MEMORANDUM

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To:	Gregory Masota, North Central Texas Council of Governments
From:	David Halloin, P.E., PTOE (TX PE #88511) Tom Hartmann, P.E., PTOE (TX PE #109948)
	Kimley-Horn and Associates, Inc. (TX #F-928)
Date:	June 30, 2022
Subject:	RTSRP IV - US 75/Central Expressway Corridor

Kimley-Horn has developed incident timing plans for US 75/Central Expressway Corridor in Dallas between Ross Avenue and IH 635 under the North Central Texas Council of Governments (NCTCOG) Regional Traffic Signal Retiming Program (RTSRP) Phase IV. The timing plans are intended for deployment when a significant incident occurs on the mainlanes of US 75/Central Expressway causing traffic to divert to the frontage roads. Generally, the incident timing plans are intended to maximize capacity and one-way progression on the frontage roads. This memorandum documents the development and expected benefits of incident timing plans.

Background

Frontage road coordination is typically not a priority when developing coordinated timing. Crossing arterial progression is typically given priority under the assumption that drivers choose the mainlanes of a freeway facility rather than traveling along frontage roads. The ability to coordinate operations at interchanges, when necessary, with incident management timing plans provides a preferable alternative to the coordinated signal timing that is appropriate for frontage roads during normal operations.

PILOT STUDY

The first task of RTSRP IV included an assessment of operational characteristics and common performance measures for 46 candidate project segments along 18 different freeways or tollways throughout Dallas and Tarrant Counties.

The Kimley-Horn team delivered an initial inventory in March 2015. Based on a variety of factors and critical corridor characteristics, SH 161 from IH 30 to IH 20 in Grand Prairie and SH 360 from IH 30 to IH 20 in Arlington were selected as pilot corridors for incident management timing plans. Critical factors included continuity of frontage roads and communications to signals.

POSITIVE CORRIDOR ATTRIBUTES

Based on the initial pilot corridor evaluation, the following attributes lead to successful incident timing implementations:

- Continuous frontage roads
- Favorable lane designations and control
- Controller capability to store incident plans
- Communications with permanent or remote Traffic Management Center (TMC)
- Designated TMC staff responsible for identifying incidents and implementing changes
- Ability and willingness to adjust diamond operations
- Video surveillance or other detection equipment in corridor
- Available dynamic signs or other media to communicate with drivers
- Available capacity in corridor during peak or off-peak periods
- Buy-in from key staff to make use of incident plans

BENEFITS OF THE PROGRAM

RTSRP IV has a wide range of benefits. Continuing the project and implementing incident management timing plans on corridors throughout the NCTCOG region has potential safety, air quality, operational, and economic benefits.

Incident management timing plans help improve safety for first responders, support teams, and the public by reducing non-recurrent congestion created by incidents on freeways. The likelihood of secondary incidents, such as unsuspecting drivers colliding with the back of a stopped queue on the mainlanes, can be reduced by diverting traffic to the frontage roads.

Reducing congestion improves air quality by reducing idling time and emissions.

Delay is reduced as congestion is cleared from the mainlanes more quickly, saving fuel and delay costs.

By maintaining as much capacity and safety as practical during an incident through taking advantage of additional capacity on frontage roads and adjacent arterials during incidents, both the incident itself and related congestion can be cleared more quickly.

Overall, incident management timing plans work toward the goal of providing a safer and more secure transportation environment for people and goods.

US 75/Central Expressway Corridor

Following the pilot study, Kimley-Horn re-evaluated potential project corridors. The US 75/Central Expressway Corridor in Dallas between Ross Avenue and IH 635 met the criteria listed above and was selected a production corridor. The corridor consisted of 21 diamond interchanges, one box diamond interchange, one frontage road intersection, and eight adjacent intersections, for a total of 55 project intersections. Figure 1 shows the project corridor (Dallas city limits in blue) and Table 1 lists the project intersections.

Figure 1. US 75/Central Expressway Corridor
Source: Google Earth

Table 1. Project Intersections

Index	COG #	Corridor Street	Cross Street	City
1	3275	US 75 NBFR	Ross Avenue	Dallas
2	3265	US 75 SBFR	Ross Avenue	Dallas
3	3273	US 75 NBFR	Hall Street	Dallas
4	3274	US 75 SBFR	Hall Street	Dallas
5	3322	US 75 NBFR	Lemmon Avenue	Dallas
6	3321	US 75 SBFR	Lemmon Avenue	Dallas
7	3325	US 75 NBFR	Haskell Avenue	Dallas
8	3324	US 75 SBFR	Haskell Avenue	Dallas
9	3333	US 75 NBFR	Fitzhugh Avenue	Dallas
10	3332	US 75 SBFR	Fitzhugh Avenue	Dallas
11	3344	US 75 NBFR	Henderson Avenue	Dallas
12	3343	US 75 SBFR	Knox Street	Dallas
13	3346	US 75 NBFR	Monticello Avenue	Dallas
14	3345	US 75 SBFR	Monticello Avenue	Dallas
15	3348	US 75 NBFR	McCommas Boulevard	Dallas
16	3347	US 75 SBFR	McCommas Boulevard	Dallas
17	3450	US 75 NBFR	Mockingbird Lane	Dallas
18	3449	US 75 SBFR	Mockingbird Lane	Dallas
19	3454	US 75 NBFR	SMU Boulevard	Dallas
20	3453	US 75 SBFR	SMU Boulevard	Dallas
21	3456	US 75 NBFR	University Boulevard	Dallas
22	3455	US 75 SBFR	University Boulevard	Dallas
23	3466	US 75 NBFR	Lovers Lane	Dallas
24	3465	US 75 SBFR	Lovers Lane	Dallas
25	3469	US 75 NBFR	Southwestern Boulevard	Dallas
26	3468	US 75 SBFR	Southwestern Boulevard	Dallas
27	3474	US 75 NBFR	Caruth Haven Lane	Dallas
28	3473	US 75 SBFR	Caruth Haven Lane	Dallas
29	3476	US 75 NBFR	Northwest Hwy	Dallas
30	3475	US 75 SBFR	Northwest Hwy	Dallas
31	3490	US 75 NBFR	Northpark Boulevard	Dallas
32	3489	US 75 SBFR	Northpark Boulevard	Dallas
33	3492	US 75 NBFR	Park Lane	Dallas
34	3491	US 75 SBFR	Park Lane	Dallas

Table 1. Project Intersections (continued)

Index	COG #	Corridor Street	Cross Street	City
35	3497	US 75 NBFR	Walnut Hill Lane	Dallas
36	3496	US 75 SBFR	Walnut Hill Lane	Dallas
37	3502	US 75 NBFR	Meadow Road	Dallas
38	3501	US 75 SBFR	Meadow Road	Dallas
39	3506	US 75 NBFR	Royal Lane	Dallas
40	3505	US 75 SBFR	Royal Lane	Dallas
41	3767	US 75 NBFR	Forest Lane	Dallas
42	3766	US 75 SBFR	Forest Lane	Dallas
43	5634	US 75 SBFR	Churchill Way	Dallas
44	5630	US 75 NBFR	IH-635 Diamond	Dallas
45	5631	US 75 SBFR	IH-635 Diamond	Dallas
46	5632	US 75 SBFR	IH-635 Diamond	Dallas
47	5633	US 75 NBFR	IH-635 Diamond	Dallas
48	3326	Lemmon Avenue	Washington Street	Dallas
49	3331	McKinney Avenue	Fitzhugh Avenue	Dallas
50	3330	Cole Avenue	Fitzhugh Avenue	Dallas
51	3329	Fitzhugh Avenue	Travis Street	Dallas
52	3342	McKinney Avenue	Knox Street	Dallas
53	3467	Greenville Avenue	Lovers Lane	Dallas
54	3470	Greenville Avenue	Southwestern Boulevard	Dallas
55	3494	Park Lane	Caruth Plaza	Dallas

Many of the included signals had existing coordination. In such cases, if capacity was available, new timing plans considered retaining existing cycle lengths and/or control groups whenever possible (i.e., if the normal, non-incident traffic plus the diverting volume could be accommodated by the existing cycle length).

Approach

Kimley-Horn developed a total of 12 incident timing plans based on three variables for the US 75/Central Expressway Corridor: peak period (AM, midday, PM), direction (northbound or southbound), and incident intensity (moderate or severe):

- AM Northbound Moderate Intensity
- AM Southbound Moderate Intensity
- MD Northbound Moderate Intensity
- MD Southbound Moderate Intensity
- PM Northbound Moderate Intensity
- PM Southbound Moderate Intensity
- AM Northbound Severe Intensity
- AM Southbound Severe Intensity
- MD Northbound Severe Intensity
- MD Southbound Severe Intensity
- PM Northbound Severe Intensity
- PM Southbound Severe Intensity

Moderate intensity plans used existing cycle lengths in an effort to maintain existing crossing arterial coordination. Severe intensity plans increased cycle lengths to provide additional frontage road capacity.

In general, timing plans were developed to maximize capacity and bandwidth on the frontage road in the direction of the incident. Frontage road phases were set as the coordinated phase to allow any unused split time to be returned to the incident direction. Splits on all other approaches were set to a volume/capacity (v/c) ratio of 1.00, maximizing the time available for the incident direction. Plans were designed to be modular, allowing agencies to deploy only when and where necessary. For example, a northbound incident on US 75/Central Expressway Corridor at Mockingbird Lane might only require incident plans to be activated on the 8 interchanges south of the incident, with the remaining interchanges continuing normal operations.

All plans were provided to the City of Dallas and programmed into controllers. The programming was verified in the field using Kimley-Horn's standard implementation process. However, the plans cannot be fine-tuned in advance because they are designed for an unplanned incident. The plans have all been deployed and tested, ready to be deployed during an incident.

Benefits of Diversion Timing

Typically, the benefits of signal retiming are quantified through direct measurements, such as travel time runs. On other RTSRP projects, "before" and "after" conditions of the corridor are compared. Measurements rely on comparing changes in the standard metrics included in all signal timing projects: travel time, stops, average speed, and delay. Travel time runs form the basis of traditional signal timing performance metrics. Data used to calculate the improvements in each metric can be collected using a traditional floating car technique or through crowd-sourced probe-based data

The frontage road timing presents particular challenges to objective quantification. The plans are not activated at a set time, or for a set duration. Not all intersections will require an incident plan for every incident. The unpredictable nature of the events precludes the collection of floating car travel time data. Probe-based data provides many advantages over traditional data collection methods in this scenario. The data (including historical data) is readily available and does not require infrastructure investment. Because the data is automatically collected and stored by the provider, there is no need for local storage of data. Additionally, collecting the data does not require a driver in the field traveling the corridor during each time period to be analyzed. Data can be analyzed for an entire day, not just during peak periods when collected by a floating car; this is especially useful for analyzing incident plans, which are unpredictably deployed by nature.

Counting vehicles to determine the changes in throughput at each intersection is also impractical. Hand counts are not possible, due to the unpredictability of the incidents. Automated counts, collected with devices such as Autoscope cameras or Bluetooth readers, would require devices installed at every potentially affected intersection. These counts would provide valuable data but would cost approximately $500,000 to install just on the pilot corridors. Thus, it was determined costs outweighed benefits of installing equipment to gather this volume data, and equipment was not installed.

Because diversion timing is not conducive to directly measuring benefits, a surrogate method of modeling benefits was used to compare benefits between different diversion timing plans.

MODELED BENEFITS

Synchro™ models of normal traffic conditions for AM, Midday, and PM peak conditions provide a baseline for comparison of anticipated benefits. Though each incident will have different characteristics and will add different amounts of demand to the frontage roads, one consistent benefit of each incident timing plan deployed is the additional capacity added to signalized movements intended to handle diverting traffic. In theory, the more capacity that can be added or moved to the critical intersection approaches, the greater the delay savings; thus, the more beneficial implementation of incident plans developed through this program.

Table 2. Modeled Benefits

Incident Plan	Cycle Length	Max ∆ veh	Min ∆ veh	Average ∆ veh
AM Northbound Moderate Intensity	120	2988	139	1477
AM Southbound Moderate Intensity	120	3230	149	1599
AM Northbound Severe Intensity	144	3168	549	1696
AM Southbound Severe Intensity	144	3440	436	1808
MD Northbound Moderate Intensity	120	3649	281	1365
MD Southbound Moderate Intensity	120	3525	401	1610
MD Northbound Severe Intensity	144	3869	621	1680
MD Southbound Severe Intensity	144	3745	621	1905
PM Northbound Moderate Intensity	120/144	2765	0	1181
PM Southbound Moderate Intensity	120/144	3089	0	1381
PM Northbound Severe Intensity	144/160	3040	0	1324
PM Southbound Severe Intensity	144/160	3314	32	1554

AM and PM peak traffic is near- or over-capacity on many intersection approaches within the US 75/Central Expressway Corridor, resulting in more modest opportunities to serve diverting traffic from the US 75 main lanes than outside of the actual peaks. This is especially true within the currently operating background cycle lengths being maintained for “moderate intensity” incident timing.

However, during midday and off-peak periods, opportunities to provide additional capacity (and time) for traffic diverting to the frontage road approaches is much greater, resulting in much more significant potential benefit. Because midday/off-peak plans operate for a majority of the day and week, these plans provide the best assessment of potential project benefits.

"Incident-Critical" in this assessment refers to a frontage road approach that serves anticipated diversion traffic traveling in the same direction as the main lane traffic impacted by an incident. Added capacity on these critical approaches theoretically results in driver benefit by reducing overall system delays in the corridor.

For all three peak periods (AM, MD, PM), estimated benefits were very similar, with an average added capacity per incident-critical approach of about 1450 vehicles per hour (vph) for moderate incident timing plans and 1650 vph for severe incident timing plans.

In terms of increasing available capacity, this redistribution of time to incident-critical approaches significantly increases the ability to serve diverting traffic.

ASSUMED BENEFITS

Diverting traffic from the congested mainlanes to coordinated frontage roads during incidents can be assumed to provide additional safety benefits by shifting demand from the mainlanes to the frontage roads. According to the Federal Highway Administration[1], approximately 20 percent of all incidents are secondary crashes. Queue lengths and durations should be reduced by diverting traffic to the frontage roads, therefore reducing driver exposure to secondary crashes. Shorter queues can also be cleared faster, further improving safety, reducing delay, and decreasing emissions.

These assumed benefits are difficult to accurately quantify, due to the unique characteristics and unpredictable nature of each freeway incident and drivers' reactions to incidents. Assumptions could be made based on historical crash records or national statistics to quantify benefits, but these calculations would be rough approximations at best.

Impacts to Potential Benefits of Incident Plans

Based on the initial pilot corridor evaluation, there are several factors that can impact how much benefit can be recognized by incident plans, outside of the specific corridor characteristics:

- The time the incident takes place (availability of operational staff)
- Severity of the incident
- Duration of the incident and subsequent queue impact
- How early in the incident a plan is deployed
- Weather conditions during the incident
- Information able to be provided to the motorists

[1] https://ops.fhwa.dot.gov/aboutus/one_pagers/tim.htm

Recommendations

Incident plans for the US 75/Central Expressway Corridor should be deployed by the City of Dallas as needed when a significant unplanned incident occurs on the mainlanes of US 75/Central Expressway causing traffic to divert to the frontage roads. Crowd-sourced data could be utilized to detect, monitor, and evaluate incidents and operations. Communications to drivers, including DMS, traveler information systems, and social media, should be considered in developing incident management strategies. The incident management strategy and procedure should be formalized and documented. Incident timing deployment should be logged and tracked for retrospective analysis; Table 3 below shows an example incident timing deployment log from the City of Arlington (as of November 8, 2018):

Table 3. Incident Timing Deployment Log (City of Arlington)

Date	Incident Plan Deployment Start Time	Incident Plan Deployment End Time	Duration	Direction	Comment
Friday, February 9, 2018	*8:35 PM*	*9:32 PM*	*57 minutes*	*NB*	*Incident/Backup due to lane closure*
Wednesday, May 23, 2018	*8:20 AM*	*8:35 AM*	*15 minutes*	*NB*	*Incident/Backup due to lane closure*
Tuesday, July 10, 2018	*2:40 PM*	*3:09 PM*	*29 minutes*	*SB*	*Incident/Backup due to lane closure*
Saturday, July 28, 2018	*9:59 AM*	*12:39 PM*	*160 minutes*	*SB*	*Full mainline closure due to construction*
Friday, August 10, 2018	*1:25 PM*	*2:55 PM*	*90 minutes*	*SB*	*Incident/Backup due to lane closure*
Thursday, October 11, 2018	*8:40 AM*	*9:05 AM*	*25 minutes*	*NB*	*Incident/Backup; Park Row Intersection Only*
Saturday, November 3, 2018	*12:30 PM*	*3:00 PM*	*150 minutes*	*Both*	*Full mainline closure due to construction; Park Row Intersection Only*
Thursday, November 8, 2018	*8:20 AM*	*8:35 AM*	*15 minutes*	*NB*	*Incident/Backup; Park Row Intersection Only*

Conclusions

Twelve modular incident timing plans have been developed and deployed for the US 75/Central Expressway Corridor. The plans are ready for activation by the City of Dallas as needed to meet the goals of RTSRP Phase IV, most notably maximizing capacity and one-way progression on the frontage roads during a significant incident.