

# APPENDIX F:

## COUNTERMEASURES & STRATEGIES

**COUNTERMEASURE & STRATEGIES TABLES - DEFINITIONS**

**5E Categories**

- ENG - Engineering
- EDU - Education
- EMS - Emergency Response & Post-crash Care
- ENF - Enforcement
- EVA - Evaluation

**Implementation Timeframe**

- Short-term** → Low-cost, quick-start, policy/enforcement/education initiatives (≤ 1 year).
- Medium-term** → Moderate coordination/training efforts (≈ 2–3 years).
- Long-term** → High-cost or infrastructure-heavy engineering/EMS efforts (>3 years).

**Cost Estimates**

Category	Approximate Range (Total Implementation)	Examples / Typical Applications	Notes
<b>Very-Low</b>	<\$10,000 per site or corridor	Maintenance-level treatments such as minor signage adjustments, low-cost delineation, short-term speed management tools, school safety events, and community-led outreach or education activities	Small-scale, quick build often with in-house crews and minimal design. Suitable for pilots, demonstrations, or early-action safety measures.
<b>Low</b>	<\$25,000 per site or corridor	Pavement markings, signage, rumble strips, minor signal timing updates, community outreach campaigns	Often implementable under maintenance budgets or short-term pilot funding
<b>Low–Moderate</b>	\$25,000–\$100,000	Speed feedback signs, curb extensions, pedestrian beacons (RRFBs), targeted enforcement campaigns, safety education materials	Ideal for corridor demonstration projects or annual safety allocations
<b>Moderate</b>	\$100,000–\$500,000	Signal upgrades (LPIs, phasing), pedestrian hybrid beacons (PHBs), small roundabouts, AI/conflict analytics systems, EMS coordination tools	Can often be delivered under HSIP or SS4A “Quick-Build” funding
<b>Moderate–High</b>	\$500,000–\$1,500,000	Full corridor resurfacing with safety improvements, lighting upgrades, quick-build to permanent conversion, adaptive signals	May require design and environmental documentation; typically multi-year funding
<b>High</b>	\$1.5–\$5.0 million	Major reconstruction, roundabout conversions, grade separation, comprehensive corridor retrofits, red-light/speed camera networks	Full capital improvement projects or multi-agency coordination effort
<b>Very High / Capital Intensive</b>	>\$5 million	Interchange reconstruction, major arterial redesign, bridge or grade-separated trail crossing	Rare for stand-alone safety projects; integrated with capital programs or TIP/STIP

ENGINEERING COUNTERMEASURES & STRATEGIES

Index	5E Category	Countermeasure Name	Countermeasure Description	Implementation Notes	Main Crash Type Addressed	Crash Reduction (CRF) / Crash Modification (CMF) / Effectiveness	Implementation Timeframe	Cost / Cost Tier
ENG-1	Engineering	Complete Streets Corridor Design	Design and implement corridors using Complete Streets principles—integrating sidewalks, bike facilities, safe crossings, transit features, and traffic-calming—to create continuous, predictable, multimodal routes. Apply consistent standards for lane widths, sidewalks, and bike lanes along entire corridors to eliminate gaps and support safer, context-appropriate speeds.	Apply a context-sensitive design approach that aligns roadway elements with land use, speed goals, and multimodal activity along the full length of the corridor. Ensure cross-sections remain consistent by standardizing lane widths, sidewalks, and bike facilities to avoid gaps or abrupt transitions. Incorporate traffic-calming strategies, safe crossing spacing, curb management zones, and transit accommodations where needed. Coordinate early with utilities, drainage, and access management to support a cohesive design. Engage community stakeholders throughout planning and design to ensure the corridor reflects local needs and supports safe, predictable travel for all users.	All	Combination of multiple countermeasures and strategies. No known CMF.	Medium-term	Varies
ENG-2	Engineering	Local Road Safety Audit (LRSA) Program	Establish a Local Road Safety Audit program to evaluate high-risk sites and community-identified trouble spots through multidisciplinary field reviews. Teams assess roadway conditions, human-factors issues, and multimodal needs, generating prioritized recommendations that guide near- and long-term safety improvements.	Perform multidisciplinary safety audits on local high-risk corridors or intersections, engaging engineering, enforcement, EMS, planning, and community partners. Use crash data, field observations, near-miss reviews, and roadway context to identify low-cost and systemic safety improvements. Develop standardized audit templates and follow-up procedures to ensure findings translate into actionable projects, including quick-build treatments and long-term capital improvements. Coordinate with local agencies to schedule recurring audits, monitor implementation progress, and align recommendations with HSIP, SS4A, and local transportation plans.	Varies by study area	10-60% (total crashes)	Medium-term	Low-Moderate
ENG-3	Engineering	Traffic Calming and Speed Management	Implement traffic-calming and speed-management strategies—such as lane narrowing, curb extensions, speed humps, raised crossings, chicanes, and gateway treatments—to lower operating speeds, reduce crash severity, and create safer, more predictable conditions for all roadway users.	Coordinate with local agencies to select corridors or intersections with speeding, roadway-departure, or multimodal safety concerns. Conduct on-site reviews with a multidisciplinary team to identify practical traffic-calming and speed-management opportunities such as lane narrowing, signage upgrades, enhanced markings, crossing improvements, and low-cost geometric adjustments. Document findings with clear recommendations, cost tiers, and near-term actions that can be implemented through maintenance, quick-build materials, or partnership with community groups.	Rear-End, Angle, Sideswipe, Pedestrian, Speeding	Combination of multiple countermeasures and strategies outlined below. No known CMF.	Medium-term	Moderate
ENG-4	Engineering	Speed Humps	Vertical deflection devices (typically 3–4 inches high and 12–14 feet long) to slow vehicle speeds on local residential streets and around schools, parks, and other pedestrian-focused areas.	Use on low-volume, low-speed local streets or neighborhood corridors where speeding is a recurring issue and cut-through traffic needs to be discouraged. Coordinate spacing (usually 250–500 feet apart) for consistent speed control and pair with markings, signage, and lighting for visibility. Avoid placement on primary emergency routes, steep grades, or major bus corridors unless using speed cushions designed for emergency vehicles. Incorporate community outreach and data-driven speed studies before and after installation to ensure effectiveness and support long-term acceptance. Should be paired with complementary traffic-calming strategies to reinforce consistent operating speeds.	Rear-End, Angle, Sideswipe, Pedestrian, Speeding	50–60% total 40–45% FSI	Short, medium-term	Varies based on materials \$2,000-\$15,000 Most common Asphalt ~\$6,000 Concrete ~\$10,000
ENG-5	Engineering	Speed Tables	Elongated, flat-topped vertical speed-control devices designed to reduce vehicle speeds along residential streets, school zones, and pedestrian-oriented corridors.	Install speed tables at regular spacing along corridors to maintain target speeds and support high-priority pedestrian crossings. Use high-visibility markings, lighting, and signage to enhance driver awareness, and coordinate locations with transit, drainage needs, bus routes, and emergency-response agencies. Speed tables work best on low-speed urban or suburban local streets and should be paired with complementary traffic-calming strategies to reinforce consistent operating speeds.	Rear-End, Angle, Sideswipe, Pedestrian, Speeding	36%-64% reduction in total crashes	Medium-term	Varies based on materials \$2,000-\$20,000 Most common Asphalt ~\$6,000-\$8,000 Concrete ~\$10,000-\$12,000
ENG-6	Engineering	Raised Pedestrian Crossings	A raised pedestrian crossing elevating the crosswalk to the level of the sidewalk designed to slow vehicle speeds, increase pedestrian visibility, and reinforce pedestrian priority.	Raised pedestrian crossings should be installed where lower vehicle speeds and improved pedestrian visibility are critical, such as school zones, downtowns, trail crossings, transit stops, and locations with a history of pedestrian crashes or near misses. Designs must ensure the vertical profile is appropriate for emergency response, transit vehicles, and drainage needs, and should include high-visibility markings, signage, and lighting to reinforce driver awareness. Coordinate with roadway resurfacing or traffic-calming projects to reduce cost, and ensure the crossing is level with the sidewalk to provide an accessible, continuous path for people with disabilities.	Rear-End, Angle, Sideswipe, Pedestrian, Speeding	up to 45% pedestrian up to 45% total crashes	Medium-term	Varies based on materials and length \$7,000-\$30,000 Asphalt ~\$8,000 Concrete ~\$18,000
ENG-7	Engineering	Chicanes	A horizontal traffic-calming treatment that introduces alternating curb extensions, edge-line shifts, or physical barriers to create a serpentine travel path, requiring drivers to steer laterally rather than travel in a straight line slowing vehicle speeds.	Install chicanes on corridors with documented speeding, cut-through traffic, or pedestrian activity, especially where vertical devices (speed humps/tables) are not suitable for transit or emergency response. Designs should alternate lateral shifts to narrow the driver's sightline, use landscaped curb extensions or delineators for quick-build applications, and maintain clear bicycle access. Ensure adequate drainage, visibility, and spacing (typically 200–500 feet) to produce meaningful speed reductions. Coordinate with residents, transit providers, and emergency services to confirm placement and operational impacts. Should be paired with complementary traffic-calming strategies to reinforce consistent operating speeds.	Rear-End, Angle, Sideswipe, Pedestrian, Speeding	10–20% reduction in total crashes 25–40% reduction in severe-injury crashes	Medium-term	\$2,500-\$16,000 per landscaped chicane
ENG-8	Engineering	Curb Extensions, pedestrian refuge islands, and crossing distance reductions	Geometric and streetscape treatments that shorten pedestrian crossing distances, improve visibility, and reduce exposure to moving traffic. Curb extensions (bulb-outs) narrow the roadway at intersections or midblock crossings. Pedestrian refuge islands provide a protected median space that allows pedestrians to cross in two stages. Crossing distance reductions use lane narrowing, median treatments, or reallocated street space to minimize the time pedestrians spend in the roadway.	Use in combination with medians and refuge islands. Design curb extensions and refuge islands to shorten crossing distance, slow turning speeds, and improve pedestrian visibility. Ensure ADA-compliant ramps, detectable warnings, and clear sight lines. Coordinate with drainage, truck turning paths, parking adjustments, and snow-removal needs. Use reflective elements and lighting to improve nighttime visibility and pair with high-visibility crosswalks or RRFBs at higher-risk locations. Especially effective for multilane roads. Should be paired with complementary traffic-calming strategies to reinforce consistent operating speeds.	Rear-End, Angle, Sideswipe, Pedestrian, Speeding	20-56% for pedestrian crashes 10-25% for total crashes	Short-term	Curb Extensions \$78,000-\$88,000 per corner Median Refuge Island \$57,000-\$64,000 ea
ENG-9	Engineering	Road Diet	Conversion of a four-lane or five lane undivided roadway to three lanes (one lane in each direction with a center turn lane) and reallocates excess vehicle lanes to create space for bike lanes, wider shoulders, pedestrian refuges, on-street parking, or buffer space.  Other variations include two lane to one lane + bike lanes.	Road diets are most effective on corridors with speeding, high crash rates, or operational issues tied to left-turn conflicts. They can typically be implemented as part of resurfacing projects with minimal construction cost. Evaluate traffic volumes, turning movements, transit operations, and driveway density to confirm feasibility. Use public outreach and pilot demonstrations where appropriate to build comfort with the new design. Incorporate enhanced crossings, buffered or protected bike lanes, and refuge islands where space allows to maximize multimodal safety benefits.  Consider quick build variations that incorporating low cost materials - paint, posts, cone, modular barriers, temporary marking and signage to pilot a road diet prior to capital construction.	Rear-End, Angle, Sideswipe, Pedestrian, Speeding	19–47% reduction in total crashes after 4-to-3 and 5-to-3 conversions	Varies	\$30,000 per 1000 linear feet for pavement marking and signing changes only, 4 to 3 lanes. Does not include new pavement, curb, etc.

ENGINEERING COUNTERMEASURES & STRATEGIES

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ENG-10	Engineering	Curve Signing and Delineation	Installing or upgrading curve warning signs, chevron alignment signs, delineators, retroreflective post panels, and enhanced pavement markings at horizontal curves.	Conduct a safety study to identify priority curves and apply treatments that improve visibility, provide advance notice of curve severity, and support safer speeds and lane-keeping—especially at night or in wet conditions. Focus on curves with roadway-departure or nighttime crash patterns, limited sight distance, speed-compliance issues, or outdated/non-uniform MUTCD signing, as well as systemic high-risk segments.	Fixed Object, Overturning, Roadway/Lane Departure	20-40% All Crashes 15-60% FSI 25% Nighttime	Short-term	\$6,000-\$10,000 for one curve treatment, includes up to 4 chevrons with sign posts, delineators, and one pavement marking
ENG-11	Engineering	Clear Zone Management	Removing fixed objects, relocating utilities, shielding or eliminating obstacles, clearing vegetation, managing clear zone width. Increase clear zone width and distance to hazard.	Need identified via safety study. Locations identified in systemic or site-specific crash pattern analysis including curves, rural arterials, high-speed corridors. May require new ROW. Consider higher cost utility relocation, obstacle elimination, and new ROW only when other more conservative measures have proven ineffective.	Fixed Object	Increase distance from 3.3' to 16.6': 22% (all crashes)  Increase distance from 16.7' to 30': 44% (all crashes)	Short-term	\$2,000-\$3,000 to clear vegetation per day for labor and equipment \$5,000-\$10,000 per pole to move light pole \$10,000-\$15,000+ per pole to move standard utility pole
ENG-12	Engineering	Sideslope Flattening	Flatten steep roadside slopes (e.g., 1:4 to 1:6) to reduce rollover risk and provide a more forgiving recovery area for errant vehicles. This treatment increases the likelihood that drivers can safely regain control after leaving the travel lane, lowering the severity of roadway-departure crashes.	Need identified via safety study. Rural/suburban corridors, high-speed facilities. May require grading, drainage, ROW, retaining walls. Combine with other horizontal alignment and roadway departure reduction measures.	Fixed Object, Overturning, Roadway/Lane Departure	Flatten sideslope from 1:3 to 1:4: 8% reduction in single-vehicle crashes  Flatten sideslope from 1:4 to 1:6: 12% reduction in single-vehicle crashes	Short-term (with planned/programmed projects) Long-term (stand-alone)	\$2-\$15 per cubic yard for cut/fill operations
ENG-13	Engineering	Widened Shoulders (Add/Increase Paved Shoulder Width)	Add or widen paved shoulders to provide recovery space for errant vehicles, improve maneuverability, enhance bicycle accommodation, and reduce run-off-road and opposite-direction crashes. Wider shoulders also improve bicycle safety, recovery space, and driver comfort in curves and high-speed environments.	Prioritize corridors with elevated roadway departure crashes. May also include rumble strips/strips where appropriate. May require ROW, drainage modifications, pavement widening. Combine with other horizontal alignment and roadway departure reduction measures.	Fixed Object, Overturning, Roadway/Lane Departure, opposite direction (head-on, sideswipe meeting)	15–35% reduction in roadway departure crashes (paved shoulders ≥ 4 ft)  Up to 49% crash reduction when combined with shoulder rumble strips on rural two-lane roads	Short-term (with planned/programmed projects) Long-term (stand-alone)	\$250k per mile to widen 5 feet of shoulder
ENG-14	Engineering	Longitudinal Rumble Strips	Install edgeline, shoulder and/or centerline rumble strips at those locations, especially when able to combine with resurfacing projects.	Incorporate rumble strips into typical section design guidance based on available shoulder or roadway width. Apply on rural or suburban two-lane roads with roadway departure or head-on crash history; freeways and expressways with drift-off crashes; curves, long tangent segments, or areas with known fatigue/drift issues; and on resurfacing projects where installation can be combined with paving. Use edge-line rumble stripes where run-off-road crashes occur on the shoulder side. Pair rumble strips with other horizontal alignment, delineation, and roadway-departure reduction measures for maximum benefit.	Roadway/Lane Departure, head-on, sideswipe	<u>Centerline rumble strips:</u> 44-64% (head-on FSI crashes)  <u>Shoulder rumble strips:</u> 13-51% (roadway departure FSI crashes)	Short-term (with planned/programmed projects) Long-term (stand-alone)	\$500 - \$6,000 per mile
ENG-15	Engineering	SafetyEdge <sup>SM</sup>	Shaping of the pavement edge to a 30-degree tapered angle during resurfacing or construction, eliminating vertical pavement drop-offs and allowing drivers who leave the travel lane to safely recover.	Include during any resurfacing and paving; low cost add on, rural two-lane roads with unpaved shoulders, corridors prone to pavement edge drop-off from erosion or heavy truck traffic. Proven to improve pavement durability and reduce maintenance needs. Combine with other horizontal alignment and roadway departure reduction measures.	Roadway departure crashes, loss of control, overturning, head-on.	11% FSI 21% run-off-road 19% head-on	Short-term (with planned/programmed projects) Long-term (stand-alone)	Zero or very minimal cost when implemented with new or resurfacing project
ENG-16	Engineering	Superelevation Correction	Correct superelevation on curves to match design speed and roadway conditions, improving vehicle stability, reducing skidding risk, and lowering the likelihood of roadway-departure crashes—especially in wet weather or on higher-speed rural segments.	Target top roadway departure segments with identified problem with superelevation. Conduct ball-bank or similar curve studies to identify substandard superelevations. Should be considered a last resort after trying other measures.	Curve departure	CMFs vary by site	Medium-term	\$1M-\$3M per mile to reconstruct a rural 2-lane roadway \$4M-\$7M per mile to reconstruct urban 4-lane roadway \$200k-\$500k per mile for an asphalt overlay or mill and fill
ENG-17	Engineering	Install Median/Roadside Barriers (Cable, Guardrail, or Concrete Barriers)	Install or upgrade roadside or median barriers to prevent vehicles from leaving the roadway or crossing into opposing lanes. Barrier types include high-tension cable, W-beam guardrail, and concrete median barrier, selected based on speed, median width, traffic volumes, and hazard types. These systems reduce the severity of roadway departure crashes by redirecting errant vehicles and eliminating the possibility of severe cross-median collisions.	Prioritize for corridors or intersections with run-off-road, fixed-object, rollover, or cross-median crash patterns; divided highways with narrow medians; segments with roadside hazards (slopes, trees, structures); or locations where other roadside mitigation measures are infeasible. Barrier selection depends on median width, roadway speed, truck volumes, sight distance, and available ROW. Ensure proper deflection space, terminal/end-treatment design, drainage accommodation, and clear signing/delineation for nighttime visibility. Cable and guardrail offer more forgiving impacts; concrete is appropriate for narrow medians or high-risk penetrations. Evaluate maintenance needs and coordinate with agencies on preferred barrier standards.	Cross-median, head-on, opposing direction side-swipe	Cable Barriers: Up to 90% reduction in fatal and serious cross-median crashes.  Guardrail (W-Beam): 40–60% reduction in fatal/severe outcomes compared to fixed-object or embankment crashes.  Concrete Barriers: 70–100% reduction in fatal head-on crashes by eliminating cross-median conflicts, though impact severity is higher than flexible systems.	Medium-term	\$150k per mile Cable Barrier \$250k-\$500k per mile Guardrail \$600k+ per mile for Concrete Barrier
ENG-18	Engineering	Improved Pavement Friction	Increase pavement skid resistance through high-friction surface treatments (HFST), diamond grinding, open-graded friction courses, or resurfacing strategies that restore or enhance pavement friction. Intended to reduce wet-weather crashes, run-off-road crashes on curves, and loss-of-control events.	Combine with other horizontal alignment and roadway departure reduction measures. HFST: High effectiveness; moderate cost; most cost effective for spot applications. Grinding/resurfacing: Corridor-level application; moderate unit cost.	Wet-road/curve crashes	63% FSI at ramps 48% FSI at curves (HFST)  20% all crashes  Depends on treatment	Medium-term	\$25-\$50 per sq yd for High Friction Surface Treatment
ENG-19	Engineering	Access management	Plan and control the location, number, and design of driveways, intersections, and median openings to promote the safe and efficient use of the transportation network and support land use goals	Employs access spacing, driveway management, safe turning lanes, median treatments and right-of-way management (ie R/W reservation for future widenings, good sight distance, access location).	Turning/angle and rear end crashes	25–31% FSI 5-23% all crashes	Medium-term	Moderate

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ENG-20	Engineering	Adaptive Signal Control	Install adaptive signal operations to reduce queuing conflicts, improve progression, shorten incident response times, manage speed variability, and discourage aggressive driving on high-crash corridor or intersections.	Reduces rear-end crashes caused by sudden stops and shorten queues that often lead to risky maneuvers and angle collisions. Better progression and predictability also discourage aggressive driving, while quick response to incidents or surges in demand prevents congestion-related conflicts.	Rear-end, angle, ped/bike conflicts	15-20% rear end crashes 5-7% Angle 5-10% (all crash severity) 4-10% (injury crashes) - Alluri et. al	Medium-term	\$50,000-65,000 per intersection including traffic controller, detection, and software
ENG-21	Engineering	Install Turn Lanes at High-Crash Intersections	Add or lengthen exclusive left-turn or right-turn lanes to separate turning vehicles from through traffic, reduce conflict points, improve sight distance, and decrease queuing and rear-end risk. Turn lanes are effective at intersections with heavy turning volumes, operational delays, or patterns of left-turn, rear-end, or angle crashes, and can be applied at both signalized and unsignalized locations.	Turn lane installations may require additional pavement width, minor right-of-way, or drainage adjustments. Designs should consider storage length, taper length, truck movements, sight distance, and pedestrian crossing needs. At rural high-speed locations, combine with lighting, enhanced signing, or geometric improvements. Turn lanes offer a high benefit-cost ratio and can often be added within existing right-of-way during resurfacing or intersection reconstruction projects.	Rear-End, Angle	Left Turn Lane, Unsignalized: 28-48% (total crashes) 30-55% (injury crashes)  Left Turn Lane, Signalized 20-40% reduction in total and injury crashes  Positive Offset Left Turn: 15-35% (FSI crashes)  Right Turn Lanes: 14-26% (total crashes) Unsignalized: 15-35% (injury crashes) Signalized: 10-25% (injury crashes)	Long-term	Cost per turn lane, approximately 250 feet in length  \$15,000 for pavement markings only, no new pavement  \$400k for right turn lane  \$500k-\$800k for left turn lane
ENG-22	Engineering	Protected left-turn Phasing	Install or upgrade to protected left-turn signal phasing (e.g., "green arrow only") to separate left-turn movements from opposing traffic, reduce conflict points, and improve driver decision-making at signalized intersections.	Use at intersections with significant left-turn volumes, poor sight distance, high operating speeds, or a pattern of left-turn or angle crashes. Adjust cycle lengths and coordination as needed to maintain progression, and evaluate pedestrian timing to ensure compatibility with protected-only operations.	Left-turn/angle crashes	33% (left turn crashes)  10-15% all crashes	Short, medium-term	\$1,000-\$5,000 per approach for new signal heads.  \$10,000-\$20,000 per approach if new signal supports are needed  \$150k-\$250k per intersection to rebuild signals  \$3,000-\$5,000 per intersection to retime and program signal
ENG-23	Engineering	Retroreflective Signal Backplates	Add retroreflective borders to traffic signal backplates to enhance signal visibility, increase contrast in both day and nighttime conditions, and improve recognition during power outages or low-visibility situations.	May require new supports due to increased wind load. Low-cost and easily installed on existing signal heads with minimal traffic disruption. Use MUTCD-compliant retroreflective materials and ensure uniform application across corridors to maximize recognition and driver expectancy. Often paired with signal timing adjustments, protected phasing, or lighting upgrades.	Rear-end, angle, red-light running	15% (total crashes)	Short-term	\$100-\$150 per signal head
ENG-24	Engineering	Speed Feedback Signs	Install radar-based speed feedback signs that display a driver's current speed alongside the posted limit to encourage voluntary speed reduction. These signs increase driver awareness, reduce excessive speeding, and support safer operating speeds on corridors, school zones, village centers, and other areas with speed-related crash patterns.	Use on corridors with vulnerable users, school zones, neighborhood streets, and high-risk segments identified through crash or speed studies. Pair with appropriate enforcement or traffic-calming design for greatest effectiveness. Place signs where drivers can clearly see their feedback and approaching context. Rotate or relocate units for maximum impact, integrate with enforcement or traffic-calming measures, and track speed trends for data-driven evaluation.	Speed-related crashes	5-7% (all crashes)	Short, medium-term	\$5,000-\$8,000 per sign
ENG-25	Engineering	Sight Distance Improvements	Improve stopping and intersection sight distance by clearing vegetation, removing or relocating visual obstructions, adjusting grading, realigning curves or intersections, and enhancing visibility of traffic control devices. These treatments help drivers detect hazards earlier, make safer gap-acceptance decisions, and maintain appropriate speeds—especially at curves, intersections, and driveways with limited visibility.	Combine with low-cost systemic upgrades (RPMs, chevrons). Ensure signs, signals, and pedestrian crossings are placed where they are clearly visible at appropriate approach distances. Review driveways, intersections, and curves for sight-line limitations, and coordinate improvements with maintenance crews to keep sight triangles clear over time. Use MUTCD and AASHTO guidelines to confirm required sight distances for prevailing speeds and roadway context.	Angle, Fixed Object	12-58% all crashes (depends on treatment used to improve visibility)	Medium-term	Varies
ENG-26	Engineering	Skewed Intersection Realignment	Realign skewed rural intersections to improve sight distance, simplify turning movements, shorten crossing distances, and reduce angle and turning crash risk.	This treatment typically requires geometric reconstruction, right-of-way adjustments, and utility coordination, making it more capital intensive than operational or signing upgrades. It should be considered only after lower-cost countermeasures—such as enhanced signing, markings, lighting, or speed management—have been implemented and proven insufficient. Designs must evaluate traffic volumes, crash patterns, drainage impacts, and multimodal accommodation to ensure the new alignment provides safer, more intuitive movements for all users.	Angle, Fixed Object	Varies by degree of skew	Long-term	High
ENG-27	Engineering	Enhanced Wet Reflective Pavement Markings	Install wet reflective pavement markings to increase visibility at sites with high night-time and wet weather crash risk. Enhanced wet reflective pavement markings use high-performance beads and durable materials that maintain retroreflectivity during rain and wet-road conditions, significantly improving lane visibility and driver guidance.	Use wet-reflective materials on high-risk sites. Combine with other horizontal alignment and roadway departure reduction measures. Use high-visibility, wet-reflective pavement markings during resurfacing or maintenance cycles to improve lane guidance at night and in wet conditions. Prioritize corridors with a history of roadway-departure, wet-weather, or nighttime crashes, as well as high-speed arterials and rural two-lane highways. Ensure proper bead application, material compatibility, and contractor quality control to maintain performance over time. Coordinate with winter maintenance, resurfacing schedules, and rumble strip programs to ensure long-term durability and consistent retroreflectivity.	Nighttime crashes	Varies by roadway: 13% (injury crashes) 14% (wet road crashes)	Short-term	\$5,000-\$8,000 per mile
ENG-28	Engineering	Barrier Delineators, Reflectors, and Illumination	Install reflective markers, delineators, and targeted lighting on or near roadside and median barriers to improve nighttime and low-visibility detection of barrier edges, curves, and deflection points provide low-visibility guidance along curves, ramps, medians, and roadside barriers.	Prioritize curved segments with elevated roadway departure crashes. Combine with other horizontal alignment and roadway departure reduction measures. Ensure spacing, height, and retroreflectivity comply with MUTCD standards, and replace worn or damaged units regularly. Use higher-intensity or continuous lighting at locations with severe roadway-departure crashes, complex geometry, or limited sight distance.	Fixed-object, Roadway/Lane Departure	Varies by improvement	Short-term	Barrier Reflectors \$1,000-\$5,000 per mile depending on spacing  Lighting \$5,000-\$10,000 per light pole
ENG-29	Engineering	Variable Speed Limits	Changeable signs to adjust speed limits in real time based on traffic, weather, visibility, and roadway conditions.	Establish operating rules and thresholds for when speed changes occur, and ensure coordination with traffic management centers, enforcement partners, and roadway weather sensors. Use consistent sign placement and clear messaging to support driver compliance, and monitor system performance to refine algorithms and verify safety benefits. Pair enforcement with public awareness campaigns and transparent site selection. Variable speed limits work best on corridors with recurring congestion, weather-related crash patterns, or rapidly changing operating conditions.	Speed-related crashes	34% (all crashes) 65% (rear-end crashes) 51% (FSI crashes)	Short, medium-term	\$25,000-\$50,000 for one location  \$500k-\$1M per mile for corridor-wide system

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ENG-30	Engineering	Sign Asset Management	Develop and maintain an inventory of all traffic signs, including location, condition, retroreflectivity, and MUTCD compliance. Use the asset database to schedule replacements, prioritize upgrades on high-risk corridors, and identify missing, damaged, or non-standard signs.	Use sign inventory data to plan improvements. Integrate with crash data to support data-driven safety decisions and ensure consistent, well-maintained signing across the network.	All crash types	10-40% nighttime and low-visibility crashes	Short, medium-term	Low
ENG-31	Engineering	Install Raised Pavement Markers	Install raised pavement markers (RPMs) to enhance nighttime and wet-weather delineation along lane lines, centerlines, and curve approaches. RPMs provide retroreflective, tactile, and audible feedback that improves driver lane-keeping, especially in low-visibility conditions or on dark, rural roadways.	Use RPMs on curves, multilane corridors, rural highways, and locations with frequent nighttime or wet-weather lane-departure crashes. Ensure markers are placed per MUTCD spacing and color requirements, and select durable, snow-plow-resistant products in regions with winter maintenance operations. Combine with high-visibility striping or wet-reflective markings where additional delineation is needed, and maintain regularly to ensure reflectivity and marker retention.	Nighttime, and wet weather crashes	19% (rural crashes) 21% (nighttime crashes) 10.7% FSI principal arterials	Short-term (with planned/ programmed projects) Long-term (stand-alone)	\$2,000-\$10,000 per mile depending on spacing
ENG-32	Engineering	Improved Information Load Design, Reduced Informantion Overload	Improve roadway signs, markings, and decision points by simplifying and sequencing information so drivers receive only what they need, when they need it. This reduces visual clutter and cognitive overload, making it easier for users to understand lane assignments, navigation cues, and upcoming maneuvers—especially at complex intersections and corridor segments.	Apply human-factors principles to streamline signing and markings, reduce clutter, and ensure consistency of symbols, fonts, and colors. Sequence information so drivers receive only what they need when they need it—neither too early nor too late. Use advance guide signs, lane-use arrows, pavement markings, and simplified decision points to reduce mental workload. Limit concurrent visual stimuli, prioritize critical messages to reduce cognitive load and reaction time. Regularly audit corridors for redundant, outdated, or non-compliant signs and remove or consolidate as necessary. Especially useful on complex corridors, multilane intersections, and areas with high crash rates.		10-25% reduction in crashes where decision complexity or unclear cues contribute to driver error.  CMF Clearinghouse CMFs: Removal/relocate unnecessary signage: 10-22%  Improve pavement marking clarity or add lane-use arrows: 10-15% crash reduction	Short-term	Low
ENG-33	Engineering	Roundabout	Replace existing stop-controlled or signalized intersections with a traditional single or multi-lane roundabout to reduce conflict points, lower operating speeds, eliminate severe right-angle and left-turn crashes.  In low-speed urban contexts where footprint is constrained, replace existing all-way or problematic two-way stop intersections with a mini-roundabout to reduce conflict points, lower operating speeds, eliminate severe right-angle and left-turn crashes, and improve safety for all users.	Traditional roundabouts work well in rural, suburban, and urban settings and can accommodate higher speeds, volumes, and multiple lanes. At high-speed rural locations, pair installations with advance warning signs and approach-speed reduction treatments. They offer strong benefit-cost performance, especially at intersections with severe angle crashes or recurring delays, and require public outreach to support driver understanding.  Mini-roundabouts are suited for constrained urban or residential grids where speeds and volumes are already low and right-of-way limits a conventional design. They use a fully traversable central island, a compact footprint, and greater reliance on markings and vertical deflection to manage speeds, with careful consideration of large-vehicle swept paths.	Intersection, right-angle and left-turn crashes	2-way Stop to Roundabout: 82% (FSI crashes)  Signalized to Roundabout: 78% (FSI crashes)  Multilane Roundabout: 28-48% reduction in injury crashes 60-75% reduction in fatal crashes  Mini-Roundabouts (Low-Speed Urban Contexts): 20-40% reduction in injury crashes	Long-term	\$1M-\$2M for single lane roundabout  \$1.5M-\$5M for multi-lane roundabout
ENG-34	Engineering	Reduced Left-Turn Conflict Intersection	Restricted Crossing U-Turn Intersections (RCUTs/RCLs/J-Turns), Median U-Turn Intersections (MUTs/M-Turns), and Directional Median Openings/Partial Conflict Eliminations are innovative intersection designs that remove or restrict direct left-turn and through movements from side streets, instead rerouting those movements to safer U-turn or median turnaround locations. RCUTs prohibit side-street through and left turns at the main intersection; MUTs eliminate left turns by requiring all vehicles to turn right and make a downstream U-turn; and Directional Median Openings allow only selected left-turn movements while prohibiting others to reduce conflict points.	Use when high volumes, high speeds, or severe angle/left-turn crash patterns make traditional full-movement intersections unsafe or inefficient. Evaluate corridor spacing, U-turn locations, median width, signal coordination, and accommodation for trucks and emergency vehicles. Provide clear signing and markings to guide drivers through the alternative movements, and ensure adequate lighting and visibility at U-turn points. Coordinate with access management plans to consolidate or shift driveways as needed, and engage the public early to support understanding and acceptance of the new traffic pattern. RCUTs, MUTs, and directional median openings should be paired with speed management and pedestrian accommodations where multimodal activity is present.	Intersection crashes	MUTs (Median U-Turns): ~25-40% reduction in total crashes ~30-60% reduction in injury crashes  RCUTs (J-Turns): 60-85% reduction in severe crashes Best for high-speed divided highways.	Long-term	\$1M-\$5M per intersection
ENG-35	Engineering	Grade Separated Interchange	Replace an at-grade intersection with a grade-separated interchange—using an overpass/underpass and associated ramps—to eliminate crossing conflicts, separate high-speed traffic streams, and remove the possibility of severe right-angle or left-turn crashes.	Grade-separated interchanges should be used where at-grade intersections can no longer handle traffic volumes, turning movements, or crash patterns. They are appropriate on 45-70 mph corridors with severe angle or left-turn crashes, heavy freight or regional connector demands, or where RCUT/MUT/roundabout alternatives are infeasible. Require significant right-of-way, structures, drainage, and earthwork. Evaluate spacing, ramp configurations (diamond, partial cloverleaf, DDI), and compatibility with surrounding land use and network circulation.	Intersection crashes	30% (injury crashes) 33% (all crashes)	Long-term	Very-High
ENG-36	Engineering	Improved Pavement Maintenance	Remove debris, fix potholes, maintain friction.	Embed into routine maintenance.	Single-vehicle motorcycle crashes	Resurface: 21.3% FSI  Street Condition Poor to Good: 26%	Short-term	Low
ENG-37	Engineering	Motorcycle-Friendly Barriers	Design barrier and barrier retrofits to reduce rider injury severity.	Retrofit high-risk corridors.	Fixed-object/median crashes	Reduces severity of injury	Medium-term	Low
ENG-38	Engineering	Rumble Strips with Motorcycle Gaps	Include motorcycle gaps in center and edgeline rumble strips.	Apply on rural curves/segments.	Roadway/Lane Departure crashes	14-25% reduction	Short-term	Low
ENG-39	Engineering	Transit Signal Priority and Bypass Lanes	Short dedicated lanes at signalized intersections that allow buses to move around queued traffic and reduce delay at bottlenecks. Transit Signal Priority (TSP) equips signals on key transit routes to provide early green, extended green, or reduced red time for approaching buses to improve schedule reliability and reduce conflicts with general traffic.	Pair with transit signal priority.	Transit vehicle crashes	12%-14% (all crashes)	Medium-term	\$8,000-\$35,000 per intersection for Transit Signal Priority  \$400k-\$800k for short bypass lane
ENG-40	Engineering	Bus Stop Location and Improvements	Relocate bus stops in safe locations, such as away from high-speed arterials, that still provide access to destinations arterials. Provide improvements at bus stops to improve safety and convenience of transit riders, such as bike racks, bike shelters, and lighting.	Apply on transit corridors with recurring intersection delay, unreliable schedules, or heavy bus volumes. Evaluate lane width and right-of-way constraints to determine where short queue-jump or bypass lanes can be added with minimal widening. Coordinate TSP with signal timing plans, multimodal safety goals, and transit agency operations to ensure benefits without degrading pedestrian or cross-traffic safety. Monitor before/after operations to adjust timing, and prioritize corridors with high ridership, equity needs, or frequent bus-vehicle conflicts.	Pedestrian, Transit	No known CMF	Medium-Long-term	Moderate
ENG-41	Engineering	Safe Routes to Transit	Conduct corridor walk audits to improve pedestrian access to bus stops and transit stations. Add methods for transit-riders to easily leave feedback on first/last mile challenges.	Prioritize routes with multiple VRU FSI crashes near bus stops.	Pedestrian, Transit	Decision-making tool. No known CMF	Short to Medium-term	Moderate

ENGINEERING COUNTERMEASURES & STRATEGIES

Index	5E Category	Countermeasure Name	Countermeasure Description	Implementation Notes	Main Crash Type Addressed	Crash Reduction (CRF) / Crash Modification (CMF) / Effectiveness	Implementation Timeframe	Cost / Cost Tier
ENG-42	Engineering	Marked (Striped) Bike Lanes	Install or upgrade marked on-street bike lanes using pavement striping to provide dedicated operating space for bicyclists, improve driver expectancy, and reduce conflicts between cyclists and motor vehicles. Striped bike lanes create a more predictable roadway environment and enhance bicyclist positioning, visibility, and comfort on urban and suburban roadways.	Ensure continuous and consistent lane markings along the corridor. Maintain proper lane width and avoid placing lanes within the "door zone" adjacent to on-street parking unless buffered separation is included. Enhance visibility at conflict points using green markings or dashed extensions across intersections and driveways. Pair bike lanes with speed-management and intersection crossing improvements for maximum safety benefit.	Bicycle	30% bicycle crashes	Short-medium	\$20,000-\$23,000 per 1000 linear feet
ENG-43	Engineering	Protected Bike Lanes	Create new or upgrade existing bike lanes to be separated from traffic or protected by a vertical barrier.	Follow Multi-Modal Design Guide and complete streets guidance for where protected bike lanes are most needed.	Bicycle	<u>Separating existing bike lanes</u> 53% (bicycle/vehicle crashes)  <u>New bike lanes on 4-lane roads</u> 49% (total crashes)  <u>New bike lanes on 2-lane roads</u> 30% (total crashes)	Long-term	\$90,000-\$100,000 per 1000 linear feet for flexpost separation  \$250k-\$300k per 1000 linear feet for concrete median separation
ENG-44	Engineering	Separated Two-Way Cycletracks	Construct separated two-way bicycle routes to protect cyclists.	Identify suitable pilot corridors. Combine with resurfacing or other projects.	Bike crashes and sideswipe crashes	<u>Separating existing bike lanes</u> 53% (bicycle/vehicle crashes)  <u>New bike lanes on 4-lane roads</u> 49% (total crashes)  <u>New bike lanes on 2-lane roads</u> 30% (total crashes)	Long-term → High-cost or infrastructure-heavy engineering/EMS efforts (3+ years).	\$160k-\$300k per 1000 linear feet
ENG-45	Engineering	Bike Boxes	Provide advance stop areas for turning bicycles at signalized intersections.	Combine with signals/markings.	Bicycle crashes	No known CMF	Short-term	\$7,500-\$10,000 per approach
ENG-46	Engineering	Bicycle Traffic Signals	Incorporate signals that show timing and phases for cyclists.	Consider leading bicycle intervals as well as bicycle signals.	Bike crashes	No known CMF	Medium-term	\$1,000-\$5,000 per approach for new signal heads.  \$10,000-\$20,000 per approach if new signal supports are needed  \$3,000-\$5,000 per intersection to retime and program signal
ENG-47	Engineering	Bicycle Sight Distance	Design roadway or path visibility to ensure bicyclists can see and react to conditions, obstacles, or conflicts in time to stop or maneuver safely.	Apply where curvature, intersections, or vertical grades limit visibility along bike lanes or shared-use paths. Remove or trim obstructions, improve lighting and contrast, and maintain consistent sight distance through curves, crossings, and transitions to allow bicyclists adequate time to perceive and react safely.	Intersection crashes	No known CMF	Medium-term	Moderate
ENG-48	Engineering	Improved Bicycle Storm Grates	Replace grates with parallel-bar or flush designs to prevent tire trapping and falls.	Simple retrofit, especially when resurfacing.	Single vehicle bicycle crashes	No known CMF	Long-term	\$250-\$500 per grate
ENG-49	Engineering	Bicycle Wayfinding Signs	Place route signage to guide cyclists.	Aids cyclists in finding safe bicycle routes	Wayfinding-related conflicts	No known CMF	Short-term	\$500 per sign
ENG-50	Engineering	Bicycle Facility Maintenance	Remove debris from bicycle lanes to reduce crash risk and encourage cyclists to use them.	Routine sweeping and patching	Bicycle crashes	No known CMF	Short-term	Low
ENG-51	Engineering	LED Lighting	Install or upgrade to LED roadway lighting to improve nighttime visibility for drivers, pedestrians, and bicyclists. LED systems provide higher-quality, more uniform illumination, better color rendering, and improved target visibility compared to legacy lighting. Enhanced lighting reduces the likelihood of nighttime crashes by helping drivers detect hazards earlier and improving pedestrian conspicuity at crossings and conflict points.	Install LED lighting on corridors and intersections with elevated nighttime crash risk or VRU traffic. Coordinate with utility providers and local jurisdictions. Add wet-reflective pavement markings where appropriate.	Angle, Pedestrian	42% (nighttime pedestrian injury crashes) 33-38% (nighttime at intersections) 28% (nighttime on corridors)	Medium-term	\$50,000 per intersection to install new lighting  \$5,000-\$10,000 per light pole  \$200-\$500 per pole to upgrade LED luminaire
ENG-52	Engineering	Close Active Transportation Gaps	Fill sidewalk gaps and develop multi-use paths to facilitate complete trips using active transportation.	Prioritize equity areas, urban centers, and pedestrian trip generators.	Pedestrian, Bicycle	65-89% (pedestrian crashes)	Medium-term	\$190k-\$230k per 1000 linear feet for new concrete sidewalk (5')  \$160k-\$200k per 1000 linear feet for new asphalt share use path (10')
ENG-53	Engineering	School Travel Plan Development	Provide resources to school districts to develop a School Travel Plan that includes ways to improve safety and encourage active transportation to and from school	Provide resources for school districts and cities to develop plans. ODOT also has resources and a template available.	Pedestrian	Increase in walking to school  33% (pedestrian injury crashes for school-age children) 14% (pedestrian injury crashes for all ages)	Short, medium-term	Moderate
ENG-54	Policy/Process	E-Bike, E-Scooter, and Micromobility Zone Policy	Develop a practical, research-based policy for e-bikes, e-scooters, and micromobility devices. Design infrastructure for their safe use.	Build on research, policies from other regions, and micromobility task force.	Pedestrian, Sideswipe	Decision-making tool. No known CMF	Medium, long-term	Low
ENG-55	Engineering	Pedestrian Zones (Pedestrian-Only Areas, Traffic-Calmed Streets, Shared Streets with Priority to Pedestrians)	Designate and implement pedestrian-priority or pedestrian-only zones in downtowns, commercial districts, campuses, or activity centers to eliminate or significantly reduce vehicle-pedestrian conflict points. Treatments may include pedestrian streets, plazas, shared streets with low vehicle speeds, traffic-calmed segments, raised intersections, and restrictions on through-traffic or turning movements. These zones enhance walkability, improve safety, and support economic vitality in high-foot-traffic areas.	Pedestrian zones require clear access management, signage, and curbside management strategies for deliveries, emergency vehicles, and transit. Use high-visibility materials, raised surfaces, lighting, landscaping, and street furniture to reinforce pedestrian priority. Consider time-of-day vehicle restrictions where full closures are not feasible. Pair with gateway treatments, speed management, and crosswalk enhancements on nearby streets to maintain a Safe System environment. Public outreach is essential to coordinate with businesses and community partners. This countermeasure complements EDU-15, which brands areas with safety-related messaging.	Ped fatal/severe injury risk	8.5-13.3% (pedestrian crashes)	Short-term	Very-Low

ENGINEERING COUNTERMEASURES & STRATEGIES

Index	5E Category	Countermeasure Name	Countermeasure Description	Implementation Notes	Main Crash Type Addressed	Crash Reduction (CRF) / Crash Modification (CMF) / Effectiveness	Implementation Timeframe	Cost / Cost Tier
ENG-56	Policy/Process	Speed Limit Reduction	Reduce posted speed limits to align with surrounding land use, pedestrian activity, multimodal needs, and crash risk. Lower limits help decrease impact severity, improve stopping distance, and support safer conditions for vulnerable road users, especially when combined with roadway design features that reinforce lower operating speeds. This strategy is most effective when used in coordination with traffic calming, geometric changes, and targeted enforcement.	In Ohio, lowering a statutory speed limit requires following the procedures established in the Ohio Revised Code and coordinating with ODOT when a roadway is state-maintained. Municipalities, counties, and townships may adjust speed limits on locally controlled streets through local ordinance, provided they comply with state minimums and post the appropriate OMUTCD-compliant signage. Any change on a state route or ODOT-maintained roadway must go through the formal speed-zone study process, which includes submitting a request to the ODOT District, completing an engineering and traffic investigation, and obtaining approval from the Director before installing new signs. This process is typically used on arterials, collectors, and any roadway governed by state authority, while local residential streets, downtown business districts, and school zones may be eligible for reduced limits under locally adopted ordinances. Regardless of jurisdiction, meaningful speed reduction in Ohio is most effective when paired with design or traffic-calming changes that support lower operating speeds.	All	1 mph reduction in operating speed: 5-6% reduction in fatal crashes  Reduce speed limit from 35 to 30: 20-40 % reduction in pedestrian injury crashes.  Speeds from mid 30s/40s (typical urban speeds) to below 25 mph: as much as 50-70% reduction in fatalities.  26% all crashes (major collectors)	Long-term	
ENG-57	Engineering	Extended Pedestrian Clearance Times	Increase walk/flash times for youth and older pedestrians.	Use local walking speed policy (e.g., 3.0 ft/s)	Pedestrian crashes at signals	51% all crashes	Short-term	\$3,000-\$5,000 per intersection
ENG-58	Engineering	Leading Pedestrian Intervals (LPIs)	Make WALK signal appear a few seconds before vehicles see a green light to place the pedestrian in a visible location before vehicles move.	Add where turning conflicts are high. Works best with pedestrian detection.	Pedestrian crashes	13% (pedestrian crashes)	Short-term	\$3,000-\$5,000 per intersection
ENG-59	Engineering	Enhanced Signalized Pedestrian Crossings	Add pedestrian signals with countdown timers, ADA ramps, and marked crossings at signalized intersections.	Use ADA standards at retrofit locations. Prioritize locations where ADA pedestrians frequent.	Pedestrian	Countdown: 19% all crashes  ADA Ramps: 37% all crashes  Marked Crosswalk: 14.6% FSI (all crashes)	Medium-term	\$6,000-\$7,000 for crosswalk enhancements (signs and markings)  \$4,500 per curb ramp
ENG-60	Engineering	Pedestrian Hybrid Beacons (HAWK)	Construct traffic signals that direct traffic to stop by red flashing lights while a pedestrian crosses.	Follow MUTCD spacing and warrant guidance	Pedestrian crashes	55% (pedestrian crashes) 29% (total crashes) 15% (FSI crashes)	Medium-term	\$196k-\$230k
ENG-61	Engineering	Rectangular Rapid Flashing Beacons (RRFB)	Construct high-flash beacons to alert drivers to crossing peds.	Use at uncontrolled crosswalks.	Pedestrian crashes	47% (pedestrian crashes) 98% (yield rate)	Medium-term	\$34,000-\$38,000
ENG-62	Engineering	Medians & Refuge Islands	Provide islands to facilitate two-stage crossings and protection.	Suitable fo multi-lane streets, especially T-intersections or where left turn movements are limited. Can be combined with ENG-28.	Pedestrian crashes	<u>Median with marked crosswalk</u> 46% (pedestrian crashes)  <u>Pedestrian refuge island</u> 56% (pedestrian crashes)	Medium-term	\$57,000-\$64,000

EDUCATION COUNTERMEASURES & STRATEGIES

Index	SE Category	Countermeasure Name	Countermeasure Description	Implementation Notes	Main Crash Type Addressed	Crash Reduction (CRF) / Crash Modification (CMF) / Effectiveness	Implementation Timeframe	Cost
EDU-1	Education	School Safety Patrol Program	A peer-led student program that trains youth to model safe crossing, loading, and travel behaviors to improve pedestrian safety around schools.	Identify and train student leaders; coordinate with school administrators, crossing guards, and bus/loading staff; provide scripts, visual cues, and structured arrival/dismissal procedures; run practice sessions before deployment; reinforce with signage, marked crosswalks, and announcements; include parent outreach, family education materials, and school-wide safety campaigns; evaluate effectiveness using observations of yielding, crossing behavior, and queueing patterns.	Pedestrian crashes	No known CMF	Short-term	Low
EDU-2	Education	Community Safety Ambassadors Program	A resident-led program that trains community members to promote safe speeds, support local safety activities, and act as trusted neighborhood messengers.	Recruit community champions and partner with CBOs; target underserved corridors, schools, and areas with repeated yielding/speed issues; provide ambassador training on pedestrian laws, safe-crossing protocols, and speed-feedback device operation; coordinate with engineering teams to align outreach with quick-build treatments; organize neighborhood walk audits and slow-street demonstrations; supply multilingual materials; structure regular check-ins and debriefs; track behavior changes and community participation.	Pedestrian, bike, and speeding-related crashes	Qualitative improvements in yielding/compliance (no formal CMF)	Short-term	Low
EDU-3	Education	Safety Corridor Branding & Campaigns	Corridor-specific branding and messaging campaigns designed to promote safe speeds and multimodal awareness.	Develop corridor slogans, logos, and visual identity; install branded signs, banners, and pavement decals; coordinate with quick-build pilots, temporary curb extensions, or pop-up crossings; hold outreach events with schools, businesses, and neighborhood groups; integrate speed-monitoring displays, safety pledges, social-media campaigns, and community challenges; monitor changes in yielding, speed compliance, and crash-related behaviors.	Ped/bike conflicts; speeding-related injuries	Qualitative improvements in compliance (no CMF)	Short-term	Low-Moderate
EDU-4	Education	School Safety Patrol Program (Peer-to-Peer)	Peer-training programs where older students model safe crossing, bus loading, and carline behavior for younger students.	Deploy at major arrival/dismissal points; coordinate with school crossing guards and traffic duty staff; incorporate role-playing and structured practice; provide brightly colored vests or identifiers for student mentors; integrate safety education into school assemblies; use signage and floor decals to reinforce consistent behaviors; track improvements through teacher or crossing-guard observation logs.	Pedestrian crashes	No known CMF	Short-term	Low
EDU-5	Education	Traffic Safety Coalitions	Community-led coalitions that conduct walk/bike audits and promote safe speeds, yielding, and micromobility etiquette.	Recruit diverse residents, school staff, public-health partners, and businesses; conduct recurring walk/bike audits to identify behavioral risk factors; partner with law enforcement in a community-oriented, non-punitive role; develop neighborhood safety action plans; coordinate with engineering staff to address quick-fix issues; host community meetings and safety workshops; document conditions with photos and GIS tools; evaluate changes over time.	Behavior-related crash risk factors	No known CMF	Short-term	Moderate
EDU-6	Education	Vulnerable Road User Safety Campaign	Media campaigns that increase driver awareness of pedestrians, cyclists, and transit users.	Integrate with statewide branding (e.g., ODOT "Drive to Live"); use TV, radio, billboards, transit ads, and social media; develop multilingual content; conduct seasonal pushes in high-risk periods (back-to-school, winter darkness); collaborate with schools, transit agencies, and local partners; track impressions, engagement data, and post-campaign awareness surveys.	All	No known CMF	Short, medium-term	Low
EDU-7	Education	Seatbelt Campaign	Media outreach encouraging consistent seatbelt use through reminders, ads, and awareness messaging.	Leverage national campaigns (Click It or Ticket); coordinate with high-visibility enforcement where allowed; target rural and nighttime drivers, teens, and high-risk demographics; use social media, radio, gas-pump ads, and workplace messaging; partner with healthcare and insurance networks; measure effectiveness with observational studies or pre/post behavior surveys.	All motor-vehicle occupant crashes	No known CMF	Short, medium-term	Low
EDU-8	Education	Senior Driver Self Assessment	Provides older drivers voluntary tools to assess vision, cognition, and driving skills.	Partner with healthcare providers, senior centers, and AARP; host assessment events; provide referrals for mobility-alternative resources; offer refresher training annually; provide multilingual checklists and online tools; integrate with local aging-in-place programs; track participation and referral outcomes.	Senior-related crashes	No known CMF	Short-term	Low-Moderate
EDU-9	Education	CarFit Program	Helps seniors adjust their vehicle for safer driving through in-person or virtual CarFit assessments.	Partner with DMV, insurers, hospitals, and senior groups; staff events with certified technicians; schedule regular community fitting days; use senior-center parking lots for easy access; promote through clinics, pharmacies, and aging-network partners; follow up with participants on additional resources; track number of fittings and common issues identified.	Senior-related fit/comfort issues (not crash-specific)	No known CMF	Medium-term	Low
EDU-10	Education	Youth Transportation Education	Educates teen drivers on GDL rules, distraction, impairment, and safe driving practices.	Deliver through DMV, insurers, schools, and healthcare; include interactive modules, videos, and scenario-based discussions; incorporate parental agreements and reinforcement programs; partner with driver-education instructors; include impaired-driving and distracted-driving simulations when possible; track teen and parent participation and knowledge retention.	New driver crashes	Improves compliance & self-regulation (qualitative)	Short-term	Low-Moderate
EDU-11	Education	Child/Booster Seat Education	Programs that distribute, install, and check child safety seats to improve correct use.	Partner with certified child-passenger safety technicians; coordinate with fire departments, WIC centers, clinics, and libraries; host recurring installation/check events; provide bilingual instructions and safety gear; maintain inventory of seats for low-income families; track correct-installation rates and common misuse patterns.	Child occupant injury	52% correct installation vs. 16% without program	Short-term	Low-Moderate
EDU-12	Education	GDL Education for Parents	Trains parents to monitor teen driving using agreements, digital tools, and clear GDL rules.	Implement through DMV or insurance partners; incorporate monitoring apps and parent-teen driving contracts; provide multilingual guides; deliver materials through schools, pediatricians, and PTAs; offer short instructional webinars; track tool download rates and parent feedback.	Teen crashes	No known CMF	Short-term	Low-Moderate
EDU-13	Education	Parental Involvement Campaigns	Provides parents tools and strategies to coach teens on safe driving and GDL compliance.	Include telematics, apps, and geofencing tools; distribute materials via schools, healthcare, and insurance providers; offer culturally responsive content; integrate with teen-driver education nights; provide templates for coaching conversations; evaluate through surveys and teen driving record trends.	Teen crashes	No known CMF	Short-term	Low
EDU-14	Education	Employer Fleet Monitoring	Corporate programs that monitor fatigue, distraction, aggressive driving, and speeding within fleet operations.	Implement telematics for real-time monitoring; provide targeted feedback and coaching; establish employer safety incentives; integrate findings into company safety culture; conduct periodic refresher trainings; track persistent risky behaviors and intervene with additional training or policy actions.	Fleet crashes	No known CMF	Short-term	Moderate
EDU-15	Education	DUI Safety Campaign	Media campaigns that increase awareness of impaired driving risks and promote sober driving.	Coordinate with law enforcement for high-visibility DUI patrols; align messaging with holidays and local events; use multi-platform media including social media, billboards, radio, employer toolkits; integrate with community partners; reinforce with alternative transportation options; monitor message reach through engagement analytics.	Alcohol-related crashes	Up to 13% reduction when paired with High Visibility Enforcement	Short-term	Low-Moderate
EDU-16	Education	Distracted Driving Campaign	Media campaigns addressing dangers of texting, eating, talking on the phone, and other distractions.	Partner with employers and schools to establish no-phone policies; deploy messaging through social media, school newsletters, roadside VMS signs; coordinate with enforcement blitzes; evaluate through pre/post observational studies; use youth ambassadors to reinforce messaging.	Distraction-related crashes	Observable phone use decreases during campaigns	Short-term	Low-Moderate
EDU-17	Education	Aggressive Driving Safety Campaign	Campaigns highlighting dangers of speeding, tailgating, unsafe passing, and road rage.	Use targeted messaging for high-injury corridors; deploy multi-lingual materials; coordinate with regional communications plans; pair with police speed enforcement; include testimonials or victim stories; track speeding reduction through portable radar displays.	All crash types	Indirect	Short-term	Low
EDU-18	Education	Motorcyclist Conspicuity Campaign	Campaigns encouraging use of high-visibility gear by motorcyclists.	Partner with insurers and motorcycle dealerships to distribute visibility gear discounts; collaborate with retailers; incorporate into motorcycle safety courses; run seasonal visibility pushes; highlight crash statistics showing visibility's role in survival; coordinate with driver-awareness campaigns.	Motorcycle crashes	No known CMF	Short-term	Low
EDU-19	Education	Motorcycle Awareness Safety Campaign	Campaigns encouraging drivers to look twice and share the road with motorcyclists.	Integrate with statewide motorcycle safety month; pair with DMV messaging; run bus wrap or billboard campaigns; coordinate with motorcycle clubs; use targeted social media near high-crash corridors; track awareness shifts via surveys.	Multi-vehicle conflicts	No known CMF	Short-term	Low-Moderate
EDU-20	Education	Vulnerable Road User Conspicuity Campaign	Campaigns promoting nighttime visibility tools for walkers and cyclists.	Distribute reflective gear at community events; partner with schools, senior centers, and retailers; target locations with nighttime crash patterns; collaborate with public health agencies; integrate with Safe Routes programs; reinforce with pedestrian safety enforcement.	Night pedestrian crashes	No known CMF	Short-term	Low
EDU-21	Education	Walking/Biking School Buses	Adult-supervised walking groups promoting safe, active school travel.	Recruit volunteers; train supervisors in crossing safety; map safe walking routes; coordinate with Safe Routes to School; communicate schedules with families; rotate volunteers; incorporate walking audits; evaluate participation rates; track perceived safety improvements.	Child pedestrian exposure	No known CMF	Short-term	Low

EDUCATION COUNTERMEASURES & STRATEGIES

Index	5E Category	Countermeasure Name	Countermeasure Description	Implementation Notes	Main Crash Type Addressed	Crash Reduction (CRF) / Crash Modification (CMF) / Effectiveness	Implementation Timeframe	Cost
EDU-22	Education	Senior Pedestrian Safety	Targeted pedestrian improvements and education for senior populations.	Conduct senior pedestrian audits; install refuge islands and high-visibility crosswalks; increase sign text size; provide education through senior centers and healthcare; partner with AARP; prioritize corridors with senior crash histories; combine engineering, education, and enforcement.	Pedestrian, turning crashes	Combination of other countermeasures	Short-term	Medium
EDU-23	Education	Transit Rider Education Program	Education for transit users and motorists about safe boarding, alighting, and bus stop awareness.	Develop training videos and on-board messaging; incorporate into bus operator announcements; deploy safety ambassadors at busy stops; partner with transit agencies for cross-promotion; create printed materials in multiple languages; pair with engineering upgrades at stops.	Transit-related crashes	No known CMF	Short-term	Low
EDU-24	Education	Transit Operator Training	Provide defensive driving, ped/bike awareness, and conflict avoidance training for bus operators.	Require annual refresher training; include on-road coaching; use simulators for hazard recognition; integrate crash data trends into curriculum; coordinate with union leadership; track operator safety performance; include pedestrian right-of-way modules.	Bus-ped/bike crashes	No known CMF	Short-term	Moderate
EDU-25	Education	Cyclist Safety Education	Train cyclists and motorists on safe riding and driving practices around bicycles.	Integrate programs into schools and workplaces; conduct bike rodeos and hands-on training; coordinate with police bike units; reinforce with bike lights and helmet giveaways; promote through social media and community partners; evaluate with before/after surveys.	Bike-motor conflicts	No known CMF	Short-term	Low
EDU-26	Education	Free Helmet Program	Distribute free or discounted helmets with training on correct fit and usage.	Partner with fire departments, hospitals, local retailers, and schools; prioritize low-income areas; conduct helmet-fitting workshops; integrate with Safe Routes to School programs; track helmet distribution numbers; evaluate observed helmet use rates.	Bicycle crashes	Reduces head injury risk by 48–85%	Short-term	Low

ENFORCEMENT COUNTERMEASURES & STRATEGIES

Index	5E Category	Countermeasure Name	Countermeasure Description	Implementation Notes	Main Crash Type Addressed	Crash Reduction (CRF) / Crash Modification (CMF) / Effectiveness	Implementation Timeframe	Cost
ENF-1	Enforcement	Targeted High-Injury Network Corridor Patrols	Provide and focus patrols on high-injury network corridors using updated crash data.	Coordinate with local PDs, sheriffs, county engineers.	Rear-end, Angle, Pedestrian	Evidence-based targeting—improves enforcement presence where severe crashes are concentrated.	Short-term (≤1 year)	Moderate
ENF-2	Enforcement	Police Officer Community Involvement	Engage police with the community through presence at schools and gathering places to build trust and safety awareness.	Useful as a supplement to education programs; improves compliance through visibility and community relationships.	All (VRU emphasis)	Qualitative benefits; no CMF.	Short-term	Low
ENF-3	Enforcement	Enforce Distracted Driving Laws	Increase patrols and citations for handheld device use and other forms of distracted driving. Consider using automated technologies to enhance enforcement.	Establish legal authority for automated enforcement; some communities begin with warning periods; coordinate with EDU-4 distracted-driving campaigns for max effectiveness.	Distraction-related crashes; rear-end & sideswipe collisions	32-57% reduction in handheld cellphone use	Short-term	Low
ENF-4	Enforcement	Enforce Impaired Driving Laws	Conduct sobriety checkpoints and saturation patrols during high-risk periods to deter impaired driving.	Coordinate with education campaigns; deploy during peak crash periods; use publicized enforcement for deterrence.	DUI crashes	Sobriety Checkpoints: 9% (alcohol-fatal), 17% (alcohol crashes), 10-15% (all crashes). Saturation Patrols: 18% (alcohol-fatalities).	Short-term (≤1 year)	Low
ENF-5	Enforcement	Collaborative Rural Enforcement	Create shared enforcement zones between small towns/counties to address speeding and impaired driving.	Requires county-level coordination, shared staffing/funding, unified enforcement planning.	All speeding-related crashes	Moderate impact; improves enforcement coverage in resource-limited rural areas.	Short-term (≤1 year)	Low
ENF-6	Enforcement	Automated Red-Light Enforcement	Install red-light cameras at high-violation intersections to reduce right-angle crashes.	Ensure legal authority; standardize clearance intervals to ITE guidelines; may begin with warnings.	Right-angle (signalized) crashes	Typical injury crash reduction: 20-25%	Short-term	\$60,000 - \$150,000 per intersection for installation; more for operations, data storage, maintenance, and ticket processing
ENF-7	Enforcement	Automated Speed Cameras	Deploy fixed, mobile, or point-to-point speed cameras on high-injury corridors.	Ensure legal process; coordination with police; warnings may be used initially; use high-visibility signage.	Pedestrian, Rear-end, Speed-related crashes	Fixed units: 54% (all), 47% (injury) Point-to-Point: 37% (FSI) Mobile: 20% (FSI)	Short-term (≤1 year)	\$30,000 - \$60,000 per location for installation; more for operations, data storage, maintenance, and ticket processing
ENF-8	Enforcement	Enforce Bicycle Passing Laws	Enforce 3-foot passing laws in high-bike areas to reduce motorist-bicycle conflicts.	Pair with education campaigns and engineering treatments (bike lanes, signage).	Bicycle crashes	No known CMF; improves driver compliance and reduces conflict severity.	Short-term	Moderate
ENF-9	Enforcement	Increased School Zone & Stop-for-Bus Enforcement	Increase enforcement presence in school zones and around bus stops.	Align with SRTS; enhance vertical pedestrian lighting; reinforce yielding expectations.	Speeding & pedestrian crashes near schools	Yielding increases 10-50%, sustained up to 10%.	Short-term	Moderate
ENF-10	Enforcement	Yield to Pedestrian Enforcement	Conduct targeted crosswalk enforcement at high-visibility crossings with enhanced treatments (RRFBs, markings).	Coordinate with engineering upgrades; pair with public notice campaigns.	Pedestrian crashes	Yielding increases 10-50%, sustained to 10%.	Short-term	

EMERGENCY SERVICES & POST-CRASH CARE COUNTERMEASURES & STRATEGIES

Index	5E Category	Countermeasure Name	Countermeasure Description	Implementation Notes	Main Crash Type Addressed	Crash Reduction (CRF) / Crash Modification (CMF) / Effectiveness	Implementation Timeframe	Cost
EMS-1	Emergency Response	Coordinate Emergency Response Across County Lines	Improve cross-jurisdictional communication, dispatch, and resource sharing to speed response and ensure the closest appropriate unit responds to a crash.	Establish mutual-aid agreements, shared radio channels, interoperable CAD/dispatch systems, unified staging protocols, and regional SOPs; conduct joint training and after-action reviews.	Rural and suburban severe crashes, delayed-response incidents	Regional coordination reduces response time variability and improves survival for rural/long-distance EMS events.	Long-term → High-cost or infrastructure-heavy engineering/EMS efforts (3 + years).	Medium
EMS-2	Emergency Response	Rural Response Times	Reduce EMS response and transport times in rural or underserved areas by improving access, deployment, and resource availability.	Expand ALS/BLS coverage, support volunteer EMS staffing, add strategically located stations/vehicles, use air medical when appropriate, implement AVL-enabled dynamic deployment, and coordinate with trauma centers.	Rural severe injury crashes, long-distance transport incidents	Faster response/transport times are strongly correlated with reduced fatality risk in rural trauma; access to air medical reduces time-to-definitive care.	Medium-term	Moderate-High
EMS-3	Emergency Response	Multi-Agency EMS Coordination	Strengthen coordination among EMS, fire, law enforcement, towing/recovery, and dispatch to improve scene management and reduce clearance time.	Use unified command principles, interoperable communications, joint training/drills, standard scene-management protocols, coordinated traffic control, and integrated after-action reviews.	Crash scenes with complex multi-agency operations; secondary crashes	TIM programs show 30–50% reductions in incident clearance times when multi-agency coordination is formalized.	Medium-term	Moderate
EMS-4	Emergency Response	Air-Medical (Helicopter) Coordination Protocols	Formalize helicopter EMS staging, dispatch, and landing-zone procedures to ensure rapid air-medical response for severe crashes and rural areas.	Coordinate with trauma centers, designate landing zones, update dispatch protocols, and track time-to-treatment metrics.	Severe injury / entrapment	Reduces time-to-treatment and fatality risk for rural trauma by improving rapid access to advanced care.	Long-term	High
EMS-5	Emergency Response	Optimized Trauma Transportation	Ensure crash victims are routed to the correct trauma center quickly through standardized triage and transport procedures.	Map trauma center catchments, establish EMS bypass protocols, and monitor time-to-treatment performance.	Injured crash victims	Reduces severe injury mortality by improving triage accuracy and shortening transport time.	Long-term	High
EMS-6	Emergency Response	Responder Fatigue Management	Implement systems that manage fatigue, stress, and workload to protect responder judgment, safety, and performance.	Adopt shift-length policies, mental-health supports, peer programs, and fatigue-risk management tools.	Responder-involved incidents	Reduces responder errors and secondary crash risk associated with fatigue-related impaired decision-making.	Short-term	Low-Moderate
EMS-7	Emergency Response	First Responder Visibility	Improve responder visibility at crash scenes through high-visibility PPE, vehicle lighting, and scene illumination to prevent struck-by crashes.	Use portable lighting kits, define traffic control zones, train responders on visibility practices, upgrade PPE and lighting packages; coordinate with law enforcement and DOT for temporary traffic control.	Crash scenes; responder incidents	High-visibility gear can reduce struck-by crashes by up to 47% in low-light conditions; improved scene lighting reduces approach-speed uncertainty.	Short-term	Low-Moderate
EMS-8	Emergency Response	Emergency Response Drills	Conduct recurring multi-agency training exercises to strengthen coordination, reduce scene time, and improve responder safety.	Hold quarterly drills, after-action reviews, and incorporate findings into ongoing responder training.	Secondary incidents; responder strikes	Improves clearance time and reduces incident secondary crashes by 10–25% when TIM practices are standardized.	Medium-term	Moderate
EMS-9	Emergency Response	Roadside Safety Patrols	Deploy highway safety patrols to quickly remove hazards, assist motorists, and keep travel lanes open for emergency responders.	Establish patrol routes, coordinate with DOT/EMS, share incident data, and track clearance times.	Crash scenes + secondary crashes	Proven to reduce secondary crashes by 11–20% and decrease average incident duration by 15–30%.	Medium-term	Moderate
EMS-10	Emergency Response Education	Citizen Crash Response	Train community volunteers to provide safe, basic assistance during crashes until EMS arrives, improving scene awareness and reducing risk.	Provide structured training, define volunteer protocols, supply visibility gear, coordinate with EMS/fire, and partner with trauma networks for outreach.	Severe trauma crashes	Early bystander assistance reduces critical care delay, CPR/bleeding-control programs shown to reduce mortality for time-sensitive trauma.	Short-term	Low-Moderate
EMS-11	Emergency Response	Modernize EMS Equipment	Upgrade EMS medical devices, extrication tools, and vehicle telematics to improve assessment, rescue operations, and communication.	Provide training, coordinate with fire/police/towing agencies, prioritize upgrades in high-risk or low-resource areas, and align needs with emergency plans and funding strategies.	High-speed roadway departures, rollovers, angle crashes, entrapped occupants	Modern extrication tools reduce rescue time 20–50%; advanced monitoring improves early trauma decision-making and survivability.	Long-term	High

EVALUATION COUNTERMEASURES & STRATEGIES

Index	5E Category	Countermeasure Name	Countermeasure Description	Implementation Notes	Main Crash Type Addressed	Crash Reduction (CRF) / Crash Modification (CMF) / Effectiveness	Implementation Timeframe	Cost
EVA-1	Evaluation	Comprehensive Safety Dashboard	Consolidates crash, roadway, demographic, and project data into an interactive platform for monitoring safety performance, hotspot detection, equity analysis, and progress tracking.	Publish dashboard with HIN, EMS, crash, roadway, and project data; refresh annually; use for RSA targeting and systemic investment decisions.	Systemic severe crash concentrations	Improves targeting and transparency; track annual KSI rate change.	Short-term	Low-Moderate
EVA-2	Evaluation	Biennial Safety Policy Review Task Force	Establishes a cross-agency team that regularly reviews and aligns safety policies, standards, and practices with Vision Zero/SS4A principles and current crash trends.	Include engineering, planning, EMS, enforcement, schools, transit, and public health; track policy outcomes; use data-driven findings to identify gaps and align practices with SHSP and proven countermeasures.	Policy/process safety gaps	Improves consistency with best practices across agencies; enhances safety alignment.	Medium-term	Moderate
EVA-3	Evaluation	Kinetic Energy Crash Evaluation	Analyzes crashes using kinetic energy, survivability thresholds, and conflict severity to support design decisions and countermeasure selection.	Use FHWA Safe System-Based Intersection Framework; analyze $\Delta V$ , impact angle; evaluate roundabouts, protected turns, and raised intersections for energy mitigation; integrate into planning and prioritization.	Angle, left-turn, pedestrian/bicycle, rear-end	Decision-support tool; no known CMF; improves selection of energy-reducing designs.	Medium-term	Very Low
EVA-4	Evaluation	AI-Based Conflict Analytics	Uses AI-enabled video analytics to detect, classify, and analyze near-miss conflicts and multimodal behavior to guide design refinement and safety investments.	Use for systemic screening and before-after studies; ensure consistent data collection periods; integrate with cameras or portable units; coordinate with IT for data security and storage.	Crossing/turn conflicts; near-misses	Decision-support tool; no known CMF; improves early detection of conflict trends.	Medium-term	Low-Moderate
EVA-5	Evaluation	Context-Based Intersection Evaluation and Design Optimization	Redesigns intersections by matching geometry, control, crossing treatments, and speed environment with land use and multimodal context using tools like ICE and CAP-X.	Apply in planning and early design; incorporate geometric features, curvature, and speed cues; coordinate with safety and multimodal design teams to ensure consistency between form, function, and user expectations.	High-angle and crossing conflicts; pedestrian/bicycle impacts	10-30% network-level reduction possible depending on selected intersection type and design consistency.	Short-term	Very Low
EVA-6	Evaluation	Community Assessment Project Prioritization	Applies equity-focused weighting factors so safety projects in high-poverty or disadvantaged census tracts advance more consistently.	Align with ODOT/SS4A criteria; use factors such as severe crash density, exposure risk, CDC SVI, Justice40; implement transparent scoring that elevates under-served areas.	All	N/A	Short-term	Very Low
EVA-7	Evaluation	Safety-Weighted Project Scoring	Revises funding prioritization to emphasize crash history, risk exposure, VRU needs, equity, and Safe System alignment in capital programming.	Integrate into TIP/STBG/TASA scoring; apply consistent criteria across corridors and jurisdictions; use in grant applications, capital plans, and safety programming.	All	N/A	Short-term	Very Low