NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

October 10, 2017

Global Positioning System Devices

Specialist's Factual Report
By Bill Tuccio, Ph.D.

1. EVENT SUMMARY

Location:	Lake Hughes, California
Date:	January 12, 2017
Aircraft:	Mooney M20J
Registration:	N6201N
Operator:	Private
NTSB Number:	WPR17FA055

On January 12, 2017, about 0905 Pacific standard time (PST), a Mooney M20J, N6201N, was destroyed when it impacted terrain near the Lake Hughes Very High Frequency Omnirange navigation beacon (LHS VOR) during a flight from Tehachapi Municipal Airport (TSP), Tehachapi, California to Zamperini Field Airport (TOA), Torrance, California. The private pilot/owner was fatally injured. The personal flight was conducted under the provisions of Title 14 *Code of Federal Regulations* Part 91.

2. GROUP

A group was not convened.

3. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following global positioning system (GPS) devices:

Device Manufacturer/Model:	Garmin GPSMAP 496
Serial Number:	19702450

Device Manufacturer/Model:	Garmin Aera 796
Serial Number:	2CY002242

3.1. Garmin GPSMAP 496 Device Description

The Garmin GPSMAP 496 is a battery-powered portable 12-channel GPS receiver with a 256-color TFT LCD display screen. The unit includes a built-in Jeppesen database and is capable of receiving XM satellite radio for flight information including NEXRAD radar,

lightning, METARs, TAFs, and TFRs. A built-in AOPA Airport Directory and Safe Taxi Airport Diagrams are included for selected fields. The unit stores date, route-of-flight, and flight-time information for up to 50 flights. A flight record is triggered when groundspeed exceeds 30 knots and altitude exceeds 250 feet, and ends when groundspeed drops below 30 knots for 10 minutes or more. A detailed tracklog—including latitude, longitude, date, time, and GPS altitude information for an unspecified number of points—is stored within the unit whenever the receiver has a lock on the GPS navigation signal. Position is updated within the tracklog as a function of time or distance moved, depending on how the unit has been configured. Once the current tracklog memory becomes full, new information either overwrites the oldest information or recording stops, depending on how the unit is configured. The current tracklog can be saved to long-term memory and 15 saved tracklogs can be maintained in addition to the current tracklog. Tracklog storage may be activated or de-activated at user discretion. All recorded data is stored in non-volatile memory.[1] The unit contains hardware and software permitting the download of recorded waypoint, route, and tracklog information to a PC via a built-in serial port using the NMEA 0183 version 2.0 protocol. The unit can also communicate with external devices such as a computer using a built in USB port. An internal button-battery is used to back-up power to the internal memory and real-time clock during those periods when main power is removed.

3.1.1. Garmin GPSMAP 496 Data Recovery

The Garmin GPSMAP 496 sustained minor impact damage and exposure to outdoor environmental conditions, as shown in figure 1. Power was applied to the unit, but it would not start. An internal inspection did not identify the reason for the unit not starting. The unit was disassembled and the non-volatile memory chip identified, as shown in figure 2. The chip was removed and the ball grid array re-balled, as shown in figure 3. The chip was successfully read using an EEPROM programmer and then decoded.

Figure 1. Garmin GPSMAP 496, as received.

[1] Non-volatile memory is semiconductor memory that does not require external power for data retention.

Figure 2. Garmin GPSMAP 496, non-volatile memory chip (annotated).

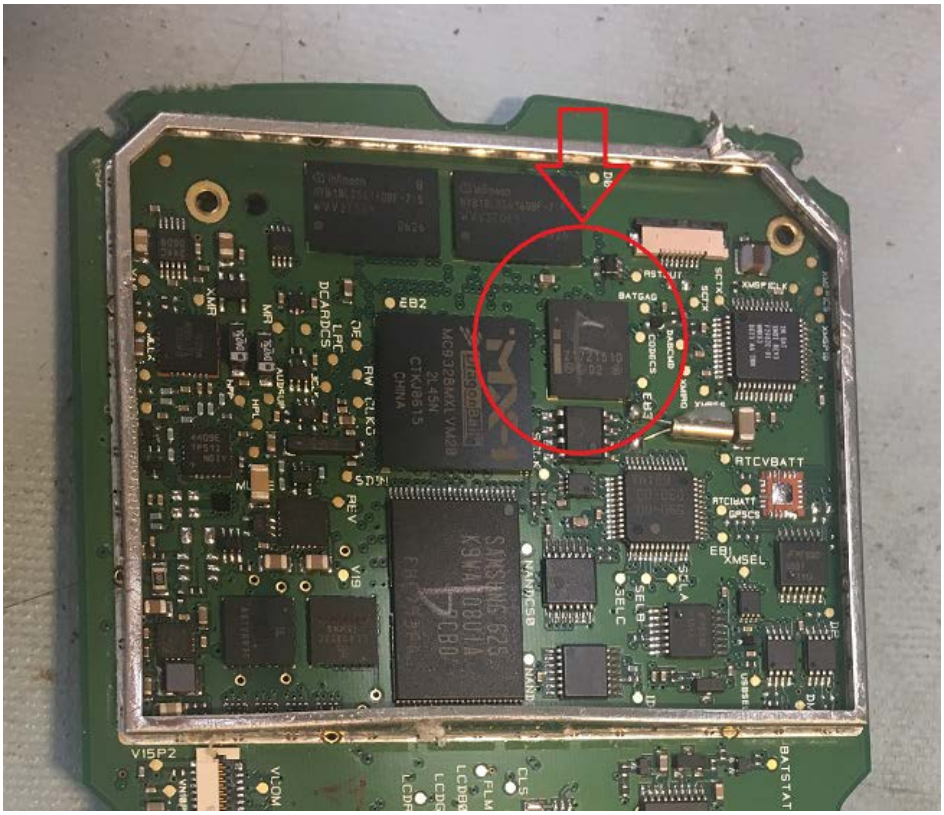
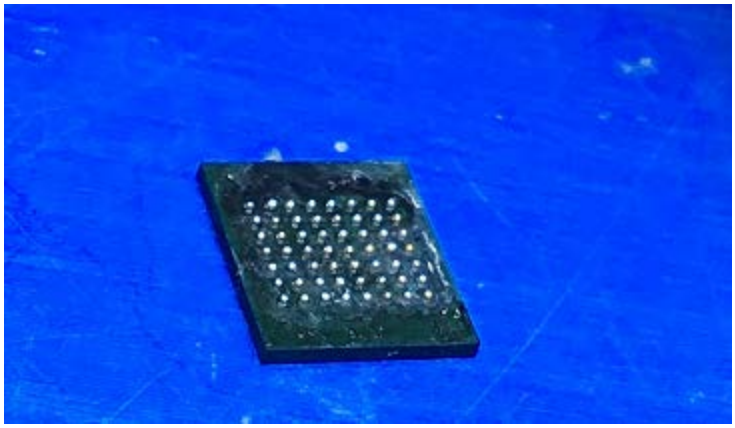


Figure 3. Garmin GPSMAP 496, non-volatile memory chip removed and re-balled.



3.1.2. Garmin GPSMAP 496 Data Description

The data extracted included 60 recording sessions from September 2012, through February 2013. The accident flight was not recorded.

3.2. Garmin Aera 796 Device Description

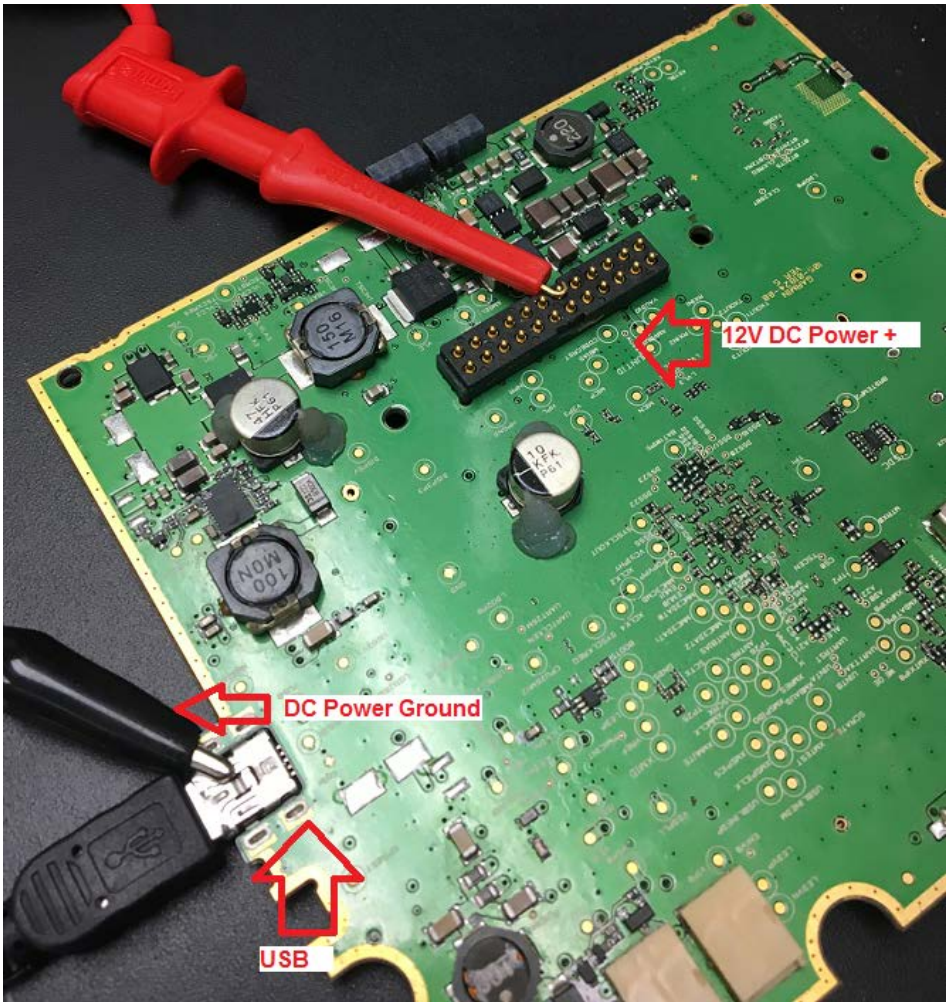
The Garmin Aera 796 provides similar tracklog recording capabilities as that of the Garmin GPSMAP 496 (as discussed in section 3.1), with a larger and enhanced user interface.

3.2.1. Garmin Aera 796 Data Recovery

The Garmin Aera 796 sustained significant impact damage and exposure to outdoor environmental conditions, as shown in figure 4. The unit was disassembled and the main internal board removed. Wiring diagrams were used to identify where 12 Volt-DC power could be applied to the board to facilitate a download. Figure 5 shows the main internal board with connections to DC power (positive), DC ground (negative), and the USB port. The unit was downloaded using the manufacturer's software.

Figure 4. Garmin Aera 796, as received.

Figure 5. Garmin Aera 796, main internal board with download connections.



3.2.2. Garmin Aera 796 Data Description

The data extracted included 38 recording sessions from December 17, 2016, through January 12, 2017 Coordinated Universal Time (UTC). Numerous flights between TSP and TOA airports were identified and are included in this report. The remainder of this report only considers data from the Garmin Aera 796.

3.2.3. Garmin Aera 796 Parameters Provided

Table 1 describes data parameters provided by the Garmin Aera 796 GPS device. Date, Time, Latitude, Longitude, and GPS Altitude are recorded by the device. Groundspeed and Track are derived from the recorded parameters.

Table 1. Garmin Aera 796 GPS Data Parameters

Parameter Name	Parameter Description
Date	Date for recorded data point (MM/DD/YYYY)
Time	Time (UTC) for recorded data point (HH:MM:SS)
Latitude	Recorded Latitude (degrees)
Longitude	Recorded Longitude (degrees)
GPS Alt	Recorded GPS Altitude (feet)
Groundspeed	Average derived groundspeed (knots)
Track	Average derived true course (degrees)

3.3. OVERLAYS AND TABULAR DATA

Figures 6 through 11 depict graphical overlays generated using Google Earth from the Garmin Aera 796. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

Figure 6 shows the accident flight (in red) and other flights (in blue) recorded for departures from TSP destined for TOA. The other flights occurred between December 17, 2016, and January 11, 2017.

Figure 7 shows flights recorded departing TOA and landing at TSP. These flights occurred between December 20, 2016, and January 11, 2017.

Figures 8 through 11 show the accident flight. Details include:

- The recording began at 16:45:31 UTC on January 12, 2017; ending on the same day at 17:03:26 UTC.
- The recording began on a taxiway at TSP at 16:45:31 UTC and the aircraft began its takeoff roll by 16:49:11 UTC.
- The aircraft initially climbed as high as 7,635 feet MSL, and then descended, with the last recorded point at 5,738 feet MSL near LHS VOR. An elevation annotated on the FAA sectional chart near LHS VOR was “5,788 feet.”

Tabular data for the entire Garmin Aera 796 recording, including those used to generate figures 6 through 11, are included as attachment 1. This attachment is provided in electronic comma-delimited (.CSV) format.

Figure 6. TSP-TOA flights (accident flight in red).

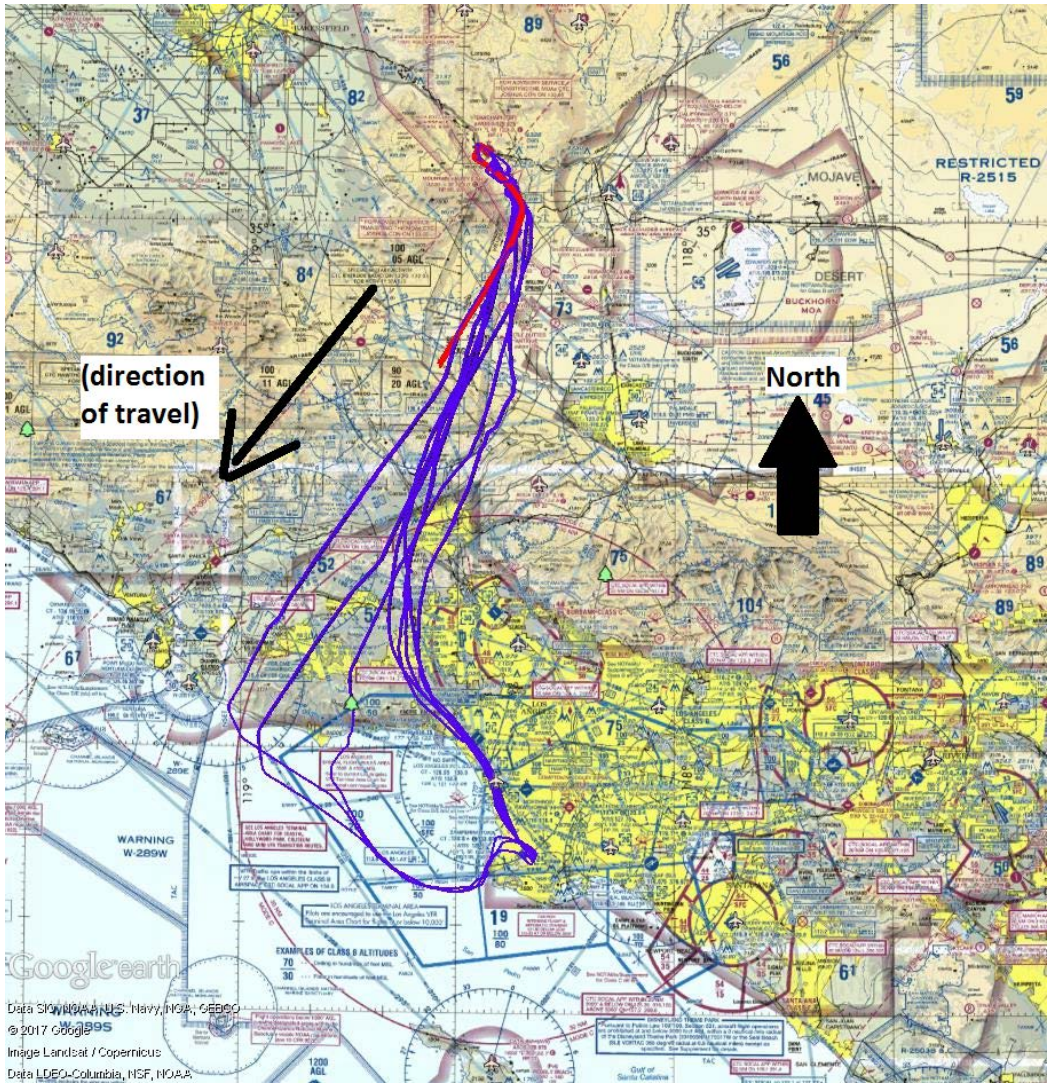


Figure 7. TOA-TSP flights.

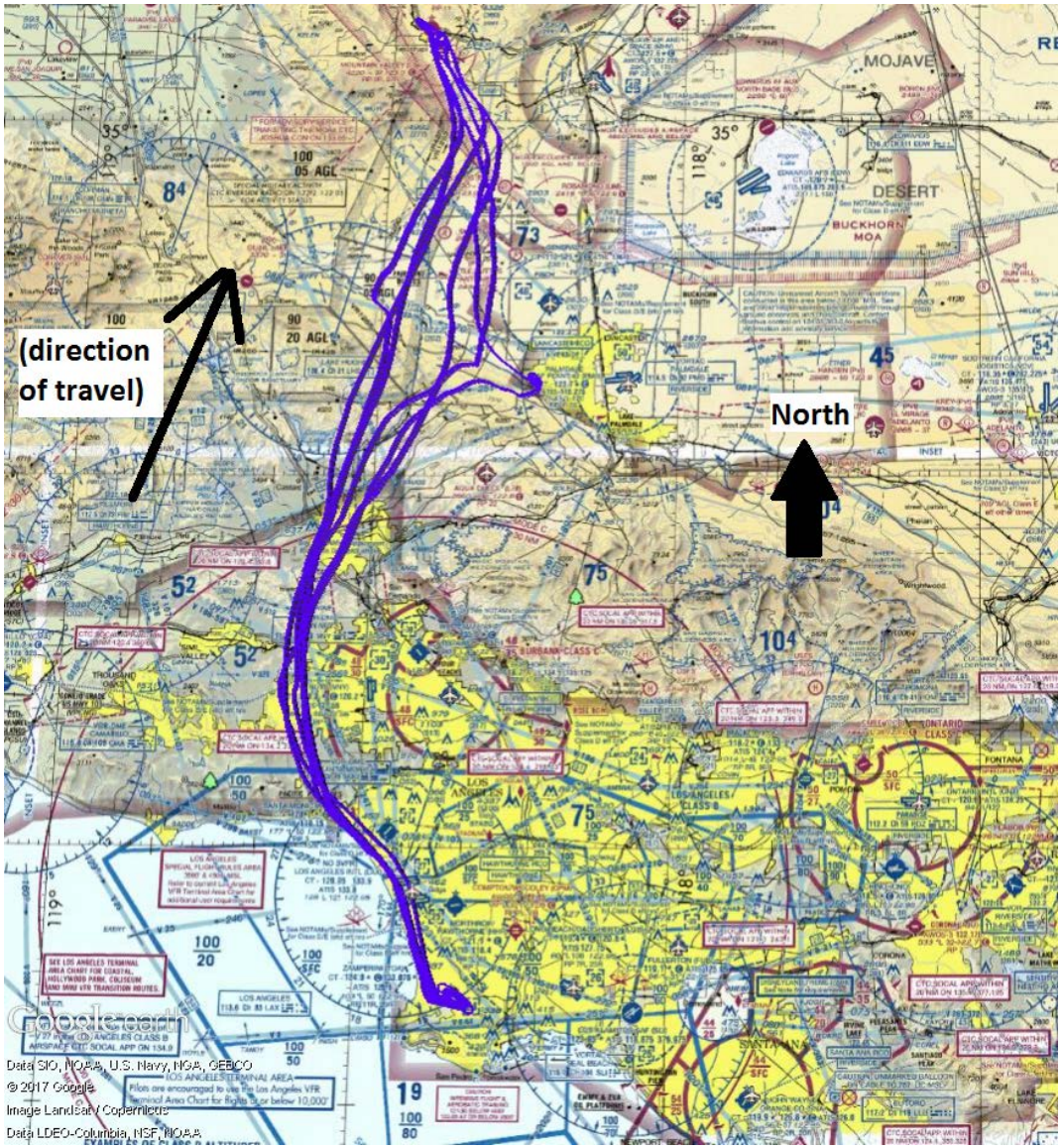


Figure 8. Accident flight overview.

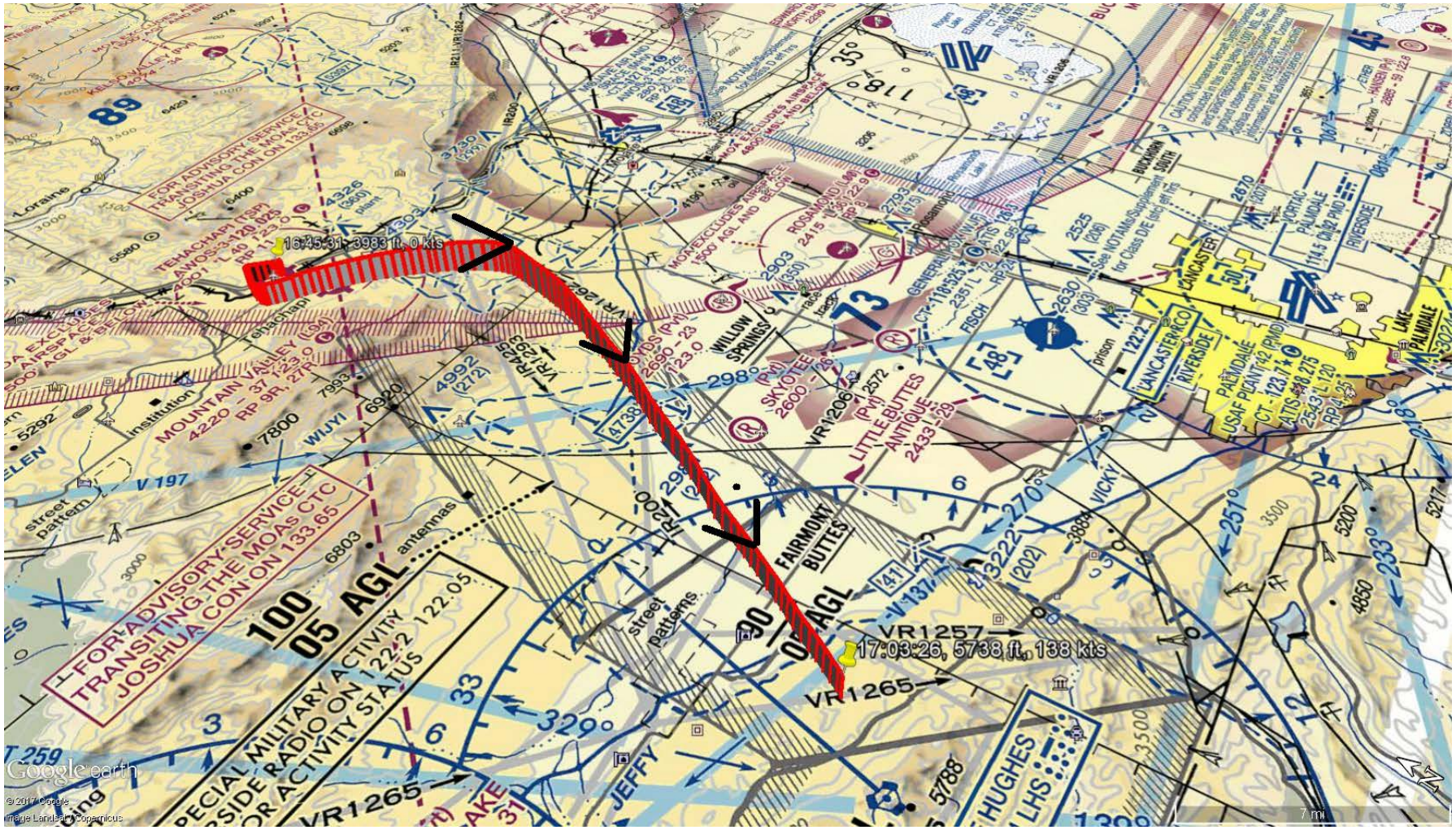


Figure 9. Accident flight start of recording.

Figure 10. Accident flight detail, aviation sectional chart overlay.

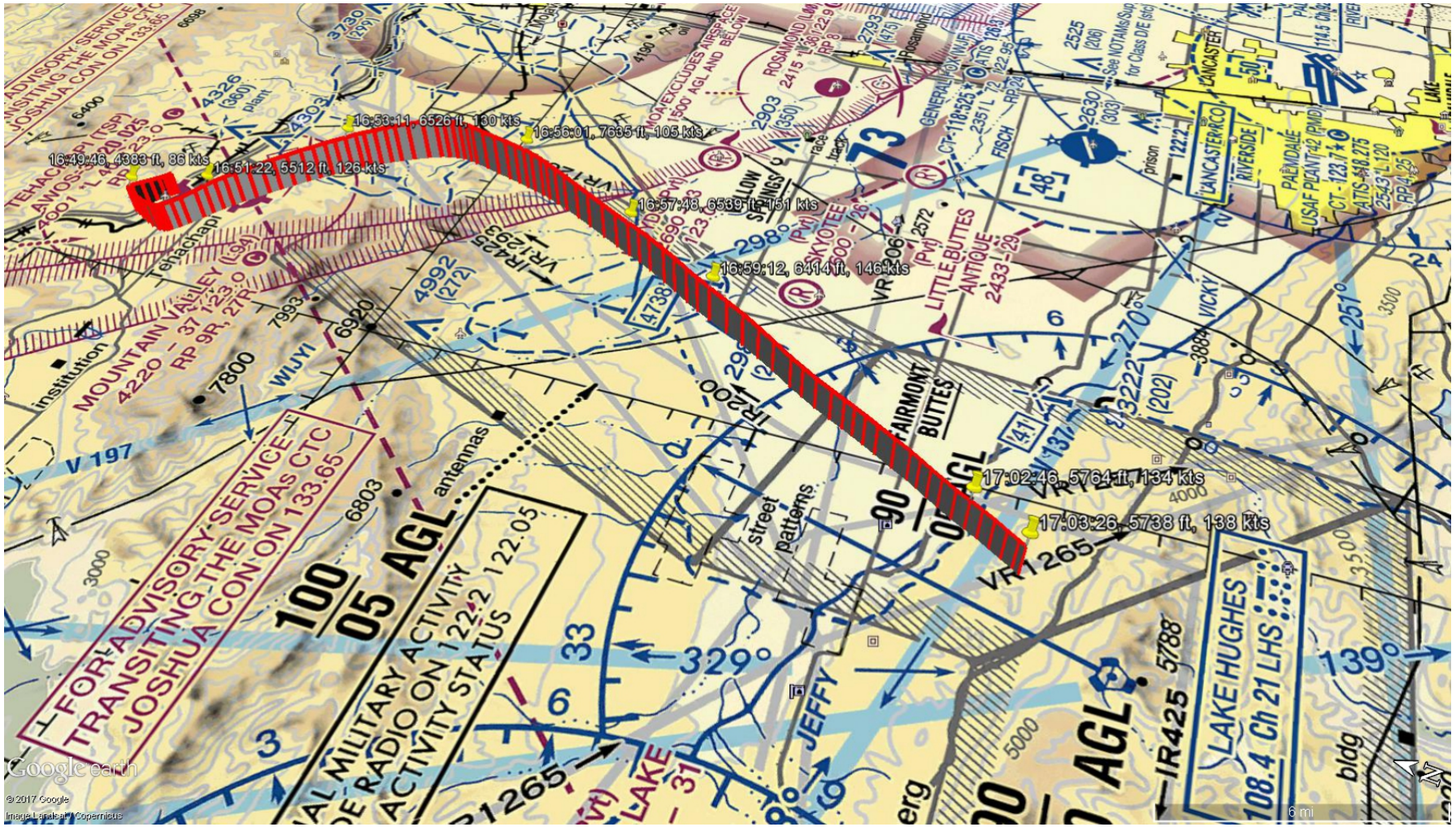


Figure 11. Accident flight overview, satellite overlay.