

Certified Advanced 208-Compliant Investigation  
Dynamic Science, Inc. (DSI), Case Number DS09028  
2008 Honda Odyssey LX  
California  
July 2009

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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 crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract <p>This on-site investigation focused on the Certified Advanced 208-Compliant (CAC) air bag system in a 2008 Honda Odyssey. The focus of the case also included the vehicle's Advanced Compatibility Engineering (ACE) body structure. The crash location was within an interchange area between an interstate and a US highway. The Honda was traveling southbound on a curved transition road to the westbound US highway. The vehicle was being driven by a 40-year-old female and the front right seat was occupied by a 26-year-old female. The other vehicle was a 1997 Chevrolet Venture that was being driven westbound on the US highway. The Honda entered the right curved transition roadway at a high rate of speed. The driver was unable to control the vehicle and the Honda departed the roadway on the left side. The Honda impacted two wooden post directional signs and traveled up an ascending embankment that separated the transition roadway from the westbound highway. The vehicle departed the embankment and was airborne as it entered the roadway. The front of the Honda impacted the right side of the Chevrolet. The Honda initiated a clockwise rotation, tripped, and initiated a right-side leading rollover. The Honda rolled three quarter turns and came to rest on its left side facing west in the inboard travel lane. The Chevrolet rotated in a clockwise direction and came to rest in the fourth lane from the left facing south. A 1995 Geo Prizm was traveling in the fifth lane. When the driver of the Geo saw the collision ahead of her, she steered to the left in an effort to avoid the Honda, and the vehicle departed the roadway. The driver and front right occupant of the Honda sustained minor injuries. They were transported to local hospitals where they were treated and released.</p>					
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**Dynamic Science, Inc.  
Crash Investigation  
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## BACKGROUND

This on-site investigation focused on the Certified Advanced 208-Compliant (CAC) air bag system in a 2008 Honda Odyssey (**Figure 1**). The multi-stage air bags were certified by the manufacturer to be compliant with the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The focus of the case also included the vehicle's Advanced Compatibility Engineering (ACE) body structure.

This two-vehicle crash occurred in July 2009 in the state of California. The crash location was within an interchange area between an interstate and a US highway. The Honda was traveling southbound on a curved transition road to the westbound US highway. The vehicle was being driven by a 40-year-old female and the front right seat was occupied by a 26-year-old female. The other vehicle was a 1997 Chevrolet Venture that was being driven westbound on the US highway by a 46-year-old male. The Chevrolet had three additional occupants: a 48-year-old female in the front row right seat, a 12-year-old female in the second row left seat, and 14-year-old female in the second row right seat.



**Figure 1.** Subject vehicle, 2008 Honda Odyssey

The Honda entered the right curved transition roadway at a high rate of speed. The driver was unable to control the vehicle and the Honda departed the roadway on the left side. The Honda impacted two wooden post directional signs and traveled up an ascending embankment that separated the transition roadway from the westbound highway. The vehicle departed the embankment and was airborne as it entered the roadway. The front of the Honda impacted the right side of the Chevrolet. The Honda initiated a clockwise rotation, tripped, and initiated a right-side leading rollover. The Honda rolled three quarter turns and came to rest on its left side facing west in the inboard travel lane. The Chevrolet rotated in a clockwise direction and came to rest in the fourth lane from the left facing south. A 1995 Geo Prizm was traveling in the fifth lane. When the driver of the Geo saw the collision ahead of her, she steered to the left in an effort to avoid the Honda, and the vehicle departed the roadway.

The driver of the Honda sustained lacerations to her head and arm and was transported to a local hospital where she was treated and released. The front right occupant sustained a forehead contusion and was transported to a local trauma center for treatment.

This CAC investigation was initiated by the National Highway Traffic Safety Administration (NHTSA) from a review of an auto auction sale list. On August 27, 2009, DSI was forwarded vehicle data and auto auction photographs with instructions to obtain cooperation. Permission to inspect the vehicle was obtained, the case was assigned, and the vehicle was inspected on August 31, 2009. The vehicle was sold to a private party prior to the vehicle inspection and permission to remove the Event Data Recorder was not obtained. The police report was obtained on September 2, 2009. Field work was completed on September 18, 2009 after obtaining the police report.

## SUMMARY

### Crash Site

The crash location was within an interchange area between an interstate and a US highway. The Honda was initially traveling on a transition road between the southbound interstate and the westbound US highway. The transition road had a single travel lane and its alignment was a sharp curve to the right (**Figure 2**). There were posted yellow and black recommended speed signs of 32 km/h (20 mph) approaching the curve. Additionally, there were black and yellow caution signs mounted on wood posts indicating the direction of the curve along the left side of the road. The transition road increased in elevation until it merged with the westbound highway. There was an ascending, partially landscaped embankment on the left side between the transition road and the highway. The westbound highway was comprised of six travel lanes and was of asphalt composition (**Figure 3**). The two left westbound lanes were the end of a transition road from a northbound roadway and were separated from the four westbound travel lanes by a double-yellow set of stripes, a solid white stripe, and raised white reflective paddle markers. The westbound travel lanes were delineated by painted broken white stripes with raised ceramic markers. The roadway at this location was level and had a posted speed limit of 105 km/h (65 mph). The weather was clear and the roadways were dry.



**Figure 2.** Transition roadway (ramp)



**Figure 3.** Westbound approach

### Pre-Crash

The Honda entered the right curved transition roadway at a police-reported speed of 97 km/h (60 mph). The Chevrolet was traveling westbound in the second lane from the right at a police-reported speed of 105 km/h (65 mph). The driver of the Honda was unable to control the vehicle and the Honda departed the transition roadway on the left side.

### Crash

The Honda impacted two wood post directional signs with its front end (Events 1 and 2) and traveled up the ascending embankment that separated the transition roadway from the westbound highway. The Honda departed the embankment and was airborne as it entered the westbound highway. The Honda crossed two westbound travel lanes and impacted the right side of the Chevrolet with its front end (Event 3). The frontal and left side air bags in the Honda deployed during this impact. For the Honda, the Missing Vehicle algorithm of the WinSMASH program computed a Total Delta-

V of 24 km/h (14.9 mph); the longitudinal and lateral components were -15.4 km/h (-9.6 mph) and 18.4 km/h (11.4 mph), respectively. For the Chevrolet, the program computed a Total Delta-V of 30 km/h (18.6 mph); the longitudinal and lateral components were -15.0 km/h (-9.3 mph) and -26.0 km/h (-16.1 mph), respectively. The results appear reasonable, based on the crush profile.

After the impact, the Honda began a clockwise rotation, tripped, and began a right-side leading rollover (Event 4). The exact trip point could not be determined on this high-speed, heavy-volume roadway. The driver of the Geo saw the collision ahead of her and steered to the left and departed the roadway in an effort to avoid the Honda.

### **Post-Crash**

The Honda rolled three quarter-turns as it traveled in a northwesterly direction and came to rest on its left side facing west in the left most travel lane. The Chevrolet rotated in a clockwise direction and came to rest in the fourth lane from the left facing east. The driver of the Honda sustained lacerations to her head and arm and was transported to a local hospital where she was treated and released. The front right occupant sustained a forehead contusion and was transported to a local trauma center where she was treated and released. The driver and rear seat occupants of the Chevrolet sustained minor injuries and were transported to a local trauma center for treatment. The front right occupant sustained fractures to the right femur, right foot, and jaw. She also sustained a laceration to the right side of her neck. She was transported to a local trauma center for treatment.

### **Vehicle Data - 2008 Honda Odyssey**

The 2008 Honda Odyssey minivan was identified by the Vehicle Identification Number (VIN): 5FNRL38288Bxxxxxx. The date of manufacture was April 2008. The Honda was equipped with a 3.5-liter, 6-cylinder engine, Anti-lock Braking System (ABS), Electronic Brake Distribution (EBD), Vehicle Stability Assist (VSA) with traction control, a Tire Pressure Monitoring System (TPMS), front-wheel drive, power steering, and seating for seven passengers. The vehicle was configured with Michelin Energy 235/65R16 tires. The tire manufacturer's recommended maximum pressure was 283 kPa (41 psi). The vehicle manufacturer's recommended cold pressure was 230 kPa (33 psi) for the front and 240 kPa (35 psi) for the rear. The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	283 kPa (41 psi)	6 mm (8/32 in)	No	Cut/abraded
LR	Tire Flat	7 mm (9/32 in)	No	Sidewall abraded
RR	Tire Flat	6 mm (8/32 in)	No	Tire debanded
RF	290 kPa (42 psi)	6 mm (8/32 in)	No	None

The seating in the Honda was configured with front bucket seats with adjustable head restraints. Both seats were adjusted to the full rear-track positions at the time of inspection. The second row was configured with bucket seats with adjustable head restraints. The third row was a 60/40 split bench seat with folding backs and adjustable head restraints.

### Vehicle Damage - 2008 Honda Odyssey

#### Exterior Damage

The Honda sustained moderate front end damage as a result of the initial impact with the Chevrolet (**Figure 4**). The direct damage began at the front left right bumper corner and extended 42 cm (16.5 in) to the right. The bumper fascia and backing bar were displaced from the vehicle during the crash. Six crush measurements documented at the bumper mounts and lower radiator support as follows:  $C_1 = 12$  cm (4.7 in),  $C_2 = 5$  cm (2.0 in),  $C_3 = 5$  cm (2.0 in),  $C_4 = 4$  cm (1.6 in),  $C_5 = 10$  cm (3.9 in),  $C_6 = 2$  cm (0.8 in). The left mount was shifted 26 cm (10.2 in) to the right and the right was shifted 20 cm (7.9 in). The Collision Deformation Classification (CDC) for the frontal impact with the Chevrolet was 10FLEW1.



**Figure 4.** Frontal damage



The impacts with the two sign posts were masked by the vehicle-to-vehicle impact. CDCs assigned to these events are 12F9999 and 12F9999.

The Honda sustained moderate to the top plane during the rollover event (**Figure 5**). The direct damage to the top of the vehicle extended laterally from roof side rail to roof side rail and measured 129 cm (50.8 in). The damage extended from the windshield header rearward 206 cm (81.1 in). The maximum vertical crush was located on the windshield header 23 cm (9.0 in) left of the right side rail and measured 12 cm (4.7 in). The maximum lateral crush was located at the left A-pillar and measured 5 cm (1.9 in).

The direct damage to the left side began at the back left bumper corner and extended forward 397 cm (156.2 in) (**Figure 6**). The damage began at the sill and extended 154 cm (60.6 in) up to the roof side rail. There was a 7 cm (2.8 in) wide scrape that began 94 cm (37.0 in) forward of the rear axle at the sill and ended 149 cm (58.6 in) forward of the rear axle 65 cm (25.5 in) above the sill. This damage was caused by the curb on the west side of the roadway. The damage to the right side consisted of minor scratches at the right rear bumper and a deformed right rear tire rim. The CDC for the rollover was 00TDDO2.

## ACE

According to Honda literature, the ACE body structure provides enhanced occupant protection in a frontal collision by reducing cabin intrusion and minimizing the potential for misalignment of the vehicle's energy-absorbing safety structure in an offset collision or in a collision between vehicles of differing size or ride height (**Figure 7**). By reducing the potential for misalignment, the ACE body helps to optimize the performance of the vehicle's safety structures while dispersing collision forces through more load paths compared to a traditional front frame structure<sup>1</sup>.



**Figure 5.** Roof damage



**Figure 6.** Left side damage



**Figure 7.** ACE body structure.

<sup>1</sup><http://automobiles.honda.com/certified-used/2005/odyssey/safety.aspx>

Measurements were documented to compare the upper bulkhead frame to an undamaged frame (**Figure 8**). The left side of frame was shifted to the right 12 cm (4.7 in) and deformed rearward 4 cm (1.6 in).

### Interior Damage

The Honda sustained moderate interior damage due to intrusion and occupant contacts. The vehicle sustained lateral intrusions of the left door and left A-pillar, and vertical intrusion of the left A-pillar, windshield header, roof, and roof side rail. Both second row doors were jammed shut and there was integrity loss to the windshield, left side window, and the backlight. There were possible occupant contact related scuffs to the left door side panel, left roof rail, roof, and glove box. A hair deposit was located along the right side roof rail.



**Figure 8.** Left upper bulkhead frame

### Manual Restraints

The Odyssey was equipped with 3-point manual lap and shoulder belts for each of the seven seating positions. The front safety belts were configured with adjustable D-ring anchorages; the driver's belt anchorage was in the full-down position and the front right passenger anchorage was in the full-up position. The second row safety belts were configured with D-ring anchorages that were in the full-down position. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The remaining outboard safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR). The driver's and front right occupant's safety belts exhibited evidence of historical usage in the form of scratches on the latch plates and were used in this crash according to the interviewee. The driver's belt exhibited evidence of occupant loading in the form of abrasions to the latch plate cover. The fascia covering the right B-pillar was displaced due to movement of the right safety belt.

The front safety belts were configured with retractor pretensioners located in the lower B-pillars. At the time of the vehicle inspection, the belts were not locked in a pretensioned position and they unspooled and retracted normally.

### Supplemental Restraint System

The Honda was equipped with advanced occupant protection systems including dual-stage, dual-threshold frontal air bags, seat-mounted side air bags, and combination rollover/side impact inflatable curtain (IC) air bags. The side impact air bag sensors were located on the driver and passenger side lower B- and C-pillars. The side air bags were designed to deploy separately, depending on which side was impacted. The front right seat position was configured with an Occupant Position Detection System (OPDS) for the right seat-mounted side air bag. The OPDS utilizes a 7-segment antenna system built into the backrest to signal the electronic control unit to deactivate the air bag in the event a child (or a small-statured adult) leans in the deployment path

of the bag. The IC air bags were located in the roof rails and provided protection for all three seating rows. The IC air bags were designed to deploy in the event of either a side impact or a rollover. A roll rate sensor is integrated into the supplemental restraint unit and detects the angle of the rollover.

The frontal air bags and driver's seat-back mounted side air bag deployed during the impact with the Chevrolet. The IC air bags deployed during the vehicle rollover. The system is designed to actuate the pretensioners in the front safety belts whenever any air bag deploys. There were no indications that they actuated.

The driver's frontal air bag deployed from the center of the steering wheel hub through H-configuration module cover flaps (**Figure 9**). The top flap measured 15 cm (6.7 in) in width and 13 cm (5.1 in) in height; the lower flap measured 15 cm (6.7 in) in width and 10 cm (3.9 in) in height. The deployed air bag measured 56 cm (22.0 in) in width in its deflated state. The air bag was tethered by a single internal strap. The tether was attached to a stitched 10 cm (3.9 in) diameter circle in the center of the front panel. Two vent ports that measured 5 cm (1.9 in) in diameter were located at the 11 and 1 o'clock aspects on the rear panel. There was a 53 x 20 cm (20.8 x 7.9 in) area of blood drops across the right upper, right lower, and left lower quadrants.



**Figure 9.** Driver's air bag

The front right passenger's frontal air bag deployed from the top of the instrument panel through H-configuration module cover flaps (**Figure 10**). The top flap measured 23 cm (9.0 in) in width and 6 cm (2.4 in) in height; the lower flap measured 23 cm (9.0 in) in width and 4 cm (1.6 in) in height. The deployed air bag measured 60 cm (23.6 in) in height and 34 cm (13.3 in) in width with a maximum excursion of 50 cm (19.6 in). Two 7 cm (2.8 in) vent ports were located on the side air bag panels at the 3 and 9 o'clock positions. There were areas of grease located on the right upper quadrant that was deposited by vehicle components that had been placed in the vehicle after the crash.



**Figure 10.** Front right passenger air bag

The driver's seat-mounted side air bag deployed from the seat back (**Figure 11**). The air bag was configured in a semi-circular shape and measured 30 cm (11.8 in) in height and 32 cm (12.5 in) in width. The air bag was configured on both sides with an 8 cm (3.1 in) circular area of stitching surrounding a circular vent port. A 9 cm (3.5 in) vent port was located at the leading edge of the air bag. On the inboard aspect of the air bag panel, there was a 10 x 4 cm (3.9 x 1.6 in) area of blood

transfers. On the outboard aspect, there was a 9 x 8 cm (3.5 x 3.1 in) dark-colored splatter mark located on the bottom of the air bag and a 3 cm (1.2 in) scuff on the upper portion.

The side IC air bags deployed through the roof rail cladding from a module located at the roof side rail (**Figure 12**). The air bag was generally rectangular and measured 250 cm (98.4 in) in length and 44 cm (17.3 in) in width. The forward aspect of the bags were attached to the A-pillar by tethers that measured 27 cm (10.6 in) in length; the rear aspect of the bags were attached to the D-pillar. The longitudinal area of coverage began near the A-pillar and extended to the D-pillar. The bag's vertical coverage began at the roof rail and extended to downward 44 cm (17.3 in). A 17 x 13 cm (6.7 x 5.1 in) smear was documented at the forward end of the outboard facing portion of the air bag.

### Rollover Dynamics

The Honda was equipped with ABS, VSA, disc brakes, and front wheel drive. Data for the rollover properties for the 2008 model year was not available. The following information was obtained for the 2007 model year, which had identical vehicle specifications. The 2007 Odyssey had a Static Stability Factor (SSF) of 1.30<sup>2</sup>. The SSF of a vehicle is an at-rest calculation of its rollover resistance, based on geometric properties.

Basically, SSR is a measure of the top-heavy characteristics of a vehicle. The Odyssey was a four-star rated vehicle, indicating that the vehicle has a risk of rollover of 14%. After the impact with the Chevrolet, the Honda began a clockwise rotation. The vehicle rotated approximately 270 degrees and then initiated a right side leading trip over. The Honda rolled three quarter turns and came to rest on its left side facing west in the inboard travel lane. The estimated roll distance from the trip point to final rest was 13.1 m (43 ft).

### Vehicle Data - 1997 Chevrolet Venture

The 1997 Chevrolet Venture was identified by the VIN: 1GNDX03EXVDxxxxxx. The Chevrolet was a 4-door minivan that was equipped with a 3.4-liter, 6-cylinder engine, automatic transmission, rear-wheel drive, and 4-wheel ABS. The vehicle sustained major right side damage from the impact with the front of the Honda and was towed from the scene. The vehicle was later declared a total loss by the insurance company and sold to a private party.



**Figure 11.** Driver's side air bag



**Figure 12.** Right IC air bag

<sup>2</sup>[www.safercar.gov](http://www.safercar.gov)

## Occupant Demographics

	<b>Driver</b>	<b>Right Front Occupant</b>
Age/Sex:	40/Female	26/Female
Seated Position:	Front left	Front right
Seat Type:	Bucket	Bucket
Seat track position:	Unknown	Unknown
Height:	152 cm (60 in)	160 cm (63 in)
Weight:	52 kg (115 lbs)	48 kg (105 lbs)
Alcohol/Drug Involvement:	None	N/A
Body Posture:	Upright	Upright
Hand Position:	Both on steering wheel, unknown clock positions	Unknown
Foot Position:	Right foot on brake, left on floor	Both feet on floor
Restraint Usage:	Lap and shoulder belt	Lap and shoulder belt
Air bags:	Frontal, side IC, and seat-mounted side air bags deployed.	Frontal and side IC air bags deployed. Seat-mounted side air bag did not deploy.

## Occupant Injuries

Driver: Injuries obtained from emergency room records, radiology report, nurse's notes, and interviewee.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Laceration, left side, back of head, 3 cm (1.2 in)	190602.1,6	Flying glass	Possible
Laceration, left arm	790600.1,2	Flying glass	Possible
Contusion, left breast	490402.1,2	Seat belt webbing	Probable

Front Right Occupant: Injuries obtained from interviewee.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Contusion, forehead	290402.1,7	Passenger air bag	Probable

## **Occupant Kinematics**

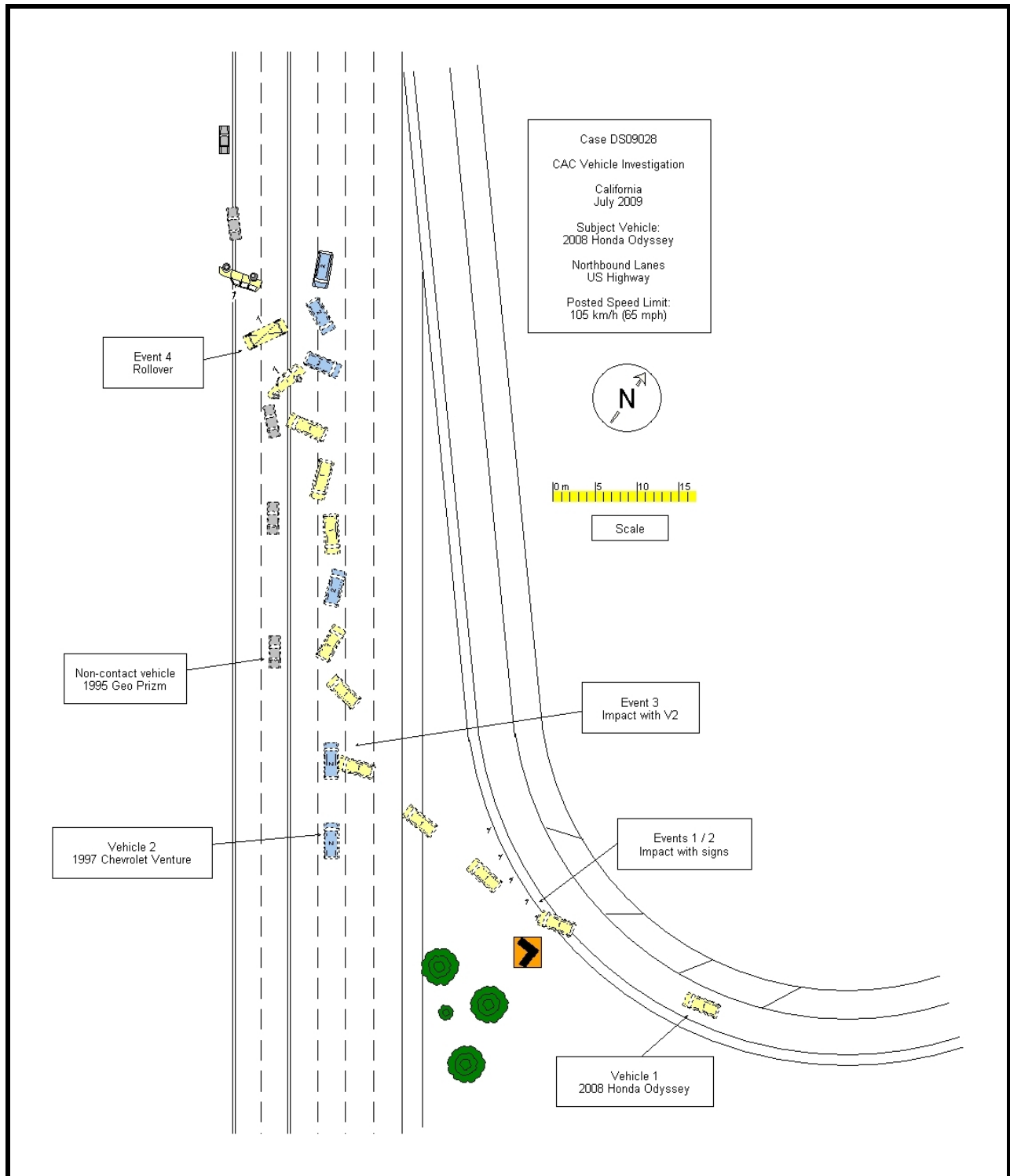
### **Driver Kinematics**

The 40-year-old female was seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. The driver was negotiating a right turn into a curve and lost control of the vehicle. The Honda impacted two sign posts as the vehicle departed the roadway. These impacts had little effect on the driver's kinematics. As the Honda ascended the embankment, the driver loaded the seat cushion to some degree. The vehicle was airborne as it entered the westbound travel lanes and probably bottomed out. At impact with the Chevrolet, the frontal air bags and driver's seat-mounted side air bag deployed. The driver initiated a forward and left lateral trajectory and loaded the shoulder harness, causing a chest contusion. The Honda was redirected into a clockwise rotation, and the driver was displaced to the left. As the Honda continued the rotation, the vehicle tripped and began a right side leading rollover. As the vehicle rolled, the left and right IC air bags deployed. The vehicle came to rest on its left side. The driver was assisted from the vehicle by a passerby. She sustained lacerations to her head and left arm, possibly from flying glass, and was transported to a local hospital for treatment where she was treated and released.

### **Front Row Right Passenger Kinematics**

The 26-year-old female front right passenger was seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. The passenger probably loaded the seat bottom to some degree as the vehicle ascended the embankment and as the vehicle returned to the roadway. At impact with the Chevrolet, she initiated a forward and left lateral trajectory. The Honda was redirected into a clockwise rotation, and she was displaced to the left. She was then displaced to the right during the first quarter-turn of the rollover sequence. As the vehicle rolled, the left and right IC air bags deployed. The vehicle came to rest on its left side. She was assisted from the vehicle by a passerby. She sustained a forehead contusion and was transported to a local trauma center where she was treated and released.

# Attachment 1. Scene Diagram



**Attachment 2. Satellite Image**



Arrow depicts area of roadway departure