CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION

CASE NO: CA05-031

VEHICLE: 2005 JEEP GRAND CHEROKEE

LOCATION: NORTH CAROLINA

CRASH DATE: MAY 2005

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. CA05-031	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Calspan On-Site Certified Advanced 208-Compliant Vehicle Crash Investigation Vehicle: 2005 Jeep Grand Cherokee Location: State of North Carolina		*5. Report Date*: April 2004 *6. Performing Organization Code*	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0294 *11. Contract or Grant No.* DTNH22-01-C-17002	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: May 2005 *14. Sponsoring Agency Code*	
15. Supplementary Note This on-site investigation focused on the performance of the Certified Advanced 208-Complaint (CAC) frontal air bag system in a 2005 Jeep Grand Cherokee			
16. Abstract This on-site investigation focused on the performance of the Certified Advanced 208-Complaint (CAC) frontal air bag system in a 2005 Jeep Grand Cherokee. The manufacturer of this vehicle has certified that the Grand Cherokee meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system included dual stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right occupant sensor, and safety belt buckle switches. The Jeep was occupied by a belted 66-year old male driver. The driver was operating the Grand Cherokee in an easterly direction on a two-lane road in a rural residential area. As he crested a hill, he observed a line of stopped eastbound traffic. The lead vehicle was attempting to turn left and was waiting for westbound traffic to clear. The driver of the Jeep steered right off-road and braked to avoid impact with stopped traffic. The Jeep traveled through an area of stumps and freshly cut trees and impacted several small diameter trees, stumps and logs, prior to impacting a 38 cm (15”) diameter spruce tree with the front center area of the Jeep. This impact was sufficient to deploy the driver’s air bag system and actuate the driver’s buckle pretensioner. The driver loaded the manual safety belt system and the deployed air bag. There was no driver loading evidence on the safety systems or the interior surfaces of the vehicle. The driver sustained a police reported non-incapacitating B-level injury and was transported by ground ambulance to a local hospital. The hospital did not have a record of treatment for this driver.			
17. Key Words Certified Advanced 208-Compliant occupant protection Driver air bag deployment		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 10	*22. Price*

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BACKGROUND

This on-site investigation focused on the performance of the Certified Advanced 208-Complaint (CAC) frontal air bag system in a 2005 Jeep Grand Cherokee **(Figure 1)**. The manufacturer of this vehicle has certified that the Grand Cherokee meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system included dual stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right occupant sensor, and safety belt buckle switches. The Jeep was occupied by a belted 66-year old male driver. The driver was operating the Grand Cherokee in an easterly direction on a two-lane road in a rural residential area. As he crested a hill, he observed a line of stopped eastbound traffic. The lead vehicle was attempting to turn left and was waiting for westbound traffic to clear. The driver of the Jeep steered right off-road and braked to avoid impact with stopped traffic. The Jeep traveled through an area of stumps and freshly cut trees and impacted several small diameter trees, stumps and logs, prior to impacting a 38 cm (15") diameter spruce tree with the front center area of the Jeep. This impact was sufficient to deploy the driver's air bag system and actuate the driver's buckle pretensioner. The driver loaded the manual safety belt system and the deployed air bag. There was no driver loading evidence on the safety systems or the interior surfaces of the vehicle. The driver sustained a police reported non-incapacitating B-level injury and was transported by ground ambulance to a local hospital. The hospital did not have a record of treatment for this driver.

Figure 1. Overall view of the 2005 Jeep Cherokee.

The crash was identified from a list of claims that was provided to NHTSA by an insurance company. The vehicle was located at an auto repair facility in the vicinity of the crash location. Due to the multiple damage locations, the insurance company considered the Jeep a total loss. Cooperation was established with the insurance company and the body shop to inspect the Jeep and remove the vehicle's Event Data Recorder (EDR) for download by Daimler-Chrysler. The case was assigned to the Calspan Special Crash Investigations team on June 1, 2005. The on-site vehicle and scene inspections were conducted on June 2, 2005.

SUMMARY

Crash Site

This single vehicle crash occurred off-road near a three-leg T-intersection during daylight hours. The roadway was configured with two travel lanes that were separated by double yellow centerlines and bordered by solid white edge lines. Both travel lanes measured 3.3 m (10.8') in width. Located west of the intersection was a hillcrest that transitioned to a downgrade of three-percent for eastbound traffic. In the vicinity of the crash site, the roadway was straight and surfaced with a new top coating of asphalt. Narrow stone and gravel shoulders bordered both travel lanes. The posted speed limit was 72 km/h (45 mph). **Figure 2** is an overall view of the Jeep's eastbound trajectory.

Figure 2 - Eastbound trajectory of the Jeep Grand Cherokee.

Located adjacent to the eastbound travel lane was an area that consisted of tall weeds and a tree line that began approximately 25 m (80') south of the referenced travel lane. Prior to the crash, this area was under construction. Numerous trees were felled and the trunks were cut into firewood length logs and scattered in the area. The tree trunks were left in place. Post-crash, additional work was conducted prior to the SCI investigation. The specific trees and/or trunks that were struck by the Jeep were no longer in place at the scene. The Cherokee did strike a 38 cm (15") diameter spruce tree that was located 27.1 m (88.9') off-road. The tree did not yield in the crash and was debarked by the frontal impact. The Crash Schematic is included as **Figure 11** of this report.

Vehicle Data

The involved vehicle in this crash was a 2005 Jeep Grand Cherokee, four-door, 4X4 sport utility vehicle. The Jeep was manufactured on 12/04 and was identified by Vehicle Identification Number (VIN) 1J4HR58215C (production number deleted). The Grand Cherokee was powered by a 5.7 liter conventionally mounted Hemi V-8 engine linked to a 5-speed automatic transmission with a console mounted transmission selector lever. The Jeep was equipped with Quadra-Drive II and traction control. The service brakes were four-wheel disc with anti-lock. The tires were Goodyear Eagle LS, size 235/65R17 mounted on OEM 5-spoke alloy wheels with a maximum tire pressure rating of 302 kPa (44 PSI). The manufacturer specified tire pressure was 228 kPa (33 PSI). The Grand Cherokee was also equipped with an onboard Direct Tire Pressure Monitoring System (TPMS). The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measured Tread Depth	Tire/Wheel Damage
Left Front	234 kPa (34 PSI)	7 mm (9/32”)	No damage
Left Rear	0 kPa	7 mm (9/32”)	Tree bark embedded into outer bead, tire deflated
Right Front	237 kPa (34.5PSI)	7 mm (9/32”)	No damage
Right Rear	0 kPa	7 mm (9/32”)	22 cm (8.5”) of outer bead fractured between spokes, tire sidewall cut and deflated

The interior of the Jeep was configured with leather wrapped power adjustable front bucket seats with adjustable head restraints, power windows and door locks, power adjustable pedals, and heated seats. The front left head restraint was adjusted 3 cm (1.125”) above the seat back while the front right was adjusted 5 cm (1.875”) above. The steering wheel was a four-spoke design with the spokes at the 3/9 and 5/7 o’clock positions.

The rear seat was a three-person bench with a 60/40-split seat back (left side wide) and adjustable head restraints for the outboard positions. A fold-down center armrest was incorporated into the left side seat back.

Crash Sequence

Pre-Crash

The driver of the Jeep Grand Cherokee was traveling in an easterly direction on a two-lane road in a posted 72 km/h (45 mph) speed zone. As he ascended a positive grade that terminated at a hillcrest, the driver observed a line of standing eastbound traffic on the down slope of the grade. The traffic was stopped for an eastbound non-contact vehicle that was waiting for westbound traffic to clear, prior to initiating a left turn into a residential driveway. The driver of the Grand Cherokee steered right and applied a braking force to avoid the stopped traffic. The Grand Cherokee departed the right road edge in a presumed tracking attitude. The vehicle entered a grassy area and overrode a shallow drainage ditch as it approached an off-road area under construction. Numerous trees were cut and the trunks were cut into long firewood lengths and left scattered at the scene. Tree stumps were scattered about the area. It should be noted that at the time of the SCI investigation, additional work was conducted in the area since the time of the crash. This involved the removal of additional trees and stumps. At the time of the SCI investigation, there was no physical evidence remaining to identify the Jeep’s trajectory or to verify the sequence of events.

Crash

The Grand Cherokee impacted two small diameter trees with the front left area of the vehicle. These minor severity impacts resulted in deformation to the hood face of the vehicle. The trees were not present at the crash site at the time of the investigation.

The left and right side areas of the Cherokee impacted two or three trees or tall stumps as it traversed the off-road area on a travel path that was nearly diagonal to the travel lanes.

These impacts resulted in minor deformation to the sheet metal of the vehicle; however, both rear tires engaged the objects that displaced the axle position rearward. All impacts to this point involved 12 o'clock directions of force.

The Cherokee continued on a presumed tracking trajectory over the irregular terrain and impacted a 38 cm (15") diameter tree that was located 27.2 m (89.1') south of the east road edge **(Figure 3)**. The center frontal area of the Jeep impacted the tree, which resulted in a sufficient longitudinal deceleration to deploy the driver's (CAC) frontal air bag and fired the buckle pretensioner. Due to the dismantled state of the Cherokee, the WinSMASH model was not used to calculate a velocity change for this crash. The known damage was isolated to the lower radiator support as the remaining frontal components were removed from the vehicle prior to the SCI inspection. The direction of force for this impact was 12 o'clock.

Figure 2. Off-road trajectory en route to tree impact located in center background of image.

Due to the slight offset right location of the tree impact, the Grand Cherokee rotated slightly in a clockwise prior to coming to rest engaged against the tree.

Post-Crash

The driver exited the vehicle unassisted post-crash and waited for emergency personnel to arrive on-scene. He was evaluated at the scene of the crash and transported by ground ambulance to a local hospital for treatment of a police-reported non-incapacitating B-level injury. The hospital did not have record of treatment for this driver. The Grand Cherokee sustained disabling damage and was towed from the scene of the crash.

Vehicle Damage

Exterior

The 2005 Jeep Cherokee sustained moderate severity damage to the front, left and right side planes of the vehicle from multiple events. The scene was under construction prior to and after the crash. There was no discernable physical evidence at the scene to plot the off-road trajectory of the vehicle, therefore the specific objects and sequence of events was unknown.

Primary – The center frontal area of the Grand Cherokee impacted a 38 cm (15") diameter spruce tree. The event was the last of six events that were involved in this crash. The direct contact damage began 4 cm (1.5") left of center and extended 33 cm (13") to the right **(Figure 4)**. This damage was measured on the hood face of the vehicle as the front bumper fascia, bumper beam, grille, and the upper radiator support were removed from the vehicle prior to the on-site investigation. A crush profile was documented at the level of the lower radiator support. The engine oil filter was located aft of the lower radiator support on the forward aspect of the aluminum block. This filter

was crushed by the tree impact. Assuming the tree penetrated to the level of the lower radiator support panel, the projected maximum crush at the bumper beam was approximately 30 cm (11.75”), located 18 cm (7”) right of the centerline **(Figure 5)**. The crush profile at the level of the lower radiator support was as follows: C1 = 8 cm (3.25”), C2 = 13 cm (5.25”), C3 = 22 cm (8.6”), C4 = 29 cm (11.4”), C5 = 26 cm (10.25”), C6 = 22 cm (8.75”). The Collision Deformation Classification (CDC) for this tree impact was 12-FCEN-1.

Figure 4. Frontal impacts to the Jeep Grand Cherokee.

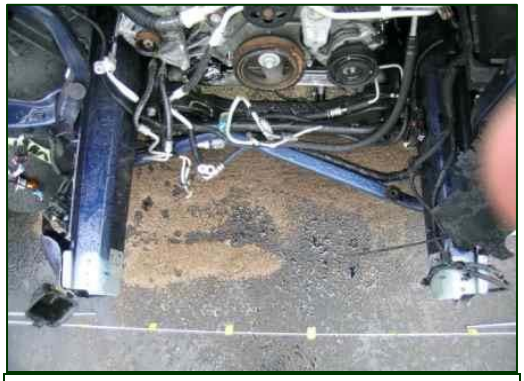

Figure 5. Overhead view of the crush depth to the lower radiator support.

Secondary – The front left aspect of the hood face exhibited two small tree impacts. The first circular dent pattern was located 57-66 cm (22.5-26”) left of center. This hood face dent was 1 cm (0.5”) in depth. The CDC for this narrow tree impact was 12-FLEN-1.

A second dent on the hood face was located 74-80 cm (29-31.5”) left of center. This shallow dent was approximately 1 cm (0.5”) in depth. The CDC for this event was 12-FLEN-1.

A superficial sideswipe impact was located on the left front fender. This impact damage consisted of abrasions with no residual crush. The damage began 42 cm (16.5”) forward of the left front axle position and extended 61 cm (24”) rearward, terminating 44 cm (17.5”) aft of the axle location. The damage was located above the level of the bumper; therefore the CDC for this sideswipe was 12-LFMS-1.

The left rear door, tire, and quarter panel area of the Jeep impacted a tree or tall stump at the crash site. The damage began on the rear edge of the rear door 36 cm (14”) forward of the rear door edge and extended 79 cm (31”) rearward, terminating at the mid point of the left quarter panel **(Figure 6)**. The left rear tire impacted the vertical object, which displaced the axle position 24 cm (9.5”) rearward. Bark was embedded into the bead of the tire at the alloy

Figure 6. Left rear impact damage.

wheel. There was no damage to the tire or wheel. A crush profile was documented along the damage length of 79 cm (31”). The crush values were as follows: C1 = 0 cm, C2 = 2 cm (0.75”), C3 = 4 cm (1.5”), C4 = 3 cm (0.9”), C5 = 0 cm , C6 = 0 cm. The CDC for this event was 12-LZES-1.

The sixth area of damage to the Jeep was located on the right side doors and right rear wheel of the vehicle. The direct contact damage, which consisted of subtle abrasions and isolated dents, began on the alloy wheel 5 cm (2”) aft of the right rear door edge and continued 160 cm (63”) forward onto the right front door **(Figure 7)**. The maximum crush for this damage pattern was 1 cm (0.25”) located on the right rear door at the location of the lower C-pillar. The right rear alloy wheel was fractured and the tire was cut from the impact. The right wheelbase was elongated 11 cm (4.2”). The CDC for this event was 12-RZES-1.

Figure 7. Right rear impact damage.

All four doors remained closed and operation post-crash. The windshield was cracked adjacent to the right A-pillar from body stress. All remaining glazing, inclusive of the sunroof was closed and intact.

Interior

The interior of the Cherokee was not damaged as a result of the crash. There was no intrusion of the passenger compartment. The driver did not contact interior components other than loading the safety belt system and the deployed air bag.

Manual Safety Belt Systems

The Jeep Grand Cherokee was equipped with manual three-point lap and shoulder belts for the five designated seated positions. All five belt systems consisted of continuous loop webbing. The front systems were equipped with adjustable D-rings and buckle pretensioners. The driver’s belt system utilized a sliding latch plate and retracted onto an Emergency Locking Retractor (ELR). The front right belt utilized a lightweight locking retractor and an ELR. The rear outboard belt systems were equipped with the lightweight locking latch plates and ELRs, while the center rear position was configured with a sliding latch plate and a switchable ELR/ Automatic Locking Retractor (ALR).

The driver was the sole occupant in this vehicle. He was restrained by the three-point manual safety belt system. Belt usage was supported by the fired status of the front left buckle pretensioner. There was no loading evidence on the belt webbing or hardware components of the system.

Certified Advanced 208-Compliant Frontal Air Bag System

The manufacturer of the Jeep Grand Cherokee has certified that this vehicle meets the advanced air bag requirements of FMVSS No. 208. The system consisted of dual stage frontal air bags for the driver and front right passenger positions, front seat track positioning sensors, safety belt buckle switches, a front right air bag status light mounted within the mid instrument panel, above the HVAC controls, and a front right occupant presence sensor. The front right occupant presence sensor was designed to calibrate the weight of the occupant and the seat track location prior to issuing a deployment command.

The system was monitored and controlled by a single point air bag control module that was mounted to the floor of the center console, located between the front seat safety belt buckles. This unit was removed from the vehicle with authorization from the insurance carrier and forward to NHTSA for download by Daimler-Chrysler. The output data did not list the deployment parameters of the CAC system.

Figure 8. Deployed front left air bag.

The crash sequence warranted the deployment of the driver's air bag system and firing of the buckle pretensioner. The driver's air bag deployed from an H-configuration module cover that was located within the four spokes of the steering wheel rim. The upper flap measured 7 cm (2.9") in height while the lower flap w as 4 cm (1.6") in height. Both flaps were 14 cm (5.6") in width at the horizontal tear seam. The driver's air bag membrane was 64 cm (25") in diameter (deflated) and was tethered by two 13 cm (5") wide bands located at the 3 and 9 o'clock positions **(Figure 8)** . The tethers were sewn to the face of the bag with a 17 cm (6.6") diameter stitch pattern. The maximum excursion of the air bag was 19 cm (7.5") located at the tether positions. The bag was vented by two ports that were 2 cm (0.75") in diameter located on the backside of the bag at the 11 and 1 o'clock positions. The ports were centered 8 cm (3") inboard of the peripheral seam.

The air bag was bar coded with a label at the 12 o'clock sector that identified the unit as follows:

P602971600CC07
CYBRYWSDAMQ
CMX CH YK

The center face of the bag membrane was stamped with the code B-13-1. There was no damage or contact evidence to the deployed driver's air bag.

The front right air bag was mounted in the mid right instrument panel and concealed by a single cover flap. There was no front right passenger in the vehicle at the time of the crash, therefore the air bag did not deploy. The front right passenger air bag on/off lamp was located on the right side of the mid instrument panel.

The driver was belted at the time of the crash; therefore, the safety belt buckle switch was engaged. The driver's buckle pretensioner actuated as a result of the crash. The convoluted sleeve of the pretensioner was compressed. The barrel of the pretensioner could not be accessed to measure the stroke of the piston travel.

Event Data Recorder

The Jeep Cherokee was equipped with an air bag control module that had Event Data Recording (EDR) capabilities. The EDR was located within the center tunnel aft of the transmission selector lever. Permission to remove the EDR from the vehicle was granted by the insurance company. The EDR was removed during the SCI investigation and forwarded to NHTSA for download by Chrysler. An output from the EDR was received and reviewed by the SCI team. The output data was incomplete and the fields related to the CAC system were not recorded by the EDR.

Occupant Data/Demographics

Driver

Age/Sex:	66-year old/Male
Height:	Not available
Weight:	Not available
Eyewear:	Unknown
Seat Track Position:	Rear track
Manual Safety Belt Use:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Egress from Vehicle:	Exited vehicle unassisted from left door
Mode of Transport From Scene:	Ground ambulance
Type of Medical Treatment:	Transported by ambulance a local hospital

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Police reported B-level injury	Unknown	Unknown

Driver Kinematics

The 66-year old male driver of the Jeep Grand Cherokee was seated in a full rear track position with the seat back reclined to a measured angle of 26 degrees. The vertical height of the power seat (measured at the leading edge) was adjusted 32 cm (12.5") above the floor of the vehicle. In this position, the, the horizontal distance between the center of the driver's air bag module cover and the seat back was 65 cm (25.5"), measured 41 cm (16") above the seat bight **(Figure 9)**. The adjustable pedals were set to a forward position with respect to the vehicle. The horizontal distance between the brake pedal and the leading edge of the seat cushion was 51 cm (20.125"). The driver was restrained by the manual 3-point lap and shoulder belt system. Although there was no loading

evidence on the belt system, usage was supported by the lack of interior contact points and the actuated position of the buckle pretensioner **(Figure 10)**.

The driver was probably minimally displaced in a forward direction during the multiple off-road events with the small diameter trees and stumps. At impact with the 38 cm (15") diameter spruce tree, the CAC frontal air bag system probably deployed and the buckle pretensioner fired. The driver responded to the frontal impact force by moving forward with respect to the vehicle. He loaded the manual belt system and the deployed air bag**,** which absorbed and distributed his loading force. There are no interior contact points within the vehicle. The driver sustained a police reported B-level, non-incapacitating injury and was transported to a local hospital. The hospital did not have a record of treatment for this driver.

Figure 9. Overall view of the driver's position and the safety systems.

Figure 10. Actuated driver's buckle pretensioner.

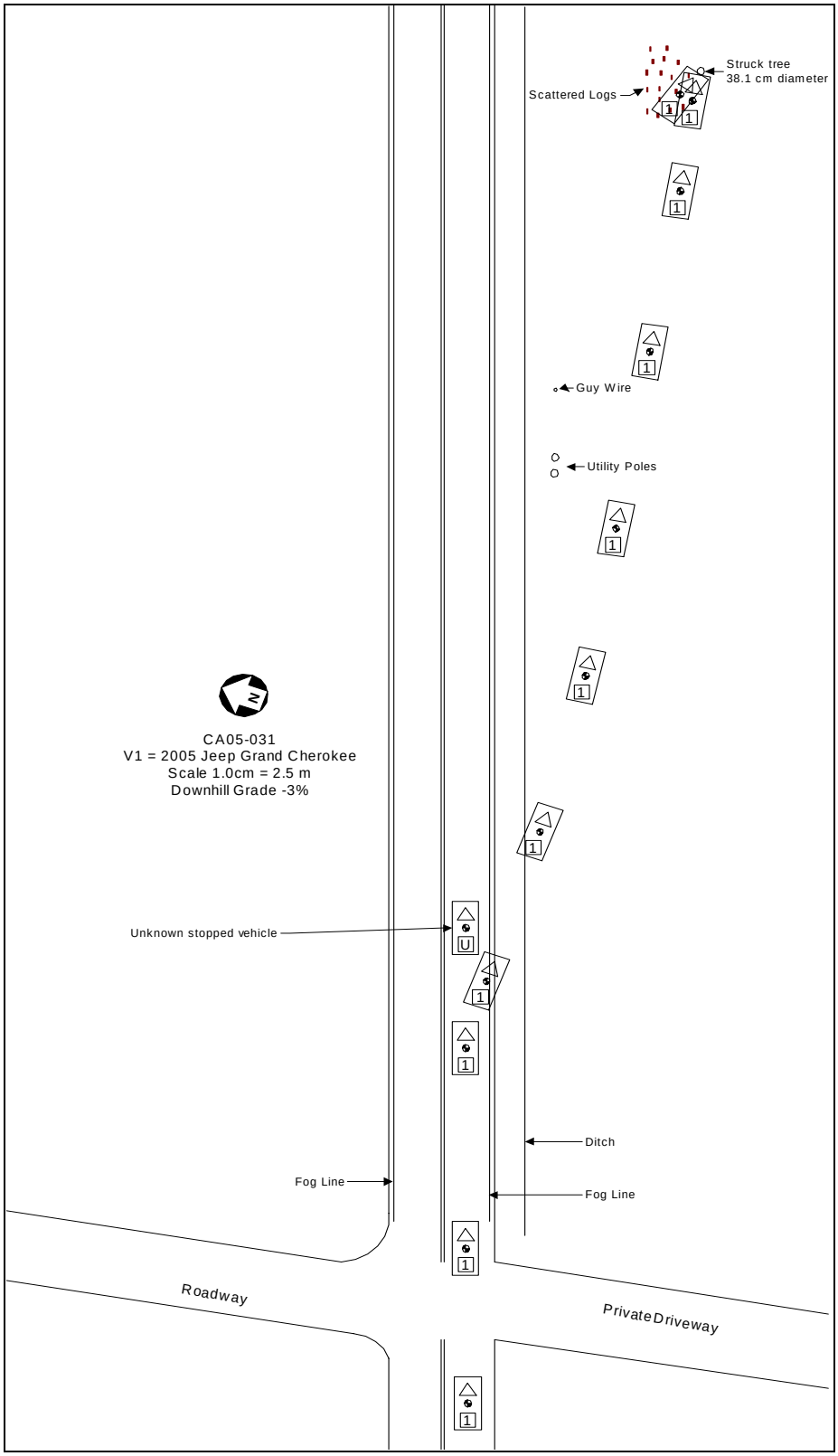

Figure 11 – Crash Schematic