

APPENDIX E

Methodology for Drawing FAR Part 77 Surfaces

Helpful Resources for Generating Part 77 Surfaces

1. Guidance from the Federal Aviation Administration (FAA) can be found at:

http://www.faa.gov/regulations_policies/faa_regulations/

Federal Aviation Regulation Title 14 Aeronautics and Space, Part 77 – Objects Affecting Navigable Airspace guidance, Subpart 77.25 - Civil airport imaginary surfaces. This subpart describes the dimensions, characteristics, and criteria of the five Part 77 surfaces, which include: horizontal, conical, primary, approach, and transitional.

2. National Geodetic Survey (NGS) provides aeronautical data for the operation of the National Airspace System, in accordance with a series of interagency agreements with the FAA.

A table showing the type and dimension of FAR Part 77 surfaces based on the runway classification can be found at and is included on the following pages as Table 1:

<http://www.ngs.noaa.gov/AERO/oisspec.html>

A plan view diagram of the FAR Part 77 surfaces can be found at:

<http://www.ngs.noaa.gov/AERO/yplanfar77.gif>

A 3-dimensional diagram of the FAR Part 77 surfaces can be found at:

<http://www.ngs.noaa.gov/AERO/3dfar77.html>

3. Airport data (5010) and runway information is provided by the FAA at:

http://www.faa.gov/airports_airtraffic/airports/airport_safety/airportdata_5010/

Enter the airport data in to the Location Selection Form and submit. A web page containing links to various reports and/or data downloads will open.

Airport Runways Data, under Data Downloads, contains information that is helpful to create the FAR Part 77 surfaces, which includes:

- Runway ID, Length, Width, Surface Type Condition
- Base End and Reciprocal End ID and Physical Elevation
- Base End and Reciprocal End Physical Latitude and Physical Longitude
- Base End and Reciprocal End Part 77 Category

4. Aerial/orthophotos can be acquired from the United States Department of Agriculture (USDA) Farm Services Agency (FSA) Aerial Photography Field Office at:

<http://www.fsa.usda.gov/FSA/apfoapp?area=apfohome&subject=landing&topic=landing>

Aerial/orthophotos may also be found at various city, county, state, or federal agencies.

Example – Auburn Municipal Airport in King County.

Airport Data (5010) and Runway Information from the FAA

• Runway ID	16/34
• Runway Length	3,400 feet
• Runway Width	75 feet
• Runway Surface Type Condition	ASPH-G (Asphalt – Good Condition)
• Base End ID	16
• Base End Physical Latitude	47-19-56.4300N
• Base End Physical Longitude	122-13-36.1300W
• Base End Physical Elevation	57 feet MSL
• Base End Part 77 Category	A(V)
• Reciprocal End ID	34
• Reciprocal End Physical Latitude	47-19-22.8976N
• Reciprocal End Physical Longitude	122-13-35.7832W
• Reciprocal End Physical Elevation	63 feet MSL
• Reciprocal End Part 77 Category	A(V)

Constructing plan view Part 77 surfaces in CAD

1. Plot the latitude/longitude of the Base End (16) and Reciprocal End (34).
(Exhibit 1, Point_A1 and Point_B1)
2. Plot the runway centerline by connecting the points for Runway 16 and Runway 34 (Centerline_A).
(Exhibit 1, Centerline_A)
3. **PRIMARY SURFACE** (Exhibit 1)

- FAR Part 77 Guidance, under Subpart 77.25 (c), states:

When the runway has a specially prepared hard surface, the primary surface extends 200 feet beyond each end of that runway; but when the runway has no specially prepared hard surface, or planned hard surface, the primary surface ends at each end of that runway.

Runway 16/34 has a prepared hard surface of asphalt (ASPH); therefore the primary surface extends 200 feet beyond each end of Runway 16/34. To achieve the 200-foot offset, create a circle with a radius of 200 feet from Point_A1 and Point_B1. Extend Centerline_A to intersect each of the created circles; the intersection points are labeled Point_A2 and Point_B2. A net increase of 400 feet will result to the extended runway centerline (Centerline_B). Delete circles.

- Both ends of Runway 16/34 are classified as A(V), which is a utility/visual runway. According to FAR Part 77 Guidance, under Subpart 77.25 (c)(1), and a table provided by the National Geodetic Survey (Table 1), the width of the primary surface is 250 feet. To achieve a width of 250 feet, offset Centerline_B by 125 feet (one-half the total width) on both sides.
- Connect the endpoints of the offset centerline to create a polygon, which is the Primary Surface.

4. HORIZONTAL SURFACE (Exhibit 2)

- FAR Part 77 Guidance, under Subpart 77.25 (a), states:

A horizontal plane 150 feet above the established airport elevation, the perimeter of which is constructed by swinging arcs of specified radii from the center of each end of the primary surface of each runway of each airport and connecting the adjacent arcs by lines tangent to those arcs.

- According to FAR Part 77 Guidance, under Subpart 77.25 (a)(1), and a table provided by the National Geodetic Survey (Table 1), the radius of a horizontal surface for an A(V) classification is 5,000 feet. Create a circle with a 5,000-foot radius from the center of each end of the primary surface (Point_A2 and Point_B2). Connect the circles by lines tangent to the circle. Break the circles at the intersection of the tangent line and delete overlapping segments. Join the two remaining arcs with the two tangent lines. The resulting closed polygon is the horizontal surface.
- Extend Centerline_B to intersect with the edge of the horizontal surface to create Centerline_C. The intersection points are labeled Point_A3 and Point_B3. A net increase of 10,000 feet will result to the extended Centerline_C.

5. APPROACH SURFACE (Exhibit 3)

- FAR Part 77 Guidance, under Subpart 77.25 (d), states:

A surface longitudinally centered on the extended runway centerline and extending outward and upward from each end of the primary surface. An approach surface is applied to each end of each runway based upon the type of approach available or planned for that runway end.

- The geometry of the approach surface is dependent upon the type of runway and approach.

The table provided by the National Geodetic Survey (Table 1) provides the geometry standards of an approach surface, which is dependent upon the runway and approach type. FAR Part 77 Guidance, under Subpart 77.25 (d) provides text narrative of approach surface geometry.

- Runway 16/34 is classified as A(V) on both runway ends. The approach surface geometry for an A(V) classification will have an inner edge width of 250 feet (same as the width of the primary surface), an outer edge width of 1,250 feet, a length of 5,000 feet (same as the horizontal surface radius), and a horizontal to vertical slope of 20:1.
- At Point_A3 and Point_B3, draw a circle with a diameter of 1,250 feet (or a radius of 625 feet). For each runway end, connect the quadrant points on each of the drafted circles with a line (labeled Line_A1 and Line_B1). Each line should be 1,250 feet long and perpendicular to the runway centerline. The midpoint of Line_A1 must pass through Point_A3 and the midpoint of Line_B1 must pass through Point_B3. Delete the circle from each end of the runway centerline.
- Connect the endpoints of Line_A1 with the corresponding endpoints of the primary surface to create a polygon, which is the approach surface for Runway 16.
- Connect the endpoints of Line_B1 with the corresponding endpoints of the primary surface to create a polygon, which is the approach surface for Runway 34.

6. CONICAL SURFACE (Exhibit 4)

- FAR Part 77 Guidance, under Subpart 77.25 (b), states:

A surface extending outward and upward from the periphery of the horizontal surface at a slope of 20 to 1 for a horizontal distance of 4,000 feet.

- Offset the horizontal surface polygon by 4,000 feet. The horizontal surface represents the inner extent of the conical surface and the offset polygon (Conical_4) represents the outer extent of the conical surface.
- Extend Centerline_C to intersect with the edge of the conical surface to create the final extended runway centerline.
- Optional – offset the horizontal surface polygon by 1,000 feet, to create polygon Conical_1, then offset polygon Conical_1 by 1,000 feet, to create polygon Conical_2, and offset polygon Conical_2 by 1,000 feet, to create polygon Conical_3. Each conical polygon represents a vertical increase in elevation of 50 feet, for a total vertical increase of 200 feet from the horizontal surface to the outer extent of the conical surface.

7. TRANSITIONAL SURFACE (Exhibit 5 and 6)

- FAR Part 77 Guidance, under Subpart 77.25 (e), states:

These surfaces extend outward and upward at right angles to the runway centerline and the runway centerline extended at a slope of 7 to 1 from the sides of the primary surface and from the sides of the approach surfaces.

- Transitional surfaces are extended from the sides of the primary surface at a horizontal to vertical slope of 7:1 until they intersect with the horizontal surface, which lies 150 feet above the established airport elevation.
- Offset each side of the primary surface, those parallel to the runway centerline, by 1,050 feet. The horizontal to vertical slope of the transitional surface is 7:1. In order to intersect the horizontal surface, the transition surface needs to reach 150 feet in the vertical direction, which results in 1,050 feet in the horizontal direction.
- As explained in FAR Part 77 Guidance, Subpart 77.25 (d), the approach slope for Runway 16/34 is 20:1, per the A(V) classification. In order to achieve 150 feet in the vertical direction to intersect the horizontal surface at a slope of 20:1 along the approach surface, the offset from the primary surface that is perpendicular to the runway centerline needs to be 3,000 feet in the horizontal direction.
- Connect the endpoints of each offset line to create a transitional surface polygon (Transitional_3).

- As with the conical surface, the transitional surface may be drawn at various intervals. Typically, the transitional surface is created at a vertical increase in elevation of 50 feet. This will require an offset parallel to the runway along the primary surface of 350 feet and 700 feet, with the 1,050 feet representing the outer edge of the transitional surface. The offset perpendicular to the runway along the primary surface will be at 1,000 feet and 2,000 feet, with the 3,000 feet representing the outer edge of the transitional surface along the approach surface. Connect the corresponding endpoints to create the inner (Transitional_1) and middle (Transitional_2) transitional surface polygons. Each transitional polygon represents a vertical increase in elevation of 50 feet, for a total vertical increase of 150 feet from the primary surface to the outer extent of the transitional surface.
8. The example to construct plan view Part 77 surfaces in CAD for Auburn Municipal described above is relatively uncomplicated because of the single A(V) runway configuration (Exhibit 6). If more than one runway exists at an airport, Part 77 surfaces can overlap and often results in a confusing CAD drawing. Consider joining polygons of the same surface, such as the horizontal surface, and deleting any excessive line work.
 9. When drafting Part 77 surfaces for runways with a PIR approach, refer to FAR Part 77 Guidance, Subpart 77.25 (d) and (e), as well as the table provided by the National Geodetic Survey (Table 1) for specifics. FAR Part 77 Guidance, Subpart 77.25 (e) states:

Transitional surfaces for those portions of the precision approach surface which project through and beyond the limits of the conical surface, extend a distance of 5,000 feet measured horizontally from the edge of the approach surface and at right angles to the runway centerline.

Table 1 OBSTRUCTION IDENTIFICATION SURFACES

FEDERAL AVIATION REGULATIONS PART 77							
DIM	ITEM	DIMENSIONAL STANDARDS (FEET)					
		VISUAL RUNWAY		NON - PRECISION INSTRUMENT RUNWAY		PRECISION INSTRUMENT RUNWAY <u>PIR</u>	
		<u>A</u>	<u>B</u>	<u>A</u>	<u>B</u>		
		<u>C</u>	<u>D</u>				
A	WIDTH OF <u>PRIMARY SURFACE</u> AND APPROACH SURFACE WIDTH AT INNER END	250	500	500	500	1,000	1,000
B	RADIUS OF <u>HORIZONTAL SURFACE</u>	5,000	5,000	5,000	10,000	10,000	10,000
		VISUAL APPROACH		NON - PRECISION INSTRUMENT APPROACH		PRECISION INSTRUMENT APPROACH	
		<u>A</u>	<u>B</u>	<u>A</u>	<u>B</u>		
				<u>C</u>	<u>D</u>		
C	APPROACH SURFACE WIDTH AT END	1,250	1,500	2,000	3,500	4,000	16,000
D	APPROACH SURFACE LENGTH	5,000	5,000	5,000	10,000	10,000	*
E	APPROACH SLOPE	20:1	20:1	20:1	34:1	34:1	*

Source: National Geodetic Survey at <http://www.ngs.noaa.gov/AERO/oisspec.html>

- A - Utility runways
- B - Runways larger than utility
- C - Visibility minimums greater than ¾ mile
- D - Visibility minimums as low as ¾ mile
- * - PIR slope is 50:1 for inner 10,000 feet and 40:1 for an additional 40,000 feet

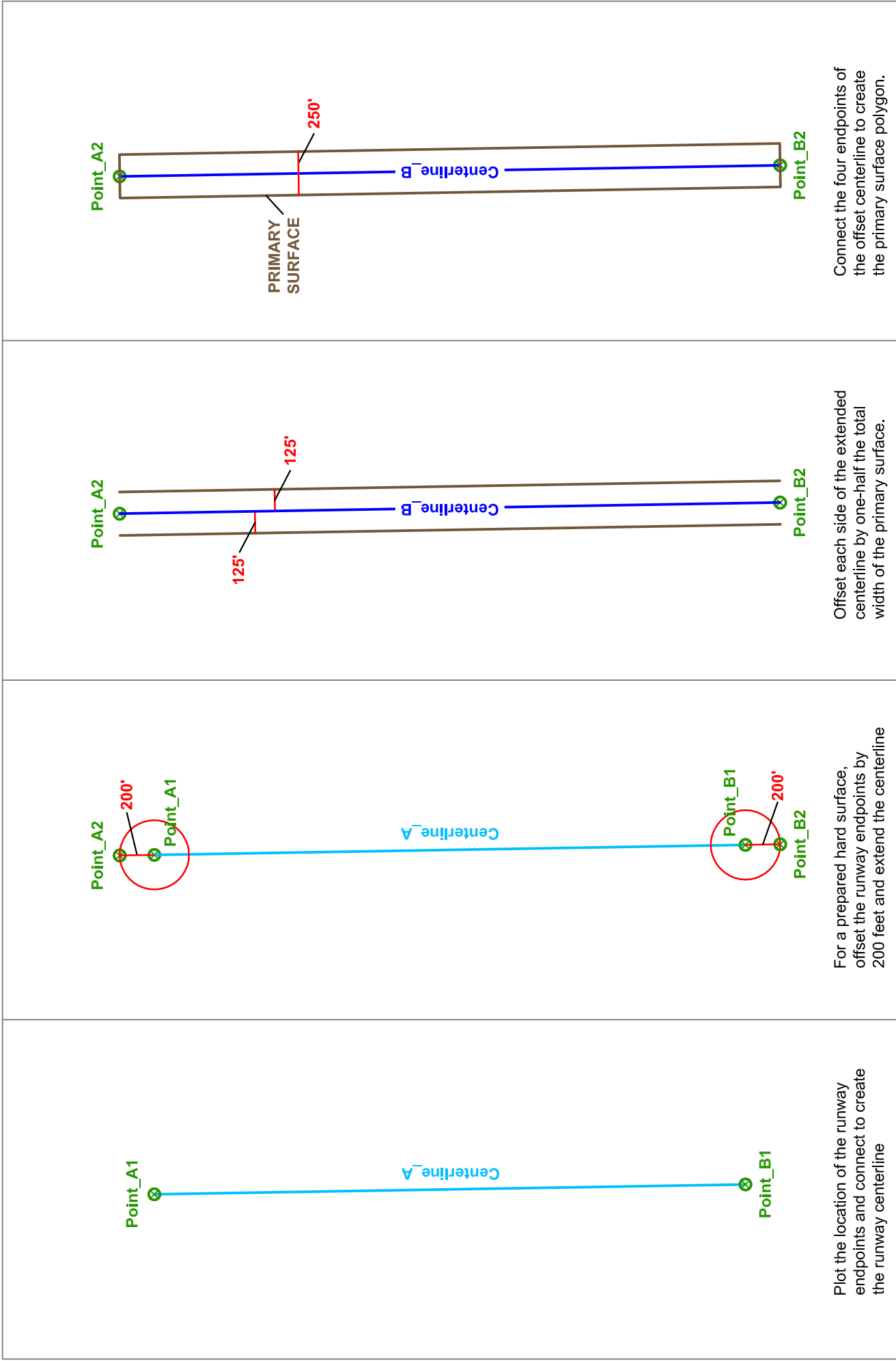
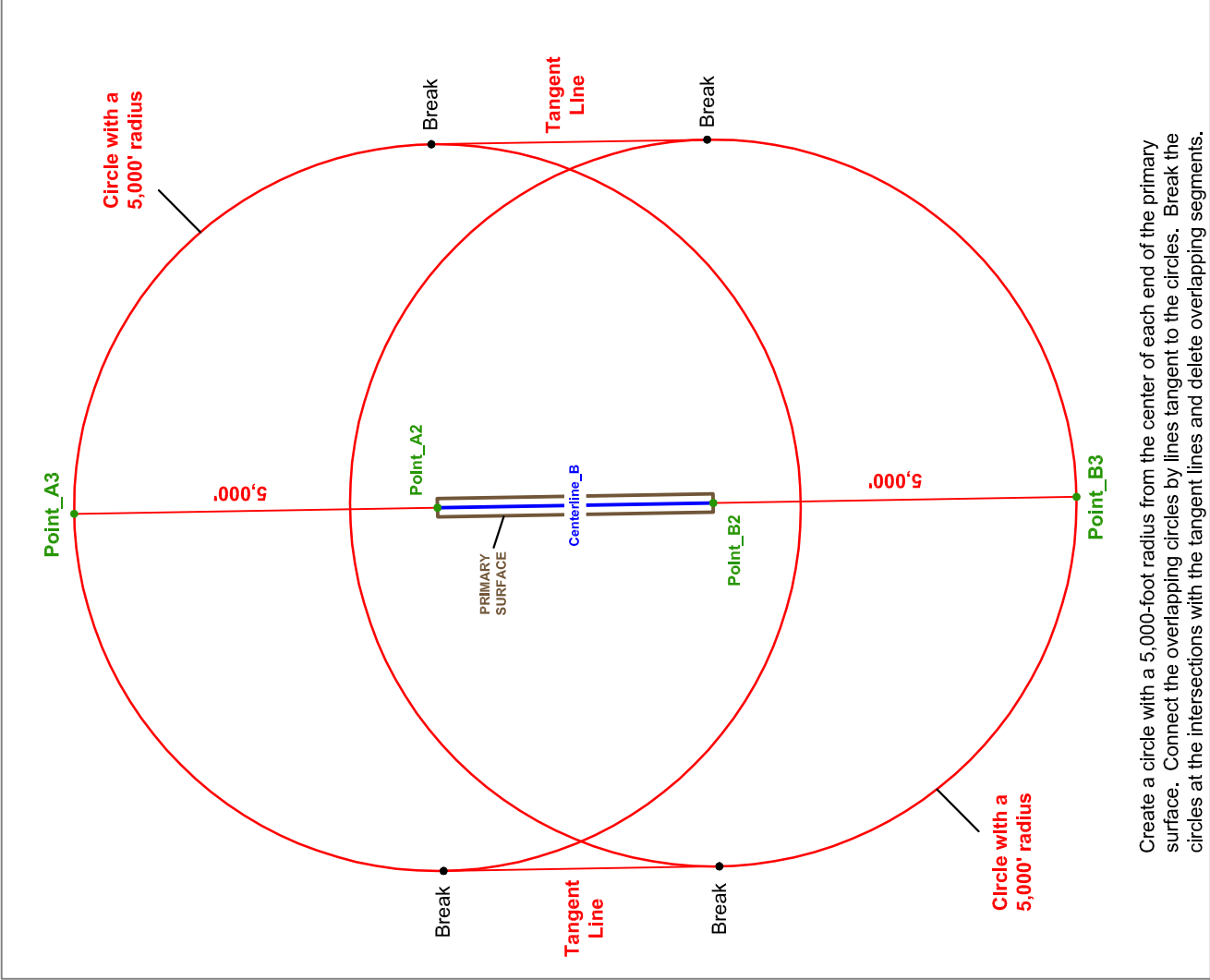
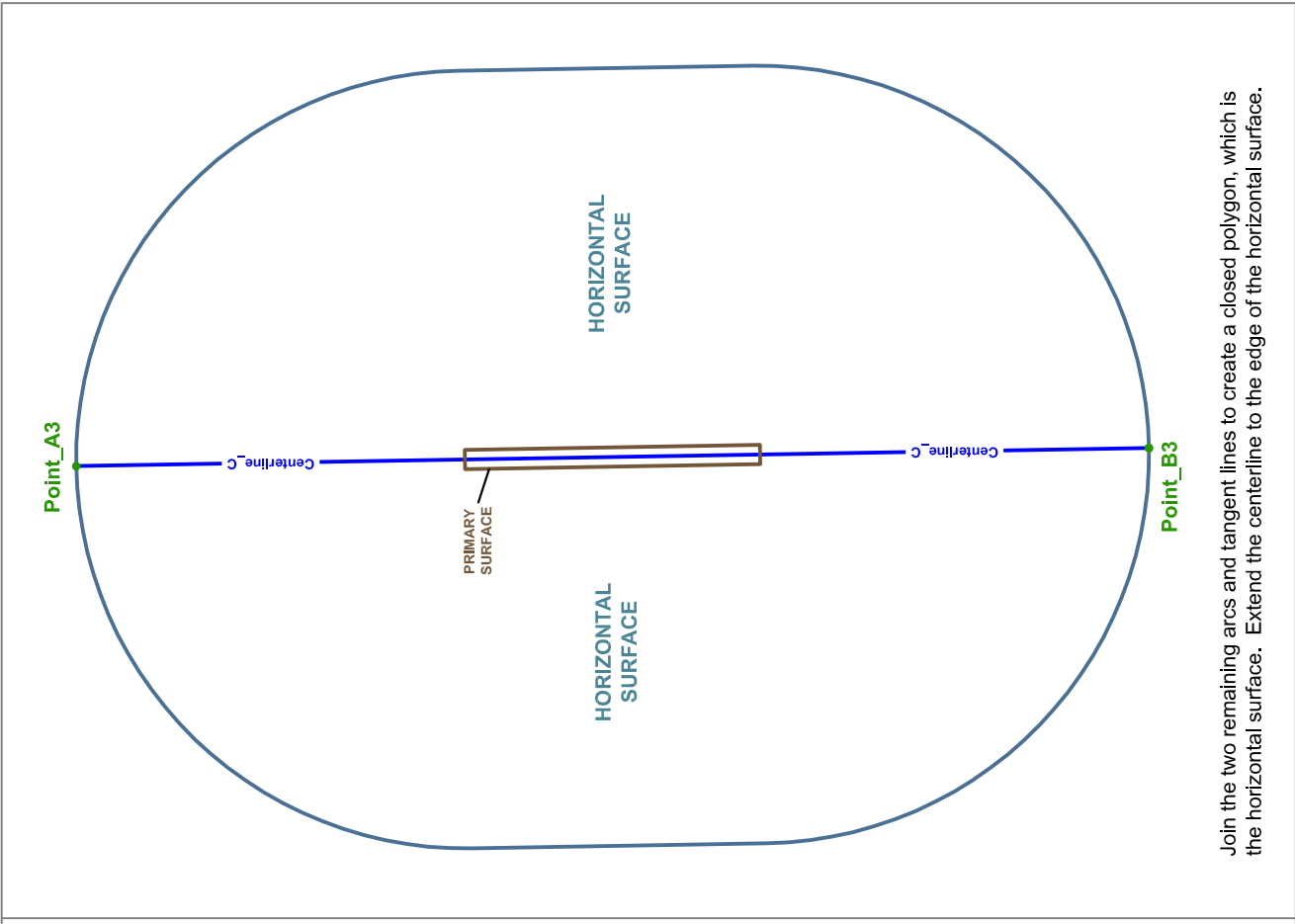


Exhibit 1 Constructing the Primary Surface for Auburn Municipal Airport in King County, Washington.

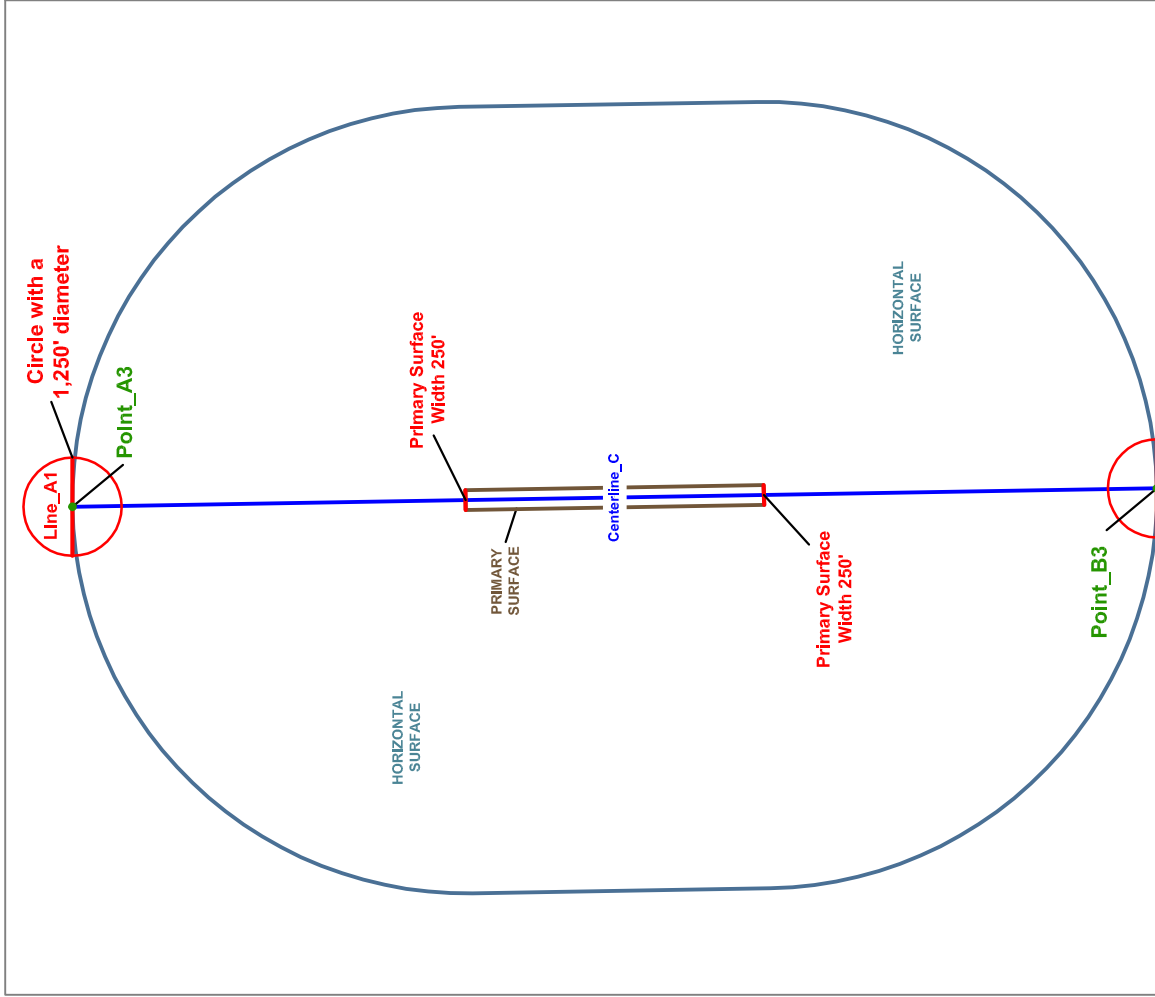


Create a circle with a 5,000-foot radius from the center of each end of the primary surface. Connect the overlapping circles by lines tangent to the circles. Break the circles at the intersections with the tangent lines and delete overlapping segments.

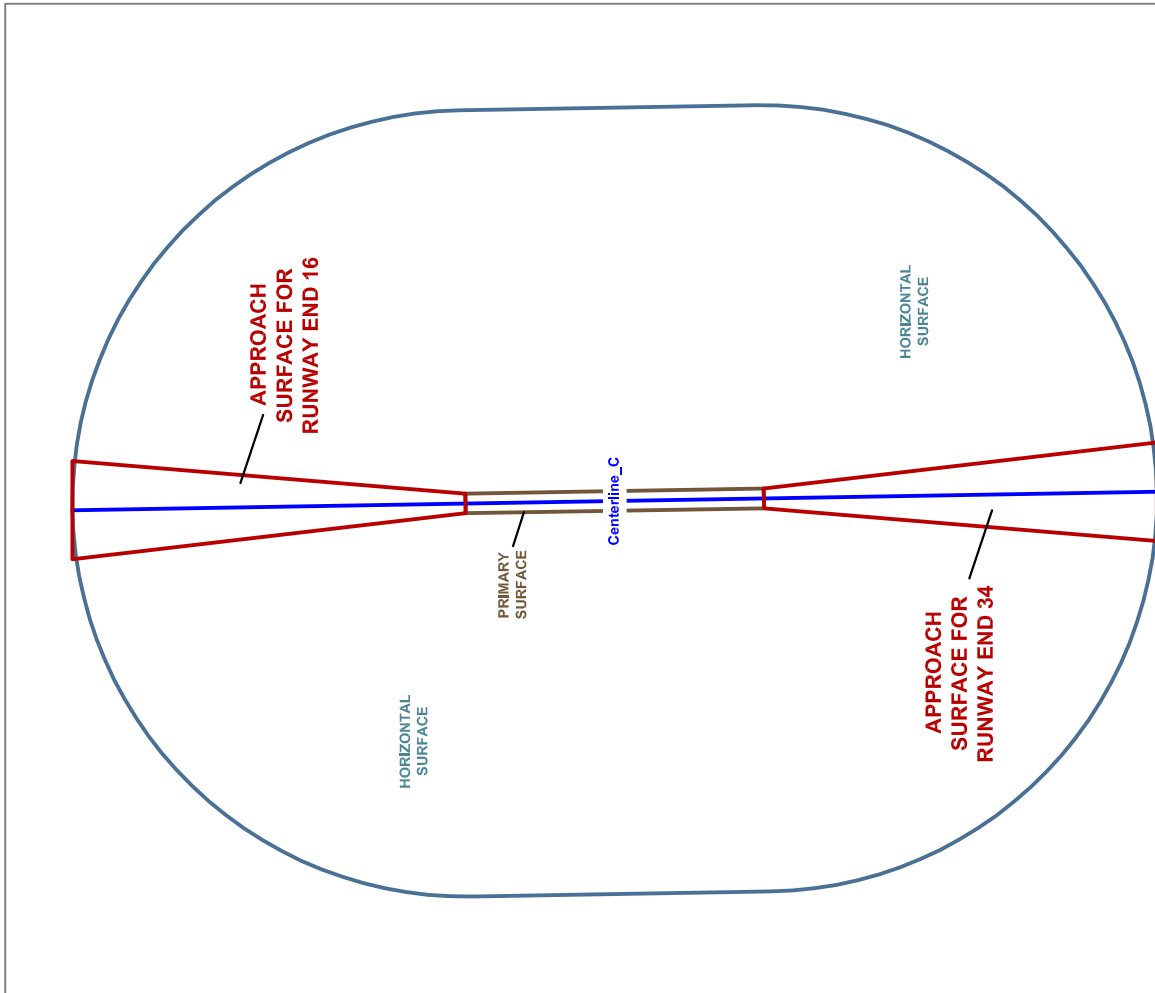


Join the two remaining arcs and tangent lines to create a closed polygon, which is the horizontal surface. Extend the centerline to the edge of the horizontal surface.

Exhibit 2 Constructing the Horizontal Surface for Auburn Municipal Airport in King County, Washington.

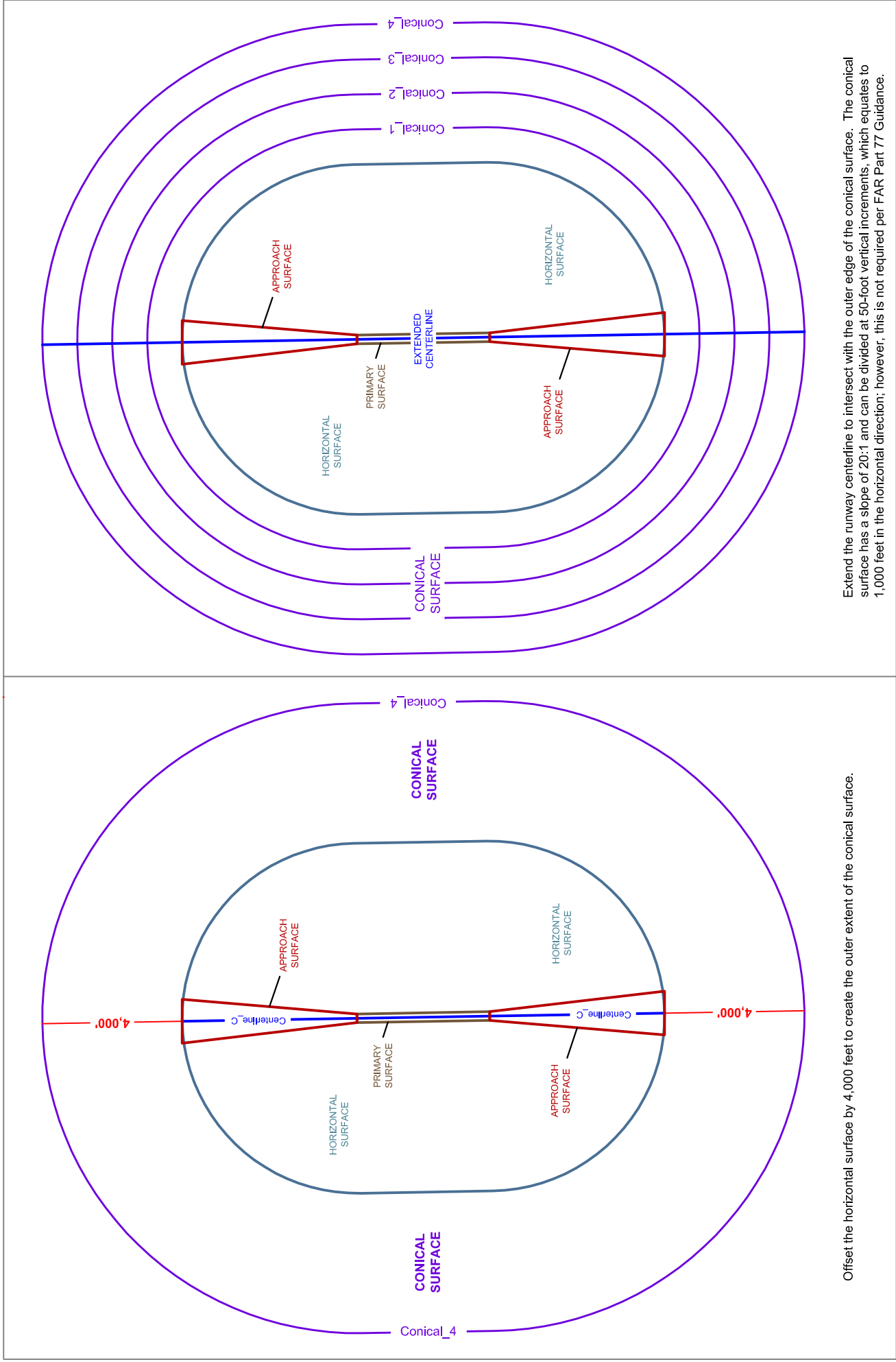


Create a circle with a 1,250-foot diameter at the intersection of the runway centerline and horizontal surface. Connect the quadrants of each circle with a line that is perpendicular to the runway and passes through the intersection of the runway and horizontal surface. Delete the two circles.



Connect the endpoints of each drafted line with the corresponding endpoints of the 250-foot wide primary surface to create a closed polygon, which is the approach surface. The approach surface will overlap the end of the primary surface that is perpendicular to the runway centerline.

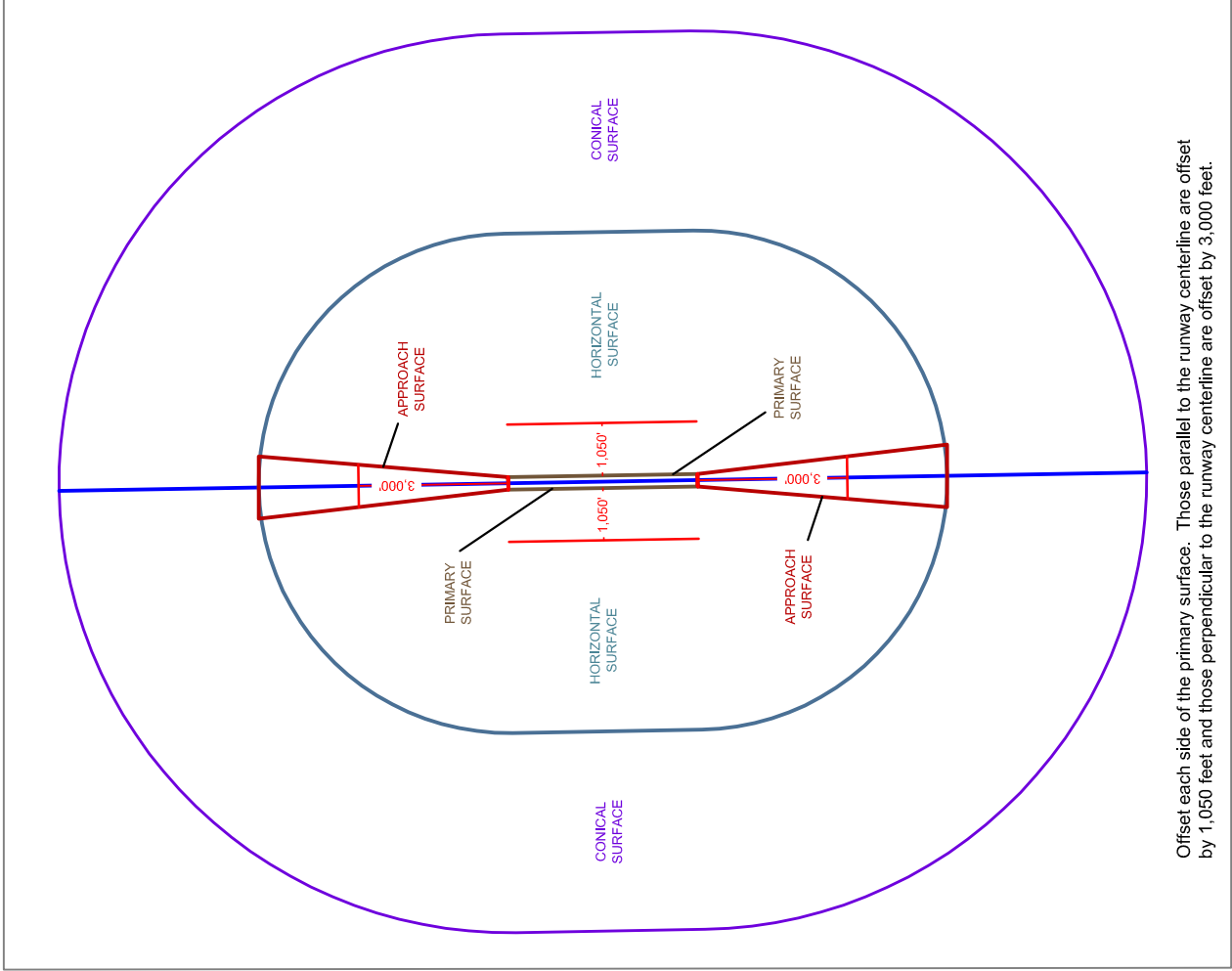
Exhibit 3 Constructing the Approach Surface for Auburn Municipal Airport in King County, Washington.



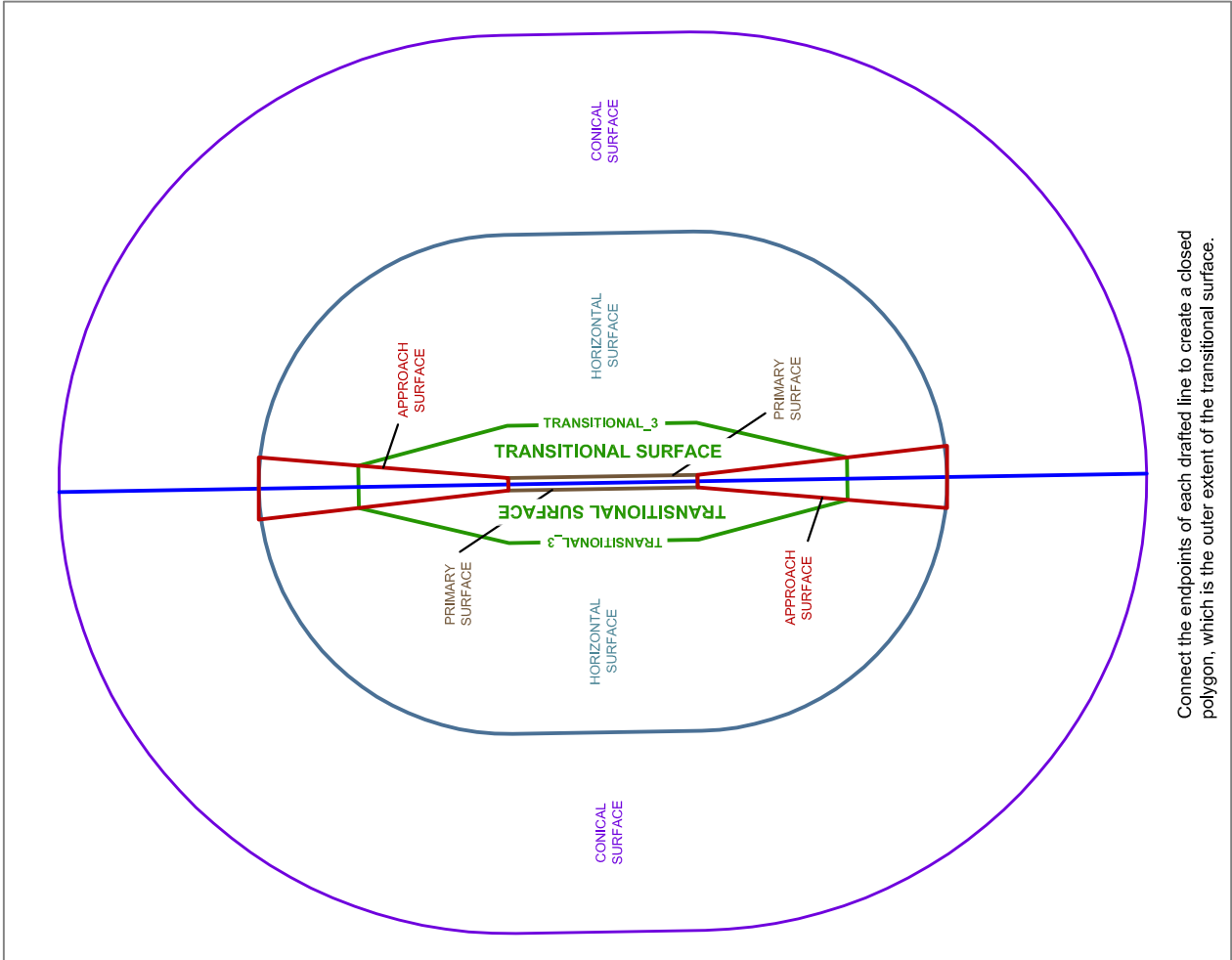
Offset the horizontal surface by 4,000 feet to create the outer extent of the conical surface.

Extend the runway centerline to intersect with the outer edge of the conical surface. The conical surface has a slope of 20:1 and can be divided at 50-foot vertical increments, which equates to 1,000 feet in the horizontal direction; however, this is not required per FAR Part 77 Guidance.

Exhibit 4 Constructing the Conical Surface for Auburn Municipal Airport in King County, Washington.

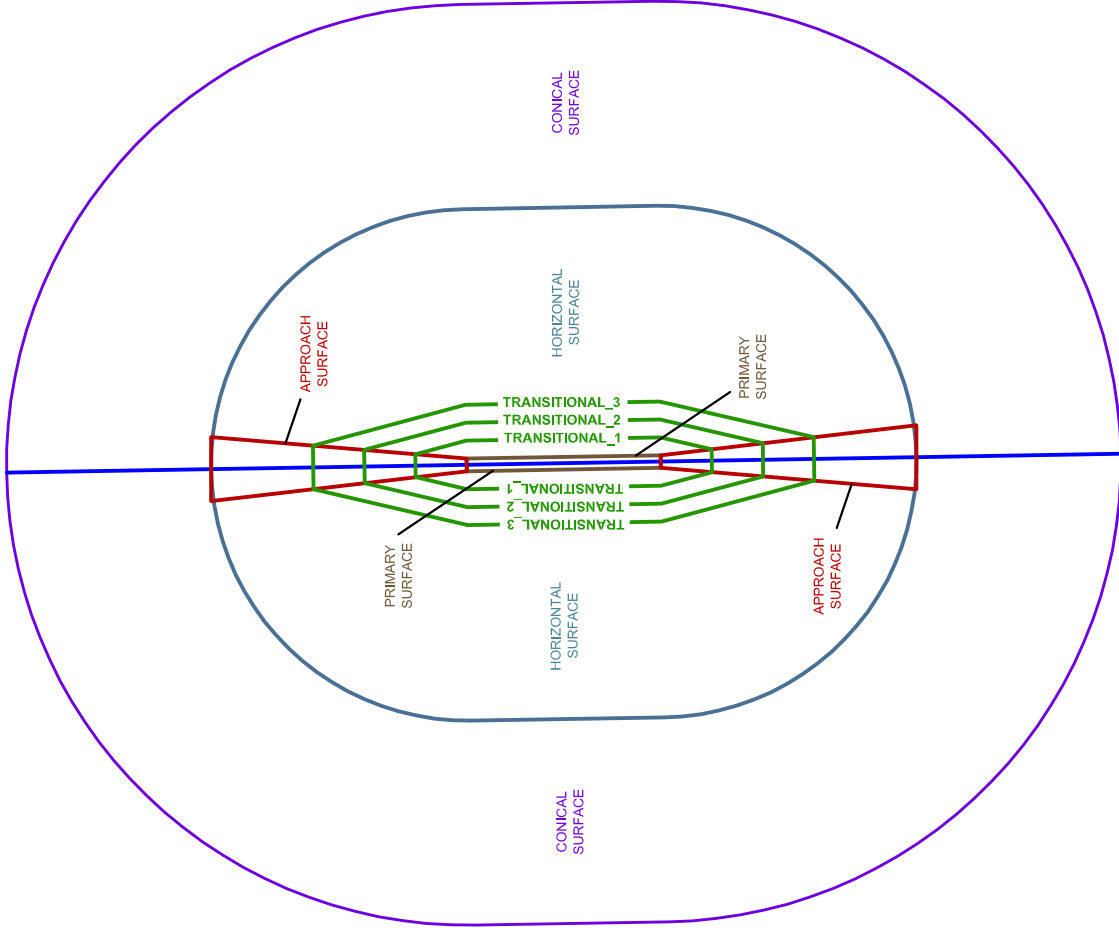


Offset each side of the primary surface. Those parallel to the runway centerline are offset by 3,000 feet and those perpendicular to the runway centerline are offset by 1,050 feet.

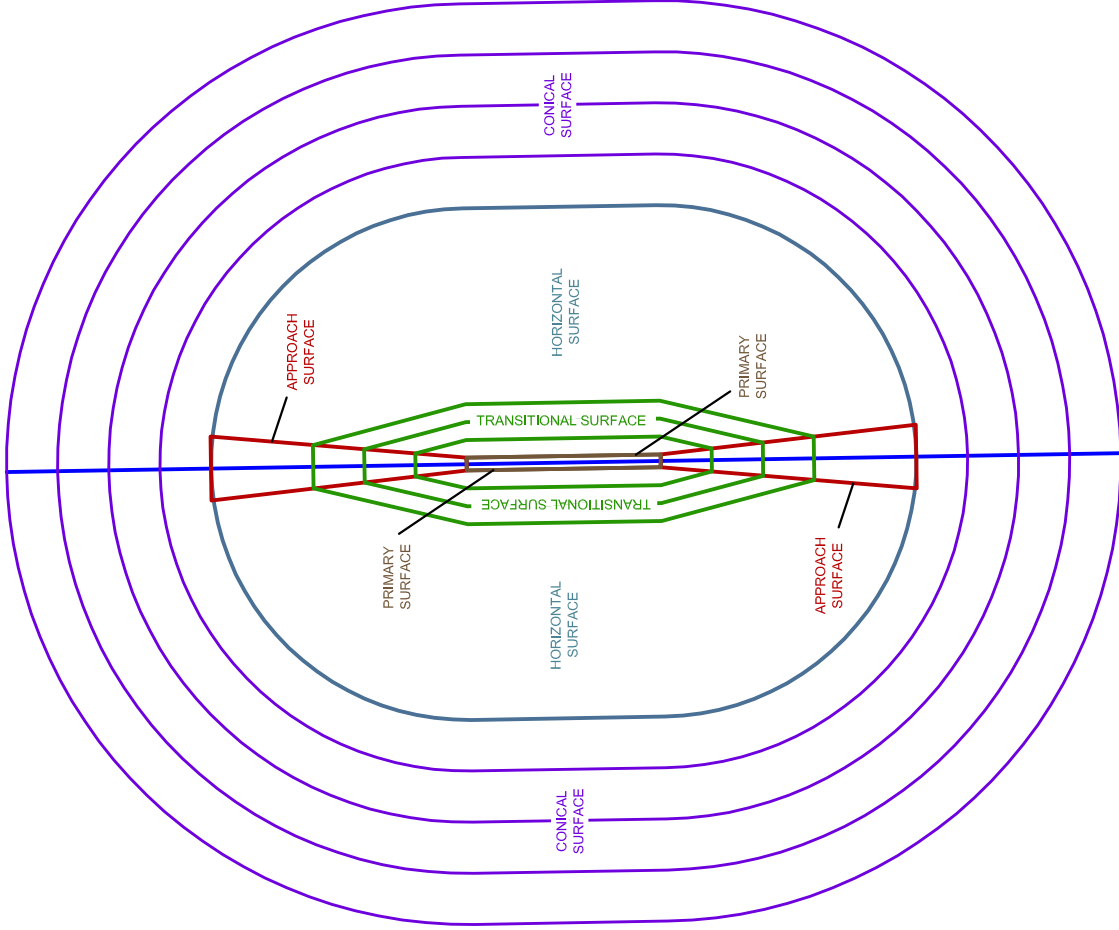


Connect the endpoints of each drafted line to create a closed polygon, which is the outer extent of the transitional surface.

Exhibit 5 Constructing the Transitional Surface for Auburn Municipal Airport in King County, Washington.



The transitional surface has a slope of 7:1 and can be divided at 50-foot vertical increments, which equates to 350 feet in the horizontal direction; however, this is not required per FAR Part 77 Guidance.



FAR Part 77 Surfaces include: primary, horizontal, approach, conical, and transitional.

Exhibit 6 FAR Part 77 Surfaces for Auburn Municipal Airport in King County, Washington.