



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

May 6, 2016

Group Chairman's Weather Study Report

METEOROLOGY

WPR16LA073

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A. ACCIDENT

Location: 2 miles northwest of Billings, Montana
Date: February 8, 2016
Time: approximately 1131 mountain standard time (1831 UTC¹)
Aircraft: Cessna T206, registration: N562H

B. METEOROLOGY GROUP

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C. SUMMARY

For a summary of the accident, refer to the *Accident Summary* report, which is available in the docket for this investigation.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did not travel for this investigation and gathered the weather data for this investigation from the NTSB's Washington D.C. office and from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Centers for Environmental Information (NCEI). All times are mountain standard time (MST) on February 8, 2016, and are based upon the 24-hour clock, where local time is -7 hours from UTC, and UTC=Z (unless otherwise noted). Directions are referenced to true north and distances in nautical miles. Heights are 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 45.80° N, longitude 108.54° W, approximate elevation 3,550 feet.

¹ UTC – is an abbreviation for Coordinated Universal Time.

E. FACTUAL INFORMATION

1.0 Synoptic Situation

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) and the Weather Prediction Center (WPC), located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular “Aviation Weather Services”, AC-0045G CHG 1.

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 1100 MST is provided as figure 1, with the approximate location of the accident site marked. The chart depicted a surface trough² stretching from northeastern Montana northward into southern Canada. There were no surface frontal boundaries near the accident site. Two surface high pressure centers with a pressure of 1045-hectopascals (hPa) were located in central and southeastern Idaho. The station models around the accident site depicted air temperatures in the low to mid 40’s Fahrenheit (F), with temperature-dew point spreads of 19° F or more, a west to southwest wind between 5 and 15 knots, and mostly clear skies. Given the lack of a surface frontal boundary near the accident site at the accident time and low-level dry air, clouds and precipitation would not be expected.

² Trough – An elongated area of relatively low atmospheric pressure or heights.

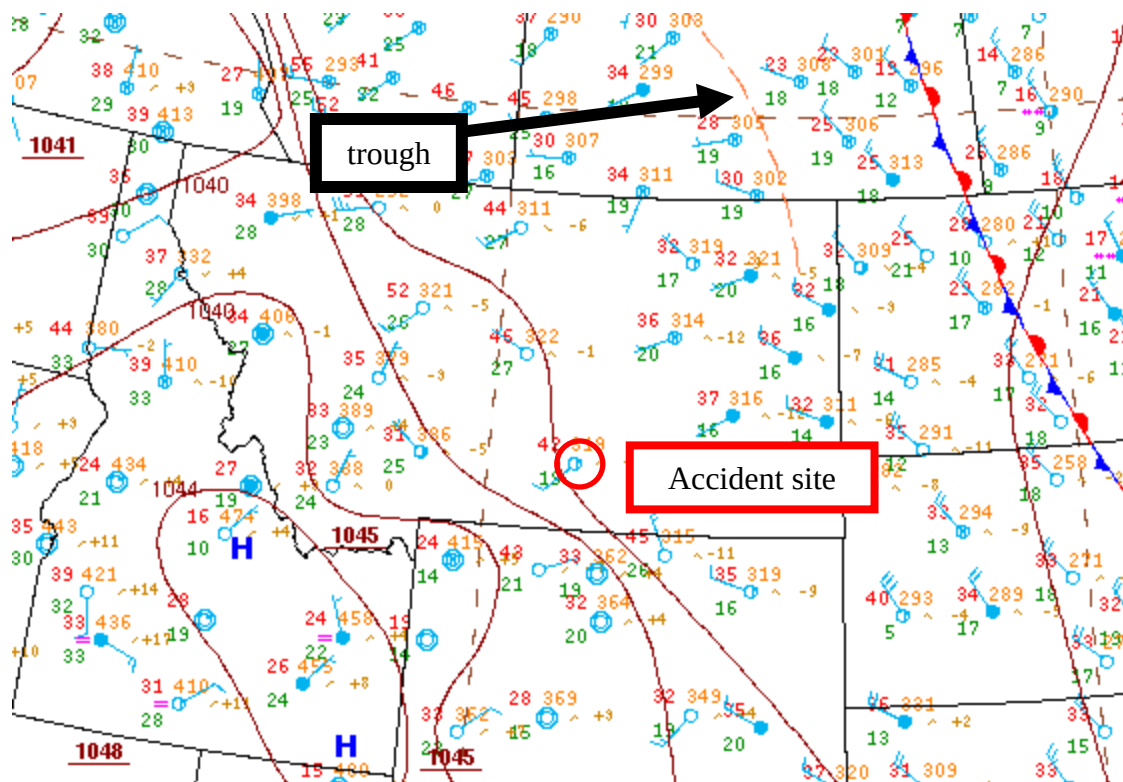


Figure 1 – NWS Surface Analysis Chart for 1100 MST

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 1700 MST at 850-, 700-, 500-, and 300-hPa are presented in figures 2 through 5. The 850-, 700-, and 500-hPa mid-level charts depicted a northwest wind at each level with wind increasing with height. No major mid-level troughs were located over or near the accident site around the accident time and therefore no cloud cover or precipitation would be expected. With the increasing wind speed with height over the mountainous terrain, gusty wind conditions would be expected with the correct vertical temperature profile. Given the vertical temperature profile likely around the accident site at the accident time (section 4.0), gusty surface wind conditions would be expected. The wind speed increased from around 30 knots at 850-hPa to near 80 knots at 300-hPa.

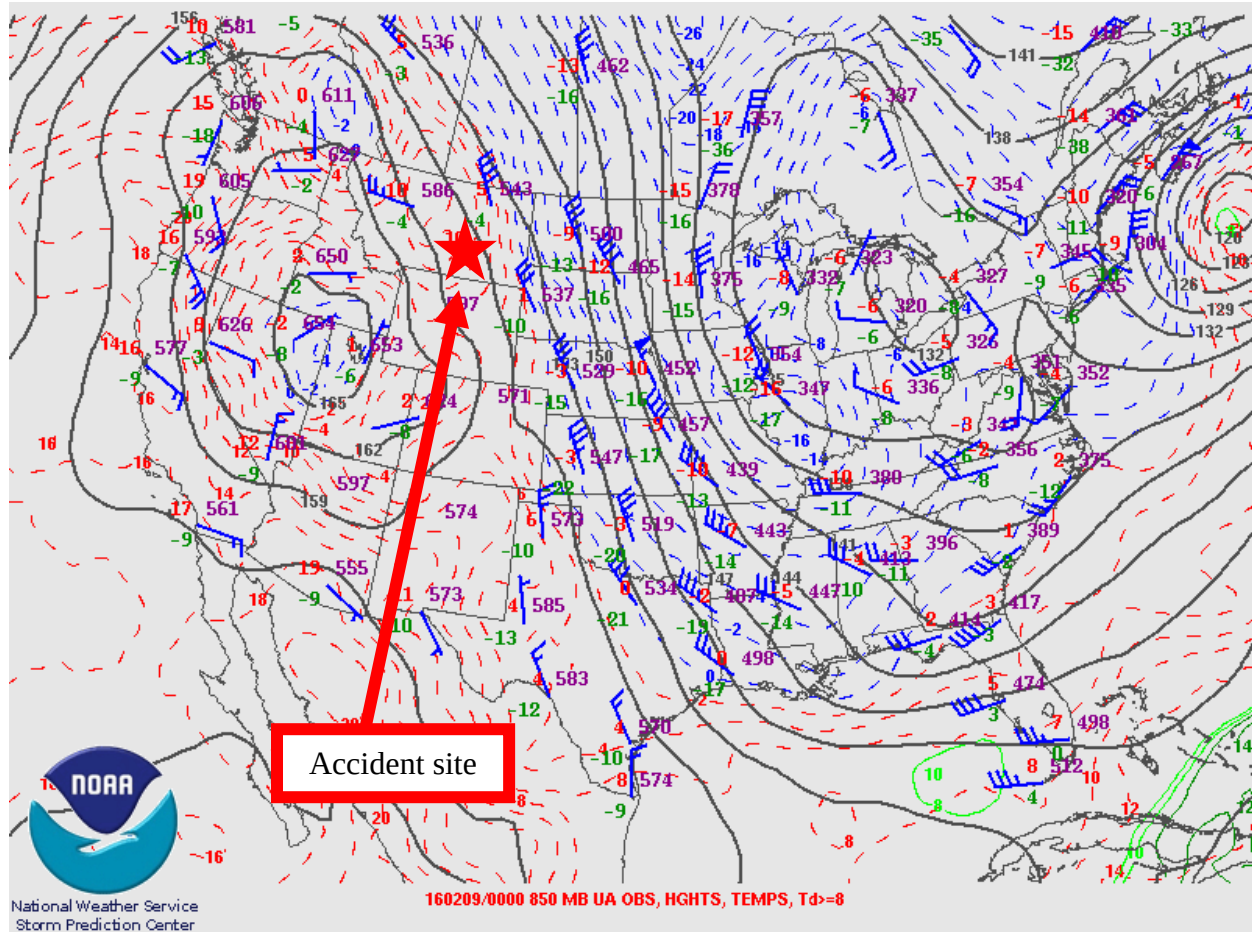


Figure 2 –850-hPa Constant Pressure Chart for 1700 MST

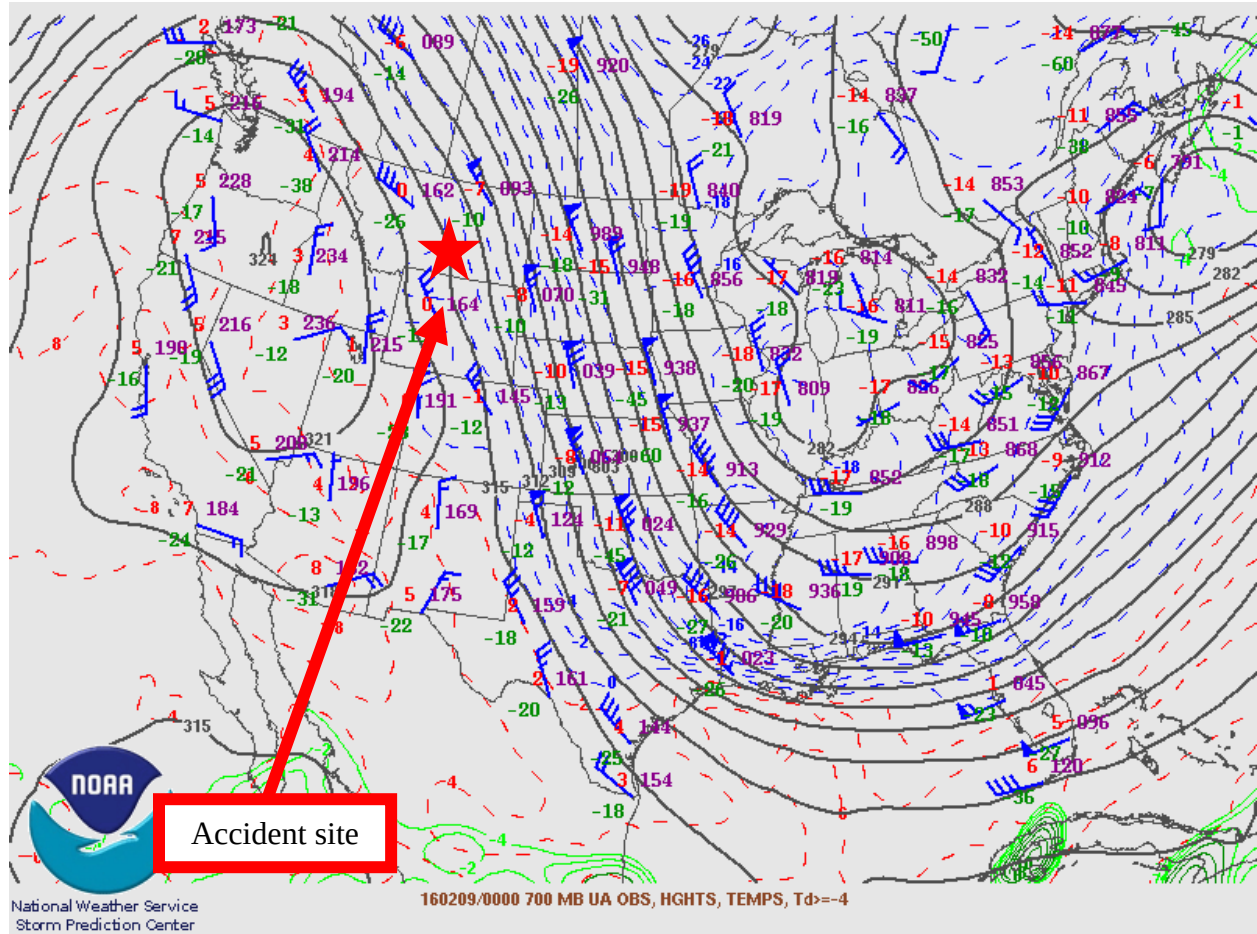


Figure 3 – 700-hPa Constant Pressure Chart for 1700 MST

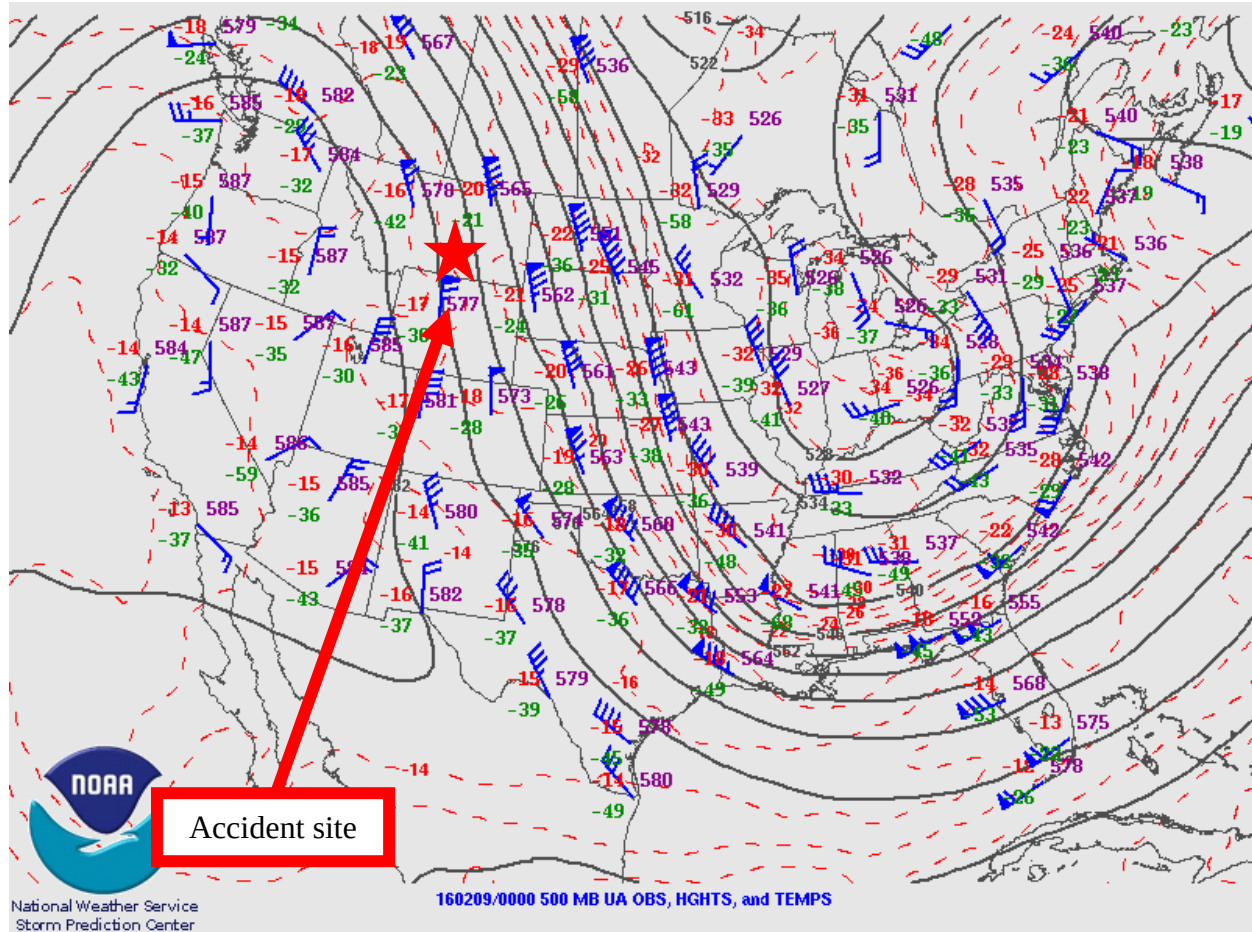


Figure 4 – 500-hPa Constant Pressure Chart for 1700 MST

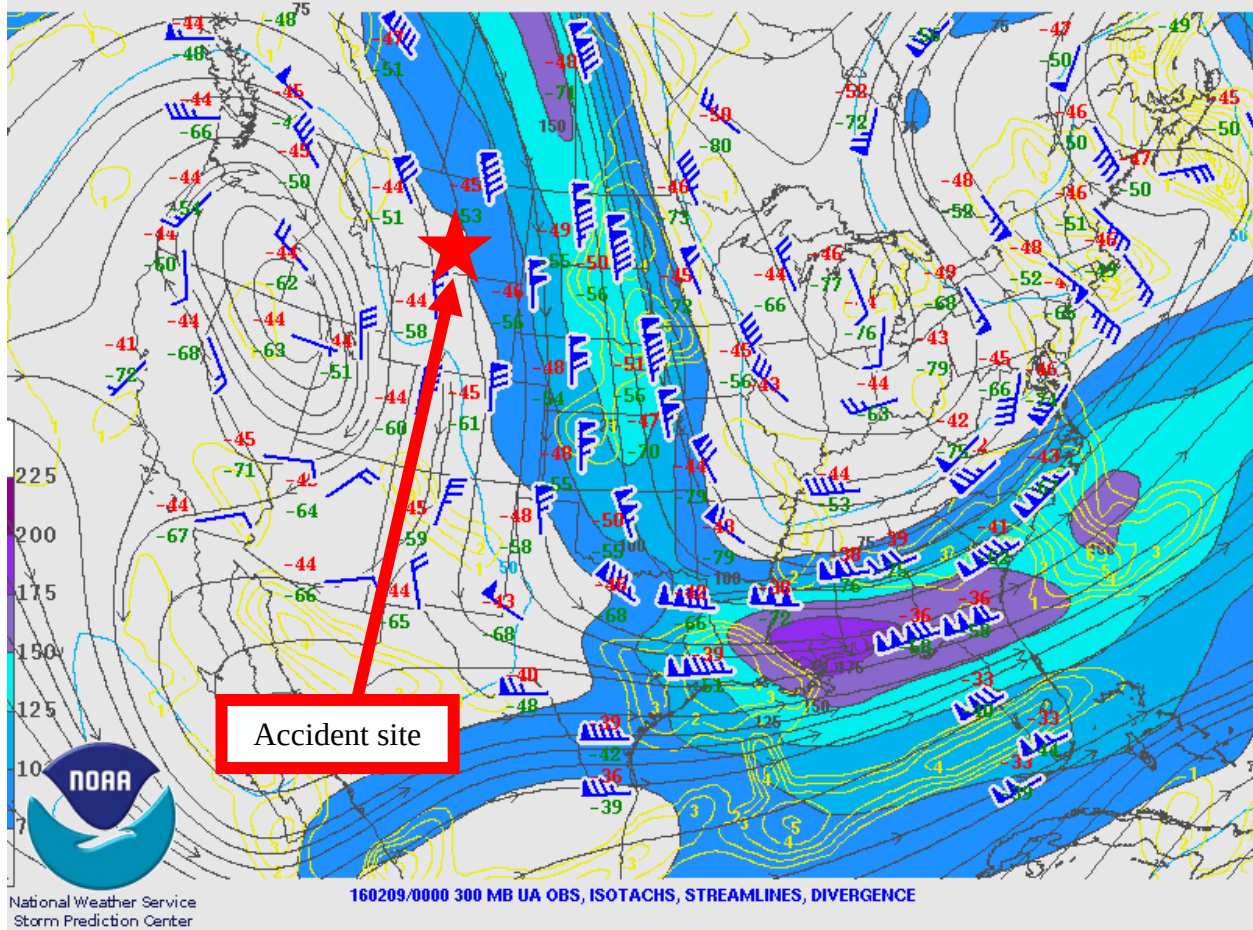


Figure 5 – 300-hPa Constant Pressure Chart for 1700 MST

2.0 Storm Prediction Center Products

No thunderstorms or severe storms were forecast.

3.0 Surface Observations

The area surrounding the accident site was documented utilizing official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language.

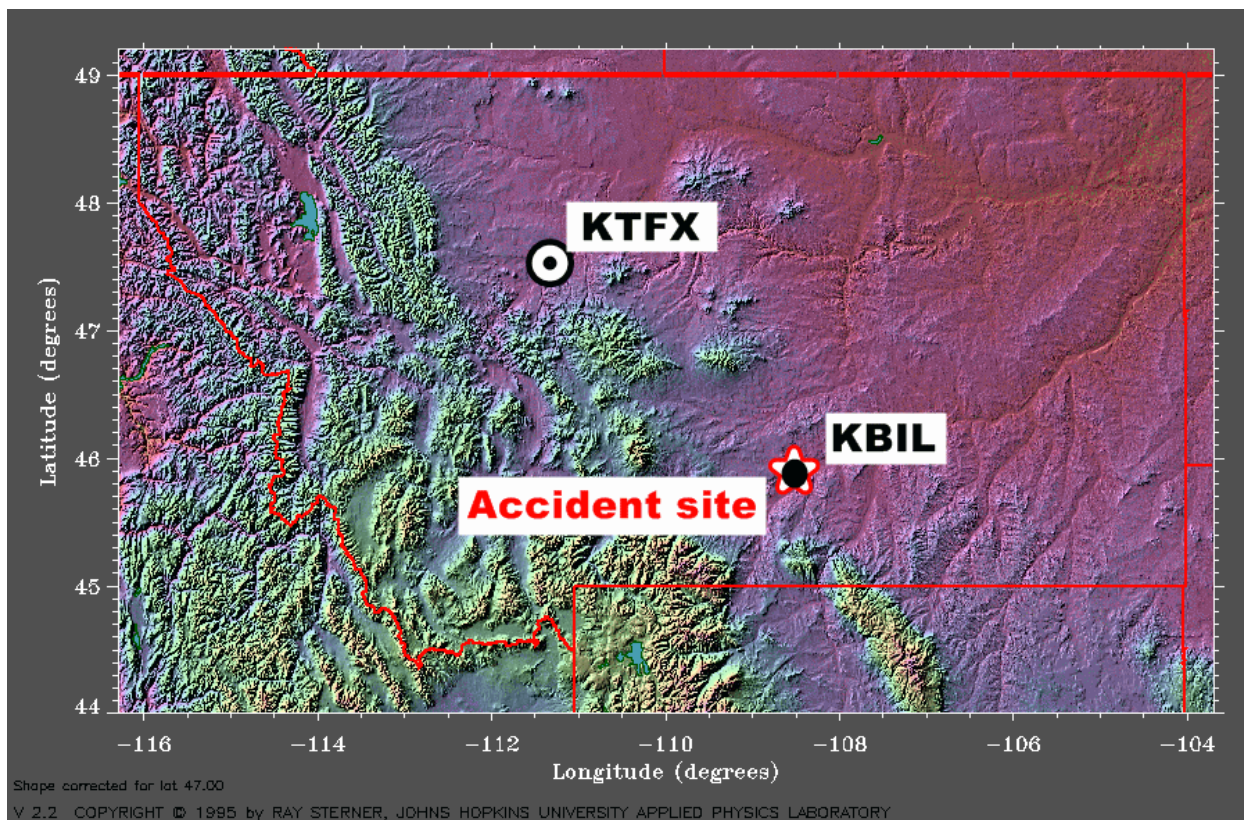


Figure 6 – Map of Montana with the location of the accident site, surface observation site, and upper air site

Billings Logan International Airport (KBIL) was the closest official weather station to the accident site located 2 miles northwest of Billings, Montana, and had an Automated Surface Observing System (ASOS³) whose reports were supplemented by a weather observer. KBIL was located within a half mile of the accident site, at an elevation of 3,652 feet, and had a 14° easterly magnetic variation⁴ (figure 6). The following observations were taken and disseminated during the times surrounding the accident⁵:

[0553 MST] KBIL 081253Z 23013KT 10SM CLR M01/M10 A3042 RMK AO2
SLP333 T10061100=

[0653 MST] KBIL 081353Z 24012KT 10SM FEW110 M02/M10 A3044 RMK
AO2 SLP340 T10171100=

³ ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

⁴ Magnetic variation – The angle (at a particular location) between magnetic north and true north.

⁵ The bold sections in this NWS product and the rest of products in the weather factual report are to highlight the individual sections that directly reference the weather conditions that are or will affect the accident location around the accident time. The local times in section 3.0 next to the METARs are provided for quick reference between UTC and local times around the accident time.

[0753 MST] KBIL 081453Z 22011KT 10SM SCT110 BKN200 M02/M10 A3043
RMK AO2 SLP340 ACSL DSNT E-SW T10171100 50007=

[0853 MST] KBIL 081553Z 22015KT 10SM FEW085 BKN200 00/M09 A3043
RMK AO2 SLP336 ACSL DSNT E-SW T00001094=

[0953 MST] KBIL 081653Z 22013KT 10SM FEW085 SCT200 02/M08 A3042
RMK AO2 SLP328 ACSL NE-SW T00221083=

[1053 MST] KBIL 081753Z 23012KT 10SM FEW085 FEW150 SCT200 06/M07
A3040 RMK AO2 SLP319 ACSL DSNT SE-S T00561072 10056 21017 58009=

ACCIDENT TIME 1131 MST

[1153 MST] KBIL 081853Z 22008G19KT 10SM FEW085 SCT200 09/M06 A3038
RMK AO2 SLP305 ACSL DSNT ALQDS T00941061=

[1253 MST] KBIL 081953Z 32023G31KT 10SM FEW085 SCT200 14/M05 A3036
RMK AO2 PK WND 32031/1951 SLP292 ACSL ALQDS T01441050=

[1353 MST] KBIL 082053Z 31022G28KT 10SM FEW085 SCT200 15/M04 A3034
RMK AO2 PK WND 29030/2042 SLP282 ACSL ALQDS T01501044 58021=

[1453 MST] KBIL 082153Z 33018G30KT 10SM FEW085 FEW120 SCT230 14/M04
A3033 RMK AO2 PK WND 32031/2128 SLP278 ACSL ALQDS T01441044=

[1553 MST] KBIL 082253Z 32020G28KT 10SM FEW120 SCT250 14/M04 A3031
RMK AO2 PK WND 33028/2249 SLP278 ACSL DSNT N-E S-W T01441039=

[1653 MST] KBIL 082353Z 31012KT 10SM SCT140 BKN270 13/M03 A3033
RMK AO2 SLP282 ACSL DSNT S-E T01281028 10150 20056 55003=

KBIL weather at 0953 MST was reported as wind from 220° at 13 knots, 10 miles visibility, few clouds at 8,500 feet above ground level (agl), scattered clouds at 20,000 feet agl, temperature of 2° Celsius (C), dew point temperature of -8° C, and an altimeter setting of 30.42 inches of mercury. Remarks, station with a precipitation discriminator, sea level pressure 1032.8 hPa, alto-cumulus standing lenticular clouds northeast through southwest, temperature 2.2° C, dew point temperature -8.3° C.

KBIL weather at 1053 MST was reported as wind from 230° at 12 knots, 10 miles visibility, few clouds at 8,500 feet agl, few clouds at 15,000 feet agl, scattered clouds at 20,000 feet agl, temperature of 6° C, dew point temperature of -7° C, and an altimeter setting of 30.40 inches of mercury. Remarks, station with a precipitation discriminator, sea level pressure 1031.9 hPa, alto-cumulus standing lenticular clouds distant⁶ southeast through south, temperature 5.6° C, dew point temperature -7.2° C, 6-hourly maximum temperature of 5.6° C, 6-hourly minimum temperature of -1.7° C, 3-hourly pressure drop of 0.9 hPa.

KBIL weather at 1153 MST was reported as wind from 220° at 8 knots with gusts to 19 knots, 10 miles visibility, few clouds at 8,500 feet agl, scattered clouds at 20,000 feet agl, temperature of 9° C, dew point temperature of -6° C, and an altimeter setting of 30.38 inches of mercury. Remarks, station with a precipitation discriminator, sea level pressure 1030.5 hPa, alto-cumulus standing lenticular clouds distant all quadrants, temperature 9.4° C, dew point temperature -6.1° C.

KBIL weather at 1253 MST was reported as wind from 320° at 23 knots with gusts to 31 knots, 10 miles visibility, few clouds at 8,500 feet agl, scattered clouds at 20,000 feet agl, temperature of 14° C, dew point temperature of -5° C, and an altimeter setting of 30.36 inches of mercury. Remarks, station with a precipitation discriminator, peak wind from 320° at 31 knots at 1251 MST, sea level pressure 1029.2 hPa, alto-cumulus standing lenticular clouds distant all quadrants, temperature 14.4° C, dew point temperature -5.0° C.

The observations from KBIL indicated that VFR⁷ ceilings and visibilities were present at the surface around the accident area and at the accident time with gusty surface winds. The surface wind magnitudes closer to the 1131 MST accident time will be further discussed in section 3.1. The standing lenticular clouds are indicative of mountain wave activity, however, that mountain wave activity remained above 15,000 feet msl at the accident time (section 7.0). The gusty surface wind conditions would be the main issue for any flight attempting to land around the accident timeframe near KBIL.

3.1 One Minute Wind Observations

The one-minute KBIL ASOS surface data was provided by the NWS for the time surrounding the accident. One-minute raw wind data was provided with two separate magnitudes and wind directions⁸. The first wind data in table 1 is the two-minute average wind speed, which was updated every 5 seconds and reported once a minute. The second source of one-minute wind data is the five-second maximum wind average, which was updated every five seconds and reported once every minute (table 1). The following table provides the meteorological data in local time (MST)⁹ as well as UTC time.

⁶ Distant indicated that the lightning was beyond 10 miles but less than 30 miles from the center of the airport (or airport location point, ALP).

⁷ Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. VFR criteria means a ceiling greater than 3,000 feet agl and greater than 6 miles visibility.

⁸ The wind directions are in reference to true north.

⁹ The one-minute wind observations from an ASOS are not automatically reported in daylight time.

Time (UTC)	Time (MST)	Dir of 2min avg wind	Speed of 2 min avg wind (knots)	Dir of max 5 sec avg wind	Speed of max 5 sec avg wind (knots)
1818	1118	224	11	219	15
1819	1119	223	12	219	15
1820	1120	219	12	217	14
1821	1121	217	13	214	14
1822	1122	217	13	216	14
1823	1123	221	12	232	13
1824	1124	222	11	222	12
1825	1125	223	10	226	14
1826	1126	223	11	220	13
1827	1127	218	11	221	12
1828	1128	215	11	210	14
1829	1129	212	12	213	13
1830	1130	217	11	213	13
1831	1131	222	12	233	17
1832	1132	224	15	223	18
1833	1133	224	16	229	18
1834	1134	225	13	232	14
1835	1135	223	12	221	14
1836	1136	222	12	213	14
1837	1137	220	12	210	14
1838	1138	218	13	219	15
1839	1139	217	13	212	14
1840	1140	216	12	216	15
1841	1141	220	12	234	13
1842	1142	233	11	255	12

Table 1 – One-minute KBIL ASOS data for the time surrounding the accident

At 1130 MST, KBIL reported the two-minute average wind from 217° at 11 knots and a five-second maximum average wind from 213° at 13 knots.

At 1131 MST, KBIL reported the two-minute average wind from 222° at 12 knots and a five-second maximum average wind from 233° at 17 knots.

At 1132 MST, KBIL reported the two-minute average wind from 224° at 15 knots and a five-second maximum average wind from 223° at 18 knots.

4.0 Upper Air Data

The closest official upper air sounding to the accident site was from Great Falls, Montana, (KTFX), located 154 miles northwest of the accident site (figure 6), with a site number 72776, and an elevation of 3,707 feet. The 1700 MST KTFX sounding was plotted on a standard Skew-T log P diagram¹⁰ with the derived stability parameters included in figure 7 (with data from the surface to 600-hPa, or 14,000 feet msl.) This data was analyzed utilizing the RAOB¹¹ software package. The sounding depicted the Lifted Condensation Level (LCL)¹² at 10,219 feet msl and a Convective Condensation Level (CCL)¹³ of 14,664 feet. The freezing level was located at 9,386 feet. The precipitable water value was 0.28 inches.

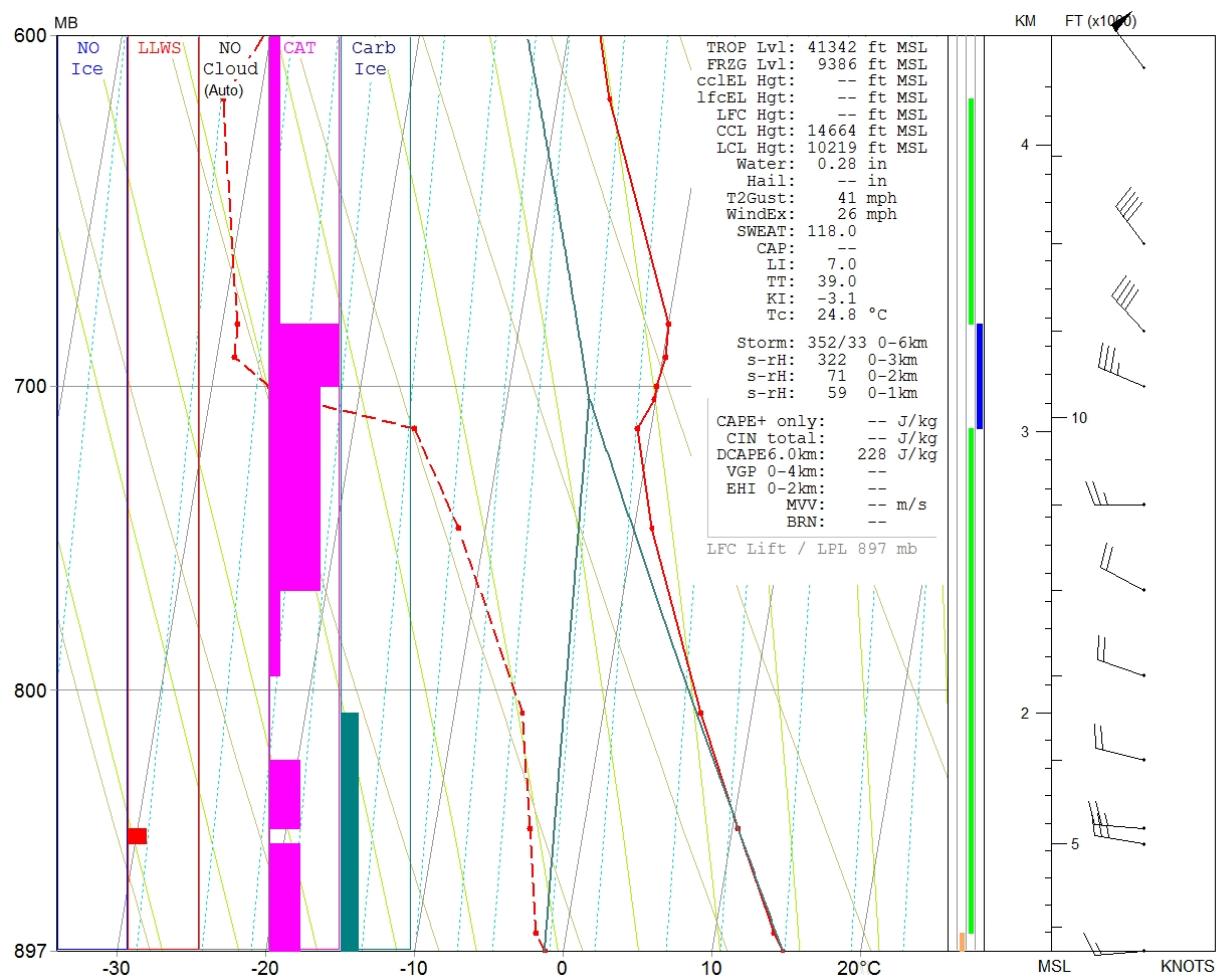


Figure 7 – 1700 MST KTFX sounding

¹⁰ Skew T log P diagram – is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

¹¹ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

¹² Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹³ Convective Condensation Level (CCL) – The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.

The 1700 MST KTFX sounding indicated a relatively dry vertical environment from the surface through 14,000 feet msl. This environment would not have been conducive of cloud formation as indicated by RAOB. Any cloud cover around the accident time would have likely been above 14,000 feet msl. No icing conditions were indicated by RAOB. The accident flight was likely VMC when landing at KBIL.

The sounding wind profile indicated there was a surface wind from 265° at 15 knots and the wind speed increased quickly to 30 knots by 5,000 feet msl while remaining out of the west. The wind remained out of the west to northwest through 14,000 feet msl with the wind speed increasing to 50 knots by 14,000 feet. Low-level wind shear (LLWS) was indicated by RAOB in the lowest 2,000 feet agl. Several layers of possible clear-air turbulence were identified by RAOB from the surface through 14,000 feet. Given the surface wind profile and upper level winds over the terrain indicated on the KTFX sounding, the accident flight likely encountered some gusty wind conditions and low-level wind shear while landing at KBIL.

5.0 Satellite Data

Visible and infrared data from the Geostationary Operational Environmental Satellite number 15 (GOES-15) was obtained from an archive at the Space Science Engineering Center (SSEC) at the University of Wisconsin-Madison (UW) in Madison, Wisconsin, and processed using the Safety Board's Man-computer Interactive Data Access System (McIDAS) software. Visible and infrared imagery (GOES-15 bands 1 and 4) at a wavelength of 0.65 microns (μm) and 10.7 μm retrieved brightness temperatures for the scene. Satellite imagery surrounding the time of the accident, from 0900 MST through 1300 MST at approximately 15-minute intervals, were reviewed and the closest images to the time of the accident are documented here.

Figures 7 and 8 present the GOES-15 visible imagery from 1130 and 1141 MST at 2X magnification with the accident site highlighted with a red square. The visible imagery indicated the cloud cover near the accident site was moving from northwest to southeast around the accident time. Figure 9 presents the GOES-15 infrared imagery from 1130 MST at 4X magnification with the accident site highlighted with a red square. The infrared imagery indicated higher cloud tops to the west and northeast of the accident site (green colors). Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 1700 MST KTFX sounding, the approximate cloud-top heights over the accident site were 8,000 feet at 1130 MST. Given that the pieces of clouds near the accident depicted on the visible imagery were quite small, it was likely the cloud cover tops were higher than 8,000 feet msl above the accident site, because the infrared imagery has only a 4 by 4 km resolution. With a 4 by 4 km resolution, the infrared imagery would not be able to accurately capture any clouds smaller than 4 by 4 km.

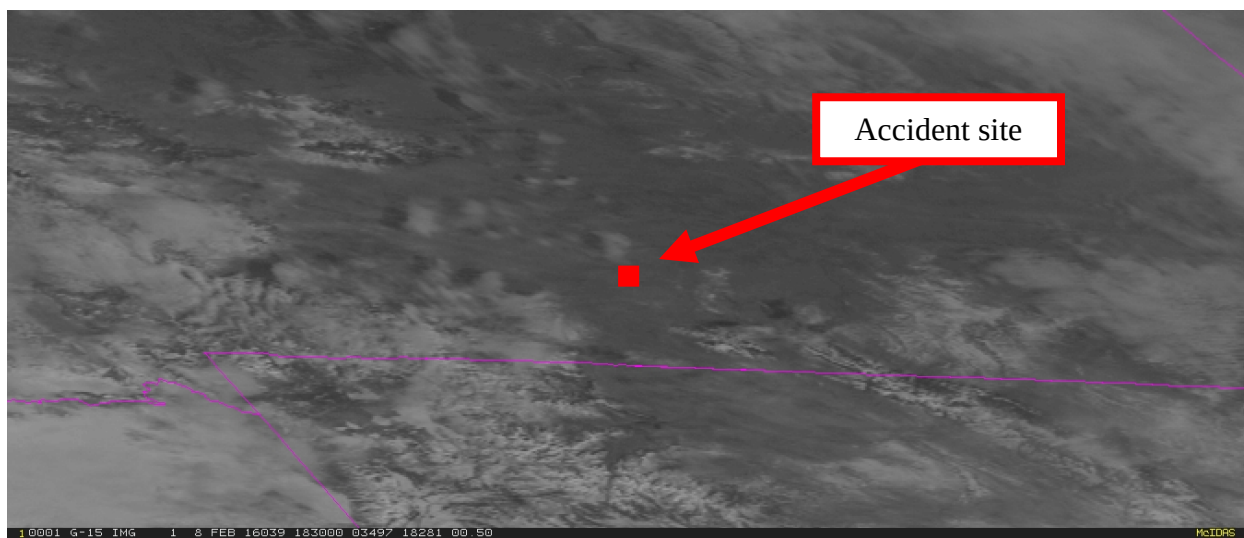


Figure 8 – GOES-15 visible image at 1130 MST

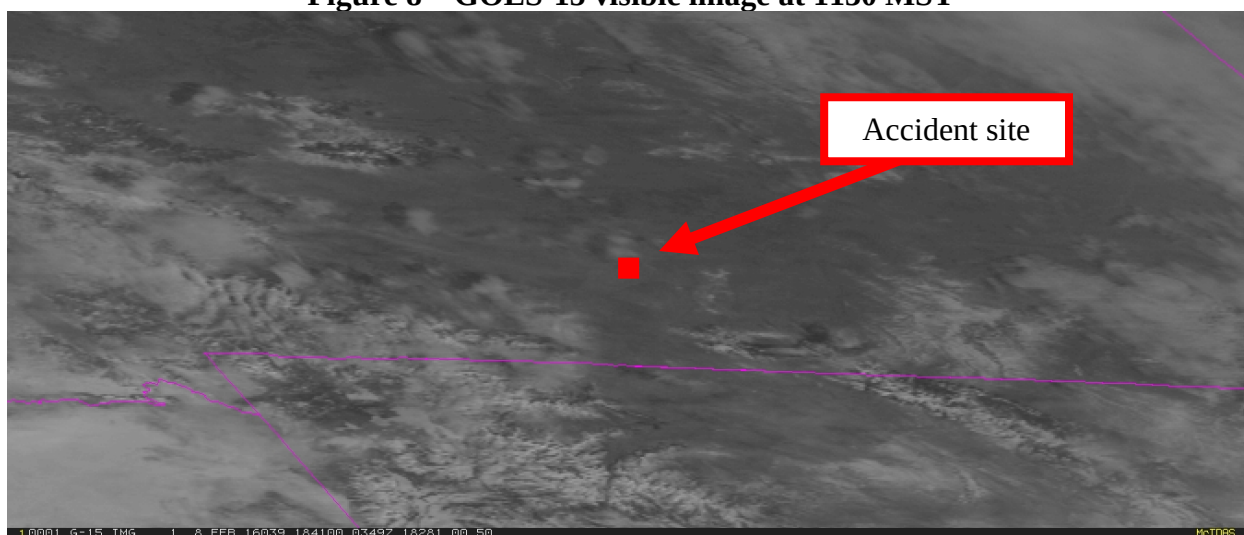


Figure 9 – GOES-15 visible image at 1141 MST

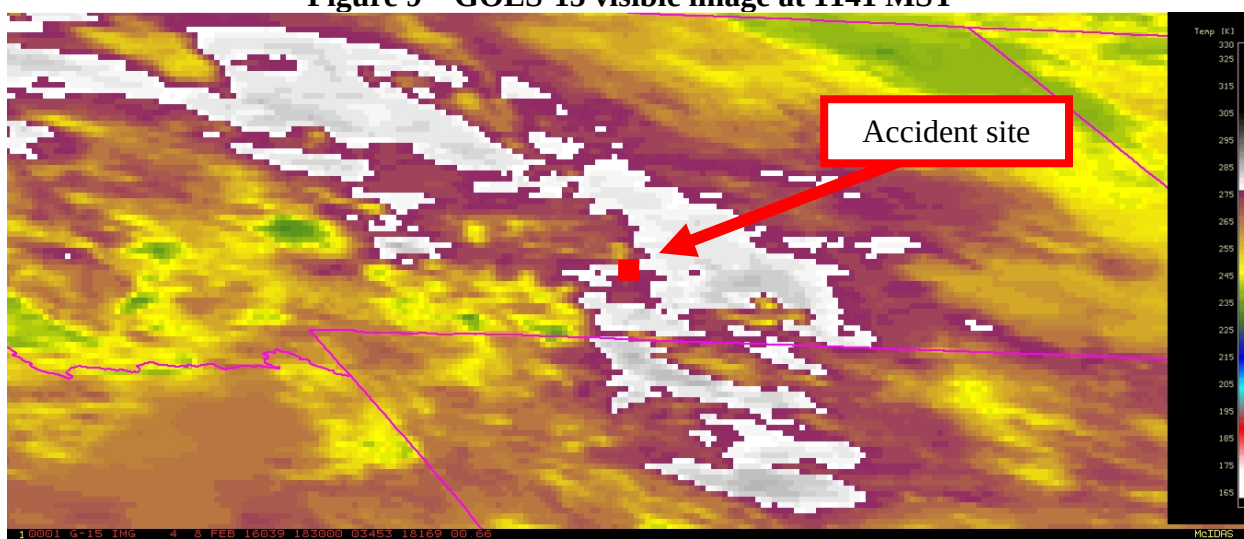


Figure 10 – GOES-15 infrared image at 1130 MST

6.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹⁴ was from Billings, Montana, (KBLX) located 4 miles northwest of the accident site with an elevation of 3,598 feet. Level II and III archive radar data was obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software. No reflectivity or precipitation targets were located above the accident site at the accident time nor would any be expected.

7.0 Pilot Reports

All pilot reports (PIREPs) were reviewed close to the accident site, from around two hours prior to the accident time to around two hours after the accident time, for below FL250¹⁵. The PIREPs are displayed below:

WRL UA /OV RLY225015 /TM 1917 /FL102 /TP C182 /SK SKC /TA 05 /WV 30337KT /TB NEG=

Routine pilot report (UA); 15 miles from Worland, Wyoming, on the 225° radial; Time – 1217 MST (1917Z); Altitude – 10,200 feet msl; Type aircraft – Cessna 182; Sky – Clear; Temperature – -5° C; Wind – From 303° at 37 knots; Turbulence – Negative.

Billings ATC recordings were reviewed from 1113 to 1138 MST and no other PIREPs were provided by flights travelling into or out of Billings, nor were any PIREPs requested by Billings ATC. It is understandable that PIREPs were not requested by Billings ATC given conditions were above the FAA JO 7110 order.

8.0 SIGMET and CWSU Advisories

No SIGMET was valid for the accident site at the accident flight at the accident time.

No Center Weather Service Unit (CWSU) Advisory (CWA) or Meteorological Impact Statement (MIS) were valid for the accident site at the accident time.

9.0 AIRMETs

No AIRMETs were valid for the accident site at the accident time. Given the lack of lower level moderate or greater PIREPs it is understandable that no AIRMETs were in effect. However, the PIREPs of mountain wave conditions above FL250 and the low-level gusty wind conditions likely did warrant an AIRMET for turbulence.

¹⁴ The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy between a 0.87° and 0.96° beam width. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.

¹⁵ Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of feet. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

10.0 Area Forecast

The Area Forecast issued at 0445 MST, valid at the accident time, forecasted a scattered to broken ceiling at 9,000 to 10,000 feet msl with tops at 11,000 feet msl and scattered to broken cirrus clouds above:

FAUS45 KPCI 081145

FA5W

_SLCC FA 081145

SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 090600

CLDS/WX VALID UNTIL 090000...OTLK VALID 090000-090600

ID MT WY NV UT CO AZ NM

.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.

.
SYNOPSIS...ALF...STG UPR RDG EXTDS FM CA TO CNTRL BC WITH LTL CHG
EXP. MOD NNWLY FLOW WL CONT FM SRN SASK-ERN WY-CNTRL-ERN CO THEN
WKNS SEWD INTO OK AND NW TX. LTL CHG EXP.
SFC...LRG HI PRES SYS EXTDS FM THE PAC NW THRU THE NRN INTRMTN
RGN THRU THE GRT BASIN INTO THE CNTRL-SRN RCKYS AND WL CONT THRU
THE PD.

.
ID
NRN...SCT-BKN080-090 TOPS 110. OTLK...VFR.
CNTRL MTNS...
ERN SXNS...SCT-BKN100-120 TOPS 130. OTLK...VFR.
WRN SXNS...SCT CI. TIL 20Z OCNL VIS 3SM BR VLYS. OTLK...VFR.
SWRN...SCT CI. TIL 20Z OCNL VIS 3-5SM BR. OTLK...VFR.
SERN...OVC060 TOPS 070. OCNL VIS 3SM BR. 21Z BKN060.
OTLK...IFR CIG..04Z IFR CIG BR.

.
MT
CONTDVD WWD...SCT-BKN070-080 TOPS 100. OTLK...VFR.
SWRN MTNS...BKN100-120 TOPS 130. 19Z SCT120. OTLK...VFR.
ERN SLOPES OF CONTDVD-CNTRL...SCT-BKN CI. OCNL SCT120.
OTLK...VFR.
ERN...SCT-BKN CI. 17Z SCT-BKN090-100 TOPS 110. OTLK...VFR.

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WY
NWRN MTNS...BKN110-120 TOPS 140. 19Z SCT120. OTLK...VFR.
SWRN SXNS...SCT CI. OCNL SCT120. OTLK...VFR.
CNTRL-ERN SXNS...SCT-BKN110-130 TOPS 140. OTLK...VFR.

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NV
NRN...SKC OR SCT CI. OTLK...VFR.
SRN...SKC. OTLK...VFR.

.
UT
NRN HLF...SCT CI. TIL 19Z OCNL VIS 3SM BR VLYS. OTLK...VFR.
SRN HLF...SKC OR SCT CI. OTLK...VFR.

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CO
MTNS AND W...
NRN SXNS...SCT-BKN120-140 TOPS 150. OTLK...VFR.
SRN SXNS...SKC OR SCT CI. OTLK...VFR.
PLAINS/FOOTHILLS...
SRN SXNS...BKN080-090 TOPS 100. BECMG 1618 SCT090. OTLK...VFR.
NRN SXNS...SCT CI. OTLK...VFR.
.
AZ
NRN HLF...SKC. OTLK...VFR.
SRN HLF...SCT CI. OTLK...VFR.
.
NM
SRN QTR...SCT CI. OTLK...VFR.
RMNDR...SKC. OTLK...VFR.
....

11.0 Terminal Aerodrome Forecast

KBIL was the closest site with a NWS TAF. The TAF valid at the time of the accident was issued at 1025 MST and was valid for a 24-hour period beginning at 1100 MST. The TAF for KBIL was as follows:

TAF KBIL 081725Z 0818/0918 **24015G25KT P6SM FEW080 SCT200**
FM090200 26006KT P6SM SCT200=

The forecast expected a wind from 240° at 15 knots with gusts to 25 knots, greater than 6 miles visibility, few clouds at 8,000 feet agl, and scattered clouds at 20,000 feet msl.

The TAF issued before the one valid at the accident time was issued at 0432 MST and was valid for a 24-hour period beginning at 0500 MST. The 0432 MST TAF for KBIL was as follows:

TAF KBIL 081132Z 0812/0912 23005KT P6SM FEW150
FM081700 28015G25KT P6SM FEW080 SCT200
FM090200 26006KT P6SM SCT200=

The forecast expected a wind from 280° at 15 knots with gusts to 25 knots, greater than 6 miles visibility, few clouds at 8,000 feet agl, and scattered clouds at 20,000 feet agl. The 0432 MST and 1025 MST KBIL TAFs were very similar except for the change in wind direction from 280° on the 0432 MST TAF to 240° on the 1025 MST TAF.

12.0 National Weather Service Area Forecast Discussion

The National Weather Service Office in Billings, Montana, issued an Area Forecast Discussion (AFD) at 0857 MST. The aviation section of the AFD mentioned VFR conditions were forecast to prevail across the area during the accident day and night. Surface wind gusts were expected to be around 40 knots over Livingston, Montana, (80 miles west of the accident site) during the accident day:

FXUS65 KBYZ 081557

AFDBYZ

AREA FORECAST DISCUSSION...UPDATED
NATIONAL WEATHER SERVICE BILLINGS MT
857 AM MST MON FEB 8 2016

.UPDATE...

A DRY NORTHERLY FLOW ALOFT WILL PREVAIL ACROSS THE FORECAST AREA TODAY. ALTHOUGH SOME MID AND HIGH LEVEL CLOUDS WILL MOVE SOUTH ACROSS THE AREA...MOST LOCATIONS WILL SEE A PARTLY SUNNY DAY. AFTERNOON HIGHS WILL BE AROUND 40 DEGREES ALONG THE DAKOTA BORDER TO AROUND 50 DEGREES ALONG THE BEARTOOTH/ABSAROKA FOOTHILLS.

HOOLEY

&&

.SHORT TERM...VALID FOR TDY AND TUE...

A STRONG RIDGE OF HIGH PRESSURE OVER THE WEST COAST PLACES OUR FORECAST AREA UNDER STRONG NORTHERLY FLOW ALOFT. THIS PATTERN WILL MEAN GENERALLY ABOVE NORMAL TEMPERATURES AND BREEZY AFTERNOONS IN SOME AREAS...PARTICULARLY THE WESTERN ZONES WHERE LEE SIDE TROUGHING WILL CREATE A TIGHT PRESSURE GRADIENT. WE DO NOT ANTICIPATE MUCH CHANCE OF HIGH WINDS IN THE GAP AREAS AS THE ORIENTATION LOOKS A LITTLE TO NORTH TO SOUTH ORIENTED. SO SUB ADVISORY WINDS LOOK GOOD AT THIS TIME IN THE SHORT TERM TIME FRAME.

THERE IS A PROGGED MINOR PERTURBATION RIDING THE NORTHERLY JET STREAM OVER THE DAKOTA PLAINS THAT WILL BRUSH OUR EASTERN BORDER TUESDAY. THUS WE WILL CONTINUE TO CARRY SOME LOW POPS AROUND THE BAKER VICINITY...BUT THIS LOOKS TO BE LOW IMPACT AT BEST. BT

.LONG TERM...VALID FOR WED...THU...FRI...SAT...SUN...

MODELS WERE IN GOOD AGREEMENT UNTIL THE WEEKEND. UPPER RIDGE AXIS WILL REMAIN ANCHORED W OF THE FORECAST AREA THROUGH FRI. BOTH MODELS BRING A BACKDOOR COLD FRONT INTO E MT THU NIGHT WITH SOME MOISTURE...SUPPORTING LOW POPS OVER THE NE ZONES. THIS MOISTURE DRIES OUT OR MOVES E OF THE AREA ON FRI. OTHERWISE...THE AIRMASS WILL BE MAINLY DRY THROUGH FRI. EXPECT WINDY CONDITIONS FROM KBIL W WED THROUGH WED NIGHT AS A SURFACE LOW PUSHES SE THROUGH THE AREA...SETTING UP A DECENT GRADIENT WITH HIGH PRESSURE OVER SE ID. WHILE 700 MB WINDS SUPPORTED A POSSIBLE GAP WIND EVENT...THE PRESSURE GRADIENT ORIENTATION WAS MORE SUPPORTIVE OF STRONG WINDS AT BIG TIMBER AND HARLOWTON. WILL KEEP AN EYE ON MODEL TRENDS IN CASE HIGHLIGHTS ARE EVENTUALLY NEEDED. LEE TROUGHING WILL KEEP WINDY CONDITIONS FROM KBIL W THROUGH AT LEAST THU.

WELL ABOVE-NORMAL TEMPERATURES ARE EXPECTED WED THROUGH FRI WITH THE WARMEST DAY BEING WED WHERE READINGS SHOULD REACH THE LOWER 60S IN CENTRAL LOCATIONS.

A SHORTWAVE APPROACHES THE REGION ON THE ECMWF ON SAT WHILE THE WAVE IS SLOWER ON THE GFS. CONDITIONS WILL CONTINUE TO BE WARM AND DRY. THE WAVE MOVES THROUGH THE AREA ON THE ECMWF SAT NIGHT WITH TRAILING VORTICITY BEHIND IT ON SUN. THE GFS BRINGS A WEAK WAVE THROUGH THE AREA ON SUN. LEFT LOW POPS ACROSS THE AREA SAT NIGHT WITH POPS OVER THE E ON SUN. THE ECMWF BRINGS IN COOLER AIR OVER THE AREA ON SUN THAN THE GFS. A BLEND OF TEMPERATURES STILL LEFT READINGS ABOVE NORMAL. ANTICYCLONIC FLOW WITH A LITTLE MOISTURE IN IT WILL BE OVER THE AREA SUN NIGHT AND MON...SUPPORTING MOUNTAIN POPS. TEMPERATURES WILL BE WELL INTO THE 50S ON MON.

ARTHUR

&&

.AVIATION...

VFR WILL PREVAIL OVER THE AREA TODAY AND TONIGHT. SURFACE WIND GUSTS TO AROUND 40 KT ARE EXPECTED OVER KLVM TODAY. ARTHUR/REIMER

&&

.PRELIMINARY POINT TEMP/POPS...

TDY TUE WED THU FRI SAT SUN

BIL 050 034/056 035/061 038/057 036/056 037/058 034/052

0/N 00/U 00/N 00/N 10/B 11/B 22/W

LVM 050 034/055 035/053 034/051 034/051 035/050 033/046

0/N 00/N 00/N 01/N 11/N 11/N 21/N

HDN 050 028/056 029/059 031/055 029/053 029/055 028/051

0/B 00/U 00/U 00/U 11/U 11/B 22/W

MLS 044 029/050 028/054 031/050 030/048 030/051 030/049

0/B 01/B 10/U 01/B 11/B 11/B 21/N

4BQ 044 030/053 029/056 030/052 029/051 029/052 030/048

0/B 11/B 10/U 00/B 11/B 01/U 22/W

BHK 040 026/044 024/050 027/045 028/043 026/044 026/045

0/B 22/W 20/U 01/B 21/B 11/B 21/N

SHR 045 028/050 024/057 028/052 028/052 027/053 027/047

0/B 00/U 00/U 00/U 10/U 10/U 22/W

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.BYZ WATCHES/WARNINGS/ADVISORIES...

MT...NONE.

WY...NONE.

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13.0 Pilot Weather Briefing

The accident pilot checked weather information prior to flight using ForeFlight and fltplan.com, however, the weather information reviewed was not able to be retrieved. There is no knowledge of any additional weather briefing information the accident pilot received.

14.0 LLWAS Data

Low-level windshear alert system (LLWAS) data was provided around the time of the accident. The LLWAS wind data was captured every 10 seconds via the 7 LLWAS sensors located around KBIL (figure 11) and more wind information from the LLWAS is provided in attachment 1. An example of what the LLWAS display looks like for the Billings ATC personnel is provided in figure 12. The LLWAS wind data from 1130 and 1131 MST is provided in figure 13 with wind magnitudes in knots and wind directions in reference to magnetic north.

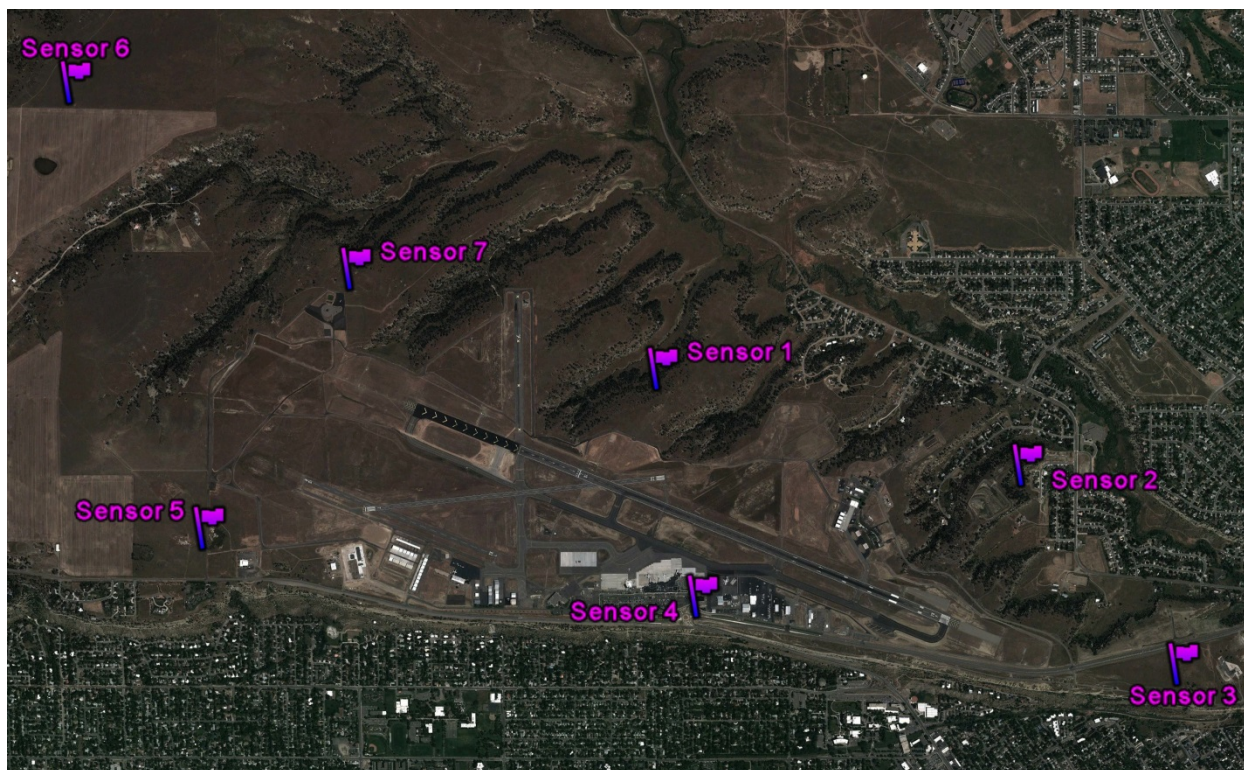


Figure 11 – Location of the 7 LLWAS sensors around KBIL



Figure 12 – Example of the LLWAS display for the Billings ATC

time (UTC)	18:30:04	18:30:14	18:30:24	18:30:34	18:30:44	18:30:54
airport wind (knots)	AW 220 09	AW 220 09	AW 220 09	AW 220 09	AW 220 09	AW 220 09
runway wind (knots)	07-A 190 08	07-A 200 08	07-A 200 08	07-A 210 08	07-A 210 08	07-A 210 07
runway wind (knots)	25-D 190 08	25-D 200 08	25-D 200 08	25-D 210 08	25-D 210 08	25-D 210 07
runway wind (knots)	25-A 210 15	25-A 210 14	25-A 210 14	25-A 210 15	25-A 210 16	25-A 210 17
runway wind (knots)	07-D 210 15	07-D 210 14	07-D 210 14	07-D 210 15	07-D 210 16	07-D 210 17
runway wind (knots)	10LA WSA 15K+ 2MF 210 13 *	10LA 210 13	10LA 200 13	10LA 200 12	10LA 200 12	10LA 200 11
runway wind (knots)	28RD WSA 15K+ 1MD 210 13 *	28RD 210 13	28RD 200 13	28RD 200 12	28RD 200 12	28RD 200 11
runway wind (knots)	28RA 220 14	28RA 220 13	28RA 220 12	28RA 220 12	28RA 220 11	28RA 220 11
runway wind (knots)	10LD 220 13	10LD 220 12	10LD 220 13	10LD 210 13	10LD 210 14	10LD 210 14
runway wind (knots)	10RA WSA 15K+ 2MF 190 08 *	10RA 200 08	10RA 200 08	10RA 210 08	10RA 210 08	10RA 210 07
runway wind (knots)	28LD WSA 15K+ 1MD 190 08 *	28LD 200 08	28LD 200 08	28LD 210 08	28LD 210 08	28LD 210 07
runway wind (knots)	28LA 220 08	28LA 220 08	28LA 220 08	28LA 220 09	28LA 210 10	28LA 210 10
runway wind (knots)	10RD 220 08	10RD 220 08	10RD 220 08	10RD 220 09	10RD 210 10	10RD 210 10
time (UTC)	18:31:04	18:31:14	18:31:24	18:31:34	18:31:44	18:31:54
airport wind (knots)	AW 220 09	AW 210 09	AW 210 08	AW 220 08	AW 220 08	AW 220 09
runway wind (knots)	07-A 200 07	07-A 200 07	07-A 200 07	07-A 200 08	07-A 200 08	07-A 200 08
runway wind (knots)	25-D 200 07	25-D 200 07	25-D 200 07	25-D 200 08	25-D 200 08	25-D 200 08
runway wind (knots)	25-A 210 17	25-A 210 18	25-A 210 17	25-A 210 16	25-A 220 15	25-A 210 15
runway wind (knots)	07-D 210 17	07-D 210 18	07-D 210 17	07-D 210 16	07-D 220 15	07-D 210 15
runway wind (knots)	10LA 200 10	10LA 200 10	10LA 210 11	10LA 210 12	10LA 220 12	10LA 210 12
runway wind (knots)	28RD 200 10	28RD 200 10	28RD 210 11	28RD 210 12	28RD 220 12	28RD 210 12
runway wind (knots)	28RA 220 11	28RA 220 12	28RA 220 13	28RA 220 13	28RA 210 13	28RA 210 13
runway wind (knots)	10LD 220 14	10LD 220 13	10LD 220 13	10LD 220 13	10LD 220 14	10LD 220 14
runway wind (knots)	10RA 200 07	10RA 200 07	10RA 200 07	10RA 200 08	10RA 200 08	10RA 200 08
runway wind (knots)	28LD 200 07	28LD 200 07	28LD 200 07	28LD 200 08	28LD 200 08	28LD 200 08
runway wind (knots)	28LA 210 09	28LA 210 08	28LA 210 08	28LA 220 08	28LA 220 09	28LA 220 09
runway wind (knots)	10RD 210 09	10RD 210 08	10RD 210 08	10RD 220 08	10RD 220 09	10RD 220 09

Figure 13 – LLWAS data from 1130 and 1131 MST

At 1130:04 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 220° at 14 knots and runway 10LD having wind from 220° at 13 knots. The other end of the runway (28RD/10LA) had a LLWS alert at 1130:04 MST.

At 1130:14 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 220° at 13 knots and runway 10LD having wind from 220° at 12 knots.

At 1130:24 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 220° at 12 knots and runway 10LD having wind from 220° at 13 knots.

At 1130:34 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 220° at 12 knots and runway 10LD having wind from 210° at 13 knots.

At 1130:44 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 220° at 11 knots and runway 10LD having wind from 210° at 14 knots.

At 1130:54 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 220° at 11 knots and runway 10LD having wind from 210° at 14 knots.

At 1131:04 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 220° at 11 knots and runway 10LD having wind from 220° at 14 knots.

At 1131:14 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 220° at 12 knots and runway 10LD having wind from 220° at 13 knots.

At 1131:24 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 220° at 13 knots and runway 10LD having wind from 220° at 13 knots.

At 1131:34 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 220° at 13 knots and runway 10LD having wind from 220° at 13 knots.

At 1131:44 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 210° at 13 knots and runway 10LD having wind from 220° at 14 knots.

At 1131:54 MST, the airport wind was reported as wind from 220° at 9 knots, with runway 28RA having wind from 210° at 13 knots and runway 10LD having wind from 220° at 14 knots.

While the wind direction of the airport wind provided to the accident flight was similar to the wind at runway 28RA/runway 10LD, the wind speed was higher and had a more variable wind direction at runway 28RA/runway 10LD that was not provided to the accident flight.

15.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on February 8, 2016, indicated the following:

SUN	
Begin civil twilight	0656 MST
Sunrise	0727 MST
Sun transit	1228 MST
Sunset	1730 MST
End civil twilight	1801 MST

F. LIST OF ATTACHMENTS

Attachment 1 – LLWAS data from KBIL

Paul Suffern
NTSB, AS-30