

MEMORANDUM

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 - IH 635 Corridor



Kimley-Horn has developed incident timing plans for the IH 635 Corridors in Dallas between IH 35 and US 75/Central Expressway 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 IH 635 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.

IH 635 Corridor

Following the pilot study, Kimley-Horn re-evaluated potential project corridors. The IH 635 Corridor in Dallas between IH 35 and US 75/Central Expressway met the criteria listed above and was selected a production corridor. The corridor consisted of 10 diamond interchanges, two box diamond interchanges, one frontage road intersection, and one adjacent intersection, for a total of 31 project intersections. The diamond interchange at IH 635 & Marsh Lane was excluded from the project due to lack of cooperation from the City of Farmers Branch, who operates and maintains the interchange but does not have communications in place and working. Some additional intersections that had previously been modeled and were in close proximity needed to be included to avoid operational problems when running incident plans. These included: US 75 & IH 635 box diamond (part of the US 75 corridor), and Preston & Harvest Hill.

Existing ramp configuration upstream and downstream of Marsh Lane in both directions allow this non-critical interchange to be removed from the project without consequence. Figure 1 shows the project corridor (Dallas city limits in blue) and Table 1 lists the project intersections.

Table 1. Project Intersections

Index	COG #	Corridor Street	Cross Street	City
1	3771	IH 635 EBFR	Coit Road	Dallas
2	3770	IH 635 WBFR	Coit Road	Dallas
3	3762	IH 635 EBFR	Hillcrest Road	Dallas
4	3761	IH 635 WBFR	Hillcrest Road	Dallas
5	3636	IH 635 EBFR	Preston Road	Dallas
6	3635	IH 635 WBFR	Preston Road	Dallas
7	3631	IH 635 EBFR	Montfort Drive	Dallas
8	3630	IH 635 WBFR	Montfort Drive	Dallas
9	3620	IH 635 WBFR	Noel Road	Dallas
10	3612	IH 635 WBFR	Inwood Road SB	Dallas
11	3617	IH 635 EBFR	Inwood Road SB	Dallas
12	3619	IH 635 WBFR	Inwood Road NB	Dallas
13	3618	IH 635 EBFR	Inwood Road NB	Dallas
14	3617	Alpha Road	Coit Road	Dallas
15	3619	Banner Drive	Coit Road	Dallas
16	3618	Hillcrest Road	Hillcrest Plaza	Dallas
17	3620	IH 635 WBFR	Welch Road	Dallas
18	3631	IH 635 EBFR	Welch Road	Dallas
19	3630	IH 635 WBFR	Midway Road	Dallas
20	3636	IH 635 EBFR	Midway Road	Dallas
21	3635	IH 635 WBFR	Webb Chapel Road	Dallas
22	3762	IH 635 EBFR	Webb Chapel Road	Dallas
23	3761	IH 635 WBFR	Josey Lane	Dallas
24	3771	IH 635 EBFR	Josey Lane	Dallas
25	3770	IH 635 WBFR	Davis/Denton Drive	Dallas
26	5630	IH 635 EBFR	Davis/Denton Drive	Dallas
27	5631	IH 635 EBFR	Harry Hines	Dallas
28	5632	IH 635 WBFR	Harry Hines	Dallas
29	5633	Josey Lane	Forest Lane	Dallas

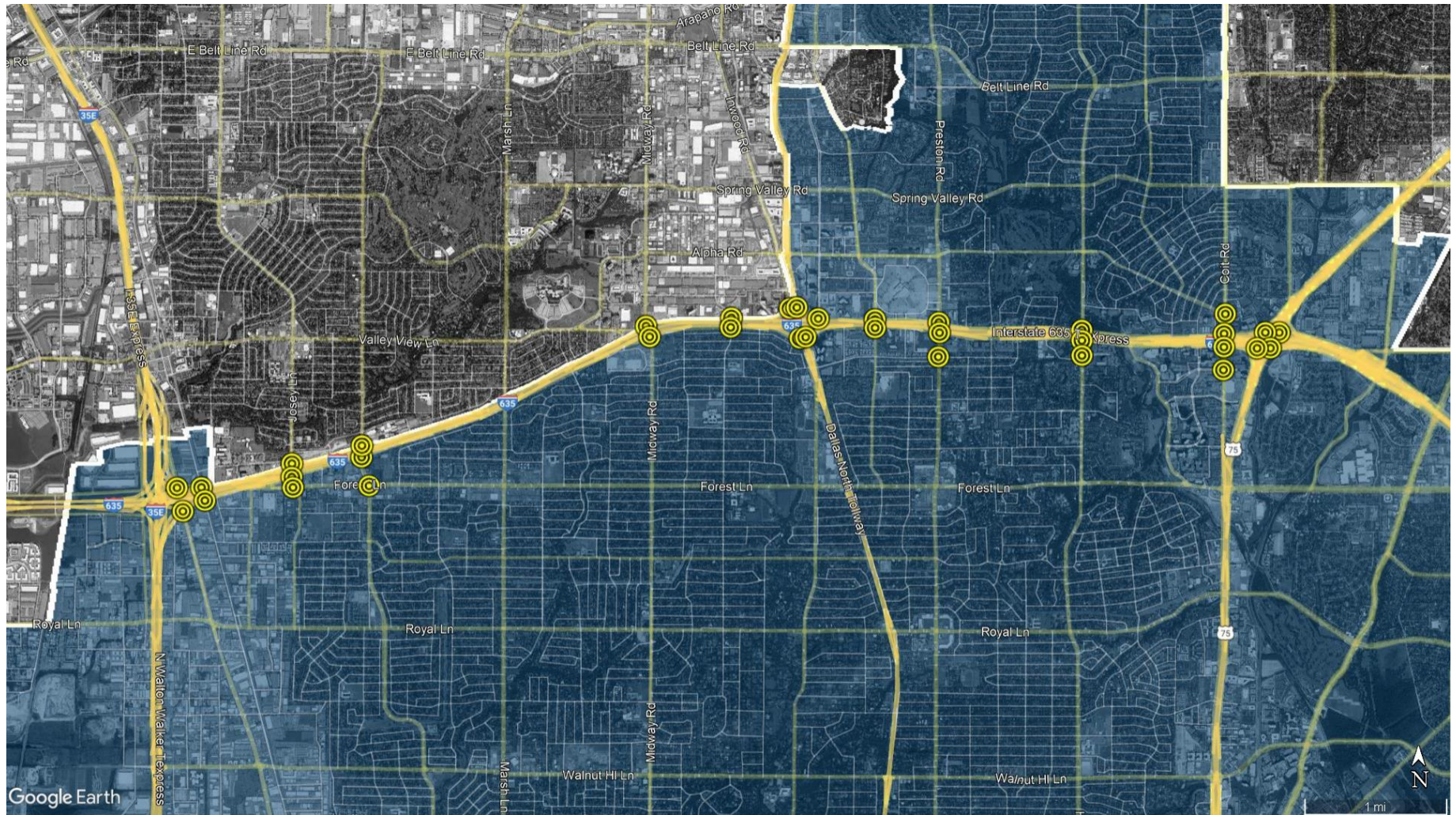


Figure 1. IH 635 Corridor
Source: Google Earth

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 IH 635 Corridor: peak period (AM, midday, PM), direction (northbound or southbound), and incident intensity (moderate or severe):

- AM Eastbound Moderate Intensity
- AM Westbound Moderate Intensity
- MD Eastbound Moderate (120 East Side) Intensity
- MD Westbound Moderate (120 East Side) Intensity
- MD Eastbound Moderate (134 East Side) Intensity
- MD Westbound Moderate (134 East Side) Intensity
- PM Eastbound Moderate Intensity
- PM Westbound Moderate Intensity
- AM Eastbound Severe Intensity
- AM Westbound Severe Intensity
- MD Eastbound Severe Intensity
- MD Westbound Severe Intensity
- PM Eastbound Severe Intensity
- PM Westbound 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 0.95, 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 westbound incident on the IH 635 Corridor at Preston Road might only require incident plans to be activated on the 5 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 Δ veh	Min Δ veh	Average Δ veh
AM Eastbound Moderate Intensity	120/160	2080	655	1199
AM Westbound Moderate Intensity	120/160	2368	302	1074
MD Eastbound Moderate (120 East Side) Intensity	100/120	2656	860	1404
MD Westbound Moderate (120 East Side) Intensity	100/120	2484	614	1450
MD Eastbound Moderate (134 East Side) Intensity	100/134	2296	1035	1558
MD Westbound Moderate (134 East Side) Intensity	100/134	2604	879	1502
PM Eastbound Moderate Intensity	144/160	1750	348	1024
PM Westbound Moderate Intensity	144/160	2262	149	1079
AM Eastbound Severe Intensity	150/180	2230	760	1257
AM Westbound Severe Intensity	150/180	2368	411	1151
MD Eastbound Severe Intensity	120/150	2426	1063	1504
MD Westbound Severe Intensity	120/150	2500	955	1515
PM Eastbound Severe Intensity	160/180	1818	509	1133
PM Westbound Severe Intensity	160/180	2352	283	1138

AM and PM peak traffic is near- or over-capacity on many intersection approaches within the IH 635 Corridor, resulting in more modest opportunities to serve diverting traffic from the IH 635 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 1280 vehicles per hour (vph) for moderate incident timing plans and 1280 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 Administration¹, 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.

OBSERVED BENEFITS

Westbound incident plans were implemented on IH 635 by the City of Dallas on April 27th. As reported by TxDOT dynamic message signs on IH 635, an incident shut down the freeway at Webb Chapel. As shown in Figure 2, travel times on the westbound frontage roads spike dramatically around 7:45 AM (red line). Once the City implemented the diversion plans at around 8:30 AM, travel times dropped until returning to the average weekday at approximately 11:30 AM.

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

Travel Time on IH 635 WBFR Between DNT and IH 35

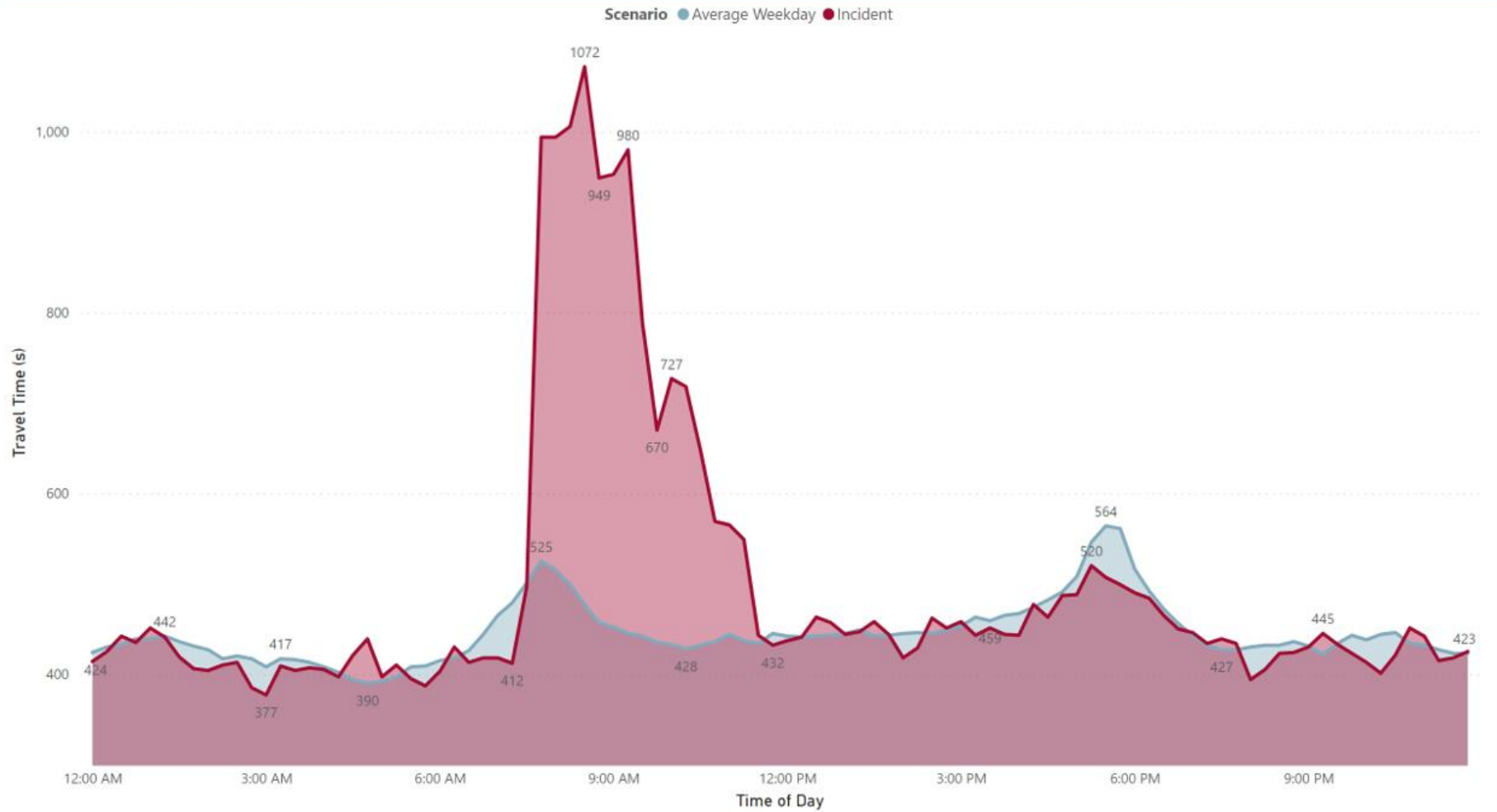


Figure 2. Travel Time on IH 635 WBFR between DNT and IH 35 on April 27, 2022 Compared to Average Weekday

Recommendations

Incident plans for the IH 635 Corridor should be deployed by the City of Dallas as needed when a significant unplanned incident occurs on the mainlanes of IH 635 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 IH 635 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.