Before-and-After Travel Time and Emissions Analyses

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Date: September 26, 2017

Background and Purpose
This memo quantifies the impacts of corridor signal retiming in Delaware by comparing travel time and emissions data before and after the retiming projects.

Approach
The Delaware Department of Transportation (DelDOT) identified signal retiming projects on corridors of interest (see Table 1). Before and after the projects, Bluetooth devices located at or near intersections on these corridors were used to collect vehicle travel time data. The advantage of Bluetooth data is the ability to look at many data samples and multiple days of data. Where Bluetooth coverage was unavailable, DelDOT collected travel time data manually. See Table 2 for results.

Synchro was then used to analyze the impact of the signal retimings on vehicle emissions using turning movement count data available from DelDOT. Table 3 shows the results of this analysis.

Table 1. Signal Retiming Projects

Project Location	County	Completed	Collection Method	Segment Length
DE 273	New Castle	Summer 2014	Manual	7.50 miles
DE 7 South	New Castle	Fall 2014	Manual	1.50 miles
DE 20	Sussex	Fall 2014	Manual	1.75 miles
DE 141	New Castle	Summer 2015	Bluetooth	6.00 miles
DE 1 (Rehoboth)	Sussex	Summer 2016	Bluetooth	5.00 miles

Findings

Table 2. Travel Time Analysis

Project Location	Peak	Direction	Before (min:sec)	After (min:sec)	Percent Change
DE 141*	AM	Northbound	18:23	16:44	–9.0%
		Southbound	11:37	12:38	8.8%
	PM	Northbound	18:20	15:27	–15.7%
		Southbound	15:33	13:07	–15.7%
DE 273	AM	Eastbound	11:52	13:13	11.4%
		Westbound	16:18	13:30	–17.2%
	PM	Eastbound	17:08	13:19	–22.3%
		Westbound	15:35	14:09	–9.2%
DE 7 South	AM	Northbound	2:22	2:01	–14.8%
		Southbound	2:12	2:02	–7.6%
	PM	Northbound	2:20	2:26	4.3%
		Southbound	2:19	2:25	4.3%
DE 1 (Rehoboth)*	Sat.	Northbound	24:27	19:10	–21.6%
		Southbound	36:08	34:22	–4.9%
DE 20	AM	Eastbound	4:15	3:57	–7.1%
		Westbound	3:40	4:12	14.6%
	PM	Eastbound	4:20	4:14	–2.3%
		Westbound	4:32	4:25	–2.6%

* Travel time data was collected using Bluetooth technology.

Table 3. Synchro Emissions Results

Project Location	Peak	Pollutants	Before (kg)	After (kg)	Percent Change
DE 141	AM	CO	64.6	60.4	–6.4%
		NOx	12.6	11.8	–6.4%
		VOC	15.0	14.0	–6.4%
	PM	CO	83.5	73.7	–11.7%
		NOx	16.2	14.3	–11.7%
		VOC	19.4	17.1	–11.8%
DE 7 South	AM	CO	9.9	8.8	–11.1%
		NOx	1.9	1.7	–10.9%
		VOC	2.3	2.0	–11.8%
	PM	CO	11.1	10.4	–6.3%
		NOx	2.2	2.0	–6.0%
		VOC	2.6	2.4	–5.5%
DE 1 (Rehoboth)	Sat.	CO	207.6	130.8	–37.0%
		NOx	40.4	25.5	–36.8%
		VOC	48.1	30.3	–37.0%
DE 20	AM	CO	10.1	9.8	–2.9%
		NOx	2.0	1.9	–2.0%
		VOC	2.3	2.3	–2.1%
	PM	CO	10.1	10.1	0.8%
		NOx	1.9	2.0	1.0%
		VOC	2.3	2.3	0.0%

A Synchro model for DE 273 was unavailable.

Recommendations

The signal retimings on DE 141, DE 273, DE 7 South, DE 1 (Rehoboth), and DE 20 resulted in improvements to both observed travel times and total vehicle emissions.

On average, corridor travel times decreased by 5.9%. Of the 18 analysis time periods and directions outlined in Table 2, only five saw increases: DE 141 southbound during the morning peak, DE 7 South northbound and southbound during the evening peak, and DE 20 westbound during the morning peak.

With the exception of DE 20 during the evening peak, the signal retimings also were followed by net decrease in emissions along all corridors during all peak periods, with average decreases of 10.7% for carbon monoxide (CO), 10.6% for nitrogen oxide (NOx), and 10.7% for volatile organic compounds (VOC). These improvements should be interpreted as decreases in emissions on a per-vehicle basis, however.

Although Delaware has a vast amount of continuous volume data available, signal system loop data does not provide the detailed turning movements needed for Synchro models. With this limitation, based on available turning movement counts, the volumes used in this analysis are the same before and after the signal retimings. It is also important to recognize that Synchro analyzes the conditions only at a designated peak hour. If turning movement counts were available both before and after the signal retimings, they might show that, as travel times decrease after signal retiming, the throughput would increase during the peak hour, leading to a net increase in emissions. However, there would still be a reduction in emissions per vehicle, and the net volume over the whole day would likely be about the same as before the retimings. Therefore, future analyses can be strengthened by incorporating volume data more accurately into Synchro.

As DelDOT continues to retime corridors where Bluetooth coverage is available, we plan to analyze the impact of those signal retiming as well. Future before-and-after analyses can be strengthened by incorporating volume data and by using Bluetooth travel time data to evaluate emissions, as outlined in our memorandum Synchro Alternatives for Emissions Evaluation.