Air Bag Related Child Passenger Investigation / Vehicle versus Animal
Dynamic Science, Inc. / Case Number: DS02-006
2000 Suzuki Esteem
Oklahoma
March, 2002

*This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.*

*The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.*

*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.*

**Technical Report Documentation Page**

| 1. Report No. | 2. Government Accession No. | 3. Recipient Catalog No. |
|---|---|---|
| DS02-006 | | |

| 4. Title and Subtitle | 5. Report Date |
|---|---|
| Air Bag Related Child Passenger Investigation | 6. Performing Organization Report No. |

| 7. Author(s) | 8. Performing Organization Report No. |
|---|---|
| Dynamic Science, Inc. | |

| 9. Performing Organization name and Address | 10. Work Unit No. (TRAIS) |
|---|---|
| Dynamic Science, Inc.<br>530 College Parkway, Ste. K<br>Annapolis, MD 21401 | 11. Contract or Grant no.<br>DTNH22-01-C-27002 |

| 12. Sponsoring Agency Name and Address | 13. Type of report and period Covered<br>[Report Month, Year] |
|---|---|
| U.S. Dept. of Transportation (NRD-32)<br>National Highway Traffic Safety Administration<br>400 7th Street, SW<br>Washington, DC 20590 | 14. Sponsoring Agency Code |

15. Supplemental Notes

16. Abstract

This air bag related child passenger crash occurred in March, 2002 at 1945 hours in the state of Oklahoma. This was an on scene investigation. The case vehicle, was a 2000 Suzuki Esteem 4-door driven by an unrestrained 25-year-old female. There was an additional occupant in the case vehicle, an unrestrained 3-year-old male child in the front right seat position. The case vehicle was traveling westbound at a driver reported 80 km/h (50 mph). As it crested a hill a 68 kg (150 lb) doe ran out in front of the vehicle. The driver braked and the case vehicle deposited 9 meters (30 ft) of pre-impact braking skid marks. The front of the case vehicle struck the doe and both frontal air bags deployed at this time. The case vehicle deposited an additional 36 meters (117 ft) from the point of impact leading to the final rest area. It came to final rest heading west. The driver of the case vehicle exited the vehicle and then took the 3-year-old child out of the vehicle and started running down the road yelling for help. A vehicle passing by stopped and transported both the driver and 3-year-old child to a local hospital arriving at the emergency room at 2008 hours. The driver was examined and quickly released. She sustained an abrasion under her chin. Emergency room records indicate that the 3-year-old child arrived with no pulse and unconscious. The mother reported that he had stopped breathing and was unconscious since the time of the crash. The 3-year-old child received medical treatment in the emergency room but he remained pulseless and without spontaneous respiration. At 2035 hours of the same day he was declared dead.

| 17. Key Words | 18. Distribution Statement |
|---|---|
| Air bag, deployment, child, fatality, front right occupant | |

| 19. Security Classif. (of this report) | 20. Security Classif. (of this page) | 21. No of pages | 22. Price |
|---|---|---|---|
| | | | |

**Form DOT F 1700.7 (8_72)** Reproduction of this form and completed page is authorized

**Dynamic Science, Inc.**
**Crash Investigation**
**Case Number: DS02-006**

## Table of Contents

**BACKGROUND:**

| | |
|---|---|
| Description: | This Air Bag Related Child Passenger case was reported to the NHTSA through the Training Safety Institute in Oklahoma City, Oklahoma from a newspaper article describing the crash. DSI was assigned the case on April 4, 2002. It should be noted that the case vehicle was inspected by the local police agency, the coroner's investigator, and the insurance company prior to this contractor's inspection of the vehicle. All field work was completed on April 23, 2002. |
| Investigation Type: | Air Bag Related Child Passenger |
| Crash Location: | Oklahoma |
| Crash Date: | March, 2002 |
| Notification Date: | April 04, 2002 |
| Field Work Completed: | April 23, 2002 |

**SUMMARY**

**Crash Site**

This single vehicle crash versus an animal occurred in March, 2002 at 1945 hours in the state of Oklahoma. The crash occurred on an east/west two lane rural road. At the area of impact, the undulating two lane asphalt roadway is straight, undivided, with a positive 1.7% grade. The roadway is bordered on both sides by depressed grassy areas. The weather was dry and clear. It was dark at the time of the crash and the roadway was not lit. There are no traffic controls present and the speed limit is 89 km/h (55 mph). A nearby resident reported to a local newspaper that there are numerous deer in the area and that numerous crashes have occurred as the deer run onto the road.

**Figure 1**. Direction of travel towards impact area (west)

**Pre-Crash**

The case vehicle, was a 2000 Suzuki Esteem 4-door driven by an unrestrained 25-year-old female. There was an additional occupant in the case vehicle, a 3-year-old male child. The driver (mother of the child) indicated that he was in the front right seat position, seated in a forward facing Cosco Vision High Back Booster child safety seat. The driver indicated that she had removed the child seat's harness to wash the child seat and could not re-install the harness into the child seat. The driver further indicated that at the time of the crash, the child seat was being

used as a belt positioning booster seat. The driver also reported that the 3-year-old child could unbuckle the vehicle seat belt and often did so because he did not like wearing the seat belt or being in the child seat. She did not know if the 3-year-old child had unbuckled the available 3-point lap and shoulder seat belt.

It is the opinion of this contractor, that the 3-year-old child was seated unrestrained in the front right seat and not using the child safety seat. A photograph taken by the coroner's investigator indicates that the child safety seat was in the right rear seat position.

The case vehicle was traveling westbound at a driver reported 80 km/h (50 mph). This contractor calculated the minimum pre-braking travel speed as 91 km/h (56 mph). As it crested a hill a 68 kg (150 lb)[1] doe ran out in front of the vehicle. The driver braked and the case vehicle deposited 9 meters (30 ft) of pre-impact skid marks. The driver disputes that she braked or deposited skid marks. She indicated she never had time to react.

**Figure 2**. Exterior damage to case vehicle

**Crash**

The front (12FDEW1) of the case vehicle struck the doe at a calculated speed of 81 km/h (51 mph). The total velocity change calculated by the WinSmash barrier only collision model for the case vehicle was 15.0 km/h (9.3 mph). The longitudinal and lateral components were -15.0 km/h (-9.3 mph) and 0.0 km/h (0.0 mph), respectively. This impact is beyond the scope of WinSmash and therefore the results are borderline and provided for informational purposes only.

**Post-Crash**

After striking the doe, the case vehicle deposited and additional 36 meters (117 ft) of skid marks leading to final rest facing west.

The driver of the case vehicle exited the vehicle and then took the 3-year-old child out of the vehicle and started running west down the road yelling for help. A passing vehicle stopped and transported the driver and the 3-year-old child to a local hospital arriving at 2008 hours. The driver was examined and quickly released, sustaining an abrasion under her chin.

Emergency room records indicate that the 3-year-old child arrived with no pulse and unconscious, with a Glasgow Coma Scale (GCS) score of 0. The mother reported that he had stopped breathing and was unconscious since the time of the crash. The 3-year-old child received medical treatment in the emergency room but he remained pulseless and without spontaneous respiration. At 2035 hours of the same day he was pronouced dead.

[1]Per police report

The body was examined by the medical examiner at 2145 hours of the same day and was released to a funeral home at 0150 hours the next morning.

The following injuries were noted in both the emergency room medical records and the examination by the medical examiner: an apparent bony drop-off between C5-C6 posteriorly (x-rays were not performed at the hospital), possible cervical neck fracture (Non-invasive autopsy), and a laceration (7.0 by 7.0 cm/2.8 by 2.8 in) on right forehead above the eye with an exposed depressed skull fracture (round puncture wound) with intra-cranial contents noted. There was an abrasion, air bag burn, on both sides of the face, neck and left shoulder, an abrasion around the right eye, and an abrasion to right shoulder/right upper arm 8.0 cm by 3.0 cm (3.1 in by 1.2 in).

The case vehicle remained at the scene and was later towed due to damage. It was subsequently declared a total loss by the insurance company.

**VEHICLE DATA - 2000 Suzuki Esteem**

The 2000 Suzuki Esteem 4-door sedan was equipped with an automatic transmission with front wheel drive.

| | |
|---|---|
| VIN: | JS2GB41S6Y5xxxxxx |
| Odometer: | 80,904 km (50,273 miles) |
| Engine: | 1.8L, L4 cylinder |
| Reported Defects: | None |
| Cargo: | Unknown |

The 2000 Suzuki Esteem was equipped with Bridgestone Potenza RE92 P185/60R14 tires. The specific tire data is as follows:

| Tire | Tread | Pressure |
|---|---|---|
| LF | 2 mm (3/32 in) | Unknown |
| LR | Unknown | Unknown |
| RF | 2 mm (3/32 in) | Unknown |
| RR | Unknown | Unknown |

The front seating positions in the 2000 Suzuki Esteem were configured with fabric covered bucket seats with adjustable head restraints that were adjusted to the full down position. The front left seat was adjusted to four notches rearward of forward most position. The front right seat was adjusted to the rear most track position. Both seat backs were slightly reclined with the front left seat back adjusted at 22 degrees from vertical and the front right seat back at 18 degrees from vertical. The three rear seating positions were configured as a fabric covered bench seat with folding backs, no head restraints and non-adjustable seat.

**Figure 3**. Driver's seat

This vehicle had four separate inspections prior to this contractor's inspection. The coroner's inspector photographed the front right and rear right seat position. The front right seat back reclined rearward into the child seat positioned in the rear right seat position. The insurance company inspection noted that the front right seat back was fully reclined and locked into this

position. On a secondary inspection, the insurance inspection found that the front right seat back
was upright and functioning properly.

This contractor's inspection of the front right seat found the seat back operational and not damaged. The back of the seat back was soiled but there was no evidence of loading or damage.

**Figure 4**. Front right seat back

## VEHICLE DAMAGE

### Exterior Damage - 2000 Suzuki Esteem

| | | |
|---|---|---|
| Damage Description: | Moderate above bumper damage to the front grille, hood, upper radiator support. Cracked windshield. | |
| CDC: | 12FDEW1 | |
| Delta V: | Total | 15.0 km/h (9.3 mph) |
| | Longitudinal | -15.0 km/h (9.3 mph) |
| | Latitudinal | 0.0 |
| | Energy | 6,269 joules (8,499 ft-lbs) |

The case vehicle sustained moderate above bumper damage that began 33 cm (13 in) to the left of the front right bumper corner and measured 103 cm (41 in). The residual averaged crush measured along the front bumper and above the bumper were as follows: C1=0 cm (0 in), C2=10.0 cm (3.9 in), C3=0 cm (0 in), C4=1.0 cm (0.4 in), C5=0 cm (0 in), C6=0 cm (0 in). The maximum crush was measured at C2. The principle direction of force was within the 12 o'clock sector and was an estimated 0 degrees. The damaged components were mainly above the front bumper and included the hood, grille, and the upper radiator support and radiator. The right side of the windshield glazing was cracked from the front right passenger's air bag.

**Figure 5**. Exterior damage

**INTERIOR DAMAGE - 2000 Suzuki Esteem**

Damage to the interior of the Suzuki Esteem was attributed to the deployment of the front right passenger's air bag and occupant contacts with the interior surfaces by the 3-year-old child.

The front right area of the windshield glazing was cracked by the deployed front right passenger's air bag. The front right sun visor bracket was cracked by contact with an unknown body part of the front right occupant. There was an indentation/depression of the roof header that began at the front right sun visor and extended rearward. The front right shoulder belt upper anchorage adjustment knob was knocked off and cracked by contact with the 3-year-old child's head. There was white transfer/smudging to the right aspect of the instrument panel that did not fit anything related to this crash. Initially this contractor thought that the child safety seat had slid forward and struck the instrument panel on impact with the deer. This was later discounted based on the coroner's investigator photographs of the post crash position of the child seat (right rear seat).

**MANUAL RESTRAINT SYSTEMS - 2000 Suzuki Esteem**

The Suzuki Esteem was configured with manual 3-point lap and shoulder safety seat belts with sliding latch plates for both front seat positions and rear outboard seat positions. The rear middle seat position was configured with a manual lap belt and a locking latch plate that was found locked into the buckle at the time of the inspection.

The driver's lap and shoulder safety seat belt was equipped with an emergency locking retractor located at the B pillar. The front right and both rear outboard safety seat belts were equipped with switchable retractors located at the B pillar.

While there was some loading evidence found on the latch and D-ring of the driver's safety belt, it was determined that she was not wearing the belt. This was based on the driver's statement. Inspection of the driver's seat belt revealed some loading evidence to the latch and the D-ring. There was a "Replace Belt" label attached to both front seat belts. The label states that if the words "Replace Belt" are exposed this indicates that the belt has been stretched. Both front seat belts had the "Replace Belts" words exposed. The safety seat belts of several exemplar vehicles were examined and the "Replace Belt" labels were also exposed even though the vehicles are reported not to have been in crashes. The driver indicated that she had purchased the vehicle new and had never been involved in a crash and that the air bag system had never been serviced. A title search was done by this contractor to see if the case vehicle had been in a previous crash. The history report search indicated that the case vehicle was originally registered as a fleet vehicle to a major car rental company on 04/18/2000. The vehicle was registered again on 10/31/2000. On 11/17/2000 the vehicle was reported to have been sold at an auction listed as a fleet vehicle with 22,773 km (14,151 miles). Ownership transfer was reported on 12/06/2000 and a title was issued on 02/08/2001 with 22,782 km (14,157 miles). It appears from the history report that the case vehicle was not involved in a previous crash.

The rear right 3-point lap and shoulder safety seat belt had evidence of historical usage, but there was no loading evidence to indicate that it was used by the 3-year-old child at the time of the crash.

**FRONTAL AIR BAG SYSTEM - 2000 Suzuki Esteem**

The case vehicle was equipped with redesigned[2] driver and front right passenger's air bags. Both air bags deployed. The driver's air bag was mounted in the steering wheel. The deflated air bag was circular in shape with a diameter of 58.0 cm (22.8 in). There were six vertical folds, two tethers, and two vent ports at the 01 and 11 o'clock positions. The air bag had a maximum excursion of 33.0 cm (13.0 in). The module cover had an "I" tear type configuration. Both right and left module covers were symmetrical and measured 8.5 cm (3.3 in) wide by 12.5 cm (4.9 in) high. Lipstick and makeup transfers were found on the upper right quadrant of the air bag. An unknown faint brownish transfer was found on the back upper left quadrant of the driver's air bag.

**Figure 6**. Driver's air bag

**Figure 7**. Driver's air bag-lipstick transfer

The front right passenger's air bag was a mid-mount design located in the right third of the instrument panel. The deflated air bag measured 50.0 cm (19.7 in) wide by 54.0 cm (21.3 in) high. There were five horizontal folds, no tethers, and no vent ports. The air bag had a maximum excursion of 46.0 cm (18.1 in). The module consisted of single module cover flap and measured 41.0 cm (16.1 in) wide by 27 cm (10.6 in) high. There were two occupant contacts that appeared to be skin transfers located on the top aspect of the air bag just left of center, and to the face of the air bag located at the right edge near the stitching. The skin transfers were from the 3-year-old child. There was also module cover scuffing on the top and right edge of the air bag.

**Figure 8**. Front right air bag with skin transfer

[2]A redesigned air bag for a given vehicle model typically has less power than the air bag in earlier model years of that vehicle model.

**CHILD SAFETY SEAT - 2000 Suzuki Esteem**

The driver indicated that the 3-year-old child was seated in a forward facing child seat that was being used as belt position booster seat. The child seat was not inspected by this contractor. Photographs were obtained from the insurance adjuster and the child seat was identified as a Cosco Vision High Back Booster child safety seat, Model #02-409-PEP that was manufactured on 12/20/2000. The child seat was in a forward facing position with the child seat harness removed. The manufacturer recommends usage of the child safety seat as a belt-positioning booster for children weighing between 13.6-36.3 kg (30-80 lbs) and a height of 129.5 cm (51.0 in). The 3-year-old child was at the recommended weight but far below the recommended height. The front right seat was equipped with a 3-point lap and shoulder safety seat belt with a sliding latch plate and a switchable retractor. The vehicle's safety belt had indications of historical usage, but there was no evidence of loading as a result of this crash. According to the driver, the 3-year-old child had the ability and history of unbuckling the safety belt.

**Figure 9**. On scene view of child seat

It is the opinion of this contractor that the unrestrained 3-year-old child was seated in the front right seat and was not using the child safety seat.

**OCCUPANT DEMOGRAPHICS - 2000 Suzuki Esteem**

| | Occupant 1 | Occupant 2 |
|---|---|---|
| Age/Sex: | 25/Female | 3/Male |
| Seated Position: | Front left | Front right |
| Seat Type: | Bucket-fabric covered seat adjusted to four notches rearward of forward most position. Seat back angle of 22 degrees from vertical[3]. | Bucket-fabric covered seat adjusted to the rear most track position. Seat back angle of 18 degrees from vertical. |
| Height: | 163.0 cm (64.0 in) | 91.0 cm (36.0 in) |
| Weight: | 44.0 kg (98.0 lbs) | 16 kg (36.0 lbs) |
| Occupation: | Unknown | N/A |
| Pre-existing Medical Condition: | Unknown | Unknown |
| Alcohol/Drug Involvement: | None | N/A |
| Driving Experience: | Unknown | N/A |
| Body Posture: | Upright, normal | Unknown |
| Hand Position: | Both hands on steering wheel | Unknown |
| Foot Position: | Right foot depressing brake pedal, left foot on floor | Unknown |
| Restraint Usage: | Lap and shoulder safety seat belt available and not used per driver | Lap and shoulder safety seat belt available but not used. |
| Air bag: | Driver's steering wheel redesigned air bag available and deployed at impact | Front right passenger's redesigned air bag mid-mounted in the right third of the instrument panel. Child interacted with the front right passenger's air bag that deployed at impact |

[3]At the time of this contractor's inspection.

**OCCUPANT INJURIES - 2000 Suzuki Esteem**

| | INJURY | OIC CODE | ICD-9 | SOURCE |
|---|---|---|---|---|
| Driver: | Scratch (laceration) under her chin | 290600.1, 8 | 873.4 | Driver's air bag |
| RF Occupant: | Apparent bony drop-off between C5-C6 posteriorly (No x-rays performed). Possible cervical neck fracture (examination of body by medical examiner). Coded as cervical spine dislocation. | 650204.2, 6 | 839.8 | Air bag |
| | Exposed depressed skull fracture (round puncture wound) intra-cranial contents noted | 150406.4, 5 | 800.95 | Safety belt upper anchorage adjustment knob/steel shaft |
| | Laceration, 7.0 by 7.0 cm (2.8 by 2.8 in), on right forehead above eye | 290602.1, 7 | 873.42 | Seat belt upper anchorage adjustment knob/steel shaft |
| | Abrasion around right eye | 290202.1, 1 | 918.0 | Air bag |
| | Abrasion, air bag burn, on both sides of face, neck and left shoulder | 290202.1, 0<br>390202.1, 0<br>790202.1, 2 | 910.0<br>910.0<br>912.00 | Air bag |
| | Abrasion to right shoulder/upper arm 8.0 cm by 3.0 cm (3.1 in by 1.2 in) | 790202.1, 1 | 912.0 | Unknown |

**OCCUPANT KINEMATICS - 2000 Suzuki Esteem**

The 25-year-old female driver (163.0 cm/64 in, 44.0 kg/98 lbs) of the case vehicle was seated in a normal, upright fashion with both of her hands on the steering wheel, her right foot was on the brake pedal and her left foot was on the floor. The fabric covered bucket seat was adjusted to four notches from forward most position. The leading edge of the seat cushion was 29.0 cm (11.4 in) rearward of the lower A pillar. The seat back was reclined 22 degrees rearward from vertical. The driver indicated that she was not wearing the available manual 3-point lap and shoulder safety seat belts. The driver indicated that the doe appeared out of nowhere in front of her vehicle. She barely had time to brake before she struck the doe. The unrestrained driver responded to the braking by exhibiting a forward trajectory. At impact with the doe, the driver contacted the driver's air bag in the early deployment sequence. There was makeup and lipstick transfer to the upper right quadrant of the air bag at the very edge where the face of the air bag is stitched together with the back. She sustained a scratch/laceration to her chin from contacting the air bag. The driver was able to exit the vehicle on her own and removed the 3-year-old from the vehicle. She began running west down the roadway screaming for help. A passing vehicle transported her to a local hospital where she was examined in the emergency room and released.

**Figure 10**. On scene view of rear right seat and child seat

**Figure 11**. Front right air bag top skin transfer

It was determined that the unrestrained 3-year-old male child (91.0 cm/36.0 in, 16 kg/36.0 lbs) was seated in the front right seat position. The Cosco Vision High Back Booster child safety seat was positioned in the right rear seat position and was not in use at the time of the crash. The case vehicle's seat belt in the front right seat position was a 3-point lap and shoulder safety seat belt with a sliding latch plate and a switchable retractor. The vehicle's safety belt had indications of historical usage, but there was no evidence of loading as a result of this crash. When the driver braked, the nose of the case vehicle "dipped" forward. The unrestrained 3-year-old child responded to the braking by exhibiting a forward trajectory. As the vehicle was 9 meters (30 ft) into a locked wheel skid, the front of the vehicle struck a 68 kg (150 lb) doe. The front right passenger's air bag deployed, and the 3-year-old child engaged the deploying air bag fully in the face, neck and left shoulder. There were two occupant contacts that appeared to be skin transfers located on the top aspect of the air bag just left of center, and to the face of the air bag located at the right edge near the stitching. The 3-year-old child sustained an abrasion, air bag burn, on both sides of his face, neck and left shoulder. The air bag lifted him up to some extent and his body contacted the right sun visor and roof header above the sun visor. The sun visor was damaged and there was a visible depression to the roof header. The 3-year-old child

engaged the front right passenger's air bag and was thrown rearwards into the front right "B" pillar where the right side of his forehead struck the seat belt upper anchorage adjustment knob/steel shaft which was in the full down position. The knob was broken off, cracked and smeared with blood and other unknown matter. The 3-year-old child sustained an exposed depressed skull fracture (round puncture wound) with intracranial contents noted, and a laceration (7.0 cm/2.8 in by 7.0 cm/2.8 in) on his right forehead above his right eye from contacting the anchorage adjustment knob. There was an abrasion to right shoulder/upper arm 8.0 cm by 3.0 cm (3.1 in by 1.2 in). The emergency room medical records noted an apparent bony drop-off between the C5-C6 posterior neck, and the medical examiner's report indicated a possible cervical neck fracture. No x-rays were performed at the hospital and the medical examiner only conducted an external examination of the body. The driver indicated that the 3-year-old child came to rest on the rear left floor area behind the driver. The driver removed him from the vehicle and they were both transported to a local hospital by a passing vehicle. The driver indicated that the 3-year-old child was not breathing and unconscious. He was seen in the emergency room at 2008 hours with no pulse and not breathing. He was pronounced dead in the emergency room at 2035 hours of the same day.

**Figure 12**. Front right header occupant contact


**Figure 13**. Front right seat belt anchorage adjustment

**Figure 14**. Front right seat belt anchorage adjustment knob

## Attachment 1. Scene Diagram

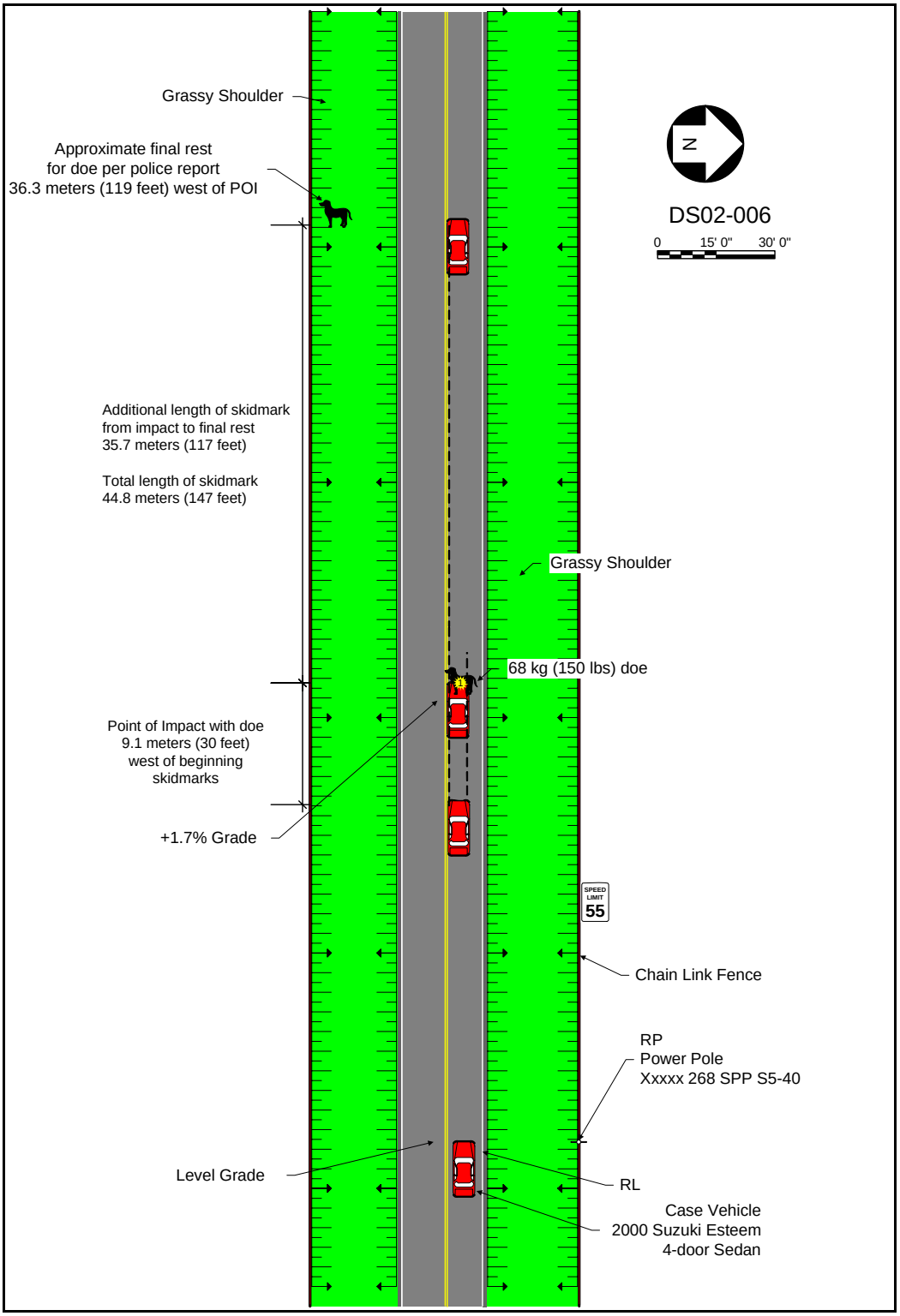


**Figure 15**. Scene diagram