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NETWORKS

# City of Shafter:

New City Municipal Fiber Network Design and Engineering  
RFP Close Out Package



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**Smart Fiber Networks**

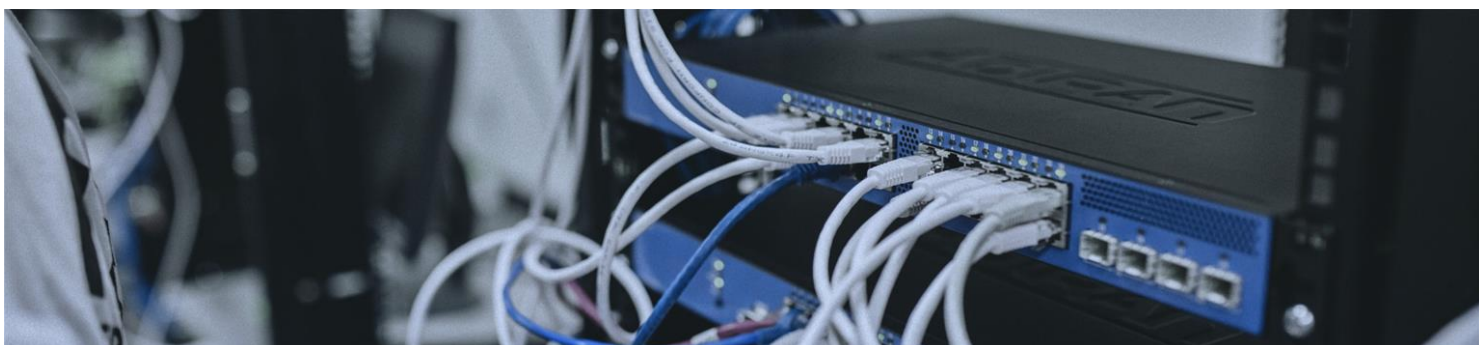
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# City of Shafter Network Overview



## Design and Engineering Approach

Our goal is to develop a versatile Fiber-to-the-X (FTTX) network capable of supporting an open-access infrastructure, which allows multiple ISPs to provide services over a shared fiber network. To inform our design, we reviewed several models from previous deployments, including a software-based (IP) solution where multiple ISPs operate on a unified fiber network managed by the owner or an appointed operator. However, this shared model often places significant demands on the operator, who must oversee the entire infrastructure, from OLT/ONU systems, NMS, and NOC to ticketing, co-location, transport networks, and field operations—all while collecting only a portion of revenue and facing high initial and maintenance costs.

## Our Approach

How can we create a service-ready fiber network without bearing the full cost upfront?

Our proposed solution, developed in collaboration with and approved by the city, shifts approximately 20% of the deployment cost to potential ISPs (including the city) only when a customer is connected. This cost-sharing approach reduces the initial investment needed for network deployment, minimizing financial exposure in areas with uncertain service demand.

## Scalable, Future-Proof Network Design

The network has been designed with scalability and adaptability in mind to support any service platform ISPs may wish to deploy, including Passive Optical Network (PON) configurations. By extending fiber to a local Fiber Distribution Hub (FDH) or Local Convergence Point (LCP), we ensure the network is future-proof. This setup simplifies service delivery by transitioning from a complex A-B-C-D topology to a streamlined A-Z model.

# Cost Structure

- **Virtual Cost (Homes Passed):** Traditional network builds often calculate costs using the “Homes Passed” (HP) metric, which measures the average cost of making service available to homes within a network’s reach. This approach can make per-home costs look appealing to potential investors, as it reflects the potential for service delivery rather than actual uptake. While HP is a helpful benchmark for estimating scale, it can obscure the full financial investment required to build and operate a reliable network.
- **Actual Cost (ROI-Based):** Our approach instead focuses on a projected Return on Investment (ROI) model, which offers a more comprehensive view of network costs. This model factors in all infrastructure investments needed for reliable operations and customer service. While ROI-based costs may appear 3-5 times higher than HP estimates, they capture the total financial commitment, including hidden expenses that arise with growth and ongoing maintenance. While the initial costs may seem significant, this model equips investors and stakeholders with a transparent, dependable projection of the network’s cost-to-value ratio over time, providing clarity for decision-making.

## Deferred Costs

To further manage financial risks, we employ a deferred cost strategy, which stages certain expenditures until demand justifies them. This approach specifically defers costs related to drop splicing, drop duct installation, and terminal placement until a customer is confirmed. By holding off on these investments until a customer joins the network, we avoid unnecessary expenditures on infrastructure that might sit unused in low-demand areas. This not only minimizes financial exposure but also allows the network to scale in a measured, responsive way.

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## Benefits of a Deferred, ROI-Based Model

By combining deferred costs with a streamlined, flexible network architecture, our strategy balances upfront investment with long-term scalability. This cost-conscious approach benefits all stakeholders by:

- **Reducing Initial Outlays:** Minimizing early financial commitments helps to manage budget constraints and facilitates a more flexible allocation of capital across project phases.
- **Maximizing Infrastructure Utilization:** Costs align with demand, ensuring that infrastructure investments support active customers rather than underutilized areas.
- **Supporting Multiple ISPs:** With open-access compatibility, our network fosters a competitive environment where multiple ISPs can leverage the infrastructure, sharing operational costs and enhancing network value for the city.
- **Improving ROI:** By deferring unnecessary expenses and focusing on scalability, we maximize potential returns and build a network capable of adapting to future growth without excessive reinvestment.

In sum, our cost structure is designed not just for building infrastructure, but for building a sustainable, adaptive business model—one that meets current needs and is ready to grow alongside future demand.

# NETWORK BREAKDOWN



## The Hub: Where it all Starts

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The primary aggregation point, housing core fiber infrastructure and managing the distribution of high-speed data across the network.



## Distribution: Connecting the Dots

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Carrying fiber from the hub to each neighborhood, efficiently routing connections through strategically placed distribution points and fiber hubs



## Customer Connections: To Your Door

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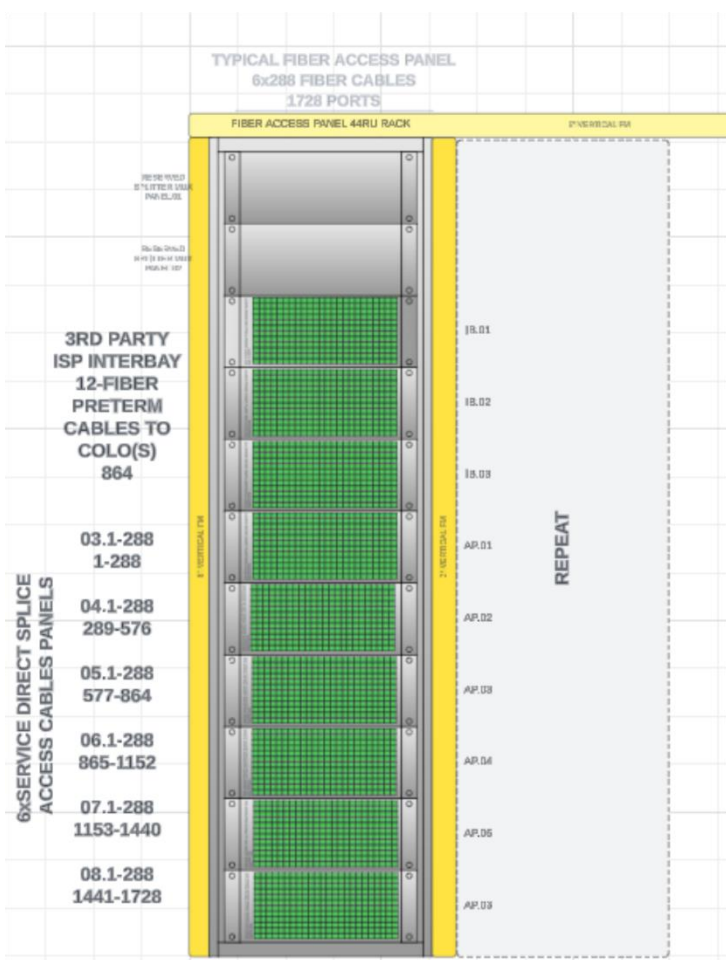
Delivering fiber directly to each home or business, linking the network to customer premises equipment (CPE) for seamless service activation.

## The Hub:

The network's central hub serves as the primary distribution point for all fiber connections across the system, linking residential, commercial, and institutional subscribers with the core fiber infrastructure. This hub will house the fiber access rack and panels that connect various sections of the network, enabling efficient data flow and managing the connections to individual customer lines.

The hub's central component is a set of three 44RU racks, designed to support 1,728 fiber ports across six panels. Each panel contains 12 trays with 24 SC/APC connectors, ensuring high-quality, low-loss connections across the network. Of the six panels, two will be dedicated to optical splitters, optimizing bandwidth distribution across multiple fiber lines while preserving signal strength. Two additional panels are reserved for third-party ISP access, supporting the network's open-access model. This allows multiple ISPs to utilize the infrastructure, fostering competition and providing consumers with choices in service providers. The remaining panels are allocated for future expansion, offering space for additional splitters or Passive Optical Network (PON) components as demand grows.

By concentrating all primary distribution and connection functions in one hub, the design simplifies network management, supports easy maintenance, and allows for future scalability. With the expectation that three racks of panels will be required initially, each rack is estimated to cost approximately \$72,000, including splicing.



# The Hub:

## Hub Bill of Materials

The hub's total estimated cost is projected at \$78,784.00, covering the fiber racks, connectors, splitters, splicing equipment, and space for additional components as the network expands to meet future needs. This setup ensures that the hub not only fulfills immediate network demands but also remains adaptable, providing flexibility for future upgrades and the integration of new technologies. This also includes estimated cost of labor involved in initial set up.

Description	OEM	Quantity	Unit Type	Unit Cost	Total Cost	Notes
44 RU Rack	Various	3	Each	\$300.00	\$900.00	
Blade HD Frame	Lynn	11	Each	\$400.00	\$4,400.00	
24 SC/APC Blade w/pigtails	Lynn	144	Each	\$75.00	\$10,800.00	
24 SC/SPC Blade Bank	Lynn	72	Each	\$50.00	\$3,600.00	
Fiber Trough	Panduit	TBD	Each		*\$2,500.00***	Requires finalized design
Splicing	Various	1728	Labor/ Per splice	\$28.00	\$48,384.00	
Construction	Various		full hub	\$2,200.00	\$2,200.00	
<b>TOTAL EST</b>					<b>\$72,784.00</b>	

# Distribution Areas:

The fiber network's distribution structure is designed to balance scalability, cost efficiency, and future-proofing, ensuring reliable service across all Distribution Areas (DAs), defined by neighborhoods. Each DA is limited to a maximum of 96 connections, which helps control fiber counts within the Distribution Fiber (F2) network. This limitation allows for reduced pole loading in aerial deployments, smaller strand sizes, and simplified service management, effectively reducing costs while maintaining high-quality connectivity within manageable service areas

## F1 and F2 Fiber Infrastructure

### F1 Fiber Infrastructure (Feeder Fiber)

The F1 network acts as the primary feeder system, carrying large volumes of data from the central hub to distribution points closer to neighborhoods. This high-capacity segment is designed for durability and scalability, utilizing 288-count fiber cables to support both underground and aerial routes:

- **Underground Feeder Fiber:** For underground deployment, the F1 network uses a 6-way micro duct system housed in 36x48 bulk vaults. This setup provides flexibility for future expansion and robust protection against environmental wear.
- **Aerial Feeder Fiber:** Aerial deployment is limited exclusively to access fiber (F2), with the F1 segment remaining underground where possible. To maintain reliability and reduce pole strain, risers and micro ducts are installed to channel fiber directly into splice cases at distribution points, ensuring streamlined access and minimal exposure.

### F2 Fiber Infrastructure (Distribution Fiber)

The F2 network serves as the distribution layer, branching from feeder fiber at designated Distribution Points and extending into each DA. This segment is optimized for flexibility, with fiber installations configured to be demand-responsive, deploying only when customers are acquired:

- **Underground Distribution Fiber:** The underground F2 fiber, designed to reach curbside locations, is installed only when service is requested. Dedicated micro ducts, typically near Comcast and AT&T infrastructure, ensure that the fiber can be efficiently extended to each property when needed. Each micro duct termination is marked with a locator ball, simplifying future identification and minimizing disruption during service activation.
- **Aerial Distribution Fiber:** Aerial F2 installations utilize smaller, demand-responsive fiber counts—12, 24, 48, or 72 fibers—depending on the anticipated load in each DA. Terminals are deployed only upon customer acquisition. To further streamline installations, each aerial terminal is equipped with a 15-foot coil of fiber cable, pre-provisioned for future splicing. This setup enables rapid connections without needing extensive rework or re-routing.

### Local Convergence Points (LCPs) and Fiber Distribution Hubs (FDHs)

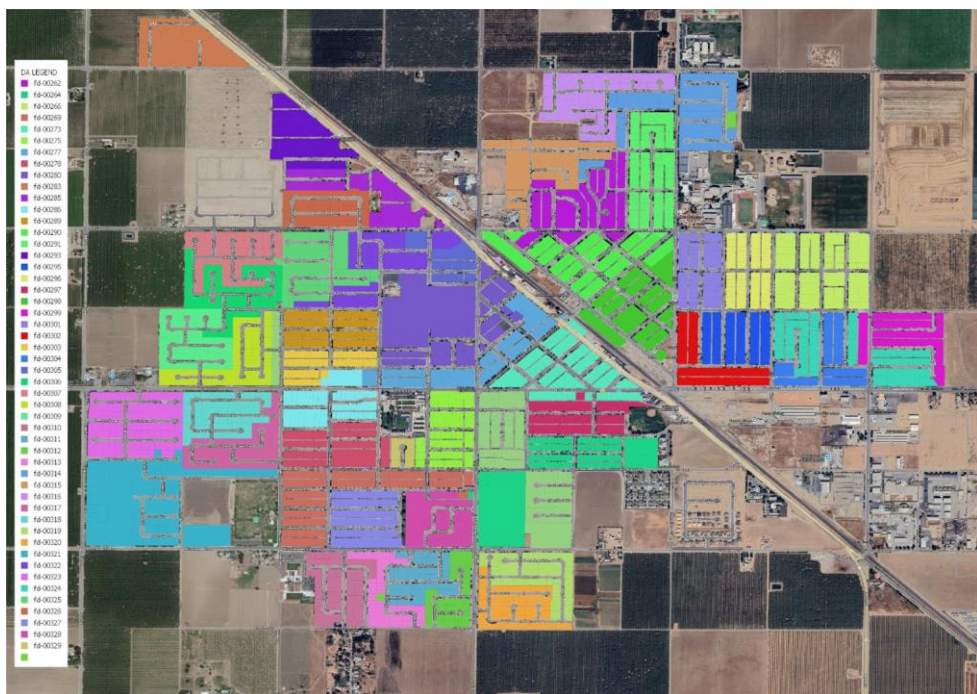
In larger neighborhoods or areas with high service density, Local Convergence Points (LCPs) or Fiber Distribution Hubs (FDHs) act as mini-hubs within each DA. The FDHs receive fiber from the Distribution Points and further split it into individual lines that can serve specific streets or clusters of homes. Each FDH is equipped with optical splitters and connectors, which segment the fiber signal for each subscriber while minimizing signal loss. This localized distribution also simplifies future maintenance and upgrades, as individual DAs can be accessed independently of the main network.

# Distribution Areas:

## Neighborhood Distribution Areas (DAs)

The final level of distribution occurs within each DA, where fiber cables reach the streets and individual properties within a neighborhood. Fiber is routed from the FDHs directly to the neighborhood through smaller conduits and drop cables. This section of the network is designed for flexibility, allowing the network to adapt easily to new customer connections or service upgrades. By defining DAs as discrete neighborhood segments, network performance can be effectively monitored and managed at a local level, ensuring consistent service quality across the entire coverage area.

Below is an overview of the various Distribution Area (DA)'s for the core of the City of Shafter. Each color corresponds to a different Distribution Area (DA).

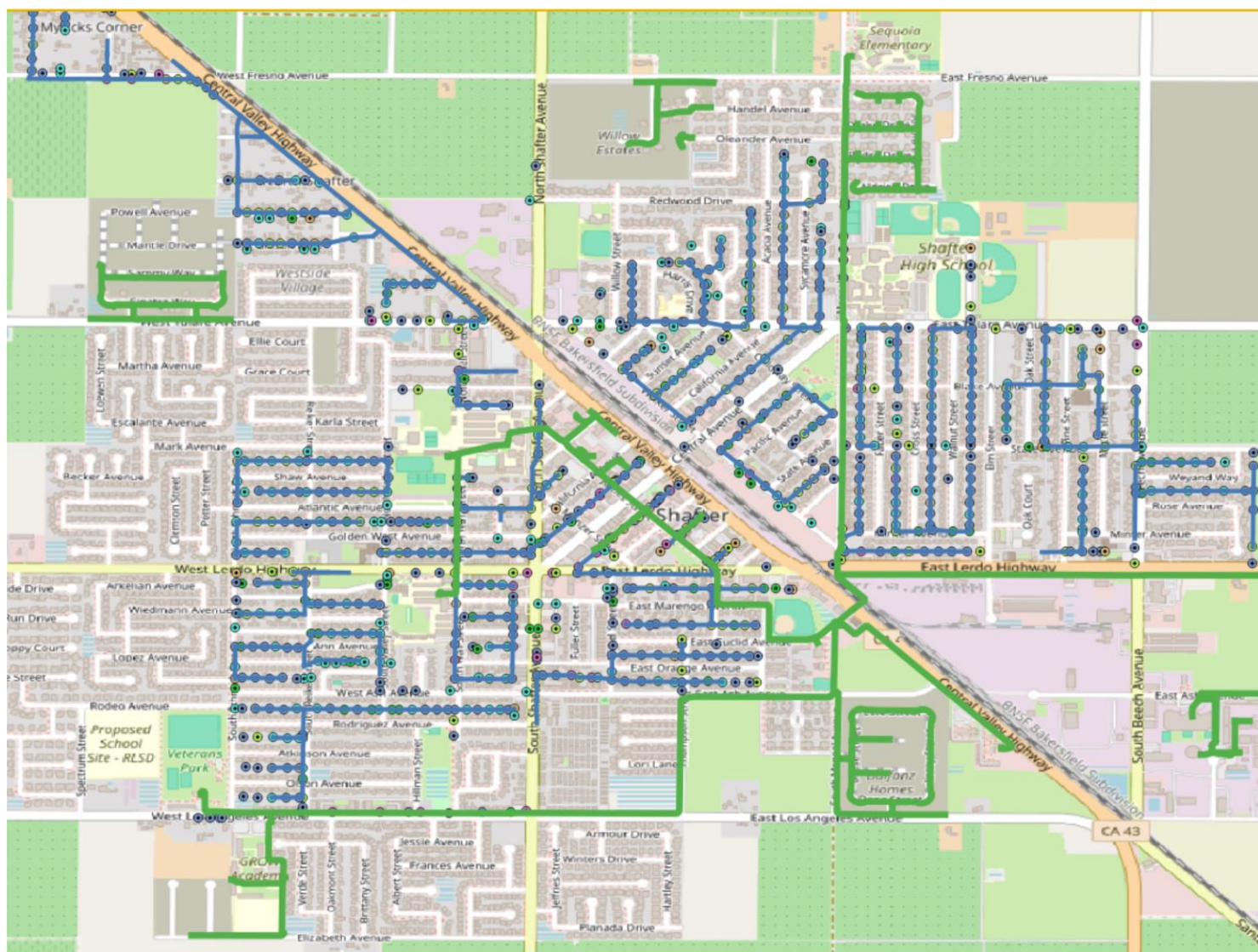


# Aerial Plant and Access Options

From a build perspective there are 2 avenues to proceed:

1. The City of Shafter (COS) obtains its own CLEC and enters into an Agreement with AT&T to lease and attach poles as a new ISP.
2. The City of Shafter (COS) enters into an P3 with a preferred ISP who will manage the AT&T attachments. The agreement would then grant to COS an IRU for all fiber with the cable with cable ownership residing with the ISP partner who manages and administers the poles and any subsequent attachments for a flat fee or percentage rate.
3. Costs for administering the poles:
  - a. Current AT&T pole rates are ~\$17 per pole, per year
  - b. MRE Engineering costs are ~\$150-\$200 per pole
  - c. Construction costs are ~\$13-\$15 per foot on new aerial construction

A survey of aerial pole locations within Shafter concluded there are ~2200 poles could potentially be used that would result in ~2650 potential homes connected via aerial fiber.



## Distribution Area:

Below is the Bill of Materials, including vendor details and estimated pricing for each item. The total projected cost for the Distribution segment of the network is \$18,627,404.06.

Please note that pricing reflects the estimates provided at the time of inquiry and may vary based on order timing and selected vendor.

Cable	Category	Quantity	Unit Type	OEM	Unit Cost	Total Cost
12F	Cable	33,472	FT	CORNING	\$0.24	\$8,032.90
24F	Cable	30,964	FT	CORNING	\$0.36	\$11,146.95
288F	Cable	164,942	FT	CORNING	\$1.21	\$199,579.23
48F	Cable	21,015	FT	CORNING	\$0.56	\$11,767.96
72F	Cable	5,810	FT	CORNING	\$0.96	\$5,577.45
96F	Cable	1,664	FT	CORNING	\$0.84	\$1,397.63
1/4 STRAND*	Strand	148,172	FT	AA Aerial	\$0.15	\$22,225.74
12 WEBFLEX F2	F2 Duct	258,330	FT	Emtelle	\$1.15	\$297,078.63
6-WAY F1	F1 Duct	723,170	FT	Emtelle	\$0.83	\$600,230.89
NID	Enclosure	3,864	Unit	Lynn Broadband	\$18.00	\$69,552.00
LOCATORS	Duct Misc	2,070	Unit	Emtelle	\$900.00	\$1,863,000.00
DUST CAPS	Duct Misc	2,070	Unit	Emtelle	\$0.82	\$1,697.40
TERMINAL	Enclosure	261	Unit	Commscope	\$200.00	\$52,200.00
SPLICE CASES	Enclosure	50	Unit	Commscope	\$300.00	\$15,000.00
FDH	Fiber Device	50	Unit	Emtelle		
BULK 4 VAULT	Enclosure	55	Unit	Channel	\$290.00	\$15,950.00
BULK 7 VAULTS	Enclosure	50	Unit	Channel	\$350.00	\$17,500.00
POLE	Labor	1,311	Unit	Structure Leasing & Engineering	\$200.00	\$262,200.00
AERIAL PATHWAY	Labor	148,172	FT	ED Tech Inc	\$11.00	\$1,629,887.39
MICROTRENCH	Labor	338,585	FT	Ditch Witch	\$40.00	\$13,543,379.90
<b>TOTAL EST</b>						<b>\$18,627,404.06</b>

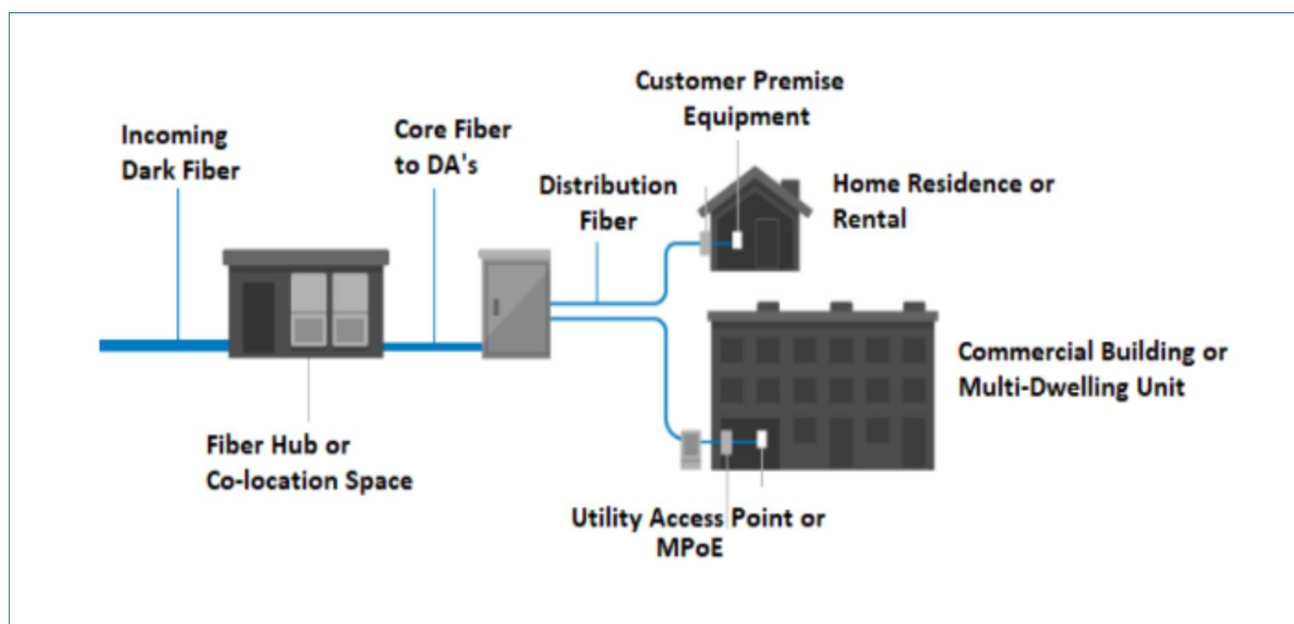
## Customer Connections:

While the design package does not include the specifics of customer connection equipment, the Customer Connection segment is essential to understanding how individual homes and businesses are linked to the network. Beginning at the Distribution Area (DA), fiber drops extend from neighborhood hubs directly to each customer's premises, completing the final segment of the network path. These fiber drops, which can be placed either aerially or underground, carry the network signal from the DA to the property, where a small terminal typically installed on or within the building facilitates the connection.

Once the fiber drop reaches the customer's premises, Customer Premises Equipment (CPE) enables data transfer from the network to user devices. CPE can vary widely depending on the ISP's service model and may include Optical Network Terminals (ONTs), wireless routers, or mesh Wi-Fi systems, each designed to deliver high-speed connectivity within the home.

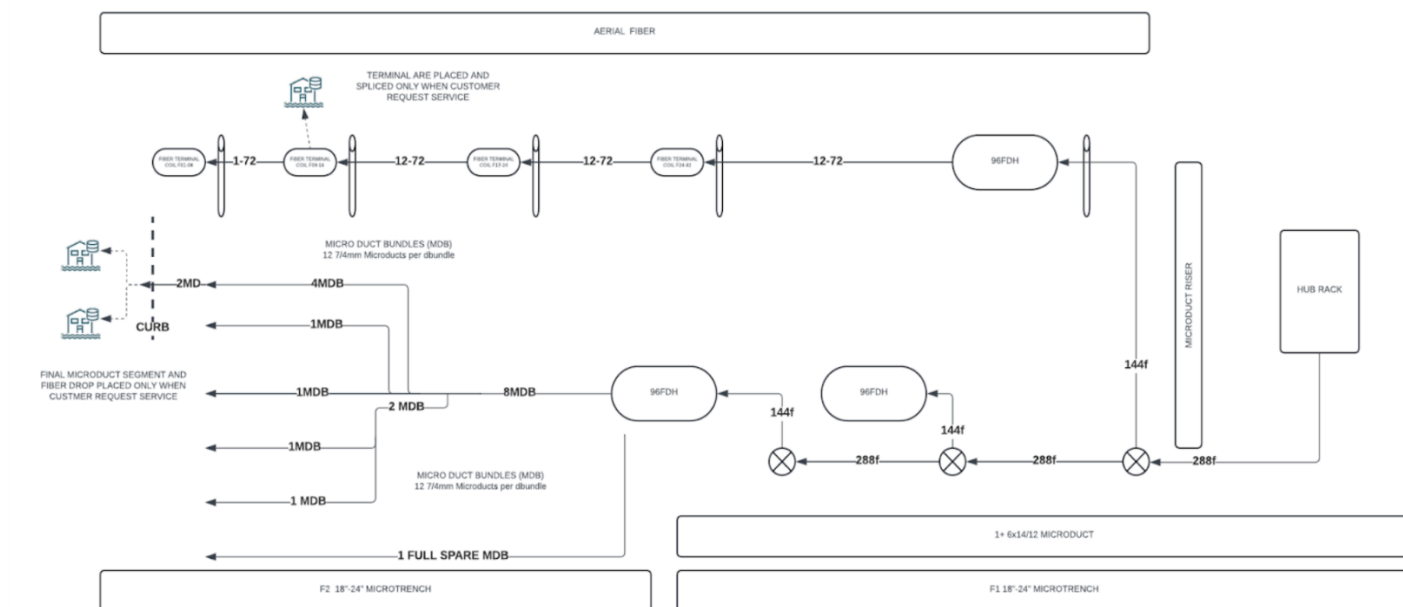
By leaving the CPE selection open, the network design provides flexibility for ISPs to use a range of technologies tailored to their service offerings, allowing each provider to deliver an optimized customer experience.

Type	Category	Quantity	Unit Type	OEM	Unit Cost	Total Cost
DROP FIBER	Cable		FT	ISP's Choice*	\$0.04	
Customer CPE			EA	ISP's Choice*	\$85.00	



## Construction Details

- **Underground:** Wherever possible, underground construction will use micro trenching to reduce costs and minimize disruption.
- **Aerial:** Aerial construction will require pole make-ready (MRE) and standard strand and fiber placement procedures. Horizontal directional drilling (HDD) may be necessary in specific challenging locations.

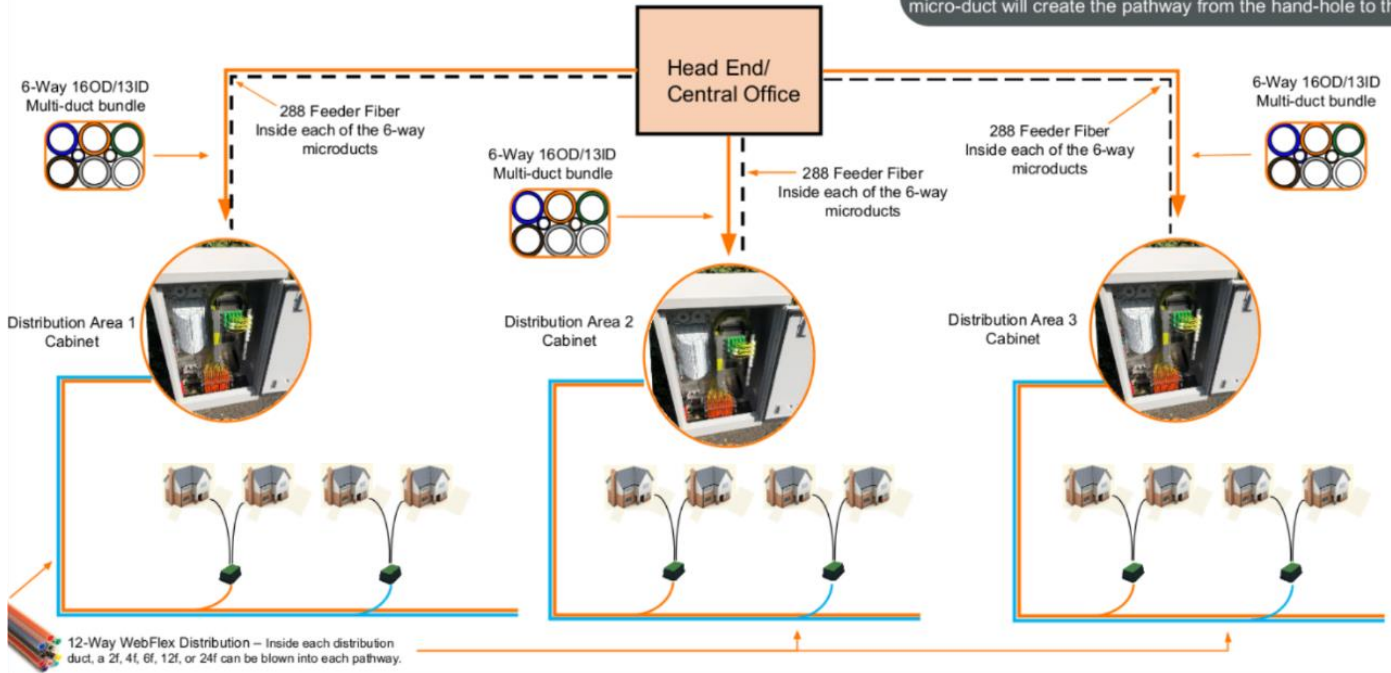


## OSP Materials

- **F1 Transport:** The Design will utilize EMTCELL 6-way 16/13 mm micro duct for transport, along with 288-strand single-mode fiber optic micro cables from Corning or CommScope. The fiber will be housed in bulk vaults.
- **F2 Service Access:** For service access, we'll deploy EMTCELL micro duct splice cases, blowable fiber drops, and locate balls for underground construction.



From the Central office, a 6-Way 16/13mm duct bundle feeds Distribution Area (DA) cabinets. The DA cabinet will act as a cross-connect between feeder and distribution. From the DA cabinet, a 12-Way WebFlex bundle distributes all the fiber to the homes/MDU's, and businesses. These ducts will stub out to a hand-hole until service is ordered. Once service is ordered, a dro micro-duct will create the pathway from the hand-hole to the NID.



## GIS Mapping and Layers

To provide a clear and comprehensive view of the proposed network design, several GIS layers have been developed to represent the network's physical and logical components. These layers detail essential network elements, including all primary devices, feeder and distribution cables, microduct pathways, logical address assignments, and the overall network footprint, distinguishing between underground and overhead segments. Additionally, supplementary GIS layers from the City of Shafter will enhance the detail and accuracy of the design map. Below is a list of the essential GIS layers supporting this network proposal.

GIS maps and layers. Below is a list of essential layers used to develop the proposed design

Layer Name	Description
fibre_devices	<p>Contains all network devices such as OLT, FDH, closures, terminals, etc</p> <p>The specification field can distinguish different types of <i>devices</i>.</p>
fibre_cables	<p>Contains all network cables such as:</p> <ul style="list-style-type: none"> <li>• 288F feeder cable (F1)</li> <li>• 12,24,48,72,96F overhead distribution cable (F2)</li> </ul> <p>The specification field can distinguish different types of <i>cable</i>.</p> <p>The fields <i>start_id</i> and <i>end_id</i> reference fibre_devices features</p>
ug_ducts	<p>Contains all underground distribution microducts.</p> <p>The specification field can distinguish different <i>types of micro duct bundles</i>.</p> <p>The duct_group field gives the <i>duct</i> bundle.</p> <p>The duct_assignment field gives the specific tube within the bundle.</p> <p>The fields <i>start_id</i> and <i>end_id</i> reference fibre_devices features</p>
assignments	<p>Contains the logical assignments between each address that the network can serve and an access point (either underground or overhead)</p>
path	<p>Includes the total network footprint.</p> <p>Whether each path segment is underground or the <i>placement</i> field indicates overhead.</p> <p>Counts along each path segment are reported as follows:</p> <ul style="list-style-type: none"> <li><i>dist_duct_bundle_cnt</i>: count of distribution duct bundles</li> <li><i>dist_duct_cnt</i>: count of distribution duct tubes (across all bundles)</li> <li><i>feeder_duct_cnt</i>: count of feeder cables</li> <li><i>oh_cable_cnt</i>: count of overhead cables</li> </ul>

parcels

It contains a replica of the input parcel data annotated with details of the assigned access point and micro duct bundle and tube (if relevant).

# Additional Resources- Product White Pages

## 12-WAY DBMF 7/4MM

Microduct, sheath and any stripe colour for illustration only, to be defined at product set up

