NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF HIGHWAY SAFETY
WASHINGTON, D.C.

HIGHWAY FACTORS GROUP CHAIRMAN'S
FACTUAL REPORT

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A. CRASH INFORMATION & CRASH SUMMARY

Refer to the *Crash Information and Crash Summary Report* in the docket for this investigation.

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C. DETAILS OF THE HIGHWAY FACTORS INVESTIGATION

The NTSB examined the following safety issue areas: pretreatment of roadways; ice treatment strategies for roadways, bridge structures and sections of roadway; and training to detect moisture and icy road conditions. The Highway Factors Factual Report begins with a discussion on prefatory data that includes the crash location, construction history, average daily traffic volumes, vehicle classification count, and traffic and fatal accident summary. The prefatory data also provides a description of the NTE Mobility Partners Segments 3, LLC (NTEMP S3) which is responsible for operations and maintenance of the section of I-35W near the crash, including the toll lanes, the general use lanes, and the frontage roads. The report summarizes the roadway data that includes speed limit, typical section, vertical and horizontal alignment, speed studies, signage plans, highway lighting, rumble strips, and pavement friction tests. The report documents the timeline of events leading up to the crash and the utilization of dynamic message signs prior to the crash. Research data was performed that includes maintenance and pre-treatment and subsequent

chemical applications. Additional research data was performed on the Texas Department of Transportation (TxDOT) environmental sensor stations and current practices to detect moisture and icy road conditions from other states. The report provides a discussion on other fatal crashes that occurred between February 10-11, 2021, in the Dallas – Fort Worth, Texas metroplex due to icy road conditions. Additional information includes highlights from the NTSB Meteorology Specialist's Factual Report, NTSB Witness Interviews, and the NTSB Video Specialist's Factual Report. The report documents research performed on the brine used by the NTEMP S3 to pretreat the I-35W southbound toll lanes on February 9, 2021. Finally, the report concludes with research performed of other private toll facilities and tabulates the injury severity for the vehicle occupants and pedestrians involved in the multi-vehicle crash.

1. Prefatory Data

1.1 Crash Location

The crash occurred in the southbound toll lanes of Interstate 35 West (I-35W) at milepost 53.5, Fort Worth, in Tarrant County, Texas. **Figure 1** is a crash map that illustrates the crash location was approximately 2 miles north of downtown Fort Worth.

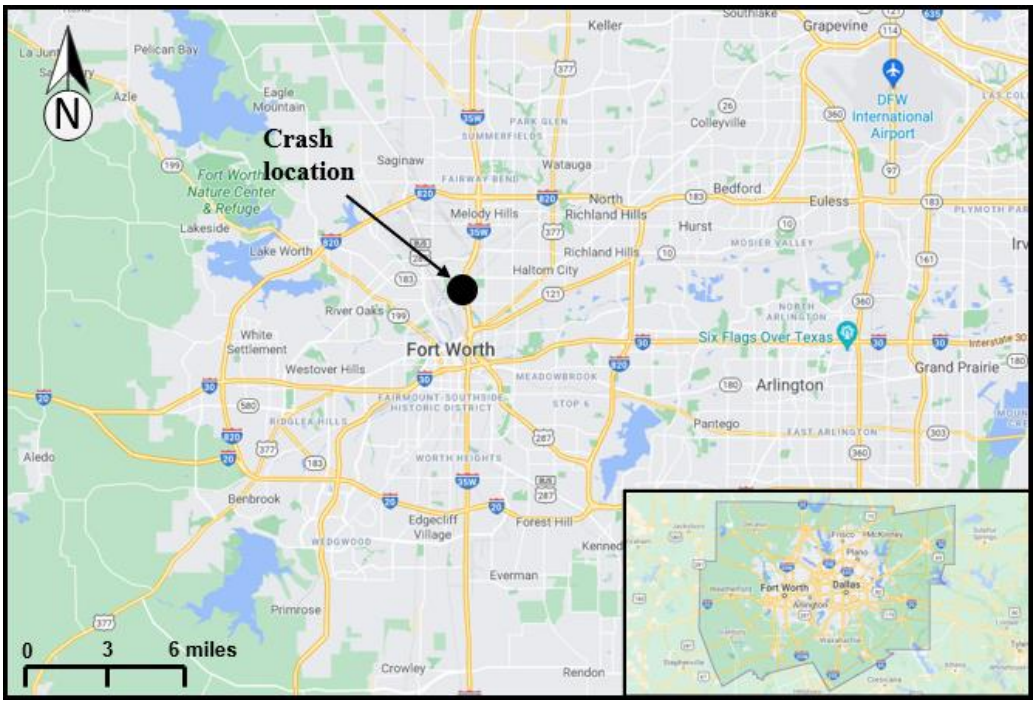

Figure 1 – Crash map (Source: Google Maps, images revised).

Figure 2 illustrates the I-35W southbound toll lanes, highlighted in red, in the vicinity of the crash. The I-35W northbound toll lanes and southbound and northbound general use lanes are also designated.

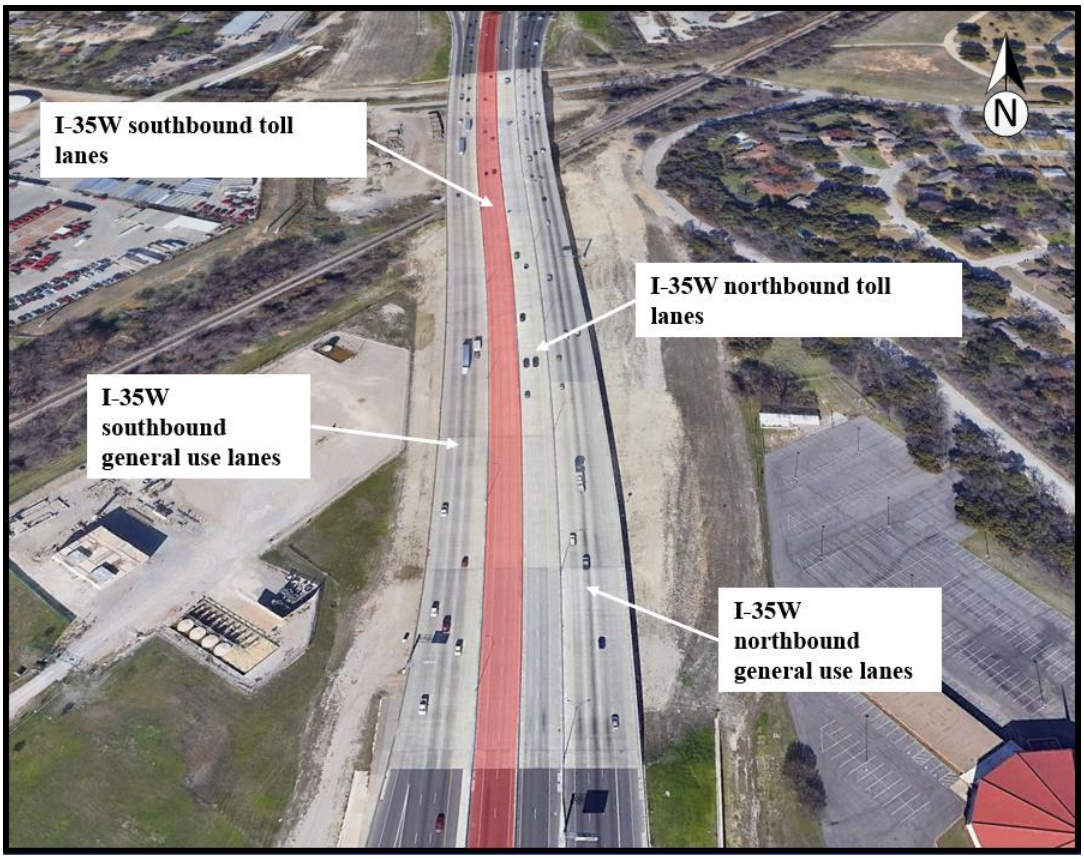

Figure 2 – I-35W southbound toll lanes, highlighted in red, in the vicinity of the crash (Source: Google Earth, image revised).

A private company, NTE Mobility Partners Segments 3, LLC (NTEMP S3), was responsible for the operation and maintenance of the toll lanes, general use lanes, and frontage roads in the section of I-35W near the crash. Their maintenance responsibilities also included monitoring environmental conditions and treating the road surface for freezing precipitation. **Figure 3** illustrates the extent of the crash scene was approximately 1,100 feet and much of the crash occurred along an elevated 1,900 feet long portion of I-35W.

Figure 3 – Extent of the crash scene was approximately 1,100 feet and much of the crash occurred along an elevated 1,900 feet long portion of I-35W (Source: Google Earth image revised).

1.2 Construction History of I-35W Toll Lanes

Figure 4 illustrates the different segments of toll facilities in the Dallas – Fort Worth metroplex. The crash occurred on I-35W in Segment 3A and this segment opened to traffic on July 18, 2018.[1] Segment 3B opened to traffic on July 20, 2017. Segment 3C is currently under construction and expected to open to traffic by September of 2023.

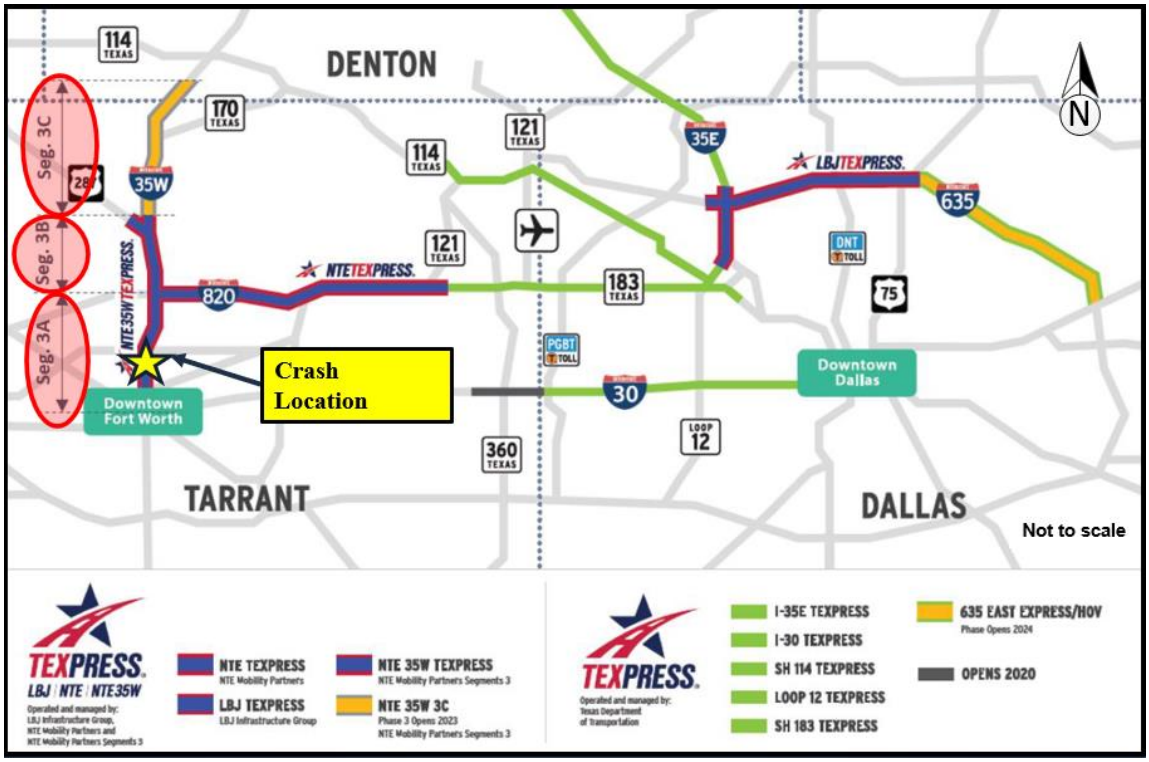

Figure 4 – Different segments of toll facilities in the Dallas – Fort Worth metroplex (Source: NTE Mobility Partners, image revised).

1.3 Average Daily Traffic Volumes

Table 1 summarizes the average daily traffic volumes on the I-35W southbound toll lanes in the vicinity of the crash from April 2018 through December 2020.[2]

Table 1 – Average daily traffic volumes on the I-35W southbound toll lanes in the vicinity of the crash.

Year	Average Daily Traffic Volumes
2018 (April through December)[3]	14,711
2019	22,686
2020	19,417

[1]A portion of Segment 3A from the I-35W/I-820 Interchange to Northside Drive, in the vicinity of the crash location, opened to traffic on April 5, 2018.
[2]See Highway Factors Attachment: Average daily traffic volumes on the I-35W southbound toll lanes in the vicinity of the crash from April 2018 through February 2021.
[3]No traffic is reported in 2018 from January through March since this portion of I-35W was opened to traffic on April 5, 2018.

1.4 Traffic and Fatal Accident History

Table 2 summarizes the traffic and fatal accident history on I-35W between Meacham Boulevard and I-30, a distance of approximately 5.3 miles, from July 2018 through December 2020.

Table 2 – Traffic and fatal accident history on I-35W between Meacham Boulevard and I-30.

Description	2018	2019	2020	Totals
I-35W southbound toll lanes				
Major accident with injuries	1	3	3	**7**
Minor accident with no injuries	9	14	12	**35**
Fatal accident	0	0	1[4]	**1**
Sub-Total	**10**	**17**	**16**	**43**
I-35W northbound toll lanes				
Major accident with injuries	2	2	3	**7**
Minor accident with no injuries	7	10	8	**25**
Fatal accident	0	0	0	**0**
Sub-Total	**9**	**12**	**11**	**32**
I-35W southbound general use lanes				
Major accident with injuries	12	17	13	**42**
Minor accident with no injuries	18	54	44	**116**
Fatal accident	0	0	0	**0**
Sub-Total	**30**	**71**	**57**	**158**
I-35W northbound general use lanes				
Major accident with injuries	11	13	9	**33**
Minor accident with no injuries	45	80	56	**181**
Fatal accident	0	1[5]	0	**1**
Sub-Total	**56**	**94**	**65**	**215**
Grand Totals	**105**	**194**	**149**	**448**

[4]Fatal accident occurred on April 19, 2020, in the I-35W southbound toll lanes prior to Meacham Boulevard. A vehicle hit a pedestrian who was pronounced deceased on scene.

[5]Fatal accident occurred on May 10, 2019, in the I-35W northbound general use lanes at Spur 280. The driver of a vehicle failed to control speed and struck the rear of another vehicle under cloudy weather and wet pavement conditions. The right rear passenger of the vehicle who was struck was transported to a hospital where the passenger was pronounced deceased.

Tables 3 and 4 further summarize the traffic and fatal accident history broken down by type of vehicle collision and weather conditions, respectively, on I-35W between Meacham Boulevard and I-30 from July 2018 through December 2020.

Table 3 – Type of vehicle collision history on I-35W between Meacham Boulevard and I-30.

Type of vehicle collision	2018	2019	2020	Totals
I-35W southbound toll lanes				
Head on	0	0	0	**0**
Loss of control	5	8	5	**18**
Nose to tail	0	0	0	**0**
Rollover	0	0	0	**0**
Vehicle – Object	2	1	2	**5**
Vehicle – Vehicle	3	7	4	**14**
No information	0	1	5	**6**
Sub-Total	**10**	**17**	**16**	**43**
I-35W northbound toll lanes				
Head on	0	0	0	**0**
Loss of control	5	1	5	**11**
Nose to tail	0	0	2	**2**
Rollover	0	0	0	**0**
Vehicle – Object	1	4	0	**5**
Vehicle – Vehicle	3	7	2	**12**
No information	0	0	2	**2**
Sub-Total	**9**	**12**	**11**	**32**
I-35W southbound general use lanes				
Head on	0	0	1	**1**
Loss of control	8	15	19	**42**
Nose to tail	0	6	4	**10**
Rollover	0	0	0	**0**
Vehicle – Object	6	6	0	**12**
Vehicle – Vehicle	16	44	15	**75**
No information	0	0	18	**18**
Sub-Total	**30**	**71**	**57**	**158**
I-35W northbound general use lanes				
Head on	0	0	1	**1**
Loss of control	6	17	17	**40**
Nose to tail	0	4	8	**12**
Rollover	1	0	1	**2**
Vehicle – Object	7	1	1	**9**
Vehicle – Vehicle	42	68	20	**130**
No information	0	4	17	**21**
Sub-Total	**56**	**94**	**65**	**215**
Grand Totals	**105**	**194**	**149**	**448**

Table 4 – Weather condition accident history on I-35W between Meacham Boulevard and I-30.

Weather condition	2018	2019	2020	Totals
I-35W southbound toll lanes				
Clear	3	12	10	**25**
Fog	0	0	0	**0**
Overcast	1	0	0	**1**
Rain	6	5	6	**17**
Sub-Total	**10**	**17**	**16**	**43**
I-35W northbound toll lanes				
Clear	5	10	9	**24**
Fog	1	0	0	**1**
Overcast	0	2	1	**3**
Rain	3	0	1	**4**
Sub-Total	**9**	**12**	**11**	**32**
I-35W southbound general use lanes				
Clear	25	58	47	**130**
Fog	0	1	0	**1**
Overcast	2	6	1	**9**
Rain	3	6	9	**18**
Sub-Total	**30**	**71**	**57**	**158**
I-35W northbound general use lanes				
Clear	46	81	59	**186**
Fog	0	1	0	**1**
Overcast	4	6	0	**10**
Rain	6	6	6	**18**
Sub-Total	**56**	**94**	**65**	**215**
Grand Totals	**105**	**194**	**149**	**448**

1.5 NTE Mobility Partners Segments 3, LLC (NTEMP S3)

General Overview

As indicated in the Facility Agreement between NTE Mobility Partners Segments 3, LLC (NTEMP S3) and the Texas Department of Transportation (TxDOT), NTEMP S3 is responsible for operations and maintenance within the facility (I-35W) right-of-way, including the toll lanes, the general use lanes, and the frontage roads.[6] In addition, during the operating period, NTEMP S3 is required to carry out the operations and maintenance work, which consists of the operation, management, administration, maintenance, repair, preservation, modification, reconstruction, rehabilitation, restoration, renewal, and replacement of the facility in accordance with 1) good industry practice, 2) the Facility Agreement documents, 3) all laws, 4) all governmental approvals, 5) the approved facility management plan and all related plans and documentation, and 6) all other

[6]See Highway Factors Attachment: Portions of Amended and Restated Facility Agreement, North Tarrant Express Segments 3A, 3B and 3C Facility between Texas Department of Transportation and NTE Mobility Partners Segments 3 LLC, dated July 30, 2019.

applicable safety, environmental and other requirements, taking into account the facility right-of-way limits and other constraints affecting the facility.[7]

Policing, Security and Incident Response

Texas law establishes that the Texas Department of Public Safety and any other public law enforcement agencies with jurisdiction to provide traffic patrol, traffic law enforcement, and other police and public safety services and agreements with state and local agencies must provide any necessary enhanced services due to the NTEMP S3's construction, operation, maintenance, or other activities on or affecting the facility. NTEMP S3 must not engage private security services for traffic patrol or traffic law enforcement (other than passive security devices or technology to protect, collect, accumulate, transfer, and deposit tolls and incidental charges or to identify toll violators), unless approved by the Texas Department of Transportation (TxDOT). NTEMP S3 must also coordinate and cooperate, at its own expense, with TxDOT or any enforcement agencies for TxDOT that are installing, maintaining, or replacing cameras or other equipment on the facility for traffic regulation or enforcement. NTEMP S3 is responsible for the safety and security of the facility and the workers and public on the facility during construction, operation, and maintenance activities and must implement incident response, safety, and security procedures, protocols, and requirements set forth in the facility management plan.

Facility Oversight

The Texas Department of Transportation and its authorized representative may monitor, inspect, sample, measure, attend, observe, or conduct tests and investigations, and conduct any other oversight for any part or aspect of the facility or the work, to the extent necessary or advisable to comply with federal agency requirements, to verify the NTEMP S3's compliance with the Facility Agreement documents and the facility management plan and to verify the independent engineer's proper performance of its responsibilities and obligations. NTEMP S3 is obligated to cooperate with both the independent engineer and the Texas Department of Transportation to facilitate their oversight functions. The name of the independent engineering company is Jacobs Engineering Group Inc.

Toll Collection

The Texas Department of Transportation agreed to perform or require the North Texas Tollway Authority (NTTA) to perform toll collection and customer services for the facility on behalf of the NTEMP S3, including posting transponder transactions to customer accounts, providing interoperability functions, processing video transactions, remitting payments to the NTEMP S3, and providing toll collection enforcement services.

Funding and Importance of Toll Facility

The I-35W project (Segments 3A, 3B, and 3C) which included the reconstruction of the existing general use lanes and frontage roads, plus the addition of new toll lanes, was originally funded in 2013 with a combination of 1) equity from the shareholders of NTE Mobility Partners Segments 3, 2) Private Activity Bonds (PABs), 3) Transportation Infrastructure Finance and

[7]The operating period is set to expire on June 22, 2061, unless otherwise terminated earlier in accordance with the provisions of the Facility Agreement.

Innovation Act (TIFIA) loans, and 4) public funds. Later, in 2019, there was an additional equity commitment from the shareholders plus a new PABs issuance.[8] The total investment in the I-35W project will be approximately $2.3 billion. Segment 3C is not fully funded yet, as it is under construction. NTEMP S3 has the right to collect tolls from the users of the toll lanes during the term of the Facility Agreement that is set to expire on June 22, 2061. One of the main advantages of delivering the project as a Private Public Partnership (PPP) is the advancement by several years of this critical project to the Dallas – Fort Worth metroplex. Without the private investment, this project would not likely have been completed.

2. Roadway Data

2.1 Speed Limit

The posted regulatory speed limit for I-35W was 75 miles per hour (mph) for the southbound and northbound toll lanes and 65 mph for the southbound and northbound general use lanes.[9]

2.2 Typical Section

Figure 5 illustrates the I-35W southbound toll lanes, highlighted in red, looking to the south in the vicinity of the crash location with the downtown Fort Worth skyline shown in the background. Here, the highway consisted of two lanes, approximately 24-feet-wide (12-feet-wide per lane), bordered by a left paved shoulder, approximately 4-feet-wide, and a right paved shoulder, approximately 10-feet-wide.[10] At the edge of the left and right paved shoulders, a 42-inch-high concrete barrier and 36-inch-high concrete barrier existed, respectively.[11] In the vicinity of the crash, the concrete barriers along both sides of the travel lanes were continuous and not configured with any spacings or gaps allowing for vehicle or pedestrian passage.

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[8]The additional equity commitment was a result of a change order executed between NTEMP S3 and TxDOT for Segment 3C.

[9]Texas Transportation Code 545.351 Maximum Speed Requirement requires:
(a) An operator may not drive at a speed greater than is reasonable and prudent under the circumstances then existing.
(b) An operator:
(1) may not drive a vehicle at a speed greater than is reasonable and prudent under the conditions and having regard for actual and potential hazards then existing; and
(2) shall control the speed of the vehicle as necessary to avoid colliding with another person or vehicle that is on or entering the highway in compliance with law and the duty of each person to use due care.
(c) An operator shall, consistent with Subsections (a) and (b), drive at an appropriate reduced speed if:
(1) the operator is approaching and crossing an intersection or railroad grade crossing;
(2) the operator is approaching and going around a curve;
(3) the operator is approaching a hill crest;
(4) the operator is traveling on a narrow or winding roadway; and
(5) a special hazard exists with regard to traffic, including pedestrians, or weather or highway conditions.

[10]See Highway Factors Attachment: Typical section of I-35W southbound toll lanes in the vicinity of the crash.

[11]The 42-inch-high concrete barrier that separated the southbound toll lanes from the northbound toll lanes was a single-slope concrete barrier. The 36-inch-high concrete barrier that separated the southbound toll lanes from the southbound general use lanes (which are on two different bridge decks) were two back-to-back traffic single slope concrete barriers. The environmental documents, which were prepared and submitted by TxDOT in the schematic design in the procurement process, required concrete traffic barriers separating the managed lanes from the general use lanes. This design was submitted to the Federal Highway Administration.

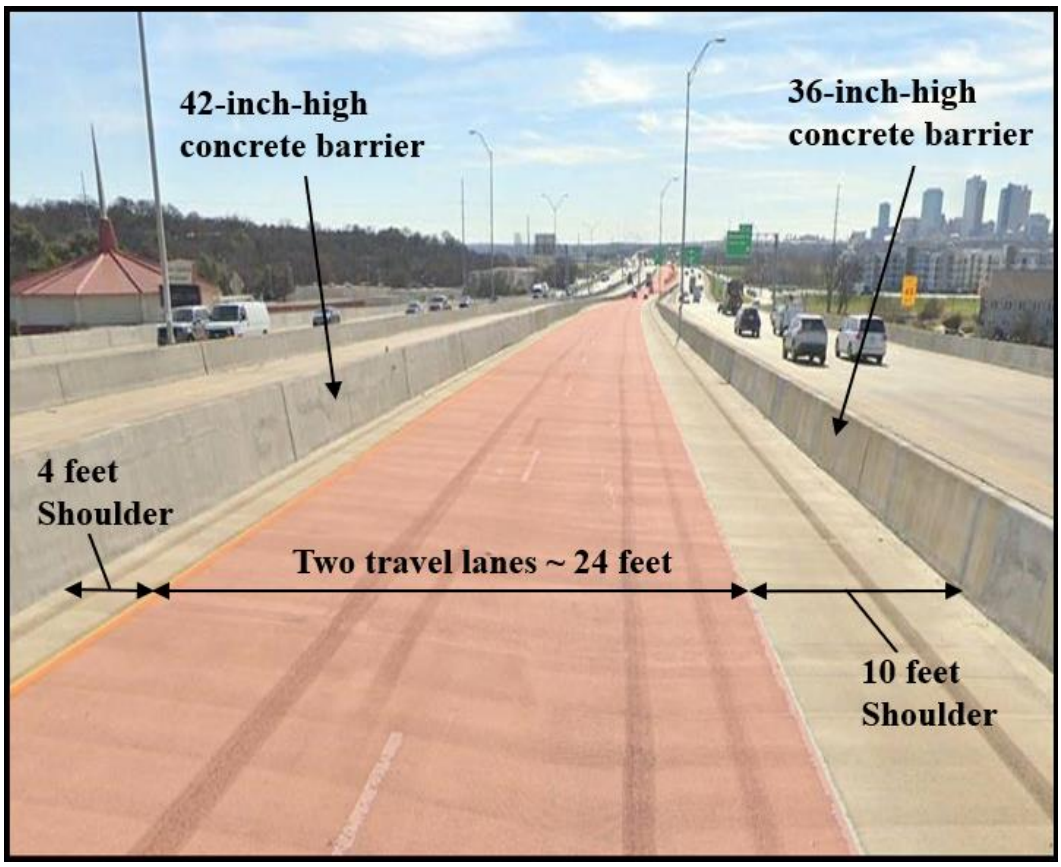

Figure 5 – View of I-35W southbound toll lanes, highlighted in red, looking to the south in the vicinity of the crash location with the downtown Fort Worth skyline shown in the background (Source: Google Earth Street view image from January 2020, revised).

Figure 6 illustrates the I-35W southbound toll lanes, highlighted in red, looking to the north showing the hill crest and 3% downgrade slope leading up to the crash location.

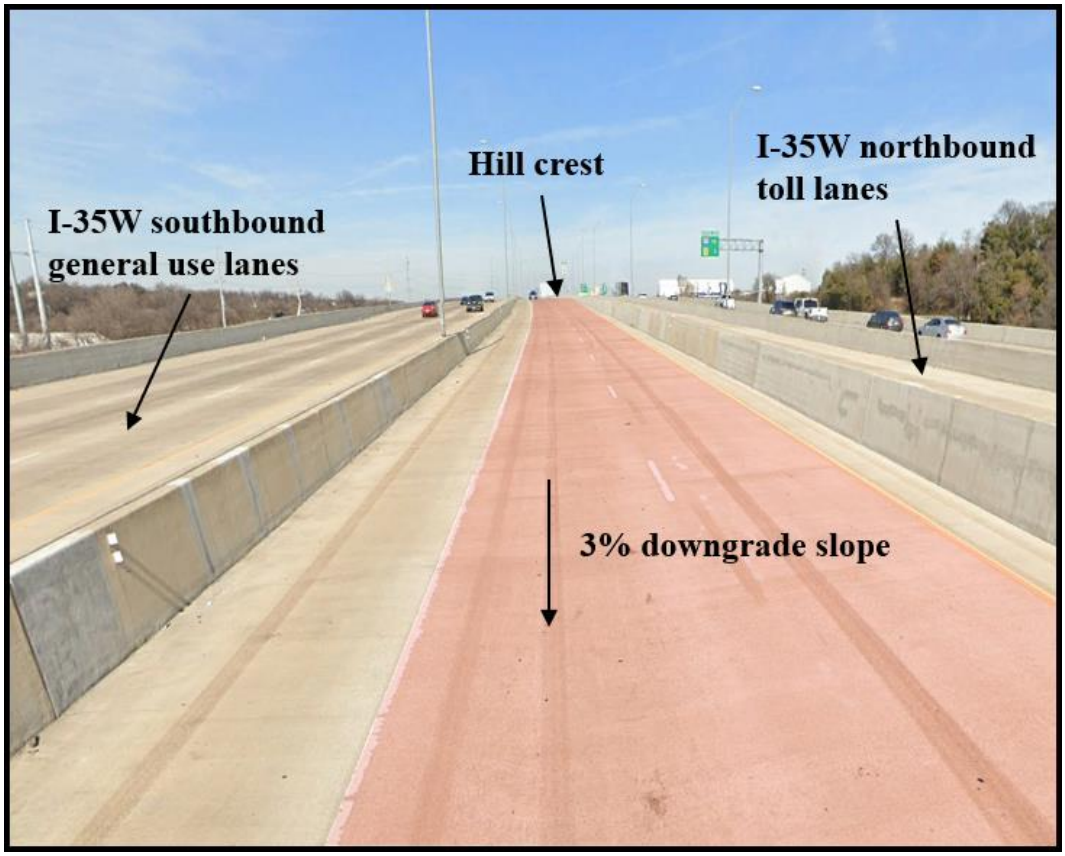

Figure 6 – View of I-35W southbound toll lanes, highlighted in red, looking to the north showing the hill crest and 3% downgrade slope leading up to the crash location (Source: Google Earth Street view image from January 2020, revised).

2.3 Vertical Alignment

The vertical alignment of the elevated portion of I-35W leading up to the crash location consisted of a 3% downgrade slope.[12] **Figure 7** illustrates the 3% downgrade slope of the elevated portion of I-35W prior to the crash location.

[12]See Highway Factors Attachment: Vertical alignment of I-35W southbound toll lanes in the vicinity of the crash.

Figure 7 – View of 3% downgrade slope of the elevated portion of I-35W, highlighted in red, prior to the crash location looking to the southwest (Source: Google Earth Street view image, revised).

The vertical alignment in the vicinity of the hill crest prior to the crash location consisted of a crest vertical curve with the following characteristics:[13]

- Upgrade slope = Positive (+) 3% grade (southbound toll lanes)
- Crest vertical curve length = 1,493 feet
- Downgrade slope = Negative (-) 3% grade (southbound toll lanes)

The TxDOT design parameters for the roadway allowed for such slopes as this up to 3%. Approximately 1,000 feet past the crest of the vertical curve was the location of the rear of the queue once the crashes started happening.

2.4 Horizontal Alignment

The horizontal alignment in the vicinity of the crash location consisted of a 12,000-feet radius curve to the right for motorists traveling in the southbound direction of I-35W.[14]

[13]A crest vertical curve is a curve that connects inclined sections of roadway, forming a crest. A sag vertical curve is a curve that connects descending sections of roadway, forming a sag.
[14]Highway Factors Attachment – As-built construction plans of I-35W in the vicinity of the crash.

2.5 Speed Studies

Speed studies were performed in the I-35W southbound toll lanes by the Texas Department of Transportation (TxDOT) on July 23, 2020 and submitted to the NTEMP S3 in September 2020.[15] **Table 5** summarizes the speed studies performed by TxDOT in the I-35W southbound toll lanes for a distance of approximately 8 miles.[16]

Table 5 – Speed studies performed by TxDOT in the I-35W southbound toll lanes for a distance of approximately 8 miles.

Approximate Mile Point of Check Station[17]	Location of Mile Point	Total Vehicles Recorded	Maximum Speed (mph)	85th Percentile Speed[18] (mph)
8.400	Approximately 0.14 miles north of Pharr Street	125	84	76
8.940	Approximately 0.24 miles south of Yucca Avenue	125	87	77
9.952	Approximately 0.30 miles south of NE 28th Street (check station closest to the crash)	125	85	75
10.810	Approximately 0.56 miles north of NE 28th Street	125	87	81
11.750	Approximately 0.60 miles south of Meacham Boulevard	125	90	78
12.785	Approximately 0.20 miles north of Meacham Boulevard	125	88	79
13.800	Approximately 0.15 miles north of I-820W	125	92	79
14.700	Approximately 0.45 miles south of Western Center Boulevard	125	88	76
15.620	Approximately 0.50 miles south of Basswood Boulevard	125	75	65
16.420	Approximately 0.38 miles south of US 287	125	93	79

NTE Mobility Partners Segments 3, LLC had deployed Microwave Vehicle Detectors (MVD) along the corridor in the southbound toll lanes before and after the crash location that detected average speeds.[19]

[15]This 2020 speed study verified a similar 2018 speed study, that TxDOT used pursuant to TxDOT manual "Procedures for Establishing Speed Zones," to establish the speed limits for the southbound toll lanes. NTEMP S3 is prohibited by Section 8.1.7.3 of its Facilities Agreement with TxDOT from changing these speed limits.

[16]See Highway Factors Attachment: Speed studies performed by TxDOT in the I-35W southbound toll lanes for a distance of approximately 8 miles.

[17]Approximate Mile Points of Check Stations are estimated and do not correspond to the mileposts posted on I-35W.

[18]The 85th percentile speed is the speed at which 85% of the vehicle traffic is traveling either at or below that speed or, 15% of the vehicle traffic is traveling above that speed.

[19]See Highway Factors Attachment - NTE Mobility Partners Segments 3, LLC Microwave Vehicle Detectors (MVD) deployed along the corridor in the southbound toll lanes before and after the crash location.

2.6 Signage

Table 6 summarizes a brief listing of the regulatory and warning signs located in the 4 miles leading up to the crash in the southbound toll lanes of I-35W.[20]

Table 6 – Brief listing of the regulatory and warning signs located in the 4 miles leading up to and at the time of the crash in the southbound toll lanes of I-35W.

Signage	Distance from Signage to Crash	Location of Signage	Signage Measurements
	300 feet	Mounted on top of barrier separating southbound toll lanes from northbound toll lanes	48” x 60”
	4,600 feet	Mounted on top of barrier separating southbound toll lanes from northbound toll lanes	48” x 60”
	7,900 feet (1.5 miles)	Mounted to the right of southbound toll lanes	48” x 60”
	9,850 feet (1.9 miles)	Mounted on top of barrier separating southbound toll lanes from northbound toll lanes	48” x 48”
	13,800 feet (2.6 miles)	Mounted to the right of southbound toll lanes	48” x 60”
	16,100 feet (3.0 miles)	Mounted to the right of southbound toll lanes	48” x 48”

[20]See Highway Factors Attachment: Signage plans on I-35W in the vicinity of the crash.

	20,500 feet (3.9 miles)	Mounted on top of barrier separating southbound toll lanes from northbound toll lanes	48” x 48”

2.7 Highway Lighting

One or two 400-watt high pressure sodium luminaires were attached on top of several single poles in the vicinity of the crash. One single line of poles was mounted on top of the barrier separating the southbound toll lanes from the southbound general use lanes and another single line of poles was mounted on top of the barrier separating the northbound toll lanes from the northbound general use lanes.[21]

The single line of poles, for both southbound and northbound directions, extended approximately 48-feet high from the top of the barrier. The spacing of the poles in between the southbound toll lanes and the southbound general use lanes was approximately 250-300 feet on center. The poles in between the northbound toll lanes and northbound general use lanes had a similar spacing.

2.8 Rumble Strips

In the vicinity of the crash, there were no rumble strips adjacent to the southbound toll lanes on the elevated portion of I-35W, nor were they allowed. FHWA recommended the following regarding applying rumble strips on bridge decks:[22]

> *“Rumble strips are not normally applied to bridge decks due to the presence of rebar.”*

TxDOT recommended the following regarding the installation of rumble strips on bridge decks:[23]

> *“Rumble strips shall not be milled or depressed into bridge decks.”*

Grooved longitudinal rumble strips did exist adjacent to the southbound toll lanes in the left and right shoulders for portions of the roadway that were at grade.[24] For areas in which exit, and entrance ramps existed, rumble strips were not installed. The rumble strip dimensions were approximately 16-inches long and 7-inches wide.[25] The rumble strips were spaced approximately 5-inches apart measured from the edge of the rumble strip. The depression of the rumble strip into the pavement was approximately 1/2-inch. The rumble strips were offset from the edge of traveled way by approximately 4-inches on both sides.

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[21]See Highway Factors Attachment: Illumination plans on I-35W in the vicinity of the crash.
[22]Rumble Strip Implementation Guide, FHWA, April 2015, page 5.
[23]Edgeline Rumble Strips on Freeways and Divided Highways RS (1)-13, Texas Department of Transportation, General Notes, April 2006.
[24]At grade is frequently referred to as a roadway on the same level as the earthen surface.
[25]See Highway Factors Attachment: Rumble strip detail on I-35W in the vicinity of the crash.

2.9 Pavement Friction Tests

In the vicinity of the crash, the following auditable sections (SB 3A026, SB 3A027, SB 3A028, SB 3A029, and SB 3A030) were assigned to I-35W by NTEMP S3.[26] The length of each auditable section is approximately 0.1 mile, comprising a total section length of 0.5 miles.

A NTEMP S3 contractor, performed skid testing on I-35W using a locked-wheel skid friction tester on November 5, 2019.[27] The locked-wheel skid friction tester met all the specifications set forth in the American Society for Testing and Materials (ASTM) E-274, *Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire*. All tests were performed using an ASTM E-524 smooth testing tire in the left wheel path of each lane. The test speed for the toll lanes was set at 50 mph, a speed required by TxDOT but varying from the ASTM E-274 standard of 40 mph.[28] The results of the skid testing can be found in a *2019 Pavement Inspection Report* prepared for the NTEMP S3 by Data Transfer Solutions, LLC.[29]

Table 7 summarizes the friction numbers in the right and left lanes of the I-35W southbound toll lanes in the vicinity of the crash performed on November 5, 2019.

[26]An auditable section is a pre-defined pavement management section of the project – generally 0.1 miles in length – used to report pavement-related condition values. Most pavement inspection values – including roughness index, rutting, and pavement condition score – are reported for each auditable section. Skid friction values are reported on nominal 0.5-mile-long pavement sections that generally, though not always, consist of five individual auditable sections. The 0.5-mile pavement sections for skid are pre-defined, and performance specifications do not require the analysis of "rolling" 0.5-mile sections along the project length.

[27]Applied Research Associates (ARA) who performed the skid testing on I-35W, was a subcontractor to Data Transfer Solutions, LLC who was the prime contractor to NTEMP S3 for the pavement inspection services.

[28]Actual test speeds varied between 50.1 and 51.5 mph.

[29]See Highway Factors Attachment: 2019 Pavement Inspection Report, North Tarrant Expressway, Segment 3, May 2020, prepared by Data Transfer Solutions, LLC.

Table 7 – Friction numbers in the right and left lanes of the I-35W southbound toll lanes in the vicinity of the crash performed on November 5, 2019.[30]

Auditable Section	Direction	Lane	Friction Number	Tire	Speed (mph)	Wheel Path
SB 3A026	SB - Toll Lanes	Left	28.2	Smooth	50	LWP
SB 3A026	SB - Toll Lanes	Left	29.0	Smooth	50	LWP
SB 3A026	SB - Toll Lanes	Right	29.5	Smooth	50	LWP
SB 3A026	SB - Toll Lanes	Right	33.9	Smooth	50	LWP
SB 3A027	SB - Toll Lanes	Left	32.2	Smooth	50	LWP
SB 3A027	SB - Toll Lanes	Left	34.6	Smooth	50	LWP
SB 3A027	SB - Toll Lanes	Right	26.4	Smooth	50	LWP
SB 3A027	SB - Toll Lanes	Right	29.5	Smooth	50	LWP
SB 3A028	SB - Toll Lanes	Left	27.4	Smooth	50	LWP
SB 3A028	SB - Toll Lanes	Left	27.9	Smooth	50	LWP
SB 3A028	SB - Toll Lanes	Right	25.9	Smooth	50	LWP
SB 3A028	SB - Toll Lanes	Right	28.8	Smooth	50	LWP
SB 3A029	SB - Toll Lanes	Left	26.8	Smooth	50	LWP
SB 3A029	SB - Toll Lanes	Left	30.2	Smooth	50	LWP
SB 3A029	SB - Toll Lanes	Right	27.6	Smooth	50	LWP
SB 3A029	SB - Toll Lanes	Right	29.3	Smooth	50	LWP
SB 3A030	SB - Toll Lanes	Left	29.9	Smooth	50	LWP
SB 3A030	SB - Toll Lanes	Left	33.1	Smooth	50	LWP
SB 3A030	SB - Toll Lanes	Right	30.3	Smooth	50	LWP
SB 3A030	SB - Toll Lanes	Right	31.7	Smooth	50	LWP
Avg. 0.5-mile skid resistance (SB 3A026 – SB 3A030)		**Left**	**29.9**			
Avg. 0.5-mile skid resistance (SB 3A026 – SB 3A030)		**Right**	**29.3**			

The NTEMP S3 followed guidance regarding evaluation of smooth tire test results which indicated the following:[31]

- For main lanes (including toll lanes, general use lanes, ramps and connectors) and frontage roads – 0.5-mile sections with average skid resistance of greater than or equal to 30 will be deemed compliant.

- For main lanes (including toll lanes, general use lanes, ramps and connectors) and frontage roads – 0.5-mile sections with average skid resistance greater or equal to 25 but less than 30, site investigation will be performed by developer and if warranted,

[30]The average 0.5-mile skid resistance values shown in Table 7 do not necessarily reflect the average 0.5-mile skid resistance values shown in the *2019 Pavement Inspection Report*. This is due to the data reporting requirements per the TxDOT/NTEMP3 operations and maintenance (O&M) agreement, which require remediation only in the event the predefined 0.5-mile segment fails to meet O&M requirements. The location of the crash fell into two different 0.5-mile segments, both of which had passing averages in the *2019 Pavement Inspection Report*. The passing 0.5-mile segments in the *2019 Pavement Inspection Report* includes skid values of both the toll lanes and the general use lanes and are therefore not solely indicative of the skid values reflected in Table 7.

[31]Approved FMP/PMP in placed during 2.11.21; Chapter 2C O&M Plan (December 17, 2020).

remedial measures will be identified and implemented. The site investigation may include pavement condition assessment, review of wet weather accident history, and recommendations for or against any corrective actions at that time.

- For main lanes (including toll lanes, general use lanes, ramps and connectors) and frontage roads – 0.5-mile sections with average skid resistance less than 25, site investigation will be performed by a Professional Engineer licensed to practice in State of Texas and if warranted, remedial measures will be identified and implemented. The site investigation may include pavement condition assessment, review of wet weather accident history, and recommendations for or against any corrective actions at that time.

- Skid resistance below 15 requires corrective action to increase skid resistance to acceptable level regardless of site investigation.

3. Timeline of Events Leading up to the Crash

Table 8 summarizes the timeline of events leading up to the multivehicle crash at approximately 6:00 a.m. on February 11, 2021.

Table 8 – Timeline of events leading up to the multivehicle crash.

Date	Time	Description
2/08/2021	Approx. 10:32 a.m.	First alert received by NTEMP S3 for this winter weather alert provided by the National Weather Service,[32] *"A cold front will move slowly through North Texas starting tonight and Tuesday and continuing south into Central Texas on Tuesday and Tuesday night. Temperatures near or below freezing across northern and northwestern parts of the area are possible, mainly for the nighttime and morning hours. Behind the front, light precipitation may occur. Precipitation chances are highest on Wednesday and Thursday. Most of this precipitation will be in the form of light rain, but where and when temperatures are below freezing, some light freezing drizzle or freezing rain may occur. Some pockets of light sleet may also occur. Any impacts from icing are highly dependent on how far south the freezing line gets and that remains very uncertain at this time, but confidence increases in light accumulations farther to the northwest one goes."*
2/09/2021	Approx. 10:12 a.m.	NTEMP S3 maintenance technicians pretreat the traffic lanes in the vicinity of the crash with an Ice Slicer NM brine solution.[33] The solution was applied to the two southbound toll lanes. NTEMP S3 closed-circuit television (CCTV) camera located north of Northside Drive/Yucca Avenue pointing towards the crash site captures truck and brine sprayer applying the brine solution to the two southbound toll lanes.
2/11/2021	Approx. 3:20 a.m.	Internal Incident Details Report shows the NTEMP S3 Traffic Management Center (TMC) notifying NTEMP S3 Customer Assistance at approximately 3:20 a.m. regarding a crash that occurred at 3:00 a.m. in the northbound general use lanes of I-35W, in the vicinity of Western Center Boulevard, approximately 5 miles north of the crash site.[34] The 3:00 a.m. crash occurred due in part to the icy road conditions on an elevated bridge. NTEMP S3 dispatches maintenance crew members at 3:23 a.m. who arrive on-scene between 3:30 and 4:00 a.m. NTEMP S3 maintenance crew members used salt to spot treat the southbound and northbound toll lanes and general use lanes, including entrance and exit ramps. Completion of spot treatment was at 4:43 a.m. Upon completion of this work, two maintenance crew members are dispatched to treat a second incident

[32]See Highway Factors Attachment: First alert received by NTEMP S3 for this winter weather alert provided by the National Weather Service at approximately 10:32 a.m. on February 8, 2021.
[33]Ice Slicer NM (also known as Ice Slicer CB) is available as a commercial product. It is comprised of sodium chloride (90-98%), magnesium chloride (0.30-3.0%), potassium chloride (0.30-3.0%), and calcium chloride (0.30-3.0%).
[34]See Highway Factors Attachment: Texas Peace Officer's Crash Report at 0300 on February 11, 2021.

		in the Fort Worth area south of Belknap Street in the vicinity of US-287 and TX-280 Spur ramps.
2/11/2021	Approx. 3:40 a.m.	NTEMP S3 activated cautionary message "ICY CONDITIONS EXIST" and "PLEASE USE CAUTION" at 7 dynamic message signs (DMS) within 8.3 miles of the crash site. See description and location map of each dynamic message sign later in this factual report.
2/11/2021	Approx. 4:40 a.m.	Moisture detected by NTEMP S3 maintenance crew member at approximately 4:40 a.m. while patrolling downtown Fort Worth area south of Belknap Street in the vicinity of US-287 and TX-280 Spur ramps, approximately 2 miles south of the crash site. NTEMP S3 maintenance crew members arrived at the downtown Fort Worth location at approximately 4:50 a.m. NTEMP S3 maintenance crew members use salt to treat the US-287 entrance ramps to northbound toll lanes and general use lanes, and TX-280 entrance ramps to northbound and southbound general use lanes. Completion of salt treatment was approximately 5:20 a.m.
2/11/2021	Approx. 6:00 a.m.	Multivehicle crash occurred in the southbound toll lanes of I-35W near the exit to Northside Drive and involved about 130 vehicles.[35]

[35]See Highway Factors Attachment: Texas Peace Officer's Crash Report at 0600 on February 11, 2021.

4. Dynamic Message Signs

Figure 8 illustrates a location map of the 7 dynamic message signs (DMS) utilized by NTEMP S3 within 8.3 miles of the crash site.

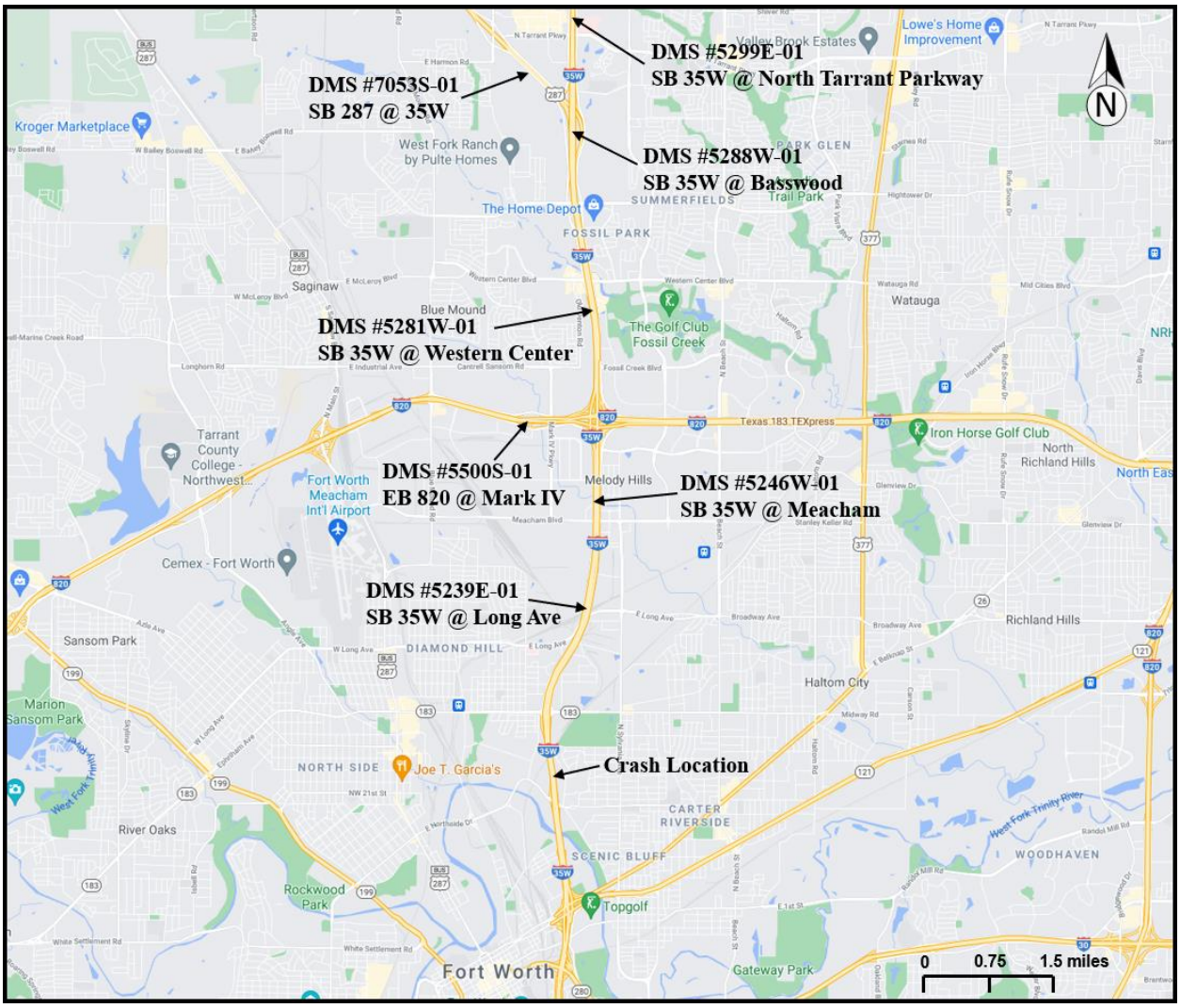

Figure 8 – Location map of the 7 dynamic message signs (DMS) utilized by NTEMP S3 within 8.3 miles of the crash site (Source: Google Maps image revised).

Table 9 provides excerpts from the logs of the 7 dynamic message signs (DMS) utilized by NTEMP S3 within 8.3 miles of the crash site with the messages displayed and corresponding dates and times.[36]

Table 9 – Excerpts from the logs of the 7 dynamic message signs (DMS) utilized by NTEMP S3 within 8.3 miles of the crash site with the messages displayed and corresponding dates and times.

DMS #5299E-01 Location: SB 35W @ North Tarrant Parkway Distance from DMS sign to crash: 8.3 miles	
Date/Time	**Message**
2/11/21 8:30:13 a.m.	Message board displayed "ACCIDENT SB 35W @ NORTHSIDE ALL LANES" and "BLOCKED USE CAUTION"
2/11/21 3:40:06 a.m.	Message board displayed "ICY CONDITIONS EXIST" and "PLEASE USE CAUTION"
2/10/21 8:20:34 p.m.	Message board displayed "WINTER WEATHER ADVISORY" and "DRIVE WITH CAUTION"
2/10/21 8:20:07 a.m.	Message board displayed "MAINTAIN SOCIAL DISTANCING" and "ON THE ROAD AND WITH EACH OTHER"
2/9/21 10:54:04 p.m.	Message board displayed "ICE PREVENTION OPERATIONS AHEAD" and "WATCH FOR ROAD CREWS"
2/9/21 10:00:07 p.m.	Message board displayed "SILVER ALERT BEAUMONT TEXAS CALL POLICE" and *(Description of Vehicle Omitted)*
2/9/21 8:24:45 a.m.	Message board displayed "ICE PREVENTION OPERATIONS AHEAD" and "WATCH FOR ROAD CREWS"
DMS #7053S-01 Location: SB 287 @ 35W Distance from DMS sign to crash: 7.6 miles	
Date/Time	**Message**
2/11/21 8:29:48 a.m.	Message board displayed "ACCIDENT SB 35W @ NORTHSIDE ALL LANES" and "BLOCKED USE CAUTION"
2/11/21 3:40:06 a.m.	Message board displayed "ICY CONDITIONS EXIST" and "PLEASE USE CAUTION"
2/10/21 8:20:35 p.m.	Message board displayed "WINTER WEATHER ADVISORY" and "DRIVE WITH CAUTION"
2/10/21 8:20:15 a.m.	Message board displayed "MAINTAIN SOCIAL DISTANCING" and "ON THE ROAD AND WITH EACH OTHER"
2/9/21 8:24:46 a.m.	Message board displayed "ICE PREVENTION OPERATIONS AHEAD" and "WATCH FOR ROAD CREWS"
DMS #5288W-01 Location: SB 35W @ Basswood Distance from DMS sign to crash: 5.6 miles	
Date/Time	**Message**
2/11/21 8:29:27 a.m.	Message board displayed "ACCIDENT SB 35W @ NORTHSIDE ALL LANES" and "BLOCKED USE CAUTION"

[36]See Highway Factors Attachment: Excerpts from the logs of the 7 dynamic message signs (DMS) utilized by NTEMP S3 within 8.3 miles of the crash site with the messages displayed and corresponding dates and times.

2/11/21 3:40:06 a.m.	Message board displayed “ICY CONDITIONS EXIST” and “PLEASE USE CAUTION”
2/10/21 8:20:34 p.m.	Message board displayed “WINTER WEATHER ADVISORY” and “DRIVE WITH CAUTION”
2/10/21 8:25:31 a.m.	Message board displayed “MAINTAIN SOCIAL DISTANCING” and “ON THE ROAD AND WITH EACH OTHER”
2/9/21 10:54:22 p.m.	Message board displayed “ICE PREVENTION OPERATIONS AHEAD” and “WATCH FOR ROAD CREWS”
2/9/21 10:00:07 p.m.	Message board displayed “SILVER ALERT BEAUMONT TEXAS CALL POLICE” and *(Description of Vehicle Omitted)*
2/9/21 8:24:45 a.m.	Message board displayed “ICE PREVENTION OPERATIONS AHEAD” and “WATCH FOR ROAD CREWS”
DMS #5281W-01 Location: SB 35W @ Western Center Distance from DMS sign to crash: 5.0 miles	
Date/Time	**Message**
2/12/21 10:19:08 a.m.	Message board displayed “ICE PREVENTION OPERATIONS AHEAD” and “WATCH FOR ROAD CREWS”
2/11/21 5:02:57 a.m.	Message board displayed “ICY CONDITIONS EXIST” and “PLEASE USE CAUTION”
2/11/21 5:02:46 a.m.	Message board displayed “MAINTAIN SOCIAL DISTANCING” and “ON THE ROAD AND WITH EACH OTHER”
2/11/21 4:07:21 a.m.	Message board displayed “ACCIDENT NB 35W @ WESTERN C ALL LANES” and “BLOCKED USE CAUTION”
2/11/21 3:40:06 a.m.	Message board displayed “ICY CONDITIONS EXIST” and “PLEASE USE CAUTION”
2/11/21 3:28:01 a.m.	Message board displayed “ACCIDENT NB 35W @ WESTERN C VARIOUS LANES” and “BLOCKED USE CAUTION”
2/10/21 8:20:35 p.m.	Message board displayed “WINTER WEATHER ADVISORY” and “DRIVE WITH CAUTION”
2/10/21 8:25:25 a.m.	Message board displayed “MAINTAIN SOCIAL DISTANCING” and “ON THE ROAD AND WITH EACH OTHER”
2/9/21 10:57:10 p.m.	Message board displayed “ICE PREVENTION OPERATIONS AHEAD” and “WATCH FOR ROAD CREWS”
2/9/21 10:01:53 p.m.	Message board displayed “SILVER ALERT BEAUMONT TEXAS CALL POLICE” and *(Description of Vehicle Omitted)*
2/9/21 8:24:45 a.m.	Message board displayed “ICE PREVENTION OPERATIONS AHEAD” and “WATCH FOR ROAD CREWS”
DMS #5500S-01 Location: EB 820 @ Mark IV Distance from DMS sign to crash: 4.6 miles	
Date/Time	**Message**
2/11/21 6:29:26 a.m.	Message board displayed “ACCIDENT SB 35W @ NORTHSIDE ALL LANES” and “BLOCKED USE CAUTION”
2/11/21 3:40:06 a.m.	Message board displayed “ICY CONDITIONS EXIST” and “PLEASE USE CAUTION”

2/10/21 8:20:35 p.m.	Message board displayed “WINTER WEATHER ADVISORY” and “DRIVE WITH CAUTION”
2/10/21 8:20:41 a.m.	Message board displayed “MAINTAIN SOCIAL DISTANCING” and “ON THE ROAD AND WITH EACH OTHER”
2/9/21 10:54:29 p.m.	Message board displayed “ICE PREVENTION OPERATIONS AHEAD” and “WATCH FOR ROAD CREWS”
2/9/21 10:00:07 p.m.	Message board displayed “SILVER ALERT BEAUMONT TEXAS CALL POLICE” and *(Description of Vehicle Omitted)*
2/9/21 8:24:45 a.m.	Message board displayed “ICE PREVENTION OPERATIONS AHEAD” and “WATCH FOR ROAD CREWS”
DMS #5246W-01 Location: SB 35W @ Meacham Distance from DMS sign to crash: 3.4 miles	
Date/Time	**Message**
2/11/21 6:21:36 a.m.	Message board displayed “ACCIDENT SB 35W @ NORTHSIDE ALL LANES” and “BLOCKED USE CAUTION”
2/11/21 3:40:06 a.m.	Message board displayed “ICY CONDITIONS EXIST” and “PLEASE USE CAUTION”
2/10/21 8:20:35 p.m.	Message board displayed “WINTER WEATHER ADVISORY” and “DRIVE WITH CAUTION”
2/10/21 8:25:40 a.m.	Message board displayed “MAINTAIN SOCIAL DISTANCING” and “ON THE ROAD AND WITH EACH OTHER”
2/10/21 8:25:39 a.m.	Message board displayed “BUCS AND CHIEFS DON’T GET BLITZED” and “DRIVE SOBER THERE IS NO INSTANT REPLAY”
2/10/21 8:25:37 a.m.	Message board displayed “MAINTAIN SOCIAL DISTANCING” and “ON THE ROAD AND WITH EACH OTHER”
2/9/21 8:24:46 a.m.	Message board displayed “ICE PREVENTION OPERATIONS AHEAD” and “WATCH FOR ROAD CREWS”
DMS #5239E-01 Location: SB 35W @ Long Ave Distance from DMS sign to crash: 2.3 miles	
Date/Time	**Message**
2/11/21 6:28:36 a.m.	Message board displayed “ACCIDENT SB 35W @ NORTHSIDE ALL LANES” and “BLOCKED USE CAUTION”
2/11/21 3:40:06 a.m.	Message board displayed “ICY CONDITIONS EXIST” and “PLEASE USE CAUTION”
2/10/21 8:20:34 p.m.	Message board displayed “WINTER WEATHER ADVISORY” and “DRIVE WITH CAUTION”
2/10/21 5:25:28 p.m.	Message board displayed “MAINTAIN SOCIAL DISTANCING” and “ON THE ROAD AND WITH EACH OTHER”
2/10/21 9:01:50 a.m.	Message board displayed “ICE PREVENTION OPERATIONS AHEAD” and “WATCH FOR ROAD CREWS”
2/9/21 8:24:46 a.m.	Message board displayed “ICE PREVENTION OPERATIONS AHEAD” and “WATCH FOR ROAD CREWS”

5. Research Data

Table 10 summarizes the lane-miles of interstate and non-interstate highways maintained by the NTE Mobility Partners Segments 3, LLC and the TxDOT – Fort Worth District.[37]

Table 10 – Lane-miles of interstate and non-interstate highways maintained by the NTE Mobility Partners Segments 3, LLC and the TxDOT – Fort Worth District.

Classification of Highways	NTE Mobility Partners Segments 3, LLC (lane-miles)		TxDOT – Fort Worth District (lane-miles)[38]
Interstate Highways	Segment 3 (I-35W)	Toll lanes = 50.9	1,703
		General use lanes = 89.7	
		Frontage roads = 47.1	
Non-Interstate Highways	0		7,305
Totals	**187.7**		**9,008**

Table 11 summarizes the pre-treatment and subsequent chemical applications used by the NTE Mobility Partners Segments 3, LLC and the TxDOT – Fort Worth District.

Table 11 – Pre-treatment and subsequent chemical applications used by the NTE Mobility Partners Segments 3, LLC and the TxDOT – Fort Worth District.

Type of Application	NTE Mobility Partners Segments 3, LLC	TxDOT – Fort Worth District
Pre-treatment	Ice Slicer NM in a brine solution	Sodium chloride (salt) in a brine solution
Subsequent chemical applications	Ice Slicer NM in granular form	Granular sodium chloride (salt) and granular magnesium chloride

[37]The Fort Worth District of TxDOT comprises nine counties: Erath, Hood, Jack, Johnson, Palo Pinto, Parker, Somervell, Tarrant, and Wise. The Fort Worth District covers an area of approximately 6,949 square miles.
[38]Reported lane-miles for interstate highways include frontage roads in the TxDOT-Fort Worth District.

6. TxDOT Environmental Sensor Stations

A TxDOT Environmental Sensor Station (ESS) measures multiple types of weather information, such as road temperature, road moisture, air temperature, wind speed, wind direction, precipitation, humidity, flood warning, and visibility, among other types of information.[39] Environmental data gathered from an ESS is reported to a central office in the TxDOT District office for processing and review by TxDOT staff responsible for maintenance and traffic operations.

TxDOT is comprised of 25 Districts. **Figure 9** illustrates the location of each District within the state of Texas.

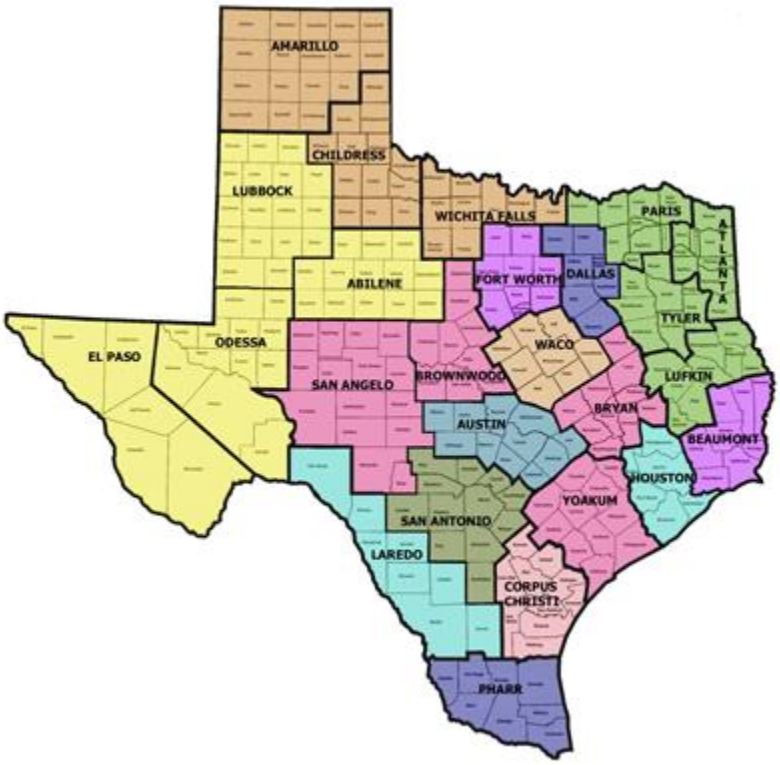

Figure 9 – Location of each District within the state of Texas (Source: TxDOT).

[39]A TxDOT Road Weather Information System (RWIS) station is a type of Environmental Sensor Station (ESS) that measures roadway temperature and moisture.

Table 12 summarizes the location of Environmental Sensor Stations (ESS) in the TxDOT Districts.[40] The Fort Worth District does not currently have any ESS stations.[41] At the time of the crash, NTEMP S3 had one RWIS station located east of Riverside Drive, approximately 4 miles northeast of the crash site.

Table 12 – Location of Environmental Sensor Stations (ESS) in the TxDOT Districts.

District Name	Total # of ESS in the District	ESS Location in the District	# of Sensors within each ESS & Broken Down by the Environmental Condition being Monitored									
			Road Temp	Road Moisture	Air Temp	Wind Speed	Wind Direction	Precipitation	Humidity	Flood Warning	Visibility	Bridge (Yes/No)
Lubbock	3	IH27 / N. LP289 (Lubbock)								1		No
		IH27 @ FM2060 (Abernathy)								1		No
		IH27 @ FM1914 (Hale Center)								1		No
Houston	35	IH610 @ Ship Channel	1	1	1	1	1	1	1			Yes
		IH45 @ Downtown 610 E. Loop						1		1		No
		US59 / 69 @ McGowen Street						1		1		No
		IH10 E. @ Normandy						1		1		No
		SH146 @ Fred Harman Bridge	1	1	1	1	1	1	1			Yes
		IH10 W. @ Beltway						1		1		No
		IH45 S. @ Causeway	1	1	1	1	1	1	1			Yes
		IH45 S. @ Tellepsen S/B						1		1		No
		IH45 S. @ Tellepsen N/B						1		1		No
		IH10 W. Addicks Park & Ride	1	1	1	1	1	1	1			Yes
		US290 @ FM529						1		1		No
		IH45 @ HOV N. Travis						1		1		No
		IH45 @ HOV Louisiana								1		No
		IH10 @ Silber						1		1		No
		IH10 @ Washington						1		1		No
		IH10 W. Eldridge						1		1		No
		IH10 W. @ SH6						1		1		No
		IH W. @ San Jacinto						1		1		No
		SH146 @ Kemah Bridge	1	1	1	1	1	1	1			Yes
		FM3005 @ Jamaica Beach						1				No
		Harborside @ 21 Street						1		1		No
		SH36 @ Brazos River	1	1	1	1	1	1	1	1		Yes
		SH35 @ Brazos River	1	1	1	1	1	1	1	1		Yes
		SH99 @ Brazos River	1	1	1	1	1	1	1	1		Yes
		SH6 @ Hempstead	1	1	1	1	1	1	1			Yes
		SH59 / 69 @ Peach Creek	1	1	1	1	1	1	1	1		Yes

[40]See Highway Factors Attachment: Location of Environmental Sensor Stations (ESS) in the TxDOT Districts.
[41]While TxDOT's Fort Worth District does not currently have any ESS stations and there is no project with the technology on the letting schedule; the use of RWIS and ESS is regularly considered by TxDOT Districts and TxDOT has allowed the installation of RWIS sites on state right of way by outside entities.

		IH45 N. @ FM1097 @ Lake Conroe	1	1	1	1	1	1	1			Yes
		IH610 E. Loop N/B @ Clinton						1		1		No
		IH610 E. Loop N/B IH10 East						1		1		No
		IH10 E. W/B @ Wayside / US90 Alt.						1		1		No
		US59 / 69 @ Kelly						1		1		No
		Spur 5 @ IH45 Gulf						1		1		No
		IH45 Gulf @ IH610 HOV						1		1		No
		Aggie Expressway Over FM1486	3	3	1	1	1	1	1			No
		Aggie Expressway	2	2	1	1	1	1	1			No
San Antonio	31									31		No
Pharr	1	SH100 (Queen Isabella Causeway) Bridge connecting Port Isabel (Mainland) with South Padre Island	1	1	1	1	1	1				Yes
Laredo	6	SL480 (Eagle Pass) #1								1		No
		SL480 (Eagle Pass) #2								1		No
		US90 (Del Rio) #1								1		No
		US90 (Del Rio) #2								1		No
		US90 (Del Rio) #3								1		No
		FM1021 (Eagle Pass) #1								1		No
Totals	**76**		**17**	**17**	**14**	**14**	**14**	**35**	**13**	**65**	**0**	

TxDOT provided the following photographs of Environmental Sensor Stations (ESS) used in the Houston and Pharr Districts. **Figures 10 through 11** illustrate Environmental Sensor Stations (ESS) used in the Houston and Pharr Districts.

Figure 10 – Environmental Sensor Station (ESS) used in the Houston District on FM1097 (Rotary Friendship Bridge) over Lake Conroe looking in the eastbound direction (Source: TxDOT).

Figure 11 – Environmental Sensor Station (ESS) used in the Pharr District on SH100 (Queen Isabella Causeway) connecting Port Isabel with South Padre Island looking in the westbound direction (Source: TxDOT).

Figures 12 illustrates an Environmental Sensor Station (ESS) operated by Houston TranStar.[42]

Figure 12 – Environmental Sensor Station (ESS) operated by Houston TranStar (Source: TxDOT).

[42]Houston TranStar is a unique partnership of representatives from the City of Houston, Harris County, METRO and TxDOT who share resources and exchange information to keep motorists informed and roadways clear.

TxDOT sponsored a technical report *Weather-Savvy Roads: Sensors and Data for Enhancing Road Weather Management: Final Report* performed by the Center for Transportation Research at The University of Texas at Austin.[43] The technical report indicated the following:

Chapter 1. Introduction and Executive Summary

Wildfires, flash floods, freezing events, and other types of extreme weather events have a significant impact on safety and mobility throughout Texas. The Texas Department of Transportation (TxDOT) plays a critical role in enabling effective inter-agency coordination for the evacuation of affected residents, as well as the delivery of necessary resources in emergency conditions. Operating TxDOT roadways in the safest way feasible is of paramount importance: deaths caused by frozen or flooded roadway conditions can be avoided if receptive travelers are better informed and prepared.

7.2.3 IceSight 2020

The IceSight 2020 is a remote road surface condition sensor that uses laser and infrared optical technology to read the temperature of a specific spot of pavement while characterizing the surface conditions: dry, wet, slushy, or icy. The use case is to remotely detect the temperature of a vulnerable section of roadway and to understand the water condition of the surface.

The unit depicted in Figure 7.4 consists of the sensor unit attached to a power supply. In a field installation, the sensor would also be supported by a sizeable solar panel, and a cabinet containing a datalogger, cellular modem, and two 12V lead-acid batteries.

[43] *Weather-Savvy Roads: Sensors and Data for Enhancing Road Weather Management: Final Report*, performed by the Center for Transportation Research at The University of Texas at Austin, sponsoring agency Texas Department of Transportation Research and Technology Implementation Office, December 2018, published July 2019.

Figure 7.4 IceSight 2020 in its demo station.

The live demonstration consisted of a laptop attached to the activated sensor, and displaying its raw output. Most use cases would allow for processing of that output and rendition of the information in a more graphical form.

7.2.4 Mobile IceSight

The Mobile IceSight uses the same technology as the IceSight 2020, but in a more compact form factor that is meant to be mounted to a vehicle (Figure 7.5). Meanwhile, the device is connected to a mobile processing unit (MPU). Inside the MPU is a GPS receiver and a cellular network modem. These are powered by the 12V outlet in the vehicle. The theory of operation is that when the power is applied to the MPU, measurements of surface conditions and temperatures will be immediately sent wirelessly to a vendor-provided cloud service that collects the data. As data is collected, it appears within the "Glance" web app that displays the vehicle position on a map along with a trail that depicts the roadway conditions (Figure 7.6). The same web app allows recorded data to be downloaded for further analysis.

A use case for the Mobile IceSight is to record roadway surface conditions to understand the conditions during a susceptible time, such as shortly before freezing conditions are predicted to set in. Insight can be gained on whether specific sections of vulnerable roadway (e.g. bridges and flyovers, as well as curves) need immediate treating for ice prevention.

Figure 7.5 Mobile IceSight mounted on vehicle.

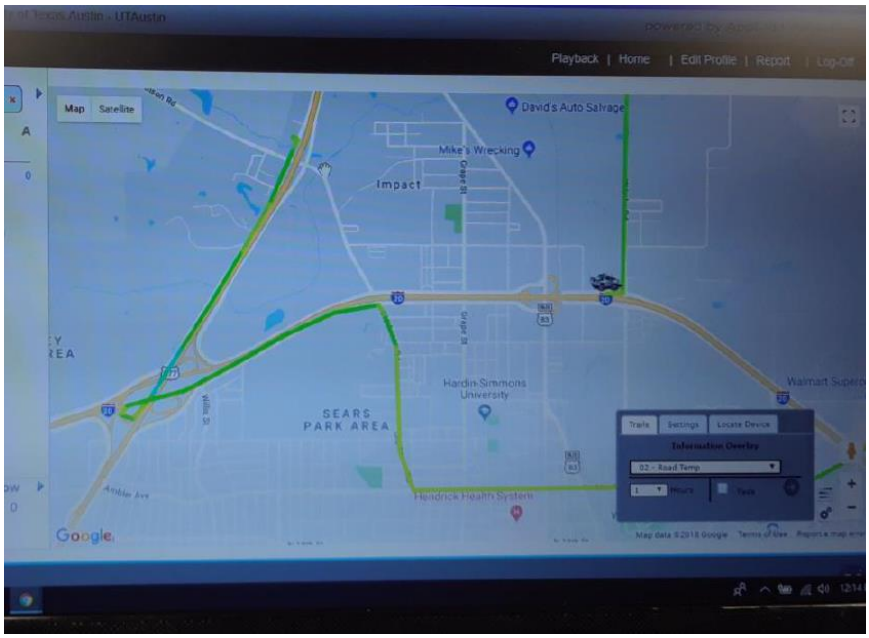

Figure 7.6 Mobile IceSight and web app as demonstrated.

The TxDOT Research and Technology Implementation (RTI) Division contracted with the Center for Transportation Research (CTR) at the University of Texas in Austin on April 23, 2019, to develop and demonstrate weather-responsive management strategies. The project entailed the following:[44]

[44]*Develop and Demonstrate Weather-Responsive Management Strategies*, RTI Project Agreement between the Texas Department of Transportation and The University of Texas at Austin Center for Transportation Research, Project Number 0-7007, Document Date April 23, 2019.

This project shall demonstrate a strategy to improve safety and reliability to reduce costs and improve dissemination of information to travelers via roadway ice maintenance and traffic operations integrations. The demonstrated strategy leverages mobile and connected vehicle data, as well as weather-related data sources, to closely track Receiving Agency ice prevention and response activities, public driving patterns, and regional precipitation.

The outcome is to optimize the application of anti-icing agent and ice removal activities, as well as to inform travelers of road conditions and treatment progress.

The project mandates that the instruments identified in the *Develop and Demonstrate Weather-Responsive Management Strategies* project be tested in real-world conditions with operational feedback. In order to achieve this mandate, the project has been extended by TxDOT to May 31, 2022. Field testing will be conducted in the Amarillo and Lubbock Districts in the winter of 2021-22.

6.1 Current Practices to Detect Moisture and Icy Road Conditions used by the TxDOT - Fort Worth District and by NTEMP S3

Current practices used by the TxDOT – Fort Worth District to detect moisture and icy road conditions are conducted through visual observation which includes TxDOT maintenance section crews patrolling roadways in advance of inclement weather to detect moisture and monitor air and road temperatures. TxDOT's Fort Worth District has operational roadway temperature devices installed on 67 vehicles which are used throughout the District to check roadway temperatures. TxDOT – Fort Worth District employees emphasize the monitoring of bridges and overpasses while patrolling roadways prior to and during inclement weather.

Current practices used by NTEMP S3 to detect moisture and ice formation (along with pavement temperature) are monitored by on-duty NTEMP S3 employees through visual observation and the use of hand-held infrared thermometers. NTEMP S3 employees emphasize the monitoring of bridges and overpasses while patrolling roadways prior to and during inclement weather.

7. Research on Road Weather Sensors

The Massachusetts Department of Transportation (MassDOT) provided NTSB investigators with information regarding road weather sensors used on interstates and state highways in Massachusetts:[45]

> Understanding road conditions before, during, and after winter weather events is critical for roadway safety and mobility. Massachusetts DOT (MassDOT) received a State Transportation Innovation Council (STIC) grant to purchase mobile road weather information stations (MARWIS) for fleet vehicles to help improve situational awareness of the road network.
>
> The sensors determine road condition, height of ice, water, or snow, grip level, air temperature, relative humidity, dew point, frost point, and road temperature. The information is collected through a mobile application and transmitted to supervisors and the office in real-time. This is critical as these supervisors make final decisions on road treatment.
>
> The mobile sensors have provided significant improvements in MassDOT's salt use. When assessing predicted salt application versus actual last winter season, MassDOT only used 86 percent of its predicted salt amount. This resulted in approximately 18,000 fewer tons of salt used with a cost savings of over $900,000. In addition, this reduction also leads to significant reductions in environmental impacts from salt application.

The MassDOT had equipped its vehicles with the Vaisala Mobile Detector MD30.[46] Features of the Vaisala Mobile Detector MD30 include the following:[47]

- Compact, multi-parameter mobile sensor
- Designed for any vehicle
- Proven technology optimized for mobile measurements
- Simultaneous water, ice, and snow layer reporting
- Molded design to withstand heavy vibration and water ingress
- Patent pending double hood for window protection
- Hand removable hood for easy window cleaning
- Targeted to enable more accurate maintenance decision making and salt usage optimization

[45]U.S. Department of Transportation, Federal Highway Administration, Every Day Counts (EDC) News Weekly Newsletter; November 4, 2021.
[46]Additional information on the Vaisala Mobile Detector MD30 can be accessed at https://www.vaisala.com/en/measurement/road-winter-maintenance.
[47]Due to the significant difference in climate and system size between Texas and Massachusetts, the efficacy of the system may not be comparable. TxDOT is working with the University of Texas in evaluating a similar vehicle mounted system and is familiar with this type of technology.

The MassDOT had 25 vehicles equipped with the Vaisala Mobile Detector MD30 in its fleet to date and has been using the detector for approximately 2 years. **Figure 13** illustrates the Vaisala Mobile Detector MD30.

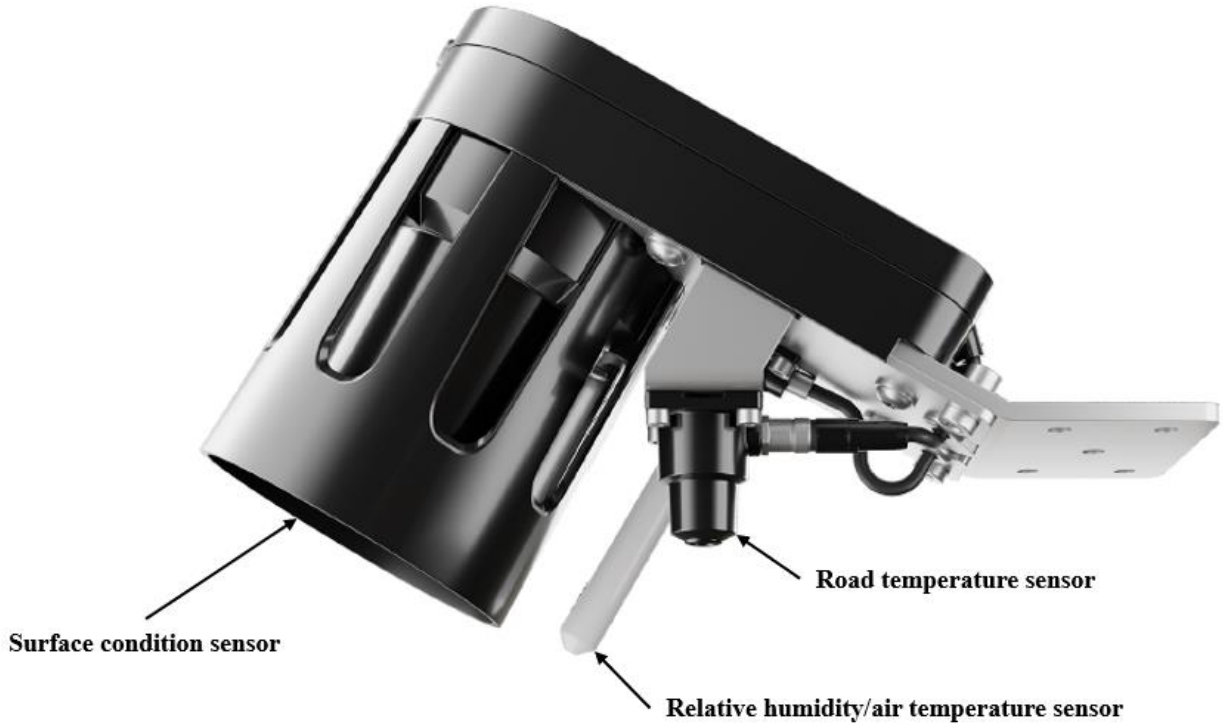

Figure 13 – Vaisala Mobile Detector MD30 used on MassDOT vehicles (Source: Vaisala Road Winter Maintenance revised).

The specifications require the surface condition sensor be pointed toward the wheel path and the road temperature sensor be pointed toward the ground. **Figure 14** illustrates the Vaisala Mobile Detector MD30 mounted on the front bumper of a MassDOT vehicle.

Figure 14 – Vaisala Mobile Detector MD30 mounted on the front bumper of a MassDOT vehicle (Source: MassDOT).

The Vaisala Mobile Detector MD30 can also be mounted beneath the front and rear bumpers on MassDOT vehicles as illustrated in **Figure 15**.

Figure 15 – Vaisala Mobile Detector MD30 mounted beneath the front and rear bumpers on MassDOT vehicles (Source: MassDOT).

8. Other Fatal Crashes that occurred between February 10-11, 2021, in the Dallas – Fort Worth, Texas Metroplex

Table 13 summarizes other fatal crashes that occurred between February 10-11, 2021, in the Dallas – Fort Worth, Texas metroplex due to icy road conditions.

Table 13 – Other fatal crashes that occurred between February 10-11, 2021, in the Dallas – Fort Worth, Texas metroplex due to icy road conditions.

Crash Date	Crash Time	County Name	Location	Number of Fatalities	Description
2/10/21	11:15 pm	Dallas	I-45 @ Lamar Street[48]	1	Pedestrian was struck and killed due to vehicles sliding on the ice. The weather conditions at the time of the crash were reported as sleet/hail and the surface conditions were reported as ice. The roadway alignment was reported as straight with a hillcrest.[49]
2/11/21	0:52 am	Dallas	I-45 @ Illinois Avenue	2	Vehicle lost traction on overpass due to ice and collided with concrete barrier wall. Vehicle was redirected across the freeway and collided with metal guardrail. Vehicle slid down metal guardrail and overturned striking light pole. The surface conditions at the time of the crash were reported as icy.[50]

9. NTSB Meteorology Specialist's Factual Report

The NTSB *Meteorology Specialist's Factual Report* provides a meteorological review on the weather conditions and National Weather Service (NWS) products applicable to the local Fort Worth, Texas area around the time of the crash and for the days preceding the crash. The full report can be found in the NTSB public docket for this investigation.[51] Highlights from the NTSB *Meteorology Specialist's Factual Report* include the following:

1. **Surface Observations** – A review of the Fort Worth Meacham International Airport (KFTW), Fort Worth, Texas, observations prior to the crash indicated between 0134 and 0210 CST light freezing rain and mist were reported. It was the first measurable precipitation reported in February, with less than 0.01 inches reported during that period. The crash also occurred after approximately 36 hours of consecutive below freezing temperatures reported at KFTW.

[48]I-45 is operated and maintained by TxDOT.
[49]See Highway Factors Attachment: Texas Peace Officer's Crash Report at 2315 on February 10, 2021.
[50]See Highway Factors Attachment: Texas Peace Officer's Crash Report at 0052 on February 11, 2021.
[51]The NTSB public docket can be accessed at https://data.ntsb.gov/Docket/Forms/searchdocket and keying in HWY21FH005 for the NTSB Accident ID number.

2. **Hazardous Weather Outlook** - The NWS Dallas/Fort Worth (KFWD) Weather Forecast Office (WFO) issued several Hazardous Weather Outlooks (HWO) from February 8, 2021, up until the time of the crash.

a. ***224 AM CST Mon Feb 8 2021*** - *.DAYS TWO THROUGH SEVEN...Tuesday through Sunday. There is a chance of freezing rain and sleet Wednesday night into Thursday across North Texas. No significant impacts are expected at this time.*

b. ***1143 AM CST Mon Feb 8 2021*** - *.DAYS TWO THROUGH SEVEN...Tuesday through Sunday. There is a chance of freezing rain and sleet Wednesday night into Thursday across North Texas. No significant impacts are expected at this time.*

c. ***218 PM CST Mon Feb 8 2021*** - *.DAYS TWO THROUGH SEVEN...Tuesday through Sunday. There is a chance of freezing rain and sleet Wednesday night into Thursday across North Texas. No significant impacts are expected at this time.*

d. ***605 PM CST Mon Feb 8 2021*** - *.DAYS TWO THROUGH SEVEN...Tuesday through Sunday. There is a chance of freezing rain and sleet Wednesday night into Thursday across North Texas. No significant impacts are expected at this time.*

e. ***340 AM CST Tue Feb 9 2021*** - *.DAYS TWO THROUGH SEVEN...Wednesday through Monday. There is a chance of freezing rain and sleet late Wednesday into Thursday across North Texas. Some minor accumulations on area roads, especially bridges and overpasses, may cause a few travel delays.*

f. ***744 AM CST Tue Feb 9 2021*** - *.DAYS TWO THROUGH SEVEN...Wednesday through Monday. There is a chance of freezing rain and sleet late Wednesday into Thursday across North Texas. Some minor accumulations on area roads, especially bridges and overpasses, may cause a few travel delays.*

g. ***1213 PM CST Tue Feb 9 2021*** - *.DAYS TWO THROUGH SEVEN...Wednesday through Monday. There is a chance of freezing rain and sleet late Wednesday into Thursday across North Texas. Some minor accumulations on area roads, especially bridges and overpasses, may cause a few travel delays.*

h. ***339 PM CST Tue Feb 9 2021*** - *.DAYS TWO THROUGH SEVEN...Wednesday through Monday. Areas of freezing rain are expected to develop again late Wednesday into Thursday across North Texas. Some minor ice accumulations on area roads, especially bridges and overpasses, will likely cause a few travel delays.*

i. ***359 AM CST Wed Feb 10 2021*** - *.DAY ONE...Today and Tonight. Areas of freezing drizzle or light freezing rain remain possible through tonight, mainly for areas along and northwest of a line from Sulphur Springs to Goldthwaite. This*

could result in ice accumulations and travel impacts on area roads, particularly bridges and overpasses.

j. ***346 PM CST Wed Feb 10 2021*** *- .DAY ONE...Tonight. Areas of freezing rain and drizzle will develop tonight and continue into early Thursday. A few bursts of sleet may also occur in thunderstorms overnight. This could result in ice accumulations and travel impacts on area roads, particularly bridges and overpasses.*

k. ***835 PM CST Wed Feb 10 2021*** *- .DAY ONE...Tonight. Areas of freezing rain and drizzle will develop tonight and continue into early Thursday. A few bursts of sleet may also occur in thunderstorms overnight. This could result in ice accumulations and travel impacts on area roads, particularly bridges and overpasses.*

l. ***411 AM CST Thu Feb 11 2021*** *- .DAY ONE...Today and Tonight. Areas of freezing rain and drizzle will continue through mid afternoon, with the best chances along and south of I-20. Precipitation will gradually shift south with time and should be confined to the Central Texas counties by afternoon. This could result in ice accumulations and travel impacts on area roads, particularly bridges and overpasses.*

m. ***553 AM CST Thu Feb 11 2021*** *- .DAY ONE...Today and Tonight. Areas of freezing rain and light sleet will continue across both North and Central Texas this morning, before ending in North Texas by midday. This afternoon, another more widespread area of freezing rain and sleet is expected to move into Central Texas. This could result in ice accumulations and travel impacts on area roads, especially on bridges and overpasses.*

3. **Winter Weather Messages** – The NWS issues Winter Weather Messages (WSW) whenever a winter weather event such as snow, sleet, ice, or dangerous wind chills are expected to occur that can impact public safety.[52] The following advisories were issued by the NWS KFWD WFO from February 10, 2021, up until the time of the crash.

a. ***1157 PM CST Wed Feb 10 2021*** *- ...WINTER WEATHER ADVISORY REMAINS IN EFFECT UNTIL 3 PM CST THURSDAY... * WHAT...Areas of freezing rain and freezing drizzle will continue into early Thursday. Some brief bursts of sleet may also occur at times. Ice accumulations of up to 1/10 of an inch will be possible, mainly on elevated surfaces. Some slick roads, bridges, and overpasses can be expected through Thursday.*

b. ***526 AM CST Thu Feb 11 2021*** *- ...WINTER WEATHER ADVISORY NOW IN EFFECT UNTIL NOON CST TODAY... * WHAT...Areas of light freezing rain and some sleet will continue through the morning hours. This could result in ice*

[52]NWS instruction 10-513 Winter Weather Products Specifications.

accumulations of up to 1/10 of an inch, mainly on elevated surfaces. Some slick roads, bridges, and overpasses can be expected through the morning.

4. **Storm Summary** - The NWS KFWD WFO issued a summary of the event on February 11-12, 2021, with a map of the ice accumulations across the region as illustrated in **Figure 16**.

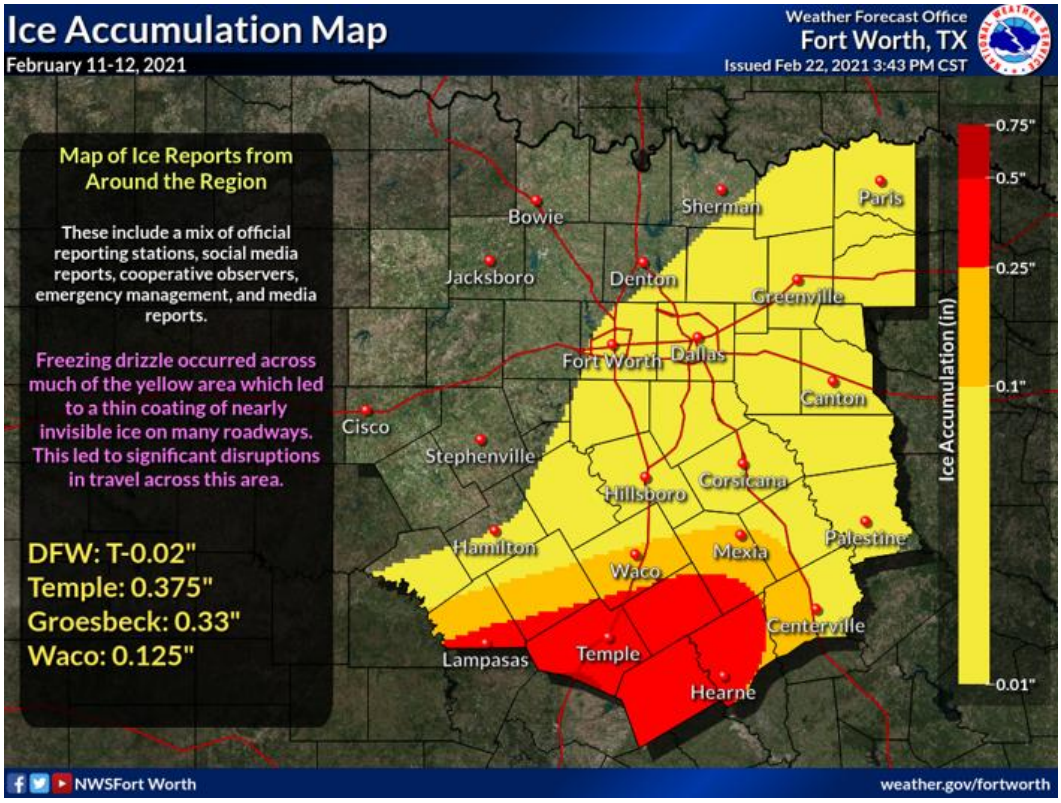

Figure 16 – Fort Worth, Texas Summary of the February 11-12, 2021 Ice Storm (Source: NWS).

According to the NWS the highest ice accumulations up to 0.5-inches occurred across portions of central Texas.

What caused the event? The record cold spell and extended period of wintry weather was caused by the upper-level polar vortex[53] dropping south from the north pole and then lingering over south-central Canada for more than a week. This allowed cold arctic air to gradually spill southward into Texas. At the same time several upper-level disturbances riding the jet stream moved through the area providing lift and moisture for winter precipitation. These disturbances show up as waves or dips in the lines that move in from the west. Ahead of each wave upper-

[53] Polar vortex is a persistent, large-scale, upper-level area of low pressure and cold air surrounding the Earth's poles. The term "vortex" refers to the counterclockwise flow of air that helps keep the colder air near the Poles. It is a common feature and typically increases in strength during the winter and weakens during the summer as thermal gradients weaken. During winter in the northern hemisphere, the polar vortex will expand, sending cold artic air southward with the jet stream.

level lift increases and moisture is drawn up from the south. Since it was already so cold, this precipitation fell as snow, sleet, and freezing rain.

5. **Astronomical Conditions** - At the time of the accident dark nighttime conditions prevailed with both the sun and the moon below the horizon, with overcast clouds reported over the area.

10. NTSB Witness Interviews

NTSB investigators conducted a total of 30 interviews of staff with the NTE Mobility Partners Segments 3, LLC (NTEMP S3), the Fort Worth Police Department (FWPD), the Fort Worth Fire Department (FWFD), and the Metropolitan Area EMS Authority (MedStar). A copy of interview transcriptions for each interview can be found in the NTSB public docket for this investigation.[54]

Table 14 lists the names, titles, organization, and date of interview. All of the witness interviews were transcribed.

Table 14 – Summary of NTSB Witness Interviews.

Witness Interview Names	Witness Interview Titles	Organization	Date of Interview
Myron Davis	Maintenance Manager	NTEMP S3	March 31, 2021
Jorge Escobar	Maintenance Technician	NTEMP S3	June 23, 2021
Ray Gonzalez	Maintenance Technician	NTEMP S3	March 31, 2021
Edgar Hernandez	Maintenance Technician	NTEMP S3	June 23, 2021
Cutter Kittrell	Maintenance Technician	NTEMP S3	June 23, 2021
Edward Longoria	Maintenance Technician	NTEMP S3	March 31, 2021
Claude McClure	Supervisor	NTEMP S3	June 23, 2021
Kevin Porter	Maintenance Technician	NTEMP S3	March 31, 2021
Darroen Reed	Customer Service Technician	NTEMP S3	June 23, 2021
Andrew Robinson	Maintenance Technician	NTEMP S3	March 31, 2021
Adam Tobias	Maintenance Supervisor	NTEMP S3	March 31, 2021
Jonathan Torres	Night Shift Lead	NTEMP S3	June 23, 2021
Mathew Waldrop	Maintenance Technician	NTEMP S3	June 23, 2021
Brandon Warde	Customer Assistance	NTEMP S3	March 31, 2021
Andrew Williams	Maintenance Technician	NTEMP S3	June 23, 2021
Richard Camacho	Sergeant	FWPD	March 31, 2021
Tyler Glapa	Sergeant	FWPD	March 31, 2021
Shawn Greene	Officer	FWPD	March 31, 2021
Marcus Mendoza	Officer	FWPD	March 31, 2021

[54]The NTSB public docket can be accessed at https://data.ntsb.gov/Docket/Forms/searchdocket and keying in HWY21FH005 for the NTSB Accident ID number. See the following: Highway Factors Attachment: NTE Mobility Partners Segments 3, LLC Witness Interview Transcripts; Highway Factors Attachment: Errata Sheets to NTE Mobility Partners Segments 3, LLC Witness Interview Transcripts; Highway Factors Attachment: Fort Worth Police Department Witness Interview Transcripts; Highway Factors Attachment: Fort Worth Fire Department Witness Interview Transcripts; and, Highway Factors Attachment: Metropolitan Area EMS Authority Witness Interview Transcripts.

Tamara Valle	Officer	FWPD	March 31, 2021
Matthew Brown	Engineer	FWFD	March 30, 2021
Steven Brownen	Lieutenant	FWFD	March 30, 2021
Brian Call	Lieutenant	FWFD	March 30, 2021
Courtney Pennington	Lieutenant	FWFD	March 30, 2021
Calvin Tipton	Captain	FWFD	March 30, 2021
Randy Behringer	Medic	MedStar	March 30, 2021
Dwight McDaniel III	Medic	MedStar	March 30, 2021
Richard Ponikiewski	Medic	MedStar	March 30, 2021
Heath Stone	Operations Manager	MedStar	March 30, 2021
James Ward	Lead Field Medic	MedStar	March 30, 2021

Specific information taken from the witness interviews can be grouped according to the following topic areas:

- Topic Area #1 – Were the pavement conditions slippery when responding to the crash? (Topic begins on page 45)
- Topic Area #2 – Did first responders get hurt while responding to the crash due to the slippery conditions? (Topic begins on page 49)
- Topic Area #3 – What devices are used to detect moisture or icy road conditions? (Topic begins on page 50)
- Topic Area #4 – Is there any formal certification to become a spot checker? (Topic begins on page 52)

Topic Area #1 – Were the pavement conditions slippery when responding to the crash?

Richard Camacho – Sergeant – Fort Worth Police Department - Date of Interview: March 31, 2021

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Q. And what did you observe about the roadway when you got out?
A. The road was slick. Actually walking on – it was slick to the point like, basically, it's like being on an ice rink. And I was walking up the service road, and it's kind of inclined there, if you know how that incline is, and it was pretty slick.

Tyler Glapa – Sergeant – Fort Worth Police Department - Date of Interview: March 31, 2021

Page 7 o1 *Q. And, when you got out of your car, what did you observe about*
the roadway?
A. It was very slick.

Marcus Mendoza – Officer – Fort Worth Police Department - Date of Interview: March 31, 2021

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Q. And what were the conditions like?
A. When I arrived?
Q. When you first got –
A. When I first got on, they – on the main lanes, there was cars scattered throughout the lanes. Of course, the tollway,

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there was the pileup. And the road, when I stepped out of my vehicle, it was completely slick, like it was ice. I mean, cars were barely able to move, and I had to balance myself.

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Q. Okay. You indicated earlier that when you got out of your vehicle, you slipped and slide.
A. That's correct.
Q. Did you see any other individuals slipping and sliding?
A. Yes, there was multiple firemen out there sliding around, and then actually, one of the firemen started pulling sand bags, and he gave me a sandbag, and he told me, you need to make a walkway so we don't slip attending to the victims.

Tamara Valle – Officer – Fort Worth Police Department - Date of Interview: March 31, 2021

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Q. Okay.
A. When I did get out, it was very slippery, and immediately getting out of the car, it was slippery, and then once you started to walk a little farther down – there was two portions of the accident. Towards the – I guess the beginning half that was further to the south, that's where it was very slippery.

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Q. ...Did you see any other individuals while you were there slip and slide?
A. Oh, absolutely.
Q. Can you give approximate number or –
A. Fifteen, twenty.
Q. Fifteen people?
A. Oh, yeah.
Q. Okay.

A. Because, you know, once people started coming out from the toll lanes of the crash, they would get over, and it was super slippery.

Matthew Brown – Engineer – Fort Worth Fire Department - Date of Interview: March 30, 2021

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Q. Okay. When you got out of the vehicle on the southbound toll lanes, did you slip or –
A. I had a handle to hold onto, and yeah, I needed it. And everyone that was there was falling, I mean, the whole time.
Q. So you saw numerous individuals slipping and –
A. Oh, absolutely.
Q. -- falling.
A. Absolutely.

Brain Call – Lieutenant – Fort Worth Fire Department - Date of Interview: March 30, 2021

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Q. Okay. When you got out of your vehicle, did you experience icy conditions –
A. Yes.
Q. -- on the southbound general use lanes?
A. Yes.
Q. Okay. Did you hop over the barrier at any point to the southbound toll lanes?
A. Yes.
Q. Okay. Did you experience icy conditions walking on the southbound toll lanes?
A. Yes.

Courtney Pennington – Lieutenant – Fort Worth Fire Department - Date of Interview: March 30, 2021

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Q. Did you walk on the – any other portion of I-35 besides the southbound toll lanes? Did you --
A. Yes.
Q. -- walk on the northbound toll lane?
A. No, I just stayed on the southbound toll lane, but I jumped over on the regular 35 and walked, and it was slick in there too.

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Q. That was slick as well?
A. Yes. I recall that being slick.
Q. The same amount of slickness?
A. It did not feel as slick to me as the tollway. That's just my personal opinion. I remember thinking, oh my gosh, this is so slick, you could wipeout. Usually, you can kind of sort of catch yourself. This was so slick, you had to be very, very careful. Like it was extra slick for whatever reason.
Q. And you're – what you're referring to is the southbound toll lane?
A. Correct, correct.

Calvin Tipton – Captain – Fort Worth Fire Department - Date of Interview: March 30, 2021

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Q. All of them, okay. And so what was the roadway like when you began to walk on it?
A. Well, we got out to get the people into our truck, and it was a sheet of ice.

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Q. Did you experience any slipping and sliding personally?
A. Oh, yeah.
Q. Okay. Did you see any other individuals slipping and sliding?

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A. Oh, everybody.
Q. Okay. On the general – on the northbound general use lanes?
A. Yes.
Q. Did you see individuals slipping on the northbound toll lanes and southbound toll lanes?
A. Yes.

Dwight McDaniel III – Medic – Metropolitan Area EMS Authority - Date of Interview: March 30, 2021

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Q. Okay. When you got to the crash scene, did you see any other individuals slip or slide?
A. Yes.
Q. How many?

A. I'd have to count in my head – at least ten people. I know a couple of the arriving fire crews, a couple of them weren't aware of how slippery it was, and they slipped while they were approaching the wreckage. I know I saw a couple of the people that were involved as they were walking out of their vehicles, they were slipping as well. Yeah, there were at least two firefighters I remember falling on their back. I, myself, I fell twice. Yeah. It was – if I – if I had to put a number, I'm sure it was more people, but that's just who I saw.

James Ward – Lead Field Medic – Metropolitan Area EMS Authority - Date of Interview: March 30, 2021

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Q. Just to summarize, again, the pavement conditions for the southbound toll lanes in the vicinity of the crash, could you summarize those pavement conditions when you arrived on scene?
A. When I hopped over the barrier, they were – they were hard – difficult to walk on. I never drove on them. I was only

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walking on them because I was on regular southbound. I was not on the expressway. So they were very slick, handling patients and everything else over the wall. Barriers were completely iced over and everything like that. But they were – they were slick.

Q. Okay. Can you describe the pavement condition in the general southbound purpose lanes adjacent to the southbound toll lanes?
A. They were slick.
Q. They were slick. Okay.
A. Those were the ones I was on and slid across."

Topic Area #2 – Did first responders get hurt while responding to the crash due to the slippery conditions?

Richard Camacho – Sergeant – Fort Worth Police Department - Date of Interview: March 31, 2021

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He had actually slipped, slipped crossing over from the southbound side over the wall into the expressway. I believe that's where he slipped. And he fell, and he ended up injuring his shoulder. So that was initially my mission was try to get him out and get him some help.
Q. Okay.

21 A. So I had to basically walk probably half a mile just to get
22 to him. So it was pretty slick. It was pretty slick. I mean,
23 the roads were slicked over by that point.

Tamara Valle – Officer – Fort Worth Police Department - Date of Interview: March 31, 2021

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20 Q. Okay.
21 A. And I don't know if – we had another officer that actually
22 did slip and hurt his shoulder on the ice, and he was dispatched
23 to the toll lanes, but he jumped the concrete median to help in
24 the main lanes, and he ended up hurting his shoulder, and he was
25 taken to the hospital from that scene."

Topic Area #3 – What devices are used to detect moisture or icy road conditions?

Jorge Escobar – Maintenance Technician – NTE Mobility Partners Segments 3, LLC - Date of Interview: June 23, 2021

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16 Q. Do you use any other devices such as bridge sensor detection
17 systems or Roadway Information Systems to detect moisture or icy
18 road conditions?
19 A. No, I don't. I think customer assist they do go out there
20 with a – check the bridge temperatures, but as far as we do is
21 just basically brake checking.

Cutter Kittrell – Maintenance Technician – NTE Mobility Partners Segments 3, LLC - Date of Interview: June 23, 2021

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24 Q. Do the spot checks solely rely on visual observation?
25 A. To the best of my knowledge, yes.

Claude McClure – Supervisor – NTE Mobility Partners Segments 3, LLC - Date of Interview: June 23, 2021

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25 Q. Do you use any other devices to detect moisture, such as

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1 bridge sensor detection systems or Road Weather Information

Systems?
A. The only thing that we do – I can tell you that we do for that stuff is we check bridge temperatures.
Q. And how do you do that?
A. With the bridge – our customer assist. It's to check all the bridges. He has a laser. He'll send us the data and we'll put it on a sheet and send it when we have those for documentation of doing those too. Yeah, we just take the bridge temperature with one of those little laser readings. Bridge decks, I mean.

Darroen Reed – Customer Service Technician – NTE Mobility Partners Segments 3, LLC - Date of Interview: June 23, 2021

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Q. No? Okay. And when you detect moisture, it's a visual observation, correct?
A. Yes, sir.
Q. It relies solely on visual observation?
A. Yes, sir.
Q. You don't use any other sensor – bridge sensor –
A. No, sir, I don't.
Q. -- programs or Roadway Information Systems to detect moisture?
A. No, sir.

Jonathan Torres – Night Shift Lead – NTE Mobility Partners Segments 3, LLC - Date of Interview: June 23, 2021

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Q. Do you use any other devices to detect moisture, such as bridge sensor detection systems and Road Weather Information Systems?
A. The temperature of the bridges, we do have a temperature gun that we do have our customer assist to be checking, yes, on bridges.
Q. Okay. Describe how that is done.
A. If there's going to be a cold night, we usually tell our

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customer assist to take that temperature gun, go on one of the high bridges and check the temperature and just report back what it says, and that's how our manager will figure out, like, if it needs to be detected – or protected, I mean, checked over.

Mathew Waldrop – Maintenance Technician – NTE Mobility Partners Segments 3, LLC - Date of Interview: June 23, 2021

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Q. Okay. Do the spot checks solely rely on visual observation?
A. No. We also do light brake checks as well.
Q. Okay. And do you use any other devices to detect moisture such as bridge sensor detection systems or Road Weather Information Systems?
A. No.

Andrew Williams – Maintenance Technician – NTE Mobility Partners Segments 3, LLC - Date of Interview: June 23, 2021

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Q. So would you say your spot checks rely on visual observation only?
A. Well, yes, and then I come through that area and – every 30 minutes to an hour and just check, you know what I'm saying? That's what I did, you know.
Q. Do you use any other devices like bridge sensor monitors or Roadway Information Systems to detect moisture or icy road conditions?
A. No, I didn't (indiscernible)."

Topic Area #4 – Is there any formal certification to become a spot checker?[55]

Jorge Escobar – Maintenance Technician – North Tarrant Express Mobility Partners Segments 3 - Date of Interview: June 23, 2021

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Q. Okay. Do you receive formal certification to become a spot checker?
A. No, we just had – usually, the training classes are called, I guess, rodeo – snow and ice rodeo[56] *or something and they just basically go over all the equipment we're going to be using during the snow and ice and how to do it and they split up into teams, maybe four or five people to a group, and they have like different sections that they go over.*

Cutter Kittrell – Maintenance Technician – North Tarrant Express Mobility Partners Segments 3 - Date of Interview: June 23, 2021

[55]There is no recognized authority offering "formal certification" as a spot checker for roadway ice.
[56]See Highway Factors Attachment - 2020 NTEMP S3 Snow and Ice Rodeo Agenda.

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Q. Do you receive formal certification to become a spot checker?
A. No, sir.
Q. Can you talk about the training you received to become a spot checker?
A. There wasn't any training. They basically just tell us to drive and stop and if we skid, you know, that's pretty much it.

Claude McClure – Supervisor – North Tarrant Express Mobility Partners Segments 3 - Date of Interview: June 23, 2021

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Q. Do you receive any formal certification to become a spot-checker?
A. There's no formal certification. It's just more of a

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training. Basically, it's our duty to go out there to make sure that the roads are safe, working for NTE.

Darroen Reed – Customer Service Technician – North Tarrant Express Mobility Partners Segments 3 - Date of Interview: June 23, 2021

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Q. Okay. Do you receive any formal certification for when you -- to detect moisture, when you –
A. No, sir.
Q. No formal certification?
A. No, sir.
Q. Can you talk about the training, any training that you received, to detect moisture?
A. I have no – anything – any training pertaining to detecting

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moisture.
Q. Right. You received no training?
A. No, sir.

Jonathan Torres – Night Shift Lead – North Tarrant Express Mobility Partners Segments 3 - Date of Interview: June 23, 2021

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12 Q. Okay. Do you receive formal certification to become a spot
13 checker?
14 A. Do I have a certification? Not that I know of, no.

Mathew Waldrop – Maintenance Technician – North Tarrant Express Mobility Partners Segments 3 - Date of Interview: June 23, 2021

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22 Q. Okay. As part of your spot checks, do you receive formal
23 certification to become a spot checker?
24 A. No. I mean, we get our snow and ice training, but it's
25 not a card or anything, but they do tell us what to

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1 look for, how to check.

Andrew Williams – Maintenance Technician – North Tarrant Express Mobility Partners Segments 3 - Date of Interview: June 23, 2021

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9 Q. Did – do you receive, like, a formal certification to become
10 a spot checker? Do you receive a certificate or anything of that
11 sort?
12 A. We have been to classes, you know what I'm saying, to show
13 how to work these machines."

11. NTSB Research and Engineering Video Study

The NTSB *Video Specialist's Factual Report* provides a review of video files obtained during the investigation. The video files obtained during the investigation include the following:

- Four MPEG-4 (.mp4) video files from two traffic cameras located near the accident site.
- Two .mp4 video files downloaded from an onboard image recorder installed on a combination vehicle that was involved in the accident.[57]
- One .mp4 video file from a bystander that recorded portions of the accident sequence with their cell phone.

[57]This specific combination vehicle consisted of a truck tractor pulling a FedEx Ground semi-trailer.

The full report can be found in the NTSB public docket for this investigation.[58] Highlights from the NTSB Video Specialist's Factual Report include the following:

1. Two traffic cameras 1 and 2, near the accident site recorded video data leading up to and including the accident. Four video files, two files from each camera, were transmitted electronically to the NTSB for review. The NTSB *Video Specialist's Factual Report* described vehicles sliding and spinning down the roadway, vehicles striking the concrete barrier, vehicles impacting multiple previously crashed vehicles, and the traffic conditions.

2. **Figure 17** illustrates the locations of traffic cameras 1 and 2 relative to the accident scene.

Figure 17 – Locations of traffic cameras 1 and 2 relative to the accident scene (Source: NTSB *Video Specialist's Factual Report*).

3. Traffic camera 1 was located on the east side of I-35W, south of the Yucca Avenue exit. Traffic camera 1 could be rotated to view toward the south or north. **Figure 18** is a screenshot of traffic camera 1's view when it was facing toward the south at the beginning of the recording.

[58]The NTSB public docket can be accessed at https://data.ntsb.gov/Docket/Forms/searchdocket and keying in HWY21FH005 for the NTSB Accident ID number.

Figure 18 – Screenshot of traffic camera 1's view when it was facing toward the south at the beginning of the recording (Source: NTSB *Video Specialist's Factual Report*).

4. **Figure 19** is a screenshot of traffic camera 1's view after it panned and faced toward the north about 22 minutes into the recording.

Figure 19 – Screenshot of traffic camera 1's view after it panned and faced toward the north about 22 minutes into the recording (Source: *NTSB Video Specialist's Factual Report*).

5. Traffic camera 2 was located on the east side of I-35W, north of the Yucca Avenue exit. Traffic camera 2 was fixed to view north toward an express lanes electronic variable pricing sign and could not be rotated. The express lanes electronic variable pricing sign obstructed the view of a large portion of the roadway. **Figure 20** is a screenshot of traffic camera 2's view for the duration of the recording.

Figure 20 – Screenshot of traffic camera 2's view north toward an express lane electronic variable pricing sign (Source: NTSB *Video Specialist's Factual Report*).

6. Traffic cameras 1 and 2 contained the date, local time, and location information in the upper-left corner.

7. The NTSB *Video Specialist's Factual Report* provides a table indicating the traffic conditions in each travel lane at the start of each video recording and every 5 minutes thereafter for traffic cameras 1 and 2. Traffic conditions were also indicated for selected events deemed pertinent for the video illustrating a semi-truck pulling a FedEx Ground trailer.

The traffic conditions are categorized as follows:

- Green (G) – vehicles were moving near or above normal or 'free-flow' speeds, with little to no congestion
- Yellow (Y) – vehicles were moving slower than normal or 'free-flow' speeds, minor congestion
- Red (R) – vehicles were completely stopped or in stop-and-go traffic, major congestion

A sample of a table indicating the traffic conditions as it appeared in the NTSB *Video Specialist's Factual Report* is shown below:

SB		NB	
General Use	Tolled	Tolled	General Use
Y	Y	G	R

8. **Figure 21** is a screenshot of the semi-truck pulling a FedEx Ground trailer at the beginning of the video traveling in the I-35W southbound toll lanes.

Figure 21 – Screenshot of the semi-truck pulling a FedEx Ground trailer at the beginning of the video traveling in the I-35W southbound toll lanes (Source: NTSB *Video Specialist's Factual Report*).

9. Two videos from a forward-facing onboard image recorder on a combination vehicle were sent electronically to the NTSB for review.[59] The videos contained the date and timestamp in the upper-right corner. Below the date and timestamp was a GPS-derived speed and the speed limit in miles per hour (mph). The NTSB *Video Specialist's Factual Report* described the elevated road surface as shiny and reflective, the speed of the combination vehicle at different time intervals, the traffic conditions, the roadway ahead was blocked with multiple vehicle collisions, and the combination vehicle sliding and striking the rear of different vehicles.[60]

10. A cell phone video from a bystander (referred to as Bystander 1 as shown in **Figure 15**) who was standing in the left shoulder of the southbound general use lanes adjacent to a concrete barrier approximately 1/3 mile north of Northside Drive/Yucca Avenue was sent electronically to the NTSB for review. The NTSB *Video Specialist's Factual Report* described a list of the vehicles in the bystander video, the tops of the concrete barriers and roadway appeared shiny and reflective consistent with freezing precipitation, vehicles sliding at a high rate of speed toward the previously crashed vehicles that were blocking the roadway, vehicles colliding into the queue of other vehicles that had previously crashed, vehicles sliding sideways down the roadway toward the accident site, and a person seen exiting a previously crashed vehicle and climbing over the concrete barrier separating the southbound toll lanes and southbound general use lanes.

11. The lighting conditions were dark for all videos sent electronically to the NTSB for review.

[59]This specific combination vehicle consisted of a truck tractor pulling a FedEx Ground semi-trailer.
[60]Refer to the NTSB *Video Specialist's Factual Report* in the public docket regarding the speed of the combination vehicle at different time intervals and the traffic conditions.

12. Research on brine used by NTE Mobility Partners Segments 3, LLC

NTEMP S3 maintenance technicians pretreated the I-35W southbound toll lanes on February 9, 2021, at 10:12 a.m., approximately 44 hours before the crash with an Ice Slicer NM brine solution. Ice Slicer NM is available as a commercial product from EnviroTech Services Inc. and the predominant ingredient is sodium chloride, commonly known as salt, which makes up 90-98% of Ice Slicer NM.[61] NTEMP S3 closed-circuit television (CCTV) camera located north of Northside Drive/Yucca Avenue pointing towards the crash site confirmed an NTEMP S3 truck and brine sprayer applying the brine solution to the I-35W southbound toll lanes on February 9, 2021, at 10:12 a.m.

NTEMP S3 used a AccuBatch Brine Maker to fabricate the brine solution to a 23.3% salinity in accordance with TxDOT recommendations and best practices.[62] The AccuBatch Brine Maker is capable of producing up to 800 gallons of brine solution per batch.[63] In addition, the Brine Maker is pre-calibrated at a 23.3% rate and does not require additional calibration under the manual user and vendor instructions.

Figure 22 illustrates the AccuBatch Brine Maker located at the NTEMP S3 maintenance facility.

Figure 22 – AccuBatch Brine Maker located at the NTEMP S3 maintenance facility (Source: photograph taken on April 29, 2021, by NTSB investigators).

[61]Ice Slicer NM is comprised of sodium chloride (90-98%), magnesium chloride (0.30-3.0%), potassium chloride (0.30-3.0%), and calcium chloride (0.30-3.0%).
[62]NTEMP S3 received the Accubatch Brine Maker from Cargill Deicing Technology on April 29, 2020.
[63]See Highway Factors Attachment: AccuBatch Brine Maker Operator Manual located at the NTEMP S3 maintenance facility.

NTEMP S3 maintenance technicians applied the Ice Slicer NM brine solution to the I-35W southbound toll lanes on February 9, 2021from Western Center Boulevard (milepost 57.5) to Spur 280 (milepost 51.6), a distance of approximately 5.9 miles. The crash occurred at milepost 53.5. The Ice Slicer NM brine solution was applied at a rate of approximately 44 gallons per lane mile.

Figure 23 illustrates the NTEMP S3 truck and brine sprayer that applied the brine solution to the I-35W southbound toll lanes located at the NTEMP S3 maintenance facility.[64] The brine solution was held in a tank and distributed through a sprayer apparatus that consisted of 4 nozzles on each side of the truck to spray the adjacent lanes and shoulders. Additional nozzles were located in the back of the truck to spray the lane in which the truck was travelling. The capacity of the tank was approximately 1,235 gallons.

[64]The NTEMP S3 truck was a 2009 Western Star dump track with 3 axles. The NTEMP S3 brine sprayer was a Henderson LAS X liquid application sprayer. See Highway Factors Attachment: Henderson LAS X liquid application sprayer located at the NTEMP S3 maintenance facility.

Figure 23 – NTEMP S3 truck and brine sprayer that applied the brine solution to the I-35W southbound toll lanes located at the NTEMP S3 maintenance facility (Source: photograph taken on April 29, 2021, by NTSB investigators).

The NTEMP S3 advised NTSB investigators the optimum efficiency of the Ice Slicer NM brine solution was 24-to-72 hours (or 1-to-3 days) in advance of a storm. For the reader's reference, the Ice Slicer NM brine solution was applied by NTEMP S3 maintenance technicians to the I-35W southbound toll lanes approximately 44 hours before the crash.

The National Cooperative Highway Research Program (NCHRP) Report 526 *Snow and Ice Control: Guidelines for Materials and Methods* indicated the following regarding pretreating with liquid chemicals:[65]

> **Pretreating for and Treating Frost, Black Ice, and Icing with Liquid Chemicals**
>
> …A 23-percent solution of liquid NaCl applied at 40 to 60 gal/LM (or equivalent effective amount of other chemical) has proven to provide protection from these conditions that are nonprecipitation events…In the absence of precipitation, these treatments are effective for at least 3 days and possibly up to 5 days depending on traffic volume. If the liquid treatment is allowed to dry before the event, it will be slightly more effective.

The Texas Department of Transportation (TxDOT) *Snow and Ice Control Operations Manual* indicated the following regarding pretreating with liquid chemicals:[66]

> **Section 5 – Recommendations for Use of Liquid Chemicals**
>
> **Pretreatment**

[65] *Snow and Ice Control: Guidelines for Materials and Methods*, National Cooperative Highway Research Program (NCHRP) Report 526, Robert R. Blackburn and Karin M. Bauer, Midwest Research Institute, Kansas City, MO; Duane E. Amsler, Sr., AFM Engineering Services, Slingerlands, NY; S. Edward Boselly, Weather Solutions Group, Olympia, WA; and A. Dean McElroy, Consultant, Overland Park, KS; 2004, page 21.
[66] *Snow and Ice Control Operations Manual*, Texas Department of Transportation (TxDOT), January 2017, page 2-7.

A pretreatment can be made prior to a storm, as long as the storm does not start out with above freezing temperatures and rain, washing the chemical away.

Benefits from liquid pretreatments can include higher friction and better pavement conditions early in a storm. These benefits are generally short-lived and should not be expected over a long period. Subsequent chemical applications should be made as soon as conditions begin to deteriorate. Pretreatments can be thought of as "buying time" in the early stages of a storm until subsequent chemical applications become effective.

Figure 24 illustrates the underside of a generic bridge. Bridges are exposed to the surrounding air on all sides.[67] Bridge decks will at some point match below freezing temperatures, and the combination of below freezing temperatures and a small amount of precipitation can create a thin layer of black ice on the bridge.[68]

Figure 24 – Underside of a generic bridge. White arrows represent surrounding air on all sides of the bridge and not wind direction (Source: Google Earth Street view image revised).

[67]Bridges and overpasses are prone for black ice because cold air is able to flow underneath the road surface, since it is elevated, therefore lowering the pavement temperature. Once formed black ice is hard to detect and leads to hazardous driving conditions and an increased risk of car accidents.

[68]The National Weather Service (NWS) defines "black ice" as patchy ice on roadways or other transportation surfaces that cannot easily be seen. It is often clear (not white) with the black road surface visible underneath. It is most prevalent during the early morning hours, especially after snow melt on the roadways has a chance to refreeze overnight when the temperature drops below freezing. Black ice can also form when roadways are slick from rain and temperatures drop below freezing overnight. Common locations for black ice formation include bridges, elevated overpasses, and spots on the road shaded by trees or another object.

13. Injury severity including vehicle and occupant information

Table 15 summarizes the injury severity for the vehicle occupants and pedestrians involved in the multi-vehicle crash.

Table 15 – Injury severity for the vehicle occupants and pedestrians involved in the multi-vehicle crash.

Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	Fatalities	Not Injured	Unknown	Total
14	66	6	6	23	21	**136**

Tables 16 and 17 summarize the vehicle and occupant information for the six fatalities involved in the multi-vehicle crash.

Table 16 – Vehicle information for the six fatalities involved in the multi-vehicle crash.

	Vehicle Year	Vehicle Color	Vehicle Make	Vehicle Model	Body Style
Fatality 1[69]	n/a	n/a	n/a	n/a	n/a
Fatality 2[70]	n/a	n/a	n/a	n/a	n/a
Fatality 3	2017	White	Ford	F250	Pickup
Fatality 4	2020	Red	Ford	F250	Pickup
Fatality 5	2007	White	Ford	F350	Pickup
Fatality 6	2017	Gray	Honda	Accord	P4

Table 17 – Occupant information for the six fatalities involved in the multi-vehicle crash.

	Person Type	Seat Position	Age	Sex	Ejected	Restraint Used
Fatality 1[71]	n/a	n/a	45	Male	n/a	n/a
Fatality 2[72]	n/a	n/a	46	Female	n/a	n/a
Fatality 3	Driver	Front Left	54	Male	No	Shoulder and lap belt
Fatality 4	Driver	Front Left	49	Male	No	Shoulder and lap belt
Fatality 5	Driver	Front Left	47	Male	No	Shoulder and lap belt
Fatality 6	Driver	Front Left	34	Female	No	Shoulder and lap belt

[69]Occupant left their vehicle and was struck as a pedestrian in the southbound toll lanes.
[70]Ibid.
[71]Ibid.
[72]Ibid.

The vehicle damage rating was identical for all four vehicles that involved fatalities within their vehicles and included the following:

- Vehicle Damage Rating 1 - the force was head-on and distributed across the front of the vehicle with total damage.

- Vehicle Damage Rating 2 – the force was from the rear and distributed across the rear of the vehicle with total damage.

The Fort Worth Police Department did not cite any of the drivers in the multivehicle crash for excessive speed or driving too fast.[73]

14. Research of Other Private and State Regulated Toll Facilities

NTSB investigators conducted a survey of 9 private and state regulated toll facilities to determine their snow and ice removal pre-treatment operations.[74] The 9 private and state regulated toll facilities included the following:

1. Chicago Skyway located in Chicago, IL
2. Dulles Greenway located in Sterling, VA
3. Intercounty Connector located in Montgomery and Prince George's County, MD
4. Massachusetts Turnpike located in Boston, MA
5. North Texas Tollway Authority located in Plano, TX
6. Northwest Parkway located in Broomfield, CO
7. Pocahontas Parkway located in Richmond, VA
8. Southern Connector located in Piedmont, SC
9. State Highway 130 Segments 5 and 6 located in Buda, TX

The following provides the survey list of questions to each of the 9 private and state regulated toll facilities:

General Operations:

1. Is the toll facility private or state regulated?
2. When was the toll facility officially opened to traffic?
3. How many lane miles does the toll facility maintain?
4. How many days did the toll facility respond to snow and ice removal events in each of the last 5 years?

	2016	2017	2018	2019	2020
Days with Snow and Ice Removal Events					

[73] The lack of evidence sufficient to issue such citations is not meant to imply that the drivers in the multivehicle crash were driving at speeds that were reasonable for the circumstances.
[74] See Highway Factors Attachment: Responses to Survey of Toll Facilities.

Snow and Ice Removal Pre-treatment Operations: Describe and/or provide documentation of the following:

5. All pre-treatment options and subsequent chemical applications currently used by the toll facility during snow and ice removal events.

   5a. How long each specific pre-treatment option and subsequent chemical applications are effective in treating the roadway after initial application.

   5b. Any formal criteria of when to use specific pre-treatment options and subsequent chemical applications.

Snow and Ice Removal: Describe and/or provide documentation of the following:

6. An inventory (trucks, plows, front-end loaders, spreaders, etc.) including the number of covered salt storage facilities and quantities of salt that are dedicated to snow and ice removal events.

7. Methods/technologies to monitor moisture and ice formation on roadways, highway overpasses, or bridges.

   7a. If you use sensor detection systems, the systems, and procedures for their use.

   7b. If you do not use sensor detection systems, any future plans by the toll facility to utilize them or other technologies capable of monitoring moisture and ice formation on roadways, highway overpasses or bridges.

8. Procedures for snow and ice removal.

   8a. If you have formal procedures in place, provide a copy of the established procedures.

9. Training procedures for maintenance technicians who perform spot checks and inspections of road conditions during snow and ice removal events. Provide details on the training procedures necessary to become a spot checker (i.e., initial number of training days/hours, certification requirements, length of annual refresher courses, etc.)

Documentation Checklist: Please provide the following if available.

- ✓ Pre-treatment options, durations of effectiveness, and criteria for use
- ✓ Inventory of snow and ice equipment
- ✓ Systems/methods used to detect moisture and icy conditions
- ✓ Operational and training procedures for snow and ice removal
- ✓ Contract between toll authority and state, including snow and ice removal events

15. NTEMP S3 Post-Crash Initiatives

The NTEMP S3 initiated the following post-crash initiatives:

1. The fleet of maintenance vehicles that are equipped for winter maintenance has been increased. The inventory of dump trucks is being increased from three to six. The number of pick-up trucks has been increased from ten to thirteen. While previously three

pick-up trucks were outfitted to spray brine, now ten pick-up trucks can do so. These vehicles are still shared for use along Segments 1-3 of the road.

2. Salt storage has been increased by over 400 tons.

3. National Weather Service continues to be used for weather forecasting, in addition to local weather stations. A new weather forecast vendor, DTN,[75] that provides more localized and customized forecasts and alerts, has been added. This vendor also provides 24/7 access to a meteorologist and pavement temperature forecasting.

4. Eighteen weather sensors from Frost Technologies have been added.[76] These weather sensors capture air and pavement temperatures, as well as relative humidity. Photographs of the road are also transmitted. The weather sensors have been strategically placed in areas where freezing is more likely to occur. These sensors also trigger real-time alerts via email to designated employees when certain conditions are detected on the road.[77]

5. Maintenance vehicles have been equipped with infrared thermometers and with GPS devices and controllers from Force America (dump trucks only) linked to the sprayers and spreaders.[78] Data can be captured electronically that previously had to be captured manually and make them real-time accessible through a computer dashboard. It also allows the technicians to obtain pavement temperature readings without having to stop and exit the vehicles.

6. Training materials have been updated to include the new technologies and processes that have been implemented. On-line AASHTO training has also been adopted.

16. Speed Limit Laws in Texas

TxDOT is a statutory agency, created by the Texas Legislature through statute and having only the powers delegated to it through statute. TxDOT has been granted no authority to use speed safety cameras, variable speed limit signs, or automated speed enforcement. Speed limits are set by statute according to the type of road (Texas Transportation Code Chapter 545, Subchapter H, Section 545.352).[79] TxDOT is granted authority to alter those speed limits through the Texas Transportation Commission only after conducting an engineering and traffic investigation. The engineering and traffic investigation shall follow TxDOT's Procedures for Establishing Speed Zones as adopted by the commission.[80] TxDOT's Procedures for Establishing Speed Zones indicated the following:

[75] Information about DTN's transportation solutions is available here: Transportation - DTN
[76] Information about Frost Technologies' weather stations is available here: Advanced Infrared Site Monitoring | Frost Technologies (frostcontrolsys.com).
[77] See Highway Factors Attachment - NTEMP S3 Information on New Weather Sensors and Training Materials.
[78] Specifically, NTEMP S3 is using the ARC Air and Conditions System (infrared thermometer), the IX-402-G (GPS) and 5100 EX (dump truck controller).
[79] https://statutes.capitol.texas.gov/Docs/TN/htm/TN.545.htm.
[80] Procedures for Establishing Speed Zones, Texas Department of Transportation, revised August 2015.

Section 2 – Determining the 85th Percentile Speed

General Concepts

The maximum speed limits posted as the result of a study should be based primarily on the 85th percentile speed, when adequate speed samples can be secured. The 85th percentile speed is a value that is used by many states and cities for establishing regulatory speed zones.

Speed checks should be made as quickly as possible, but it is not necessary to check the speed of every car. In many cases, traffic will be much too heavy for the observer to check all cars.

Theory

Use of the 85th percentile speed concept is based on the theory that:

- the large majority of drivers:
    - are reasonable and prudent
    - do not want to have a crash
    - desire to reach their destination in the shortest possible time
- a speed at or below which 85 percent of people drive at any given location under good weather and visibility conditions may be considered as the maximum safe speed for that location."

In Texas, the burden is on the driver to drive at a reasonable speed for the circumstances, regardless of what the posted speed limit is (Texas Transportation Code Chapter 545, Subchapter H, Section 545.351).

"Sec. 545.351. MAXIMUM SPEED REQUIREMENT. (a) An operator may not drive at a speed greater than is reasonable and prudent under the circumstances then existing. (b) An operator:

(1) may not drive a vehicle at a speed greater than is reasonable and prudent under the conditions and having regard for actual and potential hazards then existing; and

(2) shall control the speed of the vehicle as necessary to avoid colliding with another person or vehicle that is on or entering the highway in compliance with law and the duty of each person to use due care.

(c) An operator shall, consistent with Subsections (a) and (b), drive at an appropriate reduced speed if:

(1) the operator is approaching and crossing an intersection or railroad grade crossing;

(2) the operator is approaching and going around a curve;

(3) the operator is approaching a hill crest;

(4) the operator is traveling on a narrow or winding roadway; and

(5) a special hazard exists with regard to traffic, including pedestrians, or weather or highway conditions."

D. DOCKET MATERIAL

The following attachments and photographs are included in the docket for this investigation:

LIST OF ATTACHMENTS

Highway Factors Attachment – Average daily traffic volumes on the I-35W southbound toll lanes in the vicinity of the crash from April 2018 through February 2021.

Highway Factors Attachment – Portions of Amended and Restated Facility Agreement, North Tarrant Express Segments 3A, 3B and 3C Facility between Texas Department of Transportation and NTE Mobility Partners Segments 3 LLC, dated July 30, 2019.

Highway Factors Attachment – Typical section of I-35W in the vicinity of the crash.

Highway Factors Attachment – Vertical alignment of I-35W southbound toll lanes in the vicinity of the crash.

Highway Factors Attachment – Excerpts of as-built construction plans of I-35W in the vicinity of the crash.

Highway Factors Attachment – Excerpts of speed studies performed by TxDOT in the I-35W southbound toll lanes for a distance of approximately 8 miles.

Highway Factors Attachment - NTE Mobility Partners Segments 3, LLC Microwave Vehicle Detectors (MVD) deployed and speed data along the corridor in the southbound toll lanes before and after the crash location.

Highway Factors Attachment – Excerpts of signage as-built plans on I-35W in the vicinity of the crash.

Highway Factors Attachment – Excerpts of illumination as-built plans on I-35W in the vicinity of the crash.

Highway Factors Attachment – Rumble strip detail on I-35W in the vicinity of the crash.

Highway Factors Attachment – 2019 Pavement Inspection Report, North Tarrant Expressway, Segment 3, May 2020, prepared by Data Transfer Solutions, LLC.

Highway Factors Attachment – First alert received by NTEMP S3 for this winter weather alert provided by the National Weather Service at approximately 10:32 a.m. on February 8, 2021.

Highway Factors Attachment – Texas Peace Officer's Crash Report at 0300 on February 11, 2021.

Highway Factors Attachment – Texas Peace Officer's Crash Report at 0600 on February 11, 2021.

Highway Factors Attachment – Excerpts from the logs of the 7 dynamic message signs (DMS) utilized by NTEMP S3 within 8.3 miles of the crash site with the messages displayed and corresponding dates and times.

Highway Factors Attachment – Location of Environmental Sensor Stations (ESS) in the TxDOT Districts.

Highway Factors Attachment – Texas Peace Officer's Crash Report at 2315 on February 10, 2021.

Highway Factors Attachment – Texas Peace Officer's Crash Report at 0052 on February 11, 2021.

Highway Factors Attachment – NTE Mobility Partners Segments 3, LLC Witness Interview Transcripts.

Highway Factors Attachment – Errata Sheets to NTE Mobility Partners Segments 3, LLC Witness Interview Transcripts.

Highway Factors Attachment – Fort Worth Police Department Witness Interview Transcripts.

Highway Factors Attachment – Fort Worth Fire Department Witness Interview Transcripts.

Highway Factors Attachment – Metropolitan Area EMS Authority Witness Interview Transcripts.

Highway Factors Attachment - 2020 NTEMP S3 Snow and Ice Rodeo Agenda.

Highway Factors Attachment – AccuBatch Brine Maker Operator Manual located at the NTEMP S3 maintenance facility.

Highway Factors Attachment – Henderson LAS X liquid application sprayer located at the NTEMP S3 maintenance facility.

Highway Factors Attachment – Responses to Survey of Toll Facilities.

Highway Factors Attachment - NTEMP S3 Information on New Weather Sensors and Training Materials.

LIST OF PHOTOGRAPHS

Highway Factors Photo 1 – View of I-35W southbound toll lanes standing on the left paved shoulder immediately north of the crash scene illustrating patches of ice on the roadway surface and top of the concrete barrier separating the I-35W southbound toll lanes and I-35W northbound toll lanes with the downtown Fort Worth skyline shown in the background looking to the south.

Highway Factors Photo 2 – View of northern end of the I-35W southbound toll lanes crash scene standing on the left paved shoulder of the I-35W southbound general use lanes looking to the south.

Highway Factors Photo 3 – Another view of northern end of the I-35W southbound toll lanes crash scene standing on the left paved shoulder of the I-35W southbound general use lanes looking to the south.

Highway Factors Photo 4 – View of damaged vehicles at the northern end of the I-35W southbound toll lanes crash scene standing on the left paved shoulder of the I-35W southbound general use lanes looking to the southeast.

Highway Factors Photo 5 – Another view of damaged vehicles at the northern end of the I-35W southbound toll lanes crash scene standing on the left paved shoulder of the I-35W southbound general use lanes looking to the southeast.

Highway Factors Photo 6 – View of damaged vehicles at the northern end of the I-35W southbound toll lanes crash scene standing on the left paved shoulder of the I-35W southbound general use lanes looking to the northeast.

Highway Factors Photo 7 – View of damaged vehicles at the northern end of the I-35W southbound toll lanes crash scene standing above the white pavement marking separating the right paved shoulder from the right travel lane of the I-35W southbound toll lanes looking to the north.

Highway Factors Photo 8 – View of damaged vehicles at the northern end of the I-35W southbound toll lanes crash scene standing above the travel lanes of the I-35W southbound toll lanes looking to the south.

Highway Factors Photo 9 - View of damaged vehicles at the midsection of the I-35W southbound toll lanes crash scene standing on the left paved shoulder of the I-35W southbound general use lanes looking to the south.

Highway Factors Photo 10 – View of damaged vehicles at the southern end of the I-35W southbound toll lanes crash scene standing on the left paved shoulder of the I-35W southbound general use lanes illustrating bags of coated salt on top of the concrete barrier used by first responders to treat ice on the roadway surface looking to the southeast.

Highway Factors Photo 11 – View of damaged vehicles at the southern end of the I-35W southbound toll lanes crash scene standing on the left paved shoulder of the I-35W southbound general use lanes illustrating bags of coated salt on top of the concrete barrier used by first responders to treat ice on the roadway surface looking to the northeast.

Highway Factors Photo 12 – View of damaged vehicles at the southern end of the I-35W southbound toll lanes crash scene standing on the left paved shoulder of the I-35W southbound toll lanes looking to the north.

Highway Factors Photo 13 - View of damaged vehicles at the southern end of the I-35W southbound toll lanes crash scene standing on the left paved shoulder of the I-35W northbound toll lanes illustrating bags of coated salt on top of the concrete barrier used by first responders to treat ice on the roadway surface looking to the northwest.

Highway Factors Photo 14 – View of damaged tractor pulling a FedEx trailer hanging over the concrete barrier separating the I-35W southbound toll lanes and I-35W northbound toll lanes standing on the left travel lane of the I-35W northbound toll lanes looking to the north.

Highway Factors Photo 15 – View of damaged tractor pulling a FedEx trailer hanging over the concrete barrier separating the I-35W southbound toll lanes and I-35W northbound toll lanes standing on the right travel lane of the I-35W northbound toll lanes looking to the south.

Highway Factors Photo 16 - View of damaged tractor pulling a FedEx trailer hanging over the concrete barrier separating the I-35W southbound toll lanes and I-35W northbound toll lanes standing on the left paved shoulder of the I-35W northbound toll lanes looking to the south.

Highway Factors Photo 17 – View of damaged vehicles at the northern end of the I-35W southbound toll lanes crash scene standing on the left travel lane of the I-35W southbound toll lanes looking to the north.

Highway Factors Photo 18 – View of damaged vehicles at the northern end of the I-35W southbound toll lanes crash scene standing on the right travel lane of the I-35W southbound toll lanes illustrating the ice on the roadway surface looking to the southwest.

END OF REPORT

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