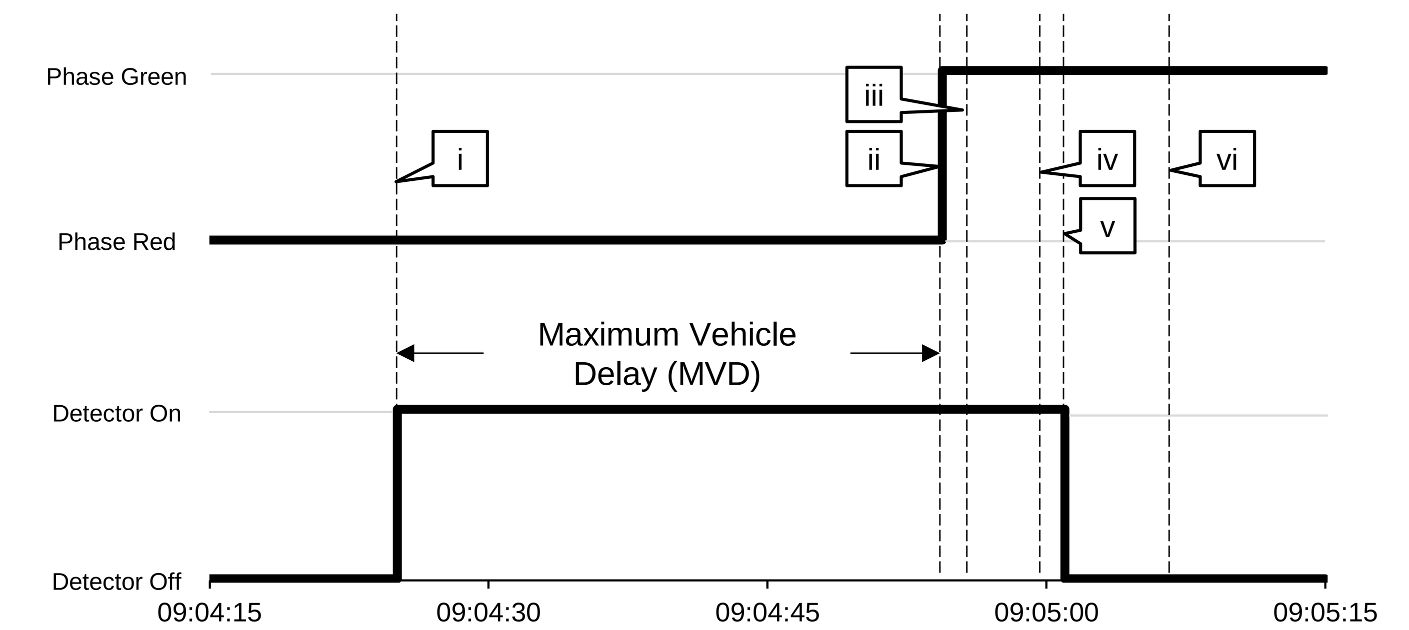
15-0385

Characterizing Signalized Intersection Performance using Maximum Vehicle Delay

Steven M. Lavrenz[1], Christopher M. Day[1], Alexander M. Hainen[3], W. Benjamin Smith[2], Amanda Stevens[2], Howell Li[1], and Darcy M. Bullock[1]
1 = Purdue University, 2 = Indiana Department of Transportation, 3 = University of Alabama

MVD CONCEPTUAL OVERVIEW



[i] 09:04:25 first arrival/detector on

[ii] 09:04:54 start of green

[iii] 09:04:56 first vehicle departure

[iv] 09:05:00 last vehicle departure

[v] 09:05:01 detector off

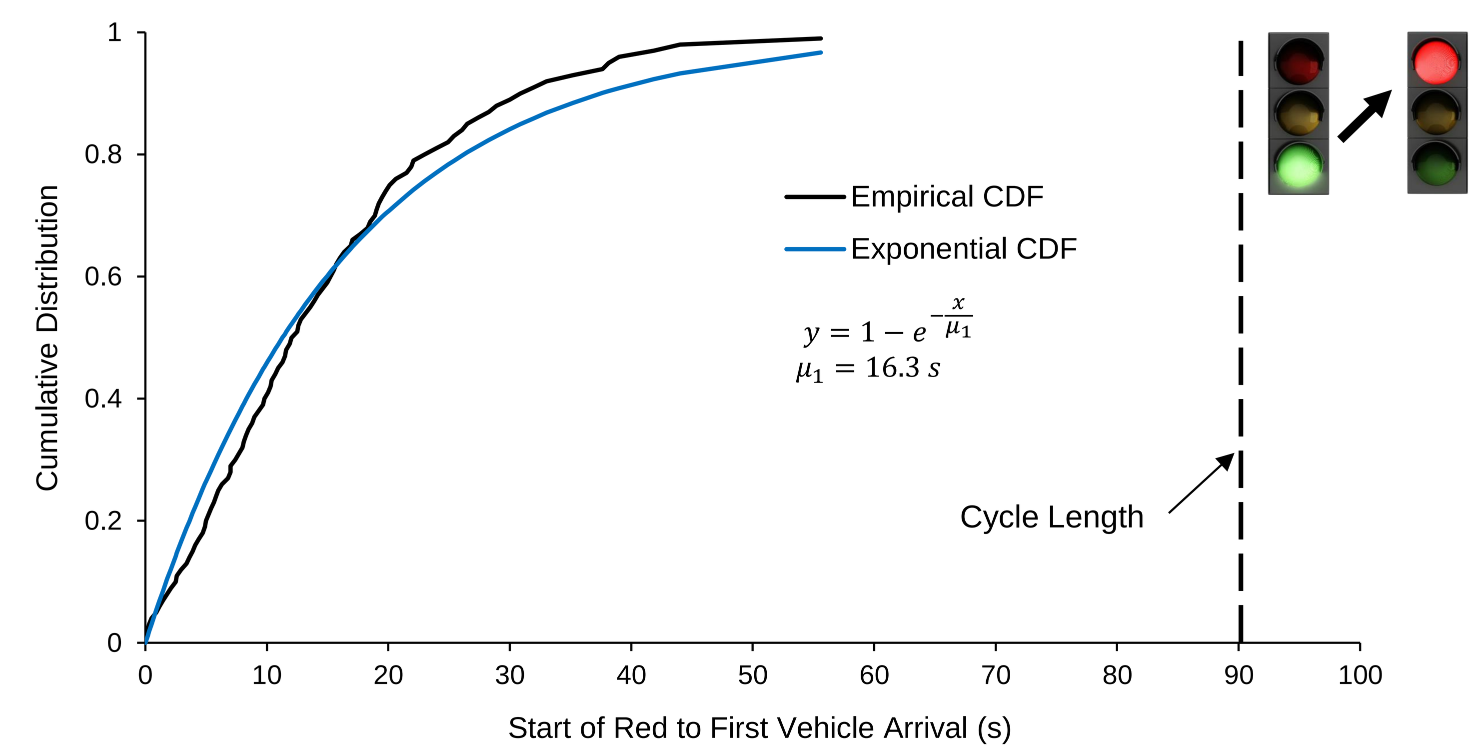
[vi] 09:05:07 approach clear

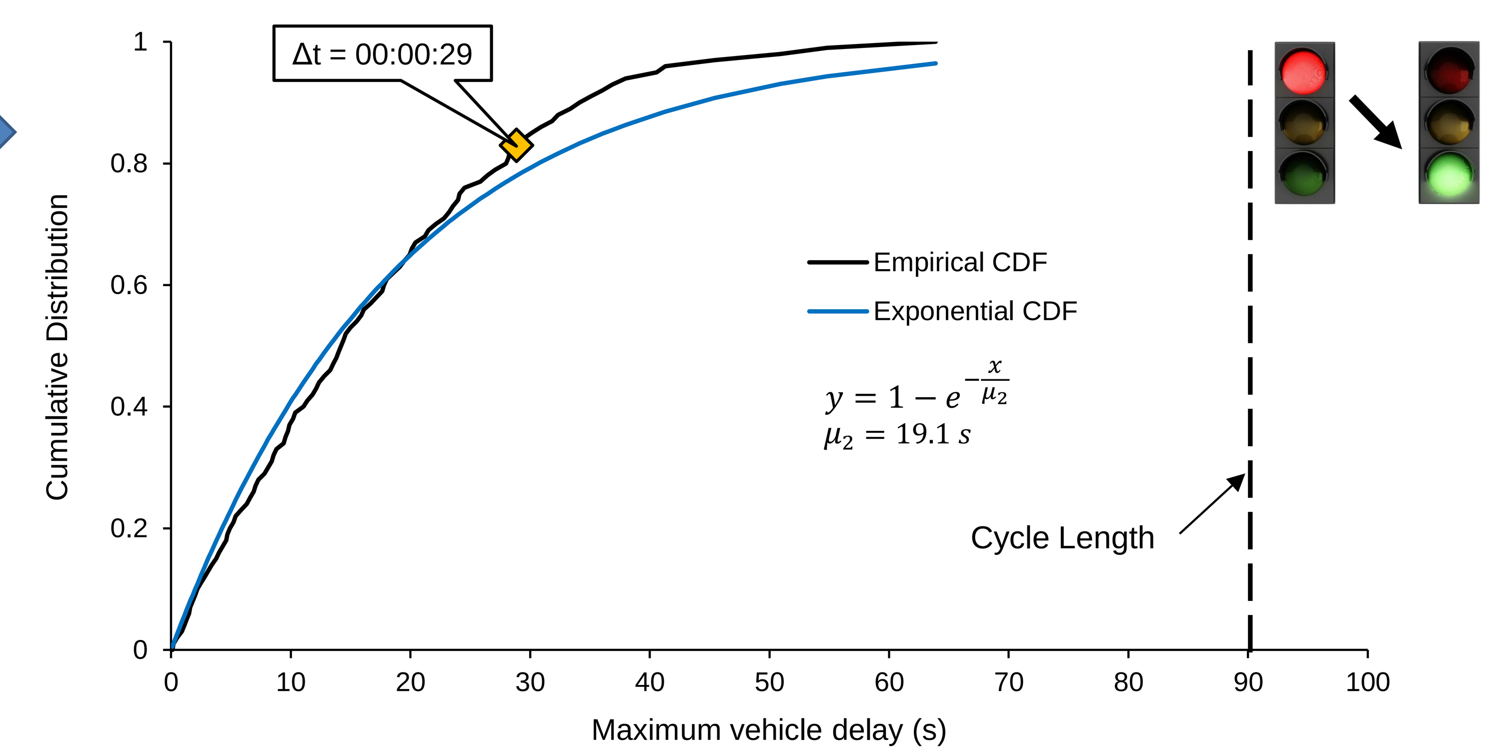
ABSTRACT

Average delay is perhaps the most commonly used measure for characterizing the performance of signalized intersections. Current methodologies for estimating the average delay rely on the use of models based on volumes and green times. In practice, it is challenging to develop such real-time measurements of delay, due to the difficulty of accurately measuring vehicle arrivals and departures. However, measuring wait time after the first vehicle arrival during the red interval can be an important performance measure for low and moderate volume conditions. The maximum wait time performance measure provides an upper bound, or maximum, on individual vehicle delay during a given cycle and facilitates comparison between different types of operation.

This paper demonstrates the effectiveness of this "maximum vehicle delay" (MVD) performance measure with four different case studies, including split adjustment, implementation of coordination at a non-coordinated intersection, varying cycle length, and use of phase reservice. The paper concludes that maximum vehicle delay can be used to characterize the impact of timing adjustments, as well as the implementation of more unique controller features, on individual movements at the intersection.

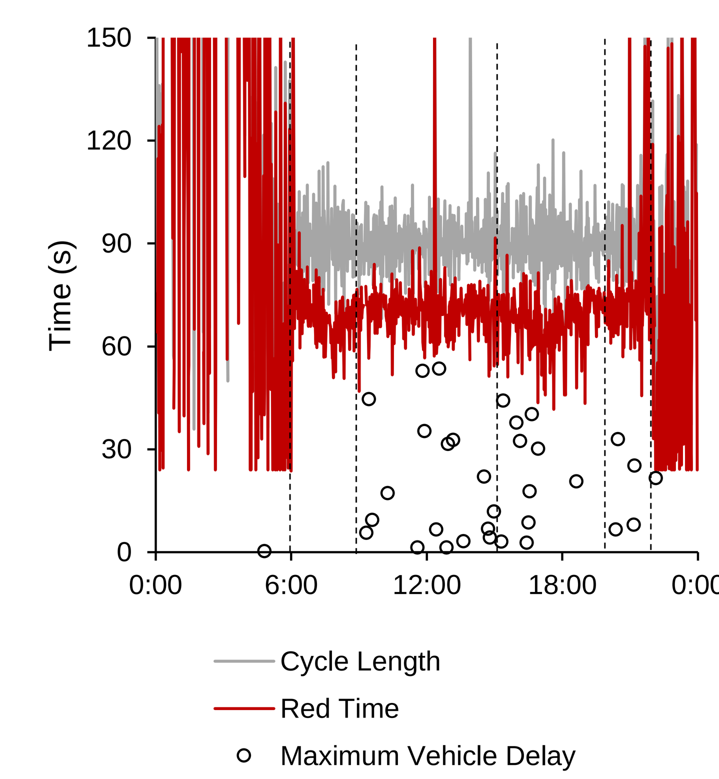
MVD & VEHICLE ARRIVALS

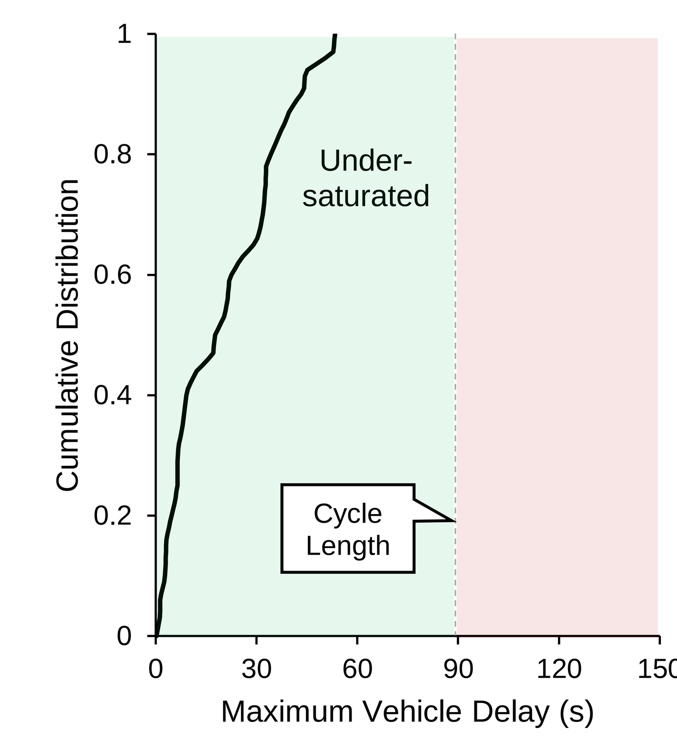


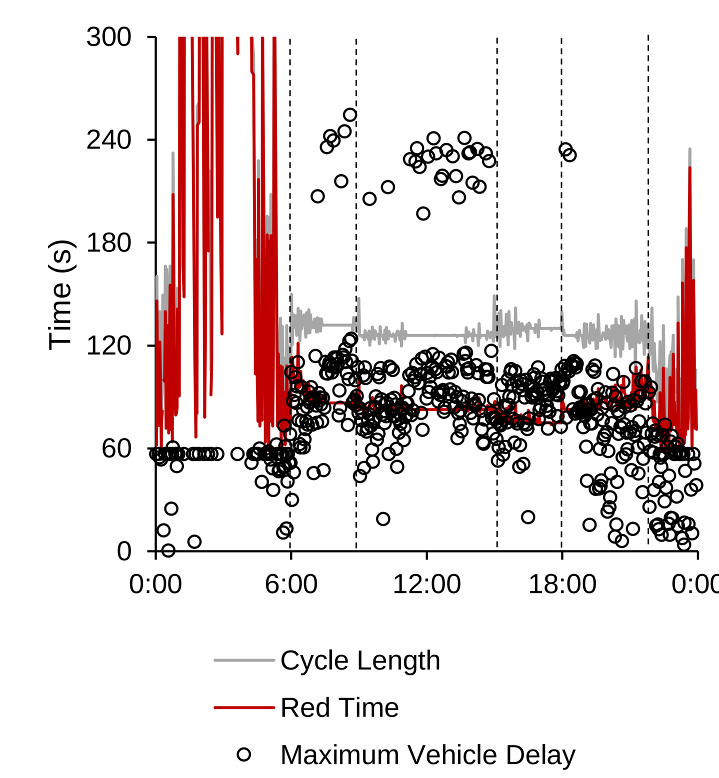


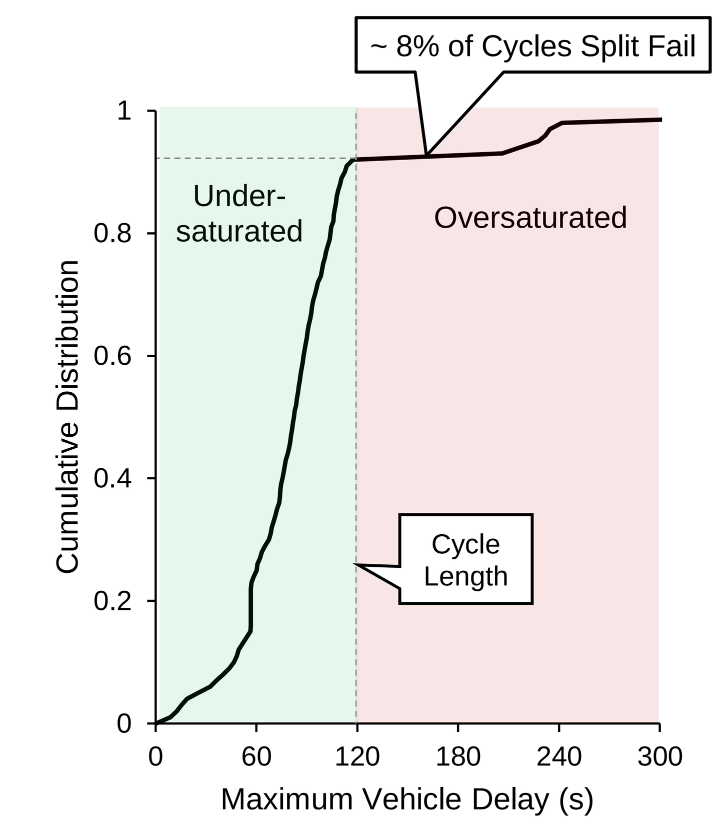
MVD can be modeled using the same Poisson Process as vehicle arrivals

MVD & SPLIT FAILURES







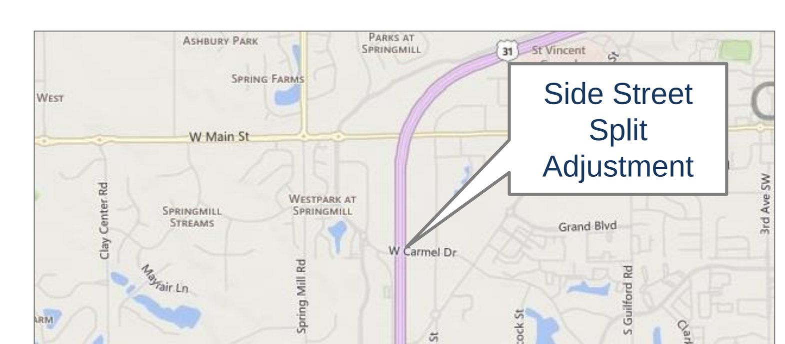


DATA COLLECTION

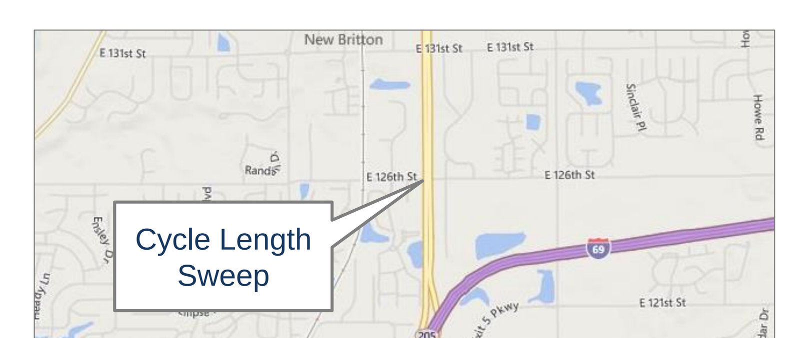
	Start	End	TOD Plan	Details
US31 & 126th St.	July 15, 2013	July 19, 2013	0900 to 1500	No adjustments
	July 29, 2013	August 2, 2013	0900 to 1500	Split adjustments on phase 3/8
US231 & State St.	December 2, 2013	December 6, 2013	0600 to 0900; 1500 to 1900	No coordination (free mode)
	April 21, 2014	April 25, 2014	0600 to 0900; 1500 to 1900	Coordination on phase 2/6
SR37 & 126th St.	May 9th, 2013	May 9th, 2013	1900 to 2200	104s Cycle Length
	May 22nd, 2013	May 22nd, 2013	1900 to 2200	108s Cycle Length
	July 2nd, 2013	July 2nd, 2013	1900 to 2200	112s Cycle Length
	June 19th, 2013	June 19th, 2013	1900 to 2200	116s Cycle Length
	July 24th, 2013	July 24th, 2013	1900 to 2200	120s Cycle Length
	May 13th, 2013	May 13th, 2013	1900 to 2200	124s Cycle Length
US231 & Martin Jischke Dr.	February 3, 2014	February 3, 2014	0900 to 1500	Phase Reservice
	February 4, 2014	February 4, 2014	0900 to 1500	No Phase Reservice

STUDY LOCATIONS

US231, West Lafayette, IN



US31, Carmel, IN



SR37, Fishers, IN

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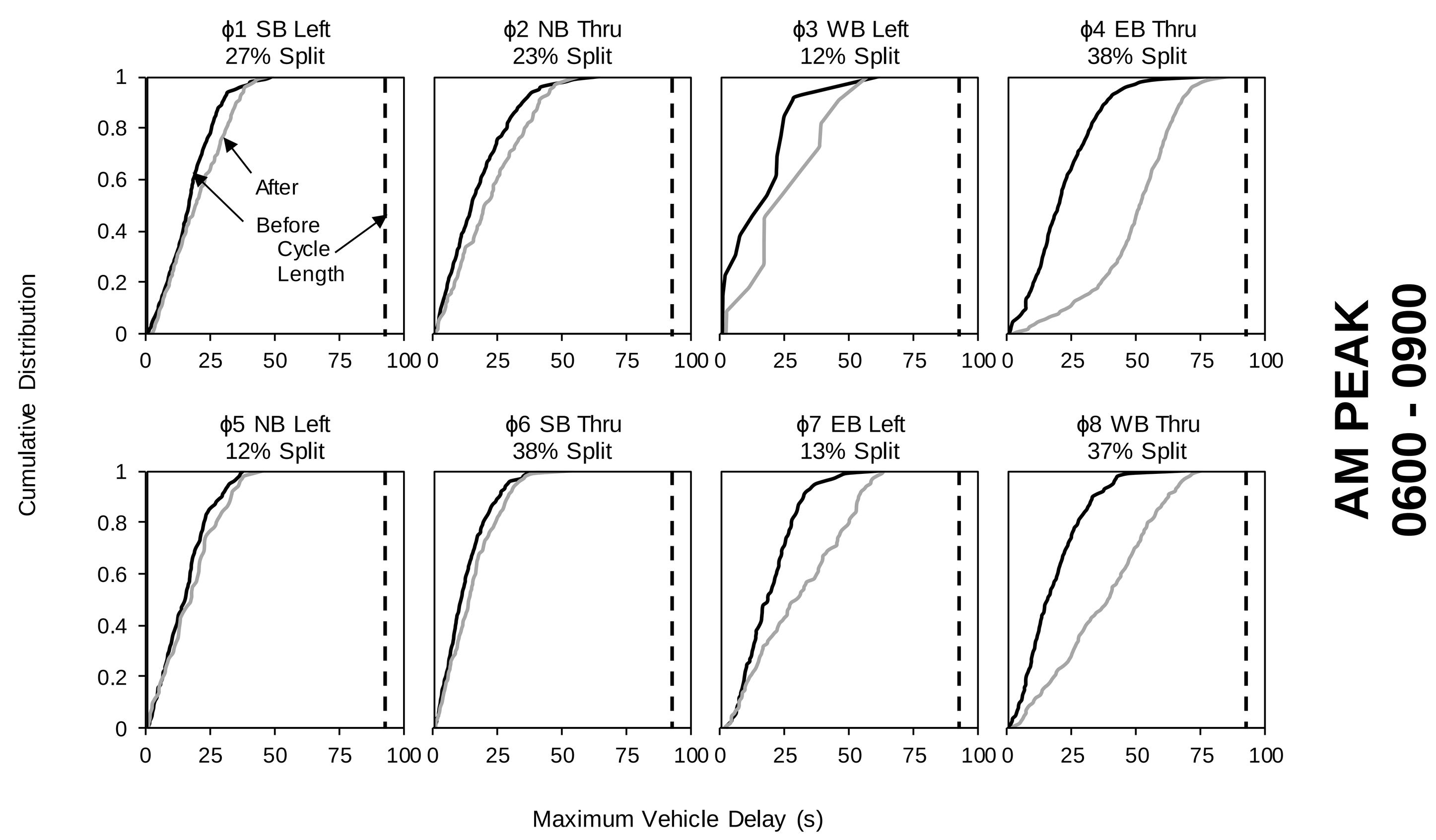
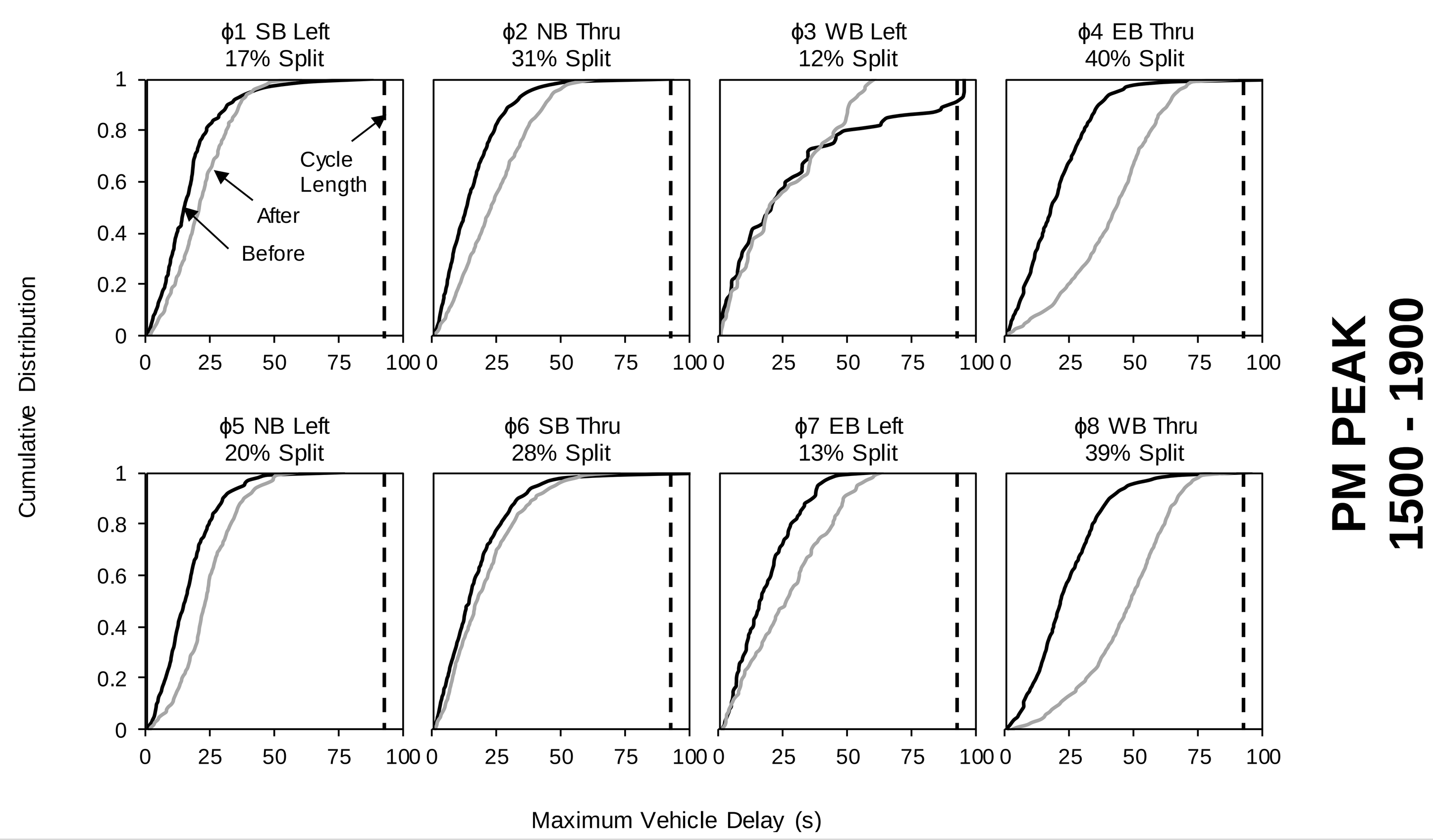
COORDINATION IMPACTS

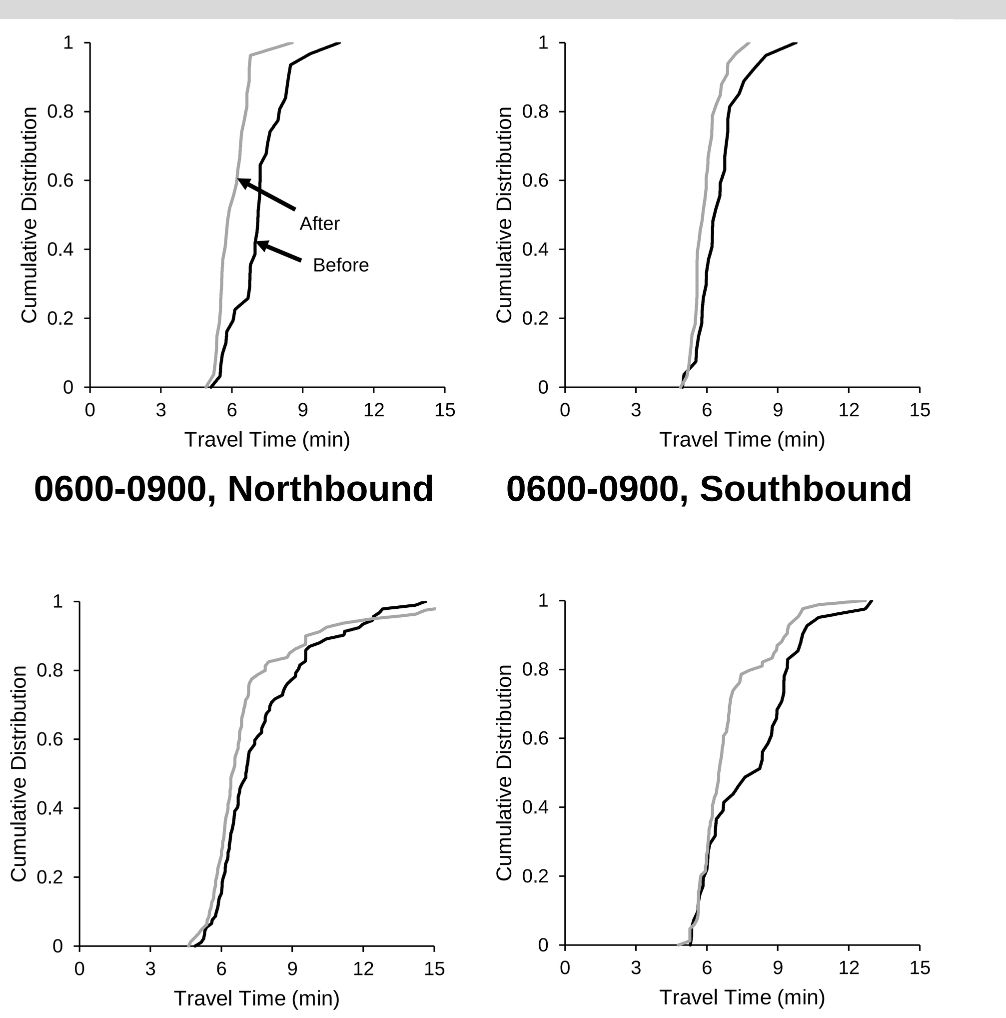


AM PEAK 0600 - 0900



PM PEAK 1500 - 1900

Mainline Travel Time Improvements



0600-0900, Northbound

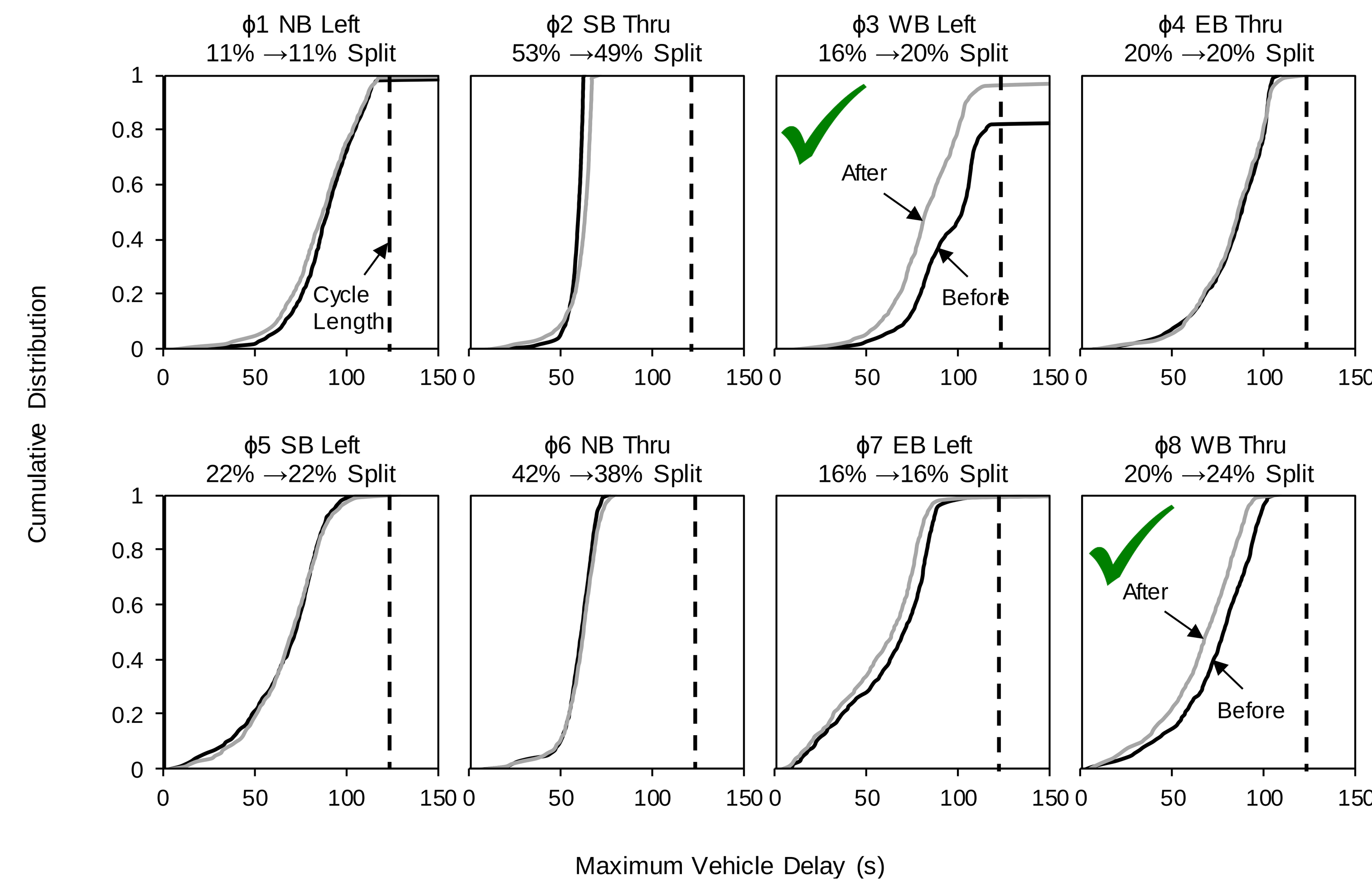
0600-0900, Southbound

1500-1900, Northbound

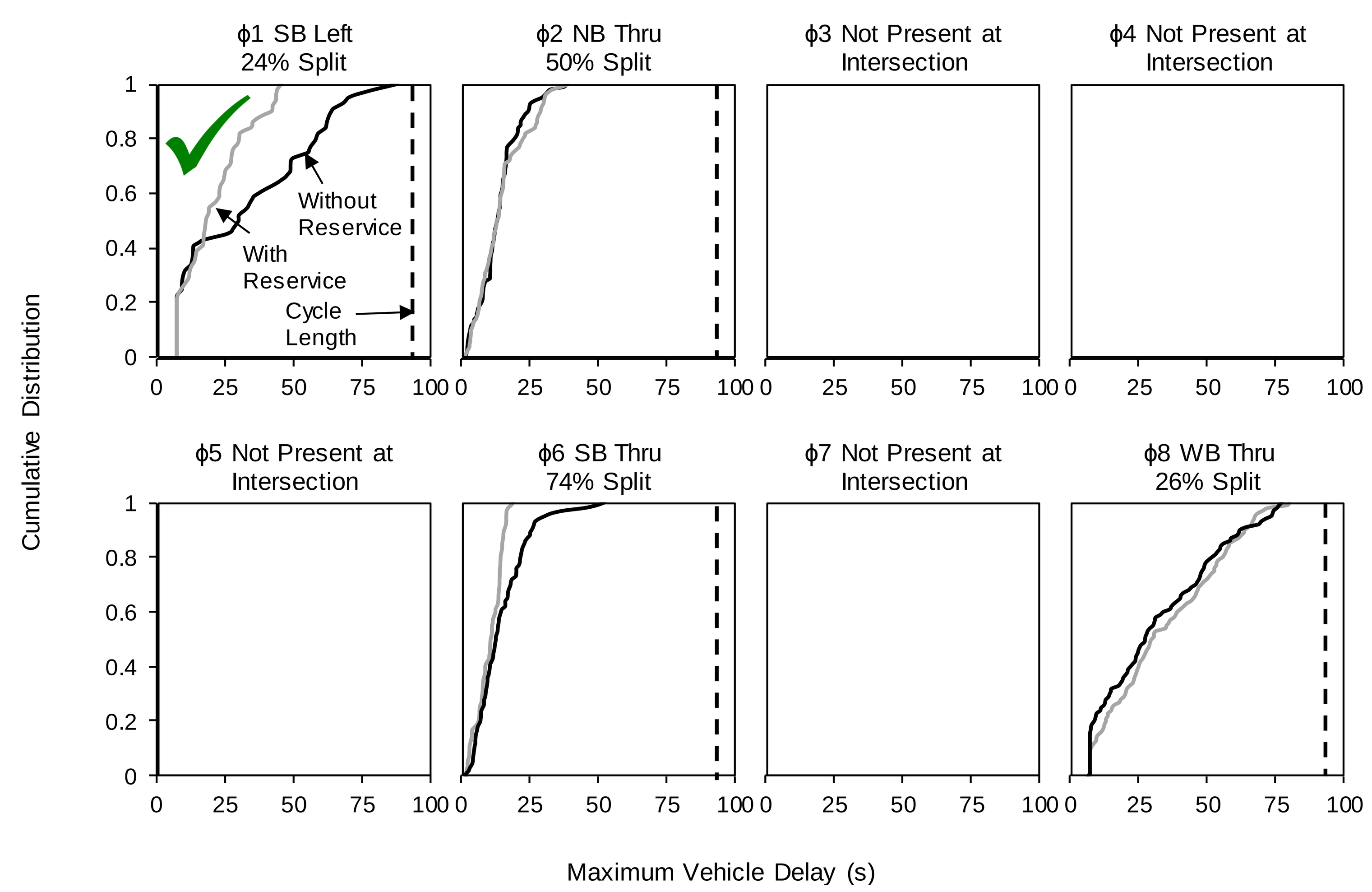
1500-1900, Southbound

US231, West Lafayette, IN

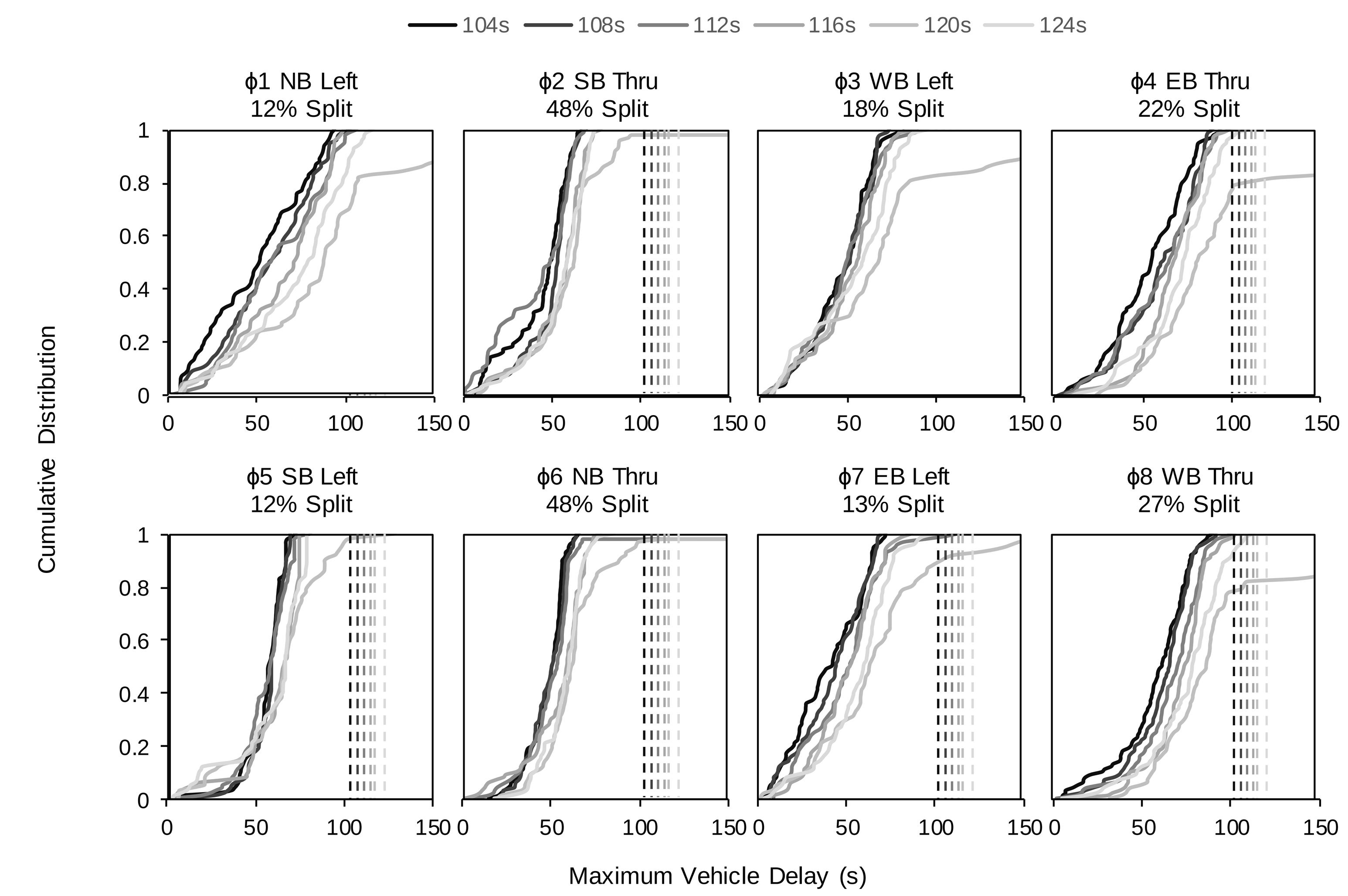
SPLIT ADJUSTMENTS

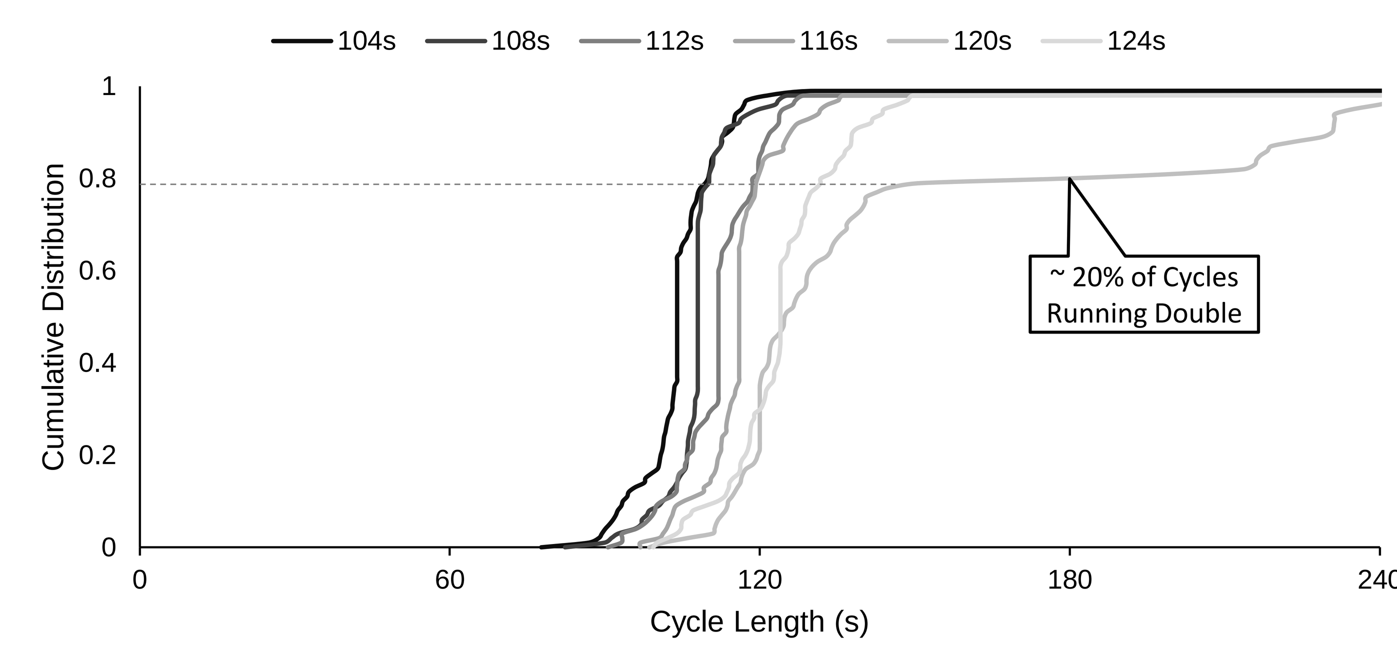


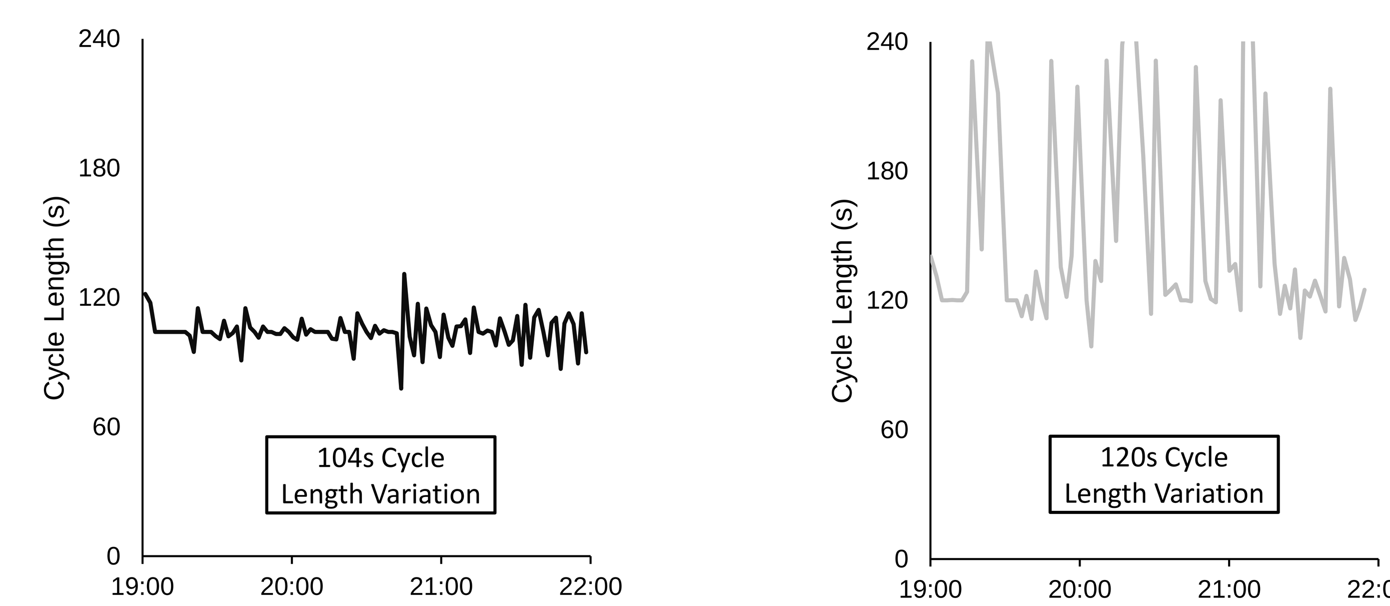
PHASE RESERVE



CYCLE LENGTH SWEEP







CONCLUSIONS

1. MVD used to assess side-street split adjustments, identify split failures, and quantify reductions in driver delay.
2. Side street MVD increased with coordination, while mainline travel times decreased. This enables trade-offs between coordinated and non-coordinated phases to be characterized.
3. MVD is useful for identifying controller issues. Increased cycle length resulted in increased MVD for the mainline protected left and side street phases.
4. MVD can used to demonstrate the impact of specialty controller features, such as phase reserve.