**“You cannot escape the responsibility of tomorrow,**

**by evading it today”**

- *Abraham Lincoln*

## 2.0 Existing System Evaluation

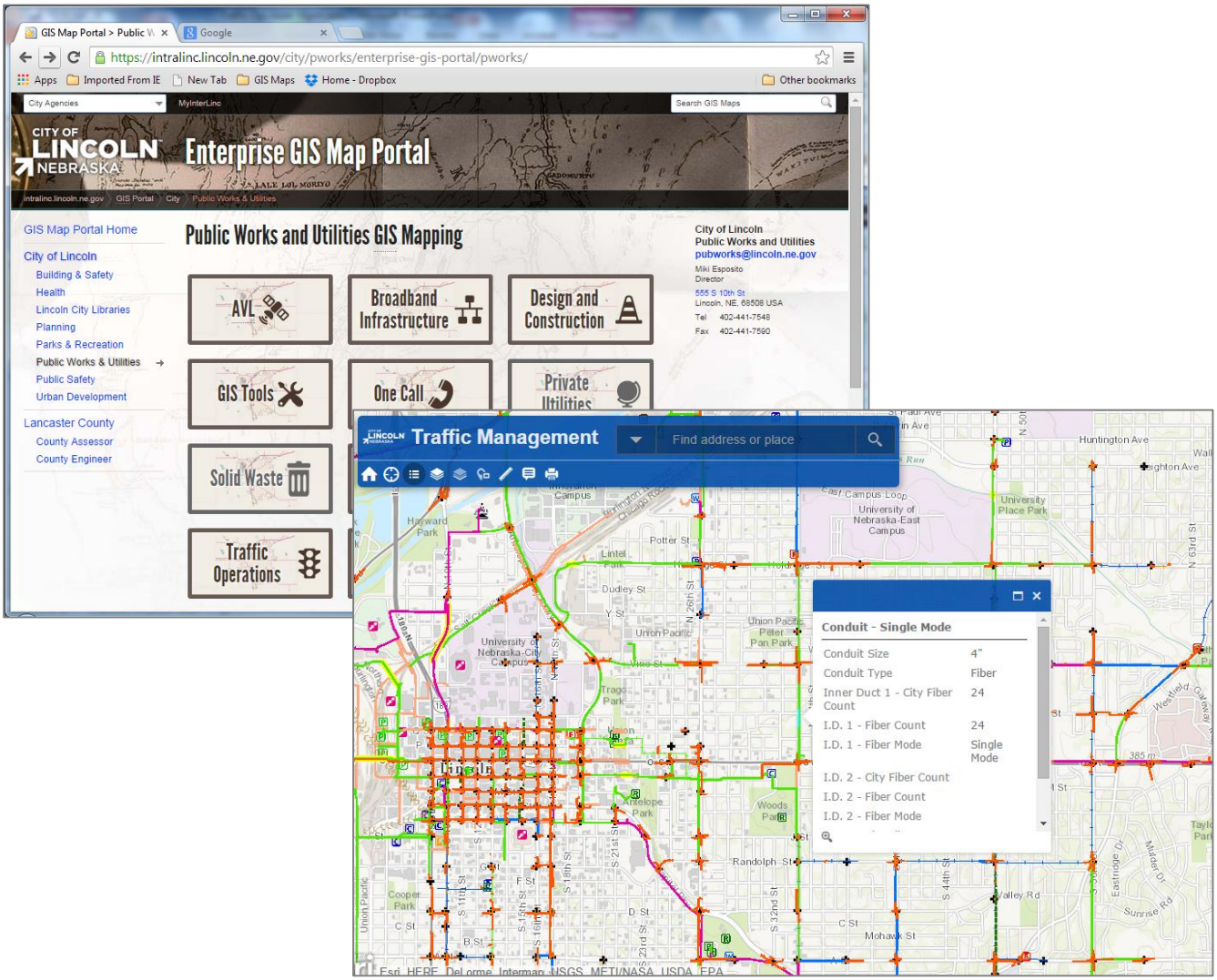
In order to properly conduct any system evaluation, detailed knowledge of the existing conditions is required. There are many components to the various traffic management system assets – multiple types of equipment, products, technical specifications, and annual purchase contracts for infrastructure, in addition to annual maintenance logs, and work orders. As such, getting a pulse of these current system components – age, condition, compatibility, and operational characteristics, reveals information about the overall system health.

A major effort was undertaken in 2014 to improve upon the records and asset management of this system information. What started as a plethora of hard copy data and unknowns in folders and cardboard boxes, was updated into a fully electronic, GIS mapping and database effort, with web-based tools to store all valuable information.


Asset Management is a key component of any complex system. By vastly improving upon the data access, knowledge, and condition status of these systems in 2014-2015, the Traffic team has revamped maintenance programs and workflow. More is known about the system components and communications network (both historical and new items) than ever before. Information sharing via web-based GIS tools, field techs logging work and system updates on mobile tablets, and efficiencies in troubleshooting via automated notifications – are all items that have improved with a focus on this asset management.

With the enhancements of diligent asset management comes the benefit of real, accurate, self-assessment. The power of self-assessment with any system or program is learning about, and measuring performance. Often times this "look in the mirror" yields positive results and outcomes, and sometimes a closer examination can provide great opportunity for improvement.

With the massive amounts of data now at our fingertips, and easy to find and navigate, more and more is known about the systems daily. Every traffic signal pole, every cabinet, every pull box and underground piece of conduit, every fiber optic cable – where it runs, where it is spliced and which facility it serves, is now all known. Every vehicle detector loop, every camera, every signal and flashing beacon is now mapped, with database characteristics through the Map Portal. And more importantly, new data is added almost daily, and locations of facilities can be corrected on the fly through the One-Call Locate process, and field staff outfitted with mobile tablets. This further improves the reduction of utility hits, and costly emergency repairs. The sections that follow summarize many of the existing assets. In addition, an asset management inventory is included in Appendix A.



## 2.1 Traffic Signal System Hardware

Several of the specific traffic signal system components were documented and evaluated as part of reviewing the existing system. While there are dozens of key hardware items, the priority components are summarized in the subsections that follow.

### 2.1.1 Traffic Signals

The City of Lincoln currently owns and operates approximately 430 traffic signals. The Nebraska Department of Roads (NDOR) currently owns and operates 5 traffic signals, in and around the city.

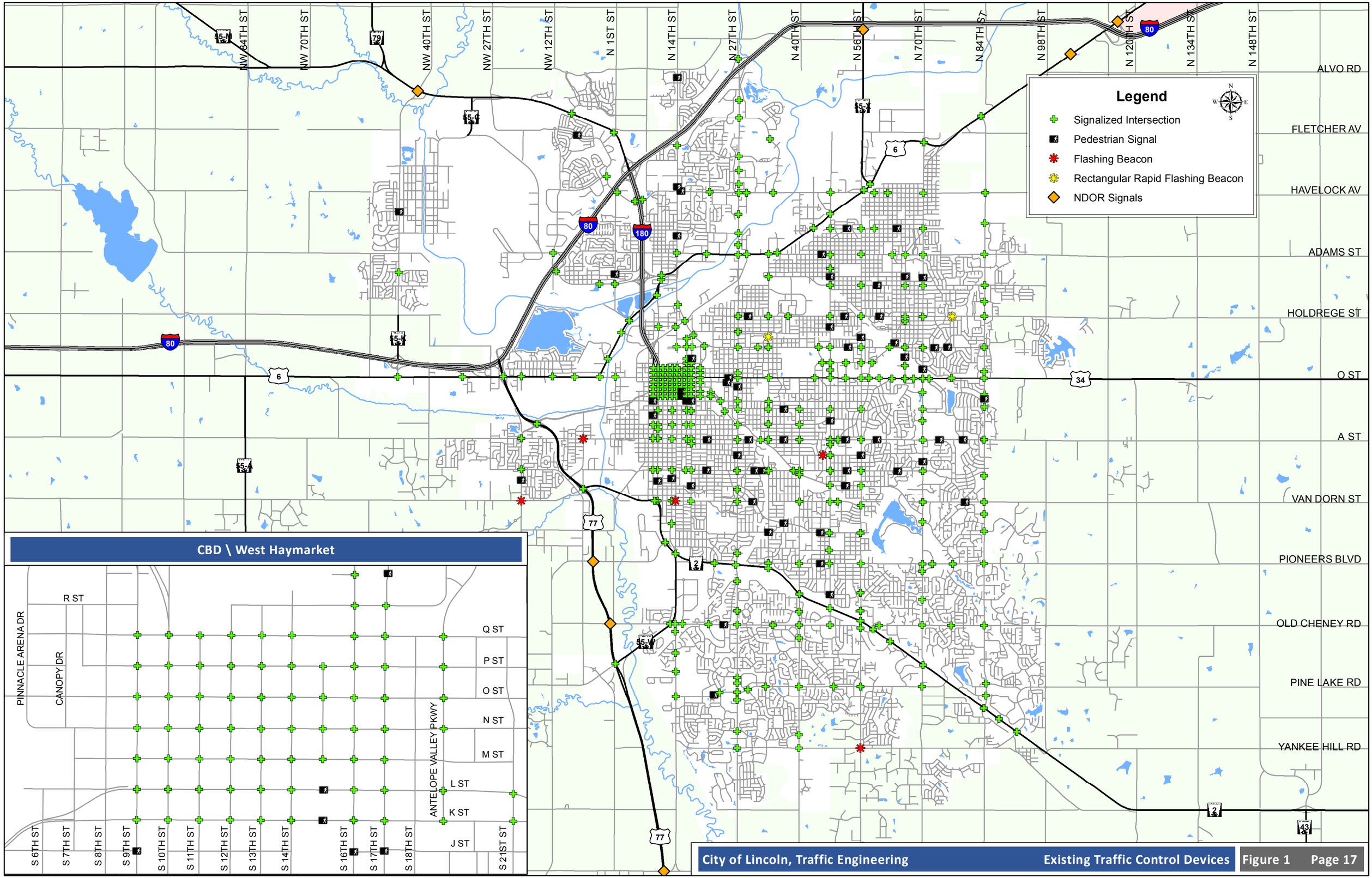
Table 1 summarizes the number of traffic signals by type, including full vehicle installations, pedestrian installations, rectangular rapid flashing beacon (RRFB) locations, and other flashing beacon facilities.

**TABLE 1 – TRAFFIC SIGNAL TYPES**

| Type of Installation | Number |
|---|---|
| Vehicle Signals | 350 |
| Pedestrian Signals | 66 |
| Flashing Beacons | 14 |
| RRFB Locations | 2 |
| TOTAL | **432** |

*Note: Currently 71 intersections are still span wire construction.

Additional signals are expected to be constructed and/or activated during the 2015/2016 construction season. Some of these projects will be upgrades to existing signals. Figure 1 illustrates the type and location of all existing traffic control devices.


NW 84TH ST
NW 70TH ST
NW 40TH ST
NW 27TH ST
NW 12TH ST
N 1ST ST
N 14TH ST
N 27TH ST
N 40TH ST
N 56TH ST
N 70TH ST
N 84TH ST
N 98TH ST
N 120TH ST
N 134TH ST
N 148TH ST
ALVO RD
FLETCHER AV
HAVELOCK AV
ADAMS ST
HOLDREGE ST
O ST
A ST
VAN DORN ST
PIONEERS BLVD
OLD CHENEY RD
PINE LAKE RD
YANKEE HILL RD
Legend
Signalized Intersection
Pedestrian Signal
Flashing Beacon
Rectangular Rapid Flashing Beacon
NDOR Signals
CBD \ West Haymarket
R ST
Q ST
P ST
O ST
N ST
M ST
L ST
K ST
J ST
PINNACLE ARENA DR
CANOPY DR
ANTELOPE VALLEY PKWY
S 6TH ST
S 7TH ST
S 8TH ST
S 9TH ST
S 10TH ST
S 11TH ST
S 12TH ST
S 13TH ST
S 14TH ST
S 16TH ST
S 17TH ST
S 18TH ST
S 21ST ST

### 2.1.2 Signal Controllers

Current traffic signal controllers in the field are Eagle EPAC models, operating on SEPAC local software. The city currently uses 3 different chassis with a variety of different versions of this software. As an example the "M52" controller model has up to 4 software versions, all with subtle differences and capabilities. Table 2 summarizes the types of controllers and number of each utilized throughout the City of Lincoln.

**TABLE 2 – TRAFFIC SIGNAL CONTROLLER TYPES**

| Controller Type | Number |
|---|---|
| M52 – RELEASED 2002 | 225 |
| M40 – RELEASED 1996 | 135 |
| M03 – RELEASED 1984 | 56 |
| TOTAL | **416** |

### 2.1.3 Cabinets

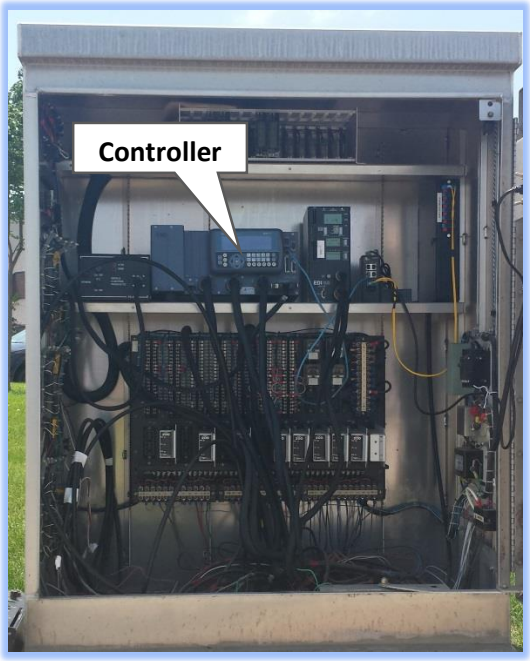
The City of Lincoln has a variety of traffic signal and ITS cabinets in the field. Table 3 summarizes the types of cabinets and number of each utilized throughout the City of Lincoln.

**TABLE 3 – TRAFFIC CABINET TYPES**

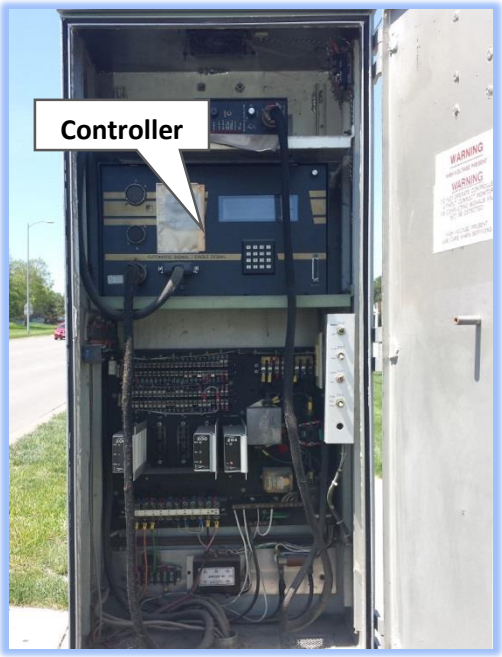
| Cabinet Type | Number |
|---|---|
| TS-C | 304 |
| TS-B | 61 |
| TS-A | 75 |
| 346 ITS | 5 |
| TOTAL | **445** |

Today the National Electrical Manufacturers Association (NEMA) maintains the TS2 standard for traffic signal cabinets, controllers and related equipment used by the City of Lincoln. The TS2 standard that new city cabinets are built to is backwards compatible with the TS1 standard that the city's older cabinets were previously built to. These standards specify a range of cabinet sizes, which are designated as A, B and C; all having shelves, and a door on one side. Lincoln cabinet inputs and outputs consist of binary (on / off) logic wires connected to the controller via three connectors designated as 'A', 'B', and 'C'. It is common for these cabinets to provide additional input / output control wires via a connector designated as 'D'. All of the controller inputs and outputs are available to the operator via the cabinet back board or side panels.

The photos below illustrates different cabinets and different internal components.




**NEMA TS-C Cabinet**




**NEMA TS-A Cabinet**

### 2.1.4 Detection

Throughout the traffic signal controlled intersections across the City, different types of vehicle detection are utilized to detect the presence and approach of vehicles on various legs of the intersection. These vehicle detectors are required to help the signals run efficiently and assist with safety (clearance intervals) on higher speed approaches. The detectors are identified as 1) inductive loops, 2) optical cameras, 3) magnetic probe, 4) infrared cameras, and 5) wireless magnetics. In addition, pedestrian crossing signals generally use pedestrian-activated push-button detection. The remaining signals may or may not have detection, depending on their specific function, location and actuation requirements. (Example – CBD area intersections that run in "pretimed" mode). Most signals use a combination of primarily loops and cameras. Table 4 shows the breakdown of these intersections.

**TABLE 4 – VEHICLE DETECTOR TYPES**

| Detector Used | Number of Intersections |
|---|---|
| Loops Only | 156 |
| Loops w/ Cameras | 134 |
| Camera Only | 18 |
| No Detection Used | 108 |

Despite rigorous maintenance activities, the existing system of detectors are in need of updating. Based upon inventory data, more than 30% of the current detection is faulty. Due to continued pavement rehab projects historically that have resulted in saw-cut loops with shorter lifespan, or outdated camera detectors beyond their lifecycle and warranty, the resultant detection system requires priority attention. The photos below depict typical loop placement in the pavement that are no longer in service.

**Saw-cut Loop in Damaged Pavement**

**Saw-cut Loop Wire Damage**

Many of the arterial / arterial intersections can have upwards of 60 to 70 loops – both stop bar detection and advanced detection loops on the approaches. With over 15,000 vehicle detection locations Citywide it is evident that this aging infrastructure, in addition to paving rehab projects, presents operational challenges.

An additional opportunity for improvement lies within several of the older camera detection locations that have experienced an increasing failure rate over the last 3 seasons. Much of this is due to the age and technology components within the older model cameras and the need for field hardened requirements. The Traffic Engineering team has completed new procurement specifications and has approved new products as of this Fall, 2015. A picture of typical, older, non-intrusive camera detection on a signal mast arm is illustrated at right.

Many of the weekly calls and complaints from citizens regarding the signal system are in response to failed detection issues. Whether it is an issue of side street traffic not being detected and being served a green signal indication, or mainline arterial signals turning red, with no side street vehicles present, this is typically an issue with the intersection detection system. Figure 2 illustrates the existing faulty detection locations.

NW 84TH ST
NW 70TH ST
NW 40TH ST
NW 27TH ST
NW 12TH ST
N 1ST ST
N 14TH ST
N 27TH ST
N 40TH ST
N 56TH ST
N 70TH ST
N 84TH ST
N 98TH ST
N 120TH ST
N 134TH ST
N 148TH ST

ALVO RD
FLETCHER AV
HAVELOCK AV
ADAMS ST
HOLDREGE ST
O ST
A ST
VAN DORN ST
PIONEERS BLVD
OLD CHENEY RD
PINE LAKE RD
YANKEE HILL RD

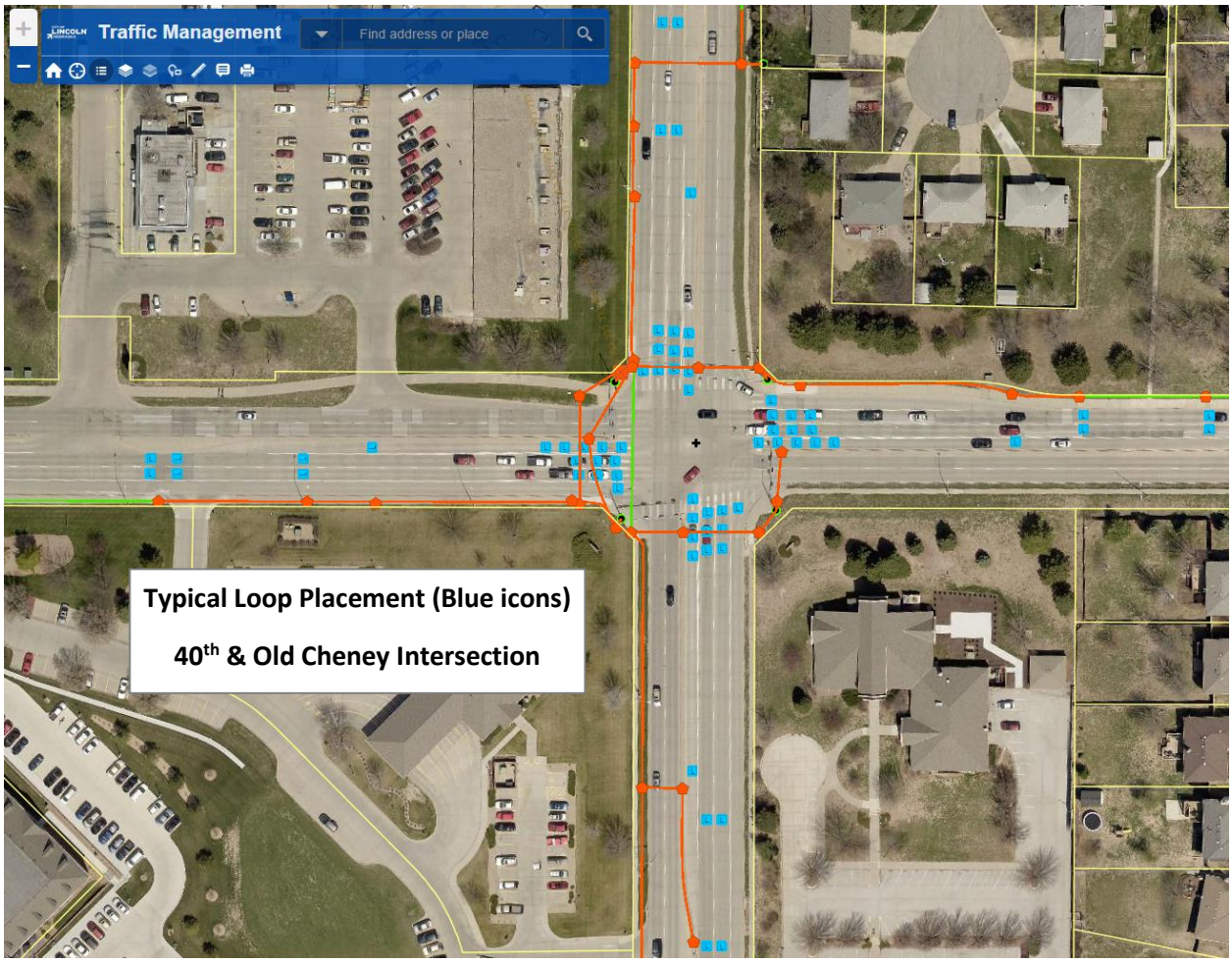
## Legend

- Signalized Intersection
- Pedestrian Signal
- Flashing Beacon
- Rectangular Rapid Flashing Beacon
- NDOR Signal
- Faulty Detection

## CBD \ West Haymarket

R ST
Q ST
P ST
O ST
N ST
M ST
L ST
K ST
J ST
PINNACLE ARENA DR
CANOPY DR
ANTELOPE VALLEY PKWY
S 6TH ST
S 7TH ST
S 8TH ST
S 9TH ST
S 10TH ST
S 11TH ST
S 12TH ST
S 13TH ST
S 14TH ST
S 16TH ST
S 17TH ST
S 18TH ST
S 21ST ST

As depicted in the typical intersection layout below (40th & Old Cheney), when these detection locations begin to fail, it costs money and time to troubleshoot specific locations. Furthermore, for individual loop fixes it can mean lane closures and lengthy downtime and delays for traffic if new saw-cut loops are needed.



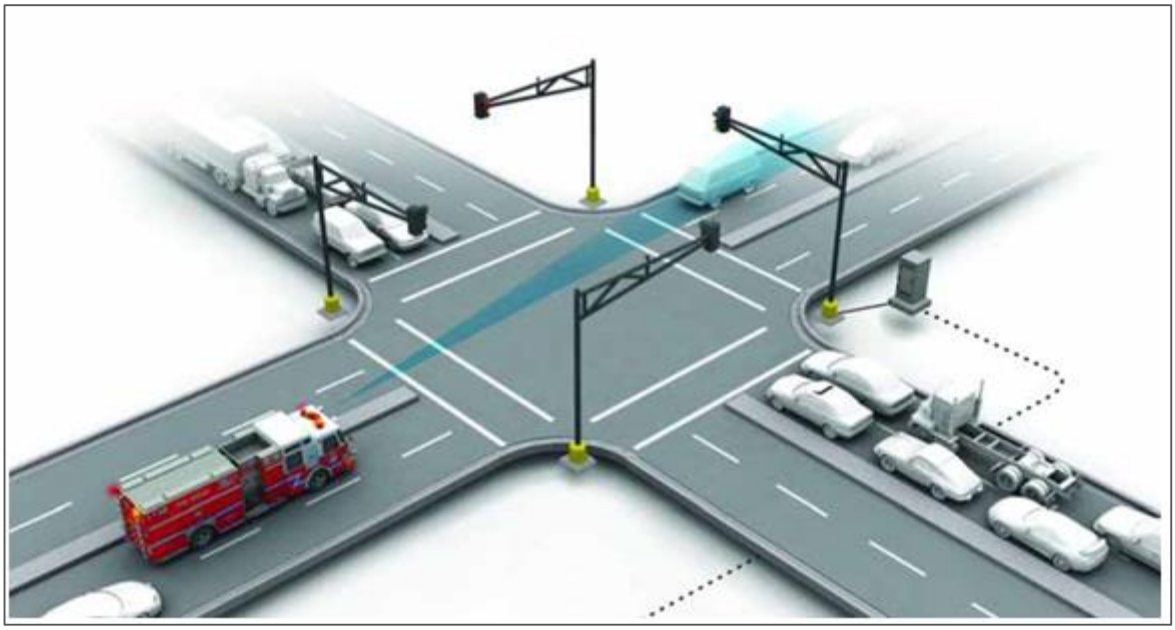

**Typical Vehicle Detection Zone Layout**

Traffic Operations has enacted an internal best practice of "no new saw-cut loops" in pavement if they can be avoided with any other feasible solution. The goal is to avoid damage to old concrete, or elimination of these cuts in newly rehabilitated pavement. In addition, with costs of loop replacement at approximately $1,000 each it is easy to drive detection costs north of $50,000 during rehab work. By comparison, a new non-intrusive detection system can be installed for less than $25,000 per intersection. Options for these types of deployments within the existing environment will save time and money.

### 2.1.5 Emergency Vehicle Preemption (EVP)

Emergency vehicle preemption systems give priority to specific emergency vehicles as they approach an intersection (causing the signal to cycle and provide green indications quickly in a responsive manner). EVP systems are currently deployed at 166 signals in the City of Lincoln. Some intersections are equipped with only a single approach to the intersection, and others with multiple approaches depending on typical emergency vehicle routes.


EVP systems include one or two receivers mounted on signal mast arms and in-vehicle transmitters with the various emergency responder vehicles. All current EVP systems use infrared technology to provide preemption for any emergency vehicles (typically police, fire, ambulance) equipped with a transmitter device and approaching a signal from any direction.



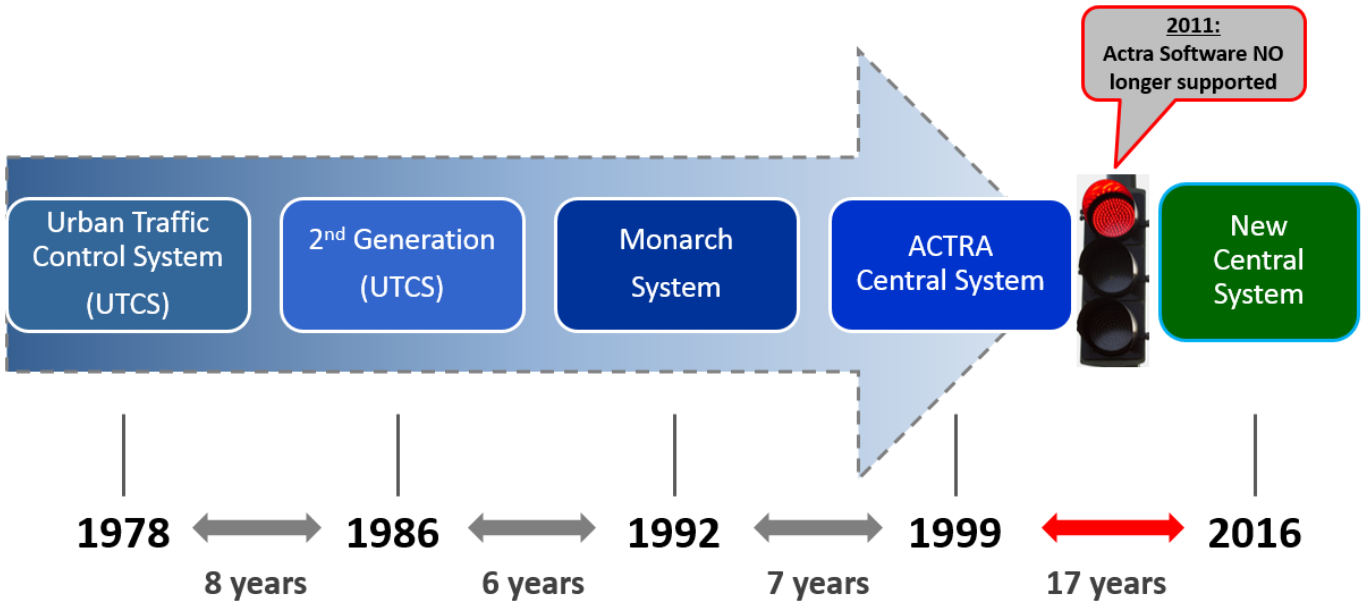
**Typical EVP System Concept**

These locations are periodically review with Lincoln Fire and Rescue for additions, removals, and/or modifications based upon new station locations or new traffic signals constructed. A continued challenge of these systems is the request for new locations or maintenance of existing locations with no prioritized and defined budget for such between the emergency response agencies and Public Works.

## 2.2 Central Signal System Software

The City of Lincoln currently utilizes a central signal system software package to communicate in near real time to the majority of the traffic signal controlled intersections throughout the City. This software is installed at the MSC and is used to keep field controller clocks in synch, download and upload signal timing information, store signal settings in the database and provide alarm notifications of system or communication failures.

In 1999 the City of Lincoln purchased this Actra system, a Siemens product. It has been the software used for timing and coordination of the City's intersections. While the system has been a good product, it has become dated, along with the associated controller hardware and software that is installed in the field locations. As of 2011 Siemens stopped servicing or updating additional builds and patches for the software. Thus the vendors that sell and represent the products also discontinued support and servicing of the Actra software package. A timeline of the City of Lincoln signal system software packages, and migration path is illustrated below.




**City of Lincoln – Signal System Upgrade Timeline**

An additional, paramount challenge is that the system is not compatible with operating systems newer than Windows XP. Due to the City's recent upgrade of Windows 7 across user PC's and system servers, this enterprise software now resides solely on one computer in the Traffic Team offices, and one laptop in the traffic signal shop. As such, critical staff beyond the signal system technician do not have access to this software, including the Traffic Engineer.

## 2.3 Communications Systems

The following section provides a brief description of the existing communications infrastructure currently in use, its condition, and the typical installations for the traffic management system. The previously developed "Lincoln Technology Improvement System, Broadband Infrastructure Plan" was completed in coordination with Traffic Engineering staff and provides additional detail on the City's overall communications network. An Executive Summary of this document is included in Appendix C for additional information.

Traffic ITS and Communications staff currently operate and maintain the entire City of Lincoln communications system. This includes both wired and wireless infrastructure to all signals, field devices, and City buildings throughout the network. Much work has been done to continue to improve the high speed characteristics of this system providing improved reliability and connectivity to various stakeholders.

### 2.3.1 Existing Communications Infrastructure

There are currently three primary types of communication media throughout the City: 1) twisted pair copper (overhead and in conduit), 2) wireless radios, and 3) fiber optic cable. Table 5 summarizes the type of communication media in use by the traffic field devices.

**TABLE 5 – INTERSECTION COMMUNICATION IN-USE**

| Communication Type | Number of Cabinets |
|---|---|
| Fiber | 213 |
| Copper | 170 |
| Radio | 33 |

**Note: Intersections may use multiple communication types*

Copper communication lines are the oldest of all types of communication media. Many older parts of the city are still connected using these copper links. Radios are used when no conduit connects isolated intersections and to bridge unconnected areas. The city has recently been focusing on installing fiber optic cable, with a majority installed to numerous intersection locations and facilities. The City has underway several upgrade projects to replace all of the multi-mode fiber to single-mode fiber and hopes to have it all replaced within the next 2-3 years. Table 6 below and Figure 3 on the following page illustrates the existing communications system characteristics and locations.

**TABLE 6 – COMMUNICATION LENGTHS**

| Communication Type | Length |
|---|---|
| Fiber | 144 miles |
| Copper | 27 miles |
| Radio | 25 miles |
| All Aerial | 19 miles |

NW 84TH ST
NW 70TH ST
NW 40TH ST
NW 27TH ST
NW 12TH ST
N 1ST ST
N 14TH ST
N 27TH ST
N 40TH ST
N 56TH ST
N 70TH ST
N 84TH ST
N 98TH ST
N 120TH ST
N 134TH ST
N 148TH ST

ALVO RD
FLETCHER AV
HAVELOCK AV
ADAMS ST
HOLDREGE ST
O ST
A ST
VAN DORN ST
PIONEERS BLVD
OLD CHENEY RD
PINE LAKE RD
YANKEE HILL RD

**Legend**

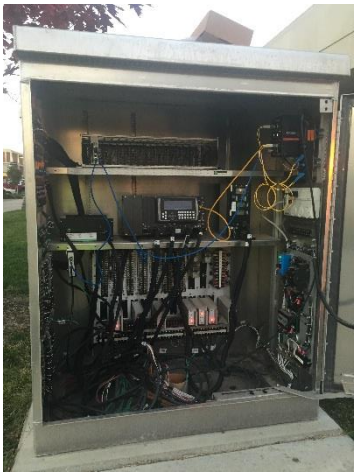
- Multi Mode Fiber Cable
- Aerial Cable
- Single Mode Fiber Cable
- Aerial Cable
- Copper Cable
- Aerial Cable
- Wireless Signal

N
W
E
S

## CBD \ West Haymarket

R ST
Q ST
P ST
O ST
N ST
M ST
L ST
K ST
J ST
PINNACLE ARENA DR
CANOPY DR
ANTELOPE VALLEY PKWY
S 6TH ST
S 7TH ST
S 8TH ST
S 9TH ST
S 10TH ST
S 11TH ST
S 12TH ST
S 13TH ST
S 14TH ST
S 16TH ST
S 17TH ST
S 18TH ST
S 21ST ST

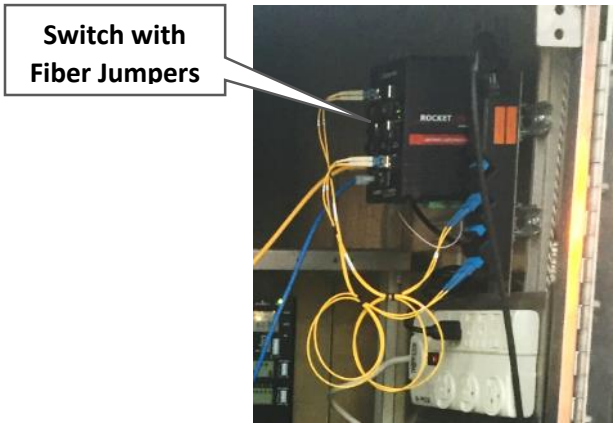
Vast improvements have recently been made to the way that cabinets and infrastructure is tied to the fiber optic communications system. Previously, fiber optic cables were brought into the physical signal or ITS cabinets via the underground system of conduits and pull boxes. The cables were then terminated within cabinets (physically cut) and then routed back out of these cabinets and down the line to the next facility. Recent changes to this setup have been made by the Traffic Team to avoid damage to fiber cable within cabinets that are in turn damaged during vehicle crashes or construction activity. In addition, only the fibers utilized for connectivity (one pair) are cut and spliced with fiber optic jumpers underground in the nearby pull box. This allows for no degradation to the mainline cable (losses) and maintains improved infrastructure for future users.



**Signal Cabinet**

**Fiber Box with Splice Enclosure**

Within the field device cabinets, the City is installing managed Ethernet switches so that signal controllers, detection, cameras, and other devices can be plugged in and assigned IP addresses on the network. These allow for remote monitoring of the communications system and improved efficiency while deploying additional equipment.



## 2.4 Intelligent Transportation Systems (ITS) Devices

Several ITS devices are operated and maintained in the current Traffic Management System. These devices are utilized to proactively manage traffic, provide traveler information, and evaluate performance of intersections and roadways. The following sections summarize these existing ITS devices.

### 2.4.1 Closed Circuit Television (CCTV) Cameras

Traffic Operations currently maintains and operates over sixty pan-tilt-zoom (PTZ) CCTV cameras. They are located throughout the city at major intersections and other strategic view locations such as Haymarket Park and select parking structures. The cameras are vital to monitoring special event traffic and are coordinated with viewing privileges amongst many other City entities including the Lincoln Police Department, Lincoln Fire and Rescue, Street Maintenance etc. In addition, local news affiliates are also granted limited viewing access. All of the existing cameras are IP addressable (Ethernet communications). Currently the software used to view all of the cameras, a basic AXIS viewer, is no longer supported and is a Windows XP based program. The Traffic Team working in coordination with the GIS team, developed a basic web viewer as part of the GIS Web Portal initiative. Traffic Engineering is currently leading a City and County procurement of a camera management software that will be compatible amongst all local agencies including partnerships with the University of Nebraska Transportation Center, and UNL Police Department amongst others.

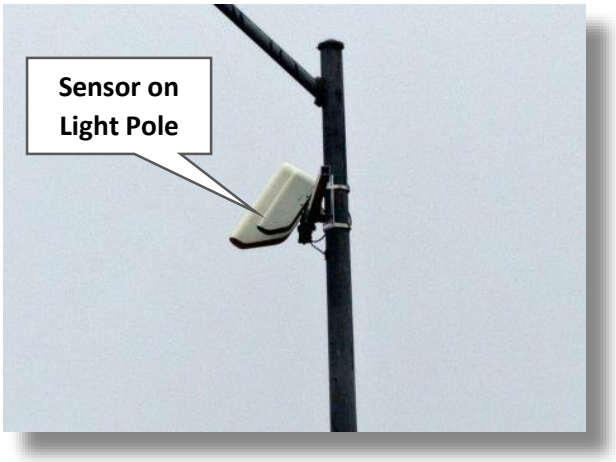
### 2.4.2 Dynamic Message Signs (DMS)

The City of Lincoln currently owns and operates a fleet of 44 DMS, consisting of approximately 27 Portable DMS Trailers, and 17 Permanent DMS on arterial roadways. The signs are used frequently for construction project traffic control and detour information, special event traffic management, and public safety announcements. With the recent addition of Pinnacle Bank Arena, the portable boards have been deployed multiple times at recurring locations to provide parking information.

The fleet of both portable and permanent signs each have a mix of primarily two separate make/models, provided by a variation of differing vendors. These signs are also currently controlled by a mix of different software applications. These applications include Centrallo, Northra, and Vangaurd control software. With the exception of newer, off the shelf software supplied with recent permanent DMS on the N. 27th Street arterial, most of the other software packages are outdated, no longer supported by the manufacturer and/or vendor, and are not easily accessible by multiple staff. Often times, the simple task of creating, and sending a message remotely to these signs is not achievable from the office, thus requiring staff time and resources to manually post messages in the field at the sign location on site. This results in challenges during emergencies and incidents (like the recent flooding events in 2015).

### 2.4.3 Condition Detection and Warning Systems

There are currently two bridge locations in the City that are instrumented with Ice Detection and Warning Systems to provide additional traveler information during inclement weather. These systems are located on the Harris Overpass ('O' Street), and on the newly rehabilitated N. 27th Street Viaduct over Leighton Avenue. The condition detection component consists of a non-intrusive sensor (infrared camera) mounted on a bridge light pole. The sensor can provide surface state temperature, moisture conditions, and calculates a "grip" coefficient. The warning system components include two permanent arterial DMS locations in advance of the bridge that are connected to the sensors and communications network/equipment at centralized cabinets below the structures.




The systems can be set to automatically post warning messages to the DMS, based upon sensor outputs during snow/ice conditions. Traffic staff have access to the sensor status remotely, and can also override any messaging for the system. Routine maintenance and calibration testing of the systems are required to keep them in acceptable operations.

Additional condition detection and warning systems include the "Road Impassable" detection and flashing beacon systems located at select underpass locations near Cornhusker Highway with both 48th Street and Havelock Avenue. These systems are currently linked via radio communications to the pump station locations. The assemblies also have outdated hardware that is frequently repaired and maintained to remain operational in times of flooding. Figure 4 illustrates the City of Lincoln existing ITS devices, while Figure 5 illustrates the total Traffic Management System.

NW 84TH ST
NW 70TH ST
NW 40TH ST
NW 27TH ST
NW 12TH ST
N 1ST ST
N 14TH ST
N 27TH ST
N 40TH ST
N 56TH ST
N 70TH ST
N 84TH ST
N 98TH ST
N 120TH ST
N 134TH ST
N 148TH ST

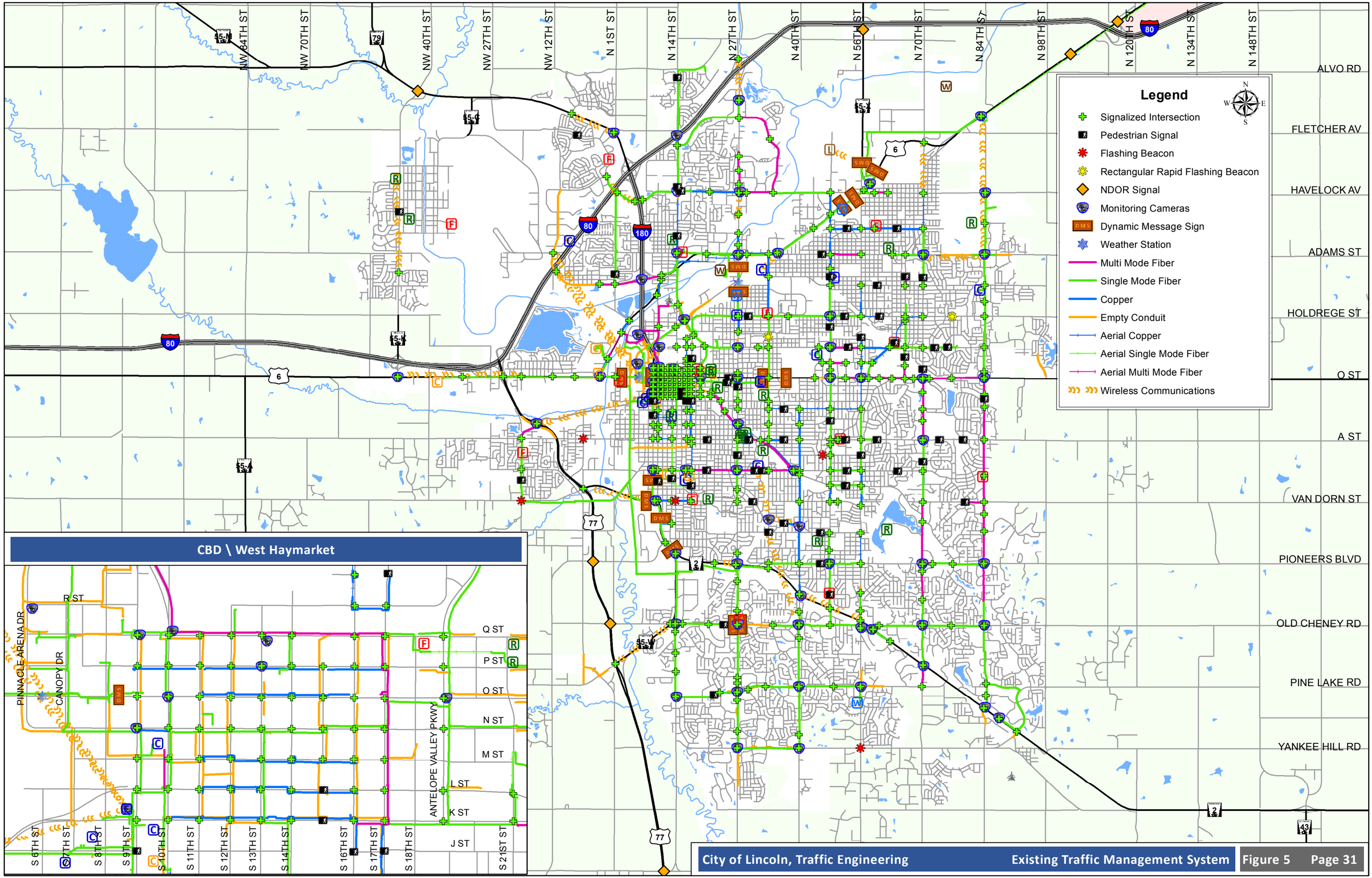
ALVO RD
FLETCHER AV
HAVELOCK AV
ADAMS ST
HOLDREGE ST
O ST
A ST
VAN DORN ST
PIONEERS BLVD
OLD CHENEY RD
PINE LAKE RD
YANKEE HILL RD

## Legend

- Monitoring Camera
- Dynamic Message Sign
- Weather Station

## CBD \ West Haymarket

R ST
Q ST
P ST
O ST
N ST
M ST
L ST
K ST
J ST
PINNACLE ARENA DR
CANOPY DR
ANTELOPE VALLEY PKWY
S 6TH ST
S 7TH ST
S 8TH ST
S 9TH ST
S 10TH ST
S 11TH ST
S 12TH ST
S 13TH ST
S 14TH ST
S 16TH ST
S 17TH ST
S 18TH ST
S 21ST ST


NW 84TH ST
NW 70TH ST
NW 40TH ST
NW 27TH ST
NW 12TH ST
N 1ST ST
N 14TH ST
N 27TH ST
N 40TH ST
N 56TH ST
N 70TH ST
N 84TH ST
N 98TH ST
N 120TH ST
N 134TH ST
N 148TH ST
ALVO RD
FLETCHER AV
HAVELOCK AV
ADAMS ST
HOLDREGE ST
O ST
A ST
VAN DORN ST
PIONEERS BLVD
OLD CHENEY RD
PINE LAKE RD
YANKEE HILL RD
Legend
Signalized Intersection
Pedestrian Signal
Flashing Beacon
Rectangular Rapid Flashing Beacon
NDOR Signal
Monitoring Cameras
Dynamic Message Sign
Weather Station
Multi Mode Fiber
Single Mode Fiber
Copper
Empty Conduit
Aerial Copper
Aerial Single Mode Fiber
Aerial Multi Mode Fiber
Wireless Communications
CBD \ West Haymarket
R ST
Q ST
P ST
O ST
N ST
M ST
L ST
K ST
J ST
PINNACLE ARENA DR
CANOPY DR
ANTELOPE VALLEY PKWY
S 6TH ST
S 7TH ST
S 8TH ST
S 9TH ST
S 10TH ST
S 11TH ST
S 12TH ST
S 13TH ST
S 14TH ST
S 16TH ST
S 17TH ST
S 18TH ST
S 21ST ST

## 2.5 Traffic System Management - Existing

The following subsections describe the existing conditions assessment of system staffing, key operational activities, preventative maintenance, and the signal rehabilitation program.

### 2.5.1 Existing Staffing

All staff that conducts work related to the traffic management system are a part of the Traffic Engineering Division within the Public Works Department. In general, there are numerous roles and responsibilities that are carried out by staff in various subsections of the Traffic Team. This includes not only specific signal system related work flow, but overall requirements to address traffic engineering functions within the City of Lincoln metropolitan area. There is a wide array of needs required within these sections as numerous citywide projects and initiatives involve the traffic engineering discipline, and associated coordination. On a daily, weekly, monthly, or annual basis, the Traffic Engineer and support staff are engaged in multiple tasks – a sampling is included below:

- Management, task scheduling, & performance evaluation of staff
- Budget management of (signals, signs/markings, safety, CIP)
- Specifications development and annual updates for over 50 traffic products (equipment/hardware)
- Development & update of City specifications and over 20 Lincoln Standard Plans
- Review, update, accept and process over 20 annual commodity and service contracts
- Coordination with multiple other City Departments on planning initiatives & inquiries
- Maintenance, operations, and inspection of over 430 traffic signals citywide
- Maintenance, operations, and inspection of 70 CCTV cameras
- Maintenance, operations, and inspection of 17 permanent DMS and 27 PDMS for traveler info.
- Guidance & input as member of City's Complete Streets Committee
- Guidance & input as member of NDOR Safety Committee
- Review & response to over 600 annual traffic inquiries from public & internal stakeholders
- Coordination w/ ten engineers & PM's in Design & Construction (D&C), including numerous construction inspection staff on multiple CIP projects
- Design review of plans, specs & estimate packages for Traffic related components of D&C CIP projects
- Management of annual citywide durable marking contract
- Coordination of temporary traffic control plan design/approvals
- Detour route planning & analysis
- Consultant oversight & Traffic Operations project management
- Delivery & oversight of citywide traffic count program
- Delivery & oversight of citywide Crash Study program
- Guidance & input as member of City's Special Events Team
- Review & approval of over 250 special event permits annually
- Field review and operational support for special events

- Coordination & deployment of temporary traffic controls for numerous city-sponsored special events
- Emergency response/callouts with LPD officers to fatality crashes
- Emergency response and repair to over 50 annual traffic equipment damage incidents (vehicle hits)
- Regular on-call for emergency signal malfunctions
- Maintenance & replacement programming of 40,000 signs
- Inspection & contractor inquiry response to signal, signing & marking projects citywide
- Planning, design, contractor coordination & final inspection of fiber optic projects
- Maintenance, operations & inspection of over 150 miles of communications conduit/cable
- Analysis & evaluation of traffic studies for capacity, pedestrians, cyclists, speed limits, signal warrants, signal phasing & safety
- Evaluation & update of school route walking maps for all LPS school facilities citywide
- Review and planning support for LPS school projects & on-going inquiries at existing sites
- Review, approval, and processing of over 500 annual invoices for products, equipment & services
- Evaluation & input as part of consultant design project selection committees
- Coordination with Railroad field and management staff regarding at-grade crossings & pre-emption
- Monthly testing/documentation of Railroad Quiet Zone equipment at crossing sites
- Input and guidance with Planning Dept. staff as part of Oversight Team on LRTP development
- Traffic signal timing evaluation and phasing adjustments
- Pedestrian & Bicycle route analysis, signing, marking, and crosswalk evaluation

In addition to the above sampling of tasks items, the Traffic Team has staff involved in numerous daily meetings to facilitate coordination with multiple departments on status of projects, inquiries, reviews and approvals for new developments, on-going construction activities, and many other strategic planning activities.

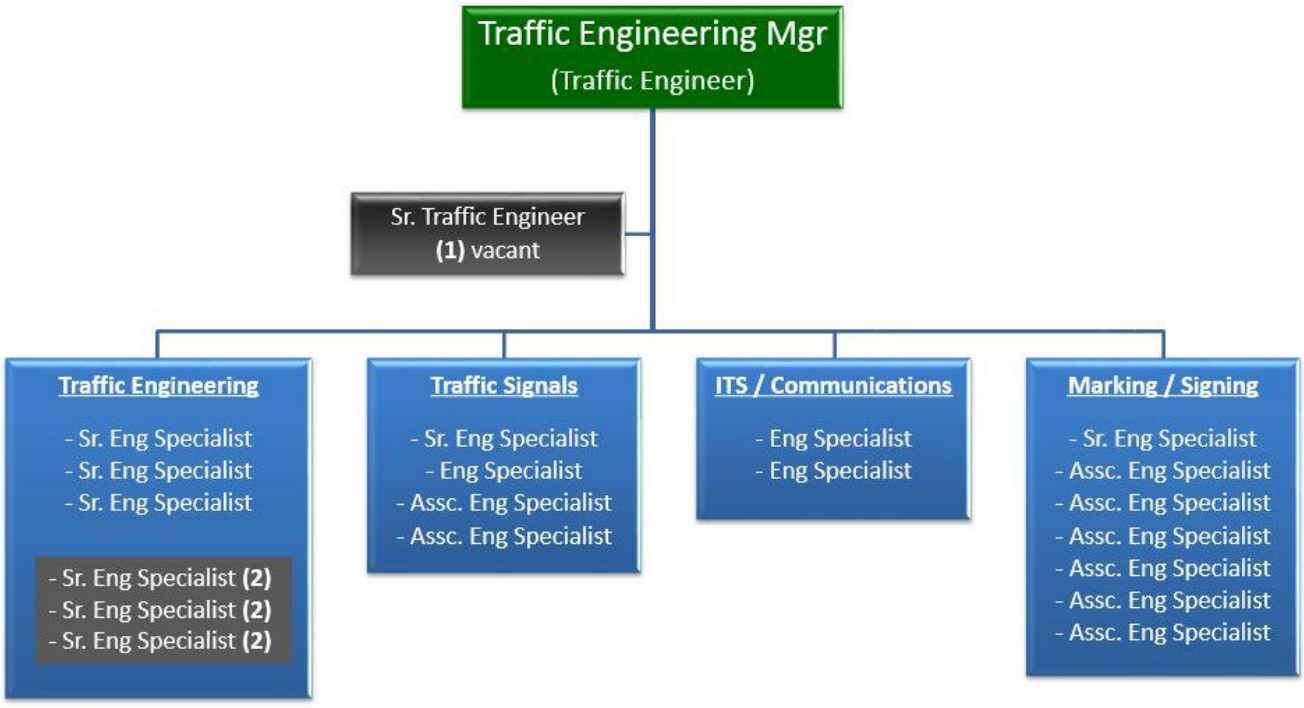
More specifically, there are functional sections within Traffic Engineering to address the demanding workload and varied work type. These include the following:

- **Traffic Operations & Safety** – Traffic studies, data collection, capacity and safety analysis, special events, traffic control, project development, planning and programming, GIS asset management, public response etc.
- **Traffic Signals** – Maintenance and operations of signal system, inspections, cabinet evaluation program, overhead electrical, construction project inspection & management, signal planning and programming, GIS asset management, contractor coordination, utility locates etc.

- **ITS / Communications** – Maintenance and operations of citywide fiber optic infrastructure and network to all city facilities, ITS device planning, installation and maintenance, GIS asset management, and review, approval, inspection of fiber optic communications system installations by contractors
- **Marking / Signing Shop** – Maintenance and operations of 40,000 signs citywide (not including street name signs) and pavement marking program, operations of sign trucks for installations, marking equipment operations – paint trucks, paint carts, parking stall reviews, and project inspections & installations

For purposes of the systems included for discussion within this Traffic Management Master Plan, the staffing resources include the following:

Currently, staff members that have duties devoted to the traffic signal system and ITS infrastructure are located at the MSC facility. This includes 6 full-time technician staff located in the signal shop, one full-time technician with primary signal system/timing responsibilities, and one Manager / Traffic Engineer with ¼ time dedicated to the system. Of these staff, two (2) of the 6 technician staff members are dedicated solely to ITS and communications infrastructure, and one additional signal technician is dedicated to full-time underground Traffic Utility Locate work during construction season (75% workload annually). An existing conditions organizational chart illustrating these staff, and the entire Traffic Team is included below:




(1) Moved to Traffic Engineering Manager with formation of ROW Construction Mgmt Section
(2) Moved to implement ROW Construction Mgmt Section

As illustrated in the functioning organizational chart, one manager and three additional technician level staff were utilized to join members from other Sections in the implementation of the City's new ROW Construction Management Section. This section was formed in timely fashion ahead of the coming construction season to better allow the City to coordinate and ensure performance of private construction in the public street Right of Way.

The technical staff perform typical work hours covering time periods from 7AM to 5PM on a Monday through Friday schedule. Staff in the traffic signal shop overlap hours in the morning and afternoon to better cover traffic activity (10 hrs of the day). Currently, there are no 24/7 operations, nor staffing coverage during the remainder of the AM and PM peak traffic periods on a daily basis. Members of the traffic signal shop do rotate weekly (single staff member) to provide an emergency "on-call" staffing as needed for equipment failures, damaged equipment, power outages, facilities hit by contractors etc. These staff work on a "call-back" pay system and receive overtime pay for work performed outside normal business hours.

Based upon current resource levels, goals and requirements for many on-going maintenance and operational activities in Traffic Engineering are not being satisfied. Several publications and sources for recommendations on how best to support a City's system of traffic infrastructure have been documented. Information summarized by the Federal Highway Administration (FHWA) *Improving Traffic Signal Management and Operations*, and the Institute of Transportation Engineers (ITE) *Traffic Engineering Handbook and Traffic Control System Operations: Installation, Management and Maintenance Manual* are just two industry standard sources.

Often, the number of signalized locations and other service area size parameters are utilized to derive the number of required staff and other program needs. As an example, the number of traffic signals not only results in on-going maintenance needs and technical signal timing analysis, but also drives requirements for annual data collection, response to public inquiries and/or complaints, and documentation of safety and operational characteristics. Recommendations of one traffic engineer needed to properly operate and maintain every 75 to 100 signals, and one signal technician to operate and maintain every 40 to 50 signals has been identified as industry standard. Using these guidelines for the existing system, **the City would have an existing staff of 4 to 5 traffic engineers and 8 to 10 signal technicians.** A further description and recommendation for future staffing is included in Section 4 of this plan.

### 2.5.2 Traffic Signal Timing

Currently traffic signal timing for all the signals is conducted by a Senior Technician with input from the Traffic Engineer. This includes basic timing (e.g., yellow-change and all-red clearance intervals, pedestrian walk and clearance intervals) and coordination parameters (cycle lengths, splits, and offsets), as well as responding to timing-related citizen complaints. Currently, most traffic signals operate within a coordinated time of day plan with others operating in free mode. Most intersections operate on different patterns for different times of day and special events.

As highlighted in the Executive Summary signal optimization and formal, scheduled re-timing programs have profound benefits to motorists and the City's transportation network. Due to resources and staffing, the City of Lincoln has not conducted formal signal timing optimization work in over a decade. This includes both consultant (outside) assistance, and internal development of corridor wide timing plan updates with documented before and after study results. This is a priority need that can result in huge benefits for the citizens of Lincoln.

**Facts on Signal-Related Congestion**

Delays at traffic signals contribute an estimated 5 to 10 percent of all traffic delay or 295 million vehicle-hours of delay on major roadways alone.[1] Further, the *2011 Urban Mobility Report* notes that in its reporting areas 61 percent of the street miles in the cities had some level of traffic signal coordination that reduced delay by 21.7 million person hours.[2] The U.S. Department of Transportation Intelligent Transportation Systems Joint Program Office maintains a database that documents traffic signal management and operations studies conducted by various agencies demonstrating benefit-cost ratios exceeding 40:1.[3]

[1] Congestion Reduction Toolbox. U.S. Department of Transportation Federal Highway Administration. Accessible via www.fhwa.dot.gov/congestion/toolbox

[2] *2011 Urban Mobility Report*. Methodology-Benefits of Operational Treatments. Texas Transportation Institute, 2011. Accessible via http://mobility.tamu.edu/files/2011/09/operational-treatments.pdf

[3] ITS Benefits, Costs and Lessons Learned Database. U.S. Department of Transportation (U.S. DOT) Intelligent Transportation Systems Joint Program Office. Accessible via www.benefitcost.its.dot.gov

### 2.5.3 Incident Management

The City of Lincoln currently does not have updated, pre-determined incident management signal timing modification plans for major arterial events. The Nebraska Department of Roads (NDOR) sponsored a project several years ago to develop incident management plans involving traffic diverted off I-80 for a major shutdown along various segments. The focus of this work was primarily dissemination of traveler information via permanent and portable DMS locations. As a result, a portion of this infrastructure was made permanent. To date, no major refresh of that activity has taken place. In general, City Traffic staff is notified of major incidents (vehicle crashes, fires, HazMat spills) within the city limits, and is a first responder to assist with temporary traffic control and detour routing as needed.

### 2.5.4 Special Event Management

The primary special event management coordination that takes place with Traffic Engineering are with City sponsored events such as Uncle Sam Jam, and the Lincoln Marathon. During these events, several staff and equipment are deployed to provide temporary traffic control along event areas and coordination with other law enforcement agencies and departments is conducted. In addition, the major traffic signal related impacts are during UNL home football games and other major events at Pinnacle Bank Arena. For UNL football, predetermined special event timing plans are input to the system controllers remotely from the MSC during both pregame and postgame time periods. Major coordination with LPD, and UNLPD occurs during these times of pedestrian and vehicular ingress and egress. The operation is somewhat limited currently due to lack of an ATMS software to manage all devices simultaneously. During a recent home football game, post-game operations were severely limited due to a failure in the system, causing major delays, motorist frustration, and increased manual direction by LPD officers. All of this could have been avoided with a modernized system and basic remote access by a signal system engineer.


**UNL Football Game Day Traffic**

### 2.5.5 Traffic Signal Preventative Maintenance

Traffic Operations has a new and efficient preventative maintenance program, which was just recently upgraded to a complete digital process using Beehive Software. Limited only by staffing resources which force much work task overlap during construction season, the program is lean but performing at a high level. Each year a technician visits each traffic signal cabinet to remove, test, and replace the signal conflict monitor and check and repair every component inside of the cabinet. Every 3 years an overhead technician ideally visits each intersection to visually inspect all hardware on the mast arms and poles, and will replace or repair as necessary any brackets and mounting hardware (current resources limit this). Through pro-active work scheduling versus knee-jerk field reviews, technician staff with mobile devices are now able to complete work logs remotely and be efficient with time and vehicle fuel savings by areas of the City where they are scheduled.

### 2.5.6 Communications Maintenance

Traffic Engineering ITS staff monitors the status of the communications system on a daily basis. Every traffic signal, PTZ camera, wireless radio, UNL devices, serial to Ethernet devices, and various equipment for other city departments are verified online every morning and throughout the day. Using network software analytics and device polling, an increasing portion of the remote work is able to be confirmed. When an issue arises with field devices or network connectivity to City facilities staff responds as quick as possible to replace or repair the issue. In addition, annual unit price contracts and on-call contractors are used if there are major construction impacts or fiber cuts that need to be spliced.

### 2.5.7 Traffic Signal Rehabilitation Program

In addition to the planning, design, operation, and maintenance of the traffic signal system level infrastructure and ITS components, the City of Lincoln Traffic Team is also focused on a routine Signal Rehabilitation Program. This includes the on-going and necessary replacement of aging traffic signal poles, mast arms, combo lighting, cabinets, wiring etc. at existing traffic signal locations.


A typical life-span of 30 years for signal structures is the primary threshold for total replacement needs based on pole standards, with many of the other signal components having a much shorter service life (detection, cabinet equipment etc.). Beyond the annual development impacts that often require new or existing intersections to be controlled with traffic signalization, the current signalized intersection inventory must be evaluated for replacement of aging and functionally obsolete equipment. In general, the City replaces 2 to 3 traffic signals as needed annually as part of major roadway projects during the construction season. Unfortunately, these roadway project locations alone do not always align with the highest priority need for individual traffic signal replacements at specific older intersections city wide. As such, Traffic Engineering also attempts to replace as much of the older infrastructure as fiscally feasible. An additional 2-3 stand-alone signal projects are programmed annually. In addition to these two scenarios, there are typically a couple brand new signals turned on each year due to new development – adding further to the overall signalized intersection total.