Characteristics of Tire Marks During Braking and Acceleration During a U-turn on Gravel Shoulders - Part 3

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Gorski Consulting has embarked on a research study to document the characteristics of tire marks that exist outside of a paved road surface. This study has involved documentation of hundreds of incidents, both collision-involved, but also incidents of simple travel onto a gravel shoulder that may involve a deceleration, a stop, an acceleration and a steering component. This study has already produced two articles that have been previously posted on the Gorski Consulting website. Those two articles dealt primarily with evidence of acceleration.

In this third article the discussion will be with respect to tire marks that were created by an unknown vehicle as it steered onto the right shoulder and then made a U-turn. The tire marks were reproduced by a test vehicle that travelled over the approximate same location and performed a similar U-turn. Comparisons are made between the characteristics of the tire marks produced by the two vehicles. As in the previous articles we return to the site on Clarke Road north of Fanshawe Park Road in the north-east of the City of London, Ontario (See Figure 1).

The original tire marks were discovered on December 4, 2013. Figure 2 shows a southerly view of the east shoulder of Clarke Road at the north end of the S-curve. For those readers who have examined the previous two articles the content of what is visible in Figure 2 should be familiar. It shows the tire marks of a northbound vehicle that travelled onto the shoulder (toward the camera). It is likely that the vehicle came to a stop and the driver turned the steering wheel hard to the left to commence a U-turn. Thus we see the typical curved tire marks as the turn takes place.

Figure 3 shows the tire mark created by the right front tire. As one would expect, the straight portion of the tire mark was created as the vehicle was slowing while approaching the camera. The tire then stopped at the point where the tire mark changes direction. This abrupt change in direction can only occur when the tire is stopped, or almost stopped, because time is needed to change the tire's pointing direction during steering.

In the background of Figure 3 is the curved tire mark created by the right rear tire. As discussed in the previous articles, as the right front tire moves toward the new direction, the right rear tire follows along but in a more gradual change in direction. Thus we have the typical sweeping curve of the rear tire mark which is inboard of the right front tire mark.

Figure 1: View looking south at the S-curve of Clarke Road north of Fanshawe Park Road in London, Ontario on October 11, 2013. This is the "Laboratory" where a number research studies have been conducted at Gorski Consulting.

Figure 2: View, looking south, along the east shoulder of Clarke Road at the north end of the S-curve. This view shows the tire marks of a northbound vehicle that travelled on the shoulder and then made a sharp left turn that continued onto the opposite (west) shoulder where it completed a U-turn.

Figure 3: View of tire mark created by the right front tire of the unknown vehicle.

Figure 4: View of the tire marks with their explanations.

Figure 3 shows an interesting feature of the unknown vehicle. The right front tire mark does not display any tire tread. This is likely because the front tires of the vehicle were "bald" or did not contain a tire tread. This is an uncommon finding.

Figure 4 shows the tire marks caused by the left side tires of the unknown vehicle. It shows a close-up view of the "scallop" markings within the left front tire mark at the point where the unknown vehicle began to accelerate forward from its stopped position. As noted previously, such scallop markings are an indication of acceleration.

As the unknown vehicle accelerated into the U-turn it crossed the road such that the right side tires travelled onto the west shoulder, as shown in Figure 5.

Figure 5: View, looking south, along the west shoulder of Clarke Road where the right side tires of the unknown vehicle created visible tire marks and the vehicle subsequently moved off into the background after completing the U-turn.

Figure 6 shows the two right side tire marks of the unknown vehicle on the west shoulder near the point where they converge and the vehicle reenters the paved road. Here we can appreciate the difference in the tire tread that is visible in the right rear tire mark but not in the right front tire mark. Again, this is a sign that the right front tire is bald.

Figure 6: View of the characteristics of the tire marks caused by the right side tires of the unknown vehicle.

It is unlikely that many vehicles would be riding the roads with two bald front tires and two rear tires with tread in them. Although uncommon it is these kinds of unique features of a vehicle or its tires which can help to solidify an opinion that a particular tire mark was caused by a particular vehicle. Obviously the pattern of the tread imprint can also be used to establish a vehicle's identity.

As an experiment to gain further insight into how these tire marks were created a test was conducted by driving a vehicle northbound onto the east shoulder in the area where those tire marks were found. The test vehicle was driven at a speed of 60 km/h and the driver steered the vehicle onto the east shoulder, generally parallel to the tire marks that were found. As the test vehicle approached the suspected stop position of the unknown vehicle the driver applied hard braking such that the test vehicle same to a stop in a similar location to the unknown vehicle. Figures 7, 8 and 9 show views of the test vehicle immediately after the test was performed.

Figure 10 is a view looking south at the tire marks produced by the right side tires of the unknown vehicle and the subsequent test vehicle. Obvious differences include the difference in apparent roughness of the surface within each tire. Although, at this location, the tread is visible within the original tire mark because the rear tire rode over the front, there is still a level of smoothness apparent within that is not duplicated in the roughness of the tire mark produced in the test. We know that the test involved significant braking and we suggest that this is the reason for the difference as well as the fact that the right front tire of the unknown vehicle was likely bald.

Figure 7: View, looking north, along the east shoulder of Clarke Road toward the stopped position of the test vehicle after it entered the shoulder at a speed of 60 km/h and then was braked to a stop.

Figure 8: View, looking north, along the east shoulder of the Clarke Road at the stopped position of the test vehicle.

Figure 9: View of test vehicle and tire marks behind it.

Figure 10: View, looking south, at the tire marks produced by the original, unknown vehicle and that produced in the test.

A second difference in the tire marks shown in Figure 10 is the extent of "straightness" or lack of straightness between the two. The original tire mark is very straight whereas the tire mark from the test is curved. We suggest that this is another indication of the difference in speed at which the two tire marks were produced. At a speed of 60 km/h our test required that the driver get onto the shoulder in hurry, straighten the vehicle's path and then apply hard braking, thus the reason for the lack of straightness. In contrast we suggest that the unknown vehicle rolled along at a gently, slow speed in a scenario where the mystery driver was in no hurry or in need to adjust the vehicle's motion other than bring it to a gradual halt prior to steering the wheels hard to the left to commence the U-turn. Thus information about the path of the tire mark can may also help in determining how a tire mark was created.

Evidence of high levels of braking may also show up if there are indications that the anti-locking braking was engaged. In Figure 11 we see the last portion of the tire mark created by the right side tires and just behind the right rear tire we can see a clear tire tread whereas closer to the bottom of the view we can see that the tread has been disorganized and disturbed. This difference can be a sign that the ABS system was cycling on and off and changing the rate of rotation or the tire.

Figure 11: View, looking north, toward the right rear tire of the test vehicle at its rest position. The characteristics of the tire mark produced by the right side tires can be seen in the foreground.

Figures 12, 13 and 14 show views of the right front tire at its rest position and we can see the characteristics of the tire mark and the manner in which the gravel/soil was disbursed as the vehicle can to a stop.

In Figure 12 we see the degree to which the gravel/soil has been pushed to the sides of the tire producing the wall similar to what is created during acceleration. At the top right corner of photo, in the shadows just in front of the tire, one might be able to pick-up the curving tire mark caused by the right rear tire of the unknown vehicle.

Figure 12: View of the right front tire of the test vehicle at its rest position after the test was completed.

Figures 13 and 14 show the extent to which the gravel/soil has been built up in front of the stopped right front tire. One can imagine how this build up of loose material would be moved when the tire is stopped but the driver turns the steering wheel hard to the left to begin the U-turn.

Figure 13: View of the shoulder conditions around the stopped position of the right front tire of the test vehicle.

Figure 14: View of wall of gravel/soil on the sides and in front of the right front tire at its rest position.

On the left side of the test vehicle Figure 15 shows the tire mark of the left front tire that is just in front of the left rear tire. Here we can see another area of disturbed tire tread within the mark indicative of the activation of the ABS system.

Figure 15: View of the tire mark along the left side of the test vehicle.

After the above photos were taken the test driver turned the steering wheel hard to the left and performed a U-turn to approximate the motion created by the unknown vehicle. We will see shortly that this motion caused the right side tires of the test vehicle cross onto the west shoulder in the vicinity of the unknown vehicle's tire marks.

Before reviewing the marks on the west shoulder we first examine what evidence was present on the east shoulder after the test vehicle vacated that area. Figure 16 provides a view, looking west, at the location where the test vehicle came to its stop and then started its U-turn. The labels of the tire marks show that this is also where the unknown vehicle came to a stop although the unknown vehicle's stop position was slightly further north. A label at the bottom of Figure 16 identified the original, right-front tire mark of the unknown vehicle. At the extreme right edge of Figure 16 one can also see the curved tire mark of the right-rear tire of the unknown vehicle.

As expected the gravel/soil clinging to the tires of the test vehicle transferred themselves onto the pavement as the test vehicle continued into its U-turn and thus we can clearly see its path as it crossed over to the west shoulder.

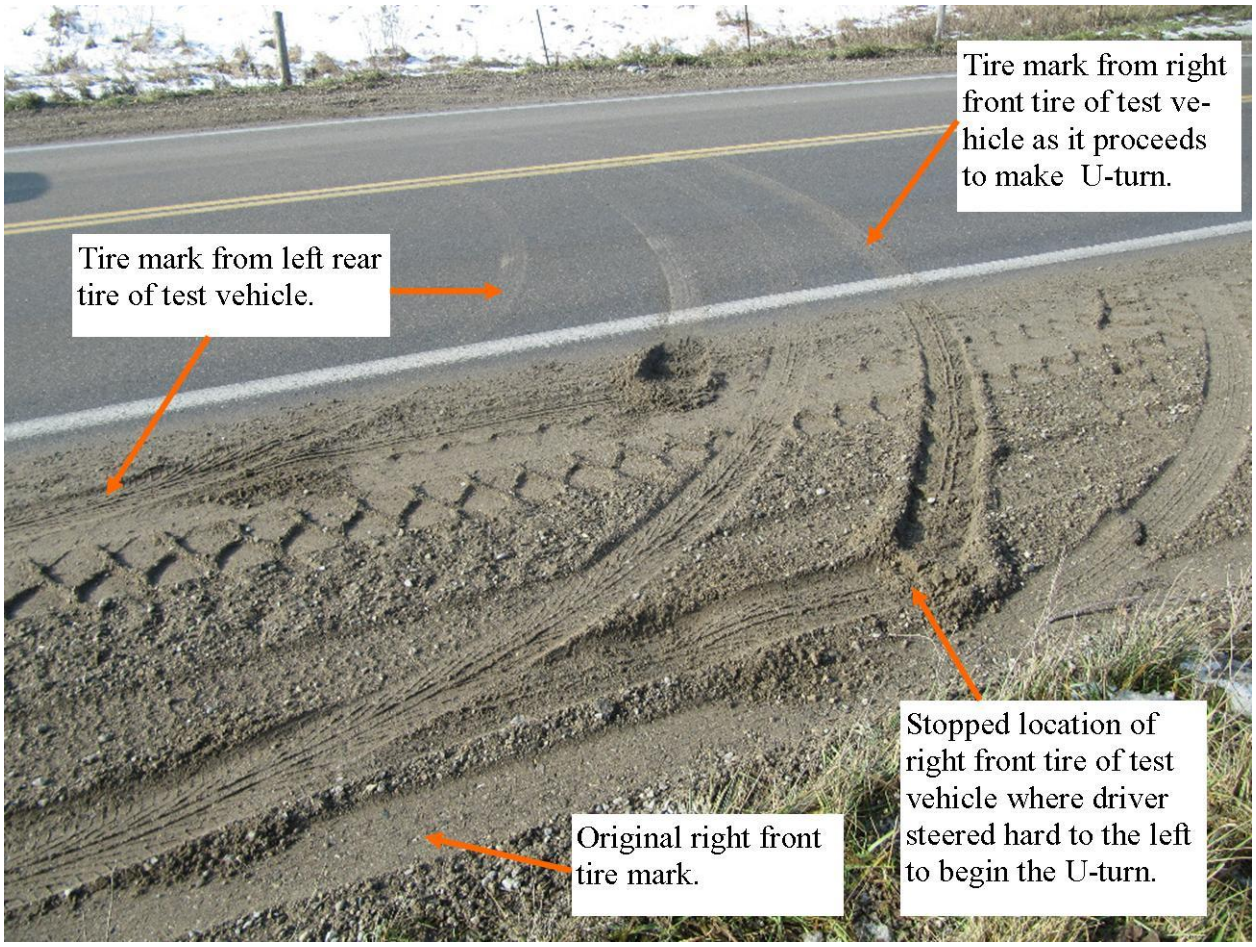

Figure 16: View of the stopped location of the test vehicle after it vacated the east shoulder.

One can clearly see the sharp change in direction of the paths of the front tires of the test vehicle as the driver steering hard to the left. Although not labelled one should also be able to detect the more gradual, curved path of the right rear tire of the test vehicle as its path separates from that of the right front tire. Thus there are various obvious differences in the paths and characteristics of the tire marks produced by the two right tires. These differences have now been demonstrated in several examples of in the three articles that have been written so far.

As an aside, the identification and discussion of all these tire marks has been done in a scenario where other tire marks exist on the shoulders that were created by other vehicles. In a closed course researchers might find it easier to point out the various features of tire marks as they are isolated without the interference of these extraneous marks. Our point is that, in the real world, the investigator will not experience these pristine conditions. When an investigator attends a collision site, or the site of any incident involving vehicular crime, there will be numerous tire marks, foot prints,

markings from debris, etc. that will interfere with the visualization of the evidence that is of relevance. Thus it is useful, using the setting that we do, to train investigators to separate the various layers of evidence that may originally appear to be some kind of Gregorian knot.

Returning to our example once again, Figure 17 shows the east shoulder from a view looking southward onto the tire marks. Once again labels have been provided to highlight some of the prominent features of the marks.

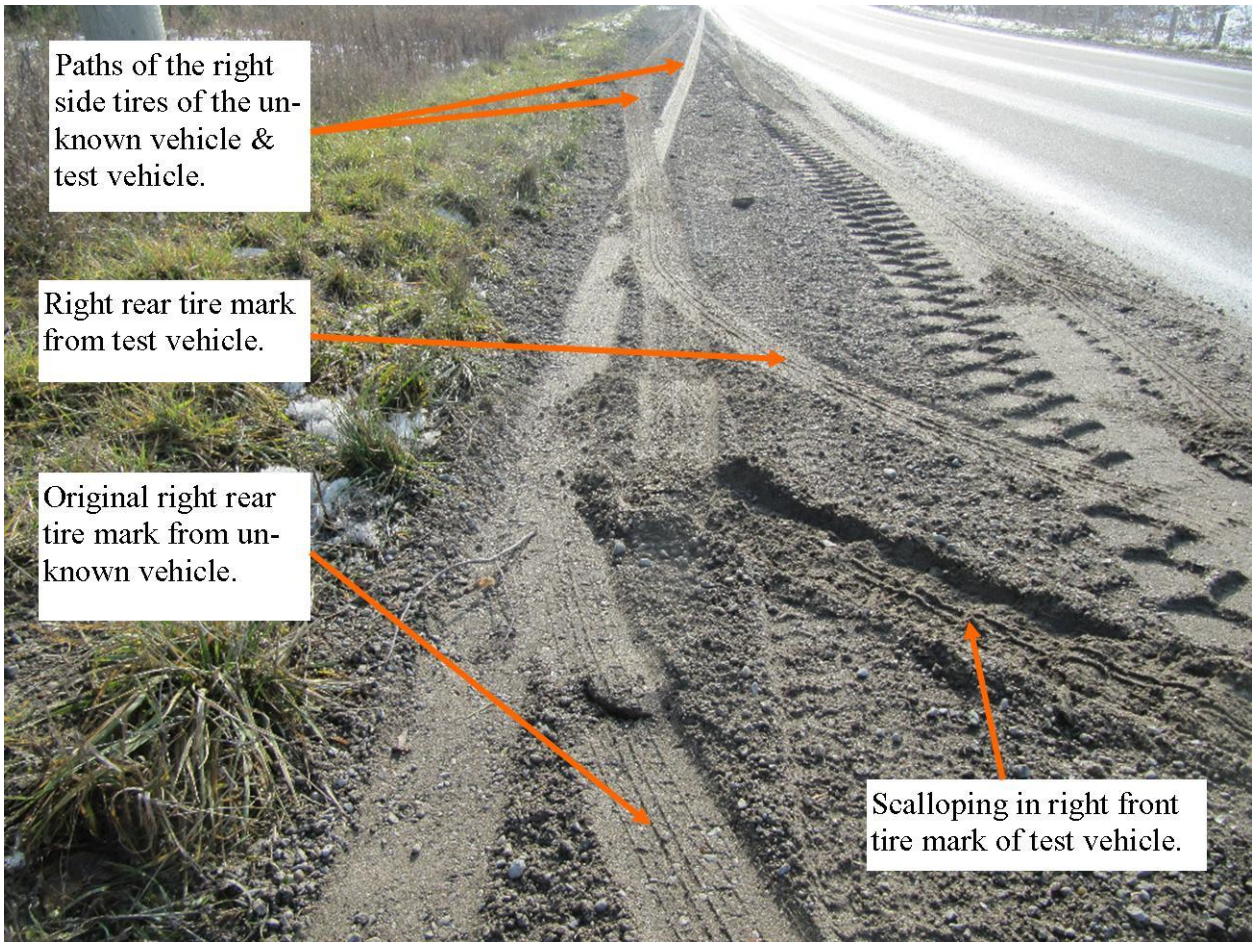

Figure 17: View, looking south, along the tire marks on the east shoulder of Clarke Road.

Looking onto the background of Figure 17, one can re-examine the paths of the right front tires of the two vehicles. It can be observed that the unknown vehicle has followed a very "straight line" path without changes in direction. Alternatively, our test vehicle demonstrates a prominent change in direction. First, the test vehicle exits the pavement at a sharper angle, then it straightens out to travel somewhat parallel to the shoulder. Again, these are signs of the differences in speed of the two vehicles.

As mentioned a number of times in previous examples, one can see the typical scalloping marks in the acceleration of the right front tire of the test vehicle as it begins its forward motion into the U-turn.

The tire marks on the west shoulder caused by the unidentified vehicle during the completion of its U-turn were previously shown in Figure 5. Now in Figure 18 the result can be seen after the test vehicle made a similar U-turn which created the two additional tire marks from its right side tires.

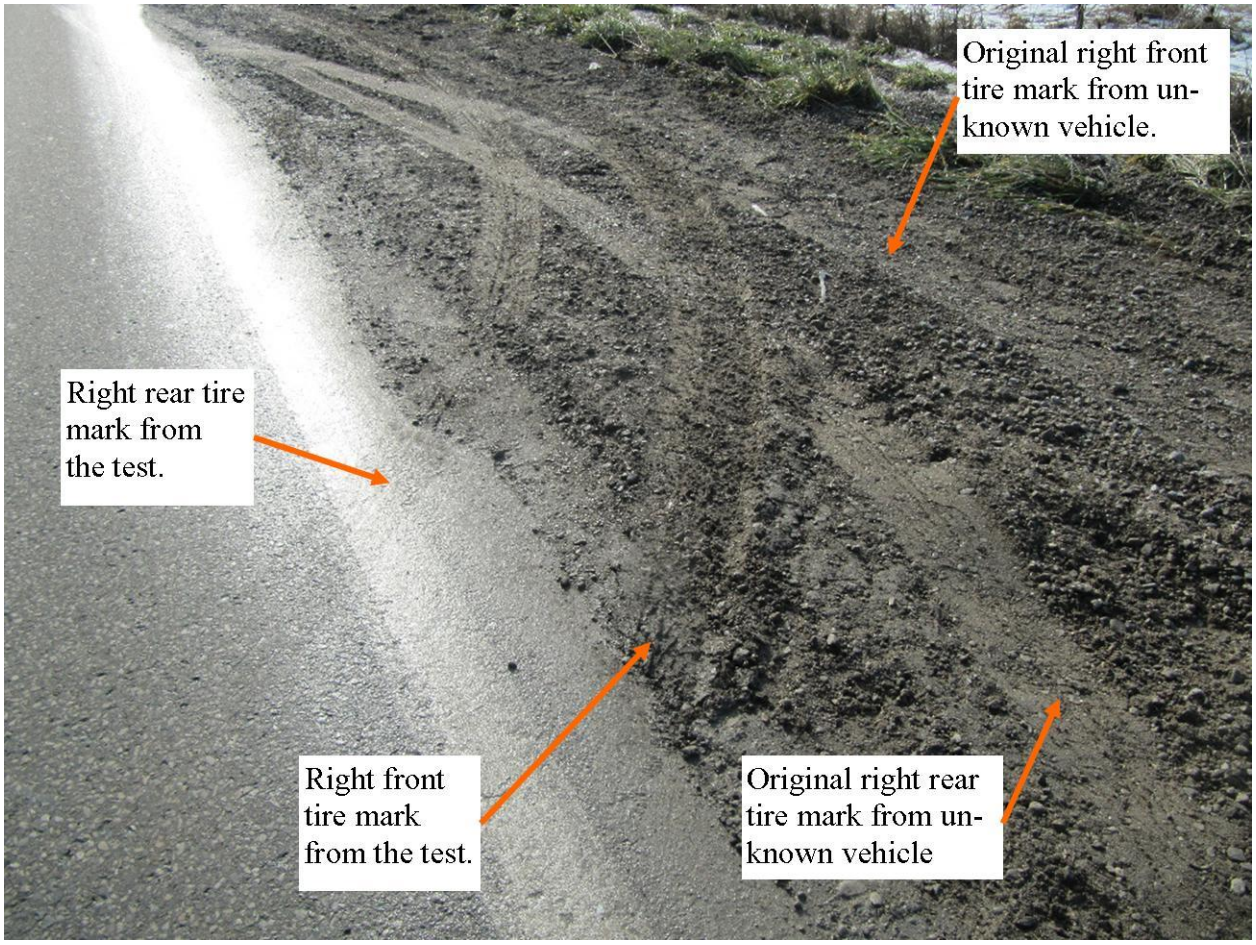

Figure 18: View of the right side tire marks of the test vehicle on the west shoulder superimposed over the marks of the unidentified vehicle.

We see the same general paths of two vehicles although the turn made by the unknown vehicle was a few metres north of the one made by the test vehicle. One might also recognize the slight roughening of the surface within the right front tire mark of the test vehicle. There is also a ridge on the outside edge of the right front tire of the test vehicle. The ridge is not visible on the inside edge of the mark. We also see the tread in the right rear tire mark of the test vehicle suggesting a lack of accelerative power being applied, in contrast to the acceleration indications of the right front tire mark. These observations are carried through to the southward view of the marks shown in Figure 19.

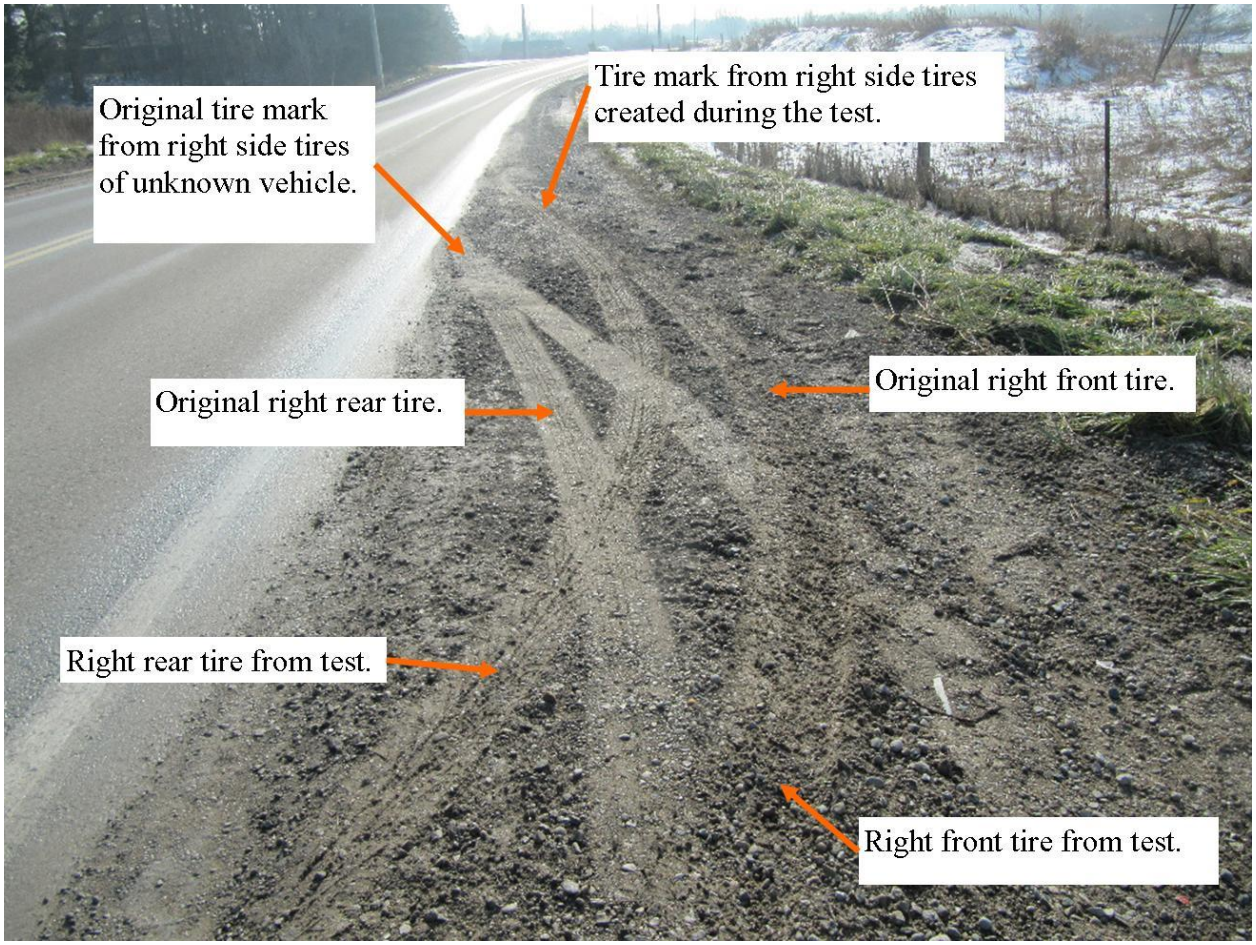

Figure 19: Figure 19: View, looking south along the west shoulder of Clarke Road showing the U-turn tire marks of the two vehicles.

When such tire marks are seen in a complicated collision scene or other crime scene, intertwined with markings of other vehicles performing other motions it can become somewhat taxing to separate everything and make sense of it all. This why we need to study the evidence from individual motions while doing so in a less complicated setting. As this study progresses into examining the more complicated sites of real life collisions it will be necessary to separate witness vehicles from old tire marks, emergency vehicle markings from collision evidence, and so on. This process can be challenging.