

FIBER NETWORK

ASSESSMENT AND MASTER PLAN

CM8-918-3965

**Strategic Fiber Network Master Plan
Excerpts for IT Bond Subcommittee
From the October 2020 DRAFT**



Kimley»Horn



Table 1 – Fiber Network Recommendations Summary

ID	Recommendation	Project Limits	Brief Scope / Description	Planning Cost Estimate	Key Personnel / Groups Involved	Time to Complete
CAPITAL						
PRIORITY #1 (NEAR-TERM 0-7 YEARS): COMPLETE REMAINING INVENTORY AND OSP DATABASE UPDATES						
C-1A	Dobson Road Field Verification Project	From the northeast corner of Price Road and Innovation Street to the southwest corner of Dobson Road and Chandler Boulevard	<p>Description: Investigate approximately 3.1 miles of 144-strand fiber cable on City “TAN Fiber” loop that runs from the northeast corner of Price Road and Innovation Street (SP-04719) to the southwest corner of Dobson Road and Chandler Boulevard (SP-00062). Identify and document the cable’s independent pull box and conduit system along with any unknown splice enclosures. Add/update information in the City’s OSP database, and update records as appropriate.</p> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Field Verification: <ul style="list-style-type: none"> ▪ Pull Boxes ▪ Conduit/Fiber Cable Paths via Tracer Wire or Mule Tape ▪ Splice Enclosures o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Pull Boxes, Conduit, and Cable information. ▪ Record Drawing Redlines ▪ Splice Detail Spreadsheets - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting ▪ Provide Existing Record Drawings o Contractor Escorts to Locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details o Updating OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box Locations ▪ Conduit/Cable Paths Including Cable Information ▪ Splice Point Locations and Details <p>Background: This project is necessary to alleviate the gaps between the existing fiber network assets in the field, record drawings, and OSP database. Assets such as pull boxes, conduit and cable paths, splice enclosure locations were found to have discrepancies between the three and could not be alleviated throughout the various field audits performed. After this information is added to the database this information can be used for future capital projects and simplify the implementation of the recommended network topologies as new fiber cables will be installed and connected to this cable.</p>	<p>Field Verification: \$38,000</p> <p>Database Update: \$9,000</p> <p>See cost detail provided in Appendix E1.1</p>	<p>Owner: Fiber Manager</p> <p>Support: Fiber Personnel</p>	<p>Develop RFP: 1 month</p> <p>Bid/Selection: 1 month</p> <p>Project Completion: 2 months</p>

C-1B	Dobson Road Field Verification Project	From south of the San Tan Freeway on the west side of Dobson Road to the northwest corner of Dobson Road and Elgin Street	<p>Description: Investigate approximately 0.91 miles of 48 strand fiber cable that run from south of the San Tan Freeway on the west side of Dobson Road (SP-00102) to the northwest corner of Dobson Road and Elgin Street (SP-00104). Identify and document the cable’s independent pull box and conduit system along with any unknown splice enclosures. Add/update information in the City’s OSP database, and update records as appropriate.</p> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Field Verification: <ul style="list-style-type: none"> ▪ Pull Boxes ▪ Conduit/Fiber Cable Paths via Tracer Wire or Mule Tape ▪ Splice Enclosures o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Pull Box, Conduit, and Cable Information ▪ Record Drawing Redlines ▪ Splice Detail Spreadsheets - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box Locations ▪ Conduit/Cable Paths Including Cable Information ▪ Splice Point Locations and Details <p>Background: This project is necessary to alleviate the gaps between the existing fiber network assets in the field, record drawings, and OSP database. Assets such as pull boxes, conduit and cable paths, splice enclosure locations were found to have discrepancies between the three and could not be alleviated throughout the various field audits performed. After this information is added to the database this information can be used for future capital projects and simplify the implementation of the recommended network topologies as new fiber cables will be installed and connected to this cable.</p>	<p>Field Verification: \$12,000</p> <p>Database Update: \$3,000</p> <p>See cost detail provided in Appendix E1.2</p>	<p>Owner: Fiber Manager</p> <p>Support: Fiber Personnel</p>	<p>Develop RFP: 1 month</p> <p>Bid/Selection: 1 month</p> <p>Project Completion: 2 months</p>
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C-1C	Tumbleweed Park Field Verification Project	Tumbleweed Recreation Center, Tumbleweed Park Tennis Center and Facilities Service Center at the intersection of Germann Road and Pioneer Parkway	<p>Description: Investigate where the cables exit the Recreation Center. Identify and document the cables' independent pull box and conduit systems associated with the unknown cable paths and any additional assets (i.e. splice enclosures, LIU panels, fiber cables, network switches, etc.) located at the Facilities Service Center and Tennis Center. Add/update information in the City's OSP database, and update records as appropriate.</p> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Field Verification: <ul style="list-style-type: none"> ▪ Pull Boxes ▪ Conduit/Fiber Cable Paths via Tracer Wire or Mule Tape ▪ Conduit/Fiber Cable Building Entrances ▪ Splice Enclosures ▪ LIU Patch Panels and IFD Panels ▪ LIU OTDR Testing ▪ Network Switches o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Pull Box, Conduit, and Cable Information ▪ Record Drawing Redlines ▪ Splice Detail Spreadsheets ▪ OTDR Test Results - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to Locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details ▪ OTDR Test Results o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box Locations ▪ Conduit/Cable Paths Including Cable Information ▪ Splice Point Locations and Details ▪ LIU Patch Panels and IDF Panels ▪ OTDR Test Results <p>Background: This project is necessary to alleviate the gaps between the existing fiber network assets in the field, record drawings, and OSP database of various facilities located at Tumbleweed Park. The Tumbleweed Recreation Center utilizes a 24 strand fiber cable to connect to the backbone cable at the splice point at Germann Road and Pioneer Parkway. In addition to the 24 strand fiber cable, the Recreation Center houses two more LIU panels to connect to the Tumbleweed Park Tennis Center and Facilities Service Center using a 12 strand fiber cable and 96 strand fiber cable, respectively. Assets such as pull boxes, conduit and cable paths, splice enclosure locations were found to have discrepancies between the three and could not be alleviated throughout the various field audits performed. After this information is verified and added to the database, it can be used for future capital projects and simplify the implementation of the recommended network topologies.</p>	<p>Field Verification: \$13,000</p> <p>Database Update: \$3,000</p> <p>See cost detail provided in Appendix E1.3</p>	<p>Owner: Fiber Manager</p> <p>Support: Fiber Personnel</p>	<p>Develop RFP: 1 month</p> <p>Bid/Selection: 1 month</p> <p>Project Completion: 2 months</p>
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C-1D	Germann Road and Hamilton Street Field Verification Project	Southwest corner of Germann Road and Hamilton Street	<p>Description: Investigate where the cables exit the splice vault. Identify and document the cables’ independent pull box and conduit systems associated with the unknown cable paths and any additional assets (i.e. splice enclosures, LIU panels, fiber cables, network switches, etc.) located at the either the Park and Ride Facility or Tumbleweed Recharge Wells Facility. Add/update information in the City’s OSP database, and update records as appropriate.</p> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Field Verification: <ul style="list-style-type: none"> ▪ Pull Boxes ▪ Conduit/Fiber Cable Paths via Tracer Wire or Mule Tape ▪ Conduit/Fiber Cable Building Entrances ▪ Splice Enclosures ▪ LIU Patch Panels and IFD Panels ▪ LIU OTDR Testing ▪ Network Switches o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Pull Box, Conduit, and Cable Information ▪ Record Drawing Redlines ▪ Splice Detail Spreadsheets ▪ OTDR Test Results - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to Locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details ▪ OTDR Test Results o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box Locations ▪ Conduit/Cable Paths Including Cable Information ▪ Splice Point Locations and Details ▪ LIU Patch Panels and IDF Panels ▪ OTDR Test Results <p>Background: This project is necessary to alleviate the gaps between the existing fiber network assets in the field, record drawings, and OSP database for facilities located at the Germann Road and Hamilton Street intersection. The splice vault located near the southwest corner of contains three 96 strand fiber cables with only two entering the splice enclosure. One black backbone cable and yellow branch cable. The yellow 96 strand fiber cable either terminates at the Park and Ride Facility or the Tumbleweed Recharge Well , both of which are located on the southeast corner of the intersection where an additional cable for the SCADA DMZ network connects to the same switch, creating a security risk for the SCADA network if the cables are located in the Park and Ride facility. Both facilities need to be visited to verify the correct termination location and alleviate the potential security risk. After this information is added to the database this information can be used for future capital projects and simplify the implementation of the recommended network topologies as new fiber cables will be installed and connected to this cable.</p>	<p>Field Verification: \$9,000</p> <p>Database Update: \$2,000</p> <p>See cost detail provided in Appendix E1.4</p>	<p>Owner: Fiber Manager</p> <p>Support: Fiber Staff, Water/Wastewater, Valley Metro Field Contractor</p>	<p>Develop RFP: 1 month</p> <p>Bid/Selection: 1 month</p> <p>Project Completion: 2 months</p>
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C-1E	Inventory and Audit of Chandler Downtown Campus Fiber Assets	All OSP and ISP fiber assets located on the Downtown Campus	<p>Description: Complete the field audits needed to document their conduits, fiber cables, fiber paths, pull box systems, splice enclosures, LIU panels, IFD panels, and network switches of the Downtown Campus utilizing recent OTDR test results and as-build records as a starting point. Clearly document how the City’s Downtown Campus is connected, so adjustments to the existing infrastructure can easily be identified and executed to meet the needs of each City facility and City department/division.</p> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Field Verification: <ul style="list-style-type: none"> ▪ Pull Boxes and Manholes ▪ Conduit/Fiber Cable Paths via Tracer Wire or Mule Tape ▪ Conduit/Fiber Cable Building Entrances ▪ Splice Enclosures ▪ LIU Patch Panels and IFD Panels ▪ LIU OTDR Testing ▪ Network Switches o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Pull Box, Manhole, Conduit, and Cable Information ▪ Record Drawing Redlines ▪ Splice Detail Spreadsheets ▪ OTDR Test Results - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to Locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details ▪ OTDR Test Results o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box Locations ▪ Conduit/Cable Paths Including Cable Information ▪ Splice Point Locations and Details ▪ LIU Patch Panels and IDF Panels including Patch Cable Connections to Other Equipment ▪ OTDR Test Results <p>Background: This project is necessary to alleviate the gaps between the existing fiber network assets in the field, record drawings, and OSP database of the Downtown Campus. Assets such as pull boxes, conduit and cable paths, additional IDFs, and splice enclosure locations with discrepancies between the field verified data and database can be alleviated. After this information is added to the database it can be used for future capital projects and adding secondary conduit/cable entrances to future core node facilities based on the recommended network topologies.</p>	<p>Field Verification: \$25,000</p> <p>Database Update: \$5,000</p> <p>See cost detail provided in Appendix E1.5</p>	<p>Owner: Fiber Manager</p> <p>Support: Fiber Staff, Information Technology, and Various City Departments</p>	<p>Develop RFP: 2 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 2 months</p>
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C-1F	Inventory and Audit of Various Campus Fiber Networks	All OSP and ISP fiber assets located on the individual campuses	<p>Description: It is assumed that the following Campuses will require a thorough assessment of their individual networks connecting their facilities and adding the field audited data to the OSP database:</p> <ul style="list-style-type: none"> - Tumbleweed Park Campus <ul style="list-style-type: none"> o Fiber assessment to include the Facilities Service Center, Parks & Rec Yard, Tumbleweed Ranch, Tumbleweed Recreation Center, Tennis Courts, (10) ASR Wells (the Railroad Museum will not need a connection as it is effectively a private operations on a long-term lease) - Armstrong Yard <ul style="list-style-type: none"> o Fiber assessment to include the Public Works Buildings, Transportation Buildings, and Fleet Buildings - PD West Substation <ul style="list-style-type: none"> o Fiber assessment to include Fire Station #9 - PD South Substation <ul style="list-style-type: none"> o Fiber assessment to include the Environmental Education Center at Veterans Oasis Park - PWTP, AWRF, STWS, OWRF, OBRF <p>These improvements can be conducted in a single project or broken into multiple separate smaller projects.</p> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Field Verification: <ul style="list-style-type: none"> ▪ Pull Boxes or Manholes ▪ Conduit/Fiber Cable Paths via Tracer Wire or Mule Tape ▪ Conduit/Fiber Cable Building Entrances ▪ Splice Enclosures ▪ LIU Patch Panels and IFD Panels ▪ LIU OTDR Testing ▪ Network Switches o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Pull Box, Manhole, Conduit, and Cable Information ▪ Record Drawing Redlines Based on Findings ▪ Splice Detail Spreadsheets - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details o Updating City Records o Updating City OSP Database: <ul style="list-style-type: none"> ▪ Pull Box Locations ▪ Conduit/Cable Paths Including Cable Information ▪ Splice Point Locations and Details ▪ LIU Patch Panels and IDF Panels Including Patch Cable Connections to Other Equipment <p>Background: This project is to alleviate the gaps between the existing fiber network assets in the field, record drawings, and OSP database of the various Campuses throughout the City. Assets such as pull boxes, conduit and cable paths, LIU patch panels, IDFs, and splice enclosure locations can be documented and added to the OSP database with the field verified data. This information can be used for future capital projects and adding secondary conduit/cable entrances to future core node facilities based on the recommended network topologies. Different City departments will also have records of their campus networks and an understanding of their overall connectivity. In the event of isolated outages at these campuses, City staff can easily troubleshoot the causing issues.</p>	<p>Field Verification: \$250,000</p> <p>Database Update: \$50,000</p> <p>See cost detail provided in Appendix E1.6</p>	<p>Owner: Fiber Manager</p> <p>Support: Various City Departments</p>	<p>Develop RFP: 2 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 12 months</p>
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C-1G	Replace Aged 48 Strand Fiber Cable	Various segments located in City ROW	<p>Description: Replace approximately 3.52 miles of old 48 strand fiber cables that consist of (8) buffer tubes containing (6) fibers each that have reached the end of their lifecycle (see Figures 8-12). Upgrade 8 existing splice enclosures connecting these segments of cable. Upgrade 5 existing pull boxes to splice vaults, as necessary, to properly house new splice enclosures. Not replacing or upgrading this aging infrastructure could lead to network performance issues. These improvements can be conducted in a single project or broken into multiple separate smaller projects.</p> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Removal of Existing Assets: <ul style="list-style-type: none"> ▪ 48 Strand Fiber Cable ▪ Splice Enclosures ▪ Pull Boxes o Furnishing, Pulling, and Installing: <ul style="list-style-type: none"> ▪ 144 Strand Fiber Cable ▪ Splice Enclosures (6 Cable Port) ▪ Splice Vaults o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Pull Box, Manhole, Conduit, and Cable Information ▪ Record Drawing Redlines ▪ Splice Detail Spreadsheets (if original details were modified) ▪ OTDR Testing - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning and Design: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting ▪ Project Design – Splice Details, Cable Distances, etc. ▪ Specifications – Splice Enclosures, Splice Vaults, Slack Quantities o Contractor Escorts to Locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details ▪ OTDR Test Results o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box/Vault Sizes and Locations ▪ Conduit/Cable Paths including cable information ▪ Splice Point Locations and Details ▪ OTDR Test Results <p>Background: These segments of cable and splice enclosures pose a high risk to a network fault due to their age and existing conditions. Replacing these cable segments will also increase the fiber capacity to meet the demands of the recommended network topologies and allow for smoother implementation.</p>	<p>Design: \$12,000</p> <p>Construction: \$120,000</p> <p>See cable replacement quantities detail provided in Appendix D1.4</p> <p>See cost detail provided in Appendix E1.7</p>	<p>Owner: Fiber Manager</p> <p>Support: Fiber Staff and Various City Departments</p>	<p>Develop RFP: 2 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 6 months</p>
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C-1H	Convert City Facilities to Core Switch Hub Locations – Secondary Fiber Entrance	IT Building, TMC, PD South Substation, PD West Substation, Public Safety Training Center (PSTC), PD Headquarters, Property & Evidence, OWRF, AWRF, PWTP, OBRF, Main Library	<p>Description: The following (12) facilities will need a conduit and cable entrance added based on the recommended network topologies (see Figures 8-12):</p> <ul style="list-style-type: none"> - IT Enterprise Network: <ul style="list-style-type: none"> o IT Building, PD South Substation, PD West Substation, PSTC - TMC Network <ul style="list-style-type: none"> o TMC Facility - Police Network <ul style="list-style-type: none"> o PD Headquarters, Property & Evidence - Water/Wastewater Network <ul style="list-style-type: none"> o OWRF, AWRF, OBRF, PWTP - Library Network <ul style="list-style-type: none"> o Main Library <p>Construct secondary conduit/cable entrance into each facility to provide increased reliability . This will require a new splice vault, splice enclosure, conduit and cable path (assume 1,000 feet), LIU patch panel, and equipment rack to be installed at each facility. These improvements can be conducted in a single project or broken into multiple separate smaller projects.</p> <table border="0" style="width: 100%;"> <tr> <td style="vertical-align: top;"> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Furnish and Install: <ul style="list-style-type: none"> ▪ Splice Vault ▪ Splice Enclosure ▪ Conduit ▪ 48 Strand Fiber Cable ▪ LIU Patch Panel ▪ Equipment Rack o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Splice Vault ▪ Record Drawings Redlines for Conduit/Cable Paths ▪ Splice Detail Spreadsheets ▪ OTDR Testing Results </td> <td style="vertical-align: top;"> <ul style="list-style-type: none"> - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning and Design: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to Locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details ▪ OTDR Test Results o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box/Vault Sizes and Locations ▪ Splice Enclosures and Details ▪ Conduit/Cable Paths Including Cable Information ▪ Termination Panels Including Patch Cables to Other Equipment ▪ OTDR Test Results </td> </tr> </table> <p>Background: These secondary conduit and cable entrances are necessary to improve the reliability of each recommended network topology. Once these improvements to each facility are made, the City will be able to begin reconfiguring the spicing to implement each recommended topology.</p>	<ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Furnish and Install: <ul style="list-style-type: none"> ▪ Splice Vault ▪ Splice Enclosure ▪ Conduit ▪ 48 Strand Fiber Cable ▪ LIU Patch Panel ▪ Equipment Rack o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Splice Vault ▪ Record Drawings Redlines for Conduit/Cable Paths ▪ Splice Detail Spreadsheets ▪ OTDR Testing Results 	<ul style="list-style-type: none"> - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning and Design: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to Locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details ▪ OTDR Test Results o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box/Vault Sizes and Locations ▪ Splice Enclosures and Details ▪ Conduit/Cable Paths Including Cable Information ▪ Termination Panels Including Patch Cables to Other Equipment ▪ OTDR Test Results
<ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Furnish and Install: <ul style="list-style-type: none"> ▪ Splice Vault ▪ Splice Enclosure ▪ Conduit ▪ 48 Strand Fiber Cable ▪ LIU Patch Panel ▪ Equipment Rack o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Splice Vault ▪ Record Drawings Redlines for Conduit/Cable Paths ▪ Splice Detail Spreadsheets ▪ OTDR Testing Results 	<ul style="list-style-type: none"> - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning and Design: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to Locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details ▪ OTDR Test Results o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box/Vault Sizes and Locations ▪ Splice Enclosures and Details ▪ Conduit/Cable Paths Including Cable Information ▪ Termination Panels Including Patch Cables to Other Equipment ▪ OTDR Test Results 				
<p>Design: \$89,000</p> <p>Construction: \$420,000</p> <p>See new fiber cable quantities detail provided in Appendix D1.5</p> <p>See cost detail provided in Appendix E1.8</p>	<p>Owner: Fiber Manager</p> <p>Support: Fiber Personnel, IT, and Various Department Personnel</p>	<p>Develop RFP: 4 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 14 months</p>			

C-1I	Convert City Facilities to Core Switch Hub Locations – New Core Switch Equipment	TMC, PD South Substation, PD West Substation, PSTC, PD Headquarters, Property & Evidence, OBRF	<p>Description: The following facilities will need a core switch added based on the recommended network topologies (see Figures 8-12):</p> <ul style="list-style-type: none"> - IT Enterprise Network: PD South Substation, PD West Substation, PSTC - TMC Network: TMC Facility (secondary core switch) - Police Network: PD Headquarters, Property & Evidence - Water/Wastewater Network: OBRF <p>Furnish and install new core switches, proper optics, and equipment rack/cabinet, and complete network configuration, and proposed. The City’s IT Department will furnish and install the new switches and handle the network configuration. Below is a list of minimal requirements for the switches in order to support the proposed topologies. These improvements can be conducted in a single project or broken into multiple separate smaller projects. These improvements are also anticipated to serve as upgraded equipment that will replace the existing City CWDM equipment.</p> <ul style="list-style-type: none"> - New Core Switch with City Standard Software/firmware options supporting the following: <ul style="list-style-type: none"> o 4 or more High-Capacity (10G-40Gbps range) SFP Ports for the “Core-to-Core” links between core facilities o 10 or more lower capacity (1G-10G range) SFP Ports for the “Distribution” links used to connect other non-core facilities o 10/100/1000 Base-T copper/RJ-45 Ethernet ports, if there are any local devices within the building the City wants to connect to the Core Switch - 1G SFP supporting an 80km distance over single-mode fiber - 10G SFP supporting an 80km distance over single-mode fiber - 40G SFP supporting an 80km distance over single-mode fiber - UPS for Core Switch with rack mounting provisions and an associated battery bank supporting a 4-hour run time - 144 Port LIU <p>4-Post Equipment Rack/Cabinet with side panels, front & rear doors, and fan to circulate the hot air out of the cabinet.</p>	<p>Design: \$40,000</p> <p>Construction: \$460,000 (assuming SFP optic requirements to meet proposed network topologies)</p> <p>See new fiber cable detail provided in Appendix D1.5</p> <p>See cost detail provided in Appendix E1.9</p>	<p>Owner: IT Personnel</p> <p>Support: Fiber Manager and Various City Departments</p>	<p>Project Completion: 5 months</p>
C-1J	New Distribution Switch Equipment	All non-core switch facilities (45 locations)	<p>Description: As the City prepares to implement the proposed Fiber Network Topologies (see Figures 8-12) the facilities that will be utilized as distribution hub location which will require new distribution switches to be installed and configured along with the proper optics. City’s IT Department to furnish and install new switches, proper optics, and UPS, and complete network configuration. These improvements are also anticipated to serve as upgraded equipment that will replace the existing City CWDM equipment. Below is a list of minimal requirements for the switches in order to support the proposed topologies:</p> <ul style="list-style-type: none"> - New Distribution Switch with City Standard Software/firmware options supporting the following: <ul style="list-style-type: none"> o 2 or more lower capacity (1G-10G range) SFP Ports o 24 or 48 10/100/1000 Base-T copper/RJ-45 Ethernet ports, some may need to support PoE for local devices at the facility <p>UPS for Distribution Switch with rack mounting provisions and an associated battery bank supporting a 4-hour run time.</p>	<p>Design: \$28,000</p> <p>Construction: \$327,000 (assuming minimum SFP optic requirements)</p> <p>See cost detail provided in Appendix E1.10</p>	<p>Owner: IT Personnel</p> <p>Support: Fiber Manager</p>	<p>Project Completion: 6 months</p>

C-1K	Re-splicing for Proposed Network Topologies	City-wide Splice Locations	<p>Description: There are currently (5) City Departments (IT, TMC, PD, Utilities, Library) that utilize the City’s fiber infrastructure to conduct their operations for the individual networks: In order to build out the recommended topologies for each network (see Figures 8-12), this recommendation is to design and re-splice approximately (177) existing splice locations and approximately (27) new splice locations. These improvements can be conducted in a single project or broken into multiple separate smaller projects.</p> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control Plan o Daily Work Progress Updates o Daily Inspections o Furnish and Install: <ul style="list-style-type: none"> ▪ New Splice Enclosures including splicing ▪ Existing Splice Detail Modifications o Asset Documentation: <ul style="list-style-type: none"> ▪ Splice Vault Butterfly Diagrams ▪ Conduit/Cable Paths ▪ Record Drawing Redlines ▪ OTDR Testing - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Design: <ul style="list-style-type: none"> ▪ Topology implementation ▪ Modified Splice Details for new and existing splice enclosures o Contractor Escorts to locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box/Vault Sizes and Locations ▪ Splice Enclosures and Details ▪ Conduit/Cable Paths Including Cable Information <p>Background: The city-wide re-splicing is one of the major steps to implementing the recommended network topologies. With the new splicing design at each enclosure, overall network communications will improve as old or broken splices will be remediated.</p>	<p>Design: \$122,000</p> <p>Construction: \$570,000 (assuming all splicing/re-splicing is done in a single round)</p> <p>See existing splice revisions quantities detail provided in Appendix D1.1</p> <p>See new splice revisions quantities detail provided in Appendix D1.2</p> <p>See cost detail provided in Appendix E1.11</p>	<p>Owner: Fiber Manager</p> <p>Support: Fiber Personnel and Various City Departments</p>	<p>Develop RFP: 4 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 9 months</p>
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C-1L	Add New 144 Strand Fiber Cable in Existing Conduit	City-wide Locations	<p>Description: In order to build out the individual network topologies (see Figures 8-12) for the City Departments currently utilizing the City’s fiber optic network, this recommendation is to install approximately 13.65 miles of new 144 strand fiber cable within existing conduits throughout the City. This includes (20) new splice enclosures and 30 splice revisions to be completed in existing splice enclosures. These new additions of cable will be used to reach various devices or facilities (i.e. traffic signals, ASR wells, City buildings, etc.). These improvements can be conducted in a single project or broken into multiple separate smaller projects.</p> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Furnish and Install: <ul style="list-style-type: none"> ▪ 144 Strand Fiber Cable ▪ Equipment Rack ▪ LIU Patch Panel o Asset Documentation: <ul style="list-style-type: none"> ▪ Splice Vault Butterfly Diagrams ▪ Splice Detail Spreadsheets ▪ Conduit/Cable Paths ▪ Record Drawing Redlines ▪ OTDR Testing - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Contracting o Design: <ul style="list-style-type: none"> ▪ Topology Implementation o Modified Splice Details for New and Existing Splice Enclosures o Contractor Escorts to Locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box/Vault Sizes and Locations ▪ Splice Enclosures and Details ▪ Conduit/Cable Paths Including Cable Information <p>Background: These additions of 144 strand fiber cable into existing conduit will improve the path diversity for the recommended network topologies. They also avoid having to use folded rings within the recommended topologies within the limits of the existing conduit. Finally, these improvements will create alternate paths for multiple circuits to reach various devices and facilities and avoid bottlenecks along cables with lower fiber capacity.</p>	<p>Design: \$90,000</p> <p>Construction: \$410,000 (assuming all splicing/re-splicing is done in a single round)</p> <p>See new splice revision quantities detail provided in Appendix D1.2</p> <p>See new fiber cable quantities in Appendix D1.5</p> <p>See cost detail provided in Appendix E1.12</p>	<p>Owner: Fiber Manager</p> <p>Support: Various City Departments</p>	<p>Develop RFP: 4 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 10 months</p>
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C-1M	Add Gator Patch Panels to Traffic Signals Not Currently Connected via Fiber	City-wide Locations	<p>Description: Install approximately 42 gator patch cables (assuming 200 feet of cable) and hardened network switches in traffic signal cabinets in lieu of existing twisted wire pairs or wireless radios to connect various traffic signals to the City Fiber Network. This will also require installation of approximately 42 splice enclosures to connect to nearby backbone cables, installation of 42 new traffic signal cabinet switches, splice and revisions to approximately 42 existing splice enclosures to complete the connection to the network. As noted in general topology recommendations (see Figures 8-12), active electronics for traffic signal cabinet switches should be Layer 2 capable with two 1-Gigabit optic connections to each switch at minimum.</p> <p>Background: In order to implement the proposed TMC Traffic Network Topology, the City will need to connect various traffic signals that currently utilize twisted wire pairs or wireless radios for their connections to fiber connections by installing gator patch cables and hardened network switches in their traffic signal cabinets. These additions of 144 strand cable into existing conduit will improve the path diversity for the recommended network topologies. They also avoid having to use folded rings within the recommended topologies within the limits of the existing conduit. Finally, these improvements will create alternate paths for multiple circuits to reach various devices and facilities and avoid bottlenecks along cables with lower fiber capacity.</p>	<p>Design: \$35,000</p> <p>Construction: \$410,000 (assuming all traffic signals are converted in a single round)</p> <p>See existing splice revision quantities detail provided in Appendix D1.1</p> <p>See new splice revision quantities detail provided in Appendix D1.2</p> <p>See Gator Patch quantities detail provided in Appendix D1.3</p> <p>See new fiber cable quantities detail provided in Appendix D1.5</p> <p>See cost detail provided in Appendix E1.13</p>	<p>Owner: Fiber Manager</p> <p>Support: Fiber Personnel and TMC</p>	<p>Develop RFP: 2 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 3 months</p>
C-1N	Add Traffic Signal Cabinet Layer 2 Switches with Some Layer 3 Functionality	City-wide Traffic Signal Cabinet Locations	<p>Description: In order to implement the proposed TMC Traffic Network Topology (Figure 11), the City will need to upgrade the existing network switches housed in multiple traffic signal cabinet locations. The Traffic Management Team will need to replace (159) existing switches at traffic signal locations currently connected by fiber, twisted wire pairs, wireless radios, and those with no connection. These improvements can be conducted in a single project or broken into multiple separate smaller projects.</p> <p>Background: These switches will provide the needed functionality for the Traffic Management Team to meet the reliability requirements of the recommended topology and allow for easier expansion of their network in the future. They also avoid network outages due to assets reaching the end of their lifecycle and having incompatible products when adding new signals or devices to their network.</p>	<p>Design: \$50,000</p> <p>Construction: \$550,000 (assuming all traffic signals are converted in a single round)</p> <p>See cost detail provided in Appendix E1.14</p>	<p>Owner: Fiber Manager</p> <p>Support: Fiber Personnel and TMC</p>	<p>Develop RFP: 2 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 6 months</p>

C-10	City-wide Conduit Path Field Verification and Associated OSP Database Layer	City-wide Pull Box Locations, City ROW, and Various Facilities	<p>Description: The City will conduct a City-wide conduit path field verification. The hired Contractor will confirm installation locations and end-to-end pull box connections. If there are locations where there is no tracer wire, the Contractor will need to pull new tracer wire into the conduit segment. City staff can now use the field verification findings and records to build the Duct Bank layer within the OSP database. The conduit paths can then be adjusted, and documented information can then be input into the appropriate fields. These field verifications can be conducted in a single project or broken into multiple separate smaller projects.</p> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Field Verification: <ul style="list-style-type: none"> ▪ Pull Boxes ▪ Conduit/Fiber Cable Paths via Tracer Wire or Mule Tape o Furnish and Install: <ul style="list-style-type: none"> ▪ Tracer Wire o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Pull Box, Conduit, and Cable Information ▪ Record Drawing Redlines - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Contracting ▪ Provide Existing Record Drawings o Contractor Escorts to Locations o Review Field Verification Findings: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box Locations ▪ Duct Bank Layer <ul style="list-style-type: none"> • Conduit Paths • Superduct/Innerduct Quantities, Size, etc. • End-to-End Access Point Connections ▪ Splice Point Locations <p>Background: This project is necessary to alleviate the gaps between the existing fiber network assets in the field, record drawings, and OSP database. Assets such as pull boxes, conduit and cable paths, splice enclosure locations that may have never been documented can now be added to the City’s records and database. After this information is added to the database this information can be used for future capital projects and simplify the implementation of the recommended network topologies as new fiber cables will be installed and connected to this cable.</p>	<p>Field Verification: \$1,100,000</p> <p>Database Update: \$92,000</p> <p>See cost detail provided in Appendix E1.15</p>	<p>Owner: Fiber Manager</p> <p>Support: Field Personnel</p>	<p>Develop RFP: 2 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 8 months</p>
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C-1P	Add Additional Layers and Fields to OSP Database	OSP Database	<p>Description: City staff should begin to build and update the layers in their OSP database to reflect how all assets exist in the field, within the limitations of the database software:</p> <ul style="list-style-type: none"> - Equipment Layer <ul style="list-style-type: none"> o Build new Equipment (switches) in Equipment Editor with appropriate fields (Core switches, distribution switches, traffic signal cabinet switches) o Build existing patch cable in Equipment Editor with appropriate fields o Insert Equipment and patch cables at all locations <ul style="list-style-type: none"> ▪ Connect appropriate Equipment to Termination Points - Termination Point Layer <ul style="list-style-type: none"> o Build new Termination Point (patch panels and gator patch panels) in Material Editor o Build new Termination Point (patch panels and gator patch panels) in Patch Editor to reflect existing field equipment using LIU Panel Spreadsheets for and Gator Patch Panels Spreadsheets. o Build existing patch cable in Equipment Editor with appropriate fields o Update Termination Point and patch cables at all locations <ul style="list-style-type: none"> ▪ Connect appropriate Termination Points to Equipment - Splice Point <ul style="list-style-type: none"> o Build new Splice Point (splice enclosures) in Material Editor o Update new and existing Splice Point fields to include information that currently is not captured in the database - Cable Span <ul style="list-style-type: none"> o Update new and existing Cable Span fields to include information that currently is not captured in the database - Access Point <ul style="list-style-type: none"> o Update new and existing Access Point fields to include information that currently is not captured in the database <p>Background: This project is necessary to alleviate the gaps between the existing fiber network assets in the field, record drawings, and OSP database. Assets such as pull boxes, conduit and cable paths, splice enclosure locations that may have never been documented can now be added to the City’s records and database. After this information is added to the database this information can be used for future capital projects and simplify the implementation of the recommended network topologies as new fiber cables will be installed and connected to this cable. Finally, City staff will be continuously updating the OSP database in order to keep it up to date as other projects are being completed.</p>	<p>Field Verification: \$0</p> <p>Database Update: \$350,000</p> <p>See cost detail provided in Appendix E1.16</p>	<p>Owner: Fiber Manager</p> <p>Support: Field Contractor</p>	<p>Develop RFP: 0 month(s)</p> <p>Bid/Selection: 0 month(s)</p> <p>Project Completion: 6 month(s)</p>
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ID	Recommendation	Project Limits	Brief Scope / Description	Planning Cost Estimate	Key Personnel / Groups Involved	Time to Complete
CAPITAL						
PRIORITY #2 (MID-TERM 7-13 YEARS): MODIFY EXISTING NETWORK TO CREATE RELIABILITY AND PATH DIVERSITY						
C-2A	Adding New 144 Strand Fiber Optic Cable in MCI Joint Conduit Installations	City ROW Containing MCI Joint Conduit Segments	<p>Description: Install new 144 strand fiber optic cable into segments of MCI Joint Conduit throughout the City. Splice enclosures will need to be installed along these newly installed cables. Distribution switches will also need to be installed at locations that can be added to the fiber network. Finally, existing splice details will need to be modified to accommodate for the new facilities.</p> <ul style="list-style-type: none"> - Total length of existing MCI Joint Conduit: 17.39 miles - New 144 Strand fiber cable limit: 26 miles - New Distribution Switches: 17 - New Splice Enclosures: 17 - Splice Revisions in Existing Splice Enclosures: 11 - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Furnishing and Installing: <ul style="list-style-type: none"> ▪ 144 Strand Fiber Cable ▪ Equipment Rack ▪ LIU Patch Panel o Asset Documentation: <ul style="list-style-type: none"> ▪ Splice Vault Butterfly Diagrams ▪ Splice Detail Spreadsheets ▪ Conduit/Cable Paths ▪ Record Drawing Redlines o OTDR Testing - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning and Design: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details o Furnish and Install: <ul style="list-style-type: none"> ▪ Network Distribution Switches including network configuration o Updating City Records o Updating City OSP Database: <ul style="list-style-type: none"> ▪ Pull Box/Vault Sizes and Locations ▪ Splice Enclosures and Details ▪ Conduit/Cable Paths including cable information ▪ Termination Panels including patch cables to other equipment ▪ Equipment including patch cables to other equipment 	<p>Design: \$150,000</p> <p>Construction: \$700,000</p> <p>See cable replacement quantities detail provided in Appendix D2.1</p> <p>See cost detail provided in Appendix E2.1</p>	<p>Owner: Fiber Manager</p> <p>Support: IT Personnel and PD</p>	<p>Develop RFP: 2 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 12 months</p>
			<p>Background: These additions of 144 strand cable into existing conduit will improve the path diversity for the recommended network topologies (see Figures 13-14). They also avoid having to use folded rings within the recommended topologies within the limits of the existing conduit. Finally, these improvements will create alternate paths for multiple circuits to reach various devices and facilities and avoid bottlenecks along cables with lower fiber capacity.</p>			

ID	Recommendation	Project Limits	Brief Scope / Description	Planning Cost Estimate	Key Personnel / Groups Involved	Time to Complete
C-2B	Replacement of Fiber Optic Cables Reaching the End of their Lifecycle	City-wide ROW, Splice Locations, and Conduit/Cable Paths	<p>Description: As the City continues to improve its network and reliability, much of the existing fiber optic cable will need to be replaced as they approach the end of their lifecycle (typically 20 years). Any cables installed from 2005, or earlier, to 2009 will need to be replaced throughout the Mid-term project cycle. This will include approximately 43.47 miles of existing cable that needs to be replaced with 144 strand fiber cable and splice revisions to 84 existing splice enclosures.</p> <ul style="list-style-type: none"> - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Removal of Existing Assets: <ul style="list-style-type: none"> ▪ Aged End of Lifecycle Cables ▪ Pull Boxes o Furnishing, Pulling, and Installing: <ul style="list-style-type: none"> ▪ 144 Strand Fiber Cable ▪ Splice Enclosures (6 Cable Port) o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for pull box, manhole, conduit, and cable information. ▪ Record Drawing Redlines ▪ Splice Detail Spreadsheets (if original details were modified) ▪ OTDR Testing - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning and Design: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting ▪ Project Design – Splice Details, Cable Distances, etc. ▪ Specifications – Splice Enclosures, Splice Vaults, Slack Quantities o Contractor Escorts to locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box/Vault Sizes and locations (if modified in the field) ▪ Conduit/Cable Paths Including Cable Information ▪ Splice Point Locations/Splice Details <p>Background: These segments of cable and splice enclosures pose a high risk to a network fault due to their age and existing conditions. Replacing these cable segments will also increase the fiber capacity to meet the demands of the implemented network topologies (see Figures 13-14) and allow for easier future network expansion.</p>	<p>Design: \$210,000</p> <p>Construction: \$900,000</p> <p>See cable replacement quantities detail provided in Appendix D2.1</p> <p>See cost detail provided in Appendix E2.2</p>	<p>Owner: Fiber Manager TMC Personnel</p> <p>Support: All Departments currently on the fiber network</p>	<p>Develop RFP: 2 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 4 months</p>

ID	Recommendation	Project Limits	Brief Scope / Description	Planning Cost Estimate	Key Personnel / Groups Involved	Time to Complete
C-2C	New Conduit/Fiber to Facilities within 1000' of Existing Conduit	City-wide ROW to reach various facilities and devices	<p>Description: After the recommended topologies (see Figures 8-12) have been implemented, the City can continue to expand the fiber network to reach various facilities and devices for various departments. This project quantifies the amount of facilities and devices that are within 1000 feet of existing fiber infrastructure along with the amount of new fiber infrastructure needed to reach them and connect them to the network (see Figures 13-14).</p> <ul style="list-style-type: none"> - New 144-fiber Conduit (4") = 4.84 miles - New 144-fiber Cable = 4.84 miles - IT Distribution Network Switches: 6 - Traffic Signal Network Switches: 2 - Water/Wastewater Facility Switches: 45 - New #9 Vault (for every 1000 feet of new conduit/cable): 25 - New #7 Pull Box (for every 500 feet of new conduit/cable): 50 - New Splice Enclosure & Splicing (assume one for each new switch): 53 - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control o Daily Work Progress Updates o Daily Inspections o Furnishing, Pulling, and Installing: <ul style="list-style-type: none"> ▪ 144 Strand Fiber Cable ▪ Splice Enclosures (6 Cable Port) ▪ Splice Vaults ▪ Pull Boxes o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for Pull Box, Manhole, Conduit, and Cable Information ▪ Record Drawing Redlines ▪ Splice Detail Spreadsheets (if original details were modified) ▪ OTDR Testing - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning and Design: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to Locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details o Furnish and Install: <ul style="list-style-type: none"> ▪ Network Distribution Switches Including Network Configuration o Updating City OSP Database and Records: <ul style="list-style-type: none"> ▪ Pull Box/Vault Sizes and Locations ▪ Splice Enclosures and Details ▪ Conduit/Cable Paths Including Cable Information ▪ Termination Panels Including Patch Cables to Other Equipment ▪ Equipment Including Patch Cables to Other Equipment 	<p>Design: \$280,000</p> <p>Construction: \$1,220,000</p> <p>See cable replacement quantities detail provided in Appendix D2.1</p> <p>See cost detail provided in Appendix E2.3</p>	<p>Owner: Fiber Manager</p> <p>Support: IT Personnel and PD</p>	<p>Develop RFP: 2 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 4 months</p>

Background: These additions of 144 strand cable and conduit will be primarily to reach other facilities and devices to connect them to the existing fiber network. They also help expand the limits of the existing conduit to add more devices in future projects based on different City department needs.

NON-CAPITAL

PRIORITY #3 (MID-TERM 7-13 YEARS): UPDATE DOCUMENTATION ON PERIODIC BASIS

REVIEW OF ALL DOCUMENTATION AND PROCESSES	The activities established and formalized as part of Priority #1 and #2 allow for the ongoing conversation surrounding the City's fiber network. It is recommended that the City review all documentation as part of this Master Plan in advance of the annual CIP development process, at minimum. Putting staff in place to support the City's fiber network, providing necessary training and procedures for implementation, and allowing for appropriate budgeting of the valuable asset will all lend themselves toward regular review and updates as necessary. Budget forms, job descriptions, agreements, service levels, checklists, etc. will all be reviewed on a regular basis as part of the Fiber Oversight Committee and are built into the Fiber Manager duties. Therefore, if the City is able to implement recommendations in Priority #1 and #2, the need for updating documentation on a periodic basis will be covered.
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ID	Recommendation	Project Limits	Brief Scope / Description	Planning Cost Estimate	Key Personnel / Groups Involved	Time to Complete
CAPITAL						
PRIORITY #3 (LONG-TERM 13+ YEARS): UPDATE ASSETS AND IMPROVE NETWORK						
C-3A	New Conduit/Fiber to Facilities beyond 1000' of Existing Fiber Conduit	City-wide ROW to reach various facilities and devices	<p>Description: After the recommended topologies have been implemented (see Figures 8-12), the City can continue to expand the fiber network to reach various facilities and devices for various departments. This project quantifies the amount of facilities and devices that are beyond 1000 feet of existing fiber infrastructure along with the amount of new fiber infrastructure needed to reach them and connect them to the network (see Figures 13-14).</p> <ul style="list-style-type: none"> - New 144-fiber Conduit (4") = 14.41 miles - New 144-fiber Cable = 14.41 miles - IT Distribution Network Switches: 3 - Traffic Signal Network Switches: 3 - Water/Wastewater Facility Switches: 32 - New #9 Vault (for every 1000 feet of new conduit/cable): 76 - New #7 Pull Box (for every 500 feet of new conduit/cable): 152 - New Splice Enclosure & Splicing (assume one for each new switch): 36 - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control Plan o Daily Work Progress Updates o Daily Inspections o Furnishing, Pulling, and Installing: <ul style="list-style-type: none"> ▪ 144 Strand Fiber Cable ▪ Splice Enclosures (6 Cable Port) ▪ Splice Vaults ▪ Pull boxes o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for pull box, manhole, conduit, and cable information. ▪ Record Drawing Redlines ▪ Splice Detail Spreadsheets (if original details were modified) o OTDR Testing - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning and Design: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details o Furnish and Install: <ul style="list-style-type: none"> ▪ Network Distribution Switches including network configuration o Updating City Records o Updating City OSP Database: <ul style="list-style-type: none"> ▪ Pull Box/Vault Sizes and Locations ▪ Splice Enclosures and Details ▪ Conduit/Cable Paths including cable information ▪ Termination Panels including patch cables to other equipment ▪ Equipment including patch cables to other equipment <p>Background: These additions of 144 strand cable and conduit will be primarily to reach other facilities and devices to connect them to the existing fiber network. They also help expand the limits of the existing conduit to add more devices in future projects based on different City department needs. Finally, these improvements will create alternate paths for multiple circuits to avoid bottlenecks along cables with lower fiber capacity and eventually unfold the folded rings that were created throughout the implementation of the network topologies.</p>	<p>Design: \$550,000</p> <p>Construction: \$2.550,000</p> <p>See cable replacement quantities detail provided in Appendix D2.1</p> <p>See cost detail provided in Appendix E3.1</p>	<p>Owner: Fiber Manager</p> <p>Support: TMC Personnel and IT Personnel</p>	<p>Develop RFP: 2 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 4 months</p>

ID	Recommendation	Project Limits	Brief Scope / Description	Planning Cost Estimate	Key Personnel / Groups Involved	Time to Complete
C-3B	Unfold Folded Rings	City-wide ROW to reach existing splice locations	<p>Description: After the recommended topologies have been implemented (see Figures 8-12), the City can continue to expand the fiber network to reduce the number of existing folded rings and implement the recommended network topologies. This project quantifies the amount fiber infrastructure and splice revisions needed to unfold the rings and improve their reliability (see Figures 13-14).</p> <ul style="list-style-type: none"> - New 144-fiber Conduit (4") = 4.11 miles - New 144-fiber Cable = 4.11 miles - New #9 Vault (for every 1000 feet of new conduit/cable): 21 - New #7 Pull Box (for every 500 feet of new conduit/cable): 42 - Splice Revisions in Existing Enclosures: 24 - Contractor Responsibilities: <ul style="list-style-type: none"> o Permitting (can utilize existing Annual Blanket Permit) o Traffic Control Plan o Daily Work Progress Updates o Daily Inspections o Furnishing, Pulling, and Installing: <ul style="list-style-type: none"> ▪ 144 Strand Fiber Cable ▪ Splice Enclosures (6 Cable Port) ▪ Splice Vaults ▪ Pull boxes o Asset Documentation: <ul style="list-style-type: none"> ▪ Butterfly Diagrams for pull box, manhole, conduit, and cable information. ▪ Record Drawing Redlines ▪ Splice Detail Spreadsheets (if original details were modified) o OTDR Testing - City Staff Responsibilities: <ul style="list-style-type: none"> o Project Planning and Design: <ul style="list-style-type: none"> ▪ Identifying City Records ▪ Risk Identification/Mitigation ▪ Network Outage Coordination ▪ Contracting o Contractor Escorts to locations o Project Inspections: <ul style="list-style-type: none"> ▪ Butterfly Diagrams ▪ City Record Redlines ▪ Splice Details o Furnish and Install: <ul style="list-style-type: none"> ▪ Network Distribution Switches including network configuration o Updating City Records o Updating City OSP Database: <ul style="list-style-type: none"> ▪ Pull Box/Vault Sizes and Locations ▪ Splice Enclosures and Details ▪ Conduit/Cable Paths including cable information ▪ Termination Panels including patch cables to other equipment ▪ Equipment including patch cables to other equipment <p>Background: These additions of 144 strand cable and conduit will unfold some of the folded rings created during the implementation of the network topologies. They also help expand the limits of the existing conduit to add more devices in future projects based on different City department needs. Finally, these improvements will create alternate paths for multiple circuits to avoid bottlenecks along cables with lower fiber capacity and increase the overall reliability of the fiber network.</p>	<p>Design: \$150,000</p> <p>Construction: \$680,000</p> <p>See cable replacement quantities detail provided in Appendix D2.1</p> <p>See cost detail provided in Appendix E3.2</p>	<p>Owner: Fiber Manager</p> <p>Support: TMC Personnel IT Personnel</p>	<p>Develop RFP: 2 months</p> <p>Bid/Selection: 2 months</p> <p>Project Completion: 4 months</p>

Near-Term: 0-7 Years



Near-term recommendations are most vital to begin the migration to new network topologies for each of the individual fiber networks. Each individual line on each of these maps represents a pair of fibers connecting one facility to another. The legends describe the topology and the method to read rings or topologies within the main network. The full list of near-term recommendations are found in *Table 2* below and the individual fiber network topology recommendation maps to implement in the near-term using these projects are shown in *Figure 9 through 13*.

Table 2 – Near-Term Recommendations Summary

ID	Recommendations	Design / Field Verification	Construction / Database Updates
PRIORITY #1 (NEAR-TERM 0-7 YEARS): COMPLETE REMAINING INVENTORY AND OSP DATABASE UPDATES			
C-1A	Dobson Road Field Verification Project	\$38,000	\$9,000
C-1B	Dobson Road Field Verification Project	\$12,000	\$3,000
C-1C	Tumbleweed Park Field Verification Project	\$13,000	\$3,000
C-1D	Germann Road and Hamilton Street Field Verification Project	\$9,000	\$2,000
C-1E	Inventory and Audit of Chandler Downtown Campus Fiber Assets	\$25,000	\$5,000
C-1F	Inventory and Audit of Various Campus Fiber Networks	\$250,000	\$50,000
C-1G	Replace Aged 48 Strand Fiber Cable	\$12,000	\$120,000
ID	Recommendations	Design / Field Verification	Construction / Database Updates
C-1H	Convert City Facilities to Core Switch Hub Locations – Secondary Fiber Entrance	\$89,000	\$420,000
C-1I	Convert City Facilities to Core Switch Hub Locations – New Core Switch Equipment	\$40,000	\$460,000
C-1J	New Distribution Switch Equipment	\$28,000	\$327,000
C-1K	Re-splicing for Proposed Network Topologies	\$122,000	\$570,000
C-1L	Add New 144 Strand Fiber Cable in Existing Conduit	\$90,000	\$410,000
C-1M	Add Gator Patch Panels to Traffic Signals Not Currently Connected via Fiber	\$35,000	\$410,000
C-1N	Add Traffic Signal Cabinet Layer 2 Switches with Some Layer 3 Functionality	\$50,000	\$550,000
C-1O	City-wide Conduit Path Field Verification and Associated OSP Database Layer	\$1,100,000	\$92,000
C-1P	Add Additional Layers and Fields to OSP Database	\$0	\$350,000
TOTAL		\$1,926,750	\$3,781,000

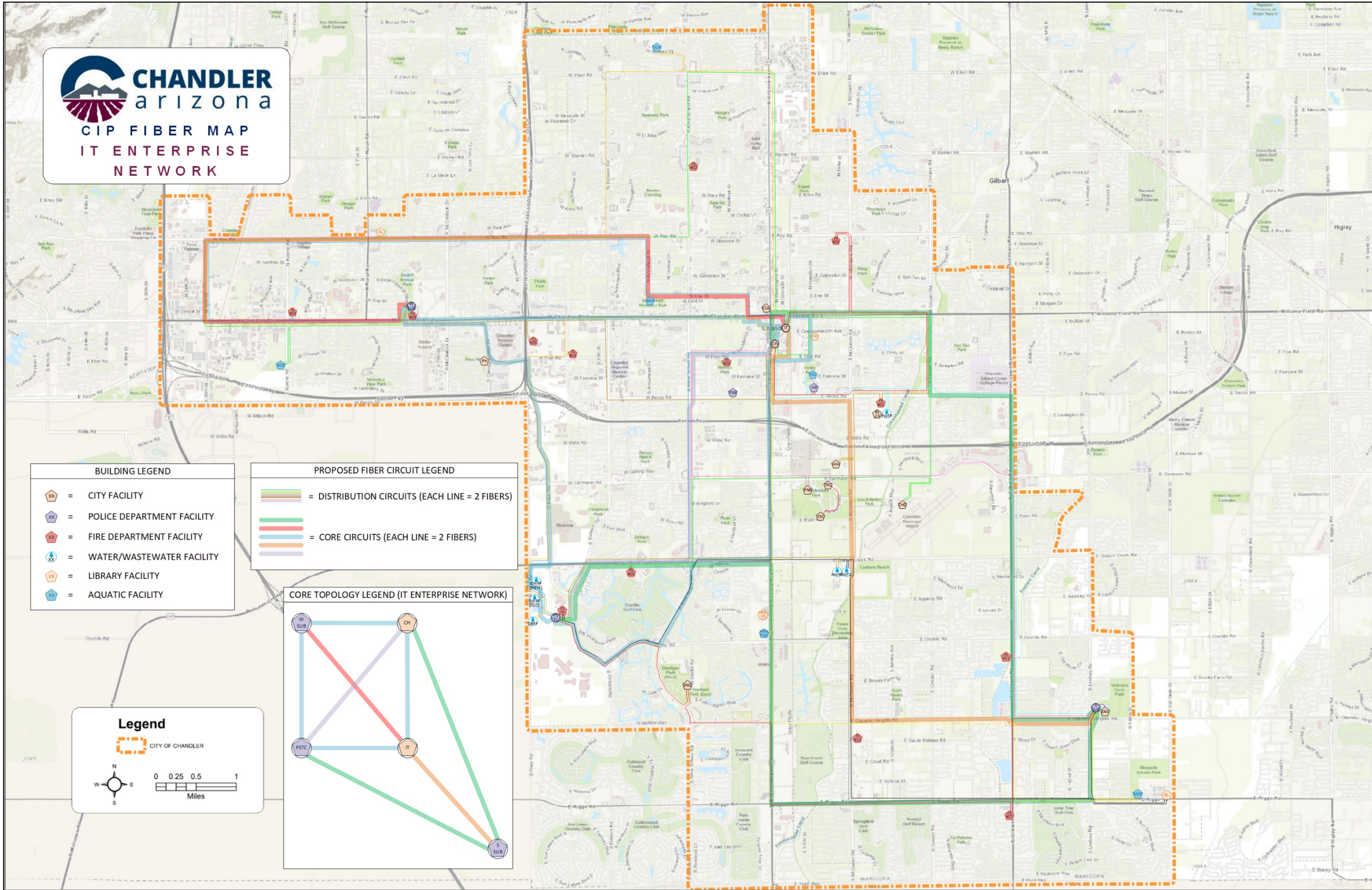


Figure 9 – IT Fiber Network Recommendation Map

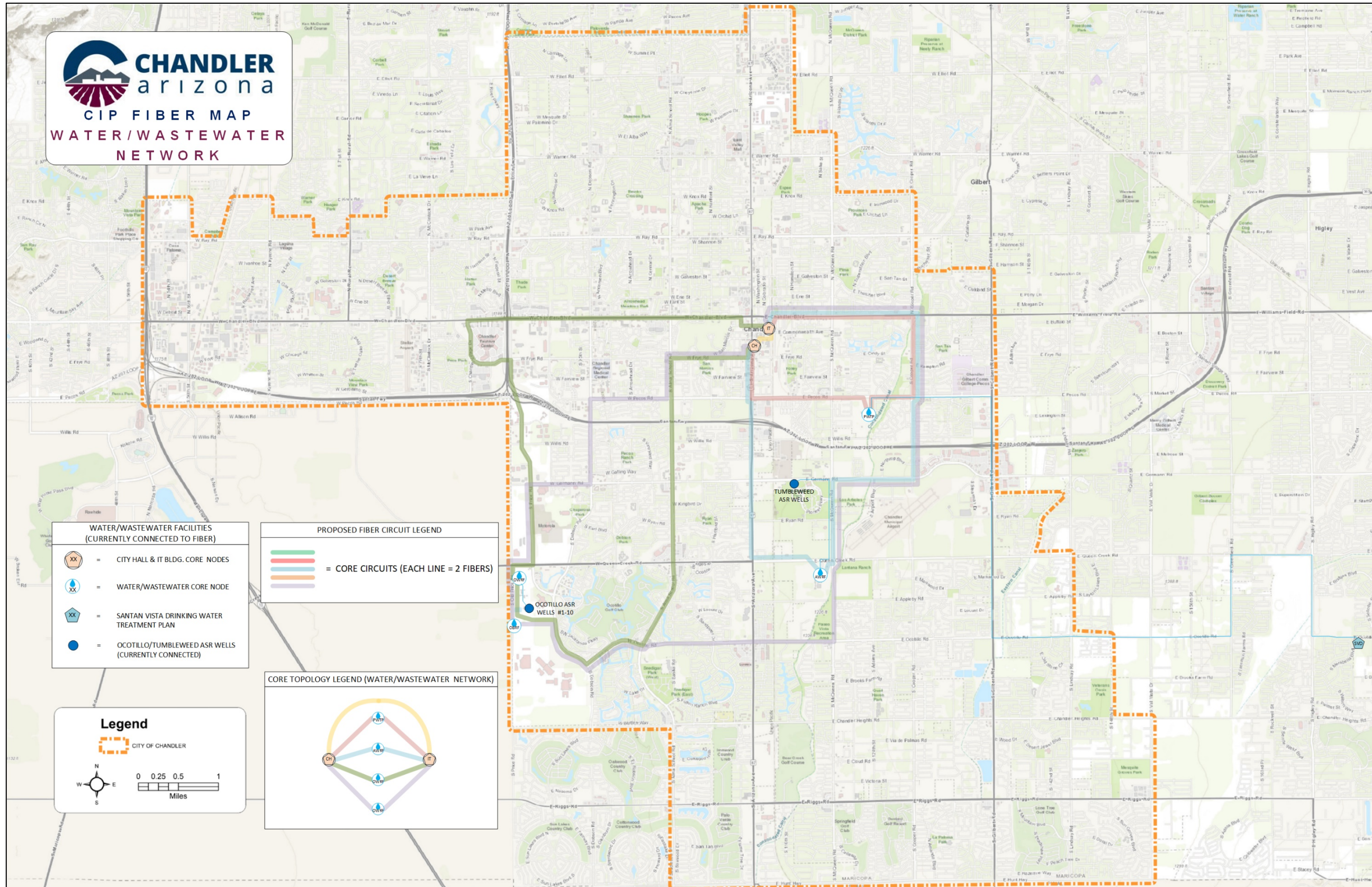


Figure 10 – Utilities Fiber Network Recommendation Map

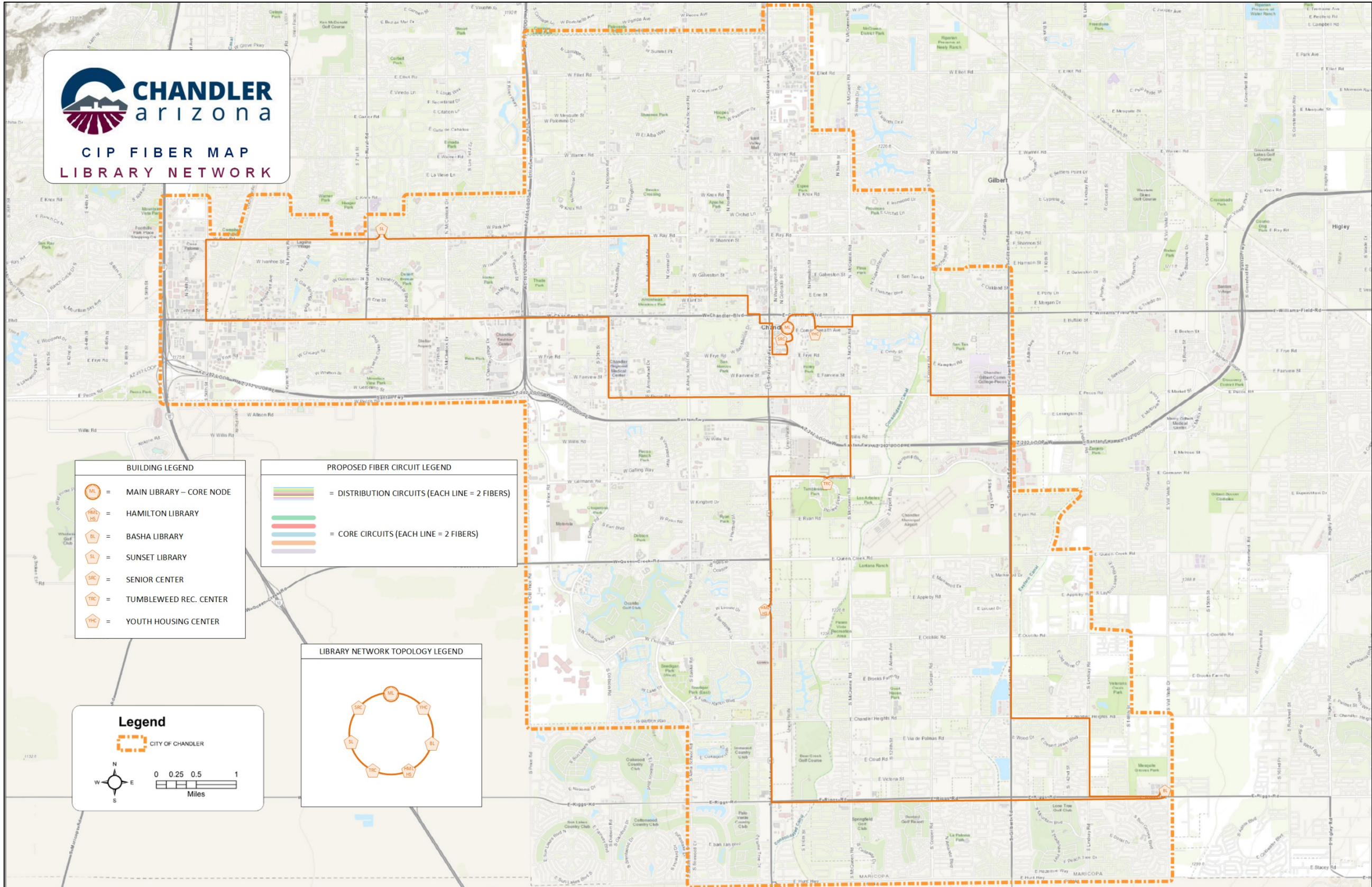


Figure 11 – Library Fiber Network Recommendation Map

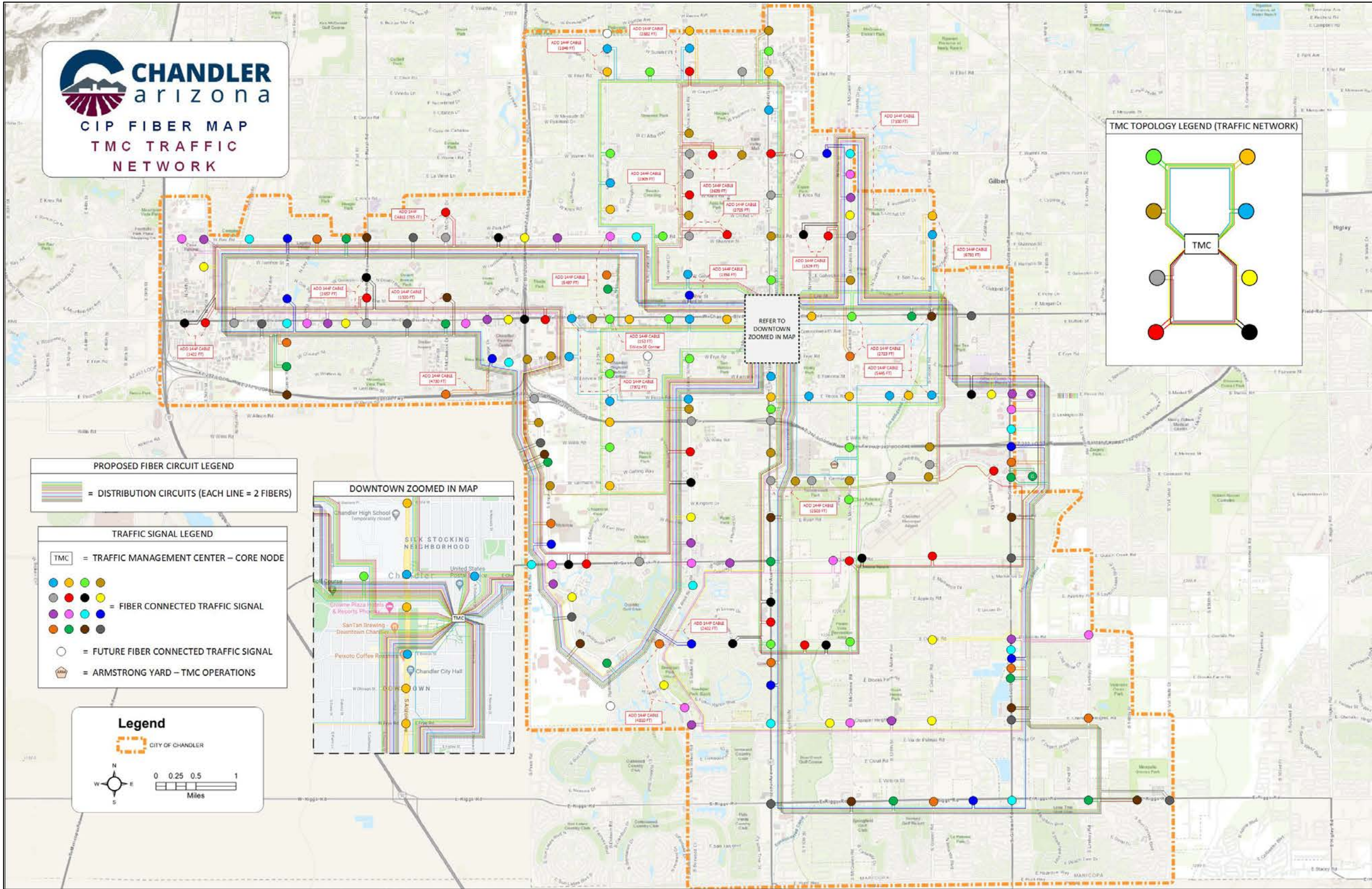


Figure 12 – TMC Fiber Network Recommendation Map

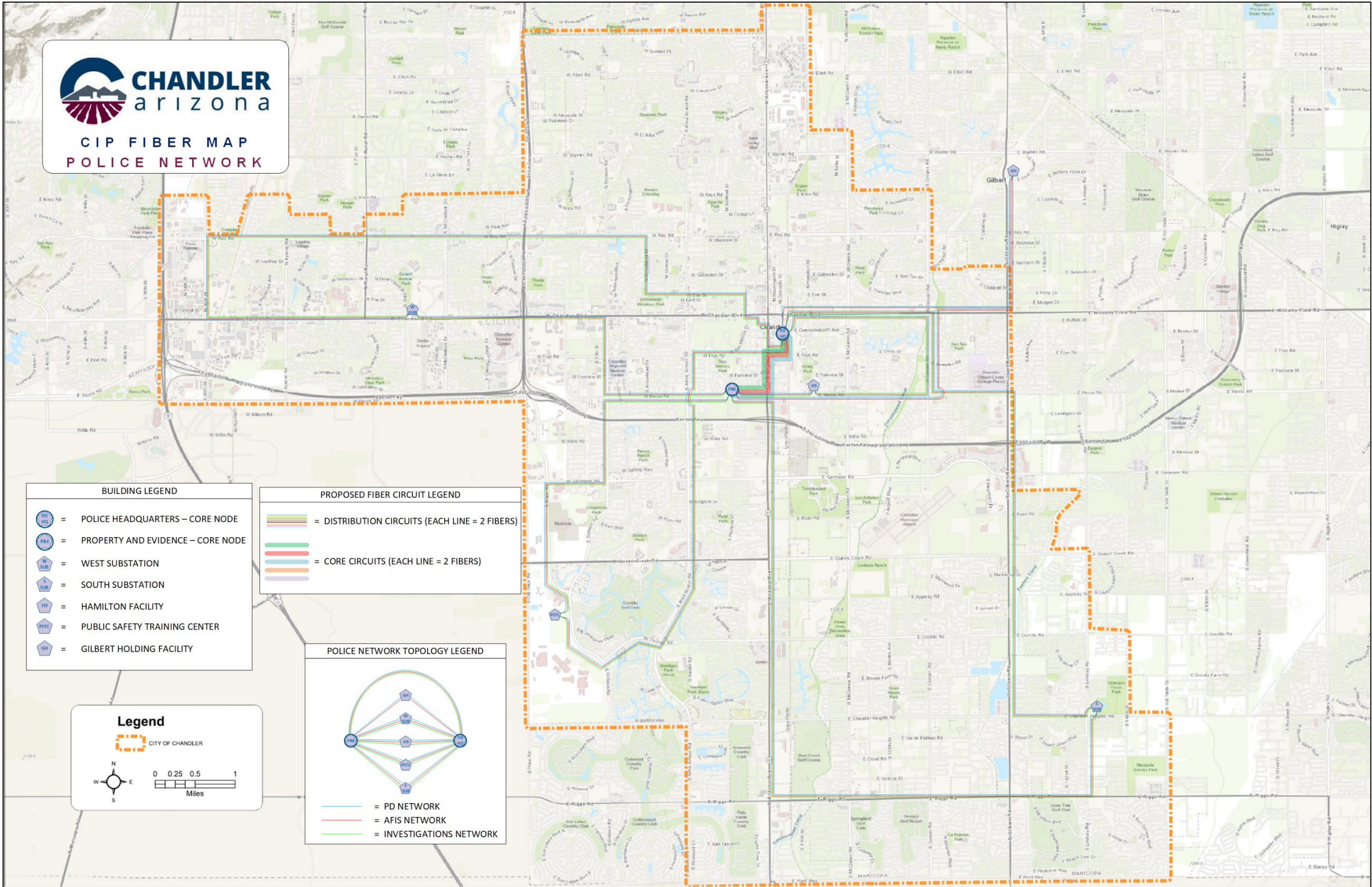


Figure 13 – PD Fiber Network Recommendation Map



Mid-Term: 7-13 Years



Mid-Term recommendations expand on the efforts conducted throughout the various audits and activities performed in the near-term. The following recommendations should be conducted over the next seven-year period along with the City’s ongoing near-term projects that should be completed before these mid-term projects. The full list of mid-term recommendations are found in Table 3 and their locations are shown in Figure 14.

Table 3 – Mid-Term Recommendations Summary

ID	Recommendations	Design / Field Verification	Construction / Database Updates
PRIORITY #2 (MID-TERM 7-13 YEARS): MODIFY EXISTING NETWORK TO CREATE RELIABILITY AND PATH DIVERSITY			
C-2A	Adding New 144 Strand Fiber Optic Cable in MCI Joint Conduit Installations	\$150,000	\$700,000
C-2B	Replacement of Fiber Optic Cables Reaching the End of their Lifecycle	\$210,000	\$900,000
C-2C	New Conduit/Fiber to Facilities within 1000’ of Existing Conduit	\$280,000	\$1,220,000
TOTAL		\$640,000	\$2,820,000

Long-Term: 13 Years and Beyond



Long-term recommendations reflect the efforts conducted throughout the recommended near-term and mid-term projects. With well-kept fiber asset records and an up-to-date OSP database these project recommendations should be conducted afterward as they are more time consuming and cost intensive. Long-Term projects were identified as such because they are not as critical for network connectivity, although they will increase the diversity of the network and continue to increase the number of City facilities connected to the City’s fiber infrastructure. The full list of long-term projects is found in Table 4 and their locations are shown in Figure 14.

Table 4 – Long-Term Recommendations Summary

ID	Recommendations	Design / Field Verification	Construction / Database Updates
PRIORITY #3 (LONG-TERM 13+ YEARS): UPDATE ASSETS AND IMPROVE NETWORK			
C-3A	New Conduit/Fiber to Facilities beyond 1000’ of Existing Fiber Conduit	\$550,000	\$2,550,000
C-3B	Unfold Folded Rings	\$150,000	\$680,000
TOTAL		\$700,000	\$3,230,000



Figure 15 shows a map of the existing City conduit with a 1000-foot buffer surrounding all existing conduit alignments. This map gives the City guidance for which additional facilities will be more feasible to add in the mid- or long-term timeframes for different departments. If two departments have facilities in close proximity to each other, perhaps a splitting of cost of a new fiber connection would be warranted.

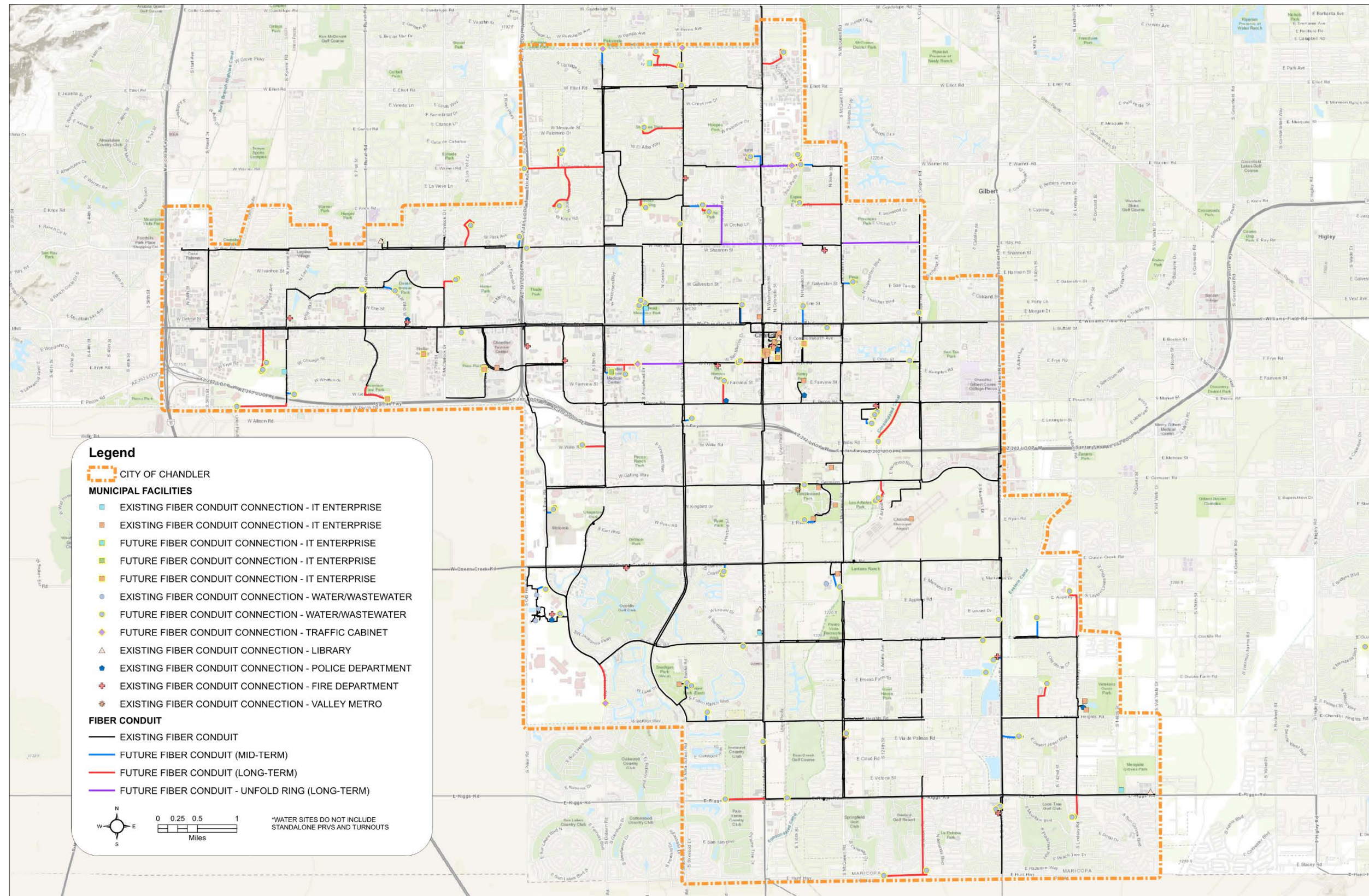


Figure 14 – Mid-Term and Long-Term Recommendations Map

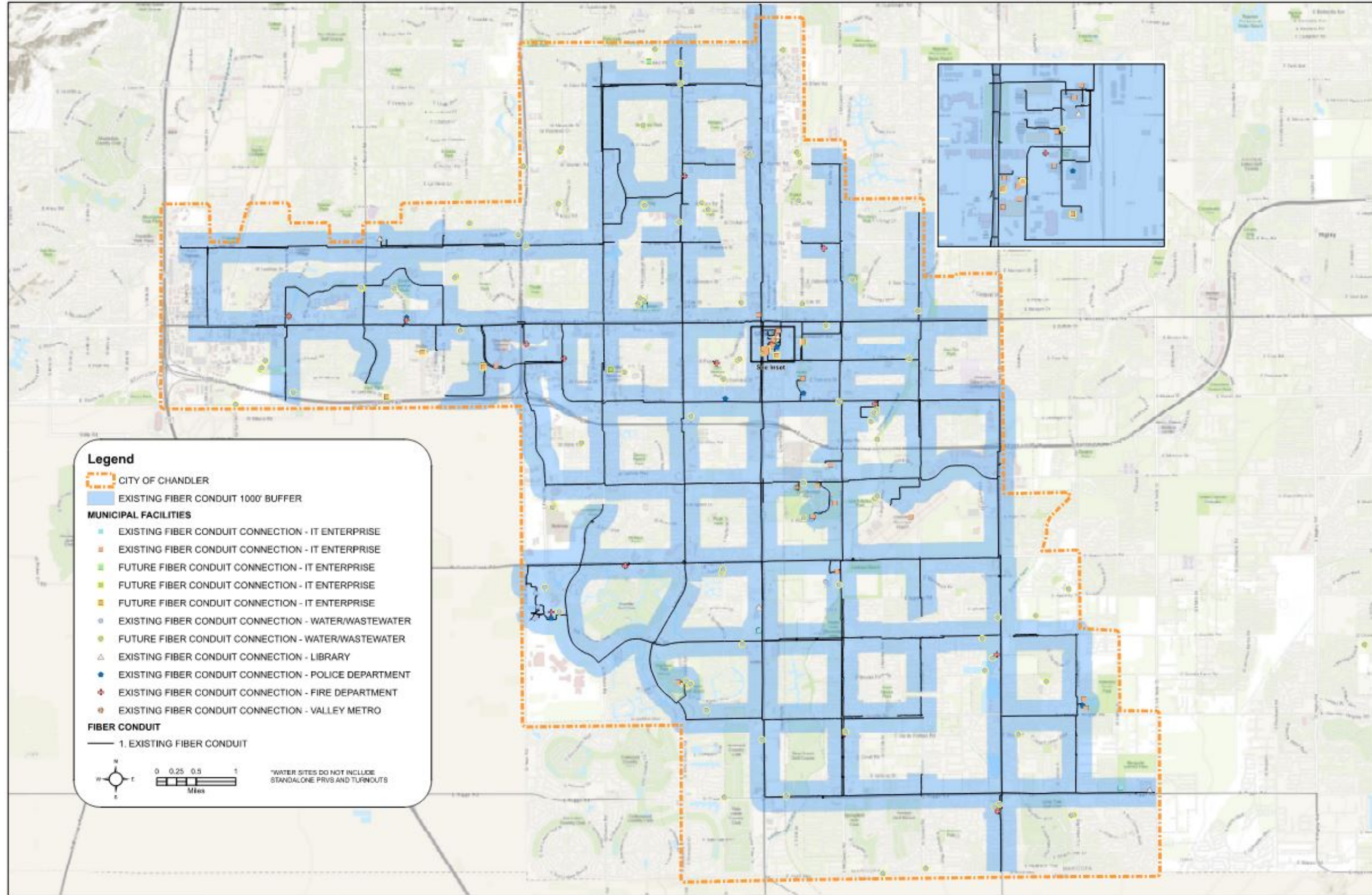


Figure 15 – Mid-Term and Long-Term Recommendations Map