

Potential Safety Defects Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS03013
2002 Mini Cooper
Maryland
March, 2003

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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 be 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 crash-worthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract <p>This two vehicle crash occurred in March, 2003 at 0912 hours. The crash occurred within the area of a "T" intersection located within a rural area. The weather was clear and there were no viewing restrictions present. It was daylight at the time of the crash. The posted speed limit for both the east and westbound travel directions is 64 km/h (40 mph).</p> <p>The case vehicle is a 2002 Mini (BMW parent company) Cooper S three-door hatchback driven by an unrestrained 53-year-old female. The other vehicle is a 2002 Dodge Durango SUV driven by a 38-year-old. There were three additional occupants in the Dodge vehicle—a 75-year-old female, a 3-year-old male, and a 20-year-old male. The driver of the case vehicle pulled to the right merge/shoulder area and initiated a U-turn in order to make the turn at the intersection. At this time, the other vehicle approached the intersection from the west (same initial travel direction as the case vehicle). The other vehicle passed through the intersection and struck the case vehicle as it was making its U-turn. The front plane of the other vehicle struck the left side plane of the case vehicle somewhere near the yellow double center line. As a result of the impact, the left side rail mounted air curtain in the case vehicle deployed. The driver's seat back mounted air bag did not deploy. The case vehicle's frontal air bags did not deploy. The driver of the case vehicle was extricated by EMS personnel. She was transported from the scene, by air, to a Level 1 trauma center with incapacitating injuries, including: a left clavicle fracture, left 2nd rib fracture, right mandibular fractures, right occipital condyle fracture, and a left pulmonary contusion. The driver, left rear occupant, and right rear occupant of the other vehicle did not report any injuries. The front right occupant was reported to be transported to a local hospital with non-incapacitating injuries. Both vehicles were towed from the scene due to damage sustained in the crash.</p>					
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Dynamic Science, Inc.
Crash Investigation
Case Number: DS03013

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BACKGROUND:

Description: This potential Safety Defects Case was identified by the National Highway Traffic Safety Administration (NHTSA). The side air curtain deployed and the driver's seat back mounted side air bag did not. DSI was assigned the case on April 25, 2003. The case was conducted as a remote investigation.

Investigation Type: Remote
Crash Location: Maryland
Crash Date: March, 2003
Notification Date: April 25, 2003
Field Work Completed: NA

SUMMARY

Crash Site

This two vehicle crash occurred in March, 2003 at 0912 hours. The crash occurred within the area of a "T" intersection located within a rural area. There is an east/west roadway consisting of two bituminous, undivided travel lanes. These travel lanes measure approximately 3.0 m (10.0 ft) in width with a total combined width of 6.1 m (20.0 ft). The east and westbound lanes are separated by a painted, yellow, double center line. The roadway has a slight right to left curve as it leads into and passes through the intersection. On the north side of this roadway, just east of the intersection, is a drainage gully. This gully is relatively shallow near the intersection, but gets deeper the further east one travels. Just north of the gully is an embankment (positive grade) and a wooden fence. The intersecting roadway enters the intersection at the south side (southern leg). This bituminous roadway consists of two lanes (no separating center lines present) that run generally north and south and has a total width of 7.4 m (24.4 ft). On the north side of the intersection there appears to be a common use driveway (private) leading to three large homes. This driveway measures 5.3 m (17.5 ft).



Figure 1. Approach to area of impact (east)



Figure 2. Area of impact/area of U turn by case vehicle (east)

As the east/west roadway passes through the intersection, it becomes four, undivided travel lanes. The two east/west travel lanes remain the same, but are joined by dedicated right turn lanes leading to the intersecting roadway/driveway and merge lanes leading from the intersecting roadway/driveway. These turn lanes and merge areas each measure approximately 4.0 m (13.2 ft) in width.

The east/west travel lanes are relatively level (0.8% grade). The intersecting roadway and driveway have a negative downhill grade leading into the intersection, but the intersection itself is relatively level. There are no traffic signals present for this intersection except for a stop sign located at the southeast corner which controls entry into the intersection from the intersecting roadway (northbound travel direction). All roadways, as well as the intersection, were dry and free of defects. The weather was clear and there were no viewing restrictions present. It was daylight at the time of the crash. The posted speed limit for both the east and westbound travel directions is 64 km/h (40 mph).

Pre-Crash

The case vehicle is a 2002 Mini (BMW parent company) Cooper S three-door hatchback driven by an unrestrained 53-year-old female (173 cm/68 in, 88 kg/190 lbs). The case vehicle was equipped with the following safety features: dual stage driver and front right passenger air bags, driver and front passenger seat-mounted side air bags, an advanced head protection system (inflatable curtains for both front and rear outboard occupants), and side-impact door beams with interlocking anchoring system. The driver does not appear to have been restrained by the manual, three point lap/shoulder belt. However, it should be noted that there was damage to the left side B-pillar as result of EMS extrication work. The manual belt webbing was cut, but at a location that would suggest that the belt was retracted when the EMS cut through the B-pillar.



Figure 3. Left side, case vehicle

The other vehicle is a 2002 Dodge Durango SUV driven by a 38-year-old female. There were three additional occupants in the Dodge vehicle—a 75-year-old female, a 3-year-old male, and a 20-year-old male.

Both vehicles were traveling east, approaching the intersection, on the two lane, undivided roadway. It is unknown how far back the Dodge was from the case vehicle. The driver of the case vehicle, who was looking for a connecting street, entered and passed through the intersection but realized she had passed her designated turn.

Crash

The driver of the case vehicle pulled to the right merge/shoulder area and initiated a U-turn in order to make the turn at the intersection (it is unknown whether the driver intended to turn at the private driveway or at the intersecting road which led to the new homes development). At this time, the other vehicle approached the intersection from the west (same initial travel direction as the case vehicle). The other vehicle passed through the intersection and struck the case vehicle as it was making its U-turn. Based upon final rest, it appears that the driver of the other vehicle steered left in order to avoid the



Figure 4. Left side, case vehicle

case vehicle, but it is unknown if any braking took place (no pre-impact skidding was found at the scene). The front plane of the other vehicle struck the left side plane of the case vehicle (08LYAW3) somewhere near the yellow double center line. The impact heading for the case vehicle was estimated to be 10 degrees with a principal direction of force (PDOF) of 250 degrees. The heading for the other vehicle was estimated to be 80 degrees with an estimated PDOF of 10 degrees. The total velocity change for the case vehicle was calculated by the WinSmash collision model as 24.0 km/h (14.9 mph). The longitudinal and lateral delta V components were 8.2 km/h (5.1 mph) and 22.6 km/h (14.0 mph), respectively. As a result of the impact, the left side rail mounted air curtain in the case vehicle deployed. The driver's seat back mounted air bag failed to deploy. The case vehicle's frontal air bags did not deploy. Both frontal air bags in the other vehicle deployed as a result of the impact (per repair shop). Due to the impact, the case vehicle was rotated clockwise and redirected. The other vehicle does not appear to have been redirected.

Both vehicles traveled northeasterly, with an approximate heading angle of 30 to 40 degrees, and departed the roadway near the beginning of the aforementioned drainage gully. The distance each vehicle traveled, from the likely area of the impact to rest, was approximately 14 m (46 ft). Post crash tire scuffs/markings were present and continued into the grass area of the roadside. Some of the grass surface was gouged/furrowed. This gouging may have been from the vehicles coming to rest or from subsequent towing. However, it is believed that the area of the gully/embankment (rest) helped impede both vehicles' progress, but was not enough to warrant a separate impact (the occupants of both vehicles probably experienced some forward deceleration as a result). Both vehicles came to rest facing a northeasterly direction.

Post-Crash

The driver of the case vehicle was extricated by EMS personnel. She was transported from the scene, by air, to a Level 1 trauma center with incapacitating injuries, including: a left clavicle fracture, left 2nd rib fracture, right mandibular fractures, right occipital condyle fracture, and a left pulmonary contusion. She arrived at the trauma center with a Glasgow Coma Scale (GCS) of 15. She underwent a mandibulomaxillary fixation and was hospitalized for two days.

The driver, left rear occupant, and right rear occupant of the other vehicle did not report any injuries. The front right occupant was reported to be transported to a local hospital with non-incapacitating injuries.

Both vehicles were towed from the scene due to damage sustained in the crash.

VEHICLE DATA - 2002 Mini (BMW parent company) Cooper S three-door hatchback

The 2002 Mini Cooper S three-door hatchback was equipped with a five-speed manual transmission, front wheel drive, and 4-wheel disc brakes.

VIN:	WMWRE33412TDxxxxx
Odometer:	Unknown
Engine:	1.6L, 4 cylinder
Reported Defects:	None noted
Cargo:	Unknown

The front seating positions in the 2002 Mini Cooper were configured with bucket seats with adjustable head restraints. The rear seating positions were configured with a bench seat with folding backs. The outboard rear seat positions were equipped with adjustable head restraints.

VEHICLE DAMAGE

Exterior Damage - 2002 Mini Cooper

Damage Description:	Moderate side impact damage. Roof cut off during extrication. Towed due to vehicle damage.	
CDC:	08LYAW3	
Delta V:	Total	24.0 km/h (14.9 mph)
	Longitudinal	8.2 km/h (5.1 mph)
	Latitudinal	22.6 km/h (14.0 mph)
	Energy	29,764 joules (21,953 ft-lbs)

The maximum crush depth was 43 cm (17 in) located above the C3 position along the measurement field. The direct damage began 12 cm (4.7 in) forward of the left rear axle and extended 215 cm (84.6 in) up the right side. The direct damage to the area just behind the left side door (B-pillar and back) is mostly minor buckling/deformation and scratching.

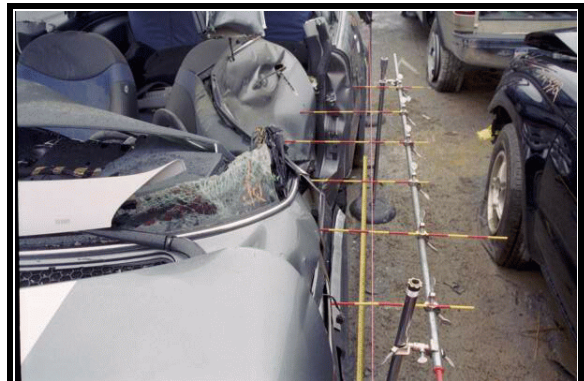


Figure 5. Side view of left side crush

This is believed to be the result of inconsequential contact between the left and right sides of the vehicles or possibly emergency medical services extraction methods. Since this minor damage/scraping could not be accurately attributed to a post crash source, it was included in the direct damage width. The total damage width (field L) began 68.0 cm (26.8 in) forward of the left rear axle and extended 124.0 cm (48.8 in) up the left side. This crush profile included the driver's door and a portion of the left front fender area (based upon damage inflection points). The height of the crush, from the ground was around 60.0 cm (23.6 in). This height seems to match up with the overall bumper height of a Dodge Durango (2003 used for comparison) of 51 to 60 cm (20 to 24 in). The damage pattern to the case vehicle appears to be from the front right half of the other vehicle's bumper, including its front right corner.



Figure 6. Side view of crush as viewed from rear of vehicle

Interior Damage - 2002 Mini Cooper

Interior damage to the 2002 Mini Cooper was moderate and attributed to occupant contact and passenger compartment intrusion. The windshield was cracked from impact forces and the front left glazing had disintegrated. There was intrusion to the left side from the door side panel, A pillar, B pillar, and the sill. The intrusion to the door was most significant and measured 32.0 cm (12.5 in) laterally. The left door was slightly opened with striker/latch failure. The upper portion of the steering wheel rim (left side more than right) was noticeably deformed (bent forward). The steering column was broken loose and was being supported by the seat cushion (likely damage by a combination of intrusion and EMS manipulation). The position of the tilt mechanism could not be determined. The door panel was intruded and was blocking the region where the seat back mounted side air bag would deploy.

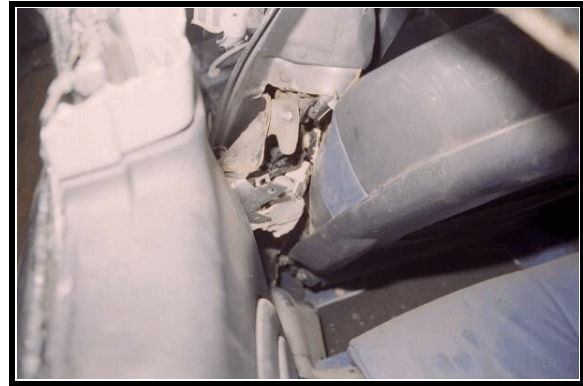


Figure 7. Latch/striker failure

The seat back was found in a somewhat reclined state and slightly skewed due to the intruded door panel. The adjustable head rest was not in place and was likely removed by the responding EMS personnel. The driver's seat belt was found cut. The B-pillar was cut through just below the shoulder anchorage point. The sliding latch plate was found unattached from the buckle housing, and laying on the driver's seat. The latch plate did exhibit some scratching that would suggest prior use.

MANUAL RESTRAINT SYSTEMS - 2002 Mini Cooper

The 2002 Mini Cooper was configured with a manual 3-point lap and shoulder belts for both front positions and both rear positions. The front seat belts were equipped with pyrotechnic pretensioners that did not actuate during the crash. The seat belts were equipped with sliding latch plates.

SAFETY SYSTEMS - 2002 Mini Cooper

The 2002 Mini Cooper was equipped with dual stage driver and front right passenger air bags, driver and front passenger seat back mounted side air bags, an Advanced Head Protection System (inflatable curtains for both front and rear outboard occupants), and side-impact door beams with interlocking anchoring system.

The driver's air bag was mounted in the steering wheel hub and did not deploy. The front right passenger's air bag was mounted in the mid instrument panel and did not deploy. The left and right head protection side curtains were concealed in the roof along the side wall, stretching from the A pillar to the C pillar. The driver and front right passenger side air bags were housed in the seat back. It is this contractor's understanding that both the side air bags and side curtains use the same crash sensor.

As a result of the left side impact with the front of the 2002 Dodge Durango SUV, the left side rail mounted air curtain in the case vehicle deployed. The driver's seat back mounted air bag did not deploy.

The left side air curtain measured 133.0 cm (52.3 in) long by 20.0 cm (7.9 in) high. The curtain was damaged somewhat during the extrication (roof removal) process. There were no occupant contacts visible.

According to Mini Cooper, "... the two [side air bag and side air curtain] often deploy together because of the angle of impact needed to make them deploy, but they can deploy independently of each other." However, it appears that in this above threshold impact both air bags should have deployed. The reason for the non-deployment is not known. The most likely reason would seem to be the fact that this was a relatively long crash event due to the overriding nature of the impact. Because the time was so long, and the level of velocity change would not have been known early on, the system's logic may have determined that there was insufficient time to deploy the side air bag.

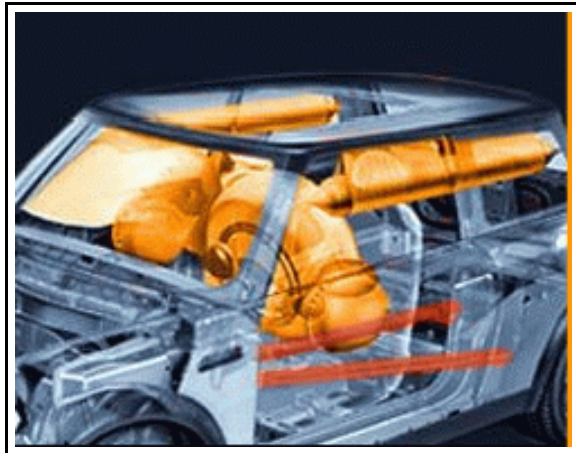


Figure 8. Overview of air bag systems



Figure 9. Exterior view, left side air curtain (roof had been cut off and was put back onto vehicle backwards)



Figure 10. Driver's side air bag location



Figure 11. Exemplar view of deployed seat mounted air bag

VEHICLE DATA - 2002 Dodge Durango SUV

Description:	2002 Dodge Durango SUV	
VIN:	1B4HS28N71Fxxxxxx	
Odometer:	Unknown	
Engine:	8 cylinder, 4.71 L	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Moderate frontal damage. Vehicle towed from the scene due to damage.	
CDC:	Unknown	
Delta V:	Total	13.0 km/h (8.1 mph)
	Longitudinal	-13.0 km/h (-8.1 mph)
	Latitudinal	0 km/h (0 mph)
	Energy	12,590 joules (9,286 ft lbs)

OCCUPANT DEMOGRAPHICS - 2002 Mini Cooper

Occupant 1

Age/Sex: 53/Female

Seated Position: Front left

Seat Type: Fabric covered bucket seat with folding back. Seat adjusted to between the middle and forward most track position. Seat back slightly reclined.

Height: 173 cm (68 in)

Weight: 86 kg (190 lbs)

Occupation: Unknown

Pre-existing Medical Condition: Hysterectomy.

Alcohol/Drug Involvement: None

Driving Experience: Presumed to be >20 years

Body Posture: Normal, upright

Hand Position: Left hand on steering wheel, right hand manual gear shift

Foot Position: Right foot on accelerator pedal, left on or near clutch pedal

Restraint Usage: Lap and shoulder belt available, not used

Air bag: Front air bag available, did not deploy. Seat back mounted side air bag available, did not deploy. Side air curtain available, did deploy.

OCCUPANT DEMOGRAPHICS - 2002 Dodge Durango SUV

	Driver	Occupant 2
Age/Sex:	39/Female	75/Female
Seated Position:	Front left	Front right
Seat Type:	Unknown	Unknown
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	Unknown
Driving Experience:	Unknown	Unknown
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt used, per police report	Lap and shoulder belt used, per police report

	Occupant 3	Occupant 4
Age/Sex:	20/Male	3/Male
Seated Position:	Rear left	Rear right
Seat Type:	Unknown	Unknown
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt used, per police report	Unknown type child/youth restraint used, per police report

OCCUPANT INJURIES - 2002 Mini Cooper

Driver: Injuries obtained from discharge summary. Fractures identified in radiology report.

<u>Injury</u>	<u>OIC code</u>	<u>Injury mechanism</u>	<u>Confidence level</u>
Comminuted condylar fracture of mandible on the right side. Transverse fracture, right mandibular neck	250616.2,1	Door (indirect)	Certain
Type I occipital condyle fracture, right side	150402.2,1	Door (indirect)	Certain
Left clavicle fracture	752200.2,2	Door	Certain
Left 2 nd rib fracture, right 1 st rib fracture	450220.2,3	Door	Certain
Left apical pulmonary contusions	441406.3,2	Door	Certain
: Abrasion, left elbow	790202.1,2	Door	Certain
Multiple contusions	990400.1,9	Unknown	Unknown

OCCUPANT INJURIES - 2002 Dodge Durango SUV

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Not injured			
Rear left occupant:	Not injured			
Rear right occupant:	Not injured			

OCCUPANT KINEMATICS - 2002 Mini Cooper

The 53-year-old female driver of the case vehicle was seated in a manually adjusted bucket seat. The seat was found positioned between the middle and forward most track position. The driver was not using the available 3-point lap and shoulder belt. At the time of the crash, the driver was sitting upright in her seat, her left hand was on the steering wheel and her right hand was on the gear shift. Her left foot was on or near the clutch pedal and her right foot was on the gas pedal. The driver had mentioned that she sits very low in the vehicle (seat height can be manually adjusted) and that her left shoulder was about even with the window sill. Also, her torso and head were probably twisted/turned to the left somewhat, in order to facilitate the U-turn to the left. The steering maneuver also would have moved the top portions of the steering wheel rim to the left (counter-clockwise rim rotation) and potentially moving her left hand into close proximity to the door panel.



Figure 12. Left door side panel



Figure 13. Left side intrusion

At impact, the driver was projected left and slightly rearward. Her left shoulder, left upper arm and left flank engaged the intruding left side door panel. This contact caused the left rib fracture, left clavicle fracture, left elbow abrasion, and the left pulmonary contusion. The left side of the driver's jaw either engaged the door panel as it was pushed inward or her own left shoulder. This contact caused a contrecoup type skeletal fracture to the right mandible and occipital condyles as the jaw was pushed to the right. Her left hand was possibly "sandwiched" between the steering wheel rim and the door panel; however, the driver did mention that her left hand was caught between the two components, post crash, but was able to extricate her left hand from that area. Since the impact was relatively high on this vehicle, it should be noted that, the entrapment the EMS personnel noted was likely due to the occupant being somewhat pinned by the upper portions of the interior door panel riding atop her left thigh and blocking her chest. The first row width is approximately 132 cm (52 in) total with each individual seat width measuring approximately 55 cm (22 in), not including the center console. Based upon post crash inspection, the door panel intruded laterally 32 cm (12.6 in) reducing the driver's measured seating space (point specific) to 23 cm (9 in). The interior door intrusion is also believed to have deformed the upper left portions of the steering wheel rim.

Attachment 1. Scene diagram

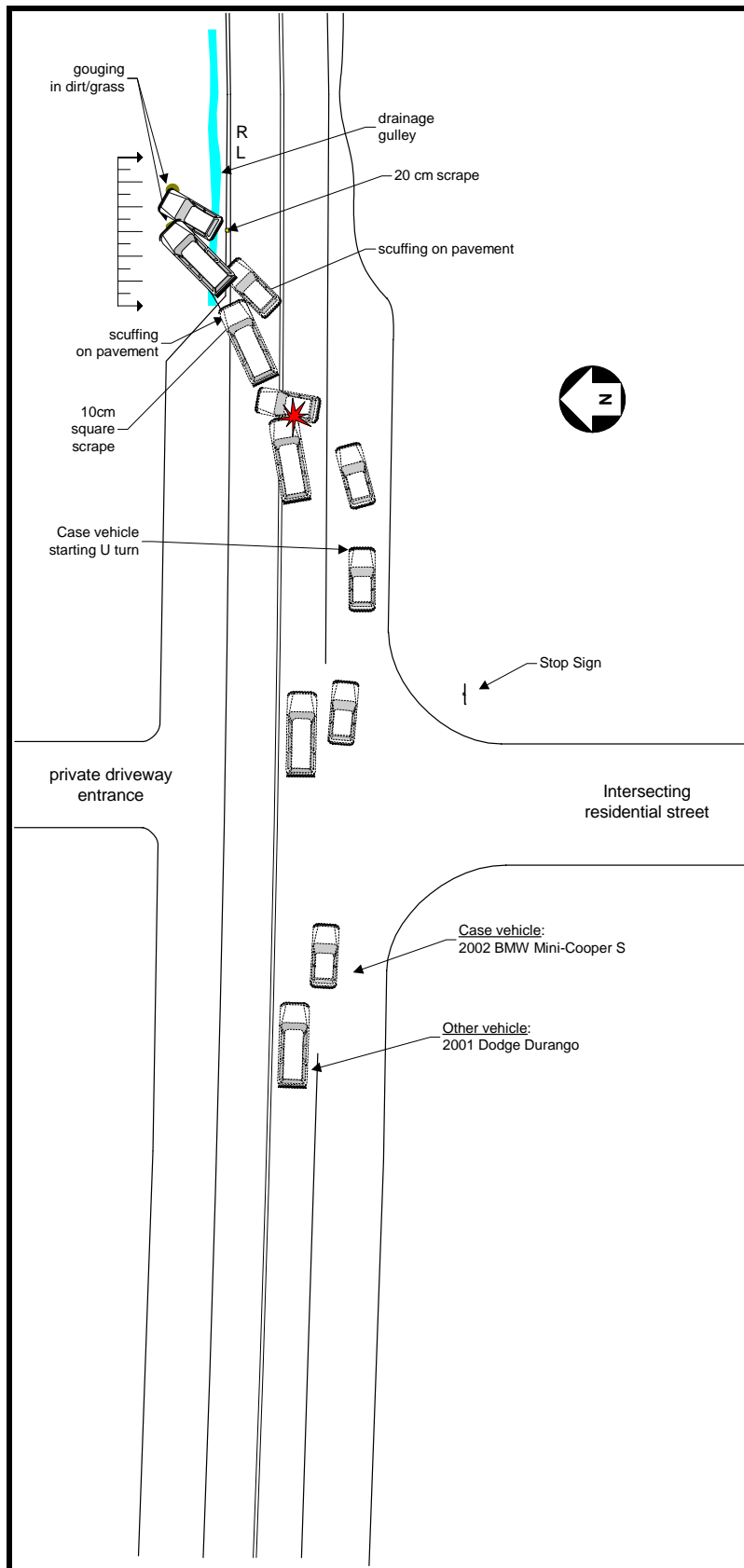


Figure 14. Scene diagram