CITY OF LUCAS

Broadband Design and Financial Model

Magellan ADVISORS

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FINAL

Table of Contents

1. Executive Summary ____ *5*

2. What does Broadband mean to the City of Lucas? ____ *10*

2.1. Broadband Benefits to the Lucas Residents ____ 11

2.2. Lucas Technology and Communications Survey ____ 13

3. State of Broadband in Lucas ____ *18*

3.1. FCC Reported Broadband Supply ____ 18

3.2. Lucas Fixed Internet Providers ____ 20

3.3. Market Supply ____ 20

3.4. Other Providers and Network Assets ____ 24

4. Broadband Opportunities ____ *26*

4.1. Overview of Municipal Fiber Networks ____ 26

4.1.1. Fiber Is Critical Infrastructure ____ 27

4.1.2. Fiber is an Investment in Lucas' Future ____ 28

4.1.3. Fiber is the Next Utility ____ 28

5. FTTH Municipal Business Models ____ *29*

5.1. Policy Participation Only ____ 30

5.2. Infrastructure Provider ____ 30

5.3. Government Services Provider ____ 30

5.4. Open-access Provider ____ 31

5.5. Retail Service Provider – Business Only ____ 31

5.6. Retail Service Provider – Business & Residential ____ 31

5.7. Public-Private or Public-Public Partnership ____ 31

6. Lucas Regulatory Environment ____ *32*

6.1. Texas Regulatory Restrictions on Municipalities ____ 32

7. Lucas FTTH Network Overview ____ *34*

7.1. Conceptual Fiber-Optic Network Design ____ 34

7.2. Network Architecture ____ 38

7.3. Broadband Utility Operations Overview ____ 51

8. Lucas FTTH Services and Uptake ____ *55*

8.1. The Competitive Broadband Marketplace ____ 55

8.2. Proposed Products & Pricing 57
8.3. Uptake Scenarios 58
9. Lucas FTTH Financial Plan 59
9.1. Financial Information, Assumptions, Forecasts and Risks Disclaimer 59
9.2. Financial Plan Overview 60
9.3. Capital Expenditures 61
9.4. Customer Demand 65
9.5. Service Revenues 67
9.6. Operating Expenditures 69
9.7. Reserves 70
9.8. End-of-Year Free Cash 71
9.9. Pro Forma 73
10. Funding 77
11. Proposed Timeline for Buildout 79
12. Recommendations and Next Steps 81
Appendix A: Market Analysis Data 84
Residential 84
Business Market Analysis 91
Appendix B: Broadband-Friendly Policies 98
Holistic Policy Approaches 99
Focused Broadband Policies 100
Wireless Communication (Tower Siting and Antenna Collocation) 100
Wired (Conduit & Fiber) Rights-of-Way Excavations 103
Joint Trench and Joint Build Agreements 106
Conduit and Fiber Standards for New Home Construction 108
Engineering/Construction Specifications 109
Appendix C: Glossary 112

Table of Figures

FIGURE 1: FUNDING BREAKDOWN 7
FIGURE 2: 20-YEAR FINANCIAL METRICS 8
FIGURE 3: LUCAS RESIDENTIAL MAP 9
FIGURE 4: SURVEY ZONING MAP 15
FIGURE 5: 2019 SPEED TEST SURVEY DATA POINTS 16
FIGURE 6: HEAT MAP OF SPEED TEST SURVEY RESPONSES BELOW 25 MBPS 17
FIGURE 7: FCC FIXED BROADBAND DEPLOYMENT MAP 18
FIGURE 8: FCC FIXED BROADBAND AVAILABILITY MAP FOR 100/10 MBPS AND 1000/1000 MBPS SERVICE 19
FIGURE 9: MARKET ANALYSIS ADDRESS DATA POINTS 21
FIGURE 10: LUCAS METRO NETWORKS 25
FIGURE 11: LUCAS LONG HAUL NETWORKS 25
FIGURE 12: RISK AND REWARD CONTINUUM 30
FIGURE 13: CONCEPTUAL NETWORK DESIGN FOR THE LUCAS NETWORK 34
FIGURE 14: LUCAS FTTH BILL OF MATERIALS 36
FIGURE 15: NETWORK ARCHITECTURE OF A FIBER-TO-THE-PREMISES NETWORK 38
FIGURE 16: SERVICE DELIVERY SCHEMATIC 41
FIGURE 17: ITU FAMILY OF PON STANDARDS 43
FIGURE 18: FTTH ARCHITECTURE 44
FIGURE 19: RESIDENTIAL DEMAND UPTAKE 66
FIGURE 20: BUSINESS AND ANCHOR DEMAND UPTAKE 67
FIGURE 21: SERVICE REVENUES 68
FIGURE 22: OPERATING EXPENDITURES 69
FIGURE 23: RENEWAL AND REPLACEMENT RESERVE 71
FIGURE 24: END-OF-YEAR FREE CASH BASED ON UPTAKE 72
FIGURE 25: DEBT SERVICE PAYOFF 78

Table of Tables

TABLE 1: LUCAS TECHNOLOGY AND COMMUNICATIONS SURVEY ZONING MAP 14
TABLE 2: 2019 SPEED TEST SURVEY RESULTS 16
TABLE 3: BROADBAND PROVIDERS IN LUCAS, TX 20
TABLE 4: MARKET ANALYSIS ADDRESSES 21
TABLE 5: MARKET ANALYSIS FINDINGS 22
TABLE 6: SERVICE / CORE EQUIPMENT REQUIREMENTS 42
TABLE 7: STAFFING PLAN** 54
TABLE 8: RESIDENTIAL AND BUSINESS OFFERINGS 57
TABLE 9: UPTAKE COMPARISON 58
TABLE 10: 20-YEAR CAPITAL COST SUMMARY 65
TABLE 11: FINANCIAL MODEL BORROWING SUMMARY 78

1. Executive Summary

Forward thinking cities rely upon municipal fiber-optic (fiber) networks to adapt to the changing digital landscape in their communities. As more civic functions are carried out online or require interconnectivity, these networks help local governments meet the growing demands of their constituents and the other local public organizations serving them. Municipal fiber networks have also become assets through which municipalities can foster the development of leading-edge broadband services in their communities. These "Gigabit Communities" utilize technology to support the economic and community needs of their constituents, bringing world-class broadband to their communities.

As soon as November of 2020, the City of Lucas could ask the voters to support the selling of bonds to finance the buildout of a Fiber-to-the-Home (FTTH) network across the Lucas community, connecting every resident and business throughout the City with up to 10 Gbps Internet speeds. In addition, it would connect City facilities, sites and water system assets, and will directly support Smarter Government, through the deployment of future Smart City initiatives the City may decide to undertake. Examples could include traffic/mobility projects, surveillance and public safety systems, and the ability to deploy sensor systems for stormwater, environmental reporting, and other uses.

The lack of competition by the City's Internet providers is nothing new and has led to widespread service offerings that barely meet the FCC's stated definition to be classified as broadband. Lack of investment in the local infrastructure throughout Lucas is providing many users across the City with abysmal Internet services which directly impacts their daily lives negatively. Should the Lucas voters approve the necessary financing to move this project forward, the funding would be utilized to establish a Fiber Broadband Utility Division, structured as a City Enterprise Fund, to deliver a fiber connection and up to 10 Gbps of Internet bandwidth to each and every resident and business in Lucas, delivered as essential infrastructure. The City has sought guidance and participation from incumbent providers to deliver these types of next-generation broadband services, however it has not found a willing participant. The current solutions across Lucas are vast, but mainly consist of a patch work of very small fiber service areas, with legacy copper infrastructure connecting most across the community.

The City completed a formal survey of residents in 2018 called The Technology and Communications Survey. In 2019, the City's Technology Committee conducted a Speed Test Survey. In summary, almost all respondents to the 2018 survey (97%) stated that they have Internet in the home, while over half (55%) stated they purchase less than 20 Mbps (not broadband speeds) from their Internet provider. The survey did not inquire whether the respondent would purchase higher speeds or if those speeds were available to their location. Zones 3 and 4 located in South and East Lucas are generally satisfied with their Internet provider, while northern and western zones 1 and 2 are generally dissatisfied. An overview of the two surveys are provided in Section 2.2 of this document.

As many cities have witnessed, fiber-optic services have been transformational for their communities, and their citizens in many cases have rallied around the effort.

Some examples of other communities that made similar investments include:

- City of Mont Belvieu, TX – Launched in 2018, due to successful presales efforts, the City has hit 70% take rates within 24-months. First municipal ISP in Texas, reported fastest Internet speeds in the State.

- City of Cedar Falls, IA – Launched before 2000, Cedar Falls Utilities is the utility provider in the City, providing all utilities, including Garbage, Gas and Telecom. Has attained nearly 90% take rates across its City, providing triple-play services.

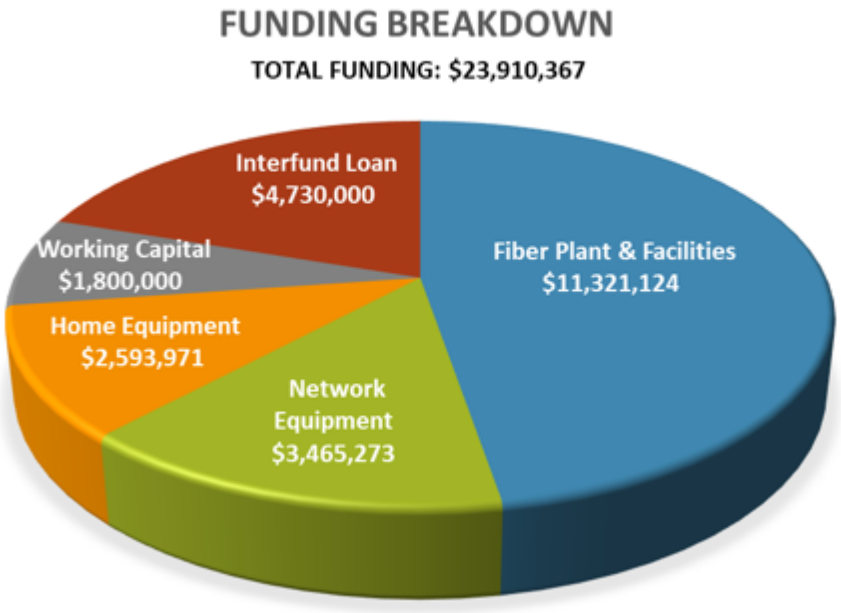
- City of Waverly, IA – Launched FTTH in 2016, and reached 50% take rates within 18-months of launch.

- City of Longmont, CO – Longmont NextLight provides access to about 100% of its homes and businesses and was ranked by PC Magazine as the "Fastest ISP in America."

- City of Chattanooga, TN – One of the first municipal utility FTTH projects in the US, Chattanooga's EPB now serves over 100,000 subscribers, and has reported recently that most of its net income in the past year has come from its telecommunications business, not its power division.

The total 20-year estimated capital costs are $20.65M, however, the City would look to only fund the initial buildout costs of $17.38M. Remaining capital costs would be covered through revenue and use of replacement/refresh reserves funds. Additional funding of $1.8M in working capital and $4.73M in Interfund Loans are planned for initial operating expenses and early end-of-year shortfalls.

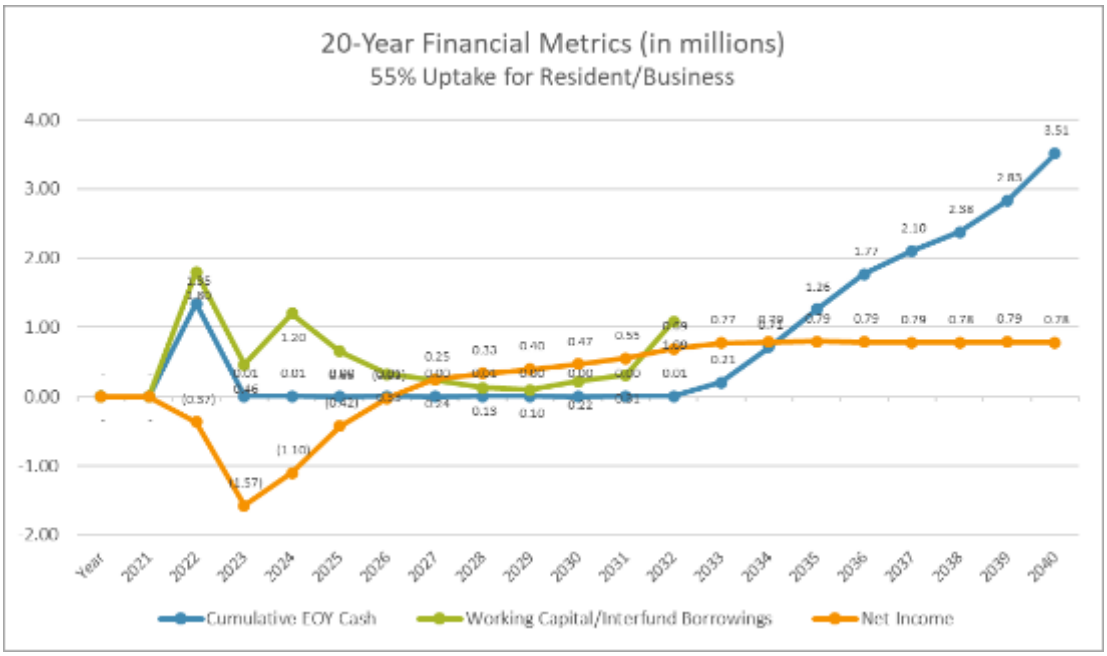
Figure 1: Funding Breakdown



Under a scenario of 55% the City would generate positive net income within 3 years after subscriber rollout and generate excess free-cash flow in 20 years of $3.51M and $13.64M in 30 years. Rates for 1 Gbps Internet Services would be $115/mo, while 10 Gbps Internet Services would be $195/mo.

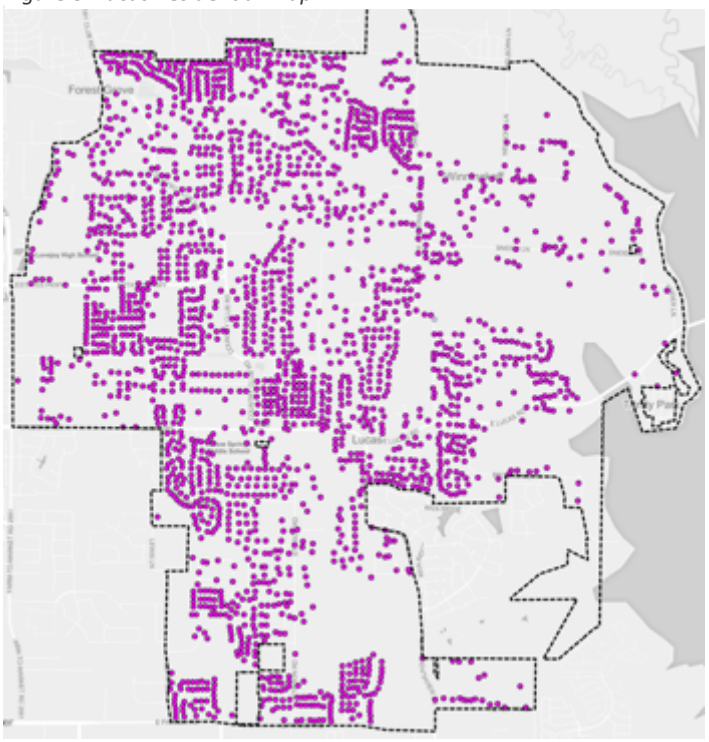
The following graph depicts a summary of 20-year key metrics.

Figure 2: 20-Year Financial Metrics



The Broadband Utility would require a team of 8 FTEs to manage the network, and service its customers. Participation of 55% of the City's residential households and businesses is required to ensure the network can become and maintain long-term sustainability. There are 1,714 residential passings north of Lucas Road and 744 south of Lucas Road. It can be assumed that there is greater demand north of Lucas Road due to 50% of residents that engaged in the Speed Test Survey and reported speeds less than 25 Mbps. It is also known that more infrastructure improvements and better services are available in the South. Due to these factors it could further be assumed that the City would expect greater subscribership or take rates in north Lucas.

Figure 3: Lucas Residential Map



The need for a 55% residential uptake is a result of two key factors. One, Lucas' desire to keep rates as low as possible and, two, Lucas' larger lot sizes creating a fairly low subscriber density in comparison to the size of the fiber buildout mileage. For comparison, Lucas needs to build out approximately 107.85 miles of backbone and distribution fiber for its 2,458 residential premises ("passings"), or on average, 232 feet per passing. Mont Belvieu, TX, and Dayton, TX, on the other hand, both had approximately 110 feet per passing. Lucas has approximately double the cost per passing than these cities, requiring the need for a higher uptake percentage.

The network buildout, comprised of 107.85 miles of backbone and feeder distribution fiber, is planned to be completed within three years from start of network design. During year one, network design, engineering, and permitting will be completed, as well as, purchase of designated buildout materials, and selection of a construction vendor. Year two will consist of 100% buildout of the fiber backbone ring and 40% of the distribution network. Also, in year two, standup of the data center including network equipment, hiring and training of initial personnel, establishment of operating policies, and pre-sales will occur. Initial customer rollout will occur beginning in year three along with buildout of the remaining 60% of the distribution network. Rollout to entire customer base will be available by year 4.

2. What does Broadband mean to the City of Lucas?

Digital technology keeps us informed, helps us plan and make decisions, and allows us to communicate and share with others. As more of our lives transition to the digital world, access to the Internet and its multitude of applications becomes increasingly important. Online applications for business, health, education, security and entertainment are integrated into our daily lives, and new ones appear regularly. All of this depends on digital connectivity via network infrastructure that brings the Internet into our homes and offices, and right into our hands. The Coronavirus Pandemic has made these things even more apparent, important, and necessary for people around the globe, and particularly in towns like Lucas, TX.

Broadband is a common term for a connection that is fast enough for consistent, reliable Internet access. Just like local roads feed into state roads, which feed into the interstate highway system to interconnect individuals to the country's infrastructure, local broadband infrastructure connects to regional and national high-speed networks that interconnect with the global Internet. If local infrastructure is insufficient, users (workers, students, professionals, and other people) will have difficulty doing what they need to do. The uses and nature of broadband are evolving rapidly. What's adequate today, skills and business practices as well as technology and infrastructure, will not cut it tomorrow.

The current FCC standard for broadband is at least 25 Mbps (megabits per second) download and 3 Mbps upload speed[1], which is a step up from just a few years ago and is increasingly seen as too slow. Fiber-optic broadband in many communities delivers 1 Gbps (gigabit per second, equal to 1,000 Mbps) connections and some communities are beginning to deploy 10 Gbps. Wireless connections are getting faster even as they become more numerous. Cellular LTE (Long Term Evolution) is moving from 4G to 5G, which will require more antenna and deliver much faster speeds (up to 1 Gbps). These new versions of wireless are more flexible and faster than before. Autonomous vehicles, drones, and other robots will use high-frequency short-range wireless connections. Other wireless connections using CB

[1] Download and upload speed refer to how fast data moves from the network to user and user to network. (i.e. how long it takes to download a movie or song and send an email with attachments)

radio and TV broadcast frequencies are emerging, as are long-range, low-power connections for the Internet of Things (IoT). Fiber connections are the foundation for wireless and all other connections and are supported by the fibers' conceptually unlimited bandwidth.

While many cities deploy fiber networks to bolster economic development, others with similar makeup as Lucas do it for reasons that target a better quality of life for its residents. However, the residents in Lucas are affluent, many living in large homes over 3,000 square feet, and many working from home full-time or telecommuting often. Many are running businesses and creating wealth out of their living rooms, and projects like this impact their economic abilities greatly. The COVID-19 pandemic has further exacerbated this, forcing many people to begin working from home that may not have in the past, children to do virtual learning rather than in the classroom, and families to stay in place as much as possible. We heard stories of issues with all family members connecting at the same time, struggling to work for employment and education purposes concurrently. Some individuals purchase service from multiple wireless or satellite providers, use boosters and their service continues to be dismal. The Internet services available to the residents in Lucas are generally not meeting their needs and this will continue to be an issue as fiber providers have no plans to upgrade or expand services into Lucas.

2.1. BROADBAND BENEFITS TO THE LUCAS RESIDENTS

Home-Based Businesses and Telecommuting

> "There is an even broader belief that using broadband to make home-based entrepreneurs a major economic development force, with 52% of respondents saying this is a likely outcome and another 25% who have had personal experience in this area." - International Economic Development Council

In 2010, DirecTV announced the creation of a virtual call center, allowing 100 residents in southwestern Virginia to work from home, relying solely upon municipal broadband access. In Powell, WY, 150 home-based English teachers were connected to students in South Korea by the Korean venture capital firm, Skylake Incuvest; this unorthodox pairing was made possible by Powell's investment in

FTTH. Policymakers in Ashland, OR, hope to use the city's fiber network, Ashland Fiber Net, to incentivize and support Internet-based home businesses.

According to Global Workplace Analytics in 2018, telecommuting continues to grow year after year. In fact, some analysts predict that 30% of workers in industrialized countries will be telecommuting within just a few years. It's already higher than that in some industries and regions. When allowing telecommuting, employers benefit by saving money and by increasing productivity. The benefits of working from home are plentiful, but telecommuters need high quality next generation broadband in order to take full advantage of this arrangement.

Advanced Healthcare, Education and Research

> "We are embarking on new initiatives with our local school district and regional colleges and universities to leverage broadband and to facilitate discussion between schools and the business community to strengthen, retain, and attract a quality workforce." - Dana McDaniel, Deputy City Manager of Dublin, Ohio

In Danville, VA, their municipal broadband has long served the Danville Regional Medical Center, one of the city's largest employers. Medical companies, Ohio Health and Cardinal Health; Battelle Memorial Institute, a non-profit that relies on quantum computing to encrypt information; and numerous educational facilities use the Dublin, OH municipally-owned fiber network for their healthcare, education, and research needs.

Remote aspects of healthcare, both monitoring and acute care, increase demand on bandwidth through the use of robotics and haptic devices. All telehealth fields are growing, including teletherapy and telepsychiatry, with universities and colleges needing real time access to licensed counselors for interventions. Policies in remote imaging, cardiology, and transmission of Electronic Health Records are expected to increase demands further with needs for low latency becoming increasingly critical.

"Aging in place" is a term used to describe seniors living in the place of their choice for as long as possible, while getting the services they require, and all needs met without moving in with children or being placed in a nursing or assisted living facility. New gadgets and technological advancements have been made to make

"aging in place" easier and more attainable for the growing population of seniors. Home-based telehealth, or home health monitoring solutions, keep physicians in touch with patients and monitor their health without visiting an office. There have been other advances including but not limited to fall detection systems, wearable sensors that collect real time health data, and stove guards.[2] Reliable, high-speed Internet access is required for these new technological advances, and the retirees of Lucas would see value in being able to utilize these products and services.

Home Values

> "As more research on housing prices and home Internet access surfaces, the value of FTTH deployments appears to be on the rise. A 2014 study by the consulting firm RVA LLC revealed a $5,250 increase in the value of a $300,000 home. Now, according to the newest study, a similar increase in value can be seen in homes worth half this amount." – Fiber-to-the-Home Americas

Housing prices increased by 50% in one year when Google decided to locate a data center in the City of The Dalles, OR, on account of its advanced technological infrastructure and high-speed municipal broadband access. A study by the Fiber-To-The-Home Council and the University of Colorado showed that single family homes that boast a FTTH connection are worth, on average, 3.1% more than their fiberless counterparts. As the testimonial above confirms, high-speed fiber-based networks are a critical component to growth and maintenance of local economies in the Digital Age.

2.2. LUCAS TECHNOLOGY AND COMMUNICATIONS SURVEY

In October 2018, the City of Lucas conducted a residential Technology and Communication Survey aimed at learning how residents felt about technology-related services available in Lucas, and how well the City communicated with its community. The survey had 400 respondents, or approximately 17% of the households in Lucas summarized into four city zones. Of the data gathered from the survey, 61% of the survey respondents are not getting the minimum broadband

[2] http://aginginplace.com

data speeds as defined by the FCC (i.e. speeds of 25 Mbps for downloads and 3 Mbps for uploads, "25/3"), to their homes. However, an overwhelming majority of respondents paid attention to communication from the City and rated those communications highly. Close to 100% of respondents read the local Lucas Leader and 72% of respondents had a very good or excellent opinion of City of Lucas communications. This could be indicative of the opinion of the residents who may see value in development of a locally owned broadband utility, or at minimum, those who will be listening closely to this topic.

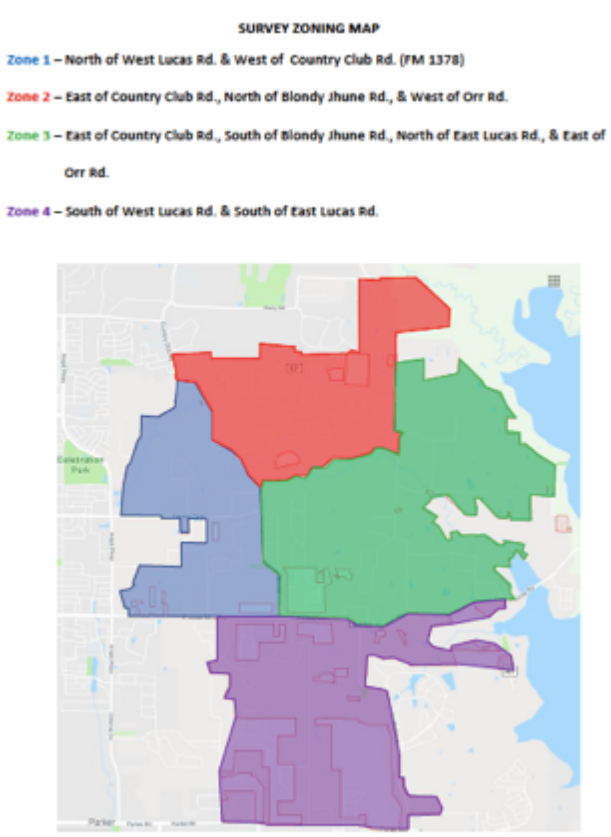
While almost all respondents (97%) stated that they have Internet in the home, over half (55%) stated they purchase less than 20 Mbps (not broadband speeds) from their Internet provider. The survey did not ask if this is all the speed they needed or whether these speeds were all that is available to their location. Conversely, about half of respondents (46%) stated that they were dissatisfied or very dissatisfied with their Internet service provider.

When analyzing the results of the City Zones, we find the following:

Table 1: Lucas Technology and Communications Survey Zoning Map

Zone	% of Total Responses	Dominant Provider	Satisfaction (Satisfied to Very Satisfied)
Zone 1	22%	AT&T (65%)	46%
Zone 2	29%	AT&T (48%)	26%
Zone 3	32%	AT&T (46%)	66%
Zone 4	17%	Frontier (93%)	57%

Figure 4: Survey Zoning Map



Zone's 3 and 4 are generally satisfied with their services, while Zone's 1 and 2 are generally dissatisfied. Again, the survey did not inquire whether residents could or would purchase higher speeds or a different service for their homes. During meetings with City Council and the City Tech Committee, Magellan was advised that Internet access is a prevailing issue in the City of Lucas. And while Zone 4 is well served at this point in time, the City has heard from many constituents in other zones that high-speed Internet is not available, and the Internet services residents receive do not meet their needs today.

This survey was conducted in 2018, prior to the COVID-19 pandemic. While we cannot say for certain, but if the survey was distributed in 2020 the results may be quite different regarding Internet provider satisfaction. The pandemic has amplified Internet issues across the country, with huge signs of increased Internet activity choking many local networks. People need to be able to work, learn, engage in the economy and entertain themselves from their homes more so today than they did two years ago. Although the satisfaction with Internet service providers were relatively split in 2018, those figures have most likely increased today, especially given the lack of recent investment by those providers in the Lucas market.

The City of Lucas will most likely put this issue to the voters in 2020 or 2021 and doing so should give the City additional insight into whether the residents are currently satisfied with their Internet today and whether they would look to subscribe from a City of Lucas provided Internet service.

2019 Speed Test Survey

In the summer of 2019, the City conducted a speed test survey yielding 514 speed test results from across the city. While there were some residents reporting acceptable speeds, the median download speed was 19 Mbps and upload speed was 4.6 Mbps, both below FCC defined broadband speed minimums. In addition, no test result showed speeds close to 1 Gbps.

Table 2: 2019 Speed Test Survey Results

Speeds Reported	Download (Mbps)	Upload (Mbps)
Minimum	0.05	0.01
Maximum	504.54	518.45
Median	19.315	4.605
Average	41.01824903	23.18212062

Magellan Advisors utilized our GIS mapping system to plot the survey results according to speeds recorded: under 25 Mbps, 25-99 Mbps and over 100 Mbps. As can be seen in the figure, many of the low speed tests (under 25 Mbps) occur north of Lucas Rd and the higher speed tests (over 100 Mbps) occur in the south.

Figure 5: 2019 Speed Test Survey Data Points

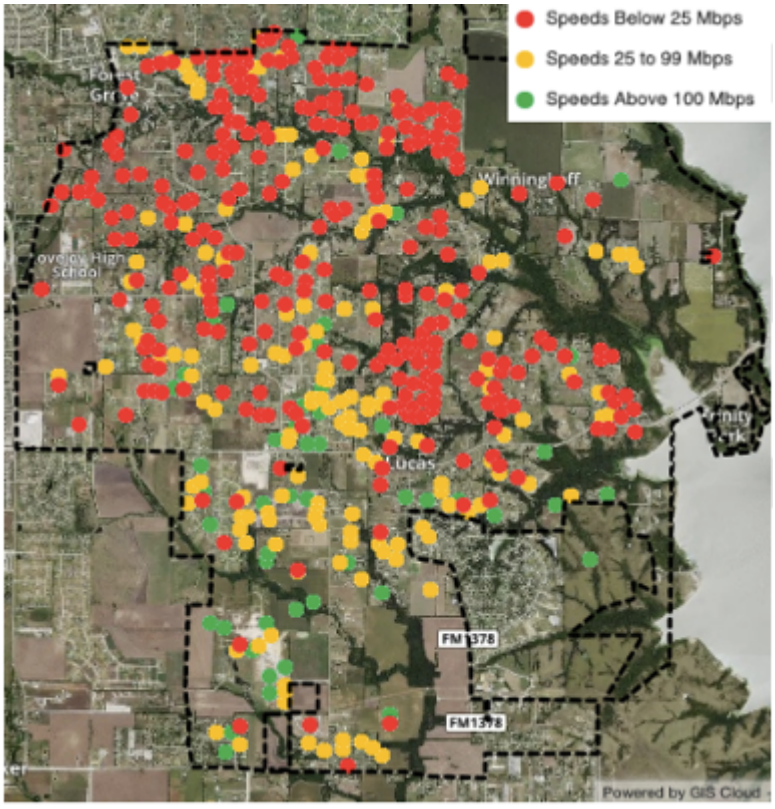
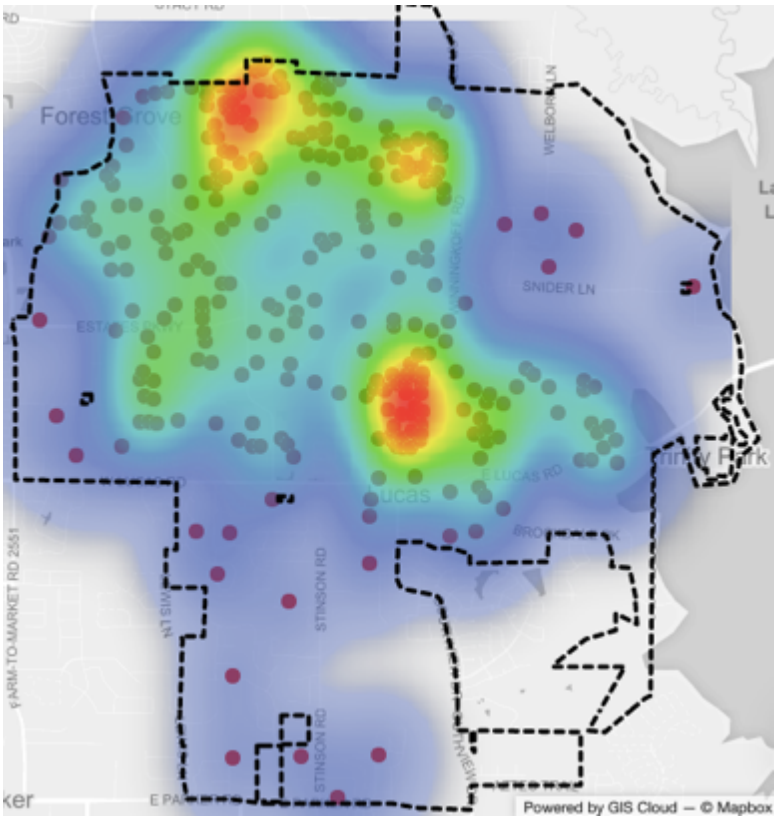


Figure 6: Heat Map of Speed Test Survey Responses Below 25 Mbps



When the above survey data is further analyzed using a heat map. The heat map depicts areas with lower density of speeds below 25 Mbps (blue) ranging to higher densities (red). As shown, most of the areas with lower than 25 Mbps are in the north sections of Lucas. These areas of Lucas could be planned during the initial phases of the distribution build out to capture take rates at the onset of the project.

3. State of Broadband in Lucas

3.1. FCC REPORTED BROADBAND SUPPLY

U.S. Baseline Coverage

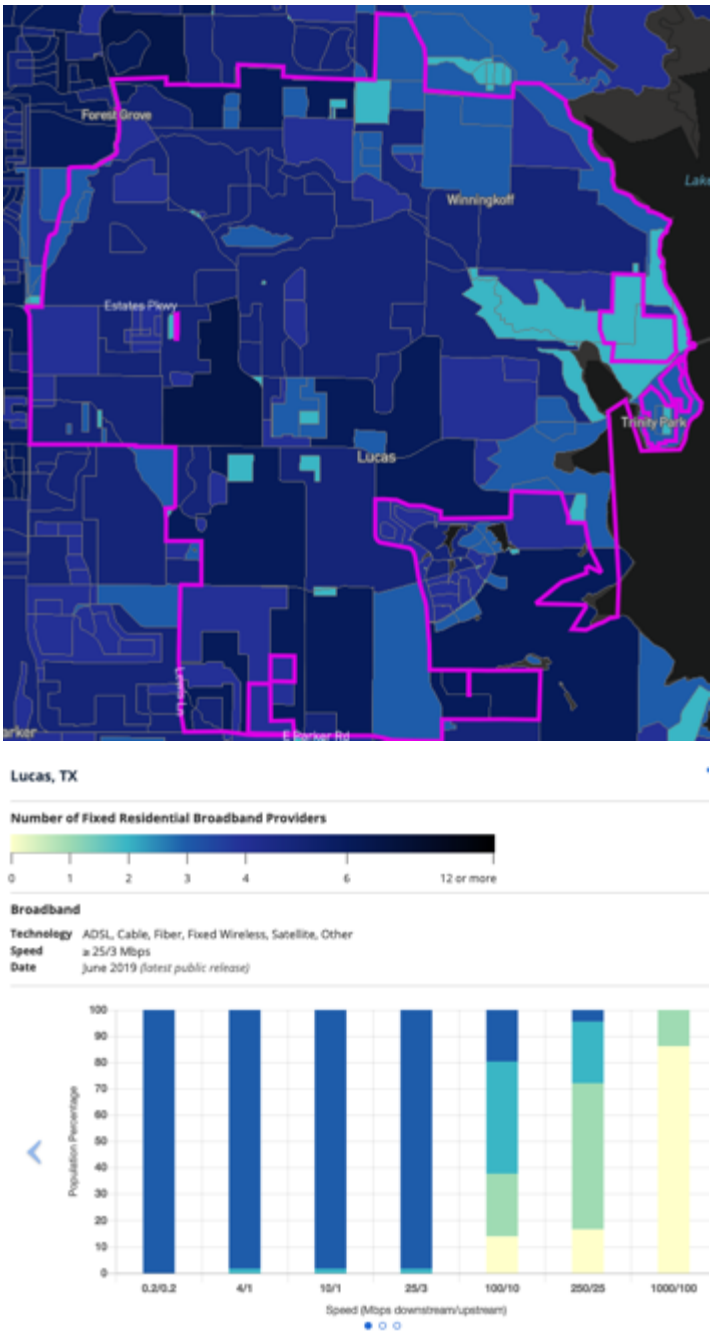
OOKLA is reporting fixed and mobile Speedtest results on a monthly basis. Reported by OOKLA, as of April 2020, the nationwide USA average fixed Internet download speed was 132.6 Mbps, and average upload speed was 47.7 Mbps. At a global level, the U.S. ranked 11th in the world for average fixed Internet speed.

Texas shows an average download speed of 106.98 Mbps and upload speed of 39.39 Mbps. Suddenlink, Spectrum and AT&T are major providers in the state. All state they have 1 Gbps service available from fiber and cable in some areas.

FCC Baseline Data for Lucas, TX

The FCC's most recent fixed broadband availability map as of Dec 31, 2018, shown above, is based on data self-reported by Internet Service Providers. Darker shading indicates a higher number of Internet Service Providers offering speeds of at least 25/3 Mbps. Black shading represents 12 or more providers. The light green color on the map indicates only 1 or 2 providers of broadband service, but this data may include higher latency satellite service

Figure 7: FCC Fixed Broadband Deployment Map

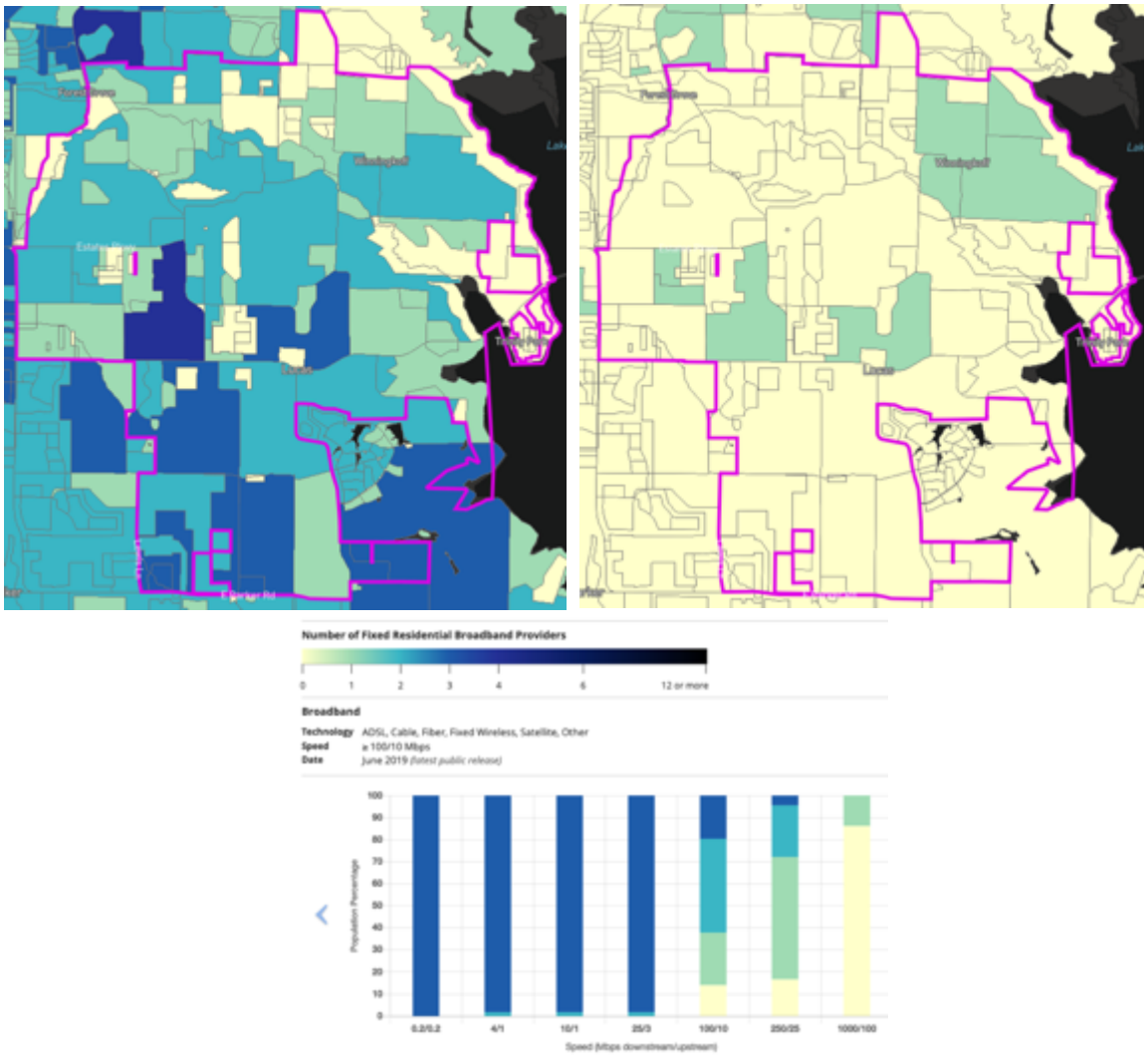


that affects usability for interactive applications such as gaming and voice calls. In addition, like mobile broadband providers, satellite service providers often cap the amount of Internet data that can be downloaded and uploaded each month, imposing additional charges for data overages. This map indicates that 99% of the Lucas area has 25/3 Mbps service available from at least 2 providers.

It is important to mention that this data is self-reported provider data and if the provider serves one address within the census block with 25/3 Mbps service or higher it is considered served. It also includes satellite providers whose services have issues with latency and reliability.

The following maps show the service availability for 100/10 Mbps service and 1000/1000 Mbps service.

Figure 8: FCC Fixed Broadband Availability Map For 100/10 Mbps and 1000/1000 Mbps Service



The FCC Data indicates that 100/10 Mbps service is available from at least 2 providers for 43% of the service area. However, not all locations in the same census block may be able to access the same level of service. The Gigbit service (1000/1000) is only available to 14% of the city area from 1 provider. The lighter tan areas in the map indicate no service of that class available.

3.2. LUCAS FIXED INTERNET PROVIDERS

Lucas has four wired Internet providers, with two covering over 80% of the City with 25/3 Mbps service. One fixed wireless company, Rise Broadband offers service in some areas of the City as well.

Table 3: Broadband Providers in Lucas, TX

Provider	Type	Download speeds up to
Spectrum	Cable	940 Mbps
AT&T	Cable/Fiber	100 Mbps/1000 Mbps
Frontier	DSL	100 Mbps
Suddenlink	Cable	1000 Mbps
Rise Broadband	Fixed Wireless	25 Mbps

3.3. MARKET SUPPLY

An assessment of private-sector telecommunications infrastructure, companies and services in the Lucas, TX area provides context for a more targeted evaluation. It also informs companies of the City's strategies since these companies are prospective partners and potential competitors. Companies that nominally sell network services in Lucas are listed in Table 3. Magellan Advisors conducted the market analysis through multiple methods, gathering data from BroadbandNow.com, searching providers websites for offerings for residential and business addresses, and contacting providers requesting information for a specific set of addresses throughout the City.

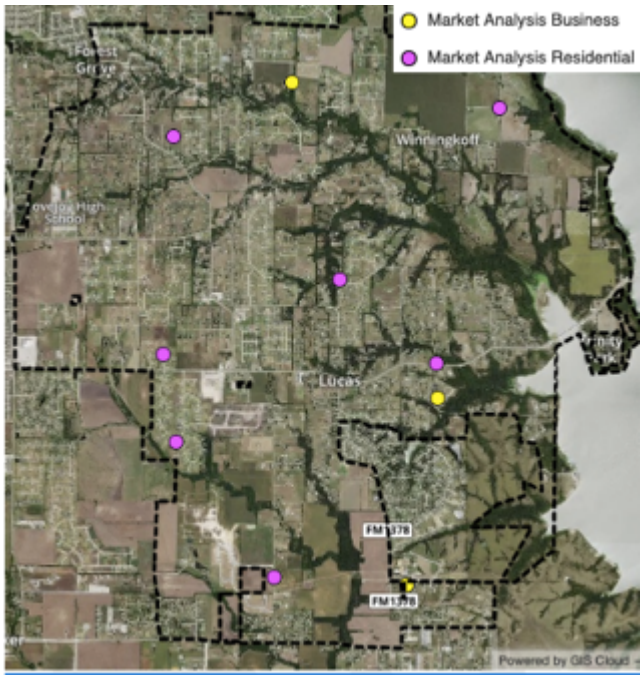
The City of Lucas conducted a Technology and Communication Survey in October of 2018. They received 400 responses of which 14 had no home-based Internet access. 169 (42%) stated their provider was AT&T, 81 (20%) Frontier, 87 (22%) Rise Broadband, 30 (8%) Suddenlink, and 0 reported Spectrum. Magellan's market analysis supports the majority of these statistics, aside from Suddenlink. Suddenlink was found to offer services at all addresses researched, with Gigabit speeds for at a price for life at $54.99 per month. At the time of the survey, 46% of respondents had access to 20 Mbps or less in their household and only 9% of households had purchased greater than 100 Mbps. The survey also found that the respondents were fairly split on satisfaction with their Internet service provider.

Lucas is comprised of one zip code, 75002. Addresses were chosen in various areas of the city to check for availability from all the providers.

Table 4: Market Analysis Addresses

	Residential Addresses	Commercial Addresses
1	1705 Stinson Rd	535 W Forest Grove Rd
2	370 Bee Caves Rd	3855 Osage Ln
3	221 Forestview Rd	1125 Brockdale Park Rd
4	1830 Country Club Rd	
5	919 E Lucas Rd	
6	285 Red Star Rd	
7	1220 Ford Ln	

Figure 9: Market Analysis Address Data Points



Incumbent telecommunications service providers

The two major providers are Spectrum and AT&T. Both state they have over 88% coverage of the Lucas Market, however we did not find Spectrum service at any location researched. According to BroadbandNow, Suddenlink provides service to 8% of the market in Lucas, however Magellan's research shows coverage to all addresses above. Rise Broadband provides fixed wireless service in Lucas as well.

General offerings by providers in Lucas are provided below. These rates are current rates offered to new customers, or promotional rates. In order to determine what current customers are truly paying in the market today, Lucas would need to conduct a survey of residents to collect this information. See Appendix A for data collected for all addresses.

Table 5: Market Analysis Findings

Provider	Residential Service Offerings	Commercial Service Offerings
Spectrum	Although Spectrum shows over 90% availability on BroadbandNow's website, Magellan did not find service at any address checked in Lucas.	Although Spectrum shows over 90% availability on BroadbandNow's website, Magellan did not find service at any address checked in Lucas.
	Magellan found AT&T service offerings at four out of seven addresses in Lucas. Generally, AT&T offers speeds 10-25 Mbps for $39.99 or $49.99 per month respectively. One address had access to AT&T Fiber with a Gigabit offering for $49.99 per month, for a 12-month period.	Magellan found AT&T service offerings at all two out of three addresses in Lucas. Two addresses had access to DSL and two to fiber. Those with DSL had speeds from 6-25 Mbps, with $40-$50 per month costs. Those with fiber had access to dedicated Internet ranging from 10 Mbps to 10 Gbps, with pricing ranging from $550 - $10,826 per month.
Frontier COMMUNICATIONS	Magellan found Frontier service offerings at two out of seven addresses in Lucas. Internet speeds offered at the two addresses included 50 Mbps, 500 Mbps and 1 Gigabit speeds for $29.99, $39.99, or $74.99 per month.	Two out of four addresses had access to FiOS Fiber with the other two had no service availability. Speeds ranged from 100 Mbps to Gigabit services, symmetrical, with pricing ranging from $49.99 - $259.99 per month with a one-year contract.
suddenlink	All addresses in Lucas that Magellan checked were found to have Suddenlink service	Suddenlink offered business services to one out of four addresses researched. Speeds

	offerings. Internet speeds offered were 100 Mbps, 400 Mbps, and Gigabit service for $39.99, $44.99, and $54.99 per month.***	at the one address ranged from 300 Mbps to Gigabit services, symmetrical, with pricing ranging from $135.39 - $405.30 per month with price increases after 12 months.
	Magellan located service options in two out of seven addresses researched. Options included speeds of 25 Mbps, 50 Mbps, and 50 Mbps with unlimited data for special pricing of $29.95 and $39.95 respectively with a $10 increase in pricing after 12 months. Normal pricing is $60 and $70 per month, respectively.	Rise Broadband offered services to all business addresses researched. Speeds ranged from 25 – 50 Mbps, with pricing ranging from $79.95 - $99.95 per month with a one-year contract.
	Grande Communications shows service to 16% of the City of Lucas on BroadbandNow's website, however Magellan could not locate service at any of the seven addresses researched. They currently advertise 300 Mbps, 600 Mbps, and 940 Mbps on their website for $35.99, $49.99 and $69.99 per month respectively for 2 years.	Grande Communications offers business services on a consultation basis.

*** 100 Mbps price for 1 year, 400 Mbps price for 2 years, Gig price for life

It is important to note a number of items regarding the predominant providers in the Lucas market. First, AT&T did reach out for discussion during this engagement and they have no plans of upgrading current infrastructure in Lucas. New greenfield development will be installed with fiber-optic infrastructure, but Lucas is largely built out and all current homes will not receive fiber services from AT&T in the foreseeable future. Second, Frontier has declared bankruptcy so the state of their infrastructure or who will be providing service using their infrastructure in the future is uncertain. Third, SuddenLink does provide a 1 Gbps service in Lucas,

however, this is via coaxial cable and speeds are not symmetrical. Typically, SuddenLink's services are 1 Gbps download and 10 or 40 Mbps upload. Users run into issues with videoconferencing and sending large files with asymmetrical services due to low upload speeds. Lastly, Magellan submitted Service Provider data requests to all providers, including requests for infrastructure maps, however only AT&T responded, but did not provide any data.

3.4. OTHER PROVIDERS AND NETWORK ASSETS

There are multiple companies with network assets in and around Lucas. These include regional "middle-mile" networks that connect local networks together, as well as national and international "long-haul" networks that pass through the area. Several of these providers are regionally focused. Some provide IP transport and enterprise network services, some lease dark fiber that users must light and manage. There are also a number of wireless service providers and data center operators as well.

Cellular wireless services

Cellular services use licensed spectrum that is ideal for mobile connectivity. Some Lucas residents may use cellular services as a primary or back-up when there are issues connecting multiple users with low bandwidth fixed connections. Antenna are mounted on towers and are contained in subscriber devices. As subscribers move, their wireless signals hand-off from one cell to the next. Some of the spectrum is used for voice, some for data and Internet access. Average mobile speeds for the Texas market area documented by OOKLA Speedtest for 2019 Q1-Q2 are 29.74 Mbps DL/9.33 Mbps Uplink. This data is specific to the whole state but indicative of speeds achievable in Lucas.

Speeds are nominally as fast as 28 Mbps (from T-Mobile) but speeds depend on numerous factors, including distance from cell site, number of subscribers in the cell coverage area, and weather. Also, cellular data services may come with data caps that slow the service or charge more for additional data.

Metro and long-haul fiber networks

As shown in Figure 10, there are two metro fiber network providers in or around Lucas. Grande Communications has metro network assets running through Lucas and Unite Private Networks has a route running just into the Lucas city boundary. Figure 11 shows two long-haul networks outside of Lucas. Hillary Communications and Zayo have long-haul networks running through adjacent Allen, TX.

Figure 10: Lucas Metro Networks

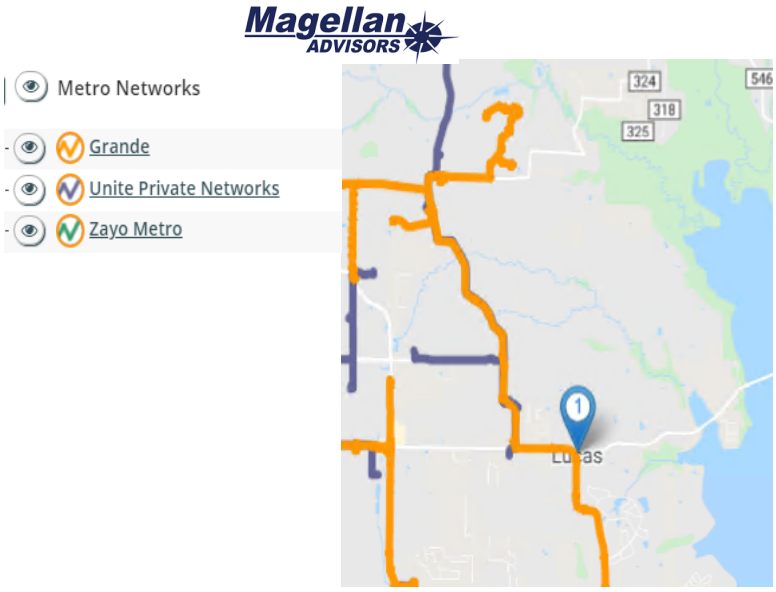
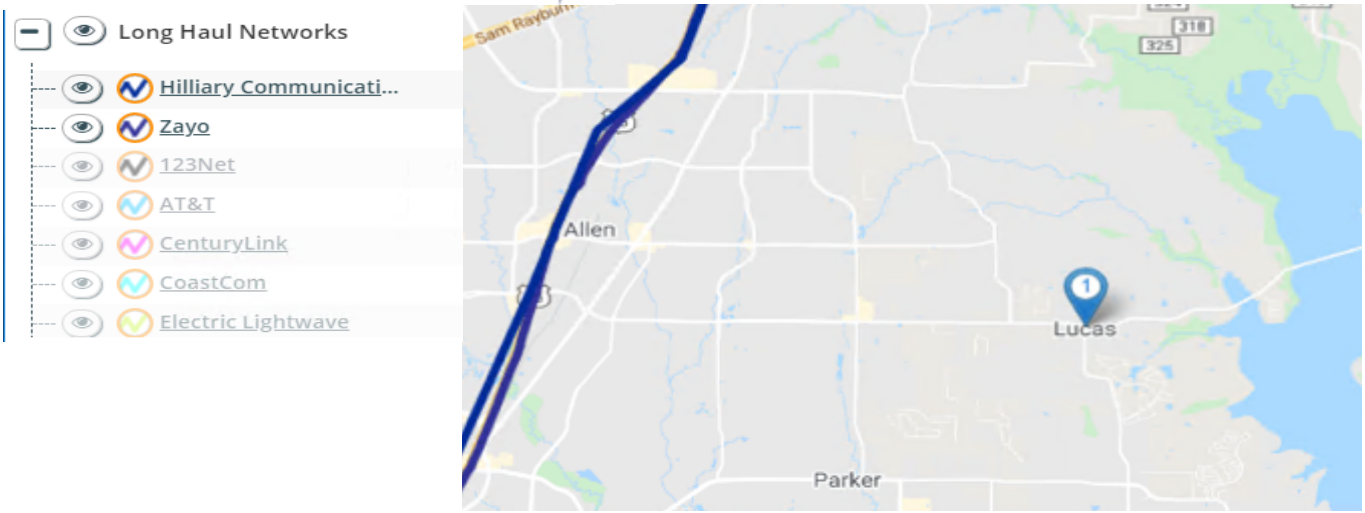


Figure 11: Lucas Long Haul Networks



4. Broadband Opportunities

The City of Lucas has the opportunity to deploy a Fiber-to-the-Premise/Fiber-to-the-Home (FTTP/FTTH) network capable of serving all homes, businesses and community anchors throughout the community. It would build a fiber backbone along major corridors in the City, creating multiple redundant fiber rings, extending to a fiber distribution network reaching all areas of the City. The fiber distribution network would pass all residential and business premises allowing for 100% of all users to sign-up for service with the City.

The City's fiber network would pass through Lucas' limited commercial corridors to enhance services available to current businesses in the City, while interconnecting education and other public sites and facilities with high-speed transport networks. The network would enable the City of Lucas to enhance its municipal services, and its smart city ambitions, enabling automated meter reading/advanced metering infrastructure technology for its water and waste water utility, intelligent transportation systems (ITS) for its traffic group, as well as cameras and other surveillance/sensor networks for public safety and general government benefit.

Municipal fiber networks have the ability to drive costs down, while increasing speeds to the end users, and improving their experience dramatically. In fact, in cities like Mont Belvieu, where MBLink is the dominant provider serving nearly 70% of premises in the community, user experience and feedback is overwhelming. As the municipal utility provider, MBLink has utilized a standing in the community as a community owned provider of water and wastewater services and has incorporated its telecommunications services into a single customer bill. Today, MBLink provides 1 Gbps symmetrical Internet services to every household in and around the City of Mont Belvieu, and was just rated as providing the fastest Internet speeds in Texas.

4.1. OVERVIEW OF MUNICIPAL FIBER NETWORKS

Fiber is the gold standard for municipal communications, broadband services, and Internet access. Fiber is used to transmit large amounts of data securely over long distances with high reliability. It supports a wide range of applications and is scalable to support nearly unlimited data capacity. Cities that own fiber consider it a capital infrastructure asset similar to water, road, and electric infrastructure.

Over 3,000 cities in the US own some form of municipal fiber and have used it for decades to support their communities. These networks are becoming increasingly important to cope with the rapid growth in connected devices, from utility assets, to streetlights, to traffic signals, to surveillance cameras. Cities that maintain these networks are able to accommodate these "Smart City" technologies that make them more efficient, reduce costs and increase the value they deliver to their constituents.

Within the past 15 years, some cities have expanded the use of these networks to enhance local broadband Internet services in their communities in order to support the needs of residents, businesses, and community organizations. As high-speed Internet access has become essential to support economic development, education, healthcare, and other community functions, cities have leveraged their networks to provide fiber-based Internet services, either directly or through partnerships with private broadband providers. Some of the key reasons why local governments have chosen to invest in this technology include:

4.1.1. FIBER IS CRITICAL INFRASTRUCTURE

Cities should classify fiber as they do other infrastructure resources, a long-term asset that supports the municipal operations and community needs. Fiber maintains a useful life of up to 50 years; however, it is depreciated over 20-years just as other capital assets typically are. The City should view fiber as an infrastructure asset that will continue to drive value, cost reductions, and new capabilities in Lucas, including a better quality of life for its residents.

The City should also consider establishing policy for the ongoing development of municipal fiber. As subsurface utility work occurs, or as new developments are built, it presents opportunities for the City to install new conduit and fiber in the right of way at reduced costs. Dig once and joint trench policies allow the City to take advantage of other subsurface utility projects for the installation of fiber. This enables the City to expand its ownership of fiber anytime subsurface utility work occurs, at preferential costs over new construction.

4.1.2. FIBER IS AN INVESTMENT IN LUCAS' FUTURE

For the City, building a fiber backbone is an investment in Lucas' future. The City will own an asset that can accommodate smart and connected technologies as more municipal and community functions are carried out online. Smart City technologies and the Internet of things are two growing ecosystems of devices that will change the way that cities carry out their missions. More devices, sensors, and more people will be connected than ever before. By building a fiber network, Lucas will be prepared to accommodate these emerging trends. The fiber backbone will keep Lucas at the leading edge of innovation and support a range of municipal, community, and broadband applications. Without it, the City cannot consider the vast majority of them.

4.1.3. FIBER IS THE NEXT UTILITY

Fiber-optic services is the next utility. Like water, wastewater and electricity, fiber connectivity paired with high-speed Internet are now an essential service. This recent pandemic has exemplified this concept. Each and every home and business in Lucas should have access to high-speed network connectivity. Where the private sector won't solve the problem, cities have created utilities, and in certain cases, Special Purpose Districts to step up and fill the gap.

Lucas Fiber would be an extension of the City's Water and Wastewater Utility operations, providing a significant public service, and elevating the community to the ranks of having the fastest Internet available across Texas and the United States. Fiber is the next utility, and through this plan, the City of Lucas would step in to make it fully accessible to all.

5. FTTH Municipal Business Models

The City of Lucas must identify how it will utilize the fiber-optic network to bring next-generation broadband services to the community. The City will also have to select the most appropriate business model that aligns with the vision of the community and its leadership, and one that fits organizationally into the City's municipal operation. While many communities strive to be a fully functioning provider of retail services, it comes with significant challenges. The fact that the City of Lucas operates its own water and wastewater utility should be considered when selecting a business model. Lucas will need to make decisions regarding insourcing or outsourcing departments to support the delivery of services, along with management and maintenance of the network.

The commonly implemented business models fall on a continuum that ranges from low risk, low investment options to higher risk, high investment options. Figure 12 illustrates this continuum. As a local government evaluates the various business model options along the continuum, it will encounter greater degrees of risk and reward; risk, in terms of financial, operational, and regulatory risk; reward, in terms of community benefits, revenue generation, and overall potential for profit. In addition, moving "up" the continuum also implies greater local government participation in the delivery of broadband services.

Figure 12: Risk and Reward Continuum

5.1. POLICY PARTICIPATION ONLY

This is the most passive model and includes permitting, right of way access, construction, fees, and franchises that regulate the cost of constructing and maintaining broadband infrastructure within its jurisdiction. This option is not considered a true business model but does significantly affect the local broadband environment and is therefore included as one option.

5.2. INFRASTRUCTURE PROVIDER

Municipalities lease and/or sell physical infrastructure, such as conduit, dark fiber, poles, tower space, and property to broadband service providers that need access within the community. These providers are often challenged with the capital costs required to construct this infrastructure, particularly in high cost urbanized environments. The Broadband Utility infrastructure provides a cost-effective alternative to providers constructing the infrastructure themselves.

5.3. GOVERNMENT SERVICES PROVIDER

These organizations are generally limited to the community anchors that fall within their jurisdiction, including local governments, school districts, higher educational organizations, public safety organizations, utilities, and occasionally healthcare providers. Many of these anchors require connectivity and often, the municipal

network provides higher capacity at lower costs than these organizations are able to obtain commercially.

5.4. OPEN-ACCESS PROVIDER

Municipalities that adopt open-access generally own a substantial fiber-optic network in their communities. Open-access allows these municipalities to "light" the fiber and equip the network with the electronics necessary to establish a "transport service" or "circuit" to service providers interconnecting with the local network. The concept of open-access is designed to enable competition among service providers across an open network that is owned by the municipality. The municipality retains neutrality and non-discriminatory practices with the providers who operate on the network.

5.5. RETAIL SERVICE PROVIDER – BUSINESS ONLY

Municipalities that provide end users services to business customers are considered retail service providers. Most commonly, municipalities provide voice and Internet services to local businesses. In many cases, a municipality may have built a fiber network for the purposes of connecting the city's primary sites that has been expanded to connect local businesses, in effort to support local economic development needs for recruitment and retention of businesses in the city.

5.6. RETAIL SERVICE PROVIDER – BUSINESS & RESIDENTIAL

Municipalities that provide end user services to businesses and residential customers are considered retail service providers. Most commonly, municipalities provide services to their businesses and residents through a municipally owned public utility or enterprise fund of the city. As a retail service provider that serves businesses and residents, the municipality is responsible for a significant number of operational functions, including management of its retail offerings, network operations, billing, provisioning, network construction, installation, general operations, and maintenance.

5.7. PUBLIC-PRIVATE OR PUBLIC-PUBLIC PARTNERSHIP

A broadband public-private or public-public partnership (P3) is a negotiated contract between a public entity (i.e. Lucas) and private or public entity to fulfill certain obligations to expand broadband services in a given area. P3s leverage

public broadband assets, such as fiber, conduit, poles, facilities with private broadband provider assets, and expertise to increase the availability and access to broadband services.

A P3 for Lucas would likely be structured in such a way that the City would end up taking on most if not all the capital risk and would be provided some type of revenue share or lease fee for its assets. The City would still need to meet debt service obligations for any infrastructure financed, while the partner would need to cover operating costs and any overhead and profit requirements. Each of these areas will likely drive rates higher than has been identified in this Study.

The investment/ROI issue has been voiced by incumbent providers who are already entrenched in the Lucas market – regional, or national competitive providers would likely require serious incentives to participate in a P3 with the City.

6. Lucas Regulatory Environment

6.1. TEXAS REGULATORY RESTRICTIONS ON MUNICIPALITIES

Regulatory restrictions will normally steer a local government toward a certain business model, one that fits within their states regulatory and legal environment. Under Texas State law, a city is prohibited from providing any service for which a certificate of convenience and necessity (CCN), a certificate of operating authority (COA), or a service provider certificate of operating authority (SPCOA) is required. This means that a city may not provide local exchange telephone service, basic local telecommunications service, or switched access service irrespective of the technology used to provide any of these services. For example, if the City were to utilize a technology such as a fiber-based network, it could not use this technology to provide the prohibited services. Texas restrictions are fairly clear that municipalities may not offer telephone access services (e.g. Internet-based Voice-Over-IP).

However, in 2017 the City of Mont Belvieu, Texas questioned the restriction on whether data services fell under the definition of local telecommunication services and sought an Expedited Declaratory Judgement from the District Court of Chambers County.

> Mont Belvieu successfully argued that the Internet access they planned to offer would connect subscribers *to the Internet*, rather than to long-distance providers or other subscribers. Because the Internet is not a "telecommunications provider" as defined by the Texas Utilities Code, Mont Belvieu's plan to connect subscribers to the Internet, rather than a telecommunications provider, is not prohibited. The Court ruled that Internet-based services fall into the category of non-switched services and do not by their nature fall within one of the prohibited services.[3]

In summary, at this time in the State of Texas based on Mont Belvieu ruling, the City of Lucas is limited to offering broadband Internet, unless the City contests for legislative changes to allow additional services. Phone and video services cannot be offered directly or through a third-party by the City, however, several Texas municipalities such as Mont Belvieu did extensive education to their community on the fast growing over-the-top video offerings available (e.g. Hulu, YouTube, Disney+, ESPN+) and how high-speed broadband is essential to utilize these offerings. In 2019, Texas created a Governor's Broadband Development Council to review changes to the current restrictions. Based on findings, video services would be procured across Lucas' Internet offerings directly through the hundreds of streaming providers available in the marketplace

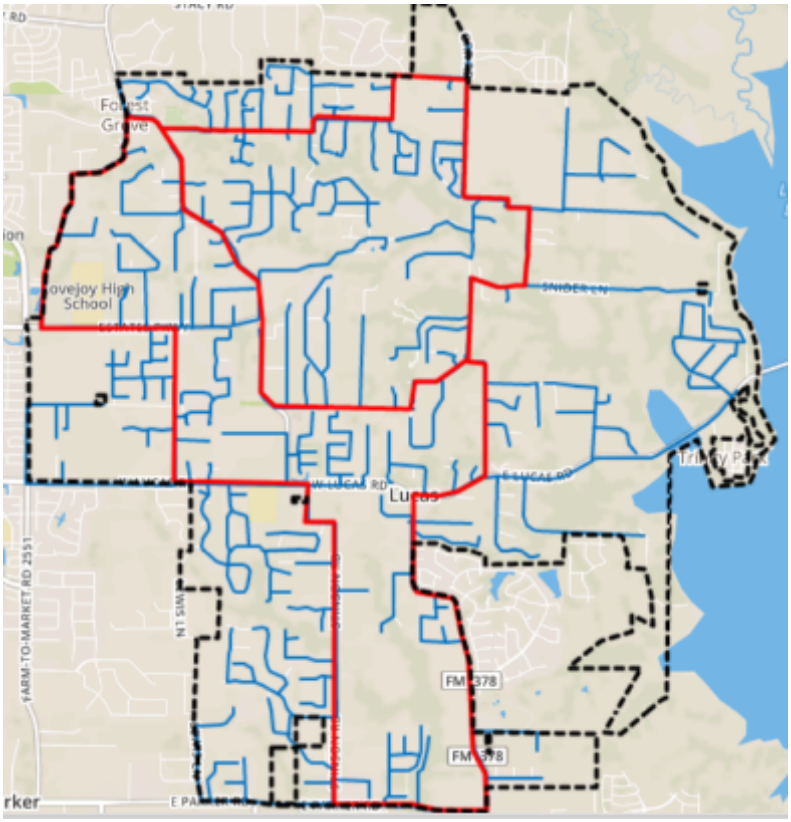
Even though it appears that the Mont Belvieu ruling is applicable to the City of Lucas, it is critical that the City of Lucas confirm with their City Attorney.

[3] Gonzalez. L. (October 17, 2018) Court confirms Texas Home Rule Authority to build, finance community network. Community Networks. https://muninetworks.org/content/court-confirms-texas-home-rule-authority-build-finance-community-network

Lucas FTTH Network Overview

6.2. CONCEPTUAL FIBER-OPTIC NETWORK DESIGN

Figure 13: Conceptual Network Design for the Lucas Network



The Broadband Utility's network will be based on a leading-edge fiber-optic broadband platform that provides direct fiber-optic connections ("FTTP") to homes, businesses, and community anchors across the service territory. Fiber-optic connectivity is the "gold standard" for broadband service providers. It is the only current technology that provides the best long-term scalability for broadband networks to accommodate the ever-growing bandwidth (i.e. speed) needs of users. In a fiber-based network, the bandwidth is almost solely dependent on the capabilities of the network equipment. The underlying fiber network remains as-is. As equipment capabilities are improved, only upgrades to the network equipment are needed to achieve greater bandwidth.

The network will be capable of providing 10 Gbps to the home and businesses through use of both XGS-PON and Active Ethernet technologies to deliver services across the fiber platform. These two technologies together will allow the City to easily offer customized solutions to end-users.

As a foundational part of the study process, Magellan developed a conceptual fiber-optic PON design for the City of Lucas. The network was designed to provide broadband services to all residents, businesses, and community anchor institutions located within the City limits. With the completion of the conceptual design of the network, estimates of formal design and build out costs were developed. These

capital cost structures provided the foundation for the development of a detailed financial model.

Currently, the proposed fiber network is a mixed underground and aerial solution with the expectation that 80% of the network will be buried and 20% placed overhead on existing electric utility poles.

The outside plant ("OSP") cost estimation for buildout of the network is based on detailed Bill of Material matrices encompassing the labor and materials needed to complete the backbone and feeder distribution networks. Below are the OSP matrices based on the conceptual design for the City of Lucas.

Figure 14: Lucas FTTH Bill of Materials

Backbone Estimates

	Assumptions				
80% underground 20% Aerial-does not incl equipment or drop costs-50% bore 50% trench					
assumes 288 backbone cable					
24" min depth					
(2) 2" conduits for underground					
hand holes every 600'					
straight splice every 5000'					
assumes no rock adder					
incl soft surface restoration & Maintenance of traffic-does not include Permit Fees					
Item	Design			Quantity	
1	Route distances		ft	106,671.00	
Item	Construction Labor Estimate	Price	Unit	Quantity	Subtotal
2	Directional Bore (2) 2"	12.00	ft	42,668.40	$512,020.80
3	Trench (2) 2" duct	6.00	ft	42,668.40	$256,010.40
3	Install Muletape in New duct	0.25	ft	170,673.60	$42,668.40
4	Install #12 Tracer wire	0.25	ft	85,336.80	$21,334.20
5	Install Fiber Cable in Duct - Including All Slack	0.80	ft	92,448.20	$73,958.56
6	Remove & Restore Concrete	18.00	sqft	853.37	$15,360.62
7	Install Handhole	300.00	each	142.23	$42,668.40
8	Install New Splice Case & Prep Cable	250.00	each	21.76	$5,440.22
9	Ground Splice Case	150.00	each	21.76	$3,264.13
10	Prep Cable in Panel	250.00	each	4.00	$1,000.00
11	Splice Fibers	20.00	each	6,267.13	$125,342.69
12	Install Loaded 4u Panel	250.00	each	4.00	$1,000.00
13	Terminate Fibers	25.00	each	576.00	$14,400.00
14	Test Network	2500.00	all	1.00	$2,500.00
15	Install Marker Post	35.00	each	106.67	$3,733.49
16	Install Marker Post with Test Station	50.00	each	35.56	$1,777.85
17	Install pole attachments	80.00	each	118.52	$9,481.87
18	Install Strand	1.10	ft	21,334.20	$23,467.62
19	Install snow shoes	100.00	each	42.67	$4,266.84
20	install aerial slack	1.80	ft	2,133.42	$3,840.16
21	install / lash aerial cable	1.80	ft	21,334.20	$38,401.56
22	tree trimming	5.00	ft	0.00	$0.00
23	install pole risers	310.00	easch	5.93	$1,837.11
24	install down guy & anchors	210.00	each	17.78	$3,733.49
25	Make Ready budget	1000.00	pole	11.85	$11,852.33
		Labor Total			**$1,219,360.74**
Item	Construction Material Estimate	Price	Unit	Quantity	Subtotal
20	Mule tape	0.03	ft	170,673.60	$5,120.21
21	288ct Fiber	2.00	ft	121,711.61	$243,423.22
22	Splice Trays	25.35	each	261.13	$6,619.66
23	Splice Cases	500.00	each	21.76	$10,880.44
24	Handholes	585.16	each	142.23	$83,226.14
25	#12 Tracer Wire	0.15	ft	85,336.80	$12,800.52
26	Ground Rods	14.00	each	21.76	$304.65
27	Marker Post	20.00	each	106.67	$2,133.42
28	Marker Post with Test Station	25.00	each	35.56	$888.93
29	2" Pipe	0.90	ft	170,673.60	$153,606.24
30	4u Fiber Panels - Loaded	4668.00	each	4.00	$18,672.00
31	pole attachment hardware	40.00	pole	118.52	$4,740.93
32	6m Strand	0.05	ft	21,334.20	$1,066.71
33	snow shoes	70.00	each	42.67	$2,986.79
34	lashing wire	0.01	ft	21,334.20	$213.34
35	u guard	110.00	pole	5.93	$651.88
36	anchors	110.00	each	17.78	$1,955.64
		Material Total			**$549,290.71**
		Total Backbone			**$1,768,651.45**

Fiber to the Premise

Assumptions

does not include equipment or drop costs
splitter cabinets sized at 288 count
avg size fiber priced at 96 count
24" min depth
(2) 2" conduits
80% underground 20% Aerial- does not include equipment or drop costs- 60% bore 40% trench
Does not include equipment or drop costs
hand holes every 300'
no rock adder included
pricing include soft surface restoration & Maintenance of traffic - Does not include permit fees
2458 Res Prems 50 Commercial

Item	Labor		Unit	Quantity	
1	Route Distances		Ft	462,800.00	

Item	Labor	Price	Unit	Quantity	Subtotal
2	Directional Bore (2) 2"	12.00	Ft	185,120.00	$2,221,440.00
3	Trench (2) 2" ducts	6.00	Ft	185,120.00	$1,110,720.00
4	Install Muletape in New duct	0.25	Ft	740,480.00	$185,120.00
5	Install #12 Tracer wire	0.25	Ft	370,240.00	$92,560.00
5	Install Fiber Cable in Duct - Including All Slack	0.80	Ft	431,946.67	$345,557.33
6	Remove & Restore Concrete	18.00	sq. feet	3,702.40	$66,643.20
7	Install Handhole	300.00	each	1,234.13	$370,240.00
8	Install New Splice Case/ NAP- Prep Cable	250.00	each	771.33	$192,833.33
9	Ground Splice Case	75.00	each	771.33	$57,850.00
10	Prep Cable in cabinet	250.00	each	12.00	$3,000.00
11	Splice Fibers	20.00	each	9,256.00	$185,120.00
12	Install splitter cabinet	2500.00	each	12.00	$30,000.00
13	install concrete base	600.00	each	12.00	$7,200.00
13	Terminate Fibers	25.00	each	3,744.00	$93,600.00
14	Test Network	2500.00	all	1.00	$2,500.00
15	Install Marker Post	35.00	each	925.60	$32,396.00
16	Install Marker Post with Test Station	50.00	each	308.53	$15,426.67
17	Install pole attachments	80.00	each	514.22	$41,137.78
18	Install Strand	1.10	Ft	92,560.00	$101,816.00
19	Install snow shoes	100.00	each	185.12	$18,512.00
20	install aerial slack	1.80	Ft	9,256.00	$16,660.80
21	install / lash aerial cable	1.80	Ft	92,560.00	$166,608.00
22	tree trimming	5.00	Ft	0.00	$0.00
23	install pole risers	310.00	each	25.71	$7,970.44
24	install down guy & anchors	210.00	each	77.13	$16,198.00
25	Make Ready budget	1000.00	pole	51.42	$51,422.22
26					$0.00
27					$0.00
		Labor Total			**$5,432,531.78**

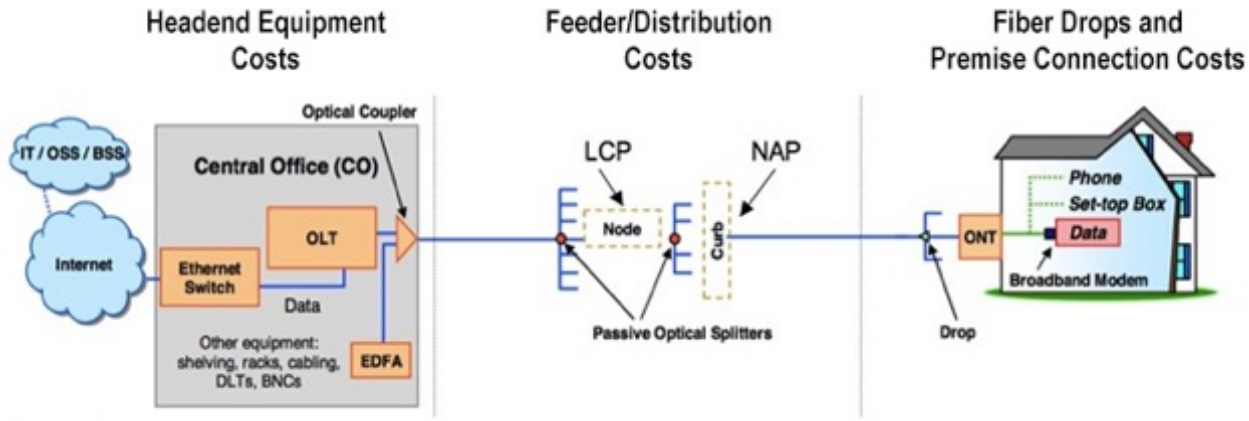
Item	Material	Price	Unit	Quantity	Subtotal
1	Mule tape	0.03	feet	740,480.00	$22,214.40
2	96 count fiber	0.55	feet	560,450.80	$308,247.94
3	Splice Trays	25.35	each	771.33	$19,553.30
4	Splice Cases	500.00	each	771.33	$385,666.67
5	Handholes	585.15	each	1,234.13	$722,153.12
6	#12 Tracer Wire	0.15	feet	370,240.00	$55,536.00
7	Ground Rods	14.00	each	771.33	$10,798.67
8	Marker Post	20.00	each	925.60	$18,512.00
9	Marker Post with Test Station	25.00	each	308.53	$7,713.33
10	2" Pipe	0.90	feet	740,480.00	$666,432.00
11	pole attachment hardware	40.00	pole	514.22	$20,568.89
12	6m Strand	0.05	ft	92,560.00	$4,628.00
13	snow shoes	70.00	each	185.12	$12,958.40
14	lashing wire	0.01	ft	92,560.00	$925.60
15	u guard	110.00	pole	25.71	$2,828.22
16	anchors	110.00	each	77.13	$8,484.67
17	288 count splitter cabinet w tails - fully loaded	6900.00	each	12.00	$82,800.00
18	cabinet pad	600.00	Each	12.00	$7,200.00
19	1x32 splitters	800.00	Each	108.00	$86,400.00
		Material Total			**$2,443,621.20**
		Total FTTP			**$7,876,152.98**

Ultimately, the conceptual network design will be the basis for creating engineered construction drawings for Lucas' fiber network should the City go forward with the project.

6.3. NETWORK ARCHITECTURE

The City's network will be designed as a passive optical (PON) architecture to support high bandwidth broadband services while minimizing operational costs. Backbone fiber will be designed to connect the City data center to the customer access equipment in a ring topology, thereby providing service protection in the event of an equipment failure or fiber cut. Distribution fiber will be designed to connect from the access equipment to the subscriber premise for service delivery. A PON system provides for the most efficient use of the City's fiber assets through the use of optical splitters in the distribution fiber, allowing a single fiber to deliver multiple services to as many as 128 subscriber endpoints depending on design requirements. This allows the backbone fiber to be reserved for connecting customer access equipment, point-to-point circuits, interconnections with other networks, and leasing to third parties. Furthermore, network equipment ports and fiber counts are greatly reduced resulting in less capital and operating costs over the long term.

Figure 15: Network architecture of a Fiber-to-the-Premises network



Fiber Backbone

The fiber backbone will contain 288 fibers and serves two critical functions of the network's operation, including protected connection of the distributed customer access equipment to the core network and connection of the core network to commercial data centers and service providers for access to third party services.

The backbone will traverse the Lucas service area to connect distributed customer access equipment located within shelters and/or cabinets at strategic points of presence (POP) throughout the service area. The connections will be made using redundant uplinks to reduce the possibility of fiber cuts or equipment failures from taking down large groups of customers. These POPs may consist of powered cabinets, prefabricated shelters, or existing structures with sufficient space for equipment racks and other components. The backbone routes may also serve to connect other critical city networks such as SCADA and AMI, saving operating costs and supporting increased functionality and operational benefits.

The Lucas network will also connect to upstream Internet service providers at one or more locations across its service area. Internet connectivity will require diverse routes to multiple upstream service providers for fault protection. These service providers may be located in nearby commercial data centers where lower cost IP service may be procured from a selection of collocated Internet service providers (ISP). These data centers may also be connecting points to cloud services and third-party transport providers.

Central Office / Data Center / Headend

A central office/data center/headend ("CO") owned and operated by the Broadband Utility will be required in a location central to the Lucas service area to provide an interconnection hub for the Broadband Utility's fiber-optic network. The CO, most importantly, will house the broadband equipment to deploy Internet services for the Lucas' service area. Currently, the CO is planned to be located within or near City Hall. The facility would need to be expanded to support the space requirements for the Broadband Utility, including a data center, office/cubicle space, storage and general workspace. Further investigation will be done to ensure that environmental components (e.g. dual cooling/dehumidifying units, dual power feeds, generator backup, fire suppression, and alarm monitoring) are included in any buildout or renovation. The CO is usually partitioned with lockable cages; a

primary cage for the fiber termination, equipment and storage. In some cases, however not proposed for Lucas, secondary cages can be included for other businesses wishing to collocate their equipment in the CO. The CO should be designed to be accessed by multiple parties (e.g. commercial colocation facilities) yet maintain the security for each party operating within the space. Access can be controlled by key cards assigned to only those personnel authorized by the City to enter the facility

Feed/Distribution Fiber

The feed/distribution fiber will extend services from the access POPs to the customer premise. Feed fiber will connect ports in the access POP electronics to passive splitters located in outdoor cabinet enclosures called local convergence points (LCPs) or neighborhood nodes, placed strategically throughout the service area. Splitters may also be located within the access POP itself. In areas where aerial deployment will be used, LCP's may be placed aerially or transitioned from the aerial pole to a ground-based LCP. Feed fibers will be sized based on the demand forecast and sizing of each enclosure to ensure that each service area is well equipped for both PON and Active Ethernet services.

Distribution fiber extends from the splitters in the LCPs to network access points (NAPs) which provide access to the individual fibers required for customer connections. NAPs may be attached to aerial strand, located in ground level pedestals or placed in underground vaults (handholes) located near the sidewalk or curb in residential neighborhoods or business districts. Fiber distribution to NAPs will be sized based on the service area density to provide service to between 8-12 premises per NAP.

Drop Fiber

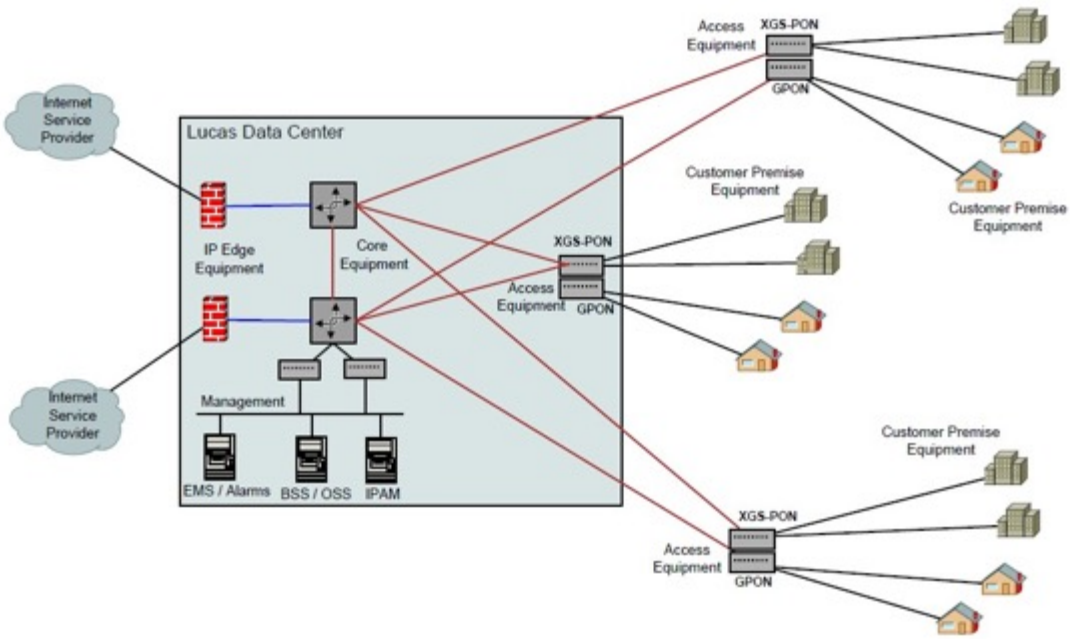
Drop fiber connects from the NAP to the customer premise equipment that delivers the required broadband services. A drop will extend fiber from the closest NAP to each business or residence procuring service within the NAPs service zone. Drop fiber will be connected to the NAP then buried to the outside of the customer premise. At the customer premise, the drop cable will be routed to a protective "clamshell" enclosure attached to a home or building for storage of slack and connection to the CPE. Drop fiber installation costs in the model are based on a maximum to 200' from the NAP/handhole to the premise. It is expected that

distances greater than 200' will be at an additional cost and borne by the subscriber. Subscribers could also incur additional drop costs for special circumstances such as burying fiber through difficult landscapes or under driveways.

Network Equipment

The network equipment required to deliver broadband services to customers is comprised of several functional groups and multiple components within each group. Each functional group and a brief overview of how it is used to deliver service to the end customer follows below. The City will operate a mixed access network consisting of both Gigabit PON (GPON) serving customers at 1 Gbps or less, and 10-Gigabit Symmetric PON (XGS-PON) for customers at 10 Gbps or less. The diagram below demonstrates the functional components of the network, how GPON and XGS-PON coexist, and how customers connect to the network to receive services.

Figure 16: Service Delivery Schematic



(i) Core Equipment

The core equipment serves to aggregate all of the access equipment connecting customers and route their network traffic to and from the IP edge equipment or other end-point destinations. This equipment makes use of standard network protocols to provide link redundancy and dynamic traffic re-routing in the event of an equipment failure or fiber cut. The core equipment will easily support thousands of customers and hundreds of gigabits of traffic throughput at deployment and will accommodate future system growth through the addition of service modules, optical interfaces, and/or software licenses. Table 6 defines the key features of the core equipment and associated service requirements.

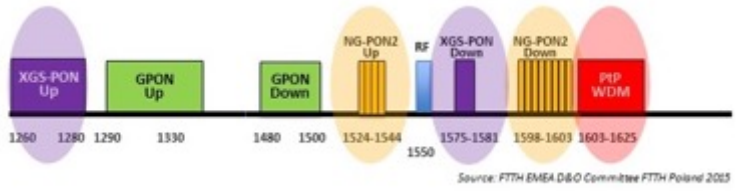
Table 6: Service / Core Equipment Requirements

SERVICE REQUIREMENT	CORE EQUIPMENT REQUIREMENT
Scalable infrastructure particularly focusing on advanced broadband applications.	Core network platform that will provide high-availability, redundancy, performance and scalability to grow broadband offerings and provide guaranteed service levels to customers and service providers.
Redundancy Factors	The core network equipment must be offered in a choice of different form factors purpose built for high availability. Equipment must have several levels of redundancy built-in to allow for a maximum amount of uptime and redundancy.
Performance Factors	The equipment must be capable of providing line-rate forwarding for all core interfaces and have enough line card storage to grow out to full capacity.
Scalability Factors	The broadband network will be required to support a minimum of 1 Gigabit for all core interconnections. Upgrades to existing capacity must be available in increments of 1 Gbps, 10 Gbps, and 100 Gbps speeds.
Quality of Service Factors	Equipment must provide QOS to classify, mark, prioritize, queue and forward multiple types of traffic that require different service levels from the network. Management of the QOS system is also an important part of managing the new core infrastructure and the network management systems should be capable of providing reports, graphs, alarms and fault management.
Management Factors	The core network equipment must support management protocols that will allow staff to easily monitor, manage and maintain the network infrastructure. An accompanying network management system capable of configuration,

	software and device management is important to manage the core network.

(ii) Access Equipment

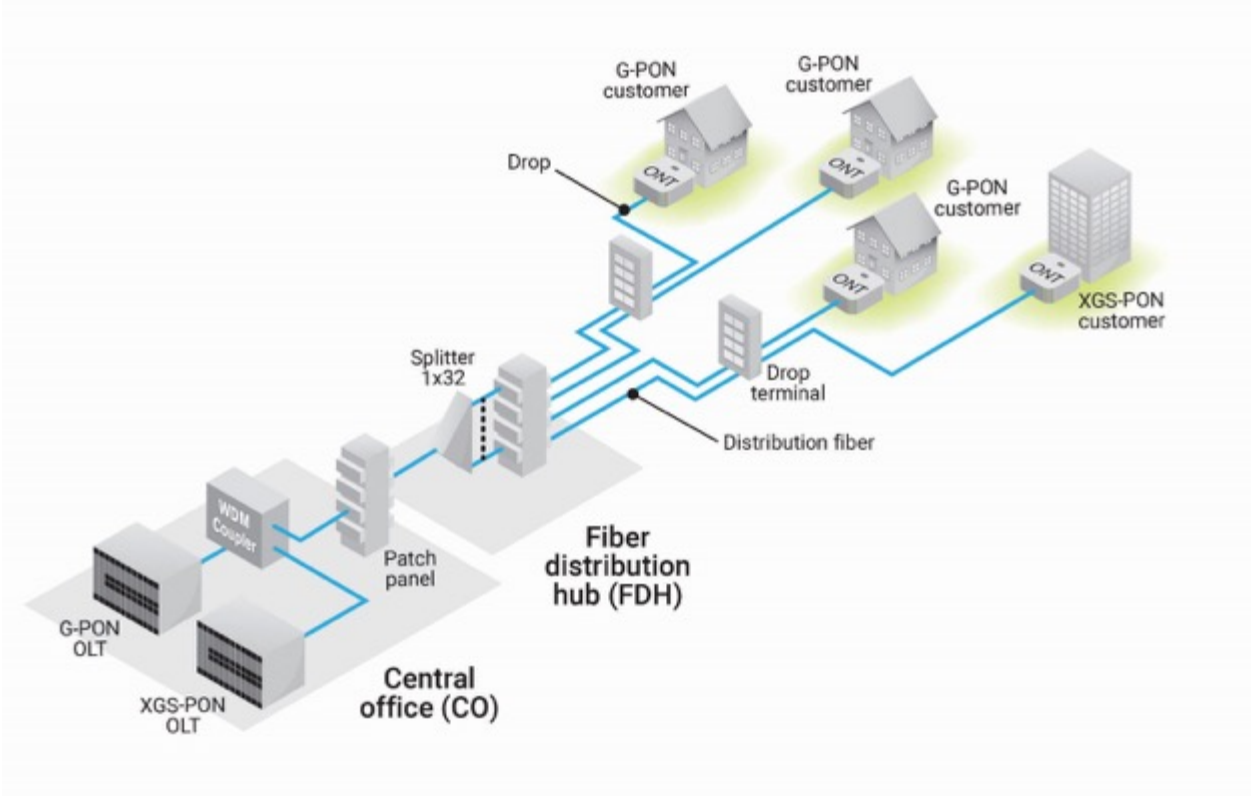
Figure 17: ITU Family of PON Standards



The Access Equipment will consist of Optical Line Terminals (OLT) and supporting components in each access POP for connection of customers to the network. OLTs support both GPON and XGS-PON technologies in the same or separate shelves and come in various capacities to support a few hundred to several thousand customers per shelf. Access Equipment will consist of a single or dual GPON shelves located in the CO. Each PON shelf will be equipped with redundant supervisory modules, power supplies, and fan trays to reduce the impact of individual hardware faults on customer operations. PON service line cards will be hot swappable for in-service replacement. The Access Equipment will connect to the Core Equipment using 10 Gbps and/or 100 Gbps uplinks in redundant pairs.

The ITU standards for PON networks support coexistence of multiple technologies over the same feed/distribution fibers by assigning separate optical wavelengths downstream and upstream to each one. G.984 (GPON) assigns 1490nm down/1310nm up, whereas G.9807 (XGS-PON) assigns 1577nm down/1270 up. Both technologies supporting splitting ratios up to 1:128, although 1:32 and 1:64 are typical to best balance cost and performance. This standardized coexistence will allow the City to deploy the appropriate technology at the best price point to service multiple customer needs using the same fiber cable plant. The standards also provide a blueprint for the addition of NG-PON2 services in the future. Figure 17 shows the entire ITU family of PON standards and their assigned wavelengths for reference.

Figure 18: FTTH Architecture



PON shelves within each access POP will contain both GPON (for customer services up to 1 Gbps) and XGS-PON (for customer services over 1 Gbps) line cards. Customers may receive service from either system through a simple change of CPE. To facilitate the coexistence, a passive optical combiner is installed between the PON ports and the splitter input. This piece of equipment combines the separate GPON and XGS-PON wavelengths onto a single feeder fiber connected to the

splitter input. Customers are then connected to a splitter output port using the distribution fiber assigned to their premise.

PON services will be provisioned through the network management and provisioning systems, allowing the City to auto-provision customers without manual configuration of the systems. For residential and small business users, auto-provisioning will enable the City to significantly reduce the amount of staff hours required to manage customer activations, terminations, and changes. It will also allow the City to minimize errors in the provisioning process due to misconfiguration of resources within the Access Equipment.

(iii) Customer Premise Equipment (CPE)

An Optical Network Unit (ONU), sometimes called an Optical Network Terminal (ONT), serves as the demarcation point between the City's fiber network and the router or firewall connecting to the customer's local area network (LAN). There are two general methods for installing ONU's. The first method involves mounting an outdoor rated ONU on an exterior wall of the structure and extending service wiring inside the premise. The second method involves extending the fiber into the premise and installing an indoor-rated ONU inside. In either case, the ONU is typically installed somewhere near the fiber entrance and an AC power source. The ONU terminates the fiber-based PON signals and provides customer access to their services through traditional copper interfaces. XGS-PON ONU's supporting greater than 1 Gbps data service may also support optical small form-factor pluggable (SFP) interfaces for connection to enterprise-class LAN equipment. For the Lucas deployment, it is anticipated that indoor ONTs will be utilized.

In addition to the ONU, the City may also provide a managed residential gateway (RG) to customers who do not have an existing router or who are interested in receiving managed services from the City. The RG looks and operates similar to consumer routers purchased from department stores or online. However, they contain software that allows the City to diagnose problems with the customer's service and provide managed Wi-Fi and other services for incremental revenue. Indoor units combining the ONU and RG into a single component at a reduced cost are available. However, the City may be limited in the available feature sets of the RG and the ability to extract incremental revenue from them. A UPS may be furnished by the City to ensure power interruptions do not cause service outages.

(iv) Internet Protocol Edge (IP Edge) Equipment

Separate from the core switches, the Broadband Utility will maintain an "Internet perimeter." The Internet perimeter will include Internet routers and Internet firewalls to be used to manage routing throughout the network. Firewalls will be utilized to protect critical back office systems, including provisioning, network management, data storage, and other information. The City's two core switches will be interconnected to two Internet routers providing redundancy for Internet services in the event of a single interface or equipment failure.

Magellan recommends that the Broadband Utility contract with two Internet providers, allowing for failover if either provider becomes unavailable. To do so, Magellan recommends that the Broadband Utility purchase a primary "tier 1" Internet provider connection that will be used during normal operations. Tier 1 is recommended to ensure that the Broadband Utility provides a high-quality Internet service to its users, although this service will come at a slightly higher cost than other Internet transit providers offer. The Broadband Utility will balance this cost with a tier 2 Internet provider to be used for its backup connection which will automatically carry the City's Internet traffic in the event that the primary provider becomes unavailable. The cost of the tier 2 connection will be significantly lower than the cost of the primary connection, thus bringing the average cost of Internet wholesale service to the Broadband Utility down significantly.

Network Management and Operations

Network management is the process of administering broadband networks through operational practices and network management systems including fault detection/analysis, performance management, provisioning of networks and maintaining quality of service. The major operational goal is to ensure network continuity through constant monitoring and expedient troubleshooting.

(i) Assets and Infrastructure

All assets must be identified and categorized by location, materials, capacity, age, physical condition and legal status/accessibility, and a comprehensive inventory of these assets must be maintained in a consistent manner. Broadband infrastructure assets include duct or conduit, dark fiber, lit fiber, public and privately-owned vertical structures, easements, rights-of-way, bridges, rail lines, rail crossings and property-specific land use restrictions. All of this must be tracked.

The network will require on-going planning. It could eventually grow to include several fiber-optic rings around the city with routes along major corridors, allowing for expansion to additional businesses and neighborhoods along the way. Construction would likely involve underground construction, which must be planned and coordinated. Access points would need to be strategically placed—near community institutions, in business districts, and by neighborhoods—to make it easy to connect to network users. As the network will be used for commercial and residential service, it will be necessary to keep detailed records about how customers are connected. This will be proprietary information that customers expect to be confidential and secure.

The fiber backbone for Lucas will consist of 288-count fiber-optic cable on major routes, while fiber distribution will be 96-count fiber. Secondary or lateral fiber should consist of 12 to 24-strand cable connecting individual community organizations, MDUs, and other end user locations. Certain key facilities may have larger count cables. Individual connections to businesses or residences may be a smaller 2 count drop cable. The network will use an in-and-out splicing design that allows community anchors and points of interest to interconnect their locations in a "ring" topology, if required, that supports high redundancy for their communications needs. A range of specialized connections will be necessary for traffic signalization, smart community technology, and future applications, and will need to be individually engineered. While such expansion is speculative and likely years from now, network management and operations should be prepared for it.

(ii) Network Standards

Standards simplify management and operations. They ensure that infrastructure deployed at different times, in different locations, by different entities is consistent and functional. Standardization is a governance best practice that goes directly to all of governance's purposes, that must be managed and operationalized. Generally, management adopts standards based on input from stakeholders, and operations assures the standards are met. Standards include contracts and operating procedures, as well as network facilities. The number of standards increase with service offerings. Regardless, there is no shortage of issues and resources that should be standardized.

Fiber, aerial, and underground standards are summarized below. Aerial specifications would be highly dependent on the pole segments and ownership.

Actual pole routes selection, if required, will occur in the network design process. A future design engineering study will also identify the final overhead requirements and specifications. Overhead placement standards and specifications should be coordinated through the public policy process with input from relevant community partners.

Outside Plant Underground Specifications[4]
Basic Fiber Specifications

- Backbone cable size – 288-count fiber
- Distribution cable size – 96-count fiber
- Lateral cable size – 12 and 24-count fiber
- Single mode, loose-tube non-armored 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

Underground - Basic Conduit Specifications

- 36” minimum acceptable depth
- 2” HDPE smooth wall reel-mounted pipe for underground duct
- Warning tape installed at 12” or 18”
- Maximum fill ratio of 50%
- Innerduct where appropriate for subdividing duct space
- Vault placement at intersections, every 500ft in commercial corridors
- Vaults sized appropriately to house underground lid-mounted pedestals and splice enclosures

Aerial

- All installation shall comply with all requirements as listed on any pole attachment agreements
- All aerial construction shall be installed using the strand and lashing method

[4] Outside Plant Specifications change from time to time.

- Strand, unless specifically directed, shall be 6m galvanized strand
- Fiber cable shall be double lashed to strand
- Cable shall be installed at specific height/location per construction drawings
- New aerial construction shall be located in the communication space on the poles
- 40” minimum separation from pole neutral is required
- Midspan cable height shall meet regulations as to minimum height for passage of vehicular traffic
- Installed aerial cables shall match sag of all existing cables to prevent midspan rubbing
- Down guy installations shall be at proper “rise and run”
- Down guys shall be galvanized 6m strand with yellow guy guards
- All anchors installed shall be either Manta Ray type or screw-in anchors
- All cable slack shall include the use of slack organizers ("snow shoes")
- 150’ of slack shall be installed every 1500’ unless specified in construction plans
- Snow shoes shall be secured to the 6m strand per manufacturer instructions
- Orange high-visibility cable tags shall be installed at every pole attachment and splice case
- Cable tags shall be weather rated and read “City of Lucas Fiber Optic Cable”
- Splice cases shall be tagged per requirements as to identify cable size, routing and count
- All pole attachments, down guys and splice cases shall be properly grounded utilizing #6 solid wire and 5/8”x8’ copper clad ground rods

It is advisable to establish a pool of spare equipment, materials, and tools for operating the network, especially for rapid response to any emergencies or outages. These assets may be held by operations or by a contracted agent to be deployed when replacement or new facilities are required. The storage and common access of such assets could reduce or eliminate the duplication of costs by any party to the network in building-out aspects of the city-wide infrastructure.

(iii) Access and uses

Publicly owned fiber can be used to reduce operating costs and enable performance improvements. The assets can also be leveraged for community and economic development. A wide range of amenities and applications can be provided via fiber. Fiber cables should be sized so they can allocate capacity among multiple applications, including:

- Community/government functions
- Future smart city applications
- Community anchor connections
- FTTH broadband services (residential/business access)
- Revenue generation
- Spare capacity

(iv) GIS and Infrastructure Record Keeping

All data about infrastructure assets and their overall configuration should be stored in a centralized GIS-based data repository. The GIS should be accessible to ensure accurate record keeping, but it should also be secured. All access and changes to the data should be tracked (e.g., there should be an activity log and audit trail). Infrastructure assets must be periodically physically inspected, verified, and updated within the GIS system. This inspection and reporting will become an ongoing function for operations.

As part of the implementation of broadband-friendly public policy measures, all municipalities should require GIS documentation of all broadband infrastructure installations, upgrades, and other items be maintained and updated. Current GIS records of conduit and fiber segments may not include fiber inventory or strand mapping. Network operations will need a fiber management platform that will provide this functionality. This will allow the City 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.

Additionally, municipalities should work with private companies deploying broadband infrastructure to put in additional conduit, inner duct or fiber with those projects. Providers will often allow municipalities to “joint trench” and share in the cost of adding additional assets. Some cities have acquired ownership rights to

fiber strands within providers' fiber cables in lieu of permit fees. This is common throughout the United States, and while there can be restrictions placed on the use of this fiber, it does allow public fiber to be constructed very economically.

6.4. BROADBAND UTILITY OPERATIONS OVERVIEW

Lucas' Broadband Utility will provide the foundation for critical communications to residents, businesses, government organizations, and community anchors. The Broadband Utility must implement effective and efficient human resources along with capable system solutions to ensure an excellent "customer experience." In order to reduce costs, the Broadband Utility should investigate enabling sharing of resources with the current city staff, wherever possible. As Lucas' network grows, it will be important that the Broadband Utility implement very efficient operating strategies that will manage the network effectively yet minimize operating cost. A key differentiator of broadband utility networks is their attention to responsive, localized, customer service. Lucas must focus on implementing such a customer service program designed to support its service level agreements with residents, businesses, and community anchors.

Key operational functions that will be required for ongoing management of the Broadband Utility include, but are not limited to:

- Drop fiber connection to end-users
- Inside wiring and inspection of end-user premises
- Service installation
- Order management and provisioning
- Customer inquiry and support
- Trouble ticketing
- Billing and payments
- Repairs and maintenance
- Network management
- Renewal and replacement

This list only provides a basic framework for the functions required by a service provider. From these processes, the Broadband Utility will be able to identify key functions that require both human and system resources, and in turn, design operations that will fit well within the organization and fulfill the requirements of the Broadband Utility. Initially, the Lucas Broadband Utility will use a combination

of their existing operational software with new manually based procedures. If the Broadband Utility opts in the future to implement a fuller feature fiber-based operational system, a thorough evaluation of specific human and system resources will need to be conducted to select the appropriate system for their needs.

Staffing Requirements

The functions listed below should be used as guidelines for general responsibilities rather than specific job descriptions. Adding new staff is often challenging for utilities implementing community broadband projects. Therefore, we break down each function employee full-time equivalent ("FTE") requirements so that the City may plan shared or new staff around the time requirements of each function.

Magellan recommends that the Lucas Broadband Utility utilize shared staff, where possible, to conserve operating dollars until the point where the network requires dedicated staff which will occur when the size of the operation and/or revenues generated reach a critical point. In many community broadband networks of similar size to Lucas' proposed network, existing staff with a few key hires, has been able to effectively manage the network for the first 12-18 months of operations. In addition, outside consulting services are often used in the first one to three years of the project to complement existing internal staff capabilities. As internal staff becomes more versed in operating the Broadband Utility, the need for external resources can be reevaluated.

The City also has the option to outsource or even develop partnerships to support different areas of the operation. The City must always weigh the corporate profit motive of any private sector partner who may participate in delivering broadband services to the community, however, customer rates may be impacted due to additional overheads, profits and investment returns which may be required. There are numerous local government partnerships with various structures which can be further explored, however, this Study assumes the City create a new Enterprise Fund within the City's municipal organization, providing high-speed Internet services to any and all residents and businesses that want the service.

The key staffing assumptions utilized in this Study include:

(i) Manager-Level

Telecom Manager/OSP Engineering Supervisor - responsible for all facets of the Broadband Utility reporting to the office of City Manager. Should have strong industry, business, and network engineering background. Would hire the position at onset of project to oversee utility turn up and rollout for the City of Lucas.

Sales and Marketing Manager - responsible for all outside sales and marketing functions for the broadband utility, including go-to-market strategy, pricing, quota management, and top-line revenue growth. Will also be responsible for business sales and business account management.

(ii) Operation-Level

Customer Support Rep (TSR Lvl 1) – responsible for customer order processing, service, billing inquiries and basic first level technical support. Position is key to driving stellar customer experience. The City of Lucas believes that current Water and Waste Water Utility customer service management and personnel can absorb much of the expected Broadband Utility workload. Plan is to add a maximum of 1.5 FTEs over the course of the first two years of operations.

Technical Service Rep – responsible for tier-2 service troubleshooting and resolution. The City of Lucas currently has staff supporting the city fiber in place today and do not expect that additional staff will be needed. However, if additional support hours are added in the future, more support staff may be needed.

Headend/Network Engineer – responsible for management of network equipment setup, configuration, upgrades, maintenance, etc.

Network/NOC Technician – monitor networks and maintain and repair routers, firewalls, and switches. These professionals exercise computer, troubleshooting, and problem-solving skills on a daily basis.

Field Services Technician – responsible for installation and maintenance of Internet service at the customer premise. Due to expertise required and equipment overhead associated with this position (e.g. truck, trencher, tools, etc.), Lucas will outsource this function to a qualified third-party for at least two to three years.

Field Locates Technician – This function can be done through standard underground utility location services provided by the local utilities. However, during high install periods normally found at initial rollout, locating service turn around may become a hindrance to connecting customers in a timely manner. Furthermore, the City as an underground telecom utility owner, conduit/fiber locating will become a normal maintenance function. When someone in the rights-of-way are designing and construction projects, the City will have to respond to any Texas811 system tickets where its infrastructure is located. Much like the City's Water Utility operation, the Broadband Utility will be required to respond accordingly.

20-Year Staffing Plan

*Table 7: Staffing Plan***

Position	Year 1*	Year 2	Year 3	Year 4-20
Telecom Mgr/ OSP Engineering Supervisor		0.5 FTE	1 FTE	1 FTE
Sales & Marketing Manager		0.5 FTE	1 FTE	1 FTE
Headend/Network Engineer		0.5 FTE	1 FTE	1 FTE
Customer Support Rep		0.5 FTE	1 FTE	1 FTE
Network/NOC Technician		0.5 FTE	1 FTE	1 FTE
Technical Service Rep			1 FTE	1 FTE
Field Services Technician			1 FTE	1 FTE
Field Locates Technician			1 FTE	1 FTE
** No staff needed. Network design occurring.*				

*** If higher than expected subscriber volume achieved, additional positions may be needed.*

7. Lucas FTTH Services and Uptake

7.1. THE COMPETITIVE BROADBAND MARKETPLACE

Sales and Marketing is a key factor in the success of any municipal broadband network. Municipal networks operate within a competitive marketplace, something most cities are unfamiliar with. In order to reach necessary take rates, the network must have a dynamic and successful sales and marketing plan and ongoing management. And it should build on the City's history, its exemplary public utility services customer knowledge, and the community brand. It's important that the citizens understand this is their local "hometown" service, built for their needs, with local public investments and local control.

All markets are dynamic and require careful attention to changing market trends, product development and consumer taste. The City should anticipate, quantify and develop plans to mitigate key controllable risks as part of executing its business strategy. Managing and responding to the competitive environment is part of the business and the City can be successful at doing so; however, it must be prepared with the right organizational resources to compete in the market.

The City must be prepared for incumbent providers to react to the City entering the market. The City should expect competitive providers to respond by upgrading their services or repackaging offerings by lowering prices and extending contracts to lock in their current customers. The City's Marketing and Sales Plan must be reflective of the market and should engage the community for education of what separates the City's services from the other providers. This is the City's value proposition.

Branding

The Lucas brand should convey a high-tech orientation with local relevance. The City's name would be market-friendly to utilize for the City's broadband service. The City will need to create identities for its brand and broadband product offerings and packages. With the new broadband enterprise specifically, the City should design a

complementary broadband logo with the same color palette, typesetting and other design elements as the overall City branding.

Branding goes well beyond a logo into the essence of establishing a recognizable trademark and company culture and reputation that demonstrates the City's values and customer care proposition. The City brand is often characterized by how customers describe the City's services and how City employees describe the City's culture and operating philosophies in the presence of customers and potential customers in public.

Customer Engagement

As the City begins to engage its customers, it must be strategic in its approach. The City will be prepared to position itself in this new market. The City's sales team will be equipped with the facts or "truth" behind their competitors' offers and services and be able to show how the City's service exceeds each of the competition's value propositions. The sales teams will keep this knowledge up to date in order to ensure that the City maintains competitiveness and understands what moves the competition makes in response to the City's market entry.

Technology Driven Customers

Today, we are amid a shift in behavior among consumers rapidly adopting a lifestyle that demands nonstop connectivity regardless of distance, time, location and environment. This constant "being online" is critical to more productivity, expanding leisure and entertainment opportunities, providing greater security, and feeling of belonging and engagement. These new critical demands create both challenges and opportunities for the City as it enters the broadband business. Technology-centric customers are generally the largest Internet users and, for broadband providers, are generally the most profitable. The City should target this customer group in its initial launch of broadband services. These customers consist primarily of young families with children and single and married working professionals. Technology-driven customers are the most targeted customers by the competition and the fastest growing market segment.

These customers desire interactivity and engagement products and place a high value on customer service, something the City's current customers value from the Water Utility. Technology-driven customers prefer Internet speed and reliability

over price and are often inclined to spend more on an offer with higher speed and reliability than to spend less on an offer with lower speed and reliability.

The City will adopt approaches and methods that fully utilize cyber and digital forms of technology and outreach. Two-way engagement uses rich media, social, and mobile to enable "conversations."

7.2. PROPOSED PRODUCTS & PRICING

As a retail provider, Lucas would provide a standard set of blazing fast Internet offerings to residents and businesses.

Table 8: Residential and Business Offerings

Residential Offerings

Residential Service	Percent of Subscribers Taking Service	Monthly Rate
1 Gbps x 1 Gbps	90%	$115.00
10 Gbps x 10 Gbps	10%	$195.00

**Managed Services ("White Glove) included in residential pricing

Business Offerings

Business Service	Percent of Subscribers Taking Service	Monthly Rate
250 Mbps x 250 Mbps SMB	56%	$225.00
1 Gbps x 1 Gbps SMB	36%	$350.00
1 Gbps x 1 Gbps SMB	5%	$450.00
1 Gbps x 1 Gbps Dedicated	3%	$1,195.00
Managed Services ("White Glove")	50%	$12.95

**Sales tax is not incurred for consumers on Internet services in the state of Texas.

7.3. UPTAKE SCENARIOS

In determining suggested services and pricing, multiple scenarios were investigated to discover what combination of prices and residential/business subscriber penetration ("uptake") levels best met the City of Lucas' goals to deliver high-speed broadband at the lowest possible price while maintaining a sustainable Broadband Utility. Scenarios involved various combinations based on residential 1 Gbps service pricing and residential/business uptakes. Variations were run with pricing at each $10 interval starting at a monthly service price of $79 through $159. In conjunction with the pricing variations, multiple uptakes ranging from 45% to 65% were run for each price point above. Based on analyses of the results, it has been determined that the best price /uptake combination to meet Lucas' goals is a 1 Gbps residential service at $115/month at an uptake of 55%. Combinations of pricing and uptakes below these levels (e.g. 45% uptake) was not sustainable due to the amount of interfund loans needed to support a positive end-of-year cash flow. Debt service of the loans continually generated the need for more loans and a positive end-of-year cash position could not be obtained. Below is a synopsis of four uptakes at the $115/month price for comparison.

Table 9: Uptake Comparison

Residential Uptake	Number of Subscribers	Interfund Loan Total *(millions)*	20-Year Free Cash Flow *(millions)*
50%	1229	9.51	1.09
55%	1352	4.73	3.51
60%	1475	2.28	7.26
65%	1598	1.71	11.01

** number of uptake subscribers based on current residential households (2,458) at time of this Study*

Based on the results of these variations and conversations with the City of Lucas, several services and pricing combinations were discussed based on City of Lucas' goals, 20-year cumulative end-of-year cash levels and needed borrowing. It was determined, to create a sustainable Broadband Utility, an uptake of 55% for both residential and business was necessary with a 1 Gbps residential service price of $115/month. As shown in the table above, capturing more than 55% has a significant positive impact to the Broadband Utility's cash flows and long-term profitability.

8. Lucas FTTH Financial Plan

8.1. FINANCIAL INFORMATION, ASSUMPTIONS, FORECASTS AND RISKS DISCLAIMER

Magellan Advisors' financial models, estimates, forecasts and related financial and business risk analyses have been prepared for use solely by Magellan's Client in understanding the financial aspects of proposed broadband and telecommunications projects. Magellan accepts no responsibility or liability towards any third party in respect of this information or related content in this Report. This information is subjective in many respects, and, thus, susceptible to multiple interpretations and periodic revisions based on actual experience and business developments.

The financial information contained in this Report contains a significant number of subjective forecast assumptions including, but not limited to, subscriber take rates, rate structures, fixed and variable costs, costs of capital and related assumptions. Any deviation from the subjective forecast assumptions is likely to lead to results that are significantly different than those projected in the Report. Additionally, other events that are not explicitly allowed for in the Report and financial analysis may lead to significantly different returns or values.

Neither the financial information contained herein, nor its outputs necessarily represent the opinion of value or future investment returns that are achievable. The financial information prepared by Magellan Advisors in this Report is provided for the sole purpose of indicative results based on a given set of assumptions. Neither Magellan Advisors itself, nor its directors, employees, contractors or associates shall be liable for any direct or indirect consequential loss suffered by any person or organization as a result of using or relying on any statement in or omission from this financial information or any information provided in connection herewith.

8.2. FINANCIAL PLAN OVERVIEW

The Broadband Financial Plan information provided below depicts a financial outlook for the City's proposed Broadband Utility based on forecasts, projected revenues, capital costs, operational costs, and debt service for the project. This financial plan provides a model that projects the City's financial performance under a particular set of conditions based on an 80% underground 20% aerial fiber-optic deployment. As the City's business environment and conditions change, the outcomes produced in the model will also change. Therefore, it is important that the City periodically update their forecast and financial model with changes in the business environment as it moves towards the decision to implement the Broadband Utility, and toward securing funding.

Under current projections, the City's fiber utility would maintain positive cumulative free cash flows across the 20-year period and maintain reserve requirements for operations, equipment renewals and replacements. Based on a 55% residential subscriber uptake and a monthly rate of $115 for a residential 1 Gbps Internet service, the City would generate an annual positive free cash flow stream beginning in year 6 that could be utilized to pay down debt early, buy down the rates of services, or to begin paying a Payment in Lieu of Taxes (PILOT) or General Fund contribution to the City.

Magellan recommends a quarterly review of the forecast and financial plan for the first 24-month period to ensure that the assumptions made throughout this project remain valid. Magellan's modeling software has been engineered to allow the City to request changes to key parameters and then automatically update the underlying financial plan.

As forecasts and financial models are subject to change, Magellan cannot guarantee that financial outcomes will match those determined in the current 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).

8.3. CAPITAL EXPENDITURES

Based on the high-level conceptual design for Lucas' fiber network, 20-year estimated costs for fiber buildout labor and materials, needed equipment, buildings, OSS/BSS, and project/construction management estimations have been established. Breakdown of the 20-year capital costs encompassing initial rollout costs along with periodic renewals and replacements based on expected life of the associated assets are as follows.

(a) Design, Engineering, and Permitting **$ 711,839**

Design engineering consists of the low-level, formal design of the network. This design is needed for funding and construction vendor bids. The design will encompass the backbone and distribution networks for the entire City of Lucas. Obtaining necessary permits for the buildout will also be initiated during this phase.

(b) Construction **$10,609,285**

Construction expenses include the estimated labor and materials, along with a 10% contingency, needed to build out the backbone ring and feeder distribution portions of the network. Cost estimate is predicated on the purchasing the materials directly versus having contractor purchase**. City would likely issue a single master contract through a completive RFP for a Construction Contractor.

*****In order to reduce expenditures, it is recommended that the City purchase the materials directly in lieu of having contractor supply materials. Self-purchase of the materials could reduce costs by nearly $600K.***

Summary of items are as follows:

(a) Underground network
- Labor
  - Trenching and directional boring of 2" conduit
  - Installation of mule tape and #12 tracer wire into conduit
  - Fiber installation into conduit (Including determined slack)
  - Install vaults (handholes)
  - Removal and restoration of concrete, asphalt, etc.
  - Install splitter cabinets
  - Prep and splice fiber cable
  - Terminate fibers into data center panel
  - Install marker posts

- Material
  - #12 tracer wire
  - 1x32 splitters
  - 2" conduit
  - 288 count splitter cabinet
  - 288ct backbone fiber
  - 4u fiber panels
  - 96 distribution count fiber
  - Handholes
  - Marker posts
  - Mule tape

ii. Aerial (overhead) network

- Labor
  - Install pole attachments
  - Install fiber with determined slack
  - Install pole risers to connect aerial fiber to underground connection
  - Install down guys and anchors, as needed
  - Tree trimming as needed
  - Estimated pole make-ready costs

- Material
  - 6m Strand
  - Anchors
  - Ground Rods
  - Lashing wire
  - Pole attachment hardware
  - Snowshoes
  - Splice Cases
  - Splice Tray
  - U guard

iii. Test of entire underground and aerial network

(c) Network Equipment **$ 2,045,273**

Costs consist of equipment and services needed to install, config, and support the turn up of the network. Equipment renewal and refresh costs have been included at 10-year intervals.

- Core network and edge routing consisting of aggregation and broadband network gateway
- Network access switches
- Optical line terminals
- Security hardware/software with firewall
- Network management system
- IP services (e.g. DHCP, DNS, authentication)
- Professional services for installation and setup of equipment

(d) General Equipment **$ 657,300**

General equipment covers the equipment and tools needed for premise installations, maintenance, and overall support of the network. The majority of the equipment listed will not be needed until the Broadband Utility takes premise installations and maintenance back in-house until the third or fourth year of rollout. During the initial rollout of the utility, a third-party vendor will be used due to the expected volume of installs and personnel needed. As with network equipment, renewal and costs refresh have been included at 10-year intervals.

Equipment/tools needed:

- One field technician vehicle with full toolkit
- Network testing tools and diagnostic tools
- Trencher for underground install of customer premise fiber
- Spicing trailer

(e) Building Improvements and Network PoP's **$ 550,000**

Building improvements encompass refurbishment of a city property structure to house the Broadband Utility data center. The space for a data center is expected to be approximately 800 sq ft with the necessary environmental components (racks and cages; clean power; battery backup; fire suppression; A/C; security). Storage space for data room is minimal; about the size of a large closet.

Network Points of Presence (PoPs) are usually small physical units used in the network as to house equipment to serve as interconnection points between the backbone and the distribution network.

(f) Premise Drops **$ 4,572,970**

Premise drops consist of the labor, equipment, and material costs to connect residential and commercial customers to the network and are incremental, only connecting those customers that take service. All premise drops are envisioned to be underground from the nearest underground connection point ("handhole") to the fiber termination device (i.e. Optical Network Terminal ("ONT")) located inside the premises, wherever possible. Financial model assumes that the City of Lucas will bring the premise drop installs and maintenance in-house in year five or six. Premise equipment renewal and refresh costs have been included at 7-year intervals.

(i) Equipment and Materials

- Exterior premise connection hardware ("clamshell")
- Connectorized drop fiber from nearest handhole to clamshell
- Cable for wiring Inside of premise from clamshell to ONT
- ONT with wireless gateway and power supply

(ii) Labor

- Installation of exterior clamshell
- Trenching and installation of drop fiber to premise clamshell
- Wiring of premise from clamshell to ONT
- Installation, configuration, and testing of ONT and Internet service
- Testing and setup of customer devices to access Internet

(g) Construction and Turnkey Project Management $ 1,500,000

During the critical design and buildout years, management is essential for the oversight of all facets of the broadband project from buildout to customer rollout. A few of the key areas include:

i. Overall management of the activities needed to create a broadband utility.
ii. Daily management of construction vendor assuring the buildout is done as designed and meets all standards for underground installation.
iii. Daily inspection of buildout construction, documenting needed corrections, and assuring that corrections are made in a timely manner
iv. Verification of construction invoices to ensure invoices match actual work completed
v. Inspection of materials and assist with ordering, if needed
vi. Documenting and updating design for agreed upon changes

vii. Establishment of processes and procedures for all facets of the utility such as sales and marketing, customer ordering and support, back office functions (accounting, billing, payments, etc.), warehousing, facilities management to name a few.
viii. Assist in hiring and engaging needed personnel.
ix. Track all project tasks and hold timely status updates with the City of Lucas Project Team to ensure projects meets expectations and timelines.

20-Year Capital Cost Summary

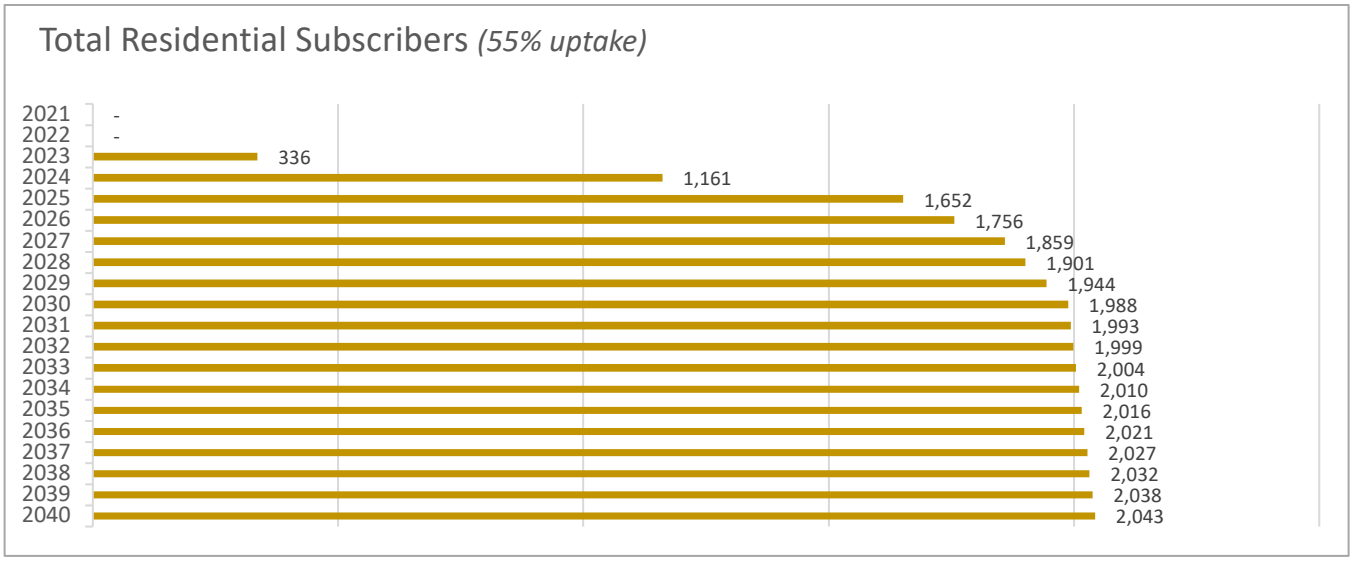
Table 10: 20-Year Capital Cost Summary

Area	Description	Estimated 20-Year Expense
Network Design	Formal low-level design of backbone and distribution networks	$ 711,839
Construction	Buildout with 10% contingency	$ 10,609,285
Network Equipment	Includes expected upgrades and refits over 20-year period	$ 2,045,273
General Equipment	Vehicles, trencher, tools, testers, etc.	$ 657,300
Building Improvements	For data center, warehouse, NOC, offices	$ 550,000
Premise Drops	Based on 55% Residential; 55% Business uptakes	$ 4,572,970
Construction and Turnkey Project Management	Management of the network buildout; inspections, and overall project management	$ 1,500,000
	Total:	$ 20,646,666

8.4. CUSTOMER DEMAND

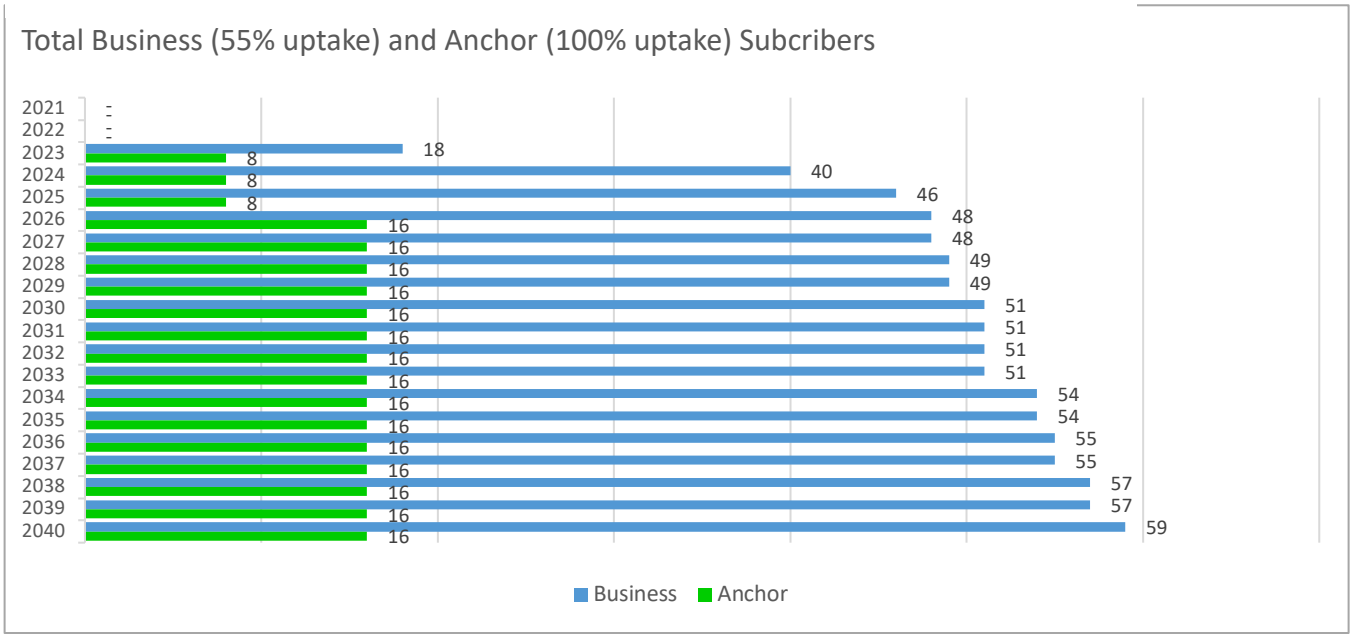
With the offered service packages and uptake expectations of 55% residential, 55% commercial and acquisition of the City and school district facilities, the following graphs exhibit the 20-year residential, business, and anchor subscriber count projections.

Figure 19: Residential Demand Uptake



Residential subscriber growth is based on additional planned residential developments being built out during years 1 – 10 increasing residential passings by an estimated 600 residences and a relatively flat growth post year 10 of 5 premises per year. There are 1,714 residential premises north of Lucas Road and 744 south of Lucas Road. It can be assumed that there is greater demand north of Lucas Road due to over 50% of residents that engaged in the Speed Test Survey and reported speeds less than 25 Mbps. It is also known that more infrastructure improvements and better services are available in the South. Due to these factors it could further be assumed that the City would expect greater subscribership or take rates in north Lucas.

Figure 20: Business and Anchor Demand Uptake

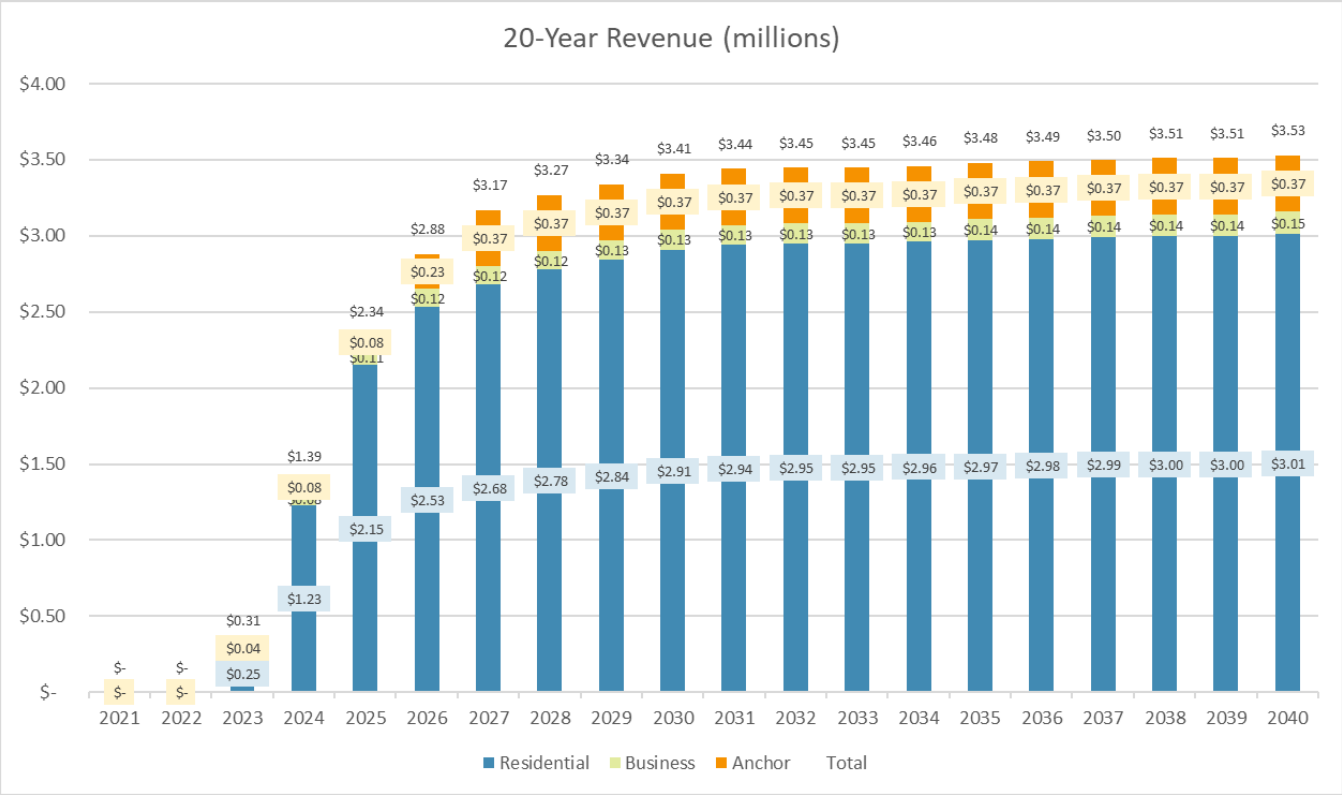


Business growth is minimal with a projection of only 1 to 2 new businesses per year starting in year 3. No anchor growth is projected for the first 20 years.

8.5. SERVICE REVENUES

Residential, business, and anchor service annual revenue growth is aligned with subscriber growth, and grows to approximately $3.41 million in 2030, with minimal increases in revenue beyond this. Pricing has been modeled to remain flat with the customer retention based on best in class service and increased bandwidth and functionality.

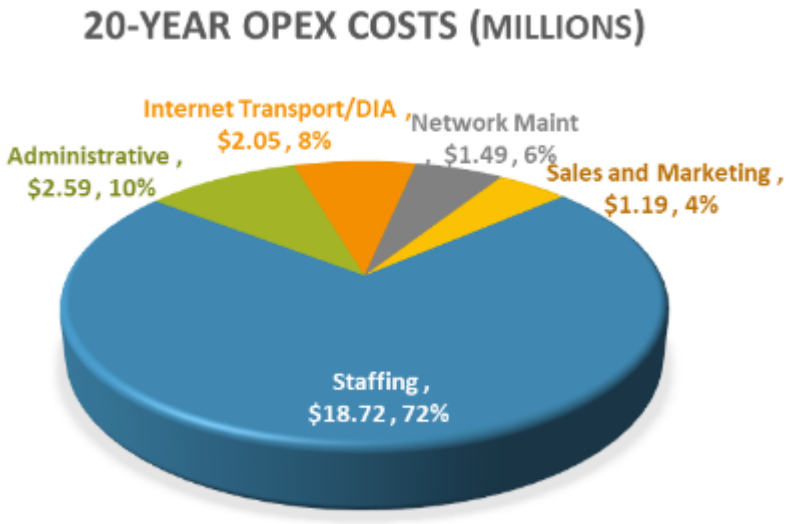
Figure 21: Service Revenues

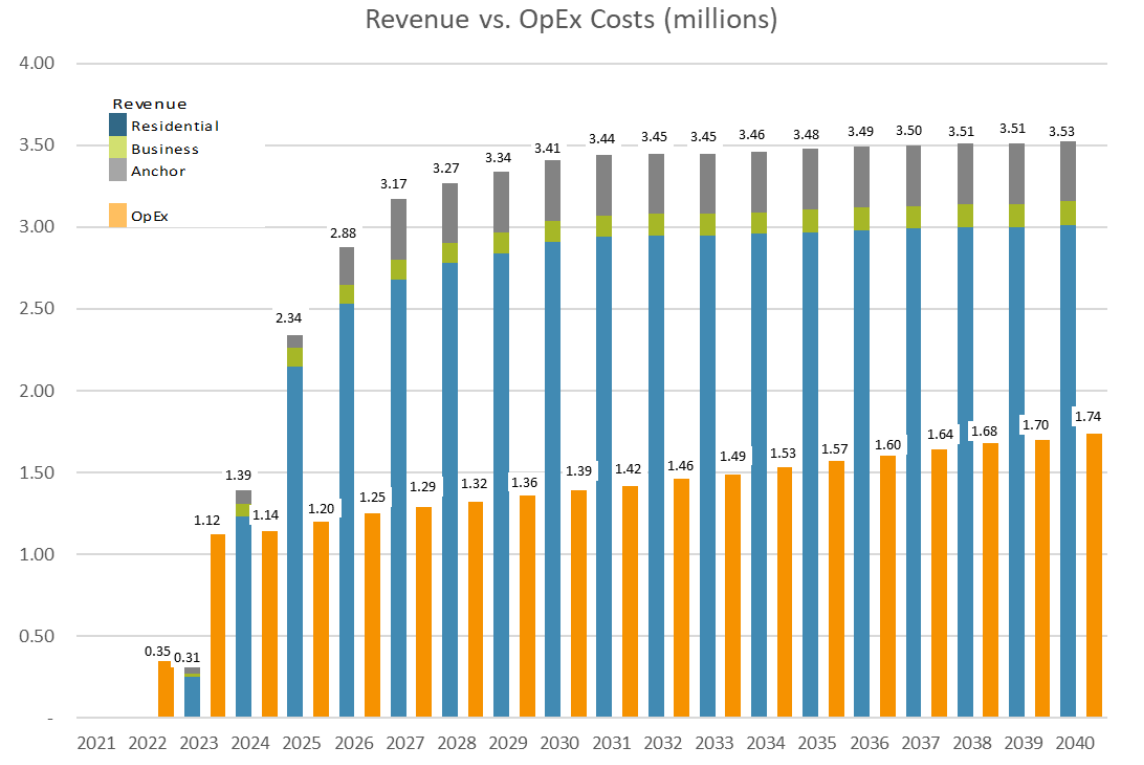


8.6. OPERATING EXPENDITURES

Based on a full retail model, breakout of expected 20-year operating expense category costs are shown below along with revenue to operating expense comparison.

Figure 22: Operating Expenditures



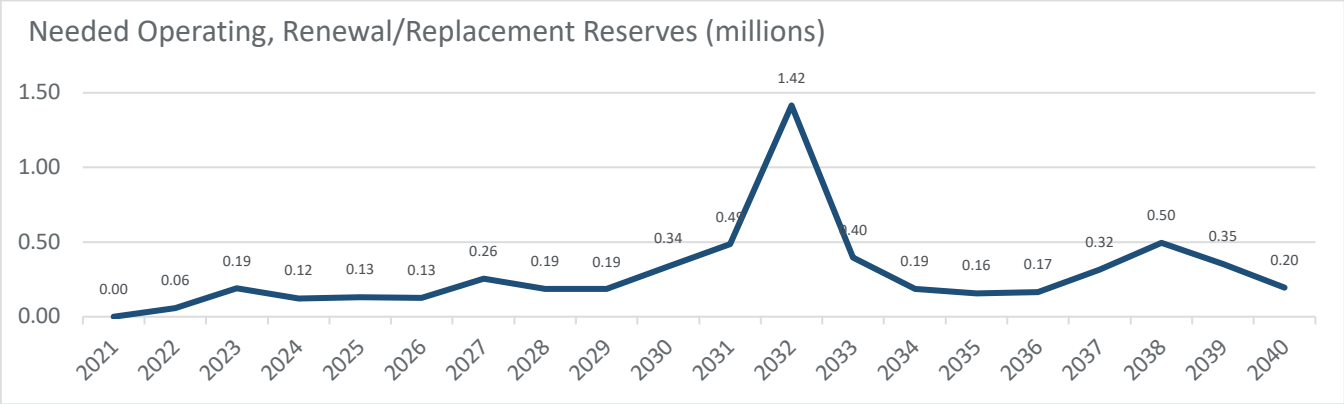


8.7. RESERVES

Three reserve funds have been built into the financial model for operations, general renewal and replacement, and capital expansion.

- Operational reserves are funded equal to two months of expected operating expenses for the depicted financial year.
- The renewal and replacement reserve is funded based on expected capital and network maintenance costs for the year as shown below.

Figure 23: Renewal and Replacement Reserve



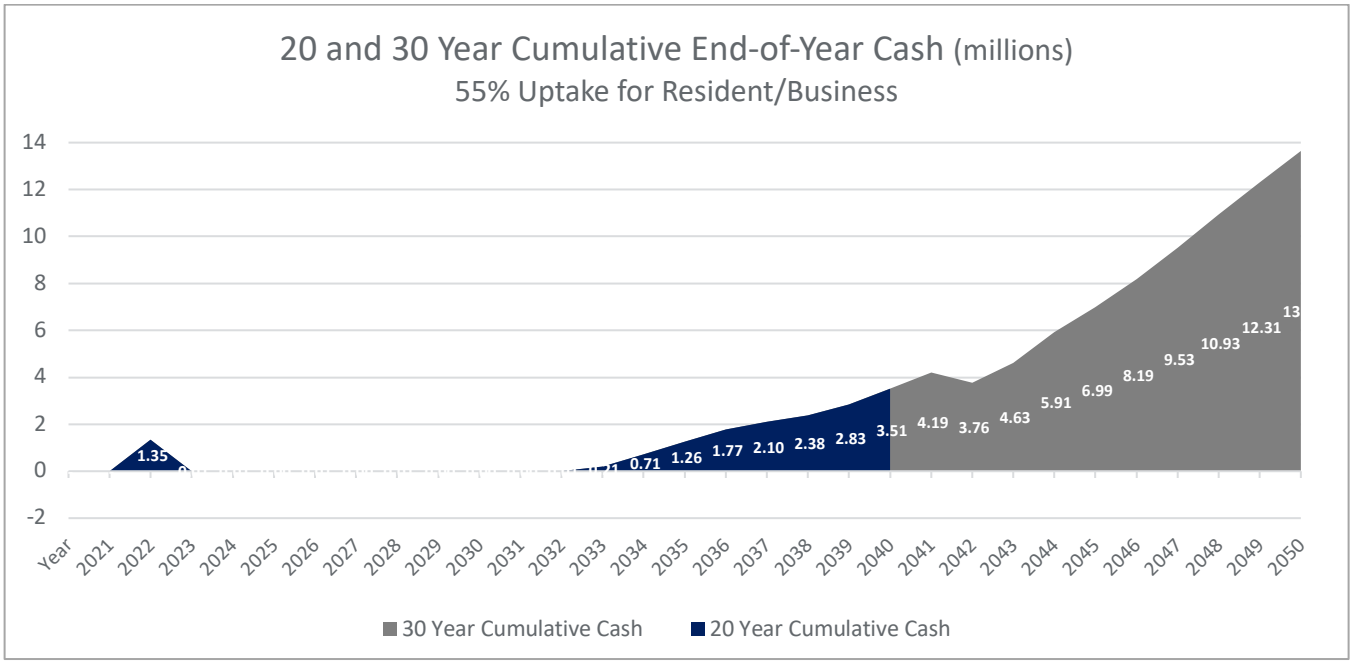
- Based on the fact that the model covers a full citywide build out, capital expansion reserves have not been funded.

Using the reserves in this manner keeps reserve balances to around $500K, allowing additional monies to be allocated to reduce debt.

8.8. END-OF-YEAR FREE CASH

With a residential rate of $115.00 per month and an achieved 55% residential uptake, a 55% business uptake, and capture of the City and school district facilities within four years, the Broadband Utility would achieve a 20-year cumulative end-of-year free cash of approximately $3.51M. Cumulative free cash accelerates after year 20 due to the majority of debt being retired. Based on conversations with the City of Lucas, they feel that a 55% residential uptake is achievable and that higher uptakes are possible.

Figure 24: End-of-Year Free Cash Based on Uptake



New residential developments within Lucas will also have a positive impact to cash flow on the assumption that a 55% uptake will also be achievable in these developments. Further, the City can work with site developers during design and buildout to include the City's telecommunications infrastructure requirements, deploying network expansions as efficiently as possible.

8.9. PRO FORMA

Below is the 20-year pro forma showing the financial performance based on the revenue and cost projections.

Pro Forma — Fiscal (October-September) — *Proprietary and Confidential Information*

Total Network-Mixed

	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	2025-2026	2026-2027	2027-2028	2028-2029	2029-2030
Year #	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Service Revenues										
Residential	-	-	248,160	1,104,930	2,075,850	2,515,200	2,668,110	2,774,880	2,837,370	2,901,720
Business	-	-	21,016	73,152	111,928	121,011	122,438	124,538	126,638	128,066
Community Anchor	-	-	42,240	84,480	84,480	228,480	372,480	372,480	372,480	372,480
Subtotal: Service Revenues	-	-	311,416	1,262,562	2,272,258	2,864,691	3,163,028	3,271,898	3,336,488	3,402,266
Installation Revenues										
Residential	-	-	-	123,750	73,650	15,600	15,450	6,300	6,450	6,600
Business	-	-	3,600	4,500	1,200	300	-	300	-	300
Anchor & Dedicated	-	-	-	-	-	-	-	-	-	-
Subtotal: Installation Revenues	-	-	3,600	128,250	74,850	15,900	15,450	6,600	6,450	6,900
TOTAL REVENUES	-	-	315,016	1,390,812	2,347,108	2,880,591	3,178,478	3,278,498	3,342,938	3,409,166
Cost of Services										
Direct Staffing	-	49,952	314,028	323,448	333,151	343,146	353,441	364,044	374,965	386,214
1-Network & Headend Maintenance	-	-	69,442	70,831	72,248	73,693	75,167	76,670	78,203	79,767
2-OSP Maint (1K/mi) - moved to use of reserves	-	-	-	-	-	-	-	-	-	-
3-Facilities Maintenance	-	-	10,000	10,200	10,404	10,612	10,824	11,041	11,262	11,487
4-Utilities	-	9,901	20,199	20,603	21,015	21,435	21,864	22,301	22,747	23,202
5-Software Maintenance (15% of purchase)	-	-	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500
6-Direct Internet Access (DIA)	-	-	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000
7-10GB Ethernet Transport	-	-	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000
8-Cloud Support DME (50% subs) (prog calculated)	-	-	1,518	6,751	12,558	15,177	16,143	16,778	17,152	17,535
9-Vehicle Maintenance (% of purchase cost)	-	-	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500
10-Miscellaneous Cost of Services	-	99	2,262	2,334	2,412	2,459	2,490	2,518	2,544	2,570
11-Pole Attachments (632)	-	-	6,320	12,640	12,640	12,640	12,640	12,640	12,640	12,640
Subtotal: Cost of Services	-	59,952	548,769	571,807	589,429	604,162	617,569	630,992	644,513	658,415
GROSS PROFIT	-	(59,952)	(233,753)	819,005	1,757,679	2,276,428	2,560,910	2,647,507	2,698,426	2,750,751
Sales, General & Administrative Expenses										
Indirect Staffing	-	230,549	474,931	489,178	503,852	518,969	534,539	550,575	567,092	584,104
1-Staffing Agency Costs (see personnel tab)	-	-	-	-	-	-	-	-	-	-
2-Sales and Marketing Startup (first 2 yrs)	-	50,000	50,000	-	-	-	-	-	-	-
3-Ongoing Sales/Mktg (2% gross rev; yr 3+)	-	-	-	25,251	45,445	57,294	63,261	65,438	66,730	68,045
4-Professional & Legal Fees	-	-	15,000	15,150	15,302	15,455	15,609	15,765	15,923	16,082
5-Travel & Entertainment Expense	-	5,000	5,050	5,101	5,152	5,203	5,255	5,308	5,361	5,414
6-Reporting & Compliance	-	-	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
7-Office Expense	-	-	10,000	10,100	10,201	10,303	10,406	10,510	10,615	10,721
8-General Overhead	-	-	7,500	7,575	7,651	7,727	7,805	7,883	7,961	8,041
20-Bad Debt Expense (1% of Gross)	-	-	3,114	12,626	22,723	28,647	31,630	32,719	33,365	34,023
Subtotal: Sales, General & Administrative Expenses	-	285,549	570,595	569,981	615,326	648,598	673,505	693,198	712,047	731,430
EBIT	-	(345,501)	(804,348)	249,024	1,142,353	1,627,831	1,887,405	1,954,309	1,986,379	2,019,321

Pro Forma

Total Network-Mixed	2030-2031	2031-2032	2032-2033	2033-2034	2034-2035	2035-2036	2036-2037	2037-2038	2038-2039	2039-2040
Year #	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*
Service Revenues										
Residential	2,937,930	2,946,000	2,954,070	2,962,140	2,971,380	2,979,450	2,987,520	2,995,590	3,003,660	3,011,730
Business	129,494	129,494	129,494	133,022	136,549	137,899	139,249	141,427	143,605	145,032
Community Anchor	372,480	372,480	372,480	372,480	372,480	372,480	372,480	372,480	372,480	372,480
Subtotal: Service Revenues	3,439,904	3,447,974	3,456,044	3,467,642	3,480,409	3,489,829	3,499,249	3,509,497	3,519,745	3,529,242
Installation Revenues										
Residential	750	900	750	900	900	750	900	750	900	750
Business	-	-	-	600	-	300	-	300	-	300
Anchor & Dedicated	-	-	-	-	-	-	-	-	-	-
Subtotal: Installation Revenues	750	900	750	1,500	900	1,050	900	1,050	900	1,050
TOTAL REVENUES	3,440,654	3,448,874	3,456,794	3,469,142	3,481,309	3,490,879	3,500,149	3,510,547	3,520,645	3,530,292
Cost of Services										
Direct Staffing	397,801	409,734	422,026	434,687	447,728	461,159	474,994	489,244	485,297	499,856
1-Network & Headend Maintenance	81,363	82,990	84,650	86,343	88,070	89,831	91,628	93,460	95,329	97,236
2-OSP Maint (1K/mi) - moved to use of reserves	-	-	-	-	-	-	-	-	-	-
3-Facilities Maintenance	11,717	11,951	12,190	12,434	12,682	12,936	13,195	13,459	13,728	14,002
4-Utilities	23,666	24,140	24,622	25,115	25,617	26,130	26,652	27,185	27,729	28,283
5-Software Maintenance (15% of purchase)	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500
6-Direct Internet Access (DIA)	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000
7-10GB Ethernet Transport	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000
8-Cloud Support DME (50% subs) (prog calculated)	17,752	17,800	17,848	17,905	17,966	18,018	18,070	18,122	18,174	18,227
9-Vehicle Maintenance (% of purchase cost)	3,500	3,500	7,350	7,350	7,350	7,350	7,350	7,350	7,350	7,350
10-Miscellaneous Cost of Services	2,595	2,619	2,682	2,706	2,732	2,758	2,784	2,811	2,838	2,866
11-Pole Attachments (632)	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640
Subtotal: Cost of Services	672,534	686,874	705,508	720,680	736,284	752,321	768,813	785,771	784,585	801,959
GROSS PROFIT	2,768,119	2,762,000	2,751,286	2,748,461	2,745,025	2,738,558	2,731,336	2,724,776	2,736,059	2,728,333
Sales, General & Administrative Expenses										
Indirect Staffing	601,627	619,676	638,266	657,414	677,137	697,452	718,375	739,926	762,123	784,988
1-Staffing Agency Costs (see personnel tab)	-	-	-	-	-	-	-	-	-	-
2-Sales and Marketing Startup (first 2 yrs)	-	-	-	-	-	-	-	-	-	-
3-Ongoing Sales/Mktg (2% gross rev; yr 3+)	68,798	68,959	69,121	69,353	69,608	69,797	69,985	70,190	70,395	70,585
4-Professional & Legal Fees	16,243	16,405	16,569	16,735	16,902	17,071	17,242	17,415	17,589	17,765
5-Travel & Entertainment Expense	5,468	5,523	5,578	5,634	5,690	5,747	5,805	5,863	5,922	5,981
6-Reporting & Compliance	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
7-Office Expense	10,829	10,937	11,046	11,157	11,268	11,381	11,495	11,610	11,726	11,843
8-General Overhead	8,121	8,203	8,285	8,368	8,451	8,536	8,621	8,707	8,794	8,882
20-Bad Debt Expense (1% of Gross)	34,399	34,480	34,560	34,676	34,804	34,898	34,992	35,095	35,197	35,292
Subtotal: Sales, General & Administrative Expenses	750,485	769,183	788,425	808,337	828,860	849,882	871,515	893,806	916,746	940,336
EBIT	2,017,634	1,992,817	1,962,861	1,940,124	1,916,165	1,888,676	1,859,821	1,830,970	1,819,313	1,787,997

	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	2025-2026	2026-2027	2027-2028	2028-2029	2029-2030
Year #	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Depreciation & Amortization										
Depreciation	-	-	491,757	874,793	1,066,294	1,160,180	1,180,651	1,200,118	1,208,327	1,210,637
Amortization	-	-	-	-	-	-	-	-	-	-
Subtotal: Depreciation & Amortization	-	-	491,757	874,793	1,066,294	1,160,180	1,180,651	1,200,118	1,208,327	1,210,637
EBITDA	-	(345,501)	(1,296,104)	(625,769)	76,059	467,651	706,754	754,191	778,052	808,685
Interest										
Calculated Interest	-	23,135	276,598	474,034	498,886	488,337	457,283	419,807	381,114	341,163
Subtotal: Interest Expenses	-	23,135	276,598	474,034	498,886	488,337	457,283	419,807	381,114	341,163
NET INCOME	-	(368,636)	(1,572,703)	(1,099,803)	(422,826)	(20,686)	249,471	334,384	396,938	467,522
Debt Principal Payments										
Payments	-	25,825	432,867	770,839	981,786	1,098,816	1,153,088	1,190,563	1,229,256	1,262,609
Subtotal: Principal Payments	-	25,825	432,867	770,839	981,786	1,098,816	1,153,088	1,190,563	1,229,256	1,262,609
Reserve Fund Requirements (2 mos Op-Ex need)	-	57,584	186,561	190,298	200,792	208,793	215,179	220,698	226,093	231,641
Operating Reserve Fund (max out at 2 mo of yearly Op-Ex)		57,584	128,977	3,737	10,494	8,001	6,386	5,519	5,395	5,548
Renewal & Replacement Fund		-	60,000	120,000	120,000	120,000	250,000	180,000	180,000	330,000
Capital Expansion Fund		-	-	-	-	-	-	-	-	-
Use of reserves for Post Borrowing Cap-Ex/OSP Maint	-	-	(55,927)	(110,242)	(111,345)	(112,458)	(249,852)	(172,186)	(172,755)	(325,312)
Subtotal: Annual Reserve Fund Requirements	-	57,584	133,051	13,495	19,149	15,543	6,534	13,333	12,640	10,236
Subtotal: Cumulative Reserves	-	57,584	190,634	204,129	223,279	238,822	245,355	258,689	271,329	281,564
Capital Spending										
Capital Spending	711,839	7,824,706	6,507,818	1,535,505	657,201	143,298	136,269	57,468	56,889	208,288
Other										
Subtotal: Capital Spending	711,839	7,824,706	6,507,818	1,535,505	657,201	143,298	136,269	57,468	56,889	208,288
TOTAL NON-OPERATING, CAPEX AND RESERVES	711,839	7,908,114	7,073,736	2,319,839	1,658,136	1,257,657	1,295,890	1,261,364	1,298,785	1,481,132
Cash Flow										
Beginning of Year	-	-	1,347,956	7,573	5,476	2,910	7,508	3,059	7,046	3,287
Cash Balance For Year										
Add: Net Income	-	(368,636)	(1,572,703)	(1,099,803)	(422,826)	(20,686)	249,471	334,384	396,938	467,522
Add: Depreciation	-	-	491,757	874,793	1,066,294	1,160,180	1,180,651	1,200,118	1,208,327	1,210,637
Add: New Funding	711,839	7,824,706	6,507,818	1,535,505	657,201	143,298	-	-	-	-
Less: Non-Operating, CAPEX and RESERVES	711,839	7,908,114	7,073,736	2,319,839	1,658,136	1,257,657	1,295,890	1,261,364	1,298,785	1,481,132
EOY Cash Balance	-	(452,044)	(1,646,864)	(1,009,344)	(357,468)	25,135	134,232	273,137	306,480	197,026
Cumulative EOY Cash-Pre Working Capital/Contributions	-	(452,044)	(298,908)	(1,001,772)	(351,992)	28,045	141,740	276,196	313,525	200,313
		Max WC bond amt	Interfund loan							
Add: Addl Working Capital (manual entry)		1,800,000	460,000	1,200,000	650,000	330,000	240,000	130,000	100,000	220,000
Less: Working Capital Interest	-	-	58,500	70,362	105,384	120,343	123,587	123,097	118,350	112,114
Less: Working Capital Principal	-	-	95,019	122,390	189,714	230,193	255,094	276,054	291,888	306,653
End of Year Cash Flow Final	-	1,347,956	7,573	5,476	2,910	7,508	3,059	7,046	3,287	1,546
End of Year Cash Flow Final 20 Yr Total	3,512,637									
End of Year Cash Flow Final 30 Yr Total	13,643,983									
Interfund total	$ 4,730,000									

	2030-2031	2031-2032	2032-2033	2033-2034	2034-2035	2035-2036	2036-2037	2037-2038	2038-2039	2039-2040
Year #	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*
Depreciation & Amortization										
Depreciation	1,166,500	1,040,545	961,902	950,707	938,847	934,330	929,895	925,115	925,674	926,020
Amortization	-	-	-	-	-	-	-	-	-	-
Subtotal: Depreciation & Amortization	1,166,500	1,040,545	961,902	950,707	938,847	934,330	929,895	925,115	925,674	926,020
EBITDA	851,134	952,271	1,000,959	989,417	977,317	954,346	929,926	905,855	893,638	861,977
Interest										
Calculated Interest	300,128	260,484	226,056	203,127	183,265	163,915	143,936	123,307	102,009	80,018
Subtotal: Interest Expenses	300,128	260,484	226,056	203,127	183,265	163,915	143,936	123,307	102,009	80,018
NET INCOME	551,006	691,788	774,903	786,290	794,052	790,431	785,990	782,548	791,630	781,959
Debt Principal Payments										
Payments	1,219,839	1,059,305	705,507	611,146	595,389	614,739	634,718	655,347	676,646	698,637
Subtotal: Principal Payments	1,219,839	1,059,305	705,507	611,146	595,389	614,739	634,718	655,347	676,646	698,637
Reserve Fund Requirements (2 mos Op-Ex need)	237,170	242,676	248,989	254,836	260,857	267,034	273,388	279,929	283,555	290,383
Operating Reserve Fund (max out at 2 mo of yearly Op-	5,529	5,506	6,313	5,847	6,021	6,176	6,354	6,541	3,626	6,827
Renewal & Replacement Fund	480,000	1,410,000	390,000	180,000	150,000	160,000	310,000	490,000	350,000	190,000
Capital Expansion Fund	-	-	-	-	-	-	-	-	-	-
Use of reserves for Post Borrowing Cap-Ex/OSP Maint	(472,015)	(1,404,869)	(383,591)	(175,027)	(148,840)	(150,070)	(300,292)	(484,458)	(340,145)	(184,658)
Subtotal: Annual Reserve Fund Requirements	13,514	10,638	12,722	10,820	7,181	16,106	16,062	12,083	13,481	12,169
Subtotal: Cumulative Reserves	295,078	305,716	318,438	329,258	336,440	352,546	368,608	380,692	394,172	406,342
Capital Spending										
Capital Spending	353,820	1,285,492	263,021	53,251	25,846	25,846	174,826	357,737	212,157	55,390
Other										
Subtotal: Capital Spending	353,820	1,285,492	263,021	53,251	25,846	25,846	174,826	357,737	212,157	55,390
TOTAL NON-OPERATING, CAPEX AND RESERVES	1,587,173	2,355,434	981,250	675,218	628,417	656,692	825,607	1,025,167	902,283	766,196
Cash Flow										
Beginning of Year	1,546	4,349	7,278	205,898	710,743	1,258,292	1,769,427	2,102,771	2,381,851	2,832,690
Cash Balance For Year										
Add: Net Income	551,006	691,788	774,903	786,290	794,052	790,431	785,990	782,548	791,630	781,959
Add: Depreciation	1,166,500	1,040,545	961,902	950,707	938,847	934,330	929,895	925,115	925,674	926,020
Add: New Funding	-	-	-	-	-	-	-	-	-	-
Less: Non-Operating, CAPEX and RESERVES	1,587,173	2,355,434	981,250	675,218	628,417	656,692	825,607	1,025,167	902,283	766,196
EOY Cash Balance	130,333	(623,101)	755,555	1,061,779	1,104,483	1,068,069	890,278	682,495	815,021	941,783
Cumulative EOY Cash-Pre Working Capital/Contributions	131,879	(618,752)	762,833	1,267,677	1,815,226	2,326,361	2,659,705	2,785,266	3,196,872	3,774,473
Add: Addl Working Capital (manual entry)	310,000	1,090,000								
Less: Working Capital Interest	109,297	108,705	132,584	118,792	104,553	89,850	74,670	58,996	47,803	37,520
Less: Working Capital Principal	328,233	355,265	424,351	438,142	452,382	467,084	482,264	344,419	316,380	224,316
End of Year Cash Flow Final	4,349	7,278	205,898	710,743	1,258,292	1,769,427	2,102,771	2,381,851	2,832,690	3,512,637

9. Funding

Funding needed for the broadband project would be approximately $23.91M, of which $17.3M of capital costs and $1.8M of working capital would be funded through bonding and the remainder through interfund loans. The City is considering a bond election for voters to decide approving or denying the issuance of General Obligation bonds to provide broadband Internet to all available residential and business premises located within city limits. Funding is comprised of four disparate series, each with multiple tranches, as currently assumed.

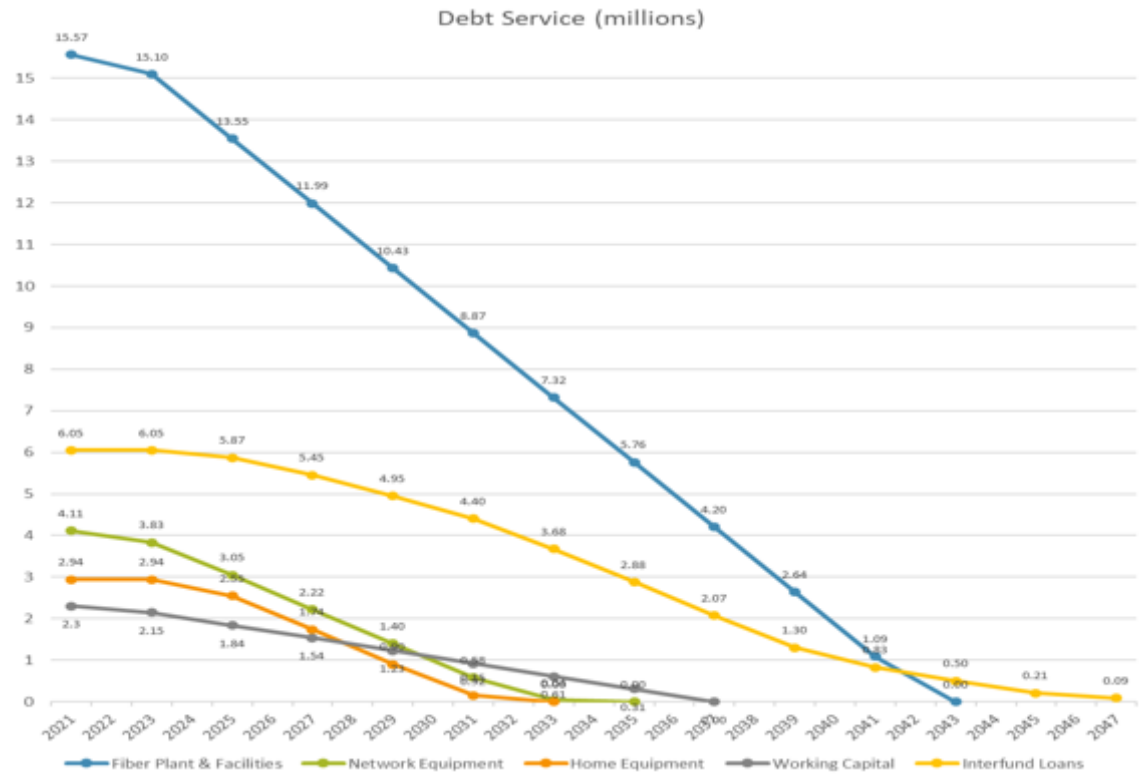
- The first funding series is for fiber plant and facilities. This sector encompasses the design, labor and materials for building of the physical fiber network. The financial model depicts three tranches totaling $11.32M over the first three years of the project. The first tranche is scheduled for funding of the low-level design of the network. Other tranches are for buildout of the network. Each tranche is structured as a 20-year general obligation bond at an interest rate of 3.25%.
- The second series comprises funding of network equipment, buildings, general equipment, and construction/project management. There are three tranches built into the model occurring in years two through four for a total of $3.47M. Each tranche is expected to be a 10-year general obligation bond at an interest rate of 3.25%. It is expected that funding will only be needed for costs applicable to the first five years of the project. After year five, renewal and replacement of equipment will be funded through use of revenue, and reserves.
- Expected premise drop expenses comprise the third series. Premise drop funding of $2.59M is made up of a total of five tranches occurring in years two through six based on a 55% uptake. Each tranche is expected to be a seven-year general obligation bond at an interest rate of 3.25%.
- The final series will be utilized for working capital and utility interfund loans needed to ensure a positive cumulative end-of-year free cash flow until the utility can be self-sufficient. Due to current bond restrictions, a maximum of 10% of funded capital expenditures, $1.8M, can be structured as working capital to support the Utility. Remainder of needed funds will be addressed

through interfund loans from the City of Lucas reserve funds or some other designated source. Series is structured to be a 15-year general obligation bond or interfund loans at an interest rate of 3.25%.

Table 11: Financial Model Borrowing Summary

Series	Number of Tranches	Term	Interest Rate	Principal	Interest	Total
Series A-Fiber Plant & Facilities	3	20	3.25%	$ 11,321,124	$ 4,251,961	$ 15,573,085
Series B-Network Equipment	3	10	3.25%	$ 3,465,273	$ 649,083	$ 4,114,356
Series C-Home Equipment	5	5	3.25%	$ 2,593,971	$ 347,992	$ 2,941,963
Series D-Working Capital Component	1	15	3.25%	$ 1,800,000	$ 502,792	$ 2,302,792
Bonding Amount				**$ 19,180,368**	**$ 5,751,828**	**$ 24,932,196**
Series D-Interfund Loan Component	10	15	3.25%	$ 4,730,000	$ 1,321,225	$ 6,051,225
Total Debt				**$ 23,910,368**	**$ 7,073,053**	**$ 30,983,421**

Figure 25: Debt Service Payoff



The estimated payback period for bond amount is 23 years and for all debt is 27 years. However, if all free cash is used to pay down the debt the payback period can be reduced by up to three years for bonded amounts and five years for all debt based on amount of free cash applied.

Rates for service could be further reduced in later years by using free cash flow to buy down service costs. In addition, if borrowing interest rates come in lower than expected, or do not have to be paid back at all, rates can be positively adjusted at that time.

The City could also look to fund portions of the capital investment through direct investment. there are multiple potential partnerships or funding sources which should be further explored, as a means to increase the amount of potential cash contributions the City could use to minimize borrowing. These include Grid Modernization initiatives with your local power providers, the potential for Lucas Water to own some of the assets, traffic funding, EDA grants, amongst others. Every dollar the City can raise to contribute to the network, can be used to reduce the rates for service, and will positively impact every other assumption or output within our model.

10. Proposed Timeline for Buildout

Fiber buildout is planned in two construction phases after network design is complete. An 18-month timeline is estimated from City of Lucas' approval of the next business plan / network design phase to the first customer install.

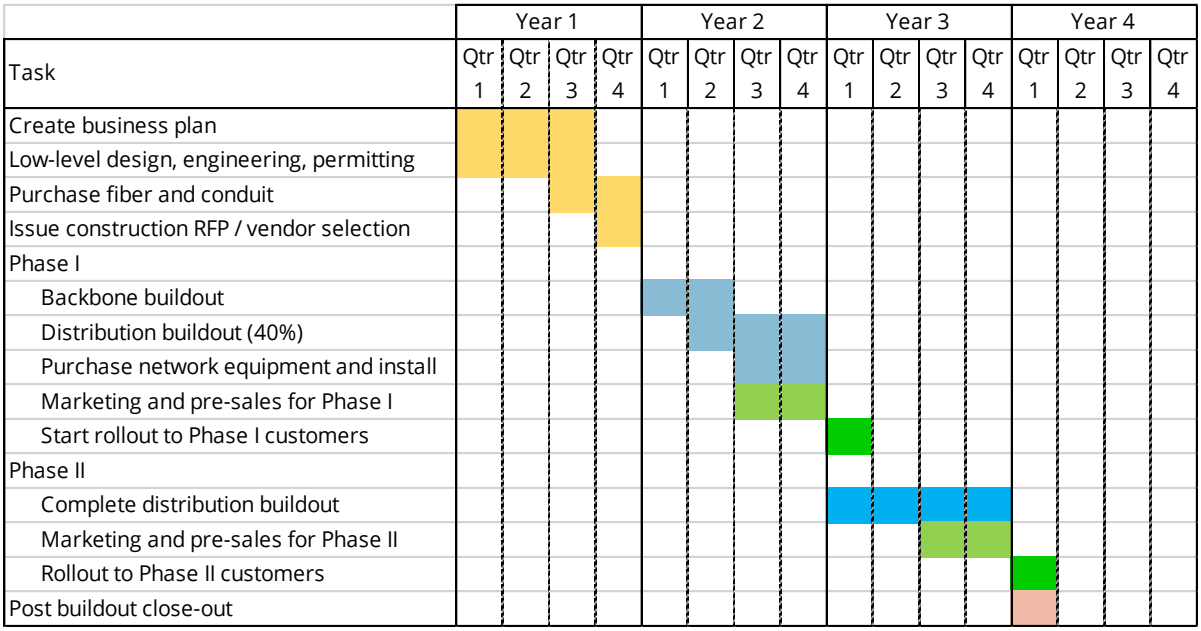
The critical steps to achieving this goal are:

- Creation and approval of a formal business plan
- Network design engineering for the City network
- Obtaining project funding
- Selection of construction, material, network equipment, and drop vendors
- Direct purchase of needed materials
- Implementation of data center and installation of equipment
- Establishment of operation policies and functions

- Marketing and pre-sales for quicker turn-up of customers
- Customer rollout

Figure 22 below shows the proposed timeline based on one full-time construction crew.

Figure 22: Proposed Timeline for City Buildout



Timeline can most likely be condensed based on adding additional construction crews where feasible.

Another tactic to connect customers earlier would be to enact a staged approach where selected areas ("fiberhoods") of the network are built out and customer connections started prior to building out the next selected fiberhood. The City Core buildout area would be segregated into fiberhoods based on geographic location, number of premises, calculated achievable revenues, and measured customer response. Measuring customer response can be achieved through pre-sales campaigns to determine what fiberhoods have the greatest demand and return. As with the standard approach, additional crews can be obtained to allow buildout of multiple fiberhoods at one time.

If desired by the City, options to possibly reduce buildout timeline would need to be reviewed and agreed upon during the construction vendor selection process.

A Lucas Fiber Utility Business Plan would ideally build upon what was learned throughout the last 2 years starting with the City and Tech Committee surveys, this Design and Financial Model Study, and culminates in an Actionable Business Plan that is shaped to guide the City through the Pre Planning, Deployment, Startup, and Operations of the City's Fiber Utility. It would also include final branding/marketing concepts, and a detailed implementation plan.

11. Recommendations and Next Steps

The City of Lucas, through commission of this Study, has decided to work to better understand what it would take to deliver high-speed next-generation broadband services to all its constituents, something the City's private sector service providers have been unable to accomplish.

Through deployment of a City owned fiber-optic network, the City of Lucas would be capable of deploying 1 Gbps and 10 Gbps services to all users within the City's limits, providing the fastest Internet services across the State of Texas, and the United States. For many residents who receive 10 Mbps to 25 Mbps today, this represents an increase in network bandwidth of at least a 40x to 100x times increase.

Based on the financial projections, and uptake assumptions, as well as detailed discussions with the City staff and leadership, this Study has determined that a financially viable broadband utility is feasible for the City to undertake.

Through this Study, should the City decide to move forward, it would structure a new Division of the City responsible for deploying, maintaining and operating the Lucas Broadband Utility Division, an enterprise fund operating within the City's municipal organization.

The success of a municipal broadband utility hinges on the ability of the organization to deliver superior Internet services at similar or lower costs than are currently available in market. For Lucas, the cost of the network build impacts the

City's ability to compete on pricing, albeit current market pricing is for services far less superior than what Lucas would deploy. Lucas would have to compete on its service offerings and the quality of the local customer services. Doing so means that the City will need to adopt a culture that understands the importance of delivering a quality service experience into its new Internet customers, a concept that the City already embraces today within its existing utility lines of business. Quality customer experiences coupled with responsive customer service are two key differentiating factors that set municipal broadband utilities apart from traditional broadband providers. With this in mind, the City is strongly positioned to deliver a better service to the residents and businesses across Lucas by implementing its own broadband communications utility, locally.

Implementations of municipal broadband utilities are complex and challenging projects technically, operationally, and financially. Magellan Advisors recommends that Lucas take a conservative and measured approach to implementing its utility, particularly focusing on building a sustainable operation through careful planning and phasing of the system.

Based on the findings of this Study, Magellan has identified the following next steps for the City to consider in implementing its broadband utility. These items comprise pre-implementation tasks that Magellan believes are critical prior to the City embarking on implementing its broadband utility.

- Complete a full internal review of this Broadband Feasibility Study to ensure the City's management has a comprehensive understanding of the project, its financial and funding needs, technical and operational requirements, and phases;
- City Management and Finance should begin to socialize the Financial Model and borrowing requirements with its financial/bond advisors and counsel;
- Seek formal agreement and approvals from the City Council on the findings of the Broadband Feasibility Study, and seek consensus on the approach to deploy;
- Gain approval from the City Council on the next steps in the broadband initiative, which would include the development of a formal City of Lucas FTTH Business Plan, begin Design, Engineering and Permitting activities associated with the fiber-optic outside plant, and prepare for contract procurement;

- Begin to implement Smart Broadband Friendly Public Policies (reference Appendix B of this Study) within the City's operating structure to accelerate infrastructure deployment, and to reduce overall project costs;
- Identify key resources within the City who will manage the development of the City's FTTH Business Plan and identify key project resources going forward.

Appendix A: Market Analysis Data

RESIDENTIAL

BroadbandNow Data			Magellan Targeted Research				
Providers	Coverage	Fastest Speeds	Address	Available Service	Speeds	Pricing	
Spectrum	92.60%	940Mbps	1705 Stinson Rd	No service available	Sent to SuddenLink's site		
			370 Bee Caves Rd	No service available	Sent to SuddenLink's site		
			221 Forestview Rd	No service available			
			1830 Country Club Rd	No service available	Sent to SuddenLink's site		
			919 E Lucas Rd	No service available	Sent to SuddenLink's site		
			285 Red Star Rd	No service available	Sent to SuddenLink's site		
			1220 Ford Ln	No service available			
AT&T	88.40%	100Mbps	1705 Stinson Rd	No service available			
			370 Bee Caves Rd	No internet available			
			221 Forestview Rd	Internet 10	Up to 10 Mbps	$49.99/m	1 TB data per month, $10 for each add'l 50 GB up to $100. $10/m equipment fee.
				Internet 10 + DIRECTV Select	Up to 10 Mbps	plus $49.99/M	155 channels
				Internet 10 + DIRECTV Choice	Up to 10 Mbps	plus $59.99/m	185 channels
				Internet 10 + DIRECTV Ultimate	Up to 10 Mbps	plus $74.99/m	250 channels
				Internet 10 + DIRECTV Entertainment	Up to 10 Mbps	plus $54.99/m	160 channels
				Internet 10 + DIRECTV Extra	Up to 10 Mbps	plus $69.99/m	235 channels and NFL Sunday Ticket
				Internet 10 + DIRECTV Premier	Up to 10 Mbps	plus $124.99/m	330 channels and NFL Sunday Ticket
			1830 Country Club Rd	Internet 25	Up to 25 Mbps	$39.99/m	No data caps
				Internet 10 + DIRECTV Select	Up to 10 Mbps	plus $39.99/M	155 channels

BroadbandNow Data			Magellan Targeted Research			
Providers	Coverage	Fastest Speeds	Address	Available Service	Speeds	Pricing	
				Internet 10 + DIRECTV Choice	Up to 10 Mbps	plus $49.99/m	185 channels
				Internet 10 + DIRECTV Ultimate	Up to 10 Mbps	plus $64.99/m	250 channels
				Internet 10 + DIRECTV Entertainment	Up to 10 Mbps	plus $44.99/m	160 channels
				Internet 10 + DIRECTV Extra	Up to 10 Mbps	plus $59.99/m	235 channels and NFL Sunday Ticket
				Internet 10 + DIRECTV Premier	Up to 10 Mbps	plus $114.99/m	330 channels and NFL Sunday Ticket
			919 E Lucas Rd	No internet service available			
			285 Red Star Rd	Internet 10	Up to 10 Mbps	$49.99/m	1 TB data per month, $10 for each add'l 50 GB up to $100. $10/m equipment fee.
				Internet 10 + DIRECTV Select	Up to 10 Mbps	plus $39.99/M	155 channels
				Internet 10 + DIRECTV Choice	Up to 10 Mbps	plus $49.99/m	185 channels
				Internet 10 + DIRECTV Ultimate	Up to 10 Mbps	plus $64.99/m	250 channels
				Internet 10 + DIRECTV Entertainment	Up to 10 Mbps	plus $44.99/m	160 channels
				Internet 10 + DIRECTV Extra	Up to 10 Mbps	plus $59.99/m	235 channels and NFL Sunday Ticket
				Internet 10 + DIRECTV Premier	Up to 10 Mbps	plus $114.99/m	330 channels and NFL Sunday Ticket
AT&T Fiber	8.00%	1000 Mbps	1400 Ford Ln	AT&T Fiber Internet 1000	Up to 1000 Mbps	$49.99/m	
				Internet 10 + DIRECTV Select	Up to 10 Mbps	plus $39.99/M	155 channels
				Internet 10 + DIRECTV Choice	Up to 10 Mbps	plus $49.99/m	185 channels

BroadbandNow Data			Magellan Targeted Research			
Providers	Coverage	Fastest Speeds	Address	Available Service	Speeds	Pricing	
				Internet 10 + DIRECTV Ultimate	Up to 10 Mbps	plus $64.99/m	250 channels
				Internet 10 + DIRECTV Entertainment	Up to 10 Mbps	plus $44.99/m	160 channels
				Internet 10 + DIRECTV Extra	Up to 10 Mbps	plus $59.99/m	235 channels and NFL Sunday Ticket
				Internet 10 + DIRECTV Premier	Up to 10 Mbps	plus $114.99/m	330 channels and NFL Sunday Ticket
Frontier DSL	13.20%	30Mbps	1705 Stinson Rd	No internet service available			
			370 Bee Caves Rd	Internet	Up to 50Mbps/50Mbps	$29.99/m	$3.99 surcharge and add phone for $10/m
				Internet	Up to 500Mbps/500Mbps	$39.99/m	$3.99 surcharge and add phone for $10/m
				Internet	Gig Service	$74.99/m	$3.99 surcharge and add phone for $10/m
			221 Forestview Rd	No internet service available			
			1830 Country Club Rd	No internet service available			
Frontier Fiber	13.10%	100Mbps	919 E Lucas Rd	Internet	Up to 50Mbps/50Mbps	$29.99/m	$3.99 surcharge and add phone for $10/m
				Internet	Up to 500Mbps/500Mbps	$39.99/m	$3.99 surcharge and add phone for $10/m
				Internet	Gig Service	$74.99/m	$3.99 surcharge and add phone for $10/m
			285 Red Star Rd	No internet service available			
			1400 Ford Ln	No internet service available			
SuddenLink	8.80%	1000Mbps	1705 Stinson Rd	Internet 100	100 Mbps	$39.99/m	Price for 1 yr, unlimited data

BroadbandNow Data			Magellan Targeted Research			
Providers	Coverage	Fastest Speeds	Address	Available Service	Speeds	Pricing
				Internet 400	400 Mbps	$44.99/m	Price for 2 yrs, unlimited data
				Internet 1 Gig	1000 Mbps	$54.99/m	Price for life, unlimited data
				Value TV and Internet 100	100 Mbps	$49.99/m	Price for 1 yr, unlimited data, 225 channels
				Value TV and Internet 400	400 Mbps	$54.99/m	Price for 2 yrs, unlimited data, 225 channels, free install
				Select TV and Internet 400	400 Mbps	$69.99/m	Price for 2 yrs, unlimited data, 290 channels, free install
				Premier TV and Internet 100	100 Mbps	$84.99/m	Price for 1 yr, unlimited data, 340 channels, free install
			370 Bee Caves Rd	Internet 100	100 Mbps	$39.99/m	Price for 1 yr, unlimited data
				Internet 400	400 Mbps	$44.99/m	Price for 2 yrs, unlimited data
				Internet 1 Gig	1000 Mbps	$54.99/m	Price for life, unlimited data
				Value TV and Internet 100	100 Mbps	$49.99/m	Price for 1 yr, unlimited data, 225 channels
				Value TV and Internet 400	400 Mbps	$54.99/m	Price for 2 yrs, unlimited data, 225 channels, free install
				Value TV and Internet 1 Gig	1000 Mbps	$64.99/m	Price for life, unlimited data
				Select TV and Internet 400	400 Mbps	$69.99/m	Price for 2 yrs, unlimited data, 290 channels, free install
			221 Forestview Rd	Internet 100	100 Mbps	$39.99/m	Price for 1 yr, unlimited data
				Internet 400	400 Mbps	$44.99/m	Price for 2 yrs, unlimited data
				Internet 1 Gig	1000 Mbps	$54.99/m	Price for life, unlimited data
				Value TV and Internet 100	100 Mbps	$49.99/m	Price for 1 yr, unlimited data, 225 channels
				Value TV and Internet 400	400 Mbps	$54.99/m	Price for 2 yrs, unlimited data, 225 channels, free install
				Value TV and Internet 1 Gig	1000 Mbps	$64.99/m	Price for life, unlimited data
				Select TV and Internet 400	400 Mbps	$69.99/m	Price for 2 yrs, unlimited data, 290 channels, free install
			1830 Country Club Rd	Internet 100	100 Mbps	$39.99/m	Price for 1 yr, unlimited data

BroadbandNow Data			Magellan Targeted Research			
Providers	Coverage	Fastest Speeds	Address	Available Service	Speeds	Pricing	
				Internet 400	400 Mbps	$44.99/m	Price for 2 yrs, unlimited data
				Internet 1 Gig	1000 Mbps	$54.99/m	Price for life, unlimited data
				Value TV and Internet 100	100 Mbps	$49.99/m	Price for 1 yr, unlimited data, 225 channels
				Value TV and Internet 400	400 Mbps	$54.99/m	Price for 2 yrs, unlimited data, 225 channels, free install
				Value TV and Internet 1 Gig	1000 Mbps	$64.99/m	Price for life, unlimited data
				Select TV and Internet 400	400 Mbps	$69.99/m	Price for 2 yrs, unlimited data, 290 channels, free install
			919 E Lucas Rd	Internet 100	100 Mbps	$39.99/m	Price for 1 yr, unlimited data
				Internet 400	400 Mbps	$44.99/m	Price for 2 yrs, unlimited data
				Internet 1 Gig	1000 Mbps	$54.99/m	Price for life, unlimited data
				Value TV and Internet 100	100 Mbps	$49.99/m	Price for 1 yr, unlimited data, 225 channels
				Value TV and Internet 400	400 Mbps	$54.99/m	Price for 2 yrs, unlimited data, 225 channels, free install
				Value TV and Internet 1 Gig	1000 Mbps	$64.99/m	Price for life, unlimited data
				Select TV and Internet 400	400 Mbps	$69.99/m	Price for 2 yrs, unlimited data, 290 channels, free install
			285 Red Star Rd	Internet 100	100 Mbps	$39.99/m	Price for 1 yr, unlimited data
				Internet 400	400 Mbps	$44.99/m	Price for 2 yrs, unlimited data
				Internet 1 Gig	1000 Mbps	$54.99/m	Price for life, unlimited data
				Value TV and Internet 100	100 Mbps	$49.99/m	Price for 1 yr, unlimited data, 225 channels
				Value TV and Internet 400	400 Mbps	$54.99/m	Price for 2 yrs, unlimited data, 225 channels, free install
				Value TV and Internet 1 Gig	1000 Mbps	$64.99/m	Price for life, unlimited data
				Select TV and Internet 400	400 Mbps	$69.99/m	Price for 2 yrs, unlimited data, 290 channels, free install

BroadbandNow Data			Magellan Targeted Research				
Providers	Coverage	Fastest Speeds	Address	Available Service	Speeds	Pricing	
				Value TV and Internet 100 and Phone	100 Mbps	$59.99/m	Price for 1 yr, unlimited data, 225 channels
				Value TV and Internet 400 and Phone	400 Mbps	$64.99/m	Price for 2 yrs, unlimited data, 225 channels, free install
				Value TV and Internet 1 Gig and Phone	1000 Mbps	$74.99/m	Price for life, unlimited data
				Select TV and Internet 400 and Phone	400 Mbps	$79.99/m	Price for 2 yrs, unlimited data, 290 channels, free install
			1400 Ford Ln	Internet 100	100 Mbps	$39.99/m	Price for 1 yr, unlimited data
				Internet 400	400 Mbps	$44.99/m	Price for 2 yr, unlimited data
				Internet 1 Gig	1000 Mbps	$54.99/m	Price for life, unlimited data
				Value TV and Internet 100	100 Mbps	$49.99/m	Price for 1 yr, unlimited data, 225 channels
				Value TV and Internet 400	400 Mbps	$54.99/m	Price for 2 yrs, unlimited data, 225 channels, free install
				Select TV and Internet 400	400 Mbps	$69.99/m	Price for 2 yrs, unlimited data, 290 channels, free install
				Premier TV and Internet 100	100 Mbps	$84.99/m	Price for 1 yr, unlimited data, 225 channels
Rise Broadband	100%	15Mbps	1705 Stinson Rd	No service available			
			370 Bee Caves Rd	No service available			
			221 Forestview Rd	No service available			
			1830 Country Club Rd	Good	Up to 25 Mbps	$60/m	Special $29.95 for 12 month, then $10 increase for the remainder 12 months
				Better	Up to 50 Mbps	$70/m	Speciall $39.95 for 12 month, then $10 increase for the remainder 12 months
				Best	Up to 50 Mbps with Unlimited Data	$70/m	Doesn't say online what the data cap is
			919 E Lucas Rd	Good	Up to 25 Mbps	$60/m	Special $29.95 for 12 month, then $10 increase for the remainder 12 months

BroadbandNow Data				Magellan Targeted Research			
Providers	Coverage	Fastest Speeds	Address	Available Service	Speeds	Pricing	
				Better	Up to 50 Mbps	$70/m	Speciall $39.95 for 12 month, then $10 increase for the remainder 12 months
				Best	Up to 50 Mbps with Unlimited Data	$70/m	Doesn't say online what the data cap is
			285 Red Star Rd	No service available			
			1400 Ford Ln	No service available			
Grande Cable	16%	1000Mbps	0 Addresses had service				

BroadbandNow Data			Magellan Targeted Research			
Providers	Coverage	Speeds	Address	Available Service	Speeds	Pricing
Spectrum	100%	940Mbps	535 W Forest Grove Rd	Not a provider under SuddenLink 866-839-5838		
			3855 Osage Ln	Not a provider under SuddenLink 866-839-5838		
			1125 Brockdale Park Rd	Not a provider under SuddenLink 866-839-5838		
Rise Broadband	100%	15Mbps	535 W Forest Grove Rd	up to 25 Mbps	$79.95, 1 yr contract	
			410 Lakeshore Blvd	up to 50Mbps	$99.95, 1 year contract	
			1125 Brockdale Park Rd	up to 50Mbps	$99.95, 1 year contract	
			3855 Osage Ln	up to 50Mbps	$89.95	
AT&T	98.30%	100Mbps	535 W Forest Grove Rd	Internet Basic 6	Up to 6 Mbps$40/m	
				Internet Basic 25	Up to 25 Mbps	$50/m
AT&T Fiber	20.50%	1000Mbps	410 Lakeshore Blvd	AT&T Wireless Internet 100 GB Data		$140/m

BroadbandNow Data				Magellan Targeted Research		
Providers	Coverage	Speeds	Address	Available Service	Speeds	Pricing
				AT&T Wireless Internet 50 GB Data		$100/m
				AT&T Dedicated Internet	10 Mbps	$550/m
				AT&T Dedicated Internet	20 Mbps	$575/m
				AT&T Dedicated Internet	50 Mbps	$798/m
				AT&T Dedicated Internet	100 Mbps	$1,076/m
				AT&T Dedicated Internet	150 Mbps	$1,238/m
				AT&T Dedicated Internet	250 Mbps	$1,576/m
				AT&T Dedicated Internet	400 Mbps	$2,146/m
				AT&T Dedicated Internet	500 Mbps	$2,470/m

BroadbandNow Data				Magellan Targeted Research		
Providers	Coverage	Speeds	Address	Available Service	Speeds	Pricing
				AT&T Dedicated Internet	600 Mbps	$2,645/m
				AT&T Dedicated Internet	1 Gbps	$3,092/m
				AT&T Dedicated Internet	2 Gbps	$4,202/m
				AT&T Dedicated Internet	3 Gbps	$5,486/m
				AT&T Dedicated Internet	4 Gbps	$6,298/m
				AT&T Dedicated Internet	5 Gbps	$6,964/m
				AT&T Dedicated Internet	6 Gbps	$7,913/m
				AT&T Dedicated Internet	7 Gbps	$8,804/m
				AT&T Dedicated Internet	8 Gbps	$9,627/m

BroadbandNow Data			Magellan Targeted Research			
Providers	Coverage	Speeds	Address	Available Service	Speeds	Pricing
				AT&T Dedicated Internet	10 Gbps	$10,826/m
			1125 Brockdale Park Rd	AT&T Wireless Broadband 8 Mbps LTE	8 Mbps	$80/m
				AT&T Wireless Broadband 12 Mbps LTE		$130/m
				AT&T Wireless Broadband 50 Mbps LTE	50 Mbps	$200/m
				AT&T Dedicated Internet	10 Mbps	$550/m
				AT&T Dedicated Internet	20 Mbps	$575/m
				AT&T Dedicated Internet	50 Mbps	$798/m
				AT&T Dedicated Internet	100 Mbps	$1,076/m
				AT&T Dedicated Internet	150 Mbps	$1,238/m

BroadbandNow Data				Magellan Targeted Research		
Providers	Coverage	Speeds	Address	Available Service	Speeds	Pricing
				AT&T Dedicated Internet	250 Mbps	$1,576/m
				AT&T Dedicated Internet	400 Mbps	$2,146/m
				AT&T Dedicated Internet	500 Mbps	$2,470/m
				AT&T Dedicated Internet	600 Mbps	$2,645/m
				AT&T Dedicated Internet	1 Gbps	$3,092/m
				AT&T Dedicated Internet	2 Gbps	$4,202/m
				AT&T Dedicated Internet	3 Gbps	$5,486/m
				AT&T Dedicated Internet	4 Gbps	$6,298/m
				AT&T Dedicated Internet	5 Gbps	$6,964/m

BroadbandNow Data			Magellan Targeted Research			
Providers	Coverage	Speeds	Address	Available Service	Speeds	Pricing
				AT&T Dedicated Internet	6 Gbps	$7,913/m
				AT&T Dedicated Internet	7 Gbps	$8,804/m
				AT&T Dedicated Internet	8 Gbps	$9,627/m
				AT&T Dedicated Internet	10 Gbps	$10,826/m
			3855 Osage Ln	No internet availability		
Frontier DSL	50%	30Mbps	535 W Forest Grove Rd	No service available		
Frontier Fiber	46.50%	100Mbps	1125 Brockdale Park Rd	FiOS Fiber	1000/1000	$259.99, 1 yr contract
					500/500	$109.99, 1 yr contract
					100/100	$69.99. 1 yr contract
			3855 Osage Ln	Fios Fiber	100/100	$49.99, 1 yr contract
					500/500	$89.99, 1 yr contract

BroadbandNow Data			Magellan Targeted Research			
Providers	Coverage	Speeds	Address	Available Service	Speeds	Pricing
					1000/1000	$239.99, 1 yr contract
SuddenLink	45.00%	1000Mbps	535 W Forest Grove Rd	Business Internet	300Mbps/30Mbps	$165.39
				Business Internet	500Mbps/50Mbps	$252.43
				Business Internet	1000Mbps/50Mbps	$405.30
			1125 Brockdale Park Rd	No service availabiliy		
			3855 Osage Ln		300/30Mbps	$135
					500/50Mbps	$215
					1 Gig	$375.44

Appendix B: Broadband-Friendly Policies

Broadband-friendly policies serve the public by:

1. Filling broadband gaps in availability or affordability,
2. Enabling services that are financially sustainable, and
3. Promoting economic development and job creation.

Local governments can accelerate broadband deployment by:

- Streamlining and facilitating access to local government owned facilities and properties to include franchising/licensing and use of rights of way, utility pole attachments (lease and rules for adding wires and equipment), zoning (rules for facilities placement, esp. wireless antennas), permitting application process and permit fees based on actual costs.
- Maximizing available assets on public lands and rights of way, particularly conduit and/or fiber installation as part of capital improvement programs to occur simultaneously with utility relocations, road widening, water and sewer installs and lighting projects supported by joint trenching and "dig once" policies.
- Implementing industry specific regulations to include master franchise agreements, broadband development standards incorporated in land development code.
- Facilitating construction with building permits, land development codes, engineering standards).
- Coordinated planning to include mapping and asset management to maximize use and reduce duplication.

Most of these activities do not require additional funding, but do require a change in approach which will ensure equitable treatment of all network service providers, including broadband and cellular services. Well-developed policies and guidelines should also serve to preserve public safety and welfare and minimize the overall impact on community aesthetics.

Policies that treat telecommunications the same as any other utility in the rights-of-way subject only to review by engineers, may provide the most expedient avenue for rapid deployment without compromising the needs of the community.

Generally, Magellan Advisors recommends "lightweight" policies that facilitate development while balancing it with social costs and ensuring costs are fully and equitably imputed to service providers. Policies should be consistent across adjacent jurisdictions and should be structured such that broader level policies can be adapted and tailored to smaller scale jurisdictions: County policies should provide elements, foundation, or a framework for city, town, and village policies. The overall goals are efficiency and flexibility along with a balance between consistency and control.

HOLISTIC POLICY APPROACHES

Some local governments have taken a holistic approach to facilitating broadband deployment and enhancing telecommunications access. This involves reviewing and amending existing policies, as well as adopting new policies based on changes in technology and community needs. A holistic approach also has standardized agreements and leases and engineering specifications for implementing those policies.

Examples

Mono County, CA developed a plan to increase accessibility, reliability and expansion including construction of infrastructure, collocations and access.

Santa Cruz, CA, developed a comprehensive Broadband Master Plan to address the major policy considerations for maximizing broadband availability. The master plan included a dig once policy, master lease agreement, encroachment permit process, and specifications for conduit, hand holds, fiber huts, and other related equipment. Geographic Information Systems data requirements in the master plan enable the city to map current and proposed broadband assets and paths, and to plan accordingly.

FOCUSED BROADBAND POLICIES

As opposed to taking a broad-brush approach and implementing a master program or plan, other cities have focused on addressing specific policies to minimize obstacles and promote telecommunications access. For each community, the policies implemented were based upon a review of assets, review of existing policies and the specific needs of the community. The primary policy focus areas include both wireless and wired telecommunication infrastructure with a specific focus on maximizing deployment of these assets, to include:

- Wireless tower regulations (siting and collocation)
- Small cell/distributed antenna systems (DAS) access to rights-of-way
- Wired access to rights of way includes: open trench, shadow conduit, dig once, and joint trenching
- Permitting and building codes
- Construction, engineering and conduit building specifications

WIRELESS COMMUNICATION (TOWER SITING AND ANTENNA COLLOCATION)

Many local jurisdictions adopted local telecommunication policies commensurate with the 1996 Telecommunications Act to regulate tower location, tower height, and tower design including color, lighting, and screening of base facilities. Antenna collocation is required where possible to reduce costs and time by maximizing the use of existing infrastructure.

Collocation is defined by the FCC as "the mounting or installation of an antenna on an existing tower, building, or structure for transmitting and/or receiving radio frequency signals for communications purposes." Collocation enhances community aesthetics by reducing the number of vertical structures needed for broadband deployment.

The FCC released additional guidelines and regulations in the October 2014 Acceleration of Broadband Deployment Order, which includes final rules implementing Section 6409(a) of the Middle-Class Tax Relief and Job Creation Act of 2012. Section 6409(a) of the Middle-Class Tax Relief and Job Creation Act of 2012 restricts local land use review of modifications and collocations by establishing the "substantial change test" and reduces the processing shot clock from 90 days to 60

days. Distributed antenna systems (DAS) and small cells, may also require compliance with these same processes.

Whether a local government is reviewing existing or developing new telecommunication policies to ensure compliance with federal and/or state regulatory changes, local governments should consider:

- Adopting policies that have uniform rules and limitations regarding tower siting to prevent unnecessary delays in approval, high leasing fees, and other red tape associated with new wireless tower infrastructure.
- Including requirements to collocate if possible rather than construct a new tower.

(i) Examples

Several local government organizations have developed model wireless communication ordinances.

The North Carolina League of Municipalities (NCLM) https://www.nclm.org/SiteCollection Documents/Resource/WirelessTelecomModelOrdinanceOct13.pdf

The Municipal Research and Services Center (MRSC) references a model ordinance created by the Kenyon Disend PLLC law firm in Issaquah and have made it available for other local governments to use. http://mrsc.org/getmedia/57ba09ad-aae9-4b3c-a2b6-923db84020fc/m58efm.aspx

The National League of Cities and the National Association of Counties (NLC and NACO) worked together with providers and local government to develop a series of resources, online at http://www.naco.org/sites/default/files/Model-Ord-NACo.pdf, including:

1. A model ordinance and application for reviewing eligible facilities requests under Section 6409(a)
2. Wireless siting best practices
3. A checklist that local government officials can use to help streamline the review process

In addition, the following cities are included as they updated existing ordinances to reflect both statutory changes and technology innovations.

Clark County, NV, land use strategy documents regarding communication towers and antennas list situations in which no permit is needed (e.g., an antenna is not visible), an administrative review is available (e.g., location on public property), or exclusive use review is required. With easily accessible documents, the County helps telecommunications carriers avoid public hearings which serves as a major incentive for the providers.

Cumberland County, PA, provides an updated model wireless ordinance to address not only the regulatory changes but the changes associated with modern technology such as distributed antenna systems (DAS).

Other examples:

- Centennial, CO
- Ouray Co, CA
- Princeton, Iowa

Small Cell/ DAS Collocation and Use of Rights-of-Way

The concepts applicable to antenna collocation on towers may also be considered for the latest small cell technology which can be attached to utility poles, streetlights and other structures in the public rights-of-way. The FCC's National Broadband Plan concluded that, "the rates, terms, and conditions for access to rights-of-way (including pole attachments) significantly impact broadband deployment." As with collocation on towers, attaching communications facilities to existing poles, ducts, conduit and other structures lowers costs of infrastructure deployment; ensures efficient use of existing infrastructure and limits impact of multiple structures in the rights-of-way.

Many states are now adopting legislation related to small cell (5G) deployment to regulate the rates, terms, and conditions of use/ lease of poles, ducts, and conduits that are owned by a "utility provider." Local government policies must comply with the state regulations in which the local government resides while protecting the interests and the aesthetics of their community.

The League of Minnesota Cities provides an excellent review with samples of model ordinances and policies addressing DAS/small cell deployment. This document is included herein along with the following referenced cities and respective documents including master leases.

(ii) Examples:

- Boston, MA
- Minneapolis, MN
- San Antonio, Texas
- San Francisco, California
- Santa Monica, CA
- Texas City Attorney Association

WIRED (CONDUIT & FIBER) RIGHTS-OF-WAY EXCAVATIONS

Sixty to eighty percent of wired broadband deployment costs are associated with excavating/opening a trench usually in the rights-of-way and/or in burying conduit. Coordination with all interested parties, including telecommunications, for street cuts and excavations, sidewalk and trail improvements, water and sewer, and street lighting projects not only minimizes disruption and damage associated with trenching, but reduces associated costs.

According to the National Broadband Plan (https://transition.fcc.gov/national-broadband-plan/national-broadband-plan.pdf) "the cost of running a strand of fiber through an existing conduit is three to four times cheaper than constructing a new aerial build."

A review of the literature reveals the use of several different terms aimed at managing the rights-of-way more efficiently and effectively, including open trench, shadow conduit, and dig once policies. The overall goals of these policies and procedures is to reduce the number of street excavations and associated costs and ensure equal access to all providers who use the rights-of-way to provide services which meet the needs of the public.

Terminology

Open Trench refers to the digging or excavation of a 'ditch' in the right-of-way for any purpose, including but not limited to deploying fiber. These policies focus on the dimensions, location, safety, signage, etc., for open trenches.

"Dig Once" policies minimize excavation and damage to rights-of-way through coordination efforts involving ALL users of the rights of way including

telecommunications when construction is planned which will create an "open trench."

Joint Building or Joint Trenching requires right-of-way users (e.g. telecommunications providers) to utilize a common or joint trench with other utilities (i.e. sewer, water, gas, electric) where a (re)developer or utility company provides a trench for undergrounding of utilities.

Shadow Conduit is used to refer to the installation of empty and/or spare conduit by a public agency when excavations occur in the public right-of-way, with agency costs limited to incremental costs. Some cities also require the installation of fiber when a trench is open for any reason.

Local governments should consider policies and implement practices that encourage:

- Coordinating construction activities in the rights-of-way to minimize disruption thus maximizing public safety and reducing overall costs associated with multiple repeated excavation projects.
- Placing conduit and/or fiber-optic cable when a trench is open for whatever reason in the rights-of-way.
- Establishing clear engineering and construction specifications.

Examples

The following examples are representative of best practices and models for managing the rights-of-way to maximize its use and facilitate broadband expansion in the community.

Berkeley, CA modified its existing code and drafted best practices policies to maximize the use of the Rights of way equitably by all providers, coordinating construction to reduce inconvenience to the public, improve safety and reduce costs.

In 1994, Boston, MA was one of the first cities to put forth a policy that mandated all telecommunications carriers to install underground conduits "in the same trench, at the same time on a shared-cost basis." The policy dictates the establishment of a "lead company" which is any company that approaches the local government first with a build-out request, thus taking the lead in construction

coordination. "the lead company and participating telecoms work together to draft the engineering plans, estimate construction costs, and submit the build-out application for review and approval. This approach has worked well in Boston to minimize street excavation and expedite the broadband deployment process."

Gonzales, CA developed a very simple one-page policy to address rights of way excavation and expansion of broadband.

In Mount Vernon, WA, conduit placement requirements were added to the city's code helping to build its open access telecommunications network. Per the city ordinance:

> 12.20.015 Construction standards for the regulation of use of public rights-of-way and public property.
>
> All developments shall be required to construct and install telecommunications conduit on all streets that are affected, disturbed, constructed and/or improved by development unless otherwise approved, pending a review by the city engineer. This conduit shall be for installing telecommunications cable, fiber- optic wiring, or other infrastructure as necessary.
>
> This conduit shall be placed at horizontal and vertical locations as determined by the city engineer. The conduit shall conform to the size, shape, and characteristics as determined by the city engineer based on industry standards. Once installed and accepted by the city, the conduit shall become the property of Mount Vernon.
>
> Development as defined in this section shall mean the construction of improvements such as buildings, homes, subdivisions, streets, and utilities. (Ord. 2927, 1999).

San Francisco, CA established a “Communication Infrastructure in Excavation Projects” guide to ensure, when feasible, fiber and conduit were included in construction projects and multiple excavations were minimized.

Sandy, OR, passed an ordinance requiring all new development to install underground fiber along with other utilities. Developers are now required to put conduit all the way into a home and to deed that conduit to the city. The code change was an expansion of existing policy adding “broadband (fiber)” to the list of public facilities. Underground communication lines join a list of other required improvements that are to be installed in new developments at no expense to the city. The city also developed a public-private fiber-to-the-premises (FTTP) project.

San Benito, CA, implemented a "dig once" policy as part of its “Complete Streets” policy by including provision for a full range of infrastructure main line and distribution, above and below ground, as appropriate, in initial roadway design and construction and in reconstruction projects involving more than surface pavement treatment.

San Francisco, CA, developed a dig once ordinance that modifies the City’s Public Works Code provisions governing all utility excavation. Only plans that include the installation of communications facilities (e.g., conduit) may be approved for permit. All excavators are required to place conduit that can be leased. Specifications for the shadow conduit is required to be placed in a joint trench above the excavator’s conduit. The City is mapping communications assets as they are installed.

Santa Cruz County, CA adopted a “dig once” ordinance as part of a broad approach to adopt policies to encourage the development of broadband.

JOINT TRENCH AND JOINT BUILD AGREEMENTS

Agreements for joint trenching/building may be developed with other telecommunications, cable or utility providers. Cost for placement of conduit or fiber may be shared amongst all entities, allowing each to take advantage of the other’s trenching. 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. In addition to a model template developed by Magellan Advisors, sample agreements are provided.

(iii) Examples:

- Collier County, Florida
- Des Moines, Iowa
- Santa Cruz
- Magellan Joint Build Agreement Template

Permitting and Building Codes

Expedited permitting codes that streamline approvals and eliminate red tape for approval of cable and antenna installation of cable or antennas in rights-of-ways or public structure will speed up the process of expanding telecommunications access in a community. Many localities have simplified the permitting efforts by placing broadband infrastructure projects solely in the public works department via encroachment permit processes. Additionally, local governments have reviewed permitting fees to cover costs and reduced overall expenses associated with permitting fees. Finally, local governments have added connectivity requirements to building codes, ensuring that new constructions are equipped with broadband access.

The Virginia Association of Counties (VACO) adopted a Virginia Tech study recommendation for review and update of permitting policies to facilitate broadband delivery. Specifically, VACO recommended issuing an overall project permit as opposed to requiring weekly or daily permits.

The State of Washington published a best-practices guide for local government permitting to streamline approval of infrastructure projects, including broadband.

Clark County, NV land use strategy documents regarding communication towers and antennas list situations in which no permit is needed (e.g., an antenna is not visible). With easily accessible documents, the county helps telecommunications carriers avoid public hearings, which serves as a major incentive for the providers.

Missoula, MT, city council members voted to reduce its fees by more than 75% for permits associated with excavation and placing communication conduit and fiber in rights-of-way.

The following guides are provided herein as models for best practices for permitting that can be implemented to enhance broadband deployment.

(iv) Other Examples:

- State of Massachusetts Best Practices Guide to Permitting
- State of Washington Best Practices Guide to Permitting

Conduit and Fiber Standards for New Home Construction

Building codes that set standards and require conduit and/or fiber during development have been essential parts of expanding broadband, particularly in underserved and rural areas. The following cities exemplify best practices for this approach.

Brentwood, CA, passed an *advanced technology systems* ordinance in 1999, requiring developers to include conduit and fiber in newly built homes. In 2014, the city reached an agreement with Sonic.net to use the conduit as the basis for a fiber to the home (FTTH) system.

Loma Linda, CA, added language to city building codes, requiring all new commercial and residential developments (or re-models involving greater than 50% of the structure) to equip new structures with fiber and copper cabling. Per the city ordinance:

> In recognition of the need to provide local residents and businesses within the community with additional options to meet their telecommunications needs, as adopted by City council resolution, all new development projects within the City, regardless of whether such new development falls within the fiber-optic master plan area, and additions that exceed more than fifty percent of the original structure that fall within the fiber-optic master plan area, will be required to participate in, and will be bound by, the connected community program and all conditions and requirements contained therein. Further, any conditions or requirements of the connected

> community program may be required as a condition of approval of any such new development or addition exceeding fifty percent of the original structure. (Ord. 629 § 1, 2004)

In Jerome, ID, all new subdivisions are now required to install fiber-conduit. According to the town's subdivision regulations:

> Fiber Optical Conduit: All developers will be required to pay for and install two-inch (2") SDR11 smooth wall Inner-duct fiber optical conduit, which is orange in color, with pull rope, PG style service boxes, forty-seven inches (47") high by forty-eight inch (48") open bottom and PG style heavy duty cover with support beam. The placement and construction of the fiber optical conduit shall be done in accordance with the Jerome standards and at the discretion of the City engineer. (Ord. 994 §2, 2006).

Sandy, OR, passed an ordinance requiring all new development to install underground fiber along with other utilities. Developers are now required to put conduit all the way into a home and to deed that conduit to the city. The city also developed a public-private FTTP project.

ENGINEERING/CONSTRUCTION SPECIFICATIONS

Engineering standards and specifications identify and define requirements and policies for designing and installing telecommunications infrastructure and substructure at all facilities including conduit placement, type and installation. Conduit-specification documents address capacity, separation of facilities, proper sizing and placement, access to the conduit with detailed provisions for vaults and all access points. Cost sharing or cost recovery stipulations can be put in place for materials and labor assignment. Engineering specifications outline drawings that address

conduit sweeps, bend radius and physical placement requirements can be provided with the standard conduit specification.

The following sample guides are included, which may be helpful for guidance on telecommunications infrastructure and specifications.

(v) Examples:

- Boston Excavation Specifications
- Brentwood CA Engineering Procedures
- University of North Carolina Communications Infrastructure Guidelines
- University of Toronto Communications Infrastructure Guidelines

Microtrenching

Micro-trenching is included as a subcategory of engineering specifications as it is construction method being pursued by some cities to minimize impact and damage to roads and sidewalks. Micro-trenching is defined as "a low-impact deployment methodology in which fiber and conduit are inserted into a slot-cut trench less than ¾ inch wide and between 9-12 inches deep – without damaging or disrupting existing infrastructure. The benefits of microtrenching are that it is less disruptive than other broadband expansion methods, offers faster deployment speeds, and has significant cost-savings. Cities which have implemented the techniques include:

Jackson, WY sees a large influx of tourists each year, adding to its 9,800 residents, making reliable broadband a crucial component to economic development for the town. After securing grants from the National Telecommunications and Information Administration (NTIA) and Broadband Technology Opportunities Program (BTOP), a local provider launched the Teton Broadband Project to upgrade the fiber network of Jackson. As a popular tourist destination, minimal disruption to the environment was important to keep the integrity of the surrounding land. As a result, the project opted to use a provider for fiber installation that employed multiple techniques – directional drilling, conventional trenching, and microtrenching. The microtrenching technology use was planned for the areas within the Jackson City limits to least disrupt residents and businesses, providing a valuable solution for Jackson's issue of expanding broadband in an efficient and minimally invasive fashion.

Loma Linda, CA, installed fiber city-wide using microtrenching technologies. The city used pushable fiber cable and micro ducts in combination with microtrenching to significantly reduce costs associated with deployment of fiber network.

New York City has revised its rules to add a chapter authorizing and regulating the use of microtrenching and launched a pilot program with Verizon to test microtrenching as an efficient alternative to conventional measures. Based on the pilot project, New York has determined that microtrenching is less disruptive to pedestrian and vehicular traffic and to the structural integrity of the streets saving the City both money and time.

Appendix C: Glossary

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.
5G – Fifth Generation	The fifth generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web. It is believed that this technology will significantly increase bandwidth to users, up to 1 Gig.
ADSL – Asymmetric Digital Subscriber Line	DSL service with a larger portion of the capacity devoted to downstream communications, less to upstream. Typically thought of as a residential service.
ADSS – All-Dieletric Self-Supporting	A type of optical fiber cable that contains no conductive metal elements.
AMR/AMI – Automatic Meter Reading/Advanced Metering Infrastructure	Electrical meters that measure more than simple consumption and an associated communication network to report the measurements.
ATM – Asynchronous Transfer Mode	A data service offering that can be used for interconnection of customer's LAN. ATM provides service from 1 Mbps to 145 Mbps utilizing Cell Relay Packets.
Bandwidth	The amount of data transmitted in a given amount of time; usually 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 (which is the unit used to measure storage space), therefore a 1 Mbps connection takes about 8 seconds to transfer 1 megabyte of data (about the size of a typical digital camera photo).
BPL – Broadband over Powerline	A technology that provides broadband service over existing electrical power lines.
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).
CAD – Computer Aided Design	The use of computer systems to assist in the creation, modification, analysis, or optimization of a design.
CAI – Community Anchor Institutions	The National Telecommunications and Information Administration defined CAIs in its SBDD program 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, K-12 schools, libraries, health care facilities, social service providers, public safety entities, government and municipal offices are all community anchor institutions.

CAP – Competitive Access Provider	(or “Bypass Carrier”) A Company that provides network links between the customer and the Inter-Exchange Carrier or even directly to the Internet Service Provider. CAPs operate private networks independent of Local Exchange Carriers.
Cellular	A mobile communications system that uses a combination of radio transmission and conventional telephone switching to permit telephone communications to and from mobile users within a specified area.
CLEC – Competitive Local Exchange Carrier	Wireline service provider that is authorized under state and Federal rules to compete with ILECs to provide local telephone service. CLECs provide telephone services in one of three ways or a combination thereof: 1) by building or rebuilding telecommunications facilities of their own, 2) by leasing capacity from another local telephone company (typically an ILEC) and reselling it, and 3) by 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 at the demarcation point ("demarc").
CWDM – Coarse Wavelength Division Multiplexing	A technology similar to DWDM only utilizing less wavelengths in a more customer-facing application whereby less bandwidth is required per fiber.
Demarcation Point (“demarc”)	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.
Downstream	Data flowing from the Internet to a computer (Surfing 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.
DSLAM – Digital Subscriber Line Access Multiplier	A piece of technology installed at a telephone company's Central Office (CO) and connects the carrier to the subscriber loop (and ultimately the customer's PC).
DWDM – Dense Wavelength Division Multiplexing	An optical technology used to increase bandwidth over existing fiber-optic networks. DWDM works by combining and transmitting multiple signals simultaneously at different wavelengths on the same fiber. In effect, one fiber is transformed into multiple virtual fibers.
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.
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.
FDH – Fiber Distribution Hub	A connection and distribution point for optical fiber cables.

FTTN – Fiber to the Neighborhood	A hybrid network architecture involving optical fiber from the carrier network, terminating in a neighborhood cabinet which converts the signal from optical to electrical.
FTTP – Fiber to the premise (or FTTB – Fiber to the building)	A fiber-optic system that connects directly from the carrier network to the user premises.
FTTx – Fiber to the X	All fiber optic topologies from a provider to its customers, based on the location of the fiber's termination point
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.
GSM – Global System for Mobile Communications	This is the current radio/telephone standard developed in Europe and implemented globally except in Japan and South Korea.
HD – High Definition (Video)	Video of substantially higher resolution than standard definition.
HFC – Hybrid Fiber Coaxial	An outside plant distribution cabling concept employing both fiber-optic and coaxial cable.
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.

IEEE – Institute of Electrical Engineers	A professional association headquartered in New York City that is dedicated to advancing technological innovation and excellence.
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.
IP-VPN – Internet Protocol-Virtual Private Network	A software-defined network offering the appearance, functionality, and usefulness of a dedicated private network.
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 which, 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. The network can link workstations within a building or multiple computers with a single wireless Internet 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 (IntraLATA) 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.
Middle Mile Network	Middle mile is a term most often referring to the network connection between the last mile and greater Internet. For instance, in a rural area, the middle mile would likely connect the town's network to a larger metropolitan area where it interconnects with major carriers.
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.
ONT – Optical Network Terminal	Used to terminate the fiber-optic line, demultiplex the signal into its component parts (voice telephone, television, and Internet), and provide power to customer telephones.
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 Passive Optical Network consists of an optical line terminator located at the Central Office and a set of associated optical network terminals located at the customer's premise. Between them lies the 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 or serving equipment can be split from the main fiber using passive splitters / couplers. This allows for an expensive piece of fiber cable from the exchange to the customer to be shared among 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 government service or private business venture that is funded and operated through a collaborative partnership between a government and one or more private sector organizations. In addition to being referred to as a PPP, they are sometimes called a P3, or P^3.
QOS – Quality of Service	QoS (Quality of Service) refers to a broad collection of networking technologies and techniques. The goal of QoS is to provide guarantees on the ability of a network to deliver predictable results, which are reflected in Service Level Agreements or SLAs. Elements of network performance within the scope of QoS often include availability (uptime), bandwidth (throughput), latency (delay), and error rate. QoS involves 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 antennas.
RMS – Resource Management System	A system used to track telecommunications assets.
RPR – Resilient Packet Ring	Also known as IEEE 802.17, is a protocol standard designed for the optimized transport of data traffic over optical fiber ring networks.
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.
Streaming	Streamed data is any information/data 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.

Submarine Network	Submarine networking is the process by which data is carried on subsea cables to connect continents. Submarine networks carry 95 percent of the world's intercontinental electronic communications traffic.
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 flowing from your computer to the Internet (sending E-mail, uploading a file).
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.

VDSL – Very High Data Rate Digital Subscriber Line	A developing digital subscriber line (DSL) technology providing data transmission faster than ADSL over a single flat untwisted or twisted pair of copper wires (up to 52 Mbit/s downstream and 16 Mbit/s upstream), and on coaxial cable (up to 85 Mbit/s down and upstream); using the frequency band from 25 kHz to 12 MHz.
Video on Demand	A service that allows users to remotely choose a movie from a digital library whenever they like and be able to pause, fast-forward, and rewind their selection.
VLAN – Virtual Local Area Network	In computer networking, a single layer-2 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, Virtual LAN or VLAN.
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, such as the Internet. It enables a computer to send and receive data across shared or public networks as if it were directly connected to the private network, while benefitting from the functionality, security and management policies of the private network. This is done by establishing a virtual point-to-point connection through the use of 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.

WiFi	WiFi is a popular technology that allows an electronic device to exchange data or connect to the Internet wirelessly using radio waves. The WiFi Alliance defines WiFi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards".
WiMAX	WiMAX is a wireless technology that provides high-throughput broadband connections over long distances. WiMAX 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 palm 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.