

CR 9 (Beekman Rd) Safety Assessment

CR 29 (Carpenter/Clove Branch Rd)-Taconic State Parkway, Town of East Fishkill

January 2019

Dutchess County Transportation Council

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1. Introduction

The Dutchess County Transportation Council (DCTC) conducted a Safety Assessment (SA) of CR 9 (Beekman Rd) from CR 29 (Carpenter/Clove Branch Rd) to the Taconic State Parkway (TSP) in support of its goal to improve transportation safety in Dutchess County. The SA is intended to provide the facility owner, Dutchess County, with a list of opportunities for low-cost, short-range safety improvements, and if warranted, more expensive long-range improvements. The DCTC, in consultation with the Dutchess County Department of Public Works (DCDPW), selected the assessment location based on a county-wide analysis of crash data from 2012-2016 and input from member agencies. The key issues identified for this road included wet-road crashes, vehicle speeds unreasonable for conditions, horizontal and vertical alignments, and limited sight distances. The SA team strove to identify low-cost, high-impact improvements to address these issues.

2. Road Characteristics

CR 9 (Beekman Rd) runs in a general east-west direction between NYS Route 82 in the Town of East Fishkill to NYS Route 55 in the Town of Beekman. The 16-mile, two-lane road is maintained by the Dutchess County Department of Public Works (DCDPW). The portion of CR 9 that is the focus of this SA is located in the Town of East Fishkill and locally referred to as Beekman Rd. See Figure 1.

Within the 1.3-mile study area, Beekman Rd is a two-way, urban major collector with mostly asphalt shoulders and a posted speed limit of 45 miles per hour (mph). Based on measurements made during the assessment, travel lane widths are approximately 11 feet from the shoulder/fog line to the centerline with varying shoulder widths of 1-4 feet throughout. The pavement condition, which was assessed in 2017, is rated as good to excellent with a Pavement Condition Index (PCI) rating of 82-86. The approaching Town roads are in fair to good condition with the newer residential areas having somewhat better pavement than some of the older streets.

Fig. 1. Study Area



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Beekman Rd serves as a popular east-west connection from the TSP to Routes 82/376 in Hopewell Junction. Heavy truck traffic does not appear to be an issue on this section of Beekman Rd, though school buses frequent the road to transport students between schools and nearby residential areas. The lack of substantial shoulders, high volume of traffic, and high operating speeds discourage walking and biking on the road. See Fig. 2 and 3 for images of the road.

The DCTC routinely collects traffic volume/speed data on County and local roads throughout Dutchess County. For this section of Beekman Rd, station #828313, located between Athenian Ln and Willow Dr, provided the relevant data for this assessment. Counts at this station have been collected seven times over an 18-year period: 2000, 2003, 2006, 2009, 2012, 2015, and 2018. The 2018 counts showed an Annual Average Daily Traffic (AADT) volume of 8,448 vehicles per day, with a peak hourly volume of 841 vehicles in the evening (5-6 p.m.). Vehicles travelling in the westbound direction accounted for 53% of the volume, while the eastbound direction accounted for 47%. Heavy vehicles accounted for less than three percent of traffic in 2018, so truck traffic does not appear to be an issue. These observations were comparable to counts taken in 2015 and 2012, though heavy vehicle usage was twice as high in 2009. The station’s average recorded speed in 2018 was 42.4 mph in the eastbound direction and 44.5 mph in the westbound direction, with an 85th percentile speed of 48.7 mph eastbound and 50.4 mph westbound. Table 1 shows AADT and speed data for the count station; Fig. 5 also shows the actual count location.

Table 1. CR 9 (Beekman Rd) Traffic Count Data: CR 29 (Carpenter/Clove Branch Rd) to TSP.

Year	AADT	Peak Hour Data		85% speed		% heavy vehicles
		Hour	Volume	EB	WB	
2018	8,448	5-6 pm	841	48.7	50.4	2.7%
2015	9,103	5-6 pm	994	46.6	48.5	2.7%
2012	8,701	5-6 pm	872	46.9	48.6	3.0%
2009	9,067	5-6 pm	824	48.6	46.2	6.4%
2006	8,923	4-5 pm	827	n/a	n/a	n/a
2003	9,268	5-6 pm	799	n/a	n/a	n/a
2000	6,223	5-6 pm	581	n/a	n/a	n/a

AADT: Annual Average Daily Traffic; EB: Eastbound; WB: Westbound.

The traffic volumes on Beekman Rd are similar to other high-volume County highways such as CR 21 (Noxon Rd) in LaGrange and CR 93 (Myers Corners Rd) in Wappinger.

The intersecting Town road approaches to Beekman Rd are all stop-controlled. This segment of Beekman Rd is marked with a double yellow full barrier line and white edge lines, while the approaching Town roadways are not marked. Throughout the corridor, a variety of warning

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Fig. 2. CR 9 (Beekman Rd) looking west from Augusta Dr (West) towards CR 29 (Carpenter/Clove Branch Rd).



Fig. 3. CR 9 (Beekman Rd) looking east from Augusta Dr (West) towards Willow Dr.

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signs are used, including curve warning signs with speed advisory plaques, intersection warning signs, and hazard markers. Guiderails are present along the southern edge of Beekman Rd near Augusta Dr. (west), and east and west on the southside of the Carpenter/Clove Branch Rd intersection. The SA team noted that DCDPW intends to upgrade the traffic signals at the CR 9 (Beekman Rd)/CR 29 (Carpenter/Clove Branch Rd) intersection in 2019, which will likely improve safety at that location.

3. Safety Assessment Process

This project was the fifth application of the SA process in Dutchess County, building upon previous assessments completed by the DCTC since 2012. Given their similar design and operational characteristics to CR 9 (Beekman Rd), two previous assessments on County roads proved helpful for this iteration of the SA program: CR 9 (Beekman Rd) in Beekman and CR 16 (North Quaker Ln) in Hyde Park. As in previous assessments, the DCTC conducted this SA consistent with Road Safety Audit (RSA) guidance from the Federal Highway Administration (FHWA) and Safety Assessment Guidelines from the New York State Association of Metropolitan Planning Associations (NYSAMPO). The SA relied on the participation of an interdisciplinary team of staff from partner agencies, which included the following individuals:

- Steve Gill, Dutchess County Department of Public Works
- Scott Bryant, Town of East Fishkill Engineer
- Kenneth Williams, Town of East Fishkill Highway Superintendent
- Lt. Mike Dampf, Dutchess County Sherriff’s Office
- Lt. Jon Wood, Town of East Fishkill Police
- Mark Debald, DCTC
- Emily Dozier, DCTC
- Dylan Tuttle, DCTC



Fig. 4. The SA team included representatives from local and county law enforcement, highway, engineering, and planning agencies.

The SA took place on November 13-14, 2018, starting with a pre-assessment meeting on November 13th, followed by site visits that afternoon (both during daylight and near dusk) and the morning of November 14th. A post-assessment meeting was held on November 14th to discuss SA team observations and explore possible safety improvements; the post assessment followed a prompt-list derived from the FHWA RSA software program. The SA team used a variety of information to complete the SA, including crash and traffic data, aerial photography, and field work.

4. Crash Analysis

The DCTC analyzed five years of crash data (2013-2017) from the NYS Accident Location Information System (ALIS) database, which is a multi-agency reporting system operated by the NYS Office of Cyber Security & Critical Infrastructure Coordination (CSCIC), the NYS Department of Motor Vehicles (DMV) and the NYS Department of Transportation (NYSDOT). ALIS data originates from the Traffic and Criminal Software (TraCS) system used by police agencies and submitted via DMV accident report forms (Form MV-104). The East Fishkill Police Dept. also provided additional crash reports to the DCTC to augment the ALIS data.

This 1.3-mile stretch of Beekman Rd experienced 71 crashes from 2013-2017, which resulted in one fatality (July 27, 2014) and 45 reported injuries. The crash analysis indicated that the majority of crashes (63 percent) occurred during daytime conditions, and wet or snowy road surface conditions were present during 48 percent of the crashes. Of the 71 crashes, 25 (or 35 percent) occurred in and around the Augusta Dr (West) and Athenian Ln intersections, with many of these located on the northern edge of the curve just west of Augusta Dr (West). During the five-year period, the number of crashes on the study corridor remained relatively constant, averaging 14 crashes annually. The analysis also revealed that ten of the crashes (14 percent) were deer or animal related, which is average for Dutchess County as a whole. Lastly, about half of the crashes involved multiple vehicles, suggesting possible issues related to the intersections and turning movements. Table 2 summarizes crash data for the study corridor, and Fig. 5 shows the locations of crashes on the study corridor.

Table 2. CR 9 (Beekman Rd) Crash Summary: CR 29 (Carpenter/Clove Branch Rd) to TSP (2013-2017)

Year	Number of Crashes	Number of Fatalities	Number of Injuries	Light Conditions		Road Surface Condition		
				Daylight	Dark	Dry	Wet	Snow
2013	14	0	6	9	5	9	5	0
2014	16	1	16	7	7	9	4	1
2015	11	0	3	6	4	8	2	0
2016	15	0	6	13	2	4	11	0
2017	15	0	14	10	5	4	11	0
Total	71	1	45	45	23	34	33	1

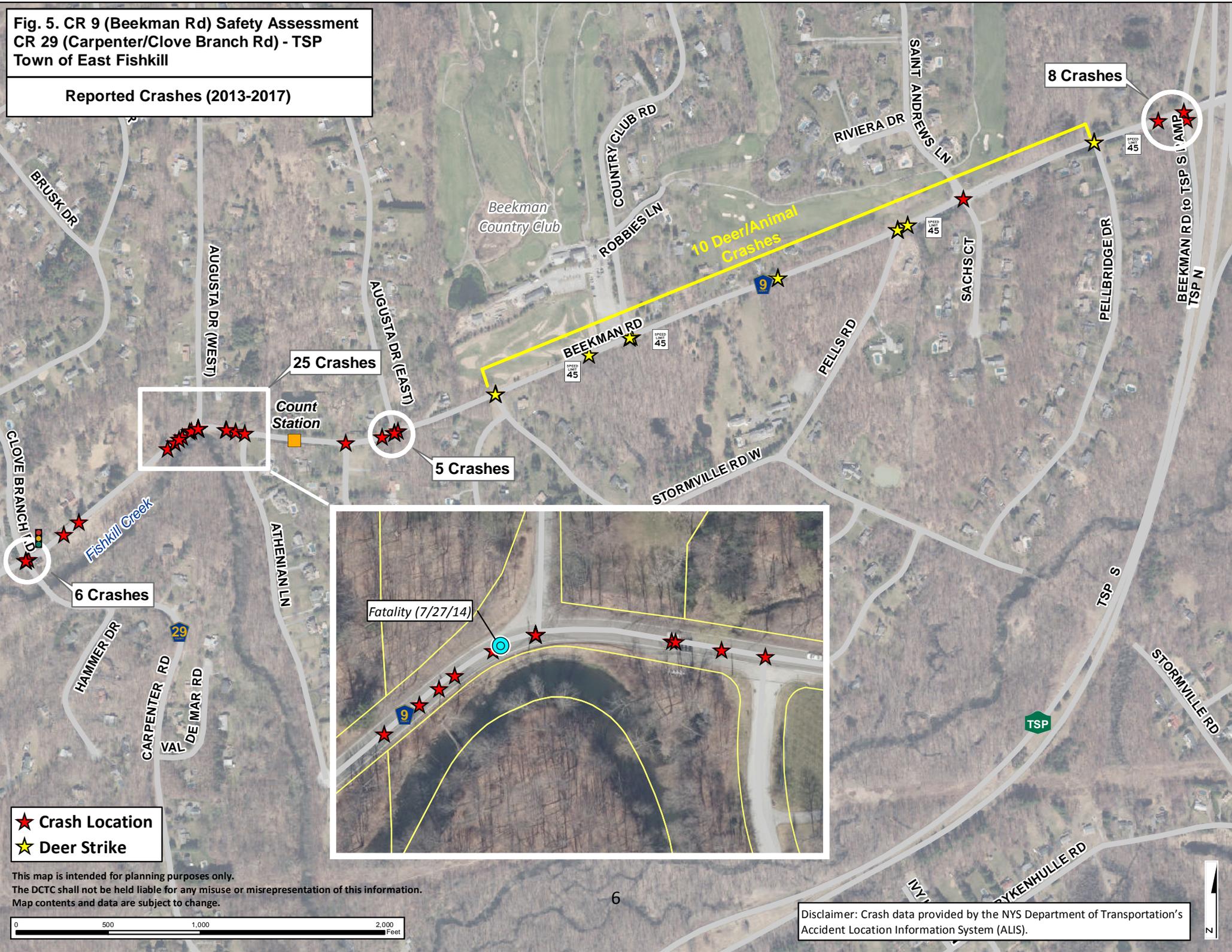
Note: Out of the 71 total crashes, 10 involved a deer or other animal.

5. Findings

This assessment provides information on issues identified by the SA team as opportunities to improve overall safety along the corridor and approaching roadways. For each safety issue, an assessment of the safety risk and suggestions for improvements are included. These suggestions should not be viewed as design-level recommendations. They are intended to be

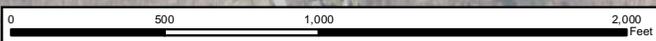
**Fig. 5. CR 9 (Beekman Rd) Safety Assessment
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Reported Crashes (2013-2017)



★ Crash Location
★ Deer Strike

This map is intended for planning purposes only.
The DCTC shall not be held liable for any misuse or misrepresentation of this information.
Map contents and data are subject to change.



Disclaimer: Crash data provided by the NYS Department of Transportation's Accident Location Information System (ALIS).

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illustrative of potential solutions to identified safety issues and are presented for consideration by the facility owner. The findings are organized by first addressing overall safety issues and then specific issues related to four locations along the corridor:

- CR 9 (Beekman Rd)/CR 29 (Carpenter/Clove Branch Rd) intersection
- CR 9 (Beekman Rd)/Augusta Dr (West) intersection
- CR 9 (Beekman Rd)/Augusta Dr (East) intersection
- CR 9 (Beekman Rd)/TSP-southbound ramps

Many of the suggested improvements in this assessment relate to the use of traffic control signs; therefore, where possible, the sign number from the 2009 Manual on Uniform Traffic Control Devices (MUTCD) is included with the sign name. In making recommendations, the SA team attempted to balance the need to inform drivers about conditions without over-saturating the corridor with signs. As per the MUTCD, regulatory and warning signs should be used conservatively because these signs tend to lose their effectiveness if used to excess. Unless otherwise noted, suggested improvements fall under the responsibility of DCDPW.

Overall Safety Issues

The SA team identified several corridor-wide safety issues: operating speeds, warning signs, road shoulders, drainage, and deer/animal strikes.

Issue #1: Vehicle operating speeds

Safety Concern: Vehicle operating speeds appear too high in some locations or during poor road conditions.

Observations: The regulatory speed limit of 45 mph appears to be a generally acceptable speed limit for this corridor under most road conditions. However, operating speeds appear slightly higher than desired in some locations, especially for vehicles descending from some of the higher elevations along the road (e.g. westbound traffic near both Augusta Dr intersections). As noted in the speed data, westbound vehicles operate at a slightly higher 85th percentile speed than eastbound vehicles (50.4 mph and 48.7 mph respectively). These high operating speeds pose a safety issue for vehicles negotiating the more challenging horizontal and vertical alignments on Beekman Rd, even more so during wet or snowy road conditions. This is particularly true for vehicles travelling westbound near the curve west of Augusta Dr (West), as evidenced by the 25 mph advisory speed plaque on the curve warning sign.

Risk Analysis: Elevated operating speeds increase the probability of a severe crash. The vertical geometry near the Augusta Dr (East) intersection may contribute to higher than desired speeds, which may substantially increase the risk of a collision.

Suggestions:

1. Evaluate the posted advisory speeds on Beekman Rd, including the adequacy of the 40 mph advisory speed for eastbound traffic near Athenian Ln and the 25 mph advisory speed for westbound traffic between the two Augusta Dr intersections.
2. Though speed enforcement is typically a useful tool to change driver behavior, it appears difficult to set up enforcement on this corridor. However, the County Sheriff could employ its speed awareness trailer/Variable Messaging Sign (VMS) to alert drivers to their operating speeds. The SA team noted that this would be a temporary measure but could still influence behavior; if feasible, a permanent speed warning sign could also be used.
3. Consider realigning sections of Beekman Rd (both horizontally and vertically), similar to what is planned for the section east of the TSP. Due to the cost of such work, the SA team identified this as a low priority, though it should be considered as a long-range improvement if circumstances and funding allow.
4. Consider narrowing travel lanes from 11 feet to 10 feet (with wider shoulders) in order to calm traffic. Though, this may not be feasible given funding constraints, and could increase the potential for sideswipe crashes involving larger vehicles.

Priority for Consideration:

Suggestion 1: High

Suggestion 2: Moderate

Suggestion 3: Low

Suggestion 4: Low



Fig. 6. The SA team noted that operating speeds on Beekman Rd seemed higher than the posted speed limit of 45 mph, which was supported by speed data collected by the DCTC in 2018.

Issue #2: Warning sign characteristics (placement, condition, and visibility)

Safety Concern: Some warning signs on Beekman Rd. have lost their retro-reflectivity, are damaged or obscured, or may not be optimally located to adequately warn drivers of imminent road hazards.

Observations: During the field visit, SA team members noted that some warning signs were

damaged and/or had lost some of their retro-reflectivity. For example, the driveway/intersection warning sign (W2-2L) east of Willow Dr is damaged and appears to have lost retro-reflectivity; it may also be too close to the intersection, reducing its effectiveness. Also, the curve warning arrows (W1-6R/L) just west and east of Augusta Dr (West) have slightly diminished retro-reflectivity; given the high number of crashes at this location, they may warrant replacement (these may also be replaced as part of an expanded safety improvement project at the intersection/curve, noted later in this SA). Some warning signs were obscured by tree branches/vegetation, notably the 25 mph advisory speed plaque mounted on the curve warning sign (W1-2L) east of Willow Dr. The SA team also observed that the warning signs on Beekman Rd did not have vertical sign post reflectors, as DCDPW has used on other County highways (including the chevron warning signs (W1-8) on CR 19-Slate Quarry Rd). Lastly, the SA Team noted that some signs may no longer be necessary, such as those on Carpenter Rd referencing the TSP median closures.

Risk Analysis: Less-effective warning signs, whether due to poor retro-reflectivity, placement, or condition, reduce driver reaction times, increasing the risk of a crash.

Suggestions:

1. Re-assess the placement of warning signs on Beekman Rd, ensuring that they're located at the best possible location to adequately warn drivers of approaching road hazards.
2. Develop a county-wide sign reflectivity monitoring program to enforce retro-reflectivity standards.
3. Replace the driveway/intersection warning sign (W2-2L) east of Willow Dr to improve retro-reflectivity and driver awareness; also consider relocating this sign further east to provide drivers with more reaction time. See Fig. 7.
4. Trim vegetation away from the 25 mph advisory speed plaque on the curve warning sign (W1-2L) east of Willow Dr.
5. Add vertical sign post reflectors to warning signs on Beekman Rd, especially for signs alerting drivers to the curve near Augusta Dr (West).
6. Consider removing the orange 'median closed' signs on CR 29 (Carpenter Rd) (southbound), since this is no longer a new traffic condition or a work zone. Instead, a 'TSP-South only' route marker could be used to inform drivers of the traffic pattern.



Fig. 7. DCDPW should consider replacing this damaged driveway warning sign east of Willow Dr.

Priority for Consideration:

Suggestion 1: High

Suggestion 2: Moderate

Suggestion 3: High

Suggestion 4: High

Suggestion 5: Moderate

Suggestion 6: Moderate

Issue #3: Shoulder widths

Safety Concern: Shoulder widths are narrow in some locations.

Observations: Paved shoulders vary from one to four feet, with some locations, notably east of Augusta Dr (West), measuring one foot or less. Some of the paved shoulders exhibited rutting due to excessive water runoff. The SA team suspected that roadway runoff was also washing out shoulder material in some locations; again, this seemed prevalent on the northern edge of Beekman Rd east of Augusta Dr (West). See Fig. 8.

Risk Analysis: Poor shoulder conditions can increase the possibility of a driver losing control of their vehicle as they drift towards the shoulder. If a driver attempts a sudden correction to regain control, the vehicle can become destabilized resulting in a crash. The lack of adequate clear areas and high operating speeds along Beekman Rd increase the chances of a severe crash.

Suggestions:

1. Reduce shoulder drop-offs by backfilling along shoulders, especially along the northern edge of Beekman Rd east of Augusta Dr (West).
2. Widen shoulders, especially along the northern edge of Beekman Rd east of Augusta Dr (West). This could be done in conjunction with other safety improvement near the intersection.
3. Consider adding a safety edge, which allows drivers who drift off the road to return to the road safely. Instead of a vertical drop-off, the safety edge shapes the edge of the pavement to 30 degrees. FHWA-supported research has shown that this is the optimal angle to allow drivers to re-enter the roadway safely. This could be done as part of a future repaving project.

Priority for Consideration:

Suggestion 1: Moderate

Suggestion 2: Moderate

Suggestion 3: Moderate

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Fig. 8. The shoulders on CR 9 (Beekman Rd) are generally three to four feet in width (middle). However, the shoulders tend to widen near the TSP (top), while locations near steep slopes and other terrain features tend to have narrower shoulders (bottom).

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Fig. 9. Water ponding and a stopped-up basin were evident at the Pellbridge Dr intersection. During winter, these areas can freeze and create unsafe conditions.



Fig. 10. This stretch of CR 9 (Beekman Rd), adjacent to the Beekman Country Club, experienced the highest number of deer/animal strikes along the study corridor.

Issue #4: Potential Road Ponding

Safety Concern: Debris is limiting the capacity of the catch basin near Pellbridge Dr to process rain water, which is resulting in ponding near Beekman Rd. See Fig. 9.

Observation: The SA team noted that the catch basin located at the southeast corner of the Pellbridge Dr intersection was overflowing, likely due to above average rainfall and leaves. This could limit its capacity to discharge water runoff during extreme weather events or prolonged wet periods. The resulting standing water could freeze during winter and create slippery conditions for vehicles entering Beekman Rd from Pellbridge Dr.

Risk Analysis: Road ponding during severe weather events could create a hazard to drivers and contribute to slippery pavement conditions.

Suggestion:

1. Clean out the catch basin at the Beekman Rd/Pellbridge Dr intersection.

Priority for Consideration:

Suggestion 1: High

Issue #5: Deer/animal strikes

Safety Concern: The SA team noted that almost all of the deer/animal strikes recorded on this section of Beekman Rd occurred on the straight section between Stormville Rd and Pellbridge Dr. See Fig. 10.

Observations: During the field visit, SA team members noted that deer were likely travelling through the Beekman Country Club property and crossing Beekman Rd, increasing the risk of a vehicle/animal strike. The SA team also noted that there was an existing fence along part of the golf course's property along Beekman Rd, though it did not run along the entire length of its border, nor was it completely deer-proof. The SA team also noted that most of the deer/animal crashes occurred during dark conditions.

Risk Analysis: The presence of deer and other animals in the area increases the risk of a crash, especially during dark conditions.

Suggestions:

1. Consider the installation of deer warning signs (W11-3) on the eastern and western approaches to Beekman Rd between Stormville Rd and Pellbridge Dr. The installation of additional signs should be done so as to avoid oversaturating the corridor.
2. Encourage the Beekman Country Club to explore installing deer-proof fencing along the entire length of their property along the



Fig. 11. Deer warning sign (W11-3).

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northern edge of Beekman Rd. The SA Team acknowledged that it is very difficult to completely prevent deer from crossing Beekman Rd, though new fencing could improve the situation.

Priority for Consideration:

Suggestion 1: Moderate

Suggestion 2: Low

CR 9 (Beekman Rd)/CR 29 (Carpenter/Clove Branch Rd) Intersection

DCDPW intends to replace the traffic signal at this intersection, to include the installation of video detection, high-visibility backup plates, and far-side mast arms. The intersection has street lights co-located on existing utility poles. There is no right-turn on red for southbound and westbound traffic due to limited visibility; the SA Team suspects that the turn restrictions have helped reduce crashes at the intersection. Given the planned improvements, the SA Team did not evaluate signal timing at the intersection. However, they identified several guiderail-related issues. See Fig. 12 and 13.

Issue #1: Guiderail not present

Safety Concern: The southern edge of Beekman Rd, just east of Carpenter Rd, has a very steep embankment that extends to a low lying area near the Fishkill Creek.

Observations: The SA Team noted that there was a steep drop-off from the southern edge of Beekman Rd, approximately 150 feet east of the Carpenter Rd intersection, down to a low lying area near the Fishkill Creek. This drop-off is marked by a series of object markers (OM3-R) that denote the roadside hazard. However, the SA Team noted that a guiderail might be warranted at this location to prevent errant vehicles from travelling down the embankment and possibly over-turning. The Team noted that there may not be space for a guiderail at the location, but should be evaluated. See Fig. 14.

Risk Analysis: Lack of adequate guiderails can result in an errant vehicle travelling down a steep, non-recoverable embankment. This is of special concern if the area at the toe of the slope contains fixed objects or other hazards such as water (in this case, the Fishkill Creek).

Suggestions:

1. Consider the installation of a new guiderail on the southern edge of the eastbound lane of Beekman Rd, in order to prevent vehicles from travelling down the embankment and possibly landing in or near Fishkill Creek. DCDPW should assess the feasibility of a new guiderail given the surrounding topography and the potential of increasing possible head-on crashes if an errant eastbound vehicle bounces off the guiderail into traffic. There is a guiderail along the residential property just east of the intersection.
2. Add reflective delineators to new guiderails installed at the location.

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Fig. 12. CR 9 (Beekman Rd)/CR 29 (Carpenter Rd/Clove Branch Rd) intersection looking east from CR 9 (Beekman Rd).



Fig. 13. CR 29 (Carpenter Rd) looking south, towards the TSP, from CR 9 (Beekman Rd).



Fig. 14. The southern edge of CR 9 (Beekman Rd), just east of the CR 29 (Carpenter/Clove Branch Rd) intersection, abuts a steep slope that is marked by a series of object markers. Due to the significant grade change from the road, DCDPW might consider installing a guiderail at this location to prevent errant vehicles from travelling down the embankment towards Fishkill Creek.



Priority for Consideration:

1. High
2. Moderate

Issue #2: Guiderail condition and type

Safety Concern: Portions of the existing guiderail west of the intersection are of the older “W” style and include a gap in the rail for use by the Hopewell Reformed Church.

Observations: The existing guiderail on the southern edge of Beekman Rd west of the Carpenter Rd intersection is the older “W” style. The guiderail also has a gap between sections to allow walking access from the Church across the street to the area near Fishkill Creek. The SA team noted that the “W” style guiderail uses end treatments that may not absorb a vehicle crash as well as a modern box beam guiderail. See Fig. 15.

Risk Analysis: Lack of adequate guiderails can result in an errant vehicle traversing down a steep, non-recoverable slope. Askew guiderail systems and turned-down end sections can also increase the risk of vehicle launching.

Suggestions:

1. Replace the eastbound guiderail with a box beam style and consider closing the gap. The SA team noted that the County standard for new installations is box beam guiderail and that DCDPW has a program to identify and replace deficient systems.
2. Add reflective delineators along the side of the guiderail.

Priority for Consideration:

Suggestion 1: Moderate

Suggestion 2: Moderate



Fig. 15. DCDPW should consider replacing this “W” style guiderail with a more modern box beam design, while also investigating the possibility of closing the gap between guiderails since an errant vehicle could impact one of the end knuckles.

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Fig. 16. A view of the Augusta Dr (West) intersection, looking west from CR 9 (Beekman Rd). This area experienced the highest number of crashes along the corridor, many occurring during wet road conditions.



Fig. 17. The view from Augusta Dr (West), looking west towards CR 9 (Beekman Rd).

CR 9 (Beekman Rd)/Augusta Dr (West) Intersection

The segment of Beekman Rd near Augusta Dr (West) had the highest number of crashes in the study area. Unsafe speeds during wet weather, coupled with the road's geometry, have resulted in numerous road departures and multiple-vehicle crashes. Beyond short-term improvements such as better signage and pavement treatments, DCDPW might consider creating a larger clear zone on the northern edge of the curve just west of the intersection. See Fig. 16 and 17.

Issue #1: Crashes during wet pavement conditions

Safety Concern: Many crashes occur during wet or snowy pavement conditions.

Observations: Crash data indicated that wet or snowy road conditions were present at 19 of the 25 crashes at this location (76 percent). Evidence of previous crashes was present during the site visit, especially at the apex of the curve, where a number of trees showed signs of repeated vehicle impacts. The area also appeared to have poor drainage that could diminish the capacity of drivers to recover from a road departure. Once off the pavement, there is a high probability of a collision with a fixed object such as a tree. The SA team noted that westbound vehicles tended to gain speed as they approached the curve, partly due to the elevation of Beekman Rd. The SA team also observed that the crash area off of Beekman Rd was moderately wooded and potentially unforgiving to errant vehicles (several vehicle parts were visible in the area, including a tire). The SA team also wondered if the super-elevation of the road might contribute to vehicles departing the road at the curve. See Fig. 18 and 19.

Risk Analysis: The combination of a tight horizontal curvature, narrow shoulders, and relatively high approach speeds create a challenging environment for drivers. The potential for a roadway departure increases when the pavement is slippery, as evidenced by the crash data. In addition, the presence of large trees just off the road, near the apex of the curve, increases the likelihood of a fixed object crash, while narrow shoulders and steep drop-offs impact recovery abilities.

Suggestions:

1. As part of normal tree maintenance, DCDPW should ensure that the County right-of-way is free and clear of obstructions and that the clear zone is sufficient for this type of facility. If vegetation is located on private property and is determined to compromise safety, DCDPW should notify the applicable property owner of the situation and suggest that they remove the obstructions.
2. The suggestion above should be done in conjunction with installing a defined clear zone at the apex of the curve on the northern edge of Beekman Rd. A clear zone is an unobstructed, traversable area beyond the edge of the travel lane that enables errant vehicles to recover from a road departure, and if unable to recover, reduces the effects

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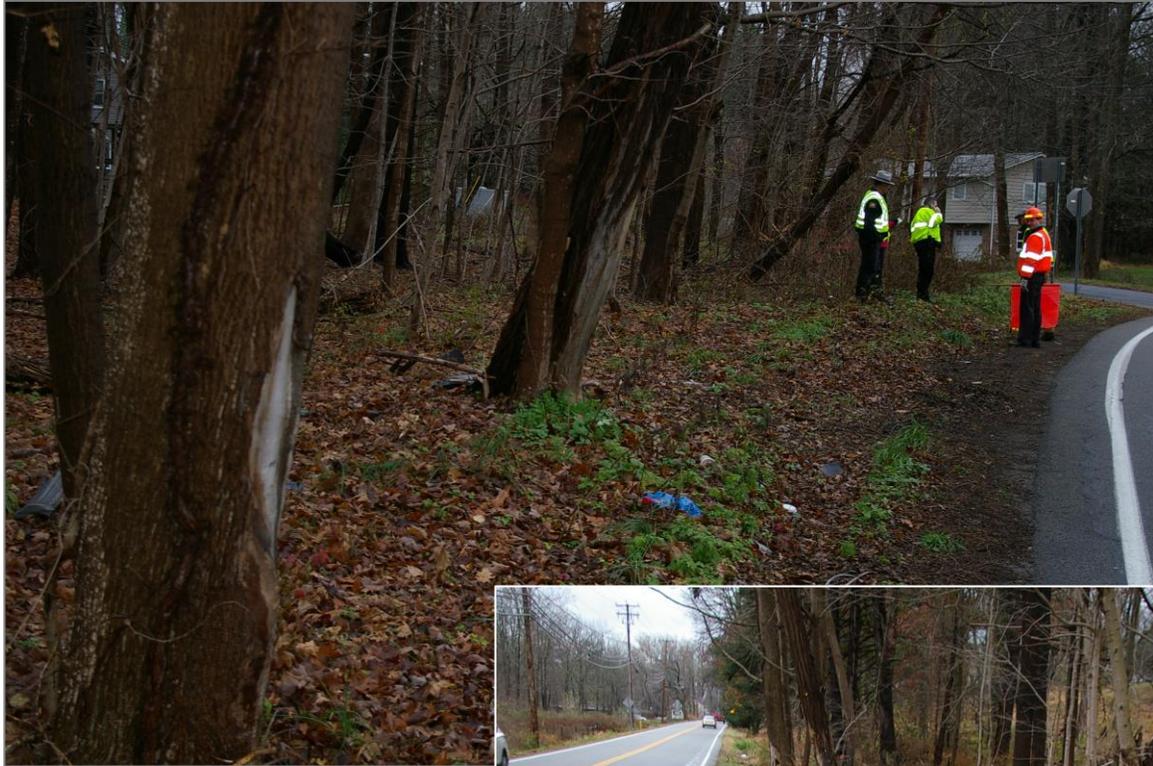


Fig. 18. This area west of the curve near Augusta Dr (West) has witnessed numerous road departure crashes, as evidenced by the vehicle debris field and tree damage.





Fig. 19. Another view of the impact area near the Augusta Dr (West) curve. The SA report recommends that this area be cleared of fixed objects.



Fig. 23. This guiderail, located on the inside curve across from Augusta Dr (West), prevents errant vehicles from entering Fishkill Creek.

of the road departure. Clear zones are free of rigid fixed objects such as trees and utility poles. For this location, this would entail removing a majority of trees located within the County right-of-way on the northern edge of Beekman Rd, just west of Augusta Dr (West). The amount of clear zone created should follow AASHTO's Roadside Design Guide and account for the road's design speed and the radius of the curve.

3. Consider installing Slippery When Wet signs (W8-5) to warn drivers approaching the curve. This would respond to the number of incidents occurring under wet pavement conditions. While the SA Team agreed that these signs are applicable, the group also felt adding more signs at or before the curves could detract from the primary message about the geometry. If installed, the placement of these signs should be carefully considered as part of the overall signage package for Beekman Rd.
4. Consider a high-friction pavement overlay or other treatment to improve skid resistance. The installation of a higher friction pavement treatment through the curve would increase the horizontal friction factor, especially during periods of rain, and help keep vehicles from departing the road. The SA team discussed alternative treatments including a rough asphalt top course and micro-surfacing. Further study and evaluation would be required to determine which would be the best treatment for Beekman Rd.
5. Assess the super-elevation of the road to ensure it meets current design standards.

Priority for Consideration:

Suggestion 1: High

Suggestion 2: High

Suggestion 3: Moderate

Suggestion 4: High

Suggestion 5: High

Issue #2: Replace warning signs

Safety Concern: The curve warning signs on both approaches to the intersection on Beekman Rd may not be located correctly based on current standards and may not effectively inform oncoming drivers of the approaching hazard.

Observation: Based on SA team member input, the two arrow warning signs (W1-6L/R) at the curve may not adequately capture the attention of drivers. At a minimum, the SA team felt that these signs should be replaced to improve their retro-reflectivity. The SA team also thought that the curve might be a suitable location for a series of two to three chevrons (W1-8L/R) on each approach. These should follow MUTCD guidance, which recommends not using chevrons as a single visual target on a long tangent, but more as a series of signs to inform drivers.

Some SA team members felt that the curve warning sign (W1-2L) east of the Augusta Dr (West) intersection, used to alert westbound drivers of the approaching curve, may not be optimally located or the right type: given the nature of the curve, some thought a left turn

warning sign (W1-1L) might be more appropriate. The Team also discussed the possibility of installing flashing beacons or LEDs to increase the visibility of the warning signs. Lastly, the SA team discussed the possibility of co-locating a street light on a nearby utility pole to improve visibility at the intersection.

Risk Analysis: Insufficient warning signs, whether due to condition, frequency, or location, elevate the chance that a driver might not adjust their behavior in time to successfully negotiate a road hazard. Placing a sign too far from the target feature increases the chance that the sign might be missed or forgotten by the time a driver reaches the curve.



Fig. 20. This warning arrow (W1-6) at Augusta Dr (West) may not fully communicate the need for drivers to exercise caution when approaching the curve on CR 9 (Beekman Rd), just west of the intersection.

Suggestions:

1. Consider installing a series of warning chevrons (W1-8L/R) in both directions to alert drivers on Beekman Rd of the approaching curve. Also, consider adding reflective vertical strips to the chevron signposts to increase their visibility (see Fig. 21). If pursued, the existing arrow warning signs (W1-6L/R) should be removed in conjunction with the installation of the chevrons.
2. If crash rates remain high after lower-cost improvements are made, consider the use of flashing beacons or LEDs to increase the visibility of the warning signs.
3. Determine if the curve warning sign (W1-2L) on Beekman Rd should be relocated to better inform westbound drivers of the curve.
4. Consider replacing the curve warning sign with a left turn warning sign (W1-1L). See Fig. 22.
5. Consider the installation of a street light on the utility pole located on the southern edge of Beekman Rd, directly opposite Augusta Dr (West).



Fig. 21. Warning chevrons (W1-8).



Fig. 22. Left turn warning sign (W1-1L).

Priority for Consideration:

- Suggestion 1: High
- Suggestion 2: Low
- Suggestion 3: High
- Suggestion 4: Moderate
- Suggestion 5: Moderate

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Fig. 24. A closer view of the guiderail from Fig. 23. Notice that it leans away from the road, likely due to repeated vehicle impacts and soil erosion.



Fig. 25. The view from Augusta Dr (East), looking east towards Beekman Rd. The vertical crest and nearby trees limit a driver's ability to see oncoming vehicles.

Issue #3: Guiderail condition

Safety Concern: A portion of the guiderail located on the southern edge of Beekman Rd, above the Fishkill Creek, may be compromised due to repeated vehicle strikes and soil erosion.

Observations: A segment of the guiderail above the Fishkill Creek is in poor condition and leaning out and away from Beekman Rd, indicating that it has been struck by vehicles and may lack suitable back-up support. The steep slope and soil erosion may have also compromised the guiderail, making its height too low to be effective. These conditions reduce the effectiveness of the guiderail, increasing the possibility of an errant vehicle falling down the embankment and into Fishkill Creek. See Fig. 23 and 24.

Risk Analysis: Lack of adequate guiderails can result in an errant vehicle traversing down a steep, non-recoverable embankment. This is of special concern if the area at the toe of the slope contains fixed objects or other hazards such as water. A steep slope also increases the chance of a vehicle overturning, and if water is present, the possibility of drowning trapped vehicle occupants.

Suggestions:

1. Repair or replace the damaged box beam guiderail located on the southern edge of Beekman Rd above the Fishkill Creek.
2. Add reflective delineators along the side of the guiderail.

Priority for Consideration:

Suggestion 1: High

Suggestion 2: High

CR 9 (Beekman Rd)/Augusta Dr (East) Intersection

The segment between Athenian Ln and Augusta Dr (East) experienced fewer crashes than the area at Augusta Dr (West), though the SA team identified some ideas to improve safety at the Augusta Dr (East) intersection.

Issue #1: Sight Distance

Safety Concern: The elevation change on Beekman Rd, just east of the intersection, restricts the sight distance for drivers exiting Augusta Ln (East).

Observations: The vertical geometry on Beekman Rd near the Augusta Dr (East) intersection creates limited sight distances for westbound vehicles on Beekman Rd and also for vehicles exiting Augusta Dr (East) onto Beekman Rd. This caused drivers to creep past the stop sign to see traffic on Beekman Rd. The SA team interviewed drivers exiting

Augusta Dr (East), who confirmed the difficulty they had seeing westbound vehicles coming from their left. They also noted that westbound vehicles tended to gain speed as they travelled down the hill towards Augusta Dr (East) and Willow Dr. The SA team also noted that large trees on the northeast corner of the intersection restricted the visibility of drivers looking east from Augusta Dr. Some SA team members discussed the possibility of creating a one-way in and out travel pattern on Augusta Dr (e.g. enter at the eastern leg and exit at the western leg); the team determined that this would be unpopular with local residents, so it was removed from consideration. Lastly, the Team noted that a street light, co-located on an existing utility pole, might be beneficial to drivers. See Fig. 25.

Risk Analysis: A lack of adequate intersection sight distance increases the risk of a collision by affecting the driver's ability to accurately judge and accept gaps in approaching traffic. High operating speeds on Beekman Rd increase the probability of a severe collision.

Suggestions:

1. As part of normal tree maintenance, DCDPW should ensure that the County right-of-way is free and clear of obstructions and that the clear zone is sufficient for this type of facility. If vegetation is located on private property and is determined to compromise safety, DCDPW should notify the applicable property owner of the situation and suggest that they remove the obstructions. For this location, DCDPW should focus on the trees at the northeast corner of the intersection.
2. Lower the vertical crest on Beekman Rd, east of the intersection. This would improve sight distance for drivers exiting Augusta Dr (East), as well as for westbound drivers on Beekman Rd. Such an improvement would have considerable costs; the SA team therefore identified this as a long-range suggestion, given the generally low number of crashes at the intersection.
3. Consider the installation of a street light on the utility pole located on the southern edge of Beekman Rd, directly opposite Augusta Dr (West).

Priority for Consideration:

Suggestion 1: Moderate

Suggestion 2: Low

Suggestion 3: Moderate

CR 9 (Beekman Rd) at TSP-Southbound Ramps

Although the area in and around the TSP-southbound ramps has experienced a relatively low number of crashes, some improvements could be made to improve safety.

Issue #1: Sight Distance

Safety Concern: The elevation change on the overpass approaching the TSP southbound off-ramp restricts sight distance for drivers travelling on Beekman Rd.

Observations: The vertical geometry on Beekman Rd over the TSP reduces the sight distance for westbound vehicles on Beekman Rd and also for vehicles exiting the TSP onto Beekman Rd. The limited line of sight may also be due to the bridge itself, which obstructs the view of drivers travelling west on Beekman Rd; these conditions make it difficult for drivers to react to vehicles exiting the TSP ramp. The SA team noted that changing the geometry would be difficult and cost prohibitive. Another option could be the installation of a traffic signal, similar to what is provided at the northbound TSP off-ramp; the SA team noted that this would require NYSDOT to conduct a signal warrant analysis. The team also noted that the off-ramp splits into two lanes, and though it's implied, there are no visible directional pavement markings informing drivers that one lane turns left and the other right (these may have also faded over time).

Risk Analysis: A lack of adequate intersection sight distance increases the risk of a collision by affecting a driver's ability to accurately judge and accept gaps in approaching traffic.

Suggestions:

1. Conduct a signal warrant analysis for the TSP southbound off-ramps at Beekman Rd (NYSDOT responsibility).
2. Add/Re-mark directional pavement markings on the TSP southbound off-ramps, denoting left and right turn movements onto Beekman Rd (NYSDOT responsibility).

Priority for Consideration:

Suggestion 1: Moderate

Suggestion 2: Moderate

6. Next Steps

The DCTC, through the work of the SA team, has prepared this report to assist DCDPW and the Town of East Fishkill with prioritizing opportunities to improve safety on this section of Beekman Rd. The suggestions are for consideration only and are in no way intended to serve as design or operational recommendations. The SA team believes it has been thorough and diligent in its work, given the information available and its field reviews. This report does not preclude the identification of additional issues pertaining to safety by the owners or the emergence of new issues over time. It is recommended that Dutchess County DCDPW review this report, document its responses to the suggestions in a formal response, and track progress towards the implementation of safety improvements prompted by this assessment.

Table 3. Suggested Actions and Priority by Location

Issue	Suggested Action	Priority
Overall Safety		
1-1	Evaluate posted advisory speeds (e.g. 40 mph and 25 mph).	High
1-2	Periodically deploy a speed awareness trailer.	Moderate
1-3	Realign the road to eliminate vertical and horizontal deficiencies.	Low
1-4	Consider narrowing travel lanes to 10 feet.	Low
2-1	Re-assess the placement of warning signs on Beekman Rd.	High
2-2	Develop a County-wide sign reflectivity monitoring program.	Moderate
2-3	Replace driveway warning sign (W2-2L) east of Willow Dr.	High
2-4	Trim vegetation away from 25 mph plaque (W1-2L) west of Willow Dr.	High
2-5	Add vertical sign post reflectors on warning signs.	Moderate
2-6	Consider removing the “median closed” sign on Carpenter Rd.	Moderate
3-1	Reduce shoulder drop-offs on Beekman Rd, east of Augusta Dr (West).	Moderate
3-2	Widen shoulders near Augusta Dr (West).	Moderate
3-3	Consider adding a safety wedge on Beekman Rd.	Moderate
4-1	Clean out the catch basin near Pellbridge Dr.	High
5-1	Consider installing deer warning signs near the golf course (W11-3).	Moderate
5-2	Encourage the golf course to install deer-proof fencing.	Low
CR 9 (Beekman Rd)/CR 29 (Clove Branch/Carpenter Rd) Intersection		
1-1	Consider installing a guiderail on the southern edge of Beekman Rd.	High
1-2	Add reflective delineators to new guiderail above.	Moderate
2-1	Replace the existing “W” style guiderail with a box beam guiderail.	Moderate
2-2	Add reflective delineators along guiderails.	Moderate
CR 9 (Beekman Rd)/Augusta Dr (West) Intersection		
1-1	Remove trees within the County right-of-away, west of intersection.	High
1-2	Create a clear zone at the apex of the curve.	High
1-3	Consider installing Slippery When Wet signs (W8-5).	Moderate
1-4	Consider a high-friction pavement overlay to improve skid resistance.	High
1-5	Assess super-elevation to ensure it meets current design standards.	High
2-1	Install warning chevrons (W1-8) for both directions at the curve.	High
2-2	Consider the use of flashing beacons or LEDs on warning signs.	Low

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2-3	Consider relocating the curve warning sign (W1-2L) at the curve.	High
2-4	Consider replacing the curve warning with a turn warning sign (W1-1).	Moderate
2-5	Consider installing a street light.	Moderate
3-1	Repair the damaged box beam guiderail.	High
3-2	Add reflective delineators along guiderails.	High

CR 9 (Beekman Rd)/Augusta Dr (East) Intersection

1-1	Clear the County right-of-away of vegetation to improve line of sight.	Moderate
1-2	Lower the vertical crest on Beekman Rd, east of Augusta Dr (East).	Low
1-3	Consider installing a street light.	Moderate

CR 9 (Beekman Rd)/TSP-Southbound Ramps

1-1	Request NYSDOT to perform a signal warrant analysis.	Moderate
1-2	Add directional pavement markings to the TSP off-ramp turning lanes.	Moderate