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

March 22, 2012

17 - GPS Factual Report

Specialist's Factual Report
by Bill Tuccio

1. EVENT

Location:	Moran Junction, Wyoming
Date:	February 15, 2012
Aircraft:	Bell 407
Registration:	N407HL
Operator:	Teton County Sheriff's Office
NTSB Number:	WPR12GA106

On February 15, 2012, at about 1300 mountain standard time, a Bell Helicopter model 407, N407HL, was substantially damaged when it impacted trees and terrain in the Bridger Teton National Forest near Moran Junction, Wyoming, during a search and rescue (SAR) mission. The commercial pilot and one SAR crewmember received serious injuries, and the other SAR crewmember was fatally injured. The public-use flight was operated by the Teton County Sheriff's Office (TCSO). Visual meteorological conditions prevailed, and no FAA flight plan was filed for the flight.

2. DETAILS OF DEVICE INVESTIGATION

The Safety Board's Vehicle Recorder Division received the following devices on March 7, 2012:

Device 1:	Garmin GPSMAP 296
Device 1 Serial Number:	67021015
Device 2:	Garmin Aera 500
Device 2 Serial Number:	1QN004326

2.1. Garmin GPSMAP 296 Device Description

The Garmin GPSMAP 296 is a battery-powered, portable 12-channel GPS receiver with a 256-color TFT LCD display screen. The unit stores date, route-of-flight, and flight-time information. 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. 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.

2.1.1. Garmin GPSMAP 296 Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had not sustained any damage and information was extracted using the manufacturer's software normally, without difficulty.

2.1.2. Garmin GPSMAP 296 Data Description

The data extracted included 10 sessions (1,944 total data points) from January 24, 2012[2] through February 15, 2012. The accident flight was the last session, recorded starting at 19:25:37 UTC and ending at 20:01:14 UTC on February 15, 2012 (230 total data points).

2.2. Garmin Aera 500 Device Description

The Garmin Aera 500 is a portable GPS unit designed for both automotive and aviation environments. It is capable of storing a detailed tracklog – including latitude, longitude, date, time, GPS altitude, and groundspeed information – within the unit whenever the receiver has a lock on the GPS navigation signal. All recorded data is stored in non-volatile memory. Communication to the device is provided by a built-in USB port.

2.2.1. Garmin Aera 500 Device Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had not sustained any damage and information was extracted using the manufacturer's software normally, without difficulty.

2.2.2. Garmin Aera 500 Device Data Description

The data extracted included 74 sessions from April 20, 2011 through February 16, 2012 (11,280 total data points). The accident flight was the 71st session, recorded starting at 19:25:39 UTC and ending at 20:01:53 UTC on February 15, 2012 (242 total data points). The first two sessions on the device, a total of 1,273 data points, had an invalid date field.

[1] Non-volatile memory is semiconductor memory that does not require external power for data retention.
[2] All dates and times are referenced to Coordinated Universal Time (UTC).

3. GPS PARAMETERS PROVIDED

Table 1 describes data parameters provided by the 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: 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 Altitude (feet, MSL[3])
Groundspeed	Average groundspeed between current and previous data point (knots)
Track	Average true course between current and previous data point (degrees)

4. OVERLAYS AND TABULAR DATA

All graphical overlays generated in this report were generated using Google Earth.

Figure 1 is a graphical overlay for the accident flight using data from the Garmin 296. Figure 2 is likewise an overlay, using data from the Garmin Aera 500. As figure 1 and 2 reveal near identical information, the Garmin Aera 500 will be used for the remaining overlays, as the Garmin Aera 500 recorded approximately 40 more seconds of data at the end of the flight than the Garmin 296.

Figure 3 shows the takeoff from Jackson, Wyoming at about 19:25:39 on February 15, 2012. The takeoff occured from a location just east of the Teton Pass Highway, Route 22.

Figure 4 shows the enroute portion of the flight to the search area between about 19:35 and 19:41:55. The groundspeed was about 115 knots with altitudes ranging from about 8,976 feet MSL to 9,823 feet MSL.

Figure 5 shows an annotated overview of the search pattern. Upon entering the search area, the helicopter first proceeded southeasterly (“1”) until about 19:43:18. The helicopter then went southwesterly (“2”), including a 360 degree turn. The helicopter then proceeded north-northwest (“3”) until about 19:49:06. The helicopter then proceeded opposite its inbound route (“4) in a southeasterly direction, ultimately going about 2.2 nautical miles farther southeast than the prior legs.

[3] MSL means altitude above mean sea level

Figures 6 through 13 show additional details of the search area flown prior to the accident. These figures 6 through 13 maintain a north-up orientation for clarity.

Figure 6 shows the route flown southeast of the search area entry point starting at about 19:41:55. The helicopter flew east-southeast from about 19:42 until 19:43; turned and flew southwesterly until about 19:43:48; executed a right 360 degree turn and then resumed southwesterly until about 19:44:44; and then flew north-northwest until about 19:46:31, crossing the initial search area entry route.

Figure 7 shows the helicopter flying northwesterly into the northwest part of the search area from 19:46:31 until about 19:48.

Figure 8 shows the northwest extent of the helicopter at the intersection of Flagstaff Road and United States Forestry Service 30120; the helicopter reversed course at this intersection between about 19:48:08 through 19:49:13.

Figure 9 shows the helicopter track back towards the east-southeast search area from 19:49:13 through 19:50:41.

Figure 10 shows the helicopter proceeding back into the southeastern search area between 19:50:41 and 19:52. The helicopter then continues further southeast through 19:52:30.

Figure 11 shows the helicopter proceeding further southeast from 19:52:30 through 19:54:12.

Figure 12 shows the helicopter executing a 360 degree turn between about 19:54:12 and 19:58:18. The helicopter position is not reported between about 19:54:49 and 19:58:09, consistent with lack of motion.

Figure 13 shows the helicopter continuing southeast then turning to the northwest between 19:58:18 and 20:00:24. During this part of the flight, the helicopter groundspeed decreased to about 25 knots. While flying this route, the helicopter executed a 360 degree, right hand turn between about 19:59:42 and 20:00:14.

Figure 14 shows the last segment of the flight, including the crash, from 20:00:24 through the last recorded point of 20:01:53. The helicopter groundspeed slowed from about 25 knots to less than 15 knots between 20:00:32 and 20:01:00 while at an altitude of about 9,665 to 9,695 feet MSL. Thereafter, the helicopter lost altitude from 9,695 feet to a final recorded altitude of 9,469 feet MSL between about 20:01:07 and 20:01:53. Due to the rapid rate of change during this period, the reported altitude and calculated groundspeed and track should be considered to have an unknown accuracy.

Tabular data used to generate figure 1 is included as Attachment 1. Tabular data used to generate figures 2 through 14 are included as Attachment 2. These attachments are provided in electronic comma-delimited (.CSV) format.

Figure 1. Accident flight as recorded by Garmin 296.

Figure 2. Accident flight as recorded by Garmin Aera 500.

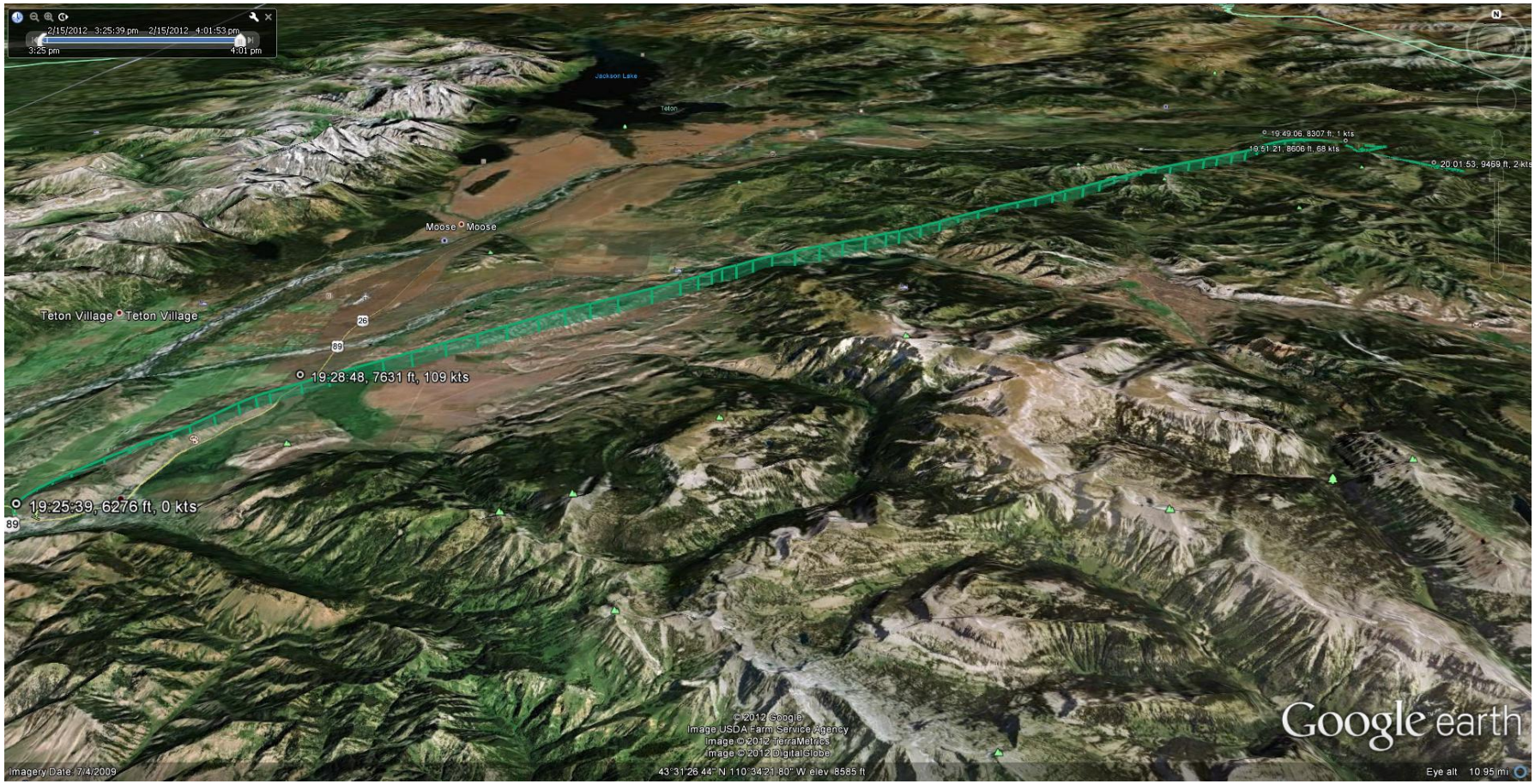

Figure 3. Takeoff as recorded by Garmin Aera 500.

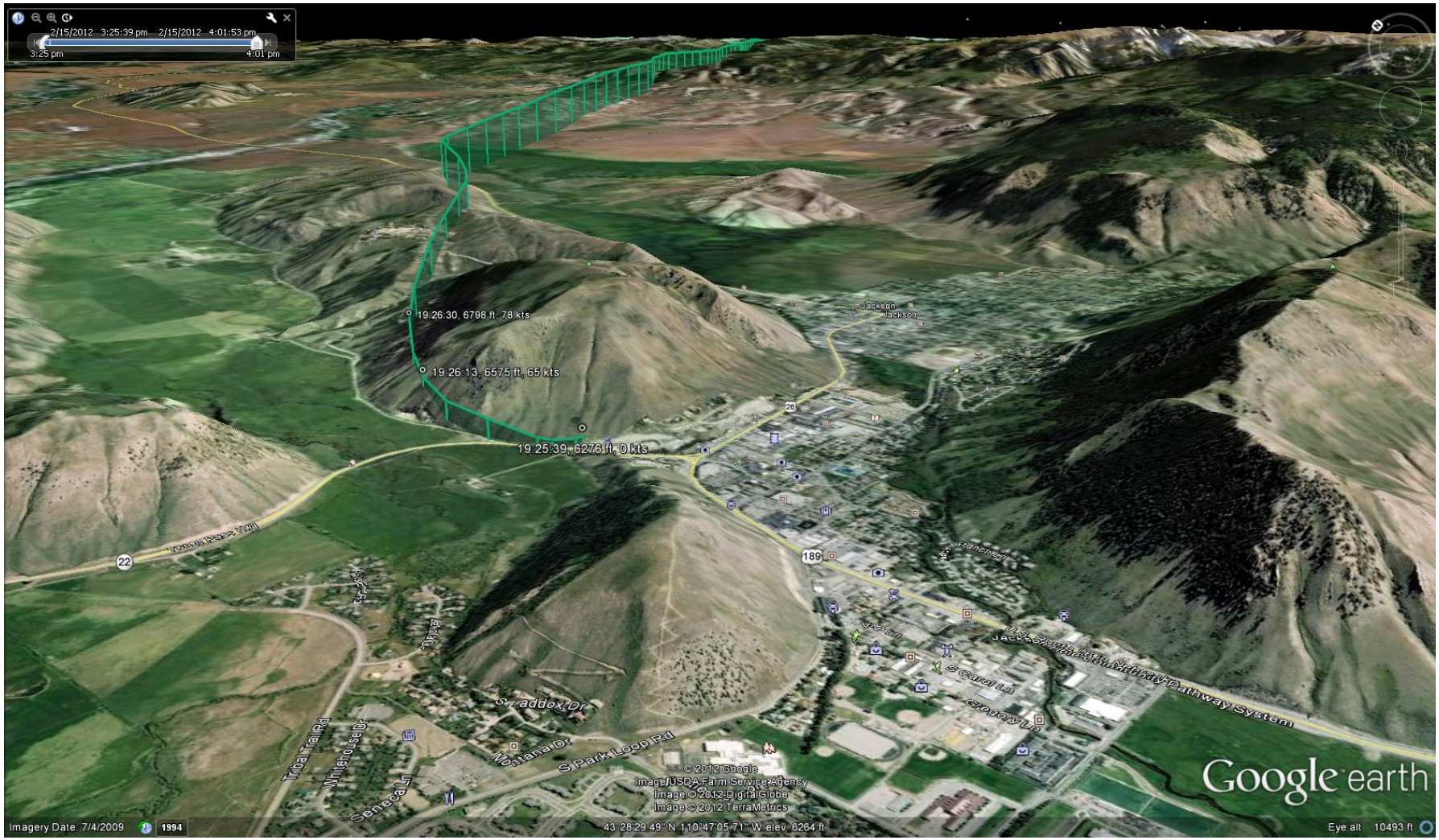

Figure 4. Enroute to search area as recorded by Garmin Aera 500.

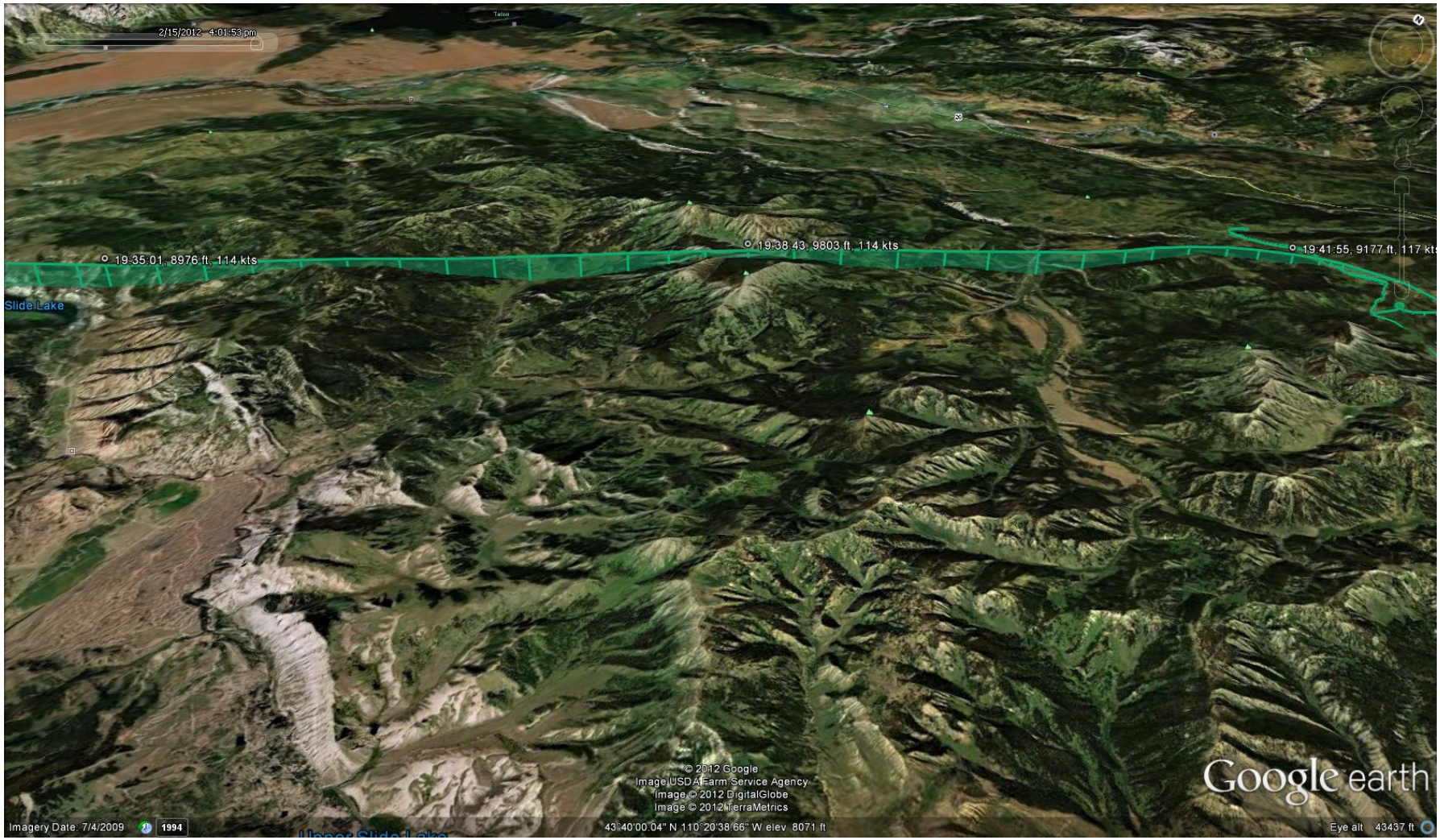

Figure 5. Overview of search pattern as recorded by Garmin Aera 500.

Figure 6. Initial entry into search area as recorded by Garmin Aera 500.

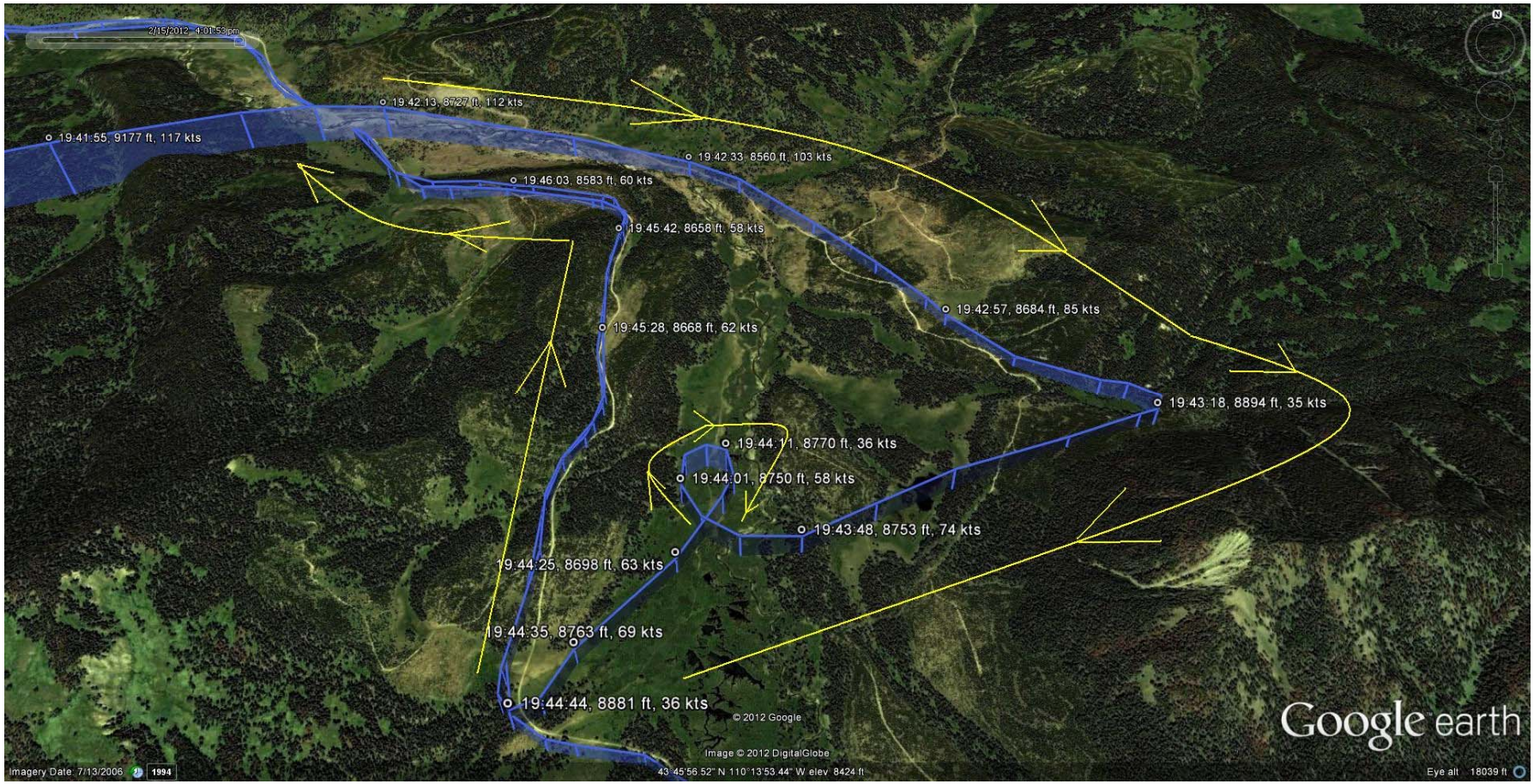

Figure 7. Northwest search area, proceeding northwest, as recorded by Garmin Aera 500.

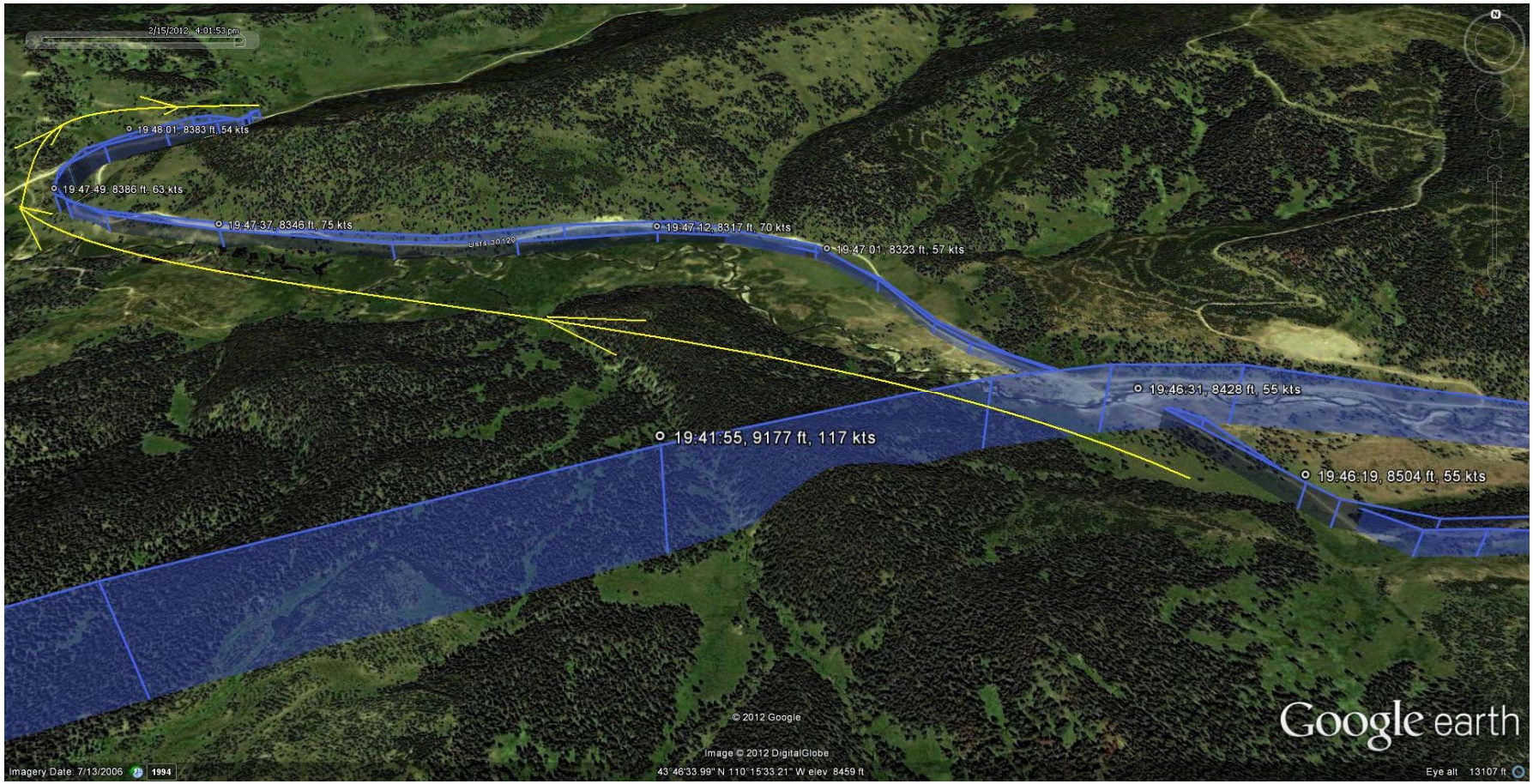

Figure 8. Northwest search area, turn back to southwest, as recorded by Garmin Aera 500.

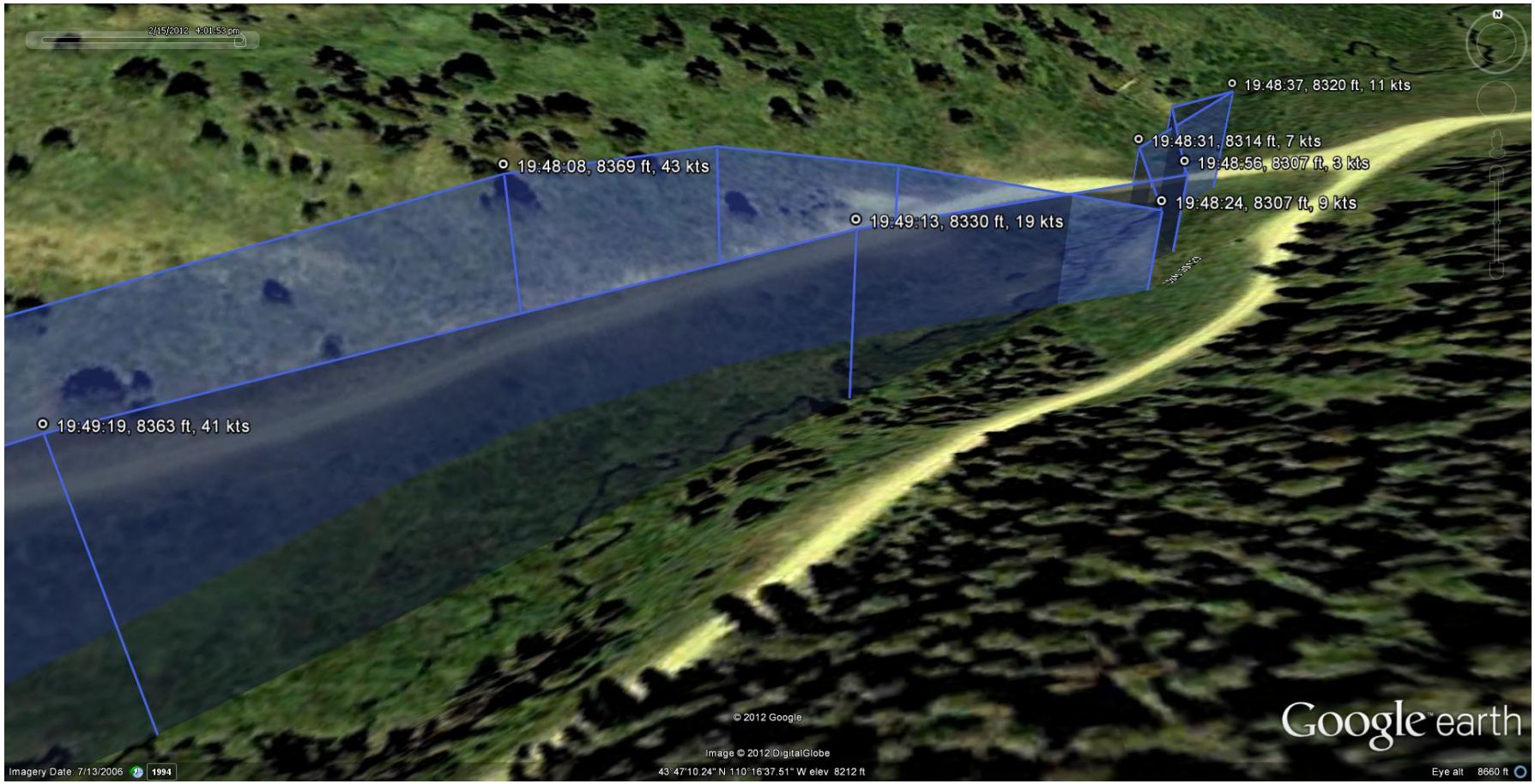

Figure 9. Northwest search area, proceeding east-southeast, as recorded by Garmin Aera 500.

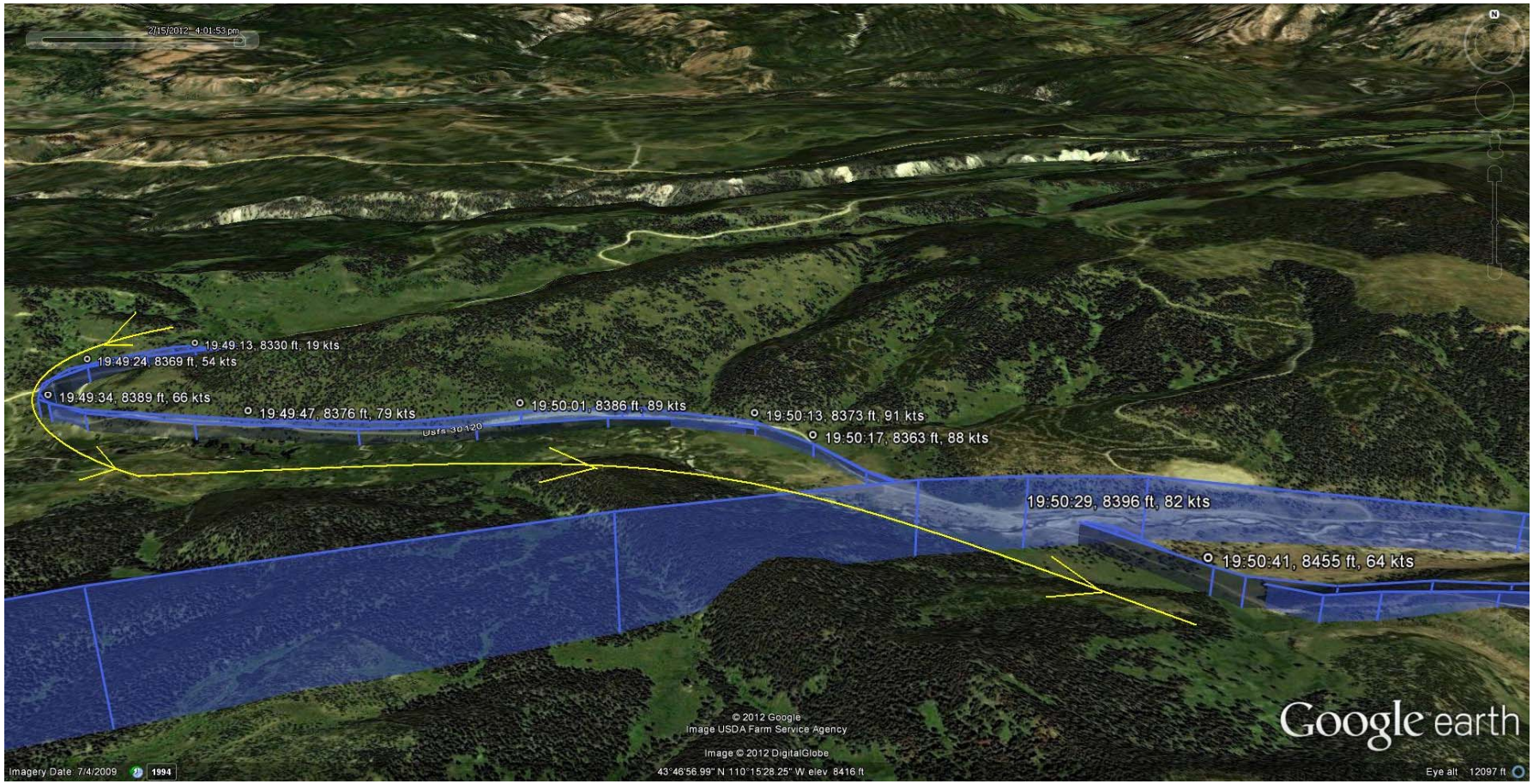

Figure 10. Southeast search area, proceeding east-southeast, as recorded by Garmin Aera 500.

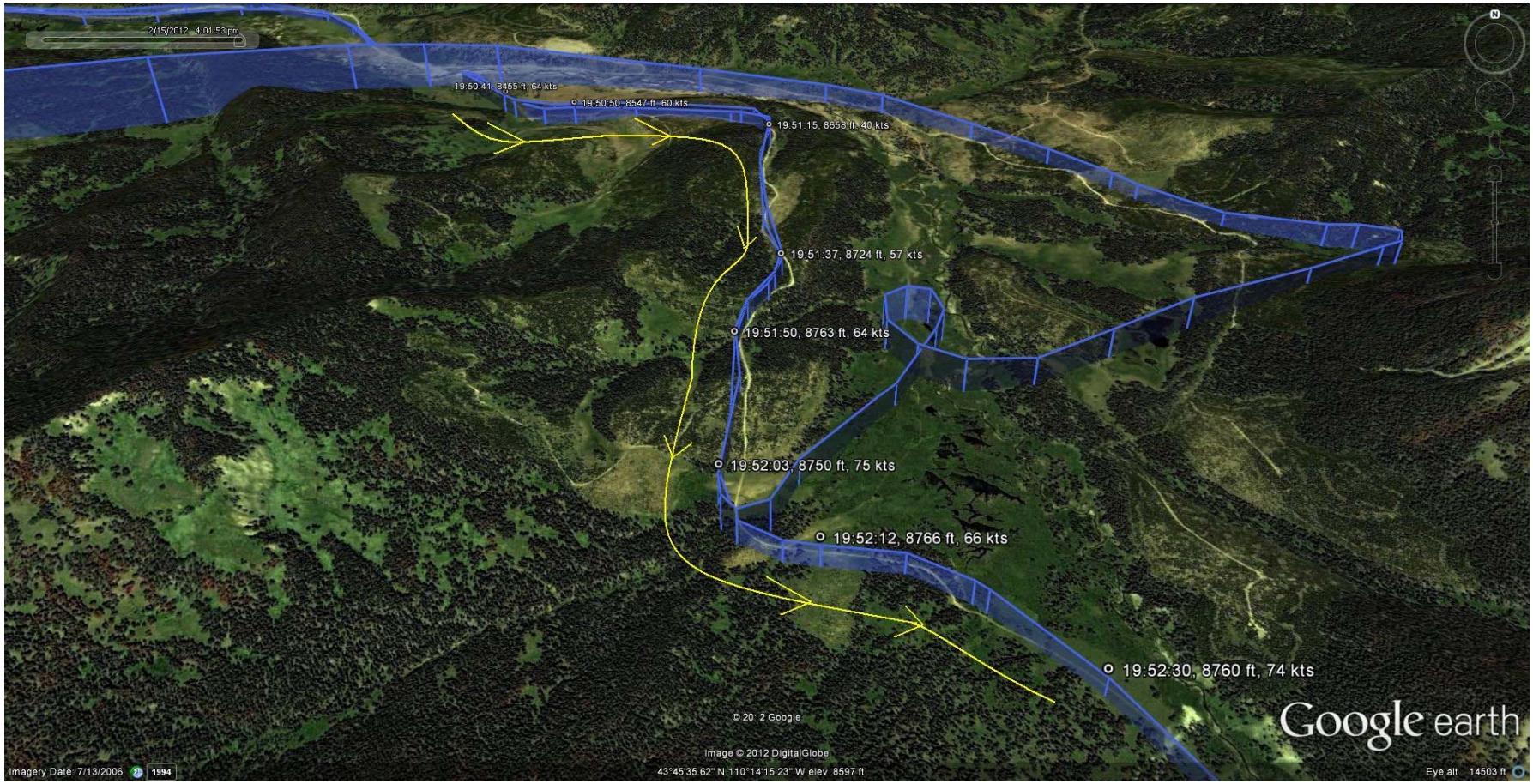

Figure 11. Further southeast search area, proceeding east-southeast, as recorded by Garmin Aera 500.

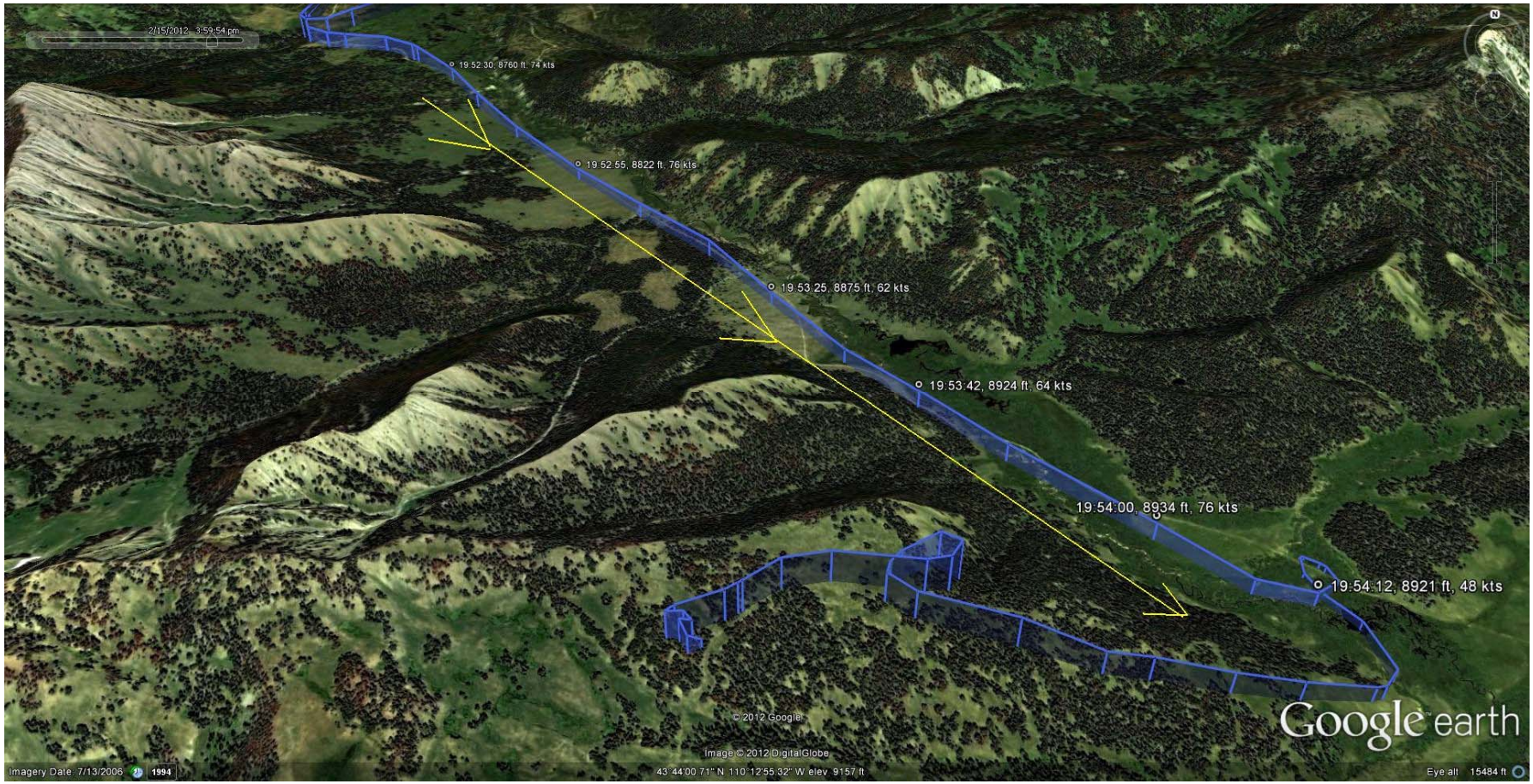

Figure 12. Turn and delay in southeast search area, as recorded by Garmin Aera 500.

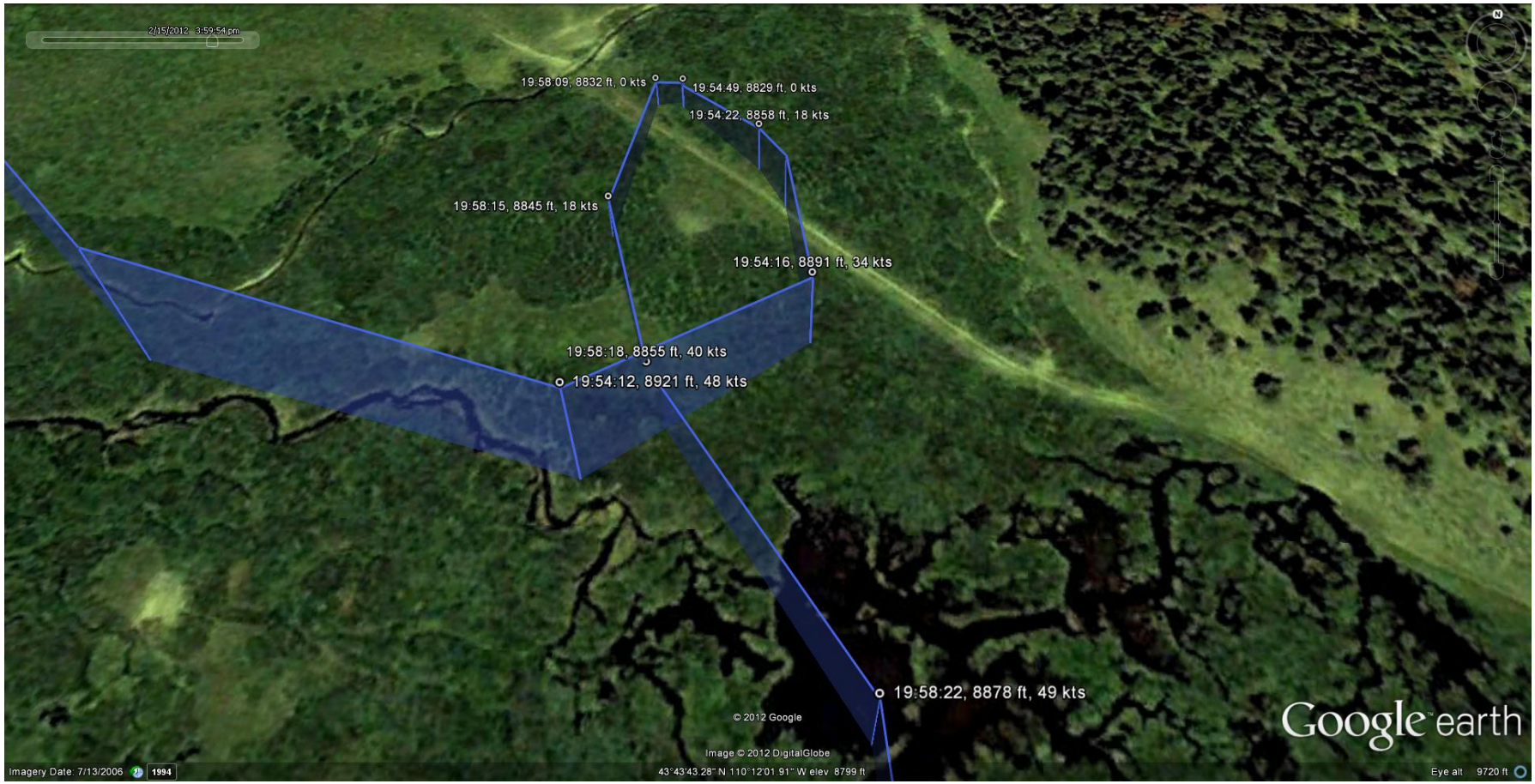

Figure 13. Southeast search area, flying northwest at slower speed, as recorded by Garmin Aera 500.

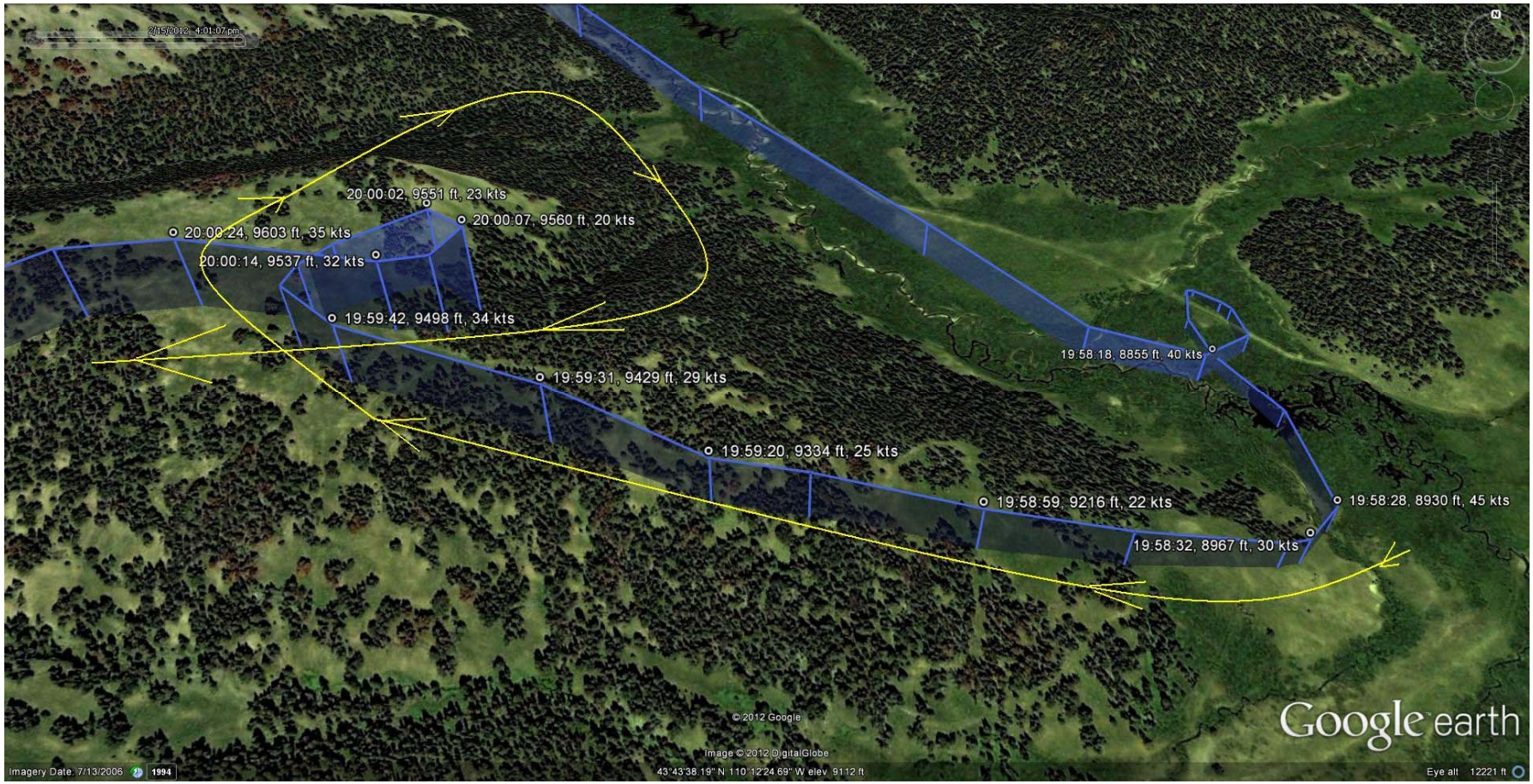

Figure 14. Last segment of flight and crash, as recorded by Garmin Aera 500.