

# TRAFFIC SIGNAL INVENTORY PROJECT

FINAL REPORT

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CTRE Management Project 00-67

JUNE 2001



*Center for Transportation  
Research and Education*

IOWA STATE UNIVERSITY



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## FINAL REPORT

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## EXECUTIVE SUMMARY

The Center for Transportation Research and Education performed a traffic signal inventory study for the Iowa Department of Transportation. The purpose of this study was to determine the level of compliance with the *Manual on Uniform Traffic Control Devices* (MUTCD) and other industry standards of traffic signals on the state highway system. Signals were randomly selected throughout the State of Iowa. Only signals in cities with a population less than 5,000 were considered.

Several intersections need to be addressed immediately to correct clearance timing settings. Red clearance intervals were frequently too short. A handful of intersections had inadequate pedestrian clearance times. Six intersections had at least one yellow clearance interval that did not meet Institute of Transportation Engineers standards. Some of the intersections likely would not meet traffic signal warrants and should be investigated for possible removal.

The most common problem found with traffic signals was a lack of maintenance. Many of the signals had at least one of the following problems: burned out lights (signals and/or pedestrian heads), pedestrian lenses in need of replacement, dirty cabinet/missing or poor filter, missing visors, or inoperative pedestrian push buttons. Timing sheets were frequently missing or out of date.

Another frequent noncompliance issue was the use of backplates. The MUTCD states that backplates *should* be used on signals viewed against a bright sky. The majority of signals inventoried did not have backplates on the mast-arm mounted signals.

The timing at some intersections could likely be improved by reducing the cycle length. Where there were multiple signals in close proximity rarely was there any attempt at signal coordination.

Finally, a number of intersections had equipment that by today's standards would be considered obsolete.

## **INTRODUCTION**

The Iowa Department of Transportation (Iowa DOT) was interested in determining to what degree the traffic signals on the state highway system meet various requirements including those outlined in the *Manual on Uniform Traffic Control Devices* (MUTCD). This project inventoried a random sample of traffic signals throughout the State of Iowa. Using this information, the Iowa DOT plans to estimate the traffic signal needs for all of the signals on the state highway system.

In particular, the scope of this project looked at three categories of traffic signal items: MUTCD, operational, and standard practice.

### **MUTCD and Other Standards**

These are items that are required or recommended by the MUTCD (millennium edition) and by organizations such as the Institute of Transportation Engineers (ITE). In particular, the following items were checked:

- Are the proper size and type of lenses being used (8 inch vs. 12 inch)? (4D.15)
- Are the individual lenses in the proper order? (4D.16)
- Are visors and backplates being used? (4D.17)
- Are the signal faces visible from the required distance, within the proper area (MUTCD Fig. 4D-2), and do they meet viewing angle criteria? (4D.15)
- Does every approach have the minimum number of heads required? (4D.15)
- Are poles and cabinets located a safe distance from the roadway? (4D.19)
- What are the yellow clearance intervals for each approach and do they meet ITE standards?
- What are the all-red clearance intervals for each approach and do they meet ITE standards?
- What is the “Walk” time for each leg?
- What are the crosswalk distance and flashing “Don’t Walk” time for each leg and do they meet ITE standards?

### **Operational Items**

These are issues related to the actual operation of the signal or signal system:

- If there are nearby signals, are they operated in a coordinated mode?
- Is there any congestion at the intersection that can be attributed to signal operations?
- What is the phasing?
- Does left-turning traffic require a separate phase? (Note: Traffic counts will not be taken as part of this project. Evaluation will be done by observation.)
- Is there an unwarranted separate left-turn phase?
- Is the signal operating in a pre-timed, fully actuated, or a semi-actuated mode?
- Which phases have pedestrian and/or vehicle actuation?
- What is the cycle length (if any)?
- What are the minimum and maximum green times for each approach?

- Are there any burned out lights, dim lights, or cracked/burned lenses?
- Are there any missing or non-functioning pedestrian heads or push buttons?
- What is the controller/cabinet type?
- Does the controller use a standard phasing pattern?
- Are all of the vehicle detectors functioning?
- Are there street light poles that could be combined with signal poles?
- Is the cabinet well maintained (no dust/dirt, clean filter, log book)?
- Are up-to-date timing sheets stored in the cabinet?

### Standard Practice

These will be items that are commonly used in traffic signal design throughout the United States that are not necessarily required by the MUTCD or ITE, but are generally considered good practice.

- Are there at least two heads at two different elevations per approach (e.g., one mast arm, one pedestal mount)?
- Is there detection for the dilemma zone (35+ mph roads only)?
- Are there redundant heads for left-turning traffic?
- Are mast-arm mounted left-turn arrows mounted over the left-turn lane?

### ANALYSIS METHODOLOGY

Each traffic signal is summarized in the Signal Inventory section of this report. Following each equipment summary is a compliance summary. The compliance summary includes those items that

- *must* be made to bring the signal into compliance with MUTCD or other industry standards
- *should* be made to increase operational efficiency
- *should* be made to comply with common practice

In determining the proper clearance intervals for both vehicles and pedestrians, the following criteria were used:

For **vehicle change intervals**, Table 11-3 in the ITE publication *Manual on Traffic Signal Design* was used for the compliance evaluation (CI). This table is based on the following equation:

$$CI = t + \frac{V}{2a} + \frac{W + L}{V}$$

where

- $t$  = reaction time = 1.0 s
- $V$  = approach speed limit (ft/s)



- $a$  = deceleration of vehicle = 10 ft/s<sup>2</sup>
- $W$  = width of intersection, curb-to-curb (ft)
- $L$  = length of vehicle = 20 ft

For **pedestrian clearance intervals**, the flashing don't walk time (FDW) was calculated from the following equation:

$$FDW = \frac{W}{v}$$

where

- $W$  = width from curb to center of farthest travel lane (ft)
- $v$  = walking speed = 4 ft/s

The Signal Inventory section of this report summarizes each set of signals. For more detailed information, the appendix contains matrices that show intersection-by-intersection results of all the inventory items. Items shaded in red in the matrices indicate those issues that should be remedied *as soon as possible*. They involve things such as damaged or missing equipment and improper clearance interval lengths. Items shaded in yellow indicate issues that do not require immediate attention but should be at least investigated in the near future. This may include issues such as missing timing sheets, poorly maintained cabinets, the addition of signal heads on poles, and the need for signal coordination.

## **PROJECT SELECTION AND DATA COLLECTION**

The Iowa DOT provided a list of intersections to be inventoried. The intersections were selected randomly throughout the State of Iowa. In total, 43 traffic signals were inventoried. All of the intersections are in jurisdictions that have populations of less than 5,000 people. The intersection list is shown in Table 1.

A standardized data collection sheet was developed to facilitate the collection of the required data. This sheet is located in the appendix of this report. Data were collected between June 23, 2000, and August 8, 2000.

Digital photographs were taken of every approach at every intersection. Photographs were also taken of signal controllers and damaged equipment. These photographs are available on CD (in a JPEG format) at the Office of Traffic and Safety at the Iowa Department of Transportation.

The CD also contains an Access database with all of the pertinent information that was collected during the surveys.

**Table 1 List of Intersections Inventoried**

<b>Int ersection</b>	<b>Jurisdiction</b>	<b>County</b>	<b>Highway</b>	<b>Cross Street</b>
01	Webster City	Hamilton	IA-928	Superior St
02	Webster City	Hamilton	IA-928	Prospect St
03	Williamsburg	Iowa	I-80	IA-149
04	Williamsburg	Iowa	I-80	IA-149
05	Mount Vernon	Linn	IA-1	1st St W
06	Wyoming	Jones	IA-64	Washington St
07	Carlisle	Warren	IA-5	Scotch Ridge Rd
08	Carlisle	Warren	IA-5	5th Street
09	Carlisle	Warren	IA-5	1st Street
10	Bloomfield	Davis	U.S. 63	E Locust
11	Bloomfield	Davis	U.S. 63	E Jefferson
12	Bloomfield	Davis	U.S. 63	E Franklin
13	Treynor	Pottawattamie	IA-92	Volkens Ave
14	Shenandoah	Page	U.S. 59	Sheridan Ave
15	Shenandoah	Page	U.S. 59	Driveway
16	Shenandoah	Page	U.S. 59	Nishna Rd
17	Garner	Hancock	U.S. 18	State St
18	Northwood	Worth	U.S. 65	10th St
19	Cresco	Howard	IA-9	S Elm St
20	Storm Lake	Buena Vista	IA-7	Lakeshore Dr
21	Storm Lake	Buena Vista	IA-7	Park St
22	Storm Lake	Buena Vista	IA-7	Richland St
23	Storm Lake	Buena Vista	IA-7	E 5th St
24	Storm Lake	Buena Vista	IA-7	Russell St
25	Storm Lake	Buena Vista	IA-7	Oneida St
26	Storm Lake	Buena Vista	IA-7	Seneca St
27	Storm Lake	Buena Vista	IA-7	Lake Ave
28	Algona	Kossuth	U.S. 169	McGregor
29	Algona	Kossuth	U.S. 169	State / Phillips
30	Algona	Kossuth	U.S. 169	Jones
31	Algona	Kossuth	U.S. 169	Call St
32	Algona	Kossuth	U.S. 169	North St
33	Algona	Kossuth	U.S. 169	Driveway
34	Estherville	Emmet	IA-9	N 17th St
35	Estherville	Emmet	IA-9	S 15th Pl
36	Estherville	Emmet	IA-9	N 13th St
37	Estherville	Emmet	IA-9	State Hwy 4
38	Estherville	Emmet	IA-9	N 8th St
39	Estherville	Emmet	IA-9	N 7th St
40	Estherville	Emmet	IA-9	N 6th St
41	Estherville	Emmet	IA-9	N 5th St
42	Estherville	Emmet	IA-9	N 1st St
43	Estherville	Emmet	IA-9	W S 1st St

## **SIGNAL INVENTORY**

### **State Highway 928, Hamilton County**

#### *Equipment Summary (Intersections 01–02)*

Until recently, there were a total of five signals on IA-928 in Hamilton County. All of them were in the downtown area of Webster City. Three of the five signals have been removed. The remaining two signals are where the highway intersects Superior Street and Prospect Street. On the day of the inventory, road construction was occurring in the downtown area. The Prospect signal was operating in a four-way red flash mode. Traffic on the highway was being detoured to adjacent one-way streets.

The Superior Street intersection is a two-phase, pre-timed signal operated by a TCT controller. Separate left-turn lanes exist for the east-west traffic on the highway. However, there is not a separate left-turn phase. Nor does there appear to be the need for one. Most of the lane markings (including lane arrows and crosswalks) are severely worn out. Two corners of the intersection do not have sidewalk ramps leading to the crosswalks. The remaining two corners have ramps but do not meet current Americans with Disabilities Act (ADA) specifications.

The Prospect Street intersection is a two-phase signal operated by a TCT controller. Separate left-turn lanes exist for the east-west traffic on the highway. However, there is not a separate left-turn phase. Nor does there appear to be the need for one. Lane markings at this location are generally in better condition than the previous location but could use a fresh application.

#### *Compliance Summary*

MUTCD: Neither of the traffic signals have backplates on any of their signal heads (see Figure 1). This is especially critical on the overhead mast arms signals on the state highway (which is an east-west street). There were no timing sheets in the cabinets.

Operations: One of the “Don’t Walk” indications at the Superior Street intersection was not operating at the time of the inventory. Also, the 80-second cycle length may want to be examined. The cycle length may be able to be shortened. Another option is to look at upgrading the intersection to a fully actuated operation. Additionally, a street name sign obscures the “Walk” indication on the southwest corner.

Standard Practice: The Superior Street approaches have signal indications on the mast arms only. There are no pole-mounted signals for these approaches (see Figure 1). The Prospect Street approaches have only pole-mounted signals (no mast arms).



**Figure 1 South Leg of Intersection 01**

### **Interstate 80, Iowa County**

#### *Equipment Summary (Intersections 03–04)*

There are two signals on I-80 in Iowa County. They are located at the eastbound and westbound off ramps at IA-149 in Williamsburg. Both signals operate in a fully actuated mode (independent of each other). There is a nearby signal on IA-149 that could be coordinated with the two signals at the interchange.

The southbound left turn to the eastbound on-ramp is a fully protected left turn. Based on observations at the time of the inventory, it appears that a fully protected left turn may not be necessary. A protected/permissive left turn (or possibly a permissive left turn) may be acceptable and more desirable. Several observations were made where left-turning vehicles stopped past the forward-most detector, thereby not placing a call for demand on the left-turn phase. Unless another car pulled in behind, the driver never got the left-turn arrow and subsequently ran the red light.

The northbound left turn to the westbound on-ramp is a fully protected left turn. Based on observations at the time of the inventory, it appears that a fully protected left turn may not be necessary. A protected/permissive left turn (or possibly a permissive left turn) may be acceptable and more desirable. Similar observations were made regarding left-turning vehicles at this intersection.

#### *Compliance Summary*

MUTCD: Both signals are fairly new and therefore are in substantial compliance with the MUTCD. However, there were not current timing sheets in the cabinets.

Operations: The fully protected left-turn phase seemed to be unnecessarily restrictive. A less restrictive protected/permissive operation may be warranted. While conducting the inventory, several drivers pulled up beyond the front-most detector. The controller did not hold the call and therefore did not bring up the left-turn phase. Subsequently, those drivers either had to wait for a vehicle to pull up behind them (to make the call) or they simply ran the red light. In the short

term, having the controller lock any call that is made on the left-turn approaches could solve this problem.

The two signals operate fully actuated. During times of heavy traffic volumes, it may be advantageous to coordinate the operation. Also, although using an eight-phase controller, neither intersection used the standard NEMA phasing (i.e., main street through movements designated as phases 2 and 6).

Standard Practice: There were not redundant left-turn signal heads for the protected left-turn phase. All signal heads are mast-arm mounted (see Figure 2).



**Figure 2 North Leg of Intersection 04**

### **State Highway 1, Linn County**

#### *Equipment Summary (Intersection 05)*

There is one signal on IA-1 in Linn County. It is located in the historic downtown area of Mount Vernon at the intersection with 1st Street West. It is a simple two-phase signal controlled by a relay-style controller that operates on a pre-timed basis. There are no pedestrian indications at the intersection. While not necessarily required, given that the intersection is in the downtown area of Mount Vernon where pedestrians are typically present, provisions for pedestrians should be made at the signal. It is also possible that this signal is no longer warranted. This signal was installed before U.S. 30 was constructed to the south of town. Therefore, traffic patterns have likely changed significantly and may no longer require a signal at this location. A four-way stop may be more efficient and safer.

#### *Compliance Summary*

MUTCD: The traffic signal does not have backplates on any of the signal heads. Nor was there a timing sheet in the cabinet.

Operations: The controller is fairly obsolete (see Figure 3). The city may want to look at upgrading the equipment and possibly making the intersection semi- or fully actuated. In the meantime, the cycle length of 80 seconds may be able to be shortened without causing any delay at the intersection.

Standard Practice: All four approaches have only pole-mounted signals (no mast arms). As shown in Figure 4, the target values of the signals may not be optimal due to other visual clutter in the driver's field of view.



**Figure 3 Controller Cabinet for Intersection 05**



**Figure 4 East Leg of Intersection 05**

## **State Highway 64, Jones County**

### *Equipment Summary (Intersection 06)*

There is one signal on IA-64 in Jones County. It is located in the downtown area of Wyoming at the intersection with Washington Street. The signal functions as a modified pedestrian crossing

signal. Highway traffic has a constant green indication and side street traffic has a flashing red indication until a pedestrian button is actuated (see Figure 5). During the pedestrian movement, both highway and side street traffic face a solid red indication. The signal is controlled by an electro-mechanical controller. The dial rests at a “home” position until a pedestrian button is actuated.

### *Compliance Summary*

**MUTCD:** The traffic signal does not have backplates on any of the signal heads. Nor was there a timing sheet in the cabinet. In all likelihood, the signal does not meet warrants for a pedestrian crossing. As the signal currently operates, it is not in compliance with the MUTCD.

**Operations:** The controller is fairly obsolete (see Figure 6). If the signal is in fact warranted, the City may want to look at upgrading the equipment and possibly making the intersection semi- or fully actuated with three-section vehicular indications on all four approaches. For an unfamiliar driver, approaching the signal on the side street may cause some confusion.

**Standard Practice:** The operation at this intersection is highly unusual. The Iowa DOT should look closely at either changing the operation of the signal or removing it completely.



**Figure 5 West Leg of Intersection 06**



**Figure 6 Controller Cabinet at Intersection 06**

## **State Highway 5, Warren County**

### *Equipment Summary (Intersections 07–09)*

There are three signals on IA-5 in Warren County located in the City of Carlisle: Scotch Ridge Road, 5th Street, and 1st Street. Highway 5 is a four-lane divided facility at this location. The signals operate in a coordinated fashion during two times of the day (6:00–8:00 a.m., 3:00–6:00 p.m.). Other times of the day the signals are fully actuated. The signals were all designed and constructed at the same time and have many similarities. All have permissive/protected left-turn arrows for traffic turning from the highway, separate left-turn lanes, advanced detection on the

highway, stop-bar detection on the side street, and the same controller/cabinet. All three signals are controlled by Multisonics 820A controllers.

The 5th Street intersection is located near a school and is marked with school crossing signs. There is a marked crosswalk on the west leg of the intersection. However, the east leg does not have a crosswalk painted on the street even though there are pedestrian indications.

#### *Compliance Summary*

**MUTCD:** There are no items that are in violation of the MUTCD. The red clearance interval at the 1st Street intersection was too short. Pedestrian indications are only provided for crossing the state highway. Although pedestrian activity may be low in this area, if indications are provided on two of the legs, the others should also have indications.

**Operations:** The signals operate in a coordinated pattern during peak hours of the day. Since the inventory was not conducted during the peak hour, it was not possible to evaluate the level of progression at the time. One of the red indications was burned out on the day of the inventory at the Scotch Ridge Road intersection.

**Standard Practice:** There were not any redundant left-turn indications for the separate left-turn phases. There were no pole mounted signal indications for traffic on Highway 5 (only mast-arm mounted).

### **U.S. Highway 63, Davis County**

#### *Equipment Summary (Intersections 10–12)*

Three signals are on U.S. 63 in Davis County. All are located in the downtown area of Bloomfield. U.S. 63 is a four-lane, undivided arterial through Bloomfield. All three signals are controlled by a Multisonics 820 controller.

The signal at East Locust operates in a coordinated fashion from 6:00 to 9:00 a.m. and from 3:00 to 4:00 p.m. It is in fixed-time mode between 9:00 a.m. and 3:00 p.m. and from 4:00 to 11:00 p.m. From 11:00 p.m. to 6:00 a.m. it is in flash. There are detectors on the side street but not on the highway. It is unclear why the controller is programmed in a coordinated mode because the adjacent signals are not programmed to be in coordination with this signal.

The signal at East Jefferson operates in a pre-timed fashion throughout the day (6:00 a.m.–11:00 p.m.) and is in flash overnight. The signal at East Franklin also operates in a pre-timed fashion throughout the day (6:00 a.m.–11:00 p.m.) and in flash overnight.

#### *Compliance Summary*

**MUTCD:** There was at least one vehicle indication visor missing at each of the three signals (see Figure 7) and there were numerous overhead backplates that were damaged and in need of replacement. The red clearance intervals were too short at all three intersections. The pedestrian clearance interval was too short at the East Jefferson intersection. None of the traffic signals have indications for pedestrians on all legs of the intersection.



Operations: At least one “Don’t Walk” lens needs to be replaced at each of the three signals (see Figure 8). The signals do not appear to be operating in a coordinated fashion despite their close proximity to each other. The left-turn phases at the Jefferson and Franklin intersections may be unwarranted. The intersection design is fairly unusual. The west legs of both the Jefferson and Franklin intersections have angle parking in the middle of the street.

Standard Practice: There were no pole mounted signal indications for traffic on Highway 63 (only mast-arm mounted).



**Figure 7 Missing Visor on Mast-arm Signal at Intersection 10**



**Figure 8 Don't Walk Lens at Intersection 10**

## **State Highway 92, Pottawattamie County**

### *Equipment Summary (Intersection 13)*

There is one signal on IA-92 in Pottawattamie County. It is a school crossing signal in Treynor. The signal is apparently manually operated during school hours. The cabinet was inaccessible with standard cabinet keys; therefore, a detailed inventory of this signal could not be accomplished.

## **U.S. Highway 59, Fremont County**

### *Equipment Summary (Intersections 14–16)*

The City of Shenandoah operates three signals on U.S. 59: Sheridan Avenue, a shopping center driveway, and Nishna Road. The intersection at Sheridan Avenue is a pre-timed, three-phase signal. The westbound approach has a protected/permissive left-turn phase. Many of the backplates were seriously damaged at this intersection. Also, the controller cabinet was hidden from the intersection behind several large shrubs.

The signal at the commercial driveway (no street designation) is a two-phase semi-actuated signal with a 60-second background cycle length. The driveway approaches have detection. The controller is a TCT.

The signal at Nishna Road is a fully actuated, two-phase signal with a TCT controller. All four approaches have detection in all approach lanes. The signal is near a railroad crossing but did not appear to have any type of railroad preemption equipment.

### *Compliance Summary*

MUTCD: There are no items that are in violation of the MUTCD. Yellow clearance intervals are inadequate at the Sheridan and shopping center intersections. The red clearance interval is too short at all three intersections. None of the signals have pedestrian indications.

Operations: Numerous backplates at the Sheridan intersection were in need of replacement (see Figure 9). There were also many dim lights at both the Sheridan and commercial driveway intersections. All three cabinets were very dirty and needed their filters replaced (see Figure 10). Timing sheets either did not exist or were not current at all three locations. The left-turn phase at Sheridan may not be warranted.

Standard Practice: The left-turn phase at the Sheridan intersection did not have a redundant arrow. The City should consider trimming or removing the shrubs around the cabinet in order to have a clear view of the intersection from the cabinet. Also, the intersections are not programmed using standard NEMA phasing for an eight-phase controller.



**Figure 9 Damaged Backplates at Intersection 14**



**Figure 10 Dirty Filter at Intersection 14**

## U.S. Highway 18, Hancock County

### *Equipment Summary (Intersection 17)*

There is one signal on U.S. 18 in Hancock County. It is located in the City of Garner. The signal operates in a fully actuated mode.

### *Compliance Summary*

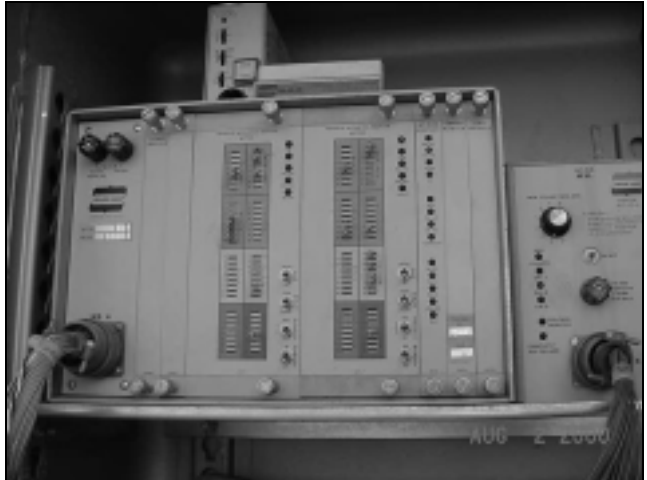
MUTCD: Only one of the four poles has signals with backplates. Backplates should be installed on all mast-arm mounted signals (see Figure 11). Both the yellow and red clearance intervals are too short. There is no accommodation for pedestrians at this intersection.

Operations: There was no timing sheet in the cabinet. The controller is very outdated (see Figure 12). Recommend upgrading to a more state of the art controller.

Standard Practice: No items to note regarding standard practice.



**Figure 11 Missing Backplates at Intersection 17**



**Figure 12 Controller for Intersection 17**

## U.S. Highway 65, Worth County

### *Equipment Summary (Intersection 18)*

The city of Northwood maintains a traffic signal at the intersection of U.S. 65 and County Highway 105. The signal operates as a fixed-time signal. Highway 65 makes up the north and east legs of this intersection.

### *Compliance Summary*

MUTCD: None of the mast-arm mounted signals have backplates. Backplates should be installed on all mast-arm mounted signals. The red clearance interval and the pedestrian “Don’t Walk” time are too short.

Operations: There was no timing sheet in the cabinet.

Standard Practice: The southbound leg is the only approach that does not have a mast -arm mounted signal head.

### **State Highway 9, Howard County**

#### *Equipment Summary (Intersection 19)*

One signal is located in the City of Cresco on IA-9 in Howard County. The signal operates in a fixed-time operation with an electro-mechanical dial controller.

### *Compliance Summary*

MUTCD: None of the mast-arm mounted signals have backplates. Backplates should be installed on all mast-arm mounted signals. The red clearance interval is too short.

Operations: There was no timing sheet in the cabinet. Some of the bulbs were very dim. Numerous pedestrian lenses need to be replaced. Cabinet needed to be cleaned out. The electro-mechanical controller should be replaced with a new unit.

Standard Practice: The southbound leg is the only approach that does not have a mast -arm mounted signal head.

### **State Highway 7, Buena Vista County**

#### *Equipment Summary (Intersections 20–27)*

There are eight signals located on IA-7 in Buena Vista County (all within the City of Storm Lake). Seven of the eight signals operate in a fully actuated mode. The remaining signal is a fixed-time signal. Various models of the TCT controller run all of the signals. With one exception, none of the vehicle indications were equipped with backplates. In general, the cabinets were fairly well maintained (minor dust and debris).

The intersection of IA-7 and Lakeshore Drive is a T-intersection. Highway 7 makes up the east and north legs of the intersection. It is a fully actuated signal with a TCT controller. The signal operates with only two phases. There is a four-section head and left lane detection for eastbound traffic on Lakeshore Drive; however, it did not appear that the controller was programmed to bring up the arrow. Nor did the arrow come on during the inventory. Observation at the time would indicate that the arrow is not needed. There are no pedestrian indications or crosswalks.

The intersection at Park Street is an offset four-legged intersection but operates in a typical two-phase fashion. It also serves as a signed (but unpainted) school crossing where the pedestrian phase is separate from the side street vehicular phase. The only crosswalk and indications is on the north leg of the intersection. It is a semi-actuated signal with a TCT controller. There are detectors on the side street only.

The Richland Street signal is a semi-actuated two-phase signal with a TCT controller. There are no pedestrian indications or crosswalks at the intersection. The side streets are equipped with loop detectors.

The 5th Street signal is a semi-actuated signal with a TCT controller. It has two pedestrian phases. One of the pedestrian phases is in automatic recall and runs concurrent with the phase that serves highway traffic. The other pedestrian phase (to cross the highway) is a signed school crossing and is a separate from any vehicular phases. Neither of the pedestrian crossings is painted on the street. The side streets are equipped with loop detectors.

The Russell Street signal is a semi-actuated signal with a TCT controller. It has a two signed but unmarked school crosswalks with a separate phase to serve pedestrians. The pedestrian crossings are only for pedestrians crossing the highway. One of the push buttons did not work, and one of the “Don’t Walk” indications was inoperative. The side streets are equipped with loop detectors.

The Oneida Street signal is a semi-actuated two-phase signal with a TCT controller. It has a signed but unmarked school crosswalk. The pedestrian phase is concurrent with the side street vehicle phase. The side streets are equipped with loop detectors.

The Seneca Street signal is a semi-actuated two-phase signal with a TCT controller. It has a signed but unmarked school crosswalk. The pedestrian phase is concurrent with the side street vehicle phase. The side streets are equipped with loop detectors.

The Lake Avenue signal operates as a fixed-time signal with leading left-turn phases on two of the four legs. Both left-turn vehicle heads are four-section indications (with a combined green arrow-yellow arrow indication). Pedestrian phases run concurrently with vehicular phases (crossing the highway only). The crosswalks are not painted. There is no vehicle detection at the intersection.

### *Compliance Summary*

MUTCD: Of the 38 mast-arm mounted signal heads on the above signals only one had a backplate. All of the red clearance intervals were too short. Four of the intersections had pedestrian clearance times that were inadequate.

Two of the intersections did not have any pedestrian indications. The remaining intersections had indications on at least one, but not all, legs.

Operations: It did not appear that there was any coordination between intersections. Most of the signals operated in a semi-actuated mode but without a background cycle length. None of the signals had timing sheets in the cabinet. Most of the cabinets were in need of cleaning due to dirt and other debris inside (see Figure 13). A pedestrian button was inoperative at Russell Street.

Pedestrian indications were burned out at 5th Street and Park Street. Detectors seemed to be locked at Lakeside Drive and Richland Street.

The separate left-turn phases may be unwarranted at Lakeside Drive and Lake Avenue. Crosswalks, especially those with a marked school crosswalk sign, need to be repainted at most of the intersections (see Figure 14). The phasing designations were not standard NEMA phasing.

Standard Practice: Several of the intersections had only pole-mounted signals for two of the four approaches. There were no redundant left-turn indications for the left-turn movements at the Lake Avenue intersection.



**Figure 13 Dirty Cabinet at Intersection 20**



**Figure 14 Missing Crosswalks at Intersection 26**

## **U.S. Highway 169, Kossuth County**

### *Equipment Summary (Intersections 28–33)*

There are six signals on U.S. Highway 169 in Kossuth County. All of them are located in the City of Algona. The intersection at McGregor is a fully actuated two-phase signal with a TCT controller. The loops on the highway are set back 140 and 180 feet from the southbound and northbound stop bars, respectively.

Highway 169 makes up the south and west legs of the State/Phillips intersection. It is also a fully actuated signal with a TCT controller. The northbound leg includes a protected/permissive left-turn phase. The westbound leg has a corresponding protected/permissive right-turn overlap phase. A loop detector in the left lane, set back from the northbound stop bar, actuates the left-turn phase.

Highway 169 makes up the east and north legs of the Jones intersection. It operates very similar to the previous intersection. It is a semi-actuated signal with a TCT controller. The west leg of the intersection is a one-way street going away from the intersection (therefore, there is no eastbound phase).

The intersections at Call Street and North Street are semi-actuated intersections with TCT controllers. The east and westbound phases are only called if vehicles are present. Both intersections are two-phase.

The final intersection in Algona is located at a commercial access driveway. The intersection is a fully actuated two-phase signal with a TCT controller. It did not appear that the pedestrian phase wires were hooked up. Pedestrian push buttons did not work on two of the corners. One of the “Don’t Walk” indications was not operative and another was poorly aimed.

### *Compliance Summary*

MUTCD: Backplates are not present on the mast-arm signals at McGregor. The remaining five signals have the appropriate backplates. The State/Phillips intersection had an unusual display for a right-turn protected phase that does not meet MUTCD requirements (Section 4D.07). The right-turn display is required to be one of the following: red arrow-yellow arrow-green arrow, red-yellow arrow-green arrow, or red-yellow-green-green arrow. The indication at this intersection is red-yellow-green (see Figure 15).

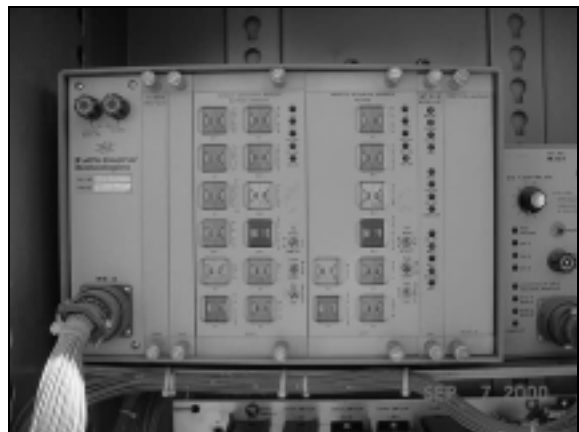
The yellow clearance interval at the McGregor intersection was too short. The red clearance interval at all of the intersections was too short. Pedestrian intervals at all of the intersections were too short.

Operations: Pedestrian heads were burned out at several of the intersections. At least one pedestrian push button was inoperative at State/Phillips and the commercial driveway intersections. It appeared that the pedestrian phase wires were not connected in the cabinet at the commercial driveway. Additionally, one of the pedestrian heads at this intersection was poorly aimed. Several of the intersections had lamps that were dim.

None of the intersections had current timing sheets in the cabinet. Most cabinets were in need of cleaning. The controller at the commercial driveway is out of date and needs to be replaced (see Figure 16).



**Figure 15 Right-Turn Phasing at Intersection 29**



**Figure 16 Controller at Intersection 33**

Standard Practice: The Jones Street, Call Street, and commercial driveway intersections have only mast-arm mounted signals (no pole mounted signals). The remaining intersections all have at least one approach that has either only pole mounted or only mast-arm mounted signal heads.

## **State Highway 9, Emmet County**

### *Equipment Summary (Intersections 34–43)*

There are 10 signals on State Highway 9 in Emmet County. All are located in the City of Estherville. The easternmost signal is located at North 17th Street. The side streets are offset from each other at this location. It is located near the high school and signed as a school crosswalk. The signal is a two-phase, semi-actuated signal with a TCT controller.

The intersection at South 15th Place is a T-intersection with a semi-actuated signal (TCT controller). The pedestrian button on one of the corners was inoperative.

The North 13th Street intersection is controlled by a two-phase semi-actuated signal.

The six intersections at 9th Street (Highway 4), 8th Street, 7th Street, 6th Street, 5th Street, and 1st Street all have pre-timed, two-phase signals. All have Crouse-Hinds controllers and are operating on a 64-second cycle length. They appear to have a coordination pattern programmed into them and the clocks are currently in synch with each other.

The final intersection in Estherville is located at West 1st Street. It is a semi-actuated, two-phase signal with a Crouse-Hinds controller. It is also designated as a school crossing.

### *Compliance Summary*

MUTCD: Some of the intersections did not have backplates on the mast-arm mounted signals. The yellow clearance interval at the Hwy 4 intersection was too short. The red clearance intervals at all of the intersections were inadequate. The pedestrian clearance time at the South 15th Place intersection was too short.

Several of the downtown signals likely do not meet traffic signal warrants and should be investigated for possible removal.

Only three of the signals had any pedestrian indications (but not on all legs). Those three are the designated school crossings. The remaining intersections had no pedestrian indications at all. Given the potential for pedestrian activity, the City should investigate installing pedestrian indications at those intersections.

Operations: The six downtown signals appeared to be operating in a coordinated manner. Time-space diagrams found in the cabinet seemed to support that an attempt was made to achieve some level of progression. However, they were done by hand and could likely be improved using one of the available signal coordination software programs.

The controllers at the North 17th Street, South 15th Place, and West 1st Street are out of date and should be replaced with a more modern controller (similar to that shown in Figure 16).



Standard Practice: All but one of the Estherville signals had no mast-arm mounted signals for the side street.

## **RECOMMENDATIONS**

Recommendations for the traffic signals in Iowa center around five primary categories: (1) clearance intervals, (2) maintenance, (3) backplates, (4) timing issues, and (5) update technology. They are not listed in order of importance, but rather indicate a priority based on necessity, ease of implementation, and cost.

### **Clearance Intervals**

Clearance intervals (yellow, red, and pedestrian) *must be brought into compliance* with the standard practices issued by the Institute of Transportation Engineers. Improper clearance intervals may lead to increases in crashes at intersections. Improper pedestrian clearance times may put pedestrians in danger of being struck by vehicles. The cost to do this is negligible since it does not involve replacing or purchasing equipment. Proper times should be calculated and implemented immediately. Priority: HIGH.

### **Maintenance**

Maintenance was clearly the most prevalent problem at nearly every signal inventoried. Issues such as burned out lights, damaged backplates, dirty cabinets, damaged pedestrian heads, and nonfunctioning detectors existed at virtually every intersection. Costs will be fairly low for most maintenance items. The important thing is for jurisdictions to understand the benefits of periodic maintenance (not just responding to trouble calls). Like any piece of equipment, establishing a regular maintenance program can significantly reduce overall costs. Priority: HIGH.

### **Backplates**

Many of the intersections did not have backplates on their mast-arm mounted signal heads. Backplates serve an important role in helping drivers see traffic signals against a bright background and particularly when the sun is either shining directly on the signal or is directly behind the signal. Costs for backplates are minimal compared to other signal items. Installation is not difficult either. Priority: MEDIUM.

### **Timing Issues**

Timing is essentially a type of maintenance. As traffic patterns change, timing should periodically be updated. Some intersections had longer cycle lengths than needed to efficiently move traffic. Some jurisdictions had multiple signals that could benefit from implementing a coordinated signal timing plan. Benefits of improved timing include reduced crash rates, reduced motorist delay, lower pollution. Jurisdictions should hire a qualified traffic engineer to look at traffic signal timing issues. Therefore, when evaluating budget needs for the coming year, they may want to set aside some money for this purpose. Priority: MEDIUM.

## **Update Technology**

Numerous intersections had equipment that would be considered obsolete by today's standards. While they may still be functional, there may be benefits to upgrading to a more state-of-the-art piece of equipment. For example, some pre-timed signals may be changed to semi- or fully actuated signals. Costs can be fairly significant for controller and cabinet upgrades. Depending on the age of the equipment, this may or may not be feasible. Priority: LOW.

## **APPENDIX**

Int. #	Lens Size/Type	Lens Order	Visors	Backplates	Visibility	Min. # of Heads	Lateral Distance	Jurisdiction
1				N				Webster City
2				N				
3								Williamsburg
4								
5				N				Mount Vernon
6				N		P		Wyoming
7								
8								Carlisle
9								
10			P	P				
11			P	P				Bloomfield
12			P					
13								Treynor
14				P				
15								Shenandoah
16								
17				N				Garner
18				N				Northwood
19				N				Cresco
20				N				
21				N				
22				N				
23				N				
24				N				Storm Lake
25				N				
26				N				
27				N				
28				N				
29								
30								Algona
31								
32								
33								
34								
35				N				
36				N				
37								
38				N				Estherville
39				N				
40				N				
41				N				
42								
43								

**Key**

- P** Partially Compliant
- N** Non-Compliant

Int. #	Nearby Signals?	Coordinated?	Congestion due to Timing	LT Phase(s) Needed?	Unnecessary LT Phase(s)?	Operation Mode	Cycle Length	Yellow Clearance	Red Clearance	Pedestrian Clearance	Burned Out Dim Lights	Burned Out Pedestrian Heads	Inopp. Pedestrian Push Buttons	Phasing	Non-Functioning Detectors	Combine Poles	Cabinet Maintained	Current Timing Sheets	Jurisdiction	
1	N	-	N	N	N	PT	80	Y	Y	Y	N	Y	-	-	-	N	Y	N	Webster City	
2	N	-	N	N	N	PT	80	Y	Y	Y	?	?	-	-	-	N	Y	N	Williamsburg	
3	Y	N	N	N	C	F	-	?	Y	-	N	-	-	NS	-	P	Y	N		
4	Y	N	N	N	C	F	-	?	Y	-	N	-	-	NS	N	N	Y	N		
5	N	-	N	N	N	PT	80	Y	Y	-	N	-	-	-	N	N	Y	N	Mount Vernon	
6	N	-	N	N	N	PT	50	N	-	N	Y	Y	N	-	-	N	Y	N	Wyoming	
7	Y	Y+	N	N	N	S+F	70	Y	Y	Y	Y	N	N	ST	N	N	Y	Y	Carlisle	
8	Y	Y+	N	N	N	S+F	70	Y	Y	Y	N	N	N	ST	N	N	Y	Y		
9	Y	Y+	N	N	N	S+F	70	Y	N	Y	N	N	N	ST	N	N	Y	Y		
10	Y	N	N	N	N	S+F	60	Y	N	Y	Y	Y	N	ST	N	N	N	N	Bloomfield	
11	Y	N	N	N	P	PT	?	Y	N	N	Y	Y	-	ST	-	N	N	N		
12	Y	N	N	N	P	PT	?	Y	N	Y	Y	Y	-	ST	-	P	N	N		
13	N	-	N	N	N	?	?	?	?	?	?	?	?	-	-	N	?	?	Treynor	
14	Y	N	N	N	Y	PT	60	N	N	-	Y	-	-	NS	N	P	N	N	Shenandoah	
15	Y	N	N	N	N	PT	60	N	N	-	Y	-	-	NS	-	N	N	N		
16	Y	N	N	N	N	F	-	Y	N	-	N	-	-	NS	-	P	N	N		
17	N	-	N	N	N	F	-	N	?	-	N	-	-	-	N	P	Y	N	Garner	
18	N	-	N	N	N	PT	50	Y	N	N	N	N	-	NS	-	N	Y	N	Northwood	
19	N	-	N	N	N	PT	80	Y	N	Y	Y	Y	-	-	-	N	N	N	Cresco	
20	Y	N	N	N	P	F	-	Y	N	-	N	-	-	NS	Y	N	N	N	Storm Lake	
21	Y	N	N	N	N	S	-	Y	N	Y	Y	Y	N	NS	N	N	N	N		
22	Y	N	N	N	N	S	-	Y	N	-	Y	-	-	NS	Y	N	N	N		
23	Y	N	N	N	N	S	-	Y	N	N	Y	Y	N	NS	N	Y	Y	N		
24	Y	N	N	N	N	S	-	Y	N	Y	Y	Y	Y	NS	N	N	N	N		
25	Y	N	N	N	N	S	-	Y	N	N	Y	N	N	NS	N	N	N	N		
26	Y	N	N	N	N	S	-	Y	N	N	Y	Y	N	NS	N	N	N	N		
27	Y	N	N	P	N	PT	60	Y	N	N	Y	N	-	NS	-	N	Y	N		
28	Y	N	N	N	N	F	-	N	N	N	Y	Y	N	NS	N	P	N	N	Algona	
29	Y	N	N	N	N	F	-	Y	N	N	Y	N	Y	ST	N	Y	Y	N		
30	Y	N	N	N	N	S	50	Y	N	N	Y	Y	N	ST	Y	Y	N	N		
31	Y	N	N	N	N	S	50	Y	N	N	N	Y	N	NS	N	Y	N	N		
32	Y	N	N	N	N	S	50	Y	N	N	Y	N	N	NS	N	Y	N	N		
33	N	-	N	P	N	F	-	Y	N	N	N	Y	Y	-	N	N	Y	N	Estherville	
34	Y	N	N	N	N	S	-	Y	N	Y	N	N	N	-	Y	N	N	Y		N
35	Y	N	N	N	N	S	-	Y	N	N	Y	N	Y	NS	N	N	Y	N		
36	Y	N	N	N	N	S	-	Y	N	-	N	-	-	NS	N	P	Y	N		
37	Y	N	N	P	N	PT	64	N	N	-	N	-	-	-	-	N	Y	N		
38	Y	Y	N	N	N	PT	64	Y	N	-	Y	-	-	-	-	N	Y	N		
39	Y	Y	N	N	N	PT	64	Y	N	-	N	-	-	-	-	N	Y	N		
40	Y	Y	N	N	N	PT	64	Y	N	-	Y	-	-	-	-	N	Y	N		
41	Y	Y	N	N	N	PT	64	Y	N	-	Y	-	-	-	-	N	Y	N		
42	Y	N	N	N	N	S	-	Y	N	-	N	-	-	NS	N	N	Y	N		
43	Y	N	N	N	N	S	-	Y	N	Y	N	N	N	-	N	N	Y	N		

**Key**

Y Yes  
N No  
P Possible  
C Change to Other Method

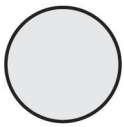
F Fully Actuated  
S Semi-Actuated  
PT Pre-Timed

ST Standard  
NS Non-Standard

Int. #	Different Elevations?	Dilemma Zone Detection	Redundant LT Heads	Arrows over Turn Lanes	Jurisdiction
1	N	N	-	-	Webster City
2	N	N	-	-	
3	N	N	N	-	Williamsburg
4	N	N	N	Y	
5	N	N	-	Y	Mount Vernon
6	Y	N	-	-	Wyoming
7	N	Y	N	Y	Carlisle
8	N	Y	N	Y	
9	N	Y	N	Y	
10	N	N	-	-	Bloomfield
11	N	N	Y	Y	
12	N	N	Y	Y	
13	-	-	-	-	Treynor
14	Y	N	N	Y	Shenandoah
15	Y	N	-	-	
16	Y	N	-	-	
17	Y	N	-	-	Garner
18	N	N	-	-	Northwood
19	Y	N	-	-	Cresco
20	Y	N	N	Y	Storm Lake
21	Y	N	-	-	
22	Y	N	-	-	
23	N	N	-	-	
24	N	N	-	-	
25	N	N	-	-	
26	N	N	-	-	
27	Y	N	N	Y	
28	N	Y	-	-	Algona
29	N	N	N	Y	
30	N	N	N	Y	
31	N	N	-	-	
32	N	N	-	-	
33	N	N	-	-	Estherville
34	N	N	-	-	
35	N	N	-	-	
36	N	N	-	-	
37	Y	N	-	-	
38	N	N	-	-	
39	N	N	-	-	
40	N	N	-	-	
41	N	N	-	-	
42	N	N	-	-	
43	N	N	-	-	

**Key**

**Y** Yes  
**N** No



North Arrow

Sight Distance:

LT Phase: Per Pro P/P

State Hwy:

Sidestreet:

Date Inventoried:

Jurisdiction:

Hwy Speed:

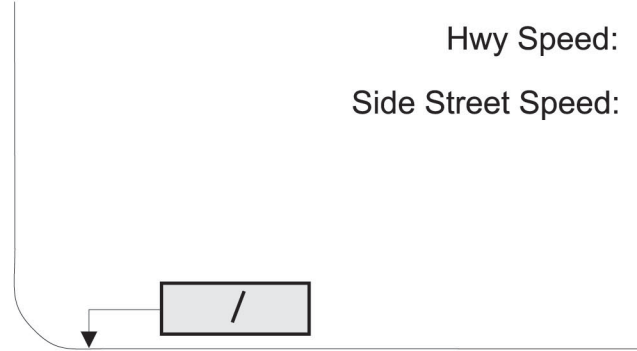
Side Street Speed:

Sight Distance:

LT Phase: Per

Pro

P/P

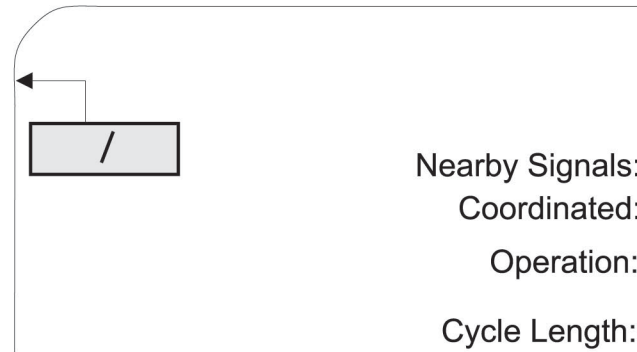


Sight Distance:

LT Phase: Per

Pro

P/P



Sight Distance:

LT Phase: Per Pro P/P

Nearby Signals: Y N

Coordinated: Y N

Operation: Pre Semi Fully

Cycle Length:

Controller Type:

Key

Cabinet

Detector

Fixed Object

## Checklist

Checked	Item	Comments
<input type="checkbox"/>	Size and type of lenses	
<input type="checkbox"/>	Lenses in proper order	
<input type="checkbox"/>	Visors and backplates	
<input type="checkbox"/>	Left-turn phases needed	
<input type="checkbox"/>	Unnecessary LT phases	
<input type="checkbox"/>	Burned out/dim lights, cracked lenses	
<input type="checkbox"/>	Non-functioning ped heads/buttons	
<input type="checkbox"/>	Non-functioning loops	
<input type="checkbox"/>	Street lights to be combined	
<input type="checkbox"/>	Well-maintained cabinet	
<input type="checkbox"/>	Timing sheets	

	1	2	3	4	5	6	7	8
Walk								
FDW								
Min Green								
Max Green								
Yellow								
All-Red								

Single Ring Controller Phasing:

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Dual Ring Controller Phasing:
