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Memorandum

SRF No. 7798

To: Kate Miner, Carver County

From: Nick Erpelding, P.E., PTOE
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Date: April 29, 2015

Subject: Carver County Traffic Signal Communication Plan

Introduction

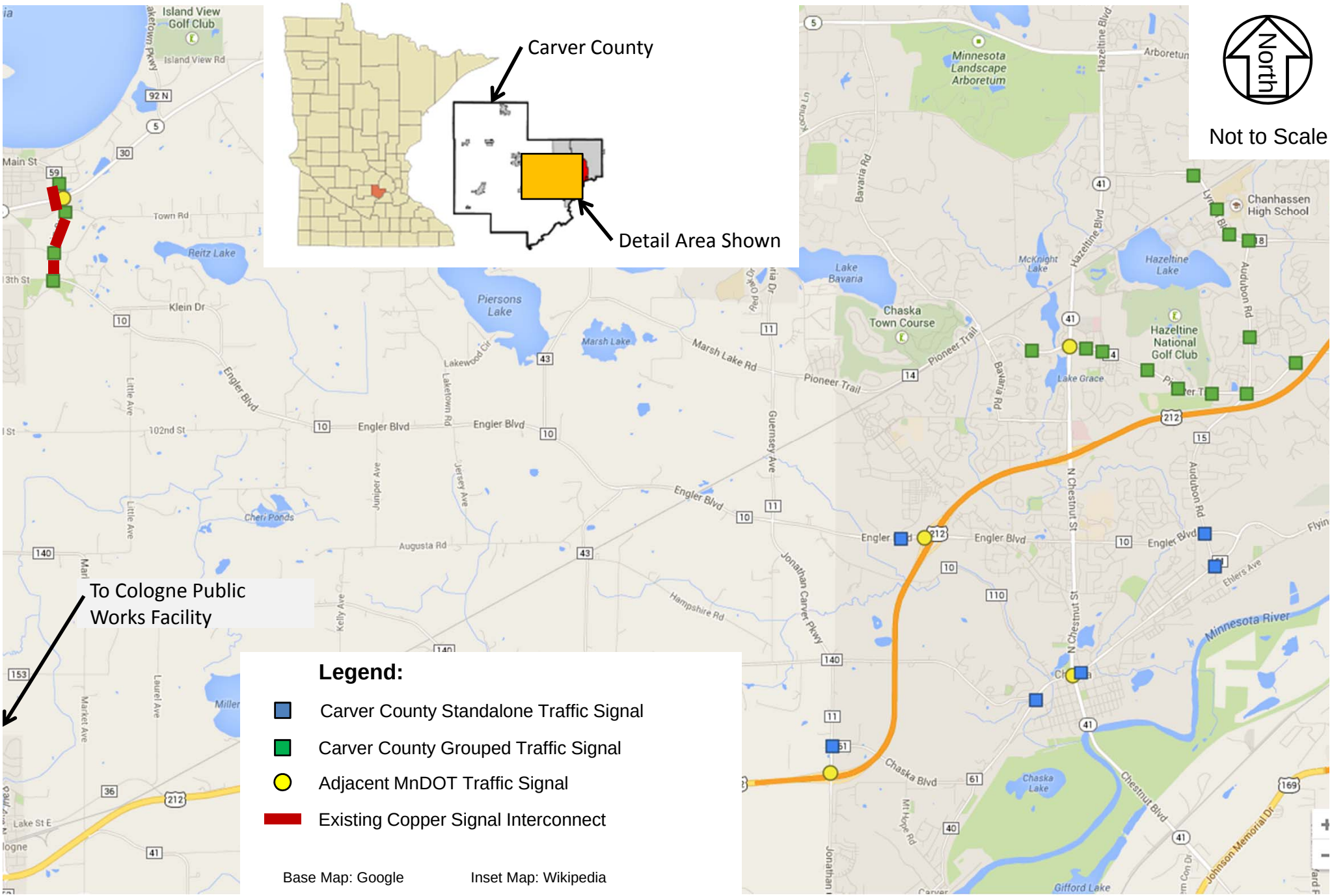
In 2012, Carver County was nearing completion of a large-scale fiber-optic infrastructure deployment to connect county administrative facilities, libraries and a number of other users with a robust, high capacity network. The network deployment brought fiber lines close to a number of existing signalized intersections. The County approached SRF for help in determining how to take advantage of the fiber to improve the monitoring and management capabilities of the existing county signal system, and to take a larger look at how the initial buildout could be expanded in the future to connect all existing and anticipated County signals and roundabouts.

This memo includes:

- A description of Carver County's existing traffic signal system.
- Background on the reasons for moving toward use of an Advanced Traffic Management System for traffic signal management and operations.
- Discussion on the method used to determine which future intersections to include in the communications plan.
- Vision for a completed signal network with detailed recommendations and cost estimates.

Carver County Traffic Signal System Overview

Carver County's traffic signal system consists of roughly 25 intersections, mostly located in the eastern half of the County, as shown in Figure 1. The locations of adjacent signalized intersections owned/operated by MnDOT are also noted.



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Existing Traffic Signal System

Traffic Signal Communication Plan

Carver County

Figure 1

The overall system includes a mix of grouped and standalone intersections, as depicted in Figure 1.

The local signal controllers within the Waconia (Main Street) group are interconnected to each other with twisted pair copper to form what are known as a closed-loop system, with basic intersection operations handled by the local signal controllers and coordinated operation carried out via an on-street master. No connection has yet been established from the County's Traffic Operations Center (TOC) at the Public Works facility in Cologne to the on-street masters for management (uploading and downloading) of timing plans and viewing of system and intersection status.

The local signal controllers within the CSAH 14 and CSAH 18 groups are not currently interconnected, though fiber optic cable has been installed to each of the cabinets. Coordinated signal operations for these intersections are carried out via time-based coordination.

Need for Advanced Traffic Management System

Due to the availability of affordable industrial networking hardware and the poor reliability of dial-up and serial-based communications, the closed loop / on-street master architecture is nearing the end of its useful service life. Many agencies in positions similar to the County are converting from a series of connected closed-loop systems to a single centralized network connecting all of their signals.

A system used to centrally manage various components of transportation infrastructure is referred to as an Advanced Traffic Management System, or ATMS. Management and operation of traffic signals is one of many functions that an ATMS can provide for an agency.

Identification of Future Traffic Control Locations

Constructing the underlying network of communications links needed to support an ATMS is often the most difficult, if not costly, part of deploying a new ATMS installation. In order to cost-effectively provide long term benefit, planning for which intersections to include is an important first step in the deployment of an ATMS system.

To determine which existing and future intersections to include in Carver County's network, an assessment of the transportation system was completed based on the Carver County Capital Improvement Plan, input from County staff, forecast volumes and anticipated roadway reconstructions or alignments. This approach allowed objective measures, such as traffic volumes and programmed construction to be considered along with measures that required engineering judgment, such as likely land use patterns and roadway changes that are anticipated but not yet programmed.

Each intersection was assigned a type (signal, roundabout, or TBD) and a priority value. The intersections were then entered into a database that allowed for a systematic approach to planning interconnections according to the process described in the following section.

Existing uncontrolled and anticipated future intersections were subjectively given a priority score of Low, Medium, or High for each of these measures. The intent was to identify intersections which would likely require a higher traffic control device (roundabout or traffic signal) to manage traffic. Intersections meeting the High Priority conditions for a given measure are more likely to need a traffic control device sooner. Intersections matching the Low Priority categories would require a significant increase in traffic or significant roadway improvements before meeting warrants for a signal or roundabout. Table 2, below, summarizes the measures used in the analysis and the criteria used to prioritize each intersection for each measure.

Table 1. Priority Criteria

Measure	Low Priority	Medium Priority	High Priority
Existing Volumes	Low Volumes	Moderate volumes near, but not likely meeting warrants	Volumes nearly or already meeting traffic control warrant
Forecast Volumes	Those just meeting thresholds	Solidly within thresholds for traffic control device	Those significantly above thresholds
Roadway Network	Requires new roadway or significant upgrade; not planned	Roadway network upgrades being planned	Roadway network already exists
Surrounding Land Use	No immediate development pending	Near developing or developed areas	Within or on the edge of developing or developed areas
Previous, Existing, or Pending Project	No project currently planned in area	Projects being considered or needed in future	Area has already been studied with roadway / traffic control upgrades

Communication Plan Development

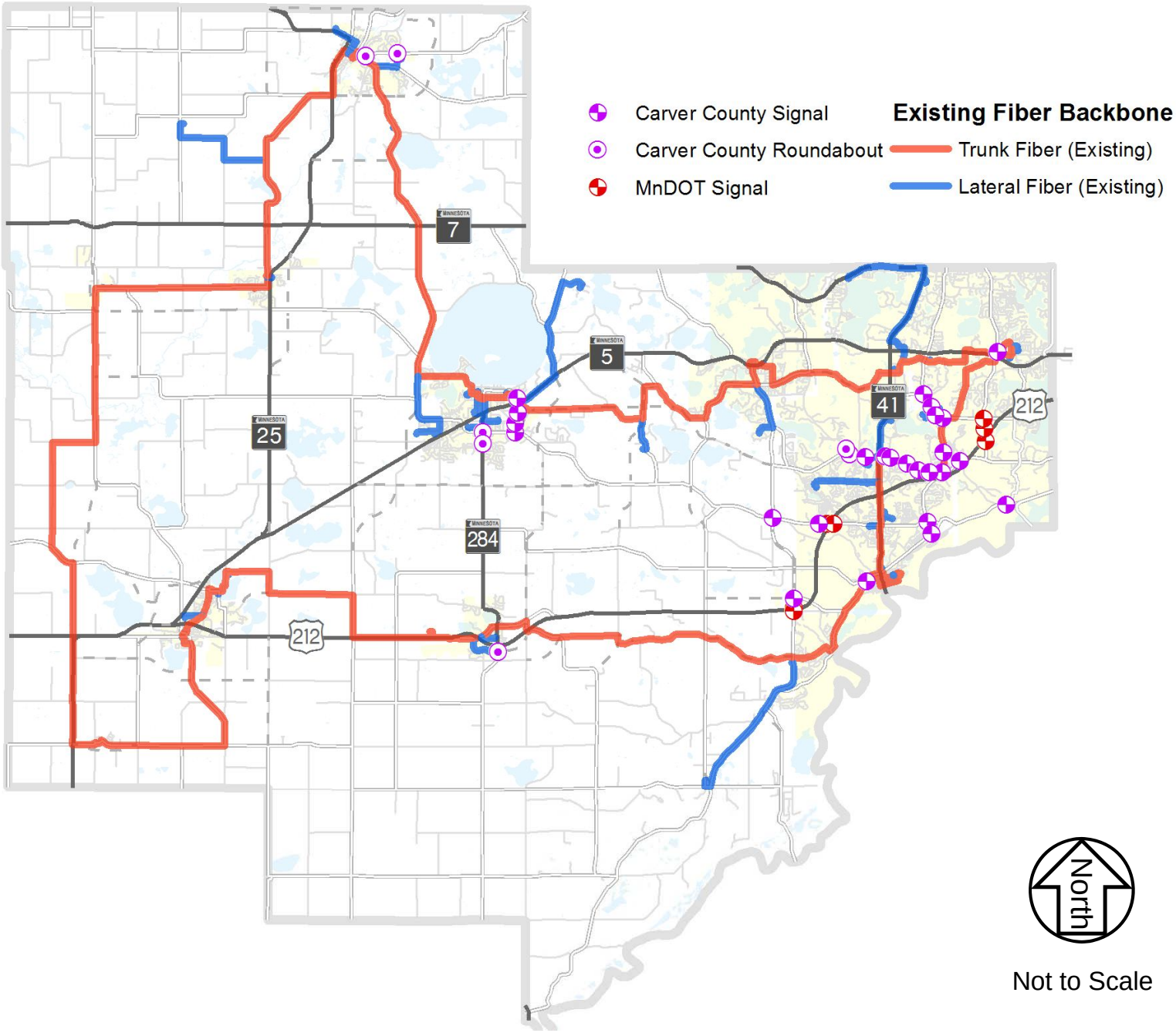
Once the set of intersections to include in the network had been determined, the following process was used to determine how best to connect each intersection. This process used Geographic Information System (GIS) data processing to ensure that results were repeatable, and that different assumptions about the devices to be connected could be tested and the effect on overall costs determined. Based on feedback from County staff, fiber optic connections are assumed to all traffic control devices. During final system design, other media (such as copper twisted pair, co-axial or wireless connections) may be evaluated to optimize the cost/performance tradeoffs.

The plan development process proceeded in a stepwise fashion as follows:

1. Identify and map all existing signals, interconnect and fiber optic infrastructure (see Figure 2).
2. Identify and map possible future traffic control devices.

3. Assign priorities based on the method described in the previous section.
4. Select only the medium- and high-priority traffic control locations.
5. Identify County rights-of-way, assuming that new fiber installations will follow these paths.
6. Calculate the shortest distance from each traffic control device, following County right-of-way, to the nearest available fiber connection point.
7. For each segment identified in the previous step, calculate the distance and associate it with the appropriate traffic control device.
8. Using a planning estimate for cost per foot, calculate the cost for each segment of planned fiber.
9. Map all of the new segments and review network geography for consistency.
10. Create simple overview schematic plan showing the connections between traffic control devices and the fiber optic infrastructure.
11. Create detailed (near design level) schematics. Include detail on type of interconnect media, which fibers used, handholes, splice vaults.

The results of steps 9 and 10 (overview map and overview schematic) are shown in Figures 3 and 4 below. A detailed, full-size overview map is provided in Appendix A. The results of step 11 (detailed schematics) are provided in Appendix B.



Existing Traffic Signals and Fiber Optic Network

Figure 2

Traffic Signal Communication Plan

Carver County

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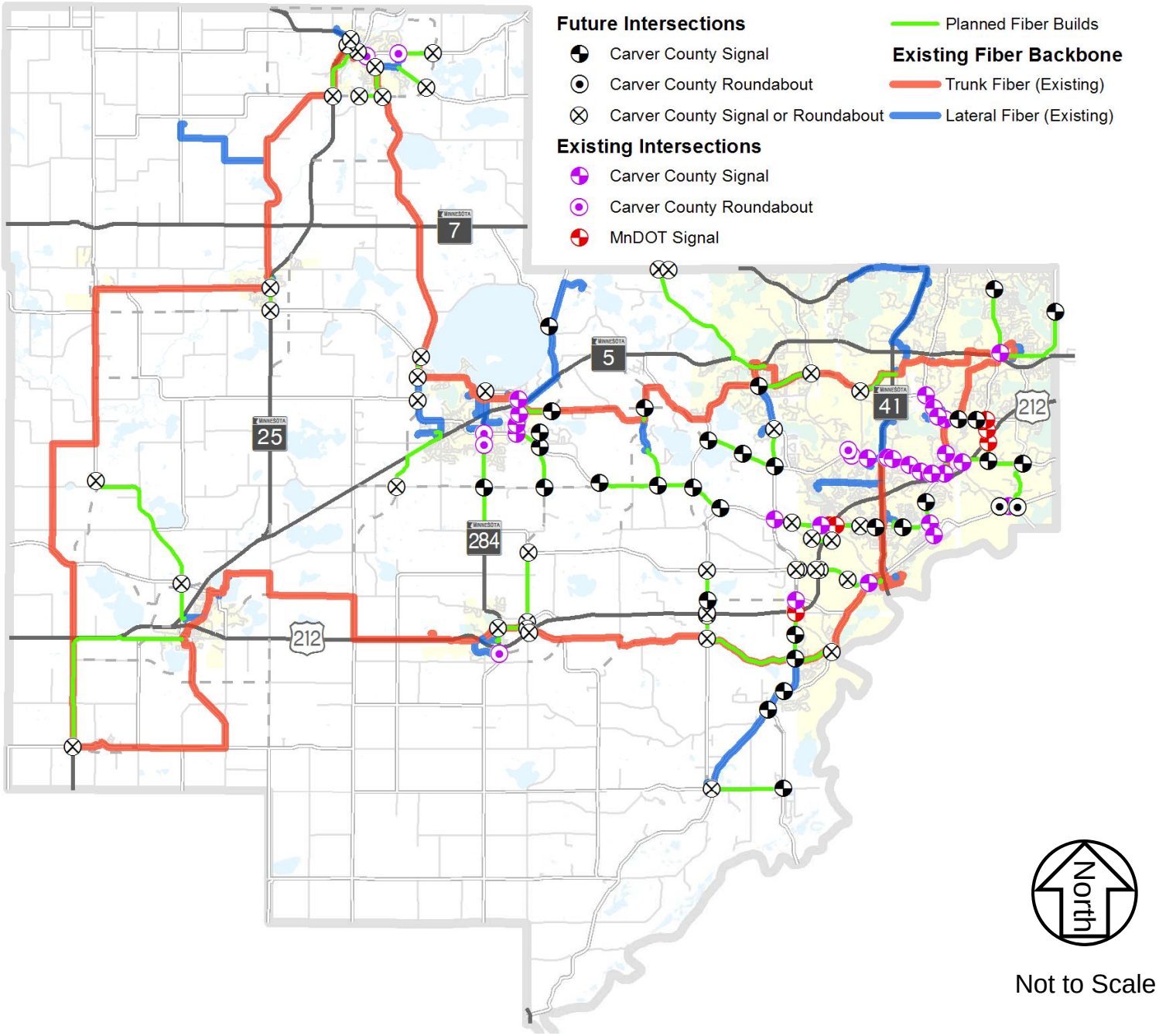

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Future Traffic Signals and Fiber Optic Network

Traffic Signal Communication Plan

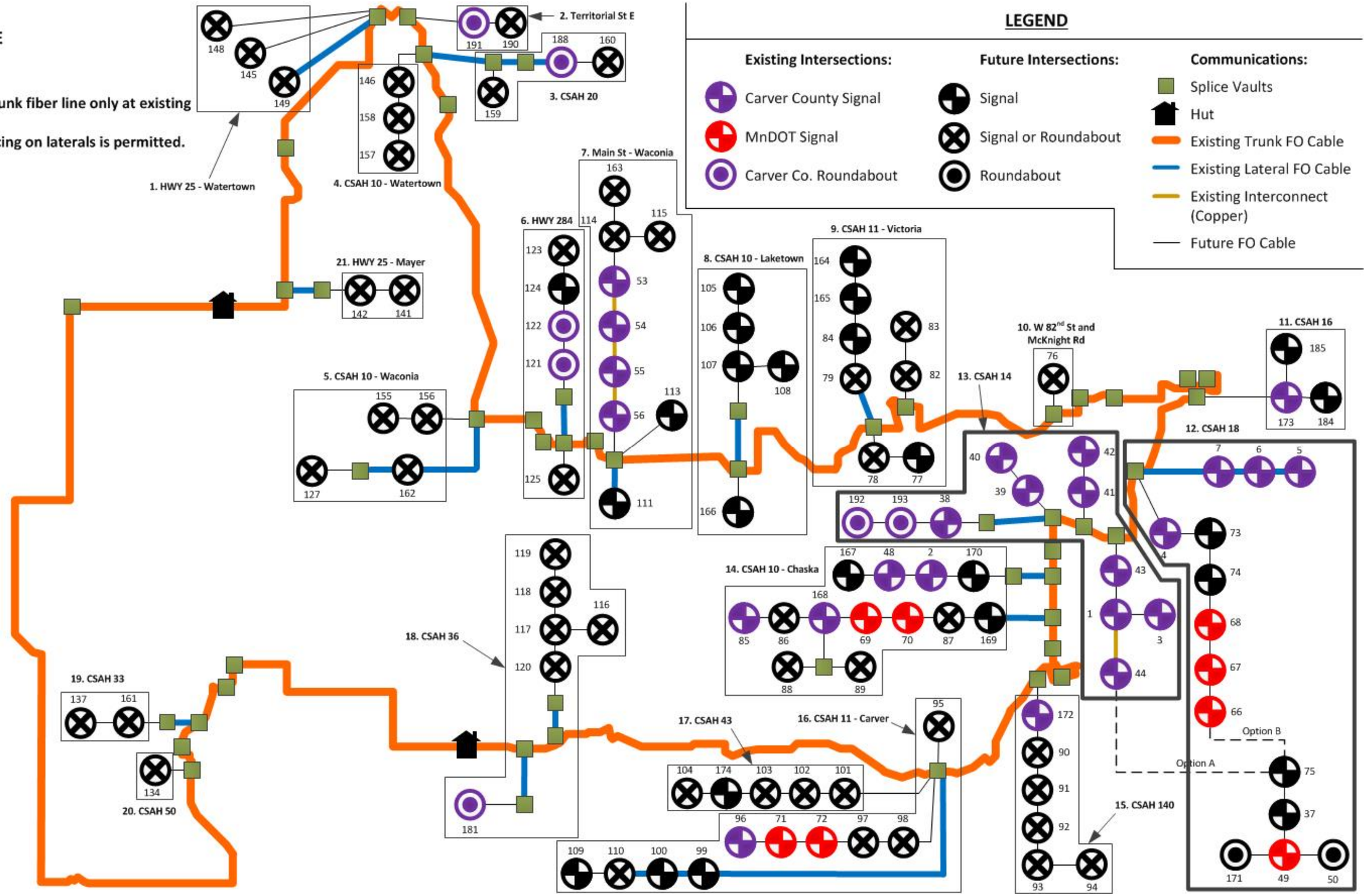
Carver County

Figure 3

NOT TO SCALE

Notes:

1. Assumes splicing to trunk fiber line only at existing splice vaults.
2. Assumes midway splicing on laterals is permitted.



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Future Fiber Optic Network

Traffic Signal Communication Plan

Carver County

Figure 4

Cost Estimate

Communications Links

A planning level estimate of the cost to add each intersection to the overall communications network was completed. This estimate includes hardware installation costs related to communication lines (in general, fiber optic cable), Ethernet switches, and design and integration costs. A detailed estimate of the cost to connect a typical intersection is provided in Table 2.

Table 2. Site Equipment Cost Estimate Assumptions

Item	Unit	Qty. per Site	Cost per Unit	Cost per Site
Fiber optic splice	Each	4	$45	$180
Fiber optic splice closure	Each	1	$510	$510
Fiber optic termination panel	Each	1	$500	$500
Splice Vault	Each	1	$1,500	$1,500
Pull Box	Each	Varies	$950	Varies
Ethernet switches	Each	1	$1,600	$1600 (incl. w/ new cabinets)
Ethernet switch power supply	Each	1	$195	$195
Fiber optic interfaces for switch	Each	2	$650	$1,300

These costs were aggregated with the cost per foot of fiber optic cable ($4.10 per foot for 2-inch conduit and $2.35 per foot for 96-strand fiber optic cable) to produce and overall planning estimate of $11.50 per foot for fiber optics, including all splicing, hardware, electronics and installation. This $11.50 per foot price was used to generate a planning level cost estimate for each segment, discussed in Signal Group Estimates section below.

Prior to procuring hardware based on the following recommendations, a detailed investigation of intended operations and the capabilities of specific products should be performed.

Signal Group Estimates

For purposes of presentation, traffic control devices were logically grouped into "chains" of devices that connect to a single point on the fiber optic backbone. This allows for more detailed cost estimates, and groups signals that are likely to be deployed within a similar time frame. In total there were 21 groups in the county, as shown in Figure 4. (Note: existing signals shown in **bold**.)

Table 3. Interconnect Cost Estimates

Group Name	Group Number	Intersection Numbers	Fiber Length (feet)	Cost Per Group
Highway 25 - Watertown	1	145, 148, 149	7,600	$88,000
Territorial St E	2	**191**, 190	1,000	$12,000
County Road 20	3	**188**, 159, 160	9,000	$104,000
County Road 10 - Watertown	4	146, 157, 158	6,400	$73,000
County Road 10 - Waconia	5	155, 156, 162, 127	12,800	$147,000
Highway 284	6	**121**, **122**, 123, 124, 125	13,400	$154,000
Main St - Waconia	7	**53**, **54**, **55**, **56**, 114, 163, 111, 113, 115	14,400	$165,000
County Road 10 - Laketown	8	105, 106, 107, 108, 166	21,900	$252,000
County Road 11 - Victoria	9	79, 84, 165, 164, 78, 77, 82, 83	40,500	$466,000
W 82nd St and McKnight Rd	10	76	5,500	$63,000
County Road 16	11	**173**, 184, 185	19,200	$221,000
County Road 18	12	**4**, **5**, **6**, **7**, 73, 74, **66**, **67**, **68**, 75, 37, **49**, 50, 171	22,900	$264,000
County Road 14	13	**44, 1, 3, 43, 42, 41, 40, 39, 38, 193, 192**	8,800	$101,000
County Road 10 - Chaska	14	170, **2**, **48**, 167, 169, 87, **70**, **69**, **168**, 86, **85**, 88, 89	26,400	$303,000
County Road 140	15	**172**, 90, 91, 92, 93, 94	11,500	$ 132,000
County Road 11 - Carver	16	95, 98, 97, **71**, **72**, **96**, 99, 100, 110, 109	21,000	$242,000
County Road 43	17	101, 102, 103, 174, 104	19,900	$229,000
County Road 36	18	**181**, 120, 117, 118, 119, 116	15,800	$182,000
County Road 33	19	137, 161	23,500	$270,000
County Road 50	20	134	26,200	$301,000
Highway 25 - Mayer	21	142, 141	4,000	$ 46,000
TOTAL – ALL SIGNALS, EXISTING AND FUTURE			331,700	$3.8 M

Centracs

While several ATMS software packages could be used to perform signal management and monitoring functions desired by the County, in practice the software provided by the manufacturer of the traffic signal controllers to be managed provides the highest level of compatibility and functionality. For Carver County, this means that Centracs, Econolite's ATMS solution, is the first option to consider.

Numerous other agencies in Minnesota and nearby states have moved from Econolite closed loop systems to a Centracs ATMS system with success, including:

- City of St. Paul
- City of St. Cloud/Stearns County/MnDOT District 3 St. Cloud
- City of Grand Forks, North Dakota
- City of Duluth (installation underway)
- WisDOT

The primary disadvantage of conversion to an ATMS system (Centracs or other), is cost. Initial cost for ATMS hardware and software can range from $100,000 to more than $300,000. Ongoing yearly software management costs can exceed $20,000. Both initial and ongoing costs can vary widely. Carver County should work directly with Econolite's local vendor's representative, Traffic Control Corporation, to confirm deployment needs and costs.

Prioritization and General Recommendations

The following should be considered in prioritizing when to add each intersection.

- Resources should be focused on connecting the grouped intersections in Waconia, on CSAH 18, and on CSAH 14 first. These are contained in Signal Groups 7, 12 and 13.
- Once the grouped intersections have been connected to the communications network, the County's next focus should be on procuring Centracs (or another ATMS platform) and making it operational.
- After the County's ATMS is up and running, the remaining existing standalone intersections should be brought online as funding becomes available.
- After all existing intersections are online, the County should plan for building out the remaining linkages in geographical groups. Where possible, the addition of these links should be tied to other construction work to minimize cost.
- As the County reconstructs and adds new roadway, fiber optic cable (or, at a minimum, conduit for future fiber optic cable installation) should be provided along the entire length of the roadway in the locations shown in the Communications Plan.

Appendix A

Full Size Overview Map – Future Traffic Signals and Fiber Optic Network

Appendix B

Detailed Fiber Schematics