

**CRASH DATA RESEARCH CENTER**

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**CALSPAN REMOTE SCHOOL BUS  
CRASH INVESTIGATION**

**CASE NO: CA04-047**

**VEHICLE: 2004 BLUE BIRD ALL AMERICAN SCHOOL BUS**

**LOCATION: FLORIDA**

**CRASH DATE: NOVEMBER 2004**

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

<p>1. Report No. CA04-047</p>	<p>2. Government Accession No.</p>	<p>3. Recipient's Catalog No.</p>	
<p>4. Title and Subtitle Calspan Remote School Bus Crash Investigation Vehicle: 2004 Blue Bird All American School Bus Location: State of Florida</p>		<p>5. Report Date: March 2007</p>	
		<p>6. Performing Organization Code</p>	
<p>7. Author(s) Crash Data Research Center</p>		<p>8. Performing Organization Report No.</p>	
<p>9. Performing Organization Name and Address Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225</p>		<p>10. Work Unit No. C00410.0000.0248</p>	
		<p>11. Contract or Grant No. DTNH22-01-C-17002</p>	
<p>12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590</p>		<p>13. Type of Report and Period Covered Technical Report Crash Date: November 2004</p>	
		<p>14. Sponsoring Agency Code</p>	
<p>15. Supplementary Note This remote investigation focused on the severity of the crash and the ejection portal of a 15-year old female student passenger of a rear-engine, 2004 84-passenger Blue Bird school bus that was involved in an intersection crash with a 2004 Dodge Ram 1500 pickup truck.</p>			
<p>16. Abstract This remote investigation focused on the severity of the crash and the ejection portal of a 15-year old female student passenger of a rear-engine, 2004 84-passenger Blue Bird school bus that was involved in an intersection crash with a 2004 Dodge Ram 1500 pickup truck. The school bus overturned and ejected the 46-year old female driver and 15-year old female student through the double full view outward opening entrance door. At the time of the crash, the bus was occupied by an unrestrained driver and nine unrestrained student passengers. The bus was equipped with lap belts for all passenger positions. The driver of the bus was traveling southbound and did not stop at a posted stop sign at a four-leg intersection. The bus entered the intersection and impacted the 2004 Dodge Ram, which was being operated by a 40-year old male driver. After the initial impact, the two vehicles side slapped resulting in damage to the right rear of the bus and left rear of the Dodge. The bus continued forward and began rotating counterclockwise (CCW) while departing the southeast side of the roadway. The bus rotated approximately 110 degrees before tripping CCW on the grassy roadside and overturning right side leading, completing three quarter turns. The bus came to rest on its left side against a small diameter pine tree. The driver of the bus sustained police-reported fractures to her ribs and arms and was transported to a regional medical center for treatment. The ejected 15-year old female passenger sustained fractures to her skull, face, sternum, ribs, and right femur, brain lacerations and contusions, bilateral lung lacerations, and multiple soft-tissue injuries. She was pronounced deceased at the scene. Two additional students were transported to a local hospital for treatment and the remaining six were either treated at the scene or taken to a medical facility later for observation. The admission and injury status of these students was not reported. The bus sustained moderate damage and was towed from the scene. The Dodge sustained severe damage and was also towed from the scene.</p>			
<p>17. Key Words School bus rollover Multiple ejections Student fatality</p>		<p>18. Distribution Statement General Public</p>	
<p>19. Security Classif. (of this report) Unclassified</p>	<p>20. Security Classif. (of this page) Unclassified</p>	<p>21. No. of Pages 12</p>	<p>22. Price</p>

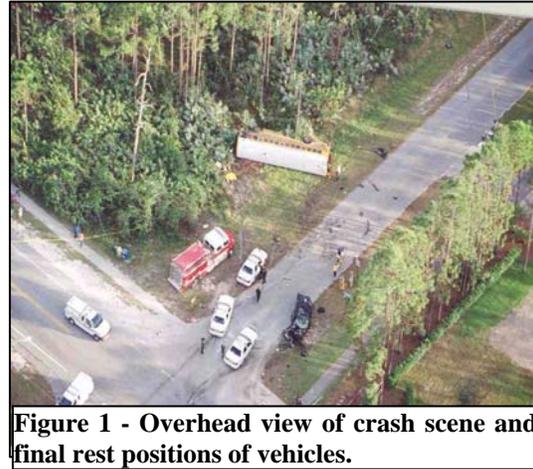
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**CALSPAN REMOTE SCHOOL BUS CRASH INVESTIGATION**  
**CASE NO.: CA04-047**  
**VEHICLE: 2004 BLUE BIRD SCHOOL ALL AMERICAN SCHOOL BUS**  
**LOCATION: FLORIDA**  
**CRASH DATE: NOVEMBER 2004**

**BACKGROUND**

This remote investigation focused on the severity of the crash and the ejection portal of a 15-year old female student passenger of a rear-engine, 2004 84-passenger Blue Bird school bus that was involved in an intersection crash with a 2004 Dodge Ram 1500 pickup truck. The school bus overturned and ejected the 46-year old female driver and 15-year old female student through the double full view outward opening entrance door. **Figure 1** is an overhead view of the crash scene and final rest positions of the vehicles. At the time of the crash, the bus was occupied by an unrestrained driver and nine unrestrained student passengers.



**Figure 1 - Overhead view of crash scene and final rest positions of vehicles.**

The bus was equipped with lap belts for all passenger positions. The driver of the bus was traveling southbound and did not stop at a posted stop sign at a four-leg intersection. The bus entered the intersection and impacted the 2004 Dodge Ram, which was being operated by a 40-year old male driver. After the initial impact, the two vehicles side slapped resulting in damage to the right rear of the bus and left rear of the Dodge. The bus continued forward and began rotating counterclockwise (CCW) while departing the southeast side of the roadway. The bus rotated approximately 110 degrees before tripping CCW on the grassy roadside and overturning right side leading, completing three quarter turns. The bus came to rest on its left side against a small diameter pine tree. The driver of the bus sustained police-reported fractures to her ribs and arms and was transported to a regional medical center for treatment. The ejected 15-year old female passenger sustained fractures to her skull, face, sternum, ribs, and right femur, brain lacerations and contusions, bilateral lung lacerations, and multiple soft-tissue injuries. She was pronounced deceased at the scene. Two additional students were transported to a local hospital for treatment and the remaining six were either treated at the scene or taken to a medical facility later for observation. The admission and injury status of these students was not reported. The bus sustained moderate damage and was towed from the scene. The Dodge sustained severe damage and was also towed from the scene.

Notification of the crash was obtained through an Internet news search and forwarded to the Calspan Special Crash Investigations team in November 2004. The case was assigned as a remote level investigation. The SCI team obtained a detailed Police

Accident Report (PAR), a set of on-scene images, and the autopsy report for the decedent that provided the basis for the report.

## **SUMMARY**

### ***Crash Site***

This two-vehicle crash occurred during daylight hours of November of 2004 in the state of Florida. At the time of the crash, there were no adverse weather conditions and the asphalt road surfaces were dry. The crash scene consisted of a north/south roadway intersecting an east/west roadway. For traffic entering the intersection from north/south roadway, access was controlled by stop signs. Both roadways consisted of one lane in each direction and were delineated by solid double-yellow painted centerlines. Asphalt shoulders with white painted fog lines bordered both roadways. The contiguous environment consisted of grassy roadsides with concrete sidewalks surrounded by natural growth. The stop sign for southbound traffic was located on northwest corner and was clear of any sight obstructions. Solid white stop lines were also painted at the mouth of the intersection on the north and southbound lanes. A succession of five sets of rumble strips, centered on 18 m (60') intervals, were located on the southbound travel lane leading to the intersection. The rumble strips were designed to alert southbound traffic of the approaching controlled intersection with the last strip positioned approximately 30 m (100') prior to the intersection. Additionally, a yellow warning sign advising southbound traffic of the approaching stop sign was positioned on the west shoulder 100 m (330') feet prior to the intersection. Both roadways were straight and level. The north/south roadway had a posted speed limit of 64 km/h (40 mph) while the east/west roadway had a speed limit of 72 km/h (45 mph). An SCI crash schematic compiled after an analysis of the PAR and on-scene images is included as **Figure 11** at the end of this narrative report.

### ***Vehicle Data – 2004 Bluebird All American School Bus***

The 2004 Bluebird All American rear-engine 84-passenger school bus was identified by the Vehicle Identification Number (VIN): 1BABNBXA44F (production number omitted). The passenger seating consisted of bench seats with high backs on steel framework, designed for compartmentalization. The number of rows on the bus was unknown; however, it was designed to accommodate up to 84 passengers. Safety features include split-sash windows with a 23 cm (9") opening; dual overhead emergency roof exits; a 76 x 198 cm (30 x 78") double full-view outward opening entrance door equipped with 3,429 sq. cm (1350 sq. in.) of tempered safety glass; a left side mid-bus positioned emergency exit with associated reflective tape; and a 140 x 56 cm (55 x 22") removable rear exit window with associated reflective tape. The service brakes consisted of air brakes with 4-wheel anti-lock (ABS), and the suspension was designed with 2-leaf parabolic springs for the front axle and 2-stage leaf springs for the rear.

The driver's seat was equipped with an integral head restraint and a 3-point manual lap and shoulder restraint. The second row was equipped with 3-point lap and shoulder restraints for the outboard positions. The remaining rear seats were equipped with adjustable lap belts for all seating positions.

### ***Vehicle Data – 2004 Dodge Ram 1500 Pickup Truck***

The 2004 Dodge Ram pickup truck was identified by the VIN: 1D7HA18D54S6 (production number omitted). The 4-door quad cab pickup was equipped with a 5.7-liter, 8-cylinder engine linked to an automatic transmission with a column-mounted transmission selector. The Dodge was rear wheel drive and the service brakes consisted of four wheel disc brakes with ABS. No specific tire information was reported.

### ***Crash Sequence***

#### ***Pre-Crash***

The 46-year old female driver of the 2004 Blue Bird school bus was operating her vehicle in the southbound direction and was approaching an intersection controlled by a stop sign (**Figure 2**). The 40-year old male driver of the 2004 Dodge Ram was operating his vehicle in an eastbound direction and was approaching the same intersection. **Figure 3** is an overhead view of the crash scene with directional arrows for both vehicles.

The driver of the bus has been licensed to operate this type of vehicle for 12 years and was familiar with the area. Several students reported that before they first boarded the bus that day, they had to knock on the door to wake the sleeping driver. They further stated that this was not an uncommon occurrence as the driver is often asleep in her bus while she waits for the students to depart the school. Additionally, several students articulated that the driver customarily makes a left turn at this intersection rather than proceeding straight and they were surprised when the driver was not slowing down for the intersection. At least one student recalled the bus traversing the rumble strips and became alarmed at the speed of the bus as it approached the intersection. Another student verbally warned the driver of the stop sign just prior to the crash by anxiously saying, “Miss, you just missed the stop sign.” In response to the student’s warning, the driver purportedly looked up as if she was initially distracted, but had no time to react prior to impact. Witnesses traveling behind the bus stated that they too were alarmed at the rate of speed of the bus as it approached the controlled intersection. A driver traveling approximately 1 km (0.5 miles) behind the bus in the same travel lane claimed that in reaction to the bus’s speed and lack of braking action, he looked at his speedometer and estimated that the bus was traveling at 80 km/h (50 mph). He further said that the brake lights on the bus were not activated at any point prior to the crash.



**Figure 2 - Southbound approach of bus.**



**Figure 3 - Overhead view of crash scene.**

### ***Crash***

The front right corner and right side of the bus impacted the front left corner of the Dodge in the intersection. The bus sustained moderate frontal damage and the right side outward opening entrance door was deformed. The directions of force to the 2004 Bluebird and 2004 Dodge were in the 2 o'clock and 10 o'clock sectors, respectively. Many students reported being thrown to the right during this event. Using a 360 degree momentum analysis model based on post-crash physical evidence, the police calculated the impact speed of the bus at 70 km/h (43.7 mph) and the Dodge at 71 km/h (44.4 mph).

As the front end of the Dodge shifted to the right, the vehicle began a clockwise rotation as the bus initiated a CCW yaw. The two vehicles side slapped resulting in damage to the right side of bus just forward of its rear wheels and damage to the back third of the Dodge, primarily to the pickup's bed. Following the side slap, the Dodge continued rotating 200 degrees clockwise and came to rest partially off the west edge of the roadway facing in a northwesterly direction. Yaw marks with associated rim gouges from the left rear wheel of the Dodge were present on the roadway at the point of impact leading to the vehicle's final rest position. The marks were approximately 18 m (60') in length and were in a mostly linear attitude before arching in a clockwise direction. A linear undercarriage gouge approximately 12 m (40') in length was also present leading to the Dodge's final rest position.

The bus rotated counterclockwise approximately 110 degrees as it departed the east edge of the roadway. Several tire furrows were present on the grassy roadside as the bus was rotating. The bus tripped on the soft soil and overturned in a right side leading three quarter turn rollover event before coming to rest on its left side against a small diameter pine tree. A road sign was also impacted and knocked down by the bus during the roll sequence. The original location of this sign or the area of the bus that impacted it is not known. The female driver of the bus and the 15-year old female student seated directly behind her were ejected from the vehicle through the already compromised outward opening entrance door. The student passenger was struck by the bus during the rollover event. The bus was facing in a northeasterly direction and on its left side following the rollover.

### ***Post-Crash***

Several passers-by stopped at the crash site and saw the remaining 8 students moving toward the rear of the bus. The students exited the bus through the 140 x 56 cm (55 x 22") removable rear exit window opening with the assistance of passers-by. It was not reported whether the rear window was missing from the impact sequence or if the students, and or, witnesses removed it. The ejected driver sustained incapacitating injuries. She was transported to a medical facility for treatment; however, her admission status is unknown. The ejected 15-year old female was found approximately 3 m (8') north of the bus at the edge of a tree line on the east roadside. She was pronounced deceased at the scene by rescue personnel. Of the remaining 8 students, two were transported to a local hospital for treatment and the other six were released to their parents, who in turn, brought them to a medical facility later that day. The admission status for these student passengers was not reported. The driver of the Dodge was not injured or transported to a medical facility. Both vehicles were removed from the scene and impounded by the investigating agency.

### ***Vehicle Damage***

#### ***Exterior – 2004 Bluebird All American School Bus***

The 2004 Bluebird school bus sustained moderate damage from the impacts with the Dodge Ram and subsequent rollover. There was no on-site SCI inspection and this report is based largely on crash scene photographs provided by the investigative agency. Direct contact damage was present at the front right corner of the bus and extended down the right side a distance of approximately 80 cm (32"), terminating slightly aft of the front right wheel (**Figure 4**). The direct contact



**Figure 4 - Damaged front right corner of bus.**

damage also extended a distance of approximately 80 cm (32") across the 244 cm (96") front bumper of the bus. The front right wheel deflated and appeared to have been displaced slightly rearward. The tempered glass within the double full-view outward opening entrance door was shattered and the existing framework within the door was significantly damaged. The internal steps leading from the bus to the exit were crushed and deformed laterally. The lower aspect of the third row right split-sash window was shattered.

After the initial impact, the two vehicles side slapped resulting in moderate damage to the right side of the bus (**Figure 5**). The damage began approximately 150 cm (60") forward of the right rear axle and extended just beyond the wheel well. The right rear outboard tire was deflated and debeaded from the rim

As the bus overturned, it sustained minor buckling damage to its roof and both side planes. The upper aspect of the 3<sup>rd</sup> row split-sash window was shattered. As the vehicle completed its 3<sup>rd</sup> quarter turn, the left rear area located forward of the axle impacted a

small diameter pine tree (**Figure 6**). The damage is approximately 100 cm (40”) in width and began approximately 15 cm forward of the left rear wheel. Associative bark transfers from the tree were embedded within the yellow paint on the vehicle’s left side.



**Figure 5 - Side slap damage to the right side of the bus.**



**Figure 6 - Damage to the left side of the bus.**

***Interior - 2004 Bluebird All American School Bus***

The photographic images revealed minor interior damage associated with the rollover event of the bus. Minor buckling was visible along the entire length of the roof; however, the damage was minimal and not to the level of being considered intruded. The internal steps leading from the bus to the exit door were crushed laterally and the aforementioned door damaged in the impact with the Dodge. The laminated windshield was also fractured probably during the rollover sequence. No discernable intruded components or contact points were observed. **Figure 7** is a view of the interior of the bus from the back aspect.



**Figure 7 - Interior of the bus.**

***Exterior - 2004 Dodge Ram 1500 Pickup Truck***

The 2004 Dodge Ram pickup truck sustained severe frontal and left side damage as a result of the multiple impacts with the bus (**Figure 8**). The front of the Dodge was shifted to the right and its chrome bumper sheared from the front end. The sheet metal and engine components forward of the base of the windshield were severely deformed. The damage along the forward aspect of the vehicle’s left side began at the left front bumper corner and extended rearward to the



**Figure 8 - Damaged 2004 Dodge Ram.**

base of the A-pillar. The left front wheel was also fractured from the axle and the left front door jammed closed. Induced damage was present on the front right door and fender. The Collision Deformation Classification (CDC) for this impact was incremented for the right shift and was estimated to be 70-LFAW-5.

The Dodge also sustained damage to the left mid and rear from the subsequent side slap (**Figures 9 and 10**). This damage was located mostly to the pickup's bed, but began at the left C-pillar and extended rearward to the left rear bumper corner. The left rear wheel was deflated and the vehicle's lift gate was fractured and was found hanging from the vehicle connected only by the right side steel lift cable. The CDC for this secondary impact was 09-LZAW-3.



**Figure 9 - Left side of damaged 2004 Dodge Ram.**



**Figure 10 - Left rear of damaged Dodge Ram.**

### ***Manual Restraints - 2004 Bluebird All American School Bus***

The 2004 Bluebird school bus was equipped with a 3-point lap and shoulder belts for the driver and the 1<sup>st</sup> row outboard positions of the passenger compartment. Adjustable lap belts were present for the remaining seating positions. Details regarding the specific type of latch plates and retractors for the lap and shoulder restraints were not reported. The investigating agency reported that neither the driver nor any of the student passengers utilized the restraints. Several student passengers further articulated that it is uncommon for them to utilize the belt systems, and they are often tucked into the seat cushions.

### ***School Bus Occupants***

#### ***Driver***

Age/Sex:	46-year old/Female
Height:	152 cm (60")
Weight:	59 kg (130 lb)
Manual Safety Belt Use:	None, lap and shoulder belt was available
Usage Source:	Ejection of driver
Ejection:	Complete
Ejection Portal:	Right side outward opening door
Type of Medical Treatment:	Transported to a medical facility; unknown level of treatment

***Driver Injuries***

<b>Injury</b>	<b>Injury Severity (AIS90/Update 98)</b>	<b>Injury Source</b>
Multiple fractures to arm, NFS	Moderate (751800.2,9)	Ground
Multiple rib fractures, NFS	Moderate (450210.2,9)	Ground

*Source - Police reported*

***Driver Kinematics***

The 46-year old driver of the bus was unrestrained and presumably seated in an upright attitude in the left front seat. At impact with the Dodge, the driver responded to the 2 o'clock direction of force by initiating a forward and lateral right trajectory toward the right side of the bus. The impact tore open the right front side door and fractured the tempered glass within the door framework, which created an ejection portal for the unrestrained driver. As the two vehicles side slapped, the driver was further displaced laterally to the right. The secondary impact rotated the bus in a counterclockwise direction as its center of gravity was redirected from a southerly direction to a southeast direction. The bus entered the grassy east roadside in a near broadside yaw. As the vehicle was rotating, the driver was probably near or through the ejection portal prior to the rollover. The driver was ejected onto the roadside prior to or during the first quarter turn of the rollover sequence. It was not reported where the driver came to rest in relation to the final rest position of the bus. The driver sustained multiple fractures to her arms and ribcage probably due to ground contact. She was transported to a medical facility; however, the name or type of medical facility was sanitized from the final investigative report.

***Front Row Left Passenger***

Age/Sex: 15-year old/Female  
 Height: 157 cm (62")  
 Weight: 77 kg (170 lb)  
 Manual Safety Belt Use: None, lap belt was available  
 Usage Source: Ejection of passenger  
 Ejection: Complete  
 Ejection Portal: Right side outward opening door  
 Type of Medical Treatment: None, pronounced deceased at the scene of the crash

***Front Row Left Passenger Injuries***

<b>Injury</b>	<b>Injury Severity (AIS90/Update 98)</b>	<b>Injury Source</b>
Multiple confluent comminuted fractures of the basilar skull with avulsion of the left and right anterior fossa and linear fractures of the foramen magnum	Severe (150206.4,8)	Exterior of the school bus/ground

Multiple lacerations and contusions over the left parietal cerebrum and inferior surfaces of the left and right frontal lobes	Severe (140688.4,2; 140688.4,1; 140612.3,2; 140612.3,1)	Exterior of the school bus/ground
Comminuted fracture of the skull over the left ear with exuded brain parenchyma	Severe (150406.4,2)	Exterior of the school bus/ground
Displaced fractures of right ribs 4-6 with multiple posterior right rib fractures and a displaced fracture of the left 10 <sup>th</sup> rib	Serious (450230.3,3)	Exterior of the school bus/ground
Laceration of the hilum and the posterior surface of the right lung with bilateral hemothorax	Serious (441430.3,1)	Exterior of the school bus/ground
Contusion of the left lung	Serious (441406.3,2)	Exterior of the school bus/ground
Contusions of the liver	Moderate (541812.2,1)	Exterior of the school bus/ground
Fracture of the right maxilla	Moderate (250800.2,1)	Exterior of the school bus/ground
Fracture of the right zygoma	Moderate (251800.2,1)	Exterior of the school bus/ground
Horizontally oriented linear fracture of the left frontal, parietal and occipital calvarium	Moderate (150402.2,2)	Exterior of the school bus/ground
Disarticulation of the left clavicle	Moderate (751030.2,2)	Exterior of the school bus/ground
Transected sternum at the level of the 3 <sup>rd</sup> and 4 <sup>th</sup> ribs	Moderate (450804.2,4)	Exterior of the school bus/ground
Disarticulation of the proximal right femur (NFS)	Moderate (851818.3,1)	Exterior of the school bus/ground
Multiple abrasions of the forehead, left periorbital area, left chin, right face extending from the temple to the cheek and onto the right chin	Minor (290202.1,0)	Ground
13x13 cm abrasion of the right neck extending from the clavicle to the jaw	Minor (390202.1,1)	Ground

8x23 cm irregular laceration of the scalp above the left ear	Minor (190602.1,2)	Ground
Posterior neck abrasion	Minor (390202.1,6)	Ground
30x13 cm grouping of abrasions at the right upper chest	Minor (490202.1,1)	Ground
13x10 cm abrasion over the naval	Minor (590202.1,8)	Ground
15x23 cm abrasion over the lateral right torso	Minor (490202.1,1)	Ground
Abrasions of the posterior torso that extend from the left upper to the right mid back and upper buttocks	Minor (690202.1,0)	Ground
10x5 cm laceration of the left medial back	Minor (690602.1,2)	Ground
Abrasions spanning the lateral right arm and posterolateral forearm	Minor (790202.1,1)	Ground
8x2 cm contusion w/abrasion of the posterior lower right forearm	Minor (790402.1,1; 790202.1,1)	Ground
10x5 cm contusion of the posterior right hand, ring and 5 <sup>th</sup> fingers	Minor (790402.1,1)	Ground
Scattered abrasions of the anterior left arm	Minor (790202.1,2)	Ground
5 cm contusion of the posterior left upper arm	Minor (790402.1,2)	Ground
5x1 cm abrasion of the anterior right thigh	Minor (890202.1,1)	Ground
Abrasion over the lateral left knee	Minor (890202.1,2)	Ground

*Source – Autopsy Report*

#### ***Front Row Left Passenger Kinematics***

The 15-year old child passenger was presumably seated in the second row left position of the school bus. This was determined from an interview with the investigating police officer; however, a detailed seating schematic was not provided with the Police Accident Report (PAR) and all information relating to the teenage passengers was sanitized from the report. This passenger was dressed in a green long-sleeved sweatshirt and denim blue jeans. A backpack was found at her feet. Although numerous on-scene police images were provided for this remote-level investigation, there was insufficient detail of the interior of the bus to accurately access evidence of occupant contact and injury sources.

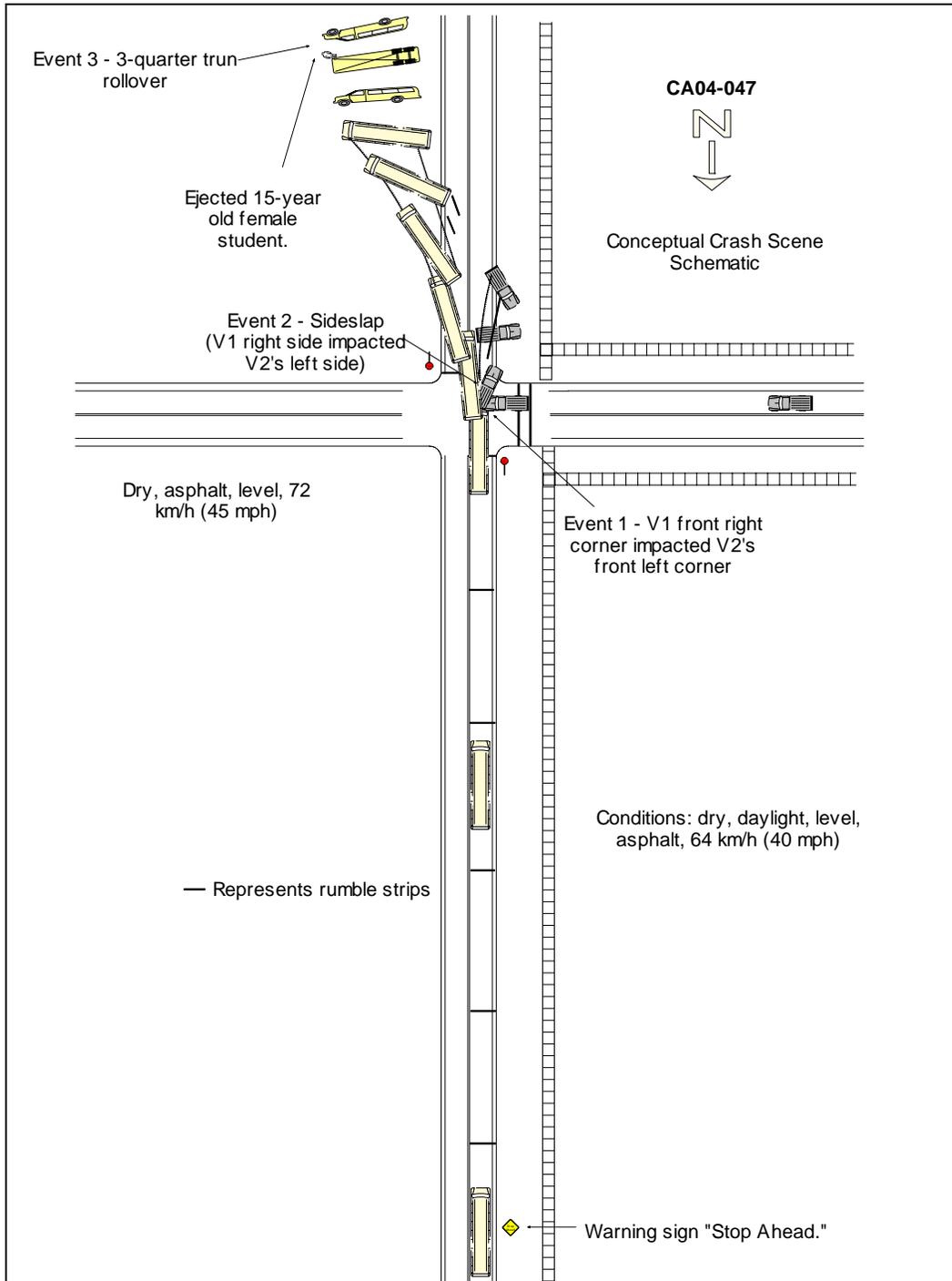
At the initial impact with the pickup truck, the 15-year old unrestrained passenger moved forward and to her right in response to the 2 o'clock direction of force. The impact tore open the right front side door which created an ejection portal for the unrestrained passenger. The impact rotated the bus in a counterclockwise direction as its center of gravity was redirected from a southerly direction to a southeast direction. The bus entered the grassy east roadside in a near broadside yaw. The school bus subsequently initiated a lateral rollover, right side leading.

The unrestrained passenger was ejected through the door opening onto the roadside at the edge of a tree line. Her ejection occurred prior to, or as the bus began to rollover. The bus subsequently struck her during the rollover sequence. Her injuries included multiple abrasions of the face, neck, torso, back, and extremities that suggested that she was rolled over by the bus, or tumbled as she was ejected from the vehicle. Her head injuries included multiple skull and basilar skull fractures with brain lacerations and contusions, and brain matter exuding from the left linear skull fracture above the left ear. She also sustained facial fractures of the maxilla and zygoma. Thoracic injuries included multiple bilateral rib fractures with lung contusions and lacerations, and contusions of the liver. Extremity injuries included Medical Examiner reported disarticulation of the left shoulder, right proximal femur (hip).

The school bus came to rest on its left side a police reported distance of 3.2 m (8') beyond the final rest position of the student passenger. Based on the extensive abrasion patterns to the passenger, it was possible that she was dragged or rolled by the bus as it continued to overturn. She was pronounced deceased at the scene of the crash.

#### ***Additional Student Passengers***

The bus was also occupied by 8 additional student passengers, four males and four females. Several students described being thrown toward the right side of the bus during the initial impact and then again during the rollover. Following the crash, the students proceeded toward the rear of the bus and exited the same through the rear window opening. The identifying information regarding these occupants was sanitized from the investigative report prior to it being provided for this remote-level SCI narrative report. Therefore, individual seating locations and demographic information is not known. It was revealed that two of the students were transported to a local hospital directly from the crash scene. The remaining six were either treated at the scene or were taken to a medical center later that day by a family member. No specific injury information was reported.



**Figure 11 – Conceptual Crash Scene Schematic**