CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE ADULT AIR BAG RELATED FATALITY INVESTIGATION

CASE NO: CA03-019

VEHICLE: 1995 MERCURY GRAND MARQUIS

LOCATION: FLORIDA

CRASH DATE: FEBRUARY 2000

Contract No. DTNH22-01-C-17002

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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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16. Abstract This on-site investigation focused on the source of injury that resulted in the death of a 45-year old female driver of a 1995 Mercury Grand Marquis. The Mercury was equipped with a first generation frontal air bag system for the driver and front right passenger positions that deployed as a result of a front left impact with a concrete base for a light pole in a super market parking lot. The impact resulted in minor damage to the vehicle. The driver was unrestrained and was observed slumped forward in close proximity to the steering assembly immediately prior to impact. The deploying driver's air bag expanded against the chest and neck of the driver resulting in abrasions of the neck and chin, a basilar skull fracture, a complete laceration of the basilar artery and three rib fractures. She was removed from the vehicle at the scene of the crash and placed on the pavement adjacent to the Grand Marquis. The driver was subsequently transported to a local hospital where she expired three hours following the crash. The Grand Marquis sustained disabling damage and was towed from the scene of the crash.			
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BACKGROUND

This on-site investigation focused on the source of injury that resulted in the death of a 45-year old female driver of a 1995 Mercury Grand Marquis **(Figure 1)**. The Mercury was equipped with a first generation frontal air bag system for the driver and front right passenger positions that deployed as a result of a front left impact with a concrete base for a light pole in a super market parking lot. The impact resulted in minor damage to the vehicle. The driver was unrestrained and was observed slumped forward in close proximity to the steering assembly immediately prior to impact. The deploying driver's air bag expanded against the chest and neck of the driver resulting in abrasions of the neck and chin, a basilar skull fracture, a complete laceration of the basilar artery and three rib fractures. She was removed from the vehicle at the scene of the crash and placed on the pavement adjacent to the Grand Marquis. The driver was subsequently transported to a local hospital where she expired three hours following the crash. The Grand Marquis sustained disabling damage and was towed from the scene of the crash.

Figure 1. 1995 Mercury Grand Marquis

The crash occurred in February 2000. A consultant to Ford notified NHTSA of the crash in March 2003 and the case was assigned to the Calspan SCI team on March 20, 2003. An attorney, who was handling the case for the deceased's family, retained the vehicle in its damaged state in a warehouse. Cooperation with this attorney was established by the Calspan SCI team and permission was granted to allow an on-site inspection of the Mercury Grand Marquis on April 4, 2003.

SUMMARY

Crash Site

The crash occurred in a parking lot of a super market during daylight hours. The parking lot was delineated into a series of parking spaces with driving lanes separating the rows of parking spaces. The Mercury entered the parking lot from a two-lane state route in a posted 56 km/h (35 mph) sped zone. The north/southbound travel lanes were separated by a painted flush median that transitioned into a left turn lane for southbound traffic south of the parking lot entrance. A northbound right-turn lane channeled traffic into the parking lot **(Figure 2)**. The state route was curved to the left with a slight negative grade relative to northbound traffic flow. A grassy drainage ditch separated the right turn lane

from the parking lot with the back wall of the ditch transitioning the positive elevation change to the parking lot. A curbed gore area separated the right turn lane into the parking lot from a designated right turn lane that directed traffic flow from the parking lot. The asphalt surfaces were dry at the time of the crash.

Figure 2. Mercury's approach to the crash site.

Figure 3. Struck pole base.

The aluminum light pole was mounted on-top of a poured concrete **(Figure 3)** base that was 61 cm (24") in diameter and 79 cm (31") in height, and was located 15.6 m (51.2') east of the gore and 24.3 m (79.7') east of the east road edge of the northbound travel lane. There was no damage reported to the pole or the concrete base. The Crash Schematic is included as **Figure 11** of this narrative report.

Vehicle Data

The 1995 Mercury Grand Marquis GS was a four-door sedan that was manufactured on 2/95 and identified by Vehicle Identification Number (VIN) 2MELM74W9SX (production number deleted). The vehicle was powered by a conventionally mounted 4.6 liter gasoline engine linked to a four-speed automatic overdrive transmission with rear wheel drive. The braking system consisted of power-assisted front disc and rear drum brakes without anti-lock. The steel fuel tank was mounted aft of the rear axle and forward of the trunk wall with a left side filler tube located aft of the axle position.

The interior was configured as a six passenger vehicle with 50/50 split bench seats with separate fold down center armrests. The front outboard seated positions were equipped with adjustable head restraints that were adjusted to the full down positions at the time of the SCI inspection. The rear seat was a three-passenger bench seat with a fold-down center armrest. At the time of the crash, the Grand Marquis had an odometer reading of 139,824 km (86,885 miles).

The Grand Marquis was equipped with P215/70R-15 Cooper Trendsetter SE all season steel belted radial tires mounted on OEM steel wheels. All tires remained inflated post-crash; however, the tires lost air pressure during the three-year storage period. The following table identifies the measured tread depth and tire pressures for each of the four tires at the time of the SCI inspection.

Position	Tire Pressure	Tread Depth	Damage
Left Front	106 kPa (15.5 PSI)	5 mm (6/32”)	None
Right Front	178 kPa (26.0 PSI)	5 mm (6/32”)	None
Left Rear	126 kPa (18.5 PSI)	6 mm (7/32”)	None
Right Rear	72 kPa (10.5 PSI)	3 mm (4/32”)	None

Several areas of previous damage were noted the Grand Marquis. Superficial sideswipe-type damage was located on the front right corner of the bumper fascia. Similar damage was also noted to the rub strip on the right front door. Abrasions were noted to the rear bumper fascia with an isolated dent to the right rear quarter panel.

Crash Sequence

Pre-Crash

The 45-year old female driver of the 1995 Mercury Grand Marquis departed her residence and was traveling in a northerly direction on the state route, apparently en route to the supermarket. The driver’s Blood Alcohol Concentration (BAC) was reported at .35. A toxicology drug screen also identified the presence of 2.0 mg/l of Diphenhydramine in her blood. The driver had driven a total distance of approximately 5 km (3 miles) from her residence to the parking lot where the crash occurred.

A witness to the crash observed the driver of the Grand Marquis traveling at a slow rate of speed as she entered the right turn lane for the supermarket parking lot. The Grand Marquis driver negotiated the right turn with a positive elevation and entered the parking lot. This witness allegedly followed the Grand Marquis and pulled along side of the vehicle and observed the driver in a slumped position in close proximity to the steering wheel. The witness visually tracked the Grand Marquis as it continued forward into the pole base.

Crash

The front left bumper area of the 1995 Mercury Grand Marquis impacted the concrete base for the light pole **(Figure 4)**. The impact resulted in a 12 o’clock direction of force and crushed the bumper beam to a maximum depth of 24 cm (9.5”). A damage algorithm of the WinSMASH program computed a total velocity change of 22 km/h (13.6 mph) with longitudinal and lateral components of -22 km/h (-13.6 mph) and 0 km/h, respectively. The impact with the concrete base deployed the Mercury’s frontal air bag system.

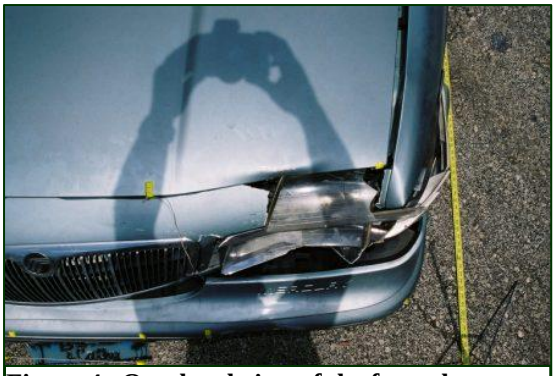

Figure 4. Overhead view of the frontal damage.

Post-Crash

The driver's husband, a medical professional, was concerned for the safety of his wife. As he learned that she had departed the residence en route to the supermarket, he departed his office and drove to the supermarket to meet his wife. As he arrived on-scene, he observed the vehicle engaged against the base of the pole. He insisted that the driver be removed from the vehicle; however, the police officer on-scene advised against removing the driver prior to the arrival of the ambulance. The husband removed the driver from the vehicle and placed her on the pavement adjacent to the Grand Marquis. The ambulance arrived on-scene and placed the driver on a cot and transported her to a local hospital where she expired three hours post-crash. An autopsy was performed on the body.

The vehicle was towed from the scene and was initially impounded by the investigating officer. The Mercury Grand Marquis was subsequently transferred to a warehouse where it was stored by a litigating attorney. The vehicle had been inspected by several reconstructionists prior to the assignment of this on-site SCI investigation.

Vehicle Damage

Exterior

The front left aspect of the Grand Marquis impacted the concrete base of the light pole. The direct contact damage of the bumper fascia began 34 cm (13.2") left of center and extended 46 cm (18") to the left corner **(Figure 5)**. The impact crushed the front bumper beam to a residual depth of 24 cm (9.5") located at the left corner of the bumper **(Figure 6)**. At maximum engagement, the leading edge of the hood contacted the base which resulted in 1 cm (0.4") of sheet metal crush that was located 54 cm (21.4") left of center. The bumper fascia rebounded from the impact event; however, the aluminum bumper beam deformed resulting in a full-width damage pattern (Field L) of 160 cm (62.75"). The crush profile at the bumper beam was as follows: C1 = 24 cm (9.5"), C2 = 23 cm, (9.2"), C3 = 18 cm (6.9"), C4 = 12 cm (4.75"), C5 = 8 cm (3."), C6 = 4 cm (1.75"). The left bumper energy absorbing device (EAD) compressed 4 cm (1.75") and punched through the leading edge of the frame rail. The right EAD did not exhibit compression. Both units had an original pre-crash length of 5 cm (2"). The Collision Deformation Classification (CDC) for this event was 12-FLEW-1.

Figure 5. Front left damage to the Grand Marquis.

Figure 6. Lateral view of the crush depth.

Components damaged by the impact included the front bumper fascia, bumper beam, the left EAD and frame rail, header panel, left headlamp assembly, hood, the radiator support panel, and the left front fender. The left wheelbase was reduced in length by 4 cm (1.4") while the right wheelbase was elongated by 1 cm (0.25").

All four doors remained closed and operational. The left front fender was displaced rearward which resulted in damage to the trailing edge as the left front door was opened post-crash, denting the sheet metal fender.

The windshield was cracked at the lower left A-pillar from rearward displacement of the frontal structure. The tempered door and backlight glazing was not damaged.

Interior

The interior of the Grand Marquis sustained minor damage that was associated with air bag deployment and occupant loading. The driver's air bag expanded against the forward positioned driver as evidenced by fabric transfers on the bag membrane. These transfers are discussed in the *Frontal Air Bag System* section of this report. Air bag expansion against the out-of-position driver, in combination with the forward kinematic response of the driver to the crash forces, resulted in compression of the energy absorbing steering column. The shear capsules yielded separation values of 4 cm (1.6") on the left and 3.8 cm (1.5") on the right side **(Figure 7)**. Both brackets were completely separated from the fixed blocks. There was no bending or deflection of the steering wheel rim.

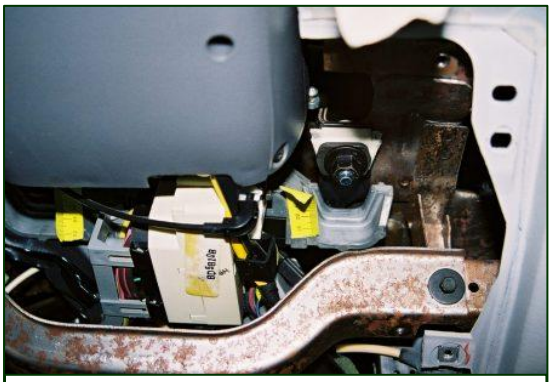

Figure 7. Right shear capsule separation.

The front right passenger air bag expanded against the rear view mirror. This expansion contact deflected the mirror laterally left and fractured the windshield at the mounting point of the mirror. The left sun visor was found separated from the headliner at the time of the SCI inspection. It was unknown if the sun visor separated during the crash as a result of occupant contact or was removed prior to, or after the crash. There was no damage to the sun visor and the visor was not equipped with a vanity mirror.

Frontal Air Bag System

The 1995 Mercury Grand Marquis was equipped with a frontal air bag system for the driver and right passenger positions. The system deployed as a result of the front left impact with the concrete base of a light pole. The system consisted of two front mounted ball-in-tube crash sensors, a passenger compartment mounted control and diagnostic module, an instrument panel air bag indicator lamp, the steering wheel mounted driver air bag module, and a mid mount passenger air bag module.

The ball-in-tube crash sensors were mounted to the leading edge of the upper radiator support panel. The sensors were identified by the following nomenclature:

Left – F5AB-14B004-AB	Right – F5AB-14B004-AB
8C01954820	8C05021088

There was no damage to the front mounted crash sensors.

The driver's air bag module was mounted within the four-spoke steering wheel rim. The spokes were positioned at the 3/9 and 5/7 o'clock positions. The air bag module consisted of asymmetrical H-configuration module cover flaps that opened at the designated tear points. The large upper flap measured 20 cm (8") horizontally and 13 cm (5") vertically while the lower flap had respective measurements of 20 cm (8") and 4 cm (1.5"). There was no damage or contact evidence on the cover flaps **(Figure 8)**. The lower flap was captured between the lower steering wheel spokes.

The driver air bag membrane measured approximately 61 cm (24") in its deflated state. The bag was vented by two 1 cm (0.5") diameter vent ports that were located on the back side of the bag at the 11 and 1 o'clock sectors. The ports were located 6 cm (2.5") below the peripheral seam and were positioned on 24 cm (9.5") centers.

The bag was tethered internally by four straps located at the 3/9 and 12/6 o'clock positions. The tethers were secured to the face of the bag by a 17 cm (6.75") diameter reinforcement that was sewn to the bag with two rows of stitching.

Figure 8. Upper cover flap.

Figure 9. Fabric transfers to the lower face of the driver's air bag.

The diver air bag membrane contained two large fabric transfers that resulted from expansion against the out-of position driver's clothing **(Figure 9)**. A large blue/green/red fabric transfer was located at the bottom aspect of the bag. The transfer was vertically oriented and began 6 cm (2.25") above the horizontal center line on the tether reinforcement and extended to the peripheral seam flaring to a width of 20 cm (8"). Several vertically oriented fabric transfers wrapped around the back side of the peripheral seam and extended 6 cm (2.5") onto the back side on the bag membrane. Scattered lateral and diagonally oriented fabric transfers extended from the peripheral seam at the 3

o'clock sector, continuing 13 cm (5") onto the face of the bag. There was no damage or tears to the bag membrane.

The front right passenger air bag deployed from a mid mount module that was mounted in the right instrument panel of the vehicle. The module was concealed by a single cover flap that measured 17 cm (6.6") vertically at the mid point and 39 cm (15.5") in length. The flap opened at the designated tear points and was hinged at the top surface. The Identification Number 4363 was stamped on the inside surface of the cover flap.

The front right passenger air bag was rectangular in shape with a measured height of 67 cm (26.5") and width of 79 cm (31"). The passenger air bag was not tethered and was configured with a single vent port located at the left (inboard) side panel. The port measured 4 cm (1.4") in diameter. The passenger air bag expanded against the right aspect of the rear view mirror and deflected the mirror laterally left. The bag expansion loaded the mirror with sufficient force to crack the windshield at the mirror mount.

Manual Restraint Systems

The Grand Marquis was equipped with 3-point lap and shoulder safety belts at the four outboard seated positions. All outboard belt systems consisted of continuous loop webbings with sliding latch plates and emergency locking retractors (ELRs). The front belt systems had adjustable D-rings. The left side was adjusted 2 cm (0.9") below the full-up position while the right side was adjusted to the full-down position. The center front and center rear seated positions were equipped with a lap belt with a cinching latch plate.

The four outboard belt systems exhibited minimal historical use for the age and mileage on the vehicle. These subtle wear patterns were consistent with infrequent usage. There was no evidence of usage on the front left belt system. In addition, the driver was observed in the vehicle post-crash as unrestrained.

Driver Demographics

Age/Sex:	45 year old/Female
Height:	166 cm (65.5")
Weight:	59 kg (131 lb)
Eyewear:	Not reported
Seat Track:	
Position:	Unknown, moved prior to SCI inspection
Manual Restraint	
Usage:	None
Usage Source:	Vehicle inspection, observations of first responders
Mode of Transport	
From Scene:	Ambulance
Type of Medical	
Treatment:	Transported to a local hospital where she expired three hours following the crash

Driver Injuries

Injury	Injury Severity AIS90/Update 98	Injury Source
Complete laceration of the basilar artery	Critical (120402.5,8)	Expanding driver's air bag
Non-displaced fractures of the petrous ridges of the base of the skull	Serious (150200.3,8)	Expanding driver's air bag
Subarachnoid hemorrhage	Serious (140684.3,9)	Expanding driver's air bag
Fractures of the anterior and lateral aspects of the right 2-4 ribs and the lateral aspect of the left 6^{th} rib	Moderate (450220.2,3)	Expanding driver's air bag
Broad area of abrasion over the inferior aspect of the chin	Minor (290202.1,8)	Expanding driver's air bag
Broad area of abrasion of the anterior and lateral aspects of the neck	Minor (390202.1,0)	Expanding driver's air bag
Contusion and laceration of the inner lower lip and upper frenulum	Minor (290402.1,8; 290600.1,8)	Expanding driver's air bag
Contusion of the inner aspect of the right upper arm	Minor (790402.1,1)	Expanding driver's air bag
Contusion of the posterior and medial aspects of the left elbow, left forearm, and left wrist	Minor (790402.1,2)	Fling injury into left door panel

Source: Autopsy

Driver Kinematics

The driver of the Mercury Grand Marquis was seated in a presumed mid track position at the time of the crash. At the time of the SCI inspection, the driver's seat track had been moved from its at-crash position to a rear track adjustment and the seat back was reclined to a measured angle of 22 degrees aft of vertical. In this adjusted position, the horizontal distance between the mid point of the air bag module cover and the seat back was 54 cm (21.1"). The driver was not restrained by the available 3-point lap and shoulder belt system. Non-usage of the safety belt system was determined by the lack of loading evidence on the systems' components and from the observations of the first responders to the crash scene.

The driver was observed by a witness to be slumped forward in close proximity to the steering wheel/air bag module immediately prior to the crash. This position was supported by clothing fabric transfers on the bottom aspect of the air bag and subsequent compression of the energy absorbing steering column. At impact, the frontal air bag

system deployed. The asymmetrical cover flaps opened at the designated tear seams and apparently did not contact the out-of-position forward driver. The expanding air bag membrane contacted the torso region of the driver as evidenced by vertically oriented blue, green, and red fabric transfers on the face of the bag, extending from the midpoint of the bag the 6 o'clock sector **(Figure 10)**. Additional laterally oriented fabric transfers were present on the bag membrane at the 3 o'clock sector.

The air bag membrane expanded against the driver's chest, anterior neck, chin and lower face. The chest contact fractured the anterior and lateral aspects of the right 2-4 ribs and the lateral aspect of the left 6th rib. The continued expansion of the air bag resulted in abrasions of the chin and neck regions, a contusion and laceration of the lower lip and a contusion of the upper frenulum from lip compression against the teeth. The expanding air bag hyper-extended the driver's neck which resulted in fractures of the petrous ridges of the base of the skull, a complete laceration of the basilar artery, and subarachnoid hemorrhage.

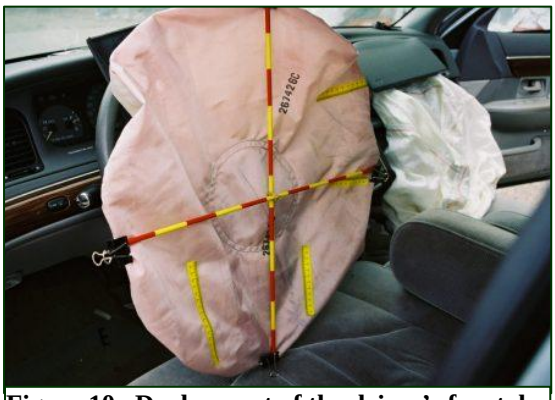

Figure 10. Deployment of the driver's frontal air bag.

The driver initiated a forward trajectory in response to the frontal impact force. The combination of the air bag expanding against her body and her loading force against the air bag, compressed the bag against the steering wheel, resulting in compression of the energy absorbing steering column.

Her arms were contacted by the expanding air bag which contused the inner aspect of the right upper arm. The left arm contacted the left door panel resulting in contusions of the left wrist, forearm and elbow.

Medical Treatment

The driver's husband, a medical professional, responded to the scene of the crash and observed the driver in the vehicle. Although the first arriving police officer recommended that he not move the driver prior to the arrival of ambulance personnel, the husband removed the driver from the left front door and placed her on the pavement adjacent to the vehicle. She was subsequently placed on a cot and transported by ambulance to a local hospital where she was evaluated for injury. The driver expired due to her injuries within three hours of the crash.

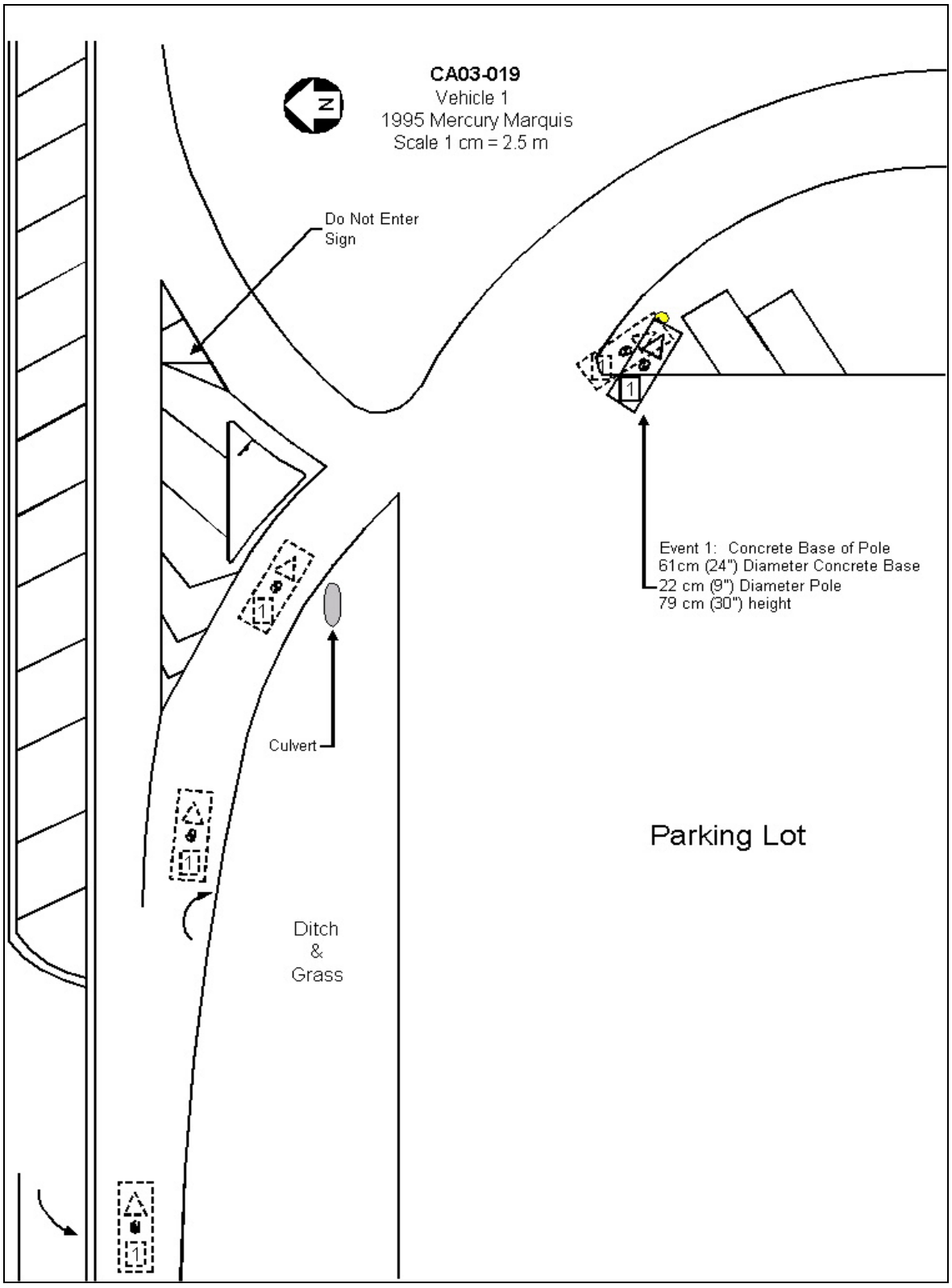

Figure 11 – Scene Schematic