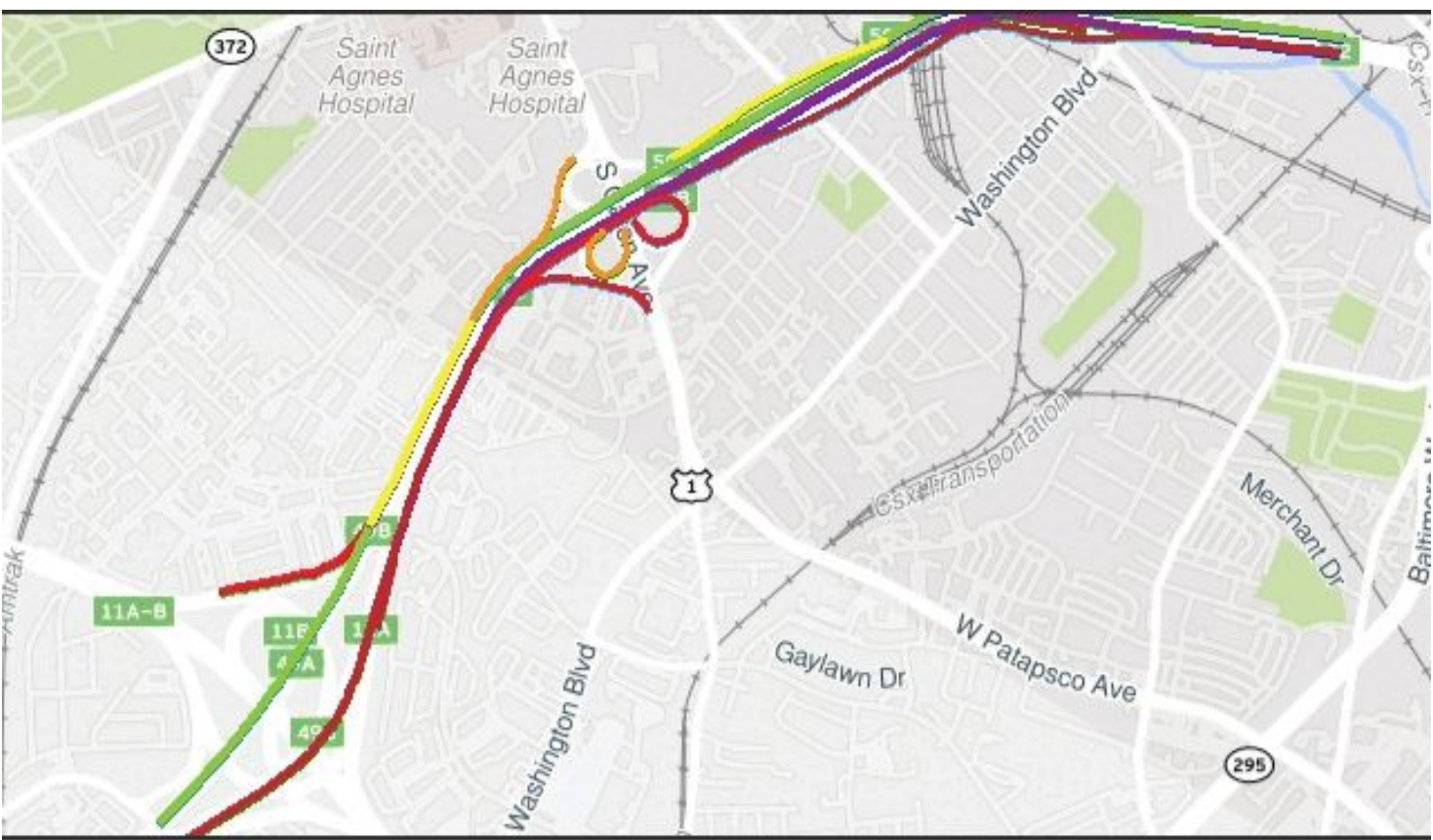


Problem Definition

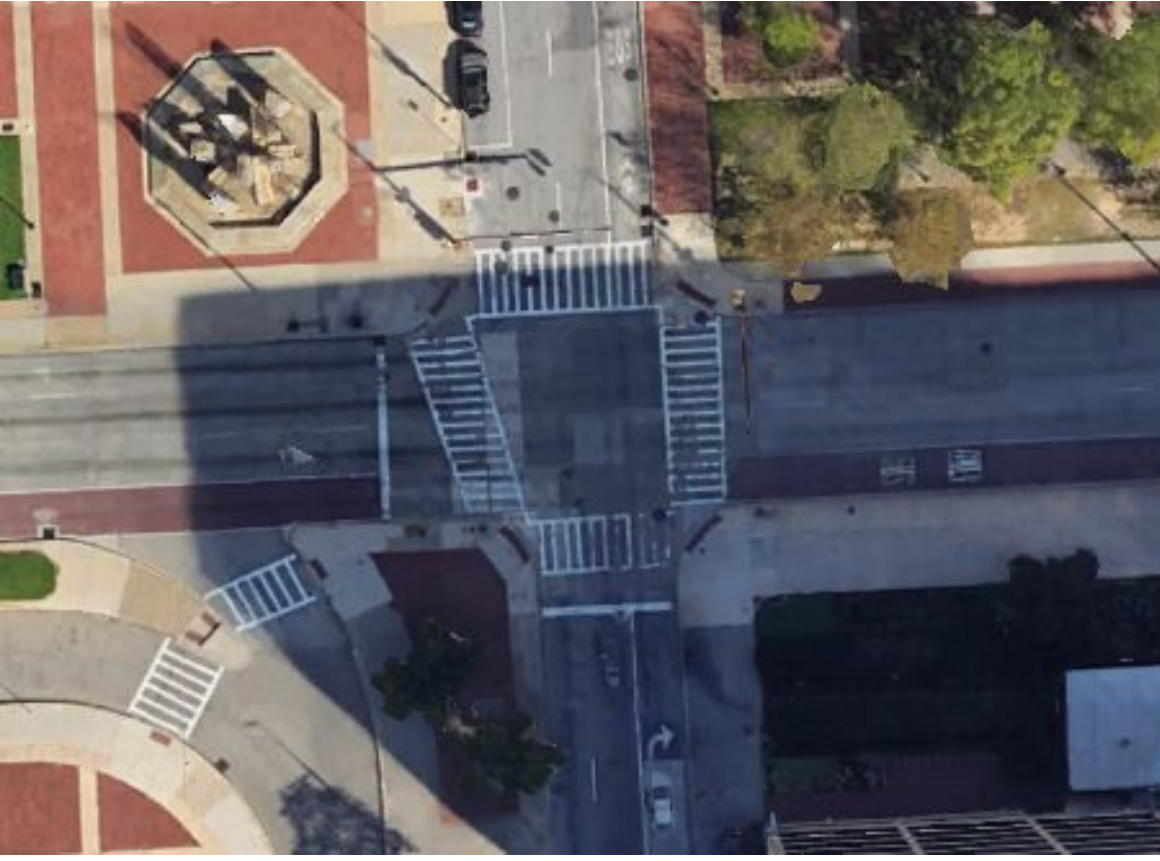
The Francis Scott Key Bridge provided an integral crossing through Baltimore into D.C. As a result of its collapse, daily commuters have been forced to take alternative routes, causing increased levels of traffic congestion, collision rates, and risk to pedestrian safety. Upon analysis of the impacts along three major interstates, I-95 demonstrated high levels of bottleneck locations and collision rates. The study focuses on achieving solutions along a 5 mile stretch of I-95 as well as a busy intersection in downtown Baltimore.



Alternative routes sought out along I-895, I-95, and I-695



Congestion along I-95N and I-95S during afternoon rush hour



Intersection along Pratt St. and Charles St. in downtown Baltimore, Site for Pedestrian Safety Study

Objectives

As a response to pending construction of the Francis Scott Key bridge, project goals include:

- Reducing traffic congestion along bottleneck points of I-95 by 30%
- Reducing crash rates along five miles of I-95 by 30%
- Improving pedestrian safety within city roads by reducing pedestrian crashes and near misses by 30%
- Implement community feedback after conducting a survey on public opinion

Data Collection

Date Range	Bottleneck Location	Volume (Veh)	Tr Road
3/1/24 - 3/25/24	I-695, MD-372 Wilkens Ave, Exit 12	103931	I-695
	I-95 S @ I-95 Exit 46	101539	I-95
	I-95 N, US-1 Alt Caton Ave Exit 50	97167	I-895
4/1/24-4/15/24	I-695, CCW, @ Edmonston Ave Exit 14	106178	I-695
	I-95 N, US-1 Alt Caton Ave Exit 50	100319	I-95
	I-895 S @ I-95 Exit 46	90295	I-895
7/1/24-7/15/24	I-695 CCW, US-40 Exit 15	102669	I-695
	I-95 N @ US-1, Alt Caton Ave Exit 50	96374	I-95
	I-895 S @ I-95/62nd St Exit 62	55268	I-895
10/1/24 - 10/15/24	I-695 CCW @ MD-144 Frederick Road Ex	103559	I-695
	I-95 N @ US-1, Alt Caton Ave, Exit 50	96,658	I-95
	I-895 N @ Holladay Ave Exit 10	35163	I-895
11/1/25 - 11/15/25	I-695, CCW, @ US-1 Southernview Blv Ex	104138	I-695
	I-95 N @ US-1, Alt Caton Ave, Exit 50	99421	I-95
	I-895 @ Moreau Road Exit 14	39350	I-895

Congestion Data along I-895, I-695, and I-95

Day 1	Total Bike	Total Scooter	Total Jaywalk	Day 3	Total Bike	Total Scooter	Total Jaywalk
	26	25	44	Compliant	31	32	25
	31	13		Obstinate	10	15	
Total	57	38		Total	41	47	
Percent jaywalk	54.386	34.211		Percent jaywalk	24.390	31.915	
Percent Jay-walking Pedestrians:		32.10%		Percent Jay-walking Pedestrians:		30.70%	

Day 2	Total Bike	Total Scooter	Total Jaywalk
Compliant	33	27	13
Obstinate	6	7	
Total	39	34	
Percent jaywalk	15.385	20.588	
Percent Jay-walking Pedestrians:		33.00%	

	Bike	Scooter	Jaywalk
Final Total	137	119	82
Percentage Jaywalking			0.32

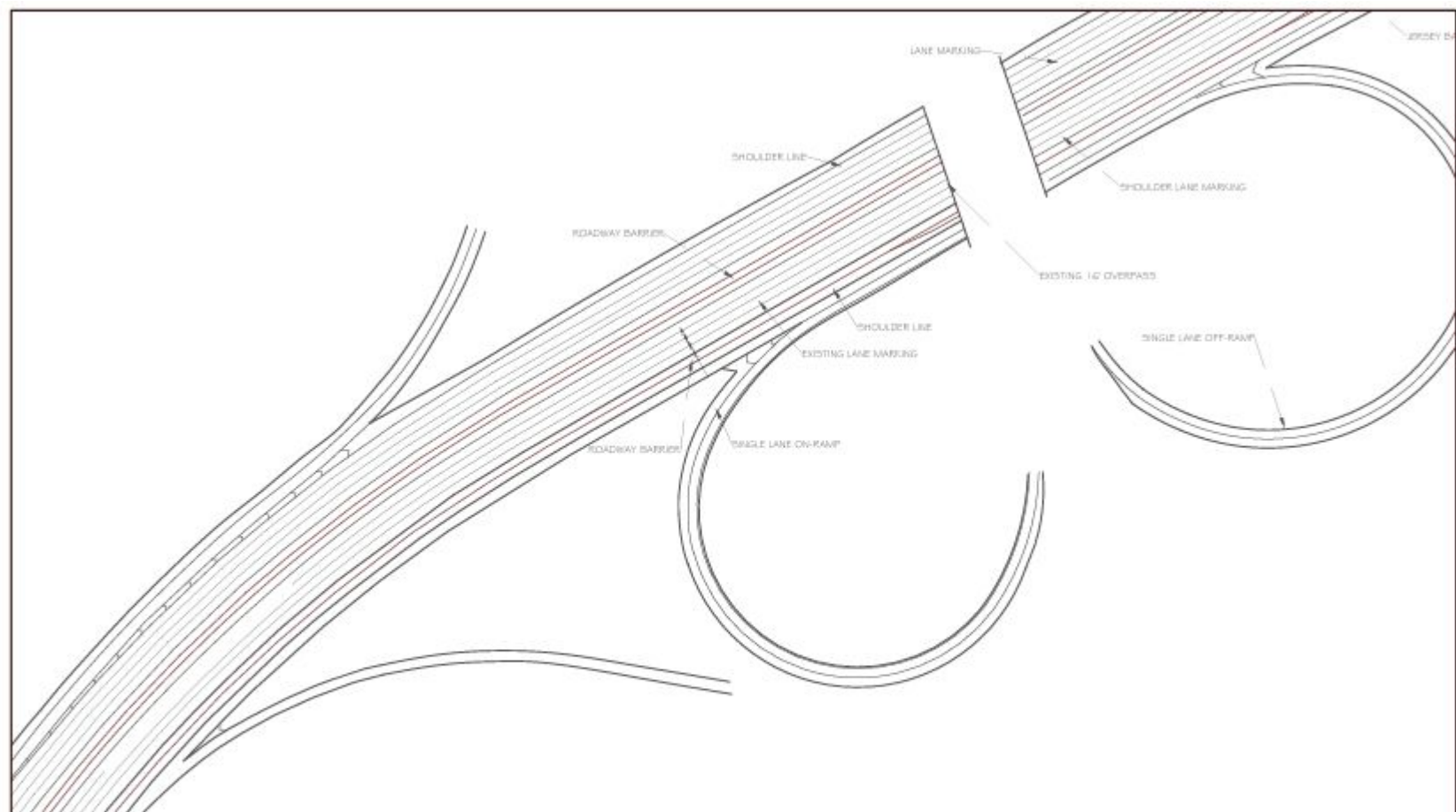
Pedestrian Safety Data along Pratt St. and Charles St. Intersection



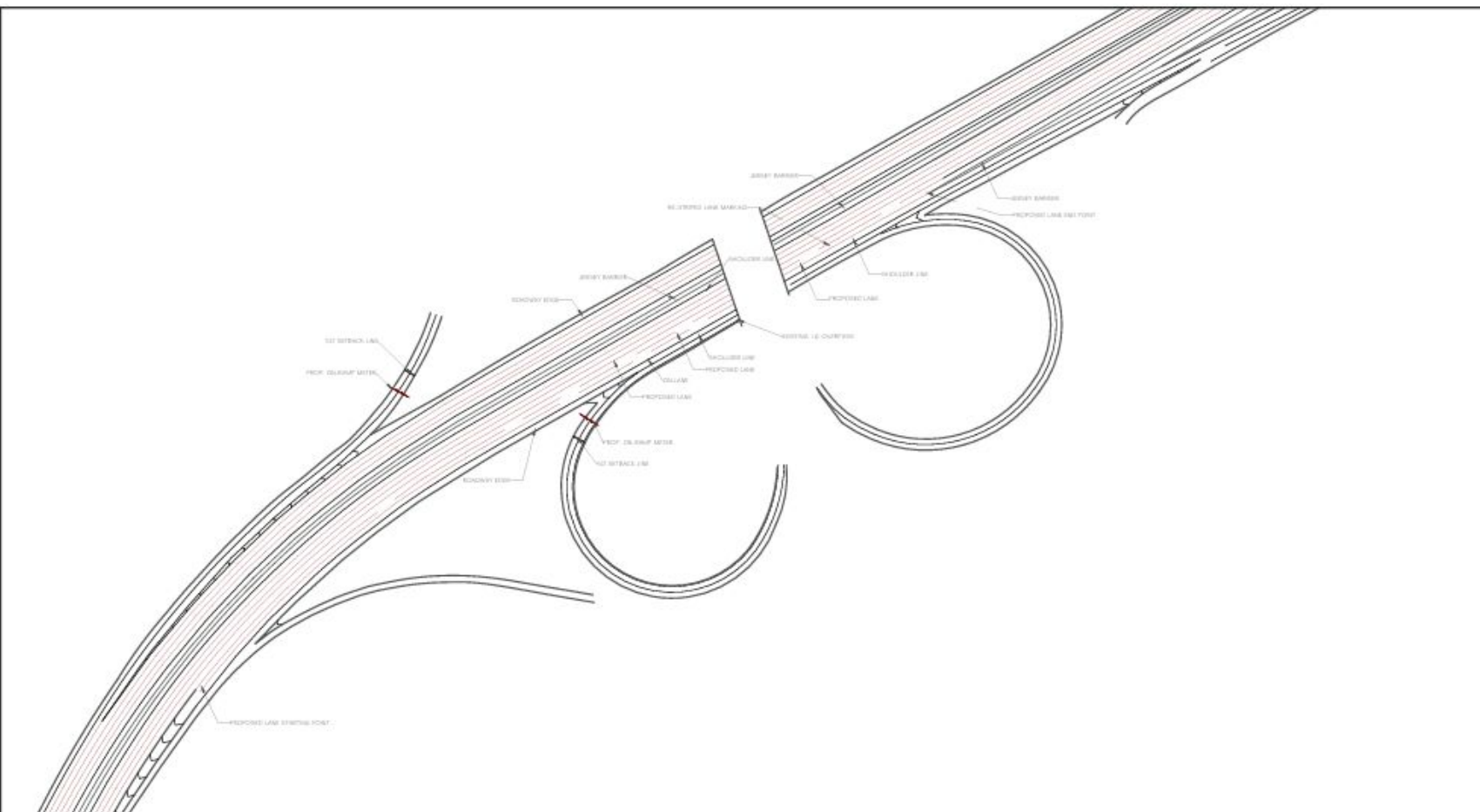
VISSIM Simulation

Proposed Solutions

- Implement work from home initiatives, reducing daily vehicle volume by 15%
- Open up toll roads on I-895 to redirect traffic from I-95

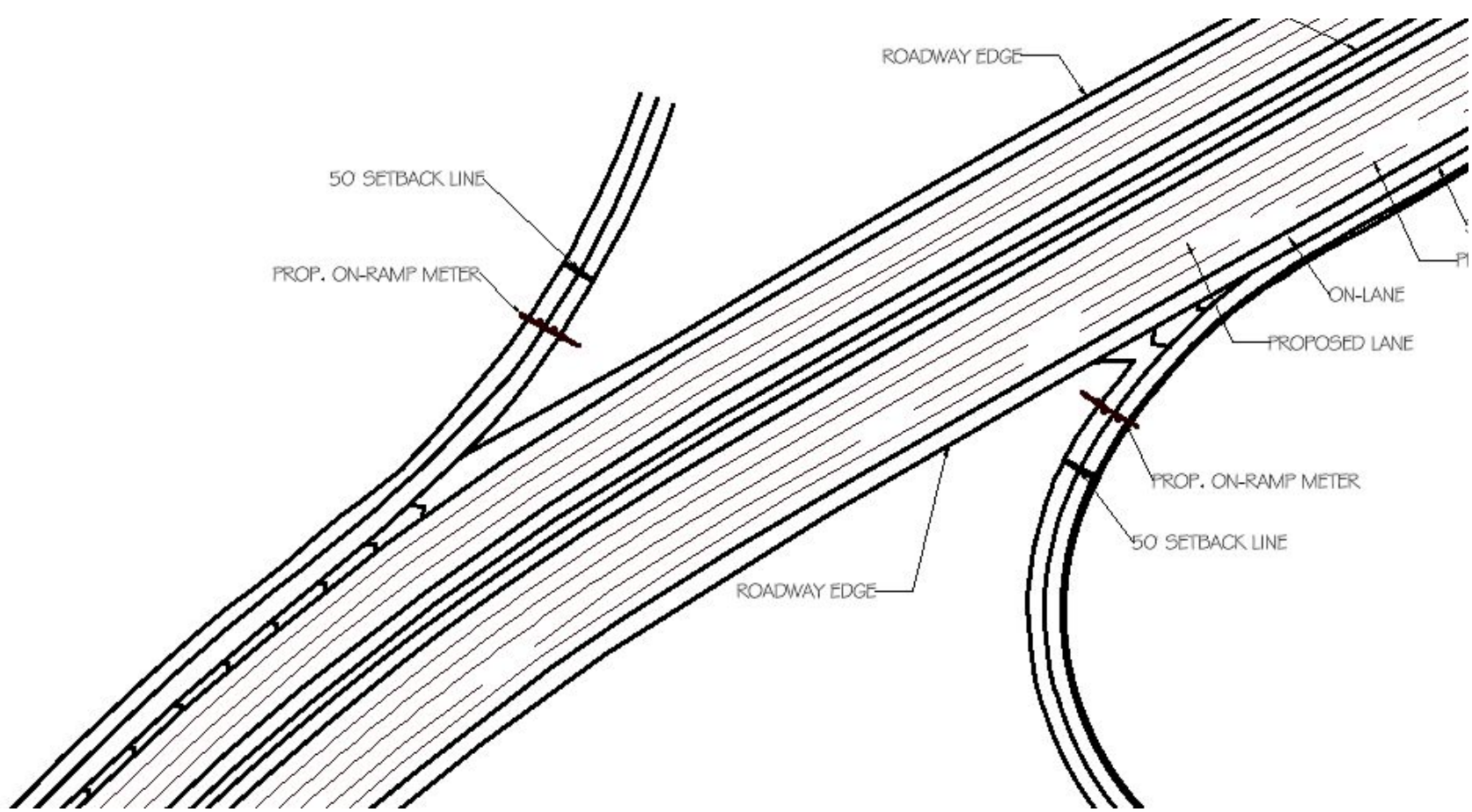


Existing Conditions



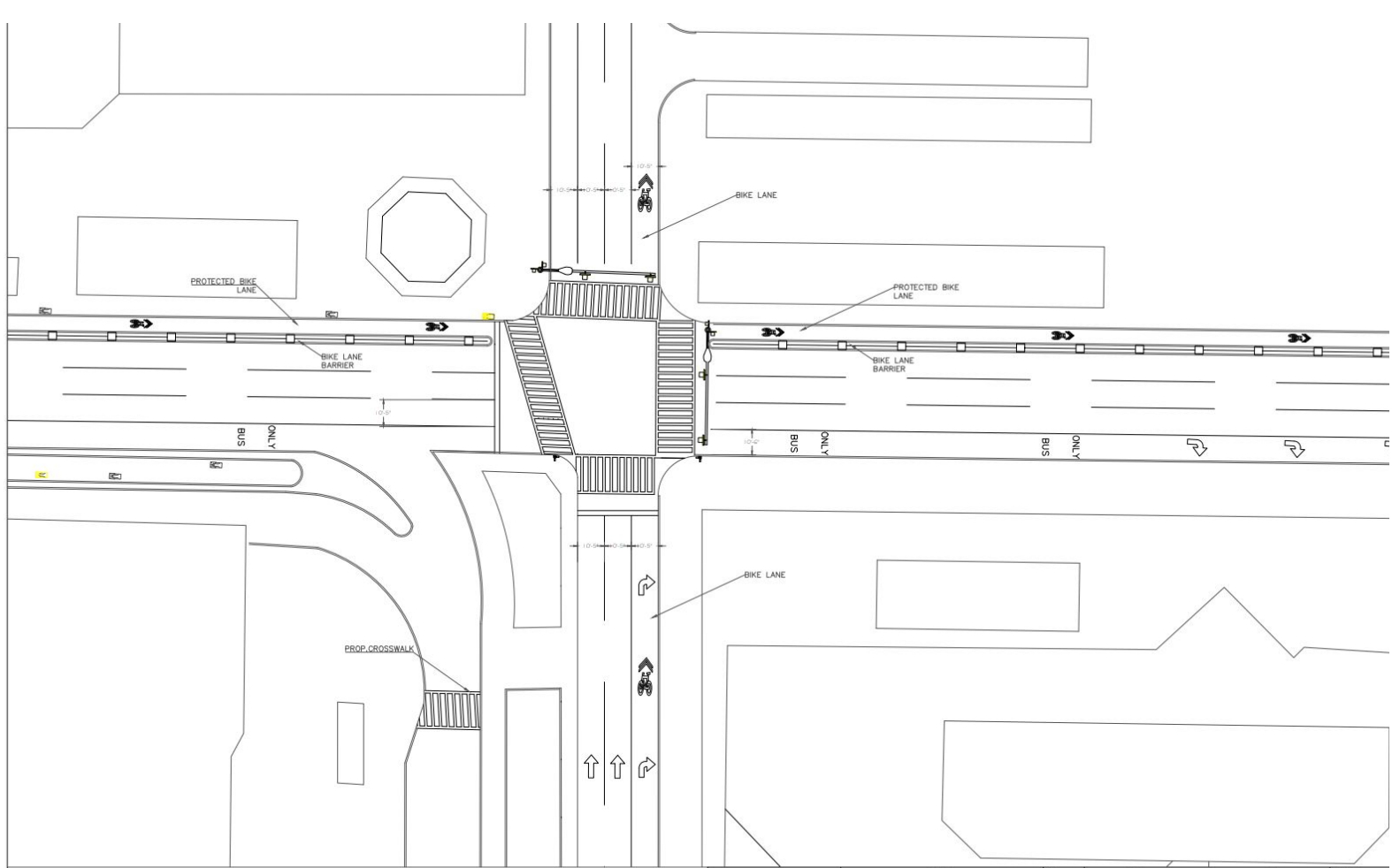
Proposed Solution

- Remove jersey barrier along ½ mile stretch of bottleneck location on I-95 North



On-Ramp Implementation

- Implement On-Ramp Metering along North and South Corridors



West Pratt Street Design Implementations

As part of the responses received in our survey reaching out to community members commuting through Baltimore, the first implemented solution reduces vehicle volume by encouraging work from home initiatives. Additional responses from a survey conducted by Yang et.al found that commuters would also prefer to take toll roads if the toll were eliminated. With the combination of all four solutions, the simulated results demonstrated reduced congestion.. Based on observed pedestrian behavior, implemented solutions for pedestrian safety include protected bike lanes throughout inner city roads. Additionally, at the West Pratt St. and Charles St. intersection, a proposed relocation of a crosswalk reduces congestion on the road caused by entering vehicles yielding to pedestrians

Cost Estimate

Installation & Construction Costs	Cost for a 1 lane on-ramp	Total cost for all on-ramps (7)	Payback Pe
Ramp meter hardware	\$50,000 - \$75,000	\$350,000 - \$525,000	5 months
Freeway Sensors	\$6,500	\$45,500	
End-of-Queue sensors	\$100	\$700	
Software and system integration	\$200,000	\$1,400,000	
Total =	\$256,600 - \$281,600	\$1,796,200 - \$1,971,200	

On-going Costs	Cost for a 1 lane on-ramp	Total cost for all on-ramps (7)	Payback Pe
Maintenance	\$1,000 - \$3,000	\$7,000 - \$21,000	5 months
Operating Costs	\$3,195	\$22,365	
Staffing	\$17,825	\$124,775	
Traffic signal retiming (every 3-5 years)	\$1,000 - \$8,000	\$7,000 - \$56,000	
Total =	\$23,020 - \$32,020	\$161,140 - \$224,140	

Total cost = \$1,957,340 - \$2,195,340

Demo	Unit	# of units	\$/unit	Cost
Dump Truck	Each	1	4850	4850
Jersey Wall Clamp	Each	1	285	285
Boom Truck	Each	1	3310	3310
Concrete Barrier	Foot	2640	18	47520
Labor	Hour	300	20	6000
				\$61,965.00
Restriping Crew				
Striping Foreman	hour	24	65	1560
Striping Machine Operator	hour	24	55	1320
Laborers	hour	120	40	4800
Traffic Control Supervisor	hour	24	50	1200
Flaggers	hour	48	25	1200
				\$10,080.00
Restriping Equipment				
Striping Truck	day	3	750	2250
Support Truck	day	3	200	600
Arrow Board Truck	day	3	500	1500
Traffic Control Devices	each	1	300	300
Pre-Marking Tools	each	1	200	200
Paint	gal	50	15	750
Glass Bead Dispenser	lb	250	0.5	125
				\$5,725.00
Total Cost:				\$165,620.00
				\$180,590.00

The following cost estimates covers the installation and construction process, as well as ongoing costs for our two solutions: the first being the installation of ramp meters and the second being the removal of the jersey barrier and restriping of lanes

Conclusion

Based on the results of our simulation and cost analysis, our proposed solution for the five mile stretch of I-95 provides a feasible relief in congestion as well as reduction in crash rates. The average travel speed was increased from 18mph on average during peak rush hour, to a flow of 35mph with the implemented solutions. While queue lengths increased along the stretch of the metered on-ramps, the overall flow of traffic on the interstate remained steady. With a project construction cost of approximately \$2 million as well as ongoing costs of \$400,000, the proposed improvements provide a feasible solution to reduce the impacts of the Key Bridge collapse