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CHAPTER C

Capacity Analysis and Facility Requirements:

Introduction.

The capacity of an airfield is primarily a function of the major aircraft operating surfaces that compose the facility and the configuration of those surfaces (runways and taxiways). However, it is also related to and considered in conjunction with; wind coverage, airspace utilization, and the availability and type of navigational aids. Capacity refers to the number of aircraft operations that a facility can accommodate on either an hourly or yearly basis. It does not refer to the size or weight of aircraft. Later in the chapter, facility requirements are used to determine the facilities needed to meet the forecast demand related to the existing and forecast aircraft fleet. Evaluation procedures will analyze runway length, dimensional criteria, aprons, hangars, and vehicular access.

Airfield Capacity Methodology

The evaluation method used to determine the capacity of the airside facilities to accommodate aviation operational demand is described in the following narrative. Evaluation of this capability is expressed in terms of potential excesses and deficiencies in capacity. The methodology used for the measurement of airfield capacity is described in Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay.* From this methodology, airfield capacity is defined in the following terms:

- **Hourly Capacity of Runways:** The maximum number of aircraft that can be accommodated under conditions of continuous demand during one-hour period.

- **Annual Service Volume:** A reasonable estimate of an airport's annual capacity (i.e., level of annual aircraft operations that will result in an average annual aircraft delay of approximately one to four minutes).

The capacity of an airport's airside facilities is a function of several factors. These factors include the layout of the airfield, local environmental conditions, specific characteristics of local aviation demand, and air traffic control requirements. The relationship of these factors and their cumulative impact on airfield capacity are examined in the following paragraphs.

Airfield Layout

The arrangement and interaction of airfield components (runways, taxiways, and ramp entrances) refers to the layout or "design" of the airfield. As previously described, Renton Municipal Airport is served by one runway: Runway 16/34. Runway 16/34 is served by a full-length parallel taxiway (Taxiway "A") with seven connector taxiways, and a partial parallel taxiway (Taxiway "B") with five connector taxiways.

Existing on-airport landside facilities include aircraft production parking areas; aircraft parking aprons; aircraft rental, repair and maintenance facilities; fixed base operator facilities; aviation training facilities; T-hangars/executive hangar structures; airport administration, and the Airport Traffic Control Tower (ATCT). The facilities are well situated to take advantage of the existing taxiway system.

Environmental Conditions

Climatological conditions specific to the location of an airport not only influence the layout of the airfield, but also affect the use of the runway system. Surface wind conditions have a direct effect on the operations of an airport; runways not oriented to take the fullest advantage of prevailing winds will restrict the capacity of the airport to varying degrees. When landing and taking off, aircraft are able to operate properly on a runway as long as the wind component perpendicular to the direction of travel (defined as a crosswind) is not excessive.

Ceiling and Visibility. Visual Flight Rules (VFR) conditions occur whenever the cloud ceiling is at least 1,000 feet about ground level and the visibility is at least three statute miles. Instrument Flight Rules (IFR) conditions at Renton Municipal Airport occur when the reported cloud ceiling is at least 800 feet, but less than 1,000 feet and/or visibility is at least one statute mile, but less than three statute miles. Due to FAA regulations, aircraft operations are restricted to Renton Municipal Airport when conditions exist that consist of a cloud ceiling less than 800 feet and/or visibility less than one statute mile. This means that aircraft are unable to commence the instrument approach into Renton Municipal Airport once the weather conditions are below the instrument approach minimums.

Meteorological data from the National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center (2005 to 2014) has been used to tabulate information at Renton Municipal Airport. This data is presented in the following table entitled *METEOROLOGICAL CONDITIONS.*

- **VFR Conditions:** A cloud ceiling equal to or greater than 1,000 feet above ground level (AGL) and the horizontal visibility is equal to or greater than 3 statute miles (SM). These conditions occur at the Airport approximately 90.5% of the time annually.

- **Marginal VFR (MVFR) Conditions:** A subset of VFR conditions, MVFR conditions exist when the cloud ceiling is above 1,000 feet, but below 3,000 feet AGL, and/or the horizontal visibility is greater than 3 SM, but less than 5 SM. At the Airport these conditions are prevalent approximately 16% of the time.

- **VFR minimums to Renton Municipal Instrument Approach minimums:** A cloud ceiling less than 1,000 feet AGL and/or visibility less than 3 SM, but ceiling is equal to or greater than 800 feet AGL and visibility is equal to or greater than 1 SM. These conditions occur at the Airport approximately 7.7% of the time annually.

- **Below Renton Municipal Instrument Approach Minimums:** A cloud ceiling less than 800 feet AGL and/or visibility less than 1 SM. These conditions occur at the Airport approximately 1.8% of the time annually.

Table C1 **METEOROLOGICAL CONDITIONS**

Weather Condition	Percent	Approximate Days Per Year
VFR (Greater Than: 1,000 FT, 3 SM)	90.5%	330
MVFR (1,000-3,000 FT; 3-5 SM)[1]	*16%*	*58*
IFR (800-1,000 FT; 1-3 SM)	7.7%	28
Below Minimums (0-800 FT; 0-1 SM)	1.8%	6

SOURCE: **Wind analysis tabulation provided by Mead & Hunt utilizing the FAA Airport Design Tools, Wind Analysis. Wind data obtained from NOAA, NCDC, Station 727934, Renton. Period of Record: 2005-2014.**

NOTE: [1] **Marginal VFR (MVFR) is a subset of the VFR Total.**

Wind Coverage. Surface wind conditions (i.e., direction and speed) generally determine the desired alignment and configurations of the runway system. Runways, which are not oriented to take advantage of prevailing winds, will restrict the capacity of an airport. Wind conditions affect all aircraft in varying degrees; however, the ability to land and takeoff in crosswind conditions varies according to pilot proficiency and aircraft type. Generally, the smaller the aircraft, the more it is affected by crosswinds.

To determine wind velocity and direction at Renton Municipal Airport, wind data to construct the all-weather wind rose was obtained for the years 2005-2014 from observations take at the Airport. There were approximately 112,370 observations available for analysis during this ten-year period. The allowable crosswind component is dependent upon the Runway Design Code (RDC) for the type of aircraft that utilize the Airport on a regular basis. As identified in the previous chapter, the RDC for Runway 16/34 is D-III.

In consideration of RDC D-III classification for Runway 16/34, these standards specify that the 16-knot crosswind component be utilized for the analysis. In addition, it is known that the Airport will continue to serve small single and multi-engine aircraft for which the 10.5-knot crosswind component is considered maximum; therefore, depending on runway designation, 16-knot components, along with 13-knot and 10.5-knot crosswind components, were analyzed. Given the potential for aircraft in the RDC D-IV to utilize the Airport, a 20-knot crosswind component was added for reference.

The following figure entitled *ALL-WEATHER WIND ROSE*, illustrates the all-weather wind coverage provided at Renton Municipal Airport. The desirable wind coverage for an airport's runway system is 95 percent. This means that the runway orientation and configuration should be developed so that the maximum crosswind component is not exceeded more than five percent of the time annually.

The following table entitled *ALL-WEATHER WIND COVERGE SUMMARY*, quantifies the wind coverage offered by the Airport's existing runway system, including the coverage for each runway end. Based on all-weather wind analysis for Renton Municipal Airport, utilizing data from the National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center (NCDC), and the FAA Wind Analysis tool, the existing runway provides the following wind coverage: 100 percent for the 20-knot crosswind component, 99.98 percent for the 16-knot crosswind component, 99.84 percent for the 13-knot crosswind component, and 99.51 percent for the 10.5-knot crosswind component. Therefore, no additional runways are required from a *wind coverage* standpoint.

The Airport is served by two RNAV (GPS), and one NDB instrument approach to Runway 16, with circling minimums to Runway 34. In an effort to analyze the effectiveness of the current approaches an IFR wind analysis has been conducted. Using the wind data obtained from the NCDC, the following table entitled *IFR WEATHER WIND COVERAGE SUMMARY*, quantifies the individual runway ends, and Runway 16/34 wind coverage analysis provided during IFR meteorological weather conditions (i.e., ceiling less than 1,000 feet AGL, but equal to or greater than 800 feet AGL and/or visibility less than 3 SM, but equal to or greater than 1 SM). From the analysis, it can be determined that Runway 16 does offer the best wind coverage under IFR meteorological conditions. The following figure entitled *IFR WEATHER WIND ROSE*, graphically portrays the IFR wind coverage.

Table C2 **ALL-WEATHER WIND COVERAGE SUMMARY**

Runway	10.5-Knot	13-Knot	16-Knot	20-Knot
Runway 16	89.99%	90.14%	90.26%	90.27%
Runway 34	81.29%	81.52%	81.60%	81.61%
Runway 16/34	99.51%	99.84%	99.98%	100%

SOURCE: Wind analysis tabulation provided by Mead & Hunt utilizing the FAA Airport Design Tools, Wind Analysis. Wind data obtained from NOAA, NCDC, Station 727934, Renton. Period of Record: 2005-2014.

NOTE: A 5-knot tailwind component was used for the individual runway end analysis.

Figure C1 **ALL-WEATHER WIND ROSE**

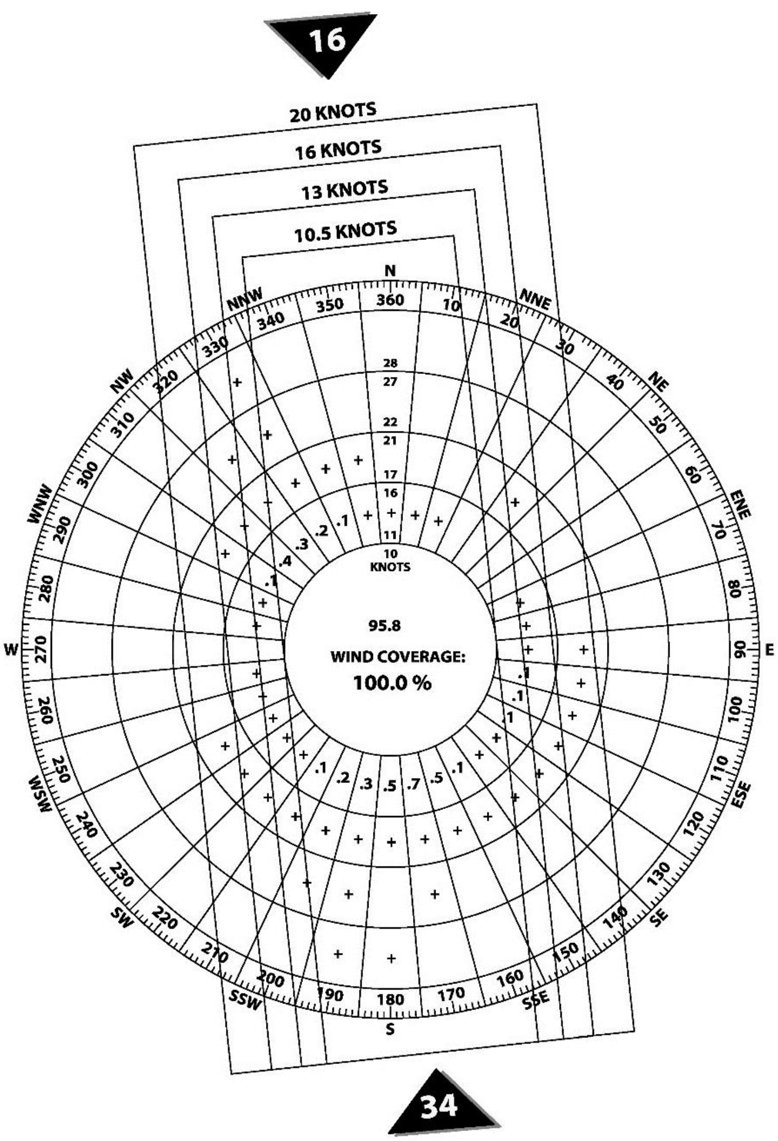


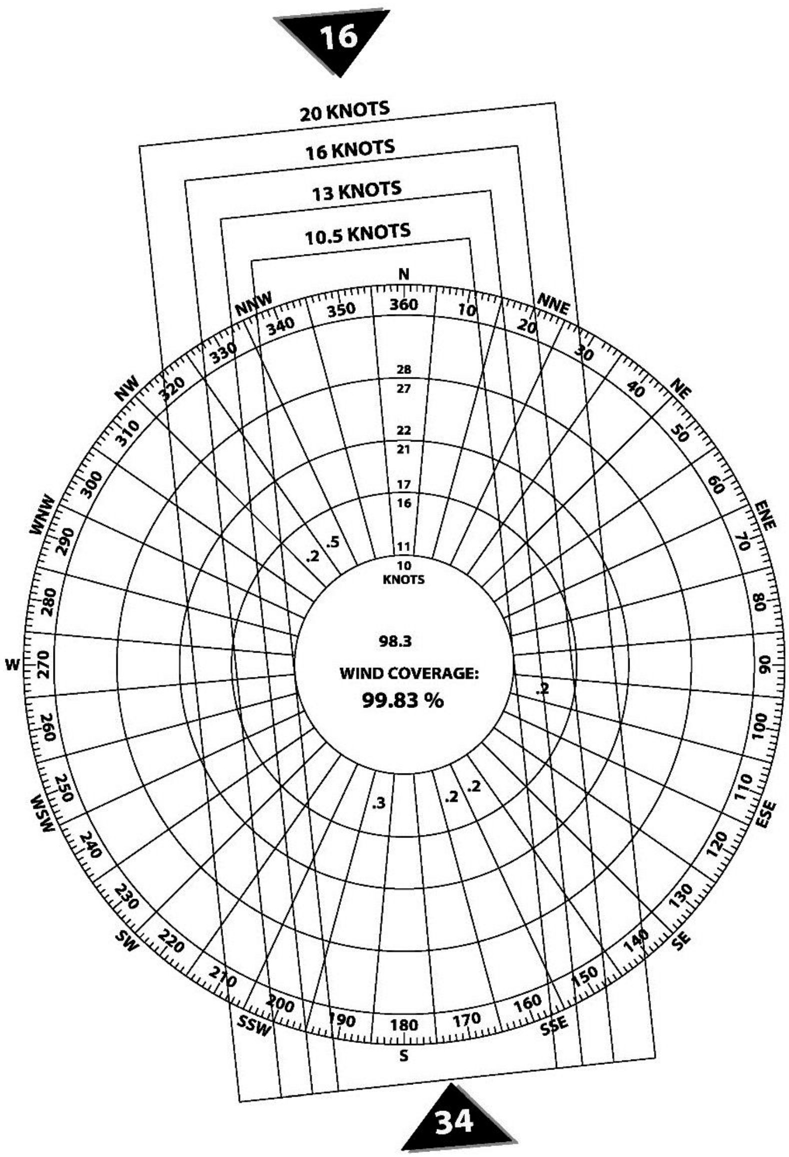
Table C3 **IFR WEATHER WIND COVERAGE SUMMARY**

Runway	10.5-Knot	13-Knot	16-Knot	20-Knot
Runway 16	92.25%	92.31%	92.40%	92.41%
Runway 34	86.24%	86.31%	86.39%	86.39%
Runway 16/34	99.67%	99.73%	99.83%	99.83%

SOURCE: **Wind analysis tabulation provided by Mead & Hunt utilizing the FAA Airport Design Tools, Wind Analysis. Wind data obtained from NOAA, NCDC, Station 727934, Renton. Period of Record: 2005-2014.**

NOTE: **A 5-knot tailwind component was used for the individual runway end analysis.**

Figure C2 **IFR WEATHER WIND ROSE**



Airfield Capacity

The majority of factors that are considered in an airfield capacity analysis have not substantially changed at Renton Municipal Airport since the preparation of the 1997 Master Plan Update. Furthermore, FAA guidance on airfield capacity analysis is still based on FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*, published in 1983 and FAA is in the process of revising this AC. Consequently, a detailed capacity analysis was not included as an element of this Airport Master Plan, rather, the results from the previous Master Plan Update are included for reference.

The previous Master Plan Update included capacity and demand calculations for the following:

- **Hourly Capacity of Runway System (VFR and IFR)**
- **Annual Service Volume (ASV)**

Hourly Runway Capacity. Calculations of hourly capacity begin with an evaluation of each possible runway use configuration at the Airport. With consideration of the Airport's aircraft mix index, annual percentage of touch-and-go operations, and taxiway exit rating, an hourly capacity was calculated. In its normal operating configuration, the Airport's VFR hourly capacity is potentially as high as 98 operations, and the IFR hourly capacity is potentially as high as 59 operations per hour.

Annual Service Volume (ASV). After determining the hourly capacity, the annual capacity or ASV can be calculated. Base on the single runway configuration at Renton Municipal Airport, and in consideration of runway use patterns, the Airport was determined to have a theoretical ASV of approximately 230,000 operations. Given the existing level of annual operations (98,916) and the forecasts of aviation activity for the 20-year planning period (121,860), the Airport is currently operating at approximately 43 percent of its ASV and is estimated to operate at approximately 53 percent of its ASV by 2034.

Airfield Facility and Airspace Requirements

To identify facility needs, it is necessary to translate the forecast aviation activity into specific types and quantities. This section addresses the actual physical facilities and/or improvements to existing facilities needed to safely and efficiently accommodate the projected demand that will be placed on the Airport. This section consists of two separate analyses: those requirements dealing with *airfield* facilities, and those dealing with *landside* facilities. The analysis of airfield requirements focuses on the determination of needed facilities and spatial considerations related to the actual operation of aircraft on the Airport. This evaluation includes the analysis of airfield dimensional criteria according to the updated FAA Advisory Circular 150/5300-13A, Change 1, *Airport Design,* the establishment of design parameters for the runway and taxiway system, and an identification of airfield instrumentation and lighting needs.

Airfield Design Standards

The types of aircraft that currently operate at Renton Municipal Airport, and those projected to utilize the facility in the future have an impact on the planning and design of airport facilities. This knowledge assists in the selection of FAA specified design standards for the Airport, which include runway and taxiway dimensional requirements, runway length, and pavement strength. These standards are based on the "design aircraft" that currently utilize the Airport, or that are projected to utilize the Airport in the future. According the AC 150/5300-13A, Change 1, *Airport Design*; the first step in defining a runway's design geometry is to determine the Runway Design Code (RDC). The design aircraft can take the form of one particular aircraft, or a composite aircraft representing a collection of aircraft classified by three parameters: Aircraft Approach Category (AAC), Airplane Design Group (ADG), and Taxiway Design Group (TDG).

As described in the previous chapter, the critical aircraft for Runway 16/34 is a combination of the Learjet series of aircraft (Aircraft Approach Category D, based on approach speed) and the Boeing 737-700, 800, 900 series (Airplane Design Group III, based on wingspan), along with approach visibility minimums of 1-mile, or a Runway Visual Range (RVR), of 5,000 feet. Therefore, the appropriate Runway Design Code (RDC) is D-III-5000. A graphical depiction of various aircraft and their RDC is included in the following figure, entitled *REPRESENTATIVE AIRCRAFT BY RUNWAY DESIGN CODE (RDC)*.

The third component of the "design aircraft" is the Taxiway Design Group (TDG). The TDG is based on both the wheelbase, the distance between the aircraft's main gear, or the overall Main Gear Width (MGW), and the distance from the aircraft cockpit to the main gear, or the Cockpit to Main Gear (CMG) distance. Each taxiway at the Renton Municipal Airport accommodates varying levels of most demanding aircraft. The Boeing 737-800 for example, has a MGW of 23 feet, and a CMG of 61.7 feet, placing the aircraft in the TDG 3 classification. As the 737s are towed and do not taxi under their own power over large portions of the Airport, various taxiways have varying degrees of "most demanding" aircraft. Taxiway design standards will be covered in greater detail in later sections.

RDC A-I
Single-Engine Aircraft - 2 to 6 Seats
Beech Bonanza
Cirrus SR22
Cessna-172

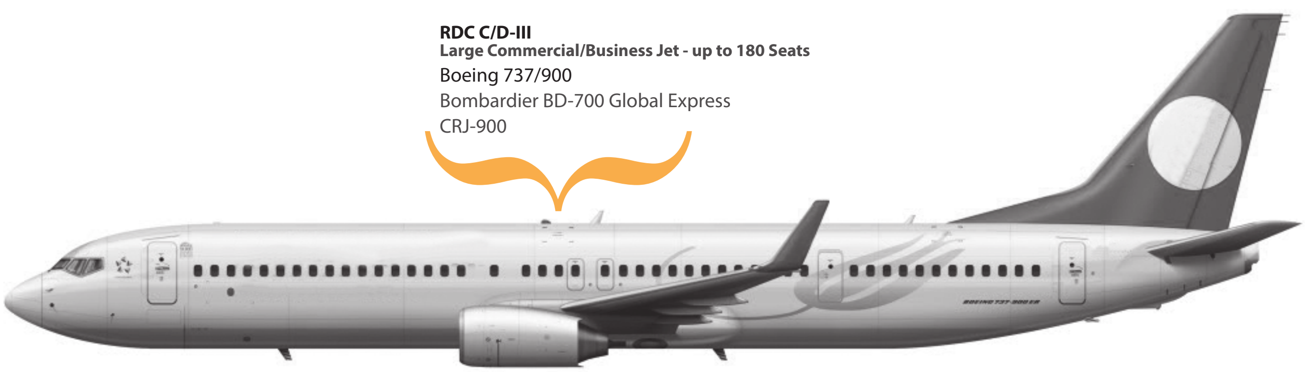
RDC B-I
Twin-Piston Aircraft - 4 to 10 Seats
Piper 31-310 Navajo
Beech Baron 58
Cessna 414

RDC B-II
Twin-Turboprop/Business Jet/Small Cabin Aircraft
6 to 12 Seats - *Includes most commercial turboprop aircraft.*
Citation Excel/XLS
Beach King Air 200
Pilatus PC-12

RDC C/D-I
Business Jets - 6 to 12 Seats
Lear 45
1124 Westwind
Hawker 400

RDC C/D-II
Commercial/Business Jet - 6 to 70 Seats
Bombardier CRJ-200
Bombardier CL-600 Challenger
Embraer ERJ-145

RDC C/D-III
Large Commercial/Business Jet - up to 180 Seats
Boeing 737/900
Bombardier BD-700 Global Express
CRJ-900



Representative Aircraft not to scale.

FIGURE C3 **Representative Aircraft by Runway Design Code (RDC)**

Approach and Departure Reference Code. FAA AC 150/5300-13A, Change 1, *Airport Design*, includes additional designations of Approach and Departure Reference Codes (APRC and DPRC). APRC and DPRC describe the *current* operational capabilities of a runway and adjacent taxiways where no special operations procedures are necessary. APRC is composed of the AAC, and ADG, and visibility minimums. ARPC is a code signifying the current operational capabilities of a runway and associated parallel taxiway with regard to landing operations. The separation distance from the runway centerline to the parallel taxiway along with particular meteorological conditions are the criteria that determine which aircraft can operate on taxiways adjacent to a runway. Renton Municipal Airport's APRC is B-III-5000 and D-II-5000 based on the separation between the runway centerline and parallel taxiway centerline of 300 feet and the approach minimums of not lower than 1-mile. While the ARPC describes the current operational capabilities of the runway, it is important to note that it does not restrict use of the runway by aircraft exceeding the AAC or ADG. Use of the runway by larger aircraft is at the pilot's discretion.

The Departure Reference Code (DPRC) is a code signifying the current operational capabilities of a runway with regard to takeoff operations where no special operating procedures are necessary. The DPRC is similar to the APRC, but is composed of only two components, AAC and ADG. Based on the runway to taxiway separation of 300 feet, Runway 16/34 has a DPRC of B-III and D-II, permitting the following airplanes to depart while another aircraft is on the parallel taxiway: AAC A & B, ADG I, II, and III; and AAC C & D, ADG I & II. This means that an airplane of an AAC D, ADG III, such as a 737, would require a runway to taxiway separation of 400 feet to depart with another Group III aircraft on the parallel taxiway. At Renton Municipal Airport the Airport Traffic Control Tower regulates the use of the parallel taxiways while D-III aircraft are operating on the Airport. However, these special operating procedures do not currently exist in writing and it is recommended that a Letter of Agreement (LOA) be drafted between the ATCT and Airport Management.

APRC and DPRC reference tables from FAA AC 5300-13A, Change 1, *Airport Design*, are presented in following figures entitled *APPROACH REFERENCE CODE (APRC)* and *DEPARTURE REFERENCE CODE (DPRC).*

Figure C4 **APPROACH REFERENCE CODE (APRC)**

Visibility Minimums	Runway to Taxiway Separation (ft)									
	≥150	≥200	≥225	≥240	≥250	≥300	≥350	≥400	≥500	≥550
Visual	B/I(S)/VIS	B/I(S)/VIS	B/I/VIS	B/II/VIS	B/II/VIS	B/III/VIS D/II/VIS	B/III/VIS	D/IV/VIS D/V/VIS	D/VI/VIS	D/VI/VIS
Not lower than 1 mile	B/I(S)/5000	B/I(S)/5000	B/I/5000	B/II/5000	B/II/5000	B/III/5000 D/II/5000	B/III/5000	D/IV/5000 D/V/5000	D/VI/5000	D/VI/5000
Not lower than 3/4 mile	B/I(S)/4000	B/I(S)/4000	B/I/4000	B/II/4000	B/II/4000	B/III/4000 D/II/4000	B/III/4000	D/IV/4000 D/V/4000	D/VI/4000	D/VI/4000
Lower than 3/4 mile but not lower than 1/2 mile		B/I(S)/2400	B/I/4000 B/I(S)/2400	B/II/4000	B/I/2400	B/III/4000 [1] D/II/4000 B/II/2400	B/III/2400	D/IV/2400 D/V/2400	D/VI/2400	D/VI/2400
Lower than 1/2 mile								D/V/2400 D/IV/1600	D/VI/2400 D/V/1600	D/VI/1600

Notes: 1. (S) denotes small aircraft
2. Entries for Approach Category D also apply to Approach Category E. However, there are no Approach Category E aircraft currently in the civil fleet.
3. For ADG VI aircraft with tail heights of less than 66 feet (20 m), ADG-V separation standards may be used.

How to use this table:

Each APRC entry denotes a combination of Aircraft Approach Category, Airplane Design Group, and visibility condition under which landing operations may be conducted without operational mitigations. Within an APRC, operations may be conducted by airplanes up to the AAC and ADG, and down to the visibility conditions noted. In this example, with visibility minimums of lower than 3/4 mile but not lower than 1/2 mile, the applicable APRCs are B/III/4000, D/II/4000, and B/II/2400. This means that following aircraft may land:

- Within Approach Categories A & B, Airplane Design Groups I(S), I, II, & III, down to 3/4 mile visibility.
- Within Approach Categories C & D, Airplane Design Groups I & II, down to 3/4 mile visibility.
- Within Approach Categories A & B, Airplane Design Groups I(S), I & II, down to 1/2 mile visibility.

Figure C5 **DEPARTURE REFERENCE CODE (DPRC)**

Runway to Taxiway Separation (ft)					
≥ 150	≥ 225	≥ 240	≥ 300	≥ 400	≥ 500
B/I(S)	B/I	B/II	B/III D/II	D/IV D/V [1]	D/VI [2]

Note: (S) denotes small aircraft
Entries for Approach Category D also apply to Approach Category E. However, there are no Approach Category E aircraft currently in the civil fleet.

1. Example: With a runway to taxiway separation of 300 feet, the following airplanes may depart:
   - Within Approach Categories A & B, Airplane Design Groups I(S), I, II, & III.
   - Within Approach Categories C & D, Airplane Design Groups I & II.
   - Thus, an airplane of Approach Category C, Airplane Design Group III requires a runway to taxiway separation of 400 feet for departure.
2. For unrestricted operations by ADG-VI airplanes, a runway to taxiway separation of 500 feet is required. However, ADG-VI airplanes may depart with aircraft on the parallel taxiway where the runway to taxiway separation is as little as 400 feet as long as **no ADG-VI aircraft** occupy the parallel taxiway beyond 1500 feet of the point of the start of takeoff roll.
   When there is snow, ice or slush contamination on the runway, ADG-VI airplanes may depart with aircraft on the parallel taxiway where the runway to taxiway separation is as little as 400 feet as long as **no aircraft** occupy the parallel taxiway beyond 1500 feet of the point of the start of takeoff roll.

Runway 16/34 Design Standards. Existing dimensions and the corresponding existing FAA design standards applicable to Runway 16/34 are presented in the following table entitled *RUNWAY 16/34 DESIGN STANDARDS MATRIX – RDC D-III ≥ ¾ MILE VISIBILITY MINIMUMS* and the following figures entitled *EXISTING RDC D-III DESIGN STANDARDS*, *EXISTING RDC D-III DIMENSIONAL STANDARDS (NORTH DETAIL),* and *EXISTING RDC D-III DIMENSIONAL STANDARDS (SOUTH DETAIL)*.

Table C4 **RUNWAY 16/34 DESIGN STANDARDS MATRIX – RDC D-III ≥ ¾-MILE VISIBILITY MINIMUMS**

Item	Existing Dimension	FAA Criteria	Standard Met
RUNWAY DESIGN			
Runway Width	200 FT	150 FT	Yes
Shoulder Width	0 FT	25 FT	Yes[1]
Crosswind Component	16 Knots	16 Knots	Yes
RUNWAY PROTECTION			
Runway Safety Area (RSA) Runway 16			
Length beyond departure end	**455 FT[6]**	1,000 FT	**No**
Length prior to threshold	**300 FT**	600 FT	**No**
Width	**300 FT**	500 FT	**No[2]**
Runway Safety Area (RSA) Runway 34			
Length beyond departure end	**300 FT**	1,000 FT	**No**
Length prior to threshold	**455 FT[6]**	600 FT	**No**
Width	**300 FT**	500 FT	**No[2]**
Runway Object Free Area (ROFA) Runway 16			
Length beyond departure end	**455 FT[6]**	1,000 FT	**No**
Length prior to threshold	**300 FT**	600 FT	**No**
Width	**300 FT**	800 FT	**No[2]**
Runway Object Free Area (ROFA) Runway 34			
Length beyond departure end	**300 FT**	1,000 FT	**No**
Length prior to threshold	**455 FT[6]**	600 FT	**No**
Width	**300 FT**	800 FT	**No[2]**
Runway Obstacle Free Zone (ROFZ)			
Length beyond Runway 16 end	200 FT	200 FT	Yes
Length beyond Runway 34 end	**160 FT**	200 FT	**No**
Width	**300 FT**	400 FT	**No[3]**
RUNWAY SEPARATION			
Runway centerline to:			
Holding position	**195 FT[4]**	250 FT	**No**
Parallel taxiway/taxilane centerline	**300 FT/350 FT[5]**	400 FT	**No**
Aircraft parking area	**350 FT**	500 FT	**No**

SOURCE: FAA Advisory Circular 150/5300-13A, Change 1, Airport Design (February 2014)

NOTE: [1] **The existing 200-foot width of the runway provides 25-foot paved shoulders.**
[2] **The RSA/ROFA width requirements are not met off both ends of Runway 16/34 given the proximity of Lake Washington at the approach end of Runway 16 and the proximity of the perimeter road and Airport Way at the approach end of Runway 34.**
[3] **For the majority of the runway, the 400-foot wide ROFZ width standard is met, except for the area near the approach end of Runway 16 where the OFZ is penetrated by the road, the Cedar River and the seaplane pullout ramp.**
[4] **Varies.**
[5] **Taxiway A centerline is 300 feet separation and Taxiway B centerline varies from 300 feet to 350 feet separation.**
[6] **Distance from threshold to closest edge of the curvilinear blast wall**

Disclaimer:
This illustration is for study purposes only, based on national FAA standards, and is not necessarily intended for implementation. For further information please see Chapter C of the Airport Master Plan and the FAQ document on the Airport's website.

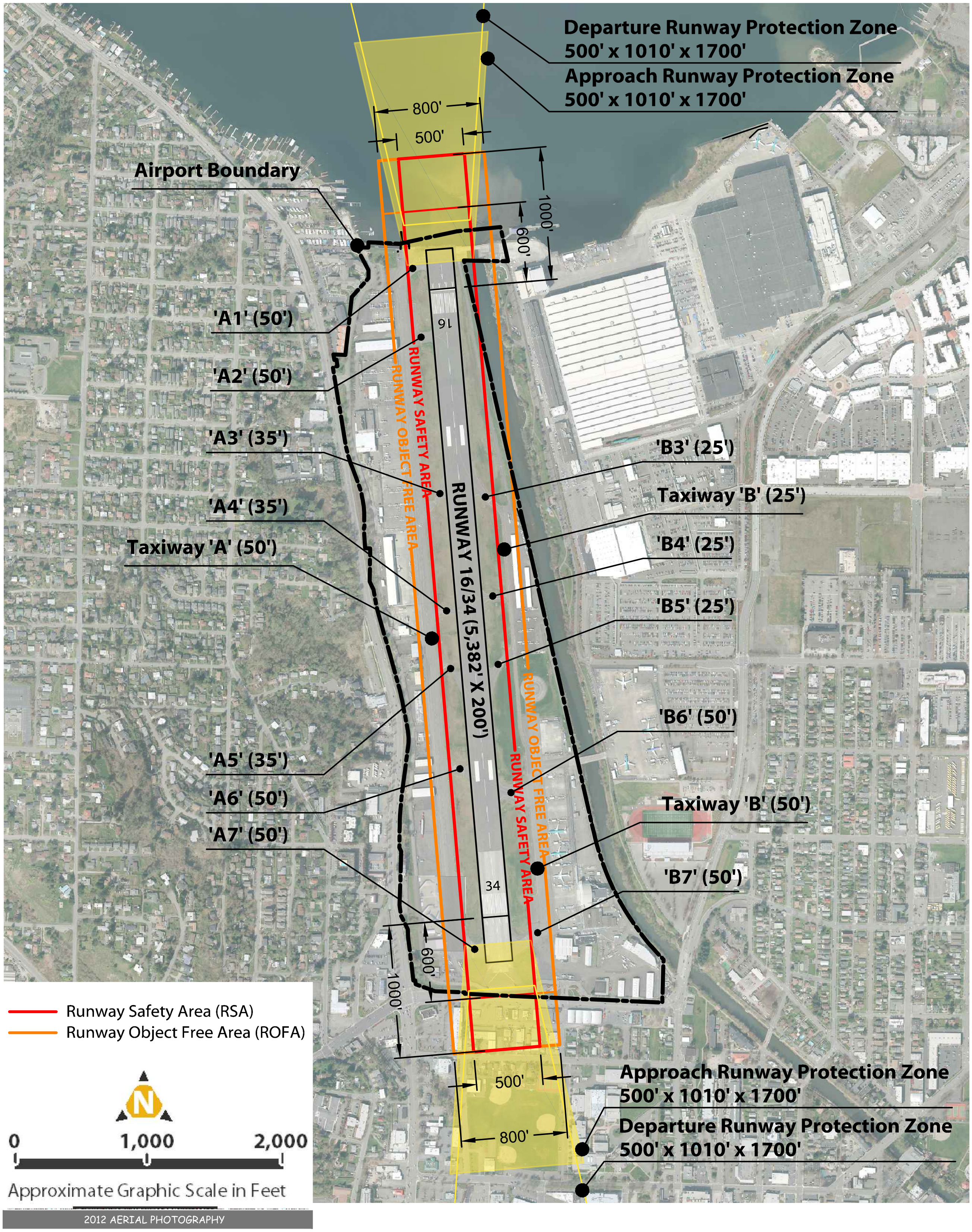
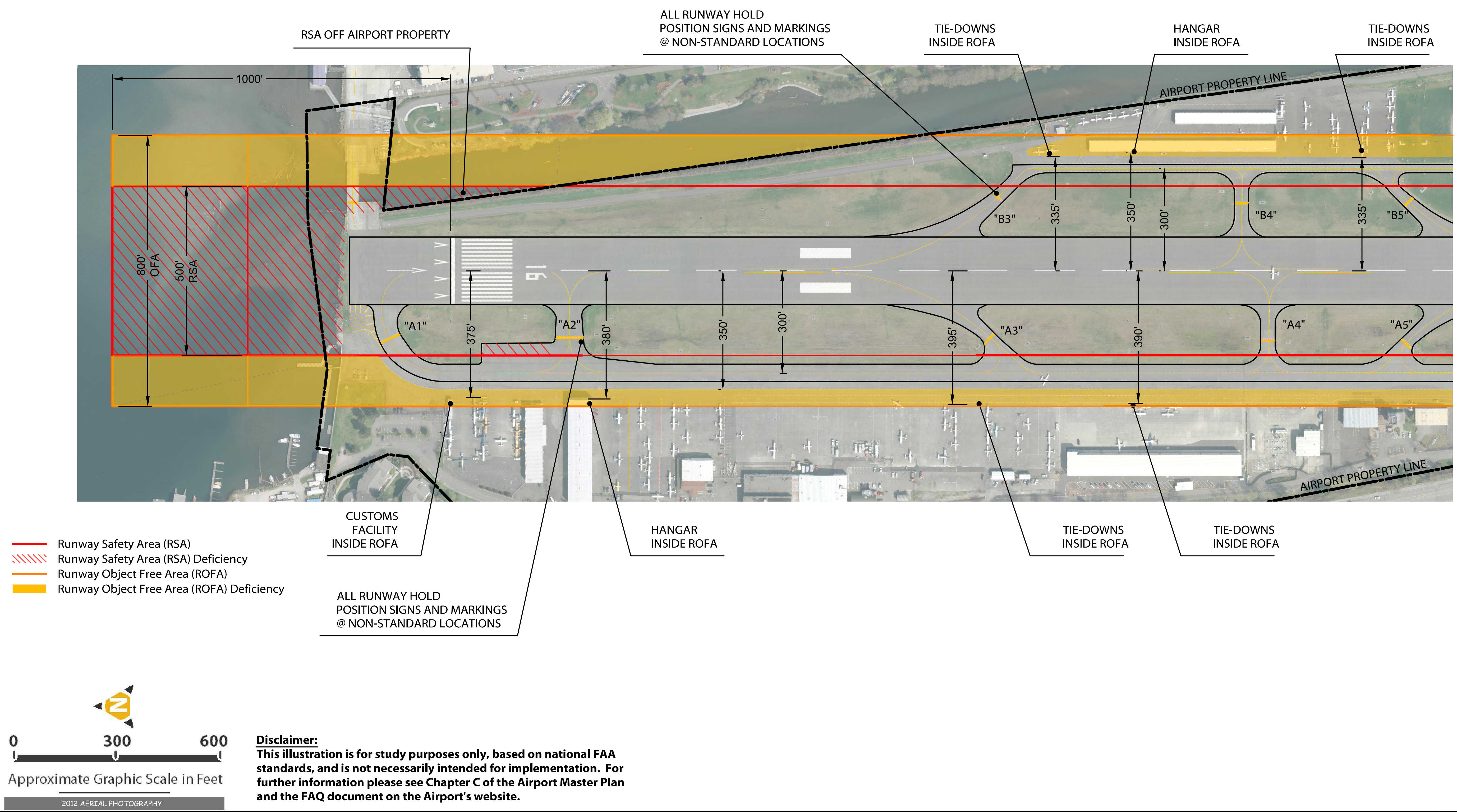
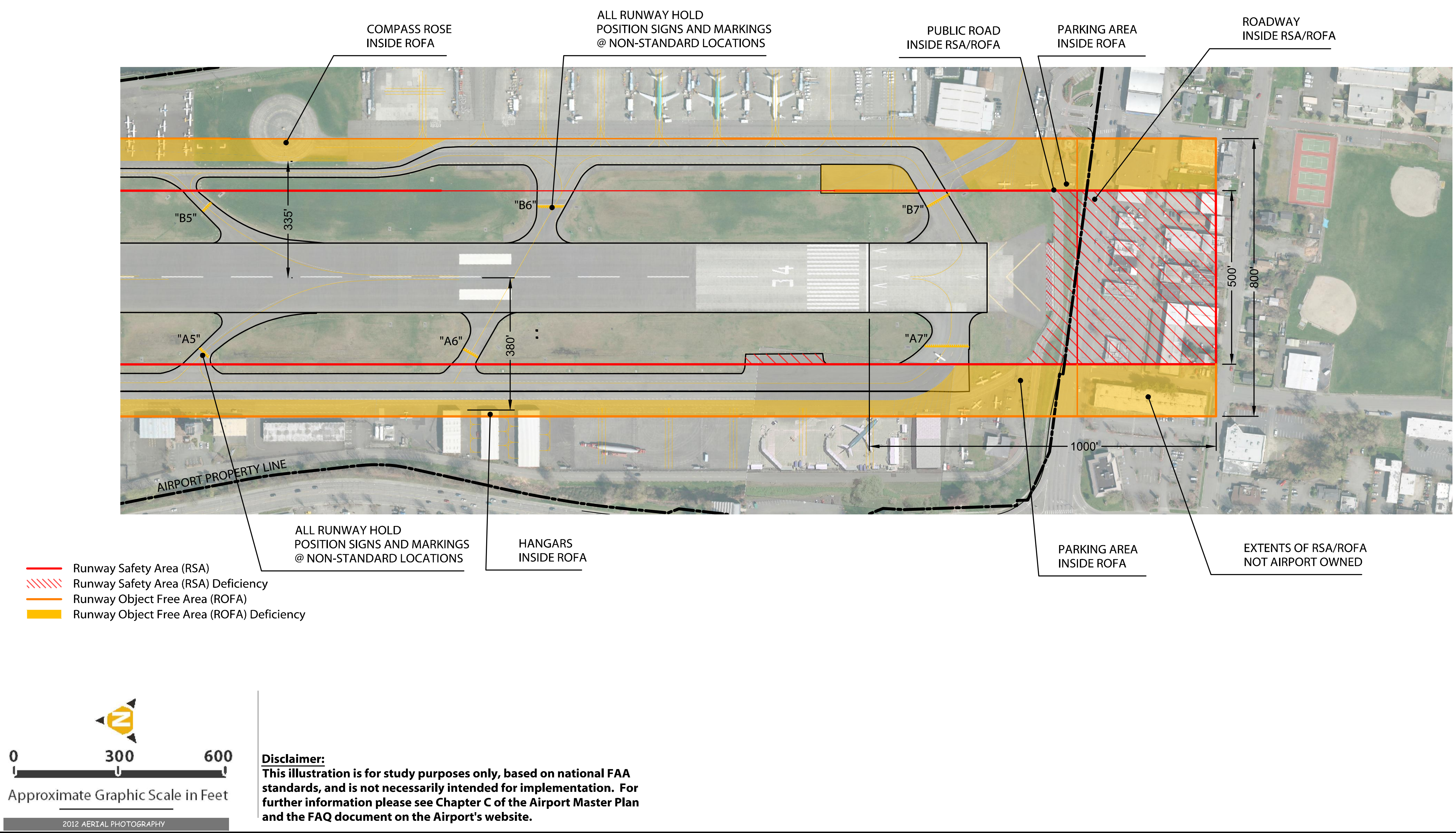


FIGURE C6 **Existing RDC D-III Design Standards**



Disclaimer:
This illustration is for study purposes only, based on national FAA standards, and is not necessarily intended for implementation. For further information please see Chapter C of the Airport Master Plan and the FAQ document on the Airport's website.

FIGURE C7 **Existing RDC D-III Dimensional Standards (North Detail)**



Disclaimer:
This illustration is for study purposes only, based on national FAA standards, and is not necessarily intended for implementation. For further information please see Chapter C of the Airport Master Plan and the FAQ document on the Airport's website.

FIGURE C8 **Existing RDC D-III Dimensional Standards (South Detail)**

Runway Safety Area (RSA). The Runway Safety Area (RSA) is an integral component of the runway environment. The RSA dimensions are based on the Runway Design Code (RDC) of that runway. The RSA enhances the safety of aircraft operations which undershoot, overrun, or veer off the runway, and it provides greater accessibility for fire-fighting and rescue equipment during such incidents.

FAA Advisory Circular 150/5300-13A, Change 1 *Airport Design*, states that the RSA is a defined surface centered on the runway centerline, prepared and suitable for reducing the risk of damage to aircraft in the event of an undershoot, overshoot, or excursion from the runway. It must be cleared and graded and have no potentially hazardous ruts, humps, depression, or other surface variations; drained by grading or storm sewers to prevent water accumulation; capable under dry conditions of supporting rescue vehicles; and free of objects except those that must be located in the RSA by function. If objects higher than three inches must be located within the RSA, then to the extent practical, they must be constructed on frangible mounted structures of the lowest practical height with the frangible point no higher than three inches above grade.

The design standard for a RDC D-III RSA width is 500 feet wide, or 250 laterally from the runway centerline. The RSA width for Runway 16/34 is limited to approximately 150 feet from the runway centerline, to the east, by the Cedar River. The design standard for a RDC D-III RSA length is to extend 1,000 feet past the departure end, and 600 feet prior to the landing threshold of the runway. The RSA at the approach end of Runway 16 is limited to approximately 300 feet, by Lake Washington to the north, while the RSA at the approach end of Runway 34 is limited to approximately 455 feet by the curvilinear blast fence and West Perimeter Road, to the south. It is also important to note that RSA standards cannot be modified or waived.

Runway Object Free Area (ROFA). The Runway Object Free Area (ROFA) is centered about the runway centerline and requires clearing the ROFA of above-ground objects protruding about the nearest point of the RSA. Except where precluded by other clearing standards, it is acceptable for object that need to be located in the ROFA for air navigation or aircraft ground maneuvering purposes to protrude above the nearest point of the RSA, and to taxi and hold aircraft in the ROFA. To the extent practicable, objects in the ROFA should meet the same frangibility requirements as the RSA. Objects non-essential for air navigation or aircraft ground maneuvering purposed must not be placed in the ROFA, this includes parked aircraft. The design standard for a RDC D-III ROFA width is 800 feet wide and the design standard for length is 1,000 feet beyond the runway end (similar to the RSA). The ROFA has very similar limits off the ends of Runway 16/34 to the RSA limits. Laterally, there are a number of ROFA penetrations. On the east side of the runway, the ROFA is penetrated by aircraft parking and tie downs, aircraft storage hangars, the compass rose and an aircraft run-up apron. On the west side of the runway, the ROFA is also penetrated by aircraft parking and ties downs, aircraft storage hangars, and the U.S. Customs facility.

Runway Obstacle Free Zone (ROFZ). The Runway Obstacle Free Zone (ROFZ) is a three-dimensional airspace along the runway and extended runway centerline that is required to be clear of obstacles for protection to aircraft landing or taking off from the runway and for missed approaches. The ROFZ extends 200 feet beyond each runway end and is 400 feet wide. For the majority of the runway, the ROFA standard is met except for the area near the approach end of Runway 16 where the OFZ is penetrated by the service road, the Cedar River and the seaplane pullout ramp.

Runway Width. The existing runway width of 200 feet exceeds the RDC D-III-5000 standard by 50 feet. FAA policies and guidelines indicate that funding for pavement maintenance and rehabilitation projects are generally limited to that required by the appropriate dimensional standards. However, given the unique operational requirements of 737 aircraft and the need for these aircraft to regularly conduct 180 degree turns on the runway, the FAA and Airport Management have determined that there is justification for maintaining a 200-foot runway width. These unique operational requirements will be further discussed in the following chapter.

Runway Pavement Strength. The runway pavement strength at Renton Municipal Airport was described in the *Inventory* chapter. Runway 16/34 has a published gross weight capacity of 100,000 pounds single wheel, 130,000 pounds double wheel, and 340,000 pounds double tandem wheel. The runway pavement strength appears adequate for the 20-years planning period, assuming routine pavement maintenance is performed. The runway is considered to be in good condition, with the lowest Pavement Condition Index (PCI) of 92 on the runway.

Runway Length. The determination of runway length recommendations for airport planning purposes is based on several factors. These factors include:

- Airport elevation Above Mean Sea Level (AMSL);
- Mean Normal Maximum daily Temperature (MNMT) of the hottest month;
- Runway gradient;
- Family grouping of critical aircraft for runway length purposes; and
- Stage length of the longest nonstop trip destination.

The calculation for runway length requirements at Renton Municipal Airport are based on an elevation of 32 feet (AMSL), 76.9° Fahrenheit MNMT, and maximum difference in runway elevation at the centerline for Runway 16/34 of 8.2 feet.

In 2005 the FAA published an update to the Advisory Circular (AC) 150/5325-4B, *Runway Length Requirements for Airport Design*. The revised AC included a process for determining recommended runway length. The first step is to determine a critical aircraft for runway length. The AC states, that if the critical aircraft is a commercial aircraft, such as the Boeing 737 series, with a Maximum Take-Off Weight (MTWO) of over 60,000 pounds, the process is to follow the instructions in Chapter 4 of the AC, and utilize the Airport Planning Manuals (APMs) published by the aircraft manufacturers. Chapter 4, states that the recommended runway length should be determined by selecting the longest runway length recommended in the APM.

According to the Boeing Commercial Airplanes, 737 Airplane Characteristics for Airport Planning, the 737-700 has the same fuselage as the 737-300 and is fitted with the new wing, stabilizer, and tail sections. The 737-700 is 110 ft. 4 in. long and can carry up to 148 passengers in an all-economy configuration. The 737-800 has a slightly longer fuselage than the 737-400 and is fitted with the new wing, stabilizers, and tail sections. The 737-800 is 129 ft. 6 in. long and can carry up to 184 passengers in an all-economy configuration. The 737-900 is a derivative of the 800 and is 8 ft. longer than the 800. Two sections were added to the 800 fuselage; a 54-inch section in front of the wing, and a 42-inch section aft of the wing. The 900 can seat as many as 189 passengers in an all-economy configuration.

The 737 MAX program has its most improved performance in cruise, which has improved the payload range capability, and created a slightly better performance in takeoff and landing length requirements, but the 737 MAX does not currently have published takeoff and landing charts for airport planning purposes and Boeing directs airport planners to the performance charts of the 737-700/800/900ER.

For the purposes of the runway length analysis, the Boeing 737 series, 700, 800, and 900, which perform their initial flight from Renton Municipal Airport, are presented in the following table entitled *RUNWAY 16/34 TAKEOFF LENGTH RECOMMENDATIONS*. Occasionally, 737 series aircraft need to return to Renton Municipal Airport. Consequently, an analysis of landing length requirements was conducted and is presented in the following table entitled *RUNWAY 16/34 LANDING LENGTH RECOMMENDATIONS*.

Table C5 **RUNWAY 16/34 TAKEOFF LENGTH RECOMMENDATIONS**

Aircraft Type	Engine Type/Model	Max Takeoff Weight (lbs.)	Runway Length Standard Data	Runway Length Hot Day (STD + 27° F)
Boeing 737-700	CFM56-7B20/22/24	154,500	5,300	5,700
Boeing 737-700W	CFM56-7B26	154,500	5,200	5,400
Boeing 737-700ER/ERW/C/CW/BBJ1	CFM56-7B26/27	171,000	6,800	7,200
Boeing 737-800/W/BBJ2	CFM56-7B24/26/27	174,200	7,600	8,200
Boeing 737-900/W	CFM56-7B24/26	174,200	9,200	9,800
Boeing 737-900ER/ERW/BBJ3	CFM56-7B26/27	187,700	9,900	10,950

SOURCE: **Boeing Commercial Airplanes, 737 Airplane Characteristics for Airport Planning (September 2013)**
NOTE: **Dry runway, zero wind, zero runway gradient, air conditioning off, optimum flap setting.**

Table C6 **RUNWAY 16/34 LANDING LENGTH RECOMMENDATIONS**

Aircraft Type	Maximum Landing Weight	Flap Setting	Dry Runway	Wet Runway
Boeing 737-700ER	134,000	30	4,900 FT	5,800 FT
Boeing 737-800	146,300	30	5,800 FT	6,600 FT
Boeing 737-900	146,300	30	5,900 FT	6,800 FT
Boeing 737-900ER	157,300	30	5,550 FT	6,450 FT

SOURCE: **Boeing Commercial Airplanes, 737 Airplane Characteristics for Airport Planning (September 2013)**
NOTE: **Standard day, zero wind, auto spoilers operative, anti-skid operative, zero runway gradient.**

Runway 16 at currently has 5,042 feet of available takeoff length and Runway 34 has 5,082 feet of available takeoff length. In both directions, Runway 16/34 has 4,742 feet of available landing length. As indicated in the previous tables, the recommended runway lengths all exceed the current available length at Airport. Also, while the majority of 737 series aircraft operations are not performed at maximum takeoff or landing weight, it is important that the Boeing aircraft be able to operate with full fuel loads as the initial flights often spend a number of hours doing flight testing prior to reaching their destinations of either Boeing Field, Paine Field, or Moses Lake. During the preparation of this runway length analysis, Airport Management also coordinated with Boeing test pilots to confirm Boeing's requirements. The Boeing takeoff length distance calculations for hot summer days also exceed runway length available. Therefore, it is the position of Airport Management and the City of Renton that any decrease in available runway length would negatively impact the safe operation of 737 series aircraft and should not be considered. For the purposes of this Airport Master Plan, airside alternatives will at a minimum, maintain the existing published takeoff and landing lengths.

Runway Protection Zones. The function of a Runway Protection Zone (RPZ) is to enhance the protection of people and property on the ground beyond the runway ends. This is achieved through airport control of the RPZ areas, and control is preferably exercised through the acquisition of sufficient property interest within the RPZ. It is desirable to clear all about ground objects from with RPZs; where this is impractical, airport owners, at minimum, should maintain the RPZ clear of all facilities supporting incompatible activities.

RPZs are trapezoidal in shape, are centered about the runway centerline, and begin 200 feet beyond the end of the area usable for takeoff or landing. The RPZ dimensions are functions of the type of aircraft using the runway and the approach visibility minimums associated with each runway end.

In FAA Memorandum *Interim Guidance on Land Uses Within a Runway Protection Zone,* the FAA Office of Airports (ARP), outlined interim policy on land uses within RPZs a comprehensive guidance documents for existing and proposed land uses within RPZs. The interim guidance requires ARP Regional Office (RO), and Airport District Office (ADO), staff to consult with National Airport Planning and Environmental Division (APP-400), when defined land uses would enter the limits of the RPZ as a result of actions such as airfield improvements (e.g., runway extensions or shifts), change in design aircraft increasing the RPZ dimensions, new or revised instrument approach procedures increasing the RPZ dimensions, or local development proposals in the RPZ.

Land uses defined in the memorandum that require consultation include buildings and structures (e.g., residences, schools, churches, hospitals or other medical care facilities, commercial/industrial buildings), recreational land uses (e.g., golf courses, sports fields, amusement parks, other places of public assembly), transportation facilities (such as, rail facilities, public roads and highways, vehicular parking facilities), above or below ground fuel storage or hazardous materials storage facilities, wastewater treatment facilities, and above ground utility infrastructure (e.g., electrical substations, including any type of solar panel installations). RO and ADO staff are further required to work with airport sponsors to identify, analyze, and document a full range of alternatives that avoid introducing a land use issues within the RPZ, minimize the impact of the land use in the RPZ (e.g., routing a new roadway through the controlled activity area, move farther away from the runway end, etc.), and mitigate risk to people and property on the ground (e.g. tunneling, depressing, and/or protecting roadways through the RPZ, implement operational measures to mitigate any risks). The following uses are permissible within a RPZ without further evaluation from the FAA; farming that meets airport design standards; irrigation channels that meet the requirements of AC 150/5200-33 and FAA/USDA manual, *Wildlife Hazard Management at Airports*; airport service roads, as long as the road is not a public road, and is directly controlled by the airport; underground facilities, as long as they meet other design criteria, such as RSA requirements: and unstaffed NAVAIDs and facilities, such as equipment for airport facilities that are considered fixed-by-function.

Currently the RPZs at each end of Runway 16/34 extend past the airport property boundary. Because the FAA recommends sponsor control of the RPZ to come from acquisition of property, further consideration should be given to the options the Airport has in regards to controlling the RPZ, through either fee simple ownership or avigation easements. In the following chapter, RPZ alternatives will be considered in addition to RSA and ROFA improvement alternatives.

In consideration of the existing instrument approach minimums and the type of aircraft the runway is designed to accommodate, the following table entitled *RUNWAY PROTECTION ZONE DIMENSIONS*, lists the existing RPZ dimensional requirements. It is also important to note that the published declared distances (described in the following section) for Runway 16/34 create separate approach and departure RPZ's for each runway end as shown in the following figures entitled *RUNWAY PROTECTION ZONE (RPZ) DETAIL (NORTH AND SOUTH)*.

Table C7 **RUNWAY PROTECTION ZONE DIMENSIONS**

Runway	Width at Runway End	Length	Width at Outer End	Airport Controls Entire RPZ
Runway 16	500 FT	1,700 FT	1,010 FT	No[1]
Runway 34	500 FT	1,700 FT	1,010 FT	No

SOURCE: **FAA Advisory Circular 150/5300-13A, Change 1, Airport Design (February 2014),**

NOTE: **[1] While the Airport does not control the entire approach and departure RPZ's to the north, they are located over Lake Washington thus preventing the development of incompatible land uses.**

Disclaimer:
This illustration is for study purposes only, based on national FAA standards, and is not necessarily intended for implementation. For further information please see Chapter C of the Airport Master Plan and the FAQ document on the Airport's website.

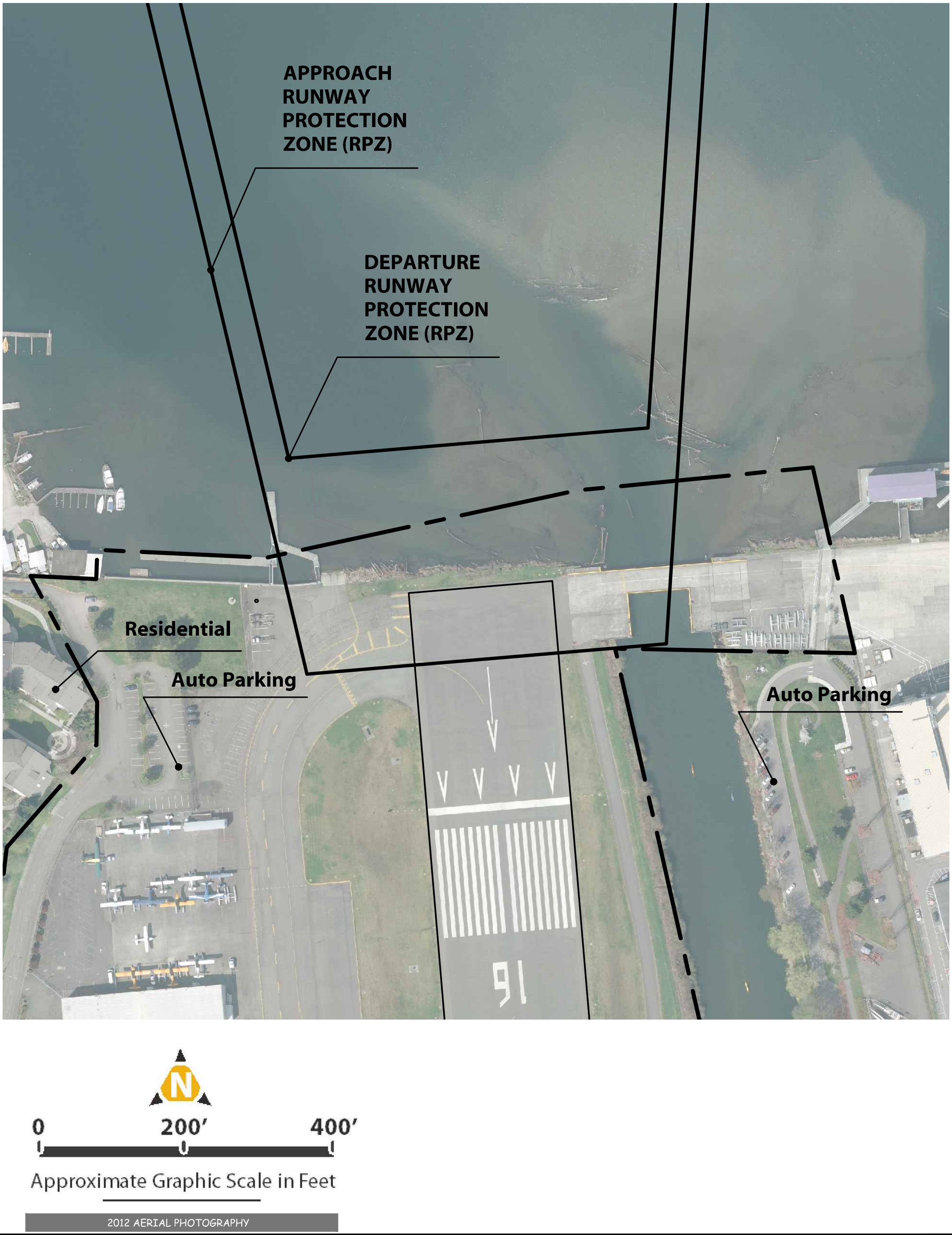


FIGURE C9 **Runway Protection Zone (RPZ) Detail (North)**

Disclaimer:
This illustration is for study purposes only, based on national FAA standards, and is not necessarily intended for implementation. For further information please see Chapter C of the Airport Master Plan and the FAQ document on the Airport's website.

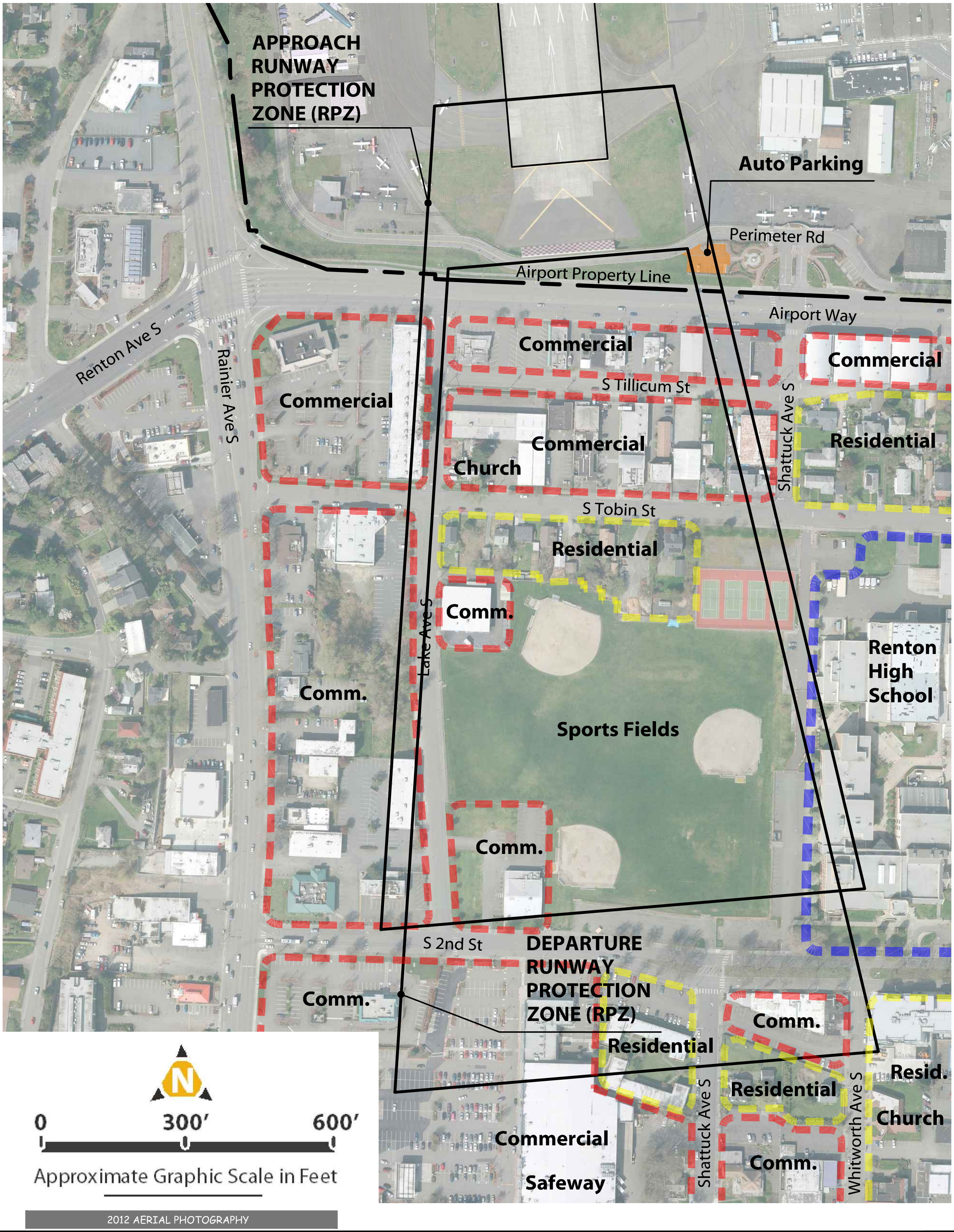


FIGURE C10 **Runway Protection Zone (RPZ) Detail (South)**

Declared Distance Application. FAA AC 150/5300-13A, Change 1 *Airport Design*, describes declared distances as the maximum distances available and suitable for meeting takeoff, rejected takeoff, and landing distance performance requirements for turbine powered aircraft. The declared distances include Takeoff Run Available (TORA), Takeoff Distance Available (TODA) which apply to takeoff; Accelerate Stop Distance Available (ASDA), which applies to a rejected takeoff; and Landing Distance Available (LDA), which applies to landing. By treating these distance independently, declared distance is a design methodology that results in declaring and reporting the TORA, TODA, ASDA, and LDA for each operation direction.

Declared distances may be used to obtain additional RSA and/or ROFA prior to the runway's threshold (the start of the LDA) and/or beyond the stop end of the LDA, and ASDA, to mitigate unacceptable incompatible land use in the RPZ, to meet runway approach and/or departure surface clearance requirements, in accordance with airport design standards to mitigate environmental impacts. Declared distances may also be used as an incremental improvement technique when it is not practical to fully meet these requirements.

At Renton Municipal Airport, the implementation of these standards permits the boundaries of the RSA and ROFA (based on current RDC B-II) to be specified independently with the establishment of displaced thresholds for Runway 16/34. The resulting published declared distances for Runway 16/34 are presented in the following table and figure entitled *EXISTING RUNWAY 16/34 DECLARED DISTANCES.*

Table C8 **EXISTING RUNWAY 16/34 DECLARED DISTANCES**

	Runway Approach End	
	16	**34**
Displaced Threshold	300 FT	340 FT
Takeoff Run Available (TORA)	5,382 FT	5,382 FT
Takeoff Distance Available (TODA)	5,382 FT	5,382 FT
Accelerate-Stop Distance Available (ASDA)	5,042 FT	5,082 FT
Landing Distance Available (LDA)	4,742 FT	4,742 FT

SOURCE: **December 2009 Renton Municipal Airport/Clayton Scott Field Airport Layout Plan (ALP).**

NOTE: **Threshold displacement and use of Declared Distances provides standard B-II RSA and ROFA off each runway end.**

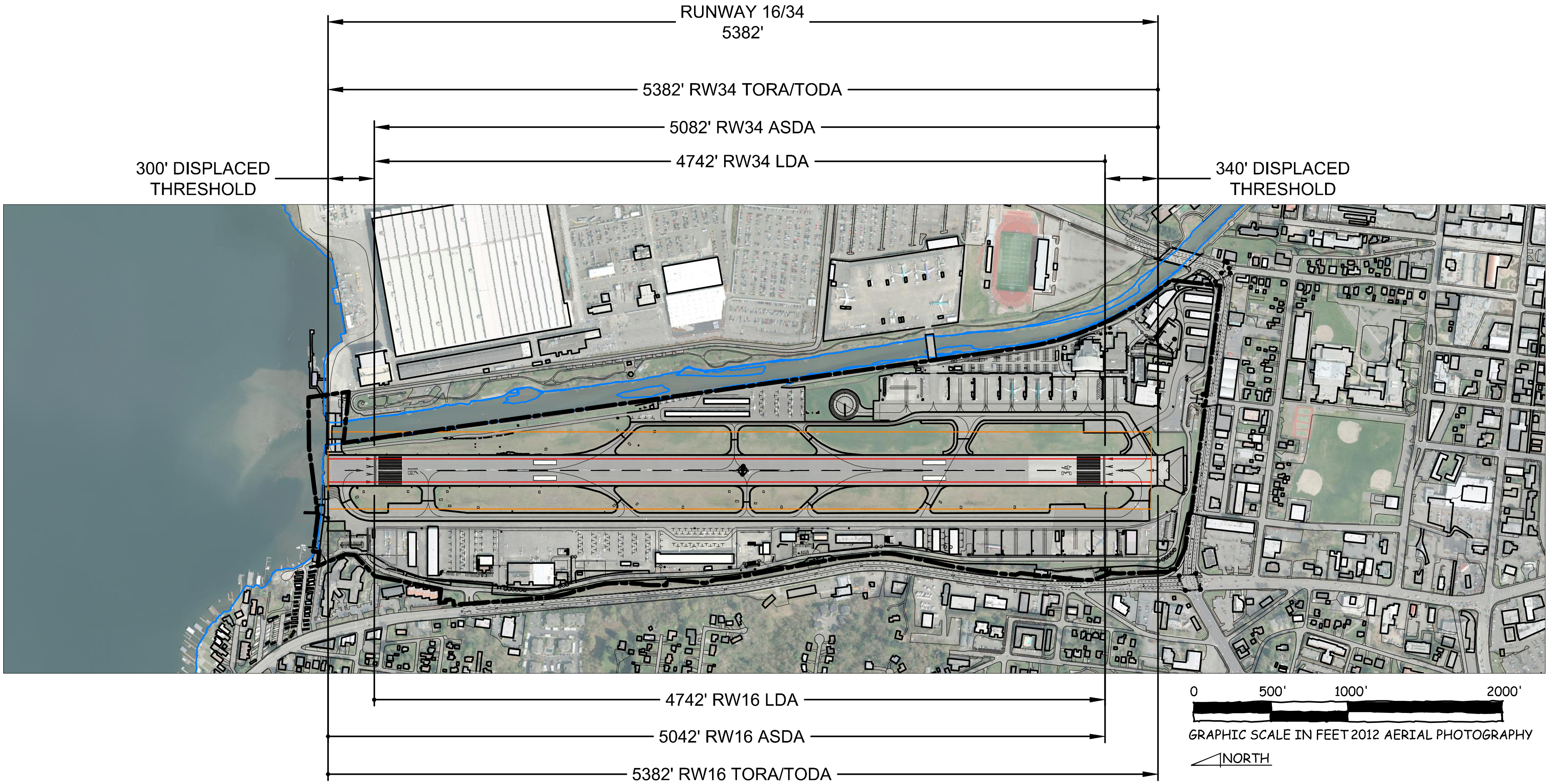


FIGURE C11 **Existing Runway 16/34 Declared Distances**

Taxiway Design Standards. Similar to the runway design standards in the previous section, the separation of taxiways and other facilities is highly dependent on the Airport Design Group of the specified design aircraft which is dictated by the aircraft wingspan. However, unlike runways, taxiway design is also influenced by the landing gear configurations (i.e., gear type, width, length, and its location on the aircraft) which combine to establish the Taxiway Design Group (TDG). These design characteristics dictate the amount of pavement width needed and the amount of pavement fillet required on the inside of a taxi turn. Pilots maneuver an airplane by maintaining the cockpit over the taxiway centerline and during taxiing the inner wheel will drift inward during the taxi turn. The amount of additional pavement needed to accommodate the drift is called the fillet.

According to AC 150/5300-13A, Change 1, *Airport Design*, Paragraph 105.b; operation of an aircraft that exceeds design criteria of the airport may operate on the airport if there are Standard Operating Procedures (SOPs) in place with Air Traffic Control (ATC). Boeing's normal procedures at the Airport are as follows; the 737 aircraft are towed from the Boeing plant across the North Bridge and then south along Taxiway A. From there, the 737s are parked either on Apron B adjacent to Taxiway A, or they are towed back across the Runway at the south end and parked in the stalls on Apron A adjacent to Taxiway B. Some 737s under tow are repositioned back across the Cedar River on Boeing's private property known as Apron D. Once ready for flight, the 737s can taxi under their own power from the parking positions adjacent to Taxiway A and Taxiway B to access the runway. Aircraft parked on Apron D must first be towed out onto Taxiway B just north of Taxiway B6 before they can fire up and taxi under power onto the runway.

As a result of this practice, Taxiway A design standards are TDG 2 for the portions of taxiway where Boeing aircraft are towed and TDG 3 for the portions of taxiway where the 737 aircraft taxi under their own power. Finally, a portion of Taxiway B from a point approximately 300 feet north of Taxiway B6 and continuing north through Taxiway B3, is only utilized by small general aviation aircraft resulting in ADG I and TDG 1B standards.

These standards are presented in the following tables entitled *TAXIWAY A1 THROUGH TAXIWAY A6 DESIGN GROUP MATRIX, TAXIWAYS A AND B (PORTIONS SERVING BOEING RAMPS) DESIGN GROUP MATRIX*, and *TAXIWAY B (B6 THROUGH B3) DESIGN GROUP MATRIX*.

Table C9 **TAXIWAY A1 THROUGH TAXIWAY A6 DESIGN GROUP MATRIX**

Item	Existing Dimension	FAA Criteria	Standard Met
TDG 2			
Taxiway Width	50 FT	35 FT	Yes
Taxiway Edge Safety Margin	10 FT	7.5 FT	Yes
Taxiway Shoulder Width[1]	20 FT	15 FT	Yes
ADG II			
Taxiway Protection			
Taxiway Safety Area (TSA)	79 FT	79 FT	Yes
Taxiway Object Free Area (TOFA)	131 FT	131 FT	Yes
Taxiway Separation			
Taxiway Centerline to Fixed or Movable Object	65.5 FT	65.5 FT	Yes

SOURCE: **FAA Advisory Circular 150/5300-13A, Change 1, Airport Design (February 2014)**

NOTE: **Taxiways referenced in this table are shown in teal in the following illustrations.**

[1] **Paved shoulders are required for ADG IV and higher, and recommended for ADG III**

Table C10 **TAXIWAYS A AND B (PORTIONS SERVING BOEING RAMPS) DESIGN GROUP MATRIX**

Item	Existing Dimension	FAA Criteria	Standard Met
TDG 3			
Taxiway Width	50 FT	50 FT	Yes
Taxiway Edge Safety Margin	10 FT	10 FT	Yes
Taxiway Shoulder Width[2]	20 FT	20 FT	Yes
ADG III			
Taxiway Protection			
Taxiway Safety Area (TSA)	118 FT	118 FT	Yes
Taxiway Object Free Area (TOFA)	**166 FT**	186 FT	**No[1]**
Taxiway Separation			
Taxiway Centerline to Fixed or Movable Object	93 FT	93 FT	Yes

SOURCE: **FAA Advisory Circular 150/5300-13A, Change 1, Airport Design (February 2014)**

NOTE: **Taxiways referenced in this table are shown in green in the following illustrations.**

[1] **Vehicle service road penetrates TOFA.**

[2] **Paved shoulders are required for ADG IV and higher, and recommended for ADG III**

Table C11 **TAXIWAY B (B6 THROUGH B3) DESIGN GROUP MATRIX**

Item	Existing Dimension	FAA Criteria	Standard Met
TDG 1B			
Taxiway Width	25 FT	25 FT	Yes
Taxiway Edge Safety Margin	5 FT	5 FT	Yes
Taxiway Shoulder Width[2]	10 FT	10 FT	Yes
ADG I			
Taxiway Protection			
Taxiway Safety Area (TSA)	49 FT	49 FT	Yes
Taxiway Object Free Area	**60 FT**	89 FT	**No[1]**
Taxiway Separation			
Taxiway Centerline to Fixed or Movable Object	**30 FT**	44.5 FT	**No[1]**

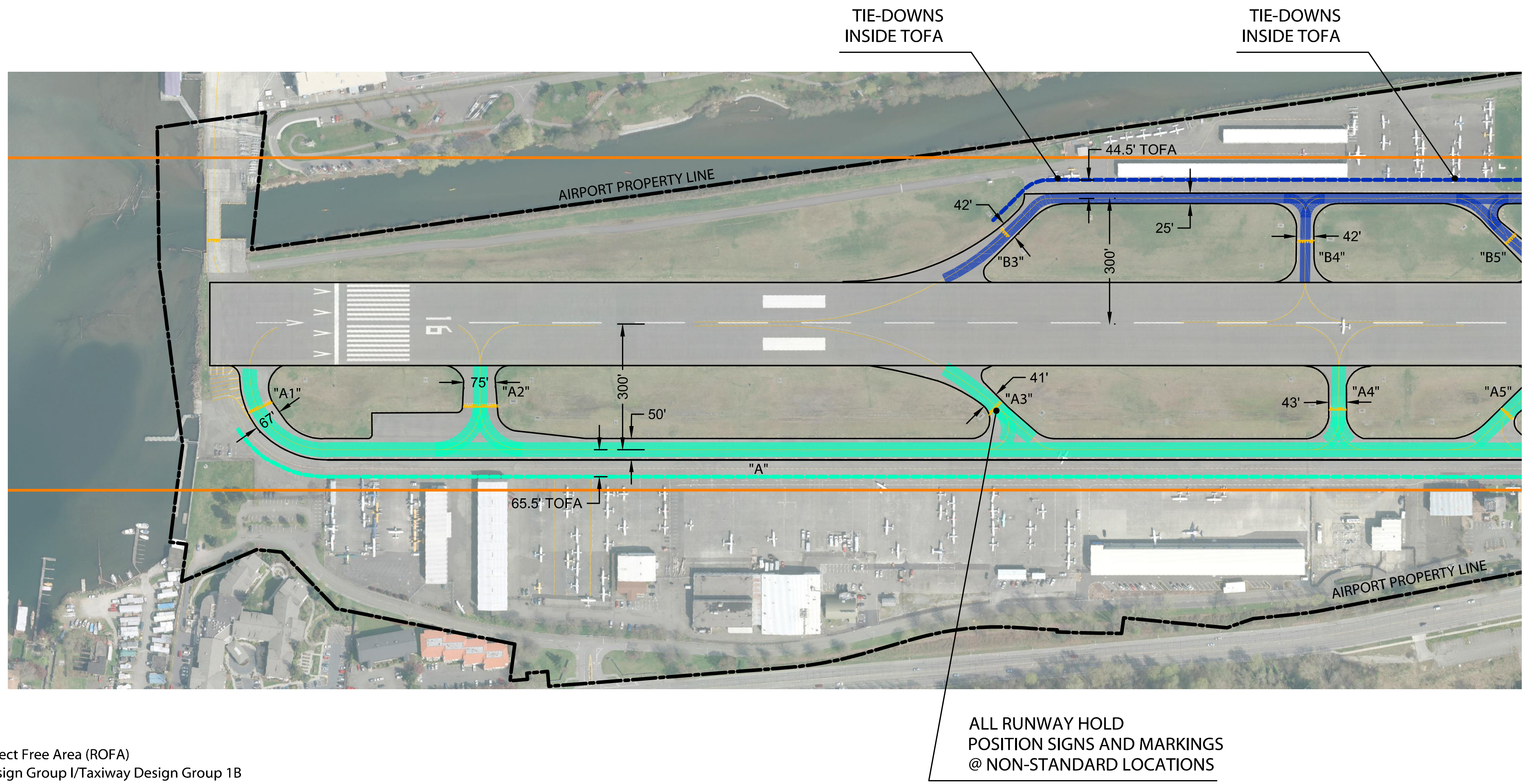
SOURCE: **FAA Advisory Circular 150/5300-13A, Change 1, Airport Design (February 2014)**

NOTE: **Taxiways referenced in this table are shown in purple in the following illustrations.**

[1] **Tie-downs penetrate TOFA and taxiway centerline to fixed or movable object.**

[2] **Paved shoulders are required for ADG IV and higher, and recommended for ADG III**

According to AC 150/5300-13A, unprotected soils adjacent to runways and taxiways are susceptible to erosion due to jet blast. A dense, well-rooted turf cover can prevent erosion and support the occasional passage of aircraft, maintenance equipment, or emergency equipment under dry conditions. Paved shoulders are only required for runways taxiways, taxilanes, and aprons accommodating ADG IV and higher aircraft, and are recommended for taxiways, taxilanes, and aprons accommodating ADG III aircraft, such as the Boeing 737 series. The taxiway design standards described in the previous tables are also presented graphically in the following figures entitled *TAXIWAY DESIGN STANDARDS (SOUTH DETAIL)* and *TAXIWAY DESIGN STANDARDS (NORTH DETAIL)*.



- Runway Object Free Area (ROFA)
- Airplane Design Group I/Taxiway Design Group 1B
- ADG I/TDG 1B Object Free Area (TOFA)
- Airplane Design Group II/Taxiway Design Group 2
- ADG II/TDG 2 Object Free Area (TOFA)

0 300 600

Approximate Graphic Scale in Feet

2012 AERIAL PHOTOGRAPHY

Disclaimer:
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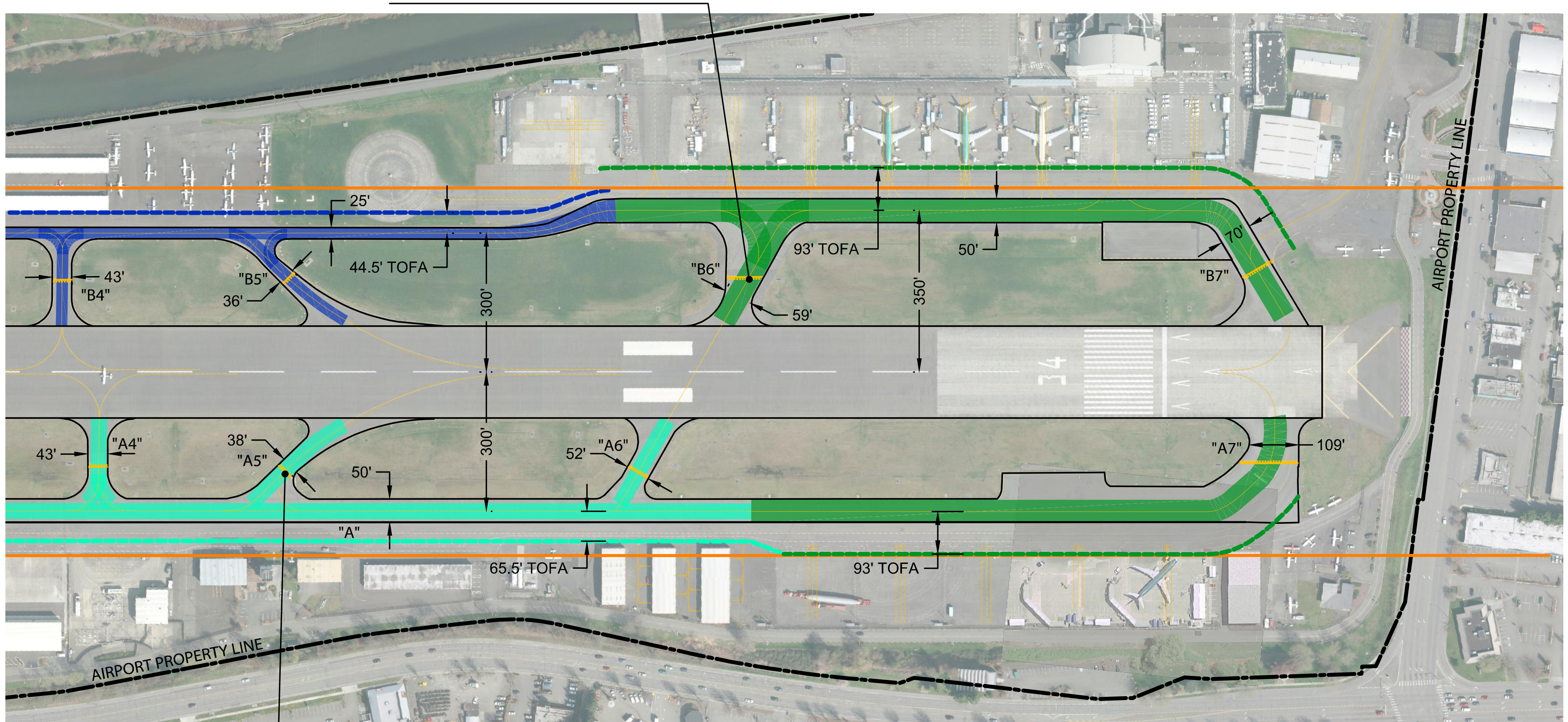
FIGURE C12 **Taxiway Design Standards (North Detail)**

Mead &Hunt

ALL RUNWAY HOLD
POSITION SIGNS AND MARKINGS
@ NON-STANDARD LOCATIONS



ALL RUNWAY HOLD
POSITION SIGNS AND MARKINGS
@ NON-STANDARD LOCATIONS

- Runway Object Free Area (ROFA)
- Airplane Design Group I/Taxiway Design Group 1B
- ADG I/TDG 1B Object Free Area (TOFA)
- Airplane Design Group II/Taxiway Design Group 2
- ADG II/TDG 2 Object Free Area (TOFA)
- Airplane Design Group III/Taxiway Design Group 3
- ADG III/TDG 3 Object Free Area (TOFA)

0 300 600

Approximate Graphic Scale in Feet

2012 AERIAL PHOTOGRAPHY

Disclaimer:
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FIGURE C13 **Taxiway Design Standards (South Detail)**

Exit Taxiway Analysis

As noted in the previous chapter, the west side of Runway 16/34 is provided with seven connector/exit taxiways, while the east side of Runway 16/34 is provided with five connector/exit taxiways at various locations along the runway, which are designed to varying standards and dimensions (i.e., various TDGs). According to the FAA taxiway design guidance provided in AC 150/5300-13A, Change 1 *Airport Design*, right-angled taxiways are the recommended standard for all runway/taxiway intersections, expect where there is a need for high-speed exit taxiways at congested airports to enhance throughput capacity. At Renton Municipal Airport, the high-speed exit taxiways (B3, A3, B5 and A5) serve to facilitate quick and efficient exit off the runway by smaller single engine piston and turboprop type aircraft.

Optimally located/aligned exit taxiways minimize runway occupancy times and allow the airfield to be used more efficiently. Table 4-13 of AC 150/5300-13A provides the cumulative percentages of aircraft typically able to exit runways at specific exit taxiway locations, in 500-foot increments. Percentages for both wet and dry runway conditions are included as are right-angled and acute-angled exit taxiway configurations. It should be noted that since the percentages provided in Table 4-13 are based on 500-foot increments, the approximate exit percentage for those exit taxiways locating in between the 500-foot increments were interpolated.

As presented in the following table entitled *RUNWAY 16/34 EXIT TAXIWAY ANALYSIS*, the optimal location for small single engine aircraft is at 2,400 feet, while for small multi-engine aircraft the optimal location would be between 3,800 and 4,400 feet. While a number of the exit taxiways at Renton Municipal Airport are not optimally located, the expense to add and/or relocated exit taxiways is considered cost prohibitive and not necessary at this time for airfield capacity purposes. This information will be utilized in subsequent chapters and give consideration to the potential removal of unnecessary taxiways due to proximity to the runway threshold, rate of use, and overall probability of use.

Table C12 **RUNWAY 16/34 EXIT TAXIWAY ANALYSIS**

Exit	Distance From Landing Threshold (In Feet)	Percentage of Aircraft Exiting Runway					
		Dry Conditions			Wet Conditions		
		S	T	L	S	T	L
Runway 16							
Taxiway “A2” (R)	350	0%	0%	0%	0%	0%	0%
Taxiway “A3” (A)	1,400	49%	0%	0%	21%	0%	0%
Taxiway “B3” (A)	1,400	49%	0%	0%	21%	0%	0%
Taxiway “B4” (R)	2,330	92%	9%	0%	78%	1%	0%
Taxiway “A4” (R)	2,420	96%	10%	0%	81%	1%	0%
Taxiway “A6” (R)	3,650	91%	89%	7%	91%	73%	1%
Taxiway “B6” (R)	3,800	95%	93%	8%	95%	76%	1%
Taxiway “A7” (R)	4,985	100%	100%	49%	100%	100%	12%
Taxiway “B7” (R)	4,985	100%	100%	49%	100%	100%	12%
Runway 34							
Taxiway “B6” (R)	950	6%	0%	0%	4%	0%	0%
Taxiway “A6” (A)	1,050	37%	0%	0%	16%	0%	0%
Taxiway “A5” (A)	1,750	79%	1%	0%	53%	0%	0%
Taxiway “B5” (A)	1,750	79%	1%	0%	53%	0%	0%
Taxiway “A4” (R)	2,320	92%	9%	0%	78%	1%	0%
Taxiway “B4” (R)	2,400	95%	10%	0%	81%	1%	0%
Taxiway “A2” (R)	4,400	99%	98%	49%	98%	95%	4%
Taxiway “A1” (R)	4,950	99%	99%	49%	99%	99%	12%

SOURCE: **FAA Advisory Circular 150/5300-13A, Change 1, Airport Design (February 2014), Table 4-13.**

NOTE: **S- Small, single engine (12,500 lbs. or less)**

T – Small, twin engine (12,500 lbs. or less)

L – Large (12,500 lbs. to 300,000 lbs.)

Federal Aviation Regulations (FAR) Part 77

Safe and efficient landing and takeoff operations at an airport require that certain areas on and near the airport are clear of objects or restricted to object with certain function, composition, and/or height. Obstruction clearing standards and criteria are established to create a safer environment for aircraft operations on or near the airport. Any existing or proposed object, whether man-made or of natural growth that penetrates obstruction clearance surfaces is classified as an "obstruction" and is presumed to be a hazard to air navigation. These obstructions are subject to FAA aeronautical study, after which the FAA issues a determination stating if the obstruction is in fact considered a hazard.

The criteria contained in Federal Aviation Regulations (FAR), Part 77 *Safe, Efficient Use, and Preservation of Navigable Airspace*, apply to existing and proposed manmade objects and/or objects of natural growth and terrain (i.e., obstructions). These guidelines define the critical areas in the vicinity of airport that should be kept free of obstructions. Secondary areas may contain obstructions if they are determined to be non-hazardous by aeronautical study and/or if they are marked and lighted as specified in the aeronautical study determination. Airfield navigational aids, as well as lighting and visual aids, by nature of their location, may constitute obstructions. However, these objects do not violate FAR Part 77 requirements, as they are essential to the operation of the Airport.

The *Primary Surface* is a surface that is longitudinally centered on the runway. This surface extends 200 feet beyond each end of the runway for a hard surface runway such are Runway 16/34. The *Primary Surface* also varies based upon the pavement strength of the runway, and the current instrument approach visibility minimums of the runway. Runway 16/34 has a pavement strength greater than utility, or 12,500 pounds, with the current instrument approach visibility of 1 statute mile. These parameters result in a *Primary Surface* that is 500 feet wide, (250 feet from centerline on each side of the runway).

The *Approach Surface* is longitudinally centered on the extended runway centerline and extends outward and upward from each end to the *Primary Surface* at a specific slope, expressed in horizontal feet by vertical feet. For example, a 20:1 slope rises one unit vertically for every 20 units horizontally. An *Approach Surface* is applied to each end of the runway based upon the type of approach available or planned for that runway end. The inner width of the *Approach Surface* is the same as the *Primary Surface* (500 Feet), and expands uniformly to a width of 3,500 feet. The *Approach Surface* for Runway 16/34 extends for a horizontal distance of 10,000 feet at a slope of 34:1. As part of this Master Plan, aerial photography and obstruction data is being acquired that will allow further analysis of the FAR Part 77 surfaces and potential obstructions. The FAR Part 77 imaginary surfaces for the Renton Municipal Airport and the known associated terrain penetrations of these surfaces are presented in the following figure entitled *FAR PART 77 SURFACES*.

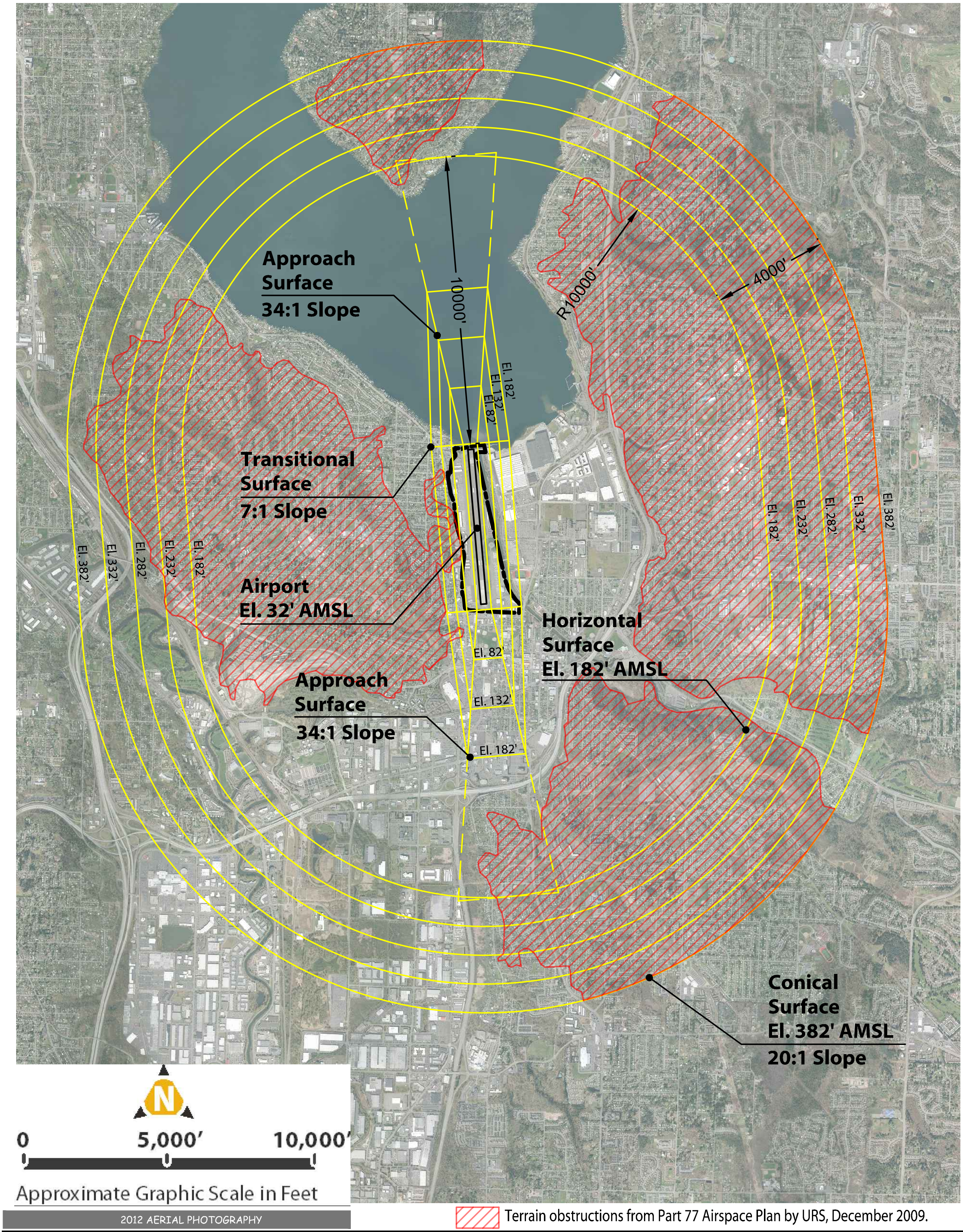

FIGURE C14 **FAR Part 77 Surfaces**

Runway End Siting Surfaces

Criteria contained in FAA AC 150/5300-13A, Change 1 *Airport Design* provides guidance for the proper siting of runway ends and thresholds. The criteria are in the form of evaluation surfaces that are typically trapezoidal shaped and extend away from the runway ends along the centerline at a specific slope, expressed in horizontal feet by vertical feet. The specific size, slope, and starting point of the trapezoid depends upon the visibility minimums and the type of procedure associated with the runway end.

Threshold Siting Analysis. Thresholds are located to provide proper clearance over obstacles for landing aircraft on approach to a runway end. When an object is beyond an airport owner's ability to remove, relocate, or lower obstructs the airspace required for aircraft to land at the beginning of the runway for takeoff, the landing threshold may require a location other than the end of the pavement (i.e., a displaced threshold). Like the RPZ criteria, the threshold siting criteria are based on the type of aircraft and approach visibility minimums associated with each runway end. The appropriate existing Threshold Siting Surface (TSS) for Runway 16 has a slope of 30:1; and Runway 34 the TSS slope is 20:1.

Runway 16, currently has a Localizer Performance with Vertical Guidance (LPV), instrument approach, designating Runway 16 as Runway Type 8, or an approach end expected to accommodate approaches with vertical guidance. Runway 34, currently has circling instrument approaches, which support night operations serving greater than approach Category B aircraft, resulting in a Runway Type 5 classification. As stated previously, as part of this Master Plan, aerial photography and obstruction data is being acquired that will allow further analysis of the threshold siting surfaces and potential obstructions.

Departure Surface Analysis. Departure ends of runways normally mark the end of the full-strength runway pavement available and suitable for departures. Departure surfaces, when clear of obstacles, allow pilots to follow standard departure procedures. If obstacles penetrate the departure surface, then the obstacles must be evaluated through the Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) process. After the OE/AAA process, departure procedure amendments such as non-standard climb rates, non-standard (higher) departure minimums, or a reduction in the length of Takeoff Distance Available (TODA) may be required. Departure surfaces begin at the end of the TODA, are trapezoidal in shape, extend along the extended runway centerline, and have a slope of 40:1. The existing criteria for Renton Municipal Airport are presented in the following table entitled *RUNWAY END SITING CRITERIA.*

Table C13 **RUNWAY END SITING CRITERIA**

Runway Type	Distance from Runway End	Width at Inner Edge	Length	Width at Outer End	Slope
Type 5: (Runway 34)	200 FT	800 FT	10,000 FT	3,800 FT	20:1
Type 8: (Runway 16)	0 FT	400 FT	10,000 FT	1,520 FT	30:1
Departure Surface: (Runway 16/34)	0 FT	1,000 FT	10,200 FT	6,466 FT	40:1

SOURCE: FAA Advisory Circular 150/5300-13A, Change 1, Airport Design (February 2014), Table 3-2)
NOTE: Obstruction evaluation of these surfaces is an element of this Airport Master Plan.

Landside Facility Requirements

Landside facilities are those facilities which support the airside facilities, but are not actually a part of the aircraft operating surfaces. These consist of such facilities as terminal buildings, hangars, aprons, access roads, and support facilities. Following an analysis of these facilities, current deficiencies can be noted in terms of accommodating both existing and future aviation needs at the Airport.

Passenger Terminal Requirements

Given that Renton Municipal Airport does not currently accommodate commercial passenger service and is not forecast to serve such a role within the 20-year planning period, a passenger terminal is not a requirement.

General Aviation Requirements

Aircraft based at Renton Municipal Airport are stored in various hangar and apron areas on the east and west sides of Runway 16/34. Currently, an estimated 274 aircraft are based at the Airport. Approximately 157 aircraft are stored in hangars of various size while the remaining 117 are stored on tiedown aprons or at various other apron areas on the Airport. Over the course of the twenty-year planning period the demand for additional based aircraft is forecast to increase to 337, indicating that an increase in storage facilities to accommodate at least 63 additional aircraft is required. Unfortunately, as described in the *Inventory of Existing Conditions* chapter, the Airport is very land poor with limited space for the development of additional aircraft storage area (aprons or hangars). It is also assumed that future storage spaces will reflect some of the characteristics of current storage patterns, with the majority of the based aircraft fleet being stored in hangars.

Tiedown Storage Requirements/Based Aircraft. Aircraft tiedowns are provided for those aircraft that do not require, or do not desire, to pay the cost for hangar storage. Space calculations for these areas are based on an airport planning guidance of 360 square yards of apron for each aircraft to be tied down. This amount of space allows for aircraft parking and circulation between the rows of parked aircraft. Past trends indicate that as more aircraft are based at the Airport, hangar storage capacity is surpassed before additional hangars are supplied. This indicates that increased tiedown space for based aircraft should be considered in the development plan.

Tiedown Storage Requirements/Itinerant Aircraft. In addition to the needs of the based aircraft tiedown areas addressed in the preceding section, transient aircraft (often referred to as itinerant aircraft) also require apron parking areas at Renton Municipal Airport. This storage is provided in the form of transient aircraft tiedown space. In calculating the area requirements for these tiedowns, typically, an area of 400 square yards per aircraft is used. The development plan for the Airport will should consider additional areas for apron development to satisfy this demand.

Aircraft Hangar Storage Requirements. The following table entitled *GENERAL AVIATION FACILITY REQUIREMENTS, 2014-2034* shows the type of facilities and the number of units or acres needed for that facility in order to meet the forecast demand for each development phase. It is expected that most of the owners of aircraft that will be newly based at the Airport will desire some type of indoor storage facility. The actual type of hangar storage facility to accommodate based aircraft has been identified as either smaller T-hangars/clear span hangars and larger FBO type shared hangars, although the actual number, size, and location of these hangars will depend on user needs and financial feasibility.

Access and perimeter roadway locations, auto parking requirements, and land requirements, are not included in this tabulation because the amount of land necessary for these facilities will be a function of the location of other facilities, as well as the most effective routing of roadways.

The following table will assist in the development of detailed facility staging discussed later. Again, it is assumed that the majority of aircraft owners will desire indoor storage. This assumption leads to the conclusion illustrated in the following table that increased area for the construction of hangars is necessary and that the demand for additional aircraft parking apron will also continue to increase.

Table C14 **GENERAL AVIATION FACILITY REQUIREMENTS, 2014-2034**

	Total Number Required				
Facility	**2014[1]**	**2019**	**2024**	**2029**	**2034**
Apron Space					
Transient Aircraft GA Apron (acres)	-	4.9	5.1	5.4	5.7
Based Aircraft GA Apron (acres)	-	7.7	8.1	8.6	9.0
Total Apron (acres)	**13.8[2,3]**	**12.6**	**13.2**	**14.0**	**14.7**
Total Tie Downs	**160**	**154**	**162**	**171**	**179**
Hangar Space					
Number of Aircraft in Smaller Hangars	132	139	147	154	163
Number of Aircraft in Larger Hangars	25	27	29	31	32
Total Aircraft in Hangars	**157**	**166**	**176**	**185**	**195**

SOURCE: **Mead & Hunt, projections based planning rule of thumb space requirements.**

[1] **Actual.**

[2] **Does not differentiate between based and/or itinerant apron.**

[3] **Does not include Aprons A & B which are leased by the Boeing Company.**

Support Facilities Requirements

In addition to the aviation and airport access facilities described previously, there are several airport support facilities, which have quantifiable requirements and which are vital to the efficient and safe operation of the Airport. The support facilities at Renton Municipal Airport that require further evaluation include the aircraft manufacturing facilities, the Airport Traffic Control Tower (ATCT), the fuel storage facility, the airport maintenance facility and the U.S. Customs Facility.

Aircraft Manufacturing Facilities. As described previously, the *Boeing Commercial Airplane Group* assembles all lines of the Boeing 737 aircraft adjacent to the Renton Municipal Airport. Boeing is the major lease holder at the Airport, and leases manufacturing related areas on airport property. Boeing also has facilities which are accessed through a through-the-fence agreement and two taxilane bridges over the Cedar River. The taxilane bridges are labeled as the North Bridge and the South Bridge. In addition to Boeing's regular parking areas (Aprons A and B), there is one additional apron area located adjacent to Rainer Flight Service that Boeing has leased for temporary 737 aircraft parking during the transition to the new Boeing 737 MAX aircraft type. Boeing has entered into a 5-year lease for this apron as the need is anticipated to be short term.

Airport Traffic Control Tower (ATCT). At a towered airport, the ATCT is the facility that supervises, directs, and monitors the arrival and departure traffic including the immediate airspace surrounding the airport (i.e., within approximately 5 miles). The tower at the Renton Municipal Airport is a federal contract tower and is located on the west side of Runway 16/34 at approximately midfield, adjacent to Taxiway A5. The ATCT was constructed in 1961 and is approximately 55 feet tall. The ATCT has clear line of sight (LOS) to most areas on the Airport with the one exception being the taxilane leading to the southeast development area where the LOS is currently blocked by a hangar. There are also structural concerns with the ATCT due to past earthquake damage. Given the age of the ATCT and the structural concerns, it is recommended that a facility condition assessment be conducted and based on the results of that assessment, a future ATCT siting study be considered.

Fuel Storage Facility. Renton Municipal Airport has two 10,000 gallon Jet A above ground tanks, and two 10,000 gallon Avgas or 100 Low Lead above ground tanks. There are also below ground tanks owned and operate by The Boeing Company. Boeing operates four Jet A tanks which are 40,000 gallons each, one diesel tank at 15,000 gallons, and one recycled waste oil tank at 15,000 gallons. The fuel storage requirements of the Airport are variable based upon individual supplier and distributor policies. For this reason, future fuel storage requirements will be dependent upon the individual distributors and space should be reserved for the expansion of existing fuel storage facilities as required.

Maintenance Facility. The Renton Municipal Airport Maintenance Facility is located on west side of the Airport, adjacent to Apron C and Rainier Flight Service. The Maintenance Facility is a small World War II era Quonset hut type structure with approximately 550 square feet. The facility is not large enough to store all the Airport's equipment and consequently, much of the equipment is stored outside. Consideration should be given to the replacement and expansion of this facility.

Aerospace Training Center Facility. As briefly described in the Inventory chapter, the City of Renton is developing a training center at the Airport with funding from the State legislature. The center is being designed to bring together many of the local players in the aerospace industry, as well as educational facilities like Renton Technical College to provide a place to train the next generation of aerospace workers. The training center will be developed on the site of the old Chamber of Commerce building on the west side of the Airport adjacent to Rainer Avenue.

U.S. Customs Service Facility. Federal Inspection Service (FIS) is provided by the U.S. Customs Service. U.S. Customs controls the entry and clearance of aircraft arriving into the United States and inspect the crew, passengers, baggage, stores, and cargo carried thereon. All inspections regardless of type of aircraft, must be conducted at the inspection facility, located in a portable building at the north end of the Airport. Aircraft to be inspected are required to taxi to the inspection station, park their aircraft, wait for the Customs Agent, and once cleared proceed to their desired aircraft parking. Commercial carriers must request landing rights in advance in writing, post an international carrier's bond in an amount established by Customs, and transmit the crew and passenger data electronically to Customs. Given the location of the Customs facility and the temporary nature of the structure, consideration should be given to a new location for a permanent facility.

Ground Access, Circulation, and Parking Requirements

As an employment center and to facilitate efficient use of the Airport, ground access is an important element in the overall ability of the Renton Municipal Airport to function properly.

Regional Auto Access-Highways. The Renton Municipal Airport enjoys good regional access from many Puget Sound locations. The Airport is located south of Lake Washington and north and west of Interstate 405. The Airport is also located in close proximity to the intersection of Interstate 405 and Interstate 5, the major north/south freeway connecting the Renton area to Seattle.

Local Auto Access-Streets. Local access from Interstate 405 is primarily provided via State Highway 167/Rainier Avenue with the primary access point at Rainer Avenue at the northwest corner of the Airport which connects to West Perimeter Road. Although access is also available via other interchanges with Interstate 405 and a number of local roads including Renton Avenue, Airport Way and Logan Avenue North. Two secondary access point exist on the south side of the Airport connecting Airport Way to East Perimeter Road and Logan Ave North to East Perimeter Road.

On-Airport Roadways. On-Airport access to airport facilities is accomplished via West Perimeter Road and East Perimeter Road. These two roads meet at the south entrance to the Airport connected to Airport Way. Airport Way serves as a commuter road for Boeing employees living east of the Airport. The two on-airport perimeter roads are considered to have adequate capacity to serve airport tenant and users.

In the development of airfield alternatives, consideration should be given to the impact that alternatives might have to roadways including West Perimeter Road, East Perimeter Road, Airport Way, Rainier Avenue and other roadways in the vicinity of the Airport.

Summary

The information provide in this chapter provides the basis for understanding what facility improvements at the Airport might help in the effort to meet current FAA design standards and to accommodate future aviation demand efficiently and safely. The following are the major improvement considerations that have been identified in this chapter by order of priority. As stated previously, RSA standards cannot be modified or waived so these will receive the highest priority in the following chapter of this Master Plan followed by Priority Number 2, RPZ standards; and Priority 3, other non-standard conditions. In addition to the non-standard conditions, there are a number of other improvement considerations for this Airport Master Plan. The following priorities will be analyzed concurrently throughout the alternatives process.

Priority Number 1 – RSA Standards.

- Analysis of potential RSA enhancements to the greatest extent practicable per RDC D-III standards in accordance with FAA guidance included in Orders 5200.8 – *Runway Safety Area Program* and 5200.9 – *Financial Feasibility and Equivalency of Runway Safety Area Improvements and Engineered Material Arresting Systems*.

Priority Number 2 – RPZ Standards.

- Analysis of potential RPZ enhancements per RDC D-III standards in accordance with FAA guidance memo entitled *Interim Guidance on Land Uses within a Runway Protection Zone*.

Priority Number 3 – Other Non-standard Conditions.

- Analysis of additional non-standard conditions associated with the upgrade from RDC B-II to D-III including runway/taxiway separation, ROFA penetrations, ROFZ penetrations, runway centerline/aircraft parking separation, etc.
- Analysis of non-standard pavement marking and signage per RDC D-III standards including runway centerline/hold position separation.
- Analysis of non-standard TOFA penetrations.

Additional Development Considerations

- Continued maintenance and rehabilitation of Runway 16/34.
- Continued maintenance and rehabilitation of Taxiway A and Taxiway B.
- Areas programmed for future general aviation related development and redevelopment in consideration of existing and projected demand. Particularly, improvements to the southeast development area.
- Areas programmed for future aircraft manufacturing related development and aircraft parking.
- Future instrument approach capabilities of Runway 16/34.
- Off-airport land use compatibility and zoning.

It is important to note that the recommendations in this Airport Master Plan are provided to understand what facilities improvements might be needed at the Airport, and where those facilities might be best placed. In other words, the Master Plan provides comprehensive recommendations on how various parcels of the Airport might be best developed, in consideration of potential demand and community/environmental influences. One of the basic assumptions for a master plan (for a complex facility like an airport), is that if a future improvement is identified on the recommended development plan, it will only be built if there is actual demand, if the project is financially feasible, and if environmental impacts are not significant. In summary, the facility needs information provided in this chapter will be used to develop alternatives for the configuration of future airport facilities.

The facility requirements described in this chapter are summarized in the following table entitled *FACILITY REQUIREMENTS SUMMARY, 2014-2034*.

Table C15 **FACILITY REQUIREMENTS SUMMARY, 2014-2034**

Facility	2014[1]	2019	2024	2029	2034
Runway and Taxiway Design Codes					
Runway 16/34	B-II	D-III	D-III	D-III	D-III
Taxiway A (A1 to A6)	ADG II/ TDG 2	ADG II/ TDG 2	ADG II/ TDG 2	ADG II/ TDG 2	ADG II/ TDG 2
Taxiway A & B (Portions serving Boeing ramps)	ADG III/ TDG 3	ADG III/ TDG 3	ADG III/ TDG 3	ADG III/ TDG 3	ADG III/ TDG 3
Taxiway B (North of B6 to B3)	ADG I/ TDG 1B	ADG I/ TDG 1B	ADG I/ TDG 1B	ADG I/ TDG 1B	ADG I/ TDG 1B
Runway Takeoff Distance	5,082/ 5,042 FT	5,082/ 5,042 FT	5,082/ 5,042 FT	5,082/ 5,042 FT	5,082/ 5,042 FT
Runway Landing Distance	4,742 FT	4,742 FT	4,742 FT	4,742 FT	4,742 FT
Runway Width	200 FT	200 FT	200 FT	200 FT	200 FT
Instrument Approach Enhancement					
Runway 16 Approach	GPS/1-Mile Vis	GPS and RNP/1-Mile Vis	GPS and RNP/1-Mile Vis	GPS and RNP/1-Mile Vis	GPS and RNP/1-Mile Vis
Runway 34 Approach	Circling/1 ¼-Mile Vis	Same	Same	Same	Same
General Aviation Apron and Hangar Requirements					
Total Apron (acres)	13.8[2,3]	12.6	13.2	14.0	14.7
Total Aircraft Tie Downs	160	154	162	171	179
Small Aircraft Hangar Spaces	132	139	147	154	163
Large Aircraft Hangar Spaces	25	27	29	31	32

SOURCE: Mead & Hunt, projections based planning rule of thumb space requirements.

[1] Actual.

[2] Does not differentiate between based and/or itinerant apron.

[3] Does not include Aprons A & B which are leased by the Boeing Company.