RUNWAY 17 DEPARTURE OPERATIONS REPORT

July 2019

Community Relations Office

Metropolitan Airports Commission
6040 28th Avenue South, Minneapolis, MN 55450
metroairports.org

RUNWAY 17 DEPARTURE OPERATIONS REPORT

Table of Contents

List of Figures

EXECUTIVE SUMMARY

During MSP Noise Oversight Committee (NOC) Listening Sessions in 2018, residents shared concerns about the use of Runway 17 for aircraft departing Minneapolis-St. Paul International Airport (MSP). In response, the NOC included an item in the 2019 Work Plan to study the use of Runway 17 in a manner that investigated the concerns raised by the residents. MAC staff worked in partnership with the residents, the Eagan Airport Relations Commission and the NOC to develop a scope and objective for the study. In addition to creating the scope, these groups worked together to establish the following statement of purpose for the study: *Working collaboratively with neighbors and communities south of the airport, the MAC will identify concerns related to Runway 17 Departures and compile a report that will identify operational necessities of Runway 17, highlight trends in the use of the runway and identify changes experienced after FAA implemented new rules to address Converging Runway Operations.*

Prior to construction of Runway 17-35, a significant amount of environmental study took place through the Federal Environmental Impact Statement (FEIS) for the MSP Dual Track Airport Planning Process and subsequent Runway 17 Departure Procedure Environmental Assessment (EA) completed in 2003. The studies projected that 37.1% of daytime departures and 34.6% of nighttime departures in 2005 would use Runway 17 after the runway's opening, for a total runway use of 36.7%. Which means the runway was projected to be used for most departing flights, superseding Runways 12L and 12R combined by over 10 percentage points. Runway 17 was constructed to be used to the south as a departure-only runway. After opening in 2005, actual use of this runway for departures remained below 25% every year until new rules regarding Converging Runway Operations (CRO) were implemented.

Acting on a safety recommendation from the National Transportation Safety Board (NTSB), in 2014 the FAA established separation standards for converging runway operations (CRO) on non-intersecting runways at airports nationwide. In 2015, the FAA determined the CRO mitigations it had developed for MSP were insufficient to meet these new standards. New air traffic tactics were required to adhere to the new CRO separation standards. While CRO does not directly impact Runway 17 departures, an indirect result is decreased use of a North Flow configuration at MSP (favoring departures off Runways 30L, 30R and 35) due to complexities introduced by CRO. This decreased use of North Flow inversely increased the use of South Flow (favoring departures off Runways 12L, 12R and 17), thus increasing departures from Runway 17, over Bloomington and parts of Eagan.

In 2016, 2017 and 2018—the three full years since CRO standards were implemented—the use of Runway 17 for departures increased to 33.3%, 31.0% and 33.7%, respectively. While there were increases in the percentage use of the runway compared to recent years, actual operational counts and percentages remain below those forecast in the 2003 EA. The EA forecasted 574,984 daily operations at MSP with 36.7% of all departures on Runway 17, resulting in 105,510 departures on that runway. In 2018, MSP had 406,913 total operations and 68,565, or 33.7%, departed from Runway 17.

This study investigates a number of operational trends identified by the community as points of concern. For comparison purposes, aircraft activity in 2014 was used to evaluate trends prior to the CRO standards, and 2018 was used to evaluate operational variations after CRO standards were implemented.

While the use of Runway 17 has increased post-CRO, the study finds that specific operational characteristics of the runway have not changed significantly. The frequency of flights during short periods of time (15-minute intervals) has not increased. The Runway 17 flight path (or heading) distribution has varied little after 2015. The study determines that there is a larger volume of air traffic on each heading; however, aircraft are not using new headings compared to the headings used before the new CRO standards. The study also finds the altitudes of aircraft departing Runway 17 decreased in 2018 compared to 2014. This variation is not a result of CRO, but rather a change in weather conditions, particularly warmer temperatures in 2018 with less headwind to help aircraft climb.

When evaluating the combination of runways used, the study finds that the FAA has increased the use of a mixed configuration at MSP. This configuration occurs when aircraft are arriving on Runways 30L and 30R and departing from Runway 17 and, to a lesser extent, Runways 30L and 30R. Although this configuration adds to the number of Runway 17 departures, it has a net benefit to residents living in central Eagan because it reduces the number of departures flying eastbound over the middle of the city. Instead, aircraft are instructed to fly straight out from the runway to remain separated from arrivals to Runways 30L and 30R using adjacent airspace. The land use in areas straight-out from the runway are more compatible with aircraft noise than areas of central Eagan.

Finally, the study further compares operations, aircraft types and headings in 2018 with what was projected in the 2003 EA. More total operations and louder aircraft in the EA produced a much larger noise exposure area than what is actually experienced today. The EA acknowledged that variances in runway and flight track use will occur due to weather, safety and aircraft interactions. The MAC's current practice is to evaluate operational changes on an annual basis through the MSP Annual Noise Contour Report. This report includes actual annual noise contours, which are used to determine residential noise mitigation eligibility. Even with the increase in Runway 17 departures experienced in 2016, 2017, and 2018, the actual annual noise contours from these years do not extend south of the Minnesota River, nor do they extend beyond the MAC's previous residential noise mitigation program area in the area of Runway 17 departure activity.

1. Introduction

The Metropolitan Airports Commission (MAC) is a public corporation governed by a board of commissioners that reports to the Governor of Minnesota and the Minnesota State Legislature. The MAC is charged with managing a system of seven airports within the Minneapolis-St. Paul metropolitan area, including Minneapolis-St. Paul International Airport (MSP). In addition to the MAC, other air transportation entities play critical roles in the successful operation of an airport. The Federal Aviation Administration (FAA) regulates all aircraft activity. At MSP, the FAA's Air Traffic Control (ATC) is solely responsible for directing aircraft on the ground and in the air. ATC's highest priority is the safe and efficient movement of air traffic. Air transportation companies, such as airlines, provide transportation services for people and products. **Figure 1 - Air Transportation Entities** below outlines the primary air transportation units responsible for the successful operation of MSP.

Figure 1 - Air Transportation Entities

The MAC has designated the Noise Oversight Committee (NOC) as its primary advisory body regarding aircraft noise issues associated with flight operations at MSP. Based on feedback provided from members of the public who attended quarterly Listening Sessions in 2018, the NOC directed MAC staff to conduct an analysis of MSP Runway 17 departure activity over cities to the south of the airport. A graphic of the MSP runway layout is provided in **Appendix B**. Residents of communities south of MSP, the Eagan Airport Relations Commission, and MAC staff collaboratively designed the objective and scope of this analysis to ensure the components would effectively incorporate observations and noise concerns from residents of these communities. The study objective is provided below, and the final scope developed in conjunction with the residents is provided in **Appendix A.**

Objective: Working collaboratively with neighbors and communities south of the airport, the MAC will identify concerns related to Runway 17 Departures and compile a report that will identify operational necessities of Runway 17, highlight trends in the use of the runway and identify changes experienced post-CRO.

2. BACKGROUND

In 1989, the Minnesota Legislature enacted the Metropolitan Airport Planning Act. This act provided the basis of determining whether the long-term air transportation needs of the Twin Cities metropolitan area and the State could best be met by enhancing capacity at MSP, or by developing a replacement air carrier airport elsewhere within the metropolitan area. In what came to be known as the "Dual Track Airport Planning Process," the legislation directed the MAC, in conjunction with the public and with cooperating federal, State, and local agencies, to complete a series of studies and documents which would evaluate long-range aviation alternatives to fulfill the aviation needs in the Twin Cities area for a 30-year period.

The *Dual Track Airport Planning Process Report to the Legislature: Summary* was submitted to the Minnesota Legislature on March 18, 1996. In April of 1996, legislation was passed that stopped further study of a new airport and directed MAC to implement the Long-term Comprehensive Plan (LTCP) for MSP.

The MSP LTCP included construction of a new runway on the west side of the airport. The FAA's Final Record of Decision on the Federal Environmental Impact Statement (FEIS) for *Minneapolis-St. Paul International Airport Dual-Track Airport Planning Process New Runway 17/35 and Airport Layout Plan Approval* was completed in September of 1998. Runway 17-35 construction was completed in October 2005. This runway provided an opportunity to route aircraft over an unpopulated area – the Minnesota River Valley.

During construction of the runway, an Environmental Assessment (EA) was conducted to fulfill federal requirements for the environmental review of potential aircraft departure procedures designed for Runway 17 and to establish a noise abatement departure procedure for westbound departure operations to be routed such that they avoid close-in residential areas southwest of the runway. This document projected that 37.1% of daytime departures and 34.6% of nighttime departures in 2005 would use Runway 17 after the runway's opening. The combined final use percentage for Runway 17 projected by the EA was 36.7%, which totals 105,510 annual operations. This percentage is the highest for departure operations, superseding Runways 12L and 12R combined by over 10 percentage points. Runway 17 was projected to be used the highest amount because it was constructed to be used to the south as a departure-only runway. That is, when aircraft are departing Runway 17, aircraft are not simultaneously arriving on the runway, as they are on Runways 12L and 12R. This allows successive aircraft departures from the runway without waiting to sequence arriving aircraft between departures. The same is true for the runway used in the opposite direction. When Runway 35 is being used, it becomes an arrival-only runway, without departures to the north over Minneapolis.

In practice, the runway has never been used to the 36.7% that was predicted in the EA. In all years prior to 2015, the highest percent usage occurred in 2007 when just under 58,000 departures used Runway 17. This total represents just under 26% of all departures that year. **Figure 2 - Runway 17 Departures by Year** displays the total departures from MSP, the total departures from Runway 17 and the percent use by year, beginning in 2005 when the runway was operational.

As shown in **Appendix C**, Runway 17 is used during two primary airport configurations: (1) South Flow – where aircraft are departing from Runways 12L, 12R and 17 and arriving on Runways 12L and 12R; and (2) Mixed Flow A – where aircraft are departing from Runway 17 along with a smaller number of departures on Runways 30L and 30R, with aircraft arriving to Runways 30L and 30R.

The MSP Runway Use System (RUS) prioritizes arrival and departure runways to promote flight activity over less-populated residential areas as much as possible. During a South Flow, the Priority 1 departure runways (12L and 12R) are used for aircraft taking off. The Priority 2 departure runway (17) is also being used, typically to a greater extent than the first priority runways since Runway 17 does not have simultaneous arrival operations. In a South Flow, however, the lowest priority arrival runways (12L and 12R) are used for all aircraft arriving to MSP.

The RUS is maximized in Mixed Flow A, where the Priority 1 arrival runways (30L and 30R) are used for arrivals, while the Priority 2 departure runway (17) is used for the majority of departures. The last priority departure runways (30L and 30R) are used to a lesser extent for aircraft taking off. An additional benefit in this configuration is the aircraft departing from Runway 17 do not turn left over residential areas of Eagan because they need to stay separated from the inbound aircraft arriving to Runways 30L and 30R. Thus, the departures are flying over more compatible land uses for a longer period of time.

In 2014 the FAA, acting on a safety recommendation from the National Transportation Safety Board (NTSB), amended Order 7110.65 (Air Traffic Control) to establish separation standards for non-intersecting converging runway operations (CRO) at airports nationwide. The FAA defines non-intersecting converging runway operations when the extended centerline of two runways intersect within one nautical mile of the two runway departure ends, posing a potential risk if a landing aircraft on one runway discontinues its approach and goes around concurrent with a simultaneous departure from the other runway, and neither aircraft diverges from its initial flight path. The FAA's first priority is the safe movement of air traffic.

On July 24, 2015, the FAA determined that the Runways 30L and 35 Converging Runway mitigations in place at MSP, as documented in a Safety Risk Management Document, were not sufficient to meet the standards of the Converging Runway requirement. A temporary suspension was put in place for arrivals to MSP Runway 35. On August 28, 2015, the FAA began allowing arrivals to Runway 35 using an approved separation technique to comply with the new Converging Runway requirements, which uses an Arrival-Departure Window (ADW) off the approach end of Runway 35 to effectively alternate Runway 30L departures with Runway 35 arrivals.

In January 2016, in addition to Runway 30L, the FAA determined that the new Converging Runway standards apply to MSP Runway 30R, and implementation of a second ADW off the approach end of Runway 35 was required.

While CRO does not directly impact Runway 17 departures, an indirect result of CRO is decreased use of a North Flow configuration at MSP, due to complexities introduced by CRO. This decreased use of North Flow inversely increased the use of South Flow, thus increasing departures from Runway 17. In 2016, 2017 and 2018—the three full years since CRO standards were implemented—the use of Runway 17 for departures increased to 33.3%, 31.0% and 33.7% respectively.

While the Runway 17 departure levels in all three of these years were still below the use projected during the planning process, the communities below departure flights paths for Runway 17 noticed an increase and began to seek information from the MAC and the NOC.

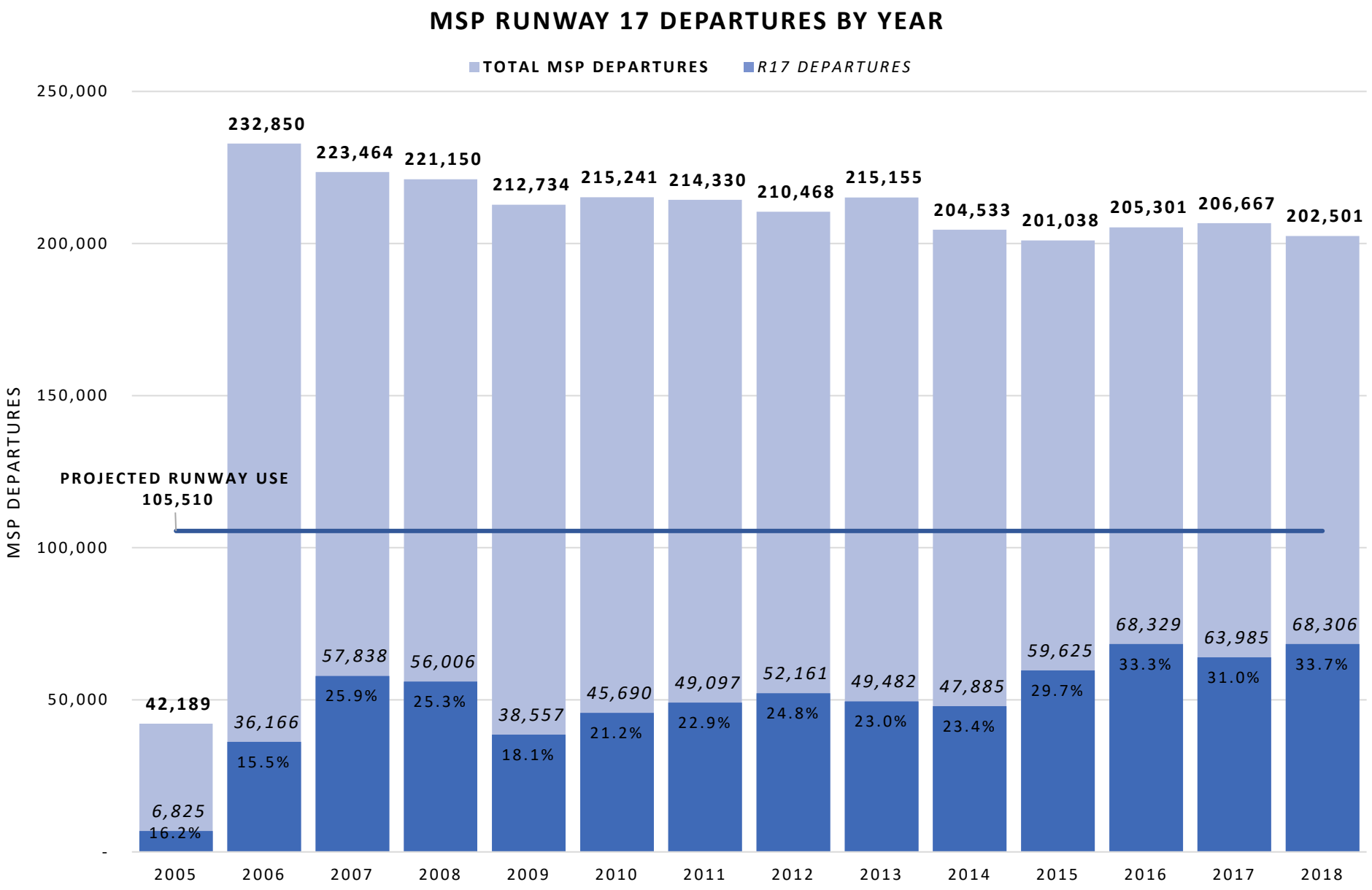


Figure 2 - Runway 17 Departures by Year

3. PRE-CRO DAY VS. POST-CRO DAY

The Converging Runway Operation (CRO) requirements put in place at MSP have changed runway use decisions. Additionally, MSP has experienced other runway use changes since July 2015 that are not the direct result of CRO requirements. Weather, special events and airfield maintenance all impact the operational flow of air traffic daily. Airline schedules and changing fleet characteristics affect runway use monthly and annually. It is important to note that these inherent operational impacts occur independent of CRO.

The overall use of Runway 17 post-CRO is a fundamental concern raised by residents. The study scope includes an assessment into how a typical day in a South Flow has changed. Specifically, the community wanted the study to (1) investigate daily peak hour trends; (2) investigate current and historic departure peaks; and (3) build a typical day for Runway 17 departure operations in a South Flow pre-CRO and compare it to a day post-CRO. The following paragraphs describe this assessment.

In 2014, there were 93 days where Runway 17 was used for at least half the hours in the day while the airport was in a South Flow. In 2018, that level rose to 134 days. To further examine this, **Figure 3 - Average Annual Day** shows the average number of Runway 17 departures during each hour when the airport was in a South Flow during 2014 compared to 2018. As shown, Runway 17 was used very little between 23:00 and 5:00. In 2014, the average daily total for departures between these hours was 0.9. The average daily total rose slightly to 1.1 in 2018.

Throughout the remainder of the day, peaks and valleys are prevalent, which are driven by airline scheduling trends. The first peak of the day in both years occurred in the 7:00 hour followed by the first valley in the 8:00 hour. After 8:00, differences occur between the two years.

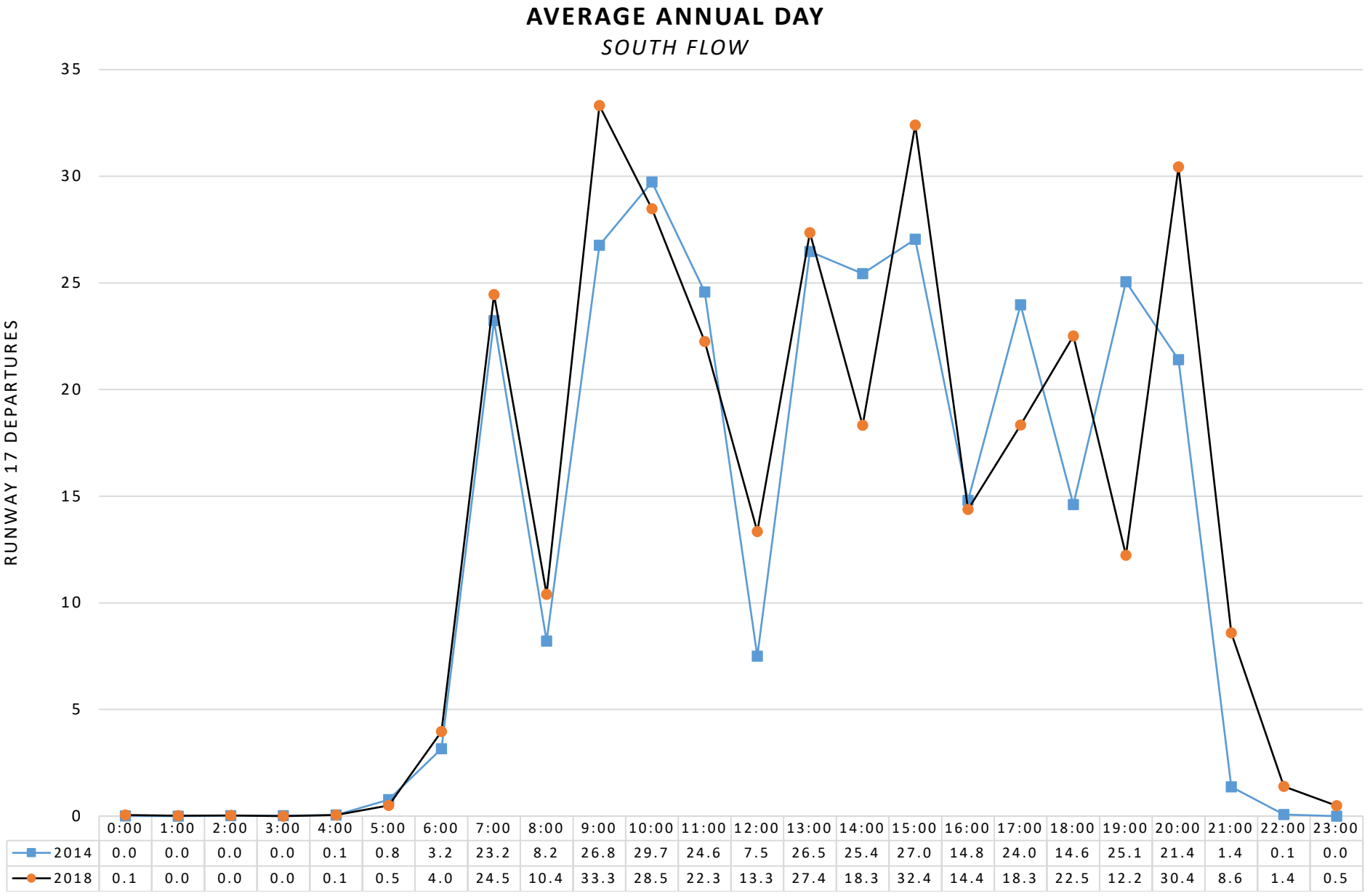
In 2018, higher peaks are generally surrounded by valleys, indicating a rush of departure activity in a more condensed period of time, surrounded by respite periods. In 2014, the peaks are not as high and the activity is often spread over two to three hours. For example, during the 9:00-11:00 period, the average in 2014 stays high for all three hours, averaging 81 departures during the three hours. During 2018, the three hours had 84 average annual departures, however they were more condensed into the 9:00 hour. This trend is also visible in the 13:00-15:00 period when 2014 had 79 average departures, evenly spread in those three hours and 2018 had 78 average departures, primarily occurring in the 13:00 and 15:00 hours with a slight respite period in the middle.

Depictions of average days are informative, but averages can be misleading. **Figure 4 - Peak Hour Departure Operations** depicts the highest number of Runway 17 departures that occurred on any given hour during 2014 and 2018. In general, the peaks and valleys are like the averages. The 0:00 – 2:00 hours were all higher than expected with Super Bowl traffic departing MSP on Monday, February 5, 2018.

As noted earlier, CRO impacted the use of runways at MSP. The community requesting this study is specifically interested in the total days spend in a South Flow. It is common that community concern increases as the consecutive days spent in one flow increases. **Figure 5 - MSP South Flow Days** compares both of those metrics from 2014 to 2018.

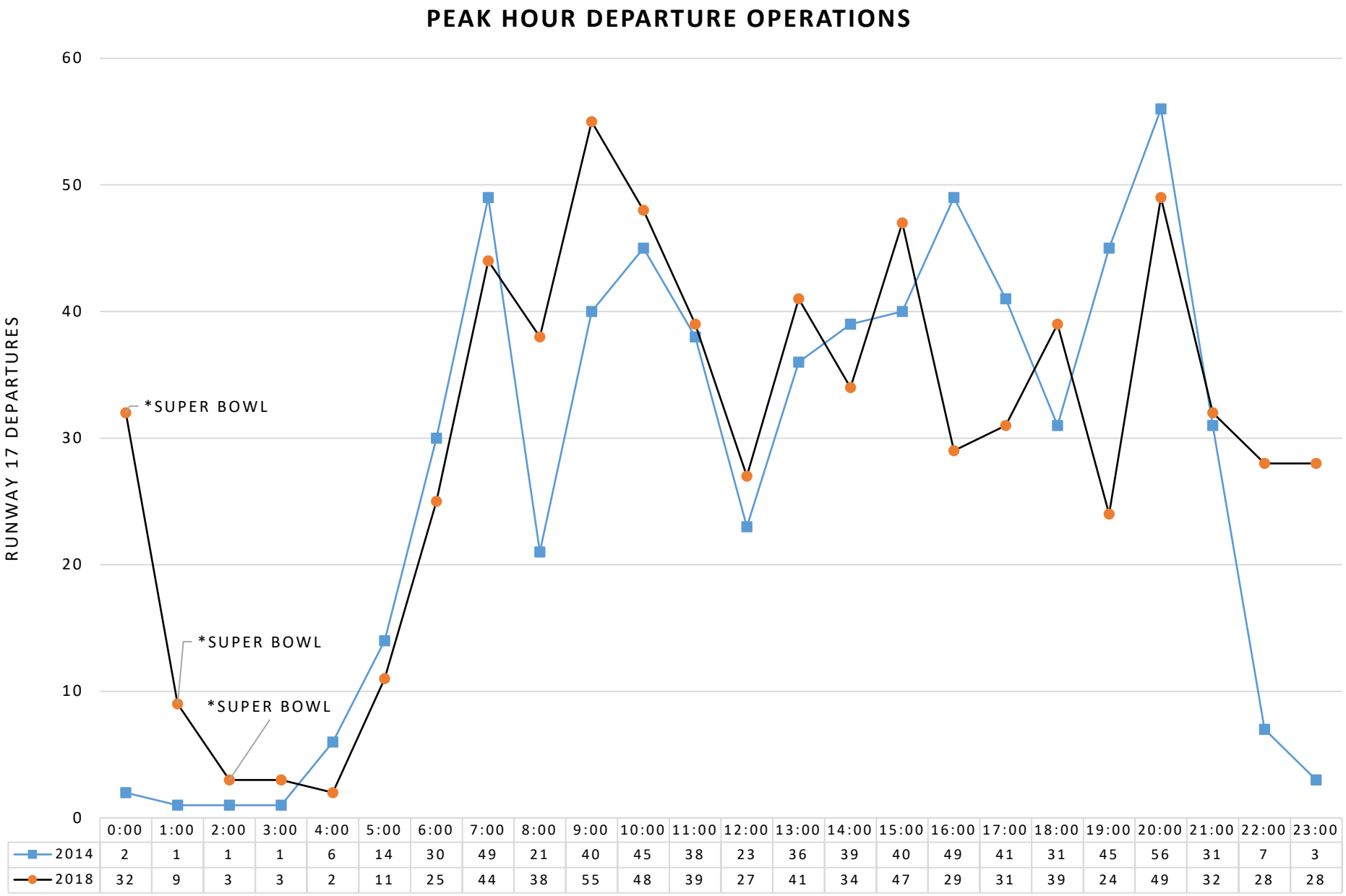
The data in Figure 3 shows the number of days in which 12 or more hours were spent in South Flow; the data in Figure 5 shows the number of days in which six or more hours were spent in South Flow. In 2014 there were 147 days with at least six hours of South Flow activity. In 2018, that jumped to 180. June and September of 2018 both had more than 20 days during the month with at least six hours of South Flow. In addition to more days with South Flow operations, there were higher successive days in 2018. March, June and September all had a period of more than 10 days in a row with at least six hours of South Flow operations. The highest such month in 2014 was June with seven consecutive days. In short, during 2018 the airport was configured in a South Flow more often and stayed there longer as compared to 2014.

It is also important to know how the individual runways are used in airport configurations when Runway 17 is active. **Figure 6 - Departure Runway Distribution** lays out the distribution in 2014 and 2018 in South Flow and Mixed Flow A. These percentages do not reflect the annual percent use of departures. They are only including the time the airport was configured in a South Flow or a Mixed Flow A, respectively. When MSP was configured in a South Flow in 2014, 59% of all departures used Runway 17. That percentage increased to 63% in 2018. More traffic was shifted away from the parallel runways. The MSP Runway Use System (RUS) prioritizes Runways 12L and 12R above Runway 17 for departures. This change decreased the use of the highest priority runways. In the Mixed Flow A configuration, 42% of all departures used Runway 17 in 2014. That use increased to 47% in 2018. The use of Runway 30R for departures also increased between 2014 and 2018 while the use of Runway 30L dropped from 24% to 14%. This change improved the use of the Runway Use System as Runway 17 departures are prioritized above departures from Runways 30L and 30R.



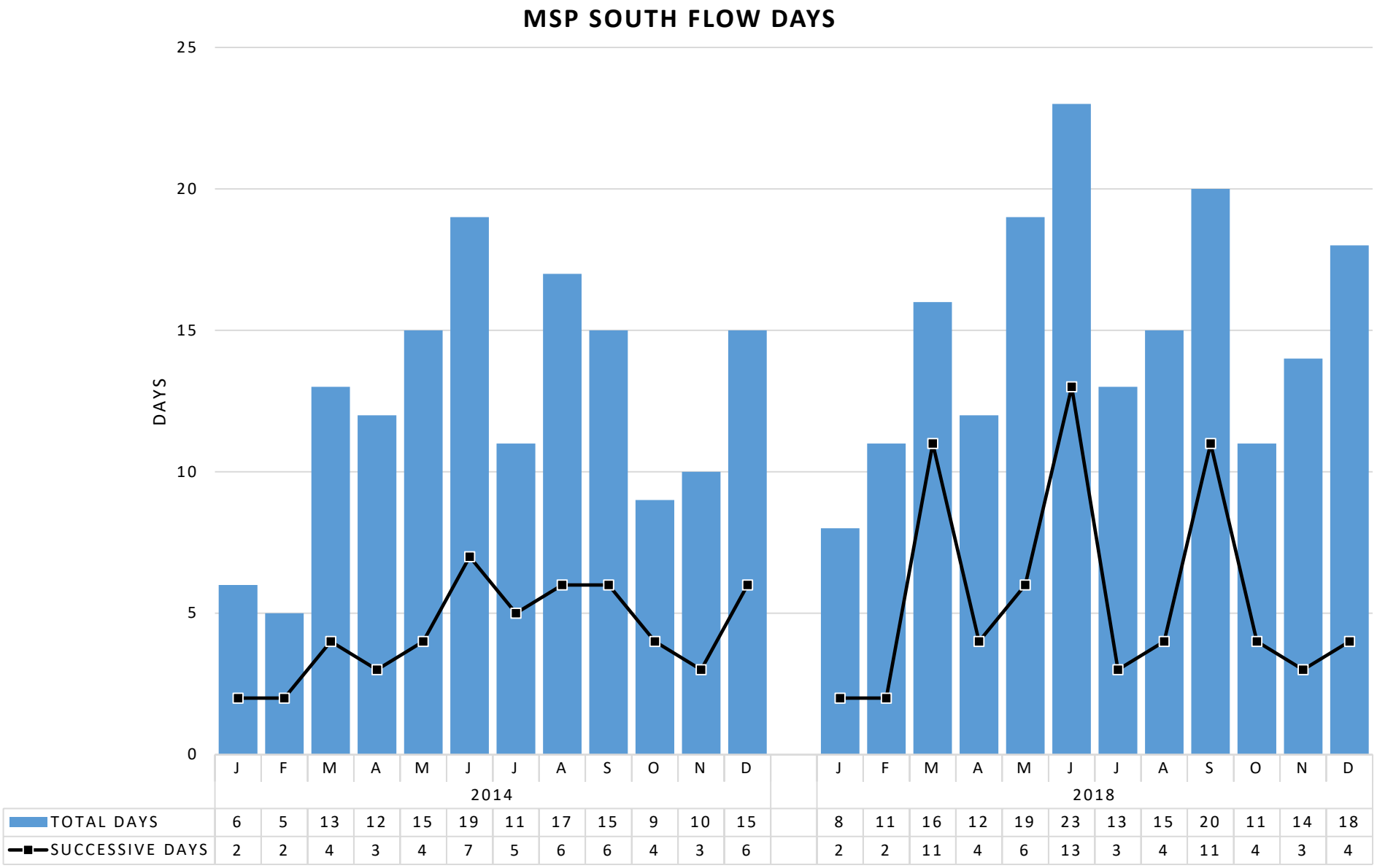
	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
2014	0.0	0.0	0.0	0.0	0.1	0.8	3.2	23.2	8.2	26.8	29.7	24.6	7.5	26.5	25.4	27.0	14.8	24.0	14.6	25.1	21.4	1.4	0.1	0.0
2018	0.1	0.0	0.0	0.0	0.1	0.5	4.0	24.5	10.4	33.3	28.5	22.3	13.3	27.4	18.3	32.4	14.4	18.3	22.5	12.2	30.4	8.6	1.4	0.5

Figure 3 - Average Annual Day



	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
2014	2	1	1	1	6	14	30	49	21	40	45	38	23	36	39	40	49	41	31	45	56	31	7	3
2018	32	9	3	3	2	11	25	44	38	55	48	39	27	41	34	47	29	31	39	24	49	32	28	28

Figure 4 - Peak Hour Departure Operations



	J	F	M	A	M	J	J	A	S	O	N	D		J	F	M	A	M	J	J	A	S	O	N	D
TOTAL DAYS	6	5	13	12	15	19	11	17	15	9	10	15		8	11	16	12	19	23	13	15	20	11	14	18
SUCCESSIVE DAYS	2	2	4	3	4	7	5	6	6	4	3	6		2	2	11	4	6	13	3	4	11	4	3	4

**Days were counted when South Flow was used at least 6 hours or more*

Figure 5 - MSP South Flow Days

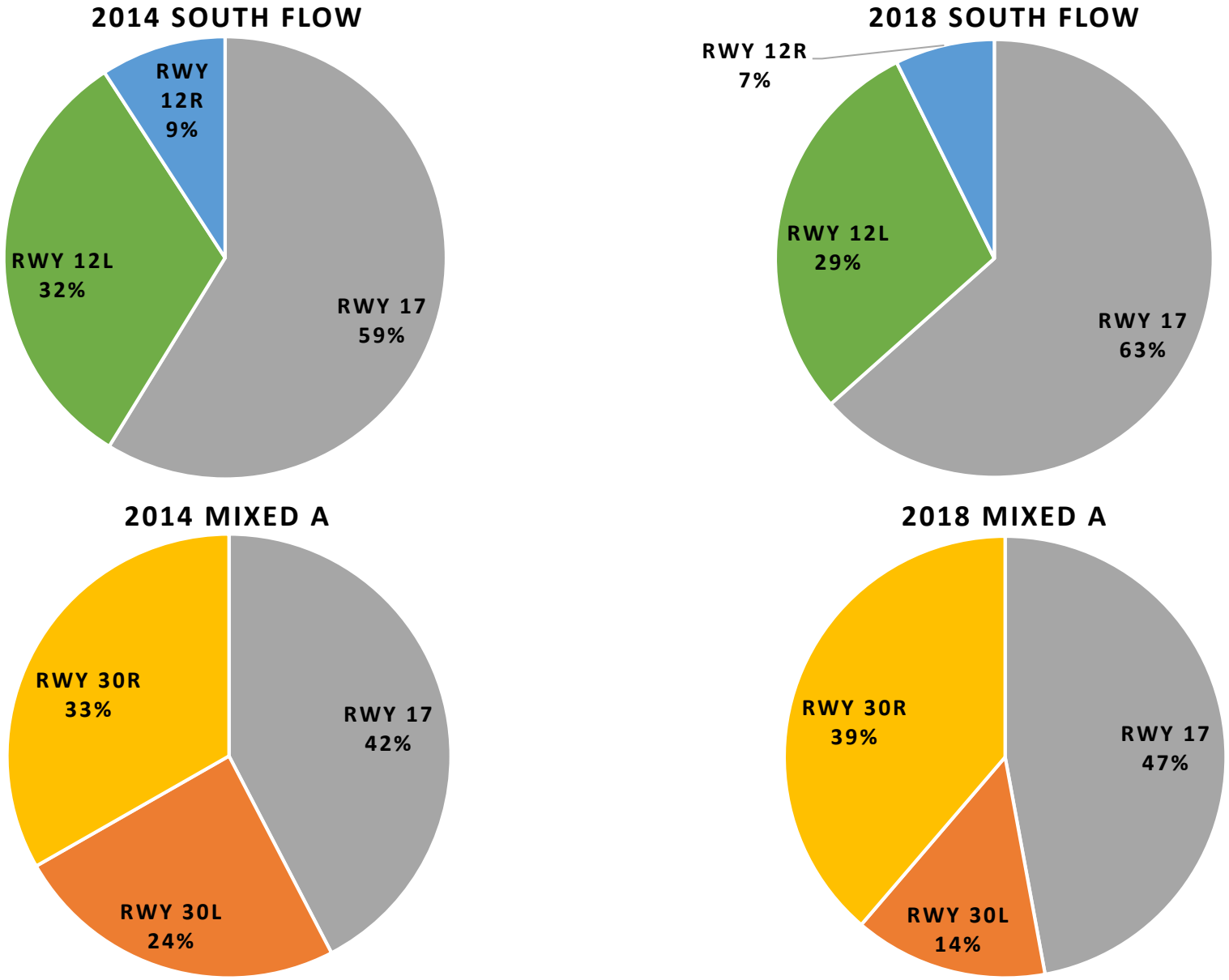


Figure 6 - Departure Runway Distribution

4. Flight Frequency

The use of Runway 17 has increased from 2014 to 2018, as described in Section 2. The number of days in the year and hours in the day when Runway 17 was chosen for departing aircraft increased during that time. One common experience communicated by residents was that the frequency of flights in short periods of time has changed.

The following analysis contains data for all of 2014 and 2018. The MAC stores runway-use data provided by the FAA Aviation System Performance Metrics (ASPM) data, categorized in 15-minute segments. This data was used to effectively assess change in frequency of flights in short periods of time. Periods of South Flow, when Runways 12L, 12R and 17 are being used for departures, were isolated from periods when Mixed Flow A was active. In Mixed Flow A, Runway 30L, 30R and 17 are utilized for departure. Overall, instances of South Flow were higher in 2018 than in 2014. To investigate whether the flight frequency within the 15-minute segments has changed, this analysis counts the number of Runway 17 departures during all 15-minute segments in 2014 and compares them to 2018. **Figure 7 - Runway 17 15-Minute South Flow Departure Usage** displays the percent of time Runway 17 departures occurred at various levels of frequency (i.e. the number of Runway 17 departures per 15-minutes was 0, 1-2, 3-4, 5-6, etc.).

It is important to note that although Runway 17 may be included in the FAA's ASPM data, indicating the runway is available for departure, it may not necessarily be used. Overnight hours are the most frequent occurrence of this situation. Often Runway 17 is available for use with no actual departures from the runway. For example, the Runway Use System prioritizes a departure on Runway 12L or 12R before a departure on Runway 17; therefore, Runways 12L and 12R will be considered before a departure on Runway 17. **Figure 7 - Runway 17 15-Minute South Flow Departure Usage** visually displays this as well, showing the highest percentages of 15-minute segments where Runway 17 was available for use, did not have any departures on that runway. While there are many instances when Runway 17 is available, 38% of the time in 2018 it was not used during any given 15-minute block. Figure 7 shows that these situations dropped between 2014 and 2018.

Figure 7 also shows that the decrease of 15-minute blocks when the runway is available but not used was offset by increases in the blocks when 3-4 departures occurred, 5-6 departures occurred, and 7-8 departures occurred. These groups increased between 0.6% and 2.6%. The number of times when nine or more departures operated from Runway 17 in a 15-minute block during 2018 was equal to or below what was observed in 2014. The occurrences of 15-minute blocks when MSP was configured in South Flow and Runway 17 had at least one departure increased from 2014 to 2018; however, the average number of aircraft departing within any given 15-minutes period dropped from 2014 to 2018. In these situations, the average departures per 15-minutes was 5.96 in 2014 falling to 5.74 in 2018. In short, flights were not departing more frequently in short (15-minute) periods of time in 2018; there were simply more 15-minute segments spent in South Flow with Runway 17 departures.

Figure 8 - Runway 17 15-Minute Mixed Flow Departure Usage isolates the same information for the Mixed Flow A configuration. Occurrences of Mixed Flow A available for use are much lower than South Flow. Between 2014 and 2018, the occurrences of Mixed Flow A increased. Much of that increase occurred during the 00:00 – 05:00 hours. The RUS stipulates that Mixed Flow A would be prioritized above North

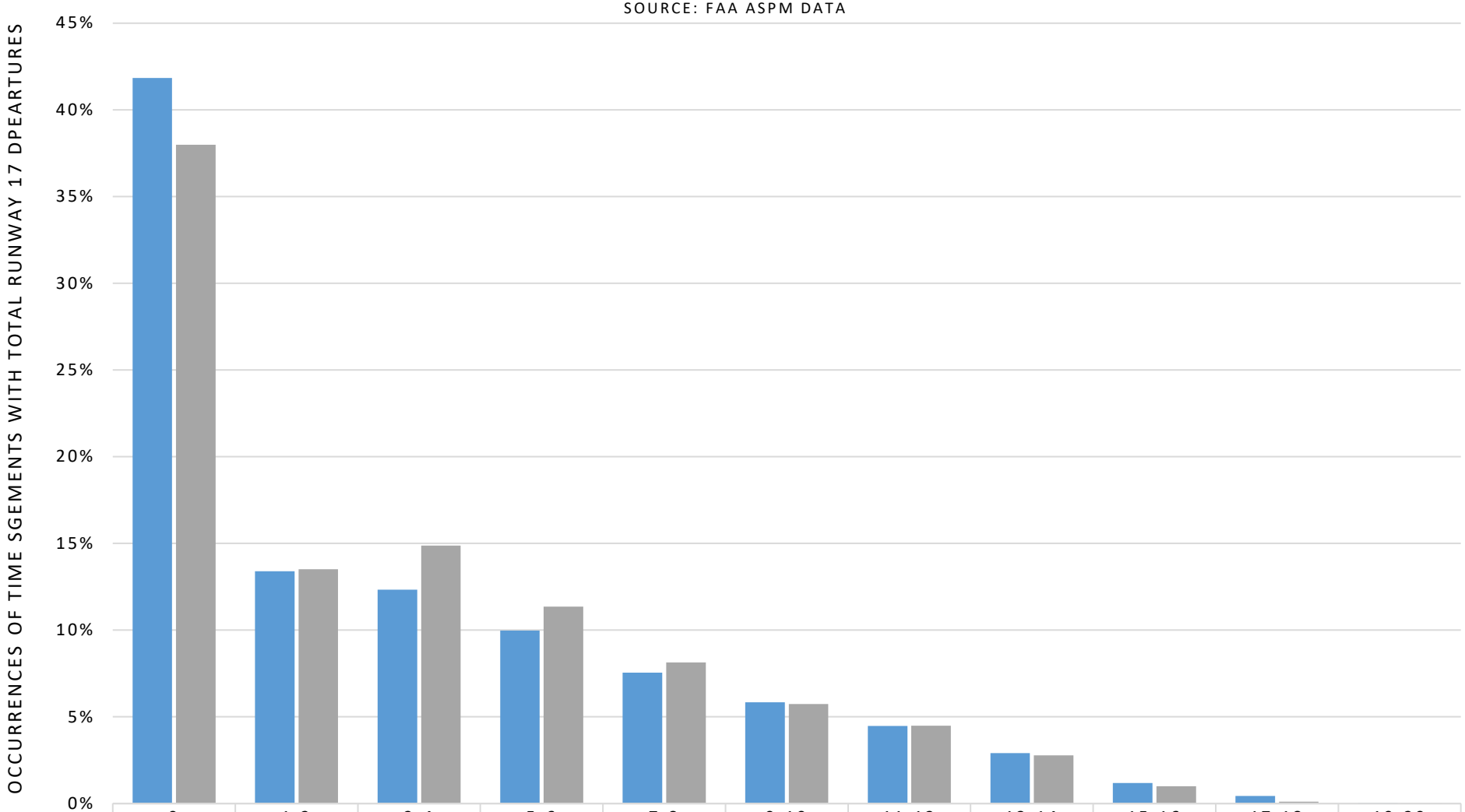
Flow as arrivals would use the Priority 1 runways and departures would use the Priority 2 runway. In 2018, the number of 15-minute segments the runway was available for use but not actually used increased nearly four times from 2014. From a percentage basis, 23.6% of the time that Runway 17 was available it was not used in 2014. That increased to 39% in 2018. The distribution of frequency in Mixed Flow A decreased between 2014 and 2018 in the 1-2, 3-4, 5-6 and 11-12 groups. There was an increase in the 7-8, and 13-14 group.

There were no occurrences of more than 16 departures in a 15-minute segment in 2014 or 2018. This is likely due to flight path constraints placed on departing aircraft from Runway 17 in this configuration. The Runway 17 departure airspace is reduced to allow adequate space for the aircraft arriving to Runways 30L and 30R; therefore, fewer heading options exist off Runway 17. The average departures per 15-minutes in Mixed Flow A was 3.67 in 2014, increasing to 4.34 in 2018.

RUNWAY 17 15-MINUTE DEPARTURE USE

SOUTH FLOW

SOURCE: FAA ASPM DATA



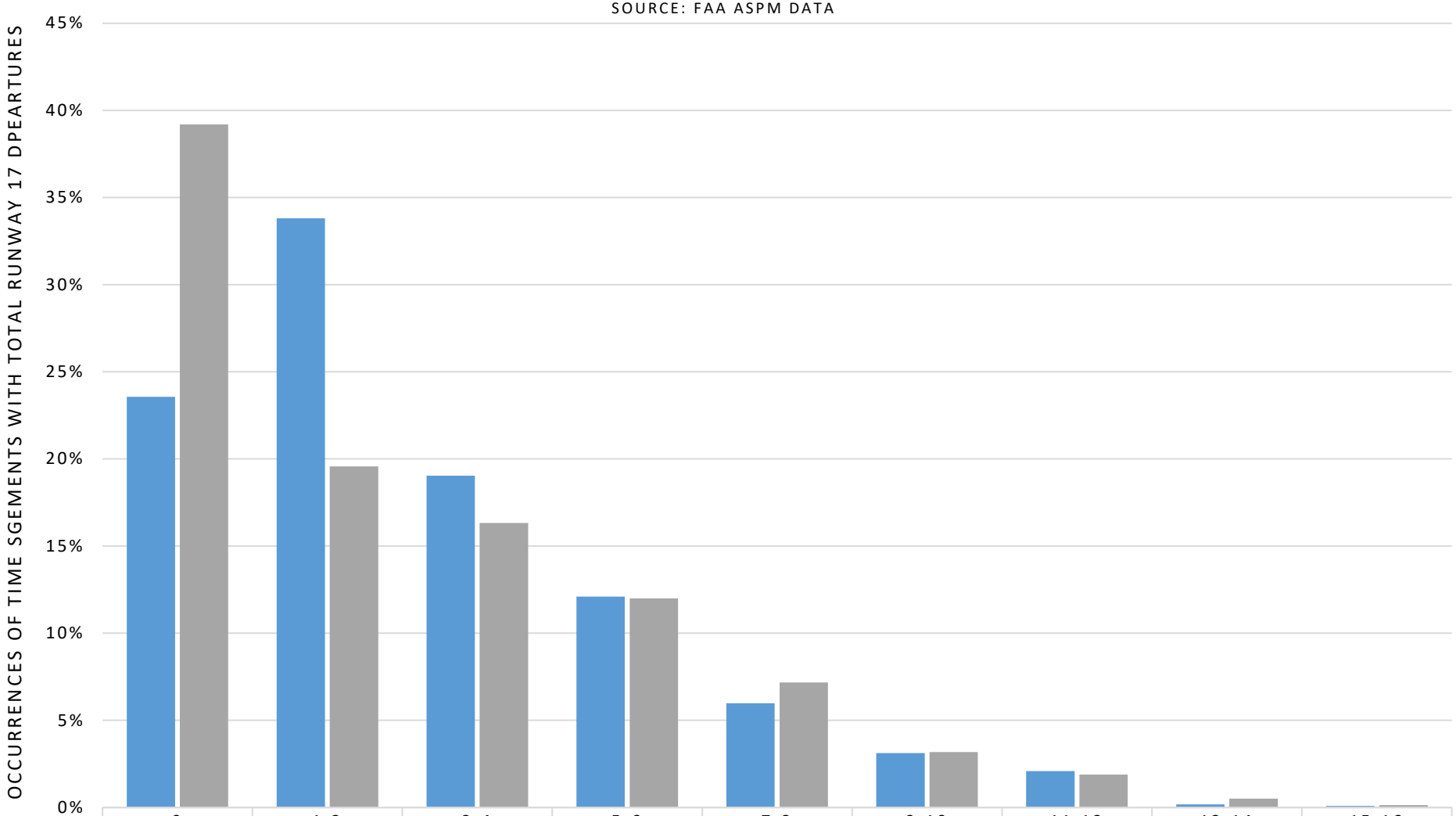
	0	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20
2014	41.8%	13.4%	12.3%	10.0%	7.5%	5.8%	4.5%	2.9%	1.2%	0.4%	0.1%
2018	38.0%	13.5%	14.9%	11.4%	8.1%	5.7%	4.5%	2.8%	1.0%	0.1%	0.0%

Figure 7 - Runway 17 15-Minute South Flow Departure Usage

RUNWAY 17 15-MINUTE DEPARTURE USE

MIXED FLOW A

SOURCE: FAA ASPM DATA



	0	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16
2014	23.6%	33.8%	19.0%	12.1%	6.0%	3.1%	2.1%	0.2%	0.1%
2018	39.2%	19.6%	16.3%	12.0%	7.2%	3.2%	1.9%	0.5%	0.1%

Figure 8 - Runway 17 15-Minute Mixed Flow Departure Usage

5. Runway 17 Departure Headings

In both primary runway-use configurations when Runway 17 is used, the runway serves aircraft departing to destinations that are generally west, southwest, south, and southeast of MSP. This covers a broad range of geographic locales. To accommodate that traffic, FAA Air Traffic Control (ATC) assigns a broad range of headings from 095° to 285°. While there is a range available to ATC, the FAA uses primary headings for departure. These headings are chosen after considering numerous criteria including the aircraft's destination, routing, aircraft type, weather conditions, other air traffic and airport configuration. Since using primary headings improves consistency, repeatability and safety. The residents who helped create the scope for this study expressed that while departures are fanned, the use of primary headings leads to periods with multiple overflights in specific areas of the community.

For the purpose of modeling aircraft noise, the Aviation Environmental Design Tool (AEDT) uses model tracks; however, the actual flight paths would be distributed along these tracks. Aircraft were assigned a modeled track and then dispersed off the base track using a standard distribution method within the model. The industry and the MAC continue to use this method during the development of aircraft noise exposure contours. **Figure 9 - Runway 17 Modeled Departure Tracks** below shows the location of the different tracks for Runway 17 departures. These tracks were developed using actual flight data and continue to be evaluated on an annual basis. Actual flights can be assigned to a modeled track using a best fit approach. These same tracks in **Figure 9** are categorized by general headings in **Figure 10 - Runway 17 Departure Modeled Tracks by Heading**.

The result of this process is encapsulated in **Figure 11 - Runway 17 Departure Heading Use**. The figure shows variation in departure heading usage and also shows that the departure headings used today are the same headings that have been issued since the opening of Runway 17 in 2005. Focusing on 2014 and 2018 annual heading usages does not show any new headings as a result of CRO. The most common tracks flown by aircraft departing Runway 17 are the tracks categorized by a 210° heading. This use has been above 25% of all Runway 17 departures every year, increasing to 35% in 2014 before falling back down to 33% in 2018. This flight track is directed over the Minnesota River Valley and dramatically reduces instances of aircraft overflight impacts immediately south of the Minnesota River Valley in Northeast Burnsville.

The second most common tracks used in 2018 are labeled as 140°. The use of these tracks has slowly increased over time, peaking at 22% in 2014 before ending 2018 with 21% of all Runway 17 departures.

The early years of Runway 17 use had pronounced variability in some of the headings utilized. The tracks labeled as 120° were used less than 15% in late 2005 and less than 10% in 2006. This use quickly jumped in 2007 to 19%, increasing to its peak use in 2012 at 23%. Since 2012, the use of the 120° tracks has fallen down to 17% in 2018. Conversely, the 185° heading tracks were used for 17% of all departures in 2006 before dropping under 5% until 2015. This heading has increased every year since 2014 and finished 2018 at 9% of all Runway 17 departures.

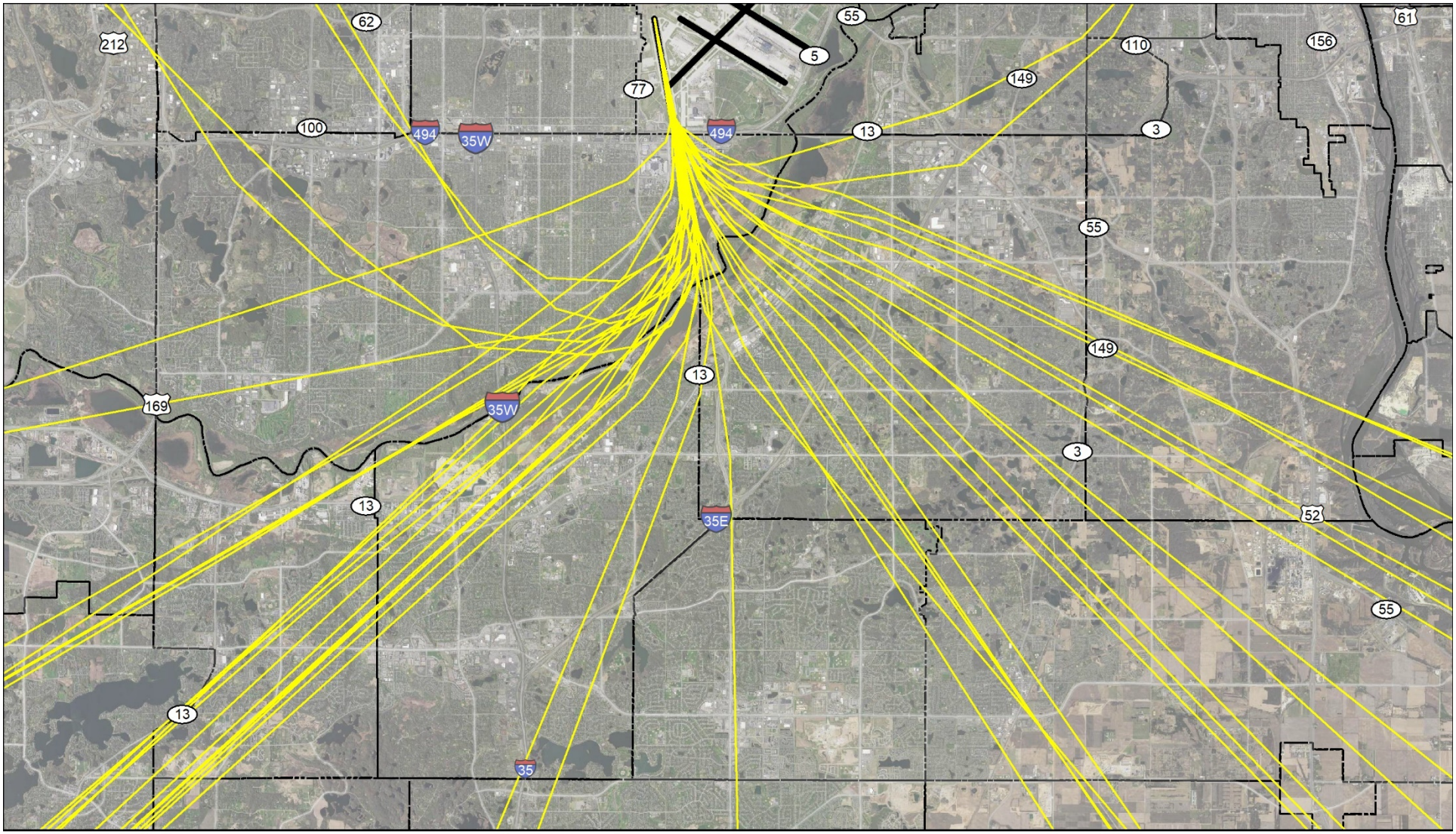
Figure 11 represents all aircraft types in all weather conditions in all airport configurations. The use of these tracks changes considerably when specific variables are considered. Data and density maps for

carrier jet departures under different variables are presented in **Appendix D**. In the Mixed Flow A configuration, arrivals to Runways 30L and 30R need to be separated from Runway 17 departures. To accomplish this, aircraft that would typically be assigned a heading east of 170° are assigned runway heading, 170°, and their east bound turn is delayed until after the departing traffic is separated from the arrival traffic. In this configuration, Runway 17 departures flew the tracks categorized at 170° or higher 97% of the time. This has the effect of reducing the number of aircraft overflights in residential areas of central Eagan.

The aircraft destination and associated routing are important determinants to the heading assigned to a departure. Destination is determined by the aircraft operator. At MSP, airlines determine the schedule of aircraft operations, and the frequency of flights to their chosen destinations. How quickly the airlines change the schedule would be contingent on their responsiveness to market demand. **Figure 12 - Top 5 Destinations by Heading** displays the top five destinations that airlines fly to after departing from Runway 17, based on the heading flown after departure.

Because airline scheduling decisions vary throughout the day, headings that favor certain regions of the country may be more prevalent during certain hours of the day. **Figure 13 - 2014 Heading-Use by Time** and **Figure 14 - 2018 Heading-Use by Time** provide the utilization of headings by hours of the day in 2014 and 2018. These charts only determine how heading-use fluctuates during the day; it does not account for total volume of departures during these hours.

In 2018, the 210° heading saw peak usage in the 11:00, 14:00 and 19:00 hours. This is a slight change from 2014 when the peaks occurred at 9:00, 11:00, 14:00 and 18:00. The 170° heading saw its biggest use in the overnight hours. Runway 17 is not used frequently during these hours, but when it is used, it is typically used in Mixed Flow A. The use was a reduction from 2014 when the 170° was used for 46% of all departures between 22:00 and 06:00.



R17 Departure Model Tracks

0 1 2 4 Miles

Figure 9 - Runway 17 Modeled Departure Tracks

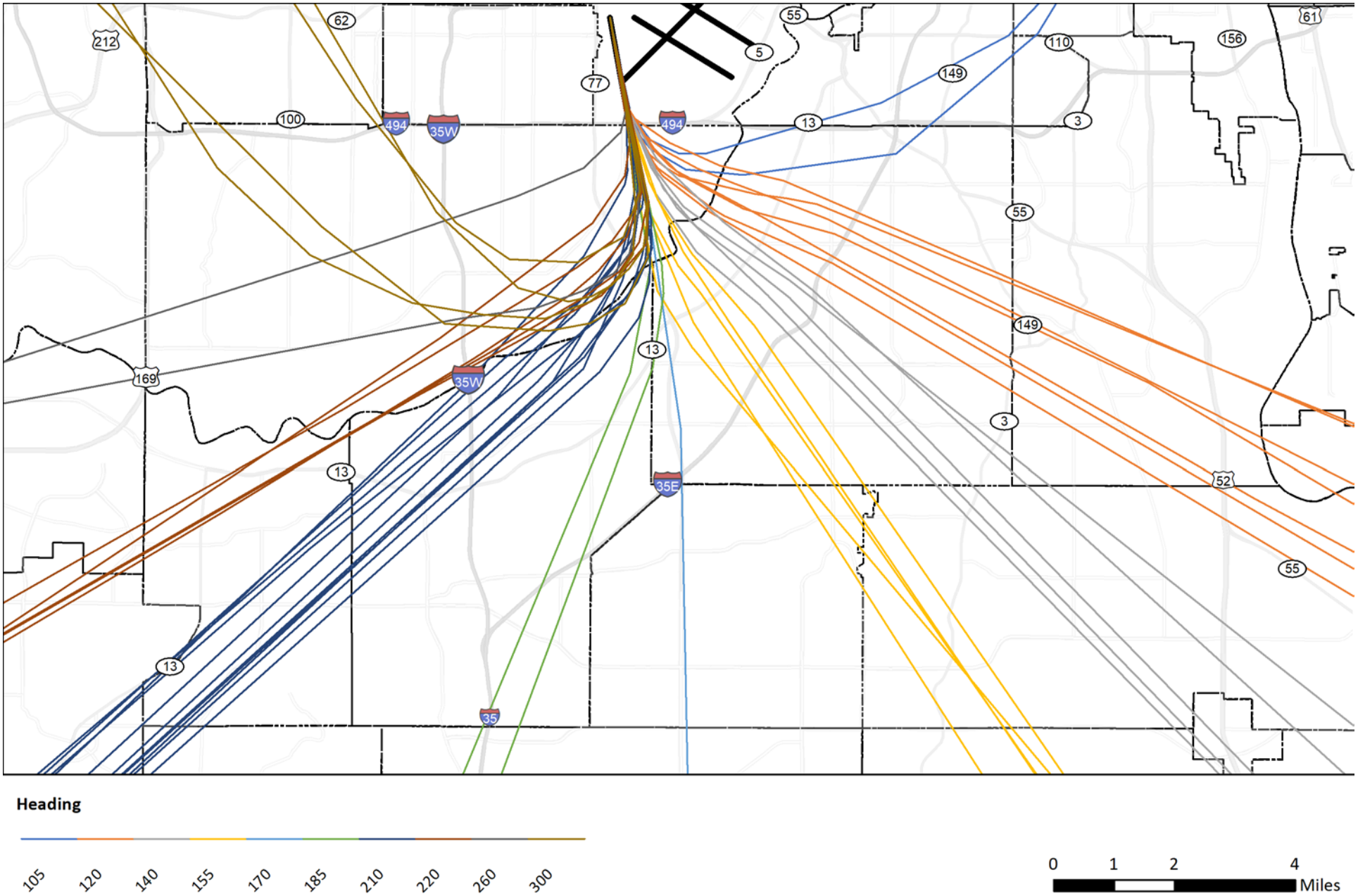


Figure 10 - Runway 17 Departure Modeled Tracks by Heading

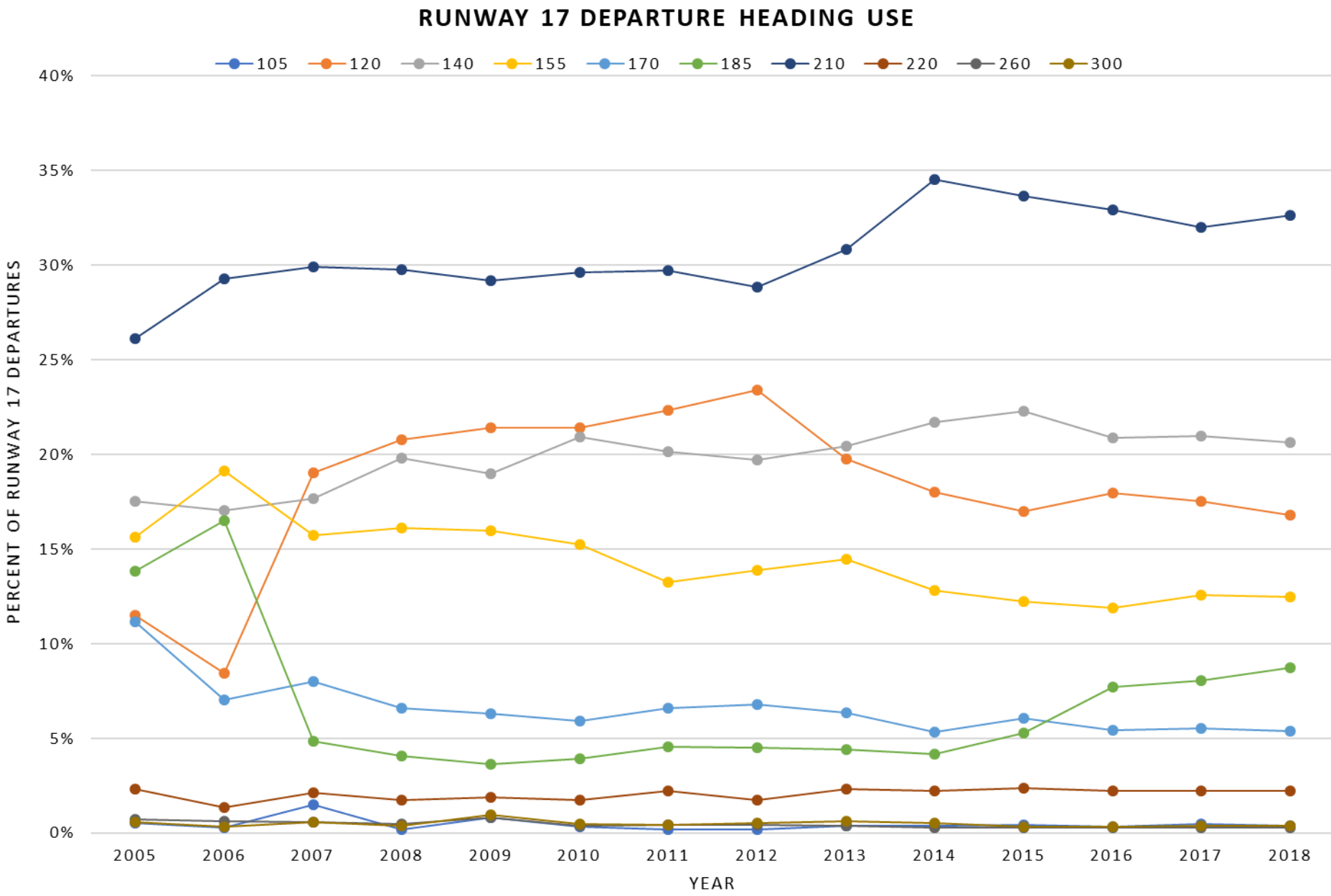


Figure 11 - Runway 17 Departure Heading Use

2018 Destination Rank

Heading	1	2	3	4	5
120°	New York - LaGuardia	Washington - Reagan	Detroit	New York - JFK	Philadelphia
140°	Chicago – O'Hare	Atlanta	Chicago - Midway	New York - Newark	Orlando
155°	Chicago – O'Hare	Chicago - Midway	St. Louis	Atlanta	Memphis
170°	Chicago – O'Hare	Chicago - Midway	Atlanta	St. Louis	New York - Newark
185°	Chicago – O'Hare	Chicago - Midway	Atlanta	Dallas - Ft. Worth	Denver
210°	Denver	Phoenix	Dallas - Ft. Worth	Houston - Intercontinental	Las Vegas

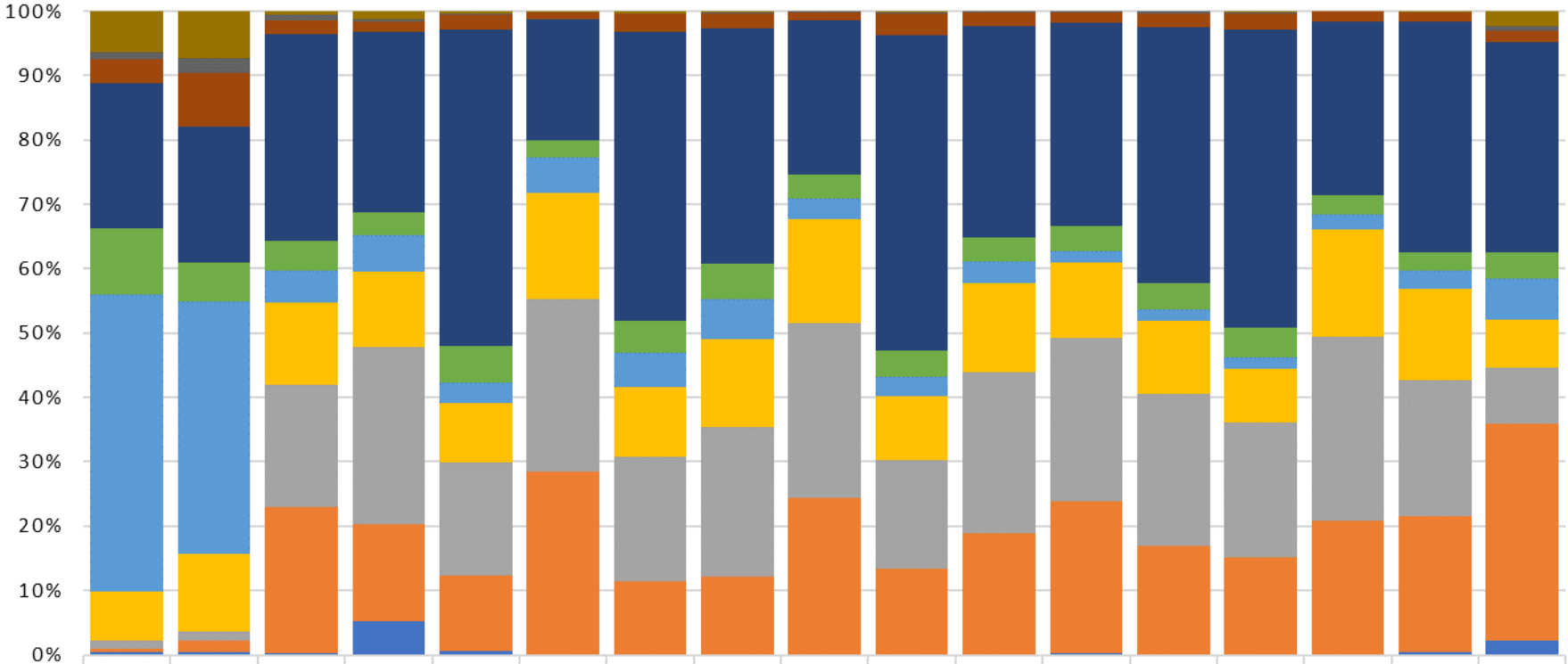
2014 Destination Rank

Heading	1	2	3	4	5
120°	Milwaukee	Detroit	Philadelphia	Madison	New York - LaGuardia
140°	Chicago – O'Hare	Chicago - Midway	Atlanta	New York - Newark	Indianapolis
155°	Chicago – O'Hare	Chicago - Midway	St. Louis	Atlanta	Memphis
170°	Chicago – O'Hare	Atlanta	Chicago - Midway	Charlotte	St. Louis
185°	Denver	Chicago – O'Hare	Dallas - Ft. Worth	Phoenix	Houston - Intercontinental
210°	Denver	Dallas - Ft. Worth	Phoenix	Houston - Intercontinental	Los Angeles

Figure 12 - Top 5 Destinations by Heading

RUNWAY 17 DEPARTURE HEADING USE BY TIME PERIOD

2014

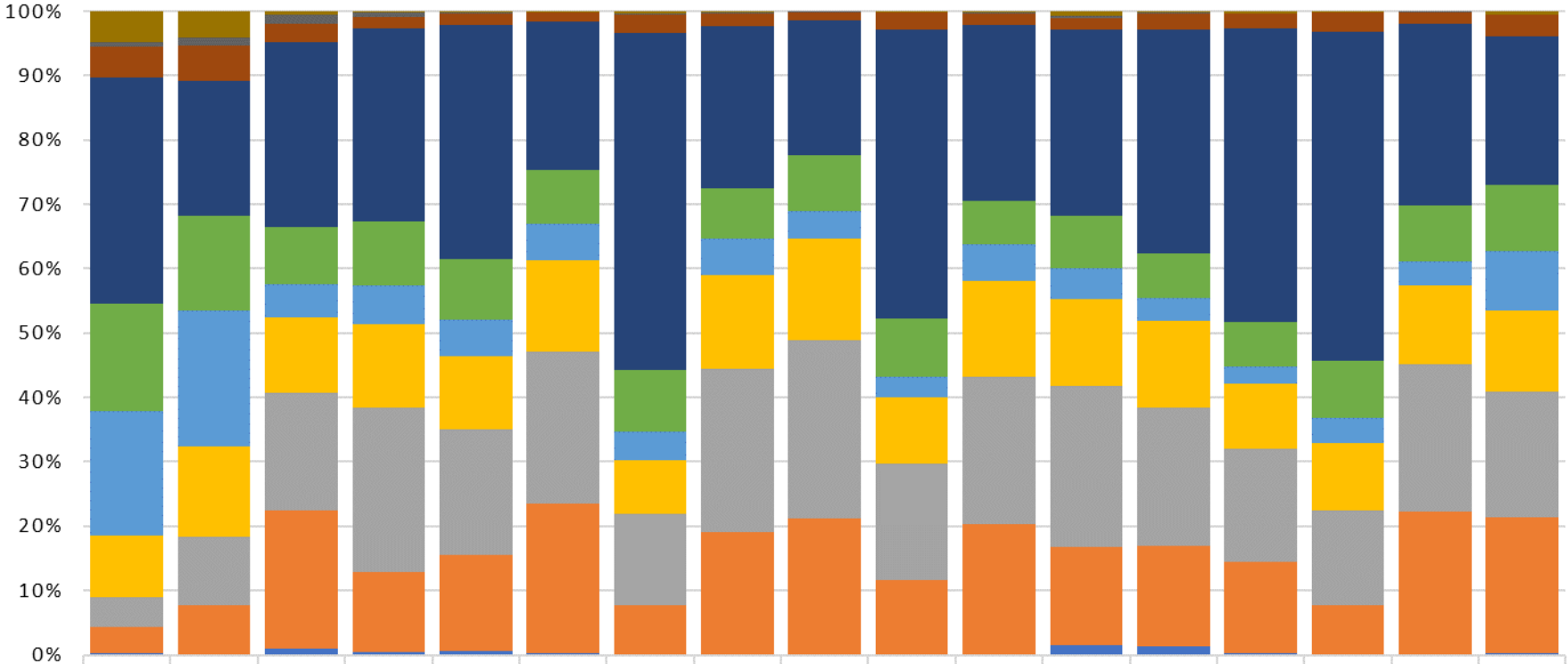


	22:00 - 5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00
300	6%	7%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%
260	1%	2%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
220	4%	8%	2%	1%	2%	1%	3%	2%	1%	3%	2%	2%	2%	3%	2%	1%	2%
210	23%	21%	32%	28%	49%	19%	45%	37%	24%	49%	33%	32%	40%	46%	27%	36%	33%
185	10%	6%	5%	4%	6%	3%	5%	5%	4%	4%	4%	4%	4%	5%	3%	3%	4%
170	46%	39%	5%	6%	3%	6%	5%	6%	3%	3%	3%	2%	2%	2%	2%	3%	6%
155	8%	12%	13%	12%	9%	17%	11%	14%	16%	10%	14%	12%	11%	8%	17%	14%	7%
140	1%	1%	19%	28%	17%	27%	19%	23%	27%	17%	25%	25%	24%	21%	28%	21%	9%
120	1%	2%	23%	15%	12%	28%	11%	12%	24%	13%	19%	24%	17%	15%	21%	21%	34%
105	0%	0%	0%	5%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%

Figure 13 - 2014 Heading-Use by Time

RUNWAY 17 DEPARTURE HEADING USE BY TIME PERIOD

2018



	22:00 - 5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00
300	5%	4%	1%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%
260	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
220	5%	5%	3%	2%	2%	1%	3%	2%	1%	3%	2%	2%	2%	2%	3%	2%	3%
210	35%	21%	29%	30%	36%	23%	52%	25%	21%	45%	27%	29%	35%	46%	51%	28%	23%
185	17%	15%	9%	10%	9%	8%	10%	8%	9%	9%	7%	8%	7%	7%	9%	9%	10%
170	19%	21%	5%	6%	6%	6%	4%	6%	4%	3%	6%	5%	4%	3%	4%	4%	9%
155	9%	14%	12%	13%	11%	14%	8%	15%	16%	10%	15%	14%	13%	10%	10%	12%	13%
140	5%	11%	18%	25%	19%	24%	14%	25%	28%	18%	23%	25%	22%	18%	15%	23%	19%
120	4%	8%	21%	13%	15%	23%	8%	19%	21%	11%	20%	15%	16%	14%	8%	22%	21%
105	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%

Figure 14 - 2018 Heading-Use by Time

6. AEDT Noise Model Data

The Federal Aviation Administration Office of Environment and Energy (FAA-AEE) recognizes that the environmental consequences stemming from the operation of commercial aviation – primarily noise, emissions, and fuel consumption – are highly interdependent and occur simultaneously throughout all phases of flight. The Aviation Environmental Design Tool (AEDT) is a software system that is designed to model aviation related operations in space and time to compute noise, emissions, and fuel consumption. AEDT evaluates noise and emissions impacts from aircraft operations using data inputs such as runway-use, flight tracks, aircraft fleet mix, aircraft performance and thrust settings, topography information, and atmospheric conditions to generate noise contours depicting an annualized average day of aircraft noise impacts. Quantifying aircraft-specific noise characteristics in AEDT is accomplished by employing a comprehensive aircraft noise database developed under the auspices of Federal Aviation Regulation (FAR) Part 36. As part of the airworthiness certification process, aircraft manufacturers are required to subject aircraft to a battery of noise tests that document takeoff, sideline, and approach noise levels.

AEDT is the federally prescribed model required to develop the annual Day-Night Average Sound Level (DNL) contour, which is the basis for the MSP Annual Noise Contour Report and related noise mitigation program. While the focus on traditional AEDT modeling efforts is typically DNL contour, the software has the capability to produce alternate noise metrics.

The MAC maintains a system of 39 Remote Monitoring Towers (RMT). These RMTs are permanently installed and operate 24-hours per day in neighborhoods near MSP, to capture sounds from aircraft as they approach the airport or depart from the airport. Each RMT site consists of laboratory-quality noise monitoring equipment that includes a noise analyzer, a preamplifier and a measurement microphone. This equipment undergoes annual calibration and certification by an independent accredited laboratory.

The analyzer in each RMT monitors noise levels continuously, utilizing slow response with A-weighting as directed by the Federal Aviation Regulations (14 CFR Part 150). The analyzer is set to detect an event when the sound pressure level (SPL) reaches 65 dBA and records an event when the SPL remains at or above 63 dBA for at least eight seconds. These measured noise events are downloaded daily and correlated with flight tracks to determine whether the noise source was an aircraft event or a community event.

The MAC system of 39 RMTs is one of the most extensive aircraft noise monitoring systems in the world. The data collected provides important information about sound levels and aircraft activity in the areas where the monitors exist. To augment the permanent system, AEDT can be used to determine the modeled events at specific points around MSP that are not covered by an RMT.

MAC's Noise and Operations Monitoring System (MACNOMS) data for aircraft operations including aircraft type, aircraft track, aircraft altitude and operation time were input into the AEDT software for modeling. AEDT allows for multiple noise metrics to be used. In this evaluation, the number of noise events above 65 dBA (also referred to as "count above 65") was used to coincide with the MAC RMTs. Using a dense grid system, the model output displays how many times aircraft caused the sound pressure to rise above 65 dBA at various points throughout the community. To make the results applicable to this analysis, actual aircraft departures from Runway 17 over the course of the entire year in 2014 and in 2018 were modeled.

The MACNOMS total operations number is marginally lower than the operations number reported in the FAA's Operations Network (OPSNET). Additionally, MACNOMS does not contain necessary attributes for every aircraft that operated at MSP. Operations by unknown aircraft types were discarded as it would not be possible to model aircraft noise from an unknown type. In 2014 and 2018, there were .1% and .2% of operations with incomplete attributes respectively. To rectify the disparity between the MACNOMS data and FAA reported operations, the total data count was adjusted upwards by 1.2% for 2018 and 2.4% for 2014 to reflect the total reported by the FAA. After this adjustment was applied, the total departures modeled from Runway 17 in 2018 was 68,577 while the total number of departures modeled for 2014 was 48,273.

The results of the AEDT models are displayed in **Figure 15 - 2014 Runway 17 Departure Events Above 65 dB** and **Figure 16 - 2018 Runway 17 Departure Events Above 65 dB**. Given the more than 20,000 departure increase of aircraft using Runway 17 between 2014 and 2018, it is not surprising that the modeled events also increased in specific areas. Areas of eastern Bloomington and northwestern Eagan saw modeled events increase by more than 10,000 events. The modeled locations in eastern Richfield, eastern Bloomington, northeastern Burnsville, and western and central Eagan near I-35E and Pilot Knob had increased between 5,000 and 10,000 events.

Modeled sites in southern Savage, southwestern Burnsville, southeastern Apple Valley, far southeastern Eagan, northern Eagan, central and southern Inver Grove Heights all returned fewer modeled events in 2018 than in 2014.

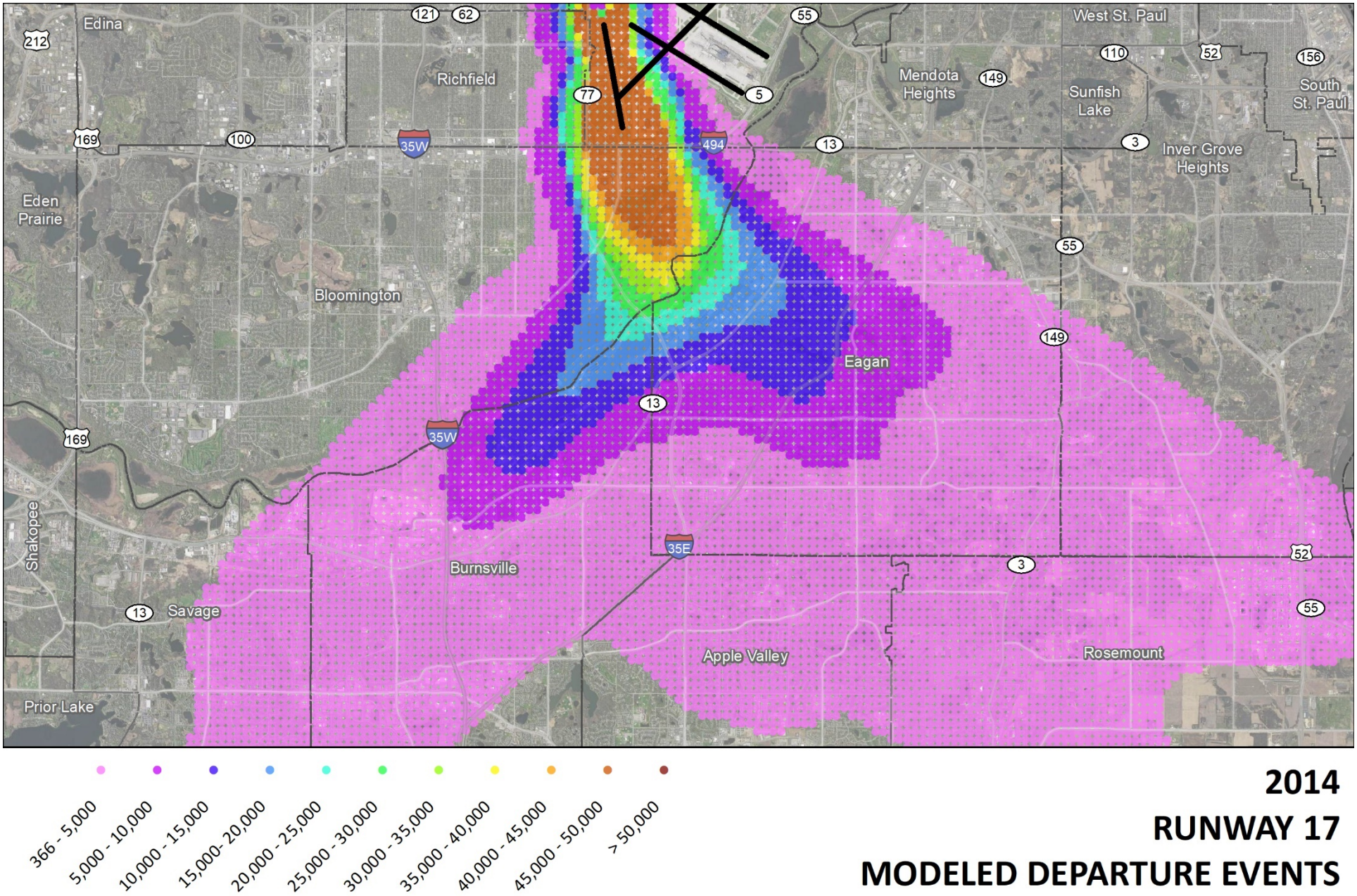


Figure 15 - 2014 Runway 17 Departure Events Above 65 dB

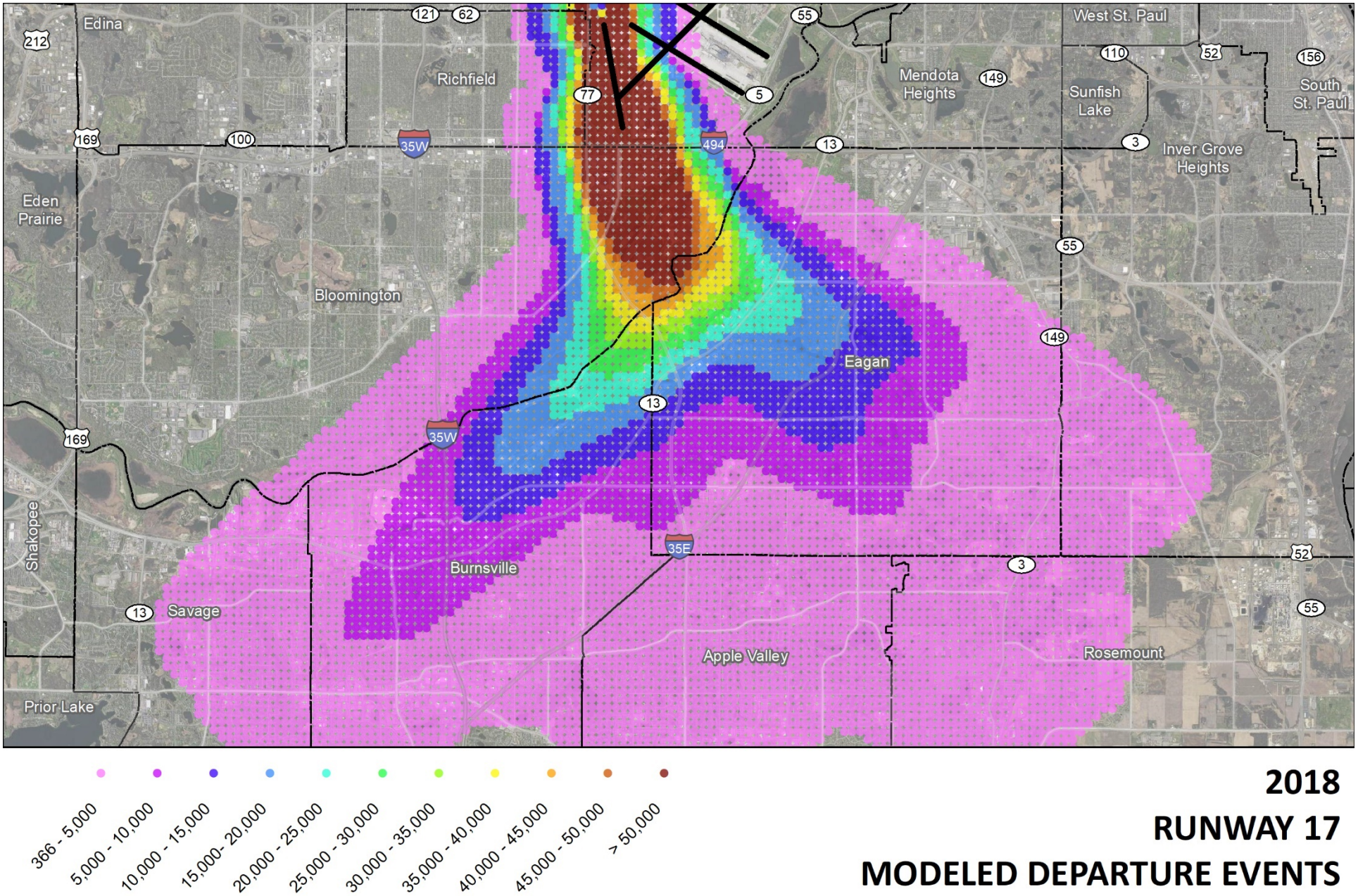


Figure 16 - 2018 Runway 17 Departure Events Above 65 dB

7. Land Use

One of the elements in the study scope was to investigate land use for areas that underlie typical Runway 17 departure paths to better understand which areas are compatible with aircraft operations at specific noise levels.

FAA regulations Part 150 – Airport Noise Compatibility Planning delineates compatible land uses from non-compatible land uses. Part 150 does that through the following two definitions:

> "*Compatible land use* means the use of land that is identified under this part as normally compatible with the outdoor noise environment (or an adequately attenuated noise level reduction for any indoor activities involved) at the location because the yearly day-night average sound level is at or below that identified for that or similar use under appendix A (Table 1) of this part.
>
> *Noncompatible land use* means the use of land that is identified under this part as normally not compatible with the outdoor noise environment (or an adequately attenuated noise reduction level for the indoor activities involved at the location) because the yearly day-night average sound level is above that identified for that or similar use under appendix A (Table 1) of this part."

The referenced Table 1 for Part 150, included for reference in this document in **Appendix E**, lists the land uses and associated Noise Level Reduction (NLR) recommended by the FAA for land uses within certain DNL levels. The Day-Night Average Sound Level (DNL) is the total accumulation of all sound energy spread uniformly over a 24-hour period. The DNL calculation applies a 10-decibel penalty on aircraft operations between 10:00 P.M. and 7:00 A.M. Examples of land uses above 65 dB DNL that would be considered noncompatible by this part include residential, mobile home parks, transient lodging, schools, outdoor music shells and amphitheaters. Hospitals, nursing homes and churches within the 65 dB DNL are considered generally compatible but the outdoor to indoor NLR of 25 dB should be achieved through incorporations of noise attenuation into the design and construction of the structure.

MetroGIS updates parcel data on a quarterly basis. The data is available via the Minnesota Geospatial Commons website. Parcel and associated land use data are supplied from the county where the parcel resides. Parcel data from April 2019 was acquired from the seven-county Minneapolis-St. Paul metro area and labeled as compatible or noncompatible using the criteria from FAR Part 150.

Figure 17 - Minneapolis-St. Paul Metropolitan Parcel Data provides a regional view of the land uses surrounding MSP. **Figure 18 - Parcel Data south of MSP** gives a closer view of the area South of MSP that are typically overflown by MSP Runway 17 Departures. **Figure 19 - Parcel Data with 2018 Runway 17 Departure Density** lays the 2018 Runway 17 Departure density data over the land use area to illustrate the land uses south of the airport that see the highest density of departures from Runway 17. The land use north and west of the airport are less compatible with aircraft overflights. The commercial area south of the airport and the Minnesota River to the south and west of MSP allows for more overflights with compatible land use. Additionally, areas southeast of MSP in Mendota Heights and Eagan have been zoned

to be more compatible with aircraft overflights. Because of these known land uses, numerous noise abatement procedures have been established to leverage these conditions. The Runway Use System prioritized runways that direct aircraft towards these areas. The 215° Departure Heading was designed to keep aircraft over the river. The Eagan-Mendota Heights Corridor procedure was also designed to contain aircraft over commercial and industrial land uses.

Figure 17 - Minneapolis-St. Paul Metropolitan Parcel Data

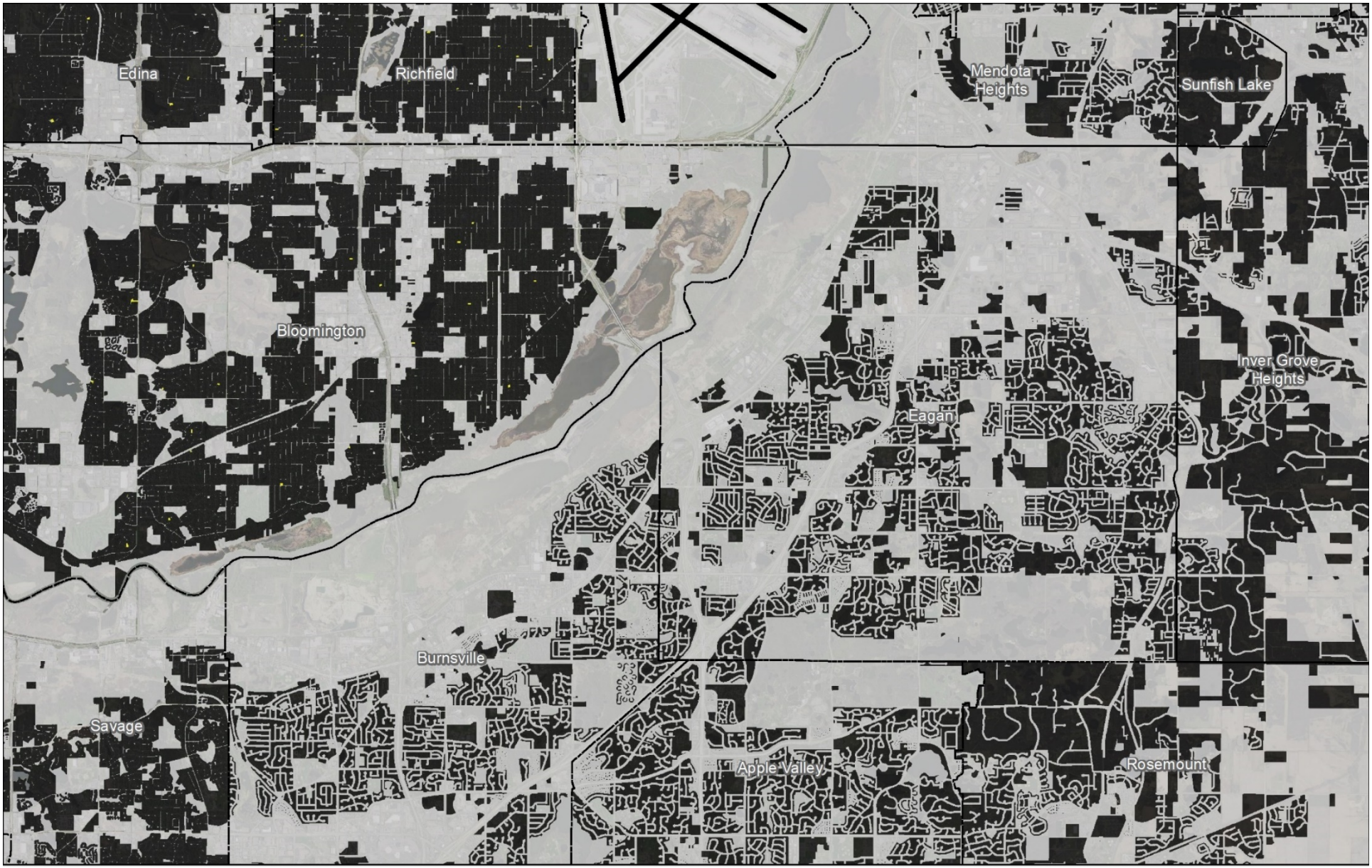


Figure 18 - Parcel Data south of MSP

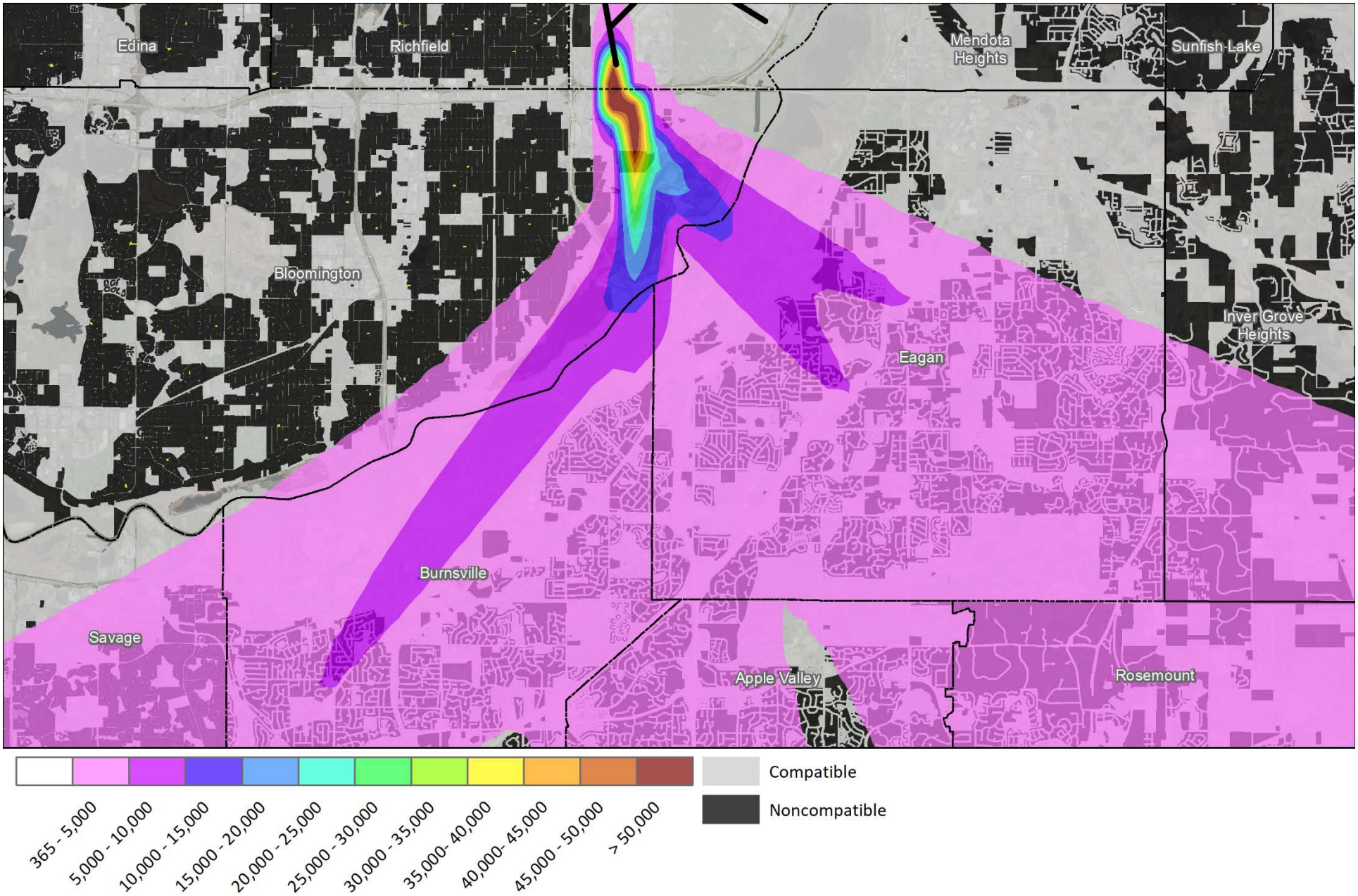


Figure 19 - Parcel Data with 2018 Runway 17 Departure Density

8. Runway 17 Departure Procedure Environmental Assessment

As discussed in Section 2, the construction of Runway 17 was the culmination of decades of planning by the MAC and extensive public involvement. This planning effort was done at the direction of the Minnesota Legislature to determine the long-term suitability of the airport's location. During the Dual-Track planning process, the Minnesota Legislature passed legislation that kept MSP in its current location rather than relocate it. Planning for MSP's future in its current location, the MAC began implementation of the 2010 Plan to ensure the facility provided an efficient and safe airport to meet forecasted air travel demands. One of the most visible components of the 2010 Plan was the construction of Runway 17-35. The Record of Decision on the Environmental Impact Statement that evaluated the 2010 Plan included consideration of future noise abatement procedures off of Runway 17. The *Environmental Assessment for the Implementation of a Departure Procedure off of Runway 17* (EA) was conducted and completed in 2003 as Runway 17-35 was being constructed.

The EA contains the following text in Section 3.2:

> The Proposed Action is to direct aircraft that have initial departure headings east of runway heading (headings ranging from 95° to 170°) to initiate their turns as soon as possible when departing Runway 17. This recommendation was made due to the fact that there is no one flight path considered "better" than another when departing to the southeast over the existing residentially developed areas. This is consistent with the FEIS documentation for Runway 17.
>
> When conducting the same evaluation for departure headings west of runway centerline (headings from 170° to 285°) two main considerations arose: (1) Heavily residential developed areas exist west of runway heading almost immediately off the runway end and (2) the Minnesota River Valley south of the airport offers an area where departure operations could overfly at higher altitudes in an effort to reduce residential overflight impacts close-in to the airport.
>
> A delayed turn point off runway heading (170°) for westbound jet departures offers a solution that not only reduces the number of residents within the 65 and 60 DNL contours, but is also feasible for implementation according to the FAA's airspace management and safety criteria.
>
> As a result of evaluations and comprehensive input as part of the 2000 MSP Part 150 Update process, the recommended Runway 17 departure tracks include departure turns, when able, for departures east of 170° to 95° and a 2.5 Nautical Mile (from the start of takeoff) Turn Point, as determined by Distance Measuring Equipment (DME), at which time jet departure operations would turn from runway heading (170°) to westbound departure headings between 171° and 285°.

This EA was completed prior to the opening of Runway 17-35. Assumptions were made to effectively conduct an evaluation of the airport operations prior to opening of the runway. Table 8-1 below shows the average daily operations that were projected in the 2003 EA. At the time, the airport was projected

to have a total of 1,5735.3 operations each day in 2005. Of those, 261.8 average daily operations were projected to be in Hushkit Stage 3 Jets, with 29.3 occurring at night. Hushkit Stage 3 Jets are older, louder aircraft such as the DC9 and B727 that have been "hushkitted" to meet the Stage 3 noise standard.

Table 8-1 – EA Average Daily Operations

Aircraft Type	Day	Night	Total
Manufactured to be Stage 3	924.7	137.6	1062.3
Hushkit Stage 3	232.5	29.3	261.8
Propeller	205.1	46.1	251.2
Total	**1362.3**	**213.0**	**1575.3**

Source: Environmental Assessment for the Implementation of a Departure Procedure off of Runway 17 Table A-1

Other assumptions in the 2003 EA were based on the number of flights operating on each runway. Table 8-2 below shows the projected runway use after Runway 17/35 opened in 2005.

Table 8-2 – Revised RUS Forecast 2005 Average Annual Runway Use

Runway	Arrival			Departure		
	Day	Night	Total	Day	Night	Total
4	0.1%	3.8%	0.5%	0.2%	0.4%	0.2%
22	0.5%	2.5%	0.7%	0.1%	0.8%	0.3%
12L	21.7%	17.8%	21.2%	9.5%	12.5%	9.9%
12R	14.6%	12.0%	14.3%	15.9%	18.6%	16.2%
30L	21.1%	24.2%	21.5%	14.8%	13.2%	14.5%
30R	25.5%	26.0%	25.5%	22.4%	19.9%	22.1%
17	0.1%	0.1%	0.1%	37.1%	34.6%	36.7%
35	16.6%	13.7%	16.2%	0.1%	0.1%	0.1%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Environmental Assessment for the Implementation of a Departure Procedure off of Runway 17 Table A-6

Tables 8-3 and 8-4 below details the average daily operations and runway use in 2018.

Table 8-3 – 2018 Average Daily Operations

Aircraft Type	2018 Day	2018 Night	2018 Total
Manufactured to be Stage 3	953.3	117.4	1070.8
Hushkit Stage 3	0.3	0.5	0.8
Propeller	38.3	2.3	40.5
Helicopter	0.1	0.0	0.1
Military	1.9	0.0	2.0
Total	**994.5**	**120.3**	**1,114.8**

Source: MACNOMS

Table 8-4 – 2018 Annual Runway Use

Runway	Arrival			Departure		
	Day	Night	Total	Day	Night	Total
4	0.0%	0.3%	0.1%	0.5%	1.0%	0.5%
22	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
12L	22.2%	14.2%	21.3%	14.2%	18.6%	14.7%
12R	25.6%	27.5%	25.8%	4.1%	24.9%	6.2%
30L	24.8%	34.7%	25.9%	23.2%	25.0%	23.4%
30R	21.9%	16.6%	21.3%	21.6%	18.5%	21.3%
17	0.0%	0.6%	0.1%	36.3%	11.7%	33.8%
35	5.4%	6.1%	5.5%	0.0%	0.2%	0.0%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: MACNOMS

The following tables provide the change from the 2003 EA assumptions to actual conditions in 2018. As shown in Table 8-5, the EA forecasted far more operations in 2005 than occurred in 2018. From an average day standpoint, there were 461.1 fewer operations in 2018 than were forecast for 2005. This equates to an annual reduction of over 168,000 operations. Additionally, there were far fewer propeller and Hushkit Stage 3 operations in 2018 than were forecasted in the EA. There were 261.8 Hushkit operations forecast and 2018 had less than one per day. Additionally, 251.2 propeller operations were expected in 2005, however MSP experienced only 41 per day in 2018.

Table 8-5 – EA vs. 2018 Average Daily Operations

Aircraft Type	Average Daily Operations						
	Day		Night		Total		Difference between EA and 2018
	2018	EA	2018	EA	2018	EA	
Manufactured to be Stage 3	953.3	924.7	117.4	137.6	1070.8	1062.3	8.5
Hushkit Stage 3	0.3	232.5	0.5	29.3	0.8	261.8	-261
Propeller	38.3	205.1	2.3	46.1	40.5	251.2	-210.7
Helicopter	0.1	0.0	0.0	0.0	0.1	0.0	0.1
Military	1.9	0.0	0.0	0.0	2.0	0.0	2.0
Total	**994.5**	**1362.3**	**120.3**	**213.0**	**1,114.8**	**1575.3**	**-461.1**

Runway-use also varied in 2018 from what was forecast for 2005, detailed in Table 8-6 and 8-7 below. The biggest differences in arrivals occurred on Runways 12R and 35. Runway 12R arrivals were forecast to be 14% in 2005 and were closer to 26% in 2018. Arrivals to Runway 35 were expected at 16% but were actually below 6%. For departures, the south parallel, Runway 12R-30L, saw the biggest differences. Runway 12R was expected to handle 16% of the departures but only took 6% in 2018. Runway 30L departures were expected to be just above 14% but actually were over 23% in 2018.

Table 8-6 – EA vs. 2018 Runway Use Percentages

Runway	Arrival			Departure		
	2018	EA	Change	2018	EA	Change
4	0.1%	0.5%	-0.4%	0.5%	0.2%	0.3%
22	0.0%	0.7%	-0.7%	0.0%	0.3%	-0.3%
12L	21.3%	21.2%	0.1%	14.7%	9.9%	4.8%
12R	25.8%	14.3%	11.5%	6.2%	16.2%	-10.0%
30L	25.9%	21.5%	4.4%	23.4%	14.5%	8.9%
30R	21.3%	25.5%	-4.2%	21.3%	22.1%	-0.8%
17	0.1%	0.1%	0.0%	33.8%	36.7%	-2.9%
35	5.5%	16.2%	-10.7%	0.0%	0.1%	-0.1%
Total	**100.0%**	**100.0%**	**0.0%**	**100.0%**	**100.0%**	**0.0%**

The change in percentage use of the runway does not fully capture the magnitude of the operational change. In 2003 when the EA was published, it was expected that there would be 574,985 operations at MSP when the runway opened in 2005. In 2018, there were only 406,913. Using the runway use percentages in Tables 8-2 and 8-5 in combination with the daily operations number from Tables 8-1 and 8-4 allows for the comparison of the actual change in operations from what was forecast in the EA to what occurred in 2018 in Table 8-9.

Table 8-7 – Runway Use Total Annual Operations

Forecast EA Runway Use	Runway	Arrival			Departure		
		Day	Night	Total	Day	Night	Total
	4	249	1,477	1,437	497	155	575
	22	1,243	972	2,012	249	311	862
	12L	53,950	6,919	60,948	23,619	4,859	28,462
	12R	36,298	4,665	41,111	39,531	7,230	46,574
	30L	52,459	9,407	61,811	36,796	5,131	41,686
	30R	63,398	10,107	73,311	55,691	7,736	63,536
	17	249	39	287	92,238	13,450	105,510
	35	41,271	5,326	46,574	249	39	287
	Total	**248,620**	**38,873**	**287,492**	**248,620**	**38,873**	**287,492**

2018 Actual Runway Use	Runway	Arrival			Departure		
		2018 Day	2018 Night	2018 Total	2018 Day	2018 Night	2018 Total
	4	0	66	203	907	220	1,017
	22	0	0	0	0	0	0
	12L	40,292	3,118	43,336	25,772	4,084	29,908
	12R	46,463	6,038	52,492	7,441	5,467	12,614
	30L	45,011	7,618	52,695	42,107	5,489	47,609
	30R	39,748	3,644	43,336	39,203	4,062	43,336
	17	0	132	203	65,883	2,569	68,768
	35	9,801	1,339	11,190	0	44	0
	Total	**181,496**	**21,955**	**203,457**	**181,496**	**21,955**	**203,457**

Difference	Runway	Arrival			Departure		
		Day	Night	Total	Day	Night	Total
	4	-249	-1,411	-1,234	410	64	442
	22	-1,243	-972	-2,012	-249	-311	-862
	12L	-13,658	-3,802	-17,612	2,154	-775	1,446
	12R	10,165	1,373	11,380	-32,089	-1,764	-33,959
	30L	-7,448	-1,789	-9,116	5,311	358	5,922
	30R	-23,650	-6,462	-29,974	-16,488	-3,674	-20,200
	17	-249	93	-84	-26,355	-10,881	-36,741
	35	-31,470	-3,986	-35,384	-249	5	-287
	Total	**-67,124**	**-16,918**	**-84,036**	**-67,124**	**-16,918**	**-84,036**

For purposes of modeling noise exposure and noise contour development, specific departure tracks must be developed and modeled. Although the headings assigned by the FAA are in 5-degree

increments from 095-degrees to 285-dgrees, the noise modeling in the EA only allowed backbone flight tracks representing specific headings to be evaluated.

Comparisons of a grouping of headings during 2018 and what was evaluated in the 2003 EA is shown below in Table 8-10. Some headings were grouped for comparison purposes. The headings of 105° or less were expected for 10% of all Runway 17 departure tracks but were flown by less than 1% of tracks in 2018. Headings 120° and 140° in 2018, saw an increase of 32% from the anticipated tracks in the EA. Headings between 170° and 200° were 34% below the assumptions in 2018. A similar amount of increase was seen in the 210° tracks. Usage on tracks in 2018 over 220° were 22% below what was forecast in the EA.

Table 8-8 – Flight Track Use Percentages

Track Heading	2018	EA	Change
<105°	0.4%	10.1%	-9.7%
120°	16.8%	0.0%	16.8%
140°	20.7%	5.1%	15.6%
155°-160°	12.5%	12.0%	0.5%
170°	5.4%	17.3%	-11.9%
185°-200°	8.8%	30.8%	-22.0%
210°	32.7%	0.0%	32.7%
>220°	2.9%	24.7%	-21.8%

The assumptions from the 2003 EA were made with sound judgement based on current operations at MSP. The assumptions in the previous tables were to be representative of conditions in 2005 when Runway 17-35 opened. The EA notes that the runway and flight track use results derived in the analysis are not absolutes. Variances will occur due to weather and safety, aircraft interactions. In the 15 years that have passed since the EA was completed numerous changes have occurred, not the least of which include the opening of Runway 17-35 and the actual use of the pavement for departures and how the departures interact with surrounding air traffic. On an annual basis, the MAC develops noise contour maps to assess the noise exposure from actual operations occurring the previous year. This allows variations in aircraft operations, fleet mix, runway use and flight track use to be consistently evaluated and considered for residential noise mitigation eligibility. Even with the increase in Runway 17 departures experienced in 2018 and the variation in flight track use presented above, the 2018 60 DNL noise contour does not extend south of the Minnesota River, nor does it extend beyond the MAC's residential noise mitigation program area.

9. Runway 17 Departure Altitude

Departure procedures are an important part of any discussion related to aircraft overflights. Because sound pressure travels as a wave, the distance away from a sound source is important. For aircraft overflights, that is a combination of lateral distance—i.e. distance along the ground—as well as altitude or distance above the ground. The Inverse-Square Law can be used a general rule of thumb in this instance. This axiom states that sound pressure will decrease by 50% as the distance away from a sound source doubles. Due to the logarithmic scale for sound, that equates to a six-decibel reduction for every doubling of distance. Because sound waves are impacted by atmospheric and physical environment conditions, measured values may not fully conform to this rule. To reduce the sound of aircraft, the flight track could be moved away from the receiver or the aircraft could be higher. Unfortunately, the laws of physics do not always allow for aircraft to be higher.

To conduct a reasonable comparison between aircraft departures before 2015 and departures after 2015 the study identified average departure altitudes at multiple measurement points along a track. Concentric rings centered on the start of takeoff roll from Runway 17 every mile between two miles and ten miles were used as measurement gates. **Figure 20 - Runway 17 Distance Measurement Rings** illustrates the location of those rings. The altitude of 44,795 carrier jet departures from 2014 and 63,454 carrier jet departures from 2018 at each gate were recorded and analyzed.

Weather conditions were also analyzed for 2014 and 2018, because altitude is dependent on temperature and wind conditions. Departure altitudes are more impacted by temperature and wind than arrival altitudes. As temperatures rise, altitudes will be lower. Similarly, strong headwinds will increase lift for departures, resulting in higher altitudes. The average temperature at MSP in 2014 was 43.1° Fahrenheit. That temperature increased in 2018 to an average of 46.6° Fahrenheit. Wind roses are presented in **Figure 21 - 2014 and 2018 Annual MSP Wind Rose**. During 2014, strong headwinds (over 10 mph out of a direction between 080° and 260°) occurred 20% of the time. During 2018, this was 18% of the time. Based solely on the warmer temperatures and weaker headwinds, it would be expected that average departure altitudes from Runway 17 would be lower in 2018 than 2014.

Figure 22 - Average RJ Departure Altitude and **Figure 23 - Average Narrowbody Departure Altitude** display the result of the comparison. Based on wind and temperature, the expectation that altitudes would be lower is realized. The small gap between the two years also is more pronounced as the aircraft continued away from MSP. For Regional Jets, the degree of altitude variation ranges from 41 feet to 199 feet, increasing as the aircraft travel further from the runway. The change also is noticeably pronounced in the narrowbody class of jet more than in the regional jet class. The difference in altitude from 2014 to 2018 is only 34 feet at two miles increasing to 462 feet at ten miles. Average altitudes for the top three most used aircraft types departing from Runway 17 in 2018 (Canadair Regional Jet 900, Boeing 737-800 and Canadair Regional Jet 200) are displayed in **Appendix F**.

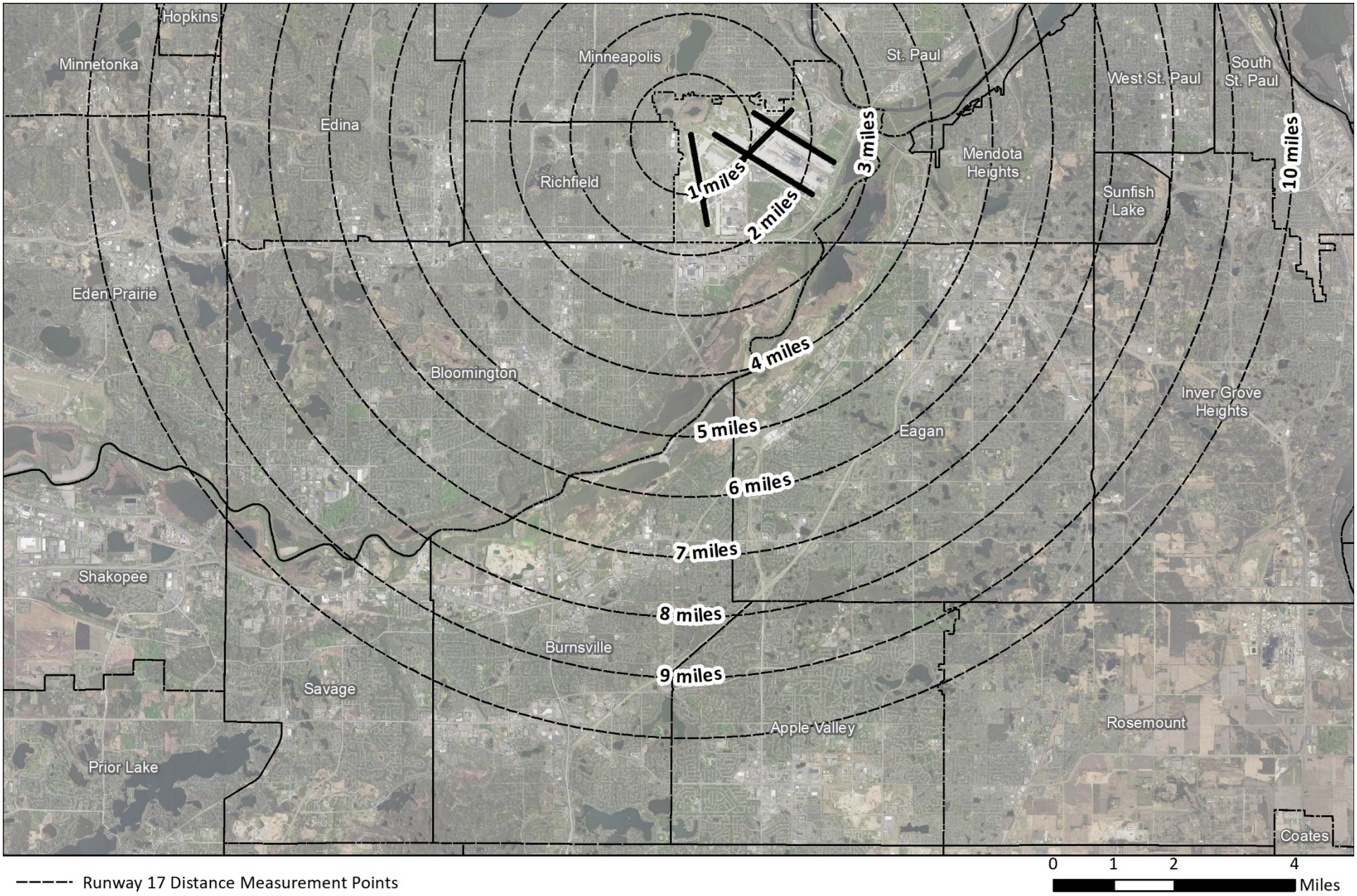


Figure 20 - Runway 17 Distance Measurement Rings

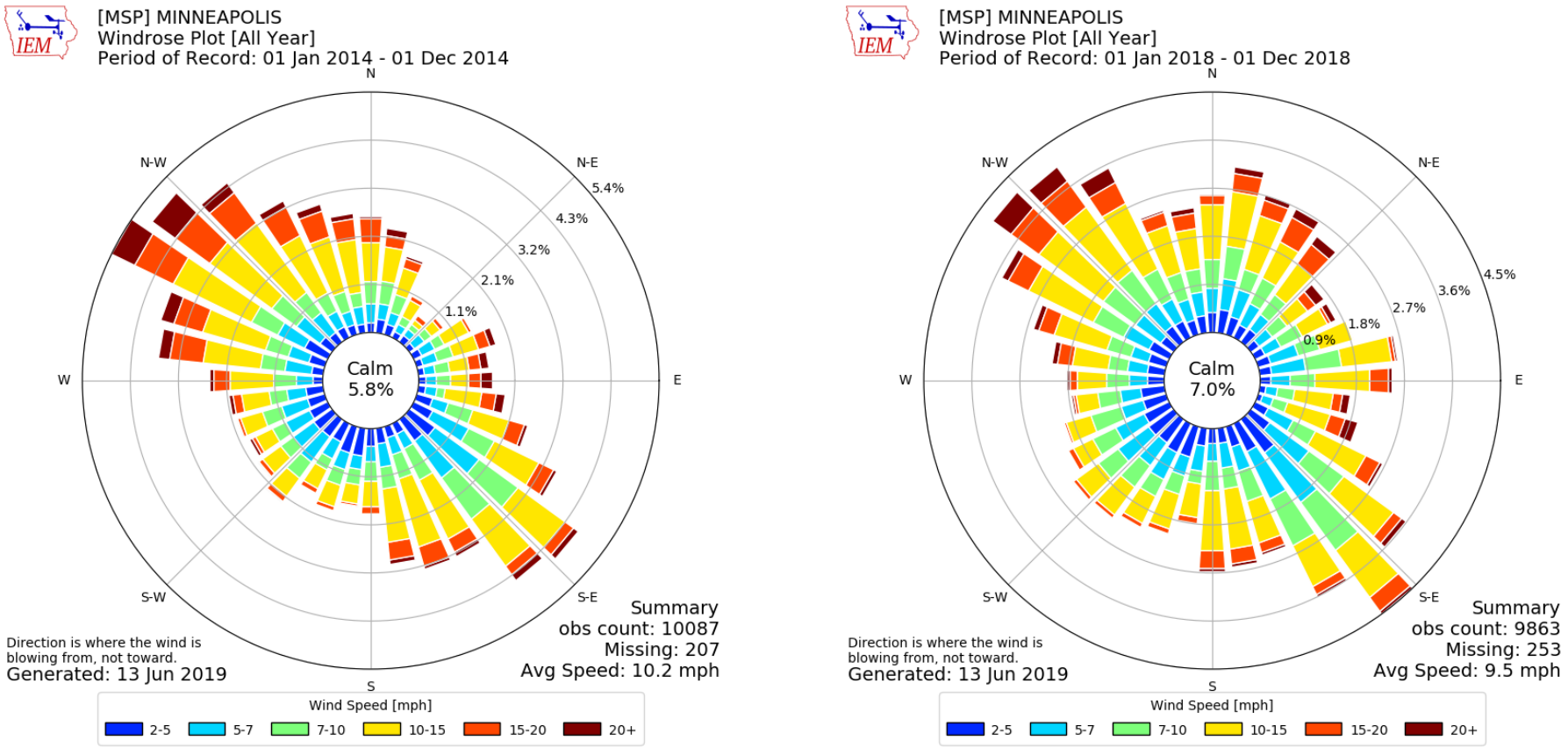


Figure 21 - 2014 and 2018 Annual MSP Wind Rose

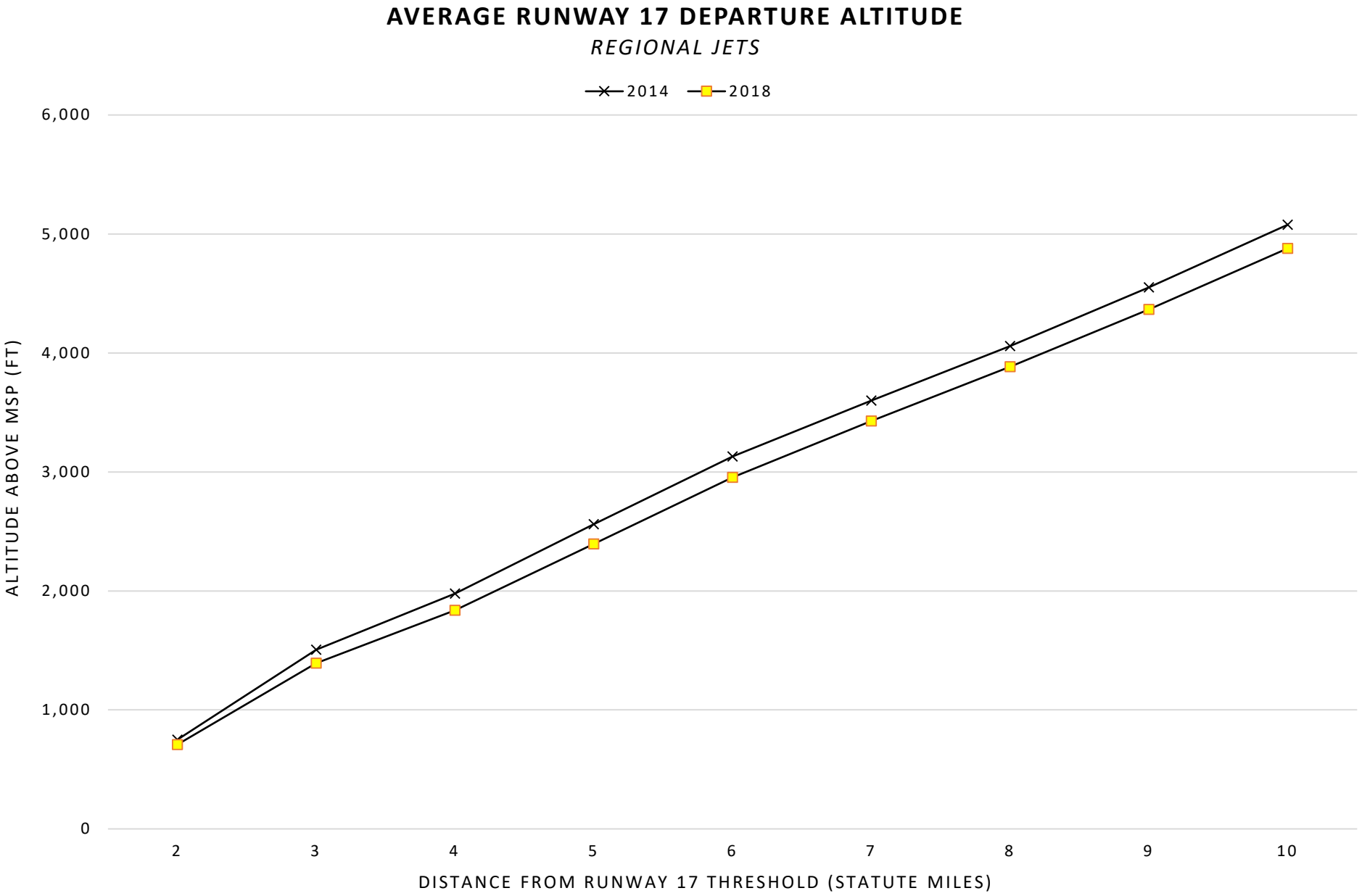


Figure 22 - Average RJ Departure Altitude

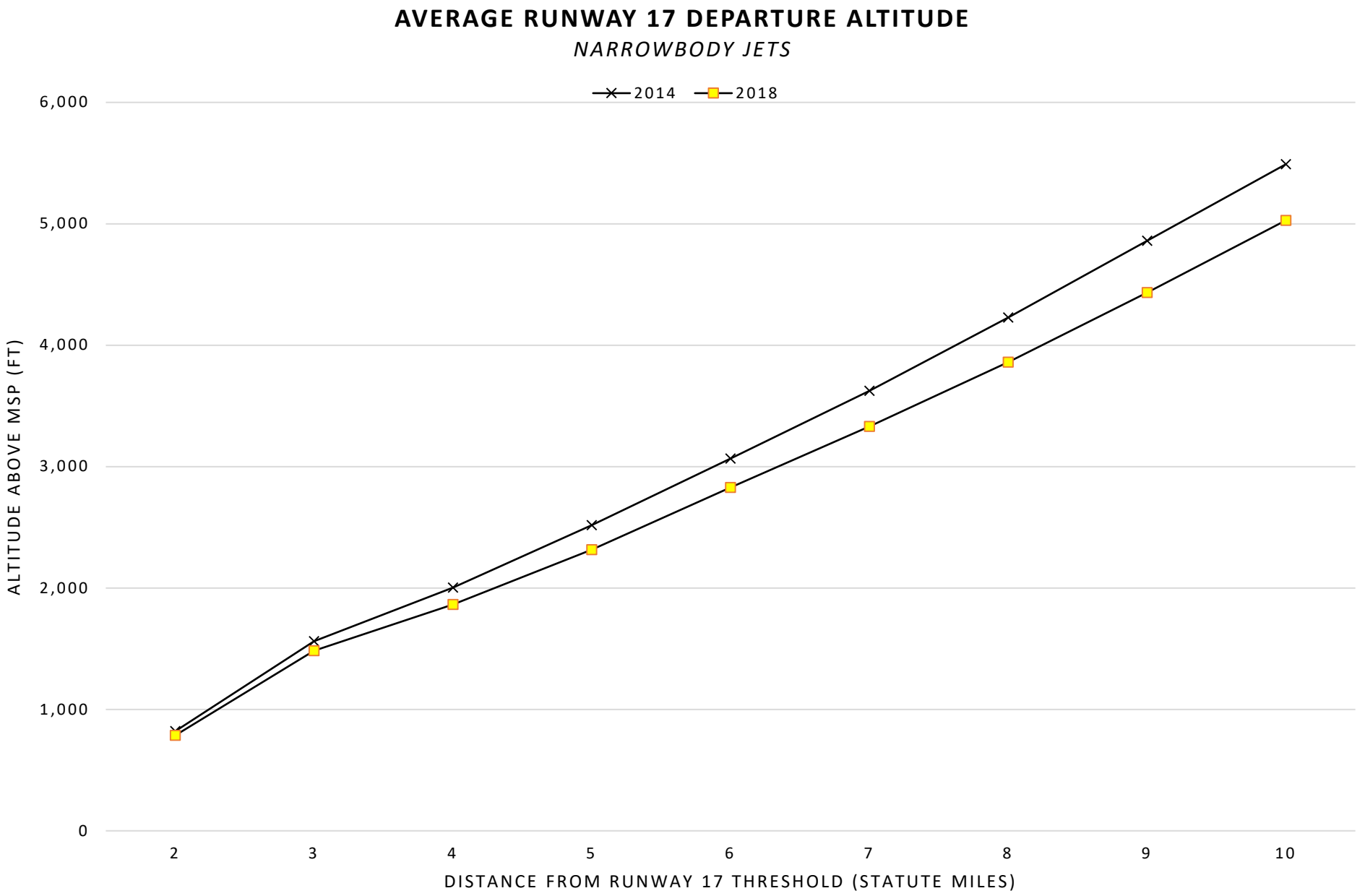


Figure 23 - Average Narrowbody Departure Altitude

APPENDIX

APPENDIX A

Runway 17 Departure Study Scope

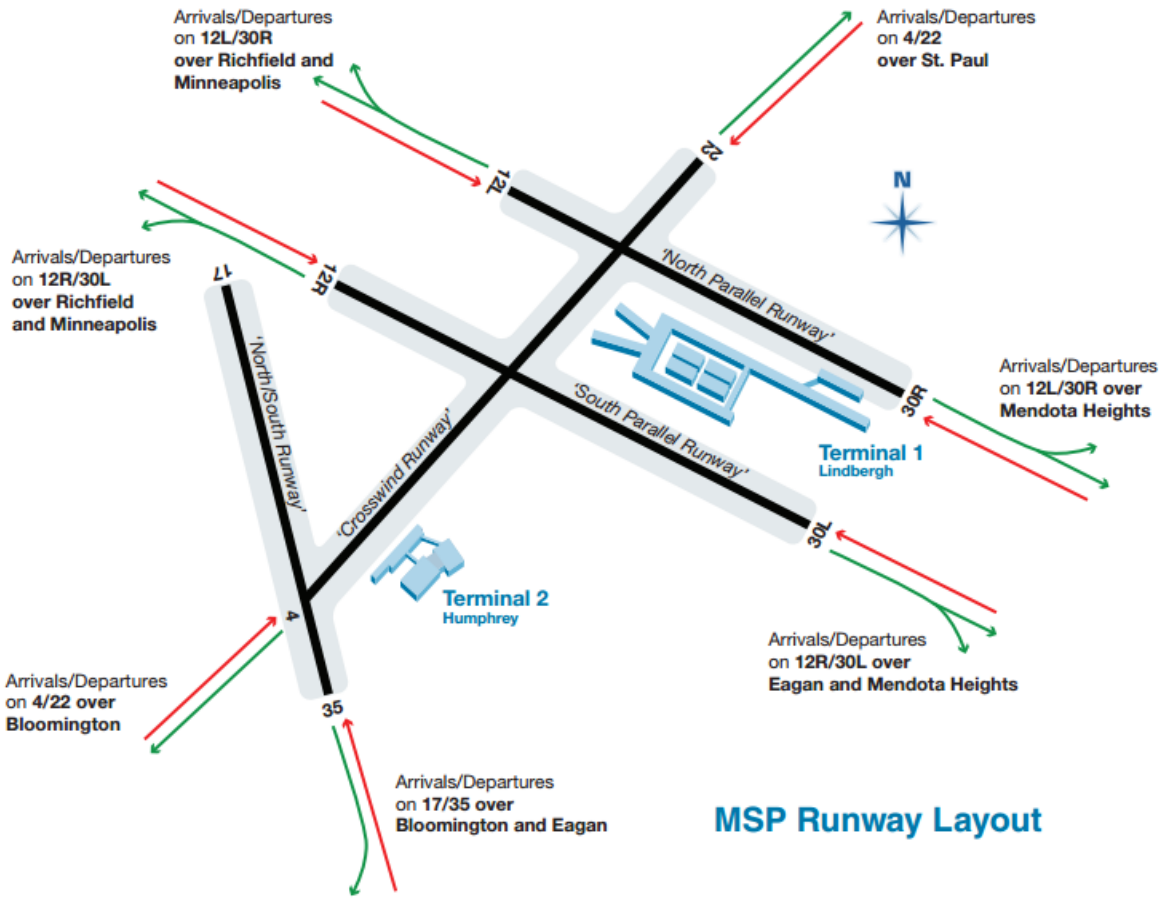
Objective: Working collaboratively with neighbors and communities south of the airport, the MAC will identify concerns related to Runway 17 Departures and compile a report that will identify operational necessities of Runway 17, highlight trends in the use of the runway and identify changes experienced post-CRO.

Report Outline

1. Executive Summary
2. Pre-CRO day vs. Post-CRO day
    a. How has a typical South Flow day changed?
        i. Daily peak hour trends
        ii. Past departure peaks and current departure peaks
        iii. Build a typical day for Runway 17 departures pre-CRO and compare it to a day post-CRO
    b. Successive Days in a South Flow
    c. Examine departure runway distribution during South Flow
3. Flight frequency
    a. Analyze 15 minutes segments and produce metrics highlighting the frequency of flights departing Runway 17. Compare pre-CRO to post-CRO
4. Headings
    a. Very few primary headings used
        i. Compare IFR vs VFR
        ii. Evaluate 105° and 170° departure headings
    b. Headings in Mixed Flow A vs. South Flow
    c. Provide data on aircraft destination by heading
    d. Highlight the use of headings by time of day
5. Noise Model Data
    a. Develop Count Above 65 dB density graphics for Runway 17 departures pre-CRO and post-CRO
6. Land Use
    a. Provide an overhead graphic of land use for areas that underlie typical Runway 17 departure paths. Categorize land uses as compatible or non-compatible
7. Runway 17 EA
    a. Compare and contrast assumptions made in the Runway 17 Departure Headings EA to 2018
8. Runway 17 Departure Altitude

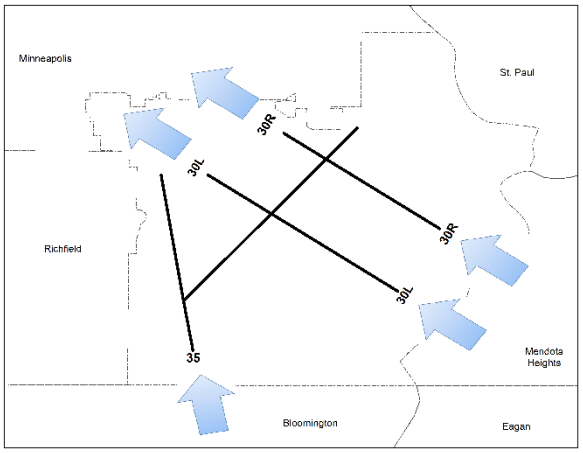
APPENDIX B

Runway Diagram

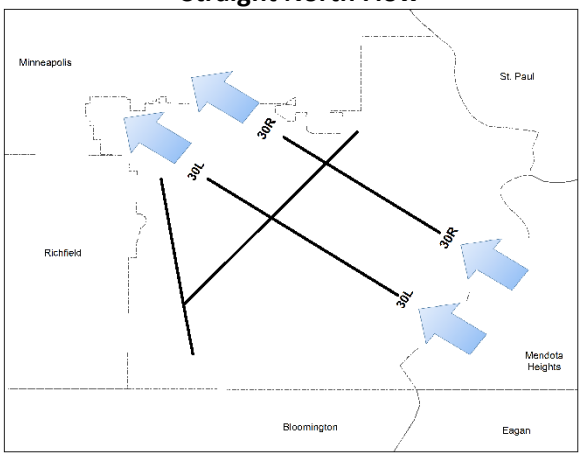


APPENDIX C
Airport Configurations

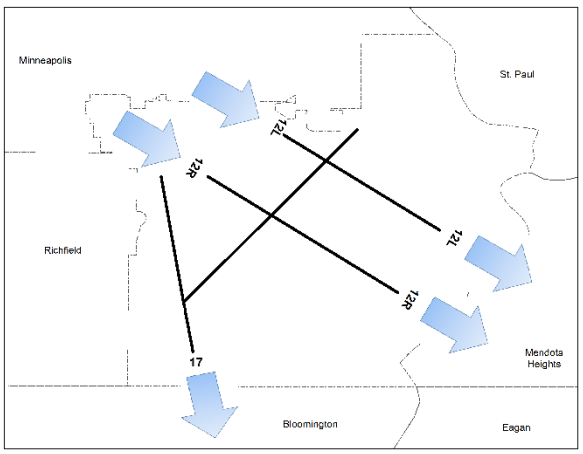
North Flow



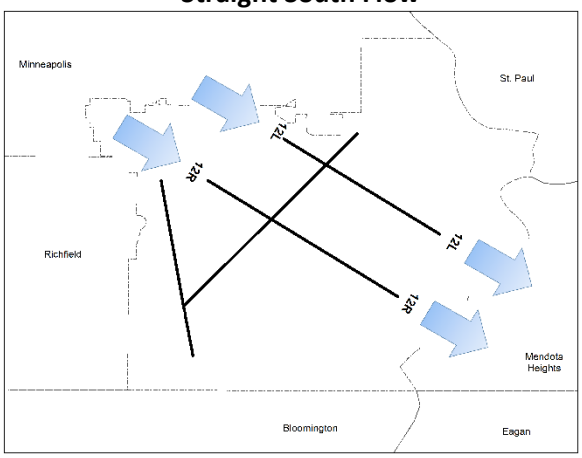
Straight North Flow



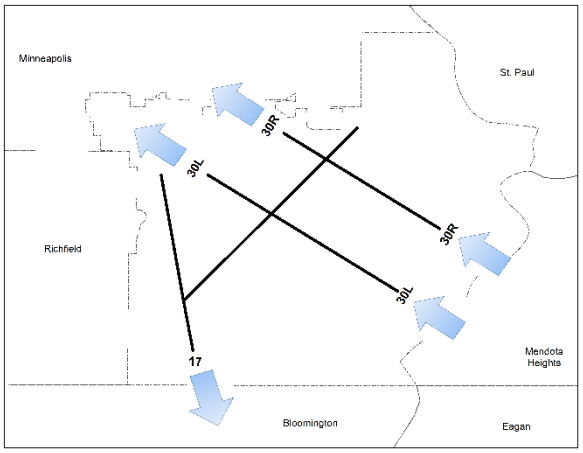
South Flow



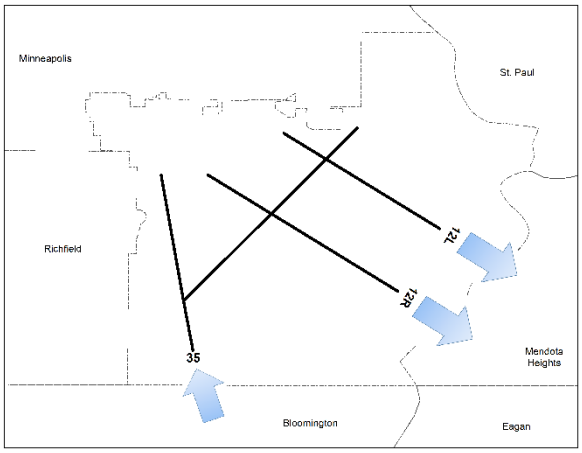
Straight South Flow



Mixed Flow A

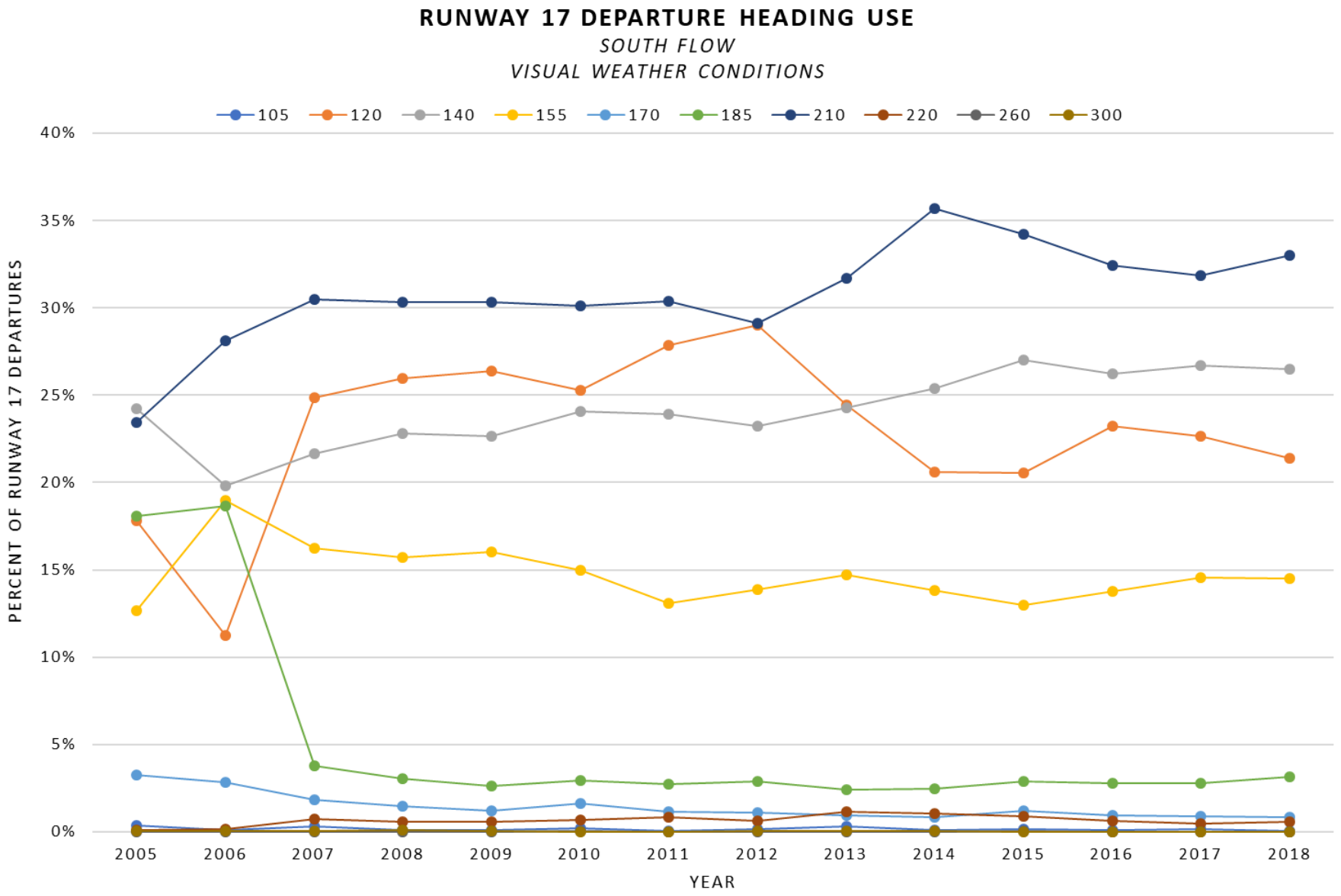


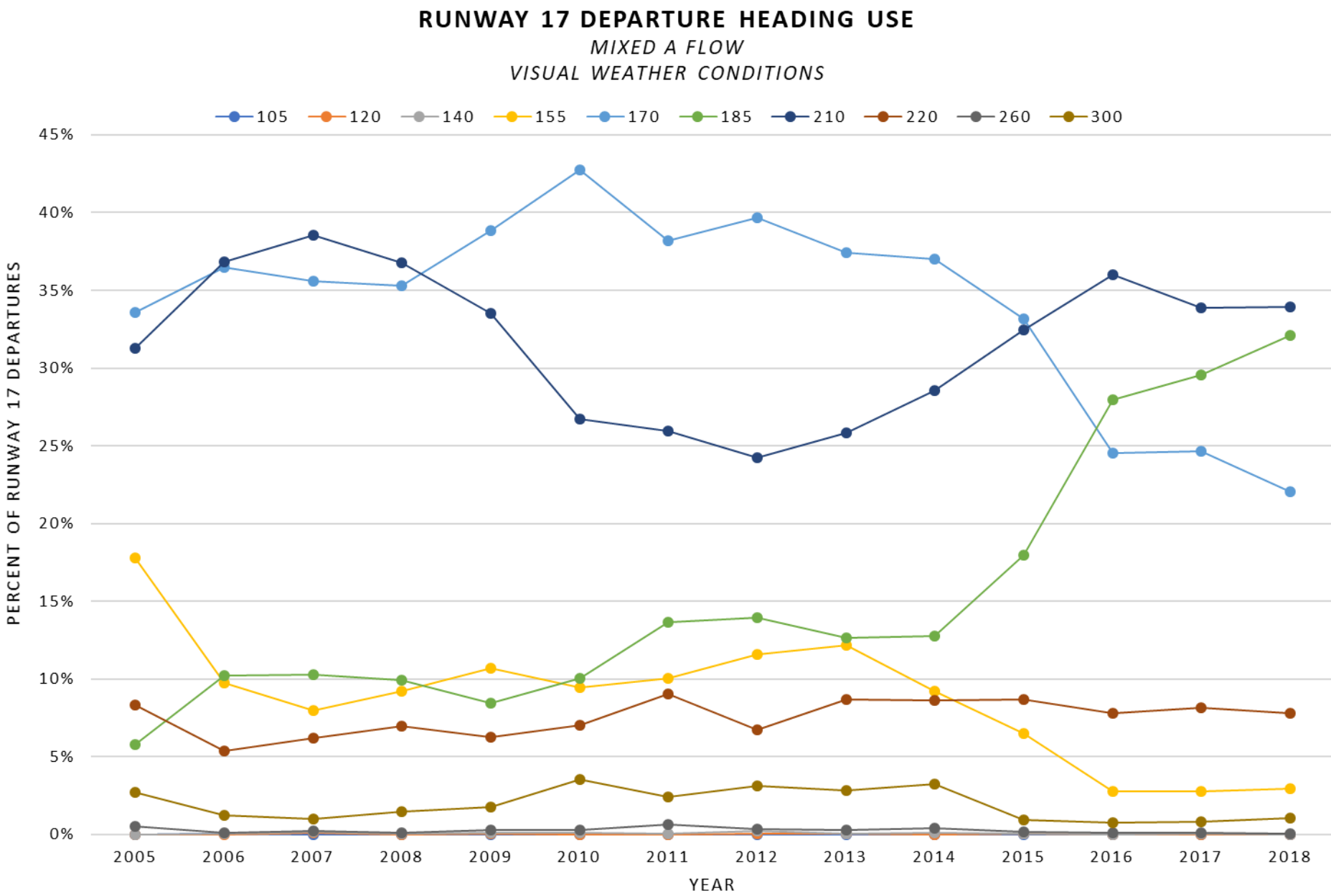
Mixed Flow B



APPENDIX D

Runway 17 Departure Heading Usage

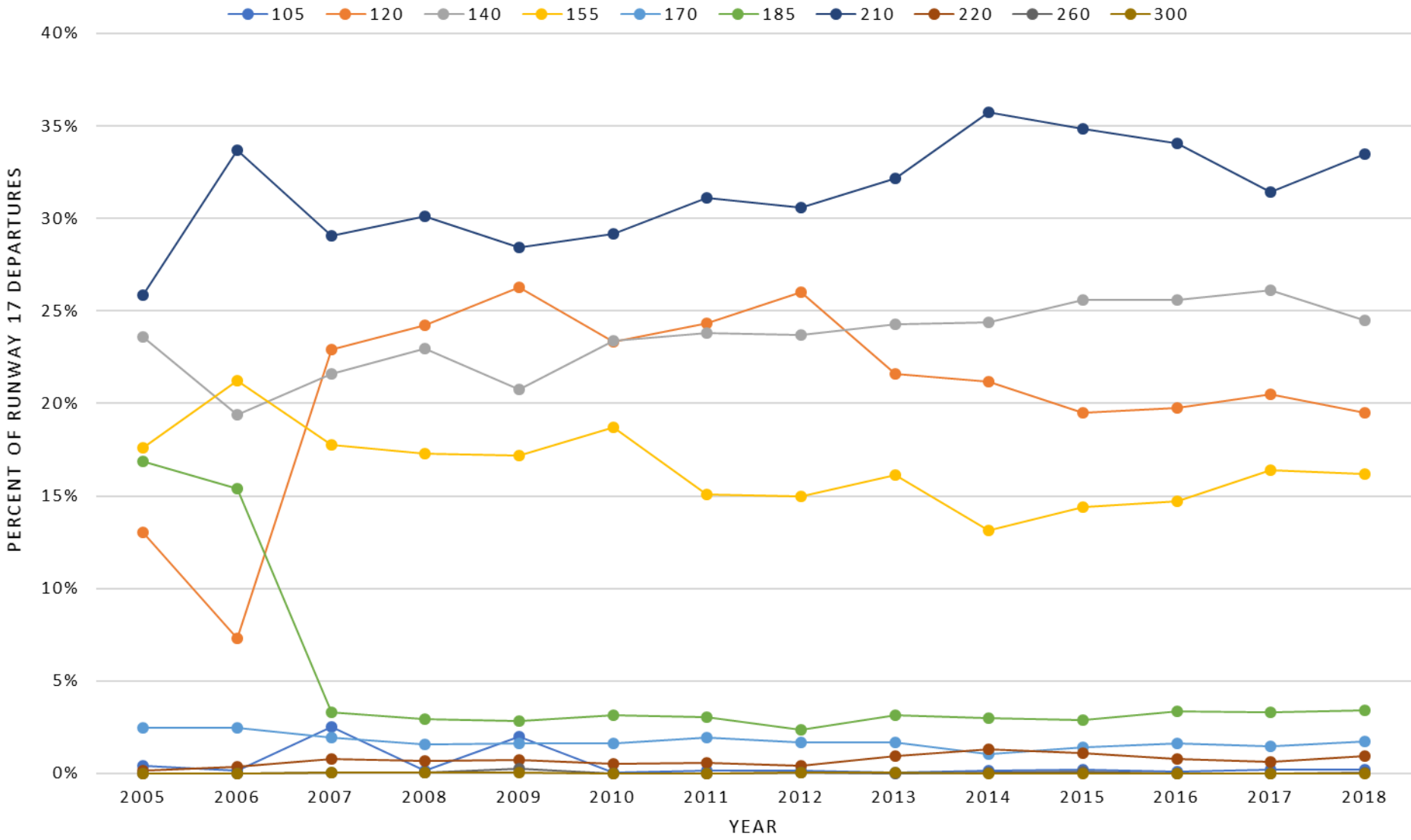



RUNWAY 17 DEPARTURE HEADING USE
MIXED A FLOW
VISUAL WEATHER CONDITIONS
105
120
140
155
170
185
210
220
260
300
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
PERCENT OF RUNWAY 17 DEPARTURES
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
YEAR

RUNWAY 17 DEPARTURE HEADING USE

SOUTH FLOW

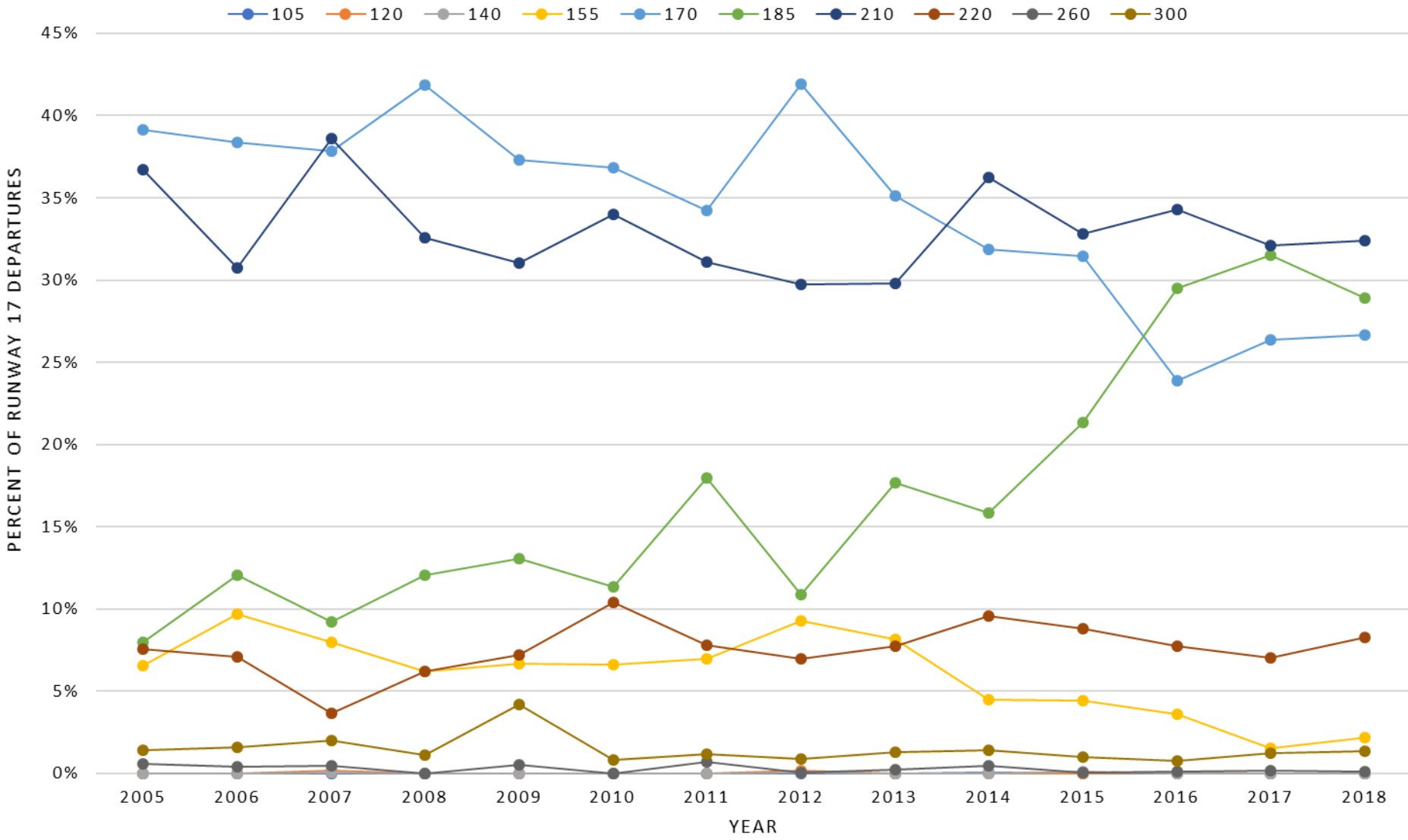
INSTRUMENT WEATHER CONDITIONS

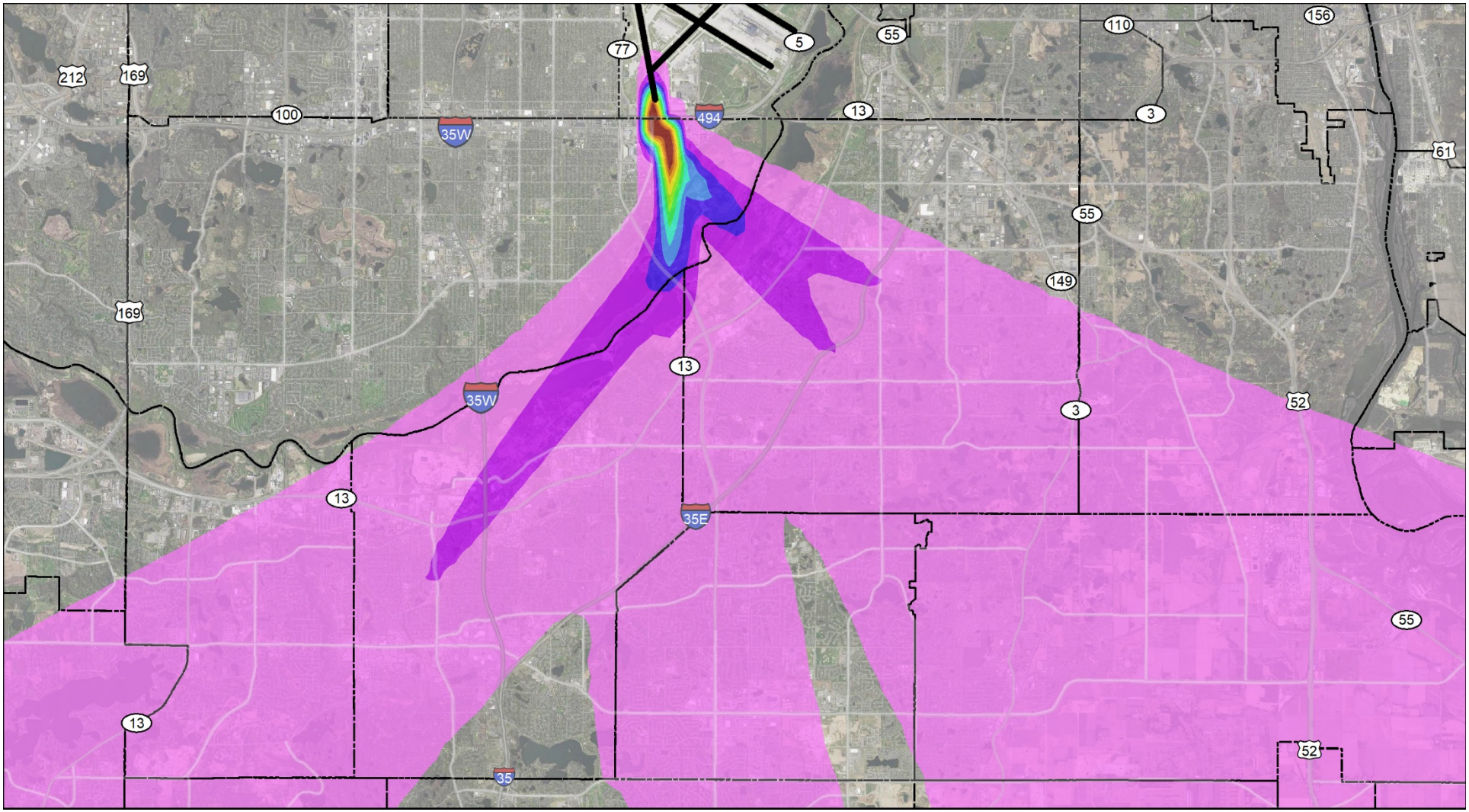


RUNWAY 17 DEPARTURE HEADING USE

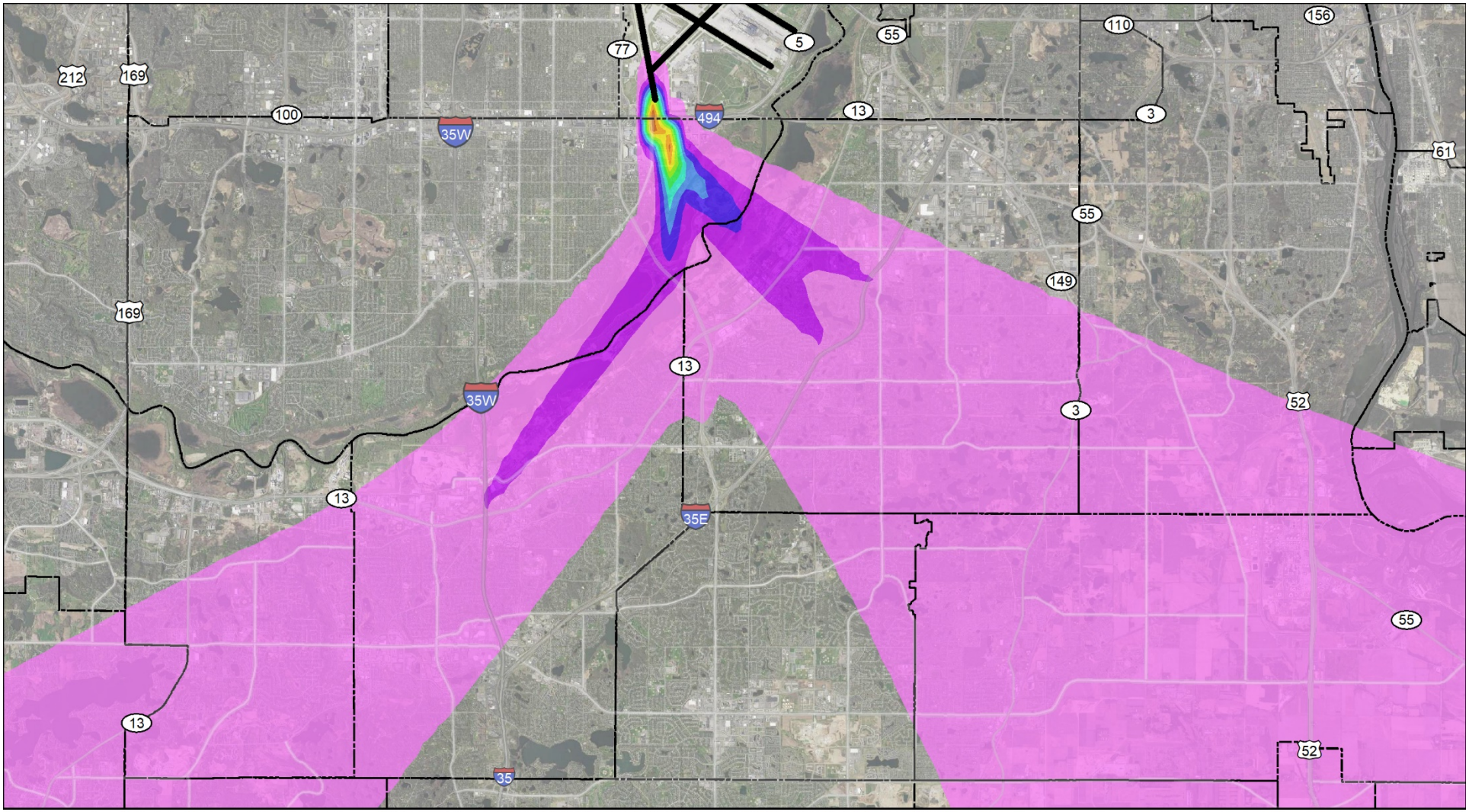
MIXED A FLOW

INSTRUMENT WEATHER CONDITIONS



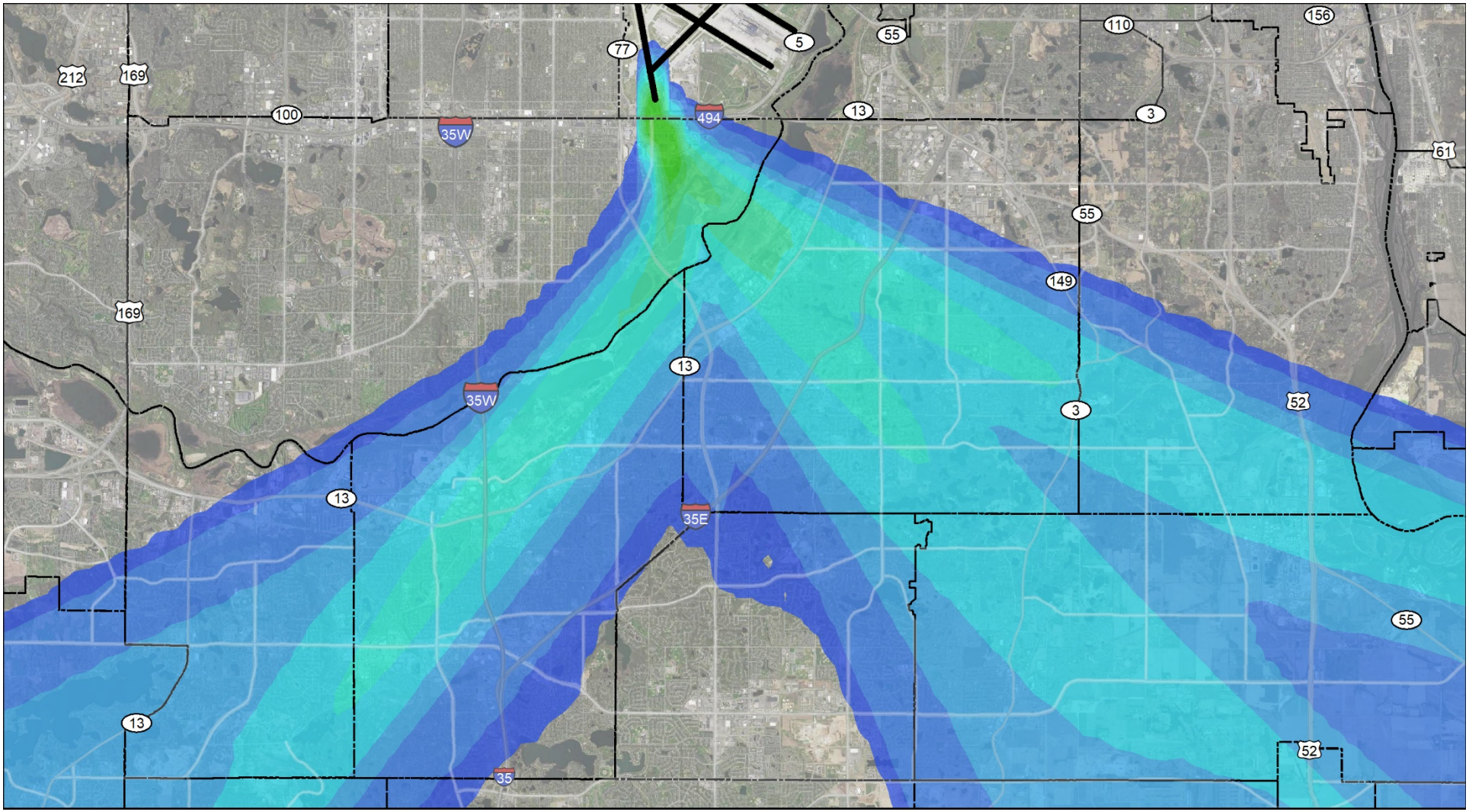


2018
ANNUAL RUNWAY 17
DEPARTURE DENSITY

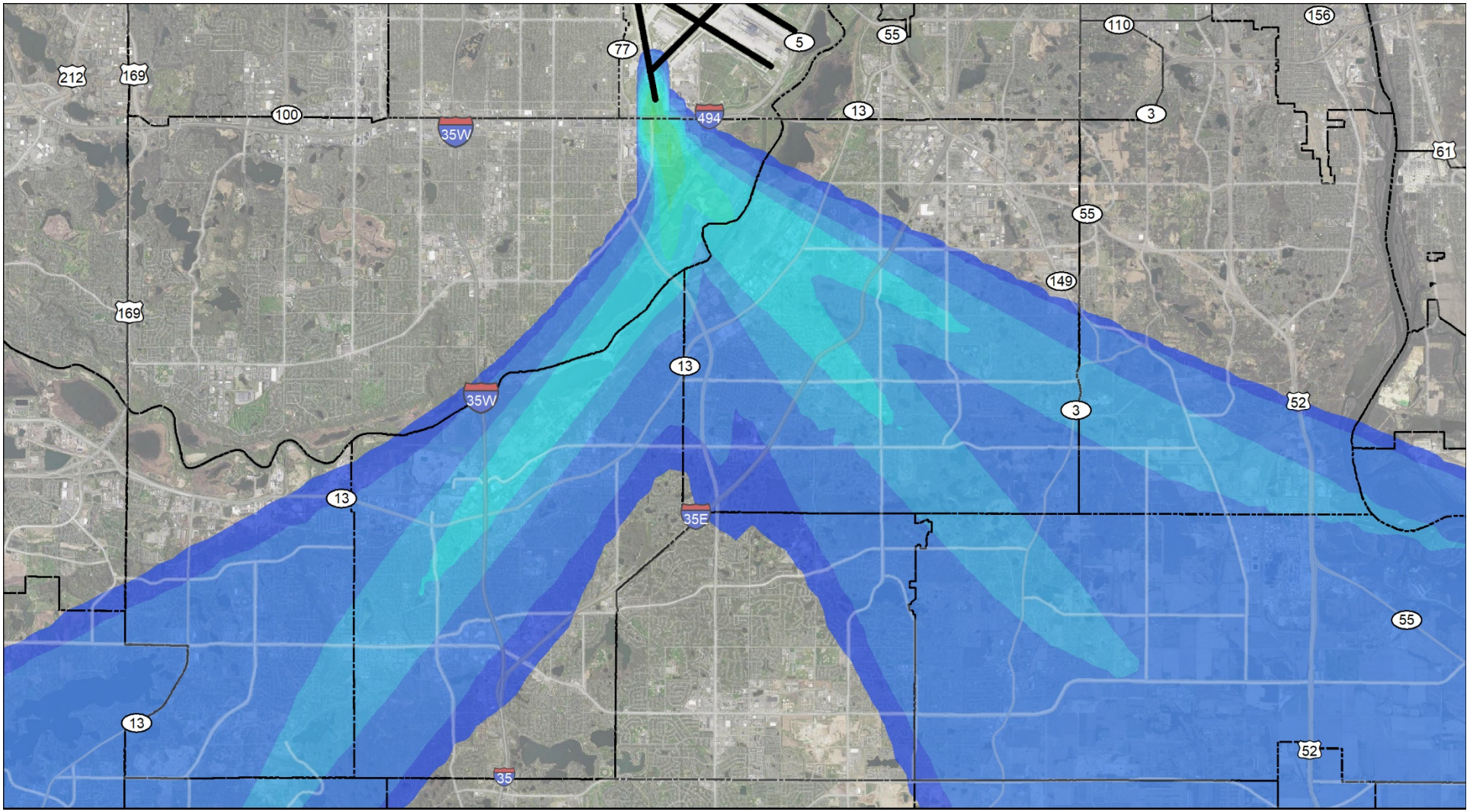


365 - 5,000
5,000 - 10,000
10,000 - 15,000
15,000 - 20,000
20,000 - 25,000
25,000 - 30,000
30,000 - 35,000
35,000- 40,000
40,000- 45,000
45,000 - 50,000
> 50,000

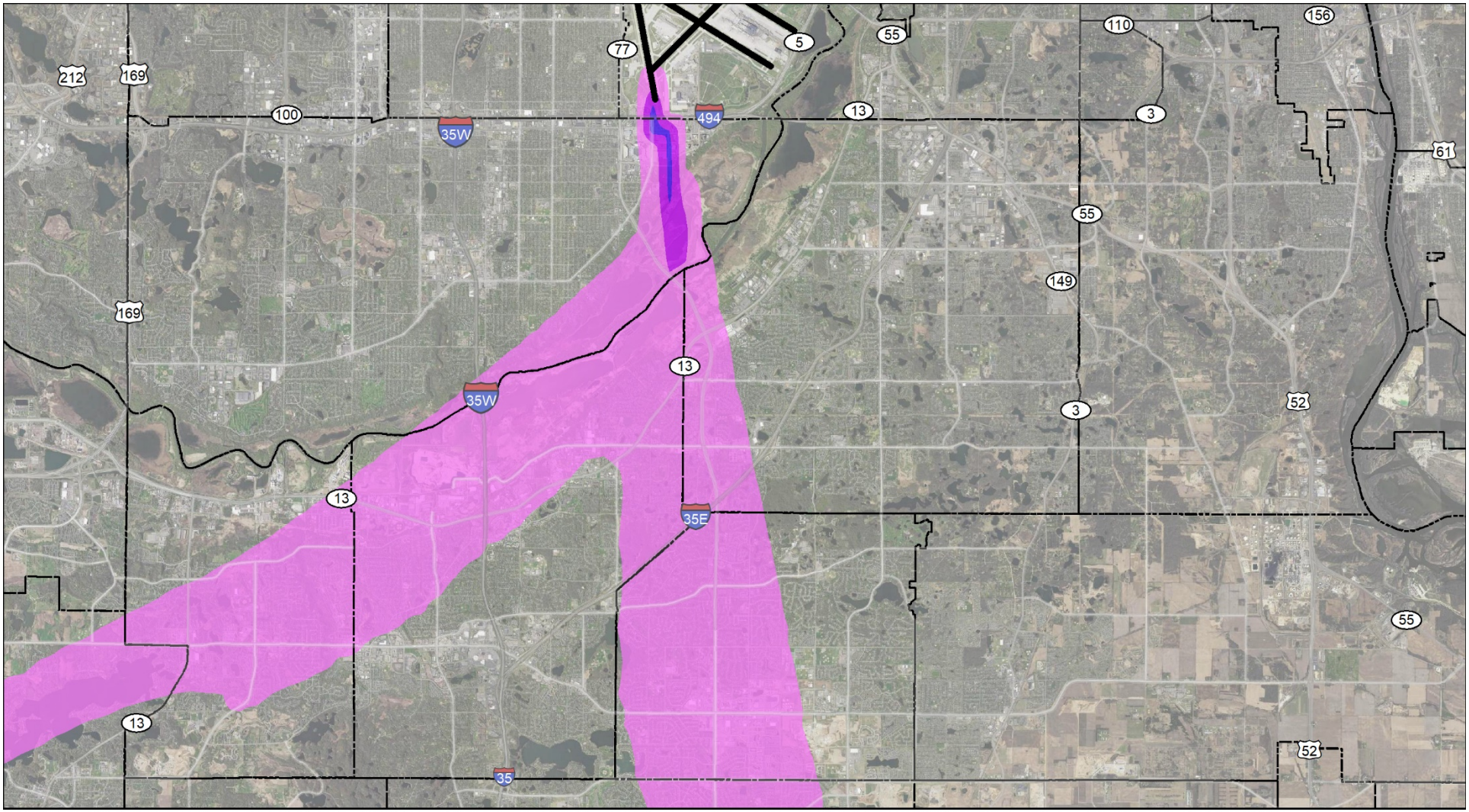
2018 ANNUAL RUNWAY 17 DEPARTURE DENSITY SOUTH FLOW

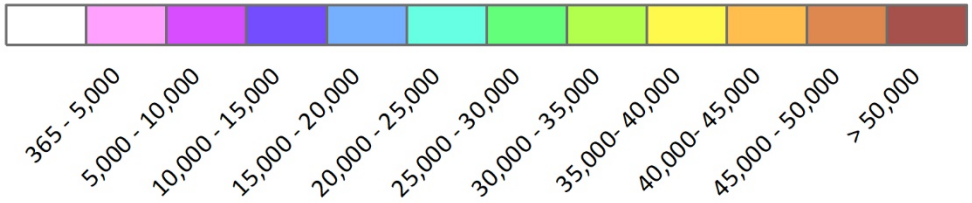


2018 ANNUAL RUNWAY 17 DEPARTURE DENSITY SOUTH FLOW VISUAL CONDITIONS

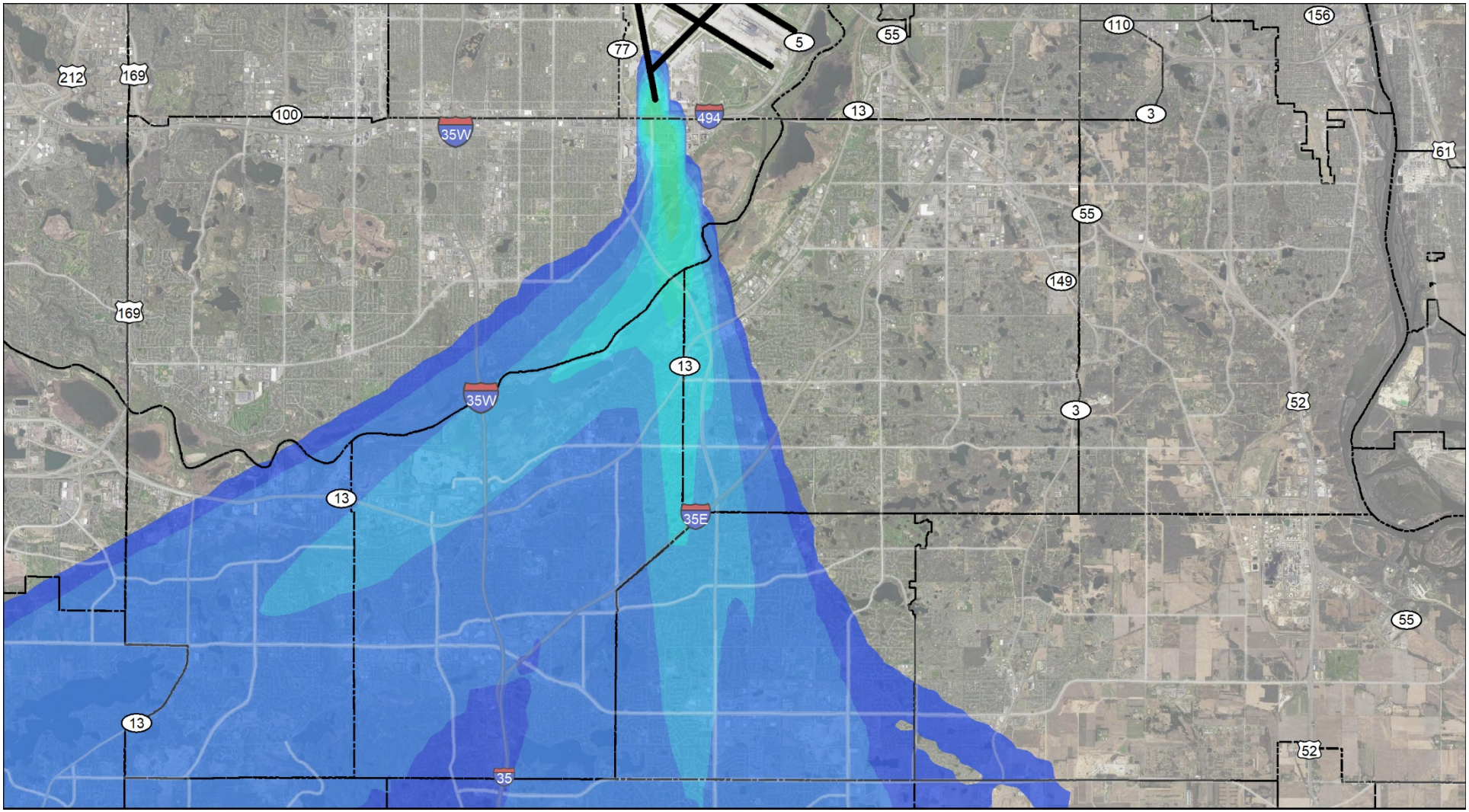


2018 ANNUAL RUNWAY 17
DEPARTURE DENSITY
SOUTH FLOW INSTRUMENT CONDITIONS

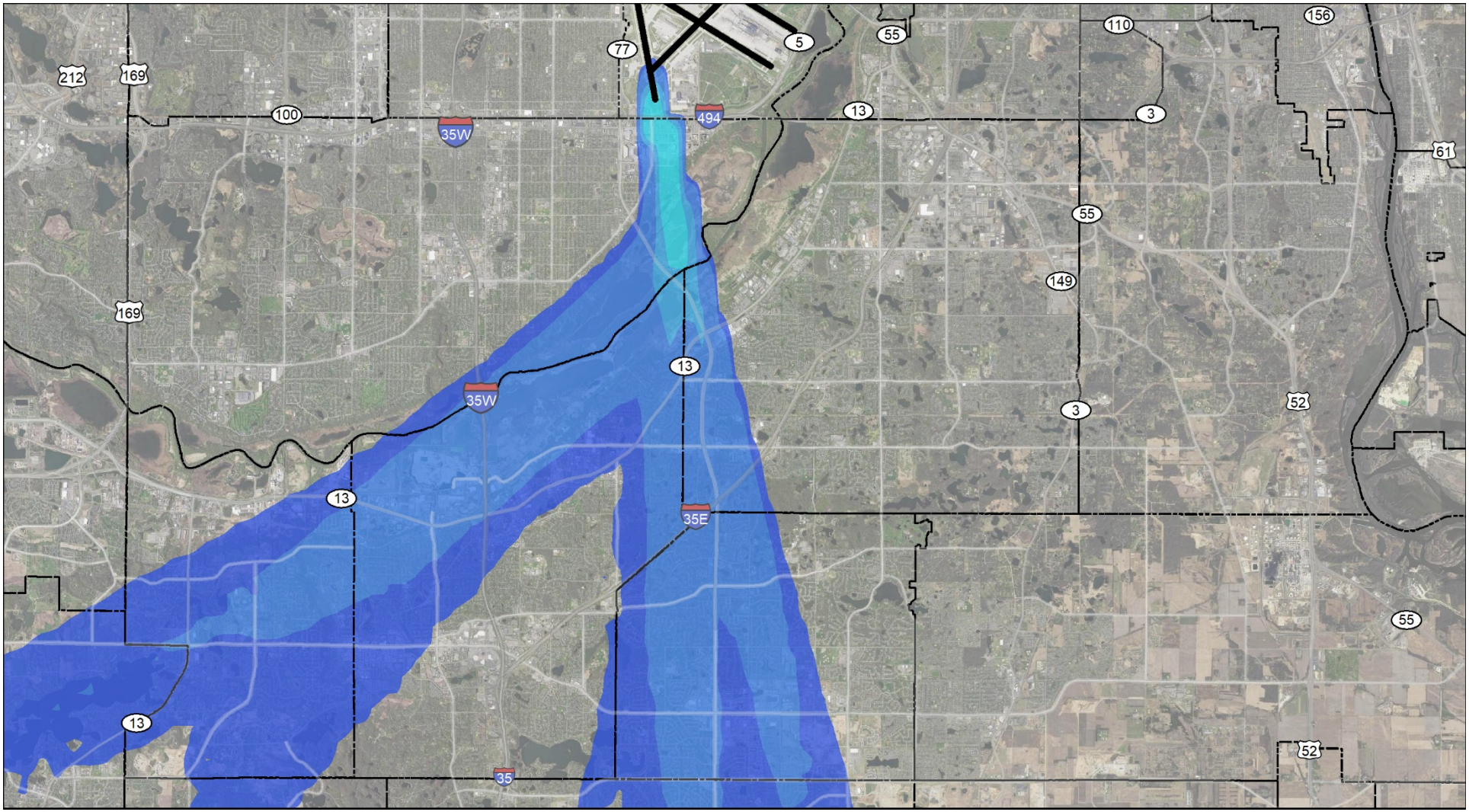




2018 ANNUAL RUNWAY 17 DEPARTURE DENSITY MIXED FLOW



2018 ANNUAL RUNWAY 17 DEPARTURE DENSITY MIXED FLOW VISUAL CONDITIONS



0 - 50
50 - 100
100 - 500
500 - 1,000
1,000 - 2,500
2,500 - 5,000
5,000 - 10,000
10,000 - 15,000
15,000 - 20,000
> 20,000

2018 ANNUAL RUNWAY 17
DEPARTURE DENSITY
MIXED FLOW INSTRUMENT CONDITIONS

APPENDIX E

FAR Part 150 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.

*The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable or unacceptable 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 TO TABLE 1

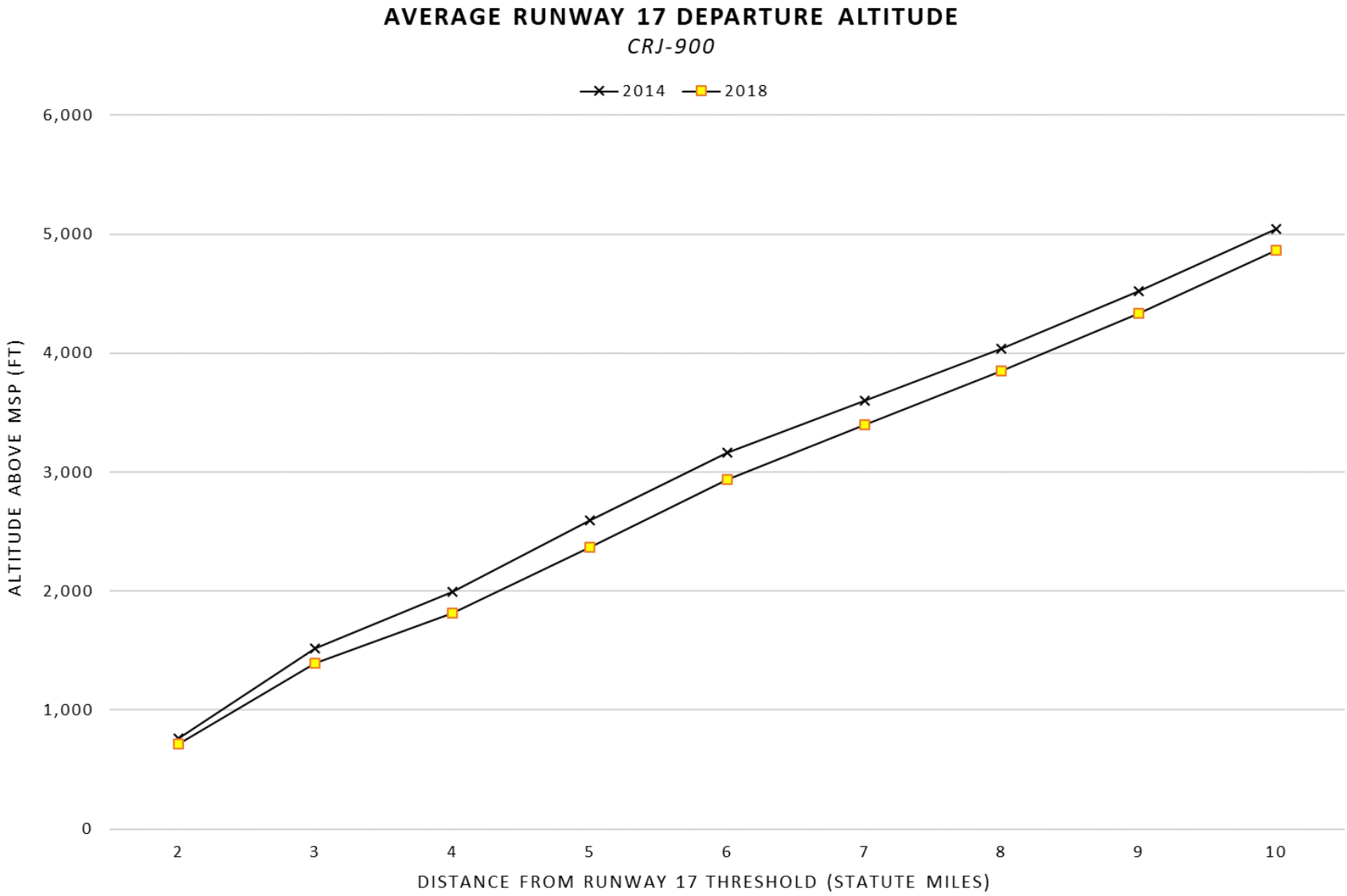
- SLUCM = Standard Land Use Coding Manual.
- Y (Yes) = Land Use and related structures compatible without restrictions.
- N (No) = Land Use and related structures are not compatible and should be prohibited.
- NLR = Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.
- 25, 30, or 35 = Land use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structure.

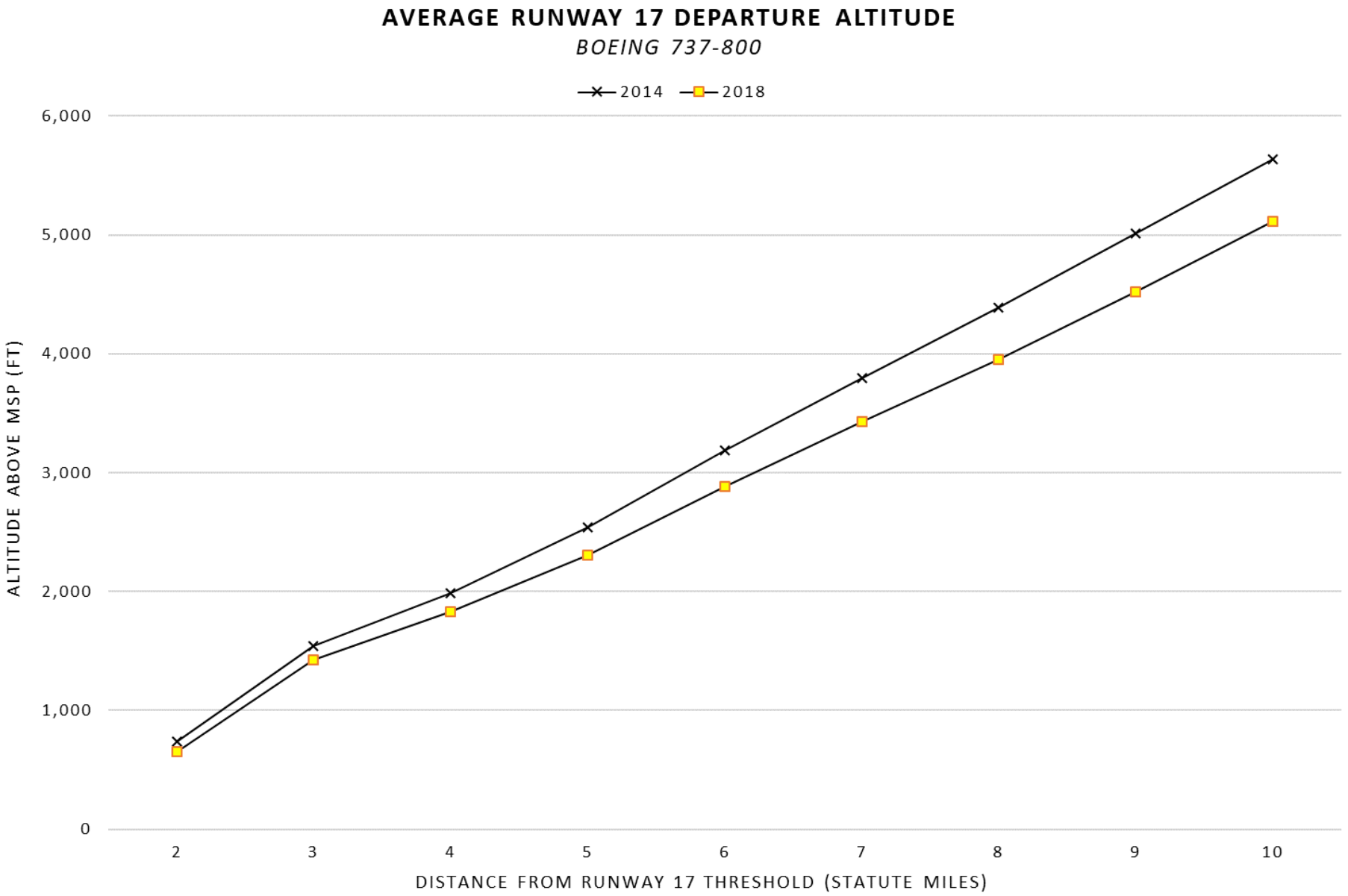
NOTES FOR TABLE 1

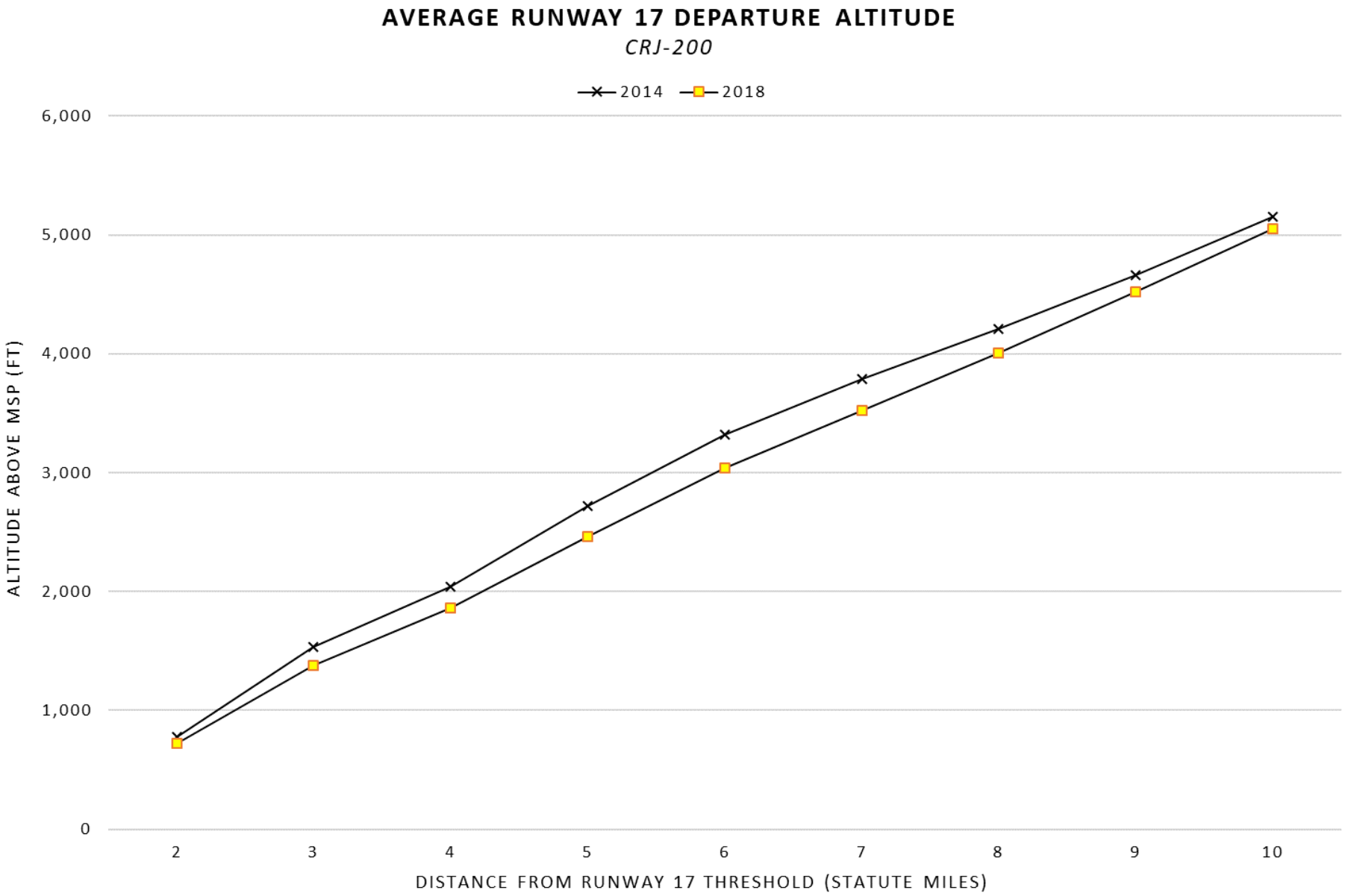
1. Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be 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 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 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 level is low.
5. Land use compatible provided special sound reinforcement systems are installed.
6. Residential buildings require an NLR of 25.
7. Residential buildings require an NLR of 30.
8. Residential buildings not permitted.

APPENDIX F

Average Runway 17 Departure Altitude




AVERAGE RUNWAY 17 DEPARTURE ALTITUDE
BOEING 737-800
2014
2018
6,000
5,000
4,000
3,000
2,000
1,000
0
ALTITUDE ABOVE MSP (FT)
2
3
4
5
6
7
8
9
10
DISTANCE FROM RUNWAY 17 THRESHOLD (STATUTE MILES)


AVERAGE RUNWAY 17 DEPARTURE ALTITUDE
CRJ-200
2014
2018
6,000
5,000
4,000
3,000
2,000
1,000
0
ALTITUDE ABOVE MSP (FT)
2
3
4
5
6
7
8
9
10
DISTANCE FROM RUNWAY 17 THRESHOLD (STATUTE MILES)