

Characteristics of Tire Marks During Acceleration on Gravel Shoulders - Part 1

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An Ontario police officer was killed when a vehicle accelerated from a gravel shoulder when he partially entered the vehicle after he opened the driver's door. As the driver and police officer struggled and the vehicle continued to accelerate the vehicle eventually rolled and pinned the police officer beneath it, resulting in the fatality.

A critical issue in the subsequent police investigation and trial was the intent of the driver and whether he deliberately caused the officer's death. The vehicle was not equipped with an event data recorder ("Black Box") therefore there was little information about the onset of the acceleration.

This is just a single example of the importance of understanding the characteristics of tire marks on a gravel shoulder. While many collision reconstruction agencies and courses discuss methods of determining vehicle speed there is actually no publicly-available instruction to students of motor vehicle accident reconstruction to guide them in the interpretation of tire marks on gravel shoulders. This fact is revealing as many police experts and others who must conduct such a reconstruction do so after the initial emergency vehicles and witness vehicles have trampled through the evidence. Yet there is no guidance to these experts to instruct them on separating those tire marks that occur post-impact, versus those that are related to the collision incident.

Similarly the activities of associated vehicles and witnesses prior to a collision are rarely evaluated based on the physical evidence in terms of tire marks that may reveal their activities. In some instances the issue of relevance is simple and a detailed evaluation of such tire marks is not necessary. However in other instances investigators rely on witness statements or the statements of previous investigators without studying the physical evidence of the tire marks on the site to confirm whether the statements match that evidence.

For these reasons Gorski Consulting 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. It is hoped that the results of these inquiries will be posted in a series of articles on the Gorski Consulting website. Given the extreme number of photographs that may be involved it will be necessary to conduct

this discussion in a series of many small steps, as the volume of photographs will otherwise make these such articles too lengthy.

In the opening of this series we present a case where a vehicle has travelled onto a gravel shoulder on a number of occasions and we will follow its path. The site of these occurrences takes us to Clarke Road north of Fanshawe Park Road in the north-east of the City of London, Ontario. This particular location is referred to as our "Laboratory" because of the number of observations and tests that have been performed here by Gorski Consulting over the last number of years. The site contains an unusual S-curve with causes vehicles to exit the paved road surface and therefore this is a good location to find a number of a loss-of-control and other tire marks on the shoulders.



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.

In the present case we will not be looking at tire marks from a loss-of-control collision. Rather we want to discuss the evidence that indicates that a vehicle has been accelerating on the gravel shoulder and what that evidence looks like. The vehicle in question was travelling northbound on Clarke Road, likely a few hours before our examination date of August 20, 2014. The vehicle continued to travel onto the east gravel shoulder of Clarke Road on a number of instances, including an instance where the vehicle stopped on the shoulder, reversed a short distance and then accelerated forward again.

We begin our discussion in Figure 2 where we see a northward view along Clarke Road just a few hundred metres south of the S-curve where most of the historical testing was conducted. Figure 2 shows a general view of the road surface along with the east shoulder where we will see the first instance of the vehicle's travel off of the pavement. As we look at the details of the tire mark on the shoulder we will recognize that there is a deceleration phase, a rolling-tire phase and then an acceleration phase accompanied by slight left steering as the vehicle re-entered the pavement.



Figure 2

Figure 3 shows that, as the vehicle exits the paved road surface its tire marks are not visible because the tires are rolling. Then, as the driver applies the brake the tires begin to slow their rotation thus there is a progressive increase in the slip of the tires across the gravel surface. This increase in slip causes an increase in the disturbance of the gravel surface until that disturbance begins to be visible as the tire mark.

A closer view of the tire mark produced by the right side wheels in Figure 4 shows how the visibility of the mark is increased as braking is increased. We see the obvious disturbance of the gravel and soil of the shoulder as the sliding tire moves across it.

In Figures 5 and 6 we see that the right side tires eventually move toward the edge of the grass and as they do the brakes are released such that we begin to see the tread of the tire within the tire mark in the background of Figure 6.

As the right side tires enter the grass it is possible to study the characteristics of the tire mark caused by the left side tires to determine the vehicle's status. Thus Figure 7 is a general view of the area where the left side tire mark becomes visible. Figures 8 and 9

show that the tire mark contains a visible tread indicating a reduction in the extent of braking.



Figure 3



Figure 4



Upon approach to the edge of grass braking is reduced as evidenced by lack of disturbance and beginning of visible tread within tire mark.

Figure 5



Closer view of tire mark near the edge of the grass showing how the gravel disturbance is reduced and the tread of the tire becomes visible as the tire begins an increased level of rolling and less braking.

Figure 6

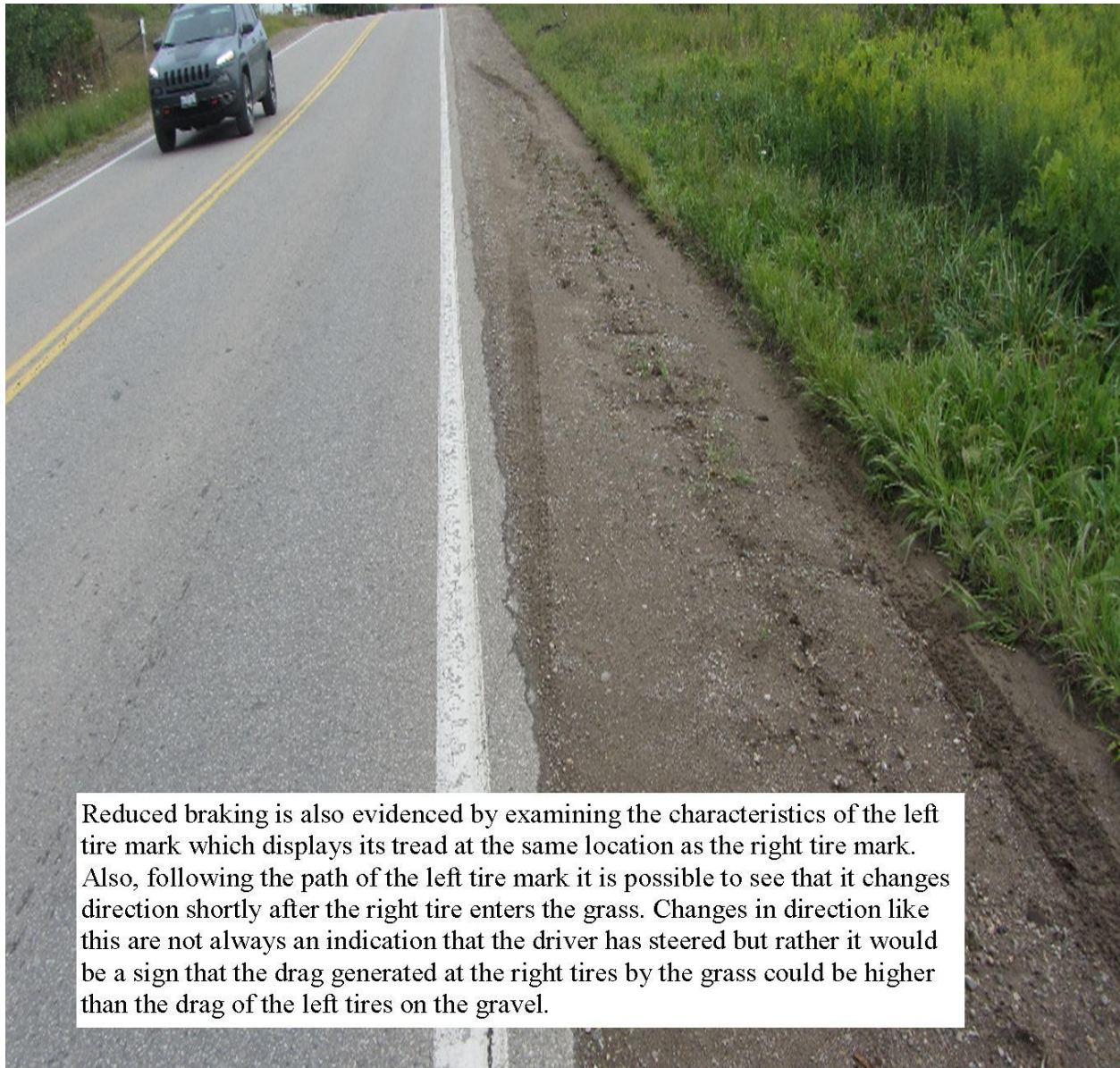
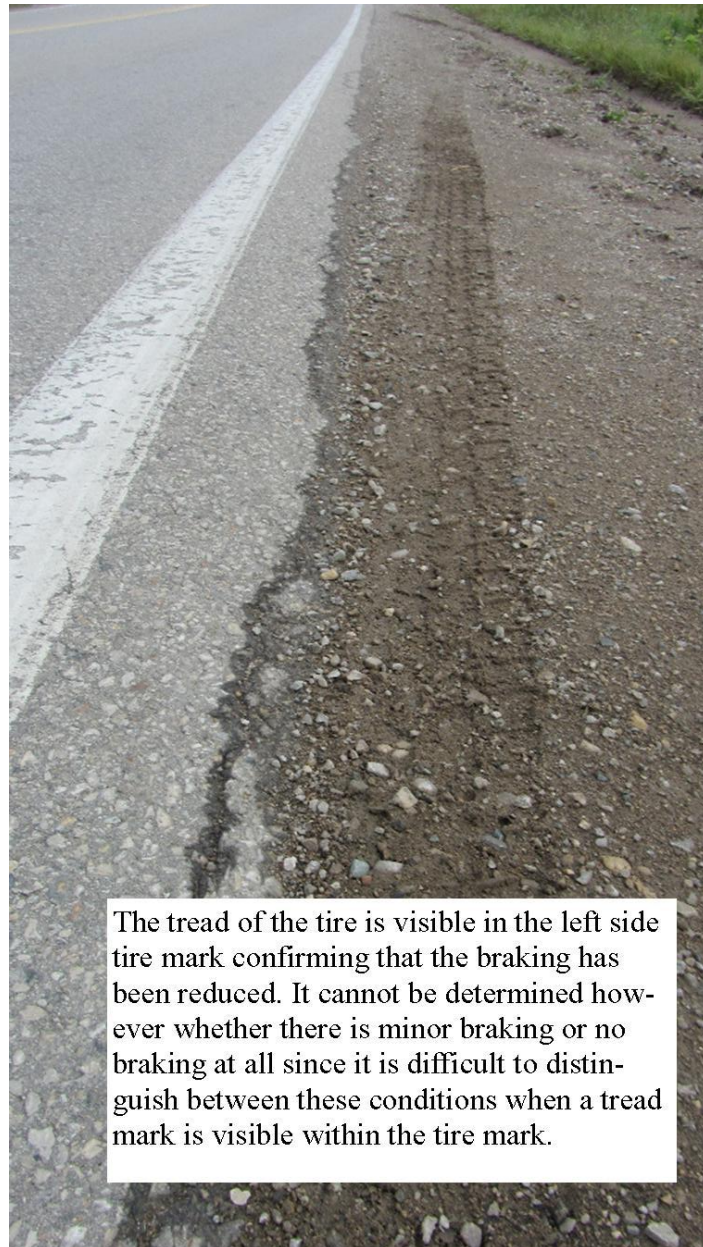


Figure 7



The tread of the tire is visible in the left side tire mark confirming that the braking has been reduced. It cannot be determined however whether there is minor braking or no braking at all since it is difficult to distinguish between these conditions when a tread mark is visible within the tire mark.

Figure 8



View of the tracking portion of the left tires. In the background the tire marks become dark as the gravel becomes disturbed by an aggressive acceleration.

Figure 9

It needs to be clarified that the presence of a visible tread in the tire mark does not indicate that there was no braking. It only indicates that, if braking was present, it was not sufficient to cause the tire to slide to the degree that the disturbance of the gravel/soil was visible to the investigator's eye.

As shown in Figure 10, after riding the shoulder for a short distance the driver steers slightly to the left and applies hard acceleration. The view of the tire mark produced by the left side tires results in the disturbance of the gravel/soil shown in the background of Figure 10. In Figure 11 the acceleration is recognized by the presence of equi-distant "scallops" within the tire mark where the sliding tire has pushed the gravel/soil rearwards during its slippage. As the sliding of the tire increases there is a full upheaval of the surface as shown in Figure 12, such that the scalloping is no longer visible.

As shown in Figure 13 the vehicle gains speed such that the extent of slippage of the tire is reduced and the extent of disturbance of the surface is reduced. Thus the visibility of the tire mark is also reduced.

This marks the end of the first instance of the vehicle's entrance onto the east shoulder. The vehicle re-enters the paved roadway and continues to travel northward for a couple of hundred metres to a location where it enters the south portion of the S-curve. Here, once again, the vehicle exits the paved roadway and re-enters the east shoulder. Figure 14 shows the location of the tire marks after they become visible on the east shoulder. In this case there is a small quantity of standing water on the edge of the shoulder near the edge of the grass.

Figure 15 shows the tire mark produced by the right side tires of the vehicle as it enters into a muddy area before entering the standing water. In the foreground of Figure 15 we can see a clear imprint of the vehicle's tread indicating, at least, that there is a lack of braking or acceleration, or that the tire is not slipping with respect to the surface. However, just before the tire enters the standing water, we see an upheaval in the mark such that the tread is no longer visible. This might suggest that there was either some braking or acceleration involved. While this is a possibility it also needs to be understood that, in an area of a muddy surface the mud tends to cling to the tire and this might cause the disruption of the surface irrespective of any braking or acceleration. Figure 16 shows a closer view of the transition between the tracking tire and the upheaval prior to entering the standing water.

When in doubt about the conditions at the right side tire mark, it is possible to examine the characteristics of the tire mark caused by the left side tires. Figure 17 shows a southward view of the east shoulder near the standing water and the left side tire mark is visible at the right edge of the view, while the right side tire mark is in the water/grass. It is possible to see the scalloped marks within the left side tire mark. Figure 18 shows a closer view of that left side tire mark and it clearly shows the scalloped markings indicative of acceleration. Thus, when there is uncertainty within one tire mark it is possible to gain further insight by looking at the characteristics of the mark produced by the tires on the other side of the vehicle.



The tire mark caused by the left side tires shows a sudden change in character as the vehicle is accelerated aggressively producing the disturbance of the gravel in the background.

Figure 10

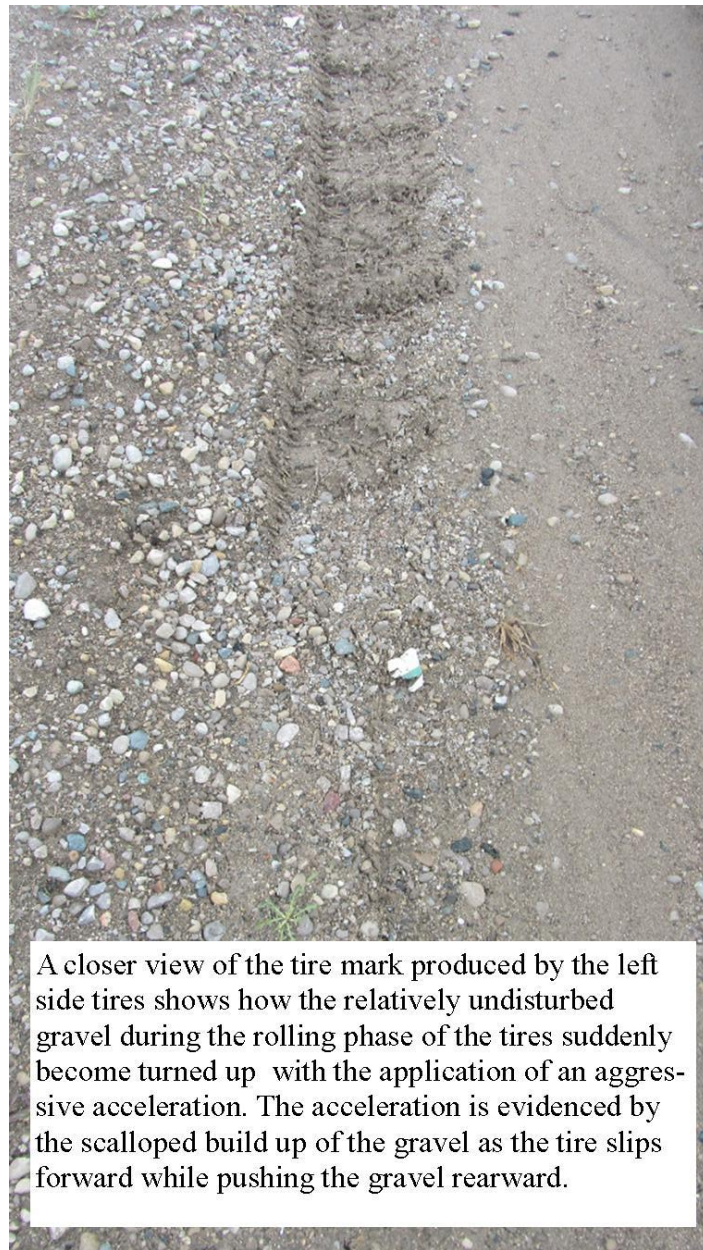


Figure 11



As the acceleration continues the scalloped character of the tire mark changes to a full upheaval without pattern of specific markings with the mark.

Figure 12



Figure 13

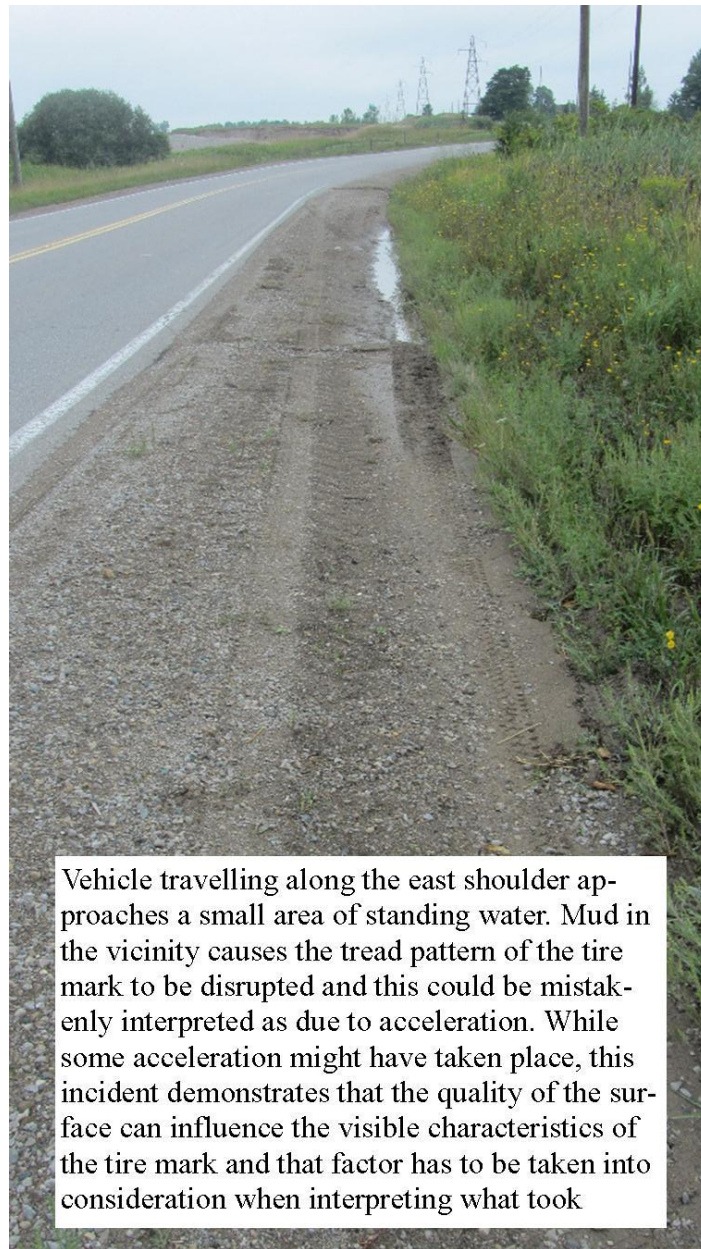


Figure 14



Closer view of right tire mark as it approaches an area of standing water. While there could be some acceleration that causes the tread of the mark to be disturbed, the other factor that needs to be considered is that the mud in the vicinity of the water can be lifted up and disturbed even when a tire is simply rolling over it.

Figure 15



View of right side tire mark travelling over some mud on the east shoulder. The disruption of the tread pattern needs to be carefully evaluated as to whether it occurred from acceleration, due to the special characteristics of the muddy surface, or from a combination of both.

Figure 16



A view looking back toward the south, shows the left side tire mark which contains the scalloped indications of acceleration. Thus, examining the characteristics of the left side tire mark can help to interpret the meaning of the markings in the right side tire.

Figure 17



View, looking south, at the scalloped acceleration markings in the left side tire mark indicating that acceleration was taking place.

Figure 18

Figure 18 provides the last view of the second acceleration of the vehicle on the east shoulder. Following this the vehicle re-enters the paved road surface for a second time and continues northward again. It passes through the S-curve and near the end of that curve it is steered off the paved surface and back onto the east shoulder for a third time. However, during this third exit the tire mark evidence becomes more complicated as the vehicle stops on the shoulder, reverses, then stops a second time before accelerating forward while travelling north on the east shoulder. The explanation of the next few tire marks will be challenging however this also offers an opportunity for readers to learn to detect the differences in the characteristics of the tire marks and how it is possible to differentiate one set of tire marks from another.

Figure 19 provides an overall view of the east shoulder of the Clarke Road at the north end of the S-curve in the vicinity where the vehicle exited the paved road surface. The tire marks that reside there are not very visible in this view.

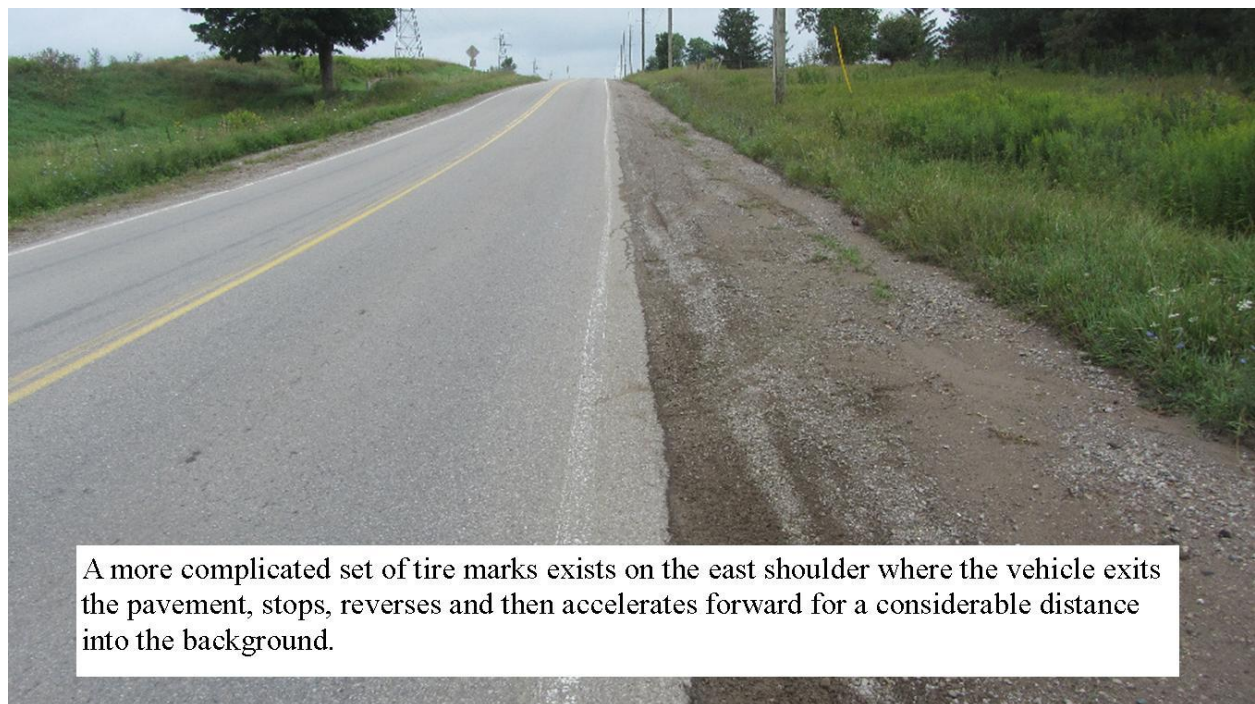


Figure 19

However, as we approach closer to the tire marks we can see in Figure 20 that those marks start to be visible. If one looks in a direction in line with the closest utility pole in the background of Figure 20 it is possible to see some faint tire marks travelling at a diagonal to the length of the shoulder. These marks were caused by the vehicle as it initially exited the pavement and entered the shoulder. Because these marks were created first, portions of these marks were destroyed by the vehicle as it reversed over them and then accelerated over them upon leaving the area. So the challenge is to describe these various marks in a way that can be understood.



Figure 20

In Figure 21 we show a closer view of the tire marks and an orange arrow points to the location of the diagonal tire marks that were generated when the vehicle entered the shoulder.

Figure 22 shows an even closer view where the diagonal tire marks are well visualized. Here we can see (in the foreground) the left side tires of the vehicle as it reversed and then accelerated over the same location.

In the foreground of Figure 23 we see the end of the tire mark produced by the right side tires at the point where the vehicle stopped its reversing. From this end point the vehicle then accelerated forward (away from the camera) over the original, reversing tire mark. Thus the last characteristics that we see in this mark are those of acceleration. Figure 24 shows a close-up of the end of the tire mark where the vehicle stopped reversing and then accelerated forward.

Figure 25 shows the right side tire mark which contains the obvious scalloping imprints within the mark which is indicative of acceleration.

In Figures 25 and 26 we see a somewhat oval looking imprint just to the left of the acceleration tire mark produced by the right side tires. This oval impression is where the right front tire came to a halt at the end of the reversing motion. If one looks closely at the top of Figure 26 the faint imprint from the tire's reversing can still be seen just to the left of the acceleration mark. The reversing mark contains the imprint of the tire's tread.



Figure 21



This northward view shows the initial, rolling tire marks of the right side wheels as they move diagonally across the shoulder. The initial marks are disrupted by the markings produced by the vehicle's return to the location during reversing and then the final acceleration forward.

Figure 22



View of the prominent tire mark produced by the right side tires of the vehicle as it reversed toward the camera, stopped in the foreground and then accelerated over the same location. The initial rolling tire marks from entering the shoulder can be seen at the upper left of this view.

Figure 23



This view shows the location where the right rear tire of the vehicle stopped after it had been reversing toward the camera. The vehicle then moved forward, away from the camera and produced the upheaval in the tire mark that can be seen in the background.

Figure 24



Figure 25

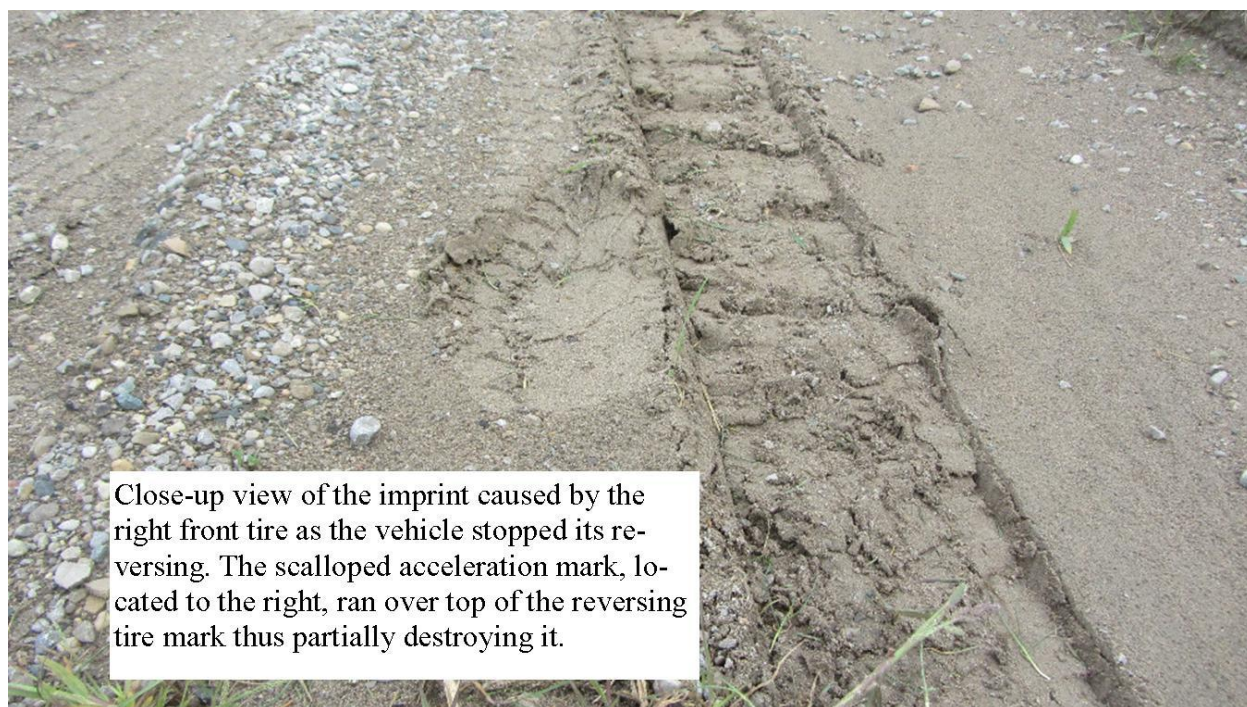


Figure 26

To help clarify the previous descriptions, Figures 27 and 28 provide views looking south with labels that describe the various tire marks.

Figure 29 provides a southward view of the location where the vehicle stopped its forward motion onto the shoulder and before it started reversing. Of course this view also shows the acceleration tire marks that rode over the reversing tire marks and erased those reversing tire marks.

Figure 30 provides a close-up view of only the right side tire marks and this is at the location where the vehicle stopped and began its reversing motion.

The vehicle accelerated in a forward (northward) direction after having stopped its reversing motion. This forward acceleration was on the east shoulder and the vehicle continued in a generally straight path for another approximate 100 metres without returning to the paved road surface. This travel on the shoulder can be seen in Figure 31 (northward view) and Figure 32 (southward view). The left side tires are riding on the paved surface while the right side tires on the gravel shoulder thus only the single tire mark from the right side tires is visible.

As the vehicle tracks up a slight incline the right side tire mark become less visible as noted in Figure 33. The vehicle also begins to move slightly toward the grass edge such that the left tires also enter the shoulder. When the tires of both sides of the vehicle are on the shoulder the vehicle commences another short acceleration as shown in Figure 34. As shown in Figure 35 (left side tires) and Figure 36 (right side tires) the scalloped imprints within the tire marks are an indication of that acceleration.

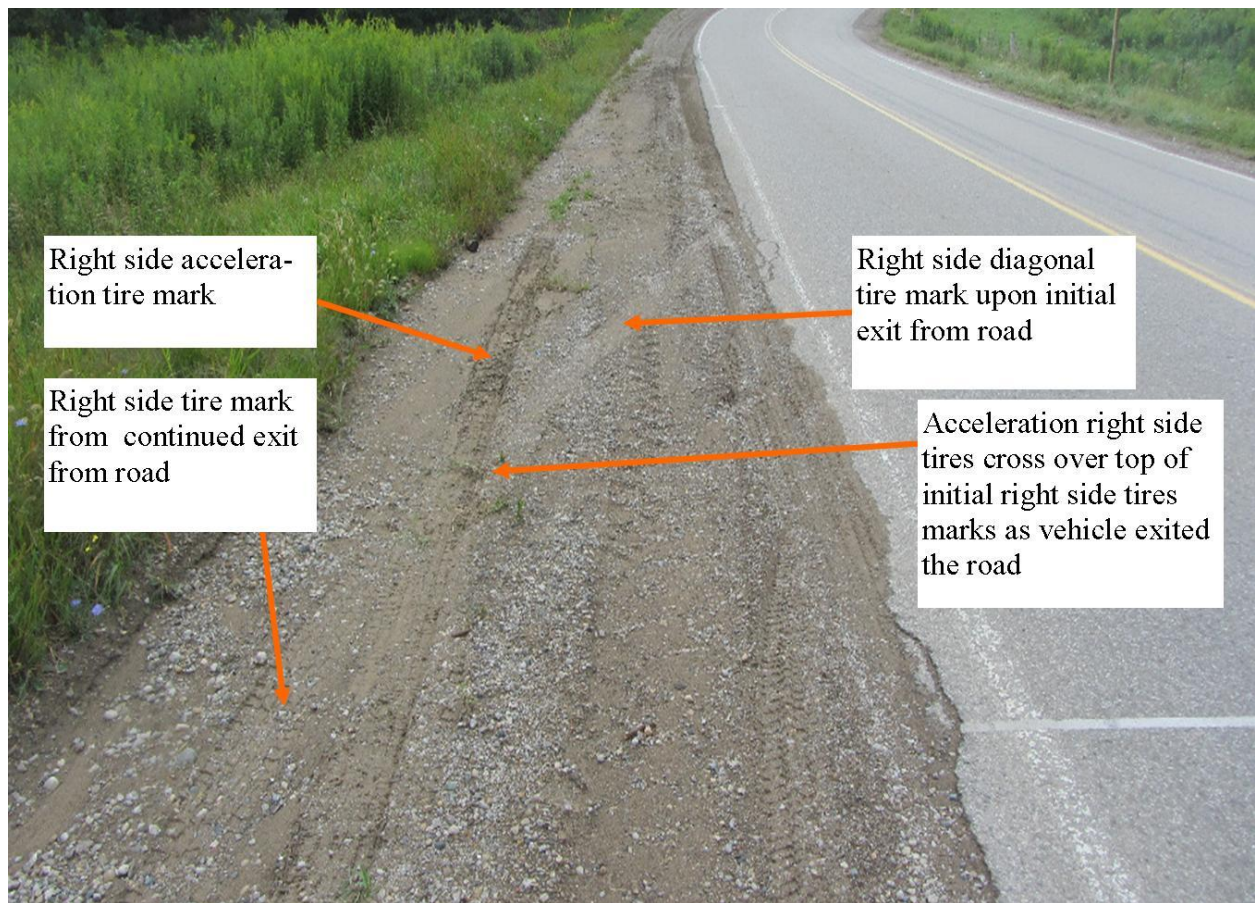


Figure 27

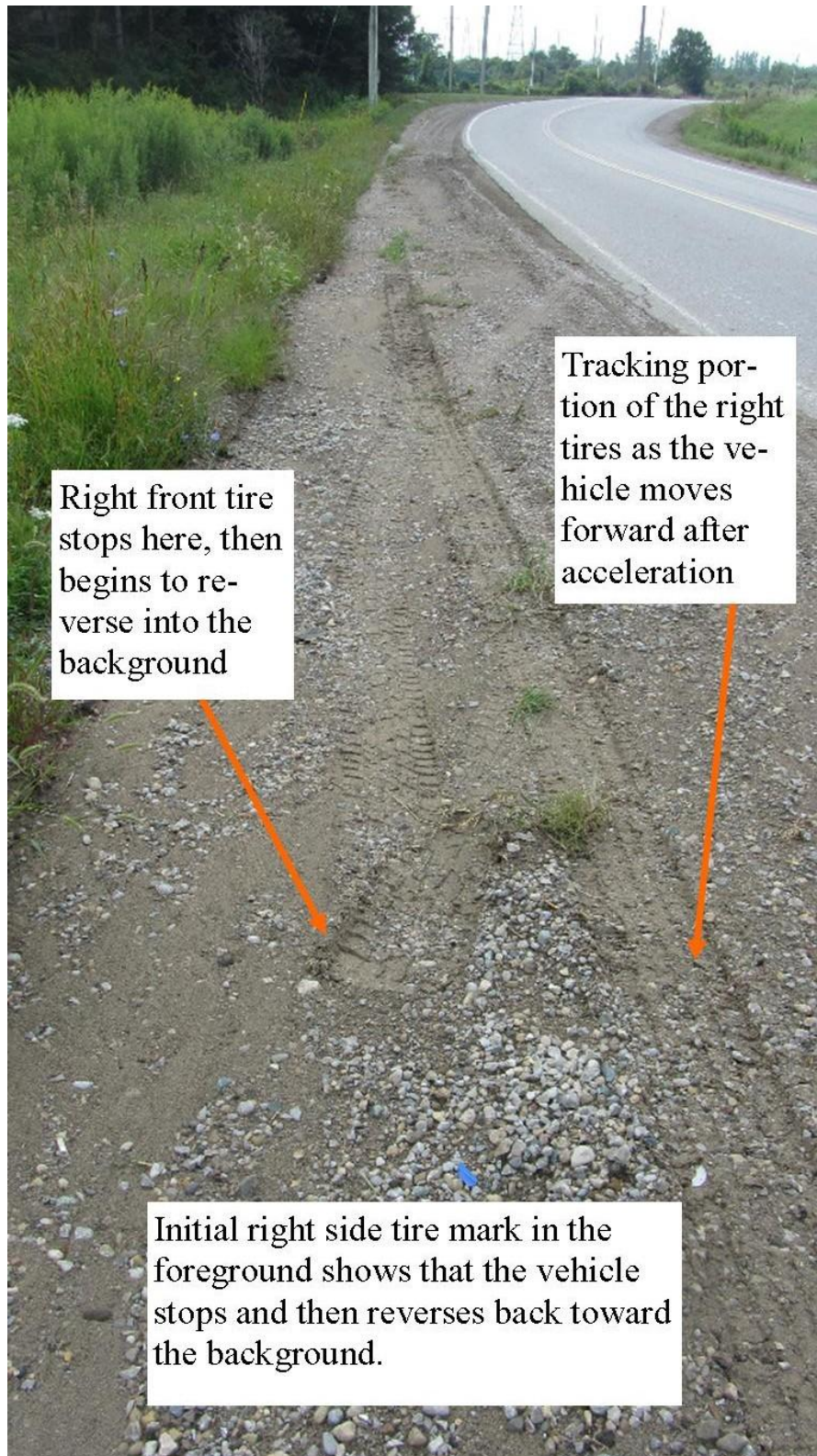


Figure 28



Figure 29

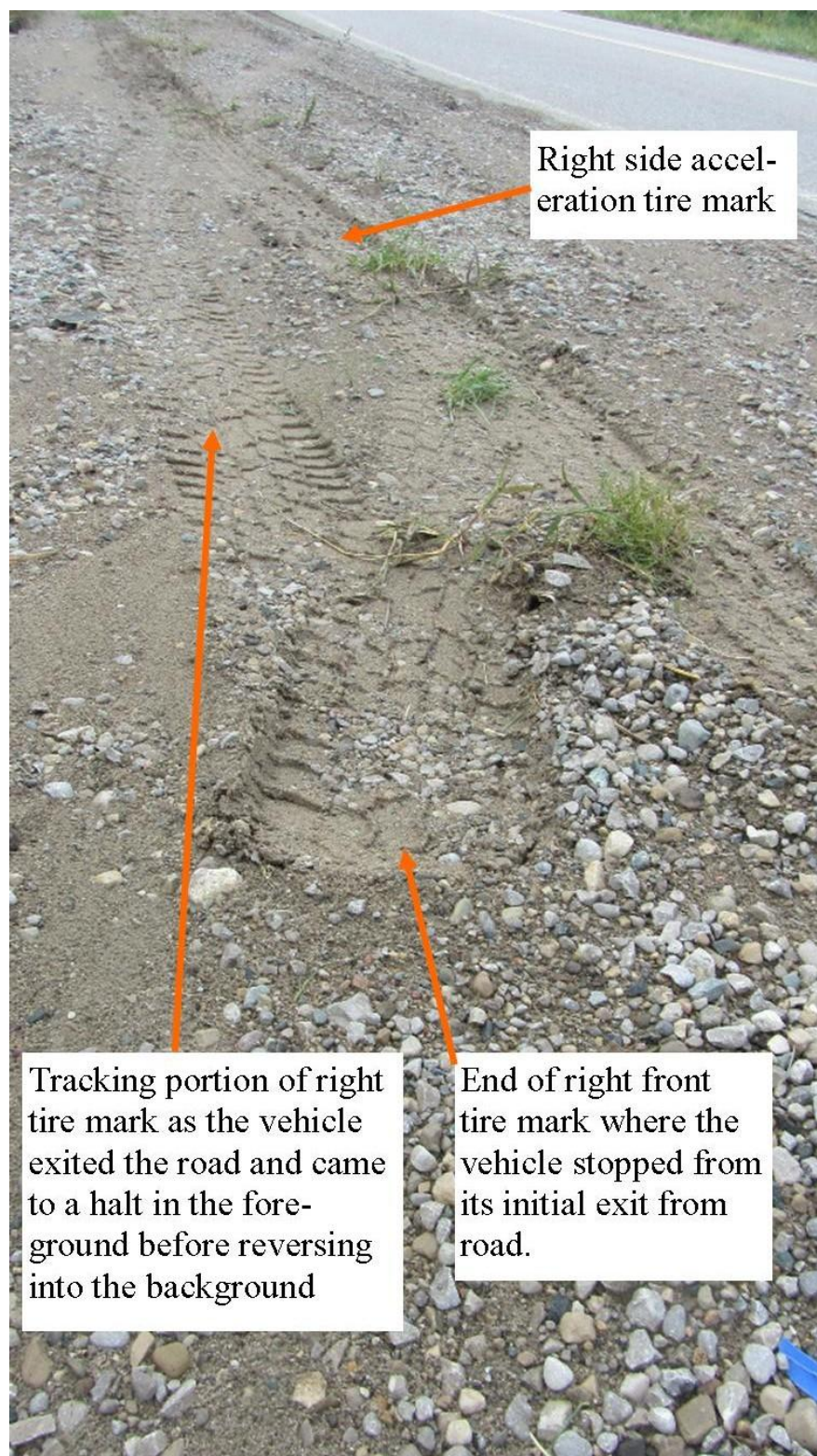


Figure 30

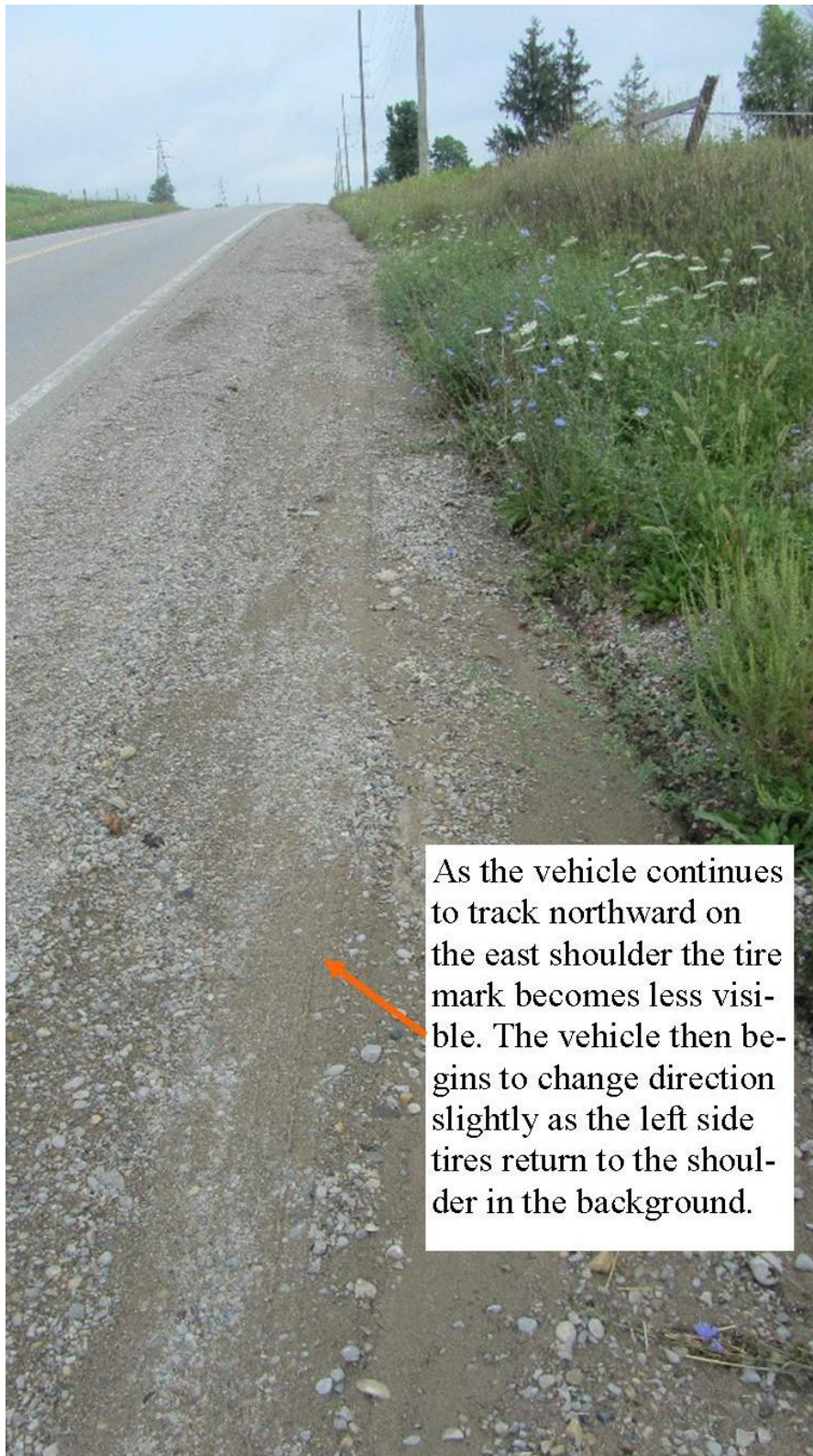


Tracking portion of the tire mark produced by the right side tires as the vehicle proceeds further north along the east shoulder.

Figure 31



Figure 32



As the vehicle continues to track northward on the east shoulder the tire mark becomes less visible. The vehicle then begins to change direction slightly as the left side tires return to the shoulder in the background.

Figure 33

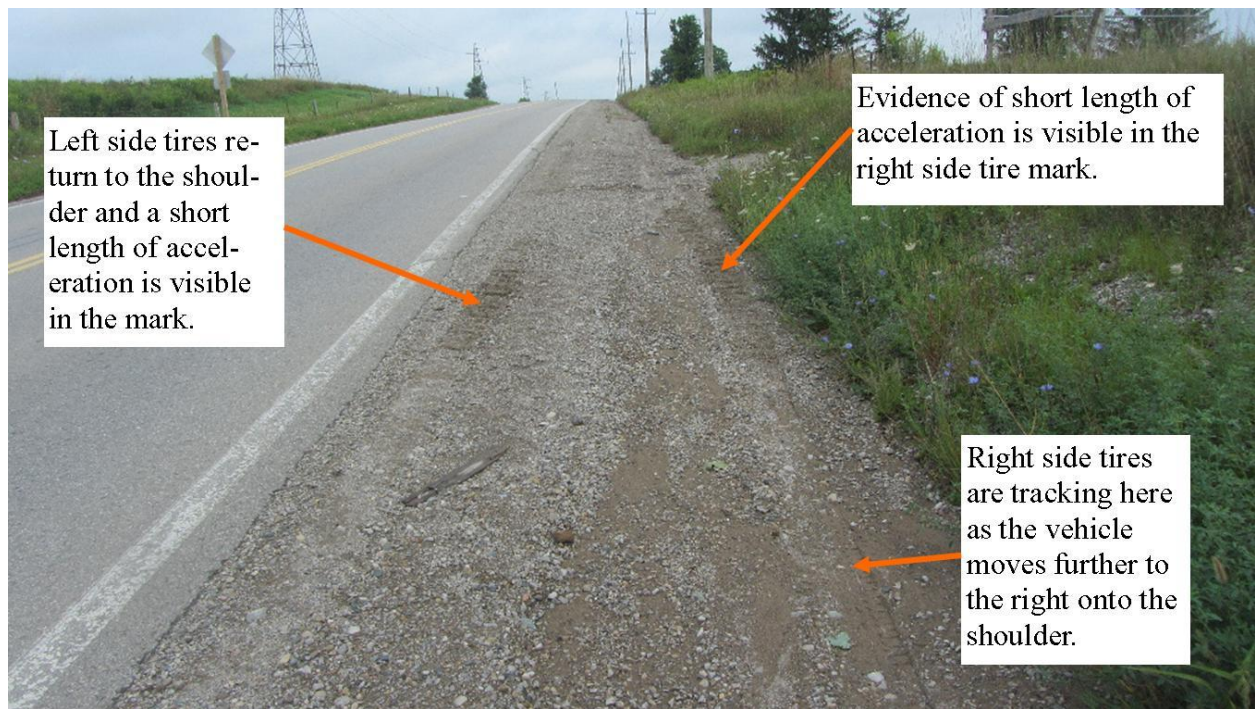


Figure 34

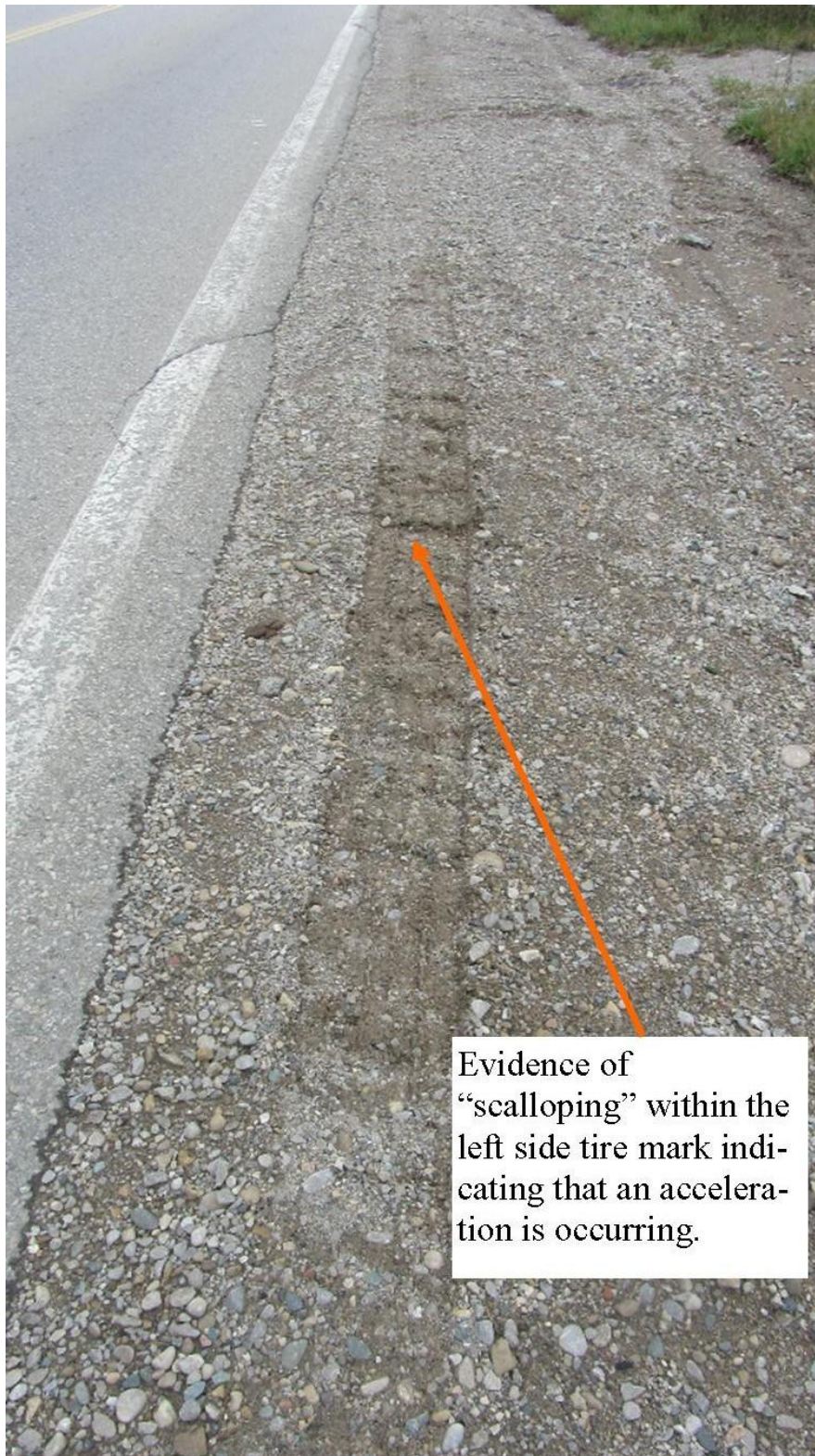


Figure 35



Figure 36

Although not previously discussed the reader should note that the vehicle producing these tire marks was a rear-wheel drive vehicle. We will allow readers to review all the previous photos to develop an understanding why that is so rather than being told. After some thought the reason should become obvious. However, the obvious difference between front wheel drive and rear wheel drive acceleration marks will be discussed in further articles.

In summary, this first article in the series has followed a single vehicle as it entered and exited the east shoulder of Clarke Road on several occasions. We observed four incidents of hard acceleration and one incident of the vehicle reversing on the shoulder.

This is a curious set of evidence as one would wonder what the driver's intentions were. Was the driver looking for something along the roadway. Was the driver waiting for something to come along the road? Why the sudden bursts of acceleration? It raises questions that, without further information, cannot be resolved.

However, one might consider, what if this vehicle had been involved in some kind of significant collision with another vehicle after all of these motions on the shoulder? Would it not be useful for police or other investigators to be able to detect these tire marks and identify their meaning? What if there had been witnesses to the hypothetical collision, would it not be useful to compare those statements to the pre-collision motions that were determined in the tire marks? Surely, the study of such evidence is of value not only in the reconstruction of motor vehicle collisions but also in the study of any significant incidents where investigation is required.

In many incidents of significant motor vehicle collisions, primarily in rural environments, many vehicles end up stopping or passing through a gravel shoulder. Sometimes the collision-involved vehicles enter a shoulder before a collision. Sometimes vehicles with indirect involvement in a collision may enter a shoulder and then the driver's attempt to re-enter the paved road leads to interference, loss-of-control and an impact between other vehicles. In other instances witnesses travel onto a gravel shoulder and their vehicles perform motions that may reveal something about the truth of the witness information. Still in other instances initial police arrival, ambulance, fire and other emergency vehicles stop on shoulders and their creation of tire marks must be eradicated from the evidence of the actual incident. All these instances demonstrate that a thorough understanding of tire marks on gravel shoulders is a useful tool in the investigator's toolbox.

In the modern age the sophistication of vehicular sensors and modules may appear to demonstrate that the investigator's knowledge of the physical evidence related to motor vehicle collisions is passé. The reconstructionist only needs to plug into a Diagnostic Link Connector (DLC) with some scanning instrument and everything worth knowing will be fully revealed. That notion is as false as any previous belief that a utopia is just around the corner. Indeed technological sophistication only means that new problems and questions will emerge to replace those that would appear to be solved. Our problem may be that the new problems and questions may become more complicated to solve in line with the complication of our new technology.

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