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Washington Dulles International Airport

Aircraft Noise Contour Map Update

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1. PURPOSE

In 2018, the Metropolitan Washington Airports Authority (MWAA) initiated an update to the long-range noise contour[1] map for Washington Dulles International Airport (Dulles International or the Airport). Historically, MWAA has provided local planning jurisdictions a long-range noise contour map as an aid toward the development of compatible land use around Dulles International. The long-range noise contours, called the Ultimate Conditions Noise Contours, represent day-night average sound level (DNL)[2] exposure contours based on full-build development and maximum sustainable operations that the runways at Dulles International can accommodate. The objective of this effort is to provide an updated noise contour map reflective not only of long-range airport development and operations assumptions but also reflective of recent and anticipated changes in the aviation environment. The Ultimate Conditions Noise Contours will help guide future land use planning decisions and continue to promote land use compatibility around the Airport.

MWAA updated the noise contours for several reasons:

- The existing Airport Overlay Districts were established in the early 1990s. Since then, changes in the aviation environment have occurred, and the vision for Dulles International should reflect these changes.
- Flight tracks and overall utility of the airfield at Dulles International have evolved and will continue to evolve with implementation of the Federal Aviation Administration's (FAA) NextGen modernization program (which is described in Section 3.1.5.1).
- The FAA is modifying flight procedures to allow for the triple simultaneous arrival runway operations at Dulles International during low visibility conditions or when aircraft are operating under Instrument Flight Rules (IFR), which will likely increase the utility and capacity of the airfield.

MWAA recognized the value of working collaboratively with subject matter experts and stakeholders to perform this update. Therefore, a Local Jurisdictional Stakeholder Working Group was established. The Working Group comprised MWAA interdisciplinary staff, appointed professional technical staff from local governments (including Fairfax County, the Town of Herndon, and Loudoun County), airline representatives, and FAA officials whose participation and input were essential to the success of this effort. The aircraft noise contour map update team reviewed key milestones (e.g., assumptions, methodology) with the Working Group, as summarized throughout this report.

1 Noise contour lines are continuous lines on a map representing equal levels of noise exposure, similar to terrain contours.

2 Day-night average sound level (DNL) is based on sound levels measured in relative intensity of sound, or decibels (dB), on the "A" weighted scale (dBA). This scale most closely approximates the response characteristics of the human ear to sound. The higher the number on the scale, the louder is the sound. DNL represents noise exposure events over a 24-hour period. To account for human sensitivity to noise between the hours of 10 p.m. and 7 a.m., noise events occurring during these hours receive a "penalty" when DNL is calculated. Each nighttime event is measured as if 10 daytime events occurred. FAA established DNL as the primary metric for aircraft noise analysis and expressing aircraft noise exposure in the United States. DNL has been widely accepted as the best available method to describe aircraft noise exposure and is the noise descriptor required by the FAA for use in aircraft noise exposure analyses and noise compatibility planning. It also has been identified by the US Environmental Protection Agency as the principal metric for airport noise analyses. The current federally established residential and other noise-sensitive facilities (e.g., hospitals, places of worship, and schools) compatibility threshold is DNL 65 dBA. FAA land use compatibility guidelines related to aircraft operations are described in Table 1 of Title 14 Code of Federal Regulations Part 150 Section A150.101.

2. BACKGROUND

The following sections describe the history of aircraft noise compatibility planning around Dulles International, changes to the Airport's airfield, changes in FAA air traffic management and procedures, and the evolution of aircraft types and their use at the Airport.

2.1 NOISE COMPATIBILITY PLANNING HISTORY

The Washington Airport Act of 1950 provided for "the construction, protection, operation, and maintenance of a public airport in or in the vicinity of the District of Columbia." This resulted in the construction of Dulles International Airport on a 10,000-acre site, 26 miles west of Washington, DC, that was selected by President Dwight Eisenhower in 1958 upon the completion of a thorough study of possible locations. The size of the site allowed for the establishment of the airport property boundary at least 8,000 feet from the ends of all runways, which provided a buffer between the operational area of the Airport and the Airport's neighbors. Planning for the Airport, in conjunction with the actions of local governments to zone the land around the site to ensure compatibility, helped the Airport to become a good neighbor in the Virginia countryside.

Preservation of the Airport's utility was a primary planning guideline and assumption in the 1985 Master Plan, which was prepared by the FAA, the airport operator at the time. The Master Plan's planning guidelines and assumptions included:

- Preserve Maximum (Five Runway) Airfield Capacity – The FAA recognized that Dulles International was the only airport in the region capable of providing large increases in airfield capacity. For this reason, the site was to be reserved to ensure that the potential long-term air carrier needs of the region would be met.
- Protect Maximum Airport Site Capacity – The FAA recognized the need to plan for and protect the ultimate capability of the Airport site.[3]

As a part of the 1985 Master Plan, the FAA conducted a Federal Aviation Regulations (FAR) Part 150 Noise Compatibility Program (FAR Part 150 Study) for the Airport in 1985 to promote compatibility between community development and aircraft noise. The need for the FAR Part 150 Study arose from "increasing pressures for the development of potentially incompatible land uses in the vicinity of the Airport."[4] At the time, jurisdictions around the Airport, primarily Fairfax and Loudoun Counties, were "interested in integrating Airport development recommendations and its effects with compatible off-Airport land use planning, using the most up-to-date data available."[5] At the time, much of the area surrounding Dulles International was undeveloped; therefore, the emphasis of the FAR Part 150 Study was to ensure existing compatibility was maintained and enhanced in the future.

3 Peat, Marwick, Mitchell & Company Airport Consulting Services, *Washington Dulles International Airport: Master Plan Update Final Technical Report*, 1985.

4 Peat, Marwick, Mitchell & Company Airport Consulting Services, "Noise Compatibility Program for Washington Dulles International Airport," memorandum to Mr. James A. Wilding, Federal Aviation Administration, January 17, 1985, p. 1.

5 Peat, Marwick, Mitchell & Company Airport Consulting Services, "Noise Compatibility Program for Washington Dulles International Airport," memorandum to Mr. James A. Wilding, Federal Aviation Administration, January 17, 1985, p. 2.

As part of the FAR Part 150 Study, representatives of Fairfax and Loudoun Counties requested an updated potential noise contour for long-term land use planning purposes. The updated potential noise contour was based on the possibility of two new runways (a five-runway airfield) as shown on the Airport Layout Plan (ALP), and aircraft activity "that might potentially occur beyond the year 2000."[6] A year was not associated with the potential noise contour, as the FAA did not know when the two new runways would be needed. The potential noise contour was intended to "provide the basis for protecting the Airport against possible encroachment by noise-sensitive land uses and ensuring that future development in the environs [would] be compatible with the Airport if the two runways [were] built."[7] The level of future aircraft operations used to determine the noise contour was based on the effective capacity of the future airfield depicted on the ALP. The effective capacity was measured based on the annual service volume (ASV) of the five-runway airfield.[8] ASV of an airfield represents a reasonable estimate of the runway capacity, accounting for the overall usage patterns over a year; it considers differences in forecast activity levels, runway use, aircraft mix, weather conditions, and other factors that may vary within a single year. ASV represents the approximate number of total operations that the Airport can support in a year, as well as the theoretical capacity or limit of operations that the Airport can safely accommodate at an acceptable level of delay. The methodology to calculate ASV is contained in FAA Advisory Circular 150/5060, *Airport Capacity and Delay*.

The FAR Part 150 Study included development of long-range aircraft noise contours based on the potential use of the airfield with two additional air carrier runways. Loudoun and Fairfax Counties incorporated the long-range noise contours into their respective future land use plans as aircraft noise overlay zoning districts.

On June 7, 1987, Dulles International and Ronald Reagan Washington National Airport (Reagan National Airport) were transferred to MWAA under a 50-year lease, which was authorized by the Metropolitan Washington Airports Act of 1986, Title VI of Public Law 99-500 (amended to extend the term to 80 years or to 2067). Since the transfer, the MWAA has maintained the primary planning goals outlined in the 1985 Master Plan.

Between 1985 and 1993, two separate actions had a direct effect on future aircraft operations and associated noise levels at Dulles International: the FAA's Expanded East Coast Plan (EECP) and the Airport Noise and Capacity Act (ANCA) of 1990. In 1988, the FAA implemented the EECP to address aircraft delays in the New York/New Jersey metropolitan area and to increase air traffic system efficiency in other rapidly growing areas in the Northeast. Implementation of the EECP resulted in revisions to air traffic control routes at the Airport by establishing different departure and arrival flight corridors for aircraft, as well as by raising the altitude ceilings for approach control areas. The EECP also required runway assignment determinations to include the destination or origin city, instead of assigning runways based primarily on airfield locations to provide more efficient use of the airspace. This resulted in runway use changes at Dulles International. In 1990, the US Congress enacted ANCA to address national concerns

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6 Peat, Marwick, Mitchell & Company Airport Consulting Services, *Final Report: FAR Part 150 Noise Compatibility Program, Washington Dulles International Airport*, January 1985, p. 11.

7 Peat, Marwick, Mitchell & Company Airport Consulting Services, *Final Report: FAR Part 150 Noise Compatibility Program, Washington Dulles International Airport*, January 1985, p. 32.

8 Peat, Marwick, Mitchell & Company Airport Consulting Services, *Final Report: FAR Part 150 Noise Compatibility Program, Washington Dulles International Airport*, January 1985, p. 11.

related to aircraft noise. ANCA required the phase-out of louder Stage 2[9] aircraft weighing more than 75,000 pounds by 2000.

In 1993, MWAA updated the forecast and long-range noise contours as an addendum to the 1985 FAR Part 150 Study. The potential number of operations continued to be based on the ASV of the five-runway airfield.[10] Fleet-mix assumptions accounted for the phaseout of the Stage 2 aircraft weighing more than 75,000 pounds; long-term runway use projections were based on updated runway assignment determinations, as a result of EECP; and operation levels by user category (i.e., air carrier, air taxi, general aviation, and military) were adjusted based on moderate increases in air carrier and air taxi operations experienced between 1985 and 1992.[11] In addition, the updated FAR Part 150 Study included evaluation of the potential noise contours with and without preferential nighttime runway use under the future five-runway airfield.

Loudoun and Fairfax Counties used these updated long-range noise contours to define the aircraft noise overlay zoning districts that exist today. Loudoun and Fairfax Counties' Airport Impact Overlay Districts serve as the basis to convey applicable land-use compatibility, disclosure information, and construction requirements for new residential units located near the Airport.[12, 13, 14]

Fairfax County evaluated the noise contour scenarios in the amended FAR Part 150 Study and ratified a composite set of contours based on the greatest extents of each of the DNL 65, 70, and 75 dBA contours. For the DNL 60 dBA contour, Fairfax County selected the contour representing the "Potential with Preferential Nighttime Runway Use" scenario from the amended FAR Part 150 Study, which included the long-term potential level of operations projected at the time of the study (1993) for five runways, and assumed preferred use of Runways 1C, 12L (current Runway 12), 12R and 19C for nighttime arrivals and Runways 1C, 19C, 30L (current Runway 20) and Runway 30R for nighttime departures. The preferential runway use procedure was a noise abatement measure proposed and evaluated during the FAR Part 150 Study process, but the procedure was not submitted to FAA for review and acceptance.

Loudoun County ratified the contours representing the "Potential with Preferential Nighttime Runway Use" noise contours to define its aircraft noise overlay zoning district. In addition, Loudoun County included a 1-mile buffer starting at the DNL 60 dBA contour for purchase disclosure purposes. In 1993, Loudoun County was recognized as a national leader in land-use planning associated with a growing international airport when the county adopted its Airport Impact Overlay District. Other jurisdictions in partnership with a neighboring airport (e.g., City of Portland and Portland International Airport; City of Orlando and Orlando International Airport; City of Mesa and Phoenix-

9 Stage 2 aircraft met the 1969 noise standards established by Title 14 Code of Federal Regulation Section 36.

10 Peat, Marwick, Mitchell & Company Airport Consulting Services, *Addendum: FAR Part 150 Noise Compatibility Program, Washington Dulles International Airport*, March 1993, p. 30.

11 Peat, Marwick, Mitchell & Company Airport Consulting Services, *Addendum: FAR Part 150 Noise Compatibility Program, Washington Dulles International Airport*, March 1993, p. 31.

12 Loudoun County, Virginia, Zoning Ordinance, AI-Airport Impact Overlay District § 4-1400.

13 Fairfax County, Virginia, Zoning Ordinance, Airport Noise Impact Overlay District § 7-400.

14 Fairfax County, *Fairfax County Comprehensive Plan*, "Land Use Planning within the Dulles Airport Noise Impact Area," 2017 ed., March 14, 2017, pp. 19–23.

Mesa Gateway Airport) have followed Loudoun County's lead to ratify long-term potential noise contours to convey disclosure information, land use compatibility, and acoustic requirements inside a home to protect residents from future adverse noise impacts and to safeguard an airport's ability to meet future demand.[15, 16, 17]

2.2 CHANGES IN AIRFIELD LAYOUT

Following the 1993 FAR Part 150 Study Addendum, the location of the proposed third north-south runway (the fourth Airport runway) changed based on the results of capacity studies completed in 2003. The 1985 Master Plan included a third north-south runway located 2,500 feet west of then Runway 1L-19R, which is now Runway 1C-19C. The 2003 capacity studies indicated that the north-south runways (Runways 1L-19R, 1C-19C, and 1R-19L) needed to accommodate triple simultaneous independent operations in both good and bad weather to meet mid- and long-term goals, requiring all three runways to be at least 4,300 feet apart from each other. Therefore, MWAA modified the ALP to reflect proposed Runway 1L-19R located 4,300 feet west of Runway 1C-19C. The FAA prepared an Environmental Impact Statement (EIS) to assess potential significant environmental impacts caused by the proposed improvements and to identify mitigation measures, referred to herein as the 2005 Dulles New Runway EIS. In 2005, the FAA issued the Final EIS and Record of Decision, approving the preferred alternative. Air traffic controller training for simultaneous approach/departure procedures and Air Traffic Control (ATC) terminal and enroute procedures were developed, and the decision to modify and/or develop ATC and airspace management procedures was accepted.[18] The third north-south parallel runway, Runway 1L-19R, was opened on November 20, 2008. The aircraft noise overlay zoning districts used by Loudoun and Fairfax Counties, however, are based on the originally planned location or Runway 1L-19R prior to the 2003 capacity studies. This update study was completed to reflect the current location of Runway 1L-19R.

2.3 CHANGES IN AIR TRAFFIC MANAGEMENT AND PROCEDURES AND AIRCRAFT

In addition to changes in the airfield, changes in airspace procedures have occurred since 1993 taking advantage of Global Positioning System (GPS) technology. The Department of Defense initiated GPS development in 1973 and began employing GPS in 1993. The intent was to reduce reliance on land-based navigation aids and to provide navigational guidance in areas where there are no land-based aids. GPS has become the most popular means of navigation for civil and commercial aircraft. The FAA and airlines began testing GPS technology in the 1990s. By 2000, airlines began installing GPS-based navigation equipment in aircraft, and the FAA began developing flight procedure[19] design criteria for GPS-based routes. GPS, along with Area Navigation (RNAV)[20] and Flight Management

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[15] City of Portland, Oregon, Portland International Airport Noise Impact Zone § 33.470.

[16] City of Orlando, Florida, AN Aircraft Noise Overlay District § 58.370 through § 58.384.

[17] City of Mesa, Arizona, Airfield Overlay District § 11-19. Note that other jurisdictions in the vicinity of Phoenix-Mesa Gateway Airport have also adopted overlays based on noise contours developed by the Phoenix-Mesa Gateway Airport Authority.

[18] US Department of Transportation, Federal Aviation Administration in Cooperation with the US Army Corps of Engineers. *New Runways, Terminal Facilities and Related Facilities at Washington Dulles International Airport – Record of Decision*, October 14, 2005.

[19] "Procedure" is a predefined set of guidance instructions that define a route for a pilot to follow.

[20] RNAV permits aircraft operation on any flight path within the coverage of referenced navigation aids like GPS, distance measuring equipment (DME), and/or very high omnidirectional range (VOR) transmitters. The method relies on navigational aids to provide the lateral position of an aircraft.

Systems (FMS),[21] allows flight paths to be defined with fewer navigational limitations and for aircraft to follow those procedures in a consistent and predictable manner.

In addition to enhanced technologies, air traffic control facility consolidation has changed air navigation. Prior to 1999, air traffic in the Baltimore-Washington metropolitan area was managed by four Terminal Radar Approach Control (TRACON) facilities. In 1999, these were consolidated into one facility—the Potomac TRACON. This consolidation streamlined communication among controllers and removed multiple boundary restrictions, allowing aircraft to descend, climb, and operate on more direct routing in and out of the Baltimore-Washington metropolitan area. Between 2000 and 2003, the FAA conducted an airspace redesign to leverage the facility consolidation to increase air traffic efficiency and to enhance safety. The FAA evaluated changes to aircraft routes and altitudes, but it did not change initial departures or final approach routes within 3 to 5 miles from an airport. The FAA prepared an EIS to assess potential environmental impacts and published the Final EIS for the Potomac Consolidated TRACON Airspace Redesign on January 22, 2003.[22]

As more commercial service aircraft were equipped with GPS-based RNAV and FMS capabilities, the need to implement flight procedures based on GPS navigation became more apparent. In February 2012, US Congress enacted the FAA Modernization and Reform Act of 2012 to modernize the nation's air transportation system. Among other provisions, the act required the implementation of Performance-Based Navigation (PBN) procedures[23] at 35 of the nation's busiest airports, including Dulles International, by June 30, 2015. Accordingly, the FAA proposed to increase the efficiency of the Washington metropolitan area (called the Washington, DC, Metroplex) airspace through the implementation of additional GPS-based RNAV-defined instrument flight procedures (IFPs)[24] that improved upon existing, but less efficient, ground-based and/or radar vector procedures (referred to as conventional procedures).[25]

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[21] Flight Management System (FMS) includes a navigation database, positioning sensors, automatic flight guidance, and a flight management computer. As a system, it references the entered flight path, uses various sensors to determine the aircraft's position, and in automatic flight guidance assists the aircraft along the designated flight path laterally and vertically.

[22] US Department of Transportation, Federal Aviation Administration, *Final Environmental Impact Statement for the Potomac Consolidated TRACON Airspace Redesign*, December 2002.

[23] PBN is an advanced, satellite-enabled form of air navigation in the National Airspace System that creates precise three-dimensional flight paths. Procedures are based on the RNAV method of navigation and the precision requirements to ensure aircraft are within a set distance from the intended route (known as lateral containment); requirements are based on the type of navigation (e.g., satellite or ground-based navigational aid), equipment on the aircraft, and pilot training.

[24] IFPs specify standard routings, maneuvering areas, flight altitudes, and visibility minimums for IFR. These procedures include airways, jet routes, off-airway routes, Standard Instrument Approach Procedures (SIAP(s)), Standard Instrument Departure Procedures/ Departure Procedures (SID(s))/ DP(s)), and Standard Terminal Arrival Routes (STAR(s)).

[25] Conventional procedures are less accurate than PBN procedures because radio signal limitations that can arise between ground-based navigational aids and aircraft due to factors such as terrain. As a result, ground-based navigational aid procedures require large areas of clearance on either side of a route's main path to account for potential obstructions. Furthermore, conventional procedures are dependent on where ground-based navigational aids are located, which can result in less efficient routing. Because conventional procedures are less accurate, the actual location of an aircraft, both laterally and vertically, can be less predictable. The lack of accuracy and predictability requires ATC to use aircraft management tools and coordination techniques, such as speed control, level flight segments, and vectoring, to guide aircraft and provide an additional margin of safety.

The FAA designed multiple arrival and departure procedures for airports located in the Washington metropolitan area. The procedure designs were intended to: improve flexibility in transitioning traffic between the enroute[26] portion of the flight and the airport runways; reduce complexity to maintain separation between arrivals and departures in the airspace; and provide more predictable horizontal and vertical paths. The use of RNAV procedures results in little dispersion along the routes due to the predictable and repeatable nature of the GPS-based navigation technology.

The FAA defined five new GPS-based RNAV Standard Instrument Departures (SIDs)[27] and four GPS-based RNAV Standard Terminal Arrival Routes (STARs)[28] for the Washington, DC, area. This increased the number of such procedures from 8 to 13 for Dulles International. In addition, the STARs included predictable runway transition routes and optimized profile descents to the runways at the Airport.[29] The SIDs did not include RNAV off-the-ground[30] because the air traffic controllers in the Airport Traffic Control Tower (ATCT) preferred to assign routes from the runway to the appropriate SID to maintain diverging departure headings and to provide more direct routing.[31]

In December 2013, the FAA issued a Finding of No Significant Impact and Record of Decision for the Environmental Assessment for the Washington, DC, Optimization of the Airspace and Procedures in the Metroplex; implementation was completed in June 2015. As a result, approximately 1.5 million gallons of fuel are saved annually, at a value of approximately $4.3 million, for all operations at Dulles International, compared with the pre-Metroplex period in 2011, due to a reduction in time, distance, and level of flight between a high-altitude (above 18,000 feet Mean Sea Level) cruise route (enroute) and the Airport (e.g., from start of descent from a high-altitude level cruise route to the

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26 Enroute is the cruise phase of flight above 18,000 feet Mean Sea Level).

27 SID is an instrument-based procedure that provides pilots with defined lateral and vertical guidance to facilitate safe and predictable navigation from an airport through the terminal airspace to a jet route in the enroute airspace). Departing aircraft operating under IFR use this instrument-based procedure. A SID may be based on vectoring, following a route defined by ground-based navigational aids (NAVAIDs) (e.g., Very-High Omnidirectional Beacon [VOR]), or a combination of both. This is called a "conventional" SID. Because of the increased precision inherent in RNAV technology, an RNAV SID, which provides GPS-based navigation, defines a more predictable route through the airspace than does a conventional SID. The portion of a SID that provides a path serving a runway at an airport is referred to as a "runway transition." A SID may have several runway transitions serving one or more runways at one or more airports. From the common segment of the route, guidance may then be provided in the SID to one or more jet routes in the enroute airspace. This is referred to as an "enroute transition."

28 STAR is an instrument-based procedure that defines a route from the enroute airspace to the final approach to a runway. The final approach is the segment of flight when an aircraft is aligned with the landing runway and operates along a straight route at a constant rate of descent to the runway. Arriving aircraft operating under IFR use this instrument-based procedure. A STAR can provide full guidance from enroute airspace through a terminal airspace entry gate, to a commonly used segment of the STAR in the terminal airspace, and then to the final approach to one or more runways at one or more airports. Guidance from the enroute airspace to the terminal airspace is called an "enroute transition"; from the common segment of the STAR in the terminal airspace to the final approach to a runway end, is called a "runway transition." A STAR can provide only partial guidance through the terminal airspace and may not include runway transitions.

29 Department of Transportation, Federal Aviation Administration, *Draft Environmental Assessment for Washington, D.C., Optimization of Airspace and Procedures in the Metroplex*, June 2013, pp. 3–35.

30 "Off-the-ground" RNAV departure procedures define a precise path starting from the runway to the enroute airspace. This type of RNAV design segment will narrow aircraft overflight dispersion over areas near an airport.

31 Nicholson, Tommy, Mitre Corporation, *Washington DC Metroplex Post-Implementation Analysis*, http://maacommunityrelations.com/_media/client/anznoiseupdate/2017/Final_Enc_4_of_4_DC_Metroplex.pdf (accessed April 4, 2018), p. 7.

final approach to a runway or from a runway to a high-altitude level cruise route).[32] Additional benefits beyond individual flight efficiency have also been observed, including: reduced controller/pilot transmissions, reduced complexity for pilots and controllers, and more predictable and repeatable flight paths.[33]

2.4 AIRCRAFT TYPE AND USE EVOLUTION AT THE AIRPORT

Similar to the air traffic system, the types of aircraft operating at Dulles International have evolved. Aircraft performance, noise levels, and emissions have substantially improved since 1993. As fuel prices rose, airlines not only moved toward more efficient aircraft, they also focused more on load factor (i.e., the ratio of the typical number of seats filled on an aircraft to the aircraft's seating capacity) instead of frequency of service. Therefore, to support passenger growth, airlines chose to use larger aircraft instead of adding additional flights. Airplane Design Group (ADG) is an FAA classification of aircraft wingspan and tail height, and it is a direct indictor of the size of an aircraft.[34] **Table 2-1** presents dimensions and example aircraft for each ADG category. **Exhibit 2-1** depicts the change in the percentage use by ADG at the Airport since 2010, based on data reported by the FAA.[35]

2.5 STAKEHOLDER INPUT

A Working Group kick-off meeting was held on April 8, 2018. At this meeting, Working Group members were briefed on the purpose of the study, the important role Dulles International plays in the local and regional economy, the history and tradition of using a long-term noise contour for land use compatibility planning around Dulles International, and changes to the aviation environment since the last long-term noise contour was developed in 1993. A copy of the presentation is provided in **Appendix A**.

Working Group members did not indicate any concerns related to the purpose of the study. The following topics were discussed at this meeting:

- Following Working Group member inquiries regarding FAA's proposed Triple Simultaneous Parallel Approach and FAA NextGen program, members were briefed on triple simultaneous parallel approaches for Dulles International and were provided a link to FAA NextGen program website.
- The Working Group was informed that future noise model flight tracks would be developed based on FAA input and expectations related to planned NextGen program implementation at Dulles International.
- The Working Group was also briefed on the DNL metric and provided a general overview of FAA's noise model. The Working Group asked about FAA's efforts to evaluate the appropriateness of current policy of using and applying the DNL metric. They were provided an overview of FAA's current efforts and were informed that no changes to current policy were expected within the timeframe of the study.

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[32] Nicholson, Tommy, Mitre Corporation, *Washington DC Metroplex Post-Implementation Analysis*, http://maacommunityrelations.com/_media/client/anznoiseupdate/2017/Final_Enc_4_of_4_DC_Metroplex.pdf (accessed April 4, 2018), p. 11.

[33] Nicholson, Tommy, Mitre Corporation, *Washington DC Metroplex Post-Implementation Analysis*, http://maacommunityrelations.com/_media/client/anznoiseupdate/2017/Final_Enc_4_of_4_DC_Metroplex.pdf (accessed April 4, 2018), pp. 17–18.

[34] The longer the wingspan, the larger the aircraft. The smallest ADG is ADG I (less than 49 feed), and the longest is ADG VI (between 214 feet and less than 262 feet).

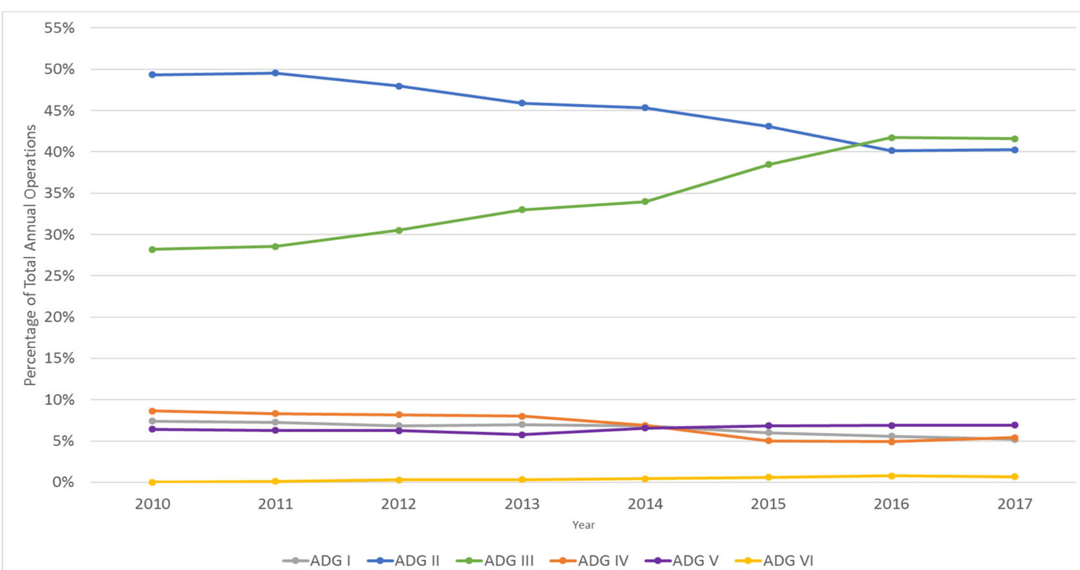
[35] US Department of Transportation, Federal Aviation Administration, "Traffic Flow Management System Counts: Airport View," https://aspm.faa.gov/tfms/sys/Airport.asp (accessed April 16, 2018).

TABLE 2-1 TYPICAL AIRPLANE DESIGN GROUP AIRCRAFT

AIRPLANE DESIGN GROUP (ADG)	WINGSPAN (FT)	TAIL HEIGHT (FT)	TYPICAL AIRCRAFT TYPES AT DULLES INTERNATIONAL[1]
ADG I	Less than 49	Less than 20	Beech Bonanza 36, Beech King Air 90, Beechjet 400, Cessna Citation CJ1/2, Embraer Phenom 100, Learjet 35/45/55/60
ADG II	49 to less than 79	20 to less than 30	Bombardier CRJ-200/700, Bombardier Challenger 300/600/601/604, Cessna 208 Caravan, Cessna Citation Sovereign, Cessna Excel, Embraer ERJ-135/145, Gulfstream III/IV, Pilatus PC-12
ADG III	79 to less than 118	30 to less than 45	Airbus 319/320, Boeing 717, Boeing 737-700/800/900, Boeing MD-88, Bombardier BD-700 Global Express, Bombardier CRJ-900, Bombardier DHC8-200, Bombardier Q400, Embraer ERJ-175/190, Gulfstream V/VI
ADG IV	118 to less than 171	45 to less than 60	Airbus 300-600, Airbus 310, Boeing 757-200/300, Boeing 767-200/300/400, Boeing DC-10, Boeing MD-11
ADG V	171 to less than 214	60 to less than 66	Airbus 330-200/300, Airbus 340-300/600, Boeing 747-400, Boeing 777-200/300, Boeing 787-800/900
ADG VI	214 to less than 262	66 to less than 80	Airbus A380, Antonov AN-124, Boeing 747-800

NOTE:
1 Typical aircraft type at the Airport were based on the FAA's Traffic Flow Management System Counts report for 2017, which are grouped by ADG type and equipment type.
SOURCE: Ricondo & Associates, Inc., April 2018.

EXHIBIT 2-1 PERCENTAGE OF TOTAL ANNUAL OPERATIONS BY AIRPLANE DESIGN GROUP TYPE FROM 2010 TO 2017



NOTE: ADG – Airplane Design Group
SOURCE: Federal Aviation Administration, https://aspm.faa.gov/tfms/sys/Airport.asp (accessed April 16, 2018).

- The Working Group was informed that future aircraft would be based on current airline aircraft orders and public news releases related to aircraft retirements.
- Members from Loudoun and Fairfax County shared current efforts related to land use plans and emphasized urgency to complete the update as soon as possible.
- The planned process and timeline to update the noise contour map was shared with the Working Group.

3. INVENTORY

The purpose of the inventory was to collect and document the information required for the FAA's Aviation Environmental Design Tool (AEDT) noise model, as well as to provide a general understanding of Dulles International's ability to accommodate current and future demand. The inventory provides an overview of the existing airfield, Airport facilities, and air traffic system, which are critical elements to modeling aircraft noise exposure.

This section also provides a summary of planned airfield and FAA air traffic management improvements, as well as the potential to serve future air service needs based on available acreage within the Airport boundary. The inventory includes an evaluation of the most recent full year of data from MWAA's Airport Noise and Operations Monitoring System (ANOMS) to quantify existing average annual day (AAD) operations at Dulles International. Finally, this section depicts generalized land use and zoning within Loudoun and Fairfax Counties and summarizes protections related to aircraft noise within each county. The existing land use served as a basemap for the updated noise contour maps and may be used for consideration in ongoing land use planning in the vicinity of Dulles International.

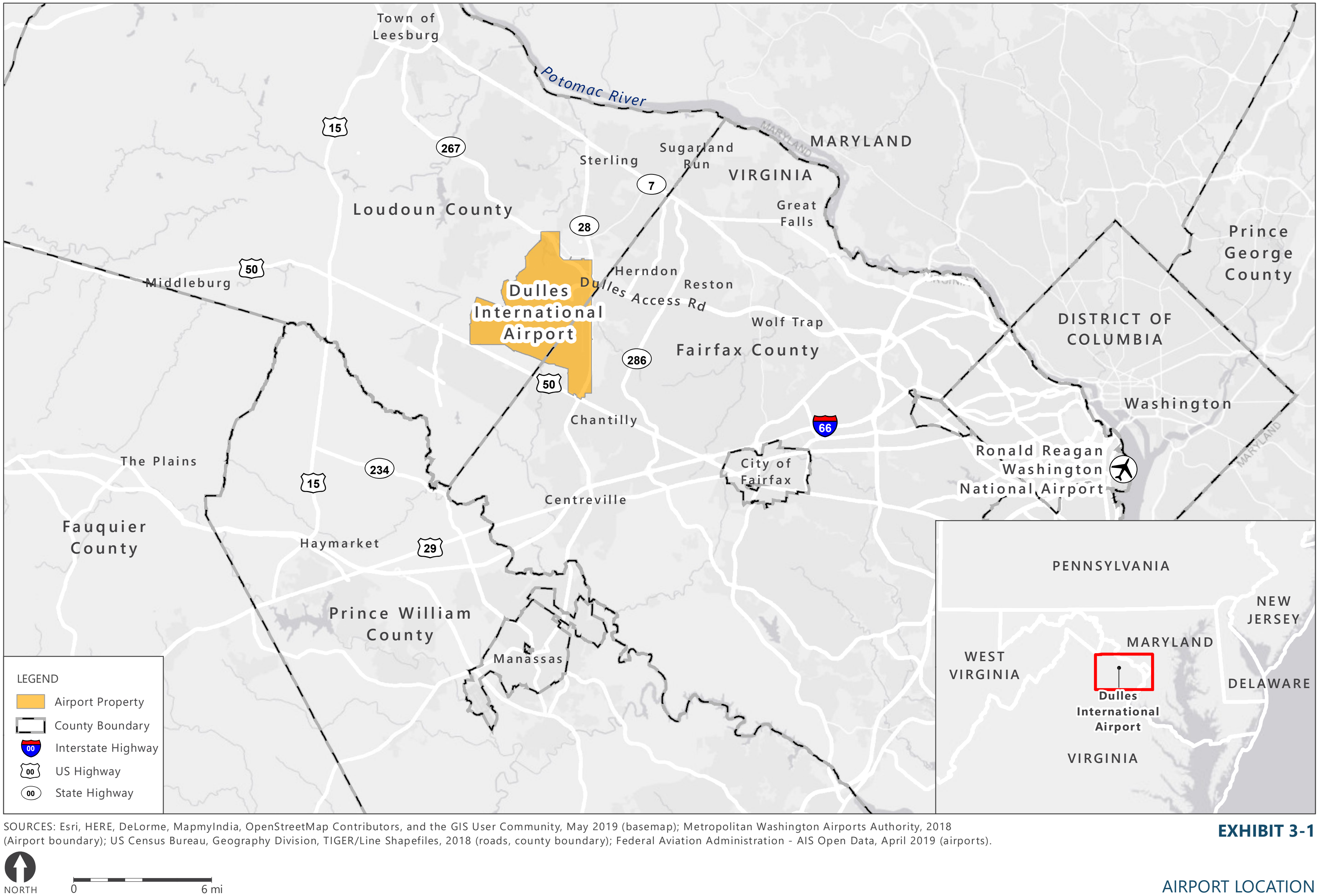
3.1 WASHINGTON DULLES INTERNATIONAL AIRPORT

Dulles International is one of three major commercial airports serving the greater Washington, DC, area. As presented on **Exhibit 3-1**, the Airport is located approximately 26 miles west of Washington, DC, in Fairfax and Loudoun Counties, Virginia, north of US Route 50, south and west of the Potomac River, west of State Route 286, and east of US Highway 15.

Dulles International and its immediate environs are shown on **Exhibit 3-2**. The Airport is located on approximately 11,800 acres of land, with approximately 5,000 acres utilized for aircraft operations. The Airport is connected to the region's highway system via the MWAA-operated, 16-mile Airport Access Highway dedicated to Airport users, named the Dulles Airport Access Road. A 23-mile extension of the Washington, DC, Metrorail system's Silver Line, which includes a station at Dulles International, is under construction and is anticipated to become operational in 2020. The extension is called the Dulles Corridor Metrorail Project and is discussed further in Section 3.1.1.

3.1.1 AIRPORT HISTORY

For 21 years beginning in 1941, National Airport (now Ronald Reagan Washington National Airport) was the only airport serving the Washington, DC, area. The US Congress passed the Washington Airport Act of 1950 to meet the growing demand for airport capacity near the nation's capital following World War II. In 1958, President Dwight D. Eisenhower selected a site to construct Dulles International, named after President Eisenhower's Secretary of State, John Foster Dulles. The Airport opened in 1962. Dulles International was the first airport in the country to be originally designed for commercial jets. Another unique feature of the Airport was specially designed mobile lounges, which were used to transport passengers from the terminal building to their aircraft on the jet ramp. The mobile lounges, each accommodated up to 102 passengers, protected passengers from weather, jet noise, and jet blast, and provided access to the concourses and Airport gates without long walking distances.



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); Metropolitan Washington Airports Authority, 2018 (Airport boundary); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (roads, county boundary); Federal Aviation Administration - AIS Open Data, April 2019 (airports).

EXHIBIT 3-1

AIRPORT LOCATION

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-1_AirportLocation_20190529.mxd

SOURCES: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. March 2018 (aerial imagery); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, runways).

EXHIBIT 3-2

NORTH 0 4,500 ft

WASHINGTON DULLES INTERNATIONAL AIRPORT AND IMMEDIATE ENVIRONS

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-2_ImmediateEnvirons_20190529.mxd

MWAA completed a comprehensive capital program called the Dulles Development Program (D2) to construct major improvements, for which the FAA had prepared the 2005 Dulles New Runway EIS and approved the program in the 2005 Record of Decision. The improvements included construction of a fourth runway (Runway 01L-19R) and connecting taxiways, new air cargo buildings, Main Terminal improvements and Z-gate additions, an AeroTrain people mover system to replace the mobile lounges, additional parking garages and lots, a new ATCT, rehabilitation of Concourses C and D, expansions of the International Arrivals Building (IAB), new jet ramps, and new Concourse B-gates.[36]

MWAA is currently constructing a 23-mile extension of Washington's existing Metrorail System, called the Dulles Corridor Metrorail Project. Phase 1 was completed in July 2014, and connects East Falls Church with Tysons Corner and Reston, Virginia's largest employment centers, with downtown Washington, DC, and Largo, Maryland. The line is called the Silver Line. Phase 2 is underway and will extend the Silver Line from the Reston Town Center to Ashburn in eastern Loudoun County. Phase 2 includes the Dulles Airport Station, which is currently under construction.

3.1.2 AIRPORT'S AVIATION ROLE

Dulles International is a primary,[37] large-hub airport.[38] In 2017, the Airport served 22.7 million total passengers: approximately 66 percent of those passengers were domestic travelers and approximately 34 percent of those passengers were international travelers.[39] Dulles International is a connecting hub and international gateway for United Airlines. The Airport's economic base, geographic location, and role as a hub for United Airlines enable Dulles International to serve as the greater Washington, DC, area's international gateway. As a large-hub airport, Dulles International is critical to the national transportation system and contributes to a productive national economy and the nation's international competitiveness.

The Airport's commercial operations serve US destinations (domestic) and international destinations in North and South America, Europe, Asia, and Africa. As of June 2018, the Airport is served by 7 domestic airlines (Alaska/Virgin America, American Airlines, Delta Air Lines, Frontier Airlines, JetBlue Airways, Southwest Airlines, and United Airlines), 33 foreign-flag airlines, and 4 all-cargo airlines. As of June 2018, the Airport served 135 nonstop markets (cities): 78 domestic and 57 international. The Airport's domestic and international service markets are shown on **Exhibits 3-3** and **3-4**, respectively.

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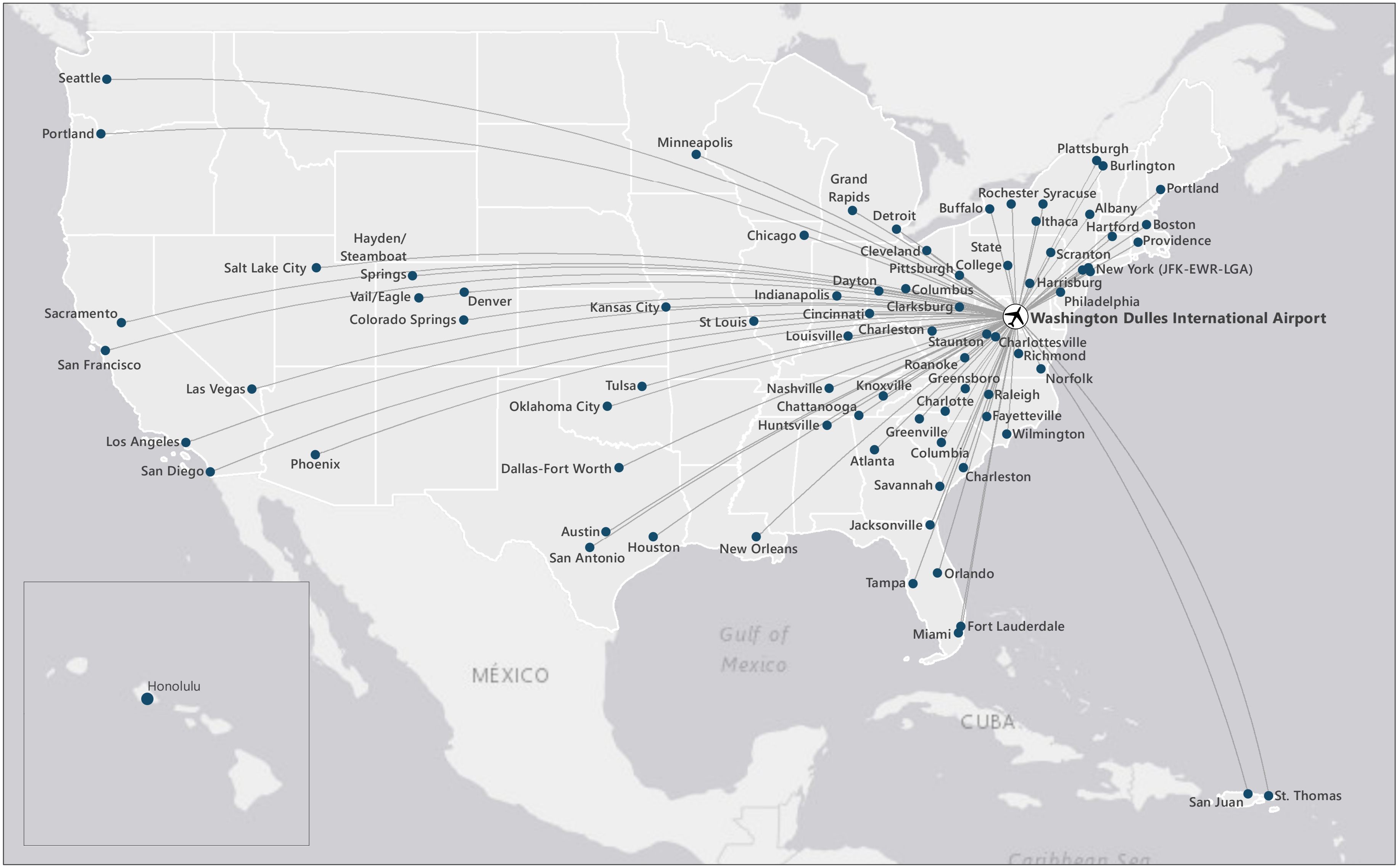
[36] Washington Dulles International Airport, "History of Washington Dulles International Airport," http://www.flydulles.com/iad/history (accessed May 2018).

[37] Primary airports are defined as public airports receiving scheduled air carrier service with 10,000 or more enplaned passengers per year. Primary airports are grouped into four categories: large, medium, small, and nonhub.

[38] Large hub airports are defined by FAA as public airports that serve over 1.0 percent of the annual passengers in the United States.

[39] Metropolitan Washington Airports Authority, "Dulles Air Traffic Statistics," http://www.mwaa.com/about/dulles-air-traffic-statistics (accessed May 14, 2018).



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); Diio, LLC., Diio Mi Schedule Dynamic Table Report, June 2018; OpenFlights.org, June 2018 (routes and airports); US Census, Geography Division, TIGER/Line Shapefiles, 2018 (state boundary).

EXHIBIT 3-3

NORTH

0 500 mi

EXISTING NONSTOP DOMESTIC SERVICE ROUTES

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-3_DomesticDestinations_20190529.mxd

SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); Dii, LLC., Diio Mi Schedule Dynamic Table Report, June 2018; OpenFlights.org, June 2018 (routes and airports).

EXHIBIT 3-4

NORTH

0 1,250 mi

EXISTING NONSTOP INTERNATIONAL SERVICE ROUTES

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-4_InternationalDestinations_20190529.mxd

The Regional Plan Association identified 11 megaregions in the United States. Megaregions represent large networks of metropolitan areas where the majority of population growth by mid-century is anticipated to occur. The Washington, DC, area is part of the critical Northeast Megaregion.[40] Dulles International is one of the major airports within the Northeast Megaregion. The Airport's location within the megaregion enables it to serve current passenger and cargo aviation demand within the region, and the size of the Airport allows for the development of additional facilities to accommodate increased demand.

Locally, Dulles International is an important component of the economy. It is a large employer, and it is the international gateway for the surrounding communities. The 2015 Washington-Baltimore Regional Air Passenger Survey found that 74 percent of Dulles International's passengers were from the Virginia suburbs and the District of Columbia.[41] **Exhibit 3-5** shows the concentration of originating passengers from these jurisdictions surrounding Dulles International.

3.1.3 AIRPORT FACILITIES OVERVIEW

Exhibit 3-6 depicts an aerial image of Dulles International with major facilities identified. Major facilities associated with the airfield, air service facilities, and future development are discussed in the following subsections.

3.1.3.1 AIRFIELD

Runways

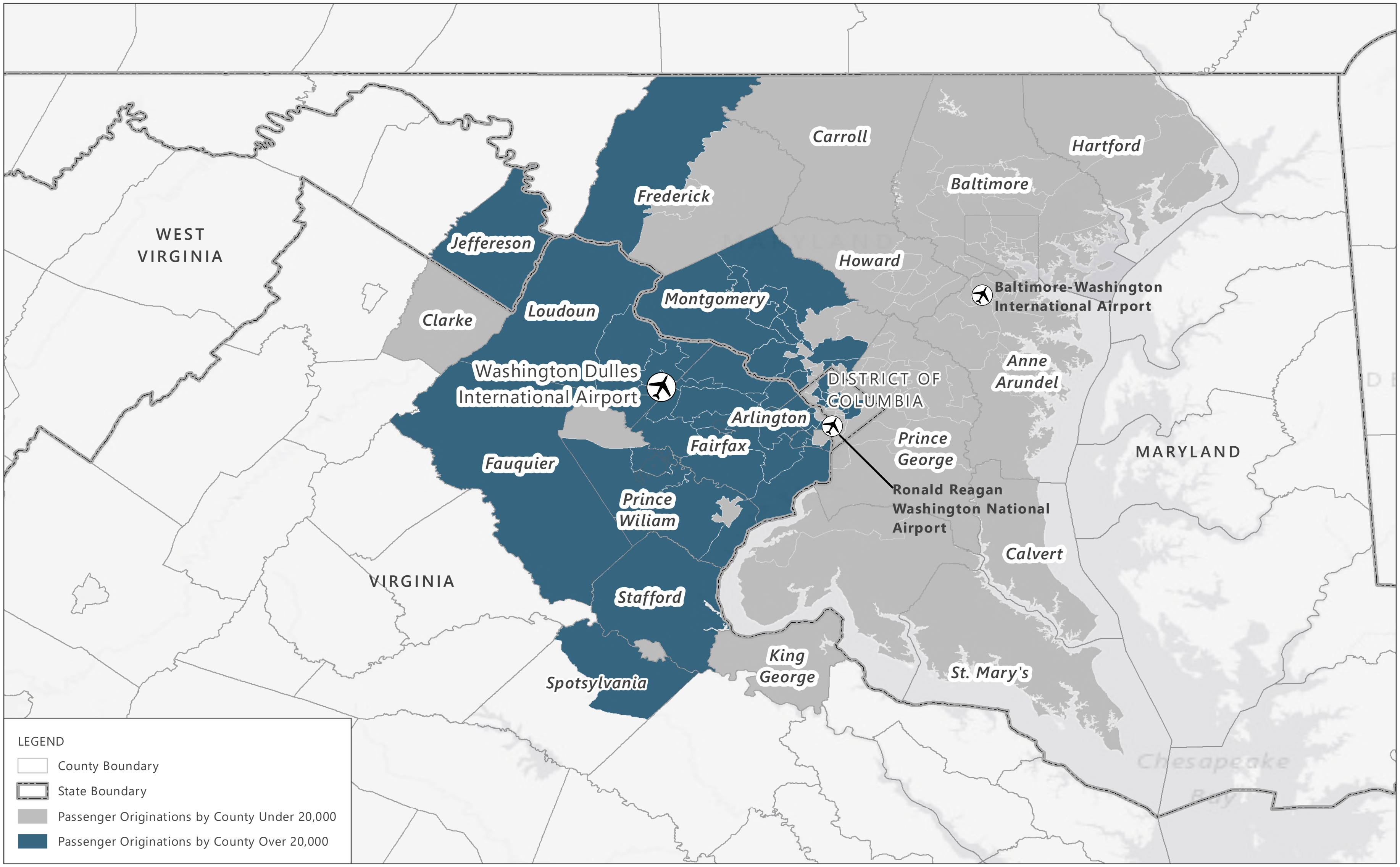
As shown on Exhibit 3-6, Dulles International has four runways: Runway 1L-19R (9,400 feet long), Runway 1C-19C (11,500 feet long), Runway 1R-19L (11,500 feet long), and Runway 12-30 (10,500 feet long). All runways are capable of accommodating ADG VI aircraft (e.g., Airbus A380, Boeing 747-800). Runway 12-30 was reconstructed in 2004 to accommodate heavier aircraft than those estimated in the original design. Runway 1L-19R was constructed in 2008. The ALP includes a future 10,500-foot-long, 150-foot-wide fifth runway, parallel to and south of existing Runway 12-30.[42]

Table 3-1 summarizes runway dimension and service capability data.

[40] America 2050 Regional Plan Association, "Megaregions," http://www.america2050.org/content/megaregions.html#more (accessed June 2018).

[41] National Capital Region Transportation Planning Board, "Washington-Baltimore Regional Air Passenger Survey Geographic Findings – 2015," November 2016.

[42] Metropolitan Washington Airports Authority, "Dulles Development Projects," http://www.mwaa.com/business/dulles-international-airport-capital-improvements (accessed June 2018).



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); National Capital Region Transportation Planning Board, Washington-Baltimore Region Air Passenger Survey, 2015 (data); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county and state boundary); Federal Aviation Administration - AIS Open Data, April 2019 (airports).

NORTH 0 25 mi

EXHIBIT 3-5

2015 ANNUAL ORIGINATIONS AT WASHINGTON DULLES INTERNATIONAL AIRPORT

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-5_AnnualOriginations_20190529.mxd

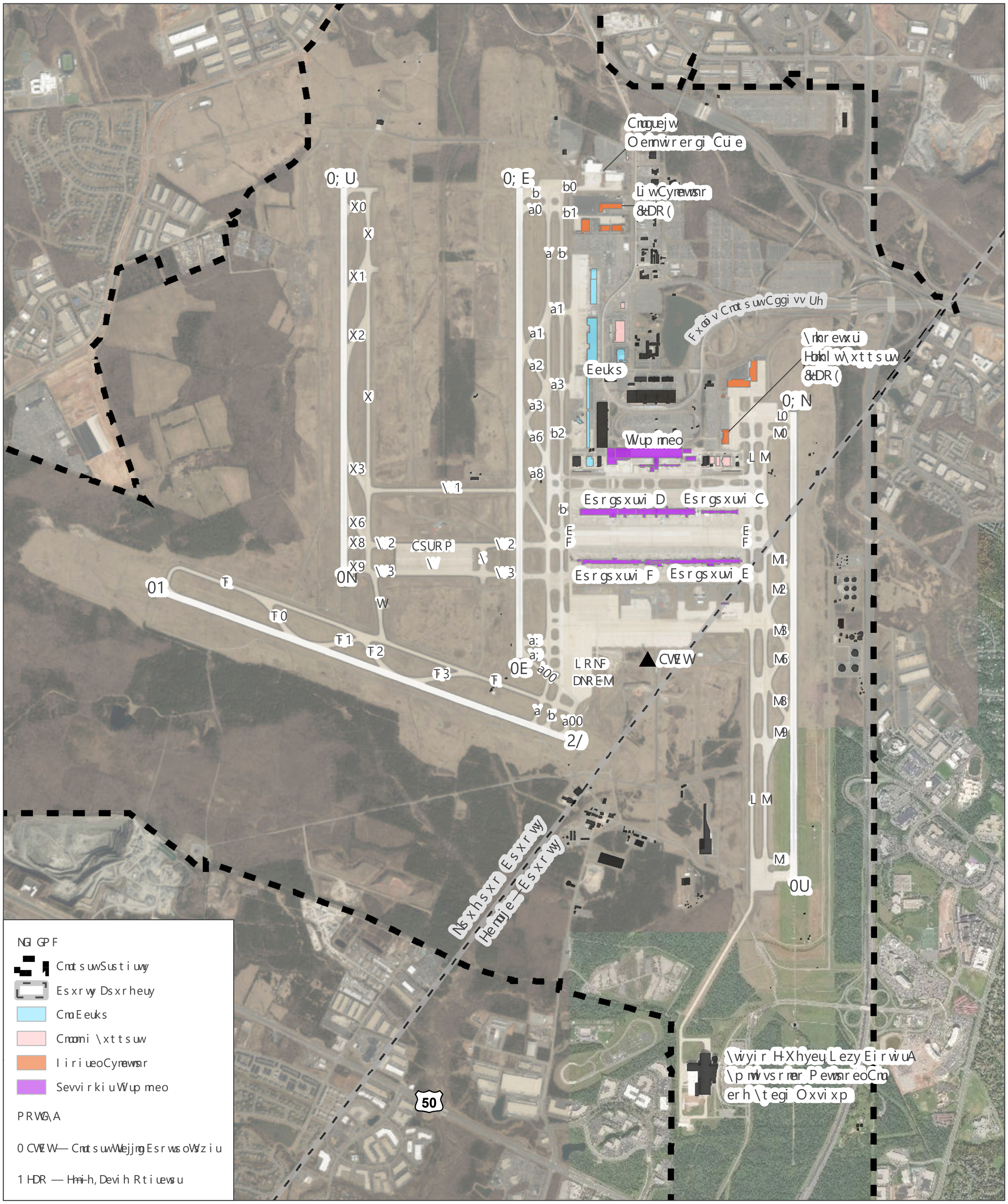


EXHIBIT 3-6

TABLE 3-1 DULLES INTERNATIONAL RUNWAYS

	RUNWAY END							
	1L	19R	1C	19C	1R	19L	12	30
Length (ft)	9,400	9,400	11,500	11,500	11,500	11,500	10,501	10,501
Width (ft)	150	150	150	150	150	150	150	150
Service Date	2008	2008	1962	1962	1962	1962	1962	1962
Latitude	38-56.698000N	38-58.246408N	38-56.343987N	38-58.238443N	38-55.425433N	38-57.319750N	38-56.626333N	38-56.016617N
Longitude	077-28.488585W	077-28.466375W	077-27.586652W	077-27.559087W	077-26.187033W	077-26.158767W	077-29.426650W	077-27.353883W
Approach Aids								
ILS	CAT III	CAT III	CAT II	CAT III	CAT III	CAT II	ILS or LOC/DME	No
PAPI	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RNAV/GPS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Runway End Elevations (ft MSL)	296.0	276.9	286.1	268.7	311.7	293.2	309.8	287.8
Approach Lights	ALSF2	ALSF2	MALSR	ALSF2	ALSF2	MALSR	MALSR	No
Runway Lighting	HIRL	HIRL	HIRL	HIRL	HIRL	HIRL	HIRL	HIRL
Runway Marking	Precision	Precision	Precision	Precision	Precision	Precision	Precision	Precision

NOTES:
ALSF2 – Approach Lighting System with Sequenced Flashing Lights in ILS CAT-II Configuration
CAT – Category level of a precision for a final approach
DME – Distance Measuring Equipment
HIRL – High Intensity Runway Edge Lights
ILS – Instrument Landing System
LOC – Localizer
MALSR – Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights
MSL – Mean Sea Level
PAPI – Precision Approach Path Indicators
RNAV/GPS – Area Navigation / Global Positioning System
SOURCES: Washington Dulles International Airport, Virginia Airport Layout Plan, July 27, 2016; Federal Aviation Administration, Instrument Flight Procedure Information Gateway, https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/application/?event=procedure.results&nasrId=IAD#searchResultsTop (accessed May 2018); Federal Aviation Administration, Airport/Facility Directory Dulles, https://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/dafd/search/advanced/ (accessed May 2018).

Exhibit 3-7 depicts the North Flow runway operating configuration. When the Dulles International ATCT is operating the Airport in North Flow, the preferred departure runways are 1R and 30, and the preferred arrival runways are 1C and 1R. **Exhibit 3-8** depicts the South Flow runway operating configuration. When ATCT is operating the Airport in South Flow, the preferred departure runways are 19L and 30, and the preferred arrival runways are 19L and 19C. Secondary runways are utilized as needed, when required by operation levels.[43]

Taxiways

A network of taxiways serves the airfield at Dulles International. Each runway has a series of high-speed turnoffs to allow aircraft to exit the runway at a high speed for higher runway utilization rates.

Taxiways A, B, C, D, E, and F are crossfield taxiways. Taxilanes A and B serve Z gates and Concourses A and B gates, while Taxilanes C and D serve Concourses A, B, C, and D gates. Taxilane E serves Concourses C and D gates. Taxiways J and K are full-length parallel taxiways to Runway 1R-19L; they provide access to the eastern side of the terminal and concourses and the east general aviation ramp for the Signature Fixed Base Operator (FBO) facility. Taxiways Y and Z are full-length parallel taxiways to Runway 1C-19C; they provide access to the western side of the terminal and concourses, the west general aviation ramp to Jet Aviation FBO, and the cargo terminals. Taxiway U is a full-length parallel taxiway to Runway 1L-19R, and Taxiway Q is a full-length parallel taxiway to Runway 12-30. Taxiways W2, W3, and W4 were built at the time Runway 1R-19L was constructed to provide access to and from the runway.

Navigational Aids

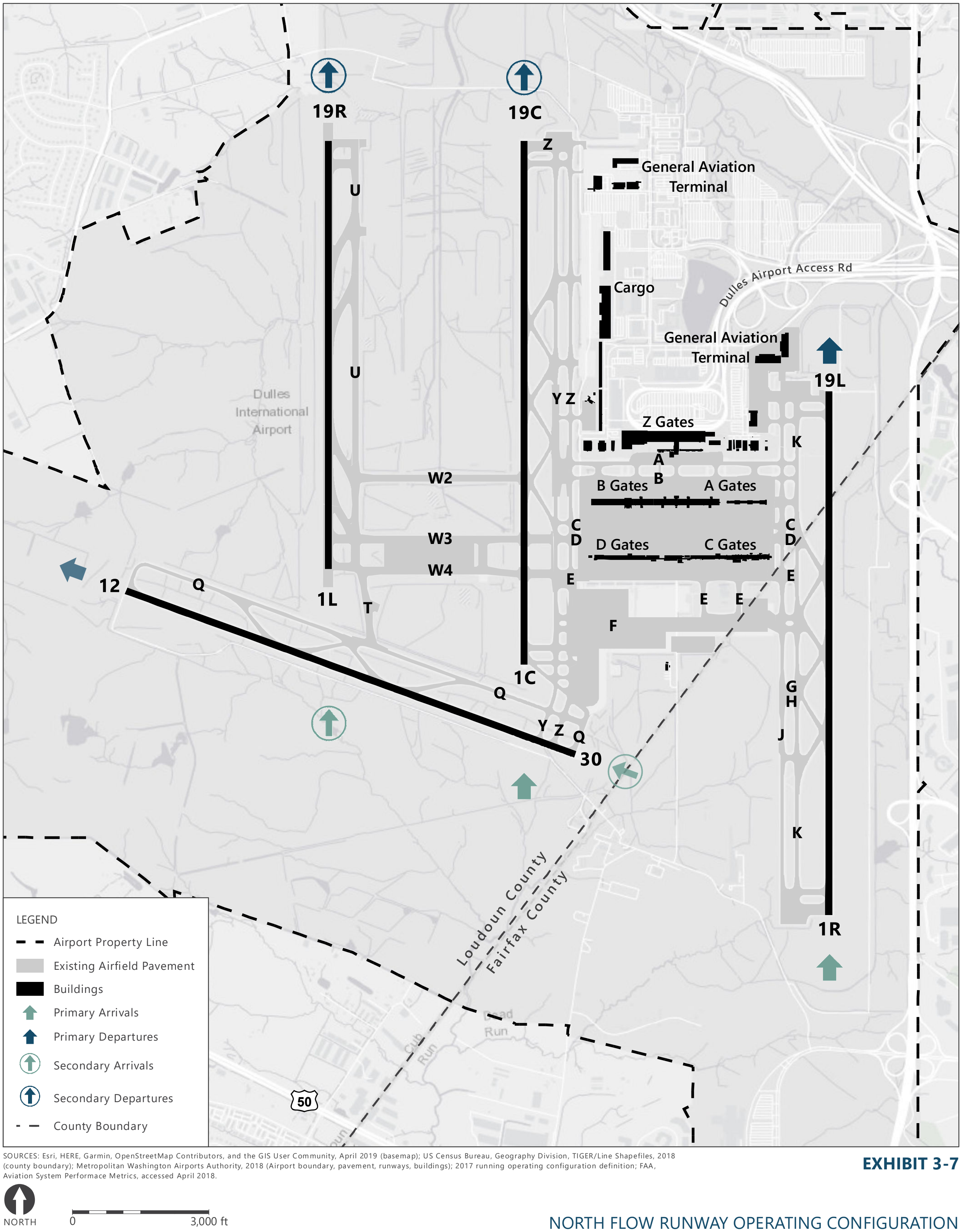
The Airport is equipped with a variety of navigational aids, airfield lighting, and airfield markings to assist pilots in safely navigating to the Airport runways during nighttime and inclement weather conditions. The approach aids that serve Dulles International are summarized in Table 2-1 and described in more detail below.

Instrument Landing System (ILS) – An ILS is a type of precision ground-based electronic landing navigational aid that has been in use in the United States for more than 50 years. An ILS guides pilots to runways during periods of limited visibility or inclement weather. An ILS has several components, including:

- localizer (LOC) antenna that provides lateral course guidance to the runway along an extended centerline;
- glide slope (GS) antenna that provides vertical descent course guidance typically along a 3-degree angle;
- marker beacons along the extended runway centerline to mark key points along the approach; and
- approach lighting system to aid pilots in locating the runway.

Non-precision LOC instrument approach procedures are often available when a GS is not installed or not functioning. A LOC approach provides lateral guidance along the extended runway centerline to a runway, and it indicates if an aircraft on the approach is left or right of the centerline.

[43] Washington Dulles International Airport, *Noise Contour Map Update*, April 4, 2018.



SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); 2017 running operating configuration definition; FAA, Aviation System Performace Metrics, accessed April 2018.

EXHIBIT 3-7

NORTH FLOW RUNWAY OPERATING CONFIGURATION

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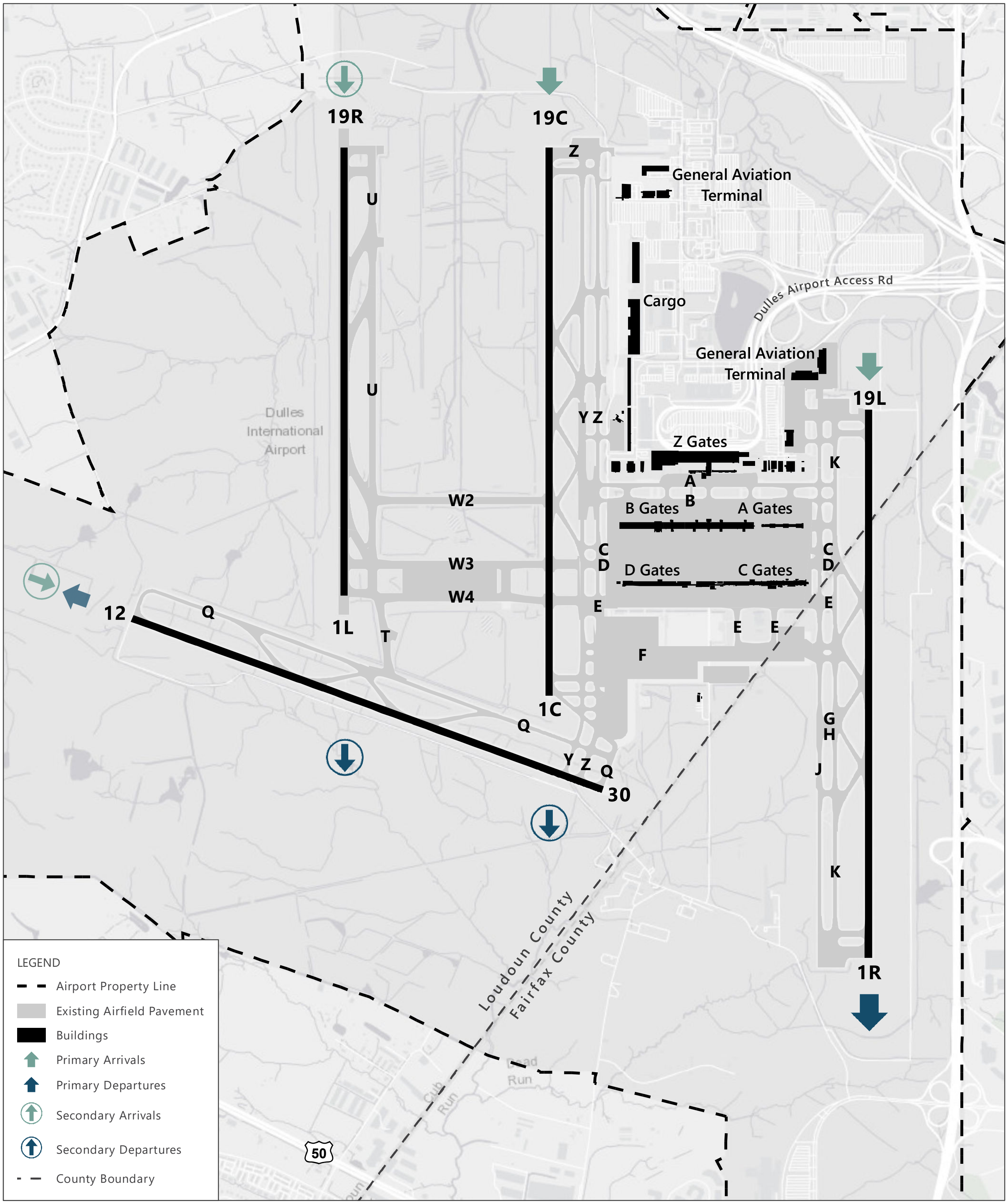

SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); 2017 running operating configuration definition; FAA, Aviation System Performace Metrics, accessed April 2018.

NORTH 0 3,000 ft

EXHIBIT 3-8

SOUTH FLOW RUNWAY OPERATING CONFIGURATION

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-8_SouthFlowRwyOperatingConfiguration_20190530.mxd

Precision Approach Path Indicator (PAPI) – PAPIs are lights located on the left side of the landing runway that give pilots a more precise indication of the approach path of the aircraft. The series of lights indicate if an aircraft is above, at, or below a designated descent path to the runway's landing threshold.

Global Positioning System – The GPS, operated by the Department of Defense, uses a network of satellites with known reference points to enable aircraft equipped with GPS receivers to determine their latitude, longitude, and altitude. GPS systems can be used during all phases of flight.

Area Navigation – RNAV is a method of IFR navigation that permits aircraft operation on any desired flight path using the combination of GPS and an aircraft's FMS. Approach procedures and terminal procedures, including departure procedures and standard terminal arrivals, are designed using RNAV to reduce dependency on ground-based navigation and ATC vectoring.

3.1.3.2 AIR SERVICES FACILITIES

Terminals and Concourses

The Airport's passenger terminal complex consists of the Main Terminal and four midfield concourses (Concourses A, B, C, and D), which can be reached via an automated people mover (AeroTrain) and Mobile Lounges. The AeroTrain was completed in January 2010; it replaced a majority of the mobile lounge system that was originally used to transport passengers between the Main Terminal and the midfield concourses. Mobile lounges continue to be used to Concourse D and for all international arrivals from Concourse B. The Main Terminal includes four permanent passenger loading bridge-equipped aircraft gates, referred to as the Z Gates. Adjacent to the Main Terminal on the westside is the IAB, which was expanded in 2011. All passenger check-in, security screening, and baggage claim functions are accommodated in the Main Terminal. Concourses A and B are connected and located south of the Main Terminal. Concourses C and D, the most southern passenger terminal facilities at Dulles International, were constructed as separate buildings, but as passenger demand increased, more gates were constructed at both concourses, and the two concourses eventually were joined. Processing of international arrivals is accommodated at both the IAB and the Concourse C Federal Inspection Services (FIS) facility. The Main Terminal building was designed by architect Eero Saarinen, and the terminal building was selected for a First Honor Award by the American Institute of Architects in 1966. As such, the Main Terminal at the Airport is eligible for listing on the National Register of Historic Places.

Surface Transportation

Ground transportation to Dulles International is provided via private automobile, taxi, transportation network companies (such as Uber and Lyft), shared van services, and livery vehicles, as well as direct bus transportation from the Airport's Terminal to the Wiehle-Reston East Metrorail Station on Metrorail's Silver Line. Metrorail service to the Airport from the Washington, DC, metropolitan area is anticipated to become operational in 2020, following the completion of the Dulles Corridor Metrorail Project.

As of 2017, 23,108 public parking spaces were available at the Airport, with 14,455 surface spaces (including 173 for-hire vehicle spaces), 8,325 garage spaces (including 8 electric car charging stations), and 328 cell phone waiting area spaces. In addition, there are approximately 6,500 employee surface parking spaces.[44]

Cargo

Cargo activity at Dulles International is dominated by United Airlines (belly cargo) and Federal Express (FedEx; an integrated cargo carrier); together, they handled 52.2 percent of the cargo weight in 2017. Third-ranking United Parcel Service (UPS; an integrated cargo carrier) accounted for 5.6 percent of the total cargo weight in 2017. All-cargo airlines serving the Airport's service region operate at Dulles International and Baltimore/Washington International Thurgood Marshall Airport (BWI Marshall). Only cargo carried in the baggage compartments of passenger aircraft may utilize Reagan National Airport. Dulles International ranked 13th among US airports in terms of international cargo weight for the 12 months ending September 30, 2017.[45] Dulles International features 6 cargo buildings, with a total of approximately 550,000 square feet of cargo space, and offers competitive landing weights and fuel prices, a cooperative work environment with local stakeholders, such as government and economic development agencies, a promotional cooperative program for airlines, a catchment area that covers the entire East Coast within a one-day drive, an extensive direct international network, and a Freighter Incentive Program.

Fixed-Base Operators

Jet Aviation and Signature Flight Support provide general aviation and business services at the Airport. Signature Flight Support has an approximately 57,000-square-foot facility on the east side of the Airport, and Jet Aviation has an approximately 75,000-square-foot facility north of the Main Terminal on the west side of the Airport property.

Aircraft Maintenace Operations

United Airlines has a maintenance facility located on the north end of the airfield on land leased from MWAA. The maintenance facility includes an aircraft maintenance hangar of sufficient size to accommodate two Boeing 767 aircraft or a single Boeing 787 or Airbus 350 aircraft.

Other Airport Facilities

In 2003, the Smithsonian Institution opened the National Air and Space Museum, Steven F. Udvar-Hazy Center (the Center) at Dulles International. The Smithsonian Institution constructed two roadways to access the Center. MWAA has title to, and is required to maintain, these roadways and must allow patrons ingress to and egress from the Center. As seen on Exhibit 3-6, a taxiway on the airfield also connects the Center to the airfield.

[44] Metropolitan Washington Airports Authority, *Airport System Revenue and Refunding Bonds Series 2017A Operating Statement*, October 1, 2017.

[45] US Department of Transportation, T-100, May 2018.

3.1.3.3 FUTURE/PLANNED AIRFIELD AND AIRPORT FACILITIES

The Airport's 2015–2024 Capital Construction Program for Dulles International[46] includes:

- The replacement of deteriorated airfield pavement.
- The construction of additional domestic gates—up to six additional gates will be constructed, when required, for increased domestic airline operations.
- Improvements to the capacity of the Main Terminal and IAB, including improvement to the baggage handling systems and enhancement of the capacity of the IAB.
- Upgrades to utilities and systems at Concourses A, B, C, and D, including replacement of electrical equipment and other utility systems.
- Major maintenance of the AeroTrain system.
- Rehabilitation of the mobile lounge fleet.
- Reconstruction of sections of the Dulles Airport Access Road.
- Upgrades to utility systems and other infrastructure.

The FAA approved the Master Plan for Dulles International in 1985[47] and issued a Record of Decision on the 2005 Dulles New Runway EIS (prepared to comply with the National Environmental Policy Act [NEPA]) for additional runways and airfield improvements in 2005.[48] The future fifth runway and airfield improvements are depicted on the FAA-approved ALP dated July 2016. Operational needs will trigger the construction of the remaining projects not yet implemented. **Exhibit 3-9** depicts those projects included on the current ALP, which include the following:

- construction of a fifth runway parallel to Runway 12-30 and taxiways and holding aprons associated with the runway (runway dimension and service capability data are summarized in **Table 3-2**)
- construction of two additional east/west taxiways between Runways 1L-19R and 1C-19C on the northside of the airfield
- construction of a taxiway west of Runway 1L-19R connected to new holding aprons
- construction of a permanent Tier Two concourse
- construction of Tier Three and Tier Four concourses
- construction of the South Terminal with associated roadway access to the terminal
- expansion of the AeroTrain to connect from the Main Terminal, concourses, and South Terminal
- expansion of automobile parking facilities
- construction of additional roads on Airport land
- expansion of existing roads

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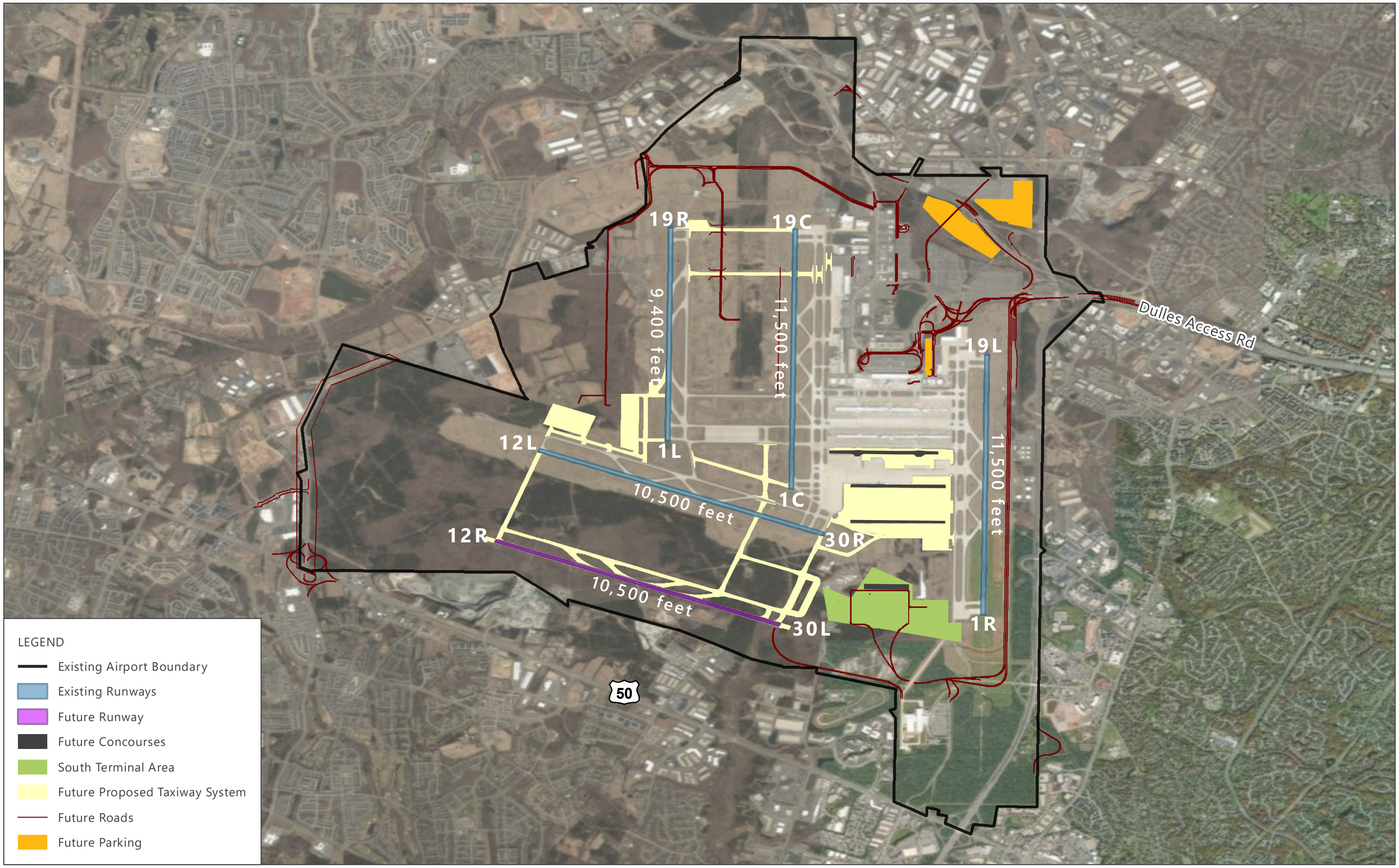
[46] Metropolitan Washington Airports Authority, *Airport System Revenue and Refunding Bonds Series 2017A Operating Statement*, October 1, 2017.

[47] Peat, Marwick, Mitchell & Company Airport Consulting Services, *Washington Dulles International Airport: Master Plan Update Final Technical Report*, 1985.

[48] US Department of Transportation, Federal Aviation Administration In Cooperation with the Army Corps of Engineers, *"Final Environmental Impact Statement for New Runways, Terminal Facilities and Related Facilities at Washington Dulles International Airport*, August 2005.



SOURCES: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, March 2018 (aerial imagery); Metropolitan Washington Airports Authority, 2018 (Airport components).

EXHIBIT 3-9

FUTURE PLANNED AIRFIELD AND AIRPORT FACILITIES

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TABLE 3-2 FUTURE RUNWAY 12R-30L PROPOSED DIMENSIONS AND SERVICE CAPABILITY DATA

	FUTURE RUNWAY END	
	12R	30L
Length (ft)	10,500	10,500
Width (ft)	150	150
Latitude	38-55'57.72"	28-55'21.17"
Longitude	77-29'44.8	77-27'40.45
Approach Aids		
PAPI	Yes	Yes
Runway End Elevations (ft MSL)	290.0	320.0
Approach Lights	MALSR	MALSR
Runway Lighting	HIRL, CL	HIRL, CL
Runway Marking	Precision	Precision

NOTES:
PAPI – Precision Approach Path Indicators
MSL – Mean Sea Level
MALSR – Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights
HIRL – High Intensity Runway Edge Lights
CL – Centerline Lighting System
SOURCE: Washington Dulles International Airport, Virginia Airport Layout Plan, July 27, 2016.

The Dulles Corridor Metrorail Project (Silver Line) is currently under construction, with an estimated project completion date of 2020.

The Airport's Master Plan also includes potential future development of areas on the west side of Dulles International under "Non-Aviation Commercial" use. This project, the Western Lands Area and Airport Support Zone, received NEPA approval via a Finding of No Significant Impact from the FAA in March 2018. The improvements include potential cargo, general aviation, Airport support facilities, and commercial/industrial nonaeronautical improvements. The Western Lands Area was sold by MWAA in November 2018. The area north of the Main Terminal has been evaluated for potential commercial development, including hotel and retail uses.

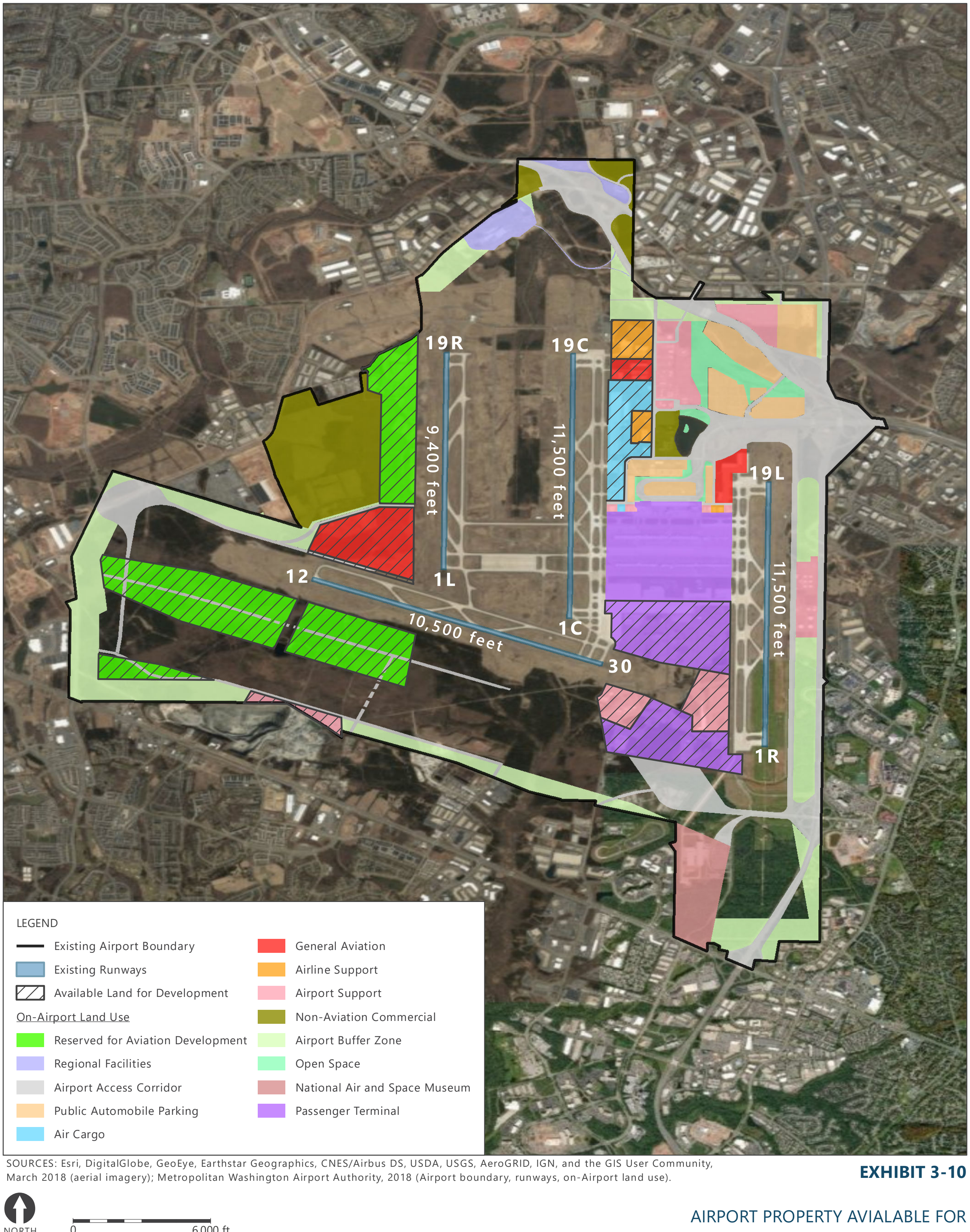
3.1.3.4 AVAILABLE ACREAGE FOR DEVELOPMENT

Exhibit 3-10 displays estimated on-Airport available acreage for aviation-related development based on the current approved land-use plan for the Airport. A total of approximately 1,620 acres have been identified as available for on-Airport development, as displayed in **Table 3-3**.

TABLE 3-3 AVAILABLE ACREAGE FOR DEVELOPMENT

ON-AIRPORT LAND USE	APPROXIMATE TOTAL AREA (ACRES)
Reserved for Aviation Development	830
Airport Support	160
Passenger Terminal	450
General Aviation	180
TOTAL	**1,620**

SOURCE: Ricondo & Associates, Inc., May 2018 (based on MWAA's 2017 On-Airport Land Use Map).



SOURCES: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, March 2018 (aerial imagery); Metropolitan Washington Airport Authority, 2018 (Airport boundary, runways, on-Airport land use).

EXHIBIT 3-10

AIRPORT PROPERTY AVIALABLE FOR AVIATION-RELATED DEVELOPMENT

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3.1.3.5 AREA AIRSPACE

After the events of September 11, 2001, flight restrictions were implemented throughout the National Airspace System that effectively shut down all flight operations, except for military, law enforcement, and emergency-related aircraft operations for a limited period of time. Dulles International is inside the Washington, DC, metropolitan area Flight Restricted Zone (DC FRZ). Beginning September 13, 2001, flight restrictions were incrementally lifted; however, the flight restrictions associated with the DC FRZ remained in place. On February 13, 2002, the FAA proceeded with emergency rulemaking that codified the FRZ within 13 to 15 nautical miles of the Washington, DC, Very-High Frequency Omni-Directional Range and Distance Measuring Equipment (VOR/DME) facility located at Reagan National Airport. On December 15, 2008, the FAA released its final rule, making the Air Defense Identification Zone (ADIZ)[49] permanent as a Special Flight Rules Area (SFRA),[50] which included the DC FRZ. The SFRA and permanent FRZ went into effect on February 17, 2009. As shown on **Exhibit 3-11**, the DC FRZ covers an approximate 13 to 15 nautical mile radius surrounding Washington, DC. Therefore, Dulles International air traffic cannot enter this area unless a flight plan has been filed to arrive at an airport located within the DC FRZ, such as at Reagan National Airport. Due to the DC FRZ, no traffic arriving at or departing from Dulles International overflies the area east of the Airport. Flights must head north or south before proceeding east, and operational limitations restrict Runway 30 arrivals and Runway 12 departures. In addition, the available airspace for ATC to manage traffic arriving in and departing out of Dulles International's airspace is limited.

3.1.3.6 AIR TRAFFIC CONTROL

The structure of and procedures followed within the airspace serving the Airport influence aircraft routings to and from the airfield. For example, the DC FRZ restricts flights from entering, unless the flight has a flight plan to an airport within the FRZ. This limits the available airspace for ATC to manage traffic to/from Dulles International. This section describes the airspace structure and the procedures followed by the three FAA ATC facilities serving the Airport.

The role of the three FAA ATC facilities serving aircraft arriving at or departing from the Airport, or overflying the immediate area, is to facilitate the safe, efficient, and expeditious movement of air traffic.

Airport Traffic Control Tower

The Dulles International ATCT provides ATC services to aircraft operating in the immediate vicinity of and on the airfield at the Airport. This facility is located south of the passenger terminals. The Dulles International ATCT authorizes aircraft to arrive at and depart from the Airport and to move on the ground.

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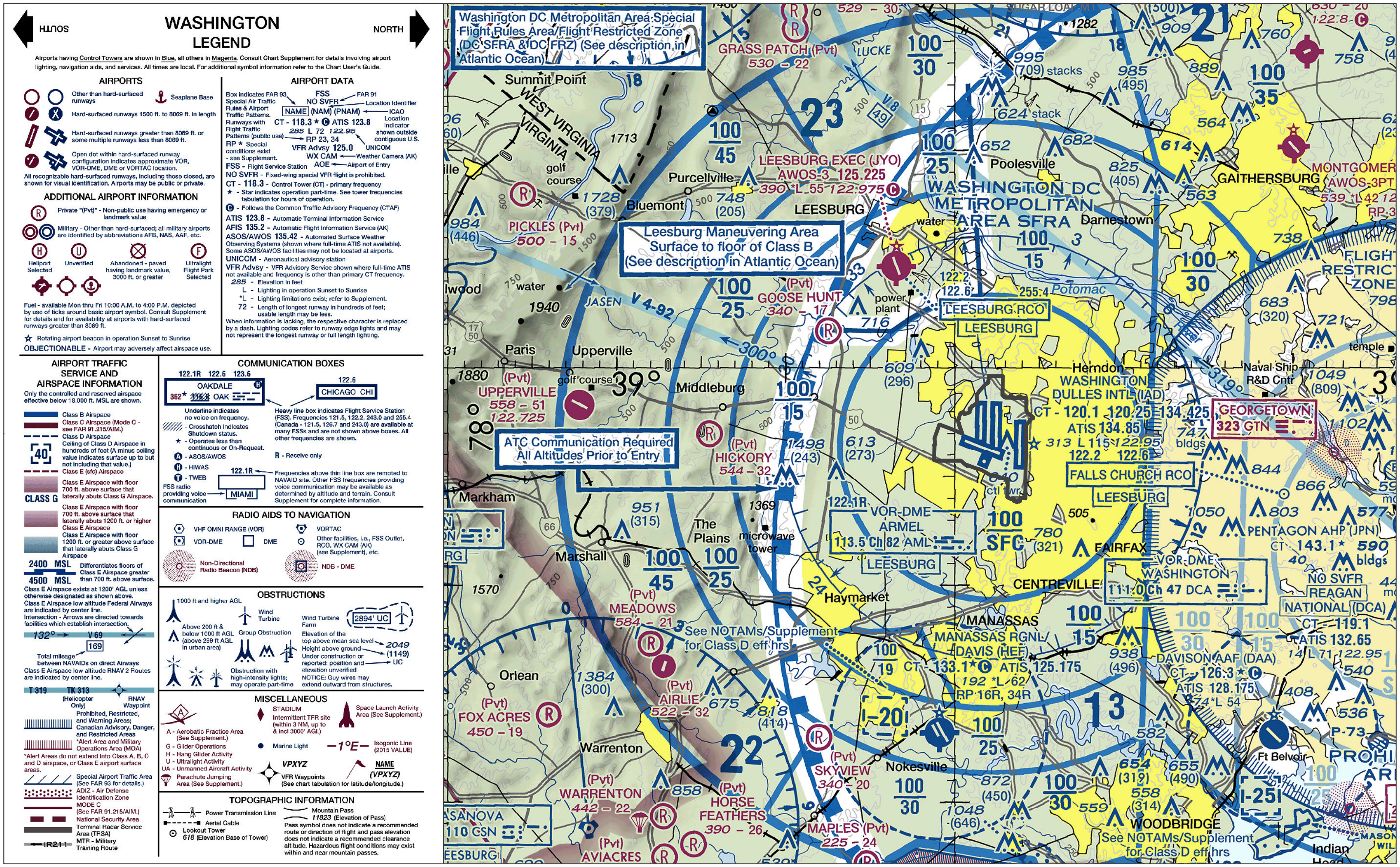
[49] An ADIZ is designated airspace over land or water in which the identification, location, and control of civil aircraft are performed in the interest of national security.

[50] An SFRA is a designated area of airspace region in which the normal regulations of flight do not apply in whole or in part. To operate within the Washington, D.C., SFRA, pilots of general aviation aircraft are required to: file a special fight rules flight plan, obtain a discrete transponder code, and always remain in contact with ATC.



SOURCES: US Department of Transportation, Federal Aviation Administration, January 2019 (VFR chart); Metropolitan Washington Airports Authority, 2018 (Airport boundary).

EXHIBIT 3-11

NORTH 0 10 mi

WASHINGTON AREA SECTIONAL AERONAUTICAL CHART

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Potomac Terminal Radar Approach Control

The Potomac TRACON is in Vint Hill in Fauquier County, Virginia. The TRACON provides radar ATC services to aircraft arriving at and departing from the Airport, as well as other airports in the region, including Reagan National Airport and BWI.

Federal Aviation Administration Washington Center Air Route Traffic Control Center

The FAA Washington Center Air Route Traffic Control Center (ARTCC), located in Leesburg in Loudoun County, Virginia, primarily provides ATC services to aircraft operating under IFR within controlled airspace during the enroute phase of flight. ARTCC also provides radar services to aircraft operating under visual flight rules (VFR) as conditions permit.[51]

3.1.4 AIR TRAFFIC PROCEDURES

Dulles International's airspace is structured so that arriving and departing aircraft can operate in a safe and efficient manner. STARs and SIDs simplify and expedite IFR arrival and departure procedures in the Airport's airspace. SIDS and STARS provide standard procedures to facilitate safe and predictable navigation through the terminal airspace to a specific route in the nation's airspace.

3.1.4.1 STANDARD TERMINAL ARRIVAL ROUTE PROCEDURES

A STAR is an FAA air traffic–controlled, published instrument procedure that aircraft typically use when arriving in the terminal airspace when filed under an IFR flight plan. A STAR provides defined lateral and vertical guidance to produce predictability and order when managing traffic in a busy airspace. Aircraft equipped with GPS and FMS can utilize RNAV STARs, while non-GPS-equipped aircraft utilize conventional STARs, which rely on ground-based navigational aids, such as a VOR or ATC-directed headings and descent altitudes.

At Dulles International, the Potomac TRACON and Washington Center ARTCC use 12 STARs—7 of which are based on RNAV and 5 are conventional arrival procedures—as shown in **Table 3-4**.

[51] The en route phase of flight is the period when an aircraft is operating between the airport where the flight originated and the destination airport.

TABLE 3-4 DULLES INTERNATIONAL STANDARD TERMINAL ARRIVALS PROCEDURES

PROCEDURE NAME	PROCEDURE TYPE	ARRIVAL "FROM" DIRECTION
CAVLR THREE	RNAV	South
COATT FIVE	Conventional	South
DELRO FOUR	Conventional	South, Southwest
DOCCS TWO	Conventional	Southwest
GIBBZ TWO	RNAV	Southwest, Northwest
HYPER SEVEN	RNAV	Northeast
HYPER SEVEN	RNAV	Northeast
LEGGO FOUR	RNAV	North, Northeast
MAPEL TWO	RNAV	North, Northwest
PRIVO ONE	Conventional	North, Northwest
SELINSGROVE FIVE	Conventional	North, Northeast
WIGOL ONE	RNAV	Southwest

NOTE:
RNAV – Area Navigation
SOURCE: Federal Aviation Administration, Instrument Flight Procedure Information Gateway,
https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/application/?event=procedure.results&nasrId=IAD#searchResultsTop (accessed May 2018).

3.1.5 STANDARD INSTRUMENT DEPARTURE PROCEDURES

A SID is an FAA air traffic-controlled, published instrument procedure that aircraft typically use when departing from the terminal airspace when filed under an IFR flight plan. A SID provides defined lateral and vertical guidance to produce predictability and order when managing traffic out of a busy airspace. Aircraft equipped with GPS and FMS can utilize RNAV SIDs, while non-GPS-equipped aircraft utilize conventional SIDs, which rely on ground-based navigational aids, such as a VOR or ATC-directed headings and climbing altitudes.

At Dulles International, the Potomac TRACON and the Washington Center ARTCC utilize 10 SIDs. Nine SIDs are RNAV, while one route is a conventional SID, as shown in **Table 3-5**.

TABLE 3-5 DULLES INTERNATIONAL STANDARD INSTRUMENT DEPARTURES PROCEDURES

PROCEDURE NAME	PROCEDURE TYPE	DEPARTURE "TO" DIRECTION
BUNZZ THREE	RNAV	West
CAPITAL ONE	Conventional	North, Northeast, Northwest, South, Southeast, Southwest, East, West
CLTCH TWO	RNAV	Southwest
JCOBY THREE	RNAV	East
JDUBB TWO	RNAV	Southwest
JERES TWO	RNAV	North, Northeast
MCRAY TWO	RNAV	North, Northwest
RNLDI FOUR	RNAV	West
SCRAM FOUR	RNAV	Southwest
WOOLY ONE	RNAV	East

NOTE: RNAV – Area Navigation
SOURCE: Federal Aviation Administration, Instrument Flight Procedure Information Gateway,
https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/application/?event=procedure.results&nasrId=IAD#searchResultsTop (accessed May 2018).

3.1.5.1 FEDERAL AVIATION ADMINISTRATION NEXTGEN PROGRAM

The NextGen program is the FAA-led long-term plan to modernize the nation's air transportation system from a ground-based system of ATC to a GPS-based system of air traffic management that allows for the development of PBN procedures.[52] NextGen is a series of programs that together will create a comprehensive modernized next generation aviation system. The FAA NextGen implementation plan current at the time this study began was the 2016 NextGen Implementation Plan. The NextGen Implementation Plan describes the NextGen programs and scheduled implementation of several components within each program through 2022. The 2016 Plan included two improvements at Dulles International:

- Improved Multiple Runway Operations (IMRO) Simultaneous Triple Approaches – IMRO Simultaneous Triple Approaches will enable the use of triple simultaneous approaches (three aircraft on the approach path at the same time to the north-south parallel runways) during periods of reduced visibility.[53] Historically, aircraft weight categories determined the required separation between a lead aircraft and a trailing aircraft on the same path to protect from wake turbulence.
- Wake Turbulence Separation Recategorization (RECAT), Phase 2.5 – Under RECAT, the FAA has developed wake turbulence separations for each unique pair of specific aircraft types, using wake turbulence-based data that accounts for more than aircraft weight data (e.g., approach speed, wing design), allowing for reductions in required wake turbulence separations between actual aircraft types.[54, 55] RECAT is being implemented in phases; FAA planned Phase 2.5 to be available for Dulles International in the third quarter of 2018.[56] Both of these measures will increase runway throughput at the Airport.

3.1.6 REGIONAL ECONOMIC IMPACT

Dulles International is an asset critical in the Washington, DC, metropolitan area. The Airport is a major source of regional employment and economic benefit to the Commonwealth of Virginia, generating 51,149 jobs and $2.9 billion in associated labor income in 2016.[57] Dulles International jobs and visitor spending generated $315 million in local/state tax revenues in 2016.[58] The Airport's impact on the economy is also reflected in the growing number of ancillary businesses located at or near the Airport. Several other businesses have been attracted to the Washington, DC, metropolitan area by the easy access to the nation's major hubs and international business centers provided by the Airport. There is no accurate means to measure this impact, but the ability to access major business

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52 US Department of Transportation, Federal Aviation Administration, "What is NextGen?" https://www.faa.gov/nextgen/what_is_nextgen/ (accessed May 2018).

53 US Department of Transportation, Federal Aviation Administration, "NextGen Implementation Plan 2016," https://www.faa.gov/nextgen/media/NextGen_Implementation_Plan-2016.pdf (accessed May 2018).

54 Cheng, Tittsworth, Gallo, and Awwad, "The Development of Wake Turbulence Recategorization in the United States," 8th American Institute of Aeronautics and Astronautics Atmospheric and Space Environments Conference, June 2016, file:///C:/Users/rbauer/Downloads/dot_12304_DS1%20(1).pdf (accessed May 2018).

55 US Department of Transportation, Federal Aviation Administration, Order 7110.125, Change 1, *Wake Turbulence Recategorization – Phase II*, November 15, 2016.

56 US Department of Transportation, Federal Aviation Administration, *NextGen Priorities—Joint Implementation Plan Update Including the Northeast Corridor*, October 2017.

57 Commonwealth of Virginia, Virginia Department of Aviation, Virginia Airport System Economic Impact Study Technical Report, May 1, 2018.

58 *Ibid.*

centers via air service helps to explain the more than 400 internationally owned businesses located in Fairfax County and many others throughout the Washington, DC, metropolitan area in 2012.[59]

3.1.7 CURRENT NOISE MANAGEMENT PROGRAM

No specific noise abatement procedures or preferential nighttime runway use programs are published for the Airport. However, 19 noise monitors are positioned along flight corridors that align with the Airport's runways. The primary objective is to monitor noise experienced in neighboring communities as the result of aircraft and community noise contributions to establish historical trends. MWAA operates a Noise Information Office to address aircraft noise concerns and to help residents understand the facts, science, and regulations associated with aircraft noise. The Noise Information Office responds to questions and complaints, and monitors aircraft operations and noise levels in the community. Representatives meet frequently with individuals, groups, elected officials, airline representatives, and the FAA to discuss Airport operations.[60]

3.2 EXISTING FLIGHT OPERATION ACTIVITY

Information about aircraft operations was derived from MWAA's ANOMS data for 2017. Data collected for each flight included the date and time, flight number, aircraft type, operation mode (arrival or departure), destination/origin, and runway.

In addition, aircraft operations counts from the Dulles International ATCT were assessed to supplement the ANOMS data. The FAA categorizes ATCT-counted operations as either itinerant or local. Itinerant operations are those conducted by aircraft that travel to or from the Airport. Local operations are those conducted by aircraft that generally remain within sight of the ATCT (e.g., touch and go training operations). Due to the level and type of operations at Dulles International, local operations do not typically occur on an average day. The FAA also tracks ATCT-counted operations by four user categories:

- air carrier – commercial aircraft with seating capacities of more than 60 passengers, or a maximum payload capacity of more than 18,000 pounds carrying passengers or cargo
- air taxi – commercial and for-hire aircraft with maximum seating capacities of 60 passengers, or a maximum payload capacity of 18,000 pounds of cargo for hire or compensation
- general aviation – noncommercial, civil aircraft operations
- military – aircraft operated by any branch of the US armed services

The user category was assigned to each flight recorded in the ANOMS data, and the number of aircraft operations obtained from the ANOMS data was normalized to equal counts made by Dulles International ATCT personnel.

The FAA's Aviation System Performance Metrics (ASPM) web data also provided supplemental information to the ANOMS data. ASPM reports provide data on airport weather, runway configuration, and airport arrival and departure

[59] Commonwealth of Virginia, Virginia Department of Aviation, Virginia Airport System Economic Impact Study Technical Report, May 1, 2018.

[60] Metropolitan Washington Airports Authority, "Dulles International – Aircraft Noise Information," http://www.flydulles.com/iad/iad-dulles-intl-aircraft-noise-information (accessed May 2018).

rates. The hourly runway operating configuration data from ASPM was applied to the ANOMS data to include the FAA-reported runway operating configuration (North Flow or South Flow) for each hour in 2017.

The following sections provide a summary of the key operation patterns used as input into the AEDT noise model, such as AAD operations by operation mode, time of day, aircraft type, and runway.

3.2.1 EXISTING ACTIVITY LEVELS

Tables 3-6 and **3-7** presents annual and average daily operations by user category for 2017 and by time of day (daytime [7:00 a.m. to 9:59 p.m.] and nighttime [10:00 p.m. to 6:59 a.m.]), respectively. Dulles International accommodated 806 itinerant operations on an AAD in 2017, the majority of which were air carrier operations. Air Carriers accounted for 61 percent of 2017 operations at the Airport, Air Taxi 25 percent, and General Aviation 13 percent.

TABLE 3-6 ANNUAL AND AVERAGE ANNUAL DAY OPERATIONS BY USER CATEGORY – 2017

USER CATEGORY	ANNUAL OPERATIONS	AVERAGE DAILY OPERATIONS	OPERATIONS PERCENTAGE
Air Carriers	180,324	494	61.3%
Air Taxi	74,836	205	25.5%
General Aviation	38,614	106	13.1%
Military	292	1	0.1%
Total	294,066	806	100.0%

SOURCES: HMMH, May 2018; Ricondo & Associates, Inc., May 2018.

TABLE 3-7 AVERAGE ANNUAL DAY ARRIVAL AND DEPARTURE COUNTS BY USER CATEGORY AND TIME OF DAY – 2017

	ARRIVALS		DEPARTURES		ALL OPERATIONS	
USER CATEGORY	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Air Carriers	211.34	35.68	201.24	45.78	412.58	81.46
Air Taxi	91.26	11.25	86.44	16.07	177.70	27.33
General Aviation	48.95	3.95	48.87	4.03	97.81	7.98
Military	0.38	0.02	0.33	0.07	0.71	0.09
Total	351.92	50.91	336.88	65.95	688.80	116.86

NOTE: May not add up due to rounding.
SOURCE: HMMH, May 2018.

As shown in **Table 3-8**, 85 percent of all operations occur during daytime hours, and 15 percent occur during the nighttime hours. The day-night split is similar for air carrier and air taxi arrivals and departures and military departures; while the general aviation arrivals and departures and military arrivals reflect lower proportions of nighttime operations than the overall average.

TABLE 3-8 PERCENTAGE OF AVERAGE ANNUAL DAY OPERATIONS BY TIME OF DAY BY USER CATEGORY – 2017

USER CATEGORY	ARRIVALS		DEPARTURES		ALL OPERATIONS	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Air Carriers	86%	14%	81%	19%	84%	16%
Air Taxi	89%	11%	84%	16%	87%	13%
General Aviation	93%	7%	92%	8%	92%	8%
Military	94%	6%	84%	16%	89%	11%
Total	**87%**	**13%**	**84%**	**16%**	**85%**	**15%**

SOURCES: HMMH, May 2018; Ricondo & Associates, Inc., May 2018.

3.2.2 EXISTING FLEET MIX

Table 3-9 summarizes annual proportions of arrivals and departures by time of day (daytime and nighttime periods) for each user category and for specific aircraft types for 2017. The proportions are based on total operations for each operation type (arrival, departure or all operations) and time of day (day, night or total).

TABLE 3-9 (1 OF 6) PERCENTAGES OF ANNUAL AIRCRAFT OPERATIONS BY AIRCRAFT TYPE, USER CATEGORY, AND TIME OF DAY – 2017

USER CATEGORY	AIRCRAFT CATEGORY	AIRCRAFT TYPE	ARRIVALS			DEPARTURES			ALL OPERATIONS		
			DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL
Air Carrier	Jet	A124	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		A306	0.0%	1.1%	**0.2%**	0.0%	0.9%	**0.2%**	0.0%	1.0%	**0.2%**
		A332	0.2%	0.2%	**0.2%**	0.2%	0.0%	**0.2%**	0.2%	0.1%	**0.2%**
		A333	1.2%	1.0%	**1.1%**	0.8%	2.6%	**1.1%**	1.0%	1.9%	**1.1%**
		A343	0.1%	0.1%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		A346	0.1%	0.2%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		A388	0.4%	0.0%	**0.4%**	0.5%	0.0%	**0.4%**	0.5%	0.0%	**0.4%**
		B744	0.5%	0.1%	**0.4%**	0.3%	1.1%	**0.4%**	0.4%	0.7%	**0.4%**
		B748	0.3%	0.0%	**0.3%**	0.3%	0.0%	**0.3%**	0.3%	0.0%	**0.3%**
		B763	1.0%	2.7%	**1.2%**	0.9%	2.7%	**1.2%**	1.0%	2.7%	**1.2%**
		B764	1.3%	2.3%	**1.4%**	1.4%	1.6%	**1.4%**	1.3%	1.9%	**1.4%**
		B772	2.5%	0.2%	**2.2%**	2.2%	2.5%	**2.2%**	2.3%	1.5%	**2.2%**
		B77L	0.2%	0.2%	**0.2%**	0.2%	0.0%	**0.2%**	0.2%	0.1%	**0.2%**
		B77W	1.8%	0.2%	**1.6%**	1.9%	0.2%	**1.6%**	1.8%	0.2%	**1.6%**
		B788	0.4%	0.4%	**0.4%**	0.3%	0.8%	**0.4%**	0.4%	0.6%	**0.4%**
		B789	0.6%	0.0%	**0.5%**	0.3%	1.5%	**0.5%**	0.5%	0.9%	**0.5%**
		DC10	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		DC87	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		MD11	0.0%	0.1%	**0.0%**	0.0%	0.1%	**0.0%**	0.0%	0.1%	**0.0%**
		A319	1.0%	1.6%	**1.1%**	1.1%	0.9%	**1.1%**	1.0%	1.2%	**1.1%**
		A320	5.1%	8.6%	**5.6%**	5.8%	4.6%	**5.6%**	5.4%	6.3%	**5.6%**
		A321	0.3%	0.2%	**0.3%**	0.3%	0.0%	**0.3%**	0.3%	0.1%	**0.3%**
		B712	0.5%	0.6%	**0.5%**	0.5%	0.4%	**0.5%**	0.5%	0.5%	**0.5%**

TABLE 3-9 (2 OF 6) PERCENTAGES OF ANNUAL AIRCRAFT OPERATIONS BY AIRCRAFT TYPE, USER CATEGORY, AND TIME OF DAY – 2017

USER CATEGORY	AIRCRAFT CATEGORY	AIRCRAFT TYPE	ARRIVALS			DEPARTURES			ALL OPERATIONS		
			DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL
		B733	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		B734	0.0%	0.1%	**0.0%**	0.0%	0.1%	**0.0%**	0.0%	0.1%	**0.0%**
		B737	1.4%	3.3%	**1.6%**	1.5%	2.1%	**1.6%**	1.4%	2.6%	**1.6%**
		B738	3.9%	11.7%	**4.9%**	5.0%	4.4%	**4.9%**	4.5%	7.6%	**4.9%**
		B739	7.9%	12.8%	**8.6%**	8.4%	9.1%	**8.6%**	8.2%	10.7%	**8.6%**
		B752	2.2%	4.4%	**2.5%**	2.2%	3.7%	**2.5%**	2.2%	4.0%	**2.5%**
		B753	0.0%	0.2%	**0.1%**	0.1%	0.0%	**0.1%**	0.0%	0.1%	**0.1%**
		CRJ7	14.9%	7.0%	**13.9%**	13.9%	14.1%	**13.9%**	14.4%	11.0%	**13.9%**
		CRJ9	2.1%	2.8%	**2.2%**	2.2%	2.3%	**2.2%**	2.1%	2.5%	**2.2%**
		E170	4.7%	2.7%	**4.4%**	3.8%	7.8%	**4.4%**	4.2%	5.6%	**4.4%**
		E190	1.3%	2.0%	**1.4%**	1.3%	1.6%	**1.4%**	1.3%	1.8%	**1.4%**
		E75L	1.6%	0.8%	**1.5%**	1.3%	2.6%	**1.5%**	1.5%	1.9%	**1.5%**
		MD82	0.1%	0.1%	**0.1%**	0.2%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		MD83	0.5%	0.1%	**0.4%**	0.5%	0.0%	**0.4%**	0.5%	0.1%	**0.4%**
		MD88	1.1%	1.8%	**1.2%**	1.2%	1.2%	**1.2%**	1.1%	1.5%	**1.2%**
		MD90	0.1%	0.3%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.2%	**0.1%**
Air Carrier	Turbo Prop	DH8D	0.8%	0.1%	**0.7%**	0.9%	0.0%	**0.7%**	0.8%	0.1%	**0.7%**
Air Carrier	**Total**		**60.1%**	**70.1%**	**61.3%**	**59.7%**	**69.4%**	**61.3%**	**59.9%**	**69.7%**	**61.3%**
Air Taxi	Helicopter	B06	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		HELO	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
Air Taxi	Jet	CL60	0.6%	0.4%	**0.6%**	0.7%	0.3%	**0.6%**	0.6%	0.4%	**0.6%**
		CRJ1	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		CRJ2	3.3%	1.7%	**3.1%**	3.2%	2.7%	**3.1%**	3.3%	2.3%	**3.1%**
		E135	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		E145	0.6%	0.3%	**0.6%**	0.6%	0.5%	**0.6%**	0.6%	0.4%	**0.6%**
		E35L	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		E45X	6.6%	4.1%	**6.3%**	6.3%	6.4%	**6.3%**	6.5%	5.4%	**6.3%**
		F2TH	0.4%	0.2%	**0.4%**	0.4%	0.1%	**0.4%**	0.4%	0.2%	**0.4%**
		F900	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		FA7X	0.0%	0.1%	**0.0%**	0.1%	0.0%	**0.0%**	0.0%	0.1%	**0.0%**
		GL5T	0.2%	0.2%	**0.2%**	0.2%	0.1%	**0.2%**	0.2%	0.2%	**0.2%**
		GLEX	0.2%	0.2%	**0.2%**	0.2%	0.2%	**0.2%**	0.2%	0.2%	**0.2%**
		GLF3	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		GLF4	0.3%	0.4%	**0.3%**	0.4%	0.2%	**0.3%**	0.3%	0.3%	**0.3%**
		GLF5	0.1%	0.1%	**0.1%**	0.2%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		GLF6	0.1%	0.1%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.1%	**0.1%**
		ASTR	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		BE40	0.5%	0.2%	**0.5%**	0.5%	0.1%	**0.5%**	0.5%	0.2%	**0.5%**
		C25A	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		C25B	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		C25C	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C525	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C550	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		C560	0.3%	0.2%	**0.3%**	0.3%	0.1%	**0.3%**	0.3%	0.1%	**0.3%**
		C56X	1.3%	0.6%	**1.2%**	1.3%	0.3%	**1.2%**	1.3%	0.4%	**1.2%**
		C650	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**

TABLE 3-9 (3 OF 6) PERCENTAGES OF ANNUAL AIRCRAFT OPERATIONS BY AIRCRAFT TYPE, USER CATEGORY, AND TIME OF DAY – 2017

USER CATEGORY	AIRCRAFT CATEGORY	AIRCRAFT TYPE	ARRIVALS			DEPARTURES			ALL OPERATIONS		
			DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL
		C680	0.7%	0.4%	**0.6%**	0.7%	0.2%	**0.6%**	0.7%	0.3%	**0.6%**
		C68A	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C750	0.5%	0.3%	**0.5%**	0.6%	0.2%	**0.5%**	0.5%	0.3%	**0.5%**
		CL30	0.7%	0.4%	**0.7%**	0.8%	0.3%	**0.7%**	0.8%	0.3%	**0.7%**
		CL35	0.4%	0.2%	**0.4%**	0.4%	0.2%	**0.4%**	0.4%	0.2%	**0.4%**
		E50P	0.0%	0.2%	**0.0%**	0.0%	0.1%	**0.0%**	0.0%	0.1%	**0.0%**
		E545	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		E550	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		E55P	0.8%	0.3%	**0.8%**	0.9%	0.3%	**0.8%**	0.9%	0.3%	**0.8%**
		EA50	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		FA10	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		FA50	0.1%	0.1%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		G150	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		G280	0.1%	0.1%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		GALX	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**
		H25B	0.5%	0.3%	**0.5%**	0.6%	0.2%	**0.5%**	0.5%	0.3%	**0.5%**
		HA4T	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		HDJT	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		J328	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		LJ31	0.0%	0.1%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.1%	**0.0%**
		LJ35	0.1%	0.2%	**0.1%**	0.1%	0.2%	**0.1%**	0.1%	0.2%	**0.1%**
		LJ45	0.2%	0.1%	**0.2%**	0.2%	0.0%	**0.2%**	0.2%	0.1%	**0.2%**
		LJ55	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		LJ60	0.2%	0.2%	**0.2%**	0.2%	0.1%	**0.2%**	0.2%	0.2%	**0.2%**
		LJ70	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		LJ75	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
Air Taxi	Prop	BE36	0.0%	1.6%	**0.2%**	0.0%	1.2%	**0.2%**	0.0%	1.4%	**0.2%**
		BE58	0.0%	0.1%	**0.0%**	0.0%	0.1%	**0.0%**	0.0%	0.1%	**0.0%**
		C172	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		EV97	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		PA28	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		PA31	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		SR22	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
Air Taxi	Prop	AEST	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		B350	0.4%	0.1%	**0.4%**	0.4%	0.1%	**0.4%**	0.4%	0.1%	**0.4%**
		BE20	0.0%	0.1%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		BE30	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		BE9L	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C208	0.7%	0.4%	**0.7%**	0.7%	0.3%	**0.7%**	0.7%	0.3%	**0.7%**
		DH8B	3.5%	3.4%	**3.5%**	3.2%	5.1%	**3.5%**	3.4%	4.3%	**3.5%**
		DH8C	0.5%	0.6%	**0.5%**	0.4%	0.8%	**0.5%**	0.5%	0.7%	**0.5%**
		P180	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		PC12	0.5%	3.4%	**0.9%**	0.5%	2.8%	**0.9%**	0.5%	3.1%	**0.9%**
Air Taxi	**Total**		**25.9%**	**22.1%**	**25.4%**	**25.7%**	**24.4%**	**25.4%**	**25.8%**	**23.4%**	**25.4%**

TABLE 3-9 (4 OF 6) PERCENTAGES OF ANNUAL AIRCRAFT OPERATIONS BY AIRCRAFT TYPE, USER CATEGORY, AND TIME OF DAY – 2017

USER CATEGORY	AIRCRAFT CATEGORY	AIRCRAFT TYPE	ARRIVALS			DEPARTURES			ALL OPERATIONS		
			DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL
General Aviation	Helicopter	A109	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		A139	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		AS50	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		AS55	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		B06	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		B407	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		B412	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		B427	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		B429	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		B430	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		EC20	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		EC30	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		EC35	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		HELO	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		S76	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
General Aviation	Jet	B762	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		B763	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		CL35	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		A320	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		B737	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		B738	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		B739	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		B752	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		CL60	0.6%	0.3%	**0.6%**	0.7%	0.3%	**0.6%**	0.7%	0.3%	**0.6%**
		CRJ2	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		E135	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		E170	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		E190	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		E35L	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		E45X	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		E75L	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		F2TH	0.6%	0.2%	**0.6%**	0.7%	0.2%	**0.6%**	0.6%	0.2%	**0.6%**
		F900	0.6%	0.3%	**0.5%**	0.6%	0.2%	**0.5%**	0.6%	0.3%	**0.5%**
		FA7X	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		GL5T	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		GLEX	0.5%	0.4%	**0.5%**	0.5%	0.3%	**0.5%**	0.5%	0.3%	**0.5%**
		GLF3	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		GLF4	0.9%	0.7%	**0.9%**	1.0%	0.4%	**0.9%**	0.9%	0.6%	**0.9%**
		GLF5	1.0%	0.7%	**0.9%**	1.0%	0.5%	**0.9%**	1.0%	0.6%	**0.9%**
		GLF6	0.2%	0.3%	**0.2%**	0.2%	0.2%	**0.2%**	0.2%	0.2%	**0.2%**
		ASTR	0.1%	0.0%	**0.0%**	0.1%	0.0%	**0.0%**	0.1%	0.0%	**0.0%**
		BE40	0.3%	0.2%	**0.3%**	0.4%	0.1%	**0.3%**	0.4%	0.2%	**0.3%**
		C25A	0.2%	0.1%	**0.1%**	0.2%	0.0%	**0.1%**	0.2%	0.1%	**0.1%**
		C25B	0.2%	0.1%	**0.2%**	0.2%	0.0%	**0.2%**	0.2%	0.1%	**0.2%**

TABLE 3-9 (5 OF 6) PERCENTAGES OF ANNUAL AIRCRAFT OPERATIONS BY AIRCRAFT TYPE, USER CATEGORY, AND TIME OF DAY – 2017

USER CATEGORY	AIRCRAFT CATEGORY	AIRCRAFT TYPE	ARRIVALS			DEPARTURES			ALL OPERATIONS		
			DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL
		C25C	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		C501	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C510	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C525	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		C550	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		C560	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**
		C56X	0.5%	0.2%	**0.5%**	0.5%	0.1%	**0.5%**	0.5%	0.1%	**0.5%**
		C650	0.1%	0.0%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.0%	**0.1%**
		C680	0.6%	0.3%	**0.5%**	0.6%	0.2%	**0.5%**	0.6%	0.2%	**0.5%**
		C68A	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C750	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**
		CL30	0.7%	0.2%	**0.6%**	0.7%	0.2%	**0.6%**	0.7%	0.2%	**0.6%**
		E50P	0.1%	0.1%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.1%	**0.1%**
		E550	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		E55P	0.2%	0.2%	**0.2%**	0.3%	0.1%	**0.2%**	0.3%	0.2%	**0.2%**
		EA50	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		FA10	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		FA20	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		FA50	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**
		G150	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**
		G280	0.4%	0.2%	**0.3%**	0.4%	0.1%	**0.3%**	0.4%	0.2%	**0.3%**
		GALX	0.3%	0.2%	**0.3%**	0.3%	0.1%	**0.3%**	0.3%	0.2%	**0.3%**
		H25A	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		H25B	0.7%	0.3%	**0.6%**	0.7%	0.2%	**0.6%**	0.7%	0.3%	**0.6%**
		H25C	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		HA4T	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		HDJT	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		LJ31	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		LJ35	0.0%	0.1%	**0.0%**	0.0%	0.1%	**0.0%**	0.0%	0.1%	**0.0%**
		LJ40	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		LJ45	0.5%	0.1%	**0.4%**	0.5%	0.3%	**0.4%**	0.5%	0.2%	**0.4%**
		LJ55	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		LJ60	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**
		LJ75	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		PRM1	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		SBR1	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		WW24	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
General Aviation	Prop	AA5	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		BE33	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		BE36	0.1%	0.2%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.1%	**0.1%**
		BE55	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		BE58	0.1%	0.2%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		C172	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**	0.1%	0.0%	**0.1%**
		C182	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C206	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**

TABLE 3-9 (6 OF 6) PERCENTAGES OF ANNUAL AIRCRAFT OPERATIONS BY AIRCRAFT TYPE, USER CATEGORY, AND TIME OF DAY – 2017

USER CATEGORY	AIRCRAFT CATEGORY	AIRCRAFT TYPE	ARRIVALS			DEPARTURES			ALL OPERATIONS		
			DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL
		C210	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C310	0.0%	0.1%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.1%	**0.0%**
		C340	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C414	0.0%	0.1%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C421	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		COL3	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		DA40	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		M20P	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		P28A	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		P28R	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		P32R	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		PA24	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		PA27	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		PA31	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		PA32	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		PA34	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		SR22	0.2%	0.1%	**0.1%**	0.2%	0.1%	**0.1%**	0.2%	0.1%	**0.1%**
General Aviation	Turbo Prop	B190	0.2%	0.0%	**0.1%**	0.2%	0.0%	**0.1%**	0.2%	0.0%	**0.1%**
		B350	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**
		BE10	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		BE20	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**
		BE30	0.1%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		BE50	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		BE9L	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**	0.1%	0.1%	**0.1%**
		BE9T	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		C208	0.2%	0.1%	**0.1%**	0.2%	0.1%	**0.1%**	0.2%	0.1%	**0.1%**
		C441	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		D328	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		DH8B	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		DH8C	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		MU2	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		P180	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		P46T	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		PA46	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		PAY2	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		PC12	0.2%	0.2%	**0.2%**	0.2%	0.1%	**0.2%**	0.2%	0.1%	**0.2%**
		TBM7	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
		TBM8	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**	0.0%	0.0%	**0.0%**
General Aviation	**Total**		**13.9%**	**7.8%**	**13.1%**	**14.5%**	**6.1%**	**13.1%**	**14.2%**	**6.8%**	**13.1%**
Military	**Total**		**0.1%**	**0.0%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**

NOTES:
1 Day = 7:00 a.m. through 9:59 p.m.
2 Night = 10:00 p.m. through 6:59 a.m.
Totals may not add up due to rounding.
SOURCES: HMMH, May 2018; Ricondo & Associates, Inc., May 2018.

3.2.3 EXISTING RUNWAY OPERATING CONFIGURATION USE

The Dulles International ATCT selects runway operating configurations based on wind, weather conditions, and operational demand. **Table 3-10** shows runway configuration use by time of day. Overall, North Flow occurred 58 percent of the time, and South Flow occurred 42 percent of the time in 2017. As shown in Table 3-10, the use of each runway operating configuration does not differ substantially between daytime and nighttime hours.

TABLE 3-10 AVERAGE ANNUAL DAY RUNWAY OPERATING CONFIGURATION USE BY TIME OF DAY

RUNWAY OPERATING CONFIGURATION	OPERATIONS			PERCENTAGES		
	DAY[1]	NIGHT[2]	TOTAL	DAY[1]	NIGHT[2]	TOTAL
North Flow	403.78	66.48	**470.25**	59%	57%	**58%**
South Flow	284.32	50.29	**334.61**	41%	43%	**42%**
Total	**688.10**	**116.77**	**804.86**	**100%**	**100%**	**100%**

NOTES:
1 Day = 7:00 a.m. through 9:59 p.m.
2 Night = 10:00 p.m. through 6:59 a.m.
SOURCES: HMMH, May 2018; Ricondo & Associates, Inc., May 2018.

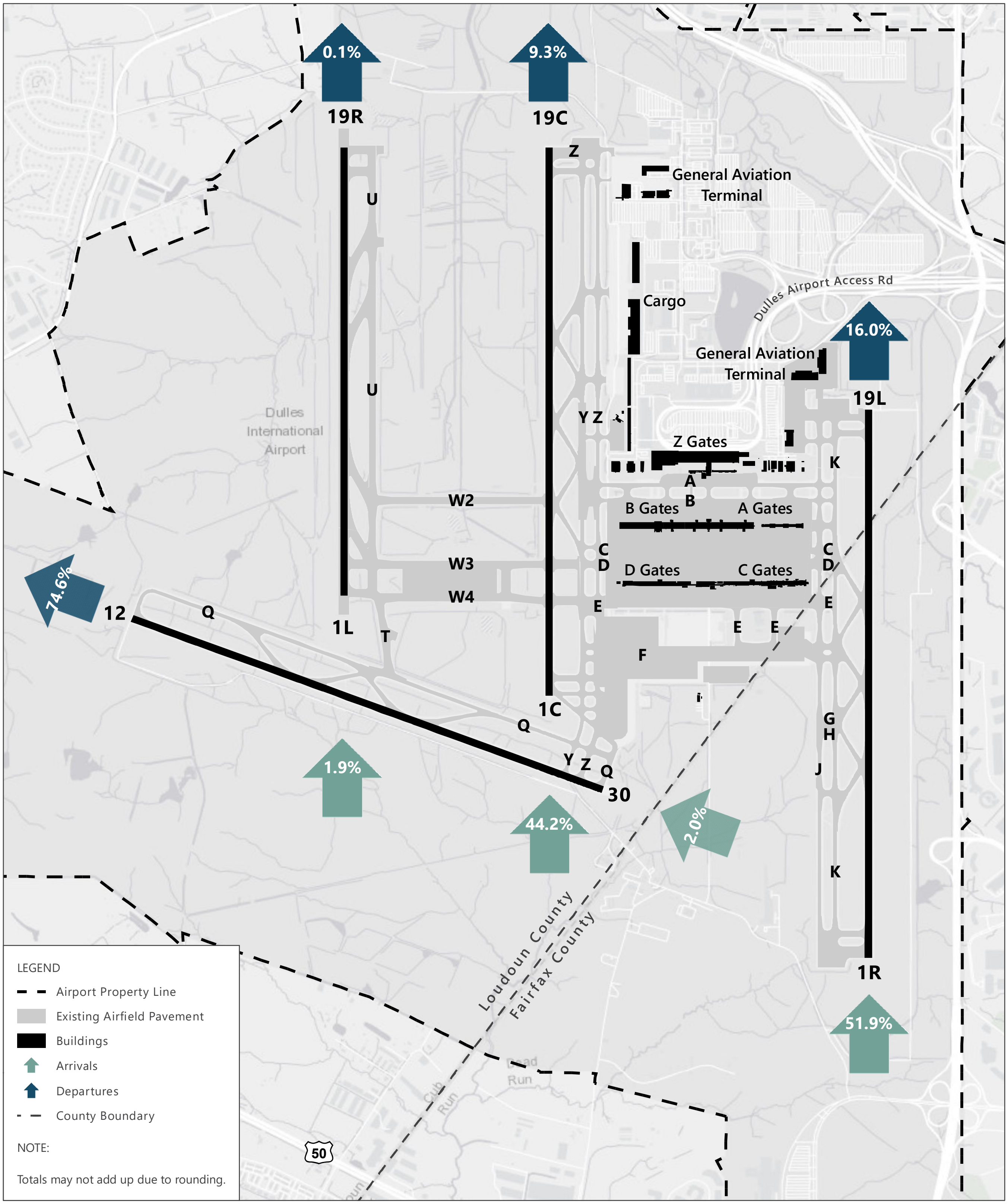
3.2.4 EXISTING RUNWAY USE

The following subsections summarize the use of North Flow and South Flow runway operating configurations based on the full year of ANOMS data and FAA ASPM data collected for 2017.

3.2.4.1 NORTH FLOW RUNWAY USE

Exhibits 3-12, **3-13**, and **3-14** depict the AAD runway use percentages for all hours, and for daytime and nighttime, respectively, for the North Flow runway operating configuration. Approximately 52 percent of all North Flow arrivals occurred on Runway 1R, and 44 percent on Runway 1C. Runway 1L was used for approximately 2 percent of north flow arrivals. The low use is due to the additional taxi time and runway crossings necessary to taxi to the terminals. During conditions of strong winds from the northwest, the Dulles International ATCT is limited to use of Runway 30 for arrivals and departures, which is a Northwest Flow. These conditions are infrequent during a typical year (approximately 2 percent of all arrivals and departures in a year); therefore, operations that occurred in Northwest Flow was combined with operations under the North Flow runway operating configuration for modeling purposes. As a result, Exhibit 3-12 includes approximately 2 percent of all arrivals landing on Runway 30.

Close to 75 percent of all departures during North Flow occurred on Runway 30. Approximately 16 percent departed from Runway 1R. During peak departure demand periods, the Dulles International ATCT uses Runway 1C for departures; and in 2017, this occurred for approximately 9 percent of all north flow departures. The Dulles International ATCT does not use Runway 1L often for departures during north flow due to the additional taxi time and additional complexities when crossing Runway 1C-19C.



SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); 2017 running operating configuration definition; FAA, Aviation System Performace Metrics, accessed April 2018; 2017 runway use: MWAA Airport Noise and Operations Management System, January 1, 2017 to December 31, 2017.

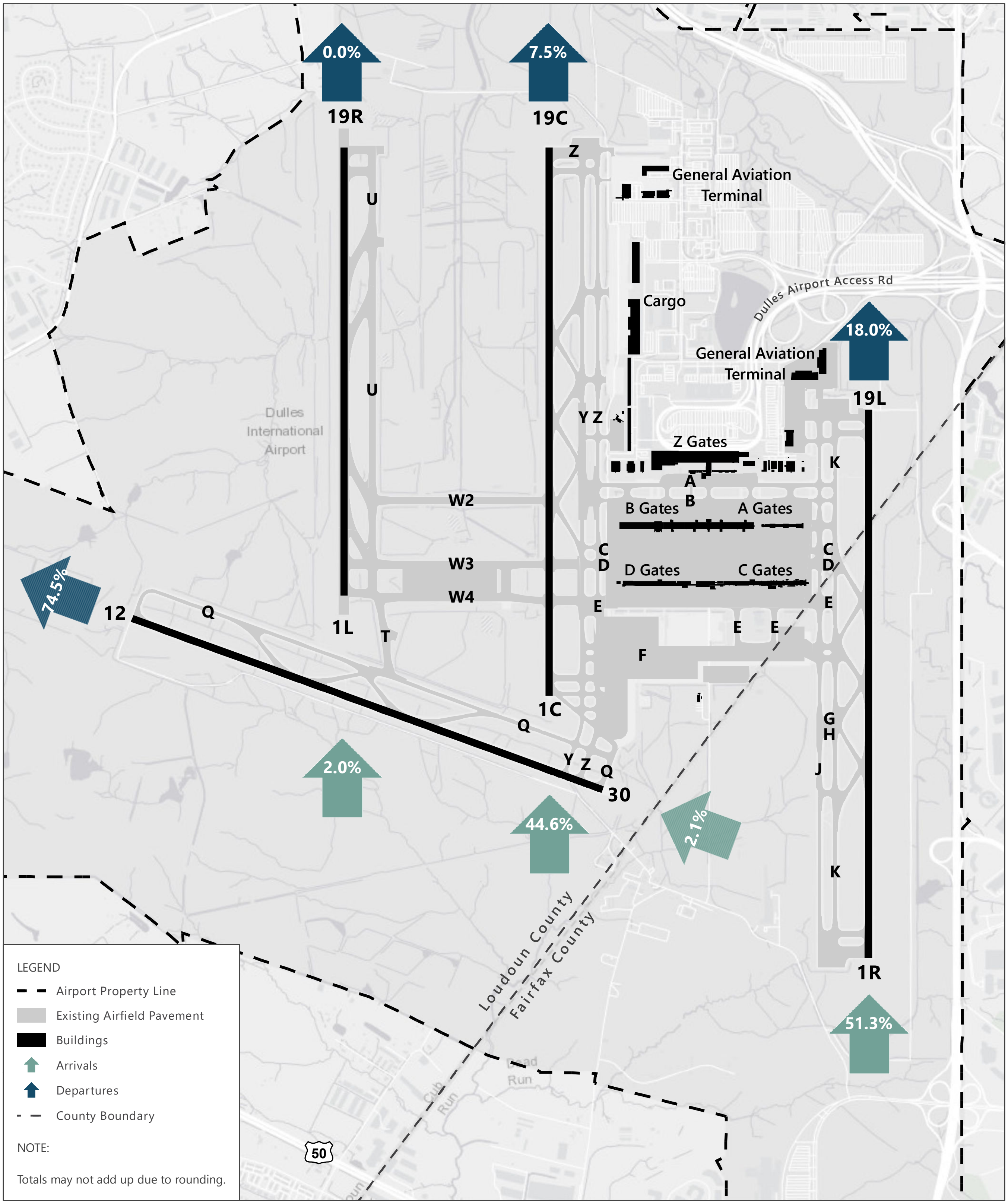
EXHIBIT 3-12

NORTH

0 3,000 ft

NORTH FLOW RUNWAY USE FOR ALL HOURS - 2017

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-12_NorthFlowRwyUseForAllHours2017_20190530.mxd



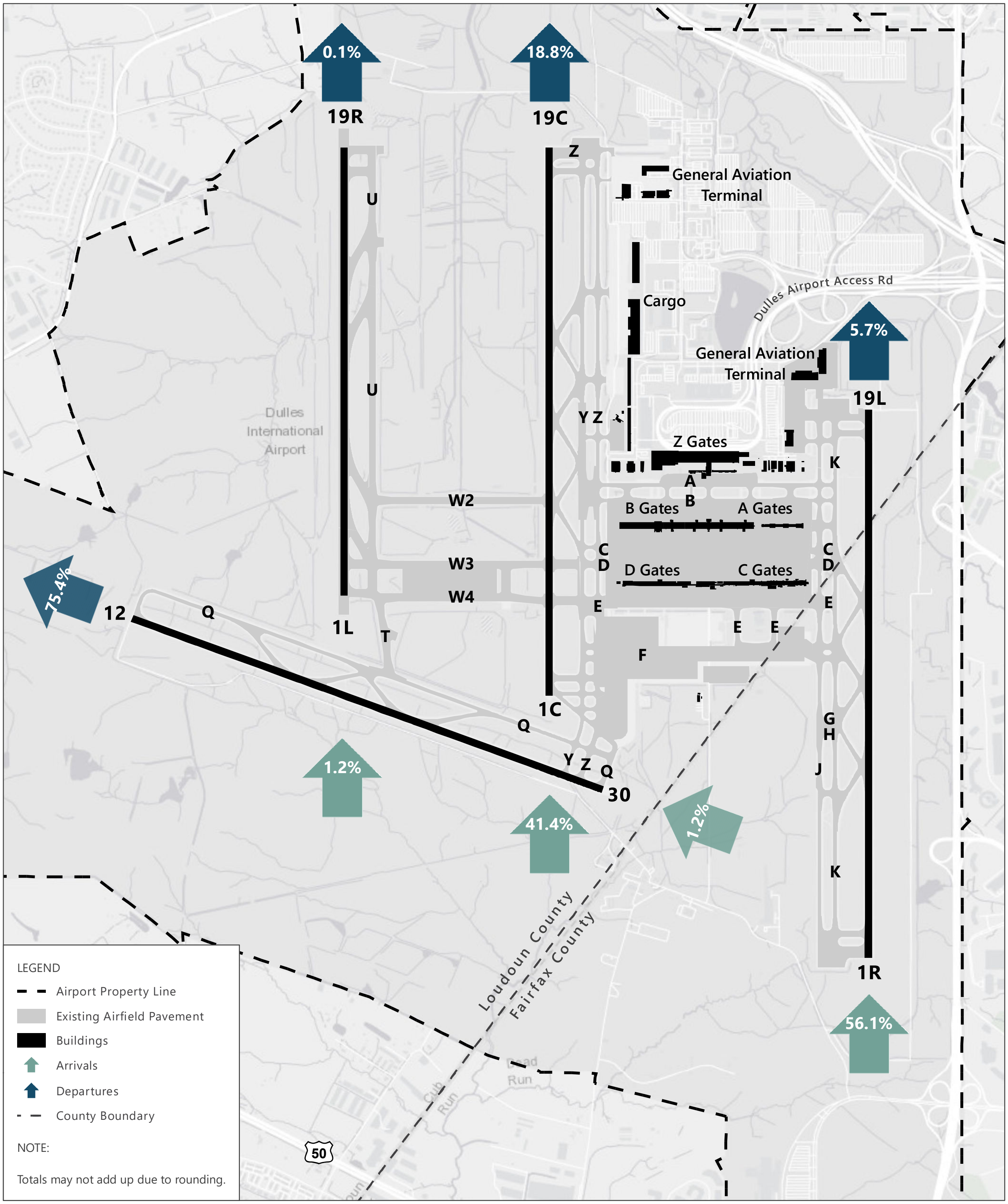
SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); 2017 running operating configuration definition; FAA, Aviation System Performace Metrics, accessed April 2018; 2017 runway use: MWAA Airport Noise and Operations Management System, January 1, 2017 to December 31, 2017.

EXHIBIT 3-13

NORTH 0 3,000 ft

NORTH FLOW RUNWAY USE FOR DAYTIME HOURS - 2017

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-13_NorthFlowRwyUseForDaytimeHours2017_20190530.mxd



SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); 2017 running operating configuration definition; FAA, Aviation System Performace Metrics, accessed April 2018; 2017 runway use: MWAA Airport Noise and Operations Management System, January 1, 2017 to December 31, 2017.

EXHIBIT 3-14

NORTH 0 3,000 ft

NORTH FLOW RUNWAY USE FOR NIGHTTIME HOURS - 2017

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-14_NorthFlowRwyUseForNighttimeHours2017_20190530.mxd

Runway-use patterns were slightly different during the nighttime hours than during the daytime hours. The following patterns were identified:

- Runway 1R was used approximately 4 percent more for arrivals during the nighttime period than the daytime period.
- Runway 30 departure use was similar between daytime and nighttime hours (approximately 75 percent), but a higher percentage of departures occurred on Runway 1C during nighttime hours (approximately 19 percent) compared to the daytime (approximately 8 percent).
- Departure use of Runway 1R was lower at night (approximately 6 percent) than during the day (approximately 18 percent). The data suggests that the Dulles International ATCT primarily assigns Runway 1C over Runway 1R for nighttime departures, which differs from daytime use of these runways.

The difference in runway use between daytime and nighttime may be due to the reduced level of operations and Dulles International ATCT's ability to accommodate pilot requests during low demand periods (nighttime hours) for the runway end closest to the west side concourse gates and cargo apron

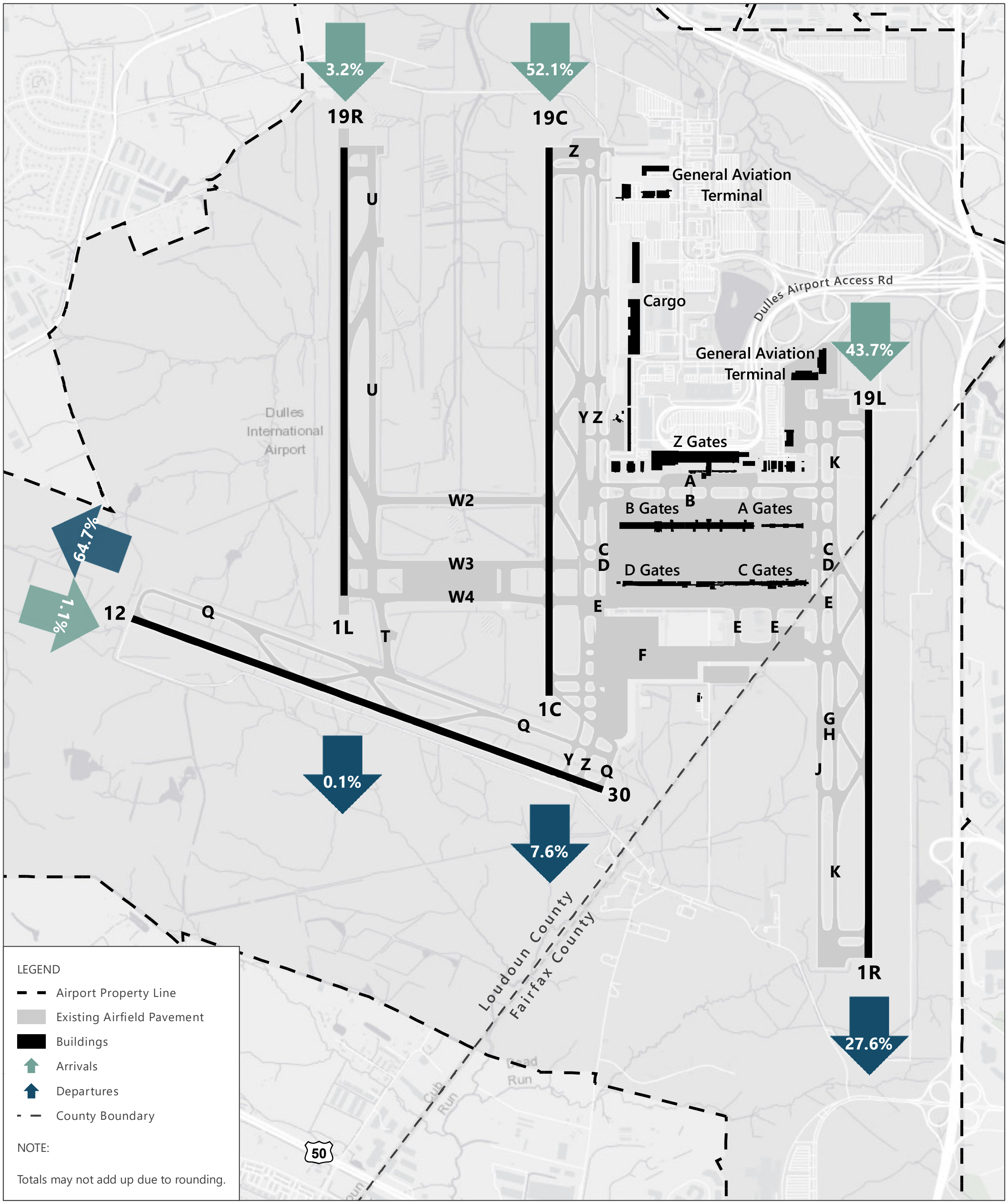
3.2.4.2 SOUTH FLOW RUNWAY USE

Exhibits 3-15, **3-16**, and **3-17** depict the AAD runway use for all hours, and for daytime and nighttime, respectively, for the South Flow runway operating configuration. Approximately 52 percent of all South Flow arrivals occurred on Runway 19C, and 44 percent on Runway 19L. Runway 19R was used approximately 3 percent for arrivals. The low use is most likely due to the additional taxi time and runway crossings necessary to reach the terminals.

Approximately 65 percent of all departures during South Flow occurred on Runway 30. Approximately 28 percent of aircraft departed from Runway 19L. During peak departure demand periods, the Dulles International ATCT uses Runway 19C for departures. In 2017, approximately 8 percent of all departures used Runway 19C. The ATCT does not use Runway 19R often because of the additional taxi time and the additional complexities when crossing Runway 1C-19C. In addition, 2017 demand levels did not often require the use of Runway 19R.

Runway use patterns were slightly different during the nighttime hours than during the daytime hours. The following patterns were identified:

- Runway 19C was used slightly more during the nighttime period compared to the daytime period.
- Runway 30 departure use was higher during nighttime hours (approximately 73 percent) compared to the daytime hours (approximately 61 percent).
- Departures on Runways 19C and 19L during nighttime hours were more evenly distributed than during the daytime hours.
  - Runway 19C was used approximately 12 percent at night compared to approximately 7 percent during the daytime.
  - Departures from Runway 19L were lower at night (approximately 15 percent) compared to the daytime (approximately 32 percent).



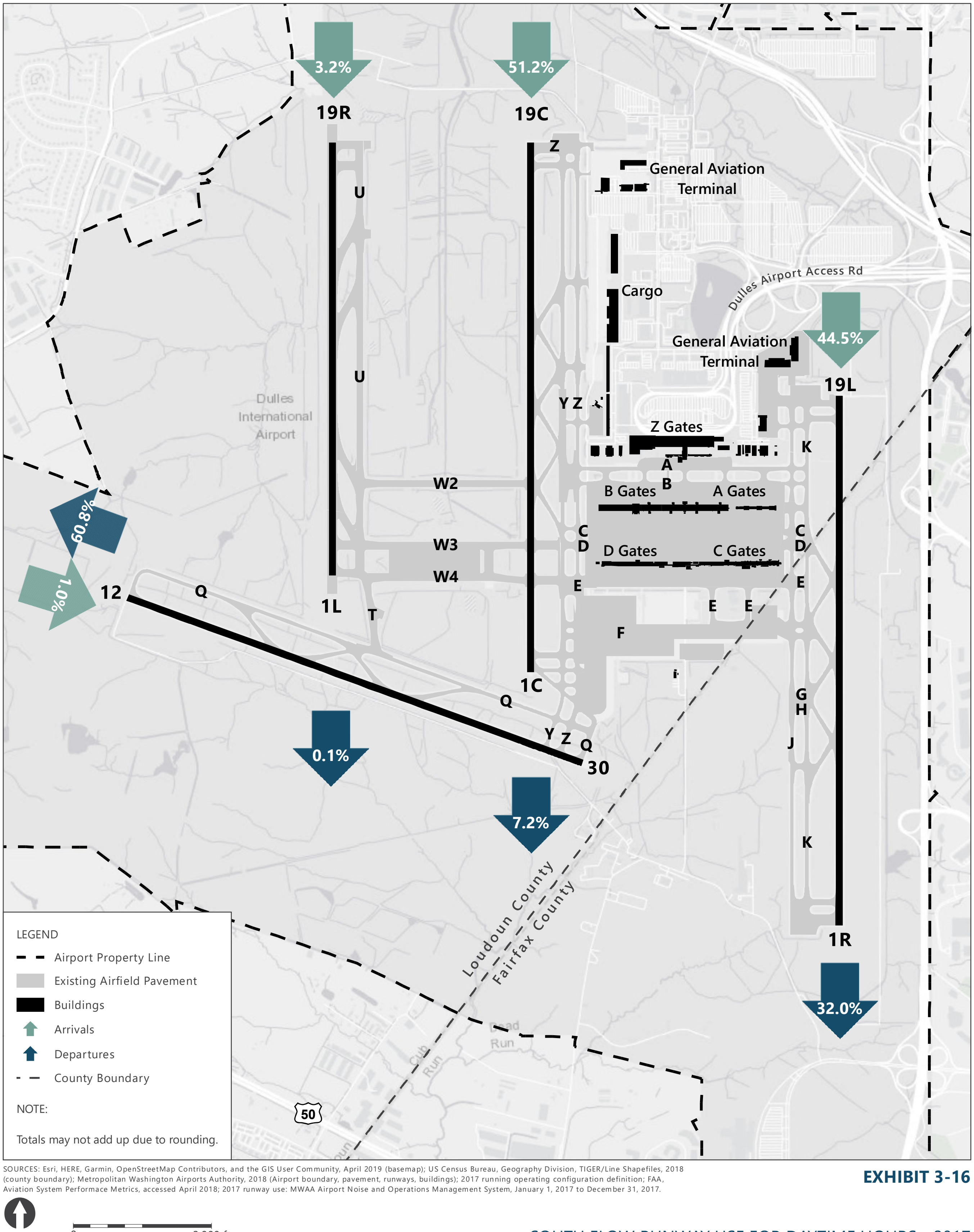
SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); 2017 running operating configuration definition; FAA, Aviation System Performace Metrics, accessed April 2018; 2017 runway use: MWAA Airport Noise and Operations Management System, January 1, 2017 to December 31, 2017.

EXHIBIT 3-15

NORTH 0 3,000 ft

SOUTH FLOW RUNWAY USE FOR ALL HOURS - 2017

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-15_SouthFlowRwyUseForAllHours2017_20190530.mxd

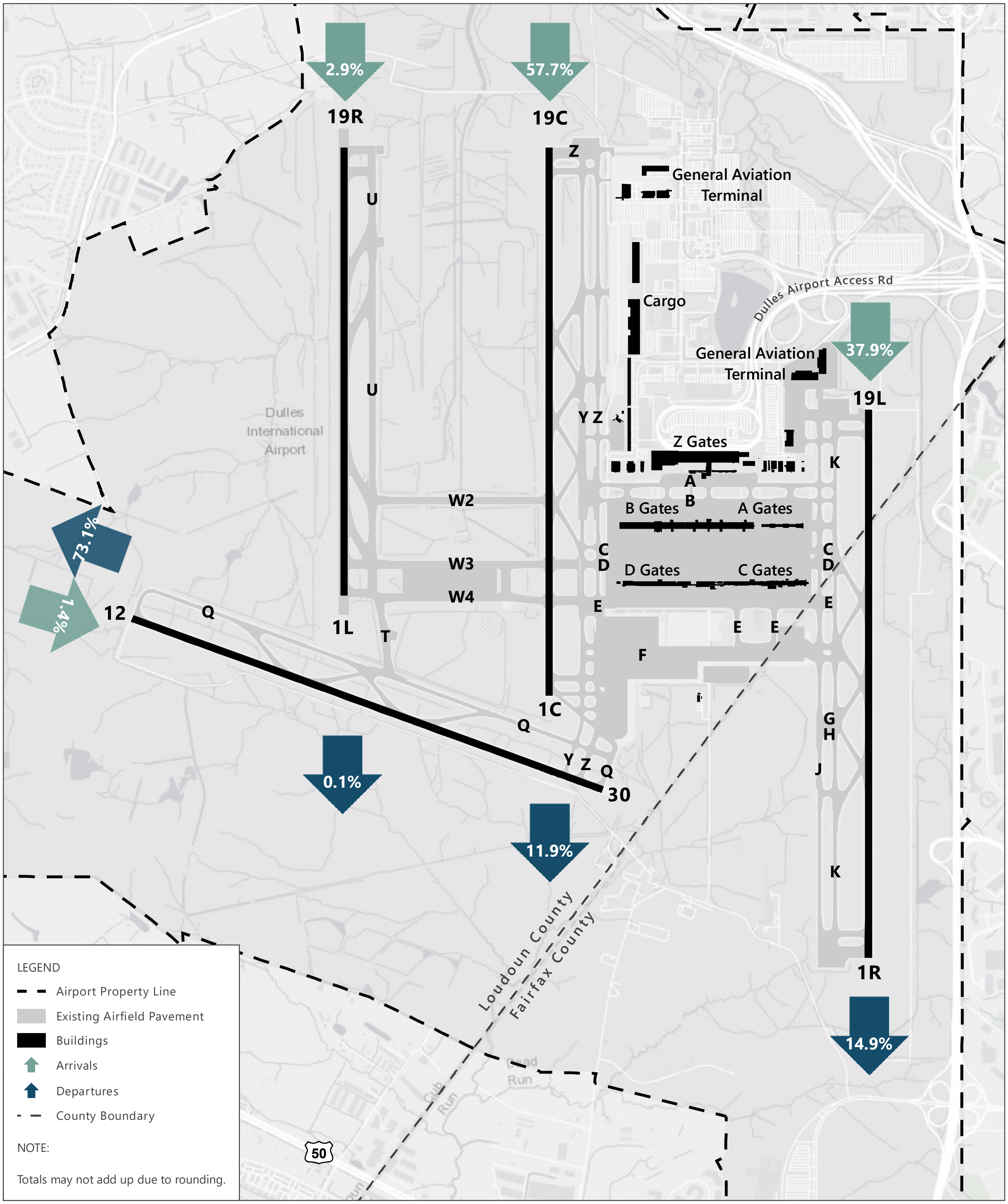


SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); 2017 running operating configuration definition; FAA, Aviation System Performace Metrics, accessed April 2018; 2017 runway use: MWAA Airport Noise and Operations Management System, January 1, 2017 to December 31, 2017.

EXHIBIT 3-16

SOUTH FLOW RUNWAY USE FOR DAYTIME HOURS - 2017

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-16_SouthFlowRwyUseForDaytimeHours2017_20190530.mxd



SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); 2017 running operating configuration definition; FAA, Aviation System Performace Metrics, accessed April 2018; 2017 runway use: MWAA Airport Noise and Operations Management System, January 1, 2017 to December 31, 2017.

EXHIBIT 3-17

NORTH

0 3,000 ft

SOUTH FLOW RUNWAY USE FOR NIGHTTIME HOURS - 2017

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-17_SouthFlowRwyUseForNighttimeHours2017_20190530.mxd

The Dulles International ATCT primarily assigns Runway 19C over Runway 19L for nighttime departures, which differs from daytime use of these runways. It is likely that the Dulles International ATCT is better able to accommodate pilot requests during low demand periods (nighttime hours) for the runway end closest to the west side concourse gates and cargo apron. Pilots departing from the east side of the concourses may request Runway 19L due to its proximity to those gates. This may be the reason that runway use is more evenly distributed between Runways 19L and 19C during the nighttime hours.

3.3 EXISTING LAND USE AND ZONING

Analysis of the land use and zoning information within the Airport's environs assists in identifying sensitive land-use areas in relation to aircraft noise. A review of existing land uses and zoning protections located in Dulles International's environs identified the relationship between land uses and exposure to aircraft noise from departing and arriving aircraft.

Existing land use and zoning, including land-use compatibility, zoning ordinances, and plans and policies in relation to aircraft noise that affect development on- and off-Airport within Fairfax County, Loudoun County, and the Town of Herndon are summarized in this section. This section depicts the generalized land uses within Fairfax County and Loudoun County, which can serve as a basemap for further aircraft noise analyses. Data were collected in May 2018 from the open-source data websites hosted by Loudoun County and Fairfax County. The Fairfax County data included data for the Town of Herndon.

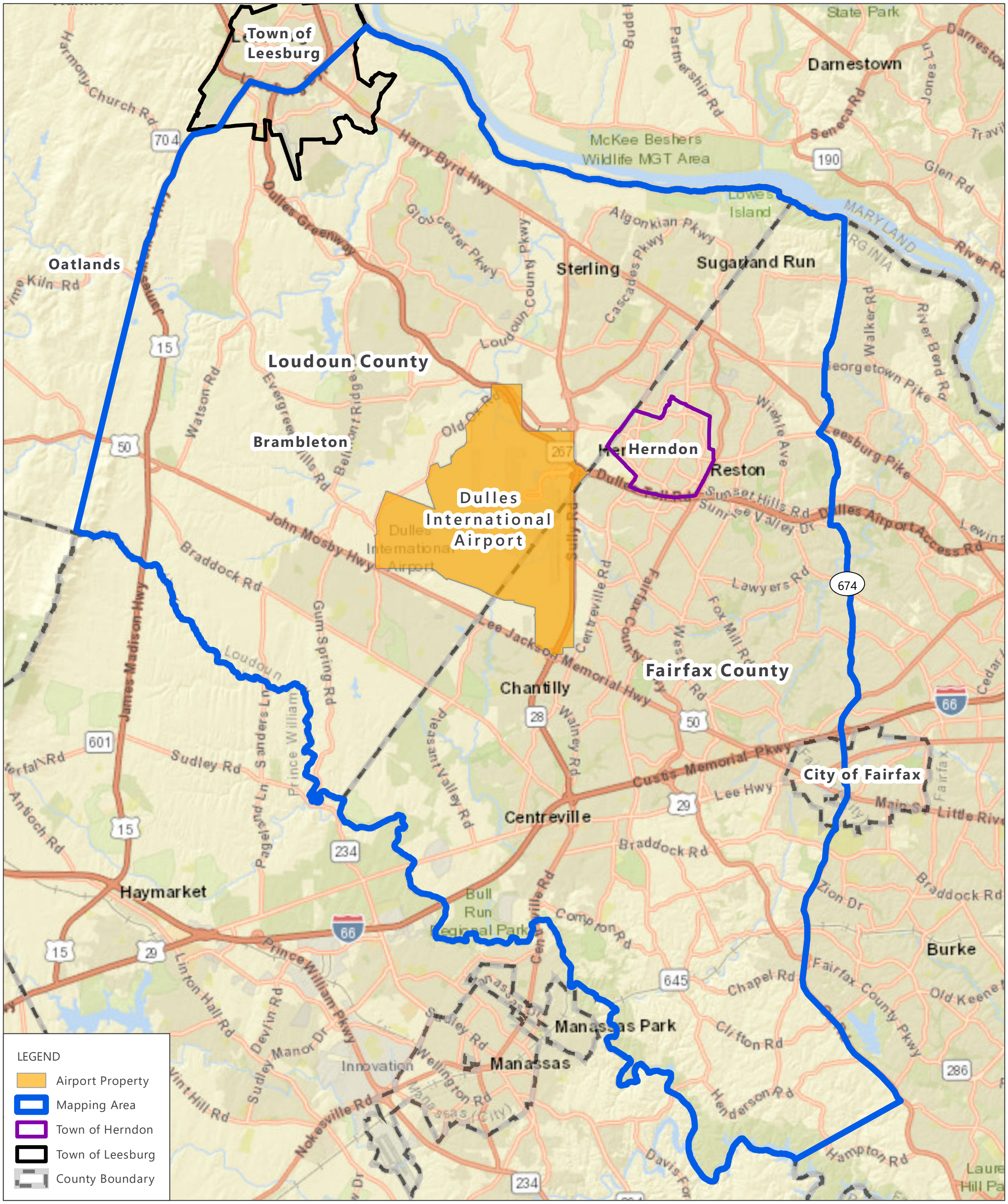
3.3.1 LAND USE / ZONING MAPPING AREA

As shown on **Exhibit 3-18**, the Land Use / Zoning Mapping Area (Mapping Area), generally bounded by State Highway 15 in the west, Fairfax County and Loudoun County boundaries in the north and south, and Highway 674 in the east, was established to generate a comprehensive collection and review of land use and zoning surrounding the Airport. The Mapping Area is centered on the Airport and is approximately 335 square miles.

The Mapping Area was defined using several criteria relevant to aircraft noise:

- The Fairfax County and Loudoun County Airport Impact Overlay District contours, as depicted on **Exhibit 3-19** and **Exhibit 3-20**, respectively, provided a starting point.
- The Mapping Area was defined to include area out to a distance of 40,000 feet from each existing and future runway end.
- Arrival and departure operation flight track data[61] were plotted in GIS to consider flight patterns to help define the Mapping Area.
- The Mapping Area was then further refined using natural and jurisdictional boundaries and roadways.

[61] Arrival and departure data were generated from a sample of 36 representative days of arrival and departure operations for the year 2017.



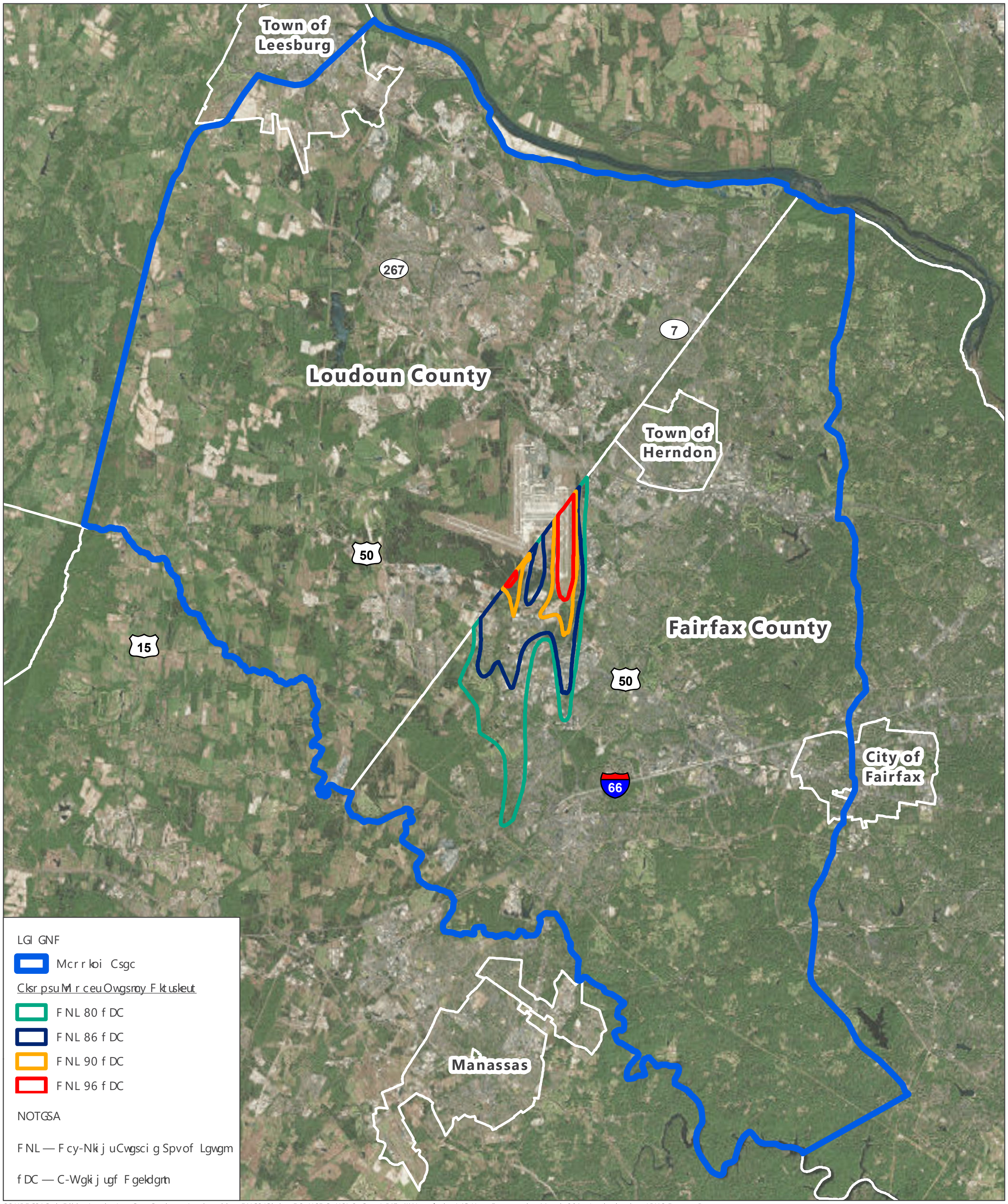
SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (place, county boundary); Ricondo & Associates, Inc., May 2018 (mapping area); Metropolitan Washington Airports Authority, 2018 (Airport boundary).

EXHIBIT 3-18

NORTH 0 3.5 mi

LAND USE AND ZONING MAPPING AREA

P:\GIS\Projects\IAD\MXD\IAD_Exhibit3-18_LUZoningMappingArea_20190529.mxd



SOUREGSAGtsk, F ki kucmh mpdg, I gpGyg, Gcsuj tucs I gpi scr j ket, ENGS/Cksdvt F S, USF C, USI S, CgsplRM, MN, cof uj g I M Utgs Epn n vokuy, Mcsej 201: (cgskcmkn ci gsy)BUS Egotvt Dvsgcv, I gpi scr j y F kwktkpo, TMI GR/Lkog Sj cr gHkmgt, 201: (r mceg, epvouy dpvof csy)BHckshcx E pvouy, \ksi kokc, 2016 (zpokoi pwgsmy f ktuskeut)BRkepof p & Cttpekcugt, Moe., 201: (n cr r koi csgc).

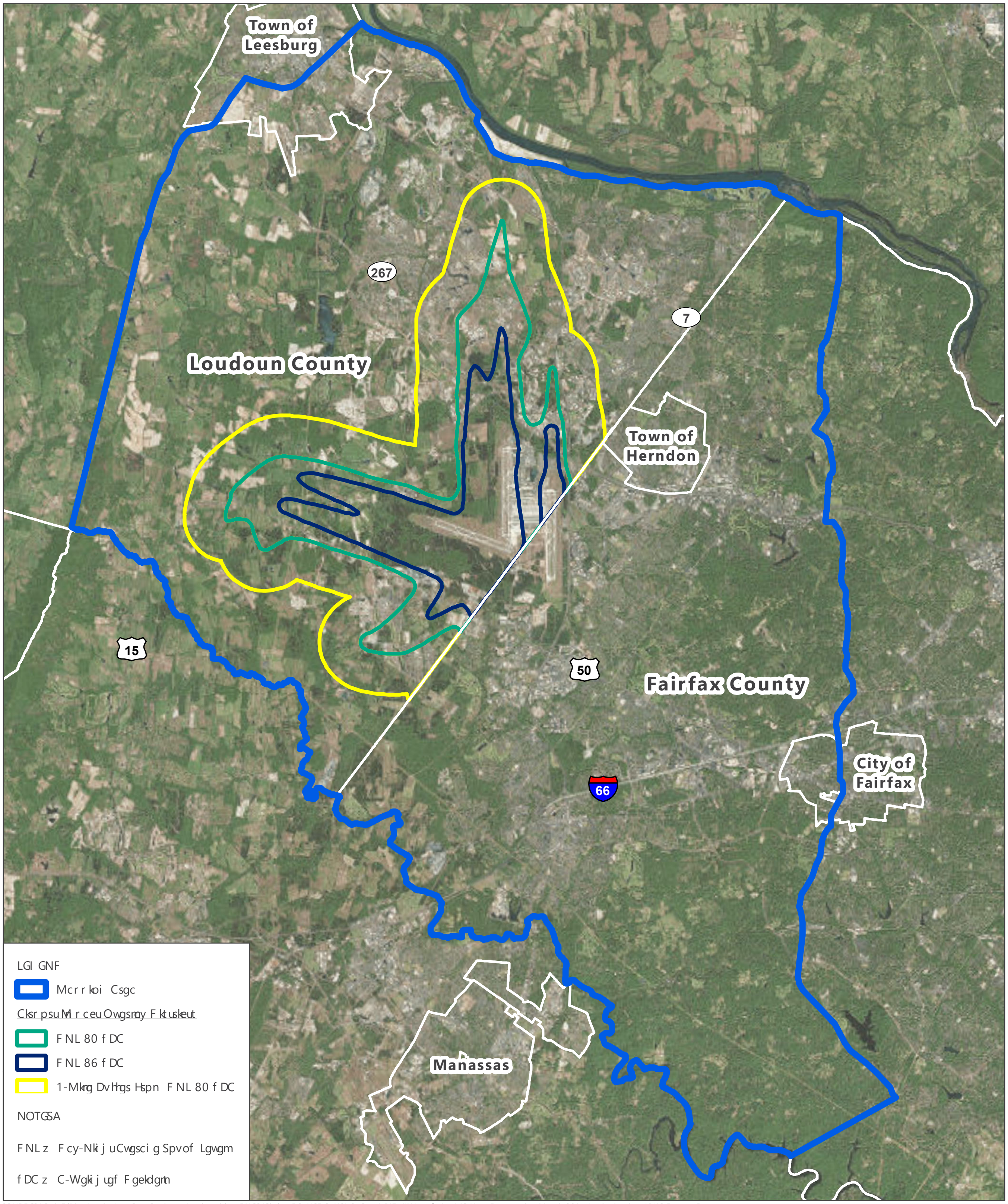
EXHIBIT 3-19

NORTL

0 3.6 n k

HCNHCX EOUNT\
CNPORT NMPCET O\ GRLC\ F NSTRNTS

PAl MaPsplgeuaMF aMXF aMF bGxj kdku3-1; bHckshcx_pokoi Owgsmyb201; 062; .n xf



SOUREGSAGtsk, F ki kucrh mpdg, I gpGyg, Gcsuj tucs I gpi scr j ket, ENGS/Cksdvt F S, USF C, USI S, CgsplRM, MN, cof uj g I M Utgs Epn n vokuy, Mcsej 201: (cgskcmkn ci gsy)BUS Egotvt Dvsgcv, I gpi scr j y F kwktkpo, TMI GR/Lkog Sj cr gHkmgt, 201: (r moeg, epvouy dpvof csy)BLpvf pvo Epvouy, \ksi kokc, 2019 (Lpvf pvo cksr psu kn r ceu pwgsmy f ktuskeut)BRkepof p & Cttpekcugt, Mde., 201: (n cr r koi csgc).

EXHIBIT 3-20

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3.3.2 LAND USE COMPATIBILITY GUIDELINES AND ZONING ORDINANCES FOR AIRCRAFT NOISE

The Airport is considered in Fairfax County's Comprehensive Plan and Loudoun County's General Plan. The *Fairfax County Comprehensive Plan, 2017 Edition*, is the comprehensive planning document that outlines the goals, objectives, and policies that are used to guide decision-making about the built and natural environment. The *Loudoun County Revised General Plan, 2018* outlines strategic plans and goals to promote county growth, while preserving environmental and historical features within Loudoun County.

The current zoning ordinance for the area inside the Mapping Area is detailed in Fairfax County Zoning Ordinance, (Airport Noise Impact Overlay District [§ 7-400]), and the Loudoun County Zoning Ordinance, (AI-Airport Impact Overlay District [§ 4-1400]). The Town of Herndon zoning ordinance does not include an airport impact overlay district. These zoning ordinances are intended to promote a sustainable and healthy environment for the community, mitigating adverse impacts of aircraft noise and promoting the implementation of comprehensive plans within each area.

The following subsections summarize jurisdictions with land-use compatibility plans and zoning authority in areas adjacent to or near the Airport within the Mapping Area.

3.3.2.1 LAND USE COMPATIBILITY PLANNING GUIDELINES

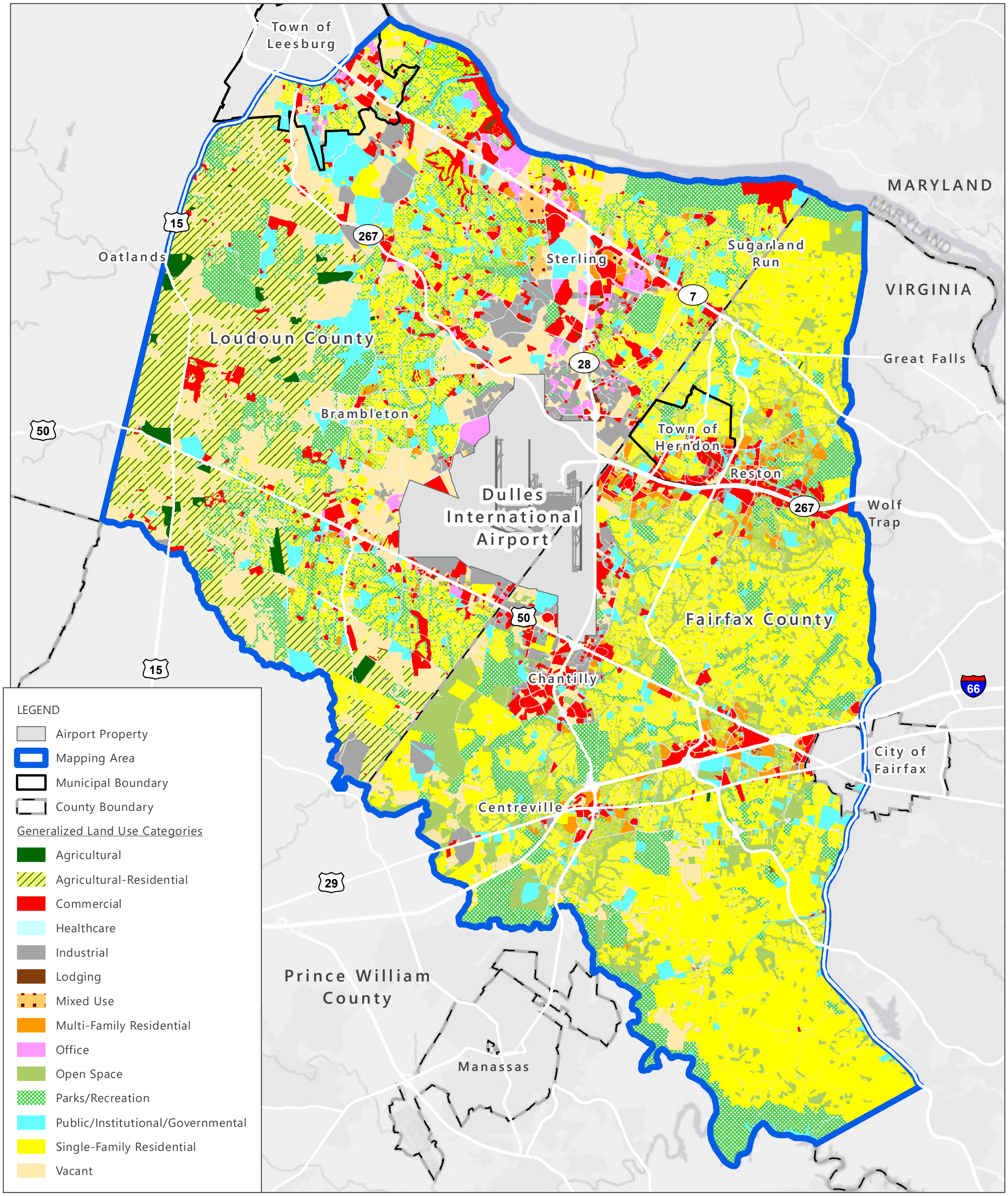
As shown on **Exhibit 3-21**, the majority of Fairfax County within the Mapping Area comprises residential land uses, primarily single-family to the northeast of the Airport near the communities of Sugarland Run and Herndon and southeast of the Airport near the communities of Chantilly and Centreville. Multi-family land use is located due east of the Airport. Approximately 51,000 acres of residential land use are located within the portion of Fairfax County in the Mapping Area. The residential land use areas are interspersed with public, institutional, and governmental land uses, which include properties such as schools, public libraries, and houses of worship. Commercial and industrial land uses are located along arterial roadways, predominantly south and east of the Airport, near the communities of Chantilly and Reston. Agricultural, open space, and parks/recreation land uses are located south of the Airport, along the south boundary of the Mapping Area, and north of Sugarland Run. The *Fairfax County Comprehensive Plan, 2017 Edition* advises that residential land uses are not recommended in aircraft noise contours of DNL 60 dBA and higher.[62] Further, Fairfax County adopted a policy that new residential development will not occur where the projected aircraft noise exceeds DNL 60 dBA.[63]

Loudoun County

As shown on Exhibit 3-21, the land uses in the Loudoun County portion of the Mapping Area comprise residential and agricultural-residential, public, institutional, governmental, commercial, and vacant lands. Approximately 36,000 acres of the Mapping Area in Loudoun County is residential land. Office, industrial, commercial, and vacant lands are primarily located directly west of Airport property and north of the Airport near the community of Sterling.

[62] Fairfax County, Fairfax County Comprehensive Plan, "Land Use Planning within the Dulles Airport Noise Impact Area," 2017 ed., March 14, 2017, p. 22.

[63] Fairfax County, Fairfax County Comprehensive Plan, "Land Use Planning within the Dulles Airport Noise Impact Area," 2017 ed., March 14, 2017, p. 9.



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (place, county boundary); Fairfax County, 2017, https://data-fairfaxcountygis.opendata.arcgis.com/ (accessed April 2018) (land use); Loudoun County, 2018, https://data-loudoungis.opendata.arcgis.com/ (accessed April 2018) (land use); Ricondo & Associates, Inc., May 2018 (mapping area); Metropolitan Washington Airports Authority, 2018 (Airport components); parcels designations updated based on teleconfences with Fairfax and Loudoun County between June and July 2018.

NORTH 0 3.5 mi

EXHIBIT 3-21

GENERALIZED EXISTING LAND USE
IN THE MAPPING AREA

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Loudoun County's current comprehensive land use plan references the zoning ordinances related to aircraft noise compatibility. Refer to Section 3.3.2.3 regarding aircraft noise compatibility requirements for Loudoun County.

Town of Herndon

The Town of Herndon's Comprehensive Plan does not identify compatibility guidelines as related to aircraft noise in general or specific to Dulles International.[64]

3.3.2.2 GENERALIZED EXISTING LAND USE

The existing land-use designations for Fairfax County and Loudoun County, depicted on Exhibit 3-21, include 13 generalized land use designations, which were combined and simplified from 34 unique land-use designations[65] that exist within the Mapping Area. **Table 3-11** lists the generalized existing land-use categories for the Mapping Area, and relates them to the Fairfax and Loudoun County unique designations provided in the geospatial data.

TABLE 3-11 GENERALIZED LAND USE CATEGORIES IN THE AIRPORT ENVIRONS

GENERALIZED LAND-USE CATEGORIES	UNIQUE LAND-USE DESIGNATIONS BY COUNTY	
	FAIRFAX	LOUDOUN
Agricultural	Agricultural	Farm
Commercial	Commercial	Miscellaneous Multiuse Other: Nonpublic Retail
Healthcare	--	Medical Office
Industrial	Industrial, Light and Heavy	Heavy Industrial Light Industrial Flex
Lodging	--	Hotel
Mixed Use[1]	Group Quarter	Group Quarter
Multi-Family Residential	High-Density Residential	Multi-Family Attached Multi-Family Stacked
Office	--	Data Center General Office
Open Space	Open Land, not Forested or Developed	
Parks/Recreation	Recreation	Golf Course Homeowner's Association
Public/Institutional/Governmental	Institutional Public Utilities	Airport Church Other: Public Public
Single-Family Residential	Low-Density Residential Medium-Density Residential	Single-Family Attached Single-Family Detached
Vacant	--	Vacant

NOTES:
-- Not Applicable
1 Mixed-use is currently not present within the Mapping Area, but is included in table as requested by Fairfax County for potential future land use reference.
SOURCES: Fairfax County, 2017 (land use); Loudoun County (land use); Ricondo & Associates, Inc., May 2018.

[64] Town of Herndon, Virginia, Code of Ordinances, 2000.

[65] Fairfax County, 2017 https://data-fairfaxcountygis.opendata.arcgis.com (accessed April 12, 2018); Loudoun County, 2018, https://data-loudoungis.opendata.arcgis.com (accessed April 12, 2018); parcels designations updated based on teleconfences with Fairfax and Loudoun County between June and July 2018.

3.3.2.3 ZONING ORDINANCES

Fairfax County

Fairfax County has established zoning for areas to the south and east of the Airport. As shown on **Exhibit 3-22**, areas directly surrounding the Airport are zoned as Industrial. Industrially zoned areas are also located along US Route 287, an arterial roadway. Areas to the east of the Airport are primarily zoned as Single-Family Residential, while the community of Centreville, directly south of the Airport, is primarily zoned as Multi-Family Residential. Within the portion of Fairfax County in the Mapping Area, 88,681 acres are zoned as Residential. Residential uses within the DNL 65 to 75 dBA exposure area are not recommended, but are permitted if acoustical treatment is installed to achieve interior noise levels within living spaces at or below DNL 45 dBA. For areas exposed to DNL 75 dBA or higher, new residential units are not permitted; however, additions to existing units and new units on certain lots are permitted if acoustical treatment is installed to achieve interior noise levels within living spaces at or below DNL 45 dBA.[66]

Loudoun County

Loudoun County has established zoning for areas to the north and west of the Airport, as shown on Exhibit 3-22. Areas zoned as Industrial and Commercial are in the immediate vicinity and north of the Airport. Areas to the west of the Airport are primarily zoned as Agricultural, Mixed Use, and Single-Family Residential. Within the portion of Loudoun County in the Mapping Area, 58,742 acres are zoned as Residential.

The Loudoun County Zoning Ordinance states that no new residential development will be permitted within DNL 65 dBA. The plan states that the county requires interior acoustical residential treatments and avigation easements in the banded contour between DNL 60 and 65 dBA. Full-disclosure statements are required for those living within the area between the DNL 60 and 65 dBA contours, as well as in a 1-mile buffer outside of the DNL 60 dBA contour. Loudoun County adopted a policy that restricts new residential development within areas exposed to DNL 65 dBA and higher. [67]

Town of Herndon

The Town of Herndon's zoning ordinance does not identify compatibility regulations or residential restrictions as related to aircraft noise in general or specific to Dulles International.[68]

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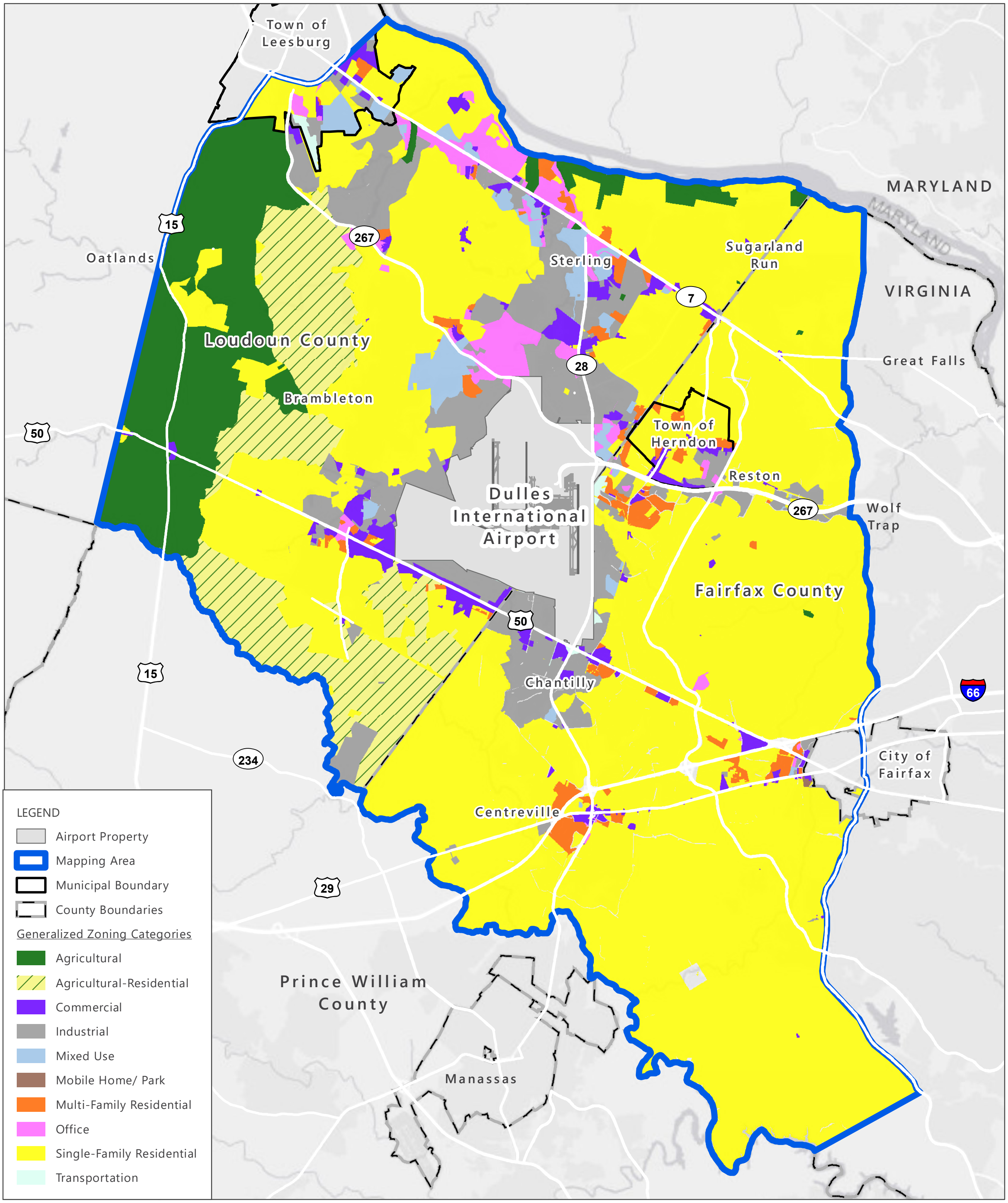
[66] Fairfax County, Virginia, Zoning Ordinance, Airport Noise Impact Overlay District § 7-400.

[67] Loudoun County, Virginia, Zoning Ordinance, AI-Airport Impact Overlay District § 4-1400.

[68] Town of Herndon, Virginia, Code of Ordinances, 2000.



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (place, county boundary); Fairfax County, 2017, https://data-fairfaxcountygis.opendata.arcgis.com/ (accessed April 2018) (zoning); Loudoun County, 2018, https://data-loudoungis.opendata.arcgis.com/ (accessed April 2018) (zoning); Metropolitan Washington Airports Authority, 2018 (Airport components); Ricondo & Associates, Inc., May 2018 (mapping area).

EXHIBIT 3-22

GENERALIZED EXISTING ZONING IN THE MAPPING AREA

NORTH 0 3.5 mi

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3.3.2.4 GENERALIZED EXISTING ZONING

The existing zoning for Fairfax and Loudoun Counties, and the Town of Herndon, depicted on Exhibit 3-22, includes Agricultural, Commercial, Industrial, Mixed Use, Mobile Home/Park, Multi-Family Residential, Office, Single-Family Residential, and Transportation. These 9 zoning designations were developed by combining and simplifying the 118 unique zoning district designations[69] that exist within the Mapping Area. **Table 3-12** correlates the generalized zoning categories in the Mapping Area and to the specific use codes and descriptions established by Fairfax County, Loudoun County, and the Town of Herndon.

3.4 STAKEHOLDER INPUT

The inventory data collection process and existing inventory data collected (e.g. existing airfield facilities, landings/takeoffs, runway use, flight track patterns, FAA-published approaches and procedures, and generalized land use) were presented to the Working Group on June 6, 2018. The briefing included an overview of the five-runway airfield and planned on-Airport land use. A copy of the presentation is provided in Appendix A.

During the inventory process, Loudoun County and Fairfax County Working Group members reviewed the existing generalized land use categories and provided input on specific designations. All members were provided an opportunity to review Sections 1, 2 and, 3 and comments received were addressed accordingly.

3.5 PROJECT PURPOSE, INVENTORY, AND PROCESS PUBLIC WORKSHOP

Based on consultation with the Working Group, MWAA held two public workshops from 6:00 p.m. to 8:00 p.m.—one on June 27, 2018, at Dulles International and a second on June 28, 2018, at Rock Ridge High School in Ashburn, Virginia. Attendees from the general public were provided an overview of the study purpose, the study process, the changes that occurred since 1993, the important role Dulles International plays in the local and regional economy, and the historical use of long-term contours for land use compatibility planning, existing land use around Dulles International. Attendees were also provided information related to existing landing/takeoff operation levels, flight track patterns, and runway use at Dulles International. **Appendix B** includes a copy of the workshop boards, sign-in sheets and comments submitted by attendees. A total of 31 members of the public attended the June 27, 2018, public workshop, and 22 attended the June 28, 2018, public workshop.

Experts were available to inform attendees about the study and why MWAA was conducting the study as well as to answer questions. MWAA also posted the workshop boards to their website for those who could not attend. Attendees were provided an opportunity to submit written comments and/or submit comments via email up to 30 calendar days after the last workshop date. MWAA received nine written comments, which are available in Appendix B. In response to the comments, MWAA developed a Frequently Asked Questions document and posted it to its website. Appendix B includes a copy of the Frequently Asked Questions document.

[69] Fairfax County, https://data-fairfaxcountygis.opendata.arcgis.com (accessed April 12, 2018); Loudoun County, https://data-loudoungis.opendata.arcgis.com (accessed April 12, 2018); Town of Leesburg, Leesburg Zoning Map, http://www.arcgis.com/home/item.html?id=4d14881478c14dfdbc74b86576716096 (accessed May 1, 2018); TO BE UPDATED UPON RECEIPT OF CITY OF FAIRFAX DATA

TABLE 3-12 (1 OF 2) GENERALIZED ZONING CATEGORIES IN THE AIRPORT ENVIRONS

GENERALIZED ZONING CATEGORY	FAIRFAX COUNTY		LOUDOUN COUNTY		TOWN OF HERNDON	
	USE CODE	DESCRIPTION	USE CODE	DESCRIPTION	USE CODE	DESCRIPTION
Agricultural	R-A	Rural Agricultural District	A3	Agricultural/Residential		
			AR1	Agricultural Rural - 1		
			AR2	Agricultural Rural - 2		
Commercial	C-5	Neighborhood Retail Commercial District	C1	Planned Development - Commercial Center	CC	Central Commercial District
	C-6	Community Retail Commercial District	CLI	Commercial/Light Industry	CO	Commercial Office District
	C-7	Regional Retail Commercial District	GB	General Business	CS	Commercial Services District
	C-8	Highway Commercial District	PDCC(CC)	Planned Development - Commercial Center (Community Center)	PD-TD	Planned Development - Traditional Downtown
	PD-TOC	Planned Development - Transit Oriented Care	PDCC(NC)	Planned Development - Commercial Center (Neighborhood Center)		
	PD-W	Planned Development – World Gate	PDCC(RC)	Planned Development - Commercial Center (Regional Center)		
			PDCC(SC)	Planned Development - Commercial Center (Small Regional Center)		
			PDCH	Planned Development - Commercial Center		
			PDMUB	Planned Development – Mixed-Use Business District		
			PDSA	Planned Development - Special Activity		
			RC	Rural Commercial District		
Industrial	I-2	Industrial Research District	I1	Mineral Resources - Heavy Industry	O&LI	Office and Light Industrial District
	I-3	Light Intensity Industrial District	MRHI	Mineral Resources - Heavy Industry		
	I-4	Medium Intensity Industrial District	PDGI	Planned Development - General Industry		
	I-5	General Industrial District	PDIP	Planned Development - Industrial Park		
	I-6	Heavy Industrial District				
Mixed Use	PRM	Planned Residential Mixed-Use District	PDH3	Planned Development Housing – 3 Net Residential Density		
			PDH4	Planned Development Housing - 4 Net Residential Density		
			PDH6	Planned Development Housing - 6 Net Residential Density		
			PDRV	Planned Development - Rural Village		
			PDSC	Planned Development - Commercial Center		
			PDTC	Planned Development - Town Center		
			PDTRC	Planned Development - Transit Related Center		
Mobile Home/Park	R-MHP	Residential District, Mobile Home Park	JLMA1	Joint Land Management Area - 1		
Multi-Family Residential	PDH-12	Planned Development Housing Project, 12 Dwelling Units/Acre	R16	Townhouse/Multi-Family Residential	RM	Residential Multi-Family
	PDH-16	Planned Development Housing Project, 16 Dwelling Units/Acre	R24	Multi-Family Residential	RTC	Residential Townhouse Cluster District
	PDH-20	Planned Development Housing Project, 20 Dwelling Units/Acre				
	PDH-30	Planned Development Housing Project, 30 Dwelling Units/Acre				
	R-12	Residential Districts, 12 Dwelling Units/Acre				
	R-16	Residential Districts, 16 Dwelling Units/Acre				
	R-20	Residential Districts, 20 Dwelling Units/Acre				
	R-30	Residential Districts, 30 Dwelling Units/Acre				

TABLE 3-12 (2 OF 2) GENERALIZED ZONING CATEGORIES IN THE AIRPORT ENVIRONS

GENERALIZED ZONING CATEGORY	FAIRFAX COUNTY		LOUDOUN COUNTY		TOWN OF HERNDON	
	USE CODE	DESCRIPTION	USE CODE	DESCRIPTION	USE CODE	DESCRIPTION
Office	C-2	Limited Office District	PDOP	Planned Development - Office Park	PD-B	Planned Development Business District
	C-3	Office District	PDRDP	Planned Development - Research and Development Park		
	C-4	High Intensity Office District				
Single-Family Residential	PDC	Planned Development Housing District	CR1	Country Residential - 1	PD-D	Planned Development Downtown District
	PDH-1	Planned Development Housing Project, 1 Dwelling Unit/Acre	CR2	Country Residential - 2	PD-R	Planned Development - Residential
	PDH-2	Planned Development Housing Project, 2 Dwelling Units/Acre	JLMA20	Joint Land Management Area - 20	R-10	Residential Single-Family District
	PDH-3	Planned Development Housing Project, 3 Dwelling Units/Acre	JLMA3	Joint Land Management Area - 3	R-15	Residential Single-Family District
	PDH-4	Planned Development Housing Project, 4 Dwelling Units/Acre	PDAAAR	Planned Development - Active Adult/Age Restricted		
	PDH-5	Planned Development Housing Project, 5 Dwelling Units/Acre	R1	Single Family Residential		
	PDH-8	Planned Development Housing Project, 8 Dwelling Units/Acre	R2	Single Family Residential		
	PRC	Planned Residential Community District	R3	Single Family Residential		
	R-1	Residential Districts, 1 Dwelling Unit/Acre	R4	Single Family Residential		
	R-2	Residential Districts, 2 Dwelling Units/Acre	R8	Single Family Residential		
Single-Family Residential (continued)	R-3	Residential Districts, 3 Dwelling Units/Acre	TR10	Transitional Residential - 10		
	R-4	Residential Districts, 4 Dwelling Units/Acre	TR1LF	Transitional Residential - 1 (Lower Foley)		
	R-5	Residential Districts, 5 Dwelling Units/Acre	TR1UBF	Transitional Residential - 1 (Upper Broad Run and Upper Foley)		
	R-8	Residential Districts, 8 Dwelling Units/Acre	TR2	Transitional Residential - 2		
	R-C	Residential-Conservation District	TR3LBR	Transitional Residential - 3 (Lower Bull Run)		
	R-E	Residential Estate District	TR3LF	Transitional Residential - 3 (Lower Foley)		
			TR3UBF	Transitional Residential - 3 (Upper Broad Run and Upper Foley)		
Transportation			IAD	Washington Dulles International Airport		

SOURCES: Fairfax County, 2017 (zoning); Loudoun County (zoning); Town of Herndon, Virginia, 2000 (code of ordinances); Loudoun County, 1993 (zoning ordinance); Fairfax County, 2018 (zoning ordinance); Ricondo & Associates, Inc., May 2018.

4. ULTIMATE LEVELS OF OPERATIONS

Dulles International is a key driver of the Washington, DC, metropolitan area economy. This section describes the long-term role the Airport may serve toward meeting global, national, regional, and metropolitan area air service demand. Projected airfield configurations, the ultimate AAD flight operations (annual aircraft operations divided by 365 days), and ultimate AAD runway use and flight track patterns for each airfield configuration were used to determine the ultimate levels of operations and calculate updated noise contours for long-term land use planning.

4.1 GLOBAL, NATIONAL, REGIONAL, AND METROPOLITAN AREA IMPORTANCE

According to the FAA Aerospace Forecast, nationwide domestic and international passenger demand is expected to increase through the forecast horizon from fiscal year (FY) 2018 to FY 2038.[1] FAA forecasts indicate that international growth will be higher than domestic passenger growth. According to the same forecast, air cargo operators' Revenue Ton per Mile (RTM) will grow as well. Domestic RTM is expected to increase an average of 1.9 percent per year during the forecast timeframe, while international RTM is expected to increase an average of 4.7 percent per year, based on projected growth of the world Gross Domestic Product (GDP). Over 70 percent of international cargo tonnage is flown by all-cargo carriers. This share is projected to increase through FY 2038.[2]

The FAA expects faster growth for large hub airports than for smaller airports in the United States as airlines continue to consolidate their operations at large hubs.[3] Dulles International is a very important part of the National Airport System (NAS), trans-Atlantic, South America and mid-Atlantic air service markets. Furthermore, it is the only major hub airport in the United States with a planned additional runway (parallel to Runway 12-30) with environmental approval that can be constructed to accommodate demand, along with the acreage needed to expand passenger and cargo facilities.[4] As described in Section 3.1.3.4, there are 1,620 acres available to accommodate additional passenger and cargo facilities. No other large hub airport in major metropolitan areas in the northeast United States has the same expansion capabilities as Dulles International. This ability to expand can be attractive to passenger and cargo carriers as other major hub airports become more constrained, causing the level of service (e.g., on-time performance, passenger processing, etc.) to deteriorate. Dulles International is well positioned to become a larger domestic hub and critical international gateway as demand continues to grow and other large hub airports continue to be or become constrained.

Dulles International is uniquely located with regard to key socioeconomic factors. There is a large, affluent, and diverse population in the region, characterized by the following:

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1 US Department of Transportation, Federal Aviation Administration, *FAA Aerospace Forecast Fiscal Years 2018 to 2038*, May 2018, 16.

2 Ibid, 21.

3 Ibid, 2.

4 Runway 12R-30L was included in the *Final Environmental Impact Statement for New Runways, Terminal Facilities and Related Facilities at Washington Dulles International Airport,* which received a favorable FAA Record of Decision in October 2005. It is anticipated that, prior to construction, additional environmental review would be required to address any changes that may have occurred since the original approval.

- sixth largest (population) metro region based on a core-based statistical area (CBSA) defined by Office of Management and Budget[5]
- fifth fastest growing CBSA metropolitan region[6]
- highest median household income based on the twenty-five largest CBSAs[7]
- unemployment rate within the top six of all CBSAs[8]
- fifth largest GDP based on all CBSAs[9]
- highest US share of corporate travelers or professional and business services which are heavy users of premium class air service[10]
- home to big business – 70 companies with over $1 billion in revenue with a headquarter presence in the Washington DC metropolitan area[11]
- core hub for the internet through the Data Center Alley located in the Dulles Corridor.[12]
- eighth most visited US city by overseas visitors[13]

The Airport's ability to accommodate a higher level of growth in domestic and international passenger and cargo demand compared to other large hub airports provides an opportunity to expand the Airport's role of supporting the continued growth in the Washington, DC, metropolitan area economy and becoming an international passenger and cargo gateway for the Northeast megaregion. As metropolitan areas continue to expand, they begin to grow together and form megaregions. The Northeast megaregion is one of several emerging in the United States (see **Exhibit 4-1**). The Northeast megaregion, which includes metropolitan areas such as Baltimore, Boston, New York, Philadelphia, and Washington, DC, produced more than one quarter of the US GDP in 2016.[14] Based on the production capabilities of the Northeast megaregion, it is reasonable to assume that a notable portion of the FAA's forecast nationwide passenger and cargo demand growth is expected to occur within this megaregion. Dulles International is in a unique position to increase its global connections for the Northeast megaregion and bolster the Washington, DC, metropolitan area's role as a global business center.

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5 Metropolitan Washington Airports Authority, March 2019 based on US Census bureau annual Core Based Statistical Area (CBSA) population update via SpatialTEQ.

6 Metropolitan Washington Airports Authority, March 2019 based on US Census bureau annual Core Based Statistical Area (CBSA) population update via SpatialTEQ.

7 Metropolitan Washington Airports Authority, March 2019 based on US Census bureau annual Core Based Statistical Area (CBSA) income update via SpatialTEQ.

8 Bureau of Labor Statistics. News Release: Metropolitan Area Employment and Unemployment – November 2018, January 23, 2019.

9 Bureau of Economic Analysis, *News Release: Gross Domestic Product by Metropolitan Area, 2017*. Table 1,

10 Metropolitan Washington Airports Authority, March 2019 based on Bureau of Economic Analysis data dated July 2018.

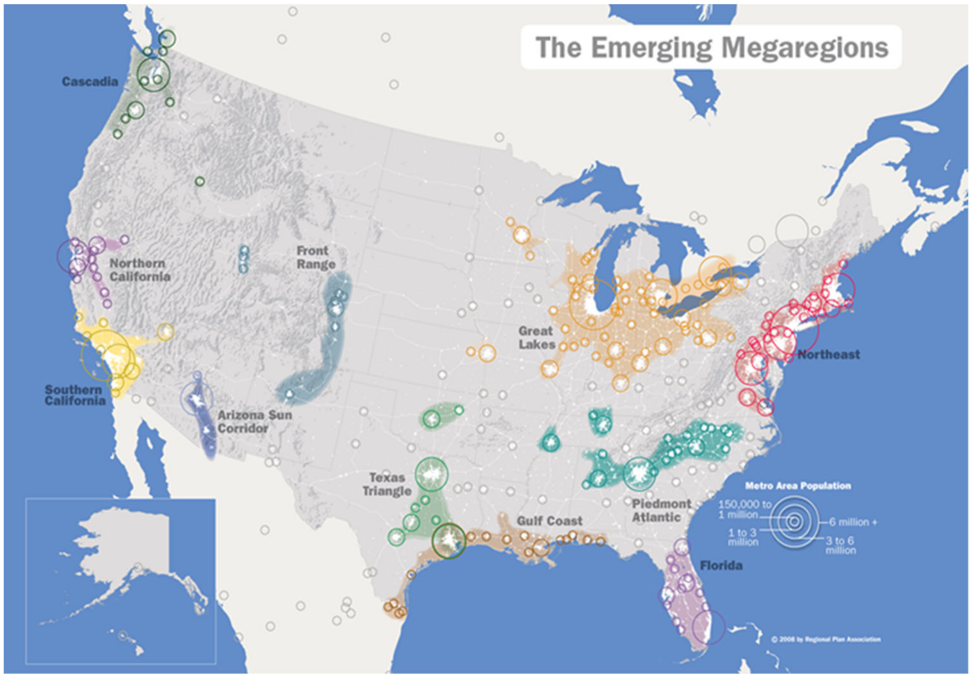
11 Metropolitan Washington Airports Authority, August 30, 2018 based on Uniworld Online data.

12 Business Insider. "Evidence is mounting that Amazon's HQ2 will land in 'the bull's-eye of America's internet." March 30, 2018 (https://www.businessinsider.com/amazon-hq2-could-go-to-virginia-evidence-2018-3)

13 National Travel and Tourism. Overseas Visitors to Select US Cities – 2015 to 2016. August 2017 (https://travel.trade.gov/outreachpages/download_data_table/Top%20Cities%202016.pdf)

14 US Department of Commerce, Bureau of Economic Analysis, *News Release: Gross Domestic Product by Metropolitan Area, 2016*, September 20, 2017, Table 1, 6-13.

EXHIBIT 4-1 EMERGING MEGAREGIONS IN THE UNITED STATES



SOURCE: Our Maps, America 2050-Regional Plan Association, http://www.america2050.org/maps/ (accessed March 29, 2018).

The Washington, DC, metropolitan area is the sixth most populated US metropolitan area. Since 2010, the population within the metropolitan area has grown from 5.6 million to just over 6.2 million people.[15] According to the US Department of Commerce, the Washington, DC, metropolitan area produces the fifth highest GDP among metropolitan areas and generated $509 million (3.0 percent) of the total US GDP in 2016.[16]

Both population and income are projected to grow within the Washington, DC, metropolitan area. According to the Metropolitan Washington Council of Governments (MWCOG), comprising local government members[17], the region will add approximately 1.5 million people and over 1.1 million jobs by 2045. Fairfax County and Loudoun County are expected to experience growth in population and jobs through 2045. Fairfax County population is forecast to increase 25 percent with a 37 percent increase in jobs, and Loudoun County population is forecast to increase 37 percent with a 77 percent growth rate in jobs.[18] As the only airport within the Washington, DC, metropolitan area

[15] US Department of Commerce, US Census Bureau, Population Division, *Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2017*, May 2018, https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t (accessed July 16, 2018).

[16] US Department of Commerce, Bureau of Economic Analysis, *News Release: Gross Domestic Product by Metropolitan Area, 2016*, September 20, 2017, Table 1, 6-13.

[17] Members of the Metropolitan Council of Governments include District of Columbia, Arlington County, Charles County, Fairfax County, Frederick County, Loudoun County, Montgomery County, Prince George's County, Prince William County, City of Alexandria, City of Bowie, City of College Park, City of Fairfax, City of Falls Church, City of Frederick, City of Gaithersburg, City of Greenbelt, City of Manassas, City of Manassas Park, City of Rockville, City of Takoma Park, and Town of Bladensburg.

[18] Metropolitan Washington Council of Governments, Growth Trends to 2045-Cooperative Forecasting in Metropolitan Washington, November 2016.

with the potential for increasing airfield capacity, Dulles International can play a key role as the metropolitan area transitions from a federally dependent economic base to a more diversified global business hub, attracting additional domestic and international air service to an airport with room to grow and inter-modal connection (e.g., Sliver Line) to existing and future business centers.

The connectivity of the Washington, DC, metropolitan area to national and global economies is facilitated by the airlines serving the Airport. This connectivity is most visible in the growing numbers of business and leisure visitors and the strong hospitality industry that remains a key growth sector in the Washington, DC, metropolitan area economy. Business and leisure visitors accessing the Washington, DC, metropolitan area by airplane constitute a major source of direct and related business that impact every sector of the local economy and keep the hospitality industry in a competitive position within the global business and leisure travel market.[19]

As mentioned previously in Section 3.1.6, the Airport serves as a major source of regional employment and economic benefit to the Commonwealth of Virginia, The Airport's impact on the economy is also reflected in the growing number of ancillary businesses located at and near the Airport. The ability to access major business centers via air service helps to explain the more than 400 internationally owned businesses located in Fairfax County and many others throughout the Washington, DC, metropolitan area in 2012.[20]

As the regional economy shifts from a federally dependent economic base to a global business center, connectivity to primary business centers elsewhere in the world will determine which of today's major business centers will become dominant global centers. The ability to support an increase in air service for international and domestic passenger and cargo routes will be critical to position the Washington, DC, metropolitan area as a global center for business. In addition to the Silver Line connection at Dulles International, the capability to expand puts the Airport in a very good position to play a critical role in diversifying the economic base as a federal and global business center.[21]

It is crucial to protect the ability of the Airport to expand from potential incompatible land use and to ensure current and future residents are not exposed to high levels of noise. Substantial growth in operations at Dulles International is reasonably foreseeable based on the anticipated growth in nationwide population and passenger and cargo demand, expanded productivity in the Washington, DC, metropolitan area and the Northeast megaregion, diversification of the Washington, DC, metropolitan area economy, and the Airport's unique position to expand. For purposes of this aircraft noise analysis, the level of operations the Airport can accommodate prior to reaching capacity constraints is referred to as the ultimate level of operations.

4.2 ULTIMATE LEVEL OF OPERATIONS

The methodology for determining the ultimate level of operations at Dulles International involved estimating future hourly runway operating configuration capacities (hourly runway capacity) and translating those hourly runway capacities into ASVs for the existing and future airfield configurations:

- the existing airfield with four runways (four-runway airfield configuration)
- an ultimate build airfield with five runways (five-runway airfield configuration)

[19] Metropolitan Washington Airports Authority, *2012 Economic Impact Study*, December 30, 2013.

[20] *Ibid.*

[21] *Ibid.*

An airfield configuration represents the number and layout of runways. The four- and five-runway airfield configurations are described in Sections 3.1.3.1 and 3.1.3.3, respectively. The ASVs represent the ultimate levels of operations that can be accommodated on the two airfield configurations. The following sections provide an overview of ASV, the methodology applied to calculate ASV, the primary input and assumptions used, and the resulting ASVs for the two airfield configurations.

4.2.1 ANNUAL SERVICE VOLUME

ASV represents the number of aircraft operations that an airfield can reasonably accommodate in a year. The assumptions used in this calculation account for runway use, aircraft mix, weather conditions, and other factors that vary throughout the year.[22] The FAA assigns which runway operating configuration is in use at an airport at any given time based on wind, weather, and demand. Typically, different runway operating configurations have different hourly capacities because of the runway geometry; therefore, the ASV must account for the hourly runway capacities of each of the runway operating configurations and the percentages of time each configuration is used over the year. ASV must also account for seasonal and hourly variations in demand and peaking characteristics at the airport. The formula to calculate ASV is:

$$ASV = C_w \times D \times H$$

Where,

- C_w represents the weighted hourly runway capacity of the airfield, reflecting the hourly capacities of each of the runway operating configurations and the percentage time each is used.
- D represents the ratio of annual demand to Peak Month Average Day (PMAD) demand.[23] This accounts for seasonal variations in activity throughout the year. The more days per year an airport experiences PMAD demand, the higher the D value.
- H represents the ratio of PMAD demand to demand during the peak hour of the PMAD. This accounts for hourly peaking characteristics at an airport. If all hours are at peak level, the H value would be 24.

4.2.1.1 METHODOLOGY

The development of ASV for this noise analysis only considered hourly runway capacity. It was assumed that other facilities, including taxiways, terminals, and airspace routes, could be developed without constraint to match the capacity of the runway system.

The hourly runway capacity for each runway operating configuration was estimated using runwaySimulator, a tool developed by FAA that calculates maximum sustainable runway throughput using the following inputs: runway geometry, runway use, ATC procedures, weather conditions, and aircraft fleet mix. A variety of runway operation assumptions such as separation distance between two landing aircraft on the same approach were made in developing the runwaySimulator inputs and calculating ASV to account for how the Airport might operate in the future. Previous runwaySimulator data for Dulles International provided by FAA were the basis for developing the inputs. The parameters and assumptions were adjusted based on discussions with FAA. Assumptions were reviewed

22 US Department of Transportation, Federal Aviation Administration, Advisory Circular 150/5060-5, *Airport Capacity and Delay, Change 2*, December 1995.

23 Peak Month Average Day is the average daily (24-hour day) demand of a month of most use in a year.

by the Working Group and other FAA representatives that did not participate directly on the Working Group.[24] Aircraft fleet mix and hourly and seasonal activity distribution for estimated long-range activity at Dulles International were applied to support the hourly runway capacity and ASV analysis.

Runway use and weather are the two primary factors affecting airfield capacity. Hourly runway capacity is generally lower in poor weather (low visibility and/or low cloud ceiling) than in good weather (visibility greater than three miles and a high cloud ceiling). The major runway operating configurations and conditions the capacity analysis should account for were developed using a statistical analysis of FAA's ASPM database of runway operations and weather conditions at the Airport from 2008 through 2017.

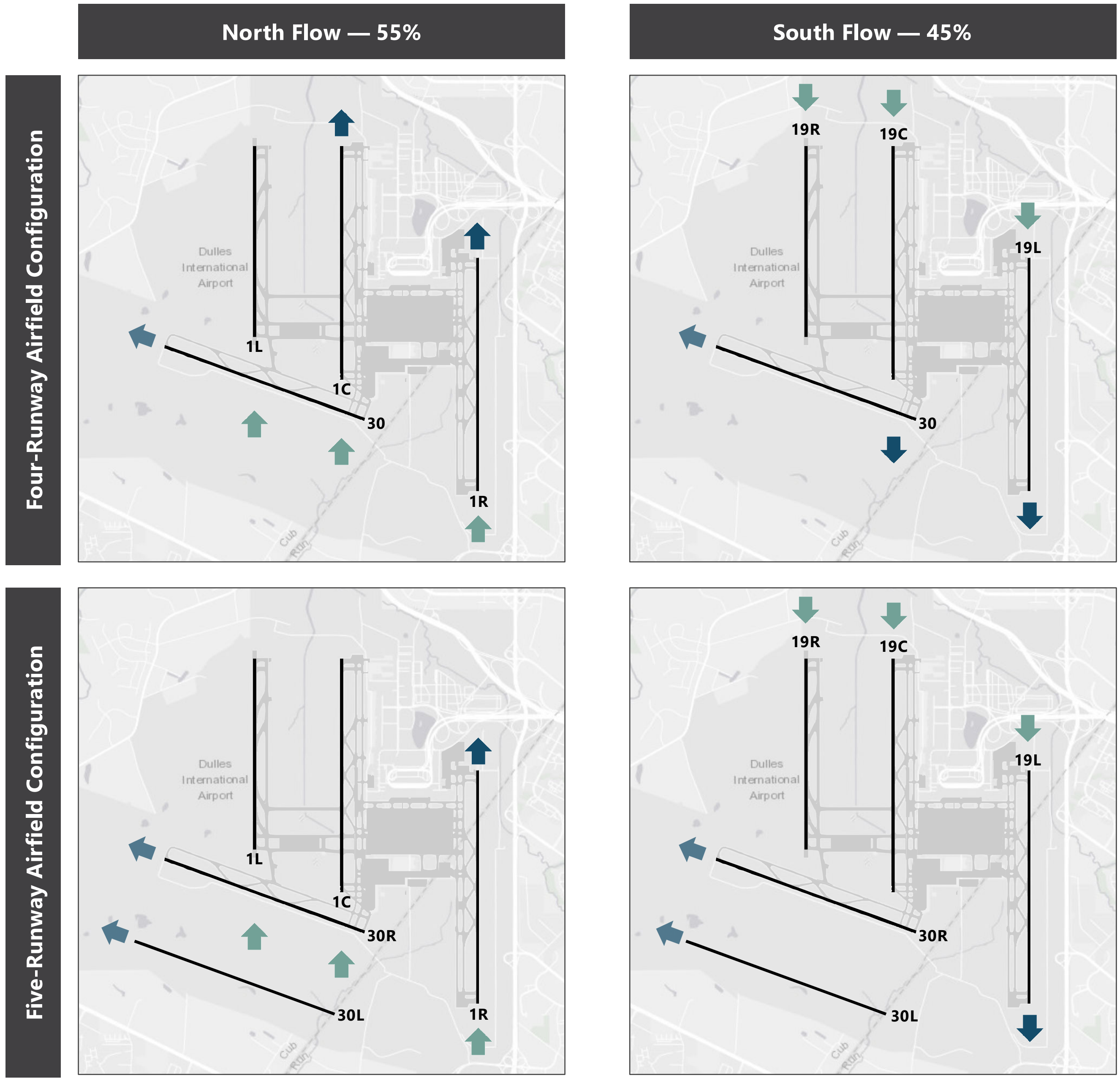
The projected peak period fleet mix provided in **Table 4-1** represents the projected peak period fleet mix derived from a high-level analysis of long-range activity. Generalized runway operating configurations and expected annual runway use for the four-and five-runway airfield configurations are depicted on **Exhibit 4-2**.

TABLE 4-1 PROJECTED PEAK PERIOD FLEET MIX

AIRCRAFT SIZE CATEGORIES[1]	PERCENTAGE OF FLEET
Heavy Widebody Jet	14%
Large Narrowbody Jet	41%
Regional Jet	38%
Business Jet	5%
Commuter Turboprop	2%

NOTES:
1 Aircraft Size Category Definitions:
Heavy Widebody Jet: jet aircraft weighing more than 255,000 pounds that are wide enough to accommodate two passenger aisles with 7-abreast seating or more (e.g., Boeing 747-400, Boeing 767-300, Boeing 777-300, Airbus 340, Airbus 380 and Airbus 300)
Large Narrowbody Jet: jet aircraft weighing more than 41,000 and up to 255,000 pounds with a single passenger aisle permitting up to 6-abreast seating (e.g., Boeing 737-700/800, Airbus 319, and Airbus 320).
Regional Jet: narrowbody jet aircraft weighing between 12,500 and 255,000 pounds used primarily for short-distance scheduled service (e.g., Embraer 145, Embraer 190, Bombardier CRJ-200, and Bombardier CRJ-700/900)
Business Jet: jet aircraft weighing between 12,500 and 255,000 pounds used primarily as for-hire non-scheduled service for business travel (e.g., Learjet 35, Learjet 70/75, Gulfstream IV/V, Bombardier Challenger 300, Bombardier Global 6000, Citation CJ-4, and Cessna Citation X)
Commuter Turboprops: aircraft with turbine-driven propeller engines at all weights used for scheduled short-distance service (e.g., Bombardier Q-400)
SOURCE: Ricondo & Associates, Inc., June 2018.

[24] Dulles International Noise Contour Map Update Working Group comprises local government agency representatives, MWAA lines-of-business representatives, and the FAA. The Working Group provides input to MWAA regarding the development of the noise contour map update at key milestones in the process.



LEGEND

- Runways
- Existing Airfield Pavement
- Arrivals
- Departures

SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); Ricondo & Associates, Inc., July 2018 (simulated airfield operating configuration).

EXHIBIT 4-2

NORTH

0 8,000 ft

SIMULATED RUNWAY OPERATING CONFIGURATIONS

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4.2.1.2 SUMMARY OF INPUT

Assumptions used for the hourly runway capacity analysis and ASV calculation were consistent with those used for previous FAA capacity studies for the Airport. The assumptions were updated and refined so that ASVs would reflect the ultimate levels of operations (near capacity for the four- and five-runway airfield configurations). The hourly runway capacity analysis results are shown on **Exhibit 4-3**. The following assumptions were applied to the hourly runway capacity analysis:

- Pilot training and touch-and-go activity would not occur in the future.
- Constraints associated with non-intersecting converging runway operations (CRO) in the South Flow runway operating configuration that limit departures on Runway 30 when arrivals are on Runway 19R would remain in place (and would apply to operations on future Runway 12R-30L).[25]
- RECAT would be implemented.
- Independent triple-parallel approaches to Runaways 1L-19R, 1C-19C, and 1R-19L would be available in all weather conditions.
- Time-Based Flow Management (TBFM) would be implemented.[26]
- Additional NextGen long-term capability such as the replacement of ground radar with Automatic Dependent Surveillance-Broadcast (ADS-B) and other potential capabilities not yet identified for the Airport would provide additional consistency for in-trail arrival separations.[27]

Activity profiles and relative relationships between hourly, daily, and annual operations factors (the D and H factors described in Section 4.2.1) are used to calculate ASV from the hourly runway capacities. Peaking characteristics used in the ASV calculation are determined using the shape of daily and hourly activity profiles. Summer is typically the busiest season at Dulles International with winter months being less busy, which results in a D factor less than 365. The number and magnitude of peak hours at Dulles International vary, which results in an H factor less than 24. Activity profiles evolve over time as market conditions change and hourly demand approaches capacity, encouraging growth in off-peak periods that eventually results in flattened profiles and higher D and H factors.

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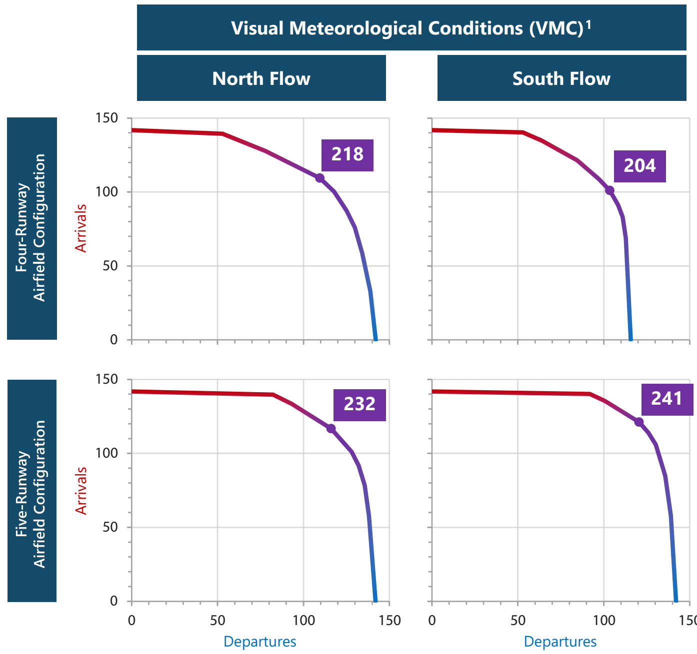
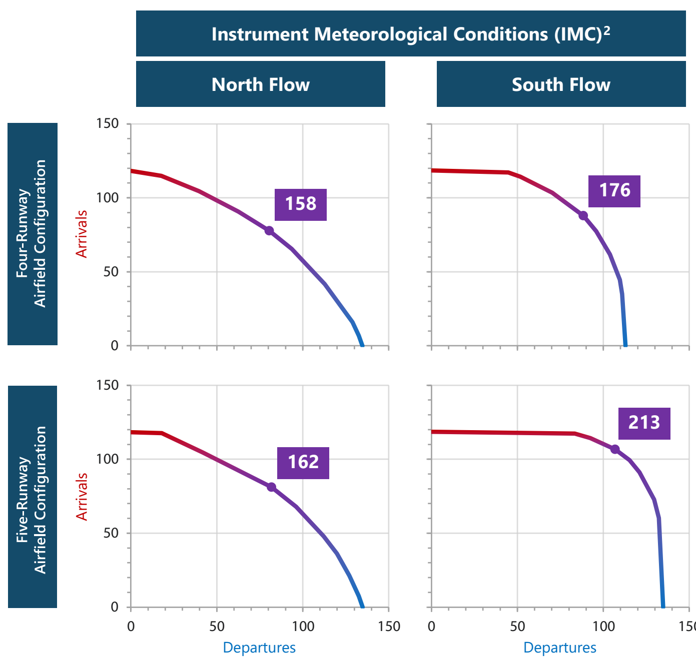
[25] In April 2014, the FAA implemented new rules [FAA Notices N JO 7110.652, N JO 7110.655, and N JO 7110.690] to manage operations on runways that do not physically intersect but have converging flight paths, to reduce conflicts, minimize risk, and increase safety. The goals for managing non-intersecting converging runway operations are to: (1) create safe separations between departing and arriving aircraft on runways with converging flight paths and (2) create safer missed-approach procedures for aircraft arriving on runways with aircraft departing aircraft on runways with converging flight paths.

[26] TBFM is a comprehensive method that includes hardware, software, processes, and initiatives to manage air traffic flows based on time to balance demand with capacity. It provides a dynamic timed-based environment, which increases efficiency and minimizes delays compared to the use of static miles-in-trail separation. TBFM is an automated method of departure scheduling, enroute adjustments, arrival management, and optimization of flight paths to provide accurate estimated time of arrival at key waypoints to optimize the flow of traffic into a terminal area by adding more predictability to the ATC system.

[27] Automatic Dependent Surveillance-Broadcast (ADS-B) provides real-time, precise monitoring of aircraft locations and enhances situational awareness for both ATC and pilots. Pilots will be able to see what air traffic controllers see. ADS-B provides better coverage than ground radar because the ground stations are much easier to place. Ultimately, this system will replace the ground radar tracking system.





NOTES:

1 Visual Meteorological Conditions (VMC) generally occur during fair to good weather, when pilots have sufficient visibility to fly the aircraft maintaining visual separation from terrain and other aircraft.

2 Instrument Meteorological Conditions (IMC) occur during periods when visibility falls to less than 3 statute miles or the cloud ceiling (i.e., the distance from the ground to the bottom layer of clouds, defined as the point where the clouds cover more than 50 percent of the sky) drops below 1,000 feet.

SOURCE: Ricondo & Associates, Inc., Runway Simulator Output, July 2018.

EXHIBIT 4-3

NORTH 0 Not to scale

SIMULATED HOURLY RUNWAY CAPACITY

To determine representative daily and hourly peaking characteristics for the Airport under the four- and five-runway airfield configurations, peaking characteristics were observed for 2017 and 2005, the two years when the Airport experienced its highest level of operations. The analysis showed that the Airport's current activity profile is not close to capacity constrained conditions or when operation levels were at peak levels in 2005. Therefore, application of current peaking characteristics to calculate ASV is not appropriate.

In addition to D and H factors calculated for 2005 historic operations, previous ASV analysis for the Airport conducted by the FAA were considered as a basis for determining an appropriate D and H factor reflecting conditions close to constrained conditions. The FAA estimated D and H factors for 2005 Dulles New Runway EIS, and a D factor associated with FAA's ASV analysis for Dulles International in 2012. The D and H factors for the 2005 Dulles New Runway EIS was 329 and 12, respectively.[28] The FAA 2012 ASV Study did not provide an H factor but indicated a D factor of 331.[29] The D and H factor for 2005 based on historic data was 340 and 14, respectively. The average of the D and H factors calculated for 2005 actual operations, the 2005 Dulles New Runway EIS, and the FAA 2012 ASV Study were used to provide the D and H factor for this ASV analysis: 333 D factor and 13 H factor. Both the D and H factors fall within the FAA's typical range of demand factors for airports that accommodate a high number of large and heavy aircraft operations, 310 to 350 for the D factor and 11 to 15 for the H factor.[30]

4.2.1.3 RESULTS

The ASVs for Dulles International, representing the ultimate levels of operations, were estimated to be 900,000 annual aircraft operations for the four-runway airfield configuration and 1,004,000 annual aircraft operations for the five-runway airfield configuration. As listed in **Table 4-2**, the AAD operations associated with the ASVs are 2,466 and 2,751 for the four- and five-runway airfield configurations, respectively.

4.2.1.4 STAKEHOLDER INPUT SUMMARY

An overview of ASV was presented to the Working Group on April 20, 2018. The ASV methodology, input assumptions, and results were presented to the Working Group at meetings on August 13, 2018 and January 7, 2019. Copies of the presentations provided at the three meetings are provided in Appendix A. On January 7, 2019, MWAA reported a refinement to the ASVs, which were lower than those presented on August 13, 2018. After further consideration, the ASVs shared on August 13, 2018, were determined to represent aggressive peaking characteristics not yet observed at Dulles International and not supported by previous ASV analysis for the Airport. Thus, the updated ASVs presented on January 7, 2019, were based more heavily on observed levels and estimated levels based on previous analyses. The Working Group did not express concerns related to the ASV analysis and results. Compared to the previous noise contour map update in 1993, the ASV increases from 740,000 annual operations to 1,004,000, assuming the five-runway airfield configuration. The Working Group supported the application of the proposed ASV levels for the four- and five-runway airfield operating configurations as a reasonable representation of ultimate level of operations conditions.

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28 US Department of Transportation, Federal Aviation Administration In Cooperation with the Army Corps of Engineers, *Final Environmental Impact Statement for New Runways, Terminal Facilities and Related Facilities at Washington Dulles International Airport*, Appendix A-2. "Annual Service Volume Calculations." August 2005.

29 US Department of Transportation, Federal Aviation Administration. *Draft Washington Dulles International Airport Annual Service Volume Study*. August 2012.

30 US Department of Transportation, Federal Aviation Administration, Advisory Circular 150/5060-5, *Airport Capacity and Delay, Change 2*, December 1995.

TABLE 4-2 ANNUAL SERVICE VOLUME CALCULATIONS

CONFIG	WEATHER	FLOW	MIX INDEX [1]	ANNUAL UTILIZATION [2] (P)	FOUR-RUNWAY AIRFIELD			FIVE- RUNWAY AIRFIELD		
					HOURLY CAPACITY [3] (C)	PERCENT OF MAXIMUM HOURLY CAPACITY [4]	WEIGHTING FACTOR [5] (W)	HOURLY CAPACITY [3] (C)	PERCENT OF MAXIMUM HOURLY CAPACITY [4]	WEIGHTING FACTOR [5] (W)
1	VMC	North	100	46.5%	218	100%	1.0	232	96%	1.0
2		South	100	34.8%	204	94%	1.0	241	100%	1.0
3	IMC	North	100	8.6%	158	72%	0.5	162	67%	0.5
4		South	100	10.1%	176	81%	0.5	213	88%	0.5
Weighted Hourly Capacity (Cw) [6]					208			232		
Annual / Average Daily Demand [7] (D)					333					
Average Daily / Peak Hour Demand [7] (H)					13					
ASV (Annual Aircraft Operations) [8]					**900,000**			**1,004,000**		
ASV AAD					**2,466**			**2,751**		

NOTES:

1 Mix Index = Class C + (2 x B757) + (3 x Class D) where:
Class C = % of Large aircraft with Maximum Certified Takeoff Weight (MTOW) between 12,500 and 300,000 pounds (excluding B757 aircraft)
B757 = % of Boeing 757 aircraft
Class D = % of Heavy aircraft with MTOW greater than 300,000 pounds
Calculated using 2017 operations

2 Annual utilization based on analysis of 2008-2017 ASPM weather and configuration by hour data

3 Hourly capacity based on runwaySimulator analysis

4 Each configuration capacity divided by the maximum configuration capacity

5 As determined using Table 3-1 of Advisory Circular 150/5060-5, except IMC = 0.5 as documented in FAA's DRAFT Washington Dulles International Airport Annual Service Volume Study conducted in 2012

6 Cw = ((P1 x C1 x W1) + (P2 x C2 x W2) + (P3 x C3 x W3) + (P4 x C4 x W4)) / ((P1 x W1) + (P2 x W2) + (P3 x W3) + (P4 x W4))

7 Calculated using average of forecast ASV value in the FAA's Environmental Impact Statement for New Runways, Terminal Facilities and Related Facilities at Washington Dulles International Airport (August 2005), FAA's value in the Washington Dulles International Airport Annual Service Volume Study (August 2012), and estimated value for the Airport at the highest operation level (2005).

8 Annual Service Volume in Aircraft Operations. ASV = Cw x D x H

SOURCES: Ricondo and Associates, Inc., July 2018 (runwaySimulator hourly capacity output); FAA, Advisory Circular 150/5060-5, *Airport Capacity and Delay, Change 2*, December 1, 1995 (ASV formula); US Department of Transportation, FAA, Environmental Impact Statement for New Runways, Terminal Facilities and Related Facilities at Washington Dulles International Airport, August 2005 (ASV D and H factor) ; US Department of Transportation, FAA, DRAFT Washington Dulles International Airport Annual Service Volume Study, August 2012 (D factor); FAA, OPSNET, July 2018 (2005 operation levels at Dulles International); Innovata, July 2018 (2005 flight schedule at Dulles International).

4.2.2 FOUR- AND FIVE-RUNWAY ASV AVERAGE ANNUAL DAY OPERATIONS

Aircraft fleet mix and operational characteristics were defined to model aircraft noise associated with the ultimate levels of operations for the four- and five-runway airfield configurations (2,466 and 2,751 operations, respectively).

4.2.2.1 METHODOLOGY

The methodology for developing the fleet mix and operational characteristics for the four- and five-runway ASV AADs can be summarized in eight steps.

Step 1 – Develop representative 2017 AAD operations database

This step used operations data from MWAA's ANOMS for 2017 to identify a representative AAD for 2017. The information provided for each aircraft operation in the database included:

- aircraft type (e.g., Boeing 737-700, Airbus 320, Airbus 380) and typical number of seats
- operation mode (arrival or departure)
- destination stage length (departures only)[31]
- time of day—day (7:00 a.m. to 9:59 p.m.) or night (10:00 p.m. to 6:59 a.m.)
- user category (air carrier, air taxi, general aviation, or military)
- operator type (scheduled air carrier, cargo air carrier, scheduled air taxi, unscheduled air taxi, cargo air taxi, general aviation, or military)
- aircraft weight category (super heavy jet,[32] heavy jet,[33] large jet,[34] small jet,[35] turbine propeller, or piston propeller)

A day in 2017 that closely represents the 2017 AAD operation levels was selected as the baseline schedule of operations at Dulles International, which served as a starting point to develop the four- and five-runway ASV AAD operations schedules.

Step 2 – Add nighttime scheduled passenger and cargo flights

The aircraft noise exposure analysis is based on the DNL noise metric, which increases nighttime noise events by 10 decibels (dBA) to account for higher public sensitivity to noise events during nighttime hours (10:00 p.m. to 6:59 a.m.). MWAA conducted research on the potential cargo market and discussed long-term future plans with multiple current and potential scheduled passenger service operators at the Airport. Because of the proprietary nature of the information shared with MWAA, additional details related to long-term planning are not publicly

[31] Stage length is a number in FAA's AEDT model that represents a range of trip distances for departures. The trip distance correlates with an aircraft's weight based on a fixed passenger load factor and expected fuel load to reach a destination. AEDT defines the range as follows:

1	0 to 500 nautical miles	2	501 to 1,000 nautical miles	3	1,001 to 1,500 nautical miles
4	1,501 to 2,500 nautical miles	5	2,501 to 3,500 nautical miles	6	3,501 to 4,500 nautical miles
7	4,501 to 5,500 nautical miles	8	5,501 to 6,500 nautical miles	9	More than 6,500 nautical miles

[32] Super heavy jet – specifically identified heavy jet aircraft by FAA: Airbus A380 and Antonov An-225

[33] Heavy jet – jet engine aircraft with a maximum takeoff weight of more than 255,000 pounds

[34] Large jet – jet engine aircraft with a maximum takeoff weight of more than 41,000 pounds up to 255,000 pounds

[35] Small jet – jet engine aircraft with a maximum takeoff weight of 41,000 pounds or less

available. Based on this input, MWAA provided the following additional nighttime cargo and passenger operations for inclusion in the four- and five-runway ASV AAD operations file:

- additional cargo nighttime operations: 24 per night
- additional passenger nighttime operations: 208 per night

Step 3 – Estimate the average annual growth rate by user category using the FAA Terminal Area Forecast

The FAA prepares a Terminal Area Forecast (TAF) for US airports on an annual basis. The TAF contains historical and forecast data for passenger enplanements, airport operations, TRACON operations, and based aircraft. Airport activity data contained in the TAF consist of the following:

- enplanements (sum of originating and connecting passengers departing an airport) for air carriers and regional carriers
- itinerant operations by user category
- local operations for civil and military user categories
- TRACON operations for aircraft operations under radar control

The TAF is a demand-driven forecast for aviation services based on local and national economic conditions, as well as conditions within the aviation industry.[36] The FAA prepares the TAF to support setting meeting planning, budgeting, and staffing requirements. In addition, state aviation authorities and other aviation planners use the TAF as the basis for planning airport improvements.

The TAF used for this analysis was based on historical operations data at Dulles International through 2017 and provided a forecast through 2045.[37] The annual forecast of itinerant operations provides an indication of expected operations growth rates. The TAF indicates that annual growth rates in operations differ among the four user categories; therefore, a general growth rate for all operations at Dulles International was not appropriate. The growth rate for each user category shown in **Table 4-3** was established using the average annual growth rate for the last five years of the TAF (2041 – 2045).

TABLE 4-3 AVERAGE ANNUAL GROWTH RATES BY USER CATEGORY

USER CATEGORY	AVERAGE ANNUAL GROWTH RATE BETWEEN 2041 AND 2045
Air Carrier	1.65%
Air Taxi	1.20%
General Aviation	0.30%
Military	0.00%

SOURCE: Federal Aviation Administration, 2017 TAF, https://taf.faa.gov/ (accessed July 17, 2018).

[36] US Department of Transportation, Federal Aviation Administration, *Forecast Process for 2017 TAF,* https://taf.faa.gov/Downloads/ForecastProcessfor2017TAF.pdf (accessed November 15, 2018).

[37] US Department of Transportation, Federal Aviation Administration, *2017 Terminal Area Forecast*, "IAD Facility Report," https://taf.faa.gov/ (accessed July 17, 2018).

Step 4 – Increase operations by user category to reach the four- and five-runway ASV operations

The FAA forecasts operations at the Airport to reach 445,628 in 2045, less than half of the ASVs for the four- and five-runway airfield configurations. Starting with forecast 2045 operations, the number of operations for each user category was increased by its respective average annual growth rate from Step 2 (see Table 4-3), until the total annual operations equaled the ASV operations for the four- and five-runway airfield configurations. The ASV AAD operations for each user category was calculated by dividing the ASV by 365.

Step 5 – Replicate 2017 AAD flights to equal four- and five-runway ASV operations by user category

Each flight, except for those added at night in Step 2, in the 2017 representative AAD operations database was replicated until the operations for each user category equaled the number of ASV AAD operations for the user category. Ultimately, the 2017 representative AAD operations became a preliminary version of the four- and five-runway ASV AAD operations file.

Step 6 – Substitute aircraft planned for retirement or replacement

This step identified aircraft in the ASV AAD operations data from Step 5 that were subject to future replacement or retirement. Aircraft planned for retirement were replaced with anticipated replacement aircraft based on orders and announcements from airlines. Examples of retirements and replacements are as follows:

- retirements: Boeing 757, Boeing 767, Boeing MD-80/90, DC-10-30, MD-11, and 50-seat regional jets (e.g., Bombardier Canadair Regional Jets [CRJ] and Embraer 145)
- replacements: retiring aircraft would be replaced with newer generation aircraft, such as the Airbus 350, Airbus 319/320/321 NEO, Boeing 787, Boeing 737-MAX, Embraer 190, and Bombardier CRJ-900

Step 7 – Increase passenger aircraft size as appropriate

In this step, the available seating for passenger aircraft was calculated for the four- and five-runway ASV AAD operations data and compared with the projected numbers of departing and arriving passengers during the ASV AADs, assuming an 83 percent load factor (the rationale supporting this assumption is discussed below). This assessment identified the need to increase aircraft size to accommodate the projected numbers of passengers.

The projected numbers of annual passengers for the four- and five-runway airfield configurations ASV operations were based on the average annual growth rate for 2017 TAF passenger enplanements from 2041 to 2045. Because enplanements only represent passengers on departing flights, the numbers of enplanements were multiplied by two to calculate projected ASV total annual passengers. The total numbers of annual passengers were divided by 365 days to get the ASV AAD numbers of passengers.

The FAA forecasts industry-wide load factors to increase from 84.5 percent in 2017 to 86.6 percent in 2038, approximately 0.1 percent per year.[38] The Dulles International scheduled passenger airline load factor in 2017 was approximately 78 percent.[39,40] If the 0.1 percent growth rate is applied, the load factor in 2038 at the Airport would be 80.1 percent. For the ultimate operation conditions, an additional 3 percent was added to provide a conservative long-term load factor assumption. As a result, the ASV AAD load factor was assumed to be 83 percent. The actual

[38] US Department of Transportation, Federal Aviation Administration, *FAA Aerospace Forecast Fiscal Years 2018 to 2038*, May 2018.

[39] US Department of Transportation, Federal Aviation Administration, *2017 Terminal Area Forecast: Washington Dulles International Airport*, https://taf.faa.gov/ (accessed July 17, 2018).

[40] Diio LLC., Diio Mi Daily Extract Report: Washington Dulles International Airport, June 2018 (accessed June 11, 2018).

numbers of seats on similar aircraft vary slightly because airlines order aircraft with different seating arrangements. The numbers of seats on similar aircraft were assumed to be the same for purposes of this analysis.

To estimate the number of total aircraft seats needed to accommodate the projected ASV AAD numbers of passengers for the four- and five-runway airfield configurations, the total numbers of AAD passengers were multiplied by the ASV AAD load factor. These figures were then compared to the available seats reflected in the preliminary ASV AAD operations data developed in Step 6. Based on the analysis, it was not necessary to replace smaller aircraft with larger aircraft types to reach the estimated numbers of seats required to serve the ASV AAD passenger demand for the four- and five-runway airfield configurations.

Step 8 – Develop the AEDT operations file for four- and five-runway ASV AAD operations

The final step of this analysis involved converting the preliminary operations data from Step 7 into the noise model operations input format for the AEDT. The operations input data includes:

- aircraft type
- operation mode (arrival or departure)
- stage length profile number
- daytime AAD operation counts
- nighttime AAD operation counts

The ASV AAD operations file for the four- and five-runway airfield configurations were distributed among the runways and related noise model flight tracks as the input is generated in the AEDT model. Refer to Section 5.2.1 for more information related to the AEDT AAD operations data.

4.2.2.2 FOUR-RUNWAY AIRFIELD ASV AAD OPERATIONS

The following information provides a summary of the ASV AAD operations for the four-runway airfield configuration (four-runway airfield). **Table 4-4** shows the ASV AAD operations and distribution by air service category for the four-runway airfield. The air service category represents the type of service provided at Dulles International. Scheduled passenger service includes all domestic and international airlines that publish and sell seats on a scheduled basis. Non-scheduled passenger service includes charter flights for hire that do not operate scheduled flights. General aviation operations fall into the same category as non-scheduled passenger service. Cargo service represents operations transporting cargo and no passengers. Military service are operations performed by or for the military.

TABLE 4-4 ANNUAL SERVICE VOLUME AVERAGE ANNUAL DAY OPERATIONS BY AIR SERVICE CATEGORY – FOUR-RUNWAY AIRFIELD

AIR SERVICE CATEGORY	AAD OPERATIONS	PERCENT OF TOTAL
Scheduled Passenger	2,129	86%
Cargo	32 [1]	1%
General Aviation/Non-Scheduled Passenger	303	12%
Military	2	<1%
Total	**2,466**	**100%**

NOTE:
1 Prior to adding the 24 nighttime cargo flights, there were 8 cargo flights in the preliminary ASV AAD operations as a result of increasing existing cargo flights present in the 2017 AAD representative operations database. This brings the total number of cargo flights to 32.
SOURCE: Ricondo & Associates, Inc. December 2018.

Table 4-5 presents the ASV AAD operations by aircraft category and by time of day for the four-runway airfield.

TABLE 4-5 ANNUAL SERVICE VOLUME AVERAGE ANNUAL DAY OPERATIONS BY AIRCRAFT CATEGORY AND TIME OF DAY – FOUR-RUNWAY AIRFIELD

AIRCRAFT CATEGORY	DAYTIME[1]			NIGHTTIME[2]			TOTAL		
	ARRIVAL	DEPARTURE	TOTAL	ARRIVAL	DEPARTURE	TOTAL	ARRIVAL	DEPARTURE	TOTAL
Super Heavy Jet	9	9	18	1	1	2	10	10	20
Heavy Jet	125	124	249	19	20	39	144	144	288
Large Jet	800	797	1,597	109	114	223	909	911	1,820
Small Jet	79	81	160	9	7	16	88	88	176
Turbine Propeller	73	73	146	8	8	16	81	81	162
Total	**1,086**	**1,084**	**2,170**	**146**	**150**	**296**	**1,232**	**1,234**	**2,466**

NOTES:
1 Day is 7:00 a.m. to 9:59 p.m.
2 Night is 10:00 p.m. to 6:59 a.m.
SOURCE: Ricondo & Associates, Inc. December 2018.

Table 4-6 compares the 2017 and four-runway airfield ASV AAD operations by user category. The share of air carrier operations is projected to increase from 61 percent in 2017 to 83 percent of total operations under the four-runway airfield ASV AAD, while the shares of air taxi and general aviation operations, including both scheduled and non-scheduled operations, are projected to decrease. **Exhibit 4-4** provides a visual representation of the comparison.

Table 4-7 provides the same comparison as Table 4-6, but by aircraft category. The share of heavy jet and large jet activity is projected to increase by approximately 2 and 7 percent, respectively, while operations of small jet and turbine propeller are both projected to decrease in share of total operations. **Exhibit 4-5** provides a visual comparison of AAD operations between 2017 and the four-runway airfield ASV AAD operations level by aircraft category.

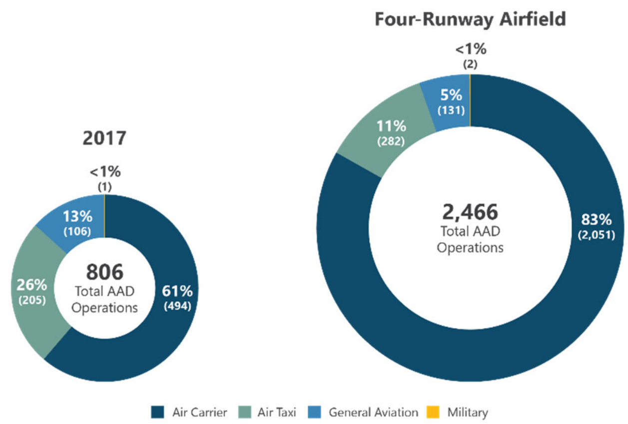
Table 4-8 compares the 2017 and four-runway airfield ASV AAD operations by time of day. The share of total operations occurring at night is projected to decrease from 15 percent to 12 percent, primarily driven by the assumption that operation levels will increase at a faster rate for daytime hours based on passenger demand. The share of total operations occurring at night may be lower compared to 2017, but the projected count of nighttime operations for the four-runway airfield ASV AAD would increase by 152 percent compared to 2017. **Exhibit 4-6** provides a visual comparison of operations by time of day between 2017 and the four-runway airfield ASV AAD operations.

TABLE 4-6 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY USER CATEGORY – FOUR-RUNWAY AIRFIELD ANNUAL SERVICE VOLUME TO 2017

USER CATEGORY	2017		FOUR-RUNWAY AIRFIELD ASV	
	AAD OPERATIONS	PERCENT OF TOTAL AAD	AAD OPERATIONS	PERCENT OF TOTAL AAD
Air Carrier	494	61%	2,051	83%
Air Taxi	205	26%	282	11%
General Aviation	106	13%	131	5%
Military	1	<1%	2	<1%
Total	**806**	**100%**	**2,466**	**100%**

SOURCES: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (four-runway ASV AAD).

EXHIBIT 4-4 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY USER CATEGORY – FOUR-RUNWAY AIRFIELD ANNUAL SERVICE VOLUME TO 2017



NOTES

Air carrier – commercial aircraft with seating capacities of more than 60 passengers, or a maximum payload capacity of more than 18,000 pounds carrying passengers or cargo

Air taxi – commercial and for-hire aircraft with maximum seating capacities of 60 passengers or a maximum payload capacity of 18,000 pounds of cargo for hire or compensation

General Aviation – noncommercial, civil aircraft operations.

Military – aircraft operated by any branch of the United States armed services

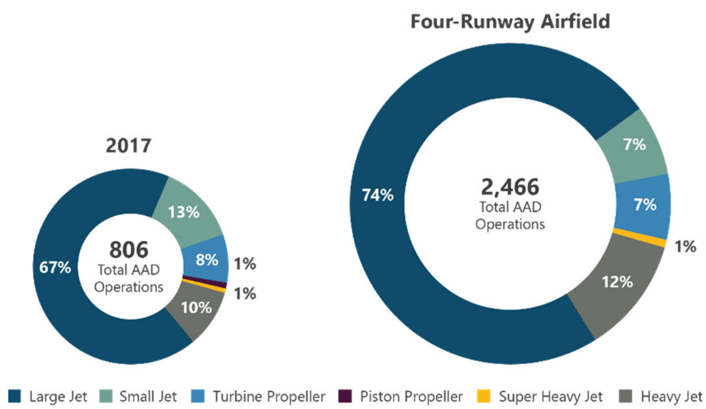
SOURCES: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (four-runway ASV AAD).

TABLE 4-7 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY AIRCRAFT CATEGORY – FOUR-RUNWAY AIRFIELD ANNUAL SERVICE VOLUME TO 2017

AIRCRAFT CATEGORY	2017		FOUR-RUNWAY AIRFIELD ASV	
	AAD OPERATIONS	PERCENT OF TOTAL AAD	AAD OPERATIONS	PERCENT OF TOTAL AAD
Super Heavy Jet	6	1%	20	1%
Heavy Jet	82	10%	288	12%
Large Jet	542	67%	1,820	74%
Small Jet	106	13%	176	7%
Turbine Propeller	64	8%	162	7%
Piston Propeller	6	1%	0	0%
Total	**806**	**100%**	**2,466**	**100%**

SOURCES: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (four-runway ASV AAD).

EXHIBIT 4-5 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY AIRCRAFT CATEGORY – FOUR-RUNWAY AIRFIELD ANNUAL SERVICE VOLUME TO 2017



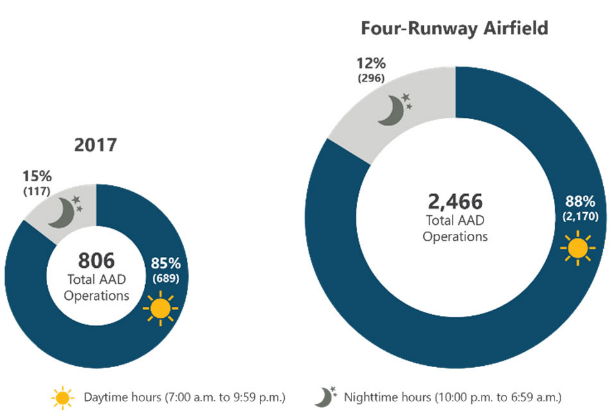
SOURCES: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (four-runway ASV AAD).

TABLE 4-8 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY TIME OF DAY – FOUR-RUNWAY AIRFIELD ANNUAL SERVICE VOLUME TO 2017

	2017		FOUR-RUNWAY AIRFIELD ASV	
TIME OF DAY	AAD OPERATIONS	PERCENT OF TOTAL AAD	AAD OPERATIONS	PERCENT OF TOTAL AAD
Daytime	689	85%	2,170	88%
Nighttime	117	15%	296	12%
Total	**806**	**100%**	**2,466**	**100%**

NOTES:
Daytime is 7:00 a.m. to 9:59 p.m.
Nighttime is 10:00 p.m. to 6:59 a.m.
SOURCE: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (four-runway ASV AAD).

EXHIBIT 4-6 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY TIME OF DAY – FOUR-RUNWAY AIRFIELD ANNUAL SERVICE VOLUME TO 2017



SOURCE: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (four-runway ASV AAD).

4.2.2.3 FIVE-RUNWAY AIRFIELD ASV AAD OPERATIONS

The following information provides a summary of the ASV AAD operations for the five-runway airfield configuration (five-runway airfield). **Table 4-9** shows the ASV AAD operations and distribution by air service category for the five-runway airfield.

TABLE 4-9 ASV AAD OPERATIONS BY AIR SERVICE CATEGORY – FIVE-RUNWAY AIRFIELD

AIR SERVICE CATEGORY	AAD OPERATIONS	PERCENT OF TOTAL
Scheduled Passenger	2,394	87%
Cargo	32[1]	1%
General Aviation/Non-Scheduled Passenger	323	12%
Military	2	<1%
Total	**2,751**	**100%**

NOTE:
1 Prior to adding the 24 nighttime cargo flights, there were 8 cargo flights in the preliminary ASV AAD operations as a result of increasing existing cargo flights present in the 2017 AAD representative operations database. This brings the total number of cargo flights to 32.
SOURCE: Ricondo & Associates, Inc., December 2018.

Table 4-10 shows total operations under the five-runway ASV AAD by aircraft category and time of day for the five-runway airfield.

TABLE 4-10 ASV AAD OPERATIONS BY AIRCRAFT CATEGORY AND TIME OF DAY – FIVE-RUNWAY AIRFIELD

	DAYTIME[1]			NIGHTTIME[2]			TOTAL		
AIRCRAFT CATEGORY	ARRIVAL	DEPARTURE	TOTAL	ARRIVAL	DEPARTURE	TOTAL	ARRIVAL	DEPARTURE	TOTAL
Super Heavy Jet	10	10	20	1	1	2	11	11	22
Heavy Jet	143	139	282	19	23	42	162	162	324
Large Jet	893	895	1,788	123	122	245	1016	1017	2,033
Small Jet	81	81	162	10	10	20	91	91	182
Turbine Propeller	85	84	169	10	11	21	95	95	190
Total	**1,212**	**1,209**	**2,421**	**163**	**167**	**330**	**1,375**	**1,376**	**2,751**

NOTES:
1 Day is 7:00 a.m. to 9:59 p.m.
2 Night is 10:00 p.m. to 6:59 a.m.
SOURCE: Ricondo & Associates, Inc., December 2018.

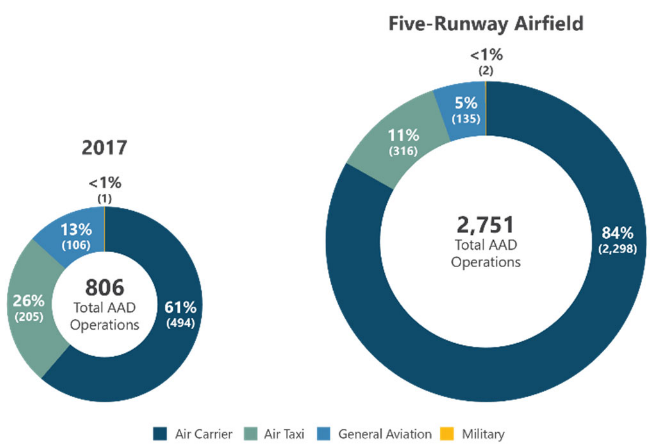
Table 4-11 compares the 2017 and five-runway airfield ASV AAD operations by user category. The share of air carrier operations is projected to increase from 61 percent in 2017 to 84 percent of total operations for the five-runway airfield ASV AAD. Air taxi and general aviation, including both scheduled and non-scheduled operations, are projected to decrease in the share of total operations. **Exhibit 4-7** provides a visual representation of the comparison.

TABLE 4-11 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY USER CATEGORY – FIVE-RUNWAY AIRFIELD ASV AND 2017

	2017		FIVE-RUNWAY AIRFIELD ASV	
USER CATEGORY	AAD OPERATIONS	PERCENT OF TOTAL AAD	AAD OPERATIONS	PERCENT OF TOTAL AAD
Air Carrier	494	61%	2,298	84%
Air Taxi	205	26%	316	11%
General Aviation	106	13%	135	5%
Military	1	< 1%	2	< 1%
Total	**806**	**100%**	**2,751**	**100%**

SOURCES: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (five-runway ASV AAD).

EXHIBIT 4-7 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY USER CATEGORY – FIVE-RUNWAY AIRFIELD ANNUAL SERVICE VOLUME TO 2017



NOTES

Air carrier – commercial aircraft with seating capacities of more than 60 passengers, or a maximum payload capacity of more than 18,000 pounds carrying passengers or cargo

Air taxi – commercial and for-hire aircraft with maximum seating capacities of 60 passengers or a maximum payload capacity of 18,000 pounds of cargo for hire or compensation

General Aviation – noncommercial, civil aircraft operations.

Military – aircraft operated by any branch of the United States armed services

SOURCES: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (five-runway ASV AAD).

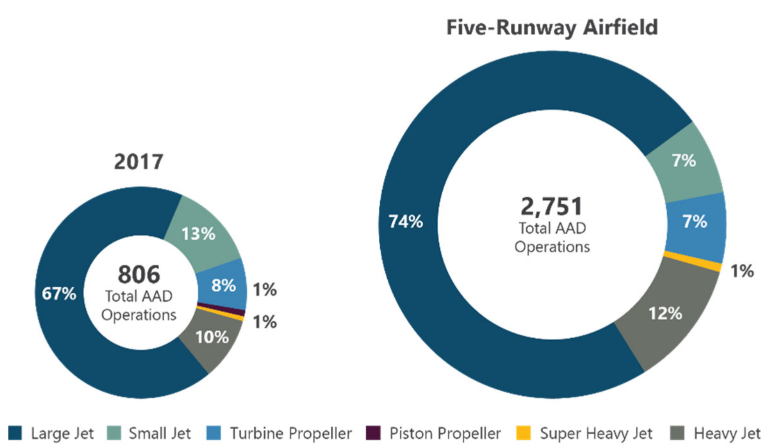
Table 4-12 provides the same comparison as Table 4-11, but by aircraft category. Heavy jet and large jet share of total operations is projected to increase by approximately 2 and 7 percent, respectively, while small jet and turbine propeller are projected to decrease in the share of total operations. **Exhibit 4-8** provides a visual comparison of operations by time of day between 2017 and the five-runway airfield ASV AAD operations.

TABLE 4-12 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY AIRCRAFT CATEGORY – FIVE-RUNWAY AIRFIELD ANNUAL SERVICE VOLUME TO 2017

	2017		FIVE-RUNWAY AIRFIELD ASV	
AIRCRAFT CATEGORY	AAD OPERATIONS	PERCENT OF TOTAL AAD	AAD OPERATIONS	PERCENT OF TOTAL AAD
Super Heavy Jet	6	1%	22	1%
Heavy Jet	82	10%	324	12%
Large Jet	542	67%	2,033	74%
Small Jet	106	13%	182	7%
Turbine Propeller	64	8%	190	7%
Piston Propeller	6	1%	0	0%
Total	**806**	**100%**	**2,751**	**100%**

SOURCES: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (five-runway ASV AAD).

EXHIBIT 4-8 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY AIRCRAFT CATEGORY – FIVE-RUNWAY AIRFIELD ANNUAL SERVICE VOLUME TO 2017



SOURCES: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (five-runway ASV AAD).

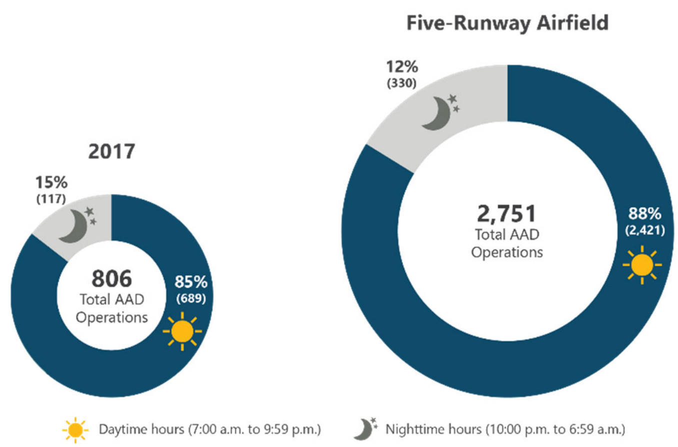
Table 4-13 presents the five-runway airfield ASV AAD operations by time of day compared to 2017 AAD operations. The share of total operations occurring at night is projected to decrease from 15 percent to 12 percent, primarily driven by the assumption that operation levels will increase at a faster rate for daytime hours based on passenger demand. The share of total operations occurring at night may be lower compared to 2017, but the projected count of nighttime operations for the five-runway airfield ASV AAD would increase by 182 percent compared to 2017. **Exhibit 4-9** provides a visual comparison of operations by time of day between 2017 and the five-runway airfield ASV AAD operations.

TABLE 4-13 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY TIME OF DAY – FIVE-RUNWAY AIRFIELD ANNUAL SERVICE VOLUME AND 2017

	2017		FIVE-RUNWAY AIRFIELD ASV	
TIME OF DAY	AAD OPERATIONS	PERCENT OF TOTAL AAD	AAD OPERATIONS	PERCENT OF TOTAL AAD
Daytime	689	85%	2,421	88%
Nighttime	117	15%	330	12%
Total	**806**	**100%**	**2,751**	**100%**

SOURCES: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (five-runway ASV AAD).

EXHIBIT 4-9 COMPARISON OF AVERAGE ANNUAL DAY OPERATIONS BY TIME OF DAY – FIVE-RUNWAY AIRFIELD ANNUAL SERVICE VOLUME TO 2017



SOURCE: Harris Miller Miller & Hanson Inc., May 2018 (2017 AAD operations); Ricondo & Associates, Inc., December 2018 (five-runway ASV AAD).

4.2.2.4 STAKEHOLDER INPUT SUMMARY

The methodology and summary results of the four- and five-runway airfield ASV AAD operations were presented and discussed at the Working Group meetings held on September 25, 2018, and January 7, 2018. Appendix A contains a copy of the presentation. Key discussion points included:

- Members of the Working Group asked about the departure stage length and were informed that it is based on great circle distance between the Airport and a destination. The higher the stage length value, the heavier the aircraft when modeled in AEDT. The additional weight on longer flights accounts for a fixed load factor and onboard fuel to reach the destination.
- Working Group members also asked about the difference between the air carrier and air taxi categories related to seats. It was explained that air taxi aircraft have no more than 60 seats or a maximum payload capacity of 18,000 pounds or less. An air carrier operates aircraft with more than 60 seats or a maximum payload capacity of more than 18,000 pounds.
- Finally, Working Group members asked why cargo operations do not change between the four- and five-runway airfield ASVs. Cargo operations at the Airport are independent of the number of available runways because

cargo flights typically occur during low demand nighttime hours and would only need one runway. Regarding the ultimate level of cargo operations, MWAA shared with the Working Group that a reasonable long-term future assumption for the Airport is to serve as a medium-size cargo hub. Currently, the number of cargo operations at Dulles International does not equate to a medium-size cargo hub operation. If becoming a larger cargo hub is a possibility in the future, MWAA would evaluate whether the noise contour map would need updating. Expanding to a large hub cargo facility would also require additional NEPA review, including land use analysis.

In summary, based on the information presented and additional clarifications, the Working Group did not indicate any substantial concerns related to the four- and five-runway airfield ASV AAD operations summary results.

Following the Working Group meeting, refinements were made to the four- and five-runway ASV AAD operations data to reflect the updated ASV levels based on refined D and H factors and adjusted assumptions related to increases in nighttime operations. The refined D and H factors reduced the total number of operations, and the adjusted increase in nighttime operations reduced the nighttime percentage share of total operations. The updated ASV AAD operations results were shared with the Working Group at the January 7, 2019, meeting. The Working Group did not indicate any substantial concerns related to reasons for the update, and the updated four- and five-runway airfield ASV AAD operations results.

4.3 RUNWAY OPERATING CONFIGURATIONS AND RUNWAY USE PATTERNS FOR ULTIMATE OPERATIONS CONDITIONS

Runway use is a key variable in modeling aircraft noise at an airport. The type of operation (arrival or departure) and the frequency of operations influence the overall size and shape of noise exposure contours. Runway operating configurations represent the combination of runways and how the runways are used. Each runway operating configuration definition includes the expected use of each runway end. Section 3.1.3.1 provides an overview of existing runway operating configurations for Dulles International, and Section 3.2.4 describes existing runway use.

This section describes the methodology used to project the runway operating configuration and individual runway use patterns for the four- and five-runway airfields with ASV AAD operations. The runway use patterns described in this section served as a guide for aircraft noise modelers to assign ASV AAD operations to the runways. The modeled runway use differed slightly from the runway use patterns due to the preferred nighttime cargo runway use. All nighttime cargo operations were assigned to the appropriate preferred runway for three cargo expansion options described in Section 4.3.4. Modeled runway use data are provided in Section 5.2.2.1 for each modeled airfield configuration.

4.3.1 METHODOLOGY AND ASSUMPTIONS

The following sources of data and information were used to develop the runway operating configuration and runway use patterns for Dulles International for the four- and five-runway airfields with ASV AAD operations:

- Runway Use – How the runways have been used for each runway operating configuration in the past and are expected to continue in the future with some changes with the fifth runway in place were defined using the following information:
  - MWAA's ANOMS data for 2017 were used to determine existing runway operating configuration use and individual runway use patterns.

- Long-term runway operating configuration use was assessed based on data reported by the FAA between 2008 and 2017 from FAA's ASPM runway configuration reported data.[41]
- Runway operating configuration and individual runway use for the 2005 Dulles New Runway EIS noise model was considered as the runway use for the four- and five-runway airfield serving ASV AAD operations.[42]

- Weather Conditions – Weather affects FAA's selection of runway operating configurations; therefore, frequency of weather occurrences between 2008 and 2017 from FAA's ASPM daily weather by hour report were assessed to capture long-term potential frequency of runway operating configurations.[43] Weather factors evaluated include:
  - wind direction
  - visual meteorological conditions (VMC)[44]
  - instrument meteorological conditions (IMC)[45]
- Operation Conditions/Demand – Characteristics of operations (e.g., peaking, fleet mix) affect runway use patterns under each runway operating configuration, such as increased use of secondary runways for arrivals and departures. Operation characteristics were evaluated based on existing and ASV AAD operations:
  - Existing Operation Conditions – 2017 data from MWAA's ANOMS and airline schedule data provided by Diio LLC was used to develop an operation condition baseline.
  - ASV AAD – Peaking characteristics and fleet mix based on the ASV analysis described in Section 4.2.1 and operations file described in Section 4.2.2 were used to assess ultimate operation conditions that affect runway use.
- Airfield/Runway Layout – The airfield and runway layout defined the runway end locations, direction, length, and width for the four- and five-runway airfield.[46]
  - The four-runway airfield is the same as the existing airfield and is based on the approved ALP.
  - The five-runway airfield includes the same runways as the four-runway airfield with the addition of Runway 12R-30L based on the approved ALP.

Historical runway use was analyzed to define existing runway operating configurations. North and South Flows represented approximately 58 and 42 percent of annual operations, respectively, in 2017 (refer to Section 3.2.3 for a summary of 2017 runway operating configuration use). Based on a long-term historical use analysis using the

[41] US Department of Transportation, Federal Aviation Administration, "Aviation System Performance Metrics, Airport Efficiency – Daily Weather by Hour Report from 01/01/2008 To 12/31/2017," https://aspm.faa.gov/apm/sys/Efficiency.asp (accessed April 23, 2018).

[42] US Department of Transportation, Federal Aviation Administration in Cooperation with the US Army Corps of Engineers, *Final Environmental Impact Statement for New Runways, Terminal Facilities and Related Facilities at Washington Dulles International Airport*, August 2005.

[43] US Department of Transportation, Federal Aviation Administration, "Aviation System Performance Metrics, Airport Efficiency – Daily Weather by Hour Report from 01/01/2008 To 12/31/2017," https://aspm.faa.gov/apm/sys/Efficiency.asp (accessed on April 23, 2018).

[44] Visual Meteorological Conditions (VMC) generally occur during fair to good weather, when pilots have sufficient visibility to fly the aircraft maintaining visual separation from terrain and other aircraft.

[45] Instrument Meteorological Conditions (IMC) occur during periods when visibility falls to less than 3 statute miles or the cloud ceiling (i.e., the distance from the ground to the bottom layer of clouds, defined as the point where the clouds cover more than 50 percent of the sky) drops below 1,000 feet.

[46] Metropolitan Washington Airports Authority, *Washington Dulles International Airport, Virginia Airport Layout Plan*, July 27, 2016.

FAA's ASPM data, North and South Flows represented approximately 55 and 45 percent of annual operations, respectively, from 2008 through 2017. The long-term data showed very little variance between North and South Flow use from year to year. Therefore, it was assumed that the long-term average would best represent runway use in the future.

According to the FAA's ASPM data, 9 unique runway operating configurations were used at the Airport from 2008 to 2017. The North or South Flow runway operating configurations were used over 99 percent of the time between 2008 and 2017 and comprised 8 of the 9 unique runway operating configurations. The only exceptions were operations assigned to Runway 30 in a northwest runway operating configuration where all departures and arrivals used Runway 30.[47] The 9 unique runway operating configuration definitions were simplified in this analysis to represent predominant North and South Flows by combining all unique runway operating configurations landing and departing in a northerly direction as North Flow and all operations landing and departing in a southerly direct as South Flow. The northeast runway operating configuration was assigned to the North Flow runway operating configuration.

The current definitions of North and South Flow runway operating configurations were maintained for the four- and five-airfield configurations at ASV AAD operations, but projected runway use patterns were modified based on anticipated demand changes. The key assumptions were as follows:

- Airport operations will be close to capacity-constrained levels (refer to Section 4.2.1).
- Taxiways and other facilities (terminals, gates, cargo, and general aviation facilities) will be adequate to accommodate ASV AAD aircraft movements on the airfield without causing delay on the runways.
- Airspace and air traffic procedures will be able to match the hourly capacity of the four- and five-runway airfield (described in Table 4-2 in Section 4.2.1.3), assuming long-term NextGen capabilities are implemented.

Runway use patterns for the four- and five-runway airfields under North and South Flow runway operating configurations were determined by reviewing previous studies that considered future runway use and by relying on assumptions that were confirmed by Dulles International ATCT and Potomac TRACON (refer to Section 4.3.5) for how the airfield might be operated by ATC at high operations demand.[48,49] Some air traffic conditions have changed since the previous studies were completed. These include traffic management related to the DC FRZ described in Section 3.1.3.5, intersecting CRO management (see Section 4.2.1.2, footnote 27), and wake turbulence separation recategorization (see Section 3.1.5.1) and procedures (e.g., PBN RNAV procedures, Required Navigation Performance [RNP] approach procedures, and independent triple parallel approaches). These and additional future ATC capabilities (e.g., TBFM described in Section 4.2.1.2, footnote 28) and long-term NextGen capabilities) were considered when defining the projected runway use patterns.

4.3.2 2017 RUNWAY USE

Existing runway operating configurations and runway use for 2017 at the Airport are depicted on **Exhibit 4-10**.

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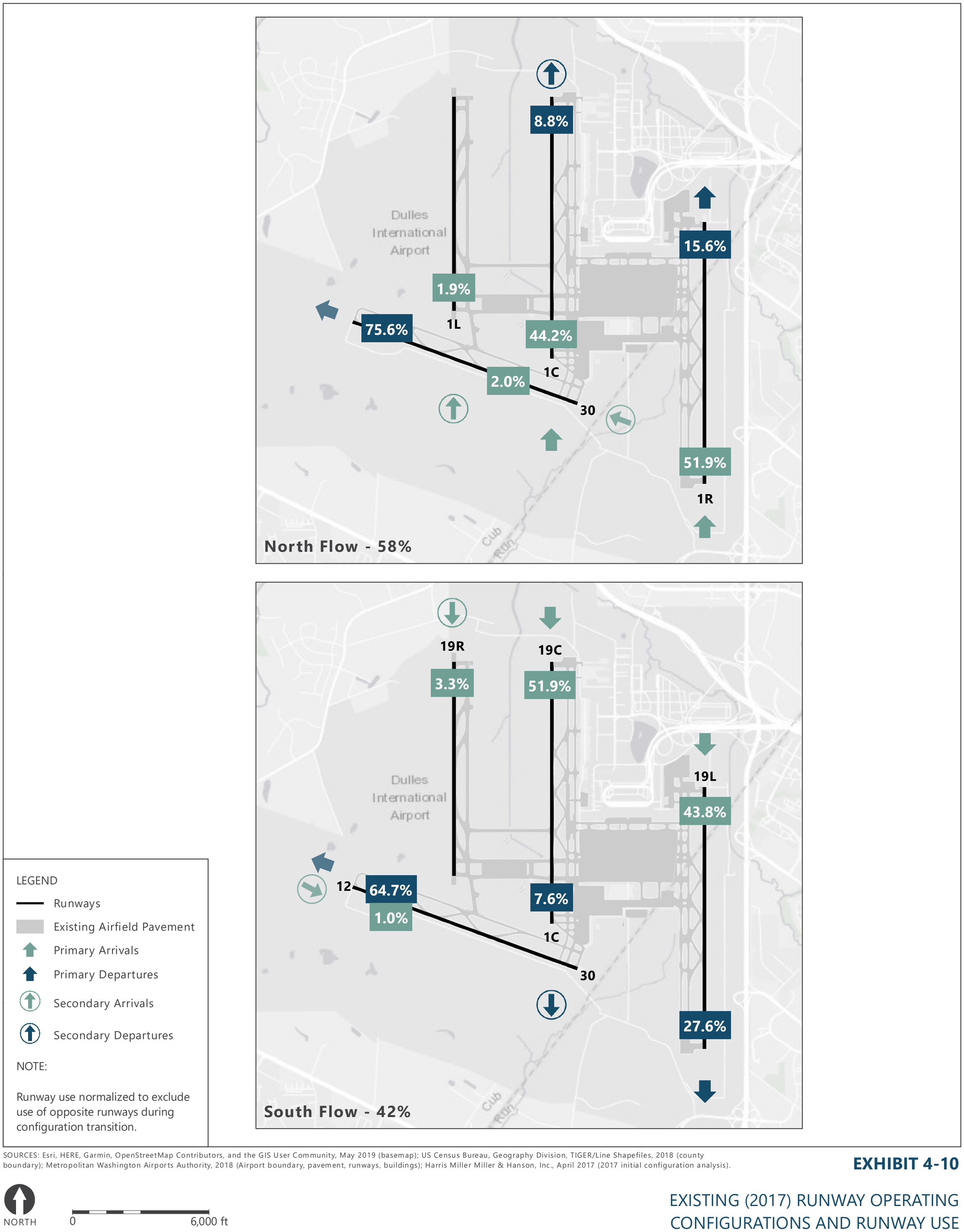
[47] US Department of Transportation, Federal Aviation Administration, "Aviation System Performance Metrics, Airport Efficiency – Daily Weather by Hour Report from 01/01/2008 To 12/31/2017," https://aspm.faa.gov/apm/sys/Efficiency.asp (accessed on April 23, 2018).

[48] US Department of Transportation, Federal Aviation Administration, *Dulles Airport New Runways Environmental Impact Statement, Appendix D-8, 2010 Build Alternative 3 Interim Construction Scenario Integrated Noise Model Inputs*, June 2005.

[49] US Department of Transportation, Federal Aviation Administration, *Dulles Airport New Runways Environmental Impact Statement, Appendix D-13, 2025 Build Alternative 3 Integrated Noise Model Inputs*, June 2005.



SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); Harris Miller Miller & Hanson, Inc., April 2017 (2017 initial configuration analysis).

EXHIBIT 4-10

EXISTING (2017) RUNWAY OPERATING CONFIGURATIONS AND RUNWAY USE

P:\GIS\Projects\IAD\MXD\IAD_Exhibit4-10_2017RWYOperatingConfig-RwyUse_20190531.mxd

4.3.3 FOUR- AND FIVE-RUNWAY AIRFIELD RUNWAY OPERATING CONFIGURATION AND RUNWAY USE PATTERNS

Analysis of runway use patterns for the four- and five-runway airfield under ultimate operating conditions (when the Airport will be operating at ASV AAD operations levels as described in Section 4.2.1) were based on the following key factors:

- Demand would be near a constrained level of flight activity and require additional use of secondary runways.
- Current ground traffic management procedures to manage departure queues and runway crossings would continue.
- Preferred runway assignments based on flight origin or destination would be maintained.
- ATC wake turbulence separation requirements would be reduced based on RECAT.
- Frequency of independent triple-simultaneous approaches would increase.
- CRO separation requirements to maintain safe separation of aircraft on non-intersecting converging runways would continue.
- The DC FRZ east of the Airport would remain.
- More consistent spacing between aircraft would occur as enhanced TBFM techniques and software capabilities advance.
- Existing late night (11:00 p.m. to 5:59 a.m.) runway use patterns would be the same as existing patterns when demand levels are low, except for cargo operations (refer to Section 4.3.4).

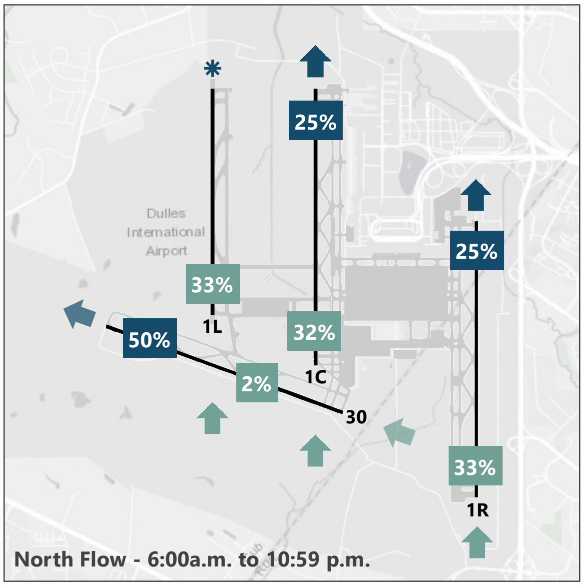
It was assumed that at ASV AAD operations, the use of secondary runways would increase compared to existing use. It was also assumed that the airspace could be configured and traffic distributed depending on origin for arrivals or destination for departures, allowing the proposed distribution percentages to be achieved on an annual basis. The assumptions described were reviewed with the Dulles International ATCT and Potomac TRACON. Adjustments to runway use were made based on input from these parties.

Projected runway use patterns for high demand periods (6:00 a.m. to 10:59 p.m.) and low demand periods (11:00 p.m. to 5:59 a.m.), excluding late night cargo operations, are depicted on **Exhibit 4-11** for the four-runway airfield and **Exhibit 4-12** for the five-runway airfield. These percentages represent targets for the distribution of operations on runways for the noise analysis before incorporating late night cargo runway use. Modeled runway use, including late night cargo operations, is provided in Section 5.2.2.1.

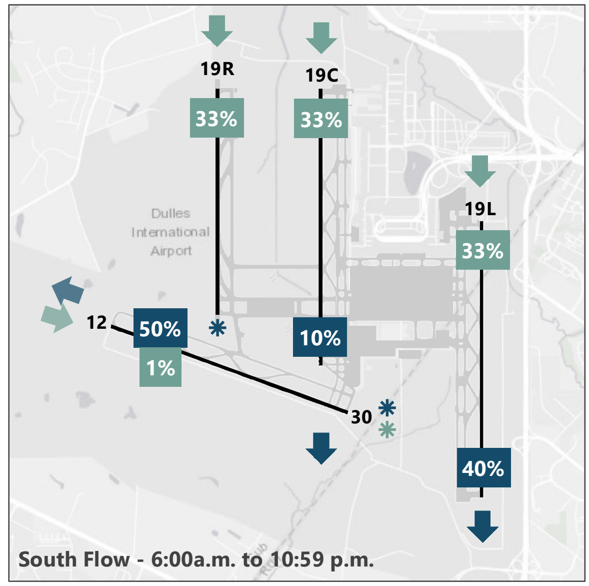
4.3.4 FOUR- AND FIVE-RUNWAY AIRFIELD NIGHTTIME CARGO RUNWAY USE PATTERNS

Several options exist for expanding cargo facilities at the Airport. Exhibit 3-10 in Section 3.1.3.4 depicts a total of approximately 1,620 acres available for on-Airport development. It was assumed the current cargo facilities would not provide sufficient square footage and efficient landside access for ASV cargo operations. **Exhibits 4-13**, **4-14**, and **4-15** depict potential sites on the west, southeast, and south side of the Airport and the preferred runway for each location, respectively. The sites are each sufficiently sized to accommodate the ASV cargo operations described in Section 4.2.2.1. Cargo operations typically occur during late night hours (11:00 p.m. to 5:59 a.m.) when demand levels are low—both on the airfield and on the landside roadway system. The closest runway to a cargo facility would be the preferred runway requested by cargo operators due to the time-sensitivity and the desire to minimize taxiing to and from the runway.

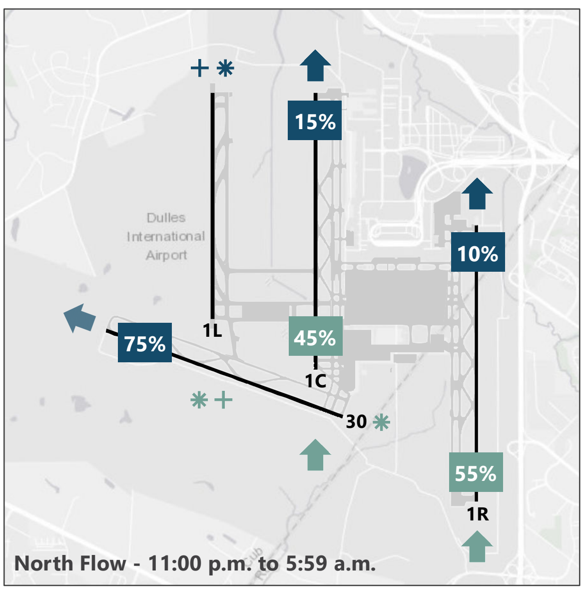
55% **45%**



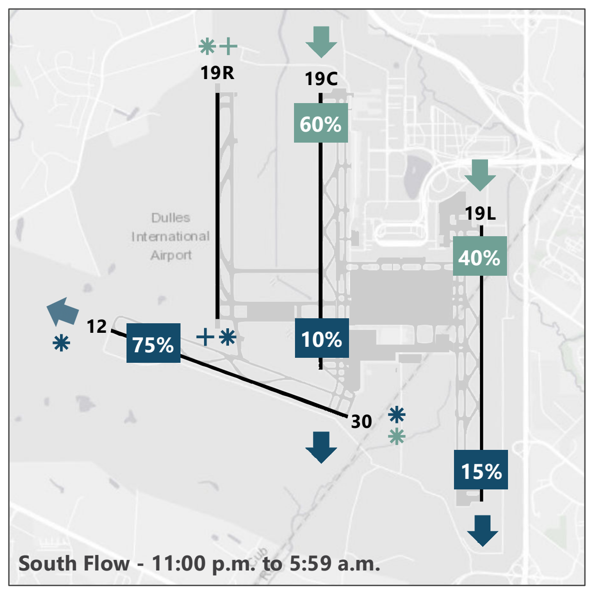
North Flow - 6:00a.m. to 10:59 p.m.



South Flow - 6:00a.m. to 10:59 p.m.



North Flow - 11:00 p.m. to 5:59 a.m.



South Flow - 11:00 p.m. to 5:59 a.m.

LEGEND

- Runways
- Existing Airfield Pavement
- Arrivals
- Departures

NOTES:

+Proposed runway use depicted does not yet include late night cargo operations scenarios. Will be included when operations are assigned to runways and flight tracks in AEDT.

*Graphics do not depict runway use below 0.5 percent. Model will maintain some use of those runways based on 2017 patterns.

Modeled runway use will vary slightly based on operation assignments to runways and flight tracks.

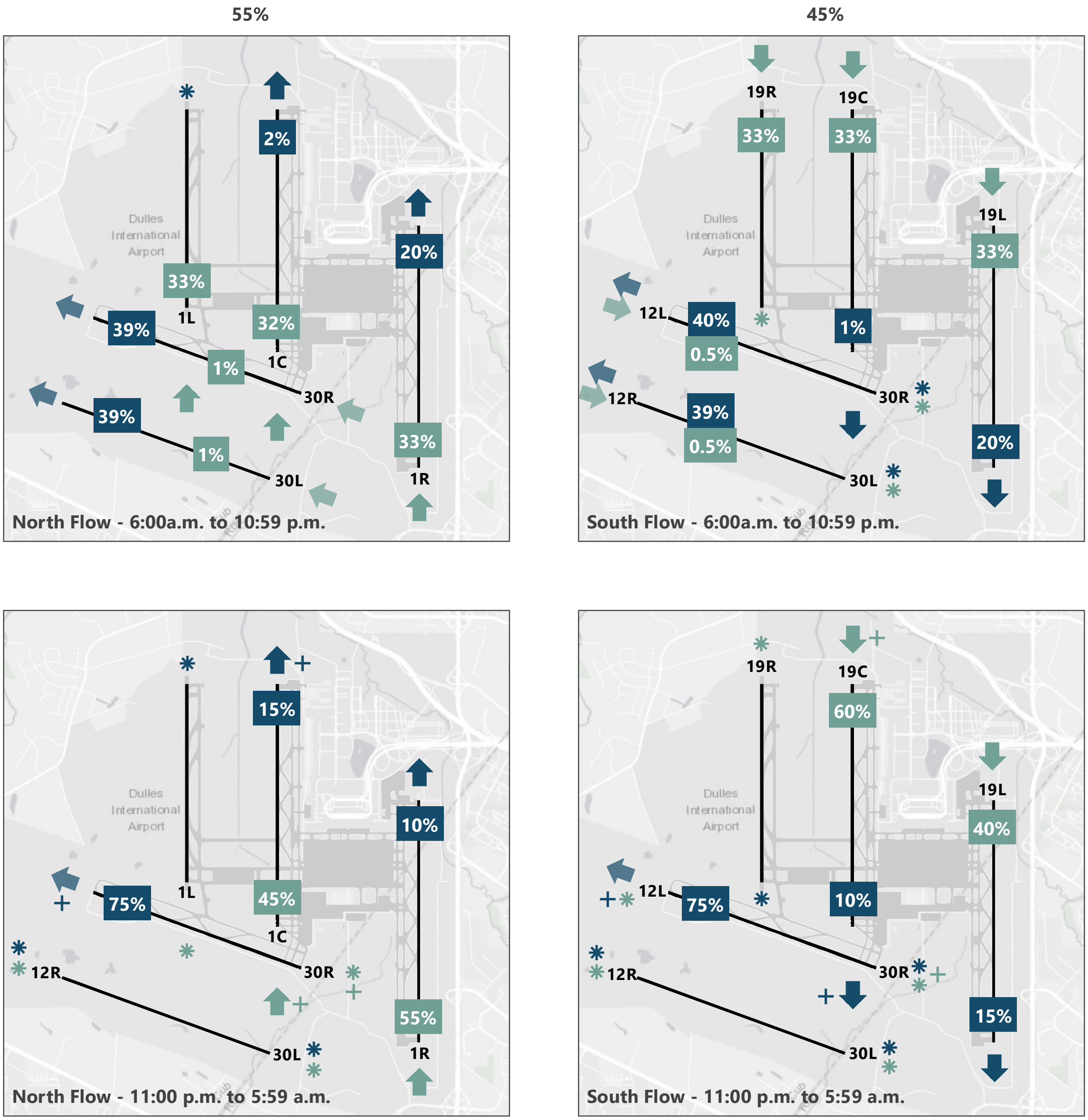
SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); Ricondo & Associates, Inc., August 2018 (projected runway use patterns).

EXHIBIT 4-11

NORTH 0 8,000 ft

PROJECTED RUNWAY USE PATTERNS - FOUR-RUNWAY AIRFIELD CONFIGURATION

P:\GIS\Projects\IAD\MXD\IAD_Exhibit4-11_ProjectedRwyUsePatternsFour-RunwayAirfieldConfiguration_20190531.mxd



LEGEND

- Runways
- Existing Airfield Pavement
- Arrivals
- Departures

NOTES:

+ Proposed runway use depicted does not yet include late night cargo operations scenarios. Will be included when operations are assigned to runways and flight tracks in AEDT.

* Graphics do not depict runway use below 0.5 percent. Model will maintain some use of those runways based on 2017 patterns.

Modeled runway use will vary slightly based on operation assignments to runways and flight tracks.

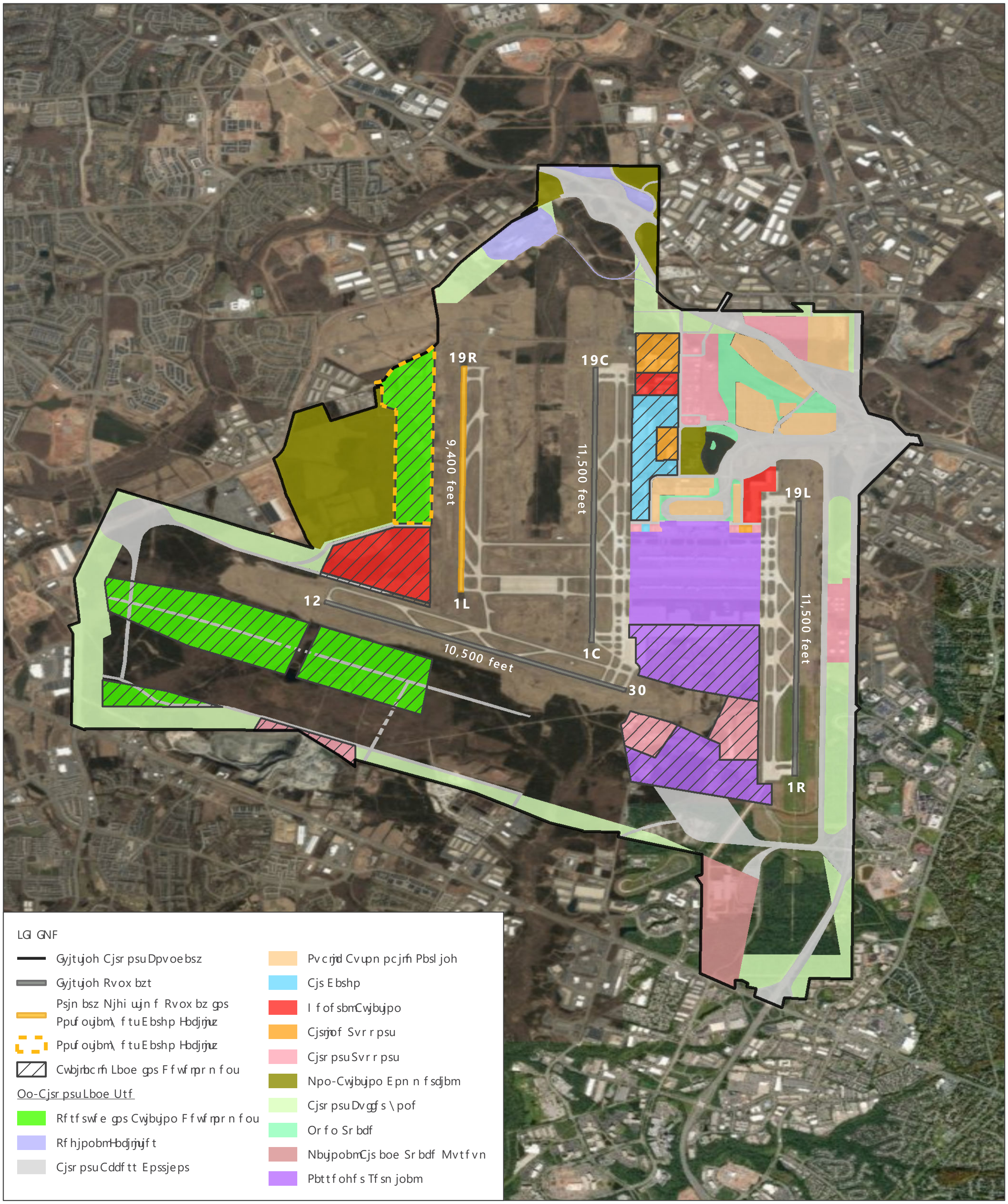
SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); Ricondo & Associates, Inc., August 2018 (projected runway use patterns).

EXHIBIT 4-12

NORTH 0 8,000 ft

PROJECTED RUNWAY USE PATTERNS - FIVE-RUNWAY AIRFIELD CONFIGURATION

P:\GIS\Projects\IAD\MXD\IAD_Exhibit4-12_ProjectedRwyUsePatternsFive-RunwayAirfieldConfiguration_20190531.mxd



SOUREGSAGtsj, F jhjubmhmpcf, I f pGzf , Gbsui tubs I f phsbr i jdt, ENGS/Cjscvt F S, USF C, USI S, Cf spl RM, MN, boe ui f I M Utf s Epn n vojuz, Mbsdi 201: (jn bhf sz c btf n br)B Mf uspr pmjubo \ bti johupo Cjsr psu Cvui psjuz, 201: (Cjsr psu c pv oe bsz, svox bzt, po-Cjsr psu mboe vtf)BRjdpoe p & Cttpdjbuf t, Md., Odupc f s 201: (r puf oujbm dbshp gbdjmjuz mpdbujpot).

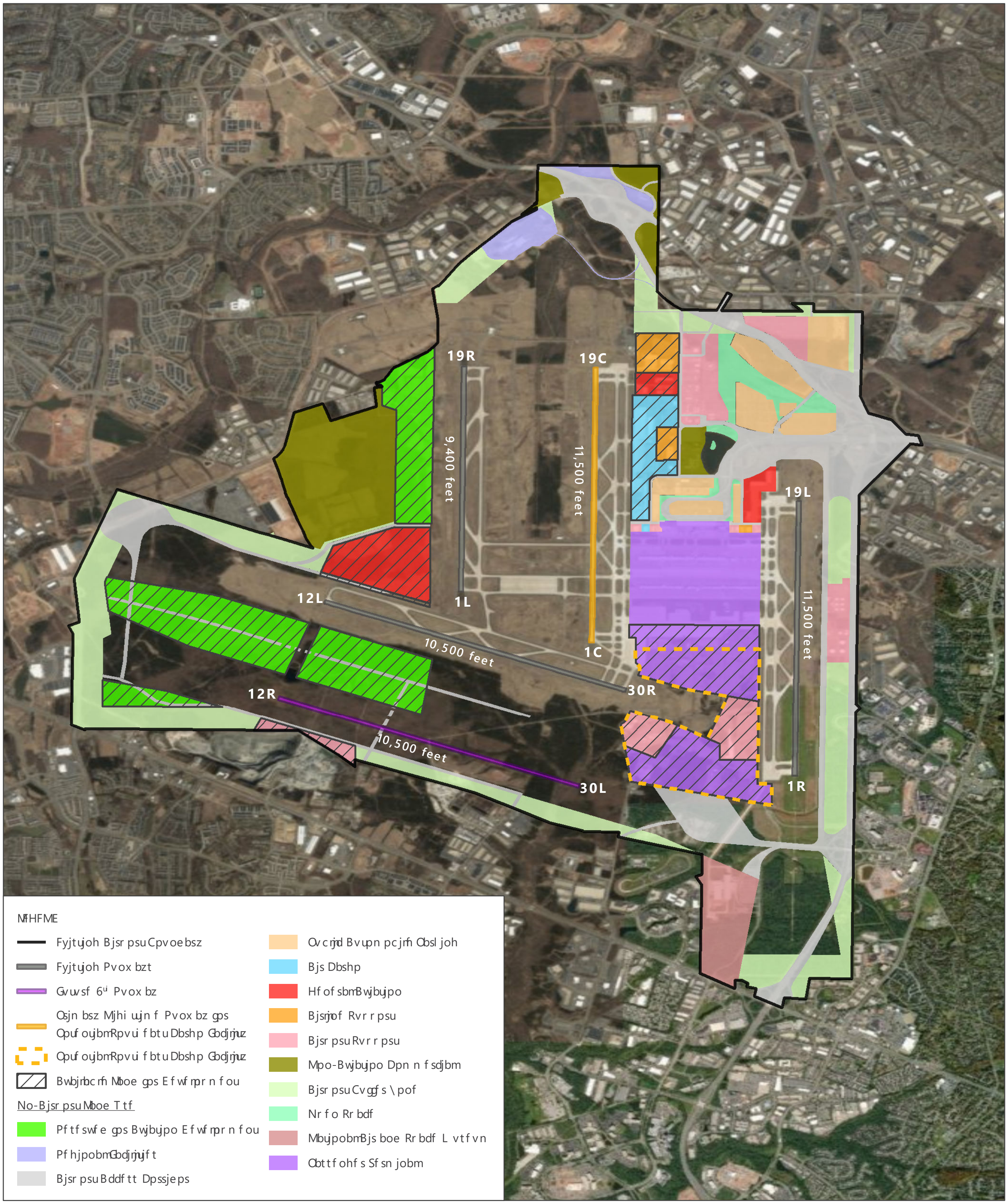
EXHIBIT 4-13

NORTL

0 9,000 gu

\ GST ECRI O HCEMMIX LOECTMON —
HOUR-RUN\ CX CMRHMLF EONHMURCTMON

PAI M_Psplf dut_MF_MWF_MF aGyi jcju6-13a\ f tu Ebshp Hbdjmjuz Lpdbujpoa6R\ Xa201; 082; .n ye



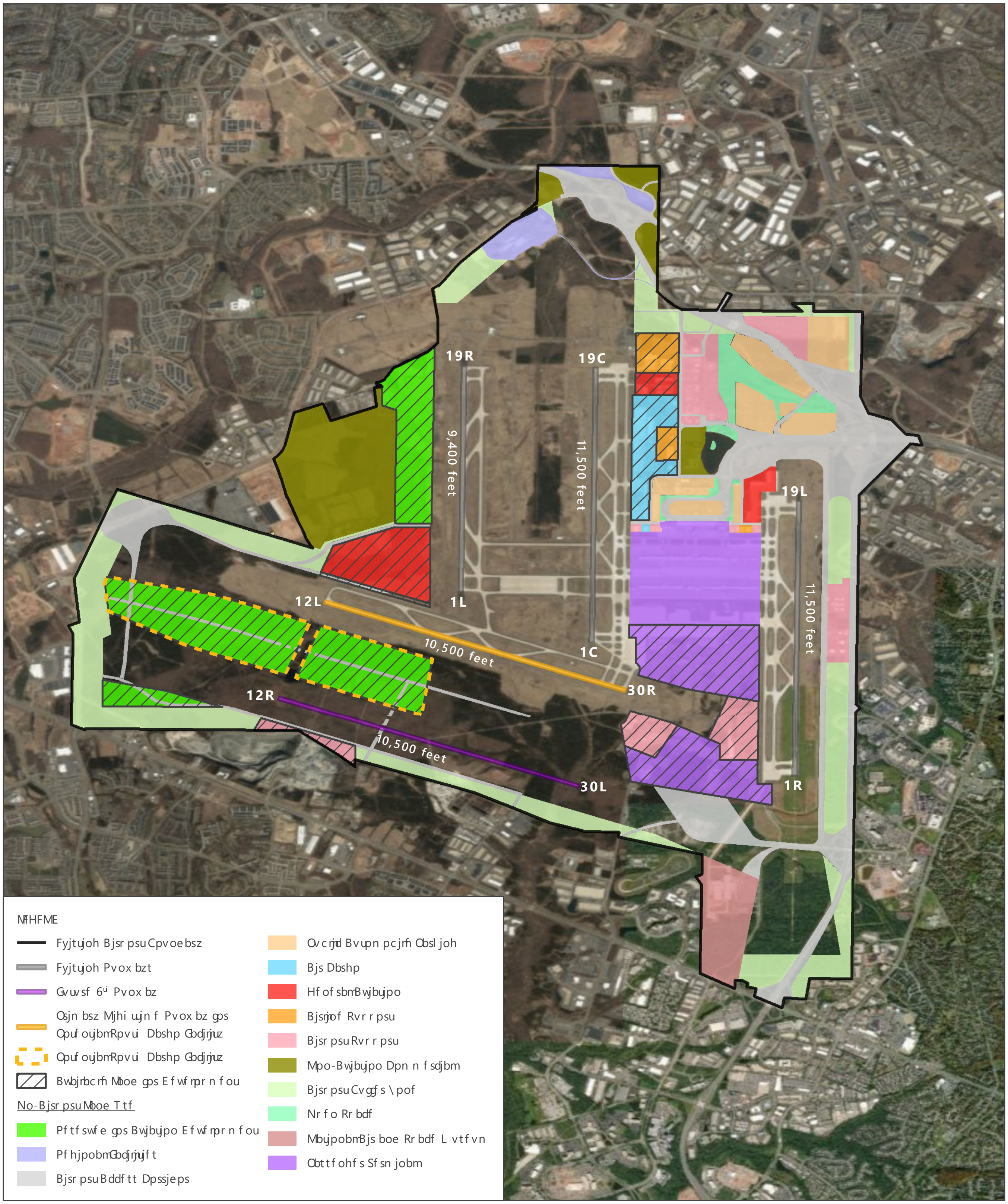
RNTPDFR; Ftsj, Ejhjubmhmpcf, HfpFzf, Fbsui tubs Hfphsbqijdt, DMFR/Bjscvt ER, TREB, TRHR, BfspHPLE, IHM, boe ui f HJT Vtfs Dpn n vojuz, L bsdi 2019 (jn bhfsz cbtfn bq)A
L fusprpmjubo \ bti johupo Bjsqpsu Bvuipsjuz, 2019 (Bjsqpsu cpvoebsz, svox bzt, opo-Bjsqpsu mboe vtf)APjdpoep & Bttpdjbuft, Jod., Ndupcfs 2019 (qpufoujbm dbshp gbdjmjuz mpdbujpot).

EXHIBIT 4-14

RNTSI FBRS DBPHN GBDJMJSX MNDBSJNM— GLUF-PTM\ BX BLPGJME DNMGJHT PBSJNM

MNPSI 0 8,000 gu

Q_HJR_Ospkfdut_LBE_L WE_LBE aFyi jcju3-13aRpvi f btuDbshpGbdjmjuzMpdbujpoa6P\ Xa201: 062: .n ye



RNT PDFR; Ftsj, E jhjubmHmpcf, Hf pFzf , Fbsui tubs Hf phsbr i jdt, DMFR/Bjscvt E R, T RE B, T RHR, Bf spHPLE, LHM, boe ui f HLR T tf s Dpn n vojuz, L bsdi 2019 (jn bhf sz cbtf n br)A
L f uspr pmjubo \ bti johupo Bjsr psu Bvui psjuz, 2019 (Bjsr psu cpv oe bsz, sv ox bzt, po-Bjsr psu mboe vtf)APjdpoe p & Bttpdjbuf t, Lod., Ndupc f s 2019 (r puf oujbmdbshp gbdjmjuz mpdbujpot).

EXHIBIT 4-15

MNPSI

0 8,000 gu

RNT SI DBPHN GBDLMSX MNDBSLNM —
GLUF-PT M\ BX BLPGLFME DNMGLHT PBSLNM

Q_HLR_Osplf dut_LBE_L WE_LBE aFyi jc ju3-16aRpvui DbshpGbdjmjuzMpdbujpoa6P\ Xa201: 062: .n ye

For purposes of this analysis, all late night cargo flights are assigned the closest runway to a potential cargo facility location on the Airport for the four- and five-runway airfield configurations. Exhibit 4-13 represents the four-runway airfield configuration with a cargo facility located on the west side of the Airport and Runway 1L-19R as the preferred runway. Exhibit 4-14 depicts the five-runway airfield configuration with a cargo facility located in the southeast corner of the Airport, south of the terminal area. The preferred runway for this configuration would be Runway 1C-19C. Exhibit 4-15 depicts the five-runway airfield with a south cargo facility located between existing Runway 12-30 and future runway 12R-30L with Runway 12L-30R as the preferred runway.

All three possible cargo facility locations are compatible with the four- and five-runway airfield configurations. The number of cargo operations are the same for both airfield configurations. The focus of the noise contour map update process is to account for multiple scenarios for nighttime cargo flights. Each of the three airfield configurations for cargo was modeled separately and could potentially be combined to account for the multiple long-term cargo location possibilities. Nighttime cargo flights were assigned to the preferred runway using the 55 percent North Flow and 45 percent South Flow runway use pattern.

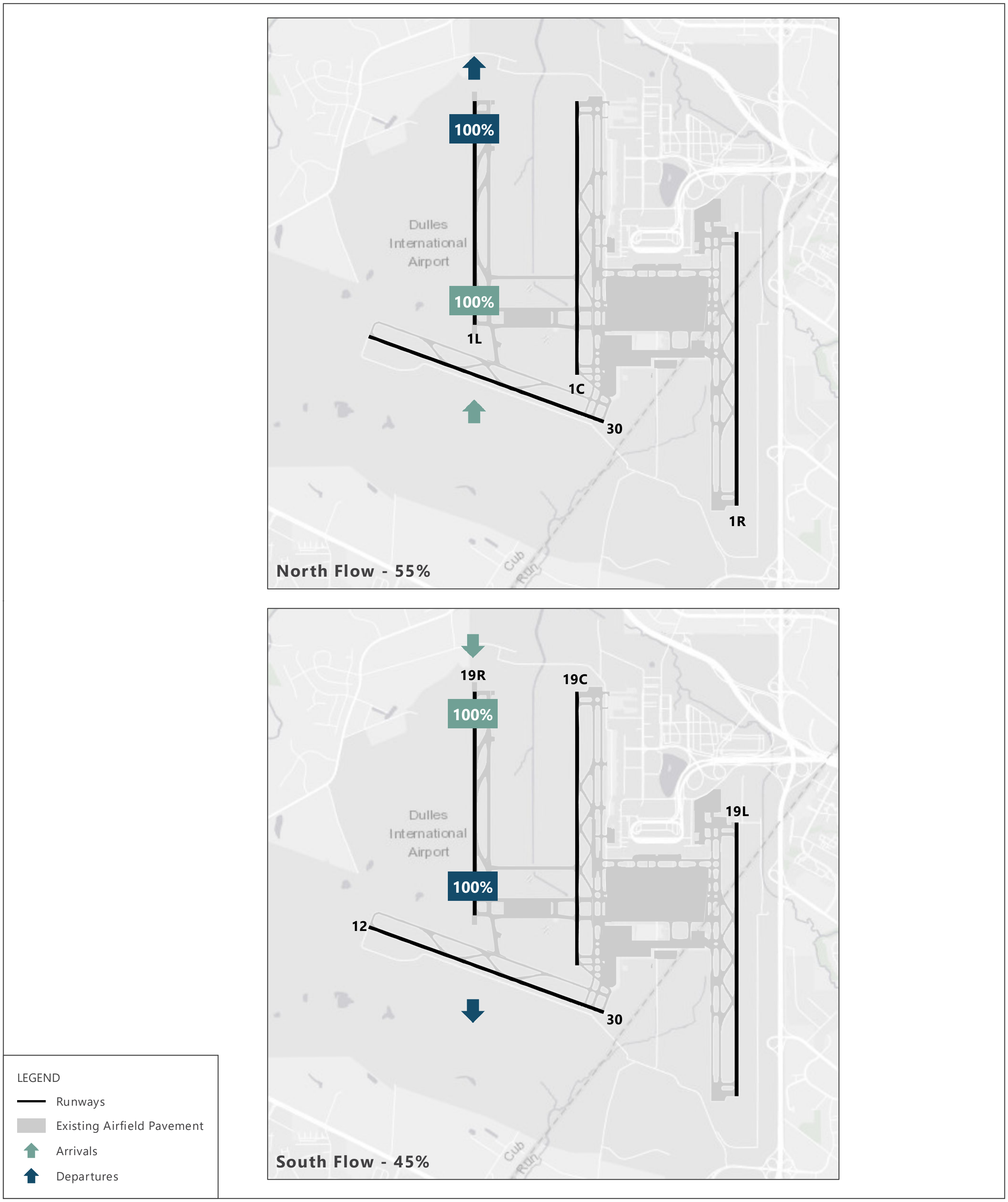
For the five-runway airfield configuration with a south cargo facility, the cargo runway use pattern favors arrivals and departures on Runway 30R instead of Runway 12L because of the constrained airspace to the east caused by the DC FRZ limiting the amount of airspace necessary to manage departures, and historically low use of existing Runway 12 due to historical wind patterns and CRO spacing requirements. Based on discussions with Dulles International ATCT and Potomac TRACON, changes in the DC FRZ east of the Airport and use of long-term NextGen capabilities to resolve airspace and separation constraints related to Runway 12 departures were not reasonably foreseeable at the time this analysis was conducted. The AAD runway use patterns for each runway end are reflected in the North and South Flow runway operating configurations (North Flow [arrivals and departures on Runway 30R] at 99 percent and South Flow [arrivals and departures on Runway 12L] at 1 percent).

Exhibits 4-16, **4-17**, and **4-18** depict the projected cargo runway use patterns previously discussed for the west, southeast, and south cargo facility layouts, respectively, for ASV AAD cargo operations. The cargo runway use pattern assumptions are in addition to the runway use patterns depicted on Exhibits 4-11 and 4-12 for the four- and five-runway airfield configurations, respectively. The modeled runway use for each of the three airfield configurations, based on the runway use patterns and cargo runway use, are provided in Section 5.2.2.1.

4.3.5 STAKEHOLDER INPUT SUMMARY

The three proposed airfield configurations for nighttime cargo operations were presented to the Working Group at a meeting on April 20, 2018. Appendix A contains a copy of the presentation. Working Group attendees recognized that three different potential configurations were modeled to account for different potential traffic patterns for long-term nighttime cargo flights. The Working Group concurred with the preferred runways associated with each of the three possible cargo facility locations to account for possible nighttime cargo traffic patterns in the noise model results.

Three meetings with Dulles International ATCT and Potomac TRACON subject matter experts were held on May 23, 2018, June 28, 2018, and September 7, 2018, to review assumptions and results. Input from the first meeting was used to develop a preliminary runway use estimates. The preliminary runway use estimates were the subject of the second meeting at which additional input was sought. Refined assumptions and results were reviewed again with Dulles International ATCT and Potomac TRACON at the third meeting. The FAA considered the assumptions and results reviewed at the September 7, 2018, meeting reasonable as long-term estimates.



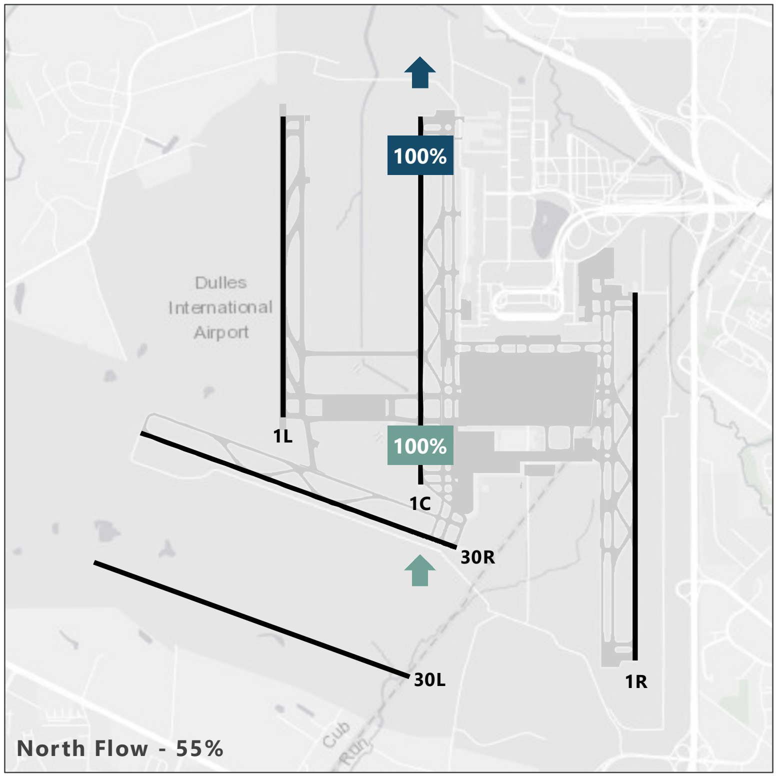
SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); Ricondo & Associates, Inc., October 2018 (cargo nighttime runway use pattern).

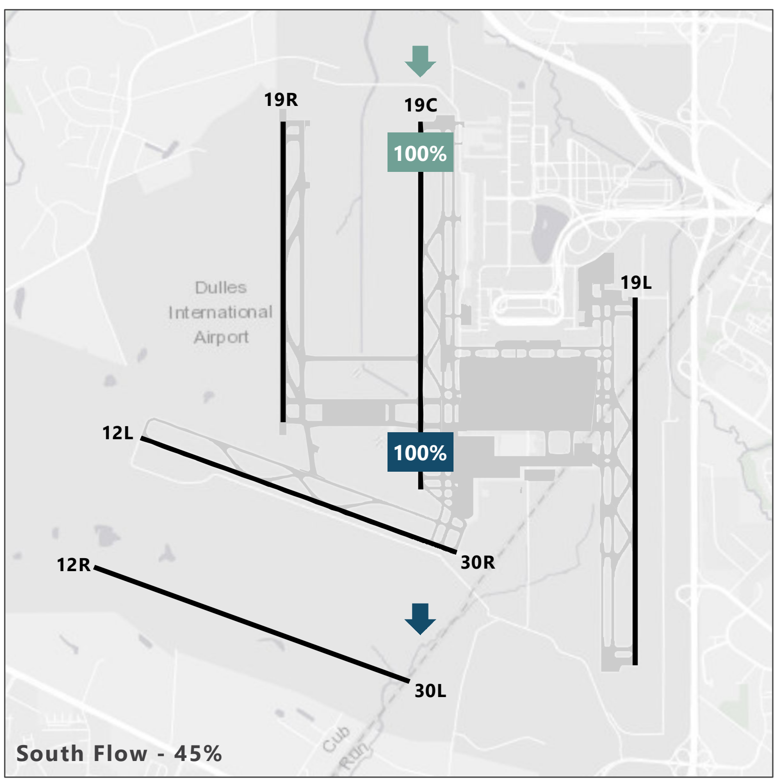
EXHIBIT 4-16

NORTH 0 6,000 ft

FOUR-RUNWAY AIRFIELD CONFIGURATION WITH WEST CARGO FACILITY - NIGHTTIME RUNWAY USE PATTERN

P:\GIS\Projects\IAD\MXD\IAD_Exhibit4-16_Four-RwyAirfieldWestCargoFacility-NighttimeRwyUsePattern_20190531.mxd





LEGEND
- Runways
- Existing Airfield Pavement
- Arrivals
- Departures

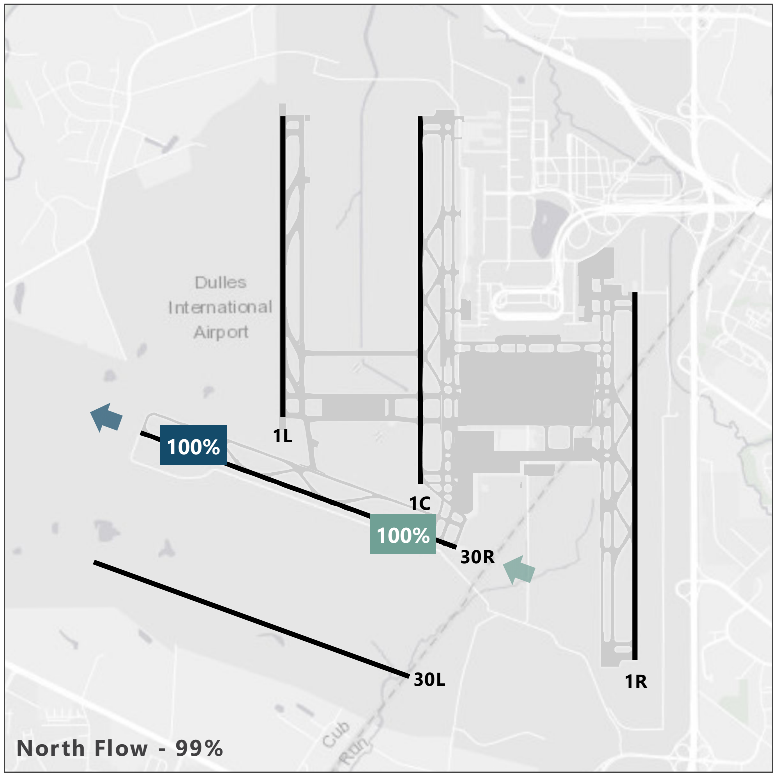
SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); Ricondo & Associates, Inc., October 2018 (cargo nighttime runway use pattern).

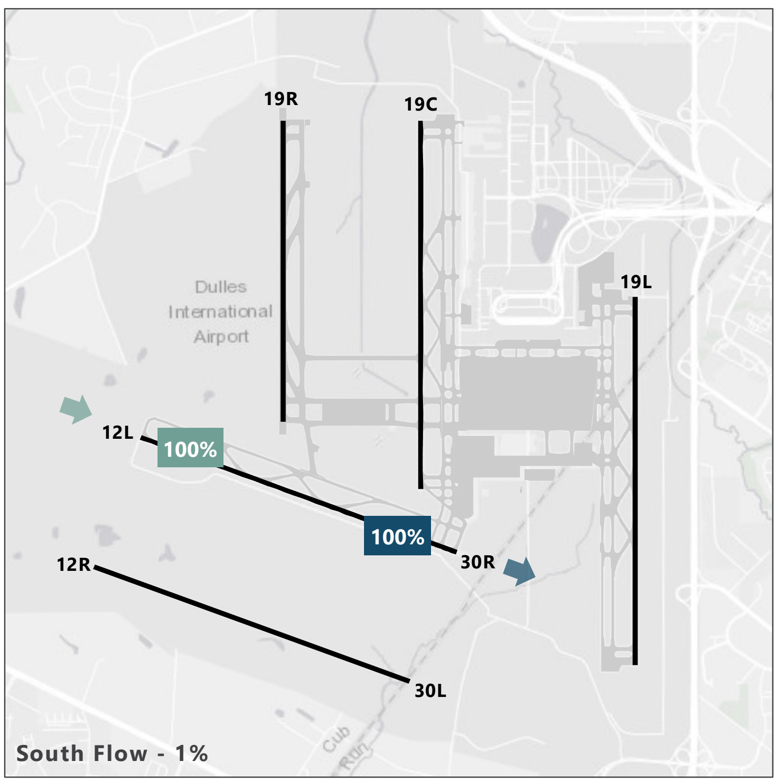
NORTH 0 6,000 ft

EXHIBIT 4-17

FIVE-RUNWAY AIRFIELD CONFIGURATION WITH SOUTHEAST CARGO FACILITY - NIGHTTIME RUNWAY USE PATTERN

P:\GIS\Projects\IAD\MXD\IAD_Exhibit4-17_Five-RwyAirfieldSoutheastCargoFacility-NighttimeRwyUsePattern_20190531.mxd





LEGEND

- Runways
- Existing Airfield Pavement
- Arrivals
- Departures

SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, May 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways, buildings); Ricondo & Associates, Inc., October 2018 (cargo nighttime runway use pattern).

NORTH 0 6,000 ft

EXHIBIT 4-18

FIVE-RUNWAY AIRFIELD CONFIGURATION WITH SOUTH CARGO FACILITY - NIGHTTIME RUNWAY USE PATTERN

P:\GIS\Projects\IAD\MXD\IAD_Exhibit4-18_Five-RwyAirfieldSouthCargoFacility-NighttimeRwyUsePattern_20190531.mxd

The Working Group reviewed the proposed runway operating configuration and runway use patterns at the August 13, 2018 meeting. The Working Group attendees were provided a summary of the methodology and preliminary runway use patterns, pending FAA final review. Members did not express any concerns with the proposed runway operating configurations and runway use patterns for the four- and five-runway airfield configurations.

4.4 NOISE MODEL FLIGHT TRACKS FOR ULTIMATE OPERATIONS CONDITIONS

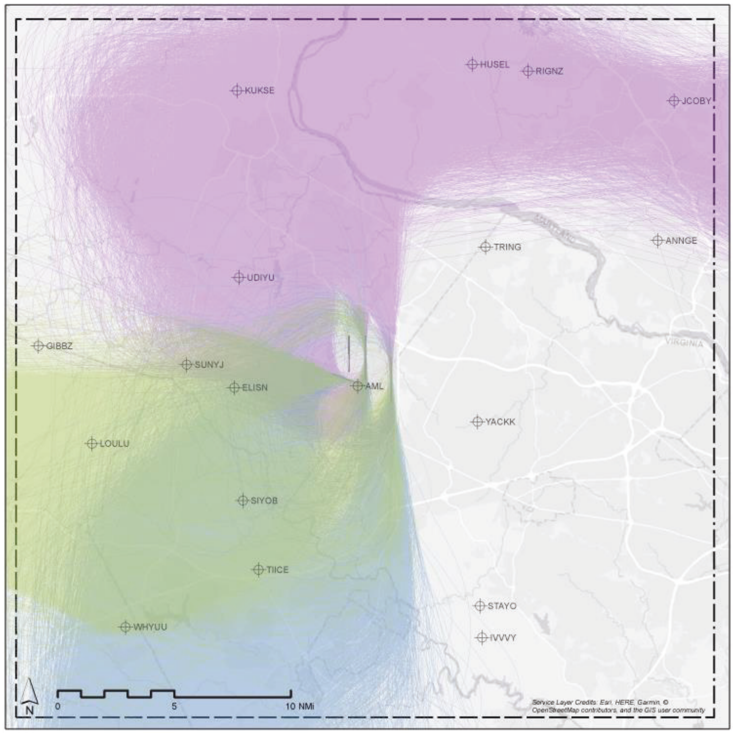
All noise modeling in this study was completed using AEDT. The AEDT noise model flight tracks represent aircraft flight corridors (flights heading in a similar direction but dispersed on either side of the defined course) with a system of primary flight noise model tracks (or "backbone" tracks) and additional "dispersed" noise model tracks. The backbone noise model track lies at the center of the corridor, with one or more dispersed noise model tracks on each side. The AEDT distributes the operations assigned to a track among the backbone and dispersed noise model tracks using a normal distribution or a user-defined distribution based on the observed radar track density. This dispersion more accurately represents each flight corridor by accounting for variability attributable to weather, aircraft type, traffic, pilot technique, and other factors. The combination of backbone and dispersed tracks serve as representative AEDT noise model flight tracks (noise model flight tracks).

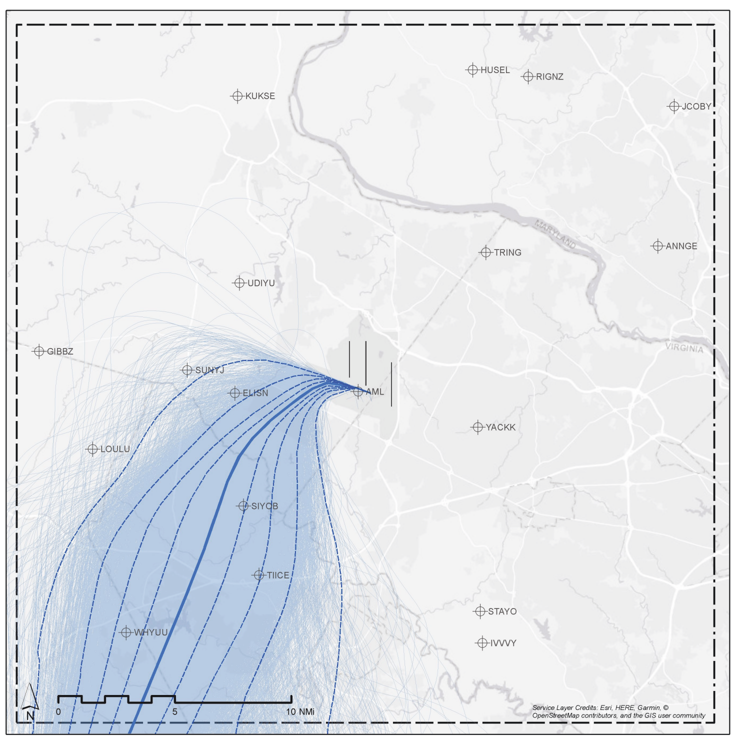
The noise model flight tracks for the four- and five-runway airfield configurations were developed using a three-step process. First, a large sample of Dulles International flight radar data from MWAA's ANOMS was collected and analyzed to identify existing flight corridors. Second, the flight tracks for each corridor were converted into noise model tracks. Finally, the noise model flight tracks were modified for changes in the Airport runway layout for the five-runway airfield configuration and ATC procedures assumed for ultimate operation conditions.

4.4.1 2017 FLIGHT TRACKS

Existing (2017) noise model flight tracks served as the baseline in the development of the ultimate operation condition noise model flight tracks. The noise model flight tracks for 2017 were derived from a full-year sample of radar data from MWAA's ANOMS. The area of detailed noise model flight track creation was limited to a study area that extended 15 nautical miles to the north, south, east, and west of Dulles International, and is depicted as a dashed box on **Exhibits 4-19** through **4-26**. The arrivals and departures were reviewed to ensure the accuracy of runway assignments, and radar tracks with unusable geometry were excluded from the analysis. Each radar track was tagged with its propulsion type (jet, turbine-propeller, and piston propeller), aircraft weight category (heavy, large, small), and time of day (daytime – 7:00 a.m. to 9:59 p.m., nighttime – 10:00 p.m. to 6:59 a.m.). The geometries of the radar tracks were reviewed to group flights with similar flight paths into the same corridors (e.g., aircraft following the same arrival or departure procedure). The groups of radar tracks are referred to as bundles.

Following the data clean-up and tagging stage, noise model flight tracks for each corridor were created for individual bundles of radar tracks by a particular aircraft group arriving at or departing from a particular runway. Exhibit 4-19 depicts the noise model flight track creation process. In the top panel of the exhibit, departure radar tracks from multiple runways are separated into three different corridors based on direction and geometry with departures to the southwest shown in blue. The bottom panel of the exhibit depicts only the bundle of departure radar tracks to the southwest on Runway 30 by one aircraft group. The average geometry of this radar track bundle was then converted into noise model flight tracks with the backbone and dispersed model flight tracks shown as solid and dashed lines, respectively.





LEGEND

- Departures to the East
- Departures to the West
- Departures to the South
- 15 Nautical Mile Noise Model Study Area
- AEDT Noise Model Backbone Track
- AEDT Noise Model Dispersed Track
- Airspace Waypoint/Fix

SOURCE: Harris Miller Miller & Hanson Inc., October 2018.

EXHIBIT 4-19

NORTH 0 Not to scale

NOISE MODEL FLIGHT TRACK CREATION PROCESS

corporate:Creative Services:01 Projects:01 Client Projects:2019:MWAA:IAD:17081045-7.4_IAD Aircraft Noise Overlay Document Exhibits:IAD Long-Range Potential Operation Patterns Folder:IAD Long-Range Potential Operation Patterns-v2.indd

LEGEND

- - - 15 Nautical Mile Noise Model Study Area
— 2017 AEDT Arrival Noise Model Backbone Tracks
- - - 2017 AEDT Arrival Noise Model Dispersed Tracks
⊕ Airspace Waypoint/Fix

SOURCE: Harris Miller Miller & Hanson Inc., October 2018.

EXHIBIT 4-20

NORTH 0 Not to scale

2017 NORTH FLOW ARRIVAL NOISE MODEL FLIGHT TRACKS

corporate:Creative Services:01 Projects:01 Client Projects:2019:MWAA:IAD:17081045-7.4_IAD Aircraft Noise Overlay Document Exhibits:IAD Long-Range Potential Operation Patterns Folder:IAD Long-Range Potential Operation Patterns-v2.indd

LEGEND

- - - 15 Nautical Mile Noise Model Study Area
— 2017 AEDT Arrival Noise Model Backbone Tracks
- - - 2017 AEDT Arrival Noise Model Dispersed Tracks
⊕ Airspace Waypoint/Fix

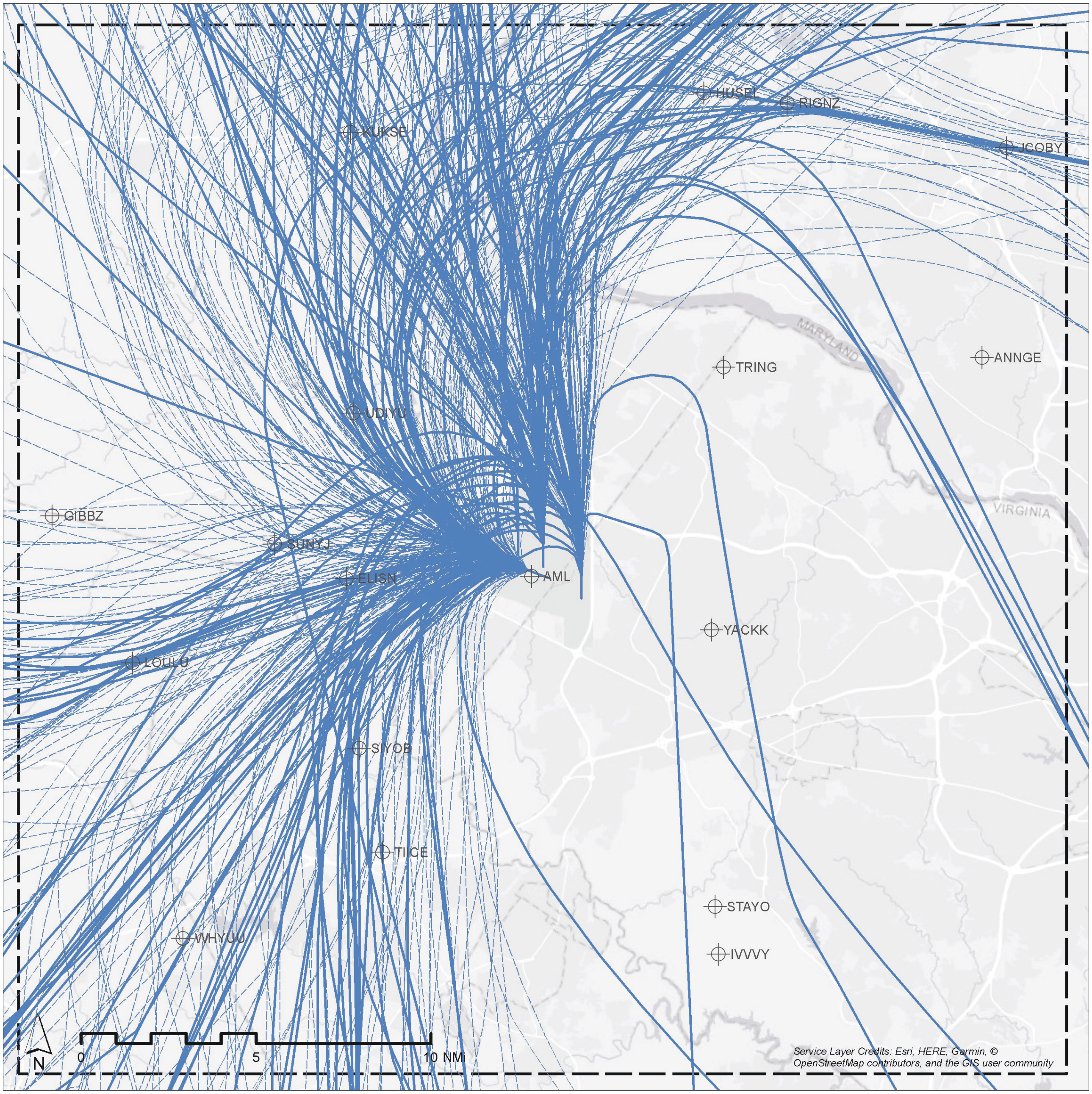
SOURCE: Harris Miller Miller & Hanson Inc., October 2018.

EXHIBIT 4-21

NORTH 0 Not to scale

2017 SOUTH FLOW ARRIVAL NOISE MODEL FLIGHT TRACKS

corporate:Creative Services:01 Projects:01 Client Projects:2019:MWAA:IAD:17081045-7.4_IAD Aircraft Noise Overlay Document Exhibits:IAD Long-Range Potential Operation Patterns Folder:IAD Long-Range Potential Operation Patterns-v2.indd



LEGEND

- - - 15 Nautical Mile Noise Model Study Area
— 2017 AEDT Departure Noise Model Backbone Tracks
- - - 2017 AEDT Departure Noise Model Dispersed Tracks
⊕ Airspace Waypoint/Fix

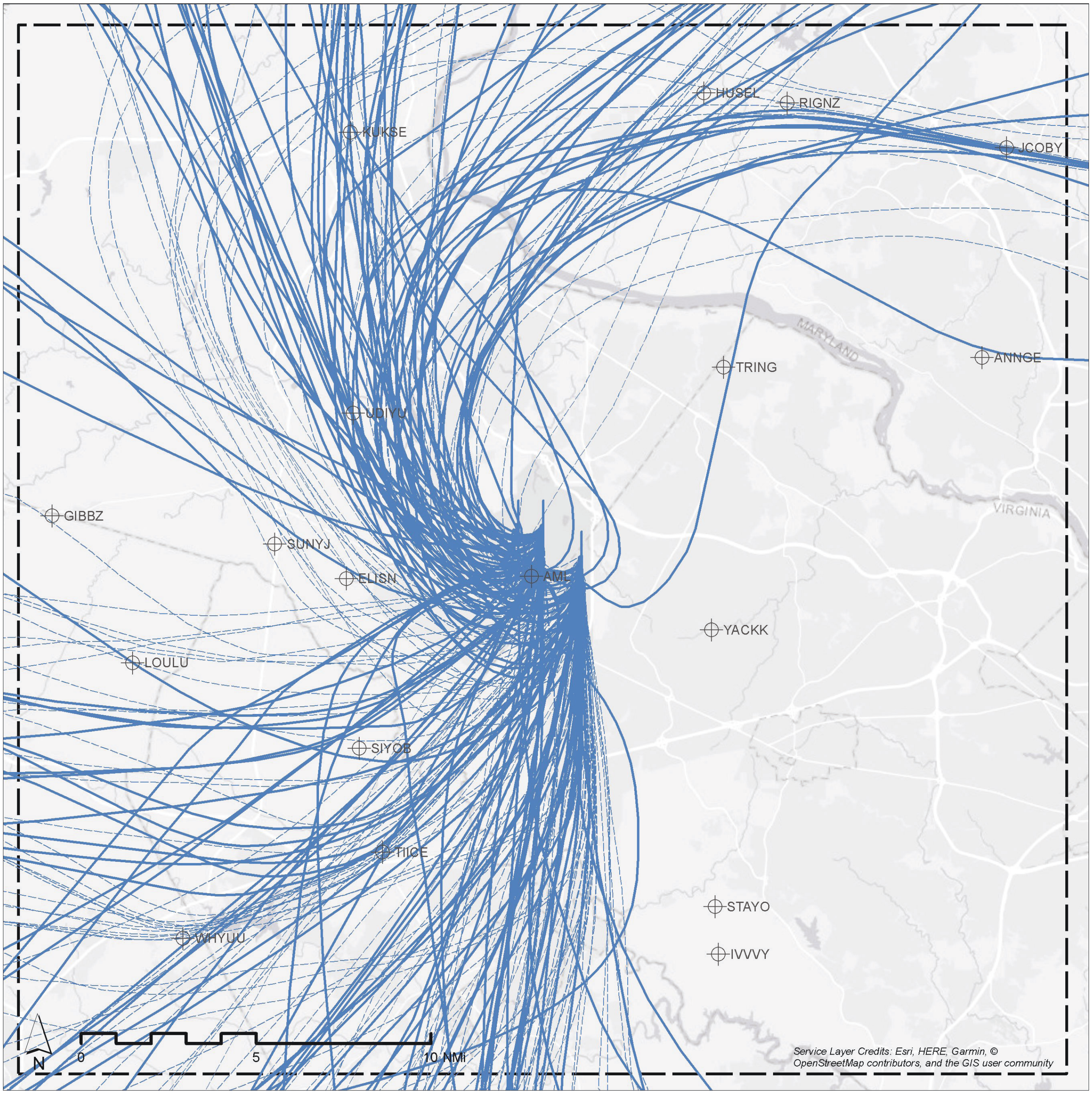
SOURCE: Harris Miller Miller & Hanson Inc., October 2018.

EXHIBIT 4-22

NORTH 0 Not to scale

2017 NORTH FLOW DEPARTURE NOISE MODEL FLIGHT TRACKS

corporate:Creative Services:01 Projects:01 Client Projects:2019:MWAA:IAD:17081045-7.4_IAD Aircraft Noise Overlay Document Exhibits:IAD Long-Range Potential Operation Patterns Folder:IAD Long-Range Potential Operation Patterns-v2.indd



LEGEND

- 15 Nautical Mile Noise Model Study Area
- 2017 AEDT Departure Noise Model Backbone Tracks
- 2017 AEDT Departure Noise Model Dispersed Tracks
- Airspace Waypoint/Fix

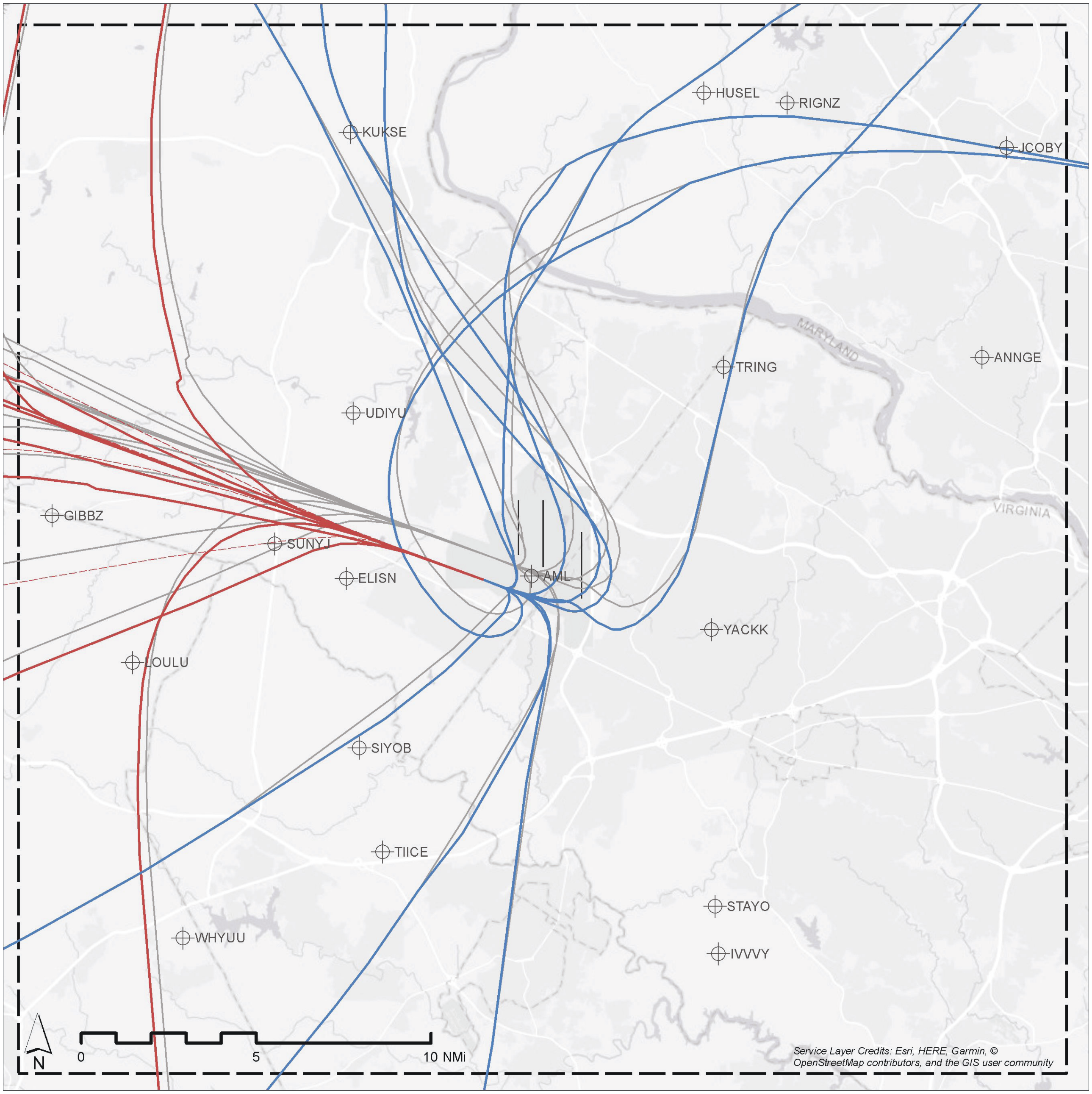
SOURCE: Harris Miller Miller & Hanson Inc., October 2018.

EXHIBIT 4-23

NORTH 0 Not to scale

2017 SOUTH FLOW DEPARTURE NOISE MODEL FLIGHT TRACKS

corporate:Creative Services:01 Projects:01 Client Projects:2019:MWAA:IAD:17081045-7.4_IAD Aircraft Noise Overlay Document Exhibits:IAD Long-Range Potential Operation Patterns Folder:IAD Long-Range Potential Operation Patterns-v2.indd



LEGEND

- 15 Nautical Mile Noise Model Study Area
- Runway 12R-Ultimate AEDT Departure Noise Model Tracks
- Runway 12R-Ultimate AEDT Arrival Noise Model Tracks
- 2017 AEDT Arrival and Departure Noise Model Tracks
- Airspace Waypoint/Fix

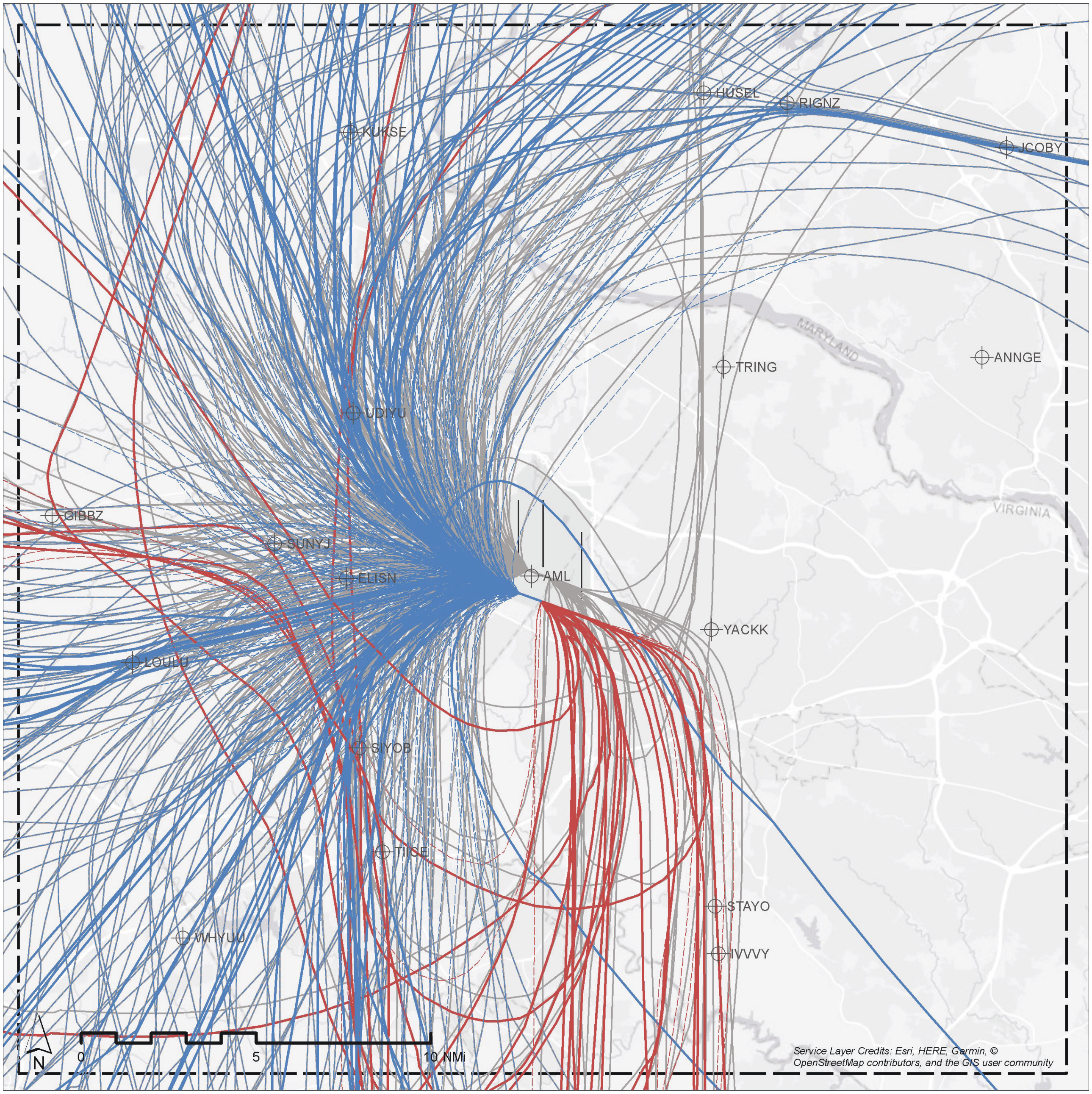
SOURCE: Harris Miller Miller & Hanson Inc., October 2018.

EXHIBIT 4-24

NORTH 0 Not to scale

FIVE-RUNWAY AIRFIELD CONFIGURATION – RUNWAY 12R NOISE MODEL FLIGHT TRACKS

corporate:Creative Services:01 Projects:01 Client Projects:2019:MWAA:IAD:17081045-7.4_IAD Aircraft Noise Overlay Document Exhibits:IAD Long-Range Potential Operation Patterns Folder:IAD Long-Range Potential Operation Patterns-v2.indd



LEGEND

- - - 15 Nautical Mile Noise Model Study Area
— Runway 30L-Ultimate AEDT Departure Noise Model Tracks
— Runway 30L-Ultimate AEDT Arrival Noise Model Tracks
— Runway 30R - 2017 AEDT Arrival and Departure Noise Model Tracks
⌖ Airspace Waypoint/Fix

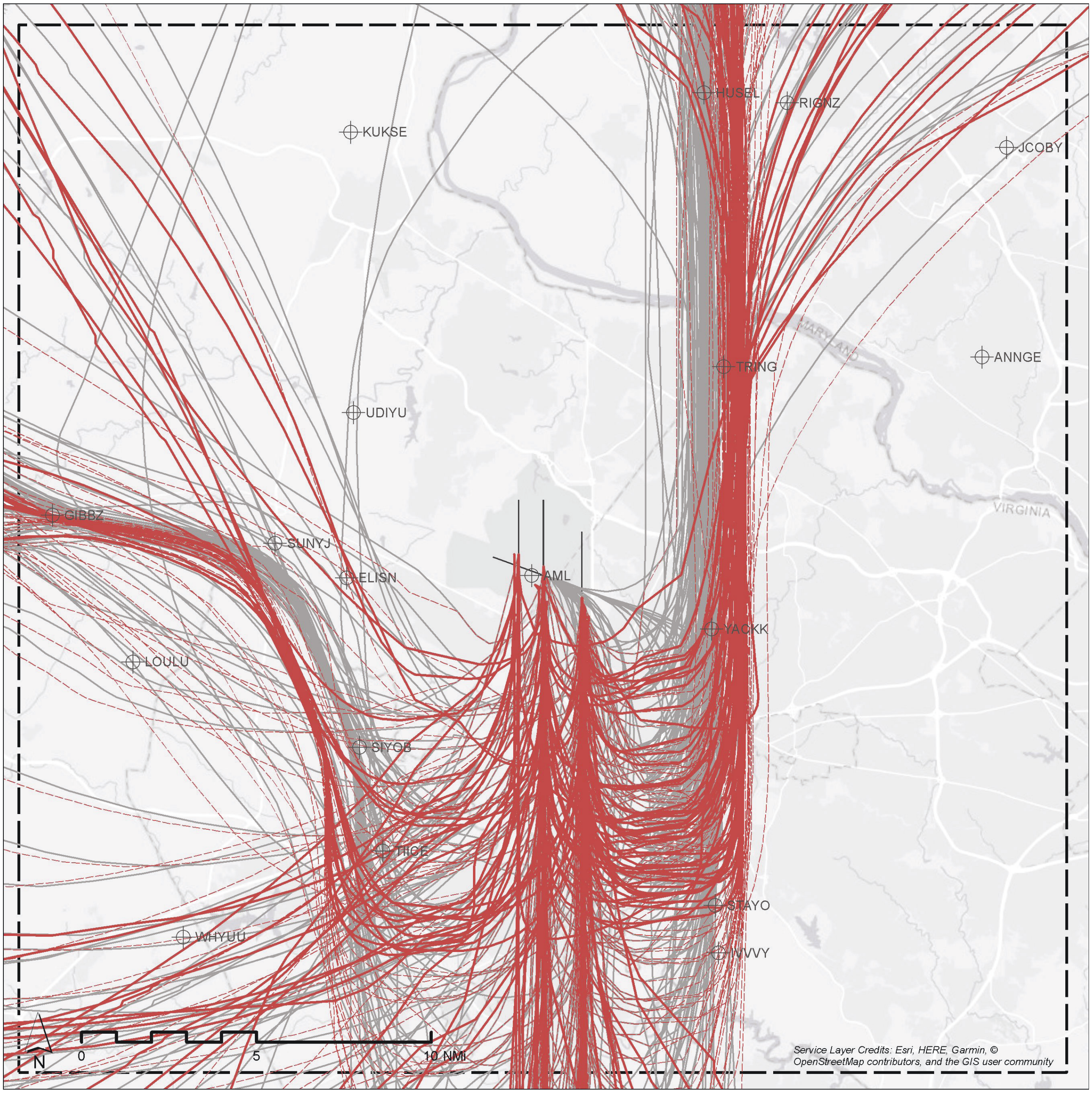
SOURCE: Harris Miller Miller & Hanson Inc., October 2018.

NORTH 0 Not to scale

EXHIBIT 4-25

FIVE-RUNWAY AIRFIELD CONFIGURATION –
RUNWAY 30L NOISE MODEL FLIGHT TRACKS

corporate:Creative Services:01 Projects:01 Client Projects:2019:MWAA:IAD:17081045-7.4_IAD Aircraft Noise Overlay Document Exhibits:IAD Long-Range Potential Operation Patterns Folder:IAD Long-Range Potential Operation Patterns-v2.indd



LEGEND

- 15 Nautical Mile Noise Model Study Area
- Ultimate AEDT Arrival Noise Model Backbone Tracks
- Ultimate AEDT Arrival Noise Model Dispersed Tracks
- 2017 AEDT Arrival Noise Model Tracks
- Airspace Waypoint/Fix

SOURCE: Harris Miller Miller & Hanson Inc., October 2018.

NORTH 0 Not to scale

EXHIBIT 4-26

FOUR-RUNWAY AIRFIELD CONFIGURATION – NORTH FLOW ARRIVAL NOISE MODEL FLIGHT TRACKS

corporate:Creative Services:01 Projects:01 Client Projects:2019:MWAA:IAD:17081045-7.4_IAD Aircraft Noise Overlay Document Exhibits:IAD Long-Range Potential Operation Patterns Folder:IAD Long-Range Potential Operation Patterns-v2.indd

Over 270,000 individual ANOMS radar tracks were grouped into 573 bundles (e.g., large jet departures on Runway 30 using the CLTCH TWO SID procedure). From each of these bundles, between one and nine noise model flight tracks were created, depending on the number of radar tracks within the bundle.

Exhibit 4-20 and Exhibit 4-21 depict the 2017 noise model flight tracks for North Flow arrivals and South Flow arrivals, respectively. Exhibit 4-22 and Exhibit 4-23 depict the 2017 noise model flight tracks for North Flow departures and South Flow departures, respectively.

4.4.2 FOUR- AND FIVE-RUNWAY AIRFIELD NOISE MODEL FLIGHT TRACKS FOR ULTIMATE OPERATIONS CONDITIONS

The noise model flight tracks for the four- and five-runway airfield configurations for ultimate operation conditions were based upon three sources: the 2017 noise model flight tracks, the 2005 Dulles New Runway EIS,[50] and input from the Dulles International ATCT and Potomac TRACON subject matter experts.

4.4.2.1 FOUR- AND FIVE-RUNWAY AIRFIELD CONFIGURATION NOISE MODEL FLIGHT TRACK DEVELOPMENT PROCESS AND ASSUMPTIONS

Development of the noise model flight tracks for the four-runway airfield started with the 2017 noise model flight tracks and modifications were made to account for long-term developments such as FAA NextGen initiatives. Development of the noise model flight tracks for the five-runway airfield began with the same 2017 noise model flight tracks but considered the noise model flight track information for the five-runway airfield developed for the 2005 Dulles New Runway EIS. Information from the 2005 Dulles New Runway EIS provided a starting point for modeling potential noise model flight track location and geometry for future Runway 12R-30L. The Dulles International ATCT and Potomac TRACON reviewed this information, along with 2017 representative AEDT noise model tracks, as a basis to discuss potential changes in the short- and long-term future for both the four- and five-runway airfields.

Discussions regarding long-term developments focused primarily on the reasonableness of assumptions related to future Runway 12R-30L noise model flight track location and geometry, the future impact of FAA's NextGen initiatives (e.g., enhanced RNP precision SIDs and STARs, increased use of RNP approaches with TBFM, and ADS-B), and the potential impact of these developments on AAD noise model flight track locations and dispersion. Based on the discussions with the FAA, the 2017 noise model flight tracks were modified and new representative AEDT noise model flight tracks were added to model a reasonable projection of future AAD flight paths for the four- and five-runway airfields. The noise model tracks for the four- and five-runway airfields were reviewed with Dulles International ATCT and Potomac TRACON at a second meeting to confirm the reasonableness of these projected tracks and refinements were conducted prior to finalizing the noise model flight tracks for noise modeling.

Based on FAA feedback, the assumptions for the four- and five-runway airfield noise model flight tracks were established. Changes to arrival paths included:

- New arrival procedures related to independent triple-simultaneous instrument approaches
- Relocated downwind legs for North Flow arrivals.
- New RNP approach procedures with Radial-to-Fix (RF) legs to provide more predictable curved paths for the base leg of an approach.

[50] US Department of Transportation, Federal Aviation Administration in Cooperation with the US Army Corps of Engineers, *"Final Environmental Impact Statement for New Runways, Terminal Facilities and Related Facilities at Washington Dulles International Airport*, August 2005.

Other changes to arrival paths identified by the FAA would likely be outside the 15-mile study area.

Departures would continue to be dispersed upon multiple headings by Dulles International ATCT from a runway. The FAA has no long-term plans to develop and implement RNAV-type procedures causing narrower departure paths from the departure end of a runway.

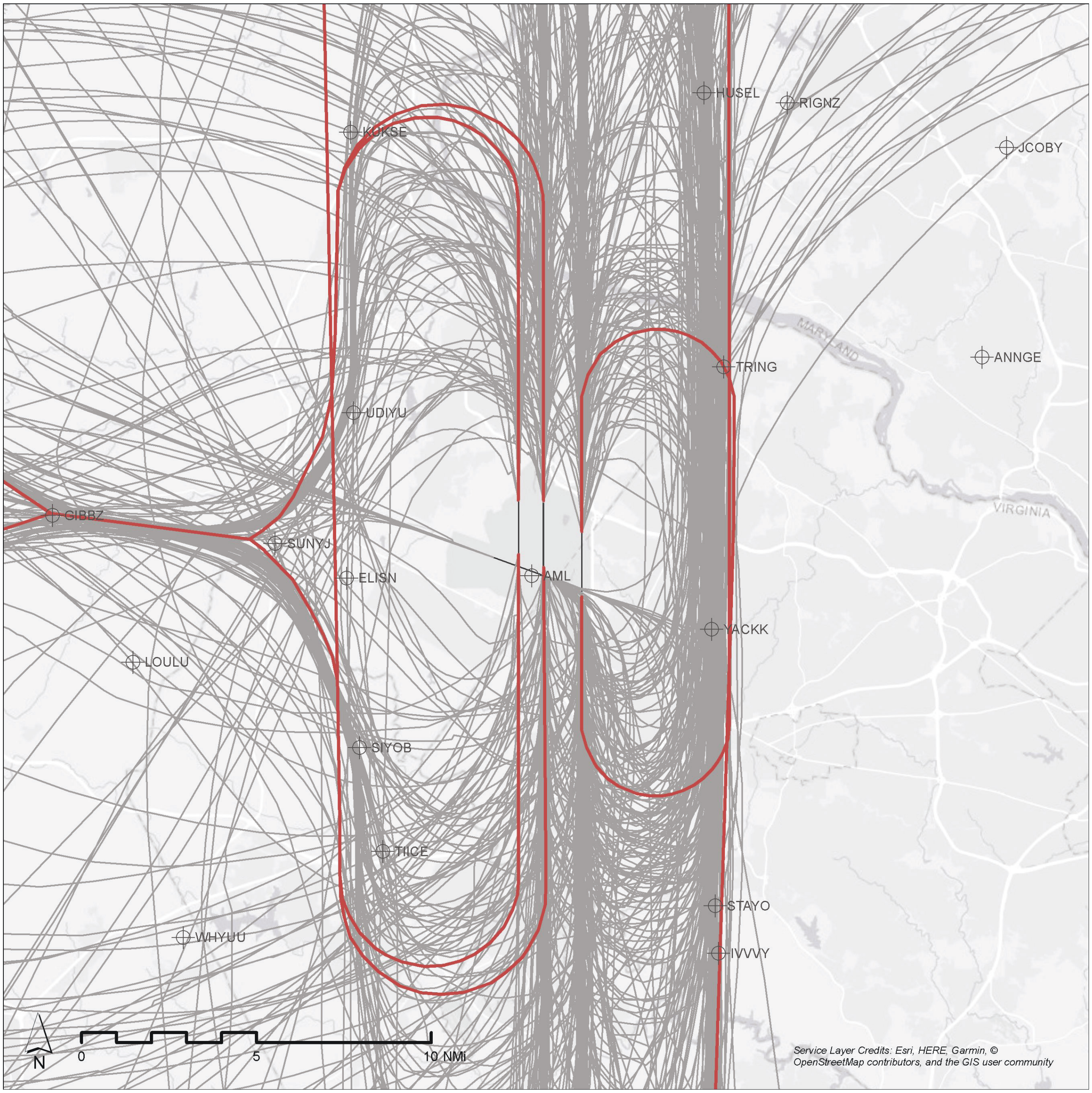
Flight paths for fifth runway (Runway 12R-30L) would differ within the immediate area near the Airport but would be similar to existing Runway 12-30 paths farther from the Airport. RNP approaches would be applied to provide more predictable and precise flight paths for aircraft landing on Runway 30 (four-runway airfield configuration) and Runways 30L/30R (five-runway airfield configuration) while staying clear of the DC FRZ.

4.4.2.2 CHANGES TO 2017 FLIGHT TRACKS

As reported in the 2005 Dulles New Runway EIS, the FAA envisioned a new runway (Runway 12R-30L) that would be the same length as, and parallel to, Runway 12-30. The arrival noise model flight tracks for the five-runway airfield configuration, depicted in red on Exhibit 4-24 for Runway 12R and on Exhibit 4-25 for Runway 30L, were created by replicating the 2017 arrival noise model flight tracks for Runway 12-30. The departure noise model flight tracks, depicted in blue on Exhibit 4-24 for Runway 12L and on Exhibit 4-25 for Runway 30L, were created by replicating the 2017 Runway 12-30 departure noise model flight tracks to Runway 12R-30L and then modifying the departure noise model flight tracks to converge with the existing Runway 12-30 tracks at the same initial departure transition navigational fixes. For comparison purposes, the existing Runway 12 and Runway 30 noise model flight tracks are depicted as gray lines in the background on Exhibits 4-24 and 4-25, respectively.

Exhibit 4-26 depicts the noise model flight tracks for North Flow arrivals under the four-runway airfield configuration. Based on FAA input, changes are expected to occur to standard arrival procedures from the north, joining the final approach to Runways 1L, 1C, or 1R as a result of the triple independent instrument approach design efforts. The relocated arrival noise model flight tracks are shown in red on Exhibit 4-20 and the 2017 arrival noise model flight tracks are shown in gray. The arrival traffic coming from the north heading south, while staying west of the Airport, is expected to be moved farther west. The arrival traffic coming from the north heading south while staying east of the Airport is expected to be moved farther east. The increased distance from the Airport was required to meet RNP procedure design criteria. The noise model flight tracks changes are also applicable to the five-runway airfield configuration.

Exhibit 4-27 depicts the noise model flight tracks for RNP approaches for the four-runway airfield configuration. The RNP approach tracks are shown in red and the 2017 arrival noise model flight tracks are shown in gray. Aircraft are expected to follow these RNP approach paths with very little dispersion in the long-term future. The noise model flight tracks changes associated with the RNP procedures are also applicable to the five-runway airfield configuration.



LEGEND

- 15 Nautical Mile Noise Model Study Area
- Ultimate AEDT Arrival Noise Model Backbone Tracks
- 2017 AEDT Arrival Noise Model Tracks
- Airspace Waypoint/Fix

SOURCE: Harris Miller Miller & Hanson Inc., October 2018.

NORTH 0 Not to scale

EXHIBIT 4-27

FOUR-RUNWAY AIRFIELD CONFIGURATION – RNP APPROACH NOISE MODEL FLIGHT TRACKS

corporate:Creative Services:01 Projects:01 Client Projects:2019:MWAA:IAD:17081045-7.4_IAD Aircraft Noise Overlay Document Exhibits:IAD Long-Range Potential Operation Patterns Folder:IAD Long-Range Potential Operation Patterns-v2.indd

4.4.2.3 STAKEHOLDER INPUT SUMMARY

Meetings were held on June 28, 2018, and September 7, 2018, with Dulles International ATCT and Potomac TRACON to request subject matter expert feedback and review noise model flight tracks for the four- and five-runway airfield configurations. (Refer to Section 4.4.2.1 for more information related to coordination with the FAA.) The FAA indicated the noise model tracks were reasonable based on current expectations related to the existing and reasonably foreseeable future air traffic environment.

The methodology used to develop the noise model flight tracks and the results for 2017 and the two airfield configurations were presented to the Working Group at the August 13, 2018, meeting. Appendix A contains a copy of the presentation. Members of the Working Group did not express any concerns about the information presented and accepted the recommendation to proceed forward with noise modeling. The results of the noise modeling are summarized in Section 5.

5. NOISE MODEL INPUT AND RESULTS

This section summarizes FAA guidance on airport noise modeling, describes the noise modeling inputs used for the airfield configurations, and presents the results of the analysis of ultimate conditions. Refer to **Appendix C** for additional information related to aircraft noise modeling and metrics.

5.1 FAA NOISE MODEL AND METRICS

The FAA regulates navigable airspace and all civil aircraft operations occurring within that airspace. Under US law, the FAA is the primary steward of the NAS. The NAS includes all civil airports, air traffic communications, navigation, and surveillance infrastructure and is governed by operating rules and policies. Both the design and operation of civil airports in the US must comply with FAA regulations. In accordance with FAA, DNL was the metric used to quantify noise levels, and AEDT was applied to determine predicted noise exposure contours quantified by the DNL metric. This section describes the AEDT model and DNL metric.

5.1.1 AVIATION ENVIRONMENTAL DESIGN TOOL

The analyses for this study relied on the most recent AEDT version that was available at the initiation of the noise analysis (Version 2d released September 26, 2017).[1] AEDT uses airfield geometry, aircraft operations/noise model flight track input, and an internal database of aircraft noise and performance characteristics to calculate the noise generated by individual operations. AEDT combines the noise levels from individual flights to quantify the total noise exposure at a series of grid points surrounding the Airport. These results can be reported at each point, or presented as a set of contour lines, connecting equal levels of noise exposure, similar to terrain contours.

Detailed user inputs to the AEDT fall into two general categories:

- physical characteristics
  - airfield layout
  - flight path geometry
  - terrain
  - weather data
- operational characteristics
  - aircraft operations
  - AAD operations for each runway
  - AAD operations for each noise model flight track

Historical data (traceable to sources including Airport operations records and radar track data) were used to develop descriptions of the existing physical and operational characteristics. Projected physical and operational characteristics of the Airport's and NAS capability were used to evaluate the noise exposure levels associated with ultimate conditions at the Airport. Refer to Section 4 for more detail related to the ultimate conditions.

[1] US Department of Transportation, Federal Aviation Administration Aviation Environmental Design Tool Version 2d Technical Manual, September 2017.

5.1.2 DAY NIGHT AVERAGE SOUND LEVEL

The FAA requires use of the DNL metric to estimate aircraft noise levels near airports. DNL represents 24-hour average sound levels associated with noise exposure from average daily aircraft operations over the course of a year. The US Environmental Protection Agency originally chose DNL as the most appropriate measure of airport noise, based on the following considerations applicable to this study:[2]

- The measure should be applicable to the evaluation of pervasive long-term noise in various defined areas and under various conditions over long periods of time.
- The measure should correlate well with known effects of the noise environment on the individual and the public.
- The measure should be simple, practical, and accurate. In principal, it should be useful for planning as well as for enforcement or monitoring purposes.

Most federal agencies with regulatory responsibility to address noise have formally adopted the DNL metric. The Federal Interagency Committee on Noise (FICON) reaffirmed the appropriateness of DNL in 1992, stating in its summary report that "[t]here are no new descriptors or metrics of sufficient scientific standing to substitute for the present DNL cumulative noise exposure metric."[3]

DNL represents the average noise level over a 24-hour period. All aircraft noise events occurring at night (defined as 10:00 p.m. to 6:59 a.m.) are increased by 10 dBA to reflect the increased impact of nighttime noise events, when background noise levels decrease. When calculating aircraft exposure, this 10-dBA increase is mathematically identical to counting each nighttime aircraft noise event 10 times. Based on these calculations, the contribution of nighttime operations to DNL noise exposure is typically greater than the daytime contribution when nighttime operations exceed approximately 9 percent of the total AAD operations.

DNL can be either measured by sound level monitors or estimated through specialized computer software. Measurements are only practical for obtaining DNL values at a limited numbers of points, and—in the absence of a permanently installed monitoring system measuring noise continuously for a year—only for relatively short periods of time. Most airport noise studies use computer-generated DNL estimates, which are depicted as noise exposure contours.

Exhibit 5-1 provides an example DNL measurement, showing the effect of the nighttime adjustment on the DNL calculation. Each light blue bar on Exhibit 5-1 represents the average hourly noise level, and the hourly noise levels that occur between 10:00 p.m. and 6:59 a.m. are increased by the 10-dBA nighttime weighting shown in dark blue. The DNL (often notated as L_{dn} in equations) for the full 24-hour period is represented by the black line.

DNL estimates provide a quantitative basis for identifying potential land use incompatibility. Appendix A of Title 14 Code of Federal Regulation Part 150, *Airport Noise Compatibility Planning*[4], provides land use compatibility guidelines as a function of DNL values. These guidelines identify land uses that normally are compatible or incompatible with various levels of aircraft noise, and they indicate that all land uses, including residential, are considered compatible with aircraft noise levels below DNL 65 dBA. FAA and MWAA do not have authority, however, to enforce land use compatibility guidelines. Loudoun and Fairfax Counties are ultimately responsible for

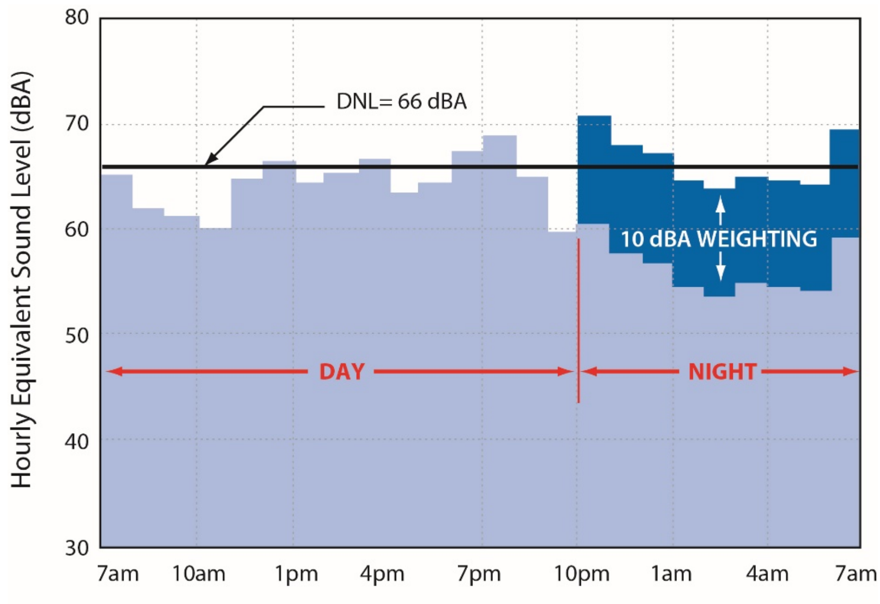
[2] US Environmental Protection Agency, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, Report No. 550/9-74-004, March 1974, Section 2.

[3] Federal Interagency Committee on Noise, *Federal Agency Review of Selected Airport Noise Analysis Issues*, August 1992, page ES-1.

[4] 14 CFR Part 150

determining acceptable and permissible land uses based on aircraft noise exposure levels associated with Dulles International.

EXHIBIT 5-1 DAY-NIGHT AVERAGE SOUND LEVEL EXAMPLE CALCULATION



SOURCE: Harris Miller Miller & Hanson Inc., March 2019.

5.2 DATA FOR NOISE MODEL DEVELOPMENT

The subsections below describe the inputs used in the AEDT for each of the three airfield configurations defined for ultimate conditions (i.e., four-runway airfield with west cargo facility, five-runway airfield with southeast cargo facility, and five-runway airfield with south cargo facility). The resulting DNL levels for each airfield configuration were derived from the projected AAD aircraft operations, runway layout and use patterns, and noise model flight track and use described in Section 4. The noise exposure levels, expressed in DNL, for each of the three airfield configurations were then combined to calculate the Ultimate Conditions noise contours.

5.2.1 AIRCRAFT ACTIVITY LEVELS

AEDT noise modeling requires a detailed specification of the number of operations, types of aircraft, and the time of day each aircraft takes off and lands. The number of flights is important to the noise generated, and the time of day for aircraft operations is equally important, as explained in Section 5.1.2.

5.2.1.1 AIRCRAFT FLEET MIX

The AEDT includes a database of noise and performance data for more than 300 different aircraft types, including fixed-wing aircraft and helicopters, both civilian and military. Noise data for each aircraft type cover a range of distances from the source (from 200 feet to 25,000 feet) at specific thrust levels. The AEDT accesses its database of applicable noise and performance data for each departure and arrival conducted by each specified aircraft type. For aircraft not included in the AEDT database, AEDT links to an external set of aircraft noise and performance data that reflect over 5,000 real-world aircraft variants.

The appropriate aircraft type was selected in AEDT for every forecast AAD departure and arrival at Dulles International for the four- and five-runway airfield configurations. **Tables 5-1** and **5-2** summarize the projected number of daily operations under ultimate conditions by each AEDT aircraft type and the percentage of total operations by each aircraft type, under the four- and five-runway airfield configurations, respectively. The tables are organized by aircraft category. Tables 5-1 and 5-2 also include the unique aircraft identifier in AEDT (AEDT Equipment), its description (AEDT Airframe), and the identifier for the aircraft noise and performance (ANP) data that is used to represent the aircraft in the model (AEDT ANP Type).

TABLE 5-1 (1 OF 2) FOUR-RUNWAY AIRFIELD – ULTIMATE CONDITION OPERATIONS BY AIRCRAFT TYPE

AIRCRAFT CATEGORY	AEDT EQUIPMENT	AEDT AIRFRAME	AEDT ANP TYPE	DAILY OPERATIONS	PERCENTAGE OF TOTAL DAILY OPERATIONS
Heavy Jet	4809	Airbus A350-900 series	A330-343	82	3.3%
	2462	Airbus A380-800 Series/Trent 970	A380-861	16	0.6%
	4634	Antonov 124 Ruslan	74720B	2	0.1%
	3994	B787-8R	7878R	4	0.2%
	5290	Boeing 747-800 Freighter	7478	2	0.1%
	4087	Boeing 767-300 ER Freighter with General Electric CF6-80C2B6F engine	767300	2	0.1%
	5275	Boeing 767-300 ER Freighter with Pratt & Whitney PW 4060 engine	767300	17	0.7%
	665	Boeing 777-300 ER	7773ER	143	5.8%
	672	Boeing 777-300 Series	777300	2	0.1%
	5291	Boeing 787-900 Dreamliner	7878R	38	1.5%
			Heavy Jet Subtotal	**308**	**12.5%**
Large Jet	4252	Airbus A319-NEO	A319-131	60	2.4%
	5314	Airbus A320-NEO	A320-211	106	4.3%
	4256	Airbus A321-NEO	A321-232	6	0.2%
	4129	Boeing 737-800 MAX	7378MAX	319	12.9%
	5211	Boeing 737-800 with winglets	737800	5	0.2%
	4130	Boeing 737-900 MAX	737800	412	16.7%
	4805	Bombardier Challenger 600	CL601	20	0.8%
	1255	Bombardier CRJ-900	CRJ9-ER	429	17.4%
	1780	Bombardier Global Express	BD-700-1A10	14	0.6%
	1310	Dassault Falcon 2000	CNA750	6	0.2%
	4034	Dassault Falcon 900-EX	CNA750	4	0.2%
	4747	Embraer ERJ135 Legacy Business	EMB145	4	0.2%
	3070	Embraer ERJ170	EMB170	146	5.9%
	3975	Embraer ERJ190-LR	EMB190	236	9.6%
	5351	Embraer Legacy 650	CNA55B	6	0.2%
	4203	Gulfstream G450	GIV	25	1.0%
	1925	Gulfstream G550	GV	22	0.9%
			Large Jet Subtotal	**1,820**	**73.8%**

TABLE 5-1 (2 OF 2) FOUR-RUNWAY AIRFIELD – ULTIMATE CONDITION OPERATIONS BY AIRCRAFT TYPE

AIRCRAFT CATEGORY	AEDT EQUIPMENT	AEDT AIRFRAME	AEDT ANP TYPE	DAILY OPERATIONS	PERCENTAGE OF TOTAL DAILY OPERATIONS
Small Jet	4856	Bombardier Challenger 300	CL600	24	1.0%
	5345	Bombardier Challenger 350	CL600	6	0.2%
	2027	Bombardier Learjet 31	LEAR35	6	0.2%
	4843	Bombardier Learjet 45	LEAR35	10	0.4%
	2033	Bombardier Learjet 60	LEAR35	4	0.2%
	4248	Bombardier Learjet 75	LEAR35	2	0.1%
	3974	Cessna 525 Citation Jet	CNA525C	8	0.3%
	4327	Cessna 550 Citation II	CNA55B	6	0.2%
	4640	Cessna 560 Citation XLS	CNA560XL	20	0.8%
	3047	Cessna 680 Citation Sovereign	CNA680	12	0.5%
	1314	Cessna 750 Citation X	CNA750	12	0.5%
	3993	Embraer 505	CNA55B	12	0.5%
	5335	Embraer Legacy 450 (EMB-545)	CNA510	4	0.2%
	5350	Embraer Legacy 500 (EMB-550)	CNA55B	2	0.1%
	3738	Gulfstream G200	CNA750	8	0.3%
	4198	Gulfstream G280	IA1125	4	0.2%
	5296	Raytheon Beechjet 400	MU3001	12	0.5%
	1315	Raytheon Hawker 4000 Horizon	CNA750	4	0.2%
	2014	Raytheon Hawker 800	LEAR35	18	0.7%
	5186	Raytheon Premier I	MU3001	2	0.1%
		Small Jet Subtotal		**176**	**7.1%**
Turbine Propeller	1705	Bombardier de Havilland Dash 8 Q400	DHC830	99	4.0%
	2106	Cessna 208 Caravan	CNA208	19	0.8%
	4778	De Havilland DHC-8-200	DHC830	14	0.6%
	3122	Pilatus PC-12	CNA208	16	0.6%
	36	Raytheon Beech 1900-C	1900D	2	0.1%
	1503	Raytheon Super King Air 300	DHC6	12	0.5%
		Turbine Propeller Subtotal		**162**	**6.6%**
		Total		**2,466**	**100.0%**

NOTES:
Totals may not add due to rounding.
AEDT – Aviation Environmental Design Tool
ANP Type – Aircraft Noise and Performance aircraft data record
SOURCES: Ricondo & Associates, Inc., December 2018 (four-runway ASV AAD operations); Harris Miller Miller & Hanson Inc., December 2018 (AEDT aircraft assignment).

TABLE 5-2 (1 OF 2) FIVE-RUNWAY AIRFIELD – ULTIMATE CONDITION OPERATIONS BY AIRCRAFT TYPE

AIRCRAFT CATEGORY	AEDT EQUIPMENT	AEDT AIRFRAME	AEDT ANP TYPE	DAILY OPERATIONS	PERCENTAGE OF TOTAL DAILY OPERATIONS
Heavy Jet	4809	Airbus A350-900 series	A330-343	91	3.3%
	2462	Airbus A380-800 Series/Trent 970	A380-861	18	0.7%
	4634	Antonov 124 Ruslan	74720B	2	0.1%
	3994	B787-8R	7878R	4	0.1%
	5290	Boeing 747-800 Freighter	7478	2	0.1%
	4087	Boeing 767-300 ER Freighter with General Electric CF6-80C2B6F engine	767300	2	0.1%
	5275	Boeing 767-300 ER Freighter with Pratt & Whitney PW 4060 engine	767300	17	0.6%
	665	Boeing 777-300 ER	7773ER	165	6.0%
	672	Boeing 777-300 Series	777300	2	0.1%
	5291	Boeing 787-900 Dreamliner	7878R	43	1.6%
			Heavy Jet Subtotal	**346**	**12.6%**
Large Jet	4252	Airbus A319-NEO	A319-131	68	2.5%
	5314	Airbus A320-NEO	A320-211	110	4.0%
	4256	Airbus A321-NEO	A321-232	6	0.2%
	4129	Boeing 737-800 MAX	7378MAX	348	12.6%
	5211	Boeing 737-800 with winglets	737800	5	0.2%
	4130	Boeing 737-900 MAX	737800	481	17.5%
	4805	Bombardier Challenger 600	CL601	20	0.7%
	1255	Bombardier CRJ-900	CRJ9-ER	484	17.6%
	1780	Bombardier Global Express	BD-700-1A10	14	0.5%
	1310	Dassault Falcon 2000	CNA750	8	0.3%
	4034	Dassault Falcon 900-EX	CNA750	2	0.1%
	4747	Embraer ERJ135 Legacy Business	EMB145	4	0.1%
	3070	Embraer ERJ170	EMB170	154	5.6%
	3975	Embraer ERJ190-LR	EMB190	266	9.7%
	5351	Embraer Legacy 650	CNA55B	6	0.2%
	4203	Gulfstream G450	GIV	31	1.1%
	1925	Gulfstream G550	GV	26	0.9%
			Large Jet Subtotal	**2,033**	**73.9%**

TABLE 5-2 (2 OF 2) FIVE-RUNWAY AIRFIELD – ULTIMATE CONDITION OPERATIONS BY AIRCRAFT TYPE

AIRCRAFT CATEGORY	AEDT EQUIPMENT	AEDT AIRFRAME	AEDT ANP TYPE	DAILY OPERATIONS	PERCENTAGE OF TOTAL DAILY OPERATIONS
Small Jet	4856	Bombardier Challenger 300	CL600	24	0.9%
	5345	Bombardier Challenger 350	CL600	6	0.2%
	2027	Bombardier Learjet 31	LEAR35	8	0.3%
	4843	Bombardier Learjet 45	LEAR35	8	0.3%
	2033	Bombardier Learjet 60	LEAR35	6	0.2%
	4248	Bombardier Learjet 75	LEAR35	2	0.1%
	3974	Cessna 525 Citation Jet	CNA525C	10	0.4%
	4327	Cessna 550 Citation II	CNA55B	6	0.2%
	4640	Cessna 560 Citation XLS	CNA560XL	24	0.9%
	3047	Cessna 680 Citation Sovereign	CNA680	12	0.4%
	1314	Cessna 750 Citation X	CNA750	12	0.4%
	3993	Embraer 505	CNA55B	8	0.3%
	5335	Embraer Legacy 450 (EMB-545)	CNA510	4	0.1%
	5350	Embraer Legacy 500 (EMB-550)	CNA55B	2	0.1%
	3738	Gulfstream G200	CNA750	12	0.4%
	4198	Gulfstream G280	IA1125	4	0.1%
	5296	Raytheon Beechjet 400	MU3001	14	0.5%
	1315	Raytheon Hawker 4000 Horizon	CNA750	2	.1%
	2014	Raytheon Hawker 800	LEAR35	16	0.6%
	5186	Raytheon Premier I	MU3001	2	0.1%
			Small Jet Subtotal	**182**	**6.6%**
Turbine Propeller	1705	Bombardier de Havilland Dash 8 Q400	DHC830	118	4.3%
	2106	Cessna 208 Caravan	CNA208	21	0.8%
	4778	De Havilland DHC-8-200	DHC830	17	0.6%
	3122	Pilatus PC-12	CNA208	16	0.6%
	36	Raytheon Beech 1900-C	1900D	2	0.1%
	1503	Raytheon Super King Air 300	DHC6	16	0.6%
			Turbine Propeller Subtotal	**190**	**6.9%**
			Total	**2,751**	**100.0%**

NOTES:
Totals may not add due to rounding.
AEDT – Aviation Environmental Design Tool
ANP Type – Aircraft Noise and Performance aircraft data record
SOURCES: Ricondo & Associates, Inc., December 2018 (five-runway ASV AAD operations); Harris Miller Miller & Hanson Inc., December 2018 (AEDT aircraft assignment).

5.2.1.2 AIRCRAFT OPERATIONS BY TIME OF DAY

Tables 5-3 and **5-4** present the distribution of ultimate condition operations to daytime and nighttime periods by aircraft category for the four-and five-runway airfield configurations, respectively. In each case, the forecast nighttime operations represent 12 percent of the total AAD operations, which is higher than in 2017.

TABLE 5-3 FOUR-RUNWAY AIRFIELD – TIME OF DAY DISTRIBUTION OF ULTIMATE CONDITION OPERATIONS BY AIRCRAFT CATEGORY

AIRCRAFT CATEGORY	ARRIVALS		DEPARTURES		TOTAL OPERATIONS	
	DAYTIME	NIGHTTIME	DAYTIME	NIGHTTIME	DAYTIME	NIGHTTIME
Heavy Jet	87%	13%	86%	14%	**87%**	**13%**
Large Jet	88%	12%	87%	13%	**88%**	**12%**
Small Jet	90%	10%	92%	8%	**91%**	**9%**
Turbine Propeller	90%	10%	90%	10%	**90%**	**10%**
Total	**88%**	**12%**	**88%**	**12%**	88%	12%

NOTES:
Daytime – 7:00 a.m. to 9:59 p.m.
Nighttime – 10:00 p.m. to 6:59 a.m.
SOURCE: Ricondo & Associates, Inc., December 2018 (four-runway airfield ASV AAD operations); Harris Miller Miller & Hanson Inc., December 2018 (percentage calculations).

TABLE 5-4 FIVE-RUNWAY AIRFIELD – TIME OF DAY DISTRIBUTION OF ULTIMATE CONDITIONS OPERATIONS BY AIRCRAFT CATEGORY

AIRCRAFT CATEGORY	ARRIVALS		DEPARTURES		TOTAL OPERATIONS	
	DAYTIME	NIGHTTIME	DAYTIME	NIGHTTIME	DAYTIME	NIGHTTIME
Heavy Jet	88%	12%	86%	14%	**87%**	**13%**
Large Jet	88%	12%	88%	12%	**88%**	**12%**
Small Jet	89%	11%	89%	11%	**89%**	**11%**
Turbine Propeller	89%	11%	88%	12%	**89%**	**11%**
Total	**88%**	**12%**	**88%**	**12%**	**88%**	**12%**

NOTES:
Daytime – 7:00 a.m. to 9:59 p.m.
Nighttime – 10:00 p.m. to 6:59 a.m.
SOURCE: Ricondo & Associates, Inc., December 2018 (five-runway airfield ASV AAD operations); Harris Miller Miller & Hanson Inc., December 2018 (percentage calculations).

5.2.1.3 DEPARTURE STAGE LENGTH

The AEDT database contains multiple departure performance profiles for each AEDT aircraft type, representing trip distances in nautical miles (NM), also referred to as stage length. The stage length, which only applies to departures, is important because longer flights carry more fuel (weight), which affects aircraft climb performance. **Table 5-5** defines the stage lengths used for the AEDT. Aircraft in the AEDT database that are capable of flying longer distances (more than 500 NM) have profiles defined for the longer stage lengths. Aircraft in the database not capable of operating more than 500 NM have only one departure profile (stage length 1).

TABLE 5-5 DEFINITION OF DEPARTURE STAGE LENGTHS

STAGE LENGTH	TRIP DISTANCE (NAUTICAL MILES)
1	0 to 500
2	>500 to 1,000
3	>1,000 to 1,500
4	>1,500 to 2,500
5	>2,500 to 3,500
6	>3,500 to 4,500
7	>4,500 to 5,500
8	>5,500 to 6,500
9	>6,500 to 7,500
10	>7,500 to 8,500
11	>8,500

NOTE: > Greater Than
SOURCE: US Department of Transportation, Federal Aviation Administration, *Aviation Environmental Design Tool Version 2d Technical Manual*, September 2017.

Tables 5-6 and **5-7** show the distribution of modeled departure stage lengths by aircraft category for the four- and five-runway airfield configurations, respectively. For both the four- and five-runway airfields, heavy jets are the only aircraft category that operate at 9 of the 11 stage lengths. Large jets only operate at stage lengths 1 through 5, with more than half (54 percent) of large jets operating at stage length 1. The small jet and turbine propeller categories operate exclusively at stage length 1. The percentage of operations by stage length indicates how airlines use different aircraft sizes for destinations of varying distances, with international destinations (typically the longest routes) most frequently served by heavy jet aircraft.

TABLE 5-6 FOUR-RUNWAY AIRFIELD – DISTRIBUTION OF DEPARTURES BY STAGE LENGTH

AIRCRAFT CATEGORY	AEDT DEPARTURE STAGE LENGTH									TOTAL
	1	2	3	4	5	6	7	8	9	
Heavy Jet	4%	5%	3%	6%	26%	24%	21%	10%	1%	100%
Large Jet	54%	15%	13%	16%	2%	0%	0%	0%	0%	100%
Small Jet	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Turbine Propeller	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Total	**54%**	**12%**	**10%**	**13%**	**4%**	**3%**	**3%**	**1%**	**0%**	**100%**

NOTE: AEDT – Aviation Environmental Design Tool
SOURCES: Ricondo & Associates, Inc., December 2018 (four-runway airfield ASV AAD operations); Harris Miller Miller & Hanson Inc., December 2018 (percentage calculations).

TABLE 5-7 FIVE-RUNWAY AIRFIELD – DISTRIBUTION OF DEPARTURES BY STAGE LENGTH

AIRCRAFT CATEGORY	AEDT DEPARTURE STAGE LENGTH 1	2	3	4	5	6	7	8	9	TOTAL
Heavy Jet	3%	5%	3%	6%	28%	23%	20%	11%	1%	100%
Large Jet	54%	15%	13%	16%	2%	0%	0%	0%	0%	100%
Small Jet	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Turbine Propeller	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Total	**54%**	**12%**	**10%**	**13%**	**5%**	**3%**	**3%**	**1%**	**0%**	**100%**

NOTES:

AEDT – Aviation Environmental Design Tool

SOURCES: Ricondo & Associates, Inc., December 2018 (five-runway airfield ASV AAD operations); Harris Miller Miller & Hanson Inc., December 2018 (percentage calculations).

5.2.2 AIRCRAFT OPERATION PATTERNS

The distribution of aircraft operations on runways and flight tracks developed as input to the noise model determine the shape of the modeled noise contours. The subsections below describe the runway and noise model flight track distributions for each of the four- and five-runway airfield configurations.

5.2.2.1 MODELLED RUNWAY USE

Modelled runway use refers to the frequency with which aircraft utilize each runway during the course of a year, as determined or permitted by wind, weather, aircraft weight, ATC conditions, and to a certain extent, pilot choice. Of these factors, wind is the primary factor affecting runway use because aircraft generally take off and land into the wind. While the overall sizes of the noise contours are determined by the aircraft operations summarized in Table 5-1 and Table 5-2 and percentage of nighttime operations summarized in Table 5-3 and Table 5-4, the general shape of the noise contours is determined by the modeled runway use. Section 4.3.3 and Section 4.3.4 describe the development of the runway use patterns for this study.

Four-Runway Airfield Configuration with West Cargo Facility

Tables 5-8 and **5-9** list the modeled runway use percentages (i.e., the distribution of operations to runway ends) for the four-runway airfield configuration with the west cargo facility. All daytime cargo operations were assigned runways based on the runway use patterns described in Section 4.3.3, which resulted in the modeled runway use listed in Table 5-8. As shown in Table 5-9, the modeled runway use for nighttime cargo aircraft was based on the patterns described in Section 4.3.4, and use of the closest runway to the potential west cargo facility—Runway 1L-19R.

Exhibits 5-2 and **5-3** display the number of AAD arrivals and departures on each runway end under the four-runway airfield with the west cargo facility. Exhibit 5-2 shows the average daily operations for North Flow, which was projected to be in use 55 percent of the time under ultimate conditions. Exhibit 5-3 shows the average daily operations for South Flow, which was projected to be in use 45 percent of the time under ultimate conditions.

Five Runway Airfield Configuration with Southeast Cargo Facility

Tables 5-10 and **5-11** list the modeled runway use percentages for the five-runway airfield configuration with the southeast cargo facility. All daytime cargo operations were assigned runways based on the runway use patterns described in Section 4.3.3, which resulted in the modeled runway use listed in Table 5-10. As shown in Table 5-11, the modeled runway use for nighttime cargo aircraft were based on the patterns described in Section 4.3.4 and use of the closest runway to the potential southeast cargo facility—Runway 1C-19C.

TABLE 5-8 FOUR-RUNWAY AIRFIELD CONFIGURATION WITH WEST CARGO FACILITY – ULTIMATE CONDITION MODELLED RUNWAY USE – ALL OPERATIONS EXCEPT NIGHTTIME CARGO

OPERATION TYPE	TIME OF DAY	RUNWAY END								TOTAL
		1L	1C	1R	12	19L	19C	19R	30	
Arrival	Daytime	18.2%	17.6%	18.2%	0.5%	14.8%	14.9%	14.9%	1.1%	100.0%
	Nighttime	0.0%	24.7%	30.2%	0.0%	18.0%	27.0%	0.0%	0.0%	100.0%
Departure	Daytime	0.0%	13.7%	13.8%	0.0%	18.0%	4.5%	0.0%	50.0%	100.0%
	Nighttime	0.0%	8.2%	5.5%	0.0%	6.7%	4.5%	0.0%	75.0%	100.0%

NOTES:
Totals may not add due to rounding.
Daytime – 7:00 a.m. to 9:59 p.m.
Nighttime – 10:00 p.m. to 6:59 a.m.
SOURCES: Ricondo & Associates, Inc., September 2018 (projected ultimate conditions runway use patterns); Harris Miller Miller & Hanson Inc., December 2018 (modeled runway use based on AAD operations assigned to runways).

TABLE 5-9 FOUR-RUNWAY AIRFIELD CONFIGURATION WITH WEST CARGO FACILITY – ULTIMATE CONDITION MODELLED RUNWAY USE– NIGHTTIME CARGO OPERATIONS

OPERATION TYPE	RUNWAY END								TOTAL
	1L	1C	1R	12	19L	19C	19R	30	
Arrival	55.0%	0.0%	0.0%	0.0%	0.0%	0.0%	45.0%	0.0%	100.0%
Departure	55.0%	0.0%	0.0%	0.0%	0.0%	0.0%	45.0%	0.0%	100.0%

SOURCES: Ricondo & Associates, Inc., September 2018 (projected ultimate conditions runway use patterns); Harris Miller Miller & Hanson Inc., December 2018 (modeled runway use based on AAD operations assigned to runways).

TABLE 5-10 FIVE-RUNWAY AIRFIELD CONFIGURATION WITH SOUTHEAST CARGO FACILITY – ULTIMATE CONDITION MODELLED RUNWAY USE – ALL OPERATIONS EXCEPT NIGHTTIME CARGO

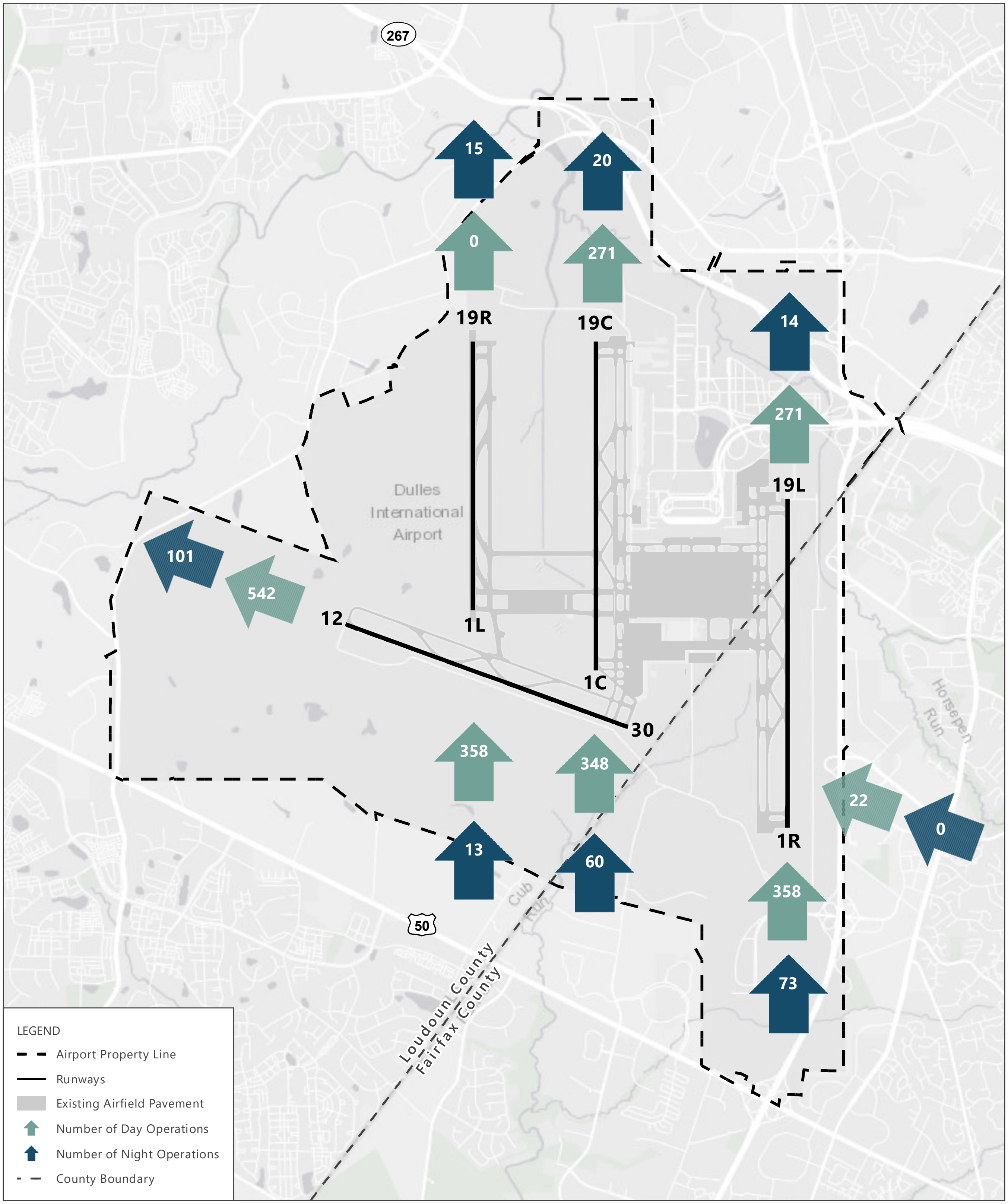
OPERATION TYPE	TIME OF DAY	RUNWAY END										TOTAL
		1L	1C	1R	12L	12R	19L	19C	19R	30L	30R	
Arrival	Daytime	18.2%	17.6%	18.2%	0.2%	0.2%	14.8%	14.9%	14.9%	0.6%	0.6%	100.0%
	Nighttime	0.0%	24.7%	30.2%	0.0%	0.0%	18.0%	27.0%	0.0%	0.0%	0.0%	100.0%
Departure	Daytime	0.0%	1.1%	11.0%	0.0%	0.0%	9.0%	0.4%	0.0%	39.0%	39.4%	100.0%
	Nighttime	0.0%	8.2%	5.5%	0.0%	0.0%	6.7%	4.5%	0.0%	0.0%	75.0%	100.0%

NOTES:
Totals may not add due to rounding.
Daytime – 7:00 a.m. to 9:59 p.m.
Nighttime – 10:00 p.m. to 6:59 a.m.
SOURCES: Ricondo & Associates, Inc., September 2018 (projected ultimate conditions runway use patterns); Harris Miller Miller & Hanson Inc., December 2018 (modeled runway use based on AAD operations assigned to runways).

TABLE 5-11 FIVE-RUNWAY AIRFIELD CONFIGURATION WITH SOUTHEAST CARGO FACILITY – ULTIMATE CONDITION MODELLED RUNWAY USE – NIGHTTIME CARGO OPERATIONS

OPERATION TYPE	RUNWAY END										TOTAL
	1L	1C	1R	12L	12R	19L	19C	19R	30L	30R	
Arrival	0.0%	55.0%	0.0%	0.0%	0.0%	0.0%	45.0%	0.0%	0.0%	0.0%	100.0%
Departure	0.0%	55.0%	0.0%	0.0%	0.0%	0.0%	45.0%	0.0%	0.0%	0.0%	100.0%

SOURCES: Ricondo & Associates, Inc., September 2018 (projected ultimate conditions runway use patterns); Harris Miller Miller & Hanson Inc., December 2018 (modeled runway use based on AAD operations assigned to runways).



SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways); Ricondo & Associates, Inc., September 2018 (runway use).

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EXHIBIT 5-2

FOUR-RUNWAY AIRFIELD CONFIGURATION WITH WEST CARGO FACILITY - NUMBER OF OPERATIONS BY RUNWAY END AND TIME OF DAY - NORTH FLOW

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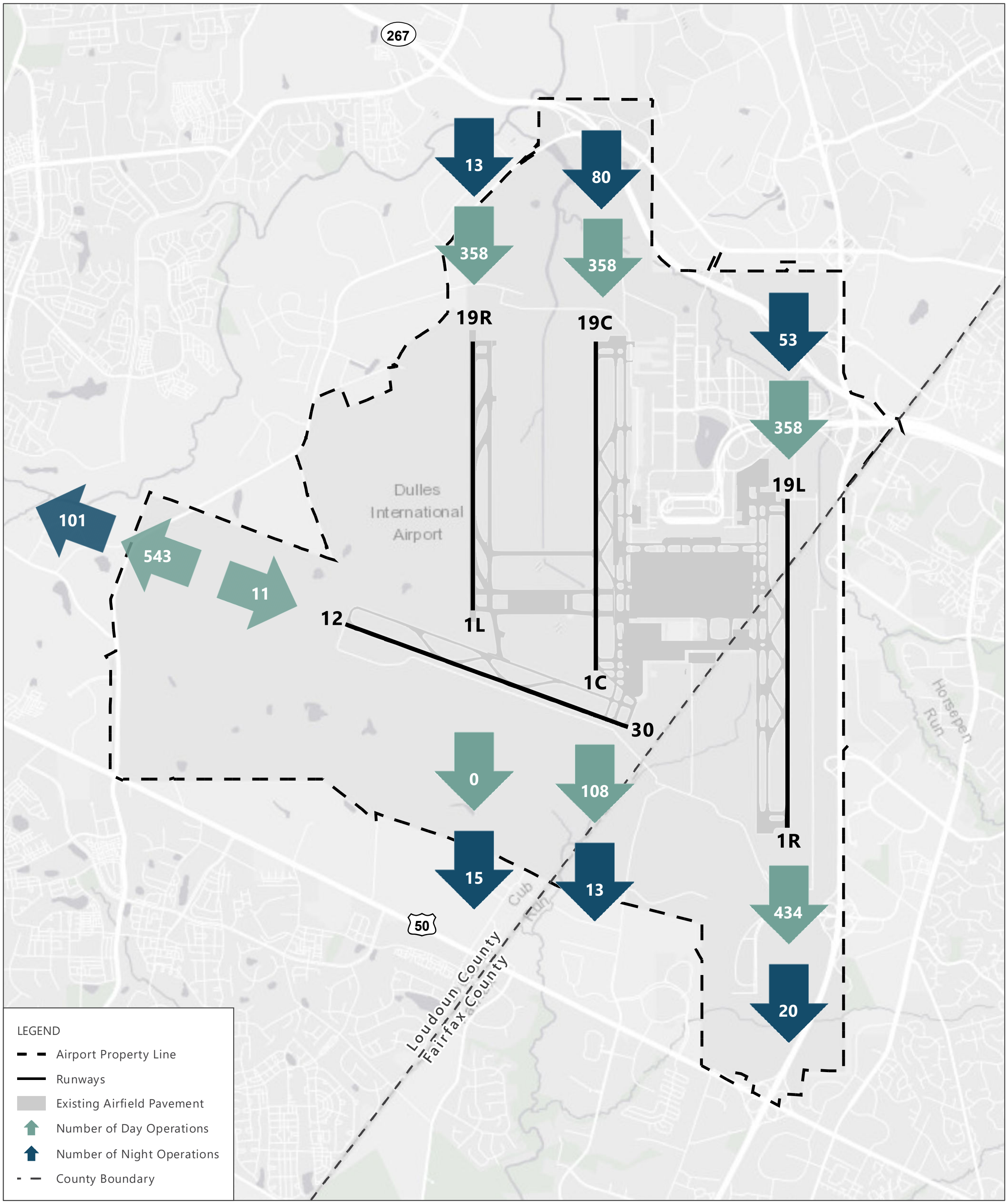

SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways); Ricondo & Associates, Inc., September 2018 (runway use).

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EXHIBIT 5-3

FOUR-RUNWAY AIRFIELD CONFIGURATION WITH WEST CARGO FACILITY - NUMBER OF OPERATIONS BY RUNWAY END AND TIME OF DAY - SOUTH FLOW

P:\GIS\Projects\IAD\MXD\IAD_Exhibit5-3_Four-RwyWestCargo-OpsSouthFlow_20190531.mxd

Exhibits 5-4 and **5-5** display the number of AAD arrivals and departures on each runway end under the five-runway airfield with the southeast cargo facility. Exhibit 5-4 shows the average daily operations for North Flow, which was projected to be in use 55 percent of the time under ultimate conditions. Exhibit 5-5 shows the average daily operations for South Flow, which was projected to be in use 45 percent of the time under ultimate conditions.

Five Runway Airfield Configuration with South Cargo Facility

Tables 5-12 and **5-13** list the modeled runway use for the five-runway airfield configuration with the south cargo facility. All non-nighttime cargo operations were assigned runways based on the runway use patterns described in Section 4.3.3, which resulted in the modeled runway use listed in Table 5-12. As shown in Table 5-13, the modeled runway use for nighttime cargo aircraft were based on the patterns described in Section 4.3.4 and use of the closest runway to the potential south cargo facility—Runway 12L-30R.

TABLE 5-12 FIVE-RUNWAY AIRFIELD CONFIGURATION WITH SOUTH CARGO FACILITY – ULTIMATE CONDITION MODELLED RUNWAY USE – ALL OPERATIONS EXCEPT NIGHTTIME CARGO

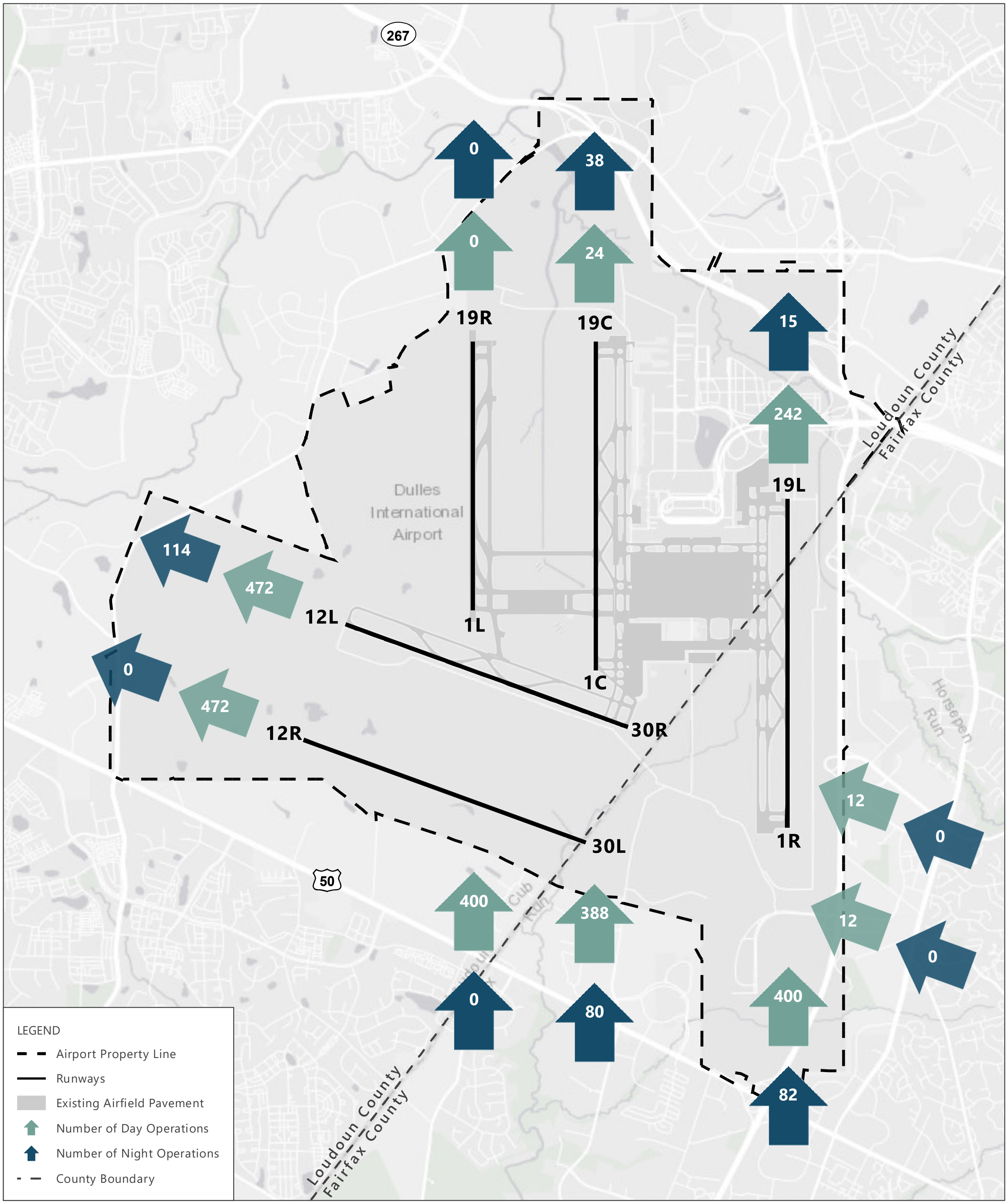
OPERATION TYPE	TIME OF DAY	RUNWAY END										TOTAL
		1L	1C	1R	12L	12R	19L	19C	19R	30L	30R	
Arrival	Daytime	18.2%	17.6%	18.2%	0.2%	0.2%	14.8%	14.9%	14.9%	0.6%	0.6%	100.0%
	Nighttime	0.0%	24.7%	30.2%	0.0%	0.0%	18.0%	27.0%	0.0%	0.0%	0.0%	100.0%
Departure	Daytime	0.0%	1.1%	11.0%	0.0%	0.0%	9.0%	0.4%	0.0%	39.0%	39.4%	100.0%
	Nighttime	0.0%	8.2%	5.5%	0.0%	0.0%	6.7%	4.5%	0.0%	0.0%	75.0%	100.0%

NOTES:
Totals may not add due to rounding.
Daytime – 7:00 a.m. to 9:59 p.m.
Nighttime – 10:00 p.m. to 6:59 a.m.
SOURCES: Ricondo & Associates, Inc., September 2018 (projected ultimate conditions runway use patterns); Harris Miller Miller & Hanson Inc., December 2018 (modeled runway use based on AAD operations assigned to runways).

TABLE 5-13 FIVE-RUNWAY AIRFIELD CONFIGURATION WITH SOUTH CARGO FACILITY – ULTIMATE CONDITION MODELLED RUNWAY USE – NIGHTTIME CARGO OPERATIONS

OPERATION TYPE	RUNWAY END										TOTAL
	1L	1C	1R	12L	12R	19L	19C	19R	30L	30R	
Arrival	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	99.0%	100.0%
Departure	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	99.0%	100.0%

SOURCES: Ricondo & Associates, Inc., September 2018 (projected ultimate conditions runway use patterns); Harris Miller Miller & Hanson Inc., December 2018 (modeled runway use based on AAD operations assigned to runways).



SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways); Ricondo & Associates, Inc., September 2018 (runway use).

EXHIBIT 5-4

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FIVE-RUNWAY AIRFIELD CONFIGURATION WITH SOUTHEAST CARGO FACILITY - NUMBER OF OPERATIONS BY RUNWAY END AND TIME OF DAY - NORTH FLOW

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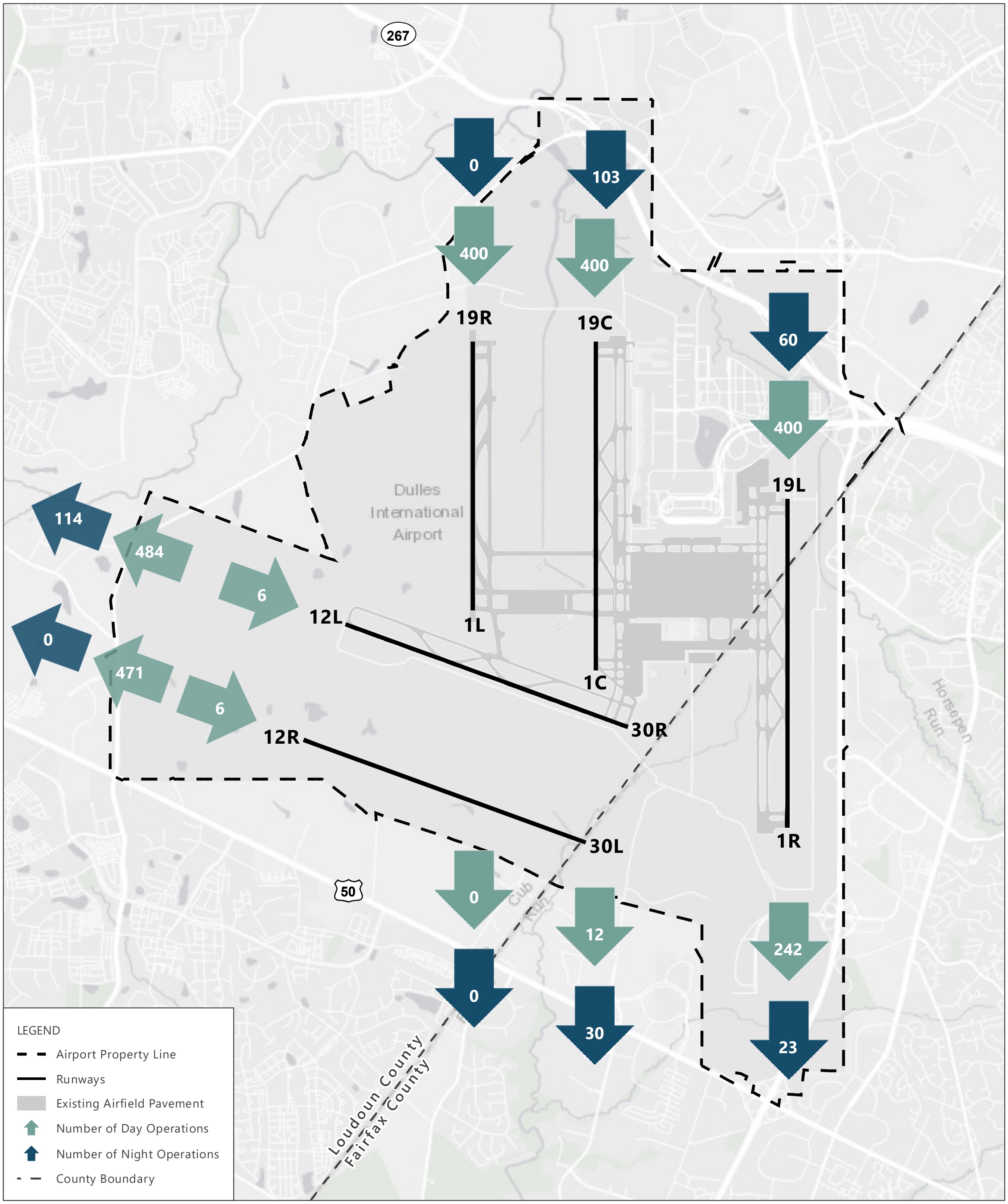

SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways); Ricondo & Associates, Inc., September 2018 (runway use).

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EXHIBIT 5-5

FIVE-RUNWAY AIRFIELD CONFIGURATION WITH SOUTHEAST CARGO FACILITY - NUMBER OF OPERATIONS BY RUNWAY END AND TIME OF DAY - SOUTH FLOW

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Exhibits 5-6 and **5-7** display the number of AAD arrivals and departures on each runway end under the five-runway airfield with the south cargo facility. Exhibit 5-6 shows the average daily operations for North Flow, which was projected to be in use 55 percent of the time under ultimate conditions. Exhibit 5-7 shows the average daily operations for South Flow, which was projected to be in use 45 percent of the time under ultimate conditions.

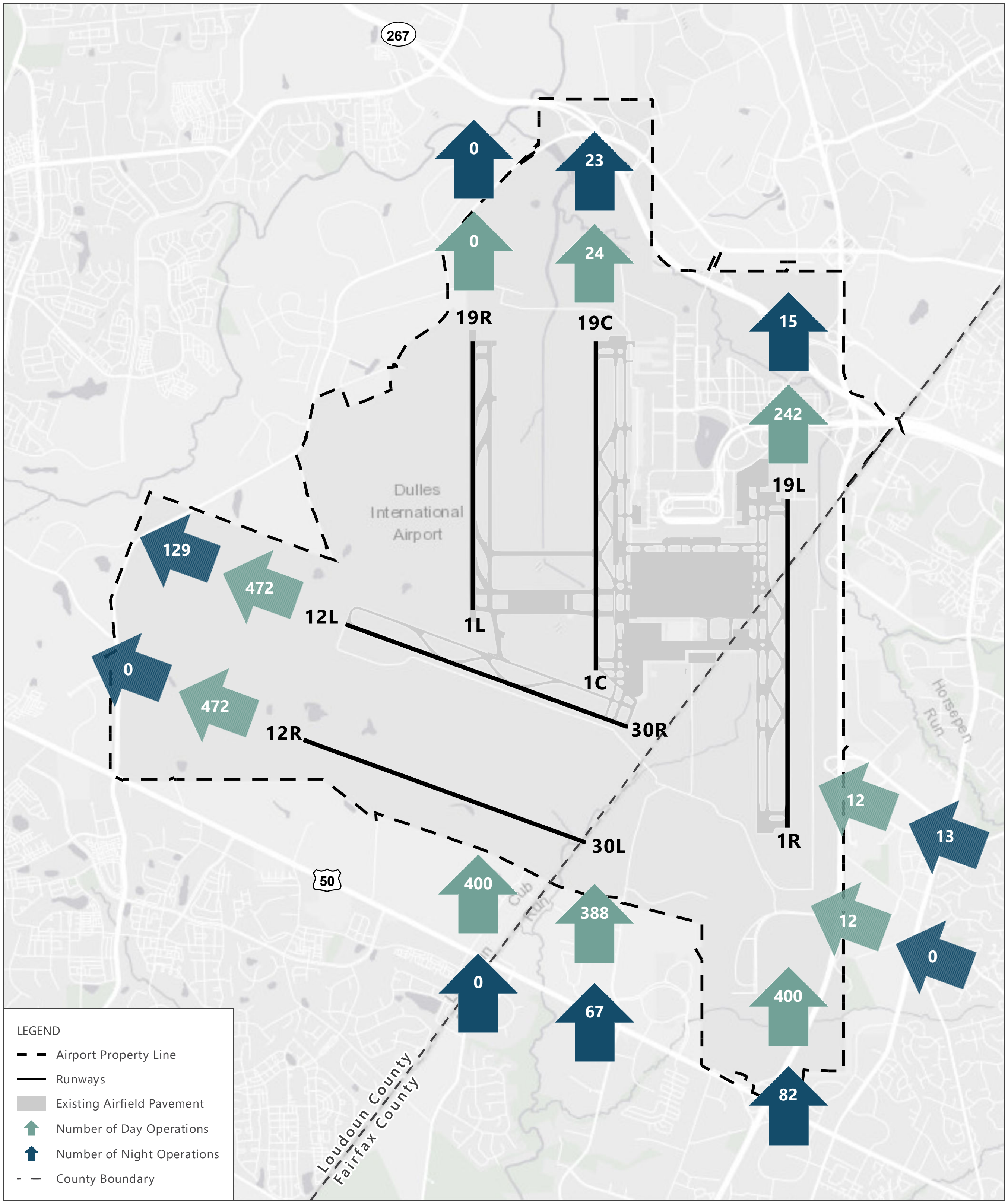
5.2.2.2 NOISE MODEL FLIGHT TRACKS AND USE

The shape of the noise contours that are representative of AAD operations was affected by paths aircraft are expected to follow to or from each runway end. Flight paths defined in the noise model are referred to as noise model flight tracks. The 2017 radar tracks and FAA air traffic controller input on projected flight paths related to new Runway 12R-30L and planned NextGen flight procedure designs were used to develop the noise model flight tracks and their average annual use. Use rates describe the percentage of aircraft within a particular group that use each noise model flight track. Refer to Section 4.4 for more details related to the ultimate conditions noise model flight track development process. The noise model flight tracks and average annual use rates were entered into the AEDT model.

Through the noise model flight track creation process, 538 noise model flight tracks were defined. Each consisted of a centerline track (backbone track) and 0 to 8 additional dispersed tracks (sub-tracks) flanking the centerline track to model the appropriate width of a traffic corridor. The noise model flight tracks were generated separately for each of the four aircraft categories (i.e., heavy jet, large jet, small jet, and turbine propeller) on each runway end (i.e., 8 runway ends for the four-runway airfield and 10 for the five-runway airfield). The use rates were computed separately for daytime and nighttime periods, resulting in thousands of individual noise model track usage percentage values across the three airfield configurations modeled. For summary purposes, the individual noise model tracks were grouped based on the procedure followed to and from the Airport. The procedure name was used to label the group of noise model tracks. The exhibits and tables below summarize the various noise model flight track groups and use rates. The rates were based on total operations by runway operating configuration and time of day.

Four-Runway Airfield Configuration with West Cargo Facility

Exhibit 5-8 through **5-11** present the four-runway airfield configuration with the west cargo facility noise model flight tracks representing AAD North Flow arrivals, North Flow departures, South Flow arrivals, and South Flow departures, respectively, under ultimate conditions. The noise model flight track development study area is shown as a dashed line. Noise model flight tracks were not designed beyond the study area. The noise model flight tracks are labeled at the location where the tracks cross this development study area boundary. **Tables 5-14** and **5-15** present the aggregate usage of each noise model flight track for arrivals and departures, respectively, for all aircraft groups and runways in the four-runway airfield with the west cargo facility. The usage rates are broken down by runway operating configuration (North and South Flow) and time of day.



SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways); Ricondo & Associates, Inc., September 2018 (runway use).

EXHIBIT 5-6

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FIVE-RUNWAY AIRFIELD CONFIGURATION WITH SOUTH CARGO FACILITY - NUMBER OF OPERATIONS BY RUNWAY END AND TIME OF DAY - NORTH FLOW

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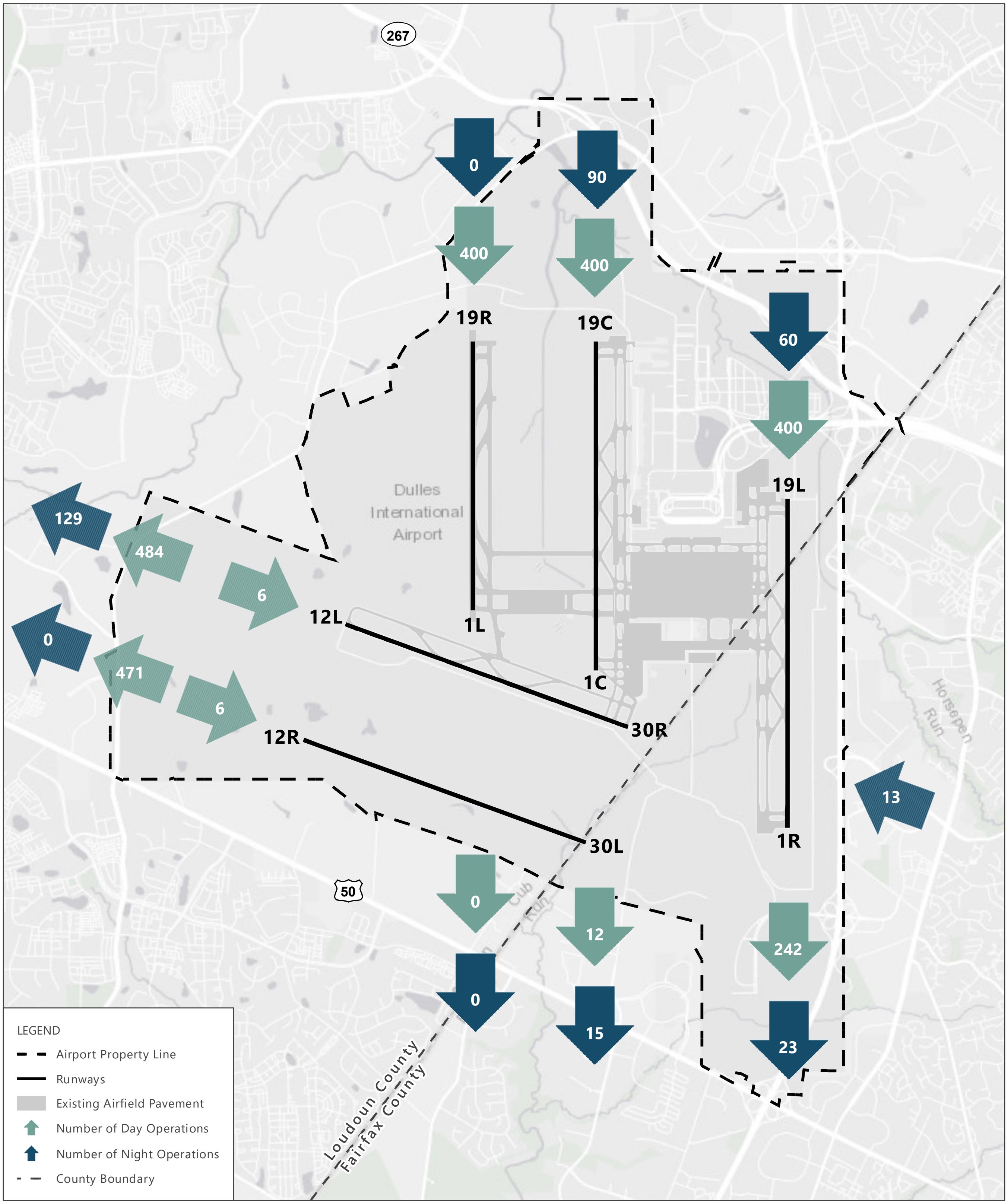

SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, April 2019 (basemap); US Census Bureau, Geography Division, TIGER/Line Shapefiles, 2018 (county boundary); Metropolitan Washington Airports Authority, 2018 (Airport boundary, pavement, runways); Ricondo & Associates, Inc., September 2018 (runway use).

EXHIBIT 5-7

NORTH 0 5,000 ft

FIVE-RUNWAY AIRFIELD CONFIGURATION WITH SOUTH CARGO FACILITY - NUMBER OF OPERATIONS BY RUNWAY END AND TIME OF DAY - SOUTH FLOW

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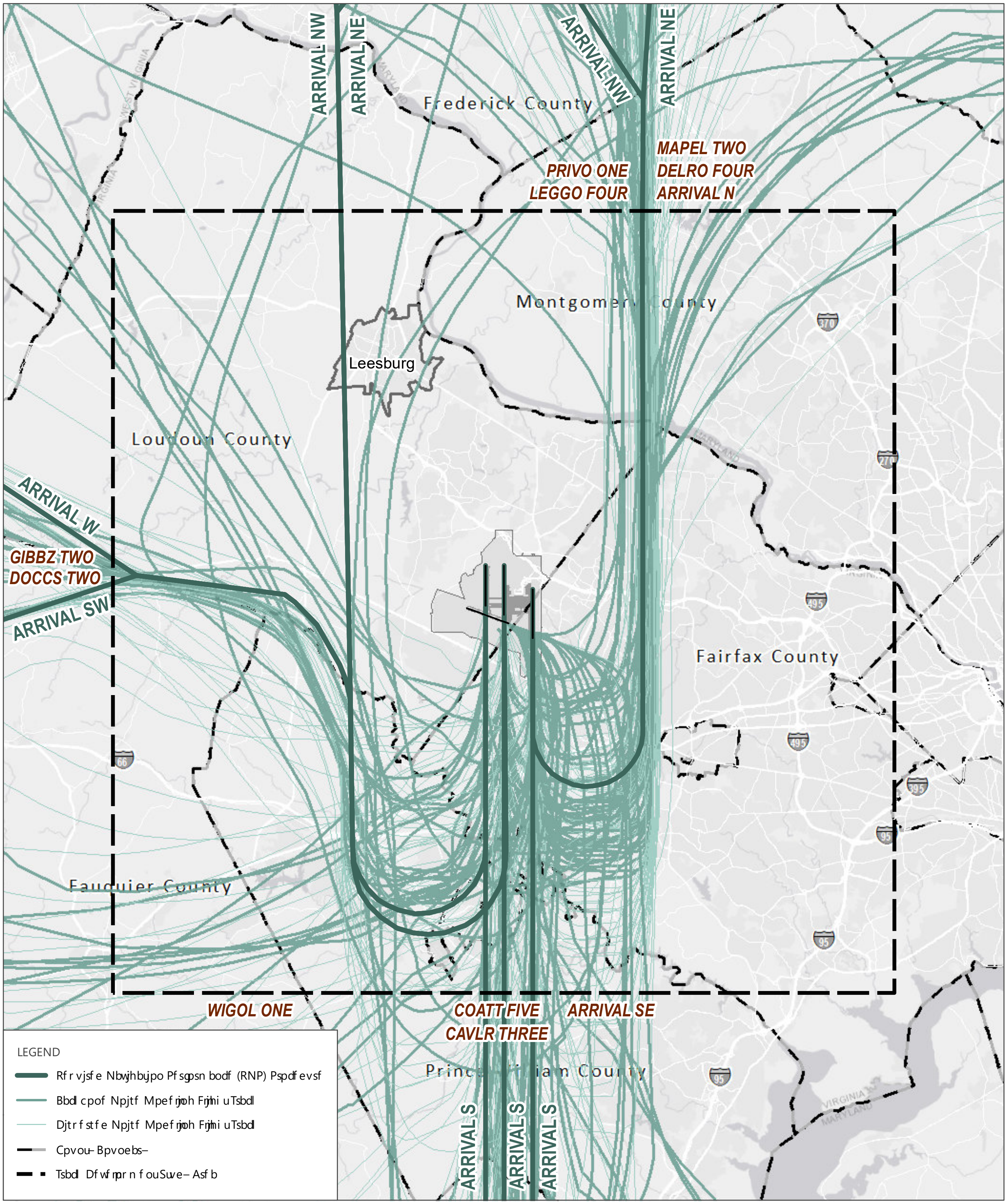

SOURCES: Et sj, HERE, Df Lpsn f, Mbr n –loejb, Or f oSusf f uMbr Cpousjc vupst, boe ui f GIS Utf s Cpn n voju-, Ar sjm 2019 (c btf n br); US Cf otvt Bvsf bv, Gf phsbr i – Djwjtjpo, TIGER/Ljof Si br f gjmf t, 2018 (dpvou- c pvoebs–); Mf uspr pmjubo X bt i johupo Ajsr psut Avu i psju-, Mbsdi 2018 (2017 sbebs gmjhi u usbdl t), Ar sjm 2018 (bjsgjf me hf pn f us–); Ff ef sbm Awjbujpo Aen jojt usbujpo, Jvof 2018 (gvuvsf r spdf evsf t); Hbssjt Mjmfs Mjmfs & Hbotpo Iod., Df df n c f s 2018 (n pef mubdl t).

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EXHIBIT 5-8

FOUR-RUNX A\ AIRFIELD CONFIGURATION X ITH X EST CARGO FACILIT\ – NOISE MODEL FLIGHT TRACKS – NORTH FLOX ARRIWALS

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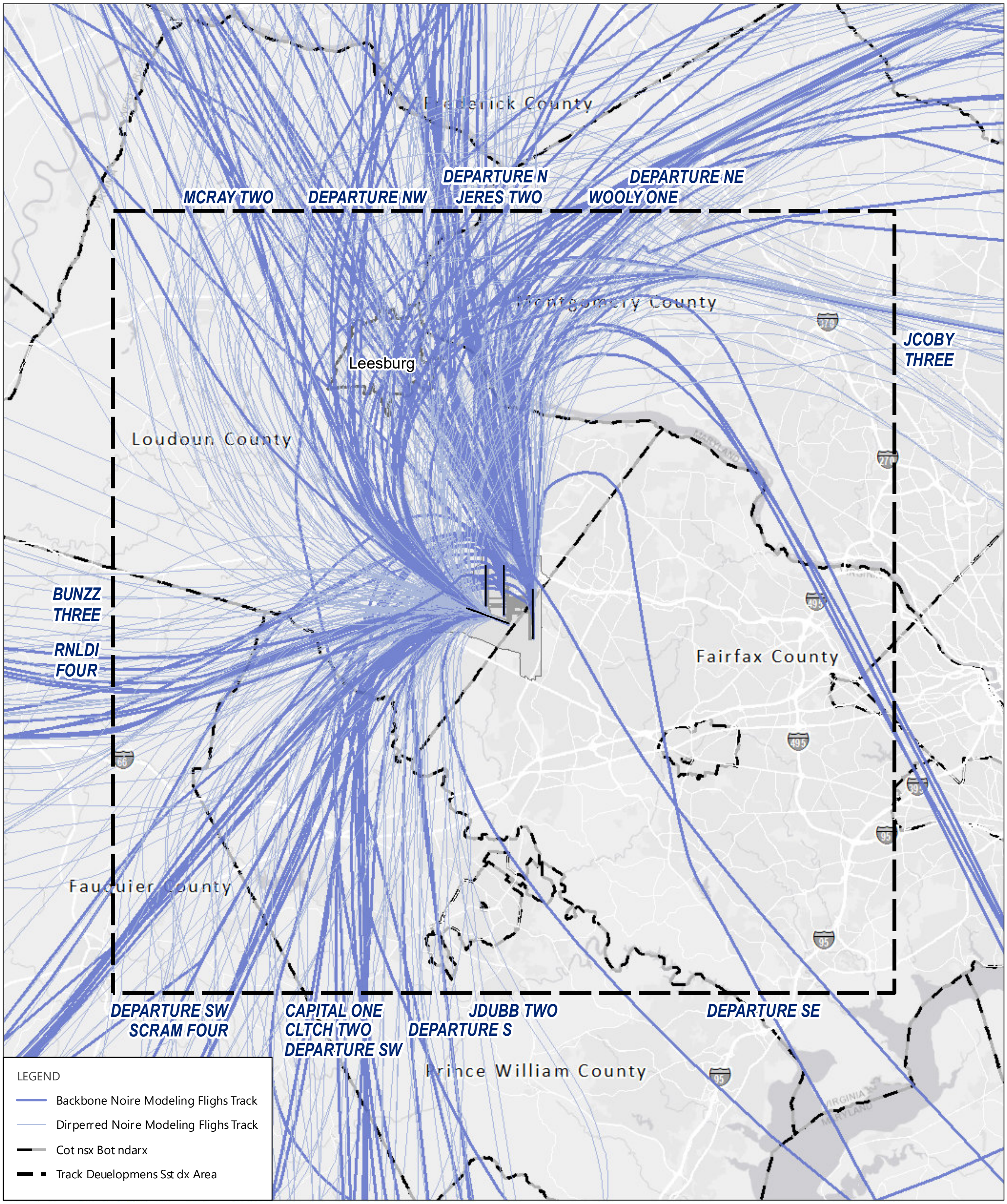

SOURCES: Erri, HERE, DeLorme, MapmxIndia, OpenSsreesMap Consribt sorr, and she GIS Urer Commt nisx, April 2019 (baremap); US Cenrt r Bt reat , Geographx Diuirion, TIGER/Line Shapefiler, 2018 (cot nsx bot ndarx); Mesropolisan Warhingson Airporsr At shorisx, March 2018 (2017 radar flighs srackr), April 2018 (airfield geomesrx); Federal Auiasion Adminirsrasion, Jt ne 2018 (ft st re procedt rer); Harrir Miller Miller & Hanron Inc., December 2018 (model srackr).

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EXHIBIT 5-9

FOUR-RUNWAY AIRFIELD CONFIGURATION WITH WEST CARGO FACILITY y NOISE MODEL FLIGHT TRACKS y NORTH FLOW DEPARTURES

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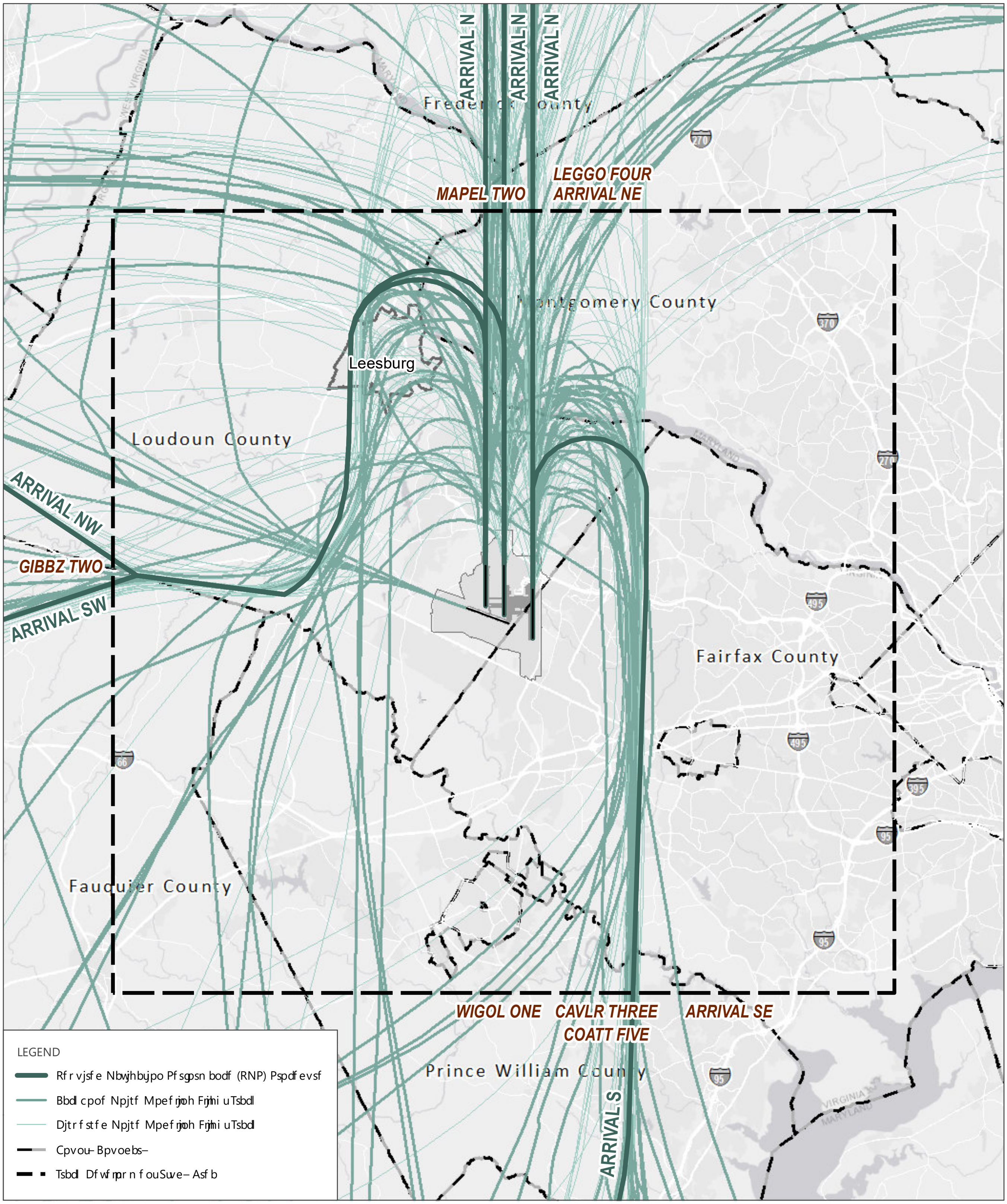

SOURCES: Et sj, HERE, Df Lpsn f, Mbr n –loejb, Or f oSusf f uMbr Cpousjc vupst, boe ui f GIS Utf s Cpn n voju-, Ar sjm2019 (cbtf n br); US Cf otvt Bvsf bv, Gf phsbr i – Djwjtjpo, TIGER/Ljof Si br f gjmft, 2018 (dpvou- c pvoebs–); Mf uspr pmjubo X bti johupo Ajsr psut Avui psju-, Mbsdi 2018 (2017 sbebs gjmhi uusbdl t), Ar sjm2018 (bjsgjf me hf pn f us–); Ff ef sbm Awjbujpo Aen jojt usbujpo, Jvof 2018 (gvuvsf r spdf evsf t); Hbssjt Mjmfs Mjmfs & Hbotpo lod., Df df n c f s 2018 (n pef mubdl t).

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EXHIBIT 5-10

FOUR-RUNX A\ AIRFIELD CONFIGURATION X ITH X EST CARGO FACILIT\ – NOISE MODEL FLIGHT TRACKS – SOUTH FLOX ARRIWALS

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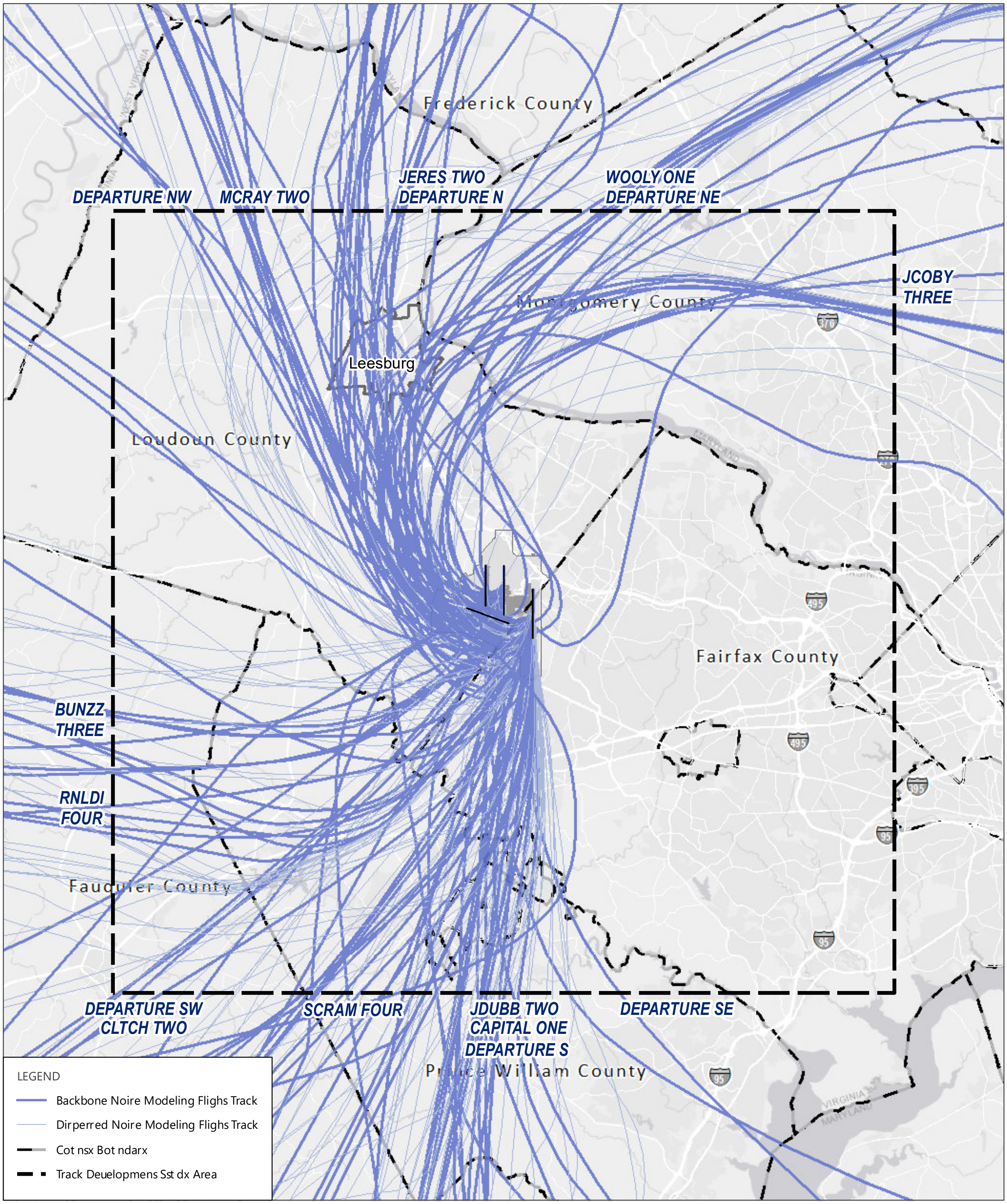

SOURCES: Erri, HERE, DeLorme, MapmxIndia, OpenSsreesMap Consribt sorr, and she GIS Urer Commt nisx, April 2019 (baremap); US Cenrt r Bt reat , Geographx Diuirion, TIGER/Line Shapefiler, 2018 (cot nsx bot ndarx); Mesropolisan Warhingson Airporsr At shorisx, March 2018 (2017 radar flighs srackr), April 2018 (airfield geomesrx); Federal Auiasion Adminirsrasion, Jt ne 2018 (ft st re procedt rer); Harrir Miller Miller & Hanron Inc., December 2018 (model srackr).

EXHIBIT 5-11

FOUR-RUNWAY AIRFIELD CONFIGURATION WITH WEST CARGO FACILITY y NOISE MODEL FLIGHT TRACKS y SOUTH FLOW DEPARTURES

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TABLE 5-14 FOUR-RUNWAY AIRFIELD CONFIGURATION WITH WEST CARGO FACILITY – NOISE MODEL FLIGHT TRACK USAGE – ARRIVALS

NOISE MODEL TRACK NAME	NORTH FLOW (EXHIBIT 5-8)			SOUTH FLOW (EXHIBIT 5-10)		
	DAYTIME	NIGHTTIME	TOTAL	DAYTIME	NIGHTTIME	TOTAL
CAVLR THREE	1.6%	1.3%	**1.6%**	2.0%	2.0%	**2.0%**
COATT FIVE	<0.1%	<0.1%	**<0.1%**	<0.1%	<0.1%	**<0.1%**
DELRO FOUR	1.5%	1.0%	**1.5%**	<0.1%	<0.1%	**<0.1%**
DOCCS TWO	<0.1%	<0.1%	**<0.1%**	<0.1%	<0.1%	**<0.1%**
LEGGO FOUR	0.6%	<0.1%	**0.6%**	1.9%	1.4%	**1.9%**
WIGOL ONE	<0.1%	<0.1%	**<0.1%**	<0.1%	<0.1%	**<0.1%**
PRIVO ONE	<0.1%	<0.1%	**<0.1%**	<0.1%	<0.1%	**<0.1%**
MAPEL TWO	0.6%	<0.1%	**0.6%**	<0.1%	<0.1%	**<0.1%**
GIBBZ TWO	4.7%	1.7%	**4.3%**	3.8%	0.9%	**3.4%**
ARRIVAL S	22.2%	40.6%	**24.4%**	15.4%	12.6%	**15.1%**
ARRIVAL SW	11.1%	22.5%	**12.4%**	5.6%	8.5%	**6.0%**
ARRIVAL SE	<0.1%	<0.1%	**<0.1%**	<0.1%	<0.1%	**<0.1%**
ARRIVAL NE	21.6%	20.9%	**21.5%**	<0.1%	0.5%	**<0.1%**
ARRIVAL N	<0.1%	<0.1%	**<0.1%**	42.2%	62.2%	**44.6%**
ARRIVAL NW	36.0%	11.0%	**33.1%**	28.3%	11.3%	**26.3%**
TOTAL	100.0%	100.0%	**100.0%**	100.0%	100.0%	**100.0%**

NOTES:
Totals may not add due to rounding.
Daytime – 7:00 a.m. to 9:59 p.m.
Nighttime – 10:00 p.m. to 6:59 a.m.
SOURCE: Harris Miller Miller & Hanson Inc., December 2018.

TABLE 5-15 FOUR-RUNWAY AIRFIELD CONFIGURATION WITH WEST CARGO FACILITY – NOISE MODEL FLIGHT TRACK USAGE – DEPARTURES

NOISE MODEL TRACK NAME	NORTH FLOW (EXHIBIT 5-9)			SOUTH FLOW (EXHIBIT 5-11)		
	DAYTIME	NIGHTTIME	TOTAL	DAYTIME	NIGHTTIME	TOTAL
BUNZZ THREE	7.7%	10.5%	**8.1%**	14.7%	9.8%	**14.3%**
CAPITAL ONE	1.3%	2.7%	**1.5%**	0.6%	<0.1%	**0.6%**
CLTCH TWO	6.1%	7.7%	**6.3%**	14.2%	6.2%	**13.5%**
JCOBY THREE	25.0%	21.5%	**24.5%**	6.0%	8.5%	**6.2%**
JDUBB TWO	7.5%	8.8%	**7.7%**	14.5%	7.4%	**13.9%**
JERES TWO	13.7%	7.6%	**12.9%**	4.2%	2.3%	**4.1%**
MCRAY TWO	10.8%	8.2%	**10.5%**	3.9%	3.5%	**3.8%**
RNLDI FOUR	11.2%	10.9%	**11.2%**	22.1%	10.1%	**21.0%**
SCRAM FOUR	<0.1%	0.7%	**<0.1%**	5.4%	4.7%	**5.3%**
WOOLY ONE	8.3%	4.7%	**7.8%**	5.5%	3.1%	**5.2%**
DEPARTURE NW	3.9%	5.0%	**4.0%**	<0.1%	<0.1%	**<0.1%**
DEPARTURE N	<0.1%	6.1%	**1.2%**	<0.1%	<0.1%	**<0.1%**
DEPARTURE NE	0.9%	1.9%	**1.1%**	0.6%	2.7%	**0.8%**
DEPARTURE SE	<0.1%	<0.1%	**<0.1%**	<0.1%	0.7%	**<0.1%**
DEPARTURE S	0.8%	1.7%	**0.9%**	3.0%	37.8%	**6.0%**
DEPARTURE SW	1.6%	1.9%	**1.6%**	4.8%	2.4%	**4.6%**
TOTAL	100.0%	100.0%	**100.0%**	100.0%	100.0%	**100.0%**

NOTES:
Totals may not add due to rounding.
Daytime – 7:00 a.m. to 9:59 p.m.
Nighttime – 10:00 p.m. to 6:59 a.m.
SOURCE: Harris Miller Miller & Hanson Inc., December 2018.

Five-Runway Airfield Configuration with Southwest or South Cargo Facility

Exhibits 5-12 through **5-15** present the five-runway airfield noise model flight tracks for AAD North Flow arrivals, North Flow departures, South Flow arrivals, and South Flow departures, respectively, under ultimate conditions. For the five-runway airfield, the noise model flight tracks with a southeast cargo facility and with a south cargo facility are identical.

The noise model tracks are the same for both five-runway airfield configurations, but the usage rates differ based on the preferred runway for nighttime cargo arrivals and departures. **Tables 5-16** and **5-17** present the aggregate usage of each noise model flight track for arrivals and departures, respectively, for all aircraft groups and runways in the five-runway airfield configuration with the southeast cargo facility. The usage rates are broken down by runway operating configuration (North and South Flow) and time of day. **Tables 5-18** and **5-19** present the same information for the five-runway airfield configuration with the south cargo facility.

5.2.3 METEOROLOGICAL CONDITIONS

The AEDT accounts for the effects of airfield elevation and AAD meteorological conditions on aircraft performance. Aircraft taking off from an airport with a high temperature and/or a high elevation require more thrust than aircraft taking off at lower temperatures and elevations. The performance data used by the AEDT model define the length of the takeoff roll (based on aircraft takeoff weight), the climb rate, and the speed for each flight segment. The AEDT also accounts for the effect of temperature and humidity on sound propagation. For Dulles International, the AEDT database used the following data for average conditions:

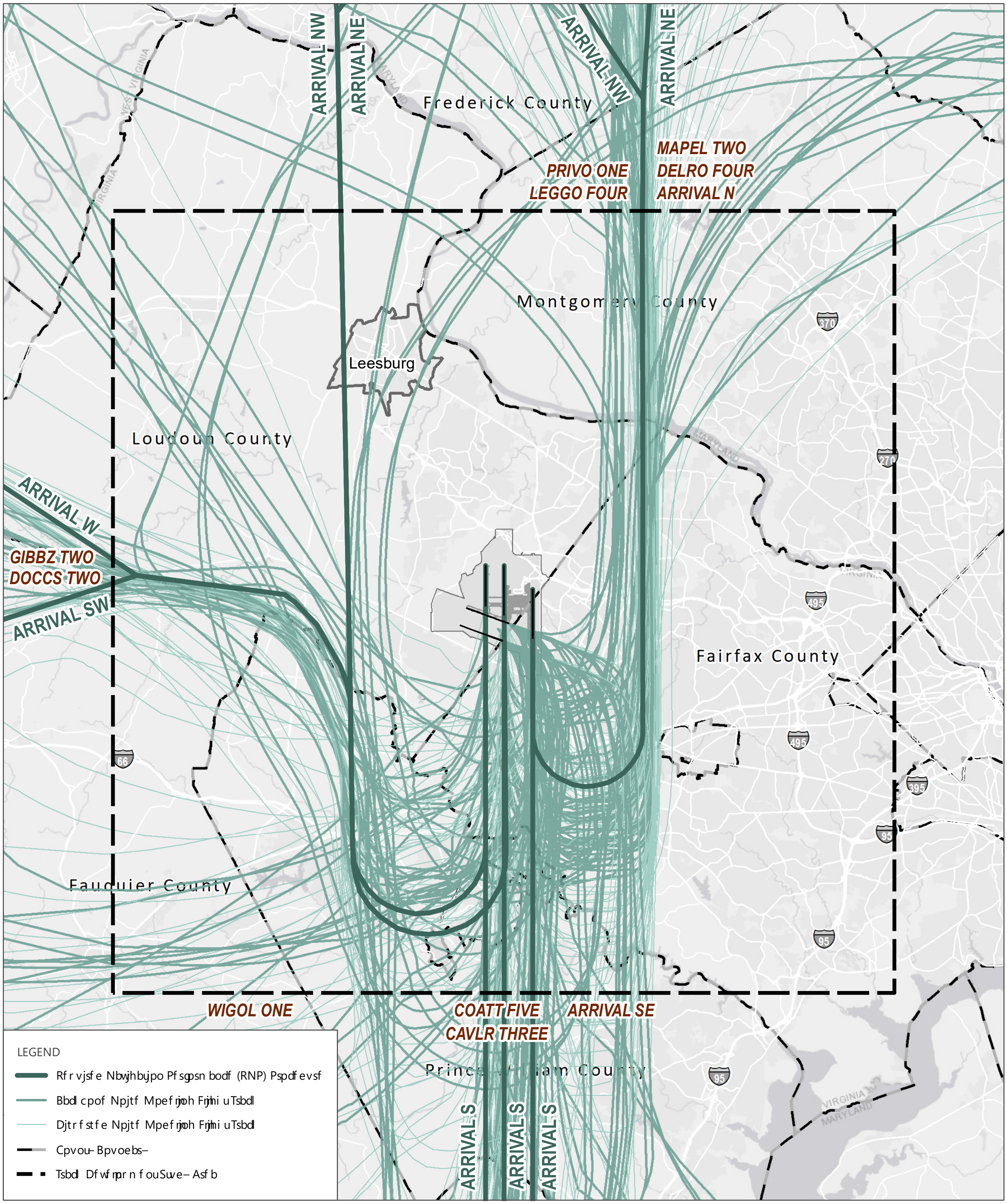
- temperature of 54.0 degrees Fahrenheit
- sea-level pressure of 1017.7 millibars
- relative humidity of 67.98 percent
- wind speed of 5.93 knots

5.3 ULTIMATE CONDITIONS NOISE CONTOURS

The following subsections describe the methodology used to combine the calculated noise exposure levels in DNL for the three airfield configurations (i.e., four-runway airfield configuration with west cargo facility, five-runway airfield configuration with southwest cargo facility, and five-runway airfield configuration with south cargo facility); depict the DNL 60, 65, 70 and 75 dBA noise contours for ultimate conditions; and summarize areas exposed to noise levels higher than DNL 60 dBA in the vicinity of Dulles International.

5.3.1 METHODOLOGY

The calculated DNL noise exposure for each of the three airfield configurations were combined into a single composite DNL noise contour to represent the Ultimate Conditions. **Exhibit 5-16** illustrates the process used to develop the Ultimate Conditions noise contours. For a specific noise contour level (e.g., DNL 65 dBA), the contours for the three airfield configurations were overlaid on each other. The composite contour for that noise level reflects the maximum extent of the combined contours. This process was repeated for each DNL noise contour level to produce the full composite Ultimate Conditions noise contours. **Exhibit 5-17** illustrates the Ultimate Conditions noise contours over existing generalized land uses.



SOURCES: Etsj, HERE, Df Lpsn f, Mbr n –loejb, Or f oSusf f uMbr Cpousjc vupst, boe ui f GIS Utf s Cpn n voju-, Ar sjm2019 (cbtf n br); US Cf otvt Bvsf bv, Gf phsbr i – Djwjtjpo, TIGER/Ljof Si br f gjmft, 2018 (dpvou- cpvoebs–); Mf uspr pmjubo X bti johupo Ajsr psut Avui psju-, Mbsdi 2018 (2017 sbebs gjmi uusbdl t), Ar sjm2018 (bjsgjf me hf pn f us–, Rvox b– 12R-30L); Ff ef sbm Awjbujpo Aen jojt usbujpo, Jvof 2018 (gvuvsf r spdf evsf t); Hbssjt Mjmfs Mjmfs & Hbotpo Iod., Df df n c f s 2018 (n pef musbdl t).

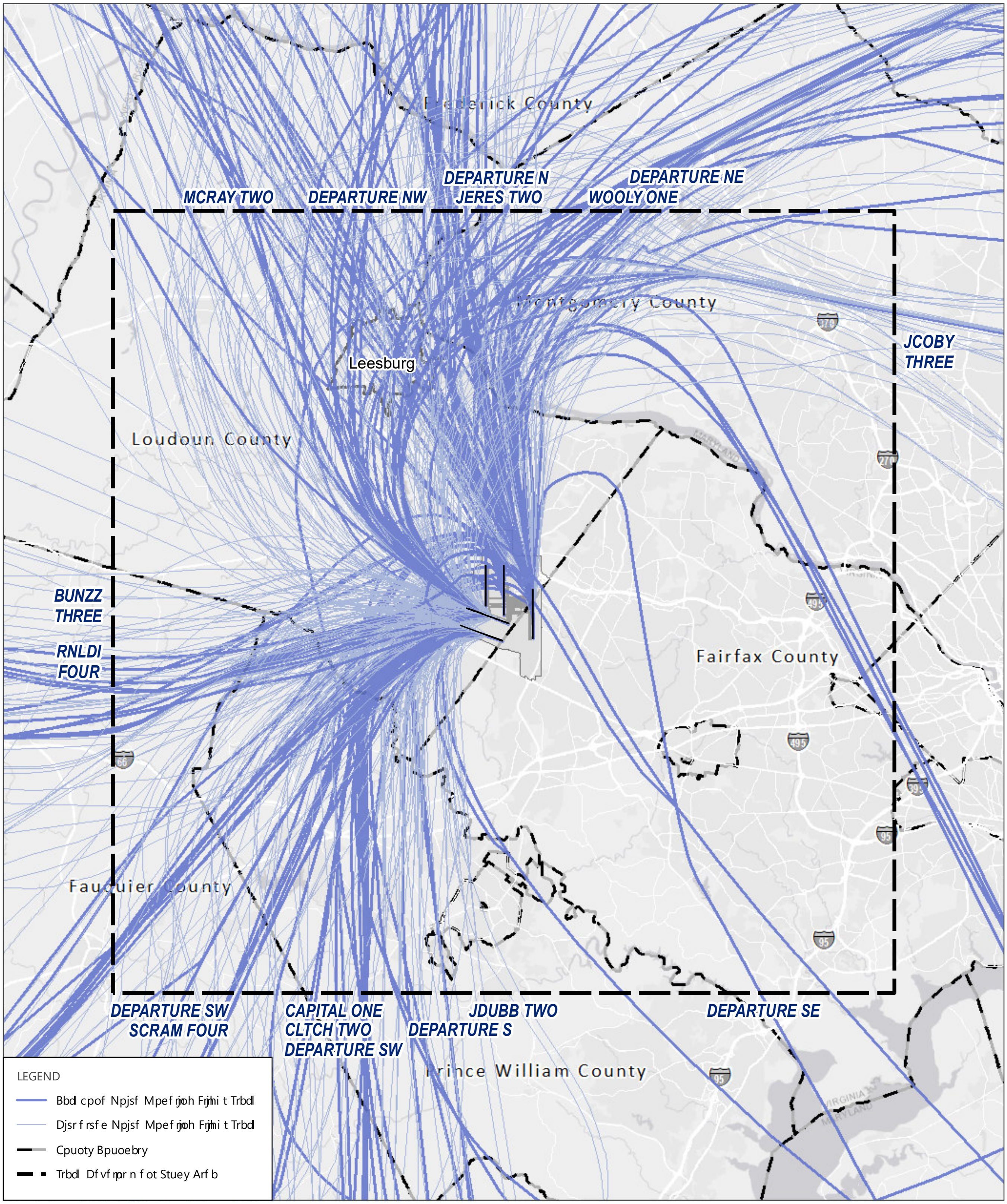
NORTH

0 40,000 gu

EXHIBIT 5-12

FIWE-RUNX A\ AIRFIELD X ITH SOUTH OR SOUTHEAST CARGO FACILIT\ –
NOISE MODEL FLIGHT TRACKS – NORTH FLOX ARRIWALS

_gt1_wpmh_Psplf dut_309YYY_309630aOo-CbmaPbboojohaIADaDCA_GIS_309630aIADaFrjmi uaTsbdl taSdf obsjp2a3aNpsui gpx aARR.n ye



SOURCES: Esrj, HERE, Df Lprn f, Mbr n yloejb, Or f oStrf f tMbr Cpotrjcutprs, boe ti f GIS Usf r Cpn n uojty, Ar rjm 2019 (c bsf n br); US Cf osus Burf bu, Gf phrbr i y Djvjsjpo, TIGER/Ljof Si br f gjrhs, 2018 (dpuoty cpuoebry); Mf trpr pjtbo X bsi johtpo Ajrr prts Auti prjty, Mbrdi 2018 (2017 rbebr gjhi t trbdl s), Ar rjm 2018 (bjrgjf me hf pn f try, ruowby 12R-30L); Ff ef rbm Avjbtjpo Aen jojstrbtjpo, Juof 2018 (gjturf r rpdf eurf s); Hbrrjs Mjmfr Mjmfr & Hbospo Iod., Df df n cf r 2018 (n pef mtrbdl s).

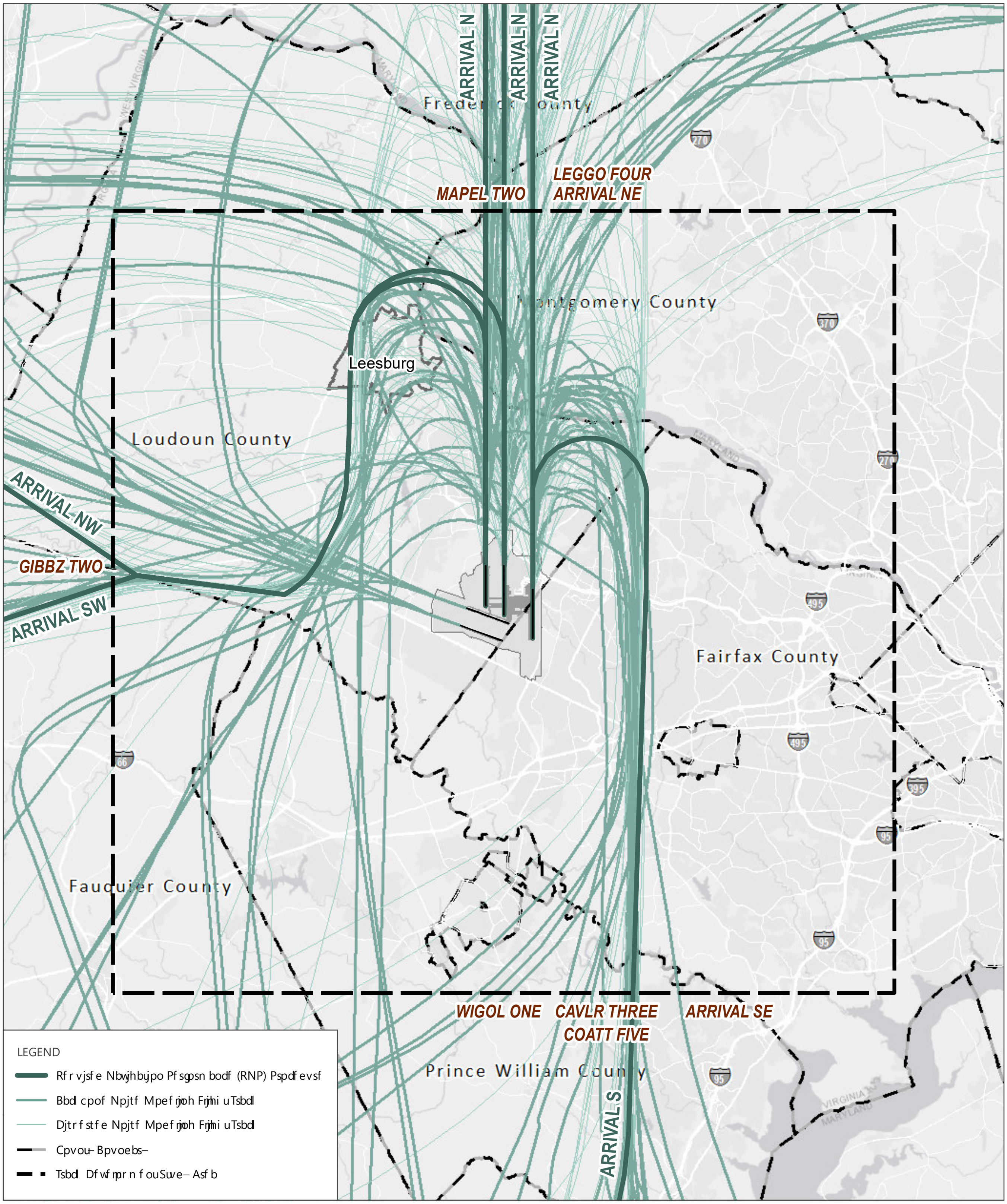
EXHIBIT 5-13

NORTH

0 40,000 gt

FIWE-RUNX A\ AIRFIELD X ITH SOUTH OR SOUTHEAST CARGO FACILIT\ – NOISE MODEL FLIGHT TRACKS – NORTH FLOX DEPARTURES

__FS1_vpm_Prpkf dts_309YYY_309630aOo-CbmmPrboojohalADaDCA_GIS_309630alADaFgihi taTrbdl saSdf obrjp2a3aNprti gpwaDEP.n xe



SOURCES: Etsj, HERE, Df Lpsn f, Mbr n –loejb, Or f oSusf f uMbr Cpousjc vupst, boe ui f GIS Utf s Cpn n voju-, Ar sjm2019 (cbtf n br); US Cf otvt Bvsf bv, Gf phsbr i – Djwjtjpo, TIGER/Ljof Si br f gjmt, 2018 (dpv ou- cpv oebs–); Mf uspr pmjubo X bti johupo Ajsr psut Avui psju-, Mbsdi 2018 (2017 sbebs gmjhi uusbdl t), Ar sjm2018 (bjsgjf me hf pn f us–, Rvox b– 12R-30L); Ff ef sbm Awjbujpo Aen jojt usbujpo, Jvof 2018 (gvuvsf r spdf evsf t); Hbssjt Mjmfs Mjmfs & Hbotpo Iod., Df df n c f s 2018 (n pef musbdl t).

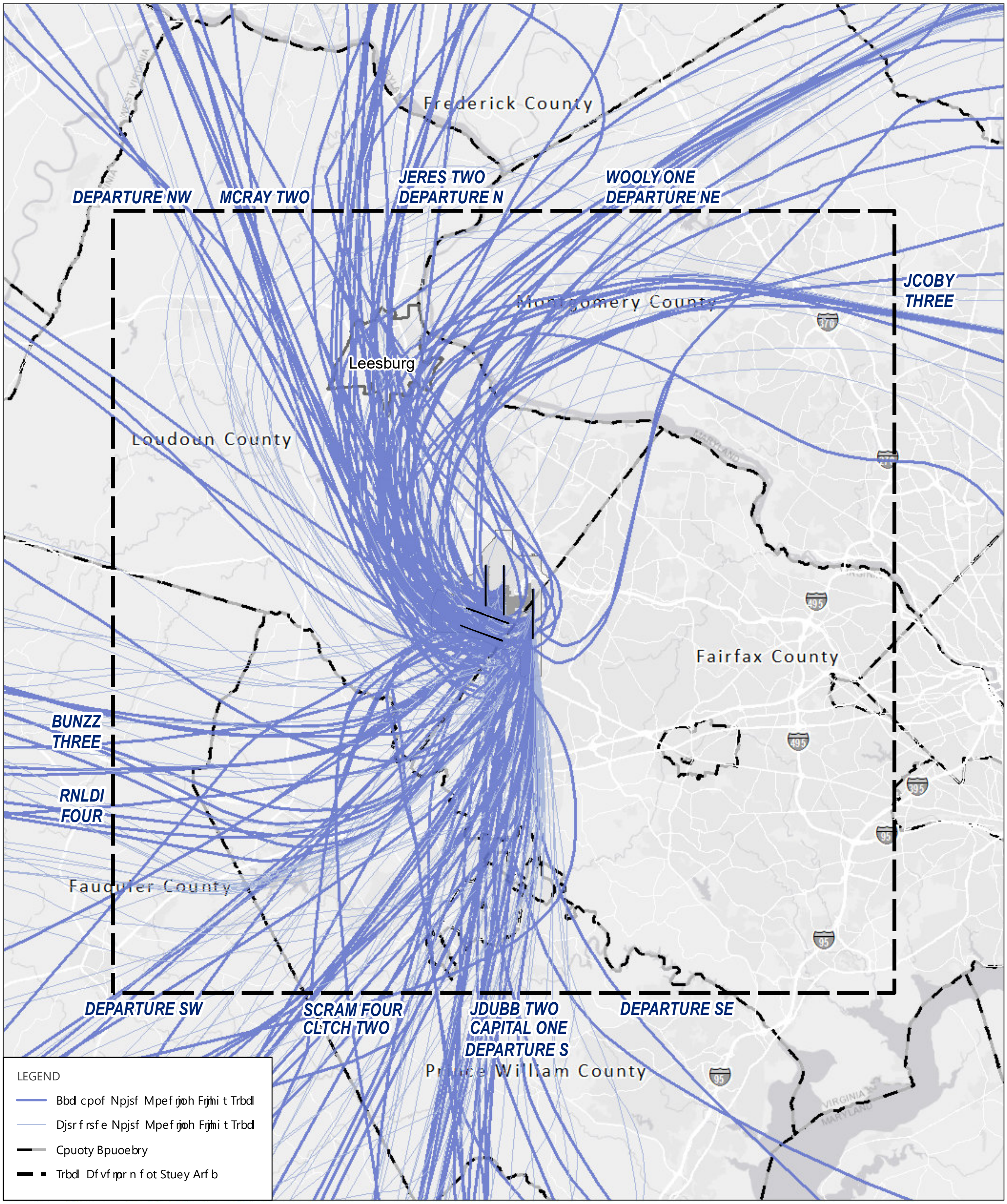
NORTH

0 40,000 gu

EXHIBIT 5-14

FIWE-RUNX A\ AIRFIELD X ITH SOUTH OR SOUTHEAST CARGO FACILIT\ – NOISE MODEL FLIGHT TRACKS – SOUTH FLOX ARRIWALS

__FS1_wpmh_Psplf dut_309YYY_309630aOo-CbmmPrboojohaIADaDCA_GIS_309630aIADaFmjhi uaTsbdl taSdf obsjp2a3aSpvi gpx aARR.n ye



SOURCES: Esrj, HERE, Df Lpm f, Mbr n yloejb, Or f oStrf f tMbr Cpotrjcutprs, boe ti f GIS Usf r Cpn n uojty, Ar rjm2019 (cbsf n br); US Cf osus Burf bu, Gf phrbr i y Djvjsjpo, TIGER/Ljof Si br f gjmfs, 2018 (dpuoty cpuoebry); Mf trpr pmjtbo X bsi johtpo Ajrr prts Auti prjty, Mbrdi 2018 (2017 rbebr gmjhi t trbdl s), Ar rjm2018 (bjrgf me hf pn f try, Ruowby 12R-30L); Ff ef rbm Avjbtjpo Aen jojstrbtjpo, Juof 2018 (gtutrf r rpdf eurf s); Hbrrjs Mjmfr Mjmfr & Hbospo Iod., Df df n c f r 2018 (n pef mtrbdl s).

EXHIBIT 5-15

FIVE-RUNX A\ AIRFIELD X ITH SOUTH OR SOUTHEAST CARGO FACILIT\ – NOISE MODEL FLIGHT TRACKS – SOUTH FLOX DEPARTURES

__FS1_vpmh_Prpkf dts_309YYY_309630aOo-CbmmPrboojohaIADaDCA_GIS_309630aIADaFmjhi taTrbdl saSdf obrjp2a3aSputi gmpwaDEP.n xe

TABLE 5-16 FIVE-RUNWAY AIRFIELD WITH SOUTHEAST CARGO FACILITY – NOISE MODEL FLIGHT TRACK USAGE – ARRIVALS

NOISE MODEL TRACK NAME	NORTH FLOW (EXHIBIT 5-12)			SOUTH FLOW (EXHIBIT 5-14)		
	DAYTIME	NIGHTTIME	TOTAL	DAYTIME	NIGHTTIME	TOTAL
CAVLR THREE	1.6%	1.3%	**1.6%**	2.0%	2.1%	**2.0%**
COATT FIVE	<0.1%	<0.1%	**<0.1%**	<0.1%	<0.1%	**<0.1%**
DELRO FOUR	1.5%	1.0%	**1.5%**	0.0%	0.0%	**0.0%**
DOCCS TWO	<0.1%	<0.1%	**<0.1%**	0.0%	0.0%	**0.0%**
LEGGO FOUR	0.6%	0.5%	**0.6%**	1.9%	1.5%	**1.9%**
WIGOL ONE	<0.1%	<0.1%	**<0.1%**	<0.1%	<0.1%	**<0.1%**
PRIVO ONE	<0.1%	<0.1%	**<0.1%**	0.0%	0.0%	**0.0%**
MAPEL TWO	0.6%	<0.1%	**0.6%**	<0.1%	<0.1%	**<0.1%**
GIBBZ TWO	4.7%	1.8%	**4.3%**	3.7%	1.1%	**3.4%**
ARRIVAL S	22.0%	41.2%	**24.3%**	15.4%	12.6%	**15.1%**
ARRIVAL SW	11.3%	20.3%	**12.3%**	5.6%	9.2%	**6.1%**
ARRIVAL SE	<0.1%	<0.1%	**<0.1%**	<0.1%	<0.1%	**<0.1%**
ARRIVAL NE	21.6%	21.2%	**21.6%**	<0.1%	0.6%	**<0.1%**
ARRIVAL N	<0.1%	<0.1%	**<0.1%**	42.4%	59.8%	**44.5%**
ARRIVAL NW	35.9%	12.2%	**33.1%**	28.2%	12.7%	**26.3%**
TOTAL	100.0%	100.0%	**100.0%**	100.0%	100.0%	**100.0%**

NOTES:
Totals may not add due to rounding.
Daytime – 7:00 a.m. to 9:59 p.m.
Nighttime – 10:00 p.m. to 6:59 a.m.
SOURCE: Harris Miller Miller & Hanson Inc., December 2018.

TABLE 5-17 FIVE-RUNWAY AIRFIELD WITH SOUTHEAST CARGO FACILITY – NOISE MODEL FLIGHT TRACK USAGE – DEPARTURES

NOISE MODEL TRACK NAME	NORTH FLOW (EXHIBIT 5-13)			SOUTH FLOW (EXHIBIT 5-15)		
	DAYTIME	NIGHTTIME	TOTAL	DAYTIME	NIGHTTIME	TOTAL
BUNZZ THREE	9.3%	10.3%	**9.4%**	16.1%	10.5%	**15.1%**
CAPITAL ONE	1.5%	2.7%	**1.6%**	0.7%	<0.1%	**0.6%**
CLTCH TWO	9.5%	7.6%	**9.3%**	15.5%	6.8%	**13.9%**
JCOBY THREE	18.0%	25.7%	**18.9%**	3.8%	30.2%	**8.6%**
JDUBB TWO	10.6%	8.7%	**10.4%**	15.5%	7.8%	**14.1%**
JERES TWO	9.2%	7.7%	**9.0%**	2.7%	3.5%	**2.8%**
MCRAY TWO	6.8%	8.4%	**7.0%**	1.8%	4.6%	**2.3%**
RNLDI FOUR	18.5%	10.9%	**17.6%**	24.1%	15.6%	**22.6%**
SCRAM FOUR	<0.1%	0.8%	**<0.1%**	5.8%	5.4%	**5.7%**
WOOLY ONE	6.4%	5.2%	**6.2%**	4.5%	3.6%	**4.3%**
DEPARTURE NW	4.4%	5.0%	**4.4%**	<0.1%	<0.1%	**<0.1%**
DEPARTURE N	<0.1%	0.8%	**<0.1%**	<0.1%	0.5%	**<0.1%**
DEPARTURE NE	0.9%	2.0%	**1.0%**	<0.1%	3.6%	**1.0%**
DEPARTURE SE	<0.1%	<0.1%	**<0.1%**	<0.1%	1.7%	**<0.1%**
DEPARTURE S	1.2%	1.7%	**1.3%**	3.2%	2.9%	**3.1%**
DEPARTURE SW	2.8%	2.2%	**2.7%**	5.4%	2.9%	**5.0%**
TOTAL	100.0%	100.0%	**100.0%**	100.0%	100.0%	**100.0%**

NOTES:
Totals may not add due to rounding.
Daytime – 7:00 a.m. to 9:59 p.m.
Nighttime – 10:00 p.m. to 6:59 a.m.
SOURCE: Harris Miller Miller & Hanson Inc., December 2018.

TABLE 5-18 FIVE-RUNWAY AIRFIELD WITH SOUTH CARGO FACILITY – NOISE MODEL FLIGHT TRACK USAGE – ARRIVALS

NOISE MODEL TRACK NAME	NORTH FLOW (EXHIBIT 5-12)			SOUTH FLOW (EXHIBIT 5-14		
	DAYTIME	NIGHTTIME	TOTAL	DAYTIME	NIGHTTIME	TOTAL
CAVLR THREE	1.6%	1.5%	**1.6%**	2.0%	2.3%	**2.1%**
COATT FIVE	<0.1%	<0.1%	**<0.1%**	<0.1%	<0.1%	**<0.1%**
DELRO FOUR	1.5%	1.1%	**1.5%**	0.0%	0.0%	**0.0%**
DOCCS TWO	<0.1%	<0.1%	**<0.1%**	0.0%	0.0%	**0.0%**
LEGGO FOUR	0.6%	<0.1%	**0.6%**	1.9%	1.6%	**1.9%**
WIGOL ONE	<0.1%	<0.1%	**<0.1%**	<0.1%	<0.1%	**<0.1%**
PRIVO ONE	<0.1%	<0.1%	**<0.1%**	0.0%	0.0%	**0.0%**
MAPEL TWO	0.6%	<0.1%	**0.6%**	<0.1%	<0.1%	**<0.1%**
GIBBZ TWO	4.7%	2.5%	**4.4%**	3.7%	1.0%	**3.4%**
ARRIVAL S	22.0%	38.0%	**24.0%**	15.4%	13.9%	**15.2%**
ARRIVAL SW	11.3%	21.9%	**12.6%**	5.6%	9.6%	**6.1%**
ARRIVAL SE	<0.1%	<0.1%	**<0.1%**	<0.1%	<0.1%	**<0.1%**
ARRIVAL NE	21.6%	24.0%	**21.9%**	<0.1%	0.6%	**<0.1%**
ARRIVAL N	<0.1%	<0.1%	**<0.1%**	42.4%	59.1%	**44.2%**
ARRIVAL NW	35.9%	9.9%	**32.6%**	28.2%	11.4%	**26.3%**
TOTAL	100.0%	100.0%	**100.0%**	100.0%	100.0%	**100.0%**

NOTES:
Totals may not add due to rounding.
Daytime – 7:00 a.m. to 9:59 p.m.
Nighttime – 10:00 p.m. to 6:59 a.m.
SOURCE: Harris Miller Miller & Hanson Inc., December 2018.

TABLE 5-19 FIVE-RUNWAY AIRFIELD WITH SOUTH CARGO FACILITY – NOISE MODEL FLIGHT TRACK USAGE – DEPARTURES

NOISE MODEL TRACK NAME	NORTH FLOW (EXHIBIT 5-13)			SOUTH FLOW (EXHIBIT 5-15)		
	DAYTIME	NIGHTTIME	TOTAL	DAYTIME	NIGHTTIME	TOTAL
BUNZZ THREE	9.3%	10.7%	**9.5%**	16.1%	14.4%	**15.9%**
CAPITAL ONE	1.5%	2.6%	**1.6%**	0.7%	<0.1%	**0.7%**
CLTCH TWO	9.5%	7.4%	**9.3%**	15.5%	9.2%	**14.7%**
JCOBY THREE	18.0%	25.5%	**18.9%**	3.8%	13.4%	**5.0%**
JDUBB TWO	10.6%	8.8%	**10.4%**	15.5%	10.9%	**14.9%**
JERES TWO	9.2%	7.4%	**9.0%**	2.7%	3.5%	**2.8%**
MCRAY TWO	6.8%	7.9%	**6.9%**	1.8%	5.3%	**2.3%**
RNLDI FOUR	18.5%	12.2%	**17.7%**	24.1%	15.1%	**22.9%**
SCRAM FOUR	<0.1%	0.8%	**<0.1%**	5.8%	7.2%	**6.0%**
WOOLY ONE	6.4%	4.9%	**6.2%**	4.5%	4.9%	**4.5%**
DEPARTURE NW	4.4%	4.8%	**4.4%**	<0.1%	0.7%	**<0.1%**
DEPARTURE N	<0.1%	0.8%	**<0.1%**	<0.1%	0.6%	**<0.1%**
DEPARTURE NE	0.9%	2.0%	**1.0%**	<0.1%	5.0%	**1.0%**
DEPARTURE SE	<0.1%	0.5%	**<0.1%**	<0.1%	1.3%	**<0.1%**
DEPARTURE S	1.2%	1.7%	**1.3%**	3.2%	3.9%	**3.3%**
DEPARTURE SW	2.8%	2.1%	**2.7%**	5.4%	4.2%	**5.3%**
TOTAL	100.0%	100.0%	**100.0%**	100.0%	100.0%	**100.0%**

NOTES:
Totals may not add due to rounding.
Daytime – 7:00 a.m. to 9:59 p.m.
Nighttime – 10:00 p.m. to 6:59 a.m.
SOURCE: Harris Miller Miller & Hanson Inc., December 2018.

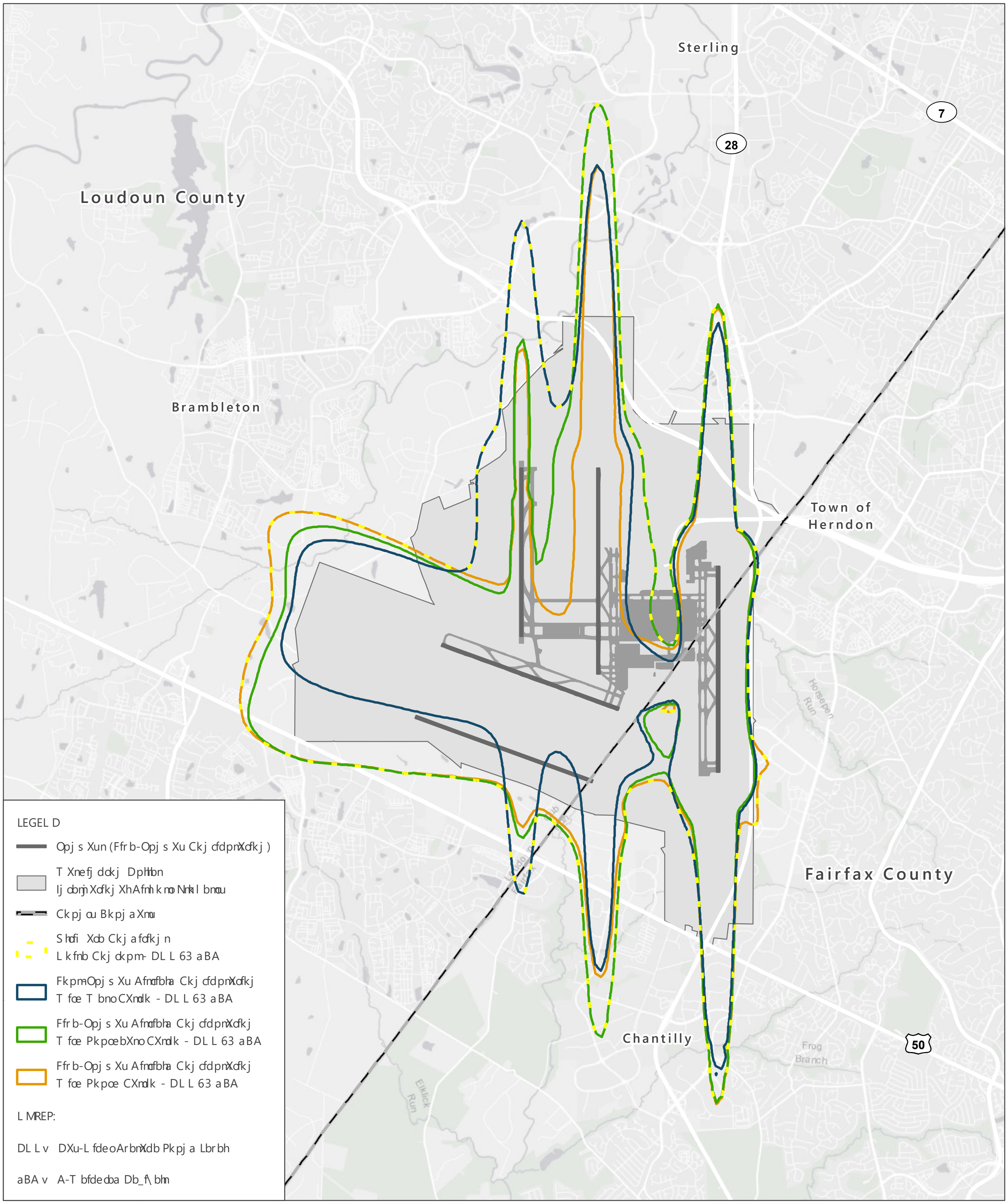
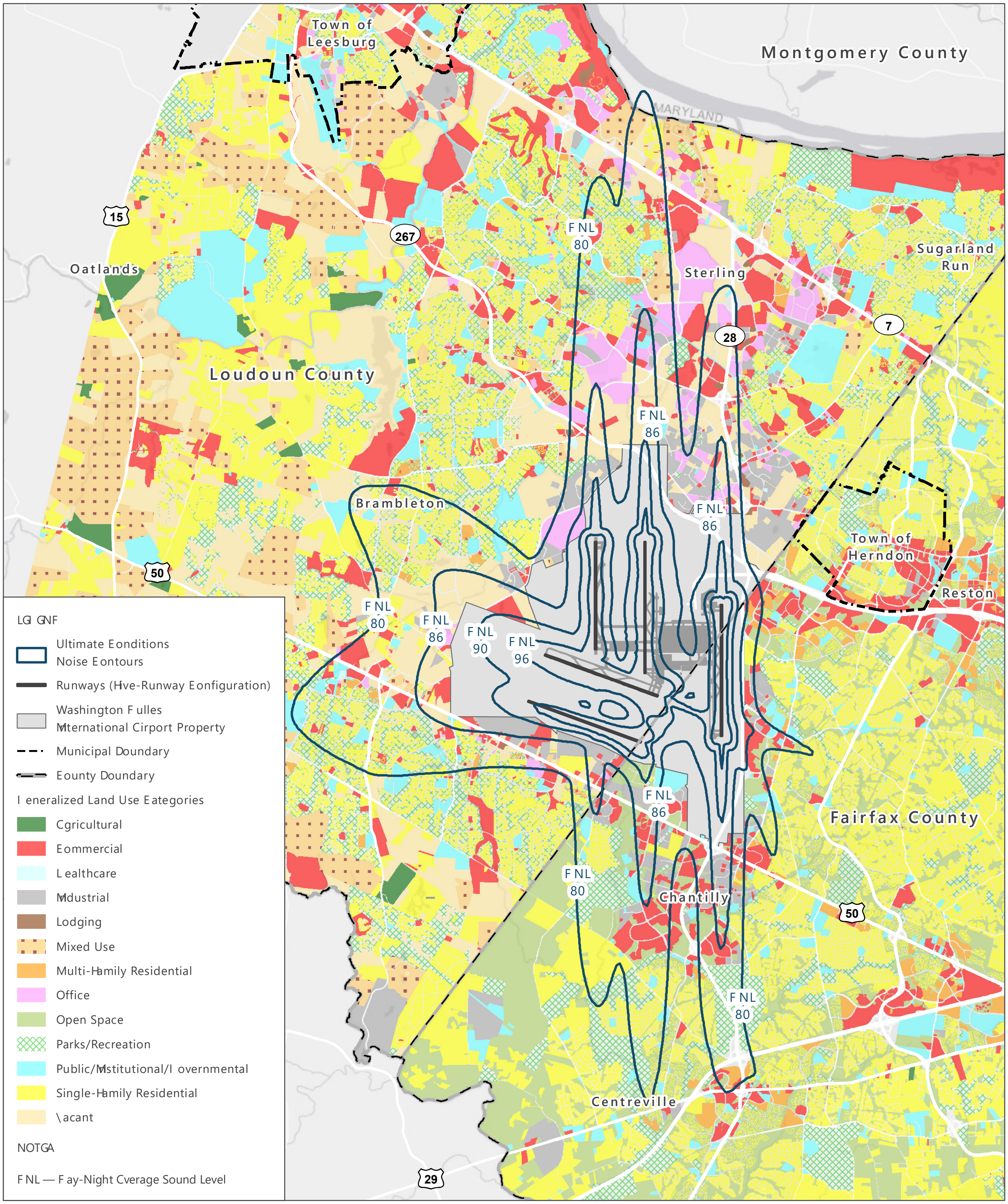


EXHIBIT 5-16

S LRIMARE CML DIRIML P -
L MIPE CML RMS O CMMNMPIRE NOMCEPP

N\GIP\Nhdgb_cn\IAD\MUD\IADW!tef\ fc3-16W!ki l knfcbNht_bmW20190329.i ta



SOURE GSAGsri, L GRG, F eLorme, MapmyMdia, OpenStreetMap Eontributors, and the I M User Eommunity, May 201; (basemap)BUS Eensus Dureau, I eography F ivision, TMGR/Line Shapefiles, 201: (place, county boundary)B Hairfax Eounty, 2019, httpsA/data-fairfaxcountygis.opendata.arcgis.com/ (accessed May 201:) (land use)BLoudoun Eounty, 201: , httpsA/data-loudoungis.opendata.arcgis.com/ (accessed May 201:) (land use)BL arris Miller Miller & L anson Mc., Hebruary 201; (contours)BMetropolitan Washington Cirports Cuthority, 201: (Cirport components, runways)BRicondo & Cssociates, Mc., May 201: (generalized land use).

NORTL

0 12,600 ft

EXHIBIT 5-17

ULTMCTGEONF MMONS - NOMGEONTOURS

PAI M\Projects\MF\MXF\MF_Gxhibit6-19_LU_UltimateEonditions_201; 0631.mxd

5.3.2 AIRCRAFT NOISE EXPOSURE AREA SUMMARY

Table 5-20 presents the total area of each banded contour level for the Ultimate Conditions noise contour, both on and off Airport property. The DNL 75 dBA and higher banded contour is entirely on Airport property, and approximately 68 percent of DNL 65 dBA and higher exposure levels are on Airport property.

TABLE 5-20 ULTIMATE CONDITIONS NOISE CONTOURS – AREA BY ON VERSUS OFF AIRPORT PROPERTY

CONTOUR BAND (DNL[2])	AREA ON AIRPORT PROPERTY[1]		AREA OFF AIRPORT PROERPTY[1]		TOTAL AREA	
	SQUARE MILES	PERCENTAGE OF TOTAL AREA	SQUARE MILES	PERCENTAGE OF TOTAL AREA	SQUARE MILES	ACRES
60-65	2.86	9%	29.57	91%	32.43	20,755.20
65-70	5.50	46%	6.48	54%	11.98	7,667.20
70-75	5.12	97%	0.14	3%	5.26	3,366.40
75+	3.55	100%	0.00	0%	3.55	2,272.00
65+	**14.17**	**68%**	**6.62**	**32%**	**20.79**	**13,305.60**
60+	**17.03**	**32%**	**36.19**	**68%**	**53.22**	**34,060.80**

NOTES: DNL – Day-Night Average Sound Level
1 The areas within the Ultimate Conditions noise contours were calculated in NAD 1983 State Plane – Virginia North FIPS 4501 (US feet) (EPSG: 2283).
2 DNL contour bands are calculated as A-weighted decibels (dBA).
SOURCE: Ricondo & Associates, Inc., April 2019.

5.3.3 GENERALIZED LAND USE COMPATIBILITY SUMMARY

Table 5-21 presents area by generalized land use category within each banded contour level for the Ultimate Conditions noise contours. Of the residential land use area (comprising single-family, multi-family, and mixed uses) within the DNL 60 dBA and higher contour, over 90 percent of the area would be in the DNL 60-65 dBA contour band. As depicted on Exhibit 5-17, the residential uses are primarily located north, west, and south of Airport property. The land use comprising most of the area (approximately 83 percent) within the DNL 65 dBA and higher exposure area is designated as public/ institutional/ governmental, industrial and commercial uses, and residential land uses (primarily mixed use) comprise 3.4 percent of the total exposure area within this level of aircraft noise exposure.

TABLE 5-21 ULTIMATE CONDITIONS NOISE CONTOURS – AREA BY GENERALIZED LAND USE CATEGORY

GENERALIZED LAND USE CATEGORY	AREA[1] IN CONTOUR BAND[2] (SQUARE MILES)						AREA[1] IN CONTOUR BAND[2] (ACRES)	
	DNL 60-65	DNL 65-70	DNL 70-75	DNL 75+	DNL 65+	DNL 60+	DNL 65+	DNL 60+
Single Family Residential	5.39	0.10	0.00	0.00	0.10	5.49	65.71	3,515.03
Multi-Family Residential	0.46	0.00	0.00	0.00	0.00	0.46	0.00	294.91
Mixed Use	0.91	0.35	0.15	0.07	0.58	1.48	368.62	949.15
Healthcare	0.04	0.00	0.00	0.00	0.00	0.05	1.04	29.84
Lodging	0.05	0.01	0.00	0.00	0.01	0.06	6.85	40.18
Parks/Recreation	5.00	0.06	0.00	0.00	0.06	5.06	39.29	3,236.57
Commercial	3.01	0.82	0.02	0.00	0.84	3.85	538.17	2,463.57
Industrial	2.50	1.19	0.03	0.00	1.22	3.72	781.70	2,381.22
Office	1.70	0.35	0.00	0.00	0.35	2.05	224.05	1,309.38
Open Space	1.80	0.31	0.05	0.00	0.35	2.16	226.84	1,381.06
Public/Institutional/Governmental	4.03	6.31	4.98	3.48	14.76	18.79	9,448.47	12,026.53
Vacant	4.27	1.97	0.02	0.00	1.99	6.25	1,271.64	4,003.08
Total	**29.16**	**11.47**	**5.25**	**3.55**	**20.26**	**49.42**	**12,972.38**	**31,630.52**

NOTES:
Totals may not add up due to rounding
DNL – Day-Night Average Sound Level
1 The areas within the Ultimate Conditions noise contours were calculated in NAD 1983 State Plane – Virginia North FIPS 4501 (US feet) (EPSG: 2283).
2 DNL contour bands are calculated as A-weighted decibels (dBA).
SOURCE: Ricondo & Associates, Inc., April 2019.

5.3.4 STAKEHOLDER INPUT SUMMARY

A draft version of the Ultimate Conditions noise contours was presented to the Working Group on January 7, 2019. Appendix A contains a copy of that presentation. Members were briefed on the methodology, operational assumptions, and Ultimate Conditions noise contour results. Members were also briefed on a comparison between the draft version of the Ultimate Conditions noise contours and the current Airport Noise Impact Overlay District contours maintained by Loudoun and Fairfax Counties. Members of the Working Group did not express any concerns over the information presented. An updated version of the Ultimate Conditions noise contours, which corrected the four-runway airfield configuration with west cargo nighttime runway use on Runway 1L-19R for cargo operations was developed and shared with Working Group members in February 2019.

5.3.5 ULTIMATE CONDITIONS RESULTS PUBLIC WORKSHOP SUMMARY

A public workshop, attended by 25 individuals, was held on February 28, 2019, from 5:00 p.m. to 8:00 p.m. at Dulles International. The purpose of the workshop was to brief attendees from the general public on the purpose of the study, the importance of Dulles International to the local and regional economy, the history of using ultimate conditions noise contours for land use planning, and to explain the methodology and results of this noise analysis to update the projected Ultimate Conditions noise contours. Attendees were also briefed on MWAA's recommendation to Loudoun and Fairfax Counties to maintain their existing Airport Noise Impact Overlay District contours and also protect for the Ultimate Conditions noise contours by combining the two DNL contour sets to represent a composite airport noise impact overlay district. Appendix B includes the workshop boards and sign-in sheets from this public workshop. Workshop attendees did not provide comments, nor were any comments submitted to the MWAA via email during the public comment period from February 28, 2019, through March 29, 2019.

RICONDO®

May 2019

Washington Dulles International Airport

Aircraft Noise Contour Map Update

Appendices

Prepared for:

Planning Department
Metropolitan Washington Airports Authority

Prepared by:

RICONDO

Harris Miller Miller & Hanson, Inc.

APPENDIX A

Working Group Coordination – Presentations

A.1 | APRIL 8, 2018 – KICK-OFF MEETING

A.2 | APRIL 20, 2018 – AIRFIELD CONFIGURATION, ANNUAL SERVICE VOLUME (ASV) METHODOLOGY AND NOISE MODEL DEVELOPMENT METHODOLOGY

A.3 | JUNE 8, 2018 – INVENTORY OVERVIEW AND 2017 OPERATIONS

A.4 | AUGUST 13, 2018 – PROJECTED ASV RESULTS, RUNWAY PATTERNS AND FLIGHT TRACK CHANGES

A.5 | SEPTEMBER 25, 2018 – PROJECTED ASV ANNUAL AVERAGE DAY (AAD) OPERATIONS

A.6 | JANUARY 7, 2019 – DRAFT NOISE EXPOSURE MAP RESULTS

APPENDIX A WORK GROUP COORDINATION - PRESENTATIONS

APRIL 8, 2018 – KICK-OFF MEETING


METROPOLITAN WASHINGTON AIRPORTS AUTHORITY


Washington Dulles International Airport (IAD) Noise Contour Map Update

For Publication on MWAA Website

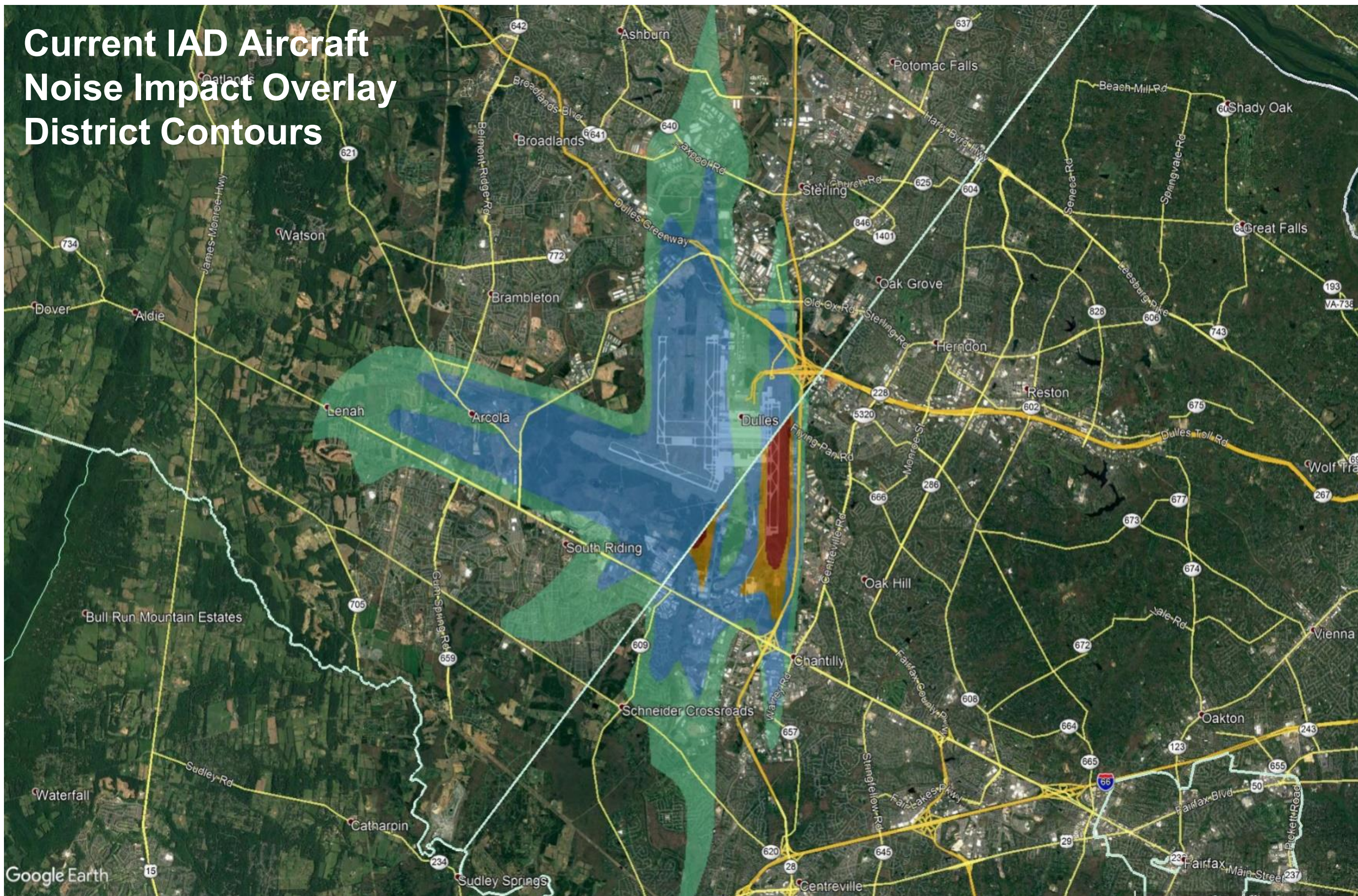
April 4, 2018

Contents

Purpose

- Update the Dulles Airport noise contour map to incorporate changes in the aviation environment so that the future vision reflects these changes.
    - Flight tracks and overall utility of the airfield have evolved
    - Evolution will continue with implementation of NextGen
    - Flight procedures will soon allow for triple simultaneous runway operations during low visibility conditions (IFR)

Introduction



Legend

- DNL 60
- DNL 65
- DNL 70
- DNL 75
- County Boundary

Note: Loudoun County does not use the DNL 70 and 75 contours to define their Aircraft Noise Impact Overlay District. Loudoun County also applies a 1 mile buffer around the DNL 60 contour line, which is not depicted on the map.

Source: Google Earth (aerial photography); Loudoun County Open Geospatial Data (noise overlay contours; county boundary); Fairfax County Open Geospatial Data (noise overlay contours; county boundary), March 2018.

What is a DNL Noise Contour?

- DNL – Day-Night Average Sound Level
  - Represents average noise for a 24-hour period
  - Provides 10 dB weighting factor for nighttime (10:00 pm to 6:59 am) operations
- DNL Contour – a line representing equal DNL, similar to a terrain contour representing equal elevation levels

Noise Contours

- Represent average annual noise rather than at a specific moment or over a given day
- Highlight existing or potential areas of significant aircraft noise exposure as defined by the FAA
- Assess the relative aircraft noise exposure of different runway and/or flight corridor alternatives to compare potential noise impacts of various alternatives
- Provide guidance for land use planners in the development of land use control measures, such as zoning ordinances, subdivision regulations, building codes, and airport overlay zones

FAA Land Use Compatibility

Land Use	Yearly day-night sound level (Ldn) in decibels					
	>65	65-70	70-75	75-80	80-85	Over 85
Residential (SFD, SFA, MFA)	√					
Public Use (schools)	√	-25-30dB	-25-30dB			
Public Use (hospitals, nursing homes, churches, auditoriums and concert halls)	√	-25dB	-30dB			
Public Use (transportation)	√	√	√ -25dB	√ -30dB	√ -35dB	√ -35dB
Public Use (parking)	√	√	√ -25dB	√ -30dB	√ -35dB	
Commercial Use (offices, business, professional, retail trade, communication)	√	√	√ -25dB	√ -30dB		
Commercial Use (wholesale, retail- building materials, hardware and farm equipment, utilities)	√	√	√ -25dB	√ -30dB	√ -35dB	
Manufacturing (general)	√	√	√ -25dB	√ -30dB	√ -35dB	
Manufacturing (livestock farming and breeding)	√					
Recreational (outdoor sports arenas and spectator sports)	√	√	√			
Recreational (outdoor music shells, amphitheaters)	√					
Recreational (amusements, parks, resorts and camps)	√	√	√			
Recreational (golf courses, riding stables and water recreation)	√	√	√ -25dB	√ -30dB		

Land Use Compatibility (Cont'd)

TABLE 1—LAND USE COMPATIBILITY* WITH YEARLY DAY-NIGHT AVERAGE SOUND LEVELS

Land use	Yearly day-night average sound level (L_{dn}) in decibels					
	Below 65	65–70	70–75	75–80	80–85	Over 85
RESIDENTIAL						
Residential, other than mobile homes and transient lodgings.	Y	N(1)	N(1)	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N(1)	N(1)	N(1)	N	N
PUBLIC USE						
Schools	Y	N(1)	N(1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Governmental services	Y	Y	25	30	N	N
Transportation	Y	Y	Y(2)	Y(3)	Y(4)	Y(4)
Parking	Y	Y	Y(2)	Y(3)	Y(4)	N
COMMERCIAL USE						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail—building materials, hardware and farm equipment.	Y	Y	Y(2)	Y(3)	Y(4)	N
Retail trade—general	Y	Y	25	30	N	N
Utilities	Y	Y	Y(2)	Y(3)	Y(4)	N
Communication	Y	Y	25	30	N	N
MANUFACTURING AND PRODUCTION						
Manufacturing, general	Y	Y	Y(2)	Y(3)	Y(4)	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y(6)	Y(7)	Y(8)	Y(8)	Y(8)
Livestock farming and breeding	Y	Y(6)	Y(7)	N	N	N
Mining and fishing, resource production and extraction.	Y	Y	Y	Y	Y	Y
RECREATIONAL						
Outdoor sports arenas and spectator sports	Y	Y(5)	Y(5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts and camps	Y	Y	Y	N	N	N
Golf courses, riding stables and water recreation.	Y	Y	25	30	N	N

Numbers in parentheses refer to notes.

IAD Noise Contours and Land Use Planning

- Aircraft noise, and its impact on regional communities, was a primary consideration during the planning of the airfield
- Long-range noise contours have been a resource and an aid toward the development of compatible land use
- Land use planning based upon Potential Noise Contours
  - Represent long-range development at IAD
  - Account for maximum number of operations the runways can accept

Noise Contour Map Timeline

- 1985: FAA (airport operator at the time) conducted and completed a Title 14 Code of Federal Regulations (CFR) Part 150 – not “accepted” or “approved”
  - Loudoun and Fairfax Counties adopted the zoning overlay districts based on the contours developed by MWAA.
- 1988: FAA Expanded East Coast Plan – changed procedures and runway use at IAD
- 1990: Airport Noise and Capacity Act – require phase out of older/louder Stage 2 aircraft weighing more than 75,000 pounds

Noise Contour Map Timeline (continued)

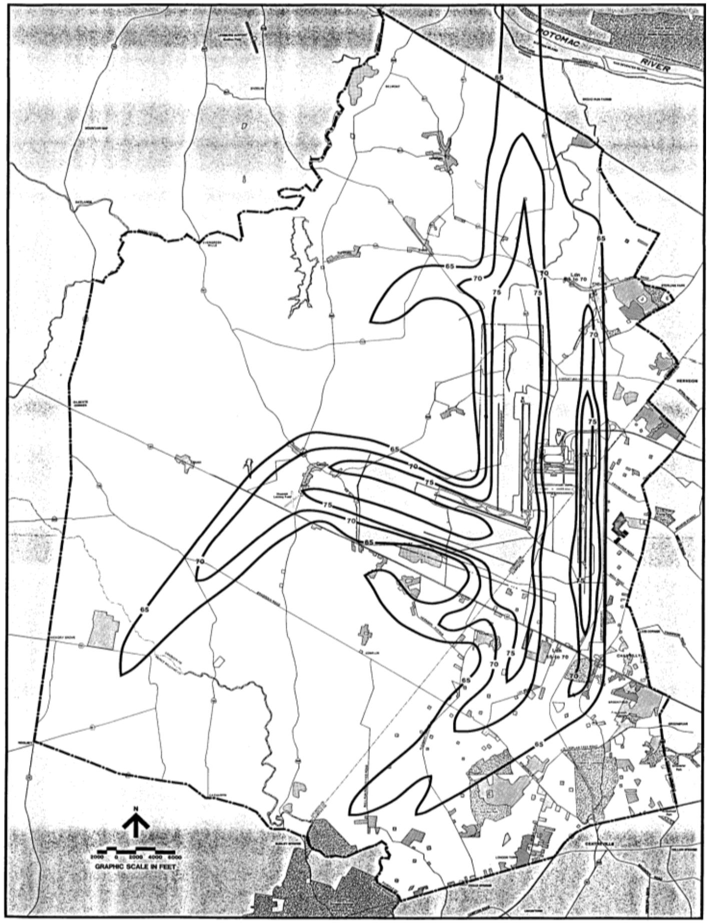
- 1993: MWAA conducted a Noise Exposure Map (NEM) update
  - Calculated long range planning noise exposure contours – “Potential Noise Exposure” reflecting an ultimate build scenario
  - Loudoun and Fairfax Counties agreed to accept the Potential Noise Exposure contours for Land Use Planning
- 2005: FAA prepared the new runways EIS

Noise Contour Map Defined

- The noise contour map will be developed based on a potential scenario(s) which are encountered during or at full-build of the Airport.

Noise Contour Map Timeline (continued)

1985 Potential Noise Contours



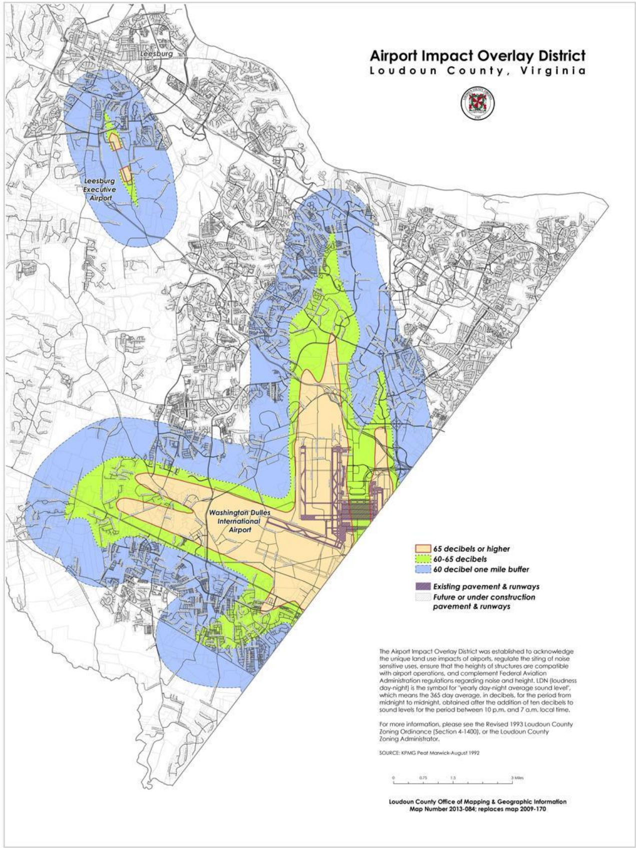
1993 Potential Noise Contours

Fairfax and Loudoun County Zoning

- Since 1985, Loudoun and Fairfax Counties have applied Potential Noise Contours recommended by MWAA as a tool for effective land use planning and zoning for long-term compatibility with IAD.
- IAD in partnership with Fairfax and Loudoun Counties is often used as a model for effective planning and zoning related to compatible development for the aerotropolis concept.
- Other major airports, such as DFW, were built in less-populated areas but over time became surrounded by more dense population.
- Several airports are using an approach similar to IAD and the surrounding communities to prevent residential incompatibility:
  - Portland International Airport
  - Orlando International Airport
  - Phoenix-Mesa Gateway Airport

Loudoun County Zoning

- Established the Airport Impact Overlay District in 1993
- Recognized as a national leader in airport-compatible land use planning for adopting its Airport Impact Overlay District
- Uses IAD Potential Noise Contours calculated for the full-build 5 runway layout to define the Airport Impact Overlay District.



Source: Loudoun County, Virginia, Zoning Ordinance, AI-Airport Impact Overlay District § 4-1400.

Loudoun County Zoning (continued)

Residential Limitations:

– **Areas outside of, but within one (1) mile of the DNL 60**: Disclosure statement that the home is located within an area that will be impacted by aircraft overflights and aircraft noise.

– **Areas between the DNL 60-65 aircraft noise contours**:

  - Disclosure statement that the home is located within an area that will be impacted by aircraft overflights and aircraft noise.
  - Incorporate acoustical treatment into all dwelling units to ensure that interior noise levels within living spaces do not exceed DNL 45.
  - Prior to issuing a zoning permit for a residential lot, owner(s) of such parcel(s) shall dedicate an avigation easement to MWAA, indicating the right of flight to pass over the property, as a means to securing the long-term economic viability of IAD.

Source: Loudoun County, Virginia, Zoning Ordinance, AI-Airport Impact Overlay District § 4-1400.

Loudoun County Zoning (continued)

Residential Limitations (continued):

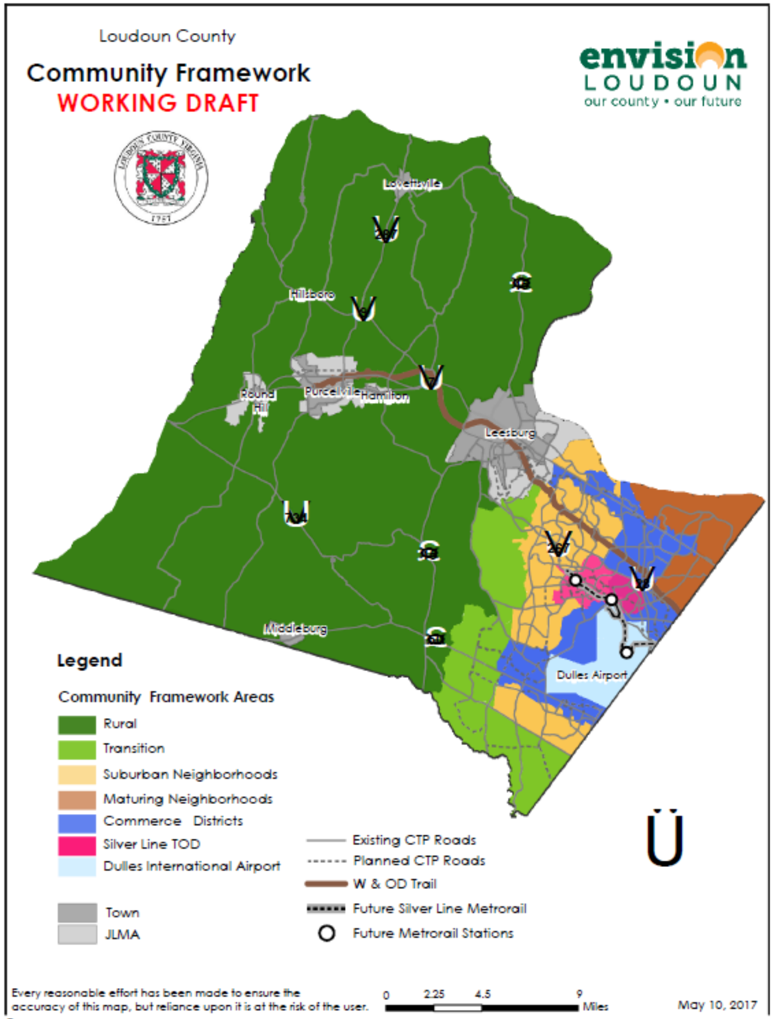
– **Areas of DNL 65 or higher aircraft noise contours**:
  - Residential units are not permitted, however;
  - New dwelling units and additions to existing may be permitted provided:
    – lot was recorded or had record plat approval prior to the effective date of adoption of this Ordinance
    – new dwelling unit or addition complies with the acoustical treatment requirements for residential districts set forth in the Virginia Uniform Statewide Building Code.

– No building or other structure shall be located in a manner or built to a height which constitutes a hazard to aerial navigation.

Source: Loudoun County, Virginia, Zoning Ordinance, AI-Airport Impact Overlay District § 4-1400.

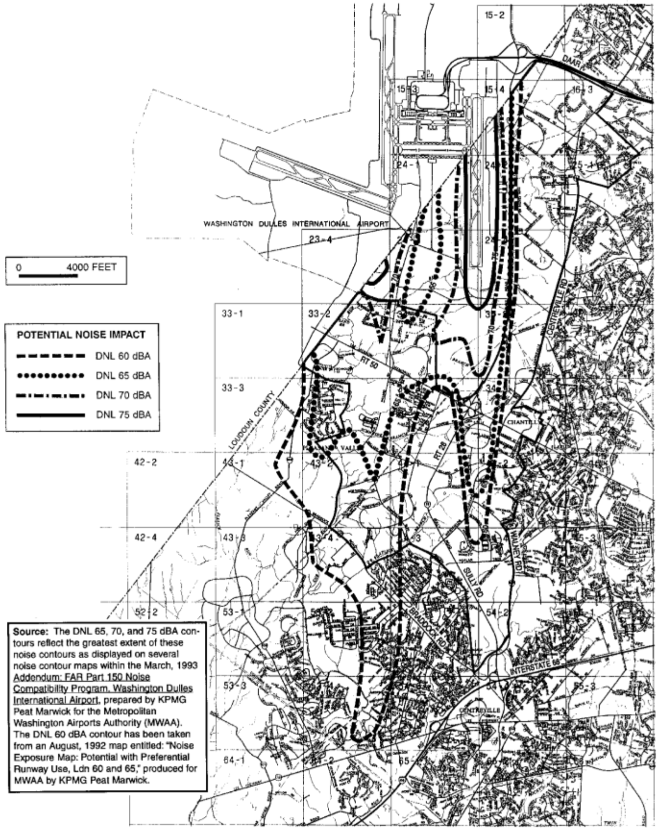
Loudoun County Zoning (continued)

- Envision Loudoun: A New Comprehensive Plan that will serve as Loudoun County government's guiding document for land use for the foreseeable future



Fairfax County Zoning

- Updated the Airport Impact Overlay District in 1993 based on largest extents of the amended FAR Part 150 Study and the potential post 2000 noise contours
- Uses airport impact overlay to define construction requirements for new residential units
- Provides compatibility table for different types of uses



Source: Fairfax County, Virginia, Zoning Ordinance, Airport Noise Impact Overlay District § 7-400.

Fairfax County Zoning (continued)

Residential Limitations:

– **Areas between the DNL 65-70 aircraft noise contours**:

Permitted only with acoustical treatment to achieve interior noise levels within living spaces that do not exceed DNL 45.

– **Areas between the DNL 70-75 aircraft noise contours**:

Permitted only with acoustical treatment to achieve interior noise levels within living spaces that do not exceed DNL 45.

– **Areas within the DNL 75 aircraft noise contours**:

- New units: Not permitted.
- Additions to existing units and new units on certain lots: permitted only with acoustical treatment to achieve interior noise levels within living spaces that do not exceed DNL 45.

Source: Fairfax County, Virginia, Zoning Ordinance, Airport Noise Impact Overlay District § 7-400.

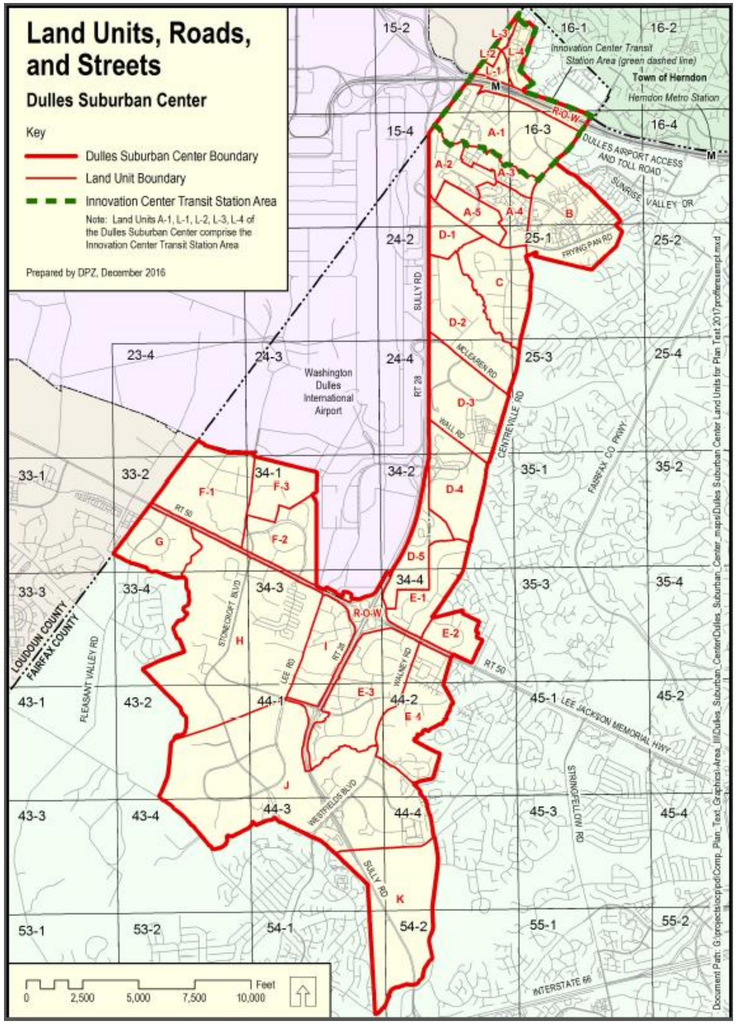
Fairfax County Comprehensive Plan

- Fairfax County's Comprehensive Plan includes land use compatibility guidelines, and is used to establish the basis for land use decisions within the designated Dulles Airport Noise Impact Area.
- Areas with projected aircraft noise exposures exceeding DNL 60 according to the Dulles Airport Noise Impact Area are not recommended.
- Where new residential development does occur near Washington Dulles International Airport, disclosure measures should be provided.
- No structure shall be located in a manner or built to a height which constitutes a hazard to aerial navigation.

Source: Fairfax County. *Fairfax County Comprehensive Plan*. "Land Use Planning within the Dulles Airport Noise Impact Area." 2017 Edition. Amended through 3/14/2017. Pages 19-23.

Fairfax County Dulles Suburban Center Study

- A land use planning study that will update recommendations for future land uses and development

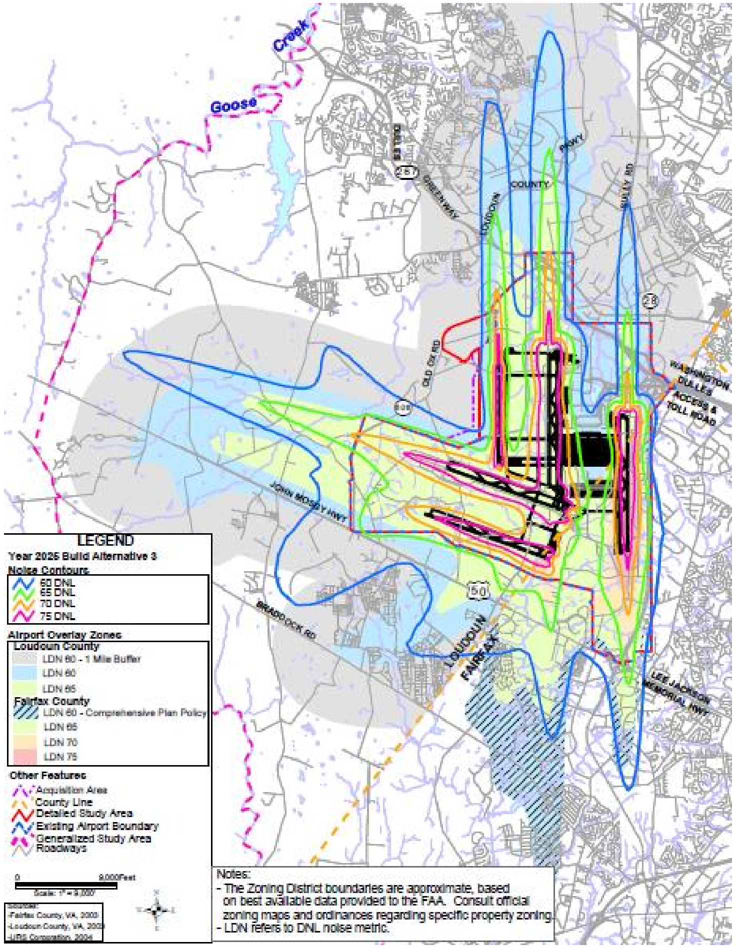


Transformation Since 1993

- 2002: FAA Potomac Terminal Radar Approach Control (TRACON) Consolidation
- 2005: FAA IAD New Runways EIS (proposed Runway 1L-19R relocation from 3,400’ to 4,300’ from 1C-19C)
- 2005: Airport Begins Acquiring 800 ac. Of Additional Property
- 2008: Runway 1L-19R opened
- 2009: NextGen Area Navigation GPS Approaches/Departures Implemented
- 2014: FAA Washington, DC Metroplex Area Navigational Procedures
- 2017: FAA Begins Implementation Of Triple Simultaneous Arrival/Departure During IFR conditions

2005 FAA EIS – Potential Aircraft Noise Contour

2025 Alternative 3 Noise Contours compared to Loudoun/Fairfax County Noise Overlays



Transformation Since 1993 (continued)

Fleet Mix:

- Up-gauging of aircraft (e.g., from 50-seat regional jets to 70- and 90-seat aircraft, from 90-seat regional jets to 737 and A-320 aircraft)
- Introduction of very large aircraft (e.g., Airbus 380 and Boeing 747-800)
- Increasing percentage of quieter Stage 4 models in the fleet mix
- Cargo operations and facilities grow

Transformation Since 1993 (continued)

- Future Enhancements:
  - Simultaneous triple parallel runway approaches during low visibility conditions or Instrument Meteorological Conditions (IMC) at IAD
  - Wake turbulence separation reduction
  - Equivalent Lateral Spacing Operations (ELSO)
  - Required Navigation Performance (RNP) based procedures

Noise Contour Map Update
Need

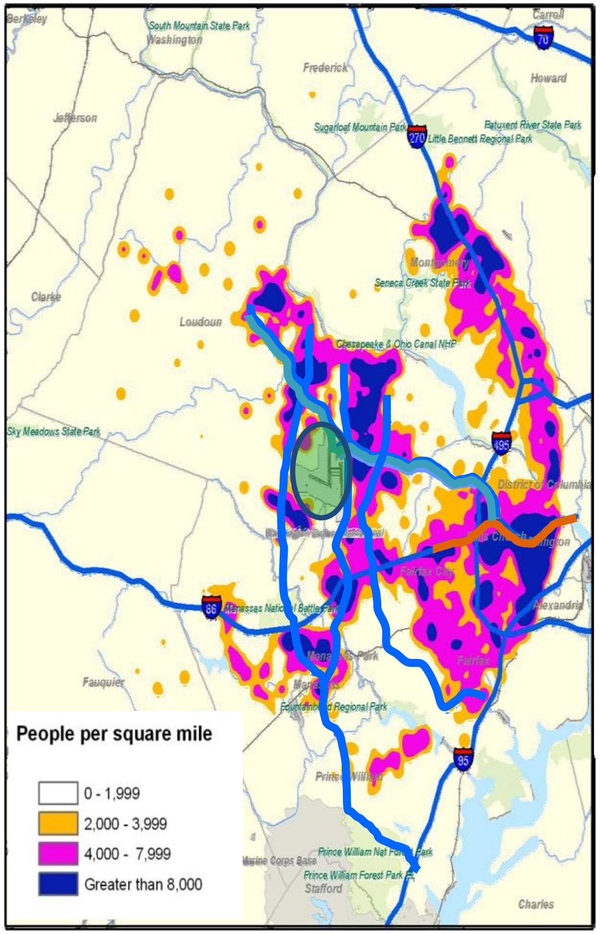
- Incorporate changes since the 1993 update critical to the region and the Airport
  - Significant Tool The Airport Uses To Assist Local Governments With Their Off-Airport Land Planning and Zoning Decisions

- Continue to ensure compatibility between the Airport and local jurisdictional land use

Changes to Incorporate

- New FAA procedures allow for simultaneous use of triple parallel runways during low visibility conditions
- Flight tracks due to NextGen enhancements
- Capacity improvements due to NextGen
- Airfield layout
- Changes in forecast Airport development related aircraft activity

Regional Population Growth - 2040



1970
1980
1990
2000
2010
2020
2030
2040

Regional Population Growth - 2045

Table 3: Round 9.0 Econometric Model Results – Total Population and Heads of Households (Thousands)

	2015	2020	2025	2030	2035	2040	2045
Total Population	5,486.5	5,793.6	6,043.6	6,274.3	6,488.7	6,686.6	6,888.4
Heads of Households	2,009.4	2,146.2	2,276.2	2,400.2	2,519.6	2,642.7	2,775.4

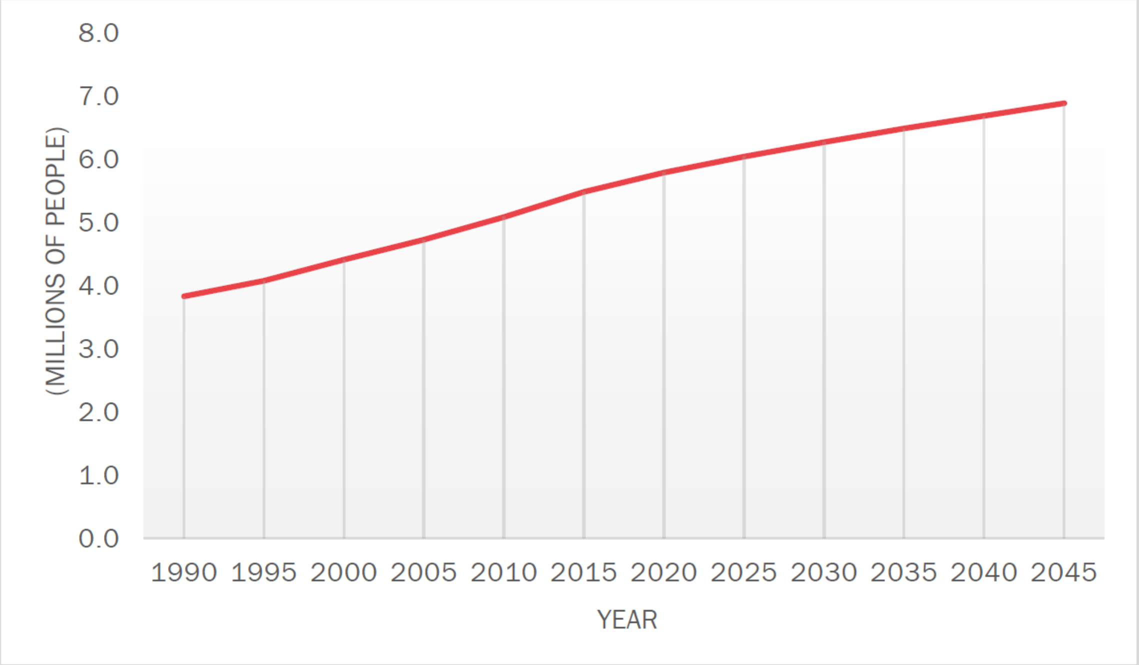


Figure 5: Historic and Forecast Population, 1990 to 2045

Source: Table 3 and Figure 5 exert from Metropolitan Washington Council of Governments. *Growth Trends to 2045-Cooperative Forecasting in Metropolitan Washington*. November 2016.

Regional Population Forecasted Growth by Jurisdiction

Counties/Cities served by IAD

Figure 14: Percent Change in Population Growth by Jurisdiction, 2015 to 2045

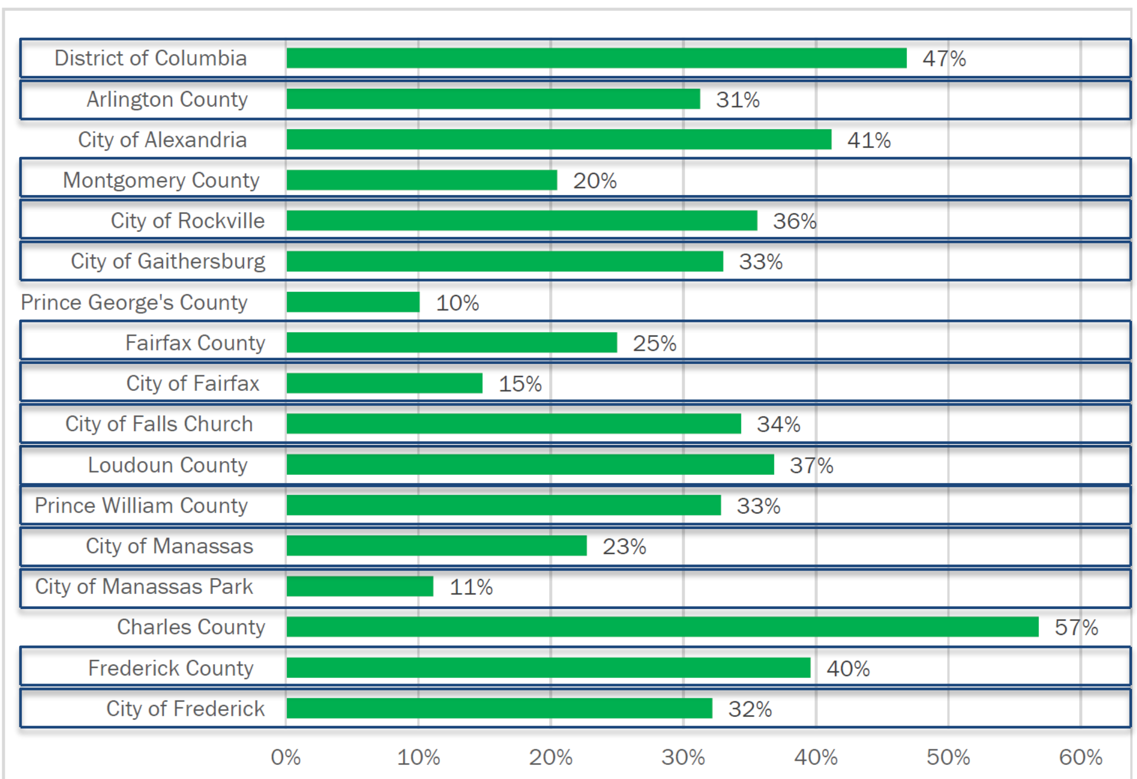
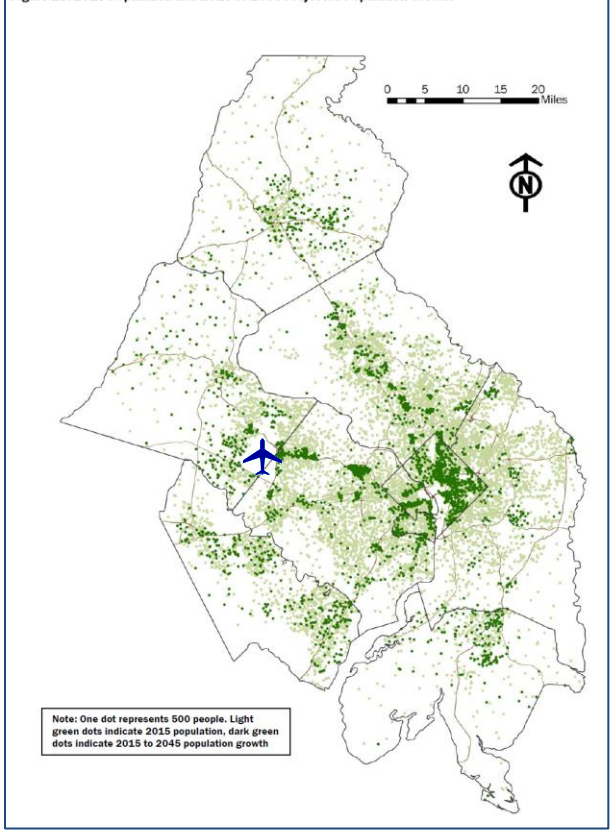


Figure 15: 2015 Population and 2015 to 2045 Projected Population Growth



Source: Figure 14 and 15 exert from Metropolitan Washington Council of Governments. *Growth Trends to 2045-Cooperative Forecasting in Metropolitan Washington*. November 2016. Jurisdictions served by IAD based on Metropolitan Washington Council of Governments. *Washington-Baltimore Regional Air Passenger Survey Geographic Findings – 2015*. November 2016.

IAD Air Service Growth in Region

Washington Airports Overview

WASHINGTON
WHERE BUSINESS AND GOVERNMENT CONNECT

Dulles International Leads Washington Airports in New Domestic Destinations

● Existing Destinations By Airline

🔴 New Airline Destination Service in 2014

AA – American
AS - Alaska
B6 – JetBlue
DL – Delta
F9 – Frontier
NK – Spirit
UA – United
VX – Virgin America

	IAD (21 New)					DCA (15 New)					BWI (6 New)		
Market	UA	F9	WN	DL	AA	AA	DL	WN	B6*	VX	WN	NK	AS
Akron/Canton						●		🔴					
Atlanta	●	🔴		●			●	●			●		
Charleston, SC	●					●			🔴		●		
Charlotte	●	🔴			●	●					●		
Chicago Midway			●					🔴			●		
Chicago O'Hare	●	🔴				●						🔴	
Cincinnati	●	🔴				●	●						
Cleveland	●	🔴				●					●		
Dallas Love Field								🔴		🔴	🔴		
Detroit	●	🔴		●		●	●				●		
Fort Lauderdale		🔴				●			●		●	●	
Fort Myers		🔴				●		●			●		
Hartford	●					●			🔴		●		
Indianapolis	●					●		🔴			●		
Jacksonville	●	🔴				●			🔴		●		
Kansas City	●					●		🔴			●		
Las Vegas	●	🔴	🔴			●					●	●	
Madison						●	🔴				●		
Memphis		🔴				●	●				●		
Minneapolis/St Paul	●	🔴		●		●	●					🔴	
Nashville	●					●		🔴			●		
New Orleans	●					●		🔴			●		
Oakland											🔴		
Omaha						●	🔴						
Orlando	●	🔴				●			●		●		
Portland, OR	●										🔴		
San Diego	●		🔴								●		
Seattle	●										●		🔴
St Louis	●	🔴				●		●			●		
St Augustine		🔴											
Tampa	●	🔴				●		🔴	●		●		
West Palm		🔴				●					●		
Cancun	●	🔴									●		
Nassau, Bahamas		🔴				●			🔴		●		

Source: June-Dec 2014 vs. June-Dec 2013, Innovata Schedules via Diio online portal

7

Source: Presentation from Metropolitan Washington Airports Authority, Office of Air Service and Planning. *2015 Air Service Development Industry and Community Briefing*. November 2014.

IAD Air Service Growth in Region
New Domestic Service in 2018

UNITED

April 3: Twice daily service to Shenandoah Valley, VA.
April 4: Three times weekly service to Greenbrier, WV.
April 9: Twice daily service to Wilmington, NC.
All on 50 seat regional jets.

FRONTIER

April 8: Resume seasonal daily nonstop service to Colorado Springs on a 150 seat Airbus A319 & Denver on a 180 seat Airbus A320.
April 11: Starts twice weekly service to Tulsa, OK on a 150 seat Airbus A319

IAD Air Service Growth in Region
New International Service in 2018

UNITED

May 23: New seasonal daily service to Edinburgh, Scotland on a 169 seat Boeing 757.

AIR CANADA

May 1: Starts additional daily flight to Montreal, Canada on a 50 seat regional jet.

volaris

May 17: Twice weekly service from Dulles International to San Salvador, El Salvador with continuing service to San Jose, Costa Rica on a 144 seat Airbus A319.

CopaAirlines

June 10: Will start to operate its third daily flight on a year-round basis using a 154 seat Boeing 737.

Primera Air

August 22: Five times weekly service from Dulles International to London, Stansted Airport on a 200 seat Airbus A321

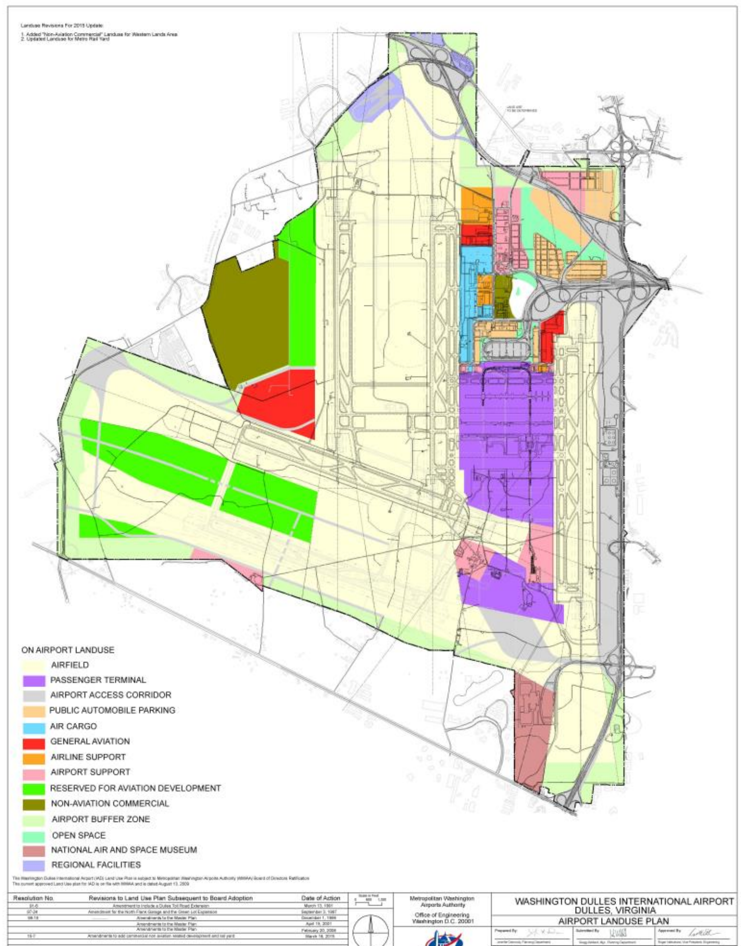
CATHAY PACIFIC

September 16: Four weekly flights between Dulles International and Hong Kong on a 334 seat Airbus A350.

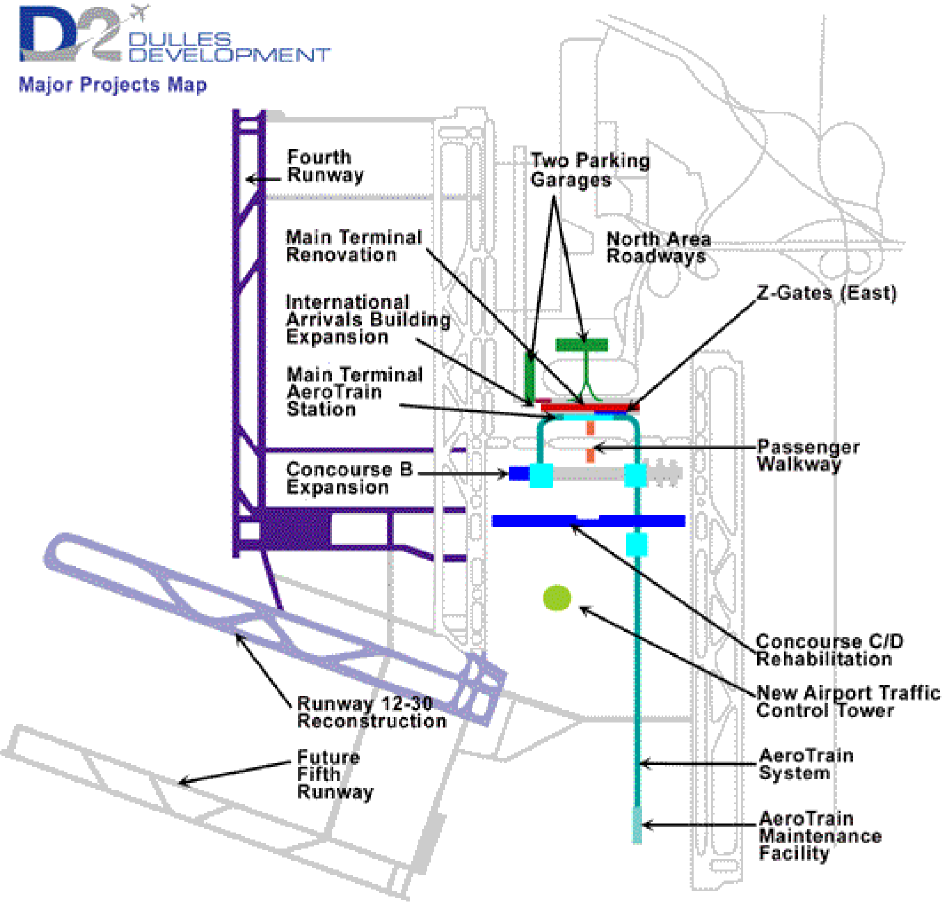
Major Surface Access Improvements In Vicinity of IAD

Source: Roadway improvements based on Virginia Department of Transportation, accessed March 31, 2018. http://www.virginiadot.org/projects/northern%20virginia/default.asp. North-south corridor based on State of Virginia, Office of Intermodal Planning and Investment. Northern Virginia North-South Corridor. Accessed 4/2/2018. http://www.vtrans.org/northern_virginia_north-south_corridor.asp. Bi-County Parkway based on Virginia Department of Transportation. Bi-County Parkway Aerial Maps for Community Meetings. Accessed 4/2/2018. http://www.virginiadot.org/projects/resources/NorthernVirginia/Bi_County/BCP_AerialMapsforCommunityMtgs_08142013.pdf. Silver Line Phase 2 based on Silver Line rail map accessed March 31, 2018. http://dullesmetro.com/silver-line-stations/.

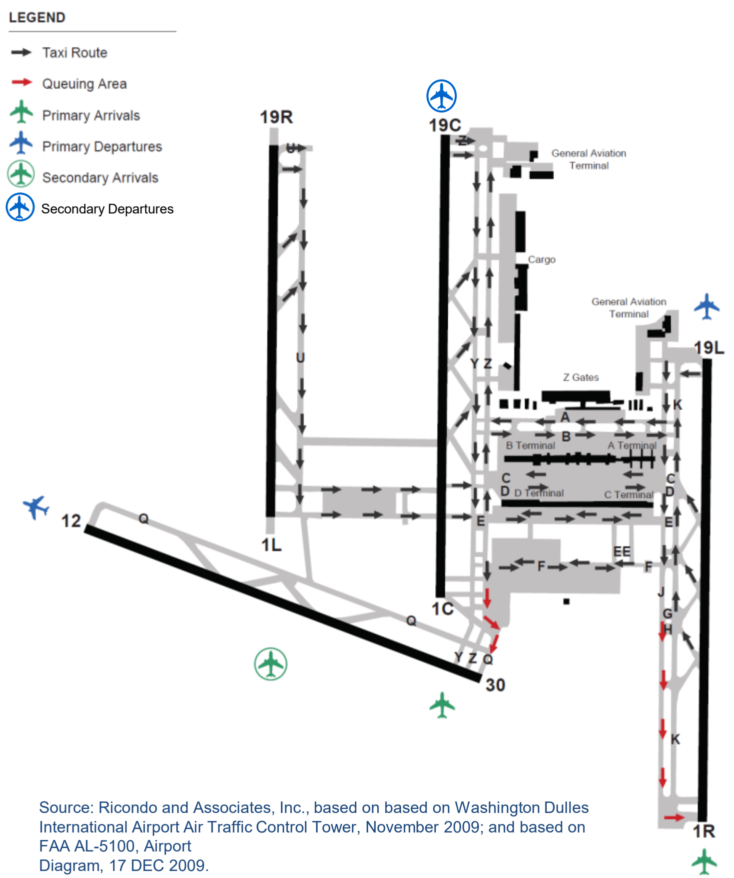
Dulles Airport
On-Airport Land Use



Dulles Airport
Capital Improvement Program

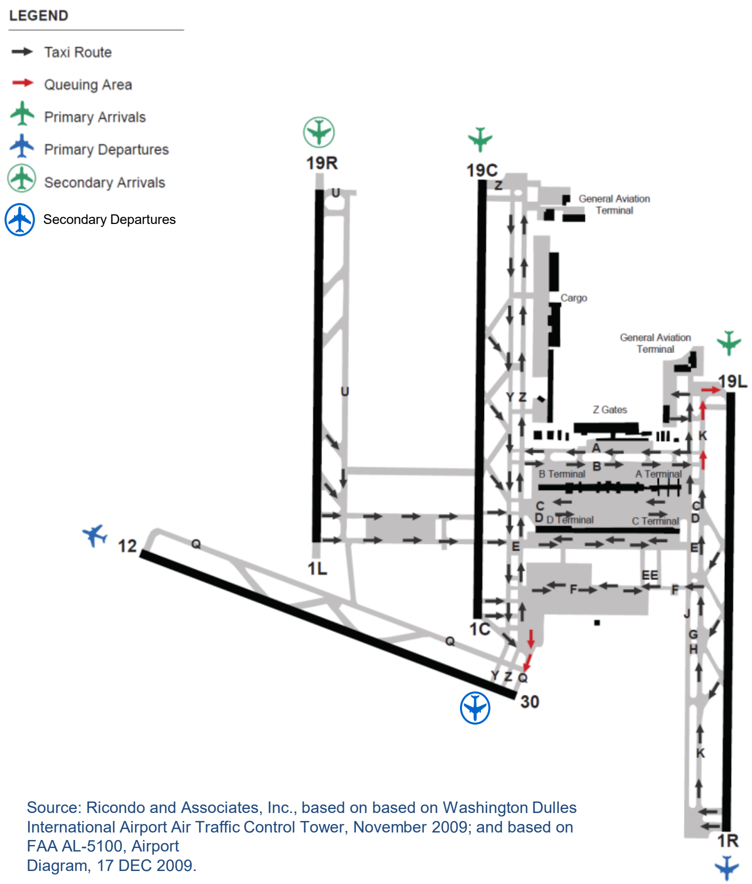


Dulles Airport
Primary Runway Operating Configurations



Source: Ricondo and Associates, Inc., based on based on Washington Dulles International Airport Air Traffic Control Tower, November 2009; and based on FAA AL-5100, Airport Diagram, 17 DEC 2009.

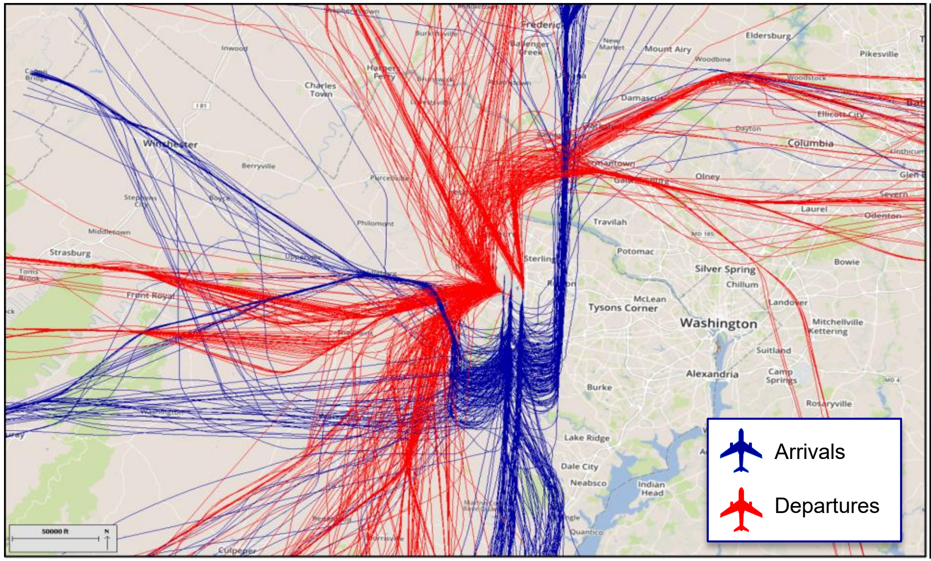
North Flow



Source: Ricondo and Associates, Inc., based on based on Washington Dulles International Airport Air Traffic Control Tower, November 2009; and based on FAA AL-5100, Airport Diagram, 17 DEC 2009.

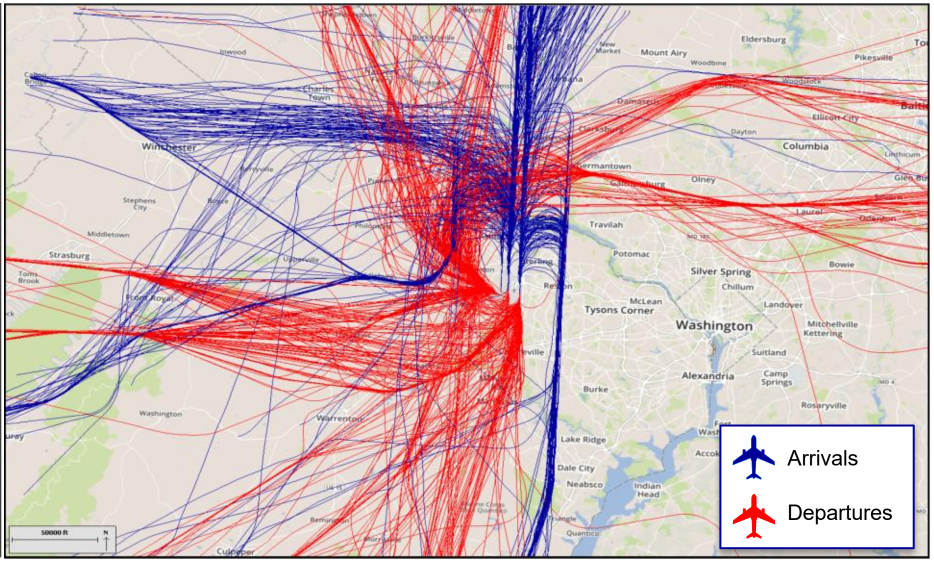
South or Mixed Flow

Dulles Airport Traffic Patterns



Source: "Dulles International - Aircraft Procedures & Guidelines." Metropolitan Washington Airport Authority. Accessed March 28, 2018. http://www.flydulles.com/iad/dulles-international-aircraft-procedures-guidelines.

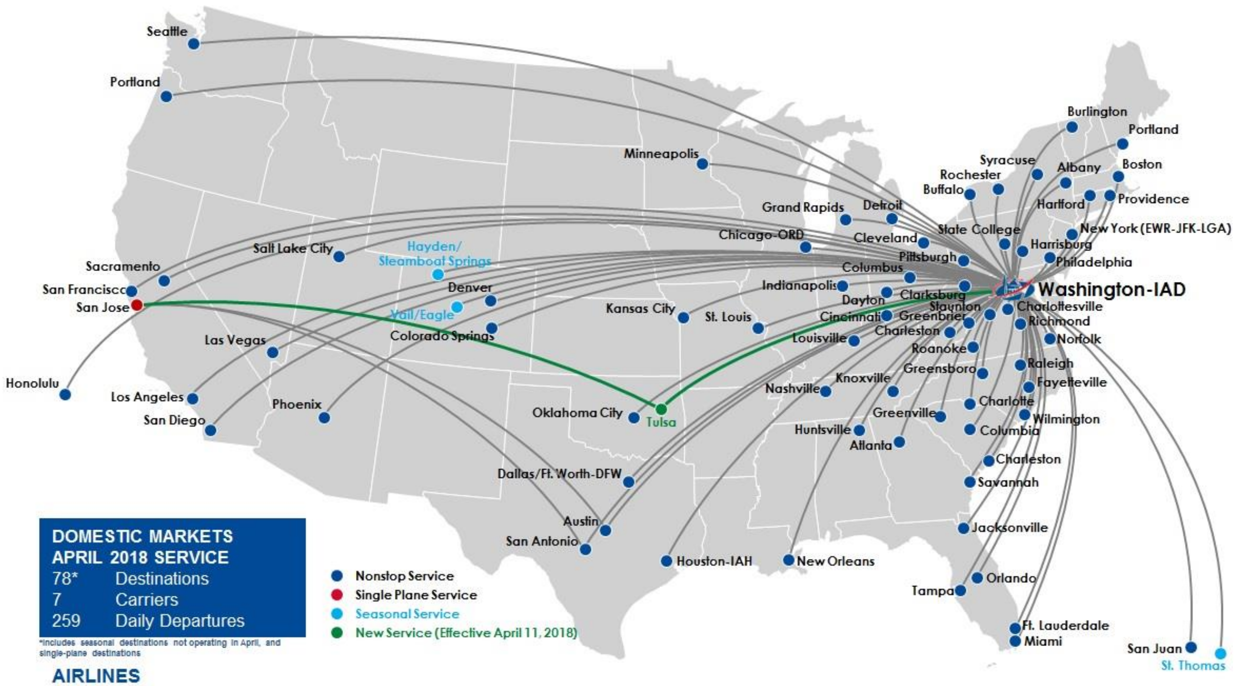
North Flow



Source: "Dulles International - Aircraft Procedures & Guidelines." Metropolitan Washington Airport Authority. Accessed March 28, 2018. http://www.flydulles.com/iad/dulles-international-aircraft-procedures-guidelines.

South or Mixed Flow

Dulles Airport
Air Service Domestic Destinations



DOMESTIC MARKETS
APRIL 2018 SERVICE

78*	Destinations
7	Carriers
259	Daily Departures

*Includes seasonal destinations not operating in April, and single-plane destinations

AIRLINES

Alaska/Virgin America
American
Delta
Frontier
JetBlue
Southwest
United

Source: Innovata Airline Schedules (February 2018 – January 2019), via Diio MI Online Portal as of February 5, 2018.

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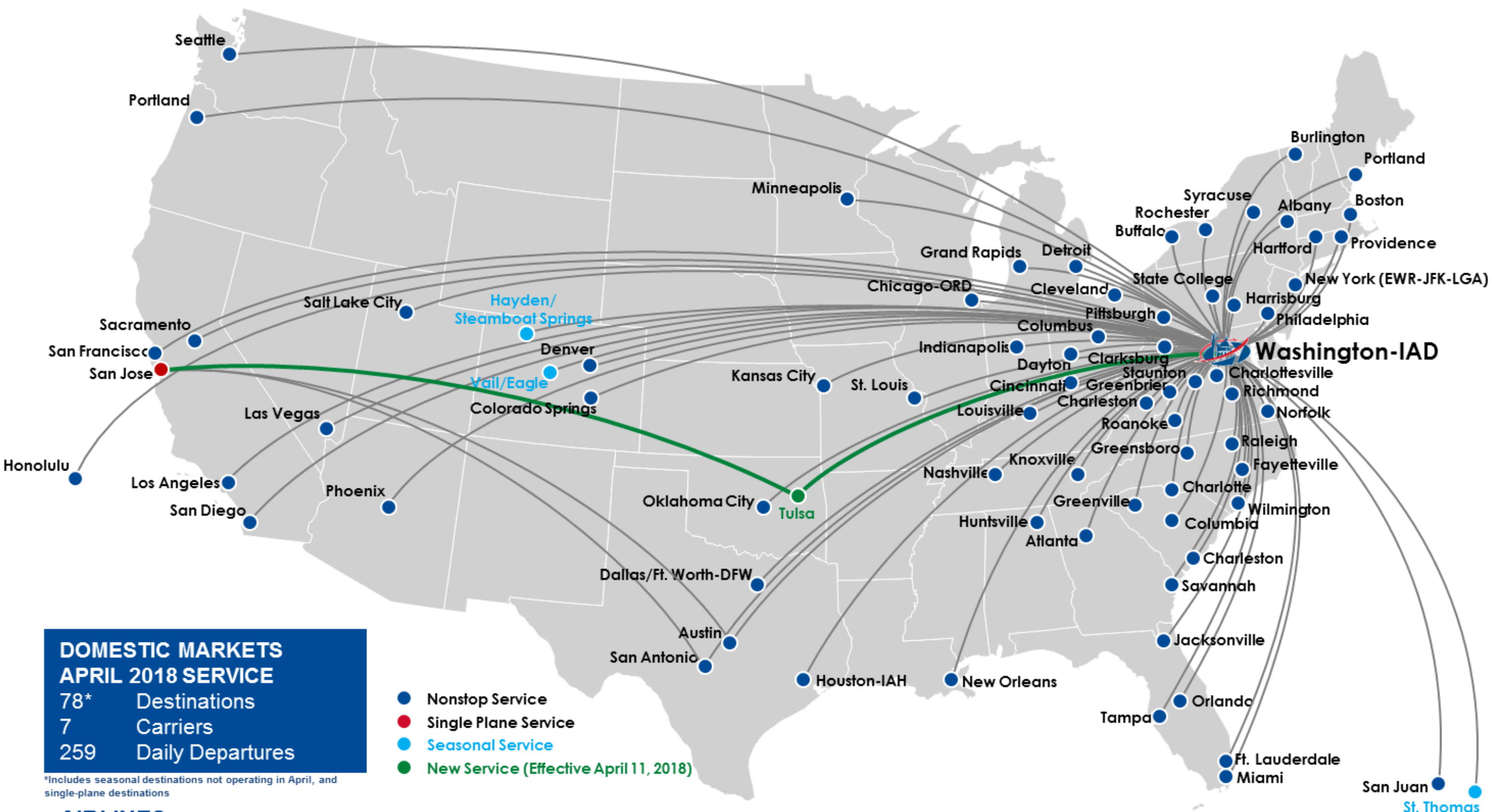
Dulles Airport
Air Service Domestic Destinations



DOMESTIC MARKETS
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259	Daily Departures

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American
Delta
Frontier
JetBlue
Southwest
United

Source: Innovata Airline Schedules (February 2018 – January 2019), via Diio MI Online Portal as of February 5, 2018.

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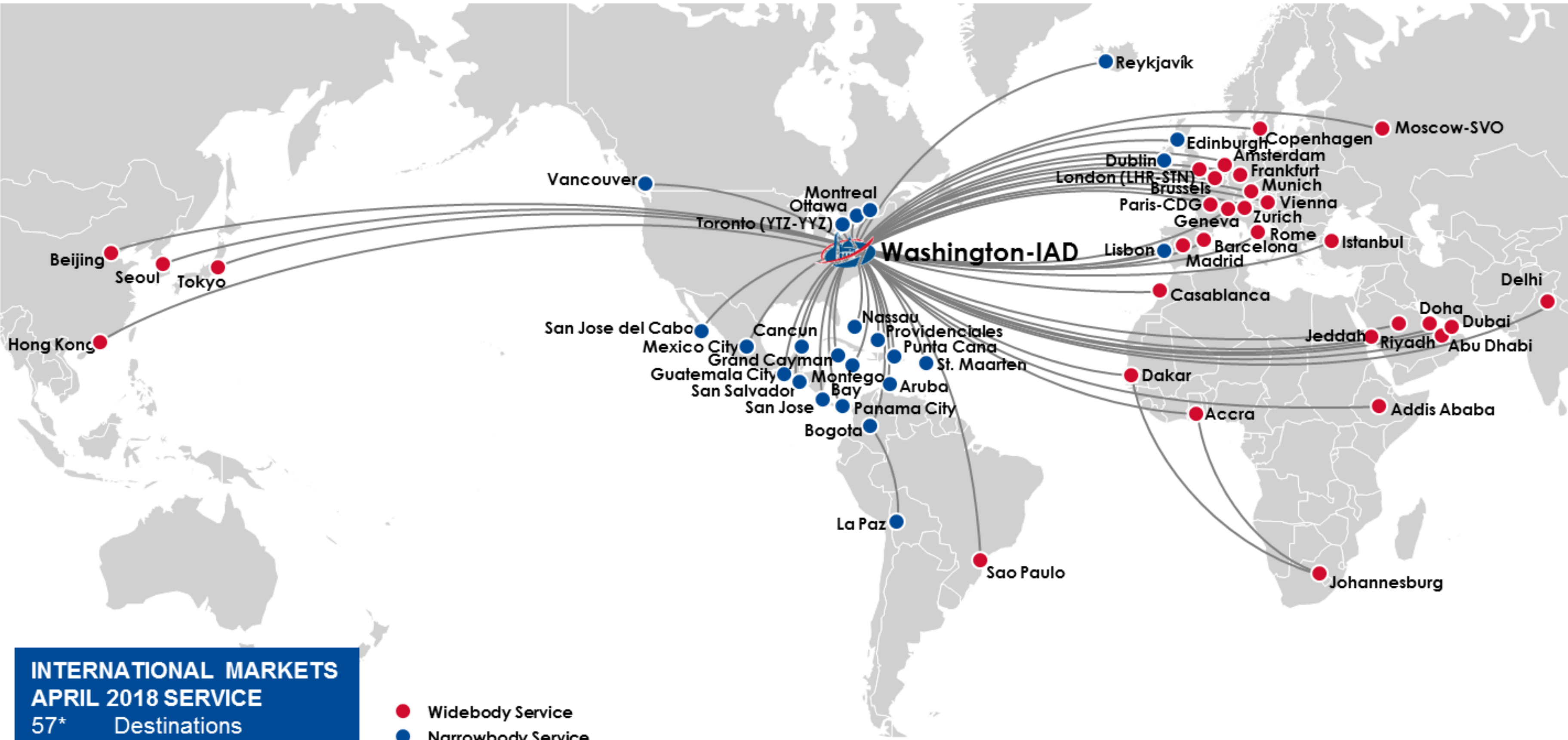
Dulles Airport
Air Service International Destinations



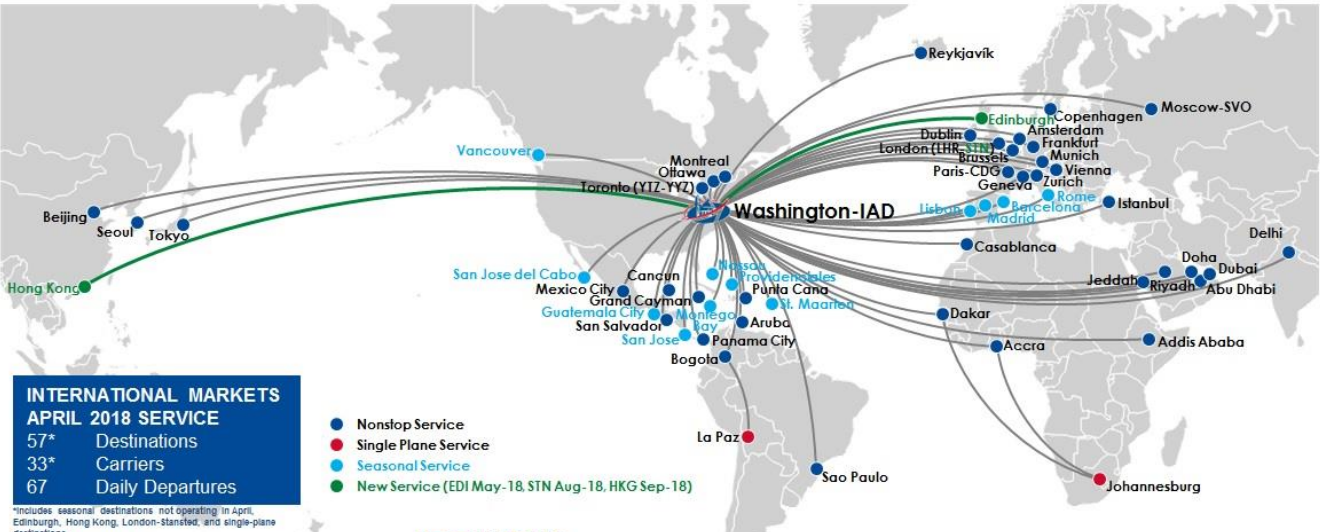
INTERNATIONAL MARKETS APRIL 2018 SERVICE

57*	Destinations
33*	Carriers
67	Daily Departures

*Includes seasonal destinations not operating in April, Edinburgh, Hong Kong, London-Stansted and single-plane destinations

Source: Innovata Airline Schedules (February 2018 – January 2019), via Diio MI Online Portal as of February 5, 2018.

Dulles Airport
Air Service International Destinations



AIRLINES

Aer Lingus
Aeroflot
Aeromexico
Air Canada
Air China
Air France
Air India
All Nippon
Austrian
Avianca
British Airways
Brussels Airlines
Cathay Pacific
Copa Airlines
Delta
Emirates
Ethiopian
Etihad
Icelandair
KLM
Korean Air
Lufthansa
Porter
Primera Air
Qatar Airways
Royal Air Maroc
SAS
Saudia
South African
Turkish Airlines
United
Virgin Atlantic
Volaris

DESTINATIONS

Abu Dhabi
Accra
Addis Ababa
Amsterdam
Aruba
Barcelona
Beijing
Bogota
Brussels
Cancun
Casablanca
Copenhagen
Dakar
Delhi
Doha
Dubai
Dublin
Edinburgh
Frankfurt
Geneva
Grand Cayman
Guatemala City
Hong Kong
Istanbul
Jeddah
Johannesburg
La Paz
Lisbon
London - LHR
London - STN
Madrid
Mexico City
Montego Bay
Montreal
Moscow
Munich
Nassau
Ottawa
Panama City
Paris
Providenciales
Punta Cana
Reykjavik
Riyadh
Rome
Saint Maarten
San Jose
San Jose Del Cabo
San Salvador
Sao Paulo
Seoul
Tokyo
Toronto - YYZ
Toronto - YTZ
Vancouver
Vienna
Zurich

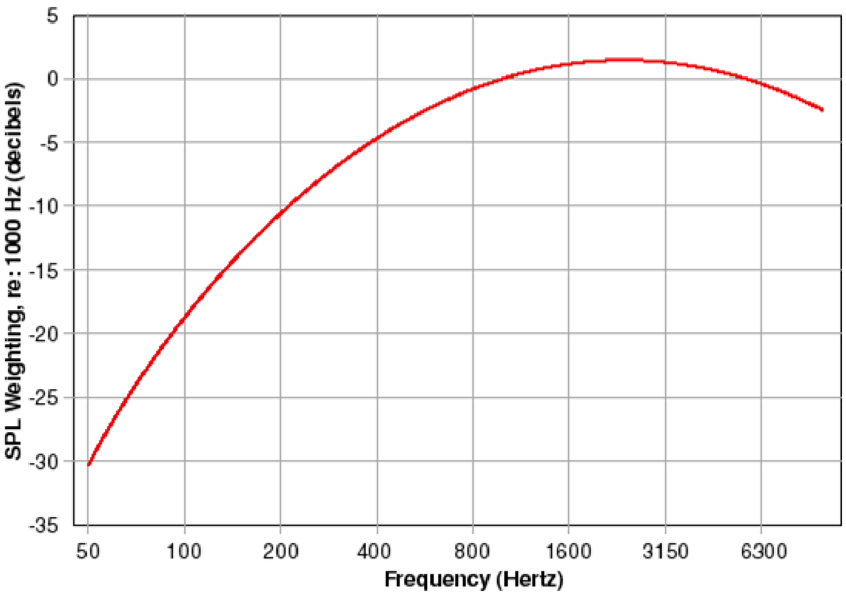
Source: Innovata Airline Schedules (February 2018 – January 2019), via Diio MI Online Portal as of February 5, 2018.

Aircraft Noise Overview – Noise Terminology

- A-Weighted Decibel, dBA
- Maximum A-Weighted Sound Level, Lmax
- Sound Exposure Level, SEL
- Equivalent Sound Level, Leq
- Day-Night Average Sound Level, DNL

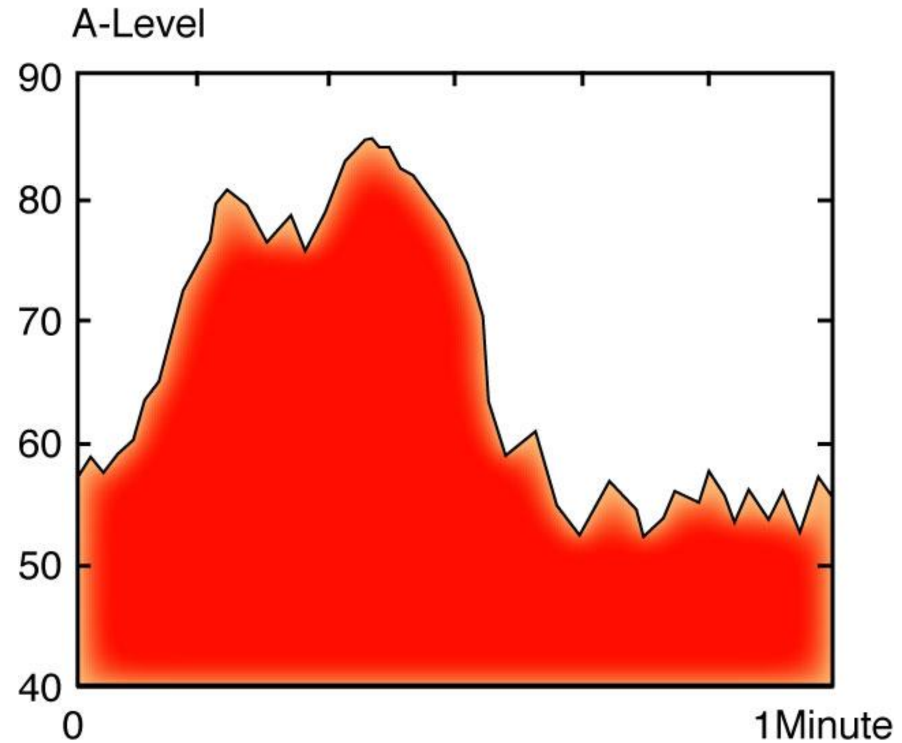
Aircraft Noise Overview – A-Weighted Sound Level

- The human auditory system is not equally sensitive to all frequencies
- To be a useful environmental analysis tool we need a way to measure sound the same way the ear hears it
- The A-weighted sound level achieves this goal
- Correlates well to human perception of noisiness
- The EPA has adopted the A-weighted sound level for environmental analyses



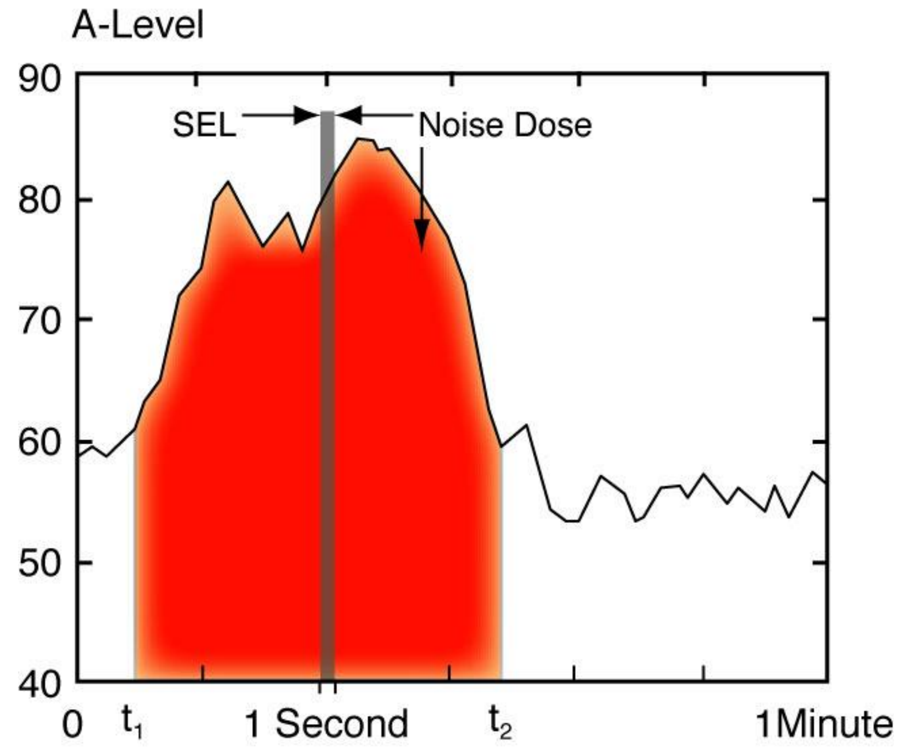
Aircraft Noise Overview – Maximum Sound Level (Lmax)

- Because of the variation in level of a sound event, it is often convenient to describe the event with its maximum sound level, abbreviated as Lmax
- Accounts only for sound amplitude (A-weighted sound level)
- Two events may have the same maximum level, but much different exposures



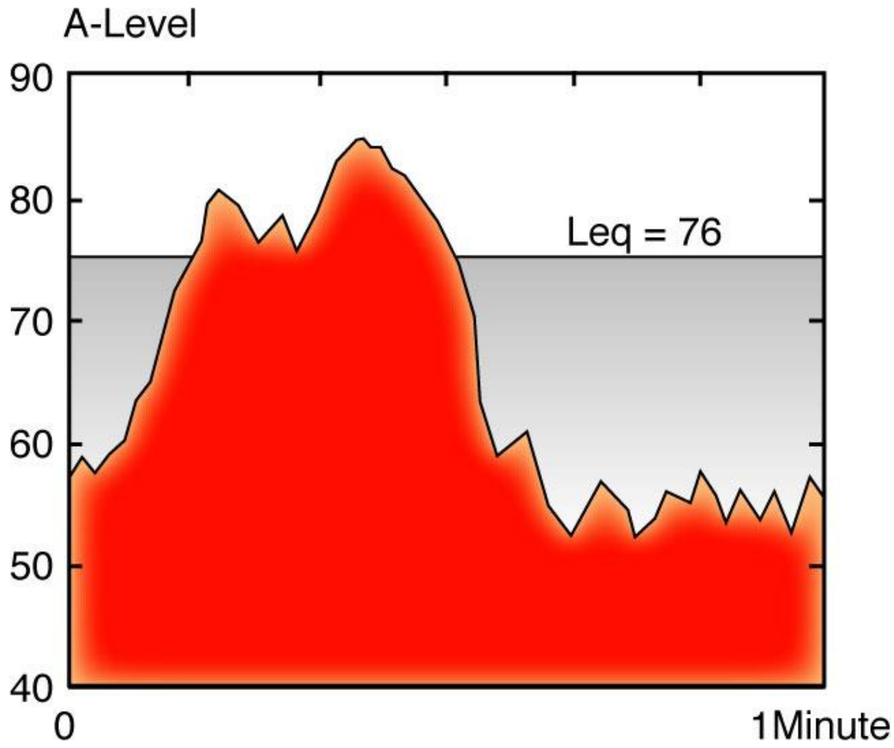
Aircraft Noise Overview – Sound Exposure Level (SEL)

- A way to describe the "noisiness" of a complete noise event
- Accounts for sound amplitude (A-weighted sound level)
- Accounts for noise event duration



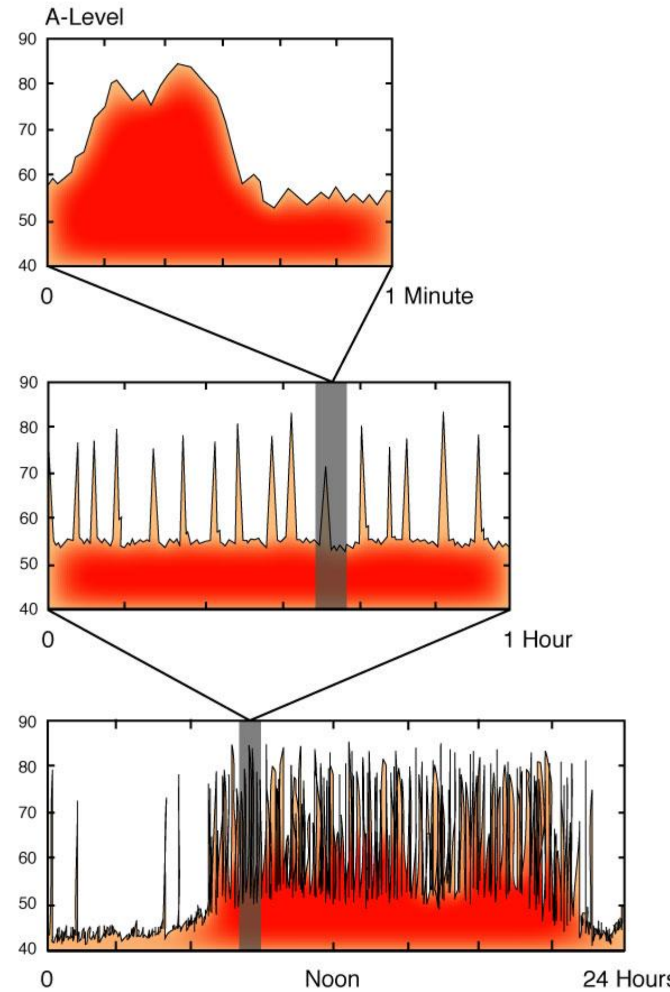
Aircraft Noise Overview – Equivalent Sound Level (Leq)

- A constant sound level “equivalent” on an energy basis of a time varying sound level over the same time period
- Leq is time-averaged
- Accounts for sound amplitude and time



Aircraft Noise Overview – Day/Night Average Noise Level (DNL)

- A way to describe the noise dose for a 24-hour period
- Accounts for noise event "noisiness" (SEL)
- Accounts for number of noise events
- Provides an additional weighting factor of 10 dB for nighttime (10:00 pm to 6:59 am) operations
  - 1 nighttime noise event is equivalent to 10 daytime noise events



Aircraft Noise Overview - How is Aircraft Noise Quantified?

- FAA specifies DNL metric to assess aircraft noise impacts
  - Title 14 CFR Part 150, Airport Noise Compatibility Planning
  - FAA Order 1050.1F, Environmental Impacts: Policies and Procedures
- Environmental Protection Agency (EPA) specified DNL for community noise and airport noise assessments
- DNL accounts for higher sensitivity to noise in the nighttime
- Found to correlate with percentage of highly annoyed by transportation noise

Aircraft Noise Overview - How is Aircraft Noise Quantified?

- DNL calculated based on average annual day operations (AAD)
- AAD represents the average aircraft operations and patterns that occurred over a consecutive 12-month period
  - Accounts for all operations and patterns and the frequency of occurrence within 12 months
  - Accounts for average weather conditions within 12 months
- DNL is calculated using the FAA's aircraft noise mode AEDT

AEDT Overview
Background

- The Aviation Environmental Design Tool (AEDT)
  - Version 2d was released in September 2017
  - Replaced
    - Integrated Noise Model (INM – airport noise)
    - Emissions and Dispersion Modeling System (EDMS)
    - AEDT version 2b / Noise Integrated Routing System (NIRS)
  - FAA tool for computation of
    - Noise
    - Emissions
    - Air Quality
    - Fuel Burn

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APRIL 20, 2018 – AIRFIELD CONFIGURATION, ANNUAL SERVICE VOLUME (ASV) METHODOLOGY AND NOISE MODEL DEVELOPMENT METHODOLOGY

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Washington Dulles International Airport (IAD) Aircraft Noise Overlay Update

Scenario Development

2nd Working Group Briefing

For Publication on MWAA Website

4/20/18

Meeting Purpose

- Discuss airfield activity scenarios to model in the Airport Environmental Decision Tool (AEDT)
- Discuss methodology to calculate ultimate operational activity input into the AEDT

Agenda

- Study Purpose
- Background
- Discussion
  - Scenario Identification
  - Annual Service Volume (ASV)
  - Potential Fleet Mix
  - Potential Operations By Time Of Day
- Conclusion
- Project Timeline/Next Steps

Study Purpose

Update the Dulles Airport noise contour map to incorporate changes in the aviation environment so that the future vision reflects these changes:

- Flight tracks and overall utility of the airfield have evolved
- Evolution will continue with implementation of NextGen
- Flight procedures will soon allow for triple simultaneous runway operations during low visibility conditions (IFR)
- Airport operational forecast changes

Background

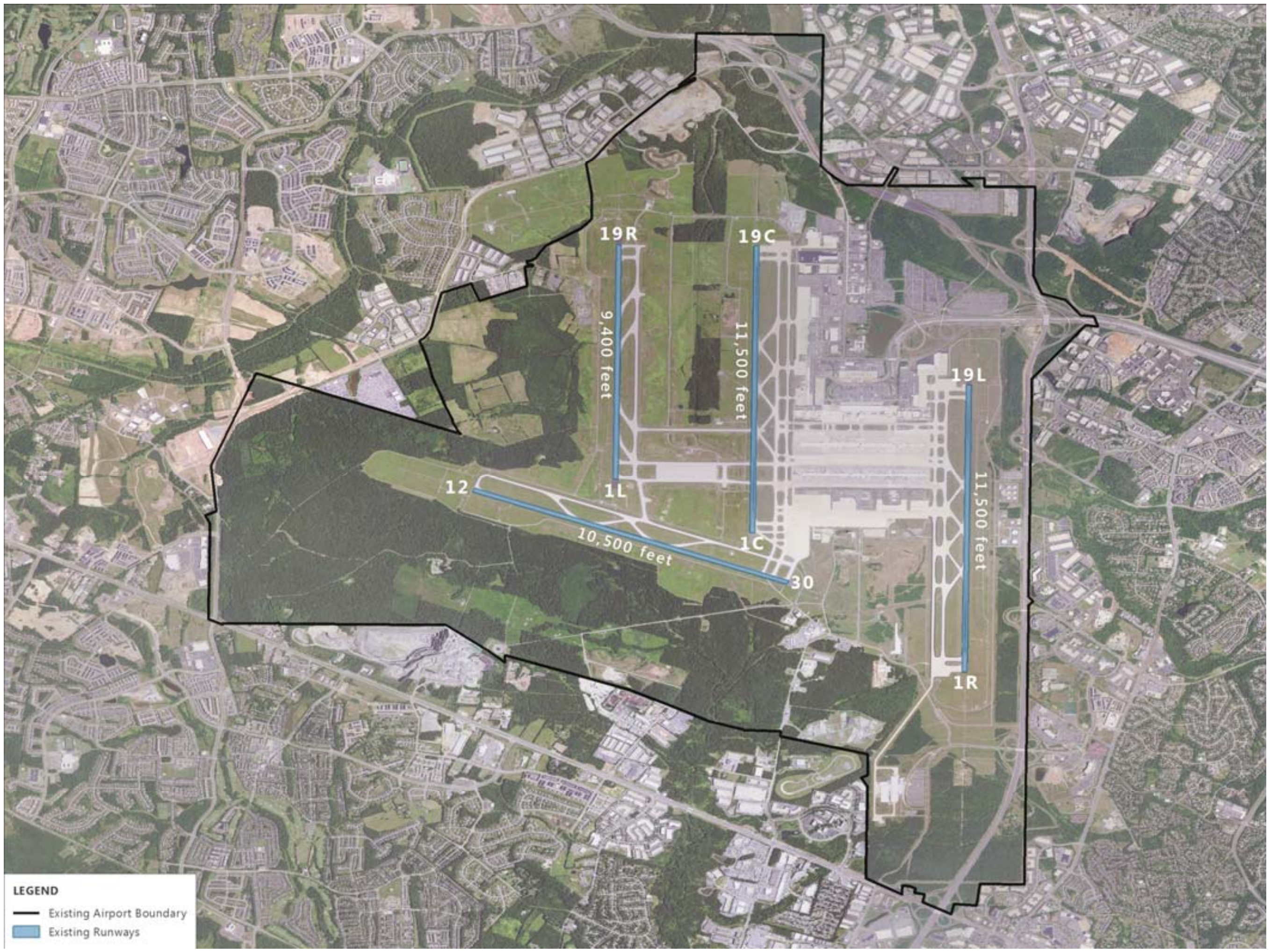
New Noise Contours Maps will:

- incorporate changes since the 1993 update critical to the region and the Airport
  - Significant tool the airport uses to assist local governments with their off-Airport land planning and zoning decisions
- continue to ensure compatibility between the Airport and local jurisdictional land use and ensure local jurisdictions have the latest information available to make land use decisions
- be based on Ultimate Build Scenarios

Discussion
Scenario Identification

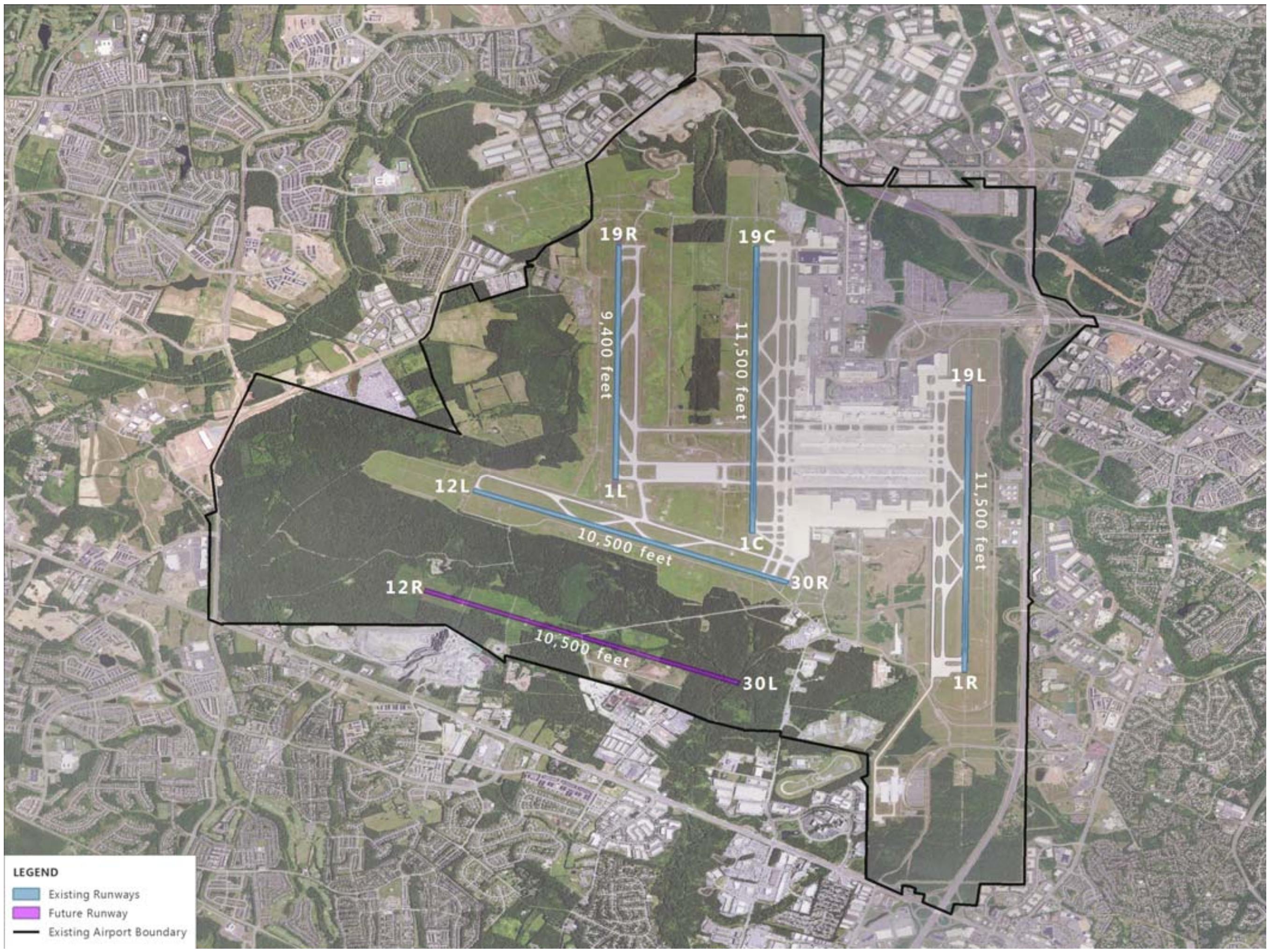
- Identify up to three scenarios reflecting ultimate runway capacity for:
  - Current four-runway airfield
  - Future five-runway full-build airfield
- Account for increased nighttime activity including passenger and air cargo aircraft
- Consider future locations for on-Airport development
- Develop various future runway use scenarios to ensure recommended overlays include areas potentially affected by long-term aircraft noise exposure

Discussion – Scenario Identification
Current 4-Runway Configuration



Source: aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016

Discussion - Scenario Identification
Future 5-Runway Configuration

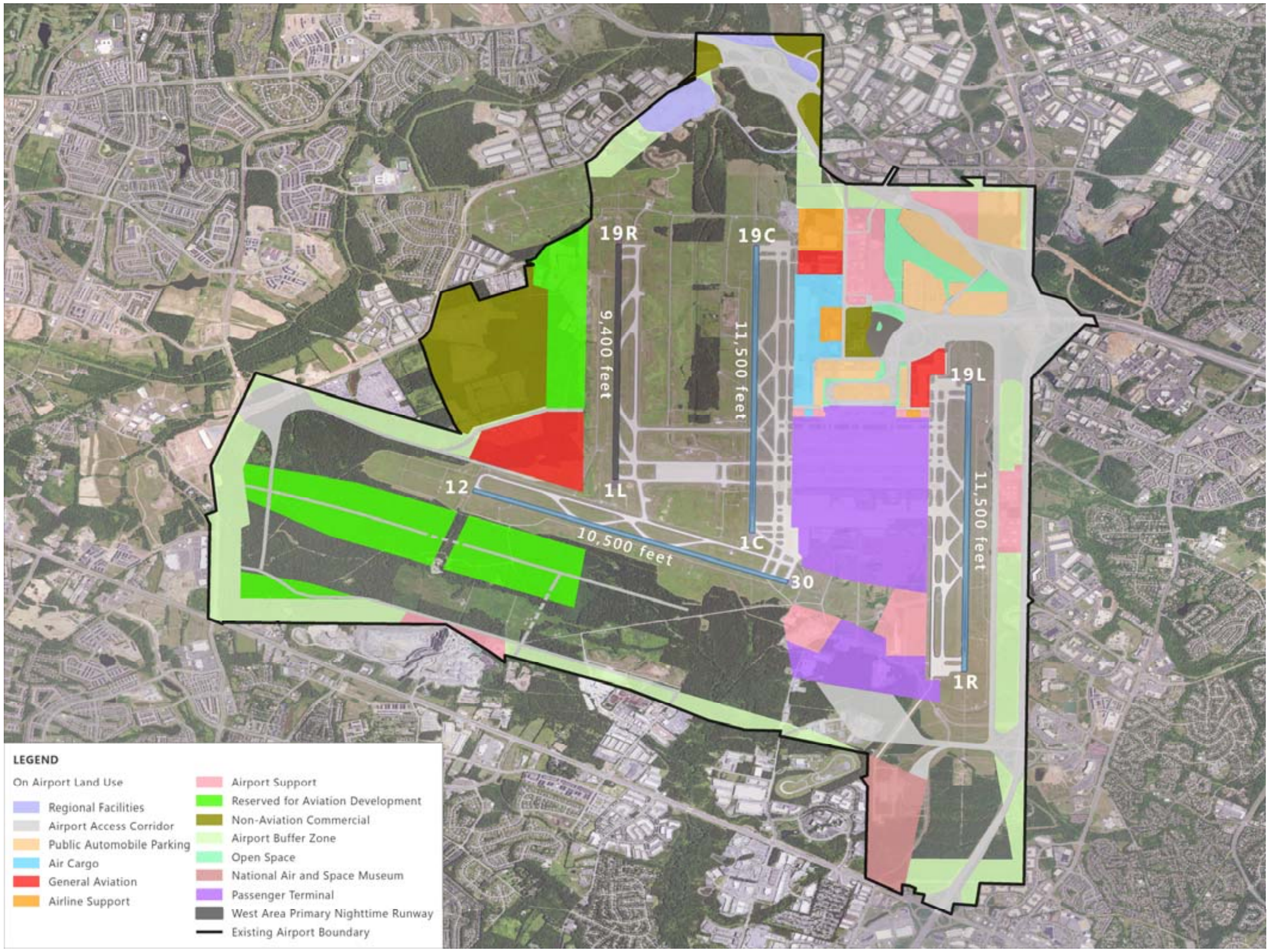


Source: aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016; new runway: MWAA, April 2018.

Discussion - Scenario Identification
Recommended Scenarios

- Scenario 1
  - Four-runway airfield
  - Most effective use of runways during daytime
  - Runway 1L-19R operational efficiency utilization for nighttime activity
- Scenario 2
  - Five-runway airfield
  - Most effective use of runways during daytime
  - Runway 1C-19C operational efficiency utilization for nighttime activity
- Scenario 3
  - Five-runway airfield
  - Most effective use of runways during daytime
  - Runway 12L-30R operational efficiency utilization for nighttime activity

Discussion Scenario Identification - Scenario 1

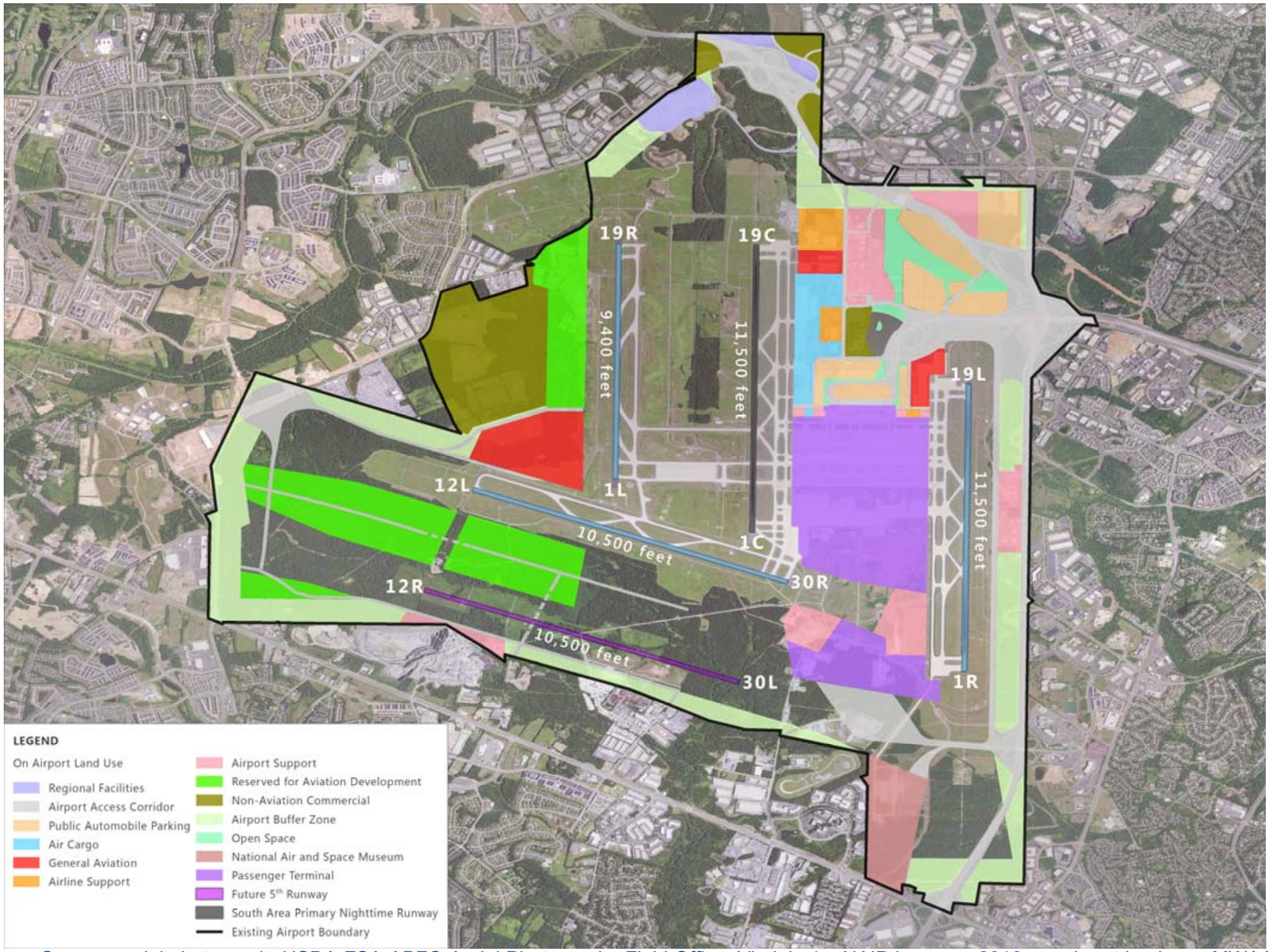


Source: aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016; on-airport land use: MWAA, April 2018

Discussion – Scenario Identification
Scenario 1

- Four-runway configuration
- Most effective runway use for safe and efficient operations during daytime periods
- Reflects primary runway use associated with on-Airport development west of Runway 1L-19R during nighttime periods

Discussion – Scenario Identification
Scenario 2



Source: aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016; on-airport land use: MWAA, April 2018; new runway: MWAA, April 2018.

Discussion – Scenario Identification
Scenario 2

- Five-runway configuration
- Most effective runway use for safe and efficient operations during daytime periods
- Reflects primary runway use associated with on-Airport development south of the existing terminal during nighttime periods

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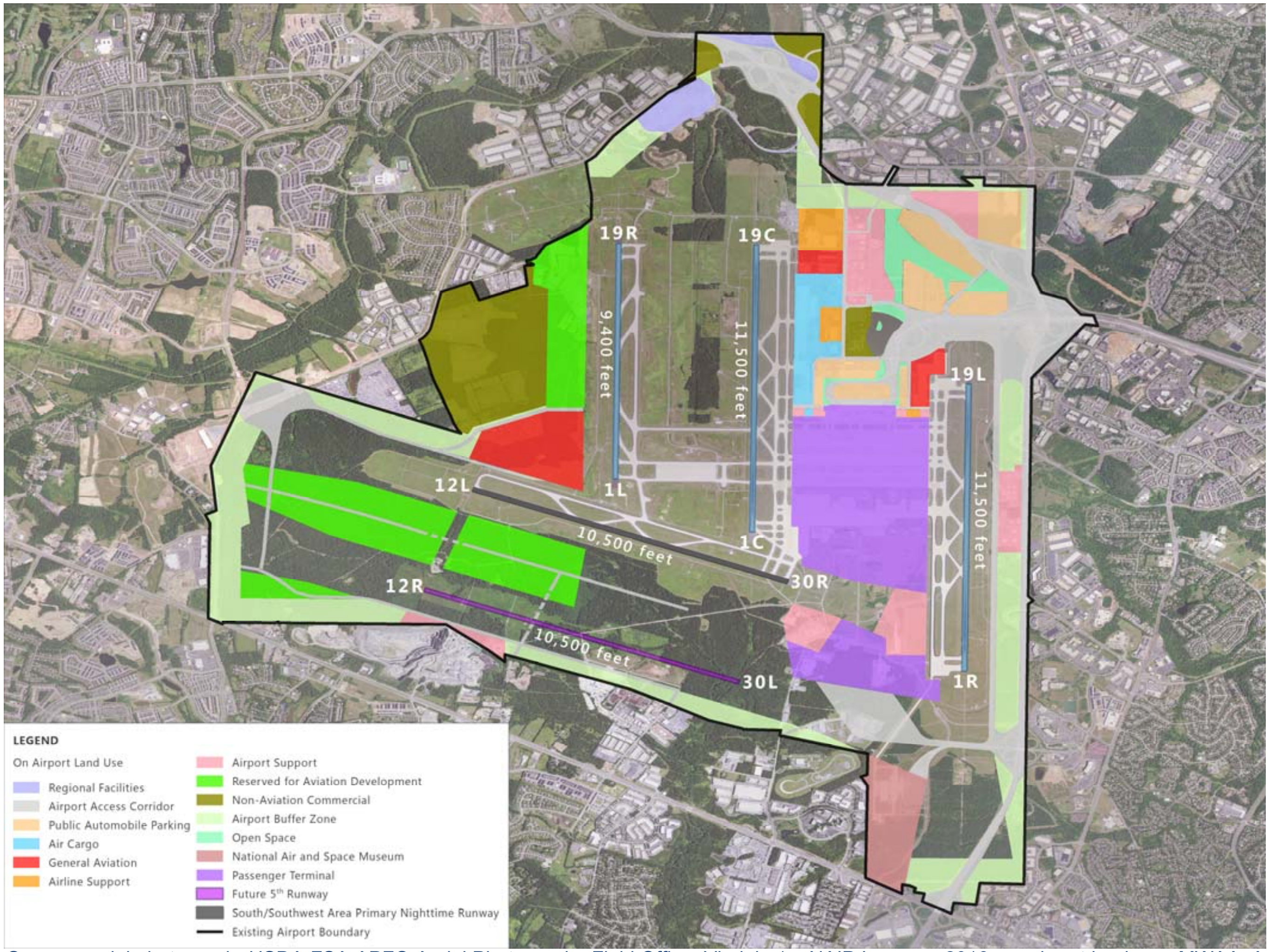
Discussion Scenario Identification - Scenario 3



Source: aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016; on-airport land use: MWAA, April 2018; new runway: MWAA, April 2018.

Discussion – Scenario Identification
Scenario 3

- Five-runway configuration
- Most effective runway use for safe and efficient operations during daytime periods
- Reflects primary runway use associated with on-Airport development south of the existing terminal or between Runways 12L-30R and 12R-30L

Discussion – Annual Service Volume Maximum Sustainable Throughput

- The number of aircraft operations that can reasonably be accommodated over a period of continuous demand (FAA Advisory Circular 150/5060-5)
- Most common time intervals are hourly and annual
- Maximum sustainable throughput is based on runway dimensions, airfield design standards, air traffic control rules/procedures, and aircraft capabilities

Discussion
Annual Service Volume

- *Annual Service Volume* - an estimate of how many aircraft operations the airport runway system can accommodate in a year
- Accounts for differences in throughput related to runway use, fleet mix, and weather conditions that would be encountered over the year
- Serves as the basis for the potential number of annual operations at IAD
- Based on a specified level of average annual delay

Discussion – Annual Service Volume Factors Affecting Airfield Capacity

- Runways
- Taxiways
- Runway exit taxiways – runway occupancy time
- Fleet mix
- Weather
- Air traffic control procedures
  - Wake turbulence separation
  - Radar separation
  - Procedure separation
  - Buffers to separation requirements
  - Divergent headings

Discussion – Potential Enhancements to IAD Airfield Capacity – 5th Runway

The fifth runway at IAD would provide:

- capability to accommodate additional landings and takeoffs.
- adequate separation from existing Runway 12-30 to allow simultaneous dual instrument arrivals in all weather conditions.
- increased throughput when wind and weather require aircraft to land/depart only in a westerly direction.

Discussion – Potential Effects on IAD Airfield Capacity – NextGen

NextGen initiatives that could potentially affect IAD include:

- triple simultaneous instrument approaches during all weather conditions.
- wake turbulence recategorization for aircraft that would reduce the required separation between aircraft landing or departing on the same runway.
- Equivalent Lateral Spacing Operations (ELSO) could increase the number of departure routes from individual and parallel runways.

Discussion
Potential Daily Operations Level Development

- Calculate ASV and average annual day (AAD) based on 4-Runway and 5-Runway scenario and foreseeable FAA NextGen improvements
- Develop potential AAD fleet mix
- Distribute AAD operations by time of day
- Add potential cargo and international operations to nighttime hours
- Prepare AEDT daily operations file representing AAD

Discussion – Annual Service Volume Calculation Methodology

- Objective: Calculate ASV for the 4- and 5-runway airfield
- Assumptions:
  - Taxiways adequate to expedite movement onto and off of all runways will be in place
  - Other facilities (terminals, gates, cargo and general aviation) will be available to accommodate demand
  - Airspace and procedures available to accommodate maximum sustained throughput
  - Airport operation level of service is tolerable up to capacity constrained levels

Discussion - Annual Service Volume Calculation Methodology *Continued*

- Apply FAA methodology to calculate maximum sustainable hourly throughput rate
- Apply historic weather conditions, historic and expected runway use, runway configuration throughput weighting
- Extrapolate ASV to account for average delay per operation equivalent to capacity constrained airport thresholds (FAA, *FACT3: Airport Capacity Needs in the National Airspace System Study*) = Potential ASV

Discussion
Potential Fleet Mix

- Begin with existing aircraft types
- Identify aircraft subject for replacement based on:
  - Age (e.g., older Boeing 737 models, Boeing 757, Boeing 747-400)
  - Airline orders
  - Airline announcements (e.g., American Airline’s recent announcement to replace Boeing 767 and Airbus 300 with Boeing 787 models)
- Assess potential replacement of smaller regional jets (e.g., Embraer 145) with larger regional jets (e.g., Embraer 190) and larger regional jets with new 100-seat mainline jets (e.g., Canadair C-Series)

Discussion
Potential Operations by Time of Day

- Day-Night Average Noise Level (DNL) reflects AAD and applies 10-dBA factor to nighttime operations
- Not sensitive to hourly peaks
- Daytime will reflect maximum sustainability hourly throughput levels
- Nighttime will reflect:
  - maximum sustainable hourly throughput levels for “shoulder” hours (6:00 am to 6:59 am and 10:00 pm to 11:00 pm)
  - potential cargo operations
  - potential international operations between 11:00 pm and 6:00 am

Progress and Next Steps

In Process

Completed

Upcoming

Inventory

- Evaluate current and future plans (MWAA and FAA)
- Assess existing operation conditions

Forecast

- Determine full-build scenario(s)
- Determine maximum potential operations
- Determine potential aircraft runway use and flight tracks

Noise Modeling

- Calculate existing aircraft noise levels
- Calculate potential aircraft noise levels for full-build scenario(s)
- Determine appropriate composite of potential scenarios, if appropriate

Conclusions

- Recommend potential aircraft noise contours for land use planning

Conclusion

- Schedule next working group meeting
- Feedback from Working Group

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JUNE 8, 2018 – INVENTORY OVERVIEW AND 2017 OPERATIONS

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Washington Dulles International Airport (IAD) Aircraft Noise Overlay Update

Inventory

3rd Working Group Briefing

6/6/18

Meeting Purpose

- Discuss inventory collection process and application
- Discuss existing airfield, operations, flight procedures, and mapping inventory
- Status update

Agenda

- Study Purpose
- Background
- Discussion
  - Inventory collection
  - Inventory application
  - Existing Airfield inventory
  - Existing Operations inventory
  - Existing Flight procedures inventory
  - Mapping inventory
- Public Workshop Plans
- Project Progress/Next Steps

Study Purpose

Update the Dulles Airport noise contour map to incorporate changes in the aviation environment so that the future vision reflects these changes:

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- Continue to ensure compatibility between the Airport and local jurisdictional land use and ensure local jurisdictions have the latest information available to make land use decisions
- Be based on Ultimate Build Scenarios

Discussion
Inventory Data Collection Status

- Existing and future airfield geometry
- Future airfield improvement plans
- Calendar year 2017 operations data
- Existing and near-future amended flight procedures
- Existing land use and zoning for Fairfax and Loudoun Counties
- Existing zoning ordinances and planning documentation for Fairfax and Loudoun Counties

Discussion - Inventory Collection Status

- In Process
- Completed
- Upcoming

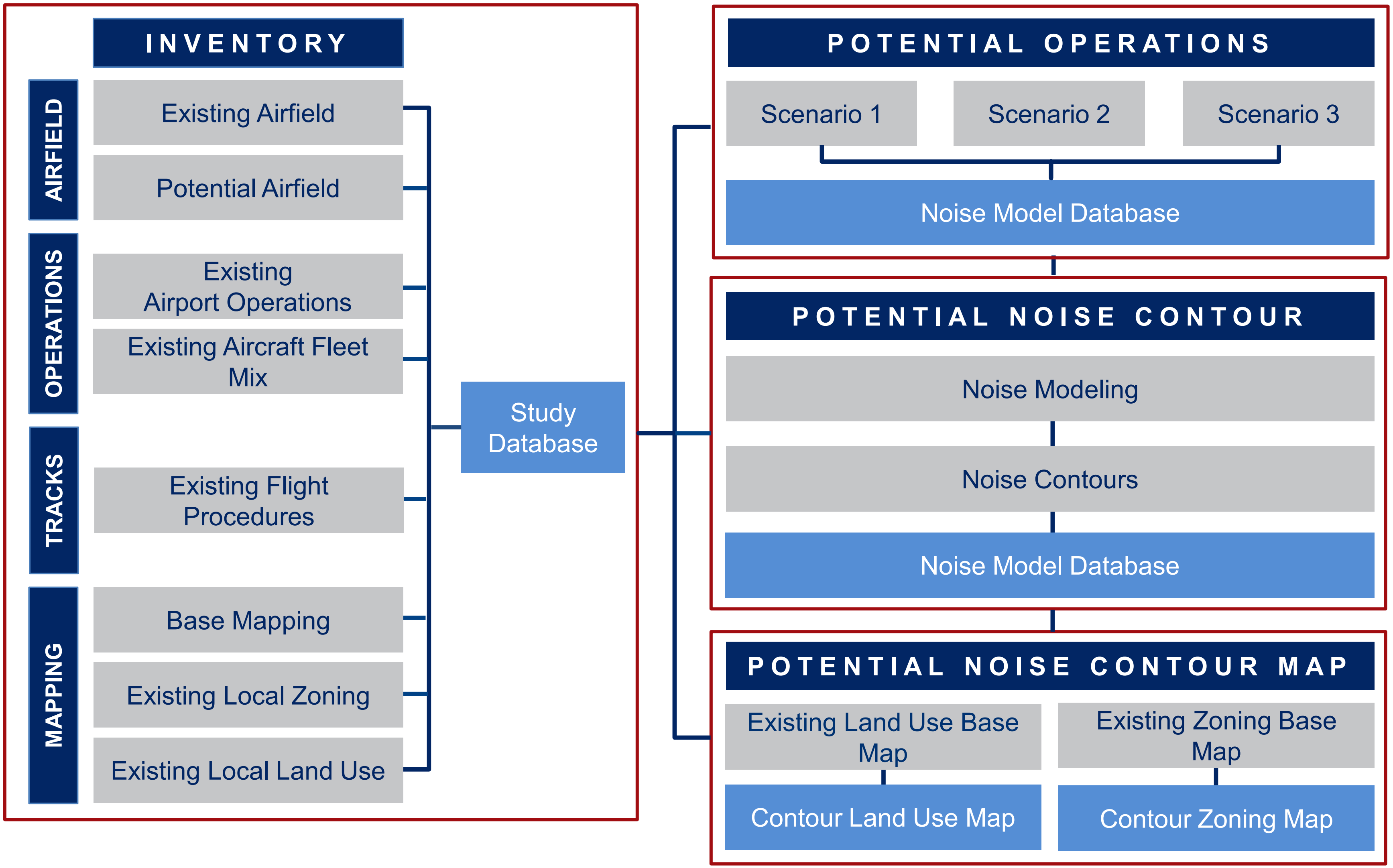
Inventory
- Evaluate current and future plans (MWAA and FAA) ✓
- Assess existing operation conditions ✓

Forecast
- Determine full-build scenario(s) ✓
- Determine maximum potential operations
- Determine potential aircraft runway use and flight tracks

Noise Modeling
- Calculate existing aircraft noise levels
- Calculate potential aircraft noise levels for full-build scenario(s)
- Determine appropriate composite of potential scenarios, if appropriate

Conclusions
- Recommend potential aircraft noise contours for land use planning

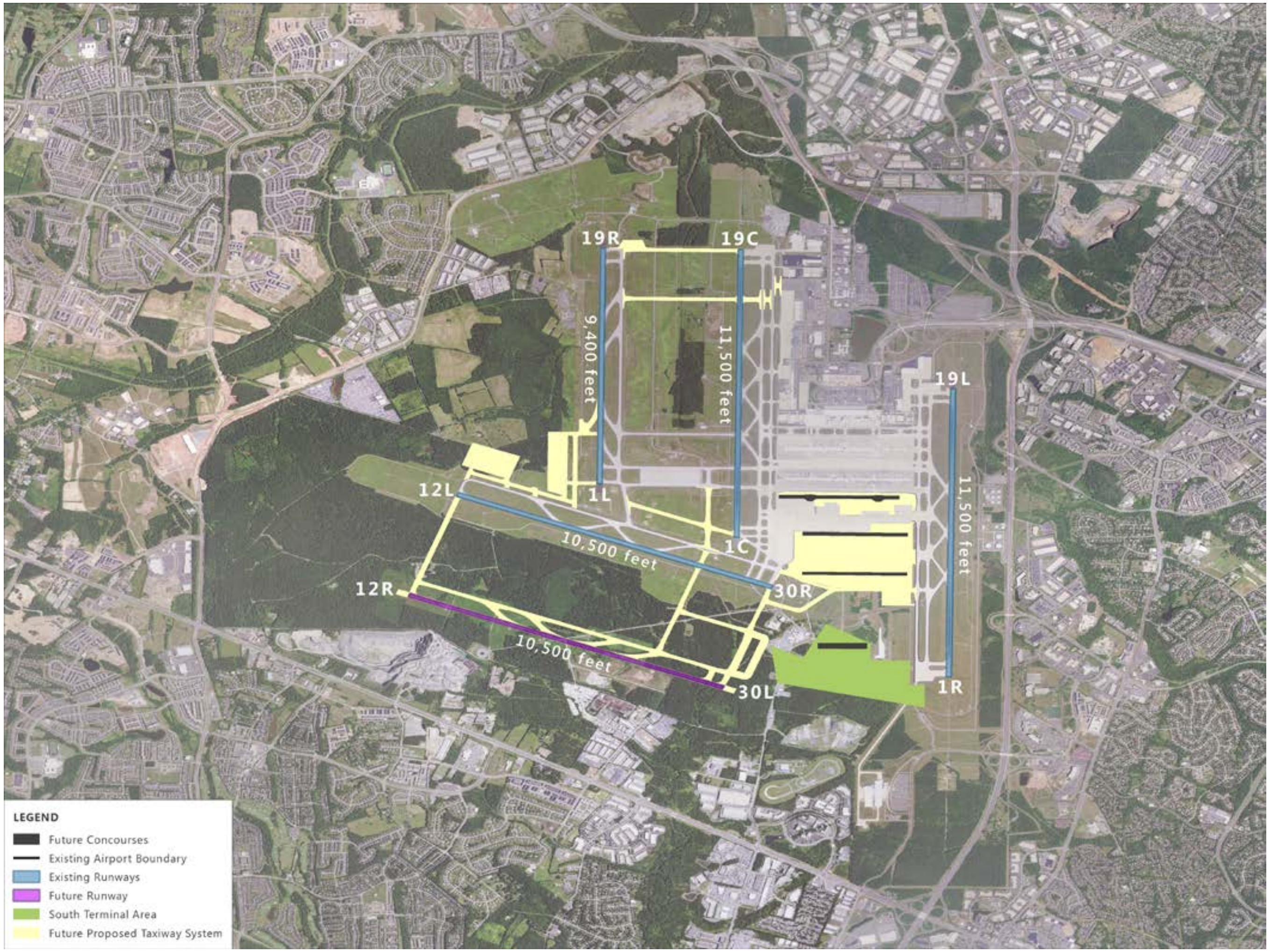
Discussion - Inventory Data Application



Discussion – Airfield Inventory
Current 4-Runway Configuration

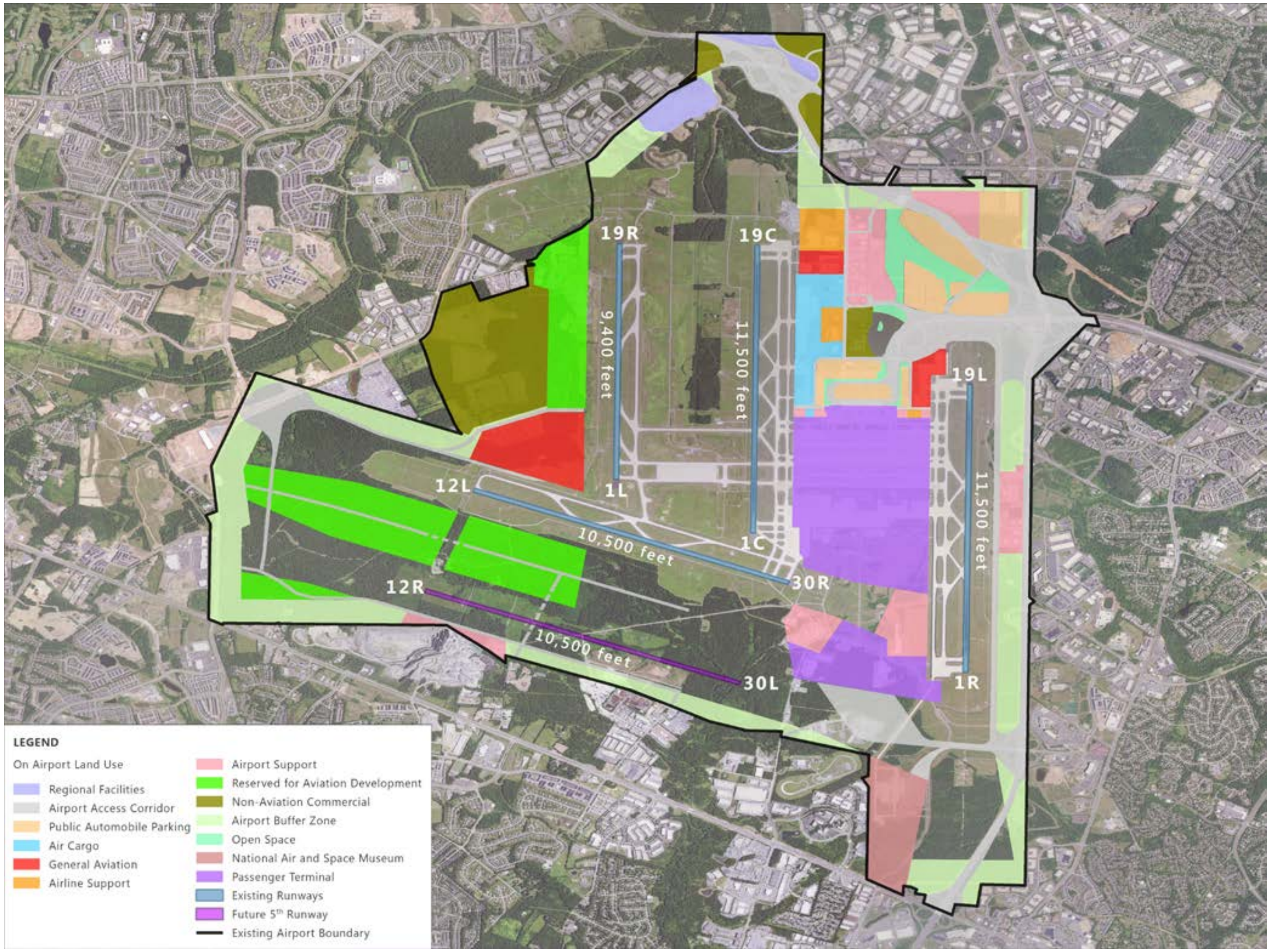
Source: aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016

Discussion – Airfield Inventory
Future 5-Runway Configuration



Source: aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016; new runway: MWAA, Airport Layout Plan, April 2018.

Discussion – Airfield Inventory
Planned On-Airport Land Use

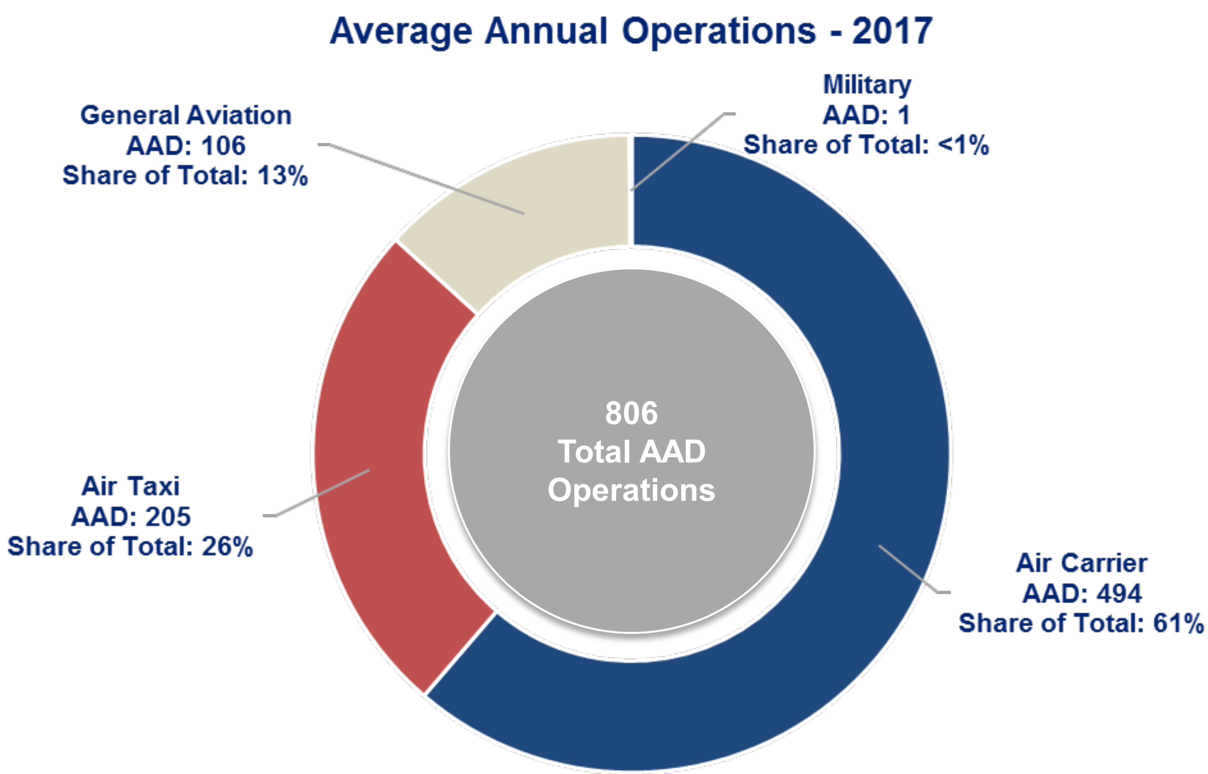


Source: aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016; on-airport land use: MWAA, April 2018; new runway: MWAA, April 2018.

Discussion – Operations Inventory

- Average Annual Day (AAD) operations – number of operations that occurred in a year divided by 365
- 2017 flight data represents existing conditions and serves as a “starting point”
- Collected and processed MWAA’s Airport Noise and Operations Management System (ANOMS) 2017 Data:
    - Airport Operations
    - Time of Day of Operation
    - Aircraft Fleet Mix
    - Runway Use

Discussion – Existing Operations Inventory
Average Annual Operation Levels

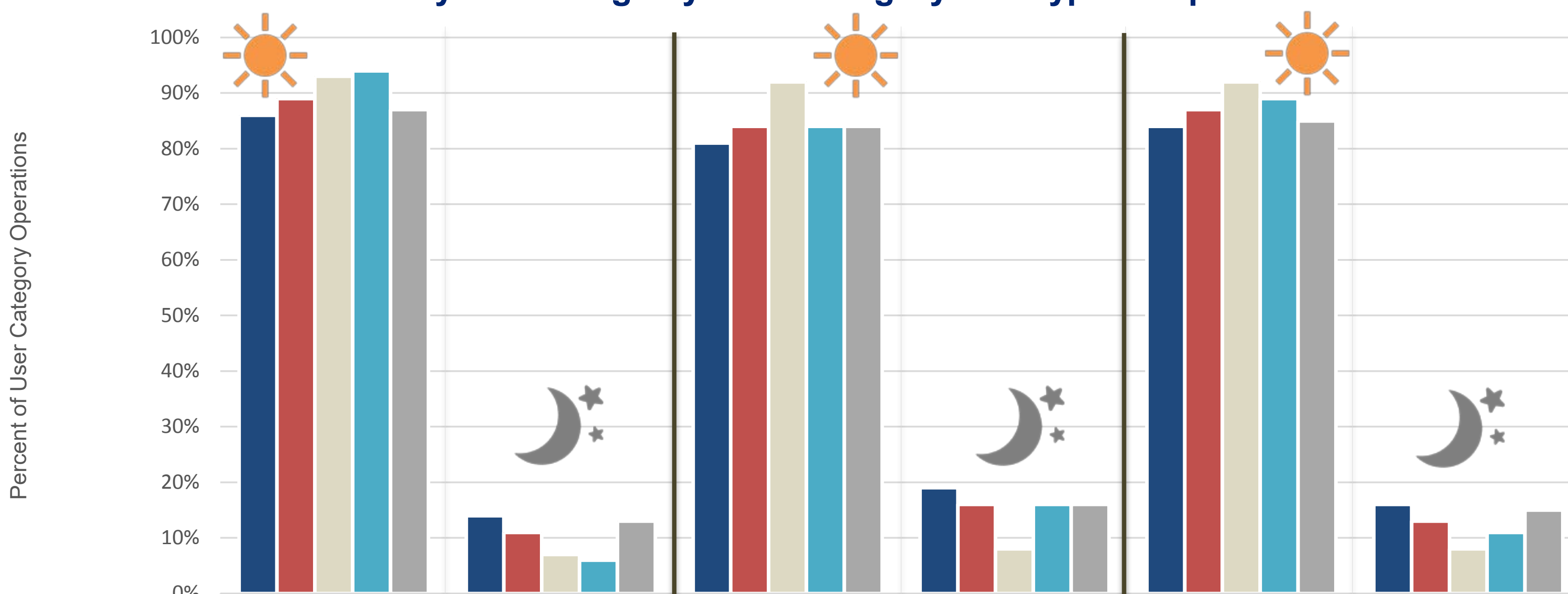


- Air carrier* – commercial aircraft with seating capacities of more than 60 passengers, or a maximum payload capacity of more than 18,000 pounds carrying passengers or cargo
- Air taxi* – commercial and for-hire aircraft with maximum seating capacities of 60 passengers or a maximum payload capacity of 18,000 pounds of cargo for hire or compensation
- General Aviation – noncommercial, civil aircraft operations.
- Military – aircraft operated by any branch of the United States armed services

* Includes air cargo

Discussion – Existing Operations Inventory AAD Operation Levels by Time of Day

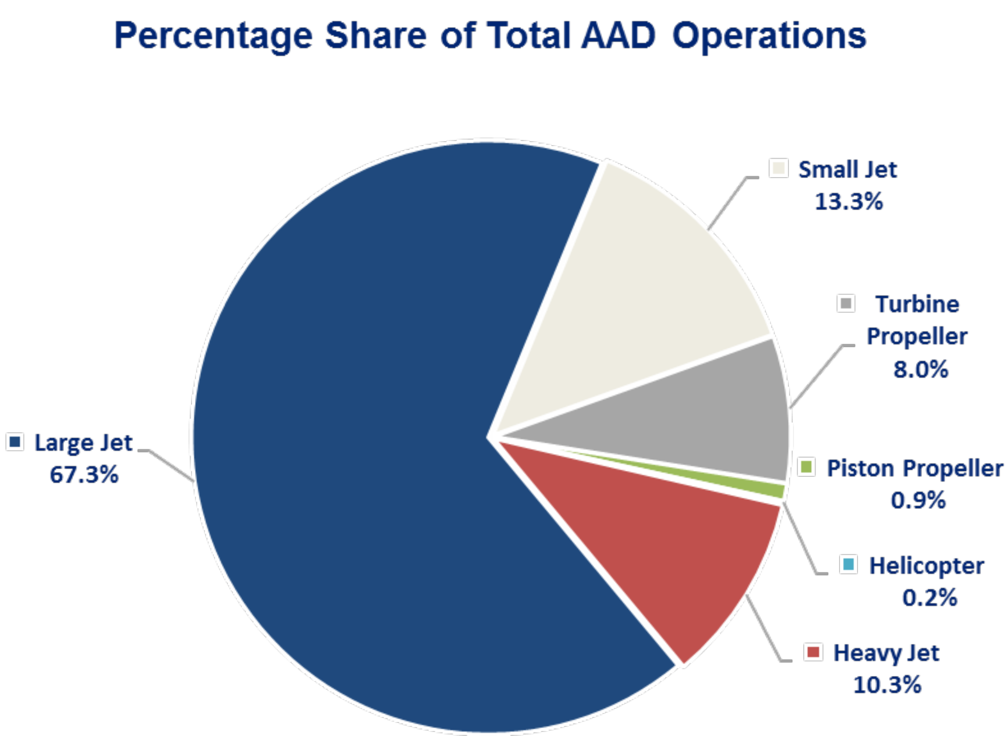
Time of Day Percentage by User Category and Type of Operation



	Arrivals – Day	Arrivals – Night	Departures – Day	Departures – Night	All Operations – Day	All Operations – Night
Air Carriers	86%	14%	81%	19%	84%	16%
Air Taxi	89%	11%	84%	16%	87%	13%
General Aviation	93%	7%	92%	8%	92%	8%
Military	94%	6%	84%	16%	89%	11%
All User Categories	87%	13%	84%	16%	85%	15%

= Daytime hours (7:00 a.m. to 9:59 p.m.) = Nighttime hours (10:00 p.m.. to 6:59 a.m.)

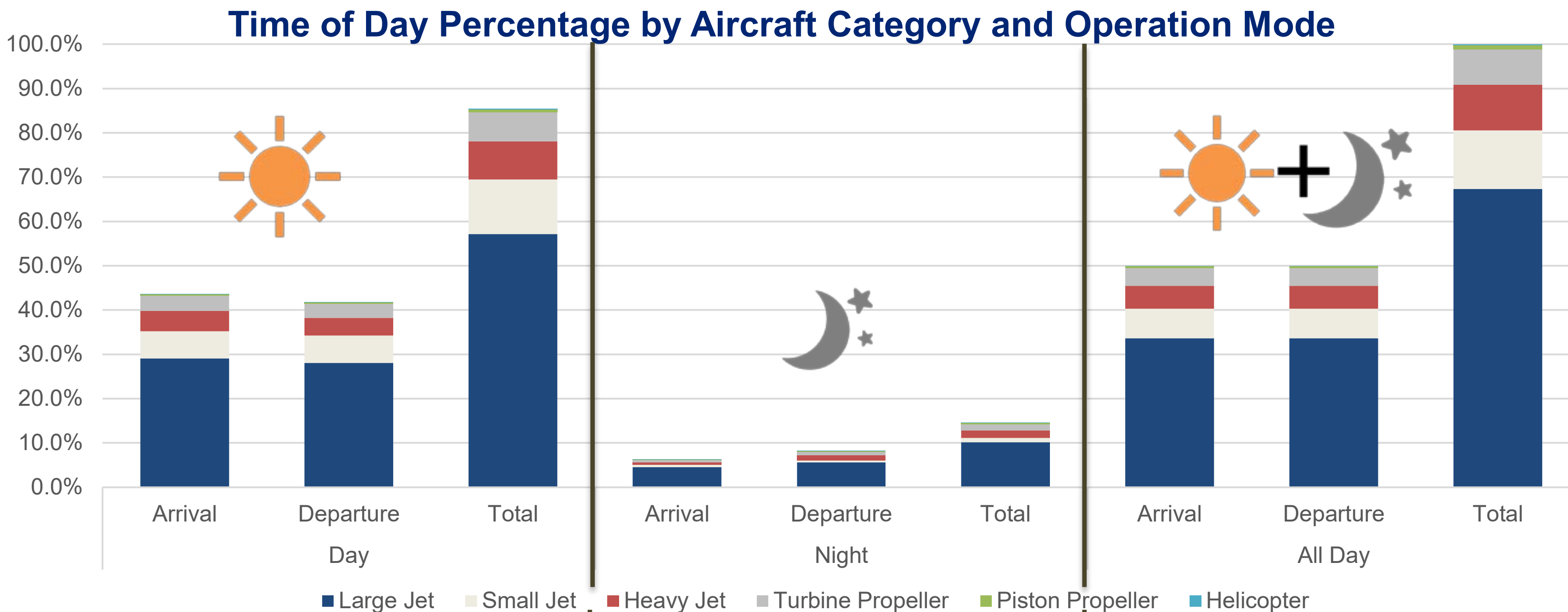
Discussion – Existing Operations Inventory Fleet Mix



Typical Aircraft Type at IAD by Aircraft Category in 2017

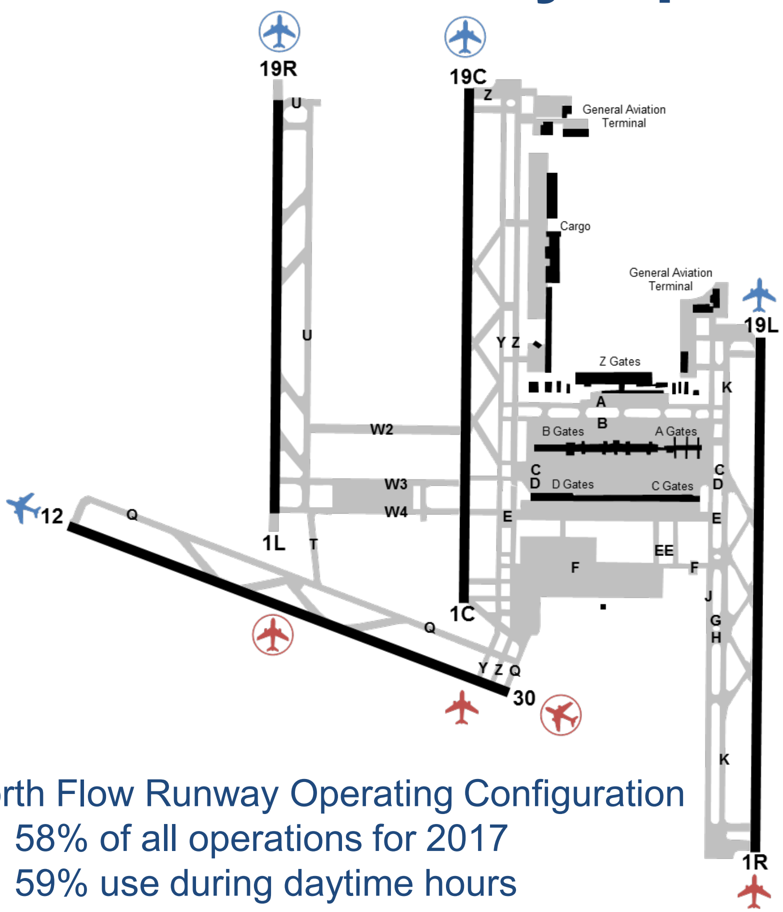
Aircraft Category	Typical Aircraft Type Operating at IAD
Heavy Jet	Boeing 787-800/900, Boeing 777-200/300, Boeing 767-300/400, Boeing 747-400/800, Airbus 330, and Airbus 380
Large Jet	Airbus 319, Airbus 320, Boeing 737-800/900, Bombardier Canadair Reginal Jet 200/700/900, Embraer 145 Extended Range, Embraer 170/175/190, Gulfstream IV/V, and McDonald Douglas 88
Small Jet	Beechjet 400, Bombardier Challenger 300, Cessna Citation Excel, Cessna Citation Sovereign, Embraer Phenom 300, Hawker 800, and Learjet 45
Turbine Propeller	Beechcraft Super King Air, Cessna 208 Caravan, Bombardier Dash 8-200/300/400, and Pilatus PC12
Piston Propeller	Beechcraft Bonanza, Beechcraft Baron, and Cirrus SR22

Discussion – Existing Operations Inventory
Fleet Mix by Time of Day



	Day			Night			All Day		
Aircraft Category	Arrival	Departure	Total	Arrival	Departure	Total	Arrival	Departure	Total
Large Jet	29.1%	28.0%	57.1%	4.6%	5.6%	10.2%	33.7%	33.7%	67.3%
Small Jet	6.2%	6.2%	12.3%	0.5%	0.5%	0.9%	6.6%	6.6%	13.3%
Heavy Jet	4.6%	4.0%	8.6%	0.6%	1.2%	1.7%	5.2%	5.2%	10.3%
Turbine Propeller	3.4%	3.2%	6.6%	0.6%	0.8%	1.4%	4.0%	4.0%	8.0%
Piston Propeller	0.3%	0.3%	0.6%	0.2%	0.1%	0.3%	0.5%	0.5%	0.9%
Helicopter	0.1%	0.1%	0.2%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%
Total	**43.7%**	**41.8%**	**85.5%**	**6.3%**	**8.2%**	**14.5%**	**50.0%**	**50.0%**	**100.0%**

Discussion – Existing Operations Inventory
Runway Operating Configurations



LEGEND

- Primary Arrivals
- Primary Departures
- Secondary Arrivals
- Secondary Arrivals

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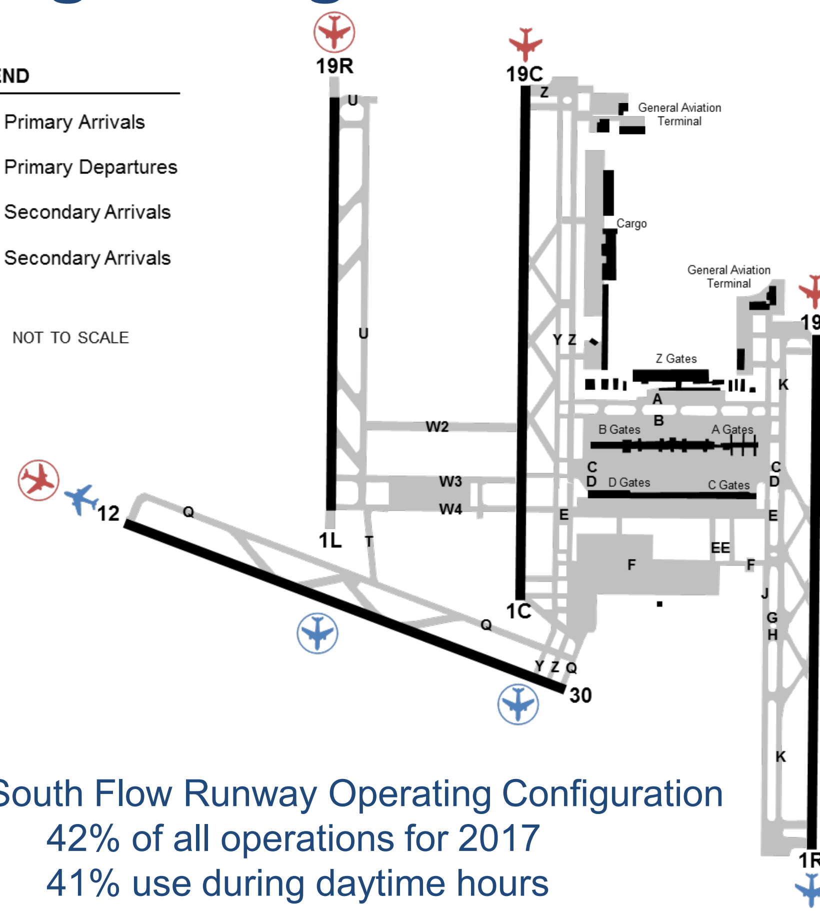
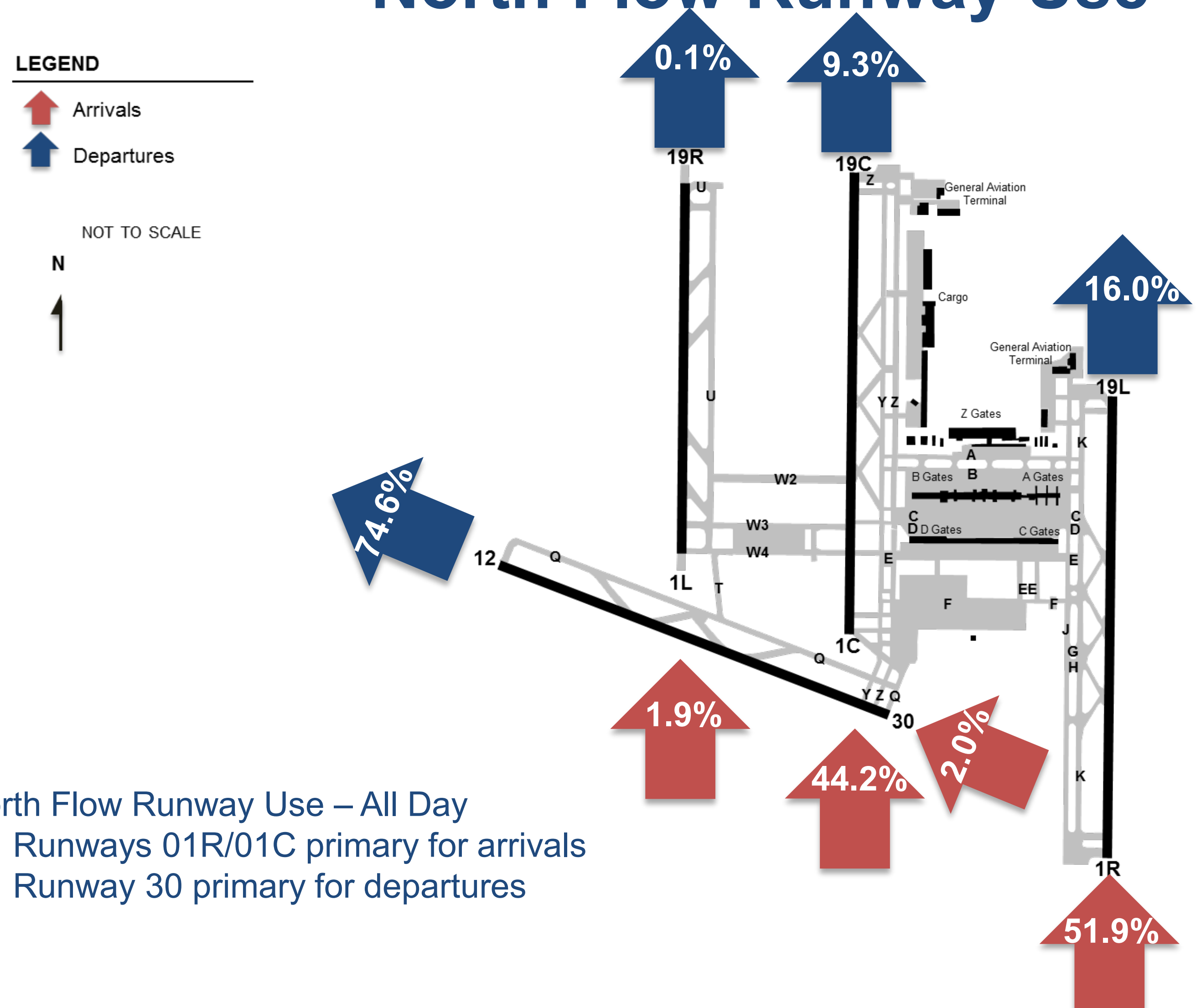


North Flow Runway Operating Configuration
- 58% of all operations for 2017
- 59% use during daytime hours
- 57% use during nighttime hours

South Flow Runway Operating Configuration
- 42% of all operations for 2017
- 41% use during daytime hours
- 43% use during nighttime hours

Note: Percentage runway operating configurations for 2017 is consistent with average use between 2008 and 2017 as reported by FAA

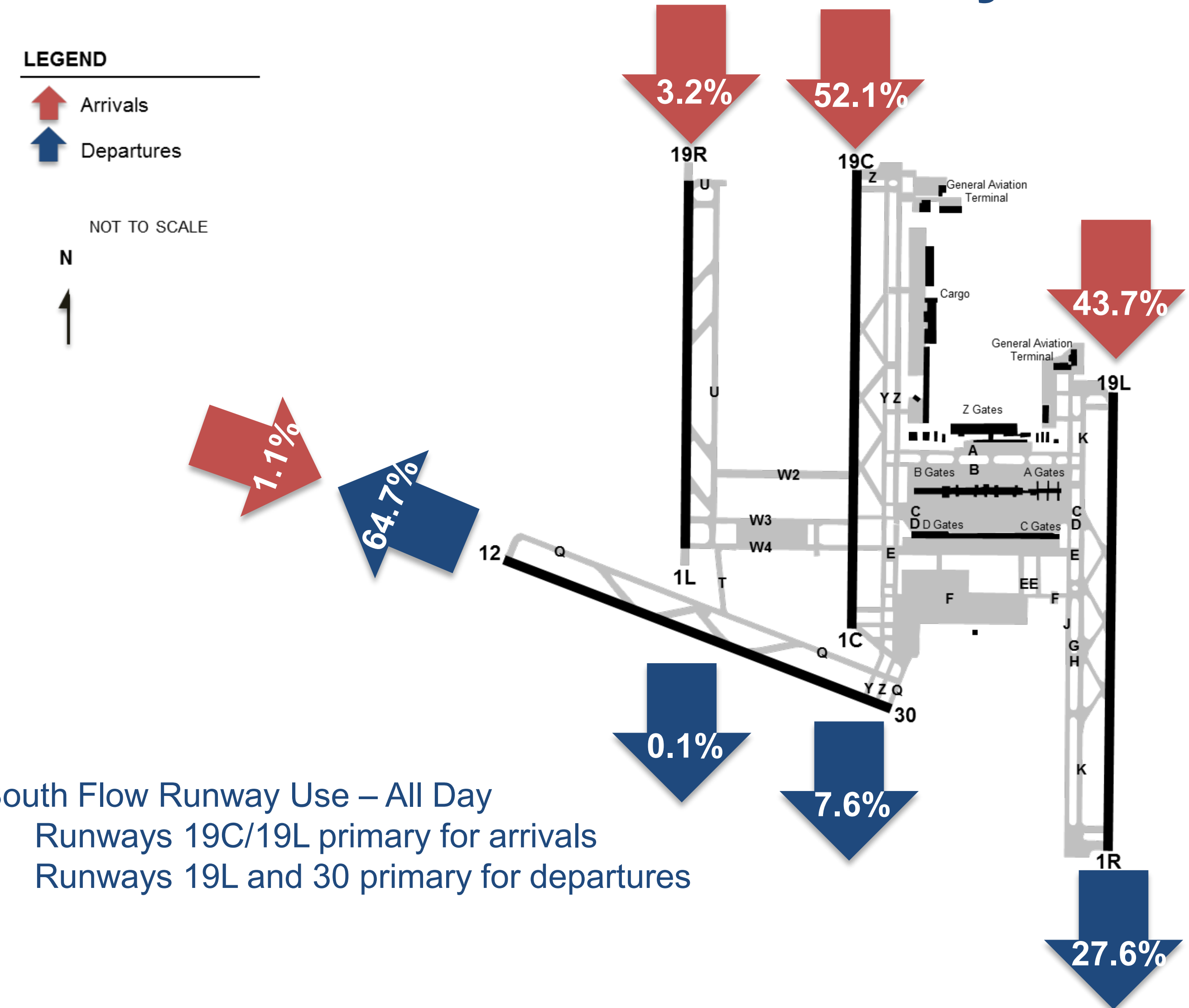
Discussion – Existing Operations Inventory
North Flow Runway Use



North Flow Runway Use – All Day

- Runways 01R/01C primary for arrivals
- Runway 30 primary for departures

Discussion – Existing Operations Inventory South Flow Runway Use



South Flow Runway Use – All Day

- Runways 19C/19L primary for arrivals
- Runways 19L and 30 primary for departures

Discussion – Existing Operations Inventory
Runway Use – Time of Day

	Daytime Arrivals								
	01L	01C	01R	12	19L	19C	19R	30	Total
North Flow	2.0%	44.6%	51.3%	0.0%	0.0%	0.0%	0.0%	2.1%	100.0%
South Flow	0.0%	0.0%	0.0%	1.0%	44.5%	51.2%	3.2%	0.0%	100.0%

	Daytime Departures								
	01L	01C	01R	12	19L	19C	19R	30	Total
North Flow	0.0%	7.5%	18.0%	0.0%	0.0%	0.0%	0.0%	74.5%	100.0%
South Flow	0.0%	0.0%	0.0%	0.0%	32.0%	7.2%	0.1%	60.8%	100.0%

	Nighttime Arrivals								
	01L	01C	01R	12	19L	19C	19R	30	Total
North Flow	1.2%	41.4%	56.1%	0.0%	0.0%	0.0%	0.0%	1.2%	100.0%
South Flow	0.0%	0.0%	0.0%	1.4%	37.9%	57.7%	2.9%	0.0%	100.0%

	Nighttime Departures								
	01L	01C	01R	12	19L	19C	19R	30	Total
North Flow	0.1%	18.8%	5.7%	0.0%	0.0%	0.0%	0.0%	75.4%	100.0%
South Flow	0.0%	0.0%	0.0%	0.0%	14.9%	11.9%	0.1%	73.1%	100.0%

Discussion – Existing Flight Procedures Inventory – Approaches and Navigational Aids

	RUNWAYS							
	01L	19R	01C	19C	01R	19L	12	30
Length (ft)	9,400	9,400	11,500	11,500	11,500	11,500	10,501	10,501
Width (ft)	150	150	150	150	150	150	150	150
Service Date	2008	2008	1962	1962	1962	1962	1962	1962
Approach Aids								
ILS	CAT III	CAT III	CAT II	CAT III	CAT III	CAT II	LOC/DME	No
PAPI	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RNAV/GPS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Approach Lights	ALSF2	ALSF2	MALSR	ALSF2	ALSF2	MALSR	MALSR	No
Runway Lighting	HIRL	HIRL	HIRL	HIRL	HIRL	HIRL	HIRL	HIRL
Runway Marking	Precision	Precision	Precision	Precision	Precision	Precision	Precision	Precision

NOTES:

ILS - Instrument Landing System

PAPI - Precision Approach Path Indicators

RNAV/GPS – Area Navigation/ Global Positioning System

ALSF2 - Approach Lighting System with Sequenced Flashing Lights in ILS CAT-II Configuration

MALSR - Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights

HIRL - High Intensity Runway Edge Lights

SOURCES: Federal Aviation Administration, Instrument Flight Procedure Information Gateway, IAD Washington/Washington Dulles Intl, “Charts,”, https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/application/?event=procedure.results&nasrId=IAD#searchResultsTop, accessed May 2018

Discussion – Existing Flight Procedures Inventory – Terminal Procedures

- Area Navigation (RNAV): procedures based primarily on Global Positioning Satellite (GPS) and/or Distance Measuring Equipment that permits aircraft operation on any desired flight path laterally and vertically within the coverage of GPS and/or DME
- Conventional: procedures based primarily on radio signals from ground-based navigational aids and/or radar vector instructions

Standard Instrument Departure (SID) Procedures

Procedure Name	Procedure Type	Departure "To" Direction
BUNZZ THREE	RNAV	West
CAPITAL ONE	Conventional	North, Northeast, Northwest, South, Southeast, Southwest, East, West
CLTCH TWO	RNAV	Southwest
JCOBY THREE	RNAV	East
JDUBB TWO	RNAV	Southwest
JERES TWO	RNAV	North, Northeast
MCRAY TWO	RNAV	North, Northwest
RNLDI FOUR	RNAV	West
SCRAM FOUR	RNAV	Southwest
WOOLY ONE	RNAV	East

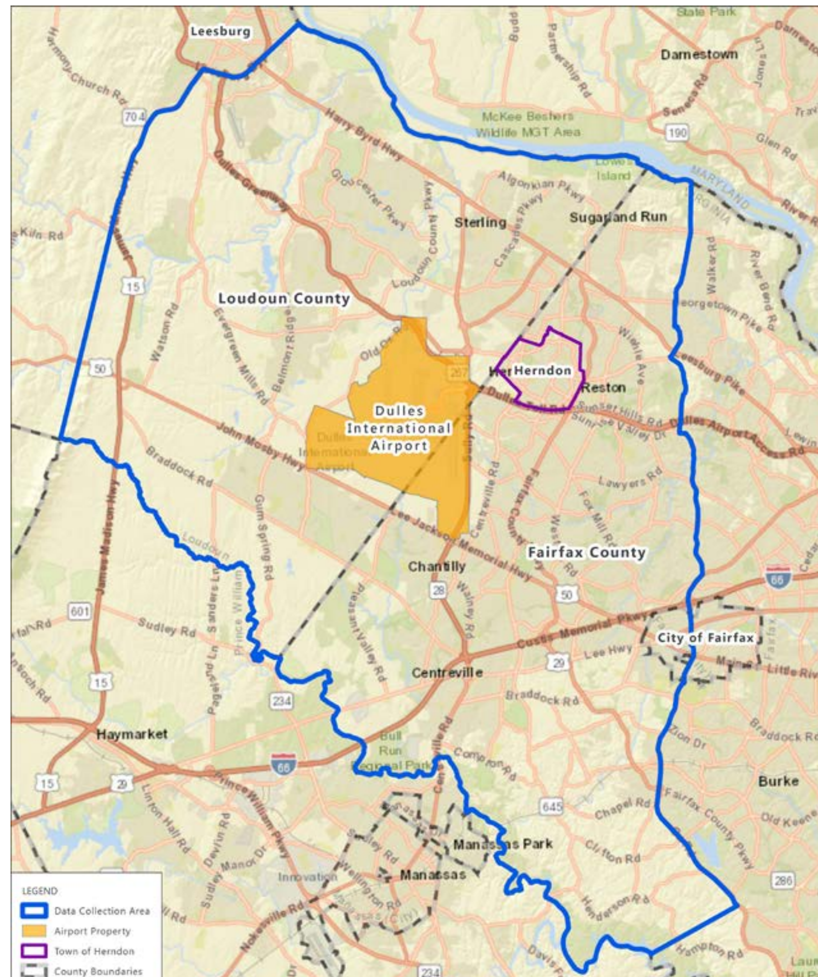
Standard Terminal Arrival (STAR) Procedures

Procedure Name	Procedure Type	Arrival "From" Direction
CAVLR THREE	RNAV	South
COATT FIVE	Conventional	South
DELRO FOUR	Conventional	South, Southwest
DOCCS TWO	Conventional	Southwest
GIBBZ TWO	RNAV	Southwest, Northwest
HYPER SEVEN	RNAV	Northeast
LEGGO FOUR	RNAV	North, Northeast
MAPEL TWO	RNAV	North, Northwest
PRIVO ONE	Conventional	North, Northwest
SELINSGROVE FIVE	Conventional	North, Northeast
WIGOL ONE	RNAV	Southwest

SOURCES: Federal Aviation Administration, Instrument Flight Procedure Information Gateway, IAD Washington/Washington Dulles Intl, "Charts,", https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/application/?event=procedure.results&nasrId=IAD#searchResultsTop, accessed May 2018

Discussion – Mapping Inventory
Local Land Use/Zoning Data Collection Area

- Radial distance of 30,000 feet plus a 10,000 feet buffer (total of a 40,000 feet radius) centered from each runway end
- Existing Loudoun and Fairfax County Aircraft Noise Zoning District contours
- 2017 sample radar tracks for North and South Flow runway operating configurations



Discussion – Mapping Inventory Generalized Land Use Categories

Loudoun County	
Distinct "LU_DISPLAY" Field Land Uses	**Ricondo Generalized Land Use Category**
Airport	Public/ Institutional/ Governmental
Church	Public/ Institutional/ Governmental
Data Center	Office
Farm	Agricultural
General Office	Office
Golf Course	Parks/Recreation
Group Quarter	Mixed Use
Heavy Industrial	Industrial
HOA	Parks/Recreation
Hotel	Lodging
Light Industrial Flex	Industrial
Medical Office	Healthcare
Miscellaneous	Commercial
Multi-Family Attached	Multi Family Residential
Multi-Family Stacked	Multi Family Residential
Multi-Use	Commercial
Other: Non-Public	Commercial
Other: Public	Public/ Institutional/ Governmental
Public	Public/ Institutional/ Governmental
Retail	Commercial
Single-Family Attached	Single Family Residential
Single-Family Detached	Single Family Residential
Vacant	Vacant

SOURCES: Loudoun County 2017 (land use) (https://data-loudoungis.opendata.arcgis.com/ Accessed April 12, 2018); Ricondo & Associates, Inc., May 2018 (generalized categories).

Fairfax County	
Distinct "CATEG" Field Land Uses	**Ricondo Generalized Land Use Category**
Agricultural	Agricultural
Commercial	Commercial
High-density Residential	Multi Family Residential
Industrial, light and heavy	Industrial
Institutional	Public/ Institutional/ Governmental
Low-density Residential	Single Family Residential
Medium-density Residential	Single Family Residential
Open land, not forested or developed	Open Space
Public	Public/ Institutional/ Governmental
Recreation	Parks/Recreation
Utilities	Public/ Institutional/ Governmental

SOURCES: Fairfax County 2017 (land use) (https://data-fairfaxcountygis.opendata.arcgis.com/ Accessed April 12, 2018)); Ricondo & Associates, Inc., May 2018 (generalized categories).

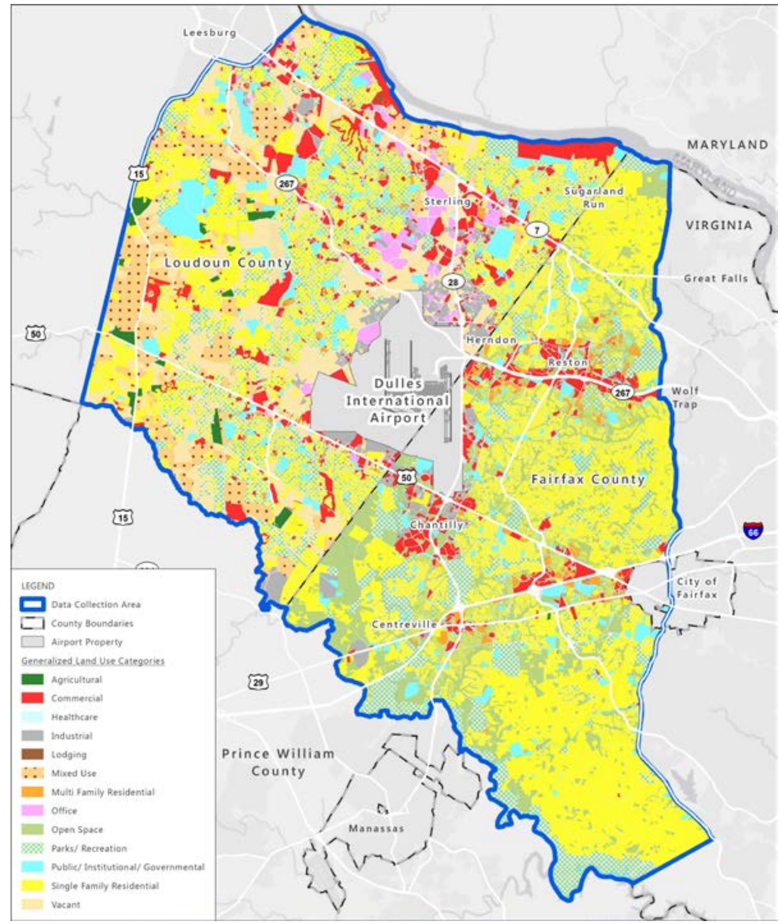
Discussion – Mapping Inventory
Existing Land Use

LEGEND

- Data Collection Area
- County Boundaries
- Airport Property

Generalized Land Use Categories

- Agricultural
- Commercial
- Healthcare
- Industrial
- Lodging
- Mixed Use
- Multi Family Residential
- Office
- Open Space
- Parks/ Recreation
- Public/ Institutional/ Governmental
- Single Family Residential
- Vacant



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap contributors, and the GIS user community, May 2018 (basemap); TIGER/Line Shapefiles, US Census Bureau, Geography Division, 2017 (place, county boundaries); Fairfax County 2017 (land use) (https://data-fairfaxcountygis.opendata.arcgis.com/ Accessed April 12, 2018); Loudoun County 2017 (land use) (https://data-loudoungis.opendata.arcgis.com/ Accessed April 12, 2018); Ricondo & Associates, Inc., May 2018 (data collection area).

Discussion – Mapping Inventory Generalized Zoning Categories – Loudoun Co.

Loudoun County		
GENERALIZED ZONING CATEGORY	ZONE USE CODE	DESCRIPTION
Agricultural	A3	Agricultural/Residential
Agricultural	AR1	Agricultural Rural - 1
Agricultural	AR2	Agricultural Rural - 2
Commercial	C1	Planned Development - Commercial Center
Commercial	CLI	Commercial/Light Industry
Single Family Residential	CR1	Country Residential - 1
Single Family Residential	CR2	Country Residential - 2
Commercial	GB	General Business
Industrial	I1	Mineral Resources - Heavy Industry
Transportation	IAD	Washington-Dulles International Airport
Multi Family Residential	JLMA1	Joint Land Management Area - 1
Single Family Residential	JLMA20	Joint Land Management Area - 20
Single Family Residential	JLMA3	Joint Land Management Area - 3
Industrial	MRHI	Mineral Resources - Heavy Industry
Single Family Residential	PDAAAR	Planned Development - Active Adult/Age Restricted
Commercial	PDCC(CC)	Planned Development - Commercial Center (Community Center)
Commercial	PDCC(NC)	Planned Development - Commercial Center (Neighborhood Center)
Commercial	PDCC(RC)	Planned Development - Commercial Center (Regional Center)
Commercial	PDCC(SC)	Planned Development - Commercial Center (Small Regional Center)
Commercial	PDCH	Planned Development - Commercial Center
Industrial	PDGI	Planned Development - General Industry
Mixed Use	PDH3	Planned Development Housing - 3
Mixed Use	PDH4	Planned Development Housing - 4
Mixed Use	PDH6	Planned Development Housing - 6
Industrial	PDIP	Planned Development - Industrial Park
Commercial	PDMUB	Planned Development - Mixed Use Business District
Office	PDOP	Planned Development - Office Park
Office	PDRDP	Planned Development - Research and Development Park
Mixed Use	PDRV	Planned Development - Rural Village
Commercial	PDSA	Planned Development - Special Activity
Mixed Use	PDSC	Planned Development - Commercial Center
Mixed Use	PDTC	Planned Development - Town Center
Mixed Use	PDTRC	Planned Development - Transit Related Center

Loudoun County (continued)		
GENERALIZED ZONING CATEGORY	ZONE USE CODE	DESCRIPTION
Single Family Residential	R1	Single Family Residential
Multi Family Residential	R16	Townhouse/Multifamily Residential
Single Family Residential	R2	Single Family Residential
Multi Family Residential	R24	Multifamily Residential
Single Family Residential	R3	Single Family Residential
Single Family Residential	R4	Single Family Residential
Single Family Residential	R8	Single Family Residential
Commercial	RC	Rural Commercial District
Commercial	B-2	Established Corridor Commercial District
Commercial	B-3	Community Retail/Commercial District
Mixed Use	B-4	Mixed-Use Business District
Industrial	I-1	Industrial/Research Park District
Transportation	MA	Municipal Airport (Special Purpose) District
Office	O-1	General Office District
Office	PEC	Planned Employment Center District
Single Family Residential	PRC	Planned Residential Neighborhood District
Mixed Use	PRN	Planned Residential Community District
Single Family Residential	R-1	Single Family Residential District
Multi Family Residential	R-16	Multifamily Residential
Single Family Residential	R-2	Single Family Residential District
Multi Family Residential	R-22	Multi-Family Residential District
Single Family Residential	R-4	Single Family Residential District
Single Family Residential	R-6	Moderate Density Residential District
Multi Family Residential	R-8	Medium Density Attached Residential District
Single Family Residential	R-E	Single-Family Residential Estate District
Single Family Residential	TR10	Transitional Residential - 10
Single Family Residential	TR1LF	Transitional Residential - 1 (Lower Foley)
Single Family Residential	TR1UBF	Transitional Residential - 1 (Upper Broad Run and Upper Foley)
Single Family Residential	TR2	Transitional Residential - 2
Single Family Residential	TR3LBR	Transitional Residential - 3 (Lower Bull Run)
Single Family Residential	TR3LF	Transitional Residential - 3 (Lower Foley)
Single Family Residential	TR3UBF	Transitional Residential - 3 (Upper Broad Run and Upper Foley)

SOURCES: Loudoun County 2017 (zoning) (https://data-loudoungis.opendata.arcgis.com/ Accessed April 12, 2018); Leesburg Zoning Map, 2017 (http://www.arcgis.com/home/item.html?id=4d14881478c14dfdbc74b86576716096 Accessed May 1, 2018); Ricondo & Associates, Inc., May 2018 (generalized zoning categories).

Town of Leesburg Zoning

Discussion – Mapping Inventory
Generalized Zoning Categories – Fairfax Co.

Fairfax County		
GENERALIZED ZONING CATEGORY	**ZONE USE CODE**	**DESCRIPTION**
Office	C-2	Limited Office District
Office	C-3	Office District
Office	C-4	High Intensity Office District
Commercial	C-5	Neighborhood Retail Commercial District
Commercial	C-6	Community Retail Commercial District
Commercial	C-7	Regional Retail Commercial District
Commercial	C-8	Highway Commercial District
Commercial	CC	Central Commercial District
Commercial	CO	Commercial Office District
Commercial	CS	Commercial Services District
Industrial	I-2	Industrial Research District
Industrial	I-3	Light Intensity Industrial District
Industrial	I-4	Medium Intensity Industrial District
Industrial	I-5	General Industrial District
Industrial	I-6	Heavy Industrial District
Industrial	O&LI	Office and Light Industrial District
Office	PD-B	Planned Development Business District
Single Family Residential	PDC	Planned Development Housing District
Single Family Residential	PD-D	Planned Development Downtown District
Single Family Residential	PDH-1	Planned Development Housing Project, One Dwelling Unit/Acre
Multi Family Residential	PDH-12	Planned Development Housing Project, Twelve Dwelling Units/Acre
Multi Family Residential	PDH-16	Planned Development Housing Project, Sixteen Dwelling Units/Acre
Single Family Residential	PDH-2	Planned Development Housing Project, Two Dwelling Units/Acre
Multi Family Residential	PDH-20	Planned Development Housing Project, Twenty Dwelling Units/Acre
Single Family Residential	PDH-3	Planned Development Housing Project, Three Dwelling Units/Acre

Fairfax County		
GENERALIZED ZONING CATEGORY	**ZONE USE CODE**	**DESCRIPTION**
Multi Family Residential	PDH-30	Planned Development Housing Project, Thirty Dwelling Units/Acre
Single Family Residential	PDH-4	Planned Development Housing Project, Four Dwelling Units/Acre
Single Family Residential	PDH-5	Planned Development Housing Project, Five Dwelling Units/Acre
Single Family Residential	PDH-8	Planned Development Housing Project, Eight Dwelling Units/Acre
Single Family Residential	PD-R	Planned Development - Residential
Commercial	PD-TD	Planned Development - Traditional Downtown
Commercial	PD-TOC	Planned Development - Transit Oriented Care
Commercial	PD-W	Planned Development - Worldgate
Single Family Residential	PRC	Planned Residential Community District
Mixed Use	PRM	Planned Residential Mixed Use District
Single Family Residential	R-1	Residential Districts, One Dwelling Unit/Acre
Single Family Residential	R-10	Residential Single-Family District
Multi Family Residential	R-12	Residential Districts, Twelve Dwelling Units/Acre
Single Family Residential	R-15	Residential Single-Family District
Multi Family Residential	R-16	Residential Districts, Sixteen Dwelling Units/Acre
Single Family Residential	R-2	Residential Districts, Two Dwelling Units/Acre
Multi Family Residential	R-20	Residential Districts, Twenty Dwelling Units/Acre
Single Family Residential	R-3	Residential Districts, Three Dwelling Units/Acre
Multi Family Residential	R-30	Residential Districts, Thirty Dwelling Units/Acre
Single Family Residential	R-4	Residential Districts, Four Dwelling Units/Acre
Single Family Residential	R-5	Residential Districts, Five Dwelling Units/Acre
Single Family Residential	R-8	Residential Districts, Eight Dwelling Units/Acre
Agricultural	R-A	Rural Agricultural District
Parks and Recreation	R-C	Residential-Conservation District
Single Family Residential	R-E	Residential Estate District
Multi Family Residential	RM	Residential Multi-Family
Mobile Home/Park	R-MHP	Residential District, Mobile Home Park
Multi Family Residential	RTC	Residential Townhouse Cluster District

SOURCES: Fairfax County 2017 (zoning) (https://data-fairfaxcountygis.opendata.arcgis.com/ Accessed April 12, 2018); Ricondo & Associates, Inc., May 2018 (generalized zoning categories).

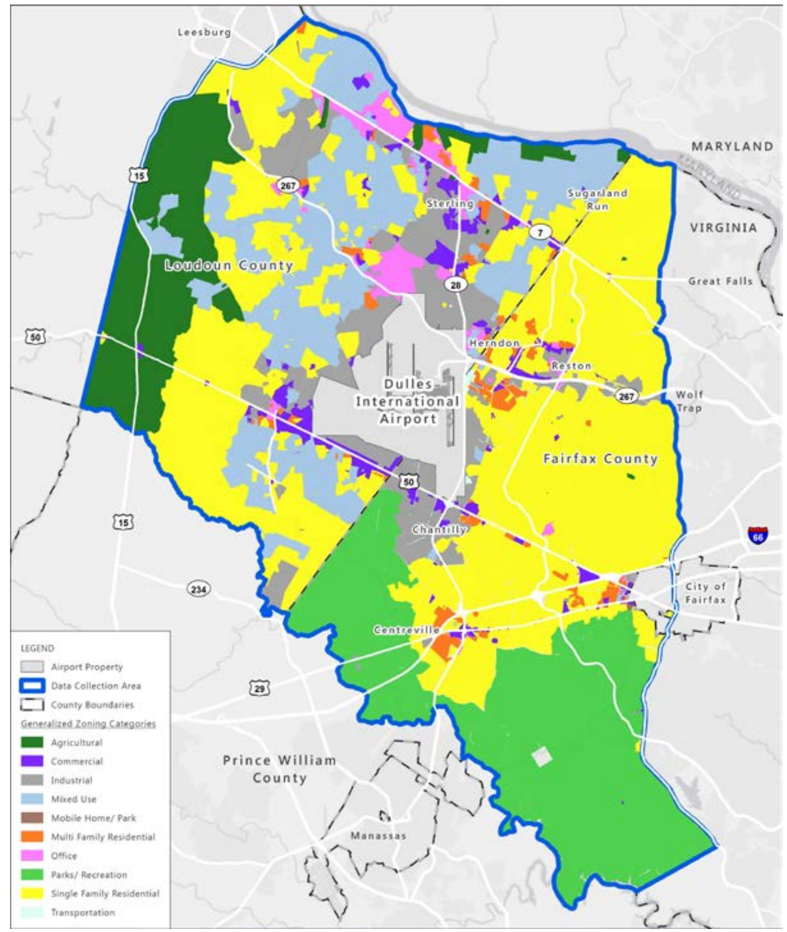
Discussion – Mapping Inventory Existing Zoning

LEGEND

- Airport Property
- Data Collection Area
- County Boundaries

Generalized Zoning Categories

- Agricultural
- Commercial
- Industrial
- Mixed Use
- Mobile Home/ Park
- Multi Family Residential
- Office
- Parks/ Recreation
- Single Family Residential
- Transportation



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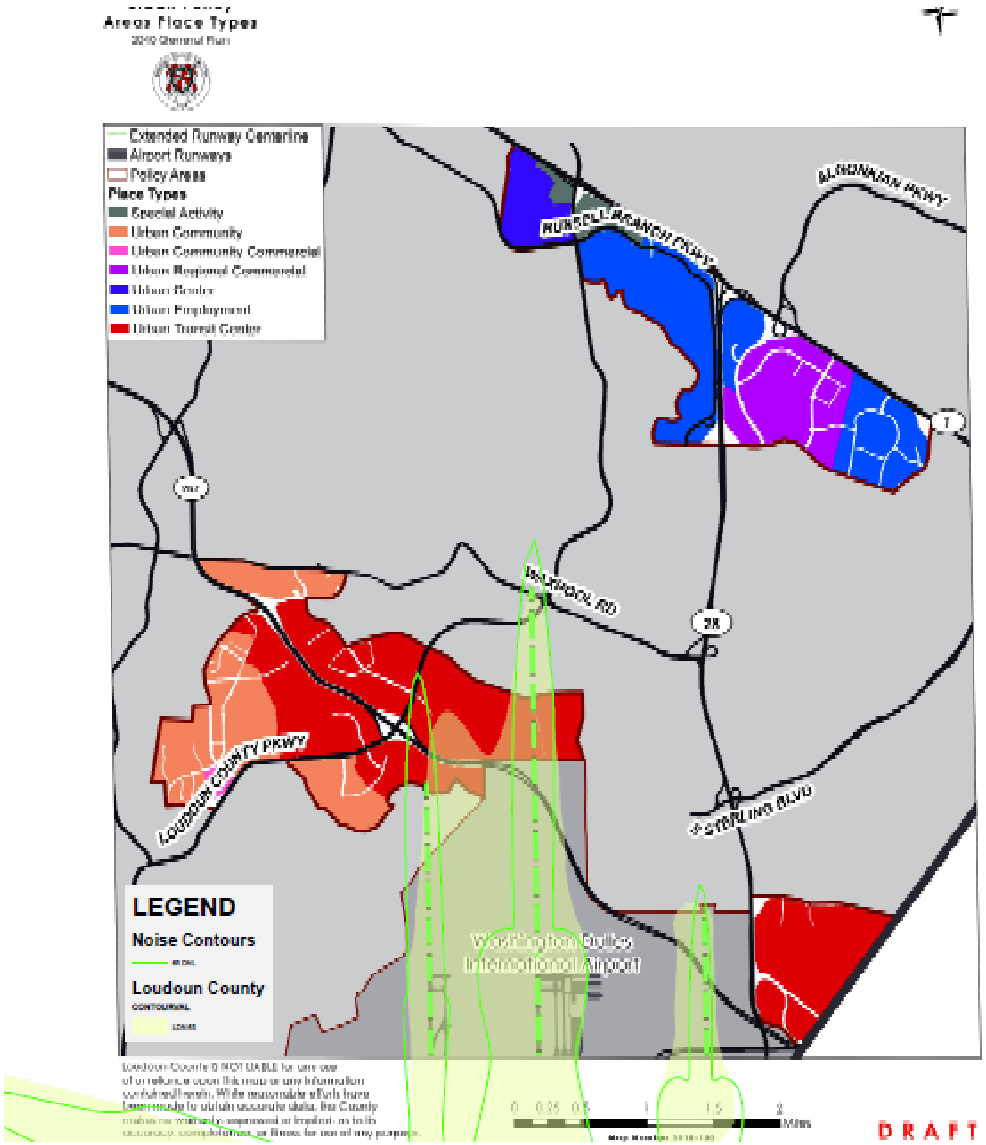
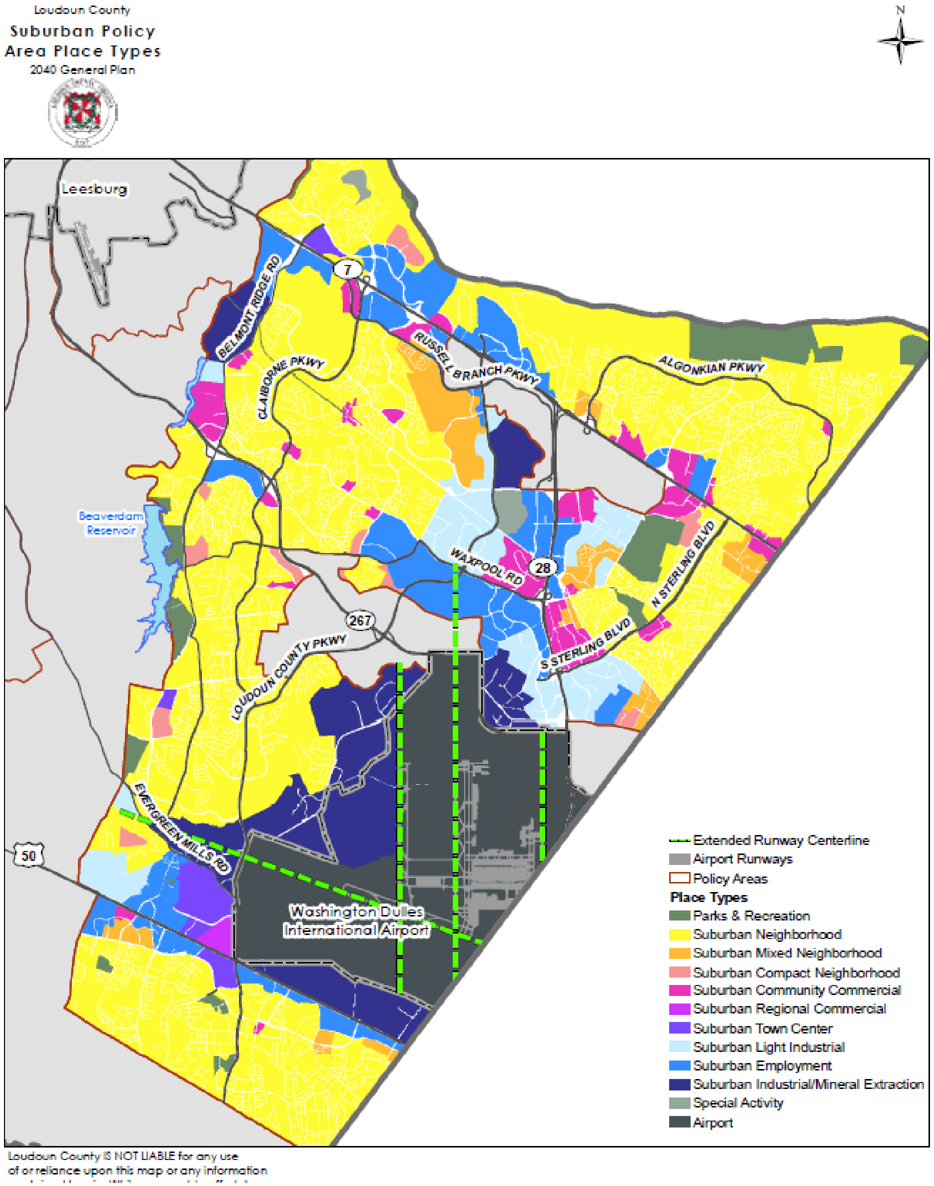
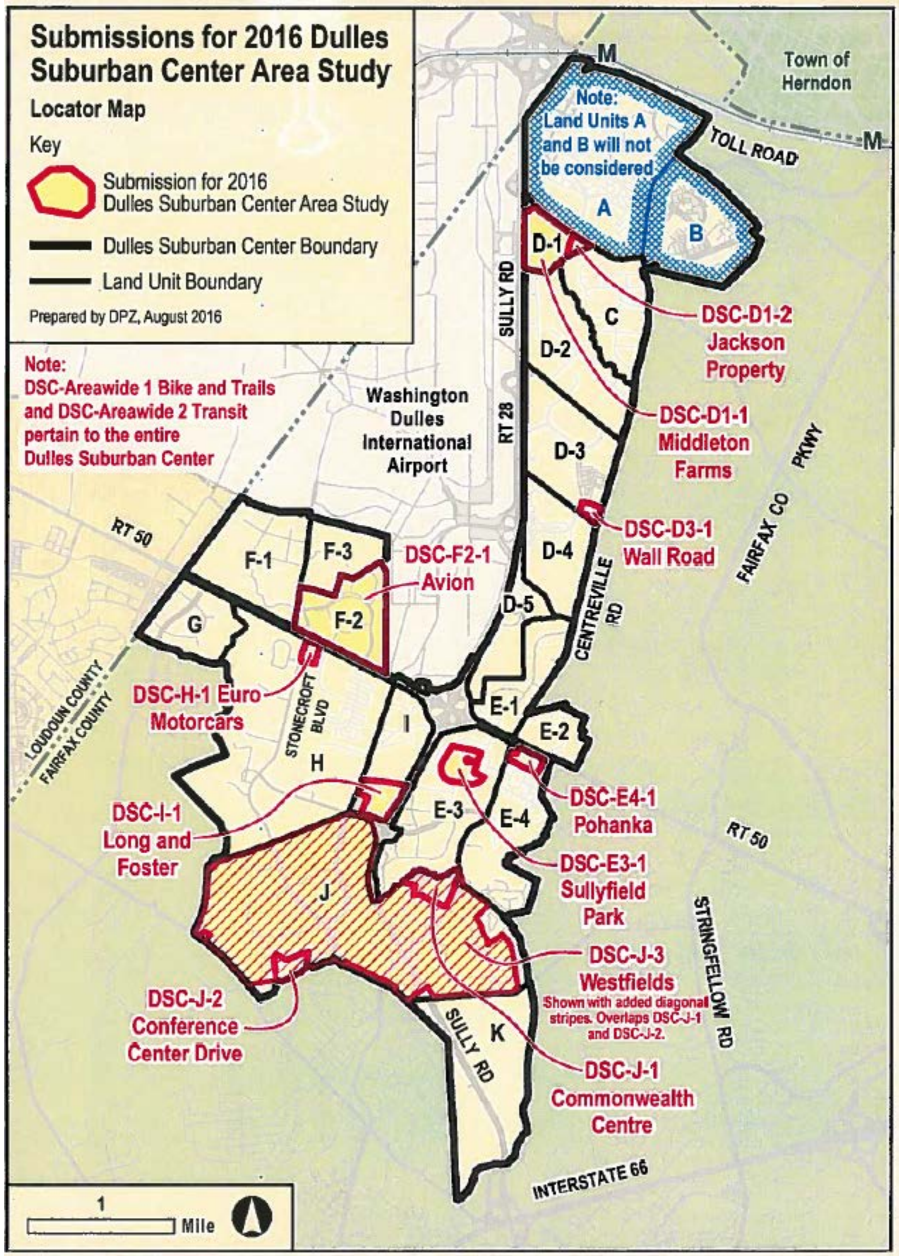
Envision Loudoun May 7, 2018 Draft Proposed Place Types





Envision Loudoun May 7, 2018 Draft Proposed Place Types

Dulles Suburban Center Study



Public Workshop Plan

- Format: series of stations with assigned experts to answer questions related to the station topics
- Topics:
  - Study Overview
    - IAD's role for local and regional economy
    - Potential growth in areas around IAD and the region
    - Why conduct the study
    - How is the study be conducted
    - Study schedule
  - Inventory
  - Aircraft Noise Overview
    - What is Day/Night Average Noise Level
    - Noise modeling process
- Two workshops
  - June 27th: Dulles Airport (45045 Aviation Drive – 2nd Floor Conference Room, 6pm – 8pm)
  - June 28th: Ashburn (Place to-be-determined)

Progress And Next Steps

In Process
Completed
Upcoming

Inventory

- Evaluate current and future plans (MWAA and FAA) ✓
- Assess existing operation conditions ✓

Forecast

- Determine full-build scenario(s) ✓
- Determine maximum potential operations
- Determine potential aircraft runway use and flight tracks

Noise Modeling

- Calculate existing aircraft noise levels
- Calculate potential aircraft noise levels for full-build scenario(s)
- Determine appropriate composite of potential scenarios, if appropriate

Conclusions

- Recommend potential aircraft noise contours for land use planning

Conclusion

- Feedback
- Schedule next working group meeting
  - Full-Build scenario annual service volume operations
  - Full-Build runway use estimates
  - Full-Build flight tracks

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AUGUST 13, 2018 – PROJECTED ASV RESULTS, RUNWAY PATTERNS AND FLIGHT TRACK CHANGES

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Washington Dulles International Airport (IAD) Aircraft Noise Contour Map Update

Ultimate ASV, Runway Use and Flight Tracks

4th Working Group Briefing

8/13/18

Meeting Purpose

- Discuss Public Workshop input
- Discuss Annual Service Volume (ASV) methodology and results
- Discuss proposed additional night operation levels
- Discuss potential runway use for each airfield operation configuration
- Discuss noise model flight track development and future potential flight track changes
- Status update

Agenda

- Study Purpose
- Background
- Discussion
  - Public workshop input
  - Annual Service Volume (ASV) operation levels
  - Additional nighttime operation levels
  - Potential runway use
  - Noise model flight tracks
  - Future noise model flight track changes
- Project Progress/Next Steps

Study Purpose

Update the Dulles Airport noise contour map to incorporate changes in the aviation environment so that the future vision reflects these changes:

- Flight tracks and overall utility of the airfield have evolved
- Evolution will continue with implementation of NextGen
- Flight procedures will soon allow for triple simultaneous runway operations during low visibility conditions (IFR)
- Airport operational forecast changes

Background

New Noise Contours Maps will:

- Incorporate changes since the 1993 update critical to the region and the Airport
  - Significant tool the airport uses to assist local jurisdictions with their off-Airport land planning and zoning decisions
- Continue to ensure compatibility between the Airport and local jurisdictional land use and ensure local jurisdictions have the latest information available to make land use decisions
- Be based on Ultimate Build Scenarios

Discussion – Public Workshop Input

- Wednesday, June 27, 2018 - Washington Dulles International Airport Office Building, Sterling VA – 31 signed-in attendees[1/]
- Thursday, June 28, 2018 - Rock Ridge High School Cafeteria, Ashburn VA – 22 signed-in attendees[1/]
- Workshop boards available at website: http://www.flydulles.com/iad/dulles-international-noise-contour-map-update

Note:
1 Signed-in count does not include MWAA and project staff who signed the signature sheet.

Discussion – Public Workshop Input

- Received 9 written comments
- Comment Topics/FAQ

1) Will the study include a nighttime curfew or limit nighttime flights in any way?

   No, the study will simply generate noise contours to assist in land use planning. In addition, Washington Dulles International Airport is a 24/7 facility and no restrictions on nighttime flights are anticipated.

2) Will the flight tracks change?

   No, the study will simply generate noise contours based on the existing and anticipated future flight tracks. In addition, MWAA is not responsible for the flight tracks as FAA determines this.

3) Why are you using 65 DNL as the acceptable noise threshold for residential.

   FAA guidelines identify the 65 DNL contour as the threshold for residential incompatibility with airport noise. This guideline is specific to aircraft noise exposure and does not consider other ambient noise sources.

4) What type of sound insulation and fair disclosure requirements are being considered?

   MWAA is generating the contours for use by Fairfax and Loudoun Counties. Specific zoning regulations including sound insulation standards and fair disclosure requirements will be addressed by the Counties.

Discussion – Public Workshop Input

5) How can I stay informed?

If you included your email address on the sign in sheet you will receive an email notification of the next public workshop anticipated in November. In addition, if you go to our website, you can sign up to receive email updates when new information is posted to the website and receive notification of next public workshop.

http://www.flydulles.com/iad/dulles-international-noise-contour-map-update

6) Who do I talk to regarding flight tracks and noise complaints?

The website below provides information on flight tracks, noise complaints and noise monitoring systems, as well as contact information for your Noise Information Office.

http://www.flydulles.com/iad/iad-dulles-intl-aircraft-noise-information

Discussion – Annual Service Volume (ASV)

Background

- Study objective is to update the 1993 noise contours to assist with ongoing future land use planning.
  - 1993 noise contours were based on ultimate build (5 runways) and Annual Service Volume (ASV) of 740,000 operations
  - The update will be based on ultimate build and ASV
  - ASV has been updated to reflect future changes due to NextGen and future vision for the airport

Discussion – Annual Service Volume (ASV)

Formula

- Annual Service Volume (ASV)
  - Annual airport capacity estimate.
  - Accounts for differences in runway use, aircraft mix, weather conditions, etc.

$$ASV = C_w \times D \times H$$

C_w: Weighted Hourly Capacity

D: Seasonal Factor

H: Hourly Peaking Factor

Discussion – Annual Service Volume (ASV)

Methodology

- Hourly Capacity (C)
  - Measure of the maximum number of aircraft operations in an hour
  - Calculated for each runway configuration
- Weighted Hourly Capacity (Cw)
  - Hourly capacity adjusted for:
    - Fleet mix
    - Percentage time each runway configuration is used

Discussion – Annual Service Volume (ASV)

Calculating Hourly Capacity (C)

- runwaySimulator program used to calculate hourly capacity (C) for each runway configuration
- Program is used by MITRE on behalf of FAA to estimate hourly runway capacity
- Updated MITRE files to include 5 runway configuration and future NextGen enhancements

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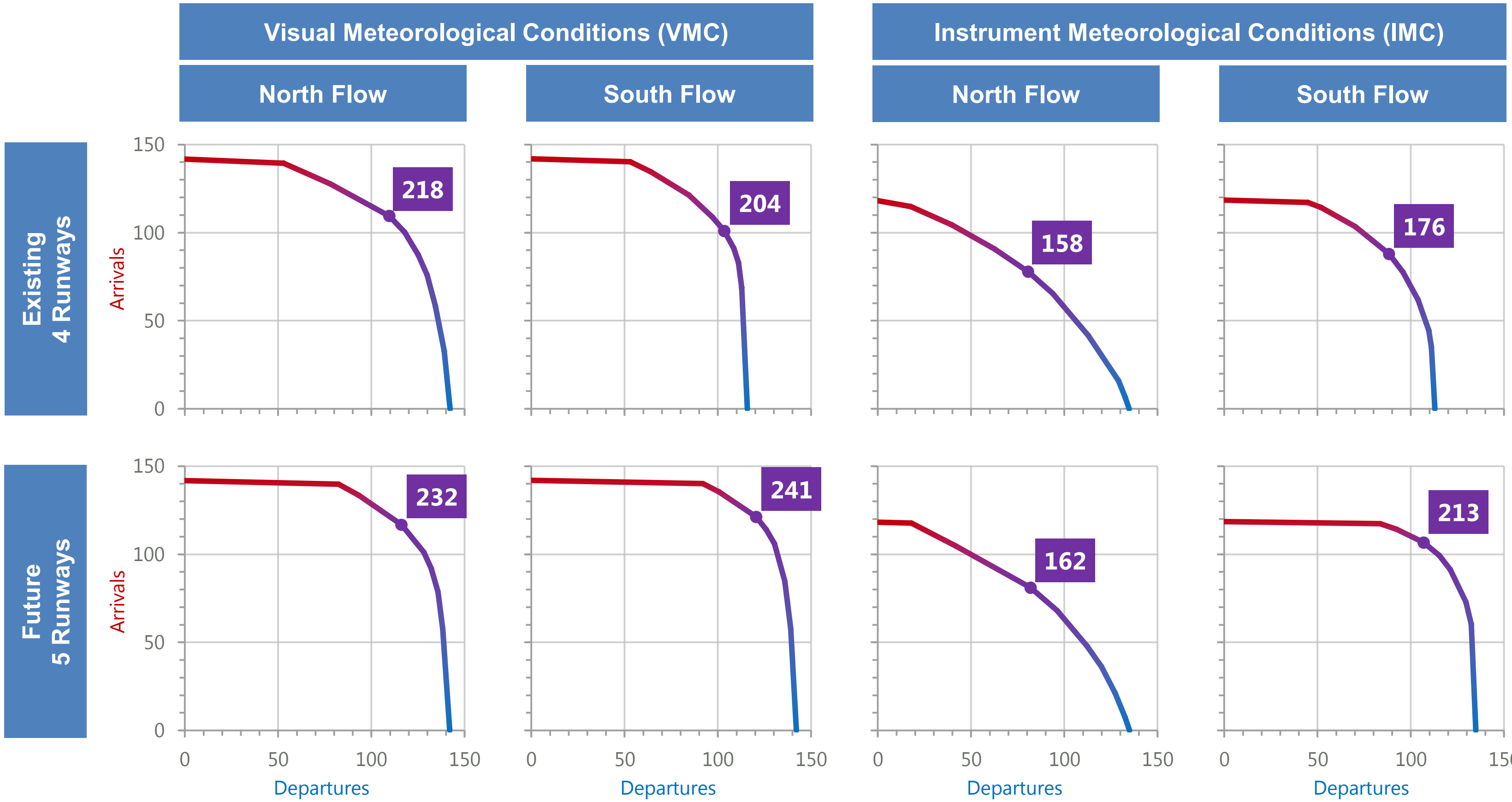
Discussion – Annual Service Volume (ASV)

Hourly Capacity by Runway Configuration



Source: Ricondo, runwaySimulator Output, July 2018.

Discussion – Annual Service Volume (ASV)

D and H Factors

- D - Ratio of Annual Demand to Peak Month Average Day (PMAD) demand
  - The higher the D value, the more days per year the airport experiences PMAD demand.
  - Example - a D value of 365 would suggest that the airport experiences the same demand every day of the year.
  - Accounts for seasonal variations in activity.
- H - Ratio of PMAD demand to demand during the peak hour of the PMAD
  - Defines the relationship between PMAD and peak hour demand
  - Theoretical maximum ratio would be 24 if demand every hour was at the peak
  - Accounts for hourly peaking characteristics of the airport.

Discussion – Annual Service Volume (ASV)

D and H Factor Benchmarking

- Existing profile of activity at IAD is not indicative of Ultimate Build conditions (near capacity)
- Benchmarking was done of other airports operating closer to their capacity
- Selected D and H factors based on shared characteristics:
  - Significant international gateway activity
  - Some late-night and early-morning operations

Discussion – Annual Service Volume (ASV)

D and H Factor for Ultimate

$$ASV = C_w \times 332 \times 15$$

Weighted Hourly Capacity

D: Seasonal Factor

H: Hourly Peaking Factor

- D and H factors are within the range of FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*, typical demand ratio range for an airport that serves large and heavy jet aircraft[1/]

Source: Federal Aviation Administration. Advisory Circular 150/5060-5, Airport Capacity and Delay. Table 3-2, "Typical Demand Ratios." September 1983.

Discussion – Annual Service Volume (ASV)

Recommended ASV

Config	Weather	Flow	Mix Index [1]	Annual Utilization [2] (P)	Existing Airfield – 4 Runways: Hourly Capacity [3] (C)	Existing Airfield – 4 Runways: Percent of Maximum Hourly Capacity [4]	Existing Airfield – 4 Runways: Weighting Factor [5] (W)	Ultimate Airfield – 5 Runways: Hourly Capacity [3] (C)	Ultimate Airfield – 5 Runways: Percent of Maximum Hourly Capacity [4]	Ultimate Airfield – 5 Runways: Weighting Factor [5] (W)
1	VMC	North	100	46.5%	218	100%	1	232	96%	1
2		South	100	34.8%	204	94%	1	241	100%	1
3	IMC	North	100	8.6%	158	72%	0.5	162	67%	0.5
4		South	100	10.1%	176	81%	0.5	213	88%	0.5
Weighted Hourly Capacity [6] (C_w)					208			232		
Annual / Average Daily Demand [7] (D)					332.04					
Average Daily / Peak Hour Demand [8] (H)					15.17					
ASV [9]					**1,048,000**			**1,169,000**		

Notes:

1 Mix index = C_1 + $2C_2$ + 3D where:
C_1 = % of Large aircraft with Maximum Certified Takeoff Weight (MTOW) between 12,500 and 300,000 pounds (excluding B757 aircraft)
C_2 = % of B757 aircraft
D = % of Heavy aircraft with MTOW greater than 300,000 pounds
Calculated using 2017 operations

2 Annual utilization based on analysis of 2008-2017 ASPM weather and configuration by hour data

3 Hourly capacity based on runwaySimulator analysis

4 Each configuration capacity divided by the maximum configuration capacity

5 As determined using Table 3-1 of Advisory Circular 150/5060-5, except IMC = 0.5 as documented in 2012 ASV Study

6 $C_w = (P_1 \times C_1 \times W_1) + (P_2 \times C_2 \times W_2) + (P_3 \times C_3 \times W_3) + (P_4 \times C_4 \times W_4) / (P_1 \times W_1) + (P_2 \times W_2) + (P_3 \times W_3) + (P_4 \times W_4)$

7 Calculated using 2017 JFK peaking characteristics, which were assumed to represent a similar demand profile to IAD at maximum utilization

8 Calculated using 2017 JFK peaking characteristics, which were assumed to represent a similar demand profile to IAD at maximum utilization

9 ASV = C_w x D x H

Sources: Ricondo, runwaySimulator Output, July 2018; FAA, Advisory Circular 150/5060-5 (Change 2) – Airport Capacity and Delay, September 23, 1983; U.S. DOT, DRAFT Washington Dulles International Airport Annual Service Volume Study, August 2012; FAA, OPSNET, July 2018; Innovata, July 2018.

Discussion – Annual Service Volume (ASV)

Recommended ASV

- 4 runway configuration - 1,048,000
  - Average Annual Day – 2,871
- 5 runway configuration - 1,169,000
  - Average Annual Day – 3,203

Discussion – Operations Input

- Operations file based on ASV
  - Arrival/Departure
  - Fleet mix
  - Time of Day (day/night)
- Operations are distributed as follows:
  - Runway Operating Configuration
  - Individual runways
  - Flight tracks to/from runways

Discussion – Night Operations

- Based on forecasted activity levels for domestic/international passenger and cargo flights

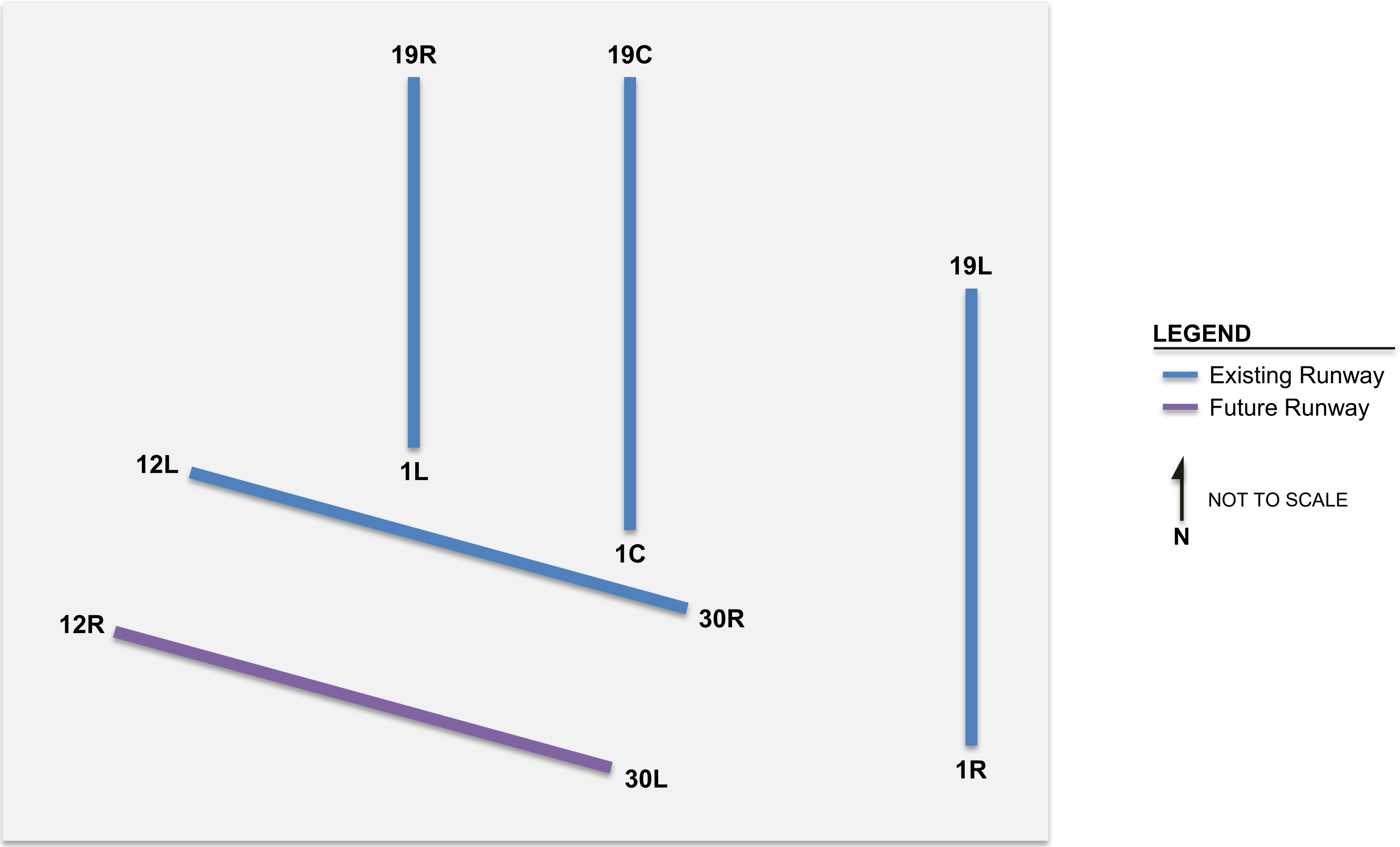
Discussion – Potential Runway Use

Airport Infrastructure Assumptions

- Taxiways/other facilities (terminals, gates, cargo and general aviation) are adequate
- Airspace and procedures available to accommodate maximum sustained throughput
  - Including foreseen NextGen capabilities
- Airport operation levels close to capacity constrained levels
  - Point when demand management may be required

Discussion – Potential Runway Use

Runway Layout



Discussion – Potential Runway Use

Airfield Operating Configurations

- Runway use
- Weather
  - Wind direction
  - Visual meteorological conditions (VMC)
  - Instrument meteorological conditions (IMC)
- Conditions/demand
  - Existing
  - Future – Ultimate Build/Capability
- Airfield
  - Existing
  - Ultimate Build – 4 runways
  - Ultimate Build – 5 runways
- Basis for assumptions
  - 2017 Airport Noise and Operations Monitoring System (ANOMS) data
  - 2005 Environmental Impact Statement (EIS) – 4 and 5 runways

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Discussion – Potential Runway Use

Primary Runway Operating Configuration Analysis

Configuration/ Weather	Share	Base Normalization	Reaggregation	Adjusted Normalization
VMC	**81.3%**			
North/West	44.9%	48.1%	46.2%	46.5%
South/West	30.9%	33.2%	34.6%	34.8%
South/East	3.1%			
North	1.0%			
South	0.6%			
Mixed	0.5%			
West	0.3%			
North/East	0.0%			
East	0.0%			
IMC	**18.7%**			
North/West	8.3%	8.8%	8.6%	8.6%
South/West	9.4%	10.0%	10.1%	10.1%
South/East	0.3%			
North	0.3%			
South	0.3%			
Mixed	0.1%			
West	0.0%			
North/East	0.0%			
East	0.0%			
North	**53.2%**	**56.9%**	**54.7%**	**55.1%**
South	**40.4%**	**43.1%**	**44.6%**	**44.9%**

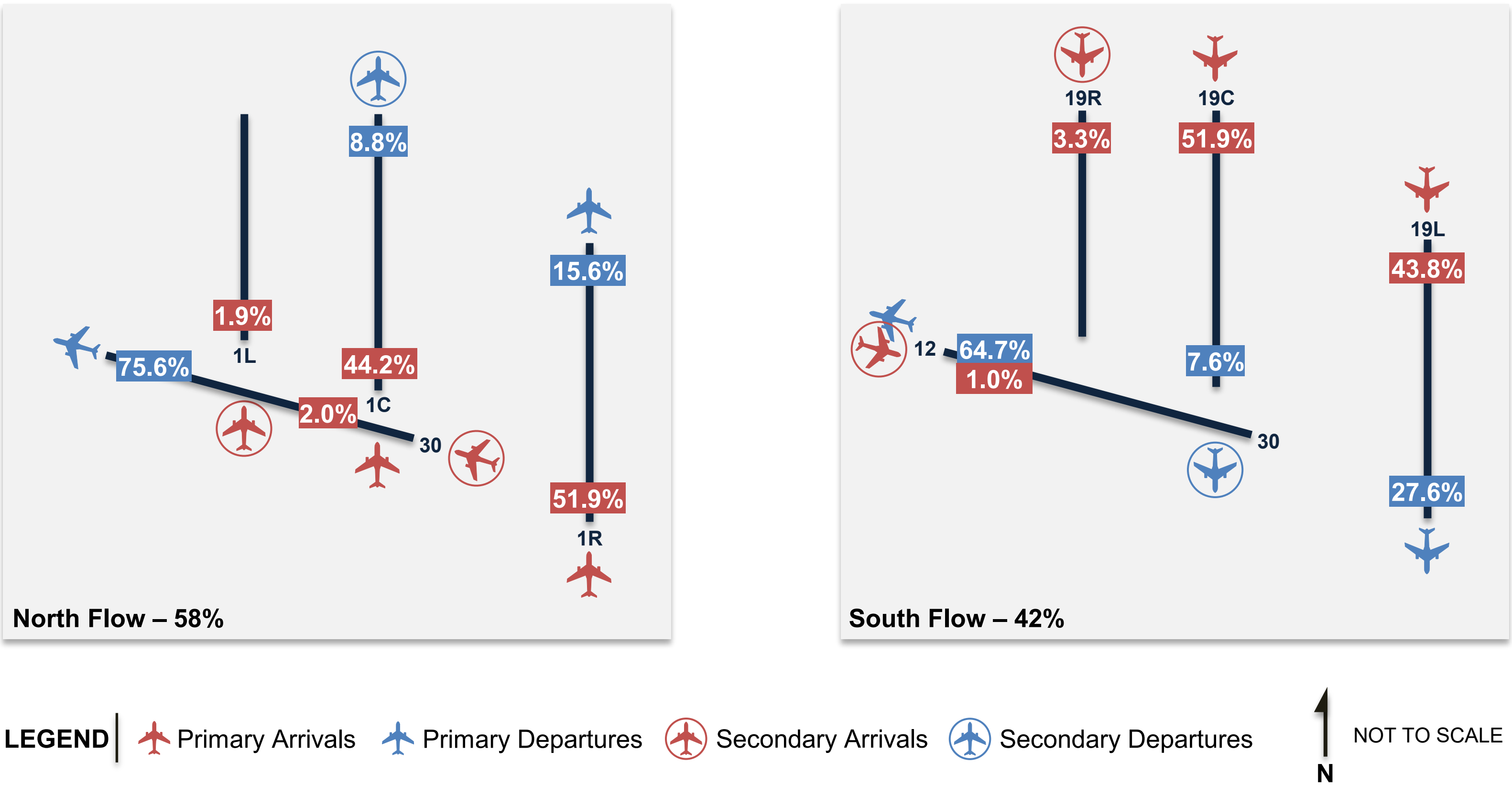
Source: FAA, ASPM, Airport Efficiency – Daily Weather by Hour Report, 2008-2017.

Configuration	Average Annual Day (AAD) Operations			AAD Share		
	Day	Night	Total	Day	Night	Total
North	404	67	470	50%	8%	58%
South	284	50	335	35%	6%	42%
Total	**688**	**117**	**805**	**85%**	**15%**	**100%**

Source: HMMH, *IAD 2017 Initial Configuration Analysis*, April 2018.

Discussion – Potential Runway Use

Existing Airfield Operating Configurations – 2017

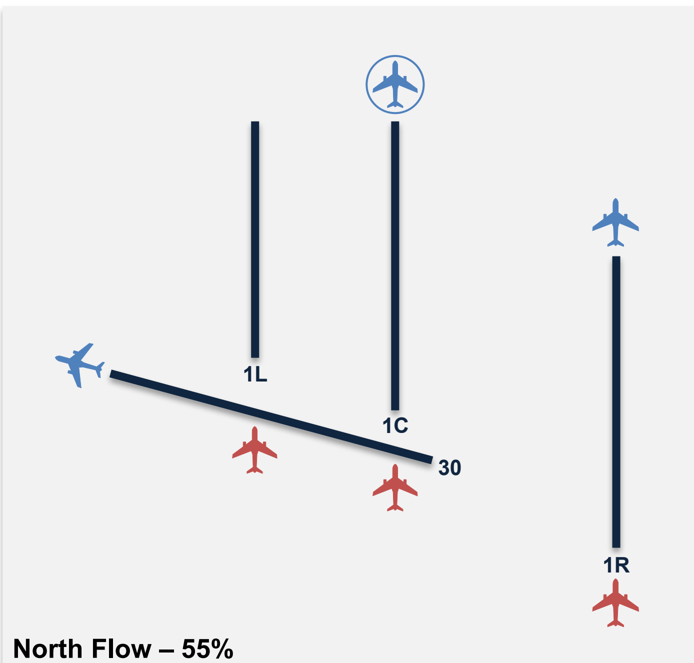


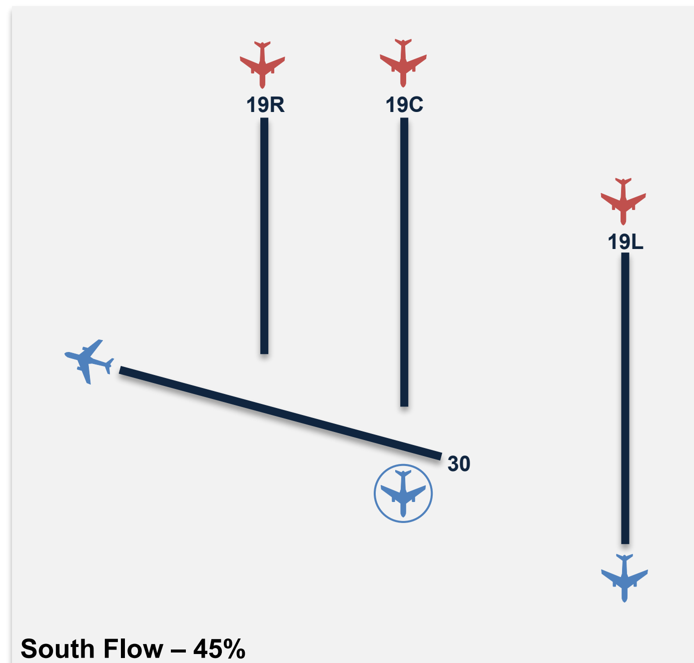
Source: HMMH, *IAD 2017 Initial Configuration Analysis*, April 2018.

Note: runway use normalized to exclude opposite runways during configuration transition in an hour
Graph does not depict runway use below 0.5 percent.

Discussion – Potential Runway Use

4-Runway Airfield Operating Configuration Definition





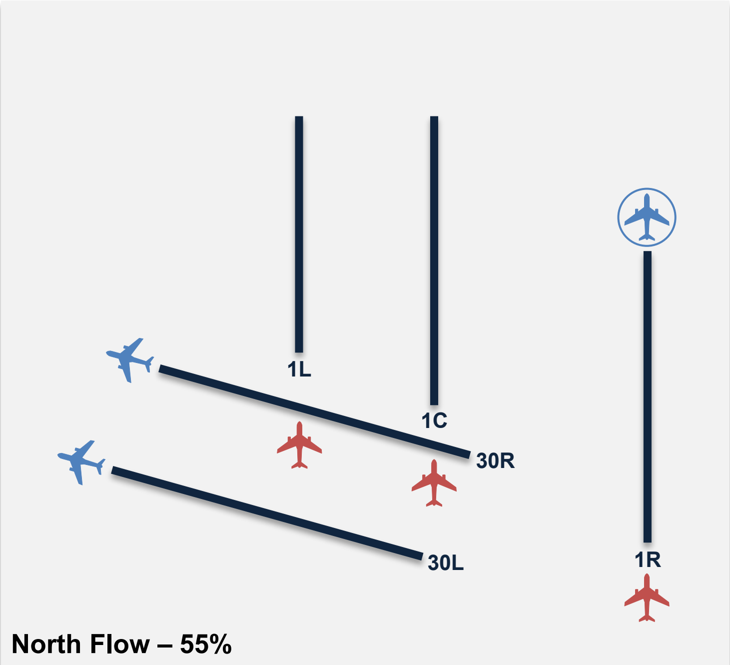
LEGEND | Primary Arrivals | Primary Departures | Secondary Arrivals | Secondary Departures

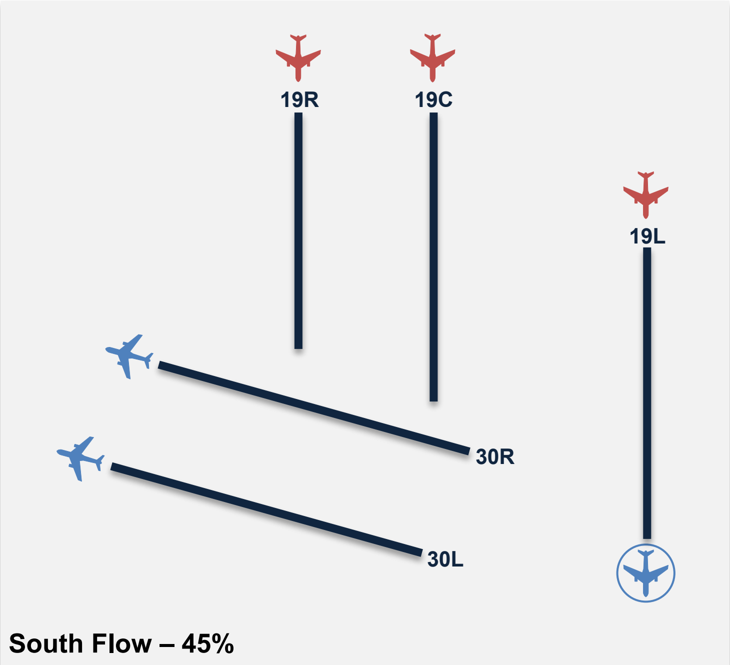
N

NOT TO SCALE

Discussion – Potential Runway Use

5-Runway Airfield Operating Configuration Definition





LEGEND | Primary Arrivals | Primary Departures | Secondary Arrivals | Secondary Departures

N

NOT TO SCALE

Discussion – Potential Runway Use

4-Runway Airfield Proposed Runway Use

LEGEND

- Arrivals
- Departures

NOT TO SCALE

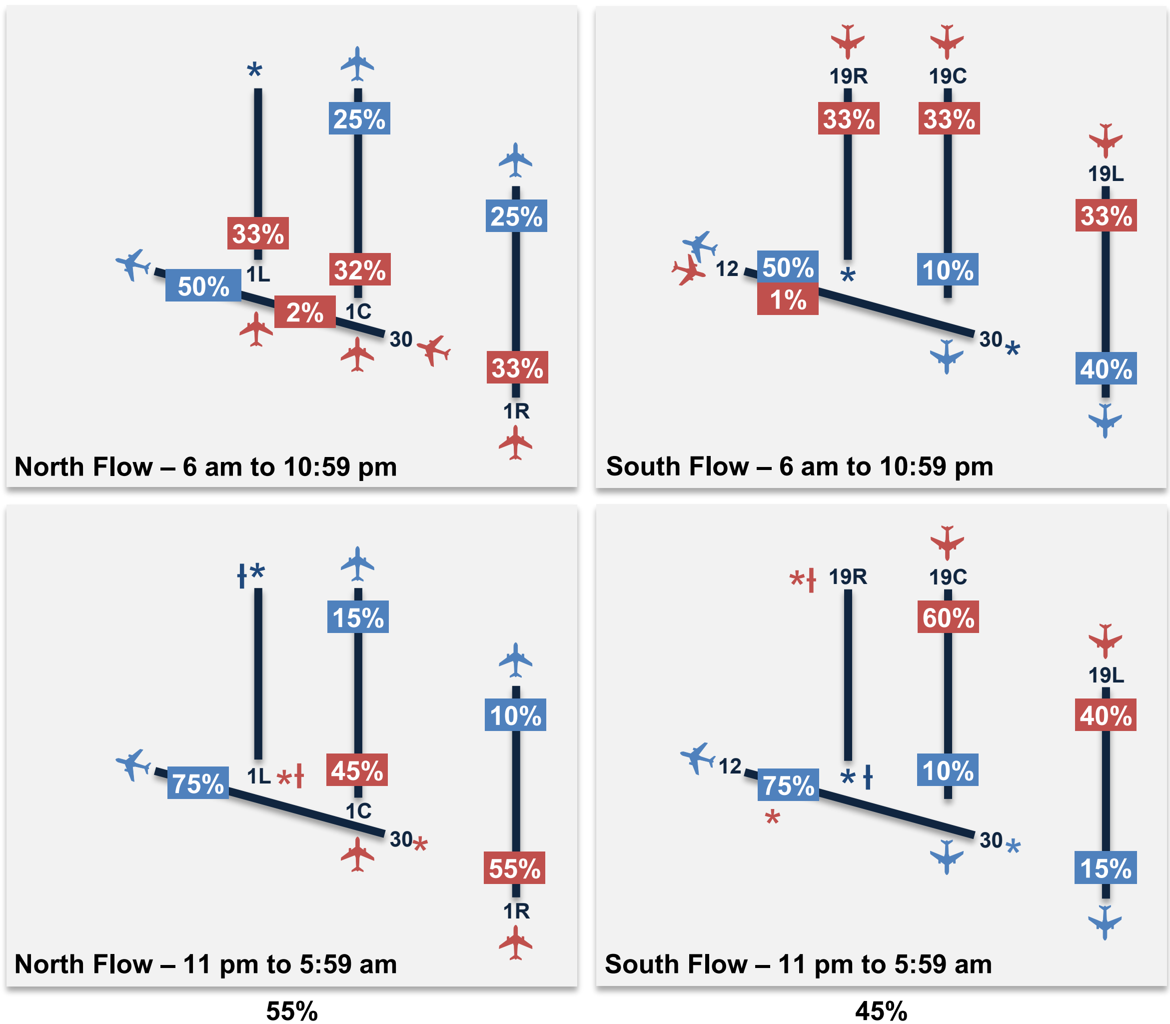
N

Note:

ǂ Proposed runway use depicted does not yet include late night cargo operation scenarios. Will be included when future operations file is completed.

* Graph does not depict runway use below 0.5 percent. Model will maintain some use of those runways based on 2017 patterns.

Modeled runway use will vary slightly based on operation assignments to runways and flight tracks



Discussion – Potential Runway Use

5-Runway Airfield Proposed Runway Use

LEGEND

Arrivals

Departures

NOT TO SCALE

N

Note:

ǂ Proposed runway use depicted does not yet include late night cargo operation scenarios. Will be included when future operations file is completed.

* Graph does not depict runway use below 0.5 percent. Model will maintain some use of those runways based on 2017 patterns.

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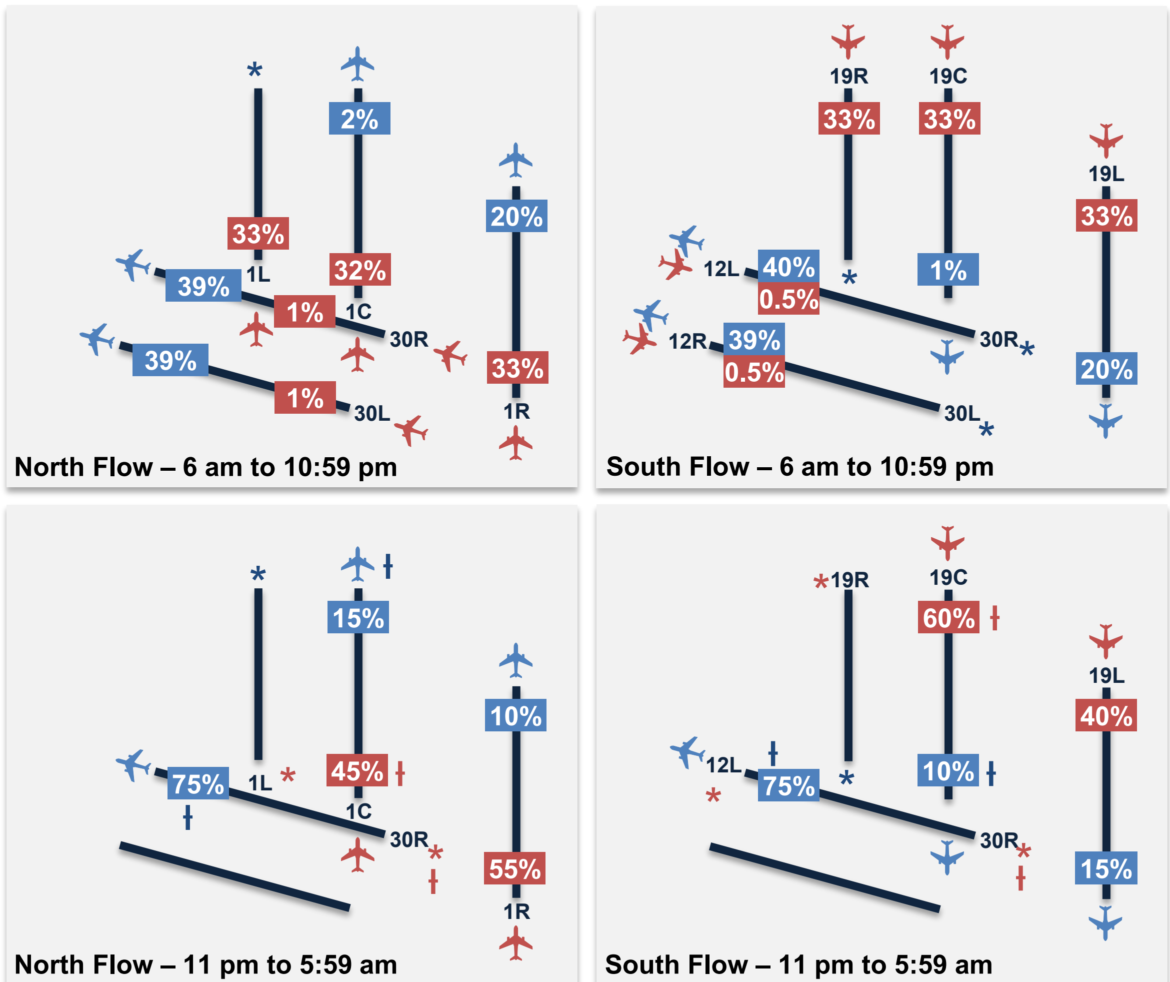

55%

45%

Discussion – Noise Modeling Flight Tracks

- Existing Flight Tracks
  - Source data and model tracks creation methodology
  - Existing flight track figures
- Future Flight Tracks
  - FAA input
  - New runway tracks
  - Other changes to existing tracks

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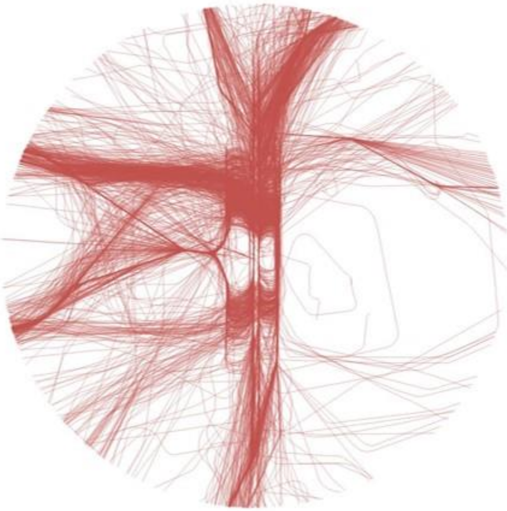
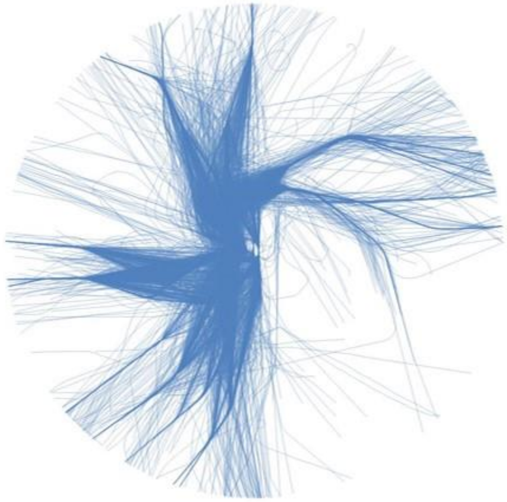
Discussion – Noise Modeling Flight Tracks

Existing Flight Tracks

- Flight Track Data
  - Source: MWAA Noise and Operations Monitoring System
  - Over 290,000 arrivals and departures from 2017
  - Coverage out 25 nmi
  - Arrivals and departures for one week shown

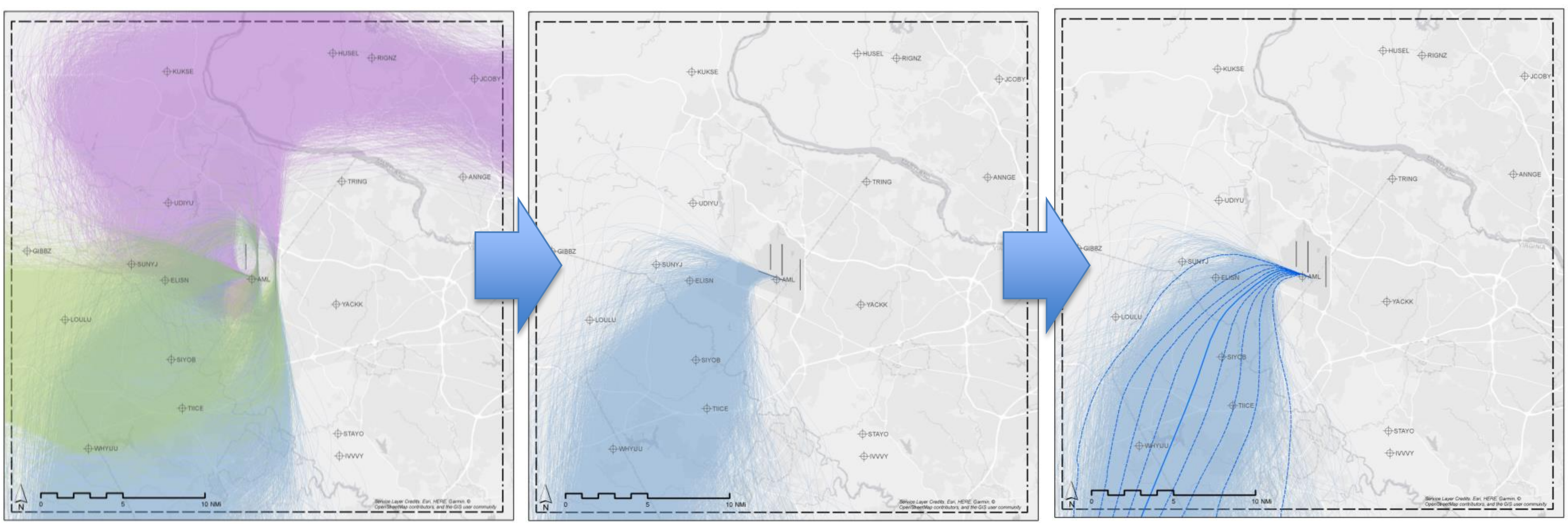




Discussion – Noise Modeling Flight Tracks

Methodology

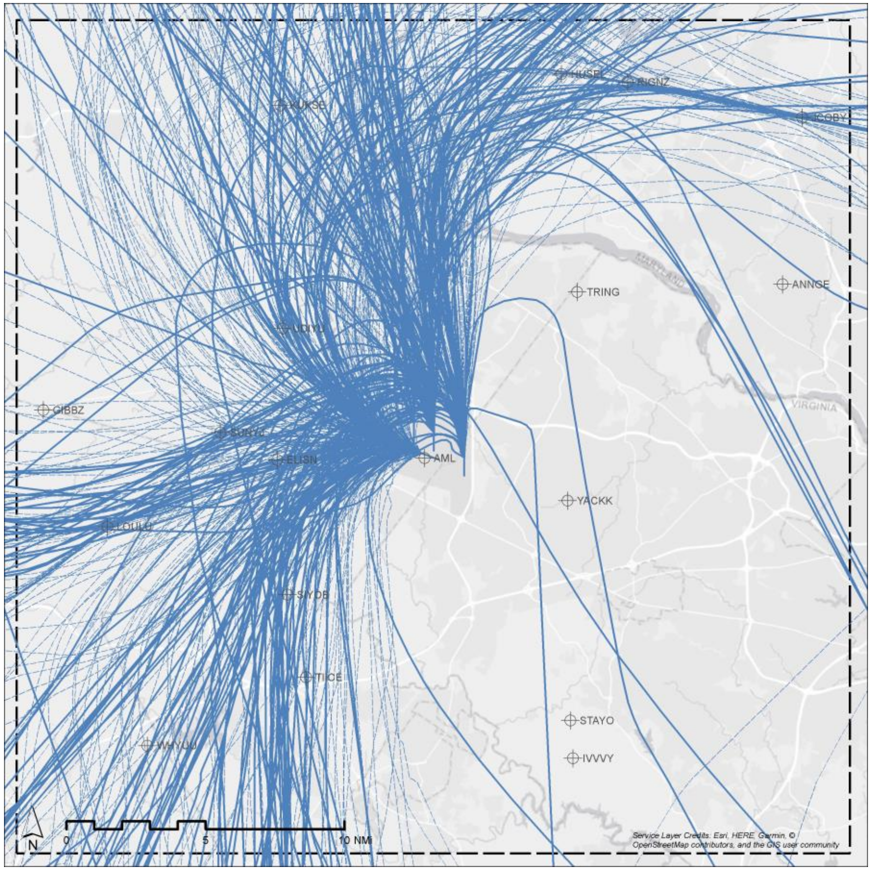
- Model Flight Track Creation Methodology
  - Bundle tracks by operation type, procedure, and runway end
  - Use software to compute the backbone and dispersed flight paths

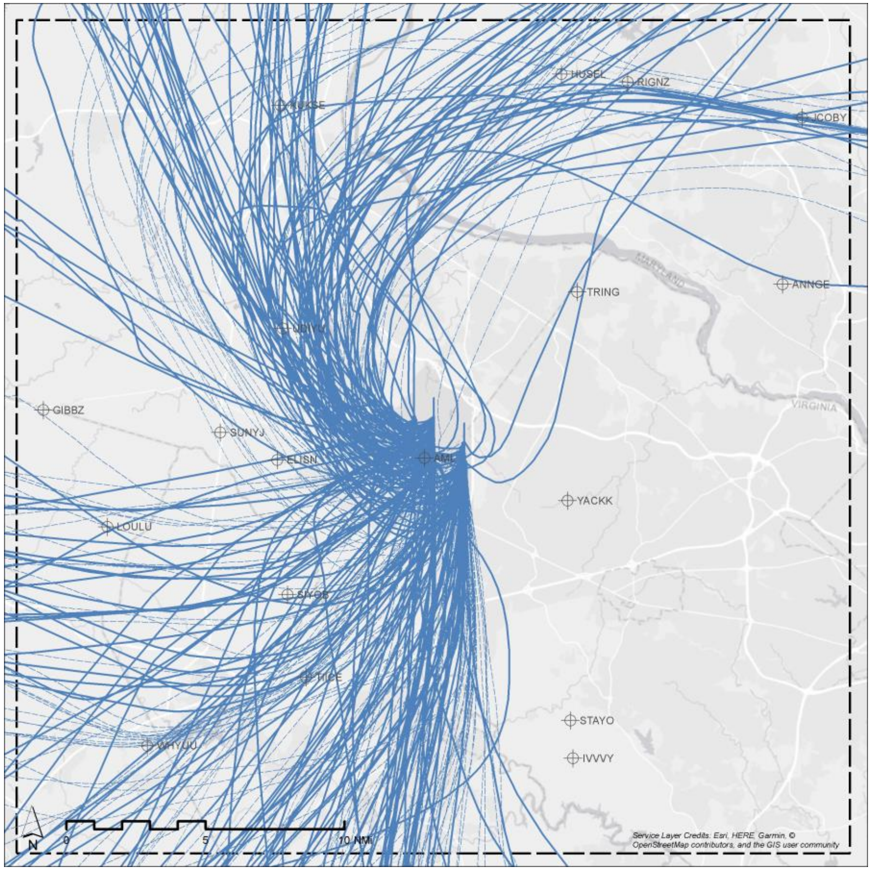


Discussion – Noise Modeling Flight Tracks

Departure Tracks

- North Flow and South Flow Departure Model Tracks

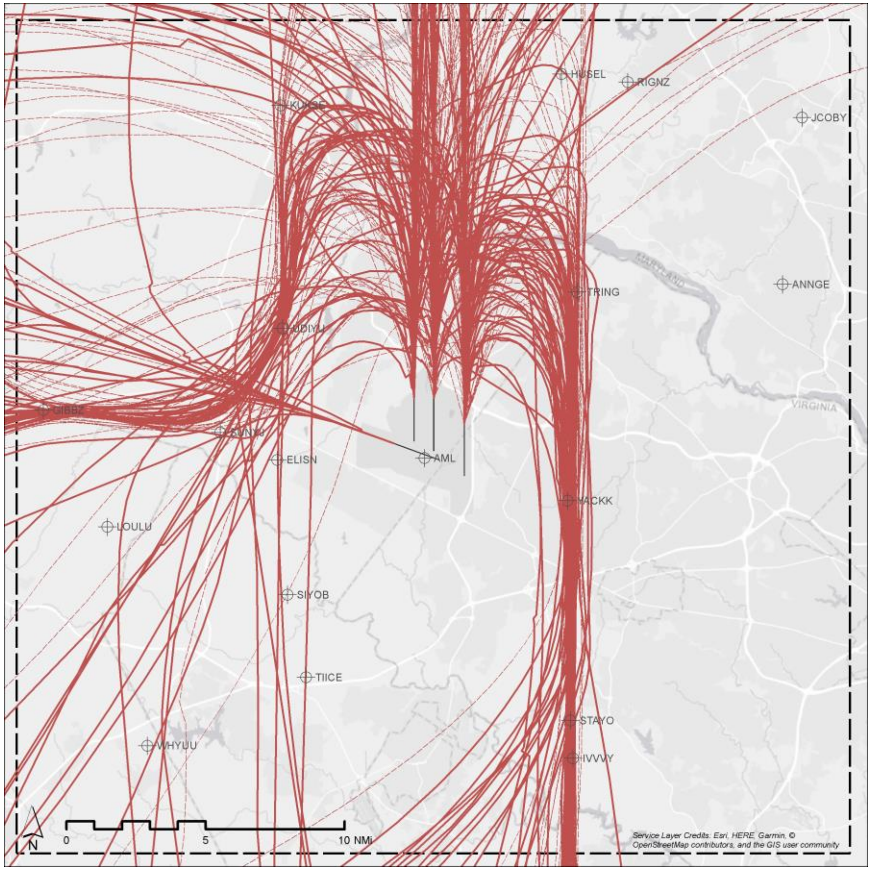




Discussion – Noise Modeling Flight Tracks

Arrival Tracks

- North Flow and South Flow Arrival Model Tracks



Discussion - Future Flight Tracks

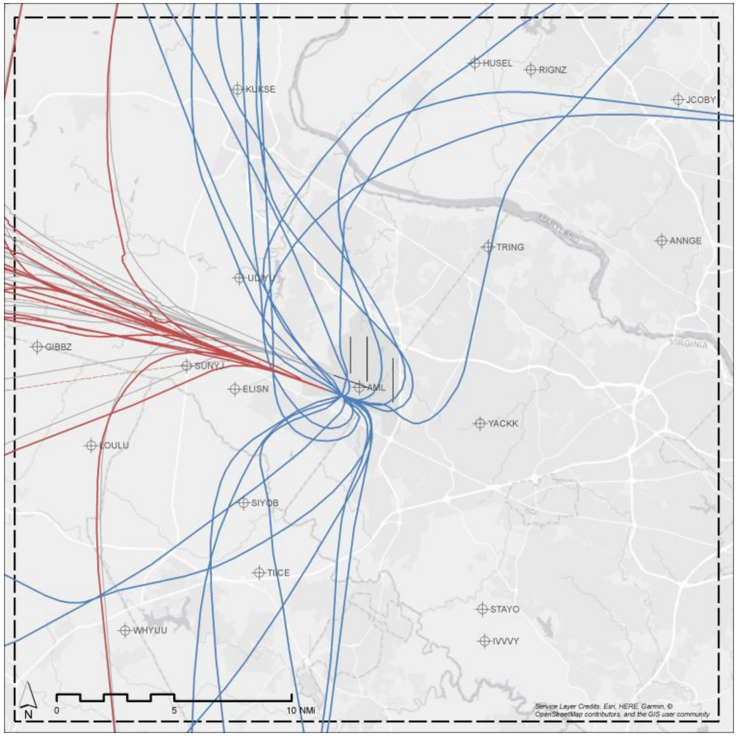
FAA Input

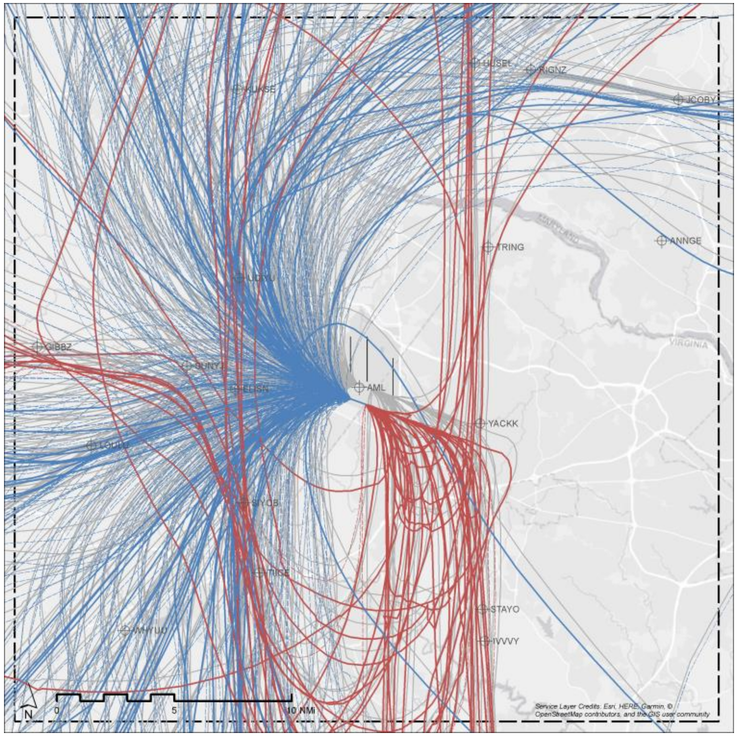
- Most track geometry will remain unchanged into the future
- Controllers will still vector aircraft near the airport
- Flight track usage may change
- New future flight tracks geometry
  - Similar flight paths for new Runway 12R/30L as existing 12/30
  - New RNP approaches
  - Modification of downwind for some arrivals

Discussion - Future Flight Tracks

New Runway 12/30 (5th Runway) Tracks

- Translated from existing Runway 12/30 tracks
- Modified to attach to existing waypoints from same procedures used for Runway 12/30 operations

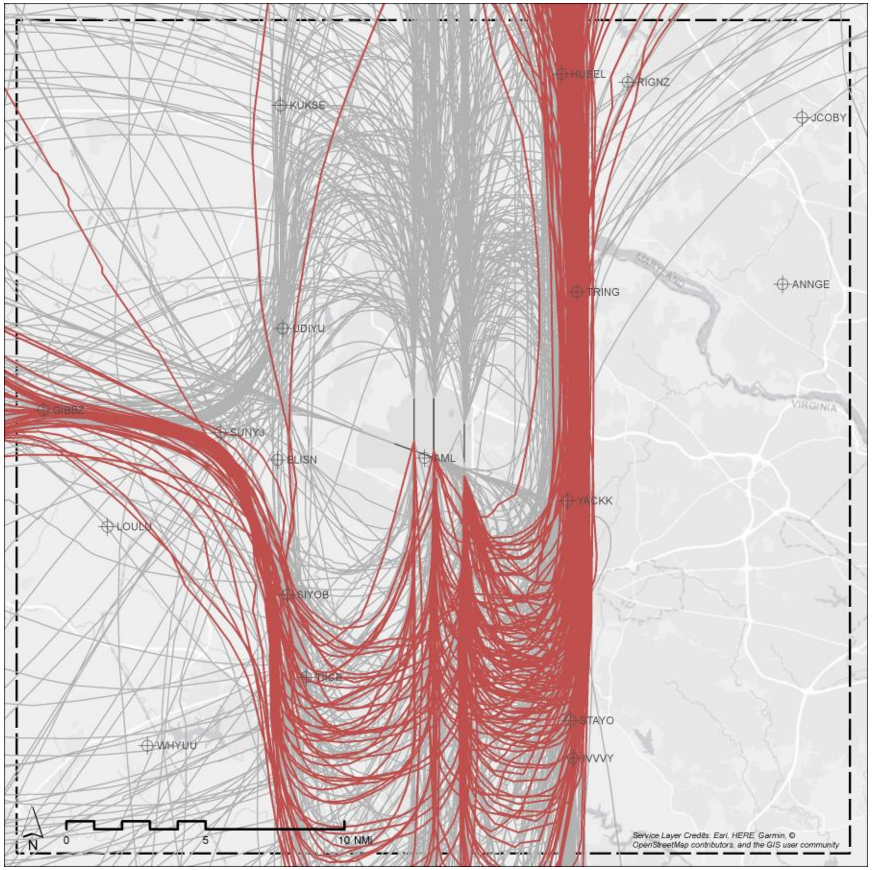




Discussion - Future Flight Tracks

Triple Arrival Procedure Modifications

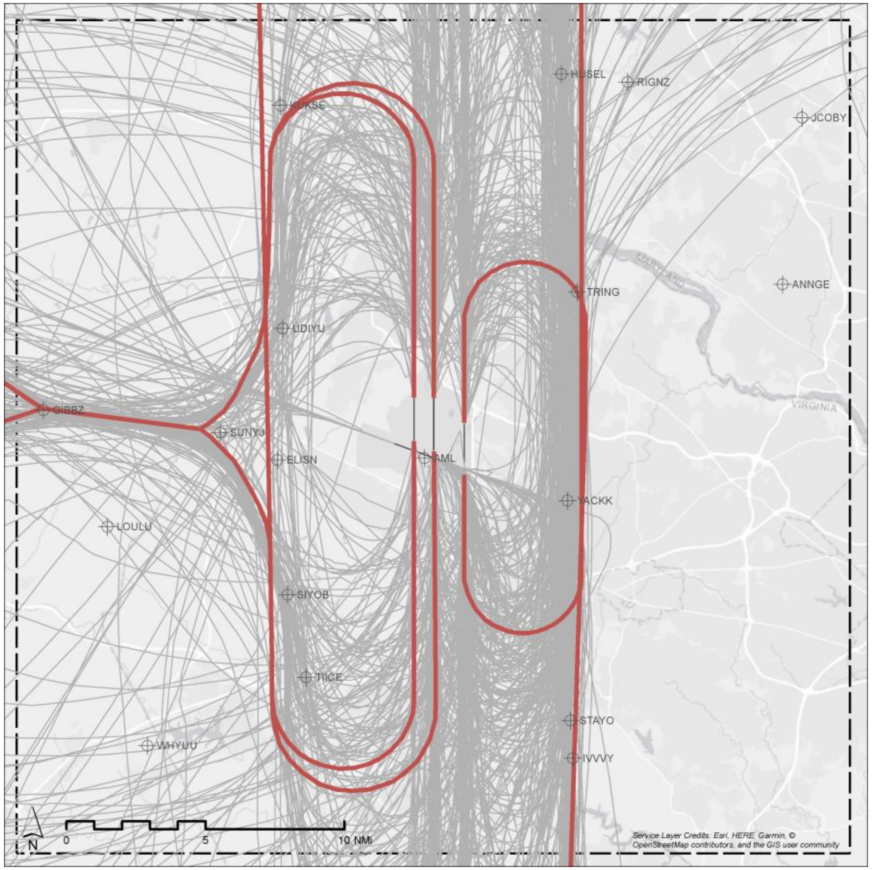
- Modified North Flow Downwind



Discussion - Future Flight Tracks

Approaches

- New RNP Approaches



Process and Next Steps

In Process
Completed
Upcoming

Inventory

- Evaluate current and future plans (MWAA and FAA) ✓
- Assess existing operation conditions ✓

Forecast

- Determine full-build scenario(s) ✓
- Determine maximum potential operations ✓
- Determine potential aircraft runway use and flight tracks ✓

Noise Modeling

- Develop baseline noise model (In Process)
- Calculate potential aircraft noise levels for full-build scenario(s) (Upcoming)
- Determine appropriate composite of potential scenarios, if appropriate

Conclusions

- Recommend potential aircraft noise contours for land use planning

As of 8/13/18

Conclusion

- Feedback
- Schedule next working group meeting
  - Ultimate average annual day operations summary

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SEPTEMBER 25, 2018 – PROJECTED ASV ANNUAL AVERAGE DAY (AAD) OPERATIONS

Meeting Purpose

- Discuss methodology of Ultimate build scenario operations AEDT model input
- Discuss proposed AEDT model input
- Status update

Agenda

- Study Purpose
- Background
  - Summary of last stakeholder meeting
  - Annual Service Volume (ASV) operation levels
- Discussion
  - Ultimate airport operations development methodology
  - Ultimate airport operations model input
    - Ultimate nighttime operations
    - Ultimate operations by user category
    - Ultimate operations by time of day
    - Ultimate operations by fleet mix
    - Ultimate operations by air service category
- Project Progress/Next Steps

Study Purpose

Update the Dulles Airport noise contour map to incorporate changes in the aviation environment so that the ultimate vision reflects these changes:

- Flight tracks and overall utility of the airfield have evolved
- Evolution will continue with implementation of NextGen
- Flight procedures will soon allow for triple simultaneous runway operations during low visibility conditions (IFR)
- Airport operational forecast changes

Background

New Noise Contours Maps will:

- Incorporate changes since the 1993 update critical to the region and the Airport
  - Significant tool the airport uses to assist local jurisdictions with their off-Airport land planning and zoning decisions
- Continue to ensure compatibility between the Airport and local jurisdictional land use and ensure local jurisdictions have the latest information available to make land use decisions
- Be based on Ultimate Build Scenarios

Background – Last Stakeholder Meeting

- Presented and agreed upon Ultimate Build Scenario 4 Runway and 5 Runway ASVs
- Presented proposed future runway use
- Presented proposed future flight tracks

Background
Ultimate Annual Service Volume (ASV)
Recommended ASV

- Ultimate ASV 4 runway configuration (ASV 4) - 1,048,000
  - Average Annual Day (AAD)– 2,871
- Ultimate ASV 5 runway configuration (ASV 5) - 1,169,000
  - Average Annual Day (AAD) – 3,203

Discussion – Ultimate Airport Operations Development Methodology

- 8 Step Process that includes:
  - Project 2017 AAD flight operations by User Category to equal Ultimate ASV 4 and ASV 5 AAD operation levels
  - Incorporate additional scheduled passenger and cargo service during nighttime hours (10:00 p.m. to 6:59 a.m.)
  - Account for aircraft retirements
  - Identify need for use of larger aircraft to accommodate potential number of enplaning and deplaning passengers at Ultimate ASV 4 and ASV 5 AAD operation levels

Discussion – Ultimate Operations Development Methodology (con't)

- **<u>Step 1:</u>** Use operations data based on MWAA's 2017 Airport Noise and Operations Management System (ANOMS) database to identify a representative average annual day of operations, which includes:
  - Aircraft type and typical number of seats
  - Operation mode (arrival/departure)
  - Origin/Destination stage length[1/]
  - Time of Day (day/night)
  - Operator type (Scheduled Air Carrier, Cargo Air Carrier, Scheduled Air Taxi, Unscheduled Air Taxi, Cargo Air Taxi, General Aviation and Military
  - User Category type (Air Carrier, Air Taxi, General Aviation and Military)

<u>Example flight:</u>
1 Boeing 767-300, 210 seats, Departure, Stage Length 6, Daytime, Scheduled Air Carrier, Air Carrier

1/ Stage length is a number in FAA's AEDT model that represents a range of trip distances for departures. AEDT defines the range as follows:

Stage Length	City Trip Length Range (nautical miles)
1	0 to 500
2	501 to 1,000
3	1,001 to 1,500
4	1,501 to 2,500
5	2,501 to 3,500
6	3.501 to 4,500
7	4,501 to 5.500
8	5,501 to 6,500
9	More than 6,500

Discussion – Ultimate Operations Development Methodology (con't)

- **<u>Step 2:</u>** Determine estimated operations growth rate for each User Category[1/] based on FAA 2017 Terminal Area Forecast (TAF) last five-year growth rates
  - Use average annual growth rate based on last five years of 2017 TAF
  - Average annual growth rate by User Category:
    - Air Carrier: 1.65%
    - Air Taxi: 1.20%
    - General Aviation: 0.3%
    - Military: 0%

1/ FAA User Category definitions:
<u>Air Carrier</u>: An air carrier operator is defined as a company for hire or compensation which operates aircraft originally designed to have more than 60 passenger seats or a maximum payload of more than 18,000 pounds carrying passengers or cargo on either a scheduled or charter basis. This includes US and foreign flagged carriers. An air carrier operator must register with the Department of Transportation.
<u>Air Taxi</u>: An air taxi operator is defined as a company for hire or compensation which operates aircraft originally designed to have no more than 60 passenger seats or a maximum payload up to 18,000 pounds carrying passengers or cargo on either a scheduled or charter basis, and/or carries passengers on an on-demand basis or limited scheduled basis.. An air taxi operator must register with the Department of Transportation.
<u>General Aviation</u>: All civil aircraft, except those classified as Air Carriers or Air Taxis
<u>Military</u>: All classes of military operations, no matter the type or size of aircraft.

Discussion – Ultimate Operations Development Methodology (con't)

- **Step 3:** Starting at the last year of the 2017 TAF, increase the individual User Category operations by the average growth rates from Step 2 until the total Ultimate ASV 4 and ASV 5 AAD operations level is achieved
- **Step 4:** Increase 2017 AAD operations by copying flights proportionately to reach Ultimate ASV 4 and ASV 5 User Category operation levels

Example 2017 flight:
1 Boeing 767-300, 210 seats, Departure, Stage Length 6, Daytime, Scheduled Air Carrier, Air Carrier

→

Example ASV 4 flight:
4 Boeing 767-300, 210 seats, Departure, Stage Length 6, Daytime, Scheduled Air Carrier, Air Carrier

Discussion – Ultimate Operations Development Methodology (con't)

- **Step 5:** Add Ultimate nighttime scheduled passenger and cargo flights to Air Carrier and Air Taxi Scheduled Passenger and Cargo operator type categories
  - Additional cargo operations: 74 per night [1/]
  - Additional passenger operations: 324 per night [1/]

1/ Provided by MWAA and discussed at Working Group Meeting #3 on August 13, 2018

Discussion – Ultimate Operations Development Methodology (con't)

- **Step 6:** Replace aircraft planned for retirement with expected replacement aircraft based on airline announcements and orders
  - Remove aircraft planned by air carriers for retirement: Boeing 757, Boeing 767, Boeing MD-80/90s, DC-10-30, MD-11, and 50-seat regional jets (e.g. Bombardier Canadair Regional Jets (CRJ); Embraer 145)
  - Replace with newer generation aircraft like the Airbus 350, Airbus 319/320/321 NEO, Boeing 787, Boeing 737-MAX, Embraer 190 and Bombardier CRJ-900

Example ASV 4 flight:
4 Boeing 767-300, 210 seats, Departure, Stage Length 6, Daytime, Scheduled Air Carrier, Air Carrier

→

Example ASV 4 flight:
4 *Boeing 787-800, 250 seats*, Departure, Stage Length 6, Daytime, Scheduled Air Carrier, Air Carrier

Discussion – Ultimate Operations Development Methodology (con't)

- **Step 7:** Determine the need to increase the size of the passenger service aircraft
  - Projected Ultimate annual passenger levels: Apply average annual growth rate in last 5 years of 2017 TAF to estimate enplanements for Ultimate ASV 4 and ASV 5 annual operation levels, and multiply by 2 to get projected total annual passengers
  - Required Seats to Serve Ultimate AAD Demand: Divide total annual passengers by a AAD load factor and then divide by 365 days to determine number of AAD scheduled airline seats required to serve the projected Ultimate ASV 4 and ASV 5 AAD passengers
  - Up-gauge Aircraft Type: Assign larger aircraft type to operations if more seats are needed

Example ASV 4 flight:
4 Boeing 787-800, 250 seats, Departure, Stage Length 6, Daytime, Scheduled Air Carrier, Air Carrier

→

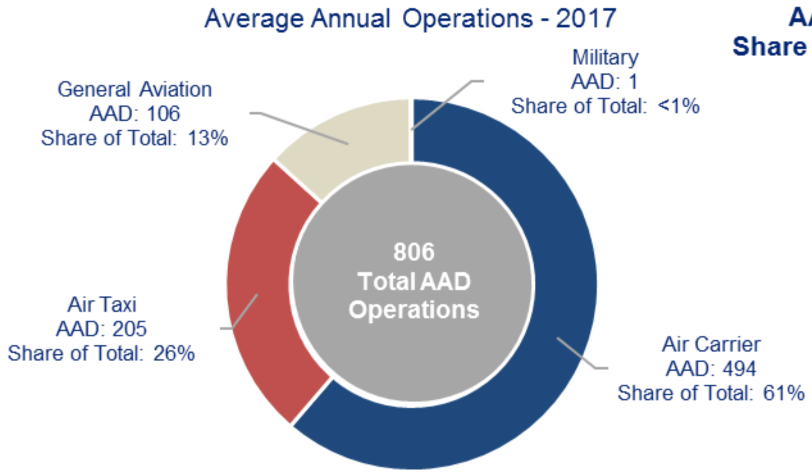
Example ASV 4 flight:
4 *Boeing 787-900, 300 seats*, Departure, Stage Length 6, Daytime, Scheduled Air Carrier, Air Carrier

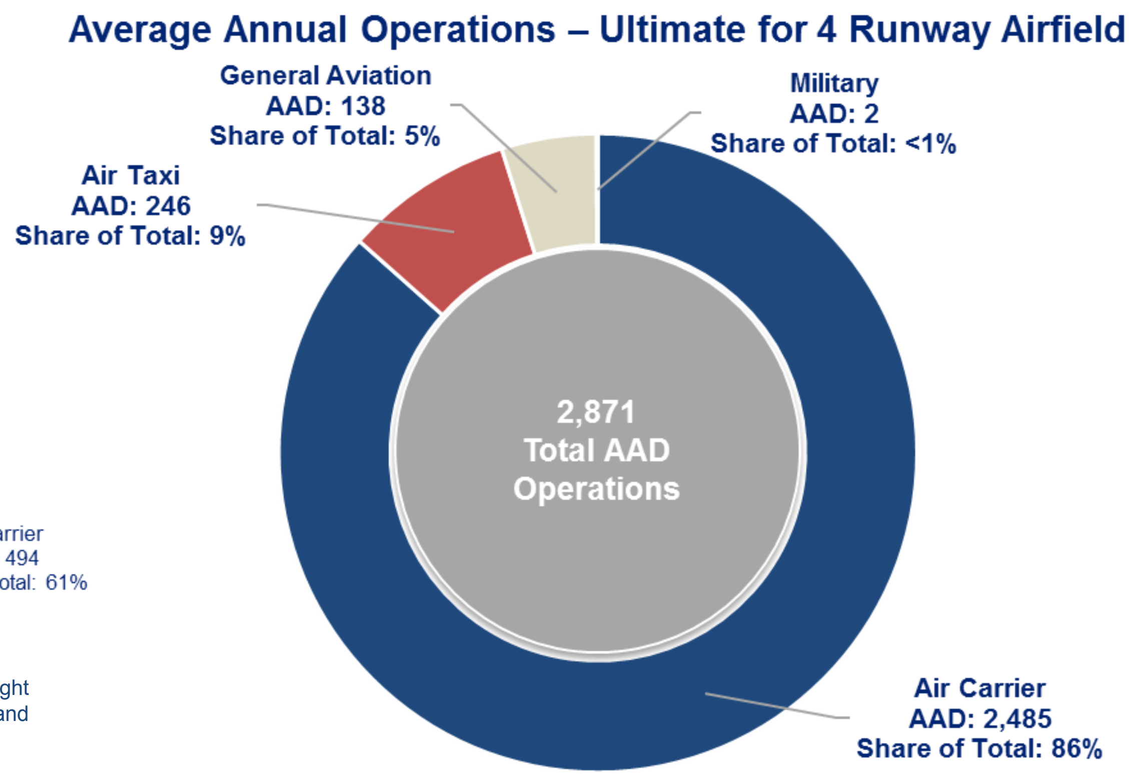
Discussion – Ultimate Operations Development Methodology (con't)

- **Step 8:** Develop AEDT operations file
  - Aircraft type
  - Operation mode (arrival or departure)
  - Stage length profile number
  - Daytime operation counts
  - Nighttime operation counts

Example ASV 4 flight result:
Aircraft Type: Boeing 787-900
Operation Mode: Departure
Stage Length: 6
Daytime Operations: 4
Nighttime Operations: 0

Discussion – Ultimate Operations by User Category – 4 Runway ASV

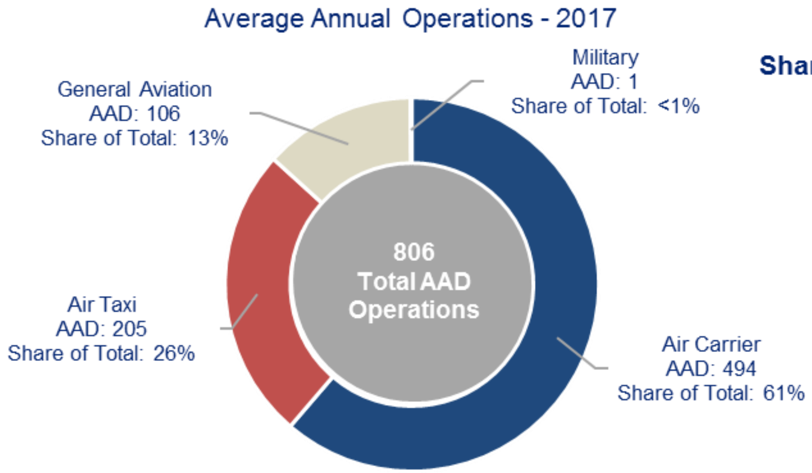


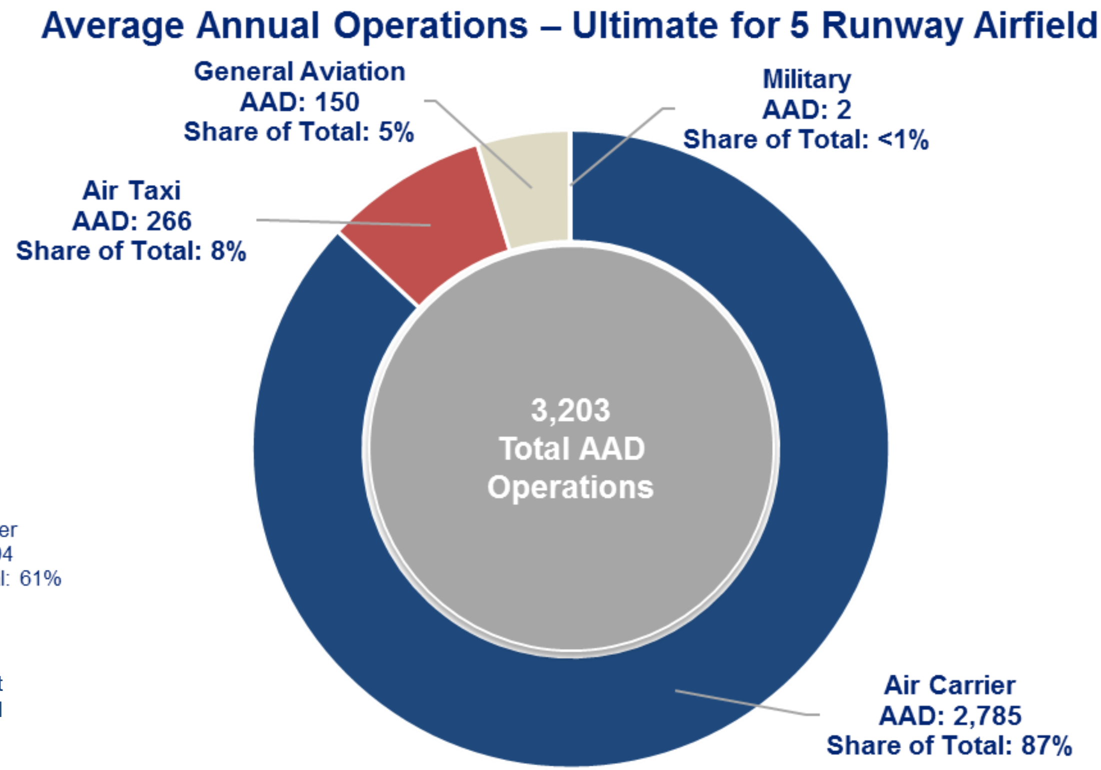


Source: 2017 Average Annual Day operations Based on full year of 2017 flight operations from MWAA's Airport Noise and Operations Monitoring System and FAA OPSNET 2017 Dulles Airport Traffic Control Tower counts

- Air carrier – commercial aircraft with seating capacities of more than 60 passengers, or a maximum payload capacity of more than 18,000 pounds carrying passengers or cargo
- Air taxi – commercial and for-hire aircraft with maximum seating capacities of 60 passengers or a maximum payload capacity of 18,000 pounds of cargo for hire or compensation
- General Aviation – noncommercial, civil aircraft operations.
- Military – aircraft operated by any branch of the United States armed services

Discussion – Ultimate Operations by User Category – 5 Runway ASV





Source: 2017 Average Annual Day operations Based on full year of 2017 flight operations from MWAA's Airport Noise and Operations Monitoring System and FAA OPSNET 2017 Dulles Airport Traffic Control Tower counts

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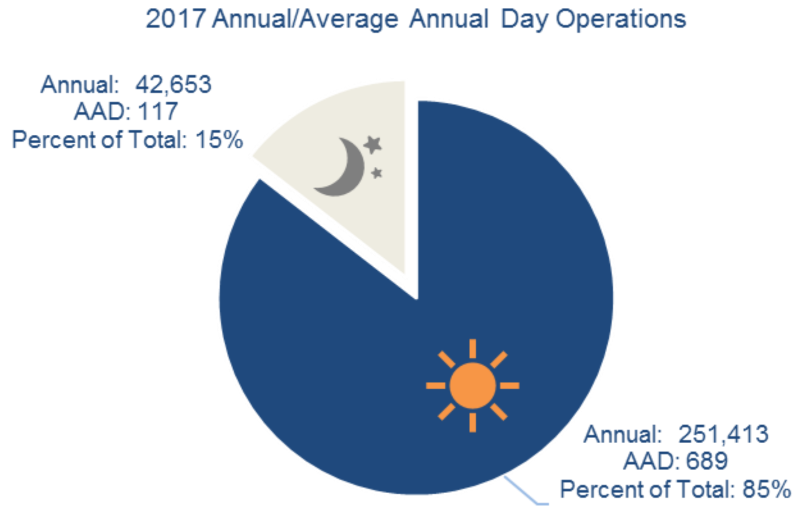
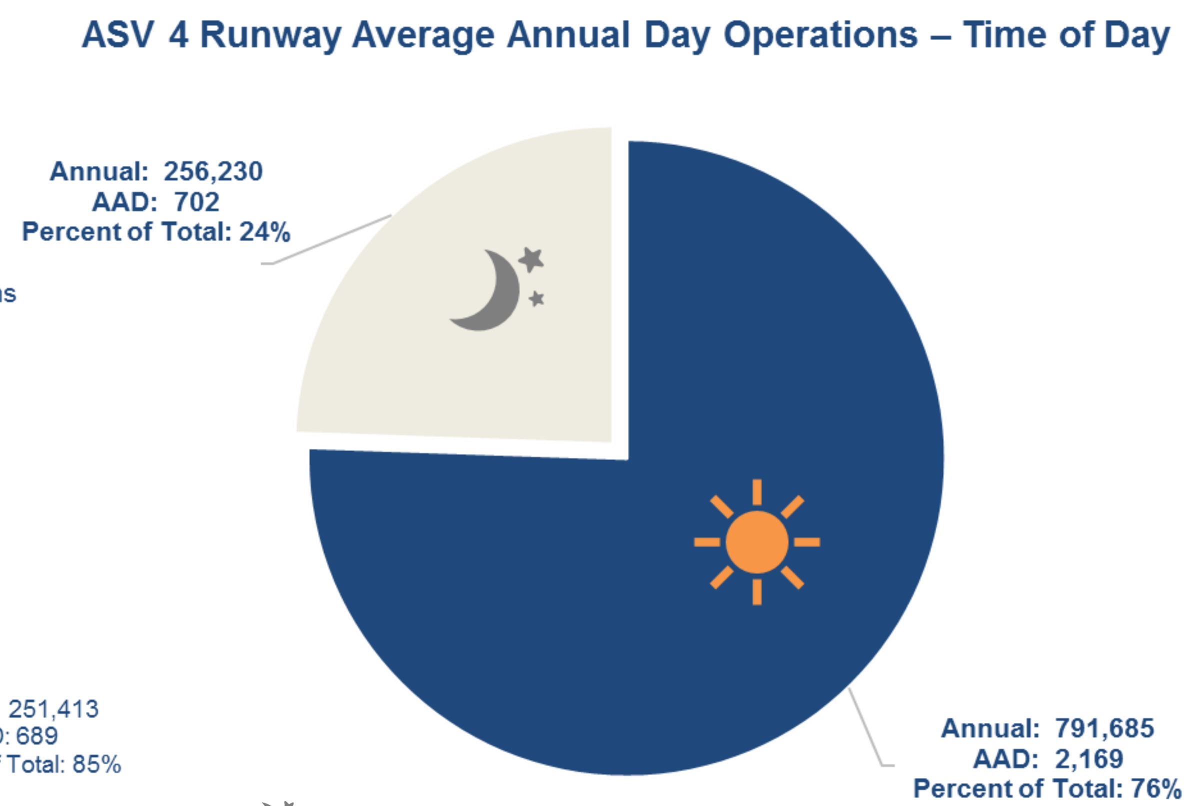
Discussion – Ultimate Operations by Time of Day – 4 Runway ASV





= Daytime hours (7:00 a.m. to 9:59 p.m.) = Nighttime hours (10:00 p.m.. to 6:59 a.m.)

Source: 2017 Annual/Average Annual Day operations by day/night based on full year of 2017 flight operations from MWAA's Airport Noise and Operations Monitoring System

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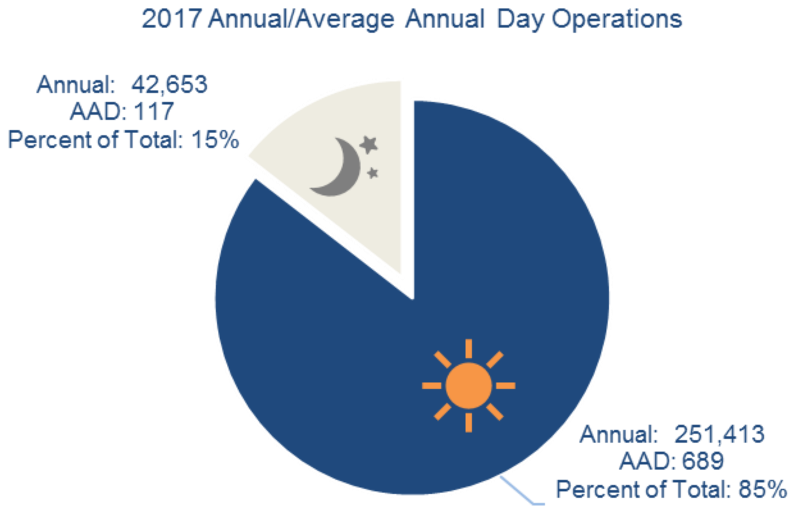
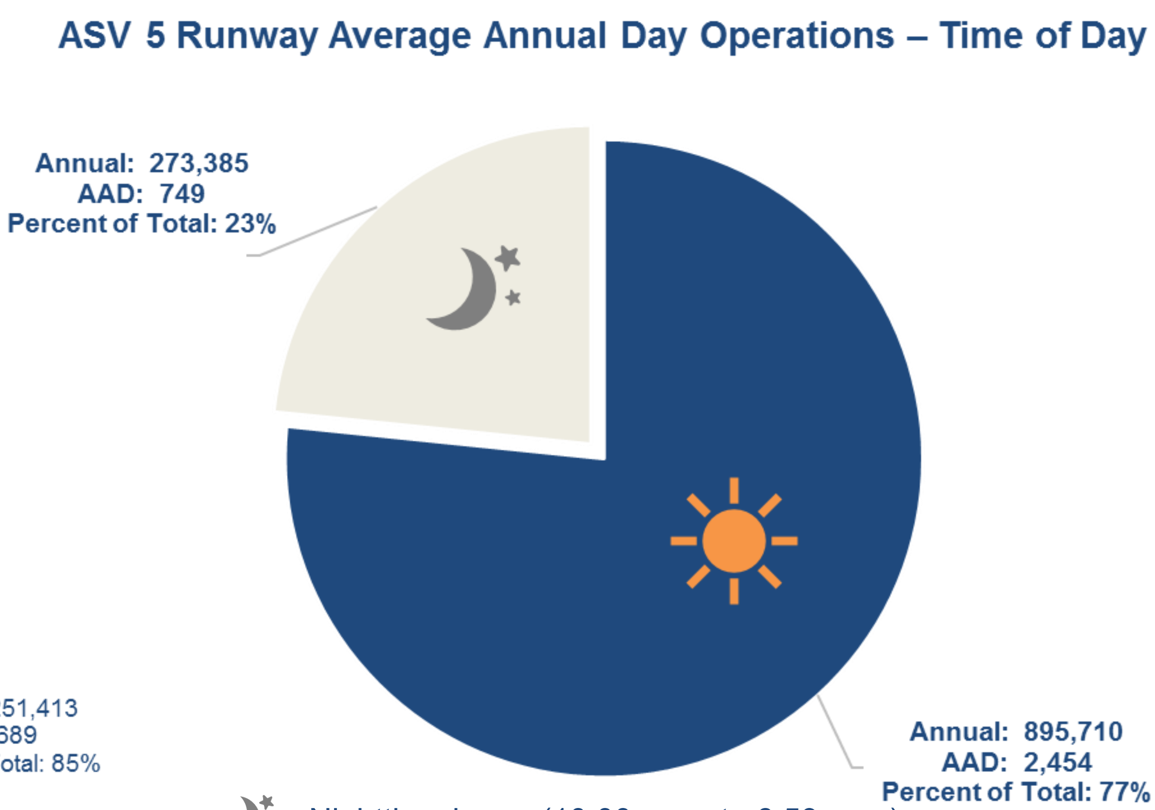
Discussion – Ultimate Operations by Time of Day – 5 Runway ASV

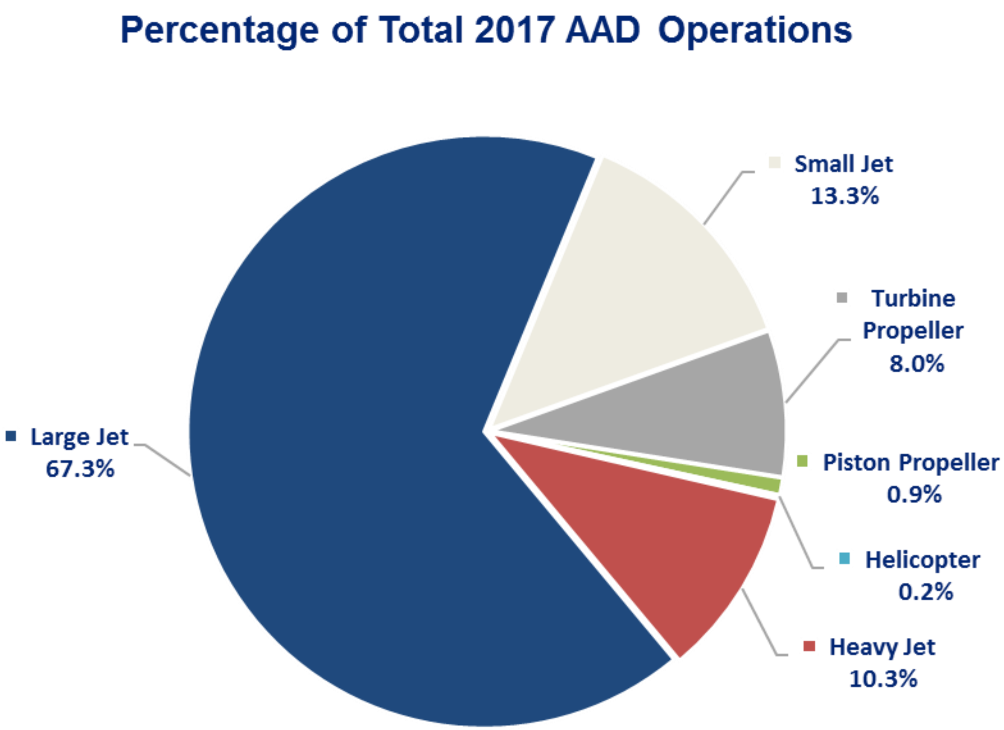




= Daytime hours (7:00 a.m. to 9:59 p.m.) = Nighttime hours (10:00 p.m.. to 6:59 a.m.)

Source: 2017 Annual/Average Annual Day operations by day/night based on full year of 2017 flight operations from MWAA's Airport Noise and Operations Monitoring System

Discussion – 2017 AAD Fleet Mix



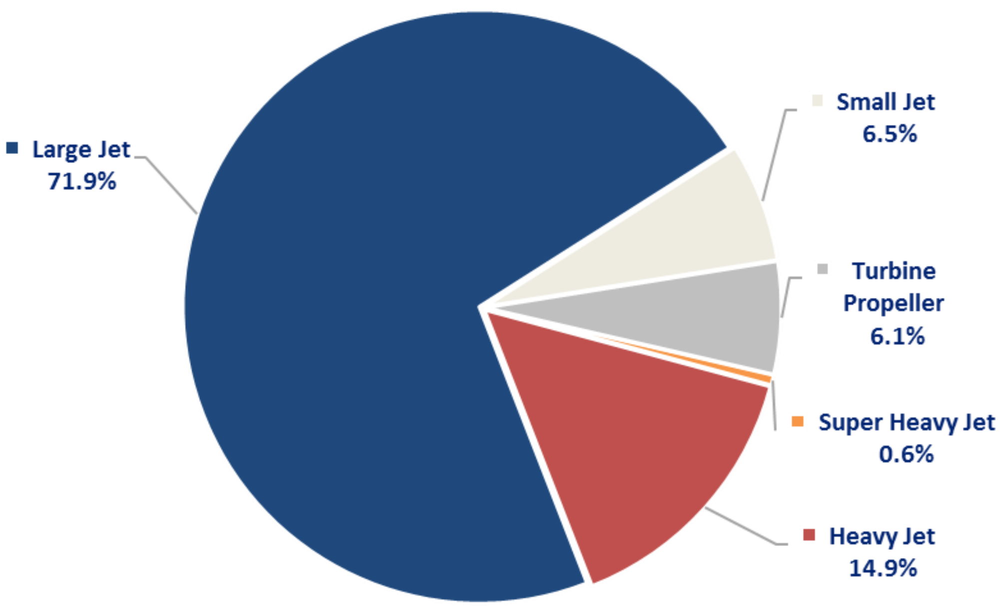
Source: 2017 AAD operations based on full year of 2017 flight operations from MWAA's Airport Noise and Operations Monitoring System

Typical Aircraft Type at IAD by Aircraft Category 2017

Aircraft Category	Typical Aircraft Type Operating at IAD
Heavy Jet	Boeing 787-800/900, Boeing 777-200/300, Boeing 767-300/400, Boeing 747-400/800, Airbus 330, and Airbus 380
Large Jet	Airbus 319, Airbus 320, Boeing 737-800/900, Bombardier Canadair Reginal Jet 200/700/900, Embraer 145 Extended Range, Embraer 170/175/190, Gulfstream IV/V, and McDonald Douglas 88
Small Jet	Beechjet 400, Bombardier Challenger 300, Cessna Citation Excel, Cessna Citation Sovereign, Embraer Phenom 300, Hawker 800, and Learjet 45
Turbine Propeller	Beechcraft Super King Air, Cessna 208 Caravan, Bombardier Dash 8-200/300/400, and Pilatus PC12
Piston Propeller	Beechcraft Bonanza, Beechcraft Baron, and Cirrus SR22

Discussion – Ultimate Fleet Mix Operations – 4 Runway ASV

Percentage of AAD Operations for 4 Runway

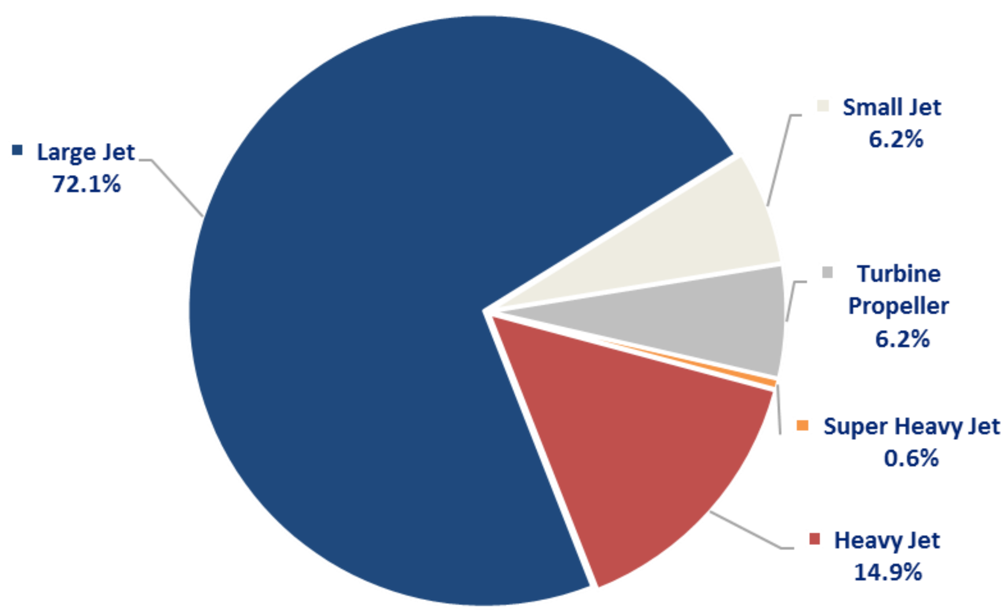


Typical Aircraft Type at IAD by Aircraft Category for Ultimate Operations

Aircraft Category	Typical Aircraft Type Operating at IAD
Super Heavy Jet	Airbus 380, Boeing 747-800 Freighter
Heavy Jet	Boeing 767 Freighter, Boeing 777X, Boeing 787-800/900, Airbus 350-900, and Airbus 330
Large Jet	Airbus 319/320/321 NEO, Boeing 737-800/900 MAX, Bombardier Canadair Reginal Jet 700/900, Embraer 175/190, Gulfstream IV/V
Small Jet	Beechjet 400, Bombardier Challenger 300, Cessna Citation Excel, Cessna Citation Sovereign, Embraer Phenom 300, Hawker 800, and Learjet 45/60
Turbine Propeller	Beechcraft Super King Air, Bombardier Dash 8-Q200/Q400, and Pilatus PC12

Discussion – Ultimate Fleet Mix Operations – 5 Runway ASV

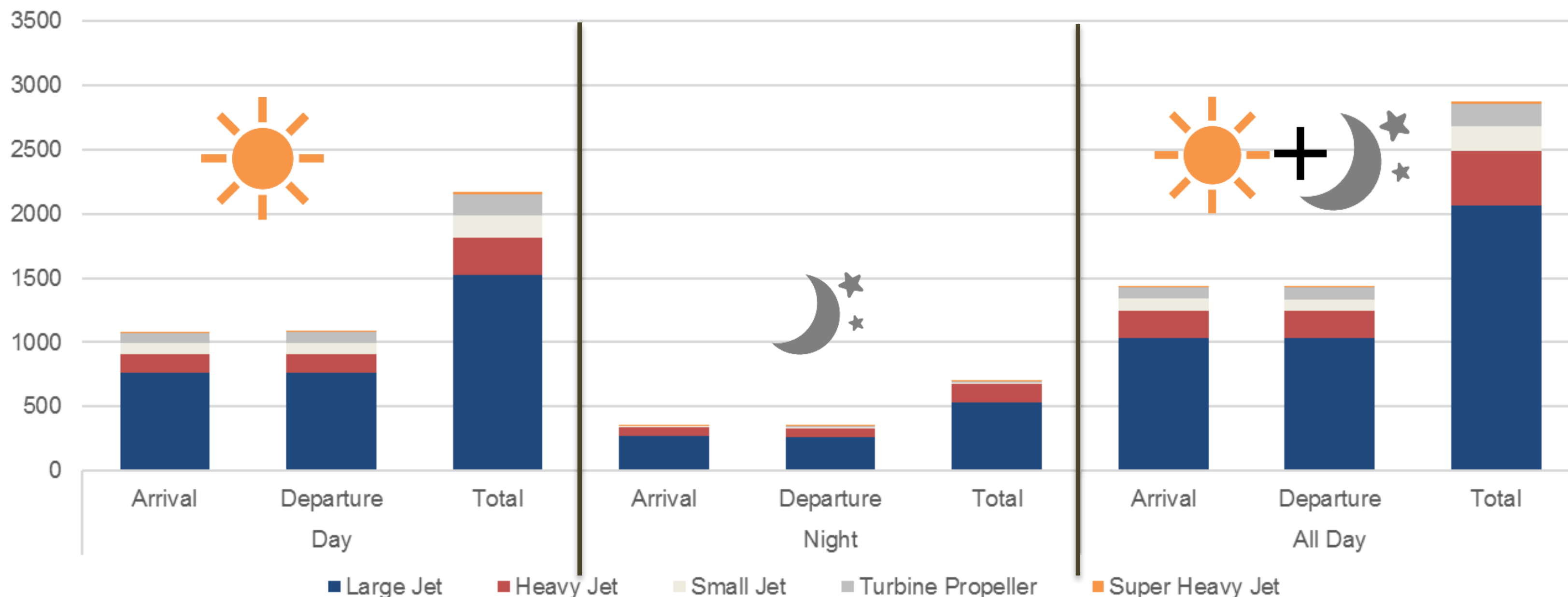
Percentage of AAD Operations for 5 Runway



Typical Aircraft Type at IAD by Aircraft Category for Ultimate Operations

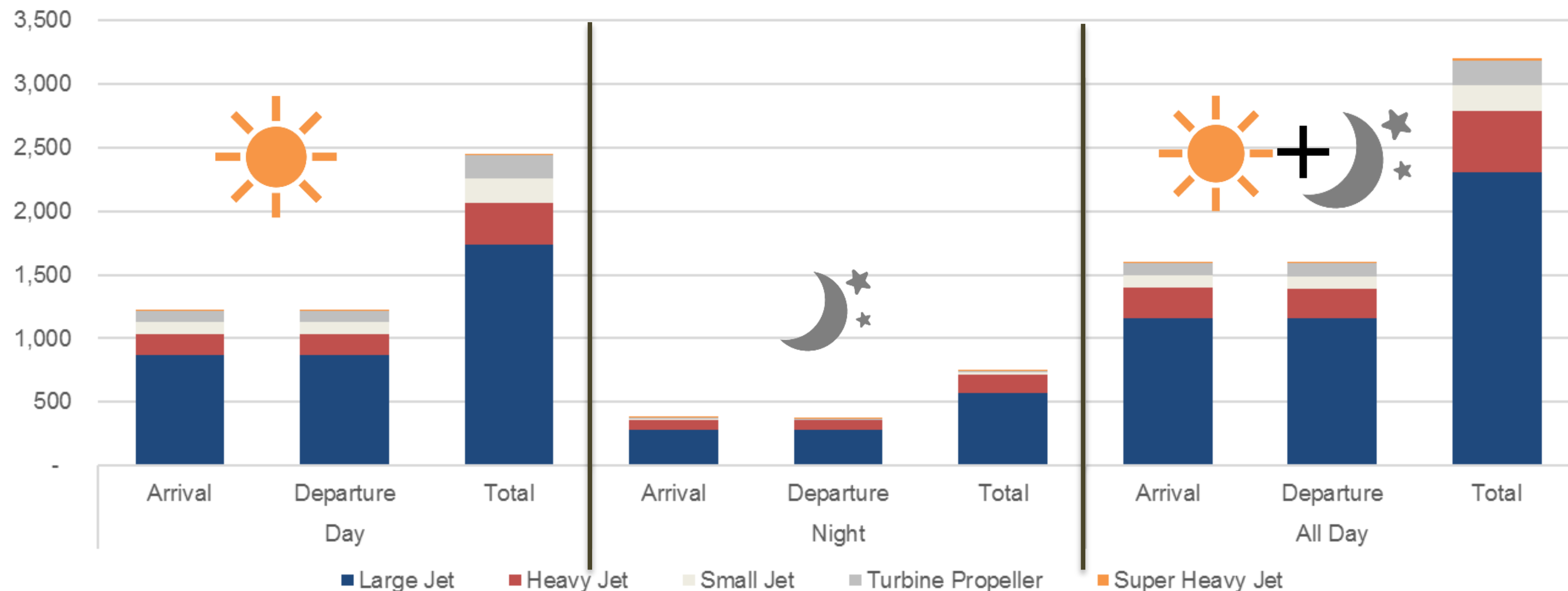
Aircraft Category	Typical Aircraft Type Operating at IAD
Super Heavy Jet	Airbus 380, Boeing 747-800 Freighter
Heavy Jet	Boeing 767 Freighter, Boeing 777X, Boeing 787-800/900, Airbus 350-900, and Airbus 330
Large Jet	Airbus 319/320/321 NEO, Boeing 737-800/900 MAX, Bombardier Canadair Reginal Jet 700/900, Embraer 175/190, Gulfstream IV/V
Small Jet	Beechjet 400, Bombardier Challenger 300, Cessna Citation Excel, Cessna Citation Sovereign, Embraer Phenom 300, Hawker 800, and Learjet 45/60
Turbine Propeller	Beechcraft Super King Air, Bombardier Dash 8-Q200/Q400, and Pilatus PC12

Discussion – Ultimate Fleet Mix Operations by Time of Day – 4 Runway ASV



	Day			Night			All Day		
Aircraft Category	Arrival	Departure	Total	Arrival	Departure	Total	Arrival	Departure	Total
Super Heavy Jet	7	7	14	1	1	2	8	8	16
Heavy Jet	144	145	289	74	66	140	218	211	429
Large Jet	763	766	1,529	268	267	535	1,031	1,033	2,064
Small Jet	86	86	172	7	7	14	93	93	186
Turbine Propeller	83	82	165	5	6	11	88	88	176
Total	**1,083**	**1,086**	**2,169**	**355**	**347**	**702**	**1,438**	**1,433**	**2,871**

Discussion – Ultimate Fleet Mix Operations by Time of Day – 5 Runway ASV



	Day			Night			All Day		
Aircraft Category	Arrival	Departure	Total	Arrival	Departure	Total	Arrival	Departure	Total
Super Heavy Jet	8	8	16	1	1	2	9	9	18
Heavy Jet	167	165	332	74	71	145	241	236	477
Large Jet	868	868	1,736	287	287	574	1,155	1,155	2,310
Small Jet	94	94	188	6	6	12	100	100	200
Turbine Propeller	91	91	182	8	8	16	99	99	198
Total	**1,228**	**1,226**	**2,454**	**376**	**373**	**749**	**1,604**	**1,599**	**3,203**

Discussion – Ultimate Operations by Air Service Category

- 4 Runway ASV: 2,871 Total
  - Scheduled Passenger operations: 2,455 (86%)
  - Cargo: 82 (3%)
  - General Aviation / Non-scheduled Passenger operations: 332 (12%)
  - Military: 2 (< 1%)
- 5 Runway ASV: 3,203 Total
  - Scheduled Passenger: 2,763 (86%)
  - Cargo: 82 (3%)
  - General Aviation / Non-scheduled Passenger: 356 (11%)
  - Military: 2 (< 1%)

Process and Next Steps (as of 9/25/2018)

In Process
Completed
Upcoming

Inventory

- Evaluate current and future plans (MWAA and FAA) ✓
- Assess existing operation conditions ✓

Forecast

- Determine full-build scenario(s) ✓
- Determine maximum potential operations ✓
- Determine potential aircraft runway use and flight tracks ✓

Noise Modeling

- Develop baseline noise model ✓
- Calculate potential aircraft noise levels for full-build scenario(s)
- Determine appropriate composite of potential scenarios, if appropriate

Conclusions

- Recommend potential aircraft noise contours for land use planning

Conclusion

- Feedback
- Schedule next working group meeting
  - Review draft airfield configuration noise contour maps
  - Review proposed draft composite noise contour map

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MWAA.COM

JANUARY 7, 2019 – DRAFT NOISE EXPOSURE MAP RESULTS

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Washington Dulles International Airport (IAD) Aircraft Noise Contour Map Update

6th Working Group Briefing

1/7/19

Agenda

- Study Purpose
- Background
  - Summary of last stakeholder meetings
  - Refresher on DNL, noise contours
  - AEDT model inputs
- Discussion
  - Updated aircraft noise contour map
  - Comparisons to existing noise overlay zones and EIS
  - Proposed overlay
- Next Steps

Study Purpose

- Update the Dulles Airport noise contour map to reflect future changes in the aviation environment including:
  - Long term FAA NextGen implementation
    - Flight paths
    - Runway use
    - Airfield capacity
  - FAA air traffic control procedures
    - Triple simultaneous operations
    - Restricted airspace
  - Airline operations
    - Fleet mix
  - Airfield development
    - Terminal
    - Cargo

Study Purpose (cont.)

- Provide local jurisdictions accurate information to guide effective land use decisions for today and in the future

- Provide local jurisdictions with a land use compatibility planning tool to inform
  - Envision Loudoun
  - Dulles Suburban Plan

Background - Technical Working Group

- Loudoun County
- Fairfax County
- Town Of Herndon
- Airlines- MWAC
- FAA
  - ADO
  - ATO
  - Region
  - Headquarters
- Dulles Airport
  - Airport Manager
  - Airport Operations
  - Government Affairs
  - Noise Office
  - Communication
  - Engineering and Planning
- Consultant Support (Ricondo & Assoc. and HMMH)

Background - IAD Noise Contours and Local Land Use Planning

- Long-range noise contours have been a resource and an aid toward the development of compatible land uses
- Noise contours help to inform local land use planning
- Aircraft noise, and its impact on regional communities, was and is a primary consideration for airport planning
- Noise contour maps are developed based on scenarios which are expected during or at full-build of the airport

Background - Stakeholder Meetings

- April 4, 2018 - Kick Off Meeting
- April 20, 2018 - Meeting #2 Link
- June 6, 2018 - Meeting #3 Link
- June 27 & 28, 2018 - Public Information Workshops #1 and #2
  - Public Information Workshop Presentation
  - Public Information Workshop Comments and Responses
- August 13, 2018 - Meeting #4 Link
- September 25, 2018 - Meeting #5 Link

Background - Airport Environmental Decision Tool (AEDT) Overview

- FAA-developed and adopted software tool for computation of noise contours
- Accurately computes noise contours based on many operational characteristics

Background - AEDT Overview

INPUT

PHYSICAL

Runway layouts,
airfield altitude,
atmospheric conditions,
flight tracks, etc.

OPERATIONAL

Aircraft types,
numbers of aircraft,
proportions by runway
and flight track,* etc.

Aircraft
Noise & Performance
Database

OUTPUT

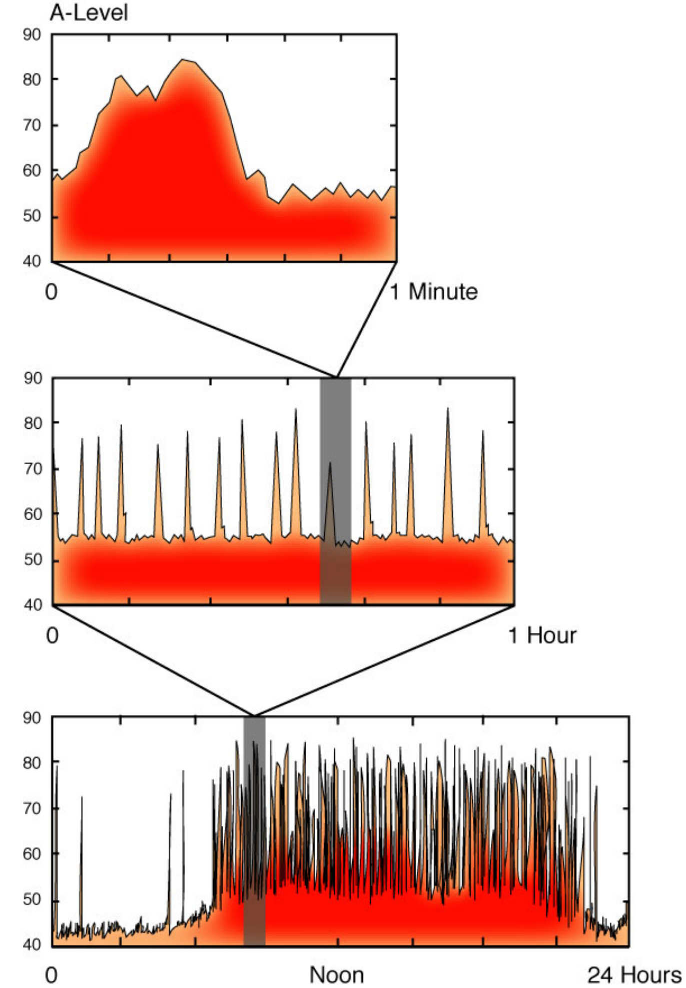
Noise Contours

Detailed reports
for specific
locations

*Flight tracks are controlled by FAA

Background - Day/Night Average Noise Level (DNL)

- A way to describe the noise dose for a 24-hour period
- Accounts for noise event “noisiness” (SEL)
- Accounts for number of noise events
- Provides an additional weighting factor of 10 dB for nighttime (10:00 pm to 6:59 am) operations
  - 1 nighttime noise event is equivalent to 10 daytime noise events



Background - What is a DNL Noise Contour?

- DNL – Day-Night Average Sound Level
  - Represents average noise for a 24-hour period
  - 10 dB weighting factor for nighttime (10:00 pm to 6:59 am) operations
  - 24-hour average noise level on the basis of annual aircraft operations
- Average Annual Day (AAD) – represents the 24-hour average of total annual operations
- DNL Contour – a line representing equal DNL

Background - What Affects Aircraft Noise Contour Shape and Size?

- Size
  - Aircraft equipment type (certified noise levels, number of engines, and size)
  - Number of aircraft operations
  - Nighttime operations

- Shape
  - Runway location
  - Runway use (how frequently is the runway used)*
  - Operation type (arrival, departure or both)*
  - Flight track locations and dispersion*

* FAA controlled

Discussion - Methodology for Contour Development

- Determine Airport's Annual Service Volume (ASV)
- Define Average Annual Day operational level
  - Day and night time activity
- Identify Aircraft Fleet Mix
  - Passenger, Cargo, General Aviation, Military, other
  - Aircraft size
- Define Flight Tracks*
  - Arrival and departures by origin/destination
- Load data into AEDT model
- Generate 60 – 75 DNL contours

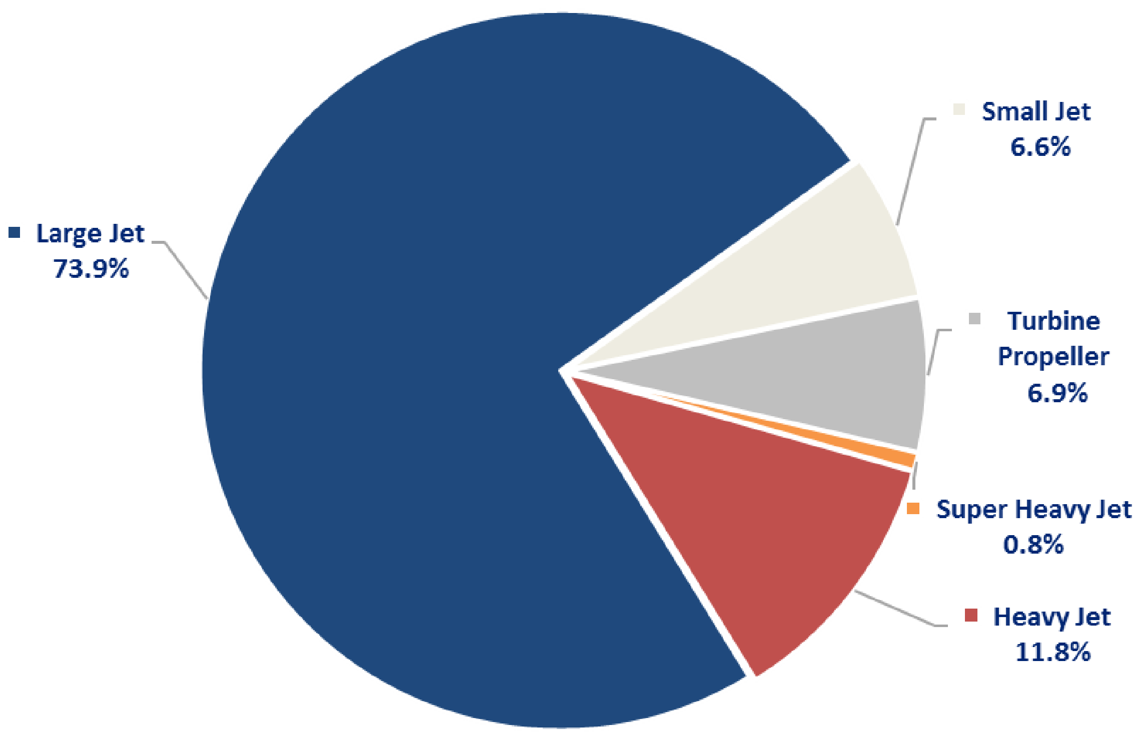
* FAA controlled

Discussion - Methodology for Contour Development (cont.)

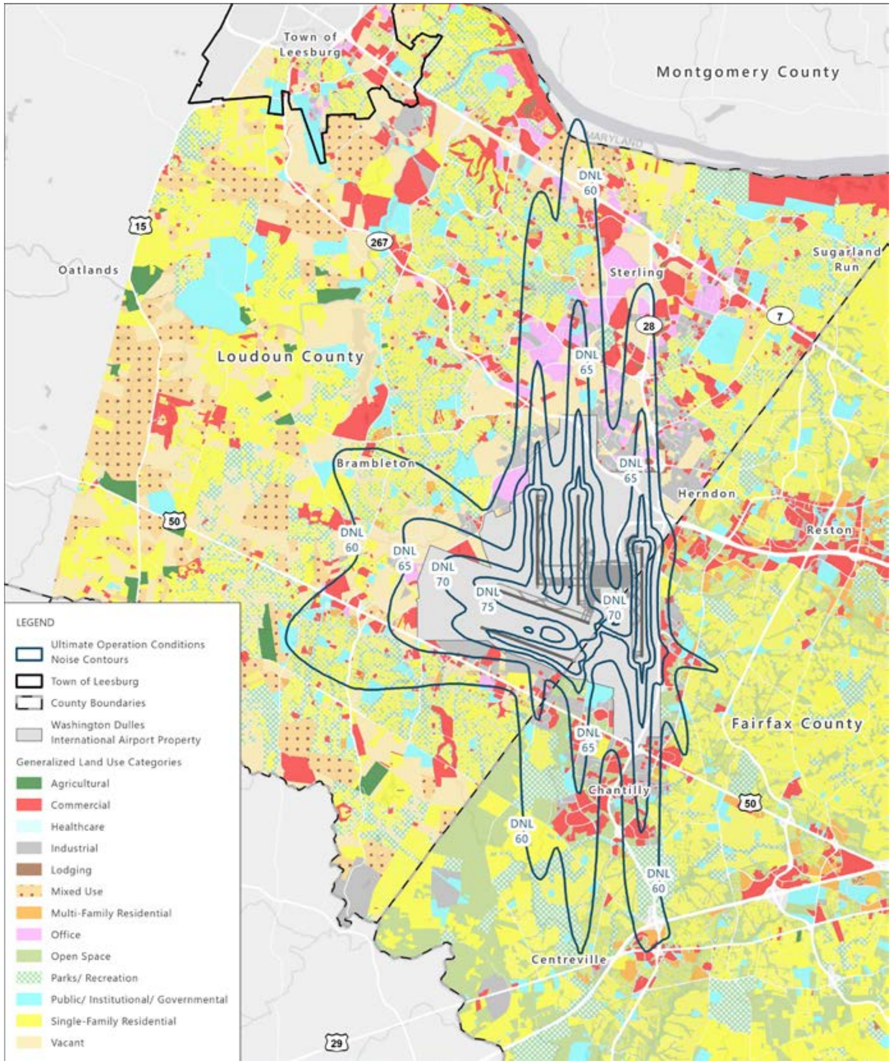
- Approximately 1M operations
- Fleet Mix
  - 82% Passenger (narrow & wide body)
  - 7% Corporate charter
  - 5% Passenger (regional)
  - 5% General Aviation
  - 1% Cargo/Freighter
  - <1% Military
- 88% Day / 12% Night Operations
- FAA Defined Airfield Flow
  - 55% / 45% (north / south)

Discussion - Methodology for Contour Development (cont.)

Average Annual Day Operations – 5 Runway Airfield

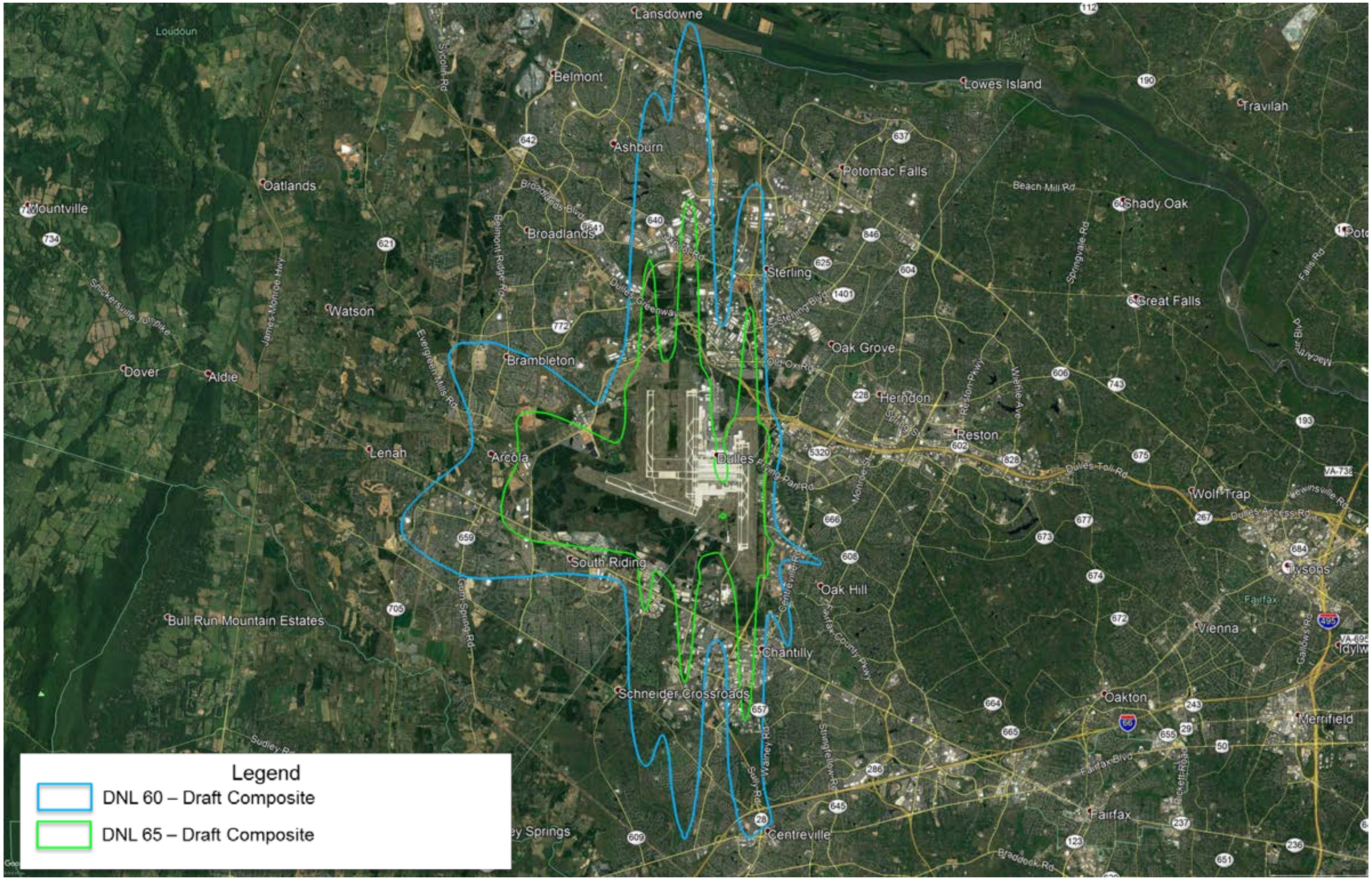


Discussion - New Noise Contour Map



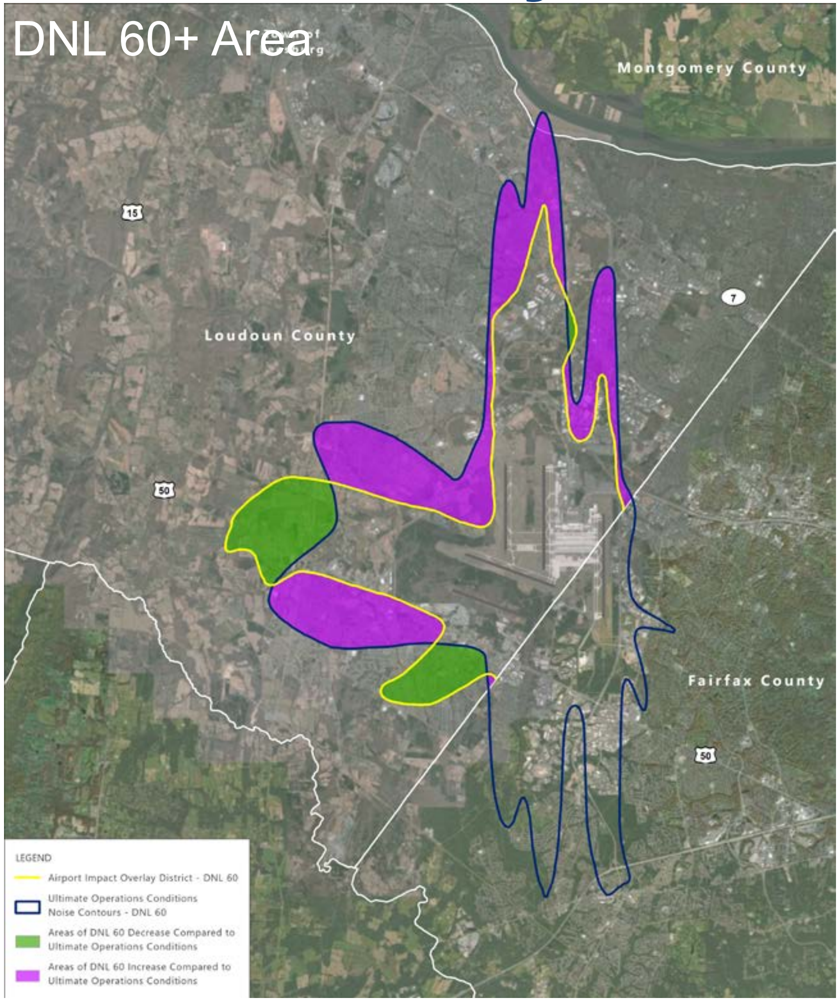
Source: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, May 2018 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Fairfax County, 2017, https://data-fairfaxcountygis.opendata.arcgis.com/ (accessed 12, 2018) (land use); Loudoun County, 2018, https:/ /data loudoungis.opendata.arcgis.com/ (accessed 12, 2018) (land use); Ricondo & Associates, Inc., May 2018 (data collection area and general land use categories); HMMH, December 2018 (draft composite contours).

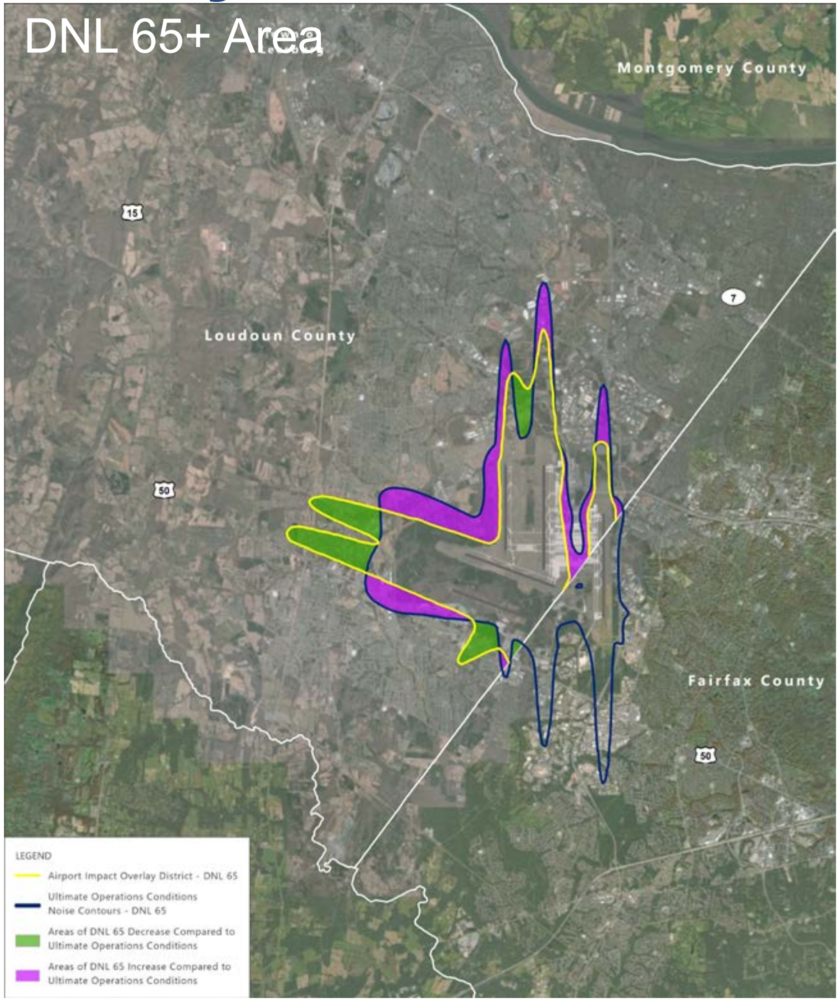
Discussion - New Noise Contour DNL 60 and DNL 65



Source: Google Earth (aerial basemap); HMMH, December 2018 (draft composite contours).

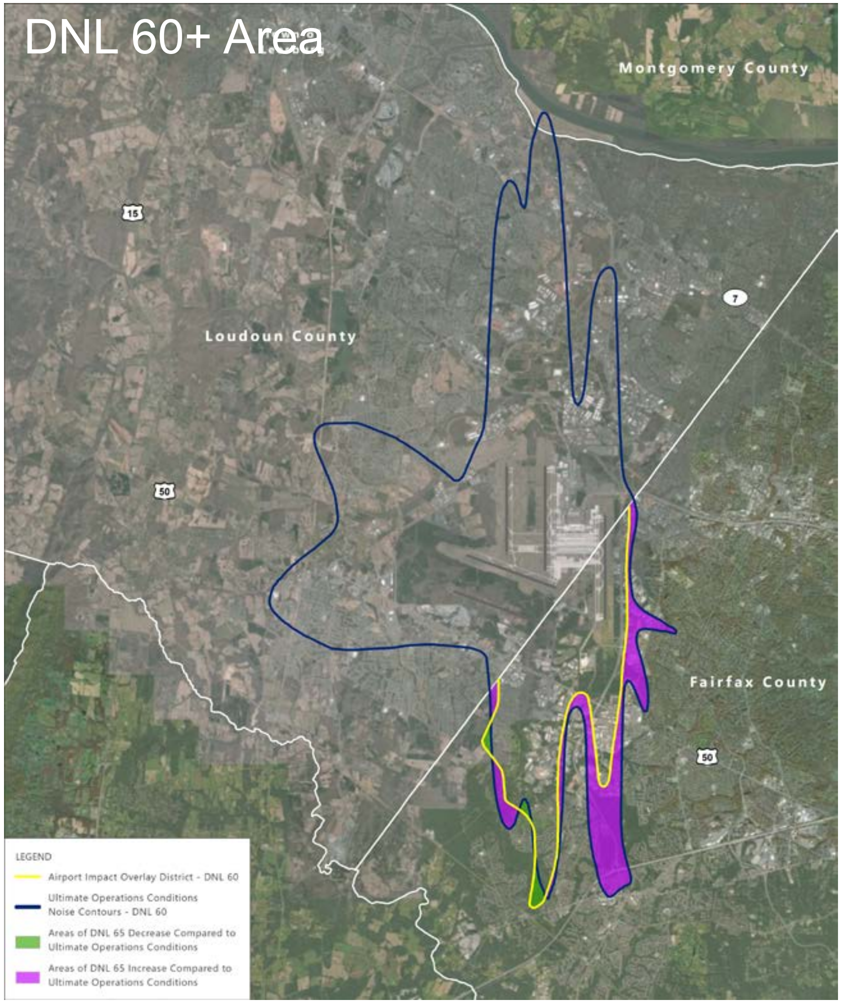
Discussion - New Noise Contour vs. Loudoun County Noise Overlay Zones

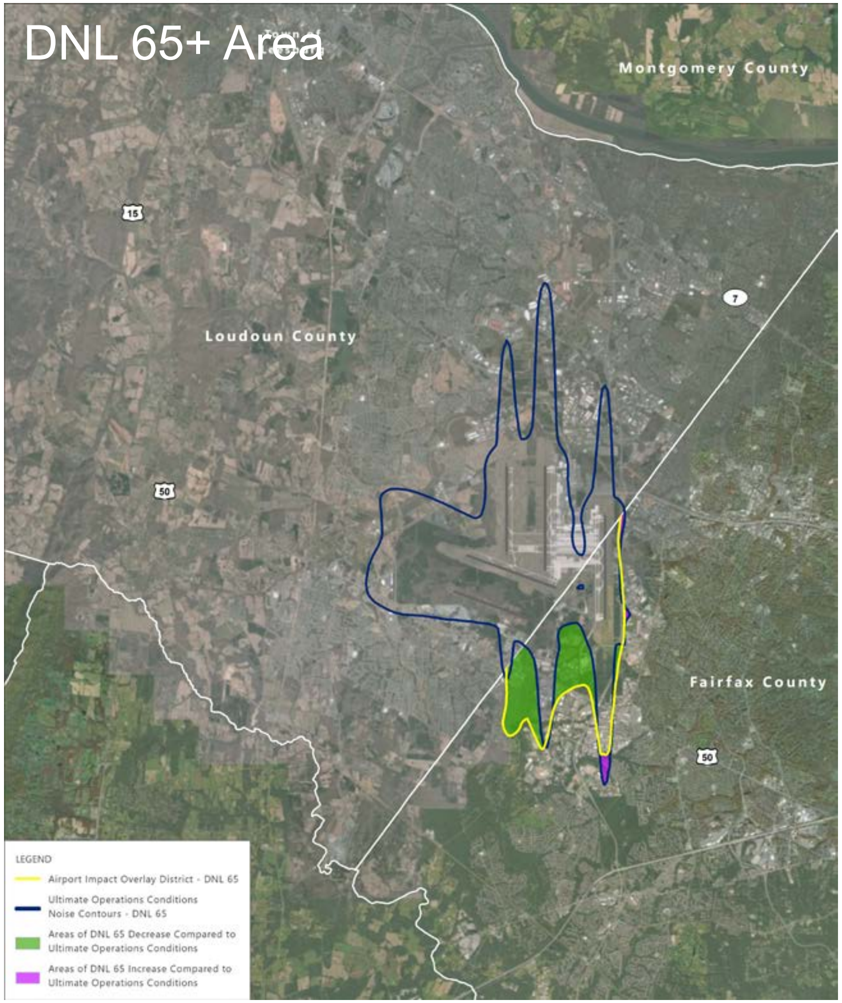




Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, May 2018 (aerial basemap); Loudoun County, Virginia, 2017 (Loudoun airport impact overlay districts); HMMH, December 2018 (draft composite contours).

Discussion - New Noise Contours vs. Fairfax County Noise Overlay Zones





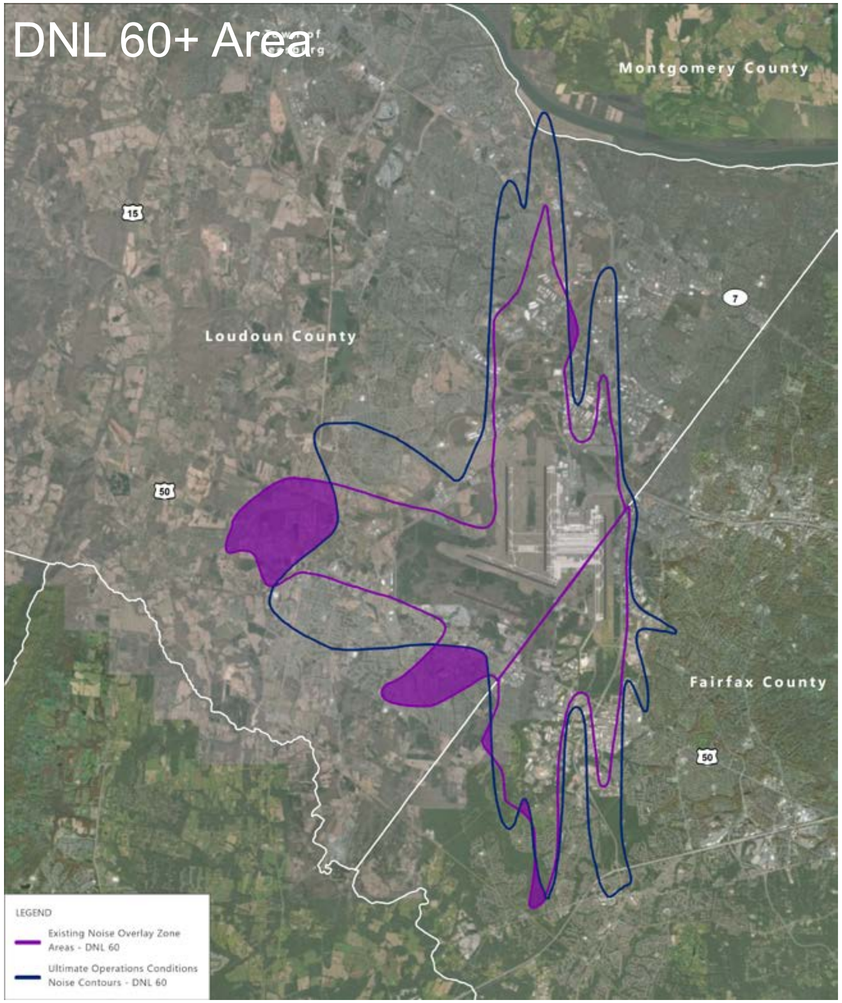
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, May 2018 (aerial basemap); Fairfax County, Virginia, 2017 (Fairfax airport impact overlay districts); HMMH, December 2018 (draft composite contours).

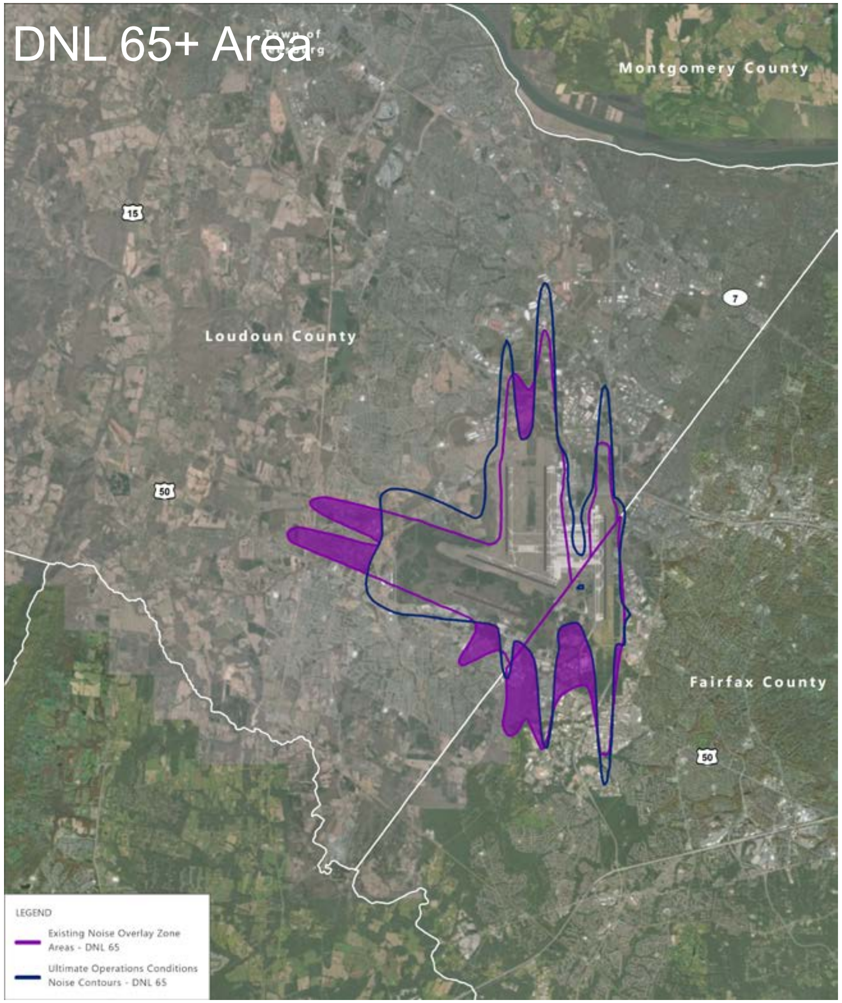
Discussion - Land Use Compatibility

- Protect for Today's Airport use and for Tomorrow

- The Airports Authority will be recommending that Loudoun County and Fairfax County protect their existing Airport Impact Overlay Districts (DNL 60 and DNL 65) and the new Noise contours.

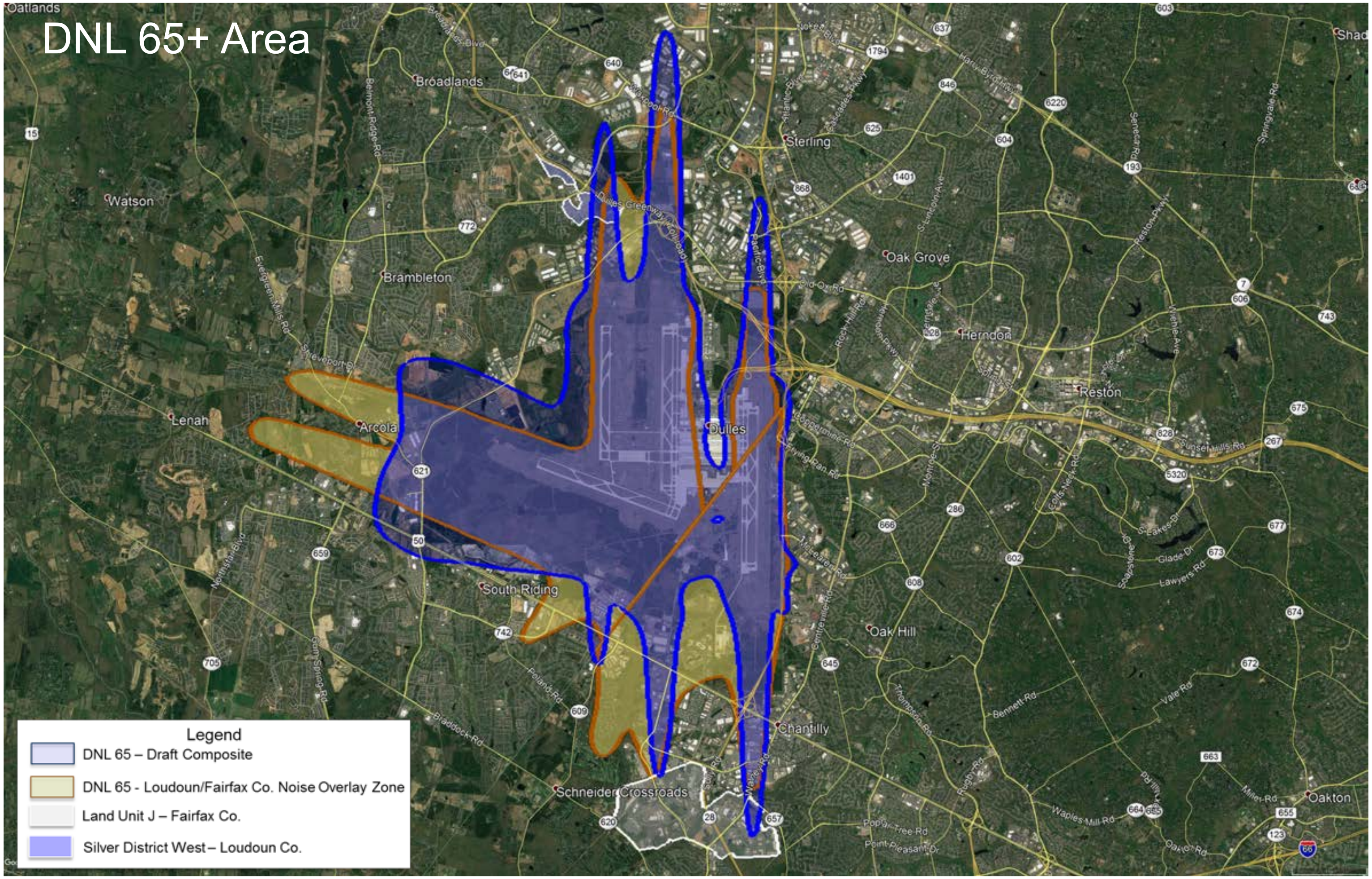
Discussion - Land Use Compatibility





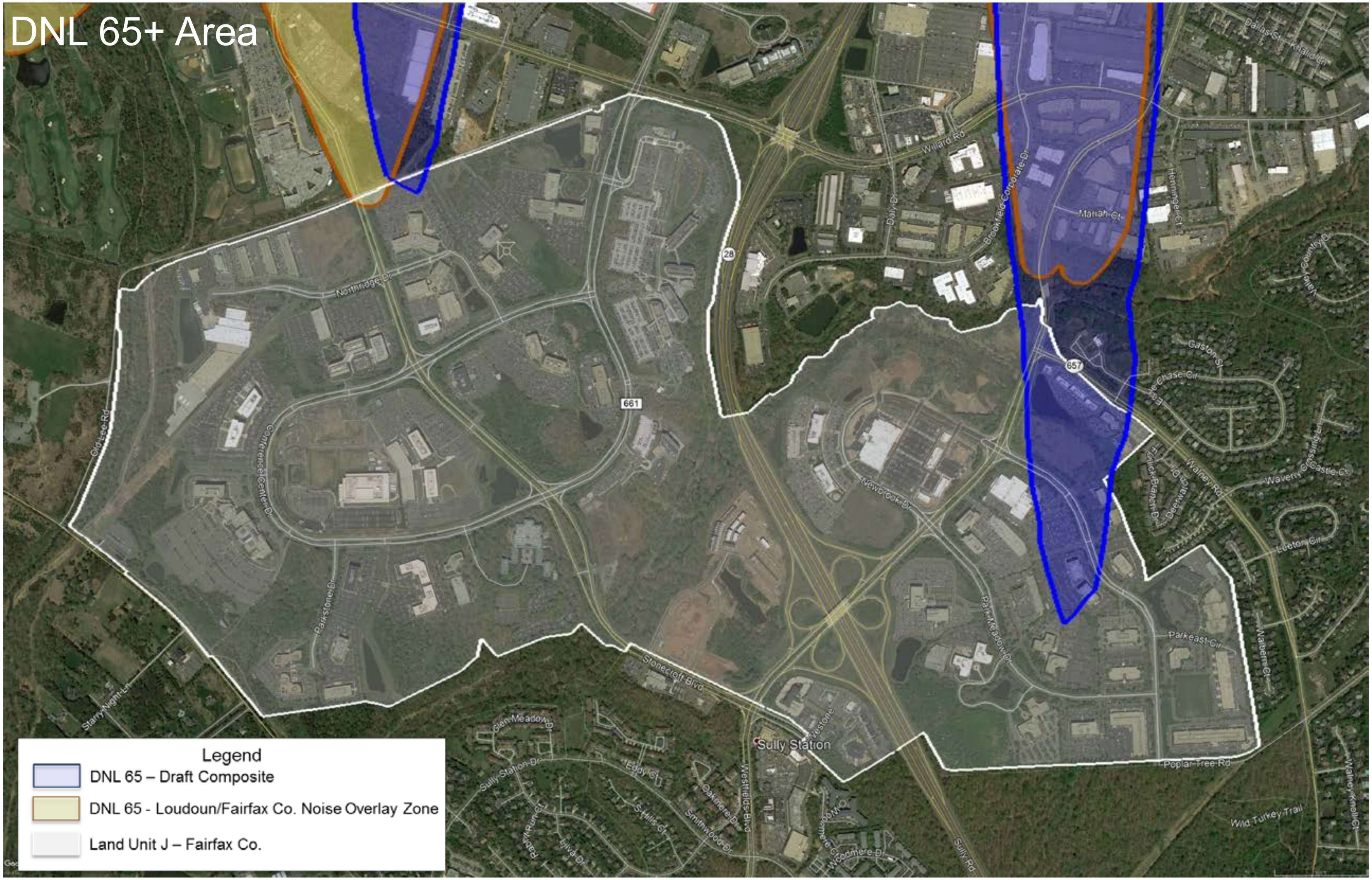
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, May 2018 (aerial basemap); Loudoun County, Virginia, 2017 (Loudoun airport impact overlay districts); Fairfax County, Virginia, 2017 (Fairfax airport impact overlay districts); URS, November 2005 (EIS 2025 contours); HMMH, December 2018 (draft composite contours).

Discussion - Silver District West & Dulles Suburban Center/Westfields J



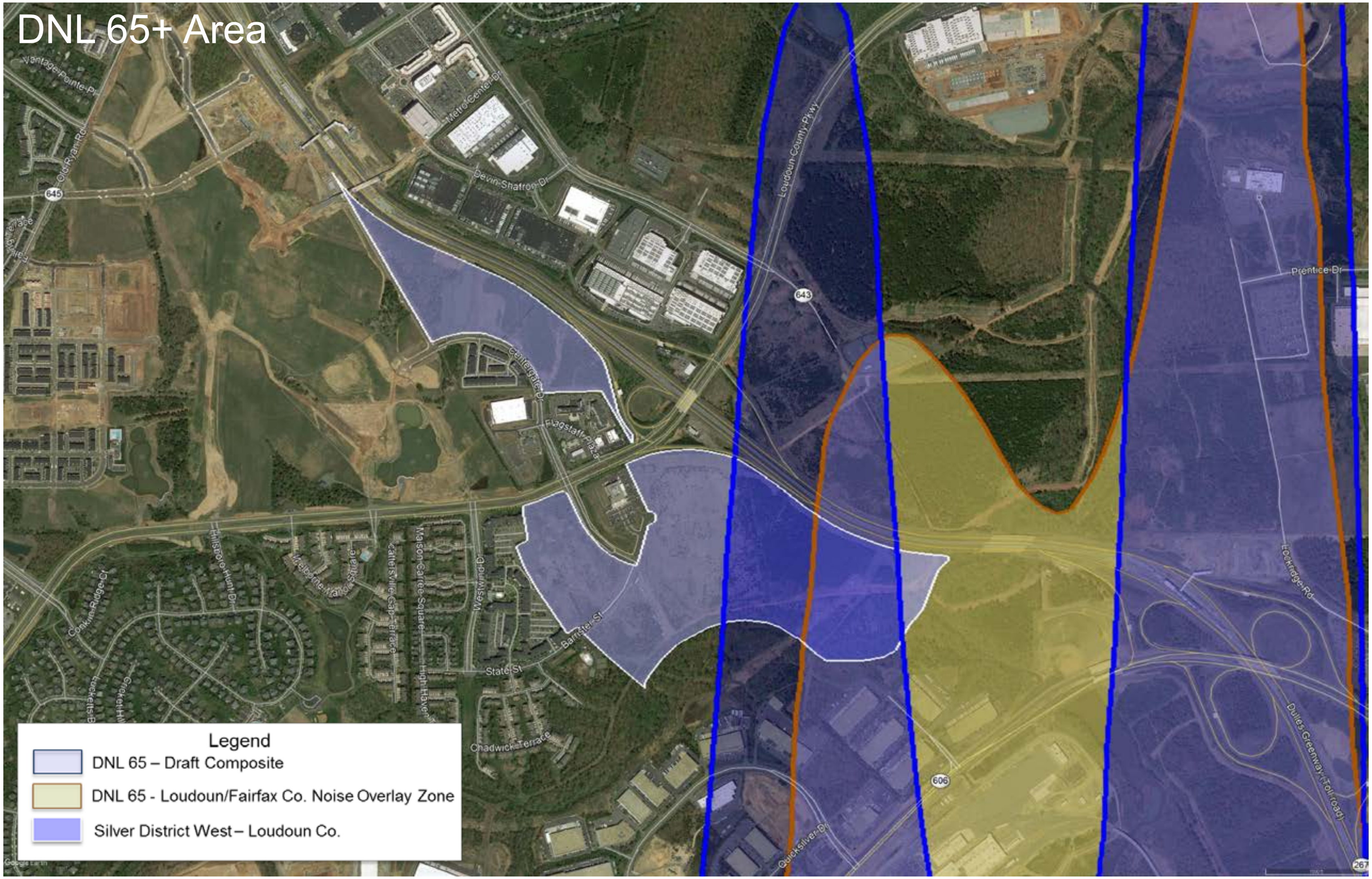
Source: Google Earth (aerial basemap); Loudoun County, Virginia, 2017 (Loudoun airport impact overlay districts); Fairfax County, Virginia, 2017 (Fairfax airport impact overlay districts); HMMH, December 2018 (draft composite contours).

Dulles Suburban Center/Westfields J



Source: Google Earth (aerial basemap); Loudoun County, Virginia, 2017 (Loudoun airport impact overlay districts); Fairfax County, Virginia, 2017 (Fairfax airport impact overlay districts); HMMH, December 2018 (draft composite contours).

Silver District West



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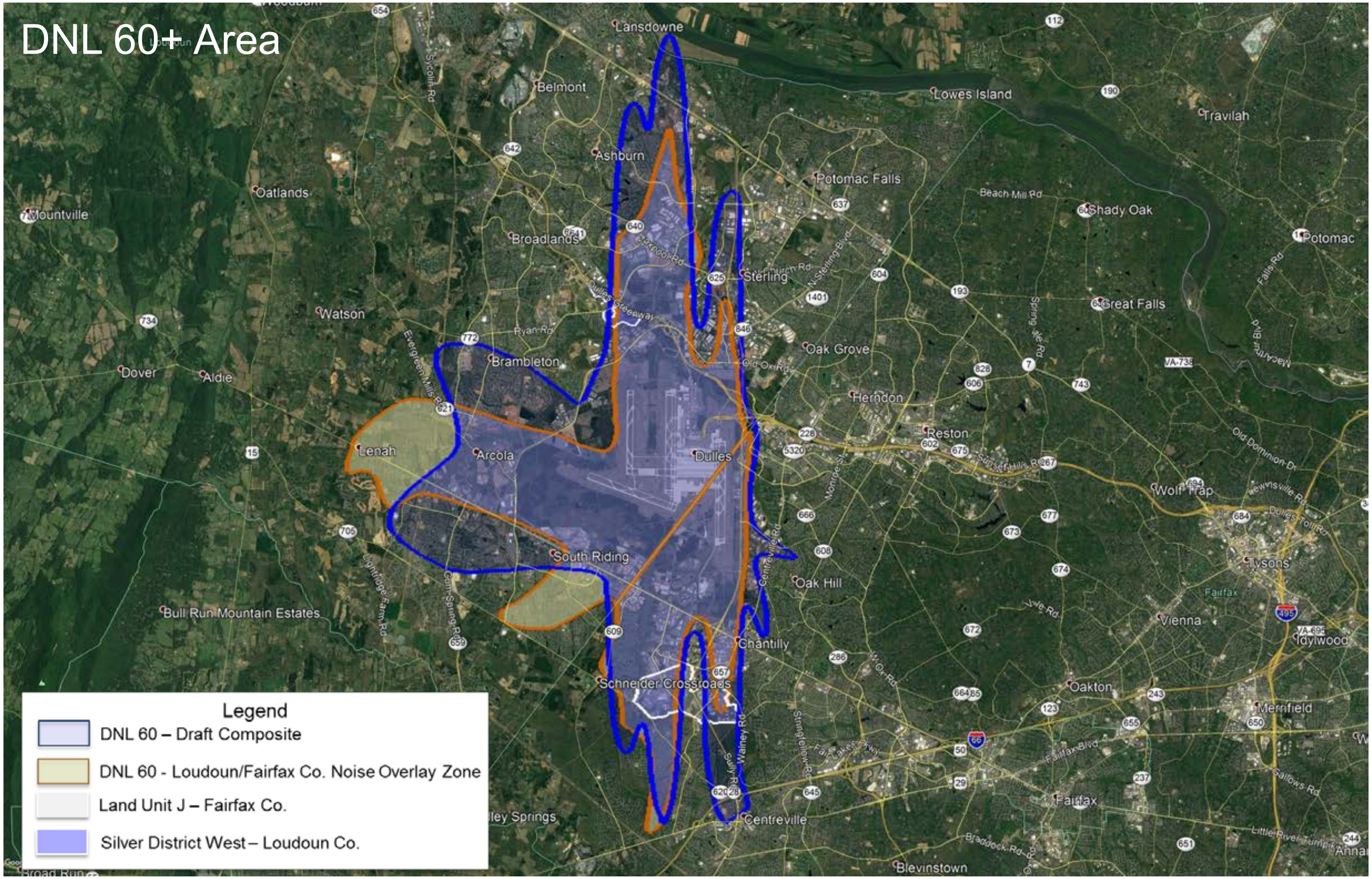
Discussion - Silver District West & Dulles Suburban Center/Westfields J



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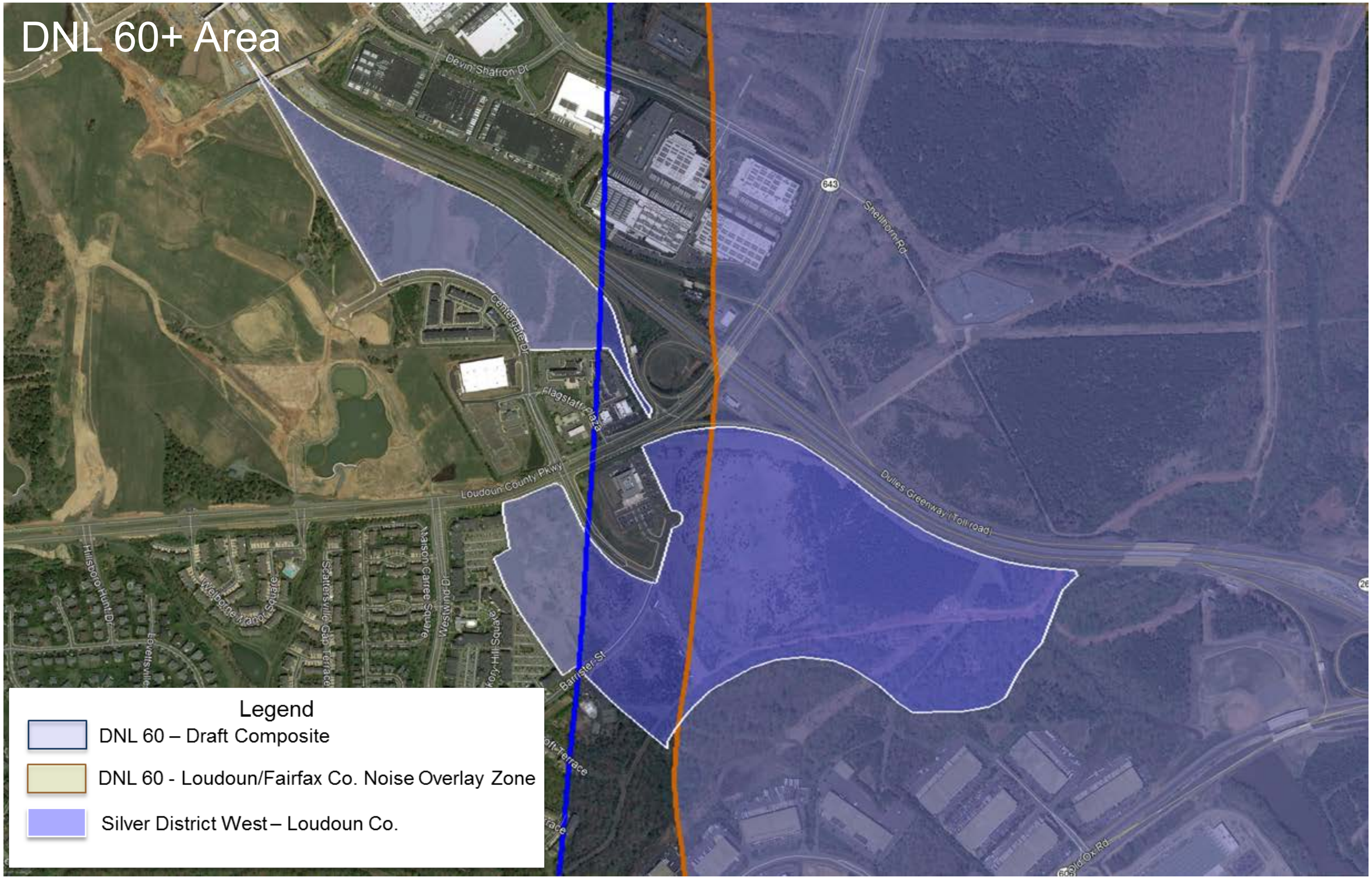
Silver District West



Source: Google Earth (aerial basemap); Loudoun County, Virginia, 2017 (Loudoun airport impact overlay districts); Fairfax County, Virginia, 2017 (Fairfax airport impact overlay districts); HMMH, December 2018 (draft composite contours).

Dulles Suburban Center/Westfields J

Source: Google Earth (aerial basemap); Loudoun County, Virginia, 2017 (Loudoun airport impact overlay districts); Fairfax County, Virginia, 2017 (Fairfax airport impact overlay districts); HMMH, December 2018 (draft composite contours).

Recommendations

- Adopt DNL 60 & 65 overlay based on the following:
  - New noise contour (2018/2019 Study)
  - Existing airport impact overlay district
- Noise contours should promote land use compatibility for current and long term development

Process and Next Steps (as of January 7, 2019)

In Process
Completed
Upcoming

Inventory
- Evaluate current and future plans (MWAA and FAA) ✓
- Assess existing operation conditions ✓

Forecast
- Determine full-build scenario(s) ✓
- Determine maximum potential operations ✓
- Determine potential aircraft runway use and flight tracks ✓

Noise Modeling
- Develop baseline noise model ✓
- Calculate potential aircraft noise levels for full-build scenario(s) ✓
- Determine appropriate composite of potential scenarios, if appropriate ✓

Conclusions
- Recommend potential aircraft noise contours for land use planning (In Process)

Next Steps

- Schedule public workshop (timing based on feedback)
- Jan. 9 – Fairfax County Westfields Unit J Task Force
- Jan. 11 – Loudoun County Planning staff presentation
- Hold public workshop & consider workshop feedback
- Feb 28 – March (TBD) – Finalize recommended overlay district for land use planning

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

MWAA.COM

@Reagan_Airport @Dulles_Airport @Dulles_Toll_Road

reaganairport FlyDulles dullestollroad

APPENDIX B

Public Outreach and Input

B.1 | WEBSITE SCREEN CAPTURE

B.2 | PROJECT PURPOSE, INVENTORY AND PROCESS PUBLIC WORKSHOP MATERIALS

B.3 | DRAFT RESULTS PUBLIC WORKSHOP MATERIALS

B.4 | MWAA FREQUENTLY ASKED QUESTIONS AND ANSWERS

APPENDIX B PUBLIC INPUT OUTREACH MATERIALS

WEBSITE SCREEN CAPTURE

Dulles International Noise Contour Map Update

Dulles International Noise Contour Map Update

The Metropolitan Washington Airports Authority is undertaking an effort in 2018 to update the noise contour maps for Washington Dulles International Airport. The objective of this effort is to provide updated noise contour maps that can help guide land use compatibility planning in the region.

Dulles Noise Contour Map Website Updates

Sign up to receive an email notice for whenever this website is updated with new information. You'll receive an email saying the website has been updated and a link to the latest website version with the new updates.

SIGN ME UP >>

(Please Note: The noise contour map update effort for Dulles International is unrelated to the Airports Authority's efforts working with the communities surrounding Ronald Reagan Washington National Airport (DCA) through the DCA Community Working Group. For information on the DCA Community Working Group activity, please click here).

There are several reasons the Airports Authority decided to embark on this effort at this time:

- There have been changes in the aviation environment since the early 1990s, when the existing Airport Overlay Districts were established, and the future vision for Dulles International should reflect these changes.
- Flight tracks and overall utility of the airfield at Dulles International have evolved and will continue to evolve with implementation of FAA's NextGen modernization program.
- The FAA is modifying flight procedures to allow for the triple simultaneous runway operations at Dulles International during low visibility conditions or Instrument Flight Rules (IFR), which will likely increase utility and capacity at Dulles International.

The progress for this noise contour map update effort can be viewed here. ***<--New as of 1/7/19*** The noise contour map process generally includes:

1. Inventory | Evaluate current and future plans, describe existing operation conditions

2. Forecast | Determine full-build scenarios, determine maximum potential operations, determine potential aircraft runway use and flight tracks

3. Noise Modeling | Calculate existing aircraft noise exposure levels, calculate potential aircraft noise exposure levels for full-build scenarios, determine appropriate composite of potential scenarios

4. **Conclusions |** Recommend potential aircraft noise exposure contour for land use planning

To update the noise contour maps for Washington Dulles International Airport, the Airports Authority formed a Local Jurisdictional Stakeholder Working Group, comprised of Airports Authority interdisciplinary staff, appointed professional technical staff from local governments (including Fairfax County, the Town of Herndon and Loudoun County), our airline partners' representative and key Federal Aviation Administration officials whose participation will be essential to the success of this effort. The noise contour map update process will involve regular meetings of the Working Group during the next ten months with work concluding by or before February, 2019. Fairfax County, Town of Herndon and Loudoun County professional staff on the Working group have been named to the Working Group by their respective County Executive, Town Manager and County Administrator. Staff were chosen from these three localities because a noise county map update for Dulles International is essentially a mapping effort, with a product outcome that most directly guides local land use planning in the immediate geographic vicinity of the Airport.

Local government staff participating in the Working Group are listed here:

- Fairfax County
- Town of Herndon
- Loudoun County

Periodically, the Airports Authority will post information online that is relevant to the noise contour map update process. This information may also include material that has been reviewed by the Working Group. During 2018, we anticipate posting new information during the months of April, June, August, November. In 2019, we anticipate posting new information by or before February. Individuals who wish to access this information can click below:

- Dulles Noise Contour Map Map Update Kickoff Briefing
- Dulles International Airport 101
- Dulles International Airport Cargo Operations 101

- Runway Use Scenarios
- Dulles Inventory
- Future Operations
- New Dulles Contours (DRAFT as presented Jan 7 2019) ***<-- New as of 1/7/19***

At least twice during this process, the Airports Authority anticipates hosting Public Workshops on-site or at a location near Washington Dulles International Airport. The Public Workshops will include an opportunity where individuals who are interested in this process can personally visit with noise contour map update subject matter experts who are familiar with the effort underway at Dulles International. For more information, read the press release here.

The Airports Authority is hosting a Public Workshop on:

Thursday, February 28, 2019
6:00 - 8:00 PM
Washington Dulles International Airport Office Building
45045 Aviation Drive
2nd Floor Conference Room
Sterling, VA

Building is located on the campus of Dulles International Airport. Free parking is availabe in front of the building.

The Airports Authority has held two Public Workshops previously on:

Wednesday, June 27, 2018 - Click here for the 2 written comments received on June 27.
6:00 - 8:00 PM
Washington Dulles International Airport Office Building
45045 Aviation Drive
2nd Floor Conference Room
Sterling, VA

- AND -

Thursday, June 28, 2018 - Click here for the 7 written comments received on June 28.
6:00 - 8:00 PM

Rock Ridge High School Cafeteria
43460 Loudoun Reserve Drive
Ashburn, VA 20148

Free parking is available at both locations in the front and rear of the building.

Consolidated information and comments from the June 27th and June 28th Public Workshops is posted here.   A synopsis of the comments recevied during these two Publuic Hearings has been summarized as Answers to Frequently Asked Questions (FAQ's). Click here for the FAQ's from the June 27th and June 28th Public Workshops.

A second round of Public Workshops will occur in February 2019 (Date & Location TBD).*<-- New as of 1/7/19*

Throughout this process and during the Public Workshops, the Airports Authority welcomes questions, comments and general input from the larger community. You can submit questions and comments at any time -- and, based on comments or input received, this webpage may be updated with answers to Frequently Asked Questions.

Attachment

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82.71 KB

PDF HERNDON_REPRESENTATIVE_TO_WORKING_GROUP_JAI
84.65 KB

PDF LOUDOUN_COUNTY_REPRESENTATIVE_TO_WORKING_C
93.17 KB

PDF PROJECT_TIMELINE_-_POSTED_ON_MWAA_WEBSITE
116.05 KB

PDF IAD_CONTOURMAPUPDATE_KICKOFF_BRIEFING_201804(
7.05 MB

PDF IAD_CARGO_INFORMATION_-_AIRPORT_101_APRIL_4_20
2.23 MB

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IAD_JAN_7_2019_NOISECONTOUROVERLAYASSESSMENT
3.1 MB

JAN_7_NEXT_STEPS_SLIDE_-_NEW_NOISE_CONTOURS
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1 Aviation Circle - Washington, D.C. 20001

PROJECT PURPOSE, INVENTORY AND PROCESS PUBLIC WORKSHOP MATERIAL

MEDIA ADVISORY

Dulles International Airport Hosts Public Workshops on Airport Aircraft Noise Contour Map Update

The Metropolitan Washington Airports Authority will hold two public workshops regarding the Washington Dulles International Airport Aircraft noise contour map update. These workshops will provide an overview of the study, including airfield plans, existing airport operations and basic information regarding aircraft noise and noise modeling standards.

Wednesday, June 27, 2018
6 – 8 p.m.
Washington Dulles International Airport Office Building
45045 Aviation Drive, Sterling VA
2nd Floor Conference Room
Free parking available in front of the building

Thursday, June 28, 2018
6 – 8 p.m.
Rock Ridge High School Cafeteria
43460 Loudoun Reserve Drive, Ashburn, VA
Free parking available in the front and rear of building

A noise contour map update for Dulles International will help guide local land use planning in the immediate geographic vicinity of the airport. The maps are an update to contours prepared in 1993 that serve as the basis for the Loudoun and Fairfax counties' Airport Impact Overlay Districts zoning. This helps ensure compatible land uses surrounding the airport. Public workshops include an opportunity to visit with subject matter experts involved in the effort.

The Airports Authority formed a Local Jurisdictional Stakeholder Group in 2018, comprised of Airports Authority interdisciplinary staff, appointed professional technical staff from local governments (including Fairfax County, the Town of Herndon and Loudoun County), an airline partners' representative and key Federal Aviation Administration officials, whose participation is essential to the success of this effort.

Individuals are welcome to submit questions and comments during these workshops, or at any time online until the conclusion of this process in early 2019.

###

About the Metropolitan Washington Airports Authority

The Metropolitan Washington Airports Authority operates the U.S. Capital Region's gateways to the nation and the world, Ronald Reagan Washington National Airport and Washington Dulles International Airport, as well as the Dulles Airport Access Highway, the Dulles Toll Road and construction of the Silver Line project, a 23-mile extension of the Metrorail public transit system through northern Virginia. A record 46.6 million passengers passed through the two airports in 2017.

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

WELCOME

Public Workshop

FOR

WASHINGTON DULLES INTERNATIONAL AIRPORT

Aircraft Noise Contour Map Update

June 2018

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Study Objective

Update MWAA's 1993 noise contours to assist with future land use planning and zoning activities

Update due to:

- Flight track locations and overall utility of the airfield
- FAA NextGen improvements
- Triple simultaneous runway operations during low visibility conditions (IFR)
- Future operational capability of the airport

NOTE: IFR stands for Instrument Flight Rules.

SOURCE: *FAR Part 150 Noise Compatibility Program, Washington Dulles International Airport*; Addendum Section, Exhibit L, Page 45; Metropolitan Washington Airports Authority, March 1993.

Noise Map Update Process

INVENTORY

- Evaluate current and future plans (MWAA and FAA)
- Assess existing operation conditions

FORECAST

- Determine airfield operating configurations
- Determine maximum potential operations
- Determine potential aircraft runway use and flight tracks

NOISE MODELING

- Build baseline noise model
- Calculate potential aircraft noise levels for airfield operating configurations
- Determine appropriate composite of airfield operating configurations, if appropriate

CONCLUSIONS

- Recommend potential aircraft noise contours for land use planning

KEY

Completed

In Process

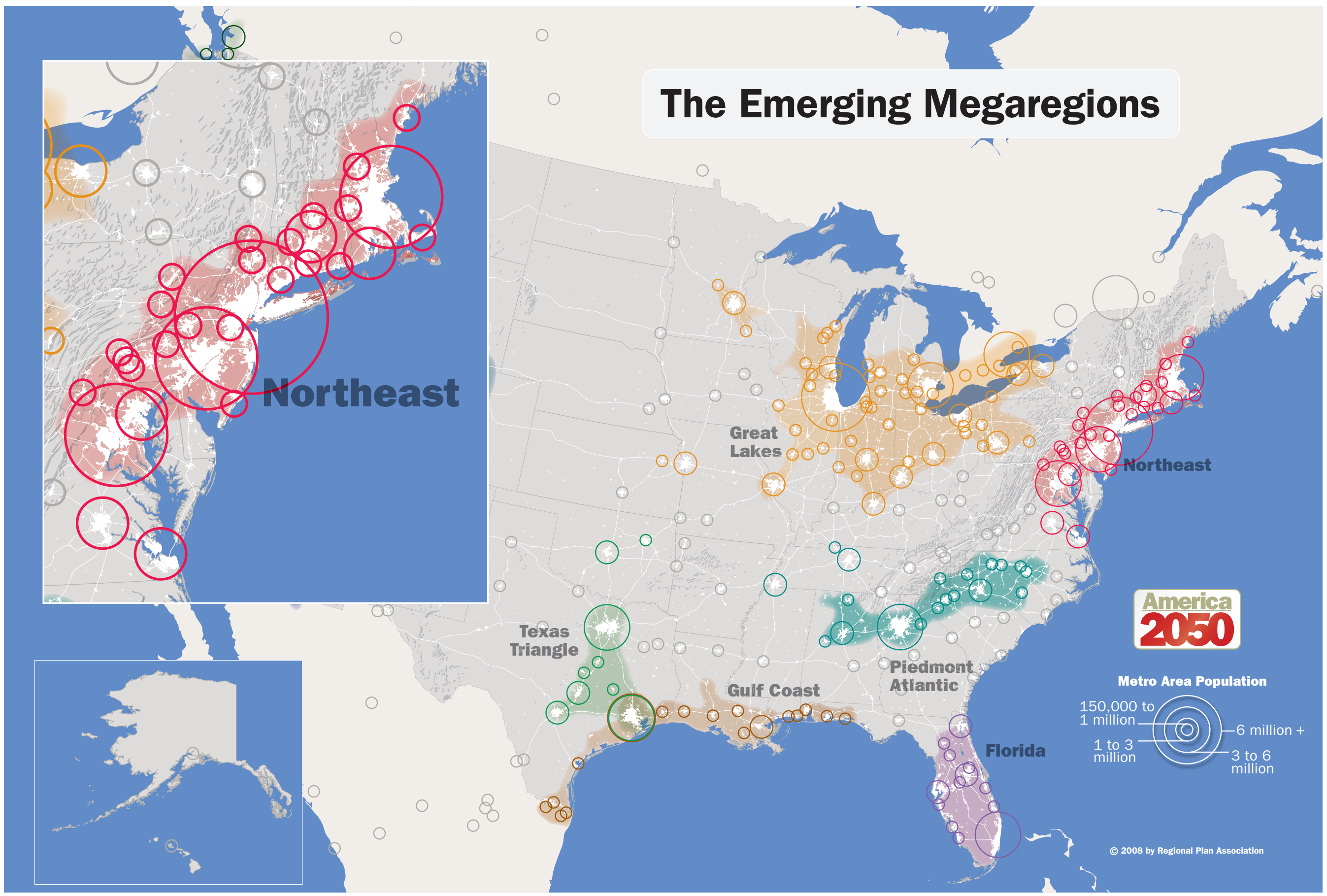
Upcoming

What Is A Noise Contour Map?

- A map that reflects a graphic representation of the Day-Night Average Sound Level (DNL) distribution in a given region. DNL represents average noise exposure events over a 24 hour period.
  - 55, 60, 65, 70, 75 DNL
- The Aviation Environmental Design Tool (AEDT) calculates the noise contour map based on: 1) Number of aircraft operations, 2) Aircraft fleet mix, 3) Runway use and utility, 4) Flight corridors, tracks, and usage, 5) Destinations, and 6) Day/night use
- A land use tool that guides jurisdictional planning and zoning decisions

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Dulles - Global and National Importance



SOURCE: Both maps taken from "Our Maps," America 2050-Regional Plan Association, http://www.america2050.org/maps/ (Accessed March 29, 2018).

- FAA forecast trends:
  - Domestic and international passenger demand to increase – international at a higher rate
  - Domestic and international cargo to increase – international at a higher rate
  - Operations at hub airports such as Dulles to grow substantially faster than the overall national trend
- Dulles is ideally positioned to accommodate domestic and international passenger and cargo demand

Dulles - Regional Importance

SIZE:	AFFLUENCE:	ECONOMY:	DESTINATION:
6.2 Million Residents	**$98,115 Per Capita Income**	**$509 Billion Regional GDP**	**$7.3 Billion Visitor Spending**
(6th largest market in the U.S.)	(Highest in the U.S.)	(5th highest in the U.S.)	(6th most visited region among international travelers)
The population of the area has grown 10.1% since 2005.	Highly educated work force drives the strongest income in the nation	While the Airport's Service Region population accounts for 1.9% of total U.S. population, it generates 2.8% of total U.S. GDP	Washington, D.C. attracted 20 million domestic and 2 million international visitors in 2016

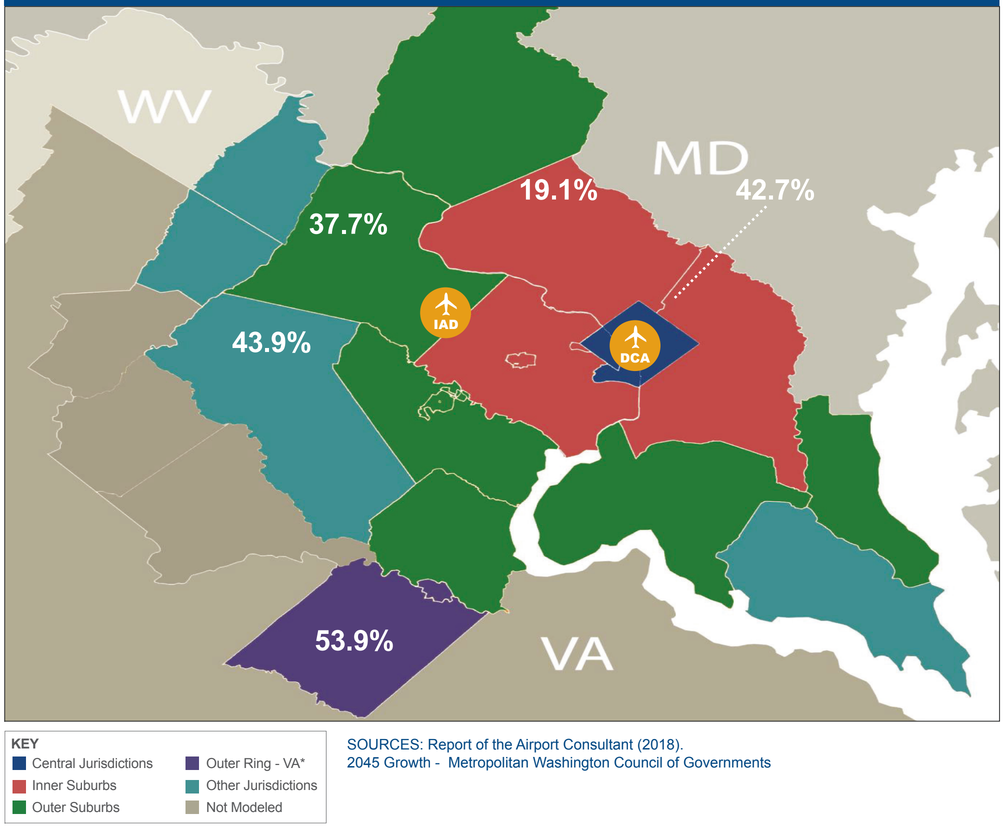
SOURCE: U.S. Census bureau annual CBSA population update via SpatialTEQ (population & income data); Bureau of Economic Analysis (GDP data)

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Enplanement Growth Supported by Population Forecasts

- The population growth averaged 1.3% annually between 2010 and 2017, consistently exceeding the national average of 0.7%
- The inner suburbs, including Fairfax County, are forecast to have the greatest total population by 2045
- The outer suburbs, including Loudoun County, are forecast to experience the fastest rates of growth through 2045

PROJECTED POPULATION GROWTH WITHIN AIRPORTS SERVICE REGION – 2015-2045



* Fredericksburg-Area Jurisdictions

SOURCES: Report of the Airport Consultant (2018).
2045 Growth - Metropolitan Washington Council of Governments

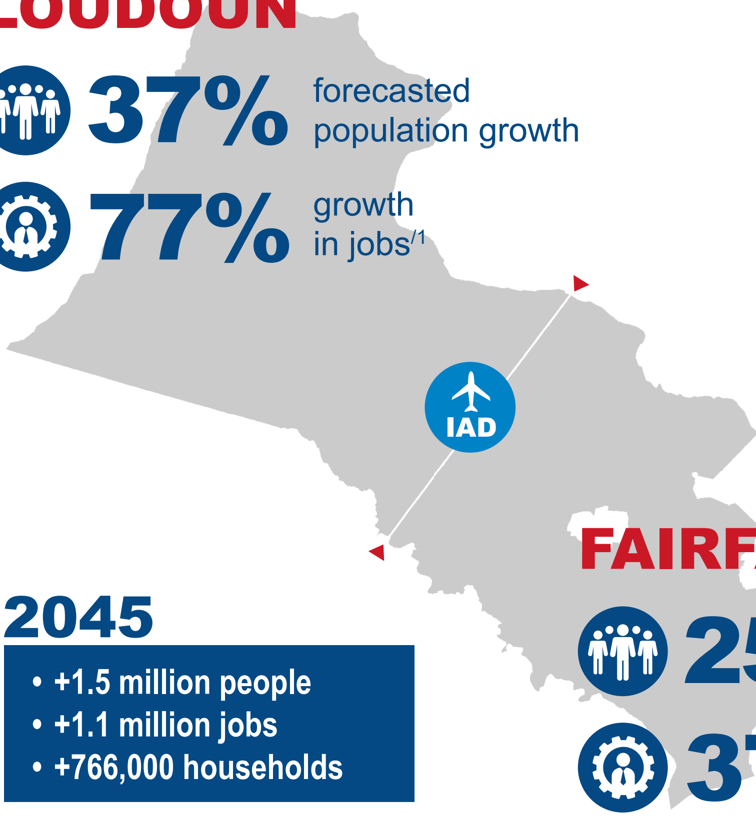
METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Significance of IAD on Local/Regional Economy

LOUDOUN

37% forecasted population growth

77% growth in jobs[1]



2045

- +1.5 million people
- +1.1 million jobs
- +766,000 households

FAIRFAX

25% forecasted population growth

37% growth in jobs[1]

- Dulles contributed **247,706 jobs** and **$9.9 billion** in associated labor **income**.[2]
- **Cargo operations** generated **19,500 jobs**, and over **$1.2 billion** in associated labor **income**.[2]

SOURCES: 1/ Metropolitan Washington Council of Governments. *Cooperative Forecasting in Metropolitan Washington-Growth Trends to 2045*, November 9, 2016.
2/ *Metropolitan Washington Airports Authority Economic Impact Study – 2012.*

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

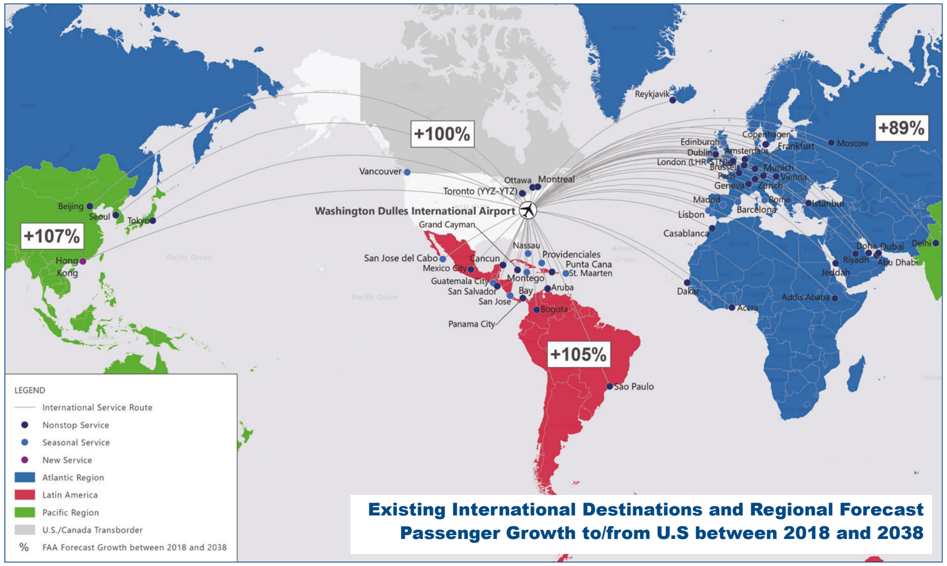
Air Service Continues To Grow

POTENTIAL INTERNATIONAL PASSENGER SERVICE

- Airline Hub expansion
- International service expansion
- Growth in local demand and domestic connecting flights for international passengers

POTENTIAL CARGO SERVICE

- Medium-size hub for one integrated cargo carrier
- Expansion of international cargo carriers
- Addition of an eCommerce cargo carrier



Existing International Destinations and Regional Forecast Passenger Growth to/from U.S between 2018 and 2038

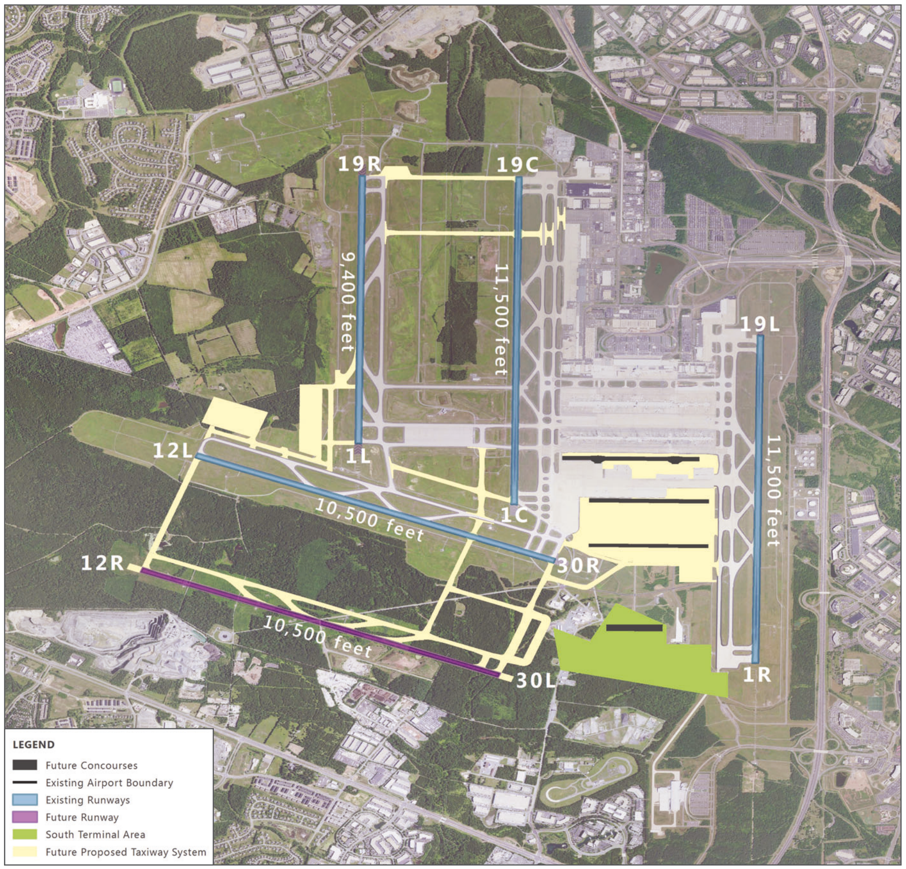
SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap contributors, and the GIS user community, May 2018 (basemap); MWAA, July 2018 (international non-stop destination data); OpenFlights.org, June 2018 (flight arcs); National Science Foundation, National Institutes of Health, 2016 (countries); FAA Aerospace Forecast Fiscal Years 2018 – 2038, Federal Aviation Administration, May 2018 (forecast growth in passengers between 2018 and 2038).

SOURCE: MWAA. 2015 Air Service Development Industry and Community Briefing. November 2014

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

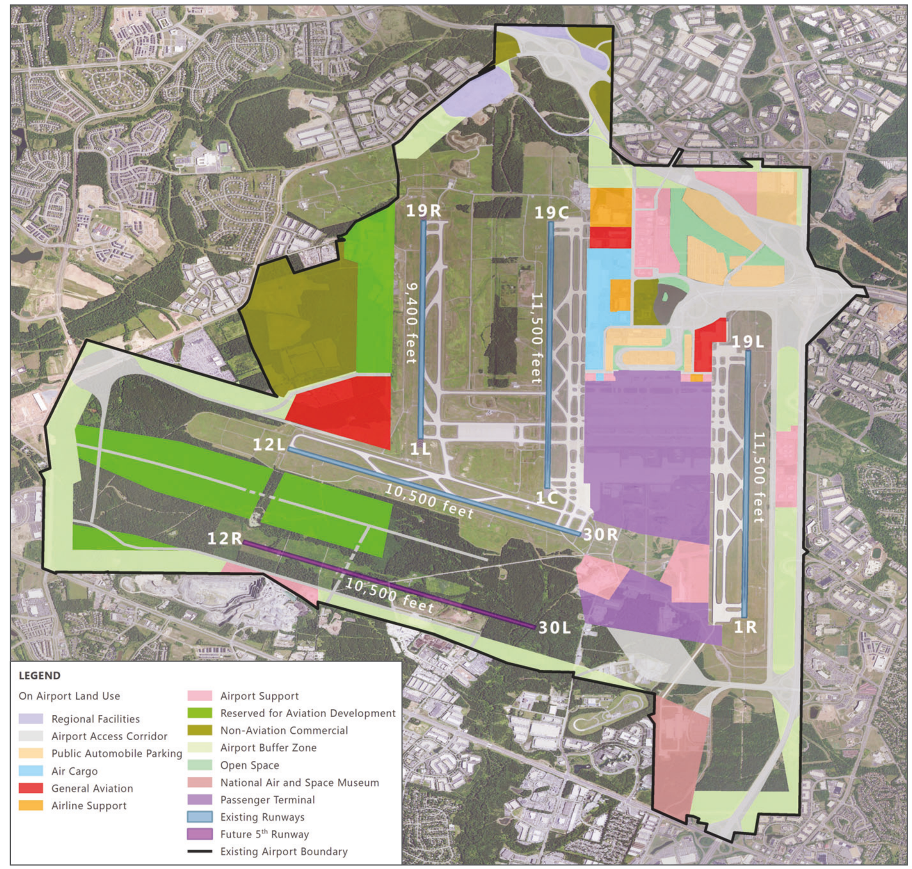
Airport Plans For Future Growth

Master Plan



SOURCES: Aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016; on-airport land use, new runway, new taxiways, concourses and south terminal, MWAA, April 2018;

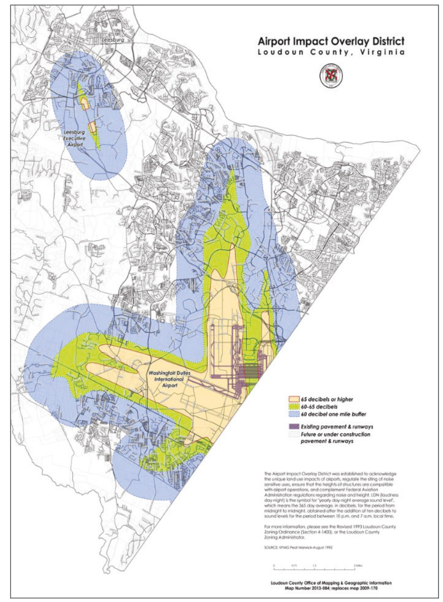
Airport Land Use Plan



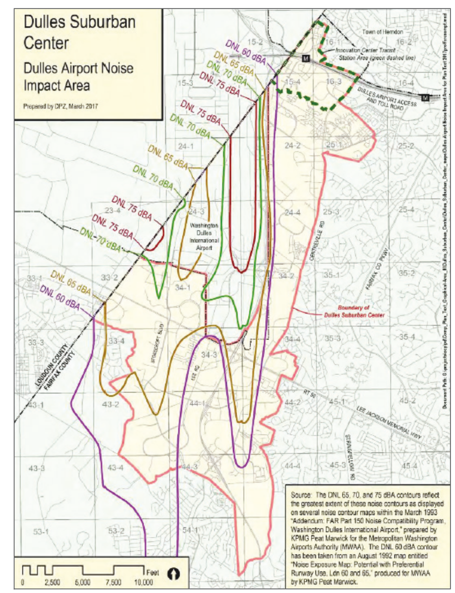
SOURCES: Aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016; on-airport land use: MWAA, April 2018; new runway: MWAA, April 2018.

Current Land Use Planning and Zoning

- Aircraft noise and its impact on regional communities was a primary consideration during the planning of the Airport in 1958
- Land use planning and zoning is based upon long-range noise contours
- Noise contours have been a resource and aid to local jurisdictions planning and zoning processes
- Updated long-range noise contours will aid local jurisdictions with on-going compatible land use planning and zoning

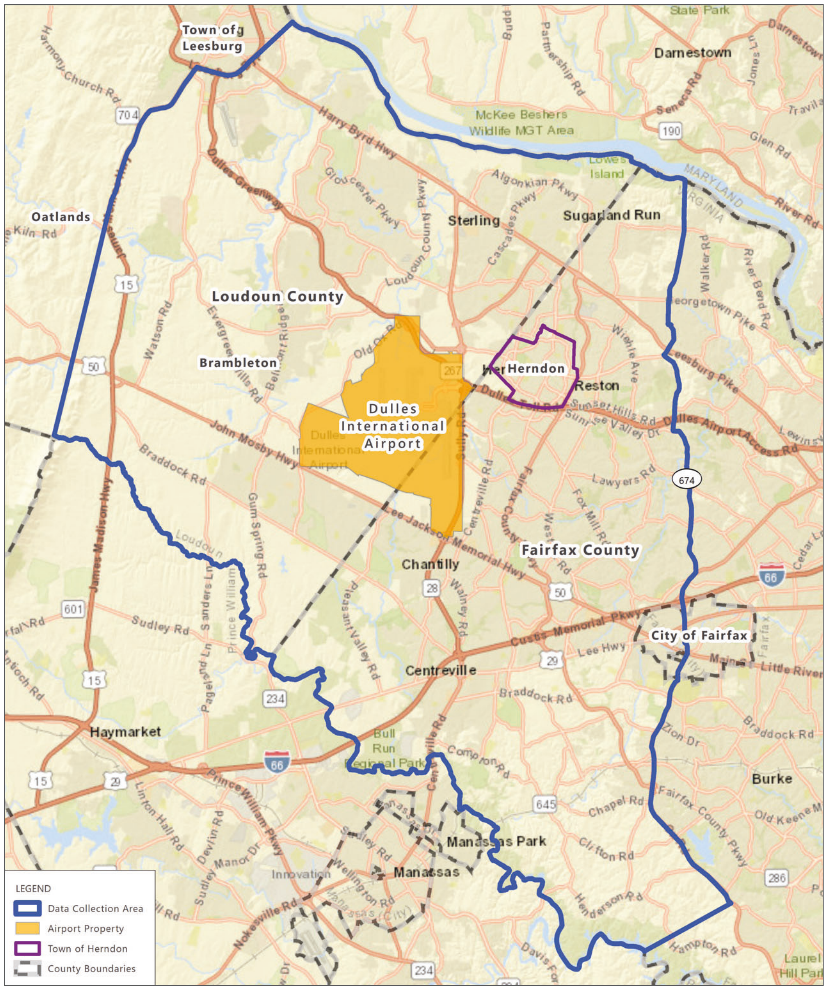


SOURCE: Loudoun County, Virginia, Zoning Ordinance, AI-Airport Impact Overlay District 4-1400



SOURCE: Fairfax County. "The Dulles Suburban Center Study". Accessed April 3, 2018. https://www.fairfaxcounty.gov/planning-zoning/dulles-suburban-center

Land Use/Zoning Data Collection Area



SOURCE: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, May 2018 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Fairfax County, 2017, https://data-fairfaxcountygis.opendata.arcgis.com/ (accessed April 12, 2018) (land use); Loudoun County, 2017, https://data-loudoungis.opendata.arcgis.com/ (accessed April 12, 2018) (land use); Ricondo & Associates, Inc., May 2018 (data collection area).

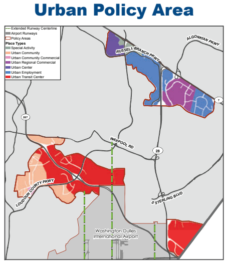
METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

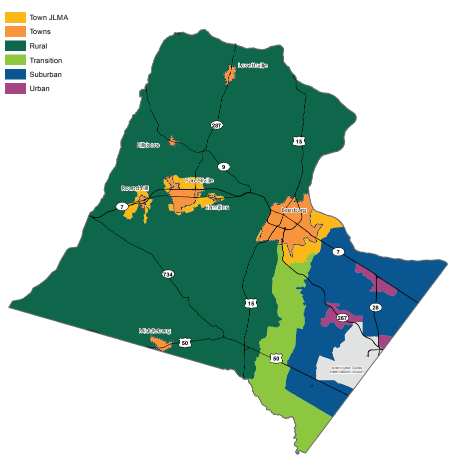
Current Land Use Planning Efforts

LOUDOUN COUNTY

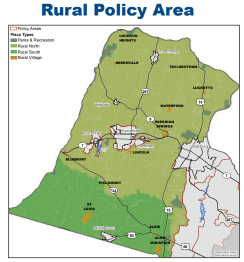
Envision Loudoun: A New Comprehensive Plan

Urban Policy Area

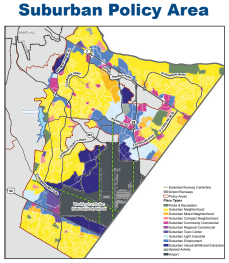




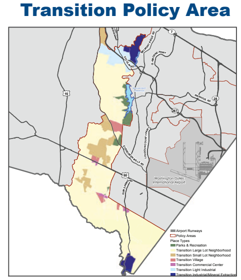
Rural Policy Area



Suburban Policy Area



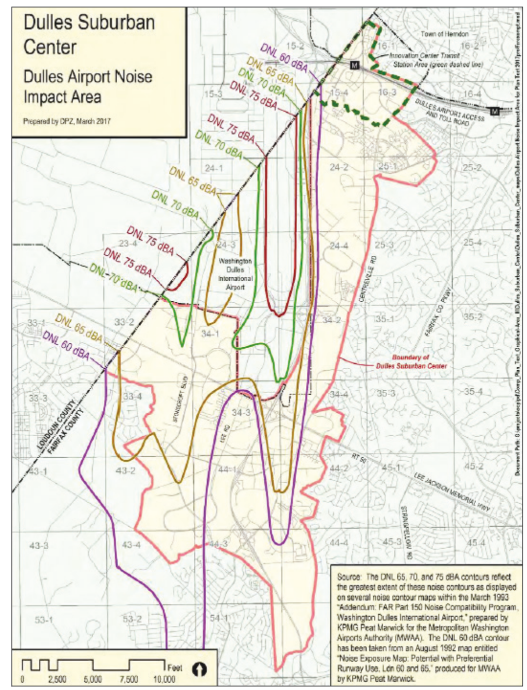
Transition Policy Area



SOURCE: Loudoun County, Envision Loudoun. – Foundations Report. March 2017.

FAIRFAX COUNTY

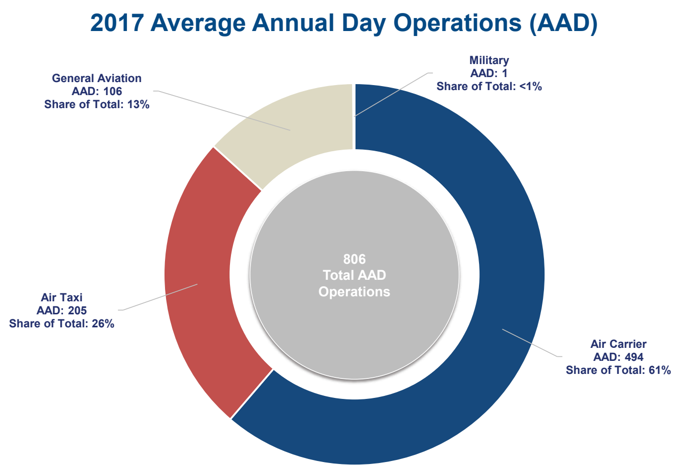
Dulles Suburban Center Plan: Updating recommendations for future land uses and development

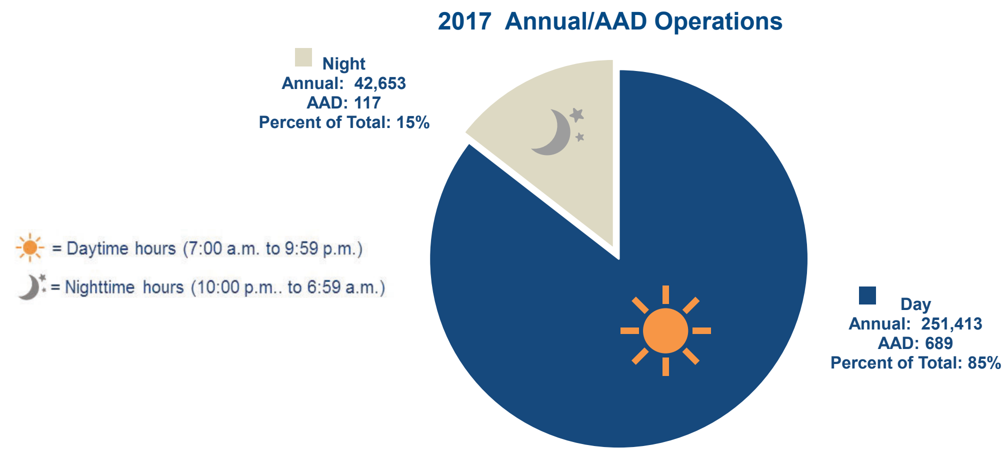


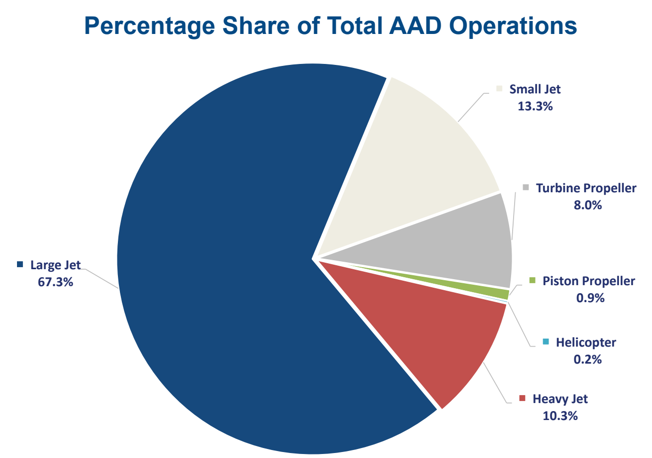
SOURCE: Fairfax County. Fairfax County Comprehensive Plan. "Land Use Planning within the Dulles Airport Noise Impact Area." 2017 Edition. Amended through 3/14/2017. Pages 19-23.

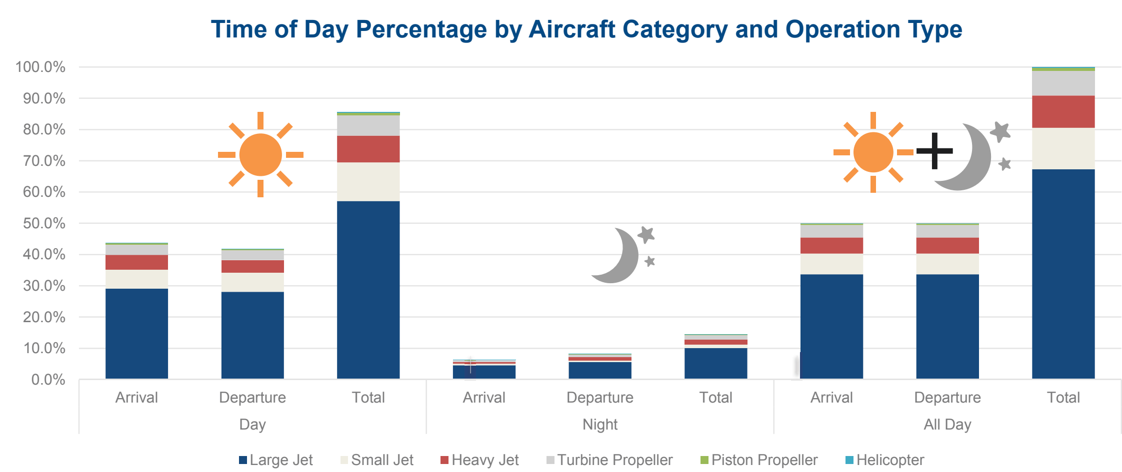
METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Existing Operations







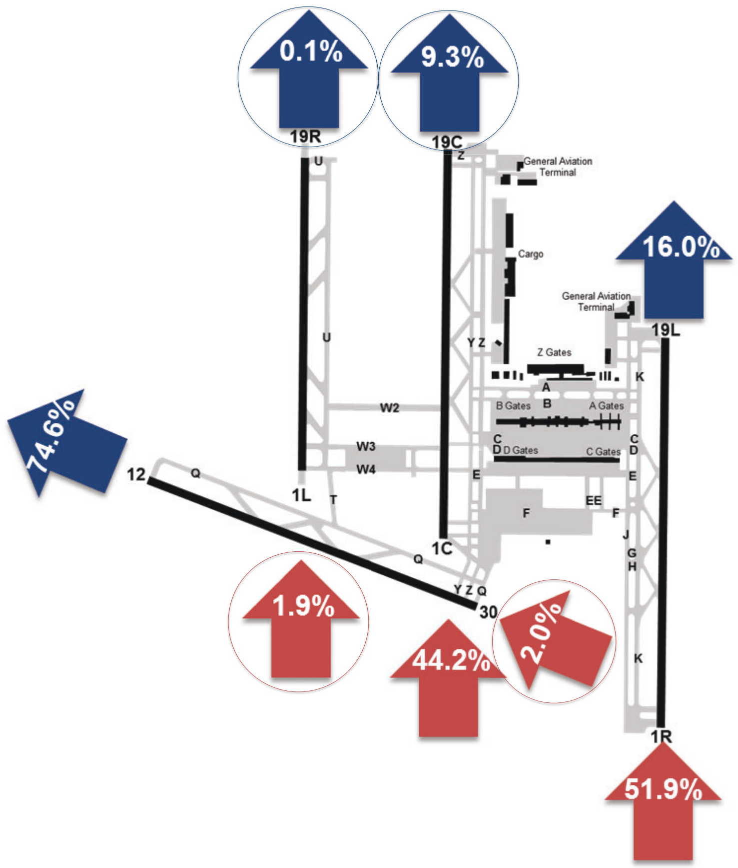


SOURCES: 2017 Airport Noise and Operations Management System (ANOMS); Federal Aviation Administration Operations Network- IAD Tower Counts.

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Existing Runway Use

NORTH FLOW: 58%



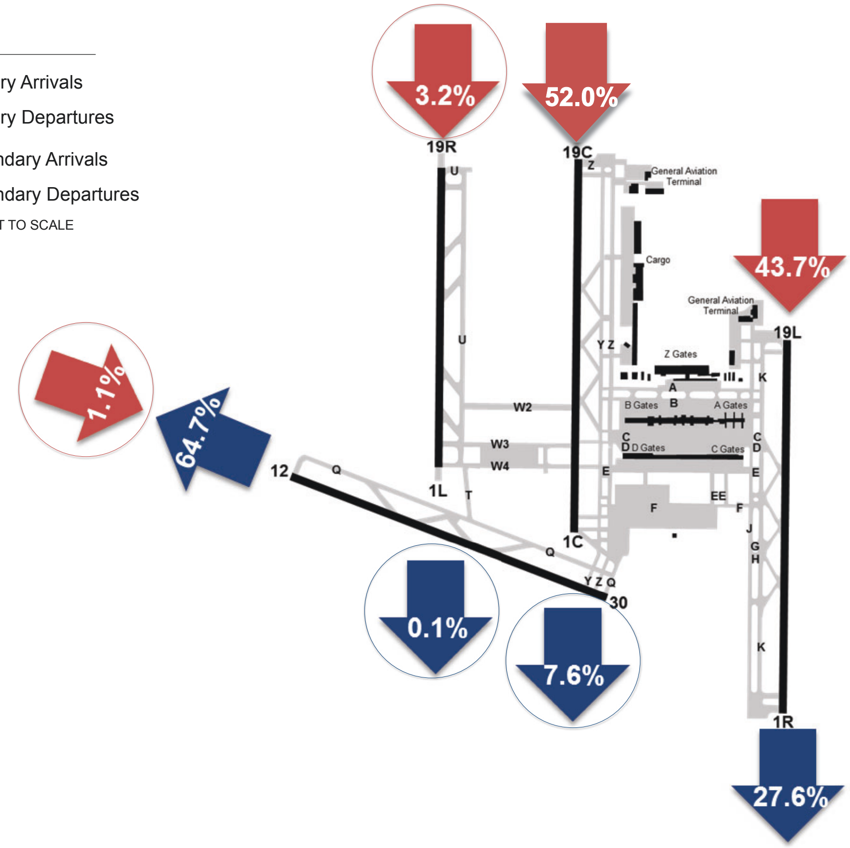
LEGEND

- Primary Arrivals
- Primary Departures
- Secondary Arrivals
- Secondary Departures

NOT TO SCALE

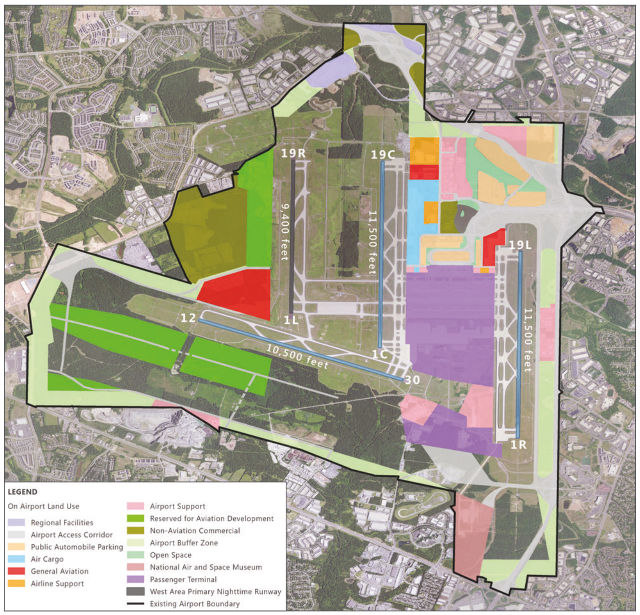
N

SOUTH FLOW: 42%



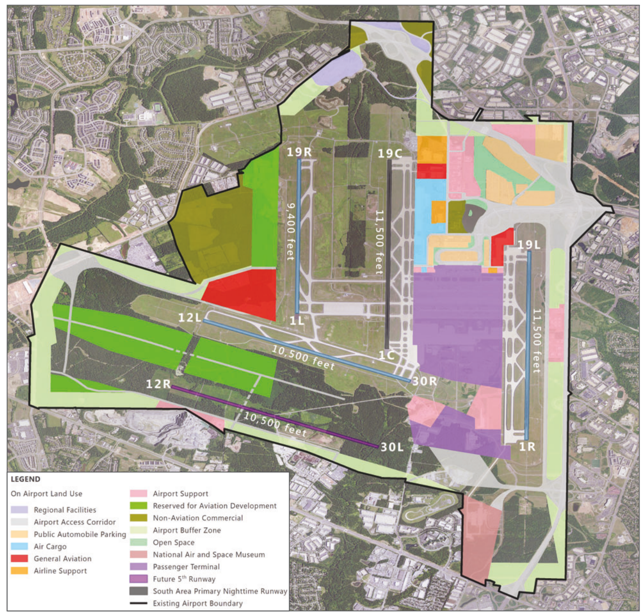
SOURCES: MWAA. 2017 Airport Noise and Operations Management System (ANOMS); Federal Aviation Administration Operations Network- IAD Tower Counts.

Airfield Operating Configurations



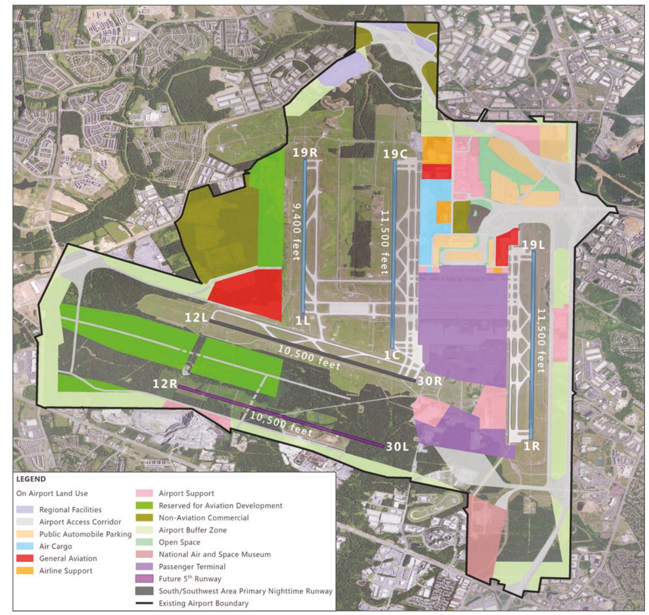
SOURCES: Aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016; on-airport land use: MWAA, April 2018

- Four-runway airfield
- Full airfield utilization during daytime
- Commercial nighttime operations based on most efficient runway use
- Runway 1L-19R primary nighttime cargo operations



SOURCES: Aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016; on-airport land use: MWAA, April 2018; new runway: MWAA, April 2018.

- Five-runway airfield
- Full airfield utilization during daytime
- Commercial nighttime operations based on most efficient runway use
- Runway 1C-19C primary nighttime cargo operations



SOURCES: Aerial photograph: USDA-FSA-APFO Aerial Photography Field Office, Virginia 1m NAIP Imagery, 2016; on-airport land use: MWAA, April 2018; new runway: MWAA, April 2018.

- Five-runway airfield
- Full airfield utilization during daytime
- Commercial nighttime operations based on most efficient runway use
- Runway 12L-30R primary nighttime cargo operations

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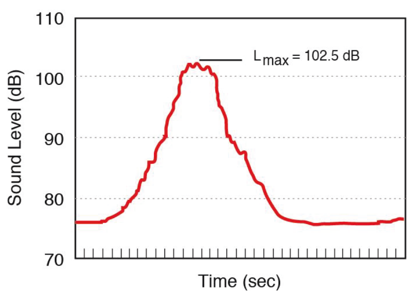
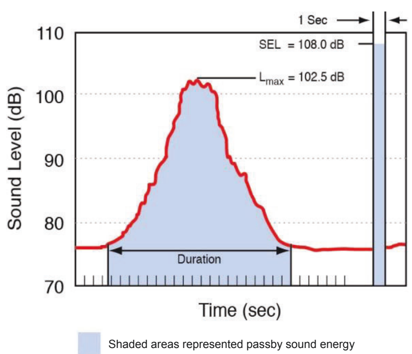
Science Of Noise - Accepted Metrics

SINGLE EVENT: PEAK SOUND LEVEL

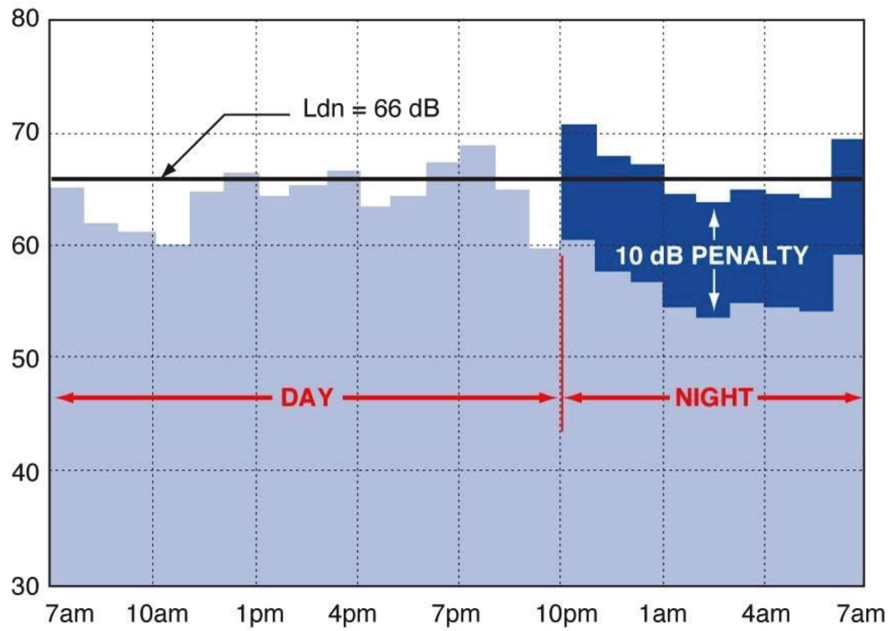


SOUND EXPOSURE LEVEL



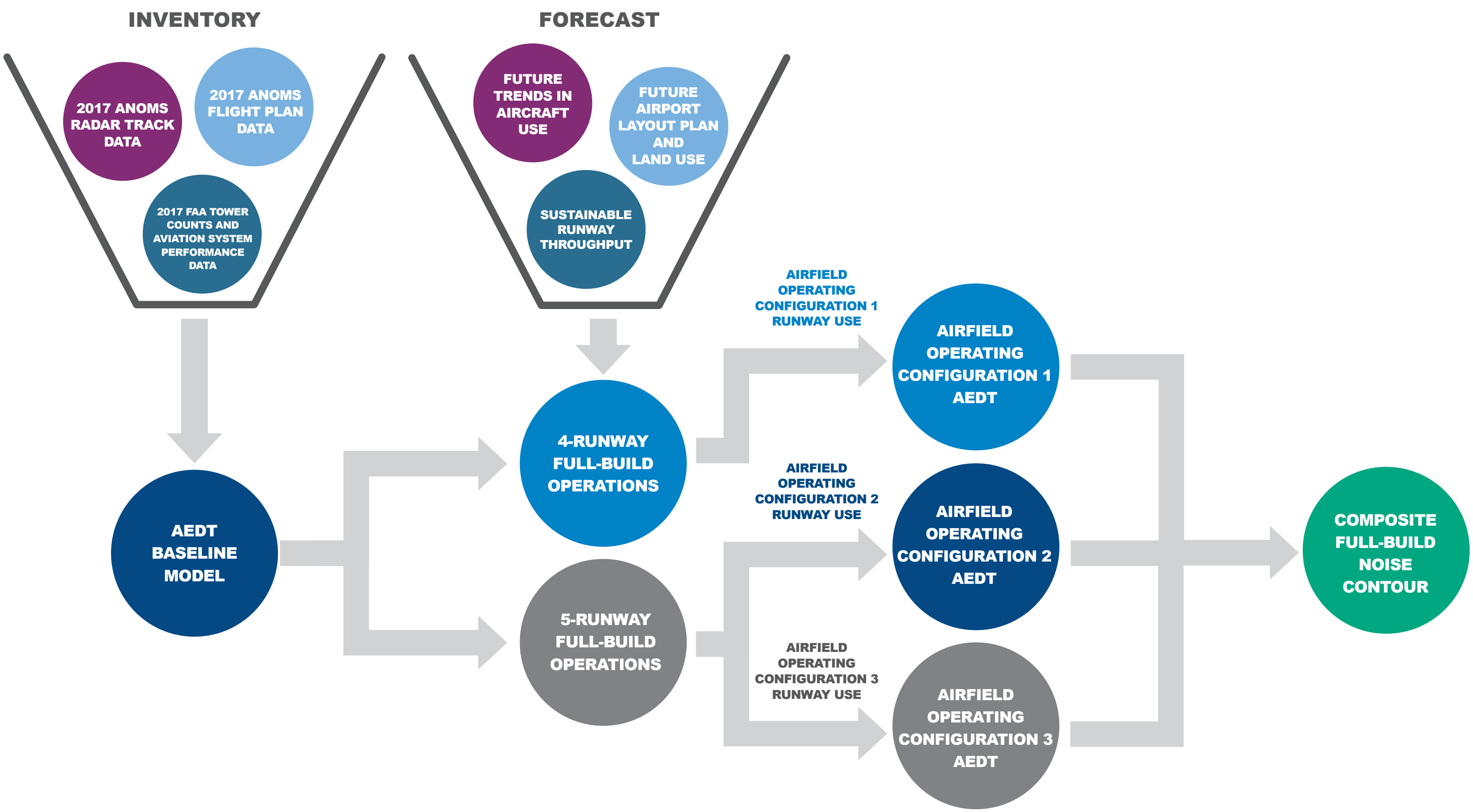
AIRCRAFT NOISE EVENTS FOR 24 HOURS

CUMULATIVE: DAY/NIGHT AVERAGE SOUND LEVEL



- A way to describe the cumulative noise dose for a 24-hour period
- Can also be described as an average of the sound level over the full day
- Accounts for noise event “noisiness” (SEL)
- Accounts for number of noise events
- Provides an additional weighting factor for nighttime operations

Noise Modeling Process



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How to Stay Informed

WEBSITE:

http://www.flydulles.com/iad/dulles-international-noise-contour-map-update

ATTEND:

2nd Public Workshop – Anticipated November 2018

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Washington Dulles International Airport

Aircraft Noise Contour Map Update

Public Workshop— Wednesday, June 27, 2018

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Aircraft Noise Contour Map Update

Public Workshop— Wednesday, June 27, 2018

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Dick DeiTos	MWAC	703-572-[illegible]
Roger Dindyal	FFX County	703-324-1383
Chris Antigone | Antigone Company	~~Antigone~~ 1880 Howard Ave #303 Vienna, VA 22182	703-790-5160

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Ted Troscianecki	6618 Smiths Trace Centreville	tedtam@aol.com
Maggie Parker	Comstock	703 · 230 · 1291
Leanna O'Donnell	Fairfax County DPZ	703-324-1272
PRAN GURURAJ	Loudoun Cty	pranguru@gmail.com
Michael Cooper	MWAA	michael.cooper@mwaa.com
Bobby Klancher	101 South St. SE Leesburg	703 442 2400
Amber-Lee Leslie	Fairfax Co Gov't	703 814 7100
Robin Bartok	17830 Oakmont Way Purcellville VA 20132	Robin.W.Bartok@loudoun.gov
JOE GORNEY	FAIRFAX COUNTY	703-324-1267

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This was a much better way of presenting the material. Much better than a speaker presenting a powerpoint to an audience.

Please provide the following: (Optional)

Name: Janie Wilson

Address: janie.wilson@fbopartners.com
(Street or Email)

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Metropolitan Washington Airports Authority
1 Aviation Circle
Washington, DC 20001-6000

EMAIL:
ADnoisecontourmap@mwaa.com

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No
@ Refreshments. ?

Please provide the following: (Optional)

Name: __________

Address: __________
(Street or Email)

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Aircraft Noise Contour Map Update

Public Workshop— Thursday, June 28, 2018

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Mei Fang	Nspiregreen.	mfang@nspiregreen.com.
Michael Cooper	MWAA	michael.cooper@mwaa.com
Jenny Wheaton	Brambleton	jenny.wheaton@brambleton.com
Lynda Gruen	Stone Ridge	dgruen1@excite.com
Kim Hart	Unison, VA	Kim@GOODWORKSVA.com
RAJASEKHAR RAJA	43607 PARISVILLE CT, STERLING, VA 20166	RRAJA2C gmail.com (CLVE III HOA Board)
Swanka Burnette Loudoun Cty Economic Dev	43777 Central Station Drive Ashburn VA 20177	swanka.burnette@loudoun.gov
Mike Rhodes	24951 Calcite Pl	mike@mikerhodes.org
RENEY MIRCHANDANI	42854 BRAEMOUNT CIRCLE	renee.mirchandani@gmail.com

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Shirley & Howard Lieberman	20857 Killawog Terr.	shirleyann@ ~~703~~ outlook.com
James Fornof	43853 Grantner Pl, Ashburn	JDFornof@aol.com 412 956-1833 (m
Chris Dabney	43872 Glenhazel Dr Ashburn	Chrisdab@gmail.com ~~540 . 392 9605~~
Rameon Minchandani	42854 BRAEMOUNT Cir	~~5777~~
JACK LEWIS	43414 CLOISTER PLACE LEESBURG,	COMMPROP@ATT.NET
Rosemarie Linder	23252 Hickory Dr. Brambleton	roselinder@gmail.com
BEN WALES	19134 Moselle Way. Leesburg.	bWales@cooley.com

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Brenda Morton		bmorton@dullesarea.com
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I think it is important for Dulles to get more input from the public in terms of noise instead of just relying on data.

I am hoping that night time flights will be limited. I also hope that flights will avoid neighborhoods.

Thank you for taking the time to explain things to the community.

Please provide the following: (Optional)

Name: ____________________

Address: ____________________
(Street or Email)

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apparently we live in the flight path of your Runway #30 NORTH. Mostly take-offs. Extremely bothersome during the night/day. Not just the noise but also the height of planes. Sometimes we see shadows of wings on a sunny day and red and green blinking lights through our windows at night! Even though your tracker states they were taking off at 4400-5500 ft. Our suggestion is for you to change the flight paths especially of the huge heavier planes from Runway #30 to the one (or build one) for those planes to take off going over Wegmans, car dealerships & data warehouses off waxpool road. That area is residence free and that would be safer for the planes as well as the residents.

Please provide the following: (Optional)

Name: ____________________

Address: rrrkm11@hotmail.com
(Street or Email)

appreciated meeting your staff and learning some stuff but that is not we wanted to hear.

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This was a very helpful workshop to get information on the study and also to better understand current conditions, such as the number of total flights.

I think it would be good to provide a noise bump for the evening hours as well as the night hours.

It's important for the public to be fully informed to ~~manage~~ manage expectations.

Ensuring that the contours are accurate based on actual flights is essential for good land use planning + to preserve the airport's potential and value to the economy.

Please provide the following: (Optional)

Name: ____________________

Address: ____________________
(Street or Email)

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Concerned about future expansion @ Dulles. Currently noise is awful and cannot imagine an increase in runways. I plan to attend any meetings where we homeowners can have input that matters.

Please provide the following: (Optional)

Name: ______

Address: ______
(Street or Email)

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1. I live in Stone Ridge South (Aldie, VA). Loudoun Co.
My neighbors did not know about this meeting. I learned about it through my soundproofing contractor.
2. Our homes have vinyl siding, 4" exterior walls and no mass loaded vinyl in the attics (as far as I know). My community would get hammered with a full build-out. The planes are already keeping me up at night, and my husband has already had to take off work →

Please provide the following: (Optional)

Name: ______

Address: ______
(Street or Email)

______

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to cover for me, because the sleep deprivati
makes it so I can't take care of my
toddler daughter.

Here's what we need:

1) A night-time ~~curfew~~ curfew. Yes, I'm
serious. We need a solid block of X
hours when planes may not fly.

2. A ~~~~ requirement that builders
provide 6" soundproofed exterior walls
with professionally-installed mass-loaded vinyl in attics and
soundproof / acoustic windows ~~~~
- and all-brick / masonry exteriors,
or at least aluminum siding - NO VINYL
SIDING!

3. All builders ~~~~ should be legally required
to CLEARLY STATE THAT THE HOME
IS IN AN AIRPORT CONTOUR! NO
STATEMENTS BURIED IN FINE PRINT!
THAT SHOULD BE ILLEGAL!

4. An airport tax to pay for soundproofing of existing homes. To do it right is extremely expensive. Priority reimbursement should go to ~~pe~~ residents with pre-existing health conditions exacerbated by the airplane noise ~~&~~ pollution, stay-at-home ~~parents~~ caregivers and owners of home-based businesses.
5. Builders should additionally be required to disclose that homebuyers may not be able to enjoy their decks, patios or community outdoor space. This should especially be the case when decks and patios are additional options for additional cost.
6. If you want locals to show, send out postcards to ~~the~~ residents, especially when they are in a contour zone.

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Hey, great that you are doing this. Thanks!
However, my real issue is with night time
air operation, most likely cargo, most likely
Runway 1L. After ≈10:15pm most evenings, cargo
flights are released to free fly at ≈ 2,000ft. off
1L. Flights heading west cut the corner right over
Ashburn Village at 2-3,000, consistently 1/minute.
I realize that this is an Ops issue, not a planning
issue, and out of scope for this study. But who is the
authority on this and how do I contact them.
Thank in advance.

Please provide the following: (Optional)

Name: James Fornof

Address: 43853 Grantner Pl. Ashburn
(Street or Email)
JDFornof@aol.com

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1 Aviation Circle
Washington, DC 20001-6000

EMAIL:
ADnoisecontourmap@mwaa.com

good works

Location address:
102 W. Washington St.
Middleburg VA 20117
Mailing address:
PO Box 1258
Middleburg VA 20118

Metropolitan Washington Airports Authority
1 Aviation Circle
Washington, DC 20001-6000

RE: Dulles Airport Noise Study—Public comment

June 28, 2018

To Whom It May Concern,

I am a 40-year resident of Loudoun County and a leading developer of Affordable Workforce Housing in the County. The need for housing for Loudoun's workforce, very much including the employees of Dulles Airport, has skyrocketed over the last 25 years. It is extremely import that all "reasonable" sites for housing in Loudoun County be considered, so long as they are within "reasonable" sound impacts from the airport.

From a review of previous airport noise studies, I understand that it is common to provide sound contours at 60 and 65 Ldn. And, on some study exhibits, 70 and 75 Ldn contours are also provided. I would encourage you to provide 70 and 75 Ldn contours on as many maps as reasonably possible in your final report.

In some MWAA publications I have seen it written that in "Ldn 65 & up……Residential dwellings shall not be permitted." In fact, the US Department of Housing and Urban Development (HUD)does allow projects in areas up to 75 Ldn under a special review process and where interior noise levels can be attenuated to levels acceptable to HUD. (Please see 24 CFR Subtitle A, Subpart B—Noise Abatement and Control attached.) Would you please take special care in the final report to reference or footnote that residential projects are acceptable up to 75 Ldn under special circumstances and with proper noise abatement.

Thank you for your consideration and attention to these comments.

Sincerely,

G. Kimball Hart
Manager

their specific responsibilities through FEDERAL REGISTER notice.

[61 FR 13333, Mar. 26, 1996]

§ 51.4 Program coverage.

Environmental standards shall apply to all HUD actions except where special provisions and exemptions are contained in each subpart.

Subpart B—Noise Abatement and Control

§ 51.100 Purpose and authority.

(a) It is the purpose of this subpart B to:

(1) Call attention to the threat of noise pollution;

(2) Encourage the control of noise at its source in cooperation with other Federal departments and agencies;

(3) Encourage land use patterns for housing and other noise sensitive urban needs that will provide a suitable separation between them and major noise sources;

(4) Generally prohibit HUD support for new construction of noise sensitive uses on sites having unacceptable noise exposure;

(5) Provide policy on the use of structural and other noise attenuation measures where needed; and

(6) Provide policy to guide implementation of various HUD programs.

(b) *Authority.* Specific authorities for noise abatement and control are contained in the Noise Control Act of 1972, as amended (42 U.S.C. 4901 *et seq.*); and the General Services Administration, Federal Management Circular 75–2; *Compatible Land Uses at Federal Airfields.*

[44 FR 40861, July 12, 1979, as amended at 61 FR 13333, Mar. 26, 1996]

§ 51.101 General policy.

(a) It is HUD's general policy to provide minimum national standards applicable to HUD programs to protect citizens against excessive noise in their communities and places of residence.

(1) *Planning assistance.* HUD requires that grantees give adequate consideration to noise exposures and sources of noise as an integral part of the urban environment when HUD assistance is provided for planning purposes, as follows:

(i) Particular emphasis shall be placed on the importance of compatible land use planning in relation to airports, highways and other sources of high noise.

(ii) Applicants shall take into consideration HUD environmental standards impacting the use of land.

(2) *Activities subject to 24 CFR part 58.* (i) Responsible entities under 24 CFR part 58 must take into consideration the noise criteria and standards in the environmental review process and consider ameliorative actions when noise sensitive land development is proposed in noise exposed areas. Responsible entities shall address deviations from the standards in their environmental reviews as required in 24 CFR part 58.

(ii) Where activities are planned in a noisy area, and HUD assistance is contemplated later for housing and/or other noise sensitive activities, the responsible entity risks denial of the HUD assistance unless the HUD standards are met.

(3) *HUD support for new construction.* HUD assistance for the construction of new noise sensitive uses is prohibited generally for projects with unacceptable noise exposures and is discouraged for projects with normally unacceptable noise exposure. (Standards of acceptability are contained in § 51.103(c).) This policy applies to all HUD programs providing assistance, subsidy or insurance for housing, manufactured home parks, nursing homes, hospitals, and all programs providing assistance or insurance for land development, redevelopment or any other provision of facilities and services which are directed to making land available for housing or noise sensitive development. The policy does not apply to research demonstration projects which do not result in new construction or reconstruction, flood insurance, interstate land sales egistration, or any action or emergency assistance under disaster assistance provisions or appropriations which are provided to save lives, protect property, protect public health and safety, remove debris and wreckage, or assistance that has the effect of restoring facilities substantially as they existed prior to the disaster.

herein so that future site choices will be consistent with these standards.

(c) *Interdepartmental coordination.* HUD shall foster appropriate coordination between field offices and other departments and agencies, particularly the Environmental Protection Agency, the Department of Transportation, Department of Defense representatives, and the Department of Veterans Affairs. HUD staff shall utilize the acceptability standards in commenting on the prospective impacts of transportation facilities and other noise generators in the Environmental Impact Statement review process.

[44 FR 40861, July 12, 1979, as amended at 54 FR 39525, Sept. 27, 1989; 61 FR 13333, Mar. 26, 1996]

§ 51.103 Criteria and standards.

These standards apply to all programs as indicated in § 51.101.

(a) *Measure of external noise environments.* The magnitude of the external noise environment at a site is determined by the value of the day-night average sound level produced as the result of the accumulation of noise from all sources contributing to the external noise environment at the site. Day-night average sound level, abbreviated as DNL and symbolized as L_{dn}, is the 24-hour average sound level, in decibels, obtained after addition of 10 decibels to sound levels in the night from 10 p.m. to 7 a.m. Mathematical expressions for average sound level and day-night average sound level are stated in the Appendix I to this subpart.

(b) *Loud impulsive sounds.* On an interim basis, when loud impulsive sounds, such as explosions or sonic booms, are experienced at a site, the day-night average sound level produced by the loud impulsive sounds alone shall have 8 decibels added to it in assessing the acceptability of the site (see appendix I to this subpart). Alternatively, the C-weighted day-night average sound level (L_{Cdn}) may be used without the 8 decibel addition, as indicated in § 51.106(a)(3). Methods for assessing the contribution of loud impulsive sounds to day-night average sound level at a site and mathematical expressions for determining whether a sound is classed as "loud impulsive" are provided in the appendix I to this subpart.

(c) *Exterior standards.* (1) The degree of acceptability of the noise environment at a site is determined by the sound levels external to buildings or other facilities containing noise sensitive uses. The standards shall usually apply at a location 2 meters (6.5 feet) from the building housing noise sensitive activities in the direction of the predominant noise source. Where the building location is undetermined, the standards shall apply 2 meters (6.5 feet) from the building setback line nearest to the predominant noise source. The standards shall also apply at other locations where it is determined that quiet outdoor space is required in an area ancillary to the principal use on the site.

(2) The noise environment inside a building is considered acceptable if: (i) The noise environment external to the building complies with these standards, and (ii) the building is constructed in a manner common to the area or, if of uncommon construction, has at least the equivalent noise attenuation characteristics.

SITE ACCEPTABILITY STANDARDS

	Day-night average sound level (in decibels)	Special approvals and requirements
Acceptable	Not exceeding 65 dB(1)	None.
Normally Unacceptable	Above 65 dB but not exceeding 75 dB	Special Approvals (2) Environmental Review (3). Attenuation (4).
Unacceptable	Above 75 dB	Special Approvals (2). Environmental Review (3). Attenuation (5).

Notes: (1) Acceptable threshold may be shifted to 70 dB in special circumstances pursuant to § 51.105(a).
(2) See § 51.104(b) for requirements.
(3) See § 51.104(b) for requirements.
(4) 5 dB additional attenuation required for sites above 65 dB but not exceeding 70 dB and 10 dB additional attenuation required for sites above 70 dB but not exceeding 75 dB. (See § 51.104(a).)
(5) Attenuation measures to be submitted to the Assistant Secretary for CPD for approval on a case-by-case basis.

(3) The project meets other program goals to provide housing in proximity to employment, public facilities and transportation.

(4) The project is in conformance with local goals and maintains the character of the neighborhood.

(5) The project sponsor has set forth reasons, acceptable to HUD, as to why the noise attenuation measures that would normally be required for new construction in the L_{dn} 65 to L_{dn} 70 zone cannot be met.

(6) Other sites which are not exposed to noise above L_{dn} 65 and which meet program objectives are generally not available.

The above factors shall be documented and made part of the project file.

[44 FR 40861, July 12, 1979, as amended at 61 FR 13334, Mar. 26, 1996]

§ 51.106 Implementation.

(a) *Use of available data.* HUD field staff shall make maximum use of noise data prepared by others when such data are determined to be current and adequately projected into the future and are in terms of the following:

(1) *Sites in the vicinity of airports.* The noise environment around airports is described sometimes in terms of Noise Exposure Forecasts, abbreviated as NEF or, in the State of California, as Community Noise Equivalent Level, abbreviated as CNEL. The noise environment for sites in the vicinity of airports for which day-night average sound level data are not available may be evaluated from NEF or CNEL analyses using the following conversions to DNL:

$DNL \approx NEF+35$
$DNL \approx CNEL$

(2) *Sites in the vicinity of highways.* Highway projects receiving Federal aid are subject to noise analyses under the procedures of the Federal Highway Administration. Where such analyses are available they may be used to assess sites subject to the requirements of this standard. The Federal Highway Administration employs two alternate sound level descriptors: (i) The A-weighted sound level not exceeded more than 10 percent of the time for the highway design hour traffic flow, symbolized as L_{10}; or (ii) the equivalent sound level for the design hour, symbolized as L_{eq}. The day-night average sound level may be estimated from the design hour L_{10} or L_{eq} values by the following relationships, provided heavy trucks do not exceed 10 percent of the total traffic flow in vehicles per 24 hours and the traffic flow between 10 p.m. and 7 a.m. does not exceed 15 percent of the average daily traffic flow in vehicles per 24 hours:

$DNL \approx L_{10}$ (design hour)—3 decibels
$DNL \approx L_{eq}$ (design hour) decibels

Where the auto/truck mix and time of day relationships as stated in this section do not exist, the HUD Noise Assessment Guidelines or other noise analysis shall be used.

(3) *Sites in the vicinity of installations producing loud impulsive sounds.* Certain Department of Defense installations produce loud impulsive sounds from artillery firing and bombing practice ranges. Noise analyses for these facilities sometimes encompass sites that may be subject to the requirements of this standard. Where such analyses are available they may be used on an interim basis to establish the acceptability of sites under this standard. The Department of Defense uses day-night average sound level based on C-weighted sound level, symbolized L_{Cdn}, for the analysis of loud impulsive sounds. Where such analyses are provided, the 8 decibel addition specified in § 51.103(b), is not required, and the same numerical values of day-night average sound level used on an interim basis to determine site suitability for non-impulsive sounds apply to the L_{Cdn}.

(4) *Use of areawide acoustical data.* HUD encourages the preparation and use of areawide acoustical information, such as noise contours for airports. Where such new or revised contours become available for airports (civil or military) and military installations they shall first be referred to the HUD State Office (Environmental Officer) for review, evaluation and decision on appropriateness for use by HUD. The HUD State Office shall submit revised contours to the Assistant Secretary for Community Planning and Development for review, evaluation and decision whenever the area affected is changed by 20 percent or more, or whenever it is

stated time period, with reference to the square of the standard reference sound pressure of 20 micropascals.

Day-night average sound level, abbreviated as DNL, and symbolized mathematically as L_{dn} is defined as:

$$L_{dn} = 10 \log_{10}\left[\frac{1}{86400}\left(\int_{0000}^{0700} 10^{[L_A(t)+10]/10}\,dt + \int_{0700}^{2200} 10^{L_A(t)/10}\,dt + \int_{2200}^{2400} 10^{[L_A(t)+10]/10}\,dt\right)\right]$$

Time t is in seconds, so the limits shown in hours and minutes are actually interpreted in seconds. $L_A(t)$ is the time varying value of A-weighted sound level, the quantity in decibels measured by an instrument satisfying requirements of American National Standard Specification for Type 1 Sound Level Meters S1.4–1971.

3. *Loud Impulsive Sounds.* When loud impulsive sounds such as sonic booms or explosions are anticipated contributors to the noise environment at a site, the contribution to day-night average sound level produced by the loud impulsive sounds shall have 8 decibels added to it in assessing the acceptability of a site.

A loud impulsive sound is defined for the purpose of this regulation as one for which:

(i) The sound is definable as a discrete event wherein the sound level increases to a maximum and then decreases in a total time interval of approximately one second or less to the ambient background level that exists without the sound; and

(ii) The maximum sound level (obtained with slow averaging time and A-weighting of a Type 1 sound level meter whose characteristics comply with ANSI S1.4–1971) exceeds the sound level prior to the onset of the event by at least 6 decibels; and

(iii) The maximum sound level obtained with fast averaging time of a sound level meter exceeds the maximum value obtained with slow averaging time by at least 4 decibels.

[44 FR 40861, July 12, 1979; 49 FR 10253, Mar. 20, 1984; 49 FR 12214, Mar. 29, 1984]

Subpart C—Siting of HUD-Assisted Projects Near Hazardous Operations Handling Conventional Fuels or Chemicals of an Explosive or Flammable Nature

AUTHORITY: 42 U.S.C. 3535(d).

SOURCE: 49 FR 5103, Feb. 10, 1984, unless otherwise noted.

§ 51.200 Purpose.

The purpose of this subpart C is to:

(a) Establish safety standards which can be used as a basis for calculating acceptable separation distances (ASD) for HUD-assisted projects from specific, stationary, hazardous operations which store, handle, or process hazardous substances;

(b) Alert those responsible for the siting of HUD-assisted projects to the inherent potential dangers when such projects are located in the vicinity of such hazardous operations;

(c) Provide guidance for identifying those hazardous operations which are most prevalent;

(d) Provide the technical guidance required to evaluate the degree of danger anticipated from explosion and thermal radiation (fire); and

(e) Provide technical guidance required to determine acceptable separation distances from such hazards.

[49 FR 5103, Feb. 10, 1984, as amended at 61 FR 13334, Mar. 26, 1996]

§ 51.201 Definitions.

The terms *Department* and *Secretary* are defined in 24 CFR part 5.

Acceptable separation distance (ASD)—means the distance beyond which the explosion or combustion of a hazard is not likely to cause structures or individuals to be subjected to blast overpressure or thermal radiation flux levels in excess of the safety standards in § 51.203. The ASD is determined by applying the safety standards established by this subpart C to the guidance set

ULTIMATE CONDITIONS NOISE CONTOUR RESULTS PUBLIC WORKSHOP MATERIALS

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WELCOME

PUBLIC WORKSHOP

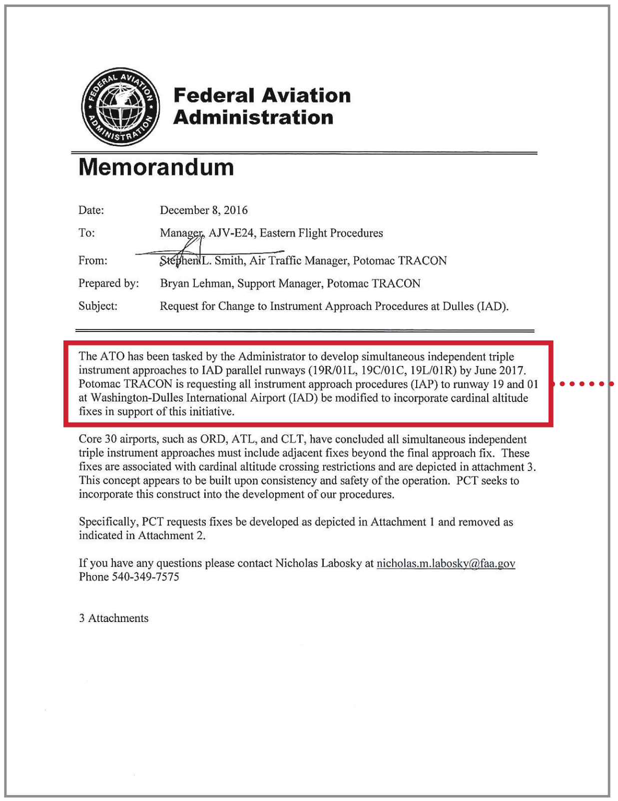
FOR

WASHINGTON DULLES INTERNATIONAL AIRPORT

AIRCRAFT NOISE CONTOUR MAP UPDATE

February 2019

Why Update Now?



Federal Aviation Administration

Memorandum

Date: December 8, 2016

To: Manager, AJV-E24, Eastern Flight Procedures

From: Stephen L. Smith, Air Traffic Manager, Potomac TRACON

Prepared by: Bryan Lehman, Support Manager, Potomac TRACON

Subject: Request for Change to Instrument Approach Procedures at Dulles (IAD).

The ATO has been tasked by the Administrator to develop simultaneous independent triple instrument approaches to IAD parallel runways (19R/01L, 19C/01C, 19L/01R) by June 2017. Potomac TRACON is requesting all instrument approach procedures (IAP) to runway 19 and 01 at Washington-Dulles International Airport (IAD) be modified to incorporate cardinal altitude fixes in support of this initiative.

Core 30 airports, such as ORD, ATL, and CLT, have concluded all simultaneous independent triple instrument approaches must include adjacent fixes beyond the final approach fix. These fixes are associated with cardinal altitude crossing restrictions and are depicted in attachment 3. This concept appears to be built upon consistency and safety of the operation. PCT seeks to incorporate this construct into the development of our procedures.

Specifically, PCT requests fixes be developed as depicted in Attachment 1 and removed as indicated in Attachment 2.

If you have any questions please contact Nicholas Labosky at nicholas.m.labosky@faa.gov
Phone 540-349-7575

3 Attachments

Aug. 9, 2017 – FAA Announces Triple Simultaneous Approaches at Washington Dulles (*)

> The ATO has been tasked by the Administrator to develop simultaneous independent triple instrument approaches to IAD parallel runways (19R/01L, 19C/01C, 19L/01R) by June 2017. Potomac TRACON is requesting all instrument approach procedures (IAP) to runway 19 and 01 at Washington-Dulles International Airport (IAD) be modified to incorporate cardinal altitude fixes in support of this initiative.

(*) With the implementation of FAA's NextGen across the national airspace, Washington Dulles' flight procedures will soon allow for triple simultaneous runway operations in North Flow and/or in South Flow during low visibility conditions.

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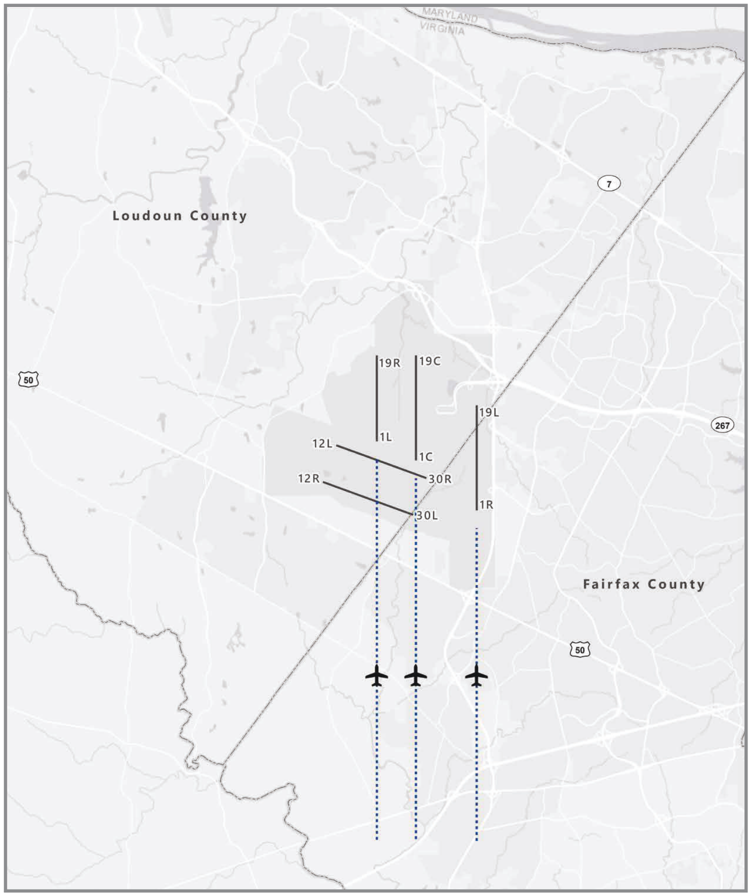
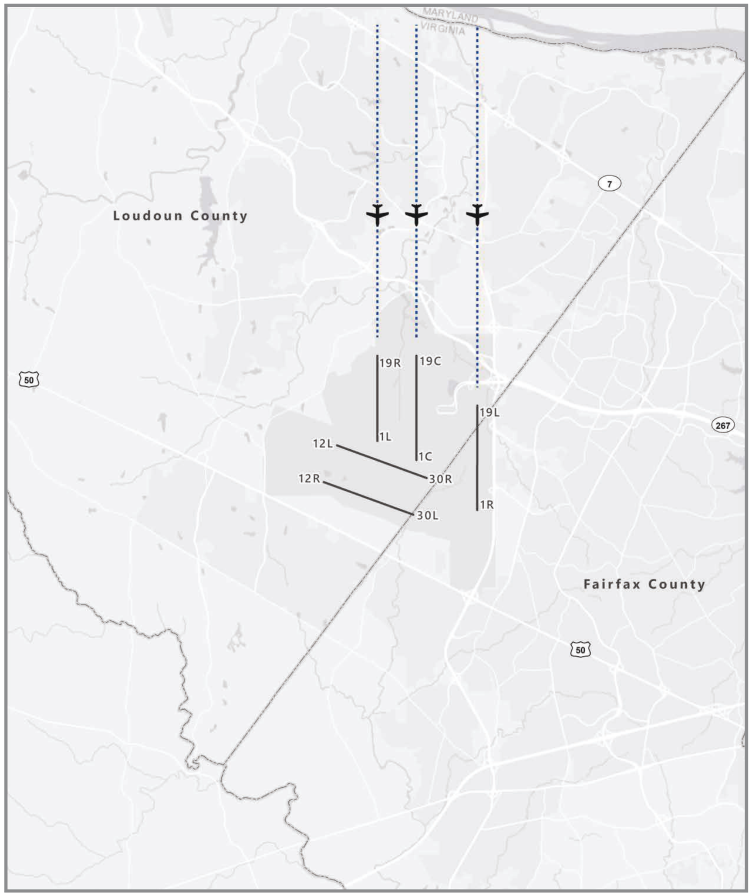
Triple Simultaneous Approaches

North Flow Triple Approach



South Flow Triple Approach



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Ricondo & Associates, Inc., February 2019 (approach, runways).

Changes To Be Addressed

Update the Dulles Airport noise contour map with stakeholder collaboration to reflect future changes in the aviation environment including:

Long-term FAA NextGen implementation

- Flight paths
- Runway use
- Airfield capacity

FAA air traffic control procedures

- Triple simultaneous operations
- Restricted airspace

Airline operations

- Fleet mix

Airfield development

- Terminal
- Cargo

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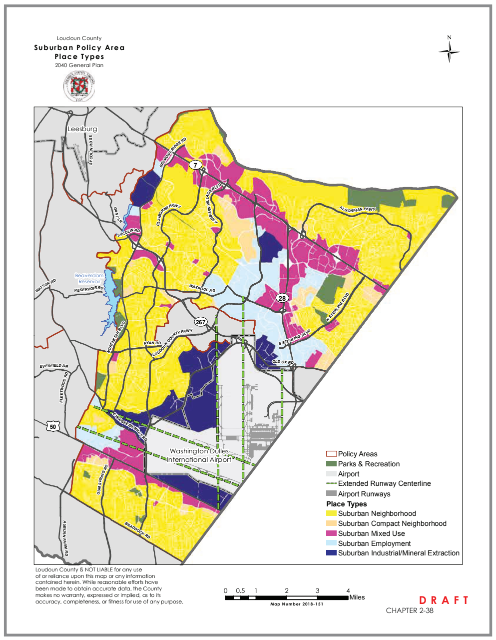
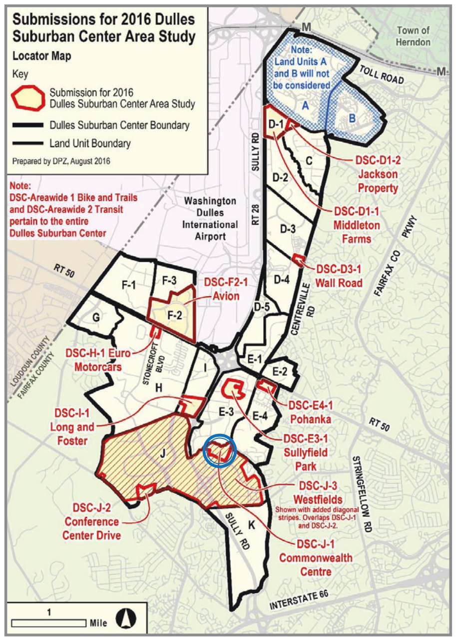
Objective



SOURCES: Loudoun County, Envision Loudoun, *DRAFT Loudoun 2040 General Plan*. October 23, 2018.



SOURCES: Johnson, Clara. Fairfax County, Department of Planning and Zoning. DSC-J-1 *Commonweath Centre*, November 7, 2016. Retrieved at https://www.fairfaxcounty.gov/planning-zoning/sites/planning-zoning/files/assets/documents/compplanamend/dullessuburbancenter/presentations/advisorygroup/november%207,%202016/dsc-j-1_staff_presentation.pdf on February 11, 2019.

- Provide accurate information to local jurisdictions to guide effective land use decisions for today and in the future
- Provide local jurisdictions with a land use compatibility planning tool to inform:
  - Loudoun County: Envision Loudoun
  - Fairfax County: Dulles Suburban Area Plan

Noise Map Update Process

KEY
- ✓ Completed
- ⟳ In Process

INVENTORY
- Evaluate current and future plans (MWAA and FAA) ✓
- Assess existing operation conditions ✓

FORECAST
- Determine airfield operating configurations ✓
- Determine maximum potential operations ✓
- Determine potential aircraft runway use and flight paths ✓

NOISE MODELING
- Build baseline noise model ✓
- Calculate potential aircraft noise levels for airfield operating configurations ✓
- Determine appropriate composite of airfield operating configurations, if appropriate ✓

CONCLUSIONS
- Complete noise contour map ✓
- Recommend potential aircraft noise contours for land use planning ✓
- Finalize documentation ⟳
- Share recommended airport noise contours with local land use jurisdictions and remain a resource as Counties deliberate adoption ⟳

Ultimate Conditions

Five-Runway Airfield

Growth in Passenger and Cargo Operations

Evolution of Aircraft

Long-Term FAA NextGen Improvements

FAA's Triple Simultaneous Parallel Approaches

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Stakeholder & Public Input

APRIL 4, 2018	Working Group Kick-off Meeting
APRIL 20, 2018	Working Group Airfield Configurations, Annual Service Volume Methodology Discussion
JUNE 6, 2018	Working Group Inventory and Existing Condition Operations Discussion
JUNE 27 & 28, 2018	Public Information Workshops #1 and #2 (Frequently Asked Questions)
AUGUST 13, 2018	Working Group Preliminary Annual Service Volume and Ultimate Conditions Runway Use/Flight Path Patterns Discussion
SEPTEMBER 25, 2018	Working Group Preliminary Ultimate Condition Operation Levels Discussion
JANUARY 7, 2019	Working Group Draft Composite Noise Contour Review
FEBRUARY 28, 2019	**Final Public Information Workshop #3** Sharing Ultimate Conditions Noise Contours and Recommended Noise Overlay

Why Protect Dulles International?

Global and National Importance	Population Growth
Economic Impact	Growth in Air Service Demand

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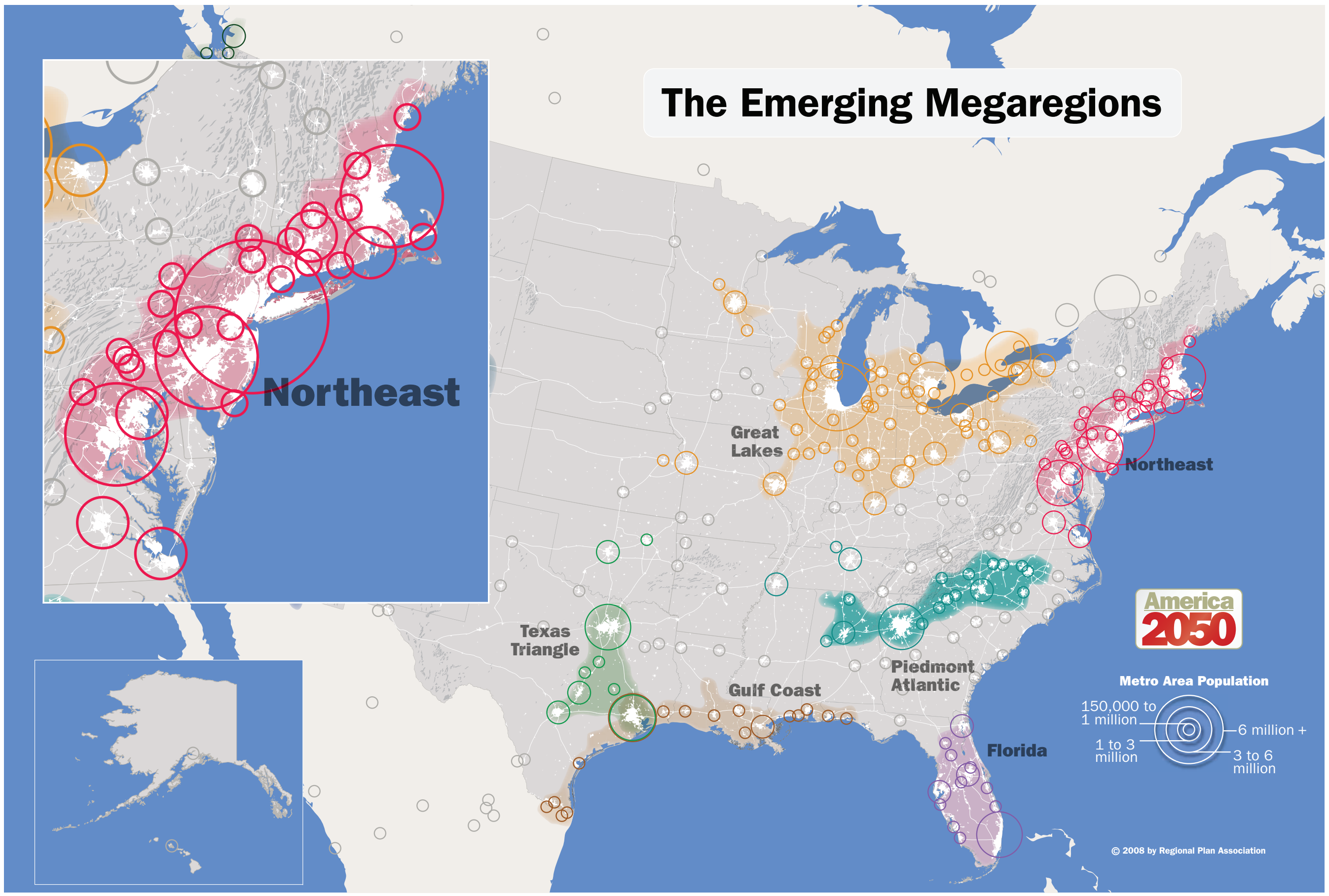
Dulles – Global and National Importance



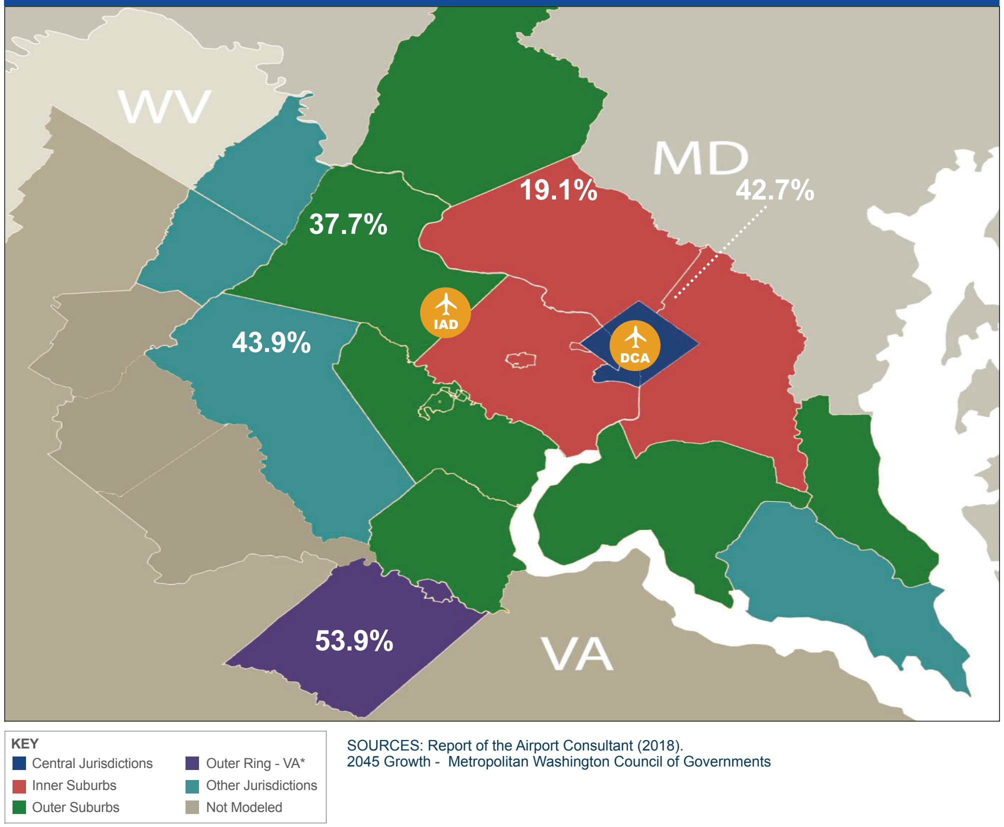
SOURCE: Both maps taken from "Our Maps," America 2050-Regional Plan Association, http://www.america2050.org/maps/ (Accessed March 29, 2018).

- FAA forecast trends:
  - Domestic and international passenger demand to increase – international at a higher rate
  - Domestic and international cargo to increase – international at a higher rate
  - Operations at hub airports such as Dulles to grow substantially faster than the overall national trend
- Dulles is ideally positioned to accommodate domestic and international passenger and cargo demand

Enplanement Growth Supported by Population Forecasts

- The population growth averaged 1.3% annually between 2010 and 2017, consistently exceeding the national average of 0.7%
- The inner suburbs, including Fairfax County, are forecast to have the greatest total population by 2045
- The outer suburbs, including Loudoun County, are forecast to experience the fastest rates of growth through 2045

PROJECTED POPULATION GROWTH WITHIN AIRPORTS SERVICE REGION – 2015-2045



* Fredericksburg-Area Jurisdictions

SOURCES: Report of the Airport Consultant (2018).
2045 Growth - Metropolitan Washington Council of Governments

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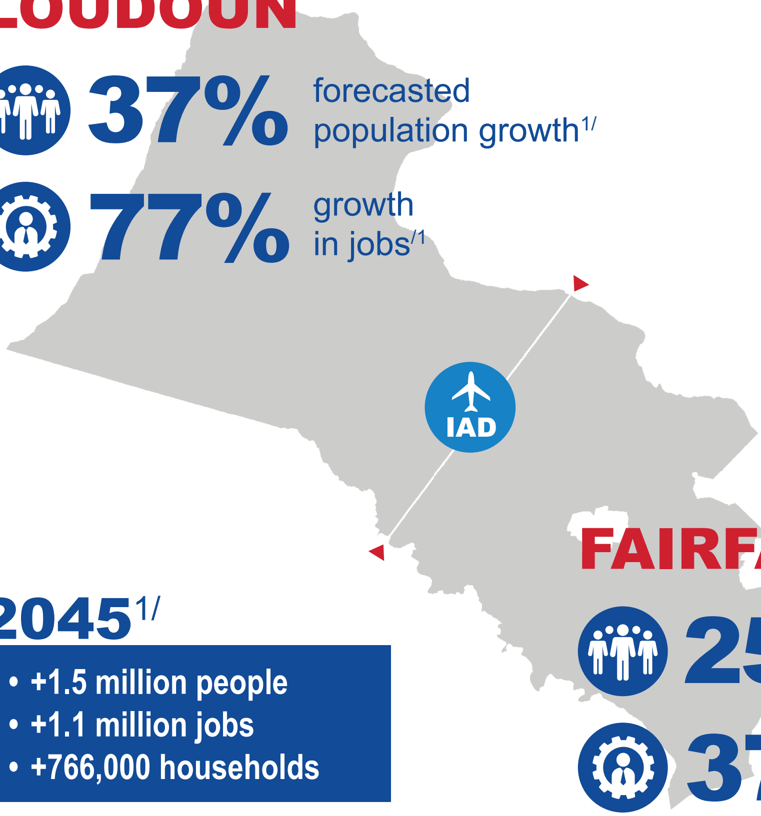
Significance of IAD on Local/ Commonwealth of Virginia Economy

LOUDOUN

37% forecasted population growth[1/]

77% growth in jobs[/1]



2045[1/]

- +1.5 million people
- +1.1 million jobs
- +766,000 households

FAIRFAX

25% forecasted population growth[1/]

37% growth in jobs[/1]

- Dulles contributed **51,149 jobs** and **$2.9 billion** in associated labor **income** in the Commonwealth of Virginia in 2016.[/2]
- **Dulles jobs** and **visitor spending** generated **$315 million** in local/ state tax revenues in 2016.[/2]

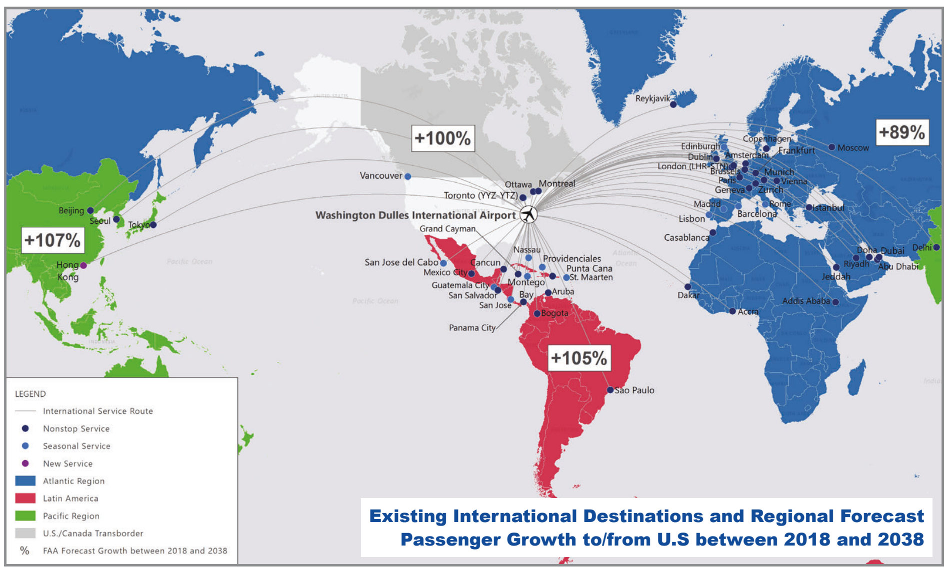
SOURCES: 1/ Metropolitan Washington Council of Governments. *Cooperative Forecasting in Metropolitan Washington-Growth Trends to 2045*, November 9, 2016.
2/ Commonwealth of Virginia. Virginia Department of Aviation. *Virginia Airport System Economic Impact Technical Report*. May 2018.

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Air Service Continues To Grow

POTENTIAL INTERNATIONAL PASSENGER SERVICE

- Airline hub expansion
- International service expansion
- Growth in local demand and domestic connecting flights for international passengers

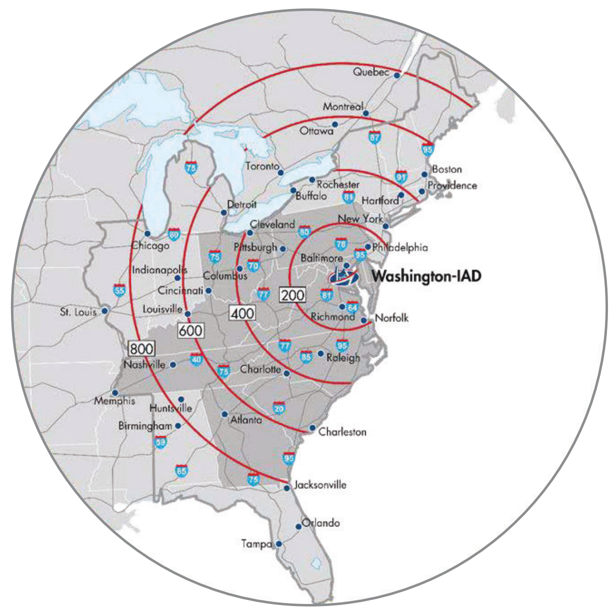


Existing International Destinations and Regional Forecast Passenger Growth to/from U.S between 2018 and 2038

SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap contributors, and the GIS user community, May 2018 (basemap); MWAA, July 2018 (international non-stop destination data); OpenFlights.org, June 2018 (flight arcs); National Science Foundation, National Institutes of Health, 2016 (countries); FAA Aerospace Forecast Fiscal Years 2018 – 2038, Federal Aviation Administration, May 2018 (forecast growth in passengers between 2018 and 2038).

POTENTIAL CARGO SERVICE

- Medium-size hub for one integrated cargo carrier
- Expansion of international cargo carriers
- Addition of an eCommerce cargo carrier



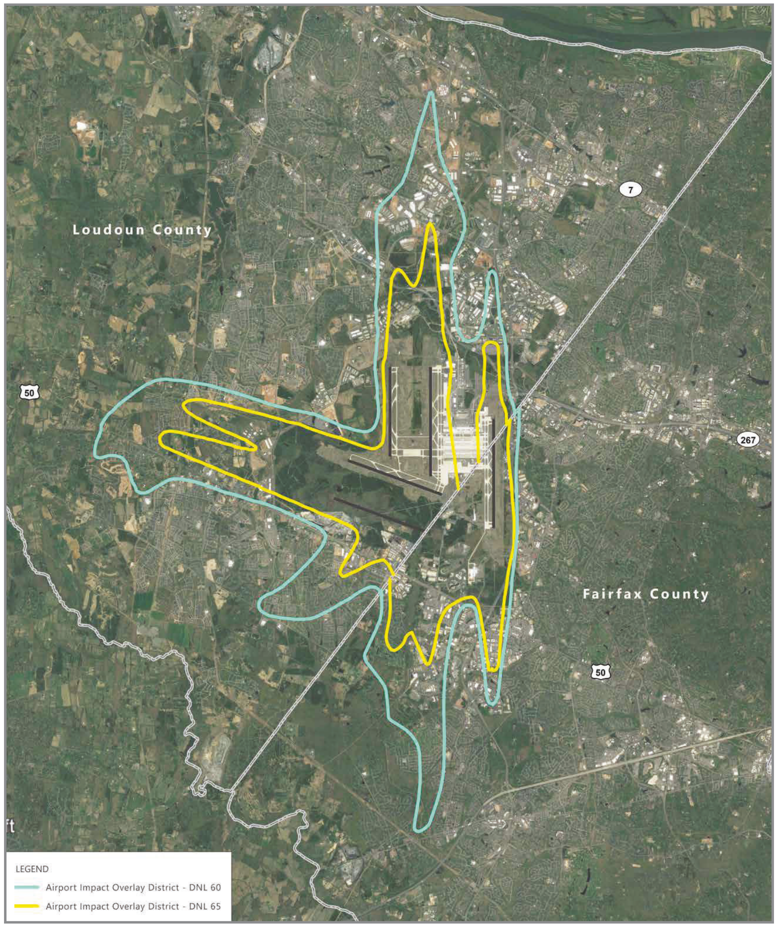
SOURCE: MWAA. 2015 Air Service Development Industry and Community Briefing. November 2014

Dulles Noise Contours History

Current Airport Noise Impact Overlay Districts

Full-Build Aircraft Noise Contours Timeline

Existing Airport Noise Impact Overlay Districts for Loudoun and Fairfax

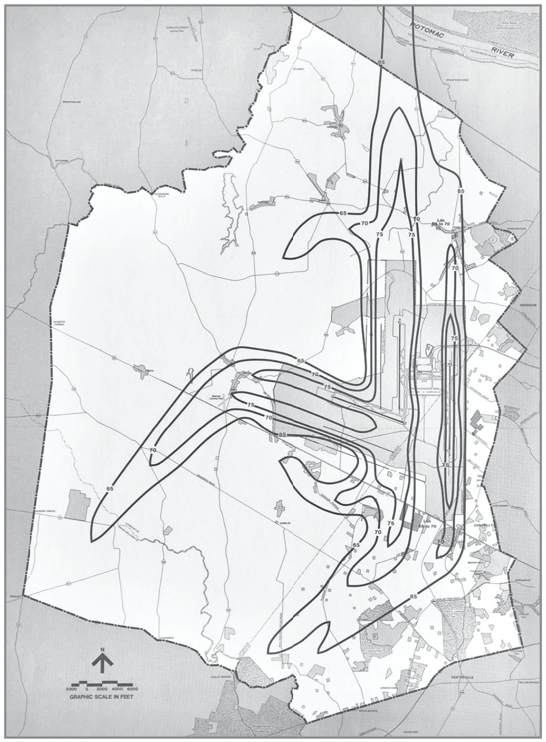


SOURCES: Google Earth Pro, Image Landsat/Copernicus, Data SIO, NOAA, U.S. Navy, NGA, GEBCO, 2010 (aerial photography); Loudoun County Open Geospatial Data, March 2018 (noise overlay contours); Fairfax County Open Geospatial Data, March 2018 (noise overlay contours).

Dulles Noise Contour Map Timeline

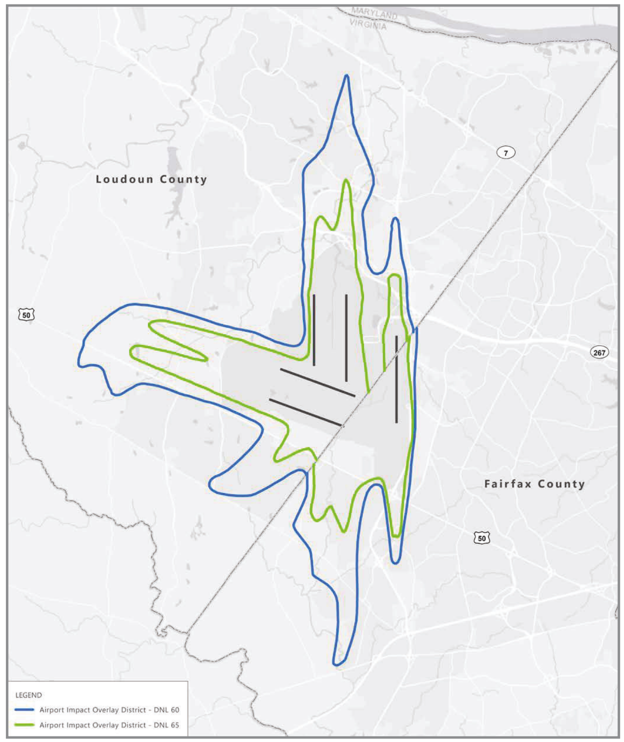
Chronological Noise Contour Changes

1985 FAR Part 150 Potential Noise Contours Projection: Five-Runway, Full Build



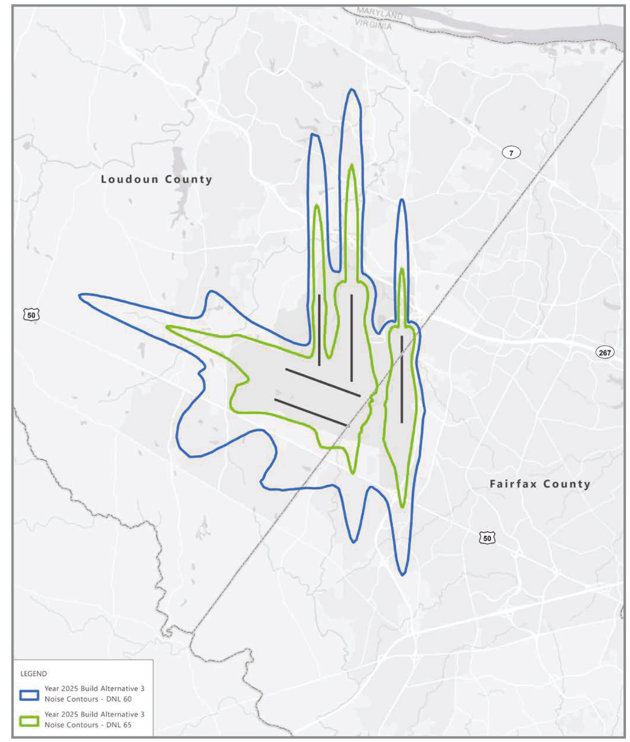
SOURCE: Peat Marwick. *Noise Compatibility Program Washington Dulles International Airport*. Exhibit 15 January 1985

1993 FAR Part 150 Addendum Potential Noise Contours Adopted County Impact Overlays Projection: Five-Runway, Full Build



SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); Loudoun County Open Geospatial Data, March 2018 (noise overlay contours); Fairfax County Open Geospatial Data, March 2018 (noise overlay contours).

2005 Environmental Impact Statement Potential Noise Contours Projection: Five-Runway, Year 2025



SOURCES: Esri, HERE, Garmin, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); Federal Aviation Administration. *Final Environmental Impact Statement for New Runways, Terminal Facilities and Related Facilities at Washington Dulles International Airport*. August 2005 (contours).

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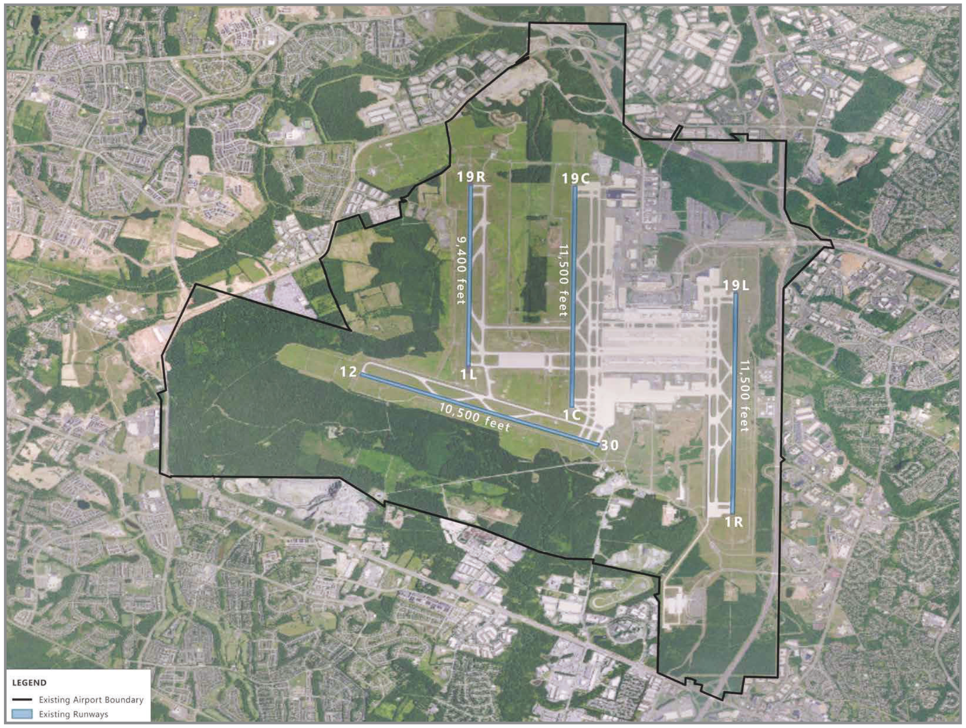
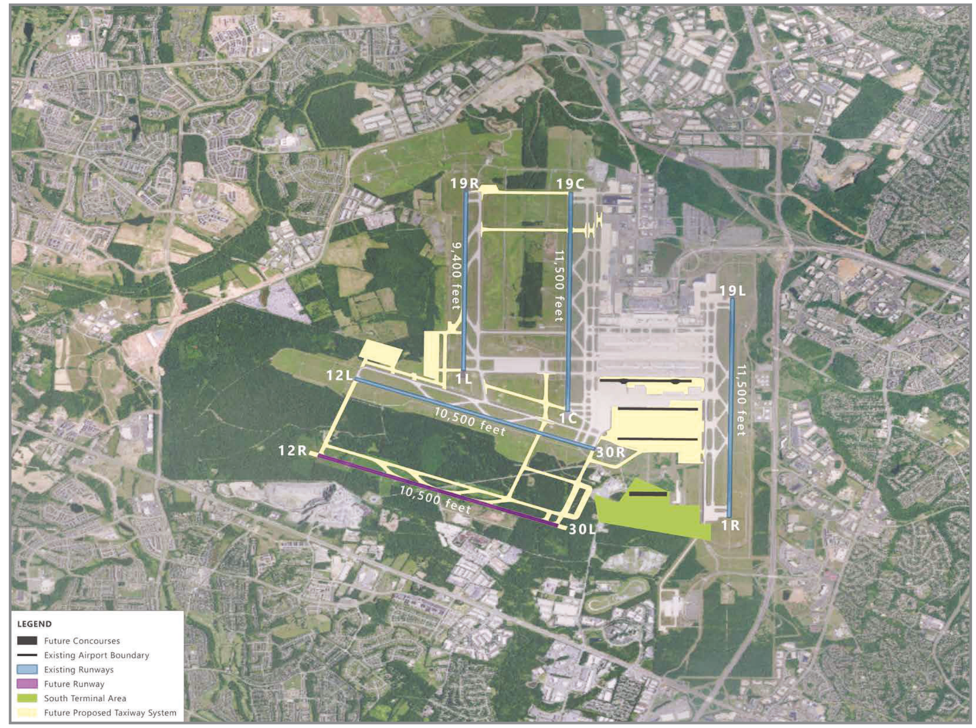
Dulles International Airfield Configurations

Four-Runway (Existing)



SOURCES: USGS, USDA-FSA-APFO Aerial Photography Field Office Virginia 1m NAIP Imagery, 2015 (imagery); Metropolitan Washington Airports Authority, April 2018 (Airport Layout Plan).

Five-Runway (Future)



SOURCES: USGS, USDA-FSA-APFO Aerial Photography Field Office Virginia 1m NAIP Imagery, 2015 (imagery); Metropolitan Washington Airports Authority, April 2018 (Airport Layout Plan).

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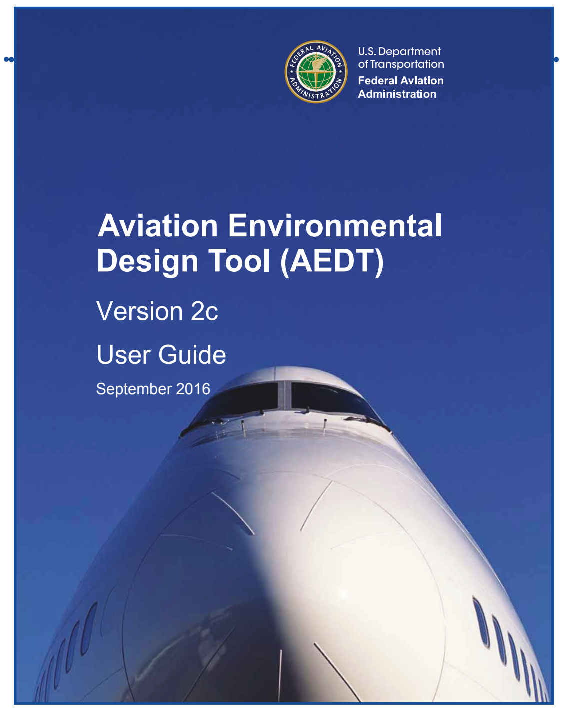
FAA's Airport Environmental Decision Tool (AEDT)

- FAA-developed and adopted software tool for computation of noise contours
- Accurately computes noise contours based on many operational characteristics

INPUT

PHYSICAL
For example:
- Runway layouts
- Airfield elevation
- Atmospheric conditions
- Flight tracks

OPERATIONAL
For example:
- Aircraft types
- Aircraft operation numbers
- Airport use by runway
- Flight track

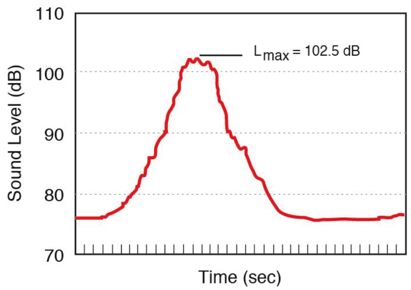


OUTPUT

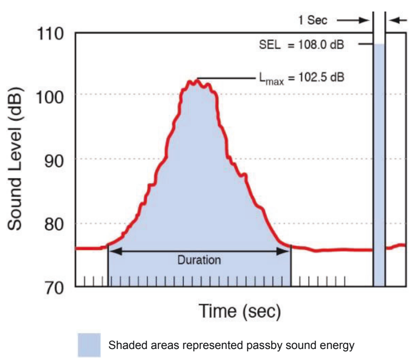
- Noise exposure contours
- Location-specific detailed reports
- Emissions and fuel consumption

Day/Night Average Sound Level – DNL

SINGLE EVENT: PEAK SOUND LEVEL

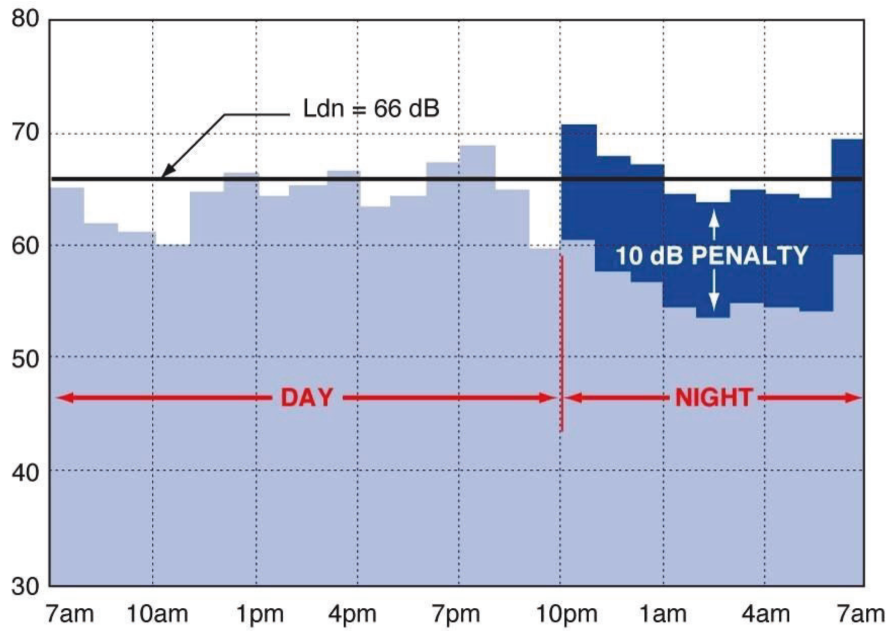


SOUND EXPOSURE LEVEL



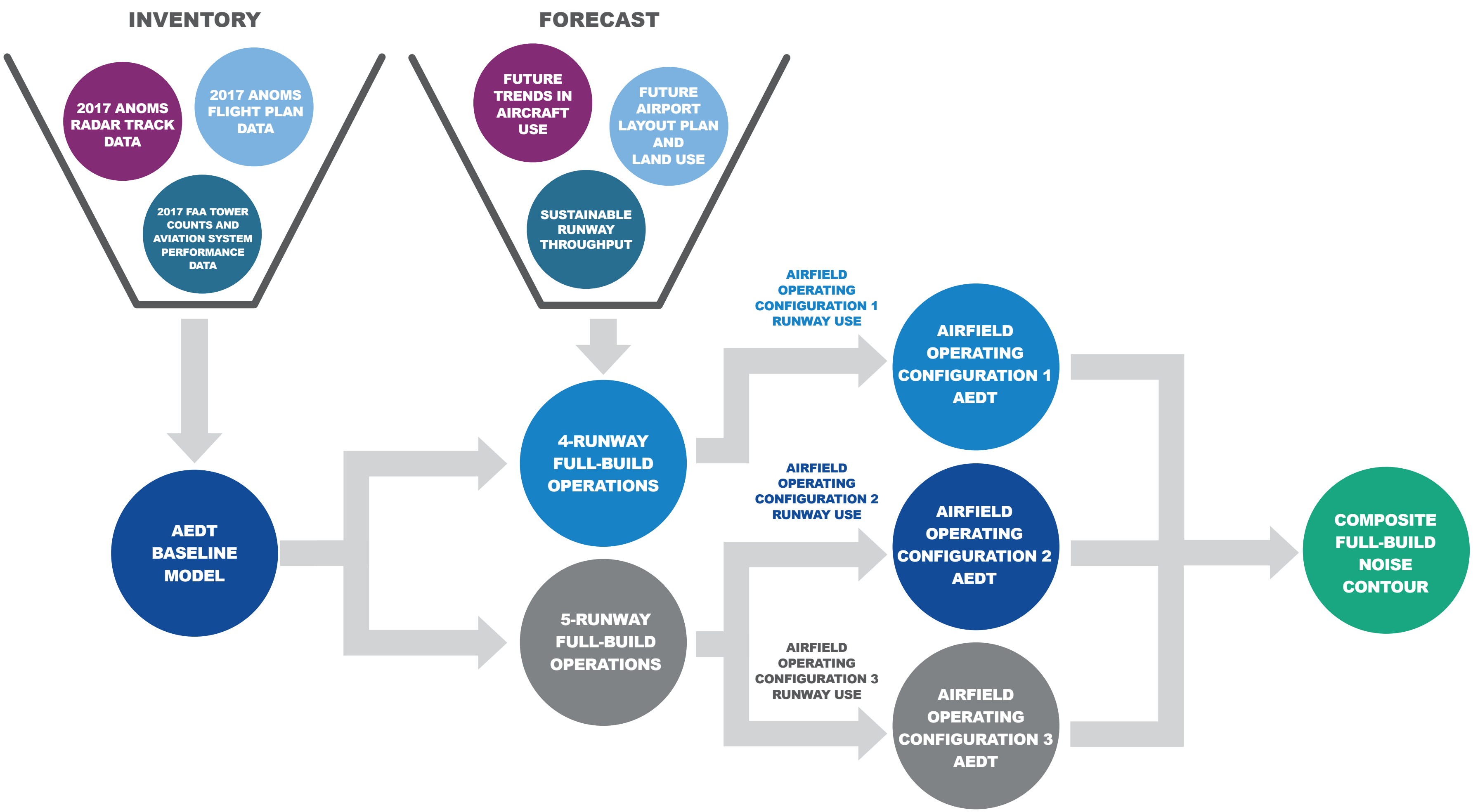
AIRCRAFT NOISE EVENTS FOR 24 HOURS

CUMULATIVE: DAY/NIGHT AVERAGE SOUND LEVEL



- A way to describe the cumulative noise dose for a 24-hour period
- Can also be described as an average of the sound level over the full day
- Accounts for noise event “noisiness” (SEL)
- Accounts for number of noise events
- Provides an additional weighting factor for nighttime operations

Noise Modeling Process



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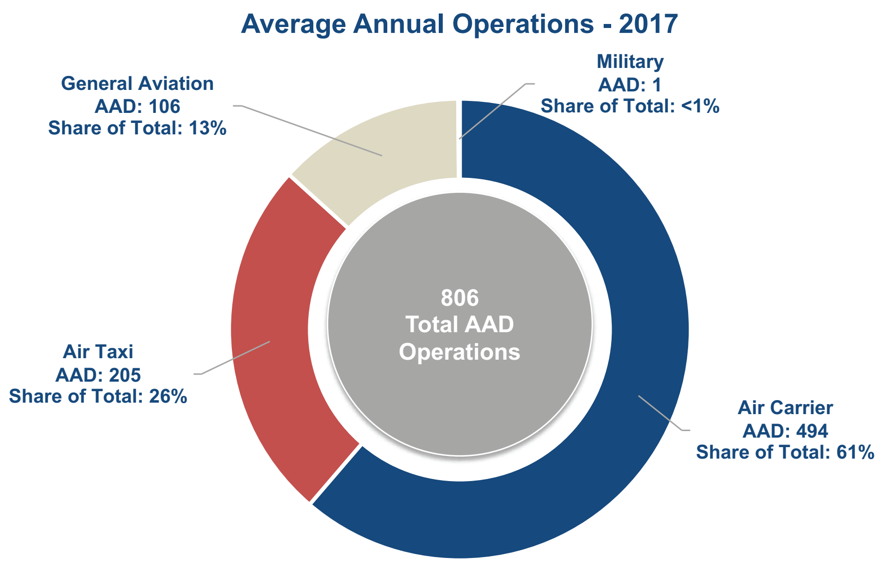
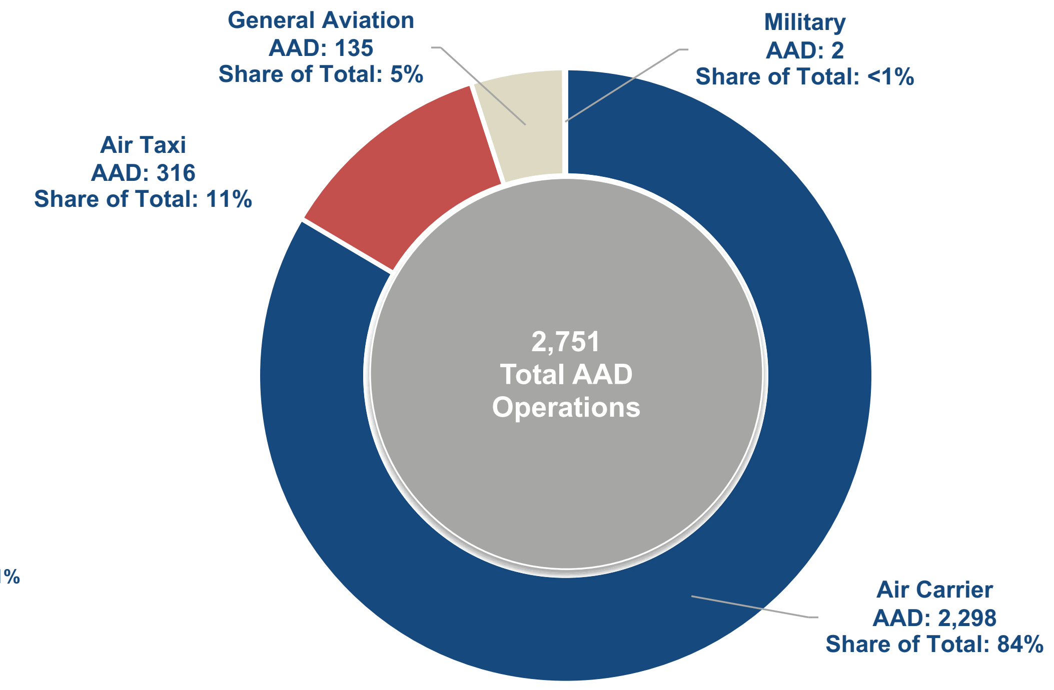
Ultimate Conditions Operations – Five Runway





SOURCES: Metropolitan Washington Airports Authority, Airport Noise and Operations Monitoring System, February 2018 (2017 fight and radar track operations data); Federal Aviation Administration, February 2018 (OPSNET tower operation counts); Harris Miller Miller and Hanson, April 2018 (2017 average annual day operations by user category); Ricondo & Associates, Inc., December 2018 (ultimate levels of average annual day operations by user category).

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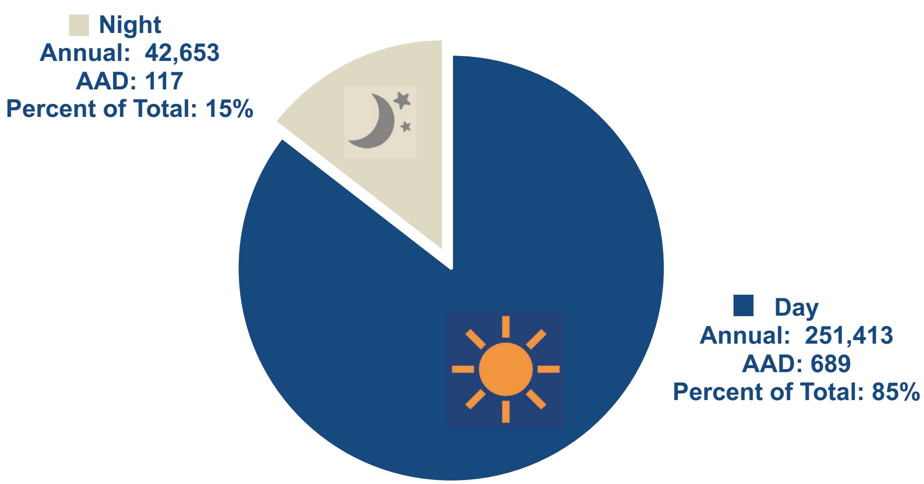
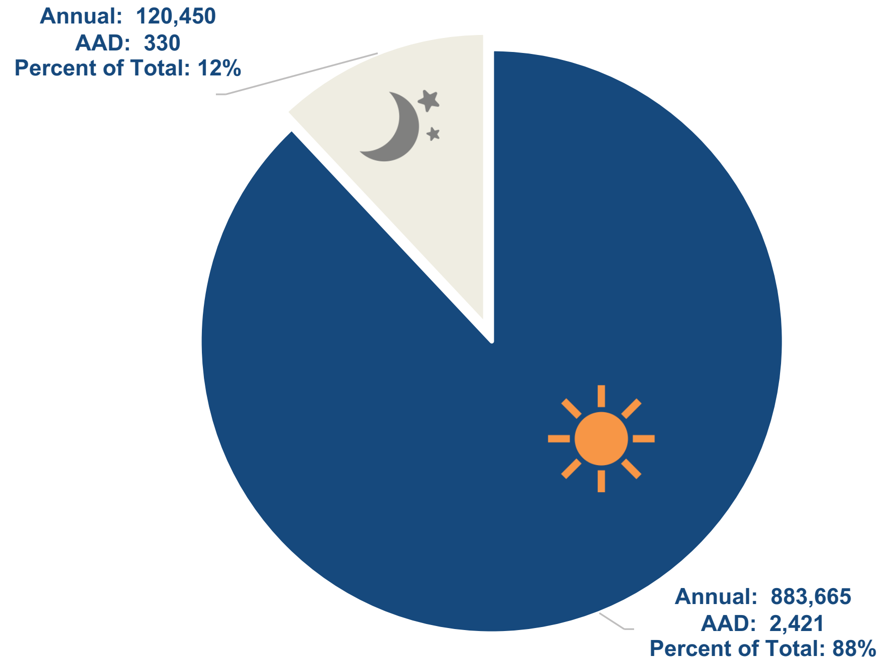
Ultimate Conditions Operations – Five Runway

Time of Day

Average Annual Operations - 2017





= Daytime hours (7:00 a.m. to 9:59 p.m.) = Nighttime hours (10:00 p.m.. to 6:59 a.m.)

SOURCES: Metropolitan Washington Airports Authority, Airport Noise and Operations Monitoring System, February 2018 (2017 fight and radar track operations data); Harris Miller Miller and Hanson, April 2018 (2017 average annual day operations by day/night); Ricondo & Associates, Inc., December 2018 (ultimate levels of average annual day operations by time of day).

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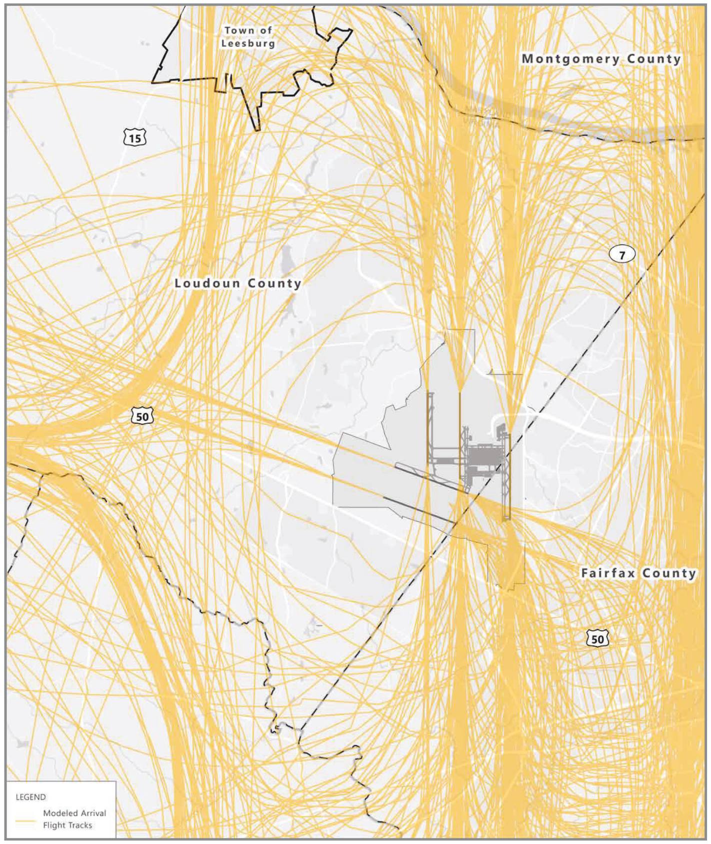
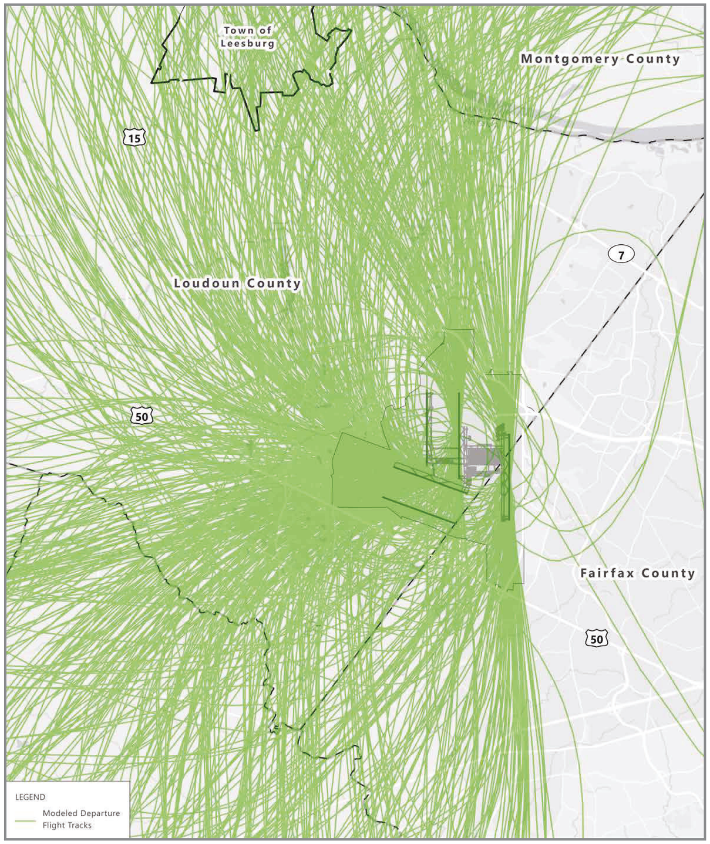
Five-Runway Airfield Noise Model Tracks

Arrival Flight Paths



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Harris Miller Miller and Hanson, December 2018 (five-runway noise model tracks).

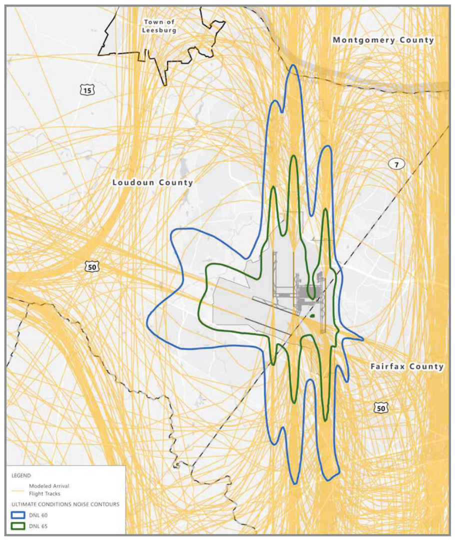
Departure Flight Paths



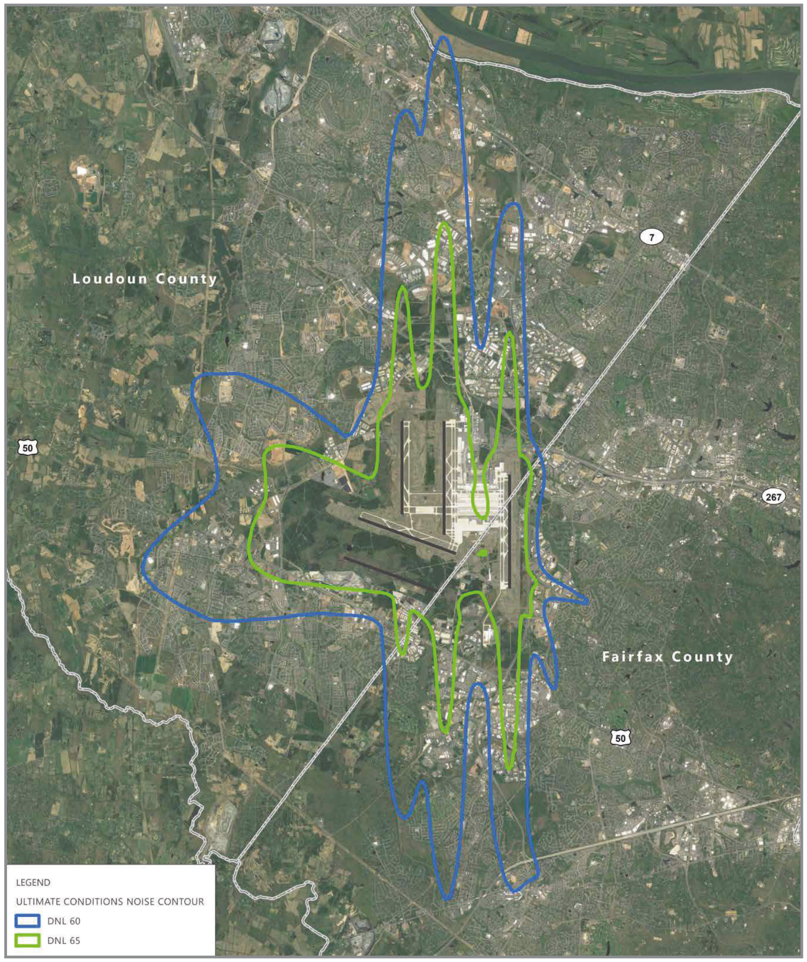
SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Harris Miller Miller and Hanson, December 2018 (five-runway noise model tracks).

Ultimate Conditions Noise Contours DNL 60 and DNL 65

Arrival Flight Paths



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Harris MIller Miller and Hanson, December 2018 (five-runway noise model tracks); Harris Miller Miller and Hanson, February 2019 (Ultimate Conditions DNL 60 and DNL 65 contours).



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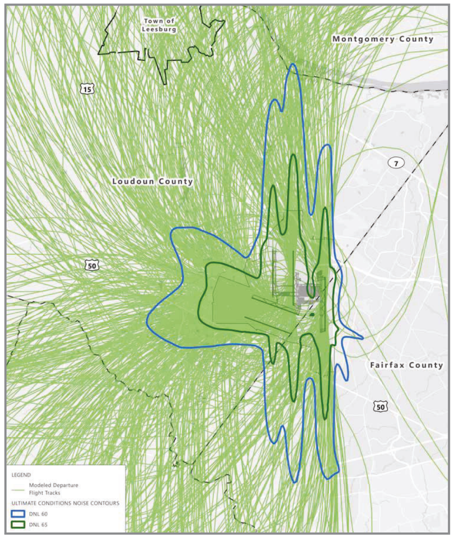

SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Harris MIller Miller and Hanson, December 2018 (five-runway noise model tracks); Harris Miller Miller and Hanson, February 2019 (Ultimate Conditions DNL 60 and DNL 65 contours).

SOURCES: Google Earth Pro, Image Landsat/Copernicus, Data SIO, NOAA, U.S. Navy, NGA, GEBCO, 2010 (aerial photography); Harris Miller Miller and Hanson, February 2019 (Ultimate Conditions contours).

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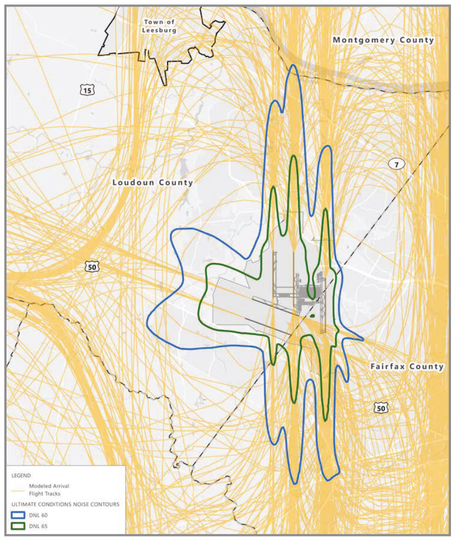
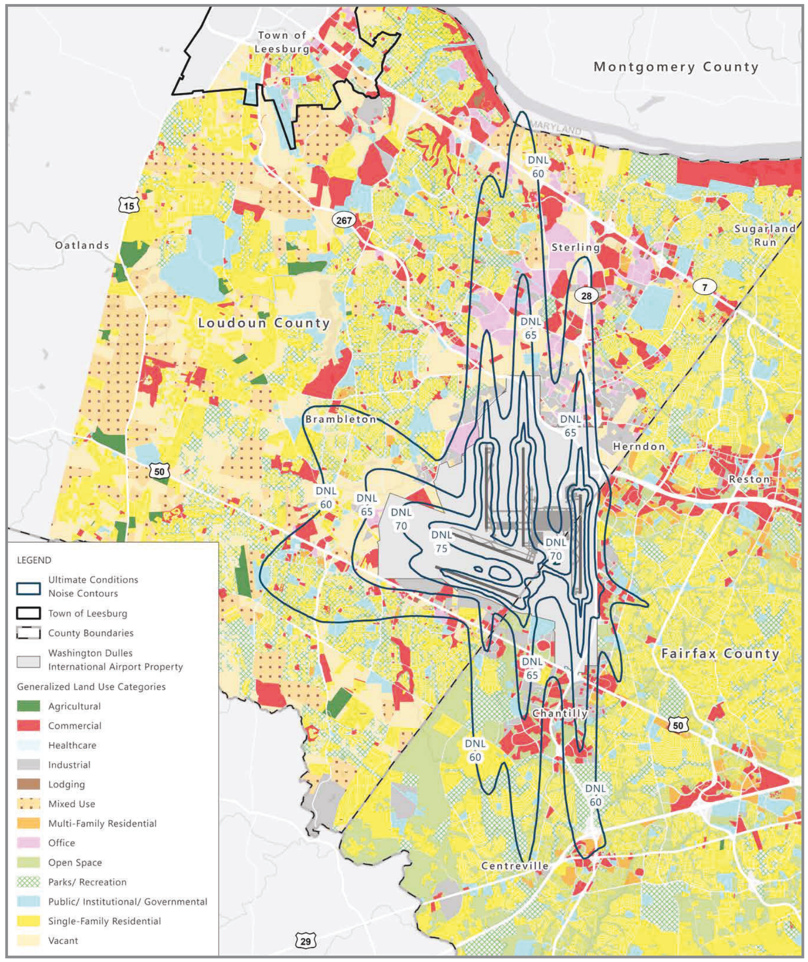
Ultimate Conditions Noise Contours & Existing Land Use

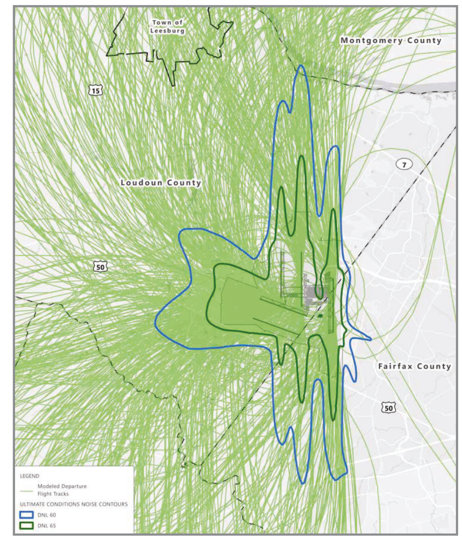
Arrival Flight Paths



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Harris MIller Miller and Hanson, December 2018 (five-runway noise model tracks); Harris Miller Miller and Hanson, February 2019 (Ultimate Conditions DNL 60 and DNL 65 contours).



Departure Flight Paths



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Harris MIller Miller and Hanson, December 2018 (five-runway noise model tracks); Harris Miller Miller and Hanson, February 2019 (Ultimate Conditions DNL 60 and DNL 65 contours).

SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Fairfax County, 2017, https://data-fairfaxcountygis.opendata.arcgis.com/ (accessed 12, 2018) (land use); Loudoun County, 2018, https://data-loudoungis.opendata.arcgis.com/ (accessed 12, 2018) (land use); Harris Miller Miller and Hanson, February 2019 (Ultimate Conditions contours).

Long-Term Land Use Compatibility Considerations

- **Consider today's airport use and protect for tomorrow's growth**

- **Maintain** current protections
  - Existing overlays have served the Counties well
  - Protect for transition over time from current to Ultimate conditions

- **Plan** for Ultimate Conditions
  - Five-Runway Airfield
  - NextGen implementation
  - Triple Simultaneous Parallel Approach
  - Aviation operations growth (passenger and cargo)

Recommendation for Local Land Use Compatibility

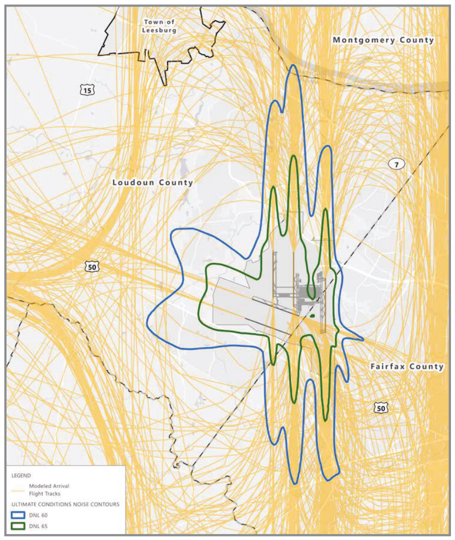
(Consider Today's Airport Use and Tomorrow's Growth)

Loudoun County and Fairfax County maintain their existing Airport Noise Impact Overlay Districts (DNL 60 and DNL 65) and also protect for the Ultimate Conditions Noise Contours (DNL 60 and DNL 65)

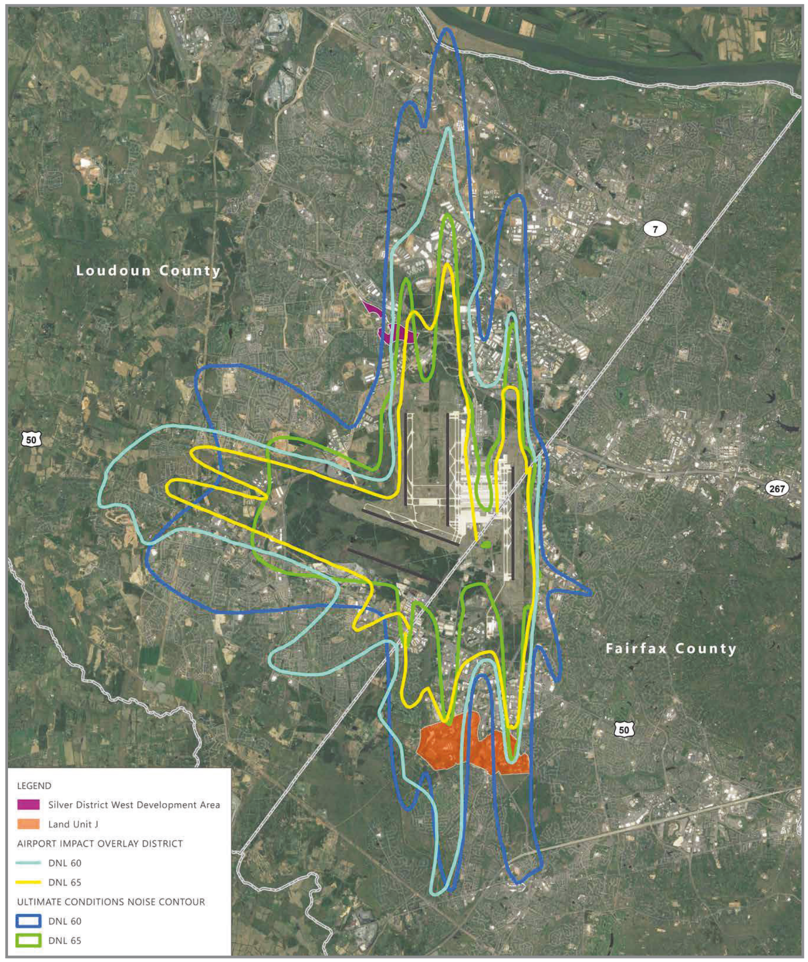
METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Ultimate Conditions Noise Contours with Existing Airport Noise Impact Overlay Districts

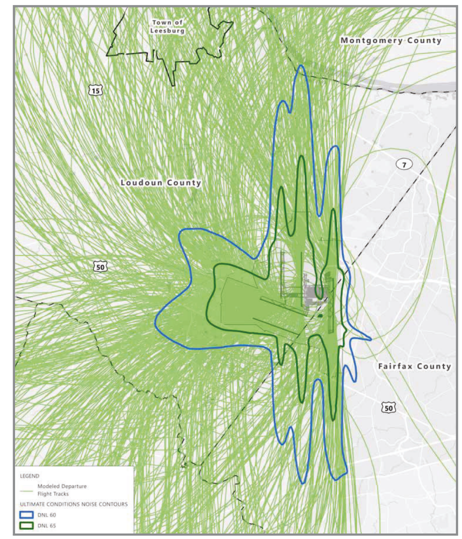
Arrival Flight Paths



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Harris MIller Miller and Hanson, December 2018 (five-runway noise model tracks); Harris Miller Miller and Hanson, February 2019 (Ultimate Conditions DNL 60 and DNL 65 contours).



Departure Flight Paths



SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Harris MIller Miller and Hanson, December 2018 (five-runway noise model tracks); Harris Miller Miller and Hanson, February 2019 (Ultimate Conditions DNL 60 and DNL 65 contours).

SOURCES: Google Earth Pro, Image Landsat/Copernicus, Data SIO, NOAA, U.S. Navy, NGA, GEBCO, 2010 (aerial photography); Harris Miller Miller and Hanson, February 2019 (Ultimate Conditions contours); Loudoun County Open Geospatial Data, March 2018 (noise overlay contours); Fairfax County Open Geospatial Data, March 2018 (noise overlay contours); MWAA, January 2019.

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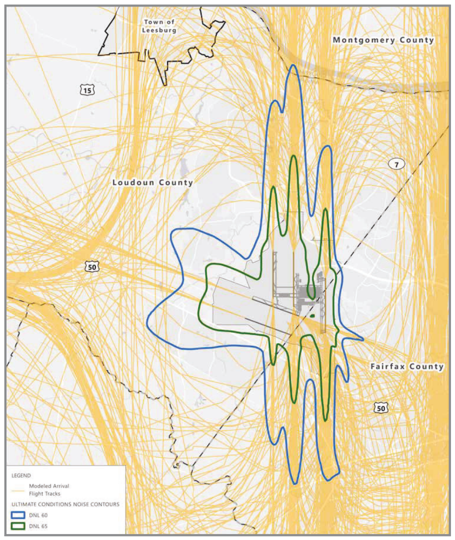
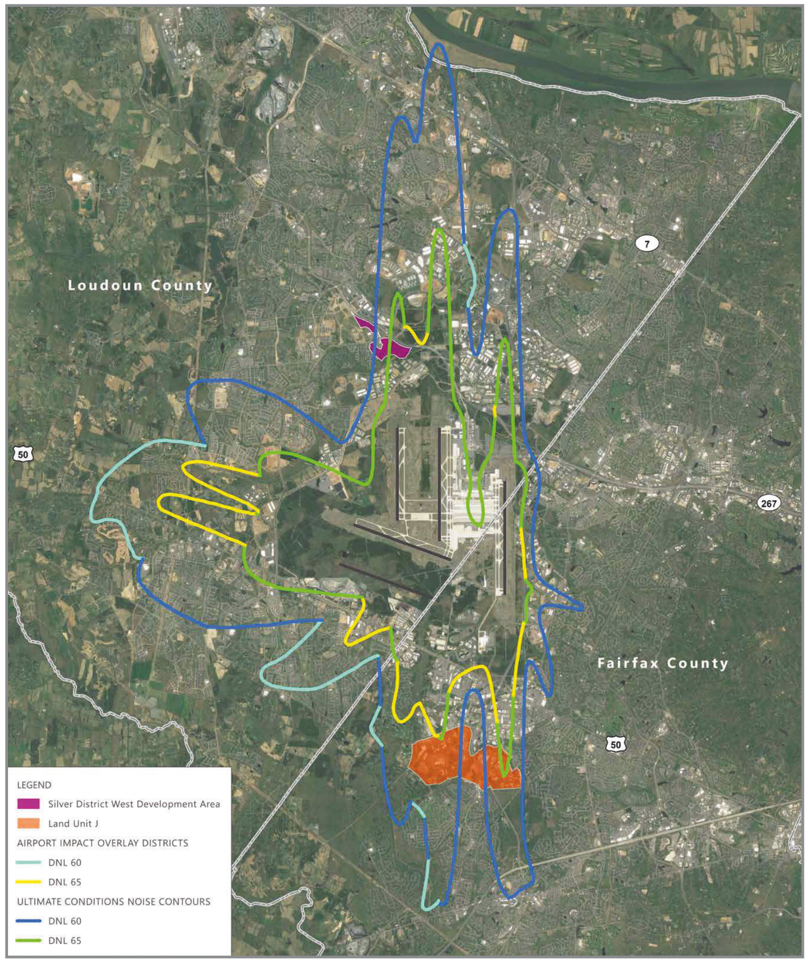
Combine Existing Airport Noise Impact Overlay Districts and Ultimate Conditions Noise Contours

Arrival Flight Paths

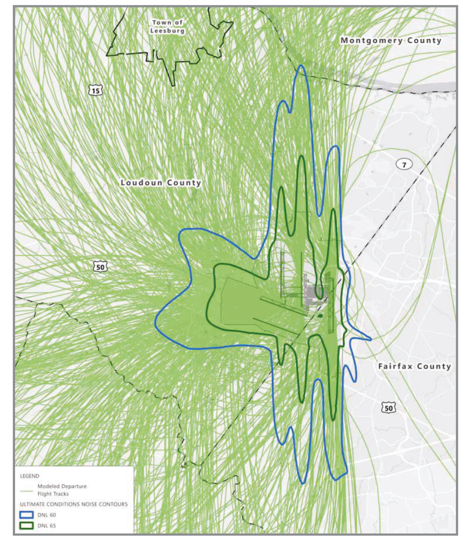


SOURCES: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap Contributors, and the GIS User Community, January 2019 (basemap); U.S. Census Bureau, Geography Division, TIGER/Line Shapefiles, 2017 (place, county boundaries); Harris MIller Miller and Hanson, December 2018 (five-runway noise model tracks); Harris Miller Miller and Hanson, February 2019 (Ultimate Conditions DNL 60 and DNL 65 contours).



SOURCES: Google Earth Pro, Image Landsat/Copernicus, Data SIO, NOAA, U.S. Navy, NGA, GEBCO, 2010 (aerial photography); Ricondo & Associates, Inc., February 2019, based on Loudoun County Open Geospatial Data, March 2018 (noise overlay contours), Fairfax County Open Geospatial Data, March 2018 (noise overlay contours), Harris Miller Miller and Hanson, February 2019 (Ultimate Conditions contours).

Departure Flight Paths



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Next Steps

REVIEW
Comments received at Public Workshop

FINALIZE
Ultimate Conditions Noise Contours documentation

SHARE
Recommended airport noise contours with Loudoun County and Fairfax County

How to Stay Informed

www.flydulles.com/iad/dulles-international-noise-contour-map-update

METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Washington Dulles International Airport

Aircraft Noise Contour Map Update

Public Workshop— Thursday, February 28, 2019

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SIGN-IN SHEET

Washington Dulles International Airport

Aircraft Noise Contour Map Update

Public Workshop— Thursday, February 28, 2019

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Keith Meurlin	Wash Airports Task Force	703-572-8714
Tia Walbridge	17170 Brookdale Ln Round Hill VA 20141	571-271-2279
JACK LEWIS	43414 CLOISTER PL LEESBURG, VA 20176	703-821-8218 COMMPROP@ATT.NET

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METROPOLITAN WASHINGTON AIRPORTS AUTHORITY

Washington Dulles International Airport

Aircraft Noise Contour Map Update

Public Workshop— Thursday, February 28, 2019

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MICHAEL COYLE / FFX BOS	4900 STONECROFT BLVD	MCOYLE@FAIRFAXCOUNTY.GOV
FRANK LESEL	6208 Hidden Canyon Rd Centreville VA 20120	flesel@cox.net
Jenny Wheaton / Brambleton	42395 Ryan Rd. Brambleton, VA 20148	jenny.wheaton@brambleton.com
JOE GORNEY	Fairfax County DPZ	joseph.gorney@fairfaxcounty.gov
Carol Hawn	Fairfax Co. Airports Adv. Comm.	

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Dulles International Airport Hosts Public Workshop on Airport Aircraft Noise Contour Map Update

Published: February 14, 2019

Public comments are welcome during the workshop and online

Topics

NOISE

The Metropolitan Washington Airports Authority will hold a public workshop regarding the Washington Dulles International Airport aircraft noise contour map update. This workshop will provide an overview of the study including airfield plans, existing airport operations and basic information regarding aircraft noise and noise modeling standards.

Thursday, February 28, 2019
6 – 8 p.m.
Washington Dulles International Airport Office Building
45045 Aviation Drive
2nd Floor Conference Room
Sterling, VA

Building is located on the campus of Dulles International Airport.
Free parking available in front of the building

A noise contour map update for Dulles International will help guide local land use planning in the immediate vicinity of the airport. The maps are an update to contours prepared in 1993 that serve as the basis for the Loudoun and Fairfax counties' airport impact overlay districts zoning. This helps ensure compatible land uses surrounding the airport. Public workshops include an opportunity for individuals interested in this process to talk with subject matter experts involved in the effort.

The Airports Authority formed a Local Jurisdictional Stakeholder Group in 2018, comprised of Airports Authority interdisciplinary staff, appointed professional technical staff from local governments (including Fairfax County, the Town of Herndon and Loudoun County), an airline representative and key Federal Aviation Administration officials, whose participation is essential to the success of this effort.

The public is welcome to submit questions and comments during these workshops, or at any time online until the conclusion of this process.

MWAA FREQUENTLY ASKED QUESTIONS AND ANSWERS

Discussion – Public Workshop Input

- Received 9 written comments
- Comment Topics/FAQ

1) Will the study include a nighttime curfew or limit nighttime flights in any way?

   No, the study will simply generate noise contours to assist in land use planning. In addition, Washington Dulles International Airport is a 24/7 facility and no restrictions on nighttime flights are anticipated.

2) Will the flight tracks change?

   No, the study will simply generate noise contours based on the existing and anticipated future flight tracks. In addition, MWAA is not responsible for the flight tracks as FAA determines this.

3) Why are you using 65 DNL as the acceptable noise threshold for residential.

   FAA guidelines identify the 65 DNL contour as the threshold for residential incompatibility with airport noise. This guideline is specific to aircraft noise exposure and does not consider other ambient noise sources.

4) What type of sound insulation and fair disclosure requirements are being considered?

   MWAA is generating the contours for use by Fairfax and Loudoun Counties. Specific zoning regulations including sound insulation standards and fair disclosure requirements will be addressed by the Counties.

Discussion – Public Workshop Input

5) How can I stay informed?

If you included your email address on the sign in sheet you will receive an email notification of the next public workshop anticipated in November. In addition, if you go to our website, you can sign up to receive email updates when new information is posted to the website and receive notification of next public workshop.

http://www.flydulles.com/iad/dulles-international-noise-contour-map-update

6) Who do I talk to regarding flight tracks and noise complaints?

The website below provides information on flight tracks, noise complaints and noise monitoring systems, as well as contact information for your Noise Information Office.

http://www.flydulles.com/iad/iad-dulles-intl-aircraft-noise-information

APPENDIX C

Fundamentals of Aircraft Noise Analysis

TABLE OF CONTENTS

APPENDIX C FUNDAMENTALS OF AIRCRAFT NOISE ANALYSIS

This appendix provides basic information about the description and measurement of sound and aircraft noise and a discussion of the effects of aircraft noise on people.[1] The information is based on standard industry knowledge and practice related to aircraft noise analysis and is provided as background to aid in the understanding of technical aspects of sound and the human perception of noise.

C.1 THE NATURE OF SOUND

Sound is transmitted by alternating compression and decompression in air pressure caused by vibrations of the source material. These changes in atmospheric pressure are called sound waves. Sound waves dissipate with increasing distance from the source. They can also be reflected, diffracted, refracted, or scattered. When the source stops vibrating, the sound waves disappear almost instantly and the sound ceases.

Sound conveys information to listeners. It can be instructional, alarming, pleasant and relaxing, or annoying. Identical sounds can be characterized by different people, or even by the same person at different times, as desirable or unwanted. Unwanted sound is commonly referred to as noise.

The measurement and human perception of sound involves two physical characteristics—intensity and frequency.[2] Intensity is a measure of the strength or magnitude of the sound vibrations and is expressed in terms of the sound pressure level (SPL). The higher the SPL, the more intense is the perception of that sound. The other characteristic is sound frequency, or "pitch" — the speed of vibration. Frequencies are expressed in terms of cycles per second or hertz (Hz). Examples of low frequency sounds include a rumble or roar, while high frequency sounds are typified by sirens or screeches. Noise analysis accounts for both intensity and frequency in the units used to measure sound.

C.1.1 SOUND INTENSITY

Decibel (dB)

The human ear is sensitive to an extremely wide range of sound pressure levels covering a scale of from 1 to 10,000,000,000,000. Although physicists typically measure pressure using the linear Pascal scale, sound is measured using the logarithmic decibel (dB) scale. Given the tremendous range of sound pressures, the logarithmic scale allows for greater ease in describing and computing sound levels than would a linear scale. On the decibel scale, sound intensities typically range from 1 dB, the threshold of hearing for a person with excellent hearing, to 130 dB,

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[1] Portions of this appendix have been derived from previous reports also serving as primers on the basics of noise perception and measurement. The following reports were particularly important sources for the text of this appendix:

- Jacobs Consultancy Inc., *FAR Part 150 Noise Compatibility Study for Baton Rouge Metropolitan Airport*, Appendix D, Attachment 1, Principles of Aircraft Noise Analysis, May 2007.
- Landrum & Brown*, FAR Part 150 Noise Compatibility Study for Albany International Airport*, 2005
- Ricondo & Associates, Inc., *FAR Part 150 Noise Compatibility Study Update for McCarran International Airport*, November 2006.

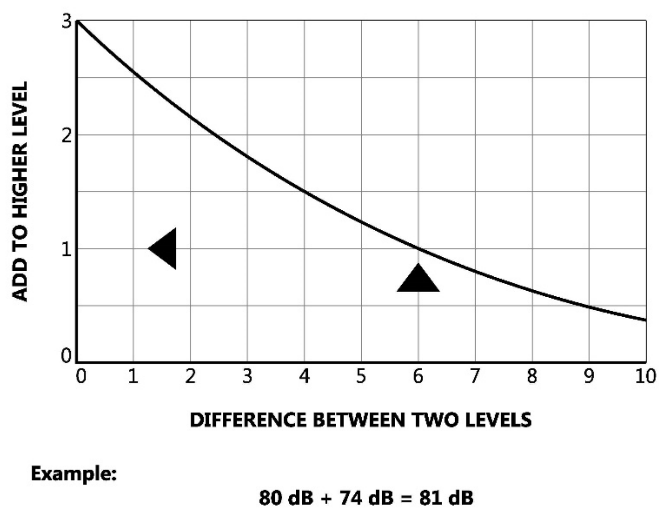
[2] Environmental Protection Agency, Office of Noise Abatement and Control, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, Report No. 550/9-74-004. Washington, DC, March 1974, p A-1.

the threshold of pain. A sound of 130 dB contains 10 trillion (10^{13}) times more sound pressure than the least audible sound.

By definition, a 10-decibel increase in sound is equal to a tenfold (10^1) increase in the mean square sound pressure of the reference sound. A 20-decibel increase is a 100-fold (10^2) increase in the mean square sound pressure of the reference sound. A 30-decibel increase is a 1,000-fold (10^3) increase in mean sound pressure, and so forth.

A logarithmic scale requires different mathematics than used with linear scales. The sound pressures of two separate sounds, expressed in decibels, are not arithmetically additive. **Exhibit C-1** depicts a graph showing the additive factors for summing two sound levels that differ by 10 decibels or less. In the example, a sound of 74 dB is added to a sound of 80 dB. Since the two sounds differ by 6 dB, the graph indicates that 1 dB should be added to the higher of the two levels (80 dB) to compute the sum of 81 dB, (substantially different than the arithmetic sum of 154).

EXHIBIT C-1: EXAMPLE OF ADDING TWO DECIBEL LEVELS



SOURCE: Ricondo & Associates, Inc., December 2014 based on A. Peterson, *Handbook of Noise Measurement*, (9th ed.) West Concord: General Radio Company, 1980, Figure 2-4, p.9. (recreated exhibit)

If two events have the same sound pressure level, the sum of the combined events is 3 dB higher than the level of either event alone. When two events differ by 10 decibels or more, the additive factor is less than one-half of a dB. When two events differ by 17 decibels or more, the additive factor is less than one-tenth of a dB.

Logarithmic averaging also yields results that are quite different from simple arithmetic. Consider two sound events, one at 100 dB and the other at 50 dB. Using conventional arithmetic, the average would be 75 dB. The true result, using logarithmic math, is 97 dB. This is because 100 dB has 100,000 times more energy than 50 dB and overwhelmingly dominates the computation of the average.

Helpful Rules of Thumb

Several rules of thumb are useful in considering noise measurement and sound propagation.

- As noted earlier, if two sounds of the same noise level are added, the sound level increases by approximately 3 dB. For example: 60 dB + 60 dB = 63 dB.
- The sum of two sounds of different levels is only somewhat higher than the louder level. For example: 60 dB + 70 dB = 70.4 dB, and 70 dB + 71 dB = 73.5 dB.
- The average level among multiple sounds is much more greatly influenced by the louder than by the quieter levels. Assume, for example, three sounds of equal duration: 55, 60, and 100 dB. The average sound level is 95 dB.
- The sound level decreases approximately 6 dB for each doubling of distance from the source.
- Although the human ear can detect changes in sound levels as faint as 1 dB in a laboratory setting, the typical person does not perceive changes of less than approximately 3 dB in an everyday environment.
- A 10 dB change in sound level is a tenfold increase (or decrease) in acoustical energy but is perceived by the average person as a doubling (or halving) of the sound's loudness.

C.1.1 SOUND FREQUENCY

The pitch (or frequency) of sound can vary from a low rumble to a shrill whistle. One's ability to hear a sound depends greatly on the frequency composition. Although the audible frequency range for a young person with excellent hearing ranges from 20 to 20,000 hertz, the human ear is most sensitive at frequencies between 1,000 and 6,000 hertz.[3] Sounds at frequencies above 10,000 hertz (high-pitched hissing) and below 100 hertz (low rumble) are much more difficult to hear.

A-Weighted Sound

Acousticians have developed different frequency-weighting scales for measuring sounds to support different kinds of studies. Three examples are depicted in **Exhibit C-2**. The A-weighting scale deemphasizes the contribution of frequencies below 500 hertz compared with the B and C-weighting scales. A-weighting, which was developed to support studies involving human hearing, emphasizes the mid-range frequencies, where the human ear is most sensitive, and de-emphasizes high and low frequencies.[4] Since the A-weighted scale (expressed as dBA) provides a better prediction of human reaction to environmental noise than the unweighted scale and is relatively simple to use, it is used as the basis for the metrics most frequently used in noise compatibility planning.[5]

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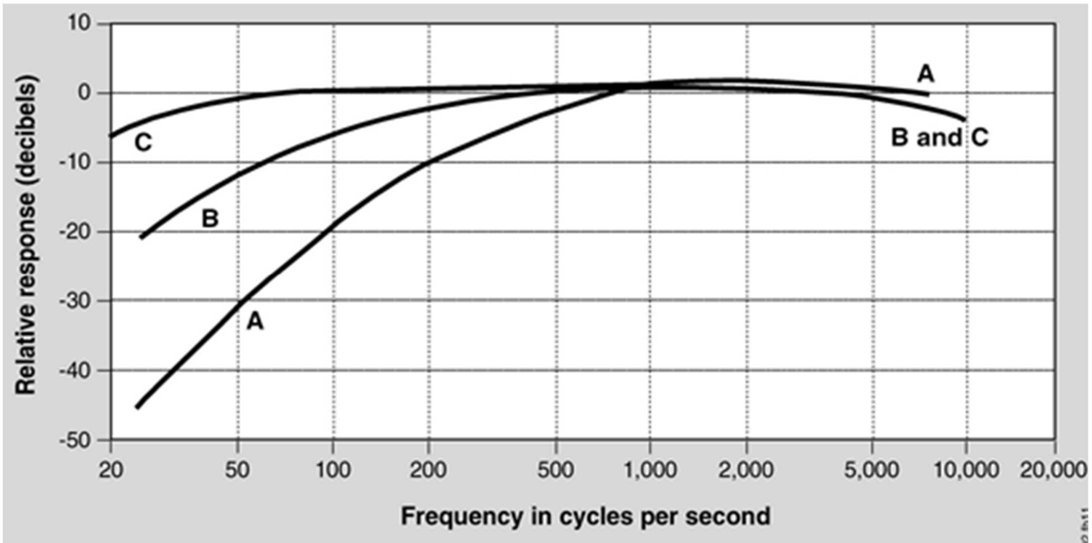
[3] Berglund, Birgitta, et al., eds., *Guidelines for Community Noise*, World Health Organization, Geneva, Cluster of Sustainable Development and Healthy Environment (SDE), Department for Protection of the Human Environment (PRE), Occupational and Environmental Health (OEH), April 1999, Table 4.1, p. vii – viii; Environmental Protection Agency, Office of Noise Abatement and Control, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, Report No. 550/9-74-004. Washington, DC, March 1974, p. A-2 – A-5.

[4] Decibel levels on the A-weighting scale are typically labeled as "dBA." The "A" is often dropped where the context clearly indicates that A-weighted sound levels are the subject of the analysis and discussion.

[5] Environmental Protection Agency, Office of Noise Abatement and Control, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, Report No. 550/9-74-004. Washington, DC, March 1974, p A-3.

EXHIBIT C-2: FREQUENCY RESPONSE



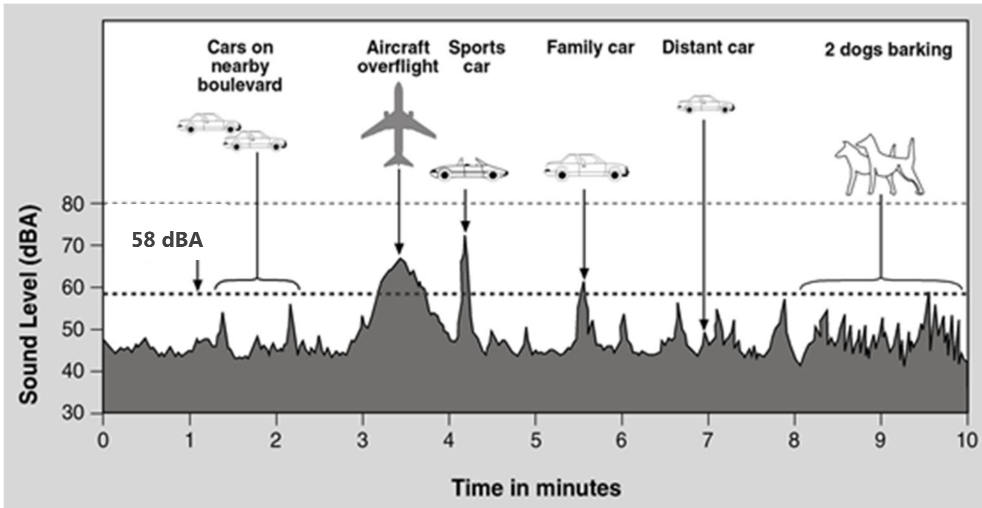
SOURCE: Jacobs Consultancy Inc., May 2007 based on A. Peterson and E. Gross, *Handbook of Noise Measurement*, (6th ed.) West Concord: General Radio Company, 1967.

C.2 SOUND METRICS

The decibel and the A-weighting scale represent only the foundation for the analysis of sound and noise. Many descriptors, or metrics, have been developed to aid in the measurement and analysis of sound. Most were developed to account for the additional dimension of time. The duration of a sound, or the variability of sound over a given period of time, is crucial in determining its potential effect on people.

Consider the sounds in a typical suburban neighborhood on a typical afternoon. If a short time history of those sounds is plotted on a graph, it would look very much like **Exhibit C-3**. According to the graph, the background, or prevailing ambient residential sound level in the absence of any identifiable noise sources, is approximately 45 dBA during the 10-minute period. During a large proportion of the time, roughly three-quarters of the period, the sound level remains below 50 dBA. The highest sound level, caused by a nearby sports car, is approximately 70 dBA, while an aircraft generates a maximum sound level of about 68 dBA (typical of a neighborhood that is a considerable distance from an airport). Based on calculating the logarithmic average of the sound energy for the 10-minute period, the average sound level is 58 dBA. The following subsections discuss the noise metrics that an acoustician would use to analyze the noise conditions in this example.

EXHIBIT C-3: COMPARATIVE NOISE LEVELS



SOURCE: Jacobs Consultancy Inc., May 2007 based on Environmental Protection Agency, Protective Noise Levels, Condensed Version of EPA Levels Document, November 1978.

C.2.1 MAXIMUM SOUND LEVEL

One obvious way of describing noise is to measure the maximum sound level (Lmax). The maximum sound level offers a simple way to compare different sound events. In Exhibit C-3, the sports car is the loudest event, the aircraft the next loudest, and the family car the third loudest. The Lmax metric, however, merely describes the peak level; it conveys no information about the duration of the sound. According to the graph, the two automobile noise events have a similar duration, but the aircraft overflight is considerably longer.

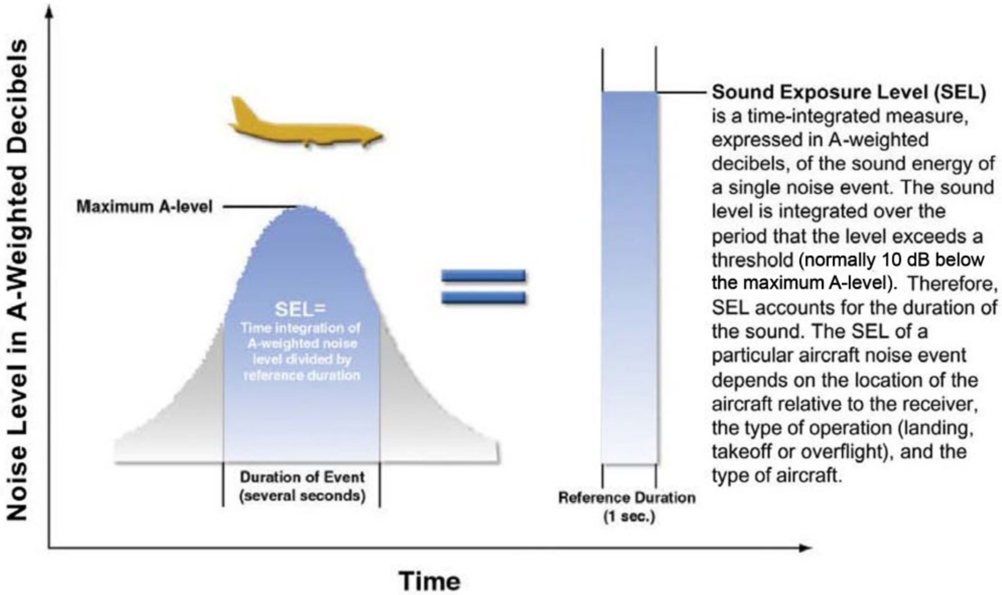
C.2.2 SOUND EXPOSURE LEVEL

In noise exposure analyses, it is also important to consider the duration of individual noise events. Clearly, the longer a noise lasts the greater its potential to disrupt activity and cause annoyance. Laboratory tests indicate that the acceptability of noise decreases at a rate of roughly 3 dB per doubling of duration.[6] In other words, two sounds are likely to be judged equally acceptable if one had an intensity of 3 dB more than the other, but half the duration of the other.

The sound exposure level (SEL) metric was developed to describe the total acoustical energy of a sound event by accounting for both the sound level and duration. SEL is computed by integrating the total sound energy of the event over a standard duration of one second. The SEL concept is depicted in **Exhibit C-4**. In many environmental studies, aircraft noise events will tend to last from 30 seconds to a minute. The SEL for an aircraft noise event tends to range from 5 to 12 dBA higher than the Lmax for the event.

[6] Galloway, William J. "Predicting community response to noise from laboratory data," in *Transportation Noises: A Symposium on Acceptability Criteria,* 1970.

EXHIBIT C-4: SOUND EXPOSURE LEVELS



SOURCE: Ricondo & Associates, Inc., November 2006.

C.2.3 EQUIVALENT SOUND LEVEL

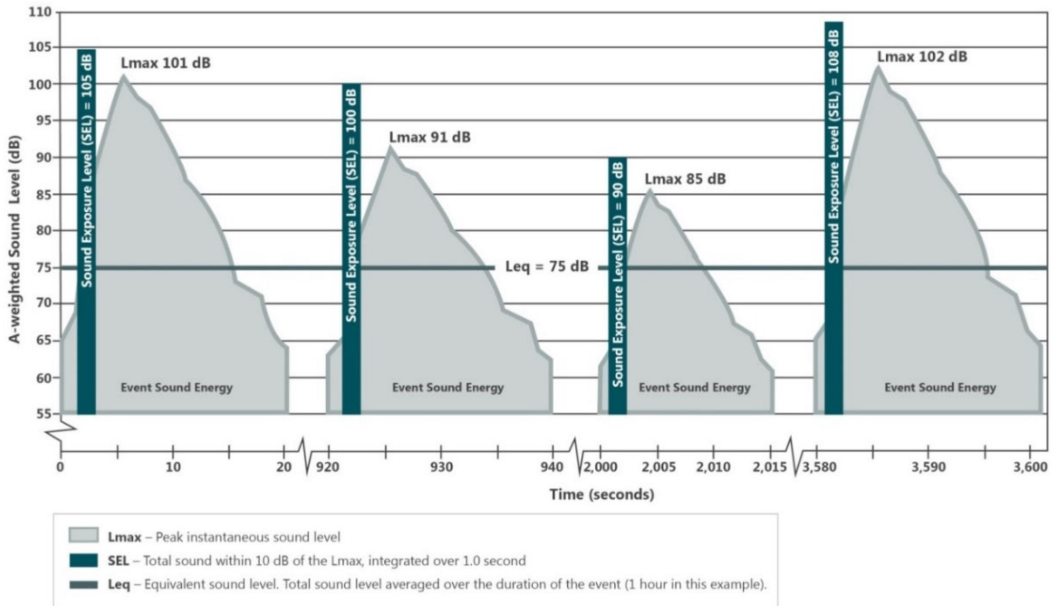
Both Lmax and SEL measure individual events. But the number of events can also be an important consideration in estimating the effect of noise. One way to describe this factor might be to count the number of events exceeding SEL 80 dBA, plus the number that exceed SEL 75 dBA, plus the number that exceed SEL 70 dBA, etc. A more efficient way to combine the description of sound exposure level and the number of events is to compute the time-average of the total sound energy over a specified period. The equivalent sound level (Leq) metric was developed for this purpose.

Leq is computed by summing logarithmically the SELs for all noise events during a given period, say one hour or 24 hours, and then averaging the sum over the number of seconds during the period. Leq is known as a cumulative noise dosage metric. Research indicates that many kinds of noise effects, including community annoyance and reaction to noise, are best understood using cumulative metrics.[7]

Exhibit C-5 illustrates how the Lmax, SEL, and Leq metrics can be used to describe a series of aircraft noise events over a one-hour period. In the example, four aircraft events occur during the hour, with Lmax levels ranging from 85 dBA to 102 dBA. When each event is converted to an SEL, to account for the duration of each event, the SEL values range from 90 dBA to 108 dBA. The cumulative noise exposure during the one-hour period, expressed as Leq, is 75 dB.

[7] Environmental Protection Agency, Office of Noise Abatement and Control, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, Report No. 550/9-74-004. Washington, DC, March 1974, p A-5.

EXHIBIT C-5: AIRCRAFT NOISE AND DIFFERENT DESCRIPTORS



Four aircraft overflights occur during a one-hour period.
The peak sound levels (Lmax) range from 85 dB to 102 dB.
The total sound energy of the events (SEL) range from 90 dB to 108 dB.
The cumulative sound level during the hour (Leq) is 75 dB – the same as a steady sound of 75 dB throughout the entire hour.

SOURCE: *ACRP Report 15, Aircraft Noise: A Toolkit for Managing Community Expectations*, Transportation Research Board, Airport Cooperative Research Program, 2009, Figure 6-2, p. 115.

C.2.4 DAY-NIGHT AVERAGE SOUND LEVEL

One additional factor also can be important in measuring sound—the time-of-day during which the events occur. Studies indicate that people are more sensitive to intrusive sounds when they are trying to sleep or relax at home.[8] Most people are engaged in these activities at home in the evening and at night. An additional factor is that background sound levels tend to be considerably lower at night that at other times of day because of the decrease in human activity. Acousticians have developed various 24-hour noise metrics that include weighting adjustments to account for periods of time when noise is presumed to be more disruptive. One of these metrics, the day-night average sound level (DNL) has become accepted in the United States as a standard for many kinds of environmental noise studies, including airport noise studies.

The US Environmental Protection Agency (US EPA) developed DNL as a 24-hour cumulative metric that could be used to predict the average response of communities to noise. DNL has become the accepted standard for aircraft noise analysis in the United States. Its use is specifically required by the FAA as accordance with Title 14 Code of Federal Regulations (CFR) Part 150.[9]

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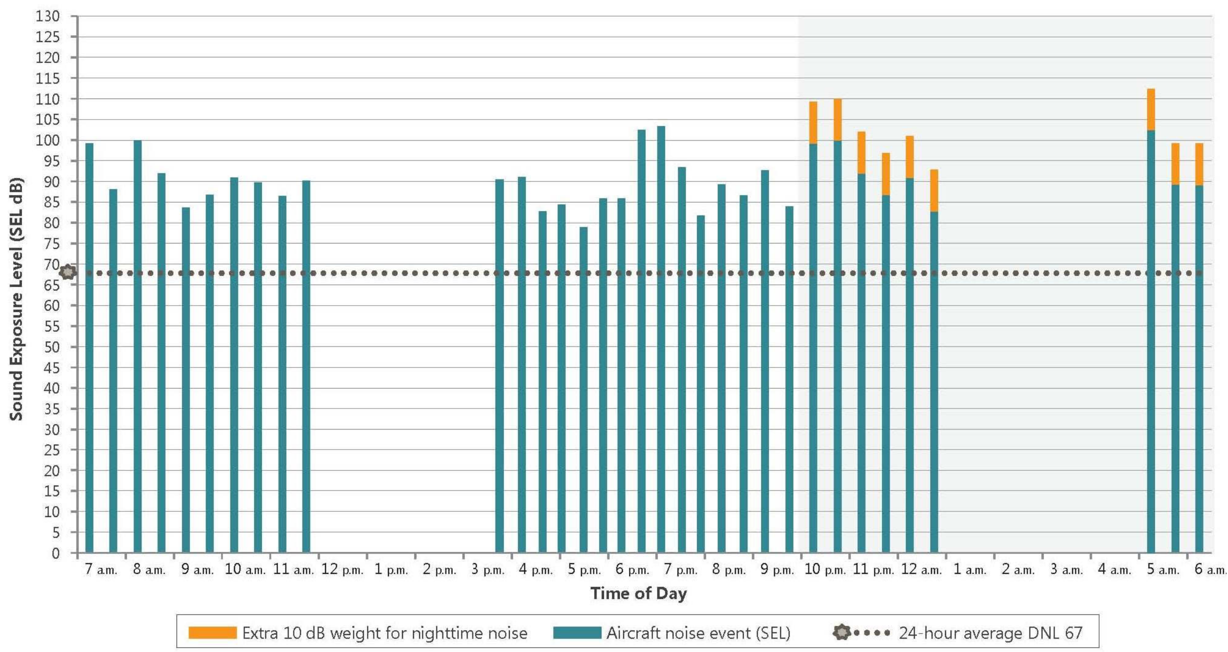
8 Environmental Protection Agency, Office of Noise Abatement and Control, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, Report No. 550/9-74-004. Washington, DC, March 1974, p. D-19 – D-27.

9 14 CFR Part 150, Appendix A.

DNL is computed in the same way as Leq, except that it is always developed only for 24-hour periods. In addition, noise events occurring at night (between 10:00 p.m. and 7:00 a.m.) are assigned an additional weight of 10 decibels. This is often referred to as the "10-dB penalty." (See **Exhibit C-6**) The 10-dB penalty is intended to account for the presumed additional disruption of noise during the hours when most people are trying to sleep. Recalling the nature of the logarithmic decibel scale, the extra 10-dB weight is equivalent to a tenfold increase in the sound energy of the event. In other words, DNL treats a nighttime event as equivalent to 10 daytime events of the same level.

In airport noise studies, DNL is typically developed to represent the 24-hour cumulative noise level for an average day during a calendar year — the yearly day-night average sound level, formally abbreviated as YDNL. Typically, however, the "Y" is dropped and the term DNL is used when the context of the study clearly indicates that the yearly DNL is the subject of study.

EXHIBIT C-6: 24-HOUR NOISE PATTERN



NOTES:

DNL is the metric (or descriptor) that the FAA and the U.S. Department of Defense use to describe the noise environment around civilian and military airports. DNL represents the total, time-weighted noise occurring during a 24-hour period. Noise events after 10:00 p.m. and before 7:00 a.m. are assigned an extra 10 decibels (dB) in the DNL calculation to reflect the increased sensitivity of people to nighttime noise. For Part 150 studies, the DNL levels are calculated for an "average day" during the study year.

In this example, 34 aircraft noise events occur during the 24-hour period – 25 in daytime and 9 in nighttime hours. The noise levels of the events range from 78 dB to 103 dB. The extra 10 dB assigned to the nighttime events gives them noise levels as high as 112 dB. The cumulative aircraft noise level for the 24-hour period is DNL 67, a high noise level that many people would consider to be annoying at home.

SOURCE: Ricondo & Associates, Inc., March 2015.

C.3 THE AVIATION ENVIRONMENTAL DESIGN TOOL

The FAA's Aviation Environmental Design Tool (AEDT) is a computer model used to calculate aircraft noise exposure and to develop aircraft noise exposure maps (NEMs). AEDT replaced FAA's Integrated Noise Model (INM) in May 2015. The model has undergone continual refinement since. The FAA and the Department of Transportation's Transportation Systems Center, Volpe Laboratory is responsible for research and development of the AEDT model.

The AEDT uses a database of aircraft noise, thrust, and distance relationships and a series of sound propagation and attenuation algorithms to predict aircraft noise levels based on user-supplied input data. Among the required data are the number and time of day of operations by aircraft type, runway usage, flight tracks and flight track use, climb and descent profiles, average climatic conditions, airfield elevation, and terrain mapping.

C.3.1 AEDT DATABASE

The AEDT aircraft database includes information for commercial, general aviation, and military aircraft powered by turbojet, turbofan, turboprop, and reciprocating engines. For each aircraft in the database, the following information is provided:

1. a set of departure profiles for each applicable trip length,
2. a set of approach parameters, and
3. noise versus distance curves for several thrust settings.

Aircraft performance data is provided to the FAA by the aircraft manufacturers. Noise levels in the database are based on certified noise measurements pursuant to Title 14 CFR Part 36, *Noise Standards: Aircraft Type and Airworthiness Certification*.[10] The noise levels in AEDT are expressed in terms of SEL.

C.3.2 USER-SUPPLIED INPUT DATA

An aircraft noise analysis depends largely on aircraft operations data, which include annual aircraft activity levels, fleet mix, stage length, and operations by time of day. Airport operational data, including annual average runway use and flight tracks, are also essential for noise modeling. Data for each of these factors are input to the AEDT to calculate noise exposure and to generate NEMs.

Aircraft Operations by Aircraft Type and Time-of-day

The number of takeoffs and landings (operations), by aircraft type and time-of-day, is a critical input to the AEDT. Historical operations data are available from the FAA. FAA data sources also record operations by aircraft type. Data on the time-of-day of operations can be derived directly from FAA radar data, if available. If radar data are not available, the time-of-day of operations can be estimated from commercial aircraft schedules and interviews with air traffic control (ATC) officials.[11] For future year analysis, forecast flight schedules are used to develop the aircraft operations input.

[10] 14 C.F.R. § 36

[11] When the noise analysis is intended to produce results using the DNL metric, the time of operations need only be divided between daytime (7:00 a.m. to 10:00 p.m.) and nighttime (10:00 p.m. to 7:00 a.m.).

Departure Stage Length

Stage length refers to the average distance an aircraft travels nonstop after departure. Departure operations in the AEDT are divided into multiple stage length categories that correspond to approximate nonstop flight distances. Each stage length associates the aircraft operation with a takeoff weight that represents a typical passenger load factor and fuel requirement. Takeoff weight can influence aircraft noise characteristics because of its effect on the length of runway needed for takeoff and rate of climb and the amount of thrust required for effective climb performance. Generally, the farther the aircraft travels nonstop after departure, the greater and heavier the fuel load. Thus, the AEDT stage length serves as a proxy for aircraft takeoff weight.

Runway Use

The assignment of takeoffs and landings to each runway end is an important influence on noise exposure. Recall that DNL contours reflect both the loudness of aircraft and the frequency of aircraft noise events. This means that, all other things being equal, the noise exposure in areas affected by aircraft operations on a frequently used runway will be greater than those areas affected by aircraft operations on a rarely used runway.

Runway use can be determined from the analysis of radar data, which include the landings and takeoffs on each runway, by aircraft type. When radar data are not available, runway use can be estimated by understanding the origins and destinations of scheduled flights and through interviews with ATC personnel.

Flight Tracks

A flight track is a projection on the ground of an aircraft's path in the sky. The best source of flight track data is FAA radar. The radar system records the three-dimensional flight path of each aircraft operating at an airport and records detailed flight information for any aircraft flying under Instrument Flight Rules (IFR)[12], including aircraft type, operating airline, and commercial flight number.[13] Flight tracks for aircraft operating under Visual Flight Rules (VFR)[14] are also recorded, but without detailed identification data.

Radar flight track data are analyzed to determine average flight track locations for various aircraft types and destinations. As part of the analysis, radar data are compared with published arrival and departure procedures as a quality control check and to reveal discrepancies that may require investigation or consultation with ATC personnel. The AEDT enables the import of the results of the flight track analysis and enables the analyst to specify the dispersion of flight tracks on either side of an average flight track centerline.[15]

Other Data

The AEDT requires the input of other data that also affect aircraft performance and therefore noise exposure. This information includes the airfield elevation and average annual temperature, which combine to describe the average density altitude at the airport. As the density altitude increases (with increased elevation or temperature), aircraft

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[12] 14 C.F.R. Part 91.

[13] All commercial aircraft and most high performance business aircraft fly under IFR.

[14] 14 C.F.R. Part 91.

[15] Even aircraft flying on the same route will not follow identical flight tracks. Variations in pilot technique, aircraft operating characteristics, winds, and temperature combine to result in the dispersion of flight tracks.

climb performance decreases. This means that a greater amount of thrust is required to maintain satisfactory climb performance as the density altitude increases.

An optional item that can be input into the AEDT analysis is a digital terrain model for the area of analysis. This allows the AEDT to calculate the actual distance of an aircraft from various points on the ground, and the associated noise level, throughout the study area. Without this digital terrain data, the AEDT calculates noise by implicitly assuming that the entire study area is at the same elevation as the modeled airport.

C.3.3 AEDT OUTPUT

The AEDT can compute and produce results in the form of noise contour maps or data tables reporting results for designated grid points around an airport. While the AEDT can describe noise using a variety of metrics, DNL noise contour maps are the most common format for AEDT output and are specifically required for Title 14 CFR Part 150 noise compatibility studies and environmental assessments.

Noise Contours

The noise contour maps derived from the AEDT show lines of equal noise exposure and are analogous to topographic contour maps around a peak. The set of concentric noise contours extending outward from the airport's runways "slope downward" to successively lower noise levels. An official NEM shows contours at intervals of DNL 5 dBA increments and include the DNL 65, 70, and 75 dBA contours. Noise above DNL 75 dBA is considered by the FAA to represent "severe" noise exposure, while DNL 65 represents the threshold of "significant" noise exposure for noise-sensitive uses, including residential.

Grid Points

The AEDT can also calculate noise levels using DNL or other metrics for specific locations, referred to as grid points and present the information in a number of formats. The grid point analysis is especially helpful in determining changes in noise levels resulting from some action. For example, significant changes in noise exposure, defined as a DNL 1.5 dBA increase at or above DNL 65 dBA in a noise-sensitive area, may be more easily assessed by comparing the differences in noise levels at a given set of grid points than by comparing changes in noise contours.

C.3.4 LIMITATIONS OF NOISE MODELING

The validity and accuracy of noise modeling depend on the accuracy of the basic information used in the calculations. For future airport activities, the reliability of calculations is affected by a number of uncertainties.

Aviation activity levels—e.g., the forecast number of aircraft operations, the types of aircraft serving the airport, the times of operation (daytime and nighttime), and aircraft flight tracks—are estimates. While great care is typically taken in developing these estimates, the degree to which they reflect actual conditions at any given time may vary.

Aircraft acoustical and performance characteristics are also estimates, although the FAA is committed to continually updating and revising this information in successively refined versions of the AEDT. When new aircraft designs are involved that are not included in the AEDT database, aircraft noise data and flight characteristics must be estimated.

The DNL and related cumulative noise metrics were designed considering the typical human response to aircraft noise. Because people vary in their responses to noise, the DNL scale can only indicate an average response to aircraft noise from a community but cannot predict each individual's reaction.

Given the uncertainty associated with forecasting, noise contours for current operating conditions can be assumed to be more reliable than those projected for future conditions. Also, noise contours are more reliable closer to the airport. As distance from the airport increases, the potential for aircraft to deviate from the assumed profiles and flight tracks also increases.

Noise contour maps provide valid comparisons between different projected operating conditions as long as consistent assumptions are used for all scenarios. Thus, sets of DNL calculations can effectively show:

- the degree of anticipated change in aircraft noise exposure over time; and
- the relative merits of alternative operating scenarios from the standpoint of noise exposure.

Importantly, a line drawn on a map does not imply that a particular noise condition exists on one side of that line and not on the other. DNL calculations are merely a means for comparing noise effects, not for precisely defining them relative to specific parcels of land. Nevertheless, DNL contours can be used to:

- highlight an existing or potential aircraft noise problem that requires attention;
- assist in the preparation of noise compatibility programs; and
- provide guidance in the development of land use controls, such as zoning ordinances, subdivision regulations, and building codes, to promote noise-compatible development.

C.4 COMMUNITY ANNOYANCE

Considerable research has been done to investigate the sensitivity of people to transportation noise at their residences. Interestingly, noise itself is only one of several factors contributing to reported annoyance. Studies have found that important contributors to annoyance include fear of the source of the noise, socioeconomic factors, and age. In addition, noise sensitivity varies greatly among individuals.[16]

Research has found that noise-based annoyance among communities of people tends to follow a typical pattern, despite the variation among individuals. In 1978, T.J. Schultz published a study synthesizing the results of several such studies.[17] Schultz found that annoyance increased along an S-shaped curve as noise, expressed by cumulative noise metrics, increased. This work was updated in 1994 by adding more studies to the analysis, resulting in the revised Schultz Curve presented in **Exhibit C-7**.

The Schultz Curve was derived from the results of numerous studies of the effect of transportation noise on people at their residences. According to the equation, 0.8 percent of people are highly annoyed by noise of DNL 45 dBA, 3.1 percent by noise of DNL 55 dBA, 6.1 percent by DNL 60 dBA, 11.6 percent by DNL 65 dBA, 20.9 percent by DNL 70 dBA, and 34.8 percent by DNL 75 dBA.

The relationship shown in the revised Schultz Curve has provided the basis for some Federal agencies and state governments to establish thresholds above which noise is presumed to constitute an adverse impact on residences and other sensitive land uses.

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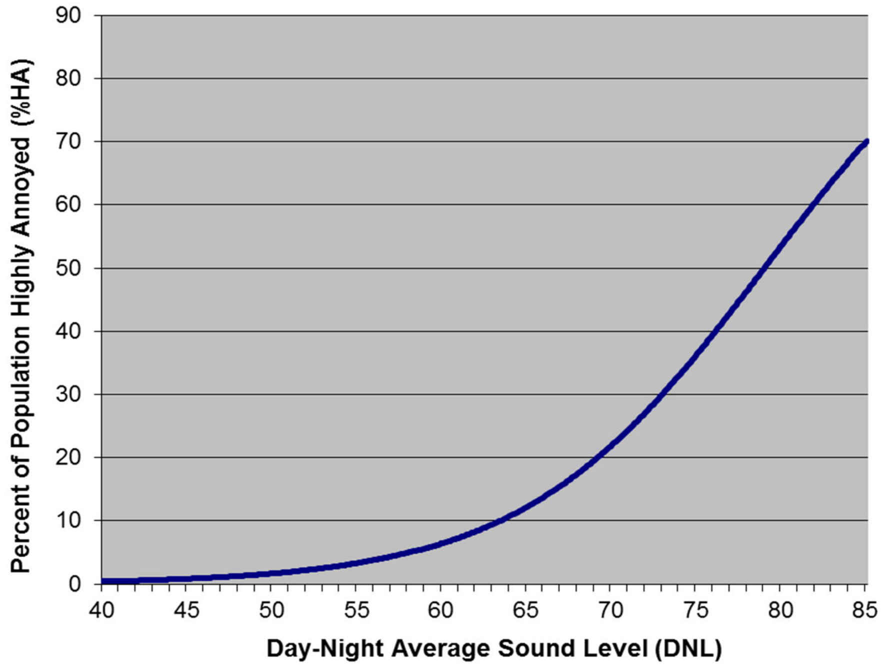
[16] Miedema, Henk M.E. Annoyance caused by environmental noise: elements for evidence-based noise policies in *Journal of Social Issues*, Vol. 63, No. 1, 2007, p. 41-57.

[17] Schultz, Theodore J., Synthesis of social surveys on noise annoyance, *Journal of the Acoustical Society of America*, Vol. 64, No. 2, August 1978, p. 377-405.

EXHIBIT C-7: REVISED SCHULTZ CURVE



SOURCE: Finegold, L.S., et al., Community annoyance and sleep disturbance: updated criteria for assessing the impacts of general transportation noise on people in *Noise Control Engineering Journal*, Vol. 42, No. 1, 1994, Figure 1, p. 26.

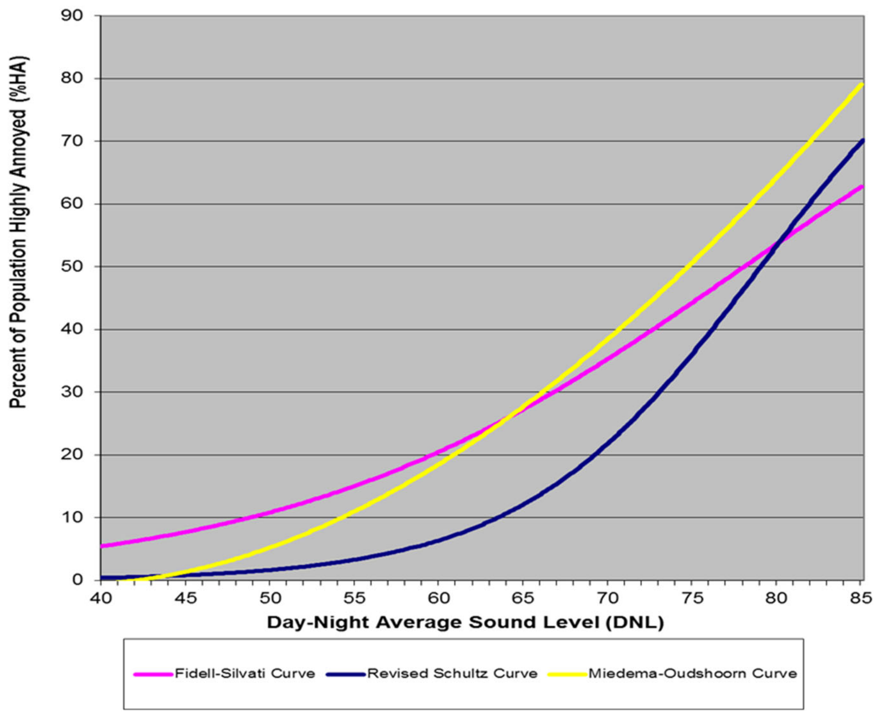
Since the development of the revised Schultz Curve, additional studies have developed new annoyance curves indicating a tendency for populations to become annoyed with aircraft noise at lower levels. Two such annoyance curves, the Miedema-Oudshoorn Curve and the Fidell-Silvati Curve, are compared with the revised Schultz Curve in **Exhibit C-8**.

The Miedema-Oudshoorn Curve was developed in 2001 as part of a study examining annoyance associated with noise emanating from multiple transportation modes. While the study examined annoyance related to multiple noise-generating transportation modes, the Miedema-Oudshoorn Curve depicted on Exhibit C-8 represents annoyance associated exclusively with aircraft noise.[18] The noise data used to develop the Miedema-Oudshoorn Curve was collected from previous noise studies conducted at airports in Australia, Europe, and North America. The Miedema-Oudshoorn study found evidence indicating that aircraft noise tends to be more annoying than ground transportation noise at any given cumulative noise level.[19]

[18] Miedema, H.M.E. and C.G.M. Oudshoorn, Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals in *Environmental Health Perspectives*, Vol. 109, No. 4, April 2001, p. 410-411.

[19] Miedema, H.M.E. and C.G.M. Oudshoorn, Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals. *Environmental Health Perspectives*, Vol. 109, No. 4, April 2001, p. 414.

EXHIBIT C-8: COMPARISON OF NOISE ANNOYANCE CURVES



SOURCES: Fidell, Sanford and Laura Silvati, Parsimonious alternatives to regression analysis for characterizing prevalence rates of aircraft noise annoyance in *Noise Control Engineering Journal*, Vol. 52, No. 2, March – April 2004. (Fidell-Silvati Curve); Finegold, L.S., et al., Community annoyance and sleep disturbance: updated criteria for assessing the impacts of general transportation noise on people in *Noise Control Engineering Journal*, Vol. 42, No. 1, 1994 (Revised Schultz Curve); Miedema, H.M.E. and C.G.M. Oudshoorn, Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals, in *Environmental Health Perspectives*, Vol. 109, No. 4 April 2001 (Miedema-Oudshoorn Curve).

The Fidell-Silvati Curve was developed in 2004 as part of a study analyzing annoyance resulting from aircraft noise. This study focused exclusively on aircraft noise-induced annoyance.[20]

Although more recent studies have found that higher percentages of populations are annoyed by aircraft noise at lower levels than the Schultz Curve, the FAA still regards the revised Schultz Curve to be authoritative for its purposes. However, in light of the recent research, the FAA is undertaking an extensive study at approximately 20 airports across the United States to reexamine community annoyance induced by aircraft noise.[21] The study is expected to be completed by late 2020 in accordance with the FAA Reauthorization Act of 2019.[22]

[20] Fidell, Sanford and Laura Silvati. Parsimonious alternatives to regression analysis for characterizing prevalence rates of aircraft noise annoyance. *Noise Control Engineering Journal*, Vol. 52, No. 2, March – April 2004.

[21] Sizov, Natalia and Lynne Pickard, Federal Aviation Administration, Office of Environment and Energy. *An Update on Research to Guide United States Policy on Aircraft Noise Impact*, July 2011.

[22] Federal Aviation Administration Reauthorization Act of 2019, H.R. 302, 115th Cong.,2nd Sess. (2018)

C.5 LAND USE COMPATIBILITY

The concept of land use compatibility is based on a simple principle. People tend to be more or less disturbed by noise depending on their activities at any given time. For example, most people place a greater premium on quiet when they are at home than when they are shopping or at work.

The compatibility of various land uses with different levels of noise has been the subject of study and numerous sets of guidelines in the United States for over 50 years. Some of the most significant milestones are discussed in this section.

C.5.1 PIONEERING EFFORTS IN LAND USE COMPATIBILITY GUIDELINES

Numerous sets of noise/land use compatibility guidelines have been developed by federal agencies through the years. In 1964 the FAA and Department of Defense published guidelines for land use planning in areas prone to aircraft noise.[23] In 1971, the Department of Housing and Urban Development published noise assessment guidelines for evaluating sites suitable for housing assistance.[24] Both sets of guidelines identified DNL 65 dBA as the threshold above which aircraft noise becomes problematic or "normally unacceptable" for residential land use.

USEPA Levels Document – 1974

In 1974 the USEPA suggested maximum noise exposure levels to protect public health with an adequate margin of safety.[25] Noise levels above DNL 55 dBA were considered to interfere with outdoor activities. The EPA suggested that indoor activities may become hampered if interior noise levels exceed DNL 45 dBA. It is generally assumed that standard residential construction attenuates noise by approximately 20 dBA, with doors and windows closed. Therefore, a DNL 45 dBA interior noise level corresponds to a DNL 65 dBA exterior noise level. **Table C-2** illustrates the USEPA's guidelines.

The FAA issued an advisory circular concerning airport land use compatibility planning in 1977 that included the USEPA's guidelines.[26]

[23] Bolt Beranek and Newman, Inc., *Land Use Planning Relating to Aircraft Noise*. U.S. Department of Defense, AFM 86-5, TM 5-365, NAVDOCKS P-98, October 1, 1964. (Available from Defense Technical Information Center as document number AD0615015.)

[24] Shultz, T.J. and N.M. McMahon, *HUD Noise Assessment Guidelines,* Report No. HUD TE/NA 171, August 1971. (Available from National Technical Information Service as document number PB-210 590.)

[25] U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *Information on Levels of Environmental Noise Requisite to Protect Health and Welfare with an Adequate Margin of Safety*, Report No. 550/9-74-004. Washington, DC, March 1974.

[26] Federal Aviation Administration, Advisory Circular 150/5050-6, *Airport Land Use Compatibility Planning,* December 30, 1977.

TABLE C-2: SUMMARY OF NOISE LEVELS IDENTIFIED AS REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

EFFECT	LEVEL (DBA)	AREA
Hearing Loss	DNL 74 +	All areas
Outdoor activity interference and annoyance	DNL 55 +	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis of use.
	DNL 59 +	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	DNL 45 +	Indoor residential areas
	DNL 49 +	Other indoor areas with human activities such as schools, etc.

SOURCE: U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *Information on Levels of Environmental Noise Requisite to Protect Health and Welfare with an Adequate Margin of Safety,* Report No. 550/9-74-004, Washington, DC, March 1974.

Federal Interagency Committee on Urban Noise – 1980

In 1977, the Federal Interagency Committee on Urban Noise (FICUN) was formed with representatives from the USEPA, Department of Transportation, Department of Housing and Urban Development, Department of Defense, and the Veterans Administration. In 1980, they published land use compatibility guidelines for DNL noise levels. DNL 65 dBA was described as the threshold of significant impact for residential land uses and noise-sensitive institutions and facilities (including hospitals, nursing homes, schools, cultural activities, auditoriums, and outdoor music shells). Residential land use was designated as compatible within the DNL 55 to 65 dBA range; however, a footnote explained that this designation reflected the individual Federal agencies' consideration of cost and feasibility factors, past community experiences, and program objectives. The footnote further indicated that local governments may have different goals or conditions to consider when evaluating these guidelines.[27]

American National Standards Institute – 1980 – 2007

In 1980 the American National Standards Institute (ANSI) also published land use compatibility recommendations for noise. These guidelines were most recently updated and reissued in 2007.[28] The current version of the standard describes single-family housing with extensive outdoor use as marginally compatible with noise between DNL 55 and 60 dBA and incompatible with noise above DNL 60 dBA. Single and multi-family housing with moderate outdoor use is considered marginally compatible with noise between DNL 60 and 65 dBA and incompatible with noise above DNL 65 dBA. Housing with limited outdoor use, libraries and religious facilities are considered marginally compatible with noise between DNL 60 and 65 dBA and compatible with noise between DNL 65 and 75 dBA only if sound insulation is installed.

World Health Organization – 1999

The WHO, in its *Guidelines for Community Noise*, included a summary of the research on the adverse effects of noise on individuals and communities and recommended noise exposure guidelines to ensure the health and well-being

[27] Federal Interagency Committee on Urban Noise, *Guidelines for Considering Noise in Land Use Planning and Control*, June 1980, p. 6.

[28] ANSI/ASA S12.9-2007 / Part 5, *Quantities and Procedures for Description and Measurement of Environmental Sound – Part 5: Sound Level Descriptors for Determination of Compatible Land Use*, Approved by the American National Standards Institute, Inc., November 14, 2007.

of people in various environmental settings. The noise exposure guidelines were offered as "targets to be achieved in the long-term."[29]

The WHO guidelines are based on the Leq metric and specify the time period upon which the various guideline thresholds are based. Excerpts from the WHO guidelines are presented in **Table C-3**.

TABLE C-3: WHO GUIDELINE VALUES FOR COMMUNITY NOISE IN SPECIFIC ENVIRONMENTS

SPECIFIC ENVIRONMENT	CRITICAL HEALTH EFFECT(S)	L_{EQ} (DBA)	OUTDOOR L_{EQ} (DBA)*	TIME BASE (HOURS)
Outdoor living area	Serious annoyance – daytime and evening	55	55	16
	Moderate annoyance – daytime and evening	50	50	16
Dwelling, indoors	Speech intelligibility & moderate annoyance – daytime & evening	35	50-70	16
Inside bedrooms	Sleep disturbance – nighttime	30	45-65	8
Outside bedrooms (outdoors)	Sleep disturbance – windows open	45	45	8
School class rooms, & pre-schools — indoors	Speech intelligibility, disturbance of information extraction, message communication	35	50-70	during class
School, playground – outdoors	Annoyance (external source)	55	55	during play
Hospital, ward rooms – indoors	Sleep disturbance – nighttime	30	45-65	8
	Sleep disturbance – daytime and evenings	30	45-65	16

NOTES:

* The outdoor noise level corresponding to any interior level depends on the outdoor-to-indoor noise level reduction (NLR) that the building can achieve. The following NLRs are assumed in this table, based on experience with residential sound insulation programs in the United States:

NLR with windows open – 15 dB

NLR, standard construction with windows closed – 20 dB

NLR, sound-insulated building with windows closed – 25 to 35 dB, depending on the extent of the sound insulation

SOURCE: Berglund, Birgitta, et al., eds., *Guidelines for Community Noise*, World Health Organization, Geneva, Cluster of Sustainable Development and Healthy Environment (SDE), Department for Protection of the Human Environment (PRE), Occupational and Environmental Health (OEH), April 1999, Table 4.1, p. 47.

The WHO guidelines suggest that the average noise level for 16 hours between 7:00 a.m. and 11:00 p.m. (Leq(16)) of 55 dBA should be considered the maximum acceptable noise level in outdoor living areas to protect against serious annoyance and Leq(16) 50 dBA to protect against moderate annoyance. Maximum indoor Leqs for dwellings and schools are considered to be 35 dBA. This corresponds to outdoor levels of 50 dBA with windows open, 55 dBA with windows closed, and 60 to 70 dB for a sound-insulated building with windows closed. Maximum indoor levels for residential sleeping rooms and patient rooms in hospitals is recommended at 30 dBA, corresponding to outdoor

[29] Berglund, Birgitta, et al., eds., *Guidelines for Community Noise*, World Health Organization, Geneva, Cluster of Sustainable Development and Healthy Environment (SDE), Department for Protection of the Human Environment (PRE), Occupational and Environmental Health (OEH), April 1999, p. xviii.

levels of 45 dBA with windows open, 50 dBA with windows closed, and 55 to 65 dBA for a sound-insulated building with windows closed.

Part 150 Land Use Compatibility Guidelines

The FAA adopted land use compatibility guidelines relating types of land use to airport sound levels when it promulgated 14 CFR Part 150 in 1985. These guidelines, reproduced in **Table C-4**, *Land Use Compatibility Guidelines – 14 CFR Part 150*, show the compatibility parameters for residential, public (schools, churches, nursing homes, hospitals, libraries), commercial, manufacturing and production, and recreational land uses.

The Part 150 guidelines are the basis for defining areas within which noise projects approved in Part 150 Noise Compatibility Programs are potentially eligible for federal funding through the Airport Improvement Program. The *Airport Improvement Handbook* states, "Noise compatibility projects usually must be located in areas where noise measured in day-night average sound level (DNL) is 65 (dBA) or greater."[30] Federal funding is potentially available for certain noise mitigation projects at noise levels below DNL 65 if the airport sponsor determines that incompatible land uses exist below DNL 65 dBA and the FAA concurs with the sponsor's determination.[31]

As shown in Table C-4, all land uses exposed to noise below DNL 65 dBA are considered to be compatible with airport operations. Residential land uses are incompatible with noise levels above DNL 65 dBA. If local communities consider it necessary to allow housing in areas exposed to noise above DNL 65, sound attenuation measures should be required. Schools and other public use facilities located between DNL 65 and 75 dBA are conditionally compatible if measures are taken to attenuate outdoor noise by 25 to 30 dBA. Above DNL 75 dBA, schools, hospitals, nursing homes, and churches are considered incompatible land uses.

The FAA's land use compatibility table is intended as a guideline, not a regulation. As explained in a note to Table C-4, the FAA recognizes that local communities may wish to establish land use compatibility standards that differ from the Part 150 guidelines. This is reiterated in the text of Part 150: "For the purpose of compliance with this part, all land uses are considered to be compatible with noise levels less than Ldn 65 dB. Local needs or values may dictate further delineation based on local requirements or determinations."[32] The authority for local communities to establish their own land use compatibility standards is also acknowledged in the FAA's *Airport Improvement Program Handbook*: "The FAA can consider a lower level of noise than the DNL 65 dB noise contour only if both the jurisdictions with land use authority surrounding the airport and the sponsor have each formally adopted a lower local standard (per a footnote to Table 1 of Appendix A in 14 CFR part 150.)"[33]

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[30] FAA Order 5100.38A, Chapter 7, paragraph 710.b.

[31] FAA Order 5100.38D, *Airport Improvement Program Handbook*, September 30, 2014, Appendix R, §R-6(c). Even if an airport operator declares a significant noise impact threshold lower than DNL 65, securing funding for mitigation programs at levels below DNL 65 is unlikely because of higher priorities placed by the FAA on mitigating noise effects in areas exposed to noise above DNL 65.

[32] 14 CFR Part 150, Appendix A Part B *Noise Exposure Map Development*, Section A150.101 *Noise contours and land usages*, paragraph (d)

[33] FAA Order 5100.38D, *Airport Improvement Program Handbook*, September 30, 2014, Appendix R, §R-6(c).

TABLE C-4 (1 OF 2): LAND USE COMPATIBILITY GUIDELINES – 14 CFR PART 150

LAND USE	YEARLY DAY-NIGHT AVERAGE SOUND LEVEL (DNL) IN A-WEIGHTED DECIBELS (DBA)					
	BELOW 65	65-70	70-75	75-80	80-85	OVER 85
RESIDENTIAL						
Residential, other than mobile homes and transient lodgings	Y	N[1]	N[1]	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N[1]	N[1]	N[1]	N	N
PUBLIC USE						
Schools, hospitals, nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Governmental services	Y	Y	25	30	N	N
Transportation	Y	Y	Y[2]	Y[3]	Y[4]	N[4]
Parking	Y	Y	Y[2]	Y[3]	Y[4]	N
COMMERCIAL USE						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail -- building materials, hardware, and farm equipment	Y	Y	Y[2]	Y[3]	Y[4]	N
Retail trade, general	Y	Y	25	30	N	N
Utilities	Y	Y	Y[2]	Y[3]	Y[4]	N
Communication	Y	Y	25	30	N	N
MANUFACTURING AND PRODUCTION						
Manufacturing, general	Y	Y	Y[2]	Y[3]	Y[4]	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y[6]	Y[7]	Y[8]	Y[8]	Y[8]
Livestock farming and breeding	Y	Y[6]	Y[7]	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL						
Outdoor sports arenas and spectator sports	Y	Y	Y[5]	N[5]	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

TABLE C-4 (2 OF 2): LAND USE COMPATIBILITY GUIDELINES – 14 CFR PART 150

The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable under Federal, State, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

Key

Y (Yes)	Land use and related structures compatible without restrictions.
Y^x, 25, 30, 35	Land use and related structures are compatible subject to stated conditions.
N[1]	Land use and related structures are not compatible, but if the community determines that they must be allowed, the conditions described in Note 1 must be observed.
N (No)	Land use and related structures are not compatible and should be prohibited.
NLR	Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure
	25, 30, 35 Land use and related structures generally compatible; measures to achieve a NLR of 25, 30, or 35 dB must be incorporated into design and construction of structure.

Notes

1. Where the community determines that residential or school uses must be allowed, measures to achieve outdoor-to-indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.
2. Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
3. Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
4. Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
5. Land use compatible provided special sound reinforcement systems are installed.
6. Residential buildings require a NLR of 25 dB.
7. Residential buildings require a NLR of 30 dB.
8. Residential buildings not permitted.

SOURCE: Title 14 CFR Part 150, *Airport Noise Compatibility Planning*, Appendix A, Table 1 (table and notes); Ricondo & Associates, Inc., December 2014 (shading).

APPENDIX D

Glossary of Terms and Acronyms

APPENDIX D GLOSSARY OF TERMS AND ACRONYMS

ACRONYM/ABBREVIATION	DEFINITION
14 CFR Part 150	Title 14 Code of Federal Regulations Part 150
2005 Dulles New Runway EIS	Final Environmental Impact Statement for New Runways, Terminal Facilities and Related Facilities at Washington Dulles International Airport
AAD	Average Annual Day
ADG	Airplane Design Group
ADS-B	Automatic Dependent Surveillance-Broadcast
ANP	Aircraft noise and performance (for use in AEDT model)
ADIZ	Air Defense Identification Zone
AEDT	Aviation Environmental Design Tool
ALP	Airport Layout Plan
ANCA	Airport Noise and Capacity Act
ANOMS	Airport Noise and Operations Monitoring System
ARTCC	Air Route Traffic Control Center
ASPM	Aviation System Performance Metrics
ASV	Annual service volume
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
BWI Marshall	Baltimore/Washington International Thurgood Marshall
CBSA	Core Based Statistical Area
CFR	Code of Federal Regulations
CRO	non-intersecting converging runway operations
D2	Dulles Development Program
dBA	A-weighted decibels
DC FRZ	Washington DC Flight Restriction Zone
DME	Distance Measuring Equipment
DNL	day-night average sound level
DP	Departure Procedure
Dulles International or the Airport	Washington Dulles International Airport
Dulles International ATCT	Washington Dulles Air Traffic Control Tower
EECP	Expanded East Coast Plan
EIS	Environmental Impact Study
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FAR Part 150 Study	Part 150 Noise Compatibility Program
FBO	Fixed Base Operator
FICON	The Federal Interagency Committee on Noise
FIS	Federal Inspection Services
FMS	flight management system
FRZ	Flight Restricted Zone
FY	Fiscal Year
GDP	Gross Domestic Product

ACRONYM/ABBREVIATION	DEFINITION
GPS	Global Positioning System
GS	Glide slope
IAB	International Arrivals Building
IFPs	instrument flight procedures
IFR	instrument flight rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IMRO	Improved Multiple Runway Operations
LOC	Localizer
LU/Z-MA	Land Use / Zoning Mapping Area
MSL	Mean Seal Level
MWAA	Metropolitan Washington Airports Authority
MWCOG	Metropolitan Washington Council of Governments
NAS	National Airspace System
NAVAID	Navigational Aid
NEPA	National Environmental Policy Act
NM	Nautical mile
PAPI	Precision Approach Path Indicator
PBN	performance-based navigation
PMAD	Peak Month Average Day
Potomac TRACON	Potomac Terminal Radar Approach Control
Reagan National Airport	Ronald Reagan Washington National Airport
RECAT	Wake Recategorization
RF	Radial-to-Fix
RNAV	area navigation
RNP	Required Navigation Performance
RTM	Revenue Tons per Mile
SFRA	Special Flight Rules Area
SIAP	Simultaneous Instrument Approach
SIDs	standard instrument departures
STARs	standard terminal arrival routes
TAF	Terminal Area Forecast
TBFM	Time-Based Flow Management
TRACON	Terminal Radar Approach Control
VFR	visual flight rules
VMC	Visual Meteorological Conditions
VOR	Very-High Frequency Omni-Directional Range
VOR/DME	Very-High Frequency Omni-Directional Range and Distance Measuring Equipment
WMATA	Washington Metropolitan Area Transit Authority
Working Group	Local Jurisdictional Stakeholder Working Group