National Transportation Safety Board
Office of Marine Safety
Washington, DC 20594

DCA24MM031

METEOROLOGY

Specialist's Factual Report

November 12, 2024

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A. ACCIDENT

Location: Baltimore, Maryland
Date: March 26, 2024
Time: 0129 eastern daylight time (EDT)
0529 universal coordinated time (UTC)
Vessel: *M/V Dali*

B. METEOROLOGY SPECIALIST

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C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Senior Meteorologist was not on scene for this investigation and conducted the meteorology phase of the investigation remotely, collecting data from official National Weather Service (NWS) sources including the Weather Prediction Center (WPC) and the National Center for Environmental Information (NCEI). All times are eastern daylight time (EDT) based upon the 24 hour clock, local time is +4 hours to UTC, and UTC=Z. Directions are referenced to true north and distances in nautical miles. Heights are in feet (ft) above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident site was located at latitude 39.236445° N and longitude 76.529216° W, at the time of the collision[1] with the bridge as the ship was departing Baltimore Harbor on the Patapsco River and approaching the Chesapeake Bay.

D. FACTUAL INFORMATION

1.0 Synoptic Conditions

The synoptic or large scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction (NCEP).

[1] The ship's power loss occurred at approximately 0127 EDT.

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 0200 EDT on March 26, 2024, with the approximate accident site marked by the red star is included as figure 1. The chart depicted a high pressure system over the area with a central pressure of 1026-hectopascals (hPa)[2] with a ridge[3] extending southward over Maryland, Virginia, into the Carolina's. The station models depicted general calm to light winds, clear skies, with temperatures in the mid 40's and 30's degrees Fahrenheit (°F) over the region. No significant weather was depicted in the vicinity of the accident site.

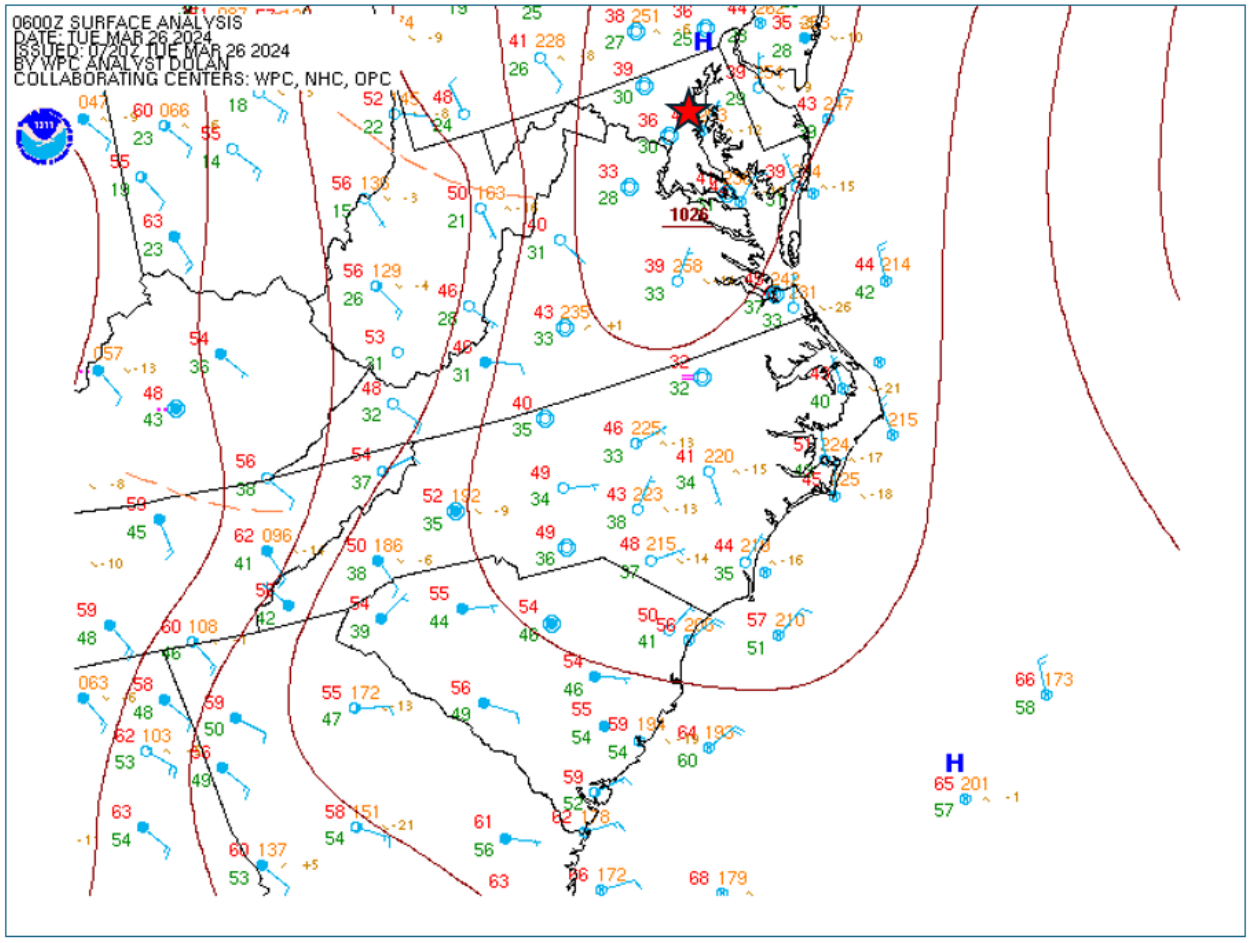

Figure 1 - NWS Surface Analysis Chart over the central-east portion of the United States for 0200 EDT with the approximate accident site marked by the red star.

[2] Hectopascals (hPa) is the standard unit for reporting pressure and is interchangeable with the former term millibar (mb) with the same units. Standard sea-level pressure is 1013.25-hPa.

[3] Ridge is an elongated area of high pressure is typically associated with light winds, generally clears skies, and fair weather. It can also be associated with radiation fog in the cooler months of the year is sufficient moisture is present.

2.0 Surface Observations

The closest weather reporting station were documented using official Aviation Routine Weather Reports (METAR) and Aviation Selected Special Weather Reports (SPECI), National Oceanic and Atmospheric Administration (NOAA) buoys, and other marine stations in the immediate vicinity. Cloud heights are reported above ground level (agl) in the following section. The magnetic variation was 11° west over the region. Figure 2 is a map of the general observation sites, and the approximate location of the accident site marked by the red star.

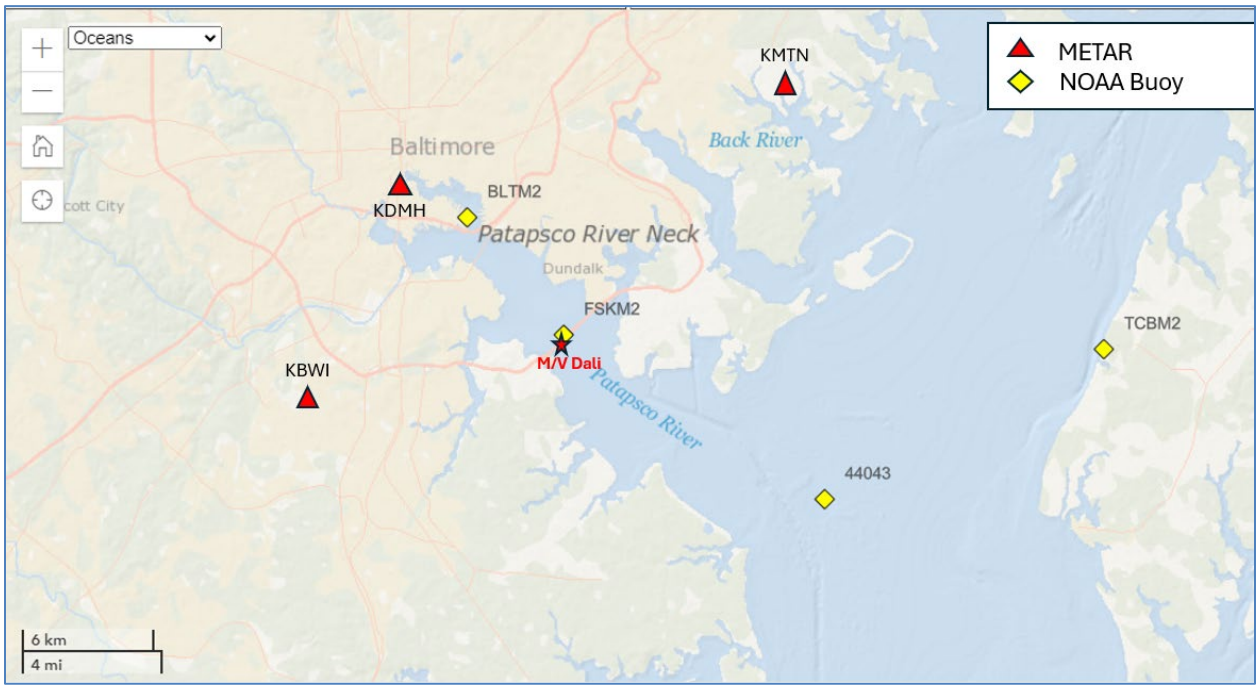

Figure 2 - General reporting points of atmospheric conditions over the area with the accident site marked by the red star.

2.1 Francis Scott Key Bridge, Maryland

The closest weather sensors were located on the Francis Scott Key Bridge northeast tower[4], station FSKM2 – 8574728, located about 0.25 miles north (azimuth of 17.5°) from the accident site at an elevation of 14.57 ft and is depicted in figure 3 with the approximate accident location marked by the red star. The station reported at 0130 EDT a calm wind, a temperature of 44° F, and a pressure of 30.27 inches of mercury (inHg). The following table of data was reported surrounding the period.

[4] The location is mounted on Dolphin 2.

Date	Time (EDT)	Wind Speed (kts)	Wind Dir (deg)	Peak Gust (kts)	Temp (°F)
2024/03/26	0100	0.97	292	1.36	43.9
2024/03/26	0106	0.0	284	0.58	43.7
2024/03/26	0112	0.97	034	1.36	43.9
2024/03/26	0118	0.58	061	1.17	44.1
2024/03/26	0124	0.58	049	1.56	44.1
2024/03/26	0130	0.78	051	1.56	44.4

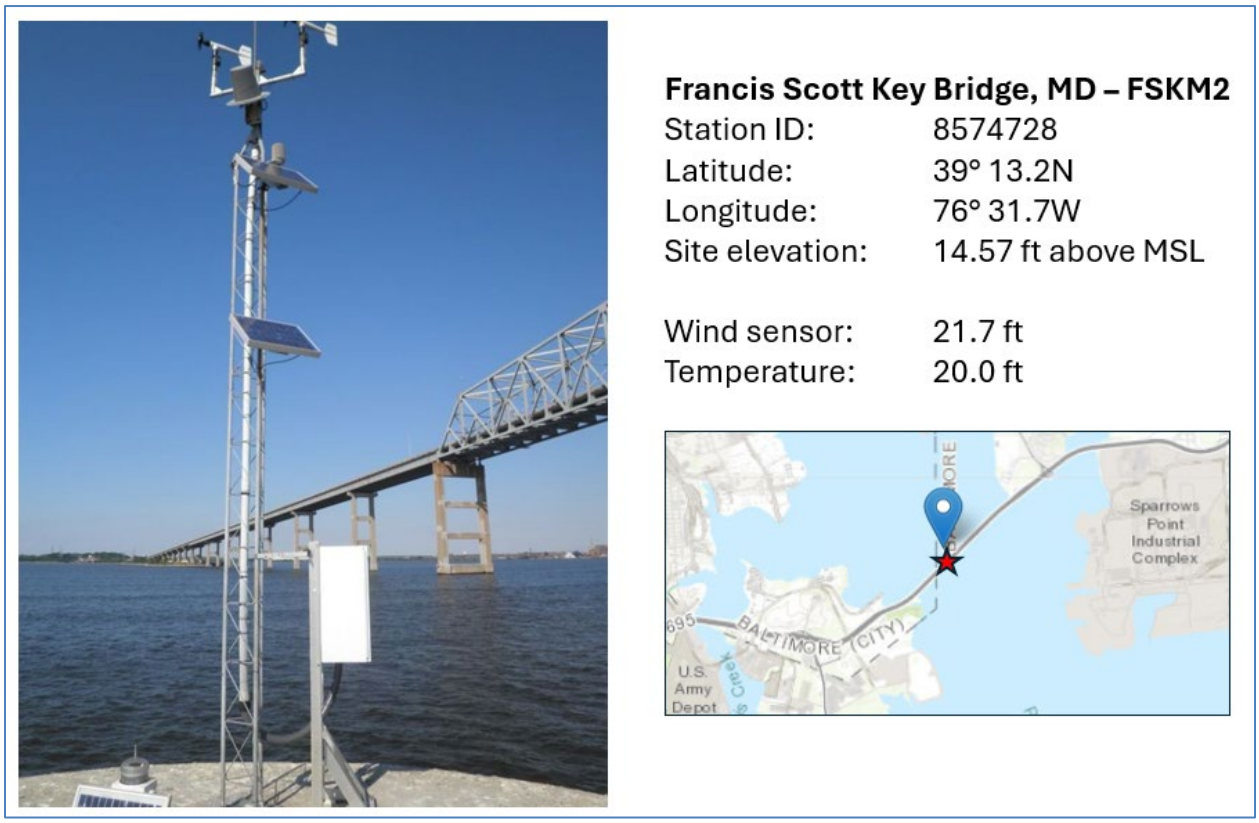

Figure 3 - Scott Key Bridge Weather Sensor.

2.2 Baltimore Harbor

Another shore based marine weather reporting site was within the Baltimore Harbor, station BLTM2 - 8574680, located about 4 miles northwest of the accident site at an elevation of 4.38 ft. Surrounding the time of the accident the station reported calm winds, temperature of 43°F, and a water temperature of 48°F. Figure 4 is a photo of the station and site specifics. Surrounding the period the following conditions were reported in table form below.

Date	Time (EDT)	Wind Speed (kts)	Wind Dir (deg)	Peak Gust (kts)	Temp (°F)	WTMP (°F)
2024/03/25	2300	3.89	143	6.41	46.6	48.4
2024/03/25	0000	0.19	196	1.17	45.0	48.4
2024/03/26	0100	0.00	262	0.00	43.7	48.4
2024/03/26	0118	0.00	M	0.00	43.7	48.3
2024/03/26	0124	0.00	M	0.5	43.7	48.3
2024/03/26	0130	0.00	M	0.0	43.7	48.3
2024/03/26	0136	0.00	M	0.0	43.7	48.3
2024/03/26	0200	3.11	067	3.5	44.6	48.4

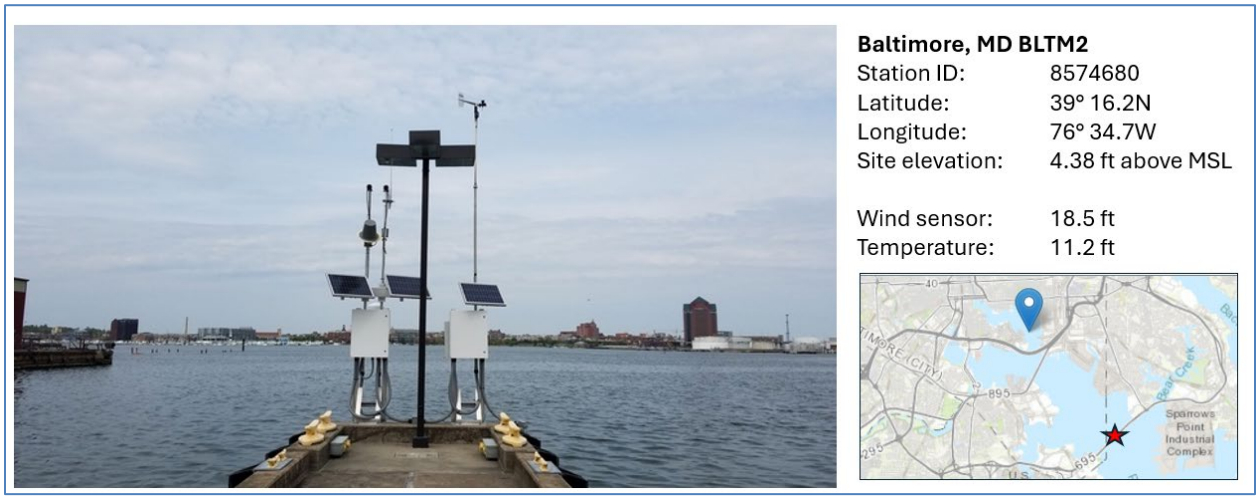

Figure 4 - Baltimore Harbor, BLTM2 – 8574680 located about 4 miles northwest of accident site.

2.3 Baltimore/Downtown

The Baltimore/Downtown weather station (KDMH) was located about 5.76 miles northwest of the accident site and the Key Bridge. The Automated Surface Observation System (ASOS) which did report, wind, visibility, weather type, or cloud information and was not augmented by any observers. At the time of the accident the following conditions were reported.

> *Baltimore/Downtown weather observation at 0053 EDT, automated, temperature 46°F (8°C)*[5]*, dew point temperature 30°F (-1°C), altimeter setting 30.30 inHg. Remarks: automated station without a precipitation discriminator, sea-level pressure 1026.2-hPa, temperature 8.3°C, dew point -0.6°C, 24-hour maximum temperature 14.0°C, minimum temperature 4.4°C.*

[5] Temperatures and dew point temperatures in METARs are typically provided in degrees Celsius (C). For this report they are converted to °F.

2.4 Baltimore/Washington International Airport

The next closest official weather observation reported was from Baltimore/Washington International Thurgood Marshall Airport (KBWI), Baltimore, Maryland, located 7 miles west-southwest of the accident site at an elevation of 143 ft. The airport had a federally installed and maintained ASOS, which was augmented by certified weather observers. At the time of the accident the following conditions were being reported.

> *Baltimore weather observation at 0054 EDT, wind calm, visibility 10 miles or more, a few clouds at 25,000 ft agl, temperature 39°F (4°C), dew point temperature 30°F (-1°C), altimeter setting 30.29 inHg. Remarks: automated station with a precipitation discriminator, sea-level pressure 1025.8-hPa, temperature 3.9°C, dew point -1.1°C, 24-hour maximum temperature 11.7°C, minimum temperature 0.6°C.*

A review of the observations for the previous 24 hours indicated clear and dry conditions with no precipitation of obscurations to visibility.

2.5 NWS Display of Observations

A depiction of the weather observations and regional weather radar image from the NWS Aviation Weather Center's website for 0130 EDT is included in figure 5, and graphically depicts the conditions at KDMH and KBWI. The regional weather radar mosaic for the period depicted no meteorological echoes associated with precipitation over the region during the period. The reporting stations surrounding the accident site all reported calm wind, visibility at 10 miles or more, with clear to a few high level clouds over the area at the time.

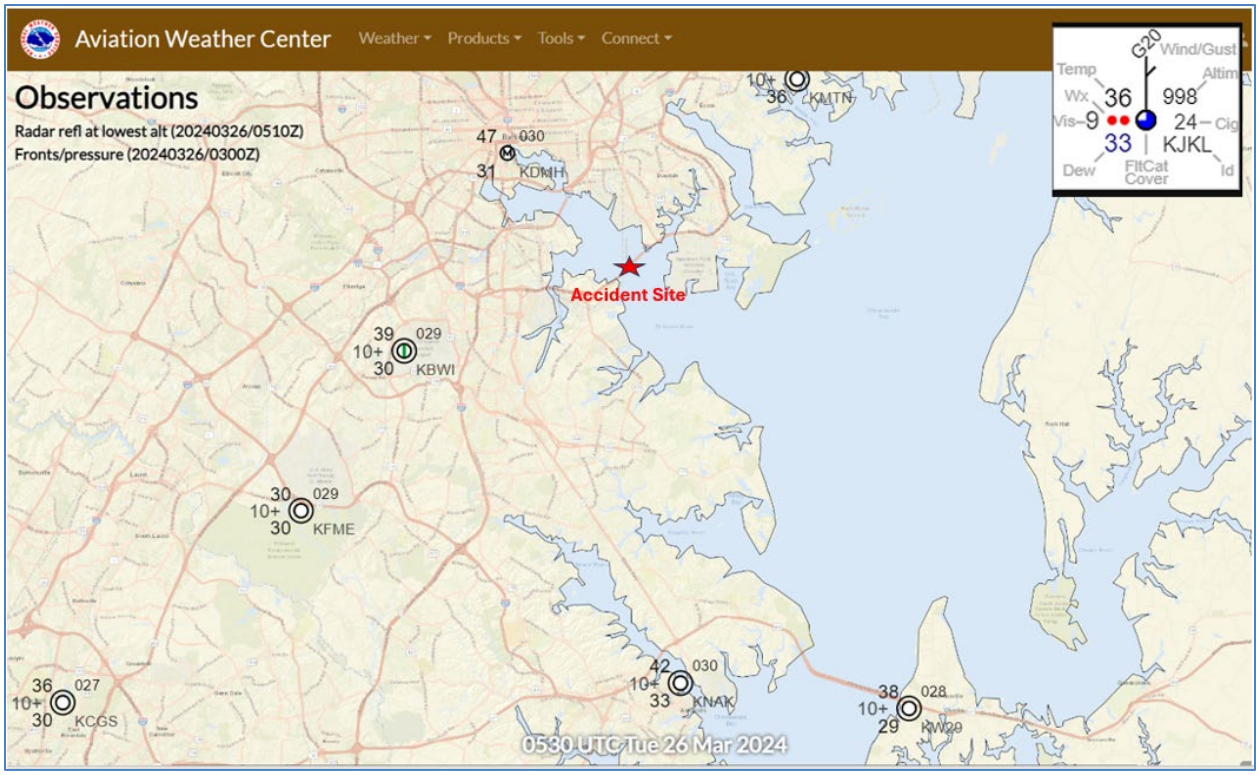

Figure 5 - NWS Aviation Weather Center depiction of observations and weather radar for 0130 EDT, with the approximate accident site is marked by the red star.

3.0 Tide Information

The Baltimore Harbor, station BLTM2 – 8574680, observed and predicted tide table[6] is included as figure 6. The predicted low tide for Baltimore was at 0220 EDT at 0.12 ft, which was verified at 1.82 ft. High tide was expected at 0820 EDT at 1.31 ft, and was verified at 3.11 ft.

[6] https://tidesandcurrents.noaa.gov/

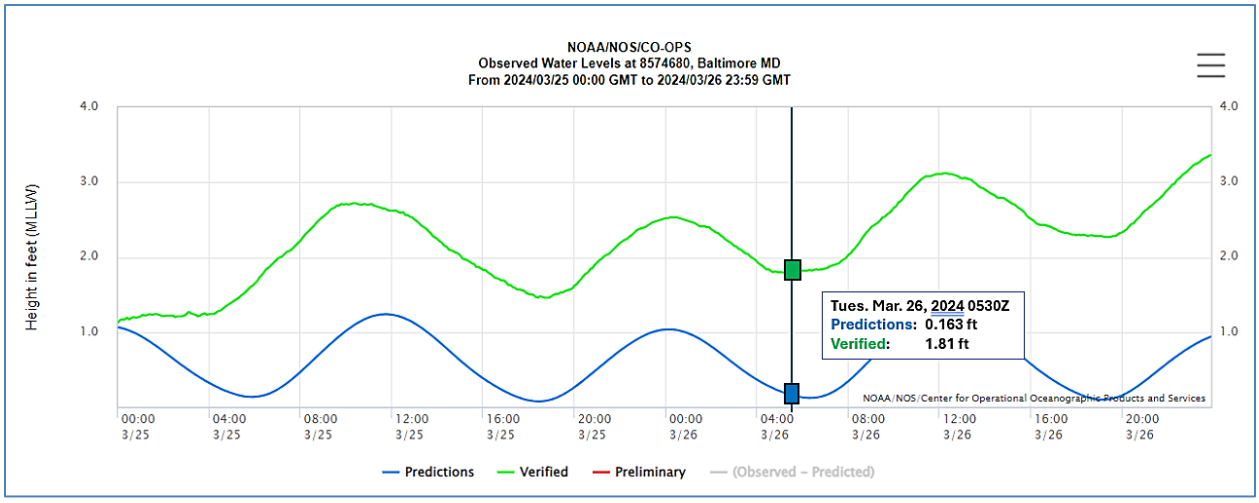

Figure 6 - Baltimore Harbor BLTM2 predicted and observed tidal information surrounding the period. The vertical line indicates the tidal conditions at the approximate time of the accident.

No current information was archived for retrieval.

4.0 NWS Weather Forecasts and Warnings

The NWS Baltimore/Washington (KLWX) Weather Forecast Office (WFO) located in Sterling, Virginia, was responsible for weather forecast and advisories over the area. The Coastal Waters Forecast (CWF), Area Forecast Discussion (AFD), and Coastal Hazard Messages (CFW) issued during the period are included below.

4.1 Coastal Waters Forecast

The NWS Coastal Waters Forecast current at the time of the accident was issued by KLWX at 2234 EDT on March 25, 2024, and was as follows:

FZUS51 KLWX 260234
CWFLWX

Coastal Waters Forecast
National Weather Service Baltimore MD/Washington DC
1034 PM EDT Mon Mar 25 2024

Tidal Potomac River and Maryland portion of Chesapeake Bay.

Forecasts of wave heights do not include effects of wind direction relative to tidal currents. Expect higher waves when winds are blowing against the tidal flow.

ANZ500-260800-
1034 PM EDT Mon Mar 25 2024
.SYNOPSIS FOR THE TIDAL POTOMAC AND MD PORTION OF THE CHESAPEAKE BAY...

High pressure will build into the area through Tuesday. *A slow moving front will approach the area Wednesday. Low pressure will develop along the coast Thursday and depart to the northeast Friday. Small Craft Advisories are likely Thursday through Friday.*

ANZ538-260800-
Patapsco River including Baltimore Harbor-
1034 PM EDT Mon Mar 25 2024

.REST OF TONIGHT...E winds 10 kt. Waves 1 ft.

.TUE...E winds 5 to 10 kt. Waves 1 ft.

.TUE NIGHT...SE winds 5 to 10 kt. Waves 1 ft.

.WED...SE winds 5 kt. Waves flat. A chance of rain.

.WED NIGHT...E winds 5 kt. Waves flat. Rain likely.

.THU...N winds 5 to 10 kt. Waves 1 ft. Rain likely.

.THU NIGHT...NW winds 10 to 15 kt with gusts to 25 kt. Waves 1 to 2 ft. A chance of rain.

.FRI...NW winds 15 to 20 kt...diminishing to 10 kt after midnight. Waves 1 to 2 ft.

.SAT...W winds 10 kt. Waves 1 ft.

4.2 Area Forecast Discussion

The NWS Area Forecast Discussions (AFD) are issued by each WFO to describe the short-term weather conditions within their region with a marine section that includes the general conditions as it relates to the creation of the local forecasts. These are useful for additional marine-related issues that cannot be encoded into the general coastal waters forecast and reasoning behind the forecast. These are generated roughly every 6 hours and corresponds to the release of the latest forecasts issued for that office. The NWS KILX WFO issued the following AFD at 2109 EDT on March 25, 2024, prior to the accident.

FXUS61 KLWX 260109
AFDLWX

Area Forecast Discussion
National Weather Service Baltimore MD/Washington DC
909 PM EDT Mon Mar 25 2024

.SYNOPSIS...
Surface ridging will keep fair and seasonable weather conditions through Tuesday.
Showers return to the area Tuesday night as a weak cold front approaches and eventually crosses the area Thursday morning. A backdoor front will cross the area Saturday.

.NEAR TERM /THROUGH TONIGHT/...
High-level cirrus is starting to move over the area. Otherwise, dry and quiet conditions prevail tonight. Some gusty downslope winds on the western slopes of the Alleghenies late tonight with gusts up to 30-35mph possible. Lows drop to the low to mid 30s.

.MARINE...
SCAs remain in effect through tonight with some gusts getting to 20 knots at times before dissipating Tuesday morning. Gusts likely stay below SCA criteria through Wednesday.

A front will be pushing through Thursday while low pressure develops offshore. N to NW winds will continually increase, and advisories appear likely Thursday into Friday. At least SCA-level northwesterly winds are expected on Thursday and Friday, with Gales possible.

.TIDES/COASTAL FLOODING...
Water levels have snapped back to elevated levels this evening and should continue to slowly rise over the next few days due to persistent onshore flow. Minor to moderate coastal flooding is expected over the next few days. Coastal Flood Advisories and Warnings are in effect to account for high tide impacts.

.LWX WATCHES/WARNINGS/ADVISORIES...
DC...Coastal Flood Advisory until 1 AM EDT Tuesday for DCZ001.
Coastal Flood Watch from 1 AM EDT Tuesday through Wednesday afternoon for DCZ001.
MD...Coastal Flood Advisory until 1 AM EDT Tuesday for MDZ017.
Coastal Flood Advisory until 3 PM EDT Wednesday for MDZ011-016-508.
Coastal Flood Advisory until 3 AM EDT Tuesday for MDZ014.
Coastal Flood Warning from 3 AM Tuesday to noon EDT Wednesday for MDZ014.
Coastal Flood Warning from 1 AM Tuesday to 6 AM EDT Wednesday for MDZ017.
Coastal Flood Advisory until 7 PM EDT Wednesday for MDZ018.
VA...Coastal Flood Advisory until 3 PM EDT Wednesday for VAZ053-055-057-527.
Coastal Flood Advisory until 3 PM EDT Wednesday for VAZ054.
WV...None.
MARINE...Small Craft Advisory until 5 AM EDT Tuesday for ANZ534-537-543.

SYNOPSIS...ADM
NEAR TERM...KRR
SHORT TERM...ADM
LONG TERM...KJP
AVIATION...KRR/ADM/KJP
MARINE...ADM/KJP
TIDES/COASTAL FLOODING...KRR

4.3 Coastal Hazard Message

The following Marine weather hazards were current during the period.

WHUS41 KLWX 260359
CFWLWX

Coastal Hazard Message

National Weather Service Baltimore MD/Washington DC
1159 PM EDT Mon Mar 25 2024

MDZ011-016-VAZ057-261200-
/O.CON.KLWX.CF.Y.0032.000000T0000Z-240327T1900Z/
Southern Baltimore-Charles-King George-
1159 PM EDT Mon Mar 25 2024

...COASTAL FLOOD ADVISORY REMAINS IN EFFECT UNTIL 3 PM EDT WEDNESDAY...

** WHAT...Up to one foot of inundation above ground level in low lying areas due to tidal flooding.*

** WHERE...In Maryland, Southern Baltimore and Charles Counties. In Virginia, King George County.*

** WHEN...Until 3 PM EDT Wednesday, especially around the time of high tide.*

** IMPACTS...At 3.5 feet, flooding is occurring at the end of Thames Street in Baltimore. Water covers the promenade in the Inner Harbor in multiple locations. At 3.0 feet, water begins encroaching upon yards in the Bowleys Quarters area. At 3.5 feet, water reaches yards near Cobb Island and docks near Dahlgren.*

** ADDITIONAL DETAILS...Tides two and a half to three feet above normal. The next high tides at Indian Head are 9:32 AM and 9:56 PM. The next high tides at Goose Bay are 5:38 AM and 6:02 PM. The next high tides at Dahlgren are 4:27 AM and 4:41 PM. The next high tides at Fort McHenry Baltimore are 8:17 AM and 8:34 PM.*

PRECAUTIONARY/PREPAREDNESS ACTIONS...

If travel is required, allow extra time as some roads may be closed. Do not drive around barricades or through water of unknown depth. Take the necessary actions to protect flood-prone property.

Time of high total tides are approximate to the nearest hour.

NW Branch Patapsco River at Baltimore MD
MLLW Categories - Minor 3.0 ft, Moderate 5.0 ft, Major 6.0 ft
MHHW Categories - Minor 1.3 ft, Moderate 3.3 ft, Major 4.3 ft

Day/Time	Total Tide ft MLLW	Total Tide ft MHHW	Departure from Norm ft	Waves ft	Flood Impact
26/08 AM	3.4	1.7	2.1	0.5	Minor
26/08 PM	3.7	2.0	2.6	0.5	Minor
27/09 AM	3.9	2.2	2.5	0.5	Minor
27/09 PM	2.9	1.2	1.9	0.5	None
28/09 AM	2.9	1.2	1.4	0.5	None
28/08 PM	1.9	0.2	1.1	0.5	None

5.0 Astronomical Conditions

The astronomical conditions were obtained from the United States Naval Observatory's Multiyear Interactive Computer Almanac (MICA) software program and provided the conditions over the collision location in Baltimore, Maryland. The time of the accident is included in bold print for reference.

Sun	**Time**
Sunset	1924 EDT March 25, 2024
End civil twilight	1950
Nautical dusk[7]	2022
Accident	***0129 EDT March 26, 2024***
Nautical dawn	0602
Begin civil twilight	0632
Sunrise	0700

Moon	**Time**
Moonrise	2057 EDT March 25, 2024
Accident	***0129 EDT March 26, 2024***
Moon culmination	0149
Moonset	0713

At the time of the accident nighttime conditions prevailed with the Sun more than 48° below the horizon. The moon at 43° above the horizon at an azimuth of 173°. The phase of the moon was a full moon on March 25, with 99% illuminated at the time of the accident.

Submitted by:

Donald Eick
NTSB Senior Meteorologist

[7] Nautical dawn and dusk occur when the Sun is 12° below the horizon, with civil twilight when the Sun is at 6° or less. During nautical twilight both the horizon and the brighter stars are usually visible for navigation at sea.