National Transportation Safety Board
Office of Highway Safety
Washington, DC 20594

HWY23FH013

HIGHWAY FACTORS–TECHNICAL RECONSTRUCTION

Group Chair's Factual Report

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A. CRASH

Location: Millersburg, Marion County, Oregon
Date: May 18, 2023
Time: 02:05 p.m. PDT

B. HIGHWAY FACTORS–TECHNICAL RECONSTRUCTION GROUP

Group Chair	Robert Squire National Transportation Safety Board Washington, DC
Group Member	Lieutenant Christopher Zohner Oregon State Police
Group Member	Carol Cartwright Keith Blair Oregon Department of Transportation

C. CRASH SUMMARY

For a summary of the crash, refer to the *Crash Information and Summary Report*, which can be found in the NTSB docket for this investigation.

D. DETAILS OF THE INVESTIGATION

For this investigation, the Highway Factors and Technical Reconstruction Groups combined tasks to address the respective relevant investigative areas. In support of these tasks the combined group relied upon information, data and documentation provided by the Oregon State Police (OSP) and Oregon Department of Transportation (ODOT). In addition to this support, the group conducted on-scene documentation of the crash location and the involved vehicles. Factual reports prepared by other NTSB investigative groups should be consulted for information related to other aspects of the investigation, including additional information referenced within this report.

The crash involved the collinear impact of three combination vehicles – two commercial truck tractors towing semitrailers and a light duty vehicle towing a small utility trailer. The basic vehicle descriptions included a 2018 Freightliner Cascadia Truck tractor in combination with a 2014 Utility semitrailer (Freightliner combination 1), a 2001 Ford E-350 van towing a small utility trailer (Ford combination) and a 2024

Freightliner truck tractor in combination with a 2024 Utility semitrailer (Freightliner combination 2).[1]

At the time of the collision the Freightliner combination 2 and Ford combination vehicles were stopped on the right shoulder of northbound Interstate 5 near mile point 241 and were subsequently struck in the rear by the Freightliner combination 1.

1.0 Crash Location and Highway Prefatory Information

The crash events occurred on the right shoulder of northbound Interstate-5 (I-5) near mile point 241 about 2.5 miles north of Millersburg, Oregon. Identified as Pacific Highway and maintained by ODOT, this area of I-5 is oriented north-south exhibiting headings of 5° and 185°, respectively. In total, ODOT is responsible for about 308 miles of I-5 through the state. The crash occurred adjacent mile point 241 located between the exit and entrance ramps of the Santiam River Rest Area.[2]

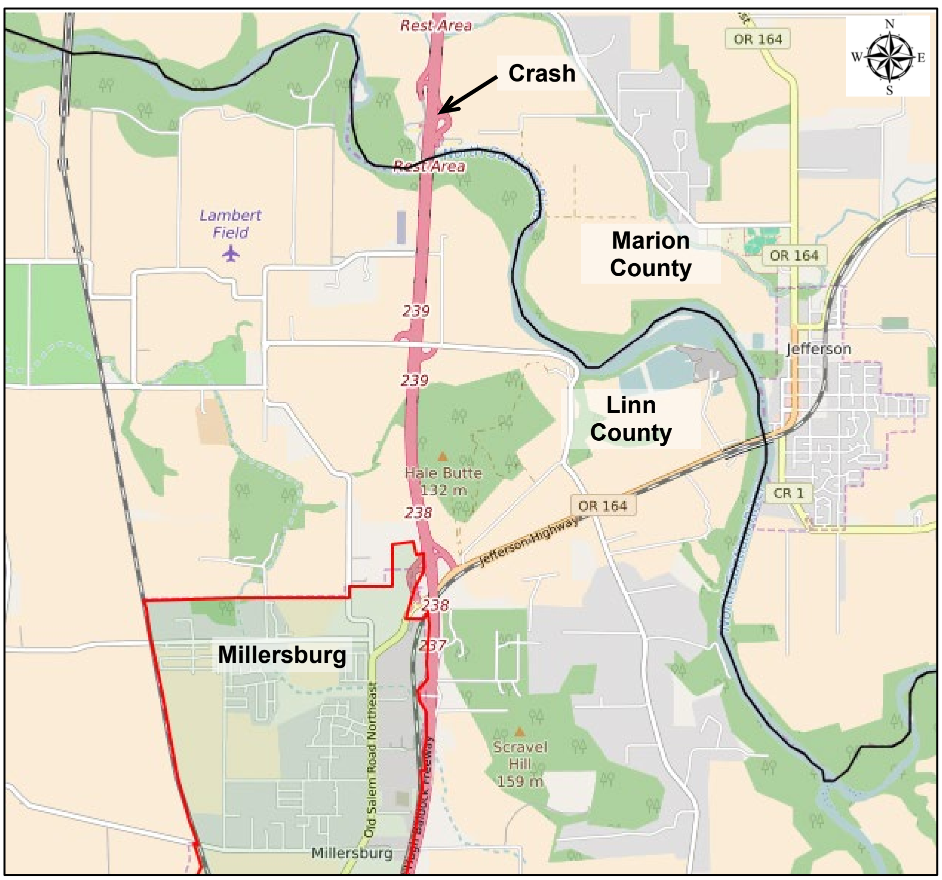

Figure 1: Area map depicting crash location in relation to the city of Millersburg.

[1] Certain vehicle information was acquired from other sources and could not be corroborated.
[2] Mile point numbers increase in the northbound direction of travel.

The shoulder area at this located exhibited an approximate width of 24-25 feet. The approximate geographical coordinates at the site are 44.741842°N / -123.051938°W.

1.1 Highway Prefatory Information

In general, I-5 is a north-south highway with the north- and southbound roadways separated by an earthen median. The crash occurred along a tangent highway segment that began just over 1.6 miles south of the site and continued at least 0.6 miles further north. The northbound roadway featured two travel lanes, each measuring about 12 feet in width and paved shoulders adjacent the left and right travel lanes having nominal widths of six and 10-12 feet, respectively. Nominal cross slope percentage was two percent across the travel lanes and up to 5% on the shoulders. The original construction of I-5 that encompassed the crash site was completed in March 1957. ODOT reported that a reconstruction of the northbound lanes was completed in May 1993 followed by surface repaving in April 2017.

Through the crash area, the northbound roadway exhibits atypical shoulder widths. The crash occurred on the right shoulder between the I-5 exit and entrance ramps to the Santiam River Rest Area that exhibits a width of 24-25 feet. The wide shoulder extends about 1,080 feet as measured between the ramp gores.[3] The median and left shoulder widths measured about 40 and 17-18 feet, respectively.[4] Regarding vertical alignment, the roadway exhibits a descending grade of 1.5% through the crash area as the roadway continues to descend from the Santiam River bridge about 1,266 feet to the south.

Broken white pavement striping separates the two northbound travel lanes. The lanes are further delineated by solid white and yellow pavement striping designating the right and left shoulders, respectively. The pavement markings exhibited no visible deficiencies. Street lighting is present around the ramps and right shoulder of the highway main line around the rest area exit and entrance ramps. The highway speed limit is posted at 60 mph for trucks and 65 mph for other vehicles.[5] Milled shoulder rumble strips were observed on the left and right shoulders through the highway segment exhibiting the wider shoulder area. For the right shoulder, the rumble strips began around the physical gore at the rest area exit ramp.

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[3] The term "gore" is defined as a triangular plot of land as designated when a road forks at the intersection with second road, or merges on and off from a larger one that may also be distinguished by pavement striping.

[4] These widths varied along other segments of the highway.

[5] Oregon Revised Statute §811.111 defines motor truck with a gross vehicle weight rating of more than 10,000 pounds or a truck tractor with a gross vehicle weight rating of more than 8,000 pounds. Certain passenger transport vehicles may also be subject to the lower posted speed limit.

The wide shoulder on which the crash occurred can be described as a linear extension of the dedicated exit into the rest area. At the north end of the bridge, the exit ramp begins a rightward heading toward the rest area. The dedicated exit (exit only) lane begins about 1,960 feet south of the bridge or about 4,050 feet from the area of impact.[6] About 590 feet before the north end of the Santiam River bridge the broken white dashed line that designated the exit-only lane changes to a solid white line. The pavement striping creates a gore area beginning at the north end of the bridge. The ramp continues along a tangent for about 800 feet before transitioning to a 360-foot radius rightward curve that creates a heading change of about 224°. **Figure 2** depicts a Google Earth aerial view of I-5 area adjacent to the Santiam River.

Two overhead cantilever supported signs designate the far-right lane as an exit only lane for the rest area. The blue informational service signs state "rest area travel info center" also display a yellow "exit only" panel. The first sign is located about 1,980 feet south of pavement striping gore area where the exit ramp diverges from the highway mainline and the second about 170 feet past the gore. **Figures 3** and **4** depict the rest area exit-only signage observed during the site examination.

The highway exit ramp led into the rest area where a sign directs parking for "cars" and "trailer and trucks". The northbound rest area had 13 parking spaces designed for large and combination vehicles (includes any vehicle towing a trailer).[7] The southern edge of this area also had designated parking stalls for single, light duty vehicles.

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[6] Distance includes about 350 feet of taper at the onset of the dedicated lane.
[7] Examination of the southbound rest area found a total of 11 parking spaces designated for large and combination vehicles.

Figure 2: Modified Google Earth image depicting Interstate-5 and the adjacent rest areas.

Figure 3: Cantilever supported informational service sign stating "rest area travel info center" with a yellow "exit only" panel located about 1980 feet south of the ramp gore.

Figure 4: Cantilever supported informational service sign stating "rest area travel info center" with a yellow "exit only" panel located about 170 feet past the ramp gore.

1.2 Traffic Volume and Vehicle Classification

ODOT reported an annual average daily traffic (AADT) volume of 66,723 around the 241.1-mile point for both the north- and southbound roadways. Volume was nearly divided equally between the two roadways with a reported AADT of 33,579 for the northbound roadway and 33,144 for the southbound roadway. Traffic volume data was also provided for the northbound rest area exit and entrance ramps. The AADT for the highway exit ramp leading to the rest area was reported at 966, while the return to highway ramp was reported at 1,080. The pass-through roadway that connects the two rest areas reported an AADT of 295.

Vehicle classification data depict that about 84% of vehicles traveling this segment of I-5 classify as light duty (passenger vehicles, pickups, and vans). Just over 15% are heavy duty trucks with nearly 12% identified as combination vehicles. **Table 1** depicts vehicle classification data.

Table 1: I-5 vehicle classification data[8]

FHWA Vehicle Class	Description	Percent
1	Motorcycle	0.3
2	Passenger car	65.1
3	Pickup, van	19.1
4	Buses	0.2
5	Single unit truck - 2 axle (6 wheels)	2.8
6	Single unit truck - 3 axle	0.5
7	Single unit truck - 4+ axle	0.1
8	Single trailer - 3 or 4 axles combined	1.1
9	Single trailer - 5 axle combined)	8.6
10	Single trailer - 6+ axles combined	1.2
11	Multiple trailer - 5 or less axles combined	0.1
12	Multiple trailer - 6 axles combined	0.1
13	Multiple trailer - 7+ axles combined	0.8

[8] For additional information on vehicle classification see https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/13091/002.cfm

1.3 Crash Data

ODOT provided highway crash data for a two-mile segment of I-5 between mile points 240 and 242, covering about one mile north and south of the crash site, over a five-year period from 2017 through 2021. Annual totals are presented in **Table 2**.

Table 2: I-5 crash history mile points 240-242 for years 2017-2021

Year	Fatal	Injury/Possible Injury	Property Damage	Total Crashes	Truck Involved	Dry	Wet	Day	Dark	Off Highway
2017	2	18	13	33	5 (15%)	23	9	26	7	11 (33%)
2018	1	11	6	18	2 (11%)	15	3	15	3	3 (17%)
2019	0	16	11	27	1 (4%)	12	14	17	9	11 (41%)
2020	0	13	9	22	8 (36%)	10	11	12	10	14 (64%)
2021	0	22	14	36	6 (17%)	15	21	26	10	18 (50%)

While the data reveal limited occurrences of fatal injuries, almost 59% of the crash over the five-year period involved injury or possible injury. About 71% of crashes occurred during daylight hours and 56% under dry conditions. Truck crash involvement was similar to the vehicle classification data presented in **Table 1**.

A 2017 ODOT summary reported an average truck speed of 61 mph (65 mph for 85th%) along I-5 between mile points 202 to 251, which encompassed the crash site.[9] The data noted extreme congestion for the peak congestion level. The segment conveyed a crash rate of 0.24 versus a statewide rate of 0.33 for all vehicles. Trucks had an "at fault" rate of about 38%.

The five-year crash data revealed 11 occurrences classified as involving a parked combination vehicle. The two fatal crashes that occurred in 2017 involved fatal injury to the striking passenger vehicle drivers. For the other crashes, two crashes involved minor injuries, four crashes involved possible injury and three crashes reported no injuries. For each crash, the striking vehicle driver was identified as "at-fault". Of the eleven crashes only one occurred during wet weather and all but three occurred during hours of darkness.

Crash reports for six of the 11 crashes were available for additional review. One crash involved a combination vehicle striking another combination vehicle, otherwise the crashes involved passenger type vehicles striking the stopped combination vehicle. Causation factors included - a passenger vehicle losing control while traveling at high speed, a passenger vehicle driver suffering a medical condition, a passenger vehicle driver falling asleep, a hit and run collision and one collision where an errant tire bounced off a parked combination vehicle and struck the passenger vehicle. Three previous crashes involving a parked combination vehicle appeared in proximity to the

[9] Data referenced 2012-2014 crash data and 2015 vehicle volumes.

current crash. **Figure 5** depicts a Google Earth image of the I-5 corridor around the Santiam River rest areas and the approximate geographic positions of the current crash and 11 other parked combination vehicle crashes.

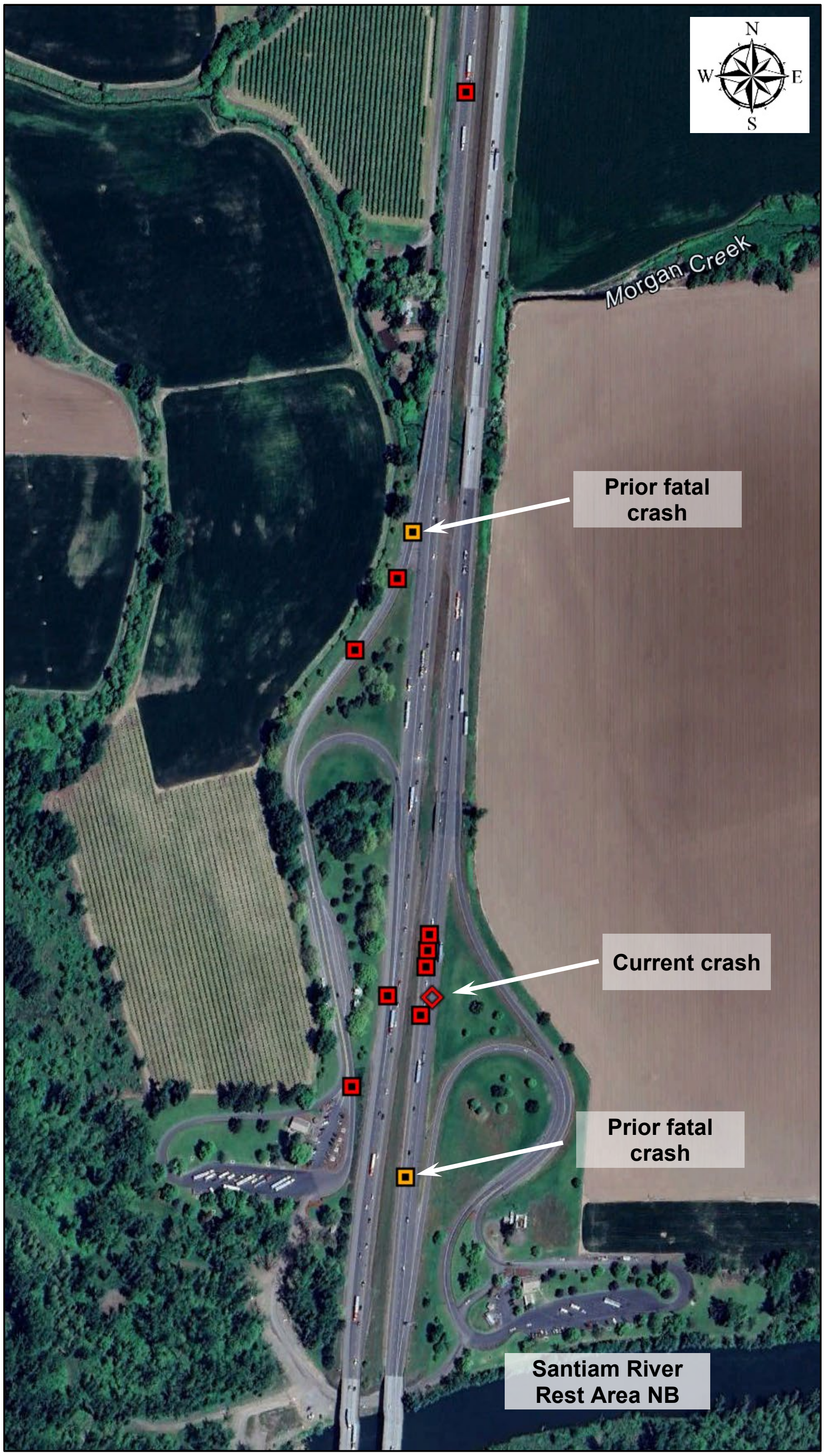

Figure 5: Google Earth image modified to depict approximate locations of the previous parked combination vehicle crashes as referenced by reported geographic position data. (Note that positions are approximate and imprecise to identify details such as lane position.)

While no signage was present along the shoulder, Oregon Revised Statute §811.550(12) prohibits parking on throughways (see ORS §801.524) except under certain circumstances such as emergencies (also see ORS §811.560).

1.4 Future Highway Improvement Research

A December 2021 ODOT sponsored study titled *I-5 Reconnaissance Study: Delaney Road to OR-34* provided insight into future improvements for the I-5 corridor that encompassed the crash site.[10] The stated purpose of the study was "to determine the feasibility, approximate cost, and conceptual engineering configuration of the modernization and widening of Interstate-5 (I-5) between the Delaney Road interchange just south of Salem (mile point 248.4) to Oregon Route (OR) 34 south of Albany (mile point 228.0)." As summarized, "the key components of improvements evaluated in the Study include the addition of one general travel lane in each direction, the consolidation of existing ramps and interchanges into a new interchange in Millersburg, and the reconfiguration of the OR-99E/Knox Butte Road and the US 20 interchanges in Albany." The study noted substandard shoulders, insufficient vertical clearance, and outdated interchange ramps at several locations. In addition, this segment of I-5 "carries high truck traffic and has several pinch points because of slowdowns created by vertical climbs or interchange merging and weaving movements." The study project explored solutions that would modernize the main thoroughfare, interchanges, and ramps to current standards, improve safety and address capacity for projected demand.

Proposed improvements to the I-5 segment adjacent to the rest area (Santiam River bridge to Exit 244 at OR-164) were addressed in Phase 3 of the study with an estimated start date of 2035. Issues along this segment were reported as substandard shoulders and sign structures, and congestion. The proposed response is to widen the thoroughfare from two lanes to three in each direction. The study notes that the Santiam River bridge is already widened to accommodate the additional lane. The widening of the bridge approaches further explains the wide shoulder adjacent to the northbound rest area.

1.5 State of Oregon Truck Parking and Rest Area Information

The issues and concerns with truck parking have been acknowledged for over two decades. The recognition of the safety value of highway rest areas dates back well into the 1980's.[11] At the federal level the Federal Highway Administration (FHWA) has

[10] Report available at https://digital.osl.state.or.us/islandora/object/osl:1007039
[11] Adams and Reierson, Safety Rest Areas: Planning, Location and Design, Transportation Research Record number 822, Transportation Research Board, Washington DC, 1981

offered guidance and certain financial incentives to states.[12] In May 2000, the National Transportation Safety Board (NTSB) issued a Highway Special Investigation Report titled "Truck Parking Areas" further identifying the transportation safety issues with the limited availability of truck parking.[13]

In July 2020 ODOT released the *Oregon Commercial Truck Parking Study Final Report,* which explored the issues of truck parking in the state of Oregon.[14] The report identified the existence of approximately 5,500 truck parking spaces at rest areas, truck stops, and ports of entry within the study corridors. Included in the total, the study described approximately 4,300 parking spaces as striped and 1,100 as unstriped. There were approximately 914 striped spaces at rest areas, about 4,400 at truck stops, and 154 at ports of entry. Statewide, a total of 109 facilities were identified consisting of 39 rest areas, 62 truck stops and 6 ports of entry. Most of the truck parking facilities are located on I-5 and I-84. I-5 lists 16 rest areas, 26 truck stops and two ports of entry. The report concludes that truck stops offer more truck parking than rest areas.

Noted truck parking issues include the general lack of available parking necessary for driver compliance with hours-of-service (HOS) regulations, traffic delays associated with congestion and parking limitations at rest areas, such as difficulty knowing if and where spaces are available. The report notes that drivers tend to respond to parking problems by parking on highway ramps or in other undesignated areas. Drivers complain that this is often due to HOS regulations that either require them "to plan ahead and often stop short of their hours (impacting utilization) or find themselves having to pull over in unplanned locations for mandatory breaks."

1.5.1 Truck Parking Solutions Examined - Statewide

The *Oregon Commercial Truck Parking Study Final Report* examined solutions from other state, regional and federal truck parking plans and consolidated these concepts to propose possible solutions and best practices for truck parking management. The broad goals of the study were to: *assess and address commercial truck parking needs for required driver rest periods; increase safety with practical, innovative and cost-effective strategies that include effective technologies; enhance the economic competitiveness of the state's major freight routes and improve safety;* and *develop the information necessary to support decisions regarding future approaches to truck parking issues in Oregon including the determination of Oregon's role in the*

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[12] FHWA resources concerning truck parking can be accessed at https://ops.fhwa.dot.gov/freight/infrastructure/truck_parking/index.htm

[13] National Transportation Safety Board, *Highway Special Investigation Report Truck Parking Areas,* SIR-00/01, May 2000, www.ntsb.gov/news/events/Documents/truck_bus-SIR0001.pdf.

[14] Report available at www.oregon.gov/odot/Planning/Documents/OCTPS_final_report_with_Appendices_and_exec_summary-Full_Report.pdf

provision of truck parking. The report, categorized potential solutions into several areas:

- Data and Technology Deployment
  - Primarily utilized to provide real-time communication to truckers on availability and location of truck stops and rest areas. Includes sensing technologies such as in-pavement sensors, entry-exit gates, radar, camera systems to determine utilization and availability of parking spaces and communication media such as dynamic message signs, smartphone and web apps and in-cab navigation to disseminate the information to truckers in real time.
  - An associated parking reservation system to assist drivers with trip planning and ensure predictability.
  - Lower cost solutions can include installing static truck parking signage on highways and distributing visor card trucking maps to drivers.
  - Interoperability with neighboring states for other development of specific solutions.

- Creative use of right of way for public truck parking capacity expansion
  - Expanding truck parking spaces on interstate or other segments with significant parking needs.
  - Use of publicly owned excess right of way at existing rest areas and other locations on interstates, as well as improving geometrics at existing locations.
  - Examination of urban land parcels to determine viability of conversion to truck parking areas.

- Expansion of public-private partnerships
  - Partnering with private businesses and truck stops to expand parking facilities and coordinate signage.
  - Explore cost-sharing agreements for construction and maintenance of parking areas with private partners.
  - Explore the use of warehouse and distribution center parking by drivers.

- Policy and Regulations
  - Review local, state, and regional policies to identify whether parking expansion is being hampered by regulations.

- Coalitions and Institutional Oversight
    - Establish truck parking committees within the agency to champion truck parking goals and oversee implementation of truck parking plans and objectives.
    - Participate in a cohesive regional multi-state truck parking coalition with a goal to matching supply and demand, increase roadway safety and policy conformity, including collaborative initiatives such as the MAASTO example of a corridor-level Truck Parking Information Management System (TPIMS).

- Public and Private Outreach
    - Develop guidelines and mitigation strategies aimed at easing public opposition to truck parking.

The study defined areas for prioritization to include:

- Site-specific solutions that are implemented at specific locations and facilities where supply or utilization is low or where the technology is feasible. Examples would include use of excess right of way at rest areas, undesignated parking locations and weigh stations. Site-specific solutions gravitated towards technology deployment at parking locations or public capacity or partnering with private sector.
- Statewide solutions that are implemented at either the state level or corridor level and have costs and resultant benefits that impact truck parking across the entire state or corridor. Examples would include installing dynamic message signs across entire corridors or developing a statewide truck parking availability mobile application. Statewide solutions focused on data and technology deployment such as real-time parking availability dissemination, as well as policy and regulatory modifications, use of right of way and public and private outreach.

In conclusion, the study offered several statewide recommendations.

1. *Place high importance on interoperability with other states when implementing improvements that will disseminate real-time information about parking availability.*
2. *A parking reservation system further assists truck drivers in planning their trips in advance and ensures predictability. Many truck drivers spend over an hour looking for a spot and/or park earlier to ensure they get a spot. This hurts efficiency and as such many trucks try to stay east of Portland.*

3. *Work with Metropolitan Planning Organizations (MPO) and cities to address truck parking in MPO freight plans and Transportation System Plans.*
4. *Develop materials to educate the public and elected officials about the importance of truck parking in freight transportation and industrial development.*
5. *Consider developing policies and regulations that could limit or prohibit truck parking in certain areas on ODOT ROW to increase safety*
6. *Consider development of a coalition with neighboring states in order to address truck parking issues on I-5.*
7. *Develop a Truck Parking Information Management System (TPIMS) to better address commercial vehicle parking needs throughout the state.*

1.5.2 Crash Area Corridor

One of the transportation corridors analyzed in the Oregon truck parking study included I-5 between Salem and Albany (21 miles) that encompassed the crash site. The primary issues identified in that corridor included *"undesignated parking at the Santiam Rest area and the highway shoulders … due to insufficient spaces at the rest area and Albany's Love truck stop. However, safety and convenience could be other reasons for undesignated parking."*

Suggested solutions included:

- *Increase truck parking capacity through expansion and other improvements to the Santiam River rest area (utilizing excess right of way, restriping, improved geometrics).*
- *Consider managing and improving the undesignated truck parking in and around the rest areas. Consider expanding the undesignated parking using excess right of way, if available, and making it into designated parking.*
- *Investigate the provision of real-time parking information for the rest area using dynamic message signs, smartphone apps or websites.*
- *Investigate creation of a public-private partnership with Albany's Love truck stop.*
- *Work with Albany's Love truck stop to determine if real-time parking info needs to be more accessible. If so, determine what type of assistance ODOT can provide.*

As noted, the northbound Santiam River rest area has 13 striped, large vehicle parking spaces while the southbound direction has 11 striped, large vehicle spaces. The next closest rest areas are approximately 40 miles to the north and 35 miles to the south.

1.5.3 Additional Truck Parking Research in Oregon

In January 2018, Anderson, et al., published the results of a study titled "*Understanding Probable Reasons for Freeway Ramp and Shoulder Parking by Truck Drivers: An Emerging Safety Issue to Oregon Highway Users*".[15] Their research identified "that driver characteristics, trip characteristics, factors related to difficulty parking, real-time information, effectiveness of parking improvements, and importance of truck parking features" influenced the probable reason for drivers to park on freeway ramps and shoulders.

2.0 Post-Collision Site Documentation and Roadway Evidence

The crash site was confined to the northbound roadway right shoulder between the entry and exit ramps for the Santiam River rest area. The site was photographically documented by Oregon State Police (OSP) investigators using terrestrial and small unmanned aerial system (sUAS, i.e., aerial drone) methodologies. NTSB investigators examined the scene after the crash, including the acquisition of terrestrial photography and limited 3D scanning to assist with identifying certain dimensional data.

NTSB investigators noted that the intensity of some collision-created tire friction marks and debris trails had diminished by the time investigators examined the scene. Some roadway evidence was marked by OSP investigators using paint applied to the roadway surface. The sUAS images provided by OSP were processed using Pix4DMapper photogrammetry software from which a three-dimensional point cloud and two-dimensional orthomosaic image were created for analysis.[16] NTSB investigators also deployed terrestrial three-dimensional scanning about the identified area of impact for additional analytic reference.[17] Screen capture images of the 3D point clouds created from the OSP sUAS photographs are depicted in **Figures 6 and 7**.

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[15] Anderson, Hernandez and Roll, Understanding Probable Reasons for Freeway Ramp and Shoulder Parking by Truck Drivers: An Emerging Safety Issue to Oregon Highway Users, 97th Annual meeting of the Transportation Research Board, Washington, D.C., January 2018.

[16] Pix4DMapper is a photogrammetry software package designed to use overlapping photographic images to generate 3D point clouds. Additional outputs from the generated point cloud include 3D models (textured mesh), digital surface and terrain models, and 2D orthomosaic maps. An orthomosaic is an image with high detail and resolution made by combining many smaller images and is corrected for lens distortion, camera tilt, perspective, and topographic relief.

[17] 3D scanning was completed using the FARO Focus Premium 350 laser scanner. Scans were rendered into three-dimensional (3D) point clouds using FARO Scene® software.

Figure 6: Screen capture of 3D point cloud created from the OSP sUAS aerial photographs depicting vehicle positions of rest following the collision.

Figure 7: Screen capture of 3D point cloud created from the OSP sUAS aerial photographs depicting vehicle positions of rest following the collision.

The approximate area of impact, or more appropriately an area of maximum engagement was established at a location where roadway surface scars (e.g., gouges, scrapes) and fluid debris stains originated. This area was centered about 20 feet onto the right shoulder from the travelway edge line and approximately 1,126 feet northward of the rest area exit ramp gore (apex of the lane striping that delineated the gore). Extending northward along the shoulder, fluid debris and pavement scars were intermixed with intermittent tire friction marks. About 63 feet northward of the area of initial contact, a more intense or darker fluid debris trail appeared to begin. Beginning about 167 feet north of the area of impact the onset of a series of more prominent tire friction marks was observed. These marks initially exhibited a trajectory parallel with the shoulder then transitioned to an angular heading toward the travelway.

OSP investigators had applied colored paint marking to highlight certain pavement surface evidence such as gouges, scrapes, and tire friction marks. Southward from the area of impact two parallel tire friction marks, characteristic of a dual wheel assembly, were observed and similarly marked. The onset of the marks was marked 40 feet south of (before) the area of impact and terminated 61 feet to the north within the fluid debris trail. Shortly after their onset, the marks exhibited a very slight angular heading toward the right roadside. **Figure 8** depicts a two-dimensional orthomosaic image of the post-collision positions of rest for the vehicles. The image was created from the OSP sUAS photogrammetry project. The vehicles and certain roadway evidence have been labeled for reference.

At final rest, the Ford van was oriented northward parallel to the roadway and about 16 feet off the pavement on the right roadside. The van was positioned about 241 feet north of the onset of the fluid debris or the approximate area of impact. Remnants of the light duty utility trailer, primarily the perimeter frame and axle, that had been coupled to the Ford were located on the shoulder about 127 feet north of the area of impact and 15 feet behind the second Freightliner combination.

Freightliner combination 1 was also facing northward but was angled at about eight degrees toward the roadside and was mostly off the pavement. The truck tractor was completely off the pavement onto the roadside while the driver-side wheels of the semitrailer remained on the pavement. The front of the truck tractor was about 175 feet north of the area of impact.

Freightliner 2 remained on the shoulder and was basically oriented northward. The truck tractor and semitrailer were skewed with the semitrailer angled slightly toward the travel lanes while the truck tractor was angled toward the roadside. The front of the combination vehicle was positioned about 214 feet north of the approximate area of impact.

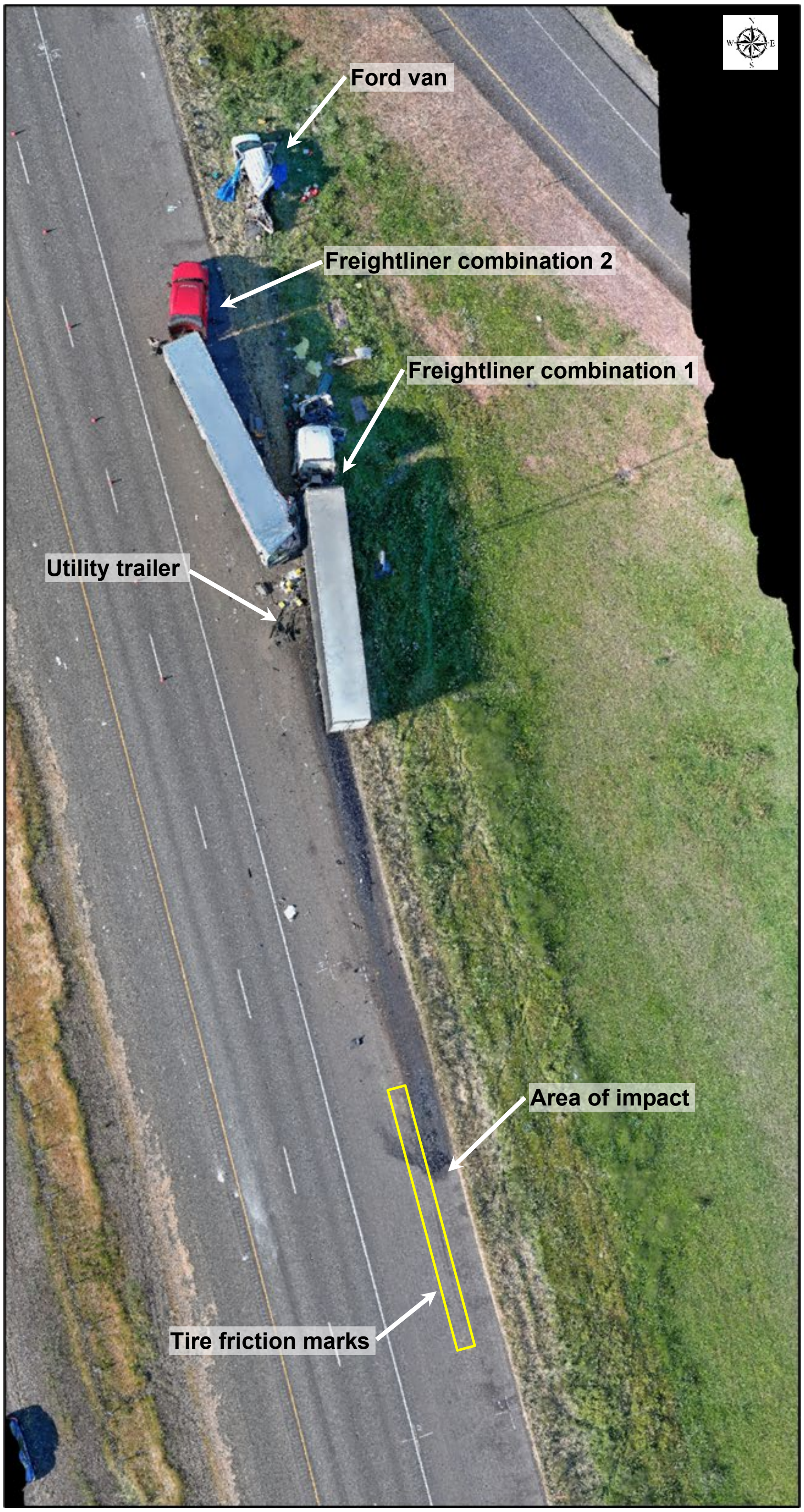

Figure 8: Orthomosaic image of post-collision vehicle orientation and positions of rest created from the Pix4DMapper photogrammetry project using OSP sUAS photographs.

3.0 Vehicles

Three vehicles were involved in the collision – two were commercial truck tractor – semitrailer combinations and the third a light duty van coupled with a light duty utility trailer. Both commercial combinations were Freightliner truck tractor coupled with semitrailers. For identification, the striking unit is referred to as Freightliner combination 1 and the stopped unit as Freightliner combination 2.[18]

3.1 2018 Freightliner Cascadia coupled with 2015 Utility semitrailer

The striking unit was identified as a 2018 Freightliner Cascadia truck tractor coupled with a 53-foot Utility curtainside semitrailer.[19,20] The truck tractor exhibited contact damage at the front of the Truck tractor that encompassed about two-thirds of the vehicle width extending inboard about 74-76 inches from the driver's side edge. Contact damage extended along the driver's side of the truck tractor encompassing the hood, front fender and wheel and trailing aft ward to include damage and displacement of the driver's door. Contact damage extended vertically at the A-pillar and leading edge of the driver's door to a height of about 7.5 feet. Rearward of the sleeper, contact damage was observed to the outer driver's side drive wheels. The trailing drive axle (axle 3) was displaced due to broken suspension components. Apparent biological material was observed along the entire length of the truck tractor driver's side with heavier deposits rearward of the cab door. The engine oil pan was fractured and the lower half missing.

The semitrailer exhibited contact damage at the driver's side front corner. Evidence of contact extended the full vertical height of the semitrailer. An apparent fragment from the Freightliner 2 semitrailer was embedded in the upper corner structure. Some minor damage was observed to lower portions of the curtain sidewall along the driver's side between the front corner and the landing gear. Apparent biological material was spread along the driver's side of head wall. **Figure 9** depicts a screen capture image of the truck tractor 3D point cloud rendered from scanning of the Freightliner combination.

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[18] The vehicles were examined by NTSB investigators following their removal to secure facilities. NTSB investigators were limited to external examination of the vehicles at the time of the visit.
[19] Vehicle identification was based on review of registration documents and photographs of VIN labels.
[20] A curtainside trailer, or curtain van, is a dry van and a flatbed trailer combined into one trailer. It loads like a flatbed but protects like a van with a ceiling, front wall, and rear doors. The sides are open to allow access for loading, and the rear swing doors allow it to be dock loaded, similar to a dry van.

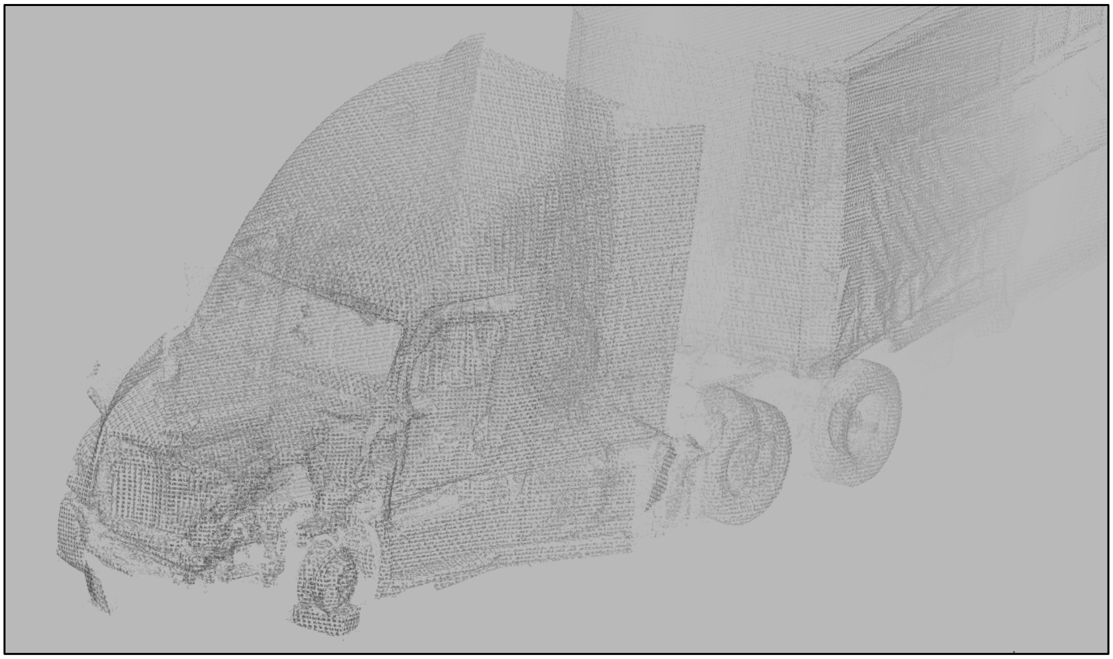

Figure 9: Screen capture image of the Freightliner combination 3D point cloud created from 3D scanning. (Rendered in greyscale to obscure visible biological material on the vehicle.)

3.2 2001 Ford E-350 van towing single-axle utility trailer

The first vehicle struck by Freightliner combination 1 was identified as a 2001 Ford E-350 van configured for passenger transport. The Ford was towing a small utility trailer configured to transport a fiberglass portable toilet and sink assembly (an exemplar photograph of the van/utility trailer combination is available in the NTSB Motor Carrier Group Chair factual report).[21] At the time of the crash, the Ford was reported to be stationary on the shoulder.

The Ford exhibited catastrophic impact damage at the rear and driver-side of the vehicle. Impact at the rear of the van exhibited a slight offset toward the passenger side and resulted in at least 81 inches of forward intrusion that extended to about the C-pillar. Damage extended vertically to approximately 7.5 feet, which was consistent with the vertical damage height to the Freightliner 1 truck tractor. Damage at the rear exhibited an override of the vehicle frame. The driver's side of the Ford displayed substantial damage characteristic of a sideswipe contact that resulted in the sidewall separating from the vehicle and being folded rearward exposing the vehicle interior. Contact at the driver's side originated around the B-pillar. The front and passenger side of the vehicle exhibited no evidence of contact damage.

[21] Van identification was based on observation of VIN label. The utility trailer manufacturer was not identified.

The utility trailer was destroyed in the collision. The two primary longitudinal frame rails remained attached to the axle but exhibited substantial deformation. Other components of the trailer were displaced, deformed or otherwise unrecovered. The remnants exhibited evidence of having been overridden. Neither the trailer make, model nor the original dimensions could be discerned from the debris. Similar single-axle utility trailers tend to have nominal dimensions of 136 inches in length, 68.5 inches in width and a deck height of 25 inches.

Figure 10 depicts a screen capture image of the Ford van 3D point cloud rendered from scanning of the vehicle. **Figure 11** depicts a photograph of the utility trailer remnants.

Figure 10: Screen capture image of the Ford van 3D point cloud created from 3D scanning.

Figure 11: Photograph depicting the remnants of the utility trailer towed by the Ford van.

3.3 2024 Freightliner Cascadia coupled with 2024 Utility semitrailer

The second commercial combination vehicle involved in the collision was identified as a 2024 Freightliner Cascadia truck tractor coupled with a 2024 Utility 53-foot dry van.[22] At the time of the crash the combination was stationary on the shoulder. Post-collision, the semitrailer exhibited contact damage while the truck tractor was undamaged.

Contact to the semitrailer was observed at the passenger side rear corner extending laterally inboard about seven inches and vertically to the roofline. Biological material was present around the area of contact including remnants of the rear rollup door and aft portion of the right sidewall. The right rear of the trailer deck and right longitudinal frame rail were slightly displaced forward and upward. The passenger side sidewall was displaced forward creating an opening in the sidewall that extended about 6.5 feet from the rear corner and exposing the interior. The rear (door) frame including the vertical and horizontal structure was displaced forward. What would have been the upper right (passenger side) corner of the rear frame displayed evidence of contact damage. **Figure 12** depicts a photograph of the damaged Utility semitrailer.

[22] Vehicle identification based on review of registration documents and observation of the VIN label on the semitrailer.

Figure 12: Photograph depicting damage to the Utility semitrailer.

4.0 Electronic Data

4.1 Freightliner Combination 1 Engine Control Module and Advanced Driver Assistance System

The prospect of electronic data related to the crash event was confined to the striking Freightliner combination (combination 1). Potential sources for the retention of event data resided with the engine control module (ECM) and the Video Radar Decision Unit (VRDU).

ECM recorded event data can include an acceleration related trigger (commonly referred to as hard braking), a last stop event or a fault code trigger. When events are triggered, data such as vehicle speed, throttle, engine RPM, etc. may be recorded in a time series format associated with the event. The VDRU module is a component of the Daimler Detroit Assurance collision mitigation system. If the mitigation system is active, certain data can be recorded.

At the time of the initial NTSB vehicle examination, OSP declined assistance from Freightliner and elected to have the modules imaged by a third-party contractor. The status of any data or the functionality of any collision mitigation system is not known.

E. REFERENCES

NTSB Motor Carrier Group Chair Factual Report

F. DOCKET MATERIAL

Attachment 1: Highway Plans (2017)
Attachment 2: Crash Data-5 Year

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