City of Carroll

112 E. 5th Street Carroll, Iowa 51401-2799 (712) 792-1000 FAX: (712) 792-0139

MEMO TO: Gerald L. Clausen, City Manager

FROM: Randall M. Krauel, Director of Public Works RMK

DATE: March 23, 2016

SUBJECT: US 30 Traffic Signal Study

Snyder & Associates, Inc. has completed the US 30 Traffic Signal Study. A copy of the Study is attached. In addition to the 15 pages attached, there is a 93-page Appendix that is available, if desired.

The Study was completed under the Traffic Engineering Assistance Program managed by the Iowa Department of Transportation. The purpose of the Study was to evaluate the need for existing traffic signals along the US 30 corridor and impacts of removing unwarranted signals. The Study Scope of Services included field review, crash history review, traffic operations analysis and traffic signal warrant analysis.

The recommendations are detailed in the Study and summarized as follows:

1. Remove existing traffic signal installations at Adams Street and Court Street intersections.

2. Provide adequate sight distance for STOP control at Adams Street and Court Street.

3. Adjust traffic signal timing and coordination plans at the remaining signalized intersections to provide improved traffic operations.

The estimate cost for removal of the signals at Adams Street and Court Street is $41,500.00.

The procedure for traffic signal removal if an engineering study indicates that the traffic control signal is no longer justified, and a decision is made to remove the signals, is as follows:

A. Determine the appropriate traffic control to be used after removal of the signal.
B. Remove any sight-distance restrictions, as necessary.
C. Inform the public of the removal study.
D. Flash or cover the signal heads for a minimum of 90 days, and install the appropriate stop control or other traffic control devices.
E. Remove the signal if the engineering data collected during the removal study period confirms that the signal is no longer needed.

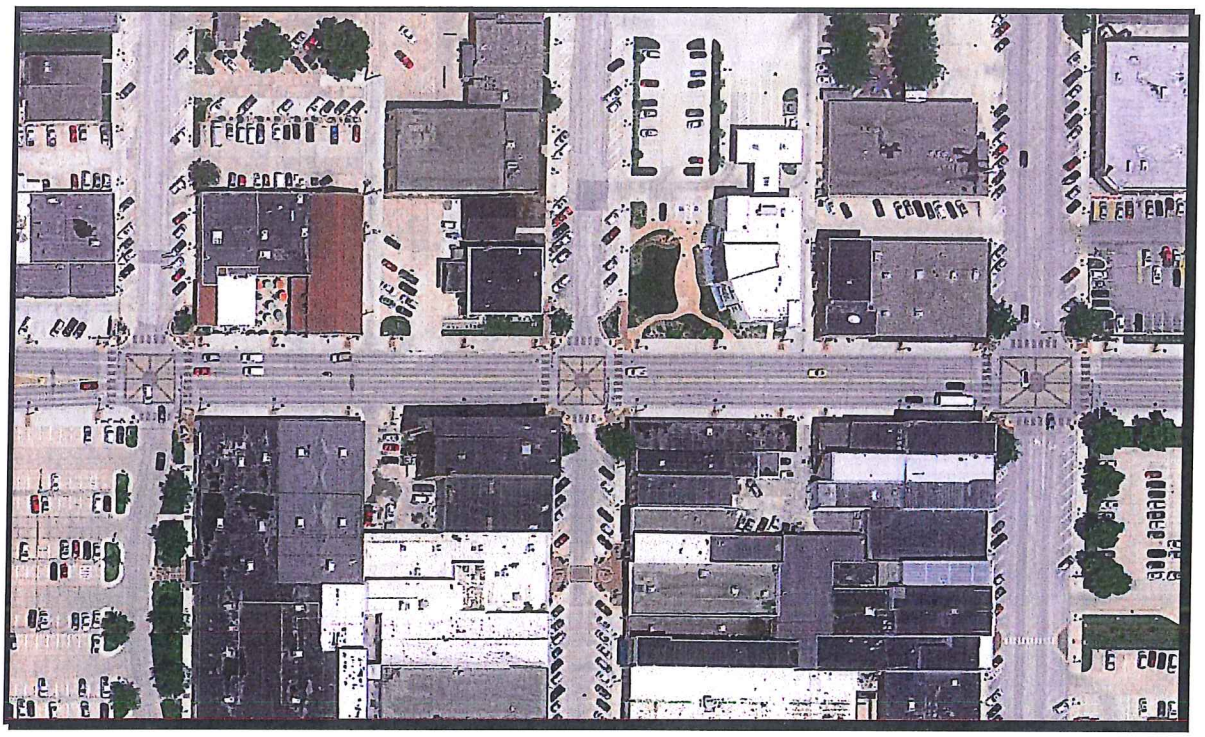
RECOMMENDATION: Mayor and City Council consideration, acceptance of the US 30 Traffic Signal Study and decision to remove/not remove the traffic signals at Adams Street and Court Street.

RMK:ds

attachment

TRAFFIC ENGINEERING ASSISTANCE PROGRAM

US 30 Traffic Signal Study



Prepared for:

City of Carroll

In Cooperation With:
Iowa Department of Transportation &
Iowa Department of Public Safety
Governor's Traffic Safety Bureau

March 4, 2016

IOWADOT

Iowa Department of Public Safety
GOVERNOR'S TRAFFIC SAFETY BUREAU

ENGINEERS & PLANNERS
SNYDER & ASSOCIATES, INC.
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March 4, 2016

Mr. Randy Krauel, P.E.
Director of Public Works
City of Carroll
112 E. 5th Street
Carroll, Iowa 51401

RE: US 30 TRAFFIC SIGNAL STUDY
CARROLL, IOWA
IOWA TRAFFIC ENGINEERING ASSISTANCE PROGRAM
S&A PROJECT NO.: 112.0600P

Dear Mr. Krauel:

Snyder & Associates has completed the US 30 Traffic Signal Study. Enclosed, for your use, are three copies of the final report.

The study was requested by the City of Carroll and completed as part of Iowa's Traffic Engineering Assistance Program (TEAP). TEAP is managed by the Iowa Department of Transportation and is partially funded through the Iowa Governor's Traffic Safety Bureau, as provided by the U.S. Department of Transportation, in accordance with the provisions of Section 402, Title 23, United States Code. The opinions, findings and conclusions expressed in this report are those of Snyder & Associates, Inc.

We are pleased to provide assistance to the City of Carroll through the completion of this study. Should you have any questions regarding this study, please contact us.

Sincerely,

SNYDER & ASSOCIATES, INC.

Anthony J. Boes

Anthony J. Boes, P.E., PTOE
Project Manager

Enclosures

cc: Steven Schroder, P.E., Iowa DOT, Office of Traffic & Safety (w/ 2 copies)
Brian Catus, P.E., Iowa DOT District 3 (w/ 1 copy)

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MAR - 7 2016
City of Carroll

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INFORMATION SHEET
IOWA DEPARTMENT OF TRANSPORTATION
TRAFFIC ENGINEERING ASSISTANCE PROGRAM

US 30 TRAFFIC SIGNAL STUDY

March 4, 2016

1. Local Jurisdiction: City of Carroll, Iowa

2. Reason TEAP Study Originated: To evaluate the need for existing traffic signals along the US 30 corridor and impacts of removing unwarranted signals.

3. Scope of Services Provided: Performed field review, crash history review, traffic operations analyses, traffic signal warrant analyses and developed recommendations.

4. The Consultant, Snyder & Associates, submitted a final report dated March 4, 2016 with the following recommendations:

   A. Upon approval by the Iowa DOT and the City of Carroll, proceed with removal of existing traffic signal installations at the Adams Street and Court Street intersections. Providing northbound and southbound STOP control at these intersections is recommended. The signal removal process should be in accordance with MUTCD recommendations.

      Removal of the signals may result in a reduction in rear-end crashes at the Adams Street and Court Street intersections. Significant changes to the occurrence of other crash types are not expected. In addition to traffic operational and potential safety benefits associated with removal of these signals, ongoing traffic signal maintenance and electricity costs will be reduced. Also, costs associated with the future replacement of the aging signal installations (typically $150,000 - $200,000 per intersection) will be avoided.

   B. Prior to ending traffic signal operation and providing STOP control, perform field measurements to verify if adequate sight distance is provided. Modify intersection conditions as needed to provide adequate sight distance. This will likely require modifications to the stop line location, crosswalk location and ADA pedestrian ramps at the south leg of the Court Street intersection. Trimming trees and shrubs may be necessary at both intersections.

   C. After signal operation is ended at the Adams Street and Court Street intersections, adjust traffic signal timing and coordination plans at the remaining signalized intersections to provide improved traffic operations. Timing and coordination plans used for analysis of proposed conditions in this study are shown in Table 7. Pedestrian and vehicle clearance intervals should be reviewed and adjusted as

needed per current MUTCD and ITE recommendations.

D. Although MUTCD traffic signal warrants (urban criteria) are not met at the Quint Avenue and West Street intersections, removal of these traffic signals is not recommended at this time. With STOP control at these intersections, projected average delays are 50.8 seconds (LOS F) southbound at West Street in PM peak, and 34.0 seconds (LOS D) southbound at Quint Avenue in the noon peak. The Quint Avenue signal also serves a commercial development south of US 30, and possible future redevelopment in this area could increase the need for the signal.

5. The order of magnitude cost opinion for removal of the Adams Street and Court Street signals and associated work is $41,500. Cost opinions include engineering and administration costs.

6. A potential funding source to assist with signal removals and associated work is the Iowa DOT "Urban State Traffic Engineering Program" (U-STEP).

TRAFFIC ENGINEERING ASSISTANCE PROGRAM
US 30 TRAFFIC SIGNAL STUDY
CARROLL, IOWA

Prepared by:

Snyder & Associates, Inc.

Prepared for:

City of Carroll

In Cooperation with:

Iowa Department of Transportation &
Iowa Department of Public Safety
Governor's Traffic Safety Bureau

March 4, 2016

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Iowa.

Anthony J. Boes 3/4/16

Anthony J. Boes, P.E. Date
License Number 12387
My License Renewal Date is December 31, 2017
Pages or sheets covered by this seal
All

Background

At the request of the Iowa DOT and the City of Carroll, through the Iowa DOT Traffic Engineering Assistance Program (TEAP), this study evaluated traffic signal needs, traffic operations and safety along US Highway 30 corridor. The study examined existing conditions and identified recommended changes to existing signalized intersections.

Existing Conditions

US 30 is a primary highway carrying 12,200 to 12,800 vehicles per day between Quint Avenue and Clark Street, according to Iowa DOT 2011 traffic count data. The posted speed limit along the study corridor varies from 25 to 35 mph. The study limits, shown in Figure 1, include seven signalized US 30 intersections: Quint Avenue, West Street, Carroll Street, Adams Street, Main Street, Court Street and Clark Street. These signals are interconnected via hardwire interconnect, and are running a single coordination plan. A previous TEAP study completed in 2005 found that traffic conditions at four of the signalized intersections did not satisfy any *Manual on Uniform Traffic Control Devices* (MUTCD) traffic signal warrants. These intersections are Quint Avenue, West Street, Adams Street and Court Street.

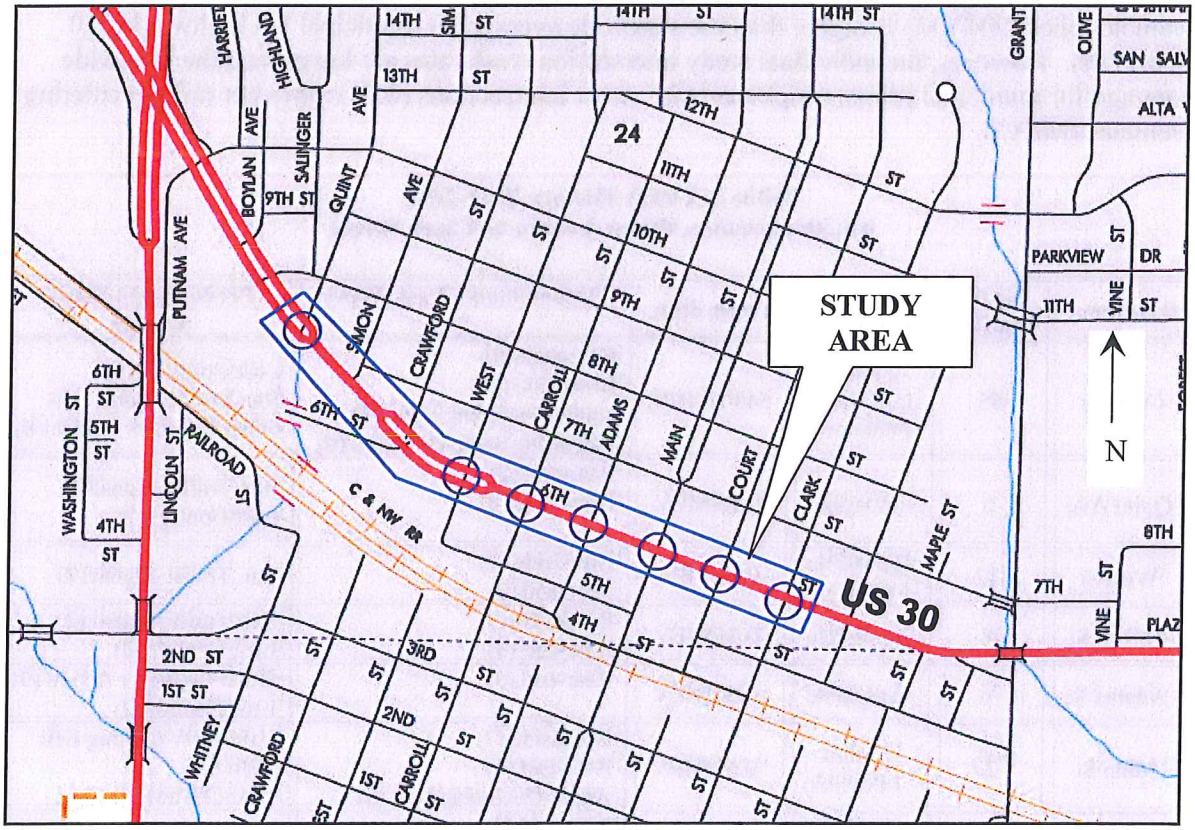

Figure 1: Study Area

Between Carroll Street and Clark Street, US 30 is a four-lane, undivided, urban cross-section highway. West of Carroll Street, the roadway widens to provide raised medians and left turn lanes at the West Street and Quint Avenue intersections.

Traffic Data

In order to evaluate MUTCD traffic signal warrants, 11-hour (7:00AM – 6:00 PM) intersection approach traffic counts were conducted by the City of Carroll at the four intersections that previously did not meet warrant criteria. Peak hour (11:30 AM – 1:30 PM and 3:00 – 5:00 PM) intersection turning movement counts were also conducted at all seven study intersections for use in analysis of existing traffic operations and possible changes in traffic control. Historic traffic count data shows that the noon and PM peak hours have significantly higher traffic volumes than the AM peak hour. Current traffic count data is provided in the appendix.

Crash History

Iowa DOT crash data for the five-year period from 2011 through 2015 were analyzed. As shown in Table 1 the study corridor experienced 85 reported crashes, resulting in two minor injuries, and 15 possible injuries. The overall corridor crash rate of 540 crashes per hundred million vehicle miles (HMVM) is higher than the statewide average for municipal US highways (250 /HMVM). However, the individual study intersection crash rates are lower than the statewide average for municipal primary highway/ city street intersections (0.9 crashes per million entering vehicles (MEV)).

Table 1: Crash History 2011-2015
US 30 Corridor, Quint Avenue to Clark Street

Location	No. of Crashes	No. of Injuries	Crash Rate	Predominant Crash Types	Predominant Major Causes
Corridor	85	2 minor 15 possible 1 unknown	540/HMVM	Rear-end (30) Broadside (26) Angle Oncoming Left (10) Sideswipe Same Direction (9)	Lost Control (18) Ran Traffic Signal (14) Other Improper Action (8)
Quint Ave	5	1 possible	0.15/MEV	Rear-end (2) Broadside (2)	Ran Traffic Signal (2) Lost Control (2)
West St	12	2 possible 1 unknown	0.37/MEV	Broadside (7) Rear-end (2)	Ran Traffic Signal (7)
Carroll St	8	1 possible	0.26/MEV	Broadside (3) Rear-end (3)	Ran Traffic Signal (2) Lost Control (2)
Adams St	6	1 possible	0.24/MEV	Rear-end (5)	Other Improper Action (3) Lost Control (2)
Main St	27	1 minor 1 possible	0.69/MEV	Broadside (7) Rear-end (7) Angle Oncoming Left (5)	FTYROW Making Left Turn (6) Lost Control (6)
Court St	8	1 minor 3 possible	0.31/MEV	Rear-end (3) Broadside (2)	None
Clark St	10	4 possible	0.32/MEV	Rear-end (4) Broadside (3) Angle Oncoming Left (2)	Lost Control (4)

Crashes at the signalized intersections accounted for approximately 89% of crashes along the study corridor. Predominant crash types reported were rear-end (30) and broadside (26).

Traffic Signal Warrant Analysis

MUTCD traffic signal warrants were evaluated at the Quint Avenue, West Street, Adams Street and Court Street intersections, using traffic count data provided by the City. The following traffic volume related warrants were evaluated:

- Warrant 1: Eight-Hour Vehicular Volume
- Warrant 2: Four-Hour Vehicular Volume
- Warrant 3: Peak Hour

The MUTCD provides reduced traffic volume criteria for communities with a population less than 10,000 or intersections with a major street speed limit greater than 40 mph. The US Census Bureau estimated 2014 population for the City of Carroll is 10,007, down from 10,103 in 2010. Therefore, the reduced (rural) and normal (urban) traffic volume criteria were considered in the warrant analyses. Analysis results are summarized in Table 2. Detailed summaries are provided in the appendix.

Table 2: Traffic Signal Warrant Analysis Results

US 30 Intersection	Criteria	Warrants Satisfied?		
		Warrant 1	Warrant 2	Warrant 3
Quint Ave	Urban	No	No	No
	Rural	Yes	Yes	Yes
West St	Urban	No	No	No
	Rural	Yes	Yes	Yes
Adams St	Urban	No	No	No
	Rural	No	No	No
Court St	Urban	No	No	No
	Rural	Yes	Yes	Yes

Warrant analyses show that with urban criteria, none of the four intersections satisfy at least one warrant. With rural criteria, the Quint Avenue, West Street and Court Street intersections satisfy all three warrants. No warrants are satisfied at the Adams Street intersection with urban or rural criteria.

Traffic Operations Analysis

Traffic operations analyses were performed for the study intersections using *Synchro* traffic analysis and modeling software. *Synchro* methods were used for analysis of signalized intersections because *Highway Capacity Manual* (HCM) methods do not directly consider coordinated signal operations, do not evaluate right turns on red, and do not allow non-NEMA signal phase designations.

Intersection delay, caused by traffic volume, turning vehicles, number of lanes, arrival patterns, and traffic control is qualitatively described by a performance measure called 'Level of Service' (LOS), which 'grades' delay on a scale of A-F. LOS A is considered the most desirable level, with the least delay, while LOS F is least desirable, with the most delay. LOS criteria defined by the HCM for signalized and unsignalized intersections are shown in Table 3. Analyses of existing conditions were performed for the noon and PM peak hours, and are summarized in Table 4.

Table 3: Level of Service (LOS) Definition

LOS	Average Delay per Vehicle (sec)	
	Unsignalized Intersection	Signalized Intersection
A	Less than 10	Less than 10
B	10-15	10-20
C	15-25	20-35
D	25-35	35-55
E	35-50	55-80
F	Greater than 50	Greater than 80

Based on traffic signal warrant analysis results and analysis of intersection operations with minor approach STOP control, additional analysis of the study intersections was performed assuming that signals are removed, and north-south STOP control is provided at the Adams Street and Court Street intersections. HCM methods were used for analysis of the unsignalized intersections. Analyses also included optimized traffic signal timing and coordination along the US 30 corridor. Analysis results for this scenario (proposed) are shown in Table 5.

Analysis results for existing conditions show acceptable (LOS A-B overall) traffic operations at each intersection. With signals removed at Adams Street and Court Street, similar traffic operations are projected at the remaining signalized intersections, with overall average delays decreasing by approximately 9%. Removing signals at Adams Street and Court Street would nearly eliminate US 30 traffic delays at these intersections, and would increase delays for the STOP controlled north-south approaches by approximately 6 - 9 seconds.

Synchro US 30 corridor measures of effectiveness (MOE) were evaluated for each scenario, including total vehicle delay, stops, and travel time. The MOE summary is provided in Table 6. Analyses indicate that a reduction of 3 - 4 hours of total delay would be provided in each of the peak hours analyzed. Assuming these peak hours include approximately 20% of the daily traffic, total delay reductions would be approximately 17.5 hours per day or 6,400 hours per year.

Figures 2 and 3 are time-space diagrams illustrating signal progression along US 30 for existing and proposed conditions, in the PM peak hour. As shown, improved coordinated green band widths (12 seconds to 16 seconds) are provided with removed signals and optimized timings.

Table 4: Traffic Operations Analysis Results – Existing Conditions

Intersection	Control	Approach	Noon Peak		PM Peak	
			Average Delay (sec)	LOS	Average Delay (sec)	LOS
Quint Ave	Signal	EB	6.8	A	7.4	A
		WB	1.6	A	1.0	A
		NB	13.6	B	12.4	B
		SB	20.7	C	17.4	B
		Overall	5.6	A	4.8	A
West St	Signal	EB	2.7	A	2.9	A
		WB	5.7	A	7.5	A
		NB	15.5	B	14.7	B
		SB	17.8	B	19.5	B
		Overall	5.9	A	7.0	A
Carroll St	Signal	EB	7.5	A	8.6	A
		WB	8.0	A	8.6	A
		NB	14.2	B	14.9	B
		SB	14.1	B	15.3	B
		Overall	8.8	A	9.6	A
Adams St	Signal	EB	4.4	A	3.3	A
		WB	2.5	A	3.0	A
		SB	12.4	B	12.6	B
		Overall	4.0	A	3.6	A
Main St	Signal	EB	5.7	A	6.1	A
		WB	10.0	A	10.1	B
		NB	13.8	B	15.4	B
		SB	14.3	B	15.7	B
		Overall	9.2	A	10.4	B
Court St	Signal	EB	6.0	A	5.8	A
		WB	4.8	A	4.8	A
		NB	11.4	B	11.8	B
		SB	13.4	B	11.4	B
		Overall	5.9	A	5.8	A
Clark St	Signal	EB	1.3	A	1.8	A
		WB	7.4	A	7.8	A
		NB	15.6	B	20.8	C
		SB	18.6	B	13.0	B
		Overall	8.0	A	8.2	A

Table 5: Traffic Operations Analysis Results – Proposed Conditions

Intersection	Control	Approach	Noon Peak		PM Peak	
			Average Delay (sec)	LOS	Average Delay (sec)	LOS
Quint Ave	Signal	EB	6.8	A	7.4	A
		WB	2.7	A	2.7	A
		NB	13.6	B	12.7	B
		SB	20.7	C	17.4	B
		Overall	6.1	A	5.7	A
West St	Signal	EB	2.0	A	2.5	A
		WB	1.6	A	2.4	A
		NB	15.5	B	14.7	B
		SB	17.8	B	19.5	B
		Overall	3.8	A	4.3	A
Carroll St	Signal	EB	6.2	A	6.1	A
		WB	6.0	A	6.2	A
		NB	12.3	B	12.9	B
		SB	12.6	B	13.7	B
		Overall	7.2	A	7.2	A
Adams St	SB STOP	EB	0.2	--	0.3	--
		WB	0.7	--	1.0	--
		SB	18.2	C	19.0	C
Main St	Signal	EB	5.6	A	4.0	A
		WB	6.9	A	7.8	A
		NB	12.9	B	14.3	B
		SB	13.5	B	14.7	B
		Overall	7.9	A	8.5	B
Court St	N-S STOP	EB	0.1	--	0.1	--
		WB	0.3	--	0.2	--
		NB	20.7	C	20.7	C
		SB	22.3	C	19.6	C
Clark St	Signal	EB	6.2	A	7.1	A
		WB	9.4	A	9.9	A
		NB	12.7	B	16.4	B
		SB	15.1	B	11.0	B
		Overall	9.6	A	10.1	B

Table 6: Measures of Effectiveness - US 30 Traffic

MOE	Period	Scenario		Percent Change
		Existing	Proposed	
Total Delay (hr)	Noon Peak	11	8	-27%
	PM Peak	13	9	-31%
Stops (#)	Noon Peak	2528	2035	-20%
	PM Peak	2927	2482	-15%
Travel Time (hr)	Noon Peak	38	35	-8%
	PM Peak	43	39	-9%

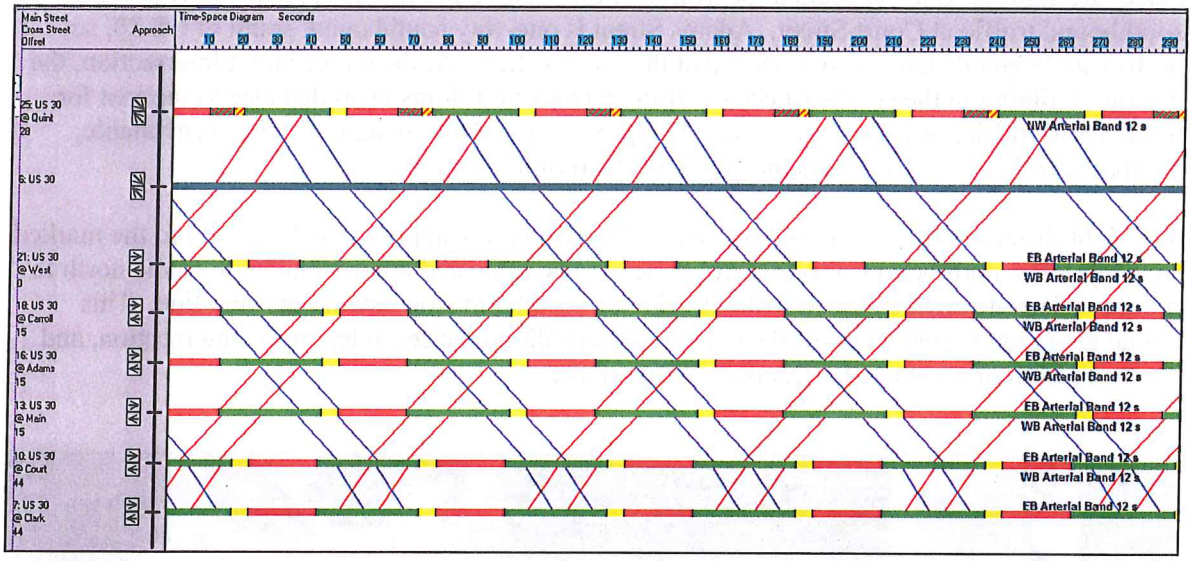

Figure 2: Time-Space Diagram – Existing Conditions

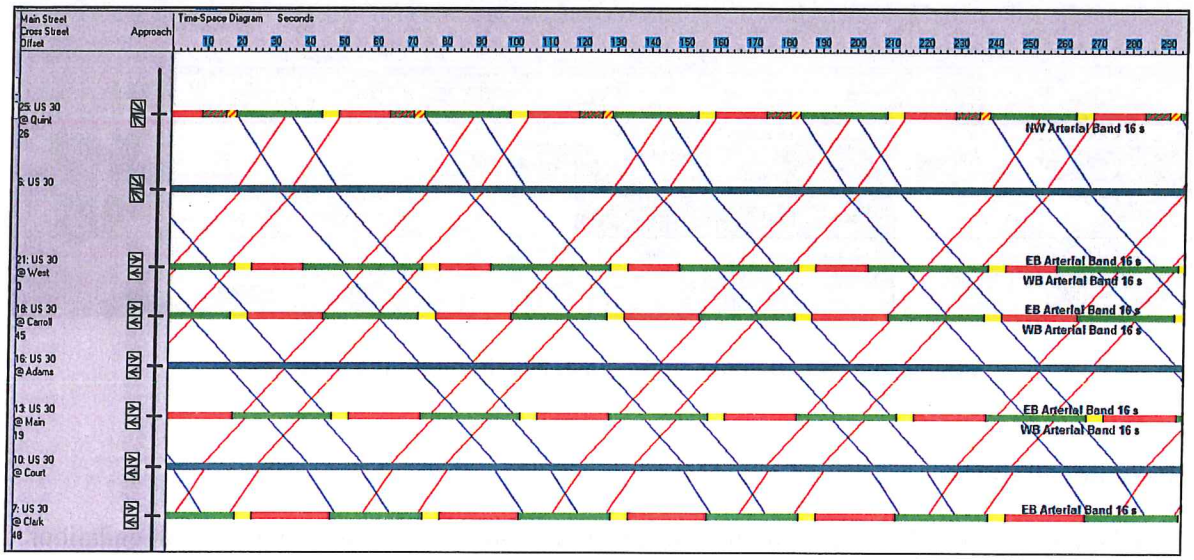

Figure 3: Time-Space Diagram – Proposed Conditions

Intersection Sight Distance

A review of intersection sight distance was performed to evaluate if adequate sight distance is available at the Adams Street and Court Street intersections, with STOP control for the north and south approaches. Per AASHTO, for a 30 mph design speed, 352' of sight distance is needed for a left turn onto a four-lane road, and 287' is needed for a right turn.

Adequate sight distance appears to be available for southbound traffic at Adams Street and southbound traffic at Court Street. Adams Street is one-way southbound, south of US 30, so northbound sight distance is not needed at this intersection. At the Court Street intersection, the existing building in the southeast corner of the intersection limits sight distance to the east for northbound traffic. As shown in Figure 4, approximately 160' of sight distance is available, compared to 352' needed for the northbound left turn movement.

The sight distance review is based on a driver's eye location approximately 8' behind the marked stop line. The northbound stop line would need to be relocated approximately 8' to the north to provide adequate sight distance without vehicles needing to stop beyond the stop line. This would also require relocation of the existing crosswalk on the south leg of the intersection, and reconstruction of associated ADA pedestrian ramps.

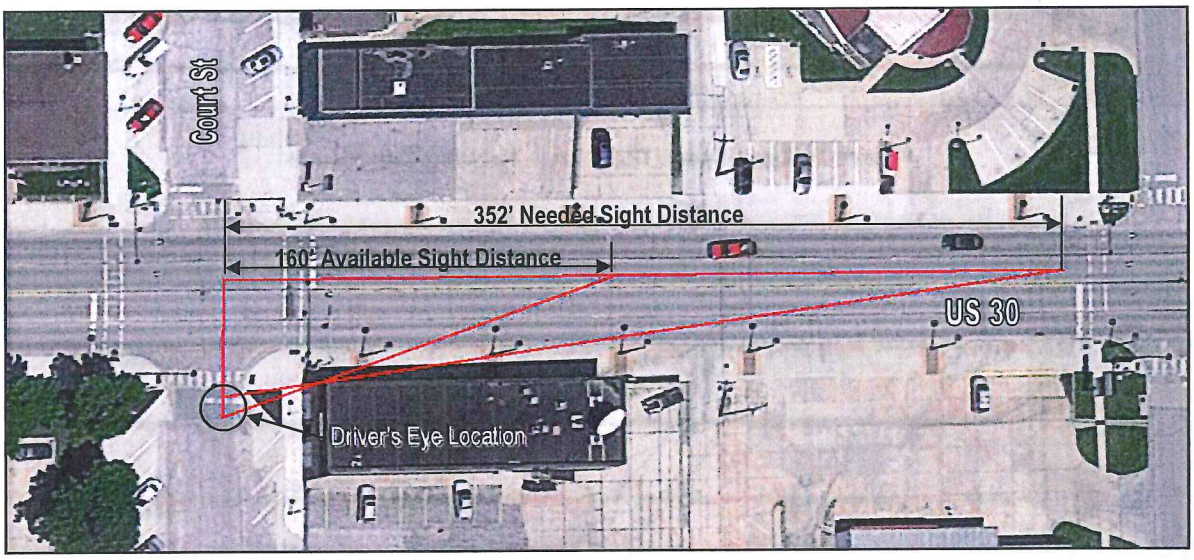

Figure 4: Sight Distance to the East, Northbound at Court Street

Recommendations

Based on review of existing conditions and analyses performed, the following recommendations are provided:

1. Upon approval by the Iowa DOT and the City of Carroll, proceed with removal of existing traffic signal installations at the Adams Street and Court Street intersections. Providing northbound and southbound STOP control at these intersections is recommended. According to the MUTCD, the following steps should be followed when an engineering study determines that a traffic signal is no longer justified, and a decision is made to remove it.

   A. Determine the appropriate traffic control to be used after removal of the signal.

   B. Remove any sight-distance restrictions as necessary.

C. Inform the public of the removal study.

D. Flash or cover the signal heads for a minimum of 90 days, and install the appropriate stop control or other traffic control devices.

E. Remove the signal if the engineering data collected during the removal study period confirms that the signal is no longer needed.

Instead of total removal of a traffic control signal, the poles, controller cabinet, and cables may remain in place after removal of the signal heads for continued analysis.

Removal of the signals may result in a reduction in rear-end crashes at the Adams Street and Court Street intersections. Significant changes to the occurrence of other crash types are not expected. In addition to traffic operational and potential safety benefits associated with removal of these signals, ongoing traffic signal maintenance and electricity costs will be reduced. Also, costs associated with the future replacement of the aging signal installations (typically $150,000 - $200,000 per intersection) will be avoided.

2. Prior to ending traffic signal operation and providing STOP control, perform field measurements to verify if adequate sight distance is provided. Modify intersection conditions as needed to provide adequate sight distance. This will likely require modifications to the stop line location, crosswalk location and ADA pedestrian ramps at the south leg of the Court Street intersection. Trimming trees and shrubs may be necessary at both intersections.

3. After signal operation is ended at the Adams Street and Court Street intersections, adjust traffic signal timing and coordination plans at the remaining signalized intersections to provide improved traffic operations. Timing and coordination plans used for analysis of proposed conditions in this study are shown in Table 7. Pedestrian and vehicle clearance intervals should be reviewed and adjusted as needed per current MUTCD and ITE recommendations.

Table 7: Proposed Signal Timing and Coordination Plans

Intersection	Offset (sec)	Split (sec)		
		East-West	North-South	E-W Lefts
Quint Ave	26	23	22	10
West St	0	24	21	10
Carroll St	45	33	22	--
Main St	19	34	21	--
Clark St	48	32	23	--

Notes:

- Cycle length = 55 seconds (same as existing)
- Offset defined as beginning of east-west phases

4. Although MUTCD traffic signal warrants (urban criteria) are not met at the Quint Avenue and West Street intersections, removal of these traffic signals is not recommended at this time. With STOP control at these intersections, projected average delays are 50.8 seconds (LOS F) southbound at West Street in PM peak, and 34.0 seconds (LOS D) southbound at Quint Avenue in the noon peak. The Quint Avenue signal also serves a commercial development south of US 30, and possible future redevelopment in this area could increase the need for the signal.

Cost Opinion

An order of magnitude cost opinion for removal of the Adams Street and Vine Street traffic signals (including engineering and administration) is shown in Table 8.

Table 8: Signal Removal Cost Opinion

Item #	Item	Description	Estimated Cost
1	Signal Removal	• Removal study • Remove Adams St and Court St signals. • Patch pavement and brick pavers. • Install STOP signs.	$26,000
2	Sight Distance Improvements	• Verify sight distance. • Relocate stop line and crosswalk pavement markings south leg of Court St. • Relocate Court St south leg crossing ADA pedestrian ramps.	$9,500
3	Traffic Signal Timing	• Review and adjust signal clearance intervals. • Develop, implement and field adjust revised signal timing and coordination plans.	$6,000
Total			$41,500

Potential Funding Sources

In addition to City capital improvement funds, funding may be available through the Iowa DOT "Urban State Traffic Engineering Program" (U-STEP). U-STEP funding is available to solve traffic operation or safety problems on primary roads in Iowa cities. The project must be on a State Route. Maximum project funding is $200,000 for spot improvements and $400,000 for linear improvements. A 45% local match is required. The City must provide administration and engineering for the project. An engineering analysis of the problem area (such as this TEAP study) is required. Letters of request are submitted to the Iowa DOT District Engineer. Further information on potential funding sources is available on the Iowa DOT website at http://www.iowadot.gov/fundguid.htm.