Assignment 6: Obstruction Analysis and Wind Rose Analysis

Date Due: October 20 2025

Instructor: Trani

Problem #1

Use the Iowa State Mesonet model data to construct a Wind Rose for Winchester Airport (OKV). Specifically, collect 30 years of wind data for Winchester (OKV) using the Automated Surface Observing Systems (ASOS) as demonstrated in class.

(a) Collect the data using the Iowa State Mesonet model (look at the Virginia ASOS network) and **create a custom wind rose that contains 36 direction bins** and the following wind speeds (knots). Show me the Iowa State Mesonet Wind Rose.

☑ Optional. User provided wind speed bins

0 - 3 - 5 - 10 - 16 - 21 - 28 +

(b) Collect the raw data used to generate the Iowa State Mesonet wind rose and bring the data using Excel.

Table 1. Partial Data for Winchester, Virginia Airport (OKV). Only First Quadrant Data Shown.

# Windrose Data Table (Percent Frequency) for WINCHESTER RGNL (OKV)							
# Observations Used/Missing/Total: 241810/0/241810							
# 31 Dec 1994 08:00 PM - 13 Oct 2025 12:55 AM America/New_York							
#							
# Wind Speed Units: knots							
# Generated 13 Oct 2025 19:09 UTC, contact: akrherz@iastate.edu							
# First value in table is CALM							
Direction	Calm	3.0 4.9	5.0 9.9	10.0 15.9	16.0 20.9	21.0 27.9	28.0+
355-004	30.27	0.69	0.424	0.055	0.001	0.001	0
005-014		0.665	0.429	0.029	0.001	0	0
015-024		0.637	0.384	0.03	0.001	0	0
025-034		0.713	0.376	0.024	0.002	0	0
035-044		0.598	0.28	0.014	0	0	0
045-054		0.411	0.178	0.008	0	0	0
055-064		0.356	0.16	0.006	0	0	0
065-074		0.363	0.149	0.005	0	0	0
075-084		0.523	0.257	0.007	0	0	0
085-094		0.61	0.41	0.016	0.001	0	0

(c) Find the percent of time, the wind is stronger than 20 knots at Winchester (from any direction).

Perform a new query in the Iowa State Mesonet Database to isolate wind speeds above 20 knots. Table 2 shows the new query with a new set of wind speed ranges. The estimate is that **1.057 percent of the time**, **wind speeds exceed 20 knots** at Winchester Regional Airport.

Table 2. Partial Data for Winchester, Virginia Airport (OKV) to Estimate Wind Speeds Above 20 knots.

Direction	Calm	2.0 4.9	5.0 9.9	10.0 19.9	20.0 24.9	25.0 29.9	30.0+
355-004	30.26	0.691	0.426	0.056	0.001	0	0
005-014		0.665	0.429	0.031	0	0	0
015-024		0.637	0.384	0.031	0	0	0
025-034		0.712	0.376	0.026	0	0	0
035-044		0.598	0.28	0.014	0	0	0
045-054		0.411	0.178	0.008	0	0	0
055-064		0.356	0.16	0.006	0	0	0
065-074		0.363	0.149	0.005	0	0	0
075-084		0.522	0.257	0.007	0	0	0
315-324		0.751	1.858	1.376	0.058	0.005	0
325-334		0.748	1.355	0.515	0.008	0.001	0
335-344		0.723	0.789	0.193	0.005	0.001	0
345-354		0.63	0.526	0.085	0.001	0	0
		Sum of Values Above 20 knots			**1.057**		

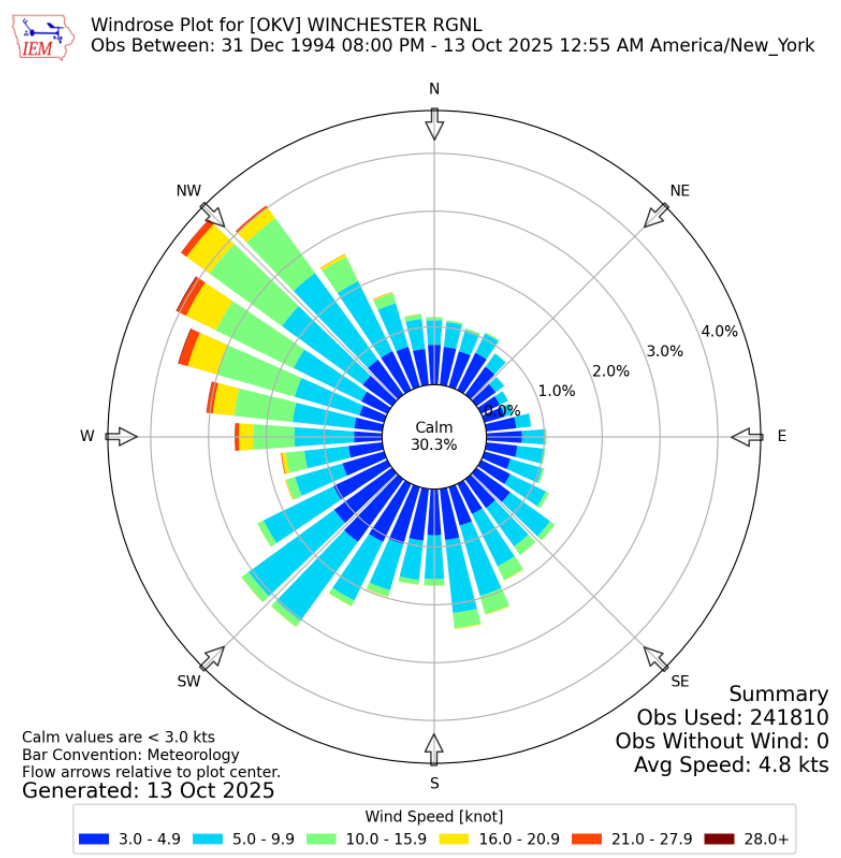
(d) Find the percent of time with calm winds (< 3 knots).

30.26% of time, winds are calm at Winchester Regional Airport. The value is reported automatically by the Mesonet Custom Wind Rose.

(e) Find the predominant orientation of the wind.

The predominant winds come from the Northwest (NW). Table 3 illustrates the custom wind rose generated by the Iowa State Mesonet (IEM) model. Looking at the IEM wind rose data, the best runway orientation (without doing further analysis, is between 305-315 degrees with respect to the true North.

Table 3. Custom Wind Rose for Winchester, Virginia Airport (OKV). Source: IEM Model.



(f) Find the design crosswind wind speed used in the wind rose analysis if the Embraer Praetor 500 (also known as Legacy 450) is the critical aircraft (see Figure 1). State the ADG and AAC groups used in the analysis.

Use the FAA Aircraft Characteristic Database to find the ADG and AAC group of the Embraer Legacy 450. The most recent versions of the Legacy 450 are named Praetor 500 to differentiate the new avionics and performance improvements of the new model. The ICAO and FAA code for the Legacy 450 is E545. The E545 belongs to groups ADG II and AAC B. According to Table 3-1 in the FAA AC 150/5300-13B, the design crosswind for the Embraer Legacy 450 is 13 knots.

RDC	Allowable Crosswind Component
A-I and B-I *	10.5 knots
A-II and B-II	13 knots
A-III, B-III, C-I through D-III D-I through D-III	16 knots
A-IV and B-IV, C-IV through C-VI, D-IV through D-VI	20 knots
E-I through E-VI	20 knots

* Includes A-I and B-I small aircraft.

Table 3-1 in FAA AC 150/5300-13B.

Figure 1. Embraer Legacy 450 (Praetor 500) (A.A. Trani).

(g) Determine if the runway's **current orientation** satisfies the FAA criteria for crosswind coverage. Remember that ASOS stations report wind according to the **magnetic north**. Tell me the actual coverage of the runway (assuming both runway ends are used). **Use the Autocad templates provided in class to construct the wind rose and calculate the coverage provided.**

The Winchester Regional Airport has a single runway oriented 144 and 324 degrees true. The wind rose diagram with the runway orientation rectangle is shown in Figure 2. The percent of wind conditions not covered by both runways is 1.38%. **Therefore, the crosswind coverage is 98.62%. The runway satisfies the 95% coverage criteria.**

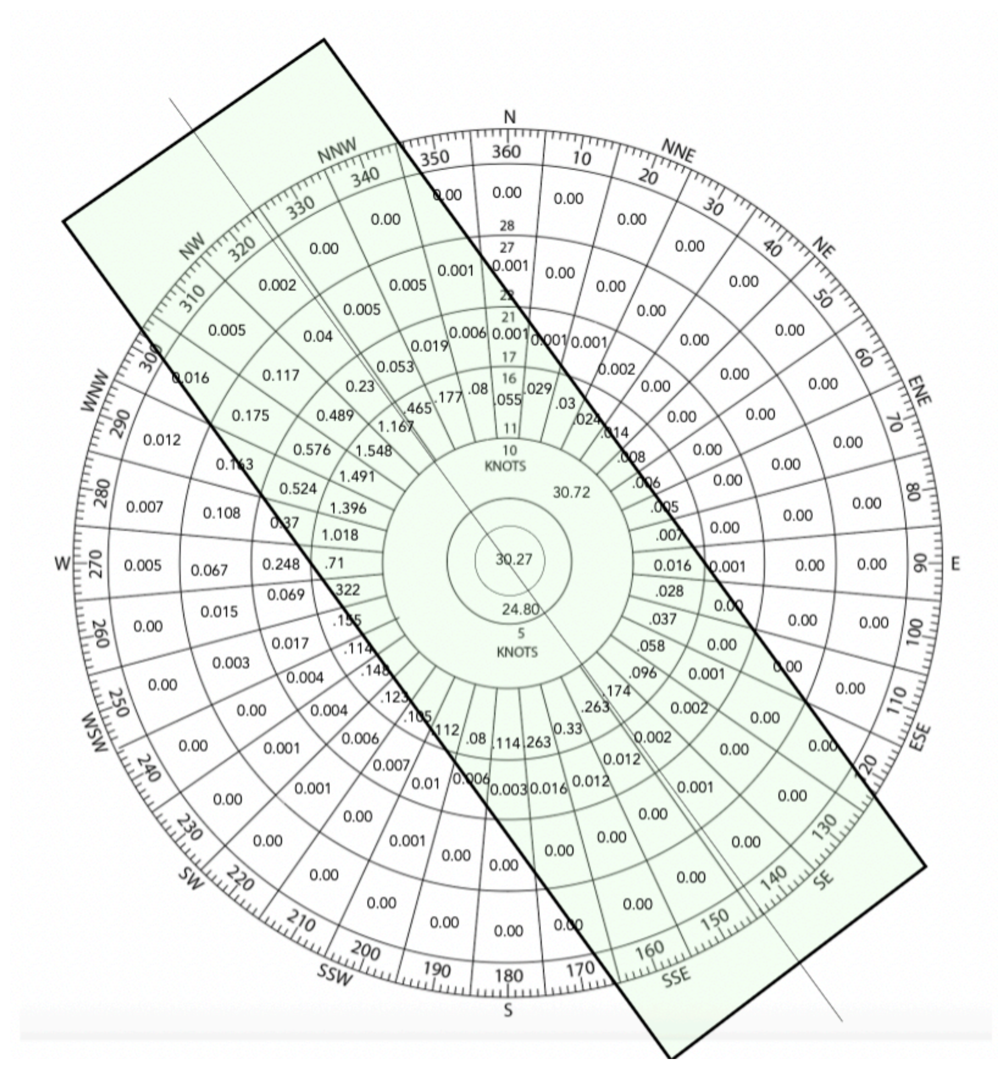


Figure 2. Wind Rose for Winchester, Virginia Airport (OKV). 13-knot Crosswind Coverage for ADG II and AAC B. Magnetic Orientation of the Runway is 144/324 degrees.

(h) Find the percent of time the airport could have operations on each runway end (departures and arrivals operating against the wind) based on wind conditions. In your calculations for each runway end, assume zero tailwinds.

Figure 3 shows the wind rose to estimate the coverage for landings on runway 14 (144 degrees magnetic). The calculations adds the percentages shown in Table 4. The calculation in Table 4 is done in two ways:

A) Coverage counting half of the calm winds (strictly enforcing no tailwind component)

B) Coverage council all calm winds. Technically, pilots can takeoff in either direction when the winds are reported calm.

Table 4. Calculation of Crosswind Coverage for runway 14 at Winchester Regional Airport.

Wind Component	Percent (%)
50% of the calm winds (0-3 knots)	15.1
50% of the winds reported between 3-5 knots	12.4
50% of the winds reported between 5-10 knots	15.4
The percentage coverage in the rectangle shown in Figure 3 not counting winds from 0-10 knots.	1.9
Total Coverage (1/2 of calm winds) (%)	**44.7**
Total Coverage (all calm winds) (%)	**59.8**

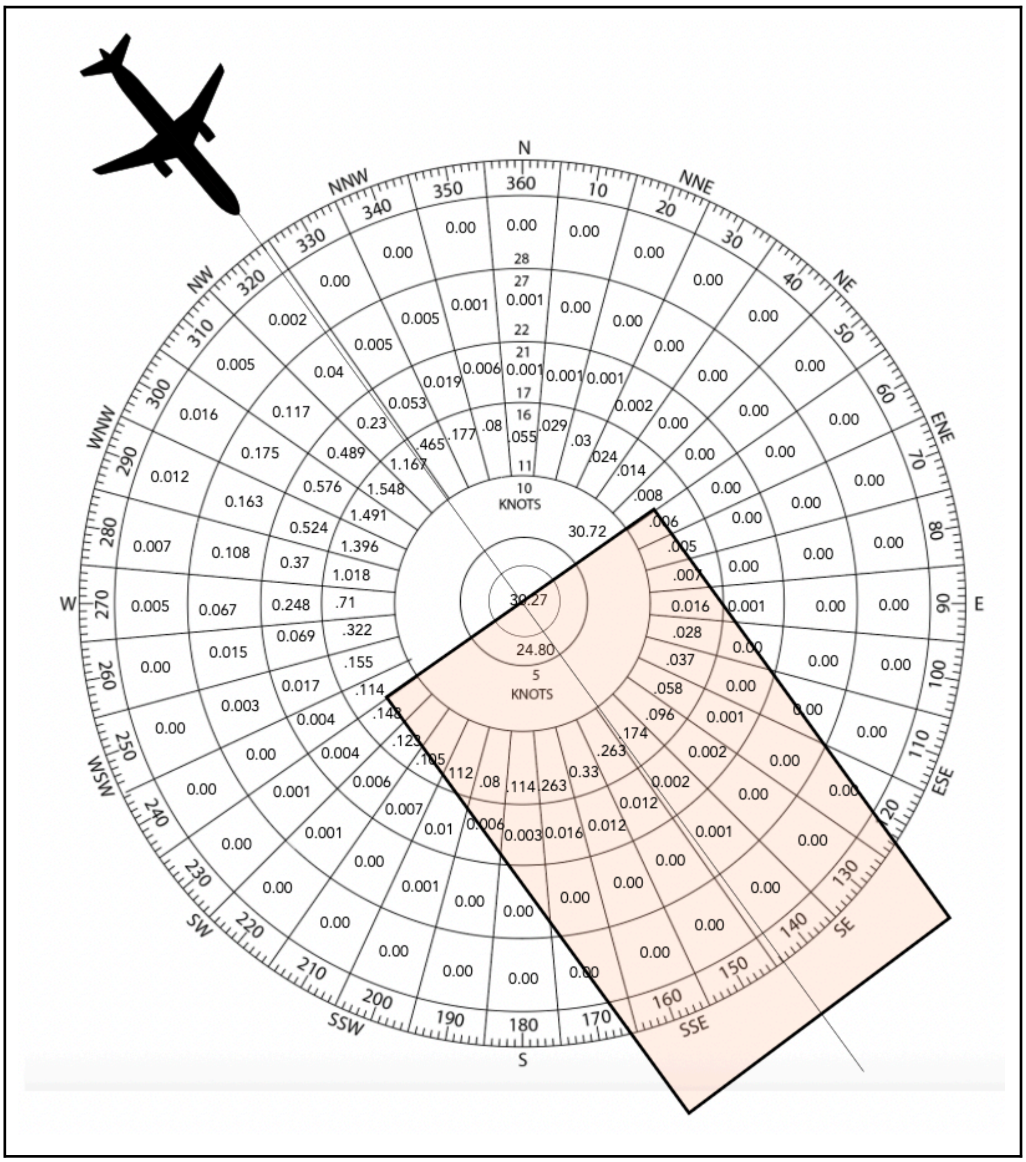


Figure 3. Wind Rose for Winchester, Virginia Airport (OKV). 13-knot Crosswind Coverage for ADG II and AAC B. Magnetic Orientation of the Runway is 144 degrees (Runway 14). ***Coverage is ~44.7% Counting 50% of Calm Winds.***

Figure 4 shows the wind rose to estimate the coverage for landings on runway 32 (324 degrees magnetic). The calculations adds the percentages shown in Table 5. The calculation in Table 5 is done in two ways:

A) Coverage counting half of the calm winds (strictly enforcing no tailwind component)
B) Coverage council all calm winds. Technically, pilots can takeoff in either direction when the winds are reported calm.

Table 5. Calculation of Crosswind Coverage for runway 32 at Winchester Regional Airport.

Wind Component	Percent (%)
50% of the calm winds (0-3 knots)	15.1
50% of the winds reported between 3-5 knots	12.4
50% of the winds reported between 5-10 knots	15.4
The percentage coverage in the red rectangle shown in Figure 4 not counting winds from 0-10 knots.	11.1
Total Coverage (counting half of calm winds) (%)	**53.9**
Total Coverage (counting all calm winds) (%)	**69.1**

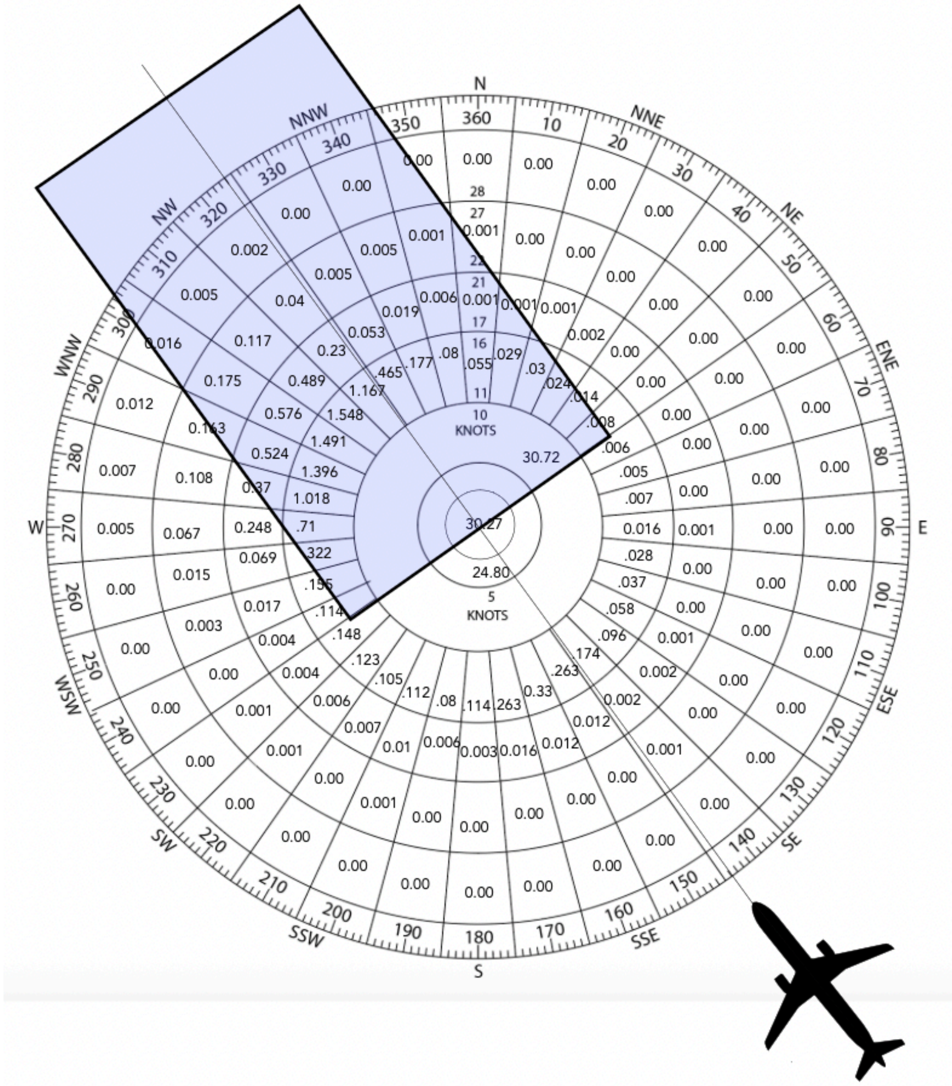


Figure 4. Wind Rose for Winchester, Virginia Airport (OKV). 13-knot Crosswind Coverage for ADG II and AAC B. Magnetic Orientation of the Runway is 324 degrees (Runway 32). ***Coverage is 53.9%.***

Note:

You should always make a validation that the percentages calculated add up to ~100%. Table 6 illustrates the check sum calculation.

Table 6. Check Sum of Wind Coverage Calculations for Winchester Regional Airport.

Wind Coverage	Percent (%)
Runway 14 (zero tailwind strictly enforced)	44.70
Runway 32 (zero tailwind strictly enforced)	53.90
Percent of wind conditions not covered by both runways at 13-knot wind speed design limit.	1.38
Total percent wind calculation (Check sum)	**99.98**

The addition of all wind values is within 0.02%. This seems acceptable because we estimated the fractions covered in each small wedge of the wind rose.

Problem #2

Use the Elevation profile function in Google Earth to check for obstructions to navigation on the approach to runway 33 at Aspen-Pitkin County Airport (ASE).

Figure 2.1. Sample Image in Google Earth Showing Runway 33 Threshold at Aspen-Pitkin County Airport (ASE).

a) As demonstrated in class, create a straight path from the runway 33 threshold (to the Southeast). Define a long path segment that spans the complete approach surface. For this analysis, ensure the path segment created is aligned with the runway centerline (see Figure 2). **Note: Distances reported by Google Earth in the elevation profiles are in statute miles.**

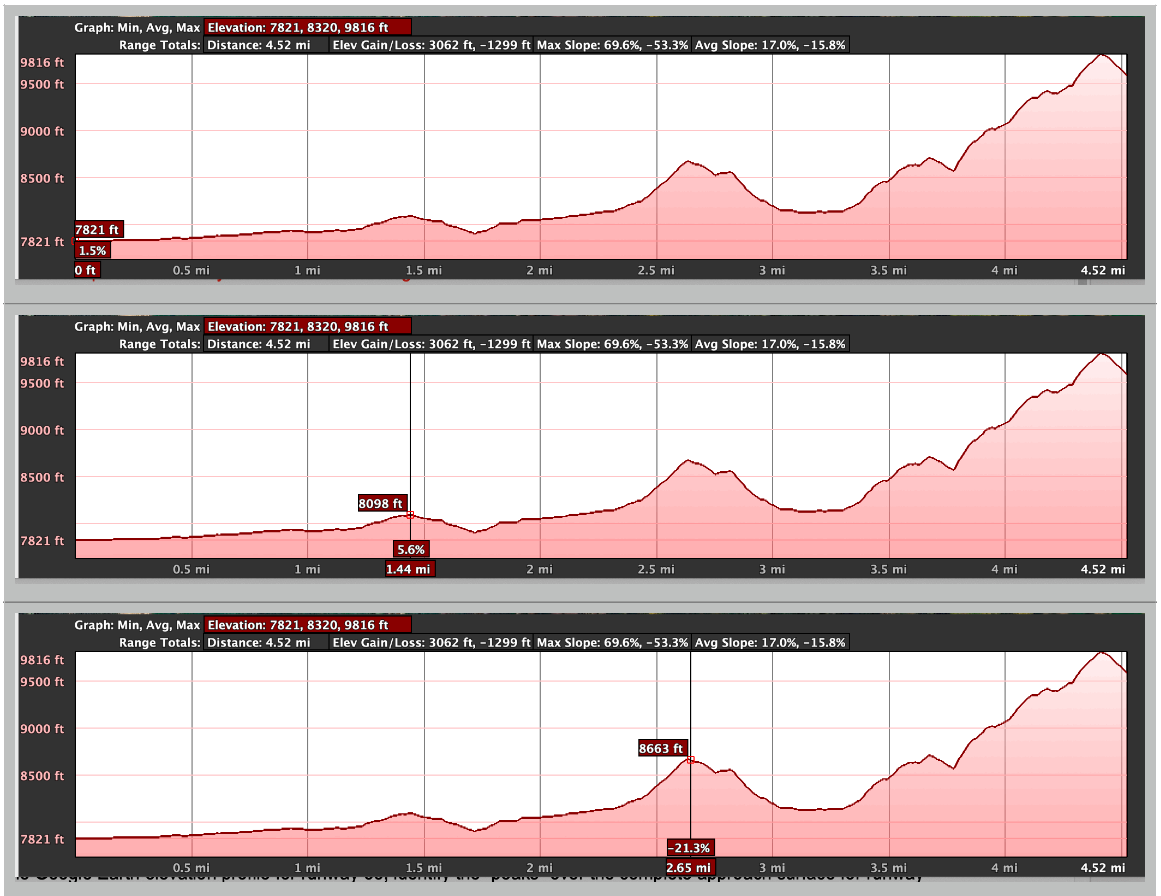


Figure 2.2. Elevation Profile for Runway 33 at Aspen-Pitkin County Airport (ASE).

b) Using the runway markings in Google Earth, explain the precision of the runway ends at ASE airport. Verify with Airnav.

Both runways are non-precision runways based on the markings.

c) Using the Google Earth elevation profile for runway 33, identify the "peaks" over the complete approach surface for runway 33. Clearly state the dimensions of the imaginary approach surface used.

For non-precision runways, the Part 77 approach surface extend 10,200 from the end of the runway (10,000 feet beyond the primary surface). The slope of the approach surface is 34:1 for non-precision runways. The runway 33 threshold has an elevation of 7,838 feet (Airnav).

d) Estimate if the "peaks" identified in part (c) constitute obstacles to navigation for runway 33 at Aspen. According to Flightaware IFR charts, Aspen has approaches with visibility minima as low as 1.5 statute miles. You only need to check the peaks identified in your elevation plot. Use the FAR Part 77 standards to do the analysis. Show your calculations and the slopes required for the imaginary surfaces for runway 33. Clearly state the size of the imaginary approach surface used.

Using a conversion factor of 5,280 feet to a mile, the first peak (see Figure 2.2) has an elevation over sea level of 8,098 feet (260 feet over the runway threshold elevation).

The first peak is located 7,600 feet from the runway end or 7,400 feet from the start of the approach surface. At a slope 34:1, the maximum permissible height of the approach surface is 217.6 feet. The first peak is an instruction to navigation.

e) Using the calculations and your analysis of parts (c-d) to explain the possible reason for a displaced threshold on runway 33.

It is clear that the displaced threshold is an attempt to provide clearance from some local obstacles. While, Google Earth is a good tool to do first-order analyses, a local survey of the obstacles around the airport is needed.

f) If a telephone company wants to build a cell tower 1.2 nautical miles from the runway (aligned with the extended centerline of the runway), find the maximum permissible height of the tower using Part 77 standards. Show your calculations.

The location of the cell tower is 1.38 statute miles from the runway end 33. At that location, the terrain is 8,078 feet above mean sea level (240 feet above the runway threshold). At the location of the tower, the approach surface height is 208 feet above the runway threshold point.

No tower should be located 1.2 nautical miles from the runway end.

g) A company wants to build a 45-foot tall hangar at the airport to house two midsize corporate jets. The hangar is planned to be 600 feet laterally from the runway centerline (in middle of the field). Is this hangar permissible according to FAR Part 77 rules? Explain the Part 77 surface that applies at the location of the hangar.

The transition surface applies at the location of the proposed hangar. The width of the primary surface is 500 feet (approach visibility minimums above 3/4 miles). The transition surface starts 250 feet from the runway centerline. At a slope 7:1, the transition surface height 600 feet from the runway centerline is:

$$h_{max} = (600 - 250)/7 = 50 \text{ feet}$$

The 45-foot hangar can be constructed.