SIGNAL OPERATIONS
WEST CENTER ROAD

Project Report

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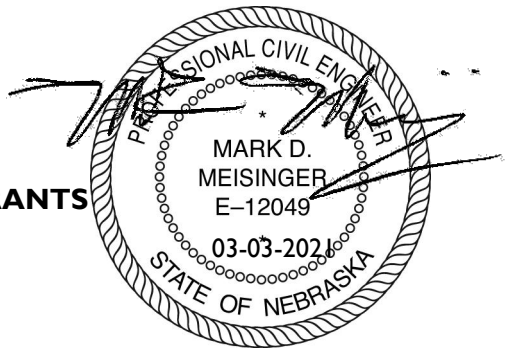

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Executive Summary

Felsburg Holt & Ullevig (FHU) and Apex Design, PC (Apex) has conducted the West Center Road (WCR) Signal Operations project of the City of Omaha Signal System Master Plan. Elements of this project included Project Administration, Data Collection, Optimization, Implementation, Performance Evaluation, and Safety Analysis.

The project encompassed 11.1 miles of West Center Road from 60th Street to 192nd Street, including 42 signalized intersections. There are also 24 additional signals along cross streets; two signals along 108th Street, two signals along 120th Street, four signals along 132nd Street, three signals along 168th Street eight signals along 180th Street, and one additional signal each along 192nd Street, 156th Street, Industrial Road, and Pacific Street. A total of 66 signalized intersections were included.

Performance Evaluation

The existing conditions Synchro model was used as a benchmark by which the implemented conditions could be compared. Network performance measures including total delay, total stops, total travel time, and fuel consumed were analyzed and are summarized in **Table ES.1**. These performance measures are calculated, not field measured, and reflect data for all vehicles in the network.

Table ES.1 Network Performance Measures – West Center Road (All)

	AM Peak			PM Peak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	852	846	-0.7%	1,850	1,702	-8.0%
Total Stops (#)	73,151	71,757	-1.9%	112,695	107,183	-4.9%
Total Travel Time (hr)	1,991	1,985	-0.3%	3,302	3,153	-4.5%
Fuel Consumed (gal)	3,052	3,039	-0.4%	4,648	4,475	-3.7%
	MD Peak			Offpeak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	612	647	5.7%	432	412	-4.6%
Total Stops (#)	65,634	58,985	-10.1%	49,072	48,307	-1.6%
Total Travel Time (hr)	1,594	1,628	2.1%	1,224	1,205	-1.6%
Fuel Consumed (gal)	2,570	2,513	-2.2%	1,987	1,960	-1.4%

Field measured performance metrics were recorded with Tru-Traffic (v10) software and a direct connect GPS receiver. Travel time runs were conducted before new timings were implemented and after fine tuning was complete to document improvements for vehicles travelling along the corridor.

Travel time was reduced by up to 3.5 minutes in the eastbound direction and 2.5 minutes in the westbound direction along West Center Road between 60th Street and 192nd Street. Along 180th Street, travel time was reduced by up to 2.5 minutes in the southbound direction and up to 0.5 minutes in the northbound direction between F Street and Burke Street. Corridor performance measures including travel time, delay, and stops for through traffic along West Center Road are summarized in **Table ES.2**.

Table ES.2 Corridor Performance Measures – West Center Road 60th St to 192nd St

		Eastbound				Westbound			
		Ex	Imp	Dif	% Dif	Ex	Imp	Dif	% Dif
AM Peak	Travel Time (sec)	1341	1184	-157	-12%	1386	1319	-67	-5%
	Delay (sec)	406	250		-39%	452	385		-15%
	Stops (#)	8.6	3.6	-5	-58%	9.7	7.9	-1.8	-19%
Offpeak	Travel Time (sec)	1328	1181	-147	-11%	1271	1290	19	1%
	Delay (sec)	392	248		-38%	336	355		6%
	Stops (#)	10.3	5.8	-4.5	-44%	9.5	10	0.5	5%
MD Peak	Travel Time (sec)	1390	1275	-115	-8%	1408	1311	-97	-7%
	Delay (sec)	454	341		-25%	474	375		-20%
	Stops (#)	9.5	7.5	-2	-21%	11.5	8.7	-2.8	-24%
PM Peak	Travel Time (sec)	1488	1273	-215	-14%	1395	1241	-154	-11%
	Delay (sec)	556	344		-39%	459	305		-34%
	Stops (#)	13.1	6.7	-6.4	-49%	10.2	5.7	-4.5	-44%
Weekend MD Peak	Travel Time (sec)	1348	1241	-107	-8%	1386	1298	-88	-6%
	Delay (sec)	414	307		-26%	453	364		-19%
	Stops (#)	9.1	6.1	-3	-33%	11.9	8.5	-3.4	-29%

The City of Omaha has developed a methodology, in-line with national industry standards, to calculate the monetary value of each benefit. Based on this methodology, the monetary benefit of this project over the next five years is anticipated to be $8,142,000. A breakdown of the project benefits is shown in **Table ES.3**. The cost to complete this project will not exceed $309,275.49. This yields an anticipated benefit/cost (B/C) ratio of at least **26:1**.

Table ES.3 Project Benefits Over 5 Years

Performance Measure	Project Benefit	Present Value
Delay Reduction	80,233 hours	$2,172,626
Fuel Consumption Reduction	837,645 gallons	$1,717,172
Emissions Reduction	8,280 tons	$567,966
Crash Reduction	87 crashes	$3,684,677

Long Term Safety and Operational Recommendations

Physical safety and operational improvements have been identified at three study intersections that exceed the Nebraska Statewide Crash Rate. These include the intersections of West Center Road with 108th Street, 114th Street, and 120th Street.

At the intersection of 108th Street with West Center Road three projects were identified:

- Project 1 includes lengthening the westbound left-turn lane by approximately 250 feet to prevent queue spill-out. It would also widen West Center Road slightly to provide a constant median width and improve lane alignment to the east of the intersection and incorporate access management.

- Project 2 would provide an eastbound right-turn lane and increase the eastbound right-turn radius to 50 feet. To accommodate truck turns. The northbound approach would be re-striped to provide dual left-turn lanes and a single shared lane for through and right-turn movements.

- Project 3 would re-construct the pedestrian bridge over West Center Road on the west leg of 108th Street; Project 2 would require modifications to the bridge.

At the intersection of 114th Street with West Center Road, an additional eastbound lane would be provided on the south curb. The additional eastbound lane would be striped as an exclusive right-turn lane and would allow for traffic in the existing eastbound through lane to proceed unimpeded to the downstream I-680 southbound on-ramp.

At the intersection of 120th Street with West Center Road, improvements would include dual left-turn lanes on the eastbound and westbound approaches, and a southbound right-turn lane. This project would incorporate access management and close driveways onto 120th Street on the southeast and northwest quadrants of the intersection.

A benefit cost analysis (BCA) was completed for each of the proposed improvements. The BCA was completed based on the lifespan of the project, assuming an improvement life period, construction costs, and maintenance costs for each project. In general, projects with a B/C ratio of 1.0 or greater have larger benefits than costs over the analysis time period.

- 108th Street with West Center Road – Project 1 – Anticipated B/C of 1.32
- 108th Street with West Center Road – Project 2 – Anticipated B/C of 5.68
- 108th Street with West Center Road – Project 3 – Anticipated B/C of 0.00
- 114th Street with West Center Road – Anticipated B/C of 5.53
- 120th Street with West Center Road – Anticipated B/C of 1.71

The overall cost of the proposed long term safety and operational improvement projects is $11.36 Million, with an overall B/C of **1.68**. The City of Omaha should consider adding each of these safety and operational improvement projects to its Capital Improvement Projects (CIP) list.

I. INTRODUCTION

A. Project Background

Felsburg Holt & Ullevig (FHU) and Apex Design, PC (Apex) has conducted the West Center Road (WCR) Traffic Signal Timing project of the City of Omaha Signal System Master Plan. Elements of this project included Project Administration, Data Collection, Evaluation and Optimization, Implementation, Safety Analysis, and Recommendations. This report is formatted with a chapter for each of these tasks and a number of Appendices with supporting technical information.

B. Signal Locations

The project encompassed 11.1 miles of West Center Road from 60th Street to 192nd Street, which includes 42 signalized intersections. There are also 24 additional signals along cross streets; a total of 66 signalized intersections were included.

The project was divided into three segments:

- WCR East
- WCR Central
- WCR West / 180th Street

A list of the intersections included in the WCR project can be found in **Table 1.1**. A map illustrating the location of the study intersections is provided in **Figure 1.1**.

WCR East

The east segment of West Center Road between 60th Street and 84th Street generally provides a four-lane divided cross-section with exclusive left-turn lanes. The study area includes eight signals along West Center Road.

WCR Central

The central segment of West Center Road between 84th Street and 144th Street is in a predominantly suburban environment. The study area includes 18 signals along West Center Road, two additional signals along 108th Street, two additional signals along 120th Street, and four additional signals along 132nd Street, for a total of 30 signals.

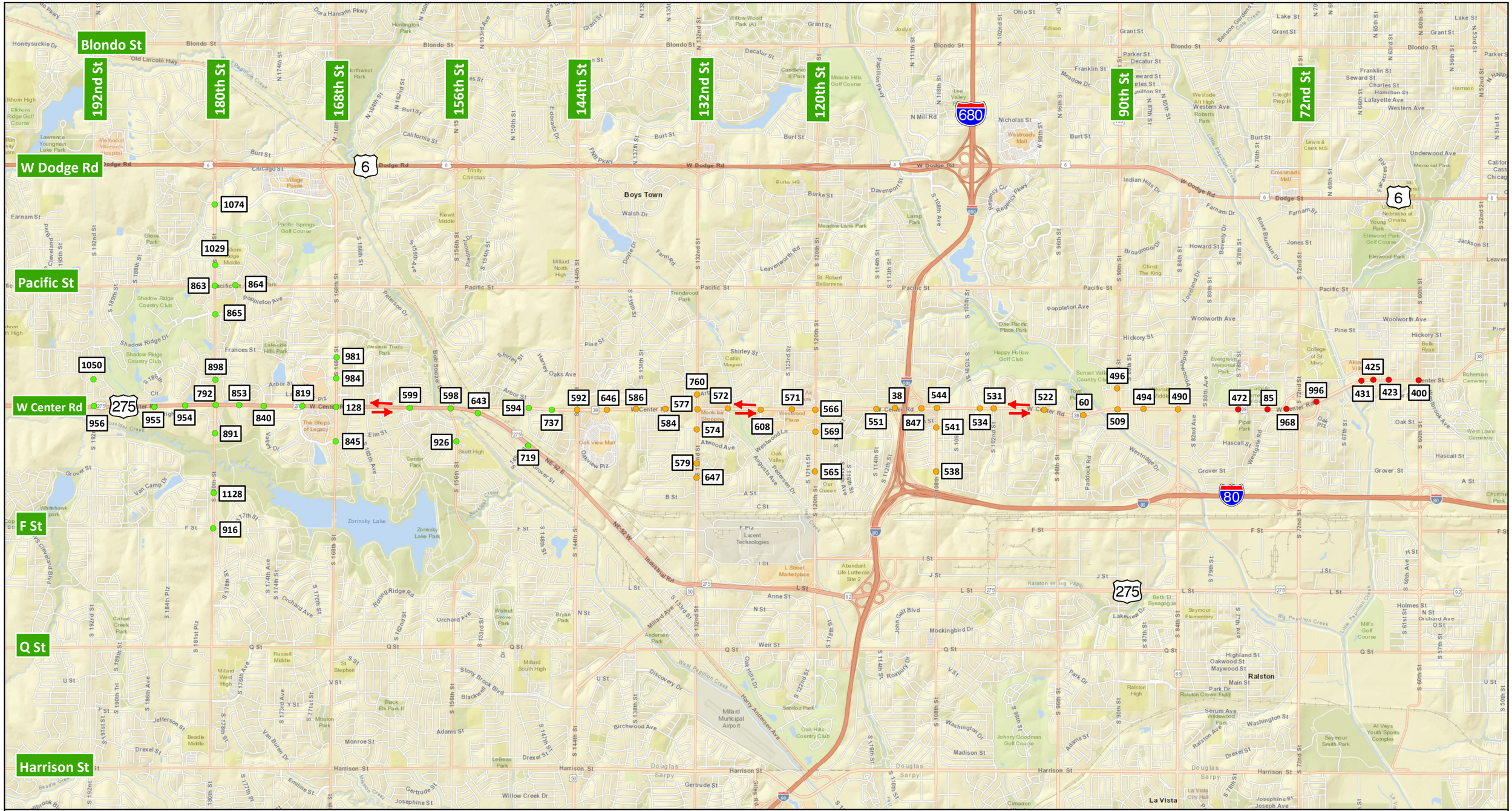
WCR West / 180th Street

The west segment of West Center Road between 146th Street and 192nd Street is in a predominantly suburban environment. The study area includes 13 signals along West Center Road, eight additional signals along 180th Street, three additional signals along 168th Street, and one additional signal each along 192nd Street, 156th Street, Industrial Road, and Pacific Street, for a total of 28 signals.

Table 1.1 Intersection List

Signal_ID	Location	Signal_ID	Location
WCR East		**WCR West**	
400	60th St & Center St	737	146th St & West Center Rd/W Center Rd
423	63rd St & Center St	594	148th St & West Center Rd
425	64th Ave & Center St	719	149th St & Industrial Rd
431	67th St & Center St	643	West Center Rd & Industrial Rd
996	72nd St East Ramps & West Center Rd	926	156th St & Spring St
968	72nd St West Ramps & West Center Rd	598	156th St/Bob Boozer & West Center Rd
85	Westgate Rd & West Center Rd	599	160th St & West Center Rd
472	78th St & West Center Rd	845	168th St & Oak St
WCR Central		128	168th St & West Center Rd
490	84th St & West Center Rd	984	168th St & Lakeside Hills Plz
494	87th St & West Center Rd	981	168th St & Frances St
509	90th St & West Center Rd	819	171st St & West Center Rd
496	90th St & Arbor St	840	175th St & West Center Rd
60	Paddock Rd & West Center Rd	853	177th St & West Center Rd
522	97th St & West Center Rd	792	180th St & West Center Rd
531	102nd St & West Center Rd	954	183rd St & West Center Rd
534	105th St & West Center Rd	955	186th St & West Center Rd
538	108th St & Grover St	956	192nd St & West Center Rd
541	108th St & Oak St	1050	192nd St & Pinehurst Ave
544	108th St & West Center Rd	**180th Street**	
847	I-680 East Ramp & West Center Rd	916	180th St & F St
38	I-680 West Ramp & West Center Rd	1128	180th St & Van Camp Dr
551	114th St & West Center Rd	891	180th St & Oak St
565	120th St & Valley St	898	180th St & Arbor St
569	120th St & Westwood Ln	865	180th St & Shadow Ridge Dr
566	120th St & West Center Rd	863	180th St & Pacific St
571	122nd Ave & West Center Rd	864	178th St & Pacific St
608	125th Ave & West Center Rd	1029	180th St & Marcy St
572	129th Ave & West Center Rd	1074	180th St & Burke St
647	132nd St & Grover St		
579	132nd St & Westwood Ln		
574	132nd St & Kingswood St/Augusta Ave		
577	132nd St & West Center Rd		
760	132nd St & Arbor St		
581	133rd Plz & West Center Rd		
584	134th Ave/135th Ave & West Center Rd		
586	139th St & West Center Rd		
646	Oak View Dr/140th St & West Center Rd		
592	144th St & West Center Rd		

Project No. MAPA-5038(18)
Control No. 22800



Legend

- WCR East
- WCR Central
- WCR West
- 24 Hr x 7 Day Traffic Counts

0 — NORTH — 2 Miles

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connecting & enhancing communities

Figure 1-1
Signal Location Map
West Center Road Signal Operations
Omaha On-Call Traffic Signal Design

Aerial Source: Douglas County NE, 3/28/2018.

II. Project Administration

A. Project Team

The project team guided the study through completion and included representatives from the City of Omaha, Nebraska Department of Transportation (NDOT), FHU, and Apex:

Representative	Organization
Mark Horak	City of Omaha
Bryan Guy	City of Omaha (City Project Manager)
Nick Gordon	City of Omaha
Garret Schram	City of Omaha
Jeff Riesselman	City of Omaha (City Traffic Engineer)
Juan Pizano	City of Omaha
Jenna Habegger	NDOT
Kevin Vrchoticky	NDOT
Tim Adams	Felsburg Holt & Ullevig
David Andersen	Felsburg Holt & Ullevig (Technical Lead)
Dan Barth	Felsburg Holt & Ullevig
Molly Mayer	Felsburg Holt & Ullevig
Mark Meisinger	Felsburg Holt & Ullevig (Project Manager)
Philip Dunham	Felsburg Holt & Ullevig
Josh Palik	Felsburg Holt & Ullevig
Peyton Weiss	Felsburg Holt & Ullevig
Jeff Ream	Apex Design
Diana McHale	Apex Design
Jeff Lancaster	Apex Design

B. Project Meetings

A series of project meetings were conducted throughout the study as listed below. The project meetings were conducted online due to the ongoing COVID-19 pandemic during 2020. **Appendix A** includes meeting minutes from each of the following meetings:

- Kickoff Meeting – July 14, 2020
- Progress Meeting – August 4, 2020
- Progress Meeting – September 8, 2020
- Progress Meeting – September 22, 2020
- Pre-Implementation Meeting – October 2, 2020
- Progress Meeting – October 13, 2020
- Implementation – October 19, 2020
- Progress Meeting – November 17, 2020

A project kick-off meeting with the City of Omaha and consultants was held on July 14, 2020, to provide an overview of goals and expectations for the WCR project. Subsequently, a series of progress meetings were held to further refine the project and the development of timing plans. A pre-implementation meeting was held on October 2, 2020 to review proposed day plan modifications, discuss signal timing plan implementation, database programing, and post-implementation fine tuning, observations and travel time runs.

III. DATA COLLECTION

A. Lane Configurations

Lane configuration data was provided by the City of Omaha and reviewed by the consultant team. The City-provided Synchro files were updated as needed to match existing conditions. Left-turn and through movement clearance distances were measured and recorded in **Appendix B** for use in calculating clearance intervals.

B. Turning Movement Counts

Peak hour turning movement counts (TMCs) for each of the project intersections were provided by the City of Omaha. These TMCs were collected prior to the COVID-19 pandemic (pre-March 2020) and represent typical historic traffic volumes. Per discussions with the City and consultant team, it was determined that historic TMCs would be utilized for evaluation and should not be factored to match COVID-19 era (2020) traffic volumes.

The TMCs were conducted from 7:00 AM to 11:00 AM and 2:00 PM to 6:00 PM. This provided data for the AM peak, offpeak, and PM peak design periods but not the MD peak design period. The 24-hour x 7-day data was used to determine which count data to factor and by how much to create estimated MD peak hour volumes. It was determined to use 2:00 PM to 3:00 PM TMC data increased by 5%.

C. 24-hour x 7-day Counts

24-hour traffic counts were conducted over a seven-day time period by the consultant team from August 23-29, 2020 at three locations along West Center Road. The 2020 Average Weekday Traffic (AWT) is summarized along with MAPA's Average Annual Weekday Traffic (AAWT) from 2016 in **Table 3.1**. A comparison of 2020 counts (during the COVID-19 pandemic) to 2016 counts shows that daily volumes were depressed by 30% to 45% at these locations.

Table 3.1 24-hour x 7-day Count Comparison

Location	Average Weekday Traffic Count		% Change
	2016*	2020	
WCR near 100th Street	40,000	22,100	-44.8%
WCR near 125th Street	40,000	27,200	-32.0%
WCR just east of 168th Street	50,000	34,800	-30.4%

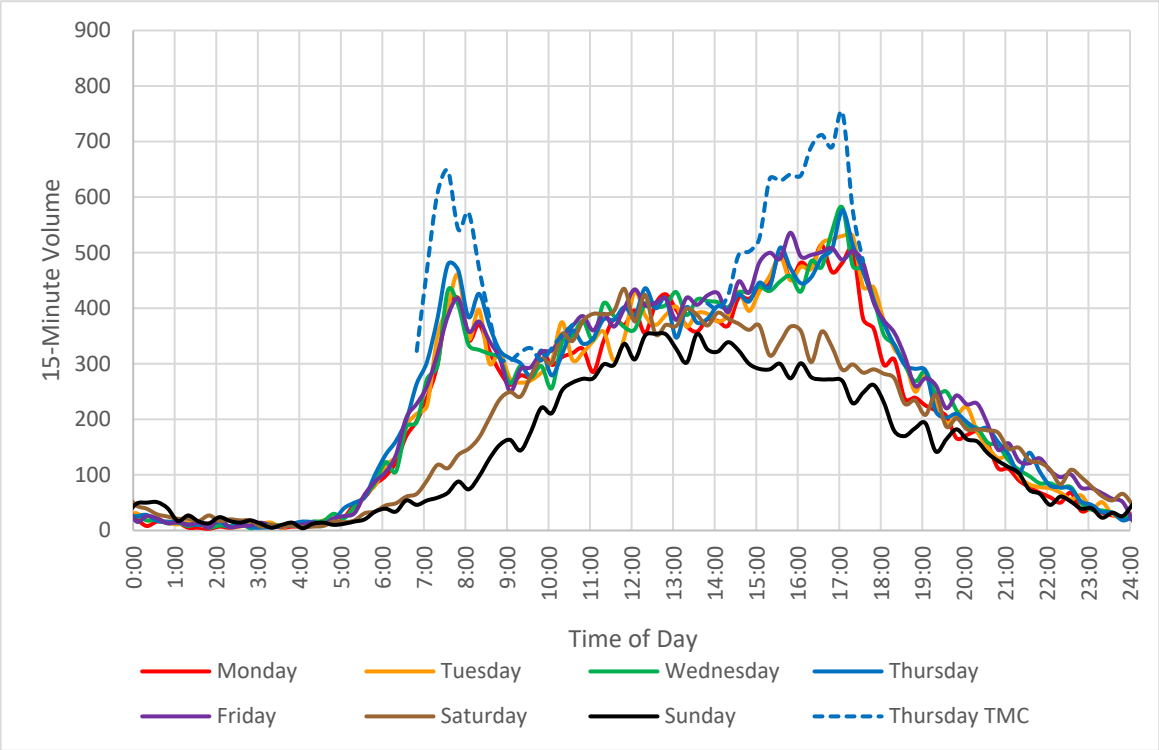
**Source: MAPA*

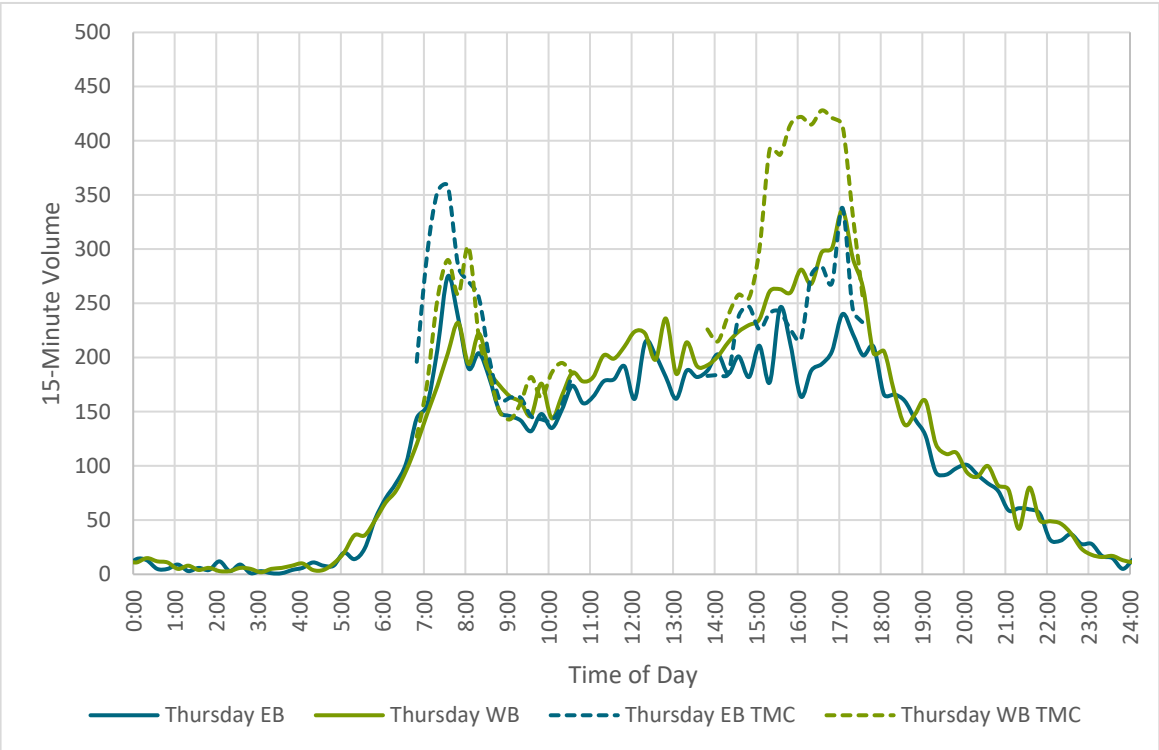
As summarized in **Appendix C**, the 24-hour x 7-day data has been plotted in the following formats:

1. Hourly bidirectional volumes by day of week
2. Average hourly directional volumes (total and per lane) for weekdays
3. Hourly directional volumes (total and per lane) for Saturdays
4. Hourly directional volumes (total and per lane) for Sundays

A comparison of the August 2020 count near 100th Street to a count conducted in October of 2019, shown on **Figure 3.1**, indicated that some peak spreading has occurred. 2020 AM and PM peak period counts are 15% to 20% lower than historic turning movement counts, and midday period counts are approximately 20% higher than historic turning movement counts.

WEST CENTER RD W/O 100TH ST





TMC Date: 10/24/2019

Segment Count Dates: 8/23/2020 - 8/29/2020

Figure 3.1
West Center Road
7-Day Counts

D. Travel Time Runs (Before)

Travel time runs were conducted for "before" conditions on each corridor, listed below, in early September 2020. At least five runs were collected in the Existing conditions during each design period and a weekend period (AM peak, MD peak, PM peak, offpeak, and Weekend MD peak). Travel time data was collected using Tru-Traffic (v10), and videos were recorded during each run using a dash cam. The travel time run information is summarized in **Appendix D** and was used as a baseline for development of timing plans.

- West Center Road from 60th Street through 192nd Street.
- 180th Street from F Street through Burke Street.
- 144th Street / Millard Avenue / 132nd Street from Stony Brook Boulevard through Arbor Street.

The 144th Street / Millard Avenue / 132nd Street corridor is part of a multi-project effort. The before runs were conducted and the traffic signals north of I Street were retimed as part of this project. The after runs and will be conducted and the signals south of Grover Street will be retimed as part of a concurrent project.

E. Intersection Observations

Intersection operations observations were conducted and logged during each design period and were used in the development of timing plans. Observations occurred in September and October 2020. Site observations include:

- Progression and queue clearance along West Center Road was generally good in all four periods, but traffic volumes were lower due to COVID-19
- 60th Street & Center Street – WB/NB is over capacity, particularly WBL in AM/PM
- 108th Street & WCR – historic long NB queues not observed in 2020, was likely related to 2019 I-680 construction
- 108th Street & WCR – EBR queues extend to I-680 on-ramp in PM
- 114th Street & WCR – EB queues routinely extend to median break in AM and Saturday MD
- 120th Street & WCR – EBL and NBL were observed to extend beyond turn lane in PM
- 132nd Street & WCR – Occasional NBL split failures in PM
- 132nd Street & WCR – NBL & NBT split failures in Saturday MD
- 139th Street & WCR – During the school dismissal period, the outside EB lane becomes a storage lane for stopped vehicles as parents line up to pick up their children from Millard North Middle School.
- 144th Street & WCR – EBL queues extend past turn bay Saturday MD
- 156th Street / Bob Boozer Dr & WCR – NBL split failures in AM / PM
- 168th Street & WCR – Low lane utilization in outside NB and SB through lanes as lanes drop after intersection
- 180th Street & WCR – Low lane utilization in outside NB and SB through lanes as lanes drop after intersection
- 192nd Street & WCR – NB queues extend to Spring Street in AM / PM

F. Traffic Analysis Parameters

Traffic operations were analyzed for the study intersections using Synchro (v10). From the analyses, a key measure or "level of service" rating of the traffic operational condition was obtained. In general,

level of service (LOS) is a qualitative assessment of traffic operational conditions within a traffic stream in terms of the average stopped delay per vehicle at a controlled intersection.

Levels of service are described by a letter designation of either A, B, C, D, E or F, with LOS A representing essentially uninterrupted flow, and LOS F representing a breakdown of traffic flow with noticeable congestion and delay. Unsignalized, or stop controlled, intersection capacity analyses produced LOS results for each movement which must yield to conflicting traffic at the intersection. Signalized intersections capacity analyses produced LOS results for the entire intersection. **Table 3.2** summarizes LOS criteria for both unsignalized and signalized intersections. In general, a LOS D or better is deemed acceptable by the City of Omaha.

Table 3.2 Level of Service (LOS) Criteria

Level of Service	Average Control Delay per Vehicle (sec/veh)	
	Signalized Intersections	Stop Sign Controlled Intersections
A	≤ 10	≤ 10
B	> 10 to 20	> 10 to 15
C	> 20 to 35	> 15 to 25
D	> 35 to 55	> 25 to 35
E	> 55 to 80	> 35 to 50
F	> 80	> 50
HCM 6th Edition, Exhibit 19-8 & Exhibit 20-2		

Each element of data collected was utilized to build a calibrated Synchro model. Once all the data was programmed into the models, the models were calibrated based on observations collected during the existing condition travel time runs. Various settings were adjusted to ensure Synchro and SimTraffic metrics reflected real world conditions as closely as possible.

IV. OPTIMIZATION

A. Clearance Interval Evaluation

Clearance intervals at each intersection were evaluated based on the City of Omaha's methodology, which is a hybrid of the 1985 ITE Proposed Recommended Practice, the 2012 NCHRP 731 Method, and the 2015 ITE Proposed Recommended Practice. **Appendix B** documents the City methodology. The City has already updated the clearance intervals at 43 signals; this evaluation updated them at the remaining 20 locations:

- 60th Street & Center Street
- 132nd Street & West Center Road
- 132nd Street & Arbor Street
- 132nd Street & Grover Street
- 132nd Street & Kingswood Street / Augusta Avenue
- 132nd Street & Westwood Lane
- 133rd Street & West Center Road
- 149th Street & Industrial Road
- Industrial Road & West Center Road
- 156th Street & West Center Road
- 160th Street & West Center Road
- 183rd Street & West Center Road
- 186th Street & West Center Road
- 192nd Street & West Center Road
- 156th Street & Spring Street
- 168th Street & Frances Street
- 180th Street & Arbor Street
- 180th Street & Oak Street
- 180th Street & F Street
- 192nd Street & Pinehurst Avenue

Appendix B includes the aerial maps of each intersection with the various distances used to calculate the recommended clearance intervals.

Tables in **Appendix B** summarize the existing and recommended clearance intervals at the 24 intersections in the study area that required updates. The tables also include recommended updates to the minimum green times and passage times for each phase at each intersection. As the tables indicate, the recommended total clearance intervals are generally the same or within one to two seconds of the current clearance intervals. However, recommended changes to minimum green times are more significant at some locations (Industrial Road & 149th Street, West Center Road & Industrial Road, etc.), which results in recommended minimum split times that are 8-12 seconds different from current minimums.

B. Left-turn Phasing Evaluation

The need for the protected portion of protected-permitted left-turn phases was evaluated based on the City of Omaha's methodology, which considers left-turn volume, opposing volume, and vehicle delay for

the left-turn movement. The analysis reviewed each movement at each intersection which currently has a five-section "dog-house" or four-section flashing yellow arrow left-turn signal indication.

Tables in **Appendix E** summarize the results of the left-turn phasing evaluation for each time period. As the tables indicate, there were several movements in several time periods where the protected portion of the left-turn phase could be omitted. Based on the results of the analysis, field observations, and engineering judgement, **Table 4.1** indicates during each time period whether each left-turn phase has the protected portion enabled or omitted for the implemented conditions.

Table 4.1 Active Phases – Implemented

Intersection	Phase	Direction	Plan 1 MD	Plan 2 AM	Plan 3 PM	Plan 4 OP
192nd St & West Center Rd	1	WBL	Enable	Enable	Enable	Enable
192nd St & West Center Rd	5	EBL	Enable	Enable	Enable	Enable
192nd St & West Center Rd	3	NBL	Enable	Enable	Enable	Enable
186th St & West Center Rd	1	WBL	Omit	Omit	Enable	Omit
183rd St & West Center Rd	1	WBL	Enable	Enable	Enable	Enable
180th St & Marcy St	7	SBL	Omit	Enable	Enable	Omit
180th St & Pacific St	1	WBL	Enable	Enable	Enable	Enable
180th St & Pacific St	5	EBL	Enable	Enable	Enable	Enable
180th St & Pacific St	3	NBL	Enable	Enable	Enable	Enable
180th St & Pacific St	7	SBL	Enable	Enable	Enable	Enable
180th St & Oak St	3	NBL	Enable	Enable	Enable	Enable
180th St & F St	3	NBL	Omit	Enable	Enable	Omit
180th St & Burke St	1	WBL	Enable	Enable	Enable	Omit
180th St & Burke St	5	EBL	Enable	Enable	Enable	Omit
180th St & Burke St	3	NBL	Enable	Enable	Enable	Omit
180th St & Burke St	7	SBL	Enable	Enable	Enable	Enable
180th St & Arbor St	3	NBL	Omit	Omit	Enable	Omit
180th St & Arbor St	7	SBL	Enable	Enable	Enable	Enable
177th St & West Center Rd	1	WBL	Omit	Omit	Omit	Omit
177th St & West Center Rd	5	EBL	Enable	Omit	Enable	Omit
175th St & West Center Rd	1	WBL	Enable	Enable	Enable	Omit
171st St & West Center Rd	1	WBL	Enable	Enable	Enable	Omit
171st St & West Center Rd	5	EBL	Enable	Enable	Enable	Omit
168th St & Oak St	3	NBL	Enable	Enable	Enable	Enable
168th St & Oak St	7	SBL	Omit	Omit	Enable	Omit
168th & Lakeside Hills Dr	3	NBL	Enable	Enable	Enable	Enable
160th & West Center Rd	1	WBL	Omit	Enable	Enable	Omit
160th & West Center Rd	5	EBL	Enable	Enable	Enable	Omit
156th St & Spring St	7	SBL	Enable	Enable	Enable	Enable
149 St & Industrial Rd	1	WBL	Enable	Enable	Enable	Enable

Table 4.1 Active Phases – Implemented

Intersection	Phase	Direction	Plan 1 MD	Plan 2 AM	Plan 3 PM	Plan 4 OP
133rd Plz & West Center Rd	1	WBL	Enable	Omit	Enable	Enable
133rd Plz & West Center Rd	5	EBL	Enable	Omit	Enable	Enable
129th Ave & West Center Rd	1	WBL	Enable	Omit	Enable	Enable
122nd Ave & West Center Rd	1	WBL	Enable	Omit	Enable	Enable
122nd Ave & West Center Rd	5	EBL	Enable	Omit	Omit	Enable
120th St & West Center Rd	1	WBL	Enable	Enable	Enable	Enable
120th St & West Center Rd	3	NBL	Enable	Enable	Enable	Enable
120th St & West Center Rd	5	EBL	Enable	Enable	Enable	Enable
120th St & West Center Rd	7	SBL	Enable	Enable	Enable	Enable
114th St & West Center Rd	1	WBL	Enable	Enable	Enable	Enable
114th St & West Center Rd	5	EBL	Enable	Enable	Enable	Enable
114th St & West Center Rd	7	SBL	Enable	Enable	Enable	Enable
I-680 West Ramp & West Center Rd	1	WBL	Enable	Enable	Enable	Enable
I-680 East Ramp & West Center Rd	5	EBL	Omit	Omit	Enable	Omit
108th St & West Center Rd	1*	WBL**	Enable	Enable	Enable	Enable
108th St & West Center Rd	3	NBL	Enable	Enable	Enable	Enable
108th St & West Center Rd	5	EBL	Omit	Enable	Enable	Omit
Paddock Rd & West Center Rd	1	WBL	Enable	Omit	Enable	Enable
90th St & West Center Rd	7	SBL	Enable	Enable	Enable	Enable
72nd St West Ramps & West Center Rd	5	EBL	Omit	Omit	Omit	Omit
72nd St East Ramps & West Center Rd	1	WBL	Omit	Omit	Omit	Omit
72nd St East Ramps & West Center Rd	3	NBL	Enable	Enable	Enable	Enable
72nd St East Ramps & West Center Rd	5	EBL	Omit	Omit	Omit	Omit
67th St & Center St	1	WBL	Omit	Omit	Omit	Omit
67th St & Center St	3	NBL	Omit	Omit	Omit	Omit
67th St & Center St	5	EBL	Enable	Enable	Enable	Enable
67th St & Center St	7	SBL	Omit	Omit	Omit	Omit
64th Ave & Center St	1	WBL	Enable	Enable	Enable	Enable
64th Ave & Center St	5	EBL	Enable	Enable	Enable	Enable
60th St & Center St	1	WBL	Enable	Enable	Enable	Enable
60th St & Center St	3	NBL	Enable	Enable	Enable	Enable
60th St & Center St	5	EBL	Enable	Enable	Enable	Enable
60th St & Center St	7	SBL	Enable	Enable	Enable	Enable
120th St & Westwood Ln	3	NBL	Omit	Enable	Enable	Omit
120th St & Valley St	7	SBL	Omit	Enable	Omit	Omit

*Phase 9 is enabled during Plan 3 as a protected only twice-per-cycle left-turn.

**Protected only left-turn during Plan 1, 2, and 3. Protected/Permitted during Plan 4 and Free Operation.

C. Leading Pedestrian Interval Evaluation

The suitability for a leading pedestrian interval (LPI) at selected locations (as determined jointly by the City and the Consultant team) was evaluated based on the City of Omaha's methodology. The selected locations for evaluation included the intersections of West Center Road with 63rd Street, 64th Avenue, and 67th Street as well as intersection of 156th Street with Spring Street based upon the surrounding land uses and roadway characteristics.

The evaluations indicated that the west leg of the intersections of West Center Road with 64th Avenue and 67th Street are candidates for a leading pedestrian interval based upon insufficient gaps for right-turning traffic due to conflicting through movement volumes. However, upon further review it was determined the LPI would not be implemented at these locations as part of this project due to relatively low pedestrian volumes. The LPI worksheets for each intersection are provided in **Appendix E**.

D. Day Plan

The day plan schedule was developed based on an analysis of the 24-hour x 7-day traffic count data, observations during the before travel time runs, and discussions with the City. **Table 4.2** generally summarizes the existing and implemented time of day schedules. **Appendix G** graphically depicts the day plan schedule and cycle lengths for each individual signal within the study area.

Table 4.2 Existing and Implemented General Day Plan Schedules

Existing Day Plan Schedule					
Weekday		Saturday		Sunday	
Time of Day	Plan	Time of Day	Plan	Time of Day	Plan
Midnight – 6:00 AM	Free/Flash	Midnight – 6:00 AM	Free/Flash	Midnight – 6:00 AM	Free/Flash
6:00 AM – 9:00 AM	Plan 2	6:00 AM – Midnight	Plan 1	6:00 AM – 10:00 PM	Plan 1
9:00 AM – 3:30 PM	Plan 1			10:00 PM - Midnight	Free/Flash
3:30 PM – 6:30 PM	Plan 3				
6:30 PM – 10:00 PM	Plan 1				
10:00 PM - Midnight	Free/Flash[1]				
Implemented Day Plan Schedule					
Weekday		Saturday		Sunday	
Time of Day	Plan	Time of Day	Plan	Time of Day	Plan
Midnight – 6:00 AM	Free/Flash	Midnight – 7:00 AM	Free/Flash	Midnight – 8:00 AM	Free/Flash
6:00 AM – 7:00 AM	Plan 4	7:00 AM – 10:00 AM	Plan 4	8:00 AM – 11:00 AM	Plan 4
7:00 AM – 9:00 AM	Plan 2	10:00 AM – 6:30 PM	Plan 1	11:00 AM – 5:00 PM	Plan 1
9:00 AM – 11:00 AM	Plan 4	6:30 PM – Midnight	Plan 4	5:00 PM – 10:00 PM	Plan 4
11:00 AM – 3:00 PM	Plan 1			10:00 PM - Midnight	Free/Flash
3:00 PM – 6:30 PM	Plan 3				
6:30 PM – 10:00 PM	Plan 4				
10:00 PM - Midnight	Free/Flash[2]				

1. On Friday, Plan 1 runs from 6:30 PM until midnight
2. On Friday, Plan 4 runs from 6:30 PM until midnight

Plan 1 – Midday; Plan 2 – AM Peak; Plan 3 – PM Peak; Plan 4 – Offpeak

E. Cycle Length Evaluation

The calibrated Synchro models were updated with new clearance intervals, minimum green times, and passage times that were determined during the clearance interval evaluation task. Cycle lengths for each corridor were then evaluated using Synchro's cycle length optimization tool. Cycle lengths were considered in 10-second intervals, but emphasis was given to maintaining the City's use of 90, 120, and 150-second cycle lengths.

The City expressed an interest in including the pedestrian clearance intervals in the minimum split value primarily due to how their legacy Wapiti based 170 controllers handle transitions due to actuated pedestrian phases extending beyond the programmed force-off. Because of this, the cycle length evaluation and progression optimization were conducted with all phases covering pedestrian clearance intervals. The implemented cycle lengths for each intersection are shown in the day plan schedules in **Appendix G**.

WCR East Segment
The West Center Road east segment is characterized by a few closely spaced intersections, approximately 0.1 mile spacing, in the Aksarben area and an interchange with 72nd Street to the west. The segment overall lends itself to lower cycle lengths. However, the intersection of 60th Street with West Center Road was experiencing cycle failures during the AM and PM peak periods. For the AM and PM peak plans, a cycle length of 120 seconds was utilized to alleviate the capacity issues at 60th Street.

During the midday plan, which will also run on weekends during the midday, a 120-second cycle length was also selected. This was largely to create a unified corridor with the central segment, but also to account for lunch rush volumes and weekend shopping traffic in the Aksarben area. A shorter cycle length of 90 seconds was utilized during the offpeak period.

WCR Central Segment
The West Center Road central segment is a suburban section with a few closely spaced intersections, but in general there is at least 0.2 miles between signalized intersections. A primary area of concern for this segment is the interaction between Interstate 680 and 108th Street. The intersections of West Center Road with 90th Street, 120th Street, and 132nd Street also presented capacity challenges. Finally, there are several schools near the West Center Road central segment that were included in the optimization and fine tuning process.

To alleviate the capacity concerns at the intersections of West Center Road with 120th Street and 132nd Street, and to account for future growth in the area, a cycle length of 150 seconds was selected for the PM peak plan. However, the 150 second cycle length was simply too long for the portion of the corridor from 84th Street to 108th Street. To create a logical break point for the change in cycle length, 108th Street was selected as the farthest East the 150-second cycle would go. The signalized intersections between 90th Street and 108th Street have minimal traffic volume and present an ideal place to transition cycle lengths. A cycle length of 120 seconds was selected for the portion of the corridor from 84th Street through 105th Street.

Volumes are lower overall during the AM peak plan than during the PM peak plan. The optimal cycle length for the AM peak plan was determined to be 120 seconds. The same cycle length was used for the entire West Center Road Central Segment.

Midday volumes are historically not much lower than AM peak volumes in the area and we have seen an increase in midday traffic volumes during the recent pandemic. Because of this, it was determined a 120-second cycle length was also optimal during the midday plan. A shorter cycle length of 90 seconds was utilized during the offpeak period.

WCR West Segment
The West Center Road West Segment is a wider, four-lane corridor with auxiliary lanes and larger arterial intersections at approximately one-mile spacing. During the AM and PM peak, this segment was already running a 120 second cycle length and regularly experienced cycle failures at several of the crossing arterials. To accommodate current volumes, as well as plan for future growth in this area, a cycle length of 150 seconds was implemented throughout the corridor to provide improved through progression.

For the midday plan, a 120 second cycle length that excluded minimum pedestrian crossing times for the cross-streets was implemented. Very few pedestrians were observed on the corridor during the midday period, so situations where a signal dropped out of coordination to extend the cross-street phase and accommodate pedestrian crossings were minimal. This plan also runs on the weekends and is planned to accommodate larger turning volumes and more vehicles making shorter trips, as opposed to weekday commuting traffic.

A Synchro cycle length evaluation was not conducted for the offpeak plan, but traffic observations along the corridor indicated that the current 90-second cycle length was operating adequately. Therefore, the 90 second cycle length was retained for the offpeak period, which also runs after the PM peak period.

168th Street
For the AM peak plan, the three signals along 168th Street operated most efficiently utilizing a half-cycle at 75 seconds, while those signals in the PM peak had the best performance using the same 150 second cycle length as West Center Road. This allowed for smoother progression during the PM peak as well as meeting pedestrian crossing times to prevent signals going into transition.

For the midday plan, a 120-second cycle length was implemented for 168h Street, as it provided the best performance and coordination with West Center Road.A Synchro cycle length evaluation was not conducted for the offpeak plan, but traffic observations along the corridor indicated that the current 90-second cycle length was operating adequately. Therefore, the 90 second cycle length was retained for the offpeak period.

180th Street
For the AM and PM peak plans, the best progression for the eight signals along 180th Street came with coordination with the 150 second cycle length running on West Center Road. This allows for driver expectation, while the longer through splits were better able to progress traffic down this corridor. Initially, several signals were half-cycled to try to reduce side-street queuing, but observations during field fine tuning in the PM noted that impacts to 180th Street progression were too great, so those signals were adjusted to run the full cycle in the PM peak. In the AM peak, Arbor Street, Oak Street and Van Camp Drive continue to run half-cycled.

For the midday plan, a 120 second cycle length was selected, again to allow this corridor to operate in coordination with West Center Road. This will also better accommodate future growth in this area, and also runs on the weekends.

A Synchro cycle length evaluation was not conducted for the offpeak plan, but traffic observations along the corridor indicated that the current 90-second cycle length was operating adequately. Therefore, the 90 second cycle length was retained for the offpeak period.

Progression Analysis
Ideally, each corridor is optimized to provide perfect progression in both directions at all times of day. However, this is often not possible, so each corridor was optimized to progress traffic in the direction of heaviest flow for directional traffic or to provide balanced progression when traffic volumes are relatively balanced directionally. When possible, two-way progression was provided.

During the AM plan, traffic flows eastbound towards downtown on West Center Road and northbound towards West Dodge Road on 180th Street and 168th Street. During the PM plan, traffic flows westbound away from downtown on West Center Road and southbound from West Dodge Road on 180th Street and 168th Street. During the MD plan, traffic flow is generally balanced but has a slightly higher flow westbound away from downtown on West Center Road and is balanced northbound and southbound on 180th Street and 168th Street. During the offpeak plan, traffic flow is generally balanced eastbound and westbound on West Center Road and is balanced northbound and southbound on 180th Street and 168th Street.

To achieve directional progression, the sequence of left-turn phases is often adjusted if the appropriate phasing is in place or flashing yellow arrows are present. Often, based on intersection spacing and cycle length, a common set of sequences will achieve optimal progression between a set of intersections with just the relative offsets adjusted to favor traffic in the heavier direction of travel. Occasionally drastically differing split demands or progression goals may lead to utilizing different sequences by time-of-day even with common cycle lengths. While operating with leading left-turns is generally preferred when all things are equal, the benefits of utilizing different sequences to achieve different goals along a corridor cannot be understated. A list of unique phases utilized at project intersections is presented in **Table 4.3**. A complete list of sequences in use for each project intersection in the existing and implemented conditions can be found in **Appendix E**.

Table 4.3 Unique Existing and Implemented Sequences

WEST CENTER RD			Pattern 1 MD	Pattern 2 AM	Pattern 3 PM	Pattern 4 Offpeak
955	186th St	Existing	Seq 2	Seq 2	Seq 2	Seq 2
		Implemented	Seq 1	Seq 1	Seq 1	Seq 1
792	180th St	Existing	Seq 2	Seq 2	Seq 2	Seq 2
		Implemented	Seq 1	Seq 13	Seq 13	Seq 1
128	168th St	Existing	Seq 2	Seq 2	Seq 5	Seq 2
		Implemented	Seq 5	Seq 3	Seq 13	Seq 7
598	156th St	Existing	Seq 2	Seq 2	Seq 5	Seq 2
		Implemented	Seq 5	Seq 3	Seq 15	Seq 9
592	144th St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 4	Seq 4	Seq 3	Seq 9
646	140th St*	Existing	Seq 4	Seq 4	Seq 2	Seq 4
		Implemented	Seq 2	Seq 4	Seq 3	Seq 2
581	133rd Plz	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 2	Seq 1	Seq 5	Seq 1
577	132nd St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 3	Seq 5	Seq 7	Seq 7
566	120th St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 5	Seq 13	Seq 5	Seq 3
551	114th St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 10	Seq 10	Seq 10	Seq 2
544	108th St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 1	Seq 5	Seq 5	Seq 4
60	Paddock Rd	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 1	Seq 1	Seq 2	Seq 1
509	90th St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 9	Seq 9	Seq 9	Seq 9
490	84th St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 1	Seq 1	Seq 2	Seq 1
996	72nd St East Ramps	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 3	Seq 3	Seq 3	Seq 3
425	64th St	Existing	Seq 1	Seq 1	Seq 1	Seq 1
		Implemented	Seq 1	Seq 2	Seq 1	Seq 1

*Not standard sequencing

V. IMPLEMENTATION

A. Controller Programming

Once optimized timings were developed and reviewed with the City, the consultants programmed the controller databases with the new timings. Prior to programming the new timings, uploads were performed to ensure the latest database was utilized. The signalized intersections within this project were operated by Wapiti based 170 standard controllers and MAXTIME based 2070 ATC standard controllers. The Wapiti controllers were programmed using TrafficView software on FHU and City laptops. MAXTIME controllers were programmed using VPN access to the City's web based MAXVIEW advanced traffic management system. Database programming was reviewed by the City prior to implementation.

B. Implementation Day

Prior to downloading the new timings, another upload was performed for each intersection on the day of implementation. This was to ensure no critical changes were made to the controller's database between the date of the upload used for programming and implementation day. Once any relevant changes were applied to the databases with new timings, the consultants downloaded the new timings to the controllers one by one from the City's traffic maintenance shop. Consultant staff were present at each intersection to ensure all movements served properly prior to downloading new timings to the next intersection.

C. Fine Tuning

Immediately following implementation, fine tuning of the optimized timings began. Each intersection was observed during each optimized time period and the corridors were repeatedly driven with GPS connected Tru-Traffic software to ensure proper operation of the timings. Changes to further improve the timings were implemented immediately via VPN connection to the City's servers from a consultant laptop in the field. This allowed the changes to be observed immediately and further refined as necessary. A summary of changes was provided to the City upon completion of the fine tuning process.

D. Public Comments

Three citizen comments regarding traffic operations were received after the new timings were implemented in October and November 2020. These were received via the Mayor's hotline and email to the Public Works Department. FHU staff subsequently made site visits to project intersections to determine if any signal timing changes needed to be made to address the comments. The following is a summary of the comments received:

- 60th Street & Center Street – A comment was received relating to the protected portion of the eastbound left-turn movement being omitted during the AM peak period. There was concern this would lead to four or more vehicles queuing up in the turn bay. A follow-up observation was conducted during the peak hour to observe the eastbound left-turn and other movements to see what could be done to improve the timings. The largest queue observed was three vehicles and all vehicles were served each cycle. No changes were made.

- Paddock Road & West Center Road - A comment was received relating to the protected portion of the westbound left-turn movement being omitted during the AM and PM school arrival and dismissal periods. There was concern with the turn not being safe to make without a green arrow and westbound left-turn queues were reportedly backing up onto West Center

Road. Multiple follow-up observations were made during the AM school arrival and PM school dismissal periods to observe the issues and determine if the signal needs to be converted to protected only or needs the protected portion enabled. No unsafe westbound left-turning movements were observed. This was due to large gaps in traffic and no opposing left-turning traffic to impeded sight-distance. The protected portion of the westbound left-turn is enabled during the PM school dismissal period but is lagging and only comes up as necessary if traffic does not clear. Traffic was never observed filling the westbound left-turn bay during the AM arrival or PM dismissal periods. No changes were made.

- 160th Street & West Center Road - A comment was received relating to the protected portion of the westbound left-turn movement being omitted. The comment was in the form of alerting the City to a malfunction report rather than reporting an operational problem. The protected portion of the westbound left-turn is still enabled during the AM and PM peak periods and is still functioning and not burnt out. The protected portion was omitted during the MD and offpeak periods. These periods were observed and adequate gaps exist during both periods to serve left-turning traffic. No changes were made.

VI. PERFORMANCE EVALUATION

A. Network Performance Measures

The existing conditions Synchro model was used as a benchmark by which the implemented conditions could be compared. Network performance measures including total delay, total stops, total travel time, and fuel consumed were analyzed. These performance measures are calculated, not field measured, and reflect data for all vehicles in the network. **Table 6.1** depicts the measures of effectiveness (MOE's) for the total project area for each analysis period. Synchro model output reports are provided in **Appendix H**.

Table 6.1 Network Performance Measures – West Center Road

	AM Peak			PM Peak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	852	846	-0.7%	1,850	1,702	-8.0%
Total Stops (#)	73,151	71,757	-1.9%	112,695	107,183	-4.9%
Total Travel Time (hr)	1,991	1,985	-0.3%	3,302	3,153	-4.5%
Fuel Consumed (gal)	3,052	3,039	-0.4%	4,648	4,475	-3.7%
	MD Peak			Offpeak		
	Ex	Imp	Dif	Ex	Imp	Dif
Total Delay (hr)	612	647	5.7%	432	412	-4.6%
Total Stops (#)	65,634	58,985	-10.1%	49,072	48,307	-1.6%
Total Travel Time (hr)	1,594	1,628	2.1%	1,224	1,205	-1.6%
Fuel Consumed (gal)	2,570	2,513	-2.2%	1,987	1,960	-1.4%

B. Intersection Performance Measures

Individual intersections were also analyzed by comparing the existing and implemented conditions Synchro models. **Table 6.2** summarizes the number of intersections where overall delay per vehicle decreased, increased by five seconds or less, or increased by greater than five seconds.

Table 6.2 Intersection Performance Measures – West Center Road

Number of intersections where:	AM	OP	MD	PM
delay decreased	29	34	28	33
delay increased ≤ 5 sec/veh	30	32	32	25
delay increased > 5 sec/veh	7	0	6	8

Table 6.3 summarizes when and where overall intersection delay increased by more than 5 seconds per vehicle. In general, overall delay at an intersection will increase when the cycle length is increased to maintain coordination but is already above its natural cycle length, when an intersection becomes a programmed stop along the corridor when it was not previously, or when clearance intervals are increased, especially if the intersection is at or near capacity.

Table 6.3 Intersections with Delay Increased Greater Than 5 Seconds per Vehicle

Intersection	Period	Existing Delay (sec/veh) - LOS	Implemented Delay (sec/veh) - LOS
90th St & West Center Rd	MD	23 - C	36 - D
97th St & West Center Rd	PM	20 - B	29 - C
122nd Ave & West Center Rd	PM	23 - C	30 - C
129th Ave & West Center Rd	PM	13 - B	19 - B
132nd St & Arbor St	MD	7 - A	13 - B
149th St & Industrial Rd	AM	14 - B	21 - C
149th St & Industrial Rd	PM	8 - A	15 - B
156th St & Spring St	AM	14 - B	21 - C
168th St & West Center Rd	AM	32 - C	41 - D
168th St & West Center Rd	MD	24 - C	30 - C
171st St & West Center Rd	MD	14 - B	20 - C
180th St & West Center Rd	AM	45 - D	51 - D
180th St & West Center Rd	MD	24 - C	33 - C
180th St & West Center Rd	PM	54 - D	60 - E
192nd St & West Center Rd	AM	61 - E	68 - E
192nd St & West Center Rd	MD	23 - C	37 - D
192nd St & West Center Rd	PM	47 - D	61 - E
180th St & F Str	AM	19 - B	25 - C
180th St & F Str	PM	15 - B	21 - C
180th St & Oak St	PM	5 - A	13 - B
180th St & Burke St	AM	15 - B	27 - C

The specific reasons for the increases in delay greater than 5 seconds per vehicle include:

- 90th St & WCR – MD – Increased cycle length resulted in additional delay and this is a programmed stop during this time period
- 97th St & WCR – PM – Increased cycle length resulted in additional delay for side street
- 122nd Ave & WCR – PM – Increased cycle length resulted in additional delay for side street
- 129th Ave & WCR – PM – Increased cycle length resulted in additional delay for side street
- 132nd St & Arbor St – MD – Increased cycle length resulted in additional delay for side street
- 149th St & Industrial Rd – AM– Increased cycle length resulted in additional delay for side street
- 149th St & Industrial Rd – PM– Increased cycle length resulted in additional delay for side street
- 156th St & Spring St – AM – Intersection is half-cycled to reduce side street delay, but resulted in increased NB and SB delay
- 168th St & WCR – AM – Increased cycle length with reduced green time to side street to improve progression on WCR

- 168th St & WCR – MD – Increased cycle length resulted in additional delay for side street
- 171st St & WCR – MD – Increased cycle length resulted in additional delay for side street
- 180th St & WCR – AM – Increased cycle length resulted in additional delay and this is a programmed stop during this time period
- 180th St & WCR – MD – Increased cycle length resulted in additional delay, however the intersection LOS remained acceptable
- 180th St & WCR – PM – Increased cycle length resulted in additional delay and this is a programmed stop during this time period
- 192nd St & WCR – AM – Increased clearance values and increased cycle length resulted in additional delay
- 192nd St & WCR – MD – Increased clearance values and increased cycle length resulted in additional delay and this is a programmed stop during this time period
- 192nd St & WCR – PM – Increased clearance values and increased cycle length resulted in additional delay
- 180th St & F St – AM – Increased cycle length resulted in additional delay for side street
- 180th St & F St – PM – Increased cycle length resulted in additional delay for side street
- 180th St & Oak St – PM – Increased cycle length resulted in additional delay for side street
- 180th St & Burke St – AM – Increased cycle length resulted in additional delay for side street and this is a programmed stop during this time period

C. Corridor Performance Measures

Field measured performance metrics were recorded with Tru-Traffic (v10) software and a direct connect GPS receiver. Travel time runs were conducted before new timings were implemented and after fine tuning was complete to document improvements for vehicles travelling along the corridor. Corridor performance measures including travel time, delay, and stops for through traffic along West Center Road and 180th Street are summarized.

Travel time was reduced by up to 3.5 minutes in the eastbound direction and 2.5 minutes in the westbound direction along West Center Road between 60th Street and 192nd Street. **Figure 6.1** depicts corridor performance MOEs for West Center Road. Along 180th Street, travel time was reduced by up to 2.5 minutes in the southbound direction and up to 0.5 minutes in the northbound direction between F Street and Burke Street. **Figure 6.2** depicts corridor performance MOEs for 180th Street. Graphical depictions of each segment of the project area are provided in **Appendix D**.

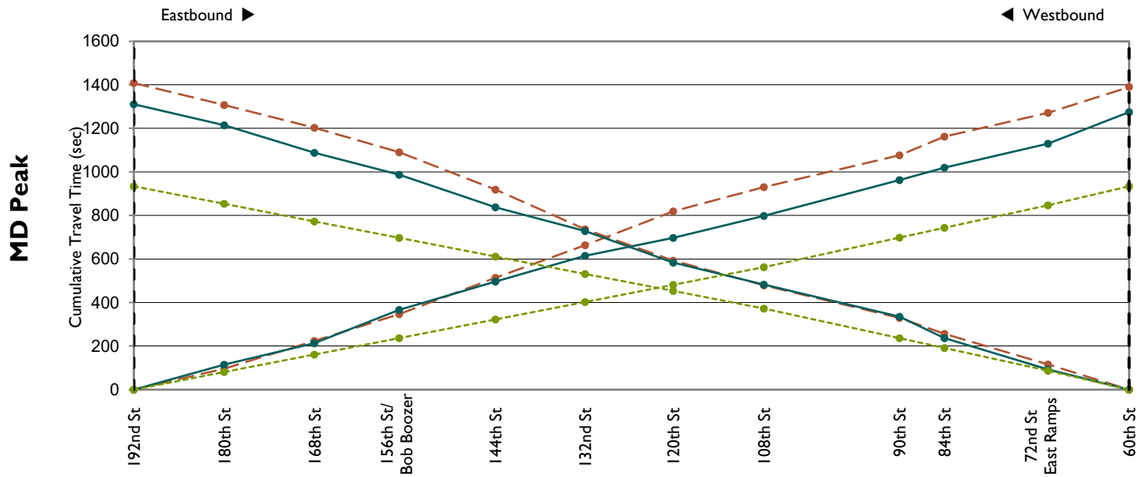
Average Total Travel Time & Delay

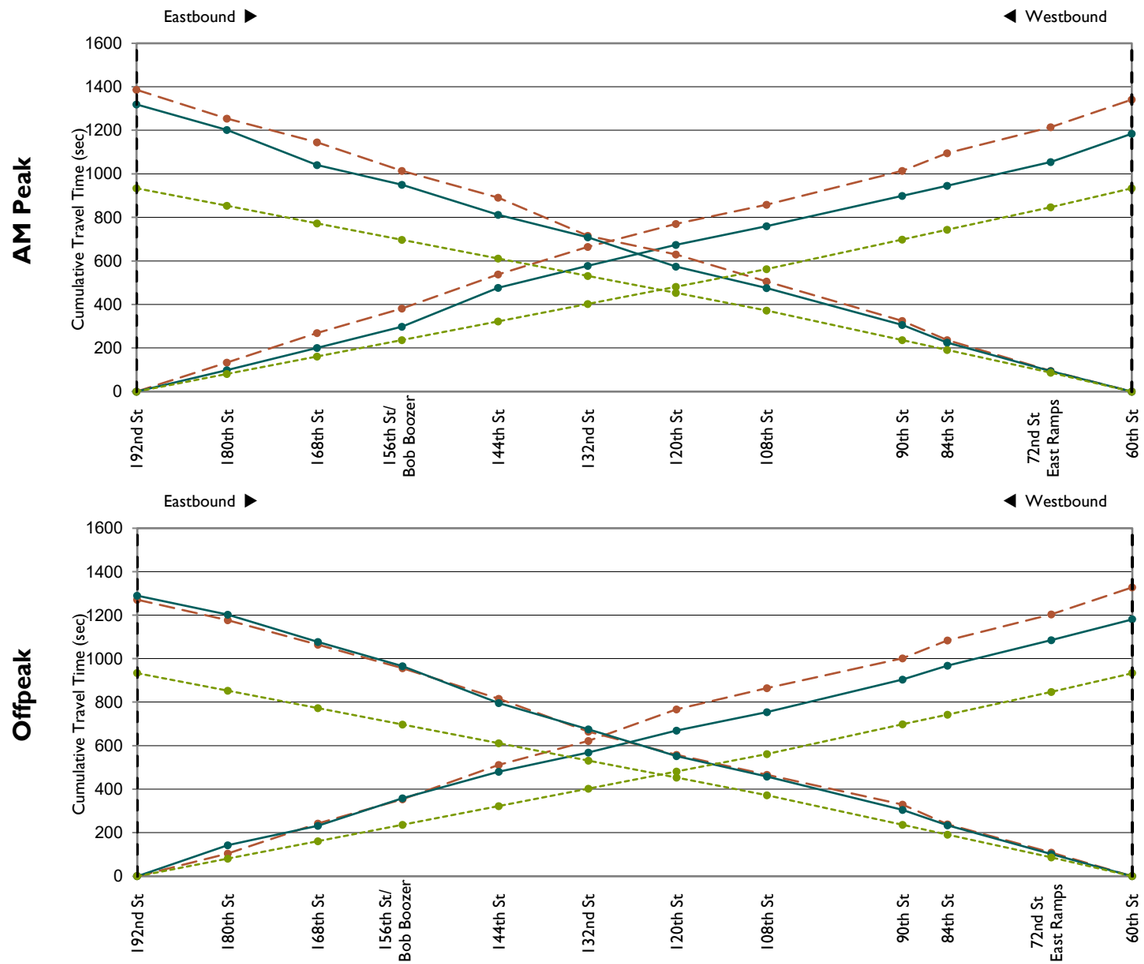
West Center Rd: 11.1 miles

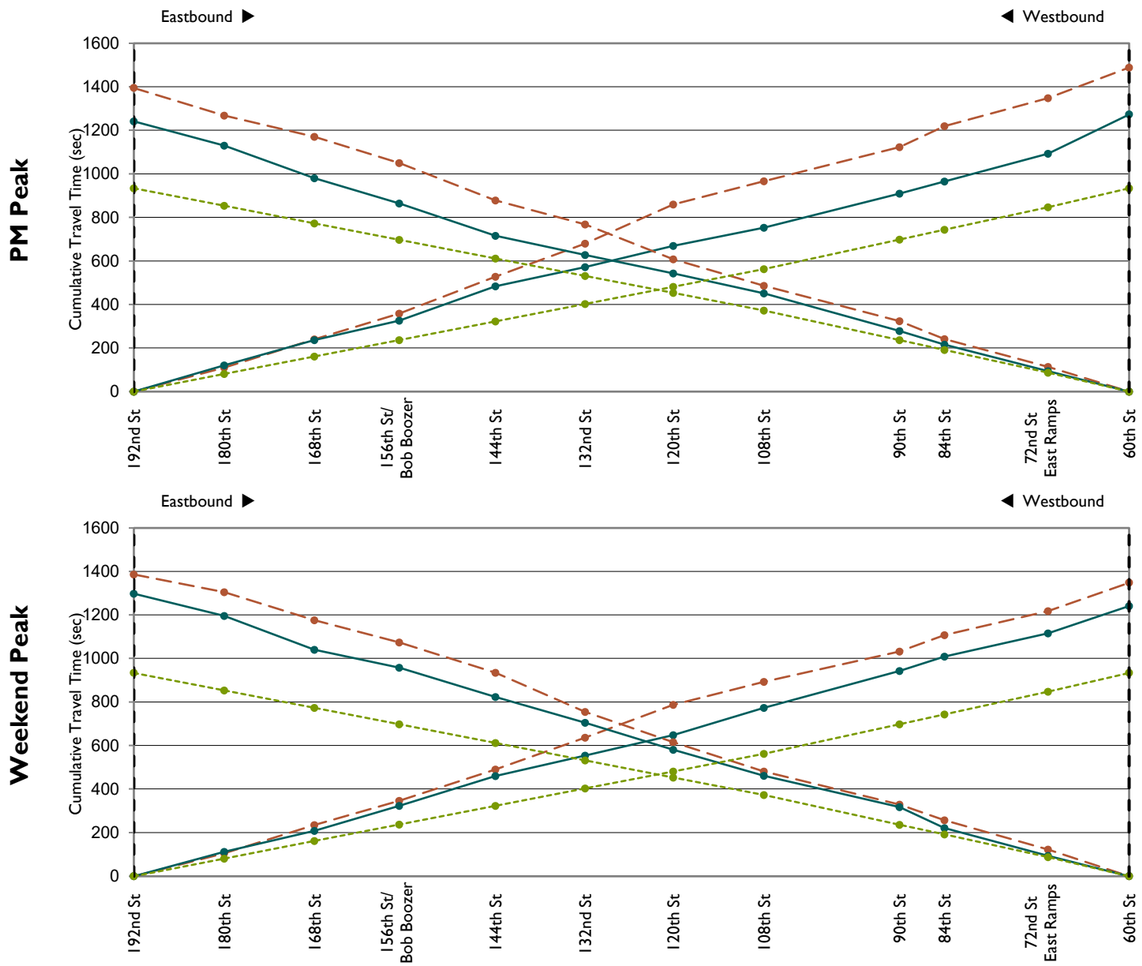
		AM Peak		Offpeak		MD Peak		PM Peak		Weekend Peak	
		Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)
Eastbound	Existing	1341	406	1328	392	1390	454	1488	556	1348	414
	Implemented	1184	250	1181	248	1275	341	1273	344	1241	307
	Difference	-157		-147		-115		-215		-107	
	% Difference	-11.7%	-38.7%	-11.1%	-37.5%	-8.3%	-25.3%	-14.4%	-38.7%	-7.9%	-25.8%
Westbound	Existing	1386	452	1271	336	1408	474	1395	459	1386	453
	Implemented	1319	385	1290	355	1311	375	1241	305	1298	364
	Difference	-67		19		-97		-154		-88	
	% Difference	-4.8%	-14.8%	1.5%	5.7%	-6.9%	-20.5%	-11.0%	-33.6%	-6.3%	-19.4%

Eastbound: 192nd St to 60th St

Westbound: 60th St to 192nd St







FELSBURG HOLT & ULLEVIG

Existing
Implemented
Free Flow

Figure 6.1
Average Travel Time & Delay
West Center Rd

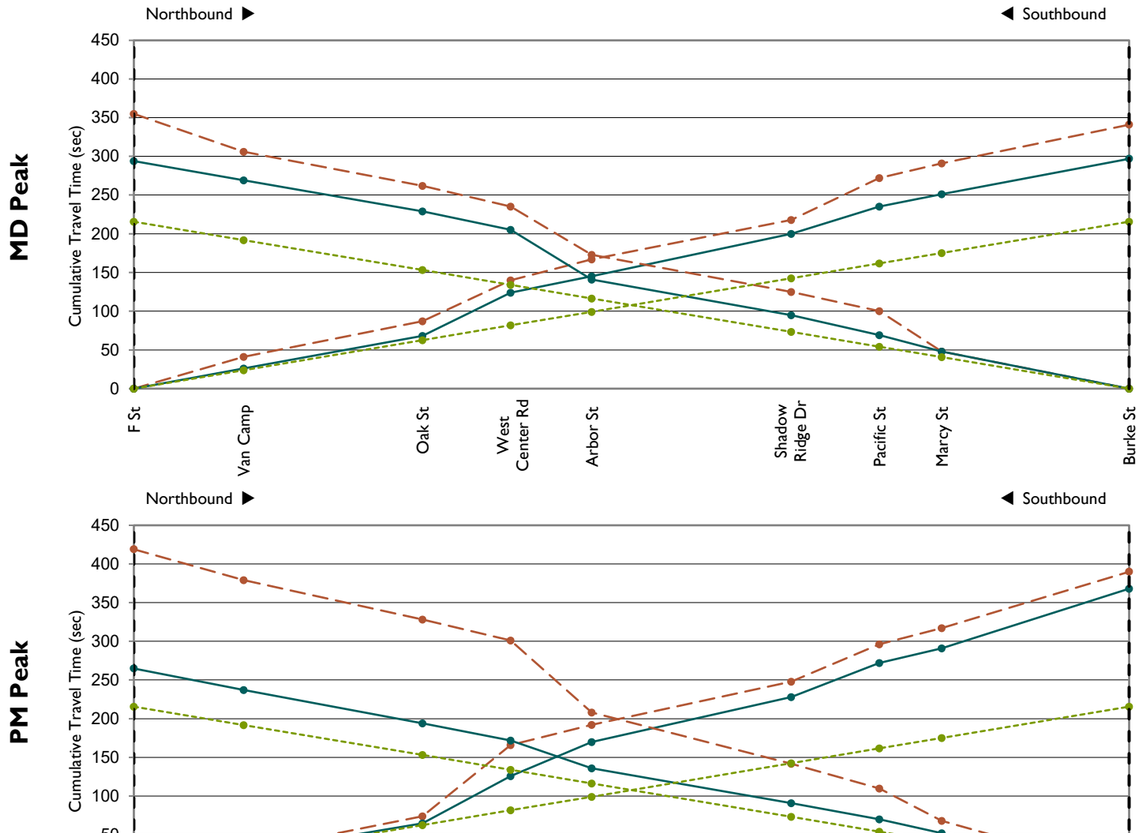
Average Total Travel Time & Delay

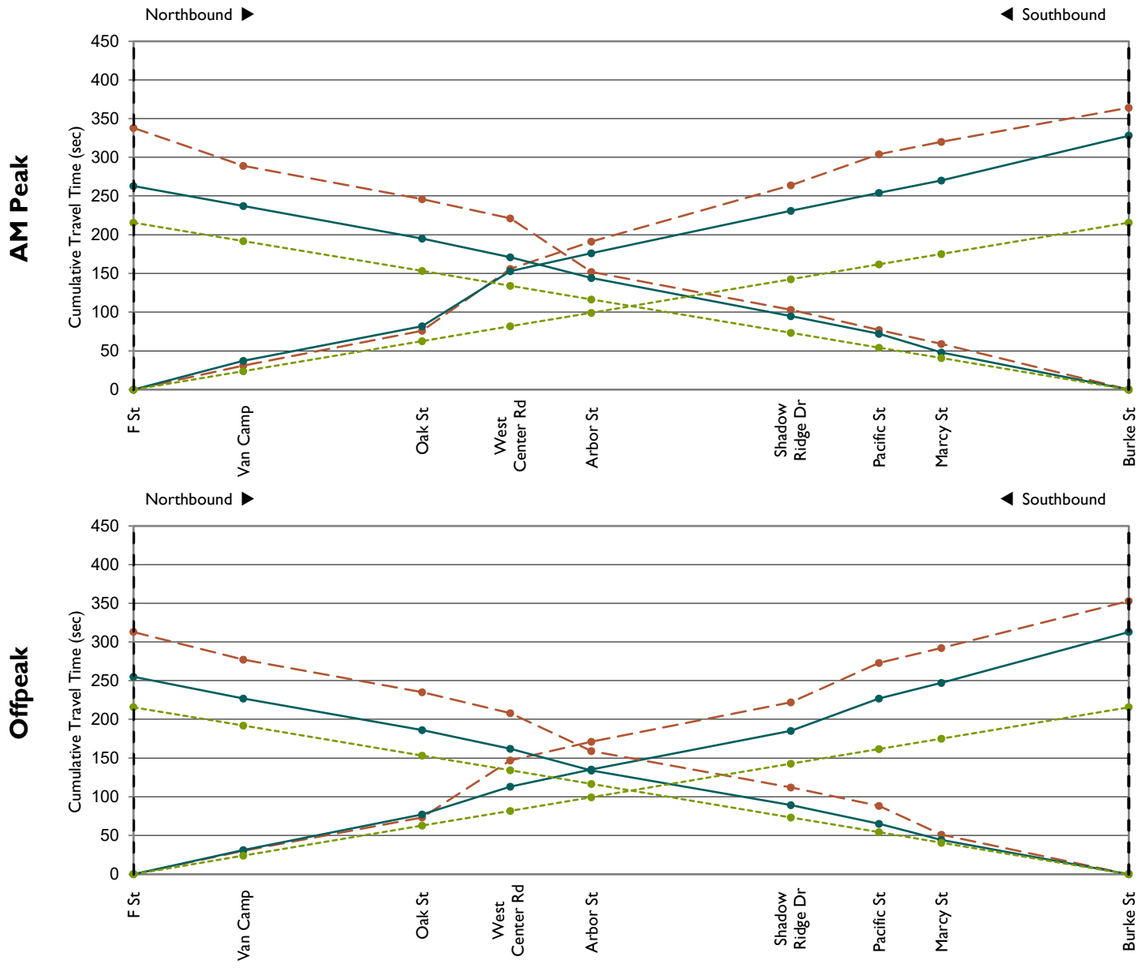
180th Street: 2.7 miles

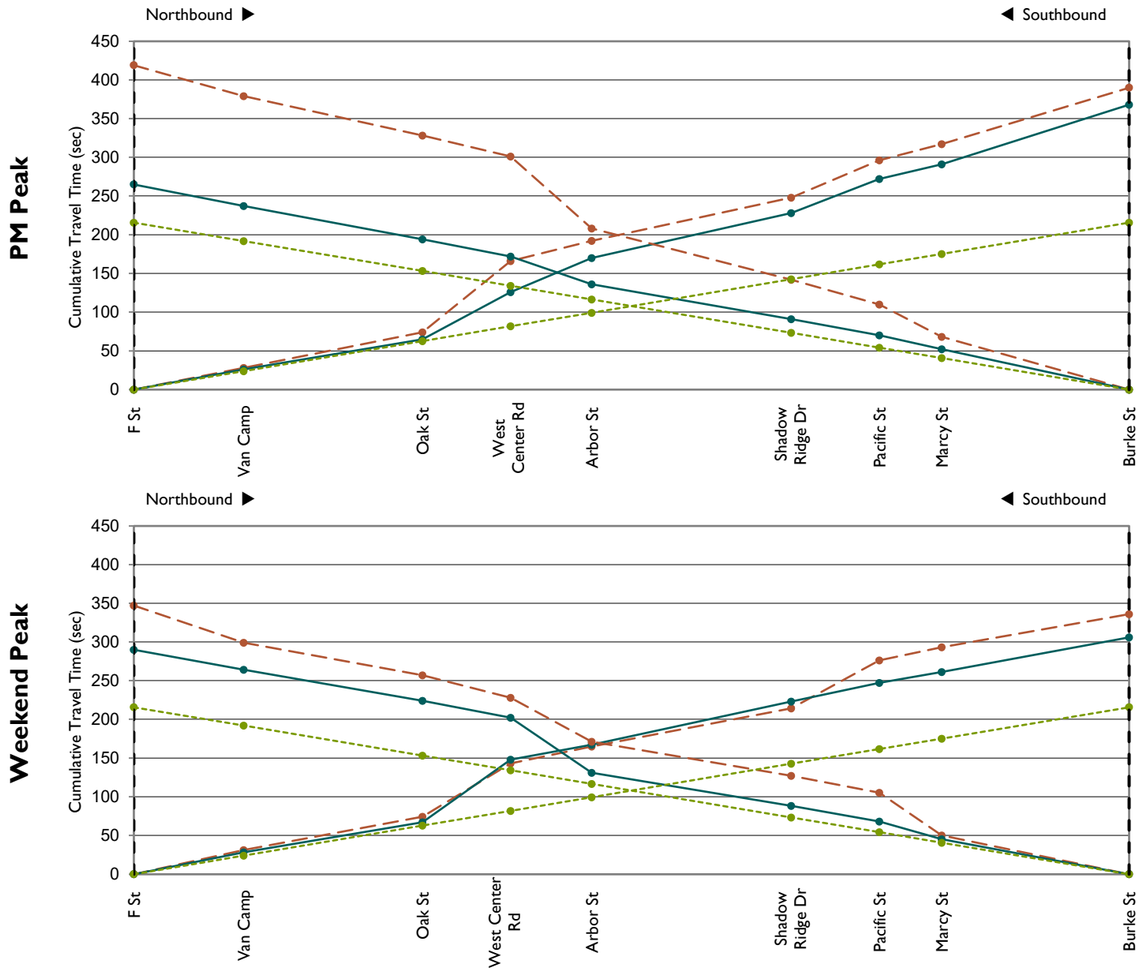
		AM Peak		Offpeak		MD Peak		PM Peak		Weekend Peak	
		Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)	Travel Time (sec)	Delay (sec)
Northbound	Existing	364	148	353	138	341	125	390	175	336	121
	Implemented	328	112	313	97	297	82	368	153	306	91
	Difference	-36		-40		-44		-22		-30	
	% Difference	-9.9%	-24.3%	-11.3%	-29.0%	-12.9%	-35.2%	-5.6%	-12.6%	-8.9%	-24.8%
Southbound	Existing	338	122	313	97	355	140	419	204	347	131
	Implemented	263	48	255	39	294	78	265	49	290	74
	Difference	-75		-58		-61		-154		-57	
	% Difference	-22.2%	-61.5%	-18.5%	-59.8%	-17.2%	-43.6%	-36.8%	-75.5%	-16.4%	-43.5%

Northbound: F St to Burke St

Southbound: Burke St to F St







Existing
Implemented
Free Flow

FELSBURG HOLT & ULLEVIG

Figure 6.2
Average Travel Time & Delay
180th Street

D. Benefit Cost Analysis (Timing)

A benefit cost analysis (BCA) was conducted to determine the City's anticipated return on investment from this project. The benefits of a retiming project are derived primarily from travel time savings, fuel savings, reductions in crash costs, reductions in greenhouse gas emissions, and air quality improvements.

The City has developed a methodology, in-line with national industry standards, to calculate the monetary value of each benefit. Based on this methodology, the monetary benefit of this project over the next five years is anticipated to be $8,142,000. A breakdown of the project benefits over the next five years is shown in **Table 6.4**. Detailed project benefit calculations are provided in **Appendix I**. The cost to complete this project will not exceed $309,275.49, yielding a benefit/cost ratio of at least **26:1**.

Table 6.4 Project Benefits Over 5 Years

Performance Measure	Project Benefit	Present Value
Delay Reduction	80,233 hours	$2,172,626
Fuel Consumption Reduction	837,645 gallons	$1,717,172
Emissions Reduction	8,281 tons	$567,966
Crash Reduction	87 crashes	$3,684,677

E. Short Term Operational Recommendations

While many operational issues stem from capacity constraints that require long term solutions, occasionally short term solutions can yield appreciable benefits at select locations. A list of short term recommendations determined during the optimization and fine-tuning process is presented below.

60th Street & Center Street
The ability to progress vehicles bidirectionally between 60th Street and 67th Street on West Center Road is hindered by the five-section protected-permitted left-turn phasing at 60th Street. Optimizing the phase sequence at this intersection would improve overall corridor performance measures. The City is already planning to install flashing yellow arrow left-turn signal heads at this intersection as part of a future project. Consider revisiting the progression of the signals from 60th Street to 67th Street once the intersection phasing has been upgraded.

139th Street & West Center Road
During the school dismissal period, the outside EB lane of West Center Road becomes a storage lane for stopped vehicles as parents line up to pick up their children from Millard North Middle School. Consider working with the school to conduct a traffic flow study to reduce or eliminate traffic queueing on to West Center Road. This may involve reversing the flow of their drop off lanes to encourage queueing within the neighborhood rather than on West Center Road.

168th Street & West Center Road and 180th Street & West Center Road
At both of these intersections, poor lane utilization was observed for the outside northbound and southbound through lanes due to a lane-drop after the intersection. Consider installing "use both lanes" signs at each intersection and "take turns merge here" signs at the lane drop locations to mitigate the lane utilization issue.

VII. SAFETY ANALYSIS

A. Short Term Safety Recommendations

Based upon operational analysis and field observations, short term safety recommendations have been identified at intersections throughout the study area. These are generally low-cost improvements and include:

- 67th Street & West Center Road – install speed limit signs for eastbound traffic
- 108th Street & West Center Road – implement twice per cycle left-turn phase for westbound to reduce queues that currently exceed available westbound left-turn bay storage
- 114th Street & West Center Road – install "Yield on FYA" signage for lagging lefts
- 120th Street & West Center Road – install "Yield on FYA" signage for lagging lefts
- General – Develop public outreach materials for FYA; to be posted on Keep Omaha Moving site

As of the date of this report, some of these short term safety improvements have been implemented or are in the process of being implemented.

B. Long Term Safety and Operational Recommendations

As part of this project, the City identified the area of West Center Road from 108th Street through 120th Street to conduct a detailed safety evaluation based upon crash history and operational performance. Long term safety and operational improvements have been developed to mitigate crash patterns and improve traffic operations. The City provided crash data for review which was used to identify crash patterns by location, type, and severity, and to calculate benefit/cost ratio for various improvements.

Crash History

Crash data for West Center Road from 108th Street through 120th Street was provided by the City of Omaha from their GIS database. The time frame for intersection crash data ranged from January 1, 2016 through December 31, 2018, and the time frame for segment crash data ranged from January 1, 2017 through December 31, 2019. Both of these represent a three-year period. The data provided detailed the location, vehicle, and roadway characteristics of each crash. Intersection and segment crashes were analyzed as part of this project.

The crash history of the study area intersections and segments by crash type were analyzed and are provided in **Appendix J**. The majority of crashes at the signalized study intersections are rear-end type, which is typical for signalized intersections. Other crash types that were common were angle, left-turn leaving, and sideswipe. Angle type collisions tend to be more severe in nature than rear-ends.

Summary tables and charts are provided in **Appendix J** that document intersection and segment crash rates recorded over the analysis time frame. Physical safety improvements have been identified at three study intersections that exceed the Nebraska Statewide Crash Rate. These include the intersections of West Center Road with 108th Street, 114th Street, and 120th Street. A benefit cost analysis (BCA) was conducted to evaluate the feasibility of improvements at these intersections.

108th Street & West Center Road

Figures 7.1, 7.2, and 7.3 depict three proposed improvement projects at the intersection of 108th Street with West Center Road. Project 1 includes lengthening the westbound left-turn lane by approximately 250 feet to prevent queue spill-out. It would also widen West Center Road slightly to

provide a constant median width and improve lane alignment to the east of the intersection. This project would also incorporate access management and close the driveway on the southeast quadrant of the intersection onto West Center Road as it is within 50 feet of 108th Street.

Project 1 is projected to cost approximately $1.68 million as summarized in **Table 7.1**. The cost estimate is based on the concept drawing in **Figure 7.1**.

Table 7.1 Estimated Project Costs – 108th & WCR Project 1

Category	Estimated Cost
Grading	$119,800
Surfacing	$792,000
Signing, Striping, & Signals	$67,200
Construction SubTotal	**$979,000**
Drainage (20%)	$195,800
Contingency (25%)	$244,800
Construction Total	**$1,419,600**
ROW (5%)	$71,000
Utilities (5%)	$71,000
Construction Engineering (8%)	$113,600
Total 2020 Project Costs	**$1,675,200**
20-year Project Cost*	$2,010,240

*The 20-year cost factors in an annual maintenance cost of 1% of the original project costs.

Project 2 would provide an eastbound right-turn lane. The eastbound right-turn radius on the southwest quadrant of the intersection with 108th Street would be improved to 50 feet. This would accommodate trucks and allow for turning vehicles to remain in the outside (west) curb lane on 108th Street. By doing so, the northbound approach could be re-striped to provide dual left-turn lanes and a single shared lane for through and right-turn movements.

Due to the proximity to the Northbound I-680 off-ramp, it is proposed to extend the eastbound right-turn lane to match the existing northbound off-ramp gore. It may be desirable to move the northbound off-ramp gore to provide additional weaving distance for conflicting movements. This would require ramp modifications; costs are not included as this would be part of a separate project likely funded by NDOT.

The eastbound right-turn lane would help reduce the number of rear-ends and side-swipes. Dual turn lanes on the northbound approach would require protected left-turn phasing, eliminating almost all occurrences of right-angle crashes in the northbound and southbound directions.

Project 2 is projected to cost approximately $0.71 million as summarized in **Table 7.2**. The cost estimate is based on the concept drawing in **Figure 7.2.** A more detailed estimate is provided in **Appendix I.**

The intersection of 108th Street with West Center Road would be expected to operate at LOS B or better in the AM, Midday, and PM peak hours in 2020 with the improvements as depicted in **Figures 7.1** and **7.2**.

Table 7.2 Estimated Project Costs – 108th & WCR Project 2

Category	Estimated Cost
Grading	$40,625
Surfacing	$248,295
Signing, Striping, & Signals	$123,400
Construction SubTotal	**$412,320**
Drainage (20%)	$82,500
Contingency (25%)	$103,100
Construction Total	**$597,920**
ROW (5%)	$29,900
Utilities (5%)	$29,900
Construction Engineering (8%)	$47,800
Total 2020 Project Costs	**$705,520**
20-year Project Cost*	$846,624

*The 20-year cost factors in an annual maintenance cost of 1% of the original project costs.

It is acknowledged that Project 2 would require modifications to the pedestrian bridge over West Center Road on the west leg of 108th Street. Project 3 would re-construct the pedestrian bridge; on-site observations and a cursory review of historic traffic counts indicate that there are sufficient pedestrian movements to warrant a grade separated pedestrian crossing in this location.

Project 3 is projected to cost approximately $2.05 million as summarized in **Table 7.3** The cost estimate is based on the concept drawing in **Figure 7.3**. A more detailed estimate is provided in **Appendix I**.

Table 7.3 Estimated Project Costs – 108th & WCR Project 3

Category	Estimated Cost
Grading	$279,300
Surfacing	$1,057,900
Construction SubTotal	**$1,337,200**
Drainage (20%)	$66,900
Contingency (25%)	$334,300
Construction Total	**$1,738,400**
ROW (5%)	$86,900
Utilities (5%)	$86,900
Construction Engineering (8%)	$139,100
Total 2020 Project Costs	**$2,051,300**
20-year Project Cost*	$2,461,560

*The 20-year cost factors in an annual maintenance cost of 1% of the original project costs.

Safety Recommendations - 108th Street Project 1

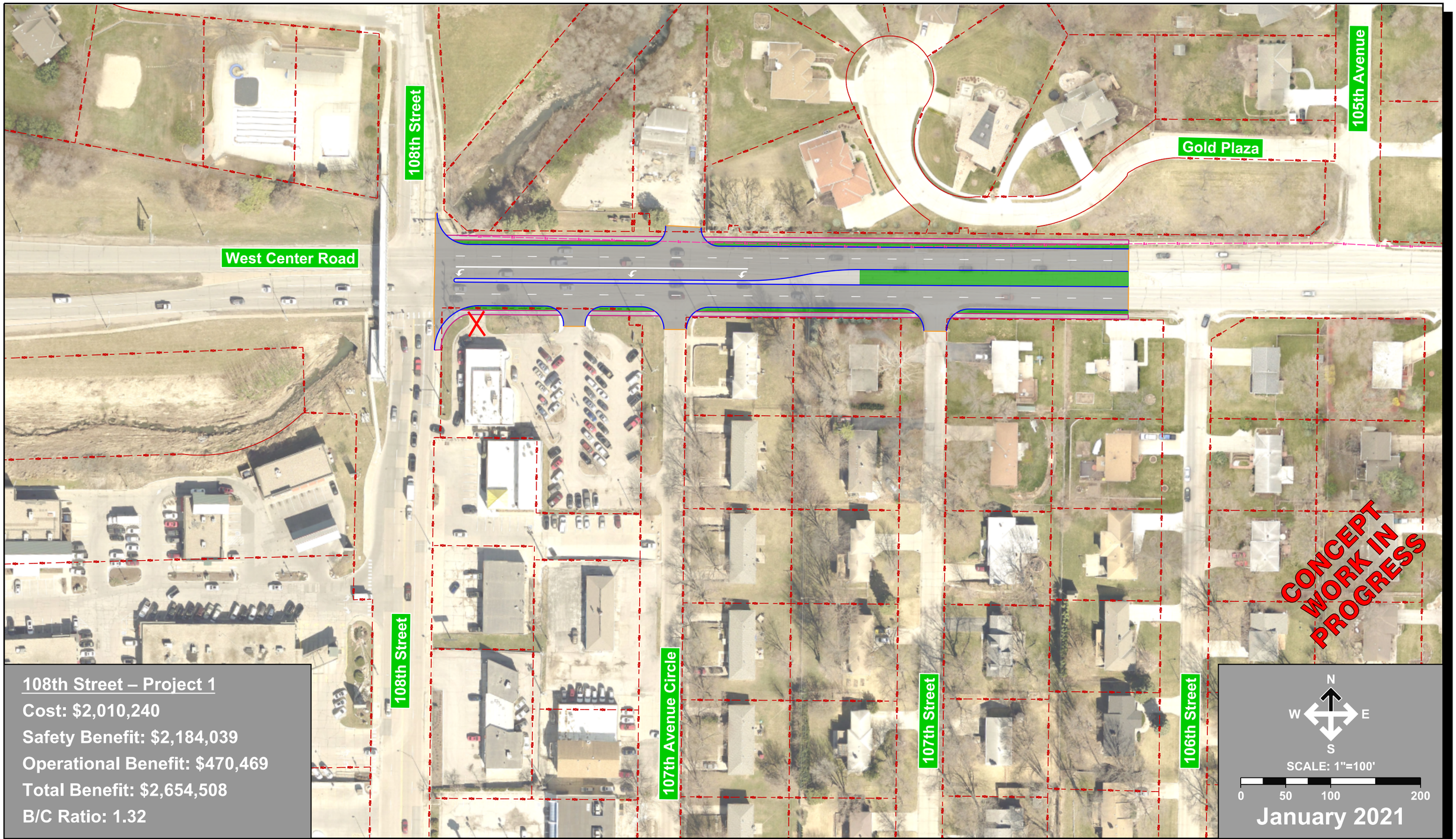
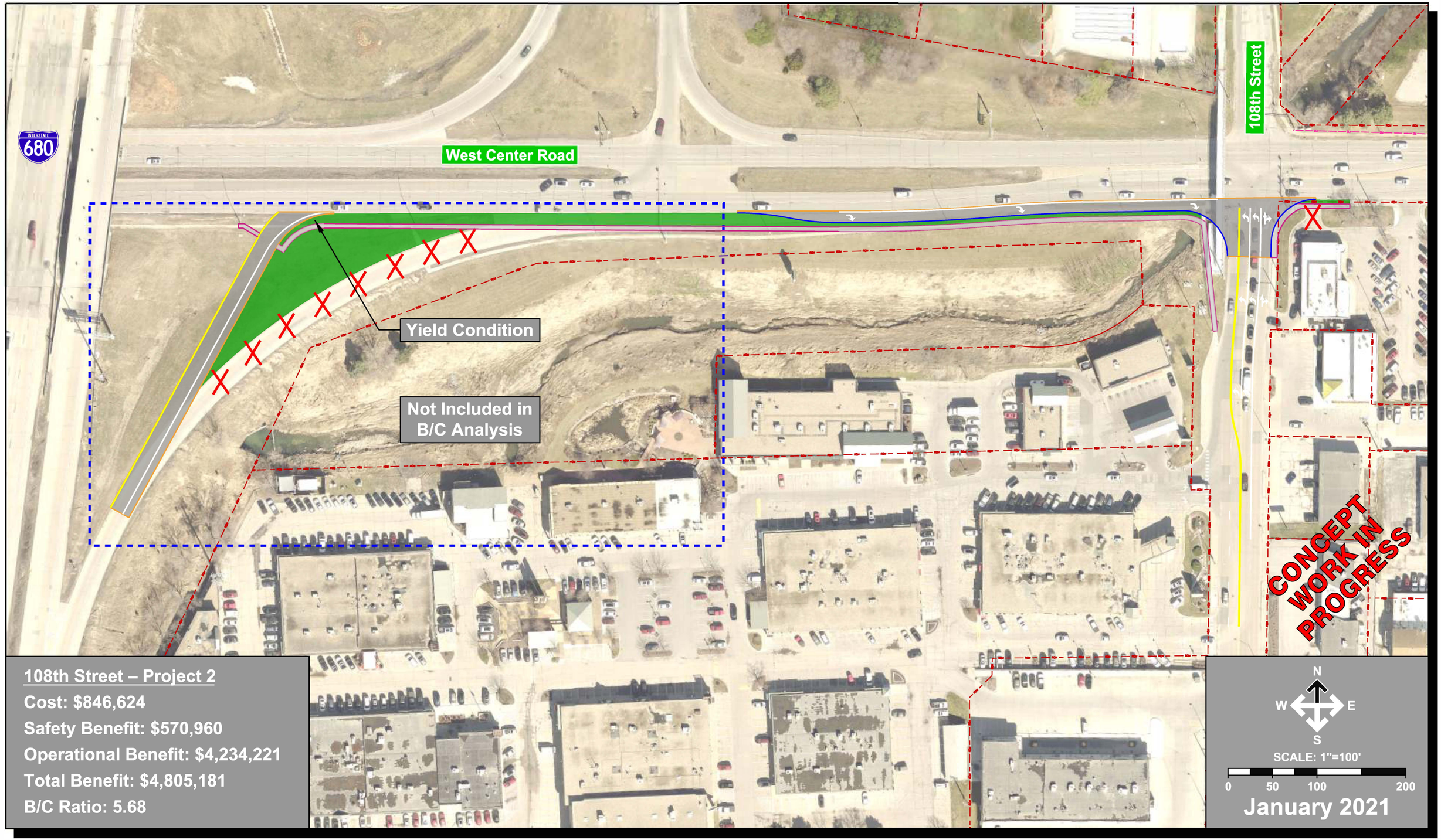


Figure 7.1

Safety Recommendations - 108th Street Project 2



108th Street – Project 2

Cost: $846,624

Safety Benefit: $570,960

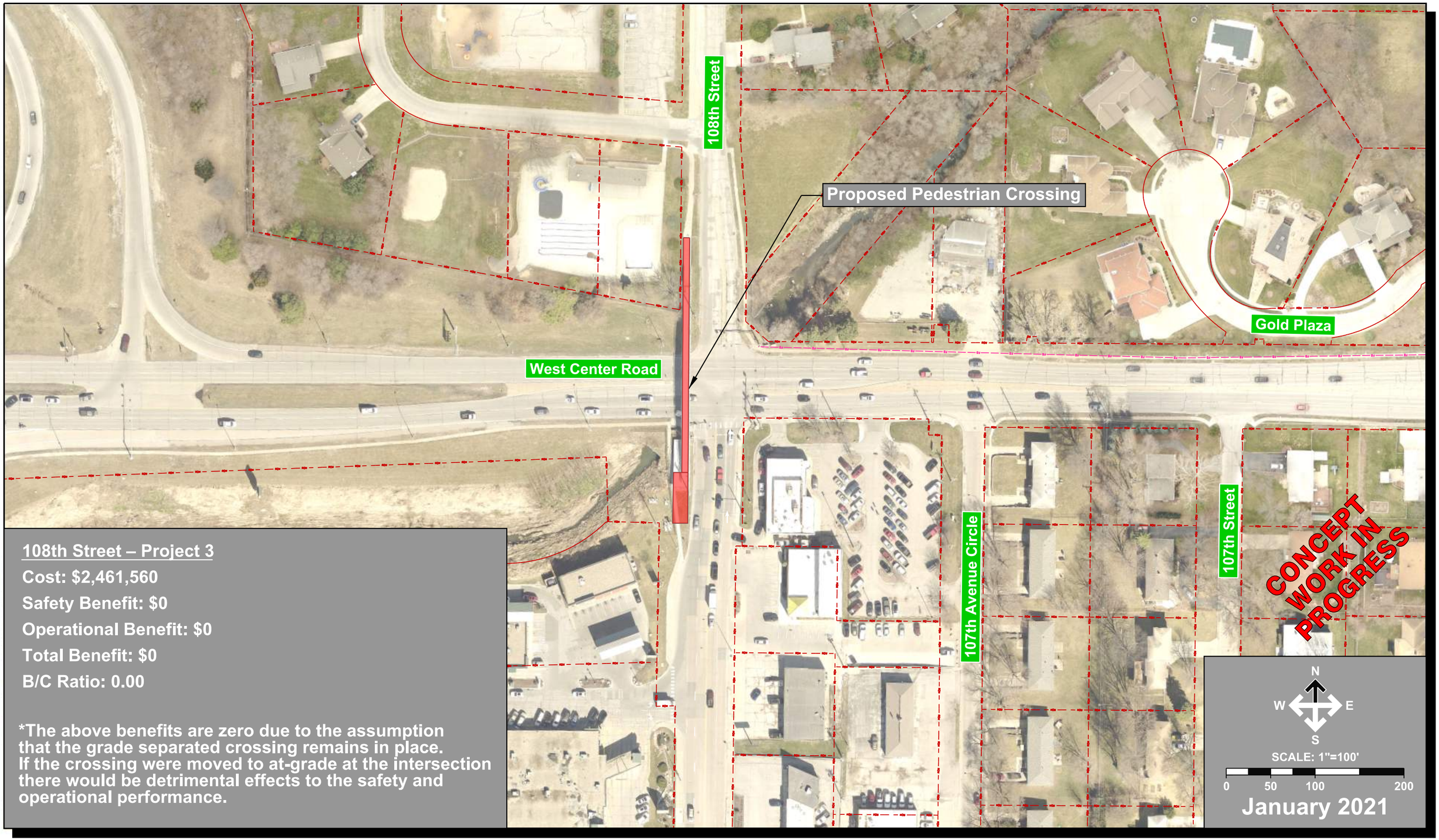
Operational Benefit: $4,234,221

Total Benefit: $4,805,181

B/C Ratio: 5.68

Figure 7.2

Safety Recommendations - 108th Street Project 3



108th Street – Project 3

Cost: $2,461,560

Safety Benefit: $0

Operational Benefit: $0

Total Benefit: $0

B/C Ratio: 0.00

*The above benefits are zero due to the assumption that the grade separated crossing remains in place. If the crossing were moved to at-grade at the intersection there would be detrimental effects to the safety and operational performance.

Figure 7.3

114th Street & West Center Road

Figure 7.4 depicts an improvement project at the intersection of 114th Street with West Center Road to provide an additional eastbound lane on the south curb. The additional eastbound lane would be striped as an exclusive right-turn lane and would allow for traffic in the existing eastbound through lane to proceed unimpeded to the downstream I-680 southbound on-ramp; this would help reduce the number of rear-end and sideswipe crashes.

The 114th Street improvements are projected to cost approximately $0.27 million as summarized in **Table 7.4**. The cost estimate is based on the concept drawing in **Figure 7.4**. A more detailed estimate is provided in **Appendix I**.

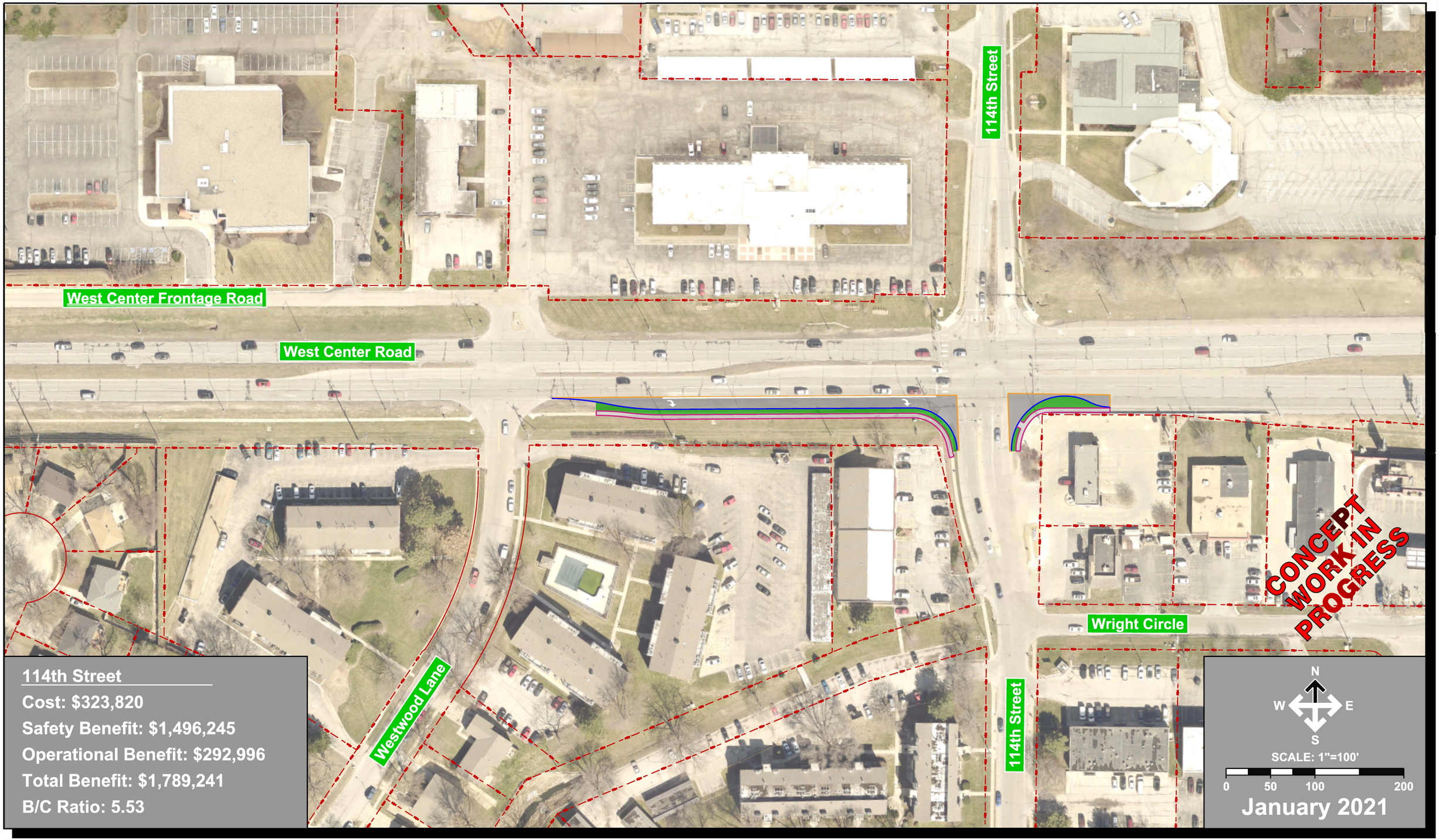
Table 7.4 Estimated Project Costs – 114th & WCR Project

Category	Estimated Cost
Grading	$18,400
Surfacing	$137,245
Signing, Striping, & Signals	$2,100
Construction SubTotal	**$157,750**
Drainage (20%)	$31,600
Contingency (25%)	$39,400
Construction Total	**$228,750**
ROW (5%)	$11,400
Utilities (5%)	$11,400
Construction Engineering (8%)	$18,300
Total 2020 Project Costs	**$269,850**
20-year Project Cost*	$323,820

*The 20-year cost factors in an annual maintenance cost of 1% of the original project costs.

The intersection of 114th Street with West Center Road would be expected to operate at LOS D or better in the AM, Midday, and PM peak hours in 2020 with the improvements as depicted in **Figure 7.4**.

Safety Recommendations - 114th Street



114th Street

Cost: $323,820

Safety Benefit: $1,496,245

Operational Benefit: $292,996

Total Benefit: $1,789,241

B/C Ratio: 5.53

January 2021

Figure 7.4

120th Street & West Center Road

Figure 7.5 depicts an improvement project at the intersection of 120th Street with West Center Road to provide dual left-turn lanes on the eastbound and westbound approaches, and a southbound right-turn lane. This project would incorporate access management and close the driveway onto 120th Street on the southeast quadrant of the intersection as it is located within the northbound right-turn lane. Access at the intersection of 120th Street with Elm Street would be limited to right-in/right-out movements only. Additionally, the intersection of Gold Plaza with 120th Street in the northwest quadrant would also be closed as it would be within the proposed southbound right-turn lane.

The dedicated southbound right-turn lane would help reduce the number of rear-ends and side-swipes. Dual turn lanes would require protected left-turn phasing, eliminating almost all occurrences of right-angle crashes in the eastbound and westbound directions.

The 120th Street improvements are projected to cost approximately $4.76 million as summarized in **Table 7.5**. The cost estimate is based on the concept drawing in **Figure 7.5**. A more detailed estimate is provided in **Appendix I**.

Table 7.5 Estimated Project Costs – 120th & WCR Project

Category	Estimated Cost
Grading	$287,725
Surfacing	$2,141,170
Signing, Striping, & Signals	$353,900
Construction SubTotal	**$2,782,800**
Drainage (20%)	$556,600
Contingency (25%)	$695,700
Construction Total	**$4,035,100**
ROW (5%)	$201,800
Utilities (5%)	$201,800
Construction Engineering (8%)	$322,800
Total 2020 Project Costs	**$4,761,500**
20-year Project Cost*	$5,713,800

*The 20-year cost factors in an annual maintenance cost of 1% of the original project costs.

The intersection of 120th Street with West Center Road would be expected to operate at LOS D or better in the AM, Midday, and PM peak hours in 2020 with the improvements as depicted in **Figure 7.5**.

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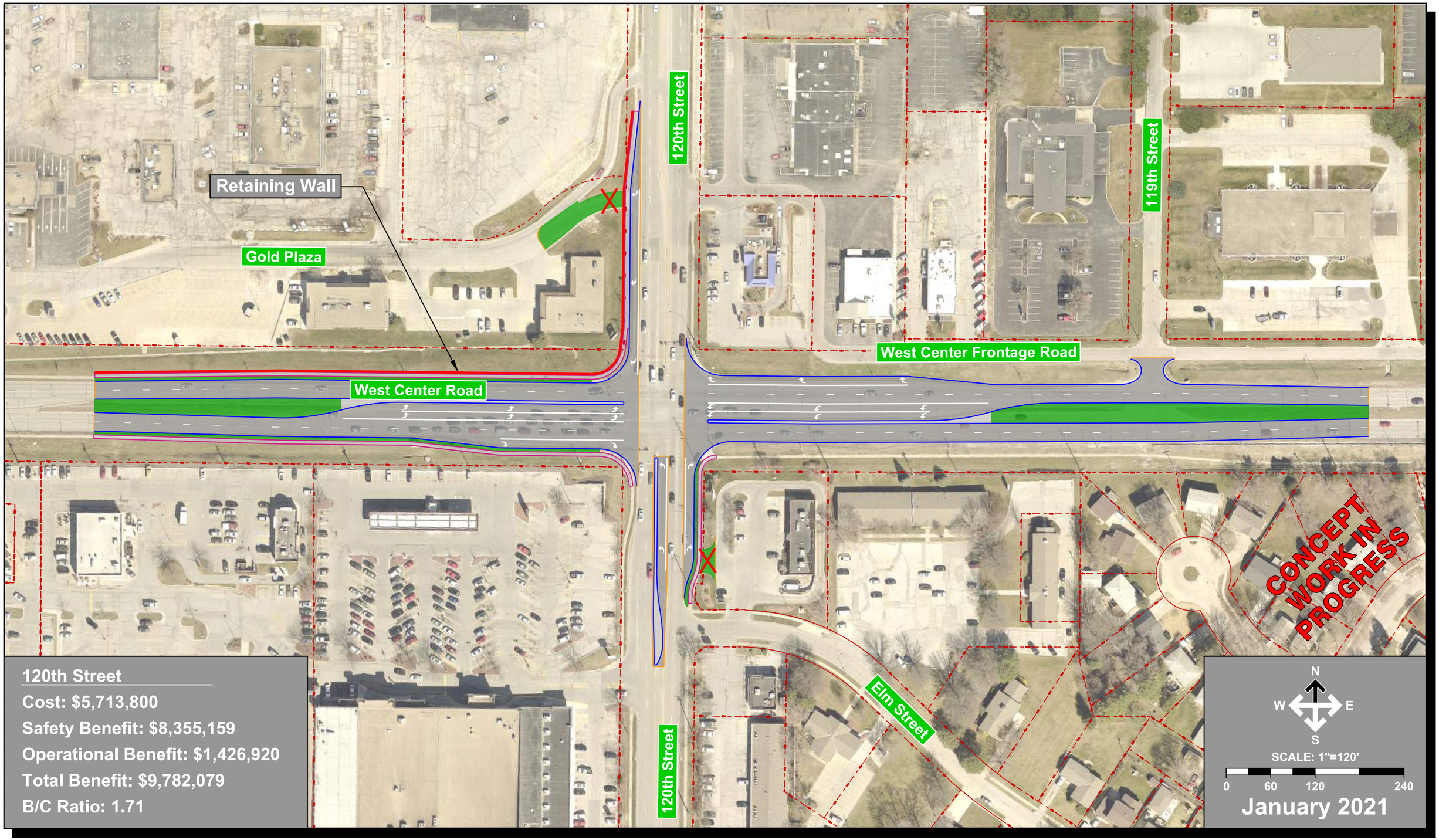
Safety Recommendations - 120th Street



120th Street

Cost: $5,713,800

Safety Benefit: $8,355,159

Operational Benefit: $1,426,920

Total Benefit: $9,782,079

B/C Ratio: 1.71

Figure 7.5

C. Benefit Cost Analysis

A benefit cost analysis (BCA) measures effectiveness of a proposed project based on a benefit/cost ratio, i.e. – the benefits divided by the costs. A benefit-cost ratio above 1.0 means the benefits of the improvement outweigh the costs of it. Benefits come in the form of operational improvements and avoided crashes due to geometric and operational changes. Costs consist of factors like construction fees, maintenance, and operational costs.

Three years (2016 to 2018 for intersections and 2017 to 2019 for segments) of crash history data along West Center Road was provided to FHU by the City of Omaha. This data was evaluated to identify problem areas and potential solutions. Crash modification factors (CMF) were used from *CMF Clearinghouse*, a web-based repository (http://www.cmfclearinghouse.org) of professionally researched and reviewed CMFs, to calculate the benefits of the roadway improvements. When more than one CMF is applied to a specific project a composite CMF factor was developed. All CMF calculations are included in **Appendix I**.

To quantify the benefit of avoided crashes, the Federal Highway Administration (FHWA) provides an estimated societal cost for crashes based on crash type, shown in **Table 7.6**. These costs are from 2019 and were increased by approximately 2-3% to account for inflation.

Table 7.6 FHWA Societal Cost of Traffic Accidents

Crash Type (Multi-Vehicle)	Societal Cost
Right Angle	$100,530
Rear End	$79,700
Sideswipe (Same Dir.)	$54,510
Sideswipe (Opposite Dir.)	$123,820
Head On	$374,700
Left-turn	$136,480
Other	$28,000

A benefit cost analysis (BCA) was completed for each of the proposed improvements. The BCA was completed based on the lifespan of the project, assuming an improvement life period, construction costs, and maintenance costs for each project. In general, projects with a B/C ratio of 1.0 or greater have larger benefits than costs over the analysis time period. Only crashes directly affected by the proposed improvement were used in the benefit/cost calculations. Detailed calculations of the benefit cost analysis are included in **Appendix I.** Below is description of the safety benefits of the improvements.

108th Street with West Center Road – Project 1

The construction cost of this countermeasure was estimated at $2.0 million and maintenance/operations costs at around $325,000 with a project life of 20 years. A weighted CMF of 0.563 was used. Additional benefits of increased storage length at the westbound left-turn lane would be expected, but due to the lack of CMFs and research for this condition, benefits were not quantified.

108th Street with West Center Road – Project 2
The construction cost of these improvements was estimated at $705,000 with maintenance / operations costs at around $140,000 with a project life of 20 years. A weighted CMF of 0.910 was used for both crash type analyses.

108th Street with West Center Road – Project 3
The construction cost of these improvements was estimated at $2.1 million with maintenance / operations costs at around $410,000 with a project life of 20 years. No CMFs were used due to the assumption that the grade separated crossing remains in place. If the crossing were moved to at-grade at the intersection there would be detrimental effects to the safety and operational performance.

114th Street with West Center Road
The construction cost of this countermeasure was estimated at $269,850 with maintenance / operations costs at around $54,000 with a project life of 20 years. A weighted CMF of 0.910 was used for both crash type analyses.

120th Street with West Center Road
The construction cost of these improvements was estimated at $4.8 million with maintenance / operations costs at around $950,000 with a project life of 20 years. A weighted CMF of 0.633 was used for both crash type analyses.

Table 7.7 shows the benefit cost analysis of the combined geometric improvements at the three intersections based on safety benefits alone. **Table 7.8** shows the benefit cost analysis of the improvements at the three intersections with both safety and operational benefits. A more detailed analysis of all scenarios is included in **Appendix I**.

Table 7.7 West Center Road – Safety: Benefit Cost Analysis

Present Value of Avoided Crashes, **BENEFIT**	$12,600,857
Present Value Cost, **COST**	$11,356,044
Safety Benefit/Cost Ratio	**1.11**

Table 7.8 West Center Road – Safety & Operational: Benefit Cost Analysis

Present Value of Avoided Crashes, **SAFETY BENEFIT**	$12,600,857
Present Value of Mitigated Delay, **OPERATIONAL BENEFIT**	$6,424,606
Present Value Cost, **COST**	$11,356,044
Safety & Operations Benefit/Cost Ratio	**1.68**

*Present value costs include estimated maintenance costs over the lifespan of the project improvements, which is estimated at 1% of the total project cost per year.