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**VERIDIAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

VERIDIAN CASE NO. CA02-006

VEHICLE - 1990 FORD F-150 PICKUP TRUCK

LOCATION - STATE OF VIRGINIA

CRASH DATE - DECEMBER 2001

Contract No. DTNH22-01-C-17002

Prepared for:

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

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

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

TECHNICAL REPORT STANDARD TITLE PAGE

1. <i>Report No.</i> CA02-006	2. <i>Government Accession No.</i>	3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> Veridian On-site Child Safety Seat Crash Investigation Vehicle: 1990 Ford F-150 Pickup Truck Location: State of Virginia		5. <i>Report Date:</i> September 2003	
7. <i>Author(s)</i> Crash Data Research Center		6. <i>Performing Organization Code</i>	
9. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Data Research Center Veridian Engineering P.O. Box 400 Buffalo, New York 14225		8. <i>Performing Organization Report No.</i>	
12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		10. <i>Work Unit No.</i> C00410.0000.0020	
15. <i>Supplementary Notes</i> On-site investigation of a run-off-road crash that involved the death of an unrestrained 43-year-old female driver of a Ford F-150 pickup truck and minor injuries to a 3-year-old female restrained in a child safety seat.		11. <i>Contract or Grant No.</i> DTNH22-01-C-17002	
16. <i>Abstract</i> This on-site investigation focused on the performance of a forward-facing convertible child safety seat (CSS) that was installed in the front right position of a 1990 Ford F-150 pickup truck. The Ford pickup truck was occupied by a 43-year-old unrestrained female driver, and a 3-year-old female who was restrained in the forward-facing CSS. The Ford F-150 was involved in a run-off-road crash with a tree. The driver fell asleep, relinquished control, and the pickup truck departed the left roadside and struck a tree with the front center aspect. Impact resulted in severe damage to the pickup truck. The driver initiated a forward trajectory and loaded the steering wheel, steering column, and instrument panel. She sustained blunt injuries which included a fracture of the right lower anterior rib, laceration of the heart lining, tear of the azygos vein, contusion of the right lung, deep laceration of the liver, laceration of the vena cava, abrasions and contusions of the face, scalp, trunk, upper, and lower extremities. She was transported by ambulance to a local hospital where she was pronounced dead. The 3-year-old female also initiated a forward trajectory and loaded the CSS as the CSS loaded the manual restraint. The child sustained a minor scalp hematoma on the right forehead and a left forehead contusion from reported contact with loose objects in the vehicle. She was transported by ambulance to a local hospital and treated and released.		13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: December 2001	
17. <i>Key Words</i> Adult driver fatality Child Safety Seat		14. <i>Sponsoring Agency Code</i>	
19. <i>Security Classif. (of this report)</i> Unclassified	20. <i>Security Classif. (of this page)</i> Unclassified	21. <i>No. of Pages</i> 12	22. <i>Price</i>

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**VERIDIAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT
VERIDIAN CASE NO. CA02-006
SUBJECT VEHICLE - 1990 FORD F-150 PICKUP TRUCK
LOCATION - STATE OF VIRGINIA
CRASH DATE - DECEMBER 2001**

BACKGROUND

This on-site investigation focused on the performance of a forward-facing convertible child safety seat (CSS) that was installed in the front right position of a 1990 Ford F-150 pickup truck. The Ford pickup truck was occupied by a 43-year-old unrestrained female driver, and a 3-year-old female who was restrained in the forward-facing CSS. The Ford F-150 was involved in a run-off-road crash with a tree (**Figure 1**). The driver fell asleep, relinquished control, and the pickup truck departed the left roadside and struck a tree with the front center aspect. Impact resulted in severe damage to the pickup truck. The driver initiated a forward trajectory and loaded the steering wheel, steering column, and instrument



Figure 1. Damaged Ford F-150 pickup truck

panel. She sustained blunt injuries which included a fracture of the right lower anterior rib, laceration of the heart lining, tear of the azygos vein, contusion of the right lung, deep laceration of the liver, laceration of the vena cava, abrasions and contusions of the face, scalp, trunk, upper, and lower extremities. She was transported by ambulance to a local hospital where she was pronounced dead. The 3-year-old female also initiated a forward trajectory and loaded the CSS as the CSS loaded the manual restraint. The child sustained a minor scalp hematoma on the right forehead and a left forehead contusion from reported contact with loose objects in the vehicle. She was transported by ambulance to a local hospital and treated and released.

This crash was identified through a local newspaper web site by the Veridian SCI team during an Internet search for fatal crashes. The notification was forwarded to NHTSA and an on-site effort was assigned to the Veridian SCI team on Monday February 12, 2002. The field activities were initiated on February 19, 2002.

SUMMARY

Crash Site

This single-vehicle crash occurred on a two-lane county roadway during the daylight hours of December 2001. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The north/south roadway consisted of two travel lanes. There were no lane markings or discernable shoulders. The roadside environment consisted of grassy fields with positive grades and residential properties on the east roadway, and a shallow grassy area with trees on the west roadside. At the crash site, a residential dirt driveway was present on the east roadside and a single tree that measured 56 cm (22") in diameter. A grassy drainage ditch was adjacent to the east road edge which

measured approximately 1 m (3') in width and 51 cm (20") in depth and was parallel to the roadway. The ditch followed the south contour of the private driveway. It widened to 2 m (6') and measured 60 cm (24") in depth around the driveway contour in front of the struck tree. There were no traffic controls present at the scene, and the posted speed limit for the county roadway was 89 km/h (55 mph). The scene schematic is included as **Figure 13**.

Pre-Crash

A family member had secured the forward-facing convertible CSS in the Ford pickup truck earlier in the day with the vehicle's 3-point lap and shoulder belt system. She also stated that the driver had been involved a previous crash approximately three weeks prior where she swerved to avoid a deer in the road and struck an unknown object. It was reported that she had sustained a skull fracture as a result of the previous crash. It was unclear if the driver's fatigue was a result of a medical condition from the pre-existing injury, or a side-effect of pain medication that the driver may have been using.



Figure 2. Southbound approach for the Ford F-150 pickup truck

The 43-year-old female driver of the Ford F-150 pickup truck was operating the vehicle southbound on the two-lane roadway (**Figure 2**). She reportedly fell asleep and relinquished control of the vehicle. The pickup truck drifted across the roadway and departed the left roadside in a tracking mode. There were no skid marks indicative of any attempted avoidance maneuvers.

Crash

The Ford F-150 pickup truck struck a tree with the front center area (**Figure 3**). The tree measured 56 cm (22") in diameter and the impact resulted in severe damage to the Ford pickup truck. The resultant direction of force was within the 12 o'clock sector for the pickup truck. The damage algorithm of the WinSMASH program computed a total delta-V of 44.0 km/h (27.3 mph) based on the frontal crush profile on the pickup truck. The longitudinal and latitudinal components were -44.0 km/h (-27.3 mph) and 0.0 km/h, respectively. There was no scene evidence indicating where the pickup truck came to final rest. However, considering the impact was slightly right of the centerline of the vehicle, the pickup truck probably rotated clockwise (CW) slightly prior to coming to rest.



Figure 3. Point of impact

Post-Crash

The driver and child were removed from the vehicle by rescue personnel. Emergency responders unbuckled the front right manual restraint in the Ford pickup truck and removed the entire CSS from the vehicle with the child in it. The driver sustained severe head and chest injuries and was transported by ambulance to a local hospital where she was pronounced dead. The 3-year-old female child sustained a minor scalp hematoma on the right forehead and a left forehead contusion and was transported by ambulance to a local hospital where she was treated and released.

VEHICLE DATA - 1990 Ford F-150 Pickup Truck

The 1990 Ford F-150 pickup truck was identified by the Vehicle Identification Number (VIN): 1FTEF14Y3LN (production sequence omitted). At the time of the vehicle inspection, the vehicle's odometer read 27,999 km (17,398 miles), although, due to the age of the vehicle, it was presumed to have been 188,816 km (117,398 miles). The vehicle was a two-door, regular cab, 4 x 4, pickup truck with a 209 cm (82") long cargo box and a 297 cm (117") wheelbase. The pickup truck was equipped with a 4.9 liter, 6-cylinder engine, four-speed manual transmission, front disc and rear drum brakes with anti-lock, power steering and cruise control. Wheel and tire data was unknown, as all wheels were removed from the vehicle prior to the inspection. The right front door was also removed prior to the inspection.

The seating in the Ford F-150 was configured with a single bench seat with a folding back and a folding center arm rest. The seat back exhibited approximately 0.6 cm (0.3") of fore and aft movement at the hinge. The right aspect of the seat back was deflected rearward approximately 3 cm (1"), but a direct relationship between the crash and the seat back deflection could not be confirmed at the time of the inspection. The seat back angle measured 15 degrees from vertical, and the seat cushion measured 0 degrees from horizontal. The seat track was jammed in place, although, the seat track appeared to be between the mid-track and full-forward positions at the time of the inspection.

A wood box that measured approximately 61 cm (24") in length, 30 cm (12") in width, and 30 cm (12") in height was found in the rear box of the pickup truck (**Figure 4**). Numerous ceramic items and accessories were present in the box. According to a family member, the box was in the cab of the pickup truck at the time of the crash, presumably on the center aspect of the bench seat. Numerous fractured ceramic items were present on the seat cushion and on the floor areas at the time of the vehicle inspection.



Figure 4. Wood box with ceramic items

VEHICLE DAMAGE

Exterior Damage - 1990 Ford F-150 Pickup Truck

The Ford F-150 sustained severe frontal damage as a result of the impact with the tree (**Figure 5**). The direct contact damage began 28 cm (11") left of the centerline on the bumper and measured 61 cm (24") laterally across the bumper. The combined direct and induced damaged involved the entire frontal width of the pickup truck and measured 146 cm (58"). The direct damage on the hood also began 28 cm (11") left of the centerline and measured 72 cm (28") laterally across the leading edge of the hood. Abrasions from direct contact with the tree were present on the center aspects of the bumper and hood. The bumper and bumper trim exhibited grass and dirt from contact with the drainage ditch adjacent to the tree. The center aspect of the front bumper was crushed rearward and the maximum crush at the bumper level was located 10" right of the centerline and measured 68 cm (27"). The left corner of the bumper was displaced inward and forward as a result of the crush. The grille and right headlight were fractured. The right front fender sustained induced outward buckling. The rear cargo box was displaced as a result of the impact, and the separation from the cab at the top aspect measured 8 cm (3") on the left side and 13 cm (5") on the right side (**Figure 6**). The rear aspect of the cab was bowed forward approximately 8 cm (3") in the center aspect. The bottom aspect of the back light exhibited a 3 cm (1") longitudinal separation that extended 53 cm (21") along the bowed contour of the cab. The Collision Deformation Classification (CDC) for the tree impact was 12-FZEW-3. Six crush measurements were taken along the front bumper and were as follows: C1 = 0.0 cm, C2 = 9 cm (4"), C3 = 50 cm (20"), C4 = 63 cm (25"), C5 = 37 cm (15"), C6 = 15 cm (6").



Figure 5. Frontal view of damaged F-150



Figure 6. Left side view showing displacement of the cargo box

Interior Damage - 1990 Ford F-150 Pickup Truck

The 1990 Ford F-150 pickup truck sustained moderate interior damage as a result of compartment intrusion and occupant contact (**Figure 7**). The windshield glazing was fractured in three distinct places from interior contacts. The windshield contact located 8 cm (3") right of center and 37 cm (15") from the windshield header had a small number of thin green fabric strands that were embedded in the fractured laminate. There were no hair or tissue transfers in the windshield fractures. The rear view mirror was displaced upward and forward. The top half of the



Figure 7. Left side interior view

steering wheel rim was deformed forward 2.0 cm (0.8") and the bottom half deformed forward 0.6 cm (0.3") from occupant loading. The tilt steering column was jammed in the full-up position and the steering column was compressed, as the right shear capsule was displaced forward 0.6 cm (0.3").

Contact evidence was documented in the Ford F-150 pickup truck (**Figure 8**). The instrument panel to the right of the steering column was fractured and separated. The left lower instrument panel was displaced and partially separated from occupant contact on the right aspect. A diagonal abrasion that measured 9 cm (4") in length was located on the inboard edge of the driver's upper instrument panel. The center instrument panel was displaced on the left side, and the trim panel around the radio and HVAC controls was separated. The floor-mounted transmission selector lever was completely separated at the floor. The glove box door was separated as a result of the impact and a longitudinal fracture was present on the front right upper instrument panel. The fracture measured 6.4 cm (2.5") in length and was located 33 cm (13") to the right of the centerline. Longitudinal intrusions were measured and were as follows:



Figure 8. View of contact evidence

Position	Component	Intruded	Direction
FL	Left toe pan	5.1 cm (2.0")	Longitudinal
FC	Rear aspect of cab (below window)	7.0 cm (2.8")	Longitudinal
FR	Right toe pan	3.2 cm (1.3")	Longitudinal

MANUAL RESTRAINT SYSTEMS - 1990 Ford F-150 Pickup Truck

The Ford F-150 pickup truck was configured with manual 3-point lap and shoulder belts with emergency locking retractors (ELR) for the driver and front right passenger positions. Each outboard manual restraint was also configured with a fixed D-ring and sliding latch plate. A lap belt with a locking latch plate was available for the center position, but was found extended behind the seat and was not accessible from the center seat position. The driver's manual restraint did not show any signs of usage in this crash. There were no abrasions on the D-ring or latch plate, and no stretch marks on the webbing indicative of belt usage. The retractor showed no signs of damage and the webbing was not restricted.

The front right passenger's manual restraint was used to install the CSS on the front right position of the pickup truck's bench seat. At the time of the vehicle inspection, the retractor did not appear to have sustained damage, and the webbing was not restricted (**Figure 9**). The sliding latch plate and front right D-ring exhibited moderate abrasions from the loading of the CSS. A lateral abrasion was present on the webbing 89 cm (35") from the floor anchor and measured 3.2 cm (1.3") in length across the webbing and 0.6 cm (0.3") in width. A plastic transfer from the child safety seat that measured 5.7 cm (2.3") in length and 2.5 cm (1.0") in width was present on the webbing 127 cm (50") from the floor anchor.



Figure 9. Front right passenger's safety belt

A label was present on the front right restraint webbing 44 cm (18") from the floor anchor that read: "CHILD SEAT - A locking clip must be used to avoid injury from child seat tipping over (see owner's guide)." When the restraint was in the buckled position, the label was on the outboard aspect of the lap belt webbing at the level of the seat cushion (**Figure 10**).



Figure 10. CSS label

CHILD SAFETY SEAT- Evenflo Utara Premier

An Evenflo Utara Premier Convertible Child Safety Seat (**Figure 11**) was installed in the front right position of the Ford F-150 pickup truck. The model number was 234119P1 and the date of manufacture was April 22, 1996. There were no NHTSA recalls associated with this seat. The seat was purchased new by the parent approximately five years prior to the crash, and was previously used by another child. The parent indicated that the seat was used in three different vehicles, and re-installed approximately once a week. At the time of the vehicle inspection, the locking clip was not attached to the CSS, and the instruction manual was not available. The convertible seat was designed to be used forward facing by children who weighed between 9 kg (20 lbs) and 20 kg (43 lbs) and who measured between 66 cm (26") and 109 cm (43"). The CSS was occupied by a 3-year-old female who weighed 15 kg (32 lb) and measured 102 cm (40") in height. The child was within the manufacturer's recommended height and weight limits outlined in the instruction manual for use of the forward-facing convertible seat. The CSS was configured with a 5-point harness system. The CSS was also configured with three sets of harness slots, and the shoulder harness straps were routed through the top set of slots at the time of the inspection.



Figure 11. Evenflo CSS

The labels that illustrated the installation guidelines and weight and height guidelines were partially removed on the outboard aspects of the CSS.

The convertible CSS exhibited signs of wear and damage associated with the crash. The forward-facing belt path showed abrasions from the vehicle's 3-point manual restraint. The entire length of the left harness strap was folded in half. The right harness strap was creased and folded in half between the harness slot and the lower right outboard slot. The fold extended through the harness retainer clip and through the latch plate loop. The left half of the harness retainer clip (**Figure 12**) was deformed forward approximately 3 cm (1"). A family member stated that the deformation to the harness retainer clip was due to frequent usage, although, minor abrasions were noted on the left harness strap at the level of the harness retainer clip. The rear aspect of the top left harness slot showed a stress mark in the plastic at the center of the bottom aspect. Both latch plates were abraded and showed signs of frequent usage.



Figure 12. Horizontal view of the deformed harness retainer clip

The forward-facing convertible CSS was installed on the front right aspect of the bench seat in the 1990 Ford F-150 pickup truck. It was installed with the vehicle's manual 3-point lap and shoulder belt that was configured with a sliding latch plate. Although the label on the front right restraint webbing suggested the use of a locking clip to secure the CSS, there was no locking clip used in the installation. The parent stated that she placed the CSS on the front right seat, routed the vehicle's 3-point belt through the rear belt path, buckled the manual restraint, and pulled on the shoulder belt webbing to tightly secure the CSS. She described the attachment to the vehicle as being snug, but might move a little. According to the parent, the child was secured in the CSS at the time of the crash with the restraint harness buckled and the harness straps positioned above the child's shoulders. The harness retainer clip was vertically located between the armpits and the navel, and the parent estimated that two fingers could fit between the harness straps and the child's chest.

OCCUPANT DEMOGRAPHICS - 1990 Ford F-150 Pickup Truck

Driver

Age/Sex:	43-year-old female
Height:	168 cm (66")
Weight:	67 kg (148 lb)
Seat Track Position:	Between mid-track and full-forward
Manual Restraint Use:	Unrestrained
Usage Source:	Vehicle inspection, police report
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a local hospital and pronounced dead on arrival

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanisms
Large, deep liver laceration, vertically oriented in the right hepatic lobe, to the left of the ligmenum venosum which extends into the parenchyma nearly completely to its posterior aspect, nearly involving the visceral surface, extending into the hepatic veins and into the superior vena cava	Critical (541828.5,1)	Loading against steering wheel rim/column
Deep laceration of inferior vena cava, 500 - 1000 cc hemoperitoneum	Serious (521204.3,7)	Loading against steering wheel rim/column
Laceration heart lining - 3 cm long tear of endocardium of right ventricle, through the myocardium, and terminating in the epicardium, without perforation	Serious (441010.3,4)	Loading against steering wheel rim/column
Tear of azygos vein, and resulting hemorrhage in the posterior mediastinum	Moderate (422202.2,4)	Loading against steering wheel rim/column
Right lung contusion 3 x 4 cm (1 x 2") on the costal margin of the lower lobe	Serious (441406.3,1)	Loading against steering wheel rim/column
Fracture of the right anterolateral 6 th rib and the 7 th costal cartilage	Moderate (450220.2,1)	Loading against steering wheel rim/column
Superficial abrasions around the eye and right side of the forehead	Minor (297202.1,1)	Steering wheel rim (probable)
Oblong abrasions present on point of chin	Minor (290202.1,8)	Steering wheel rim (probable)
Recent loss of left central upper incisor	Minor (251406.1,8)	Steering wheel rim (probable)

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanisms
Vertical laceration present on mucosa of lower lip	Minor (290602.1,8)	Steering wheel rim (probable)
Red contusion present on the right side of bridge of nose	Minor (290402.1,4)	Steering wheel rim (probable)
Multiple abrasions to scalp	Minor (190202.1,9)	Steering wheel rim (probable)
Scalp hemorrhage present over both supraorbital ridges	Minor (190402.1,5)	Steering wheel rim (probable)
Multiple abrasions to trunk	Minor (490202.1,9)	Loading against steering wheel rim/column
5 x 8 cm (2 x 3") red-blue bruise present immediately below the right costal margin	Minor (490402.1,1)	Loading against steering wheel rim/column
Bruises present on PIP joints of fingers 3, 4, and 5 of right hand	Minor (790402.1,1)	Left instrument panel
Bruises present on dorsa of fingers of left hand and 5 th metacarpal region of hand	Minor (790402.1,2)	Left instrument panel
Abrasions present over the 4 th and 5 th knuckles of the left hand	Minor (790202.1,2)	Left instrument panel
Abrasions to both arms	Minor (790202.1,3)	Left instrument panel (probable)
Contusions to both arms	Minor (790402.1,3)	Left instrument panel (probable)
Multiple abrasions to lower extremities	Minor (890202.1,3)	Left lower instrument panel
Multiple contusions to lower extremities	Minor (890402.1,3)	Left lower instrument panel

Injury source: Autopsy report

Driver Kinematics

The 43-year-old female driver was unrestrained and had the bench seat adjusted between the mid-track and full-rear positions. It was not clear if the driver fell asleep or lost consciousness due to a medical condition prior to the crash, and her pre-crash posture could not be confirmed. At impact, the driver initiated a forward trajectory and loaded the steering wheel rim with her chest, upper abdomen, and face. Her loading force was transmitted through the steering column, evidenced by shear capsule displacement. There was no contact evidence to support any facial interaction with the windshield, and based on the driver's injuries, it appeared that she may have submarined the steering wheel slightly. The loading to the steering wheel resulted in the forward deflection of the steering wheel rim and compression of the steering column on the right aspect. The loading of her chest and abdomen against the steering wheel rim and column resulted in a large, deep, liver laceration, a deep laceration of the inferior vena cava, a laceration of the heart lining, a tear of the azygos vein, a right lung contusion, a fracture of the right anterolateral 6th rib and the 7th costal cartilage, a contusion immediately below the right costal margin, and multiple abrasions to the trunk. Her head probably flexed forward and allowed her face to engage the top aspect of the steering wheel rim and top aspect of the steering wheel hub which resulted in superficial abrasions around the eye on the right side of the forehead, oblong abrasions on the chin, loss of the left central upper incisor, a vertical laceration on the mucosa of the lower lip, a contusion on the right side of the bridge of the nose, multiple abrasions to the scalp, and scalp hemorrhage present over both supraorbital ridges. Her knees struck the knee bolster, which resulted in the displacement of the right aspect of the knee bolster. She sustained multiple abrasions and contusions to the lower extremities as a result of the contact with the knee bolster. The inboard aspect of the left instrument panel exhibited a diagonal abrasion probably from the driver's right arm or hand. Her hands were probably deflected off of the steering wheel rim and into the instrument panel, which resulted in contusions of the fingers of the right hand, contusions on the dorsa of the fingers and metacarpal region of the left hand, abrasions on the 4th and 5th knuckles of the left hand, abrasions to both arms and contusions to both arms. She was removed from the vehicle by rescue personnel and transported by ambulance to a local hospital. She arrived at the hospital as a trauma code, and was pronounced dead on arrival.

Front Right Child Passenger

Age/Sex:	3-year-old female
Height:	102 cm (40")
Weight:	15 kg (32 lb)
Seat Track Position:	Between mid-track and full-forward
Manual Restraint Use:	Forward-facing convertible CSS anchored by the manual lap and shoulder belt
Usage Source:	Vehicle inspection, CSS inspection
Eyewear:	None
Type of Medical Treatment:	Transported by ambulance to a local hospital and treated and released

Front Right Child Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
4 cm (2") soft hematoma on right forehead and temple	Minor (290402.1,7)	Right knee
Left forehead contusion	Minor (290402.1,7)	Left knee

Injury source: Emergency room records

Front Right Child Passenger Kinematics

The 3-year-old female front right passenger was restrained in the forward-facing convertible CSS that was installed on the front right position of the Ford pickup truck. The CSS was installed with the manual 3-point lap and shoulder belt. Although the safety belt was configured with an ELR-only retractor, a locking clip was not used for the CSS installation. At impact, the CSS loaded the manual 3-point lap and shoulder belt and the child initiated a forward trajectory. The loading of the CSS resulted in an abrasion on the shoulder belt webbing of the vehicle, and moderate abrasions to the front right D-ring and sliding latch plate. Based on the plastic transfers on the seat belt, the CSS had an approximate forward excursion of 5 cm (2"). The child loaded the 5-point harness system of the CSS. The harness retainer clip was deformed from prior usage, which allowed it to move vertically along the harness straps as the child loaded them. The downward displacement of the harness retainer clip and folded harness straps allowed the child's upper torso to move forward out of the harness straps. Her head was displaced forward and downward as her knees were displaced upward. Her forehead struck her knees, which resulted in a 4 cm (2") soft hematoma on the right forehead and right temple and a left forehead contusion. She rebounded rearward and came to rest in the CSS. Rescue personnel removed the child and CSS from the vehicle together. The child was transported by ambulance to a local hospital, admitted for five hours and released.

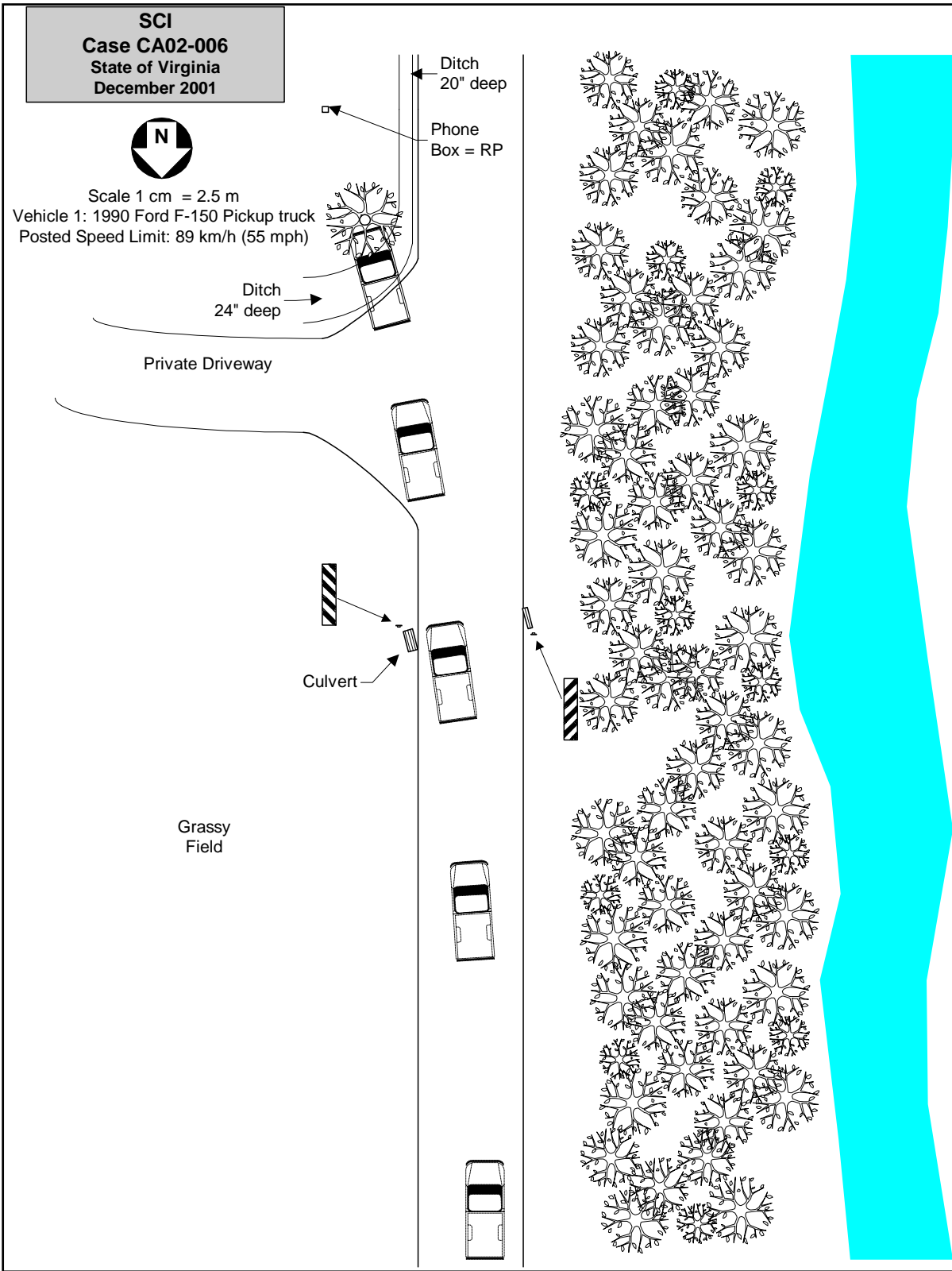


Figure 13. Scene schematic