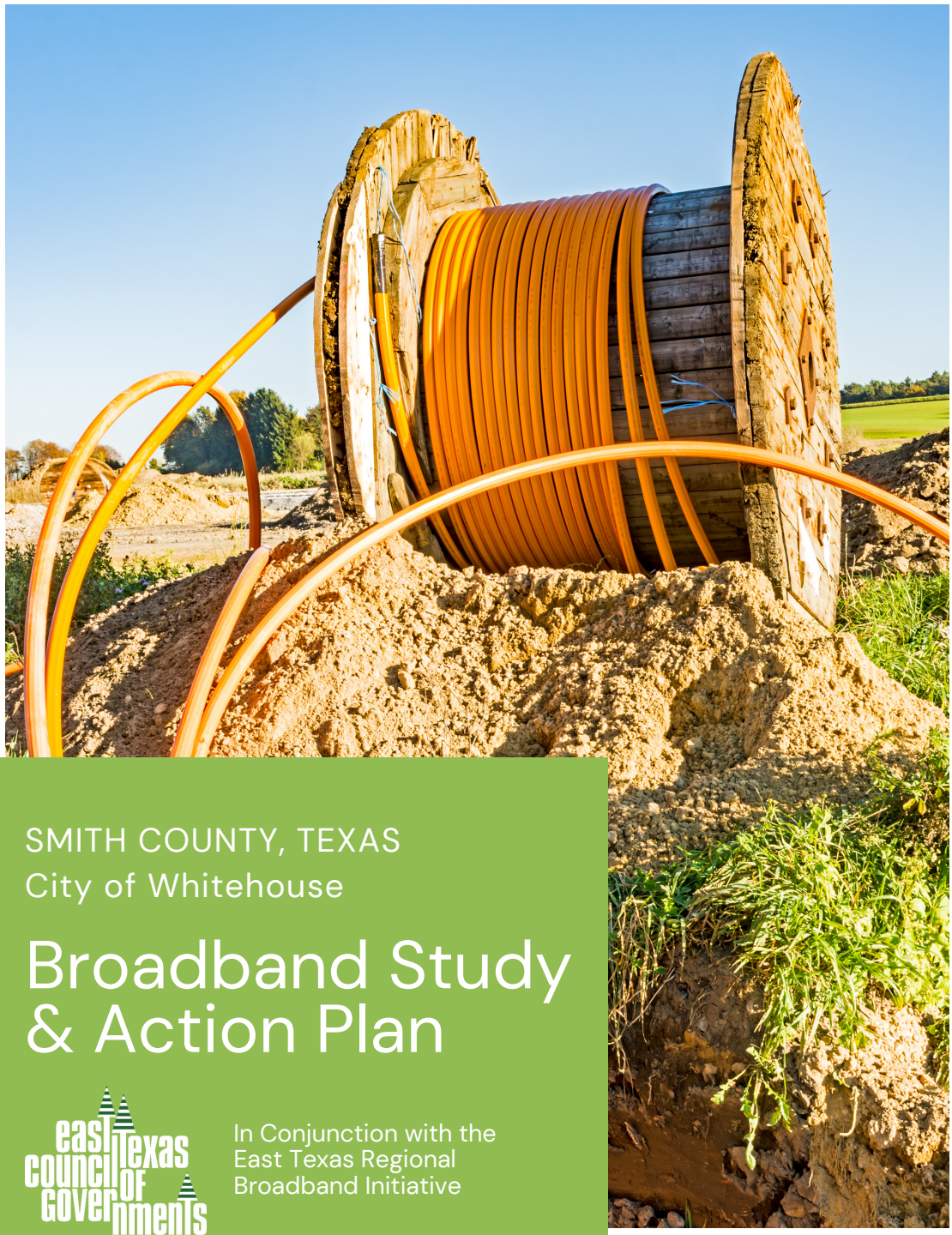


SMITH COUNTY, TEXAS
City of Whitehouse

Broadband Study & Action Plan

In Conjunction with the East Texas Regional Broadband Initiative

DESIGN NINE
broadband planners

TDC2

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

A broadband study of Smith County has been developed and managed by the East Texas Council of Governments (ETCOG). County officials, stakeholders, and interested parties in Smith County have provided input, comments, and information to support the work.

ETCOG is developing a regional broadband strategic plan for unserved and underserved rural areas of East Texas. The fourteen counties that are part of this effort include: Anderson, Camp, Cherokee, Gregg, Harrison, Henderson, Marion, Panola, Rains, Rusk, Smith, Upshur, Van Zandt, and Wood.

This initiative is addressing the broadband infrastructure needs of East Texas businesses by designing a systematic and innovative methodology that will serve as a "test case" demonstration project for other rural areas throughout Texas, specifically projects that will help businesses grow, expand, and locate in East Texas.

Essential broadband initiative partners include elected officials, Chambers of Commerce, Economic Development Corporations, and existing broadband service providers. Once complete, the strategic plan will comprise detailed project plans that interlink with other projects, area regional in their design, build capacity, and provide economies of scale.

Upon completing each county-level plan, ETCOG will support the consortium and/or individual project sponsors to implement and administer these broadband development projects by pursuing multiple funding sources such as grants, foundations, and private capital.

Because the plan is comprised of individual broadband projects, each project will begin construction as funding is secured. By using this strategy, the progress and eventual success of the initiative become manageable and measurable.

Broadband Study Team Members

East Texas Council of Governments

ETCOG serves as the bridge between federal, state, and local governments, helping cities and counties solve challenges and impact the future regionally. Established in 1970, ETCOG, either directly or through its contractors, provides programs and services for East Texas seniors, employers, and job seekers. ETCOG and its contractors also build the 9-1-1 emergency call delivery system, provide peace officer training and homeland security planning services, and deliver rural transportation services, business finance programs, and environmental grant funding for the region.

TDC2

TDC2 is a consulting, engineering, and telecom construction firm located in Wylie, Texas. The company provides a wide range of Outside Plant Fiber Optic Telecommunications services, including: Field Survey, CADD, Feasibility Studies, Long-Haul Design, Local & Last Mile Fiber Route Design, Right-of-Way/Permitting, Site Acquisition, Project Management, Inspection, and Professional Engineering Review & Certification. TDC2 also provides Aerial, Buried, and Underground telecom infrastructure construction services.

Design Nine

Design Nine is working with TCD2 on this effort. Design Nine brings an experienced team of broadband analysts and network engineers to support ETCOG's broadband study. Design Nine has worked with more than 300 county, town, and city governments over the past twenty years to help improve local broadband services.

Local Project Identification Team

The Smith County project identification team has been led by **Whitehouse Mayor James Wansley,** and includes Councilman John Chambers, and City Manager Leslie Black.

Each county's project identification team differs slightly. Teams typically include county and city officials, Economic Development Corporation representatives, and Internet Service Providers from the respective county and/or the ETCOG region if needed.

These local project teams met as many times as needed to complete the identification of three to five most important broadband development projects for each county. One of the identified projects can address residential broadband as long as telework is enhanced.

Smith County Demographics Overview

The Census estimates Smith County's total population is 241,922. The median age is 36.

Labor Force
Smith County has a labor force of 119,708 people, with an unemployment rate of 3.8%. The work distribution of total employees is 38% blue collar and 61% white collar. Smith County has a total of 94,560 employees.

Educational Attainment
39.06% of the population in Smith County have an Associate Degree or higher. 87.99% have a high school degree or higher.

Housing and Income
66.4% of households own their own home, while 33.6% rent. There are 33% more households who own their homes than there are renters. The median household income is $64,897, which is 7% less than the state, and 9% less than the national median income.

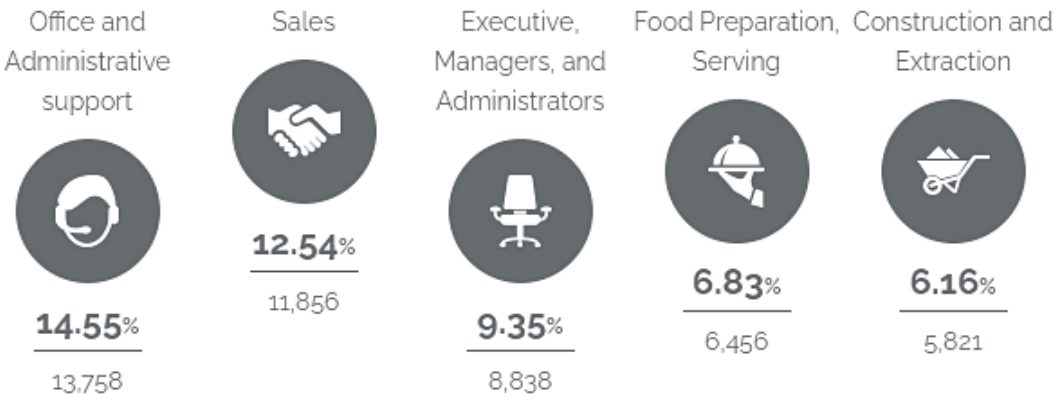
Businesses and Jobs
Smith County has a total of 10,980 businesses in 2023. The leading industries in Smith County were in Health Care and Social Services, Retail, Accommodation and Food Services, and Education.

10,980
Total Businesses

99.7K
Total Housing Units

$64.8K
Median Household Income

What are the largest job counts by occupation?



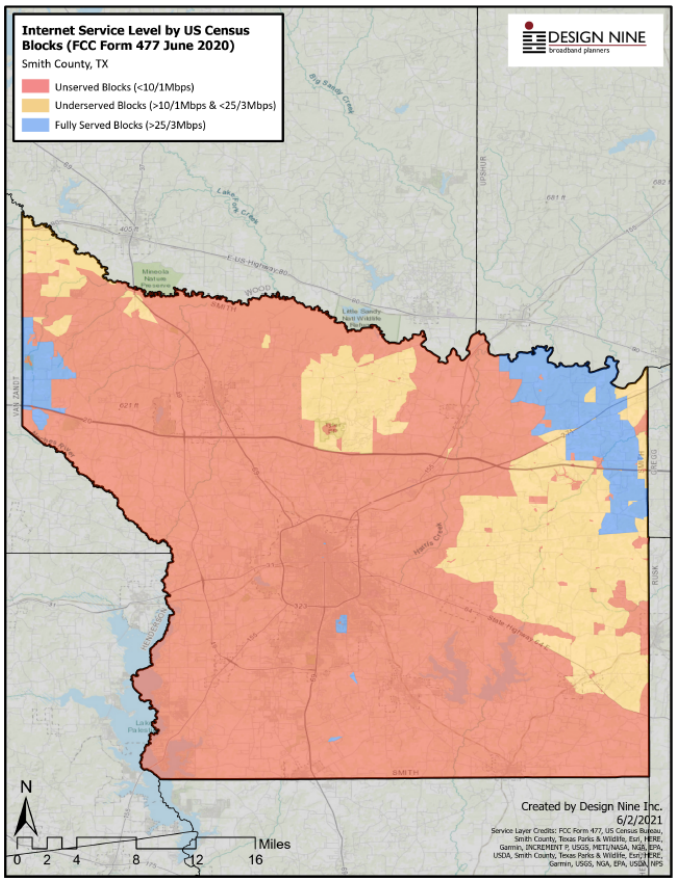
Served, Unserved, and Underserved Areas

The areas on the map below have been identified using FCC (Federal Communications Commission) 477 data. Service providers, including incumbent telephone and cable companies, file a 477 report with the FCC to identify where their service is available and at what speed, using the FCC designations:

- **Unserved** – Less than 10 Megabits down/1 Megabit up
- **Underserved** – At least 10 Megabits down/1 Megabit up and less than 25 Megabits down/3 Megabits up
- **Served** – Equal or better than 25 Megabits down/3 Megabits up

There are **two problems** with the 477 data:

- The data is self-reported by the providers, who typically report their most optimistic Internet speeds. In practice, customers may not always get the reported speeds.
- A single customer receiving service in a census block means that the provider can indicate that the entire census block is counted. So if one household receives 25/3 service, all households in that census block are counted as receiving that level of service.



Smith County Broadband Project

1

City of Whitehouse Fiber Conduit Build-Out Project

Estimated Budget: $2,497,013

Total Miles: 15.06

ROUTE
This project covers several streets inside Whitehouse, starting west of the city on FM 346E/W Main. The project follows Quail Ln to make a circle along Maji Rd. then heads N on CR 2195. This piece of the project then follows E Main eastward through town, veering SE to end, past the city limits at the intersection of E Main and CR 2134.

Other streets this project fully follows are:

Hagan Rd.
Railroad Ave.
Memory Ln.
Corey Dr.
Woodland Hills Dr.
Nunn St.
Willingham Rd.
E. Acker Tap St.
Bascom Rd.
Shahan Ranch Blvd.

Other streets partially followed are:

Forest South Dr.
CR 2133

One other section of this project starts on Highway 110 N at the intersection of Robinwood Dr., tracks south all the way through town, ending at the intersection of SH 110S and CR 2175.

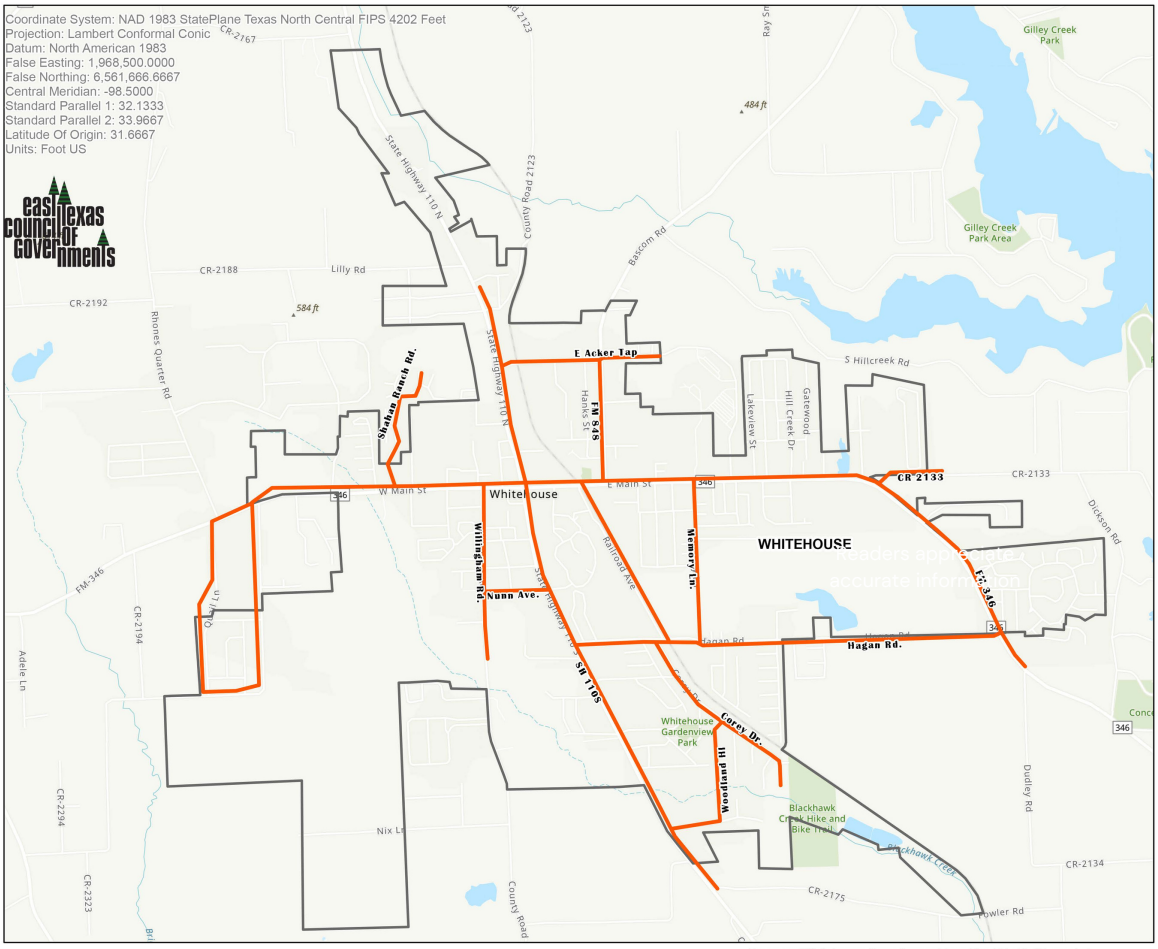
PURPOSE
This project will provide unified infrastructure for future fiber providers and will help ease the cost of build out, lessen the required permitting and easement flagging, and encourage competing providers. It will also provide a single conduit for providers, preventing the issues related to excessive digging and boring.

1

Locally identified shovel ready broadband projects

$2,497,013

Estimated to be needed for project implementation



2 ASSET ANALYSIS AND CURRENT CONDITIONS

A wide variety of assets in Smith County are identified in the following pages.

The included maps provide detail on the following:

Points of Interest – This information is used to identify key users of Internet services that could benefit from improved broadband infrastructure in the county. K12 schools, public safety facilities, fire and rescue locations, health facilities, and county facilities are included.

LMI/HUD Areas – Low and Moderate Income (LMI) and HUD-eligible areas often qualify for certain kinds of grants not available to other areas.

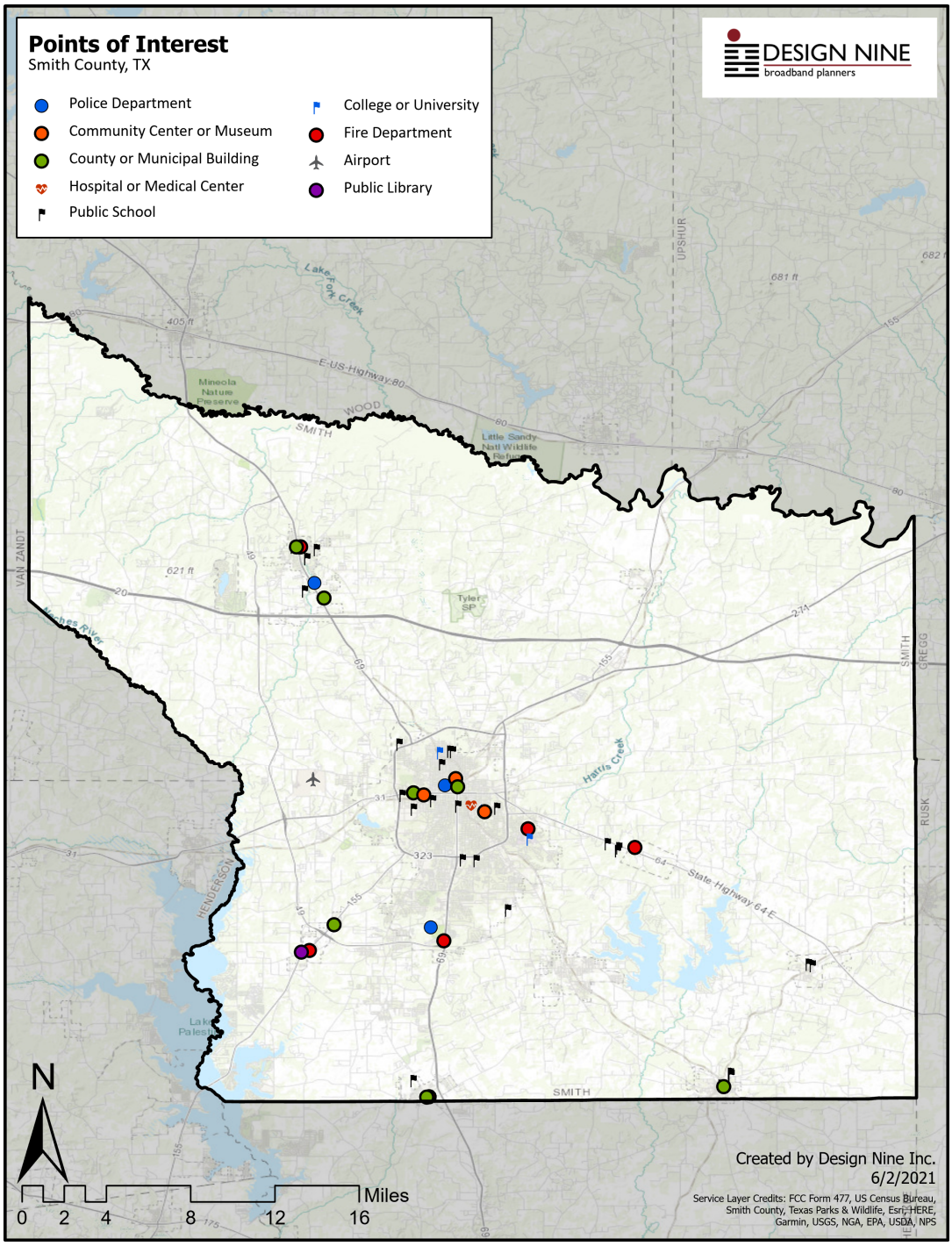
Towers – Of particular importance are towers, which can be divided approximately into two categories: publicly owned towers and privately owned towers. As a general rule, WISPs (Wireless Internet Service Providers) have found that the lease fees to obtain space on cellular towers is too high to justify the expected revenue from broadband Internet customers in the area around that tower. To improve broadband Internet coverage in rural areas of the fourteen counties, some new towers may be needed, with very modest lease fees–to attract WISPs onto those towers.

Fiber Routes – In most areas of all fourteen counties included in the study, fiber routes are typically long haul routes passing through the county to other major metro areas and/or connecting only a few institutional and enterprise customers. In some of the counties, companies like Zayo and Level3 have local fiber available for business and institutional customers.

Service Levels – This map illustrates information on served, underserved, and unserved areas in the county obtained from FCC 477 reports. The data is self-reported by the service providers.

2.1 POINTS OF INTEREST

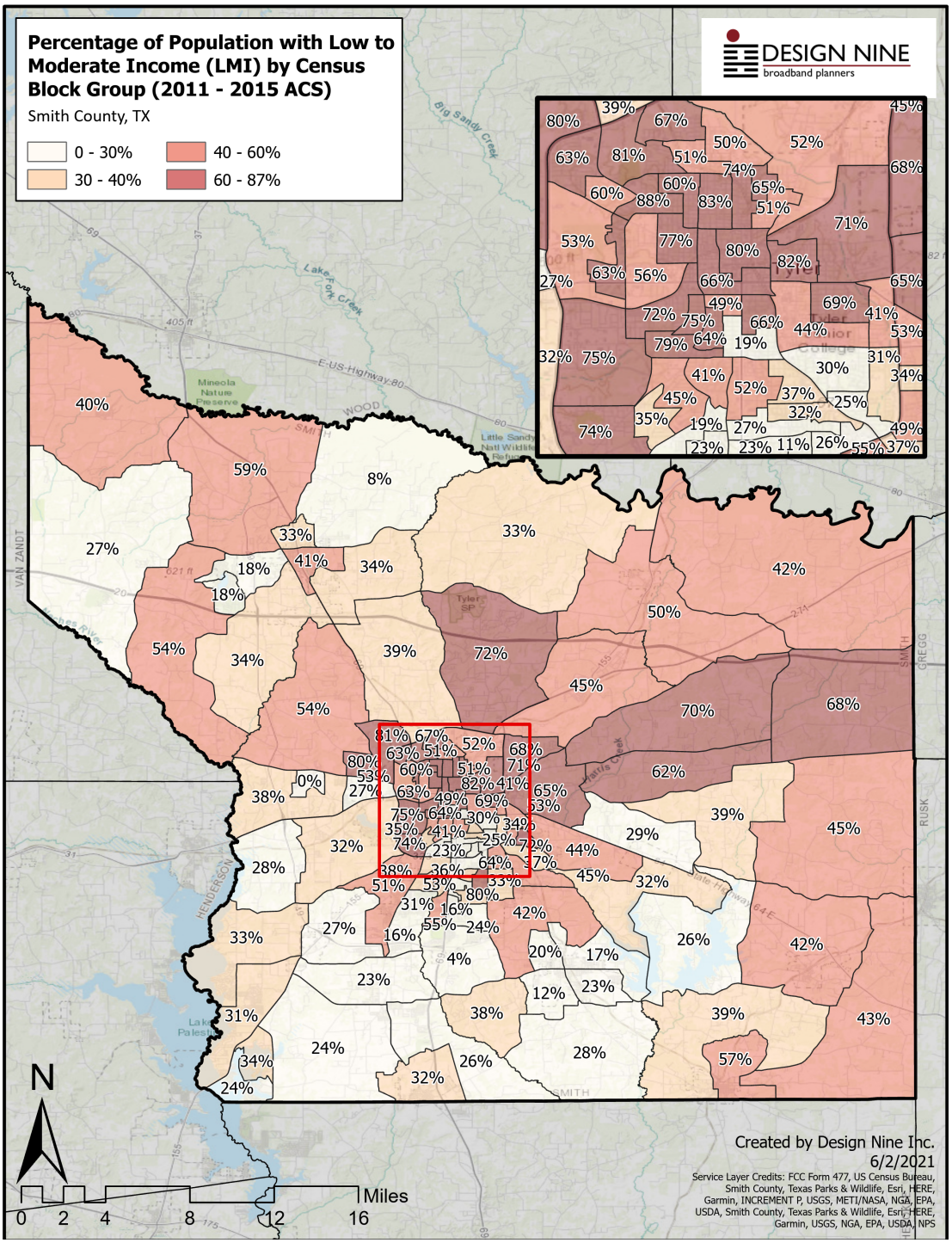
County facilities, municipal facilities, libraries, K12 and higher education facilities, fire and rescue stations, and public safety locations are all candidates to be anchor tenants for fixed point wireless and/or fiber services.

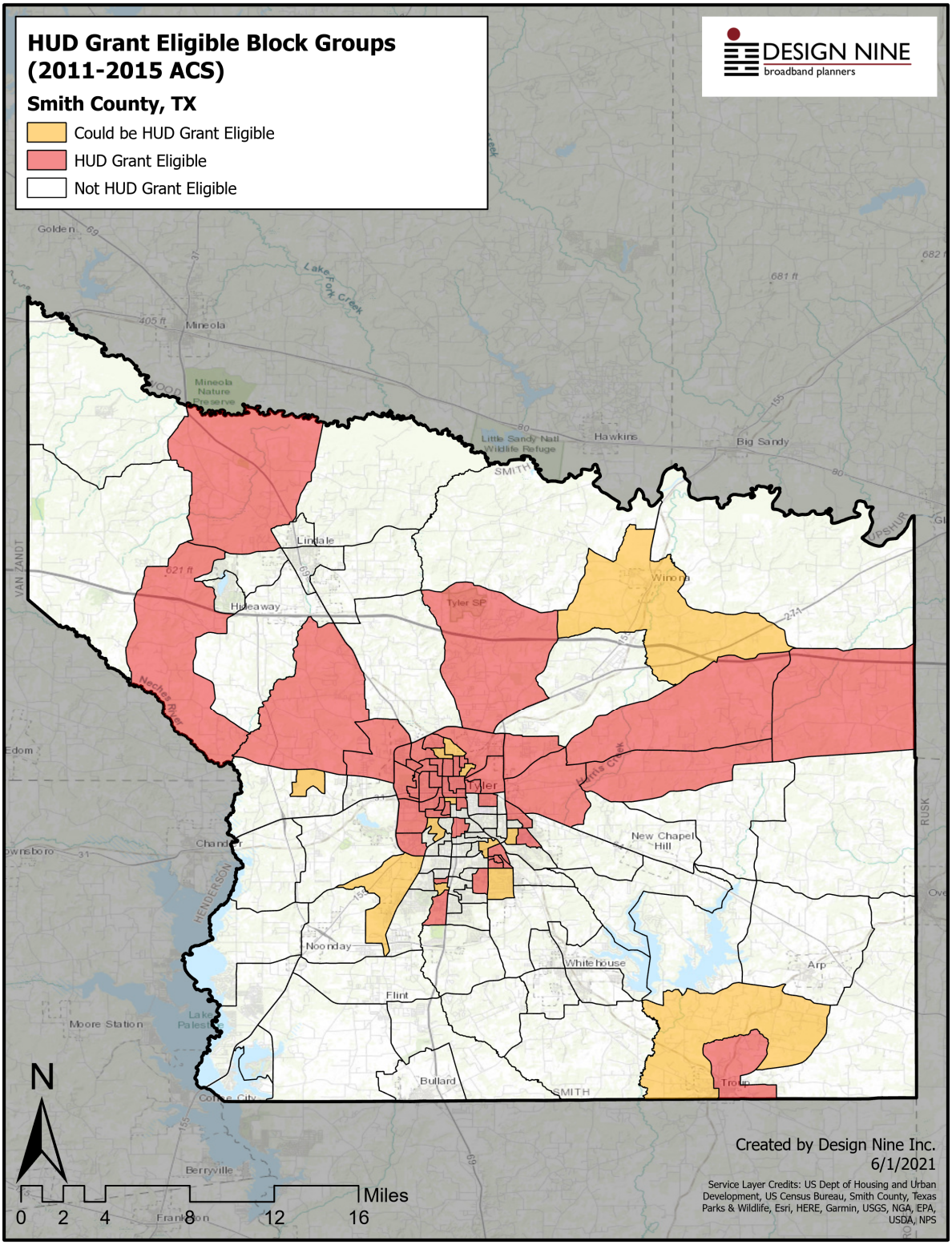


2.2 LMI AND HUD ELIGIBLE AREAS

HUD-eligible areas are determined by LMI (Low and Moderate Income) statistics—but can be different from census blocks in the county that meet LMI thresholds.

HUD-eligible census blocks can qualify for CDBG funding for telecom infrastructure projects.



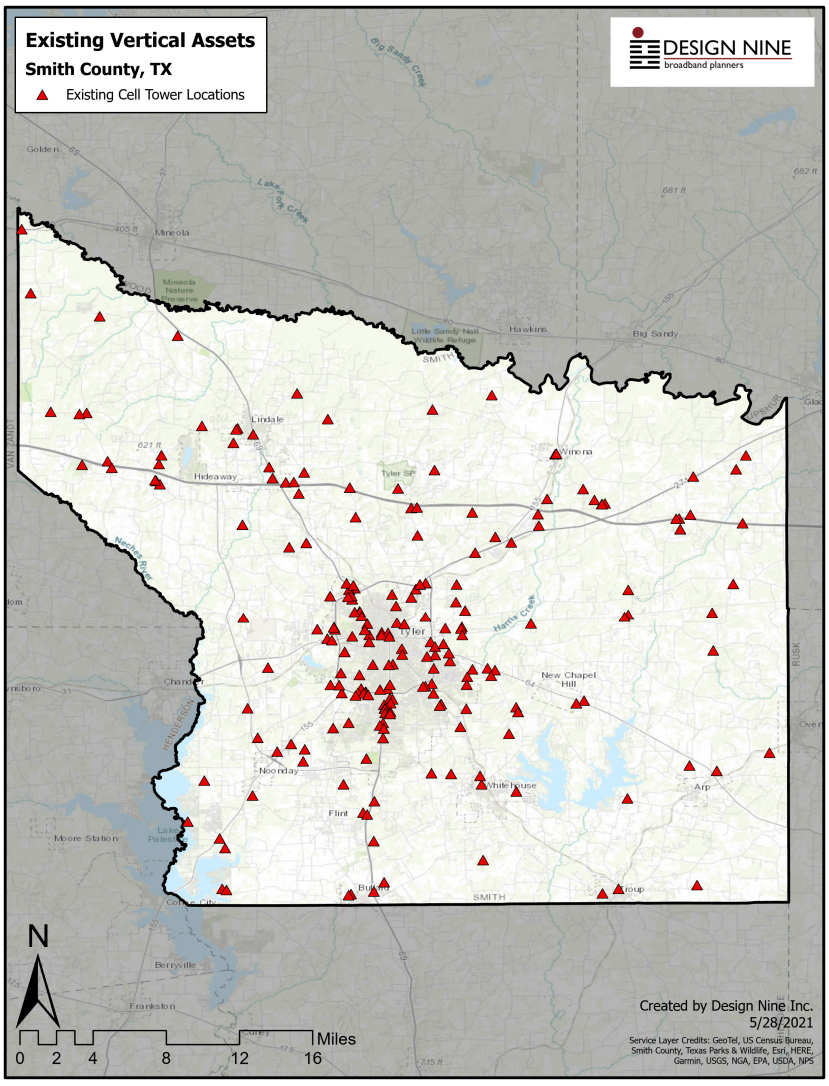

HUD Grant Eligible Block Groups
(2011-2015 ACS)
Smith County, TX
Could be HUD Grant Eligible
HUD Grant Eligible
Not HUD Grant Eligible
DESIGN NINE
broadband planners
Golden
Mineola
Lake Fork Creek
Mineola Nature Preserve
Little Sandy Natl Wildlife Refuge
Hawkins
Big Sandy
SMITH
Lindale
Winona
Hideaway
Tyler SP
Tyler
New Chapel Hill
Noonday
Whitehouse
Arp
Flint
Bullard
Troup
Moore Station
Lake Palestine
Berryville
Frankston
Edom
Chandler
Owensboro
HENDERSON
RUSK
VAN ZANDT
N
0 2 4 8 12 16
Miles
Created by Design Nine Inc.
6/1/2021
Service Layer Credits: US Dept of Housing and Urban Development, US Census Bureau, Smith County, Texas Parks & Wildlife, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

TOWERS IN THE COUNTY

A variety of publicly-owned and privately owned towers are shown here. Tower data is collected from an FCC database, County data, and other publicly available sources. The FCC database usually includes most towers that are in a locality, and generally includes all or nearly all cellular towers. Tower ownership data is not always updated in a timely manner in the FCC database.

Towers can be divided approximately into two categories: publicly owned towers and privately owned towers. Publicly owned towers can be owned by local government, by regional authorities, or by the state. In the county, privately owned cellular towers are the most common type of tower, and are generally clustered along major roadways and higher density population areas.

Many commercial towers, especially cellular towers, may have tower lease fees that are too high for a WISP (Wireless Internet Service Provider) to make a business case for putting fixed point broadband equipment on the tower. The cost to a WISP for getting on a privately owned tower often has to be checked on a case by case (tower by tower) basis.



To improve broadband Internet coverage in rural areas of the county, some new towers are going to be needed, with very modest lease fees—to attract WISPs onto those towers.

A second consideration for placing WISP equipment on a cellular tower is where space is available—that is, at what height? Space may be available at an affordable price, but the location on the tower may not be high enough to cover an area large enough for a decent number of customers.

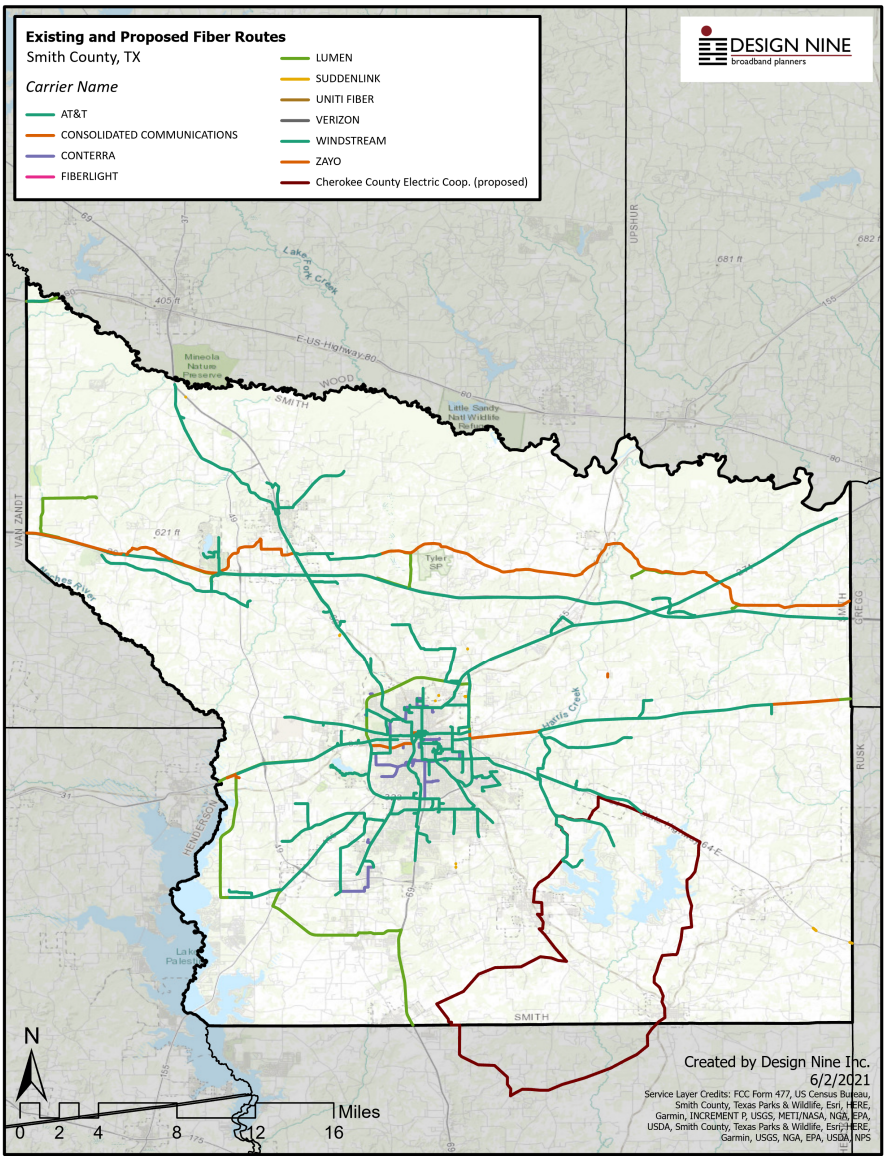
2.4 FIBER ROUTES IN THE COUNTY

Fiber route data is compiled from publicly available sources. Some telecom providers do not share their route data.

Most fiber routes, not only in the county but throughout the country have been designed as long haul point to point fiber routes between population centers. This means that even if a fiber cable passes down a rural road or a residential area, it has not been designed for residential or small business fiber to the premises.

It is highly likely that the incumbent telephone and cable providers have some fiber in Smith county. The small amount of third party fiber infrastructure in the county underscores the need for an open access middle mile fiber infrastructure. An affordable open access middle mile fiber network would make it much easier and less expensive for WISPs (Wireless Internet Service Providers) and competitive ISPs (Internet Service Providers) to expand service availability to more areas of the county, and to offer more competitive prices.

Smith County has limited long haul and commercial fiber, but there is enough to support smaller WISPs and ISPs with competitive wholesale pricing. AT&T, Verizon, Lumen, Windstream, and Zayo are among those providers that report having long haul fiber routes in the county. Most of these are located in and around the city of City of Tyler.



2.5 SERVED, UNDERSERVED, AND UNSERVED AREAS

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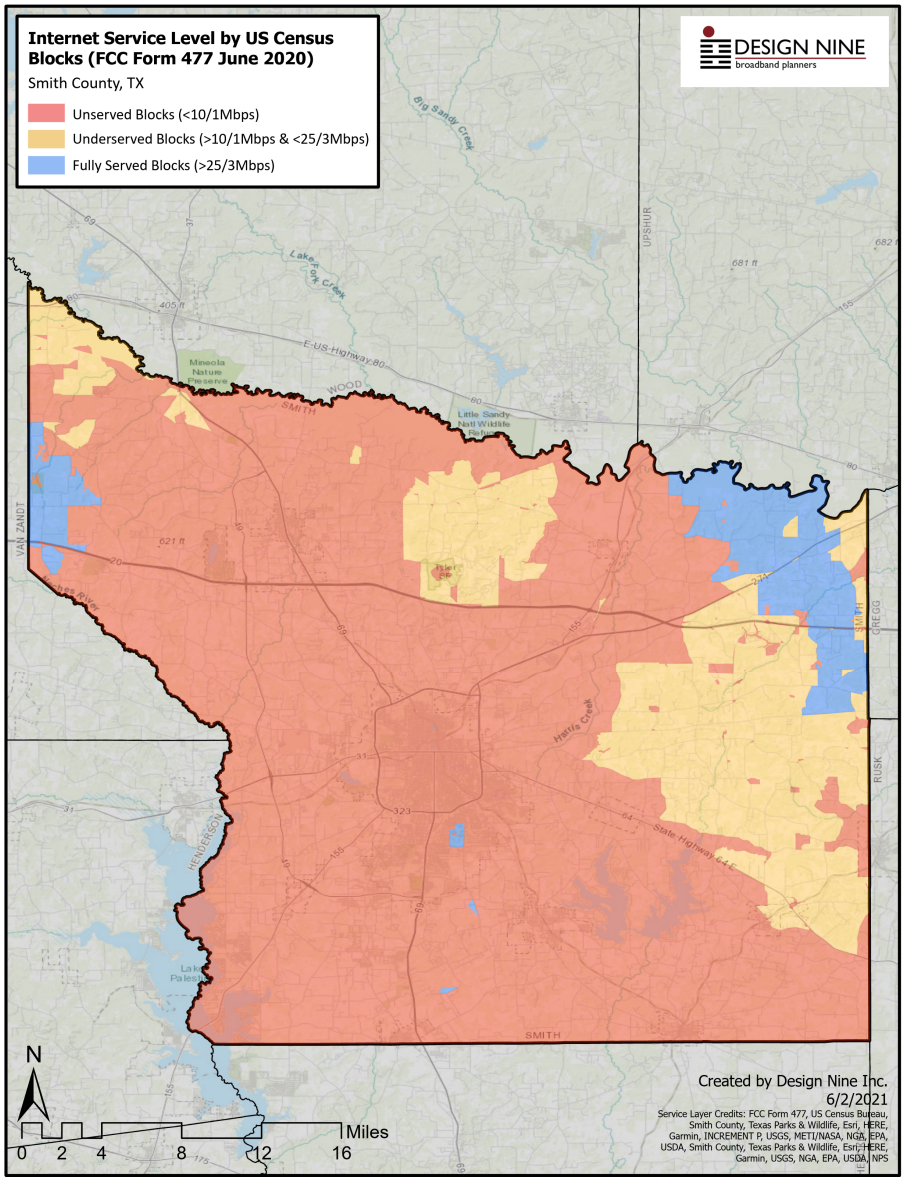

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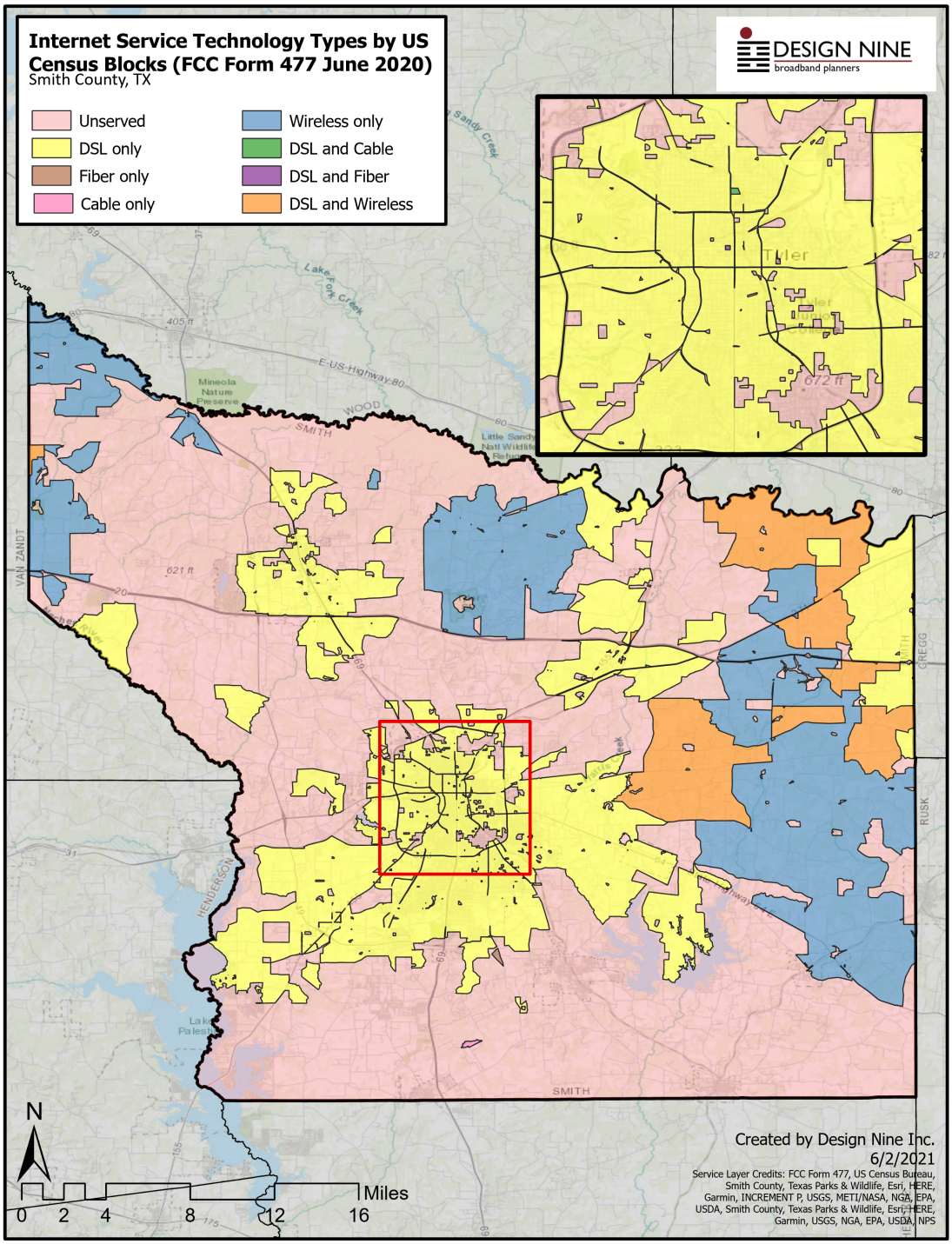
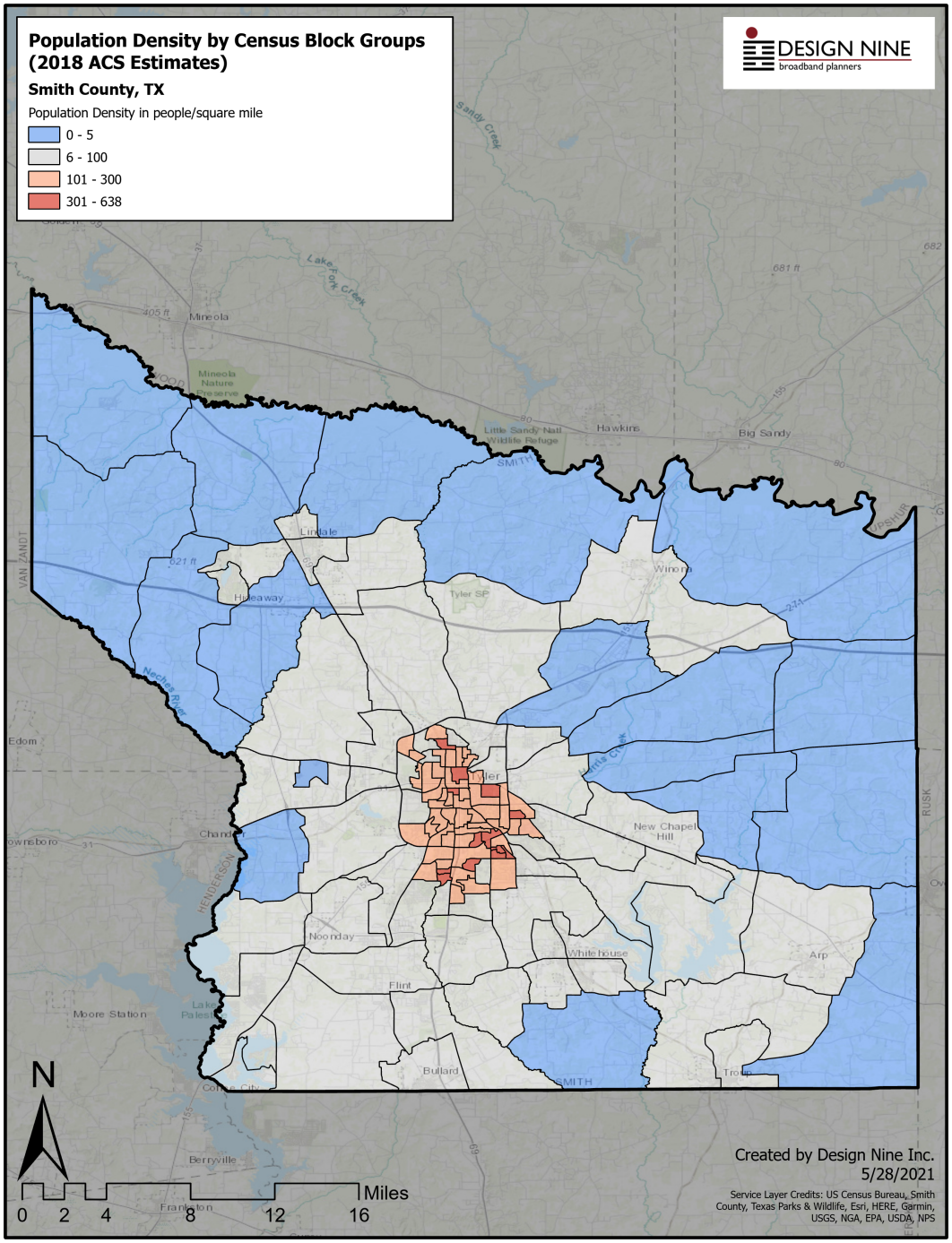
2.6 SERVICE TECHNOLOGY TYPES

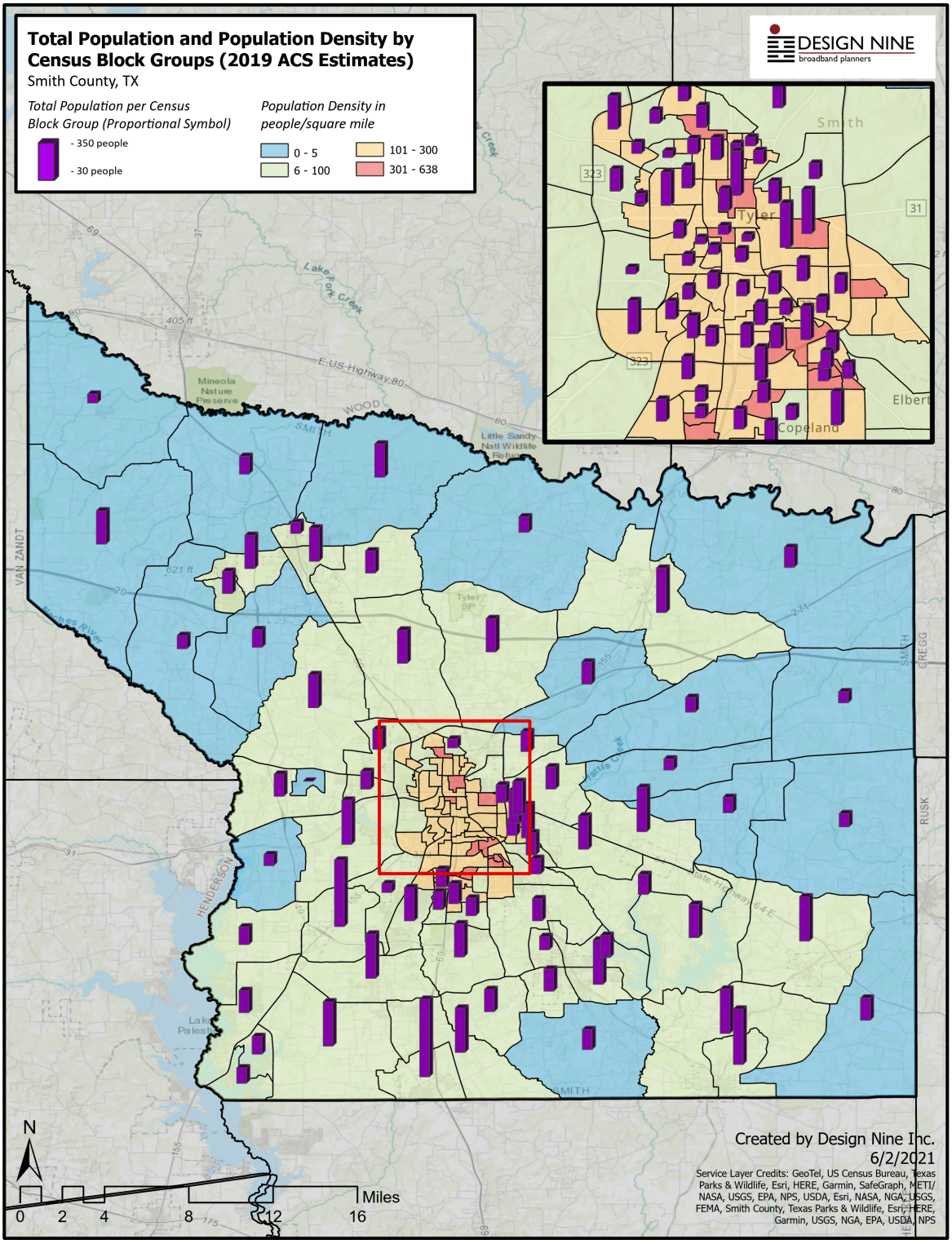
This map illustrates the types of technology (wireless,DSL, fiber) that is available in the county.



2.7 POPULATION DENSITY

The map on this page and the next page show population density in the county. In planning for broadband, population density can help determine the type of technology needed to serve a particular area of the county. For example, low density areas may be better served in the short term by fixed point wireless. Higher population density may indicate a focus on fiber may be a better solution.




Total Population and Population Density by Census Block Groups (2019 ACS Estimates)
Smith County, TX
Total Population per Census Block Group (Proportional Symbol)
- 350 people
- 30 people
Population Density in people/square mile
0 - 5
6 - 100
101 - 300
301 - 638
DESIGN NINE
broadband planners
Smith
Tyler
Elberta
Copeland
Mineola Nature Preserve
Little Sandy Natl Wildlife Refuge
Tyler SP
Lake Palestine
VAN ZANDT
HENDERSON
RUSK
GREGG
SMITH
N
0 2 4 8 12 16
Miles
Created by Design Nine Inc.
6/2/2021
Service Layer Credits: GeoTel, US Census Bureau, Texas Parks & Wildlife, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, Esri, NASA, NGA, USGS, FEMA, Smith County, Texas Parks & Wildlife, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

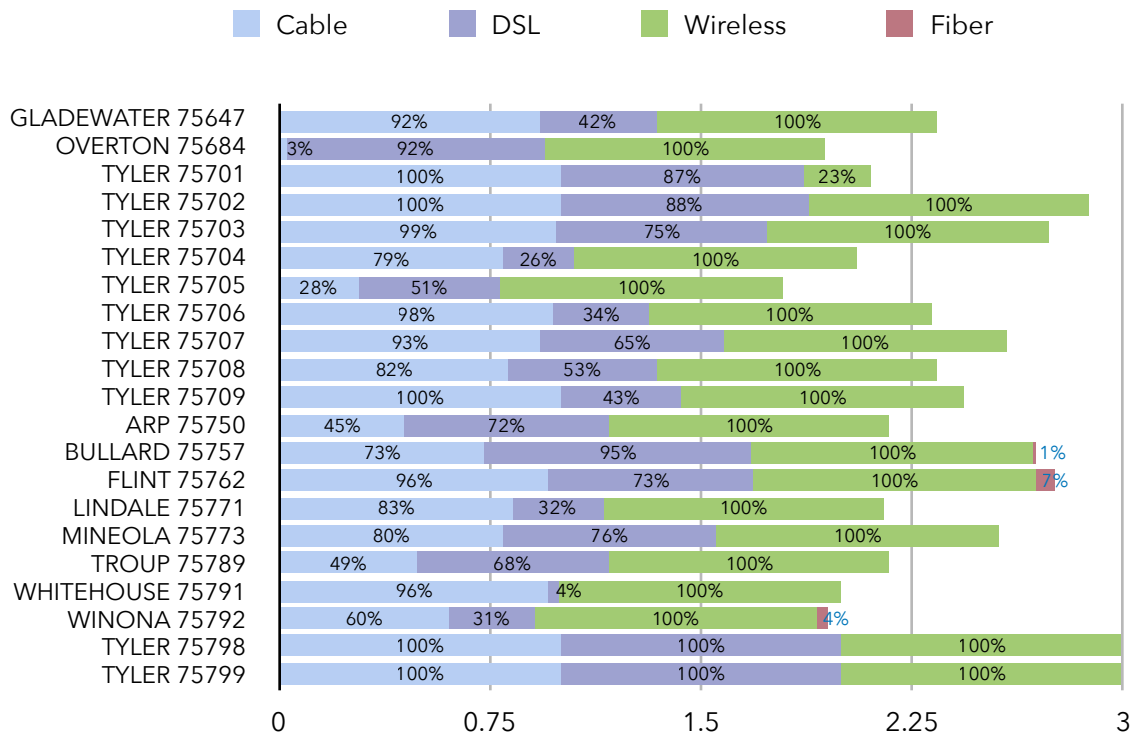
3 CURRENT PROVIDER AND SERVICES ANALYSIS

According to a February 2021, Consumer Reports Survey, 75% of Americans say they need uninterrupted access to the Internet seven days a week[1]. How they get their service is very important. This service provider report provides key insights into the services currently available in Smith County. The chart below shows estimates of available broadband technology type in many areas of the county.

This data is assembled from public sources, Decision Data which combines FCC data and data they collect from social media and Broadband Now. Also note that zip code boundaries are not aligned with local government jurisdictions, and some zip code data may include some areas outside the county. The information in these charts is current as of July 2021.

Our pricing information includes all the service providers that have been discovered with services to 2% or more residents living in zip codes with at least 5% or more of their population in Smith County.

Our report does not include information on zip code 75140, 75662, or 75790 since they have less than five percent of their population living in Smith County.

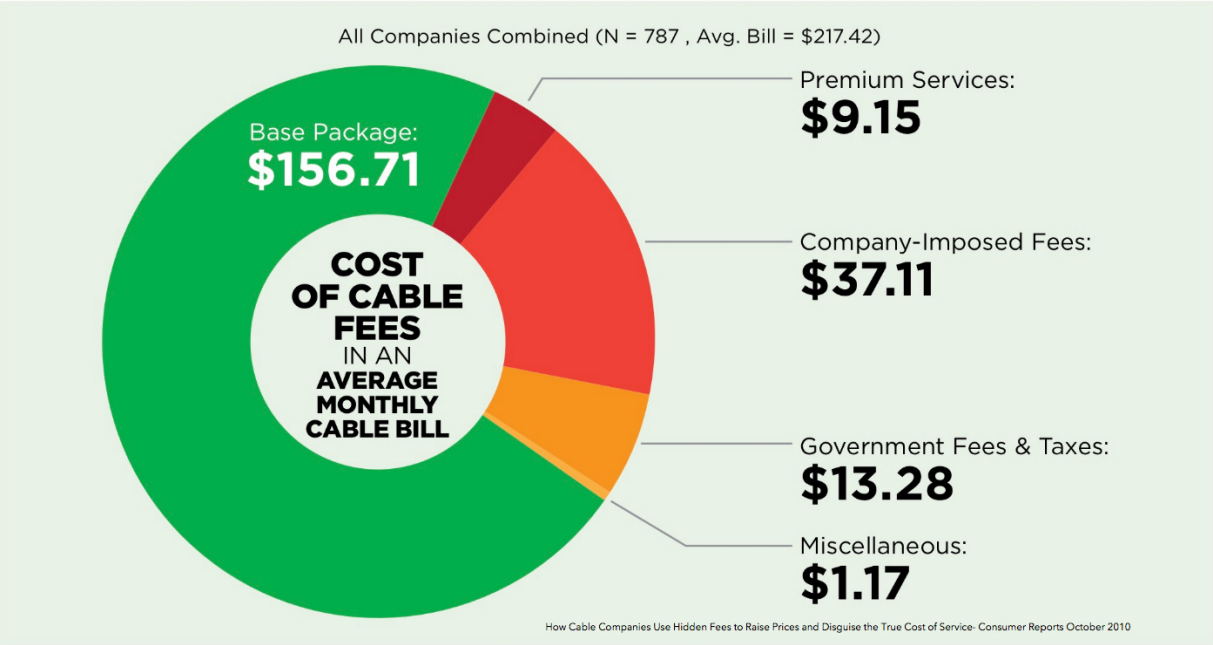


7% Fiber in 75762

3.7% Fiber in 75792

[1] Consumer Reports- Research Snapshot February 2021, The Importance of Broadband Internet

Figure A: Cost of Cable Fees in an Average Monthly Cable Bill (2018)



According to a 2019 Consumer Reports study[2], the national average advertised price for standard triple play services of Internet, television, and telephone across the country is $156.17. Because of fees and taxes, the actual national average bill is $217.42. Nationally, consumers get an average of 24% added to their bill. Data caps which were turned off early in the pandemic are back[3] and will increase prices for heavy users.

It is normal to find a statement such as this in fine print terms and conditions, "Equipment, installation, taxes and fees, including regulatory recovery fees, Broadcast TV Fee (up to $19.45/mo.), Regional Sports Fee (up to $14.45/mo.) and other applicable charges extra, and subject to change during and after the term agreement."[4] The Broadcast TV Fee was $14.95 four months ago. The Regional Sports Fee was $8.75 per month at the same time. These two fees have increased a total $10.20 monthly in areas we have researched since fall of 2020.

Cord-cutting will continue to increase in 2021 with another 27% of consumers dropping their cable service. According to OpenVault, the average home used 461.7 GB of data a month in the first quarter of 2021. That is an increase of 15% over the Q1 2020 number. Year over year increases have become standard but last year's increase is higher than growth seen in recent years. Internet users span all age groups ranging from 100% of 18- to 29-year olds to 73% of 65-year-olds and older.

---

[2] Cord Cutting Continues, Fueled By High Cable Pricing, Consumer Reports' Survey Finds, 9/17/2019

[3] Consumer Reports -Get Ready for Cable TV and Internet Price Hikes and Data Caps in the New Year 12/21/20

[4]Xfinity terms and conditions- Smith County, TX, 6/30/21

The table below illustrates the estimated telecom expenditures, public and private, over the next thirty years. Over that time period, **over $5.86 billion** will be spent on telecom services. This shows that there is money for broadband, but most of it is placed in envelopes every month and most of it leaves both the county and the state. Redirecting as little as 5% of those funds could build fiber to every home and business in Smith County.

Telecom Expenditures - Smith County, TX

Smith County 30 Year Estimated Telecom Expenditures				
Total Households	77,678			
Businesses	5,940			
Estimated Internet Access Type	Households using Cell Phone for Internet	Households with "little" broadband DSL	Households with Cable Modems	Households with no Internet
Household Percentage	9%	42%	32%	17%
Number of households	6,991	32,625	24,857	13,205
Average monthly telecom expenditures	Cell Phone for Voice/Internet $90 Cable/satellite TV: $65 bundle	Cell Phone $70 Phone: $13 Satellite TV: $60 Broadband Internet: $45	Cell Phone $70 Phone $15 TV $43 Broadband Internet $45	Cell Phone, no Internet, $70 Cable/satellite TV: $65
Monthly Cost of Services	$155	$188	$173	$135
Annual household cost	$1,860	$2,256	$2,076	$1,620
Annual cost all households	$13,003,297	$73,601,459	$51,603,049	$21,392,521
30 year expenditure	$390,098,916	$2,208,043,757	$1,548,091,469	$641,775,636
Total residential expenditures	$4,788,009,778			
Total Estimated Cost of Hidden Fees	$705,852,529			
Total Business Costs	$368,874,000			
Total expenditures	**$5,862,736,307**			

3.1 LOCAL PRICING DATA

This information provides pricing data and services available from providers in Smith County. Prices, availability and promotional offers change frequently and sometimes vary depending on street address. Information was compiled using a variety of public sources and Internet Service Provider (ISP) websites including Decision Data which combines FCC data and data they collect from social media and Broadband Now. Exact availability requires customer names and specific street addresses. Our pricing information includes all the service providers that have been discovered with services to 2% or more residents living in zip codes with at least 5% or more of their population in Smith County.

Dalton Telephone Co. Cable Internet, Dalton Telephone Co. DSL Internet, and Zthernet were not included in this report because their services were available to less than 2% of the population in only one zip code for each company, 75701 for Dalton and 75709 for Zthernet.

Summary of Service Provider Data - Smith County, TX

	Least Expensive Internet Only Service	Least Expensive Internet Only Service Meeting 25/3	Least Expensive Triple Pay Package Meeting 25/3
AT&T DSL	$55	$55	N/A
CenturyLink DSL	$49	$49	N/A
ETEX Communications DSL	$34.95	$84.95	$147.85
Frontier DSL	$37.99	$54.99	N/A
Peoples DSL	$75.95	N/A	N/A
Windstream DSL	$67	$67	N/A
Suddenlink Cable	$59.99	$89.99	N/A
CenturyLink Fiber	$65	$65	N/A
ETEX Communications Fiber	No public pricing	Unable to verify availability in Smith County	
Windstream (Kinetic) Fiber	$55	$55	$139.99*
CKS Management Wireless	Website not working, possibly no longer in business		
DCTexas Wireless	$50	N/A	N/A

ETEX Communications Wireless	$29.95	Not Available	
Gower Net Wireless	No public pricing		
Peoples Wireless	$74.95	$104.95	N/A
Skynet Wireless	No public pricing		
Texas Cellnet Wireless	$29.95	N/A	N/A
Zoom Wireless	$139	N/A	N/A
HughesNet	$59.99	$59.99	N/A
Viasat	$100	$150	N/A
Starlink	$99	$99	N/A

All the information available at the time of the report is included in this table. If a table cell has no information, that information was not found. However, if there is no information in the "One-time Fees," it does not necessarily mean there are no one-time fees. It just means that information on the one-time fees could not be found on the company's public website.

NOTE: Many ISPs do not provide upload speeds. This table indicates that no upload speed was discoverable by the abbreviation 'NA' (Not Available).

Wireline Internet service provider comparison for Smith County, TX

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Download /Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
AT&T DSL	$55	$45 1 year	$10	10/NA	1,000		$10 for each additional 50GB or $30 more for unlimited
AT&T DSL	$55	$45 1 year	$10	18/NA	1,000		$10 for each additional 50GB or $30 more for unlimited
AT&T DSL	$55	$45 1 year	$10	25/NA	1,000		$10 for each additional 50GB or $30 more for unlimited
AT&T DSL	$55	$45 1 year	$10	50/NA	1,000		$10 for each additional 50GB or $30 more for unlimited
AT&T DSL	$55	$35 1 year	$10	100/NA	1,000		$10 for each additional 50GB or $30 more for unlimited
AT&T DSL	$55	$45 1 year	$10	0.8/NA	1,000		$10 for each additional 50GB or $30 more for unlimited
AT&T DSL	$55	$45 1 year	$10	1.5/NA	1,000		$10 for each additional 50GB or $30 more for unlimited
AT&T DSL	$55	$45 1 year	$10	5/NA	1,000		$10 for each additional 50GB or $30 more for unlimited

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Download /Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
CenturyLink DSL	$49	Requires Paperless billing. Rate applies to the fastest Internet speed CenturyLink offers at your home, capped at maximum speed of up to 100 Mbps	$15 monthly modem	40/NA		If install requires copper bury or aerial delivery, a one-time fee will apply ($300 for bury; $150 for aerial); fee could be higher after property assessment, but customer will be advised	Internet only
CenturyLink DSL	$85	Requires Paperless billing. Rate applies to the fastest Internet speed CenturyLink offers at your home, capped at maximum speed of up to 100 Mbps	$15 monthly modem	40/NA		If install requires copper bury or aerial delivery, a one-time fee will apply ($300 for bury; $150 for aerial); fee could be higher after property assessment, but customer will be advised	Internet and home phone

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Download /Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
CenturyLink DSL	$187	$154.99 Requires Paperless billing. Rate applies to the fastest Internet speed CenturyLink offers at your home, capped at maximum speed of up to 100 Mbps	$15 monthly modem Regional Sports fee $9.99	40/NA		If install requires copper bury or aerial delivery, a one-time fee will apply ($300 for bury; $150 for aerial); fee could be higher after property assessment, but customer will be advised prior to install. $19.95 Activation,	Internet and home phone and Direct TV
ETEX Communications DSL	$34.95			6/1			
ETEX Communications DSL	$49.95			10/1			
ETEX Communications DSL	$59.95			15/1			
ETEX Communications DSL	$74.95			20/1			
ETEX Communications DSL	$84.95			50/3			
ETEX Communications DSL	$32.95						Lifeline

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Download /Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
ETEX Communications TV	$89.95						Basic
ETEX Communications TV	$106.95						Enhanced
Eastex Telephone Coop DSL	$109.95	1 year	$10 modem/ router	25/3		Installation charge of $185. ETC if 12 month term is not met $200	1 Ethernet port, residential phone line, extended local calling, 300 minutes long distance
Dalton Telephone DSL							
Frontier DSL	No second year pricing	$37.99- one year rate		9//NA	None	Activation $85	Internet Only
Frontier DSL	No second year pricing	$44.99- one year rate		9/NA	None	Activation $85	Internet Only
Frontier DSL	No second year pricing	$54.99- one year rate		25/NA	None	Activation $85	Internet Only
Peoples Coop DSL	$75.95	$62.95 when bundled- 1 year contract of $30 monthly phone line		6/NA		$49 activation	Internet Only
Peoples Coop DSL	$85.95	$72.95 when bundled- 1 year contract of $30 monthly phone line		10/NA		$49 activation	Internet Only

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Download /Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
Peoples Coop DSL	$95.95	$82.95 when bundled- 1 year contract of $30 monthly phone line		20/NA		$49 activation plus unspecified extra charges for 20 Mbps download speeds	Internet Only
SuddenLink	$59.99	1 year	Modem $10	20/2	150	Standard Installation $99	Internet Only
SuddenLink	$89.99	1 year	Modem $10	50/2	250	Standard Installation $99	Internet Only
SuddenLink	$99.99	1 year	Modem $10	50/5	250	Standard Installation $99	Internet Only
SuddenLink	$119.99	1 year	Modem $10	100/7.5	250	Standard Installation $99	Internet Only
SuddenLink	$139.99	1 year	Modem $10	150/25	250	Standard Installation $99	Internet Only
SuddenLink	$34.99					Broadcast Surcharge & Sports Fee $21.65	Broadcast Basic TV
SuddenLink	$34.99					Broadcast Surcharge & Sports Fee $21.65	Standard Cable TV
CenturyLink Fiber	$65			940/NA			
ETEX Communications Fiberr	Unable to verify availability or pricing in Smith County						

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Download /Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Services & Incentives
Windstream Fiber	Unable to confirm pricing or availability	According to Windstream-Kinetics salesperson, pricing is dependent on					Internet Only

Wireless Internet service provider comparison for Smith County, TX

Provider	Monthly Cost	Promo & Contract Length	Other Monthly Fees	Download /Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Incentives & Notes
CKS Management Wireless	Website not working, possibly no longer in business						
DCTexas	$85			4/1	1	100	
DCTexas	$120			8/1	1	100	
Etex Wireless	$29.95			1/1			Internet only
Etex Wireless	$59.95			6/1			Internet only
Etex Wireless	$89.95			10/1			Internet only
Gower Net Wireless	Website has no pricing						
Peoples Wireless	$74.95			15/NA			Internet only
Peoples Wireless	$104.95			25/NA			Internet only
Peoples Wireless	$134.95			50/NA			Internet only
Skynet Wireless	Website has no pricing						Internet only
Texas Cellnet Wireless*	$29.95	2 years		1/1			Internet only

Provider	Monthly Cost	Promo & Contract Length	Other Monthly Fees	Download /Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees	Incentives & Notes
Texas Cellnet Wireless*	$49.95	2 years		2/1			Internet only
Texas Cellnet Wireless*	$69.95	2 years		4/1			Internet only
Texas Cellnet Wireless*	$99.95	2 years		6/2			Internet only
Texas Cellnet Wireless*	$119.95	2 years		8/2			Internet only
Texas Cellnet Wireless*	$149.95	2 years		10/2			Internet only
Texas Cellnet Wireless*	$179.95	2 years		12/3			Internet only
Texas Cellnet Wireless*	$239.95	2 years		16/4			Internet only
Texas Cellnet Wireless*	$299.95	2 years		20/5			Internet only
Zoom Wireless	$139			8/NA	400	$149 LTE Modem Shipping $15	Internet only

*For all Texas Cellnet Wireless customers : An initial one-time fee is charged for customer premise equipment (CPE) and installation. Additional fees may apply for more complex installations if additional equipment is necessary for the installation. An itemized fee list will be quoted prior to installation.

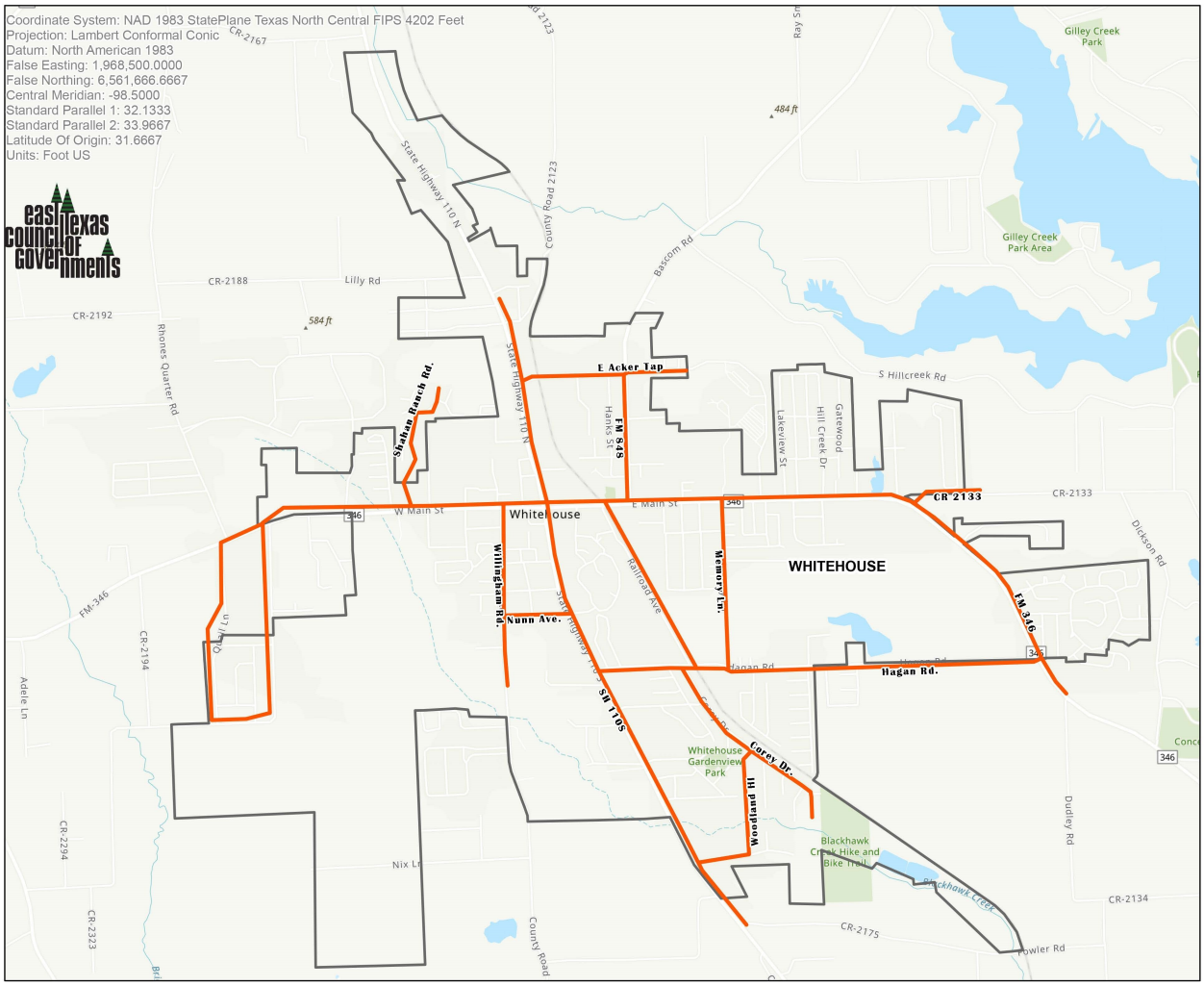
Satellite Internet service provider comparison for Smith County, TX

Provider	Monthly Cost	Promo & Contract Length	Other Monthly Fees	Download/Upload Speed (Mbps)	Data Cap (GB/ Month)	One-Time Fees
HughesNet	$59.99	$39.99 for first six months. 24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25/3	After 10 GB (speeds drop to 1-3 Mbps)	Purchase and lease options. Latest pricing is $249.99 to purchase or $99 lease activation - $99 lease activation fee waiver online- $100 equipment discount online

Provider	Monthly Cost	Promo & Contract Length	Other Monthly Fees	Download/Upload Speed (Mbps)	Data Cap (GB/ Month)	One-Time Fees
HughesNet	$69.99	$49.99 for first six months. 24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25/3	After 20 GB (speeds drop to 1-3 Mbps)	Purchase pricing is $249.99 to purchase or $99 lease activation - $99 lease activation fee waiver online- $100 equipment discount online orders
HughesNet	$99.99	$79.99 for first six months. 24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25/3	After 30 GB (speeds drop to 1-3 Mbps)	Purchase pricing is $249.99 to purchase or $99 lease activation - $99 lease activation fee waiver online- $100 equipment discount online orders
HughesNet	$149.99	$129.99 for first six months. 24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25/3	After 50 GB (speeds drop to 1-3 Mbps)	Purchase pricing is $249.99 to purchase or $99 lease activation - $99 lease activation fee waiver online- $100 equipment discount online orders
Viasat	$69.99	$49.99 for first three months 24 month contract	$12.99/month (modem)	12/3	40 GB priority data	Equipment purchase instead of lease $299.99-Setup Fee- Unknown
Viasat	$99.99	$69.99 for first three months 24 month contract	$12.99/month (modem)	25/3	60 GB priority data	Equipment purchase instead of lease $299.99-Setup Fee- Unknown
Viasat	$149.99	$99.99 for first three months 24 month contract	$12.99/month (modem)	50/3	100 GB priority data	Equipment purchase instead of lease $299.99-Setup Fee- Unknown
Viasat	$199.99	$149.99 for first three months 24 month	$12.99/month (modem)	100/3	150 GB priority data	Equipment purchase instead of lease $299.99-Setup Fee- Unknown
Starlink*	$99	Has moved from public beta*	Unknown	100/40	None	$499 for the Starlink Kit, which includes a mounting tripod, a WiFi router, and a terminal to connect to the satellites

* Starlink service has just gone from beta to standard service but availability is still by address only so Starlink may not be available in all areas. Early reports from beta testers have been generally positive. Reported speed test results vary, but many users are reporting 10 to 50 Megabit download speeds and upload speeds of 5 to 20 Megabits. Some users have seen higher speed test results. Latency is much lower than traditional geostationary satellite services like HughesNet and Viasat, but latency is still much higher than terrestrial fiber Internet connections. If pricing remains similar to what is being charged for the early users, Starlink could be a very significant improvement for rural residents and businesses.

4 SMITH COUNTY LOCALLY IDENTIFIED PROJECT



DocumentWhitehouse Open Access Tranching Prj_11x17_mcahal

4.1 WHITEHOUSE CONDUIT PROJECT COST ESTIMATE

Whitehouse Conduit Design Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Conduit Installed	15.08
2	Number of Handholes Installed	319
3	Cabinets Installed	1
4	Take Rate - Percentage of the Buildings Passed who are connected	35%
5	Aerial - Percentage of construction expected to be installed on utility poles.	0%
6	Trenching - Percentage of construction installed by trenching	0%
7	Boring - Percentage of construction installed by horizontal drilling.	35%
8	Slot Cutting - Conduit installed in street by special methods.	0%
9	Rock Saw - Required where rock prevents the use of other methods.	5%
10	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	60%
11	Aerial Info	0% Aerial is estimated to account for water body crossings and other obstacles to construction.
12	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Whitehouse Conduit Design Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Construction Materials	$523,546
2	Distribution Labor	$1,462,705
3	Structures, Cabinets, and Equipment	$13,000
4	Network Construction Subtotal	**$1,999,251**
5	Project Mgmt, Network Engineering, Integration, and Testing	$249,906
6	Misc Fees, Advertising, Technical Services	$2,999
7	Bookkeeping and Administration	$7,500
8	Engineering, Permitting	$115,452
9	Legal Costs	$2,999
10	Other Costs Subtotal	$378,857
11	Project Total	**$2,378,108**
12	Contingency at 5%	$118,905
13	Project Total (with contingency)	**$2,497,013**

The table below categorizes the proposed fiber project costs from the table on the previous page according to Federal grant application form SF424. This should assist with the development of any Federal grant applications.

Whitehouse Conduit Design SF424 Summary

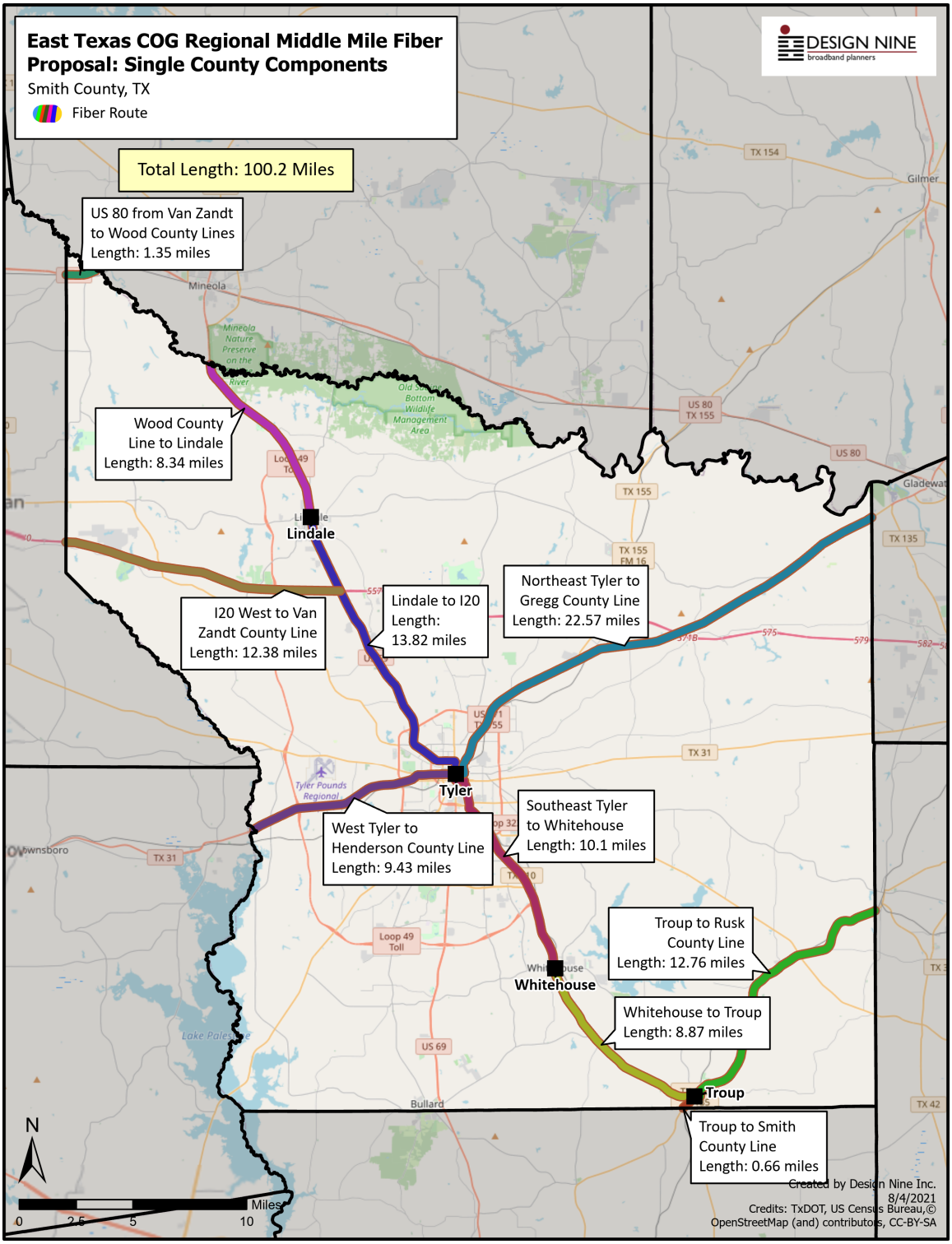
0	ITEM/PROJECT	ESTIMATED
1	Administrative and legal expenses	$10,499
2	Land, structures, rights-of-way, appraisals, etc.	$0
3	Relocation expenses and payments	$0
4	Architectural and engineering fees	$212,420
5	Other architectural and engineering fees	$115,452
6	Project inspection fees	$37,486
7	Site work	$0
8	Demolition and removal	$0
9	Construction	$1,986,251
10	Equipment	$13,000
11	Miscellaneous	$2,999
12	SUBTOTAL (sum of lines 1-11)	**$2,378,108**
13	Contingencies	$118,905
14	SUBTOTAL	**$2,497,013**
15	Project (program) income	**$0**
16	TOTAL PROJECT COSTS (subtract #15 from #14)	**$2,497,013**

5 REGIONAL MIDDLE MILE NETWORK COST ESTIMATES

The middle mile network in Smith County consists of nine segments, as shown in the table below. "Core Network" segments can be built in an initial phase to connect with other county Core Network segments to build a fully functional regional network. "Connector" segments can be added incrementally as funding becomes available to expand the reach of the network in the county.

Segment ID	Project Description	Total length (feet)	Total length (miles)	Segment Type
S1	Wood County Line to Lindale	44,025	8.338	Core Network
S2	Lindale to Tyler	72,908	13.808	Core Network
S3	Northeast Tyler to Gregg County Line	119,153	22.567	Core Network
S4	Southeast Tyler to Whitehouse	53,321	10.099	Core Network
S5	Whitehouse to Troup	49,518	9.378	Core Network
S6	Troup to Rusk County Line	68,168	12.911	Connector
S7	West Tyler to Henderson County Line	49,773	9.427	Connector
S8	I20 West to Van Zandt County Line	65,344	12.376	Core Network
S9	US 80 from Van Zandt to Wood County Lines	7,143	1.353	Connector
	Totals	**529,353**	**100.26**	

Segment ID	Estimated Buildings Passed	Estimated Hand Holes	Highway Crossings	Railroad Crossings	Recommended Number of Cabinets
S1	167	56	0	0	2.0
S2	276	92	0	1	3.0
S3	451	149	1	3	5.0
S4	202	67	0	3	3.0
S5	188	62	0	1	2.0
S6	258	86	0	1	3.0
S7	189	63	1	1	2.0
S8	248	82	2	0	3.0
S9	27	9	1	0	1.0


East Texas COG Regional Middle Mile Fiber Proposal: Single County Components
Smith County, TX
Fiber Route
DESIGN NINE
broadband planners
Total Length: 100.2 Miles
US 80 from Van Zandt to Wood County Lines Length: 1.35 miles
Wood County Line to Lindale Length: 8.34 miles
Lindale
I20 West to Van Zandt County Line Length: 12.38 miles
Lindale to I20 Length: 13.82 miles
Northeast Tyler to Gregg County Line Length: 22.57 miles
Tyler
West Tyler to Henderson County Line Length: 9.43 miles
Southeast Tyler to Whitehouse Length: 10.1 miles
Whitehouse
Troup to Rusk County Line Length: 12.76 miles
Whitehouse to Troup Length: 8.87 miles
Troup
Troup to Smith County Line Length: 0.66 miles
Mineola
Gilmer
Gladewater
Bullard
Mineola Nature Preserve on the River
Old Sabine Bottom Wildlife Management Area
Tyler Pounds Regional
Lake Palestine
TX 154
US 80
TX 155
TX 135
TX 155 FM 16
TX 31
US 69
Loop 49 Toll
TX 42
N
Miles
0
2.5
5
10
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8/4/2021
Credits: TxDOT, US Census Bureau,© OpenStreetMap (and) contributors, CC-BY-SA

SEGMENT S1: WOOD COUNTY LINE TO LINDALE

Smith - S1: Wood County Line to Lindale SF424 Summary

0	ITEM/PROJECT	ESTIMATED
1	Administrative and legal expenses	$6,933
2	Land, structures, rights-of-way, appraisals, etc.	$0
3	Relocation expenses and payments	$0
4	Architectural and engineering fees	$70,714
5	Other architectural and engineering fees	$63,851
6	Project inspection fees	$12,479
7	Site work	$0
8	Demolition and removal	$0
9	Construction	$656,210
10	Equipment	$37,060
11	Miscellaneous	$6,933
12	SUBTOTAL (sum of lines 1-11)	**$854,178**
13	Contingencies	$42,709
14	SUBTOTAL	**$896,887**
15	Project (program) income	**$0**
16	TOTAL PROJECT COSTS (subtract #15 from #14)	**$896,887**

Smith - S1: Wood County Line to Lindale Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	8.34
2	Number of Handholes Installed	56
3	Splice Closures Installed	56
4	Cabinets Installed	2
5	Number of Buildings Connected	17
6	Take Rate - Percentage of the Buildings Passed who are connected	10%
7	Aerial - Percentage of construction expected to be installed on utility poles.	2%
8	Trenching - Percentage of construction installed by trenching	5%
9	Boring - Percentage of construction installed by horizontal drilling.	28%
10	Slot Cutting - Conduit installed in street by special methods.	0%
11	Rock Saw - Required where rock prevents the use of other methods.	0%
12	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	65%
13	Aerial Info	2% Aerial is estimated to account for water body crossings and other obstacles to construction.
14	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Smith - S1: Wood County Line to Lindale Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Smith - S1: Wood County Line to Lindale Construction Materials	$196,074
2	Smith - S1: Wood County Line to Lindale Distribution Labor	$442,898
3	Smith - S1: Wood County Line to Lindale Structures, Cabinets, and Equipment	$37,060
4	Smith - S1: Wood County Line to Lindale Drop Construction	$17,238
5	Network Construction Subtotal	**$693,270**
6	Project Management, Network Engineering, Integration, and Testing	$83,192
7	Misc Fees, Advertising, Technical Services	$6,933
8	Bookkeeping and Administration	$5,200
9	Engineering, Permitting	$63,851
10	Legal Costs	$1,733
11	Other Costs Subtotal	$160,909
12	Project Total	**$854,178**
13	Contingency at 5%	$42,709
14	Project Total (with contingency)	**$896,887**

SEGMENT S2: LINDALE TO TYLER

Smith - S2: Lindale to Tyler SF424 Summary

0	ITEM/PROJECT	ESTIMATED
1	Administrative and legal expenses	$11,536
2	Land, structures, rights-of-way, appraisals, etc.	$0
3	Relocation expenses and payments	$0
4	Architectural and engineering fees	$117,669
5	Other architectural and engineering fees	$105,729
6	Project inspection fees	$20,765
7	Site work	$0
8	Demolition and removal	$0
9	Construction	$1,098,024
10	Equipment	$55,590
11	Miscellaneous	$11,536
12	SUBTOTAL (sum of lines 1-11)	**$1,420,850**
13	Contingencies	$71,042
14	SUBTOTAL	**$1,491,892**
15	Project (program) income	**$0**
16	TOTAL PROJECT COSTS (subtract #15 from #14)	**$1,491,892**

Smith - S2: Lindale to Tyler Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	13.81
2	Number of Handholes Installed	92
3	Splice Closures Installed	92
4	Cabinets Installed	3
5	Number of Buildings Connected	28
6	Take Rate - Percentage of the Buildings Passed who are connected	10%
7	Aerial - Percentage of construction expected to be installed on utility poles.	2%
8	Trenching - Percentage of construction installed by trenching	5%
9	Boring - Percentage of construction installed by horizontal drilling.	28%
10	Slot Cutting - Conduit installed in street by special methods.	0%
11	Rock Saw - Required where rock prevents the use of other methods.	0%
12	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	65%
13	Aerial Info	2% Aerial is estimated to account for water body crossings and other obstacles to construction.
14	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Smith - S2: Lindale to Tyler Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Smith - S2: Lindale to Tyler Construction Materials	$343,898
2	Smith - S2: Lindale to Tyler Distribution Labor	$725,477
3	Smith - S2: Lindale to Tyler Structures, Cabinets, and Equipment	$55,590
4	Smith - S2: Lindale to Tyler Drop Construction	$28,650
5	Network Construction Subtotal	**$1,153,614**
6	Project Management, Network Engineering, Integration, and Testing	$138,434
7	Misc Fees, Advertising, Technical Services	$11,536
8	Bookkeeping and Administration	$8,652
9	Engineering, Permitting	$105,729
10	Legal Costs	$2,884
11	Other Costs Subtotal	$267,235
12	Project Total	**$1,420,850**
13	Contingency at 5%	$71,042
14	Project Total (with contingency)	**$1,491,892**

SEGMENT S3: NORTHEAST TYLER TO GREGG COUNTY LINE

Smith - S3: Northeast Tyler to Gregg County Line SF424 Summary

0	ITEM/PROJECT	ESTIMATED
1	Administrative and legal expenses	$19,159
2	Land, structures, rights-of-way, appraisals, etc.	$0
3	Relocation expenses and payments	$0
4	Architectural and engineering fees	$195,420
5	Other architectural and engineering fees	$172,796
6	Project inspection fees	$34,486
7	Site work	$0
8	Demolition and removal	$0
9	Construction	$1,823,233
10	Equipment	$92,650
11	Miscellaneous	$19,159
12	SUBTOTAL (sum of lines 1-11)	**$2,356,902**
13	Contingencies	$117,845
14	SUBTOTAL	**$2,474,747**
15	Project (program) income	**$0**
16	TOTAL PROJECT COSTS (subtract #15 from #14)	**$2,474,747**

Smith - S3: Northeast Tyler to Gregg County Line Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	22.57
2	Number of Handholes Installed	149
3	Splice Closures Installed	149
4	Cabinets Installed	5
5	Number of Buildings Connected	46
6	Take Rate - Percentage of the Buildings Passed who are connected	10%
7	Aerial - Percentage of construction expected to be installed on utility poles.	2%
8	Trenching - Percentage of construction installed by trenching	5%
9	Boring - Percentage of construction installed by horizontal drilling.	28%
10	Slot Cutting - Conduit installed in street by special methods.	0%
11	Rock Saw - Required where rock prevents the use of other methods.	0%
12	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	65%
13	Aerial Info	2% Aerial is estimated to account for water body crossings and other obstacles to construction.
14	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Smith - S3: Northeast Tyler to Gregg County Line Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Smith - S3: Northeast Tyler to Gregg County Line Construction Materials	$598,205
2	Smith - S3: Northeast Tyler to Gregg County Line Distribution Labor	$1,177,703
3	Smith - S3: Northeast Tyler to Gregg County Line Structures, Cabinets, and Equipment	$92,650
4	Smith - S3: Northeast Tyler to Gregg County Line Drop Construction	$47,325
5	Network Construction Subtotal	**$1,915,883**
6	Project Management, Network Engineering, Integration, and Testing	$229,906
7	Misc Fees, Advertising, Technical Services	$19,159
8	Bookkeeping and Administration	$14,369
9	Engineering, Permitting	$172,796
10	Legal Costs	$4,790
11	Other Costs Subtotal	$441,020
12	Project Total	**$2,356,902**
13	Contingency at 5%	$117,845
14	Project Total (with contingency)	**$2,474,747**

SEGMENT S4: SOUTHEAST TYLER TO WHITEHOUSE

Smith - S4: Southeast Tyler to Whitehouse SF424 Summary

0	ITEM/PROJECT	ESTIMATED
1	Administrative and legal expenses	$9,066
2	Land, structures, rights-of-way, appraisals, etc.	$0
3	Relocation expenses and payments	$0
4	Architectural and engineering fees	$92,472
5	Other architectural and engineering fees	$77,326
6	Project inspection fees	$16,319
7	Site work	$0
8	Demolition and removal	$0
9	Construction	$850,997
10	Equipment	$55,590
11	Miscellaneous	$9,066
12	SUBTOTAL (sum of lines 1-11)	**$1,110,834**
13	Contingencies	$55,542
14	SUBTOTAL	**$1,166,376**
15	Project (program) income	**$0**
16	TOTAL PROJECT COSTS (subtract #15 from #14)	**$1,166,376**

Smith - S4: Southeast Tyler to Whitehouse Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	10.1
2	Number of Handholes Installed	67
3	Splice Closures Installed	67
4	Cabinets Installed	3
5	Number of Buildings Connected	21
6	Take Rate - Percentage of the Buildings Passed who are connected	10%
7	Aerial - Percentage of construction expected to be installed on utility poles.	2%
8	Trenching - Percentage of construction installed by trenching	5%
9	Boring - Percentage of construction installed by horizontal drilling.	28%
10	Slot Cutting - Conduit installed in street by special methods.	0%
11	Rock Saw - Required where rock prevents the use of other methods.	0%
12	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	65%
13	Aerial Info	2% Aerial is estimated to account for water body crossings and other obstacles to construction.
14	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Smith - S4: Southeast Tyler to Whitehouse Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Smith - S4: Southeast Tyler to Whitehouse Construction Materials	$296,933
2	Smith - S4: Southeast Tyler to Whitehouse Distribution Labor	$532,676
3	Smith - S4: Southeast Tyler to Whitehouse Structures, Cabinets, and Equipment	$55,590
4	Smith - S4: Southeast Tyler to Whitehouse Drop Construction	$21,388
5	Network Construction Subtotal	**$906,587**
6	Project Management, Network Engineering, Integration, and Testing	$108,790
7	Misc Fees, Advertising, Technical Services	$9,066
8	Bookkeeping and Administration	$6,799
9	Engineering, Permitting	$77,326
10	Legal Costs	$2,266
11	Other Costs Subtotal	$204,248
12	Project Total	**$1,110,834**
13	Contingency at 5%	$55,542
14	Project Total (with contingency)	**$1,166,376**

SEGMENT S5: WHITEHOUSE TO TROUP

Smith - S5: Whitehouse to Troup SF424 Summary

0	ITEM/PROJECT	ESTIMATED
1	Administrative and legal expenses	$7,917
2	Land, structures, rights-of-way, appraisals, etc.	$0
3	Relocation expenses and payments	$0
4	Architectural and engineering fees	$80,753
5	Other architectural and engineering fees	$71,813
6	Project inspection fees	$14,251
7	Site work	$0
8	Demolition and removal	$0
9	Construction	$754,635
10	Equipment	$37,060
11	Miscellaneous	$7,917
12	SUBTOTAL (sum of lines 1-11)	**$974,345**
13	Contingencies	$48,717
14	SUBTOTAL	**$1,023,063**
15	Project (program) income	**$0**
16	TOTAL PROJECT COSTS (subtract #15 from #14)	**$1,023,063**

Smith - S5: Whitehouse to Troup Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	9.38
2	Number of Handholes Installed	62
3	Splice Closures Installed	62
4	Cabinets Installed	2
5	Number of Buildings Connected	19
6	Take Rate - Percentage of the Buildings Passed who are connected	10%
7	Aerial - Percentage of construction expected to be installed on utility poles.	2%
8	Trenching - Percentage of construction installed by trenching	5%
9	Boring - Percentage of construction installed by horizontal drilling.	28%
10	Slot Cutting - Conduit installed in street by special methods.	0%
11	Rock Saw - Required where rock prevents the use of other methods.	0%
12	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	65%
13	Aerial Info	2% Aerial is estimated to account for water body crossings and other obstacles to construction.
14	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Smith - S5: Whitehouse to Troup Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Smith - S5: Whitehouse to Troup Construction Materials	$240,026
2	Smith - S5: Whitehouse to Troup Distribution Labor	$495,296
3	Smith - S5: Whitehouse to Troup Structures, Cabinets, and Equipment	$37,060
4	Smith - S5: Whitehouse to Troup Drop Construction	$19,313
5	Network Construction Subtotal	**$791,695**
6	Project Management, Network Engineering, Integration, and Testing	$95,003
7	Misc Fees, Advertising, Technical Services	$7,917
8	Bookkeeping and Administration	$5,938
9	Engineering, Permitting	$71,813
10	Legal Costs	$1,979
11	Other Costs Subtotal	$182,651
12	Project Total	**$974,345**
13	Contingency at 5%	$48,717
14	Project Total (with contingency)	**$1,023,063**

SEGMENT S6: TROUP TO RUSK COUNTY LINE

Smith - S6: Troup to Rusk County Line SF424 Summary

0	ITEM/PROJECT	ESTIMATED
1	Administrative and legal expenses	$10,842
2	Land, structures, rights-of-way, appraisals, etc.	$0
3	Relocation expenses and payments	$0
4	Architectural and engineering fees	$110,592
5	Other architectural and engineering fees	$98,916
6	Project inspection fees	$19,516
7	Site work	$0
8	Demolition and removal	$0
9	Construction	$1,028,644
10	Equipment	$55,590
11	Miscellaneous	$10,842
12	SUBTOTAL (sum of lines 1-11)	**$1,334,943**
13	Contingencies	$66,747
14	SUBTOTAL	**$1,401,690**
15	Project (program) income	**$0**
16	TOTAL PROJECT COSTS (subtract #15 from #14)	**$1,401,690**

Smith - S6: Troup to Rusk County Line Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	12.92
2	Number of Handholes Installed	86
3	Splice Closures Installed	86
4	Cabinets Installed	3
5	Number of Buildings Connected	26
6	Take Rate - Percentage of the Buildings Passed who are connected	10%
7	Aerial - Percentage of construction expected to be installed on utility poles.	2%
8	Trenching - Percentage of construction installed by trenching	5%
9	Boring - Percentage of construction installed by horizontal drilling.	28%
10	Slot Cutting - Conduit installed in street by special methods.	0%
11	Rock Saw - Required where rock prevents the use of other methods.	0%
12	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	65%
13	Aerial Info	2% Aerial is estimated to account for water body crossings and other obstacles to construction.
14	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Smith - S6: Troup to Rusk County Line Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Smith - S6: Troup to Rusk County Line Construction Materials	$322,860
2	Smith - S6: Troup to Rusk County Line Distribution Labor	$679,209
3	Smith - S6: Troup to Rusk County Line Structures, Cabinets, and Equipment	$55,590
4	Smith - S6: Troup to Rusk County Line Drop Construction	$26,575
5	Network Construction Subtotal	**$1,084,234**
6	Project Management, Network Engineering, Integration, and Testing	$130,108
7	Misc Fees, Advertising, Technical Services	$10,842
8	Bookkeeping and Administration	$8,132
9	Engineering, Permitting	$98,916
10	Legal Costs	$2,711
11	Other Costs Subtotal	$250,708
12	Project Total	**$1,334,943**
13	Contingency at 5%	$66,747
14	Project Total (with contingency)	**$1,401,690**

SEGMENT S7: WEST TYLER TO HENDERSON COUNTY LINE

Smith - S7: West Tyler to Henderson County Line SF424 Summary

0	ITEM/PROJECT	ESTIMATED
1	Administrative and legal expenses	$8,037
2	Land, structures, rights-of-way, appraisals, etc.	$0
3	Relocation expenses and payments	$0
4	Architectural and engineering fees	$81,982
5	Other architectural and engineering fees	$71,813
6	Project inspection fees	$14,467
7	Site work	$0
8	Demolition and removal	$0
9	Construction	$766,682
10	Equipment	$37,060
11	Miscellaneous	$8,037
12	SUBTOTAL (sum of lines 1-11)	**$988,079**
13	Contingencies	$49,404
14	SUBTOTAL	**$1,037,483**
15	Project (program) income	**$0**
16	TOTAL PROJECT COSTS (subtract #15 from #14)	**$1,037,483**

Smith - S7: West Tyler to Henderson County Line Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	9.38
2	Number of Handholes Installed	63
3	Splice Closures Installed	63
4	Cabinets Installed	2
5	Number of Buildings Connected	19
6	Take Rate - Percentage of the Buildings Passed who are connected	10%
7	Aerial - Percentage of construction expected to be installed on utility poles.	2%
8	Trenching - Percentage of construction installed by trenching	5%
9	Boring - Percentage of construction installed by horizontal drilling.	28%
10	Slot Cutting - Conduit installed in street by special methods.	0%
11	Rock Saw - Required where rock prevents the use of other methods.	0%
12	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	65%
13	Aerial Info	2% Aerial is estimated to account for water body crossings and other obstacles to construction.
14	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Smith - S7: West Tyler to Henderson County Line Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Smith - S7: West Tyler to Henderson County Line Construction Materials	$250,814
2	Smith - S7: West Tyler to Henderson County Line Distribution Labor	$496,556
3	Smith - S7: West Tyler to Henderson County Line Structures, Cabinets, and Equipment	$37,060
4	Smith - S7: West Tyler to Henderson County Line Drop Construction	$19,313
5	Network Construction Subtotal	**$803,742**
6	Project Management, Network Engineering, Integration, and Testing	$96,449
7	Misc Fees, Advertising, Technical Services	$8,037
8	Bookkeeping and Administration	$6,028
9	Engineering, Permitting	$71,813
10	Legal Costs	$2,009
11	Other Costs Subtotal	$184,337
12	Project Total	**$988,079**
13	Contingency at 5%	$49,404
14	Project Total (with contingency)	**$1,037,483**

SEGMENT S8: 20 WEST TO VAN ZANDT COUNTY LINE

Smith - S8: I20 West to Van Zandt County Line SF424 Summary

0	ITEM/PROJECT	ESTIMATED
1	Administrative and legal expenses	$10,425
2	Land, structures, rights-of-way, appraisals, etc.	$0
3	Relocation expenses and payments	$0
4	Architectural and engineering fees	$106,338
5	Other architectural and engineering fees	$94,781
6	Project inspection fees	$18,766
7	Site work	$0
8	Demolition and removal	$0
9	Construction	$986,944
10	Equipment	$55,590
11	Miscellaneous	$10,425
12	SUBTOTAL (sum of lines 1-11)	**$1,283,270**
13	Contingencies	$64,164
14	SUBTOTAL	**$1,347,434**
15	Project (program) income	**$0**
16	TOTAL PROJECT COSTS (subtract #15 from #14)	**$1,347,434**

Smith - S8: I20 West to Van Zandt County Line Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	12.38
2	Number of Handholes Installed	82
3	Splice Closures Installed	82
4	Cabinets Installed	3
5	Number of Buildings Connected	25
6	Take Rate - Percentage of the Buildings Passed who are connected	10%
7	Aerial - Percentage of construction expected to be installed on utility poles.	2%
8	Trenching - Percentage of construction installed by trenching	5%
9	Boring - Percentage of construction installed by horizontal drilling.	28%
10	Slot Cutting - Conduit installed in street by special methods.	0%
11	Rock Saw - Required where rock prevents the use of other methods.	0%
12	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	65%
13	Aerial Info	2% Aerial is estimated to account for water body crossings and other obstacles to construction.
14	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Smith - S8: I20 West to Van Zandt County Line Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Smith - S8: I20 West to Van Zandt County Line Construction Materials	$310,288
2	Smith - S8: I20 West to Van Zandt County Line Distribution Labor	$651,119
3	Smith - S8: I20 West to Van Zandt County Line Structures, Cabinets, and Equipment	$55,590
4	Smith - S8: I20 West to Van Zandt County Line Drop Construction	$25,538
5	Network Construction Subtotal	**$1,042,534**
6	Project Management, Network Engineering, Integration, and Testing	$125,104
7	Misc Fees, Advertising, Technical Services	$10,425
8	Bookkeeping and Administration	$7,819
9	Engineering, Permitting	$94,781
10	Legal Costs	$2,606
11	Other Costs Subtotal	$240,736
12	Project Total	**$1,283,270**
13	Contingency at 5%	$64,164
14	Project Total (with contingency)	**$1,347,434**

SEGMENT S9: US 80 FROM VAN ZANDT TO WOOD COUNTY LINES

Smith - S9: US 80 from Van Zandt to Wood County Lines SF424 Summary

0	ITEM/PROJECT	ESTIMATED
1	Administrative and legal expenses	$1,435
2	Land, structures, rights-of-way, appraisals, etc.	$0
3	Relocation expenses and payments	$0
4	Architectural and engineering fees	$14,632
5	Other architectural and engineering fees	$10,412
6	Project inspection fees	$2,582
7	Site work	$0
8	Demolition and removal	$0
9	Construction	$124,926
10	Equipment	$18,530
11	Miscellaneous	$1,435
12	SUBTOTAL (sum of lines 1-11)	**$173,952**
13	Contingencies	$8,698
14	SUBTOTAL	**$182,649**
15	Project (program) income	**$0**
16	TOTAL PROJECT COSTS (subtract #15 from #14)	**$182,649**

Smith - S9: US 80 from Van Zandt to Wood County Lines Route Overview

0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	1.36
2	Number of Handholes Installed	9
3	Splice Closures Installed	9
4	Cabinets Installed	1
5	Number of Buildings Connected	3
6	Take Rate - Percentage of the Buildings Passed who are connected	10%
7	Aerial - Percentage of construction expected to be installed on utility poles.	2%
8	Trenching - Percentage of construction installed by trenching	5%
9	Boring - Percentage of construction installed by horizontal drilling.	28%
10	Slot Cutting - Conduit installed in street by special methods.	0%
11	Rock Saw - Required where rock prevents the use of other methods.	0%
12	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	65%
13	Aerial Info	2% Aerial is estimated to account for water body crossings and other obstacles to construction.
14	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Smith - S9: US 80 from Van Zandt to Wood County Lines Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Smith - S9: US 80 from Van Zandt to Wood County Lines Construction Materials	$42,478
2	Smith - S9: US 80 from Van Zandt to Wood County Lines Distribution Labor	$79,735
3	Smith - S9: US 80 from Van Zandt to Wood County Lines Structures, Cabinets, and Equipment	$18,530
4	Smith - S9: US 80 from Van Zandt to Wood County Lines Drop Construction	$2,713
5	Network Construction Subtotal	**$143,456**
6	Project Management, Network Engineering, Integration, and Testing	$17,215
7	Misc Fees, Advertising, Technical Services	$1,435
8	Bookkeeping and Administration	$1,076
9	Engineering, Permitting	$10,412
10	Legal Costs	$359
11	Other Costs Subtotal	$30,496
12	Project Total	**$173,952**
13	Contingency at 5%	$8,698
14	Project Total (with contingency)	**$182,649**

6 HOW MUCH BANDWIDTH IS ENOUGH?

Bandwidth needs for the past several years have been growing by an estimated 30% per year and show no sign of slowing.

This means residential and business bandwidth needs are doubling every three years.

As computers and associated hardware (e.g. video cameras, audio equipment, and VoIP phones) become more powerful and less expensive, new applications and services are continually emerging that drive demand for more bandwidth.

"Next generation" is the term used to describe future planning for network connectivity and infrastructure. Next-generation broadband reaps substantial benefits. There are several key benefits of Next-generation broadband:

- Dramatically faster file transfer speeds for both uploads and downloads.
- The ability to transmit streaming video, transforming the Internet into a more visual medium.
- The means to engage in true-real time collaboration.
- The ability to use many applications simultaneously.
- The ability to maintain flexible work schedules by being able to work from home on a part-time or full-time basis.
- The ability to obtain health-related services for an occasional illness and/or long term medical services for chronic illnesses.

Clearly, consumers have a strong interest in a visual medium from when and wherever they are. YouTube is the second most popular search engine after Google, which demonstrates the need to support the infrastructure to transmit streaming video. In addition to video streaming, true real-time collaboration also provides an effective way for people to interact from wherever they are. People can engage in a two-way real-time collaboration so that fruitful, visual conversations can be held between friends, family, business associates from the state, country, or internationally.

Because of fiber networks, employees have the capability of working from home. Findings suggest that if all Americans had fiber to the home, this would lead to a 5% reduction in gasoline use, a 4% reduction in carbon dioxide emissions, $5 billion in lower road expenditures, and 1.5 billion commute hours recaptured.

In Smith County today, many residents and businesses are still relying on copper-based services. The bandwidth tables below show what is likely to be needed over the the next several years in terms of bandwidth. The existing copper infrastructure is going to become a limiting factor in economic development.

6.1 JOB AND WORKFORCE CHALLENGES

Most residents and businesses in the county currently have, at best, Internet service that meets the FCC definition of "fully served," which is 25 Megabits down/3 Megabits up bandwidth. However, what has become painfully clear during the Covid pandemic is that this definition of "fully served" is not adequate to support many kinds of work from home activities. During the Covid lockdown, it

was common to have both spouses trying to work from home while K12 and/or college age children were also trying to use video-heavy distance learning resources.

When home-based workers need to connect to a corporate VPN (Virtual Private Network), bandwidth requirements can increase even more. Work from home and business from home activities should have, at a minimum, a symmetric service of at least 10 Megabits download and 10 Megabits upload speeds. Higher speed service could include service levels like 25 Megabits down/10 Megabits up. The critical requirement is an upload speed that supports work from home.

If the goal is to enhance business access to broadband, there can be no upper limit on the definition of broadband. Saying that broadband (as an example) is 5 Megabits/second of bandwidth or 10 Megabits/second is to tell the residents and businesses in the county that there will be limits on their work and job opportunities.

Broadband is a community and economic development issue, not a technology issue. The essential question is not, "What system should we buy?" or "Is 5G wireless better or cheaper than fiber?" Instead, the question is:

"What do businesses of and home-based workers of Smith County need to be able to compete globally over the next thirty years?"

In short, the county today has "little broadband" in the form of DSL limited cable modem service, along with a very limited amount of "big broadband" in the form of fiber to some businesses and residents.

If the County makes investments in broadband and telecommunications infrastructure, it is absolutely critical that those investments are able to scale gracefully to meet business and economic development needs for decades.

Two key concepts that should drive county investments in telecom are:

"Broadband" is not the Internet

Bandwidth is not a fixed number

Broadband and "the Internet" are often used interchangeably, but this has led to much confusion. Broadband refers to a delivery system, while "the Internet" is just one of many services that can be carried on a broadband network. The challenge for the County is to ensure that businesses and homes have a broadband network with sufficient bandwidth to deliver all the services that will be needed and expected within the next three to four years, including but not limited to "the Internet."

The economic impact can include the following effects:

- Difficulty retaining some existing businesses - As business bandwidth needs continue to increase over the next several years, some businesses may need to move out of the county to ensure that they have the right bandwidth to support their business operations.
- Difficulty attracting new businesses - New businesses interested in some of the advantages available in the county (e.g. small town quality of life, good recreational opportunities, affordable housing) may be deterred by the cost and limited bandwidth available, and therefore choose other areas to locate.
- Difficulty keeping younger workers and families in the county - Younger workers and families tend to be heavy users of Internet services, and real estate agents are reporting that younger house buyers are reluctant to live in areas with poor Internet service.

- Reductions in real estate value - Homes with poor Internet service are more difficult to sell, leading to reduced prices and then impacting county property taxes negatively.

6.2 BUSINESS BANDWIDTH NEEDS

The table below shows bandwidth consumption for several types of businesses and a projection of the bandwidth needed 5 and 10 years out. The Covid pandemic has had the effect of dramatically increasing the number of home-based works and has also affected business travel decisions. More and more businesses will invest in high definition (HD) quality business videoconference systems to reduce the need for travel and to maintain high quality communications with a dispersed workforce. These HD systems require substantial bandwidth; a two-way HD video conference requires 20-25 Mbps during the conference, and a three-way conference requires 30-35 Mbps during the conference.

Business Bandwidth Needs

	LARGE BUSINESS		SMALL BUSINESS		HOME BASED WORKER	
DESCRIPTION	A larger business with about 50 workstations.		A small business with 10 to 15 employees, and 7-10 workstations.		One or two people working from home.	
	Concurrent Use	Mbps	Concurrent Use	Mbps	Concurrent Use	Mbps
Telephone	20	5	5	1.5	2	0.5
Credit Card Validation	4	4	1	1		0
Security System	1	5	1	2	2	2
Internet	50	500	7	10.5	2	20
VPN Connection	20	100	5	50	2	5
Data Backup	5	7.5	1	10	2	10
Web Hosting	1	2		0		0
Workforce Training (online classes)	5	20	1	10	2	10
HD Video-conferencing	20	125	2	20	2	10
Totals		**768.5**		**105.0**		**57.5**
5 YEARS FROM NOW	3-10 Gbps		250-500 Mbps		100-200 Mbps	
10 YEARS FROM NOW	10 + Gbps		2-4 Gbps		500-750 Mbps	

As more workers are moved to home-based offices, the business location must provide network access (Virtual Private Network (VPN)) to employees working from home. These home-based workers will make extensive use of videoconferencing to attend routine office meetings remotely and to enhance communications with co-workers, including videoconferences with other home-based workers in the company. A VPN network providing remote access to just two or three home-based employees could require 50 Mbps of bandwidth during normal work hours.

6.3 RESIDENTIAL BANDWIDTH NEEDS

The table below depicts the bandwidth needed for typical residential services which are available now or will be available in the near future. The Covid pandemic has illustrated the shortcomings of cable Internet services, in which the upload and download speeds are highly asymmetric.

For home-based workers, upload speeds need to be equal to or nearly equal to download speeds. Current cable Internet systems are not able to deliver symmetric or near symmetric service. Today's shared networks (cable and wireless in particular) rely on the "bursty" nature of traffic to provide services to end users. If all end users were consuming their advertised maximum bandwidth, today's cable and DSL networks would grind to a halt.

Residential Bandwidth Needs

	RESIDENTIAL DAYTIME		EARLY EVENING		EVENING & LATE NIGHT	
DESCRIPTION	Work from home, K12 distance learning and home schooling, telemedicine, streaming video		Increased Internet use as children arrive home from school and employees from work.		Peak television and Internet use. Multiple TV's are on, phone and computer being used.	
	Concurrent Use	Mbps	Concurrent Use	Mbps	Concurrent Use	Mbps
Telephone	1	0.25	1	0.25	1	0.25
Work From Home	1	10	1	10	1	10
HD TV	1	4	2	8	2	8
Security System	1	2	1	2	1	2
Internet	1	1.5	1	1.5	2	3
Online Gaming	0	0.25	1	5	2	10
VPN Connection	0	0	1	2	1	2
Data Backup		0	1	5	1	5
Telehealth	1	4	1	4	1	4
Distance Learning/ home schooling		0	1	10	1	10
Videoconferencing		0		0		0
Average needed bandwidth		**15-25**		**25-35**		**20-35**
Five years from now	50-75 Mbps		60-90 Mbps		50-100 Mbps	
Ten years from now	150-300 Mbps		200-350 Mbps		175-250 Mbps	

Existing cable modem network users are overwhelming the digital cable networks that were upgraded as little as three or four years ago, and the firms have had to artificially reduce the bandwidth available for certain kinds of high bandwidth services (e.g. peer to peer file sharing). Some cable providers have even run into capacity issues with the TV portion of their networks, and some consumers have observed that some HD TV channels have been so highly compressed that picture quality has been noticeably degraded.

6.4 CURRENT AND FUTURE USES AND SERVICES

When analyzing future service needs, it is important to take into account ALL services that may be delivered over a broadband connection. Broadband is not a service – it is a delivery medium. Using roads as an analogy, broadband is the road, not the trucks that use the road. Internet access is a service delivered by a broadband "road," and that Internet service is just one of many services that are in demand. Today, congestion on broadband networks is not due just to increased use of email and Web surfing, but many other services.

This means that current DSL, wireless, and cable modem services are completely inadequate for future needs. Current DSL offerings are in the range of one Mbps to three Mbps for most residential users, three Mbps to five Mbps for business DSL users, and there are severe distance limitations on DSL. Higher bandwidth is possible, but as the DSL bandwidth goes up, the distance it can be delivered goes down.

Typical wireless broadband (not cellular data service) offerings are in the range of 5 Mbps to 10 Mbps. Some wireless providers are rolling out 10-20 Mbps services. As bandwidth increases, the cost of the equipment also increases, and even a 20 Mbps service is well short of the FCC definition of broadband: 25 Mbps down and 3 Mbps up.

Across the U.S., current average bandwidth for cable modem services is typically 10 to 25 Mbps, with cable companies promising much more using the phrase "up to..." to obscure actual bandwidth being delivered.

The challenge for the area is to ensure that the businesses, residents, and institutions have a telecommunications infrastructure in place that will meet future needs.

Distance learning, entertainment, and video conferencing are three major applications of internet video. Distance learning from home with live video feeds requires high-performance two to five Mbps connections in the near term, the next two to four years. Over the next four to seven years, there will be many distance-learning courses that will incorporate live HD two-way video feeds, enabling students to participate in classroom discussions at a much higher quality level. Distance learning could be an important home-based application for workforce training and retraining.

U.S. homes now have more than half a billion devices connected to the Internet, according to a study by the NPD Group. Furthermore, the average number of connected devices per household is 10 and growing rapidly. This is more than three times the average number of people per household.

7 CONNECTIVITY SOLUTIONS

7.1 OVERVIEW OF THE TECHNOLOGY

In large portions of Smith County, broadband wireless will be an important strategy for improved Internet access for businesses and residents. But both fiber and wireless technologies and systems are going to be important to meet the goal of improving access to broadband. The rest of this section provides more detail and some specific build out strategies.

Businesses and residents may obtain Internet service:

- With a small radio directly attached to their home or business that receives a signal directly from a towers owned by a private provider, from a County-owned tower (e.g. shared with public safety use), or from a community-owned tower (e.g. a coop).
- With a small radio attached to a utility pole (60 or 70') to improve line of sight to a tower.
- With a small radio directly attached to their home or business that receives a signal from a "community" utility pole. The "community" pole will receive a signal from a distant tower and redistribute it locally to a cluster of customers (typically within a half mile).
- With a fiber connection to the fiber installed in areas where economic development is important, and in other areas as additional fiber network segments are added.

The table below summarizes how fiber and wireless can work together in a variety of ways.

Distribution Type	Access Type	Capacity
Wireless	Wireless	Typical customer connection starting at 5 to 10 Megabits, can be higher, with 50 Meg connections common. More dependent on the capacity of the wireless Distribution link.
Wireless	Fiber	Users can have fiber Gigabit connections locally, but total throughput dependent upon the capacity of the wireless link, which can be up to a Gigabit, depending on distance and budget.
Fiber	Fiber	Any amount of bandwidth needed, with standard connection typically a Gigabit (1,000 Megabits).
Fiber	Wireless	Typical customer connection starting at 5 to 10 Megabits, can be higher, with 50 Meg connections common.

7.2 WIRELESS TECHNOLOGIES

WISPs (Wireless Internet Service Providers) use a wide variety of radio frequencies to deliver fixed point wireless broadband. By "fixed point," this means that these systems are not designed to support roaming in the way that cellular voice/data radios are (that is, mobile phone and data services).

Fixed point broadband is broadcast from a tower to individual homes and businesses (fixed points). Most of the frequencies used require clear line of sight between the tower and the

location where service is desired.In some parts of Texas, tree cover is often an obstacle to getting good service.

The hilly topography of of the area can work for or against good wireless broadband service. Towers located on the tops of hills and mountains can provide service over a larger area than a tower in relatively flat terrain, but hills also block the signal. A residence can be a short distance from a large tower, but heavy tree cover or an intervening hill will block service. The solution to this can be addressed in several ways:

More larger towers of 180' to 300'

The taller the tower, the wider the coverage, but as tower height increases, the cost of the tower also increases. Towers taller than 199' require a light at the top to make them visible to low-flying aircraft, and lighted towers are more expensive to erect, and the bulbs have to be changed periodically at significant expense. Many broadband towers are 180' to avoid the additional cost of lighting.

Small cell broadband utility poles

Small cell broadband utility poles, often called community poles, are shorter towers or utility poles of typically 60' to 80', located in or very near a cluster of homes. The towers can be wooden utility poles or relatively low cost steel monopoles or steel lattice towers. These towers are located to get above local tree cover so that clear line of sight to a distant taller tower is available. Local access point radios provide service to homes and businesses with line of sight to the pole. In many parts of Smith, these are going to be an important part of a strategy to get better broadband to rural residents and businesses.

Variety of radio frequencies

WISPs are beginning to deploy a wider range of licensed and unlicensed radio frequencies to overcome distance, bandwidth, and line of sight issues. Traditional 2.4 Ghz and 5.7 Ghz WiFi and WiMax frequencies are being supplemented or replaced with LTE broadband radios that provide better bandwidth and will tolerate light tree cover better (2.5 Ghz, 3.5-3.7 Ghz). Some WISPs are also using lower frequencies (e.g. 900 Mhz) that will travel farther and will also provide better penetration in light tree cover.

7.3 EMERGING WIRELESS TECHNOLOGIES

MIMO Wireless

MIMO (Multiple Input, Multiple Output) describes a variety of technologies that can be summarized as using more than one receive and transmit antenna for wireless data applications. Wireless protocols that are using the MIMO concept include IEEE 802.11n (Wi-Fi), IEEE 802.11ac (Wi-Fi), 4G, LTE (Long Term Evolution), and WiMAX. Each of these protocols use the MIMO technology to increase the amount of available bandwidth in a given section of radio frequency spectrum.

New hardware is required to make effective use of MIMO. While the technology increases wireless bandwidth, the typical amount of bandwidth being used by wireless devices is also increasing rapidly. Some applications where MIMO is likely to provide noticeable improvements are in home wireless routers, where the effective throughput will be able to better handle the demanding

bandwidth requirements of HD and 4K video streams. MIMO is slowly being developed for use with cellular smartphones, but both the phones and the cell tower radios have to be upgraded to support MIMO.

LTE/4G/5G

LTE (Long Term Evolution) is a set of protocols and technologies designed to improve the performance of voice/data smartphones. Like MIMO, both the user phone and the cell tower radios have to be upgraded to support LTE improvements. In 2013, only 19% of U.S. smartphone users were able to take advantage of LTE speeds, although that percentage has been increasing rapidly since then, and more than 85% of the U.S. cellular towers have been upgraded to LTE. As noted previously, the actual bandwidth available to a smartphone user is highly variable and depends on distance from the cell tower, the number of smartphones accessing the same tower simultaneously, and the kinds of services and content being accessed by those users.

The primary purpose of cellular bandwidth caps is to keep cellular users from using too much bandwidth and degrading the overall service. While LTE and MIMO improvements will improve overall cellular service, these technologies are not going to replace fiber to the home and fiber to the business.

In recent years, new fixed broadband wireless systems entered the marketplace using LTE frequencies, and many WISPs have begun to replace existing wireless radio systems with LTE equipment. These LTE systems do not provide any cellular voice services; they are designed specifically to support only broadband/Internet service.

Reports of performance have been mixed. In our conversations with both vendors of these systems and WISPs that have begun testing them, we get two very different stories. The vendors have been conservative in discussing the improvements, while some WISPs have been taking single user test results and suggesting that they will be able to deliver higher speeds at greater distances to all users.

There is little debate that the LTE equipment offers higher bandwidth, at somewhat greater distances, and with somewhat better penetration of light foliage and tree cover. Over the next two to four years, most WISPs will change out most of their existing radio systems for the improved LTE radios. Perhaps the most significant advantage of LTE fixed point broadband is its ability to provide better performance when clear line of sight between the customer and a tower is not available. LTE provides better penetration of light to moderate tree cover and other line of sight obstacles.

To achieve the full benefit of 5G technology, more fiber is needed.

The much touted 5G wireless technology, as of 2019, is still largely marketing hype. The official standard for 5G radio technologies is planned for release later in 2019, although some companies, like Verizon and AT&T, have begun trials of the equipment with locations largely limited to major metro areas.

5G does bring much higher speeds to wireless broadband (e.g. it might be able to deliver 30 to 50 Meg of bandwidth consistently). But 5G has significant limitations that do not make it a good solution in rural areas of the U.S.

The fact that 5G can deliver much higher bandwidth means that 5G cell sites will require fiber connections. This is going to effectively limit 5G deployments to denser urban environments where both customers and fiber are plentiful.

There is no free lunch in the physics of radio frequencies. The higher bandwidth of 5G means that cell sites need to be closer together because the 5G frequencies do not travel as far as existing 4G/LTE frequencies currently being used by the cellular industry. Most users will have to be within 500 to 1,000 feet to receive 5G service.

Some experts estimate that more than a million miles of new fiber will have to be deployed just to support the 25 largest metro areas in the U.S. 5G will not appear overnight.

As many as 60 cell sites per square mile may be needed to make 5G widely available in a given area. If, as an example, about 25%, or 270 square miles of Smith County is underserved, very conservatively, as many as zzzz or more cell sites would be needed to provide good coverage. The actual number is likely to be somewhat lower, as the 5G cell sites would be placed along rural roads and not in the middle of fields. But as an example of the problems with 5G in rural areas, if a home is more than 1,000 feet off the main road, it would receive, at best, degraded Internet speeds.

For rural areas, the cost of 5G service may be one of the most significant obstacles. The cellular carriers see the increased customer bandwidth use possible on 5G networks as a major revenue opportunity. While they will increase the "standard" bandwidth package for monthly service, bandwidth caps and rate limiting is likely to keep 5G cellular customers bills high.

White space broadband

White space broadband uses some of the frequencies that were formerly used by analog TV channels. These lower frequencies travel farther and provide better penetration of light foliage. Microsoft has been supporting a number of community white space experiments, and has promised much wider support for this technology, but there are few other users, equipment is still relatively expensive, and few WISPs have ventured into this still largely experimental technology. The Microsoft white space project in southern Virginia, although still underway, serves less than three hundred households and is still regarded as experimental. Other white space pilot projects have reported good results. River Valley Internet has indicated that their trials with white space equipment has been able to deliver 50 Meg/50 Meg service.

Low Earth Orbit (LEO) Satellite Internet

The Elon Musk-funded Starlink effort recently began offering "beta test" service. There is a one time equipment and installation fee of $499, and a monthly fee of $99. The company is promising download speeds of between 50 Meg/sec and 100 Meg/sec. Latency is lower than traditional satellite Internet services. If the prices remain reasonable, this is likely to become a much better alternative to the older satellite Internet services. Early reports from beta users indicate that is much more usable than traditional geosynchronous satellite services like Viasat and HughesNet. Users have reported good performance for streaming video (e.g. Netflix, Hulu, Prime, etc.), but that real time two-way video (e.g. Zoom, Webex, GoToMeeting) performance can be mixed, with latency (delays) reducing overall quality of videoconferences. For some rural customers, Starlink may be a good solution compared to remaining on DSL or using high-priced cellular data packages.

7.4 DARK FIBER AND LIT FIBER

About Dark Fiber

Dark fiber is installed in conduit underground and/or hung on utility poles. It is called "dark" because no network electronics are installed to "light" the fiber (using small lasers in a fiber switch). For small municipal/local government fiber installations, dark fiber has a significant advantage in terms of management–very little ongoing operational responsibility is required.

Dark fiber is leased out to service providers, who install their own network electronics in cabinets or shelters attached to the fiber cables. The providers typically lease fiber pairs between the cabinet and their customers, and are responsible for all equipment-related management and maintenance. Dark fiber networks can be used by service providers to provision either Active Ethernet or GPON services to their customers.

Dark fiber networks do not generate large amounts of revenue, but this is offset by very low maintenance costs–primarily an emergency break-fix arrangement with a local or regional firm qualified to splice fiber. Emergency break-fix contracts are usually based on a time and materials basis, so there is little or no expense if there are no fiber breaks.

Other costs include "locates," which are called in to Texas 811 and are performed by either the local Public Works department or a private sector contractor. For small fiber networks, locate costs are generally modest.

About Lit Fiber

A "lit" fiber network includes the network electronics needed to transmit data over the fiber (using the small lasers in a fiber switch, hence there is light traveling over the fiber cable). In a lit network, "lit circuits" are leased out to service providers rather than fiber pairs. The muni/local government/ community network provides the network electronics, which reduces costs for the service provider –meaning they are able to pay higher lease fees for the circuits they use to deliver services (like Internet) to their customers. Lit networks generate more revenue, but also have higher expenses because the network electronics have to be monitored and managed on a 24/7/365 basis (this task can usually be outsourced at reasonable cost). However, very small fiber deployments often do not pass enough homes or businesses to generate sufficient revenue to cover the higher costs.

Like dark fiber, a lit network incurs break-fix and locate costs as well.

7.5 THE MEET-ME BOX CONCEPT

In some of the larger towns, some smaller communities, rural neighborhoods, and subdivisions, "meet me" boxes could be installed. A meet me box is a telecom cabinet with fiber cables installed between the cabinet and nearby homes and/or buildings. Providers only have to reach the meet-me box, lowering their costs. Both wireline and wireless providers can use this infrastructure. This approach can also be used to provide fiber services in business and industrial parks. A small Virginia county installed five miles of fiber in their business park and was able to attract a Tier One provider to provide service to an existing business (a manufacturing plant that was going to leave if the county did not help them get better Internet service).

The dark fiber approach minimizes operational costs. Service providers would install their own equipment in the cabinet and would pay a small monthly lease fee for the fiber strands they use to connect customers to their services.

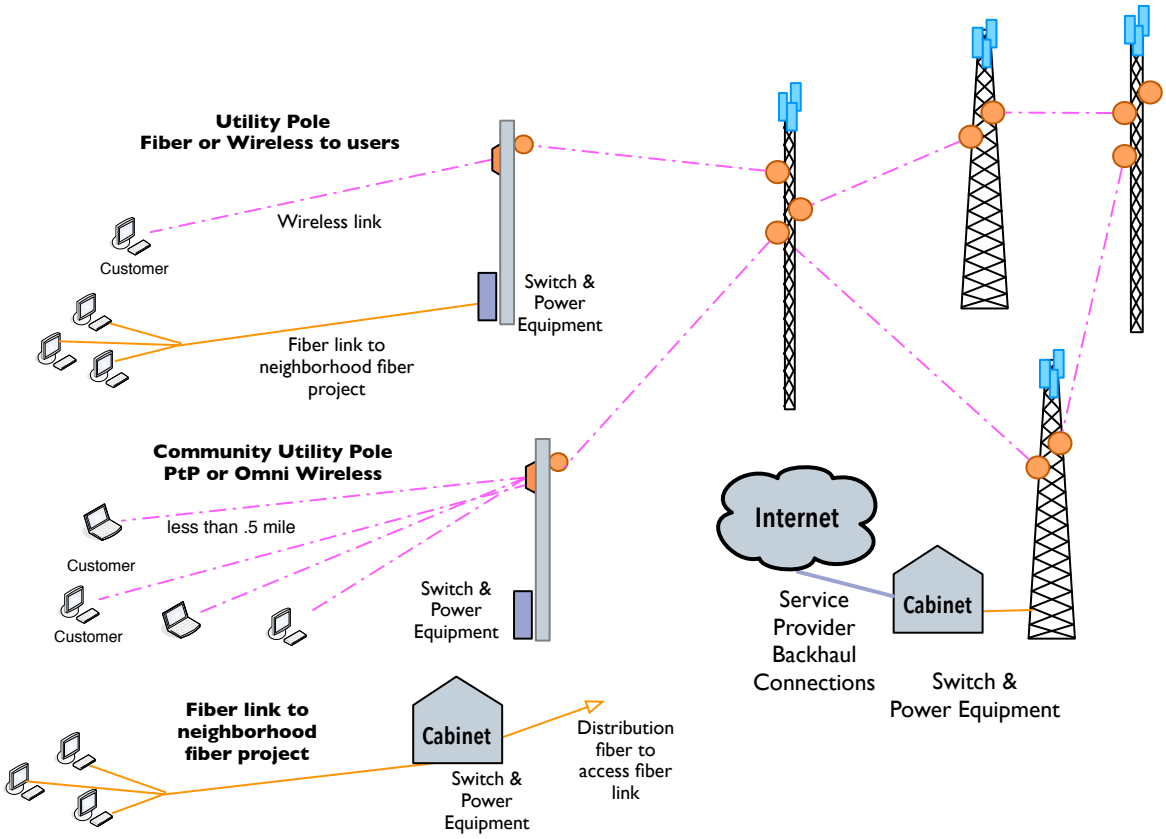
For a meet-me box installed in a "main street" area (e.g in an alley behind commercial/retail buildings) with relatively inexpensive and short fiber drop cables into nearby buildings, the lower end of an installation might start at $35,000. For a box installed in a rural sub-division that requires distribution conduit/fiber and drop cables, the cost to connect 25 homes might start at $175,000 on the low end and increase as the number of homes connected increases. Larger numbers of homes or businesses will each add to the cost, but adding more connected premises also increases the value of the infrastructure and increases the revenue potential.

7.6 CONNECTIVITY SOLUTIONS

Both wireless and fiber networks, as well as legacy copper-based networks, all share three primary components. How these are designed and deployed can vary greatly, but all networks have these three parts in some form.

- The **Core Network** provides access to the Internet, a place for service providers (ISPs) to distribute their services locally on the network, and for larger institutional and business customers to meet service providers. Smith has both landline and wireless service providers, but there are still areas that are underserved. Each of these providers has their own Core Network, but wireless broadband could be more widely available if additional county-owned towers were available to the private sector providers.
- The **Distribution** portion of the network connects the Core Network with collections of users. A Distribution network can include both fiber and wireless portions of a network.
- The **Access or Last Mile** portion of the network connects residential users and businesses to the network, and like the Distribution network, that connection will be by fiber or by a wireless link.

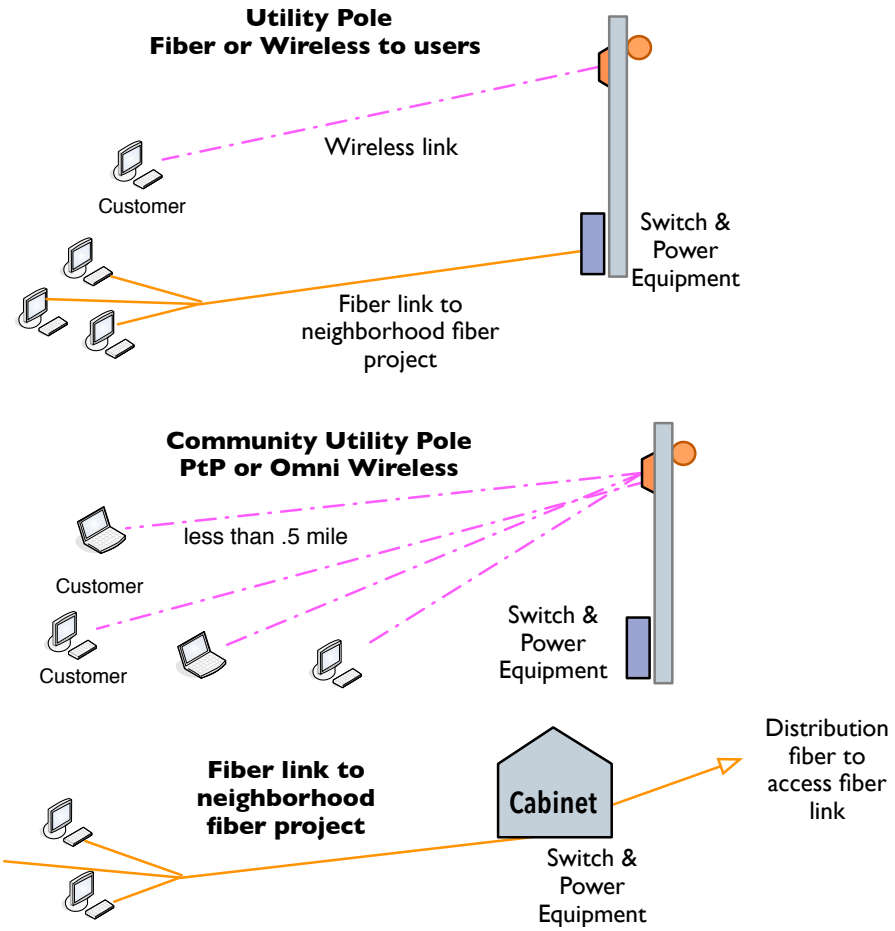
The illustration below shows the full range of technology options (fiber and wireless) and how they can be connected together in various ways to meet the diverse needs of the county. More detail is provided on the following pages.



Last Mile Access

The Last Mile Access is the portion of the network that connects customers to their service provider and the Internet. Both broadband wireless and fiber links can be utilized to provide service. There are several ways that customers can receive service:

- Service providers can install their own local access radios on the Distribution towers, using both point to multi-point and point-to-point radios to deliver service to their customers.
- A single user utility pole (or inexpensive steel lattice tower) can be installed on the property of a single resident or business. A radio at the top of the pole receives service from another tower site (typically one of the Distribution towers).
- A utility pole (or inexpensive steel lattice tower) can be installed near a cluster of homes (e.g. a rural residential sub-division, several homes in close proximity on a rural road). Service providers can install their point to multi-point radios on this pole and provide economical service to several customers from a single pole.
- A utility pole (or inexpensive steel lattice tower) can be installed in a rural subdivision. A service provider installs a point to point radio on the pole, and fiber cable can be run from the pole past several homes to offer fiber service with wireless backhaul.
- Customers near existing fiber can have a fiber drop installed directly to their home or business.



Distribution Network

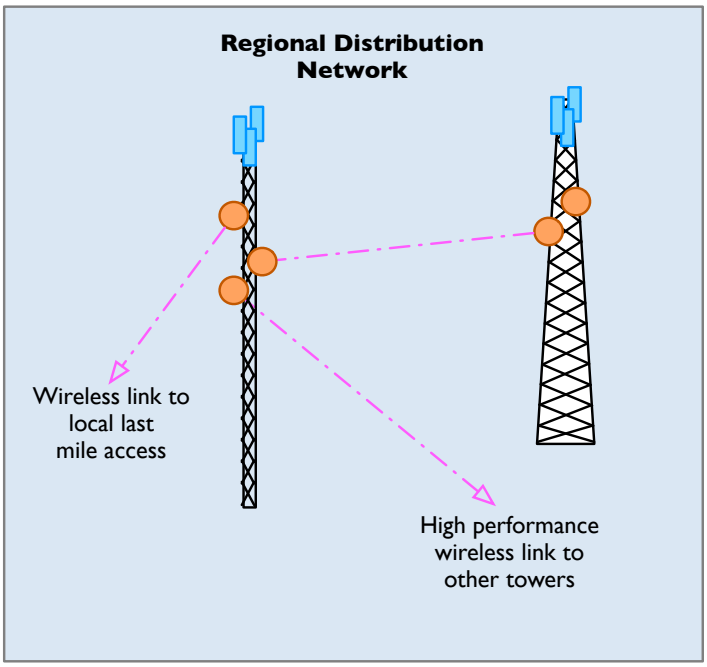
Distribution is the portion of the network between the Distribution sites to the Last Mile Access portion of the network. It is desirable for each distribution site to have a connection back to more than one Distribution site (tower) on a redundant ring. This ring topology protects against hardware failure at the port level and does provide some protection if one of the tower to tower wireless links is disabled by an equipment failure.

These tower sites are typically 120' to 180' tall to provide the height needed to enable Line Of Sight (LOS) between towers, and for local access, to enable service providers to mount point to multi-point radios on the towers.

Towers taller than 199' become subject to FAA regulations because the height can be a potential hazard to airplanes. Towers that exceed 199' usually have to be painted (alternating red/white) and have a blinking light at the top. These requirements increase the long term maintenance costs, but the taller towers can improve line of sight to other towers.

The towers can provide two functions:

- Space for backhaul connections to other towers in the county.
- Space for local access radios to provide Internet access within 2-3 miles of the tower (or farther with good Line Of Sight).

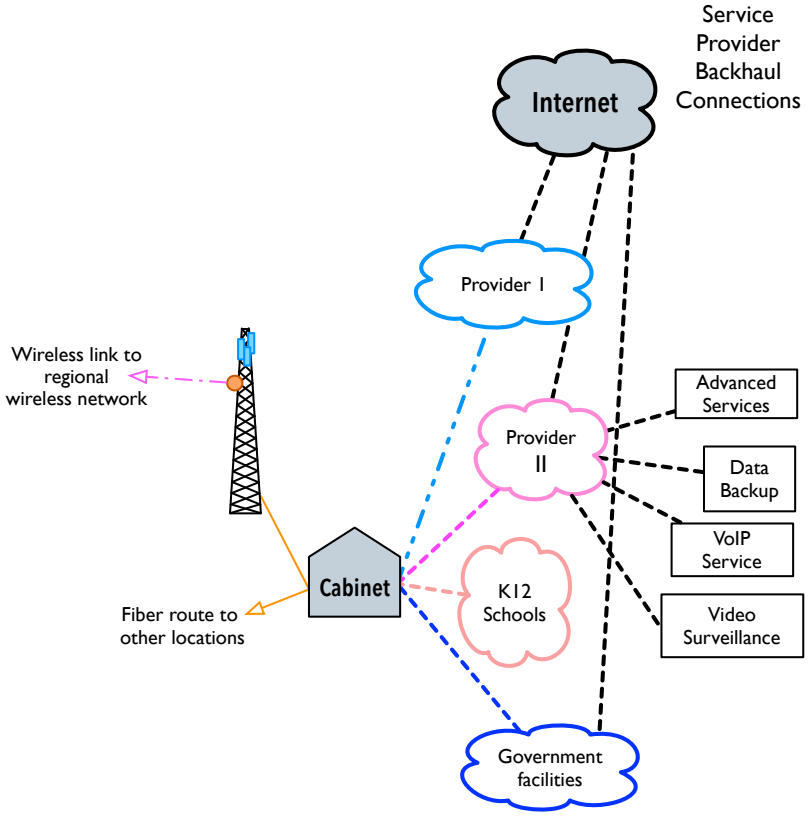


Core Network and Service Providers

In the past, the telephone company switch office (Central Office, or CO) has provided that function. Today, many communities have either a community-owned data center or a privately owned data center that offers an affordable range of options for customers of broadband services.

The Co-Location facility provides a meet point for various public and private fiber cables and networks to inter-connect. A local facility with space available for both public and private uses could help attract additional private sector investments (e.g. a long haul fiber provider wants connect to this facility because of increased access to customers).

A colocation facility is a controlled environment (i.e. secure, heated, and



air-conditioned) room with Internet access through wired and/or wireless systems. The colocation facility is a place where fiber, wireless, and copper-based network facilities meet. It is equipped to house high-end network equipment, servers, and other electronic gear.

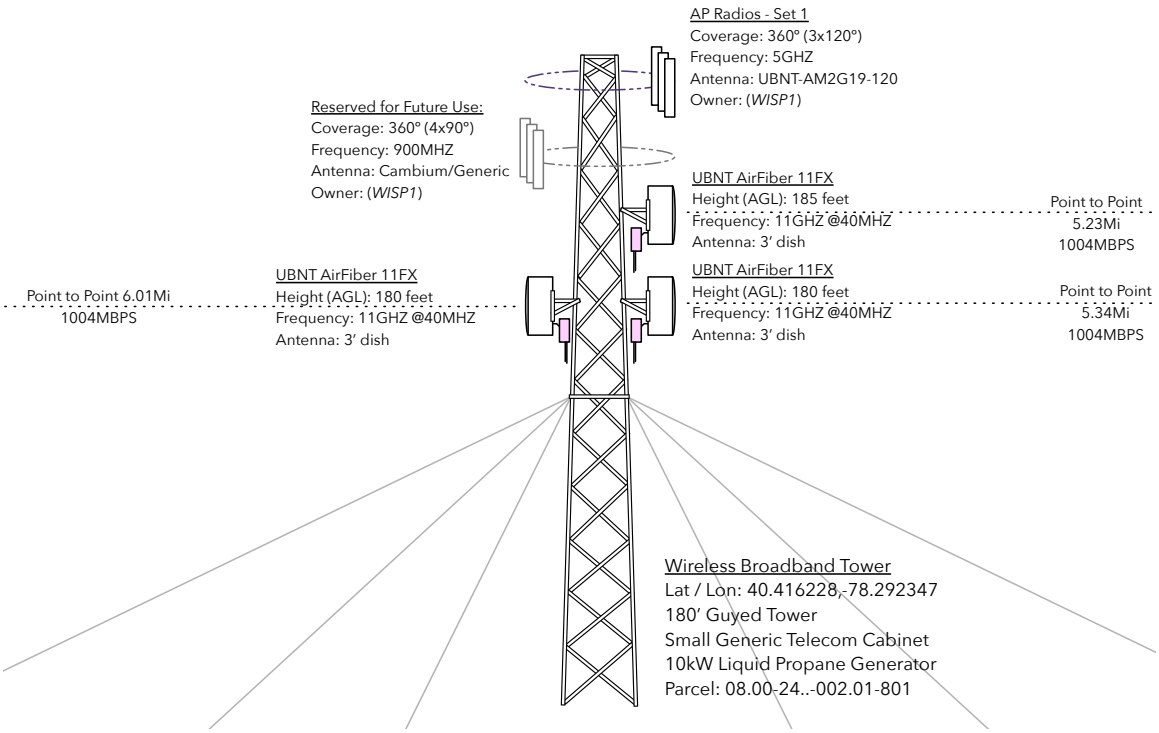
A variety of middle layer network components and services can be located within the co-lo including, for example, directory services, replicated content servers, routing services, and other elements needed to deliver new multimedia services to the home and small office from multiple, competing providers.

Characteristics of the colocation facility are:

- A reliable source of AC electric power is required, with backup UPS (Uninterruptible Power Supply) service, and additional power backup available by an onsite generator is desirable.
- Controlled access to the facility (e.g. by electronic keycard) 24 hours/day, seven days a week. Service providers need to be able to gain access to the equipment room as needed, and work activities performed at night or on weekends is common.
- Racks for locating network equipment and servers, and optionally locked cages for equipment racks.
- Sufficient cooling capacity for the network's current and long-term needs. Equipment rooms require both a cool air input vent and an air return vent.

7.7 WIRELESS NETWORK ARCHITECTURE

The diagram below shows an example of the equipment typically placed on a tower, and details about the equipment that is planned. Several sets of Access Point radios can be placed on a tower operating in different frequencies, and can be owned/operated by multiple WISPs. Point to point radios link this tower to several other sites.



When developing wireless networks there are several categories of costs at each site. Construction of the network will incur site related costs at each tower site including:

- Site development - clearing the site of trees and vegetation, construction of a tower road for access to the site, and strict adherence to all erosion and sediment control measures required by the Owner.
- Passive site equipment - In most cases, a network cabinet will be installed and a new power service will need to be run to it. At each site there will be a generator and most likely a propane tank also installed. Reliable power systems will be installed inside the cabinets, and other equipment management solutions will be installed in the cabinet for network equipment.
- The tower itself - new towers in this estimate are designed as 180' guyed towers. A guyed tower is usually a small profile lattice type tower that is supported by guy wires at several points on the tower. Guyed towers usually have a smaller visual profile than self supporting towers because they are narrow from the top all the way to the base. Self supporting towers will have the same lattice type structure but the tower widens as you get closer to the base. If the tower base is obscured by trees all around, a self supporting tower may be preferred. Some sites may require design changes based on site conditions. Other types of towers such as monopoles

could be considered for this project, especially if the owner is working with cellular providers on developing a site.

- Network equipment such as Point to Point radios, routers, switches, and access point equipment will be installed during the construction of this network. Since the network has built in redundancy the configuration will need to support automatic failover and other high-level network functions. In addition to the networking expertise needed to configure large networks such as this the contractor(s) configuring the network will need to understand spectrum management, wireless signal propagation, and other physical aspects specific to wireless networks.
- Permitting - depending on the locality developing a wireless site usually requires extensive permitting processes that require a relatively long timeline and professional services.

7.8 SMALL CELL BROADBAND POLES

Line of sight issues are a constant problem for rural residents and businesses, as clear line of sight (or near line of sight) is required for fixed wireless Internet services. Even newer technologies like white space and LTE systems work better with clear line of sight to distant towers.

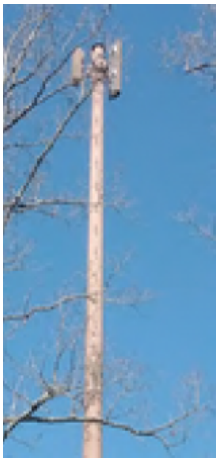
The increased use of wooden utility poles is already common in some other areas of the country, and increased use of this technique to get the customer CPE radio/antenna above tree cover is a relatively simple solution.

Ownership and Governance

The utility poles would normally be placed on private property, subject to existing or updated ordinances governing the placement of wooden utility poles. The local government would have no responsibility for maintenance and repairs.

Cost Discussion

The cost of placing an eighty foot pole can range from a low of about $2,000 to $7,000 or more, depending on permitting, engineering requirements, and the location of the pole. Some municipalities provide "by right" permitting of these poles if they are placed on private property, which can reduce the cost of installing them.



Funding Options

Because these are placed on private land, local government would not have to provide any direct funding. However, the localities could encourage wider use of this option with a public awareness campaign developed in partnership with wireless providers. Local banks could be encouraged to provide low cost financing of the poles so that property owners could make a small interest and principal payment monthly over several years to reduce the financial impact.

Recommendation and Next steps

This strategy requires minimal financial support from the County and that it has the potential of improving broadband access in rural areas of Smith quickly. The County should work with WISP partners to promote this option to improve access to new and existing wireless broadband towers.

7.9 NANO-CELL AND WIFI CALLING SERVICE

A common complaint in Smith is the poor cell service in many areas. In some parts of the county, there may be adequate broadband service via DSL or cable modem Internet, but poor cellular phone/data service. There are now two solutions to improving rural cellular service that do not involve the expense or difficulty of attracting and/or building more cellular towers.

WiFi Calling – This approach takes advantage of the WiFi Calling feature that is now common in many late model cellphones. Once the phone is connected to a WiFi network (e.g. in the home using the home's broadband Internet service), the phone will automatically route the call over the WiFi network–phone calls and text work normally, as if the phone is connected to a cellular tower.

Nano-cell Calling – Poor or no cellular service in rural areas can be addressed by promoting the wider use of "nano-cell" devices. These small pieces of equipment are connected to the DSL or wireless broadband connection and provide improved cell service in the home or business. The working distance of these devices is limited, and service generally drops off once you leave the house itself (it may work for some short distance in the yard). These devices work very well and do not require an upgrade to a newer phone.

The cellular providers do not always promote the use of these devices, so many cellular users who would benefit from their use are not aware that this option is available. The device averages around $200 retail, but the cellular providers often provide substantial rebates (50% discount or more) and in some cases may provide them at no charge.

The improved wireless broadband service will also support use of WiFi calling and/or nano-cell devices.

This strategy is important because improved broadband service can also improve cellular service without the need for more cellular towers, especially in parts of the county where cellular providers have not been able to make the business case for more towers.

8 PLANNING FOR BROADBAND

8.1 TOWER AND WIRELESS NETWORK DEVELOPMENT ACTIVITIES

This section identifies the key tasks and timelines associated with identifying ISP partner(s) and tower sites.

Tower Site and Tower Development Process

ACTIVITY	DESCRIPTION	DISCUSSION	TASKS
Issue Smith County partnership RFP	For many of the grant opportunities, a private sector ISP will be needed.	The RFP should be short and should not require large amounts of work from respondents. For best response, allow at least 45-60 days for ISPs to submit a response.	• Start RFP development by obtaining sample RFPs from other localities. • Develop draft RFP and have it reviewed. • Issue RFP. • Review responses and conduct interviews as needed. • Select best candidate.
Assess and inventory prospective tower sites in Smith County	Grant applications for wireless towers require specific locations for towers.	Use report data to identify where towers are needed.	• Appoint someone to lead tower site effort. • Assemble a list of locations from report data. • Begin meeting with property owners to determine willingness to provide space for tower and availability of road access and electric service. • Collect site agreements.

Tower Site and Tower Activities

TASKS	MONTHS											
	1	2	3	4	5	6	7	8	9	10	11	12
Obtain sample ISP partner RFPs												
ISP RFP development and review												
Issue RFP for ISP partner(s)												
Review responses and conduct interviews												
Select ISP partner(s)												
Appoint site identification team												
Collect prospective sites												
Meet with property owners												
Collect site agreements												

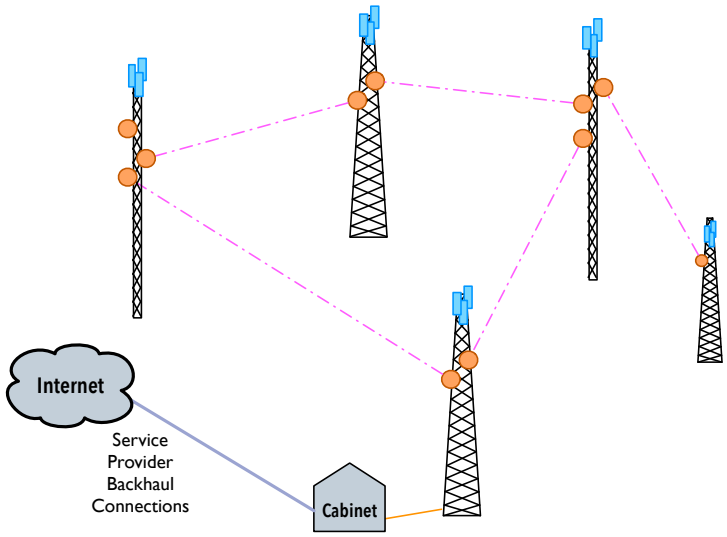
8.2 TOWER COST DETAIL

About Wireless Tower Cost Estimates

The line items for each named tower include the cost of the tower, site preparation, estimated cost of electric service, generator cost and placement, cost of the tower, and labor to assemble and erect the tower, and backbone equipment.

This section of the report provides an estimate of the cost of using existing towers to provide improved Internet access. The diagram below shows the logical design of a five-tower network. Four of the five towers have adequate line of sight between the towers to build a fully redundant ring between the towers, which will provide much more reliable service, because a single tower or equipment failure will not affect service.

Any placement of new towers should be preceded by a careful viewshed analysis of how much area/users are likely to be able to receive service. Site acquisition and site preparation costs can affect the overall cost of such a project. Existing county properties (e.g. fire/rescue stations, county parks, dump transfer sites, etc.) may be candidates for towers. Note that existing towers may require an engineering study to confirm that additional antennas can be added without exceeding the tower load limits.



Existing Tower Improvements

For existing towers owned by the state, counties, or other stakeholders that might be candidates for project use, modest upgrades to equipment at the base of the tower would be needed to make them broadband-ready.

Upgrades to existing towers typically may include adding or upgrading generators, additional cabinet or shelter space for service provider equipment, and sometime fencing and physical access changes.

Note that this estimate represents a worst-case scenario. If the site already has a generator that can be used by a new WISP co-locating on the tower, that could reduce the cost by as much as $7,500. If no road improvements are needed and existing electric service does not require a new H-frame and meter, another savings of up to about $3,000 is possible. If the tower has a current certification (i.e. had a formal engineering inspection), additional savings are possible, bringing the best-case cost to about $11,000 to $12,000.

Existing Tower Development and Improvements (Fit-up)

ITEM/PROJECT	UNITS	UNIT COST (LOW)	UNIT COST (HIGH)	COST (AVG)
Tower Study / Survey	1	$4,500	$7,000	$5,750
Site Development (Clearing, Road Improvements, etc.)	1	$0	$1,500	$750
Small Telecom Cabinet AmProd AM47P-2636-24RU or Equivalent	1	$6,000	$7,500	$6,750
10kW Liquid Propane Generator	1	$4,000	$6,000	$5,000
Cabinet Foundation and Installation	1	$2,500	$4,000	$3,250
New Power Service / Installation (assumes power available on-site)	1	$1,500	$2,500	$2,000
Power System Installation Labor	1	$300	$500	$400
Generator Installation Labor	1	$1,250	$1,700	$1,475
Propane Service Installation - tank and install by local gas company	1	$750	$1,250	$1,000
Poject management				$10,000
Total:				$36,375

New Tower

New towers have a range of configurations and cost options. This estimate is for a new 180 ft bare tower with no radio equipment. If located on existing county properties, the time needed to plan for construction can be shortened. If site acquisition or a site lease of private property is required, purchase or lease negotiations can add several months to the process. Note that a full permitting process may be required even if a new tower is placed on existing county-owned property. The permit process can add 60 to 120 days to the time needed to put a new tower in service.

New Tower Costs (180' Guyed)

ITEM/PROJECT	UNITS	UNIT COST (LOW)	UNIT COST (HIGH)	COST (AVG)
Labor and Contracting: $82,640				
Site Development (Clearing, Road Improvements, etc.)	1	$15,000	$15,000	$15,000
New Power Service / Installation	1	$1,250	$3,450	$2,350
180' Guyed Tower Construction Labor & Contracting	1	$50,000	$74,750	$62,375
Cabinet Installation Labor	1	$600	$1,150	$875
Power System Installation Labor	1	$300	$575	$438
Generator Installation Labor	1	$1,250	$1,955	$1,603
Materials: $35,735				
180' Guyed Tower Construction Materials	1	$17,500	$27,500	$22,500
Small Telecom Cabinet	1	$4,000	$6,000	$5,000
Cabinet Foundation and Installation Materials	1	$1,000	$1,500	$1,250
10kW Liquid Propane Generator	1	$4,000	$6,000	$5,000
Spare Fuses	1	$10	$20	$15
Power System Installation Materials	1	$20	$40	$30
Samlex 1000W Inverter	1	$350	$450	$400
Samlex SEC1230-UL Battery Charger	1	$200	$300	$250
100ah 12v Non Spillable Backup Battery	4	$250	$350	$1,200
DC Voltage Monitoring Device	1	$40	$60	$50
Unmanaged Rack Mount PDU (6O)	1	$35	$45	$40
Total:				$118,375
Project Management, Network Design				$37,500
Site Engineering, Surveying, Viewshed Analysis, Etc.				$9,500
Misc Fees, Technical Services				$7,500
Contingency				$11,838
TOTAL:				$184,713

New Community Pole

A single wooden utility pole or inexpensive steel lattice tower with a line-of-site wireless connection to a 180 ft tower and local access radios could provide access to any residence with line of sight within a half mile or more. This would spread the cost of pole construction and equipment costs across several households or businesses. There are many areas in the region where there is a cluster of homes along a relatively short stretch of road. All of those homes could share the use of a single local utility pole access site.

If there were twenty homes that could receive service and the cost of the pole and equipment was $12,000, each household connected would have a one-time cost of $600. There could be a matching grant program where each county could provide 50% of the cost of putting the pole and equipment in place, and the balance would have to be developed from other sources. Some localities are using this concept to offer WISPs exclusive access to the pole in return for a portion of the construction costs.

Pole costs vary depending upon what equipment is installed. Point-to-point link radio costs vary with distance from a nearby tower. More information is contained in Chapter Six - Small Cell Broadband Poles.

Neighborhood Pole Costs

ITEM/PROJECT	UNITS	COST (LOW)	COST (HIGH)	COST (AVG)
Site Development (Clearing, Road Improvements, etc.)	1	$0	$2,000	$1,000
3x3 NEMA Box	1	$300	$600	$450
New Power Service / Installation	1	$500	$1,250	$875
60' Wooden Utility Pole Construction Materials	1	$2,500	$3,500	$3,000
Unmanaged Rack Mount PDU (6O)	1	$35	$45	$40
60' Wooden Utility Pole Construction Labor & Contracting	1	$2,000	$3,000	$2,500
Neighborhood Pole Coordination and Project Management				$5,000
Total:				$12,865

Point-to-Point Links

The table below show the cost of a backhaul radio installation, with one licensed radio set (AirFiber 11FX). The licensed radios are less susceptible to interference and have higher bandwidth. A regional backhaul network between towers has several desirable characteristics:

- It reduces the cost to providers of being able to affordably offer service on all the towers.
- It increases the reliability and robustness of the WISP services because of the ring design (on at least four of the towers).
- County government data and/or public safety services could also be carried on the backhaul network to provide improved access to some remote facilities.
- K12 schools may be interested in having a redundant network to improve reliability of their existing fiber connections. This can be especially important during periods when online standardized testing is taking place.

A tower in a larger network may have one, two, or several backhaul radios included, and number of radios depends on the tower's location in the network and how many other towers it is connected to using point to point link pairs.

Licensed PTP Radio - Single Side - AirFiber 11FX

ITEM/PROJECT	UNITS	UNIT COST	COST
AF11X Radio	1	$799	$799
AF11-CA Adapter Kit	1	$49	$49
AF11FX Duplexer	2	$199	$398
AF11 X Antenna 11GHz, 35dBi	1	$379	$379
FCC Licensing	0.5	$2,000	$1,000
Shipping @ 5%	1		$131
Point to Point Link Assembly, Installation, Alignment, and Testing	1	$3,600	$3,600
Project Management, NIIT	0.5		$3,000
TOTAL			$9,356

8.3 ESTIMATED TIMELINES FOR COMPLETION

Each kind of project will have its own timeline, and will vary widely depending on the type of funding. Grant-funded projects may need six months to one year to plan and apply for funding, depending on where in the grant cycle the network owner commits to applying for a grant and the length of time that the grant agency takes to review and approve grants.

Tower improvements and construction times can be dependent on weather (more weather related delays are likely in late fall through early spring) and on procurement. Most grant-funded projects require careful attention to a public procurement process, which can add 90 to 180 days to the timeline.

Broadband Construction Timetable

Project Type	Project Execution Planning	Project Procurement	Project Engineering and Construction	Total Estimated Timeline
Improvements to existing towers	2-3 months	3-4 months	2 months	7-9 months
New towers of 180 ft	4-6 months	4-5 months	4-8 months	12-19 months
Small cell community broadband poles	3 months	2 months	2 months	6 months
Point to point tower backhaul links	2-3 months	3-5 months	1-2 months	6-10 months
Fiber to the home/ business projects	4-6 months	4-6 months	6-12 months	14-24 months

9 WORKING WITH PROVIDERS

Throughout the U.S., many ISPs and WISPs are aggressively pursuing public-private partnerships (PPPs) with county governments. These partnerships may include a variety of strategies: collaboration on a grant opportunity, shared costs of developing a new tower site, revenue sharing, fee waivers, and other sorts of cost and revenue sharing. The advantage of this kind of PPP is that the ISP or WISP typically is responsible for most of the day-to-day management of the network assets. County and local government investments are typically limited to passive assets like towers and site maintenance that requires no day to day responsibility and only occasional site and tower maintenance.

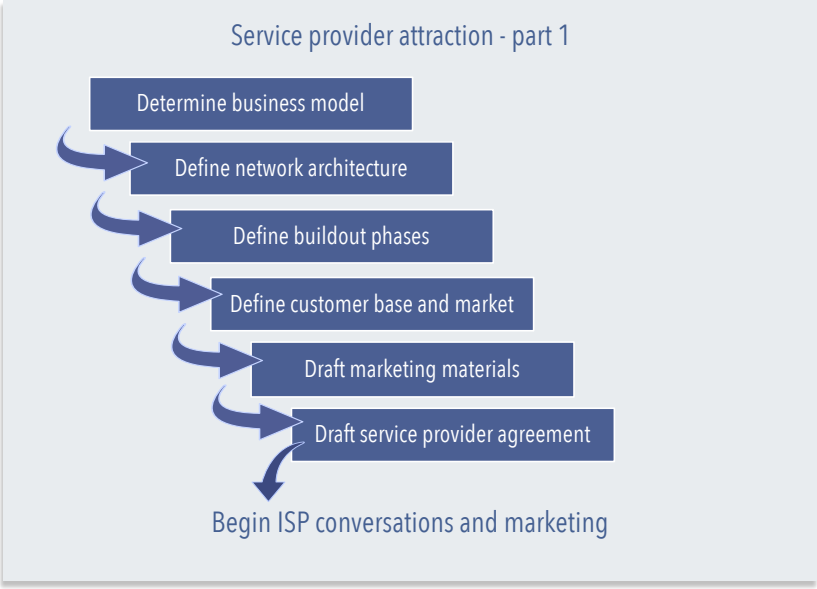
9.1 ATTRACTING PROVIDERS TO THE NETWORK

The Internet service provider business is challenging. Setting the high cost of towers aside, a WISP or an ISP making a commitment to offer competitive services in a new area must engage in a significant marketing and sales effort to identify customers who want service.

For ISPs that are interested in leasing dark fiber, the company must not only develop and execute a marketing plan, but must purchase fiber switches and customer equipment.

WISPs also have similar cost challenges. Because most broadband wireless frequencies, including the newer LTE frequencies, require or work best with line of sight between the customer and the tower, the WISP, even after identifying a potential customer, must often send a technician to the prospective customer location to determine if line of sight or near line of sight is available. It is common that a low hill, a building, trees, or other vegetation will degrade or block the signal.

If line of sight or near line of sight is available at the customer location, a second visit to install the customer antenna may be required before the customer can receive service. At this point, the WISP may have spent several hundred dollars on the acquisition of a single customer, and it can take many months of service before the WISP will even break even.



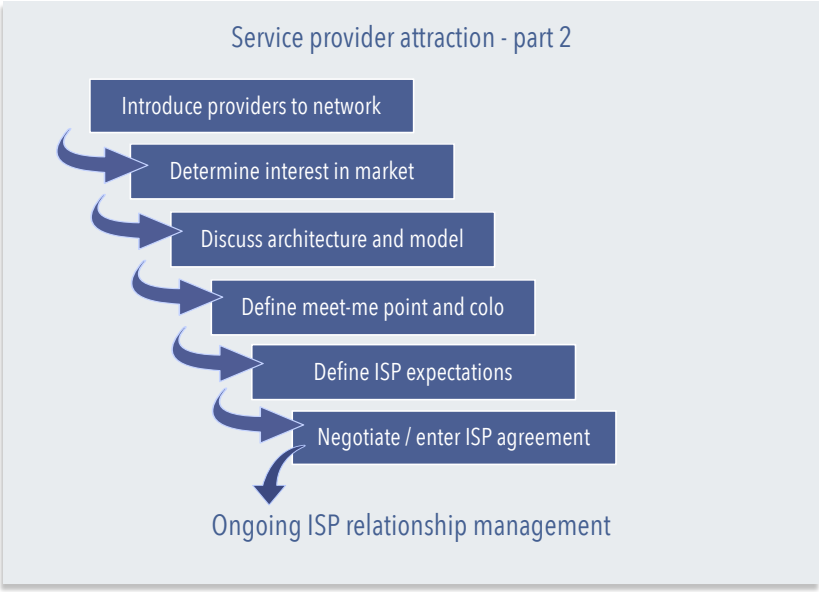
The cost of tower access be one of the most expensive parts of offering wireless Internet service. If a WISP has capital funds, it must choose where to place towers and smaller

poles very carefully, and few WISPs have the capital to build enough towers to cover an entire county.

Just as government builds roads to enable commerce and services offered by the private sector, local government can also build towers to enable Internet services. Space on those towers is offered to WISPs for modest fees with the goal of expanding and improving Internet access.

Historically, tower space lease fees have been high, because early lessees were cellular companies offering high-margin cellphone and data services. Vertical space on a county-owned tower or water tank often range between $1200 and $2500 per month. But the business margins on fixed point wireless Internet are much lower, and tower lease fees should be set at levels that allow WISPs to make a business case to spend the additional capital for radios and related equipment on a new tower.

Activity	Description	Tasks
Attract Internet Service Providers (ISPs, WISPs)	One or more service providers will be needed to lease poles, and/or manage the network, and to partner for grant funds.	• Once owners/stakeholders have approved the plan, contact local and regional ISPs to assess partnership interest. • Schedule individual meetings with the ISPs to present project goals and objectives. • Assess interest of the companies in public-private partnership. • If interest is positive, reach agreement on which grant opportunities to pursue jointly and in what area. • Develop an MOU (Memo of Understanding) that identifies what tasks the WISP will perform for grant application and what project will perform.



Typical Timeline	Months											
Tasks	May '23	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Contact ISPs and WISPs												
Schedule individual meetings												
Assess interest in partnerships												
Schedule meetings to discuss grant opportunities												
Develop MOUs as needed for grants that will be pursued jointly												

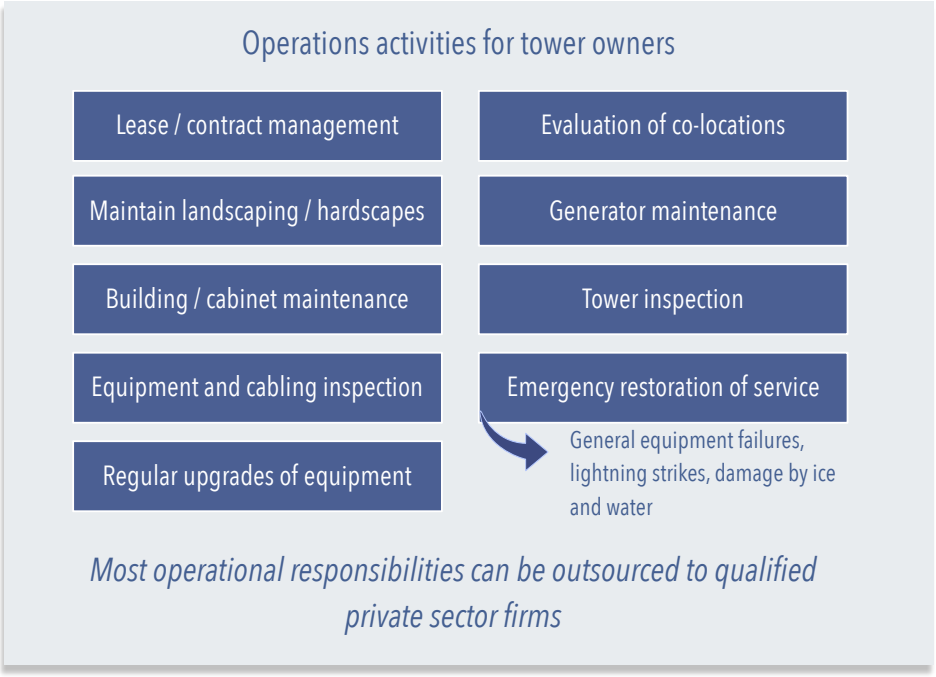
9.2 TOWER MANAGEMENT

A modest application fee, for example $200, for tower access should be nominal for WISPs; high application fees discourage WISPs from evaluating new tower opportunities.

Revenue sharing arrangements, where WISPs pay as they acquire customers, instead of a fixed lease fee are more difficult to manage. While the argument for revenue sharing seems to make sense, in practice, it requires the tower owner to have access to the accounting and financial records of the business, which can be challenging to enforce. It is also a financial disincentive for the WISP, as the fees that they have to pay for tower access continue to increase without end. The following is suggested:

- Use a single public fee schedule for all providers.
- Use a single tower space agreement for all providers.
- Tower access should be made available in ten foot vertical segments or on a per attachment basis, as high as possible on the tower without interfering with other uses, such as public safety antennas. Note that it is unlikely that any tower will have more than two providers on it.
- If a WISP is applying for space on an existing tower, no certified engineering plans should be required, but if a structural analysis is needed to determine wind and tower loading will not exceed tower specifications, the tower owner may have the WISP bear some or all of the cost of that study. Note that there appears to be high variability in the cost of these studies, and the tower owner should be careful to keep the structural analysis costs as low as possible.
- For a typical tower, identify two 10 ft spaces (where space is available) on existing towers and designate/reserve those for WISP use. The spaces should be as high as possible on each tower without interfering with other local government and public safety use. The lease cost of the lower space should be at least 20% less than the higher space. Tell WISPs exactly what space is available at each tower and at what heights; this makes it easier for WISPs to evaluate the potential market that could be served from each tower.
- If an existing shelter is available at the base of a tower and rack space for WISP equipment is available within that shelter, electric power should simply be provided as part of a very

modest lease fee for rack space. If there is no space available in the shelter (e.g. lack of space or dedicated for public safety use), then the WISP should install an H-frame and have their own electric meter installed in an area designated at the base of the tower.



- Leases should be a minimum of two years and should auto-renew if the ISP is meeting performance requirements.
- It may be more effective to have a single lease agreement with access to all towers, and the contract should require the ISP to put equipment on all towers within a certain period of time (e.g. nine to twelve months). This limits ISPs from cherry picking towers with more potential customers and ignoring towers in parts of the service area with lower population density.
- Monthly tower lease fees should be on the order of $200 to $250 per tower or an equivalent per-attachment fee (e.g. $50-$75 per attachment). Higher fees make it difficult for providers to make a business case for the cost of equipment and the extensive marketing required to develop a customer base around a tower.
- Consider offering an initial grace period on fees of three to six months, and/or offer a one-year sliding scale of fees. An example sliding scale would waive the fee for the first 3 months, charge 25% of the fee for the next 3 months, up until 12 have passed and the full fee is assessed. There are many ways to structure the initial fee period, but it is important to recognize that the WISPs incur substantial early costs to develop revenue and customers for a new tower.
- All tower leases should expire on the same date even if started at different times. This allows the tower owner to potentially make a smoother transition to a new provider if there are issues, and will give them more leverage and control over the service.

- In contracts, fee reductions should be worded as discounts that can be revoked if performance requirements are not adequately being met.
- Describe what is available for ground space, such as space for WISP cabinets, shelters, and H-frames for electric service, shared generators that may be provided. Also indicate what the WISP has to provide at the base of the tower. If new shelters will be allowed, set minimum standards for new shelters.

9.3 WORKING WITH INFRASTRUCTURE LEASES

Once dark fiber cable and/ existing or new towers have space available to lease to WISPs, there are policy and contract decisions that must be evaluated.

Tower Lease Considerations

- There should be a single public fee schedule for all providers that want to lease space on the tower.
- There should be a single tower space agreement that is used for all providers.
- Tower access should be made available in ten foot vertical segments, as high as possible on the tower without interfering with other uses (e.g. public safety antennas). Note that it is unlikely that any tower will have more than two providers on it.
- Leases should be a minimum of two years and should auto-renew if the ISP is meeting performance requirements.
- It may be more effective to have a single lease agreement with access to all towers, and the contract should require the ISP to put equipment on all towers within a certain period of time (e.g. nine to twelve months). This limits ISPs from "cherry picking" towers with more potential customers and ignoring towers in parts of the county with lower population density.
- Monthly tower lease fees should be on the order of $200 to $250 per tower. Higher fees make it difficult for providers to make a business case for the cost of equipment and the extensive marketing required to develop a customer base around a tower.
- For a typical tower, identify two (2) ten foot spaces (where space is available) on existing towers and designate/reserve those for WISP use. The spaces should be as high as possible on each tower without interfering with other local government and public safety use. The lease cost of the lower space should be at least 20% less than the higher space. Tell WISPs exactly what space is available at each tower and at what heights; this makes it easier for WISPs to evaluate the potential market that could be served from each tower.
- An initial grace period of three to six month should be offered on fees, and/or offer a one year sliding scale of fees (e.g. first three months, fee waived; months four to six, 25% of normal fee; months seven to nine, 50% of normal fee; months ten to twelve, 75% of normal fee). There are many ways to structure the initial fee period, but it is important to recognize that the WISPs incur substantial early costs to develop revenue and customers for a new tower.
- All tower leases should expire on the same date even if started at different times. This allows the enterprise to potentially make a smoother transition to a new provider if there are performance issues, and will give the project entity (e.g. County government) more leverage and control over the WISPs.

- Leases should be a minimum of two years and should auto-renew if the ISP is meeting performance requirements.
- In contracts, fee reductions should be worded as discounts that can be revoked if performance requirements are not adequately being met.
- There are considerations for ground-space (e.g. WISP cabinets, shelters, H-frames for electric service) that will have to be evaluated at each tower site. If new shelters will be allowed, the ownership entity should set minimum standards for new shelters.

Dark Fiber Lease Considerations

Passive fiber infrastructure (i.e. no electronics) can include conduit, fiber cable, splice closures, and cabinets. Because all powered network equipment would be provided by the lessee (i.e. the ISP), there is no day to day management responsibilities and only occasional routine maintenance. Emergency break-fix for situations like a cable broken by a construction firm working in the right of way can be outsourced to a qualified private sector provider. Local governments routinely manage much more complex water and sewer systems. Some guidelines for leasing dark fiber include:

- There should be a single public price list for the cost of leasing fiber strands.
- A standard master agreement should be used for leases. This agreement will typically require an SLA (Service Level Agreement) that specifies repair times for emergency break-fix (i.e. the fiber cable has been damaged and a qualified break-fix repair firm must be on call to make repairs).
- It will also be important to have IRU pricing (Indefeasible Right of Use). Fiber strand leases are typically for periods of ten years or less. IRUs are long term leases and are typically twenty to thirty years in length. IRU fees have two parts: a single upfront payment that usually reflects some portion of the construction cost for the fiber route. As an example, if a lease will include twelve strands of fiber on a ten mile route of 144 strand fiber that cost $100,000 to construct, the one time fee might be 12/144 * $100,000 = $8,333. Most IRUs also have a modest annual maintenance fee that reflects the cost of maintenance and repairs; this would also be pro-rated to reflect the number of fibers assigned to the IRU agreement.
- Splice points and who is allowed to open handholes to perform splicing must be identified in the master agreement.

9.4 PREPARING FOR TOWER EXPANSION

Activities Preparing for Tower Expansion

ACTIVITY	DESCRIPTION	DISCUSSION	TASKS
Draft tower site lease agreement	Tower site lease agreements between the property owner and the broadband entity will be needed.	The county attorney may be able to provide most or all of the legal agreements needed.	• **Establish a basic tower lease agreement that will be used with all providers.** • **Identify legal counsel who will provide a draft agreement.** • **Circulate draft agreement for comments.** • **Approve lease agreement for use.**
Identify prospective tower sites	New towers will be needed in the county. The broadband plan identifies the general area where towers will be needed and most effective, but specific tower locations will have to be identified with the assistance of residents in the area and property owners. This will be an ongoing activity for at least the first year.	Height above the surrounding terrain, proximity to roads, and proximity to electric service are factors that have to be evaluated.	• **Review broadband plan and prepare a list of sites to survey.** • **Determine road access and electric service. Closer is better.** • **Meet with property owner to discuss a potential lease.** • **If site owner is agreeable, add site to list of grant-ready tower sites.**
Identify prospective community pole sites	Many community poles will be needed to provide the maximum amount of wireless broadband availability.	Community poles should only be placed where there is a cluster of nearby residents who are prepared to purchase Internet service from the provider on the pole.	• **For each area in a build out phase, identify clusters of typically 12-25 homes.** • **Identify a local champion willing to talk to neighbors and assess demand.** • **If demand meets target, add to list for next grant application with community poles.**

Timeline Preparing for Tower Expansion

TASKS	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Obtain agreement on using one lease for all counties												
Identify legal counsel to draft agreement												
Circulate draft agreement for comment												
Obtain approval for site lease agreement												
Develop list of potential tower sites												
Assess road, electric service access												
Meet with property owners												
Add agreeable owners to prospective tower list												
Identify clusters of residents for community poles												
Identify a local champion to assess demand												
Add clusters that meet demand to prospect list for community poles												

9.5 GRANT APPLICATION ACTIVITIES

Activities for Grant Application

ACTIVITY	DESCRIPTION	DISCUSSION	TASKS
Develop a grant application	The grant application process, from start to award announcement, can be 9 to 12 months.	Broadband grant application requirements have become more stringent over time, with more grant agency oversight and review. Careful planning is essential to develop a successful application.	• Once a grant opportunity has been identified, review grant requirements to determine what counties can qualify. For example, some grants require two years of financial history. • Identify regional agency that will assist (e.g. SAP&DC). • If an ISP or WISP is needed, begin contacting potential partners. • If qualifications can be met, appoint at least two people to take the lead to prepare application. • Prepare a task list of all grant material requirements and identify data needed. • Develop a timeline for developing sections of the grant. • Identify requirements for letters of support and matching funds. Develop timeline to solicit and collect commitments. • Complete all sections of grant application with assistance from public and private partners. • Submit grant application.

Timeline for Grant Application

TASKS	MONTHS STARTING WHEN GRANT IDENTIFIED											
	1	2	3	4	5	6	7	8	9	10	11	12
Determine grant qualifications												
Identify regional agency partner												
Identify ISP or WISP partner if needed												
Appoint grant team												
Create grant task list												
Prepare timeline and assign tasks to partners												
Identify matching fund requirements and letters of support to solicit and collect as needed												
Complete all sections of the grant application												
Submit grant												
Grant agency review												
Awards announcement												

APPENDIX A: GLOSSARY

Active network: Typically a fiber network that has electronics (fiber switches and CPE) installed at each end of a fiber cable to provide "lit" service to a customer.

Asymmetric connection: The upload and download bandwidth (speed) are not equal. Cable Internet and satellite Internet services are highly asymmetric, with upload speeds typically 1/10 of download speeds. Asymmetric services are problematic for home-based businesses and workers, as it is very difficult to use common business services like two way videoconferencing or to transfer large files to other locations.

Backhaul: Typically refers to a high capacity Internet path out of a service area or locality that provides connectivity to the worldwide Internet.

Colo facility: Colo is short for Colocation. Usually refers to a prefab concrete shelter or data center where network infrastructure converges. A colo or data center can also refer to a location where several service provider networks meet to exchange data and Internet traffic.

CPE: Customer Premises Equipment, or the box usually found in a home or business that provides the Internet connection. DSL modems and cable modems are examples of CPE, and in a fiber network, there is a similarly-sized fiber modem device.

Dark fiber: Dark fiber is fiber cable that does not have any electronics at the ends of the fiber cable, so no laser light is being transmitted down the cable.

Fiber switch: Network electronic equipment usually found in a cabinet or shelter

Fiber Optic Splice Closure: See **FOSC**.

FOSC: Fiber Optic Splice Closure. Typically a water and air tight cylindrical container where fiber cable is split open to allow splicing (connecting together) of fiber strands for a drop to a premises.

FTTH/FTTP/FTTx: Fiber to the Home (FTTH), Fiber to the Premises (FTTP), and Fiber to the X (FTTx) all refer to Internet and other broadband services delivered over fiber cable to the home or business rather than the copper cables traditionally used by the telephone and cable companies.

Handhole: Handholes are open bottom boxes with removable lids that are installed in the ground with the lids at ground level. The handholes provide access to fiber cable and splice closures that are placed in the handhole. Handholes are also called **pull boxes**.

IP video: Video in various forms, including traditional packages of TV programming, delivered over the Internet rather than by cable TV or satellite systems.

Latency: The time required for information to travel across the network from one point to another. Satellite Internet suffers from very high latency because the signals must travel a round trip to the satellite in stationary orbit (22,500 miles each way). High latency makes it very difficult to use services like videoconferencing.

Lit network: A "lit"network (or lit fiber) is the same as an active network. "Lit" refers to the fact that the fiber equipment at each end use small lasers transmitting very high frequency light to send the two way data traffic over the fiber.

MST: Multiport Service Terminals are widely used in fiber to the home deployments to connect individual home drop cables to larger distribution cables on poles or in handholes. Pre-connectorized drop cables snap into the MST ports and do not require any splicing.

Passive network: Refers to infrastructure that does not have any powered equipment associated with it. Examples include wireless towers, conduit (plastic duct), handholes, and dark fiber.

Pull boxes: Pull boxes (also called handholes) are used to provide access to fiber cable and splice closures. They are called pull boxes because they are also used during the fiber cable construction process to pull the fiber cable through conduit between two pull boxes.

Splice closures: Splice closures come in a variety of sizes and shapes and are used to provide access to fiber cable that has been cut open to give installers access to individual fiber strands. Splice closures are designed to be waterproof (to keep moisture out of the fiber cable) and can be mounted on aerial fiber cable or placed underground in handholes. Also called **FOSC**s.

Splicing: The process of providing a transparent joint (connection) between two individual fiber strands so that laser light passes through. A common use of splicing is to connect a small "drop" cable of one or two fiber strands to a much larger (e.g. 144 fiber strand) cable to provide fiber services to a single home or business.

SCADA: Supervisory Control and Data Acquisition. Used by the electric utility industry and some other utilities (e.g. water/sewer) to manage their systems.

Symmetric connection: The upload and download bandwidth (speed) is equal. This is important for businesses and for work from home/job from home opportunities.

Virtual Private Network: A VPN creates a private, controlled access link between a user's computer and a corporate or education network in a different location. VPNs are often encrypted to protect company and personal data. VPNs usually require a symmetric connection (equal upload and download speeds) to work properly.