

**TRANSPORTATION SCIENCES
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**ON-SITE SIDE IMPACT OCCUPANT PROTECTION SYSTEM CRASH
INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

VERIDIAN CASE NO. CA01-050

VEHICLE - 2001 HONDA CIVIC

LOCATION - STATE OF NEW YORK

CRASH DATE - NOVEMBER 2001

Contract No. DTNH22-01-C-17002

Prepared for:

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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.

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<p>16. <i>Abstract</i> This on-site investigation focused on the side impact crash of a 2001 Honda Civic. The Civic was occupied by a 50-year-old female driver who was restrained by the manual 3-point lap and shoulder belt. The vehicle was equipped with frontal air bags and seat back-mounted side impact air bags for the front-seated occupants. The driver of the Civic initiated a left turn maneuver from the right roadside, but failed to detect a Toyota Tacoma pickup truck approaching from the rear. The front aspect of the pickup truck struck the left side passenger area of the Civic. The impact resulted in moderate damage to both vehicles and was sufficient to deploy the driver's side impact air bag in the Civic. The driver initiated a lateral trajectory to the left, loaded the deployed side air bag, and struck intruding components. She sustained a deep left scalp laceration from contact with the left B-pillar. She sustained fractures of the left ribs 11 and 12, a left kidney laceration and contusion, spleen lacerations, left adrenal contusion, and transverse process fractures of L2, L3, and L4 from contact with the intruded door panel, arm rest, and lateral motion. She was transported by ambulance to a regional trauma center and admitted for treatment.</p>			
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**ON-SITE SIDE IMPACT OCCUPANT PROTECTION INVESTIGATION
SCI TECHNICAL SUMMARY REPORT
VERIDIAN CASE NO. CA01-050
SUBJECT VEHICLE - 2001 HONDA CIVIC
LOCATION - STATE OF NEW YORK
CRASH DATE - NOVEMBER 2001**

BACKGROUND

This on-site investigation focused on the side impact crash of a 2001 Honda Civic (**Figure 1**). The Civic was occupied by a 50-year-old female driver who was restrained by the manual 3-point lap and shoulder belt. The vehicle was equipped with frontal air bags and seat back-mounted side impact air bags for the front-seated occupants. The driver of the Civic initiated a left turn maneuver from the right roadside, but failed to detect a Toyota Tacoma pickup truck approaching from the rear. The front aspect of the pickup truck struck the left side passenger area of the Civic.



Figure 1. Damaged 2001 Honda Civic

The impact resulted in moderate damage to both vehicles and was sufficient to deploy the driver's side impact air bag in the Civic. The driver initiated a lateral trajectory to the left, loaded the deployed side air bag, and struck intruding components. She sustained a deep left scalp laceration from contact with the left B-pillar. She sustained fractures of the left ribs 11 and 12, a left kidney laceration and contusion, spleen lacerations, left adrenal contusion, and transverse process fractures of L2, L3, and L4 from contact with the intruded door panel, arm rest, and lateral motion. She was transported by ambulance to a regional trauma center and admitted for treatment.

The Special Crash Investigations team at Veridian were notified of the crash by the investigating police agency. The notification was forwarded to NHTSA and an on-site effort was assigned to the Veridian SCI team on Thursday, December 6, 2001. The field activities were initiated on December 7, 2001.

SUMMARY

Crash Site

This two-vehicle crash occurred during the daylight hours at the intersection of the northbound lanes of a divided state roadway and two divided local roadways. At the time of the crash, the asphalt roadway surface was dry and the weather was cloudy. The north/southbound roadway consisted of two travel lanes in each direction that were separated by a grass median. The travel lanes were bordered by asphalt shoulders. The roadway was configured in an east/west direction at the crash site. Traffic flow through the intersection was controlled by three-phase traffic signals for each leg of the intersection. Left turn lanes separated by triangular concrete gores and three-phase left turn signals controlled northbound/southbound traffic initiating left turns. The posted speed limit for the east/west roadway was 72 km/h (45 mph). The scene schematic is included as **Figure 12**.

Pre-Crash

The 50-year-old female driver of the Honda Civic had stopped her vehicle on the right shoulder of the northbound lanes of the state roadway west of the four-leg intersection (**Figure 2**). At the time of the crash, the 3-phase traffic signal was green for northbound traffic. The driver initiated a left turn across both northbound travel lanes from the right shoulder. The driver stated that she could not recall why the turn was attempted. The driver of the Civic failed to detect the approaching 1999 Toyota Tacoma pickup truck that was traveling on the inboard northbound lane. The driver of the pickup truck detected the Civic on the right shoulder prior to the crash, and removed his foot from the accelerator pedal. The driver of the pickup truck did not attempt any further avoidance maneuvers.



Figure 2. Northbound approach view for both vehicles

Crash

The full frontal area of the Toyota Tacoma pickup truck impacted the left passenger area of the Honda Civic. The initial contact was between the front right aspect of the Toyota's bumper and the left rear door of the Civic. The direction of force was in the 9 o'clock sector for the Civic and in the 12 o'clock sector for the pickup truck. The damage algorithm of the WinSMASH program computed a delta-V of 36.0 km/h (22.4 mph) for the Civic and a delta-V of 25.0 km/h (15.5 mph) for the Tacoma, based on the respective crush profiles. The specific longitudinal and lateral components for the Civic were -6.3 km/h (-3.9 mph) and 35.5 km/h (22.0 mph), respectively. The specific longitudinal and lateral components for the Tacoma were -24.6 km/h (-15.3 mph) and -4.3 km/h (-2.7 mph), respectively. The impact was sufficient to deploy the driver's side impact air bag in the Honda Civic and the redesigned frontal air bag system in the Toyota pickup truck.



Figure 3. Area of final rest showing gouge marks from the Civic

The Civic rotated in a counterclockwise (CCW) direction as the entire front bumper of the pickup truck engaged the left passenger area of the Civic. The vehicles remained engaged as the Toyota pickup truck's momentum pushed the Civic in a lateral direction across the intersection and onto the grassy median. Gouge marks from the right wheels of the Civic were present on the asphalt road surface and gouge marks in the median were present from all four wheels of the Civic. The Civic came to rest facing northwest in the median. The Toyota pickup truck came to rest straddling the left road edge facing east.

Post-Crash

The driver of the Toyota pickup truck exited the vehicle under his own power. He was not injured. The injured driver of the Civic remained in the vehicle for emergency personnel. Rescue personnel opened the front and rear right side doors, cut through the upper aspect of the right B-pillar, and folded the right rear door and the B-pillar outward to gain access to the driver. The driver of the Civic was transported by ambulance to a regional trauma center. She stated that she had lost consciousness after the crash, but regained consciousness in the ambulance. Emergency personnel reported to her that her condition deteriorated rapidly after she was removed from the vehicle and upon arrival at the trauma center; she had a weak pulse and decreased level of responsiveness. She was admitted and was placed in the Intensive Care Unit for two or three days. She was discharged five days following the crash.

VEHICLE DATA - 2001 Honda Civic

The 2001 Honda Civic was identified by the Vehicle Identification Number (VIN): 2HGES26731H (production sequence omitted). The vehicle was a four-door sedan and was equipped with a 1.7 liter, 4-cylinder engine, a four-speed automatic transmission, front wheel drive, front disc and rear drum brakes with anti-lock. The Civic was equipped with the EX trim package which included: air conditioning, cruise control, a keyless entry system, power door locks, manual adjustable height driver's seat, power mirrors, a power moonroof, power windows, and a tilt steering wheel. The Civic was configured with a digital odometer and the vehicle's mileage was not known. The Civic was equipped with Firestone FR690 P185/65R15 tires. The tire data for the Civic was as follows:

Tire	Tread	Pressure
Left front	6.4 mm (8/32")	151.7 kpa (22 psi)
Left rear	6.4 mm (8/32")	165.5 kpa (24 psi)
Right front	6.4 mm (8/32")	0.0 kpa (0.0 psi)
Right rear	6.4 mm (8/32")	0.0 kpa (0.0 psi)

The front seating positions in the Honda Civic were configured with bucket seats. The driver's seat track was adjusted to 19.1 cm (7.5") rear of the full-forward position and 5.1 cm (2.0") forward of the full-rear position. The seat back recline angle was approximately 30 degrees from vertical at the time of the vehicle inspection. The front right seat was adjusted to 22.9 cm (9.0") rear of the full-forward position and 1.3 cm (0.5") forward of the full-rear track position. The front right seat and seat back were most likely repositioned by rescue personnel to facilitate the extrication of the driver. The rear seating was configured with a three-person bench seat with a 60/40 split folding back. The outboard rear seating positions were configured with integral head restraints.

VEHICLE DAMAGE

Exterior Damage - 2001 Honda Civic

The 2001 Honda Civic sustained moderate damage as a result of the impact with the Toyota pickup truck (**Figure 4**). The direct contact damage began 8 cm (3") aft of the leading edge of the left front door and extended 132 cm (52") rearward. The combined direct and induced damage measured 252 cm (99") and began at the leading edge of the left front door and extended to 3 cm (1") aft of the rear edge of the left rear door. Both left side doors were crushed and displaced. The maximum crush was located on the left rear door approximately 50 cm (20") forward of the rear edge and measured approximately 50 cm (20") at the belt line and approximately 45 cm (18") at the mid-door. The front left door latch was separated from the striker plate (**Figure 5**). It appeared that the separation may have been due to an attempt by rescue personnel to open the door with hydraulic spreaders, but it could not be confirmed. The leading edge of the left front door was displaced outward approximately 3 cm (1") and displaced forward over the left front fender by approximately 3 cm (1").

The left rear door latch was also separated from the striker plate and the sheet metal at the lower aspect of the C-pillar was torn above the left rear wheel (**Figure 6**). The striker plate appeared to have been pulled forward, away from the sheet metal prior to the disengagement from the door latch. Both left doors were abraded and crushed from the impact, however, there was no damage to the left front fender and minor induced buckling on the rear left quarter panel. The roof separated from the roof side rail above both left doors as a result of the lateral displacement of the left doors and the left B-pillar. The roof was buckled laterally. The rear aspect of the left sill was crushed laterally and forward from engagement of the right bumper and right frame rail of the Toyota pickup truck. The rear aspect of the left sill was also rotated slightly upward. The Collision Deformation Classification (CDC) was 09-LPEW-3. Six crush measurements were taken along the left side plane at the mid-door level and were as follows: C1 = 0.0 cm, C2 = 12.7 cm (5.0"), C3 = 43.2 cm (17.0"), C4 = 41.9 cm (16.5"), C5 = 15.9 cm (6.3"), C6 = 0.0 cm.

The Civic impacted a reflector post with the right side area as it slid laterally onto the grassy median. There was no identifying damage on the right side of the Civic from this impact, however, the post was found adjacent to the final rest position of the Civic. Both right tires were debeaded and deflated. Both right side



Figure 4. Left side damage to the Honda Civic

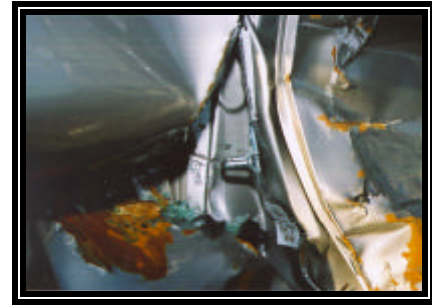


Figure 5. Close-up of the left front door latch/striker separation

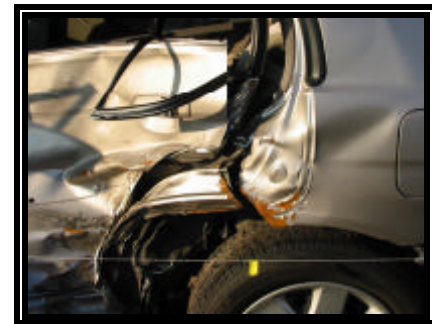


Figure 6. Close-up of left rear door latch/striker separation and torn sheet metal

wheel covers sustained abrasions and deformation. The right front wheel also exhibited large amounts of dirt on the wheel cover. The CDC for the secondary impact with the reflector post was 03-RPEU-1.

Damage to the right side of the Civic was a result of extrication efforts by rescue personnel, and may have masked any damage associated with the reflector post. The right B-pillar was cut through at the top aspect and a single cut was made at the bottom aspect. Rescue personnel opened the right front and right rear doors and folded the rear door and B-pillar outward to gain access to the driver.

Interior Damage - 2001 Honda Civic

Interior damage was moderate and attributed to compartment intrusion (**Figure 7**). The windshield was fractured on the left aspect from impact forces. All of the left side window glazing disintegrated. The backlight glazing also disintegrated as a result of impact forces. Left side components that intruded into the driver’s seat area included: the left front door, the left roof side rail, and the left B-pillar. The left interior door panel was fractured and separated below the arm rest. The left front seat was crushed laterally and slightly displaced in a clockwise direction toward the middle of the Civic from contact with the left B-pillar and left rear door. The vertical separation between the seat cushion and the seat back measured 5 cm (2") on the outboard aspect. The center console was fractured. The driver’s armrest was in the up position against the inboard aspect of the driver’s seat back. There was no evidence of loading to the arm rest, but the driver could not recall if it was down at the time of the crash. The interior aspect of the B-pillar exhibited a scuff, most likely from the deployed driver’s side impact air bag. Body fluids were noted on the driver’s head restraint. There were no additional identifiable occupant contacts. The documented intrusions were as follows:



Figure 7. View through the backlight showing lateral intrusion

Position	Intruded Component	Intrusion	Direction
11	Left front door armrest	21.0 cm (8.3")	Lateral
11	Left front door (rear aspect)	29.2 cm (11.5")	Lateral
11	Left roof side rail	12.7 cm (5.0")	Lateral
11	Left B-pillar	27.9 cm (11.0")	Lateral
21	Left rear door	31.1 cm (12.3")	Lateral
21	Left roof side rail	15.2 cm (6.0")	Lateral

Exterior Damage - 1999 Toyota Tacoma Pickup Truck

The 1999 Toyota Tacoma pickup truck sustained moderate frontal damage as a result of the impact with the Honda Civic (**Figure 8**). The direct damage measured 150 cm (59") from bumper corner to bumper corner. The maximum crush was located at the front right bumper corner and measured approximately 30 cm (12"). The bumper was crushed against the right front wheel and the wheel was displaced rearward and restricted between the bumper and the right fender. The right front tire was deflated and debanded. The right frame rail protruded forward from the plastic bumper fascia 8 cm (3"). The hood and grille area sustained direct contact damage, the hood was buckled, and the bug shield on the leading edge of the hood was fractured 13 cm (5") right of center. The cargo box was shifted approximately 3 cm (1") to the right as a result of the impact. The CDC for the impact with the Civic was 12-FDEW-2. Six crush measurements were taken along the front bumper of the Toyota Tacoma and were as follows: C1 = 0.0 cm, C2 = 0.0 cm, C3 = 5.7 cm (2.3"), C4 = 15.9 cm (6.3"), C5 = 25.9 cm (10.2"), C6 = 30.5 cm (12.0").



Figure 8. Damaged 1999 Toyota Tacoma pickup truck

MANUAL RESTRAINT SYSTEM - 2001 Honda Civic

The front seat positions in the Honda Civic were equipped with manual 3-point, continuous loop, lap and shoulder belts with sliding latch plates and inertial lock/belt sensitive retractors. The front right lap and shoulder belt was also equipped with a switchable/automatic locking retractor (ALR). Both front manual restraints were configured with buckle pretensioners located on the inboard aspects of the front seat tracks which did not deploy in this crash. The driver's adjustable D-ring was in the full-up position and the front right D-ring was in the full-down position at the time of the vehicle inspection. The driver's manual restraint was restricted in the used position (**Figure 9**) and the webbing exhibited two triangular black transfers on the outboard aspect. The webbing was stretched from occupant loading, and abrasions were noted on the driver's D-ring and sliding latch plate that were indicative of occupant loading. The front right restraint webbing was cut below the D-ring to facilitate the cutting of the B-pillar to extricate the driver.



Figure 9. View of driver's manual restraint

The rear seat positions were equipped with manual 3-point continuous loop lap and shoulder belts with sliding latch plates and inertial lock/belt sensitive retractors. Each rear seat restraint was configured with a switchable/ALR.

FRONTAL AIR BAG SYSTEM - 2001 Honda Civic

The 2001 Honda Civic was equipped with dual-stage frontal air bags which did not deploy in this crash. The system was controlled by a single-point sensing/control module that was located under the forward aspect of the center console.

SIDE IMPACT AIR BAG SYSTEM - 2001 Honda Civic

The 2001 Honda Civic was equipped with side impact air bags for the driver and front right seat positions. The side air bag system was equipped with a sensor in the front right seat back that was linked to a Side Air Bag light on the instrument panel. If an occupant leaned into the deployment path of the right front passenger's side air bag, the system was designed to shut off the right front passenger's side impact air bag and illuminate the indicator light on the instrument panel.

The driver's side impact air bag deployed as a result of the left side impact with the Toyota pickup truck (**Figure 10**). The driver's side impact air bag measured 28.9 cm (11.4") in length at the top aspect and 24.1 cm (9.5") on the bottom aspect. The height measured 25.4 cm (10.0") at the front aspect and the rear aspect was angled downward into the module and measured 15.2 cm (6.0"). The air bag was vented by two circular 6.7 cm (2.6") diameter external ports located on the forward aspect. The top port was centered 7.0 cm (2.8") below the top seam and the bottom port was centered 5.7 cm (2.3") above the bottom seam. The driver's side impact air bag was tethered internally by a lateral tether that measured 5.7 cm (2.3") in length and 1.5 cm (0.6") in width. Superficial scuff marks were noted on the bottom aspect of the air bag. The forward excursion of the driver's side air bag from the leading edge of the seat back measured 28 cm (11") at the top aspect and 20 cm (8") at the bottom aspect. The top aspect of the air bag was located 10 cm (4") below the top aspect of the seat back and the bottom aspect was located 18 cm (7") above the seat cushion.

There was no contact evidence on the inboard aspect of the driver's side impact air bag, however, multiple thin, red linear transfers were noted on the outboard aspect of the air bag membrane (**Figure 11**). The transfers were located 15 cm (6") rearward of the leading edge of the air bag and 5 cm (2") below the top aspect.



Figure 10. Deployed driver's side impact air bag



Figure 11. View showing red linear transfers on the outboard aspect of the driver's side impact air bag

OCCUPANT DEMOGRAPHICS - 2001 Honda Civic

Driver

Age/Sex: 50-year-old female
Height: 168 cm (66")
Weight: 74 kg (163 lb)
Seat Track Position: Between mid-track and full-rear positions
Manual Restraint Use: Manual 3-point lap and shoulder belt
Usage Source: Vehicle inspection, interview
Eyewear: Prescription eyeglasses
Type of Medical Treatment: Transported by ambulance to a regional trauma center and admitted

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Fractured left ribs (11 and 12)	Moderate (450220.2,2)	Intruded left door panel/arm rest
Left kidney contusion (NFS)	Moderate (541612.2,2)	Intruded left door panel/arm rest
Left kidney laceration (Grade II)	Moderate (541622.2,2)	Intruded left door panel/arm rest
Multiple spleen lacerations (Grade I - II)	Moderate (544222.2,2)	Intruded left door panel/arm rest
Transverse process fractures of L2, L3, and L4	Moderate (650620.2,8)	Intruded left door panel/arm rest and lateral motion
5 cm (2") laceration on the left temporal scalp	Minor (190602.1,2)	Intruded left B-pillar
Left adrenal contusion	Minor (540212.1,2)	Intruded left door panel/arm rest

Injury source: Emergency room records, discharge summary

Driver Kinematics

The 50-year-old female driver was seated in an upright posture with the seat track adjusted between the mid-track and full-rear positions. She was restrained by the manual 3-point lap and shoulder belt system. The driver could not recall the events prior to the crash.

At impact, the driver's side impact air bag deployed and the driver initiated a lateral trajectory to the left.

She stated that her prescription eyeglasses were knocked off as a result of the impact. She loaded the manual restraint and struck her head on the left front door window glazing and possibly the window frame and the intruded left B-pillar which resulted in a 5 cm (2") left scalp laceration. The driver loaded through the deployed driver's side air bag and loaded the intruded left front door panel, arm rest, and left B-pillar. She sustained fractures of the left ribs 11 and 12, a left kidney laceration and contusion, spleen lacerations, left adrenal contusion, and transverse process fractures of L2, L3, and L4 from contact with the intruded door panel, arm rest, and lateral motion. She rebounded to the right and loaded the manual restraint. The driver could not recall if the driver's armrest on the right aspect of the driver's seat back was down or if she made contact with it.

The driver recalled that she had difficulty breathing after the vehicle came to rest, but stated that she lost consciousness prior to being removed from the vehicle. She also recalled that rescue personnel did not suspect serious injuries, however, after she was removed from the vehicle, her condition deteriorated rapidly. She was transported by ambulance to a regional trauma center and had a weak pulse upon arrival. She was admitted into the intensive care unit for two or three days, and was discharged from the trauma center six days following the crash.

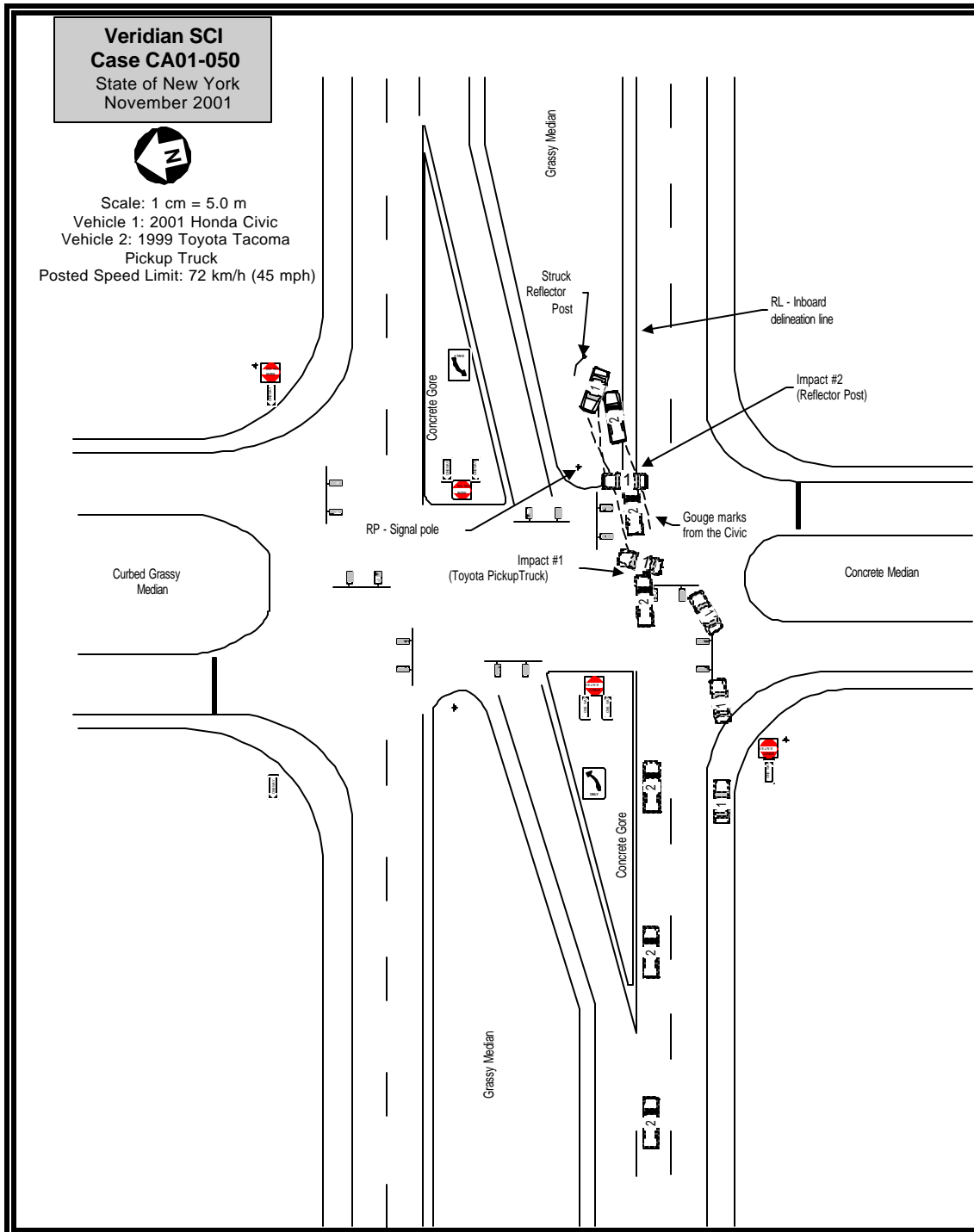


Figure 12. Scene schematic