Crash Reconstruction and Transportation Engineering Analysis

40-12724 (State v. Norris)

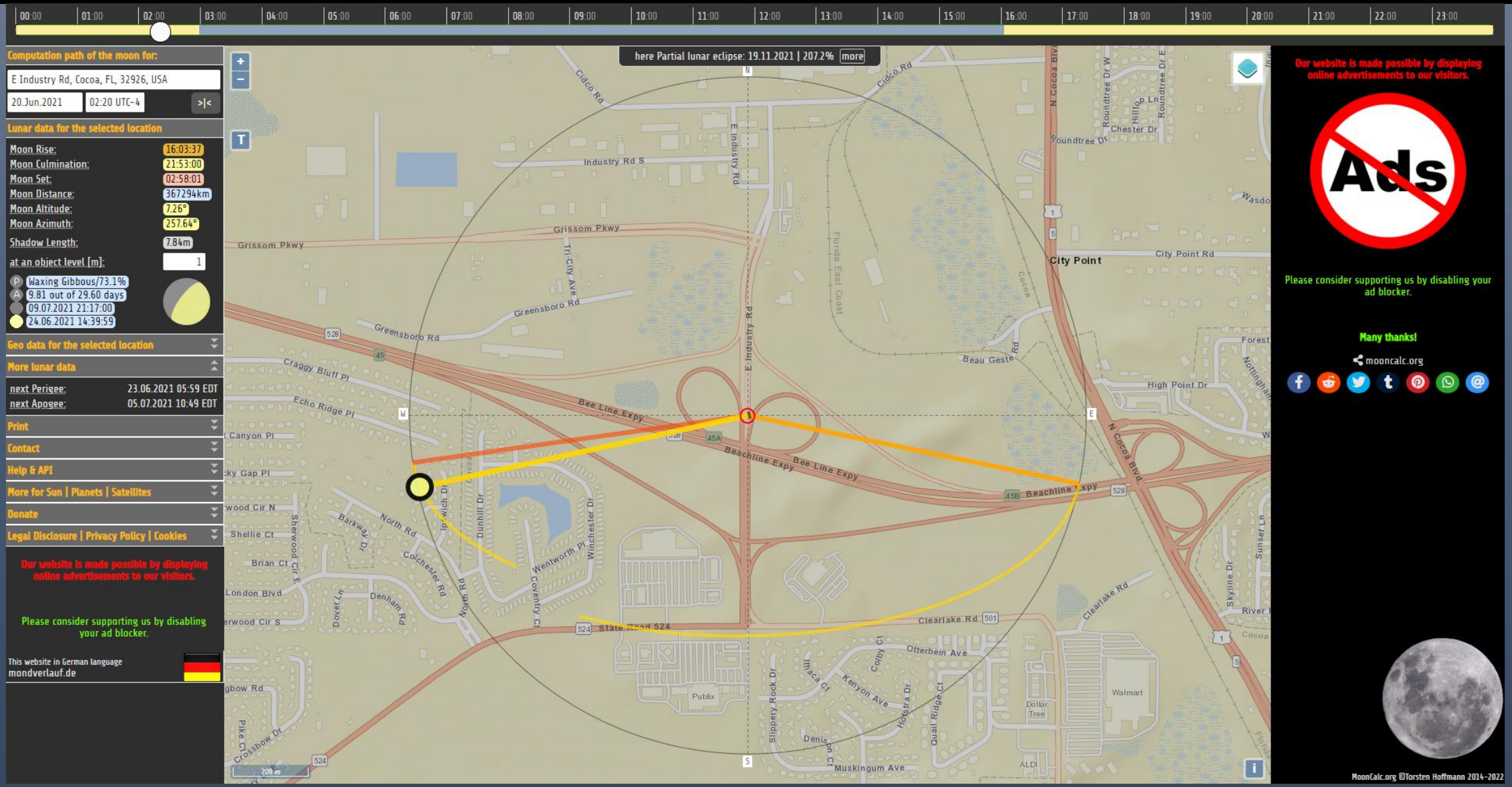
Kelly Palframan, Ph.D., P.E.

FOCUS
FORENSICS

Crash Information

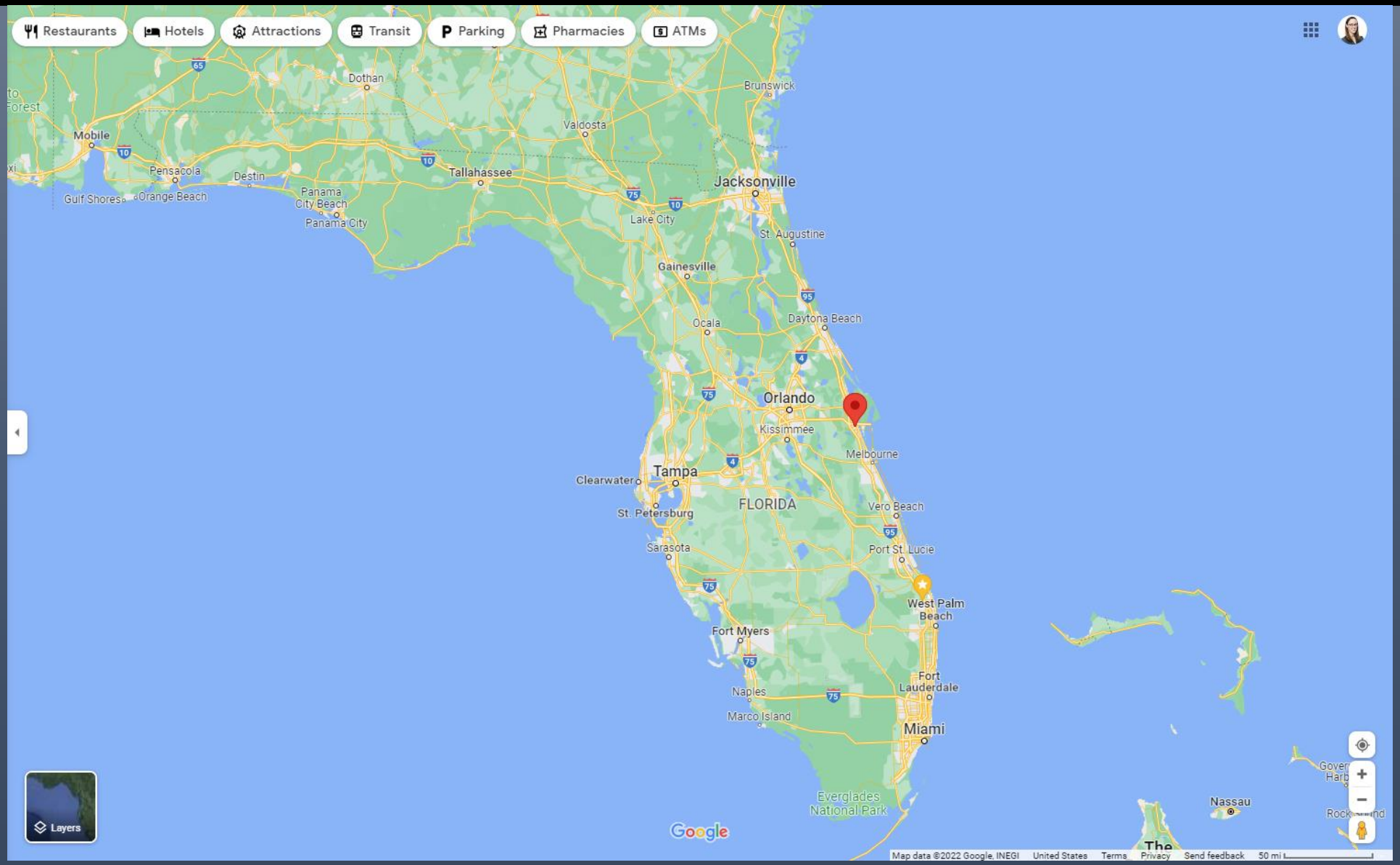
- Date: Sunday, June 20, 2021
- Time: 2:20 am
  - Astronomical Twilight at 9:57 pm on June 19, 2021
  - 4 days before a full moon
  - Moonset at 2:57 am on June 20th
  - Astronomical Twilight until 4:52 am on June 20th
- Weather: clear, dry
- Lighting:
  - No permanent overhead lighting
  - Minimal ambient lighting from the moon (nearly moonset)

Moon Phase and Position



- The moon was nearly setting at the time of the crash. It's contribution to the available light would be negligible.

Location



- The subject crash occurred in Cocoa, Brevard County, Florida

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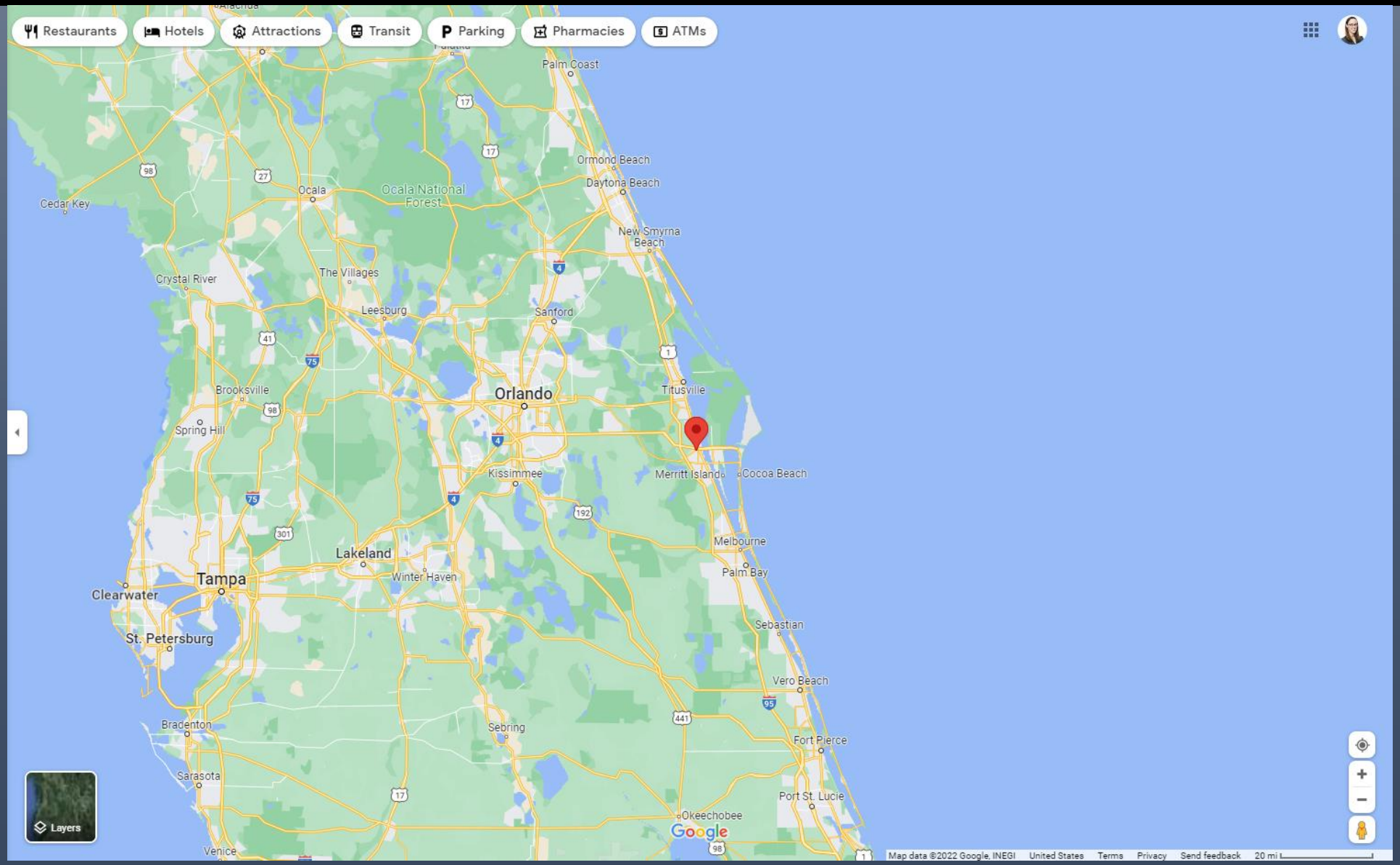

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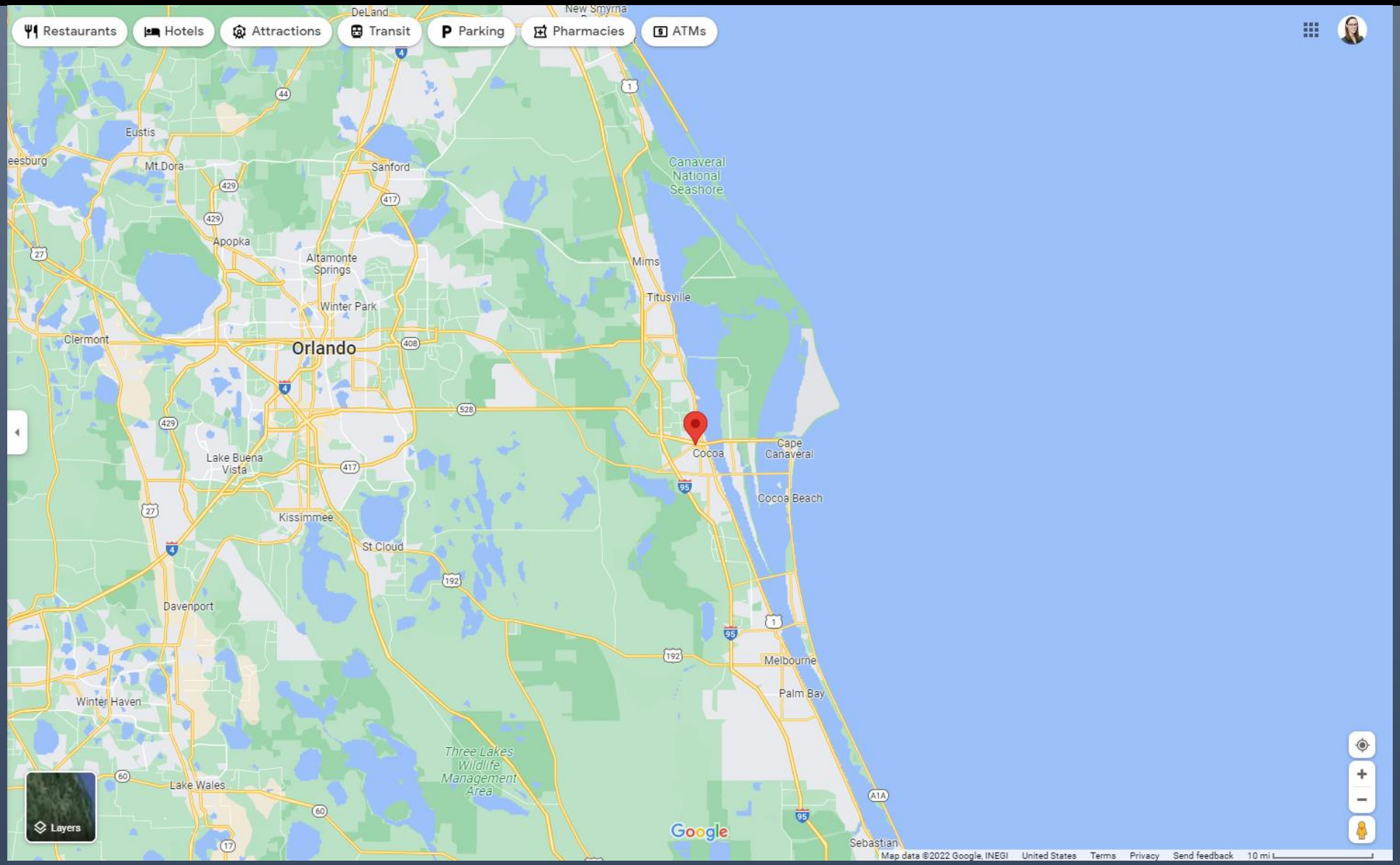

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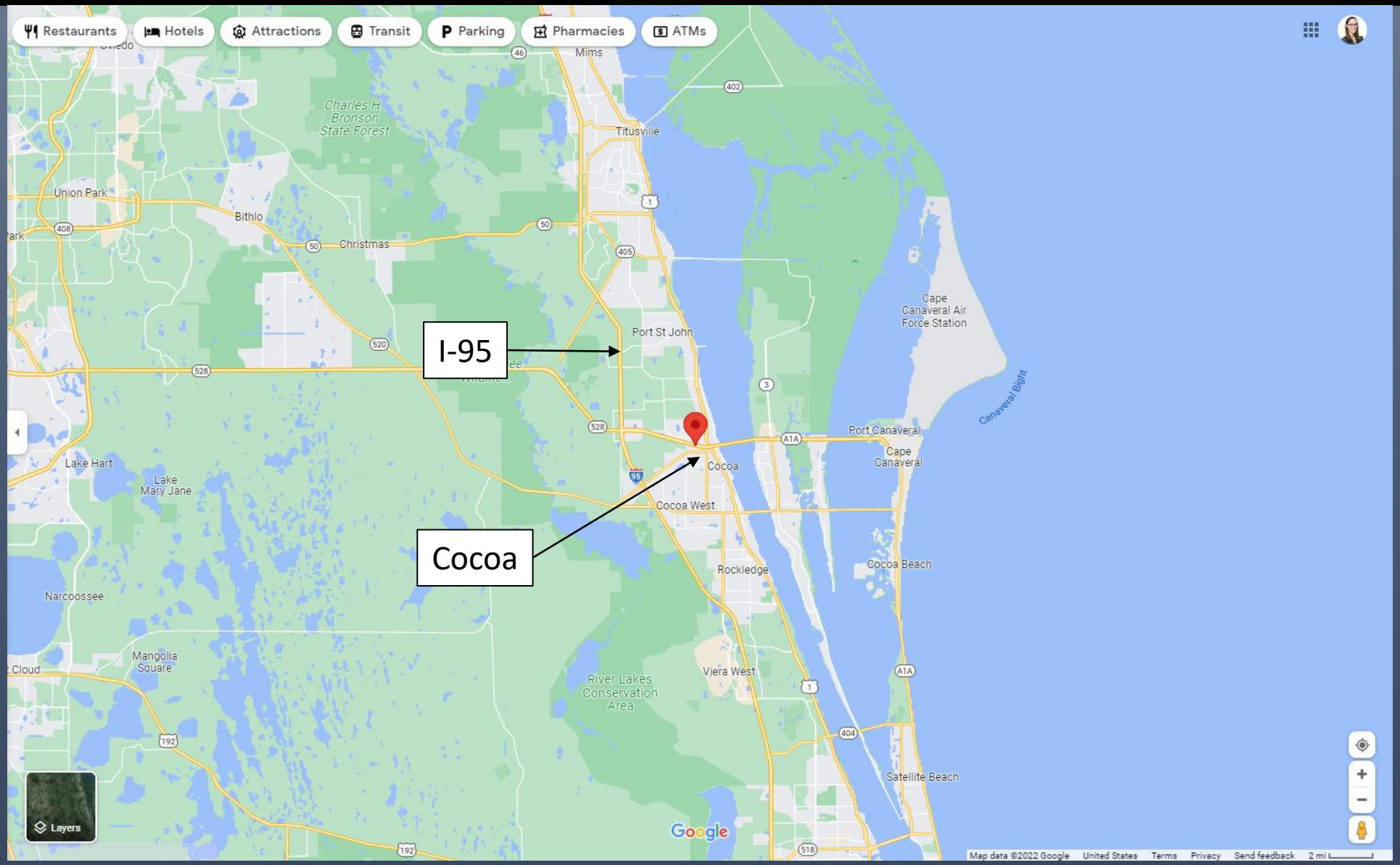

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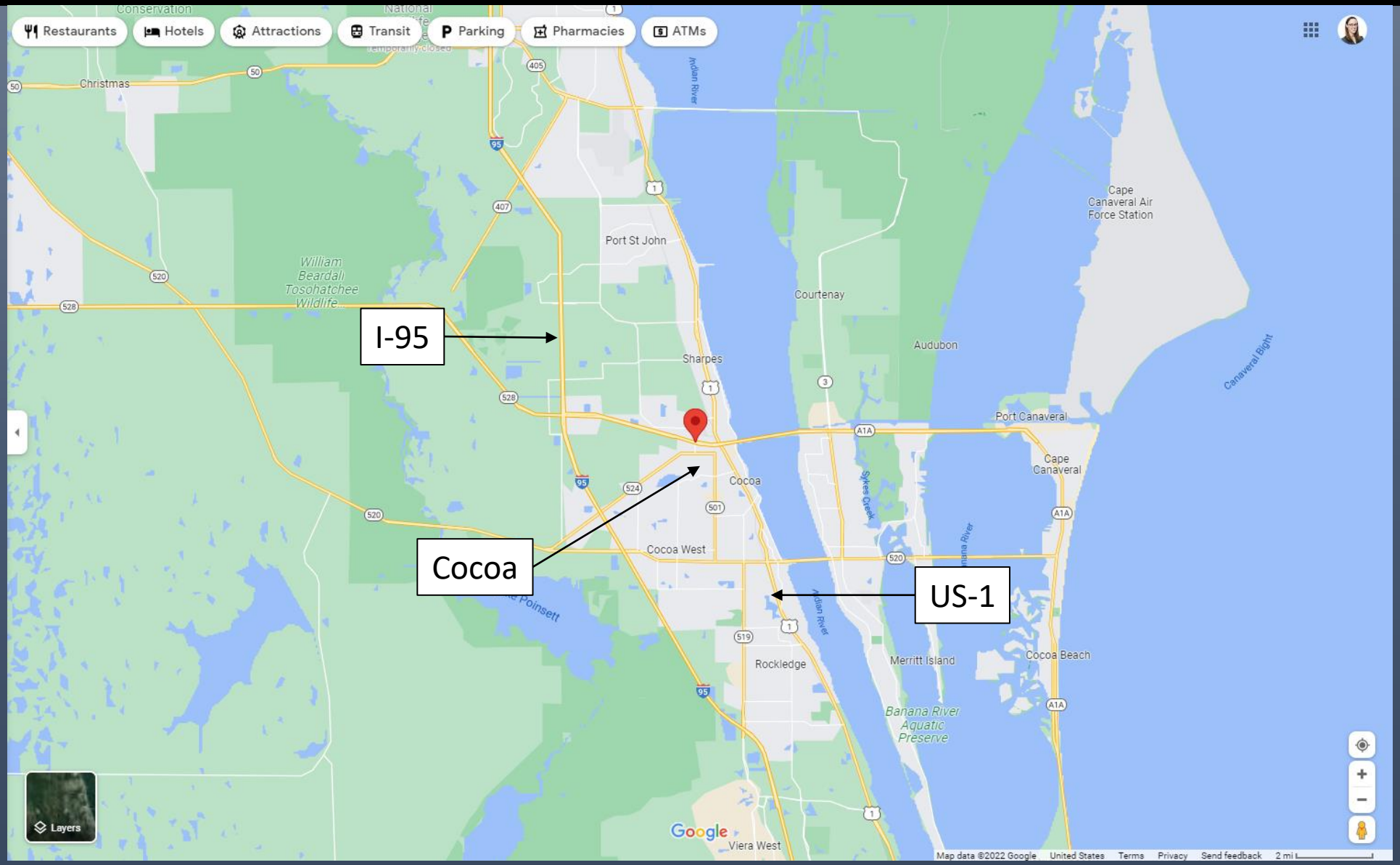

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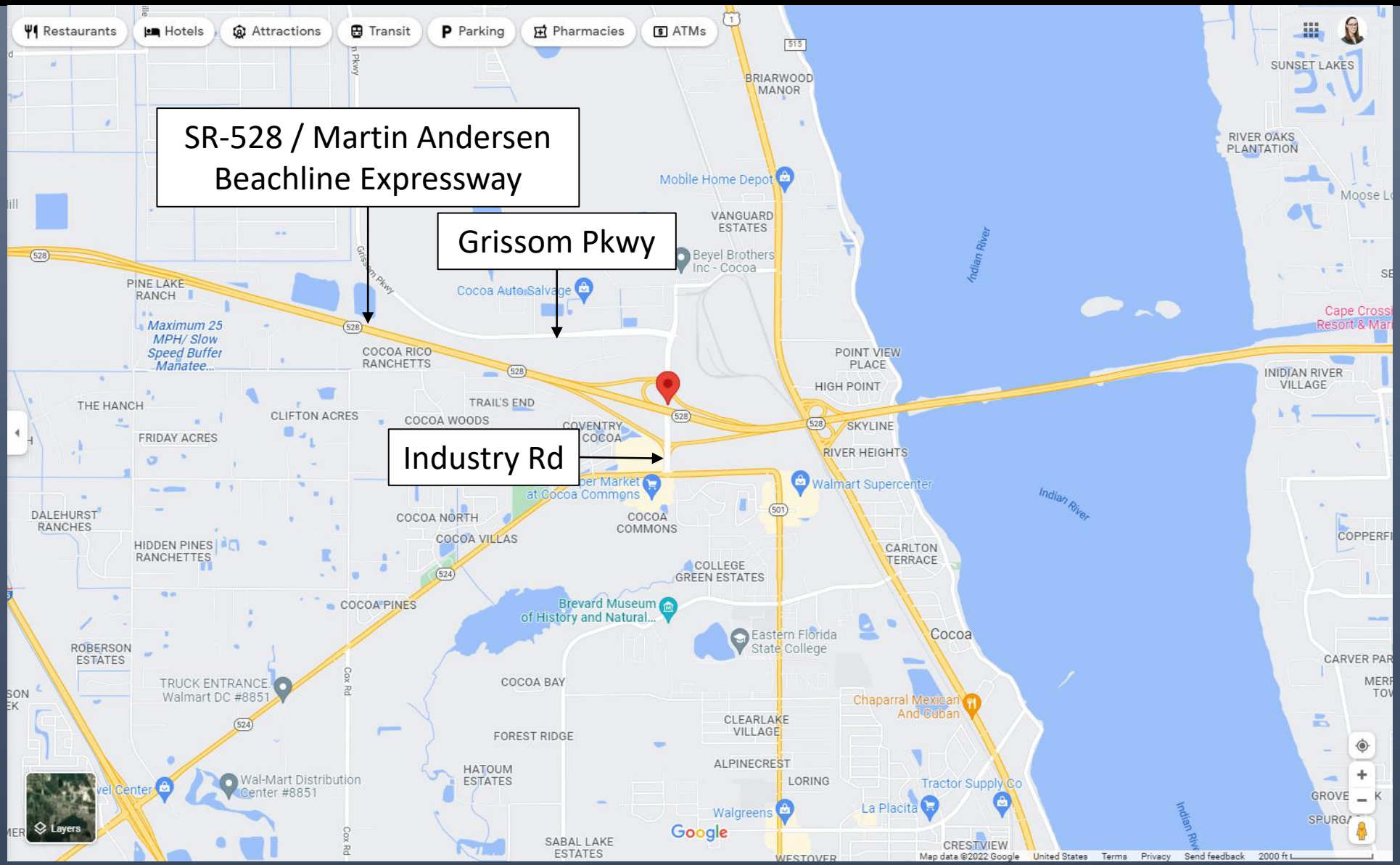

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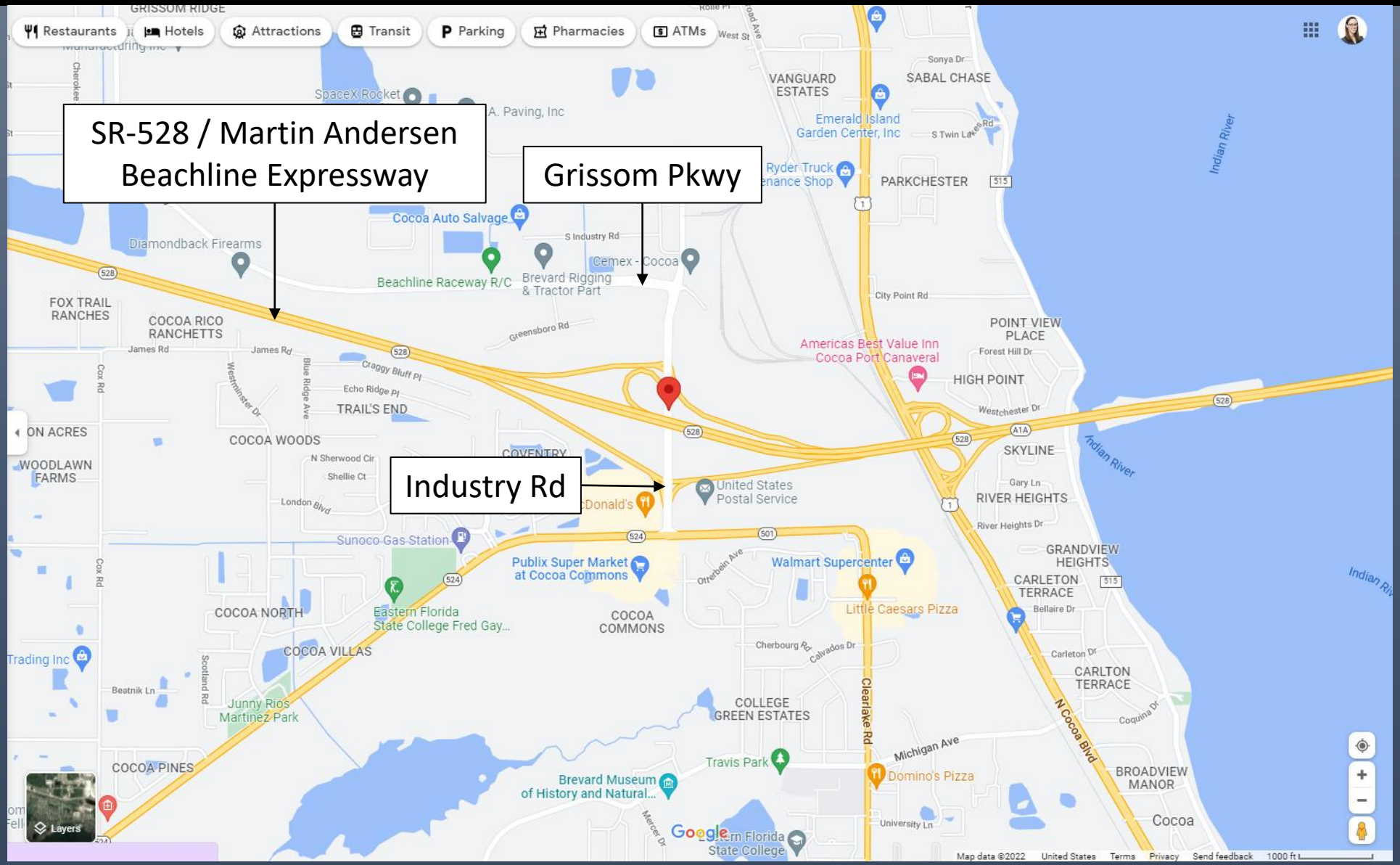

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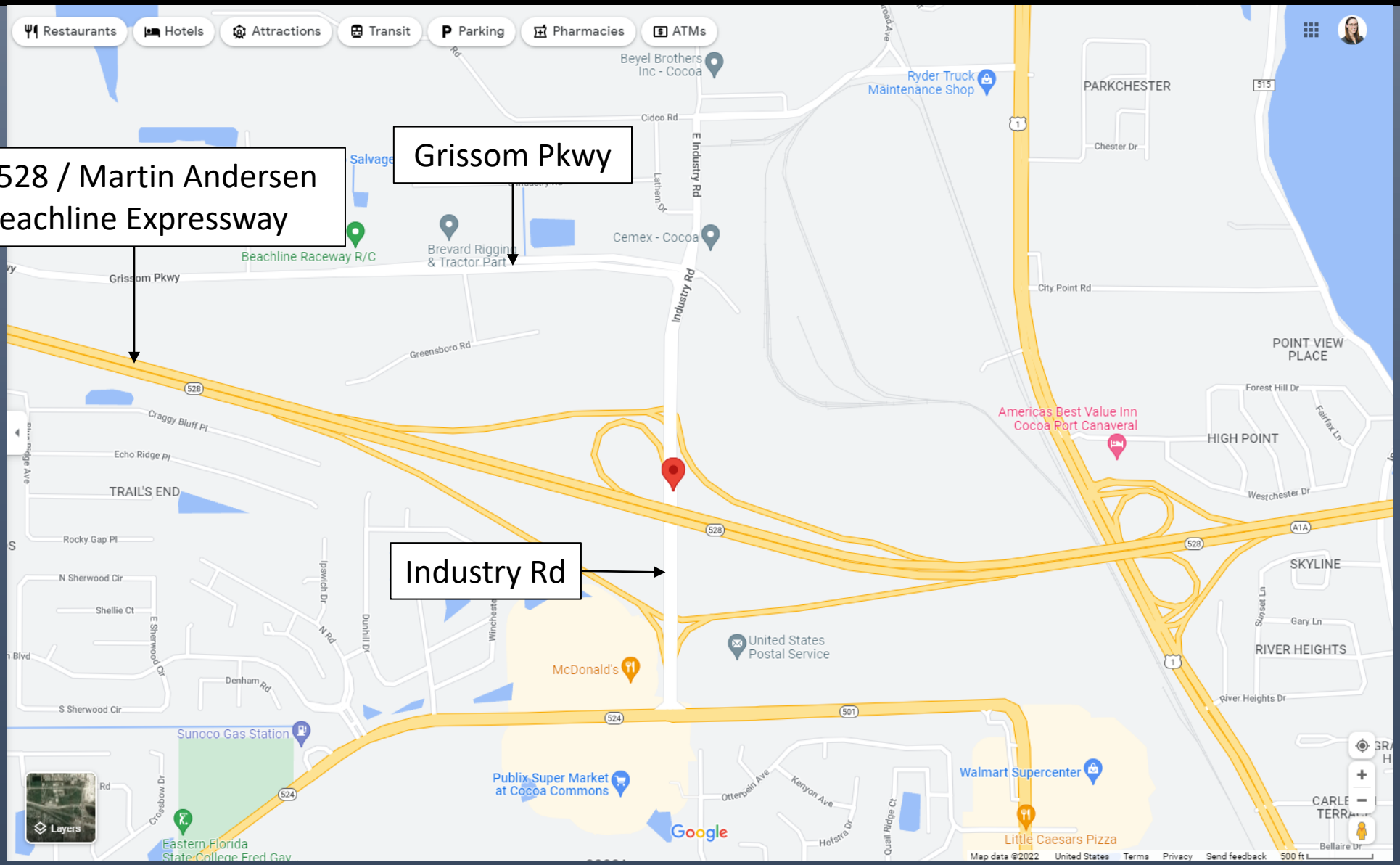

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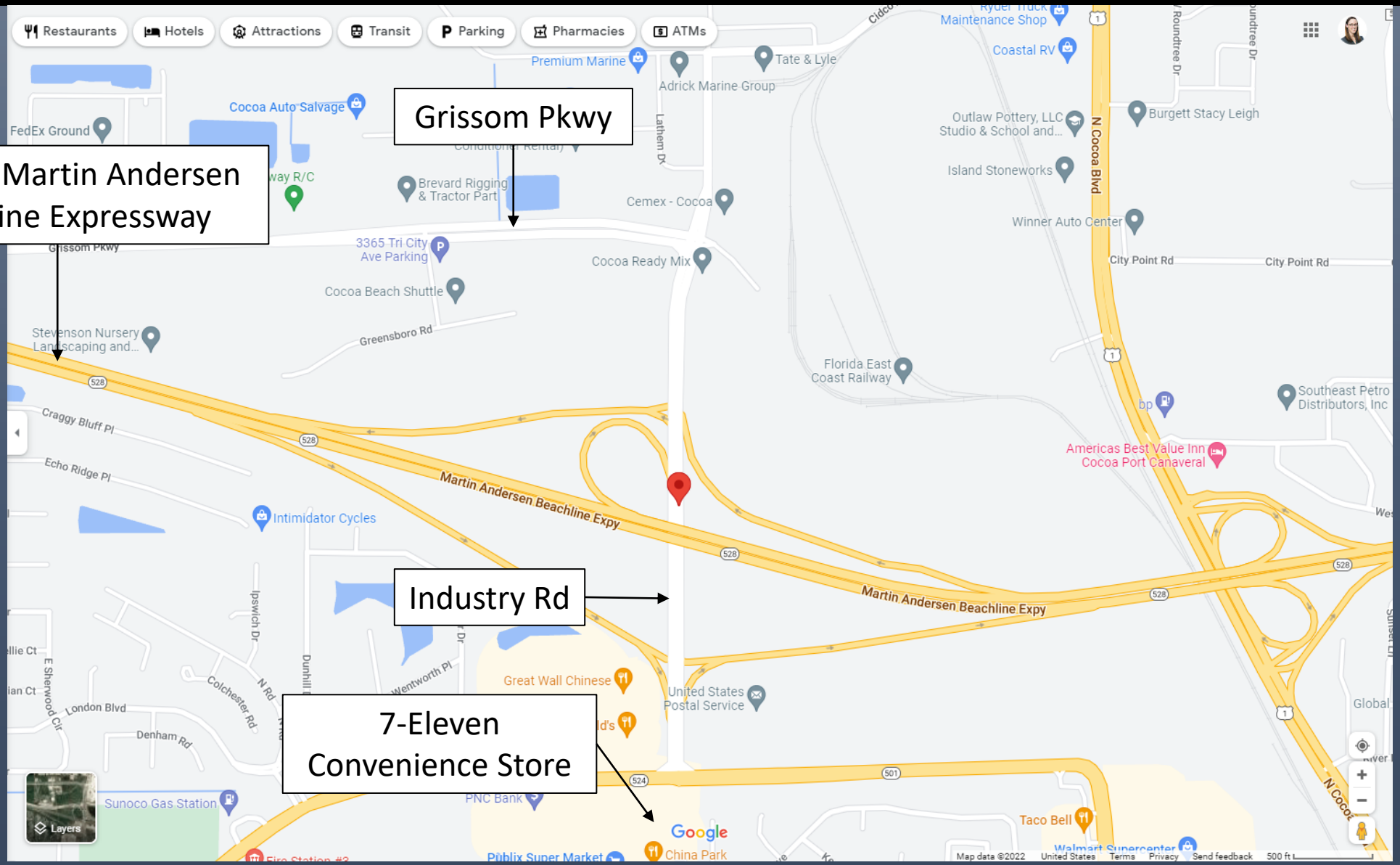

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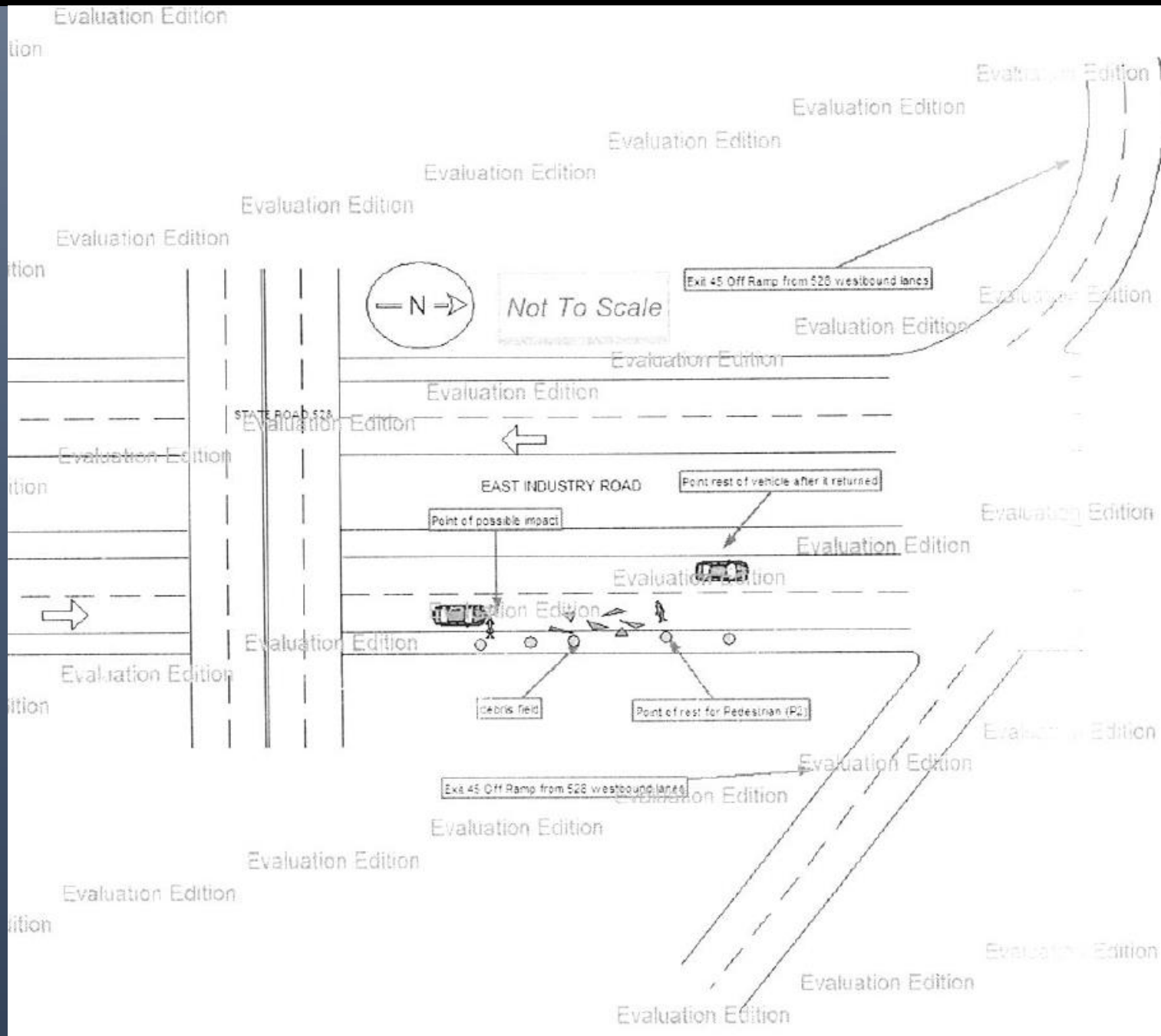
Location

- The speed limit on Industry Road was 45 mph.
- The road was under construction at the time of the crash.

Crash Information

- Ms. Lucas was a pedestrian walking northbound along Industry Road.
- Ms. Norris was driving a white 2009 Chevrolet Impala northbound along Industry Road.
- Contact occurred Ms. Norris's vehicle and Ms. Lucas leading to a fatal outcome.



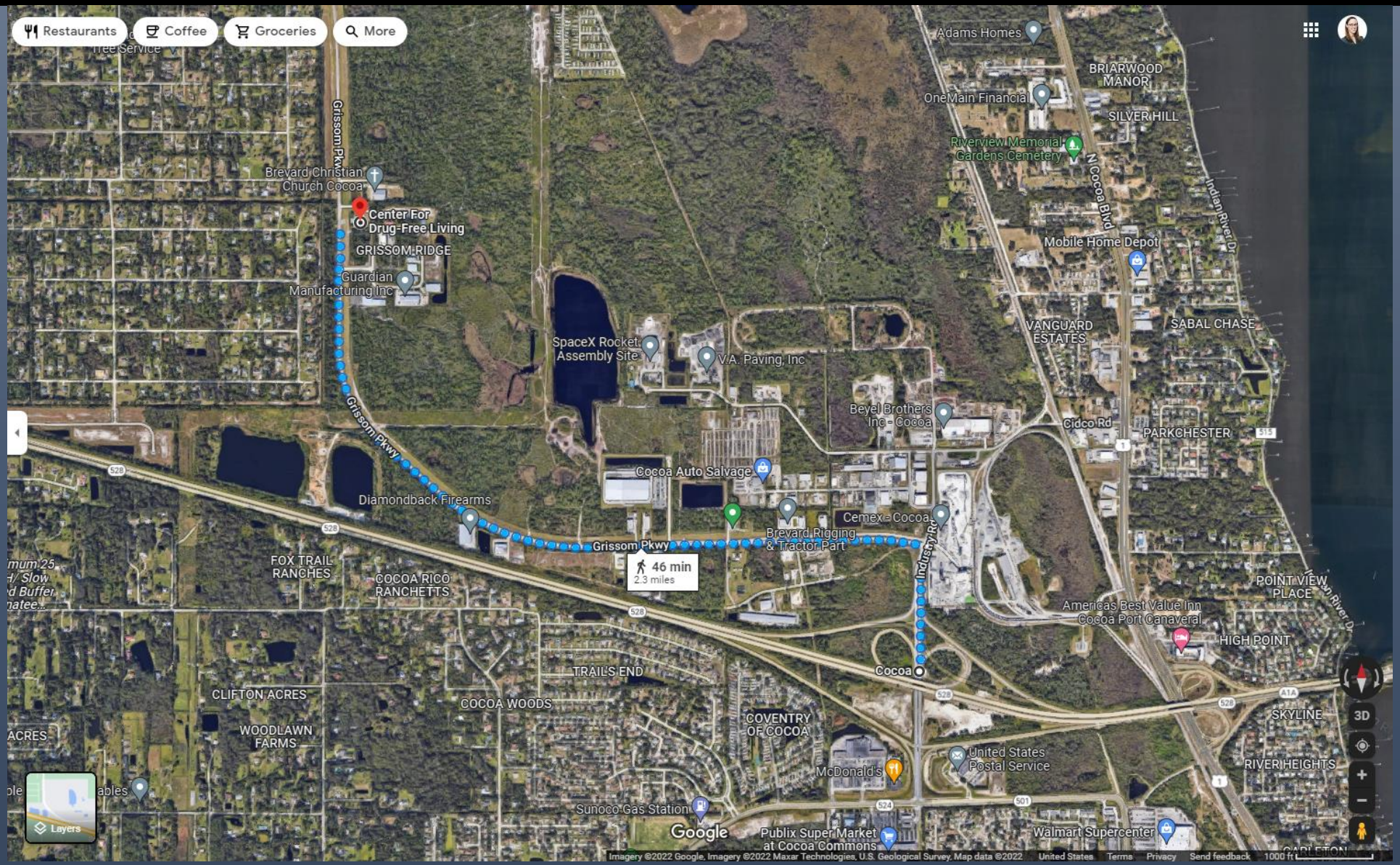
Vehicle

- 2009 Chevrolet Impala
  - VIN: 2G2WS57M9912693
  - Downloaded by the Cocoa Police Department
    - No events pertaining to this collision were recorded and/or recovered

  - Front Bumper Height (top): 1.92 ft
  - Hood (top front): 2.5ft
  - Base of Windshield: 3.17 ft
  - Height: 4.92 ft

Exemplar 2009 Chevrolet Impala

Location



- Ms. Lucas was heading back to her residence at Aspire Health Partners, 3905 Grissom Parkway, Cocoa, Brevard County, Florida

Crash Information

- Security footage captured just prior to the crash show Ms. Lucas wearing light colored pants and a red shirt.

Scene Photos

- The police photographed the scene on the night of the crash.
- The police set up a portable light source to illuminate the scene during their investigation.

Scene Photos

- Drums and a flashing arrow board were present on the night of the crash.
- The roadway was being narrowed from two northbound lanes to one northbound lane.

Scene Photos

- The first piece of evidence was found on the skip line approximately 78 ft north of Ms. Lucas's final rest.

Scene Photos

- Looking backwards towards the point of impact.

Scene Photos

- There were no tire marks prior to impact and no tire marks from impact to the vehicle's rest position.

Scene Photos

- Looking backwards towards impact.
- No visible tire marks after impact.

Scene Photos

- Looking at debris field.
- No visible tire marks after impact.

Scene Photos

- Blood stains indicate that Ms. Lucas came to rest just north of the flashing arrow board.

Scene Photos

- Looking backwards towards Ms. Lucas's final rest position.

Scene Photos

- Ms. Norris's vehicle in a stopped position at the scene of the crash.

Scene Photos

- Ms. Norris's vehicle relative to Ms. Lucas's final rest position.

Scene Photos

- Debris field marked with evidence markers.

Scene Photos

- Damage to the front right headlight, front right portion of the hood, and passenger side of the windshield.

Scene Photos

- Damage to the front right headlight, front right portion of the hood, and passenger side of the windshield.

Scene Photos

- Damage to the front right headlight, front right portion of the hood, and passenger side of the windshield.

Scene Photos

- The right side view shows no signs of contact with Ms. Lucas's body.

Scene Photos

- The right rear view shows no signs of contact with Ms. Lucas's body.

Scene Photos

- The rear of the vehicle shows no signs of contact with Ms. Lucas's body.

Scene Photos

- Close-up of contact evidence and vehicle damage.

Scene Photos

- Front right headlight assembly was broken.

Scene Photos

- Dent from body contact is in line with the front right headlight.

Scene Photos

- Dent from body contact continues along the hood.

Scene Photos

- Dents approximately halfway up the A-pillar from contact with Ms. Lucas's head.
- Black hair is visible in the cracked glass near the A-pillar.

Scene Photos

- Ms. Lucas's head penetrated the windshield and temporarily intruded into the occupant compartment.

- Markings on the roof of the vehicle are not consistent with marks from pedestrian-to-vehicle contact.

Scene Photos

- Close-up of the dented hood above the right headlight.

Scene Photos

- Close-up of the dented hood above the right headlight.

Scene Photos

- Potential fluid marks on the passenger side window.

Scene Photos

- Items hanging from rear view mirror.

Scene Videos

- Arrow board is illuminated in a flashing manner.

Witness Statements – Gary Horton (7Eleven)

- June 23, 2021 - Interview with Officer Landis
  - Mr. Gary Horton worked at the 7Eleven located at State Road 524 and Industry Road.
  - He remembered Ms. Lucas coming in for a cup of water prior to the crash.
  - He told her to help herself to the cups and water.
  - Ms. Lucas drank water in the parking lot then continued walking north until she was out of sight.
- November 10, 2021 – Interview with Sergeant Bradshaw
  - When Ms. Lucas came into his 7Eleven to get a drink, he said that Ms. Lucas mentioned she was heading back to her rehabilitation facility on Grissom Parkway.
  - She left the property heading northbound and crossing the street at the northbound/southbound crosswalk on the corner of 524 and industry Road. She then utilized the eastbound/westbound crosswalk to cross East Industry Road. Before she got to the end of the crosswalk, she turned north and started walking in the roadway “in and out of the turn lane then changed and started walking in the easternmost threw (sic) lane northbound.” She continued weaving back and forth between the two lanes until he lost sight of her.

Witness Statements – Ms. Norris (driver)

- Night of Crash – Post Constitutional Right Interview
  - She was alone in her vehicle.
  - She didn't know what she struck or where it came from.
- Morning of Crash – Written Statement
  - She was driving down Industry Road when something crashed into her windshield. When she realized what had happened, she "turned back around" to see what she hit. A man had stopped as well.
  - The man called the police and requested an ambulance.
  - She never saw the person prior to impact.
  - She stopped immediately once she knew that she hit something.

Cocoa Police Department — **Prosecution / Witness Affidavit**

Date	Time	Current Location – Statement Made At	Case Number
6/20/21	0530	1226 W. King St, Cocoa, FL 32922	2021-24473

Name	Age	Date of Birth
Suzanna Paige Norris		2/21/72

Sex	Race	Place of Birth	ID Type & Number
F	W		FL DL N620-795-72-561-0

Home Address	City	State	Zip
6360 Arborwood Ave	Cocoa	FL	32927

Cell Phone	Other Phone/Family Member	E-Mail Address
321-536-5916		

I, Suzanna Norris, do hereby voluntarily make the following statement without threat, coercion, offer of benefit, or favor by any persons whomsoever.

I was heading home from Cocoa village and when I was driving down Industry Rd something crashed into my vehicle. When I realizes what had happened I turned back around to see what I had hit and there was a man that had stopped as well. There was a woman who had been hit. He called 1 the authorities as the ambulance and police arrived to care for the person who had been hit. I have cooperated fully and I never saw the person who walked in front of me, but upon knowing that I hit something I stopped immediately to see if I could help in any way. I was alone in the car.

For Law Enforcement Use Only

Sworn to and subscribed to me this 20 day of June, 2021.

#52

☒ Law Enforcement Officer (Ref. FSS 943.01) conducting official duties.
☐ Notary Public – Commission Expires:
☐ Personally Known to Me or ☒ Produced Identification
Type of ID & Number Listed Above

Total Value of Property Stolen/Damaged: — Amount If Applicable $

I will testify in court. — Initial

I will prosecute criminally. — Initial If Applicable

I have received & reviewed the Victim's Rights Package and/or Domestic Violence Rights and Responsibilities, and it has been explained to me. — Initial If Applicable

I Swear/Affirm the Above and/or Attached Statements are Correct and True.

X

Affiant Signature

COPY

Page 1 of 1

Form # CPD 6 (08/2019)

Police Body Cam Footage

- RBS1 Body Cam Video Footage starting at 3:18
  - She was driving down the road and suddenly her windshield broke.
  - She turned around and came back to the site of the crash to see if she hurt anyone.
  - “I was driving down this road and all of the sudden this happened (gesturing towards broken windshield) and I turned around (gesturing that she proceeded northbound and then did a u-turn) and came back around and this is what I found.”

Homicide Report Narrative

odor emitting from her person from a distance of approximately 3 feet. As Ms. Norris spoke with me I also noticed she had slightly slurred speech. During my conversation, I asked her if she remembered anything from the crash. Ms. Norris explained that she was driving home and without warning her windshield exploded. *Ms. Norris said she did not know the cause and continued to drive north; however, after approximately a few hundred yards she made a U-turn and returned back to the scene. Upon arriving back to the scene, she noticed a person lying in the middle of the roadway. Ms. Norris said she exited her vehicle and noticed another driver had already pulled over as well and was calling 911.*
Shortly after my conversation with Ms. Norris, Officer C. Mod
on scene to assist me in my investigation. I requested he acco
to Rockledge Regional Medical Center for a blood draw of her

scene.
I met with Ms. Norris again. During this conversation I was wearing my department issued body camera to record the conversation between she and I. All recorded footage was uploaded to the department Evidence.Com database for review. I asked Ms. Norris to talk with me about the traffic crash portion of the incident. *Ms. Norris stated, in substance, that she was driving on Industry Road and realized later that she had struck something with her vehicle. When she turned around and returned to the area, she noticed a person lying in the roadway. Ms. Norris said she did not see the person before impact and either the person was there or had run in front of her vehicle prior to the collision.* I asked her why she had taken that route through the area. Ms. Norris explained she was driving home to the Port St. John area of Cocoa, Florida. I asked her if she was the driver of the vehicle to which she stated she was the driver during the crash and the sole occupant as well. I provided Ms. Norris a written affidavit to complete in reference to the crash only.

- Excerpts from the Homicide Report Narrative written by Officer Landis.

Witness Statements – Michael Baker (Post-crash)

- June 21, 2021 – Written Statement
  - He was driving to work when he came across a vehicle stopped in the middle of Industry Road. The driver, Ms. Norris, was standing behind the vehicle looking at the pedestrian on the ground. Ms. Norris asked him to move the pedestrian.
  - Ms. Norris told him that she wasn't sure if she hit someone so she made a second pass and saw Ms. Lucas.

- November 12, 2021 – Interview with Sergeant Bradshaw
  - Mr. Baker came upon the crash after it had already occurred.
  - He remembers Ms. Norris asked him to move Ms. Lucas from the roadway.

Reconstruction Analysis

Reviewing the Vehicle's Blackbox

Determining Vehicle Impact Speed

Assessing Avoidance Capabilities

CDR Imaging

BOSCH

CDR CRASH DATA RETRIEVAL

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN	2G1WS57M991269361
User	Cpl. W. Mulligan
Case Number	2021-00024473
EDR Data Imaging Date	11/24/2021
Crash Date	06/20/2021
Filename	2G1WS57M991269361_ACM.CDRX
Saved on	Wednesday, November 24 2021 at 10:01:30
Imaged with CDR version	Crash Data Retrieval Tool 21.3
Imaged with Software Licensed to (Company Name)	Florida Highway Patrol
Reported with CDR version	Crash Data Retrieval Tool 21.3
Reported with Software Licensed to (Company Name)	Florida Highway Patrol
EDR Device Type	Airbag Control Module
Event(s) recovered	None

- Ms. Norris's CDR was imaged approximately 5 months after the subject crash.
- No events were recorded during this collision event.
- CDRs need to experience a nearly instantaneous change in speed of 5-7 mph before data is recorded. This is typically unlikely in pedestrian crashes.

Reconstruction

Vertical Dimensions			
Height:	59	4.92	1.50
Ground to -			
Front Bumper (Top)	23	1.92	0.58
Headlight - center	28	2.33	0.71
Hood - top front:	30	2.50	0.76
Base of Windshield	38	3.17	0.97
Rear Bumper - top:	28	2.33	0.71
Trunk - top rear:	44	3.67	1.12
Base of Rear Window:	45	3.75	1.14

- Ms. Lucas was the same height as a 50th percentile male crash test dummy (5’9”).
- The knees of a 50th percentile standing male are approximately 1.62 ft above the ground.
- The impacting vehicle can be approximated as a low-fronted vehicle where the upper edge of the front of the vehicle is at or below the knees of a 50th percentile standing male.

Reconstruction

Figure 1 – Forward Projection Trajectory example.

Figure 2 – Wrap Trajectory example.

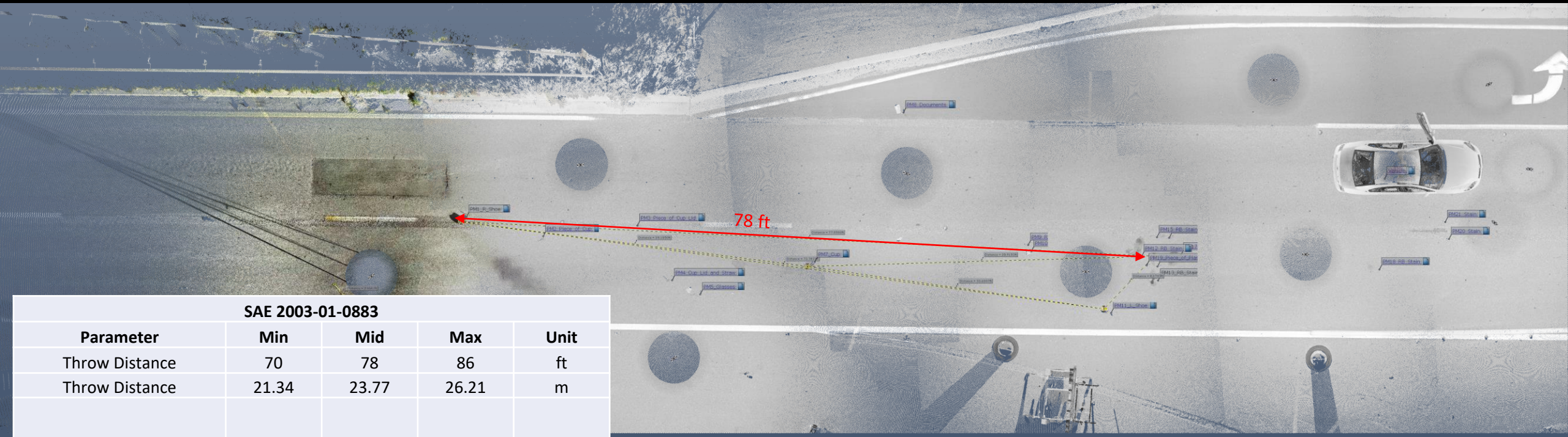
- Given the low profile of the vehicle, the high center of gravity of the pedestrian, and the damage to the vehicle, this case is considered a pedestrian crash with a wrap trajectory where the pedestrian's body physically wraps around the leading edge of the vehicle prior to enduring a secondary contact with the vehicle's windshield.
- After the secondary impact, the pedestrian's body disengages from the vehicle.

Reconstruction

Speed		WRAP Trajectory General Damage Summary
(kph)	(mph)	
< 20	<12	Surface cleaning marks
25	16	Head contact near bottom edge of windshield when pedestrian C.G. ~60 cm above low-fronted vehicle's bumper assembly; otherwise, head contact near middle of hood for average-sized vehicle and pedestrian. Body contact on roof when pedestrian C.G. ~85 cm above low-fronted vehicle's bumper assembly.
25-40	16-25	Head contact near trailing portion of hood or cowl; slight body panel deformation.
40	25	Head contact near bottom edge of windshield for impacts significantly below (~50 cm) pedestrian's C.G. (i.e. typical braking low-fronted vehicle).
40-50	25-31	Clearly defined dents on body panels.
50	31	Head contact near bottom edge of windshield when pedestrian C.G. ~40 cm above low-fronted vehicle's bumper assembly. Body contact on roof when pedestrian C.G. ~60 cm above low-fronted vehicle's bumper assembly.
50-55	31-34	Head contact near middle of windshield for typical braking low-fronted vehicle.
60	37	Head contact near bottom edge of windshield when vehicle's upper leading edge near pedestrian's C.G.
>60	>37	More probable body to roof contact.
70	43	Head contact near upper frame of windshield; significant deformation of body panels.
80	50	Pelvic contact with roof; roof deformation (unbraked vehicle).

- Given the vehicle properties and the location of the damage on the vehicle's hood and windshield, the vehicle was going approximately 31-34 mph at impact.

Reconstruction



SAE 2003-01-0883				
Parameter	**Min**	**Mid**	**Max**	**Unit**
Throw Distance	70	78	86	ft
Throw Distance	21.34	23.77	26.21	m
Wrap	56.3	59.9	63.3	km/h
V at Impact	**35.0**	**37.2**	**39.3**	**mph**

Wrap Trajectory Model:

$$V_v = 9.84S^{0.57}$$

- The point of impact was taken to be the location of the pedestrian's right shoe. It was measured as being 78 ft upstream of the pedestrian's final rest position.
- Using a pedestrian throw distance model (metric units) given the location of the right shoe, the vehicle impact speed was determined to be 35-39 mph.

Reconstruction

- The full range of impact speeds was determined to be:
  - 31-34 mph from the vehicle damage model
  - 35-39 mph from the pedestrian throw distance model

- The full range of impact speeds was utilized in my analysis.

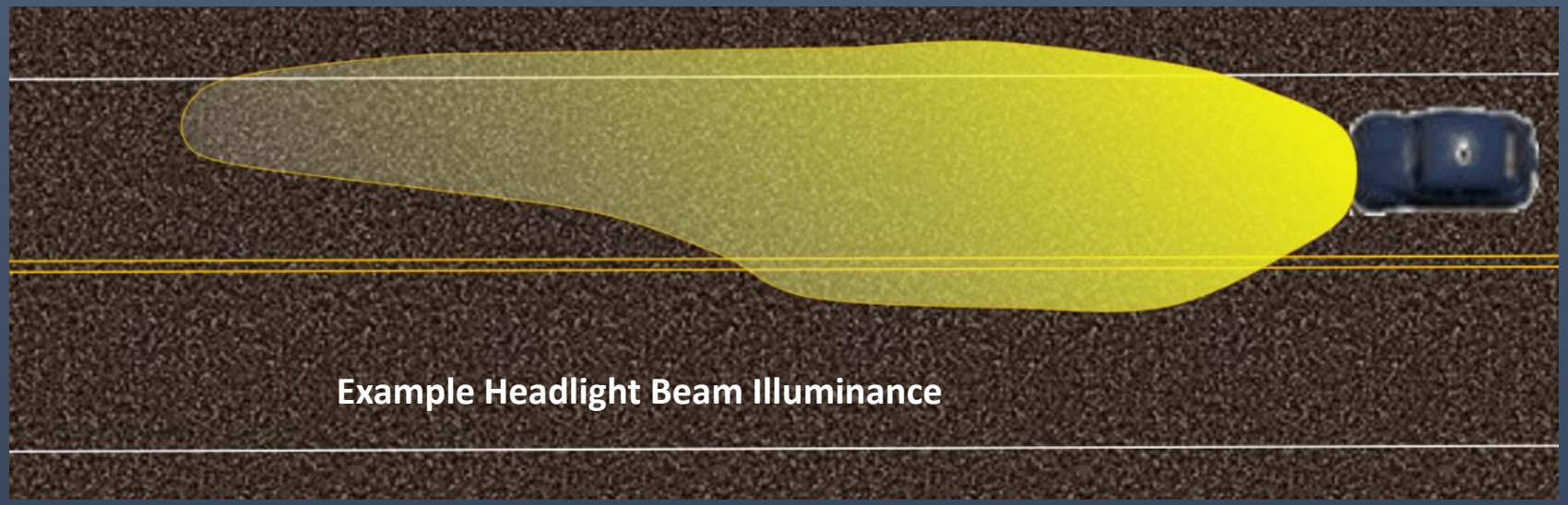
Reconstruction

- When a crash occurs in dark conditions, one needs to analyze the amount of light needed to detect a pedestrian relative to how much light is available.

- Light sources in this case:
  - Overhead street lights – none
  - Moon (fullness and position) – negligible (0.04 to 0.06 Lux)
  - Headlights – see next slides

Analysis

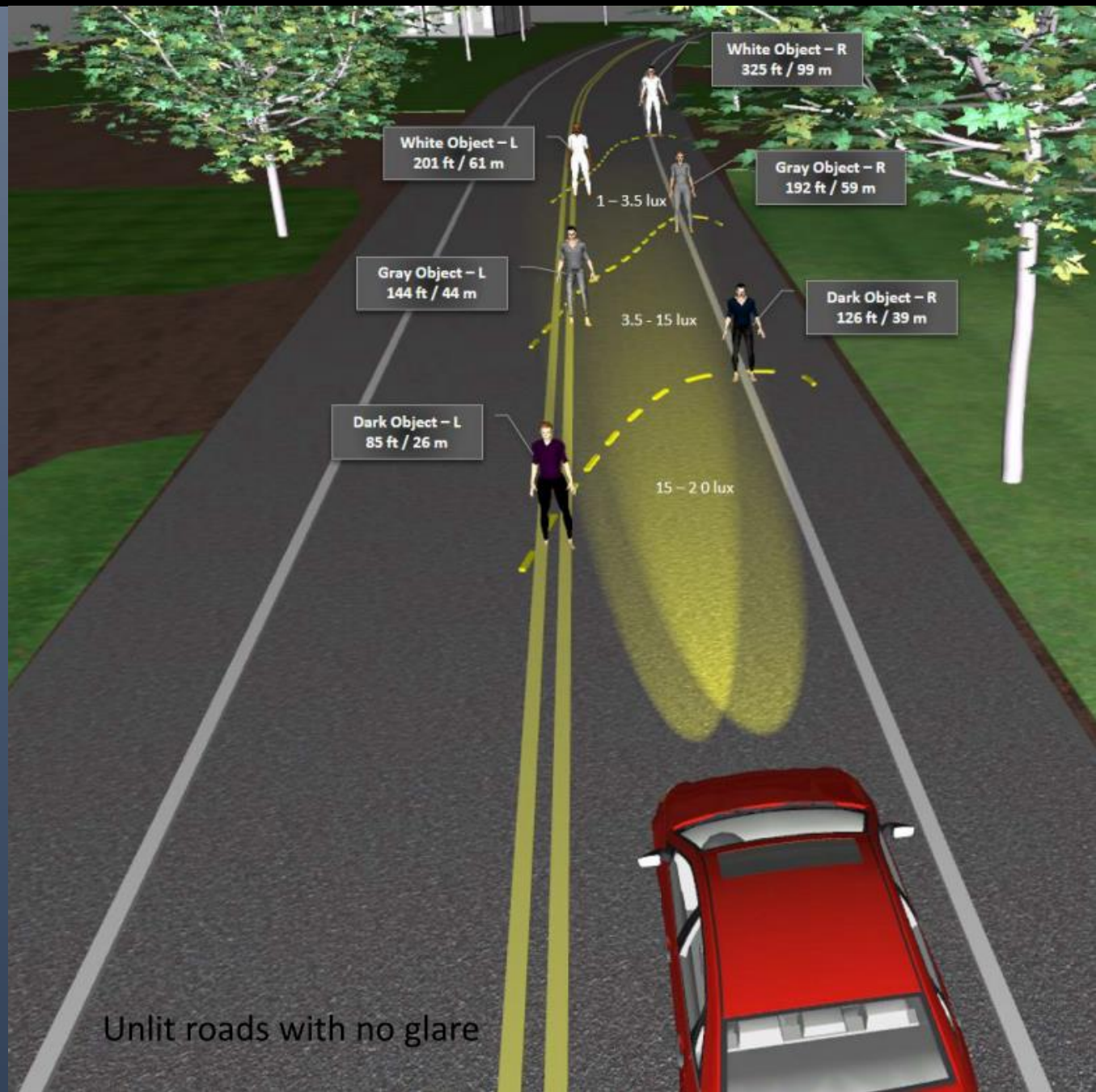
- Florida Statutes require 150 ft of illumination from a vehicle's low beam headlights. It does not require headlights to have symmetric light distribution.
- Pedestrians located on the driver's side of the vehicle are less illuminated than on the right side; therefore, they are more readily detectible right side vs. left side.



Example Headlight Beam Illuminance

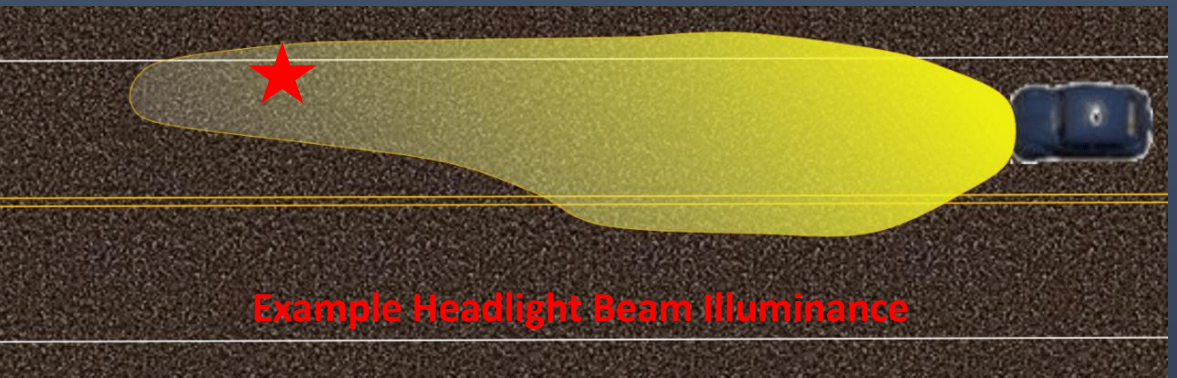
Analysis

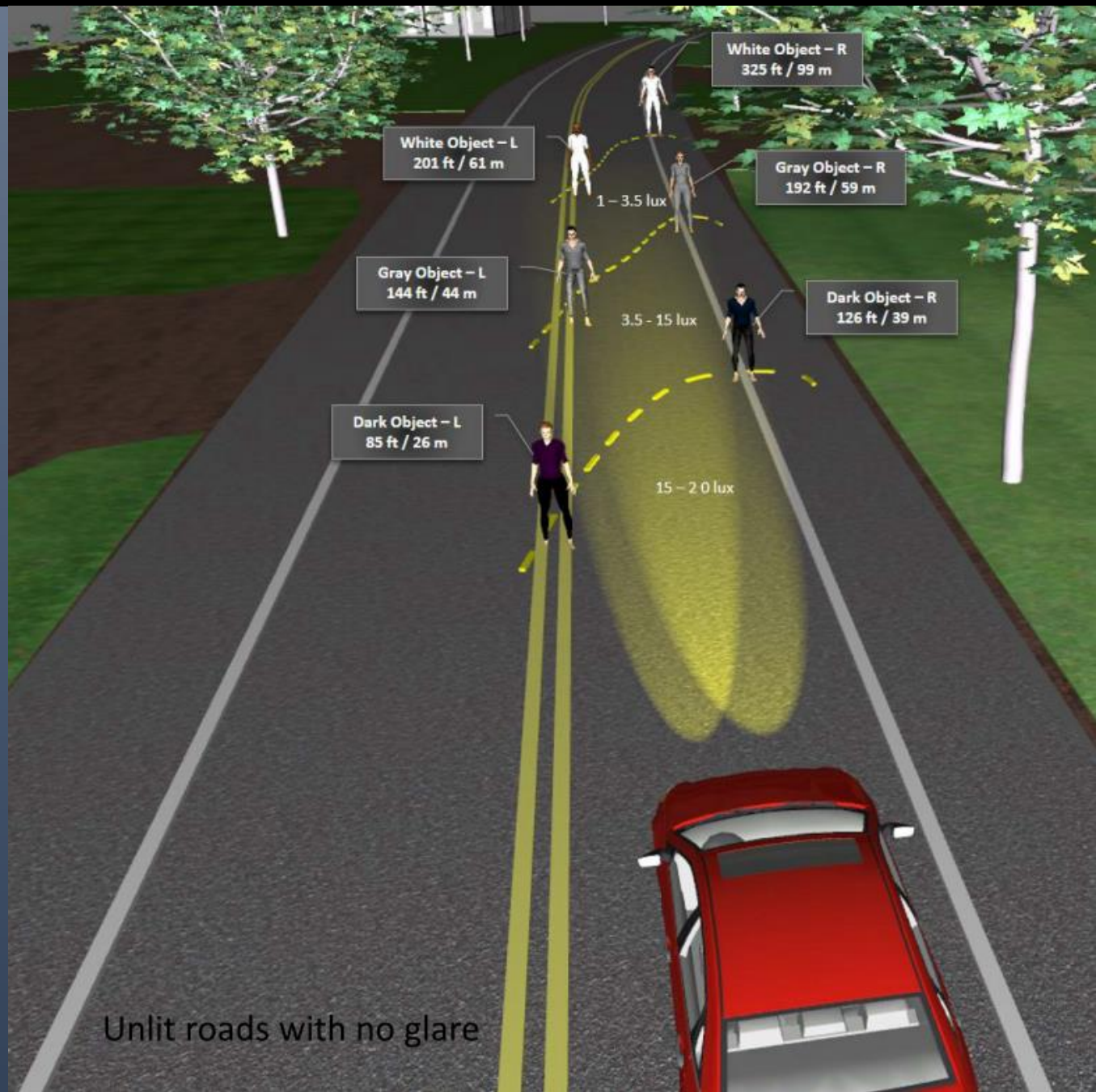
- Typical pedestrian visibility on dark unlit roads with no glare.
- Pedestrian clothing is averaged out into a grey-scale representation for the purposes of nighttime pedestrian visibility.
- A red shirt and light-colored pants would conservatively be considered a light grey object.



Analysis

- Under the conditions presented in this case:
  - Given the age of the Chevrolet Impala's headlights and the relative position of Ms. Lucas within the headlight projection, the headlights would have provided 3 to 5 Lux of illumination onto Ms. Lucas beginning when the Chevrolet was 180 to 226 feet prior to impact, with increasing illumination as the vehicle drew closer.





Analysis

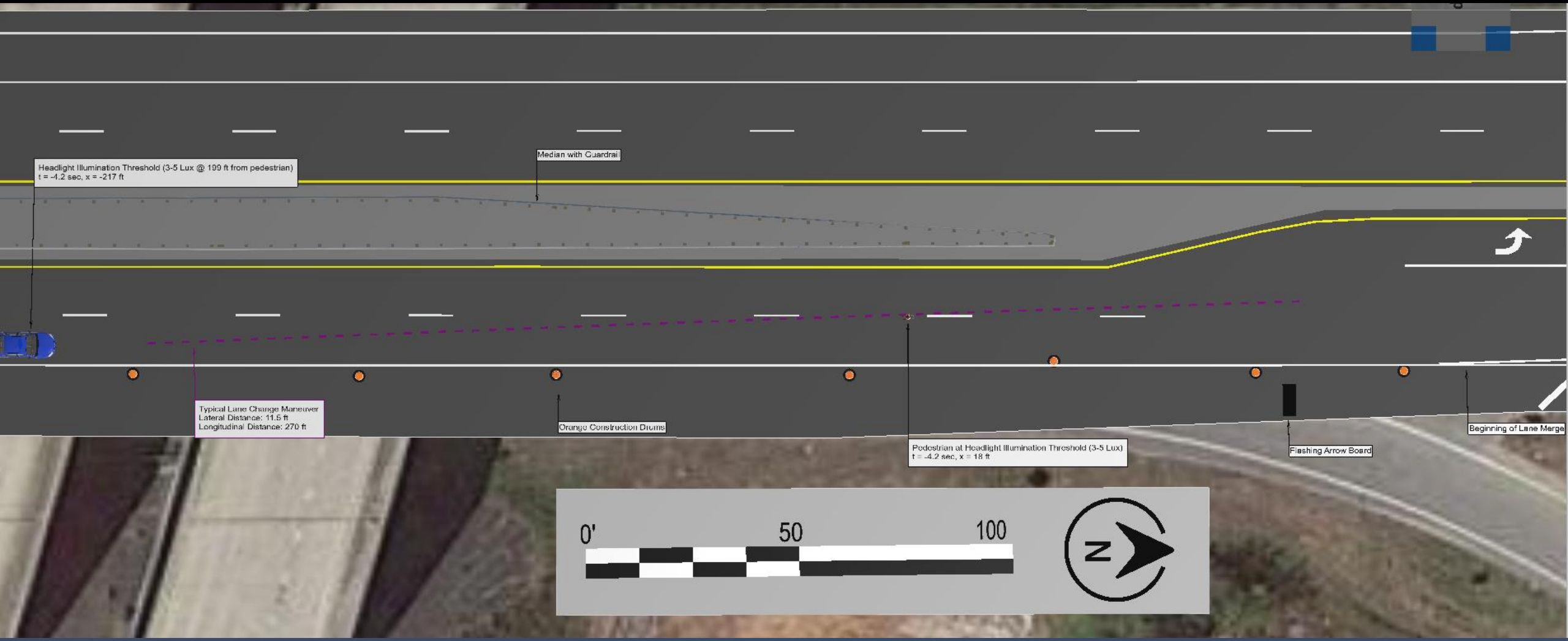
- Under the conditions presented in this case, a typical attentive and unimpaired driver would:
  - Respond to a threat in the roadway within 1.4 to 1.8 seconds of detecting an emergency hazard (perception response time; PRT)
  - Initiate an avoidance maneuver
    - Braking avoidance requires an additional 0.25 seconds before the vehicle slows due to brake system latency
    - Steering maneuvers occur right after the completion of the PRT

Reconstruction Notes

Sensitivity Analysis	Low-end	Typical	High-end
Headlight Detection Threshold (3-5 Lux of illumination for pedestrian walking within the vehicle's path)	180 ft	199 ft	226 ft
Perception Response Distance + Emergency Stopping Distance	119 ft	150 ft	178 ft
Perception Response Distance + Steering Avoidance	95 ft	127 ft	153 ft

- These values pertain to a pre-impact travel speed equal to the calculated impact speed of 31-39 mph.
- Support: The driver testified that she never saw the pedestrian prior to impact therefore she would have no reason to reduce her speed prior to impact.

Reconstruction



- The above diagram demonstrates the sequence of events with the vehicle traveling at a constant speed of 35 mph (middle of the 31-39 mph range) prior to impact. The pedestrian is modeled as walking 4.2 ft/s which is typical for a 37 year old female pedestrian.
- A typical, attentive and unimpaired driver would be able to see and detect a pedestrian walking in the roadway wearing light colored clothing when the pedestrian is 199 feet ahead of the vehicle.

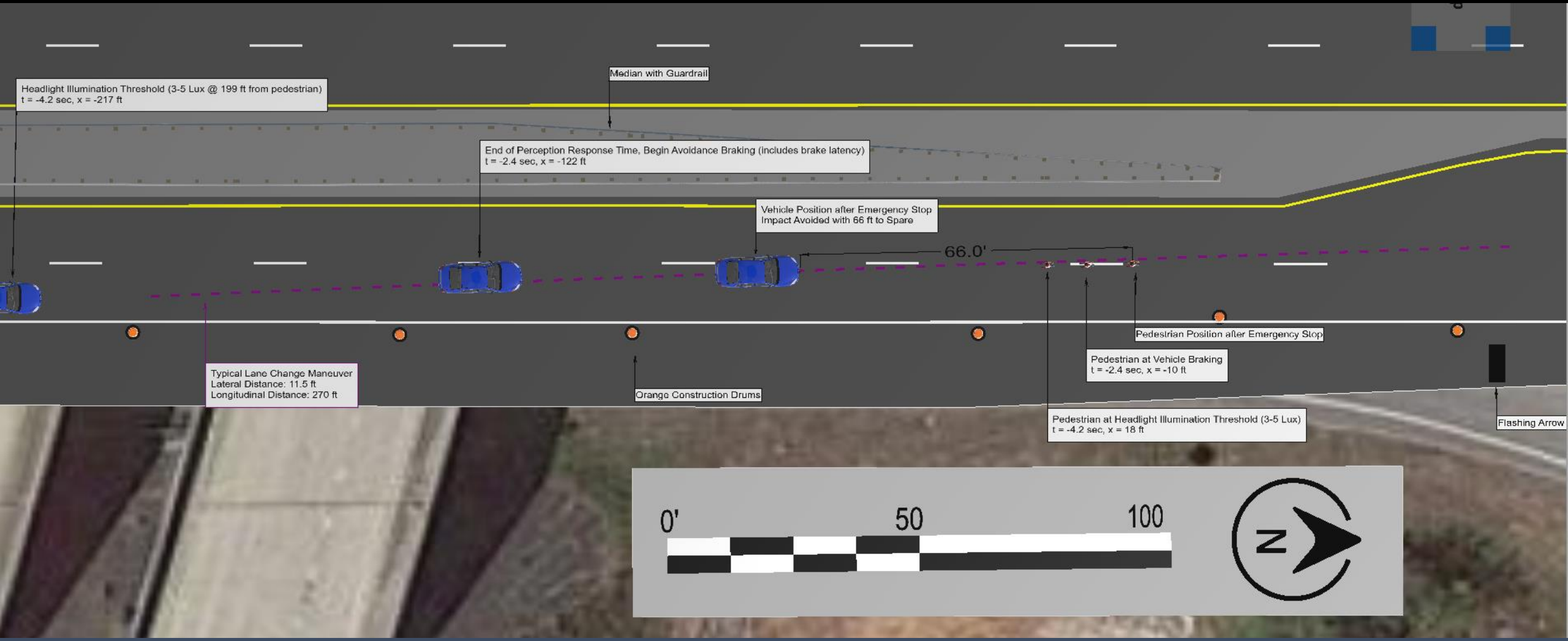
Reconstruction

- Impact occurred when the vehicle and pedestrian were both straddling the skip line between the two travel lanes. This is consistent with a casual lane change in response to a lane merge ahead.

Reconstruction

- The pedestrian came to rest approximately 78 ft after impact.

Reconstruction – Stopping Avoidance



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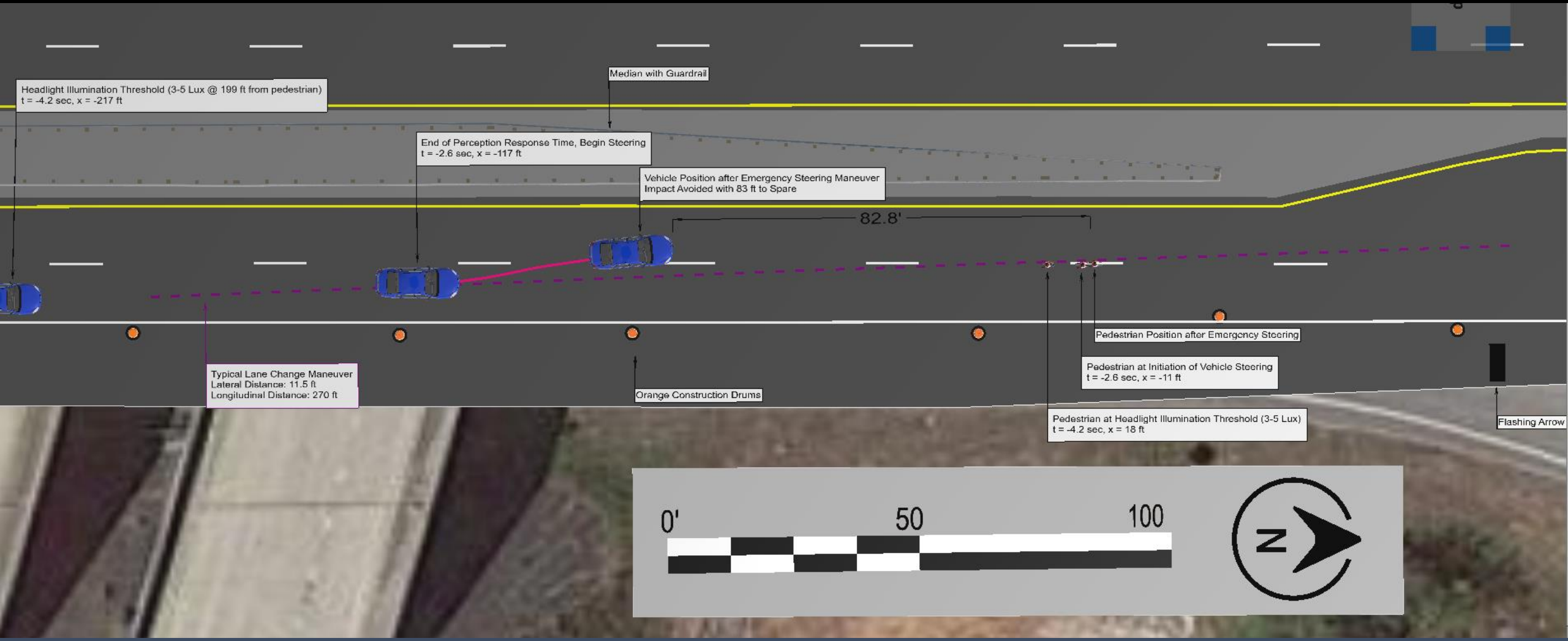
- A typical, attentive and unimpaired driver would be able to:
  - See and detect a pedestrian walking in the roadway wearing light-colored clothing when the pedestrian is 199 feet ahead of the vehicle.
  - Perceive and initiate a hard braking response to an emergency hazard within 95 ft of detecting the pedestrian.
  - Brake to a stop within 150 ft of detecting the pedestrian (leaving 66 ft to spare between the vehicle and the pedestrian).

Reconstruction – Steering Avoidance



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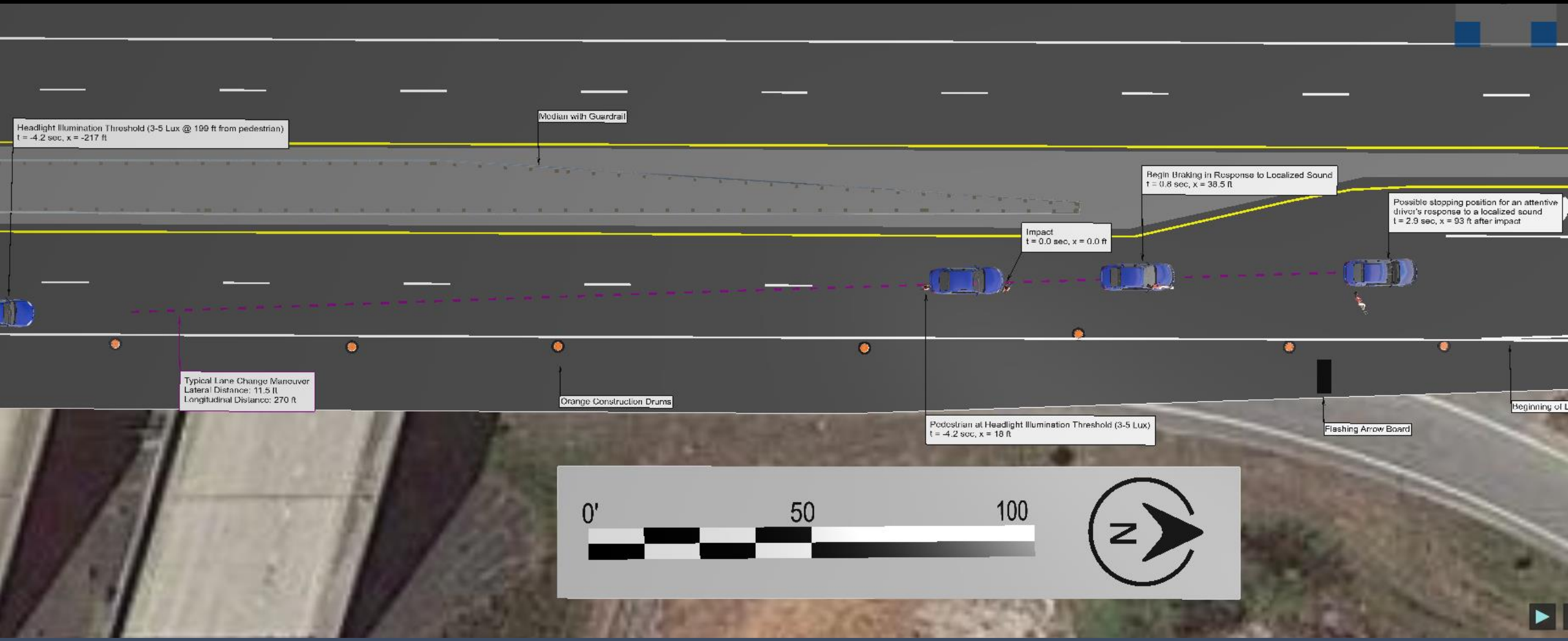
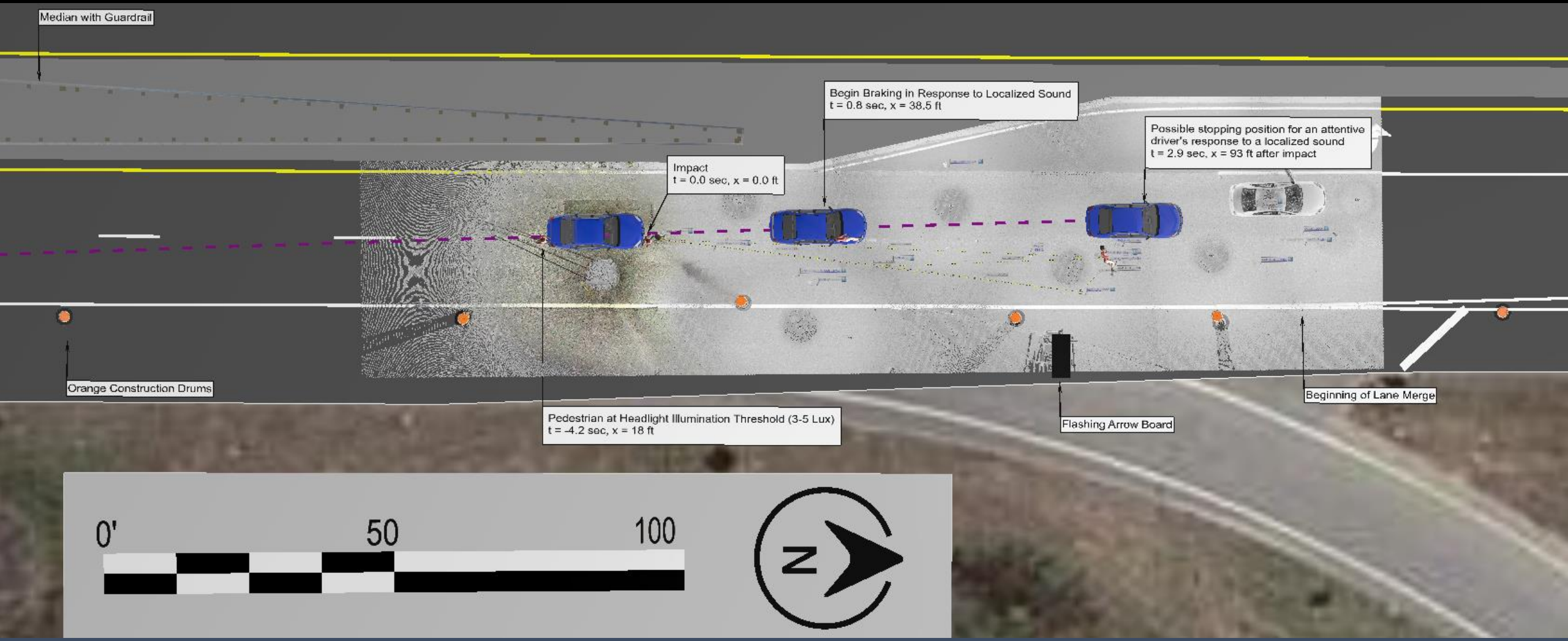
- A typical, attentive and unimpaired driver would be able to:
  - See and detect a pedestrian walking in the roadway wearing light-colored clothing when the pedestrian is 199 feet ahead of the vehicle.
  - Perceive and initiate a steering response to move the vehicle 2-3 ft laterally in response to an emergency hazard within 82.5 ft of detecting the pedestrian.
  - Execute an emergency steering maneuver within 127 ft of detecting the pedestrian (leaving 83 ft to spare between the vehicle and the pedestrian).

Reconstruction – Response to a Localized Sound



- The above diagram demonstrates the sequence of events with the vehicle traveling at a constant speed of 35 mph (middle of the 31-39 mph range) prior to impact. The pedestrian is modeled as walking 4.2 ft/s.
- A typical, attentive and unimpaired driver would be able to:
  - See and detect a pedestrian walking in the roadway wearing light colored clothing when the pedestrian is 199 feet ahead of the vehicle.
- A typical, unimpaired driver would respond to a localized sound within 0.5 seconds of the sound. Braking would take effect approximately 0.25 seconds later. A vehicle traveling 35 mph would come to a complete hard stop approximately 93 ft after impact.

Reconstruction – Response to a Localized Sound



- The above diagram demonstrates the sequence of events with the vehicle traveling at a constant speed of 35 mph (middle of the 31-39 mph range) prior to impact. The pedestrian is modeled as walking 4.2 ft/s.
- The documented stopped position of Ms. Norris's vehicle is further downstream than would be expected for a driver responding to a localized sound.

Reconstruction Hypotheticals

- I was asked to evaluate two hypothetical scenarios:

1. Would this crash have been avoidable to a range of typical drivers who were traveling at or near the 45 mph speed limit?

2. What if Ms. Norris was traveling at or near the 45 mph speed limit and applied the brakes prior to impacting Ms. Lucas at 31-39 mph?

Reconstruction Hypotheticals

1. Would this crash have been avoidable to a range of typical drivers who were traveling at or near the 45 mph speed limit?

Sensitivity Analysis	Low-end	Typical	High-end
Headlight Detection Threshold (3-5 Lux of illumination for pedestrian walking within the vehicle's path)	180 ft	199 ft	226 ft
Perception Response Distance + Stopping Distance	170 ft	196 ft	217 ft
Perception Response Distance + Steering Avoidance	113 ft	144 ft	168 ft

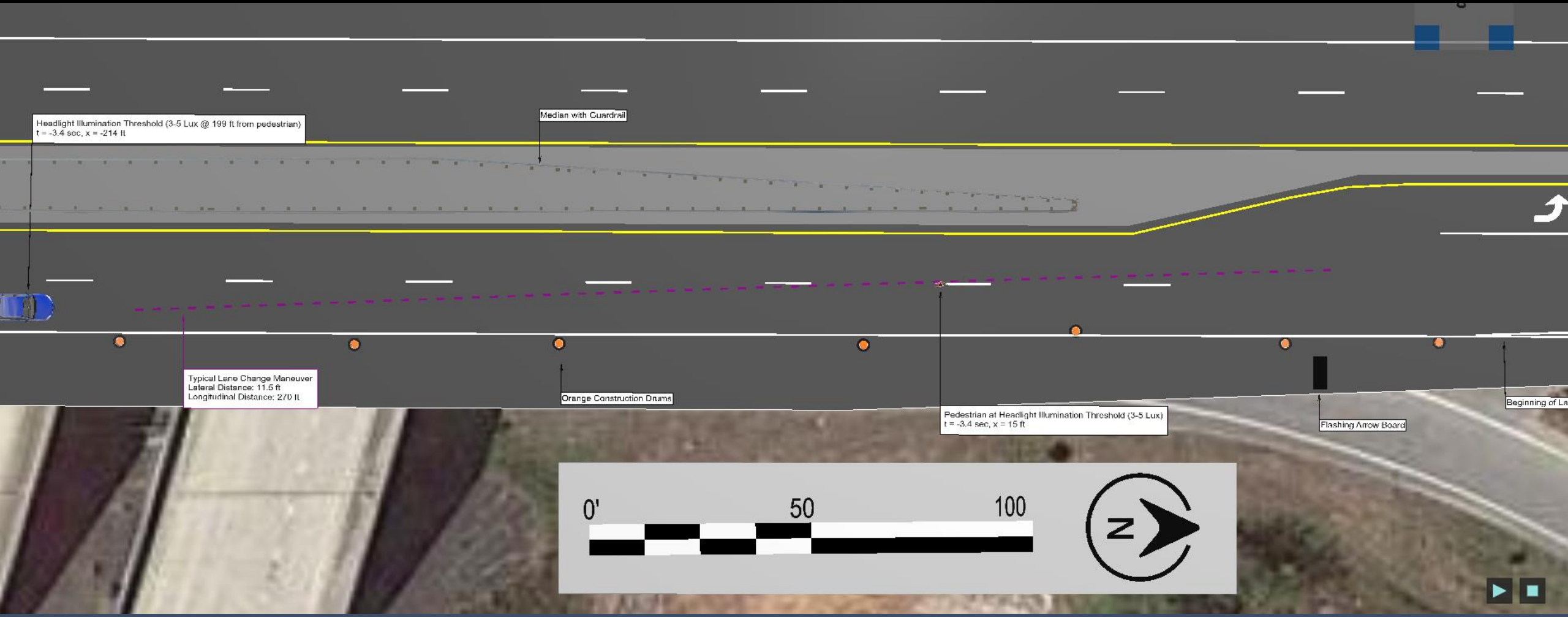
- These values consider a pre-impact travel speed equal to 40-45 mph.
- If comparing the low end of the headlight detection threshold (180 ft) with the high end of the speed and PRT ranges, a typical attentive driver would not be able to come to a complete stop prior to impact (impact speed of 14 mph); however, the crash remains avoidable by means of a steering response.

Reconstruction Hypotheticals

2. What if Ms. Norris was traveling at or near the 45 mph speed limit and applied the brakes prior to impacting Ms. Lucas at 31-39 mph?

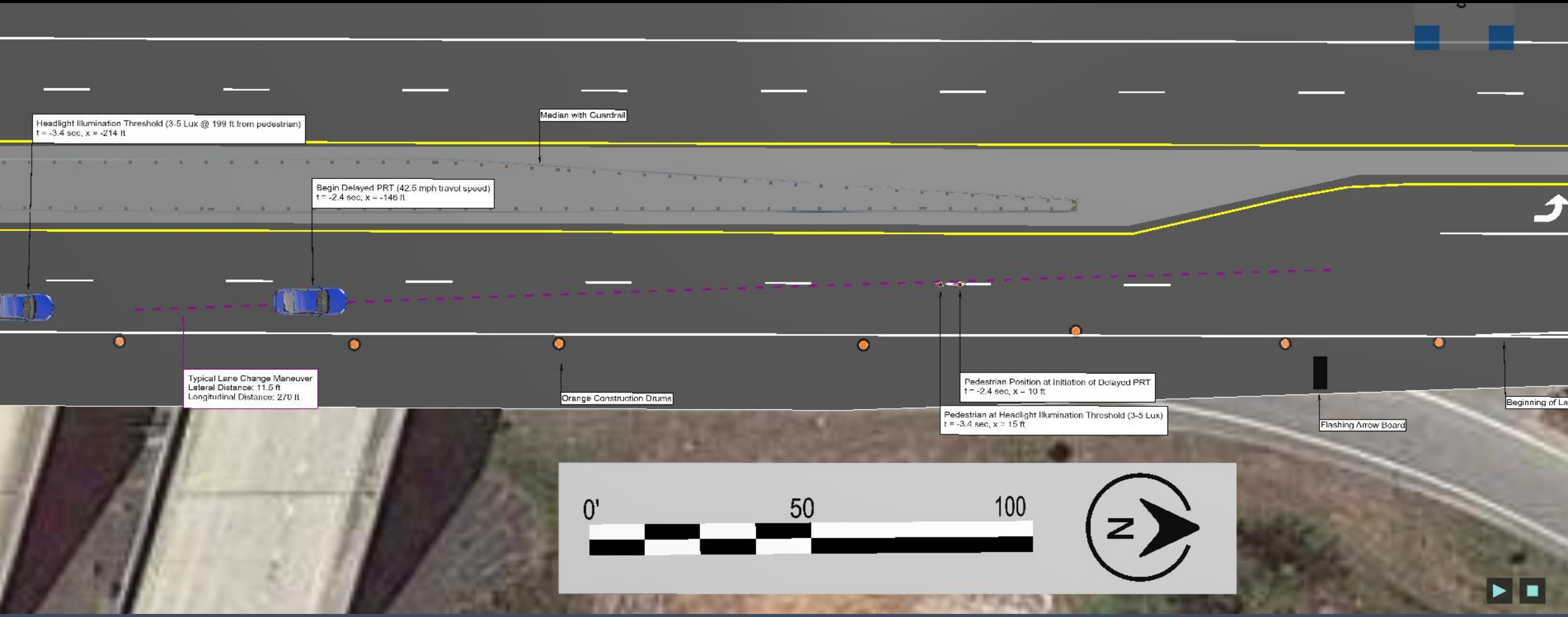
   Support: The speed limit was 45 mph, but the impact speed was 31-39 mph. There may have been some pre-impact braking that did not leave physical evidence on the roadway.

Reconstruction Hypothetical



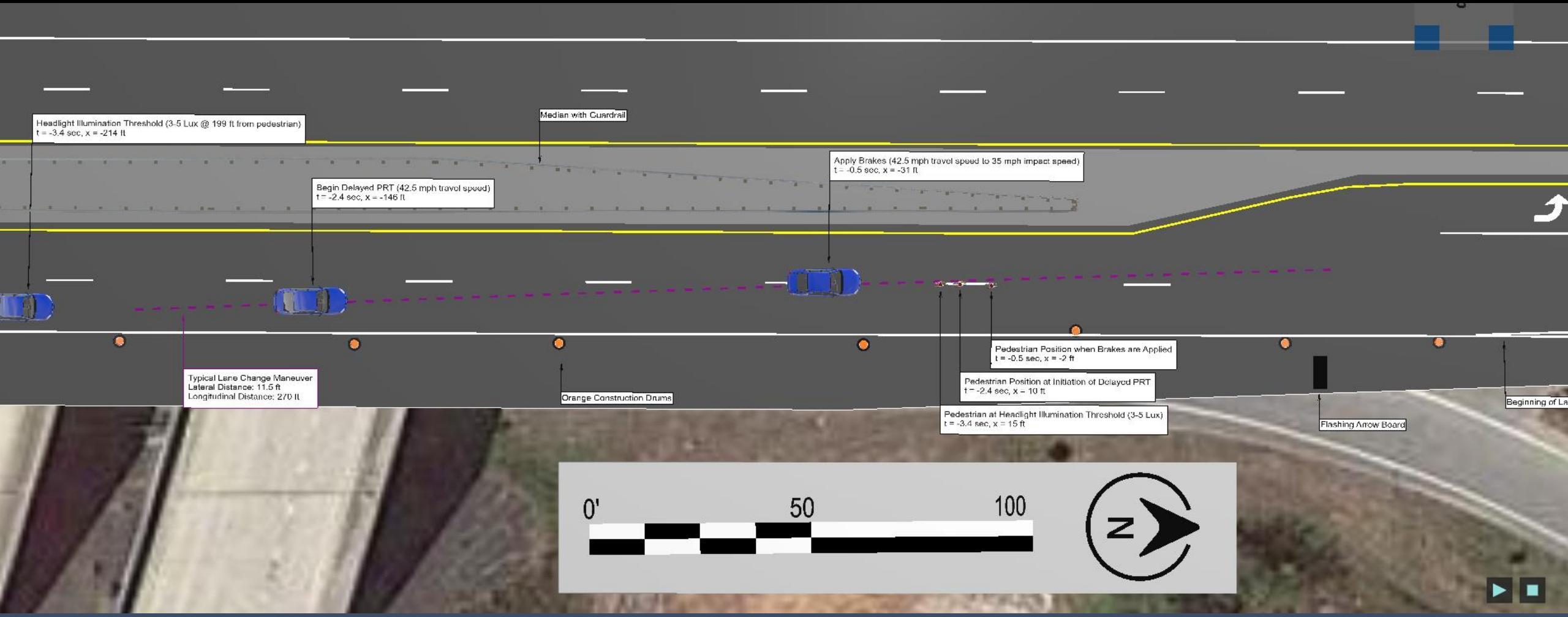
- The above diagram demonstrates the sequence of events with the vehicle traveling at an initial speed of 42.5 mph (middle of the 40-45 mph range) prior to impact. The pedestrian is modeled as walking 4.2 ft/s.
- A typical, unimpaired driver would be able to:
  - See and detect a pedestrian walking in the roadway wearing light colored clothing when the pedestrian is 199 feet ahead of the vehicle.

Reconstruction Hypothetical



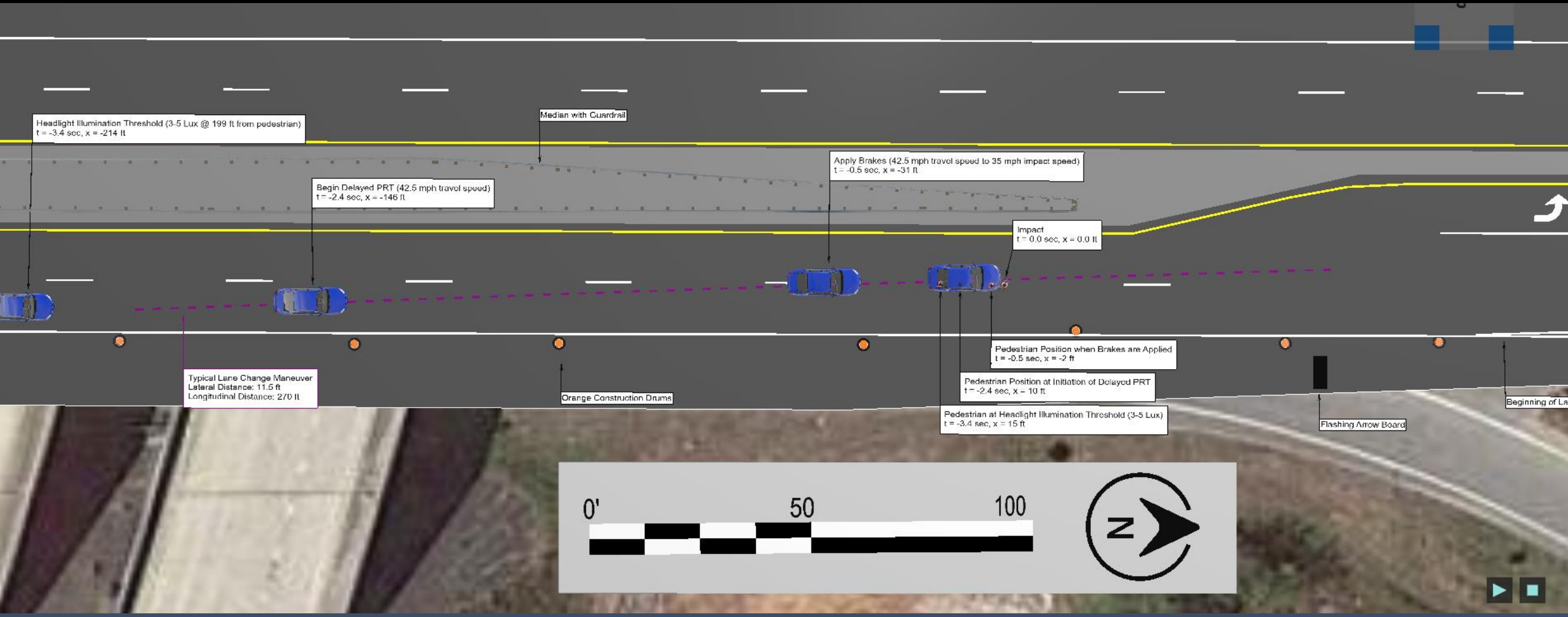
- In order to decelerate from 42.5 mph to an impact speed of approximately 35 mph, the driver would've began to see and detect the pedestrian approximately 1.0 seconds after the pedestrian was detectable within the vehicle's headlight beams.

Reconstruction Hypothetical



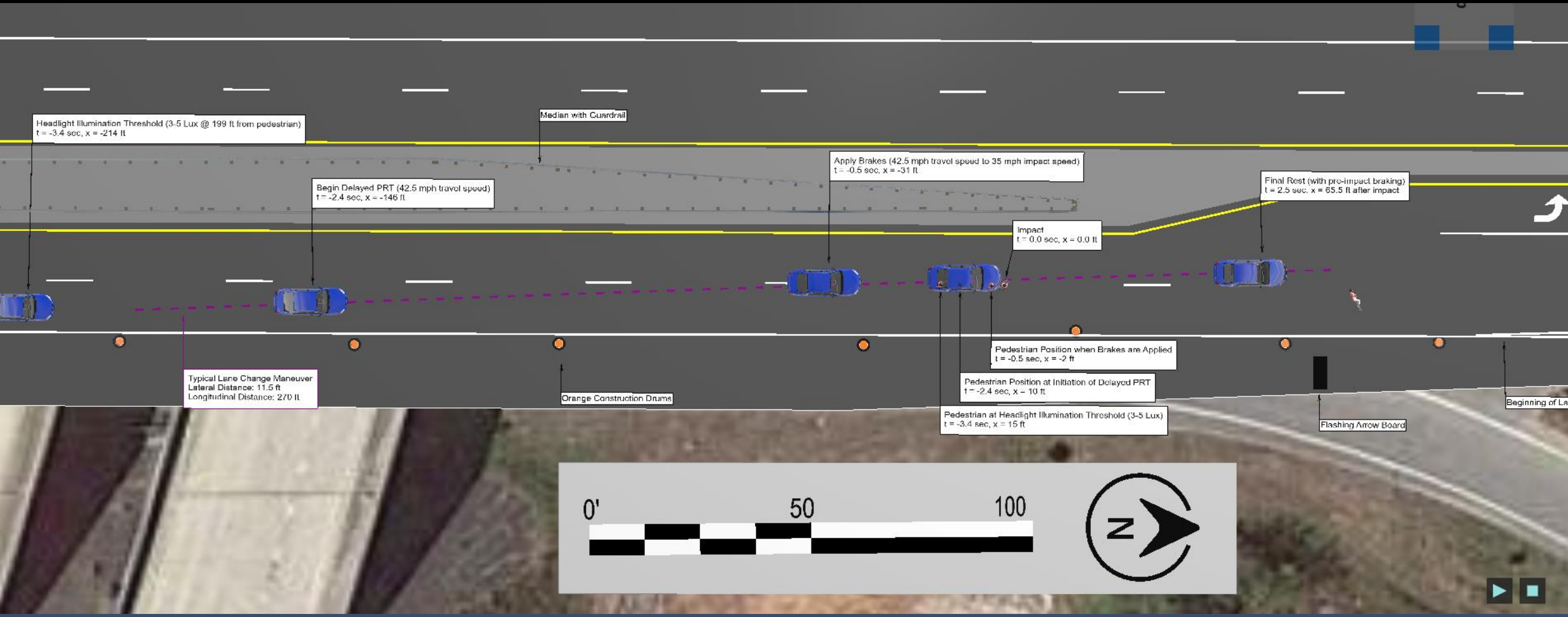
- Driver would've began braking approximately 0.5 seconds prior to impact to reach an impact speed of 35 mph.

Reconstruction Hypothetical



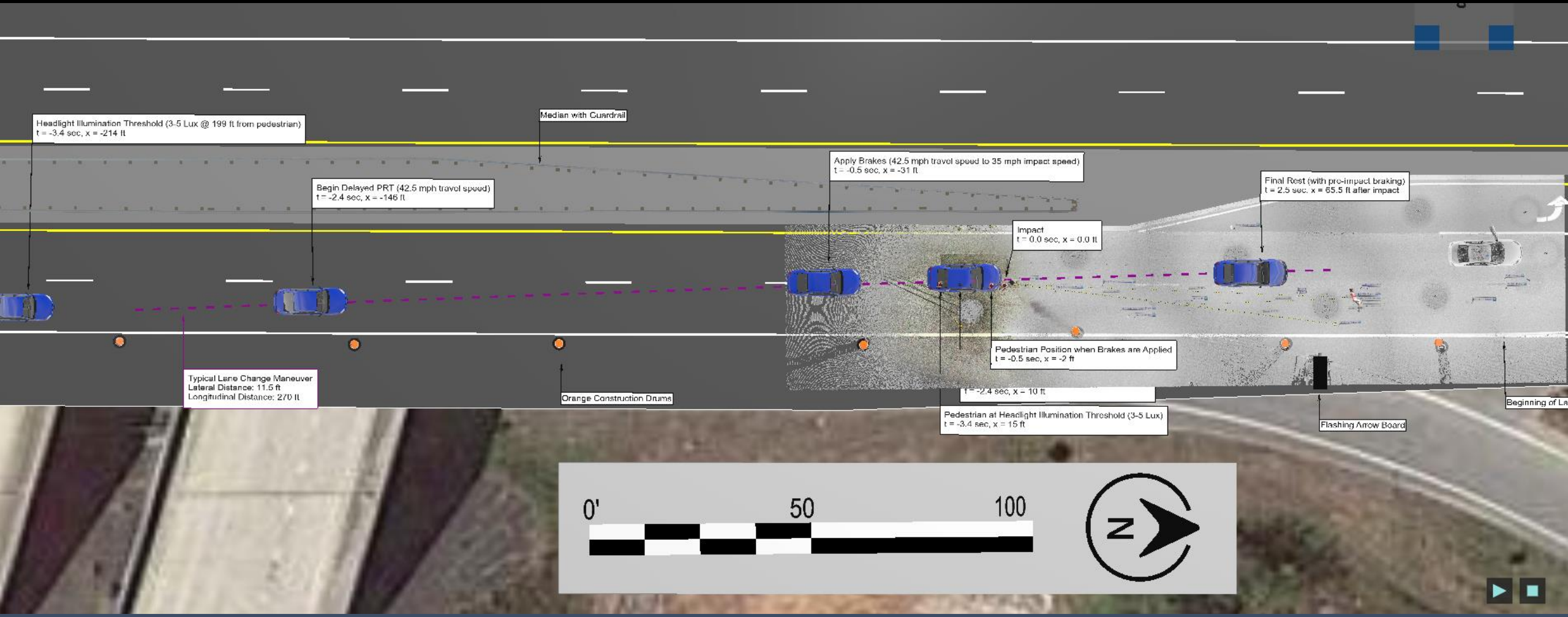
- Impact would’ve occurred at the same location and speed as the previous analysis.

Reconstruction Hypothetical



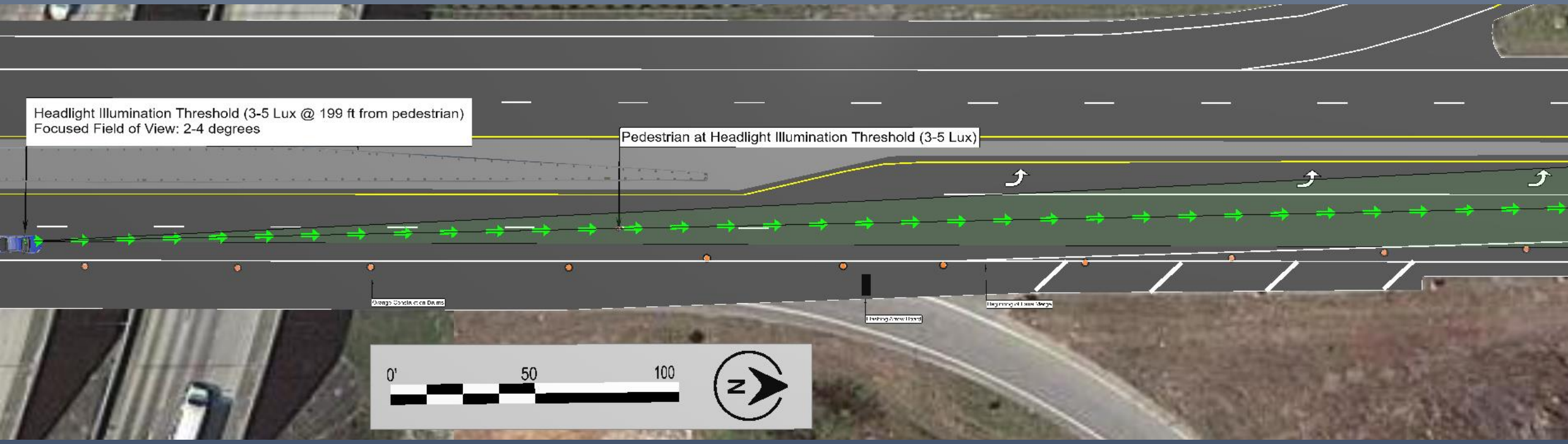
- A typical, unimpaired driver would continue to apply the same level of braking and be at a complete stop approximately 65.5 ft after impact.

Reconstruction Hypothetical



- The documented stopped position of Ms. Norris's vehicle is further downstream than would be expected for a driver who was constantly braking for at least 0.5 seconds prior to impact.

Driver's Field of View



- Given a typical field of view of 2-4 degrees,
  - The pedestrian was centered within the field of view at the time she was detectable.
  - The orange construction drums were laterally and longitudinally distanced from the pedestrian, and outside of the driver's field of view by over 500 ft.
  - The presence of the orange construction drums had a negligible effect on the pedestrian's detectability.

Materials Received and Reviewed

- Florida Traffic Crash Report 2021-00024473
- Traffic Homicide Report and Notes regarding Case #2021-00024473
- Photos of the scene and vehicle taken by police
- Body cam videos at the scene
- Autopsy photos
- Screenshots from body cam and security videos
- Maps and aerials
- Vehicle specifications
- Moon and weather data