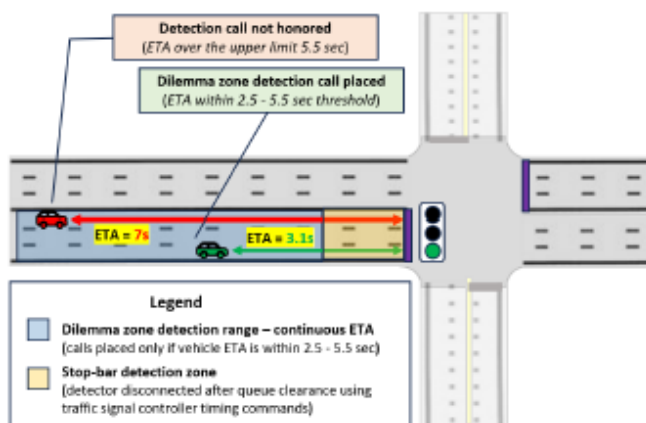


TRANSPORTATION ACHIEVEMENT AWARD — SAFETY

Macomb County's ETA-Based Dilemma Zone Protection and Late-Window Gap-Out Strategy — Macomb County Department of Roads

ITE—A Community of Transportation Professionals is proud to recognize the **Macomb County Department of Roads (MCDR)** as the recipient of the [2026 Transportation Achievement Award](#) in the Safety category for its **ETA-based dilemma zone protection and late-window gap-out strategy**.

ITE's Transportation Achievement Awards recognize excellence in advancing transportation to meet human needs. Macomb County's program exemplifies this purpose by applying advanced detection, data-driven signal timing, and scalable safety logic to reduce end-of-phase crash risk at high-speed and coordinated signalized intersections.



Several major arterials in Macomb County operate with high approach speeds, inconsistent platoon arrivals, and fluctuating demand cycles. In these conditions, fixed phase termination can place motorists in the dilemma zone, where drivers must quickly decide whether to stop or proceed when the signal changes to yellow. These situations can contribute to rear-end crashes when drivers brake abruptly and angle or opposing-movement crashes when vehicles enter

late on red.

To address this challenge, MCDR implemented a performance-based safety countermeasure using existing signal infrastructure. The County deployed advanced estimated time of arrival (ETA)-based dilemma zone detection and programmed traffic signal controllers to provide live phase termination through either gap-out or extension. This approach allows the system to continuously track approaching vehicles, estimate speed, distance, and ETA, and determine whether a vehicle should receive green extension protection or whether the phase can safely terminate early.

The strategy was tailored for both non-coordinated and coordinated through phases. On non-coordinated phases, stop-bar detection is temporarily disconnected after initial queue clearance, allowing advanced detection to guide phase termination based on vehicles' ETA to the stop bar. On

coordinated phases, timing files were modified to allow gap-out during the final 10, 15, or 20 seconds of the coordinated split, depending on the cycle length. This late-window gap-out strategy helps maintain progression quality while enabling real-time, demand-responsive termination.

The detection system monitors vehicles as far as approximately 900 ft. upstream and applies a dynamic protection window aligned with Federal Highway Administration dilemma zone thresholds of 2.5 to 5.5 seconds. Vehicles within that window receive green extension protection, while phases can terminate early when no vehicles require protection. Operational safeguards, including retained stop-bar presence detection and a one-second minimum extension, help support queue clearance, counts, performance measures, and safe departures.

Macomb County deployed the strategy in two waves: 17 intersections in 2023 and nine intersections in 2024. The program included isolated high-speed approaches as well as multiple intersections along coordinated arterials, demonstrating its applicability across different traffic environments. Its vendor-neutral, detection-driven design allows for low-cost expansion across diverse corridors.

The results show measurable safety benefits. For the 17 intersections configured in 2023, rear-end crashes decreased by 20.5 percent and head-on left-turn crashes decreased by 22.7 percent, while countywide trends rose slightly. KAB injury crashes remained flat at the treatment sites while increasing countywide. For the nine intersections configured in 2024, rear-end crashes decreased by 14.3 percent and angle crashes decreased by 45.5 percent, compared with countywide increases. KAB injury crashes also showed a large drop at treatment sites, while countywide KAB crashes increased.

The evaluation used a structured before-and-after methodology, including per-year crash normalization and strict screening criteria. The analysis focused on police-reported crashes from 2021 through 2025 within 150 ft. of signalized intersections and included rear-end, angle, and head-on left-turn crashes most plausibly influenced by signal operations, detection, and phase termination logic. It also filtered out crashes involving factors such as distracted driving, impaired driving, work zones, emergency vehicles, and congestion-related conditions to better isolate the effects of the signal strategy.

Macomb County's approach worked because it improved the driver experience at the most critical moments in the signal cycle. ETA-based tracking reduces surprise yellow onsets near the stop bar, decreasing hard braking and late entries. Late-window gap-out prevents unnecessary late greens during low demand, reducing exposure at the end of coordinated splits. Queue clearance logic, a one-second safety margin, and careful tuning between detection layout and controller settings further support safer and more predictable operations.

By combining ETA-based dilemma zone protection, coordinated-phase late-window gap-out, rigorous crash analysis, and tunable parameters that can be adapted to local conditions, Macomb County has

2026 Excellence in Transportation Award Winner



created a scalable, low-cost, vendor-neutral model for improving intersection safety. ITE congratulates the Macomb County Department of Roads on this achievement and celebrates its leadership in using signal operations and existing infrastructure to reduce crash risk and improve safety for the traveling public.

Learn more about [ITE's Awards Program](#).