Master Plan 2050

Chapter 3 | Aviation Activity Forecast

3

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PREPARED FOR
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3.1 Background

This chapter presents comprehensive forecasts of aviation activity (i.e. demand) at the Cincinnati/Northern Kentucky International Airport (CVG or the Airport). The forecasts were developed as part of the Master Plan presented herein as a basis for determining future facility requirements at the Airport.

The aviation activity forecast includes annual projections for enplaned passengers, air cargo throughput, and aircraft operations through 2050, with a base year of 2017. Projections for passengers and aircraft operations were also developed on monthly, daily, and peak hour levels. Additional details are presented for the following key future demand years: 2022, 2027, 2032, 2037, and 2050.

The forecasts presented herein represent market-driven demand for air services. Unless explicitly stated, all of the forecasts are unconstrained, and as such, do not take facility constraints or other limiting factors into consideration. In other words, for the purposes of estimated future demand, the forecasts assume facilities can be provided to meet demand.

All of the years discussed in the text, tables, and exhibits are expressed in calendar years unless otherwise stated.

3.1.1 Historical Aviation Activity

This section provides a summary of the historical activity levels and the current passenger air service at the Airport. The information in this section provides a context for the forecast. Although the past is not a perfect predictor of the future, an analysis of historical data provides the opportunity to understand factors that have affected traffic and how those factors may influence the forecast in the future.

3.1.1.1 *Passenger Activity*

Passenger Activity Trends

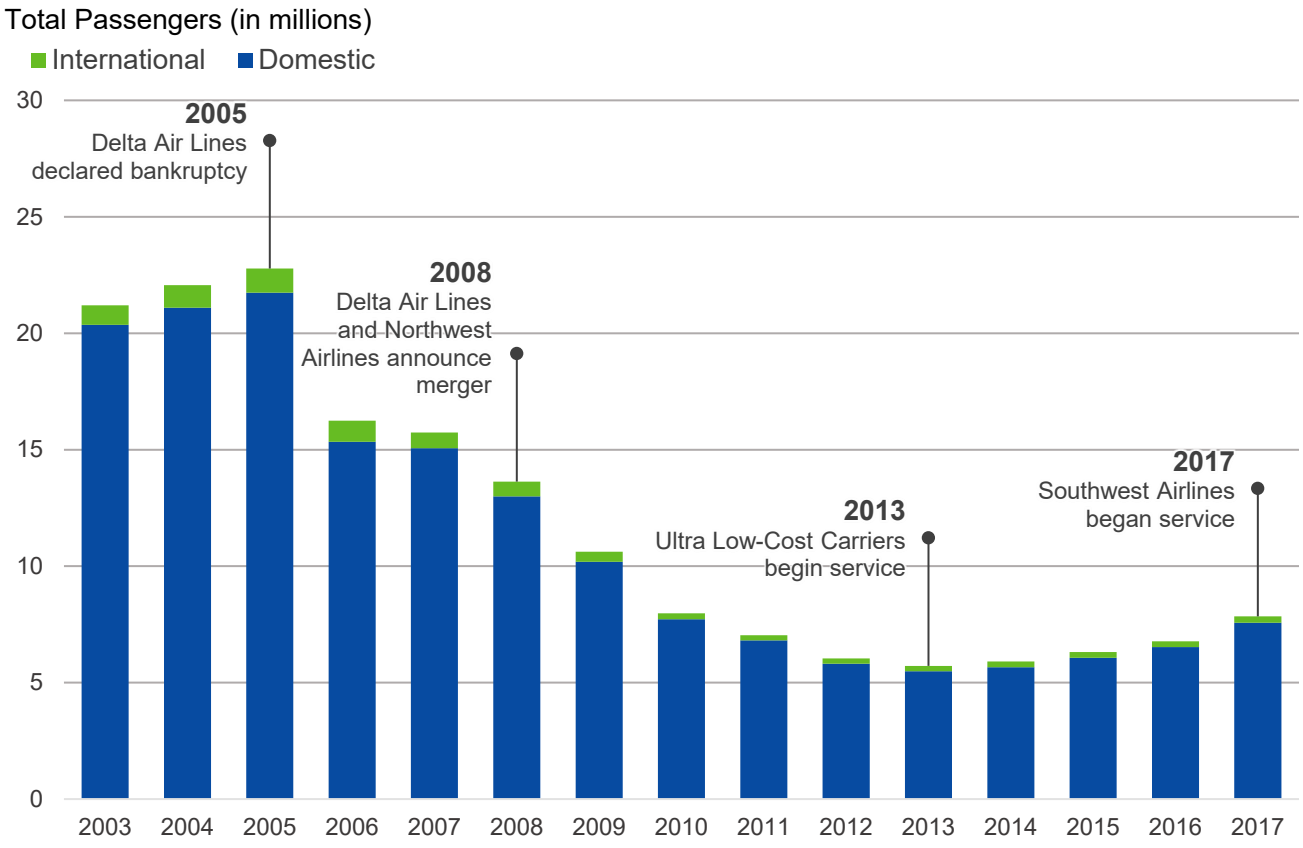
The Airport is classified by the FAA as a medium hub airport[1] based on its percentage of nationwide enplaned passengers.[2] In the mid-1980s, Delta Air Lines created at hub at CVG and in 1992, the airline spent millions constructing Terminal 3. The investment made CVG the second largest hub for Delta Air Lines spurring passenger growth at the Airport. Through the 1990s, passenger traffic at CVG grew at a rapid pace, approximately 8.6 percent per year on average during this period primarily due to increased Comair and Delta Connection flights. The growth prompted the construction of runway 18L/36R. However, in 2001 there was a sharp decline in passenger traffic as a result of a strike by Comair pilots,[3] an economic recession, and the September 11 terrorist attacks. Passenger traffic rebounded the following year, but growth for the following three years never reached the rates seen through a majority of the 1990s. As demonstrated in **Exhibit 3.1-1**, ***Historical Passenger Throughput***, passenger traffic followed a downward trend from 2005 through 2013 but has since begun to recover. **Table 3.1-1, *Historical Passenger Throughput***, provides the passenger traffic by segment (domestic and international) since 2003. The key factors behind the changes in passenger traffic are discussed below:

- **2003-2005:** Passenger traffic increases naturally as the local demand and connecting traffic both increase due to Delta Air Lines strong presence at the Airport. In 2005, the Airport reported a peak of 22.8 million passengers.
- **2006-2007:** On September 14, 2005, Delta Air Lines filed for reorganization under Chapter 11 bankruptcy. As a result, the airline cut more than a quarter of its flights at the CVG hub which equated to a 28.7 percent decline in passenger traffic at the Airport the following calendar year. Passenger traffic continued to decline through 2007 as a result of the continued restructuring of Delta Air Lines.
- **2008-2012:** On April 14, 2008, Delta Air Lines and Northwest Airlines announced plans to merge under the Delta name. On September 26, 2008, the merger was approved by the respective airlines' shareholders and was subsequently approved by the U.S. Department of Justice in October 29, 2008. In December 2009, the operating certificates were merged. Delta Air Lines post-merger strategy included plans to significantly downsize its CVG hub operation. As a result, connecting passengers declined substantially, from 4.6 million in 2008 to less than a million in 2012. It should be noted that during this period, local traffic remained relatively constant.
- **2013-2017:** In May 2013, Frontier Airlines became CVG's first low-cost carrier since the late 1990s when the airline launched service to Denver International Airport (DEN). The following year, another low-cost carrier, Allegiant Air, began service. These carriers helped to spur growth in local traffic at the Airport. Meanwhile, traditional full-service carriers, American Airlines and United Airlines, also increased their capacity to their major hubs. Southwest Airlines began commercial service in June of 2017 with service to Baltimore-Washington International

1 Federal Aviation Administration, Report to Congress: National Plan of Integrated Airport Systems (NPIAS) 2017-2021, September 30, 2016.
2 To be classified as a medium-hub airport, the airport must have at least 0.25 percent but less than 1 percent of the national annual enplaned passengers.
3 On March 26, 2001, Comair's pilots officially went on strike. At the time, Comair was Delta Air Lines exclusive provider for regional connections at CVG.

Thurgood Marshall Airport (BWI) and Chicago Midway International Airport (MDW). From 2013 through 2017, passenger traffic increased from 5.7 million to 7.8 million, representing an average annual growth rate (AAGR) of 8.2 percent.

EXHIBIT 3.1-1 HISTORICAL PASSENGER THROUGHPUT



Source: KCAB

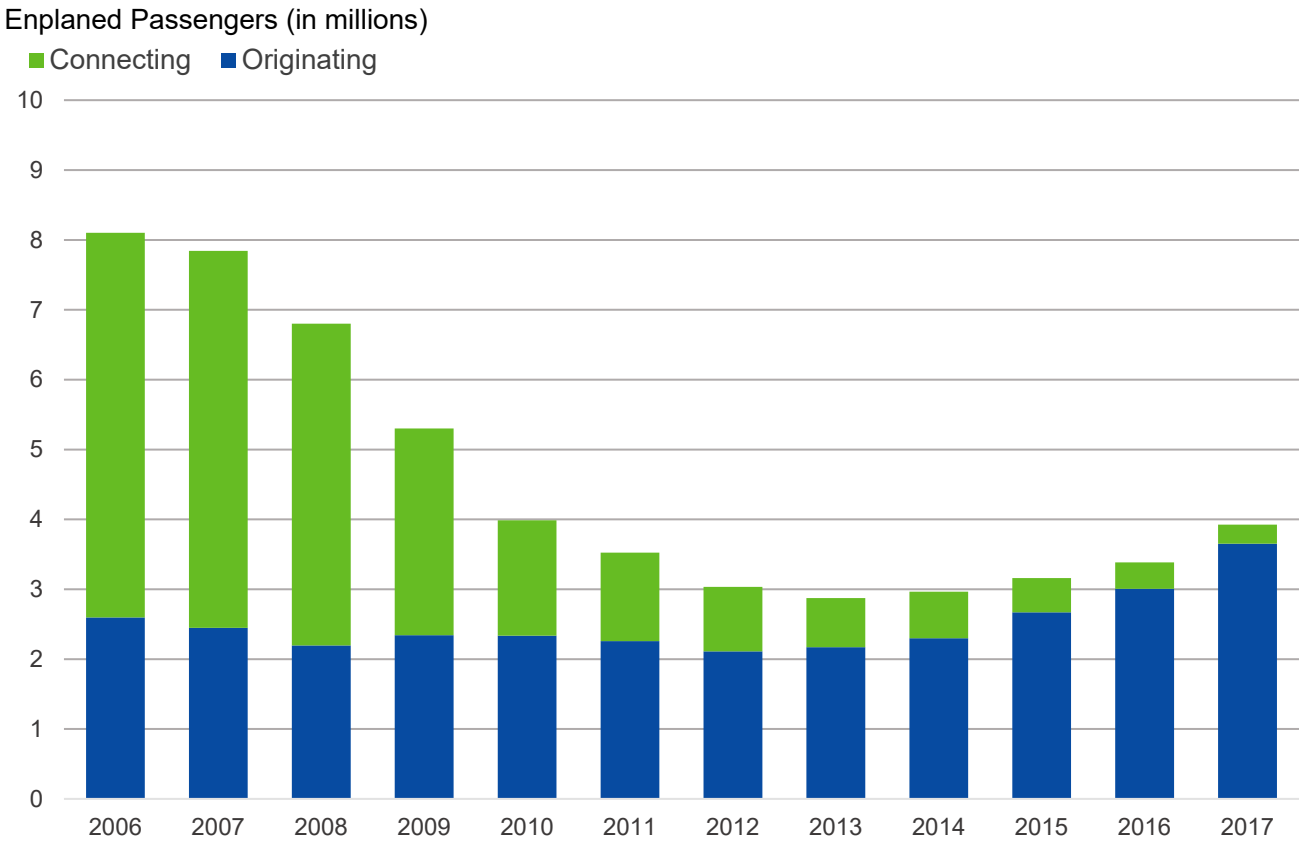
TABLE 3.1-1 HISTORICAL PASSENGER THROUGHPUT

Year	Total Passengers		
	Domestic	International	Total
2003	20,364,536	832,911	**21,197,447**
2004	21,095,602	966,955	**22,062,557**
2005	21,742,929	1,035,856	**22,778,785**
2006	15,341,324	903,638	**16,244,962**
2007	15,068,468	667,752	**15,736,220**
2008	12,999,485	630,958	**13,630,443**
2009	10,190,102	432,083	**10,622,185**
2010	7,724,239	253,349	**7,977,588**
2011	6,815,241	219,022	**7,034,263**
2012	5,814,917	223,677	**6,038,594**
2013	5,485,995	232,260	**5,718,255**
2014	5,662,320	246,391	**5,908,711**
2015	6,063,029	253,303	**6,316,332**
2016	6,526,127	247,778	**6,773,905**
2017	7,570,313	271,836	**7,842,149**
Range	Average Annual Growth Rate		
2013-17	8.4%	4.0%	**8.2%**
2003-17	-6.8%	-7.7%	**-6.9%**

Source: KCAB

Delta Air Lines has had a significant presence at CVG since the mid-1980s when the airline established a hub. The airline quickly become the largest carrier at the Airport and the majority of the growth at the Airport was dependent on Delta Air Lines' hubbing strategy By, the mid-2000s, more than half of the passenger traffic at CVG was connecting passengers, most of which were handled by Comair and Delta Connection flights. However, the number of connecting passengers at CVG declined rapidly as a result of Delta Air Lines' bankruptcy which was followed by the eventual merger with Northwest Airlines. In 2006, 67.9 percent of all enplaned passengers at CVG were connecting. From 2006 through 2014, originating enplaned passengers remained relatively steady despite a decline of available nonstop markets. In 2013, the introduction of low-cost and ultra-low-cost carriers led to a significant decline in the average airfare at CVG, particularly to traditional vacation destinations. As a result, originating enplaned passengers have increased at an average annual rate of 13.9 percent per annum since 2013. In 2017, there were 273,888 connecting enplaned passengers, which accounted for just 7.0 percent of enplaned passengers. **Exhibit 3.1-2, *Historical Enplaned Passengers by Type***, graphically depicts how the share of connecting passengers has changed over time as well as the recent growth in originating traffic.

EXHIBIT 3.1-2 HISTORICAL ENPLANED PASSENGERS BY TYPE



Source: KCAB.

In 2007, Delta Air Lines accounted for 91.4 percent of the enplaned passengers. The decline of Delta Air Lines' connecting passengers at the Airport combined with increasing competition by other airlines has reduced Delta Air Lines' market share at the Airport. In 2017, Delta Air Lines accounted for 45.1 percent of the enplaned passengers at the Airport. Other legacy carriers, American Airline and United Airlines, have nearly doubled their enplaned passengers over this period and in 2017 combined account for 25.8 percent of the enplaned passengers, up from 7.8 percent in 2007. Low-cost carriers and ultra-low-cost carriers, Frontier Airlines; Allegiant Air; and Southwest Airlines, accounted for 28.3 percent of the enplaned passengers in 2017. **Table 3.1-2, *Historical Enplaned Passenger Market Share***, provides a summary of the airline market share based on enplaned passengers since 2007.

TABLE 3.1-2 HISTORICAL ENPLANED PASSENGER MARKET SHARE

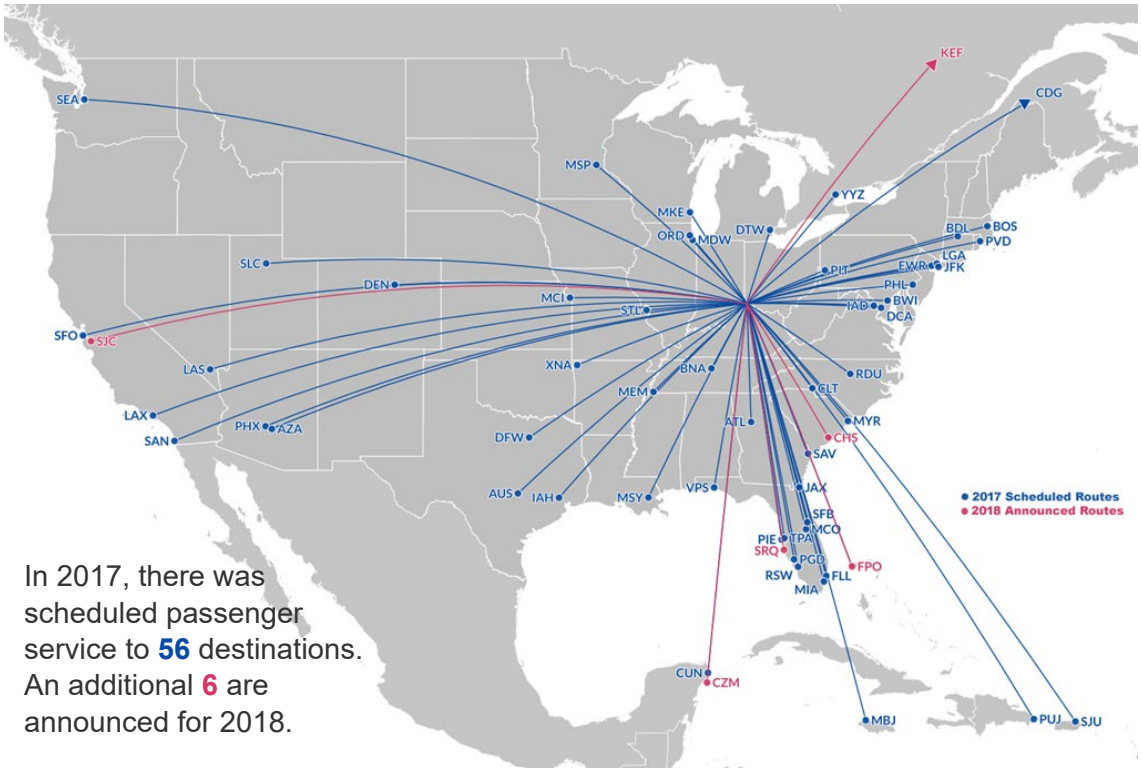
Year	Market Share				
	Delta Air Lines	Other Legacy Carriers	LCC & ULCC	Other Airlines	Grand Total
2007	91.4%	7.8%	0.0%	0.7%	100.0%
2008	90.8%	8.4%	0.0%	0.8%	100.0%
2009	89.5%	9.8%	0.0%	0.7%	100.0%
2010	84.5%	14.8%	0.0%	0.7%	100.0%
2011	82.0%	17.5%	0.0%	0.5%	100.0%
2012	78.3%	21.0%	0.0%	0.7%	100.0%
2013	74.4%	23.5%	1.1%	1.0%	100.0%
2014	67.8%	25.0%	6.2%	1.0%	100.0%
2015	56.3%	25.8%	16.5%	1.4%	100.0%
2016	51.1%	27.2%	20.7%	1.0%	100.0%
2017	45.1%	25.8%	28.3%	0.8%	100.0%

Source: KCAB

Passenger Air Service

In 2017, there was scheduled service to 56 domestic and international destinations from CVG.[4] Delta Air Lines provides service to the most destinations with service to 32 domestic and three international destinations (Cancun, Paris, and Toronto) with an additional two destinations (Austin and Phoenix) announced to start in 2018. American Airlines (eight destinations) and United Airlines (six destinations) limit their offerings to their domestic hubs. Frontier Airlines provides service to 18 destinations and has announced service to five new markets starting in 2018 (Austin, Jacksonville, Raleigh-Durham, San Antonio, and San Jose California). Allegiant Air has 19 destinations served from CVG with an additional two destinations (Charleston and Sarasota) announced to start in 2018. Southwest Airlines began service at CVG in June 2017 and provides service to Chicago Midway International Airport (MDW) and Baltimore-Washington International Thurgood Marshall Airport (BWI) with an additional destination (Denver) announced to start in 2018. Air Canada provides scheduled international service to Toronto. Apple Vacations and Vacation Express provide additional international charter service. WOW Air will begin new international service to Keflavik International Airport (KEF) in May 2018. **Exhibit 3.1-3, *Map of Nonstop Destinations***, provides a map of the scheduled nonstop destinations in 2017 and the new destinations announced thus far for 2018.

EXHIBIT 3.1-3 MAP OF NONSTOP DESTINATIONS



In 2017, there was scheduled passenger service to **56** destinations. An additional **6** are announced for 2018.

Sources: KCAB, Nonstop Cities accessed at www.cvgairport.com/flight/cities

[4] These destinations include year-round and seasonal service.

Top Passenger Markets

An overwhelming majority of passenger traffic at CVG is now origin and destination (O&D), or local passengers versus connecting passengers. **Table 3.1-3, Top 25 *O&D Markets***, presents the share of O&D passengers for the top 25 O&D markets in 2016. The top 25 regional markets accounted for a combined share of 76.1 percent of the O&D passengers at CVG. Florida is the highest demand region from CVG and accounts for 21.1 percent of the O&D enplanements.

TABLE 3.1-3 TOP 25 O&D MARKETS IN 2016

Market	Airports	Originating Passengers	Share of Originating Passengers
Central Florida	MCO / TPA / SFB / PIE / SRQ / DAB / MLB	307,175	10.8%
South Florida	FLL / RSW / PGD / MIA / PBI / EYW	247,559	8.7%
New York / Newark	LGA / EWR / JFK / HPN / SWF / ISP	200,296	7.0%
Las Vegas	LAS	135,995	4.8%
Los Angeles Basin	LAX / SNA / ONT / PSP / BUR / SBA	123,577	4.3%
Washington / Baltimore	DCA / BWI / IAD	113,869	4.0%
Dallas / Ft. Worth	DFW / DAL	96,607	3.4%
Denver	DEN	85,450	3.0%
Chicago	ORD / MDW	85,164	3.0%
Atlanta	ATL	81,625	2.9%
San Francisco Bay Area	SFO / SJC / OAK	78,602	2.8%
Philadelphia	PHL	72,281	2.5%
Boston	BOS	71,336	2.5%
Phoenix	PHX / AZA	64,245	2.3%
Houston	IAH / HOU	64,057	2.2%
North Florida	JAX / VPS / PNS / ECP / TLH / GNV	46,350	1.6%
Minneapolis / St. Paul	MSP	43,792	1.5%
Charlotte	CLT	42,159	1.5%
Seattle	SEA	40,879	1.4%
Toronto*	YYZ	34,340	1.2%
Salt Lake City	SLC	30,226	1.1%
New Orleans	MSY	27,672	1.0%
San Diego	SAN	26,503	0.9%
Austin	AUS	26,150	0.9%
Cancun*	CUN	24,367	0.9%
Top 25 Markets		**2,170,276**	**76.1%**
Other Markets		679,945	23.9%
Grand Total		**2,850,221**	**100.0%**

Notes: Asterisk (*) indicates an international destination. Totals may not equal 100% due to rounding.
Source: U.S. Department of Transportation, Air Passenger Origin-Destination Survey

3.1.1.2 *Cargo Activity*

Air Cargo Throughput

Air cargo at airports is comprised of two segments: air mail and air freight. Air mail refers to parcels that are carried by aircraft as part of a contract with the U.S. Postal Service. Air freight refers to all air cargo that is not air mail. Since 2011, less than one percent of the total air cargo processed at CVG was air mail. Prior to 2004, air cargo increased at a steady pace. However, in 2005 DHL moved its sorting operations from CVG to Airborne Air Park in Wilmington Ohio (ILN) upon entering the US domestic express business. The impact to air cargo throughput was dramatic as only 47,728 tons of cargo were processed at CVG in 2006, almost a tenth of the throughput in 2004. DHL's operation at the Airborne Air Park was relatively short lived. In 2009, DHL refocused its US operations on handling international business and moved its operation back to CVG. Since returning to CVG, DHL has invested $275 million in its facilities at the Airport and has a total of $505 million invested in its hub facilities that were relocated to the south airfield area of the Airport in 2002. In 2013, DHL designated CVG, one of just three global "super hubs" in the world. The latest expansion to the hub was completed in 2016 and added 16 wide-body parking positions. This investment has resulted in significant growth in cargo activity. Since DHL's first full year after returning to CVG, air cargo has increased at an AAGR of 14.0 percent.

In January 2017, Amazon Air announced plans to create a $1.4 billion worldwide cargo hub at CVG. The facility will support a fleet of 100+ freighter aircraft on more than 900 acres at the south end of the Airport's property. The hub is expected to open in 2020 with the ultimate build-out to be completed by 2028. In the interim, Amazon has entered a collaboration with DHL that allows DHL to run its American hub at night while Amazon uses the facilities during the daytime. Under this collaboration, Amazon Air began service at CVG in May of 2017. With less than eight full month in 2017 and under constrained operations, Amazon processed 127,505 tons of cargo.

In 2017, cargo throughput at the Airport reached an all-time high of 1.0 million tons representing a growth of 27.3 percent when compared to 2016. CVG is now the eighth largest air cargo airport in North America. **Exhibit 3.1 4, *Historical Air Cargo Throughput***, provides a graphical representation of the air cargo throughput at CVG since 2003.

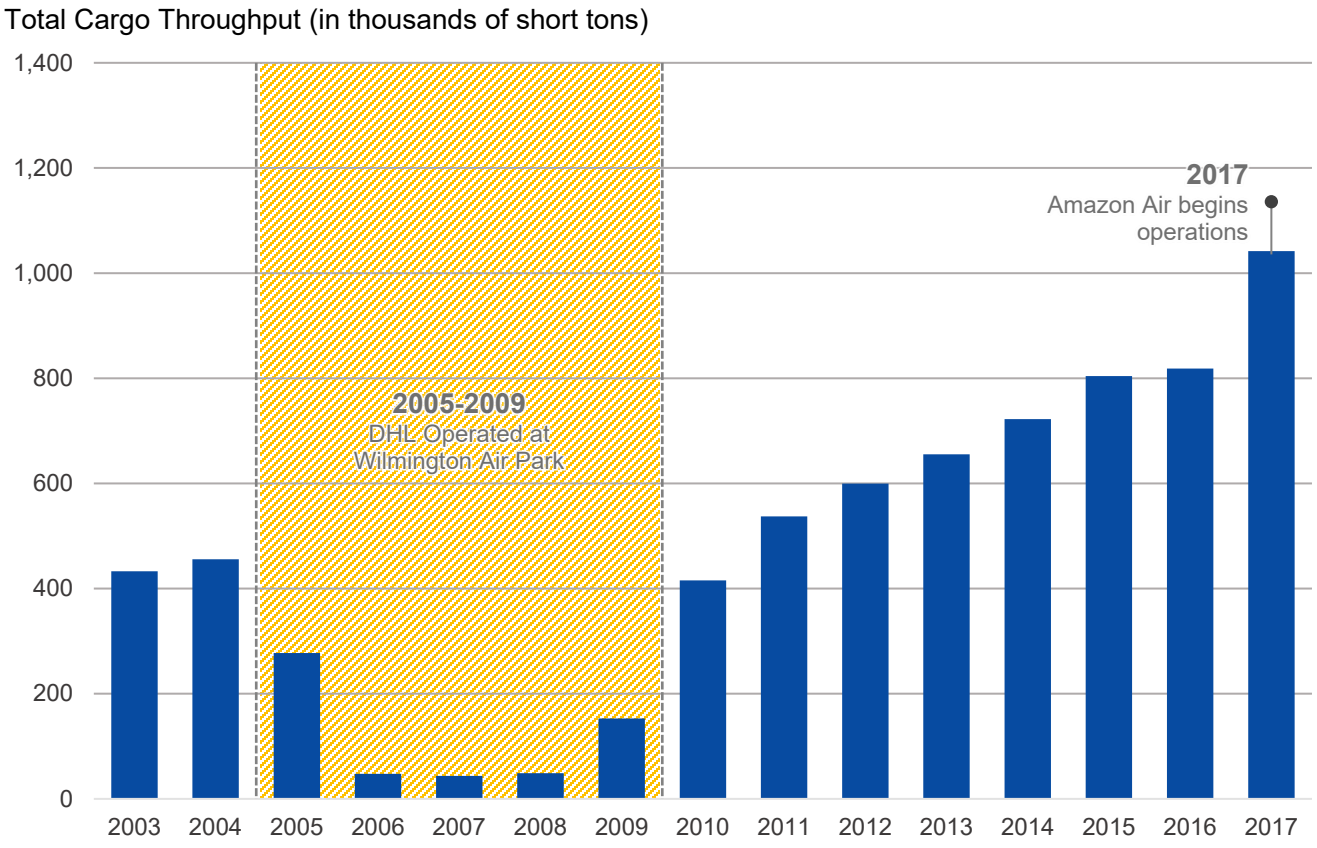
Mode of Transportation

There are two shipping methods for transporting air cargo: (1) in the cargo compartment (belly) of commercial passenger aircraft or (2) aboard dedicated all-cargo aircraft (freighters).

Most passenger airlines accommodate air cargo as a byproduct of their primary activity of carrying passengers. Cargo fills belly space in passenger aircraft that would otherwise be empty. The incremental cost of transporting cargo in passenger aircraft is negligible and includes ground handling expenses and a modest increase in fuel consumption.

The majority of cargo processed at CVG (98.7 percent since 2011) has been handled by all-cargo carriers, and more specifically DHL. In 2017, DHL handled 84.7 percent and Amazon Air handled 12.2 percent of all air cargo processed at the Airport.

EXHIBIT 3.1-4 HISTORICAL AIR CARGO THROUGHPUT



Source: KCAB

3.1.1.3 *Aircraft Operations*

An aircraft operation consists of either a takeoff or landing. For the purposes of developing the forecasts, aircraft operations were classified into five key categories: (1) passenger; (2) freighter; (3) air taxi; (4) general aviation; and (5) military.

Passenger aircraft operations refer to operations handled by airlines with scheduled service, i.e. certified as a scheduled air carrier by the FAA under Part 121.[5] Unsurprisingly, passenger aircraft operations have closely reflected the changes in passenger throughput. This includes a significant decline in passenger aircraft operations from 2005 through 2013 resulting from Delta Air Lines declaring bankruptcy followed by its merger with Northwest Airlines. Since 2013, passenger aircraft operations have appeared to stabilize.

In 2007, freighter aircraft operations were only 2.2 percent of the total aircraft operations at the Airport. DHL relocated its sorting operations to CVG in 2009 and by 2010 freighter operations accounted for 11.0 percent of the aircraft operations at the Airport. Since 2010, freighter aircraft operations have continued to increase as DHL invested in its hub at CVG. The introduction of Amazon Air, which began service in May, contributed in a significant increase in freighter operations in 2017. In 2017, there were 36,004 freighter aircraft operations, nearly a quarter of the total aircraft operations at CVG.

Air taxi represents chartered aircraft operated by companies that operate under Part 91[6] (i.e., not certificated as scheduled air carrier by the FAA and not covered under Part 121). Business charters at CVG, such as NetJets, provide ad-hoc service utilizing mostly business jet aircraft. These airlines account for a majority of the air taxi service at CVG. Currently, the fixed based operator (FBO) at CVG, Delta Jet Center, does not have a U.S. Customs and Border Protection (CBP) facility to be able to process international arriving passengers. Therefore, international air taxi operations are required to stop at an intermediary airport prior to CVG or operate at another nearby airport. This has hampered the potential for growth of air taxi operations at the Airport. In 2017, air taxi aircraft operations were down 59.4 percent compared to 2007.

5 14 Code of Federal Regulations Part 121
6 14 Code of Federal Regulations Part 91

A new General Aviation Facility (GAF) is scheduled to be constructed in 2018 adjacent to the Delta Jet Center FBO facility. The GAF will have CBP processing capabilities to will allow international air taxi aircraft arriving from an international origin to fly directly to CVG and clear customs and immigration without having to stop at an intermediate airport.

General aviation (GA) aircraft operations represent all civil operations not classified as commercial (i.e., passenger, freighter, or air taxi). GA aircraft operations can be further classified as either local or itinerant.[7] In 2017, GA aircraft operations were down 9.3 percent compared to 2007.

Military aircraft operations represent operations conducted by military or government aircraft. Military aircraft operations can be further classified as either local or itinerant. Over the past decade, military aircraft operations have been relatively steady. There have been 188 aircraft operations on average since 2007.

A summary of the aircraft operations by classification is provided in **Table 3.1-4, *Historical Aircraft Operations***.

[7] Local operations include aircraft operating in the traffic pattern or within sight of the tower, or aircraft known to be departing or arriving from flight in local practice areas, or aircraft executing practice instrument approaches at the airport. Itinerant operations are those not classified as local, i.e. operations of aircraft going from one airport to another.

TABLE 3.1-4 HISTORICAL AIRCRAFT OPERATIONS

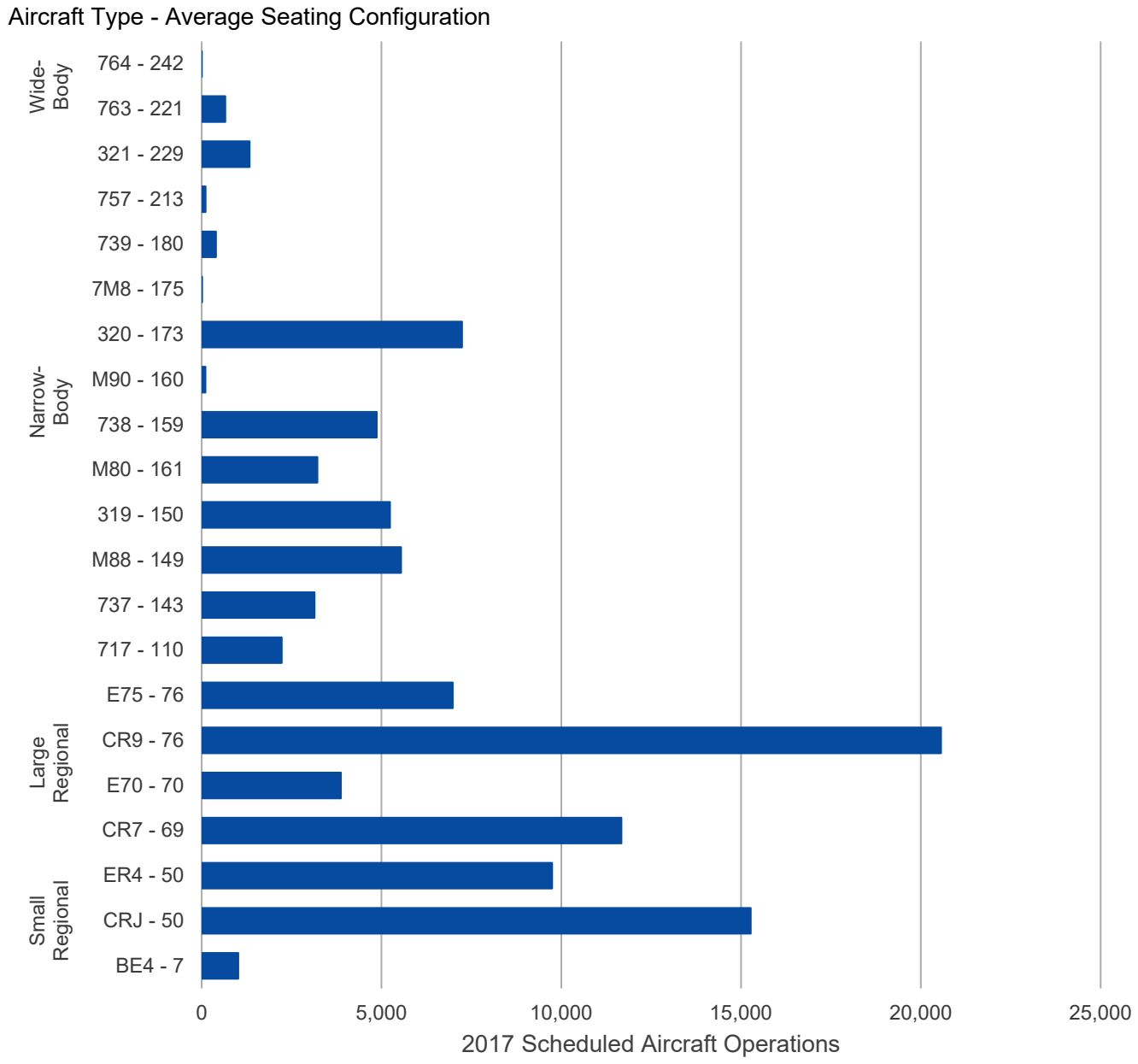
Year	Aircraft Operations						Grand Total
	Passenger		Cargo	Air Taxi	General Aviation	Military	
	Domestic	International					
2007	296,400	8,574	7,938	8,506	6,499	152	**328,069**
2008	258,512	7,900	5,452	7,926	5,531	163	**285,484**
2009	196,772	5,384	10,820	5,335	4,205	161	**222,677**
2010	142,442	4,052	20,212	6,016	4,751	124	**177,597**
2011	125,824	4,486	21,564	5,468	4,441	129	**161,912**
2012	107,640	3,804	23,440	3,514	4,828	221	**143,447**
2013	102,642	3,574	23,592	2,865	4,808	190	**137,671**
2014	97,048	3,778	24,598	2,611	5,394	89	**133,518**
2015	94,130	3,302	26,308	3,356	5,994	135	**133,225**
2016	96,746	3,586	27,970	2,443	6,297	183	**137,225**
2017	101,154	3,824	36,004	3,453	5,896	132	**150,463**

Source: KCAB

3.1.1.4 *Aircraft Fleet Mix*

Airlines providing scheduled passenger air service at CVG deploy a predominately regional jet fleet (aircraft with 76 or fewer seats). In 2017, nearly two-thirds of all scheduled passenger service utilized a regional aircraft compared to 32.4 percent narrow-body and 0.6 percent wide-body. **Exhibit 3.1-5, *Scheduled Passenger Aircraft Operations by Aircraft Type***, graphically depicts the number of scheduled passenger aircraft operations by aircraft type for 2017.

EXHIBIT 3.1-5 SCHEDULED PASSENGER AIRCRAFT OPERATIONS BY AIRCRAFT TYPE



Sources: OAG Aviation Worldwide Ltd, OAG Schedules Analyzer

In 2017, 20.3 percent of the scheduled domestic service utilized the Canadair Regional Jet 900 aircraft. Historically, the smaller Canadair Regional Jet 200 has been the most utilized aircraft at the Airport. However, recent trends in the airline industry shifted the demand from smaller 50-seat regional jets to larger 70+ seat regional jets as the major airlines have opted to use these aircraft due to their cost-efficiency. This trend is evident at CVG in 2017 as small regional aircraft accounted for just 23.2 percent of the scheduled domestic service as compared to 35.3 percent the year prior. All of the airlines with regional service, including Delta Air Lines, have contributed to this shift at CVG. The shift to larger regional aircraft have resulted in an average seating configuration for domestic flights to increase from an average of 56.6 seats per regional aircraft operation in 2014 to 64.7 seats per regional aircraft operation in 2017.

There has been another significant shift in aircraft utilization at the Airport in recent years. American Airlines and United Airlines have historically relied on regional jets, particularly the Canadair Regional Jet 900 and the Embraer 175 respectively. However, both airlines have been deploying some narrow-body aircraft (American Airlines is utilizing the McDonnell Douglas MD-80 and United Airlines is utilizing the Airbus A319-100) on scheduled flights to their respective domestic hubs. Rapidly growing low-cost and ultra-low-cost carriers deploy a fleet entirely comprised of narrow-body aircraft to cater to their O&D traffic. Therefore, narrow-body aircraft are accounting for an increasing share of the domestic fleet at the Airport. Combined with the shift to larger regional aircraft, the increased use of narrow-body aircraft has increased the average seats per aircraft operation for domestic flights from 72.9 seats in 2014 to 95.7 seats in 2017.

Flights to and from Canada (Toronto Pearson International Airport) are provided by Delta Air Lines and Air Canada and exclusively utilize variants of the Canadair Regional Jet 200. Delta Air Lines, Apple Vacation,[8] and Vacation Express[9] provide seasonal service to Latin America and the Caribbean. These flights utilize narrow-body aircraft such as the Airbus A320 and the McDonnell Douglas MD-88. A daily scheduled transoceanic flight to Paris-Charles de Gaulle Airport (CDG) is provided by Delta Air Lines utilizing a Boeing 767-300 aircraft.

3.1.1.5 *Based Aircraft*

The FAA Form 5010-1, Airport Master Record, provides a description of the facilities, the number of the aircraft operations from the previous year, and the based aircraft at a particular airport. The 5010-1 for CVG indicates 13 aircraft (two single-engine, one multi-engine, and ten jet) are currently based at the airport.

8 Apple Vacation is an all-inclusive vacation provider that provides flights operated by Allegiant Air, Frontier Airlines, Miami Air, Swift Air, VivaAerobus and Volaris.

9 Vacation Express is an all-inclusive vacation provider that provides flights operated by Miami Air, Sunwing Airlines, Swift Air, VivaAerobus, and Volaris.

3.1.2 Prior Forecast

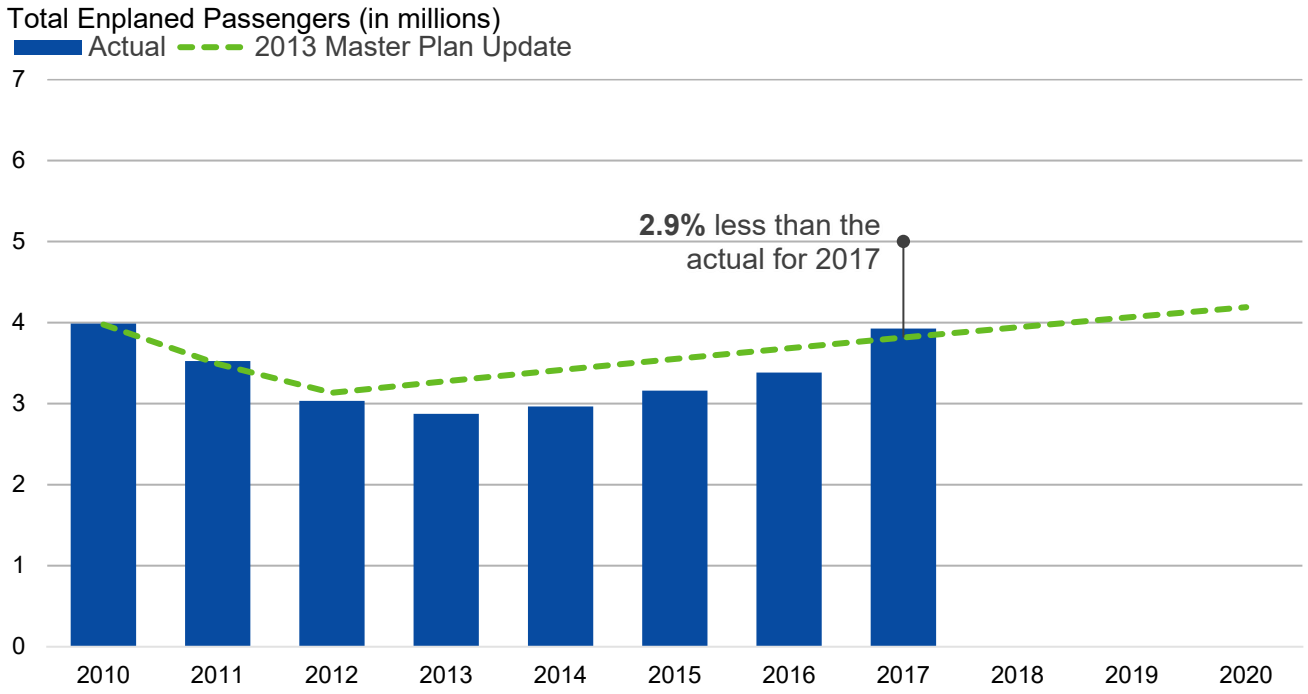
The most recent forecast of aviation activity at CVG was prepared as part of the Master Plan Update completed in 2013 (2013 Master Plan). The 2013 Master Plan used 2010 as the base year and provided projections of passenger enplanements, passenger operations, cargo operations, and cargo landed weights for the period 2011 through 2035. For GA and military operations, the forecast developed projections based on the FAA's 2011 Terminal Area Forecast (TAF) for the Airport.

At the time of development of the 2013 Master Plan forecast, CVG was undergoing a number of changes including the downsizing of Delta Air Lines hub operation and the development of DHL's North American hub. In order to account for the uncertainty due to these factors, multiple scenarios were developed. The baseline forecast was used to develop the facility requirements for the 2013 Master Plan. As such, discussion and comparisons made in this document to the 2013 Master Plan forecast will reflect the baseline forecast unless otherwise noted.

The enplaned passenger forecast was developed based on the assumption that long-term O&D traffic levels at CVG will achieve equilibrium with peer markets. Peer airports were defined as those that have similar economic or regional characteristics. A time series of ratios were created using the historical O&D enplaned passengers and metropolitan statistical area (MSA) socio-economic data that included population, per capita personal income (PCPI), and personal income. The weighted averages in the time series were applied to the socio-economic data of Cincinnati. The result was the projected O&D enplaned passengers. The O&D traffic was converted to total enplaned passengers by assuming annual ratios of local versus connecting traffic based on peer airports. The forecast estimated that enplaned passengers at the Airport would first decrease from 4.0 million in 2010 to 3.1 million in 2012 and then increase to 5.8 million in 2035. The 2013 Master Plan projected 3.8 million enplaned passengers in 2017. The actual number of enplaned passengers at CVG in 2017 was 3.9 million, 2.9 percent higher than the forecast. The main reason for the variance is the significant growth that the Airport experienced in 2017 as a direct result of the success of low-cost and ultra-low-cost carriers. **Exhibit 3.1-6, *2013 Master Plan Enplaned Passenger Forecast Comparison***, provides a comparison of actual enplaned passenger to the forecast provided in the 2013 Master Plan.

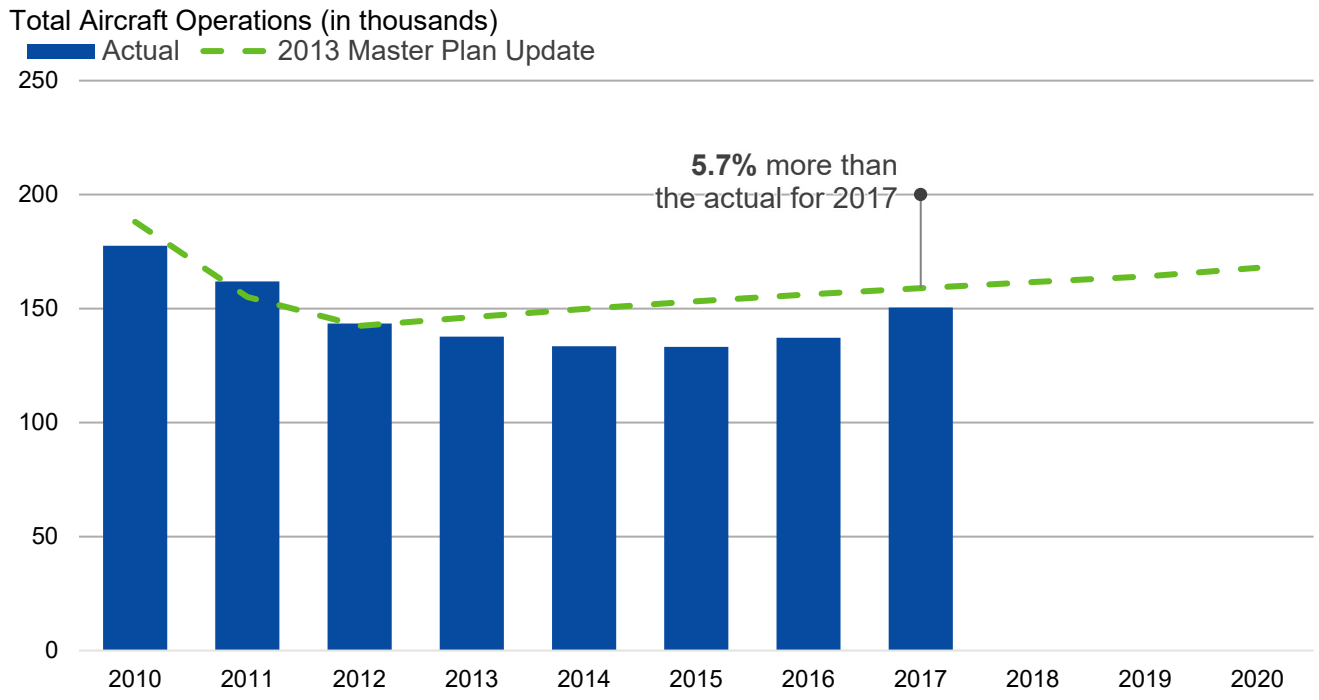
The 2013 Master Plan estimated that aircraft operations would first decrease from 188,064 in 2010 to 142,419 in 2012 and then increase to 192,660 in 2035. The forecast estimated 158,994 aircraft operations in 2017. The actual number of aircraft operations at CVG in 2017 was 150,463, 5.4 percent lower than the forecast. **Exhibit 3.1-7, *2013 Master Plan Aircraft Operations Forecast Comparison***, provides a comparison of actual aircraft operations to the forecast provided in the 2013 Master Plan.

EXHIBIT 3.1-6 2013 MASTER PLAN ENPLANED PASSENGER FORECAST COMPARISON



Sources: CVG 2035 Master Plan Report, June 2013; KCAB

EXHIBIT 3.1-7 2013 MASTER PLAN AIRCRAFT OPERATIONS FORECAST COMPARISON



Sources: CVG 2035 Master Plan Report, June 2013; KCAB

3.2 Drivers of Air Traffic

The intrinsic link between the level of activity and socio-economic growth are well documented. Simply put, growth in population, employment, income, and tourism activity typically lead to increased demand for air travel both for business and for leisure purposes. An individual's demand for air travel is often referred to as "underlying demand" in that it cannot be realized without the presence of air service at a price that results in the decision to fly. This section discusses the socio-economic factors as well as changes to the strategies of airlines that affect aviation demand at CVG.

All socio-economic data provided in this section were provided by Woods & Poole Economic, Inc. unless otherwise noted. Woods & Poole is an independent vendor and nationally recognized firm that provides expert economic and demographic analysis.

3.2.1 Air Service Area

The City of Cincinnati is located in Ohio at the confluence of the Licking River and the Ohio River. According to the U.S. Census Bureau there are an estimated 298,800 people living within the city limits making it the third largest city in Ohio, behind Columbus (860,090 people) and Cleveland (385,809 people).

A majority of the area served by CVG includes the Cincinnati-Middletown, OH-KY-IN Metropolitan Area (Cincinnati MSA). The Cincinnati MSA is comprised of five counties in Ohio (Hamilton, Butler, Warren, Clermont, and Brown), seven counties in Kentucky (Boone, Kenton, Campbell, Gallatin, Grant, Pendleton, and Bracken), and three counties in Indiana (Union, Dearborn, and Ohio). [10] **Exhibit 3.2-1, *Cincinnati MSA Map***, provides a map of the Cincinnati MSA.

[10] U.S. Office of Management and Budget, Revised Delineations of Metropolitan Statistical Areas, Micropolitan Statistical Areas, and Combined Statistical Areas, and Guidance on Uses of the Delineations of These Areas.

EXHIBIT 3.2-1 CINCINNATI MSA MAP

Source: Landrum & Brown analysis

3.2.2 Economic Base for Air Travel

3.2.2.1 *United States Economy*

Historically, the United States economy, as measured by gross domestic product (GDP) has grown at a relatively steady rate, averaging 3.1 percent per annum between 1960 and 2016. The rate of growth has been remarkably stable reflecting both the size and the maturity of the United States economy. Individual years have fluctuated around the long-term trend for a variety of reasons including macro-economic factors, fuel shocks, war, and terrorist attacks.

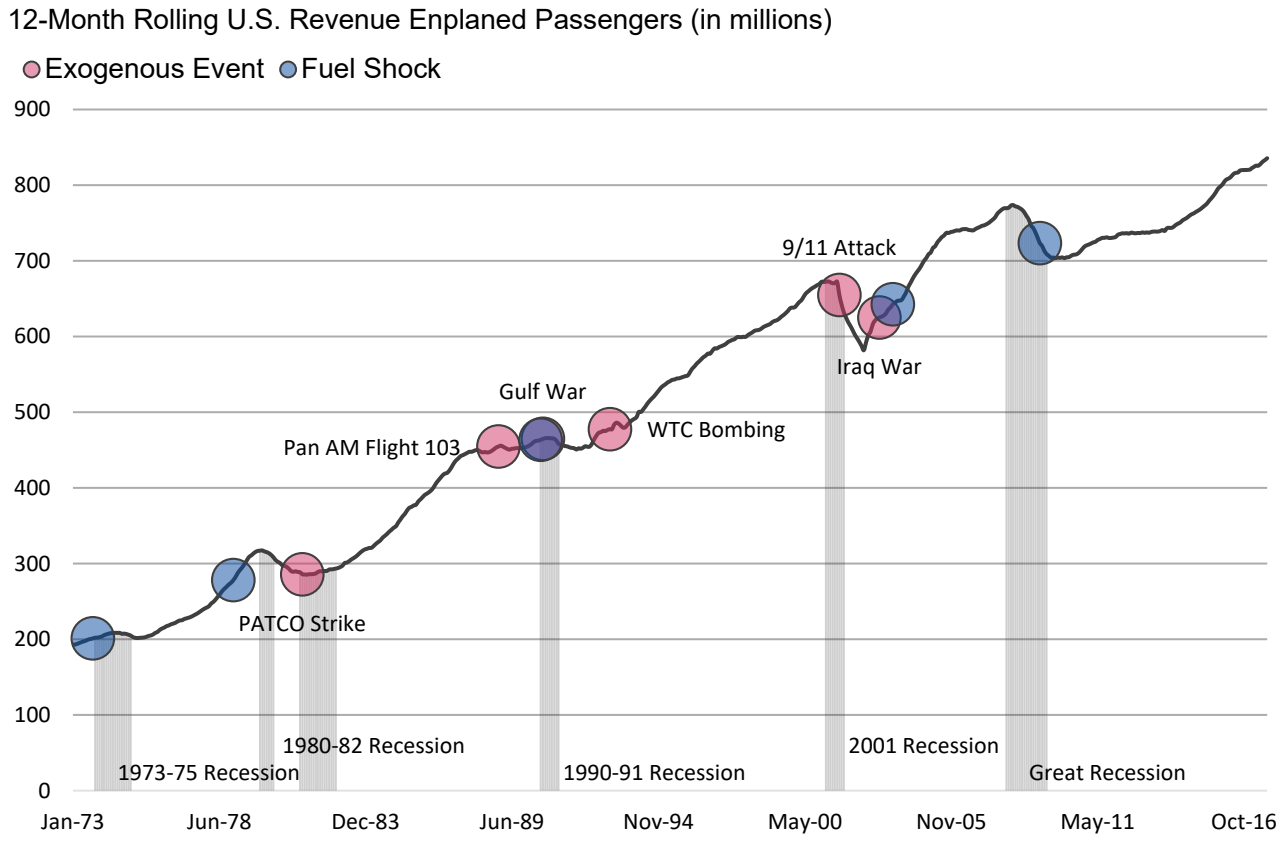
There have been two official economic recessions in the United States thus far in the 21st century. The first occurred between March and November of 2001 and was compounded by the September 11, 2001 terrorist attacks. The negative impact of these events on the airline industry is well documented. The recession itself was short-lived by historical standards and the economy returned to positive growth rates quickly, fueled by a gradual but prolonged reduction in interest rates.

The second recession, often referred to as the 'Great Recession', occurred between December 2007 and June 2009.[11] This was the worst financial crisis to affect the United States since the Great Depression and it was the longest recession since the airline industry was deregulated[12] in 1978. The nation's unemployment rate rose from 5.0 percent in December 2007, to a high of 10.0 percent in October 2009. [13]

Exhibit 3.2-2, *United States Aviation System Shocks & Recoveries*, presents how strongly passenger traffic in the United States has been correlated with the nation's economy. During economic contractions, there is a notable decline in passenger volumes while during the subsequent economic expansions there is significant growth in passenger volumes. Additionally, it is clear that exogenous shocks such as terrorist attacks have a short but significant impact to the passenger volumes.

11 National Bureau of Economic Research, U.S. Business Cycle Expansions and Contractions, September 20, 2010.
12 Deregulation refers to the Airline Deregulations Act of 1978, which reduced government control over the commercial aviation industry.
13 National Bureau of Economic Research, U.S. Business Cycle Expansions and Contractions, September 20, 2010.

EXHIBIT 3.2-2 UNITED STATES AVIATION SYSTEM SHOCKS & RECOVERIES

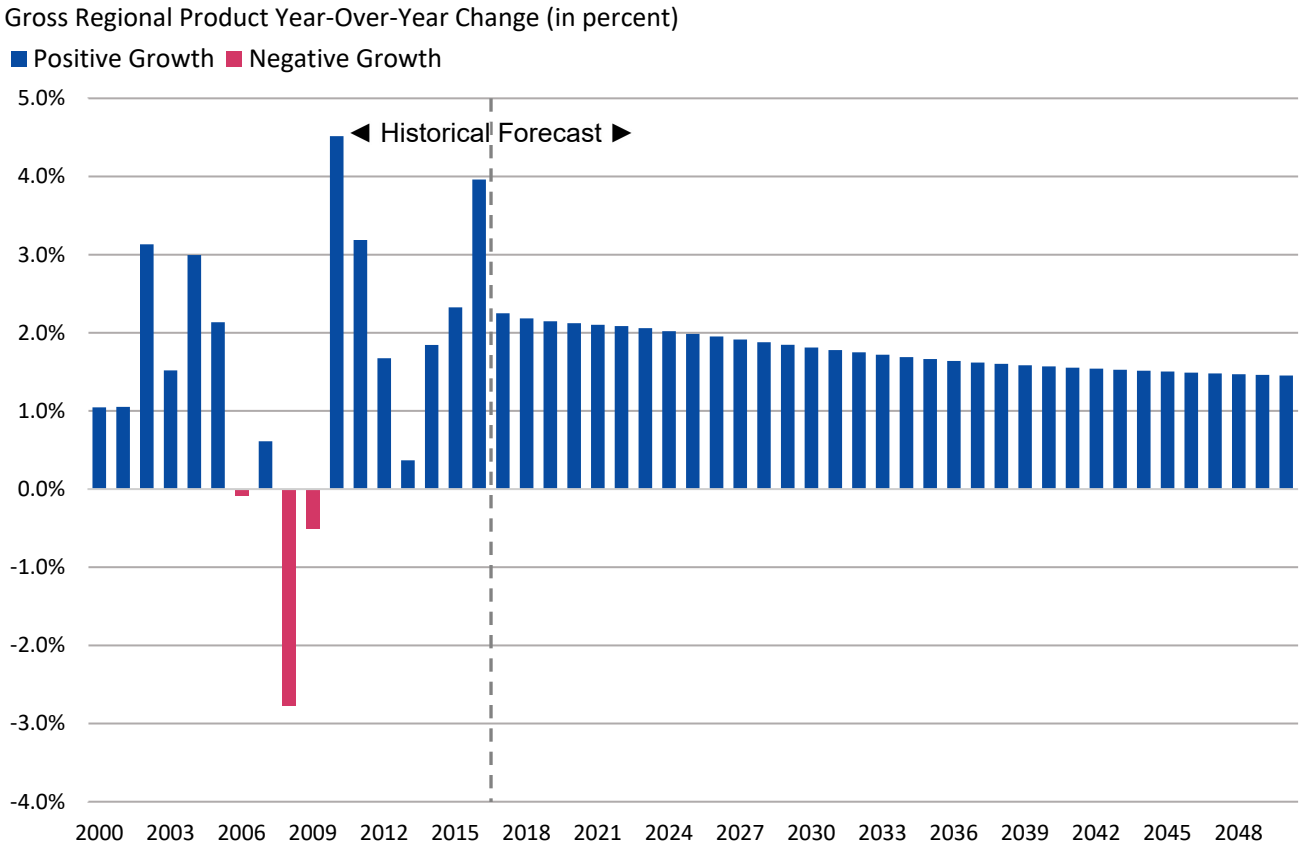


Source: U.S. Bureau of Transportation Statistics, U.S. Air Carrier Traffic Statistics

3.2.2.2 *Regional Economy*

Gross regional product (GRP) is a measure of the value of goods and services produced in a state or region. All data provided in dollar values, including GRP, in this document are expressed in real value, i.e. adjusted for inflation, rather than a nominal value. Since 2000, the GRP of the Cincinnati MSA has closely mirrored that of the United States as a whole. In 2001 and 2002, there was a significant decline in the MSA's GRP resulting from the economic slowdown but the economy quickly recovered. However, this recovery was short-lived as the Great Recession influenced the local economy in 2008 and 2009. The Cincinnati MSA's economy had strong growth in 2010 and 2011 allowing the region to recover quickly after the Great Recession. Through 2050, the Cincinnati MSA's GRP is forecasted to increase at an AAGR of 1.8 percent, which is slightly below the growth rate for the national GDP of 1.9 percent. **Exhibit 3.2-3, *Historical and Forecast Gross Regional Product – Cincinnati MSA***, graphically presents the historical and forecast year-over-year growth of the GRP of the Cincinnati MSA.

EXHIBIT 3.2-3 HISTORICAL AND FORECAST GROSS REGIONAL PRODUCT – CINCINNATI MSA

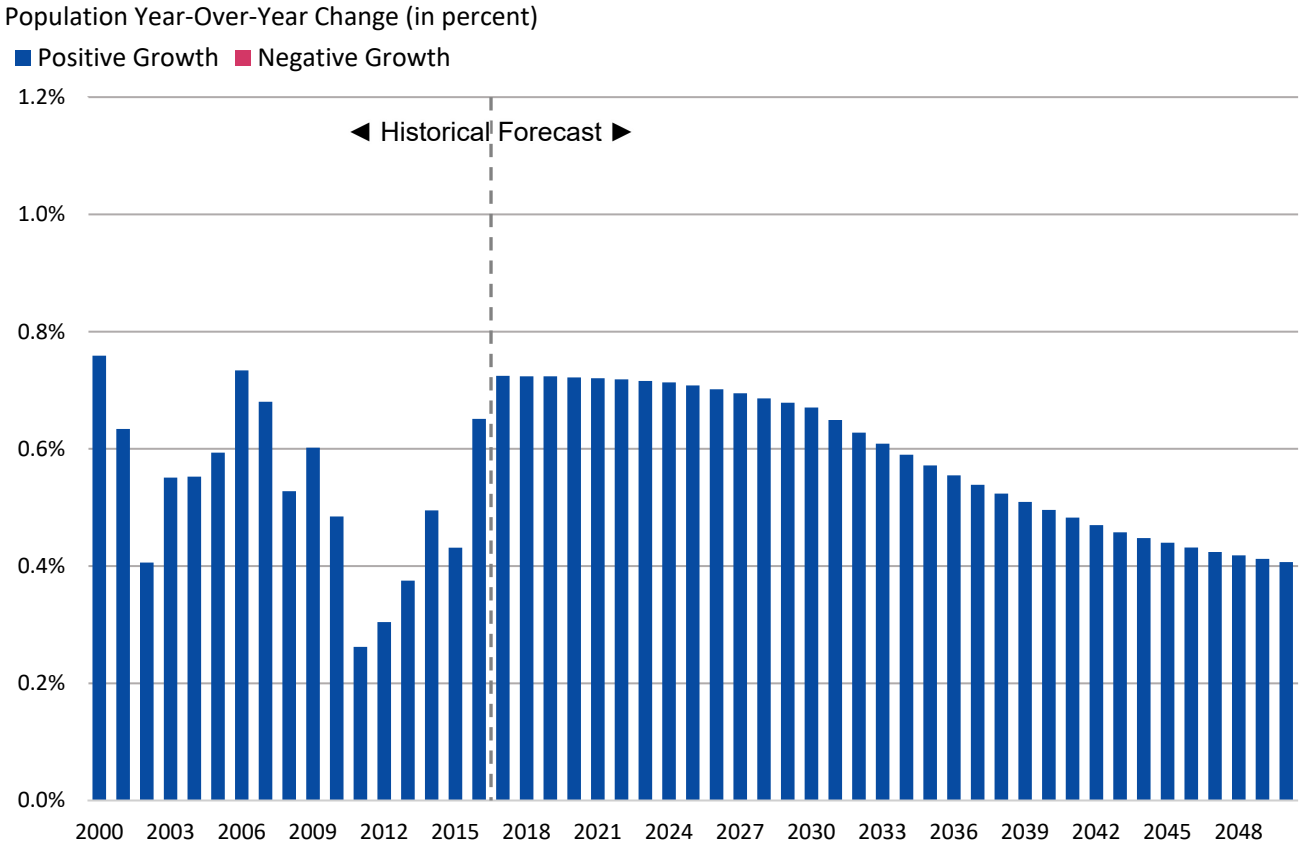


Note: Growth rates reflect real GDP.
Source: Woods & Poole, The Complete Economic and Demographic Data Source (CEDDS) 2017

3.2.3 Population Growth

According to the U.S. Census Bureau, the Cincinnati MSA was ranked as the 28th most populated of the 382 MSAs in the United States in 2016 and the largest metropolitan area that includes parts of Ohio. Since 2010, population within the Cincinnati MSA has increased at an AAGR of 0.5 percent, as the nation as a whole increased 0.9 percent. Through 2050, the Cincinnati MSA's population is forecasted to increase at an AAGR of 0.6 percent, which is below the growth rate for the national population of 0.8 percent. **Exhibit 3.2-4, *Historical and Forecast Population – Cincinnati MSA***, graphically depicts the historical and forecast year-over-year growth of the population in the Cincinnati MSA.

EXHIBIT 3.2-4 HISTORICAL AND FORECAST POPULATION – CINCINNATI MSA



Source: Woods & Poole, The Complete Economic and Demographic Data Source (CEDDS) 2017

3.2.4 Employment

Growth in employment is an important indicator of the overall health of the local economy. Changes in population and employment tend to be closely correlated as people migrate in and out of areas largely depending on their ability to find work.

3.2.4.1 *Major Employers*

Cincinnati includes a well-educated talent pool for businesses. According to the U.S. Census Bureau, 33.1 percent of the population in the Cincinnati MSA have a bachelor's degree or higher, compared to 30.6 percent nationally, and 13.3 percent of the population have a graduate degree, compared to 11.6 nationally. This educated workforce has been a reason that the area has been home to some of the largest companies in the United States. **Table 3.2 1, *Cincinnati MSA Largest Employers***, provides a list of the largest companies in the region.

TABLE 3.2-1 CINCINNATI MSA LARGEST EMPLOYERS

Employer	Local Employees
The Kroger Co.	21,263
Cincinnati Children's Hospital Medical Center	15,429
Cincinnati/Northern Kentucky International Airport	12,682
TriHealth Inc.	12,000
UC Health	11,241
University of Cincinnati	10,551
General Electric	10,500
Mercy Health	10,442
Procter & Gamble Co.	10,000
St. Elizabeth Healthcare	8,413
Fifth Third Bancorp	7,496
City of Cincinnati	6,732
Christ Hospital Health Network	5,851
Archdiocese of Cincinnati	5,610
Internal Revenue Service	4,657
Cincinnati Public Schools	4,500
Hamilton County	4,464
Fidelity Investments	4,400
Miami University	4,265
Kings Island	4,200
Macy's Inc.	3,800
Amazon.com LLC	3,500
Boone County Schools	3,301
Cincinnati Financial Corp.	3,286
State of Ohio	3,195

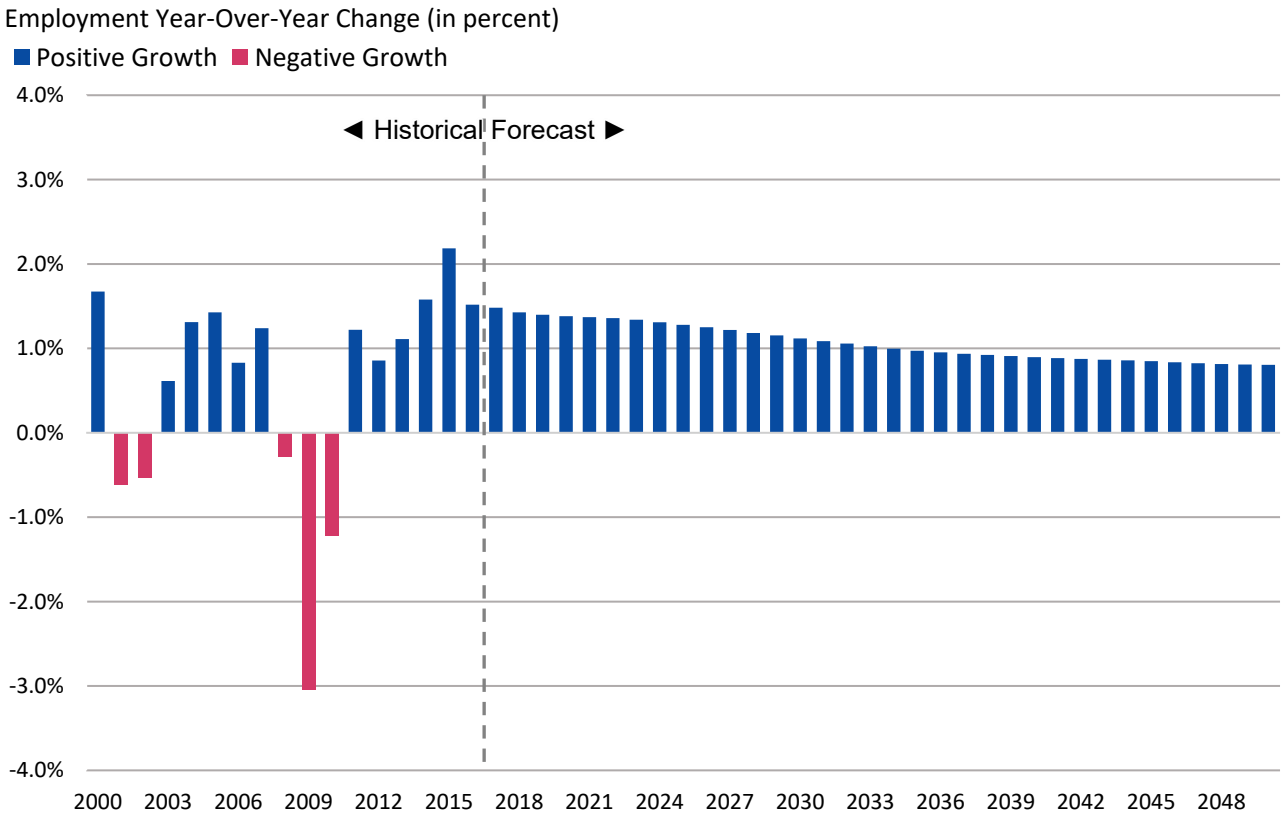
Sources: Cincinnati Business Courier, Book of Lists, 2017

Cincinnati is headquarters to more than 50,000 businesses. With eight Fortune 500® companies,[14] there are more such companies per capita than New York, Chicago, or Los Angeles. Additionally, there are five other companies within the Fortune 1000®.

3.2.4.2 *Employment Growth*

Since 2000, employment in the Cincinnati MSA has increased at half the rate of the United States as a whole. Significant declines in employment during the recent economic recessions is the primary cause of this slow growth as employment during these periods took longer to recover in Cincinnati than the rest of the nation. However, there has been reasonable growth in employment over the past six years, which lends to a belief that employment will continue to experience healthy growth in the future. Through 2050, employment is forecast to increase at an AAGR of 1.1 percent, the same as the national average. **Exhibit 3.2-5, *Historical and Forecast Employment – Cincinnati MSA***, graphically presents the historical and forecast year-over-year growth of the employment in the Cincinnati MSA.

EXHIBIT 3.2-5 HISTORICAL AND FORECAST EMPLOYMENT – CINCINNATI MSA



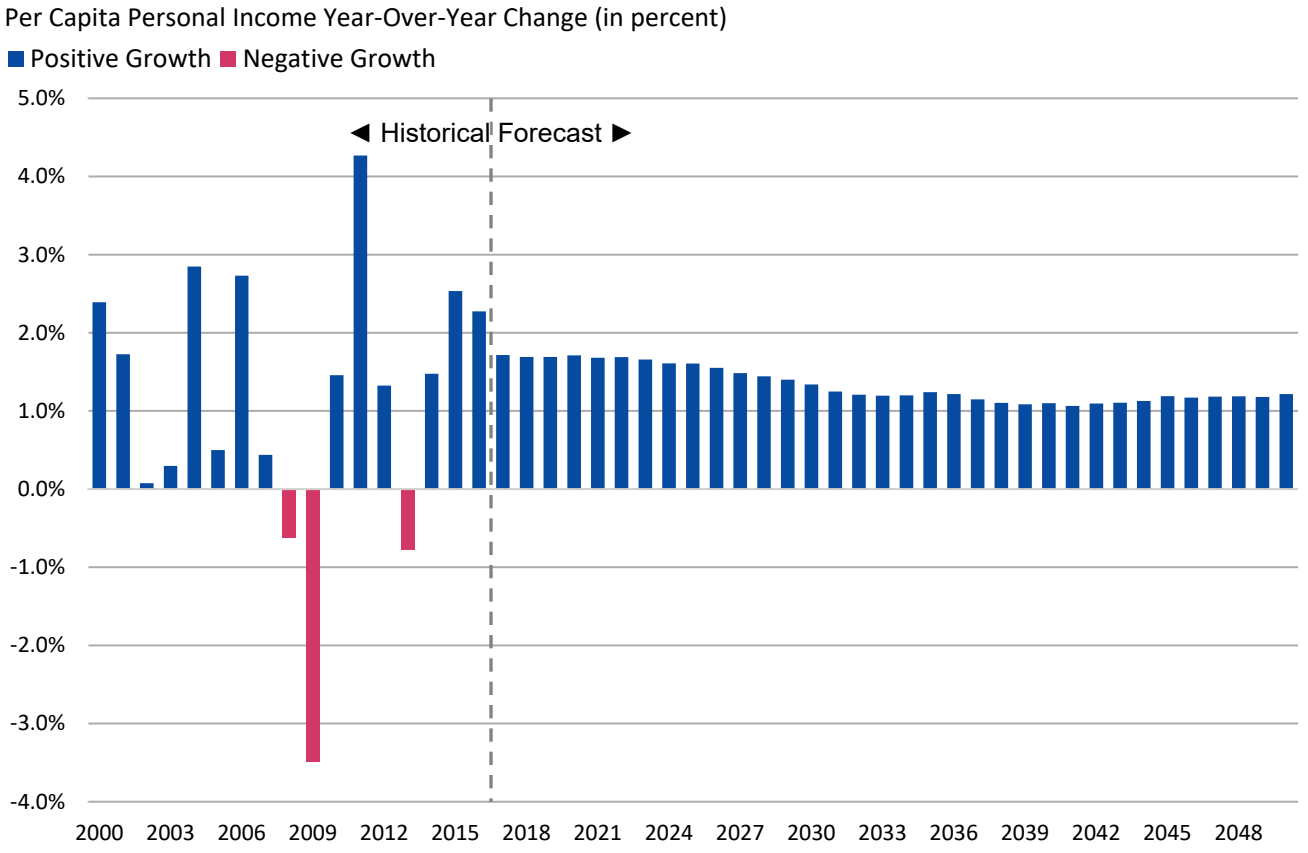
Source: Woods & Poole, The Complete Economic and Demographic Data Source (CEDDS) 2017

[14] Cincinnati Fortune 500® companies include AK Steel Holding, Cincinnati Financial, Kroger, Procter & Gamble, Macy's, Fifth Third Bancorp, American Financial Group, and Western & Southern Financial Group.

3.2.5 Personal Income

Income statistics are broad indicators of relative earning power and wealth of an area and inferences can be made relative to an individual's or community's ability to purchase air travel. Per capita personal income (PCPI) corresponds to the income per inhabitant (total income divided by total population). In 2000, the Cincinnati MSA had a PCPI of $37,326, which was higher than the national average of $36,883. However, the economic downturn in the region that occurred in the 2000s had a significant impact to the average income. By 2007, the PCPI of the Cincinnati MSA slightly trailed the national average. In 2016, the PCPI of the Cincinnati MSA was $44,123 and it is forecasted to increase to $69,350 by 2050, representing an AAGR of 1.3 percent. This growth rate is higher than the expected 1.2 percent growth rate for the nation as a whole over that time. **Exhibit 3.2-6, *Historical and Forecast per Capita Personal Income – Cincinnati MSA***, graphically presents the historical and forecast year-over-year growth of the PCPI in the Cincinnati MSA.

EXHIBIT 3.2-6 HISTORICAL AND FORECAST PER CAPITA PERSONAL INCOME – CINCINNATI MSA



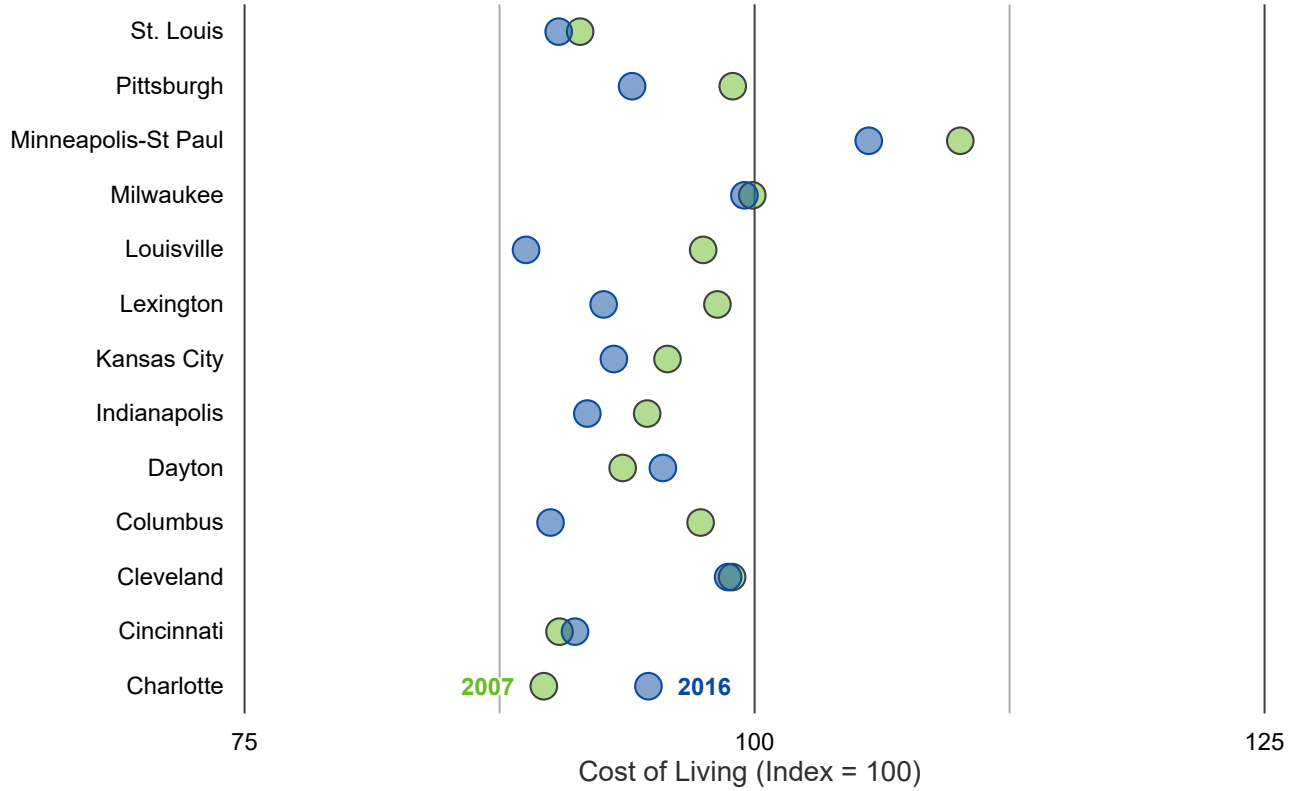
Source: Woods & Poole, The Complete Economic and Demographic Data Source (CEDDS) 2017

3.2.6 Cost of Living

Although personal income is a vital statistic, it is only a portion of determining whether a passenger has the means to afford to travel by air. If the cost of living is too high, then the passenger will not have the disposable income necessary to purchase a ticket. Additionally, the cost of living can be a significant incentive for businesses to locate in a particular city. The Council for Community and Economic Research (C2ER) provides indices that reflect the average cost of living in a particular city or region in relation to the rest of the county. A cost of living index measures regional differences in the cost of consumer goods and services, excluding taxes and non-consumer expenditures. A composite index is given to a region based on six components: housing, utilities, grocery items, transportation, health care, and miscellaneous goods and services. The index can be used in determining how much personal income will be dedicated to these components compared to the rest of the United States. For example, a composite score of 100 would indicate that, on average, the cost for goods in the region is equal to the average of the rest of the nation.

In 2016, the City of Cincinnati had a composite index of 91.2 that indicates the average cost of living in the City of Cincinnati is approximately 8.8 percent less than the rest of the nation. This index is lower than many major business centers within the Midwest of the United States. **Exhibit 3.2-7, *Cost of Living Index***, provides the 2016 indices for some comparable cities and how they have changed since 2007.

EXHIBIT 3.2-7 COST OF LIVING INDEX



Source: The Council for Community & Economic Research, Cost of Living Index

3.2.7 Tourism

Tourism is a major industry in the Cincinnati region. In 2016, there were 26.1 million visitors to the region generating over five billion dollars in revenue. Cincinnati has a number of attractions that bring visitors to the city. Some the key attractions in Cincinnati include the Cincinnati Zoo & Botanical Garden, Newport Aquarium, the Contemporary Arts Center, Cincinnati Museum Center at Union Terminal, Kings Island, Playhouse in the Park, and the National Underground Railroad Freedom Center. Cincinnati is also home to a number of sporting venues that include professional baseball, football, and soccer teams; a number of Division I Collegiate Sports; and thoroughbred racing.

There are a number of major events held throughout the year that draw visitors to the region. In 2016, the Western & Southern Open, held over 10 days in the month of August, drew approximately 200,000 fans. There are a number of music festivals throughout the year including the Cincinnati Music, Fringe, Midpoint Music, MusicNOW, and most notably the Bunberry Music Festival, which welcomes more than 40,000 each year. An end-of-summer event called Riverfest is held over Labor Day weekend. This event includes live music, a number of family friendly events, and concludes with a firework display over the Ohio River. In 2017, there were an estimated 125,000 people in attendance. Oktoberfest Zinzinnati highlights the German heritage of the city. It is the largest Oktoberfest celebration in North America with an estimated 675,000 people attending the event in 2017. The Flying Pig Marathon is held in early May. As part of the marathon, races are held throughout the weekend. In 2017, more than 37,000 people participated, and a record number is expected for 2018. Since 2003, all 50 states and the District of Columbia have been represented in the Flying Pig and 2017 there were 22 counties outside the U.S. represented.

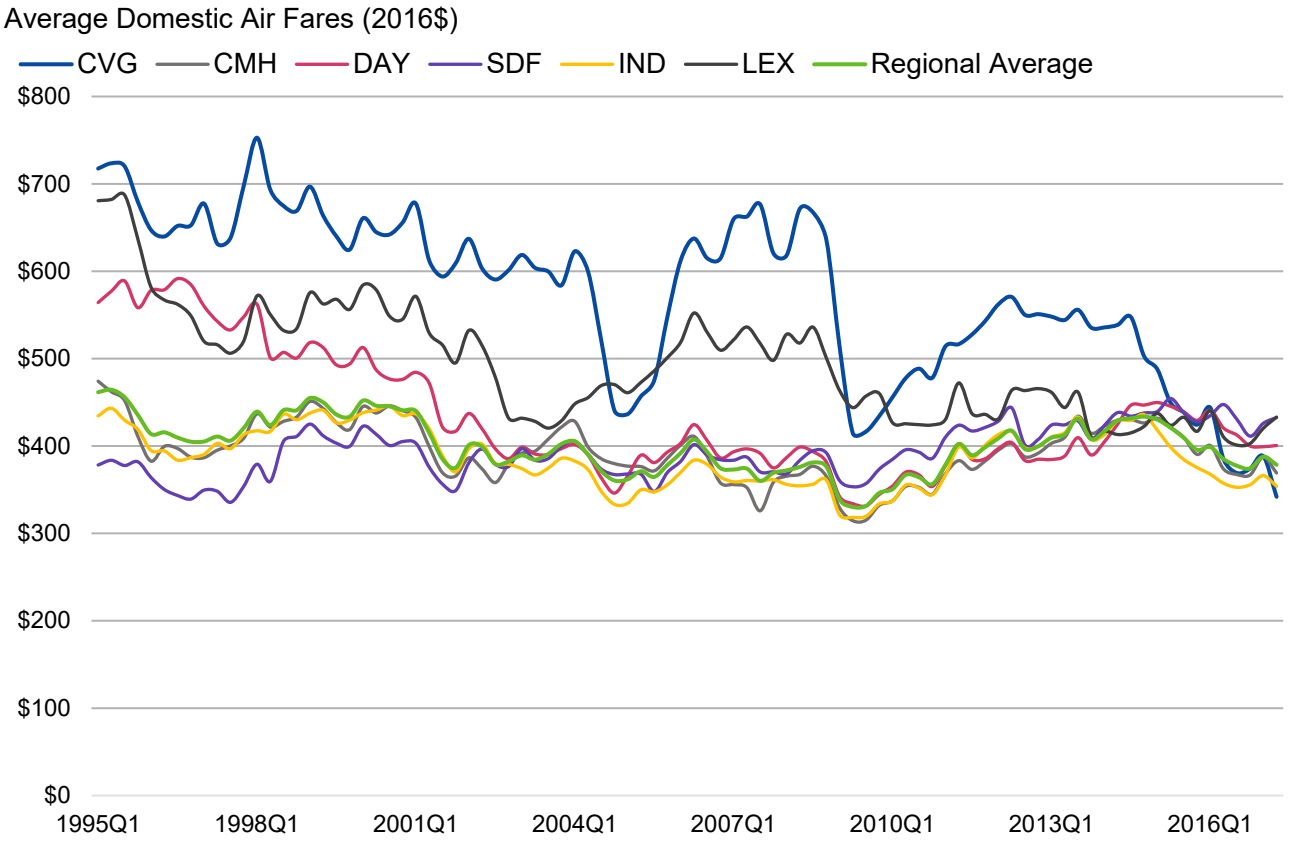
3.2.8 Price of Air Travel

The demand for air travel is inversely proportional to the prices. As airfares increase, fewer people can afford to travel for leisure. Alternatively, as airfares decrease, more people are able to afford to travel and do so more frequently. Prior to the Great Recession, airfares did not typically have a significant impact on air travel demand for business travelers. However, the economic climate prompted businesses to seek measures in order to save cost, part of which included shrinking travel budgets. Now many companies are substituting air travel with telecommunications, such as video calls, when the cost becomes too great.

Historically, airfares at CVG have been higher than the national average. The Airport was ranked as either number one or two for the highest airfares among top 100 domestic airports for ten consecutive quarters starting in mid-2012. However, rapid growth by ultra-low-cost carriers have led to lower the airfares at the Airport and significantly stimulated O&D passenger traffic. As a result, airfares at CVG have dropped 16 out of the last 17 quarters. In third quarter 2017, the Airport ranked as the 83rd highest airfares out of the top 100 domestic airports in average. CVG currently has the lowest average domestic airfares in the region at $301. **Exhibit 3.2-8, *Average Airfares at Regional Airports***, provides a comparison of the airfares of CVG to the other airports in the region including John Glenn Columbus International Airport (CMH), Indianapolis International Airport (IND), Blue Grass Airport (LEX), and Louisville International Airport (SDF).

Yield is the aviation industry's measure for average ticket prices. Yield is the average fare paid by customer to fly one mile, i.e. passenger revenue divided by revenue passenger miles. Yield has followed a similar trend to air fares explored above with extremely high yields occurring for a majority the early 2000s. However, since 2014, average yield in constant 2016 dollars has declined an average of almost two cents per year.

EXHIBIT 3.2-8 AVERAGE AIRFARES AT REGIONAL AIRPORTS



Notes: Airfares are inflation-adjusted using dollars for the 2016 fare release. Regional average is a weighted average of
Notes: Airfares are inflation-adjusted using dollars for the 2016 fare release. Regional average is a weighted average of CMH, DAY, SDF, IND, and LEX.
Sources: U.S. Department of Transportation, Average Domestic Airline Itinerary Fares by Origin City; U.S. Department of Transportation, Air Passenger Origin-Destination Survey

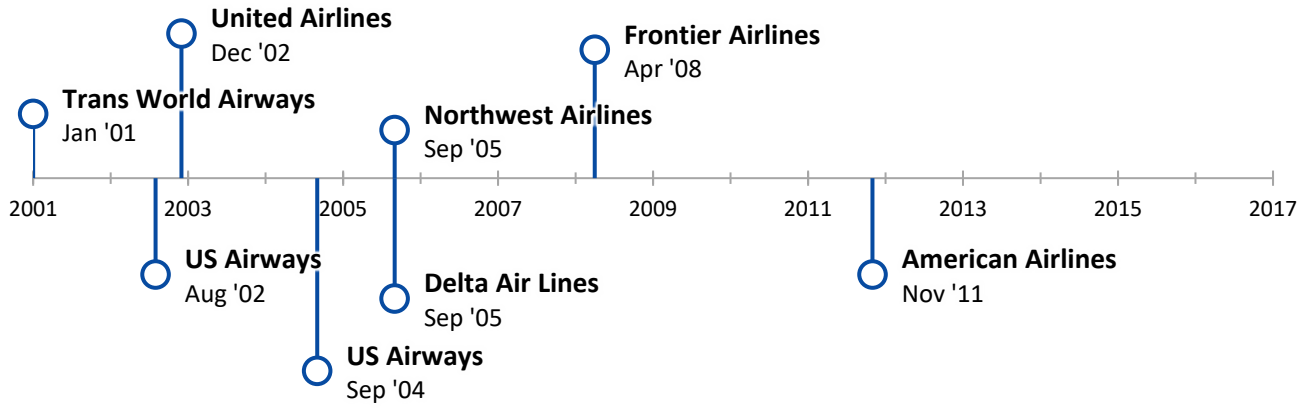
3.2.9 Airline Industry Strategies

The financial health of the airlines will play a major role in the determination of future forecasts for CVG. This section presents a summary of the airline industry factors that were considered in developing the CVG forecast.

3.2.9.1 *Airline Bankruptcies*

There have been dramatic changes to the financial health of the airline industry in the 21st century. Numerous airlines have declared bankruptcies between 2001 and 2005, and another round in 2008 resulting from the recent economic recession. The most recent airline to declare bankruptcy was American Airlines, which entered bankruptcy protection in November 2011. **Table 3.2-2, *Airline Bankruptcy Status***, presents the nine airlines that have operated at CVG and have declared bankruptcy this century.

TABLE 3.2-2 AIRLINE BANKRUPTCY STATUS



Airline	Status
Trans World Airways	Filed Chapter 11 in January 2001 as part of acquisition by American.
US Airways	Filed Chapter 11 in August 2002 and again in September 2004; emerged in September 2005 in conjunction with acquisition by America West. Acquired by American Airlines in 2013.
United Airlines	Filed Chapter 11 in December 2002; emerged in February 2006.
Northwest Airlines	Filed Chapter 11 in September 2005; emerged in May 2007. Acquired by Delta in 2008.
Delta Air Lines	Filed Chapter 11 in September 2005; emerged in April 2007. Wholly owned subsidiary Comair Airlines taken in bankruptcy with Delta Air Lines
Frontier Airlines	Filed Chapter 11 in April 2008; emerged in October 2009.
American Airlines	Filed Chapter 11 in November 2011. Wholly owned subsidiary American Eagle Airlines taken into bankruptcy with American Airlines. Emerged in December 2013.

Source: Airlines for America, U.S. Airline Bankruptcies

3.2.9.2 *Airline Mergers*

Many airlines have merged or been acquired since the turn of the 21st century, including American/TWA in 2001, US Airways/America West in 2005, Delta/Northwest in 2008, Southwest/AirTran in 2010, United/Continental in 2010-2012, American/US Airways in 2013, and most recently Alaska/Virgin in 2016.

These mergers have resulted in significant consolidation and economic control of passenger ridership. In 2000, 12 domestic airlines accounted for 93.4 of domestic passenger enplanements in the United States. In 2016, the five combined airlines resulting from these mergers accounted for 87.1 percent of the domestic enplaned passengers.

3.2.10 Domestic Capacity

After five years of negative earnings from 2000 through 2005, the United States air travel industry collectively returned to profitability in 2006 after savings from labor cuts, salary concessions, and removal of many flight perquisites were realized. The success of restructuring has produced an industry that is already relatively streamlined with very little fat left to trim. The surge in oil prices in 2008 and the ensuing economic crisis pushed airlines to start raising airfares and cutting capacity. To survive and be profitable, the airlines have had to reduce domestic capacity (the number of scheduled seats that are offered) to avoid losing money on unprofitable routes and excessive frequencies that were not supported with sufficient demand. This capacity cut was evident at CVG when airlines cut a quarter of their seating capacity in both 2009 and 2010.

3.2.11 New Scheduled Service

Domestic traffic at CVG has historically been dominated by full-service, or legacy carriers, like Delta Air Lines. However, the introduction and expansion of low-cost carriers and ultra-low-cost carriers has shifted the domestic market share. It is expected that over the next five years, low-cost and ultra-low-cost carriers will continue to spur growth in passenger traffic at the Airport.

In May 2013, Frontier Airlines became CVG's first low-cost carrier since the late 1990s when the airline launched service to Denver International Airport (DEN). The following year, another low-cost carrier, Allegiant Air, began service. These carriers helped to spur growth in local traffic at the Airport. Frontier Airlines added flights to Miami International Airport (MIA) in October 2017 and will begin service to an additional six new destinations in spring of 2018. The new service will make Frontier Airlines the second largest airline in terms of nonstop destinations at CVG. It is expected that Allegiant Air will also continue to expand its offerings over the next five years.

In June of 2017, Southwest Airlines inaugurated service at CVG. Currently, the airline is providing service to MDW and BWI and has announced new service to Denver beginning in 2018. However, given the airline's success at other Midwest airports, in particular CMH and IND, it is assumed that Southwest Airlines will rapidly grow their offering at the Airport over the next five years.

Year-round scheduled international passenger service at the Airport is provided by Delta Air Lines, Frontier, and Air Canada. Vacation Express and Apple Vacations provide seasonal scheduled charter service to the Caribbean. In 2007, Delta Air Lines provided transoceanic service to Frankfurt International Airport (FRA), Amsterdam Airport Schiphol (AMS), London Gatwick Airport (LGW), Leonardo da Vinci-Fiumicino Airport (FCO), and CDG. However, only CDG remains today but this was the result of the restructuring of Delta Air Lines' operations rather than lost demand. WOW Air has announced that it will begin service to KEF in May 2018. It is anticipated that the new service will act as a catalyst for new international service at the Airport.

3.2.12 Price of Fuel

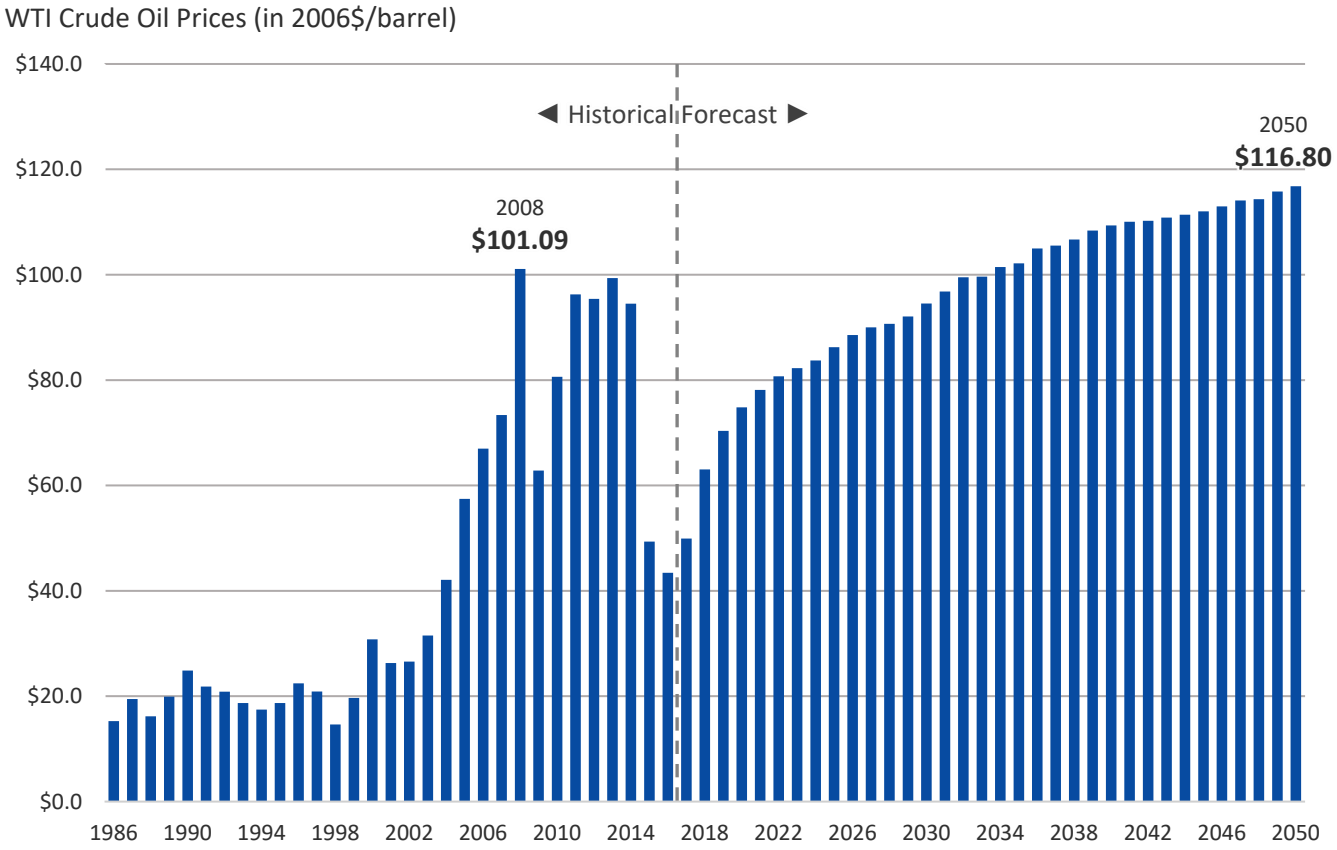
The price of oil and the associated cost of jet fuel is the largest single cost affecting the airline industry. The price of West Texas Intermediate (TWI) crude oil increased dramatically, posting a 290 percent increase in June 2008 when compared to January 2004. After averaging between $20 and $30 per barrel between 2000 and 2003, spot crude oil prices surged to about $140 per barrel in June and July 2008. Several factors drove the increase such as strong global demand, particularly in China and India, a weak United States dollar, commodity speculation, political unrest, and a reluctance to materially increase supply.

The price of oil subsequently declined sharply to $61 per barrel in 2009 due to reduced demand which resulted from the global financial crisis and subsequent economic recession. However, as the economic climate improved and political unrest continued in the Middle East, oil prices increased in the subsequent three years. In 2012, oil prices averaged $94 per barrel. The increase in the price of jet fuel put upward pressure on airlines' operating costs. As a result, airlines were faced with cutting capacity or increasing fares, and sometimes both. An additional impact of higher fuel prices has been a sharp increase in load factors as airlines look to make better use of their aircraft assets by constraining capacity.

The average price of oil dropped significantly in 2015 to $49 per barrel, the lowest since 2004 and dropped again in 2016 to $43 per barrel. The drop alleviated the pressure on airlines' operating costs. However, the airlines are slow to make changes as fuel prices are expected to increase in the future.

The U.S. Energy Information Administration (EIA) provides forecasts of the price of crude oil in a report entitled Annual Energy Outlook (AEO). In the 2017 AEO, the EIA projects that the price of oil will increase at 3.0 percent per annum through 2050, reaching $117 per barrel in 2050. **Exhibit 3.2-9, *Crude Oil Prices***, presents the historical price for crude oil and EIA's forecast of those prices.

EXHIBIT 3.2-9 CRUDE OIL PRICES



Note: WTI stands for West Texas Intermediate.
Source: U.S. Energy Information Administration, Annual Energy Outlook 2017

3.2.13 Aircraft Trends

Variable fuel costs, aircraft type, and aircraft age have an impact on which aircraft the airlines choose to fly. The next-generation Boeing 737s and Airbus 320/321s have among the best fuel economy in the industry. The airlines have designated certain aircraft for retirement that have poor fuel economy compared to newer models. Many of the 737-300,-400,-500s have all been marked for reduction of use or retirement by many domestic airlines. The MD-80 series, MD-90, and DC-9 aircraft are expected to be retired by the end of 2018 while other variants of the Boeing 737 are expected to be retired by 2020. These aircraft are expected to be replaced with the Boeing 737 700, 737-800, and 737 Max aircraft with similar or higher seating capacities. Small regional jets like the Embraer EMB-135/140 and the Canadair CRJ-100/200 are also under much scrutiny and going through reductions. At CVG, a majority of the small regional aircraft have already been eliminated from routes.

3.2.14 The Rise in E-Commerce

There is a fundamental shift ongoing in the air cargo industry. Historically, air cargo has been used as a supply chain for time-sensitive or high value product. Manufacturing has been a significant driver in air cargo and companies has provided the demand for air cargo. These companies have relocated a number of their manufacturing facilities to other parts of the world, which has led to a shift to other modes of transportation such as cargo ships. Additionally, rising fuel costs, resulting in higher shipping costs, combined with the Global Recession led companies to reevaluate the necessity of shipping their products by air. As such, companies began to rely on an increased use of trucks and ships to deliver their product. The result is that traditional air cargo has been stagnant at many airports across the United States. CVG is one of the exceptions to stagnation occurring at other airports due to the presence of DHL's Global Hub. The unique operations of DHL at CVG has resulted in increased air cargo throughput in recent years.

The increased use of e-commerce is expected to result in changes in the air cargo industry. The U.S. Census Bureau has projected that 8.9 percent of retail sales were e-commerce in the second quarter of 2017 compared to 8.0 percent in 2016.[15] Most of the current forecasts for e-commerce indicate double-digit growth in the market of the next five years. In e-commerce, venders are required to ship orders to their costumers fast, such as two-day shipping, which may require the use of air cargo despite the increased cost. Therefore, the growth in e-commerce is expected to have a significant impact on air cargo throughput.

It is believed that air cargo for e-commerce is expected to follow a similar spoke and hub model to the mainline passenger airlines. Centralized distribution centers, or hubs, will store a majority of the product then distribute the product to other airports, or spokes, on an as needed basis. As such, air cargo throughput at distribution hubs will be dependent on the needs at the spokes. The air cargo throughput at the spoke airports will be dependent on the needs of the population within air airport's catchment area.

[15] U.S. Census Bureau, Quarterly Retail E-Commerce Sales 2nd Quarter 2017, August 17, 2017.

3.2.15 FAA Aerospace Forecast

The FAA develops a set of assumptions and forecasts based on the current trends of the U.S. aviation industry. These forecasts, entitled the FAA Aerospace Forecast, are published annually and are considered to be one the most complete forecasts available for aviation activity in the U.S. The FAA Aerospace Forecast provides projections for passenger, cargo, and general aviation activity on a national level.

The FAA Aerospace Forecast[16] projects that yield in constant 2016 dollars for domestic flights in the United States will decline at an average annual rate of 0.4% per annum from 2016 through 2037.

The FAA Aerospace Forecasts[17] project the following trends in the United States GA and air taxi industry from 2016 to 2037:

- The number of active GA aircraft is forecast to increase by 0.1 percent annually
- The number of active GA jet aircraft is forecast to increase by 2.3 percent per annum
- Piston hours flown are forecast to decline at 0.8 percent per annum
- Turbo prop hours flown are forecast to increase at 1.6 percent per annum
- Turbo jet hours flown are forecast to increase at 3.0 percent per annum
- Active GA and air taxi hours flown at forecast to increase at 0.9 percent per annum

16 Federal Aviation Administration, FAA Aerospace Forecast, Fiscal Years 2017-2037.
17 Federal Aviation Administration, FAA Aerospace Forecast, Fiscal Years 2017-2037.

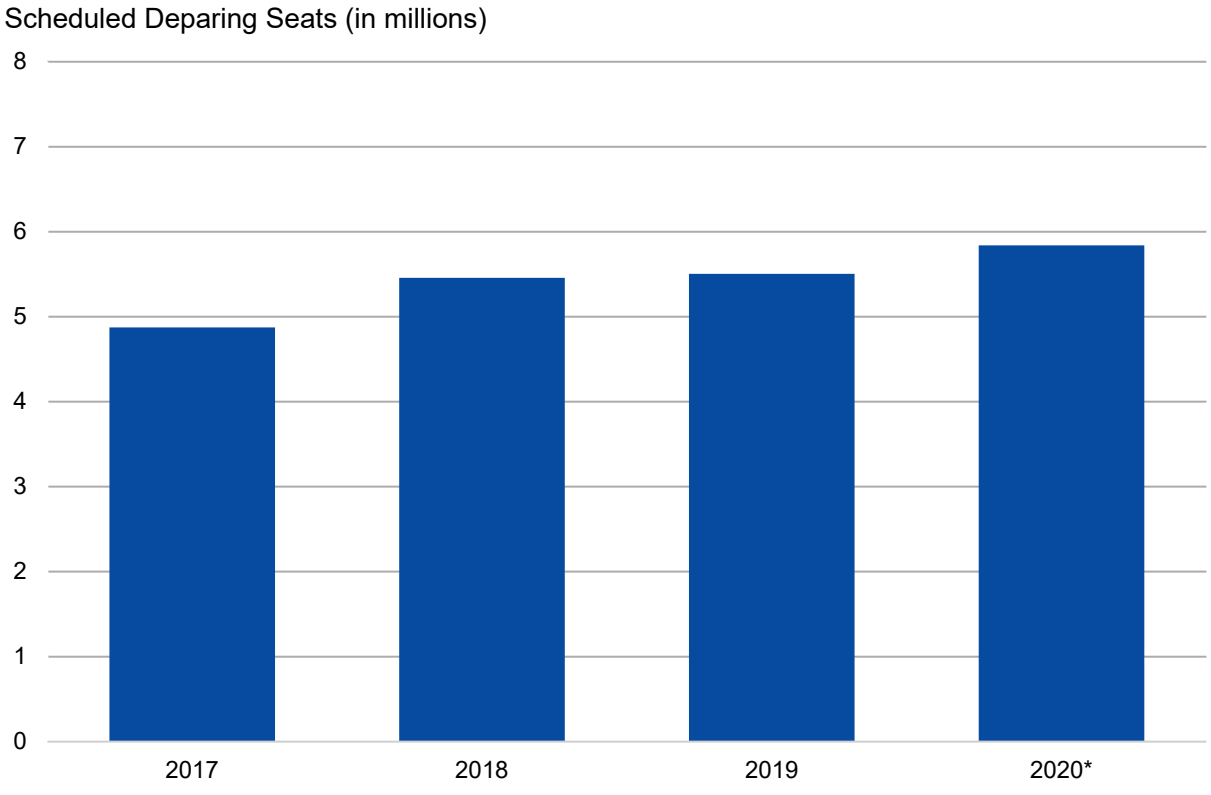
3.3 Passenger Activity Forecast

This section presents the forecast of enplaned passengers for CVG through the forecast period as well as a discussion of the methodology used. The enplaned passenger forecast reflects the historical airline activity trends, the economic base for air travel demand, and other factors that may affect the demand for air travel.

3.3.1 Short-Term Forecast Methodology (2017-2020)

The short-term forecast was developed using available year-to-date passenger volumes and passenger seating capacity from available scheduled fillings. In 2017, there were 4.9 million scheduled departing seats. In 2018, departing seats are scheduled to increase 11.9%. However, in 2019, departing seats are only expected to increase 0.9% while airlines cut service to some of the more unprofitable routes and increase load factors. While scheduled flights are not available for the entirety of 2020, there is a scheduled increase of 6.1% departing seats through August. It was assumed that the growth in seating would extend through the rest of 2020. **Exhibit 3.3-1, *Growth in Scheduled Passenger Seating***, graphically depicts the growth in scheduled departing seats through 2020. It was assumed that load factors would increase slightly in 2019 as airlines remove less profitable routes and would remain at this level through 2020. The assumed load factors were multiplied by the scheduled departing seats to determine the short-term passenger forecast.

EXHIBIT 3.3-1 GROWTH IN SCHEDULED PASSENGER SEATING



Note: 2020 is an estimate based on scheduled data through August.
Source: OAG Aviation Worldwide Ltd, OAG Schedules Analyser

3.3.2 Long-Term O&D Forecast Methodology (2020-2050)

Several standard forecasting techniques were considered in order to forecast O&D enplaned passengers, such as economic regression modeling, trend analysis, market share, and time series. It was determined that an economic regression model was the most appropriate to forecast O&D enplaned passengers at the Airport. Economic regression modeling quantifies the relationship between O&D enplaned passengers and key socioeconomic variables. This methodology recognizes that key independent variables will change over time and assumes that their fundamental relationships to the dependent variables will remain.

The first step in developing the appropriate model was to test the independent, or explanatory, variables against the dependent variable, O&D enplaned passengers. In order for an economic model to be considered appropriate, the following has to be true:

- Adequate test statistics (i.e. high coefficient of determination (R2) values and low p-value statistics), which indicate that the independent variables are good predictors of passengers at the Airport.
- The analysis does not result in theoretical contradictions (e.g., the model indicates that GDP growth is negatively correlated with traffic growth).
- The results are not overly aggressive or conservative or incompatible with historical averages.

Through the testing of multiple sets of independent variables, a multivariate linear model using the MSA's employment and the Airport's yield with a historical time-frame from 2007 through 2017 was selected to forecast total O&D enplaned passengers. The model exhibits strong regression statistics when compared with other combinations of independent variables. The model formula and relevant test statistics are provided below:

- Model
  - "O&D Enplaned Passengers = -3,964,042 + 6,554.4*" 〖"Employment" 〗_"MSA" " - 92,089.3*Yield"
- Test Statistics
  - R2 = 93.1%
  - Degrees of Freedom = 11
  - P-value = 0.0
- Independent Variables P-Values
  - Intercept = 0.0
  - 〖"Employment" 〗_"MSA" = 0.0
  - Yield = 0.0

Since a majority of the traffic at the Airport is domestic and will continue to be for the foreseeable future, a forecast for the Airport's yield was developed using the year-over-year growth rates for domestic yield from the FAA Aerospace Forecast through 2037, which assumes yield will decline at 0.3 percent annually. Beyond 2037, a logarithmic formula was used to estimate yields which results in a continued but slower decline in overall yield. **Table 3.3-1, *Regression Model Inputs***, provides the inputs used in the regression analysis and the forecasts of the independent variables.

TABLE 3.3-1 REGRESSION MODEL INPUTS

Year	O&D Enplaned Passengers	Employment (in thousands of jobs)	Airport Yield (in 2016$ cents)
2007	2,448,118	1,288	24.37
2008	2,196,391	1,285	24.26
2009	2,343,094	1,246	18.88
2010	2,335,172	1,230	20.44
2011	2,257,934	1,245	21.59
2012	2,112,322	1,256	23.40
2013	2,171,371	1,270	23.20
2014	2,299,489	1,290	22.54
2015	2,669,588	1,318	20.45
2016	3,007,532	1,338	18.43
2017	3,652,270	1,358	15.77
2018		1,378	15.74
2019		1,397	15.79
2020		1,416	15.86
2021		1,435	15.90
2022		1,455	15.93
2023		1,474	15.93
2024		1,494	15.91
2025		1,513	15.87
2026		1,532	15.81
2027		1,550	15.74
2028		1,569	15.65
2029		1,587	15.55
2030		1,605	15.46
2031		1,622	15.36
2032		1,639	15.27

Year	O&D Enplaned Passengers	Employment (in thousands of jobs)	Airport Yield (in 2016$ cents)
2033		1,656	15.18
2034		1,673	15.08
2035		1,689	14.99
2036		1,705	14.90
2037		1,721	14.81
2038		1,737	14.78
2039		1,753	14.75
2040		1,768	14.72
2041		1,784	14.69
2042		1,799	14.66
2043		1,815	14.64
2044		1,831	14.62
2045		1,846	14.60
2046		1,862	14.58
2047		1,877	14.56
2048		1,892	14.54
2049		1,908	14.52
2050		1,923	14.51

Sources: KACB; Woods & Poole, The Complete Economic and Demographic Data Source (CEDDS) 2017; FAA Aerospace Forecast, Fiscal Years 2017-2037

3.3.3 Connecting Passenger Forecast Methodology

Since 2005, the rate of connecting passengers has declined significantly. The shift from connecting traffic was most evident when the connecting rate at the Airport declined by 11.9 percentage points in 2009 and 14.4 percentage points in 2010. However, the connecting rate has declined by less than five points the last two years and current estimate of 2018 indicates that the connecting rate will decline by less than one percentage point. This gradual slowdown of the decline indicates that the Airport is beginning to reach a minimal connecting rate. It was assumed that the connecting rate would continue to decline from 7.0% in 2017 to 2.6% in 2050 with most of the decline occurring within the short-term forecast.

3.3.4 Long-Term International Forecast Methodology

It was assumed that international passenger demand would increase at the same rate as domestic O&D. Currently, most of the international demand is flying a domestic portion of an international journey (DPIJ). In other words, these passengers fly to other domestic airports prior to continuing to their final international destinations and are thus categorized as domestic passengers. As the international demand continues to grow, it was assumed that additional service would be added based on warranted demand for each of the world regions. Due to the nature of this demand, the service was not assumed to stimulate new demand but would rather cannibalize the traffic from the domestic segment. Therefore, the increase in domestic O&D enplaned passengers was lowered each time a new international flight was added.

According to the FAA's Airline Origin and Destination Survey (O&D Survey), European O&D demand has increased at an average rate of 2.4% since 2009. In 2017, there were approximately 114,000 O&D enplaned passengers flying to Europe from CVG but there were fewer than 72,000 departing seats on direct flights to Europe from CVG. Therefore, it was assumed that there is already pent up demand that is not being currently served by direct service. As such, it was assumed that a new daily European service would begin by 2022 using a 214-seat Boeing 787-800. Beyond 2022, it was assumed that European demand would increase at the same rate as total O&D passengers. When demand exceeds an average of 160 daily O&D passengers each way, based on an average 214-seat aircraft operating at a 75% load factor, a new flight was assumed to be added.

Latin American (including Mexico) O&D demand has increased at an average rate of 2.6% since 2012. In 2017, there were approximately 81,000 O&D enplaned passengers flying to Latin America from CVG but there were just over 12,000 departing seats to Latin America from CVG. Therefore, it was assumed that there is already pent up demand that is not being served by direct service. As such, it was assumed that a new daily Latin American service would begin by 2021 using mix of Airbus A319 and Airbus A320 aircraft averaging 172 seats over the year. Beyond 2021, it was assumed that Latin American demand would increase at the same rate as total O&D passengers. When demand exceeds an average of 130 daily O&D passengers each way, based on an average 172-seat aircraft operating at a 75% load factor, a new flight was assumed to be added.

Current Canadian service is capable of providing direct service to all current O&D demand. It was assumed that Canadian demand would increase at the same rate as total O&D passengers. When demand exceeds an average of 38 daily O&D passengers each way, based on an average 50-seat aircraft operating at a 75% load factor, a new flight was assumed to be added.

3.3.5 Passenger Activity Forecast Summary

Based on the assumptions used in the near-term forecast, domestic enplaned passengers are projected to increase from 3.8 million in 2017 to 4.7 million in 2020, representing an AAGR of 7.1 percent. According to the long-term domestic forecast, enplaned domestic passengers are projected to increase from 4.7 million in 2020 to 8.6 million 2050, representing an AAGR of 2.1 percent over that time period.

Based on the assumptions used in the near-term forecast, international enplaned passengers are projected to increase from 135,918 in 2017 to 152,724 in 2020, representing an AAGR of 4.0 percent. The long-term international forecast enplaned passengers are projected to increase from 152,724 in 2020 to 455,200 in 2050, representing an AAGR of 3.7 percent over that time.

Overall, total enplaned passengers at CVG are projected to increase from 3.9 million in 2017 to 9.1 million in 2050, representing an AAGR of 2.6 percent. Table 3.3-2, Enplaned Passenger Forecast Results, provides a summary of the enplaned passenger forecast by segment.

TABLE 3.3-2 ENPLANED PASSENGER FORECAST RESULTS

Year	Domestic			International	Total
	O&D	Connecting	Total		
Historical					
2007	2,114,242	5,395,841	7,510,083	333,876	7,843,959
2008	1,880,912	4,605,220	6,486,132	315,479	6,801,611
2009	2,127,053	2,957,698	5,084,751	216,042	5,300,792
2010	2,208,498	1,652,766	3,861,264	126,675	3,987,938
2011	2,148,423	1,267,552	3,415,975	109,511	3,525,486
2012	2,000,484	921,102	2,921,586	111,839	3,033,424
2013	2,055,241	703,417	2,758,658	116,130	2,874,788
2014	2,176,294	665,168	2,841,462	123,196	2,964,657
2015	2,542,937	490,660	3,033,597	126,652	3,160,248
2016	2,883,643	376,406	3,260,049	123,889	3,383,938
2017	3,516,352	273,888	3,790,240	135,918	3,926,158
Forecast					
2018	3,995,755	278,922	4,274,677	165,337	4,440,014
2019	4,171,293	204,802	4,376,095	152,948	4,529,043
2020	4,504,860	151,695	4,656,555	152,724	4,809,279
2022	4,692,400	159,300	4,851,700	265,400	5,117,100
2027	5,469,000	178,300	5,647,300	265,400	5,912,700
2032	6,224,200	195,200	6,419,400	265,400	6,684,800
2037	6,793,800	209,100	7,002,900	392,700	7,395,600
2050	8,364,700	235,400	8,600,100	455,200	9,055,300
Average Annual Growth Rates					
2007-17	5.2%	-25.8%	-6.6%	-8.6%	-6.7%
2017-22	5.9%	-10.3%	5.1%	14.3%	5.4%
2022-27	3.1%	2.3%	3.1%	0.0%	2.9%
2027-32	2.6%	1.8%	2.6%	0.0%	2.5%
2032-37	1.8%	1.4%	1.8%	8.2%	2.0%
2037-50	1.6%	0.9%	1.6%	1.1%	1.6%
2017-50	2.7%	-0.5%	2.5%	3.7%	2.6%

Sources: KCAB; Woods & Poole, The Complete Economic and Demographic Data Source (CEDDS) 2017; U.S. Department of Transportation, Air Passenger Origin-Destination Survey; Landrum & Brown analysis

3.4 Air Cargo Throughput Forecast

This section presents the forecast of air cargo throughput for CVG through the forecast period as well as a discussion of the methodology used to develop this forecast. In a similar fashion to the enplaned passenger forecast, the air cargo throughput forecast provides the basis for the all-cargo, or freighter, aircraft operations forecast.

3.4.1 Methodology

Future cargo throughput is dependent on the growth of two categories of cargo operators: traditional operators and non-traditional operators. A forecast for each category was created and the results were aggregated to provide a total cargo throughput forecast.

In order to project cargo throughput for traditional operators, such as DHL, it was determined that an economic regression model was most appropriate to forecast this category of cargo operators. Economic regression modeling quantifies the relationship between cargo throughput and socio-economic variables. This methodology recognizes that the key independent variables will change over time but assumes that their fundamental relationships to the dependent variables will remain.

The first step in developing the appropriate model was to test the independent, or explanatory, variables against the dependent variable, cargo throughput. In order for an econometric model to be considered appropriate, the following has to be true:

- Adequate test statistics (i.e. high coefficient of determination (R2) values and low p-value statistics), which indicate that the independent variables are good predictors of CVG traffic.
- Does not result in theoretical contradictions (e.g., the model indicates that GDP growth is negatively correlated with traffic growth).
- The results are not overly aggressive or conservative that are incompatible with historical averages.

Through the testing of multiple sets of independent variables, a multivariate linear model using the United States GDP and a set of dummy variables to indicate DHL short absence was selected to forecast cargo throughput for existing operators. The model exhibits strong regression statistics when compared to models with other combinations of independent variables. The model formula and relevant test statistics are provided below:

- Model:
  - "Cargo Throughput = 0.12*" 〖"GRP" 〗_"US" "-509,740.54*" 〖"Dummy" 〗_1 "-287,656*" 〖"Dummy" 〗_2 "-1,208,861.90"
  - Where: 〖"GRP" 〗_"US" = United States GDP
  - 〖"Dummy" 〗_1 = Full Years without DHL
  - 〖"Dummy" 〗_2 = Partial Years without DHL

Test Statistics:	**Independent Variables P-Values:**
R^2 = 96.7 percent	Intercept = 0.00
DF = 14	GRP_{US} = 0.00
P-Value = 0.00	$Dummy_1$ = 0.00
	$Dummy_2$ = 0.00

The R2 indicates that 96.7 percent of the variation in the cargo throughput at CVG can be explained by the model. **Table 3.3-3, *Regression Model Inputs***, provides the inputs used in the regression analysis and the forecasts of the independent variables.

TABLE 3.3-3 REGRESSION MODEL INPUTS

Year	Volume (in tons)	Gross Domestic Product (in millions of 2009 dollars)	Dummy 1 (Full Years w/o DHL)	Dummy 2 (Partial Years w/o DHL)
2003	432,872	13,063,662	0	0
2004	455,590	13,600,614	0	0
2005	277,343	14,106,895	0	1
2006	47,728	14,539,610	1	0
2007	43,759	14,820,650	1	0
2008	48,721	14,617,095	1	0
2009	152,970	14,320,115	0	1
2010	415,692	14,618,132	0	0
2011	537,139	14,792,272	0	0
2012	599,788	15,115,991	0	0
2013	655,479	15,415,698	0	0
2014	722,431	15,829,180	0	0
2015	804,088	16,501,908	0	0
2016	818,364	16,923,958	0	0
2017	914,385	17,298,638	0	0
2018		17,673,837	0	0
2019		18,052,252	0	0
2020		18,436,030	0	0
2021		18,825,583	0	0
2022		19,221,367	0	0
2023		19,622,540	0	0
2024		20,027,671	0	0
2025		20,436,994	0	0
2026		20,850,396	0	0
2027		21,267,484	0	0
2028		21,688,340	0	0
2029		22,113,028	0	0
2030		22,541,404	0	0
2031		22,972,998	0	0
2032		23,408,118	0	0
2033		23,846,446	0	0
2034		24,288,017	0	0

Year	Volume (in tons)	Gross Domestic Product (in millions of 2009 dollars)	Dummy 1 (Full Years w/o DHL)	Dummy 2 (Partial Years w/o DHL)
2035		24,733,432	0	0
2036		25,183,071	0	0
2037		25,637,132	0	0
2038		26,096,053	0	0
2039		26,559,816	0	0
2040		27,028,603	0	0
2041		27,502,574	0	0
2042		27,982,356	0	0
2043		28,467,870	0	0
2044		28,959,657	0	0
2045		29,457,796	0	0
2046		29,961,993	0	0
2047		30,472,393	0	0
2048		30,989,550	0	0
2049		31,513,954	0	0
2050		32,045,997	0	0

Sources: KACB; Woods & Poole, The Complete Economic and Demographic Data Source (CEDDS) 2017; FAA Aerospace Forecast, Fiscal Years 2017-2037

While the regression model provides a base for the traditional carrier cargo throughput, in reality the traditional carriers will be subject to operational constraints based on the available space for expansion. As such, the year-over-year growth was restricted to 1.0 percent once constraints are realized. Based on the current size of the facilities for these carriers, the space available for expansion, and the forecasted rate of growth, operational constraints were assumed to occur in 2026.

Cargo throughput for the non-traditional operator, Amazon Air, was developed based primarily on input from the operator. Amazon Air provided annual aircraft operations through the ultimate build-out, which is assumed to be completed by 2028. According to Amazon Air, on opening day in 2021, there will be 64 daily operations which will increase to 144 by 2026 and 180 by 2028. The operator also provided a fleet mix of likely aircraft types. An assumed load factor was applied to the max payload for the individual aircraft types. The share of each aircraft type with max payload is provided in **Table 3.4-1, *Share of Aircraft***. The load factors were assumed to reach 50.0 percent in 2021 and remain at this load factor through the forecast, and then annualized to estimate the future cargo throughput through 2028. The growth beyond 2028 is assumed to mirror the rate of the existing operators without constraints, i.e. the growth rates provided by the regression model were applied.

TABLE 3.4-1 SHARE OF AIRCRAFT

Aircraft	321	738	332	763	772
Payload	**46,738**	**45,787**	**132,277**	**116,183**	**224,900**
Year	Share of Daily Operations				
2018	0.0%	0.0%	0.0%	100.0%	0.0%
2019	0.0%	0.0%	0.0%	100.0%	0.0%
2020	0.0%	0.0%	0.0%	100.0%	0.0%
2021	9.4%	12.5%	37.5%	40.6%	0.0%
2022	14.3%	17.0%	32.6%	35.3%	0.7%
2023	19.3%	21.5%	27.8%	30.0%	1.4%
2024	24.2%	26.0%	22.9%	24.7%	2.1%
2025	26.7%	28.3%	20.5%	22.1%	2.4%
2026	29.2%	30.6%	18.1%	19.4%	2.8%
2027	27.4%	27.5%	20.1%	21.4%	3.6%
2028	25.6%	24.4%	22.2%	23.3%	4.4%

Source: Amazon

3.4.2 Cargo Throughput Forecast Summary

Air cargo throughput at CVG is forecast to increase from 1.0 million tons in 2017 to 4.5 million tons in 2050, representing an AAGR of 4.6 percent. **Table 3.4-2, *Air Cargo Throughput Results***, provides a summary of the air cargo throughput forecast.

TABLE 3.4-2 AIR CARGO THROUGHPUT FORECAST RESULTS

Year	Traditional Carriers	Non-Traditional Carriers	Total
Historical			
2007	43,759		43,759
2008	48,721		48,721
2009	152,970		152,970
2010	415,692		415,692
2011	537,139		537,139
2012	599,788		599,788
2013	655,479		655,479
2014	722,431		722,431
2015	804,088		804,088
2016	818,364		818,364
2017	914,385	127,505	1,041,890
Forecast			
2022	1,200,130	696,492	1,896,622
2027	1,386,314	1,303,157	2,689,471
2032	1,457,030	1,689,615	3,146,645
2037	1,531,353	1,971,306	3,502,659
2050	1,742,823	2,781,224	4,524,046
Average Annual Growth Rates			
2007-17	35.5%	n.a.	37.3%
2017-22	5.6%	40.4%	12.7%
2022-27	2.9%	13.3%	7.2%
2027-32	1.0%	5.3%	3.2%
2032-37	1.0%	3.1%	2.2%
2037-50	1.0%	2.7%	2.0%
2017-50	2.0%	9.8%	4.6%

Sources: KCAB. Woods & Poole, The Complete Economic and Demographic Data Source (CEDDS) 2017; Landrum & Brown analysis

3.5 Aircraft Operations Forecast

This section describes the methodology and the results of the aircraft operations forecast at CVG. Aircraft operations, defined as aircraft arrivals plus departures, were projected separately for four major categories: (1) passenger; (2) freighter; (3) GA and air taxi; and (4) military. These components are then aggregated to derive a total aircraft operations forecast for CVG.

3.5.1 Passenger Aircraft Operations

3.5.1.1 *Methodology*

The number of passenger aircraft operations at an airport depends on three factors: (1) total passengers, (2) average aircraft size, and (3) average load factor (percent of seats occupied). The relationship is shown in the equation below:

$$\text{Passenger Aircraft Operations} = \frac{\text{Total Passengers}}{\text{Average Load Factor} * \text{Average Aircraft Size}}$$

This relationship permits an infinite set of load factors, average aircraft size, and operations to accommodate a given number of passengers.

The short-term passenger aircraft operations forecast for new operations was developed by including those assumed flights to be added as part of the enplaned passenger forecast based on year-to-date counts and current scheduled fillings. Beyond 2020, the enplaned passenger forecast was used as the numerator in the formula above with assumed values for load factors and average aircraft size to determine passenger aircraft departures. To calculate total passenger operations, the total number of departures was multiplied by two.

In order to develop reasonable load factor and average number of seats per aircraft assumptions, enplaned passengers and passenger aircraft departures were disaggregated into categories of activity (i.e., air carrier and regional activity for both domestic and international service). In this case, air carrier refers to aircraft and the passengers transported in such aircraft with average seating capacity of more than 76 seats while regional or commuter refers to all other aircraft. The disaggregation was done using historical passenger volumes percent splits from T-100. In 2017, 57.8 percent of domestic passengers flew on air carrier aircraft. However, the shift to more air carrier aircraft, partially due to increased ultra-low-cost carrier presence, as indicated in current schedule fillings will likely result in more passengers onboard air carrier aircraft. It was assumed that more than two-thirds of passengers will be flying on air carrier aircraft by 2023. A summary of the passenger forecast disaggregated by classification is provided in Table 3.5-1, Enplaned Passenger Forecast by Classification.

Load factors and the average aircraft size, or average seats per departure (ASPD), at every airport are inherently different due to difference in how airlines choose to serve the demand for air travel to, from, and over each airport. These differences may result from a strategic focus on unit revenue versus unit costs or an emphasis on a hub and spoke system versus a point-to-point operation.

A number of sources were used to develop the historical passenger aircraft operations, load factors, and the ASPD for the Airport. The Official Airline Guide (OAG); FAA, Operations Network (OPSNET); and the United States Department of Transportation (U.S. DOT), Air Carrier Statistics database (T-100) were used to develop the total departures and seats for each segment. ASPD for each of the major groups of passenger activity was calculated from total departures and total departing seats. Average load factors were calculated for each group of passenger aircraft operations by dividing the total enplaned passengers by total departing seats.

TABLE 3.5-1 ENPLANED PASSENGER FORECAST BY CLASSIFICATION

Year	Domestic			International			Total
	Air Carrier	Commuter	Total	Air Carrier	Commuter	Total	
Historical							
2007	2,611,217	4,898,866	7,510,083	234,649	99,227	333,876	7,843,959
2008	2,235,611	4,250,521	6,486,132	228,347	87,132	315,479	6,801,611
2009	1,629,366	3,455,385	5,084,751	149,811	66,231	216,042	5,300,792
2010	1,387,033	2,474,231	3,861,264	80,918	45,757	126,675	3,987,938
2011	1,325,576	2,090,399	3,415,975	64,033	45,478	109,511	3,525,486
2012	1,108,473	1,813,113	2,921,586	72,606	39,233	111,839	3,033,424
2013	993,353	1,765,305	2,758,658	84,646	31,484	116,130	2,874,788
2014	1,098,309	1,743,153	2,841,462	90,030	33,166	123,196	2,964,657
2015	1,351,944	1,681,653	3,033,597	95,763	30,889	126,652	3,160,248
2016	1,533,491	1,726,558	3,260,049	83,975	39,914	123,889	3,383,938
2017	2,189,532	1,600,708	3,790,240	88,679	47,239	135,918	3,926,158
Forecast							
2022	3,179,821	1,671,879	4,851,700	213,797	51,603	265,400	5,117,100
2027	3,885,417	1,761,883	5,647,300	213,797	51,603	265,400	5,912,700
2032	4,416,632	2,002,768	6,419,400	213,797	51,603	265,400	6,684,800
2037	4,818,088	2,184,812	7,002,900	326,497	66,203	392,700	7,395,600
2047	5,701,910	2,585,590	8,287,500	326,497	66,203	392,700	8,680,200
2048	5,787,912	2,624,588	8,412,500	326,497	66,203	392,700	8,805,200
2049	5,830,912	2,644,088	8,475,000	388,997	66,203	455,200	8,930,200
2050	5,916,983	2,683,117	8,600,100	388,997	66,203	455,200	9,055,300
Average Annual Growth Rates							
2007-17	-1.7%	-10.6%	-6.6%	-9.3%	-7.2%	-8.6%	-6.7%
2017-22	7.7%	0.9%	5.1%	19.2%	1.8%	14.3%	5.4%
2022-27	4.1%	1.1%	3.1%	0.0%	0.0%	0.0%	2.9%
2027-32	2.6%	2.6%	2.6%	0.0%	0.0%	0.0%	2.5%
2032-37	1.8%	1.8%	1.8%	8.8%	5.1%	8.2%	2.0%
2037-50	1.6%	1.6%	1.6%	1.4%	0.0%	1.1%	1.6%
2017-50	3.1%	1.6%	2.5%	4.6%	1.0%	3.7%	2.6%

Sources: KCAB. Woods & Poole, The Complete Economic and Demographic Data Source (CEDDS) 2017; U.S. Department of Transportation, Air Carrier Statistics database (T-100); Landrum & Brown analysis

3.5.1.2 *Passengers Per Operation*

Domestic

The average number of seats per aircraft is directly related to the type of aircraft being utilized at the Airport. The majority of the domestic passenger traffic at CVG is currently handled by six mainline carriers. Therefore, in order to estimate the future average number of seats per aircraft, the fleet plans for each carrier were examined. The following is a description of the current fleet plans for each of the mainline carriers with a focus on potential changes at CVG:

- **Delta Air Lines:** Delta Air Lines uses a mix of the McDonnell Douglas MD-80, Boeing 737-800, Airbus A320-200, and Boeing 717-200 aircraft at CVG. The McDonnell Douglas MD-80 is expected to be retired in the near future with the Boeing 737-800 acting as its replacement. The Boeing 717-200 aircraft are relatively old by aircraft standards. It is assumed that the Bombardier CS100 will be the Boeing 717-200s replacement with the shift occurring as orders are delivered. Delta Air Lines has 97 Airbus A321s on order. These aircraft will be added to the fleet where applicable.
- **American Airlines:** Currently, American Airlines utilizes the McDonnell Douglas MD-80 aircraft for air carrier operations at CVG. The McDonnell Douglas MD-80 aircraft are expected to be retired by the end of 2018. These aircraft will initially be replaced with American Airlines' existing Boeing 737-800 and Airbus A319 aircraft. American Airlines has placed 100 orders for the Boeing 737 Max8 aircraft with five of the aircraft already delivered in 2017. The aircraft will likely be utilized interchangeably with the Boeing 737 800 aircraft.
- **United Airlines:** United Airlines deploys an even mix of the Airbus A319 and Airbus A320 aircraft with the occasional operation performed by the Boeing 737-900 aircraft at CVG. United Airlines has orders for the Boeing 737 Max9 aircraft, which will be utilized at the Airport as the aircraft are delivered.
- **Southwest Airlines:** Nearly all of Southwest Airlines' flights at CVG utilize the Boeing 737-700 aircraft. Currently, Southwest Airlines has a number of Boeing 737 Max8 and Boeing 737 Max7 aircraft on order. It is expected these aircraft will handle the service at CVG as deliveries are made which are expected to begin in 2018 for the Boeing 737 Max8 and 2019 for the Boeing 737 Max7.
- **Frontier Airlines:** Frontier Airlines uses a mix of Airbus A319, Airbus A320, and Airbus A321 aircraft at CVG. Frontier Airlines has a number of Airbus A320 Neo and Airbus A319 aircraft on order. It is expected the Airbus A320 Neo will handle some of the flights at CVG currently being operated by the current model Airbus A320.
- **Allegiant Air:** Allegiant Air currently uses a mix of McDonnell Douglas MD-80 and Airbus A319 aircraft at CVG. The McDonnell Douglas MD-80 is expected to be replaced by the end of 2018 with the Airbus A320 aircraft.

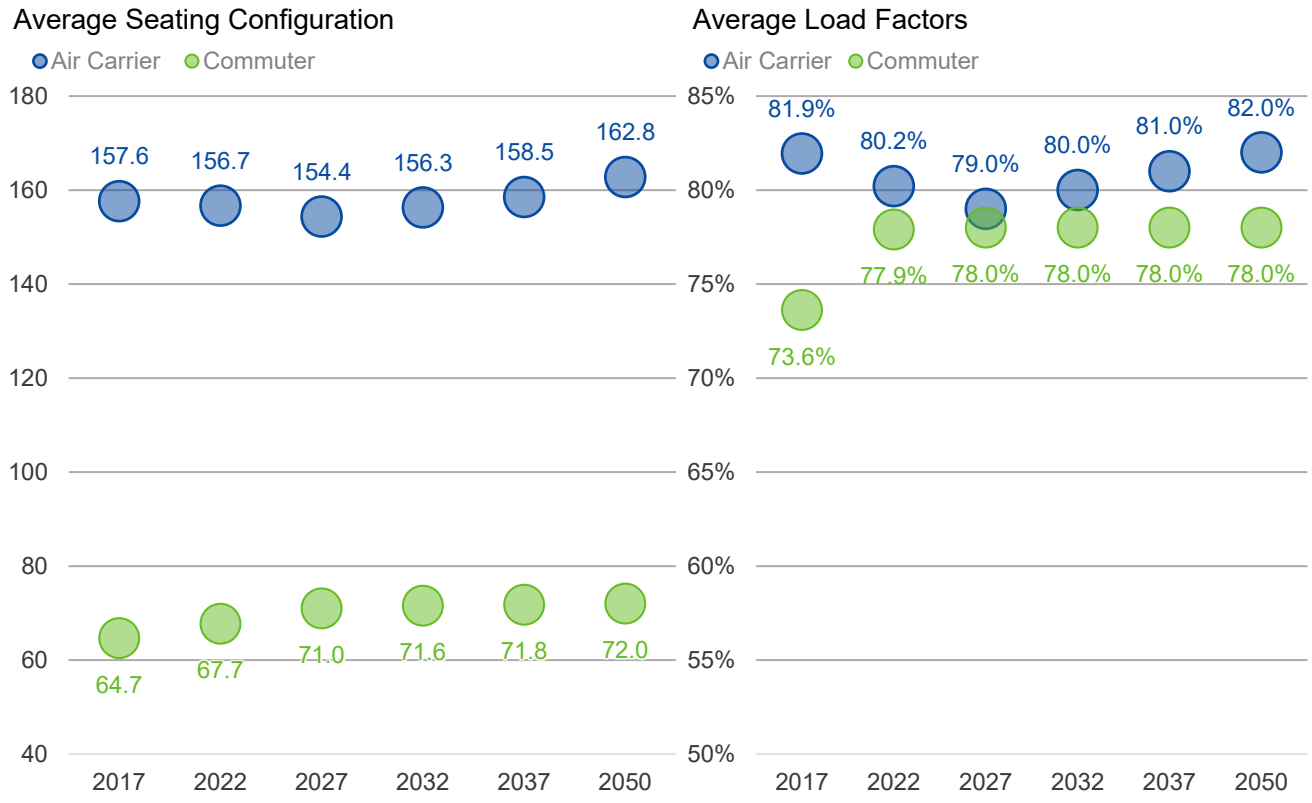
Delta Air Lines, United Airlines, and American Airlines all use regional affiliates to accommodate a majority of their passenger traffic. These regional airlines exclusively use aircraft with fewer than 76 seats, which are called regional jets. Small regional jets (aircraft with 50 or fewer seats) are being retired at an accelerated rate as airlines believe these aircraft are too expensive to fly. A significant portion of the small regional aircraft have already been eliminated from routes at CVG. It is expected that all of the regional partners of the mainline carrier will replace the majority of the small regional aircraft with larger regional aircraft (aircraft with at least 65 seats) at CVG within the next five years.

In 2017, domestic air carrier aircraft operations had a scheduled ASPD of 157.6 and an estimated average load factor of 81.9 percent. Based on the fleet plans for airlines providing domestic service at CVG, the ASPD for domestic air carrier flights is projected to increase to 162.8 by 2050 and average load factors are expected to decline slightly in the short-term as airlines increase the share of air carrier aircraft before increasing to an average of 82.0 percent.

In 2017, domestic commuter aircraft operations had a scheduled ASPD of 64.7 and an estimated average load factor of 73.6 percent. Based on the anticipated reduced utilization of small regional aircraft used for domestic service at CVG, the ASPD for domestic commuter flights is project to increase to 72.0 by 2050 and average load factors for domestic commuter flights are expected to increase to 78.0 percent.

Exhibit 3.5-1, *Domestic Passengers Per Operation Assumptions*, presents ASPD and load factors used to calculate domestic aircraft operations.

EXHIBIT 3.5-1 DOMESTIC PASSENGERS PER OPERATION ASSUMPTIONS



Sources: U.S. Department of Transportation, Air Carrier Statistics database (T-100); OAG Aviation Worldwide Ltd, OAG Schedules Analyser; Landrum & Brown analysis

International

Currently, the CDG flight operated by Delta Air Lines utilizes a Boeing 767-300 aircraft. It is assumed that the Airbus A350-900 Neo will act as its replacement. Additional transoceanic international flights in the future will also primarily use wide-body aircraft such as variants of the Boeing 787 aircraft. Flights to and from Canada will almost exclusively use regional aircraft such as the Embraer 175 and Canadair Regional Jet CRJ900. Latin American service, including Mexico, will continue to utilize narrow-body aircraft.

As discussed in the international passenger forecast, new direct international service was assumed to be added when demand reached a level that can support the flight. Based on the analysis new European service will begin in 2021, 2033, and 2048 with a 214-seat Boeing 787-900. New Latin American service, including Mexico, are expected to begin in 2020 and 2034 with a 172-seat Airbus A320-200 and new Canadian service is expected to begin in 2035 with a 76-seat Embraer 175.

3.5.1.3 *Passenger Aircraft Operations Forecast Summary*

Based on the foregoing assumptions regarding load factors and ASPD, domestic air carrier aircraft operations will increase from 33,906 in 2017 to 88,660 in 2050, representing an AAGR of 3.0 percent. Domestic commuter aircraft operations are forecast to increase 1.1 percent per annum from 67,248 in 2017 to 95,520 in 2050. International air carrier aircraft operations are forecast to increase significantly from 938 in 2017 to 5,004 in 2050, representing an AAGR of 5.2 percent. Through the forecast period, international commuter aircraft operations are forecast to increase at an AAGR of 0.8 percent, increasing from 2,886 in 2017 to 3,806 in 2050. **Table 3.5-2, *Passenger Aircraft Operations***, presents the results of the domestic and international passenger aircraft operations forecast.

3.5.1.4 *Fleet Mix*

The fleet mix forecasts were developed to match the ASPD assumptions for each segment. The fleet mix forecasts allowed for the calibration of the ASPD and load factor assumptions and, where appropriate, modifications were made prior to finalizing the average ASPD and load factor assumptions. The allocation of passenger departures by aircraft type is shown in **Table 3.5-3, *Domestic Passenger Fleet Mix***, for domestic departures and **Table 3.5-4, *International Passenger Fleet Mix***, for international departures.

TABLE 3.5-2 PASSENGER AIRCRAFT OPERATIONS

Year	Domestic			International			Total
	Air Carrier	Commuter	Total	Air Carrier	Commuter	Total	
Historical							
2007			296,400			8,574	304,974
2008			258,512			7,900	266,412
2009			196,772			5,384	202,156
2010			142,442			4,052	146,494
2011			125,824			4,486	130,310
2012			107,640			3,804	111,444
2013			102,642			3,574	106,216
2014			97,048			3,778	100,826
2015			94,130			3,302	97,432
2016	22,458	74,288	96,746	880	2,706	3,586	100,332
2017	33,906	67,248	101,154	938	2,886	3,824	104,978
Forecast							
2022	50,600	63,380	113,980	2,648	3,022	5,670	119,650
2027	63,720	63,640	127,360	2,648	3,022	5,670	133,030
2032	70,660	71,740	142,400	2,648	3,022	5,670	148,070
2037	75,040	78,060	153,100	4,220	3,810	8,030	161,130
2050	88,660	95,520	184,180	5,004	3,806	8,810	192,990
Average Annual Growth Rates							
2007-17			-10.2%			-7.8%	-10.1%
2017-22	8.3%	-1.2%	2.4%	23.1%	0.9%	8.2%	2.7%
2022-27	4.7%	0.1%	2.2%	0.0%	0.0%	0.0%	2.1%
2027-32	2.1%	2.4%	2.3%	0.0%	0.0%	0.0%	2.1%
2032-37	1.2%	1.7%	1.5%	9.8%	4.7%	7.2%	1.8%
2037-50	1.3%	1.6%	1.4%	1.3%	0.0%	0.7%	1.4%
2017-50	3.0%	1.1%	1.8%	5.2%	0.8%	2.6%	1.9%

Sources: KCAB. U.S. Department of Transportation, Air Carrier Statistics database (T-100); OAG Aviation Worldwide Ltd, OAG Schedules Analyser; Landrum & Brown analysis

TABLE 3.5-3 DOMESTIC PASSENGER FLEET MIX

Aircraft				Seating Configuration	Departures						
					2016	2017	2022	2027	2032	2037	2050
Air Carrier					11,229	16,953	25,300	31,860	35,330	37,520	44,330
	Narrow-body				11,229	16,953	25,300	31,860	35,330	37,520	44,330
		321	Airbus A321	219	602	669	1,059	1,462	1,599	1,675	1,919
		757	Boeing 757-200,-300	188	210	56	2	0	0	0	0
		7M9	Boeing 737Max 9	179	0	0	32	84	91	96	105
		3N0	Airbus A320neo	186	0	0	332	784	1,807	3,992	4,801
		739	Boeing 737-900	180	129	206	159	256	405	475	567
		7M8	Boeing 737Max 8	174	0	5	106	408	1,871	3,711	8,689
		320	Airbus A320-200	176	2,661	3,639	4,856	5,326	5,241	3,578	4,363
		738	Boeing 737-800	163	1,417	2,491	5,230	6,023	6,433	6,774	8,290
		M90	Boeing (Douglas) MD-90	160	166	57	0	0	0	0	0
		3N9	Airbus A319neo	156	0	0	215	697	780	835	1,004
		M80	Boeing (Douglas) MD-80,-82,-83	154	4,968	4,437	228	0	0	0	0
		319	Airbus A319	150	1,014	2,647	2,464	2,212	2,325	2,541	3,187
		7M7	Boeing 737Max 7	150	0	0	15	249	716	1,484	3,546
		737	Boeing 737-700	143	1	1,617	7,815	11,188	10,569	8,675	3,576
		CS1	Bombardier CS100	110	0	0	425	986	1,041	1,048	1,094
		717	Boeing 717-200	110	61	1,129	454	0	0	0	0
		E90	Embraer E190	100	0	0	1,908	2,185	2,452	2,636	3,189
Commuter					37,144	33,625	31,690	31,820	35,870	39,030	47,760
	Large Regional				20,072	21,916	28,952	29,935	34,468	37,718	46,506
		CR9	Canadair Regional Jet 900	76	11,859	10,239	11,608	12,453	14,668	16,139	20,035
		E75	Embraer 175	76	2,082	3,723	6,207	6,262	7,059	7,679	9,398
		E70	Embraer 170	70	1,438	1,871	2,023	2,066	2,329	2,535	3,101

Aircraft				Seating Configuration	Departures						
					2016	2017	2022	2027	2032	2037	2050
		CR7	Canadair Regional Jet 700	67	4,693	6,083	9,114	9,154	10,412	11,365	13,972
	Small Regional				17,072	11,709	2,738	1,885	1,402	1,312	1,254
		CRJ	Canadair Regional Jet 200	50	9,049	6,397	1,351	934	528	438	369
		ERJ	Embraer 135/140/145	50	7,644	4,795	870	434	357	357	368
		FRJ	Fairchild Dornier 328jet	30	256	0	0	0	0	0	0
		BE4	Hawker 400 Beechjet	7	123	517	517	517	517	517	517
Grand Total					**48,373**	**50,578**	**56,990**	**63,680**	**71,200**	**76,550**	**92,090**

Sources: KCAB; U.S. Department of Transportation, Air Carrier Statistics database (T-100); OAG Aviation Worldwide Ltd, OAG Schedules Analyser; Landrum & Brown, 2017

TABLE 3.5-4 INTERNATIONAL PASSENGER FLEET MIX

Aircraft			Seating Configuration	Departures						
				2016	2017	2022	2027	2032	2037	2050
Air Carrier				440	469	1,324	1,324	1,324	2,110	2,502
	Wide-body			337	329	694	694	694	1,059	1,424
		33N	Airbus A330-900 Neo	270	0	0	0	0	329	329	329
		788	Boeing 787-800	214	0	0	365	365	365	730	1,095
		763	Boeing 767-300	226	337	329	329	329	0	0	0
	Narrow-body				103	140	630	630	630	1,051	1,078
		321	Airbus A321	200	25	48	194	194	194	294	333
		320	Airbus A320	184	30	26	365	365	365	642	608
		738	Boeing 737-800	160	0	4	71	71	71	115	137
		319	Airbus A319	156	48	62	0	0	0	0	0
		M80	Boeing (Douglas) MD-80,-88	153	25	48	194	194	194	294	333
Commuter					1,353	1,444	1,511	1,511	1,511	1,904	1,904
	Large Regional				0	6	1,255	1,511	1,511	1,904	1,904
		CR9	Canadair Regional Jet 900	76	0	5	487	487	487	487	487
		E75	Embraer E175	76	0	1	768	1,024	1,024	1,417	1,417
	Small Regional				1,353	1,438	256	0	0	0	0
		CRJ	Canadair Regional Jet	50	1,353	1,438	256	0	0	0	0
Grand Total					**1,793**	**1,913**	**2,835**	**2,835**	**2,835**	**4,014**	**4,406**

Sources: KCAB; U.S. Department of Transportation, Air Carrier Statistics database (T-100); OAG Aviation Worldwide Ltd, OAG Schedules Analyzer; Landrum & Brown analysis

3.5.2 Freighter Aircraft Operations

3.5.2.1 *Methodology*

The freighter aircraft operations are a product of the cargo throughput forecast and assumed average air cargo tons per operation. Nearly all of the air cargo (99.5 percent in 2017) is handled by dedicated freighter carriers.

For non-traditional operators, such as Amazon Air, the aircraft operations through 2028 are based on the input provided by cargo operators. The remaining freighter aircraft operations forecast was derived from the air cargo throughput forecast in a similar fashion as the passenger aircraft operations.

3.5.2.2 *Tons Per Operation*

In 2017, three-fourths all of the freighter aircraft operations were conducted by DHL or their affiliates. The airline uses a mix of variants of the Boeing 737, Boeing 757, Boeing 747, Boeing 777, and Boeing 767 aircraft. It is assumed that some of the older aircraft such as the Boeing 757-200 and the Boeing 737-400 will be retired at some point during the forecast period. These aircraft will likely be replaced by aircraft of similar size and payload. Traditional operators, including DHL, are handling approximately 31.5 tons per aircraft operation. It is assumed that the average tons per aircraft of the current cargo operations will increase to 32.5 tons by 2050.

Amazon Air is expected to use primarily wide-body aircraft such as the Airbus A330-200 and Boeing 767-300 during the early stages of operations and will work to increase the average load per operation. However, the higher loads per aircraft will be short-lived as it introduces narrow-bodies such as the Airbus A321 and Boeing 737-800 into its fleet by the ultimate build-out of their facilities at CVG. As such, the tons per aircraft operation for the airline is expected to increase to 25.6 by 2022 from an estimated 18.4 tons per operation in 2017 before declining to an average of 25.0 tons by 2050.

3.5.2.3 *Freighter Aircraft Operations Forecast Summary*

Freighter aircraft operations are forecast to increase from 36,004 in 2017 to 164,870 in 2050, representing an AAGR of 4.7 percent. **Table 3.5-5, *Freighter Aircraft Operations Forecast***, provides the freighter aircraft operations forecast by carrier type.

TABLE 3.5-5 FREIGHTER AIRCRAFT OPERATIONS FORECAST

Year	Traditional Carriers			Non-Traditional Carriers		
	Percent Freighter	Tons/ Operation	Operations	Percent Freighter	Tons/ Operation	Operations
Historical						
2017	99.4%	31.5	29,060	100.0%	18.4	6,944
Forecast						
2022	99.5%	32.1	37,339	100.0%	25.6	27,206
2027	99.5%	32.0	43,322	100.0%	21.2	61,332
2032	99.5%	32.0	45,532	100.0%	22.9	73,682
2037	99.5%	32.3	47,484	100.0%	23.6	83,526
2050	99.5%	32.5	53,625	100.0%	25.0	111,249
Average Annual Growth Rates						
2017-22			5.1%			31.4%
2022-27			3.0%			17.7%
2027-32			1.0%			3.7%
2032-37			0.8%			2.5%
2037-50			0.9%			2.2%
2017-50			1.9%			8.8%

Sources: KCAB; Landrum & Brown analysis

3.5.2.4 *Fleet Mix*

As outlined above, outside of some replacements, the existing cargo operators at the Airport will not likely change their fleet materially. However, the construction of Amazon Air's hub does result in an increased share of air carrier freighters at the Airport. The allocation of freighter aircraft departures by aircraft type is presented in **Table 3.5-6, *Freighter Fleet Mix***.

TABLE 3.5-6 FREIGHTER FLEET MIX

Aircraft			Departures						
			2016	2017	2022	2027	2032	2037	2050
Air Carrier			12,482	16,440	30,267	50,000	57,159	62,953	79,551
	Wide-body		**9,734**	**13,584**	**22,772**	**29,932**	**35,860**	**39,528**	**48,868**
	306	Airbus A300-600	887	921	1,183	1,375	1,444	1,505	1,697
	310	Airbus A310	6	6	8	9	9	10	11
	748	Boeing 747-800	697	724	930	1,079	1,134	1,183	1,336
	747	Boeing 747-200, -400	1,183	1,230	1,583	1,835	1,929	2,011	2,271
	767	Boeing 767-200, -300	6,544	10,270	13,975	17,704	20,840	22,974	27,919
	332	Airbus A330-200	0	0	4,441	6,176	8,187	9,280	12,362
	777	Boeing 777	417	433	652	1,754	2,317	2,565	3,273
	Narrow-body		**2,748**	**2,856**	**7,495**	**20,068**	**21,299**	**23,425**	**30,683**
	722	Boeing 727-200	165	172	221	256	269	281	317
	321	Airbus A321	0	0	1,948	8,391	9,415	10,673	14,215
	738	Boeing 737-800	0	0	349	911	1,489	2,107	2,553
	737	Boeing 737-400	1,332	1,384	3,744	9,586	9,686	10,364	13,598
	757	Boeing 757-200	1,251	1,300	1,233	924	440	0	0
Commuter			1,503	1,562	2,006	2,327	2,448	2,552	2,886
	Small Regional		**1,503**	**1,562**	**2,006**	**2,327**	**2,448**	**2,552**	**2,886**
	BEH	Beechcraft 1900	343	357	458	532	559	584	659
	CN1	Cessna 208 Caravan	20	21	27	31	33	34	39
	EM2	Embraer EMB 120 Brasilia	243	252	324	188	198	206	233
	SH6	Shorts 360	329	342	440	255	268	280	316
	SW4	Fairchild Swearingen Merlin	506	526	675	392	412	429	485
	CRJ	Canadair Regional Jet CRJ 200	0	0	30	896	942	982	1,109
	Other Commuter		**62**	**64**	**52**	**33**	**36**	**37**	**45**
Grand Total			**13,985**	**18,002**	**32,273**	**52,327**	**59,607**	**65,505**	**82,437**

Sources: KCAB; Landrum & Brown analysis

3.5.3 Other Aircraft Operations

3.5.3.1 *Air Taxi and General Aviation*

There are a number of approaches to developing GA and air taxi aircraft operations forecasts ranging from economic, trend or time series, and market share forecasts. During the forecast development, there was no reasonable fit of the GA and air taxi aircraft operations to time series or socio-economic variables. Every socio-economic variable has increased steadily since 2007 with some exceptions in 2009 and 2010. On the other hand, GA steadily declined until 2013. This leads to a fundamental flaw in using socio-economic indicators as a predictor of GA as they provide the notion that as the economy improves, GA traffic will decline.

It was assumed that GA and air taxi aircraft operations would increase at a rate consistent with the national trends. Since 2012, GA and air taxi aircraft operations at the Airport have increased at an average rate of 2.3% per annum. During the same period, GA and air taxi hours nationally increased 0.3% compared to 0.1% growth in the GA fleet and a decline of 0.4% in total GA operations. Since the recent local trend in this segment is more consistent with hours flown, the AAGR for active GA and air taxi hours flown from the FAA Aerospace Forecast was applied to the number of aircraft operations in 2017 for GA and air taxi aircraft operations at the Airport. It was assumed that the AAGR from the Aerospace Forecast would continue at the same rate beyond the forecasted year of 2037. GA and air taxi aircraft operations at CVG are projected to increase from 9,349 in 2017 to 12,340 in 2050, representing an AAGR of 0.8 percent.

Jet aircraft account for a majority (91.4 percent) of the GA and air taxi aircraft activity at the Airport. It was assumed that due to anticipated changes to the based aircraft at the Airport due to the current expansion of the FBO at the Airport, jet aircraft are anticipated to account for an even larger percentage of the activity. By 2050, it was assumed that jets would account for 93.0% of the total GA and air taxi aircraft operations. **Table 3.5-7, *Air Taxi and General Aviation Fleet Mix***, presents the GA and air taxi forecast by aircraft type.

TABLE 3.5-7 AIR TAXI AND GENERAL AVIATION FLEET MIX

Type	Representative Aircraft	Departures						
		2016	2017	2022	2027	2032	2037	2050
Jet	CRJ9, CRJ7, CRJ2	3,994	4,283	4,366	4,583	4,814	5,056	5,740
Turboprop	BE2, BE9L, P180	152	159	157	159	162	164	167
Piston	C310, C172, SR22	220	229	228	234	240	246	259
Helicopter	EC35	4	4	4	4	4	4	4
Total		**4,370**	**4,675**	**4,755**	**4,980**	**5,220**	**5,470**	**6,170**

Sources: KCAB; Flight Track Data for 2017; Landrum & Brown analysis

3.5.3.2 *Based Aircraft Forecast*

In 2017, there were 13 based aircraft at CVG. Currently, the FBO does not include facilities to process arriving international GA passengers. The new general aviation facility (GAF) that includes CBP capabilities is scheduled to be constructed in 2018. It is assumed that the construction of such facilities would attract some companies to base their aircraft at CVG which are presumed to be exclusively jet aircraft. These Cincinnati bound flights currently clear customs and immigration at other airports before arriving at CVG. Therefore, with the ability to clear customs and immigration at CVG, it was assumed that based aircraft jets would increase 25.0 percent over the next five years. Afterwards, it was assumed that growth of based jets would increase at the national average of 2.2 percent as presented in the FAA Aerospace Forecast. The remaining based aircraft, comprised of piston and turboprop aircraft, will remain at the 2017 level throughout the forecast period. The result of the based aircraft forecast is that based aircraft at CVG will increase from 13 in 2017 to 27 in 2050. **Table 3.5-8, *Based Aircraft Forecast***, presents the based aircraft forecast.

TABLE 3.5-8 BASED AIRCRAFT FORECAST

Type	Based Aircraft					
	2017	2022	2027	2032	2037	2050
Jet	10	13	15	16	18	24
Multi-Engine	1	1	1	1	1	1
Single-Engine	2	2	2	2	2	2
Total	**13**	**16**	**18**	**19**	**21**	**27**

Sources: FAA Form 5010; Landrum & Brown analysis

3.5.3.3 *Military*

Military aircraft operations make up a very small share of the aircraft operations at the Airport. There were 132 military aircraft operations representing 0.1 percent of the total aircraft operations. It is anticipated that military operations will increase in 2018. Beyond 2018, military operations were held flat over the forecast period, equal to the estimated 2018 aircraft operations.

3.5.4 Total Aircraft Operations

The total aircraft operations forecast is the aggregation of the passenger, freighter, air taxi/GA, and military aircraft operations forecasts. Total aircraft operations are projected to increase from 150,463 in 2017 to 372,403 in 2050, representing an AAGR of 2.8 percent. **Table 3.5-9, *Total Aircraft Operations Forecast***, presents the aircraft operations forecast by segment through the forecast period.

TABLE 3.5-9 TOTAL AIRCRAFT OPERATIONS FORECAST

Year	Passenger		Cargo	Air Taxi/ General Aviation	Military	Grand Total
	Domestic	International				
Historical						
2007	296,400	8,574	7,938	15,005	152	328,069
2008	258,512	7,900	5,452	13,457	163	285,484
2009	196,772	5,384	10,820	9,540	161	222,677
2010	142,442	4,052	20,212	10,767	124	177,597
2011	125,824	4,486	21,564	9,909	129	161,912
2012	107,640	3,804	23,440	8,342	221	143,447
2013	102,642	3,574	23,592	7,673	190	137,671
2014	97,048	3,778	24,598	8,005	89	133,518
2015	94,130	3,302	26,308	9,350	135	133,225
2016	96,746	3,586	27,970	8,740	183	137,225
2017	101,154	3,824	36,004	9,349	132	150,463
Forecast						
2022	113,980	5,670	64,550	9,510	243	193,953
2027	127,360	5,670	104,650	9,960	243	247,883
2032	142,400	5,670	119,210	10,440	243	277,963
2037	153,100	8,030	131,010	10,940	243	303,323
2050	184,180	8,810	164,870	12,340	243	370,443
Average Annual Growth Rates						
2007-17	-10.2%	-7.8%	16.3%	-4.6%	-1.4%	-7.5%
2017-22	2.4%	8.2%	12.4%	0.3%	13.0%	5.2%
2022-27	2.2%	0.0%	10.1%	0.9%	0.0%	5.0%
2027-32	2.3%	0.0%	2.6%	0.9%	0.0%	2.3%
2032-37	1.5%	7.2%	1.9%	0.9%	0.0%	1.8%
2037-50	1.4%	0.7%	1.8%	0.9%	0.0%	1.5%
2017-50	1.8%	2.6%	4.7%	0.8%	1.9%	2.8%

Sources: KCAB; U.S. Department of Transportation, Air Carrier Statistics database (T-100); OAG Aviation Worldwide Ltd, OAG Schedules Analyser; Landrum & Brown analysis

3.5.5 Critical Aircraft Determination

In June 2017, FAA published Advisory Circular (AC) 150-5000-17, Critical Aircraft and Regular Use Determination, to provide guidance on the use of the design aircraft or critical aircraft in facility planning and design studies, and related FAA decision making for federally obligated airports. This AC establishes a common, uniform threshold for the number of annual aircraft operations required to identify the critical aircraft for all deliberations of the FAA Office of Airports, inclusive of planning and environmental, design and engineering, and financial decision making regarding airport development. Section 1.2.1 of the AC states the following in regards to critical aircraft determination:

> "The critical aircraft is the most demanding aircraft type, or group of aircraft with similar characteristics, that make use of the airport. Regular use is 500 annual operations, including both itinerant and local operations but excluding touch-and-go operations. An operation is either a takeoff or landing."

AC 150/5300-13A Change 1, Airport Design, provides a definition for an aircraft's airport reference code (ARC). ARC has two components; the aircraft approach category (AAC) and the airplane design group (ADG). The AAC is depicted by a letter and is determined by the reference landing speed (VREF) or approach speed of the aircraft. The ADG is depicted by a Roman numeral and is based on the physical characteristics of the aircraft, i.e. wingspan and tail height of the aircraft, whichever is more restrictive. As shown in Table 3.5-4, the freighter variant of the Boeing 747-800 had over 500 annual operations in 2017. The Boeing 747-800 has an approach speed of 161 knots which categorizes the aircraft as an AAC Code D. The Boeing 747-800 has a length of 250 feet and 2 inches; a wingspan of 224 feet and 5 inches; and a tail height of 63 feet and 1 inch. Based on these dimensions the Boeing 747-800 is categorized as ADG Code VI. No other aircraft with more than 500 annual operations, either existing or forecasted, is more restrictive in terms of runways requirements or for airport design purposes. Therefore, the Boeing 747-800 is the critical aircraft or design aircraft for CVG.

3.6 Peak Period Forecasts

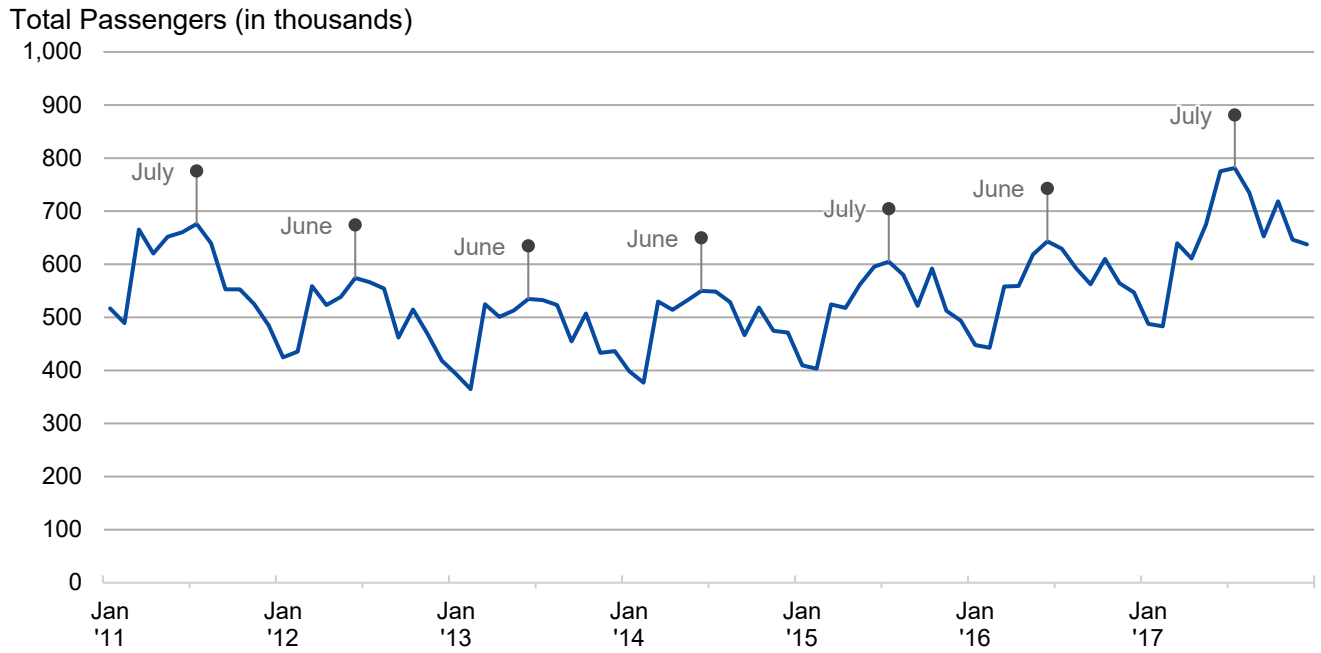
The traffic demand patterns imposed upon an airport are subject to seasonal, monthly, daily, and hourly variations. Peaking characteristics are critical in the assessment of existing facilities and airfield components to determine their ability to accommodate forecast increases in passenger and operational activity throughout the forecast period.

The annual passenger and aircraft operations forecasts for CVG were converted into month, daily, and peak hour equivalents. The peak hour aircraft operations were developed for passenger; freighter; air taxi and general aviation; military; and total aircraft operations.

3.6.1 Monthly Seasonality

Monthly enplaned passenger data from the Airport was used to determine the peak month for enplaned passengers. The Airport's busy period for enplaned passengers occurs during the summer months of June and July. Over the past five years, both June and July have had 9.4 percent of the total annual enplaned passengers. **Exhibit 3.6-1, *Monthly Enplaned Passengers***, graphically depicts the monthly seasonality for enplaned passengers at the Airport.

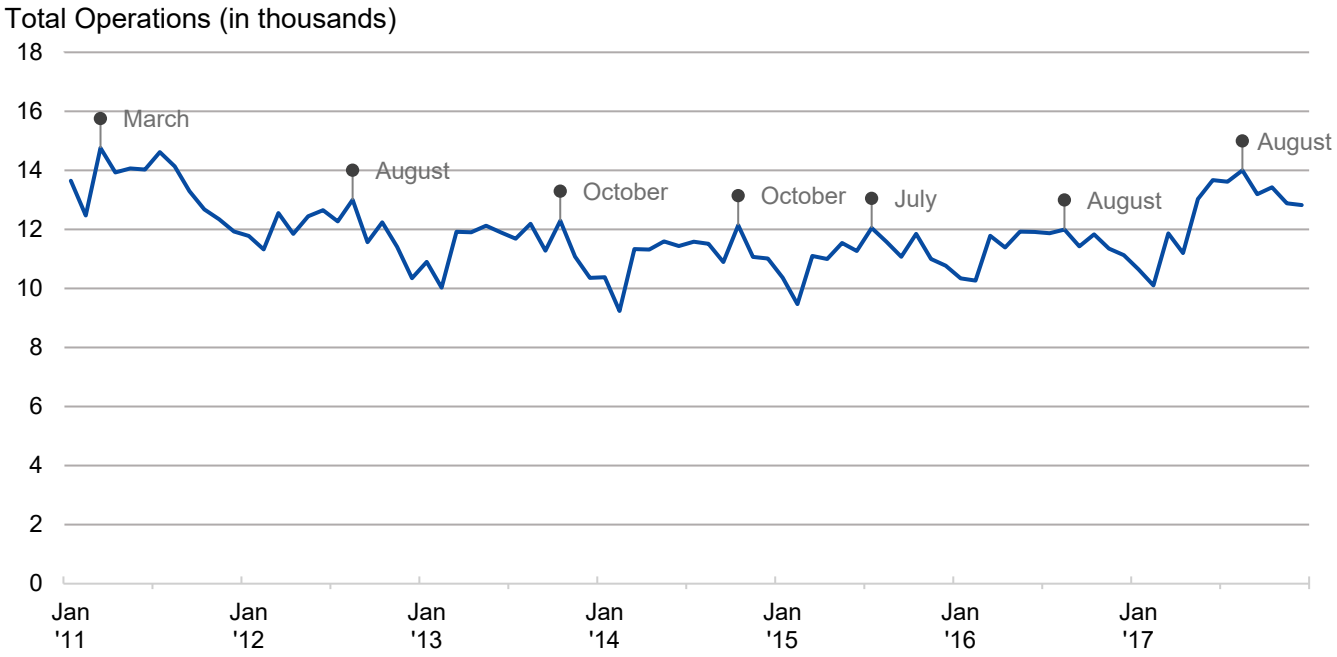
EXHIBIT 3.6-1 MONTHLY ENPLANED PASSENGERS



Source: KCAB

Although June and July are the peak months for enplaned passengers, they are rarely the peak months for aircraft operations. Total aircraft operations tend to be more random than enplaned passengers. In the fourth quarter, freighter operations tend to increase in order to meet demand for the holiday season. GA and air taxi service tends to be more random than commercial service, so although they make up a smaller percent of the overall traffic, they tend to have a more significant impact in the seasonality of aircraft operations. **Exhibit 3.6-2, *Monthly Aircraft Operations***, graphically depicts the monthly seasonality for aircraft operations at the Airport.

EXHIBIT 3.6-2 MONTHLY AIRCRAFT OPERATIONS



Source: KCAB

3.6.2 Daily Patterns

The FAA recommends the use of the average day of the peak month, typically referred to as the peak month average day (PMAD), for purposes of physical planning. As an alternative, the peak month average weekday (PMAWD) can be used at airports that have domestic service as the predominant activity and at airports where weekend activity is consistently less than weekday activity.

As demonstrated above, June and July are the peak months for enplaned passengers. From 2014 through 2016, July had more passenger operations than June. Additionally, although July typically has slightly less than June in terms of monthly-enplaned passengers, in 2016 it had more enplaned passengers per average weekday when excluding the Fourth of July holiday. In 2017, July was the peak month in terms of passengers. Therefore, July was selected as the peak month for the Airport.

Seating information is included in the scheduling data from OAG. This data was used as a proxy to determine the 2017 PMAWD as passenger data was not available at the daily level. PMAWD was used as the design day at CVG because the average weekday had 6.8 percent more seats than the average weekend. Operations at CVG were significantly lower on the Fourth of July holiday than the rest of the month and was removed from the analysis for determining the PMAWD. Wednesday, July 19, 2017 was selected because it most closely resembles the average weekday for the month.

3.6.3 Design Day Flight Schedules

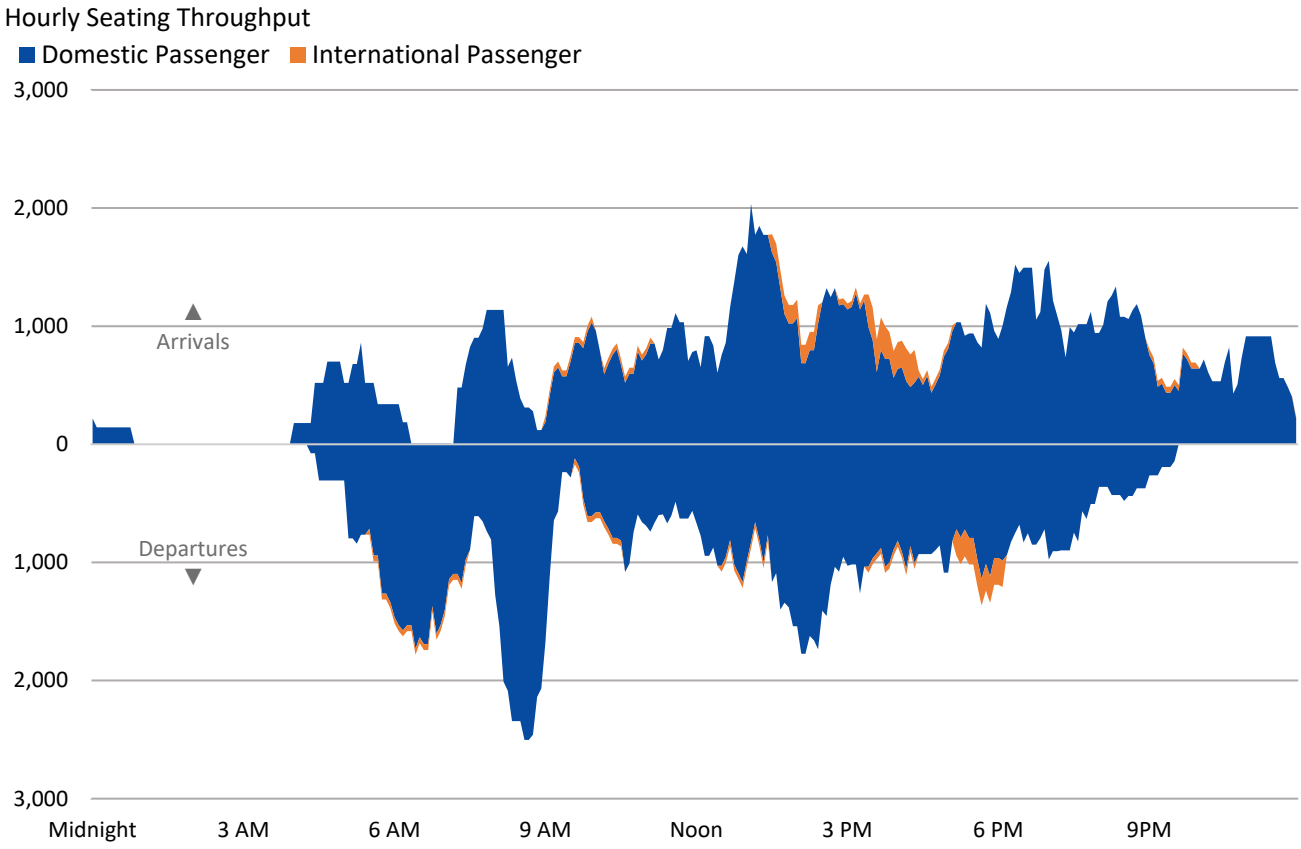
A design day flight schedule (DDFS) for 2017 was developed to determine the hourly profile of traffic at the Airport. In order to develop a DDFS that was representative of the traffic at the Airport to include scheduled and unscheduled service, a combination of OAG schedules and historical radar data was used.

OAG data for the design day provided the scheduled passenger aircraft operations. The passenger aircraft operations from OAG were supplemented with radar data for cargo, air taxi, and GA aircraft operations. Accurate military data was not available in the radar data so additional flights were added to the DDFS to account for the average day.

3.6.4 Hourly Profiles

The DDFS was analyzed to determine the hourly profile at the Airport to identify the periods of time that traffic is most concentrated. Using a clock hour as the basis for peak periods does not allow for peak periods of traffic that occurs across clock hours to be identified, i.e. traffic occurring late in the first hour combined with the traffic at the beginning of the next hour. Therefore, a rolling 60-minute hour approach was used to determine the design day profile. In this case, aircraft operations were categorized into one of 288 five-minute buckets, or bins, that occur during the given day. The sum of twelve sequential buckets represents a rolling 60-minute hour. In 2017, the peak for departing seats occurred during the second morning departure push while the arrival peak occurs during the midday. **Exhibit 3.6-3, *Rolling 60-Minute Seating Profile***, July 19, 2017, graphically presents the rolling 60-minute hour profile for scheduled passenger seats in the DDFS for 2017.

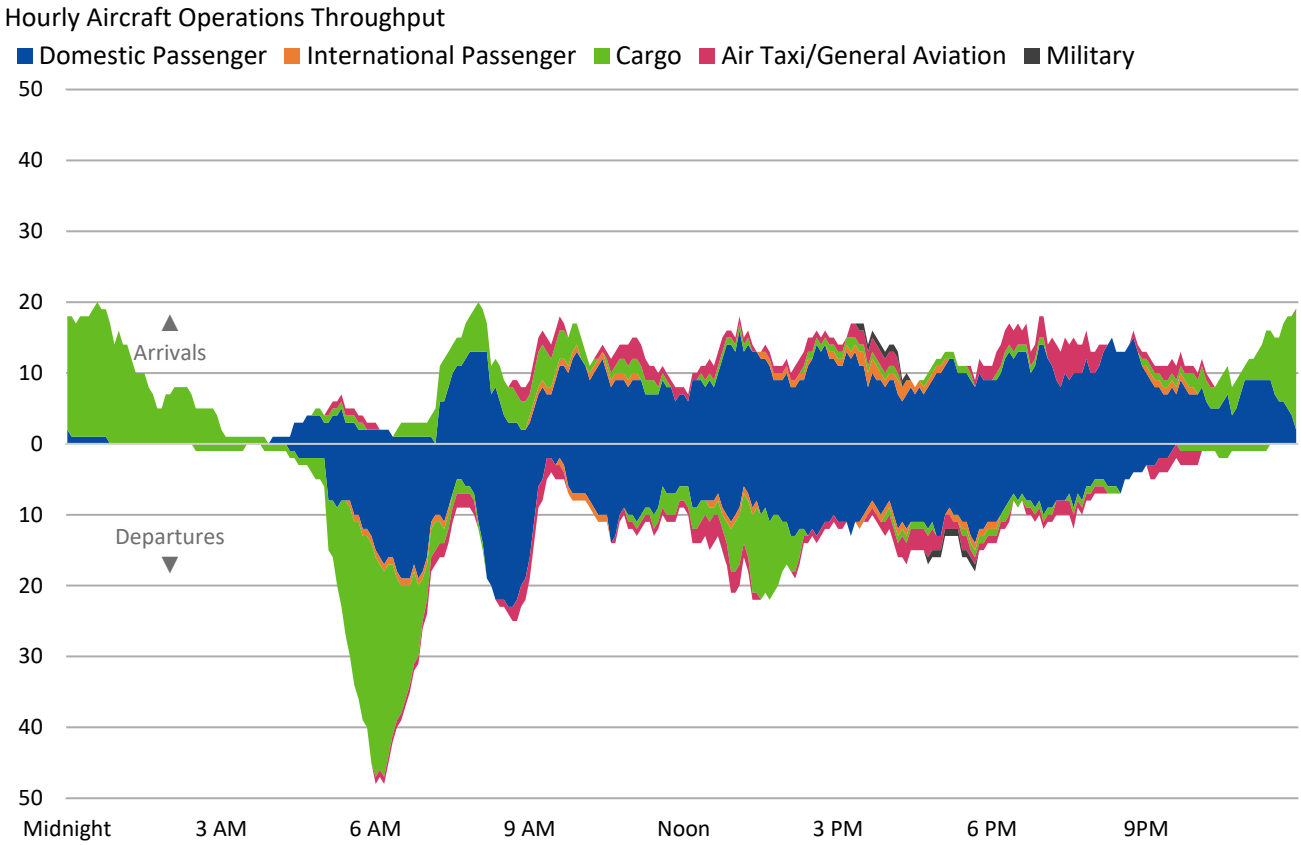
EXHIBIT 3.6-3 ROLLING 60-MINUTE SEATING PROFILE, JULY 19, 2017



Sources: OAG Aviation Worldwide Ltd, OAG Schedules Analyser; Landrum & Brown analysis

Exhibit 3.6-4, *Rolling 60-Minute Aircraft Operations Profile*, July 19, 2017, graphically presents the total aircraft operations (including scheduled passengers, cargo, air taxi, GA, and military) for the rolling 60-minute hours for the 2017 DDFS. As shown in the profile, the peaks for aircraft operations are dependent on freighter operations as the arrival peak occurs just past midnight and the departure peak is during the first morning departure peak.

EXHIBIT 3.6-4 ROLLING 60-MINUTE AIRCRAFT OPERATIONS PROFILE, JULY 19, 2017



Sources: OAG Aviation Worldwide Ltd, OAG Schedules Analyser; Flight Track Data for 2017; Landrum & Brown analysis

3.6.5 Derivative Forecast

Information regarding the peak month, average day, and peak hour from the DDFS was used to formulate metrics to determine the peak period forecast. These metrics include the peak month as a percent of the annual, the design day as a percent of the peak month, and the peak hour as a percent of the design day. These peak period metrics were adjusted based on scheduling data for Southwest Airlines at peer airports and information provided by Amazon Air. It should be noted that peak hour metrics are specific to the Airport's design day. All peak period forecast presented in this section represent the baseline forecasts.

3.6.5.1 *Aircraft Operations Forecast*

Annual aircraft operations were divided by the peak month aircraft operations, peak month aircraft operations were divided by the design day aircraft operations, and the design day aircraft operations were divided by the peak hour aircraft operations to determine the peak period factors. Peak period factors were expressed for each of the segments (scheduled passenger, cargo, GA and air taxi, and military).

It was assumed that the peak month and design day factors would remain relatively unchanged through the forecast period. However, the expansion of low-cost and ultra-low-cost carriers and Amazon Air with their unique operational profiles will have a dramatic impact on the hourly profile of aircraft operations at the Airport. Therefore, the peak hour factors were adjusted to account for these changes. **Table 3.6-1, *Peak Period Aircraft Operations Factors***, presents the peak period factors associated with aircraft operations.

The annual, monthly, daily, and hour peak aircraft operations forecasts are presented in **Table 3.6-2, *Peak Period Aircraft Operations Forecast***. The total of annual, monthly, and design day aircraft operations is the aggregation of the individual segments. However, each of the individual segments peak at different period of the day. As a result, peak hour total aircraft operations are not equal to the sum of the categories.

3.6.5.2 *Passenger Forecast*

Peak hour passengers were calculated using a similar methodology as peak hour aircraft operations. The annual and monthly passengers were determined from the Airport's records. The design day passengers are based on the scheduled seats for the design day as a share of the scheduled seats for the month. Peak hour passengers were calculated from the aircraft seating configurations in the DDFS and assumed load factors from the annual passenger aircraft operations forecast. Peak hour passengers as a percent of the day are expected to change mostly due to the new service provided by low-cost and ultra-low-cost carriers. **Table 3.6-3, *Peak Period Passengers Factors*** provides the peak period factors associated with passenger activity. **Table 3.6-4, *Peak Period Passenger Forecast***, presents the peak hour passenger forecasts for CVG.

TABLE 3.6-1 PEAK PERIOD AIRCRAFT OPERATIONS FACTORS

Segment	Level	2017	2022	2027	2032	2037	2050
Domestic Passenger	Peak Month % of Annual	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%
	Design Day % of Peak Month	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%
	Peak Hour Arrivals % of Design Day	9.7%	9.2%	9.2%	9.1%	8.8%	8.7%
	Peak Hour Departures % of Design Day	13.9%	11.9%	11.6%	11.6%	11.2%	11.3%
	Peak Hour Total % of Design Day	9.7%	9.0%	8.9%	8.8%	8.7%	8.7%
International Passenger	Peak Month % of Annual	10.1%	10.1%	10.1%	10.1%	10.1%	10.1%
	Design Day % of Peak Month	3.4%	3.6%	3.8%	3.8%	3.8%	3.8%
	Peak Hour Arrivals % of Design Day	30.8%	28.6%	27.3%	27.3%	25.8%	23.5%
	Peak Hour Departures % of Design Day	15.4%	19.0%	18.2%	18.2%	19.4%	17.6%
	Peak Hour Total % of Design Day	23.1%	22.2%	21.0%	21.0%	20.0%	16.3%
Total Passenger	Peak Month % of Annual	9.1%	9.1%	9.1%	9.1%	9.1%	9.1%
	Design Day % of Peak Month	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%
	Peak Hour Arrivals % of Design Day	9.3%	9.2%	9.2%	9.1%	9.1%	8.8%
	Peak Hour Departures % of Design Day	13.4%	11.7%	11.4%	11.5%	11.3%	11.4%
	Peak Hour Total % of Design Day	9.3%	8.9%	8.9%	8.9%	8.7%	8.7%
Freighter	Peak Month % of Annual	9.0%	8.6%	8.6%	8.6%	8.6%	8.6%
	Design Day % of Peak Month	4.2%	3.8%	3.4%	3.4%	3.4%	3.4%
	Peak Hour Arrivals % of Design Day	28.1%	27.6%	27.5%	28.2%	27.7%	27.9%
	Peak Hour Departures % of Design Day	45.9%	34.3%	28.2%	27.0%	25.7%	25.4%

Segment	Level	2017	2022	2027	2032	2037	2050
	Peak Hour Total % of Design Day	23.0%	17.4%	14.5%	14.2%	14.0%	14.0%
Air Taxi/General Aviation	Peak Month % of Annual	8.8%	8.8%	8.8%	8.8%	8.8%	8.8%
	Design Day % of Peak Month	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%
	Peak Hour Arrivals % of Design Day	23.3%	22.7%	21.7%	20.0%	19.6%	21.1%
	Peak Hour Departures % of Design Day	18.6%	18.2%	17.4%	16.0%	19.6%	17.5%
	Peak Hour Total % of Design Day	16.3%	18.2%	17.4%	16.5%	15.7%	15.7%
Military	Peak Month % of Annual	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%
	Design Day % of Peak Month	20.0%	15.0%	15.0%	15.0%	15.0%	15.0%
	Peak Hour Arrivals % of Design Day	100.0%	66.7%	66.7%	66.7%	66.7%	66.7%
	Peak Hour Departures % of Design Day	100.0%	66.7%	66.7%	66.7%	66.7%	66.7%
	Peak Hour Total % of Design Day	50.0%	33.3%	33.3%	33.3%	33.3%	33.3%
Grand Total	Peak Month % of Annual	9.1%	8.9%	8.9%	8.9%	8.9%	8.9%
	Design Day % of Peak Month	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
	Peak Hour Arrivals % of Design Day	7.6%	9.9%	10.9%	11.0%	10.6%	10.4%
	Peak Hour Departures % of Design Day	18.4%	16.9%	15.7%	16.0%	15.5%	15.1%
	Peak Hour Total % of Design Day	9.8%	8.9%	8.2%	8.3%	8.2%	8.2%

Sources: KCAB; OAG Aviation Worldwide Ltd, OAG Schedules Analyser; Flight Track Data for 2017; Landrum & Brown analysis

TABLE 3.6-2 PEAK PERIOD AIRCRAFT OPERATIONS FORECAST

Segment	Level	2017	2022	2027	2032	2037	2050
Domestic Passenger	Annual Operations	101,154	113,980	127,360	142,400	153,100	184,180
	Peak Month Operations	9,154	10,310	11,530	12,890	13,850	16,670
	Design Day Operations	330	371	415	464	499	600
	Peak Hour Arrivals	16	17	19	21	22	26
	Peak Hour Departures	23	22	24	27	28	34
	Peak Hour Operations	32	33	37	41	43	52
International Passenger	Annual Operations	3,824	5,670	5,670	5,670	8,030	8,810
	Peak Month Operations	386	570	570	570	810	890
	Design Day Operations	13	21	22	22	31	34
	Peak Hour Arrivals	2	3	3	3	4	4
	Peak Hour Departures	1	2	2	2	3	3
	Peak Hour Operations	3	5	5	5	6	6
Total Passenger	Annual Operations	104,978	119,650	133,030	148,070	161,130	192,990
	Peak Month Operations	9,540	10,880	12,100	13,460	14,660	17,560
	Design Day Operations	343	392	437	486	530	634
	Peak Hour Arrivals	16	18	20	22	24	28
	Peak Hour Departures	23	23	25	28	30	36
	Peak Hour Operations	32	35	39	43	46	55
Freighter	Annual Operations	36,004	64,550	104,650	119,210	131,010	164,870
	Peak Month Operations	3,242	5,532	8,985	10,240	11,250	14,160
	Design Day Operations	135	210	305	348	382	481
	Peak Hour Arrivals	19	29	42	49	53	67
	Peak Hour Departures	31	36	43	47	49	61
	Peak Hour Operations	31	37	44	50	53	67
Air Taxi/ General Aviation	Annual Operations	9,349	9,510	9,960	10,440	10,940	12,340
	Peak Month Operations	825	840	880	920	970	1,090

Segment	Level	2017	2022	2027	2032	2037	2050
	Design Day Operations	43	44	46	50	51	57
	Peak Hour Arrivals	5	5	5	5	5	6
	Peak Hour Departures	4	4	4	4	5	5
	Peak Hour Operations	7	8	8	8	8	9
Military	Annual Operations	132	243	243	243	243	243
	Peak Month Operations	10	20	20	20	20	20
	Design Day Operations	2	3	3	3	3	3
	Peak Hour Arrivals	1	1	1	1	1	1
	Peak Hour Departures	1	1	1	1	1	1
	Peak Hour Operations	1	1	1	1	1	1
Total	Annual Operations	150,463	193,953	247,883	277,963	303,323	370,443
	Peak Month Operations	13,617	17,272	21,985	24,640	26,900	32,830
	Design Day Operations	523	649	791	887	966	1,175
	Peak Hour Arrivals	20	32	43	49	52	62
	Peak Hour Departures	48	55	62	72	75	91
	Peak Hour Operations	51	58	65	75	79	95

Sources: KCAB; OAG Aviation Worldwide Ltd, OAG Schedules Analyser; Flight Track Data for 2017; Landrum & Brown analysis

TABLE 3.6-3 PEAK PERIOD PASSENGERS FACTORS

Segment	Level	2017	2022	2027	2032	2037	2050
Domestic Passenger	Peak Month % of Annual	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%
	Design Day % of Peak Month	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
	Peak Hour Arriving % of Design Day	12.7%	10.5%	10.5%	10.1%	9.8%	9.7%
	Peak Hour Departing % of Design Day	15.6%	12.9%	12.4%	11.6%	10.9%	10.8%
	Peak Hour Total % of Design Day	9.8%	9.1%	9.0%	9.0%	9.0%	9.0%
International Passenger	Peak Month % of Annual	11.6%	11.6%	11.6%	11.6%	11.6%	11.6%
	Design Day % of Peak Month	3.6%	3.9%	4.1%	4.1%	4.1%	4.1%
	Peak Hour Arriving % of Design Day	50.4%	44.8%	39.3%	38.6%	36.8%	35.1%
	Peak Hour Departing % of Design Day	41.7%	38.3%	33.5%	33.0%	31.5%	30.0%
	Peak Hour Total % of Design Day	29.6%	25.6%	22.4%	22.0%	21.0%	20.0%
Total Passenger	Peak Month % of Annual	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
	Design Day % of Peak Month	3.5%	3.6%	3.6%	3.6%	3.6%	3.6%
	Peak Hour Arriving % of Design Day	12.2%	10.2%	10.1%	9.8%	9.5%	9.5%
	Peak Hour Departing % of Design Day	15.0%	12.5%	12.0%	11.2%	10.5%	10.5%
	Peak Hour Total % of Design Day	9.5%	8.8%	8.7%	8.7%	8.7%	8.7%

Sources: KCAB; OAG Aviation Worldwide Ltd, OAG Schedules Analyser; Flight Track Data for 2017; Landrum & Brown analysis

TABLE 3.6-4 PEAK PERIOD PASSENGER FORECAST

Segment	Level	2017	2022	2027	2032	2037	2050
Domestic Passenger	Annual Passengers	7,580,480	9,915,600	11,468,800	12,979,200	14,373,000	17,639,800
	Peak Month Passengers	749,808	980,782	1,134,413	1,283,812	1,421,677	1,744,805
	Design Day Passengers	26,560	34,693	40,127	45,412	50,288	61,718
	Peak Hour Arriving	1,680	1,821	2,098	2,301	2,459	3,007
	Peak Hour Departing	2,070	2,246	2,485	2,635	2,733	3,325
	Peak Hour Passengers	2,600	3,154	3,608	4,084	4,522	5,550
International Passenger	Annual Passengers	271,836	318,600	356,600	390,400	418,200	470,800
	Peak Month Passengers	31,585	37,019	41,434	45,361	48,591	54,703
	Design Day Passengers	1,150	1,434	1,688	1,848	1,979	2,228
	Peak Hour Arriving	290	321	331	357	365	391
	Peak Hour Departing	240	274	283	304	311	334
	Peak Hour Passengers	340	366	378	406	416	446
Total Passenger	Annual Passengers	7,852,316	10,234,200	11,825,400	13,369,600	14,791,200	18,110,600
	Peak Month Passengers	781,393	1,017,800	1,175,847	1,329,173	1,470,268	1,799,508
	Design Day Passengers	27,710	36,127	41,815	47,259	52,268	63,946
	Peak Hour Arriving	1,690	1,835	2,115	2,319	2,478	3,030
	Peak Hour Departing	2,080	2,263	2,504	2,655	2,754	3,351
	Peak Hour Passengers	2,620	3,179	3,636	4,115	4,557	5,593

Sources: KCAB; OAG Aviation Worldwide Ltd, OAG Schedules Analyser; Flight Track Data for 2017; Landrum & Brown analysis

3.7 Comparison to the TAF

The FAA publishes its own forecast annually for each U.S. airport, including CVG. The Terminal Area Forecast (TAF) is "prepared to assist the FAA in meeting its planning, budgeting, and staffing requirements. In addition, state aviation authorities and other aviation planners use the TAF as a basis for planning airport improvements."[18] The most recent release is the 2018 TAF that was issued in early 2019.

If the Sponsor Forecast is used for FAA decision-making, such as key environmental issues, noise capability planning, airport layout plan, and initial financial decisions, the FAA requires that the Sponsor Forecast is compared to the most recent TAF to determine if they are consistent. For all classes of airports, forecasts for total passenger enplanements, based aircraft, and total aircraft operations are considered consistent with the TAF if they meet the following criterion:[19]

- Forecasts differ by less than 10 percent in the five-year forecast period
- Forecasts differ by less than 15 percent in the ten-year forecast period

If the Sponsor Forecast is not consistent with the TAF, differences must be resolved before proceeding. The Recommend Forecast is used for facility requirements and therefore is compared to the TAF.

The TAF is prepared on a U.S. Government Fiscal Year (FY) basis (October through September) rather than calendar year. The forecast presented herein was developed on a calendar year basis. When an airport's traffic is growing rapidly, a timing difference between the FY base year and the calendar base year can be significant. This timing difference distorts a straight future year comparison between the two forecasts.

The 2018 TAF includes historical information on aircraft operations from FY1990 through FY2017 and forecasts for FY2018[20] to FY2045. At airports with FAA towers like CVG, historical aircraft operations data is provided by FAA air traffic controllers, which count landings and takeoffs. These aircraft operations are recorded as either air carrier, commuter & air taxi, GA, or military. Air carrier is defined as an aircraft with seating capacity of more than 60 seats or a maximum payload capacity of more than 18,000 pounds carrying passengers or cargo for hire or compensation. Commuter & air taxi aircraft are designed to have a maximum seating capacity of 60 seats or a maximum payload capacity of 18,000 pounds carrying passengers or cargo for hire or compensation.

According to the 2018 TAF, aircraft operations at CVG increased from 138,018 in FY2013 to 145,640 in FY2017, representing an AAGR of 1.4 percent. The 2018 TAF projects that aircraft operations at CVG will increase from 145,640 in FY2017 to 210,769 in 2027, representing an AAGR of 3.8 percent.

The enplaned passenger information in the 2018 TAF includes historical values from FY1976 through FY2017, estimated enplaned passenger figures for FY2018, and forecasts from FY2019 to FY2040. Historical enplaned passenger data is obtained through the U.S. Department of Transportation T-100 Reports.

18 Federal Aviation Administration, Terminal Area Forecast Summary: Fiscal Years 2016-2045, July 2017.
19 Federal Aviation Administration, Review and Approval of Aviation Forecasts, June 2008.
20 Operations data for FAA towers and Federal contract towers for 2017 are actual.

According to the 2018 TAF, enplaned passengers at CVG increased from 2.8 million in FY2013 to an estimated 3.7 million in FY2017, representing an AAGR of 7.0 percent. During this span, enplaned passengers provided in the 2018 TAF have been on average within 4.9 percent of the Airport's records. There are two reasons for this difference. The data provided in the TAF is on a fiscal year basis. Additionally, the enplaned passengers provided in the TAF exclude non-revenue passengers and military charter passengers. In 2017, there were 3.9 million enplaned passengers at CVG, which is 6.8 percent higher than the 3.7 million for FY2017 in the 2018 TAF. The 2018 TAF projects that enplaned passengers will increase from an estimated 3.7 million in FY2017 to 5.1 million in FY2027, representing an AAGR of 3.4 percent.

In order to compare the forecast presented herein to the 2018 TAF, Appendix B and C templates from the FAA Office of Aviation Policy and Plans (APO) document, Forecasting Aviation Activity by Airport, have been completed. In order to make apt comparisons (i.e. adjust for differences resulting from FFY) the forecast presented herein has been adjusted so that there was no variance in the base year in Appendix C. The appendices are provided in the **Table 3.7-1, *FAA TAF Forecast Comparison-Appendix B***, and **Table 3.7-2, *FAA TAF Forecast Comparison-Appendix C***, respectively.

TABLE 3.7-1 FAA TAF FORECAST COMPARISON – APPENDIX B

A. Forecast Levels and Growth Rates

	Base Year 2017	Base Year + 1 year 2018	Base Year + 5 years 2022	Base Year + 10 years 2027	Base Year + 15 years 2032	Base Year to + 1 year 2017-2018	Base Year to + 5 years 2017-2022	Base Year to + 10 years 2017-2027	Base Year to + 15 years 2017-2032
Passenger Enplanements									
Air carrier	2,278,211	2,739,378	3,393,618	4,099,214	4,630,429	20.2%	8.3%	6.0%	4.8%
Commuter	1,647,947	1,700,636	1,723,482	1,813,486	2,054,371	3.2%	0.9%	1.0%	1.5%
TOTAL ENPLANEMENTS	3,926,158	4,440,014	5,117,100	5,912,700	6,684,800	13.1%	5.4%	4.2%	3.6%
Operations									
Itinerant									
Air carrier	67,020	79,161	112,880	165,312	186,521	18.1%	11.0%	9.4%	7.1%
Commuter/air taxi	73,962	73,119	71,320	72,368	80,759	-1.1%	-0.7%	-0.2%	0.6%
Total Commercial Operations	140,982	152,280	184,200	237,680	267,280	8.0%	5.5%	5.4%	4.4%
General aviation	9,349	9,160	9,510	9,960	10,440	-2.0%	0.3%	0.6%	0.7%
Military	132	243	243	243	243	84.1%	13.0%	6.3%	4.2%
Local									
General aviation	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%
Military	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%
TOTAL OPERATIONS	150,463	161,683	193,953	247,883	277,963	7.5%	5.2%	5.1%	4.2%
Instrument Operations									
Peak Hour Operations	51	55	57	64	74	7.8%	2.2%	2.3%	2.5%
Cargo/Mail									
(Enplaned + Deplaned Tons)	1,041,890	1,241,320	1,896,622	2,689,471	3,146,645	19.1%	12.7%	9.9%	7.6%
Based Aircraft									
Single Engine (Nonjet)	2	2	2	2	2				
Multi Engine (Nonjet)	1	1	1	1	1				
Jet Engine	10	10	13	15	16				
Helicopter	-	-	-	-	-				
Other	-	-	-	-	-				
TOTAL BASED AIRCRAFT	13	13	16	18	19				

B. Operational Factors

	Base Year 2017	Base Year + 1 year 2018	Base Year + 5 years 2022	Base Year + 10 years 2027	Base Year + 15 years 2032
Average aircraft size (seats)					
Air carrier	158.9	160.7	157.9	155.4	157.2
Commuter	64.1	65.4	66.8	69.9	70.6
Average enplaning load factor					
Air carrier	82.3%	83.6%	80.7%	79.5%	80.4%
Commuter	73.4%	75.3%	77.8%	77.9%	77.9%
GA operations per based aircraft	719	705	594	553	549

Source: Landrum & Brown analysis

TABLE 3.7-2 FAA TAF FORECAST COMPARISON – APPENDIX C

Segment	Forecast Year	Sponsor Forecast	2018 FAA TAF	% Variance Sponsor vs 2018 TAF
Passenger Enplanements				
Base year	2017	3,653,411	3,653,411	0.0%
Base year + 5 years	2022	4,761,619	4,689,422	1.5%
Base year + 10 years	2027	5,501,950	5,095,298	8.0%
Base year + 15 years	2032	6,220,412	5,560,298	11.9%
Commercial Operations[1]				
Base year	2017	139,475	139,475	0.0%
Base year + 5 years	2022	182,231	172,903	5.4%
Base year + 10 years	2027	235,139	205,705	14.3%
Base year + 15 years	2032	264,423	227,638	16.2%
Total Operations				
Base year	2017	145,640	145,640	0.0%
Base year + 5 years	2022	187,735	177,967	5.5%
Base year + 10 years	2027	239,937	210,769	13.8%
Base year + 15 years	2032	269,053	232,702	15.6%

[1] Commercial operations includes operations by passenger airlines, all-cargo airlines, and air taxi operators.
Notes: Sponsor forecast has been adjusted so that variance in the base year would be zero to account for differences in reporting.
Sources: Federal Aviation Administration, 2018 Terminal Area Forecast; Landrum & Brown analysis