Enghouse Networks - www.enghousenetworks.com
- Telvent - www.telvent.com

Agreements (SLA) on the fiber infrastructure and transport network, ensuring their ability to guarantee its services to its downstream retail customers.

The City's contractor should have the necessary expertise and equipment available to maintain the City's fiber-optic infrastructure. The contractor would be required to respond to emergency fiber cuts and service outages within an agreed upon service level (i.e., response within one hour, onsite within three hours). Once carrier Ethernet electronics are incorporated, given the redundant nature of the design, fiber cuts along core routes and between potential network nodes will recover immediately using ring protection services. However, fiber cuts in the non-core routes and service laterals to customers may be subject to extended periods of outages unless additional redundancy is built to specific customers who may be requesting this service (e.g., multiple lateral connections). It will be important for the partner to be local to the region and with adequate staff and equipment to deploy at any time.

The OSP contractor would likely be responsible for all aspects of OSP operations and maintenance. The responsibility would include adds, moves, and changes associated with the network as well as standard fiber maintenance. These tasks could include:

- Adding or changing fiber routes and patching requirements;
- Extending service drops to customers;
- Extending backbone and lateral segments, as required;
- Relocating fiber routes due to roadway construction activity;
- Maintaining accurate documentation on network and modifications (adds/changes);
- Maintaining splicing diagrams;
- Emergency repair services (24x7x365);
- Design-engineering, as necessary; and
- Fiber locating.

7.2 Smart Cities Recommendation

Broadband and Wi-Fi capacity can be used to transform and improve Manhattan Beach's municipal operations via Smart City applications in the areas of Advanced Metering Infrastructure (AMI); smart grids; public Wi-Fi; electric vehicle charging stations; parking management and enforcement; traffic detection and forecasting; sanitation; wastewater/storm water data; cameras and public safety; field use of tablets for inspectors; and transportation, such as intelligent parking and traffic signal prioritization. Festivals and other activities have traffic and traffic control requirements that can potentially be aided using Smart City applications, including greater use of fiber network capacity instead of radio, traffic operations, event-related detours, and installation of temporary cameras.

There are also countless other potential applications for broader community use with an extended fiber network. To name a few:

- Building security systems
- Speed sensors
- Wi-Fi in support of public meeting rooms
- Downtown visitors and commerce,
- Teen and senior centers,
- Tech classes;
- Real-time parking guidance
- Smart devices to mitigate residential traffic cut through

Minimum Broadband Plan

The City should also promote broadband within the community and for use City facilities. These items may take longer to implement but provide many features and benefits to the City. They include:

1. Approve and implement the Broadband Policies as outlined in this report.

2. Create a future network map demonstrating where potential assets should be placed in support of City facilities, Smart Cities and anchor institutions.

3. Look for opportunities to build in conjunction with other capital improvement projects.

4. Provide active participation in the South Bay Regional Consortium to leverage work being done at the regional level.

5. Adopt broadband planning activities as a cultural shift throughout the City.

6. Consider Smart City implementation through use of existing provider networks.

7. Apply for grant funds, such as those available for traffic enhancements, to build network resources.

8. Drive current providers to upgrade their networks to support the broadband services the community needs.

Appendix A: Smart Cities

National League of Cities "Smart Cities" Report

There is a vast and growing body of studies, information, products and implementations on the "Smart City." The National League of Cities has produced a report on trends in Smart City development.[19] Smart City applications require three things working together for effectiveness: computing and telecommunications infrastructure to collect data, software applications and tools to analyze and interpret the data, and a collaborative environment in the organizations that innovate, create and use Smart City applications.

The Report contains many examples of interconnection of devices in a Smart City, while noting that:

"A reliable internet ecosystem is the glue that holds the Internet of Things together":

- Transportation Congestion Sensors
- Water and Wastewater monitoring
- Parking apps and kiosks to coordinate with smart meters
- Bridge inspection systems
- Self-driving cars, shuttling people in and out of the city or making deliveries
- Waste management sensors
- Lighting
- Fire detection
- Energy monitoring
- Solar panels
- Smart logistics/freight
- Vehicle fleet communications
- Drones for public safety and infrastructure
- Monitoring cameras
- Body cameras
- Wearable detection

The Report also contains case studies for Chicago, Philadelphia, Charlotte, NC, San Francisco and New Delhi, India, along with comparisons and recommendations.

- Chicago has created an administrative structure including its Department of Innovation and Technology which provides for "an open data platform and mandated cross-functional collaboration." This structure positioned Chicago to partner with Argonne National Laboratory on the "Array of Things."
- Philadelphia created an Office of Innovation and Technology to support movement toward Smart City concepts, including programs and measures designed to lower the crime rate.
- Charlotte, NC established a PPP to help the City support its accelerating population growth, including an initiative to reduce wasted energy consumption.
- San Francisco has focused on environmental and transportation improvement measures, including programs designed to reduce traffic congestion and improve reliability of municipal transportation services.

NLC Smart City recommendations are:

1. <u>Cities should consider the outcomes that want to achieve</u>. "Data collection is not an end in itself." Initiatives need to be clearly defined.

[19] NLC Smart Cities Report.

Consider what the need is, not just what other cities are doing.

2. Cities should look for ways to partner with universities, non-profits and the private sector. Cities can even partner with other cities. There are many benefits to partnering and collaboration, including access to experience, shared risks of development, and providing project continuity. Downsides to collaboration also need to be considered in structuring any partnership.
3. Cities should continue to look for Smart City best practices. Technologies are new and at present there is significant variability and a lack of agreed standards. The National Institute of Standards and Technology is working on this matter.

Smart Cities Readiness Guide

The Smart Cities Council publishes a "Smart Cities Readiness Guide."[20] The guide has detailed information on Smart City drivers and barriers, benefits, "beyond silos," and City responsibilities. City responsibilities and opportunities are outlined as follows:

- Built Environment: Leading and planning for "smart buildings" powered by ICT, using sensors, meters, systems and software to monitor and control a wide range of building functions including lighting, energy, water, HVAC, communications, video monitoring, intrusion detection, elevator monitoring, and fire safety.
- Digital City Services: Switching to digital delivery of city services to increase citizen engagement, increase employee productivity, increase competitiveness, increase citizen satisfaction, and reduce cost. Services are delivered via the web, smartphones and kiosks, which can require implementation of new technologies, and attitudes or approaches.
- Energy: Smart energy is a priority for Smart Cities, which start with smart energy systems.
- Health and Human Services: Smart Cities ride the transformation wave provided by advances in ICT to transform the delivery of essential health and education services since "an educated and healthy city is a wealthy and successful city."
- Ideas to Action: A "roadmap" linked to a City's vision document and comprehensive plan is necessary to turn ideas to action, and make technology serve the City's larger goals. The path to a Smart City is not quick, and targets are needed for clear goals to motivate citizens and permit any required course corrections.
- Mobility and Logistics: Population growth and wasteful congestion make this a critical area for the Smart City. Traffic congestion is wasteful and costly to the economy – both directly and indirectly. There are a variety of action steps and targets that can provide for safer, more efficient transportation, including accommodating electric and autonomous vehicles and smart parking among others.
- Public Safety: Public safety relies on a lengthy list of infrastructure, agencies and people to keep the public safe. ICT in the Smart City fosters quicker and smarter responses without wasteful duplicated effort to save lives, property and resources.
- Smart Payments and Finance: Digitalizing both disbursements and collections generates significant savings and increases operational efficiency.
- Smart People: A new city hall mindset that is more open, transparent and inclusive to

[20] http://rg.smartcitiescouncil.com/readiness-guide/article/drivers-whats-driving-smart-cities

build two-way communications and create stronger initiatives.

- Telecommunications: An adequate telecommunications infrastructure is vital for business and community development and underlies the Smart City.
- Waste Management: Population growth and accelerating consumption have created a rising tide of waste, outpacing the rate of urbanization. Smart cities can collect and process waste more efficiently and recover materials which have value, with a beneficial impact on public health, the environment and sustainability/zero waste, and cost control.
- Water and Wastewater: Like energy, water is critical to everyday life. The Smart City provides intelligence for both energy and water systems and provide the platform for economical and sustainable production of both energy and water.

Smart Lighting

Smart City initiatives allow for municipalities to take light poles in the rights-of-way and utilize them for many different functionalities from light monitoring and management to deployment of sensor technologies that can monitor environmental factors that many have never thought possible, including crime activity, trends in traffic congestion, pollution, among other factors. But community standards regarding aesthetics, design and style solutions require that high functionality be coupled with pleasing design characteristics.

Current trends in smart street lighting range from cost saving LED lighting to powerful engineered solutions including sensor placement, distributed antenna systems (DAS) and Wi-Fi deployment, and municipal communications functionality (i.e. security cameras, traffic monitoring). Municipalities vary in their implementation of these devices and technologies, however, determining an appropriate street pole can assist a city or town in scaling technology for the future, enabling additional technologies to be added as they come to market.

Crucially, evolution to 5G mobile phone technology depends on closely spaced antennas – for which street lights and other poles, and traffic signal standards can be very useful. Mobile service providers often prefer exclusive rights to poles, and the evolution to 5G will likely be no different. Service providers likely will state that they cannot co-locate with their competition on the pole structures, therefore they are moving quickly to gain rights to this real estate before cities can organize and prepare for the 5G deployment coming within a few short years.

By planning strategically and installing smart street lighting with 4G wireless and possible 5G capabilities, a city or town could potentially develop a future-proof plan for advancing technology and ensure that additional structures do not enter their rights-of-way and add blight or clutter to the city. One of the of the most underutilized assets in municipalities and utility companies is the electric light pole. Their sheer numbers and locations deployed throughout municipalities makes them well suited for the delivery of 4G and 5G mobile services. Street light poles can be retrofitted with smart LED-based lighting, which leads to energy saving within a city and can be leased out to service providers for deployment of their DAS/small cell technology. Furthermore, addition of Intelligent Traffic Systems capability improves traffic efficiency and facilitates safer, coordinated, and more intelligent decisions around traffic management.

Smart Pole uses and applications include:

- <u>LED lighting and lighting applications</u>: Some view street lighting as the true backbone of Smart City services. Studies show a municipality could save 50-60% in energy costs based on the type or brand of lighting. LED lighting saves in energy costs and the lights burn three to four times longer than the traditional bulb, saving not only energy but materials as well. Numerous products on the market also allow for lighting applications, which provide for monitoring and management of lighting throughout the area. Reduction in maintenance costs are also a benefit as software systems are connected to the lights alerting public works employees of bulb outages, breaks, or issues. Additionally, various products allow for lighting to be set on timers to dim during low traffic periods, shut off during daylight hours, or be connected to sensors to brighten when pedestrians or cars pass the pole.

- Solar Panels: Solar panels are now being deployed onto street lights, enabling cities to realize a net zero energy cost in relation to the energy consumed by the lamps. However, the majority of the products currently on the market require another "head" on the lamp with the solar equipment built into it. New technology is coming onto the market evolving and allowing for smaller, more efficient use of the light pole for solar powered energy. In these newer designs, the solar panels are on the physical poles.
- Sensors: Sensors are an area of many current and potential applications. The light pole is ideal for accommodating sensors, as the poles already have electricity, and provide sensors a great view of the landscape. Additionally, light poles are great for transmitting wireless signals due to their height. Sensors are used to monitor air quality, weather conditions, and motion. Law enforcement can use sensors for parking enforcement, contacting emergency services in the event of an accident, and security cameras. Motion sensors could be configured to dynamically light up a section of road when vehicular or pedestrian movement is detected and switch off or reduce the illumination in the absence of any movement, aiding in public safety. Additionally, the sensors and networks can be sensitive to sunrise and sunset for LED operating hours, or the dimming of the lighting can be set to a schedule to accommodate city or town needs. Besides the cost savings, there are many other benefits from smart lights. The system can be used to control stop lights from a central location. One example of a public safety application enabled is for a fire truck to remotely activate the system to have street lights flash red ahead of the truck's route. Drivers are thus warned that an emergency vehicle is approaching, and it reduces travel times for the emergency vehicle.
- Wi-Fi: Smart cities connect everything – buildings, lights, meters, and streets – to the internet through the power of Wi-Fi. Connectivity provided through the emerging Wi-Fi frequencies below 1 gHz is being developed to extend the range and reach of signals through more materials and is particularly well-suited for applications with low data payloads – like sensors. This is ideal for smart devices that don't require a constant speed connection and are located in harder to reach places.
- Wireless Services/4G/5G: Currently, 4G transfer speeds top out at about one gigabit per second in perfect conditions. However, we rarely experience 4G's maximum download speed since the signal can be disrupted by buildings, microwaves, Wi-Fi signals, trees etc. 5G on the other hand, will have much higher speeds (up to 10 gigabits per second), capacity, and significantly lower latency. It will also support the thousands of internet-connected devices being introduced into our lives. The high reliability and low latency of 5G creates opportunities for city management, and public safety to control critical services and infrastructure. Cities can now connect to millions of networked devices, making real-time, intelligent, and autonomous decisions. This real-time data

will reduce maintenance and create greater operational efficiency. 5G will bring broadband and media everywhere allowing users and devices to communicate in crowded or remote areas with lightning fast broadband speeds

Best Practices-Networks to Support Smart City

Recognize Fiber as Long-Term Infrastructure
Forward-thinking local governments understand that infrastructure is not intended to be a means of directly making money for their communities. They recognize that infrastructure is an investment – whether roads, electric wires, water pipes – that acts as a facilitator, allowing the delivered service to generate much higher social and economic benefits.

In the same way, the investment in fiber infrastructure is not simply for better internet service. A fiber-optic network is more than just internet access; it is a platform for local collaboration, innovation, and economic growth. The return on investment with infrastructure is not simply money; there are many far more important and long-term social and economic benefits attached.

Capital investments in network infrastructure can greatly reduce the City's recurring costs and can be leveraged to spur additional investment and service offerings by providers. Generally, the City can invest in underground duct, vertical assets such as utility and streetlight poles and radio/wireless antenna towers, and/or fiber-optic cables, then lease these assets to providers or sell services directly to the end user.

Formalize a Broadband Implementation Plan
Manhattan Beach should consider the development of a Broadband Implementation Plan (BBP), focused on meeting the needs and demands of its City residents, business and City operations, bringing value to the greater community, and monetizing broadband assets that are or become available. A BIP would require a formal structure to be successful. There are several tasks required to formalize a Broadband Implementation Plan, including:

1. Implement a Fiber Management System
1. Create a capital fund to cover costs of building infrastructure
2. Create an enterprise fund to maintain proper budgets, cost accounting, and to track revenues of the program
3. Detail network management paradigms
4. Develop pricing policies for fiber and conduit leasing
5. Standardize agreements for fiber and conduit leasing
6. Publish rates, service levels, and terms
7. Sales and Marketing procedures
8. Document and maintain an inventory of available broadband assets

A BIP would specify a process to identify and inventory such assets and their details in an accessible GIS format. Once Manhattan Beach moves forward with development of the network, and decisions around the implementation of a BIP are made, the City can identify internal assets and review additional services.

The City can develop such assets incrementally over time by having a policy and program to install other needed infrastructure as part of other capital improvements. The general approach is to leverage City investments as opportunities present themselves to target investments in network infrastructure to generate revenue and spur development.

Promote Broadband-Friendly Public Policies
Implementation of a BIP as detailed in the previous section also requires that stakeholders and local governments evaluate current land use, permitting, construction, and right-of-way policies. Existing

informal policies and procedures also need to be examined to determine how broadband-friendly policies can encourage development of broadband infrastructure. Formalizing these policies will lead to deployment of broadband infrastructure in conjunction with other public and private infrastructure projects occurring within jurisdictions.

Public policies are frequently used as a low-risk, low-cost way to increase the supply of broadband available to serve a municipality or utility. It is important to encourage local governments, planning organizations and the developer community to adopt building and construction guidelines and techniques that lower obstacles for building and connecting to fiber infrastructure.

These policy improvements may include items that are already performed by entities in Manhattan Beach with no formal coordination. Below is a list of ways that the City can encourage broadband development through the adoption of broadband-friendly policies:

- Evaluate fees levied on broadband providers for constructing broadband infrastructure to ensure they do not discourage broadband investment.
- Streamline the broadband permitting processes within public rights-of-way to ensure broadband providers do not face unnecessary obstacles to building infrastructure.
- Identify opportunities to install fiber infrastructure in conjunction with public and private construction projects.
- Maintain broadband infrastructure specifications in a GIS-based fiber management system, requiring updates as built and processes for maintaining accurate records.
- Adopt policies that incorporate fiber as a public infrastructure and create a policy framework to promote its deployment in public and private projects, as appropriate.
- Draft policies to specific needs and adopt them into local policy, codes, and engineering standards.
- Incorporate broadband concepts with Capital Improvement Plans (CIP), as appropriate, and make a commitment to fund broadband infrastructure.

Create a Smart Cities Steering Committee

Magellan recommends that the City consider the formation of a **Smart Cities Steering Committee** after the adoption of the Fiber Master Plan. This Committee should include senior leadership from all relevant departments. The Committee should first review and investigate Smart City applications that have been under informal consideration by the various City departments (such as tying in sensors in parking decks to WAZE app, and use of street light poles for various functions such as dimming) and "vet" those applications with a view toward determining feasibility and requirements. Review and investigation of particular Smart City applications would include:

- Determining the organization(s) or department(s) that would "own" the application and its implementation;
- Organizational adaptations that must be made within the City;
- Department ranking of importance of implementing the application versus other potential Smart City applications;
- City management and council ranking of the priority of the application versus other potential Smart City applications;
- Community views on the importance and utility of the Smart City application;
- Legal or policy requirements that must be addressed (if any);
- Costs of the application and its associated equipment;
- Network implications of supporting the application, including network proximity;

- Timeline for installation of the application, including activation of the application;
- Resources needed for installing and testing the application;
- Savings and benefits for the City generated by use of the application;
- Funding and budget sources (including potential grant funding) and what budget actions are necessary; and,
- Other relevant information.

The Smart Cities Steering Committee should determine which phase each of the departments and technologies will be accomplished, depending upon the existing infrastructure capabilities and urgent Smart City application needs.

Appendix B: Public Policy Considerations

Below are a few considerations for Public Policy. These are generally considered good practice.

Some cities elect not to pursue their own build, but instead elect to take a more passive approach through policy that, over time, can increase broadband services within the City.

Many of these policy agreements can also minimize negative impacts of construction on Manhattan Beach's aesthetics and historic assets while ensuring they are prepared for the future. In addition to the policies themselves, the City should ensure that staff understands the purpose of the policies and how to integrate them into City workflows and processes.

Broadband Policy

The City of Manhattan Beach has already taken preliminary steps in the realization of broadband policies that promote best governance practices for Smart City applications and general ease of use for citizens. Prior to the completion of this report, the City has already developed and implemented a Dig Once policy, and is in the process of delivering a wireless ordinance for implementation at a later date. Proactivity on the part of the City in these regulatory and policy decisions is imperative, and Manhattan Beach is off to a running start.

Wireless Regulation and Policy Introduction

Wireless providers are looking forward to the deployment of "5G," which is distinguished from the present "4G" based wireless service by use of low power transmitters with coverage radius of approximately 400 feet – 5G thus requires close spacing of antennas and more of them. This has obvious implications for city authorities with applications for location of antennas by service providers before city and municipal authorities. These providers – Verizon, AT&T, Sprint and T-Mobile – are making a concerted push for new rules and legislation before state, local and federal authorities with jurisdiction and responsibilities for siting of wireless facilities. As stated by the FCC, the wireless industry is currently deploying and planning for additional construction of a large number of small cells, and the number of these facilities is expected to grow rapidly over the next decade. S&P Global Market Intelligence estimates that between 100,000 and 150,000 small cells will be constructed by the end of 2018, and that small cell deployments are expected to reach 455,000 by 2020 and nearly 800,000 by 2026. AT&T has reported that the substantial majority of its infrastructure deployments over the next five years will be small cell sites. In addition, Verizon is deploying small cells in several urban areas, including New York, Chicago, Atlanta, and San Francisco. Sprint announced last year a goal of deploying 70,000 small cells within two years.[21]
The placement of wireless facilities is governed by an interrelated legal framework including shared jurisdiction of state and federal authorities. The Federal Communications Commission has preempted the authority of state and local jurisdictions in other cases and may be poised to take preemptive steps again regarding siting of wireless facilities, in two current proceedings. The FCC states the "dilemma" – as well as its perspective regarding jurisdiction – as follows:

---

[21] *Streamlining Deployment of Small Cell Infrastructure by*FCC Rcd 13360, December 22, 2016, at page 3-4 (citations *Improving Wireless Facilities Siting Policies; Mobilitie, LLC Petition*omitted). ("Improving Wireless Facilities Siting Policies Public *for Declaratory Ruling*, WT Docket No. 16-421, Public Notice, 31Notice"*).*

We recognize, as did Congress in enacting Sections 253 and 332 of the Communications Act, that localities play an important role in preserving local interests such as aesthetics and safety. At the same time, the Commission has a statutory mandate to facilitate the deployment of network facilities needed to deliver more robust wireless services to consumers throughout the United States. It is our responsibility to ensure that this deployment of network facilities does not become subject to delay caused by unnecessarily time-consuming and costly siting review processes that may be in conflict with the Communications Act.[22]

The emergence of 5G technology is causing significant current rulemaking and legislative activity in both the federal and state jurisdictions. In California, AB 649 was passed but ultimately vetoed by Governor Brown.

Federal Communications Commission (FCC)

The FCC has implemented "Shot Clock" requirements that place a maximum time for local authorities to review applications to place wireless facilities. Current FCC shot clock requirements arise in two contexts. First the 60-day clock for "Wireless Facility Modifications"[23] arises from § 6409(a) of the Spectrum Act.[24] The Spectrum Act applies to applications which do not "substantially change" an existing tower or base station, and thus are eligible requests to modify existing towers or base stations which do not substantially change the physical dimensions.

Eligible requests include colocation of new transmission equipment, removal of transmission equipment or replacement of transmission equipment. All terms are defined in the rule, including "substantial change." The time-period for review is "within 60 days of the date on which an applicant submits a request seeking approval." The 60-day clock may be tolled only by mutual agreement, or when the agency determines the application is incomplete. Clear and specific written notice is required within 30 days. Requests for approval gain "deemed granted" status if the request is not acted on within the 60-day timeframe, and the applicant notifies the local authority in writing.

The second context for "shot clock" requirements is under § 332(7) of the Communications Act[25], regarding "Preservation of local zoning authority." In its Declaratory Ruling[26] in 2009 the FCC set "presumptively reasonable period of time" deadlines of 90 days for collocation applications, and 150 days for all other applications, including new siting applications. An application is defined as a request for collocation "if it does not involve a 'substantial increase in the size of the tower' as defined in the Nationwide Programmatic Agreement for the Collocation of Wireless Antennas."[27] Applications are not "deemed granted" if the local authority fails to act on a completed application within the shot clock time period for review, instead the provider must pursue any relief in court.

The FCC recently acted on specific items in the Inquiry to modify the procedures for National Historic Preservation Act (NHPA) and National Environmental Policy Act (NEPA) review of wireless infrastructure deployments. This may suggest that FCC action on the "shot clock" matters in the inquiry is forthcoming. This proceeding bears tracking because it interrelates with the efforts of wireless providers to limit municipal wireless facility siting oversight through state legislation. The wireless providers likely would be satisfied with the passage of more restrictive rules by either state legislation or the FCC, whichever comes first. The statutory provisions of the Communications Act and the Spectrum Act overlap to a certain extent, but the FCC up to now has specifically preserved the distinct standards above under the two provisions.

Wireless Infrastructure NPRM

On April 21, 2017, the FCC opened an inquiry into "accelerating wireless broadband deployment by

[22] *Id.*, at page 2.
[23] 47 CFR § 1.40001.
[24] *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, 126 Stat. 156, § 6409(a) (2012) (Spectrum Act), *codified at* 47 U.S.C. § 1455(a).
[25] 47 U.S.C. § 332(7).
[26] *Petition for Declaratory Ruling to Clarify Provisions of Section 332(c)(7) to Ensure Timely Siting Review*, Declaratory Ruling, Federal Communications Commission, 24 FCC Rcd 13994 (2009), at paragraph 45.
[27] *Id.*, at paragraph 46.

removing barriers to infrastructure investment."[28] The FCC's Notice of Proposed Rulemaking (NPRM) identifies estimated benefits from deployment of "next-generation wireless broadband," i.e., 5G, and seeks to define an "updated regulatory framework that promotes and facilitates next generation network infrastructure facility deployment" to realize those potential benefits.[29] The NPRM states "an urgent need to remove any necessary barriers" to deployment of "large numbers of wireless cell sites to meet the country's wireless broadband needs and implement next generation technologies."[30]

A large portion of the NPRM focuses on the "process for reviewing and deciding on wireless facility deployment applications conducted by State and local regulatory agencies," and examining new rules or clarifications intended "to expedite such review."[31] The NPRM appears to place the onus on State and local authorities, with only passing mention of the actions or inactions of wireless service providers – although comment is sought on that subject as well.

The FCC is seeking comments in the Wireless Infrastructure NPRM on the extent to which the above shot-clock framework should be modified, including whether the "deemed granted" remedy should now also apply for § 332 applications, changing the "rebuttable presumption" to "irrebuttable presumption" that the time frame for review is adequate. The NPRM is also examining whether the shot clocks should be aligned and shortened, i.e., the collocation shot clock under § 332 reduced to 60 days from 90 days under the Spectrum Act, and whether there should be new categories for applications, with different shot clocks. Importantly for Manhattan Beach, the NPRM also seeks comments "on the proper role of aesthetic considerations in the local approval process,"[32] opening the door that aesthetic considerations may be diminished as a factor by the FCC. Finally, the NPRM seeks comment "on the extent to which localities may be seeking to restrict the deployment of utility or communications facilities above ground and attempt to relocate electric, wireline telephone, and other utility lines in that area to underground conduits."[33]

The Mobilitie Petition

Notably, the FCC has another proceeding open on wireless siting – the Public Notice on "Improving Wireless Facilities Siting Policies," based on Mobilitie's Petition for a Declaratory Ruling. The FCC has sought comments in this matter as well, noting that:

> *Many wireless providers are deploying small cells and distributed antenna systems (DAS) to meet localized needs for coverage and increased capacity in outdoor and indoor environments. Although the facilities used in these networks are smaller and less obtrusive than traditional cell towers and antennas, they must be deployed more densely – i.e., in many more locations – to function effectively.* 34

The FCC suggests it may use provisions of the Communications Act and the Spectrum Act to "remove barriers to deployment of wireless network facilities by hastening the review and approval of siting applications by local land-use authorities."[35] The FCC has called for comments on the Mobilitie Petition to develop a "factual record" regarding whether and to what extent "the process of local land-use authorities' review of siting applications is hindering, or is likely to hinder, the deployment of wireless infrastructure."[36] The Public Notice requesting comments lists a number of complaints by wireless providers about fees, cost and time period for review of applications, and opines in other areas. It also notes instances where cities have modified processes, citing New York City, Boston, and

[28] Notice of Proposed Rulemaking and Notice of Inquiry; *In the Matter of Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment*; WT Docket No. 17-79, FCC 17-38; released April 21, 2017. ("Wireless Infrastructure NPRM" or "NPRM") The FCC has a parallel investigation into accelerating wireline broadband deployment.

[29] *Id*., at paragraph 1.

[30] *Id*.

[31] *Id*., at paragraph 4.

[32] *Id*., at paragraph 92.

[33] *Id*., at paragraph 98.

[34] Improving Wireless Facilities Siting Policies Public Notice, at page 1.

[35] Improving Wireless Facilities Siting Policies Public Notice, at page 2.

[36] *Id*.

Baltimore. The Public Notice seeks current information – systematic data, not anecdotal evidence – on a broad array of subjects:

- How have matters changed since FCC actions in 2009 and 2014 regarding the "shot clock"? Better, worse or the same?
- What local actions or inactions, if any, have the effect of hindering deployment?
- How much time currently elapses for small cell applications?
- Are processes the same for microcell applications as for macrocell?
- Should the "shot clock" vary depending on whether the request is for a single cell deployment, versus consolidated applications for multiple cells?
- How often are applications denied, and for what reasons?
- How often is litigation pursued, and how long does it take?
- What legislation, ordinances, and regulations are viewed as most problematic?
- Are application fees and charges for use of Rights-of-Way reasonable and non-discriminatory?

From comments on these questions the FCC is seeking to determine whether it should issue a declaratory ruling to clarify or expand its previous rulings in 2009 and 2014.

State and Local Authorities

Along with pushing for reexamination of FCC rules, the wireless providers – Verizon, AT&T, Sprint and T-Mobile – have embarked on a nationwide push for state legislation to limit what local authorities can do regarding placement of "small wireless facilities." The state legislative push is strategic on the part of the wireless providers looking forward to the deployment of "5G," given the vastly increased number of antennas that will be required. The state legislative framework advanced by the wireless providers generally truncates timelines, limits review, limits payments, and removes this subject from home rule authority. Such legislation has passed in some states (approximately 14, e.g., Florida) and has been introduced but not passed in other states, and vetoed in California.

Dig Once Policy

"Dig Once" can be defined as policies and/or practices that foster cooperation among entities that occupy public rights-of-way, to minimize the number and scale of excavations when installing telecommunications infrastructure in rights-of-way. Dig Once has a number of substantial benefits, including promoting and supporting the placement of broadband infrastructure (e.g., fiber-optic cable and conduit); reducing the consequences and disruptions of repeated excavations (traffic disruption, road deterioration, service outages, and wasted resources), and enhancing service reliability and aesthetics. Dig Once accomplished the goal of minimizing costs of constructing separate trenches and facilities – via shared costs of construction.

The cost savings are significant. The Federal Highway Administration estimates it is ten times more expensive to dig up and then repair an existing road to lay fiber, than to dig a channel for it when the road is being fixed or built. According to a study by the Government Accountability Office, "dig once" policies can save from 25-33% in construction costs in urban areas and approximately 16% in rural areas.[37] In addition, development of Dig Once standards and guidelines for deployment of conduit and fiber will facilitate economic development and growth, as it enables cost-effective staged or gradual deployment of broadband infrastructure. Sonoma County and several cities have therefore expressed interest in exploring and adopting Dig Once policies.

Dig Once policy discussions generally address the planning and coordination process for construction projects in the public rights-of-way. But the concept can also extend to required placement of conduit for fiber-optic conduits, as expressed in recent Congressional legislation. The Broadband Conduit Deployment Act of 2015 required the inclusion of broadband conduit during construction of any new road receiving federal funding.[38]

[37] https://eshoo.house.gov/issues/economy/eshoo-walden-introduce-dig-once-broadband-deployment-bill

[38] *Id*.

Appendix B-2. City of Manhattan Beach Dig Once Policy

Engineering Division Policy # 2017-01

CITY OF MANHATTAN BEACH

Department of Public Works
Engineering Division

DIG ONCE POLICY
(For open trench construction only)

PURPOSE:

The purpose of implementing a Dig Once policy include:

- Protecting newly and recently paved roads and sidewalks
- Ensuring efficient, non-duplicative placement of infrastructure in the Public Rights of Way (PROW)
- Minimizing the impact of construction on residential and commercial communities
- Reducing overall costs of all underground work in the PROW by capitalizing on significant economies of scale
- Enhancing the uniformity of construction
- Leveraging construction for the deployment of a public communications network

BACKGROUND:

Encouraging simultaneous underground construction and co-location of infrastructure in the PROW creates benefits both the community and all users of the PROW. The excavation of roads and cutting of sidewalks substantially reduces the lifetime and performance of those surfaces. Furthermore, each excavation diminishes the space available for future infrastructure. While aerial construction methods requiring attachments to utility poles are usually less expensive than underground construction, aerial installation have significant drawbacks, including a limit to the quantity of cables and attachments that can be placed on existing utility poles in more crowded areas, lack of ownership of overhead infrastructure, and greater exposure to outside conditions. Underground construction, using protective conduit, generally provides scalable, flexible, and durable long-term infrastructure.

POLICY DIRECTIVE:

1. Unless waived by the Public Works Director because of undue burden, or an unfavorable cost-benefit analysis, or the consideration of other relevant factors, the PROW Excavator/Permittee will install two 3-inch diameter conduits for the following types of projects that has a minimum continuous open trench length of 300 feet:
   a) Excavations for the purpose of installing utilities, including but not limited to communications, electrical, gas, water, wastewater, storm drainage.
   b) Other excavations, or work on public property or in the public right of way that provide a similar opportunity to install conduit for future use.

2. Unless the Public Works Director determines otherwise, the typical standard installation requirements are listed below:
   a) Pipe diameter 3-inch nominal.
   b) Made of PVC Schedule 40 material.
   c) Laid to a depth of not less than 18 inches below grade in concrete sidewalk areas, and not less than 24 inches below finished grade in all other areas when feasible, or the maximum feasible depth otherwise.
   d) When feasible and needed, install minimum 3-foot radius sweeps and bends.
   e) When practicable, furnish with 10 AWG insulated tracer wire inside at least one pipe and an external “warning” ribbon tape a minimum of 3-inches above the conduit.
   f) All conduit couplers and fittings shall be installed to be watertight. Conduits shall be sealed with endcaps upon installation.
3. Conduits installed will be owned by the City.
4. A record of all City-owned conduits will be documented and transferred to the City for geographic information system (GIS) entry whenever feasible.
5. The PROW Excavator/Permittee should make a documented effort to work with other utility agencies co-locate infrastructure in same trench whenever feasible to minimize construction costs, minimize future public disruptions and encourage efficient use of the PROW.
6. Each utility shall participate in periodic coordination meetings as requested by the City with other utilities and affected public agencies. The purpose of these meetings shall be to coordinate activity between public works projects and utility projects in the PROW.

Effective Date: November 1, 2017

Appendix C: Business Models

CONNECTIVITY CONSUMER

The most basic option is simply to be a user of fiber-optic based services, to continue purchasing bandwidth and connectivity from existing service providers. Manhattan Beach does this today by providing internet access to staff, as well as and interconnecting facilities for sharing documents and processing internal applications. The City also uses connectivity services to provide online applications to citizens and to share information about the City. However, the City spends a substantial amount of money on (service provider) installation charges and recurring monthly fees. As the City deploys additional applications this spending on telecommunications services will increase over time.

To the extent that the City continues as a major telecommunications customer, the City would simply purchase services and not own any assets. Since the City has numerous facilities (locations), and serves all citizens and visitors, any provider would need to have ubiquitous infrastructure in place to meet the City's requirements. There are two downsides to this approach: (a) the City would face recurring service fees that increase over time, especially with the City's desire to become a Smart City, and (b) the provider would not necessarily extend services for consumers into any part of the community just because it serves a city location in that area. The City could require a provider to offer broader or cheaper services as a condition of contract, but providers are likely to balk at any commitment that isn't clearly profitable. Therefore, the City would likely need to subsidize any expansion, which will likely create additional costs and other issues for the City. This is basically the model the City uses today.

CONDUIT AND DUCT OWNER

The City already builds and maintains parks, roads, water/sewer lines, and other physical infrastructure in the public rights-of-way. Conduit is simply another form of physical infrastructure and instead of carrying people, vehicles or water, it would carry and protect fiber-optic cables. Conduit can be installed along with any underground facility and under the "Dig Once" policy there would be minimal construction disruptions. Once conduit is in place, fiber-optic cable can be installed cheaply and quickly with little to no ground disturbance.

Through proactive broadband-friendly policies, Manhattan Beach can mandate that any utility construction include conduit that becomes property of the City. Having a public conduit system can be a boon for City aesthetics and historic preservation, allowing buildings to be updated with modern services without having to do reconstruction on the site. The City can then lease duct for a fee to generate revenue, or it give away access as a way to direct or promote development. For example, by installing conduit in enterprise zones or other areas targeted for redevelopment, the City can facilitate advanced broadband in those areas.

VERTICAL ASSET OWNER

Vertical assets, including buildings, poles, and towers, are critical for all forms of wireless communications. Antenna are essential for wireless, and they have to go somewhere. Generally, the more antennas the better for communication. By placing vertical assets adjacent to ducts and fiber, and vice-versa, the City can encourage development of next generation wireless services. Whether it's Wi-Fi in the parks, 5G advanced wireless in the commercial areas, or mobile wireless for public safety; vertical assets are key. In some cases, vertical assets simply make wireless possible. In other cases, the City could either trade out access to vertical assets for service discounts or charge providers a fee to attach to the vertical assets.

FIBER-OPTIC INFRASTRUCTURE OWNER

The City can own fiber-optic cables, and it can use those for internal purposes, as a means of directing investment and service provisioning, or it can lease cables or strands of fiber to others. By owning its own fiber, Manhattan Beach can eliminate, or at least reduce, its own recurring telecommunications service fees. Major businesses and anchor institutions often need to interconnect various sites. Some telecommunications providers are happy to lease existing fibers to avoid upfront capital costs and reduce operating expenses.

DARK FIBER PROVIDER

As detailed in the needs assessment section, many of Manhattan Beach's businesses need better connectivity. Providing "dark fiber" transport facilities to its businesses, Manhattan Beach would own the infrastructure and lease strands of fiber to individual business. This would benefit organizations with multiple locations (i.e. local government, schools, hospitals, financial institutions, manufacturers, etc.) to interconnect across a municipal network.

REDUNDANCY PROVIDER - INFRASTRUCTURE FOR RETAIL SERVICE PROVIDERS

Placing the economic future of the city in the hands of broadband service providers can have a negative effect on business recruiting and expansion efforts. Conversely, Manhattan Beach can gain a positive economic advantage by deploying fiber and having it readily available for retail providers to offer the business community.

BUSINESS AND RESIDENTIAL RETAIL SERVICE PROVIDER

Stakeholders expressed significant interest in purchasing high speed broadband services from a network deployed by the City; and this is something many cities across California have done. There are many levels and types of service providers:

- Specialized service providers offer access to a particular service or set of services, for specific purposes. For example, the City could operate a public safety surveillance network, a network of public informational kiosks, or a health information exchange.
- Managed/enterprise network services don’t necessarily provide internet access, they simply transport data among a specific set of sites, which could include an internet service provider’s point-of-presence.

Organizational & Operational	• Passive approach to broadband expansion, no active participation. • Tied to existing departmental processes, no additional staffing required. • Requires oversight and management of the policies to ensure they are being followed. • Requires the City to track infrastructure as it is being added to capital projects.
Competitive Environment	• With policies, the City can opt to not participate in the competitive environment. • Infrastructure can be utilized across several business models. • All active business models remain available for the jurisdiction to consider.
Political Environment	• Ordinance changes of this type are generally not politically sensitive. • Improves the broadband environment • Ordinances that impact developer costs may be unpopular with developers.
Funding Environment	• Lower funding requirements than all other business model options. • Funding is only needed for conduit and fiber included with capital projects. • Funding should be allocated to ensure a budget is available for new infrastructure.
Community Benefits	• Improve the broadband environment gradually without any downside risk. • Leverage public policies to make the City and its service providers more efficient. • Reduce the cost and administrative burdens of building broadband infrastructure.

Summary of Public Policy Considerations

Appendix D: FTTH Financial Model - Overhead

Pro Forma *Proprietary and Confidential Information*

Uptake (Res: 40%)	*0%*	*10%*	*20%*	*30%*	*35%*	*40%*	*40%*	*40%*	*40%*
(Bus: 25%)	*0%*	*10%*	*15%*	*20%*	*25%*	*25%*	*25%*	*25%*	*25%*
(Anc: 8%)	*1%*	*2%*	*4%*	*6%*	*8%*	*8%*	*8%*	*8%*	*8%*
Rate (Res: $85); (Bus: $399); (Anc: $750)									
Year #	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Service Revenues									
Residential	$ -	$ 255,000	$ 1,275,000	$ 3,315,000	$ 4,972,500	$ 5,737,500	$ 6,120,000	$ 6,120,000	$ 6,120,000
Business	$ -	$ 130,005	$ 216,675	$ 321,230	$ 667,910	$ 866,700	$ 866,700	$ 866,700	$ 866,700
Community Anchor	$ -	$ -	$ -	$ 540,000	$ 1,237,500	$ 1,395,000	$ 1,395,000	$ 1,395,000	$ 1,395,000
Subtotal: Service Revenues	**$ -**	**$ 385,005**	**$ 1,491,675**	**$ 4,176,230**	**$ 6,877,910**	**$ 7,999,200**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**
Installation Revenues									
Residential	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Business	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Anchor & Dedicated	$ -	$ -	$ -	$ 428,400	$ 124,950	$ -	$ -	$ -	$ -
Subtotal: Installation Revenues	**$ -**	**$ -**	**$ -**	**$ 428,400**	**$ 124,950**	**$ -**	**$ -**	**$ -**	**$ -**
Equipment Rental Revenues									
Residential	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Business	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Anchor & Dedicated	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Subtotal: Equipment Rental Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
TOTAL REVENUES	**$ -**	**$ 385,005**	**$ 1,491,675**	**$ 4,604,630**	**$ 7,002,860**	**$ 7,999,200**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**
Cost of Services									
Direct Staffing	$ -	$ 646,583	$ 895,134	$ 921,988	$ 949,648	$ 978,138	$ 1,007,482	$ 1,037,706	$ 1,068,837
Data Center Rack and Power (UM)	$ 10,000	$ 10,100	$ 10,200	$ 10,300	$ 10,400	$ 10,500	$ 10,600	$ 10,700	$ 10,800
Broadband Transport & Internet Costs	$ 100,000	$ 100,000	$ 103,000	$ 106,000	$ 109,000	$ 112,000	$ 115,000	$ 118,000	$ 121,000
Dark Fiber Leasing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Vehicle Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Facilities Maintenance, Power, Environmental	$ -	$ 10,100	$ 10,201	$ 10,303	$ 10,406	$ 10,510	$ 10,615	$ 10,721	$ 10,829
Miscellaneous	$ -	$ 11,550	$ 44,750	$ 125,287	$ 206,337	$ 239,976	$ 251,451	$ 251,451	$ 251,451
Network & Headend Maintenance	$ -	$ 20,000	$ 20,200	$ 20,402	$ 20,606	$ 20,812	$ 21,020	$ 21,230	$ 21,443
Pole attachments	$ -	$ -	$ -	$ -	$ -	$ -	$ 285,120	$ 285,120	$ 285,120
Software Maintenance	$ -	$ -	$ 5,250	$ 5,303	$ 5,355	$ 5,408	$ 5,460	$ 5,513	$ 5,565
Utilities	$ 10,000	$ 10,025	$ 10,050	$ 10,075	$ 10,100	$ 10,125	$ 10,150	$ 10,175	$ 10,200
Network Operations Outsource Contract	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Subtotal: Cost of Services	**$ 120,000**	**$ 808,358**	**$ 1,098,786**	**$ 1,209,658**	**$ 1,321,852**	**$ 1,387,469**	**$ 1,716,898**	**$ 1,750,617**	**$ 1,785,245**
GROSS PROFIT	**$ (120,000)**	**$ (423,353)**	**$ 392,889**	**$ 3,394,971**	**$ 5,681,007**	**$ 6,611,731**	**$ 6,664,802**	**$ 6,631,083**	**$ 6,596,455**
Sales, General & Administrative Expenses									
Administrative Staffing	$ 162,000	$ 320,201	$ 329,807	$ 339,702	$ 349,893	$ 360,389	$ 274,483	$ 282,717	$ 291,199
Professional & Legal Fees	$ 20,000	$ 20,400	$ 20,808	$ 21,224	$ 21,649	$ 22,082	$ 22,523	$ 22,974	$ 23,433
Sales Commissions & Marketing Expense	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Reporting & Compliance	$ -	$ 20,000	$ 20,400	$ 20,808	$ 21,224	$ 21,649	$ 22,082	$ 22,523	$ 22,974
Travel & Entertainment Expense	$ -	$ 10,200	$ 10,404	$ 10,612	$ 10,824	$ 11,041	$ 11,262	$ 11,487	$ 11,717
Office Expense	$ -	$ 10,200	$ 10,404	$ 10,612	$ 10,824	$ 11,041	$ 11,262	$ 11,487	$ 11,717
General Overhead	$ -	$ 20,400	$ 20,808	$ 21,224	$ 21,649	$ 22,082	$ 22,523	$ 22,974	$ 23,433
Cost Allocation for City Services	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Bad Debt Expense	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Subtotal: Sales, General & Administrative Expenses	**$ 182,000**	**$ 401,401**	**$ 412,631**	**$ 424,182**	**$ 436,063**	**$ 448,283**	**$ 364,134**	**$ 374,162**	**$ 384,472**
EBITDA	**$ (302,000)**	**$ (824,754)**	**$ (19,742)**	**$ 2,970,790**	**$ 5,244,945**	**$ 6,163,448**	**$ 6,300,668**	**$ 6,256,922**	**$ 6,211,983**
Depreciation & Amortization									
Depreciation	$ 32,018	$ 1,078,155	$ 2,105,305	$ 2,827,355	$ 2,957,496	$ 3,065,497	$ 3,065,498	$ 3,065,499	$ 3,065,500
Amortization	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Subtotal: Depreciation & Amortization	**$ 32,018**	**$ 1,078,155**	**$ 2,105,305**	**$ 2,827,355**	**$ 2,957,496**	**$ 3,065,497**	**$ 3,065,498**	**$ 3,065,499**	**$ 3,065,500**
EBIT	**$ (334,018)**	**$ (1,902,909)**	**$ (2,125,046)**	**$ 143,434**	**$ 2,287,449**	**$ 3,097,951**	**$ 3,235,170**	**$ 3,191,422**	**$ 3,146,483**
Interest									

Appendix D: FTTH Financial Model - Overhead

Pro Forma *Proprietary and Confidential Information*

Uptake (Res: 40%)	*0%*	*10%*	*20%*	*30%*	*35%*	*40%*	*40%*	*40%*	*40%*
(Bus: 25%)	*0%*	*10%*	*15%*	*20%*	*25%*	*25%*	*25%*	*25%*	*25%*
Borrowings	$ 26,300	$ 664,162	$ 1,306,787	$ 1,684,893	$ 1,688,383	$ 1,674,471	$ 1,594,367	$ 1,512,261	$ 1,428,102
Subtotal: Interest Expenses	**$ 26,300**	**$ 664,162**	**$ 1,306,787**	**$ 1,684,893**	**$ 1,688,383**	**$ 1,674,471**	**$ 1,594,367**	**$ 1,512,261**	**$ 1,428,102**
NET INCOME	**$ (360,318)**	**$ (2,567,071)**	**$ (3,431,833)**	**$ (1,541,458)**	**$ 599,066**	**$ 1,423,480**	**$ 1,640,802**	**$ 1,679,161**	**$ 1,718,381**
Debt Principal Payments									
Borrowings	$ 41,183	$ 1,042,643	$ 2,115,802	$ 2,843,595	$ 3,031,469	$ 3,204,145	$ 3,284,248	$ 3,366,354	$ 3,450,513
Subtotal: Principal Payments	**$ 41,183**	**$ 1,042,643**	**$ 2,115,802**	**$ 2,843,595**	**$ 3,031,469**	**$ 3,204,145**	**$ 3,284,248**	**$ 3,366,354**	**$ 3,450,513**
Reserve Fund Requirements									
Operating Reserve Fund	$ -	$ -	$ -	$ 8,169	$ 8,790	$ 9,179	$ 10,405	$ 10,624	$ 10,849
Renewal & Replacement Fund	$ -	$ -	$ -	$ 100,664	$ 135,144	$ 141,111	$ 146,061	$ 146,061	$ 146,061
Capital Expansion Fund	$ -	$ -	$ -	$ 100,664	$ 135,144	$ 141,111	$ 146,061	$ 146,061	$ 146,061
General Fund Repayment	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Subtotal: Annual Reserve Fund Requirements	**$ -**	**$ -**	**$ -**	**$ 209,498**	**$ 279,078**	**$ 291,400**	**$ 302,527**	**$ 302,745**	**$ 302,970**
Subtotal: Cumulative Reserves	**$ -**	**$ -**	**$ -**	**$ 209,498**	**$ 488,576**	**$ 779,976**	**$ 1,082,503**	**$ 1,385,248**	**$ 1,688,218**
Capital Spending									
Capital Budget	$ 750,000	$ 24,345,896	$ 25,236,218	$ 17,240,041	$ 2,983,200	$ 2,475,000	$ -	$ -	$ -
Other									
Subtotal: Capital Spending	**$ 750,000**	**$ 24,345,896**	**$ 25,236,218**	**$ 17,240,041**	**$ 2,983,200**	**$ 2,475,000**	**$ -**	**$ -**	**$ -**
TOTAL NON-OPERATING, CAPEX AND RESERVES	**$ 791,183**	**$ 25,388,539**	**$ 27,352,020**	**$ 20,293,134**	**$ 6,293,747**	**$ 5,970,545**	**$ 3,586,775**	**$ 3,669,100**	**$ 3,753,483**
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Cash Flow									
Beginning of Year	**$ -**	**$ (67,483)**	**$ (1,389,282)**	**$ (3,320,196)**	**$ (5,087,392)**	**$ (4,841,377)**	**$ (3,847,944)**	**$ (2,728,419)**	**$ (1,652,858)**
Add: Net Income	$ (360,318)	$ (2,567,071)	$ (3,431,833)	$ (1,541,458)	$ 599,066	$ 1,423,480	$ 1,640,802	$ 1,679,161	$ 1,718,381
Add: Depreciation	$ 32,018	$ 1,078,155	$ 2,105,305	$ 2,827,355	$ 2,957,496	$ 3,065,497	$ 3,065,498	$ 3,065,499	$ 3,065,500
Add: New Funding	$ 1,052,000	$ 25,555,655	$ 26,747,635	$ 17,240,041	$ 2,983,200	$ 2,475,000	$ -	$ -	$ -
Add: General Fund Infused Cash	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Less: Non-Operating, CAPEX and RESERVES	$ (791,183)	$ (25,388,539)	$ (27,352,020)	$ (20,293,134)	$ (6,293,747)	$ (5,970,545)	$ (3,586,775)	$ (3,669,100)	$ (3,753,483)
End of Year	**$ (67,483)**	**$ (1,389,282)**	**$ (3,320,196)**	**$ (5,087,392)**	**$ (4,841,377)**	**$ (3,847,944)**	**$ (2,728,419)**	**$ (1,652,858)**	**$ (622,460)**
Year-to-year Delta	**$ (67,483)**	**$ (1,321,800)**	**$ (1,930,914)**	**$ (1,767,196)**	**$ 246,015**	**$ 993,433**	**$ 1,119,526**	**$ 1,075,561**	**$ 1,030,398**

Appendix D: FTTH Financial Model - Overhead

40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
10	11	12	13	14	15	16	17	18	19	20
2027	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**
$ 6,120,000	$ 6,120,000	$ 6,120,000	$ 6,120,000	$ 6,120,000	$ 6,120,000	$ 6,120,000	$ 6,120,000	$ 6,120,000	$ 6,120,000	$ 6,120,000
$ 866,700	$ 866,700	$ 866,700	$ 866,700	$ 866,700	$ 866,700	$ 866,700	$ 866,700	$ 866,700	$ 866,700	$ 866,700
$ 1,395,000	$ 1,395,000	$ 1,395,000	$ 1,395,000	$ 1,395,000	$ 1,395,000	$ 1,395,000	$ 1,395,000	$ 1,395,000	$ 1,395,000	$ 1,395,000
$ 8,381,700	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
$ 8,381,700	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**	**$ 8,381,700**
$ 1,100,902	$ 1,133,929	$ 1,167,947	$ 1,202,986	$ 1,239,075	$ 1,276,248	$ 1,314,535	$ 1,516,448	$ 1,561,941	$ 1,608,799	$ 1,657,063
$ 10,900	$ 11,000	$ 11,100	$ 11,200	$ 11,300	$ 11,400	$ 11,500	$ 11,600	$ 11,700	$ 11,800	$ 11,900
$ 124,000	$ 127,000	$ 130,000	$ 133,000	$ 136,000	$ 139,000	$ 142,000	$ 145,000	$ 148,000	$ 151,000	$ 154,000
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 10,937	$ 11,046	$ 11,157	$ 11,268	$ 11,381	$ 11,495	$ 11,610	$ 11,726	$ 11,843	$ 11,961	$ 12,081
$ 251,451	$ 251,451	$ 251,451	$ 251,451	$ 251,451	$ 251,451	$ 251,451	$ 251,451	$ 251,451	$ 251,451	$ 251,451
$ 21,657	$ 21,874	$ 22,092	$ 22,313	$ 22,537	$ 22,762	$ 22,989	$ 23,219	$ 23,452	$ 23,686	$ 23,923
$ 285,120	$ 285,120	$ 285,120	$ 285,120	$ 285,120	$ 285,120	$ 285,120	$ 285,120	$ 285,120	$ 285,120	$ 285,120
$ 5,618	$ 5,670	$ 5,723	$ 5,775	$ 5,828	$ 5,880	$ 5,933	$ 5,985	$ 6,038	$ 6,090	$ 6,143
$ 10,225	$ 10,250	$ 10,275	$ 10,300	$ 10,325	$ 10,350	$ 10,375	$ 10,400	$ 10,425	$ 10,450	$ 10,475
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 1,820,810	**$ 1,857,340**	**$ 1,894,865**	**$ 1,933,413**	**$ 1,973,017**	**$ 2,013,705**	**$ 2,055,513**	**$ 2,260,949**	**$ 2,309,970**	**$ 2,360,358**	**$ 2,412,156**
$ 6,560,890	**$ 6,524,360**	**$ 6,486,835**	**$ 6,448,287**	**$ 6,408,683**	**$ 6,367,995**	**$ 6,326,187**	**$ 6,120,751**	**$ 6,071,730**	**$ 6,021,342**	**$ 5,969,544**
$ 299,935	$ 308,933	$ 318,201	$ 327,747	$ 337,579	$ 347,707	$ 358,138	$ 368,882	$ 379,948	$ 391,347	$ 403,087
$ 23,902	$ 24,380	$ 24,867	$ 25,365	$ 25,872	$ 26,390	$ 26,917	$ 27,456	$ 28,005	$ 28,565	$ 29,136
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 23,433	$ 23,902	$ 24,380	$ 24,867	$ 25,365	$ 25,872	$ 26,390	$ 26,917	$ 27,456	$ 28,005	$ 28,565
$ 11,951	$ 12,190	$ 12,434	$ 12,682	$ 12,936	$ 13,195	$ 13,459	$ 13,728	$ 14,002	$ 14,282	$ 14,568
$ 11,951	$ 12,190	$ 12,434	$ 12,682	$ 12,936	$ 13,195	$ 13,459	$ 13,728	$ 14,002	$ 14,282	$ 14,568
$ 23,902	$ 24,380	$ 24,867	$ 25,365	$ 25,872	$ 26,390	$ 26,917	$ 27,456	$ 28,005	$ 28,565	$ 29,136
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 395,073	**$ 405,974**	**$ 417,183**	**$ 428,709**	**$ 440,560**	**$ 452,747**	**$ 465,279**	**$ 478,166**	**$ 491,419**	**$ 505,046**	**$ 519,061**
$ 6,165,816	**$ 6,118,385**	**$ 6,069,651**	**$ 6,019,578**	**$ 5,968,123**	**$ 5,915,247**	**$ 5,860,907**	**$ 5,642,585**	**$ 5,580,312**	**$ 5,516,296**	**$ 5,450,483**
$ 3,065,501	**$ 3,065,502**	**$ 2,945,003**	**$ 2,915,504**	**$ 2,861,425**	**$ 2,843,406**	**$ 2,828,407**	**$ 2,828,408**	**$ 2,828,409**	**$ 2,828,410**	**$ 2,828,411**
$ -	**$ 1**	**$ 2**	**$ 3**	**$ 4**	**$ 5**	**$ 6**	**$ 7**	**$ 8**	**$ 9**	**$ 10**
$ 3,065,501	**$ 3,065,503**	**$ 2,945,005**	**$ 2,915,507**	**$ 2,861,429**	**$ 2,843,411**	**$ 2,828,413**	**$ 2,828,415**	**$ 2,828,417**	**$ 2,828,419**	**$ 2,828,421**
$ 3,100,315	**$ 3,052,882**	**$ 3,124,646**	**$ 3,104,071**	**$ 3,106,694**	**$ 3,071,836**	**$ 3,032,494**	**$ 2,814,170**	**$ 2,751,895**	**$ 2,687,877**	**$ 2,622,062**

Appendix D: FTTH Financial Model - Overhead

40%	*40%*	*40%*	*40%*	*40%*	*40%*	*40%*	*40%*	*40%*	*40%*	*40%*
25%	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*	*25%*
$ 1,341,839	$ 1,253,420	$ 1,162,790	$ 1,069,895	$ 974,677	$ 877,078	$ 777,040	$ 674,500	$ 569,397	$ 461,667	$ 351,243
$ 1,341,839	**$ 1,253,420**	**$ 1,162,790**	**$ 1,069,895**	**$ 974,677**	**$ 877,078**	**$ 777,040**	**$ 674,500**	**$ 569,397**	**$ 461,667**	**$ 351,243**
$ 1,758,476	**$ 1,799,462**	**$ 1,961,856**	**$ 2,034,176**	**$ 2,132,017**	**$ 2,194,758**	**$ 2,255,455**	**$ 2,139,669**	**$ 2,182,497**	**$ 2,226,210**	**$ 2,270,819**
$ 3,536,776	$ 3,625,196	$ 3,715,825	$ 3,808,721	$ 3,903,939	$ 4,001,538	$ 4,101,576	$ 4,204,115	$ 4,309,218	$ 4,416,949	$ 4,527,373
$ 3,536,776	**$ 3,625,196**	**$ 3,715,825**	**$ 3,808,721**	**$ 3,903,939**	**$ 4,001,538**	**$ 4,101,576**	**$ 4,204,115**	**$ 4,309,218**	**$ 4,416,949**	**$ 4,527,373**
$ 11,079	$ 11,317	$ 11,560	$ 11,811	$ 12,068	$ 12,332	$ 12,604	$ 13,696	$ 14,007	$ 14,327	$ 14,656
$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061
$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061	$ 146,061
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 303,201	**$ 303,438**	**$ 303,682**	**$ 303,932**	**$ 304,189**	**$ 304,454**	**$ 304,725**	**$ 305,817**	**$ 306,128**	**$ 306,448**	**$ 306,778**
$ 1,991,419	**$ 2,294,857**	**$ 2,598,538**	**$ 2,902,470**	**$ 3,206,660**	**$ 3,511,113**	**$ 3,815,839**	**$ 4,121,656**	**$ 4,427,784**	**$ 4,734,233**	**$ 5,041,010**
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
$ 3,839,977	**$ 3,928,634**	**$ 4,019,507**	**$ 4,112,653**	**$ 4,208,128**	**$ 4,305,991**	**$ 4,406,301**	**$ 4,509,932**	**$ 4,615,347**	**$ 4,723,397**	**$ 4,834,150**
2026	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
$ (622,460)	**$ 361,539**	**$ 1,297,871**	**$ 2,185,225**	**$ 3,022,255**	**$ 3,807,573**	**$ 4,539,751**	**$ 5,217,318**	**$ 5,675,470**	**$ 6,071,038**	**$ 6,402,270**
$ 1,758,476	$ 1,799,462	$ 1,961,856	$ 2,034,176	$ 2,132,017	$ 2,194,758	$ 2,255,455	$ 2,139,669	$ 2,182,497	$ 2,226,210	$ 2,270,819
$ 3,065,501	$ 3,065,503	$ 2,945,005	$ 2,915,507	$ 2,861,429	$ 2,843,411	$ 2,828,413	$ 2,828,415	$ 2,828,417	$ 2,828,419	$ 2,828,421
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ (3,839,977)	$ (3,928,634)	$ (4,019,507)	$ (4,112,653)	$ (4,208,128)	$ (4,305,991)	$ (4,406,301)	$ (4,509,932)	$ (4,615,347)	$ (4,723,397)	$ (4,834,150)
$ 361,539	**$ 1,297,871**	**$ 2,185,225**	**$ 3,022,255**	**$ 3,807,573**	**$ 4,539,751**	**$ 5,217,318**	**$ 5,675,470**	**$ 6,071,038**	**$ 6,402,270**	**$ 6,667,359**
$ 984,000	**$ 936,332**	**$ 887,354**	**$ 837,030**	**$ 785,318**	**$ 732,178**	**$ 677,566**	**$ 458,152**	**$ 395,568**	**$ 331,232**	**$ 265,090**

Appendix E: Glossary of Terms

3G – Third Generation	The third generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
4G – Fourth Generation	The fourth generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
ADSL – Asymmetric Digital Subscriber Line	DSL service with a larger portion of the capacity devoted to downstream communications, less to upstream, typically considered a residential service.
AMI – Advanced Metering Infrastructure	Electrical meters that measure more than simple consumption and an associated communication network to report the measurements.
Bandwidth	The amount of data transmitted in a given amount of time; measured in bits per second, kilobits per second (kbps), and Megabits per second (Mbps).
Bit	A single unit of data, either a one or a zero. In the world of broadband, bits are used to refer to the amount of transmitted data. A kilobit (Kb) is approximately 1,000 bits. A Megabit (Mb) is approximately 1,000,000 bits. There are 8 bits in a byte (the unit used to measure storage space), therefore a 1 Mbps connection takes about 8 seconds to transfer 1 megabyte of data.
BNC	A Bayonet Neill-Concelman connector is a miniature quick connect and disconnect radio frequency connector used for coaxial connections.
BPON – Broadband Passive Optical Network	BPON is a point-to-multipoint fiber-lean architecture network system which uses passive splitters to deliver signals to multiple users. Instead of running a separate strand of fiber from the CO to every customer, BPON uses a single strand of fiber to serve up to 32 subscribers.
Broadband	A descriptive term for evolving digital technologies that provide consumers with integrated access to voice, high-speed data service, video-demand services, and interactive delivery services (e.g. DSL, Cable internet).
CAI – Community Anchor Institutions	The NTIA defines CAIs as “Schools, libraries, medical and healthcare providers, public safety entities, community colleges and other institutions of higher education, and other community support organizations and entities.” Universities, colleges, community colleges, social service providers, public safety, government, and municipal offices are all CAIs.

CLEC – Competitive Local Exchange Carrier	Wireline service provider authorized under state and Federal law to compete with ILECs to provide local telephone service. CLECs provide services by: 1) building telecommunications facilities of their own; 2) leasing capacity from another local telephone company (typically an ILEC) and reselling it; and 3) leasing discrete parts of the ILEC network referred to as UNEs.
CO – Central Office	A circuit switch where the phone lines in a geographical area come together, usually housed in a small building.
Coaxial Cable	A type of cable that can carry large amounts of bandwidth over long distances. Cable TV and cable modem service both utilize this technology.
CPE – Customer Premise Equipment	Any terminal and associated equipment located at a subscriber's premises and connected with a carrier's telecommunication channel.
Demarcation Point	The "demarc" is the point at which the public switched telephone network ends and connects with the customer's on-premises wiring.
Dial-Up	A technology that provides customers with access to the internet over an existing telephone line.
DLEC – Data Local Exchange Carrier	DLECs deliver high-speed access to the internet, not voice. Examples of DLECs include Covad, Northpoint and Rhythms.
DLT	Data Line Termination
Downstream	Data flowing from the internet to a computer (browsing the net, getting E-mail, downloading a file).
DSL – Digital Subscriber Line	The use of a copper telephone line to deliver “always on” broadband internet service.
E-Rate	A Federal program that provides subsidy for voice and data circuits as well as internal network connections to qualified schools and libraries. The subsidy is based on a percentage designated by the FCC.
EON – Ethernet Optical Network	The use of Ethernet LAN packets running over a fiber network.
EvDO – Evolution Data Only	EvDO is a wireless technology that provides data connections that are 10 times as fast as a traditional modem. This has been overtaken by 4G LTE.

Erbium-Doped Fiber Amplifier	An optical repeater device used to boost intensity of optical signals being carried through a fiber-optic communications system
FCC – Federal Communications Commission	A Federal regulatory agency that is responsible for regulating interstate and international communications by radio, television, wire, satellite and cable in all 50 states, the District of Rock Falls, and U.S. territories.
FTTH – Fiber to the Home	A fiber optic system that connects directly from the carrier network to residences to provide high-speed internet access within the home.
FTTP – Fiber to the Premise	A fiber-optic system that connects directly from the carrier network to the user premises.
GIS – Geographic Information Systems	A system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.
GPON- Gigabit-Capable Passive Optical Network	Similar to BPON, GPON allows for greater bandwidth through the use of a faster approach (up to 2.5 Gbps in current products) than BPON.
GPS – Global Positioning System	A space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
ICT – Information and Communications Technology	Often used as an extended synonym for information technology (IT), but it is more specific term that stresses the role of unified communications and the integration of telecommunications, computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information.
ILEC – Incumbent Local Exchange Carrier	The traditional wireline telephone service providers within defined geographic areas. Prior to 1996, ILECs operated as monopolies having exclusive right and responsibility for providing local and local toll telephone service within LATAs.
ISDN – Integrated Services Digital Network	An alternative method to simultaneously carry voice, data, and other traffic, using the switched telephone network.
ISP – Internet Service Provider	A company providing internet access to consumers and businesses, acting as a bridge between customer (end-user) and infrastructure owners for dial-up, cable modem and DSL services.
ITS – Intelligent Traffic System	Advanced applications that, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic

	management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.
Kbps – Kilobits per second	1,000 bits per second. A measure of how fast data can be transmitted.
LAN – Local Area Network	A geographically localized network consisting of both hardware and software that can link computers within a building with a single connection.
LATA – Local Access and Transport Areas	A geographic area within a divested Regional Bell Operating Company is permitted to offer exchange telecommunications and exchange access service. Calls between LATAs are often thought of as long-distance service. Calls within a LATA typically include local and local toll services.
Local Loop	A generic term for the connection between the customer's premises (home, office, etc.) and the provider's serving central office. Historically, this has been a copper wire connection; but in many areas, it has transitioned to fiber optic. Also, wireless options are increasingly available for local loop capacity.
MAN – Metropolitan Area Network	A high-speed intra-city network that links multiple locations with a campus, city or LATA. A MAN typically extends as far as 30 miles.
Mbps – Megabits per second	1,000,000 bits per second. A measure of how fast data can be transmitted.
MPLS – Multiprotocol Label Switching	A mechanism in high-performance telecommunications networks that directs data from one network node to the next based on short path labels rather than long network addresses, avoiding complex lookups in a routing table.
Overbuilding	The practice of building excess capacity. In this context, it involves investment in additional infrastructure projects to provide competition.
OVS – Open Video Systems	OVS is a new option for those looking to offer cable television service outside the current framework of traditional regulation. It would allow more flexibility in providing service by reducing the build out requirements of new carriers.
PON – Passive Optical Network	A PON is an optical distribution network comprised of fibers and passive splitters or couplers. In a PON network, a single piece of fiber can be run from the serving exchange out to a subdivision or office park, and then individual fiber strands to each building can be split from the main fiber using passive splitters or couplers. This allows for an expensive piece of fiber cable from the exchange to the customer to be shared by many customers, thereby dramatically lowering the overall costs of deployment for fiber to the business (FTTB) or fiber to the home (FTTH) applications.

PPP – Public-Private Partnership	A Public–Private Partnership (PPP) is a venture funded and operated through a collaborative partnership between a government and one or more private sector organizations.
QOS – Quality of Service	Refers to a collection of technologies and techniques to provide guarantees on a network to deliver predictable results reflected in Service Level Agreements. Elements of QoS often include availability (uptime), bandwidth (throughput), latency (delay), error rate, and prioritization of network traffic.
RF – Radio Frequency	A rate of oscillation in the range of about 3 kHz to 300 GHz, which corresponds to the frequency of radio waves, and the alternating currents which carry radio signals.
Right-of-Way	A legal right of passage over land owned by another. Carriers and service providers must obtain right-of-way to dig trenches or plant poles for cable systems, and to place wireless antennae.
RUS – Rural Utility Service	A division of the United States Department of Agriculture, it promotes universal service in unserved and underserved areas of the country with grants, loans, and financing. Formerly known as "REA" or the Rural Electrification Administration.
SCADA – Supervisory Control and Data Acquisition	A type of industrial control system (ICS). Industrial control systems are computer-controlled systems that monitor and control industrial processes that exist in the physical world.
SNMP – Simple Network Management Protocol	An internet-standard protocol for managing devices on IP networks.
SONET – Synchronous Optical Network	A family of fiber-optic transmission rates.
Steaming	Streamed data is any information/data that is delivered from a server to a host where the data represents information that must be delivered in real time. This could be video, audio, graphics, slide shows, web tours, combinations of these, or any other real time application.
Subscribership	Subscribership is how many customers have subscribed for a particular telecommunications service.
Switched Network	A domestic telecommunications network usually accessed by telephone, key telephone systems, private branch exchange trunks, and data arrangements.

T-1 – Trunk Level 1	A digital transmission link with a total signaling speed of 1.544 Mbps. It is a standard for digital transmission in North America.
T-3 – Trunk Level 3	28 T1 lines or 44.736 Mbps.
UNE – Unbundled Network Element	Leased portions of a carrier's (typically an ILEC's) network used by another carrier to provide service to customers. Over time, the obligation to provide UNEs has been greatly narrowed, such that the most common UNE now is the UNE-Loop.
Universal Service	The idea of providing every home in the United States with basic telephone service.
Upstream	Data flows from a computer to the internet (sending email, uploading files).
UPS – Uninterruptable Power Supply	An electrical apparatus that provides emergency power to a load when the input power source, typically main power, fails.
USAC – Universal Service Administrative Company	An independent American nonprofit corporation designated as the administrator of the Federal Universal Service Fund (USF) by the Federal Communications Commission that manages the E-Rate program.
VLAN – Virtual Local Area Network	In computer networking, a single network may be partitioned to create multiple distinct broadcast domains, which are mutually isolated so that packets can only pass between them via one or more routers; such a domain is referred to as a Virtual Local Area Network.
VoIP – Voice over Internet Protocol	An application that employs a data network (using a broadband connection) to transmit voice conversations using internet Protocol.
VPN – Virtual Private Network	A virtual private network (VPN) extends a private network across a public network. It enables a computer to send and receive data across shared or public networks as if directly connected to a private network, benefitting from the functionality, security, and management policies of the private network. This is done by establishing a virtual point-to-point connection using dedicated connections, encryption, or a combination of the two.
WAN – Wide Area Network	A network that covers a broad area (i.e., any telecommunications network that links across metropolitan, regional, or national boundaries) using private or public network transports.
Wi-Fi	Wi-Fi is a popular technology that allows an electronic device to exchange data or connect to the internet wirelessly using radio waves. The Wi-Fi Alliance defines

	Wi-Fi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards."
Wi-Max	Wi-Max is a wireless technology that provides high-throughput broadband connections over long distances. Wi-Max can be used for a number of applications, including “last mile” broadband connections, hotspot and cellular backhaul, and high-speed enterprise connectivity for businesses.
Wireless	Telephone service transmitted via cellular, PCS, satellite, or other technologies that do not require the telephone to be connected to a land-based line.
Wireless Internet	1) internet applications and access using mobile devices such as cell phones and handheld devices. 2) Broadband internet service provided via wireless connection, such as satellite or tower transmitters.
Wireline	Service based on infrastructure on or near the ground, such as copper telephone wires or coaxial cable underground or on telephone poles.