APPENDIX B

Purpose and Need and Alternatives

Forecast Technical Memorandum

Charlotte Douglas International Airport Environmental Impact Statement

PREPARED FOR

FEDERAL AVIATION ADMINISTRATION

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IN ASSOCIATION WITH

InterVISTAS

4/18/2018

Record of Changes/Version History

Change/ Version Number	Date of Change	Sections Changed	Description	Person Entering Change
1	11/10/2017	All	Original Draft	VHB/InterVISTAS
2	1/17/2018	1, Appendix	Additional data added to tables	VHB/InterVISTAS
3	03/27/2018	All	Response to FAA Comments	VHB/InterVISTAS
4	04/18/2018	None.	Finalized.	VHB

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Introduction

In accordance with FAA Order 1050.1F "Environmental Impacts: Policies and Procedures, an EIS requires a Purpose and Need section. In order to demonstrate part of the need for capacity-related components of the Project, a passenger and operations forecast ("EIS forecast") has been completed for Charlotte Douglas International Airport ("the Airport" or "CLT"). This technical memorandum covers analysis of the historical traffic at CLT as well as the methodology and results of the long-term traffic forecast. This long-term annual forecast was used as the basis of derivative forecasts (busy day, peak hour, design day schedules), which served as inputs into the simulation modeling. Summary forecast results are shown below in **Table 1-1**. The most recent calendar year of data available as of the writing of this memorandum is 2016; therefore, 2016 was selected as the base year for this EIS.

In addition to showing the results of the EIS forecast, this memorandum also compares the EIS forecast to the Federal Aviation Administration's (FAA) 2016 Terminal Area Forecast (TAF) and the forecast completed by the Charlotte Aviation Department (the Department) in 2014 for the CLT Master Plan (known as the Airport Capacity Enhancement Plan or ACEP). The service and outlook for CLT is now updated to reflect changing conditions since completion of the ACEP.

¹ The ACEP was released in February 2016; however, the latest full year of data shown in the report and used in the forecast is 2013.

Summary of Charlotte Douglas International Airport Forecast Table 1-1 1

		Forecast				d Annual Gr	owth Rates
	Base	Base	Build	Build	Base	Build	Build
	Year	Year+1	Year	Year +5	Year+1	Year	Year +5
	2016	2017	2028	2033	2017	2028	2033
Passenger Enplanements							
Air Carrier	15,640,736	15,850,803	19,824,450	21,720,151	1.3%	2.0%	2.0%
Commuter	6,533,011	6,895,699	8,068,898	8,578,173	5.6%	1.8%	1.6%
Total	22,173,747	22,746,502	27,893,348	30,298,324	2.6%	1.9%	1.9%
Aircraft Operations							
Air Carrier	400,819	409,357	482,269	513,764	2.1%	1.6%	1.5%
Air Taxi	117,378	118,994	129,351	133,460	1.4%	0.8%	0.8%
Subtotal	518,197	528,351	611,620	647,224	2.0%	1.4%	1.3%
General Aviation	24,869	24,935	25,487	25,742	0.3%	0.2%	0.2%
Military	2,676	2,676	2,676	2,676	0.0%	0.0%	0.0%
Total Operations	545,742	555,962	639,783	675,643	1.9%	1.3%	1.3%
Peak Hour Operations	114	116	134	146	1.8%	1.4%	1.5%
Cargo/Mail							
Enplaned and Deplaned Tons	154,477	169,152	235,242	261,000	9.5%	3.6%	3.1%
Operational Factors							
Average Aircraft Size (seats)							
Air Carrier	144	144	148	150	0.0%	0.2%	0.2%
Air Taxi	59	59	62	63	0.0%	0.4%	0.4%
Average Enplaning Load Factor							
Air Carrier	83.6%	83.7%	84.3%	84.6%			
Air Taxi	80.2%	80.3%	81.4%	81.4%			

 $Source: FAA\ Operations\ Network\ (OPSNET);\ InterVISTAS\ analysis\ for\ forecast.$

Note: This summary table shows is based on a Build Year of 2028. A similar version of this table reflecting Base Year + 5, 10 and 15 years is shown in the Appendix.

Note: The forecast does not reallocate air taxi operations to air carrier as the seating capacity increases; therefore, the average aircraft size (seats) for air taxi goes above 60 seats.

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Historical Traffic Analysis

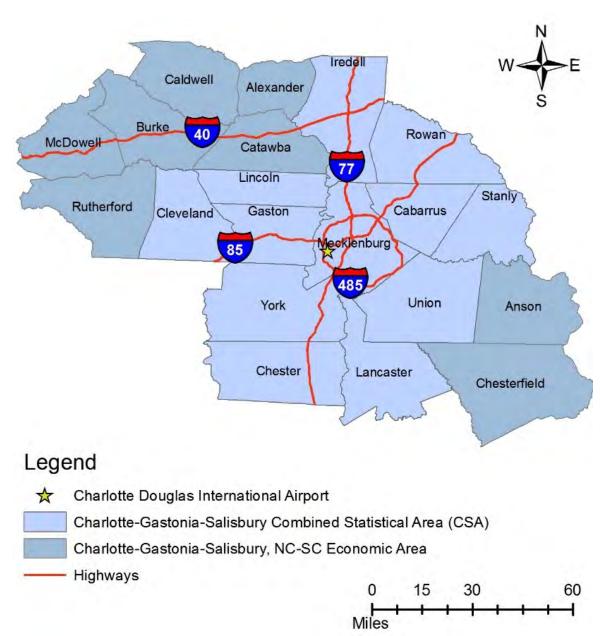
This chapter presents background information on the Charlotte Douglas International Airport ("the Airport" or "CLT"), the economics of the surrounding catchment area, historical traffic growth, the relationship between local economics and airport traffic, as well as the Airport's role as a hub in the network of the dominant air carrier American Airlines.

2.1 Catchment Area

The Airport serves the 20-county Charlotte-Gastonia-Salisbury economic area, which includes portions of both North Carolina and South Carolina (Figure 2-1).² Included in this economic area is the Charlotte-Concord Combined Statistical Area (CSA), which in turn covers the 10-county Charlotte-Concord-Gastonia Metropolitan Statistical Area (MSA) and two micropolitan areas (Albemarle and Shelby). The largest county, Mecklenburg County in North Carolina, includes the City of Charlotte and the Airport itself.

City of Charlotte, Official Statement, Bond Series 2017 A-C, May 19, 2017.

1 Figure 2-1 CLT Catchment Area



Source: County data from U.S. Census Bureau

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Within the United States, Charlotte was the 17th largest city and the 21st largest CSA (Table 2-1) in 2016.

Top 20 U.S. Cities Ranked by Population, CY 2016 Table 2-1

Rank	City	State	Population
1	New York City	New York	8,537,673
2	Los Angeles	California	3,976,322
3	Chicago	Illinois	2,704,958
4	Houston	Texas	2,303,482
5	Phoenix	Arizona	1,615,017
6	Philadelphia	Pennsylvania	1,567,872
7	San Antonio	Texas	1,492,510
8	San Diego	California	1,406,630
9	Dallas	Texas	1,317,929
10	San Jose	California	1,025,350
11	Austin	Texas	947,890
12	Jacksonville	Florida	880,619
13	San Francisco	California	870,887
14	Columbus	Ohio	860,090
15	Indianapolis	Indiana	855,164
16	Fort Worth	Texas	854,113
17	Charlotte	North Carolina	842,051
18	Seattle	Washington	704,352
19	Denver	Colorado	693,060
20	El Paso	Texas	683,080

Source: United States Census Bureau, 2017.

While the Airport's entire catchment area represents approximately a two-hour drive time, the core of the Airport's catchment is the Charlotte-Concord CSA with a population of 2.6 million (Table 2-2).

Table 2-2 **Population Comparison, CY 2016**

Area	Counties	Population
City of Charlotte	n/a	842,051
Charlotte-Concord-Gastonia MSA	10	2,474,314
Charlotte-Concord CSA	12	2,632,249
Charlotte-Gastonia-Salisbury	20	3,179,393

Source: United States Census Bureau, 2017.

Historically, the population of the Charlotte-Concord CSA has grown at a rate higher than that of the United States (Table 2-3). In addition, the CSA population is estimated to grow at an average annual rate of almost double that of the United States through 2050.

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Year	United States	10-Yr CAGR	North Carolina	10-Yr CAGR	South Carolina	10-Yr CAGR	Charlotte- Concord CSA	10-Yr CAGR
Historical								
2000	282,162		8,082		4,024		1,883	
2010	309,347	0.9%	9,559	1.7%	4,636	1.4%	2,382	2.4%
2016	324,161		10,169		4,951		2,626	
Forecast								
2020	336,383	0.8%	10,723	1.2%	5,192	1.1%	2,807	1.7%
2030	368,644	0.9%	12,215	1.3%	5,836	1.2%	3,3007	1.7%
2040	399,419	0.8%	13,732	1.2%	6,475	1.0%	3,839	1.5%
2050	428,119	0.7%	15,246	1.1%	7,096	0.9%	4,393	1.4%
CAGRs								
2000-2016	0.9%		1.4%		1.3%		2.1%	
2016-2020	0.9%		1.3%		1.2%		1.7%	
2016-2050	0.8%		1.2%		1.1%		1.5%	

Source: Complete Economic and Demographic Data Source (CEDDS), Woods & Poole Economics, Inc., 2017.

CAGR - Compound Annual Growth Rate

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6 7 8 Real per capita income in the Charlotte-Concord CSA is expected to grow at 1.1 percent annually over the period of 2016-2050 (**Table 2-4**). Comparatively, the United States anticipates similar annual real growth in per capital income over the same period (1.2 percent).

Table 2-4 Select Historical and Projected Per Capita Income (in 2009 USD)

							Charlotte-	
	United	10-Yr	North	10-Yr	South	10-Yr	Concord	10-Yr
Year	States	CAGR	Carolina	CAGR	Carolina	CAGR	CSA	CAGR
Historical								
1990	29,082		25,370		23,376		26,531	
2000	36,833	2.4%	32,719	2.6%	29,840	2.5%	34,205	2.6%
2010	39,622	0.7%	34,757	0.6%	31,638	0.6%	36,846	0.7%
2016	44,637		37,884		35,477		41,295	
Forecast								
2020	47,378	1.8%	40,272	1.5%	37,757	1.8%	43,677	1.7%
2030	54,339	1.4%	46,262	1.4%	43,450	1.4%	49,564	1.3%
2040	60,336	1.1%	51,212	1.0%	48,040	1.0%	54,367	0.9%
2050	66,890	1.0%	56,621	1.0%	53,055	1.0%	59,481	0.9%
CAGRs								
2000-2016	1.2%		0.9%		1.1%		1.2%	
2016-2020	1.5%		1.5%		1.6%		1.4%	
2016-2050	1.2%		1.2%		1.2%		1.1%	

⁹ Source: Complete Economic and Demographic Data Source (CEDDS), Woods & Poole Economics, Inc., 2017.

2.2 Background and Historical Passenger Traffic

One of the most important inputs into a traffic forecast is the historical traffic. This section shows historical data for enplaned passengers (including both Origin and Destination (O&D) passengers and connecting passengers) as well as discusses CLT's role as a hub for American Airlines.

2.2.1 Enplaned Passengers

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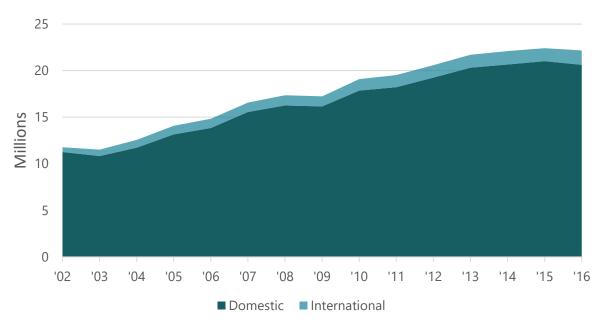
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Since 2002, the Airport has grown 4.6 percent annually on average in terms of enplaned passengers, reaching 22.2 million in 2016. During this period, average international growth (8.1 percent) almost doubled that of domestic growth (4.4 percent). As shown in Figure 2-2 below, enplanements only dipped by 0.6 percent in 2009 following the 2008-2009 economic crisis compared to a 7.2 percent drop in the United States as a whole.³ Traffic rebounded in 2010 with a rate of 10.7 percent. In 2016, traffic declined by 1.1 percent, driven by a decrease in domestic connecting passengers (O&D passengers increased). However, in the first half of 2017, enplaned passenger traffic was three percent higher than the first six months of 2016; international enplaned passengers are 20 percent higher than the same period in 2016.

Figure 2-2 Historical Enplaned Passengers at CLT, 2002-2016



Source: CLT Monthly Activity Reports

FAA Aerospace Forecast, FY 2011-2031

Since 2002, domestic traffic has increased by an average of 4.4 percent annually and international traffic has increased by an average of 8.1 percent annually (Table 2-5).

Table 2-5 **Compound Annual Growth Rates for Historical Enplaned Passengers at CLT**

CAGRs	2002-06	2006-11	2011-16	2002-16
Domestic	5.3%	5.6%	2.5%	4.4%
International	17.7%	5.7%	3.5%	8.1%
Total	5.9%	5.6%	2.6%	4.6%

Source: CLT Monthly Activity Reports CAGR - Compound Annual Growth Rate

Among the 30 large hub airports in the United States, CLT accounts for the 10th most enplaned passengers (see **Table 2-6** below).

Table 2-6 Enplaned Passengers at Top 30 U.S. Airports, CY 2016 1

2 Los Angeles International 39 3 Chicago O'Hare International 37 4 Dallas-Fort Worth International 31 5 NYC John F. Kennedy International 29 6 Denver International 29 8 Las Vegas McCarran International 21 9 Seattle-Tacoma International 21 10 Charlotte/Douglas International 22 11 Phoenix Sky Harbor International 20 12 Miami International 20 13 Orlando International 20 14 Houston George Bush Intercontinental 20 15 Newark Liberty International 19 16 Minneapolis-St Paul International 19 17 Boston Logan International 17 18 Detroit Metropolitan Wayne County 16 19 NYC LaGuardia 14 20 Philadelphia International 14 21 Fort Lauderdale/Hollywood International 14 22 Baltimore/Washington International 14 23 Ronald Reagan Washington National 11 24 Salt Lake City International 11 25 Chicago Midway International 11 26 Washington Dulles International 11	t		Passengers llions)
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	ego Ir		10.3
28 Honolulu Daniel K Inouye International 9.	ulu Da		9.7
29 Tampa International 9.	Inter		9.2
30 Portland International 9.	nd Inte		9.1

Source: FAA, Enplanements at All Commercial Service Airports (by Rank), October 10, 2017.

The ACEP was released in February 2016; however, the latest full year of data shown in the report is from 2013. In 2013, CLT accounted for the 8th most enplaned passengers in the U.S. airport;⁴ it has since been surpassed in the rankings by Las Vegas McCarran International Airport and Seattle-Tacoma International Airport.

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ACI, 2012 World Annual Traffic Report as shown in the ACEP

2.2.2 Current Service and Role as Hub

Passenger traffic at CLT comprises of O&D traffic (travel to and from Charlotte) and connecting traffic (passengers making connections at CLT) as illustrated below. As can be seen in Table 2-7, connecting traffic comprises 71 percent of passenger movements and consists mostly of domestic connections.

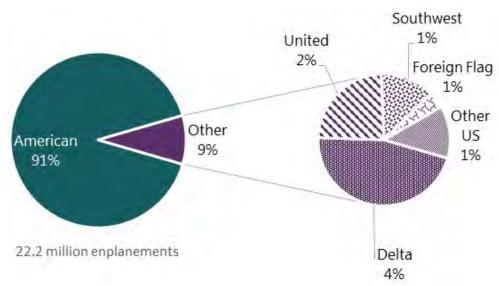
Table 2-7 **Charlotte Passenger Traffic CY 2016**

Traffic Type	Share
Domestic O&D	25.6%
International O&D	3.2%
Domestic Connecting	67.5%
International Connecting	3.7%
Total	100.0%

Source: U.S. DOT O&D and T100 data, via Flight Global's Diio Mi database.

The high rate of connections at CLT reflects its role as a hub for American Airlines which accounted for 91 percent of seat capacity and passengers in CY 2016 (Figure 2-3).5 Of the remaining nine percent of passengers, Delta Air Lines serves the largest share at four percent, followed by United Airlines at two percent.

Figure 2-3 Airline Share of CLT Enplanements, CY 2016



Source: U.S. DOT T100 via Airline Data, Inc.; CLT Monthly Traffic Reports.

Before the merger of American Airlines and US Airways in 2013,6 Charlotte was the largest of US Airways' four hubs. Now, Charlotte is American Airlines' second largest hub after Dallas/Fort Worth, as illustrated in (Table 2-8) below. After carriers merge, it is typical for changes to be made

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Innovata schedule data via Flight Global's Diio Mi database.

Although the merger was announced in 2013, the two airlines did not begin operating under one Air Operator's Certificate (AOC) until 2015.

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to the hub structure in order to optimize operations. As an example, the largest international connect flow was the U.S. Northeast-Caribbean market. Some of this traffic has since shifted to American Airlines' largest Caribbean gateway, Miami (Figure 2-4).

Overview of Capacity at American Airlines Hubs, CY 2016 Table 2-8

Seat Rank	Airport	Markets Served	Daily Departures	Daily Seats
1	Dallas/Fort Worth	202	749	95,927
2	Charlotte	158	660	71,170
3	Chicago O'Hare	133	481	49,938
4	Miami	129	333	48,061
5	Philadelphia	114	379	37,549
6	Phoenix	86	253	33,557
7	Los Angeles	70	202	27,723
8	Washington DCA	72	239	20,654
9	New York JFK	46	93	13,225

Source: Airport Records, U.S. DOT, O&D Survey, via Flight Global's Diio Mi database.

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Figure 2-4 **American Airlines Hub Locations**



Source: Innovata schedule data via Flight Global's Diio Mi database, August 2017.

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Flights from CLT reach 169 destinations; 135 of those in the United States (Table 2-9). These 135 destinations account for 95 percent of weekly departing flights. International service connects Charlotte to 34 airports with the 50 percent of those located in the Caribbean. American Airlines' focus at Charlotte is on domestic connections as it connects the United States to Latin American via its hub at Miami; Europe via its hub at New York JFK; and Asia from Los Angeles.

Table 2-9 Weekly Frequencies from CLT by Region, August 2017

Region	Weekly Departures	Weekly Departing Seats	Number of Destinations
Domestic	4,893	509,388	135
Europe	63	16,926	8
Caribbean	112	16,876	17
Mexico	30	5,048	4
Canada	46	2,984	2
Central America	7	882	3
Total	5,150	552,104	169

Source: Innovata Schedule Data via Flight Global's Diio Mi database, August 2017.

As noted above, the air service offerings at CLT has changed since the ACEP. In 2013, international flights accounted for 6.5 percent of total scheduled flights⁷ whereas in August 2017 they accounted for 5 percent. Of these international flights, 65 percent were to Latin America in 2013;8 this share has dropped to 57.8 percent in 2017.

Of the 5,150 weekly nonstop departures at CLT in August 2017, 67.8 percent are operated with narrowbody equipment (Table 2-10). Ten routes are operated with widebody aircraft.

Table 2-10 Weekly Frequency from CLT by Aircraft Type, August 2017

Aircraft Group	Weekly Departures	Weekly Departing Seats	Number of Destinations
Narrowbody	3,493	442,823	124
Regional Jet/Turboprop	1,584	89,985	90
Widebody	73	19,296	10
Total	5,150	552,104	N/A
Source: Innovata Schedule Data via	a Flight Global's Diio Mi da	tabase, August 2017	

2.2.3 Origin and Destination (O&D) Passengers

While connections account for 71.2 percent of passengers at CLT, O&D passengers play an increasing role at the Airport. Over the last 20 years, O&D passengers have increased by 4.7 percent annually on average (Table 2-11), with slightly larger growth in the international segment (see Figure 2-5). In 1996, international passengers accounted for 7.6 percent of total passengers; this share has increased to 11.1 percent in 2016. In 2016, both international and domestic O&D passengers grew, by 7.8 percent and 3.8 percent, respectively compared to 2015.

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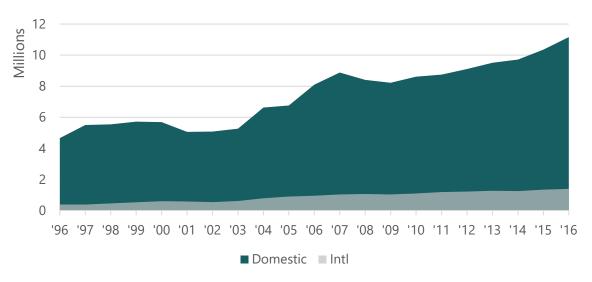
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OAG schedules as shown in the ACEP

Ibid.

Figure 2-5 Historical O&D Passengers at CLT, 1996-2016



Source: U.S. DOT O&D Survey via Flight Global's Diio Mi database.

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Table 2-11 Compound Annual Growth Rates for Historical O&D Passengers at CLT

CAGRs	1996-06	2006-16	1996-16
Domestic	5.7%	3.3%	4.5%
International	9.5%	3.9%	6.7%
Total	6.0%	3.3%	4.7%

Source: U.S. DOT O&D Survey via Flight Global's Diio Mi database.

New York City (as represented by JFK, LaGuardia and Newark airports) is the largest O&D destination from CLT, followed by Chicago (O'Hare and Midway) (see **Table 2-12**).

Table 2-12 Top 10 O&D Destinations from CLT, CY 2016

Rank	City	O&D Passengers
1	New York City	1,514,506
2	Chicago	594,468
3	Boston	474,979
4	Dallas	422,592
5	Philadelphia	339,573
6	Orlando	281,049
7	Baltimore	274,187
8	Los Angeles	272,809
9	Washington D.C.	244,093
10	San Francisco	240,379

Source: U.S. DOT O&D Survey via Airline Data, Inc.

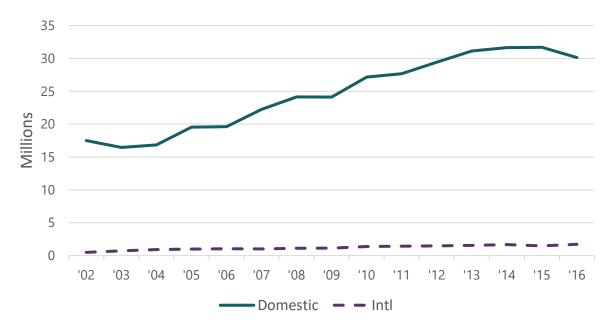
CAGR - Compound Annual Growth Rate

2.2.4 Connecting Passengers at CLT

Since 2002, the number of connecting passengers at CLT has increased by 4.2 percent annually on average (Figure 2-6 and Table 2-13), reaching 31.9 million passengers in 2016. International connections, which include connections between domestic and international flights have increased at a faster rate than domestic-to-domestic connections, likely due to the increase in the number of international flights.

Connecting traffic is a function of air carrier hubbing and network decisions (primarily American Airlines at CLT). While underlying demand can grow connecting traffic, it is American Airlines decision to flow traffic through specific hubs that will ultimately affect traffic volumes at CLT.

Figure 2-6 Historical Connecting Passengers at CLT, 2002-2016



Source: U.S. DOT O&D Survey via Flight Global's Diio Mi database

Table 2-13 Compound Annual Growth Rates for Historical Connecting Passengers at CLT

CAGRs	2002-06	2006-11	2011-16	2002-16
Domestic	2.9%	7.1%	1.7%	4.0%
International	20.5%	6.6%	3.8%	9.3%
Total	3.5%	7.1%	1.8%	4.2%

Source: U.S. DOT O&D Survey via Flight Global's Diio Mi database

Table 2-14 below shows the major domestic connecting flows (domestic-to-domestic) and Table 2-15 shows international connecting flows (domestic-to-international and international-to-international) at CLT in 2016. The major domestic-domestic flows tend to be north-to-south in nature, particularly on the eastern side of the country. CLT is geographically well-positioned to continue to handle these flows within America Airlines' network, compared with the Airline's other major hubs.

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Table 2-14 Charlotte Domestic Connecting Flows, CY 2016

Domestic Connecting Flows Northeast-to-Southeast 16.7% 14.1% Florida-to-Northeast Northeast-to-Southwest 7.5% Florida-to-Southeast 6.9% Great Lakes-to-Southeast 6.8% Florida-to-Great Lakes 6.0% Northeast-to-Pacific 5.3% Southeast-to-Southwest 5.0% Other 31.7% Total 100.0%

Source: U.S. DOT, O&D Database via Airline Data, Inc.

As shown in Table 2-15, for international, nearly two thirds of the flows are to the Caribbean and Mexico, which overlaps with American Airlines' Miami hub. Similarly, the flows to Europe overlap with Dallas and American Airlines' hubs in the Northeast.

Table 2-15 Charlotte International Connecting Flows, CY 2016

International Connecting Flows				
Domestic-to-Caribbean	50.8%			
Domestic-to-Europe	23.6%			
Domestic-to-Mexico	15.7%			
Domestic-to-Canada	5.3%			
Domestic-to-Other	2.9%			
International-to-International	1.7%			
Total	100.0%			

Source: U.S. DOT, O&D Database via Airline Data, Inc.

In 2016, domestic connecting traffic at CLT accounted for 1.9 percent of total U.S. domestic passenger traffic, while international connecting traffic accounted for 1.5 percent of total U.S. international passenger traffic (see Figure 2-7).9 Both the international and domestic connecting share of CLT compared to the national aviation market have been declining since 2013. This decline is due to an industry-wide trend towards more direct services as well as a consolidation of American Airlines' connecting traffic at other hubs such as Miami and Dallas. As discussed in the next chapter, this is a trend that is expected to continue, and it serves as one of the inputs into the long-term passenger forecast prepared for this EIS.

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[&]quot;International" here includes U.S.-Transatlantic, U.S.-Latin American, and U.S.-Canadian markets

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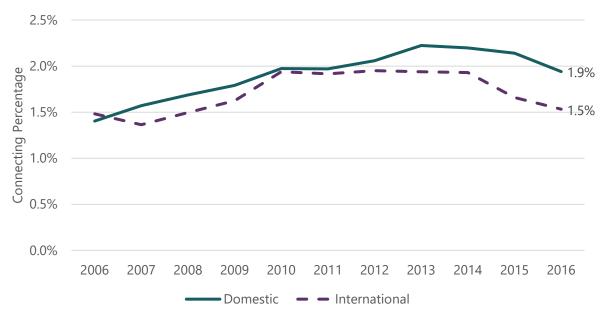
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Source: U.S. DOT O&D Survey via Flight Global's Diio Mi database, FAA

2.3 Aircraft Operations

2.3.1 Types of Aircraft Operations

Aircraft operations can be divided into categories based on aircraft size or operation purpose. The following definitions are used in the FAA's annual TAF forecast and in this technical memorandum.

- 1. **Commercial operations** (those operated as a business) can be defined based on the size of the aircraft involved:
 - a. **Air carrier** "takeoffs or landings of commercial aircraft with seating capacity of more than 60 seats" ¹⁰
 - b. Air taxi includes:
 - i. Commuter itinerant operations performed by commercial aircraft with seating capacity of 60 seats or less on scheduled flights
 - ii. On-demand itinerant operations performed by commercial aircraft with seating capacity of 60 seats or less on non-scheduled or for-hire flights

¹⁰ FAA TAF, Appendix A: Description of Activity Measures, page 26.

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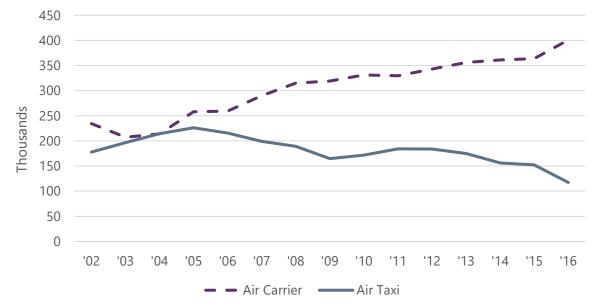
2. Non-commercial operations

- a. **General Aviation (GA) "**all civil aviation aircraft takeoffs and landings not classified as commercial or military"¹¹
- b. Military "takeoffs and landings by military aircraft" 12

2.3.2 Historical Aircraft Operations at CLT

Overall commercial operations at CLT have increased by 1.7 percent on average annually since 2002, reaching 518,197 in 2016 (**Figure 2-8**).

Figure 2-8 Historical Commercial Operations at CLT, 2002-2016



Source: FAA OPSNET

This growth has been driven by increases in air carrier operations as air taxi operations have declined over this period by 2.9 percent per annum on average (**Table 2-16**). The number of both international and domestic air carrier operations have increased by 6.1 percent and 4.1 percent, respectively.¹³

Table 2-16 Compound Annual Growth Rates for Historical Commercial Operations at CLT

CAGRs	2002-06	2006-11	2011-16	2002-16
Air Carrier	2.6%	4.9%	4.0%	3.9%
Air Taxi	4.9%	-3.1%	-8.6%	-2.9%
Total Commercial	3.6%	1.6%	0.2%	1.7%

Source: CLT Monthly Activity Reports CAGR - Compound Annual Growth Rates

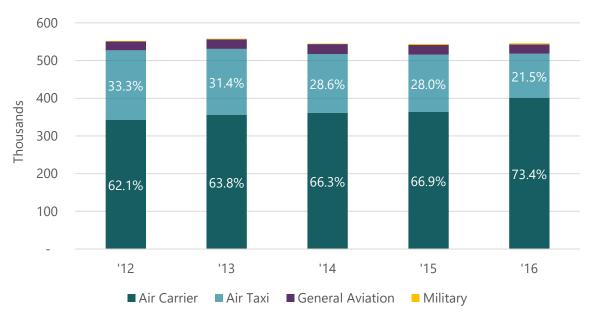
¹¹ FAA TAF, Appendix A: Description of Activity Measures, page 26.

¹² Ibid.

¹³ U.S. DOT T100 via Airline Data, Inc.

In 2016, 73.4 percent of total aircraft operations were air carrier. Almost 22 percent of operations were air taxis; 4.6 percent were General Aviation (GA); and 0.5 percent were military (Figure 2-9). General Aviation operations have been steadily falling and represent 60 percent of the level in 2002. Military operations have typically remained within a band of 1,700-2,500 per year, increasing slightly to 2,676 in 2016.

Figure 2-9 **Operations by Category, 2012-2016**



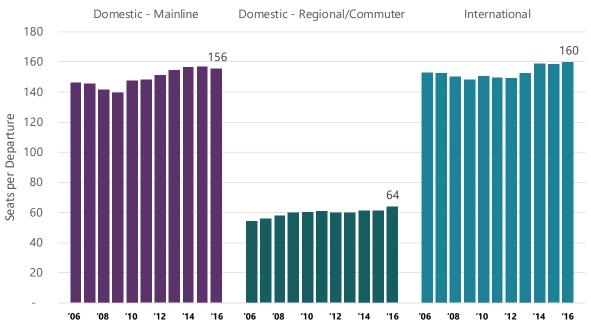
8 Source: FAA OPSNET

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2.4 Aircraft Fleet Mix

As is the case nationwide, average aircraft size at CLT has been increasing (Figure 2-10). However, the growth rate of these larger aircraft in the CLT fleet has been faster than the national rate over the last 10 years. Since 2006, the average number of scheduled seats per departure at CLT has increased from 91 to 107, an average annual growth rate of 1.6 percent or 1.6 seats per year. For comparison, among U.S. commercial carriers over the same period, average annual growth was 1.1 percent. The reason for faster growth at Charlotte is the historically large share of CLT departures operated by smaller, regional/commuter aircraft. In 2006, over 60 percent of CLT's departures were operated on regional/commuter aircraft; in 2016, this share has dropped to 53.2 percent; at the same time, the regional carriers have started operating larger regional jets, such as the CRJ 700 and Embraer 170, which typically have a capacity between 65 and 90 seats. Both these factors have contributed to an increasing aircraft size at CLT.

Figure 2-10 Average Seats per Departure at CLT (Scheduled), 2006-2016



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Source: Airline Schedules, via Airline Data, Inc.

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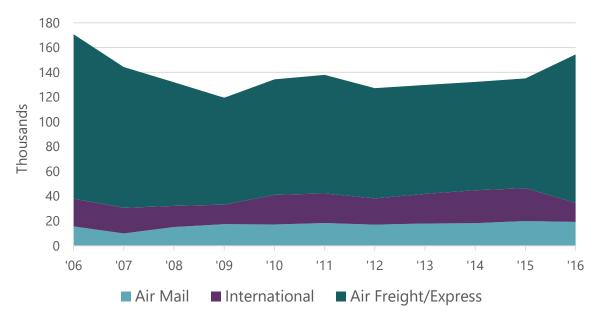
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2.5 Air Cargo

Air cargo tonnage has averaged 2.1 percent growth since the financial crisis (2009-15 growth). Domestic cargo accounts for 81 percent of total cargo enplaned and deplaned at CLT, while international makes up the remaining 19 percent. Historically, Charlotte has been served primarily by FedEx and UPS (which serve the air freight/express mail market), which together carried nearly 100 percent of cargo on scheduled cargo flights between 2012 and 2015. Belly cargo (cargo carried in the hold of commercial passenger aircraft) accounts for 33 percent of total cargo at CLT. Cargo volumes increased by 14.4 percent in 2016 to 154,000 tons (Figure 2-11 and Table 2-17) much of which can be attributed to Amazon, which contracted services with both ABX Air and Air Transport for cargo operations in and out of Charlotte. In 2016, 77.5 percent of cargo served at CLT was air freight/express mail.14

Figure 2-11 Historical Cargo at CLT (tons), 2006-2016



Source: CLT Monthly Activity Reports

Table 2-17 Compound Annual Growth Rates for Historical Cargo at CLT

CAGRs	2006-11	2011-16	2006-16
Air Freight/Express	-6.3%	4.6%	-1.0%
Air Mail	3.1%	1.0%	2.1%
International	1.4%	-8.5%	-3.6%
Total	-4.2%	2.3%	-1.0%

Source: CLT Monthly Activity Reports

Air freight/express mail includes all cargo that is not international or regular mail.

Traffic Forecast

3.1 Introduction

In the process of conducting this EIS, it is necessary to update the long-term traffic forecast for the Charlotte Douglas International Airport ("the Airport" or "CLT"). This updated forecast will be used as an input into several subsequent analyses completed for the Environmental Impact Statement (EIS) including (among others): aircraft delay modeling, noise modeling, establishment of the design aircraft type, and determination of the optimal runway length. This chapter first presents the methodology and results for projecting passengers, operations and cargo. The most recent calendar year of data available as of the writing of this memorandum is 2016; therefore, 2016 was selected as the base year for this EIS forecast. The two benchmark years chosen for this study are 2028 (the "Build Year," when the Project is expected to open) and the Build Year plus five years (2033). Both the passenger and operations forecasts are compared to both the Airport Capacity Enhancement Plan (ACEP) and the FAA's Terminal Area Forecast (TAF) to determine consistency. Where the EIS forecast differs from either the ACEP or TAF forecasts, explanations are discussed. The forecasts presented in this chapter for CLT have been submitted to the FAA's Airport District Office (ADO) for approval for use in the EIS study.

3.2 Passenger Forecast Methodology

This section presents the separate approaches used to forecast Origin and Destination (O&D) and connecting traffic.

3.2.1 Origin-Destination Traffic Forecast Methodology

The long-term passenger forecasts prepared for this EIS are based on an econometric model for domestic, Canada, the Caribbean (including Mexico and Central America), South America, trans-Atlantic, and trans-Pacific origin-destination passengers. Separate outbound (Charlotte residents) and inbound (overseas residents) models were developed using data sourced from the U.S. DOT. Various models were tested to explain traffic volumes in terms of: relevant GDP measures, population, air fares and fuel prices. The most robust models, in terms of statistical fit (adjusted r-squared and parameter t-statistics), were found to be those based on measures of real GDP (as well as dummy variables in 2001 and 2002 to capture the impacts of the events of September 11, 2001). For the domestic and outbound international models, Charlotte Combined Statistical Area (CSA) gross domestic product (GDP) was found to be the most effective explanatory variable, while the real GDP of the international regions were used for the inbound markets. The dependent variables used in the econometric analysis were in natural log terms. The key results from the econometric analysis are summarized in Appendix 1.

3-1 Traffic Forecast

As the markets mature, the responsiveness of demand to economic growth is expected to decline. To capture this, the GDP elasticities were gradually declined by 25 percent by 2035 - this of level decline is based on expert judgement and reflects the expected maturing of the market. To generate forecasts of O&D traffic, the parameters were applied to projections of real GDP sourced from Woods & Poole¹⁵ for Charlotte GDP and the U.S. Department of Agriculture Economic Research Service.¹⁶

3.2.2 Connecting Traffic

Connecting traffic at CLT is primarily a function of air carrier decisions (primarily American Airlines). While underlying demand can grow connecting traffic, it is carriers' decisions regarding flow traffic through specific hubs that will ultimately affect traffic volumes.

Connecting traffic was modelled as a function of national demand for travel and CLT's share of that demand. In 2016, domestic connecting traffic at CLT accounted for 1.9 percent of total domestic passenger traffic. The FAA forecasts that in the U.S., domestic traffic will increase by 1.7 percent per annum up to 2035. It is assumed that CLT's share of this traffic will decline by 10 percent over the forecast period as new direct services reduce the need for connecting itineraries (CLT's share will decline to 1.7 percent). As noted in Section 2.2.4, CLT's share of domestic connecting traffic has been declining in recent years, and this trend is expected to continue. This trend of declining connecting share was broadly confirmed by interviews with American Airlines. As a result, domestic connecting traffic is forecast to increase by 1.2 percent per annum (forecast values are shown in the Appendix).

The forecasts of international connecting traffic were based on the FAA forecasts of traffic to/from Canada, Latin America and Trans-Atlantic. CLT's share of these total traffic flows is assumed to decline by 25 percent, due to the development of direct services and the increased concentration of connecting flows at other hubs. As with domestic connecting traffic, CLT's share of international connecting traffic has been declining and this trend is expected to continue. This results in average growth of 2.1 percent per annum over the forecast period (compared with 3.6 percent per annum growth in total demand). Forecast connecting passenger values are shown in the Appendix.

3.3 Passengers

The EIS passenger forecast projects passengers by route group (domestic and international) as well as type of passenger. The two types of passengers projected are O&D and connecting.

- > **O&D passengers** at CLT are those beginning or ending their trip at CLT. An example of an O&D passenger would be someone traveling between Charlotte and New York City.
- > Connecting passengers at CLT are those changing planes in the Airport on their way to another destination. An example of a connecting passenger would be someone flying from New York City to Charlotte and then to Dallas.

¹⁵ Complete Economic and Demographic Data Source (CEDDS), Woods & Poole Economics, Inc., 2017.

¹⁶ U.S. Department of Agriculture Economic Research Service, https://www.ers.usda.gov/

3.3.1 Passenger Forecast Assumptions

The next three sections describe the different assumptions used to create the Base, High, and Low forecasts. Although the Base Case is that used for the majority of EIS analyses, it is important to have High and Low cases in order to test the range of possible outcomes.

3.3.1.1 Base Case

 The following assumptions were made in creating the passenger forecast:

- The United States economy as well as Charlotte's local economy will experience moderate and steady growth between 2016 and 2035 in line with current forecasts;
- > No large demand shock, such as terrorism or war, will significantly affect demand for air travel in the U.S.;
- > No significant change in airfares from Charlotte will dramatically affect demand for air travel;
- > No large change in jet fuel prices will dramatically affect the airlines' ability to serve Charlotte's from their respective bases;
- > The U.S. air traffic control system will be able to absorb incremental capacity throughout the forecast period;
- > The airport's facilities will not constrain demand; and,
- CLT's share of the U.S. industry domestic connects is forecast to decline from 1.9 percent to 1.7 percent while the share of international connections declines from 1.5 percent to 1.1 percent. This is an industry trend that reflects greater passenger volumes flying on a nonstop itinerary to reach their destination. Even though the CLT share of connecting passengers is declining, the actual volume of connecting passengers will increase.

3.3.1.2 High Case

In order to test the outer limit of the passenger forecast, a High Case was created. The following assumptions were made regarding the high forecast scenario for CLT:

- In an iterative process, O&D adjustments upward were made to the underlying independent variables in the regression analysis, i.e., economic growth rates forecast by Woods & Poole¹⁷ and the U.S. Department of Agriculture Economic Research Service. The revised economic growth rates will drive changes to O&D passengers. In the High Case, the GDP growth rate increased by 0.1 percentage points.
- > Connecting adjustments upward were made on the share of U.S. passenger growth that CLT connecting traffic represents. In the High Case, connecting shares of 1.9 percent for domestic, and 1.5 percent for international are held constant through the forecast period.

¹⁷ Complete Economic and Demographic Data Source (CEDDS), Woods & Poole Economics, Inc., 2017.

However, after review of the output, it was determined that a larger adjustment to the O&D forecast was necessary to reflect a more meaningful change in the underlying conditions. The GDP growth rate was then increased by +0.5 percentage points per annum throughout the forecast period. No change was made to initial assumptions for the connecting passenger forecast.

3.3.1.3 Low Case

In order to test the lower limit of the passenger forecast, a Low Case was created. The following assumptions were made regarding the Low Case for CLT:

- > In the Low Case, the GDP growth rated was decreased by -0.1 percentage points per annum.
- > Connecting shares were decreased from 1.9 percent to 1.6 percent for domestic, and 1.5 percent to 1.0 percent for international over the forecast period.

Similar to the high forecast, the results of the low forecast scenario were further analyzed and it was determined that an additional adjustment to the O&D passenger forecast was required. The GDP growth rate was adjusted to reflect a -0.5 percentage point change per year throughout the forecast period.

A high/low variance range of 20-25 percent was assumed when reviewing the outputs of the scenarios above.

3.3.2 Annual Passenger Forecasts

For 2017, the number of enplaned/deplaned passengers is expected to increase 2.4 percent from 2016, which reflects anticipated seat capacity growth shown in the 2017 schedule data and the year-to-date passenger figures as of April 2017. Based on the methodology and assumptions described above, the average growth rate is forecast to average 2.4 percent per annum between 2016 and 2020 (figures below **Table 3-1**). In the longer run, between 2016 and 2035, total enplanements will increase at 1.8 percent per annum. Yearly passengers at Charlotte will reach approximately 62.6 million by 2035, compared to 44.4 million in 2016. The resulting passenger forecasts are presented in **Table 3-1**, **Table 3-2**, and **Table 3-3** below.

Year	Domestic O&D	Int'l O&D	Connecting	Total
2005	6,762,157	899,855	20,544,040	28,206,052
2010	8,613,655	1,091,525	28,549,027	38,254,207
2011	8,752,758	1,193,081	29,097,869	39,043,708
2012	9,107,012	1,217,000	30,904,360	41,228,372
2013	9,513,203	1,266,955	32,676,733	43,456,891
2014	9,718,241	1,248,403	33,309,205	44,275,849
2015	10,353,573	1,343,355	33,173,903	44,870,831
2016	11,162,763	1,393,853	31,865,406	44,422,022
2017	11,547,629	1,491,064	32,454,311	45,493,004
2020	12,686,885	1,761,671	34,343,300	48,791,856
2025	14,615,653	2,285,876	36,120,282	53,021,811
2030	16,524,455	2,903,787	38,265,291	57,693,533
2035	18,378,400	3,621,209	40,604,915	62,604,524
Compound An	nual Growth Rates (C	AGRs)		
2005 – 2010	5.0%	3.9%	6.8%	6.3%
2010 – 2015	3.7%	4.2%	3.0%	3.2%
2016 – 2020	3.3%	6.0%	1.9%	2.4%
2020 – 2025	2.9%	5.3%	1.0%	1.7%
2025 – 2030	2.5%	4.9%	1.2%	1.7%
2030 – 2035	2.1%	4.5%	1.2%	1.6%
2016 – 2035	2.7%	5.2%	1.3%	1.8%

Source: Airport Statistics data for historical; U.S. DOT T100; InterVISTAS analysis for forecasts.

Note: Data is reflected in calendar years

Year	Domestic O&D	Int'l O&D	Connecting	Total
2005	6,762,157	899,855	20,544,040	28,206,052
2010	8,613,655	1,091,525	28,549,027	38,254,207
2011	8,752,758	1,193,081	29,097,869	39,043,708
2012	9,107,012	1,217,000	30,904,360	41,228,372
2013	9,513,203	1,266,955	32,676,733	43,456,891
2014	9,718,241	1,248,403	33,309,205	44,275,849
2015	10,353,573	1,343,355	33,173,903	44,870,831
2016	11,162,763	1,393,853	31,865,406	44,422,022
2017	11,612,917	1,506,527	32,616,771	45,736,215
2020	12,970,619	1,836,321	35,048,853	49,855,794
2025	15,335,467	2,508,638	37,877,975	55,722,080
2030	17,760,411	3,351,055	41,311,086	62,422,552
2035	20,196,602	4,387,422	45,223,392	69,807,416
Compound Ann	ual Growth Rates (CAG	Rs)		
2005 – 2010	5.0%	3.9%	6.8%	6.3%
2010 – 2015	3.7%	4.2%	3.0%	3.2%
2016 – 2020	3.8%	7.1%	2.4%	2.9%
2020 – 2025	3.4%	6.4%	1.6%	2.2%
2025 – 2030	3.0%	6.0%	1.8%	2.3%
2030 – 2035	2.6%	5.5%	1.8%	2.3%
2016 – 2035	3.2%	6.2%	1.9%	2.4%

Source: Airport Statistics data for historical; U.S. DOT T100; InterVISTAS analysis for forecasts.

Note: Data is reflected in calendar years

Year	Domestic O&D	Int'l O&D	Connecting	Total
2005	6,762,157	899,855	20,544,040	28,206,052
2010	8,613,655	1,091,525	28,549,027	38,254,207
2011	8,752,758	1,193,081	29,097,869	39,043,708
2012	9,107,012	1,217,000	30,904,360	41,228,372
2013	9,513,203	1,266,955	32,676,733	43,456,891
2014	9,718,241	1,248,403	33,309,205	44,275,849
2015	10,353,573	1,343,355	33,173,903	44,870,831
2016	11,162,763	1,393,853	31,865,406	44,422,022
2017	11,482,340	1,475,601	32,319,802	45,277,743
2020	12,407,831	1,689,593	33,762,591	47,860,015
2025	13,926,024	2,082,707	34,695,996	50,704,728
2030	15,368,749	2,517,566	35,829,682	53,715,997
2035	16,715,958	2,993,229	36,958,319	56,667,506
Compound Ar	nnual Growth Rates (C	AGRs)		
2005 – 2010	5.0%	3.9%	6.8%	6.3%
2010 – 2015	3.7%	4.2%	3.0%	3.2%
2016 – 2020	2.7%	4.9%	1.5%	1.9%
2020 – 2025	2.3%	4.3%	0.5%	1.2%
2025 – 2030	2.0%	3.9%	0.6%	1.2%
2030 – 2035	1.7%	3.5%	0.6%	1.1%
2016 – 2035	2.1%	4.1%	0.8%	1.3%

Source: Airport Statistics data for historical; U.S. DOT T100; InterVISTAS analysis for forecasts.

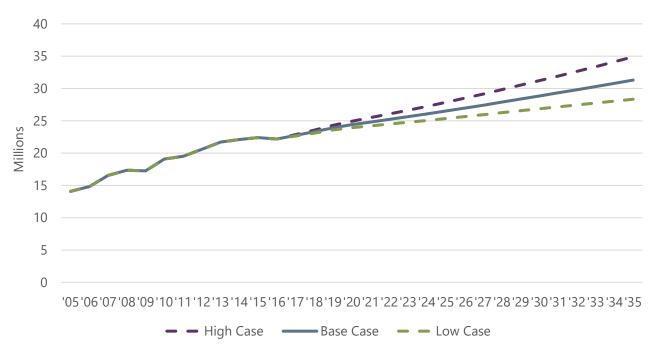
Note: Data is reflected in calendar years

The figure below (**Figure 3-1**) reflects the high and low growth scenarios compared to the base case. Forecasted enplanements for the high case are 12 percent above the base case, reaching 33.8 million enplanements in 2035. As for the low scenario, enplanements are projected to be 28.3 million, nine percent below the base case scenario. The variance for the revised high/low forecast is 23 percent.

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Figure 3-1 Enplanements Forecast – Base, High, Low Cases



Source: CLT statistics data for historical; U.S. DOT T100; InterVISTAS analysis for forecasts.

3.3.3 Comparative Enplaned Passenger Forecasts

Forecasts that are part of an EIS are required to be approved by the FAA. The FAA "must ensure that the forecast is based on reasonable planning assumptions, uses current data, and is developed using appropriate forecast methods." In addition, forecasts must be deemed to be consistent with the FAA's Terminal Area Forecast (TAF). The TAF is an annual forecast of passengers and aircraft operations produced by the FAA for all existing airports in the National Plan of Integrated Airport Systems 19. The comparison shown below (**Figure 3-2**) shows the most recent version of the TAF, which uses FY 2016 as the base year and provides forecasts for FY 2017-2045. In addition to its baseline forecast, the TAF also shows optimistic and pessimistic scenarios. In order to be approved, this EIS forecast must fall within a defined, acceptable range of the baseline TAF forecast: ±10 percent in the five-year forecast period and ±15 percent in the 10-year forecast period.

As shown in the table below **(Table 3-4)**, the EIS passenger forecast matches closely with the FAA TAF for the future forecast years.²⁰ The EIS forecast is 0.5 percent below the TAF base forecast by 2035, which is within the TAF consistency requirements required by the FAA. This forecast technical memorandum is accompanied by a letter to the FAA requesting approval for its use in this EIS process.

¹⁸ FAA, Approval of Local Forecasts, 2008, page 1.

¹⁹ CLT is a large hub airport.

The TAF forecast has been converted into calendar years for comparison purposes. Calendar year figures were determined by assuming 75 percent of operations in the base fiscal year and 25 percent of operations in the following fiscal year (i.e., for CY 2016: 75 percent of FY 2016 and 25 percent of FY 2017).

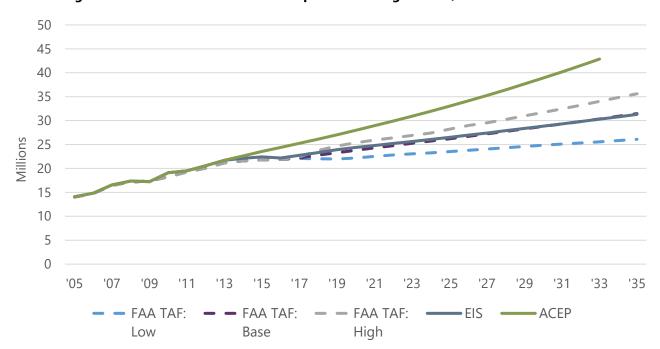
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Figure 3-2 Historical and Forecast Enplaned Passengers – EIS, TAF and ACEP



Source: Airport statistics data for historical; U.S. DOT T100 data; InterVISTAS analysis for forecasts.

FAA TAF: https://www.faa.gov/data_research/aviation/taf/

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Note: The forecast in the ACEP ends in 2033

Table 3-4 Historical and Forecast Enplaned Passengers Compound Average Growth Rates – EIS, TAF, and ACEP

Period	EIS	TAF	ACEP
2010 – 2016	2.5%	3.1%	4.2%
2016 – 2020	2.4%	2.1%	3.5%
2020 – 2025	1.7%	2.0%	3.4%
2025 – 2030	1.7%	1.9%	3.3%
2030 – 2035	1.6%	1.8%	3.3%
2016 – 2035	1.8%	1.9%	3.5%

Source: Airport statistics data for historical; U.S. DOT T100; InterVISTAS analysis for forecasts.

FAA TAF: https://www.faa.gov/data_research/aviation/taf/

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Note: ACEP Growth Rates are for 2030-2033, and 2013-2033

Note: Comparison is made between the baseline EIS and TAF forecasts.

The graph (**Figure 3-2**) and table (**Table 3-4**) above, also show a comparison of the EIS forecast to that in the ACEP. When compared to the enplanement forecast in the ACEP, both the EIS and TAF forecasts are 29.3 percent and 29.2 percent below the ACEP in 2033, respectively. The ACEP forecast used 2013 as a base year, while 2016 is the base year in the EIS forecast, and has overestimated enplanements in 2016 by over 2 million passengers.

Since the ACEP forecast was completed, several of the assumptions used in the forecast have changed.

- At the time the ACEP forecast was created, the merger of American Airlines and US Airways had only recently been announced. The ACEP forecast assumed that the merger "is not expected to negatively affect passenger growth at CLT." While the merger has not negatively affected passenger traffic at CLT as of yet, American Airlines has altered the role of CLT in its network, specifically in international routes.
- The ACEP assumed that "Growth in the Latin American economies will be the primary driver of continued growth in international air travel at CLT." While Charlotte maintained service to the Caribbean, American Airlines shifted international service among its hub and withdrew its service from Charlotte to Sao Paulo and Rio de Janeiro in Brazil, instead relying on its flights from Miami to connect the U.S. to South America. In 2016, Charlotte had no flights to South America and American Airlines is not expected to add any in the near future according to the carrier's network planners.
- In addition, the ACEP report states that "Domestic enplanements at CLT increased 4.8 percent annually between 1990 and 2013...This was primarily driven by domestic connections..." However, since the ACEP forecast was completed, domestic O&D passengers continued to grow, while domestic connections have grown more slowly or even decline (-1.1 percent on average per annum from 2013-2016).
- > The ACEP "assumed that connecting domestic enplanements would account for 75.0 percent of the total domestic enplanements throughout the forecast period." Instead, the connecting share of passengers has declined to 71.7 percent in 2016.
- > The ACEP assumed continued high fuel prices; however, fuel prices have plummeted in recent years, changing the economics of airline operations.

All of these factors/assumptions explain why the ACEP forecast is higher than that of the more recent TAF and EIS forecasts.

3.4 Operations

This section presents the methodology and results for projected aircraft operations at CLT for the 2017-2035 period.

3.4.1 Operations Forecast Assumptions

Forecasts of annual commercial passenger aircraft operations are based on forecast passenger traffic demand. Passenger aircraft landings depend on the average aircraft size and average load factor (i.e., average passenger per flight), as represented by the formula below:

Passenger Aircraft Operations

= (Passenger Forecasts)/(Avg. Aircraft Size x Avg. Load Factor)

where Avg. Aircraft Size x Avg. Load Factor = Avg. Passengers per Aircraft Movement

²¹ CLT Master Plan Update: Phase 1, Airport Capacity Enhancement Plan

²² Ibid.

²³ Ibid.

²⁴ Ibid.

Forecasts of average load factors were prepared (including marginal growth) and applied to the passenger figures (**Table 3-5**).

Table 3-5 Load Factor Assumptions

Region	2016	2035
Commuter – Domestic	80.2%	81.4%
Air Carrier – Domestic	84.0%	85.0%
Air Carrier – Canada	77.4%	82.0%
Air Carrier – Caribbean, Mexico, Central America	83.8%	85.0%
Air Carrier – South America	80.0%	82.0%
Air Carrier – Trans-Atlantic	75.1%	80.0%
Air Carrier – Trans-Pacific	80.0%	85.0%

Source: InterVISTAS assumptions.

Projections of passenger operations for Base, High and Low Cases were created by applying these load factor assumptions and assumptions regarding aircraft size (discussed in Section 3.4.5 below). Forecasts of annual general aviation and military operations were increased in line with the FAA TAF forecast.

3.4.2 Cargo Operations Forecasts

In 2016, there were 2,696 air cargo operations at CLT, 0.5 percent of total aircraft operations. The forecast of cargo aircraft operations was based on historical operations and forecast air cargo tonnage. It was assumed that the proportion of air cargo that would be transported by cargo aircraft (as opposed to passenger aircraft bellyhold), would remain at 2016 levels throughout the forecast period. Furthermore, it was assumed that the tonnage per cargo aircraft would remain constant over the forecast period.

3.4.3 Annual Operations Forecasts

The resulting base case operations forecasts are presented in **Table 3-6** below. Air carrier aircraft movements are forecast to increase by an average of 1.4 percent per annum, compared with passenger growth of 1.8 percent per annum (the lower growth due to rising load factors and the number of passengers per aircraft). Total operations for the base case forecasted are projected to grow at an average annual rate of 1.2 percent.

Table 3-6 Operations Forecast – Base Case – Charlotte Douglas International Airport

Year	Air Carrier	Air Taxi	GA	Military	Total
2010	331,110	171,836	24,414	1,741	529,101
2011	329,680	184,122	24,131	1,909	539,842
2012	343,121	183,870	23,400	1,702	552,093
2013	356,079	175,051	25,426	1,392	557,948
2014	361,273	156,188	26,321	1,396	545,178
2015	363,667	152,215	25,639	2,423	543,944
2016	400,819	117,378	24,869	2,676	545,742
2017	409,357	118,994	24,935	2,676	555,962
2020	431,503	122,231	25,083	2,676	581,494
2025	464,250	127,137	25,335	2,676	619,399
2030	494,758	130,959	25,588	2,676	653,981
2035	526,759	135,135	25,845	2,676	690,415
Compound Annu	al Growth Rates				
2010 – 2015	1.9%	-2.4%	1.0%	6.8%	0.6%
2016 – 2020	1.9%	1.0%	0.2%	0.0%	1.6%
2020 – 2025	1.5%	0.8%	0.2%	0.0%	1.3%
2025 – 2030	1.3%	0.6%	0.2%	0.0%	1.1%
2030 – 2035	1.3%	0.6%	0.2%	0.0%	1.1%
2016 – 2035	1.4%	0.7%	0.2%	0.0%	1.2%

Source: Airport Statistics data for historical; U.S. DOT T100; InterVISTAS analysis for forecasts.

Note: Data is reflected in calendar years.

Note: The forecast does not reallocate air taxi operations to air carrier as the seating capacity increases; therefore, the average aircraft size (seats) for air taxi goes above 60 seats.

Table 3-7 Operations Forecast – High Case – Charlotte Douglas International Airport

Year	Air Carrier	Air Taxi	GA	Military	Total
2010	331,110	171,836	24,414	1,741	529,101
2011	329,680	184,122	24,131	1,909	539,842
2012	343,121	183,870	23,400	1,702	552,093
2013	356,079	175,051	25,426	1,392	557,948
2014	361,273	156,188	26,321	1,396	545,178
2015	363,667	152,215	25,639	2,423	543,944
2016	400,819	117,378	24,869	2,676	545,742
2017	411,504	119,523	24,935	2,676	558,638
2020	440,726	124,439	25,083	2,676	592,925
2025	483,014	129,731	25,335	2,676	640,757
2030	531,968	138,249	25,588	2,676	698,481
2035	585,654	147,635	25,845	2,676	761,810
Compound Annu	al Growth Rates				
2010 – 2015	1.9%	-2.4%	1.0%	6.8%	0.6%
2016 – 2020	2.4%	1.5%	0.2%	0.0%	2.1%
2020 – 2025	1.8%	0.8%	0.2%	0.0%	1.6%
2025 – 2030	1.9%	1.3%	0.2%	0.0%	1.7%
2030 – 2035	1.9%	1.3%	0.2%	0.0%	1.8%
2016 – 2035	2.0%	1.2%	0.2%	0.0%	1.8%

Source: Airport Statistics data for historical; U.S. DOT T100; InterVISTAS analysis for forecasts.

Note: Data is reflected in calendar years

Note: The forecast does not reallocate air taxi operations to air carrier as the seating capacity increases; therefore, the average aircraft size (seats) for air taxi goes above 60 seats.

Table 3-8 Operations Forecast – Low Case – Charlotte Douglas International Airport

Year	Air Carrier	Air Taxi	GA	Military	Total
2010	331,110	171,836	24,414	1,741	529,101
2011	329,680	184,122	24,131	1,909	539,842
2012	343,121	183,870	23,400	1,702	552,093
2013	356,079	175,051	25,426	1,392	557,948
2014	361,273	156,188	26,321	1,396	545,178
2015	363,667	152,215	25,639	2,423	543,944
2016	400,819	117,378	24,869	2,676	545,742
2017	407,441	118,506	24,935	2,676	553,557
2020	423,357	120,210	25,083	2,676	571,326
2025	440,261	119,856	25,335	2,676	588,129
2030	459,150	121,963	25,588	2,676	609,377
2035	477,630	124,175	25,845	2,676	630,326
Compound Annu	al Growth Rates				
2010 – 2015	1.9%	-2.4%	1.0%	6.8%	0.6%
2016 – 2020	1.4%	0.6%	0.2%	0.0%	1.2%
2020 – 2025	0.8%	-0.1%	0.2%	0.0%	0.6%
2025 – 2030	0.8%	0.3%	0.2%	0.0%	0.7%
2030 – 2035	0.8%	0.4%	0.2%	0.0%	0.7%
2016 – 2035	0.9%	0.3%	0.2%	0.0%	0.8%

Source: Airport Statistics data for historical; U.S. DOT T100; InterVISTAS analysis for forecasts.

Note: Data is reflected in calendar years

Note: The forecast does not reallocate air taxi operations to air carrier as the seating capacity increases; therefore, the average aircraft size (seats) for air taxi goes above 60 seats.

In the high growth scenario, total aircraft operations at Charlotte Douglas International will reach over 761,800 operations, with an average annual growth rate of 1.8 percent through 2035 (**Figure 3-3** and **Table 3-7**). While a period of low growth is projected to reach 630,300 operations in 2035 with an average annual growth rate of 0.8 percent (**Table 3-8**).

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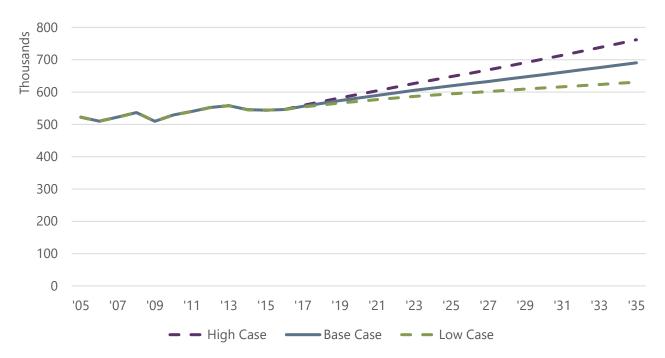
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Figure 3-3 Operations Forecast – Base, High, Low Cases – Charlotte Douglas International Airport



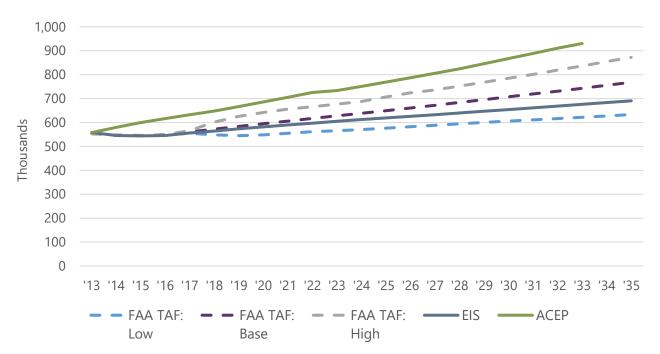
Source: Airport Statistics data for historical; U.S. DOT T100; InterVISTAS analysis for forecasts.

3.4.4 Comparative Operations Forecasts

The chart (**Figure 3-4**) and table (**Table 3-9**) below provide a comparison with the FAA TAF forecasts and the ACEP forecasts. The EIS forecast is lower than the baseline FAA forecast, with forecast volumes in 2033 being 9.1 percent below that of the TAF, and 27.4 percent below the ACEP forecast in 2033.²⁵

²⁵ The ACEP forecast extended to 2033 only.

Figure 3-4 Historical and Forecast Aircraft Operations – EIS, TAF and ACEP



Source: Airport statistics data for historical; U.S. DOT T100 data; InterVISTAS analysis for forecasts.

FAA TAF: https://www.faa.gov/data_research/aviation/taf/

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Table 3-9 Historical and Forecast Operations— EIS, TAF and ACEP

					EIS vs.	EIS vs.
	Year	EIS	FAA TAF	ACEP	TAF	ACEP
Passenger Enplaneme	ents					
Base Year	2016	22,173,747	21,900,456	24,408,300	1.2%	-9.2%
Base Year + 1	2017	22,746,502	22,231,446	25,266,400	2.3%	-10.0%
Build Year	2028	27,893,348	27,735,137	36,449,000	0.6%	-23.5%
Build Year + 5	2033	30,298,324	30,353,627	42,865,500	-0.2%	-29.3%
Commercial Operatio	ns					
Base Year	2016	518,197	521,304	579,260	-0.6%	-10.5%
Base Year + 1	2017	528,351	532,647	594,800	-0.8%	-11.2%
Build Year	2028	611,620	655,739	783,220	-6.7%	-21.9%
Build Year + 5	2033	647,224	714,678	886,260	-9.4%	-27.0%
Total Operations						
Base Year	2016	545,742	548,653	616,400	-0.5%	-11.5%
Base Year + 1	2017	555,962	560,057	632,300	-0.7%	-12.1%
Build Year	2028	639,783	683,696	824,740	-6.4%	-22.4%
Build Year + 5	2033	675,643	742,889	930,080	-9.1%	-27.4%

Source: Airport statistics data for historical; U.S. DOT T100 data; InterVISTAS analysis for forecasts.

FAA TAF: https://www.faa.gov/data_research/aviation/taf/

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Note: A version of this table with Base Year +5,10,15 years is shown in the Appendix.

Note: Comparison is made between the baseline EIS and TAF forecasts.

3.4.5 Aircraft Fleet Mix

One of the other major assumptions required to convert the passenger forecast into aircraft operations is the average aircraft size, which includes assumptions regarding how the fleet of aircraft using CLT will change in the future. Forecasts of average aircraft size were prepared and applied, pointing to a trend of larger aircraft. In particular, the fleet orders of American Airlines which include large orders for the Airbus A321neo (starting in 2019) and the Boeing B737Max8 (starting in 2021), were included. The addition of these aircraft are expected to increase the average aircraft size at CLT (confirmed in interviews with American Airlines).

Average Aircraft Size (Seats per Departure) Assumptions:

- Commuter commuter aircraft, including large and small regional jets, are assumed to increase from 59 seats in 2016 to 62 seats in 2022 and 64 seats by 2035. This increase assumes network carriers will continue retiring smaller regional jets and replace them with more efficient larger regional jets.
- Domestic seats per aircraft increase from 142 in 2016 to 145 in 2022 and 148 by 2035, as airlines upgauge; e.g., moving some operations from A319 to A320, and from A320 to A321Neo, etc.
- > Canada seats per departure to Canada decreased following the 2008-2010 financial crisis. However, seats per departure have stabilized since 2013. Average seats are forecast to increase gradually from 62 seats in 2016 to 64 in 2022 and 67 in 2035.

- Caribbean, Mexico, South America seats per departures has stayed relatively flat for this region at 159 seats assumed to be 162 seats by 2022 and 166 seats by 2035.
 - > **South America** US Airways previously serviced Brazil from 2009-2015, with average seats per departure of 204 in 2015. Service is assumed to resume by 2020, operating with 209 seats.
 - > Trans-Atlantic seats per departures are projected to increase from 261 seats in 2016 to 265 in 2035.
 - > Trans-Pacific does not currently have service, assumed this would remain the case through 2035

3.5 Cargo

This section presents the methodology and forecast results for cargo tonnage at CLT for the 2017-2035 period.

3.5.1 Cargo Forecast Assumptions

Cargo forecasts were prepared for Base, High and Low Cases, with differing assumptions for each case. The cargo growth forecast is based on expert judgement.

3.5.1.1 Base Case

The continuation of activity is expected to spur growth in the short term, averaging 6 percent per annum up to 2019. After that, cargo activity growth at the airport is expected to taper off in the long term as Amazon plans to build a centralized air hub at Cincinnati/Northern Kentucky Airport to support its growing fleet of Prime Air cargo planes. Cargo growth after 2020 is projected to range from 2-3 percent per annum in line with historical levels. While the Department does not currently have plans to expand its cargo facilities, the Department recently completed an expansion of the cargo ramp, providing 12,000 square yards of additional space. Airport facilities are assumed to accommodate future cargo activity levels.

The following assumptions were made concerning the cargo forecast at Charlotte:

- The U.S. economy as well as Charlotte's local economy will experience moderate and steady growth between 2016 and 2041;
- > Rapid growth due to Amazon will slow by 2019;
- > Key integrated carriers (e.g., FedEx, UPS, etc.) will maintain their services at Charlotte airport;
- > Passenger air carriers would continue to provide cargo services through their belly capacity; regional jets would provide limited cargo capacity
- > Long-term (2020-2035) growth is forecast to average 2.4 percent per annum, close to the average between 2011 and 2016 (2.3 percent per annum see Section 2.5).

3.5.1.2 High Case

To reflect a high growth scenario, an adjustment of +0.5 percentage points was made to the annual cargo growth rate.

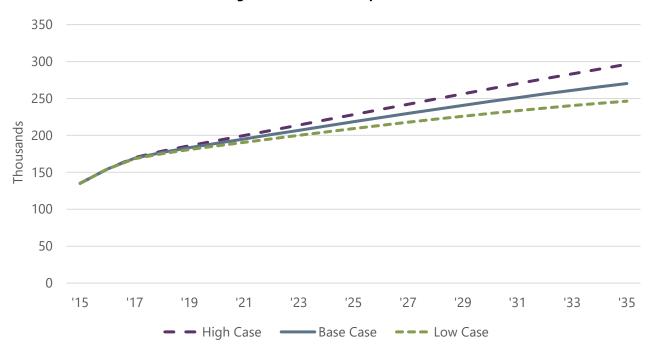
3.5.1.3 Low Case

For the low growth scenario, it was assumed Amazon growth in the early part of the forecast is curtailed, and an adjustment of -0.5 percentage points was made to the annual cargo growth rate.

3.5.2 Annual Cargo Forecasts

In the Base Case forecast, cargo tonnage is expected to grow an average of 3.0 percent per year reaching 270,215 tons in 2035, compared to 154,477 tons in 2016 (**Figure 3-5**). In the High Case forecast average annual growth increases to 3.5 percent per year, reaching 296,264 tons in 2035. While in the Low Case, cargo is projected to reach 246,346 tons by 2035, with an average annual growth rate of 2.5 percent.

Figure 3-5 Historical and Forecast Cargo Tonnage – Base, High, Low Cases – Charlotte Douglas International Airport



Source: Airport Statistics data for historical; U.S. DOT T100; InterVISTAS analysis for forecasts.

3.6 Conclusion

The forecasts presented in this technical memorandum will be used as an input into several subsequent analyses in the EIS. The Base Case forecast serves as the most likely future demand scenario given no constraints on traffic growth at the Airport; the High and Low Cases serve as indicators of how actual demand could vary above/below the Base Case depending on changes in the economic environment or changes in strategic decisions made by American Airlines. The annual forecasts for 2028 (Build Year) and 2033 (Build Year + 5) will be converted into Design Day Schedules including details of individual flights. Such schedules are required to conduct the capacity delay analysis and evaluate delays in airspace, runway usage, taxi-in/out times, and gate

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usage. Simulation of a Design Day Schedule for 2016 (based on current OAG schedules) will determine the presence and location of existing delays; the schedules for 2028 and 2033 will be used as inputs to model future delays in the absence of the Project (No Action).

Appendix 1: Additional Data

Domestic O&D Traffic Parameter Estimates (1998-2016)

Variable	Parameter Estimate	T-Statistic
Constant	-22.53	-5.92
Ln (Charlotte GDP)	1.19	10.10
Ln (2001 Dummy)	-0.13	-1.41
Ln (2002 Dummy)	-0.17	-1.83
Adjusted-R ²	0.89	

Canada O&D Traffic Parameter Estimates – Outbound (1998-2016)

Variable	Parameter Estimate	T-Statistic
Constant	-20.19	-5.09
Ln (Charlotte GDP)	0.97	7.91
Ln (2001 Dummy)	-0.05	-0.48
Ln (2002 Dummy)	0.17	1.72
Adjusted-R ²	0.79	

Canada O&D Traffic Parameter Estimates – Inbound (1998-2016)

Variable	Parameter Estimate	T-Statistic
Constant	-43.24	-10.38
Ln (Canadian GDP)	1.93	13.00
Ln (2001 Dummy)	-0.07	-0.92
Ln (2002 Dummy)	0.01	0.10
Adjusted-R ²	0.91	

Caribbean (including Mexico and the Caribbean) O&D Traffic Parameter Estimates – Outbound (1998-2016)

Variable	Parameter Estimate	T-Statistic
Constant	-73.08	-12.37
Ln (Charlotte GDP)	2.64	14.48
Ln (2001 Dummy)	-0.11	-0.78
Ln (2002 Dummy)	-0.03	-0.23
Adjusted-R ²	0.93	

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Caribbean (including Mexico and the Caribbean) O&D Traffic Parameter Estimates – Inbound (1998-2016)

Variable	Parameter Estimate	T-Statistic
Constant	-87.26	-11.52
Ln (Regional GDP)	3.50	12.93
Ln (2001 Dummy)	-0.27	-1.74
Ln (2002 Dummy)	-0.22	-1.41
Adjusted-R ²	0.92	

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South America O&D Traffic Parameter Estimates – Outbound (1998-2016)

Variable	Parameter Estimate	T-Statistic
Constant	-88.11	-8.93
Ln (Charlotte GDP)	3.03	9.94
Ln (Dummy 2001)	-0.01	-0.04
Ln (Dummy 2002)	-0.13	-0.55
Adjusted-R ²	0.87	

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South America O&D Traffic Parameter Estimates – Inbound (1998-2016)

Variable	Parameter Estimate	T-Statistic	
Constant	-97.56	-12.83	
Ln (SAM GDP)	3.67	14.06	
Ln (Dummy 2001)	0.10	0.48	
Ln (Dummy 2002)	0.01	0.06	
Adjusted-R ²	0.93		

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Trans-Atlantic O&D Traffic Parameter Estimates – Outbound (1998-2016)

Variable	Parameter Estimate	T-Statistic
Constant	-27.81	-3.97
Ln (Charlotte GDP)	1.24	5.74
Ln (Dummy 2001)	0.08	0.47
Ln (Dummy 2002)	-0.36	-2.11
Adjusted-R ²	0.72	

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Trans-Atlantic O&D Traffic Parameter Estimates – Inbound (1998-2016)

Variable	Parameter Estimate	T-Statistic
Constant	-87.76	-7.27
Ln (EU-28 GDP)	3.27	8.26
Ln (Dummy 2001)	-0.06	-0.44
Ln (Dummy 2002)	-0.40	-2.93
Adjusted-R ²	0.84	

Trans-Pacific O&D Traffic Parameter Estimates – Outbound (1998-2016)

Variable	Parameter Estimate	T-Statistic
Constant	-69.67	-10.26
Ln (Charlotte GDP)	2.49	11.85
Ln (Dummy 2001)	0.06	0.34
Ln (Dummy 2002)	0.00	0.02
Adjusted-R ²	0.90	

Trans-Pacific O&D Traffic Parameter Estimates – Inbound (1998-2016)

Variable	Parameter Estimate	T-Statistic
Constant	-37.41	-16.85
Ln (Asia GDP)	1.57	21.47
Ln (2001 Dummy)	0.04 0.51	
Ln (2002 Dummy)	0.00	-0.04
Adjusted-R ²	0.97	

Historical Values of the Independent Variables

	CLT	Canada	Caribbean	South America	Trans- Atlantic	Trans- Pacific		
	GRP	GDP	GDP	GDP	GDP	GDP		
	Real 2009	Real 2010	Real 2010	Real 2010	Real 2010	Real 2010	2001	2002
Year	(\$mns)	(\$bns)	(\$bns)	(\$bns)	(\$bns)	(\$bns)	Dummy	Dummy
1998	79,625	1,211	297	3,742	14,627	9,932	0	0
1999	84,943	1,271	308	3,743	15,050	10,262	0	0
2000	86,498	1,337	318	3,887	15,634	10,741	0	0
2001	89,212	1,359	332	3,920	15,973	11,052	1	0
2002	92,383	1,397	341	3,933	16,178	11,465	0	1
2003	96,233	1,424	351	3,998	16,405	12,012	0	0
2004	102,951	1,469	362	4,245	16,834	12,685	0	0
2005	111,670	1,515	379	4,437	17,191	13,382	0	0
2006	122,351	1,555	399	4,675	17,785	14,223	0	0
2007	128,762	1,586	415	4,937	18,346	15,251	0	0
2008	137,250	1,605	423	5,127	18,456	15,808	0	0
2009	128,097	1,561	419	5,062	17,669	16,128	0	0
2010	116,819	1,614	427	5,354	18,038	17,399	0	0
2011	120,718	1,662	437	5,599	18,350	18,250	0	0
2012	129,882	1,694	446	5,760	18,278	19,140	0	0
2013	126,752	1,728	457	5,918	18,308	20,096	0	0
2014	131,396	1,771	470	5,975	18,547	20,986	0	0
2015	140,388	1,789	483	5,959	18,882	21,922	0	0
2016	144,331	1,829	499	6,013	19,264	22,867	0	0

Source: US Department of Agriculture Economics Research Centre; Woods & Poole 2017

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Summary of Domestic Connecting Traffic Forecast (millions)

Year	U.S. Domestic Traffic	CLT Share	CLI Domestic Connections
2016	718.7	1.9%	14.0
2017	738.0	1.9%	14.2
2020	791.4	1.9%	15.0
2025	847.6	1.8%	15.7
2030	917.9	1.8%	16.5
2035	998.0	1.7%	17.4
CAGR			
2016 – 2020	2.4%		1.9%
2020 – 2025	1.4%		0.8%
2025 – 2030	1.6%		1.0%
2030 – 2035	1.7%		1.1%
2016 – 2035	1.7%		1.2%
Total Change in	n CLT Share	-10.0%	

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Summary of International Connecting Traffic Forecast (millions)

	U.S. International		CLT International
Year	Traffic	CLT Share	Connections
2016	102.3	1.5%	1.6
2017	105.2	1.5%	1.6
2020	118.3	1.5%	1.7
2025	142.7	1.4%	1.9
2030	169.9	1.2%	2.1
2035	201.3	1.1%	2.3
CAGR			
2016 – 2020	3.7%		2.3%
2020 – 2025	3.8%		2.4%
2025 – 2030	3.5%		1.9%
2030 – 2035	3.4%		1.7%
2016 – 2035	3.6		2.1%
Total Change in	CLT Share	-25.0%	

1 Summary of Charlotte Douglas International Airport Forecast – FAA Template

	Forecast					Compou	nd Annual	Growth Ra	tes
	Base Year 2016	Base Year+1 2017	Base Year+5 2021	Base Year+10 2026	Base Year+15 2031	Base Year+1 2017	Base Year+5 2021	Base Year+10 2026	Base Year+15 2031
Passenger Enplanemen	ts								
Air Carrier	15,640,736	15,850,803	17,411,598	19,089,474	20,951,150	1.3%	2.2%	2.0%	2.0%
Commuter	6,533,011	6,895,699	7,398,772	7,864,182	8,374,605	5.6%	2.5%	1.9%	1.7%
Total	22,173,747	22,746,502	24,810,370	26,953,656	29,325,755	2.6%	2.3%	2.0%	1.9%
Aircraft Operations									
Air Carrier	400,819	409,357	438,230	469,999	501,066	2.1%	1.8%	1.6%	1.5%
Air Taxi	117,378	118,994	123,291	127,823	131,798	1.4%	1.0%	0.9%	0.8%
Subtotal	518,197	528,351	561,520	597,822	632,864	2.0%	1.6%	1.4%	1.3%
General Aviation	24,869	24,935	25,134	25,386	25,639	0.3%	0.2%	0.2%	0.2%
Military	2,676	2,676	2,676	2,676	2,676	0.0%	0.0%	0.0%	0.0%
Total Operations	545,742	555,962	589,330	625,884	661,180	1.9%	1.5%	1.4%	1.3%
Peak Hour Operations	114	116	*	*	*	1.8%			
Cargo/Mail									
Enplaned and Deplaned Tons	154,477	169,152	195,221	224,125	251,111	9.5%	4.8%	3.8%	3.3%
Operational Factors									
Average Aircraft Size (se	eats)								
Air Carrier	144	144	146	147	149	0.0%	0.3%	0.2%	0.2%
Air Taxi	59	59	61	62	63	0.0%	0.7%	0.5%	0.4%
Average Enplaning Load	l Factor								
Air Carrier	83.6%	83.7%	83.9%	84.2%	84.5%				
Air Taxi	80.2%	80.3%	80.7%	81.2%	81.4%				

Source: Airport Statistics data for 2016; InterVISTAS analysis for forecast

^{*} Forecast peak hour was only estimated for 2028 (Build Year) and 2033 (Build Year +5). See Table 1-1.

Comparison of EIS and TAF Forecasts – FAA Template

	Year	EIS	FAA TAF	EIS vs TAF
Passenger Enplanements				
Base Year	2016	22,173,747	21,900,456	1.2%
Base Year + 1	2017	22,746,502	22,231,446	2.3%
Base Year + 5	2021	24,810,370	24,283,346	2.2%
Base Year + 10	2026	26,953,656	26,714,161	0.9%
Base Year + 15	2031	29,325,755	29,301,711	0.1%
Commercial Operations				
Base Year	2016	518,197	521,304	-0.6%
Base Year + 1	2017	528,351	532,647	-0.8%
Base Year + 5	2021	561,520	578,313	-2.9%
Base Year + 10	2026	597,822	632,765	-5.5%
Base Year + 15	2031	632,864	691,018	-8.4%
Total Operations				
Base Year	2016	545,742	548,653	-0.5%
Base Year + 1	2017	555,962	560,057	-0.7%
Base Year + 5	2021	589,330	605,921	-2.7%
Base Year + 10	2026	625,884	660,623	-5.3%
Base Year + 15	2031	661,180	719,127	-8.1%

Source: Airport statistics data for historical; U.S. DOT T100 data; InterVISTAS analysis for forecasts.

FAA TAF: https://www.faa.gov/data_research/aviation/taf/

Note: TAF has been converted to Calendar Years for comparison.

Gating Analysis

Charlotte Douglas International Airport Environmental Impact Statement

PREPARED FOR

FEDERAL AVIATION ADMINISTRATION

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IN ASSOCIATION WITH



5/8/2019

Record of Changes/Version History

Change/ Version Number	Date of Change	Sections Changed	Description	Person Entering Change
1	10/17/2018	All	Draft #1	VHB, TransSolutions
2	4/30/2019	All	Draft #2	TransSolutions
3	5/8/2019	All	Final	VHB, TransSolutions

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Gating Analysis Approach and Assumptions

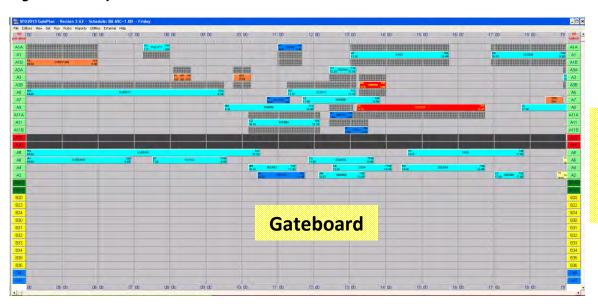
The objectives of this study were to quantify the gate requirements for the CLT EIS flight schedule forecasts for 2016, 2028 and 2033 and to verify if the number of gates identified in the Airport Capital Enhancement Program (ACEP) is still valid. This memo documents the assumptions and approach used in the gating analysis.

1.1 Approach

TransSolutions utilized a gating tool, GatePlan® for this study. Gate characteristics such as aircraft size constraints, assigned airlines, and flight origin (domestic and international) were considered and implemented into the tool. Each flight was gated, adhering to the parameters built into GatePlan®, producing a gateboard similar to that shown in **Figure 1-1**, with gates from top to bottom and the time or hours from left to right. As flights are assigned to gates, they appear in the gateboard, displaying the flight arrival time and departure time.

Parameters used included gate buffer times between flights, minimum gate occupancy times based on domestic versus international flights, splitting flights that have 3 hours or more of ground time to free up contact gates and use hardstand positions. These are described in more detail in the sections below.





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For this gating analysis, the gates were categorized as regional jet, narrow-body aircraft and widebody aircraft so that the gate requirements could be quantified regardless of the specific terminal layout. Gate requirements were also identified as international-only, domestic-only, or swing gates capable of accommodating both international and domestic arrivals.

1.2 Flight Demand

The flight demands that drive this study are based on the 2028 and 2033 forecasts developed for the Environmental Impact Statement (EIS). Table 1-1 summarizes the Average Day Peak Month (ADPM) current and projected commercial passenger flights at CLT in the future.

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Table 1-1 Current and Projected Daily Commercial Passenger Operations

Forecast Years Operations 2016 2028 2033 Arrival 737 880 937 Departure 737 880 937

Source: CLT 2035 Activity Forecast, InterVISTAS, June 2017

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Table 1-2 summarizes the commercial passenger flight schedule fleet mix for 2016, 2028, and 2033.

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Table 1-2 **Current and Projected ADPM Commercial Passenger Fleet Mix** (Daily Operations Count)

	2	016	2	028	2033				
Aircraft Group	Arrivals	Departures	Arrivals	Departures	Arrivals	Departures			
Regional Jet	398	398	481	481	494	494			
Narrow-body	330	330	388	389	431	432			
Widebody	9	9	11	10	12	11			
Total	737	737	880	880	937	937			

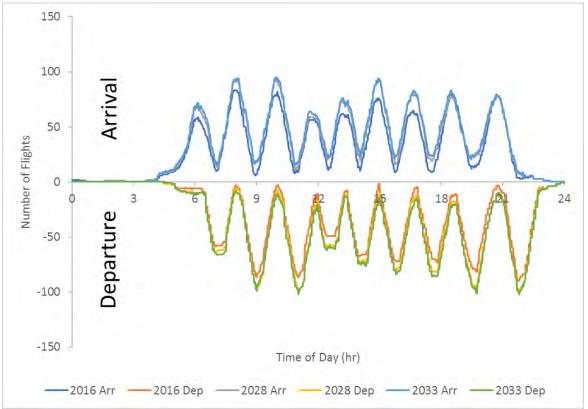
17 18 Source: CLT 2035 Activity Forecast, InterVISTAS, June 2017

19 20 Figure 1-2 illustrates the rolling 60-minute commercial passenger arrival and departure operations at CLT.

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Figure 1-2 **Rolling 60-Minute Commercial Passenger Flight Profile**



Source: TransSolutions analysis of EIS forecasts CLT EIS Study, 2018

The majority of the flights in the design day flight schedules were routed, meaning that the arriving and departing flights were paired, or matched. For flights with less than three hours' ground time, the average ground time was 62 minutes (58 minutes for regional and 68 minutes for mainline operations). Approximately 15-percent of the flights have a ground time longer than 3 hours.

1.3 Assumptions

To quantify the number of gates required to accommodate the flight schedules, the analysis assumed there are no adjacency constraints between nearby gates.

International flights must be programmed to arrive at an international-capable gate, while international departure flights may depart from any gate. Note that arrivals from airports with United States (U.S.) preclearance facilities do not require an international gate. In the CLT flight schedules, there are flights from the preclear airports of Aruba (AUA), Bermuda (BDA), Dublin (DUB), and Montreal (YUL).

For domestic flights, a minimum of 15 minutes "buffer" time was used so that at least 15 minutes was planned between the departure from a gate and the subsequent arrival to the gate. For international flights, American Airlines Operations at CLT identified that the "buffer" time used should be at least 20 minutes (email received from Rodney Frascht, April 3, 2019).

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To maximize utilization of each gate, flights with longer than three (3) hours of ground time were assumed to be towed to a hardstand as necessary. For the flights that were not matched, or those that were towed to/from a hardstand, the gate occupancy times in **Table 1-3** were used. These times were confirmed with American Airlines Operations personnel at CLT.¹

Table 1-3 **Gate Occupancy Times (in minutes)**

	Domest	ic Flights	Internatio	onal Flights
Aircraft Type	Originating/ Pull	Terminating/ Push	Originating/ Pull	Terminating/ Push
Regional Jet	50	35	55	50
Narrowbody	65	40	85	55
Widebody	70	50	130	75

Source: American Airlines Operations, CLT.

1.4 Gating Scenarios

Gate requirements were quantified for both 2028 and 2033 schedules for two gate assignment policy scenarios as described below. A scenario (Scenario 1: All Gates Shared), where all gates would be shared (common use) for all carriers, was identified but not analyzed as it was not considered to be a realistic planning option.

Predominant carrier - domestic and international. In this scenario (Scenario 2: AA Gates Dedicated; OA Gates Shared), each gate was used by the primary carrier American Airlines (AA) or by other airlines (OA). Results estimated the number of gates for these 12 categories:

- > AA Widebody international
- AA Widebody domestic
- AA Narrowbody international
- AA Narrowbody domestic
- AA Regional international
- > AA Regional domestic
- AA Widebody international
- OA Widebody international
- OA Widebody domestic
- OA Narrowbody international
- > OA Narrowbody domestic
- OA Regional international
- OA Regional domestic

If the international gates could be used for domestic flights at other times of day such that the overall domestic gate requirement is reduced, the international gates were designated as swing gates.

Email received from Rodney Frascht, FAA, April 4, 2019.

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Dedicated airline gates - domestic and international. In this scenario (Scenario 3: All Gates Dedicated), each gate was dedicated for an individual airline; no sharing of gates by multiple airlines was allowed. The results show the number of gates for the same categories as above, but the "OA" gates were split for each airline forecasted to operate at CLT. As in the above scenarios, international gates were designated as swing gates if it reduced the overall gate requirements.

Table 1-4 summarizes the gating scenarios considered in this study.

Table 1-4 **Gating Scenarios**

Scenario	Dedicated Gates by Airline	Domestic/ International	Aircraft Type (NB, WB, Reg)	Demand Year
Scenario 2: AA Gates Dedicated; OA Gates Shared (Predominant carrier – domestic or international operations)	Only for AA	√	√	2028 2033
Scenario 3: All Gates Dedicated (Dedicated airlines – domestic or international operations)	√	√	✓	2028 2033

NB: Narrowbody WB: Widebody Reg: Regional

The total number of contact gates and hardstands required to accommodate the ADPM flight schedules are reported in Chapter 2. The requirements ensure that all flights are gated, with the most efficient gate assignments, in other words using the fewest number of gates such that all flights are assigned to a gate. All gates used at any point in the day are counted in the totals. The requirements are reported by aircraft type and by airline (if relevant), along with number of operations or turns per gate per day for each of the two different scenarios.

Gating Analysis

2.1 Gating Solutions

The gating solutions from GatePlan® showing the total number of contact gates required by each of the defined 12 categories are summarized below in Table 2-1. Note that the solution for AA was the same in both scenarios.

Table 2-1 **Gating Solution Summaries**

Scenario 2: AA Gates Dedicated; OA Gates Shared

			AA G	ates					OA G	ates			
		Internation	nal		Domestic			Internation	al		Domestic	:	
Planning	Wide	Narrow		Wide	Narrow		Wide	Narrow		Wide	Narrow		Total
Year	body	body	Regional	body	body	Regional	body	body	Regional	body	body	Regional	Gates
2016	6	6	0	0	40	50	1	0	0	0	5	5	113
2028	6	8	0	0	43	61	1	0	0	0	6	8	133
2033	6	8	0	0	46	62	1	1	0	0	10	6	140

Scenario 3: All Gates Dedicated

			AA G	ates					OA G	ates			
		Internation	al		Domestic			Internation	al		Domestic	:	
Planning	Wide	Narrow		Wide	Narrow		Wide	Narrow		Wide	Narrow		Total
Year	body	body	Regional	body	body	Regional	body	body	Regional	body	body	Regional	Gates
2016	6	6	0	0	40	50	1	0	0	0	8	9	120
2028	6	8	0	0	43	61	1	0	0	0	10	11	140
2033	6	8	0	0	46	62	1	1	0	0	17	9	150

In each of the scenarios, one swing gate was used for AA's DUB arriving flight, which was gated at an international gate even though it is from a TSA Preclearance airport and could be accommodated at a domestic widebody gate. No other domestic flights were accommodated at international gates.

The number of operations per gate in each scenario for each year is shown in **Table 2-2** below.

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Table 2-2 **Operations Per Gate**

Number of Operations Per Gate

Planning Year	Scenario 2: AA Gates Dedicated; OA Gates Shared	Scenario3: All Gates Dedicated	Difference Between Scenarios
2016	7.13	6.69	0.44
2028	7.27	6.96	0.31
2033	7.32	6.85	0.47

As part of the gating analysis approach, some flights that were on the ground for more than three (3) hours were designated to be towed to a hardstand position. Additionally, for any gates that had multiple terminating flights, the earlier arriving terminating flights were accounted for at hardstand positions. Similarly, for any gates that had multiple originating flights, the later departing flights were accounted for at hardstand positions. A summary of the total number of hardstand positions needed for these two scenarios is summarized in Table 2-3.

Table 2-3 **Total Position Requirements**

Total Positions Required

	-	Scenario 2:		Scenario 3:										
	AA Gates I	Dedicated; OA G	ates Shared	A	III Gates Dedicate	ed								
Planning Year	Contact Gates	Hardstand Positions	Total Positions	Contact Gates	Hardstand Positions	Total Positions								
2016	113	33	146	120	32	152								
2028	133	36	169	140	35	175								
2033	140	32	172	150	29	179								

Note: Each hardstand positions were assumed to be able to accommodate any size aircraft.

The number of hardstand positions changes as the number of contact gates change due to a change in the fleet mix which alters the aircraft remaining overnight that can be accommodated at contact gates rather than at hardstands. Additionally, under the All Gates Dedicated scenario, fewer flights with ground times of more than 3 hours need to be split and moved to hardstand positions.

2.2 Gate Assignment – Gateboards

The gateboards showing the gate assignments for each scenario are included in **Appendix A.**

The following bullets provide information needed to interpret that gateboards,

- > The gate names on the far left are for labeling purposes only and do not identify any actual current or future gates. The yellow gates represent domestic gates and the blue gates represent international gates.
- > The gate assignments are separated by solid black lines; each grouping represents one of the following.
 - AADO AA Domestic
 - AAIN AA International
 - OADO OA Domestic

1	 OAIN – OA International
2	HS - Hardstands
3	For the individual flight pucks, the following color scheme applies
4	 Blue – Regional Jets + Turbo props
5	 Green – Narrow body
6	Orange – Widebody

2.3 Conclusion

The gating analysis shows that the number of contact gates and total positions required consistently grows as both the schedule grows and as the more restrictive requirements are applied in the All Gates Dedicated scenario.

For the 2033 schedule, in the All Gates Dedicated scenario, 150 contact gates are required as well as an additional 29 hardstand positions for a total of 179 positions.

The number of operations per gate is notably higher in the scenarios that allows sharing between airlines with between 0.3 and 0.5 more operations per gate per day in the less restrictive scenarios.

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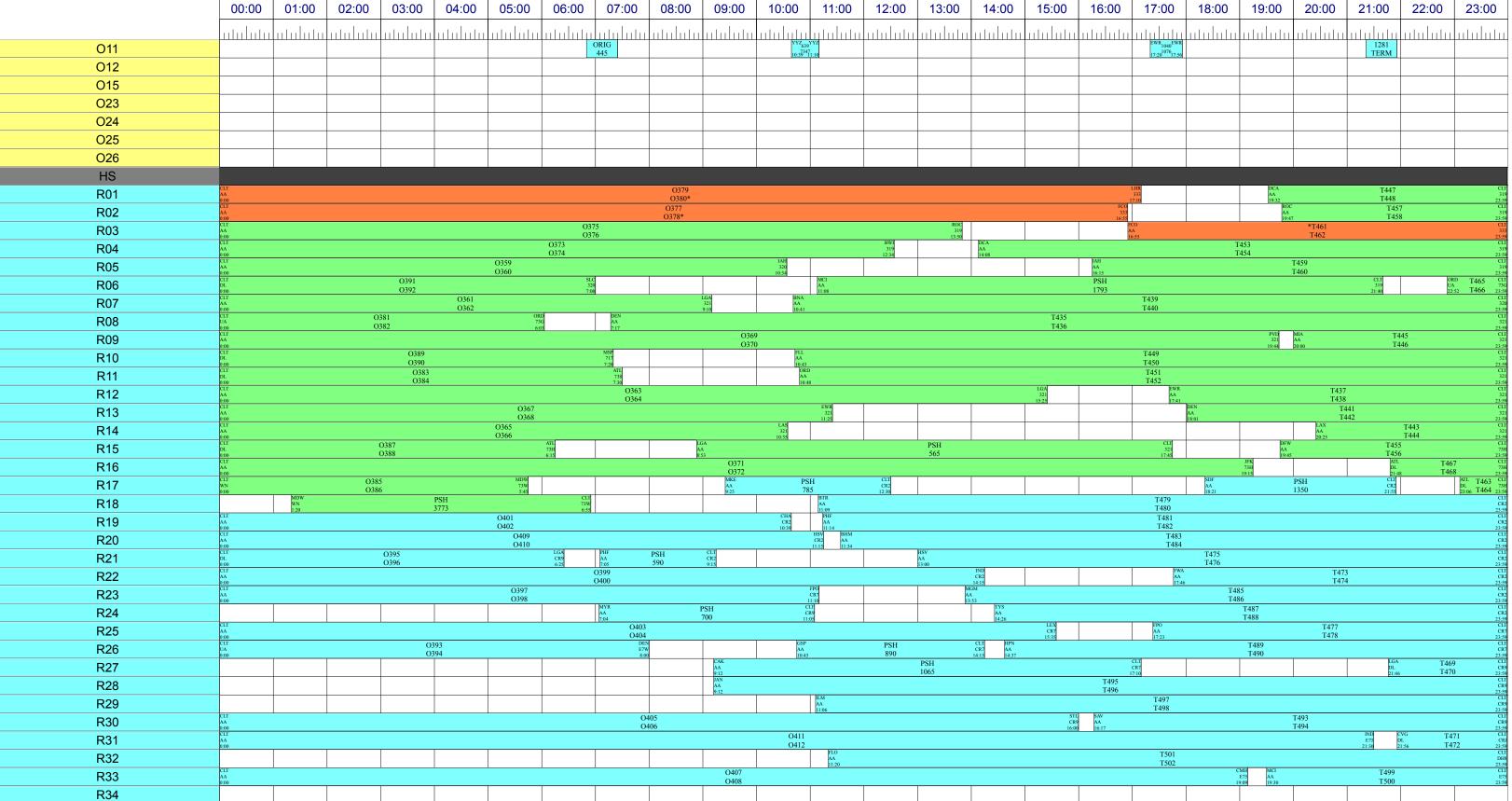
Appendix A: Gateboard Scenarios

CLT 2016 Gating Scenario 2

Date.04/11/2019 1IIIIe.13.00							CL	LT 2016-S	cenario 2												Page # 1 01
	00:00 01:00	02:00	03:00 04:0	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00 23:00
	lutulutulutulutu			1																	
AADO																					
A21					BWI 3	396 JFK 320 450 7:30	EWR 475 AA 560	PBI 320	MSY AA 10:24 71	4 STT 320	TPA 726 BC AA 3: 12:06 790 13:	OS TPA 121 AA	808 MSP 320 890 14:50	FLL 905 ATL AA 959 320 15:05 959 15:59			BWI AA	1119 1220	FLI. 320		
A22					6:36 4	150 7:30		9:20 508 FLL 320 590 9:50	10:24 / I	O 11:50	12:06 790 13:	PHL 798	PBI	15:05 959 15:59	R	SW 1015 BWI 320	18:39	1220	20:20	MSP 1264 PVD AA 320	
A23					CLTSC	C4 DFW ORIG 450 7:30	8:28 BWI 500 AA 575		ATL 612	1:19 GCM 320	ATL 722 LG AA 3 12:02 792 13	13:18 865 GA BWI 8	10 FLL		16	6:55 1065 17:45		ATL 1142	SAT 320	AA 1325 320 21:04 1325 22:05 ATL 1276 IAH 320	1349
A24					6:45	450 7:30	CLTSC4 ORIG	MSY	BWI 620 AA 690*	11:25 AUA	JFK 750	O CUN PB	70 14:30 1 832 BWI 320 320 52 890 14:50	MSP 925 AA 985	RSW	IAH 1035 ATL	P	1225 BI 1134	20:25 PHL STT 122		TERM
A25							8:29 554 RSW 50	9:14	SYR 611 MSY	11:30	BOS 724 AA 800)* 13:30 13: MIA	52 890 14:50	15:25 985 SFO 903	16:25 TPA LGA	17:15 ¹⁰⁷⁰ 17:50	LGA 1082 MSY	8:54 1205 20 FLL 1152 AA 1200		79 21:19 21:50 13 LAS AA 1286 1 21:26 1796 2:	65 22:45
A25					LAS	370 LA	8:28 41 S ATL 501	MSP	10:11 663 11:03	632 RSW	12:04 800	13:20 MIA	815 ORD	15:03 984 TPA 92 AA 72	16:24 16:44 7 LAX	1065 17:45 TT 1017	1135 18:55 SMF	19:12 1220	20:20	SEA 1286 F	:25 :SW
					6:10	658 8:0 375 SAN	8:21 560 TPA	7.120		715 320 11:55 PLS	DEN 723 TPA	0RD 80	2080 14:50	15:27 72 MCO 92		6:57 1100 TPA 10	18:20 040 LGA	RDU 1135 RS	N.	21:26 1346 ₂ FLL 1281 LA	2:26 X
A27					PHX 369	170 7:50	493	580 9:40 CLTSC4 LGA ORIG 595	LGA AA 10:00 700*	11:40 IND OF	DEN 723 TPA AA 321 12:03 782 13:02 RD 717 PHX	13:23 87		15:25 63	7 16:45	17:20 11	120 18:40 1 120 18:40 ORD ORD AA	1125 1200 32 1125	.AS SJU	1223 DFW	0
A28					6:09 460	7:40	PUSH 481	9:10 9:55	10:38 690) 11:30 AF	A 780 321 1:57 780 13:00 PHX 726 PI	TT LGA	817 MCO	.GA 900 I	тих	17:45	565 18:30 AA 18:45	; 643 ₂₀	321 AA 0:05 20:23 PHL	1330 321 22:10 1240 PHX	
A29				CLTSC4	PDX AA 6:14 46	65 321 7:45 ORD	8:01 585 ORD 50	9:45	BOS AA 705 PHL 605	321 11:45 MBJ	PHX 726 PI AA 789 32 12:06 789 13:0	21 AA 09 13:37 MCO	885 321 14:45 825 PHL	GA 900 II 5:00 975 II AX 900 PHL	321 5:15 SFO	1006 ORE	P	PHL 1145	DFW T	472 321 PA 1252 BOS	
A1				CLTSC4 ORIG 5:15 360 6:1	0.20	475 321 7:55	8:20 68		10:05 690*	321 11:30 635 FLL	MIA 734 I	DFW DF	885 321 W 832 JFK	5:00 559 16:05	AA 16:46 PIT	1908 321 18:00 TL 1017	LAS	19:05 844		A 321 0:52 1335 22:15 JFK 1262 DT	v
A3					SMF 362 6:02 408 SAN 364	321 7:30 SFO	RDU 482 8:02 565*	321 9:25 02 SEA		635 FLL 321 715 11:55	MIA 734 I 12:14 1878 I DFW 747	321 AA 13:15 13:	52 895 321 52 895 14:55	DEN 924 AA 995 DFW 920	321 16:35 FLL M	6:57 1090 1 IA 1014 SI	321 18:10 FO SAI	N 1129 C	PRD	AA 21:02 1340 32 LGA 1264 SF	0
A5					AA 6:04 450 SLC 370	321 7:30 LAX	8:22 58	514 SJU	AA 0 10:32 71 MIA 62	32 PUJ 321 10* 11:50 9 DEN	AA 12:27 804 MCO 724 MCO 321	13:24	830 TPA	AA 920 15:20 984 PHX 9	321 A. 16:24 16	3 :54 1085 18: BOS 1020	21 AA :05 18:	49 1205 ₂₀	321 0:05	AA 1204 32 21:04 557 22:2 PHX 1276 I	1 0 EN
A7					6:10 1993		AA 8:34 LAS 490	590 9:50 PUJ	DTW 611	1 321 11:45 CUN	12:04 781 13:01	DEN 801	60 890 14:50		05 321 05 16:40	AA 1020 17:00 1090 1 FLL 1020	321 18:10 SEA	AS 1135	MSP	AA 1276 21:16 1345 2: MCO 1263 BDL	321
A9					МСО	404 LGA	8:10 565* PBI 5	7.120	AA 685* BDL 63	321 11:25	PIT 725 CLE AA 319 12:05 785 13:05	AA 801 13:21 860 BOS 81	14:20	AA 908 3: 15:08 970 16:1 BOS 909 DF	0 V DFW	AA 1020 17:00 1090 1 991 DFW	321 18:10	8:55 2075 SFO 115	321 20:10 4 BOS	AA 1203 321 21:03 1329 22:09 SFO 1273 MCO	
A11					AA 6:44 CLTSC4, MIA	404 32 479 7:50		75 9:35 CUN	10:31 70)5 11:45	8NA 718 AUS	AA 81 13:30 86 PHX 81	5 14:25	AA 909 31 15:09 970 16:1		060 321 .060 17:40 MCO 1036	DEN	PHX 1154	9 20:29	21:13 1339 22:1 LAX 1269 FLL	9
A13					CLTSC4 MIA 6:15 420 7:00		8:10 490 8:10 565* MCO 490	321 9:25 SFO	RSW 613 10:13 685 MCO 613	321 A. 11:25 11	1:58 774 12:54	JFK 81		AA 905 321 15:05 960 16:00 MIA 916	ORD	1036 17:16 1105		19:14 1975	321 20:20 1175 LGA	1269 12109 1330 22:10 1270	
A12							8:10 564 PHX 491	321 9:24 MCO	10:13 2053 ₁	321 11:20 ORD	IAH 731 12:11 100 EWR 743	73H 13:19 EWR DTW	925 STI	MAA 916 15:16 1453 EWR 905	73H 16:25 MIA	PHX 1033	1091 18:11 1150	19:10 19:35	1240 20:40	TERM PVD 1280 DCA	
A10					200	7	AA 8:11 559	321 9:19	TPA 618 AA 685	321 11:25	AA 12:23 806 BDL 729 RDU		825 STL 880 319 880 14:40	AA 985	73H 16:25	17:13 678	321 18:16	LGA 1160 AA 1220 19:20 1220	321) 20:20	AA 1280 319 21:20 1334 22:14 DFW 1272 MSP	
A8					397 TER		AA 8:43	523 BOS 321 585 9:45	MSP 626 AA 690	11:30	12:09 784 13:04		07 MSY 319 75 14:35	CLTSC4 LG ORIG 15:25 970 16:1		050 17:30		TPA 1147 AA 1205 2	321	21:12 1330 321 21:12 2330 22:10	
A6					ATT	T 442 AT	8:50	SC4 ORD 575 9:35	DFW 63 AA 70	00 11:40	FLL 739 I AA 12:19 1950 1 PVD 748	319 13:15	JFK 840 AA 2249	FWR IND 93 73H AA 15:15 15:30 10	00 319 00 16:40	1021 TERM		MCO 1139 PHX AA 321 18:59 1195 19:55	1105	DEN 1278 TPA AA 321 21:18 1335 22:15	
A4					AA 6:52	1L 412 AT 32 480 8:0	ORF 509 AA 555 8:29 555	9:15	TERM	LAS DCA	12:28 800	13:20 13:39	819 SAT 319 880 14:40	PDI 000	DTW	1041 TERM			1185 FERM	MIA 1273 EWR 73H 21:13 1384 22:15	Mal
A2					AA 6:17 4	377 MCI 319 470 7:50	AA 8:46	526 DFW 321 569 9:29	CLTSC4 ORIG 10:35 680 1	AA 11:20 11:52	712 RIC 319 765 12:45	13:31 8	11 BDL 319 70 14:30	BDL 902 AA 990	319 16:30	lavo	CTI	1160 TERM	lawa	ORD 1287 AA 1277 21:27 1277	73H 22:30
B1					- Inn	nout	lun.	\mathrew (1)	CLTSC4 ORIG 10:35 680 1	11:20	CHS 745 AA 795 1		317 RDU 319 370 14:30	RSW 903 AA 990	319 16:30	IND AA 17:11 1105	319 18:25	1132 TERM	AA 20:36	1236 JFK 73H 1608 22:10	
B3					1PA AA 6:46	406 RDU 319 470 7:50	8:30 14	10 MIA 73H 48 9:30	603 TERM	CLTSC4 EV ORIG EV 11:25 730 12:	2:10	MS AA 13::	Y 831 PIT 319 51 895 14:55			lesso		19:4	1185 STL 319 5 1233 20:33	SYR AA 1264 ROC 319 21:04 1336 22:16	
B5						DCA 422 PI AA 479 7:50	EWR 496 JF AA 2529 9:0	3H 06	608 TERM		ORF 743 II AA 792 I3	319 A 3:12 1	319 3:56 895 14:55	BWI 915 AA 980	319 16:20	AUS 1035 17:15 1105	18:25	19.4	ORIG PVD 1229 20:29	RDU 1257 C AA 1345 22	11.8 319 325
B7					RIC AA 3: 6:34 4:	394 BDL 319 7:30	DTW 488 B 8:08 550 9	319 9:10		12 DFW 73H 30 11:35	LGA 737 ORD AA 785 319 12:17 785 13:05	5	CHS 842 DCA AA 319 14:02 895 14:55	DCA 913 AA 975 10	4CI 319 5:15	MCI AA 17:13 1100		JFK AA 19:09 1390	73H AA 20:10 20:38	1238 1360	RIC 319 22:40
B9							MIA AA 8:47		10:33 7	33 JAX 319 110 11:50		BUF AA 806 13:26 855		15:44	944 BWI 1005 319 16:45	ALB 1021 DT AA 1085 18:		EWR 1156 AA 2483	IAH PIT 73H AA 20:10 20:39	1239 1355	ORD 319 22:35
B11					EWR AA 6:47	407 EWR 73H 465 7:45	0.21	80 9:40	EWR AA 10:02 1458 11:05					JAX 920 AA 979	SYR 319 16:19	BWI 1027 AA 1090 1		115 SFO 321 170 19:30		PBI 1275 SY AA 1340 31 21:15 1340 22:2	R 9 0
B13							PVD AA 8:12 565*	9:25		544 BNA 700 319 11:40		808 TERM		BNA 914 RI AA 31 15:14 969 16:0	99 -		ORD 1 AA 18:04 1	084 IL 200 31 20:0	M 9 10	1299 TERM	
B15					SFO AA 6:14 455	5 7:35	RIC AA 8:15 570*	9:30	BUF AA 10:14 690	NAS 319 11:30				PHL 93 AA 15:37 99	0 16:30	RDU 1024 PW AA 17:04 1085 18:	VM 319 :05	1145 TERM		BUF 1258 ALB AA 1335 22:15	
B16						BOS 432 BN. 7:12 480 8:0	A JAX 9 AA 0 8:17 570	9:30	JAX AA 10:19 695	BWI 319 11:35				ATL 908 JAX AA 319 15:08 959 15:59	JAX AA 16:5	1010 DCA 319 0 1070 17:50		CLTSC4 JF ORIG 19:15 1200 20:0	K 10	ALB AA 21:22 1360	ATL 319 22:40
B14					6:42	402 PVD 455 7:35	MEM AA 8:43	523 RSW 319 595 9:55	628 PUSH									1147 TERM		CLTSC ₄ PULL 21:40 1793 2:	PIT 2:25
B12				CLTSC4 ORIG 5:20 365			BUF AA 8:08 559	319 9:19	10:39	639 ALB 319 715 11:55				DTW 93 AA 15:39 99	9 MSY DO 319 A 0 16:30 16	CA 1014 IAH A 319 :54 1074 17:54		STL 1150 ME AA 1200 20:0	M 9 10	RIC AA 1255 AUS 319 20:55 1330 22:10	
B10				5:	ORIG PHL 395 6:35		IND AA 8:44	524 BDL 319 590 9:50	PWM AA 10:33 699		PHL 719 PHL E90 13:00					CLE 1019 RIC AA 1074 319 16:59 1074 17:54	PIT AA 18:44	1124 PIT 319 1194 19:54		DTW 1255 LGA AA 1324 22:04	1350 TERM
B8						C4 PHL ORIG 450 7:30		0 9:30	PBI 610 PI AA 675 3 10:10 675 11:	HL 19 15				RIC 94 AA 15:41 98		PHL AA 17:16 1733	752 18:20	IAH 11 AA 19:25 12		1285 TERM	
B6					CLTSC 6:45	C4 ORIG DCA 450 7:30		518 NAS 580 9:40	STL 627 AA 690	11:30				935 TERM		NAS 1024 AA 1095	PIT 319 18:15	MSY AA 19:14 1215	319 20:15	DCA AA 21:29 1355	JAX 319 22:35
B4					CLT: 6:50	7:30 FSC4 FLL ORIG 7:35	8:35 5	515 IAH 575 9:35	SAT AA 10:39 70	39 MCI 319 00 11:40				MSY 930 BNA AA 936 319 15:30 966 16:06 NAS 910 AA 15:10 989				RIC 1151 19:11 1206 2	1PA 319 0:06	1272 TERM	
B2							ILM 484 PHL AA 1839 9:00		ROC 614 CI AA 674 31 10:14 674 11:1	15 19 14	CLTSC4 ORIG 12:34			NAS 910 AA 989	319 16:29			JAX 1155 AA 1210	319 20:10	MSY 1280 1 AA 1345 2:	319 :25
C2							CLE 510 AA 8:30 564	0 MEM 319 4 9:24	PIT 620 I AA 10:20 680 1	319 11:20		CL1 13:5	SC4 ROC ORIG 0 875 14:35					BDL 1147 MG AA 1200 20:0	9 9	IAH 1270 PBI AA 1331 22:11	
C4						CLTSC4 BOS ORIG 470 7:50	STL AA 8:51	531 PIT 319 585 9:45	ALB AA 10:23 680 1	319 11:20								BNA 1164 19:24 121:	BUF 319 20:15	MCI AA 21:40 1360	ORF 319 22:40
C6																					
C8																					
C10																					
C12																					
C14																					
C16																					
AAIN																					
I1					CI	ORIG MBJ									MB. AA	*1010 TPA 321 0 1073 17:53	GCM *1 AA 18-14 1	1094 BNA 320 189 19:49	CUN *1224 20:29 TERM		
12					6::	CLTSC4 PUJ ORIG PUJ 7:05 475* 7:55							ME AA	*893 RD	U CUN 0 AA	*1000 BOS 321 1075 17:55	SXM AA	*1120 DCA 320 1185 19:45	PUJ *1216 *1216 20:16 TERM 21:16		
						(7:05 7:55							14:	3 970 16:	u [16:40	1075 17:55	18:40	1100 19:45	20:16 21:0	ш	

	00:00	01:00 02:00 03:00	04:00 05:00 06:00	07:00	08:00 09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00 18:00	19:00	20:00 21:00	22:00	23:00
								<u>ulululu</u>		<u>lutulutu</u>		بيليباييليي	<u></u>	<u> </u>	<u></u>		
13						CLTSC4 OI 10:35						PUJ AA 16:21	*981 EWR 320 1711 18:05	PLS AA 18:55 *1135 1215	MCO 321 AA *1250 20-15 20-50 1350 MIA 321 20-15	BWI 320 22:30	
14														MBJ *1136 AA 1215	MIA 321 20:15		
I5													PUJ _{*1062} SAN 17:42 ¹⁰⁹ 58:15	*1120 PBI AA 321 18:40 1195 19:55	SXM *1224 20:24 TERM 21:09		
l6													ME AA 18:	*1115 MDT 319 35 1189 19:49			
17																	
18																	
I10												LHR AA 16:15	*975 732*		LHR 333 20:15		
I11									, ,	CDG AA 13:55		*835 100*	CDG 332 18:20				
l12									DUB AA 13:05	785 704*	_	FRA 332 16:35	CLTSC4 ORIG FCO AA 333 16:55 1105* 18:25				
I13											MAI AA 15:5	o *9	950 DUB LHR 332 AA 24 18:05 18:30	*1110 CLTSC4 333 TERM 19:30			
l14									FRA AA 13:00	*780 748*		332 16:40	CLTSC4 ORIG LHR AA 1120* 18:40				
l15											A. 15	CO *955 CLTSC4 A 333 ::55 TERM 16:55	BCN AA 18:20	*1100 1245*	BCN 332 20:45		
OADO	ATT		CUTSCL OPP	CUTTOCA	ATI DATE DATE			477	ATT		NEW	NAME OF THE PARTY	DTW AT		ODD 12 12 ODD		
O1	DL 0:22	22 823	ATL M90 ORD ORIG ORD 6:38 6:48	7:30 CLTSC4 Pari	8:15	HIV Had	ATL 676 ATL 717 11:162251 12:00	ATL 753 DL 753 12:33 1095	5 13:15 ATL DL 5 13:15 13:42	822 ATL 320 2597 14:30	DEN 897 JA 1199	320 DL 16:40	1000 DTW DL ATL 1070 ATL 1070 M8. 1524 17:20 17:50 826 18:4.	ATL 1149 5 19:09 1407 2	ATL ORD 1243 ORD 59 20:42 1290 21:30	1346 TERM	14 TE
O2	PUS	0 SH	CLTSC4 MW C	CLTSC4 BWI PULL BWI 5:55 7:40	ATL 528 ATL DL M88 8:48 2422 9:30	JFK 601 JFK B6 E90 10:01 218 10:40	noe nod	DTW	PHI F9 13:	L 830 MCO 321 49 890 14:49	DTW 0 DL 15:40 1	940 MSP 319 793 16:30 16	DW ₁₀₁ MDW HOU ₁₀₇₅ HOU ::50 ¹⁰⁴⁵ 17:25 17:55 ¹⁴⁹³ 18:30	18:55 1721 19:30	TTN 1225 TTN F9 20:25 932 21:10	1332 TERM	1387 TERM
O3			CLTSC4 _{GRIG} IAH CLTSC4 _{GRIG} ATI 5:05 350 5:50 6:15 420 7:00	CLTSC4 N ORIG 0 7:20 485 8	MSP ORD 566 UA 9:26 521	73G 10:15	BOS B6 659 E90 10:59 696 11:36	DTW 727 DTW DL 319 12:07 1629 12:50	OPD GTT CON	MSP 864 MSP 14:24 1503 14:59	ATT	ATL 978 AT DL 978 M8 16:18 2651 17:0	TL BOS 1038 BOS B6 E90 17:18 1446 18:00 1	1120 ^{DT W} 1120 ^{DT W} 18:40 ¹¹⁵⁵ 19:15	1268 TERM		1399 TERM 1400 TERM
O4			DEN 310 F9 200	319 7:20	BWI 575 9:35 ^{305:}			McO -	ORD 780 ORD UA 319 13:00 1140 13:45		ATL 904 ATL M88 15:04 2133 15:45			JFK B6 1130 E90 18:50 19:28			1400 TERM
O5			CLTSC4 _{RIG} DTW 5:15 360 6:00	CLTSC4 ORIG 7:00 465 7:45		ATL 603 ATL M90 10:03 1454 10:45		MCO 743 F9 805	321 13:24								
O6																	
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O31																	
O32																	
OAIN												MUC	*ARA MIJC				
l21												LH 16:20	*980 MUC 346 1115* 18:35				
122																	
AEDO					ORIG 530		ORIG	DIIII	DAY	823 ORF	ORF 007	GSP	1066			PULL	
D13			200		ORIG 530 510 PUSH	LEX	ORIG 5593	PULL 785		823 ORF CR2 880 14:40	ORF 907 AA 985 SDF 912	CR2 16:25 7 MKE	PUSH AVI	HSV		PULL 1350	
D12			390 PUSH	Toward Control	PULL 590 51	AA 10:40	640 780	CR2 13:00 TYS	2 AA 13:4 740	827 CR2 17 881 14:41 BHM	SDF AA 15:17 995 FAY 92		16:55 1110 CR2		240 20:40 AA 20:55 1361	22:41	
D10			AA 357 CR2 5:57 392 6:32 CHO	PHL 418 CAE AA 465 CR2 6:58 465 7:45	8:30 68	0 0 564	CR2 11:20 AGS	AA 12:20 CRW 735	870	CR2 14:30 825 TYS	FAY 92 AA 99 15:26 99 MLB	O 16:30 A 16:30 16		8:38 1190 19:50	AGS 1238 1340 8 GNV PS 1266	CAE CR2 22:20 AGS	
D8			AA 6:23	549	BTR DCA CR2 AA 9:09 9:24 TLH	674 533	CR2 11:14 EVV	$_{12:15}$ 790 $_{1}$	13-10	825 TYS CR2 5 875 14:35		944 JAN CR2 995 16:35 EX 955 VPS	TYS 1030 CAK AA 1084 18:04 CAE 1023 AGS	19:18 122	5 20:25 21:06 1350	22:30	
D6				Е 410 ВНМ	AA 8:53 HPN 502 AGS	695	CR2 11:35 GSP	PGV 725 LEX AA 779 CR2 12:05 779 12:59	AA 13:42 TLH	822 LEX CR2 865 14:25 ORIG	0AJ 022	1005 16:45 MGM	AA 1023 CR2 17:03 1075 17:55	ORF 1123 AGS CR2 18:43 5398 19:45 BHM 11	20:00 1240 20:40 20:58 1335 63 YUL GNV 128	BTR CR2 22:15	
D4			AA 6:51	410 BHM CR2 0 455 7:35 ORIG	HPN 502 AGS CR2 8:22 585 9:45 GS AGS CR2 AA 500 CR2 AGS CR2 R GS CR2 AA 500 CR	YUL AA 10:06 695 CAE 621	CR2 11:35 MYR	12:17 790 1 CLE 725 GNV	CR2 13:10	890	HSV 920 BH	16:19	FAY 1025 GNV AA 1075 CR2	GSP 1120 MKE	25 20:25 21:20 135	30 LEX CR2 55 22:35	
E1			[G	455	8:42 599 9:5	10:21 6/9	11:19 TYS	12:05 //U 12:50 OAJ 725 CHO		CHA 841 VPS AA 880 CR2 14:01 880 14:40 MYR 841 AVL	AA 920 CH 15:20 965 16:0 CHO 930		AA 1023 CR2 17:05 1075 17:55 LEX 1045 CHO	18:49 1184 19:44 YYZ 1157	19:59 1240 20:40 TERM	291 EVV	
E2			AA 6:2	NV412 LEX A CR2 52 450 7:30 DAY 434 CLE AA 470 CR2	8:11 559 9:19	VPS AA 10:06 678		12:05 769 12:40	,	MYR 841 AVL AA 880 CR2 14:01 880 14:40	15:309701		17:25 1095 18:15 BHM 1005 CHA	AA 1137 19:17 1210 EWN 1145 FAY AA 1145 CR2	MEM MLB CHO 1268	TLH	
E3				AA 434 CR2 7:14 470 7:50 CAK 428 CHA	8:21 566 9:26	10:23 680	CR2 11:20 648 SDF CR2	AGS 736 OAJ AA CR2 12:16 780 13:00 CAE 742 FAA	AY AG	PGV 847 FAY AA 847 CR2 14:07 885 14:45	CAE 922 HSV AA 960 CR2 15:22 960 16:00 EVV 923 CAK		AA 1005 CR2 17:45 1105 18:25 MOB MOB ATL SO DSM	19:05 1190 19:50 CRW 1145 FWA	20:05 1245 20:45 21:08 1335	CR2 22:15	
E5			TYS	7:08 463 7:43	8:30 5/5 9:35	AA 10:4 OR	8 700 11:40	AA 742 CI 12:22 785 13: BHM 750	:05	49 865 14:25	EVV CAK AA 923 CR2 15:23 16:00 TYS 937	EWN	AA 1030 CR2 17:10 1069 17:49 AA 1085 CR2 18:05 1125 18:4:	5 1189 19:49 MGM	20:59 1325 22:0 BTR	1295 MOB	
E7			AA 6:24 CHS 378	465 7:45	CAE 501 HSV AA CR2 8:21 549 9:09 FWA 529 MGM AA 529 CR2	67-	4	12:30 790 1	CR2 AA 13:10 13:4	S PHF 2 865 CR2 49 865 14:25 GSP YYZ AA 834 CR2	AA 937 15:37 974	CR2 16:14 GNV 060 BTR	TERM CHA 1041 TYS	MSN 1123 OAJ	1220 20:20 21:35	1295 CR2 1360 22:40 1297 GSP	
E9			6:18 450	0 7:30	8:49 585 9:45 MGM 518 TYS	BTV 621 R AA 665 11: CHA	646 PGV CR2	GNV 745 TYS 12:25 ⁷⁸⁰ 13:00 745	CVG 8	11 HSV	JAN	GNV 969 BTR 16:09 ¹⁰⁰⁵ 16:45 CRW	AA 1041 CR7 17:21 1095 18:15	18:43 1185 19:45	21:37	1257 CR2 1360 22:40 295 CRW CR2	
E11			AA 6:41	401 SAV CR9 465 7:45	AA 316 CR2 8:38 575 9:35 ORIG	AA 10:46 634	690 11:30	TERM	13:31 80	65 14:25 T 921 AUS	940 975 15:40	OCRW 5 _{16:15} 913	TERM DAY	18:52 1194 19:54 OAJ 1133 SDF	21:35	355 CR2 322:35	
E13					550 ORIG	TERN	M	12:28 8	14 13:34 13	1:51 885 14:45 R17 CHA	AA 15:13 CHA	1080	CR7 18:00 HSV 1058 PHF	18:53 1189 19:49	HPN 1250 ORF AA 1250 CR2 20:50 21:30 LEX ₂₉ CA	TERM	
E15			ORF 20	7 CVG	585	63 TER	659	CHO 732 AV AA 785 CI 12:12 785 13:	R7 AA 8	867 14:27	AA 15:40	940 GPT 1000 CR7 16:40	HSV 1058 PHF AA CR7 17:38 1100 18:20 SAV 1029 ILM	IND 1138 CAK AA CR7 18:58 5306 19:45	TYS 1259	OS AVI.	
E17			ORF 38 AA 44	4 CR9 7:24	CRW 496 GNV AA 555 GSO AA 555 DH3 9:15 595 9:55		TERM			PULL 890			SAV 1029 ILM CR9 17:09 1105 18:25		AA 1259 20:59 1345	CR7 22:25	

Date:04/11/2019 Time:13:00							CL	_T 2016-S	cenario 2											Pa	ge # 3 of 4
	00:00 01:00	02:00	03:00 04:00	05:00	06:00	07:00	08:00	09:00	10:00 11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
						n Industri								1	ntulutu				lutulutu		
E19				41111111111		404 CHS CR9 460 7:40	FAY 52 AA 8:40 56	O CRW CR2	SGF 609 SGF AA ER4 10:09 650 10:50 11:05 700 11:40	JAX 730 DTW AA 780 CRS 12:10 780 13:00	798 TERM		AVL 929 OA AA 929 CR 15:29 974 16:1-		OMA AA 17:06 1100	SAV CR9	LEX TYS AA 1156 CR7 19:16 5221 19:56		GPT 1270 AA 1334	SRQ CR7	
E18						O 412 RIC CR9	PHF 490 AA 560	GPT CR7	MSN 645 PHF AA 705 11:45	RDU 739 AA 795	CAK CR9	831 TERM	PIT 924 AA 990	LIT CR9	DTW 104 AA 117:22 111		19:16 19:56	1	PHF 128 AA 125 21:26 135	66 PHF CR7	
E16					OF 44	RIG 400 7:40	517 PUSI	9:20	OAJ 646 FLO AA DH3 10:46 693 11:33	12:19 775	13:15	TERW	CMH 921 ILM AA 975 15:21 969 16:09	16:30	PULL 1065		1120 CVG CR9 1185 19:45		130 TER	0	
E14					LYH 38	82 OAJ DH3 60 7:40	OAJ 493 AA 560	CVG CR7	IND 646 CMH AA 705 11:45		JAN AA	827 HPN CR7 7 873 14:33	ORIG 970		SYR AA 17:16 1100	CHS ME	M 1130 CHS CR9 50 1184 19:44	GSP AA	1199 1365	GSO CR9	
E12					EWN	395 FAY DH3 7:40	AVL AA 501 8:21 559	CHO CR7 9:19	ROA 621 HHH	IAD 749 AA 800	9 BNA	842 TERM	STL 9	13 PNS CR9 04 16:44	ILM 1034 OI AA 1085 18:	RF R9		166 MSY GSC CR9 230 20:30 20:4	1245	SAV CR9 22:30	
E10						ROA 424 GSO AA 470 DH3 7:04 470 7:50	SDF 51		GSO 630 EWN AA DH3 10:30 715 11:55			812 ILM CR9 875 14:35	DAY 914 SAY AA 974 16:1-		K 1013 GSP CR9 1070 17:50		SAV 1140 OR AA 1200 CR 19:00 1200 20:0	RF R9	ILM 1263 AA 1355	CHS CR9 22:35	
E21							HSV 51 8:33 57	13 JAN	SAV 638 AA 10:38 779				MHT 902 TLH AA CR9 15:02 959 15:59	D A	OSM 1018 CLE LA CR9 6:58 1070 17:50	PN AA 18:	S 1130 GRR CR9 50 1185 19:45		1270 TERM		
E23						ORIG 449	SRQ 484 TLH AA 540 9:00	SBY 555 AVL AA 555 DH3 9:15 590 9:50	BHM 613 BHM AA CR9 10:13 695 11:35	FAY 730 CHS AA CR9 12:10 774 12:54	CAK 80 AA 86	08 IAD CR9 55 14:25	MDT 907 CMH AA CR9 15:07 959 15:59		RIC 1039 1 AA 17:19 1090 1	BNA CR9 8:10	TYS 1141 SAV AA CR9 19:01 1195 19:55		1265 TERM		
E25						399 HHH 455 DH8 7:35	TYS 502 8:22 555	LIT CR9 9:15	TUL 620 DAY AA CR9 10:20 695 11:35	MYR 735 MYR AA CR9 12:15 779 12:59	al 113-33 8	13 CMH CR9 64 14:24	OKC 914 SDF AA CR9 15:14 965 16:05	PVD AA 16:5	1011 SRQ CR9 1 1060 17:40	DAB 1080 OKC AA CR9 18:00 1125 18:45		1176 CLE CR9 1230 20:30	21:25 13	285 MYR CR9 22:40	
E27					389 PUSH		MDT 488 C1 AA 1 8:08 550 9	MH E75 9:10	610 PULL PUSH 700	MEM 727 SYR AA CR9 12:07 770 12:50	SRQ AA 13:37	817 SAV CR9 14:27	BHM 910 IAD AA 960 CR9 15:10 960 16:00		TUL 1028 IAD AA CR9 17:08 1075 17:55	GS0 AA 18:	1129 DAY CR9 19 1180 19:40		ORF 1269 AA 1340	CHA CR9 22:20	
E29					SAV AA 6:36	39 56	96 65	GRR CR9 9:25	CLE 621 MDT AA CR9 10:21 685 11:25	HTS 738 AG: AA 781 DH: 12:18 781 13:0	S AUS 3 AA 11 13:4:	825 CHS CR9 875 14:35	ILM 935 AA 985	GSO CR9 16:25	XNA 1024 CVG AA CR9 17:04 1070 17:50		TLH 1159 AA 1210	GSO CR9 20:10	PNS AA 1255 CR 20:55 1325 22:0	Y 9 95	
E31						ORIG 455	CHS AA 8:09 570	MYR CR9 9:30	OMA 641 PIT AA CR9 10:41 705 11:45	AA 12:29 792	GSP	GRR 845 ATL AA CR9 14:05 895 14:55	IAD 915 DAB AA CR9 15:15 964 16:04		MYR 1039 BH AA CI 17:19 1085 18:	M R9 05	MYR 1140 PNS AA CR9 19:00 1190 19:50		AUS AA 21:05 1335	IAD CR9 22:15	
E33						ORIG 460	GSO AA 8:36	516 JAX CR9 590 9:50	OKC 642 IAD AA CR9 10:42 705 11:45	GSO 738 TRI AA DH3 12:18 779 12:59	5	PNS 836 DTW AA CR9 13:56 885 14:45	CLE 925 CR AA 974 16:1-		PWM 1030 SDF AA CR9 17:10 1074 17:54		CMH 1156 M AA 1205 20		CHS AA 21:00 1350	XNA CR9 22:30	
E35						ORIG 465	IAD AA 8:43	523 IND CR9 595 9:55	AVP AA 618 AVP CR9 10:18 680 11:20	AVL 732 LYH AA 732 DH3 12:12 770 12:50		ORF 836 MYR AA CR9 13:56 885 14:45	CHS 930 T AA 979 16	YS BNA 1 R9 AA 1 19 16:45	045 CR9 AA 17:25 17:46	1066 TUL CR9 1110 18:30	CVG 1166 AA 19:26 1215		21:33 1	293 BNA CR9 360 22:40	
E38						David Control	MSY AA 8:46	526 SDF CR9 590 9:50	DSM 619 GSO CR9 10:19 680 11:20	TRI 743 ROA AA 743 DH: 12:23 781 13:0	A 3 11	MKE 836 ABE AA CR9 13:56 885 14:45	AVP 936 AA 985	XNA CR9 16:25	CHS 1032 MDT AA 1075 CR9 17:12 1075 17:55	vozal	CHS 1143 SRQ AA 1190 19:50		ROA AA 21:00 1350	LYH DH3 22:30	
E36					HI A/ 6::	IHH ROA A 416 DH8 :56 7:30	BNA AA 8:49	590 CR9 9:50	ABE 639 CVG AA CR9 10:39 700 11:40 CVG 640 XNA	LYH 752 F 12:32 13	5:06	IND 841 PNS AA CR9 14:01 890 14:50	MYR 933 C AA 980 16	R9 20	CMH 10 AA 11 17:41	061 CR9 100 18:20	DTW 1144 GSP AA CR9 19:04 1190 19:50	IAD		355 22:35	
E34				1	6:38	398 IND E75 475 7:55	SAV 496 8:16 554	9:14	AA 049 CR9 10:49 710 11:50	12:27 804	4 13:24 13	M 832 MKE CR9 1:52 880 14:40	CVG 914 MEM AA CR9 15:14 960 16:00	VR			MKE 1161 d AA 1205 ₂₀	CR9 0:05	BNA 1: AA 1: 21:34 1.	355 22:35	
E32					AA 6:51	411 DTW E75 465 7:45	8:47	527 PNS CR9 585 9:45	CMH 650 PWM AA 710 CR9 10:50 710 11:50	SAV 727 CHA AA 727 CR7 12:07 770 12:50	eo ene	AA 855 14:19 915	LGA MEM 935 MA 9	20	POA 100	IVII	ABE 1146 OMA AA 1189 CR9 19:06 1189 19:49	DAR	21:39 1	299 LIT CR9 1355 22:35	
E30					AGS 20	O.1. SDF	OR 55		DAY 654 PVD AA 654 CR9 10:54 710 11:50	IND 732 GO AA 785 E 12:12 785 13:	:05 AA 13:40	820 DAB CR9 865 14:25		RIG 995	ROA AA 1036 17:16 1110		SDF 1168 AA 1210	20:10	21:28 1	288 PGV CR2 360 22:40	
E28					AGS 39 AA 45	50 7:30	AA 549 C		SRQ 610 ORF AA CR9 10:10 662 11:02	DTW 742 1	13	V 830 RIC CR9 50870 _{14:30} A 830 ROA	942 TERM		CRW 105 AA 110 17:30 110 EWN 1044	05 18:25	PGV AA 19:15 123	30 DH3 20:30	IAD 1281 T AA 1329 22		
E26					SDF	406 MEM	8:49	580 9:40	XNA 628 OMA AA CR9 10:28 680 11:20 MHT 630 STL	DTW 743 1 AA 790 1	13:10 AA	830 DH3 50 875 14:35 19 CRW	EWN 906 LYH AA 970 DH3 15:06 970 16:10	TRI	AA 1044 17:24 1095 HTS 1038 HE	DH3 18:15	LYH 1139 18:59 1210	DH3 20:10	SRQ 129 AA 121:39 134 CVG 128:	40 _{22:20}	
E24					AA 6:46 CHA 38	406 MEM CR9 470 7:50	DAB 51: 8:35 56: HTS	4 9:24	AA 630 CR9 10:30 680 11:20			59 DH3 59 14:19	15:38 990 LYH 935	DH3 16:30 AVL	AA 1038 DI 17:18 1085 18:	H8 AA 05 18:42	1122 CHO DH3 1189 19:49	TRI	21:22 135	0 22:30	
E22					CHA AA 6:29 45	50 CR9 7:30	AA 8:00 TRI 406 HTS	480 685 YYZ 559 BNA	DH8 11:25 CHS 627 ILM		CRW 805 F	865 DH3 14:25	FLO 920 ROA	DH3 6:24	CHO, on FLO	ROA	19:10 1215	DH3 20:15	JAX 1293 ^{C1} 21:33 ¹³²⁹ 22 MDT 1289		
E20							TRI 496 HTS AA 540 9:00	AA 559 E75 9:19 599 9:59 525 MHT	CHS 627 ILM AA CR9 10:27 676 11:16 MYR 622 SAV		AA 803 E 13:25 845 14	018 :05 CHO	AA 920 DH3 15:20 965 16:05 GSP 933 PG	v	CHO ₁₀₂₁ FLO 17:01 17:35	AA 18:43	1123 ROA 1184 DH3 1184 19:44	FLO	AA 1283 21:29 1340 LIT 127) 22:20 D IAN	
E8							AA 8:45 5	5089 9:30	AA 022 CR9 10:22 670 11:10 FAY 607 ROA		AA 13:42	822 DH8 859 14:19 HHH ₉₂₄ HHH	AA 933 DE 15:33 976 16:1 ROA 941 A	3 6 3S M	DT 1016 IND		19:09 1209	DH3 20:09	AA 127 21:18 135 MYR 1259 CV	5 CR9 5 22:35	
E6							8:38 560		AA 007 DH3 10:07 674 11:14 ORF 647 MEM		BNA	13:56 ⁸⁷⁰ 14:30	AA 941 D 15:41 979 16	19	A 1010 E75 6:56 1070 17:50 GSO 1019 CMH		TRI 1140 SBY DH3 19:00 1190 19:50 FLO	1180 HTS	AA 1235 CR 20:59 1325 22:0 IND 129	19 15 100 MDT	
E4							8:51	580 9:40	10:47 685 CR9 10:47 685 11:25		AA 13:42		959 GSO 930	i	16:59 1070 17:50	ILN	19:40	1230 DH8 1230 20:30	21:39 134	40 _{22:20}	
F1							517 TERM LYH 492 AA 580	M TRI	MEM 643 DSM AA 643 CR9 10:43 680 11:20			RIC 842 OMA AA E75 14:02 895 14:55	GSO 930 AA 987	E75 16:27	MSY 1028 F75 17:08 1079 17:59	TRI	1130 IND E75 1185 19:45		OAJ 128 AA 135 LYH 1286 RO	O 22:30	
F2 F3					C	VG 416 MYR A CR9 :56 460 7:40	RAA 8:12 580 CHO 495 AA 575		TERM						HHH 1051 AA 17:31 1095	5 DH8 5 18:15	ORIG	[LYH 1286 RO AA 1325 DH 21:26 22:0	TRI	
F4					6:	:56 460 CR9	8:15 575 EWN 512 8:32 560	9:35 SBY	HHH ₆₄₇ CRW 10.4\$ ⁷⁹ 11:19 RIC 645 CLE AA CR9 10.45 695 11:35					SGF	1011 SGF		1184 1135 TERM	2	HHH 1275 AA 1340	22:25 HHH	
F5							ORIG	CVG ₅₅₀ CAK	10:45 695 11:35 ORIG 710					16:5	1011 SGF ER4 1 1070 17:50		TERM		21:15 1340 YYZ 128 21:22 135	22:20 32 MSY	
F6							530 FLO 5:	9:10 585 9:45 23 EWN DH3 64 9:24	645 TERM										21:22 135 CMH 1274 Y AA 21:14 1330 22		
F7							CMH 51 AA 56	64 9:24 16 YYZ E75	TERM										ORIG 1325	2:10	
F8							8:36 56	9:27	11:10 715 11:55	<u> </u>									1325		
F9																					
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O7				ORIG 360			ORIG 515	IAD UA 5 9-42 6	182 IAD CVG CVG 150 CR7 11:0696 11:36		LGA 794 LG. DL CR 13:14 3642 14:0	EWR 864 IAH UA 864 E70 14:24 15:02		ORD	006 ORD YYZ 843 17:21 17:4	7349 7349 7349	LGA 1158 LG. DL CR 19:18 6227 20:0	iA 2.7	1271 TERM		1410 TERM
O8				ORIO 369	420		LGA 515 DL 9:25 3840)0.15		BKW VC 12:00		720 1025		BKV EM 17:0		L	AD 1135 IAD 8:55 19:30				1379 TERM
О9					ORIG 425		EWR 514 EV 8:34 ³⁶⁴⁸ 9: BKW BKV 8:35 ⁵⁴⁵ 9:0	VR 1.09	GA 597 LGA LGA 674 LC CI DL CI 11:14 5069 12:	GA R7 :00			LGA 906 LGA DL CR7 15:06 5099 16:00	.7.0	LGA 1032 LGA DL CR7				1281 TERM		1379 TERM
O10						ORIG 460	BKW 515 8:35 ⁵⁴⁵ 9:0	N IS	MSP 632 MSP 10:32 ⁶⁶⁷ 11:07 1	EWR 712 EWR 11:52 3311 12:27			10.00		IAH 1034 LA UA 6285 18:00	AH W 05					
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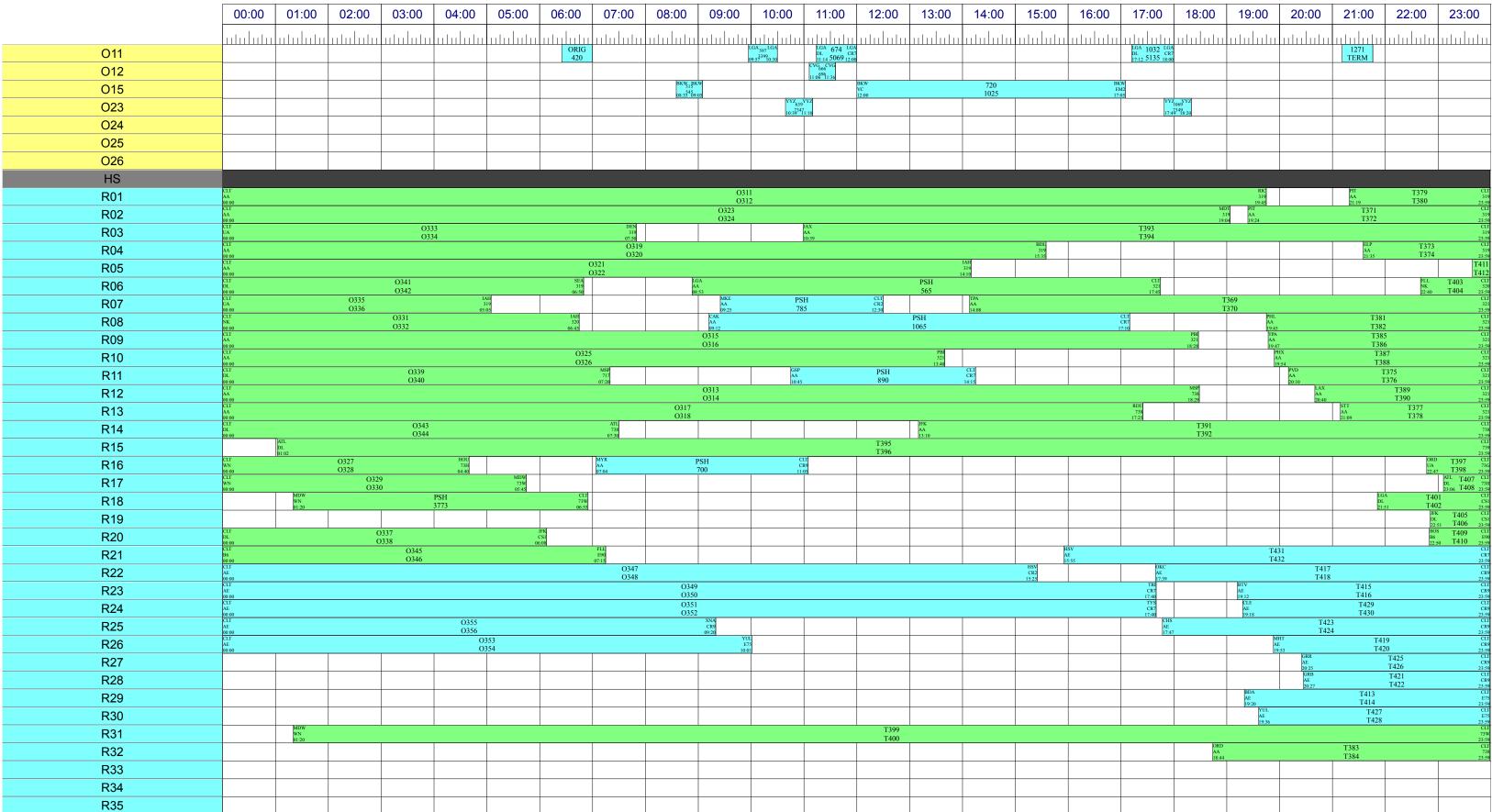


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AADO																						
A21						BWI 396 AA 450 07	JFK EWR 320 AA	475 560	PBI 320	MSY AA	624 STT 710 320	TPA 726 AA 720 12:06 790	BOS TPA 321 AA	808 MSP 320 890 14:50	FLL 905 ATL AA 320 15:05 959 15:59			BWI AA	1119 1220	FLL 320	MCI 1300 AA 1360 21:40 1360	ORF 319
A22						06:36 450 07	7:30 07:55		09:20 08 FLL 320 190 09:50	DCA AA	710 11:50 632 RS 715 11:	12:06 790 1 SW 120	3:10 13:28 PHL 798	PBI	15:05 959 15:59	R	ISW 1015 BWI 320	18:39	1220	20:20	MSP 1264 PVD	22:40
A23						CLTSC4 D ORIG D	DFW	BWI 500	0,710.0	ATL 612	GCM	ATL 722 AA 792		10 FLL		1	6:55 1065 17:45 PHL 1036	MCO 752	ATL 1142	SAT 320	AA 1325 320 21:04 1325 22:05 ATL 1276 IAH 320	1349
A24						06:45 450 07	7:30	08:20 575 CLTSC4 M:	09:35 ISY	BWI 62	* 11:25 20 AUA 320 90* 11:30	JFK 75	50 CUN PE	70 14:30 11 832 BWI 12 890 14:50	MSP 925 AA 985	RSW	17:16 1733	18:20	19:02 1225 PBI 1134	20:25 PHL STT 122		TERM
A25								08:29 554 09: RSW 508	:14	10:20 69 SYR 611 M	90* 11:30 MSY	BOS 724	0* 13:30 A7	52 890 14:50	SFO 903	16:25 TPA LGA	17:15 ¹⁰⁷⁰ 17:50	LGA 1082 MSY AA 1135 18:55	RAA 1205 20 FLL 1152 AA 1220	320 0:05 20:29 127 BWI	79 21:19 21:50 13 LAS 1286 1 21:26 1796 2:	65 22:45 HL
A26						LAS 370	LAS	08:28 413 ATL 501	09:35 MSP	10:11 663 11 CLTSC4	1:03 RIG IAH 679 11:19	12:04 800 ORD 717 PHX	13:20 MIA	815 ORD	15:03 984 TPA 92 AA 72 15:27 72	16:24 16:44 27 LAX	1065 17:45 PIT 1017	18:02 1135 18:55	19:12 1220 MSY 1154		SEA 1286 F	25 SW
						06:10 658 SEA 375	08:00 SAN P	08:21 560 PVD 492	09:20 SXM L			DEN 723 TP/	13:35 A ORD 80	2080 14:50		25 16:40 25 LAS	16:57 1100 TPA 10	18:20 040 LGA	19:14 1215 RDU 1135 RS		21:26 1346 ₂ FLL 1281 LA	321 2:26
A27						PHX 369	321 A 07:50 0 MCO	AA 08:12 565* 493	320 A 09:25 1 CLTSC4 _{RIG} LGA	.GA 600 AA 700 RDU)* 321 11:40 638 IND	DEN 723 TP/ AA 782 32 12:03 782 13:00	1 AA 13:23 8'		15:25 6.	37 321 16:45	17:20	120 18:40	18:55 1200 32 18:55 1200 20:0	0 0 .AS SJU	1223 DFW	0
A28						06:09 460	321 07:40 TPA SFO	PUSH 481	09:10 EAX	10:38	690 11:30	PHX 726	PIT LGA	817 MCO	LGA 900	PHX	17:45	GC4 DFW ORE PULL AA 565 18:30 18:4:	RIC 1151	321 AA 0:05 20:23 TPA PHL	1330 321 22:10 1240 PHX	
A29				[CI	LTSC4 _{PIC} DFW	PDX AA 06:14 465	321 AA 07:45 08:01 ORD	585 ORD 500	321 09:45 PHX	AA 10:19 PHL 605	619 MIA 705 321 11:45	PHX AA 726 12:06 789 13	321 AA 3:09 13:37 MCO	885 321 825 PHL	LGA 900 AA 975 1 LAX 900 PHI	321 6:15 SFO	1006 ORI	o e	PHL 1145	319 AA 0:06 20:40 DFW T	472 321 22:15 PA 1252 BOS	
A1				05	ORIG DFW 5:15 360 06:00	06:26 475	321 07:55 PHX RDU	08:20 680		AA 10:05 690*	* 11:30	LLI MIA 724	DFW DF	885 321 885 14:45 W 832 JFK	15:00 559 16:05	AA 16:46 PIT	32 5 1908 18:0 ATL 1017	I D LAS	AA 1143 19:05 844 JAX 1155	20:27 A	A 1232 321 0:52 1335 22:15 JIFK 1262 DTV	vi e
A3					A/ 06	MF 362 P 6:02 408 07 AN 364 S	321 AA 07:30 08:02	482 565*	321 09:25 SEA	AA 10:35 PVD	635 FI 715 3 11:	LL MIA 734 121 AA 1878 DFW 747	321 A/ 13:15 13	321 :52 895 14:55	DEN 924 15:24 995	321 16:35 FLII	AA 1017 16:57 1090	321 18:10 FOI SA	19:15 1210	319 20:10 RDI	AA 1202 32 21:02 1340 22:2 LGA 1264 SF	1 0
A5					A 0	6:04 450 07	321 7:30	FLL 502 AA 580 08:22 580	09:40	AA 10:32	632 PUJ 710* 321 710* 11:50	12:27 804	4 13:24	Y DOO TRA	DFW 920 AA 984	321 A 16:24 10	6:54 1085 ₁₈	321 AA :05 18:	AN 1129 C A 1205 20	321 0:05	21:04 557 32 21:04 557 22:2	1 0
A7						SLC AA 06:10 1993	321 07:35	08:34 £	514 SJU 321 590 09:50	AA 10:29	629 DEN 321 521 11:45	MCO 724 MCC AA 321 12:04 781 13:01	13:	X 830 TPA 321 50 890 14:50	15:35	935 SFO 321 95 16:40	BOS 1020 17:00 1090	321 18:10	BDL 1147 MG AA 1200 20:0	9 10 MSP	PHX 1276 E 21:16 1345 22	321
A9						hice	A 08	AS 490 8:10 565*	321 09:25	DTW 611 10:11 685*	* 11:25	PIT 725 CI AA 785 13:0	DEN 801 19 AA 800 05 13:21 860	14:20	LAS 908 BI AA 3 15:08 970 16:	21 10	FLL 1020 17:00 1090	321 18:10	LAS 1135 AA 2075	321 20:10	MCO 1263 BDL 321 22:09 1273 MCO 1273 MC	
A11						06:44 47	04 LGA 321 79 07:59	PBI 511 08:31 575	1 321 5 09:35	BDL AA 10:31	631 SJU 321 705 11:45		BOS 81 13:30 86	55 14:25	BOS 909 DF AA 3 15:09 970 16:		991 DFW 321 1060 17:40	DE:	SFO 115 AA 122	9 20:29	SFO 1273 MCC 21:13 1339 32 22:1	
A13						CLTSC4 MIA ORIG MIA 06:15 420 07:00	PI A. 08	HL 490 8:10 565*	321 09:25	RSW 613 10:13 685	5 11:25	BNA 718 AUS AA 774 319 11:58 774 12:54	PHX 8: AA 8: 13:31 86		ORD 905 MCO 321 15:05 960 16:00		MCO AA 17:16 1105	18:25	PHX AA 19:14 1975	20:20	LAX 1269 FLL 321 21:09 1330 22:10	
A12						RDU 377 AA 470	MCI M 319 A 07:50 08	1CO 490 .A 8:10 564	SFO 321 09:24	MCO AA 10:13 2053	3 11:20	IAH 731 AA 100	JFK 73H 13:19		MIA AA 15:16 1453	ORD 73H 16:25		DFW 1091 18:11 1150	19:10 19:35	1175 LGA 321 1240 20:40	1270 TERM	
A10							Pi A 08	PHX 491 ¹ AA 8:11 559 (MCO 321 09:19	TPA 61: AA 68:	8 ORD 321 11:25	EWR 743 AA 806	73H AA 13:26 13:45	825 STL 319 880 14:40	EWR 905 AA 985	MIA 73H 16:25	PHX AA 17:13 678	321 18:16	LGA AA 19:20 1220	DEN 321 20:20	PVD 1280 DCA AA 1334 22:14	
A8						397 TERM		LAX AA 08:43	523 BOS 321 585 09:45	MSP 6 AA 10:26	626 BOS 321 11:30	BDL 729 RD AA 31 12:09 784 13:0		07 MSY 319 175 14:35	CLTSC4 CRIG LO ORIG 15:25 970 16:	GA ORD AA 10 16:39	999 PHL 321 1050 17:30		TPA 1147 AA 1205 20	SLC 321 0:05	DFW 1272 MSP AA 321 21:12 1330 22:10	
A6								08:50	ORIG ORD 575 09:35	DFW AA 10:37	637 LGA 700 321 11:40	FLL 739 AA 1950	DCA 319 13:15	JFK 840 AA 2249	FWR IND 9: AA 15:15 15:30 10	30 DCA 319 100 16:40	1021 TERM		MCO 1139 PHX AA 321 18:59 1195 19:55		DEN 1278 TPA AA 321 21:18 1335 22:15	
A4						ATL 2 AA 06:52	412 ATL 320 480 08:00	ORF 509 O AA 08:29 555 09	ORF 319 9-15	601 TERM		PVD 748 AA 12:28 800	319 AA 13:20 13:39	819 SAT 319 880 14:40			1041 TERM			1185 TERM	MIA 1273 EWR AA 1384 22:15	
A2								MSP 52 AA 56 08:46 56		CLTSC	ORIG LAS 680 11:20	DCA 712 RIC AA 319 11:52 765 12:45	PIT 8 AA 13:31 8	11 BDL 319 70 14:30	BDL 902 AA 990	DTW 319 16:30			1160 TERM		ORD 1287 AA 1277	MIA 73H 22:30
B1								50.10	0,25	CLTSC	4 MCO 680 11:20	CHS 745 AA 795	JAX CLE	817 RDU 319 870 14:30	RSW 903 AA 990	PVD 319	IND AA 17:11 1105	STL 319	1132 TERM	EWR AA	1236 JFK 73H 1608 22:10	
B3						TPA 400 AA 470	6 RDU 319	JFK 510 08:30 148	MIA 73H	603 TERM	CLTSC4 OR		MS AA	831 PIT 319 51 895 14:55	15.05	10.30	17.11	16.23	BOS	1185 STL 319 5 1233 20:33	SYR 1264 ROC AA 1336 319 21:04 1336 22:16	
B5						DCA	422 PIT 479 319 479 07:59	EWR 496 JFK AA 2529 09:06	09.30	608 TERM	11.25	ORF 743 AA 792	IND 1319	RDU 836 IAH AA 319 3:56 895 14:55	BWI 915 AA 980	BDL 319	AUS AA 17:15 1105	BDL 319		ORIG PVD	RDU 1257 AA 1345 22	LE 319
B7						RIC 394 B 06:34 450 07	BDL DT AA	TW 488 BUI A 311 1:08 550 09:10	9		642 DFW 73H 2 330 11:35	LGA 737 OR AA 785 3 12:17 785 13:1	13:12 RD 19	CHS 842 DCA AA 895 14:55	DCA 913 AA 975	MCI 319	MCI 1033 I7:13 1100	MIA 310	JFK 1149 AA 1390	EWR BWI 73H AA	1238 1360	RIC 319
B9						06:34 +30 0)	7/:30 08:	MIA AA 08:47	527 EWR 73H 595 09:55	MDT AA	633 JAX 710 11:50	12:17 783 13:	BUF AA 13:26 855	BOS 319		944 BWI 1005 319	ALB 1021 D AA 17:01 1085 18	18:20 FW 319	EWR 1156 AA 19:16 2483	20:10 20:38 IAH PIT 73H AA	1239 1355	22:40 ORD 319
B11						EWR 407 AA 465	7 EWR 73H	BDL 501 AA 580	CLE	EWR 602 I AA 1458 1		CLTSC4 ORIo		14:15 FSC4 ORIG 875 14:25	JAX 920 AA 979	SYR 319	BWI 1027 AA 1090	RDU 319	BNA 1164 AA 129:24 1215	BUF	PBI 1275 SY AA 1340 31	22:35 R 9
B13						06:47 403	07:45		521 BWI	LGA	11:05 A 644 BNA 319 44 700 11:40	12:34	13:19 13: 808 TERM	30 14.33	BNA 914 R AA 969 16:	16:19 C 19	17:07	ORD 1	1084 III 1200 20:0	9 20:15 M	1299 TERM	9
B15						SFO 374	DEN 321	RIC 495	MEX 319	BUF 61	4 NAS	PHL 719 PHL AA 2054 E90	TERM		PHL 93	99 PBI 319	RDU 1024 PV AA : 17:04 1085 18	18:04 VM 319	1145 TERM	10	BUF 1258 ALB AA 1335 319 20:58 1335 22:15	
B16					CLTSC	06:14 455 406:14 455 ARIG PHL BOS AA 395 06:35 07:1	07:35 08 432 BNA 319 12 480 08:00	08:15 570* JAX 497 AA 570	09:30 DCA 319		519 BWI	11:59 2054 13:00			ATL 908 JAX AA 959 319 15:08 959 15:59		1010 DCA 319 50 1070 17:50	:05	CLTSC4 JF ORIG 19:15 1200 20:0	К	ALB 1282 AA 1360	ATL 319
B14					05:50	PIT 402	PVD	08:17 570 MEM AA 08:43	09:30 523 RSW 319 595 09:55	MCI AA	595 11:35				15:08 959 15:59	628	50 1070 17:50		19:15 1200 20:0	10	21:22 1360	22:40 PIT 319
B12					CLTSC4 LGA ORIG LGA	06:42 455	07:35 BU AA	JF 488 I	DTW 319	10:28 AUS AA	639 AI	LB :19			DTW 9	1793 39 MSY D 319 A	CA 1014 IAH A 319		STL 1150 ME AA 1200 20:0	M 9	RIC 1255 AUS AA 1255 319	·25
B10					05:20 363 06:05	CLTSQ	C4 BOS ORIG 470 07:50		524 BDL 590 99:50		715 311: 633 ATL 319	:55			MSY 930 BN/ AA 930 311 15:30 966 16:00	16:30	A 1074 17:54 CLE 1019 RIC AA 1074 319	PIT AA	1124 PIT	0	AA 1224 319 20:55 1330 22:10 DTW 1255 LGA 319	1350
B8						07:05 CLTSC4 ORIG F	07:50 PHL	DCA 508	CHS	PBI 610	699 11:39 PHL 319				RIC 94	1 ALB	16:59 1074 17:54	18:44	4 1194 19:54 IAH 11 AA 19:25 12	65 RIC 319	1324 22:04 20:55 1324 22:04 1285 TERM	TERM
B6						06:45 450 07 CLT SC4 ORIG D 06:45 450 07		08:28 570 IAH 5 08:38 5		AA 10:10 675 STL AA	627 DCA				NAS 910	4 16:24 BUF 319	NAS 1024	PIT 319	19:25 12	250 20:30	DCA 1289	JAX 319
B4						06:45 450 07 CLTSC4 ORIG 06:50 455	7:30 FLL	PIT 51	5 IAH	SAT	690 11:30 MCI 319				15:10 989	16:29	AA 1024 17:04 1095	18:15			1272 TERM	22:35
B2						06:50 455	ILM	484 PHL	75 09:35	ROC 614	700 11:40 CHS 319										MSY 1280 F	SUP 319
C2							08:0-	1839 09:00 CLE 510	MEM 319	10:14 674 PIT 620	0 DTW				935						1345 22 1AH 1270 PBI AA 1270 PBI 219	:25
								08:30 564 STL	09:24 531 PIT	10:20 680 ALB 62	0 11:20				TERM	1			1147		21:10 1331 22:11	
C4					+			08:51	585 09:45	10:23 68								1	TERM			
C6																						
C8																		-				
C10																						
C12																						
C14																						
C16																						
AAIN						larrea:	Mpil										L #1010 Tol	GCM	11004 PN4	lors:	ursed	
l1						06:55 465	NG MBJ 65* 07:45									MB AA 16::	*1010 TPA 321 50 1073 17:53	AA 18:14 1	1094 BNA 320 1189 19:49	20:29 TERM	21.14	DW .
l2						07:05	07:45 C4 ORIG 475* 07:55							MF A.A 14:	*893 RI 53 970 3	CUN 20 AA 10 16:40	*1000 BOS 1075 321 17:55	SXM AA 18:40	*1120 DCA 320 1185 19:45	At A./ 20	JA A *1250 1350 1350	320 22:30
												-										-

Date:04/11/2019 Time:12:51								C	CLT 2016-S	Scenario 3	3											Fayı	e # 2 of 4
	00:00	01:00 0	02:00 03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
											1												
13		+++++++++++++++++++++++++++++++++++++++		 		 		 	 	CLTSC4 _{OI}	RIG SXM		 		111111111111111111111111111111111111111	PUJ	*981 EWR 320 1711 18:05		PLS AA 18:55 1215	MCO 221			шшшш
										10:35	11:25					16:21	1711 18:05	ĺ	18:55 1215 MBJ *1136 AA 1215	20:15 MIA			
14																	PUJ*1065SA	N CUN	*1120 PBI	20:15 SXM *122LTSC4			
I5																	PUJ*1062 ^{SA} 17:42 ¹⁰⁹ 18:1		*1120 PBI 321 1195 19:55 *1115 MDT	SXM *1224 *1224 *1209 *100 *100 *1009 *1000 *1000 *1000 *1000 *1000 *1000 *1000 *100			
l6																		AA 18:35	*1115 MDT 319 1189 19:49	PUJ *1216 *1216 20:16 TERM 21:01			
17																							
I8																tun				1111			
I10																LHR AA 16:15	* 7	975 32*		333 20:15			
I11														CDG AA 13:55	1	*835 100*	C 18	CDG 332 8:20					
l12													DUB AA 13:05	785 704		FRA 332 46:35	CLTSC4 ORIG AA 1105*	FCO 333 18:25					
I13															MAI AA 15-5	*9	DUB 332 24 18:05	LHR *1 AA TE	1110 CLTSC4 333 ERM 19:30				
l14													FRA AA	*78 748) 	MAD 332	CLTSC4 ORIG AA 17:10 1120*	LHR 333	19.30				
I15													13:00	740	FC A.	0 *955 CLTSC4 A 333 55 TERM 16:55	17:10 1120	BCN AA	*1100 1245*	BCN 332 20:45			
OADO															15	:55 TERM 16:55		18:20	1243	20:45			
01	ATL DL		22 823		ATL M90	CLTSC4 ATL ORIG 06:15 420 07:00	CLTSC4 M ORIG 07:20 485 08	1SP	DTW ₅₄₄ DTW 09:04 ⁵⁷⁹ 09:39		ATL 676 ATL 717 11:162251 12:00	ATL 753 DL 12:33 109	ATL ATL DL	822 ATL 320 2597 14:30	ATL 904 ATL DL 2122 M88	MSP DL 1	1000 DTW ATL 1524 320 DL	1070 ATL M88 826 18:45	ATL 1149 DL 19:09 1407 2	ATL M88	1268 TERM	1346 TERM	14
O2	00:22		823		05:30 CLTSC4 DTW 05:15 360 06:00	06:15 *620 07:00 V	0 07:20 485 08 CLTSC4 SLC ORIG 07:00 465 07:45	AT DI	09:04 ^{5 / 9} 09:39 TL 528 ATL L 528 M88 8:48 2422 09:30		11:162251 12:00	DTW 727 DTW DL 319 12:07 1629 12:50	3 13:15	2597 14:30 MSP 864 MS 14:24 1503 14:1	P DTW ODL	16:40 1: 040 MSP 319 793 16:30	17:20 17:50	826 18:45	19:09 1407 2	20:05	TERM	TERM	1387
03				+	05:15 360 06:00	o o	07:00 465 07:45 CLTSC4 ORIC 495		3:48 2422 09:30	ATL 603 ATL M90 10:03 1454 10:45		12:07 1629 _{12:50}		14:24 1503 14:5	9 15:40 1	793 16:30 ATL 978 ATI	L	DTW ₁₁	120 ^{DTW}	+			TERM 1400 TERM
O4				+ +	CLTSC4 IAH		07:30 495	08:15	ORD 566	10:03 1454 10:45 ORD			ORD 780 ORD UA 319 13:00 1140 13:45	-	DEN 897	16:18 2651 17:00 DEN	00	18:40	19:15				TERM 1399 TERM
					OS:05 SECTION OS:50 OS:50	CLTSC4 ORD			ORD 566 UA 521	73G 10:15			13:00 1140 13:45		UA 14:57 1199	320 16:22						1332	TERM
O5	4	40			CLTS	CLTSC4 ORD 06:03 O6:48 CANG MDW C	CLTSC4 BWI		BWI 575	. DAL						ME	DW., MDW HOU,	HOU	DAL , , , , BWI			1332 TERM	
O6	PU	40 JSH			05:45	ORIG MDW C 5 390 06:30 0	CLTSC4 BWI 06:55 3773 07:40		BWI 575 09:35 ³⁰⁵⁵	5 10:10 UFK (01 JFK	BOS BOS					16:	DW ₁₀₁ MDW HOU ₁₀ :50 ¹⁰⁴⁵ 17:25 17:55 ¹⁴	493 18:30	18:55 ¹⁷²¹ 19:30 K JFK				
O13										JFK 601 JFK B6 E90 10:01 218 10:40	BOS BOS B6 659 E90 10:59 11:36						BOS 1038 BOS E90 17:18 1446 18:00	B6 18:	1130 E90 1168 E90 150 1168 19:28				
O14					lorsy		nest.					luco	nul hu	No.						long	oppl		
O18					DEN F9 05:10	310 200	319 07:20					MCO 743 F9 12:22 168	8 321 F9 8 13:24 13:	IL 830 MCO 321 321 14:49						ORD 124 F9 120 20:42 120	3 ORD 7 320 7 21:30		
O19																				TTN 1225 TTN F9 319 20:25 932 21:10			
O20																							
O27																							
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OAIN																							
																MUC	*980	MUC					
121																LH 16:20	1115*	18:35					
122																							
AEDO								ORIG	530		659	DIII	DAY	823 ORF	ORF QO7	GSP	SDF			1066		СНО	
D13						PHF		510 390	PUSH	LEX	TERM 640	PULL 785	AA 13:43 4 BTT	823 ORF CR2 880 14:40	ORF AA 907 15:07 985 SDF 917	CR2 16:25 MKE fr	AA 17:46 TLH 1015	AVL	HSV	1066 1350	1255	CR2 22:30 MGM	
D12					u	AA 06:30 GSP DCA	PHL 410 CAF	590 590	VPS CR2 09:50	AA 10:40	780 FAY	BHM CR 13:0		R 827 DAY CR2 47 881 14:41	15:17 995	16:35 I	TLH 1015 AA 1110 VL 1012 CAE	AVL CR2 18:30	AA 19:21	1161 HPN AVL CR2 AA 1240 20:40 20:55	1255 1361	CR2 22:41	
D10						05:57 ³⁹² 06:32	PHL 418 CAE AA 465 CR2 06:58 465 07:45	AA 08:30	51 68		CR2 11:20	AA 12:20	740 870	CR2 14:30	AA 92 15:26 99	CR2 A	VL 1012 CAE A 1080 CR2 6:52 1080 18:00	AA 18:38	1118 PHF CR2 1190 19:50		1340 2	CR2 2:20	
D8						AA 06:23	383 549		BTR DCA CR2 AA 09:09 09:24	564 674	CR2 11:14	CRW 735 AA 790	CR2 AA 13:10 13:4:	825 TYS CR2 5 875 14:35	MLB AA 15:44	944 CR2 995 16:35	TYS 1030 CAK AA 1030 CR2 17:10 1084 18:04	1	CAK AA 19:18 122	58 GNV CR2 25 20:25 2	PS 1266 A 1350	CR2 22:30	
D6									AA 08:53	533 695	CR2 11:35	PGV 725 LEX AA 725 CR 12:05 779 12:59	MOB AA 13:42	822 LEX CR2 865 14:25		X 955 VPS CR2 55 1005 16:45	CAE 1023 AGS AA 1075 CR2 17:03 1075 17:55	ORF AA 18:43	1123 AGS CR2 5398 19:45	AA 1200 E75 AA 20:00 20:40 20:58	1258 BT CF 1335 22:1	15	
D4						CAI AA 06::	410 BHM CR2 50 455 07:35	HPN AA 08:22	502 AGS CR2 585 09:45	YUL AA 10:06 695	11:35	GSP 737 AA 790	TLH CR2 13:10	ORIG 890	OAJ 933 AA 979	MGM CR2 16:19	PHF 1042 CR 17:22 1094 18:1-	X 2 4	BHM 11 AA 12 19:23 12	63 YUL CR2 25 20:25	GNV AA 21:20 1355	LEX CR2 22:35	
E1							ORIG 455	MOB AA 08:42	522 GSI CR2 599 09:59	CAE 621 AA 679	11:19	CLE 725 GNV AA CR2 12:05 770 12:50		CHA 841 VPS AA 841 CR2 14:01 880 14:40	HSV 920 BH AA CF 15:20 965 16:0	4 2 5	FAY 1025 GNV AA 1075 CR2 17:05 1075 17:55	GSI AA 18:	P 1129 MKE CR2 49 1184 19:44	FAY 1199 HSV AA 1199 CR7 19:59 1240 20:40	1275 TERM		
E2						GN AA	NV 412 LEX A CR2 0:52450 07:30	PGV 491 AA 559		VPS 606 AA 678	TYS CR2	OAJ 725 CHO AA 769 12:49		MYR 841 AVL AA 880 CR2 14:01 880 14:40	CHO 930 G AA 15:30 970 1	AE	LEX 1045 CH AA 1095 18:1	0 22	YYZ 1157 AA 1210	CAE	DAY AA 21:31 136	1 EVV CR2 0 22:40	
E3						06:	DAY CLE AA 434 CR2	AGS 50 AA 08:21 56		EVV 623 10:23 680	JAN	AGS 736 OA AA CR 12:16 780 13:0	J 2	PGV 847 FAY AA 847 CR2 14:07885 14:45	CAE 922 HSV AA 922 CR2 15:22 960 16:00		BHM AA 1065 1105 1105	CHA CR2	EWN 1145 FAY AA CR2 19:05 1190 19:50	MEM 1205 MLB AA 1205 CR9	CHO 1268 TL A 1335 CF 1:08 1335 22:1		
E5							07:14 07:50 CAK 428 CHA 07:08 463 07:43		510 MOB CR2 575 09:35	MKI	E 648 SDF CR2	CAE 742 F AA 12:22 785 13	AC CR2 AA	GS SDF A 829 CR2	EVV CAK AA 923 CR2		MOB 1030 MOB AT AT AT 1069 CR2	18:25	CRW 1145 FWA AA CR2 19:05 1189 19:49	20:05 20:45 CAE AA	1259 MKE	15	
E7				+ +		TYS AA	07:08 ⁴⁶³ 07:43 384 GSP CR7 465 07:45	08:30 MGM AA	575 09:35 518 TYS CR2 575 09:35	OR	IG 11:40	ВНМ 750	:05 13: MOB VP CR2 AA	:49 865 14:25 PS PHF A 829 CR2 :49 865 14:25	EVV 923 CAK AA 923 CR2 15:23 960 16:00 TYS AA 934	EWN CR2	17:10 1069 17:49 18	1:05 1123 18:45	19:05 1189 19:49 MGM AA		BTR 129 21:35 136	05 MOB CR2	
E9						06:24 CHS 378 AA 450		08:38 FV A	WA 529 MGM	BTV 621 R AA 665 11:		12:30 790	13:10	349 865 14:25 GSP YYZ AA 834 CR2	15:37 974	16:14 GNV 969 BTR 16:09 ¹⁰⁰⁵ 16:45	TERM CHA 1041 TY AA 1041 CR	S MSN	1123 OAJ	20:20	MKE 129	97 GSP	
E9						ILM	401 SAV	08	8:49 585 09:45	CHA	646 PGV	GNV 745 12:25 ⁷⁸⁰ 13:0 745 TERM		87/0	JAN 940		1008 1095 18:1	15 18:43 M	1185 19:45 ILB 1132 MSN		21:37 130 CAK 120	60 22:40 5 CRW	
						AA 06:41	465 CR9 07:45	CAE 501 AA 549 OR:21 OR	lIG	10:46	6 690 11:30	TLH ~		13:54 14:30 111 HSV CR7 14:25	JAN 940 15:40 ⁹⁷⁵ PHF	16:15 T	TERM DAY	A. 18 O	A CR7 8:52 1194 19:54 DAJ 1133 SDF		1265 135:	5 CR2 5 22:35	
E13								55	ORIG	TERM	М	TLH AA 12:28 8 CHO 732 A	VL GPT	A 885 CR9 3:51 885 14:45	AA 15:13 CHA	940 GPT	CR7 18:00 HSV 1050 I	A 11 PHF	8:53 1189 19:49		TERM		
E15						DRE CO.	7 CVG	CRW 40.C C	585	TEF	RM	AA 785 13	R7 AA :05 13:37	867 14:27	AA 15:40	1000 CR7	HSV 1058 I AA 1100 IS	CR7 8:20	IND 1138 CAK AA CR7 18:58 5306 19:45	FVC	1296 21:36 22:05	AVI	
E17						ORF 38' AA 444	CR9 4 07:24	CRW 496 GN AA CI 08:16 540 09:	ROA 555 GSO AA DH3 09:15 595 09:55	610 PUSH	ORIG 5593			PULL 890			SAV 1029 AA 1105	CR9 18:25		AA 20:5	1259 1345	CR7 22:25	

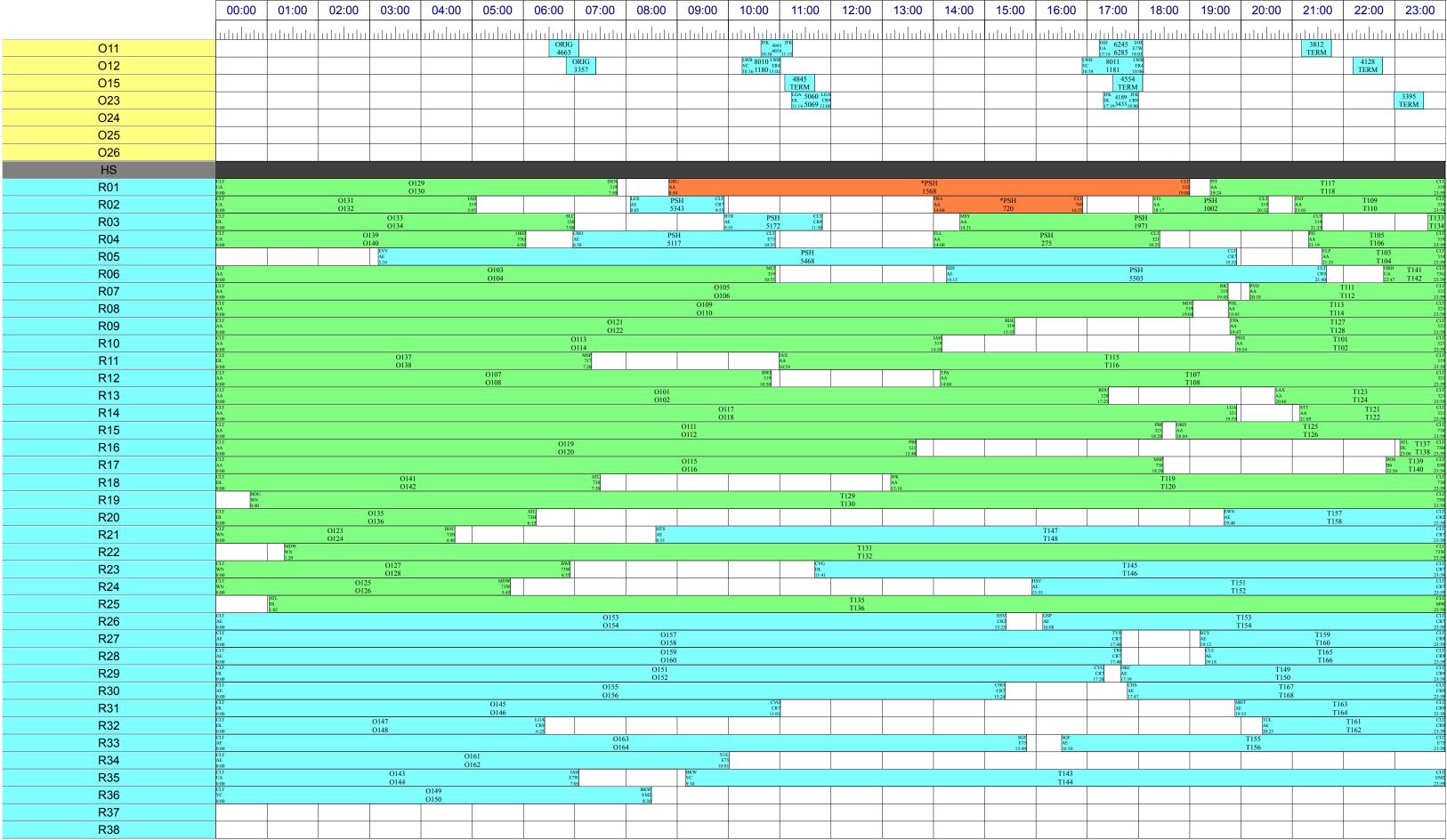
Date:04/11/2019 Time:12:51							CL	T 2016-S	cenario 3											Pa	ige # 3 of 4
	00:00 01:00	02:00	03:00 04:00	05:00	06:00 0	7:00	08:00	09:00	10:00 11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
		1						1	. 1					1	1						1
E19					IAD 404 AA 460	CHS CR9	FAY 520 08:40 560	CRW CR2	SGF 609 SGF AA ER4 10:09 650 10:50 11:05 700 11:40	JAX 730 DTW AA CR9 12:10 780 13:00	798 TERM		AVL 929 OA AA 929 CF 15:29 974 16:1	U 7	OMA AA 17:06 1100	SAV CR9	LEX TYS AA 1156 CR7 19:16 5221 19:56		GPT 1270 S AA 1334 22:10 1334	RQ CR7	
E18					GSO 412 AA 460	2 RIC	PHF 490	GPT CR7	10:09 630 10:50			831 TERM	PIT 924 AA 990	LIT CR9	DTW 10- AA 17:22 11	18:20 42 GSO CR9	19:16 19:56		PHF 1286 AA 1350 21:26 1350	PHF CR7	
E16					06:52 400 ORIG 440	07:40	08:10 300 517 PUSH	09:20	OAJ 646 FLO	12:19 /93	13:15	LEKIVI	CMH 921 ILM AA 969 16:09	16:30	PULL 1065		1120 CVG CR9 1185 19:45		1300 TERN)	
E14					LYH 382 06:22 460	OAJ DH3	OAJ 493 AA 560	CVG CR7	10:46 693 11:33 IND 646 CMH E75 10:46 705 11:45		JAN AA	827 HPN CR7 7 873 14:33	ORIG 970		SYR 1036 17:16 1100	CHS ME	M 1130 CHS	GSP AA	1199 1365	GSO CR9	
E12					EWN 395	07:40 FAY DH3	AVL 501	09:20 CHO CR7	10:46 /05 11:45 ROA 621 HHH	IAD 749	BNA	842		043 PNS CR9 004 16:44	ILM 1034 C AA 1085 18		50 1184 19:44 IAD 11 AA 19:26 12	19:59 166 MSY GSC AA	1245	SAV CR9	
E10					06:35 460	07:40 424 GSO DH3	08:21 559 SDF 512	2 HPN	GSO AA 630 DH3 10:30 715 11:55	STL 730 SAV AA 779 12:59		TERM 812 ILM CR9 875 14:35	DAY 914 SA AA 974 CF 15:14 974 16:1		AK 1013 GSP	:05	SAV 1140 OR	250 20:30 20:4 F	1350 ILM 1263	22:30 CHS CR9	
E21					07:04	470 07:50	08:32 538- HSV 513	3 JAN	10:30 715 11:55 SAV 638 AA 10:38 779		DAB	820 MEM	15:14 974 16:1 HT 902 TLH A CR9 6:02 959 15:59	4 10	0:53 1070 17:50 DSM 1018 CLE CR9	PNS AA	1200 1200 20:0 S 1130 GRR CR9	00	1270 1355	22:35	
E23					ORIC	G SR	08:33 570 Q 484 TLH CR7	0 09:30 SBY 555 AVL	BHM 613 BHM	FAY 730 CHS	CAK 80 AA 13:28 86	880 14:40 [1:	MDT oog CMH		16:58 1070 17:50 RIC 1039	BNA CR9	TYS 1141 SAV	HI	TERM ORF A 1250 CR2	1321 TERM	
E25					TRI 399	HHH	TYS 502 AA 555 09:22	09:15 ⁵⁹⁰ 09:50 LIT CR9	TUL 620 DAY	MYR 735 MYR AA 735 CR9	13:28 86 GSO 81	13 CMH CR9 54 14:24	OKC 914 SDF AA 965 16:05	PV	1011 SRQ CR9 1010 17:40	DAB 1080 OKC AA 1080 CR9	19:01 1195 19:55 DAB	1176 CLE CR9 1230 20:30	SDF 128	85 MYR	
E27					389 455	- N	MDT 400 CM	9:15 IH	10:20 695 11:35 PULL	MEM 727 SYR AA CR9 12:15 779 12:59	SRQ S	R17 SAV	BHM 010 IAD	16	TUL 1028 IAD	AA 1080 CR9 18:00 1125 18:45	1129 DAY	1230 20:30	ORF 1269 AA 1340	60 22:40 CHA CR9	
E29					PUSH	396 565	AA E7 08:08 550 09:1	GRR CR9	CLE 621 MDT AA 685 11:25	HTS 738 AGS AA DH3 12:18 781 13:01	13:37 8 AUS	825 CHS CR9 875 14:35	15:10 960 16:00	GSO	17:08 1075 17:55 XNA 1024 CVG	18:4	1180 _{19:40}	GSO	PNS 1255 DAY AA 1255 CR9 20:55 1325 22:05	22:20	
					06:36 OR	IG	CHS 489	09:25 MYR	OMA 641 PIT	12:18 781 13:01 EWN 749	1 13:45 GSP	875 14:35 GRR 845 ATL	IAD 915 DAB	16:25	MYR 1030 B	IM Dec	19:19 1210	20:10	AUS 1265	IAD	
E31 E33					45 O1	RIG	08:09 570	09:30 516 JAX	10:41 705 11:45 OKC 642 IAD AA 705 11:45	GSO 738 TRI AA DH3 12:18 779 12:59	13:12	GRR 845 ATL AA 845 CR9 14:05 895 14:55	15:15 964 16:04 CLE 925 CV	G	PWM 1030 SDF AA 17:10 1074 17:54	:05	MYR 1140 PNS AA 19:00 1190 19:50 CMH 1156 M	THT	21:05 1335 2: CHS 1260	2:15 XNA	
					4	ORIG	08:36 IAD	516 CR9 590 09:50 523 IND	AVP 618 AVP	AVL 732 LYH AA 770 12:50	ĺ	13:56 885 14:45 ORF 836 MYR	15:25 974 16:1 CHS 930	YS BNA		1066 TUL CR9	19:16 1205 20	0:05 6 ABE	21:00 1350 XNA 12	293 BNA	
E35						465	08:43 MSY	595 09:55 526 SDF	DSM 619 GSO	TRI 743 ROA		AA CR9 13:56 885 14:45 MKE 836 ABE	15:30 979 1 AVP 936	5:19 16:45 XNA	1005 CR9 AA 1045 17:25 17:4 CHS 1032 MDT	CR9 5 1110 18:30	CVG 1160 19:26 121: CHS 1143 SRQ	5 20:15	21:33 13	60 22:40 LYH	
E38					HHH _{A16} 1	ROA	AA 08:46 BNA AA	590 09:50	10:19 680 11:20	12:23 781 13:01	[[IND 841 PNS	15:36 985 MYR 933		17:12 1075 CR9	061 MYR	CHS 1143 SRQ CR9 19:03 1190 19:50 DTW 1144 GPP		ROA AA 1260 21:00 1350	22:30 92 MEM	
E36					HHH 416 06:56 450 CMH 39	8 IND	SAV 496 M	529 DAB CR9 590 09:50	ABE 639 CVG CR9 10:39 700 11:40 CVG 649 XNA	LYH 752 FI 12:32 786 12:32 13: CMH 747	.06 7 MCI ILI	M 832 MKE	15:33 980 ₁	6:20	AA 17:41	100 CR9 18:20	DTW 1144 GSP AA 1190 19:50 MKE 1161	IAD	21:32 135 BNA 129	55 22:35	
E34					06:38 47:	5 07:55 11 DTW	08:16 334 09	9:14	10:49 710 11:50 CMH 650 PWM	12:27 804	E75 AA 4 13:24 13	:52 880 14:40 YYZ 850 I	CVG 914 MEM AA 960 16:00 GA MEM 935 M AA 935 M	1YR			19:21 1205 20	0:05	21:34 13:		
E32					06:51 46	55 07:45	08:47 ORI	527 PNS 585 CR9 585 09:45	AA 050 CR9 10:50 710 11:50 DAY 654 PVD	SAV 727 CHA AA 727 CR7 12:07 770 12:50 IND 732 GS	SO SDF S	14:19 915 1	15:35 980 1	CR9 6:20 ORIG	ROA 103	6 LYH	ABE 1146 OMA AA 1189 CR9 19:06 1189 19:49	DAB	AA 12 21:39 13 CHA 128	355 22:35	
E30					AGS 301	SDF	559	9	10:54 710 CR9	IND 732 GS AA 785 E 12:12 785 13:0	75 AA (5) 13:40 SAV	820 DAB CR9 865 14:25		995	ROA AA 17:16 111 CRW 10	0 DH3 0 18:30 50 OAJ	19:28 1210	20:10	AA 126 21:28 136 IAD 1281 TY	50 CR2 22:40	
E28					AGS 391 AA 450 0	CR2)7:30	GSP 498 CR 08:18 549 09:0 GRR	529 RDU CR9	SRQ 610 ORF AA CR9 10:10 662 11:02	DTW 742 M		V 830 RIC CR9 50870 14:30	942 TERM		CRW 10 AA 17:30 11 EWN 1044		PGV AA 19:15 123	0 DH3 20:30	AA 1281 CR 21:21 1329 22:0 SRQ 1299	9 19 0. SDF	
E26					SDF 40	MEM	08:49	580 09:40	XNA 628 OMA AA CR9 10:28 680 11:20 MHT 630 STL	DTW 743 M AA 790 1		50 875 DH3 19 CRW	EWN 906 LYH AA 970 DH3 15:06 970 16:10	TRI	17:24 1095		18:59 1210	DH3 20:10	CVG 1282	022:20	
E24					SDF 40 AA 06:46 47	70 CR9 0 07:50	DAB 515 AA 515 08:35 564		AA 030 CR9 10:30 680 11:20			59 DH3 59 14:19	TRI 938 AA 990 LYH 935	16:30	AA 1038 II 17:18 1085 IS	H8 AA :05 18:42	1189 _{19:49}	TRI	21:22 1350	22:30	
E22					CHA 389 AA 450 0	CR9 AA 07:30 08:0	0 OPIG	480 685	DH8 11:25		AA 13:4	828 DH3 865 14:25	15:35 984		CHO ELO	ROA	CHO 1150 AA 1215	DH3 20:15	JAX 1293 CMI 21:33 1329 22:30 MDT 1200	19 AVP	
E20							ORIG 530	CVG 550 CAK 09:10 ⁵⁸⁵ 09:45	CHS 627 ILM AA 627 CR9 10:27 676 11:16		CRW 805 H AA 13:25 845 14:	:05	FLO 920 ROA AA 965 DH3 15:20 965 16:05	ev/	CHO ₁₀₂₁ FLO 17:01 1055 17:35	AA 18:43	1123 ROA 1184 DH3 1184 19:44	FLO	MDT 1289 21:29 1340	22:20	
E8							08:45 50	089 09:30	MYR 622 SAV AA CR9 10:22 670 11:10		AVL 8 AA 8 13:42	322 CHO 359 DH8 14:19	GSP 933 PO AA 976 16:	H3 16	MDT IND		AGS 1149 19:09 1209	DH3 20:09	LIT 1278 AA 1355	CR9 22:35	
E6							PNS 518 08:38 560		FAY 607 ROA DH3 10:07 674 11:14		I I I I I I I I I I I I I I I I I I I	HHH ₈₃₆ HHH 13:56 ⁸⁷⁰ 14:30	ROA 941 / AA 979 15:41 979	DH3 5:19	MDT 1016 IND AA 1070 E75 16:56 1070 17:50		TRI 1140 SBY AA 119:00 1190 19:50	LITE	MYR 1259 CVG AA 1325 CR9 20:59 1325 22:05	MDT	
E4							08:51	531 FAY 580 CR9 580 09:40	ORF 647 MEM AA CR9 10:47685 11:25		AA 13:42	822 GSO 885 E75 14:45	940 959	vvz	GSO 1019 CMH AA E75 16:59 1070 17:50	100	AA 19:40	1180 HTS 1230 DH8 1230 20:30	IND 1299 AA 1299 21:39 1340	022:20	
F1							517 TERM	1	MEM 643 DSM AA 680 CR9 10:43 11:20			RIC 842 OMA AA E75 14:02 895 14:55	GSO AA 15:30 987	YYZ E75 16:27	MSY 1028 JAX AA 1079 17:59	AA 18::	1130 IND E75 1185 19:45		OAJ 1284 AA 1350	EWN DH3 22:30	
F2							LYH 492 AA 580	DH3 09:40	631 TERM						HHH 105 AA 17:31 109	1 DH8 5 18:15			LYH 1286 DH3 AA 1325 DH3 21:26 22:05		
F3					CVG 41 AA 06:56 46	16 MYR CR9 50 07:40	CHO AA 08:15 575	DH3 09:35	ннн ₆₄₇ скw 10:4 ⁵⁷⁹ 11:19								ORIG 1184) 2	1253 0:53 4925	DH8 22:25	
F4							EWN 512 AA 560	SBY DH3 09:20	RIC 645 CLE AA 695 11:35					SG A. ² 16	GF 1011 SGF A 1070 ER4 :51 1070 17:50		1135 TERM		HHH 1275 AA 1340	22:20	
F5							TRI 496 HTS 08:16 540 09:00	YYZ 559 BNA AA E75 09:19 599 09:59	ORIG 710										YYZ AA 21:22 1355	MSY E75 22:35	
F6							FLO 52 AA 08:43 56	23 EWN DH3 54 _{09:24}	645 TERM										CMH 1274 YY AA 1330 22:1	Z /5 10	
F7							CMH 516 AA 567	6 YYZ 7 E75 7 09:27	IAD 670 SAT AA 11:10 715 11:55										ORIG 1325		
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O7				ORIG 360	ORIG 445			IAD UA	82 CR7 150 CR7	EWR ₇₁₂ EWR		EWR 1AH UA 3315 E70		ORD	0 ₁₀₀₆ ORD 4843 4843 _{17:21}	1/	AD 1135 IAD 8:56 160 19:30				1410 TERM
O8				ORIO		RIG 460	EWR 514 EWI 08:34 ³⁶⁴⁸ 09:0	09:42 ⁶	10:22	11:52 12:27		IAH 849 IAD 14:09 12:09 14:44		16:44	EWR ₁₀₄₀ EWR 17:20 ¹⁰⁷⁶ 17:56	1	8:55***19:30				1379 TERM
O9				369		(ORIG	19				14:09 14:44			IAH 1034 I	AH 7W			1281 TERM		TERM 1379 TERM
O10					ORIG 425		515 LGA 515 C DL 31840 00	LGA CR9	MSP 632 MSP		LGA 794 LGA DL CRS 13:14 3642 14:00	A .	LGA 906 LGA DL CR7 15:06 5099 16:00		1050 1075	:05	LGA 1158 LG DL CR 19:18 6227 20:0	A	1281		TERM
010			<u> </u>		425		08:35 3840 09	9:15	10:32 ⁶⁶⁷ 11:07		13:14 3642 14:00	ol	15:06 5099 16:00		1075		19:18 6227 20:0	00	TERM		



AADO A21 A23 A23 A24 A25 A26 A27 A28 A29 A29 A29 A29 A29 A29 A29	22:10 RIC 1922 RIC 319 22:40 S50 22:10 TERM 2070 219 22:25 783 TERM 1 SFO 321 22:20 499 DEN 365 321 22:21 38 1788 321 39 1788 321 30 1788 321 30 1788 321 30 1788 321 30 1788 321 30 1788 321 30 1788 321 30 1788 321 30 1788 321 30 1788 321 30 1788 321 30 1788 321 30 1788 321 30 1788 321 30
A21 A22 Barrier Barr	7 FLI 2005
A22 A23 A24 A25 A26 A27 A27 A28 A28 A29 A29 A29 A29 A29 A29	7 FLI 2005
A24 1	1922 319 22:40 MSP 321 SECOND TERM 5 M 2070 319 22:25 783 TERM 6 SFO 7 321 22:20 499 DEN 12:22:0 490 DE
A24	MSF
A25 Cuts(dec) 1	5 M 2070 CLE 319 2225 783 TERM 1 SF0 7 321 2220 499 DEN 1865 321 8865 321 887 887 887 888 321 39 1788 321 39 1788 321 39 12 39 13 39 12 3
A26	2070 CLE 319 2225 783 TERM 1 TERM 1 TERM 1 TERM 1 TERM 1 TERM 1 TERM 2 223
A27 A28 CLISCORD SN (KLISCORD SN (KLISCO	22-25 783 TERM 1 1 1 7 SFO 521 22-20 499 DEN 525 22-21 557 MCO 521 521 521 521 522 522 522 522 522 522
A28 CLISCALIS SALE A29 CLISCALIS SALE CLISCALIS	1 SFO 7 321 2220 499 DEN 1865 221 2223 357 MCO 357 321 357 MCO 32 1788 321 39 2235 12 331 12 331 22 15 22 15 23 15 SSM
A29 CLINGRIG LOW SAA 1944 033	7 321 2220 499 DEN 865 2225 57 321 22.19 38 ORD A 1788 321 22.15 12 321 22.15 DEN
A1	22.20 499 DEN 8865 22.25 857 321 858 ORD A 1788 321 22.35 12 321 22.15 988
A3	1865 2223 187 MCO 187 3211 22.19 DS ORD A 188 321 31 22.23 12 321 22.15
A5 CLISCA, MCI ORIGO A7 A B B B B B B B B B	22.19 DS ORD A 1788 321 339 22.235 BOS 12 321 22.15 SSW
A7 CLTSG _{RIG} RDU AA 883* 321 AA 521 DEN AA 883* 321 AA 521 DEN AA 883* 321 AA 521 DEN AA 883* 321 AA 88	BOS 22:15 22:15 RSW
17.05 7.50 8.10 9.25 10.25 11.45 12.04 071 15.01 15.32 17/2 14.35 15.35 70.5 16.40 16.45 20.15 12.12	22:15 RSW
CLISC4ORD BWI TPA PHL 926 LAS DEW ATIL PBI BWI SEA 2107 SEA TPA 720 LGA HATI RSWI SEA	1863 RSW 321
7:10 1916 7.55 8:20 9.35 11:20 12:27 13:24 13:32 14:50 15:16 443 52:1 17.20 1740 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 17:10 18:40 19:02 20:00 18:40 18:	22:26
A11 CLISCORIG MSY A12 A14 A157 B157 B164 B178 B188 B178 B	1998 ATL 738 1897 22:40
A13 DTW 925 FNT AA 100 1924 11-35	BDL 321 22:09
8.46 9.55 10.39 1845 15.09 16.10 17.01 18.15 19.20 1970 20.29 21.18	TPA 321 22:15
A10 LAX 696 TPA MCO SFO RSW PHX MCO SFO RSW PHX 1882 PHX 1885 MA 461 321 AA 461 321	PHX 321 22:15
6:14 2037 9:45 10:13 2033 11:20 12:23 1447 13:26 15:25 16:25 17:00 009 18:10 19:20 17:83 2029 21:26	PHI. 1796 321 22:25
A6 PBI DEN ATT A 1862 321 AA 445 321 AA 1862 321 AA 1862 321 AA 651 319 AA 65	DFW 321 22:10
A4 BOS BOL AX BOS BOL AX BOS BOL SIL AA 1982 321 BAS BOS BOL SIL BOS BOL SIL BOS BOL SIL BOS BOL AX BOS BOL SIL BOS BOS BOS BOL SIL BOS	4 321 22:20
$\frac{1}{100}$	1737 321 22:20
B1	MIA 738 22:30
B3 B08 LAS 1980 321 AA	PBI 319 22:11
B5 SU 1376 SRQ PVD 1AH SVU 1376 SRQ PVD 1AH SVU 1376 SRQ PVD 1AH SVW BWI AA 1364 738 AA 1496 738 AA 1496 738 AA 1496 738 AA 1496 738 B47 7.459 S47 9.53 [10.50 1404 11.40] [12.28 13.20] [15.05 16.25 [16.55 17.45] [19.04 17.20]	PVD 738 22:05
B7 MA 2448 ORD PIT 1829 DFW AA 321 AA	JFK 738 22:10
B9 BUF BUF BUF S29 DTW ATL LAH AA 2042 738 AA 2042 738 AA 2045 738 AA 2065 738 AA 2065 738 AA 2065 738 AA 2065 AA	22:15
B11 SMF 476 MBJ AA 476 AB40* 9.25 NO.02 1458 7189 SMF AA 1710 319 AB 1725 1950 1313 FERM SMF AA 1710 319 AB 1711 785 BD AB 1710 319 AB 171	321 22:10
B13 DTW BUF AA 330 PW DCA RIC AA 2077 319 AA 2077 319 AA 2077 319 AA 30 PW AA 31 P	ALB 319 22:15
B15 ROL 1751 SLC 1924 1846 1848 1849 1848 1849	22:10
B16 PHX 2020 DFW AA 2021 BDL CLE AA 1780 319	319 22:35
B14 SLC 2014 PIX A1 1978 NAS STL DTW AA 1923 319 AA 1923 319 AA 1923 319 AA 1923 319 AA 1934	319 22:00
7:12 8:00 8:15 82.9 9:30 10:33 11:50 13:26 14:15 17:04 18:15 19:09 13:70 20:10 21:12	952 319 22:25
AA 1968 337 AA 1968 337 AA 1968 357 AA 196	5563 FERM
B8 MCO	AA 1854 321 21:50 22:45
634 730 843 9.55	1870 319 22:16 DCA
B4 PIT PVD STL PIT PWM ATL PWM ATL PWM ATL PVD PWM ATL PWM	319 22:14 LGA
B2 SEA 624 LAS IND BDL AA 1756 319 AA 1756 319 AA 1847 319 AA 1848 319 AA 1848 319 AA 1847 319 AA 1848	319 22:04 SC4 SYR
	SC4 SYR PULL 15 1971 22:20
838 1978 935 [1028 1977 1130 [1340 1789 1425 [1535 1540 1915] TERM 2120	1793 319 22:25 ICI ORF A 1785 319
8:16 2529 9:06 9:23 993 10:15 10:39 11:40 15:39 16:30 PUSH 18:54 1029* 20:00 20:32 1002 21:17 21	A 1785 319 1:40 22:40 973
C8 ATL A469 321 AA 1784 319 AA 1868 319 AA 1784 319 AA 1868 319 AA 1868 319 AA 1784 319 AA 1784 319 AA 1784 319 AA 1784 319 AA 1868 319	TERM
821 413 935 10-51 1434* 12.00 15:10 16:55 736 20:00 TERM	4
C12	
C14	
C16	
AAIN CLISCA _{MOS} CUN MBJ *\$60 LAS MBJ *\$27 MIA	
CLISC4_RIG CUN AMBJ *869 LSI AA 1921 AA 1921 AA 1927 AA 1927 AA 1921 AB 1921 A	SJO CLTSC4
CITSCO _{RIG} PUI AA *860 HAY AA *368 NAS ABU *87,5135C5 ABU *880 ORI ABU *37,5135C5 ABU *37,5135C	SJO *1850LTSC4 21:55 TERM 22:40

Date:04/11/2019 Time:12:58					С	LT 2028-S	cenario 2	2										age # 2 of 4
	00:00	01:00 02:00 03:00	04:00 05:00 06:0	0 07:00	08:00	09:00	10:00	11:00 12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00 2	1:00 22:00	23:00
	1 1 1									+								
13				CLTSC4 ORIG CUN 6:55 804* 7:45	 		PLS *8	42 KIN 319 40* 12:00		111111111111111111111111111111111111111		PUJ *	*1963 ATL 738 787 17:50	CUN	*886 PBI 321 2061 19:55	PUJ *1968		
				6:55 804* 7:45 CLTSC4ORIG MBJ 6:55 843* 7:45			10:00 104	12:00				16:21	787 17:50	18:40 SXM	2061 19:55 *866 BNA 320 1867 19:49	PUJ *1968 20:16 TERM 21:01 CUN *888 CLTSC4 20:29 TERM 21:14		
14				6:55 843* 7:45				MEX *1844 SDQ				HAV *1074	BDA	SDQ *639				
I5						KI	IN *054 PAP	AA 101 319 11:00 1853* 12:00				HAV AA 16:05 1028	319 17:30 PUJ	AA 18:00 1865* *19	k 19:30	SXM *613CLTSC4 20:24 TERM 21:09		
l6						A/ 9::	IN *854 PAP A 319 55 1647* 10:50	V *1202 SIO					AA 17:42	64	43 20	321 0:05	SDO	
17							AA 10:5	*1283 SJO 321 1087* 11:55						AA 18:14	*822 DCA 320 856 19:44	UVF AA 20:15 *1342 874*	321 22:00	
18					SDQ *183 AA 982	39 UVF 321 * 9:45								MEX AA 18:35	*828 ME 1768 31 20:0	9		
I10				, ,	GRU *1062 CLTSC4 IA PUSH 332 150 PUSH 8:50				FRA *705 CLTSC AA 78 13:00 PUSH 14:0	24 39 00		LHR AA 16:15	*731 730*	LHR 789 18:40	CLTSC4 PULL AA 19:00 1568*	GRU 332 20:30		
I11											F A	CO *721 CLTSC4 A 789 5:55 TERM 16:55						
l12											F	CO *721 MAD A 789 5:55 748* 16:40		BCN AA	*745 744*	BCN 332 20:45		
I13											MA AA	.D *7	749 DU 33 24 18:0	JB LHR 32 AA	*733 732*	LHR 789		
114									<u> </u>	CDG AA	*787 704*	FRA 332	24 18:0 CLTSC4 PULL AA 720*	FCO 789	132.	20:15		
I15									DUB AA	13:55	704* 725 786*	16:35	16:55 720*	18:25 CDG 332				
OADO									13:05		786*			18:20				
	1078		CLTSC4 HOU CLTSC4 MDW	CLTSC4 BWI		BWI	DAL	BOS ₁₂₄₅ BOS				BOS 8021 BOS	S HO	OU ₁₇₄₇ HOU	DAL BWI		2808	
01	1078 TERM 9		CLISCÁRIG HOU CLISCÁRIG MDW 4:40 643 5:25 5:45 1010 6:30 DEN 201	6:55 A773 7:40 DEN	ELTSC4 _{RIC} DEN	3055 9:35 10	0:10 JFK 219 JFK	10:59 ¹²⁴⁶ 11:36	1	BNA 5136 BNA	PHL M	BOS 8021 BOS E90 16:00 8016 17:00	0 17 DW ₈₅₃ MDW	7:55 ¹⁴⁹³ 18:30	1721 18:55 19:30		2808 TERM	5812
O2	TEF	RM	5:10 200	319 7:20 7 CLTSC4 SLC	CLTSC4 DEN ORIG :50 8:35	. ATL	B6 218 E90 10:01 218 10:40	ISP 354 ISP 519 11:20 353 12:05 DTW DTW		BNA 5136 BNA WN 738 14:00 684 14:45	F9 1689 15:21		:50 ¹⁷⁴⁸ I. ATI	ATL	ATL	ATL	100	TERM
O3	1441 TERM		CLTSC4 DTW CLTSC4	7:00 SLC 7:45 ATL CLTSC4	9.49	2422 73H 9:30 DTW DTW	DL 1454 M90 10:03 10:45	DTW DTW DL 1629 319 12:07 12:50 ATL ATL DTW DL 1629 319 12:07 12:50	ATIL	1503 14:24 14:59	ATL ATI	ATL 602 ATI DL 73F 16:18 2651 17:00	DL 0 17:50	826 73H 0 18:45 DTW	DL 1407 19:09 20	73H 0:05	103 TEF	M TE
O4			CLTSC4 _{RIG} DTW CLTSC4 _{RIG} 5:15 1366 6:00 6:15 ²⁴⁸		8:05	DTW DTW 2292 9:04 9:39	F9 1028 320 10:11 10:59	DL 2251 717 DL 109	95 717	477	ATL ATL DL 2133 73H 15:04 15:45	DL 1: 16:40	322 320 524 17:20	1 18:40	DTW 1057 19:15		8017 TERM	TERM
O5			CLTSC4 ATL CLTSC4 ORIG O 4:45 823 5:30 6:03 1712 6	ORD SFO 170 UA 7:21 190	04 SFO 739 8:20		8025 BOS E90 10:51		13:42	2597 320 14:30	DL 15:40	603 MSP 319 1793 _{16:30}	BOS 1445 BOS E90 17:18 1446 18:00	B 13	8:50 19:28			876 TERM
O6			CLTSC4 BOS 5:33 8022 6:18	CLTSC4 OR 7:30	IG ATL 91 8:15	ORD 425 UA 521	73G 10:15		ORD 1484 ORD UA 319 13:00 1140 13:45		DEN 1711 UA 1199	DEN 320 16:22	SFO 11' UA 16'	76 SFO 739 18:30		TTN 933 TTN 320 20:25 932 21:10	1286 TERM	1974 TERM
O13																		
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AEDO																		
D13			PHF	5190 PHF CR2 5557 7:35	PGV AE 8:11 5187	PGV CR2	EVV 52 AE 51	241 MLB OAJ 5176 OA AE 12:05 5314 13:0	AJ MGM 544 R2 AE 515	1 SDF CR2 4 14:25	FAY AE 15:26 40	31 IND CR2	FAY AE 17:05	5486 5172		GNV AVL CR2 AE	5326 CAK CR2 5124 CR2 52:05 22:27 22:27	AEX
D12			6:30	735	MGM AE	5293 MGM CR2 5440 9:45	10:25	SDF 50	000 [13:18 3134 093 323	IND CR7	EVV 5032 AE 15:23 5366	EWN	TYS AE	5119 5256	FAY CR2	20:25 20:55 HTS 5461 20:15 ⁵⁰⁴⁹ 20:15 ⁵⁰⁴⁹	DAY 5156 PGV AE 5118 CR2 21:31 5118 22:40	
D10				GNV 5228 LEX AE 5039 CR2 6-52 7-30	FAY AE	5273 TYS	CHA AE	5277 EVV CRW 5237 BHN		5120 PHF CR2 5052 14:25	GPT 5095 CID AE 15:05 5096 15:50		5063 CAI 5259 18:0	K	19:50 CRW 5148 FWA AE CR2 19:055405 19:49	MEM 5265 MLB AE 5141 CR9	LEX 5264 MGM AE 5298 CR2 21:36 5298 22:41	
D8				6:52 50.59 7:30 CAK 5355 CHA 7:08 5277 7:43	GSP 5235 AE 5509	5297 9:35 IAD CR9	10:46 LEX AE 50	5032 11:35 AE AE CR AE AE AE AE AE AE AE A	00 13:43 CAE CR2	MYR 3777 AVL AE 4011 CR2	OAJ 531	⊿MGM AV	5259 18:0 VL 4011 CAE E 3775 CR2 5:52 3775 18:00	14	19:05 5405 19:49 CHS SRQ AE 5227 CR9	20:05 20:45	LH_5211 LFT	
D6				505	8:18 5509 8 MLI	9:09 3 5175 HPN CR7 5384 9:30	PULL 5343	63 11:20 12:25 3960 13 BHM 5142 AE 5310		14:01 4011 PGV FAY AE 5117 CR2	ORIG 3973	22 16:19 16	5:52 3775 18:00 PHF 5052 AE 17:22 5264	LEX SHV 5514 5254	TI II MCM	5222 5304	1:15 ²⁷⁶ 21:46 MOB CR7	
D6			52	PUS 279	H 8:47	5292		PULL GNV 5371 TY 5117 12:25 5305 33:0	13:10 /S GPT	14:07 3486 14:45	0	OAJ	FWA 5135 DAY	18:14 18:30 ⁵²⁵⁴ 1 AVL	4769	TRI CP7	5186	
			PU	JSH	CRW 5347	PUSH	MSN		00 AE 13:37	522	6 MGM 5366	16:14 LFT	17:11 5156 18:00 BHM	AE 18:42 5311 CHA	2 4895 TRI 4786	20:15 EWN	TERM 5099	
E1		5006		CRW	CRW 5347 AE 5142 5263	LFT	VPS 5157	5231 5104 CHA RAP 5514 DAB		CR7 14:33	4:57 5096	CR7 16:20	AE 17:45 S	5186 CR2 18:25	AE 19:00 4755	PULL TYS	TERM 5037 AVI	
E2		5006 PUSH		AE 6:45	5335	CR7 9:36	AE 5170	E75 AE 5514 CR9 11:14 11:40 12:20 CMH 45:	20 MCII Fra	YS 5204 TYS	15:07 3865 I6:	05	AE 4522 E75 16:59 17:50			5468 20:59	5100 CR7 5100 22:25	
E3				4720	4025	ORIG 5452	PHF AE 55: 10:39	11.10		YS 5294 TYS E CR2 1:51 5119 14:35	AE 15:17 395	08 MKE CR7 59 16:35	AE 17:31		49	892 025 her suu han	CR7 22:25	
E5			LYH AE 6:22	4738 OAJ CR7 4889 7:40	4935 DA TERM 8:	51	5122 5364	PHF CR7 11:45 AGS 5396 AE 5135	CR7 13:10		327 EVV 204 CR7 16:00		CHA AE 17:21	5508 5233	OAJ CR7 19:45	AE 5411 CR7 AE 20:00 20:58	5257 BTR CR7 5407 22:15	
E7			EV AI	WN 4921 GSO CR7 4826 7:50	LEX AE 8:30	533° 5514	4	JAN CR7 AE 4751 LY AE 11:20 12:12 4804 13:		5110 5150 5459	GNV HPN CR7 AE 15:15 15:44	5526 HPN CR 5166 17:00	ROA 4829 7 AE 17:16 4798	18:30	BHM 3 AE 19:23		3775 MKE CR7 4056 22:05	
E9			AG: AE 6:31	7.00	LFT AE	53 50	90	CAE TYS 5297 11:19 12:20 5512		5463 VPS 5 5453 CR7 14:40	NA 5569 ICT VPS AE 1:55 196 15:32 IS:	5 5138 HTS	CRW 474		4842 SBY CR7 3 4835 19:50		OAJ 4931 LYH AE CR7 21:24 4922 22:30	
E11			0.53	TRI 4867 HHH AE 4942 7:35	TRI 48: AE 48: 8:16 48:	52 LYH	MOB AE	5506 5514	SHV CVG 54 CR7 AE 52	466 HSV CR7 319 14:25	EWN 4773 AE 4779	LYH I CR7	TLH 5218 GNV AE 5202 17:55	BTR 5500		YUL ROA CR7 AE	4807 ROA CR7 4799 22:05	
E13				ROA 4776 FAY AE 4776 CR7	HPN 51 AE 8:22 52		SHV AE	5546 BT. CR 5364 13:0	TR AG	S 5263 DAY CR7 49 5123 14:41		5582 GPT CR7 5083 16:40	CID 5456 CII AE 5429 18:0	D MSN 27 AE	19:05 19:21 391 5437 CAK CR7 3 5306 19:45	LGA 4460 BTV AE 4582 E75	HH HHH E 4943 CR7	
E15				HHH ₄₉₁₅ ROA	MDT 4669	251 9:35 CMH MLI E75 AE	5111	GRR SAV 5185 CHA	AEX 5375 ^{AEX}	HPN 5384 MLB	PHF 5364 AE 5283	LEX CR7	5431	18:4 ORF AF	3 5306 19:45 5209 AGS	20:00 20:40 2	BTR 5074 EVV AE CR7 21:35 5038 22:40	
E17			CHS	6:56 4763 7:30 5246 SAV CR9 5295 7:45	8:08 4538 LYH 4886	9:10 9:40 SBY CR7	5514 CID 53	11:30 12:07 5582 12:50 HTS 4866 AG	13:14 13:46 GS FLC	14:02 5302 14:50 0 4904 ROA CR7 48 4829 14:35		5132 JAN 5257 16:35	TERM EWN 4939	ROA 18:4	3 5398 CR7 MLB MSN AE 5230 CR7	GP	21:35 5038 22:40 5083 SRQ CR7 0 5393 22:14	
C1/			AE 6:18	5295 CR9 7:45	8:12 4831	9:20	10:18 54	123 CR7 AE CR 12:18 4805 13:0	01 AE 13:4	48 4829 14:35	AE 15:44	5257 16:35	AE 17:24 4807	18:15	18:52 CR7 18:52 19:54	AE 21:	0 5393 CR/	

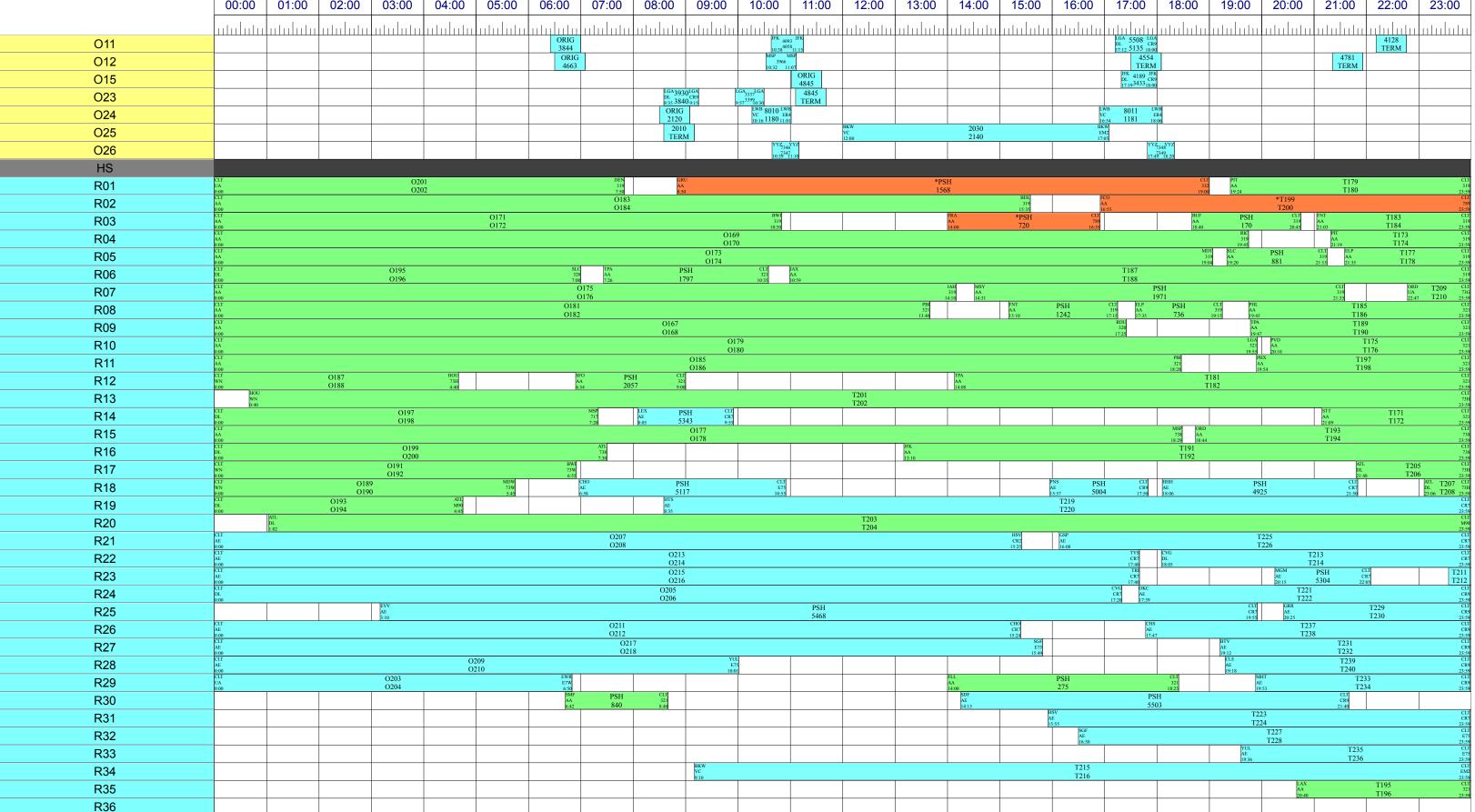
Date:04/11/2019 Time:12:58									CL1	Г <mark>2028-</mark> S	cenario 2												Pag	e # 3 of 4
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E19			+				MYR 53	357 CHS CR9 7:40	EWN 488	4 TRI CR7	FAY 4934	FLO CR7	GSP 5067 LEX	MOI 7 AE	5251 LEX CR7 5078 14:25	PWM 5572 GRR AE 5572 CR9 15:10 5567 15:50		HTS 4759 HHF AE 4759 CR 17:18 4813 18:0:		CAK AE 19:18 5143	VPS CR7	LYH 4798 LAE 21:26 4744 2	WN CR7	
E18							SAV 5	5452 MYR	OAJ 5113	FI 9:40 CVG CR7 9:20	10:07 4904 OAJ AE	11:33 4889 EWN	GSO 4903 TRI AE CR7 12:17 5153 12:59 GSO 4903 TRI AE CR7 12:18 4765 12:59	9 13:4: I B1	R 5225 BHM	TRI 47	65 AVL FPC	5077 FAY	5	AGS 4907 AE 4870 2	20:20 FLO CR7	MDT 5180 AE 5556 2	2:30 PHF CR7	
E16							6:36 5 GSO AE	5389 7:40 5026 CR9	MOB 5	278 AGS	PIA 5349		12:18 4765 12:59 LYH AE 4820		47 5311 14:30 4831 CRW 4749 CR7	ORIG	69 16:24 16:4		5513	19:09 4870 2 GRB CR9	0:09 MLB 54 AE 20:30 52	21:29 5556 2 31 MOB LGA 5 07 21:30 LGA 5 22:015	2:30 066 GSO CR9	
E14							ORF 5460 AE 5268	7:50	AVL 5365 AE 5152	396 9:45 CHO	GSO 4826 R	ROA	TRI 4841 RO/	13:12 13:39 A CRW 4824 AE 4759 01 13:25	14:19	4809 KR7 AE 4862 CR 15:20 4842 16:0	16:20 A	ORI	G GSI	P 3833 MKE CR7 49 3889 19:44	20:30 52	07 21:30 22:01 5 MOB 5060 AE 21:40 5520	112 _{22:45} LEX CR7	
							6:27 5268	7:24	0	9:19 RIG	BTR AE 5507 A AE 5503 110:34 5263 11	1:14 AGS	EWN ₄₉₃₆ F 12:29 ⁴⁸⁶² 13	13:25 4759 FLO JA	4:05 14:25 5272 15: N 5071 CPA	LYH	4804 TRI	LFT 5064 MLB	DAB 5215 OKC	PGV 4869	LYH FWA 54	76 LEX 5256	22:35	
E12							SDF	5342 STL	5	129	10:34 5263 LI	1:14 IT 5183 EYW			47 5508 CR7 47 5508 14:27 CHA 5179 ORF	CHO 5048 CAE 5239	4786 16:30 AE	16:58 5376 17:40	AE 3313 CR9 8:00 5258 18:45	19:15 4780	0:10 AE 20:30 52	35 21:30 TERM GNV 5202	СНО	
E10								5342 STL 5073 7:40 399 IAD	SRQ 5390 TLH AE CR7 8:04 5091 9:00	ROA 4790 GSO AE 4903 9:55 3850 CAE CR7	AI II MKE	3896 SDF	RDU 5415	091 MSN CR9 437 13:34 AVL	AE 5110 CR7 14:01 5110 14:40	15:30 16	:10 6 AGS	AE 17:38 536 ORIO	1 18:20	LYH 4779 CHO AE CR7 18:59 4885 19:49	1777 HTS	GNV 5202 AE 5287 2 21:20 5287 2 MKE 3959 CAE	2:30	
E21								373 CR9 7:30 DAY 5328 CLE	8:50	3814 CR7 9:45 5232 MSN	AE 10:48	3798 CR7 11:40 5468 GPT	RDU 5415 AE 12:19 5288 CHO 5152 AV	CR9 13:20 13:4:	4800 CHO 4743 14:19 OA ₄₈₇₀ EWN	ROA 492 AE 490 15:41 PIA 51	10.19	4790 AEX 5060 FWA			1767 20:30	MKE 3959 CAE AE 21:37 4010 22:20		
E23							PE	AE 3328 CR2 7:14 5282 7:50 HL 3899 CAE	AE 8:51 CAK 5242	5060 9:45	10:50	5462 11:40	CHO 5152 A AE 5086 13: ILM 5107 AV	CR9 E:05 LVP	OA ₄₈₇₉ EWN 3:50 ⁴⁹³⁹ 14:25 HHH404_HHH	PIA 51 15:43 ⁵³ AGS 400	10 16:20 . PGV	AE 5000 CR7 17:05 5324 17:45 MOB 5512 MOB	0.	19:16 5221 CK7		3945 ORF CR7 3904 21:30 HSV 5050 PIA		
E25							Ai 6:	E 3899 E75 558 3908 7:45 4544 DTW E75	AE 8:37 507 AGS 5439 BTR	1 9:30	CAE 3908 AE 3777 ROA-CHHH	E75 11:19 IAD 5373 SAT	AE 5107 CF 12:13 5189 13:1	R9 :04 5.450	HHH ₄₈₄₄ 13:56 14:30 CMH	AGS 480: 15:40 ⁴⁸⁶ JAN	16:16 CRW	MOB AE 5512 CR7 17:10 17:49 CHO CHO CHO FLO	Ai 18	AJ 5226 SDF E CR7 8:53 5477 19:49 CHO ₄₈₀₉ ROA	GSP	HSV 5050 PIA AE 5041 CR7 21:06 5041 21:45	BNA	
E27							AE 6:38	4542 7:45	8:21 5225 CR7	9:24 9:59	ROA ₄₇₆₃ HHH 10:21 ⁴⁸⁴⁴ 10:55	11:10 5210 CR9	AE 12:10 STL 5072 ILM	5458 5087	CMH CR9 14:24	JAN 5514 15:40	16:15	CHO ₄₉₁₈ FLO 17:01 47777 17:35	DSM	19:10 19:44	AE 19:59	5336	CR9 22:40 CHS	
E29							AE 6:51	4661 IND E75 4531 7:55	HSV 5329 8:33 5185	9:19	10:45 5	5290 CLE CR9 5436 11:35	STL 5073 ILM AE 5073 CR9 12:10 5345 12:59		5245 PNS CR9 5212 14:50	3909 TERM		DSM AE 16:58 5276	CR9 18:45	GNV ₅₂₅₂ BTR 19:18 19:50	MUI CID	MYR 5449 NE 5114	CR9 22:35	
E31							love	pund	ORIG 5573	YYZ 4464 BNA AE E75 9:19 4684 9:59	HHH 494 10:4 ⁴ 81	42 KW 16 11:19	IAD 5509 AE 12:29 5243	CR9 AE 13:33	5372 MEM CR9 5494 14:40	4933 TERM	CIVIC	AE 16:56	5253 5421	uci cumi	CR9 AE 5 20:22 20:40 5	530 GPT CR7 5090 TERM		
E33							6:50	3967 BHM E75 3819 7:35	CAE 3826 HSV AE 3906 9:09		ORF AE 10:47		5252 5285		1LM CR9 14:35	CVG 5166 AE 5229	CHS CR9 16:20	MSY 4662 CMH AE 4506 E75 17:08 4506 17:50	A 1	MCI 4675 CMH AE E75 8:55 4624 19:44		OMA 4556 IND AE E75 21:05 4495 22:05		
E35							OR 520	RIG 61	FLO 4914 AE 4936 8:43	9:24	OMA AE 10:41	5253 5266	6 12:59	9 13:32	247 DAB CR9 315 14:25		3190 DSM AE 16:45	1 5	5378 5036	SAT CR9 20:00		CHO 5552 AE 5177	CRW CR7 22:35	
E38								ORIG 5547	IC AI 9:0	5316 5164	CMH FLO CR9 AE 48 10:30 10:45	350 AVL 800 CR7 11:25	DTW 4542 1 AE 12:23 4510 1	MDT SRQ E75 AE 13:10 13:37	5139 SAV CR9 5151 14:27	GRR AE 15:50)	5043 5236			5077 TERM			
E36							CV AE 6:5	/G E 56	5341 5116	OKC CR9 9:20	TUL AE 10:50	5054 CR9	PGV 5187 CHO AE E75 12:05 5048 12:49		S 5433 CHS CR9 15 5181 14:35	MHT TLH AE 5072 CR9 15:02 15:59		CAE 3957 AGS AE E75 17:03 4001 17:55				CAK 5259 AE 21:35 5438 2		
E34								ORIG 5082	BHM 5346 G 8:30 5237	CRW CR2 9:20		4484 CMH E75 4457 11:45	AUS 5171 LIT AE CR9 12:05 5395 12:50	TVC ₅₁₆₇ BTV 13:10 ⁵³¹⁴ 13:44	GRR 5533 ATL AE CR9 14:05 5192 14:55	DAB AE 15:30		5460 5053	LIT CR9 19:00	YYZ 3834 AE 19:17 3968	CAE AGS E75 AE 0:10 20:38	4001 3795	GSP CR7 22:40	
E32								ORIG 5290	AEX AE		5117 5502	VPS CR9	FAY 5487 CHS AE 12:10:508412:54	5	092 JSH	CMH 4457 II AE 4674 16	.M 275	LEX 5078 AE 17:25 5552	CHO E75	IAD 55 AE 52 19:26 52		IND AE 4476	MSY E75 22:35	
E30							CHA AE	5165 5457	JAX CR9	CVG AE 0-10		OMA CR9	MYR 5289 MYR AE CR9 12:15 5053 12:59	9	SYR 522 AE 534	3 CLE MLI		5267 5514	RA CF	AP DAB R9 AE	533 523	5 CHA 8 22:20		
E28							0.29	ORIG 5252	CHO 4876 HTS AE 4866 CR7 8:15 4866 9:00	SGF AE	5177 5037	TVC CR9	MEM SYR AE 5184 CR9	1	IT 5033 MKE LE 5098 14:40	AUS AE		5200 5456	SGF CR9 18:50	03 [19.36	323	AUS 5301 AE 5299	MEM CR9	
E26								3232	ORIG 5531	BHM AE	5204 5033	OKC CR9	CLE 5282 GNV AE CR2 12:05 5063 12:50			386 244	CVG CR9	MDT 4510 JAX AE 4510 E75 16:56 4662 17:59	18:50	TLH AE 5420	GSO CR9	5069 TERM	22:35	
E24								ORIG 5432	SAV 5130 MR AE 5267 9:	9:15 EE LNK R9 AE	5415 5575	PNS CR9	IND 4470 G AE 12:12 4537 13:	iSO E75	ORF 5081 MYR AE CR9		5370 PNS CR9 5094 16:44	16:56 4002 17:59 CVG AE	5398 5040	19:19 1 1	0:10 CT GSO R9 AE	5121 DAY CR9 5374 22:05		
E22								ORIG	CHS 5207 AE 5289	MYR CR9	BHM 535 AE 10:13 547	11:25 56 PVD CR9	CAE 3814 FAE 12:22 3831 13:	E05 FAY E75	MKE 5267 ABE	PNS AE	559 500	17:00	AUS SAT CR9 AE	5210 5335	CLE PN CR9 AI	5374 22:05 S 5094 CVG CR9 -55 5109 22:05		
E20								5079	ORIG AVP 529		ORIG DAY	5042 XNA	12:22 3831 13:	:05	13:56 5140 14:45 PNS 5255 DTW AE 5255 CR9	AVL AE	5086 5180	MDT CR9	18:25 18:40	DTW 5435	20:30 20 ABE CR9	CHS TYS AE 5138 CR9		
E8							ILM 50 AE 6:41 50	096 CMH CR9	JAN	5194 IND	SRQ 5102 AE 5322	AVP CR9	PULL 5172	DAB AE	13:56 5434 14:45 5317 IAD CR9	MYR AE	5053 5066	17:55 LGA CR9	ATL 527	76 GRR CR9 19:45	20:15	21:00 22:09 JAX 4636 YYZ 21:33 4554 22:10		
E6							6:41 50	061 7:29	SDF 54	95 PNS	10:10 5322 MHT 51 AE 51 10:30 51		5172	13:40	5031 14:25 IND 5568 AUS AE CR9	15:33 CHS 500 AE	34 LIT	17:25 PWM AE 5034	18:05 555 ILM CR9	SAV ORI AE 5056 CRS		CVG 5281 I	BHM CR9	
E4									8:32 52 MYR AE	55 9:45 5431 SYR CR9 5260 10:00	XNA 535	50 BHM		ABI	14:01 5301 14:45 5191 CVG CR9	15:30 508 CLE 5436	MYR	AE 5034 17:10 5070 OMA AE 5131	18:25 SAV PN: CR9 AE	S 5212 CVG CR9 50 5303 19:45		XNA 5236 AE 21:33 5161	2:30 MYR CR9	
F1									8:47 GSO 54	117 CAK	10:28 517 MEM	5474 PWM		10.	45035 CR9 45035 RIC 8V 5051 CR9	GSO 453		AE 5131 17:06 5288 SDF CR9 5 5049 17:54	18:20 18: ME	50 5303 19:45 50 5494 CHS CR9 50 5318 19:44	FAY 5105 HSV AE CR7 19:59 5224 20:40	21:33 5161 LIT 5088 SDF AE 21:18 5334 22:20	22:40	
F2									LIT	245 9:45 5158 SDF CR9	10:43 CLE AE 5080	MDT		OKC 5504 MY AE 5527 CR	3:50 ⁵³⁷² 14:30 R GRB ₅₅₃₁ ABE	15:30 449 SAV	8 16:27 16:45 5266 STL CR9 5069 16:35	5 5049 17:54 SYR AE 5377	CHS CR9	TYS SAV AE 5144 CR9	19:59 5224 20:40	SRQ 5161	JAN CR9	
F3						GSI	P DCA		PNS 53	5330 9:50 43 FAY	10:21 OKC	11:25 IAD CR9		13:18 5527 13:5 SA	7 14:22 ⁵²⁸⁶ 14:59	MDT CMH AE 5064 CR9	5069 _{16:35}	DTW AE 5249	18:20 MYR	19:01 19:55 IND 5189 GSP		21:39 5333 CLE 5331	22:35 ILM	
F4						5:57	3802 7 6:32		8:38 54 ORIG	2110	AVP 5160 AE 5370	11:45		13	148 5265 14:26 ICT 5103 MHT	15:07 15:59 OKC 5116 SD OF GREAT	F C	17:22 CAK 5242 CLE	18:20 GSC	18:58 5155 19:50 5418 DAY		ORF 5455 AVE AE 5455 CRS	22:35	
							TYS	GSP	5136 TYS 5344 L	IT	DSM 5129	11:20 ILM			14:07 5565 CR9 14:07 14:45 CMH ₅₄₁₄ TUL	15:14 5300 16:0 BHM 5178 IAD	5 10	AE 3243 CR9 6:53 5331 17:50 ILM 5285 ORI	18:4	49 5101 19:40 MYR 5170 PNS		1AD 5286	SAV	
F5							AE 53 6:24	354 CR7 7:45	TYS 5344 L 8:22 5033 9: CMH 4547	R9 15 YYZ	DSM 5129 AE 5270 1 ABE 513	CR9 11:16 34 MEM		V	14:00 ⁵⁵⁴² 14:35	15:10 5502 CR9		17:14 5455 18:05	5 5154 AVL ILM	19:00 5103 19:50		AE 21:21 5451 2 CMH 4554 CMH	2:30	
F6									8:36 4546	9:27	AE 10:39 505 SAV 55	58 _{11:25}		A 1:	E 522	3 16:00 PIT	SAV	RIC 5321 BI	5326 _{18:30} AE 18:	4572 E75 50 19:45	III	AE 21:14 4579 22:09 VPS 5065 TLH		
F7									FWA AE 540 8:49 GRR 5	76 CR2 9:26 534 RDU	10:38 51	115 CR9 11:35 5061 PIT CR9		BNA	4695 OMA	AE 5043 15:24 ILM 534	16:14	17:19 5563 18	:10	AE 5047 C 19:16 20	R9 05	AE 21:06 5349 E75 22:15 5049		
F8									8:49 5	415 CR9 9:40	10:50	5522 11:45		AE 13:4	4556 E75 RIC 4618 GSO	15:35 54	18 _{16:25}	AE 5286 CR9 17:05 17:55 VD SRQ		5366 TERM	ND ND	TERM 5182		
F9									DAB 5352 8:35 5139 ORIG	9:24 SBY 4770 AVL	CHS 5309 AE 5350 GSP 5467	CR9 11:20 7 FPO			AE 4618 E75 14:02 4695 14:45 YYZ 4546	IAD DAI AE 5035 CR 15:15 16:0		VD SRQ E 5125 CR9 5:51 17:40	087 GSO	MKE 5098 L AE 19:21512720 CVG 5169		TERM 5451	LIT	
F10									5371 IAD 532	AE 47/0 CR7 9:15 4751 9:50 7 GRR	GSP AE 10:10 5593				14:19 4566	E75 15:15 AE 53. 15:36 52. DAY 5115 MEM	36 16:25		087 CR9 121 18:30	19:265307:		AE 3431 21:03 5200 5361	CR9 22:35	
F11									AE 532 8:43 553. BNA AE	3 9.25		HM 3819 HSV E CR2 0:59 3909 11:50			GSP ₃₉₈₉ YYZ 13:54 ³⁸³⁴ 14:30	AE 5113 CR9 15:14 5265 16:00 MEM 505		XNA 5102 CVG	554	ABE 5140 OMA AE CR9 19:06 5248 19:49	5382	TERM		
F12									8:49	5317 9:50	ILM 5082 AE 10:31 5055					15:35 520	8 16:19	XNA 5193 CVG AE CR9 17:04 5281 17:50	554 TER	M SDF	5382 TERM	PULL 5503	KNA	
F13									ORIG 5071		SGF 3706 SGF AE 3706 E75 10:09 3213 10:50		(0 pan	v		AF 15	X 5153 BTR CR7 55 5074 16:45	17:19 5182 18:05	9 5	AE 19:28	530 52		CR9 2:30	
F14									ORIO 5509		AE 10:49	526 545	58 CRS	9		AE 5431 CR9 15:20 16:00			5271 18:30	5163 TERM	5076 TERM			
F15									TLH AE 8:53	5213 VPS 5183 CR7 5183 9:50	MYR 5389 CF 10:22 5051 11:	R9				3	RIG 190	SAV 5070 GSP AE 5070 CR9 17:09 5214 17:50	55 TE	307 ERM	5337 ГЕКМ	h		
F16										ORIG 5294	BTV 4649 RIC AE 10:214618 11:05					15:37	5305 VPS E75 5065 16:45	5181 TERM	VPS AE 18:38	5385 PHF E75 19:50		YYZ 4498 MDT AE 4636 E75 21:22 4636 22:20		
F17										ORIG 5247	TUL 5196 ORF AE 5081 CR9 10:20 5081 11:02					CAE AE 15:22 3833	GSP E75 16:25	YOW 5543 YO E 17:06 5265 18	DW E75 ::10	5814 TERM				
F18									PHF 5383 8:10 5320	GPT CR7 9:20	YUL AE 10:06 3989	GSP CR7 11:35					SAT AE 6:00	5587 5553		LNK CR9 19:45		4796 TERM		
F19																								
07						ORIG 6238		ORIG 6113	EWR ₃₆₉₇ EWR 8:34 ³⁶⁴⁸ 9:09	IAD UA 6	IAD YYZ 7346 150 CR7 10:22 10:30 ³⁴⁷ 1:	YZ 10		LGA 3888 LG DL 3642 14	GA EWR 30 UA 30 14:33 3	542 EWR E7W B56 15:30	ORD	0 ₄₈₂₃ ORD YYZ,	348 348 349 18-20	AD IAD 6160 8:55 19:30				6234 TERM
O8						0230			2010 TERM	p:42	10.22 [10:39 1]:	10	WR ₃₃₆₇ EWR	µ3.14-3-0-12-14	EWR 1AI UA 3314 E7	15.50	16:4	LGA 5508 LGA DL CR9 17:12 5135 18:00	.0.2y	LGA 6224 LGA DL 6227 CR9		6302 TERM		LIMIN
O9							ORIG 3612		LGA3930LC DL 3538409	GA L	LGA ₃₃₃₇ LGA 0:57 ³³⁹⁹ 10:30	IAH 6165 IAH 11:04 6310 11:41	1.52 12:27		IAH 6115 IAD 14:09 14:44	LGA 5096 LGA DL CR9 15:06 5099 16:00		EWR ₃₄₀₁ EWR		19:18 1227 20:00		LIXIVI		
010						ORIG	ORIG		ORIG	15) 9	0:57 10:30 MSP MSI 3966 10:32 11:01	P	BKW VC		2030	15:06 3099 16:00	BI E	KW ORIG				4781 TERM		
						3312	3844		2120		10:32 11:0	7	12:00		2140		17	7:05 4554				TERM		



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	lutulutulutulutu	Intulata	ntulutulutulutu	ladadada.	ladadada			mhinhi						ntulutu	ladadada.		ntulutu	Latalata	Intoloto	ntulutu	
AADO																					
A21				CLTSC4 DFW ORIG 2451 6:00	1		PVD AA 865*	SXM BN 320 AA	821 AU 876* 11-3	BOS AA 20	MIA 44 321					DC AA	A ILM 1979 315		MSP AA 21:04 1998	BWI 320	18 TE
A22				CLTSC4 CORIG CORIG 5:20 2060 6:	GA		ORF OR AA 1770 31	9:25 10: F	MSY AA 833	STT 320	PHL AA	1789 MSP 321			BWI 1915 AA 2038	PVD 7 320 18:15 PU			LAX AA 1717	FLL 321 2:10 TERM	
A23					ORIG PHL 2010 6:35		8:29 9:1 BOS AA 170	FLL 321	BWI 876 GCM AA 320 10:20 821* 11:25	RSW AA	445	1855 321 DEN 321	MCO AA 6.	LAS 37 321	CLTSC4 ORIG	18:15 PU	EWR 1598 AA 2483 2	IAH 808 738 TERN	21:09 CA AA 1	922 RIC 922 319	
A24				5:50	0 2010 6:35 CLTSC4 MIA ORIG 1877 7:00	\	8:28	9:50 SC4 LAX PULL 2057 9:45	10:20 821* 11:25 SYR MSY AA 1909 319	12:00	580	14:20 695 TPA	15:25	16:45 LGA	17:25 1915 1 PHX 436 321	18:10 LGA MSY AA 1809 320	STL 1768 PIT	DERN SJU	753	22:40 MSP 321 2:10 TERM	
A25					CLTS	ORIG PHL	D:	TW 925 FNT	10:11 11:03 CLTSC4 RDU	TPA AA 62	BOS SMF	1810 321 14:50 1154 SAN 321 1583 14:45	LGA AA 494	16:44 PHX DFW 7	20 PHL	18:02 18:55 PDX 1853	19:10 1747 _{19:54} SJC BNA 194	20:23 5 SAT	2039 2	2:10 TERM	
					6:45	1956 7:30 CC4 ROC 868 7:30	MSY 533	A 1109 319 06 1109 9:52	10.55 11.20	PUJ LGA	13:10 13:28 ORD 1051	1583 14:45	15:00 1 N 823 LAS	6:15 AA 16:31 8	30 17:30 1891	17:58 660 19 CLTSC4 1	7320 AA 19:24 733 PVD DFW 56		TERM 724	973	
A26							8:46 508 ORD	PHX LG	ORD 1729 AA 1967* A	321 AA 89 11:50 I2:17	13:05 PUSH PHX MIA	ORD	65 321		PUSH	18:25 ²⁷⁵ 19	9:10 19:35 61	6 _{20:20} TE	724 ERM	TERM 783	
A27					0.43	C4 RSW 928 7:30 C4 SAT	AA 680 8:20 FLL	9:40 10:0 SEA	879* RDU 197	321 AA 628 11:40 11:57 EWR	321 AA 13:00 13:35 LGA	2080 321 14:50 MCO	p	BI	AA 17:40	1841	FLL 321 9:12 TERM	STL	277 TERM	TERM	
A28					6:45	1727 7:30	AA 1912 8:22	321 9:40	10:38 193	321 12:10	AA 13:37	581 321 14:45	A It	A 5:00	294 1673	1	321 AA 9:11 19:45	793 319 20:33	1971 TERM	SEO	
A29					6:50	ORIG LAX S. A.	FO 1944 AA 1946	321 A/ 9:35 10	LL 1735 ME A 32 0:03 826* 11:3	1 AA 184 0 12:06	2 321 AA 13:09 13:30	1760 321 14:30	AA 15:15		1889 1798	l lpwr	3 20:	21 05	AA 557 21:04	321 22:20	
A1					6:50	ORIG FLL EWI OAA 0 525 7:35 7:55	1866	321 9:20	AA 1837 10:32	321 AA 1 11:55 12:14	378 321 AA 13:15 13:30	891 321 14:25	SFO 704 LC AA 2050 16:	21 10	AA 2028 319 16:59 17:54	AA 18:39	416	321 20:20	PHX AA 21:16 1865		
A3					6:	CLTSC4 MCO ORIG MCO :55 1725 7:40	AA 1772 8:13	321 9:29	AA 1961 10:35	321 AA 11:55 12:19	1970 321 13:19	LAX 1810 PHL AA 321 13:50 2055 14:45	LAX 724 PHL AA 321 15:00 559 16:05	AA 16:46	1908 SI 3 1799 18	FO PE 321 A/ :05 18	1 1798 54 844	321 20:27	AA 1857 21:13	321 22:19	
A5						CLTSC4 MCI ORIG 7:05 1906 7:50	DFW AA 83 8:34	35 321 9:50	BUF NA AA 858 32 10:14 11:3	DEN 1 AA 1808 12:03	13:02	MIA 59 321 14:20	RSW AA 1992 15:03	319 A 16:30 16	CA IAH A 673 319 5:54 17:54	2 TI	084 CLTS ERM 19:45	C4 RIC ORIG 2006 20:30	BOS AA 21:39	ORD 321 22:35	
A7						CLTSC4 RDU ORIG 7:05 7:50	PHL AA 883* 8:10	321 9:25	MIA AA 521 10:29	DEN MCO 1725 321 AA 12:04 691	13:01	DFW 2091 JFK AA 321 13:52 1972 14:55	10.00	899 SFO 321 105 16:40	ATL 786 AA 16:57 678	1.AX ORD 321 AA 18:16 18:45	747	MCO 321 20:15	DFW AA 1812 21:12	BOS 321 22:15	
A9						CLTSC4 ORD ORIG 7:10 1916 7:55	BWI AA 1925 8:20	TPA P. 321 A 9:35	HL 826 LAS 1A 321 0:05 1735 11:20	DFW AA 12:27	873 ATL 321 13:24	PBI BWI AA 2063 321 13:52 14:50	SEA 2107 15:16 443	SEA 321 16:20	TPA 7: AA 17:20 17	30 LGA 321 740 18:40	ATL RSW AA 1820 321 19:02 20:00		SEA AA 186 21:26	3 RSW 321 22:26	
A11							CLTSC4 MSY ORIG 8:29 9:1-	4	DTW CUN AA 885* 321 10:11 11:25	ATL AA 206 12:02	LGA PHX 738 AA 13:12 13:31	2068 LGA 321 14:26	DFW AA 1719 15:20	FLL 321 16:24		SAN AA 18-4	487 Si 3 451 20:	LC 21 05	ATL 19 AA 18	98 ATL 738 97 22:40	
A13							STL AA	PIT 1677 319 9:45	CLTSC4 F	IAH 3 AA 12:11	82 JFK 738 00 13:19	LAS 1458 SMF AA 321 13:58 1917 14:50	LAS 748 BO AA 15:08 1999 16:	OS ORD AA	622 TPA 321 731 17:53	L.	A 2075	MSP 321 20:10	MCO AA 1704	321 2:09	
A12							0.31	2.43	CLTSC4 ORIG 10:55 1964	MCI	MA	CO 2055 PHX A 321 345 695 14:35	BOS DF AA 1775 3	W 21	EWR AA 470	SAN 321	MIA 760) PVD 321 6 2020	DEN AA 1873	TPA 321	
A10						696 TPA 321 1813 7:45	MCO AA 461	SFO 321 9:24	RSW PHX AA 679 321	PHL 1882 AA 2054	PHL 18: 319 13:00 TEI	55	DEN 428 AA 15:24 1791		FLL 609 AA 17:00 1787 1	PDX 321 18-10	RIC MC AA 1769 319	PHL AA	892 472	PHX 321 22-15	
A8					898 PUSH	7,43	MSP AA	1910 LGA 1910 321	MCO 790 TPA AA 321 10:13 2053 11:20	EWR AA	1615 EWR 1447 738 13:26		MSP AA 2046	RSW	BOS 1787 AA 609	SEA 321	LGA AA 19:20 178	BOS 321	LAS AA 179	PHL 6 321	
A6					LAS 431 AA 428		PBI AA 445	9:55 DEN 321	TPA ORD AA 1862 321	ROC AA	1907 ELP 319 254 13:45		BDL BNA AA 1715 319	16:25	MCO AA 651	DEN 321	SEA 633 AA 19:12 541	SEA TI 321 A.	PA 2039 A 890	22:25 DFW 321	
A4					SAN 579 AA 6:04 662	SFO	LAX AA 19	9:35 BOS 982 321	BDL AA 752	SJU ORF 321 AA]	13:45 1ND MCI 973 319 AA	1860 ROC 319	ORD 1999 MCO AA 321 15:05 1899 16:00	S	DEN 181 AA 565	18:25 11 DFW 321	FLL AA 1920	20:20 20 BWI 321	JFK AA 1774	DTW 321	
A2					PDX 19	7:30 930 SAN 321 487 7:50	8:43 TPA AA 19	9:45 BWI 60 321	MSP BO AA 1937 32	11:45 12:23 S PIT AA 2078	13:12 13:27 CLE DCA 319 AA	14:35 MSY 2045 319	FLL ATL AA 504 321		PHX 767 AA 466	SMF 321	SFO 662 AA 19:14 1975	20:20 LAX 321	FLL AA 1737	22:20 LAX 321	
B1					SJC 661 PI	DX 520	RSW 413 N	9:40 MSP 321	DFW AA 2064	0 12:05 LGA BNA 321 AA 653	13:05 13:28 AUS MEN 319 AA	14:35 1 SAT 1827 319	SRQ 1130 DE AA 104 3	EN M 21 A	IIA 1799 ORD	18:20	BDL T AA 1871	20:20 PA 321 321 TERM	ORD AA 12	22:20 MIA 77 738	
B3					6:00 1872 7:	1980 BOS 321	LAS 1955 M	0:20 CO 321	BOS 1967 MCO AA 1729 321 10:19 1729 11:20	11:40 11:58 BDL AA 191	2:54 13:3 RDU 1 319	JFK 2530 AA 2249	15:20 184 16: EWR 738 L	AX 819 SJU A 872 321	PHL 799 AA 1722	MCO 321	JAX AA	1861	21:27	22:30 PBI 319	
B5					6:37 EWR AA	7:50 R EWR 1364 738	8:10 1905 9 MIA AA	1496 EWR	SJU 1376	SRQ PVD	13:04 IAH 657 319	14:00 2249	15:15 It EWR AA 379	MIA R	SW BWI A 703 321	18:20	19:15 CLTSC4 MDT ORIG MDT	2043	RDU PY AA 2038 7	2:11 D 38	
B7					6:47	2011	JFK AA 148	9:55 MIA 738	AUS AA	1964	13:20 JAX 319		15:05 MIA 2448	16:25 ORD 738	6:55 17:45 PIT 1829 DFW		MCO 746 PHX	EWR AA	1245 1608	05 JFK 738	
B9					BWI	PUSH JFK 1042 738	8:30 EWR 2531 JFK	9:30	ATL IAH AA 2065 738	1849	13:15	5AT 1633	FNT 319	16:25	16:57 721 17:40 IAH EV AA 1711 7	VR SJU 8	36 SFO 321	20:36	1608 2 MIA AA 1384	2:10 EWR 738	
B11					476 PUSH	7:30	8:16 2529 9:06 ATL 713	ATL EV	10:12 11:19 WR 1451 EWR A 1451 738 10:02 1458 11:05	CHS	1849 DCA PIT AA 1950 13:15 13:31	3:48 296 BDL 1700 319	15:11 TPA 53 AA 72 15:27 72	9 LAX	17:15 18: STL	18:35 6	19 19:30 1065 1002		21:13 CLTSC4 FNT CLTSC4 319 PUI 21:17 21:25 19	22:15 L SYR	
B13					PUSH		8:21 413 DTW BUF AA 1942 319	9:35	1458 11:05 JFK DAA 330	FW DCA RI 738 AA 2077 31	1950 _{13:15} _{13:31}	14:30 TW STL A 756 319	ATL AA 15:08 1821	25 16:40 DTW	MCI AA 1701	MIA	1002 844 TERM		21:17 21:35 19' BUF AA 1940	1 22:20 ALB	
B15					RDU 172	DCA E	8:08 9:10 FNT 1751 AA 97	SLC	1924 DEN TERM HILL	11:52 12:4 1446	LAX	RDU 2069 PIT AA 319 13:56 2084 14:55	IND 18	16:30 43 DCA	17:13 DT AA 2067 3	18:20	451	1	20:58 RIC AA 1893	22:15 AUS	
					AA 1732 PHX 2020 AA 2091	7:30	BDL	9:30 CLE	PVD	5 652	13:00 887	13:56 2084 14:55 1974		64 16:40 5 ALB	17:04 18: CLTSC4 BUF	:05	TERM JFK AA 2648 738	BWI	20:55	2:10 JAX	
B16					6:09 2091 SLC 2014		AA 1780 8:21 PIT 197	9:40	AA 1831 10:32 STL DTW	11:45 T	887 ERM	PUSI	H		17:15 1242 18:00	VM	19:05 20:00 ROC	JAX 20:38	864 2035 2043	22:35	
B14					6:10 408	7:30 BOS BNA	PIT 197 8.35 852 RIC 1941	2 9:40 MEX	AA 1923 319 10:27 11:20 MDT	JAX	DITE	1934 319 14:30	AA 1653 15:13 1	6:15 BUF	AA 2052 3 17:01 18: NAS	:05 PIT	AA 1921 19:07 JFK 101	319 20:15 EWR	TERM	BUF	
B12						AA 1817 319 7:12 8:00	AA 8:15 829* PHX 423	9:30 PUJ	AA 1753 10:33 LGA	319 11:50 ALB	AA 20 13:26	02 319 14:15 CHS DCA	AA 853 15:10 RDU	321 16:29 BWI	AA 859 17:04 IND	319 18:15 STL RI	JFK 101 AA 19:09 1390 2	738 20:10	ATI 556	22:25	
B10					MCO	LGA	8:11 1965*	9:25 DCA	AA 1988 10:44 DC	319 11:55 A MCI 1267 BUF	ALB 1756 ALB	AA 1938 319 14:02 14:55	15:44 IAX	1962 319 16:45	AA 765 17:11	319 18:25 1692	:55	861 BUF	21:19 TER	M CIE	
B8					AA 6:44 RIC	2062 321 7:59 BDL	AA 1722 8:17 MEM	9:30 RSW	AA 1730 31 10:20 11:3 ELP AA 2	AA 751 319	ALB AA 12:50 1753 ALB 319 13:50	CLTSC4	AA 2036 15:20 RIC 1	319 16:19 864 PIT JAX	C DCA	TERM	MSY AA 19:14 1885		AA 207	22:25 ROCI	
B6					6:34 PIT	654 319 7:30 PVD	8:43	1853 319 9:55	11:07 ¹³	81 319 370 11:50 ATL		CLTSC4 IAH ORIG 14:10 2069 14:55	PHI.	745 16:35 16:35 PBI	1750 319 50 17:50	CLTSC4 ORIG 18:29 1317 DFW		ORIG LGA 9:55 1954 20:40 RDU	AA 1870 21:25	319 22:16 DCA	
B4					6:42	1903 319 7:35	BUF 829 DT AA 1941 9	319 0:19 BDL	AA 1814 10:33 PHL	319 11:39			AA 20- 15:37 MSY 1921 RI	47 319 16:30		AA 1752 18:11 19	OFW 321 AA 744 321 AA 19:25 1861 2 CLTSC4 DTW	319 :0:10	AA 1987 21:04 LC	319 22:14 A	
B2					6:15	624 LAS 321 658 8:00	8:44 DCA	1756 319 9:50	AA 1847 319 10:10 11:15 ALB 1707 SXM			2017	AA 1821 3 15:30 16:0 BNA 100C IAM	19 09	AUS	584 PUSH	19:15 736 20:00		AA 1981 3 20:55 22:	9 14 IAH	
C2						AA 1904 319 7:02 7:59	AA 1795 8:28	9:30	ALB 1707 SXM AA 319 10:23 613* 11:25	N	ļ.,	2017 PUSH	BNA 1886 JAX AA 319 15:14 2032 15:59		AA 1840	319 A/ 18:25 18	AS 605 PLS 315 54 1029* 20:00	1054	RSW 1805 AA 745 2	321 2:10	
C4							IAH 852 8:38 1973	8 9:35	MCI 1797 IN AA 31 10:28 1977 11:3	9 0	13:4	ORIG 0 1789 14:25	AA 15:35	Mevi	422 1540		319 19:15	1954 TERM	AA 1793 21:20	22:25 OPE	
C6							AA 1839 319 8:04 9:00	FSD 784 M 9:23 993 10:	ICI SAT 819 AA 850 115 10:39	319 11:40			AA 18 15:39	02 319 16:30			1976 TERM	la la	21:40	1785 319 22:40	
C8					AT AA 6:5	TL ATL A 469 321 52 8:00	CLE AA 1784 8:30	319 9:24	ROC CHS AA 1868 319 10:14 11:14					BUF AA 16:20		422 524	FSD 319 19:54	CLTS 20:45	SC4 MCI PH: PULL AA 5 170 21:30 21:	1854 RDU 321 0 22:45	
C10										40 MEX 319 4* 12:00			CLTSC4 ORIG 1889	16:20		CLTSC4 ORIG 1530 18:28	19:13		CLTSC4 STI PULL 21:15 881 22:00		
C12																					
C14																					
C16																					
AAIN																					
I1											CLTSC4 CUN ORIG 2:40 887* 13:30			MB AA	*869 50 749 1	LAS M 321 A	BJ *827 A 1919	MIA 321 20:15	S	O *1850 *1850 *TERM 22:40	
12						CLTSC4 PUJ ORIG PUJ 7:05 1963* 7:55	GCM AA	4 *860 HAV 1615* 9:45	PAP AA	*368 1826	NAS 319	N. A	IBJ *843 RI A 3 4:53 2056 16:		*884 BOS 1806 321 17:55	10.10 [13 PI A.	S *880 OF A 3 1:55 1851 20:	20:15 RD 21	2	22:40	
						7:05 7:55	9:00	9:45	11:00	1826	13:15	<u></u>	4:53 2000 16:	10 16:40	1000 17:55	18	:55 1831 20:	05			

Date:04/11/2019 Time:12:46					CLT 2028-	Scenario 3	3										Pag	ge # 2 of 4
	00:00	01:00 02:00 03:00	04:00 05:00 06:00	07:00	08:00 09:00	10:00	11:00 12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
	ntulutu			n tududu						ntulutu	minhitii		Induto	arta larta	lu lu lu lu	ntulutu	ndududu	
13			C	LTSC4 CUN ORIG 804* 7:45		PLS *8	342 KIN 319 40* 12:00				PUJ * AA 16:21	1963 ATL 738 787 17:50	CUN AA 18:40	*886 PBI 321 2061 19:55	PUJ CLTSC4 *1968 TERM			
14					SDQ *1839 UVF AA 321 8:00 982* 9:45	CUI AA 10::	N *1283 SJO 321 50 1087* 11:55				HAV AA 16:05 1028	BDA 319 17:30	SXM AA 18:40	*866 BNA 320 1867 19:49	20:16 21:01 CUN *888 20:29 TERM	TSC4 21:14		
15			C 6	ORIG MBJ :55 843* 7:45			MEX *1844 SDQ AA 319 11:00 1853* 12:00				,	SDQ AA 18:00	*639 1865*	GCM 319 19:30	UVF * AA 20:15	1342 SDQ 321 874* 22:00		
16					CLTSC4 _{PULL} MBJ 8:35 840* 9:25	KÍN *854 PAP AA 319 9:55 1647* 10:50						PUJ AA 17:42	*196 643			*87 ^C LTSC4 0 TERM 21:35		
17													GCM *8: AA 18:14 85	22 DCA 320 19:44	SXM *613 *613 TERM 21	SC4		
18													MEX AA 18:35	*828 ME7 1768 31 20:0	M 9 10			
I10				Gi A. 7::	RÚ *1062 CLTSC4 A PUSH 332 PUSH 8:50			FRA *705 CLTS0 AA 7. 13:00 PUSH 14:	24 89 00		LHR AA 16:15	*731 730*	LHR 789 18:40					
I11										FC(AA 15::	*721 CLTSC4 789 TERM 16:55		BCN AA 18:20	*745 744*	BCN 332 20:45			
l12										AA 15:	O *721 MAD 789 55 748* 16:40			CLTSC4 PULL AA 19:00 1568*	GRU 332 20:30			
I13										MAD AA 15:50	*7. 72		LHR AA 18:30	*733 732*	LHR 789 20:15			
l14									CDG AA 13:55	*787 704*	FRA C 332 A 16:35	LTSC4 PULL A 720*	789 18:25					
I15								AA 13:05		725 786*		C. : 18	332 3:20					
OADO	1079		CITSC4 HOLL CITSC4 MDW C	ITSC4 BW	lawi	DAI			BNA 512 (BNA		MD	W MDW HOLL	HOU	AI RWI				
O1	1078 TERM		CLTSC4 _{GRIG} HOU CLTSC4 _{GRIG} MDW CLTSC4 _{HIG}	LTSC4 BWI ORIG 3773 7:40	30: 9:35	10:10			BNA 5136 BNA WN 738 14:00 684 14:45		16:	853 HOU 17:55 17:55 17:55	193 18:30	1721 8:55 19:30				
O2	TEI	RM	CLTSC4 ATI	CLTSC4 SLC	ATI. ATI	ATI. ATI	DTW DTW	M	MSP MSP		ATL COS ATI	ATI.	ATT	ATI.	ATTI	2808	1076	10
O3	TERM		CLTSC4 4:45 823 5:30 CLTSC4 DTM	CLTSC4 SLC ORIG 7:00 7:45 CLTSC4 1	DL 2422 73H 8:48 9:30	DL 1454 M90 10:03 10:45	DTW DTW DL 1629 319 12:07 12:50 ATL ATL ATL	ATI	MSP MSP 1503 14:24 14:59	ATL ATL	ATL 602 ATL 73H DL 2651 73H 16:18 2651 17:00	DL 17:50	826 73H 18:45 DTW	DL 1407 19:09 20	73H 0:05	2808 TERM	1076 TERM	TE 522
O4			CLTSC4 DTW 6:15 1366 6:00 CLTSC4 ATL	CLTSC4 ORIG 7:20 2266 CLTSC4 CLTSC4			DL 2251 717 DL 11:16 12:00 12:33	1095 717 13:15 ATL	ATL	DL 2133 73H 15:04 15:45	DL 15 16:40	322 324 17:20	105 18:40	57 19:15				522 TERM
O5			CLTSCA _{PLC} IAH CLTSCA _{PLC} IAH CLTSCA _{PLC} IAH	CLTSC4 ORI 7:30 159 SFO 170		5 ORD		13:42	2597 320 14:30	DL 0 15:40 17	03 MSP 319 793 16:30 DEN	SFO 1176	SFO				1286	876 TERM 1974
O6			CLTSC4 IAH 5:05 1191 5:50	SFO 170- UA 1969	4 SFO ORD 42: 739 UA 42: 9 8:20 9:26 52	73G 1 10:15 8025 BOS		ORD 1484 ORD UA 319 13:00 1140 13:45		DEN 1711 UA 1199	320 16:22	SFO 1176 UA 1698	739 18:30				1286 TERM	1974 TERM
013			CLTSCA _{DIC} BOS		B6 9:24	8025 BOS 8020 10:51 JFK 219 JFK	BOS 1245 BOS			B	BOS 8021 BOS	BOS 1445 BOS	JFK	JFK JFK			8017	
014			CLTSC4 _{RIG} BOS 8022 6:18 CLTSC4 _{RIG} ORD		LTSC4 _{RIG} DEN	B6 E90 10:01 218 10:40	BOS 1245 BOS 10:59 1246 11:36			1 1	30S 8021 BOS 36 8016 E90 6:00 8016 17:00	BOS 1445 BOS B6 E90 17:18 1446 18:00	B6 18:5	1119 JFK 1118 E90 1118 19:28			8017 TERM	5812
O18			6:03 1712 6:48	7:: DEN	LTSC4 DEN ORIG 550 8:35	MCO PHIL F9 1028 320	ISP 354 ISP			PHL MC	co				TTN 933 T	TTN		5812 TERM
O19 O20			DEN 201 F9 200	7:20		F9 1028 320 10:11 10:59	ISP F9 354 ISP 11:20 353 12:05			F9 1689 3 15:21 16:	:09				TTN 933 T F9 932 21	320 1:10		
O20																		
O28 O29																		
O30 O31																		
O32																		
OAIN																		
121											MUC LH	*428 429*	MUC 359					
122											16:20	429*	18:35					
AEDO																		
D13			PHF 5	190 PHF CR2 557 7:35	PGV 5234 PGV AE 5187 CR2 8:11 5187 9:19	EVV 52	241 MLB CR2 AE 5176 132 11:40 12:05 5314	OAJ MGM 544 CR2 AE 515	1 SDF CR2 14:25	FAY AE 15:26 407	1 IND CR2	FAY AE 17:05	5486 5172		GNV CR2	GNV AE 21:20 528	2 CHO E75	
D12			[6:30 3	7:35	MGM 5293 MGM AE 5293 CR2 8:38 5440 9:45	SGF 3706 SGF AE 3706 E75 10:093213 _{10:50}	SDF AE 11:05	5093 5323	IND CR7	EVV 5032 E AE 15:23 5366 1	EWN	17:05 TYS AE 17:10	5119 5256	FAY CR2 19-50	20:25 HTS 5461 20:15 5049 20:15 5049		5156 PGV CR2 5118 22:40	
D10			GM AE	IV 5228 LEX 5039 CR2 2 5039 7:30	FAY 5273 TYS AE 5297 CR2 8:40 5297 9:35	CHA	5277 EVV CR2 AE 5237 5032 11:35	BHM DAY CR2 AE	5120 PHF 5052 CR2 5052 14:25	GPT 5095 CID AE CR7 15:05 5096 15:50		5063 CAK CR2 5259 18:04		CRW 5148 FWA AE CR2 19:05 5405 19:49	MEM 5265 CR9	LEX	5264 MGM CR2 5298 22:41	
D8			92	CAK 5355 CHA 7:08 5277 7:43	CRW 5347 BHM AE 5142 9:10		039 FAY HSV AE 390 AE 396 11:20	CAE 06 CR2 00 13-05	MYR 3777 AVL AE 4011 14:40	OAJ 5314 AE 15:33 5222	1 MGM	L 4011 CAE CR2 52 3775 18:00		CHS SRQ AE 5227 CR9 19:03 19:50	20.43	4796 ΓERM	22.71	
D6					CAE 3826 HSV AE 875 8:21 3906 9:09	BTR AE 5507 10:34	AGS BHM 5 CR7 AE 5 11:14 12:30 5:	142 TLH 218 CR2 13:10	PGV 5117 FAY AE 5117 CR2 14:07 5486 14:45	ORIG 3973		PHF 5052 LEX AE 5264 18:14	SHV 5514 TL 2 4 18:30 25254	1930 1930 1930 1930 1930 1930 1930 1930		TLH_5211LFT 21:15 ²⁷⁶ 21:46	PULL 5304	
D4					FWA 5406 CR2 8:49 5176 9:26	GSP AE 10:10 559	67 FPO GNV 5371	TYS GPT AE 13:00 13:37	5320 5226		OAJ CR7 16:14	FWA 5135 DAY AE CR2 17:11 5156 18:00	AVL AE 18:42	4769 4895		3945 ORF 3904 CR7 0 21:30		
E1				5058 PUSI	IAD 5327 GRR	PULL MSN 5343 10:45				IGM 5366 E 5096	LFT CR7 16:20	BHM AE 5311 17:45	CHA CR2 18:25			5186 TERM		
E2		5006 PUSH	CRW AE 6:45		5263 LFT CR7 5335 9:36	VPS 5157 AE 10:06 5179	CHA RAP DAB E75 AE 5514 CR9 11:14 11:40 5255 12:20	Ţ	YS 5294 TYS E CR2 3:51511914:35	ORF 3773 BHN AE 27: 15:07 3865 16:05	A 5 5	CMH 5087 AE 17:41 5121			PULL 5468	TYS 5037 AE 5100	AVL CR7 22:25	
E3			5279 PUSH		MLB 5175 HPN AE CR7 8:47 5384 9:30	PHF AE 55 10:39	57 TYS CMH	4538 MCI E75 4675 13:24		SDF AE 15:17 3959	16:35	4892 PUSH		TRI 4786 AE 4755	EWN CR7 20:30	5049 TERM		
E5			EYH 4' AE 6:22 48	389 7:40	4935 DAY AE TERM 8:51	5122 5364	PHF CR7 11:45 AGS 539 AE 12:16 513	6 FWA		27 EVV CR7 04 16:00		CHA AE 17:21	5508 5233	OAJ CR7 19:45	LFT 5411 SHV AE 5411 CR7 20:00 5523 20:40	AN 5257 AE 5407	BTR CR7 22:15	
E7			6:35	4921 GSO CR7 4826 7:50	8:30 55	337 514	JAN AVL 4751 CR7 AE 4804	13:03 A	3:50 5459	GNV HPN CR7 AE 15:15 15:44	5526 HPN CR7 5166 17:00	ROA 4829 AE 4798	LYH CR7 18:30	19:23 4	865 HPN CR7 1023 20:40	CAE 3775 MF AE 4056 CI 20:59 4056 22:	KE R7 05	
E9)93 _{7:30}	LFT AE 8:42	5390 5002	CAE CR7 11:19 TYS 529 AE 529 12:20 551	12 13:10	5463 VPS CR7 5 5453 14:40 14:	NA 5569 ICT VPS AE :55 ⁵¹⁹⁶ 15:32 15:50	5138 HTS CR7 5200 17:00	CRW 4749 AE 4931	OAJ ROA CR7 AE 18:25 18:43	4842 SBY CR7 4835 19:50		OAJ 493 AE 492 21:24 492	22 22:30	
E11			AE 6-39	4867 HHH CR7 4942 7:35	TRI 4852 LYH AE CR7 8:16 4820 9:35	MOB AE 10:45	5506 5514	SHV CVG 5. CR7 AE 13:15 13:31 5.	466 HSV CR7 319 14:25	EWN 4773 LY AE 4779 C 15:06 4779 16	YH T CR7 A :10 I	LH 5218 GNV E CR7 6:55 5202 17:55	BTR 5500 HS 18:30 505	05 19:21 391		ROA 4807 RO AE 4799 CI 21:00 4799 22:		
E13				ROA 4776 FAY AE 4934 CR7 7:04 7:40	HPN 5150 MOB AE 5251 CR7 8:22 5251 9:35	SHV AE 10:44	5546 5364	BTR A0 CR7 A1 13:00 13	GS 5263 DAY E 5123 CR7 5123 14:41	15:40	5582 GPT CR7 5083 16:40	CID 5456 CID AE 5429 CR7 17:04 5429 18:04	MSN AE 18:43	5437 CAK CR7 5306 19:45	LGA 4460 BTV AE 4582 E75 20:00 20:40	HHH AE 4943 21:15	22:20	
E15			F 6	1HH ₄₉₁₅ ROA :56 ⁴⁷⁶³ 7:30	GSP 5235 IAD AE 5509 CR9 8:18 5509 9:09	ORIG 5632	LIT 5183 EYW AE 5183 CR9 11:00 5220 11:45 SAV 5185 CR/ 12:07 5582 12:50		HPN 5384 MLB AE 5302 14:50	PHF 5364 L AE 5283 16			ORF AE 18:43	5209 AGS CR7 5398 19:45		21:35	5074 EVV 5038 CR7 22:40	
E17			CHS 52 AE 6:18 52	246 SAV CR9 7:45	LYH 4886 SBY CR7 8:12 4831 9:20	CID AE 10:18 54	320 CID HTS 4866 423 11:45 AE 4805	AGS FL	O 4904 ROA CR7 48 4829 14:35	MLB 4 AE 15:44	5132 JAN CR7 5257 16:35	EWN 4939 ROA AE CR 17:24 4807 18:1	A MI. 7 AE 5 18:	.B MSN 5 5230 CR7 19:54		GPT 5083 AE 5393	SRQ CR7 22:14	
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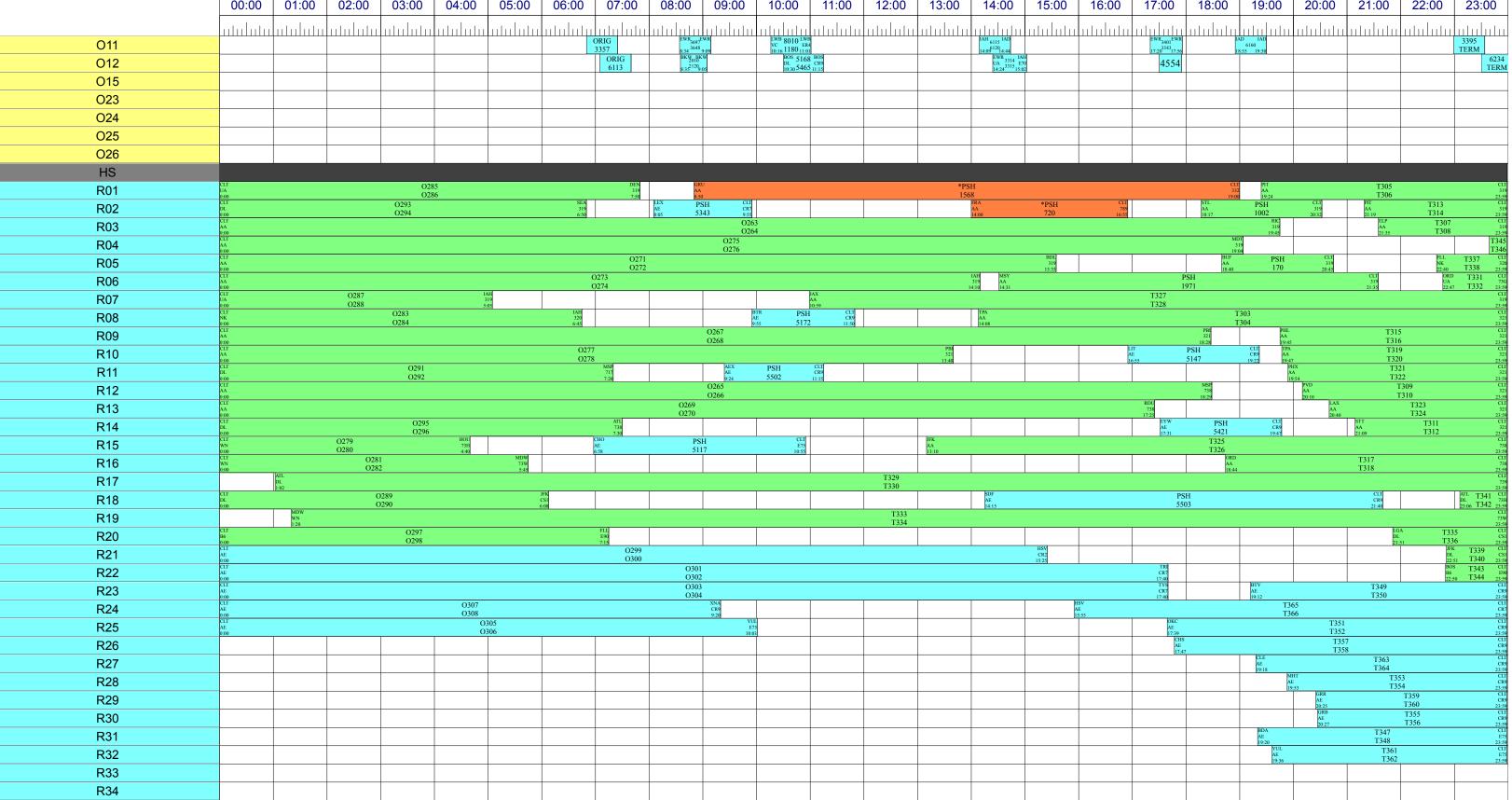
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E19					MYR 5357 CHS		884 TRI CR7 841 9:40	FAY 4934 FLO AE CR7 10:07 4904 11:33	GSP 5067 LEX AE CR7 12:17 5153 12:59	MOB 5	251 LEX	PWM 5572 GRR AE 5572 CR9 15:10 5567 15:50		HTS 4759 HB AE 4759 C 17:18 4813 18	HH R7	CAK 5036 AE 5143	VPS CR7	LYH 4798 EW AE 21:26 4744 22:3	
E18					6:29 5309 7:40 SAV 5452 MYR AF 5452 CR9	OAJ 5113	CVG CR7	OAJ 4889 EWN	GSO 4903 TRI AE CR7 12:18 4765 12:59	BTR	078 CR7 5225 BHM 5225 CR7	TRI 4765	5 AVL CR7	5431	:05	AGS 4907	20:20 FLO CR7	MDT 5180 PH	0
E16					6:36 5389 7:40 GSO MEM AE 5026 CR9	8:13 5466 MOB AE	9:20 5278 AGS	PIA 5349 PIA	12:18 4765 12:59 LYH 4820 AE 4820	GSP SBY 48	5311 14:30 CRW 31 CR7 49 14:19	ORIG	16:24	TERM	5154 AVL OA	AJ 5226 SDF	20:09 MLB 5	AE 21:29 5556 22:3 431 MOB LGA 506	6 GSO CP9
E14					0RF 5460 CVG	AVL 5365	5396 9:45	GSO 4826 ROA AE CR7 10:30 4879 11:14	12:32 4933 13	3:12 13:39 47 CRW 4824 H AE 4759 14	49 14:19 TS MSN 5204 CAK	4809 FLO 4862 ROA			65326 _{18:30} I8:	2 3833 MKE CR7	20:30 5:		
					6:27 5268 7:24 ILM 5096 CMH	8:21 5152 MDT 4669 CI	9:19 MH MLI	5111 GRR	TRI 4841 ROA AE 4926 CR7 12:23 13:01 EWN 4936 FLO	13:25 4759 14: O JAN	05 14:25 5272 15:05 5071 CR7 5508 14:27	15:20 4842 16:05 LYH 48	RO4 TRI	OR 50.	DAB 5315 OKC	₄₉ 3889 _{19:44}	LYH FWA 5.	MOB 5060 L AE 21:40 5520 22 476 LEX 5256	:35
E12					6:41 5061 CR9	8:08 4538 g	E75 AE 9:10 9:40 ROA 4790 GSO	5514 11:30	EWN ₄₉₃₆ FLO 12:29 ⁴⁸⁶² 13:0		5508 CR7 14:27 CHA 5179 ORF	15:47 47	786 16:30	6:58 5376 17:40	AE CR9 18:00 5258 18:45	PGV 4869 AE 4780 LYH 4779 CHO	20:10 AE 20:30 5:	235 21:30 TERM	
E10					SDF 5342 STL AE 5073 7:40 IAD 5399 IAD	SRQ 5390 TLH AE 5091 CR7 8:04 5091 9:00	ROA 4790 GSO AE 4790 CR7 9:15 4903 9:55	PULL 5117 Supplemental Suppleme	RDU 5415	37 13:34	AE 5110 CR7 14:01 14:40	CHO AE 5048 CR 15:30 5239 16:1 ROA 4926	7 0 AGS	AE 17:38 53 OR	361 _{18:20}	18:59 4885 19:49	4777 HTS	HSV 5050 PIA AE 5050 CR7 21:06 21:45 MKE 3959 CAE	
E21					AE CR9 6:44 5373 7:30 DAY 5328 CR2	8:50	3814 CR7 3814 9:45 5232 MSN	AE 10:48 3798 11:40 CAK 5468 GPT	AE 12:19 5288 CHO 5152 AVI	CR9 13:20 13:42	CHO 143 14:19 A ₄₀₇₀ EWN	ROA AE 4926 15:41	CR7 16:19 AEX	47	96	19:40	4767 _{20:30} CR7	MKE 3959 CAE AE 3959 CR7 21:37 4010 22:20	
E23					AE 5328 CR2 7:14 5282 7:50 PHL 3899 CAE	8:51	5060 9:45 242 JAN	AE 10:50 5462 11:40	12:12 5086 13:03	9 5 13:5	A ₄₈₇₉ EWN 0 14:25 HH ₁₀₄ HHH	PIA 5186 15:43 ⁵³¹⁰ AGS 4005 F		AEX 5060 FWA AE 5060 CR7 17:05 17:45 MOB 5512 MOB		LEX TYS AE 5283 CR7 19:16 5221 19:56	FAY 5105 HSV	21:05 4495 22:05	MGM, AEX
E25					AE 3908 E75 6:58 3908 7:45 CMH 4544 DTW		071 9:30	CAE 3908 MYR AE E75 10:21 3777 11:19 ROAHHH	AE 5107 CR9 12:13 5189 13:04	5459	HH ₄₈₄₄ 3:56 14:30 CMH	AGS 4805 I 15:40 ⁴⁸⁶⁹ I	5:16 RW	AE 5512 CR7 17:10 5060 17:49 CHO 10:10 FLO		CHO	FAY 5105 HSV AE 5105 CR7 19:59 5224 20:40	AVL 5326 CAK AE 5124 CR2 20:55 5124 22:05	MGM ₅₄₉₁ AEX 22:2 ⁷²⁹ 22:59 BNA
E27					AE 4344 E75 6:38 4542 7:45	AE 3439 C 8:21 5225 9	9:24 9:59	ROA ₄₇₆₃ HHH IAD 5373 SAT AE CR9 10:21 ⁸⁸⁴ 0:55 II:10 5210 11:55	AE 12:10 STL 5072 ILM	5458 5087	CMH CR9 14:24	JAN 5514 ^C 15:40 ⁵¹⁴⁸ 16 3909	:15 D	CHO ₄₉₁₈ FLO 17:01 17:35 SM 5056	5 DSM	CHO ₄₈₀₉ ROA 19:10 19:44 GNVBTR	AE 19:59	5336	CR9 22:40 HS
E29					AE 4661 E 6:51 4531 7:	75 8:33 518: ORIG	5 9:19	RIC 5290 CLE AE 5290 CR9 10:45 5436 11:35	STL 5073 ILM AE CR9 12:10 5345 12:59	AE 13:28	5245 PNS CR9 5212 14:50	TERM	A 10	SM 5055 E 5276	6 18:45	GNV ₅₂₅₂ BTR 19:18 ⁰²⁴ 19:50	MU	AE 3449 20:59 5114 22	R9 :35
E31					CAE 2007 BHM	5573	9:20	5292 5172	CR9 12:25	AE 13:33	5494 14:40	4933 TERM	AE 16	:56	5253 5421	ACL ACRE CMH	CR9 20:22	5090 TERM	
E33					CAE 3967 BHM AE E75 6:50 3819 7:35	CHO 4876 HTS AE CR7 8:15 4866 9:00		AE 10:47	5252 5285	liav so	CR9 14:35	CVG 5166 AE 5229	CR9 16:20	MSY AE 4662 E75 17:08 4506 17:50	A 18	MCI 4675 CMH AE E75 8:55 4624 19:44		5099 TERM	200
E35						0.45	936 9:24	OMA 5253 AE 5266		JAX 52- AE 13:32 53		T	B190 DSM AE ERM 16:45		5378 5036	SA CR 20:0	9	21:08 31// 22	RW R7 :35
E38					kura		ICT 5316 9:03 5164	CMH FLO AVL CR9 AE 4800 CR7 10:30 10:45 11:25	DTW 4542 M AE 12:23 4510 13		151 14:27	GRR AE 15:50	LET	5043 5236		19:30	5077 TERM	CAK 5259 AG AE 21:35 5438 22:3	2
E36					CVG AE 6:56	5341 5116	CR9 9:20	TUL AE 5054 CR9	PGV 5187 CHO AE E75 12:05 5048 12:49	13:45	5433 CHS CR9 5181 14:35	MHT TLH AE 5072 CR9 5:02 15:59	LII AE 16:20		5513 5147	GRB CR9 19:57	20:40	5530 GPT CR7 5491 21:30	
E34						BHM 5346 8:30 5237	5 CRW CR2 7 9:20	IND 4484 CMH AE E75 10:46 4457 11:45	AUS 5171 LIT AE 5395 12:50	13:10 13:44	GRR 5533 ATL AE CR9 14:05 5192 14:55	DAB AE 15:30		5460 5053	LIT CR9 19:00	YYZ 3834 AE 19:17 3968	20:10 AE 20:38	4001 3795	GSP CR7 22:40
E32						AEX AE 8:49		5117 VPS CR9 5502 11:50	FAY 5487 CHS AE 5487 CR9 12:10508412:54	509 PUS		CMH 4457 ILA AE 4674 16:0	4 5 9	LEX AE 17:25 5552	CHO E75 18:15	IAD 55 AE 52 19:26 52	502 MSY CR9 232 20:30	PULL 5503	
E30					CHA AE 5165 6:29 5457	JAX CR9 8:50	CVG AE 9:10	5128 OMA CR9 5504 11:20	MYR 5289 MYR AE CR9 12:15 5053 12:59		SYR 5223 AE 5349	CLE MLI CR9 AE 15:20 15:39		5267 5514	RA CR 19:0	AP DAB R9 AE 03 19:36	53 52	335 CHA CR9 238 22:20	
E28							SGF AE 9:15	5177 TVC CR9 5037 11:24	MEM SYR AE 5184 CR9 12:07 12:50	LIT AE 13::	5033 MKE CR9 51 5098 14:40	AUS AE 15:30		5200 5456	SGF CR9 18:50	TLH AE 5420 19:19	GSO CR9 20:10	AUS 5301 M AE 5299 22	EM (R9 :35
E26						ORIG 5531	BHM AE 9:15	5204 OKC CR9 5033 11:20	CLE 5282 GNV AE CR2 12:05 5063 12:50	ILY AE 13:	4 53 52 52	36 C 14 16	VG MI /R9 AE :14 16	DT 4510 JAX E 4562 E75 17:59	5			5069 TERM	
E24						SAV 5130 AE 5267	MKE LNK CR9 AE 9:14 9:33	5415 PNS CR9 5575 11:25	IAD 5509 AE 12:29 5243	CAK CR9 A 13:15 1	RF 5081 MYR E CR9 3:56 5313 14:45	STL AE 15:43	5370 PNS CR9 16:44	CVG AE 17:00	5398 5040	20	ICT GSO CR9 AE 0:06 20:4:	5121 DAY CR9 5 5374 22:05	
E22						CHS 5207 AE 5289	MYR CR9 9:30	BHM 5356 PVD AE CR9 10:13 5474 11:50	CAE 3814 FAY AE 27:22 3831 13:01	Y N 5 A	IKE 5267 ABE E CR9 3:56 5140 14:45	5592 PUSH			PULL SAT AE 18:40	5210 5335	CLE CR9 20:30	PNS 5094 CVG AE CR9 20:55 5109 22:05	
E20						AVP 5 AE 5 8:47 5	5294 ILM CR9 5525 9:25	DAY 5042 XNA AE CR9 10:54 5193 11:50		P A	NS 5255 DTW E CR9 3-56 5434 14:45	AVL AE 15:29	5086 5180	MDT CR9 17:55		DTW 5435 AE 5169	ABE CR9 20:15	CHS TYS AE 5138 CR9 21:00 22:09	
E8						JAN AE 8:37	5194 IND CR9 5568 9:55	SRQ 5102 AVP AE 5322 CR9	IND 4470 GSC AE 4537 13:0:	DAB 5: AE 13:40 5	317 IAD CR9 031 14:25	MYR AE	5053 5066	LGA CR9	ATL 527 AE 555	10000	20.13	JAX 4636 YYZ 21:33 ⁴⁵⁵⁴ 22:10	
E6							5495 PNS CR9 5255 9:45	MHT 5162 CVG AE 10:30 5166 11:40	12.12		IND 5568 AUS AE CR9 14:01 5301 14:45	CHS 5084 AE 5088	LIT	PWM 5034 AE 5070		SAV OR AE 5056 CR	F 9	CVG 5281 BH! AE 521:22 5211 22:3	4
E4					ORIG 5261	MYR AE	5431 SYR CR9 5260 10:00	XNA 5350 BHM AE 00:28 5178 11:35		ABE A	5191 CVG CR9 6035 ₁₄₋₂₅	CLE 5436 AE 5170		OMA AE 5131	SAV PNS	S 5212 CVG CR9 50 5303 19:45		XNA 5236 AE 21:33 5161	CR9
F1					ORIG 5079	GSO AE	5417 CAK CR9 5245 9:45	MEM 5474 PWM AE 10:43 5034 11:50		SAV AE	5051 RIC CR9 5372 14320	GSO 4537 AE 15:30 4498	YYZ BNA E75 AE	5288 SDF CR9 5049 17:54	MEI AE	M 5494 CHS CR9 50 5318 19:44		LIT 5088 SDF AE CR9 21:18 5334 22:20	22.90
F2					ORIG 5432	LIT AE	5158 SDF CR9 5330 9:50	CLE MDT AE 5080 CR9		OKC MYR AE 5504 CR9	GRB 5531 ABE	SAV 52	266 STL CR9	SYR AE 5377	cue	TYS SAV AE 5144 CR9		SRQ 5161 AE 21:39 5333 22	AN R9
F3				C	GSP DCA 3802		5343 FAY CR9 5487 9:40	OKC IAD AE 5510 CR9		SAT AE	5046 MLI 5046 CR9 5265 1426	MDT CMH AE 5064 CR9	16.33	DTW AE 5249	MYR) CR9	IND 5189 GSP AE 5155 19:50		CLE 5331 I AE 521:39 5250 22	LM (R9
F4				E	0.5.2	ORI 513	IG	AVP 5160 STL CR9 10:18 5370 11:20		[13:4:	ICT MHT AE 5103 CR9	OKC 5116 SDF AE CR9 15:14 5300 16:05	CAF AE	K 5243 CLE CR9 53 5331 17:50	GSO AE	5418 DAY CR9 49 5101 19:40		ORF 5455 AVP AE 5099 22:20	(55)
F5					TYS GSP AE 5354 CR7	TYS 5344 8:22 5033	LIT	DSM 5129 ILM AE CR9 10:19 5270 11:16			CMH ₅₄₁₄ TUL 14:00 ⁵⁵⁴² 14:35	BHM 5178 IAD AE 5502 16:00	110:3	ILM 5285 O AE 5455 18:	DRF CR9	MYR 5170 PNS AE 5170 CR9 19:00 5103 19:50		IAD 5286 SA AE 21:21 5451 22:3	
F6					ORIG 5252	CMH 45 AE 8:36 45	47 YYZ	ABE 5134 MEM AE 5134 CR9 10:39 5058 11:25		VPS AE	5183 9 5223		G	GSO IND AE 4522 E75 6:59 17:50	ILM AE	4572 E75		CMH 4554 CMH AE E75 21:14 4579 22:09	9
F7					ORIG 5290	PHF 5383 AE 5320	GPT CR7	SAV 5504 DAY AE CR9 10:38 5115 11:35		13:4	9 3223	PIT S AE 5043 C 15:24 16	AV R9	RIC 5321 AE 5563	BNA CR9	CMH M AE 5047 C	IHT CR9	VPS 5065 TLH AE 5349 22:15	
F8					ORIG 5082	GRR	9:20 5534 RDU CR9 5415 9:40	CMH 5061 PIT AE 5061 CR9 10:50 5522 11:45		BNA AE	4695 OMA E75 4556 14:55	15:24 16 ILM 5345 AE 15:35 5418	GSO	IAD IAD AE 5286 CR9	18:10	5366 TERM	202	21:06 3349 22:15	
F9					ORIG 5547	DAB 535 AE 8:35 513	52 SRQ	CHS 5309 GSO CR9		13:42	4550 14:55 RIC 4618 GSO AE 4618 E75 14:02 4695 14:45	IAD DAB AE 5035 CR9	PVD AE	5125 CR9		MKE 5098 AE 19:21 5127 20	AD CR9	5182 TERM	
F10					334/	ORIG 5371	SBY 4770 AVL AE 4751 CR7	YUL 3916 GSP AE CR7 10:06 3989 11:35			14:02 4695 14:45 YYZ 4546 AE 14:19 4566 1	15:15 16:04 LGA AVP 5322	XNA CDO	1 17:40 CAE 3957 AGS AE E75 17:03 4001 17:55		CVG 5169 AE 19:265307	DAB	ILM 5451	LIT IR9
F11						5571	9:15 4731 9:50 ORIG	10:06 3989 11:35 HHH ₄₉₄₂ 10:4 ⁸¹⁶ 10:4 ⁸¹⁶		G	14:19 4566 1 SP 3989 YYZ :54 ³⁸³⁴ 14:30	DAY 5115 MEM AE CR9 15:14 5265 16:00	16:25	IAD	5031 TUL CR9	ABE 5140 OMA AE 5248 19:49	20:10	5361	:35
F12						ORIG BNA AE	5325 DAB CR9 5317 9:50	10:47 ⁸ 1 1:19 ILM 5082 DSM CR9 10:31 5055 11:20		13	:54 14:30	15:14 5265 16:00 MEM 5058 AE 15:35 5208	TYS CR9	XNA 5193 CVG AE CR9 17:04 5281 17:50	65271 _{18:30} 554		5382 TERM	TERM	
F13						4850 8:49 OF	RIG	BHM 3819 HSV AE 10:59 3909 11:50				LEX	5153 BTR CR7 5 5074 16:45	MYR 5313 BF AE 17:19 5182 18:	HM	SDF AE	51	300 XN.	9
F14						OF	071 RIG	CVG 5268	8 DTW CR9			OMA 5431 DSM AE 5431 CR9		17:19 5182 18: 5077 FAY CR7 5105 17:45	:05	19:28 5163	52	219 22:3 PULL	91
F15						TLI	509 H 5213 VPS CR7	MYR 5389 SAV AE 5389 CR9	8 13:00			OR	IG	5105 17:45 SAV 5070 GSP AE 5070 CR9 17:09521417:50		5814 TERM	5337	4925	
F16						8:53	3 5183 9:50 ORIG	10:22 5051 11:10 BTV 4649 RIC AE E75				TYS 5	90 305 VPS E75 065 16:45	5181	VPS AF	5385 PHF E75	TERM	IND M AE 4476	SY 375
F17							5294 ORIG	10:214618 11:05 TUL 5196 ORP AE CR9 10:20 5081 11:02				CAE 3960	065 16:45 GSP E75	TERM YOW 5543		307		YYZ 4498 MDT	:35
F17							ORIG 5247	10:20 5081 11:02				15:22 3833 SA	16:25 T	17:06 5265 1 558'	18:10 TE	ERM LNK CR9	5076	21:22 4636 E/S	
							5129					16:	00	555.	3	19:45	TERM		
F19				ORIG	ORIG	EWR ₃₆₀₇ EV	WR IAD	IAH 6165 IAH			EWR 364	2 EWR	ORD	323 ^{ORD}	 	AD IAD			6234
07				ORIG 6238 ORIC	ORIG 3357	EWR ₃₆₉₇ EV 8:34 ³⁶⁴⁸ 9	UA 6 9:42	IAD 150 CR7 10:22 IAH 6165 IAH 11:04 ⁶³¹⁰ 11:41 EW	R ₃₃₆₇ EWR		EWR 364 14:33 335 EWR 3314 IAH	66 15:30	ORD ₄₈ 16:46	343 17:21 EWR ₃₄₀₁ EWR	18	6160 8:55 19:30			6234 TERM
O8				3312	ORIG				336/ 52 ³³¹¹ 12:27		UA 3314 E70 14:24 3315 15:02 IAH 6115 IAD			17:20 ³³⁴³ 17:56	АН			6302	TERM
O9					6113			LGA SOCO LGA		LGA 2000 LGA	14:09 14:44	LGA 5006 LGA		UA 6243 E7 17:14 6285 18:	7W ::05	LGA coat LG	A	3812	
O10					ORIG 3612			LGA 5060 LGA DL 5069 11:14 5069 12:00		LGA 3888 LGA DL CR9 13:14 3642 14:00		LGA 5096 LGA DL CR9 15:06 5099 16:00		4554		LGA 6224 LG. DL CR 19:18 6227 20:0	.9 10	TERM TERM	



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AADO				,	_																	
A21				5:15 CLTSC4 DFV 5:15 2451 6:0	7 TF A./ 6:4	PA A 46		2011 1797	To a second	321 11:20	ORD PHX AA 628 321 11:57 13:00	FLL AA 13:20		105 27:	1		P : 19	VD CLTS 321 9:10 19:45	ORIG RIC 2006 20:30	DEN T AA 1873 3 21:18 22	PA 21 15	
A22					SFO AA 6:14	89 20	98 57	1.AX 321 9:45	LGA AA 87 10:00	9* 321 11:40	RSW AA 12:00	445 580	DEN 321 14:20	BWI AA 15:15		1889 1798		Pl 3 20	HL PHL 21 AA 05 20:40	892 PI 472 22	1X 21 15	/
A23					SMF AA 6:02	476 840*		MBJ 321 9:25	AA 1909 10:11	11:03		13:18	1789 MSP 321 1855 14:50	PBI AA 16:00		294 1673	E 15	321 9:11	EWR AA 20:36	1245 JFF 1608 733 22:10		/
A24					SEA AA 6:15	624 LAS 658 8:00	BOS AA 8:28	1709 FLL 321 9:50	ORD AA 10:08	1729 PUJ 321 1967* 11:50	TPA AA 629	BOS 321 3:10 TERM			RSW AA 16:55	703 321 5 17:45		TUS 852 AA 843	TUS TP 319 AA 20:10 20	A 2039 DFV 52 890 32 52 890 22:10		
A25					SAN 579 AA 6:04 662		lan-	DTW 925 FNT AA 319 9:06 1109 9:52	RDU AA 10:38	1977 8 1936	21 12:10		695 TPA 321 1810 14:50	MCO AA 637 15:25	1AS EV 321 AA 16:45 17:	WR A 470	SAN BWI 321 AA 18:15 18:39	416	FLL 321 20:20	AA 1774 21:02	321 322:20	/
A26					0.4	ORIG PHL 1956 7:30	8:20	580 321 9:40	FLL 173 AA 826	35 MBJ 321 5* 11:30	AA 1842 12:06 13	321 AA 3:09 13:28	1154 SAN 321 1583 14:45		DFW 720 AA 830	321 17:30	РВ1 АА 18::	1 1798 54 844	321 20:27	AA 557 21:04	321 22:20	/
A27					LAS 43 AA 42	28 7:35	SFO 1944 AA 1946		DCA AA 10:32	1837 321 11:55	AA 1878	321 AA 17 13:15 13:30	760 321 14:30	Gr.	kuro	MSP AA 17:40	1836 1841 ₁₁	321 9:12	Mad	PHX 499 AA 1865	321 22:25	/
A28					PHX 202 AA 209		A 1866	321 9:20	AA 10:35	1961 321 11:55	AA 1970 12:19	321 AA 13:19 13:35	2080 321 14:50	SEA AA 15:16 443 16:20	AA 16:46	1908 SFC 321 1799 18:05	1 AA 1 18:45	747	321 20:15	AA 1704 321 21:03 22:09	100	
A29					SLC AA 6:10 40	8 7:30	AA 1 8:22	912 321 9:40	AA 8	158 321 11:30	AA 2044 12:04	321 AA 13:20 13:37	581 321 A	A 494 321 5:00 16:15	I AV	TPA 730 AA 17:20 174	0 1GA 321 40 18:40	STL 1768 PIT AA 319 19:10 1747 19:54		AA 1857 21:13 2	321 2:19	
A1					AA 6:26	696 TPA 321 1813 7:45	AA 1772 8:13 DFW	2 321 9:29	AA 10:29	521 321 11:45	AA 1808 321 12:03 13:02	1 A/ 2 13	FW 2091 JFK 321 552 1972 14:55	TPA 539 AA 725	321 AA 16:40 16:5	786 678	321 AA 18:16 18:49	487 S 451 20	21 05	AA 1812 3 21:12 22	21 15	
A3				CLTSCA	AA 6:4	2062 321 4 7:59	AA 8:34	835 321 9:50	PHL 826 10:05 1735	321 11:20	MCO AA 1725 MCO 321 12:04 691 13:01	AA 2059	14:20	SFO 704 LGA AA 321 15:03 2050 16:10	OPD	COO TRA	TE	D84 ERM	eril	AA 1717 32 21:09 22:10	0.50	
A5				CLTSC4 L ORIG 5:20 2060	A. 05 6:	A 1364 738 47 7:45	AA 883* 8:10	9:25 TPA	AA 883 10:11	11:25	AA 873 12:27	3 321 AA 13:24 13:	X 1810 PHL 321 A 2055 14:45 BW	AX 724 PHL A 321 5:00 559 16:05		622 TPA 321 731 17:53	AA 83 18:35 61	36 SFO BOS 321 AA 19 19:30 19:45	793 319 20:33	277 TERM	973 TERM	/
A7				TSC4 ATI	hen	AA 469 321 6:52 8:00	8:20 MCO	9:35 SFO	AA 10:31	752 321 11:45 MIA		A/ 13	A 2063 321 :52 DFW	PHX 1899 AA 15:35 705	321 AA 16:40 17:	OS 1787 SI 3:00 609 18: .L 609 PI	321 :10 DX	AA 1769 319 19:11 20:00		AA 1863 21:26	321 22:26 LAX	
A9			4:	TSC4 ATL ORIG 823 5:30	AA 6:37	1980 321 7:50	AA 461 PHX 423	9:24	AA 10:32 RSW	1831 321 11:45 PHX	ATL	AA 89 13:30 LGA PHX	01 321 14:25	AA 1719 3 15:20 16: LAS 748 BOS	11 AA 14 17:	:00 1787 18:	321 :10 DEN	AA 1820 321 19:02 20:00 LGA 610	BOS	AA 1737 21:21 A	321 12:20 LB	
A11					DXS	TSC4 RSW ORIG 928 7:30	8:11 1965*	* 321 9:25	RSW AA 67 10:13 MCO 790	11:25	AA 2066 12:02 1 IAH 382	738 AA 20 13:12 13:31	168 321 14:26 LAS 1458 SMF AA 321	15:08 1999 16:10		AA 651 17:16 DEN 1811	321 18:25 DFW	LGA AA 610 19:20 178	3 20:29 BWI	AA 1940 3 20:58 22 RSW 1805 IAH	19	
A13					CLTSC4 N ORIG 6:15 1877 7	.00	8:21 4	13 9:35	MCO 790 AA 205 TPA	ORD	IAH 382 I2:11 100 EWR 161:	13:19	13:58 1917 14:50	AA 1775 321 15:09 16:10 DEN 428 TI	A	DEN 1811 17:21 565 PHX 767	321 18:30 SMF	AA 1920 19:12 SEA 633	321 20:20 SEA	1805 21 21:10 745 22:10 5069	550 TERM	
A12					6:4	TSC4 SAT ORIG SAT ORIG 1727 7:30 CLTSC4 DIG MCO	LAS 1955 AA 1905 8:10 1905	LGA	AA 18 10:18 MSY	362 321 11:25 STT	12:23 144°	7 738 AA 7 13:26 13:45	2055 PHX 321 695 14:35	DEN 428 TI AA 1791 16: MSP RS	21 24 W MIA	17:13 466 1799 ORD	321 18:20	19:12 541 SFO 662	321 20:20 LAX	TERM	783	
A10						CLTSC4 MCO 6:55 1725 7:40 CLTSC4 ORIG 7:05 1963* 7:55	AA 8:46 PBI	1910 321 9:55 DEN	AA 10:24 MSP	833 320 11:50 BOS	AA 893 73 12:17 13:0	38 05	SAN	AA 2046 3 15:25 16:	21 AA 25 16:54	1908 18:00	мсо	19:14 1975	321 20:20 PA	OPD	TERM	
A8						7:05 1963* 7:55 CLTSC4 MCI ORIG 1906 7:50	8:31 LAX	445 321 9:35 BOS	AA 10:26 DFW	1937 321 11:30 LGA	10000	907 ELP 319 54 13:45 MEM	AA 14:51 SAT	65 321 ORD 1999 MCO	LGA	PHL 799 17:16 1733 PHX	321 18:20 DFW D	AA 1871 19:07 20 FW IAH 744	321 :06 RDU	MSP 1897	738 22:30 BWI	/
A6						7:05 1906 7:50 CLTSC4 ORD 7:10 1916 7:55	AA 8:43 TPA	1982 321 9:45 BWI	BOS 19	2064 321 7 11:40 67 MCO	PHL 1882 PHL 319 11:59 2054 13:00 PHT CL	AA 13:39 LE	1827 738 14:40	15:05 1899 16:00 FLL ATI	AA 16:44	436 321 17:45	AA 1752 : 18:11	FW IAH 744 321 AA 19:25 1861 MSP 766		21:04 1998	320 22:30 RIC	
A4						7:10 1916 7:55 CLTSC4 BWI ORIG 3773 7:40	RSW 41	1960 321 9:40	EWR 1451	EWR	AA 2078 31 12:05 13:0	05		AA 504 321 15:05 15:59 SRQ 1130 DEN			18:29 1317	MSP 766 19:14 TERM MCO 746 PHX	808 TERM	2043	2 319 22:40	//
A2					k	6:55 3773 7:40 CLTSC4 FLL	8:28 71.	3 9:20 MEM	AA 10:02 1458	738 11:05 SJU 1376 SRQ	BNA AUS			15:20 184 16:10	819 SJU	MCI	MIA LA	MCO 746 PHX 321 8:59 463 19:55	MSP	TERM	ATL	
B1 B3				CI	rsc4 Phl Orig 2010	5:50 525 7:35 DCA PIT	AA 17	9:24 DCA	BNA 821	10:50 1404 11:40	AA 653 319 11:58 12:54	IND MCI	ROC	16:00 EWR M	972 321 IA PIT	AA 1701 17:13 1829 DFW	18:20 AA 18:20 I8:	2075 PBI	17	ATL AA 21:16 1897 24 5563	22:40	
B5				5:5	0 2010 6:35 SJC 661	AA 1904 319 7:02 7:59 PDX	AA 172 8:17 MIA AA	9:30 EWR	BNA AA 10:01 876 ATL AA 206	IAH	AA 1973 BDL RD AA 1914 31	319 AA 13 13:12 13:27	319 14:35 JFK 2530	AA 379 7 15:05 16: EWR IND 1843	DCA DCA	721 321 CLTSC4 RI ORIG 1915	CLTSC4 ORIG 18:28 1530 1	9:13 844 TERM	TE	24 5563 RM TERM	PHL	
B7					6:00 1872 BWI	7:05 JFK 2042 738	8:47 UFK	1496 738 9:55 MIA 48 738	10:12 STL AA 1	11:19 DTW	12:09 13:0 ALB	¹⁷ ¹⁸ ¹⁷ ¹⁸ ¹⁷ ¹⁷ ¹⁸ ¹⁷ ¹⁸ ¹⁸ ¹⁸ ¹⁸ ¹⁹ ¹⁹ ¹⁹ ¹⁹ ¹⁹ ¹⁹ ¹⁹ ¹⁹	JFK 2530 AA 2249 SNA 1767 LAS 738	MSY 1821 RIC	16:40	17:25 1915 18:	1692	TERM 451 TERM		TW LGA A 1981 738	22:25	
B9					RDI 0130	7:30 DCA 732 319	8:30 EWR 2531	9:30 JFK	10:27 SAT	923 319 11:20 BNA 850 738	12:5	DCA	AA 738 14:10 278 15:00 MSY 045 319	15:30 1886 319 15:30 1886 16:09		AUS AA 1840	TERM BDL	1976	SJU	753 MSI		
B11					6:17	7:30 CLTSC4 ORIG LAX		5330 MHT	10:3 JFF	9 11:40	OCA RIC AA 2077 319	13:28 PIT	14:35 BDL 700 319	MIA 2448 OI AA 15:16 1453 16:	D LAS			TERM GRR 319	1954	2039 22:10 MIA EV AA 1384	VR 38	
B13					e	5:50 1993 7:35 CLTSC4 RDU ORIG 7:05 2011 7:50	DTW AA 1942	5089 9:30 BUF 319	10:	42 11:35 1 ELP 281 ELP AA 319 11:07 1870 11:50	887	[13:31 SAT	1633 F 8 296 15	NT JFK 1	577 SNA	1577 17:45 IAH EWE AA 1711 738	18:05 5553 R RD AA	B 19:45	TERM 861	21:13 22 ATI MCI	ORF 085 319	18 TEI
B15						7:05 2011 7:50 CLTSC4 S. 7:20 827 0	8:08 BDL	9:10 CLE 780 319	AUS AA	19	TERM 964	JAX 319	RDU 2069 PIT	RDU AA 196	738 871 _{16:45} BWI 2 319	RIC 5321 B	5 18: NA SJC 319 AA	786 AI	3Q 38	21:19 21:40	22:40	TE
B16					RIC AA	7:20 827 8: BDL 1654 319	95 8:21 MEM AA	9:40 RSW 1853 319	10:3	9 IAD 5373 SAT AA 319 11:10 5210 11:55	849	13:15 DTW AA	756 319	BNA 1886 JAX	16:45	17:19 5563 18: PI	DX 1853 S A 1853 S 7:58 660 19	585 20 SJC BNA 194 738 AA 733 19:24 733	5 SAT 738	TERM BDL AA 1952	BUF 738	
B14					6:34	7:30 1930 SAN 321 487 7:50	8:43 ST A	9:55 TL PIT A 1677 319	MDT AA	1753 JAX 1753 319	PVD AA 657	IAH CLE 7 319 AA 1	14:40 RDU 934 319	RSW AA 1992	PVD DCA 319 AA	673 IAH	7:58 000 19:	JFK 101	20:25 EWR BWI 738 AA	864 2035	JAX 319	
B12					6:14 PIT AA	1903 319	ILM PH AA 1839 31	51 9:45 L FSD 784 9 AA 993	MCI LC 319 A	11:50 GA ALB A 1988 319	CHS 1849 AA 12:25 1950	13:20 13:37	14:30	ATL 2032 AA 15:08 1821	6:30 16:54 OTW 319	17:54	LGA MSY AA 1809 320	MSY 732 AA 19:14 1885	90:10 20:38 BUF 738	1971 TERM	22:35	
B10					[6:42 CL	7:35 TSC4 ROC ORIG ROC	8:04 9:0 FNT 1751 AA 97		PIT):44 11:55	1 1267 BUF 319 15 751 12:30	13:15 BUF AA 2002	BOS 319	15:08	JAX AA	1750 DCA 1750 319	18:02 18:55	DFW JFF AA 2648 738	20:15	2035 TERM		
B8					6:4	BOS BNA AA 1817 319	RIC AA 8:15 829		1924 TERM	PBI 2754 AA 2845	12.50	13:26	FNT AA	15:02 16:06 197 124	4	17:50 BUF 319		EWR 1598 AA 2483	IAH R 738 A	IC AUS A 1893 319		
B6						p:12 8:00	BUF AA 8:08 1941	DTW 319 9-19	PWM AA		12.13		CHS DCA AA 1938 319	CLTSC4 BDI ORIG BDI	AI.	18:00 LB PWN A 2052 319	9	JAX AA 19:15	1861 2043	22:10 PE 31		
B4							IND AA 8:44	9:19 BDL 319 9:50	PBI AA 1847	PHL 7 319 11:15			CLTSC4 IAH ORIG 14:10 2069 14:55	DCA MCI AA 1653 319 15:13 16:15	17	IND AA 765	STL SAT 319 AA 18:25 18:40	5210 5335	CLE 319 20-30	SYR DO AA 1987 3 21:04 22:	A 19	
B2							8:35	1978 NAS 319 852 9:40	OK AA 10:	C IAD 4 5510 319 42 11:45			1933	STL 537 AA 509		E RIC 319 17:54	13.40	CLTSC4 MDT ORIG 19:04 1720 19:49		MSY AA 1793 21:20	PIT 319 22:25	
C2							CLTSC4 ORIC 1957		ALB 1 AA 1 10;23 6	707 SXM 319 113* 11:25			2017 PUSH	DTW AA 1802 15:39		BWI 1915 AA 2038	PVD DCA 320 AA 18:15 18:5	A ILM 1979 319 52 20:00	334 TERM			
C4							DCA	795 CHS 319 9:30	MCI AA 10:28	1797 IND 1977 11:30				MCI AA 15:35		422 1540		ELP DFW 56 319 AA 51 19:15 19:35 61	0 DEN 321 6 20:20	ALB AA 2070 21:22	CLE 319 22:25	
C6							IAH AA 8:38	852 IAH 319 1978 9:35	ROC AA 1868 10:14	CHS 319 11:14				IAH 1745 AI AA 15:35 1843 16:	B 9	1065 PUSI		MIA 760 AA 19:20 199) PVD	BOS AA 17: 21:39	ORD 321 22:35	
C8							ORF AA 177 8:29	ORE	BWI 8 AA 10:20 82	376 GCM 320 21* 11:25				NAS AA 853 15:10 1	321 A 5:29	NAS AA 859 17:04 1	PIT NA	S 605 PLS 54 1029* 20:00		SAT AA 1870 R 21:25 22	OC 519 :16	
C10							PVD AA 865* 8:12	SXM 320 9:25		BDA 1840 ME AA 31 10:51 1434* 12:0	EX 19 00	CLTSC 13:40	ORIG PBI 1789 14:25	PHL AA 2047 15:37	PBI 319 6:30			ROC AA 1921 19:07	JAX 319 20:15 20:45	C4 MCI PHX PULL AA 170 21:30 21:50	1854 RDU 321 22:45	
C12								CLTSC4 ORIG 9:05 5247 9:50		DEN AA 11:15	1446 LAX 321 652 13:00			JAX AA 2036 319 15:20 16:19	R A	RDU DTW AA 2067 319 17:04 18:05	SLC 9 AA 5 18:40		78 881	STL 319 22:00	2005 TERM	
C14										CLTSC4 ORIG MCI 10:55 1964 11:40				RIC AA 15:41 1745		5	1891 736	DTW 319 20:00		RDU PVD AA 2038 738 20:57 22:05		
C16										CLTSC4 BWI ORIG BWI 10:50 1924 11:35					BUF AA 16:20	5	122 524	FSD 319 19:54	CLTSC4 PUL 20:32	CLTSC4 PULL 21:17 21:35	SYR 12:20	
AAIN																						
I1							SDQ *183 AA 982	* 9:45		MEX *1844 SD AA 1853* 31 11:00 1853* 12:0	OQ 19 00			HAV AA 16:05	*1074 1028	BDA 319 17:30	MEX AA 18:35	*828 MEN 319 1768 20:00	AU. 20::	A *877 50 TERM 21:35		
12						CLTSC4 MBJ 6:55 843* 7:45		GCM *860 HAV AA 319 9:00 1615* 9:45		CUN *1283 SJO AA 10:50 1087* 321 11:55					PUJ *19 AA 16:21 78	963 ATL 738 17:50	GCM *82 AA 18:14 850	22 DCA 320 6 19:44	*1968 1954	SJO 21:55	*1850 TERM 22:40	
			·																			

									CI	LI 2033-5	cenario													
	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
	ntulutu					ntulutu	ntulutu	Intoloto		ntulutu							ntulutul	ntulutu	ntulutu	latalata	البالياليال	ntulutul.		
13													CLTSC4 ORI 12:40 887		SJO AA 14:35	*672 AUA 617* 321 16:05			SXM AA 18:40	*866 BNA 320 1867 19:49	SXM *613 20:24 TERM 2	i09		
14												PAP * AA 11:00 1	*368 N 1826 13	NAS 319 3:15	ME AA 14:	*843 RI 53 2056 16:	DU MBJ 21 AA 10 16-50	*869 ¹ 0 749 ₁₈	LAS 321 8:10	MBJ *827 AA 1919	MIA 321 20:15			
l5							6	CLTSC4 CUN ORIG CUN 6:55 804* 7:45			PLS * AA 10:00 1(*842 KIN 319 040* 12:00	15	5315	155	KIN a	644 KIN 319 456* 16:40	PUJ AA	*196		AS CUN *888 321 *888 TERM	TSC4		
16								7.40		KI A/	N *854 PAP A 319 55 1647* 10:50	12.00		AUA AA 13:30	*1542 625*	SJO 738 15:40	PAP *2364 AA 2541*	PAP 738	SDQ *639 AA 18:00 1865*			1342 SDQ 321 374* 22:00		
17										,	10.30			13.30		15.40	CUN AA	*884 BOS 321 1806 17:55	CUN AA	*886 PBI 321 2061 19:55	20.13	22.00		
18																	10.40	17.55	F	PLS *880 OI AA 3 18:55 1851 20:	RD 321			
I10													FR AA	*705 CLTSC4 A 789 6:00 PUSH 14:00		FCC AA	*721 MAD 789 5748* 16:40		BCN AA 18:20	*745 744*	BCN 332 20:45			
I11													133	5.00 1 0 0 11 14.00		MAD AA	*74 724	19 DU 33	B LHR 32 AA	*733 732*	LHR 789			
l12								GI A	RU *1062 CLTSC4 A PUSH 332 50 PUSH 8:50							FCC AA	*721 CLTSC4 789 55 TERM 16:55	. 16.0	18.30	7,32	20.13			
I13								-	30 8.34					CE AA	DG A	*787 704*	FRA CI 332 AA	TSC4 PULL 720*	FCO 789					
l14														<u> </u>	3.33	701	LHR AA	*731 730*	LHR 789					
I15													I I	DUB AA		725 786*	10.13	730	CDG 332	CLTSC4 PULL 19:00 1568*	GRU 332 20-20			
OADO														19.03		730			10.20	15.00	20:30			
01	1441 TERM				CLTSC4	RIG HOU CLTSO	ORIG MDW CLTS	ORIG 1AH CI	LTSC4 DEN ORIG 5290 8:35		JFK 40	093 JFK 058 11:15		i i	BNA 5136 BNA WN 738 14:00 684 14:45 MSP MSP		SEA AS 16:30 52	25 SEA HO 737 26 17:30	OU ₁₇₄₇ HOU ::55 ¹⁴⁹³ 18:30				1286 TERM	T
O2	9 TEI) RM			4:40	5:25 5:45 CLTSC4 IAH 5:05 1191 5:50	CLTSC4 ORIG 6:08 3612 6:53	CLTSC4 ORIG 7:20 2266	MSP LGA3931 DL 8:05 8:35 3841	0LGA CS1 0.9-15	86:01	LGA 5060 LGA DL CS1 11:14 5069 12:00			MSP MSP 1503 14:24 14:59		MSP DL 132	22 DTW 22 320 24 17:20	DTW 10 18:40	DTW 157 19-15		3812 TERM	T.L.	876 TERM
O3	1131					CLTSC4 ATL ORIG 612	LAS NK	165 MC 864 8-6	O		JFK 219 JFK B6 218 E90 10:01 218 10:40	ATL ATL DL 2251 717			14:59	ATL ATL DL 2133 73H		135 FLL 320 386 17:30	18:40 I	DAL BWI 1721			357 ΓERΜ	614 TERM
O4						CLTSC4 DTW ORIG 1366 6:00	CE	TSC4 SEA ORIG 0 681 7:35	8:48	9:30 DTW DTW 2292 9:04 9:39	10.40	ISP 354 ISF F9 353 12:05	9 9			LGA 5096 LGA DL CS1 15:06 5099 16:00	MDV	W ₈₅₃ MDW 1 ⁷⁴⁸ 17:25	<u> </u>	ATL ATL DL 1407 7:	TTN 933 3H F9 932 2	TN 321	4128 TERM	19 TE
O5						(C)	CLTSC4 ORD ORD 1712 6:48	SFO 170- UA 1969	4 SFO 739 9 8:20	MCO DEN WN 1685 738 9-20 10:00		11.20 000 12:05	DTW DTW DL 1629 319 12:07 12:50			DEN 1711 UA 15:10 1199	DEN 739 16:22	LGA 5508 LGA DL CS1 17:12 5135 18:00		LGA 6224 LGA DL 6227 CS1	20.23 752 2		1076 TERM	
O6						le le	CLTSC4 LG/ ORIG LG/	CLTSC4 ORI-		ORD 425 UA 521	ORD 73G	BOS 1245 BOS 10:59 1246 11:36	ATL A DL 1095	ATL 717 3:15		PHL MC F9 1689 3:	O 20	JFK 4189 JFK DL 3433 18:00	JFF B6	1119 FK 1119 E90 1118 19-28	MCO 344 LAS NK 320 20:00 541 20:50		8017 TERM	1974 TERM
O13							0.15	(7.30	6.13	9.20	10.13	10.39	12.33	3.13		15.21	<i>5</i>	17.17	10.	19.28	20.00 - 12 20.30			
O14						CLTSC4 ORIC 5:33 8022	BOS 6:18	CLTSC4 FI ORIG 7:15 8104 8:0	.1.	BOS B6 9:24	8025 BOS 8020 E90 10:51	FLL B6 11:30 810	01 FLL E90 02 12:30			B B	OS 8021 BOS 6 8016 E90 5:00 8016 17:00	BOS 1445 BOS B6 E90 17:18 1446 18:00 BNA 2465 BWN 17:20 3113 18					8103 ΓERM	
O18						<i>p.33</i>	CLTSC4 ATI ORIG 2488 7:00	D PDX AS 7:15	625 PDX 73H 626 9:00	BWI E 3055 9:35 10	OAL	11.30	OR UA	RD 1484 ORD A 319 3:00 1140 13:45		DTW 60 DL 15:40 17	03 MSP 193 16:30	BNA 2465 B WN 3113 18	BNA 73 W 8-10		CLE 486 F9 489			522 TERM
O19							0.10	CLTSC4 SLC ORIG 521 7:45	7.00	,,,,,,	ATL ATL DL 1454 739			LGA 3888 LGA DL CS1 13:14 3642 14:00		13.40	ATL 602 ATL DL 73H 16:18 2651 17:00	SFO 11 UA 17:31 16	76 SFO 739 98 18:30		20.20	21.20	ź.	5812 ERM
O20						DEN F9 5:10	201 200	DEN 319 7-20			MCO PH F9 1028 32	IL 20 59		ATI.	ATL 2597 320 14:30		DEN MCO WN 1362 738 16:20 17:00	ATL DL 17:50	826 73H			2808 TERM		
O27						J.10		7.20			10.11			13.42	14.59		10.20		10.45					
O28																								
O29																								
O30																								
O31																								
O32																								
OAIN																								
l21																	MUC LH 16:20	*428 429*	MUC 359 18:35			LGW *775 DY 7752	1 LGW * 788 23:05	
l22																		KEF WW 17:40	*201 KEF 321 202* 321 18:40					
AEDO													lou	V.	an-	4		lavo.					nc	
D13							PHF 5 AE 5 6:30 5	190 PHF CR2 7:35	AE 8:30	5337 5514	7 4	JAN CR7 11:20	OAJ 5176 OAJ AE 5176 CR2 12:05 5314 13:00	MGM 5441 AE 5154	14:25	FAY 3831 15:26 4070		AE 17:10	5119 5256	FAY CR2 19:50	HTS 5461 CRW 20:15 5049 20:50	DAY AE 21:31 511	6 CR2 8 22:40	
D12							SP DCAL I	NV TEM		5293 MGM CR2 5440 9:45	leve	10:59 3909 11:50	CLE 5282 GNV AE CR2 12:05 5063 12:50	1YS AE 13:5	S 5294 TYS CR2 515119 14:35	GPT 5095 CID AE CR7 15:05 5096 15:50	10.00	5063 CAI 5259 CR 18:0	SHV 5514 2 4 18:30 5254 19			AE 52 21:36 52	64 MGM CR2 22:41	
D10						5	SP DCA G! 3802 AI :57 6:32 6::	NV 5228 CR2 5039 7:30	8:40	5273 TYS CR2 5297 9:35	AE 10:4	A 5277 EVV CR2 46 5032 11:35	CRW 5237 BHM AE CR2 12:15 5164 13:00	AE 5: 13:43 50	5120 PHF 5052 CR2 5052 14:25	EVV 5032 E 15:23 5366 1	6:14	PHF 5052 AE 5264	CR2 18:14	5366 TERM	TRI		Gen	
D8							AE 6:22 4	738 OAJ CR7 7:40		5406 CR2 5176 9:26		5039 FAY 5463 CR2 11:20	HSV AE 3906 CR2 12:25 3960 13:05		14:07 5486 CR2 14:45	OAJ 5314 AE 533 5222	CR2 16:19	FWA 5135 DAY AE 5136 CR2 17:11 5156 18:00	AVL AE 18:42	4769 4895	CR7 AE 20:15 20:38	4001 3795	CR7 22:40 CRW	
D6							trvs	7:08 5277 7:43	TRI 485. AE 8:16 482			5557 CR2 5294 11:18	BHM 5142 TLF AE 5142 CR: 12:30 5218 CR: 12:30 13:11		5463 VPS 5453 CR7 5453 14:40	ORIG 3973	DAI	AE 5 17:45	5311 CR2 5186 18:25	TRI 4786 AE 4755	CR7 20:30	CHO 5552 AE 5177	CRW CR7 22:35	
D4							AE 6:24 CRW	5354 GSF CR7 7:45	4935 4850 8:00 8:30 8:51	LFT	5122 5364	CR7 11:45	GNV TYS 5371 12:25 305 13:00	AE 13:37	5320 5220	0 6 1 27 EVV	CR7 6:14	AE 17:05	5486 5172		CR2 20:25	TYS 5037 AE 5100 AN 5257 B	CR7 22:25	
E1							AE 6:45		5263 5335 PGV 5234	CR7 9:36	MOI AE 10:4	15 551		CR7 3:15	14:03 52	CR7 104 16:00	5513 PUSH	AE 17:46	5031 TUL CR9 5271 18:30	PULL 5147	2 YITI IA	AN 5257 B 0:58 5407 C 0:58 5407 CAK	15	
E2							AE 6:35	4921 GSO CR7 4826 7:50	AE 5254 8:11 5187			11:05 3023 12:	RAP CR9 2:10	AE 13:50	50 3439	CR7 AE 15:15 15:44	5526 HPN CR7 5166 17:00	AE 17:16 4798	18:30		3 YUL AV 5 CR7 AI 5 20:25 20	7L 5326 CAK CR7 :55 5124 22:05	MGM AEX 5491 AEX 22:27 22:59	
E3							hron	5058 PUSI	H 8:22 5033	9:15	PULL 5343	LIT 5183 EYW AE CR9 11:00 5220 11:45	AVL 4751 LYH AE CR7 12:12 4804 13:03		CR7 19 14:25 1-	E 4:57 5096	LFT AVI CR7 AE 16:20 16:5	4011 CAE CR7 52 3775 18:00	TI	2344 ERM	AE 5411 CR7 20:00 5523 20:40	041 4021	LYH	
E5							AE 6:39	4867 HHH CR7 4942 7:35	HPN 515 8:22 525	51 9:35	AE 10:44 GSP	5546 4 5364	13:00	AE 13:49	5 5263 DAY CR7 9 5123 14:41	SDF AE 15:17 3959	16:35 16	H 5218 GNV CR7 :55 5202 17:55	18:43	5209 AGS CR7 5398 19:45	AE 5265 CR9 20:05 5141 20:45	OAJ AE 21:24 4922	CR7 22:30	
E7								ROA 4776 FAY AE 4934 CR7 7:04 DAY CLE	PHF 5383 8:10 5320 LYH 4886	CR7 9:20 SBY	10:10 55	467 FPO CR7 593 11:45	TYS 5297 MOR AE 5297 CR 12:20 5512 13:10	10	HPN 5384 MLB AE CR7 14:02 5302 14:50 4904 ROA	AE 15:50	5138 HTS CR7 5200 17:00	CRW 474 AE 17:30 493	1 18:25 AE	5437 CAK CR7 5306 19:45	AE 4460 E75 20:00 4582 20:40	ROA 4807 ROA AE CR7 21:00 4799 22:05	нн	
E9							6	7:14 5282 CK2	8:12 4831	7.00	10:21 377		SAV 5185 CHA AE 5185 CR7 12:07 5582 12:50	AE 13:48	8 4829 CR7	EWN 4773 LY AE 4779 16: CHA 6	R7 10 5592 GPT	CID 5456 CII AE 5429 CR 17:04 5429 18:0	7 AI 4 18	E 5230 CR7 3:52 19:54	VPS	AE 4943 21:15 BTR 50	2:20	
E11							CHS	HHH ₄₉₁₅ ROA 6:56 ⁴⁷⁶³ 7:30	8:5	H 5213 VPS E CR7 53 5183 9:50		5320 CID CR7 5423 11:45	HTS 4866 AGS AE 4805 CR7 12:18 4805 13:01 GSP 5067 LEX AE CR7		800 CHO 743 _{14:19}	CHA 5 AE 5 15:40 5	5582 GP1 CR7 5083 16:40	EWN 4939 AE 17:24 4807	18:15	CAK AE 19:18 5143	CR7 20:20	BTR 50 AE 21:35 50	8 CR7 22:40	
E13							AE 5.	246 SAV CR9 295 7:45	8:32 4	4884 TRI CR7 4841 9:40	FAY AE 10:07 4904		12:17 5153 12:59	13:14 13:46	TEAL	PHF 5364 LI AE 5283 16:	R7 AE 10 16:48	5105 CR7	DAB 5315 OKC AE CR9 18:00 5258 18:45	19:09 4870 2	CR7 20:09	AE 5083 CI 21:10 5393 22:	7 4	
E15							MVP	Chq	8:42	5278 AGS CR7 5396 9:45	AE 10:4	46 4773 CR7	GSO 4903 TRI AE CR7 12:18 4765 12:59	AE 50	5251 LEX CR7 5078 14:25		257 16:35	HTS 4759 HH AE CR 17:18 4813 18:0		P 2922 MKF	FAY SIG - HSW	LYH 4798 AE 4744 21:26 4744	22:30	
E17							MYR AE 6:29	5309 CR9 7:40	OAJ AE 8:13 5466	CR7 9:20	PIA AE 10:26 543	CR7 31 11:19	LYH 4820 CR AE 4933 13:1	R7 AE :12 13:47	5225 BHM CR7 5311 14:30	NA 5569 ICT LEX AE :55 ⁵¹⁹⁶ 15:32 15:5	5153 BTR CR7 55 5074 16:45	ORI 479	AE 18:4	P 3833 MKE CR7 49 3889 19:44	FAY 5105 HSV AE CR7 19:59 5224 20:40	MDT 5180 AE 5556	CR7 22:30	

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	00:00 01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00 23:00
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E19				 	шшшш	SAV 5	452 MYR CR9 7:40	AVL AE 8:21 5152	CHO		MKE 3896 SDF AE 3798 11:40	TRI ROA	A CRW 4824 H 7 AE 4759 C1	IS MSN CAK	TRI 4765	AVL	OF 50	RIG	PGV 4869	LYH MLB 5	431 MOB	
								8:21 5152 GSP 5235 IAI	9:19 D DCA GSP		CAK 5468 GPT	TRI 4841 RO/ AE 4926 CR 12:23 13:0 EWN 4936 F	r ol lenv	CDW	15:38 4769 FLO 4862 ROA	16:24 DSM	50	5378	19:15 4780 SAT	FWA 5	476 LEX	
E18						AGS 529 AE 509 6:31 GSO	MEM	8:18 5509 CR CRW 5347 BHI	DCA GSP 19 5260 19 9:24 9:59 M		ND 4484 CMH	EWN ₄₉₃₆ F 12:29 ⁴⁸⁶² 13 RDU 5415	.00	31 CRV 49 CR7 14:19 14:19	AE CR7 15:20 4842 16:05	AE 16:45	LFT 5064 MLB	5036	20:00	9 AE 20:30 5:	235 21:30	O LEX
E16						AE 6:52	5026 CR9 7:50	8:16 5142 9:1	R7 10 R1	A I BTR	AE 4457 E75 10:46 4457 11:45	12:19 5288		M ₄₈₇₉ EWN 4939 0 ⁹³ 14:25 MYR 3777 AVL	15:47 478		LFT 5064 MLB AE 5064 CR7 16:58 5376 17:40	PHE	19:40 4	4767 CR7 20:30	MOB 5060 AE 21:40 5520	0 CR7 0 22:35
E14						ORF 5460 6:27 5268	7:24	AGS 5439 BTI AE CR 8:21 5225 9:0		AE 10:34	5507 CR7 5263 11:14	TLH 50 AE 12:28 54	437 CR9 13:34	AE 3777 CR7 14:01 14:40	CHO 5048 CAE AE 5048 CR7 15:30 16:10	cel	17:38 5.	319 CR7 361 _{18:20}	AE 5283 CR7 19:16 19:56	Curl	21:15 ²⁷⁶ 21:46 22:01	5066 GSO CR9 15112 _{22:45}
E12						6:46	5342 STL 5073 CR9 7:40		5232 MSN CR7 5060 9:45	A I	LO 4850 AVL LE 4800 CR7 0:45 11:25	GRB 5674 AE 5036	PNS CR9 13:15	AE 5179 CR7 14:01 14:40	ROA AE 4926 A 15:41 10	:R7 :19	AEX 5060 FWA AE 5324 CR7 17:05 17:45		YYZ 3834 AE 3968 2		CAK 5259 AE 5438	AGS CR2 22:30
E10						ILM 50 AE 50 6:41 50		CAK 524 8:37 507		M A	ASN LE 0:45	5231 5104		HPN CR7 14:33	PIA 5186 15:43 5310	5:20	MOB 5512 MOB AE 5060 CR7 17:10 17:49		MGM AE 19:40		5222 5304	MOB CR7 22:40
E21						IAD 5:	399 IAD CR9 373 7:30	BHM 5346 AE 5237	CRW CR7	ORIG 5632	SDF AE	50° 53°	93	IND CR7	AGS 4805 PC	iV	HHH AE	'	48	192 125		TRI CR7
E23						CMH		MKE AE	3850 CAE CR7 3814 9:45	GSO 4	826 ROA CR7 879 11:14	STL 5073 ILM AE 5345 12:59		HH ₄₈₄₄ HHH 3:56 14:30	ORF 3773 BHM AE 3865 E75 15:07 3865 16:05	10	CHO ₄₉₁₈ FLO 17:01 ⁴⁷⁷⁷ 17:35		GNV ₅₂₅₂ BTR 19:18 ⁵⁰²⁴ 19:50		CHS TYS AE 5138 CR9	745
E25						PI	HL 3899 CAE	HSV 5329	SAV	10:304	8/9 _{11:14} HHH CRW	JAX AE	5458 5087	CMH CR9	JAN 5514 CR	W	17:01 17:35 CHA AE	5508 5233	19:18 ³² 19:50 OAJ CR7	HI	21:00 22:09 N 3945 ORF 3904 CR7	
E27						6::	58 3908 7:45	AE 5325 8:33 5185	ORIG	BTV 4649		12:10 XNA	5087 5388 TV 5158 14:	14:24 C GRB 5531 ABE R9 5286 5286	4933	5	DSM 505	5 DSM	19:45 LIT	5440 TUL CR9 5880 20:40	50 3904 21:30 MKE AE 3775 MKE CR7 20:59 4056 22:05	
						CAE	3967 BHM	CHO 4876 HTS	5294 SBY 4770 AVL	10:21 4618 OM		253 SAV		14:22 14:59	4809 AVL	5086	16:58 527 MDT	6 18:45 BTR 5500 H		5880 20:40 02 MSY		
E29						AE 6:50	3819 7:35 ORIG	8:15 4866 9:00	AE 4751 CR7 9:15 4751 9:50	AE 10:		253 SAV CR9 266 12:59 5268 DTW	AE 13:28	5245 PNS CR9 5212 14:50	AE 15:29 CV	5086 5180	CR9 17:55 PWM 5034	18:30 ⁵⁵⁰⁵ 19	9:05 19:26 52 SAV ORI	32 20:30 F	5361 TERM 5049	
E31							5432	AE 8:47 5.	384 9:30	5111	AE 10:49 GRRI	5458 13:00	AE 13:	538 52 5272 MEM	4 CR 16:1	5052	PWM 5034 AE 5070 LGA TVC		AE 5056 CRS 19:00 20:00 DAB	0	TERM	HA
E33							rG.		14 CR7 AE 36 9:24 9:40	5111 5514	CR9 11:30	IAD 5509 AE 12:29 5243	CR9 AE 13:15 13:33	5372 MEM CR9 5494 14:40	AE 15:33	5053 5066	CR9 AE 17:25 17:40	5216 DAB CR9 5480 18:50	AE 19:36	52 kiep	135 CI 138 C22	:20 PNA
E35						CV AE 6:5	6 5	341 116	CR9 9:20	BHM AE 10:13	5356 PVI CR 5474 11:5		13:10 ⁵ 167 ^{BTV}	TUL 5357 GRB AE CR9 14:00 5227 14:55	CVG 5166 AE 5229 1	CR9 5:20	OMA AE 5131 17:06	18:20	EM 5494 CHS CR9 :50 5318 19:44	AE 19:59	5214 5336	CR9 22:40
E38						CHA AE 6:29	5165 5457	JAX CR9 8:50	CVG AE 9:10	5128 5504	OMA CR9 11:20	PULL 5172	JAX 52- AE 13:32 53	47 DAB CR9 15 14:25	CHS AE 15:30 5088	LIT BNA CR9 AE 16:30 16:45	5288 SDF CR9 5049 17:54	PN: AE 18:	S 5212 CVG CR9 :50 5303 19:45		MYR 5449 AE 20:59 5114	CHS CR9 22:35
E36								SRQ 5390 TLH AE CR7 8:04 5091 9:00	SGF AE 9:15	5177 5037	TVC CR9	FAY 5487 CHS AE CR9 12:10:508412:54	SRQ 5		HT TLH 5072 CR9		SYR AE 5377	CHS	TYS SAV AE 5144 CR9		ILM 5451 AE 21:03 5200	LIT CR9 22:35
E34								CLTSC4 BDA ORIG 682	BHM AE	5204 5033	OKC CR9	MYR 5289 MYR AE CR9 12:15 5053 12:59	AUS	5433 CHS CR9 5181 14:35	CLE 5436 MAE 15:25 5170 1		DTW AE 524	MYR) CR9	IND 5189 GSP AE CR9 18:58 5155 19:50		AUS 5301 AE 5299	MEM CR9
E32								SAV 5130 M AE 5267 9	9:15 MKE LNK CR9 AE	5415	PNS CR9	MEM SYR AE 5184 CR9 12:07 12:50		GRR 5533 ATL AE 5592 14:55	SAV 520	6 STL C.	AK 5243 CLE E 5221 CR9	18:20 GSC AE	O 5418 DAY	GSO AE	5121 DAY	22:35
E30						IND AF	4661 IND E75	IAD 532		5575 VPS 5157 AE 5157	11:25 CHA E75	MSN 550 AE 12:25 53:		5033 MKE	15:42 500 MDT CMH AE 5064 CR9	59 16:35 16	5:53 5331 17:50 PNS AE	5291 EYW CR9 5271 18:30	49 5101 19:40 TLH AE 5420	GSO CR9	ORF 5455 A AE 5099 22	VP R9
E30 E28						6:51	4531 7:55	8:43 553 CHS 5207	33 9:25 MYR	AE 10:06 5179 SRQ AE 510	2 AVP RA	12:25 53: AP DAB 5514 CP0	27 13:30 13:	51 5098 14:40 KE 5267 ABE	OKC 5116 SDF		ILM 5285 C	0271 18:30 ORF	19:19	20:10	PNS 5094 CVG	:20
								8:09 5289	9:30 5194 IND	AE 10:10 532 MHT	2 11:20 11:	PGV 5187 CHO AE 5255 E75	OKC 5504 MYR	3:56 5140 14:45	AE 15:14 5300 16:05 CLE ILM 5345 CR9 AE 5445	GSO	17:14 5455 18	:05	MYR 5170 PNS AE 5103 CR9 19:00 5103 19:50	HT	AE CR9 20:55 5109 22:05 4796	
E26									5194 IND CR9 5568 9:55 495 PNS	AE 10:30 XNA	5162 CR9 5166 11:40 5350 BHM	AE 5167 E75 12:05 5048 12:49	AE 5527 CR9 13:18 5527 13:57	SYR 5223 AE 5235 14:30 5349	15:20 15:35 5418	16:25	AE 5286 CR9 17:05 17:55 D SRQ		AE 5047 C 19:16 20 CHS SRQ	:05	TERM	SAV
E24								AE 54 8:32 52	255 9:45	AE 10:28	5178 11:35	12:13 5189 13:		3:56 5434 14:45	BHM 5178 IAD AE CR9 15:10 5502 16:00	AE 16:	TD SRQ 5125 CR9 17:40 CMH	5097 GSO	CHS SRQ AE 5227 CR9 19:03 19:50	DAR	IAD 5286 AE 5451	CR9 22:30 BHM
E22								MYR AE 8:47	5431 SYR CR9 5260 10:00	AI 10	EM 5474 PWN E CR 0:43 5034 11:5		932 BMI C 731 E75 A 731 13:30 I	RF 5081 MYR E CR9 3:56 5313 14:45	AE 5043 CR 15:24 16:1	9 4		5087 GSO 5121 18:30	CVG 5169 AE 19:2653072		CVG 5281 AE 5211	CR9 22:30
E20								GSO 5 AE 5 8:36 5	5417 CR9 5245 9:45	CLE AE 5 10:21	080 CR9 11:25	CMH 453 AE 12:27 467	75 13:24 AE 13:40 5	317 ^{IAD} CR9 CR9	IAD DAB AE 5035 CR9 15:15 16:04		XNA 5193 CVG AE CR9 17:04 5281 17:50		CHO ₄₈₀₉ ROA 19:10 ⁴⁸¹⁰ 19:44	<u></u>	XNA 5236 AE 5161	6 MYR CR9 22:40
E8								LIT AE 8-45	5158 SDF CR9 5330 9:50	AVP 51 AE 53	70 11:20	DTW 4542 AE 12:23 4510	MDT		AE 5035 CR9 15:15 16:04 AE 5322 AE 15:36 5236	XNA CR9 16:25	MYR 5313 B AE 17:19 5182 18	HM CR9 ::05	DTW 5435 AE 5169	ABE CR9 20:15	LIT 5088 S 21:18 5334 C	DF R9 -20
E6								PNS 5	343 FAY CR9 487 9:40	DSM 512 AE 10:19 52		VA 5645 MKE E E75 :40 5983 12:25		IND 5568 AUS AE CR9 14:01 5301 14:45	DAY 5115 MEM AE CR9 15:14 5265 16:00		SDF	5154 AVL 65326 _{18:30}	LYH 4779 CHO AE 4885 19:49		SRQ 5161 AE 21:39 5333	I JAN CR9
E4								BNA	5325 DAB	SAV	5504 DAY	IND 4470 G			NK 5084 LIT AE CR9 5:05 5100 15:50	Ņ	MDT 4510 JA:	(18:30	BHM 3	865 HPN CR7 023 20:40	CLE 5331	1 ILM
F1								8:49	5317 9:50 ICT 5316		8 5115 CR9 DAY 5042 XNA AE 5193 11:5	AE 12:12 4537 13: CAE 3814 F. AE 3814 F.	05 13:44- AY SAV 275 AF	5051 RIC 5372 CR9	MEM 5058	YS CR9	SAV 5070 GSP AE 17:09 5214 17:50	554	46 EV	023 20:40 V 5006 MGM CR7	21:39 5250 PULL	
								ORIG	5164 5292	10:30	CMH 5061 PIT	AGS 5396	05 13:5 FWA SAT	0 3372 14:30	PWM 5572 GRR AE 5567 CR9	:19	17:09 5214 17:50 CVG	5398	RM 19:	50 5468 20:30 ICT	5503 MKE 3959 C	AE P27
F2								5531	PUSH PUSH	CHS 5	10:50 5522 11:45	CHO 5152 AE		5046 CR9 5265 14:26 ICT 5103 MHT	OMA DSM	SHV	17:00 5815 SHV	5040	M IND	0:06	21:37 4010 22	CHO
F3								DAB 5352	5415 CR9	AE 10:27 5	309 GSO CR9 350 11:20 GSP	AE 5132 C 12:12 5086 13:	:05	AE 5103 CR9 14:07 5565 14:45	AE 5431 CR9 15:20 16:00 PNS		5815 SHV 5379 17:35	18:	4572 E75 :50 19:45 ABE 5140 OMA AE 5140 CR9		GNV 5202 AE 5287 VPS 5065 TLF	E75 22:30
F4								8:35 5139	9 9:24	AE 39	916 GSP CR7 989 11:35		509 PUS		AE 15:22	559 500		AUS CR9 18:25	AE 5140 CR9 19:06 5248 19:49		21:06 5349 E73	S S XNA
F5								ORIG 5371	9:15 4903 9:55		AE 5054 CR9 10:50 11:40			CMH ₅₄₁₄ TUL 14:00 ⁵⁵⁴² 14:35	AE 15:30		5460 5053	CR9 19:00	9 AE 10 19:28	51	300 219	CR9 22:30
F6								CMH 454 AE 454 8:36 454	6 9:27		5241 MLB CR2 5132 11:40		BNA AE 13:42	4695 OMA E75 4556 14:55	CMH 4457 ILM AE E75 15:21 4674 16:09		5431 TERM	J. A 1	JAN 5315 AE 5732	EAN E75 20:10	CMH 4554 CMH AE 4579 22:09	
F7							ORIG 5547	CAE 3826 HS' AE 3906 9:0	75 99	ILM AE 10:31	5082 DSM CR9 5055 11:20				AUS AE 15:30		5200 5456	SGF CR9 18:50	5163 TERM		5186 TERM	
F8								(ORIG 5129	MYR 538				RIC 4618 GSO AE 4695 E75 14:02 4695 14:45	MLI AE		5267 5514	R/ CF	AP R9 AE 5098 C 19:21 5127 20	AD CR9	5256 TERM	
F9								ORI 507	IG	ABI	5134 MEM CR9 59 5058 11:25		SHV 5767 JAN AE 5767 E75 13:15 13:55	14:43	GRR AE		5043 5236	19:0	BHM P	PULL 5421	5182 TERM	
F10						OR	IG	LFT AE	539	90	CAE CR7			SP 3989 YYZ :54 ³⁸³⁴ 14:30	[15:50 SAT AE		558	7	19:30 LNK CR9	7.21	HSV 5050 PIA AE 5041 CR7 21:06 5041 21:45	
F11						520	ODIC	MDT 4669 CM AE E7		02 SBN 5586 SH AE 5586 E	11:19 HV		13	:54 14:30	16:0 SBY	5851 MSN E75	555 LEX 5078	CHO N	19:45 MCI 4675 CMH AE E75		5099	
						5279	5082	AE 4669 E7 8:08 4538 9:1	ORIG	10:05 5328 10:	:55		VPS	5183	CAK	0 5321 16:45	17:25 5552 5253	2 18:15 VPS	18:55 4624 19:44 PHF	CID	TERM 5530 GPT CR7 5491 21:30 TERM	
F12						5279 PUSH	ORIG		5452 LAN 5864 SBN	TUL 5106	PULL 5117		JAN	9 5223 5071 CHA	BMI 4867	BTV	5253 PUSH	AE 18:38 BMI 468	5385 E75 19:50	5337 AE 20:40	5491 21:30 TERM JAX 4636 YYZ	
F13							5079	OPIC	9:20 5378 10:0	75 AE 5196 10:20 5081			AE 13:47	5071 CR7 5508 14:27	15:25 4837	16:40	17:03 4001 17:55	AE 468 18:30 468	85 19:20 CRW 5148 FWA	TERM	JAX 4636 YYZ 21:33 ⁴⁵⁵⁴ 22:10	
F14							ODIC	ORIG 5573	YYZ 4464 BNA AE E75 9:19 4684 9:59	10:21 10:				AE 4627 14:25 4373		65 E75	5181 TERM	DAP CALL	CRW 5148 FWA AE E75 19:05 5405 19:49	5077	OMA 1556 PURI	
F15							ORIG 5252	AVP 52 AE 55 8:47 55		EYW 5579 LN AE 10:10 5331 10:					CAE 3960 AE 3833		GSO IND AE 4522 E75 16:59 17:50	RAP 5126 XNA AE 5321 19:00		5077 ГЕКМ	OMA 4556 IND AE 4556 E75 21:05 4495 22:05	
F16							ORIG 5290	51 PU	I17 JSH	R A	CIC 5290 CLE CR9 0:45 5436 11:35			SBN 5485 F 14:30 5926 15		BMI E75 16:30	17:35 57	84 SBN 83 _{18:20}	5814 TERM		IND AE 447(21:39	MSY 5 E75 22:35
F17								ORIO 5136	G		ORF AE 10:47	5252 5285		ILM CR9	GSO 4537 AE 4498	YYZ E75	MSY 4662 CMH AE 4506 E75 17:08 4506 17:50	ROA AE	4842 SBY CR7 4835 19:50	5076 TERM		
F18								ORI 550	IG	ECP 4839 AE 4781	ECP E75	3203		YYZ 4546 L AE 4566 L	GA SGF	SGF 90	YOW 5543 AE 5265		307	5382 TERM		
F19								550	17	10:10 4/81	11:05			14:19 4500 15	3909	16:24	17:06 3263	18:10 TE	ZKIVI .	LEKIVI	YYZ 4498 M	DT 275
O7					ORIG						CVG CVG			EWR 364 UA 335	TERM EWR E7W	ORD	4823 ORD YY 4843 17:21 17:		3368 EWR		6302 AE 22	:20
					6238 ORIG	i			IAD	IAD YYZ	4845 11:06 11:36 Z ₇₃₄₆ YYZ	EWR ₃₃₆₇ EWR		14:33 335	15:30		4843 WB 8011 I	49 ³⁴⁹ 18:20 18:45 WB	5 3365 E/W		TERM	
08					3312				9:42 LC	150 CR7 10:22 10:3 .GA ₂₂₂₇ LGA	73471:10 IAH (165 IAH	11:52 3311 12:27			UL ₇₃₅₀ YUL	V	6:54 1181 1 AH 6245	ER4 8:06 AH				
09						OPTO			9::	3337 3399 10:30 MSP	11:04 6165 11:04 6310 11:41	BKW		2020	7UL ₇₃₅₀ YUL 5:05 ⁷³⁵¹ 15:40	pu	17:14 6285 18	7W ::05			4701	
O10						ORIG 4663				39 10:32	MSP 966 11:07	VC 12:00		2030 2140		El 17:	CW M2 :05				4781 TERM	



R35

CLT 2033 Gating Scenario 3

	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00 2	22:00	23:00
	111111111	<u>utulutu</u>	minimin	ntulutu		ntulutu	ntulutu	lutulutu	lutulutu					Intoloto		utulutu	ululutu	Intulutu	lutulutu	lutulutu				
AADO						CUTCOL DELL						NO.	long.							nurs ever	2C4 PVC	DEN TOU		
A21						CLTSC4 ORIG DFW 5:15 2451 6:00	AA 6:46		2 1	2011 1797	T.C.A.	321 11:20	AA 628 32 11:57 13:0	1 AA 0 13:20	pest	lower	1051 275		1	321 19:10 19:45	ORIG 8IC 6 20:30	AA 1873 321 21:18 22:15		
A22							AA 6:14	8 20	98 057	321 9:45	AA 879	11:40	AA 12:00	445 580	321 14:20	AA 15:15	DEW -	1889 1798	1	20	321 AA 0:05 20:40	892 PHX 321 472 22:15		
A23							AA 6:02	476 840*	lnos	321 9:25	1924 TERM		1446 LAX 652 32 13:0		1789 MSP 321 1855 14:50		AA 16:31	720 PHL 321 330 17:30	k c	EWR 1598 AA 2483	738 AA 20:10 20:36	1245 JFK 738 1608 22:10		
A24							AA 6:15	624 LA3 658 8:00	AA 8:28	1709 321 9:50	AA 10:08 1	1729 PUJ 321 1967* 11:50	AA 629 12:06	BOS 321 13:10 TERM	1	McO	146	AA 703 321 16:55 17:45	AA 1809 320 18:02 18:55	TUS AA 19:10 843	319 AJ 20:10 20	A 2039 DFW 321 252 890 22:10		
A25							SAN 579 6:04 662	7:30	OPD	DTW 925 FNT AA 319 9:06 1109 9:52	AA 10:38	1977 1936	321 12:10	13:23	695 TPA 321 1810 14:50	AA 6.	37 321 16:45	AA 470 17:01	321 AA 18:15 18:39	416	321 20:20	AA 1774 32 21:02 22:2	0	
A26							6:45	ORIG PHL 1956 7:30	8:20	580 321 9:40	FLL AA 10:03 826 ³	5 321 * 11:30	AA 1842 12:06	321 AA 13:09 13:28	1154 SAN 321 1583 14:45			Med	A	BI 1798 A 8:54 844	321 20:27	AA 557 32 21:04 22:2	1 0	
A27							LAS 431 AA 428		SFO 1944 8:01 1946		AA 10:32	1837 32 11:5	AA 1878	321 AA 1' 13:15 13:30	760 321 14:30	CEA	CE A CEO	AA 17:40	1836 1841	321 19:12	MCO	PHX 499 D AA 1865 22	321 1:25	
A28							PHX AA 2020 6:09 2091	7:30	A 1866	321 9:20	AA 10:35	1961 32 11:5	AA 1970	321 AA 13:19 13:35	2080 321 14:50	SEA AA 15:16 443	321 AA 16:20 16:4	1908 SI 6 1799 18:	21 AA :05 18:45	747	321 20:15	AA 1704 321 21:03 22:09		
A29							SLC AA 6:10 408	7:30	AA 1' 8:22	912 321 9:40	AA 85	58 321 11:30	AA 2044 12:04	321 AA 13:20 13:37	581 321 14:45	AA 494 15:00 1	321 5:15		30 LGA 321 740 18:40	STL 1768 PIT AA 1747 19:54		AA 1857 32:13 21:13 22:19	1	
A1							AA 6:26	696 TPA 321 1813 7:45	AA 1772 8:13	2 321 9:29	AA 10:29	521 321 11:45	AA 1808 3: 12:03 13:0	21 A. 02 13	FW 2091 JFK A 321 3:52 1972 14:55	TPA 53 AA 72 15:27 72	5 321 5 16:40	ATL 786 AA 678	321 AA 18:16 18:4	N 487 S 49 451 20	321	AA 1812 321 21:12 22:15		
A3						CITSC4 16	AA 6:44	2062 321 7:59	AA 8:34	835 321 9:50	PHL AA 10:05 1735	321 11:20	MCO 1725 MC 32 12:04 691 13:0	AA 2059	14:20	SFO 704 LC AA 3 15:03 2050 16:	0 0	C22 TPA	CLTSC4 ORIG 18:29	19:14	STI	AA 1717 321 21:09 22:10	102	
A5						CLTSC4 LG ORIG 5:20 6:1	AA 05 6:47	1364 738 7:45	AA 883* 8:10	321 9:25	AA 885	11:25	AA 87 12:27	3 321 AA 13:24 13:	1810 PHL 321 50 2055 14:45	LAX 724 PHI. AA 321 15:00 559 16:05	AA 16:39	622 TPA 321 731 17:53	AA 18:35	836 SFO BOS AA 19:30 19:45	793 319 5 20:33	277 7 TERM TE	ERM	
A7					l'i Te	C4 ATI	A. 6:	A 469 32 52 8:00 BOS	8:20 MCO	9:35 SFO	AA 10:31	752 321 11:45 MIA		A. 13	A 2063 321 3:52 DFW	15:35 7 DFW	399 SFO 321 05 16:40	BOS 1787 17:00 609 1	321 18:10 PDX	AA 1769 31 19:11 20:0	9 0 0 PVD	AA 1863 21:26 22	321 2:26	
A9					4:45	ORIG 823 5:30	AA 6:37	1980 321 7:50	AA 461 8:10 PHX 423	321 9:24 PUJ	AA 10:32 RSW	1831 321 11:45	ATL	AA 89 13:30 LGA PHX	91 321 14:25	AA 1719 15:20 LAS 748 BO	321 16:24	FLL 609 17:00 1787 1	321 18:10 DEN	MIA AA 19:20 199 LGA 61	96 20:29	AA 1737 32 21:21 22:2 BUF ALB	0	
A11							0.43	C4 ORIG 928 7:30	8:11 1965*	9:25	AA 679 10:13 MCO 790	11:25	AA 2066 12:02 IAH 382	13:12	068 321 14:26 LAS 1458 SMF	15:08 1999 16:	0 V	AA 651 17:16 DEN 181	18:25	19:20 178	33 20:29 BWI	AA 1940 319 20:58 22:15 RSW 1805 IAH	550	
A13							CLTSC4 MI ORIG 6:15 1877 7:0 CLTS	Corig SAT	8:21 41	13 9:35	10:13 2053	3 11:20 ORD	IAH 382 12:11 100 EWR 161	13:19	AA 1458 321 13:58 1917 14:50 2055 PHX	AA 1775 3 15:09 16:	1 O TPA	181 17:21 565 PHX 767	321 5 18:30 SMF	AA 1920 19:12 SEA 633	321 20:20 SEA	1803 321 21:10 745 22:10 5069	550 TERM	
A12							6:45	ORIG 1727 7:30 CLTSC4 MCO	LAS AA 8:10 1905 MSP	LGA	AA 18 10:18 MSY	11:25 STT	12:23 144	17 13:26 AA 13:45	5 695 14:35	15:24 1791 MSP	RSW	17:13 466 MIA 1799 ORD	321 18:20	19:12 541 SFO 662	321 20:20 LAX	TERM	RIC	
A10							6	·55 1725 7·40	AA 8:46 PBI	1910 321 9:55 DEN	AA 10:24 MSP	833 320 11:50 BOS	AA 893 - 12:17 13	738 i:05	SAN	AA 2046 15:25 823 LAS	321 16:25	AA 1775 321 6:54 1908 18:00 PHL 799	MCO	19:14 1975 BDL	321 20:20 TPA	AA 1922 21:29 ORD	319 22:40 MIA	
A8								CLTSC4 PUJ ORIG 7:05 1963* 7:55 CLTSC4 MCI	8:31 LAX	445 321 9:35 BOS	AA 1 10:26 DFW	1937 321 11:30 LGA	PHL 1882 PH	907 ELP 319 254 13:45 L MEM	AA 14:5 SAT	ORD 1999 MCO	LGA	17:16 1733	DFW	AA 1871 19:07 20 DFW IAH 744	321 0:06 RDU	AA 1277 21:27 MSP 1897	738 22:30 BWI	
A6								CLTSC4 MCI 7:05 1906 7:50 CLTSC4 ORD	AA 8:43 TPA	1982 321 9:45 BWI	BOS 196	2064 321 11:40	11:59 2054 31:0	9 AA 0 13:39	1827 738 14:40	15:05 1899 16:00 FLL ATI	AA 16:44	436 321 17:45 BWI 1915	AA 1752 18:11	DFW 321 AA 744 19:10 19:25 1861 ATL RSV	319 20:10 808	21:04 1998	320 22:30 073	
A4								CLTSC4 ORD ORIG 7:10 1916 7:55	AA 8:41	1960 321 9:40	BOS 196 AA 172 10:19 172	29 11:20 CLTSC4 BWI	AA 2078 13	319		AA 504 321 15:05 15:59 SRQ 1130 DI	N	BWI 1915 AA 2038	320 18:15	AA 1820 32 19:02 20:0 MCO 746 PHX	TERN	1 TE	ERM	
A2							CL	rsc4 FLL	RSW 413	3 MSP	1	10:50 1924 11:35	BNA AUS			AA 1130 3 15:20 184 16:	11 0 0 XX 819 SJU	MCI	MIA I.	AA 321 18:59 463 19:55 AS	MSP	TERM 1998	ATL	
B1						сьт	SC4 PHL	0 525 7:35 DCA PII	8:28 713	3 9:20 DCA	BNA 821	SJU 1376 SRQ AA 1404 321 10:50 1404 11:40 AUA	AA 653 319 11:58 12:54	IND MCI	ROC	A 10 EWR	MIA 321 16:50	AA 1701 17:13 PIT 1829 DFW	18:20	AA 2075 8:55 PBI	321 20:10	21:16 1897	738 22:40	
B3						5:50	SC4 PHL 2010 6:35 SJC 661 P	AA 1904 319 7:02 7:59 DX	AA 172 8:17 MIA	9:30 EWR	BNA AA 10:01 876*	IAH	AA 1973 12:23	319 AA 1 13:12 13:27 DU	860 319 14:35 JFK 2530	AA 379 15:05 EWR IND 18	738 16:25 43 DCA	16:57 721 17:40	CLTSC4 ORIG 18:28		TE	RM TERM	PHL	
B5							6:00 1872 7	738 :05 JFK	AA 8:47 JFK	9:55 MIA	AA 2065 10:12 EWR 1451	5 738 11:19 EWR	AA 1914 3 12:09 13	:04 .B 1756 ALB	JFK 2530 AA 2249 SNA 1767 LAS	738 AA 15 15:15 15:30 18 MSY 1821 RI		CLTSC4 ORIG 17:25 1915	1692 T	2084 ERM 451	Į.	AA 1796 21:26 22 DTW LGA	321	
B7							6:36 RDU	042 738 7:30 DCA	8:30 PVD	.48 738 9:30 SXM	10:02 1458 SAT	738 11:05 BNA	AA 12:	LB 1756 ALB 319 1753 13:50 DCA	14:10 278 15:00 MSY	AA 1021 3: 15:30 1886 16:0 NAS	9 9 BUF		TERM	451 TERM 786 A	BQ SJU	753 MSP		
B9							AA 173 6:17	7:30	AA 865* 8:12	9:25	JFK	850 738 11:40 DFW	DCA RIC AA 2077 319	13:28 PIT	045 319 14:35 BDL	AA 853 15:10 MIA 2448	321 16:29 ORD LAS	125 JFK	ATL 527	585 20	738 AA 0:05 20:23	2039 321 MIA EWR		
B11 B13							6:5	ORIG LAX 0 1993 7:35 BOS BN/ AA 1817 319	EWR 2531	5330 MHT 5089 9:30	10:4	330 738 11:35 ELP 281 ELP AA 281 319 11:07 1870 11:50	11:52 12:45	[13:31 SAT	700 319 14:30 1633	MIA AA 15:16 1453		125 JFK 738 5 1577 17:45	ATL AA 18:05 555	53 19:45 RDU	1954 TERM 861	AA 1384 738 21:13 22:15 ATL MCI 738 AA 1785	ORF	18
B15								7:12 8:00 CLTSC4 S ORIG 827	8:16 2529 g	738 9:06 CLE 780 319	AUS		1964	M JAX	18 296 1 RDU 2069 PIT AA 319 13:56 2084 14:55	5:11 10 PI	K 1577 SNA 738 :00 1871 16:45	17:15 18: 294 1673	05 1	8:55 EWR 321 19:11 TERM		21:19 21:40	22:40	18 TEI
B16							RIC	7:20 827 8 BDL 654 319	05 8:21 MEM	780 319 9:40 RSW 1853 319	10:39) IAD 5252 SA	1849	13:15 DTW	756 319 756 319	BNA 1886 JAX AA 319 15:14 2032 15:59	:00	1673	PDX 1853	321 19:11 TERM SJC BNA 194 738 AA 19:24 73		BDL BAA 1952	BUF	
B14							6:34	7:30	8:43 CLTSC4 ORIG 9:39	9:55	MDT	AA 53/3 3A 11:10 5210 11:5 JAX 1753 319	PVD AA 65	13:45 1AH CLE	730 319 14:40 RDU 1934 319	RSW AA 1992	PVD I	DCA IAH AA 673 319	17:58 660 ₁	JFK 101	3 20:25 EWR BWI	864 2035	JAX 319	
B12							PIT	1903 319	8:29 1957 ILM PHI AA 1839 31	9:14 L FSD 784 9 AA 993	10:33 MCI LG 319	1/53 319 11:50 iA AL 1988 31	B CHS 1849	13:20 13:37 DCA	14:30	AA 1992 15:03 ATL 2032 AA 1821	16:30 [1 DTW 319	6:54 17:54 NAS AA 859	PIT 319	MSY 732	20:10 20:38 BUF 738	1971	22:35	
B10							6:42	7:35 C4 _{RIG} ROC 868 7:30	8:04 9:00 FNT 1751		PIT	:44 11:5	CI 1267 BUF A 12:25 1950	BUF AA 2002	BOS 2 319	15:08 1821 BDL BNA AA 1715 319	16:30 JA	17:04 X DCA 1750 319	18:15	DFW JFI AA 2648 73	20:15 K	TERM 2035		
B8							6:45	7:30 CLTSC4 RDU ORIG RDU 7:05 2011 7:50	RIC AA 8:15 829	9:30 1 MEX 319	SYR 1 AA 1909	11:30 11 MSY	245 751 12:30 CLTSC	13:26 CUN ORIG 887* 13:30	14:15	15:02 16:00 RDU	1962 BWI 319	CLTSC4 BUF		19:05 20:0 ROC AA 1921	JAX 319	TERM AUS 1893 319	2005 TERM	
B6							į į	7:05 2011 7:50 CLTSC4 BWI ORIG 3773 7:40	8:15 829 BUF 829 8:08 1941	9:30 DTW 319	10:11 1	11:03 ATL 1814 319	12:40	13:30	CHS DCA AA 1938 319	15:44 CLTSC4 ORIG 15:35	16:45	ALB PW AA 2052 3	/M 19	JAX AA	20:15	0:55 22:10 PBI 319	TERM	
B4							PDX 1	930 SAN 321 487 7:50	8:08 1941 IND AA	9:19 BDL 1756 319	PBI AA 1847	11:39 PHL			14:02 14:55 CLTSC4 IAH ORIG 14:10 2069 14:55	DCA AA 1653	16:20 MCI 319	17:01 18: IND AA 765	STL SAT 319 AA	5210 5335	2043 CLE 319	22:11 SYR DCA AA 1987 319		
B2							6:14	+8 / 7:50	PIT AA	1978 NAS	10:10 OKC AA	11:15 C IAD			14:10 2009 14:55	15:13 1 STL	5370 PNS 319 5094 16:44	17:11 CLE RIC AA 2028 319	18:25 18:40	5335 CLTSC4 MDT 19:04 1720 19:49	20:30	MSY AA 1793	PIT 319	
C2									8:35 DTW AA 1942	852 9:40 BUF 319	ALB 17	42 11:45			2017 PUSH	DTW	5094 _{16:44} MSY 02 319	RIC 5321 AA 5563 1	BNA DO	19:04 1720 19:49 CA ILM A 1979 31	334 TERM	21:20 22	1:25	
C4									8:08 DCA	9:10 CHS 795 319	MCI	1797 IND		CLTSC	PUSH A PBI 1789 14:25	MCI AA	16:30	422	18:10 18	ELP DFW 50	60 DEN	ALB COTO	CLE 319	
C6									8:28	9:30 852 IAH 319 1978 9:35	ROC AA 1868	1977 11:30 CHS 3 319		13:40	14:25	15:35 IAH 174 AA 15:35 184	5 ALB 319	1540 106 PUS	65	19:15 19:35 6 1976 TERM	16 20:20 CLTSC4 PUL 20:32 100	21:22 22	ORD 321	
C8									ORF AA 1770	ORF 0 319	BWI 87 AA 82 10:20 82	76 GCM 320				15:35 184	BUF AA		422 524	FSD 319	20:32	21:17 21:39 SAT ROC AA 1870 319	22:35	
C10							C	CLTSC4 CUN ORIG 804* 745	CLE AA 17	9:15	10:20 82 STL AA 19	DTW				PHL AA 20	PBI 319		584 PUSH	844 TERM	CLTS	21:25 22:16	RDU 321	
C12							e e e e e e e e e e e e e e e e e e e	7:45 CLTSC4 MBJ ORIG 843* 7:45	8:30 ST A/	9:24 TL PIT A 1677 319	[10:27	PBI 2754 AA 11:15 2845	4 PBI 321			JAX AA 2036	16:30 SYR 319	RDU DT AA 2067 3	TW SLC	LEKIVI	78 881	21:30 21:50 STL 319	22:45	
C14								7:45	8:5	9:45		CLTSC4 MCI ORIG MCI	12:15			15:20 RIC 1	16:19 364 PIT 319 745 16:35	[17:04 18: ELP AA	1891 736	DTV 31	081 9	22:00 RDU PVD AA 2038 738		
C16										CLTSC4 JAX		10:55 1964 11:40 BDA 1840 MAA 10:51 1434* 1:	1EX 319			15:41 1	7+3 16:35	AUS AA 1840	RDI N	AAS 605 PL AA 1029* 20:0	0 S 9	20:57 22:05 CLTSC4 SYI	R	
AAIN										9:05 9:50		10:51 1434* 12	400					17:15	18:25	8:54 1029° 20:0	<u></u>	21:35 22:2	u	
I1									SDQ *183 AA 982	39 UVF * 321		MEX *1844 S	5DQ 319	AUA AA	*1542 625*	SJO 738	HAV *1074 AA 16:05 1028	BDA 319	MEX AA	*828 MEN 1768 31 20:0	M 9	SJO *18	CLTSC4 850 RM 22-40	
I2										9:45 GCM *860 HAV AA 319 9:00 1615* 9:45		PAP AA	*368 1826	NAS 319	ME AA	15:40 BJ *843 RI 4 2056 3 16: 3	16:05 1U28 U MI	17:30 BJ *869 C 749 1	18:35 LAS SXM 321 AA	*866 BNA 320 1867 19:49	*1968 1954	21:55	22:40	
								1		9:00 1015 9:45		11:00	1020	13:15	14:	55 2030 16:	u 16	30 749 1	18:40	1007 19:49	1934			

							CL	.1 2033-3	cenario 3	3												
	00:00 01:00	02:00	03:00 04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
						<u></u>										lutulutu	<u> </u>	<u> </u>	lulululu	<u>.lll.</u>		
13								KI A# 9:5	N *854 PAP A 319 55 1647* 10:50				SJO AA 14:35	*672 AUA 617* 321 16:05			GCM *8 AA 18:14 8.	822 DCA 320 19:44	CUN *88 20:29 TER	CLTSC4 M 21:14		
14									PLS *8 AA 10:00 104	842 KIN 319 40* 12:00				(VIN)		787 ATL 738 787 17:50		MBJ *827 AA 1919	321 20:15 20	UA *87, CLTSC4 0:50 TERM 21:35		
l5									CIN	N *1202 SIO				KIN A AA 15:40 2	456* 16:40	AA 17:42	*196 643	3 20	321 :05	*1242 \$	20	
l6									AA 10:5	*1283 SJO 321 50 1087* 11:55					PAP *2364 AA 2541*	738 17:15 *884 BOS	SDQ AA 18:00 *639 1865*			*1342 S 874* 22	21	
17															AA 16:40	1806 321 17:55	AA 18:40 F	*886 PBI 321 2061 19:55 PLS *880 O	SXM *613 *613 *TERM	21:09		
18						GRU *1	1062 CLTSC4					FRA *705 CLTSC4			LHR	*731	LHR 1	AA 18:55 1851 20	321 :05			
l10						7:50 PI	1062 CLTSC4 USH 332 8:50					AA 789 13:00 PUSH 14:00		FCC	AA 16:15 0 *721 MAD 789 55 748* 16:40	*731 730*	789 18:40					
I11 I12														MAD	*7.	49 ¹	DUB LHR	*733 732*	LHR			
I13														15:50 FCC AA	72 721 CLTSC4 789 789 789 789 789 789	24 19	8:05 18:30 BCN AA	*745	20:15 BCN 332			
I14												C1 A.	DG A	*787 704*	55 TERM 16:55 FRA 332 A	PULL A 720*	18:20 FCO 789	744* CLTSC4 PULL	20:45 GRU 332			
I15												DUB AA	3:55	704* 725 786*	16:35	6:55 720*	18:25 CDG 332	19:00 1568*	20:30			
OADO												13:05		786*			18:20					
01	1441 TERM			CLTSC4 DTW ORIG 5:15 1366 6:00	CLTSC4 ATL ORIG 6:15 2488 7:00	CLTSC4 MSP 7:20 2266 8:05			JFK 409.	93 JFK 93 JFK	DTW DTW DL 1629 319 12:07 12:50			DTW 60 DL 15:40 17	03 MSP 319	LGA 5508 LG DL CS 17:12 5135 18:0	A 51	LGA 6224 LGA DL CS 19:18 6227 20:0				522 TERM
O2	I EXCEVI			p:15 6:00	6:15 7:00 CLTSC4 JFK ORIG JFK 6:08 3612 6:53	p:20 8:05	LGA3930 DL 8:35 3840	LGA CS1 9:15	ATL ATL DL 1454 739 10:03 10:45	LGA 5060 LGA DL CS1 11:14 5069 12:00	12:07 12:50 ATL DL 1095	ATL 717	MSP MSP 1503 14:24 14:59	15:40 17	MSP DL 1:	DTW 322 320 524 17-20	DTW 10 18:40			3812 TERM		876 TERM
O3					6:08 6:53 CLTSC4 LGA ORIG 3844 7:00	CLTSC4 ATL ORIG 1591 8:15	ATT	9:15 ATL 2422 73H 9:30	10:45	ATL ATL DL 2251 717	12:55	LGA 3888 LGA DL CS1 13:14 3642 14:00	[14:24] 14:59	ATL ATL DL 2133 73H 15:04 15:45	ATL 602 ATI DL 731- 16:18 2651 17:00	AT DI	TL ATL L 826 73H	49.13		I LIKIVI	1076 TERM	LEKIVI
O4					7.30 C	7:00 521 7:45	0.40	9:30 DTW DTW 2292 9:04 9:39		12:00		ATI	ATL 2597 320 14:30	LGA 5096 LGA DL 5099 16:00	1/200	JFK 4189 JF DL 4189 CS 17:193433 18:0	K 51 00	ATL DL 1407 7 19:09 20	TL 3H :05		4128 TERM	19 TE
O5					CLTS 6:50	SC4 ORIG 681 7:35										763		20		2808 TERM		T
O6				CLTSC4 IAH ORIG 5:05 1191 5:50		SFO 1704 SFO UA 1969 8:2	9	ORD 425 UA 521	ORD 73G 10:15			ORD 1484 ORD UA 319 13:00 1140 _{13:45}		DEN 1711 UA 15:10 1199	DEN 739 16:22	SFO 1 UA 17:31 1	176 SFO 739 698 18:30				1286 TERM	1974 TERM
O13				CLTSC4 ORIG 5:33	G BOS 2 6:18			BOS 8 B6 9:24 8	8025 BOS E90 10:51	FLL 810 B6 810	01 FLL E90 02 12:30			B B 1	OS 8021 BOS 6 8016 E90 17:00	BOS 1445 BO B6 1446 ES 17:18 1446 18:0	98 JFR 90 B6 90 18:	K 1119 JFK 5 1118 E90 :50 1118 19:28			8017 TERM	
O14					CLTSC4 OPD	CLTSC4 ORIG 7:15 8104 8:00	DEN		B6 219 E90 10:01 218 10:40	10:59 ¹²⁴⁶ 11:36											8103 TERM	5010
O18			CITSC4	4 HOLD	ORIG ORD 5:58 1712 6:48	CLTSC4 ORIG 7:50	3 DEN) 8:35	RWI D	DAL						ME	w MDW						5812 TERM
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D12					LYH 473 AE 6:22 488	on CK/		5440 9:45		10:59 3909 11:50	CLE 5282 GNV AE CR2 12:05 5063 12:50	13:5	S 5294 TYS CR2 515119 14:35	AE CR7 15:05 5096 15:50		5063 C 5259 18	AK SHV 5514 CR2 5254 18:30 19	FLH 9:05	PULL 5172	LEX AE 21:36	5264 MGM CR2 5298 22:41	
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E1					AE 6:45	5335	5	CR7 9:36 PGV	AE 10:45	551	14 RAP	CR7 13:15	CAE AE 14:03 52 5110	04 16:00 GNV HPN	PUSH 5526 HPN	AE 17:21 ROA 482	5233	CR7 19:45 HSV 397	AE 5411 CR7 20:00 20:40 3 YUL	JAN 5257 AE 5407 AVL 5326	22:15 CAK MGM ₄₀₃ AEX	4
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Capacity/Delay Analysis and Airfield Modeling Technical Memorandum

Charlotte Douglas International Airport Environmental Impact Statement

PREPARED FOR

FEDERAL AVIATION ADMINISTRATION

Mr. Tommy Dupree Memphis Airport District Office

PREPARED BY



VHB Engineering NC, P.C.

IN ASSOCIATION WITH



TRANSSOLUTIONS

7/16/2018

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Summary of Findings

1.1 Introduction

A comprehensive development program (Airport Capital Enhancement Plan, or ACEP) was initiated by the City of Charlotte, North Carolina (Aviation Department or the "Department") to address the existing and anticipated demand at Charlotte Douglas International Airport (CLT). A Consultant Team is evaluating the existing planning data and preparing an Environmental Impact Statement (EIS) at the direction of the Federal Aviation Administration (FAA), to satisfy requirements of the National Environmental Policy Act of 1969 (NEPA). TransSolutions, LLC performed the airfield capacity/delay analysis for the Existing Conditions (2016) based on the current airfield and aviation demand in 2016, and a future No-Action alternative based on the current airfield, improvements currently under construction, and forecast demand levels representing 2028 and 2033.

The airfield capacity/delay analysis was performed using ATAC Corporation's SIMMOD Plus!® version 8.1 software, based on the FAA's Airfield and Airspace Simulation Model, SIMMOD. Simulations were run for the four predominant operational configurations: South Flow Visual Meteorological Conditions (VMC), South Flow Instrument Meteorological Conditions (IMC), North Flow VMC, and North Flow IMC. As part of the EIS effort, the Consultant Team updated the operations and passenger forecasts that were originally documented in the ACEP in early 2016 to reflect the merger of American Airlines and US Airways, as well as current trends. The Existing Conditions traffic demand level (2016) was analyzed along with the two updated forecast demand levels representing 2028 and 2033, years which reflect the construction phasing of the proposed airport improvements that are the subject of the EIS.

This summary provides findings of the following:

- > Peak hour throughput and hourly capacity
- > Average aircraft taxi times and arrival airspace delay
- > Average delay per operation
- > Average arrival gate and ramp delays
- Comparison to the ACEP

A description of the modeling methodology is presented in Section 2 and was previously reviewed by the FAA and the Department. Detailed modeling results of each simulation scenario are

1-1 Summary of Findings

presented in Section 3 of this Technical Memorandum. Section 4 provides a brief discussion of the conclusions reached based on the modeling results.

1.2 **Peak Hour Throughput and Hourly Capacity**

Due to CLT's role as a major hub operation for American Airlines, peak hour demand and capacity are key determinants of the airport system's (airfield, terminal and landside components) ability to operate efficiently, including maintaining proper schedule integrity. American Airlines' hub operation currently each day serves a total of 18 "banks" 1, or periods of time during the day when there is heavy aircraft arrival activity coming into CLT (the hub) followed by periods of heavy departure activity leaving CLT. As shown in Figure 1-1, the banks consist of nine departure banks and nine arrival banks.

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Airport Capacity Enhancement Plan, Landrum & Brown, February 2016, Page 1-1

150 100 50 0 -50 Arrival -100 Hours -150Arr2016 Arr 2028 Arr 2033 Dep 2033 Dep2016 Dep 2028

Hourly Departures and Arrival Demand (2016, 2028 and 2033)

Source: TransSolutions, LLC

Peak hour throughput is generally defined as the maximum number of aircraft operations that an airfield configuration can accommodate during a specified interval of time when there is a continuous demand for service (i.e., aircraft are always waiting to depart or land). The peak hour throughput is achievable under specific circumstances, but is not a good indication of the capacity that can be sustained for several hours. Thus the 90th percentile is often used as the measure of capacity. 2

The simulation results were analyzed to obtain rolling hour airport throughput for individual days (iterations) in each operational configuration using the highest demand level (2033) in the simulation because it will likely have the highest throughput. The maximum hourly throughput for each operational configuration and hourly capacity (90th percentile of maximum throughput) is summarized by arrivals only, departures only and all operations. The average maximum hourly throughput and capacity is also provided based on the annualized average use of each operational configuration (Section 3.5).

According to the Airport Capacity Enhancement Plan (Pg. 6-54), the DORA stakeholder group recommended that all throughput and capacity results from the ACEP simulation modeling analysis be weighted using the 90th percentile methodology, which yields a more conservative and sustainable runway throughput rate than the maximum throughput rate.

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7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24

Table 1-1 **Airport Peak Hour Throughput and Capacity**

	Arriv	als	Depart	ures	Total Operations			
Operational Configuration	Maximum Throughput	Capacity	Maximum Throughput	Capacity	Maximum Throughput	Capacity		
South VMC	84	72	78	65	141	130		
South IMC	74	68	69	66	134	130		
North VMC	77	68	78	65	138	131		
North IMC	76	68	68	63	137	127		
Annualized Average	80	70	76	65	139	130		

Capacity based on the 90th percentile of peak hour throughput for 0700-2200 local time; Annualized average based on annualized average use of each operational configuration (see Section 3.4)

Source: TransSolutions, LLC; Simmod PLUS!

1.3 Average Aircraft Taxi Times and Airspace/Ground Delays

The primary simulation metrics used in an airfield capacity/delay analysis are arrival airspace delay, taxi-in times, and taxi-out times. Arrival airspace delay is measured as the difference in the amount of time an aircraft lands on the runway and the time it would have taken to land on the runway if it were able to move unimpeded through the airspace. In the simulation analyses, most arrival delays at CLT occur when aircraft must maintain required separations and merge onto final approach, and on the airfield while waiting for a gate. While convective or adverse weather is a large source of delay in the National Airspace System (NAS), the modeling done for this project does not account for delays associated with such weather. Arrival taxi-in measures the time from when an aircraft lands on the runway until it taxis into its gate or parking position (including landing roll time on the runway, taxi time, and any taxiway or ramp delays). Taxi-out is associated with departures and measures the time from when an aircraft leaves its gate or parking position until it leaves the runway (including push-back from the gate, taxi time, departure queue wait time, and runway takeoff roll time).

The modeling results for arrival airspace delays and taxi-in times, and departure taxi-out times of each operational configuration and the annualized average are provided in Table 1-2. Taxi-in times increase uniformly from 2016 to 2033 in each operational configuration due to increased demand. Airspace delays increase more rapidly in the South Flow IMC and the two North Flow operational configurations. Departure taxi-out times increase in the South Flow and North Flow IMC operational configurations due to increased demand, resulting in ramp and taxiway congestion.

		Arri	val	Departure
Operational Configuration	Year	Average Airspace Delay	Average Taxi-In Time	Average Taxi-Out Time
South Flow VMC	2016	2.2	10.3	13.6
	2028	3.3	12.8	13.4
	2033	4.5	15.4	14.8
South Flow IMC	2016	4.3	12.4	17.7
	2028	7.3	15.2	17.9
	2033	12.6	15.4	23.4
North Flow VMC	2016	3.8	10.2	14.8
	2028	7.8	13.9	14.6
	2033	10.9	14.9	15.4
North Flow IMC	2016	3.9	11.1	18.6
	2028	8.6	12.3	23.2
	2033	12.0	12.5	26.6
Annualized	2016	3.2	10.6	15.0
Average	2028	5.8	13.4	15.3
	2033	8.3	14.9	17.1

Note: Annualized average is based on annualized average use of each operational configuration (see Section 3.4)

Source: TransSolutions, LLC; Simmod PLUS!

1.4 Average Arrival Gate and Ramp Delays

As noted previously in Section 1.2, demand at CLT is driven by the banking characteristics of the airline hub operations at the airport. Of the 18 daily banks, nine are arrival banks with heavy demand for gates in advance of each departure bank. At CLT, if the ramp is full of waiting aircraft, additional arriving flights will either wait on taxiways or arrival hold pads, which in turn affects arrival taxi-in times. The latter typically initiates a domino effect that results in a rolling increase in delay over time until the next bank begins.

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The simulation model tracked any arrival aircraft that must wait for a gate to become available after landing. Table 1-3 summarizes 95th percentile ramp delay time (in minutes)3, the total time spent waiting for a gate each day, and the average number of daily flights. With the current (2016) traffic demand, an annualized average of 267 arrivals per day, or 34 percent of all modeled arrivals, must wait for an available gate. By 2028, an average of 472 arrivals per day, or 51 percent of all modeled arrivals, would wait for a gate, and this grows to an average of 575 arrivals per day, or 58 percent of all modeled arrivals by 2033.4

Table 1-3 **Arrival Aircraft Waiting for Available Gates**

Operational Configuration	Year	95 th Percentile Waiting Time for a Gate (minutes)	Total Time Waiting for a Gate Each Day (minutes)	Average Number of Daily Flights that Wait for Gate
South Flow VMC	2016	5.9	470.1	237
	2028	8.0	1093.1	453
	2033	12.7	1862.7	519
South Flow IMC	2016	6.1	424.6	239
	2028	5.4	1095.1	472
	2033	6.7	1202.7	582
North Flow VMC	2016	6.0	636.1	292
	2028	6.4	940.8	453
	2033	5.4	1423.6	562
North Flow IMC	2016	5.6	577.9	260
	2028	6.2	993.6	434
	2033	6.2	1423.7	517
Annualized	2016	5.9	532.7	258
Average	2028	7.0	1033.1	453
	2033	9.0	1602.7	540

Note: Annualized average is based on annualized average use of each operational configuration (see Section 3.4)

Source: TransSolutions, LLC; Simmod PLUS!

Note that aircraft ramp waiting time increases more substantially in the South Flow VMC operational configuration (when arrival capacity increases due to the use of Runway 23) compared to all other scenarios with only the parallel runways in use. The increase in ramp waiting time is a function of more arrivals getting to the ramp and waiting for a gate due to the increase in runway capacity, which is evidence of an imbalance in airfield capacity and aircraft gate capacity. Also during the South Flow VMC operational configuration, the "hotspot" area near Taxiway F described in Section 1.3 causes gate waiting-related delays.

The 95th percentile is a reasonable indication of maximum wait times, without the extreme conditions that occur on rare occasions.

Percentage of modeled arrivals based on TransSolutions' analysis of Aerobahn© data between January 2015 and April 2017.

1.5 **Average Delay per Operation**

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Average minutes of delay per operation is a general indicator of the capacity of an airfield to meet existing and forecast aviation demand. As noted in Section 1.2, CLT serves as a major hub operation for American Airlines. When average delays per operation reach approximately 4 to 6 minutes, the schedule integrity of a hub operation may not be maintained. Average delay of 10 minutes or more may be considered severe at some airports, and starts to increase exponentially beyond 10 minutes of average aircraft delay.⁵

As listed in **Table 1-4**, the minutes of average delay per operation was 7.4 minutes in 2016, and would increase to 9.1 minutes in 2028 and 12.0 minutes in 2033 with the current airfield facilities and gates (except for the additional Concourse A gates in 2028 and 2033 that are currently under construction). Average minutes of delay per day were 11,725 in 2016, and would increase to 16,854 in 2028 and 23,529 in 2033.

Table 1-4 **Annualized Average Delay**

Year	Delay per Operation (minutes)	Number of Daily Operations	Minutes of Delay per Day
2016	7.4	1,582	11,725
2028	9.1	1,857	16,854
2033	12.0	1,968	23,529

Source: TransSolutions, LLC; Simmod PLUS!; Aerobahn®, January 2015 - April 2017, analyzed by TransSolutions

1.6 Comparison to ACEP

Table 1-5 lists the annualized average delay per operation in minutes for the existing and future demand levels to show how Existing Conditions (2016) and modeled future No-Action conditions airfield modeling results have changed since the completion of the ACEP. It is important to note that the EIS simulations modeled lower aviation demand levels than the ACEP because of the revised forecast effort⁶, including:

- > Two percent fewer aircraft operations in the EIS Existing Conditions (2016) compared to the ACEP Existing Conditions (2013), both in actual operations as well as simulated operations;
- 13 percent fewer aircraft operations in the EIS first future year (2028) compared to the ACEP first future year (2023); and,

⁵ FAA Airport Benefit-Cost Analysis Guidance, Office of Aviation Policy and Plans, Federal Aviation Administration, December 15, 1999, Pg. 39

⁶ Forecast Technical Memorandum, Charlotte Douglas International Airport Environmental Impact Statement, VHB in association with InterVISTAS, November 10, 2017

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> 27 percent fewer aircraft operations in the EIS second future year (2033) compared to the ACEP second future year the second future year (2033), and 7.5 percent fewer aircraft operations compared to the ACEP first future year (2023).

As average delay levels per operation approach 10 minutes, increases in demand will increase delay exponentially. Therefore, the modeled ACEP delay results are much greater than the percentage differences in operations when compared to the EIS modeled delay results.

It is also important to note that the ACEP modeling analysis was conducted using an "unconstrained" level of aviation activity. Average delay per operation of 20 minutes represents the highest level of average delay realized in actual practice, even at highly congested airports. At that level growth in operations would be constrained. Therefore, differences between the ACEP and EIS delay modeling results would be much less in reality due to constrained operations because delay would not exceed 20 minutes.

Table 1-5 **Annualized Average Delay – Comparison to ACEP**

	AC	EP	EIS	
Year	Number of Daily Operations	Delay per Operation (minutes)	Number of Daily Operations	Delay per Operation (minutes)
Existing (ACEP: 2013; EIS: 2016)	1,610	8-9	1,582	7.4
Future Year 1 (ACEP: 2023; EIS: 2028)	2,127	21-23	1,857	9.1
Future Year 2 (ACEP and EIS: 2033)	2,679	118-143	1,968	12.0

Sources: ACEP: Landrum & Brown, Exhibit 3-40; EIS: TransSolutions, LLC; Simmod PLUS!

In addition to the differences in forecasts of operations, the EIS analysis considered the following items:

Full implementation of FAA's Charlotte Metroplex Project⁷ (see Section 2.5) to improve airspace efficiency

A Metroplex is a geographic airspace area covering several airports, serving major metropolitan areas and a diversity of aviation stakeholders. FAA is focusing on airspace optimization at the Metroplex level, which provides solutions on a

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- > Inclusion of the Concourse A Improvement Project that is currently under construction, resulting in eight more gates in the EIS future No-Action than modeled in the ACEP analysis
- Observed⁸ or actual data for the following modeling inputs:
 - Varied final aircraft approach speeds based on weight category (Section 2.8)
 - Take-off and landing roll distances (Section 2.9)
 - Aircraft taxi speeds (Section 2.13)
 - Aircraft push-back times 9 (Section 2.14)
 - Flight dependability10 (Section 2.16)
- Assumption that, by Future Year 1, a system/technology will be implemented to eliminate miles-in-trail (MIT) restrictions to/from CLT airspace.

regional scale, rather than focusing on a single airport or set of procedures. The overall goal of FAA's NextGen Metroplex program is to improve the operational efficiency of the airspace serving large airports.

⁸ On-site observations at CLT Air Traffic Control Tower (ATCT) and interviews with the Air Traffic Manager, including subsequent TRACON personnel, conducted June 14-15, 2017.

⁹ Push-back is the time from when an aircraft leaves the gate to the time when the aircraft starts using its own power.

¹⁰ Flight dependability is the probability that a flight arrives or departs earlier or later than scheduled.

CLT EIS Capacity/Delay Analysis and Airfield Modeling Technical Memorandum

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Approach/Methodology

This section represents the approach and methodology used for the capacity/delay analysis. The operating assumptions are presented as well as the SIMMOD model calibration.

2.1 Objective

The objective of this analysis is to conduct an airfield capacity-delay analysis to establish an Existing Conditions and future No-Action Baseline at Charlotte Douglas International Airport (CLT) for current and future conditions, respectively. The delay analysis includes delays associated with runway use, airfield, airspace and terminal gates. This analysis does not consider any potential airfield or terminal gate improvements (aside from any that are already under construction) to enhance capacity and/or reduce delay.

2.2 Approach

ATAC Corporation's *SIMMOD Plus*!® version 8.1 was used to model the airspace/airfield operations for this analysis. The baseline in this study includes three demand levels – 2016 (Existing Conditions), 2028 and 2033 (future No-Action). For each of the three demand levels, there were two operational flows (South and North) and two weather conditions (Visual Meteorological Conditions [VMC] and Instrument Meteorological Conditions [IMC]) modeled. This analysis quantifies how the airport performs operationally under current and forecast traffic demand levels.

Information and assumptions that were used in the SIMMOD models were compiled from previous analyses and updated requirements including the following.

- Airport Capacity Enhancement Plan (ACEP) Final Report (February 2016)¹¹ prepared by Landrum & Brown, specifically the following elements:
 - Airside demand/capacity operating assumptions.
 - ACEP Simmod input files.
- Aerobahn^{® 12} data provided by CLT for January 2015 through April 2017.

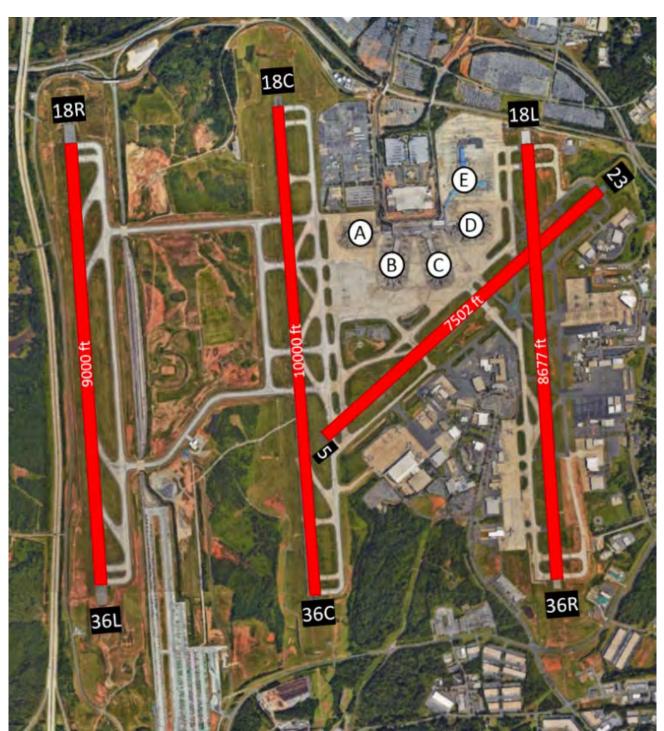
¹¹ Relevant sections of the ACEP "Chapter 3 Airside Demand/Capacity" include the Existing Airport Operating Assumptions.

¹² Aerobahn is a product by Saab Sensis Corporation for tracking aircraft movement. The data captured for each individual flight includes airline, flight number, aircraft type, runway, gate and time-stamps for runway use, gate arrival and gate departure.

1 2 3		 On-site observations at CLT Air Traffic Control Tower (ATCT) and interviews with the Air Traffic Manager, Traffic Management Coordinators, and subsequent Terminal Radar Approach Control (TRACON) personnel, conducted June 14-15, 2017.
4 5		Teleconference interview conducted with American Airlines CLT Ramp Tower Operations Manager and personnel on January 29 th , 2018.
6 7		Documents provided by CLT ATCT, such as noise abatement procedures, CLT-specific orders, ramp hand-off spot locations, etc.
8 9 10		Documents provided by the City of Charlotte, Airport Department (the Department) including Letters of Agreement, terminal gate layouts, CLT Metroplex plans, and FAA Notices to Airmen (NOTAM) records.
l1 l2		All data, performance goals, runway use configurations, and descriptions of the runway planning are summarized in this chapter.
L3	2.3	Runway Flow Usage
L4 L5		The CLT airfield consists of three parallel runways in the north/south direction (18-36) and a single crosswind runway (5-23), as depicted in Figure 2-1 .
16 17 18		Operational flows at CLT are split between North Flow and South Flow operations depending on prevailing wind conditions. The runway usage configurations during different flows are described below.
19		North Flow:
20		> Primary arrival Runways: 36L and 36R.
21		> Primary departure Runways: 36C and 36R.
22		> Runway 5-23 is typically used as a taxiway.
23		South Flow:
24		> Primary arrival Runways: 18R and 23.
25		> Primary departure Runways: 18C and 18L.
26		> In IMC, Runway 23 is not used.

Figure 2-1 CLT Airfield and Runways

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Source: Charlotte Douglas International Airport

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Table 2-1 summarizes runway use by operational flows with the primary arrival/departure runways highlighted. These percentages were used in the Existing Conditions and future No-Action baseline scenarios.

Table 2-1 Current Runway Usage

Flow	Runway	Arrivals	Departures	Overall
	5	0.5%	0.9%	0.7%
N I a mala	36C	11.9%	57.7%	34.1%
North	36L	51.9%	0.5%	26.9%
	36R	35.7%	40.9%	38.2%
	23	28.2%	0.6%	14.5%
C	18C	11.9%	46.6%	29.1%
South	18L	9.6%	52.6%	30.9%
	18R	50.3%	0.2%	25.5%

Source: Aerobahn®, January 2015 – April 2017, analyzed by TransSolutions. 13

Figure 2-2 illustrates the runway usage at CLT since January 2015, including all 24 hours of each day. Note that in North Flow:

- The percentage of arrivals on Runway 36L has been steadily increasing as the other runways have reached capacity.
- The percentage of arrivals on Runway 36C has been steadily decreasing as more arrivals land on Runway 36L.
- > Usage of specific departure runways has remained fairly consistent.

And in South Flow:

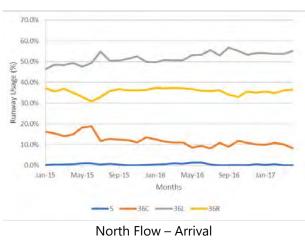
- The percentage of arrivals on Runway 18R has been steadily increasing.
- > The percentage of arrivals on Runway 23 has been steadily decreasing. This is likely due to:
 - Runway 23 arrivals constrain Runway 18C departures with the current Converging Runway Operations (CRO) and Arrival Departure Window (ADW) procedural change that took effect in early 2015.
 - Runway 23 arrivals exit into the commercial ramp area causing additional congestion to the traffic already in that area.

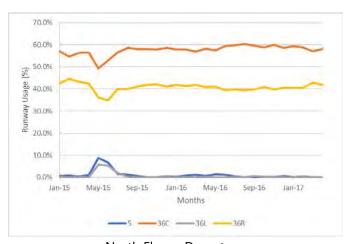
During peak departure times, more departure capacity is needed than can be achieved during CRO conditions, whereas the airport then switches to an all parallel runway configuration to

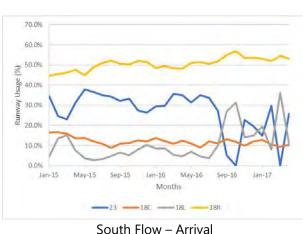
¹³ Data was analyzed for all hours (24), including noise abatement periods (2300-0700 local time).

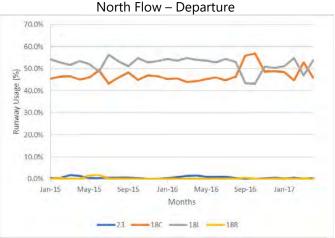
achieve more efficiency. The Runway 23 arrivals are then assigned to other runways so that departures can be better accommodated on Runway 18C.

Figure 2-2 Historical Runway Usage at CLT









South Flow – Departure

Source: Aerobahn®, January 2015 – April 2017, analyzed by TransSolutions

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Note that a rehabilitation project of Taxiway C occurred in fall 2016, which closed Runway 5-23 for most of August, September, October and half of November. Periodic runway closures occurred throughout the winter. Runway 5-23 was closed all of March 2017 for boring work in the Runway Safety Area (RSA). When the crosswind Runway 23 is not used, arrivals that would typically land on Runway 23 instead land on Runway 18L. At the same time, there is a reduced use of Runway 18L for departures and an increased use of Runway 18C by departures.

Figure 2-3 illustrates the arrival and departure runway configurations for North Flow and South Flow.

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Figure 2-3 Arrival and Departure Runway Configurations

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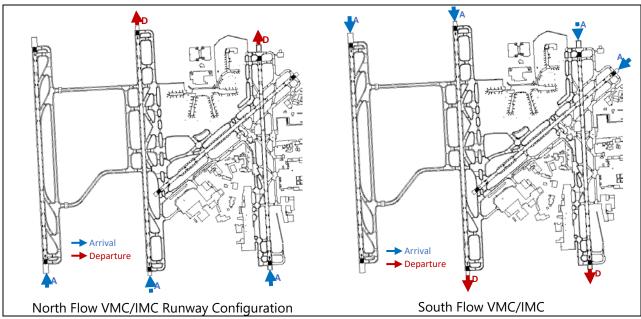
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Source: ACEP Final Report, Exhibits 3-2 and 3-3, February 2016

2.4 Additional Runway Usage Assumptions

The following section outlines the additional runway use assumptions that were used in the modeling effort.

2.4.1 Long-Haul Aircraft Operations

Runway use is mostly assigned by the direction of flight. Using this approach, some heavy and long-haul departures to the West Coast require Runway 18C-36C. More specifically:

- > In North Flow, aircraft will depart Runway 36C with no arrivals on Runway 36C until the arrival peaks require that Runway 36C also be used for arrival traffic.
- > In South Flow, aircraft will depart Runway 18C and arrive Runway 18L or 23 until the traffic peaks require that Runway 23 arrivals be re-assigned so that Runway 18L is used for arrival traffic with three parallel arrival runways.

2.4.2 General Aviation and Military Operations

In most circumstances, General Aviation (GA) and military flights primarily land/depart on Runway 18L-36R due to the proximity of their assigned ramps to this runway. In addition, Runway 23 is frequently utilized in South Flow conditions by GA and military arrivals.¹⁴

2.4.3 Cargo Operations

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26 27 In general, more than 50 percent of cargo flights operate on Runway 18C–36C due to its longer length compared to other runways. Another 25 percent of cargo traffic operates on Runway 18L–36R due to its proximity to the cargo ramps/facilities.¹⁵

2.4.4 Noise Abatement Procedures

Noise abatement procedures are included in the simulation model, based on the FAA Order CLT ATCT 1050.1j, effective December 1, 2013. Noise abatement procedures are in effect from 2300 – 0700, local time. During this time, Runway 5-23 is preferred.

For noise abatement, jet and large four-engine props aircraft are assigned the following headings until two (2) Nautical Miles (NM) from the departure end of the following runways.

- > Runway 18L, 18C, 23 and 5: runway heading.
- > Runway 36R: 025 degrees.
- > Runway 36C: 330 degrees.
- > Runway 36L: 315 degrees.
- > Runway 18R: 200 degrees.

2.5 Terminal Radar Approach Control (TRACON) Airspace

The air traffic control area managing arrivals to and departures from CLT is the TRACON. Simulation functions that direct the movement of aircraft through the airspace are described in this section.

2.5.1 Metroplex Airspace

A Metroplex is a geographic airspace area covering several airports, serving major metropolitan areas and a diversity of aviation stakeholders. Currently, the FAA is focusing on airspace optimization at the Metroplex level, which provides solutions on a regional scale, rather than focusing on a single airport or set of procedures. The overall goal of FAA's NextGen Metroplex

¹⁴ TransSolutions analysis of Aerobahn® data

¹⁵ TransSolutions analysis of Aerobahn® data

program is to improve the operational efficiency of the National Airspace System (NAS) in serving 1 2 large airports.

The FAA implemented the Charlotte Metroplex airspace changes in three phases:

- > Phase 1: October 2015.
- Phase 2: May 2016.

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Phase 3: July 2016.

The Charlotte Metroplex includes CLT as well as Columbia Metropolitan Airport(CAE), Piedmont Triad International Airport (GSO), Greenville-Spartanburg International Airport(GSP), Concord Regional (JQF) Airport, and Raleigh-Durham International Airport (RDU). The Metroplex airspace includes new arrival and departure routings serving CLT as well as procedural improvements that take advantage of some NextGen technological developments. As described in the FAA's Finding of No Significant Impact (FONSI) and Record of Decision (ROD) for the CLT Metroplex, the airspace changes consist of 46 procedures, several of which utilize Area Navigation (RNAV).¹⁶ The airspace changes are described in detail in the FAA's Environmental Assessment (EA) of the Charlotte Metroplex.¹⁷

Figure 2-4 illustrates the Metroplex airspace. The Existing Conditions and future No-Action Baseline simulation models include the implemented Metroplex airspace in the SIMMOD model based on the latitude-longitude coordinates obtained from FAA National Flight Data Center (NFDC). Figure 2-5 depicts the simulated Metroplex airspace in south-flow conditions while Figure 2-6 depicts the simulated Metroplex airspace in north-flow conditions. In these figures, arrival routes are shown in blue while departure routes are shown in purple.

¹⁶ Finding of No Significant Impact (FONSI) and Record of Decision (ROD) For the Charlotte Optimization of the Airspace and Procedures in the Metroplex (CLT OAPM), FAA, May 19, 2015

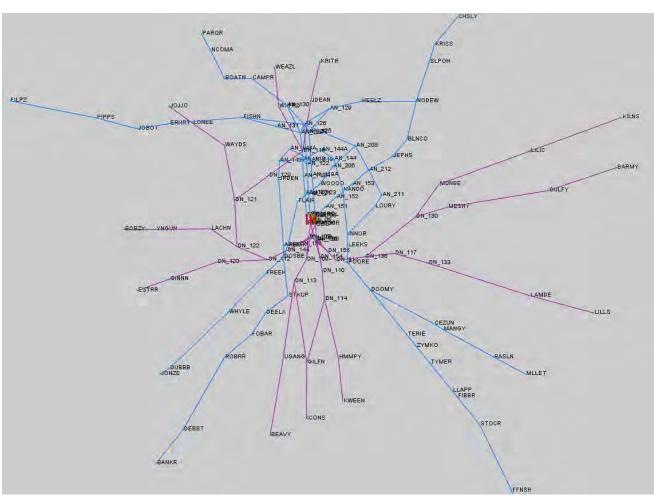
¹⁷ Draft Environmental Assessment for Charlotte Optimization of Airspace and Procedures in the Metroplex, FAA, December 2014.

Figure 2-4 Metroplex Airspace 1



Source: FAA, CLT Airport Traffic Control Tower

Figure 2-5 Simulated Airspace for South-flow



Source: TransSolutions SIMMOD model

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Figure 2-6 Simulated Airspace for North-flow

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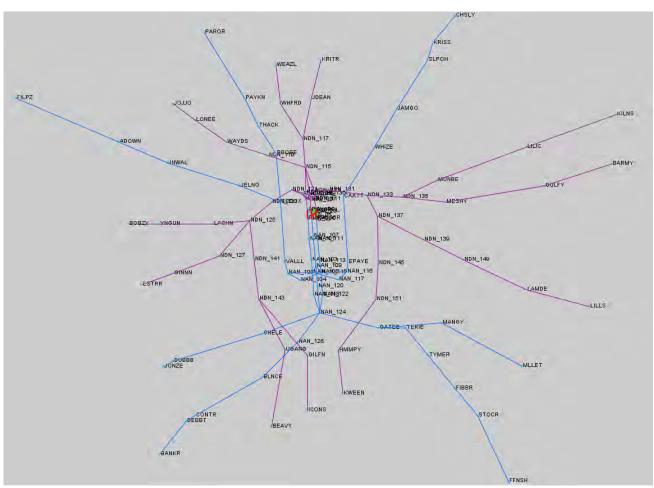
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Source: TransSolutions SIMMOD model

2.5.2 Airspace Separations

The airspace modeled in the future No-Action baseline scenarios encompasses the CLT Terminal Radar Control Facility (TRACON), which extends a maximum of 30 nautical miles from CLT. Aircraft separations in the SIMMOD model were maintained in the airspace based on the following:

- > Wake turbulence separation.
- > Route separation.
- > Departure separation.

The simulation models calculated the required separation for each of these and then applied the maximum separation between two aircraft. Each of these separations is described below.

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2.5.2.1 **Wake Turbulence Separations**

The FAA wake turbulence recategorization (RECAT) separations, summarized in **Table 2-2** below, were applied to the simulation models in the study for aircraft operating directly behind or following another aircraft. Wake turbulence separations are maintained when different category aircraft follow one another. Smaller aircraft following larger aircraft may encounter wake turbulence (vortices generated by an aircraft's wingtip) generated by larger aircraft – creating a potentially hazardous situation. Because of this, additional separation between aircraft may be required for a trailing aircraft to avoid the larger aircraft's wake turbulence. The wake turbulence separation defines the separation between arrivals to the same runways.

Table 2-2 **FAA RECAT Specifications (NM)**

Trailing Aircraft

		Upper Heavy (A332, B777)	Lower Heavy (B763)	Upper Medium (A320, E190)	Lower Medium (AT72, CRJ9)	Small (GA prop)
aft	Upper Heavy	3.0	4.0	5.0	5.0	7.0
Aircraft	Lower Heavy	3.0	3.0	3.5	3.5	6.0
ng A	Upper Medium	3.0	3.0	3.0	3.0	4.0
eadir	Lower Medium	3.0	3.0	3.0	3.0	3.0
Le	Small	3.0	3.0	3.0	3.0	3.0

Source: Federal Aviation Administration Order 7110.659A

2.5.2.2 **Route Separations**

The future No-Action Baseline will use the route separations in the ACEP SIMMOD models namely:

- South VMC and IMC: 3 NM.
- North VMC and IMC: 2.5 NM.

The route separation defines the minimum distance between flights that are assigned the same flight path consecutively, one after another.

2.5.2.3 **Departure Separations**

In the airspace surrounding CLT, consecutive departing aircraft are required to maintain departure separations for take-off from the same runway. Table 2-3 summarizes the standard aircraft separations for consecutive departures that were used in the ACEP and were incorporated in the simulation models. These define the separation between departures from the same runways. In addition, lateral separation was achieved within the SIMMOD model by ensuring these same separations are provided between the various aircraft routings.

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Table 2-3 **Runway Departure Separations (in seconds)**

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Lead Aircraft Category

Trail Aircraft	Heavy	B757	Large	Small	
Heavy	90	120	120	120	
B757	90	90	90	120	
Large	¹ 60/72	¹ 60/72	¹ 60/72	¹ 60/72	
Small	¹ 60/72	¹ 60/72	¹ 60/72	¹ 60/72	

VMC/IMC in-trail separations

Source: ACEP Final Report, Table 3-4, February 2016

To replicate variability in actual air traffic operations, the SIMMOD models will incorporate separation multipliers (both arrivals and departures) which vary the distance between aircraft on the same route. In VMC, the multipliers range from 0.55 to 1.55, which adjust a 3.0 nautical mile (nmi) separation to vary between 1.65 nmi to 4.65 nmi, with an average separation of 3.24 nmi. In IMC, the lowest multiplier is 0.978, which may reduce the 3.0 nmi separation to 2.93 nmi separation.

2.5.3 **Enroute Assignments and Metering**

Flights are assigned to specific arrival routes based on their originating airport, and are assigned specific departure routes based on their destination airport. A few representative airports along with the assigned arrival and departure route are provided in Table 2-4.

Table 2-4 **Arrival and Departure Route Assignment Examples**

City/Airport	Direction	Arrival Route	Departure Route
Albany, NY (ALB)	NE	CHSLY	KILNS, BARMY
Atlanta, GA (ATL)	WSW	FILPZ	BOBZY
Augusta, GA (AGS)	SSW	BANKR	BEAVY
Boston, MA (BOS)	E	MILLET	BARMY
Buffalo, NY (BUF)	NNE	CHSLY	KILNS, KRITR
Canton/Akron, OH (CAK)	N	CHSLY	JOJJO, WEAZL, KRITR
Charleston, SC (CHS)	SSE	STOCR	KWEEN
Columbus, OH (CMH)	NNW	PARQR	WEAZL
Dallas/Fort Worth (DFW)	W	FILPZ	ESTRR, BOBZY
Des Moines, IA (DSM)	WNW	FILPZ	BOBZY
Frankfurt, Germany (FRA)	ENE	CHSLY	BARMY
Houston (IAH)	W	FILPZ	ESTRR, BOBZY
Indianapolis, IN (IND)	NW	PARQR	JOJJO
Los Angeles, CA (LAX)	W	FILPZ	ESTRR, BOBZY
Miami, FL (MIA)	S	STOCR, BANKR	KWEEN, ICONS, BEAVY

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Myrtle Beach, SC (MYR)	SE	MILLET	LILLS
Mexico City, Mexico (MEX)	SW	JONZE	BEAVY
Nashville, TX (BNA)	W	FILPZ	ESTRR, BOBZY
New York (JFK/LGA)	Е	MILLET	BARMY
Philadelphia, PA (PHL)	Е	MILLET	BARMY
Washington, DC (DCA)	Е	MILLET	BARMY
Wilmington, NC (ILM)	ESE	MILLET	LILLS

Source: Aerobahn, analyzed by TransSolutions

While flights can get to any route from any runway, typically arrivals at CLT from the west land on Runway 18R-36L, and flights from the east land on Runway 18L-36R or Runway 23. Departures to the west typically depart Runway 18C-36C while departures to the east typically depart Runway 18L-36R. Some logical adjustments were made in the SIMMOD model to the directional assignments in order to coincide with the runway usage noted in Table 2-1.

In 2017, CLT began testing the Airspace Technology Demonstration 2 (ATD-2) specifically for departures to the enroute airspace of Washington Air Route Traffic Control Center (ARTCC), or Washington Center. Previously, departures to the northeast over the BARMY and KILNS fixes often had a miles-in-trail (MIT) restriction to handoff from the CLT airspace to Washington Center. With ATD-2, the flights going into Washington Center are assigned a take-off time prior to pushing-back from the gate, thus metering the departures into the airspace. Operating with ATD-2 has eliminated the MIT restrictions except in the event of convective weather. Based on feedback from the FAA ATC staff at CLT, it was assumed that ATD-2 or a system/technology providing a similar capability will remain in place at CLT, hence, the baseline simulations for future years did not include MIT separations. Note however that the 2016 baseline simulation assumed a 15-nmi in-trail restriction to routes departing CLT airspace into the Washington Center.

2.6 **Runway Separations and Dependencies**

Due to the crossing runway configurations at CLT, certain operations are subject to Converging Runway Operations (CRO) procedures in South Flow as described below.

- > Converging Runway Operations (CRO) Arrival Departure Window (ADW) on Runway 23.
 - When arrivals to Runway 23 are within 1.8 NM of landing, departures are blocked from Runway 18C until the arrival aircraft is 0.2 NM beyond the Runway 23 threshold (i.e., after the arriving aircraft crosses over Taxiway D).
 - This configuration operates with 3.0 NM between arrivals to get a Runway 18C departure between each pair of arrivals.
- When arrivals to Runway 23 are within 2.0 NM of landing, departures are blocked from Runway18L until the arrival aircraft crosses Runway 18L.

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Due to the runway separation, operations on the parallel runways are independent in both VMC and IMC.

- > South Flow VMC/IMC: Runways 18R, 18C, and 18L are independent.
- North Flow VMC/IMC: Runways 36L, 36C, and 36R are independent.

Table 2-5 shows the time between consecutive operations on the same runway observed from the Aerobahn® data from January 2015 to April 2017. Note that this analysis included consecutive operations less than 2.5 minutes, since operations with separations greater than that are likely not during a high demand period. This data provided the basis for the simulation model runway procedures.

Table 2-5 Aerobahn® Runway Separation Observations

Operations	Flow	Runway	5 th Percentile (min)	Avg (min)
		36L	1.1	1.5
		36C	1.3	1.8
	North	36R	1.3	1.9
		Overall	1.1	1.6
Arrival - Arrival		23	1.2	1.7
		18L	1.4	1.9
	South	18C	1.3	1.9
		18R	1.1	1.5
		Overall	1.1	1.6
		36L	0.7	1.3
	North	36C	0.7	1.3
		36R	0.7	1.5
Danastus Danastus		Overall	0.7	1.4
Departure - Departure	South	18L	0.6	1.3
		18C	0.8	1.4
		18R	0.7	1.4
		Overall	0.6	1.4
		36C	0.4	0.8
	North	36R	0.3	0.5
Arrival Donartura		Overall	0.3	0.6
Arrival - Departure		18C	0.4	0.8
	South	18L	0.5	0.8
		Overall	0.4	0.8
		36C	1.4	1.9
	North	36R	1.3	1.7
Donartura Arrival		Overall	1.3	1.7
Departure - Arrival		18C	1.5	1.9
	South	18L	1.1	1.6
		Overall	1.1	1.7

Source: Aerobahn®, January 2015 – April 2017, analyzed by TransSolutions

Aircraft Final Approach Speed 2.7

Aircraft final approach speeds are specified in the ACEP report as 140 knots for all aircraft types. In reference to FAA guidelines, aircraft final approach speeds that will be used in the Existing Conditions and future No-Action Baseline simulation models are summarized in **Table 2-6** below.

Table 2-6 **FAA Aircraft Characteristics**

SIMMOD Aircraft Category	Avg. Final Approach Speed (knots)
Upper Heavy ¹	140
Lower Heavy ²	140
Upper Medium³	130
Lower Medium ⁴	110
Small ⁵	105

Source: Federal Aviation Administration AC 150/5300-13A, Change 1: "Airport Design"

¹Includes: 332, 333, 346, 359, 788, 789 ²Includes: A300F, A306, DC10, DC10F

³Includes: 752

Includes: 319, 320, 321, 32A, 32N, 3N1, 717, 733, 737, 738, 739, 73G, 73H, 73J, 73W, 7M7, 7M8, 7M9, C130, CR2, CR7, CR9, CRA, CRJ, DH3, DH8, E70, E75, E7W, E90, ER4, ERJ, M88, M90

⁵Includes: B350, BE20, BE30, BE40, BE58, BE9L, C210, C25A, C25B, C303, C510, C550, C560, C56X, C750, CL30, CL35, CL60, CS1, E50P, E55P, EM2, F2TH, F900, FA50, G150, G280, GALX, GL5T, GLEX, GLF4, GLF5, GLF6, H25B, J328, LJ35, LJ45, LJ60, LR60, P180, PA27, PA34, PC12, SR22, SW3, SW4, TBM7, TBM8, TBM9

2.8 Aircraft Take-Off and Landing Roll

The ACEP take-off distance distribution inputs were used as follows.

- > Heavy Aircraft: 6,500-7,500 feet.
- > All other aircraft types: 5,000-6,600 feet.

The Existing Conditions and future No-Action Baseline simulation uses the take-off rolls observed in June 2017, and was supplemented by the ACEP inputs when no data were recorded, as shown in **Table 2-7**. Note that while take-off rolls are required input to the SIMMOD model, this specific parameter has no significant effect or impact on the SIMMOD model results as the runway departure separations detailed above in **Table 2-4** primarily control departure operations.

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Table 2-7 Take-Off Roll Distances

Туре	Avg. Distance (ft.)
Turboprop	3,385
Regional Jets	5,350
Narrow Body	6,640

Source: Data collected at CLT, 77 observations recorded June 14-15, 2017.

The Existing Conditions and future No-Action Baseline simulation model landing rolls used runway exit percentages obtained from Aerobahn® data. Note that the analysis of the Aerobahn® data shows a difference in runway exit location designations after January 2016, and the details of the previous data labels are not available. Thus, **Table 2-8** summarizes the runway exit percentages analyzed from Aerobahn® for February 2016 – April 2017, which were used in this study.

1 Table 2-8 Runway Exit Usage by Aircraft Type

North Flow								South Flo	w		
Runway	Exits	T-Prop	RJ	NB	WB	Runway	Exits	T-Prop	RJ	NB	WB
36L	W7	100%	97%	76%	73%	18R	W4	99%	95%	69%	54%
	W8	0%	3%	24%	27%		W3	1%	5%	31%	46%
36C	S	21%	0%	0%	1%	18C	E6	7%	2%	1%	0%
	E6	71%	52%	19%	13%		V4	24%	12%	4%	0%
	V5*	5%	25%	37%	33%		E5	45%	45%	20%	6%
	E8	2%	22%	38%	43%		S	4%	22%	17%	5%
	N	0%	1%	5%	5%		E4	19%	19%	56%	83%
	E9	0%	0%	1%	5%		E3	0%	0%	2%	6%
36R	D4	14%	0%	0%	0%	18L	C9	2%	0%	0%	0%
	D5	7%	0%	0%	0%		D7	3%	0%	0%	0%
	R	37%	22%	45%	24%		R	22%	0%	0%	0%
	D6	19%	0%	0%	0%		C8	21%	7%	3%	0%
	C9	1%	4%	6%	11%		D5	32%	0%	0%	0%
	Α	5%	8%	19%	15%		C7	1%	2%	2%	0%
	М	0%	2%	27%	29%		D4	5%	0%	0%	0%
	C10	13%	57%	3%	18%		C6	5%	61%	42%	28%
	C11	1%	3%	1%	1%		C5	0%	12%	13%	12%
	С	2%	4%	0%	0%		D3	9%	0%	0%	0%
							C4	0%	16%	37%	58%
							C3	0%	0%	1%	2%
						23	C	3%	0%	0%	0%
							R	6%	0%	0%	0%
							G	6%	0%	0%	0%
							В	52%	46%	29%	12%
							A4	28%	0%	0%	15%
							M2	0%	5%	3%	1%
							F	5%	48%	68%	72%

Source: Aerobahn®, February 2016 – April 2017.

^{*} Note that over 30% of Runway 36C arrivals indicated exiting at Taxiway E7, which is a reverse exit; the SIMMOD model assumed these arrivals use exit Taxiway V5.

2.9 Ramp Areas

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The current aircraft ramps are divided into four types:

- > Commercial Passenger.
- General Aviation.
- Cargo.
- Military/Air National Guard.

The location of each type is shown on the map in **Figure 2-5**.

Figure 2-5 Aircraft Ramps

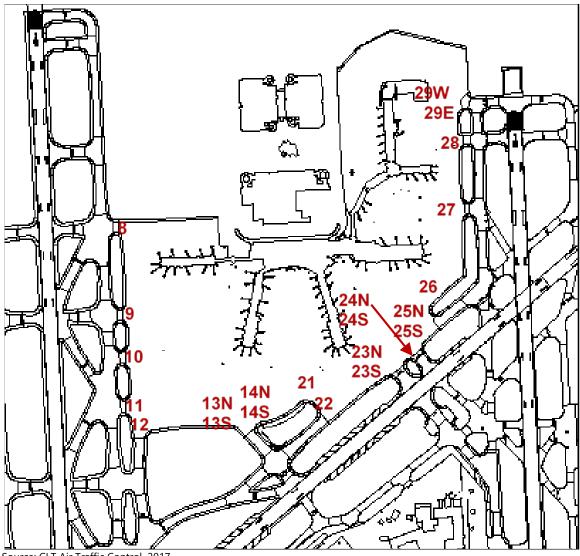


Source: TransSolutions, LLC

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Figure 2-6 Ramp Entry and Exit Points



Source: CLT Air Traffic Control, 2017

Aerobahn® data were analyzed to determine the usage of each entry and exit point at the ramp. The data also indicated a change in operations or airfield configuration after January 2016 where certain entry and exit points were no longer used or available. Table 2-9 summarizes the ramp entry and exit points for the operations from February 2016 to April 2017.

1 Table 2-9 Ramp Entry and Exit Point Usage

Ramp _	N	orth	South		
Entry/Exit	Arrivals	Departures	Arrivals	Departures	
8	4%	0%	1%	4%	
9	52%	0%	0%	41%	
10	2%	0%	0%	2%	
11	4%	0%	45%	0%	
12	0%	16%	12%	0%	
22	0%	6%	20%	0%	
27	5%	3%	5%	8%	
28	6%	1%	6%	0%	
13S,14S,13N,14N	1%	7%	5%	0%	
23S,23N	0%	62%	5%	0%	
24S,24N	13%	1%	0%	0%	
25N,25S	4%	0%	0%	26%	
29E,29W	9%	4%	1%	19%	
Total	100%	100%	100%	100%	

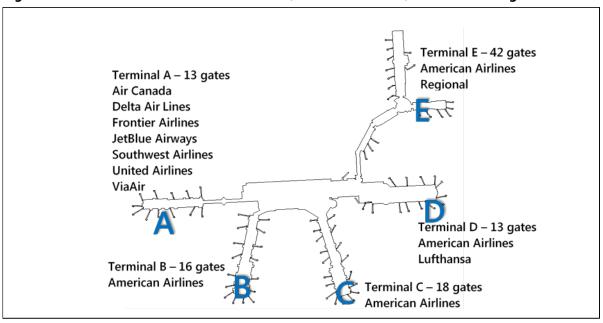
Source: Aerobahn®, February 2016 – April 2017

2.11 Airline Gate Assignment

Figure 2-7 shows the current terminal locations, number of gates, and the airlines assigned.

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Figure 2-7 CLT Terminal Concourse Location, Number of Gates, and Airline Assignments



Source: Charlotte Douglas International Airport

As observed during the Project Team's site visit at the CLT Air Traffic Control tower, a waiting area on the ramp was included in the simulation model in the southwest area of the commercial ramp (south of Concourse A) so that flights can hold there until the assigned gate becomes available. While this is predominantly used by American Airlines, all flights may wait in this area for an available gate.

For the future demand levels, additional remote stands were modeled at Concourse E for American Eagle flights to account for:

- > The heavy traffic and fast turn-around times for American Eagle flights.
- > The arrival/departure distribution applied to each flight that varies each flight's simulated times from the scheduled times.

The new pier currently being constructed at Concourse A (additional eight gates) was included in the SIMMOD model for the future No-Action traffic demands.

2.12 Aircraft Taxi Speeds

Aircraft taxi speeds used in the ACEP are summarized in Table 2-10.

Table 2-10 ACEP Taxi Speeds

Area of Airfield	Speed (knots)		
Outer Perimeter Taxiways (Arrivals)	25 knots		
Runway Crossings	10 knots		
Ramp Area Taxiways	12 knots		
Ramp Area Taxilanes	10 knots		
Gate Power-In	5 knots		

Source: ACEP Final Report, Table 3-6, February 2016

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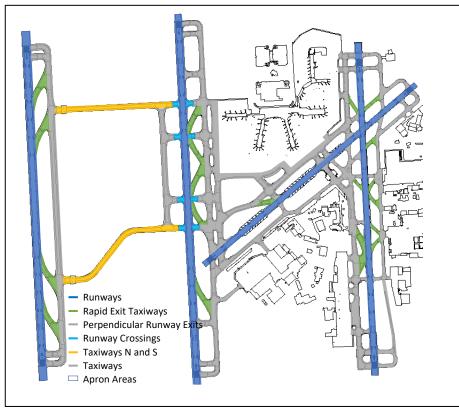
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The Existing Conditions and future No-Action Baseline used a combination of the ACEP and the onsite observations of taxi speeds collected at CLT on June 14-15, 2017, as shown in Table 2-11 and illustrated in Figure 2-8.

Table 2-11 2017 Taxi Speeds

Area of Airfield	Speed (knots)
Runways	70
Rapid Exit Taxiways (Angled Exits)	32
Perpendicular Runway Exits	15
Taxiways N and S (between Runways 18C-36C and 18R-36L)	20
Taxiways	15
Ramp Areas	10
Runway Crossings	18
C D	

Source: Data collected at CLT, 381 observations recorded, June 14-15, 2017



Different Taxi Speeds in the Airfield

Source: TransSolutions analysis, 2017

2.13 **Aircraft Pushback Times**

The pushback time begins when an aircraft starts moving from its gate, and the pushback time ends when the aircraft starts to taxi using its own power. Note that during aircraft pushback, the majority of aircraft parked in adjacent gates are able to pushback independently, However, there are a few areas near the terminal where adjacent aircraft are blocked from pushing back if the pushback paths overlap. In addition, heavy aircraft pushing back from the north side of Concourse D block pushbacks from the southeast side of Concourse E.

The ACEP applied a three (3) minute pushback time to all passenger flights.

- > The Existing Conditions and future No-Action Baseline will use the 2017 observed pushback times, shown in Table 2-12. The simulation will apply the on-site observed pushback times, as follows.
 - Pushback times vary from 2 to 5.5 minutes, shown in Figure 2-9.
 - The average time is 3.6 minutes, shown in **Table 2-12**.

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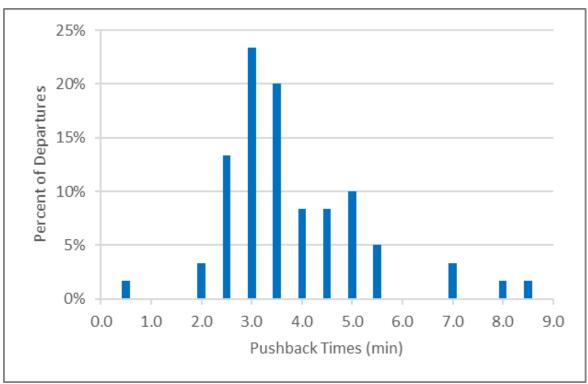
6 7 The same pushback distribution will be used for all commercial passenger aircraft types as they are not significantly different across different aircraft types.

Table 2-12 Average Pushback Time

Туре	Avg. Times (min)
T-Prop	3.2
RJ	3.8
NB	3.6
Total	3.6

Source: Data collected at CLT, 60 observations recorded, June 14-15, 2017

Figure 2-9 2017 Observed Pushback Times

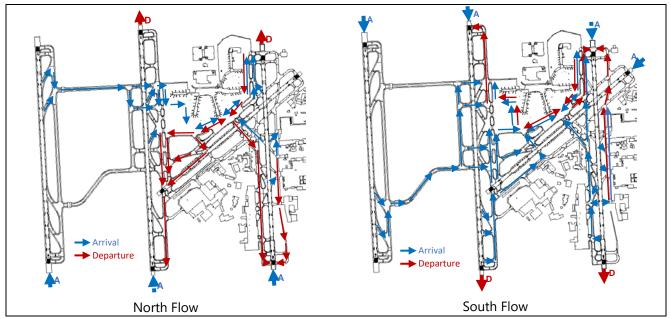


Source: Data collected at CLT, June 14-15, 2017

2.14 Taxiflows

The Existing Conditions and future No-Action Baseline used both the ACEP and 2017 observed taxiflows, illustrated in **Figure 2-10**.

Figure 2-10 North and South Taxi Flows – Integrated ACEP and 2017 Observations



Source: TransSolutions analysis of ACEP and observations

2.15 Flight Dependability

The probability that a flight arrives/departs earlier or later than scheduled is applied in the SIMMOD model to create a realistic arrival and departure profile. Negative values indicate flights that arrive or depart prior to their scheduled time, while positive values indicate flights that arrive or depart after their scheduled time.

Flight dependability varied for both arrivals and departures by 30 minutes (60 minutes in North IMC configuration) in the ACEP. The Existing Conditions and future No-Action Baseline used the data analyzed from Aerobahn®, shown in **Figure 2-11**, since this provided more detailed information.

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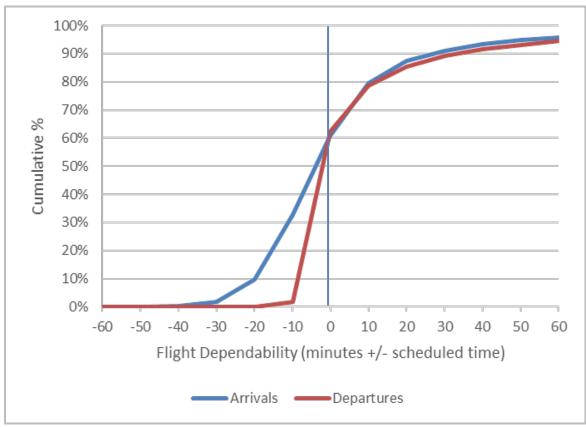
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Source: Aerobahn®, January 2015 - April 2017

2.16 Model Calibration

A necessary step in any simulation analysis is to ensure that the simulation model is an accurate representation of the actual operations. SIMMOD model calibration is accomplished by comparing results of the simulation to actual data for the same traffic demand. Typically, simulation results should be within 10 percent of the actual data for the SIMMOD model to be calibrated.

Calibration was performed for both the North Flow and South Flow models with the 2016 traffic demand in VMC. The simulation model was calibrated to reflect current operational conditions of the following elements:

> 90 percent maximum hourly runway throughput for arrivals and departures. 18

¹⁸ According to the *Airport Capacity Enhancement Plan* (Pg. 6-54), the DORA stakeholder group recommended that all throughput and capacity results from the ACEP simulation modeling analysis be weighted using the 90th percentile methodology, which yields a more conservative and sustainable runway throughput rate than the maximum throughput rate. In some calibration comparisons, both 90th and 95th percentile are presented to show the complete range of related values.

- > Hourly airport throughput for arrivals and departures. 1
 - Average arrival taxi-in times.
 - > Average departure taxi-out times.

Runway and airport throughput was also calibrated for both North Flow and South Flow in IMC. The IMC calibration did not include taxi time comparisons due to the variety of weather conditions at both CLT and other airports in IMC that can affect taxi times.

2.16.1 **VMC Calibration**

The first calibration comparison presented is hourly runway throughput. Aerobahn® data provided by CLT was analyzed for the peak month of May 2016 to obtain the hourly runway throughput on the major arrival and departure runways. The 90th-percentile hourly throughputs from Aerobahn® were compared to the simulation model's 90th-percentile hourly runway throughput. Table 2-13 summarizes the calibrated major arrival and departure runway throughput of the simulation model in VMC. The simulation model produced runway throughputs within 10 percent of the actual data from Aerobahn®, thus demonstrating that the runway throughput of the simulation model was appropriately calibrated.

Table 2-13 Hourly Runway Throughput Calibration in VMC

Flow	Operations	Main Runway	Aerobahn®*	Simulation
South	Arrivals	18R	33	33
	Departures	18C	32	31
	Departures	18L	38	35
North	Arrivals	36L	35	32
	Departures	36C	38	37
	Departures	36R	29	28

Analysis of Aerobahn® data, May 2016

In addition, the simulated throughputs for both South- and North-flow operations were compared to the FAA called rates and to the overall hourly traffic counts, analyzed for calendar years 2016 and 2017. The FAA called rates, or facility reported rates, provide an indication of CLT's ability to accommodate that number of hourly flights as the rates are used by FAA in traffic flow and metering. The analysis of ASPM data is presented in Table 2-14 when the same configuration was operational:

- South: Arriving 18R, 23, 18C and 18L | Departing 18L and 18C
- North: Arriving 36L, 36R, and 36C | Departing 36C and 36R

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1 Note: a variety of called rate values were found in ASPM for a particular runway configuration. The 2 most frequent called rate for each configuration is included in the table. For comparison purposes, 3 the ACEP throughputs are also provided.

Table 2-14 VMC Hourly Throughput Calibration by Operation Type

		ASPM ¹		Simul	ation ²	ACEP ³		
Flow	Operations	Called Rate*	Maximum Operations*	95 th % Operations*	Maximum Operations	95 th % Operations	Peak Hour	
South	Arrivals	92	78	66	77	69	71	
	Departures	82	81	70	78	66	73	
North	Arrivals	92	79	67	73	66	72	
	Departures	69	82	71	78	67	73	

- Analysis of ASPM data, 2016-2017
- 2 Simulation single day of 2016
- ACEP Table 3-11 on page 3-34

The FAA's acceptance or called arrival rates are much higher than actual hourly counts. The hourly throughput of the simulated single day is very similar to the ASPM hourly counts, especially for the 95th percentiles.

Overall, the simulated hourly airport throughput for arrivals and departures together is presented in **Table 2-15** for the 90th percentile.

Table 2-15 VMC Hourly Throughput Calibration – Total Operations

ASPM	Simulation
90 th %	90 th %
121	121
121	118

Note: Analysis of ASPM data, 2016-2017

Another primary calibration comparison in VMC is taxi-in and taxi-out times. While the simulation model produces unimpeded travel times, taxi delays and departure queue delays, the only operational statistic for comparison is the overall taxi times, which include all delays encountered taxiing between the gate and the runway. For CLT, the taxi times compare favorably, within ten percent of the actual taxi times from Aerobahn®. Table 2-16 summarizes the comparison of the calibrated taxi times of the simulation model in VMC.

Table 2-16 2017 Average Taxi Times

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2.16.2 IMC Calibration

The IMC calibration includes both hourly runway throughput and overall hourly airport throughput. The runway throughput is obtained from Aerobahn® for the January - August 2016 to obtain the hourly runway throughput on the major arrival and departure runways: arrivals on Runway 18R-36L, and departures on Runways 18C-36C and 18L-36R. Note that additional months were analyzed to obtain adequate amount of IMC hours for comparing to the simulation. The 90th-percentile hourly throughputs from Aerobahn® were compared to the simulation model's 90th-percentile hourly runway throughput in **Table 2-17**.

Table 2-17 Hourly Runway Throughput Calibration in IMC

Flow	Operations	Main Runway	Aerobahn® ¹	Simulation
South	Arrivals	18R	34	35
	Departures	18C	28	29
	Departures	18L	32	34
North	Arrivals	36L	35	32
	Departures	36C	35	35
	Departures	36R	27	26

¹ Analysis of Aerobahn® data, January - August 2016

The simulated throughputs for both South Flow and North Flow operations IMC were compared to the FAA called rates and to the overall hourly traffic counts, analyzed for calendar years 2016 and 2017. Analysis is presented in **Table 2-18** of ASPM data when the same configuration was operational as is being simulated:

- > South: Arriving 18R, 18C and 18L | Departing 18L and 18C
- > North: Arriving 36L, 36R, and 36C | Departing 36C and 36R

While several called rate values are found in ASPM for a particular runway configuration, the most frequent called rate for each configuration is presented below. In addition to maximum counts, the 95^{th} percentile is also provided for 0700 - 2200 local time. For comparison purposes, the ACEP throughputs are also provided. The hourly throughput of the simulated single day is very similar to

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¹ Analysis of Aerobahn® data, May 2016

the ASPM hourly counts, especially for the 95th percentiles.

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Table 2-18 IMC Hourly Throughput Calibration by Operation Type

		ASPM ¹		Simu	ACEP ³		
Flow	Operations	Called Rate*	Maximum Operations*	95 th % Operations*	Maximum Operations	95 th % Operations	Peak Hour
South	Arrivals	75	77	68	74	66	65
	Departures	65	74	64	68	62	68
North	Arrivals	75	76	68	73	66	65
	Departures	65	79	66	68	61	65

The simulated hourly airport throughput for arrivals and departures combined is presented in

Table 2-19 for the 90th percentile.

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Table 2-19 IMC Hourly Throughput Calibration – Total Operations ASPM Simulation

Flow	90 th %	90 th %
South	112	114
North	114	116
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Note: Analysis of ASPM data, 2016-2017

All simulation outputs compared for the 2016 calibration are within 10 to 11 percent of the actual data analyzed from FAA ASPM and Aerobahn for all four runway configurations: South Flow VMC, North Flow VMC, South Flow IMC and North Flow IMC.

¹ Analysis of ASPM data, 2016-2017

² Simulation single day of 2016

ACEP Table 3-11 on page 3-34

Simulation Findings

3.1 Introduction

This section documents the findings of the airfield capacity/delay analysis for the Existing Conditions and future No-Action alternatives. This is followed by analysis of the simulation results for the current and anticipated demand for the Environmental Impact Statement (EIS) requirement for current and future conditions. The analysis years considered are the 2016 baseline year (Existing Conditions) for which a full year of data is available, 2028 when the project elements will be in place, and 2033, which is five years after the full implementation of the Project. This simulation estimates what the future would be like, without the proposed projects, and will ultimately serve as a comparison to the proposed project alternatives.

The primary simulation metrics used in an airfield capacity/delay analysis are the following.

- Airfield/Runway throughput: Hourly throughput reports the maximum number of arrivals and departures that use the runways in a given hour. Sustainable hourly capacity is the 90th percentile of the maximum hourly throughputs.
- Arrival airspace delay: Delay is measured as the difference in the amount of time an aircraft actually lands on the runway and the time it would have taken to land on the runway if it were able to move unimpeded through the airspace. The majority of the arrival delay occurs when aircraft must maintain separations and merge onto final approach.
- > Taxi times:
 - Arrival taxi-in time ("on-to-in") Taxi-in time measures the time from when the aircraft
 lands on the runway until it taxies into its gate or ramp. It includes runway landing roll time,
 airfield taxi time, and any taxiway or ramp delays.
 - Departure taxi-out time ("out-to-off") Taxi-out time measures the time from when the aircraft departs its gate or ramp until it leaves the runway. It includes the time for push-back from the gate, airfield taxi time, departure queue wait time, and runway takeoff roll time.
- Airfield delays: Taxi delay is measured as the difference between the time an aircraft taxis between the runway and gate compared to the time it would have taken if it were able to move unimpeded on its airfield taxiing path. Departure ground delay includes the time in departure queue awaiting clearance to take-off. (Note that this airfield delay measure is included in the taxi times above.)

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Ramp delays waiting for gates: Ramp delay measures the amount of time an aircraft waits on the airfield for its assigned gate to become available. This indicates that additional gates are required to meet the traffic demand being simulated. (Note that this ramp or gate waiting delay measure is included in the airfield delays above.)

3.2 Existing Conditions and Future No-Action Modeling Analysis

In South Flow operations, arrivals primarily land on Runways 18R and Runway 23, adhering to the Converging Runway Operations (CRO) procedures with the required Arrival-Departure Window (ADW) for departures on Runway 18C. During peak arrival times, more arrival capacity is needed than can actually be achieved during CRO, in this case the Charlotte Douglas International Airport (CLT) air traffic controllers move to an all-parallel runway configuration to achieve more efficiency. The Runway 23 arrivals then are assigned to other runways so that both arrivals and departures can be accommodated on Runway 18C. As the traffic demand grows in the forecast flight schedules, there are limited opportunities to arrive on Runway 23 since the three simultaneous runway procedures are needed more frequently throughout the day. Table 3-1 summarizes the average South Flow Visual Meteorological Conditions (VMC) airspace delays and taxi times for the current and future demands.

Table 3-1 **South Flow VMC Average Delay and Taxi Times (in minutes)**

	Arr	ival	Departure		
Year	Average Airspace Delay	Average Taxi-In Time	Average Ground Delay	Average Taxi-Out Time	
2016	2.2	10.3	4.5	13.6	
2028	3.3	12.8	4.5	13.4	
2033	4.5	15.4	5.4	14.8	

Source: TransSolutions, LLC; Simmod PLUS!

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The arrival airspace delay increases by 50 percent from 2016 to 2028 and doubles from 2016 to 2033, increasing from 2.2 minutes in 2016 to 4.5 minutes in 2033.

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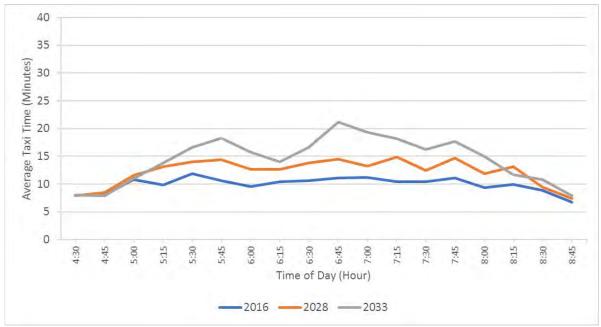
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Taxi times increase with higher demand from 2016 to 2033; average taxi-in time increases by 50 percent, while taxi-out time increases by 9 percent.

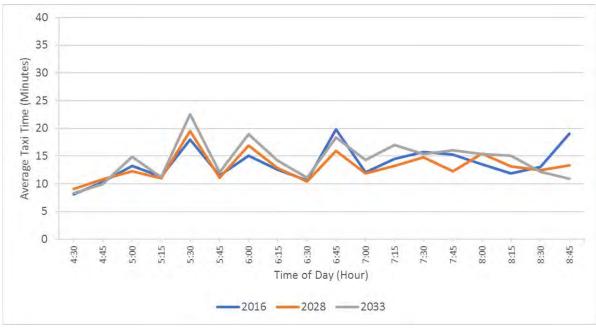
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Figure 3-1 illustrates the average taxi times in hourly increments for South Flow VMC.

Figure 3-1 South Flow VMC Hourly Average Taxi Times



Taxi-In



Taxi-Out

Source: TransSolutions, LLC; Simmod PLUS!

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3.2.1 **South Flow Instrument Meteorological Conditions (IMC)**

During Instrument Meteorological Conditions (IMC) operations, Runway 23 is not used in South Flow. Table 3-2 summarizes the average South Flow IMC airspace delays and taxi times for the current and future demands.

Table 3-2 **South Flow IMC Average Delay and Taxi Times (in minutes)**

	Arri	ival	Departure		
Year	Average Airspace Delay	Average Taxi-In Time	Average Ground Delay	Average Taxi-Out Time	
2016	4.3	12.4	8.3	17.7	
2028	7.3	15.2	8.6	17.9	
2033	12.6	15.4	13.1	23.4	

Source: TransSolutions, LLC; Simmod PLUS!

Arrival airspace delay is nearly three times higher in 2033 than in 2016. Average taxi-in time increases by 24 percent and average taxi-out time increases by nearly 32 percent from 2016 to 2033. The average departure ground delays increase 4 percent from 2016 to 2028, and another 52 percent from 2028 to 2033.

Figure 3-2 illustrates the average taxi times in hourly increments for South Flow IMC.

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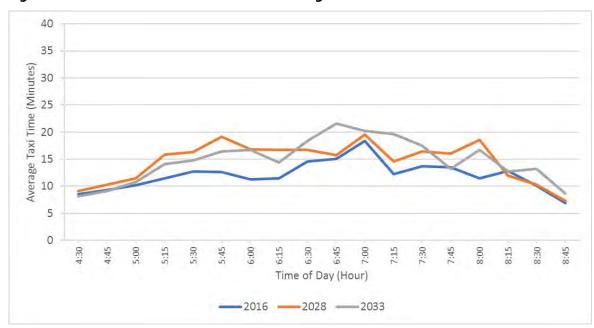
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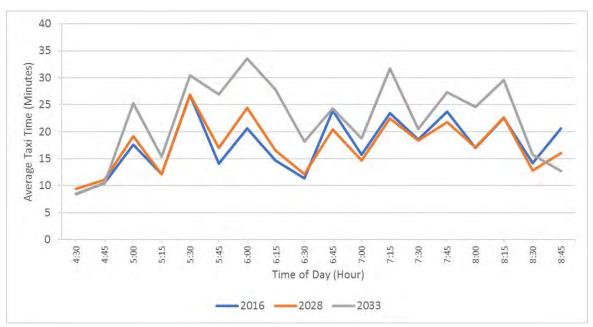
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Figure 3-2 South Flow IMC Quarter-Hour Average Taxi Times



Taxi-In



Taxi-Out

Source: TransSolutions, LLC; Simmod PLUS!

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3.2.2 **North Flow VMC**

In North Flow operations, the arrivals and departures use only the parallel runways so that Runway 5 is used as a taxiway. Often, departure aircraft taxi from their gates to Runway 36C on Runway 5. Table 3-3 summarizes the average North Flow VMC average air delay and taxi times for the current and future demands.

Table 3-3 North Flow VMC Average Delay and Taxi Times (in minutes)

	Arri	val	Departure		
Year	Average Airspace Delay	Average Taxi-In Time	Average Ground Delay	Average Taxi-Out Time	
2016	3.8	10.2	4.4	14.8	
2028	7.8	13.9	4.1	14.6	
2033	10.9	14.9	4.8	15.4	

Source: TransSolutions, LLC; Simmod PLUS!

In general, taxi-in times are similar to South Flow but taxi-out times are longer because the departure runway ends are further from the terminals. In North Flow VMC:

- Average airspace delays nearly double from 2016 to 2028 and nearly triple from 2016 to 2033.
- Average taxi-in time increases by 46 percent from 2016 to 2033.
- Average taxi-out time increases by 4 percent from 2016 to 2033.
- Average departure ground delays decreased by 7 percent from 2016 to 2028 as next generation (FAA NextGen) equipment is assumed to be in place by 2028, reducing the required departure separations. However, average departure ground delays increased by 17 percent from 2028 to 2033 due to the increase in traffic demand.

Figure 3-3 illustrates the average taxi times in hourly increments for North Flow VMC.

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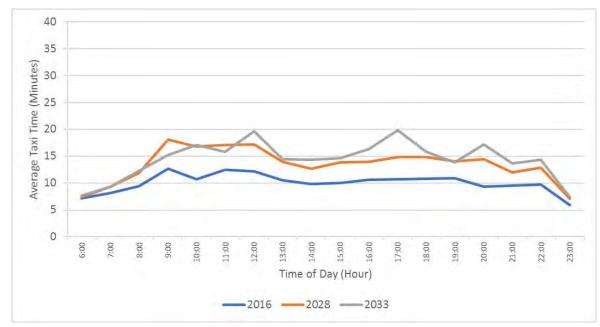
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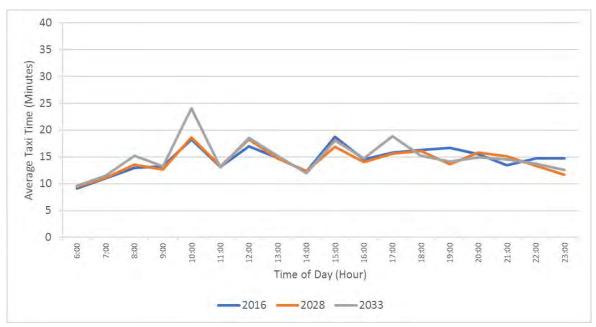
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Figure 3-3 North Flow VMC Hourly Average Taxi Times



Taxi-In



Taxi-Out

Source: TransSolutions, LLC; Simmod PLUS!

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3.2.3 **North Flow IMC**

North Flow IMC delay and taxi times are summarized in Table 3-4 for the current and future demands.

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Table 3-4 **North Flow IMC Average Delays and Taxi Times (in minutes)**

	Arr	ival	Departure		
Year	Average Airspace Delay	Average Taxi-In Time	Average Ground Delay	Average Taxi-Out Time	
2016	3.9	11.1	7.3	18.6	
2028	8.6	12.3	11.5	23.2	
2033	12.0	12.5	15.0	26.6	

Source: TransSolutions, LLC; Simmod PLUS!

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In North Flow IMC operations:

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Average airspace delay doubles from 2016 to 2028, and triples from 2016 to 2033.

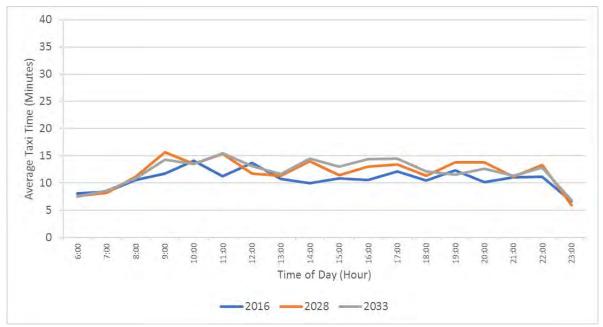
10 11 > Average departure ground delay doubles from 2016 to 2033.

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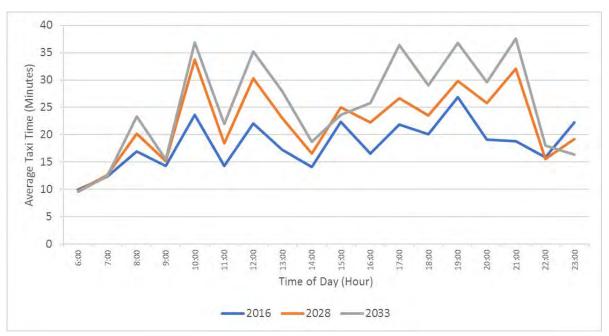
Average taxi-out time increases by 25 percent from 2016 to 2028, and by 43 percent from 2016 to 2033.

13 14 Figure 3-4 illustrates the average taxi times in hourly increments for North Flow IMC. Note that the y-scale of the graphs is increased to 40 minutes to display the quarter-hour average taxi-out times.

Figure 3-4 North Flow IMC Hourly Average Taxi Times



Taxi-In



Taxi-Out

Source: TransSolutions, LLC; Simmod PLUS!

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Hourly Airport Capacity (Peak Hour Throughput) 3.3

The simulation results were analyzed to obtain rolling hour airport throughput for individual days (iterations) in each wind/weather configuration. This analysis used the highest demand level (2033) in the simulation since it will likely have the highest throughput. The maximum hourly throughput is achievable under specific circumstances, but is not a good indication of the capacity that can be sustained for several hours. Thus the 90th percentile is often used as the measure of capacity. In Table 3-5, the hourly throughput for each wind/weather configuration is summarized by arrivals only, departures only and all operations, with 90th percentile calculated for 7:00 AM to 10:00 PM local time.

Table 3-5 **Airport Peak Hour Throughput**

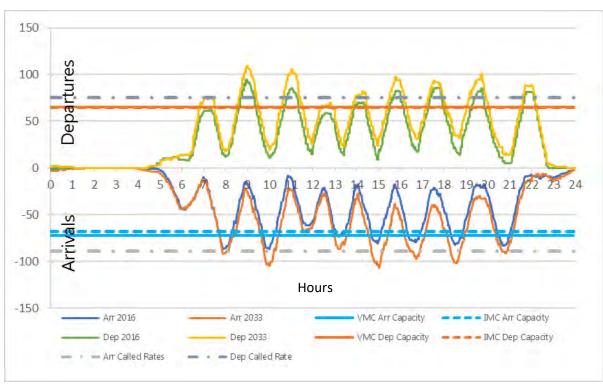
Flow /	Arri	Arrivals		Departures		Total Operations	
Weather	Maximum	Capacity	Maximum	Capacity	Maximum	Capacity	
South VMC	84	72	78	65	141	130	
South IMC	74	68	69	66	134	130	
North VMC	77	68	78	65	138	131	
North IMC	76	68	68	63	137	127	

Source: TransSolutions, LLC; Simmod PLUS!

- > In VMC, the simulated overall capacity is approximately 130 operations, with 130 operations in South Flow and 131 in North Flow.
- > In IMC, the simulated overall capacity is 126-130 operations.

These hourly capacity estimates are depicted with the rolling-hour flight schedule in Figure 3-5 below. Both arrival and departure capacity is already exceeded during peak departure times; by 2033, the capacity will be exceeded during most of the airline banks.

1 Figure 3-5 Rolling Hour Flight Schedule



Source: TransSolutions, LLC

3.4 Arrival Gate and Ramp Delays

The simulations in this analysis were run with the gate expansions currently under construction incorporated, including an additional pier at Concourse A and a few more parking positions for American Eagle. With all the domestic non-American flights parking at Concourse A, these airlines were allowed to park at any Concourse A gate.

While the simulations ran without any additional gates, more aircraft wait for an available gate as the traffic demand increases from 2016 through 2033. **Table 3-6** summarizes the number of flights and amount of time spent waiting for an open gate after landing for each simulated scenario.

Table 3-6 Arrival Aircraft Waiting on Ramp for an Available Gate

Operational Configuration	Year	95 th Percentile Waiting Time for a Gate (minutes)	Total Time Waiting for a Gate Each Day (minutes)	Average Number of Daily Flights that Wait for Gate
South Flow	2016	5.9	470.1	327
VMC	2028	8.0	1093.1	453
	2033	12.7	1862.7	519
South Flow	2016	6.1	424.6	239
IMC	2028	5.4	1095.1	472
	2033	6.7	1202.7	582
North Flow	2016	6.0	636.1	292
VMC	2028	6.4	940.8	453
	2033	5.4	1423.6	562
North Flow	2016	5.6	577.9	260
IMC	2028	6.2	993.6	434
	2033	6.2	1423.7	517

Source: TransSolutions, LLC; Simmod PLUS!

Note that with aircraft arriving on Runway 23 in South Flow, the gate waiting time increases significantly, compared to all other scenarios with only the parallel runways in use. The arrival runway throughput is higher when Runway 23 is used so that more arrivals get to the ramp and must wait for a gate.

With the current number of gates, there is not enough ramp space for the arrival flights to wait for an open gate. If the ramp is full of aircraft waiting for a gate, additional arriving flights will wait on the taxiways and may back-up to the runways, indicating that ramp capacity is being exceeded.

Summary of Simulated Results 3.5

The results from all simulation scenarios are analyzed together to provide a summary of the overall CLT operations. Figure 3-6 illustrates the average taxi times for all operational scenarios. While taxi-in times increase rather steadily from 2016 to 2033, the most notable increase occurs from 2028 to 2033 in south VMC. In general, taxi-out times increase faster from 2028 to 2033 compared with the increase from 2016 to 2028.

Annualized average times are calculated to succinctly analyze the delays and taxi times for each demand level. The FAA Aviation System Performance Metrics (ASPM) data was analyzed for 14 years, 2003 through 2017. The data excludes the hours when only the crosswind Runway 5-23 is used, North Flow is used for 44 percent of the operations and South Flow for 56 percent of the operations. IMC is used during approximately 21 percent of the operations, almost equally split between North and South Flow. Table 3-7 summarizes the percentage of the operations, 2003 through 2017, that occurred in each particular configuration (excluding the time when only the crosswind Runway 5-23 is used).

Table 3-7 **Annual Use of Runway Configurations**

Flow	Weather	Percent of Operations 19
North	IMC	10.7%
	VMC	33.3%
South	IMC	10.4%
	VMC	45.7%

Source: ASPM, analyzed by TransSolutions

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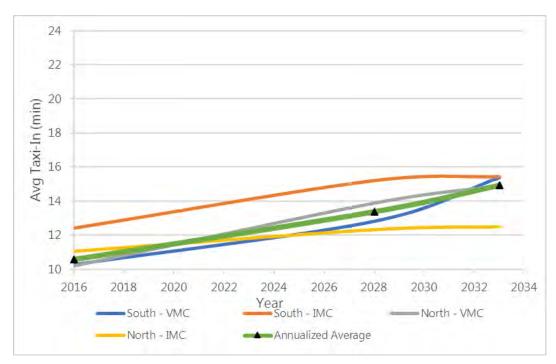
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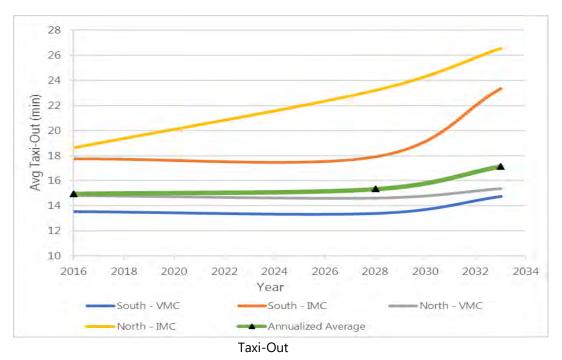
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¹⁹ Note that ACEP included configuration use for 2013 only, resulting in slightly different percentage use.

Figure 3-6 Average Taxi Times



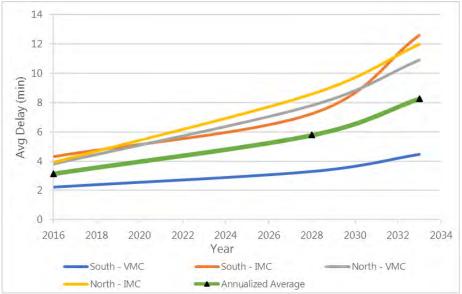
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Source: TransSolutions, LLC; Simmod PLUS!

Figure 3-7 illustrates the average airspace delays for all operational scenarios. The lowest airspace delays are experienced in South Flow VMC. Similar to the taxi-out times, the arrival airspace delays increase faster from 2028 to 2033 compared with the delays increase from 2016 to 2028.

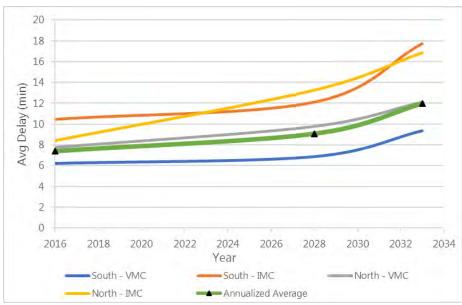
Figure 3-7 Average Airspace Delays



Source: TransSolutions, LLC; Simmod PLUS!

The average delay per operation is illustrated in Figure 3-8 for each operational scenario modeled.

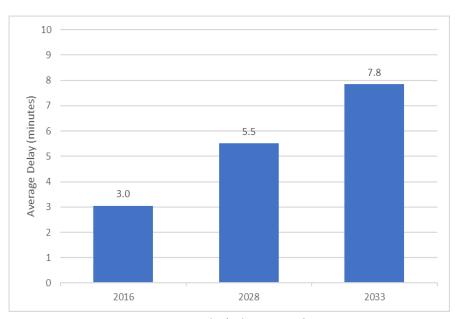
Figure 3-8 Average Delay per Operation (in minutes)



Source: TransSolutions, LLC; Simmod PLUS!

Applying the annual use of each runway configuration, a weighted average is calculated for the arrival airspace delays and for the overall taxi delays, as depicted in **Figure 3-9**.

Figure 3-9 Annualized Average Airspace and Ground Delays



Average Arrival Airspace Delay

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Average Taxi Delays

Source: TransSolutions, LLC; Simmod PLUS!

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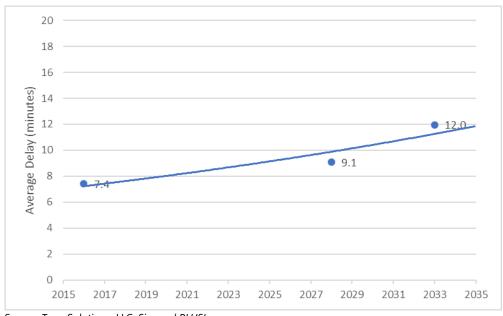
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The annualized average delays per operation, depicted in **Figure 3-10**, increase over 60 percent from 2016 to 2033.

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Figure 3-10 Annualized Average Delay per Operation (in minutes)



Source: TransSolutions, LLC; Simmod PLUS!

These average delays per operation result in the following daily total delays for the average day peak month:

- > 2016 1,582 operations with a total of 11,725 minutes of delay per day.
- > 2028 1,857 operations with a total of 16,854 minutes of delay per day.
- > 2033 1,968 operations with a total of 23,529 minutes of delay per day.

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Conclusions

Based on the Existing Conditions and future No-Action simulation analyses and findings detailed in this Technical Memorandum, the following conclusions can be made:

- > Hourly capacity of the airfield system is regularly exceeded by the arrival and departure demand of the airline hub banking periods.
- During Visual Meteorological Conditions (VMC), taxi-in times (including ramp delays due to aircraft waiting for a gate) increase more rapidly than in Instrument Meteorological Conditions (IMC), since arrival runway operations exceed gate/ramp capacity, which in turn cause more ramp congestion.
- Imbalance of arrival runway capacity and aircraft gate capacity, particularly during the predominant operational configuration of the airport (South flow VMC), results in high taxi-in delays (due to aircraft waiting on the ramp for a gate).

Based on the modeling results and other information, the Consultant Team will develop a Purpose & Need Technical Report. The Technical Report will compare the capacity (annual and hourly) of the airfield system at Charlotte Douglas International Airport (CLT) with existing and forecast demand, and will also describe the delay analysis results in the context of the National Environmental Policy Act (NEPA) requirements for Purpose & Need.

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Proposed Capacity Enhancements at Charlotte Douglas International Airport

National Environmental Policy Act Environmental Assessment

AirTOp Simulation Report

August 2021

PREPARED FOR
Charlotte Douglas International
Airport

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1 Introduction

Charlotte Douglas International Airport (CLT or Airport) is the sixth busiest airport in the US in terms of aircraft operations and the tenth busiest in terms of passenger enplanements, making it an integral part of the National Airspace System (NAS). CLT is the second busiest hub operation for American Airlines. In 2016, the airline connected approximately 58,000 passengers per day through CLT on a normal day; 67,000 passengers on a typical busy day, and even more during peak travel days. Given this level of connecting passengers, American Airlines (AA) personnel have indicated that schedule reliability is critical to maintaining minimum connection times for passengers that range from 25 to 35 minutes.

The City of Charlotte (Sponsor) completed an Airport Capacity Enhancement Program (ACEP) and Master Plan Update in February 2016. The ACEP utilized a comprehensive approach to understand the demand for and capacity of runways, taxiways, aircraft gates, ramp, and passenger processing facilities. The ACEP identified a number of deficiencies that exist at CLT. These included insufficient runway capacity, gate capacity, and ramp space to accommodate the existing and future demand. The Sponsor is now undertaking an Environmental Assessment (EA) that analyzes proposed solutions for those deficiencies.

As part of the EA, a simulation modeling analysis has been conducted to simulate the existing and future airfield and airspace improvements at the Airport. The simulation was conducted using the Air Traffic Optimization (AirTOp) model, a rule-based, fast-time simulation tool. AirTOp computes aircraft travel times and delay statistics which are used as evaluation metrics to determine differences between various simulated alternatives.

The simulation modeling began with an analysis of CLT for the base year of 2016. The EA has a base year of 2016 because this was the latest calendar year with a full year of available data when the National Environmental Policy Act (NEPA) process began.

The simulation analysis involved the following steps and is described in the sections that follow:

- Develop design day flight schedules
- Define 2016 existing conditions and modeling assumptions
- Calibrate model to actual 2016 results
- Model 2019 Baseline experiments
- Model No Action experiments
- Model Airfield Alternatives experiments

1.1 Direction, Oversight, Review, and Agreement (DORA) Process

The EA utilized the DORA process to obtain the necessary operational input from stakeholders and the Federal Aviation Administration (FAA). The DORA Work Group was comprised of representatives from the FAA, CLT Airport, airlines, and consultants. The meetings provided FAA controller input on air traffic control operations and the viability of proposed alternatives, which were crucial components of analyzing and screening the airfield alternatives. The airlines, as users of the airport's infrastructure, were active in providing their operational perspectives, including linkages to network hub operations

²⁰¹⁷ Airports Council International-North America Traffic Report

Purpose and Need Working Paper, Charlotte Douglas International Airport, Environmental Impact Statement, prepared by VHB Engineering NC, P.C. in association with Parish and Partners, Inc. and TransSolutions, July 31, 2018.

and ramp control. FAA provided their perspective and expectations regarding data and simulation analysis, as well as unique knowledge about the efficacy of ways to enhance operational efficiency. Four meetings during the EA were conducted with the stakeholder group, which builds on prior DORA coordination conducted during the Environmental Impact Statement (EIS) and ACEP.

This process has ensured that the appropriate operational expertise and experience has informed the design, analysis and decision-making for the CLT EA effort.

2 Design Day Flight Schedules

The first step in building the simulation models was to select the design day flight schedule. The schedule for the calibration year of 2016 and future years of 2028 and 2033 were developed by VHB and InterVISTAS as part of the CLT EIS.³ Subsequent to the creation of those schedules, Runway 23 ceased being a primary arrival runway during South Flow operations. To ensure that the models accurately reflect airport operations without the use of Runway 23, a 2019 Baseline demand level was added to the simulation study.

The schedule for the Baseline year of 2019 was developed by Landrum & Brown using the Average Busy Weekday, Peak Month methodology. This methodology was used in the previous ACEP study. Weekends were excluded from the selection process due to the low number of operations compared to weekdays. The selected design day would also have to meet the following criteria:

- South flow runway configuration (all day)
- Visual Meteorological Conditions weather conditions (all day)
- No runway closures or other anomalies in the normal daily operation

Based on the FAA Aviation System Performance Metrics (ASPM) database, October was the peak month of operations for 2019. However, no suitable day in October met all of the selection criteria. May was the second busiest month for 2019. Applying the criteria above, May 30, 2019, with 1,628 daily operations was the nearest demand level to the average busy weekday for May (1,638 daily ops) so May 30, 2019 was chosen as the 2019 design day.

The operation levels of the four demand schedules are compared in Table 2-1.

Table 2-1, Total Daily Operations

YEAR	DAILY OPERATIONS
2016	1,563
2019	1,628
2028	1,860
2033	1,978

Source: Landrum & Brown analysis, 2021

The rolling hour arrival and departure demand for each schedule is shown on **Exhibit 2-1**. CLT has a typical hub airline schedule, with distinct arrival and departure banks throughout the day. The 2016 schedule exceeds 80 arrivals in five hours of the day and is at or above 80 departures in six hours of the day. The peak arrival period at the Airport occurs in the 10:00 a.m. hour. From 2016 to 2033, peak hour arrival demand increases from 88 to 104 operations. The peak departure period at the Airport occurs in the 09:00 a.m. hour. From 2016 to 2033, demand increases from 93 to 110 operations in the peak departure period.

Forecast Technical Memorandum, Charlotte Douglas International Airport Environmental Impact Statement, VHB in association with InterVISTAS, November 10, 2017

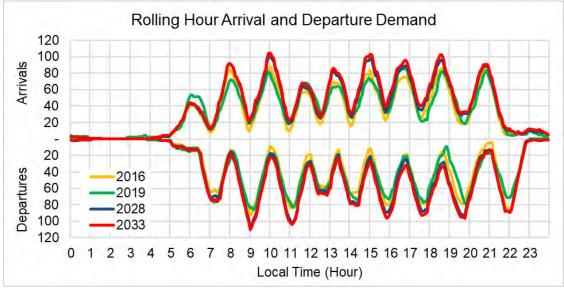


Exhibit 2-1, Rolling Hour Arrival and Departure Profiles

Source: Landrum & Brown analysis, 2020

Table 2-2 and **Table 2-3** provides a summary of the aircraft fleet mix by flight type and FAA Airplane Design Group (ADG). The tables summarize the number of aircraft by group and as a percentage of total operations.

Table 2-2, Fleet Mix by Flight Type

Flight 2016		2019		2028		2033		
Type	Number of Ops	% of Total Ops	Number of Ops	% of Total Ops	Number of Ops	% of Total Ops	Number of Ops	% of Total Ops
Passenger	1470	94%	1506	93%	1760	95%	1874	95%
General Aviation	81	5%	108	7%	84	5%	86	4%
Cargo	10	1%	14	1%	14	1%	16	1%
Military	2	0%	0	0%	2	0%	2	0%
Total	1563	100%	1628	100%	1860	100%	1978	100%

Source: Landrum & Brown analysis, 2020

Table 2-3, Fleet Mix by Design Group

	20)16	2019 2028		2033			
FAA ADG	Number of Ops	% of Total Ops	Number of Ops	% of Total Ops	Number of Ops	% of Total Ops	Number of Ops	% of Total Ops
I	19	1%	16	1%	20	1%	21	1%
II	372	24%	474	29%	494	27%	495	25%
Ш	1139	73%	1102	68%	1309	70%	1421	72%
IV	14	1%	16	1%	16	1%	18	1%
V	19	1%	20	1%	21	1%	23	1%
Total	1563	100%	1628	100%	1860	100%	1978	100%

Source: Landrum & Brown analysis, 2020

2.1 Flight Dependability

A probability distribution is applied to flight times in the simulation models to mimic variation in flight arrival/departure times. Flights that arrive or depart early are indicated by negative values, while flights that arrive or depart late are indicated by positive values.

The distributions, shown in **Exhibit 2-2**, are based on data analyzed from Aerobahn.⁴ Arrivals tend to have more variability than departures and are more likely to be early.

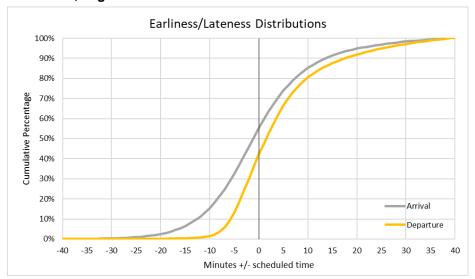


Exhibit 2-2, Flight Earliness/Lateness Distributions

Source:

Aerobahn May 2016- Apr 2017, Landrum & Brown analysis, 2020

3 2016 Airport Operating Assumptions

The first objective of this simulation analysis was to develop an AirTOp simulation model that is an appropriate representation of the actual operations at CLT. Once it has been confirmed that the simulation model reflects existing operating conditions, the model can be adjusted using various control parameters and demand levels to evaluate changes in the operation. This chapter describes the assumptions that were used to develop and calibrate the AirTOp models.

3.1 Airfield and Aircraft Apron Layouts

CLT has three parallel runways oriented in the 18/36 direction and one crosswind runway oriented in the 5/23 direction. **Exhibit 3-1** depicts the airfield as it existed in 2016. The 2016 apron areas for the passenger airlines, cargo carriers (FedEx and UPS), general aviation, and military aircraft are shown on **Exhibit 3-2**. The passenger airlines park at Concourses A through E, which are located on the north side of the Airport between Runway 18C/36C and Runway 18L/36R. The passenger airline gating assignments are shown in **Table 3-1**. The table also summarizes the number of gates in each concourse. The count is based on the number of regional and narrowbody gates. For Multiple Apron Ramp System (MARS) gates, which accommodate one widebody or two narrowbody aircraft, only the narrowbody gates are counted to avoid double counting. The cargo facilities are located to the south of the passenger terminal and Runway 5/23. The general aviation and Air National Guard aprons are located to the east of Runway 18L/36R.

⁴ Aerobahn® tracks and reports aircraft ground movements to provide a comprehensive view of airport surface operations.

^{4 |} Landrum & Brown

Exhibit 3-1, 2016 CLT Airfield



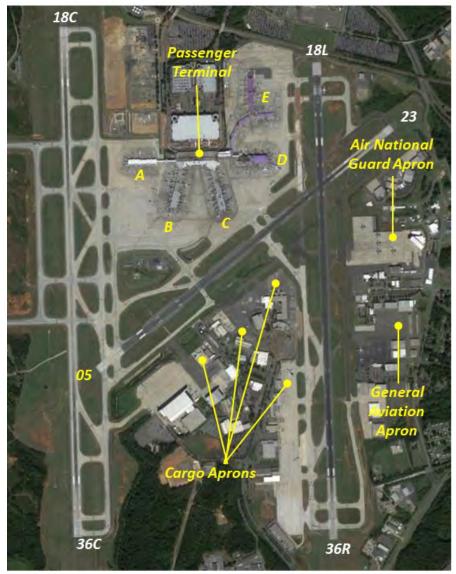
Source: ESRI ArcMap aerial imagery

Table 3-1, 2016 Airline Gating Assignment Assumptions

Concourse	Airline	Number of Gates
Α	American, Air Canada, JetBlue, Delta, Frontier, United, Southwest	13
В	American Mainline	16
С	American Mainline	18
D	American Mainline, Lufthansa	13
E	American Regional	44

Source: CLT airport and Landrum & Brown analysis, 2020

Exhibit 3-2, 2016 CLT Aircraft Parking Aprons



Source: ESRI ArcMap aerial imagery

3.2 Airfield Hold Pad Usage

CLT has one hold pad that is used to accommodate arrivals waiting for an available gate, remain overnight (RON) operations, towed aircraft, and departures waiting for a spot in the queue. This hold pad is located south of Concourse A and west of Concourse B as shown on **Exhibit 3-3**.

Exhibit 3-3, 2016 Airfield Hold Pad



Source: ESRI ArcMap aerial imagery

3.3 Runway Operating Configurations

Runway use at an airport is typically dictated by the origin/destination city, wind direction, and weather conditions. Runway use changes as demand for flights arriving from specific standard terminal arrival routes (STAR) or departing to standard instrument departure (SID) routes changes. The four primary (most often used) runway operating configurations at CLT were modeled for the EA:

- North Flow Visual Meteorological Conditions (VMC)
- North Flow Instrument Meteorological Conditions (IMC)
- South Flow VMC
- South Flow IMC

3.3.1 North Flow VMC and IMC Operating Configurations

The basic runway usage in a North Flow configuration (VMC and IMC) consists of arrivals on Runways 36L and 36R. Runway 36C is used in conjunction with Runways 36L and 36R to provide triple parallel approach capability during periods of high arrival demand. The primary departure runways are Runways 36C and 36R in both VMC and IMC. The allocation of departing aircraft to these runways is based on the destination of the flight. Runway 36C is used by aircraft departing to northbound and westbound destinations. Runway 36C is also used by international heavy aircraft heading east. Runway 36R is used by southbound and eastbound departures. **Exhibit 3-4** depicts the North Flow runway usage. There is a single jet departure heading in North Flow (no fanning permitted). However, prop aircraft can turn immediately after becoming airborne.

Exhibit 3-4, 2016 North Flow VMC/IMC Runway Configuration



Source: ESRI ArcMap aerial imagery; Landrum & Brown, 2020

3.3.2 South Flow VMC and IMC Operating Configurations

The basic runway usage in a South Flow VMC configuration consists of arrivals on Runways 23 and 18R, with Runway 18L used in lieu of Runway 23 during peak departure times⁵. In IMC, Runways 18L and 18R are used for arrivals; Runway 23 is used as a taxiway, not a runway in South Flow IMC. Runway 18C is used in conjunction with Runways 18L and 18R to provide triple parallel approach capability during periods of high arrival demand. The primary departure runways are Runways 18C and 18L in both VMC and IMC. The allocation of departing aircraft to these runways is based on the destination of the flight. Runway 18C is used by aircraft departing to northbound and westbound destinations. Runway 18C is also used by international heavy aircraft heading east. Runway 18L is used by southbound and eastbound departures. **Exhibit 3-5** depicts the South Flow runway usage.

Runway 182-362

36C

36R

36R

Exhibit 3-5, 2016 South Flow VMC/IMC Runway Configuration

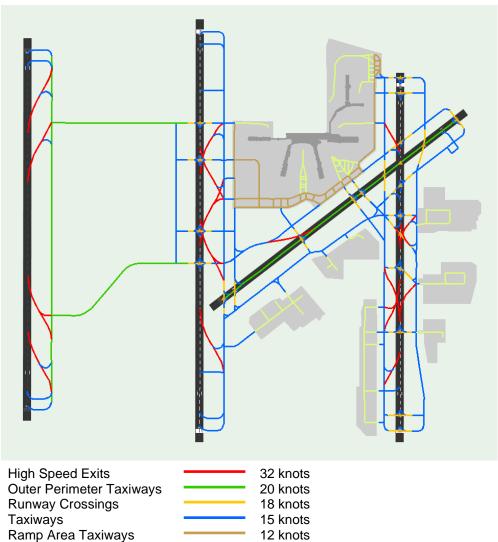
Source: ESRI ArcMap aerial imagery; Landrum & Brown, 2020

This was the standard arrival configuration in 2016. Since that time, Runway 23 is no longer a primary arrival runway.

3.4 Airfield Ground Speeds

For accurate simulation, the aircraft taxi speeds within the AirTOp model should replicate the actual taxi speeds at the Airport. **Exhibit 3-6** shows the average taxi speeds used in the model.

Exhibit 3-6, 2016 Airfield Ground Speed Assumptions



10 knots

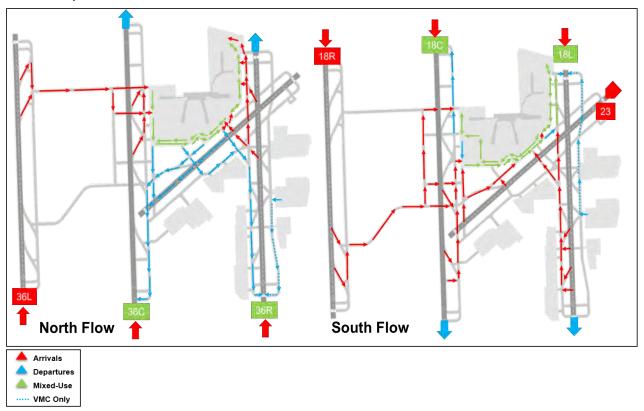
Source: ACEP, EIS, and Landrum & Brown analysis, 2020

Ramp Area Taxilanes

3.5 Airfield Taxi Flows

For accurate simulation, the aircraft movements within the AirTOp model should replicate the actual taxi flows at the Airport. The standard taxi routes are shown on **Exhibit 3-7.**

Exhibit 3-7, 2016 Taxi Routes



Source: Tower observations and ATCT feedback

3.6 Aircraft Separations

It is important to reflect the actual aircraft-to-aircraft separations in the AirTOp model because these separations have a large effect on the operating capacity of the Airport. The aircraft separation data, which is measured as the space between consecutive aircraft operations, is presented in terms of distance (nautical miles) for arrivals and in terms of time (seconds) for departures. **Table 3-2** presents the simulated minimum VMC and IMC in-trail separation distances for arrivals based on actual radar data. **Table 3-3** presents the simulated minimum VMC and IMC in-trail separation times for departures based on actual radar data from January 2013 to December 2013.

Table 3-2, Simulated Arrival In-trail Separations

Aircraft	In-trail Separations (in nautical miles)						
Category	Upper Heavy (A332, B777)	Lower Heavy (B763)	Upper Medium (A320, E190)	Lower Medium (AT72, CRJ9)	Small (GA Prop)		
Upper Heavy	3.3/3.81	4.3	5.3	5.3	7.3		
Lower Heavy	$3.3/3.8^{1}$	$3.3/3.8^{1}$	3.8	3.8	6.3		
Upper Medium	$3.3/3.8^{1}$	$3.3/3.8^{1}$	$3.3/3.8^{1}$	$3.3/3.8^{1}$	4.3		
Lower Medium	$3.3/3.8^{1}$	$3.3/3.8^{1}$	$3.3/3.8^{1}$	$3.3/3.8^{1}$	$3.3/3.8^{1}$		
Small	$3.3/3.8^{1}$	$3.3/3.8^{1}$	$3.3/3.8^{1}$	$3.3/3.8^{1}$	$3.3/3.8^{1}$		

VMC/IMC in-trail separations

Notes: 1. Arrival separations include a 0.3 nautical mile buffer. 2. Lead-to-trail arrival separation compression on final

approach allows for minimum separation below 3.3/3.8 nautical miles.

Source: ACEP; Landrum & Brown analysis, 2020

Table 3-3, Simulated Departure In-trail Separations

Aircraft	In-trail Separations (in seconds)						
Category	Upper Heavy (A332, B777)	Lower Heavy (B763)	Upper Medium (A320, E190)	Lower Medium (AT72, CRJ9)	Small (GA Prop)		
Upper Heavy	90	120	120	120	120		
Lower Heavy	90	90	90	120	120		
Upper Medium	60/72 ¹	60/72 ¹	60/72 ¹	60/72 ¹	60/72 ¹		
Lower Medium	60/72 ¹	60/72 ¹	60/72 ¹	60/72 ¹	60/72 ¹		
Small	60/72 ¹	60/72 ¹	60/72 ¹	60/72 ¹	60/72 ¹		

VMC/IMC in-trail separations

Source: ACEP; Landrum & Brown analysis, 2020

In addition to the above separations, the following in-trail separations were applied for CLT:

- Six nautical mile in-trail separations were applied at the arrival corner post fixes for transition from the center airspace to the terminal environment.
- During mixed arrival/departure operations:
 - Arrivals block departures 2.3 nautical miles from the runway threshold.
 - On the east runway, a minimum of 4.5 nautical miles arrival in-trail separation is maintained to ensure one departure between every arrival.
 - On the center runway, a minimum of 8.0 nautical miles arrival in-trail separation is maintained to allow for one departure and runway crossings between every arrival.

Vertical separation between aircraft on approaches to parallel runways is also important until the aircraft are established on the approach. Parallel approaches were assumed to be vertically separated by 1,000 feet when turning onto final approach.

3.7 Airspace Structure

The airspace route structure is a key part of the simulation model development. The CLT Metroplex terminal airspace was simulated in the AirTOp model, which represents an approximate 40-mile radius around the Airport. To create the simulation model's airspace structure, January 2015 to April 2017 Aerobahn data was analyzed and used to determine origin and destination city pair airspace fix assignments for input into the simulation flight schedule. May 2019 area navigation (RNAV) arrival and departure procedures were analyzed and used as the basis for constructing the simulation airspace.

3.7.1 Arrival Airspace

Table 3-4 provides a summary of the arrival routes and sample origin airports they serve.

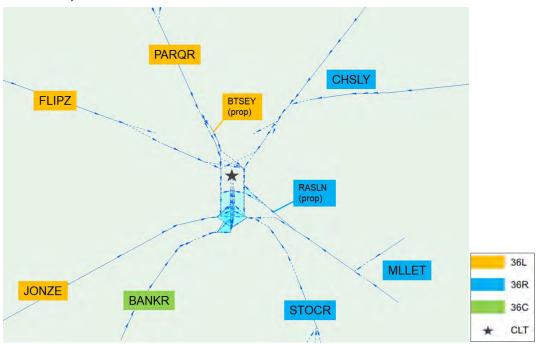
Table 3-4, Sample Origins by Arrival Routing

Arrival Route	Origin Direction	Origin Examples
PARQR	North	Midway and O'Hare (Chicago), Cleveland, Minneapolis, Seattle
CHSLY	East	Boston, Newark, New York City, Frankfurt, London Heathrow
MLLET	East	Coastal Carolina Regional, Ellis (Jacksonville NC), Florence SC
STOCR	South	Palm Beach, Southwest Florida, Fort Lauderdale
BANKR	South	Jacksonville, Miami
JONZE	West	Atlanta, Houston, Mexico City
FLIPZ	West	Denver, Dallas, Los Angeles, Phoenix, San Francisco

Note: Origin examples listing is not all-inclusive. EIS and Landrum & Brown analysis, 2020 Source:

Exhibit 3-8 and Exhibit 3-9 depict the arrival route structure for both North and South Flows. The exhibit shows the primary allocation of the arrival routes to an arrival runway. The routes that primarily feed Runway 18R/36L are shown in orange, Runway 18L/36R and Runway 23 routes are shown in blue, and the Runway 18C/36C routes are shown in green. While the primary route-runway allocations are depicted on the exhibit, arrivals were offloaded to a different runway than is shown as needed based on demand. For example, triple simultaneous approaches were simulated during various peak arrival pushes throughout the day. During these times, Runway 18C/36C served as the mixed-use offload runway.

Exhibit 3-8, 2016 North Flow Simulation Arrival Route Structure



Note: Arrivals can be offloaded to runways other than those shown on exhibit during busy periods.

Source: FAA terminal procedures

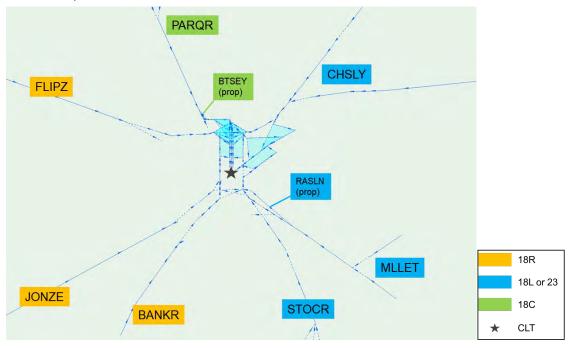


Exhibit 3-9, 2016 South Flow Simulation Arrival Route Structure

Note: Arrivals can be offloaded to runways other than those shown on exhibit during busy periods.

Source: FAA terminal procedures

3.7.2 Departure Airspace

Table 3-5 provides a summary of the departure routes and sample destination airports they serve.

Table 3-5, Sample Destinations by Departure Routing

Departure Route	Destination Direction	Destination Examples
JOJJO	North	Midway and O'Hare (Chicago), Portland, Seattle
WEAZL	North	Minneapolis, Cleveland, Detroit
KRITR	North	Buffalo, Pittsburgh, Toronto
KILNS	East	Baltimore, Dulles (Washington DC), Newark, Philadelphia
BARMY	East	Boston, Frankfurt, LaGuardia (New York City)
LILLS	East	Raleigh-Durham, Ellis (Jacksonville NC)
KWEEN	South	Myrtle Beach, Charleston
ICONS	South	Jacksonville, Miami
BEAVY	South	Cancun, Tallahassee
ESTRR	West	Austin, Dallas, Houston, Mexico City
BOBYZ	West	Denver, Dallas, Los Angeles, Phoenix, San Francisco

Note: Destination examples listing is not all-inclusive. Source: EIS and Landrum & Brown analysis, 2020

Exhibit 3-10 and **Exhibit 3-11** depict the departure route structure for both North and South Flows. The exhibit shows the primary allocation of the departure routes to a departure runway. The routes that primarily use Runway 18L/36R are shown in blue, whereas the routes that primarily use Runway 18C/36C are shown in green. In addition to the routings shown, BEAVY, ICONS, and KWEEN departures were allowed to offload to Runway 36C in North Flow. In South Flow, KRITR departures were offloaded to Runway 18L during busy periods.

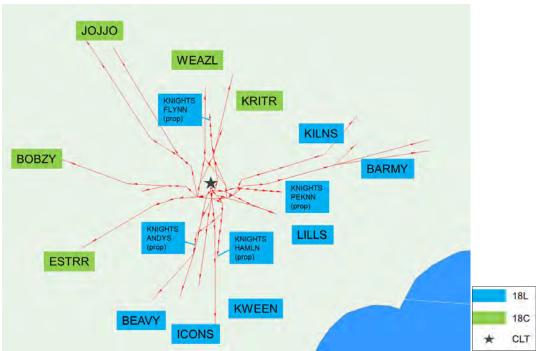
JOJJO WEAZL KRITR **KILNS** BARMY **BOBZY** KNIGHTS ANDYS (prop) LILLS KNIGHTS HAMLN (prop) **ESTRR** 36R **KWEEN** 36C **BEAVY ICONS** CLT

Exhibit 3-10, 2016 North Flow Simulation Departure Route Structure

Note: BEAVY, ICONS, and KWEEN departures can be offloaded to Runway 36C during busy periods.

Source: FAA terminal procedures

Exhibit 3-11, 2016 South Flow Simulation Departure Route Structure



Note: KRITR departures can be offloaded to Runway 18L during busy periods.

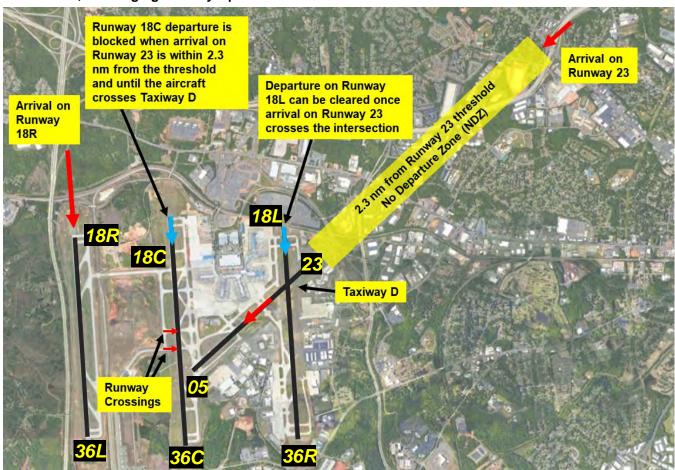
Source: FAA terminal procedures

3.7.3 Converging Runway Operation (CRO) with Arrival Departure Window (ADW)

Runway 5/23 intersects Runway 18L/36R and its flight paths intersect with Runway 18C/36C and Runway 18R/36L. As a result, operations on these runways must be coordinated when Runway 23 is being used for arrivals, as shown on **Exhibit 3-12**. This coordination involves:

- Arrivals on Runway 23 block departures on Runway 18C/36C and Runway 18L/36R when the arrival is 2.3 nautical miles or less from the Runway 23 threshold.
- Runway 18L departure cannot take off until Runway 23 arrival crosses the Runway 18L/36R intersection.
- Runway 18C cannot take off until Runway 23 arrival crosses Taxiway D.

Exhibit 3-12, Converging Runway Operation with ADW



Source: Landrum & Brown, 2020

4 Simulation Model Calibration

Calibration of a simulation model is an important step in any airside simulation analysis. The calibration process ensures that the model accurately reflects airport operations under different conditions. The ability of the model to simulate actual conditions is significant because the resulting statistics are used to assess operational performance and to determine the need for airside improvements and additional facilities. The AirTOp calibration is an update of the CLT EIS calibration, which analyzed the 2016 conditions using the SIMMOD simulation model.

Each simulation was run a minimum of ten iterations. Each of the iterations is intended to produce differing results. Probability distributions were input into the simulation model to produce random variations within the simulation so that no iteration is identical. The results of the calibration analysis presented in this chapter are based on the average of ten simulation iterations.

The following metrics were calibrated for CLT:

- Throughput rates
- Average total taxi times

4.1 Throughput Rates

A key metric in the calibration analysis is throughput rates. Throughput rates were calibrated to 2016-2017 FAA Aviation System Performance Metrics (ASPM) data or CLT's Aerobahn system data. The throughput rates were also compared to the EIS calibration effort to ensure consistency in the results.

The 90th percentile throughput was used as a measure of sustained, repeatable capacity in the calibration analysis. The maximum throughput was not used because it is not considered a reliable measure of sustained, repeatable capacity, based on FAA input and the DORA stakeholder group recommendations from the ACEP study and the first EA DORA meeting.

The simulated total operations throughput for the four calibration cases (North Flow VMC, North Flow IMC, South Flow VMC, and South Flow IMC) is compared to ASPM data and the EIS results in **Table 4-1**.

Table 4-1, Calibration Total Operations Throughput Comparison

Case	90 th	90 th Percentile Airport Throughput			
Case	ASPM	EIS	AirTOp		
North VMC	121	118	117		
North IMC	114	116	114		
South VMC	121	121	117		
South IMC	112	116	115		

Sources: Capacity/Delay Analysis and Airfield Modeling Technical Memorandum, CLT EIS; ASPM data, 2016-2017; Landrum & Brown analysis, 2020

The simulated 90th percentile throughputs are within 10 percent of the ASPM rates and the EIS simulation results. The simulation schedule has less variation than actual operations over the 2016-2017 period. Lower variation leads to fewer instances of overlapping arrival and departure peaks, which results in a lower total operations peak for the simulated throughput versus the 2016-2017 actual data. The Airport is more stressed by demand in IMC as compared to VMC. This difference occurs because the separations required between aircraft are higher in IMC than in VMC. As a result, there are less pronounced peaks in IMC than in VMC.

The simulated arrival and departure throughputs are compared to the ASPM data and the EIS results for the maximum rates and the 90th percentile rates in **Table 4-2**. The simulated arrival and departure hourly throughputs match closely with ASPM and the EIS simulation results. The FAA's Capacity Airport Rates (called rates) are also shown; the arrival called rates are much higher than actual hourly counts, so they are not considered a reliable indication of actual throughput.

Table 4-2, Calibration Arrival and Departure Throughput Comparison

		Arrival and Departure Throughput						
Case	Type of Operation	ASPM Called Rate ¹	ASPM Max	ASPM 90 th	EIS Max ²	AirTOp Max	AirTOp 90 th	
North VMC	Arrival	92	79	63	73	76	67	
NOITH VIVIC	Departure	69	82	67	78	82	63	
North IMC	Arrival	75	76	64	73	72	64	
NOTHI INC	Departure	65	79	62	68	78	59	
South	Arrival	92	78	63	77	77	68	
VMC	Departure	82	81	66	78	83	64	
South IMC	Arrival	75	77	64	74	77	66	
30utii iwc	Departure	65	74	58	68	79	61	

A variety of called rates were found in ASPM for each particular runway configuration; the most frequent called rate is shown in the table.

Source: Capacity/Delay Analysis and Airfield Modeling Technical Memorandum, CLT EIS; ASPM data, 2016-2017; Landrum & Brown analysis, 2020

The hourly throughput rate for the main operation on each runway was compared to the actual runway throughput. The simulated runway throughputs are shown with the Aerobahn data and the EIS results for the 90th percentile rates in **Table 4-3**. The simulated runway throughputs match closely with Aerobahn and the EIS simulation results.

Table 4-3, Calibration Runway Throughput Comparison

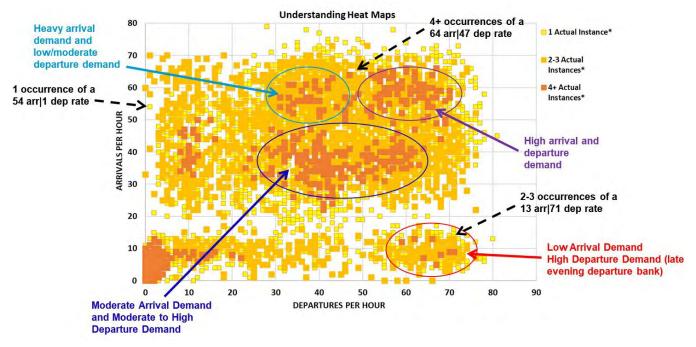
	Operation	Runway	Aerobahn – 90th	EIS - 90th	AirTOp – 90th
	Arrival	36L	35	32	34
North VMC	Departure	36C	38	37	39
	Departure	36R	29	28	27
	Arrival	36L	35	32	32
North IMC	Departure	36C	35	35	36
	Departure	36R	27	26	26
	Arrival	18R	33	33	33
South VMC	Departure	18C	32	31	32
	Departure	18L	38	35	37
	Arrival	18R	34	35	33
South IMC	Departure	18C	28	29	31
	Departure	18L	32	34	32

Source: Capacity/Delay Analysis and Airfield Modeling Technical Memorandum, CLT EIS; Aerobahn data, May 2016 for VMC, Jan-Aug 2016 for IMC; Landrum & Brown analysis, 2020

The EIS did not include 90th percentile data for arrival and departure throughput.

Simulated throughputs can also be compared to actual rates using a heat map. A heat map plots the number of hourly arrivals against the number of hourly departures. The frequency of occurrence of a particular arrival-departure rate in the data sample defines the color (heat) of the data point. This technique enables the visual differentiation of commonly occurring throughput rates from outlier throughput rates. **Exhibit 4-1** shows how heat maps work.

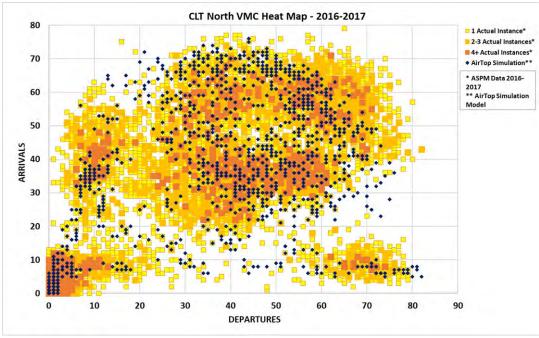
Exhibit 4-1, Heat Map Example



Source: Landrum & Brown analysis, 2020

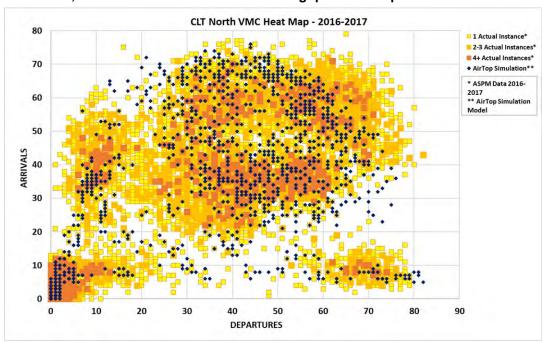
Exhibit 4-2 and **Exhibit 4-3** present the throughput rate heat map based on 2016-2017 ASPM data for the North Flow VMC and South Flow VMC operation respectively. In both flows, the simulated throughputs correlate well to the actual data.

Exhibit 4-2, Calibration North Flow VMC Throughput Heat Map – Actual Data



Source: ASPM data, 2016-2017; Landrum & Brown analysis, 2020

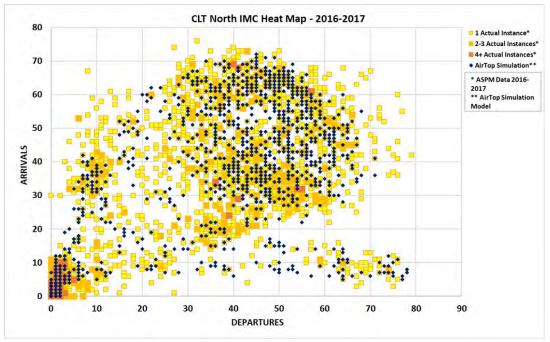
Exhibit 4-3, Calibration South Flow VMC Throughput Heat Map - Actual Data



Source: ASPM data, 2016-2017; Landrum & Brown analysis, 2020

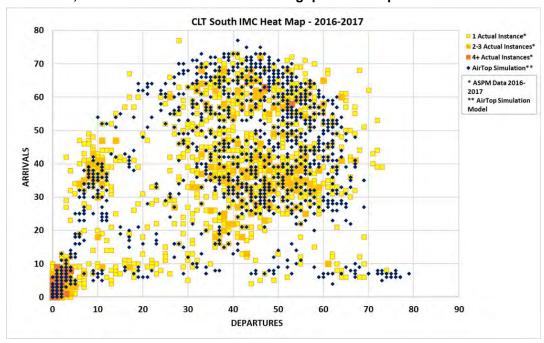
Exhibit 4-4 and Exhibit 4-5 present the throughput rate heat map based on 2016-2017 ASPM data for the North Flow VMC and South Flow IMC operation respectively. In both flows, the simulated throughputs correlate well to the actual data.

Exhibit 4-4, Calibration North Flow IMC Throughput Heat Map – Actual Data



ASPM data, 2016-2017; Landrum & Brown analysis, 2020 Source:

Exhibit 4-5, Calibration South Flow IMC Throughput Heat Map - Actual Data



Source: ASPM data, 2016-2017; Landrum & Brown analysis, 2020

4.2 Aircraft Taxi Times

Aircraft ground taxi times are a key metric in the simulation model calibration process. The AirTOp simulated taxi times were calibrated to 2016 FAA ASPM data to ensure model accuracy. **Table 4-4** provides a comparison of the average taxi times for the 2016 ASPM data versus the North Flow and South Flow VMC simulated times. IMC taxi times were assumed to be the same as the VMC taxi times so they were not compared. It is important to note that the FAA database provides the taxi times for most of the major US carriers, however not all aircraft operations are accounted for (i.e., cargo, general aviation, non-major commercial carriers). The simulation average taxi times represent the averages for all airlines and flights which were simulated in 10 iterations. The primary goal of calibrating to actual taxi times is to achieve taxi in and out times which are representative of the actual average taxi times at the Airport.

Table 4-4, Calibration Taxi Time Comparison

Case	Taxi Times (in minutes)			
Case	Arrival	Departure		
North Flow ASPM	11.0	20.3		
North Flow VMC AirTOp	11.9	20.2		
South Flow ASPM	12.4	19.5		
South Flow VMC AirTOp	11.6	17.6		

Source: ASPM data, 2016; Landrum & Brown analysis, 2020

4.3 Calibration Summary

The results of the calibration analysis for the North Flow VMC, South Flow VMC, North Flow IMC and South Flow IMC operations demonstrate that the models can successfully generate arrival and departure throughput rates and ground travel times which coincide well with actual operations. **Table 4-5** presents a summary of the final taxi time and delay metrics for the four calibrated simulation models. These results are based on the average of ten iterations of simulation runs.

Table 4-5, Calibration Results Summary

,			1 0	4.			
	Minutes per Operation						
Metric	North VMC	North IMC	South VMC	South IMC	All-Weather Annualization		
Runway Use ¹	44.8%	9.9%	38.8%	6.5%	100.0%		
Avg. Arrival Taxi Time	11.9	13.1	11.6	12.2	11.9		
Avg. Dep. Taxi Time	20.2	22.3	17.6	20.6	19.4		
Avg. Arrival Air Delay	6.1	7.5	5.1	5.6	5.8		
Avg. Arrival Delay	11.3	13.8	9.6	10.8	10.9		
Avg. Dep. Taxi Delay	7.0	9.1	6.8	9.5	7.3		
Avg. Dep. Delay	8.8	11.3	8.9	11.5	9.2		
Average Delay	10.1	12.5	9.2	11.2	10.1		

Based on ASPM configurations and ATC called rates in 2016.

Source: AirTOp simulations; ASPM data, 2016; Landrum & Brown analysis, 2020

5 2019 Baseline Operating Assumptions

Since the 2016 calibration, Runway 23 is no longer a primary arrival runway, therefore subsequent South Flow models were revised to reflect the new runway usage. To ensure that the models accurately reflect airport operations under the updated conditions, the 2019 Baseline simulation results were used to validate the models. North Flow models were not modeled for 2019 because runway usage remained the same as 2016.

The Baseline condition represents existing airside conditions (airfield, airspace, and terminal) in 2019 as shown on **Exhibit 5-1**. The primary differences between the 2016 calibrated condition and the 2019 condition are the addition of (1) the Concourse A Phase 1 Pier and (2) a deicing/hold pad to the north of the new pier. The 2019 Baseline condition was simulated with the 2019 flight schedule.



Exhibit 5-1, 2019 Baseline Airfield Layout

Source: 2020 Bing Maps imagery; Landrum & Brown, 2020

For purposes of the EA, the following 2019 Baseline modeling experiments were run:

- 2019 South Flow VMC
- 2019 South Flow IMC

5.1 Airfield and Aircraft Apron Layouts

The apron areas for the cargo carriers, general aviation, and military aircraft remain the same as in 2016. The 2019 Baseline includes the addition of the new Concourse A Phase I Pier as compared to the 2016 condition. In addition, airline usage of gates has changed since 2016. In 2019, American and Delta occupied the original Concourse A pier, while OALs moved to the Concourse A Phase I Extension Pier. The updated passenger airline gating assignments are shown in **Table 5-1**. The table also summarizes the number of gates in each concourse.

Table 5-1, 2019 Baseline Airline Gating Assignment Assumptions

Concourse	Airline Assignments	Number of Gates
Α	American, Delta	13
A Phase I Pier	Other Airlines (OALs)	9
В	American Mainline	16
С	American Mainline	18
D	American Mainline, Lufthansa	13
E	American Regional	44

Source: CLT airport and Landrum & Brown analysis, 2020

5.2 Hold Pad Usage

As with the 2016 condition, airfield deicing/hold pads were used to accommodate arrivals waiting for an available gate, RON operations, towed aircraft, and departures waiting for a spot in the queue. In the Baseline condition, the new deicing/hold pad located at the Runway 18C end can be used in addition to the existing hold pad between Concourses B and C, as shown on **Exhibit 5-2**.

Exhibit 5-2, 2019 Baseline Deicing/Hold Pads



Source: 2020 Bing Maps imagery; Landrum & Brown, 2020

5.3 **Runway Operating Configurations**

In South Flow, Runway 23 is no longer used for arrivals in the 2019 Baseline; Runway 5/23 is used as a taxiway instead. The basic runway usage in a South Flow configuration therefore consists of arrivals on Runways 18L and 18R, Runway 18C is used in conjunction with Runways 18L and 18R to provide triple parallel approach capability during periods of high arrival demand. The primary departure runways are Runways 18C and 18L in both VMC and IMC. The allocation of departing aircraft to these runways is based on the destination of the flight. Runway 18C is used by aircraft departing to northbound and westbound destinations. Runway 18C is also used by international heavy aircraft heading east. Runway 18L is used by southbound and eastbound departures. Exhibit 5-3 depicts the South Flow runway usage.

Exhibit 5-3, 2019 Baseline South Flow VMC/IMC Runway Configuration

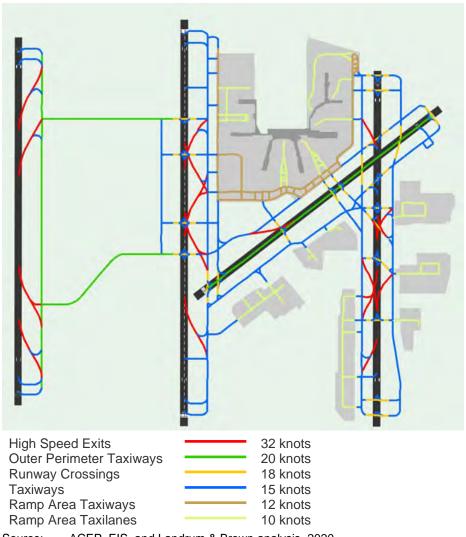


Source: 2020 Bing Maps imagery; Landrum & Brown, 2020

5.4 Airfield Ground Speeds

The overall ground speed assumptions remain the same as in 2016. **Exhibit 5-4** shows the 2019 Baseline speeds with the Concourse A pier expansion and deicing/hold pad included.

Exhibit 5-4, 2019 Baseline Airfield Ground Speed Assumptions



Source: ACEP, EIS, and Landrum & Brown analysis, 2020

5.5 Airfield Taxi Flows

Exhibit 5-5 shows the South Flow taxi routes with the Baseline improvements. Runway 23 is used as a taxiway.

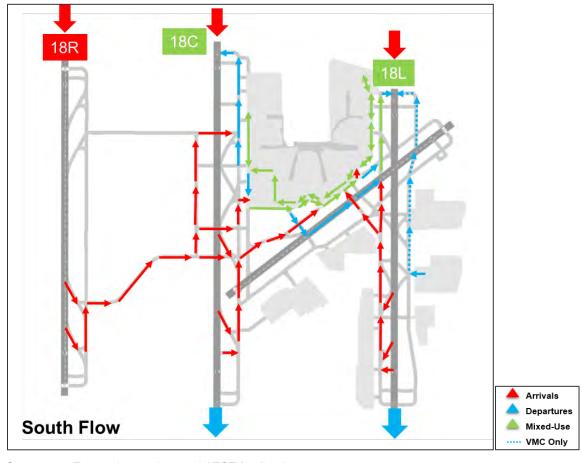


Exhibit 5-5, 2019 Baseline Taxi Routes

Source: Tower observations and ATCT feedback

5.6 Airspace Assumptions

The 2019 Baseline conditions were modeled with the same aircraft separation and airspace structure assumptions as were used for the 2016 modeling and calibration effort.

6 2019 Baseline Modeling Results

The results of the 2019 Baseline simulation models are presented in this chapter. The following metrics were validated for the South VMC and IMC models:

- Throughput rates
- Average total taxi times

6.1 Throughput Rates

A key metric in the calibration analysis is throughput rates. Throughput rates were calibrated to 2019 FAA ASPM data or CLT's Aerobahn system data. The simulated total operations throughput is compared to ASPM data in **Table 6-1**. The simulated 90th percentile throughputs are within 10 percent of the ASPM rates.

Table 6-1, 2019 Baseline Total Operations Throughput Comparison

Case	90 th Percentile Airport Throughput				
	ASPM AirTOp				
South VMC	117	118			
South IMC	111 116				

Sources: ASPM data, 2019; Landrum & Brown analysis, 2020

The simulated arrival and departure throughputs are compared to the ASPM data for the maximum rates and the 90th percentile rates in **Table 6-2.** The simulated arrival and departure hourly throughputs match closely with ASPM data. The FAA's Capacity Airport Rates (called rates) are also shown; the arrival called rates are much higher than actual hourly counts, so they are not considered a reliable indication of actual throughput. The called rates also heavily prioritize arrivals over departures, with the arrival hourly called rate being much higher than the departure rate. However, in actual operations, arrivals and departures are more balanced, with the peak departure rates slightly higher than arrival rates. The simulation takes a similar balanced approach to optimize delays.

Since the separation requirements between aircraft are higher in IMC than in VMC, the throughput is generally lower in IMC that it is in VMC. However, some IMC rates are slightly higher than VMC rates. The 2019 demand level does not constantly stress the airport during VMC as most operations are completed within the hour. During IMC, demand often spills over to the next hour, causing a backup that increases the throughput rate.

Table 6-2, 2019 Baseline Arrival and Departure Throughput Comparison

		Arrival and Departure Throughput				
Case	Type of Operation	ATC Called Rate ¹	ASPM Max	ASPM 90 th	AirTOp Max	AirTOp 90 th
South VMC	Arrival	87	73	60	68	62
	Departure	69	77	63	74	64
South IMC	Arrival	80	71	60	71	63
	Departure	69	69	57	72	59

A variety of called rates were found in ASPM for each runway configuration; the most frequent called rate is shown in the table.

Source: ASPM data, 2019; Landrum & Brown analysis, 2020

The hourly throughput rate for the main operation on each runway was compared to the actual runway throughput determined from Aerobahn data. The simulated runway throughputs are shown with the Aerobahn data for the 90th percentile rates in **Table 6-3**. The simulated runway throughputs match closely with the observed data.

Table 6-3, 2019 Baseline Runway Throughput Comparison

Case	Operation	Runway	Aerobahn – 90th	AirTOp – 90th
South VMC	Arrival	18R	34	34
	Departure	18C	34	36
	Departure	18L	30	30
South IMC	Arrival	18R	32	33
	Departure	18C	32	33
	Departure	18L	27	29

Source: Aerobahn data, January-April 2019; Landrum & Brown analysis, 2020

Simulated throughputs can also be compared to actual rates using a heat map. Exhibit 6-1 and Exhibit 6-2 present the throughput rate heat map based on 2019 ASPM data for the South Flow VMC and South Flow IMC operation respectively. In both flows, the simulated throughputs correlate well to the actual data.

CLT South VMC Heat Map - 2019 80 2-3 Actual Instances* 4+ Actual Instances* 70 AirTop Simulation** * ASPM Data 2019 60 50 30 20 10 30 40 50 70 80 90 **DEPARTURES**

Exhibit 6-1, 2019 Baseline South Flow VMC Throughput Heat Map – Actual Data

ASPM data, 2019; Landrum & Brown analysis, 2020 Source:

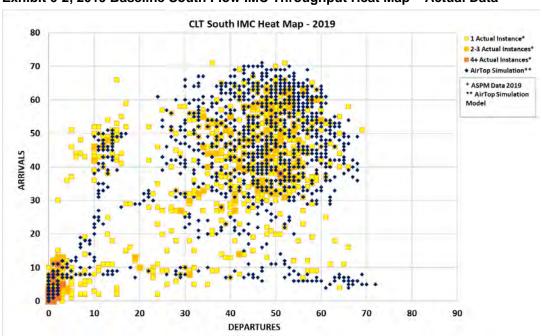


Exhibit 6-2, 2019 Baseline South Flow IMC Throughput Heat Map – Actual Data

Source: ASPM data, 2019; Landrum & Brown analysis, 2020

6.2 Aircraft Taxi Times

Aircraft ground taxi times are a key metric in the simulation model calibration process. The AirTOp simulated taxi times were calibrated to 2019 FAA ASPM data to validate model accuracy. **Table 6-4** provides a comparison of the 2019 ASPM data versus the simulated average taxi times. The comparison is only made for the VMC because the IMC and VMC taxi times were assumed to be the same. It is important to note that the FAA database provides the taxi times for most of the major US carriers, but not all aircraft operations are accounted for (i.e., cargo, general aviation, non-major commercial carriers).

Table 6-4, 2019 Baseline Taxi Time Comparison

Case	Taxi Times (in minutes)					
Case	Arrival	Departure				
South Flow ASPM	13.1	19.6				
South Flow VMC AirTOp	12.6	17.5				

Source: ASPM data, 2019; Landrum & Brown analysis, 2020

6.3 Baseline Summary

The results of the validation analysis for the South Flow VMC and South Flow IMC operations demonstrate that the models can successfully produce arrival and departure throughput rates and ground travel times which coincide well with actual operations.

7 No Action Operating Assumptions

With the 2016 and 2019 simulation models calibrated to reflect airport conditions, the models can be adjusted using various control parameters and demand levels to evaluate future changes in the operation. The No Action experiment reflects the existing airside system along with improvements that are expected to be in place by 2028, as shown on **Exhibit 7-1**. These include:

- Concourse A Phase II Pier
- North End Around Taxiway (EAT) on the Runway 18C end
- Dual taxilanes for Concourse A
- Taxiway N removal
- West hold pad between Runways 18C/36C and 18R/36L
- Taxiway S removal
- South crossfield taxiway and deicing pad

The No Action cases were simulated with the 2028 and 2033 flight schedules.

North EAT Concourse A 18C 18R Phase II Pier 18L Dual **Taxilanes** 23 Taxiway N Removal Runway 18C/36C Runway 05/23 Runway 18R/36L Runway 18L/36R West **Hold Pad** Taxiway S 05 Removal South Crossfield Taxiway & **Deicing Pad** 36L 36C 36R

Exhibit 7-1, 2028/2033 Future No Action Airfield Layout

Source: CLT airport and Landrum & Brown, 2020

For purposes of the EA, the following No Action modeling experiments were run:

- 2028 North Flow VMC
- 2028 North Flow IMC
- 2028 South Flow VMC
- 2028 South Flow IMC

- 2033 North Flow VMC
- 2033 North Flow IMC
- 2033 South Flow VMC
- 2033 South Flow IMC

7.1 Airfield and Aircraft Apron Layouts

The apron areas for the cargo carriers, general aviation, and military aircraft remain the same as in 2016 and 2019. The No Action conditions include the addition of Concourse A Phase II Pier as compared to the 2019 condition. The updated passenger airline gating assignments are shown in **Table 7-1**. The table also summarizes the number of gates in each concourse.

Table 7-1, No Action Airline Gating Assignment Assumptions

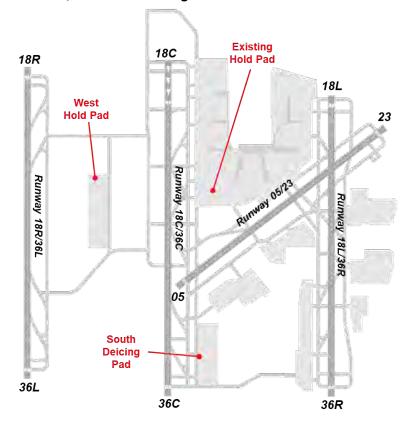
Concourse	No Action Airline Assignments	Number of Gates
Α	American	9
A Phase I Pier	Other Airlines (OALs)	9
A Phase II Pier	Other Airlines (OALs)	10
В	American Mainline	16
C	American Mainline	18
D	American Mainline, Lufthansa	13
E	American Regional	44

Source: CLT airport and Landrum & Brown analysis, 2020

7.2 Hold Pad Usage

Airfield deicing/hold pads were used to accommodate arrivals waiting for an available gate, RON operations, and towed aircraft. In the No Action condition, the South Deicing Pad and West Hold Pad can be used in addition to the existing hold pad between Concourses B and C (see **Exhibit 7-2**).

Exhibit 7-2, No Action Deicing/Hold Pads



Source: CLT airport and Landrum & Brown, 2020

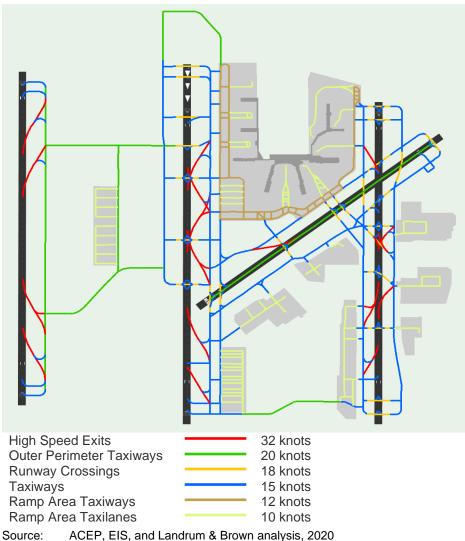
7.3 Runway Operating Configurations

For North Flow, the No Action experiments were modeled with the same runway operating configurations as the 2016 Calibration modeling effort. For South Flow, the No Action experiments were modeled with the same runway operating configurations as the 2019 Baseline modeling effort.

7.4 Airfield Ground Speeds

The overall ground speed assumptions remain the same as in 2016 and 2019. **Exhibit 7-3, No Action Airfield Ground Speed Assumptions**, shows the 2028 and 2033 No Action speeds with the No Action additions, such as the Concourse A pier and the North EAT, included.

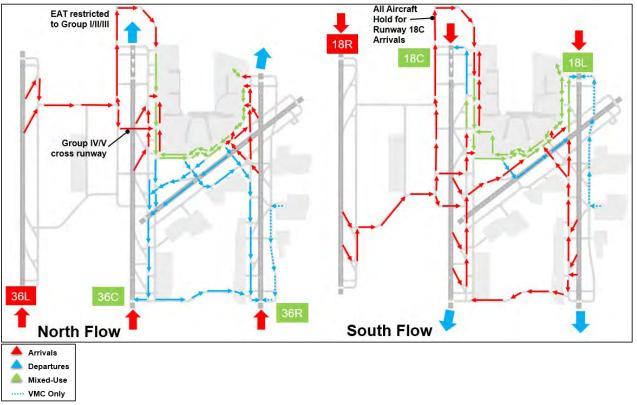
Exhibit 7-3, No Action Airfield Ground Speed Assumptions



7.5 Airfield Taxi Flows

Exhibit 7-4 shows the taxi routes in the No Action with additional projects implemented. Both North Flow and South Flow reflect the use of the new North EAT and the new dual taxilanes along Concourse A. In addition, in South Flow, Runway 23 is not used for arrivals as it was in 2016; instead Runway 5/23 is used as a taxiway.

Exhibit 7-4, No Action Taxi Routes



Source: Tower observations and ATCT feedback

7.6 Airspace Assumptions

Based on discussion with the FAA during the DORA process,⁶ the No Action and alternative simulations assumed a final approach in-trail separation of 2.5 nautical miles due to average runway occupancy time of less than 50 seconds. This separation allows arrivals to fully utilize runway capacity at higher demand levels.

With the implementation of the NASA Airspace Technology Demonstration 2 (ATD-2) system, a predecessor to the FAA Terminal Flight Data Manager (TFDM), the miles-in-trail (MIT) constraints that would have otherwise been added for northern destinations from CLT are no longer necessary. Prior to ATD-2, it was normal practice for MIT restrictions to be implemented, even during VMC, due to overhead enroute congestion. With ATD-2, flights going to the north are assigned a takeoff time prior to pushback from the gate to meter the departures into the airspace. Further improved enroute flows are anticipated with the Atlantic Coast Reroute Project.

⁶ DORA #3 follow up meeting with FAA, July 8, 2020

In addition, wake turbulence separations were updated according to Consolidated Wake Turbulence (CWT) Separation Standards issued in September 2019. Table 7-2 lists the different aircraft types in each new category. Table 7-3 presents the simulated minimum VMC and IMC in-trail separation distances for arrivals. Table 7-3 presents the simulated minimum VMC and IMC in-trail separation times for departures.

Table 7-2, CWT Categories

Α	В	С	D		Е	F	-	G	3	Н	I
Super	Upper Heavy	Lower Heavy	Non-Pai Hea		B757	Upper	Large	Lower	Large	Upper Small	Lower Small
A388	A332	A306	A124	DC85	B752	A318	C130	AT43	E170	ASTR	BE10
	A333	A30B	A339	DC86	B753	A319	C30J	AT72	E45X	B190	BE20
	A343	A310	A342	DC87		A320	CVLT	CL60	E75L	BE40	BE58
	A345	B762	A3ST	E3CF		A321	DC93	CRJ1	E75S	B350	BE99
	A346	B763	A400	E3TF		B712	DC95	CRJ2	F16	C560	C208
	A359	B764	A50	E6		B721	DH8D	CRJ7	F18H	C56X	C210
	B742	DC10	AN22	E767		B722	E190	CRJ9	F18S	C680	C25A
	B744	K35R	B1	IL62		B732	GL5T	CRJX	F900	C750	C25B
	B748	MD11	B2	IL76		B733	GLEX	DC91	FA7X	CL30	C402
	B772		B52	IL86		B734	GLF5	DH8A	GLF2	E120	C441
	B773		B703	IL96		B735	GLF6	DH8B	GLF3	F2TH	C525
	B77L		B741	K35E		B736	MD82	DH8C	GLF4	FA50	C550
	B77W		B743	KE3		B737	MD83	E135	SB20	GALX	P180
	B788		B74D	L101		B738	MD87	E145	SF34	H25B	PAY2
	B789		B74R	MYA4		B739	MD88			LJ31	PA31
	C5		B74S	R135			MD90			LJ35	PC12
	C5M		B78X	T144						LJ45	SR22
			BLCF	T160						LJ55	SW3
			BSCA	TU95						LJ60	
			C135	VMT						SH36	

Source: JO 7110.126A - Consolidated Wake Turbulence (CWT) Separation Standards. Effective Date: September 28, 2019

Table 7-3, CWT Arrival In-trail Separations

	- 11 A C										
	trail				Trailing Aircraft						
Separ	ations										
(naı	ıtical	Α	В	С	D	E	F	G	Н	1	
,	les)										
	Α	2.5/3.8 ¹	4.8	6.3	6.3	7.3	7.3	7.3	7.3	8.3	
±	В	$2.5/3.8^{1}$	3.3	4.3	4.3	5.3	5.3	5.3	5.3	6.3	
) Ta	С	2.5/3.8 ¹	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	3.8	3.8	3.8	5.3	6.3	
ij	D	$2.5/3.8^{1}$	3.3	4.3	4.3	5.3	5.3	5.3	6.3	6.3	
J 6	E	2.5/3.8 ¹	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	4.3	
Ë	F	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	4.3	
Leading Aircraft	G	2.5/3.8 ¹	$2.5/3.8^{1}$	2.5/3.81	$2.5/3.8^{1}$	$2.5/3.8^{1}$	2.5/3.81	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	
ت	Н	2.5/3.8 ¹	$2.5/3.8^{1}$	2.5/3.81	2.5/3.81	2.5/3.81	2.5/3.81	$2.5/3.8^{1}$	$2.5/3.8^{1}$	2.5/3.81	
	I	2.5/3.8 ¹	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	

VMC/IMC in-trail separations

Note: Arrival separations include a 0.3 nautical mile buffer

JO 7110.126A - Consolidated Wake Turbulence (CWT) Separation Standards. Effective Date: September 28, Source:

2019. Landrum & Brown analysis with FAA feedback, 2020

Table 7-4, CWT Departure In-trail Separations

In-trail			Trailing Aircraft									
Separations (seconds)		Α	В	С	D	E	F	G	н	1		
	Α	60/72 ¹	180	180	180	180	180	180	180	180		
#	В	60/72 ¹	120	120	120	120	120	120	120	120		
Aircraft	С	60/72 ¹	60/72 ¹	60/72 ¹	60/72 ¹	120	120	120	120	120		
į	D	60/72 ¹	120	120	120	120	120	120	120	120		
9	E	60/72 ¹	60/721	120								
Leading	F	60/72 ¹	60/721	60/721	60/721	60/721	60/721	60/72 ¹	60/721	60/72 ¹		
eac	G	60/72 ¹										
Ľ	Н	60/72 ¹										
	I	60/72 ¹										

VMC/IMC in-trail separations

Source: JO 7110.126A - Consolidated Wake Turbulence (CWT) Separation Standards. Effective Date: September 28, 2019. Landrum & Brown analysis with FAA feedback, 2020

Table 7-5 summarizes the existing and forecasted fleet mix sorted by the new wake classes.

Table 7-5, Fleet Mix by CWT Category

	20)16	20)19	2	028	2033	
CWT Category	Number of Ops	% of Total Ops	Number of Ops	% of Total Ops	Number of Ops	% of Total Ops	Number of Ops	% of Total Ops
Α	0	0%	0	0%	0	0%	0	0%
В	19	1%	20	1%	21	1%	23	1%
С	10	1%	12	1%	14	1%	16	1%
D	0	0%	0	0%	0	0%	0	0%
E	2	0%	4	0%	0	0%	0	0%
F	770	49%	683	42%	779	42%	865	44%
G	708	45%	843	52%	991	53%	1017	51%
Н	40	3%	55	3%	40	2%	42	2%
I	14	1%	11	1%	15	1%	15	1%
Total	1563	100%	1628	100%	1860	100%	1978	100%

Source: Landrum & Brown analysis, 2020

8 No Action Modeling Results

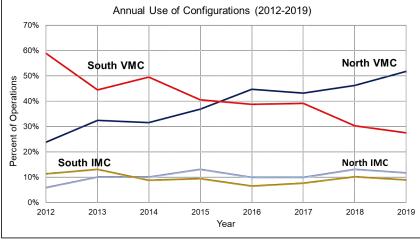
The results of the No Action simulation models are presented in this chapter. Throughput, taxi times, and delay data are presented for the 2028 (1,860 daily operations) and the 2033 (1,978 daily operations) demand levels. Each of the simulation modeling experiments was run a minimum of ten iterations to incorporate random variation in the modeling in order to produce statistically significant results.

To summarize the results for each demand level, annualized averages were calculated for each of the simulation metrics. The annualized data was calculated by averaging the results of the four flow and weather configurations, weighted by the percent of time each configuration was observed. FAA ASPM runway usage/weather data from 2012 to 2019 were analyzed to determine the frequency of each configuration, as shown in **Exhibit 8-1**. The data show a clear trend in the increase of North Flow operations and decrease of South Flow operations over this time period. Based on conversations with local Air Traffic, North Flow is favored over South Flow due to factors such as North Flow having more

departure queue space. An average of 2012 to 2019 configuration shares would likely undercount North Flow percentages at future demand levels, therefore the 2028 and 2033 simulation results were weighted solely on the 2019 shares.

Exhibit 8-1, Annual Use of Airport Configurations

Annual Use of Configurations (2012-2019)



Source: ASPM data, 2012-2019

8.1 Throughput Rates

In order to evaluate the No Action airfield's ability to manage the increase in demand, rolling hour throughput rates were calculated from the simulations. As recommended by the DORA stakeholder group, the 90th percentile throughput is used in this analysis rather than the maximum throughput. The 90th percentile methodology presents an achievable runway throughput rate, while the maximum hourly rate may not be sustainable⁷ on a recurring basis.

Exhibit 8-2 shows the 90th percentile hourly throughput rate for arrivals, departures, and overall airport operations. The 2016 calibration throughput rates are included for reference. The 2016 rates are annualized based on the shares of 2016 runway configurations, while the 2028 and 2033 rates are annualized based on the 2019 runway configurations. At the higher No Action demand levels, airfield improvements such as the addition of the North EAT and the compression of arrival separations to 2.5nm allow for the increase in throughput as compared to the 2016 Calibration.

Although the focus of the analysis was on the 90th percentile sustained throughput rate, the maximum 15-minute simulation throughput was verified with and matches the Airport Capacity Profile modeled rates for CLT.

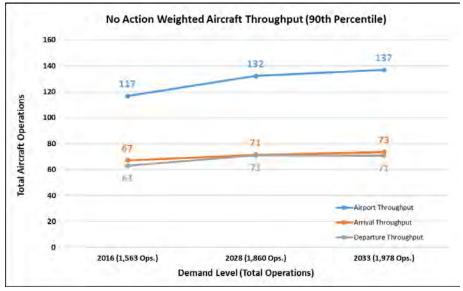


Exhibit 8-2, No Action Weighted Aircraft Throughput

Source: Landrum & Brown analysis, 2020

Table 8-1 presents the 90th percentile hourly throughput rates for each of the four weather and flow configurations. In addition to the overall airport, arrival, and departure rates, the throughput rates for the main operation on each runway is listed. The departure rate on Runway 18L/36R is lower than Runway 18C/36C because Runway 18L/36R is a mixed-use runway.

Table 8-1, No Action Aircraft Throughput by Flow

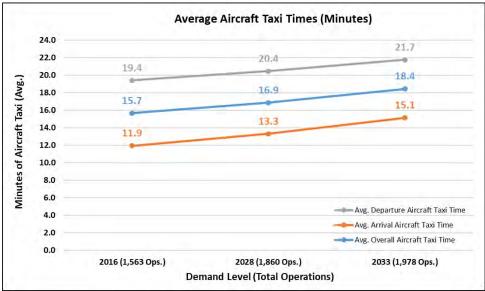
90th Percentile	2	2028 Futur	e No Action	n	2033 Future No Action			
Simulated	North	North	South	South	North	North	South	South
Throughput	VMC	IMC	VMC	IMC	VMC	IMC	VMC	IMC
Airport	134	128	132	128	139	131	137	132
Arrival	73	70	70	69	75	72	72	71
Departure	72	65	73	67	71	67	73	68
18R/36L Arrival	41	34	40	35	42	35	41	36
18C/36C Departure	44	42	44	40	45	43	45	42
18L/36R Departure	30	27	31	29	30	27	31	28

Source: Landrum & Brown analysis, 2020

8.2 Aircraft Taxi Times and Delay

To assess the impact of the increased operations on the performance of the No Action airfield, average taxi times and delay were generated from the simulation. **Exhibit 8-3** depicts the average aircraft taxi times including delays for arrivals, departures and overall airport operations. Taxi times increased as compared to the 2016 Calibration due to increased delay and the longer taxi distances when aircraft use the North EAT.

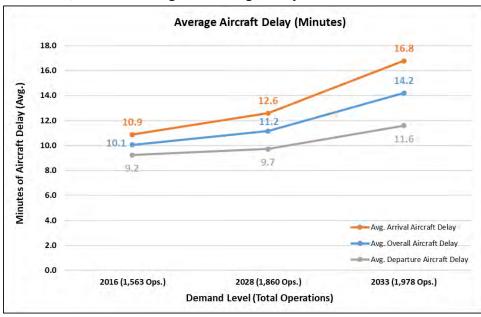
Exhibit 8-3, No Action Weighted Average Taxi Times



Source: Landrum & Brown analysis, 2020

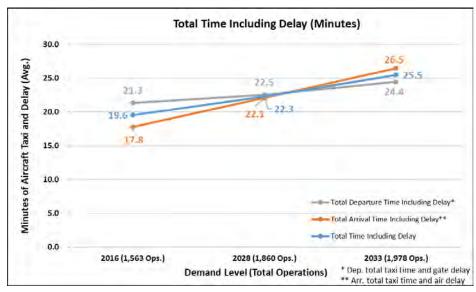
Exhibit 8-4 shows the average aircraft delays for arrivals, departures and overall airport operations. Arrival delays include air, taxi, and gate wait delays. Departure delays include taxi and gate holding delays. Delays increased when compared to the 2016 Calibration due to constraints in runway capacity, taxiway and ramp congestion, as well as gate shortages. One major bottleneck is located near the tip of Concourse C, where the flow of aircraft traffic on the taxilanes and Taxiway M is severely constricted due to the single taxilane access to Concourse E.

Exhibit 8-4, No Action Weighted Average Delay



Source: Landrum & Brown analysis, 2020 **Exhibit 8-5** shows the total aircraft times including delays for arrivals, departures and overall airport operations. Arrival total times include air delays, taxi times, taxi delays, and gate wait delays. Departure total times include gate holding delays, taxi times, and taxi delays. The total time provides a more well-rounded measure of airport performance than taxi times and delay could separately.

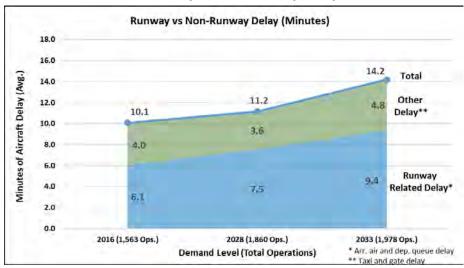
Exhibit 8-5, No Action Total Time Including Delay



Source: Landrum & Brown analysis, 2020

Exhibit 8-6 presents the delay that can be attributed to the runway versus non-runway delays. Runway related delays include arrival air delays and departure queue delays. Non-runway delays include taxi and gate delays. Arrivals and departures both experience high amounts of delay largely due to the constraint of the runway system. Taxiway and ramp congestion as well as gate shortage generate additional delays. The average runway delay of 7.5 at the 2028 demand level and 9.4 minutes at the 2033 demand level exceeds the threshold for the acceptable level of runway delay (seven minutes).

Exhibit 8-6, No Action Runway vs Non-Runway Delay

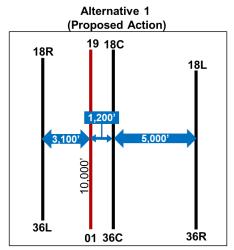


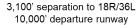
Source: Landrum & Brown analysis, 2020

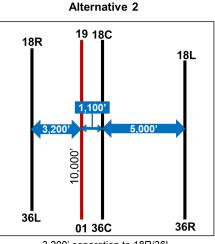
9 Airfield Alternatives Operating Assumptions

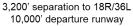
Three alternatives were developed and evaluated to meet the purpose and need identified in the EA process. Alternative 1 assumes the construction of a new 10,000 feet runway (designated as Runway 01/19 for the purposes of the EA) that is located 1,200 feet to the west of existing Runway 18C/36C. Under current FAA regulations, this separation allows for simultaneous triple independent approaches in all weather conditions on Runways 18R/36L, 18C/36C, and 18L/36R. Alternative 2 is identical to Alternative 1, except the new runway is located 100 feet closer to Runway 18C/36C. This creates a 3,200 feet separation between Runways 18R/36L and 01/19. Alternative 2 was not simulated as results were assumed to be very similar to Alternative 1. Alternative 3 includes a new 8,900 feet runway located 900 feet west of Runway 18C/36C and 3,400 feet east of Runway 18R/36L. Based on newly updated FAA Order 7110.65, the 3,400 feet spacing between Runways 01/19 and 18R/36L allows for simultaneous triple independent approaches in all weather conditions on Runways 18R/36L, 01/19, and 18L/36R. **Exhibit 9-1** depicts the main differences between the alternatives.

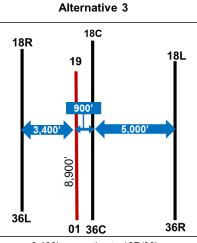
Exhibit 9-1, Alternatives Overview











3,400' separation to 18R/36L 8,900' arrival runway

Source: Landrum & Brown, 2020

For purposes of the EA, each of the following modeling experiments were run for Alternatives 1 and 3:

- 2028 North Flow VMC
- 2028 North Flow IMC
- 2028 South Flow VMC
- 2028 South Flow IMC

- 2033 North Flow VMC
- 2033 North Flow IMC
- 2033 South Flow VMC
- 2033 South Flow IMC

9.1 Airfield and Aircraft Apron Layouts

The alternatives' airfields and apron areas contain numerous improvements to support future demand levels. These include full North and South EATs, additional crossfield taxiways, extensions of Concourses B and C, and complete dual taxilanes around the terminals. This infrastructure, highlighted in **Exhibit 9-2** and **Exhibit 9-3** complements the new runway by allowing for efficient taxi flows between gates and runways and removing bottlenecks around the ramp area. Alternative 3 includes the same infrastructure improvements as Alternative 1 but has a shorter runway and does not have a full-length Taxiway V. The runway is shorter in Alternative 3 because it would be used primarily as an arrival runway so does not require the 10,000-foot length. Taxiway V cannot extend the full length of the runway due to the location of the Runway 18C/36C glideslopes.

Full North EAT 18C **Taxilanes** 19 18R 18L New Runway Concourse B&C xpansion Runway 18R/36L Runway Runway 18C/36C 01/19 Additional Taxiway/Taxilane Infrastructure 36L 36C 36R Full South EAT

Exhibit 9-2, Alternative 1 Airfield Layout

Source: CLT airport and Landrum & Brown, 2020

Full North Dual EAT 18C **Taxilanes** 18R New 19 Runway Concourse B&C xpansion Runway 18R/36L Runway Runway 01/19 18C/36C Additional Taxiway/Taxilane Infrastructure 36L 01 36C 36R Full South EAT

Exhibit 9-3, Alternative 3 Airfield Layout

Source: CLT airport and Landrum & Brown, 2020

Gating assignments assumptions, presented in **Table 9-1**, were updated to accommodate future demand. All OALs (except for Lufthansa) were assumed to operate out of the two new Concourse A piers, while the original Concourse A would exclusively serve American Mainline. Concourses B and C would continue to be used by American Mainline and accommodate some American Regional. Concourse D would remain as the international concourse, housing American and Lufthansa. Concourse E would also retain its current use serving American Regional.

Table 9-1, Alternatives Airline Gating Assignment Assumptions

Concourse	Airline Assignments	Number of Gates
Α	American Mainline	9
A Phase I Pier	Other Airlines (OALs)	9
A Phase II Pier	Other Airlines (OALs)	10
В	American Mainline, American Regional	35
С	American Mainline, American Regional	32
D	American Mainline, Lufthansa	6
E	American Regional	37

Source: CLT Terminal Area Plan Forecasts, 2020; Landrum & Brown analysis, 2020

9.2 Runway Operating Configurations

The addition of the fourth runway allows for greater flexibility in runway operating configurations. For the purposes of this study, one main set of runway configuration was assumed and simulated for each alternative. Other runway configurations and procedures can be developed based on the needs of future airport operations.

In Alternative 1, the new runway does not have sufficient spacing between it and either of its two adjacent runways to allow for triple simultaneous independent straight-in approaches, so it is intended to be used primarily by departures. Therefore, Runways 18R/36L, 18C/36C, and 18L/36R would be used for arrivals to provide simultaneous triple independent approaches capability. Runways 01/19 and 18L/36R would be used for departures. During off-peak periods when arrival demand is sparse, Runway 18C/36C could be used for departures.

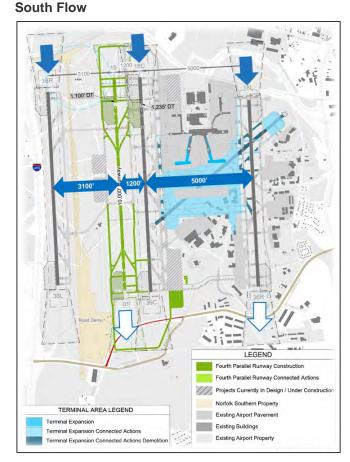
In Alternative 3, the new runway has sufficient spacing between it and Runways 18R/36L and 18L/36R to allow for triple simultaneous independent straight-in approaches, so it intended to be used primarily by arrivals. Therefore, Runways 18R/36L, 01/19, and 18L/36R would be used for arrivals to provide simultaneous triple independent approaches capability. Runways 18C/36C and 18L/36R would be used for departures.

The runway usage for each Alternative is depicted on Exhibit 9-4 and Exhibit 9-5.

Exhibit 9-4, Alternative 1 VMC/IMC Runway Configuration

North Flow

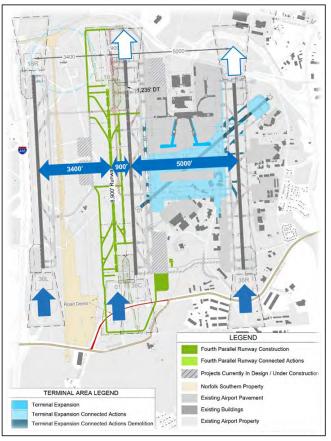
South Flow

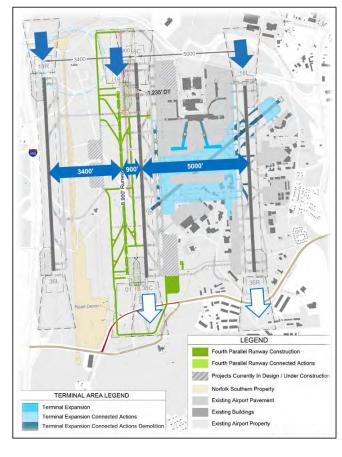


Source: Landrum & Brown, 2020

Exhibit 9-5, Alternative 3 VMC/IMC Runway Configuration

North Flow South Flow



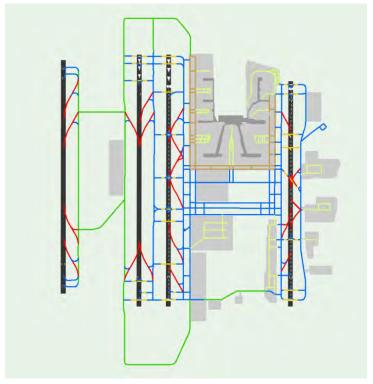


Source: Landrum & Brown, 2020

9.3 Airfield Ground Speeds

The overall ground speed assumptions are consistent with those in the No Action. New infrastructure, such as the full EATs, is subject to the speed limits listed on Exhibit 9-6 and Exhibit 9-7.

Exhibit 9-6, Alternative 1 Airfield Ground Speed Assumptions

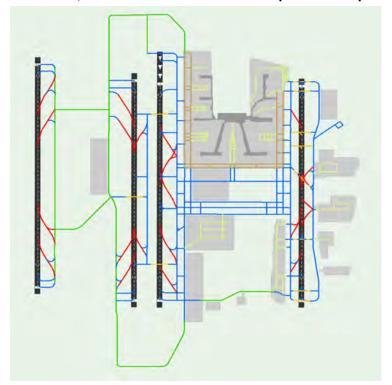


High Speed Exits
Outer Perimeter Taxiways
Runway Crossings
Taxiways
Ramp Area Taxiways
Ramp Area Taxilanes

32 knots 20 knots 18 knots 15 knots 12 knots 10 knots

Source: ACEP, EIS, and Landrum & Brown analysis, 2020

Exhibit 9-7, Alternative 3 Airfield Ground Speed Assumptions



Source: ACEP, EIS, and Landrum & Brown analysis, 2020

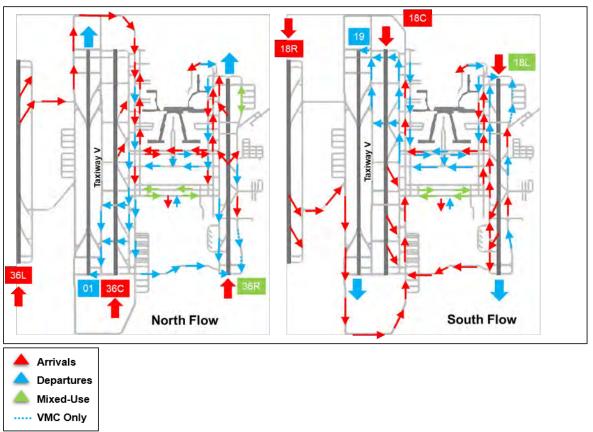
High Speed Exits
Outer Perimeter Taxiways
Runway Crossings
Taxiways
Ramp Area Taxiways
Ramp Area Taxilanes

32 knots
20 knots
18 knots
15 knots
12 knots

9.4 Airfield Taxi Flows

As depicted in **Exhibit 9-8** and **Exhibit 9-9**, both alternatives take advantage of the new crossfield taxiways to move traffic between the east and west sides of the airfield without interfering with ramp area movements. Traffic on the dual taxilanes abutting the ramp area would be unidirectional to avoid head-on conflicts. In Alternative 1, Runway 01/19 departures would cross Runway 18C/36C to access the departure queue on Taxiway V. Two locations are used in both flows to allow for two simultaneous crossings of Runway 18C/36C between each pair of arrivals. The locations were selected to avoid the high energy zone in the middle third of the runway and the glide slope critical areas. The departures would not use the EAT to reach Runway 01/19 to avoid taxiing under approaching aircraft, which is not allowed unrestricted. In Alternative 3, Runway 01/19 arrivals would exit east for a shorter taxi when there are no Runway 18C/36C departures. Otherwise, they exit west and taxi around one of the EATs to avoid interrupting the departure stream.

Exhibit 9-8, Alternative 1 Taxi Routes



Source: Landrum & Brown analysis and ATCT feedback, 2020

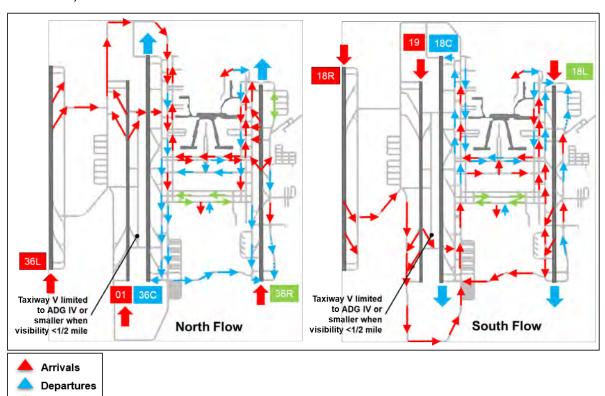


Exhibit 9-9, Alternative 3 Taxi Routes

Source: Landrum & Brown analysis and ATCT feedback, 2020

9.5 Airspace Assumptions

Mixed-Use
VMC Only

Exhibit 9-10 and **Exhibit 9-11** show the arrival fix assignments for each arrival runway. Arrival traffic can be swapped between runways to balance runway loads. Alternative 3 was assumed to have the same airspace assumptions, with Runway 18C/36C replaced by Runway 01/19.

FLIPZ

BTSEY
(prop)

RASLN
(prop)

MILET

Runway 36L

Runway 36R

Runway 36C

CLT

Exhibit 9-10, Alternative 1 North Flow Arrival Route Structure

Note: Arrivals can be offloaded to other runways during busy periods Source: FAA terminal procedures; Landrum & Brown analysis

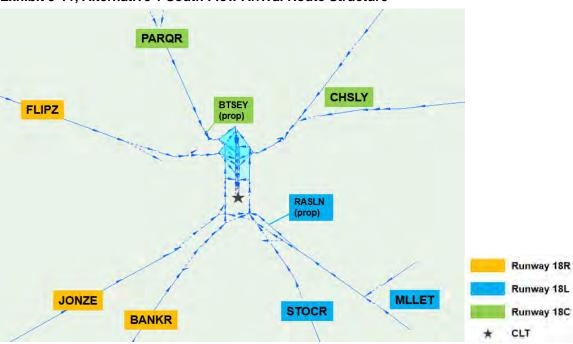


Exhibit 9-11, Alternative 1 South Flow Arrival Route Structure

Note: Arrivals can be offloaded to other runways during busy periods

Source: FAA terminal procedures; Landrum & Brown analysis

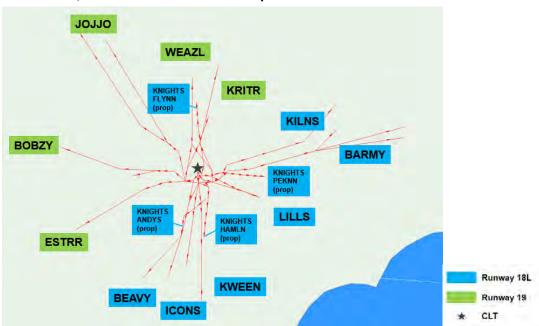
Exhibit 9-12 and Exhibit 9-13 present the primary fix allocation for each departure runway. Departures to the north (JOJJO, WEAZL, KRITR) and south (BEAVY, ICONS, KWEEN) fixes can be switched between runways to balance the runway queues during departure pushes. Alternative 3 was assumed to have the same fix assignments, with Runway 01/19 replaced by Runway 18C/36C.

JOJJO WEAZL KRITR KILNS BARMY BOBZY LILLS **ESTRR** Runway 36R **KWEEN** Runway 01 BEAVY ICONS CLT

Exhibit 9-12, Alternative 1 North Flow Departure Route Structure

Note: Departures to north and south fixes can be swapped between runways to balance the airfield Source: FAA terminal procedures; Landrum & Brown analysis, 2020

Exhibit 9-13, Alternative 1 South Flow Departure Route Structure



Departures to north and south fixes can be swapped between runways to balance the airfield Note: FAA terminal procedures; Landrum & Brown analysis, 2020 Source:

Airfield Alternatives Modeling Results

To provide a comparison against the No Action simulation results, the same metrics of throughput, taxi times, and delay were generated for the Alternative 1 and Alternative 3 simulation models. Alternative 2 was not modeled as it was expected to produce very similar results to Alternative 1. The same annualization percentages used to generate the No Action results were used for the alternatives.

10.1 Throughput Rates

The 90th percentile hourly throughput rates are displayed in **Exhibit 10-1**. The left chart presents the arrival rates, the middle chart the departure rates, and the right chart the overall airport rates. Each chart shows the No Action, Alternative 1, and Alternative 3 throughput rates for both the 2028 and 2033 demand levels. Alternatives 1 and 3 produce very similar throughputs and both outperform the No Action. This is the expected result as the alternatives add a runway and therefore allow the two center runways to operate as dedicated arrival/departure runways.

Weighted Total Throughput Weighted Arrival Throughput Weighted Departure Throughput (90th Percentile) (90th Percentile) (90th Percentile) 160 160 160 153 151 Number of Aircraft Operations 08 001 140 140 137 132 120 120 100 100 82 82 80 79 82 82 80 80 79 79 73 71 71 71 60 60 60 No Act. No Act. No Act. Alt. 1 (Prop Act.) Alt. 1 (Prop Act.) -Alt. 1 (Prop Act.) Alt. 3 -Alt. 3 -Alt. 3 40 40 40 2028 (1,860 Ops.) 2033 (1,978 Ops.) 2028 (1,860 Ops.) 2033 (1,978 Ops.) 2028 (1,860 Ops.) 2033 (1,978 Ops.) **Demand Level (Total Operations)**

Exhibit 10-1, Throughput Rates from the No Action and Alternatives Simulations

Source: Landrum & Brown analysis, 2021

The 90th percentile throughput numbers presented do not necessarily represent total airport capacity because the modeled throughput rates are also a function of the flight schedule demand. While the additional runway and updated operating procedures allow for higher hourly rates, the schedule profile does not push the airport to capacity for extended periods at a time. Higher throughput may be achievable with a higher demand level or different demand profiles.

Table 10-1 and **Table 10-2** presents the 90th percentile hourly throughput by weather and flow configurations. The overall airport, arrival, and departure rates, and the throughput rates for the main operation on each runway is listed. Alternatives 1 and 3 produce similar throughputs on each runway. It is important to note that Runway 01/19 and 18C/36C swap arrival and departure operations between the alternatives. Alternative 1 Runway 18C/36C has slightly lower arrival throughput than Alternative 3 Runway 01/19 due to departures crossing Runway 18C/36C in Alternative 1.

Table 10-1, Alternative 1 Aircraft Throughput by Flow

90th Percentile	2028 Alternative 1				2033 Alternative 1			
Simulated Throughput	North VMC	North IMC	South VMC	South IMC	North VMC	North IMC	South VMC	South IMC
Airport	145	139	146	137	153	144	153	142
Arrival	79	78	79	76	83	79	82	77
Departure	81	74	80	74	84	75	83	76
18R/36L Arrival	36	33	37	35	38	34	39	35
01/19 Departure	41	37	40	36	42	38	42	38
18C/36C Arrival	31	31	31	28	33	32	33	29
18L/36R Departure	44	40	44	40	44	40	45	41

Source: Landrum & Brown analysis, 2021

Table 10-2, Alternative 3 Aircraft Throughput by Flow

90th Percentile	2028 Alternative 3				2033 Alternative 3			
Simulated Throughput	North VMC	North IMC	South VMC	South IMC	North VMC	North IMC	South VMC	South IMC
Airport	149	140	147	138	156	144	154	143
Arrival	80	77	80	77	83	79	82	80
Departure	82	74	81	72	85	74	84	73
18R/36L Arrival	35	32	38	34	37	33	39	34
01/19 Arrival	35	30	32	30	37	31	34	31
18C/36C Departure	42	37	41	37	44	38	43	37
18L/36R Departure	44	39	44	38	45	39	45	39

Source: Landrum & Brown analysis, 2021

10.2 Aircraft Taxi Times and Delay

The average arrival, departure, and overall taxi times are presented in **Exhibit 10-2**. The No Action, Alternative 1, and Alternative 3 numbers are shown for the 2028 and 2033 demand levels. The taxi times capture delays experienced by aircraft during taxi, including time spent waiting at runway crossings and in the queue for takeoff. The alternatives have substantially lower taxi times than the No Action primarily due to the improved airfield geometry and the resulting reduced congestion around the ramp area. Alternative 1 has lower average arrival taxi times than Alternative 3 because arrivals land on Runway 18C/36C and have a short taxi in to the terminal area. Alternative 3 arrivals use the new runway and must taxi around the EAT. This is reversed for departure taxi times with Alternative 3 departures using Runway 18C/36C and Alternative 1 departures having to cross 18C/36C to depart on the new runway.

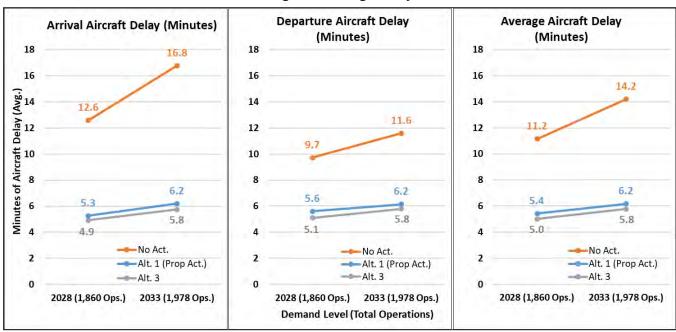
Arrival Taxi Time (Minutes) Departure Taxi Time (Minutes) Overall Taxi Time (Minutes) 22 22 22 21.7 20.4 20 20 20 18.4 •19,3 (Avg.) 18 18 16.9 18.2 ë 16 17,5 15.1 16 16 Taxi 15,2 14.6 13.3 14.9 ₺ 14 14 14 14.5 12.1 11.8 12 12 12 10.4 10.2 10 10 10 No Act. No Act. No Act. Alt. 1 (Prop Act.) -Alt. 1 (Prop Act.) -Alt. 1 (Prop Act.) Alt. 3 -Alt. 3 Alt. 3 2028 (1,860 Ops.) 2033 (1,978 Ops.) 2033 (1,978 Ops.) 2028 (1,860 Ops.) 2033 (1,978 Ops.) 2028 (1,860 Ops.) **Demand Level (Total Operations)**

Exhibit 10-2, No Action and Alternatives Weighted Average Taxi Times

Source: Landrum & Brown analysis, 2021

The average arrival, departure, and overall aircraft delays are shown in **Exhibit 10-3**. Both arrival and departure delays are slightly higher in Alternative 1 than Alternative 3 due to Runway 01/19 departures needing to cross Runway 18C/36C to reach the departure queue on Taxiway V. The departures experience delay at the runway crossing, and arrivals experience air delay due to increased arrival separations on Runway 18C/36C.

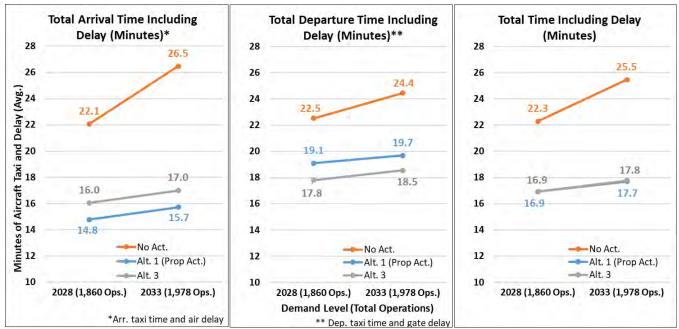
Exhibit 10-3, No Action and Alternatives Weighted Average Delay



Source: Landrum & Brown analysis, 2021

To provide a holistic measure of the alternatives, both taxi time and delay must be considered. **Exhibit 10-4** captures the total delay that aircraft experience by adding arrival air delay and departure gate holding delay to arrival and departure taxi times respectively. Both alternatives benefit from the additional runway, improved taxiway and ramp layout, and concourse extensions. These improvements result in lower air and ground delays than the No Action experiment. This difference is especially noticeable at the 2033 demand level, with the alternatives able to handle the increased traffic demand much more effectively than the No Action (note the steeper slope of the No Action lines compared to the alternatives lines). The overall airport performance for Alternatives 1 and 3 is very similar. The difference in arrivals and departures between Alternative 1 and Alternative 3 is due to the usage of Runway 18C/36C and 01/19. In Alternative 1, arrivals benefit from a short taxi in from Runway 18C/36C and departures must cross Runway 18C/36C to reach the new runway. In Alternative 3, departures use Runway 18C/36C, while arrivals use the new runway and must taxi around one of the EATs to reach the ramp area in periods of high demand.

Exhibit 10-4, No Action and Alternatives Total Time Including Delay



Source: Landrum & Brown analysis, 2021

Exhibit 10-5 presents the delay associated with the runway compared to non-runway delay. Runwayrelated delays include arrival air delays and departure queue delays. Other delays include taxi and gate delays. Alternatives 1 and 3 achieve lower delay in both categories compared to No Action, while performing very similarly to each other. The alternatives runway delays remain below the seven-minute threshold for acceptable delays.

Runway vs Non-Runway Delay (Minutes) 16 14.2 ■ Other Delay** 14 Runway Related Delay* Minutes of Aircraft Delay (Avg.) 12 11.2 4.8 10 3.6 8 6.2 5.8 5.4 6 5.0 1.5 1.1 1.4 9.4 1.0 4 7.5 4.7 4.6 2 4.0 4.0 0 Alt. 1 (Prop Alt. 1 (Prop No Act. Alt. 3 No Act. Alt. 3 Act.) Act.) 2028 (1,860 Ops.) 2033 (1,978 Ops.) **Demand Level (Total Operations)** * Arr. air and dep. queue delay ** Taxi and gate delay

Exhibit 10-5, No Action and Alternatives Runway vs Non-Runway Delay

Source: Landrum & Brown analysis, 2021

Conclusions 11

The EA simulation modeling analysis simulated two proposed airfield alternatives which provide the additional runway, taxiway, ramp and gate infrastructure necessary to accommodate the forecasted increase in aviation traffic at reasonable delay levels. The simulation modeling analysis was vetted through the official FAA DORA process which includes participation from FAA Office of Airports, Air Traffic Control staff from the Tower, TRACON and Traffic Management Units. In addition, representatives from American Airlines and other airlines, City of Charlotte Aviation Department, and Landrum & Brown participated in four working group meetings to discuss the simulation analysis methodology, approach, results and refinements. Based on the simulation modeling analysis conducted by L&B, all three alternatives would provide the required capacity and infrastructure to be able to accommodate the 2033 demand level of 1,978 daily operations while maintaining average runway delays of less than seven minutes per aircraft operation.

DORA (Direction, Oversight, Review & Agree) Coordination

Meeting #1 Materials Meeting #2 Materials Meeting #3 Materials Meeting #4 Materials



CLT DORA (Direction, Oversight, Review & Agree) Meeting #1



Agenda

- Introductions
- Meeting Objectives
- DORA Process
- EA Process Overview
- Review of Calibration
- -2019 Baseline & Future No Action Airfield Modeling Assumptions
- Next Steps

Meeting Objectives

Meeting Objectives

- To present an overview of the DORA process
- To present an overview of the Environmental Assessment (EA) process
- To present the 2019 Baseline and Future No Action modeling assumptions
- To present the next steps in the overall project

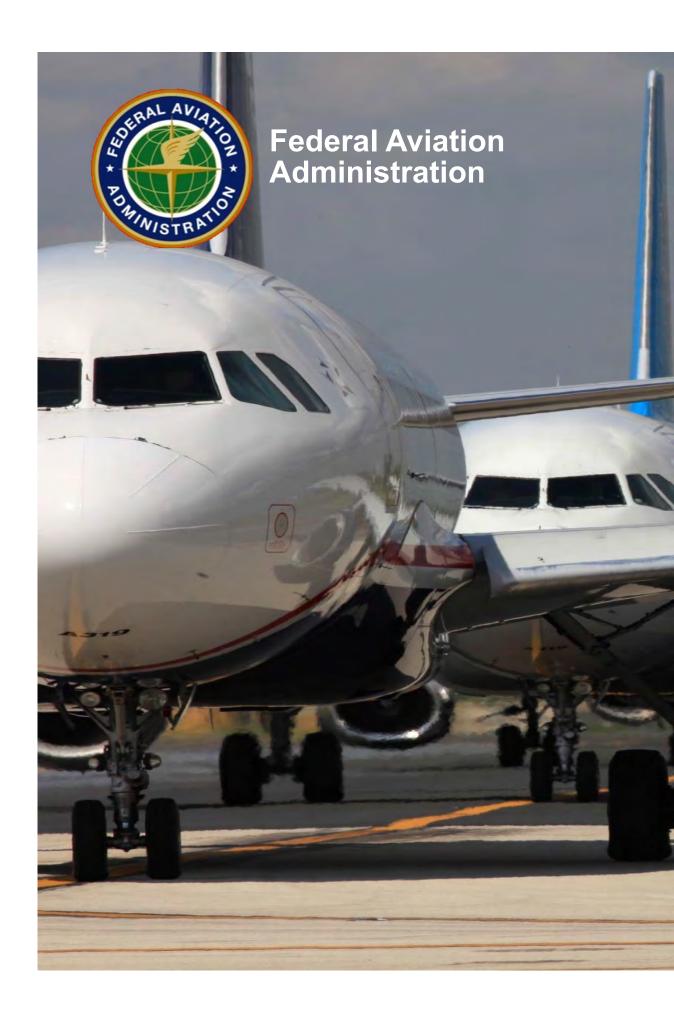
DORA Process

Charlotte Douglas International Airport EA DORA Process Overview

Prepared for: CLT EA DORA Meeting #1

By: Kent Duffy

Date: March 2020



What is DORA?

- DORA =
 Direction, Oversight, Review and Agree
- Obtaining and understanding controller input on operational issues and viability of proposed alternatives is a key to airport capacity development
- DORA has been applied successfully to other large-scale airport and airspace modernization efforts (e.g., O'Hare Modernization Program)



Objectives: Why are we here?

- Ensure collaboration w/ATO on simulation activities as needed to complete EA
 - Obtain input development of the simulation model
 - Revise and refine simulation model, rather than develop new alternatives
- Build from successful process used during planning phase
 - Update with recent changes: forecast trends, CRO, metroplex, heading usage, Atlantic coast routes, etc.
 - Validate operating assumptions used in the simulation model
 - Airspace flows and procedures, Runway usage and balancing, Aircraft separation and buffers, Taxiflows and ground movement, etc.
 - Review and validate airspace's ability to accommodate new runway throughput
- Collaboration ensures the simulation results can be used in the EA analyses with confidence



Planning Phase DORA Letter



U.S. Department of Transportation

Federal Aviation Administration

February 1, 2016

Mr. Jack Christine
Deputy Aviation Director
Charlotte-Douglas International Airport
5601 Wilkinson Boulevard
Charlotte, NC 28208

The additional analysis identified above is part of the normal maturation process as the potential airfield alternatives are further refined and assessed. The FAA considers the results of the first phase of the ACEP to be reasonable given the information that is currently available.

Winsome A. Lenfert

FAA, Division Manager Airports Southern Region

Prostell Thomas,

CLT Air Traffic Manager

Date

2/11

Re: Documentation of DORA Process, Charlotte-Douglas International Airport Airfield Capacity Enhancement Plan

This letter summarizes the process used by the Federal Aviation Administration (FAA) Office of Airports (ARP) and Air Traffic Organization (ATO) to obtain necessary input on operational feasibility of potential design alternatives considered as part of the Charlotte-Douglas International Airport (CLT) Airfield Capacity Enhancement Plan (ACEP). The ACEP is the first step of a long-term modernization effort to add significant capacity to CLT. The Direction, Oversight, Review, and Agree (DORA)

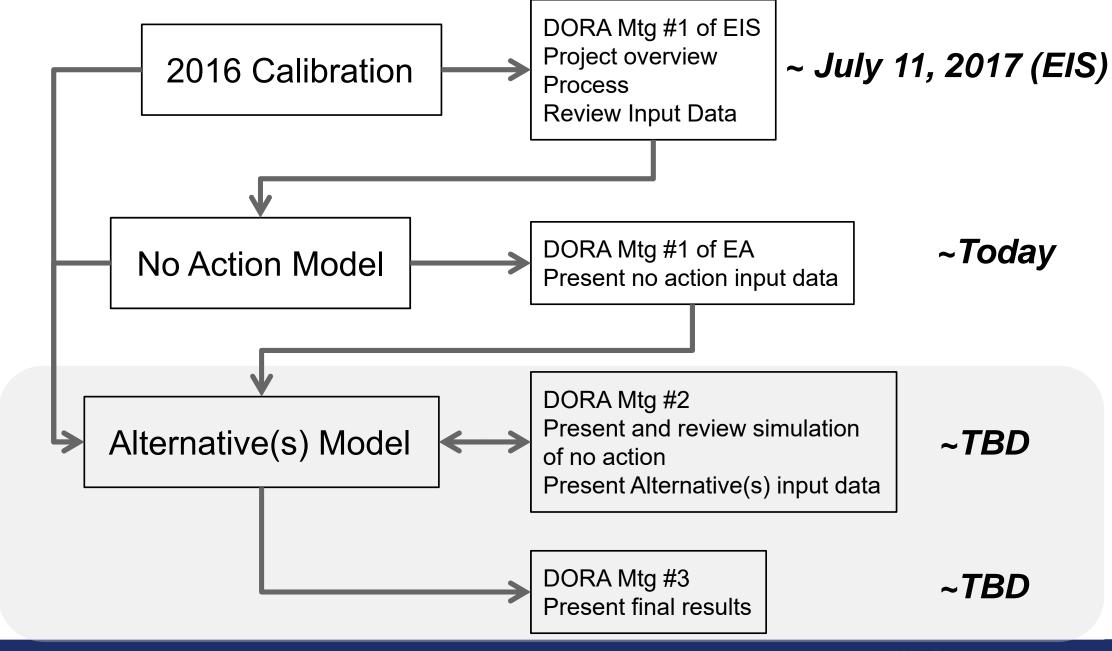
Desired Result: 2nd DORA Letter

Active ATC participation

- FAA Letter signed by ATO and ARP
- Explains process and summarizes meetings
- Identifies further analyses required in subsequent phases (e.g., design/ implementation), as needed
- Desired findings:
 - Modeling approach is <u>reasonable</u>
 - Modeling assumptions accurately reflects operational perspectives
 - Subsequent capacity, throughput and delay <u>results are reasonable</u> representations of the proposed airfield and airspace designs



DORA Process Relationship to Modeling



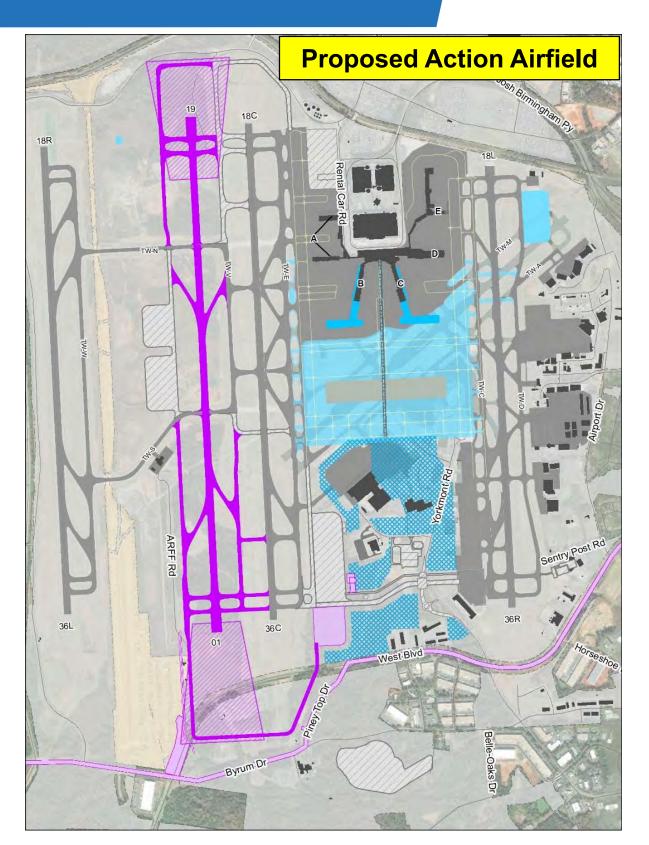
EA Process Overview

EA Process Overview - Background

- The CLT Environmental Impact Statement (EIS) that the Federal Aviation Administration (FAA) began was cancelled on February 27, 2019.
- The FAA cancelled the EIS because a runway length analysis determined only a 10,000 foot runway is required to meet the purpose and need.
- The FAA determined that this was a sufficient change to warrant cancellation of the EIS and conversion to an Environmental Assessment (EA).
- The City of Charlotte (Airport Sponsor) is responsible for preparing the EA.
- FAA is still the lead agency.
- Similar to the EIS, the EA will evaluate the potential direct, indirect, and cumulative environmental impacts that may result from the Proposed Action.

EA Process Overview – Proposed Action

- -4th Parallel Runway (10,000 feet long)
 - North and South End Around Taxiways
- Extensions of Concourse B and C
 - Decommissioning Runway 5/23
 - Crossfield Corridor
 - Dual Taxilanes Around Ramp
 - Requires the removal of gates off the end of Concourse D and E

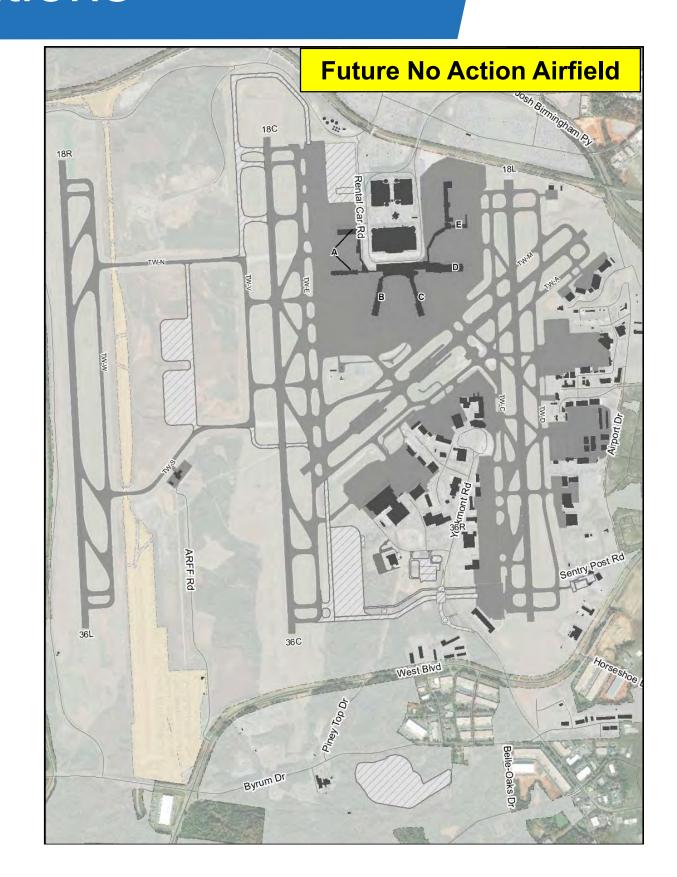


EA Process Overview

Publish Draft EA Conversion of EIS to EA Confirm Purpose and Need 8 **Public Review Period** 3 9 **Develop Alternatives** Hold Public Hearings **Study Affected Environment** 4 10 Publish Final EA **FAA** Issues the Federal 11 5 Analyze Environmental Impact **Decision** 6 **Identify Mitigation**

EA Process Overview - Simulations

- Simulations will:
 - Be used in developing the Purpose and Need, noise modeling, and air quality modeling.
 - conducted for the following scenarios:
 - 2016 Calibration
 - 2019 Baseline
 - 2028 Future No Action
 - 2033 Future No Action
 - 2028 Alternative(s)
 - 2033 Alternative(s)
 - use forecast of operations approved by the FAA.
 - include 3 independent projects as part of the Future No Action.
 - Deice Pad and crossfield taxiway
 - North End Around Taxiway around Runway 18C/36C and hold pads
 - Concourse A Phase II



Review of Calibration

Review of Calibration Findings

- As part of the EIS, the SIMMOD simulation model was calibrated for the 2016 existing conditions
- The calibrated model was approved by the FAA and shared in the EIS DORA meetings
- For purposes of the EA, the simulation model has been changed to the AirTOp simulation model and the previously approved 2016 calibration has been validated with AirTOp
- The AirTOp models produces results which are consistent with the previous calibration assessment
- The following slides summarize the results of the AirTOp calibration

Rolling Hour Operation Throughput

- Throughput rates are calibrated to 2016-2017 FAA ASPM or Aerobahn data and compared to the previous EIS calibration effort
- While the maximum throughput is achievable under certain circumstances, it is not a good indication of capacity. Therefore, the 90th percentile hourly rates is used as a measure of capacity per previous DORA stakeholder group recommendations

Total Operations Throughput

Simulated hourly throughput are within 10 percent of ASPM and EIS simulation effort

Airport Throughput						
	EIS – 90 th *	AirTOp – 90 th				
North VMC	121	118	117			
North IMC	114	116	114			
South VMC	121	121	117			
South IMC	112	116	115			

^{*} Source: Capacity/Delay Analysis and Airfield Modeling Technical Memorandum, CLT EIS ASPM data, 2016-2017

Arrival and Departure Throughput

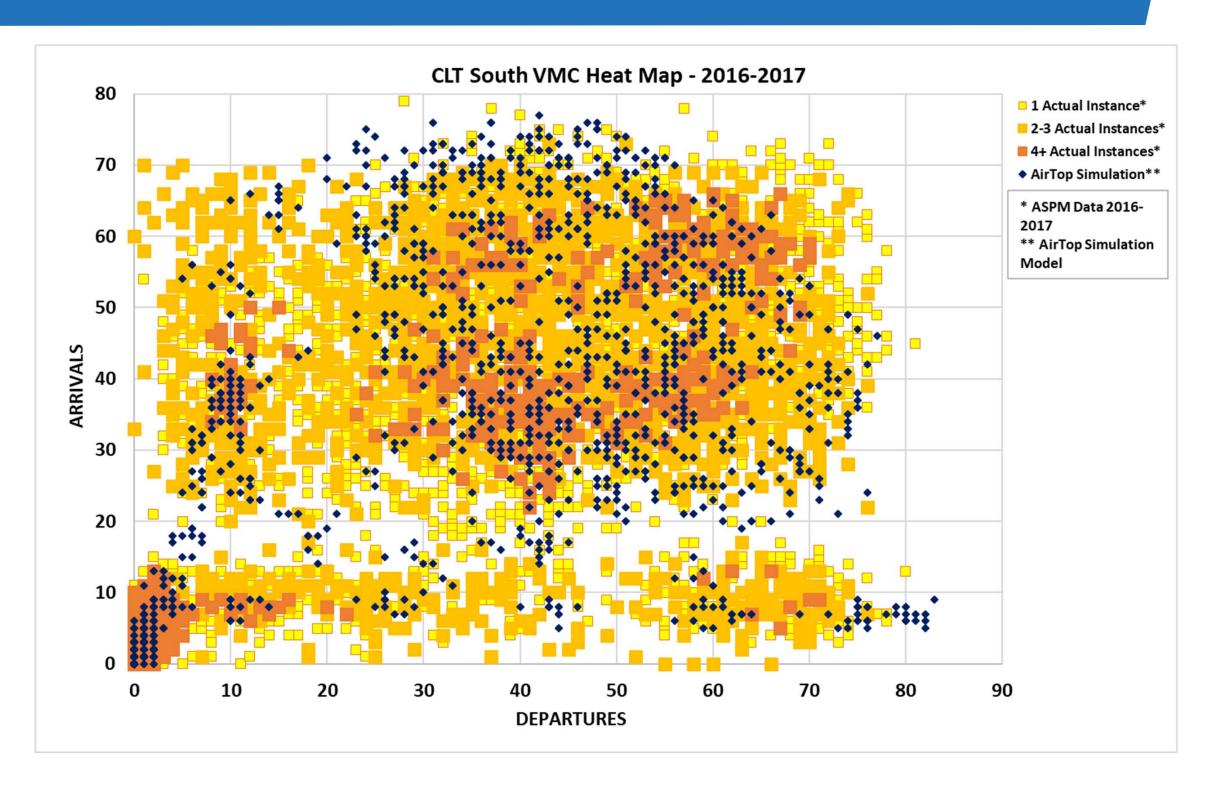
- Simulated hourly arrival and departure throughput match closely with ASPM and results of EIS simulation effort
- The FAA's Capacity Airport Arrival Rates or called arrival rates in VMC are much higher than actual hourly counts

Arrival and Departure Throughput								
	Operation	ASPM - Called Rate*	ASPM - Max*	ASPM - 90th	EIS - Max*	AirTOp - Max	AirTOp - 90th	
North VMC	Arr	92	79	63	73	76	67	
	Dep	69	82	67	78	82	63	
North IMC	Arr	75	76	64	73	72	64	
	Dep	65	79	62	68	78	59	
South VMC	Arr	92	78	63	77	77	68	
	Dep	82	81	66	78	83	64	
South IMC	Arr	75	77	64	74	77	66	
	Dep	65	74	58	68	79	61	

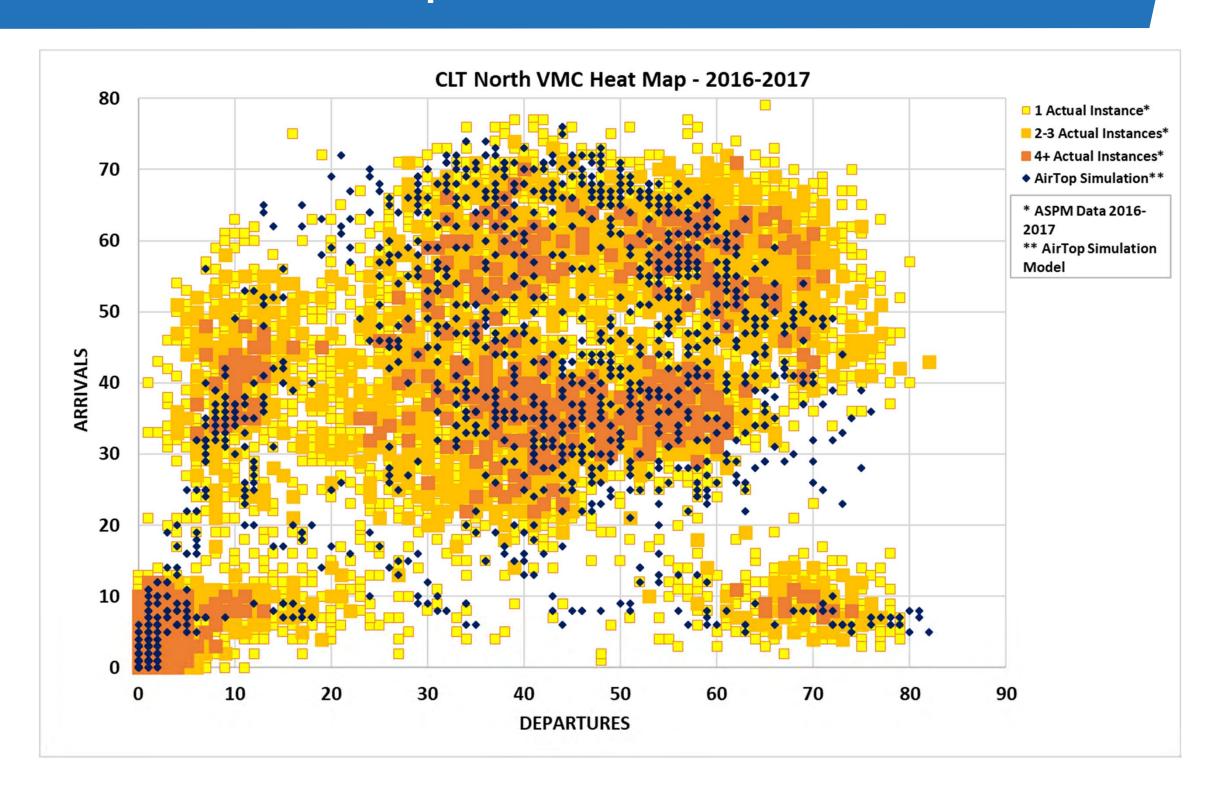
^{*} Source: Capacity/Delay Analysis and Airfield Modeling Technical Memorandum, CLT EIS ASPM data, 2016-2017

A variety of called rates were found in ASPM for a particular runway configuration, the most frequent called rate for each configuration is included in the table 90th percentile data was not provided in the EIS calibration report

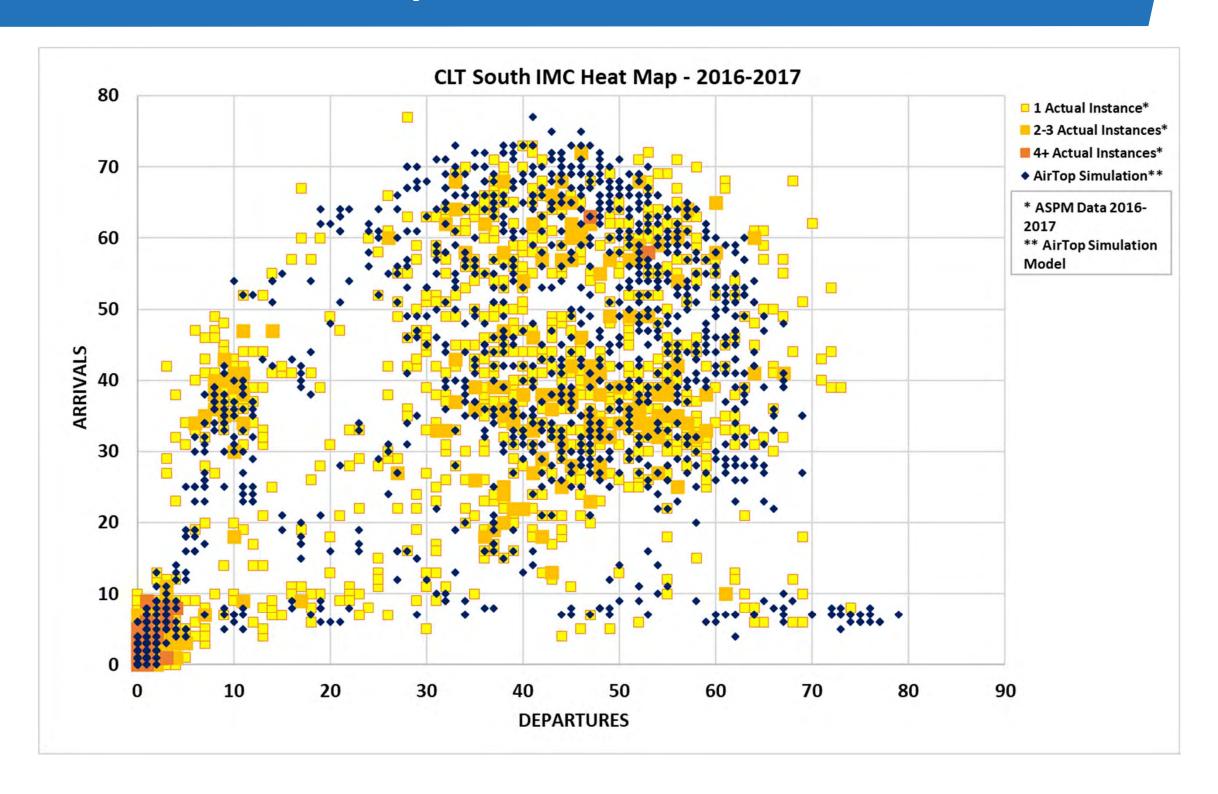
South VMC Heat Map



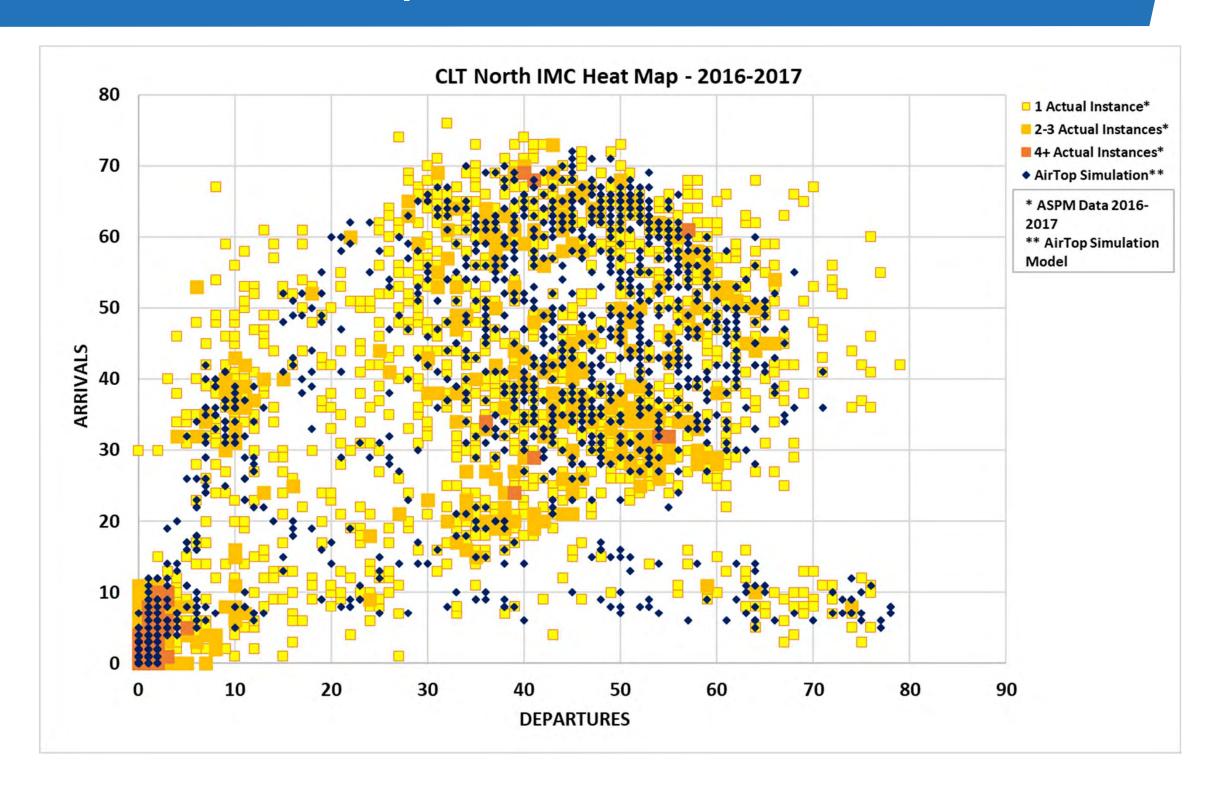
North VMC Heat Map



South IMC Heat Map



North IMC Heat Map



Aircraft Taxi Time Analysis

- A key metric in the calibration analysis are aircraft ground taxi times
- The FAA ASPM database was queried for data from 2016 regarding total taxi in (arrivals) and taxi out (departures) times
- AirTOp ground speeds are adjusted to ensure that the model produces taxi times which are within an acceptable range of actual data

2016 Average Total Taxi Times from FAA ASPM Database (minute)							
	Arrival Taxi In Time Departure Taxi Out Tim						
North Flow ASPM	11.0	20.3					
North VMC Simulation	11.9	20.2					
South Flow ASPM	12.4	19.5					
South VMC Simulation	11.6	17.6					

Calibration Simulation Modeling Results

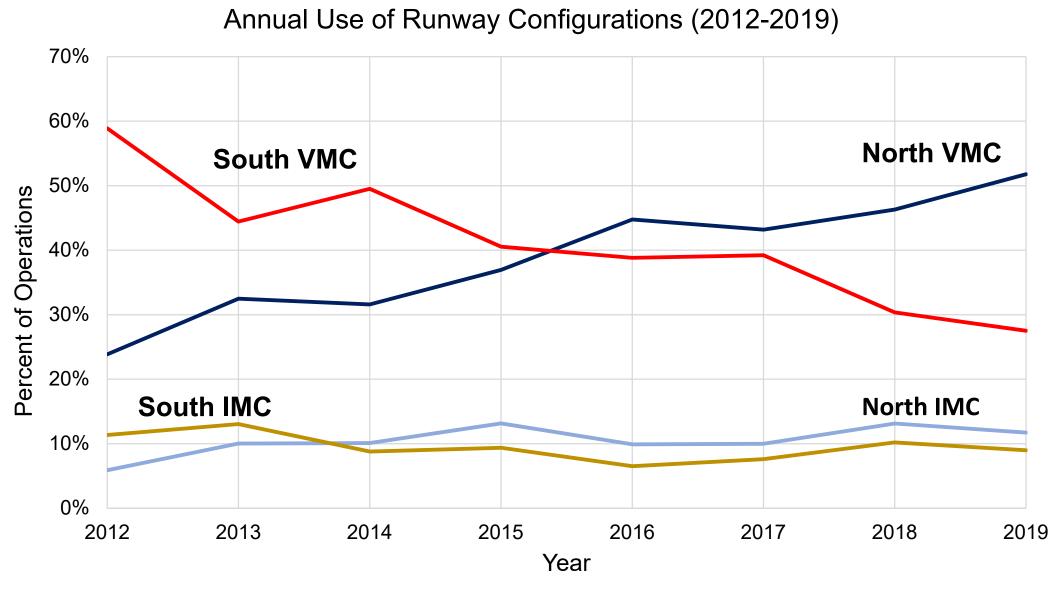
- Taxi time and delay metrics are presented for each runway configuration
- Annualization is calculated by averaging the metrics using the runway configuration use percentage

Baseline Simulation Model Results Summary (minute)								
	North VMC	North IMC	South VMC	South IMC	Annualization			
Avg arrival taxi time	11.9	13.1	11.6	12.2	11.9			
Avg departure taxi time	20.2	22.3	17.6	20.6	19.4			
Avg arrival air delay	6.1	7.5	5.1	5.6	5.8			
Avg arrival delay	11.3	13.8	9.6	10.8	10.9			
Avg departure taxi delay	7.0	9.1	6.8	9.5	7.3			
Avg departure delay	8.8	11.3	8.9	11.5	9.2			
Avg delay	10.1	12.5	9.2	11.2	10.1			
Use of Runway Configurations in 2016*		9.9%	38.8%	6.5%				

^{*} Based on ASPM configurations and called rates

Runway Configuration Changes

 Significant increase in percent of north flow operations and decrease in south flow operations over the past few years



2019 Baseline and Future No Action Airfield Modeling Assumptions

2019 Baseline and Future No Action Modeling Scenarios

- The use of Runway 5/23 has changed since the 2016 calibration
- In this section of the presentation, we review the assumptions of how the airfield is operating today
- These assumptions will be applied to the following simulation scenarios:
 - 2019 Baseline
 - 2028 Future No Action
 - 2033 Future No Action

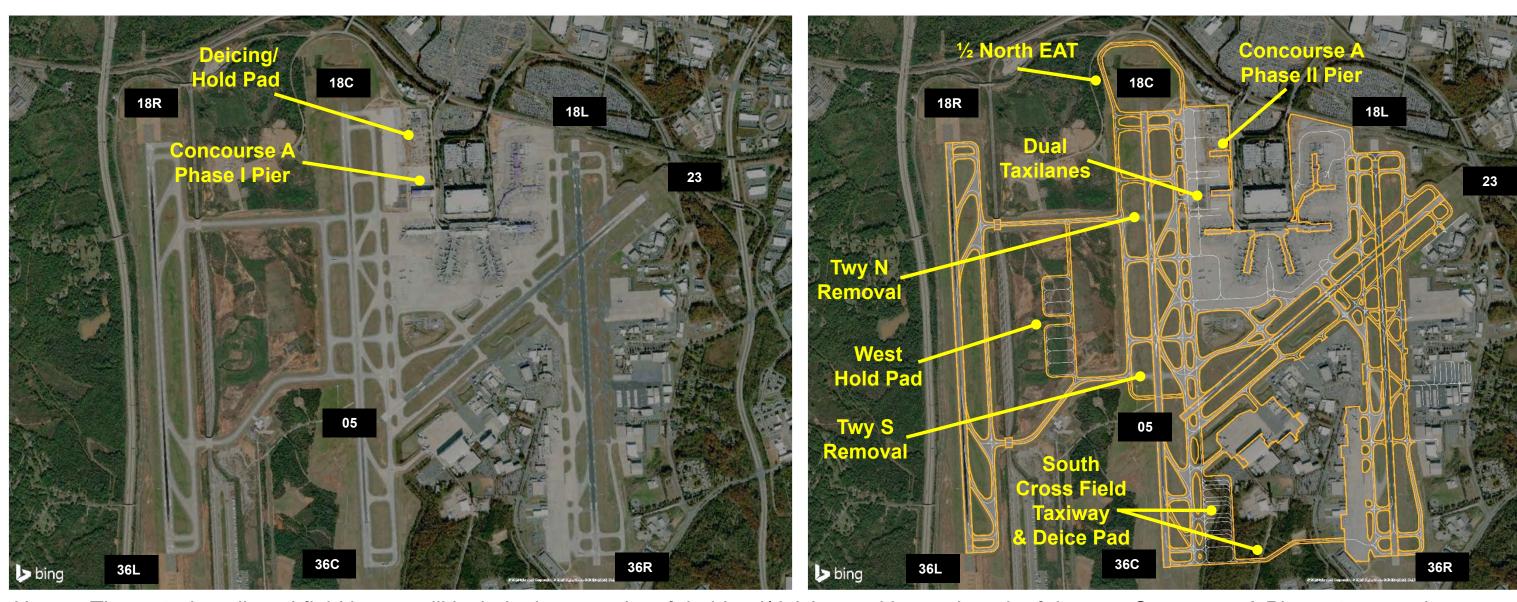
2019 Baseline and Future No Action Summary of Experiments

- Baseline Modeling Experiments
 - 2019 South VMC
 - 2019 South IMC
- Future No Action Modeling Experiments
 - 2028 South VMC
 - 2028 South IMC
 - 2028 North VMC
 - 2028 North IMC
 - 2033 South VMC
 - 2033 South IMC
 - 2033 North VMC
 - 2033 North IMC

Airfield Layouts for Simulation

2019 Baseline Airfield Layout

2028/2033 Future No Action Airfield Layout



Notes: The 2019 baseline airfield layout will include the new aircraft holdpad/deicing pad located north of the new Concourse A Phase 1 expansion

Simulation Flight Schedules

Total Daily Operations

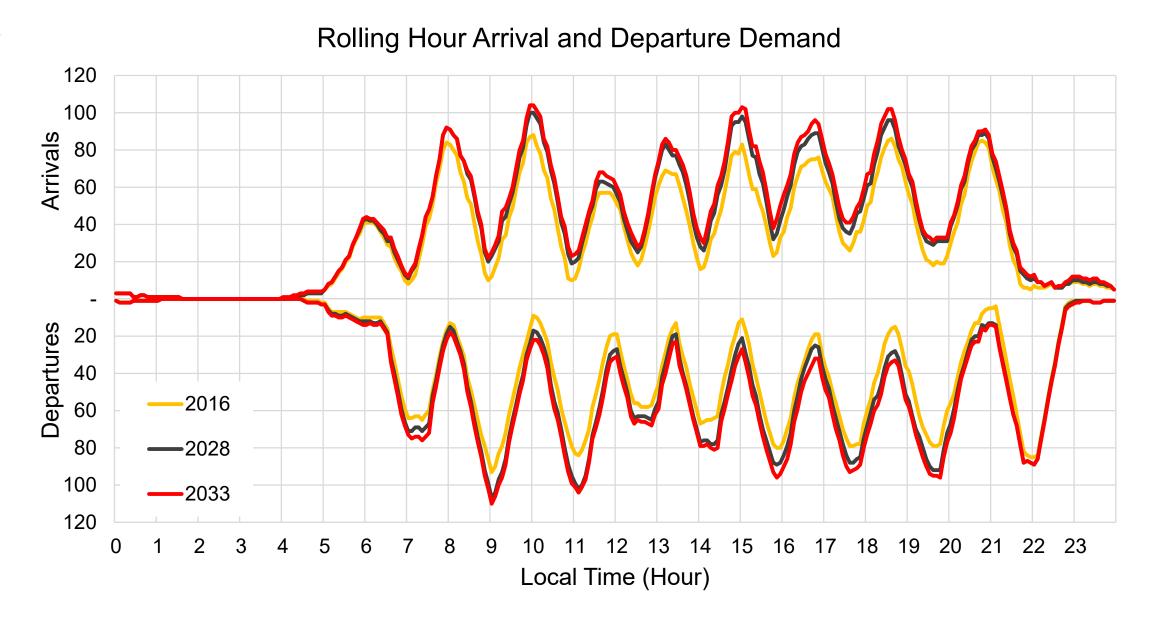
- 2016: 1,563

- 2019: 1,626*

- 2028: 1,860

- 2033: 1,978

*2019 schedule currently in development



Review of 2019 Baseline and Future No Action Modeling Assumptions

- Airfield Operating Assumptions
 - Terminal/Concourse Layouts
 - Airfield Deicing/Hold Pad Usage
 - Runway Operating Configurations
 - Aircraft Taxi Flows
 - Aircraft Ground Speeds
- Airspace Operating Assumptions
 - Airspace Route Structure
 - Intrail Separations (Wake RECAT)
 - Airspace Route Structure

Terminal/Concourse Layout Assumptions

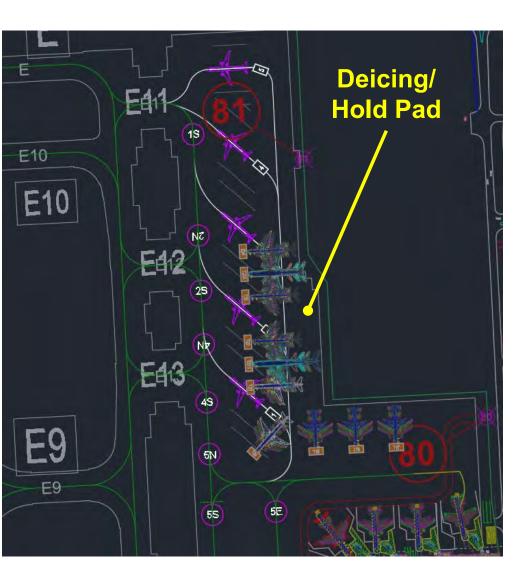
- Aircraft gate layouts will be input into AirTOp and will include airline assignment and aircraft size restrictions to simulate actual gate usage
- General Aviation and Cargo (FDX/UPS) operations were simulated and parked at their primary facility located on the existing airfield
- Aircraft holdpad and towing areas simulated
- Modeling of future gate capacity

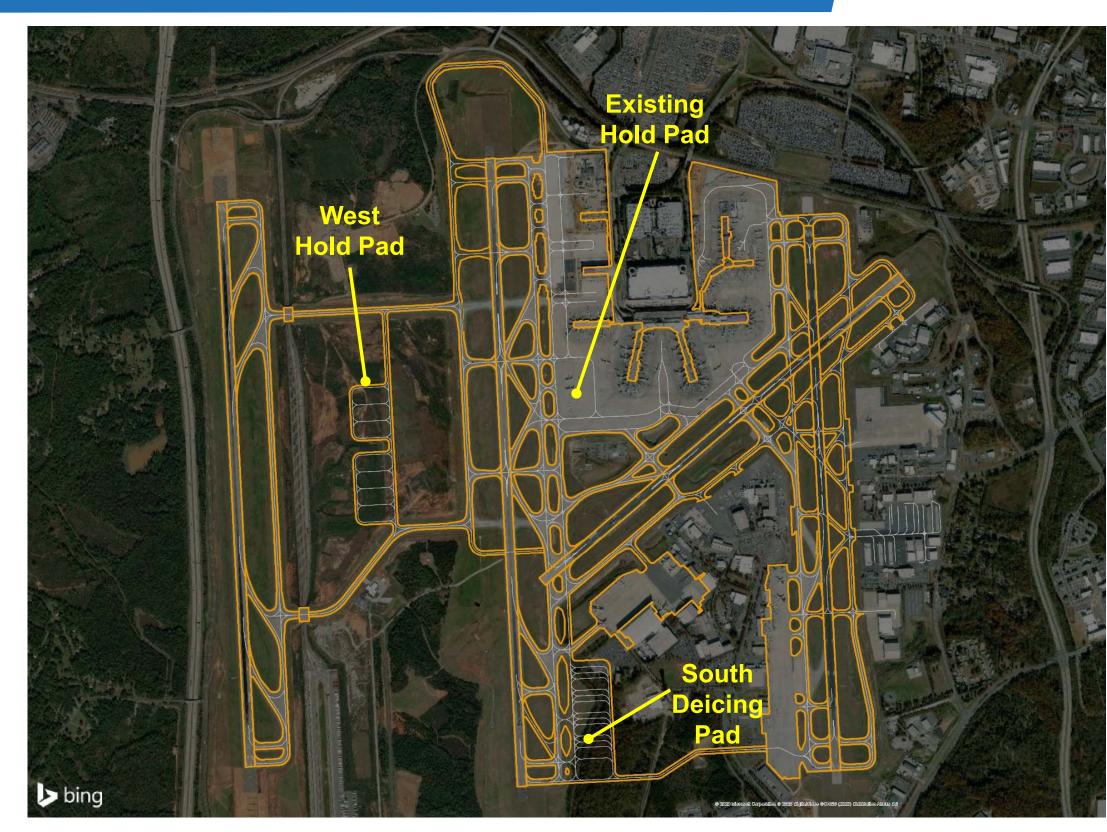
Airline Gating Assignment Assumptions (2019 Baseline)					
Concourse A	AA, DL				
Concourse A (Phase 1 Expansion)	OALs				
Concourse B & C	AA Mainline				
Concourse D	AA Mainline, LH				
Concourse E AA Regional					

Airline Gating Assignment Assumptions (2028/2033 Future No Action)					
Concourse A AA					
Concourse A (Phase 1 Expansion)	OALs				
Concourse A (Phase 2 Expansion)	OALs				
Concourse B & C	AA Mainline				
Concourse D	AA Mainline, LH				
Concourse E AA Regional					

Airfield Deicing/Hold Pad Usage

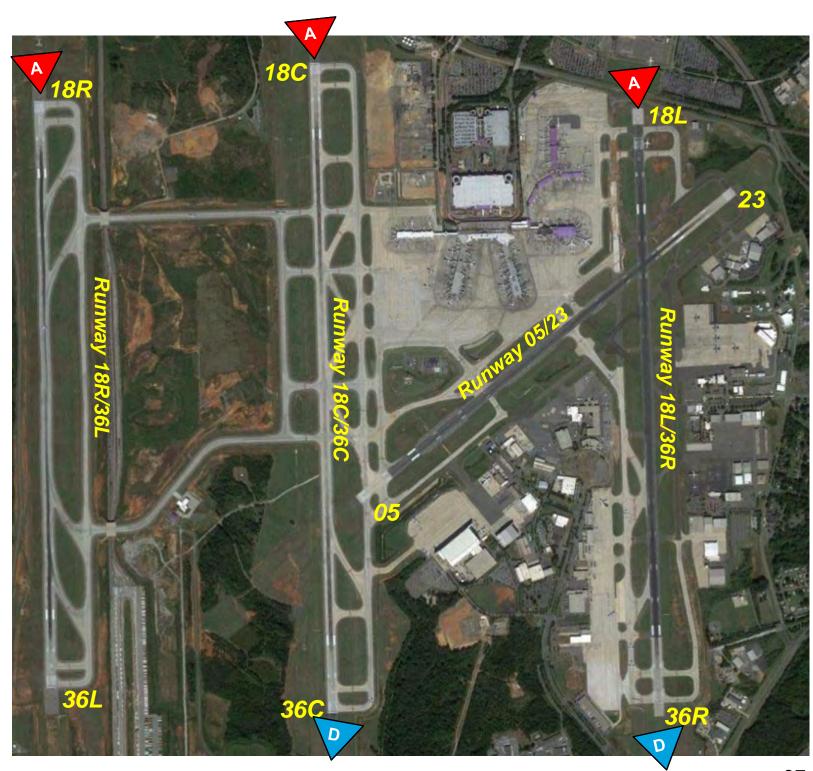
 Airfield deicing/hold pads will be simulated to accommodate arrivals waiting for gates, RON operations and aircraft towing operations





South VMC/IMC Runway Configuration

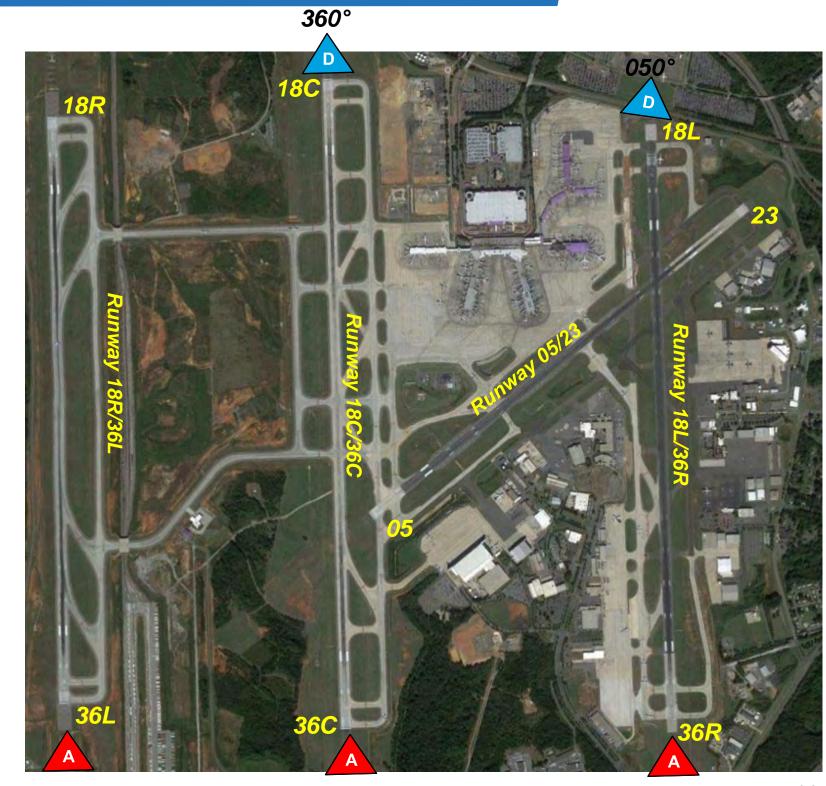
- 2019 Baseline and Future No Action runway use will be identical
- Primary Arrival Runways:
 - VMC: 18L & 18R
 - IMC: 18L & 18R
 - 18C (Trips)/Offload
- Primary Departure Runways:
 - 18C North & West
 - 18C International Heavy Eastbound
 - 18L East & South
- Runway 05/23 is used as a taxiway



190° 175°

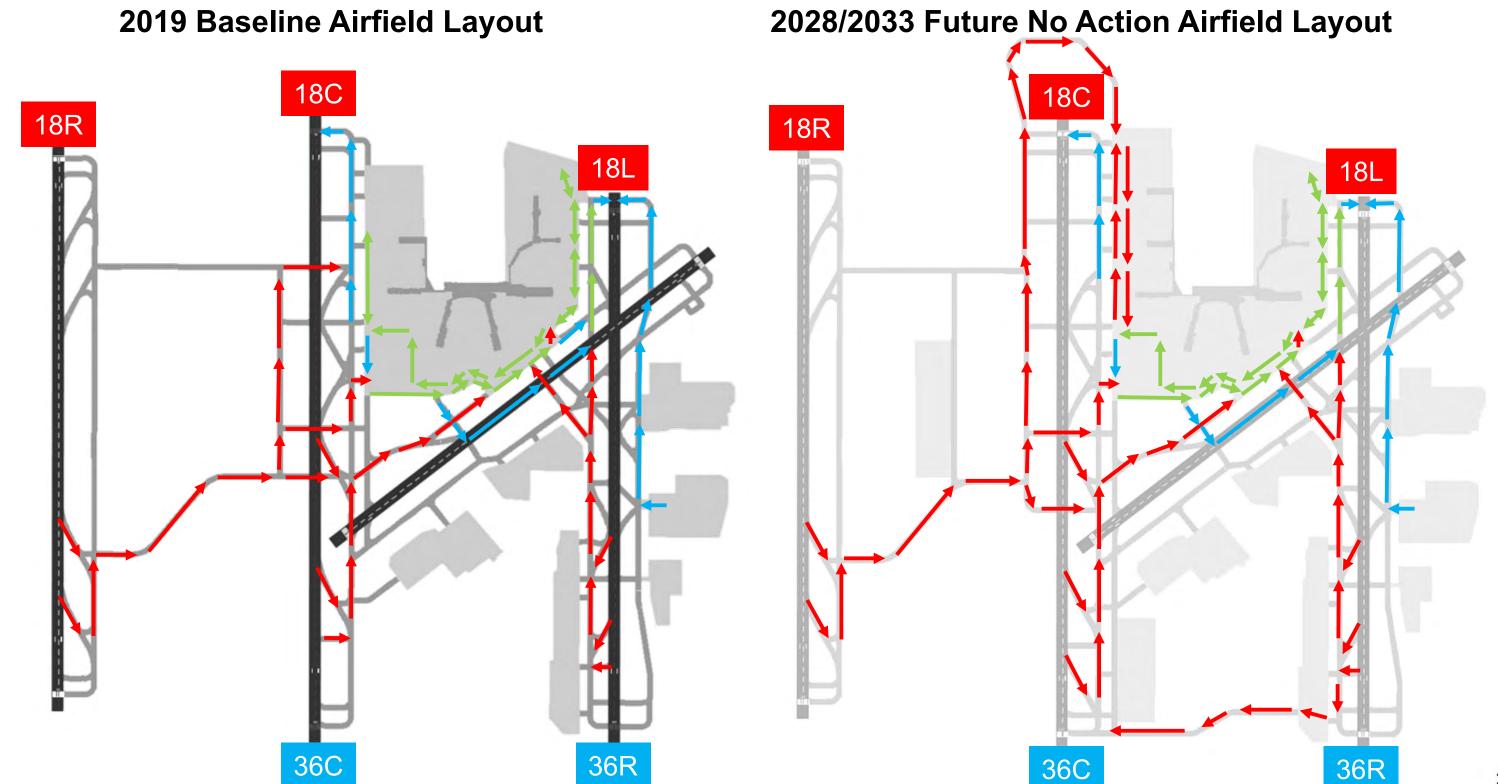
North VMC/IMC Runway Configuration

- 2019 Baseline and Future No Action runway use will be identical
- Primary Arrival Runways:
 - 36L & 36R
 - 36C (Trips)/Offload
- Primary Departure Runways:
 - 36C North & West
 - 36C International Heavy Eastbound
 - 36R East & South
 - Single jet departure heading, no fanning
 - Prop aircraft make turn immediately after becoming airborne
- Runway 05/23 is used as a taxiway



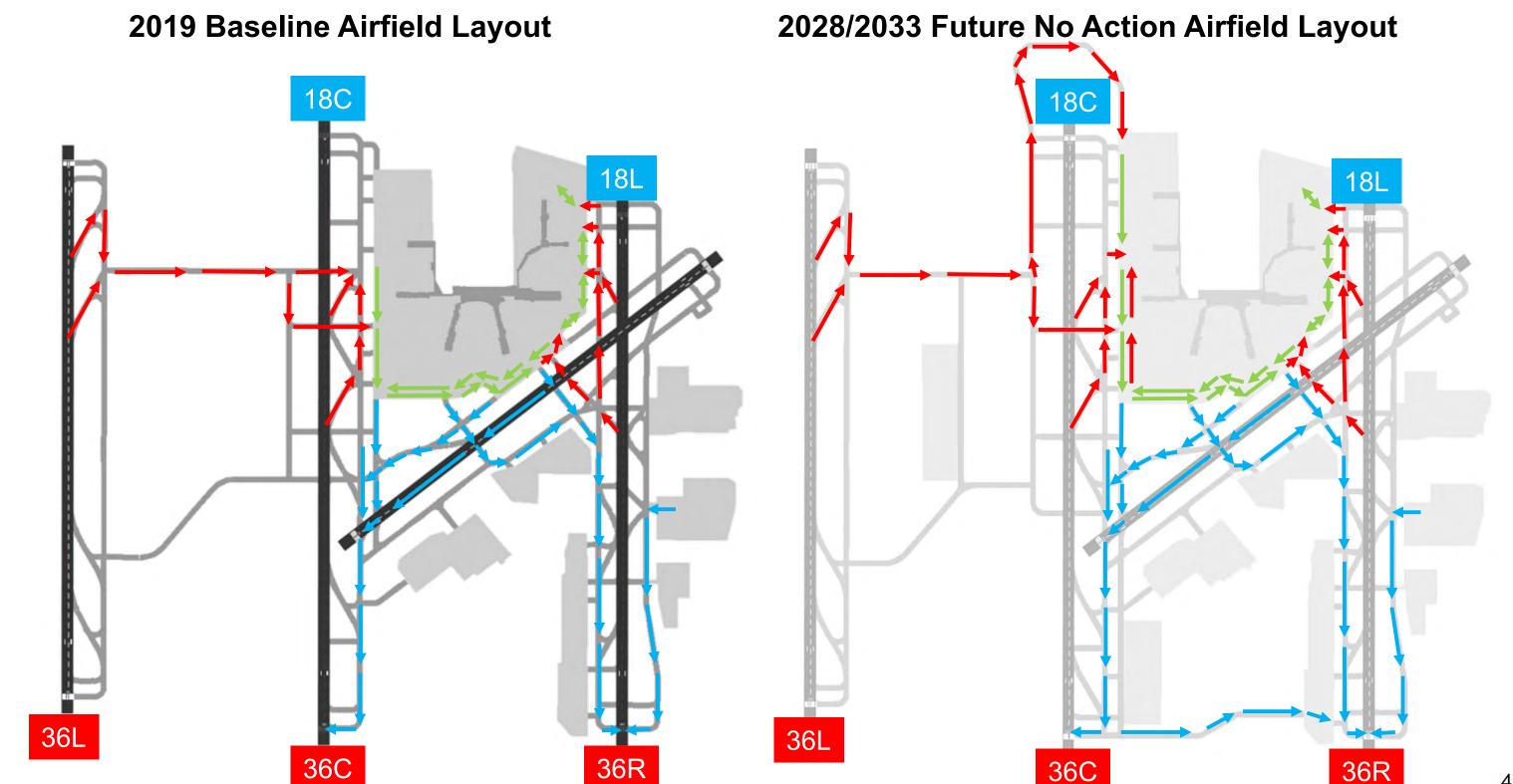
South Flow Aircraft Taxi Flows



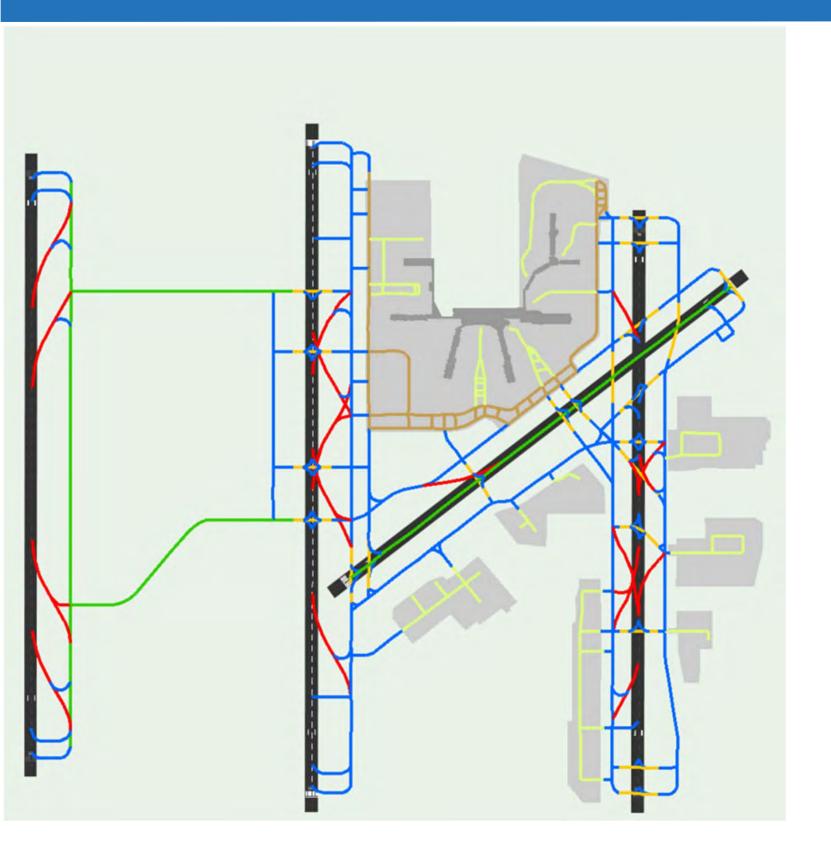


North Flow Aircraft Taxi Flows



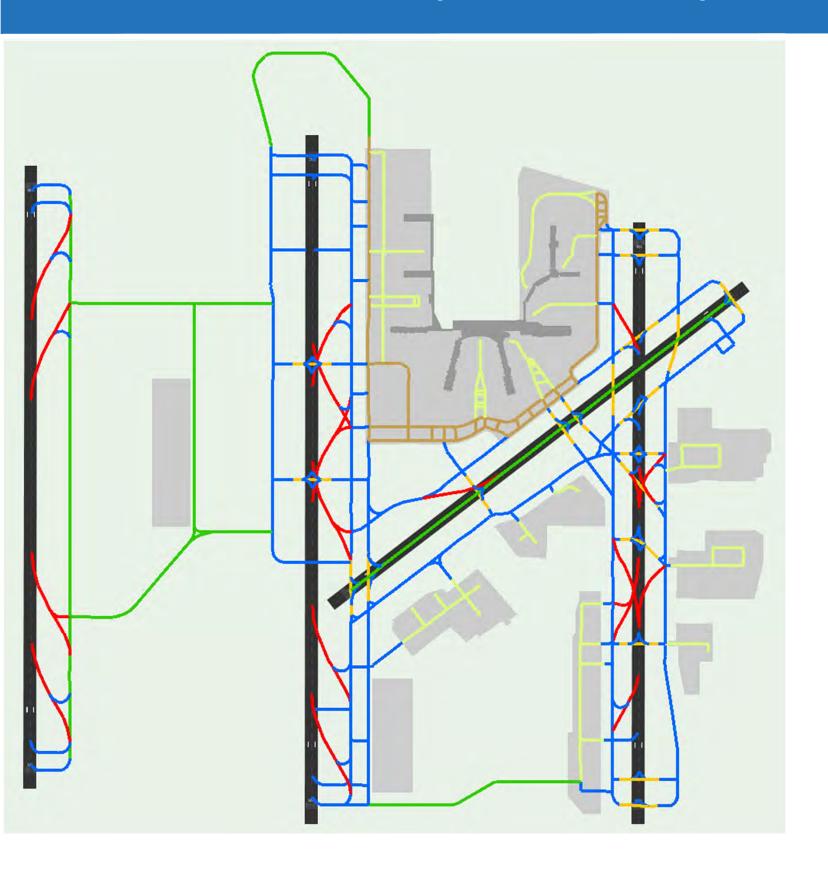


Airfield Ground Speed Assumptions – Baseline



High Speed Exits 32 knots
Outer Perimeter Taxiways 20 knots
Runway Crossings 18 knots
Taxiways 15 knots
Ramp Area Taxilanes 12 knots
Ramp Area Taxilanes 10 knots

Airfield Ground Speed Assumptions – Future No Action



High Speed Exits	32 knots
Outer Perimeter Taxiways*	20 knots
Runway Crossings	18 knots
Taxiways	15 knots
Ramp Area Taxilanes	12 knots
Ramp Area Taxilanes	10 knots

^{*}North EAT and south cross field taxiway are also assumed to have 20 knot speed limits

Airspace Operating Assumptions

Airspace Operating Assumptions/Overview

- The simulated airspace encompasses the CLT Metroplex terminal airspace which is an approximate 40nm radius around the Airport
- Currently published RNAV arrival and departure procedures were analyzed and used as the basis for constructing the simulation airspace
- Existing radar data was analyzed and used to determine origin/destination city pair airspace fix assignments for input into the simulation flight schedule
- 6 nm intrail separations were applied at arrival corner post fixes for transition from the center airspace to the terminal environment
- When operating a mixed used runway operation, arrivals block departures 2.3 nm from the runway threshold
- During mixed arrival/departure operation, minimum of 4.5 nm arrival intrail separation is kept to ensure one departure between every arrival

Intrail Separation Minimums – Wake RECAT

- Simulation of FAA Wake RECAT separation criteria will be applied to the Baseline and Future No Action scenarios
- Previous simulation modeling and intrail separation analyses indicate minimum arrival separations on final approach range between 3.3nm (VMC) and 3.8nm (IMC)

TBL 5-5-1
Wake Turbulence Separation for Directly Behind

		Follower								
		Α	В	С	D	E	F	G	Н	I
	Α		4.5 NM	6 NM	6 NM	7 NM	7 NM	7 NM	7 NM	8 NM
	В		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	5 NM	5 NM
	С					3.5 NM	3.5 NM	3.5 NM	5 NM	5 NM
_	D		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	5 NM	5 NM
Leader	E									4 NM
Fe	F									
	G									
	Н									
	I									

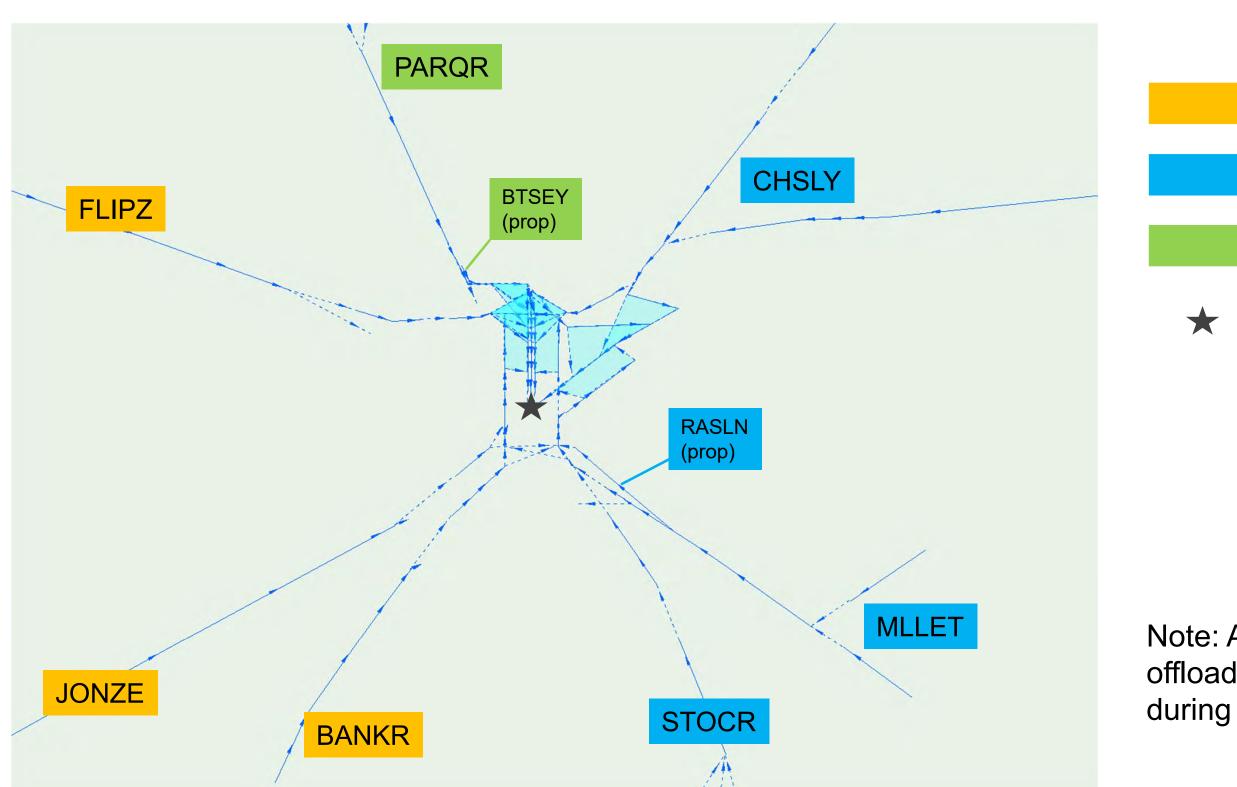
TBL 5-5-2 Wake Turbulence Separation for On Approach

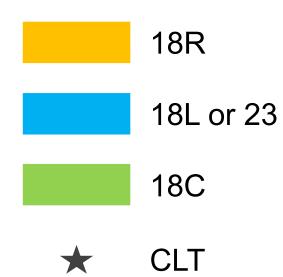
		Follower								
		Α	В	С	D	E	F	G	Н	I
	Α		4.5 NM	6 NM	6 NM	7 NM	7 NM	7 NM	7 NM	8 NM
	В		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	5 NM	6 NM
	С					3.5 NM	3.5 NM	3.5 NM	5 NM	6 NM
<u>.</u>	D		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	6 NM	6 NM
Leader	E									4 NM
Ľ	F									4 NM
	G									
	Н									
	I									

Source: JO 7110.126A - Consolidated Wake Turbulence (CWT) Separation Standards

Effective Date: September 28, 2019

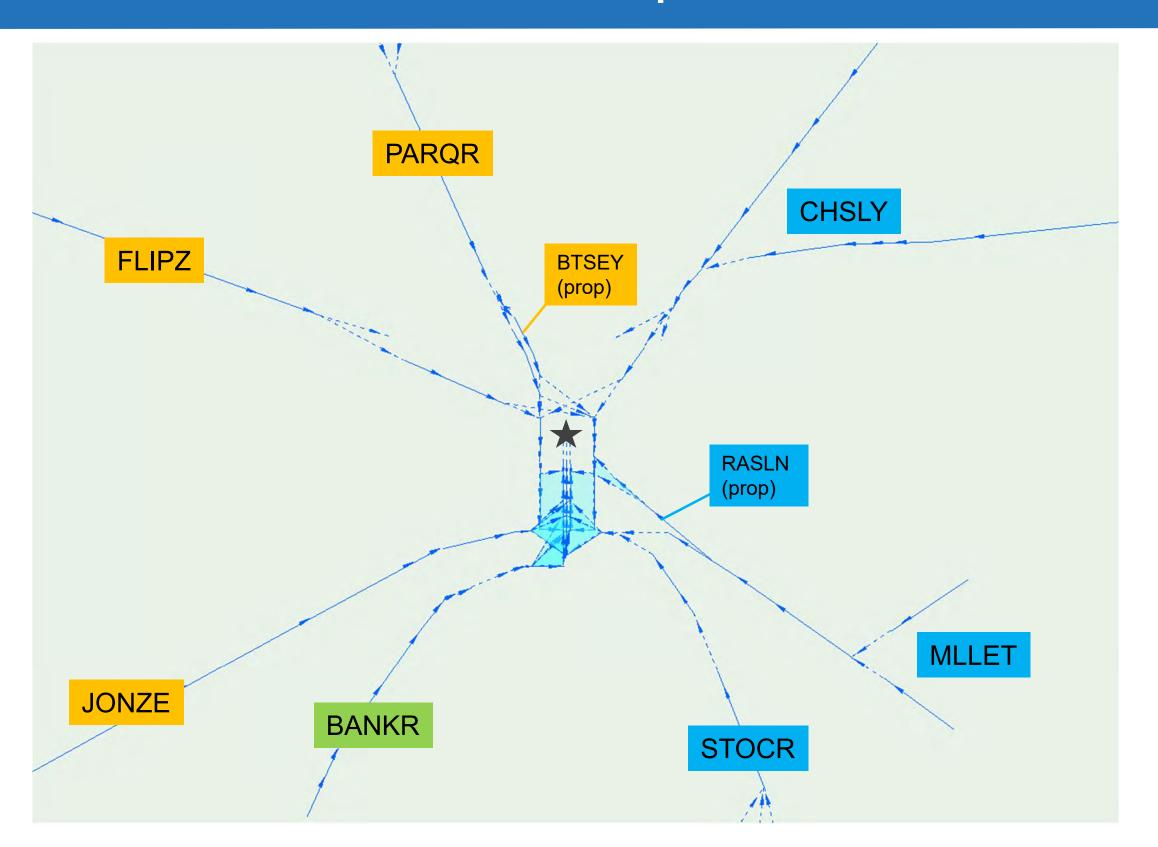
South Flow Arrival Airspace

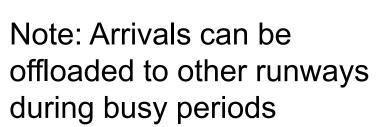




Note: Arrivals can be offloaded to other runways during busy periods

North Flow Arrival Airspace





36L

36R

36C

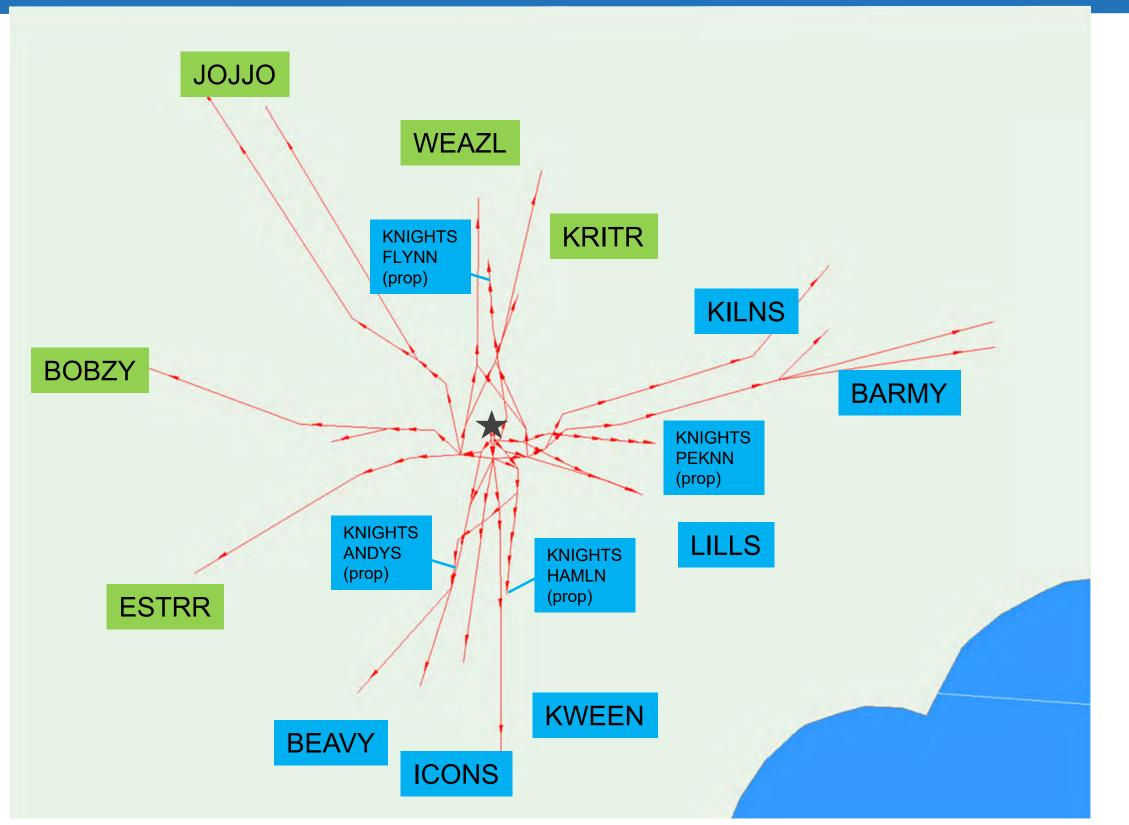
CLT

Sample Origins by Arrival Routing

Arrival Route	Origin Examples*				
<u>North</u>					
PARQR TAFTT	MDW, CLE, MSP, ORD, SEA				
	<u>East</u>				
CHSLY LYH	BOS, EWR, FRA, JFK, LHR				
<u>South</u>					
BANKR	JAX, MIA				
<u>West</u>					
JONZE BESTT	ATL, IAH, MEX				
FLIPZ COMDY	DEN, DFW, LAX, PDX, SFO				

^{*}Note that these lists are not all-inclusive. They merely contain examples of some of the major airports that use each route.

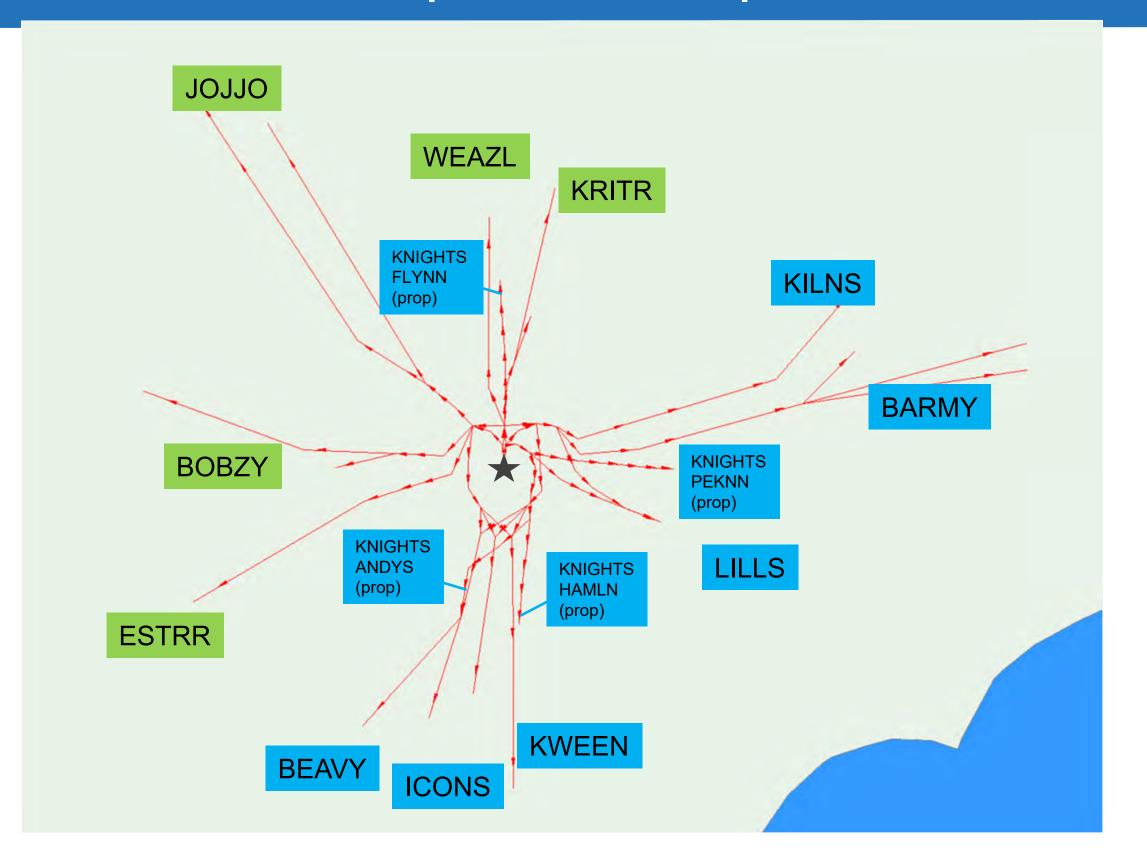
South Flow Departure Airspace

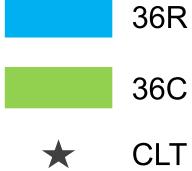




Note: KRITR departures can be offloaded to 18L during busy periods

North Flow Departure Airspace





Note: BEAVY, ICONS, and KWEEN departures can be offloaded to 36C during busy periods

Sample Destinations by Departure Routing

Departure Route	Destination Examples*
	<u>North</u>
JOJJO DODGE	MDW, ORD, PDX, SEA
KRITR FILDS	BUF, PIT, YYZ
	<u>East</u>
KILNS	BWI, IAD, EWR, PHL
BARMY RDU	BOS, FRA, LGA
	<u>South</u>
ICONS	JAX, MIA
	<u>West</u>
ESTRR	AUS, DAL, IAH, MEX
BOBZY BNA	DEN, DFW, LAX, PHX, SFO

^{*}Note that these lists are not all-inclusive. They merely contain examples of some of the major airports that use each route.

Next Steps

- Provide comments to EA Team by March 31, 2020
 - Send comments to spotter@landrum-brown.com
- Incorporate comments from DORA Team
- Conduct 2019 Baseline & 2028 & 2033 Future No Action simulations
- Conduct alternatives evaluation
- DORA Meeting #2 present results of the 2019 Baseline & Future No Action simulations
 - Tentative 3rd week of April (week of the 20th)
- Continue preparation of the Draft EA



CLT DORA (Direction, Oversight, Review & Agree) Meeting #2
June 11, 2020



Agenda

- Introductions
- Meeting Objectives
- DORA Process
- EA Process Overview
- No Action Modeling Simulation Overview
 - Airfield Operating Assumptions
 - Airspace Operating Assumptions
- Proposed Action Modeling Assumptions
 - Airfield Operating Assumptions
 - Airspace Operating Assumptions
- Next Steps

Meeting Objectives

Meeting Objectives

- To present and review Future No Action modeling assumptions and simulation modeling results
- To present the Proposed Action airfield modeling assumptions
- To present the next steps in the overall project

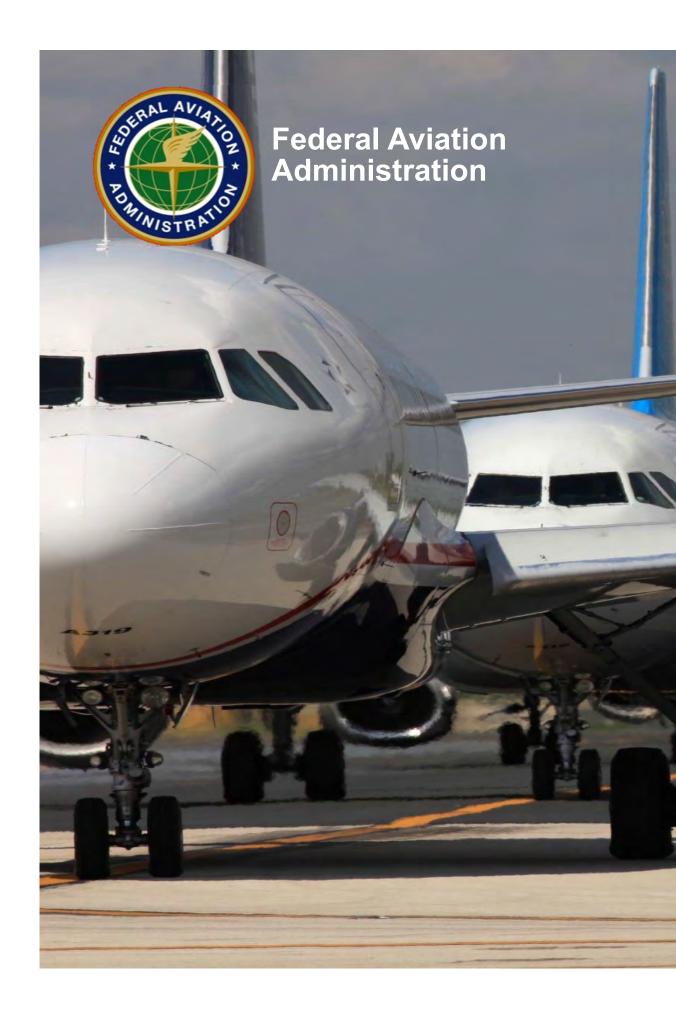
DORA Process

Charlotte Douglas International Airport EA DORA Process Overview

Prepared for: CLT EA DORA Meeting #2

By: Kent Duffy

Date: June 2020



What is DORA?

- DORA =
 Direction, Oversight, Review and Agree
- Obtaining and understanding controller input on operational issues and viability of proposed alternatives is a key to airport capacity development
- DORA has been applied successfully to other large-scale airport and airspace modernization efforts (e.g., O'Hare Modernization Program)



Objectives: Why are we here?

- Ensure collaboration w/ATO on simulation activities as needed to complete EA
 - Obtain input development of the simulation model
 - Revise and refine simulation model, rather than develop new alternatives
- Build from successful process used during planning phase
 - Update with recent changes: forecast trends, CRO, metroplex, heading usage, Atlantic coast routes, etc.
 - Validate operating assumptions used in the simulation model
 - Airspace flows and procedures, Runway usage and balancing, Aircraft separation and buffers, Taxiflows and ground movement, etc.
 - Review and validate airspace's ability to accommodate new runway throughput
- Collaboration ensures the simulation results can be used in the EA analyses with confidence



Planning Phase DORA Letter



U.S. Department of Transportation

Federal Aviation Administration

February 1, 2016

Mr. Jack Christine
Deputy Aviation Director
Charlotte-Douglas International Airport
5601 Wilkinson Boulevard
Charlotte, NC 28208

The additional analysis identified above is part of the normal maturation process as the potential airfield alternatives are further refined and assessed. The FAA considers the results of the first phase of the ACEP to be reasonable given the information that is currently available.

Winsome A. Lenfert

FAA, Division Manager Airports Southern Region

Prostell Thomas,

CLT Air Traffic Manager

05.041

Date

Re: Documentation of DORA Process, Charlotte-Douglas International Airport Airfield Capacity Enhancement Plan

This letter summarizes the process used by the Federal Aviation Administration (FAA) Office of Airports (ARP) and Air Traffic Organization (ATO) to obtain necessary input on operational feasibility of potential design alternatives considered as part of the Charlotte-Douglas International Airport (CLT) Airfield Capacity Enhancement Plan (ACEP). The ACEP is the first step of a long-term modernization effort to add significant capacity to CLT. The Direction, Oversight, Review, and Agree (DORA)

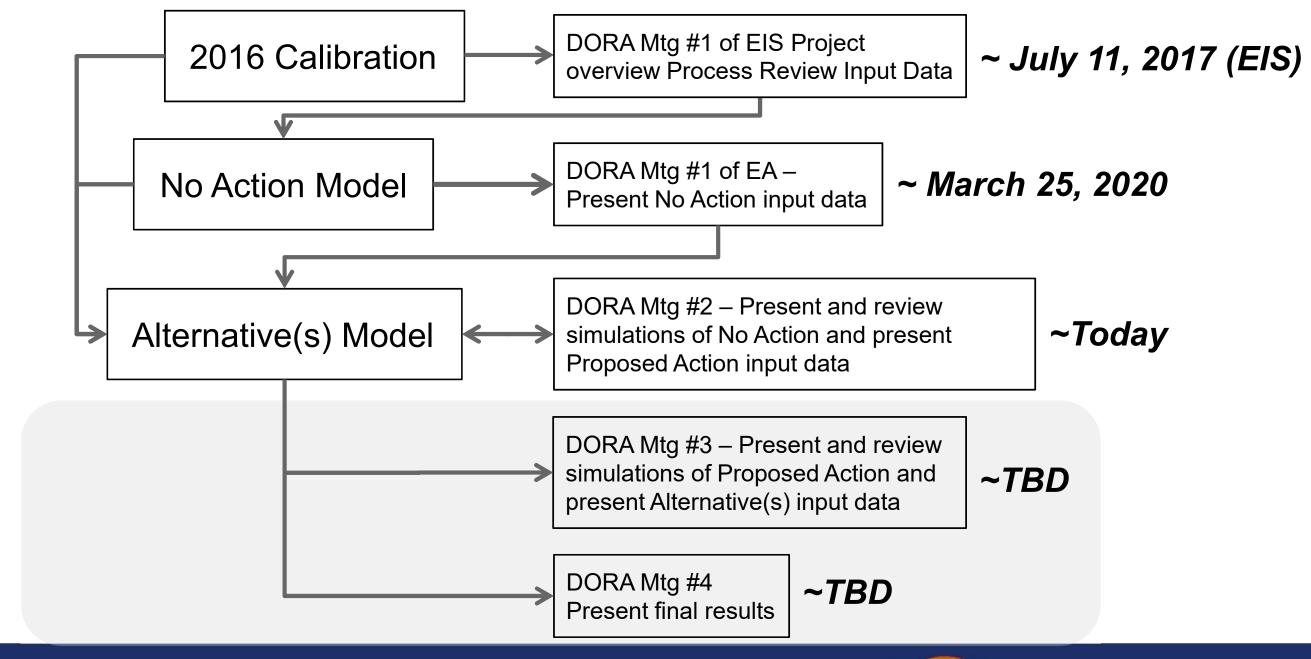
Desired Result: 2nd DORA Letter

Active ATC participation

- FAA Letter signed by ATO and ARP
- Explains process and summarizes meetings
- Identifies further analyses required in subsequent phases (e.g., design/ implementation), as needed
- Desired findings:
 - Modeling approach is <u>reasonable</u>
 - Modeling assumptions accurately reflects operational perspectives
 - Subsequent capacity, throughput and delay <u>results are reasonable</u> representations of the proposed airfield and airspace designs



DORA Process Relationship to Modeling



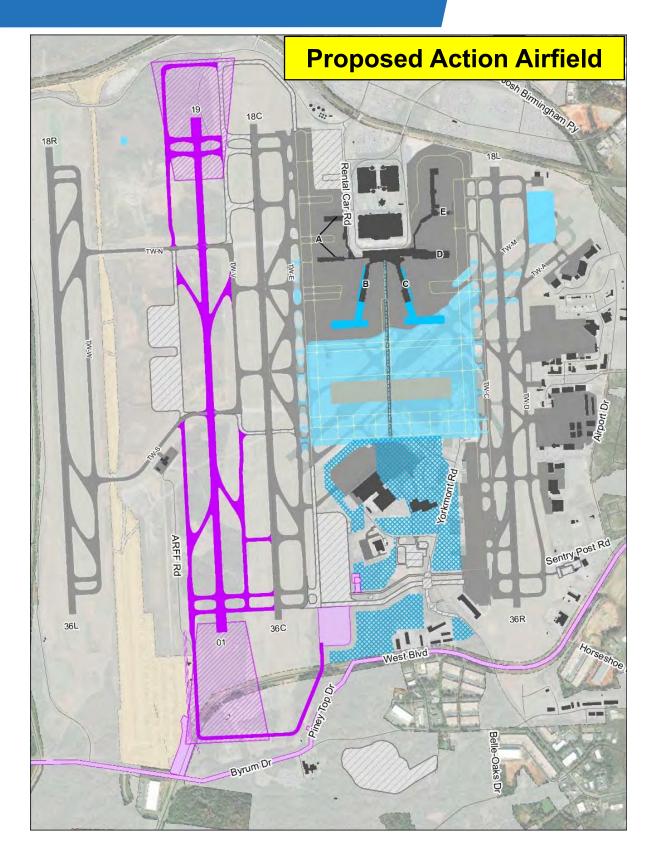
EA Process Overview

EA Process Overview - Background

- The CLT Environmental Impact Statement (EIS) that the Federal Aviation Administration (FAA) began was cancelled on February 27, 2019.
- The FAA cancelled the EIS because a runway length analysis determined only a 10,000 foot runway is required to meet the purpose and need.
- The FAA determined that this was a sufficient change to warrant cancellation of the EIS and conversion to an Environmental Assessment (EA).
- The City of Charlotte (Airport Sponsor) is responsible for preparing the EA.
- FAA is still the lead agency.
- Similar to the EIS, the EA will evaluate the potential direct, indirect, and cumulative environmental impacts that may result from the Proposed Action.

EA Process Overview – Proposed Action

- -4th Parallel Runway (10,000 feet long)
 - North and South End Around Taxiways
- Extensions of Concourse B and C
 - Decommissioning Runway 5/23
 - Crossfield Corridor
 - Dual Taxilanes Around Ramp
 - Requires the removal of gates off the end of Concourse D and E

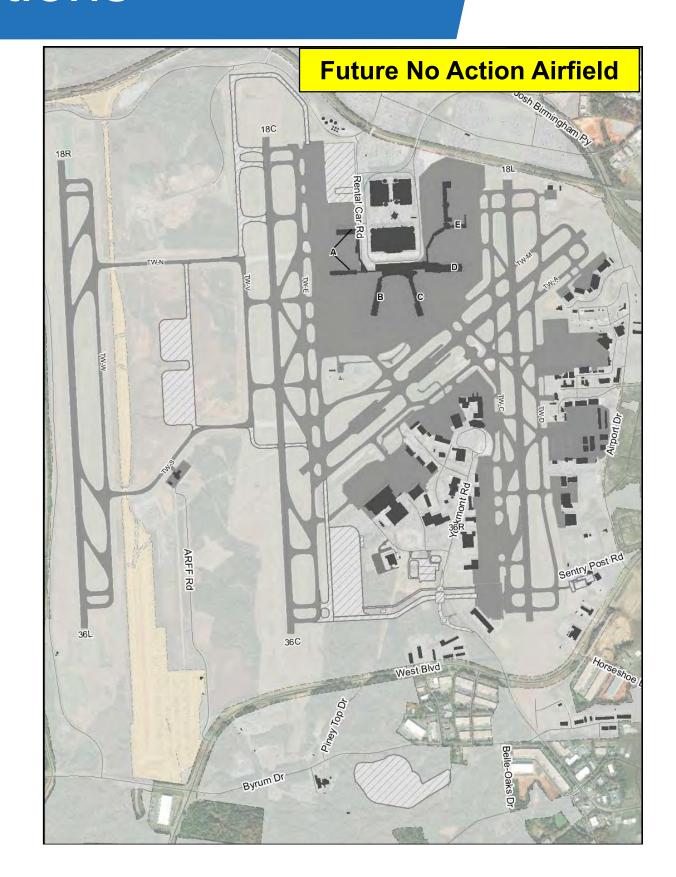


EA Process Overview

Conversion of EIS to EA Publish Draft EA Confirm Purpose and Need 8 **Public Review Period** 3 **Develop Alternatives** 9 Hold Public Hearings Study Affected Environment 4 10 Publish Final EA **FAA** Issues the Federal 11 5 **Analyze Environmental Impact Decision** 6 **Identify Mitigation**

EA Process Overview - Simulations

- Simulations will:
 - Be used in developing the Purpose and Need, noise modeling, and air quality modeling.
 - Conducted for the following scenarios:
 - 2016 Calibration
 - 2019 Baseline
 - 2028 Future No Action
 - 2033 Future No Action
 - 2028 Alternative(s)
 - 2033 Alternative(s)
 - Use forecast of operations approved by the FAA.
 - Include 3 independent projects as part of the Future No Action.
 - Deice Pad and crossfield taxiway
 - North End Around Taxiway around Runway 18C/36C, hold pads and threshold displacement (1,235 feet)
 - Concourse A Phase II



No Action Modeling Simulation Overview

Follow Up Comments Addressed From DORA #1

- The following items were identified for further discussion by Scott O'Halloran with FAA Local Air Traffic and have been addressed:
 - The use of the new west hold pads may be limited as most aircraft without a gate would have taxied past those positions by the time they are notified they need to hold.
 - The use of Taxiway B and west on Runway 05/23 was identified as a route that doesn't happen or is not common within the existing airfield.
 - Safety issues regarding the Future No Action taxi flows in South Flow (i.e. the use of Taxiway B and Runway 05/23, the amount of flow on the ramp, and one-way flow on Taxiway E).

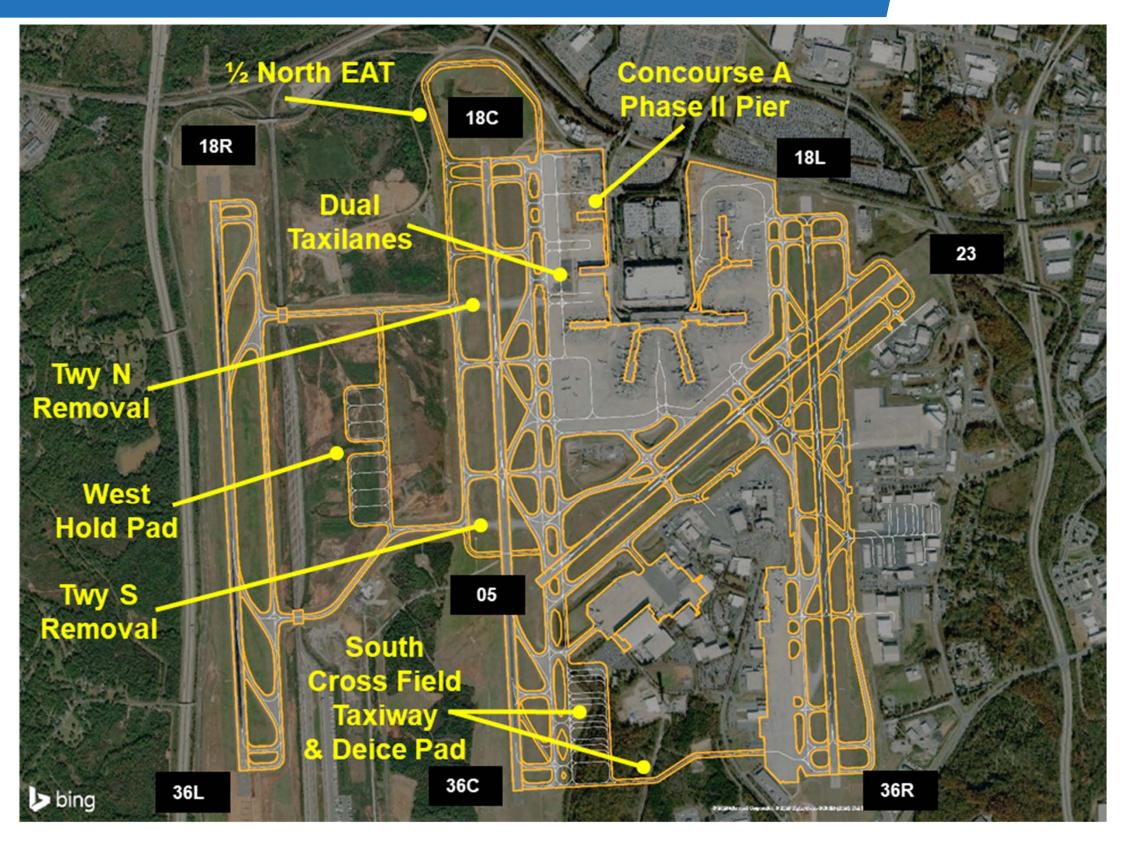
No Action Airfield Layout for Simulation

South Flow Experiments

- 2028 South VMC
- 2028 South IMC
- 2033 South VMC
- 2033 South IMC

North FlowExperiments

- 2028 North VMC
- 2028 North IMC
- 2033 North VMC
- 2033 North IMC



Simulation Flight Schedules

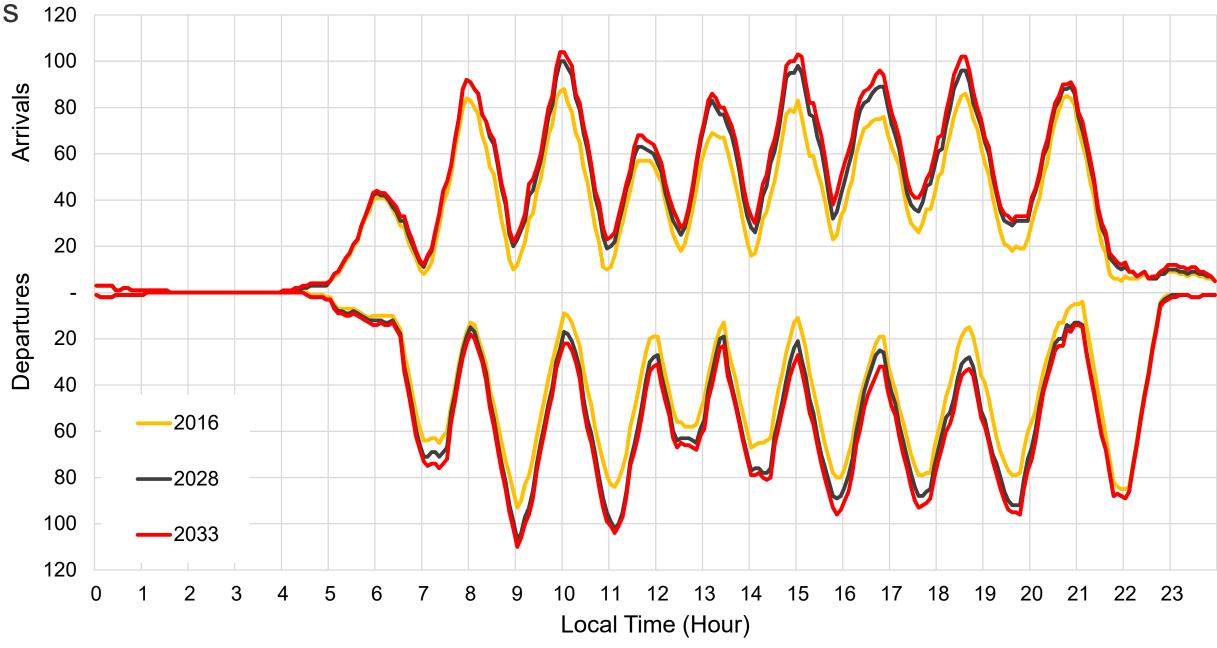
Rolling Hour Arrival and Departure Demand



- 2016: 1,563

- 2028: 1,860

- 2033: 1,978



Terminal/Concourse Layout Assumptions

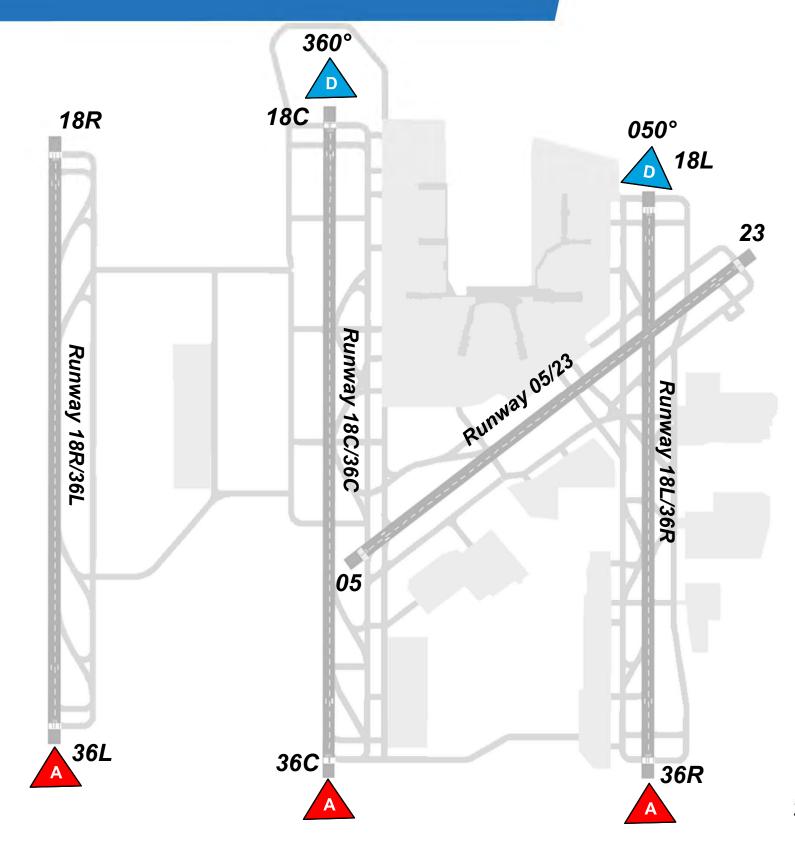
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- Aircraft holdpad and towing areas simulated
- Modeling of future gate capacity

Airline Gating Assignment Assumptions (2028/2033 Future No Action)						
Concourse A AA						
Concourse A (Phase 1 Expansion)	OALs					
Concourse A (Phase 2 Expansion)	OALs					
Concourse B & C	AA Mainline					
Concourse D AA Mainline, LH						
Concourse E	AA Regional					

North VMC/IMC Runway Configuration

- Primary Arrival Runways:
 - Runways 36L & 36R
 - Runway 36C (Trips)/Offload
- Primary Departure Runways:
 - Runway 36C North & West
 - Runway 36C International Heavy Eastbound
 - Runway 36R East & South
 - Single jet departure heading, no fanning
 - Prop aircraft make turn immediately after becoming airborne
- Runway 05/23 is used as a taxiway

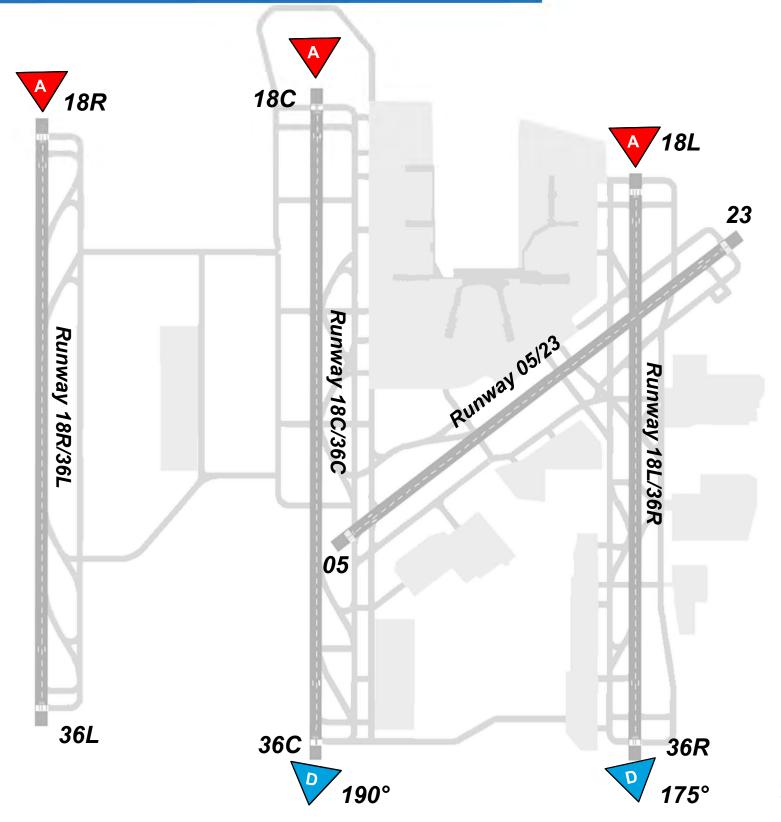
Configuration	36L, 36C, 36R	36C, 36R
	AAR	ADR
VMC	87	69
IMC	80	69



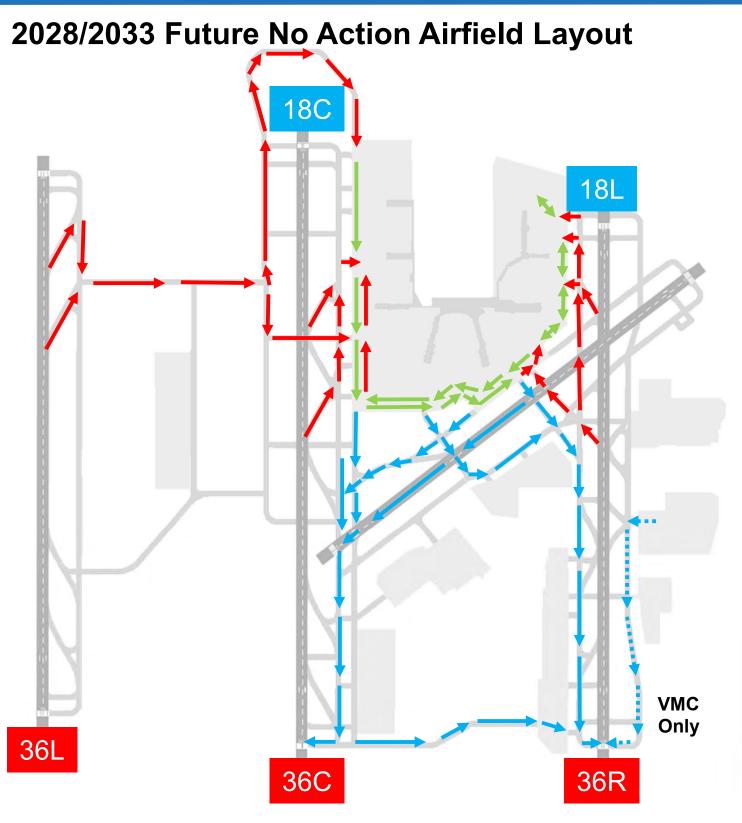
South VMC/IMC Runway Configuration

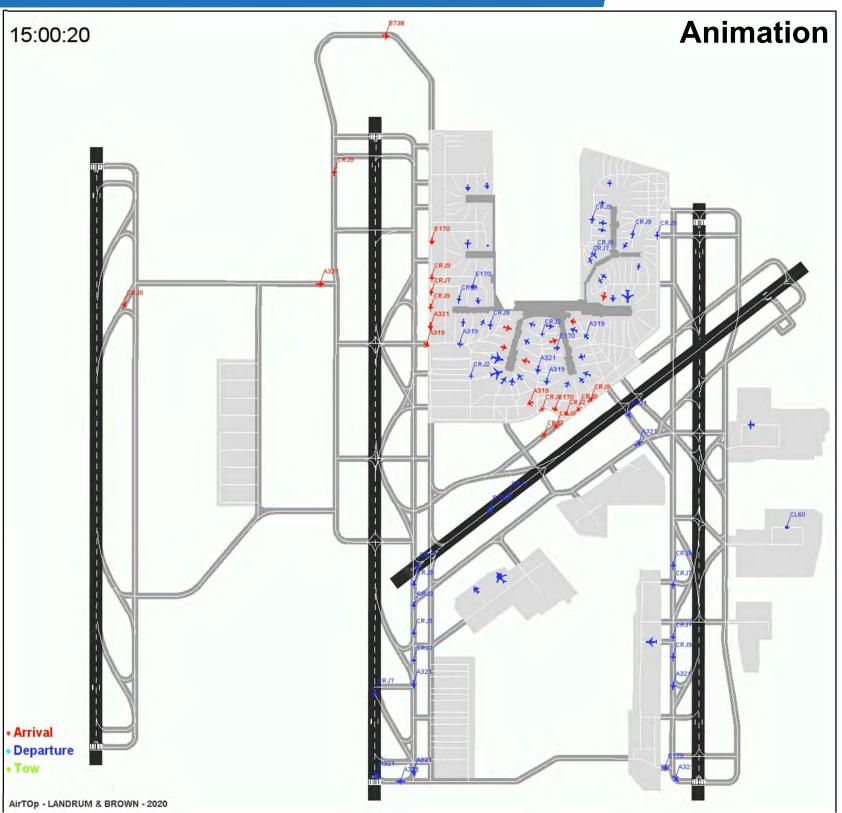
- Primary Arrival Runways:
 - Runways 18L & 18R
 - Runway 18C (Trips)/Offload
- Primary Departure Runways:
 - Runway 18C North & West
 - Runway 18C International Heavy Eastbound
 - Runway 18L East & South
- Runway 05/23 is used as a taxiway

Configuration	18L, 18C, 18R	18C, 18L		
	AAR	ADR		
VMC	87	69		
IMC	80	69		

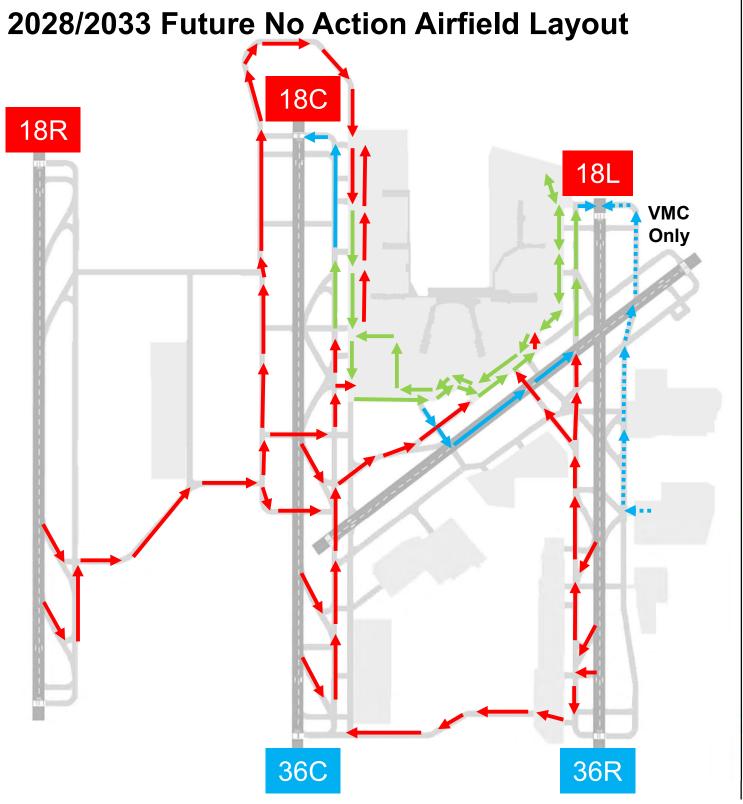


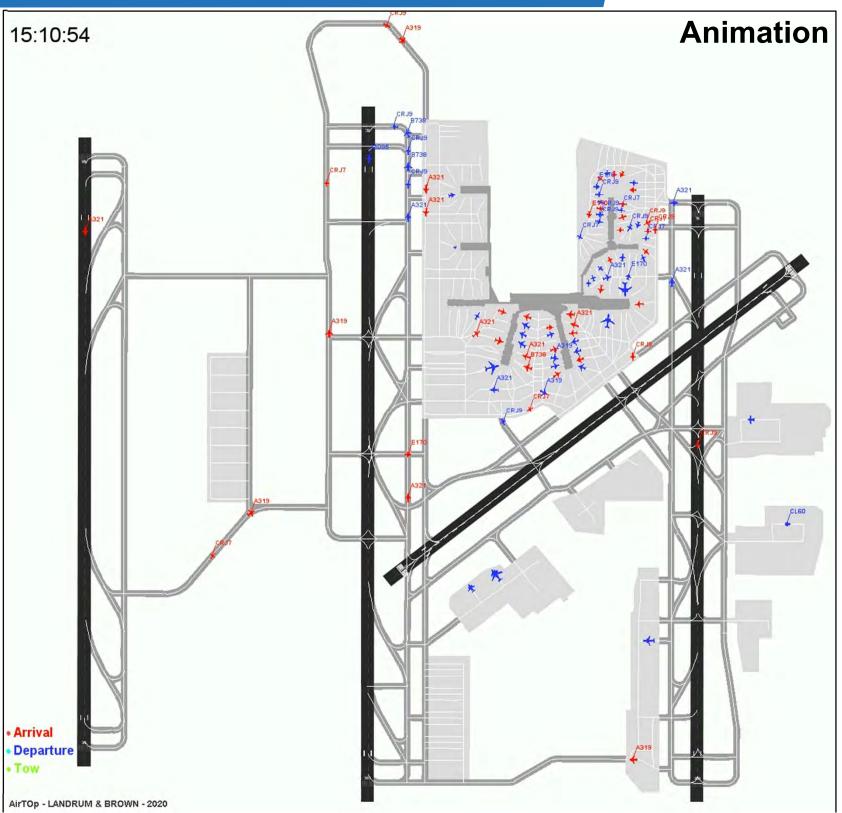
North Flow Aircraft Taxi Flow Animation



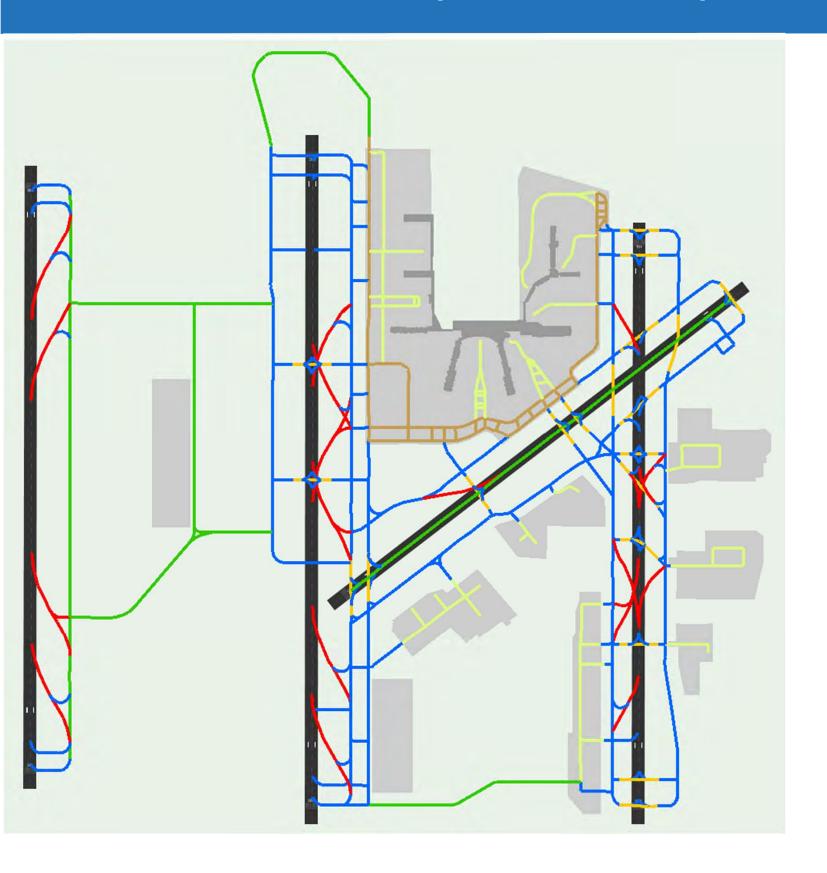


South Flow Aircraft Taxi Flow Animation





Airfield Ground Speed Assumptions – Future No Action



High Speed Exits	32 knots
Outer Perimeter Taxiways*	20 knots
Runway Crossings	18 knots
Taxiways	15 knots
Ramp Area Taxilanes	12 knots
Ramp Area Taxilanes	10 knots

^{*}North EAT and south cross field taxiway are also assumed to have 20 knot speed limits

No Action Airspace Operating Assumptions

Airspace Operating Assumptions/Overview

- Simulated airspace is the CLT Metroplex airspace that was modeled in the simulation calibration modeling analysis
- Existing radar data was analyzed and used to determine origin/destination city pair airspace fix assignments for input into the simulation flight schedule
- 6 nm intrail separations were applied at arrival corner post fixes for transition from the center airspace to the terminal environment
- When operating a mixed used runway operation, arrivals block departures 2.3 nm from the runway threshold
- During mixed arrival/departure operation, minimum of 4.5 nm arrival intrail separation is kept to ensure one departure between every arrival

Intrail Separation Minimums – Wake RECAT

- Simulation of FAA Wake RECAT separation criteria will be applied to the Baseline and Future No Action scenarios
- Previous simulation modeling and intrail separation analyses indicate minimum arrival separations on final approach range between 3.3nm (VMC) and 3.8nm (IMC)

TBL 5-5-1
Wake Turbulence Separation for Directly Behind

			Follower							
		Α	В	С	D	E	F	G	Н	I
	Α		4.5 NM	6 NM	6 NM	7 NM	7 NM	7 NM	7 NM	8 NM
	В		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	5 NM	5 NM
	С					3.5 NM	3.5 NM	3.5 NM	5 NM	5 NM
<u>.</u>	D		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	5 NM	5 NM
Leader	E									4 NM
Le	F									
	G									
	Н									
	I									

TBL~5-5-2 Wake Turbulence Separation for On Approach

			Follower							
		Α	В	С	D	E	F	G	Н	ı
	Α		4.5 NM	6 NM	6 NM	7 NM	7 NM	7 NM	7 NM	8 NM
	В		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	5 NM	6 NM
	С					3.5 NM	3.5 NM	3.5 NM	5 NM	6 NM
<u>_</u>	D		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	6 NM	6 NM
Leader	E									4 NM
Ľ	F									4 NM
	G									
	Н									
	I									

Source: JO 7110.126A - Consolidated Wake Turbulence (CWT) Separation Standards

Effective Date: September 28, 2019

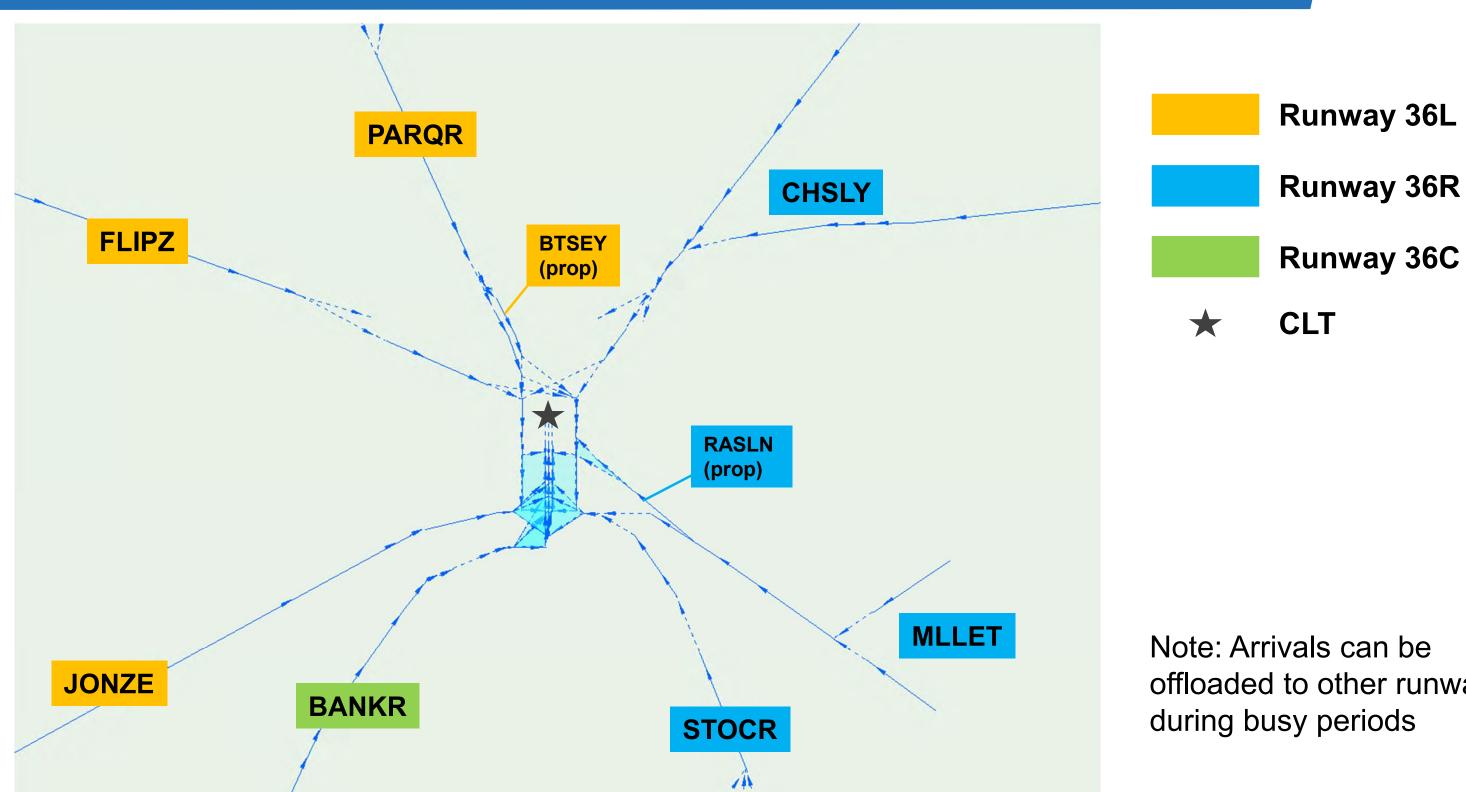
Sample Airport Route/City Pairs

Arrival Route	Origin Examples*						
<u>North</u>							
PARQR TAFTT	MDW, CLE, MSP, ORD, SEA						
<u>East</u>							
CHSLY LYH	BOS, EWR, FRA, JFK, LHR						
	<u>South</u>						
BANKR	JAX, MIA						
West							
JONZE BESTT	ATL, IAH, MEX						
FLIPZ COMDY	DEN, DFW, LAX, PDX, SFO						

Departure Route Destination Examples*					
<u>North</u>					
JOJJO DODGE	MDW, ORD, PDX, SEA				
KRITR FILDS	BUF, PIT, YYZ				
<u>East</u>					
KILNS	BWI, IAD, EWR, PHL				
BARMY RDU	BOS, FRA, LGA				
	<u>South</u>				
ICONS	JAX, MIA				
<u>West</u>					
ESTRR	AUS, DAL, IAH, MEX				
BOBZY BNA	DEN, DFW, LAX, PHX, SFO				

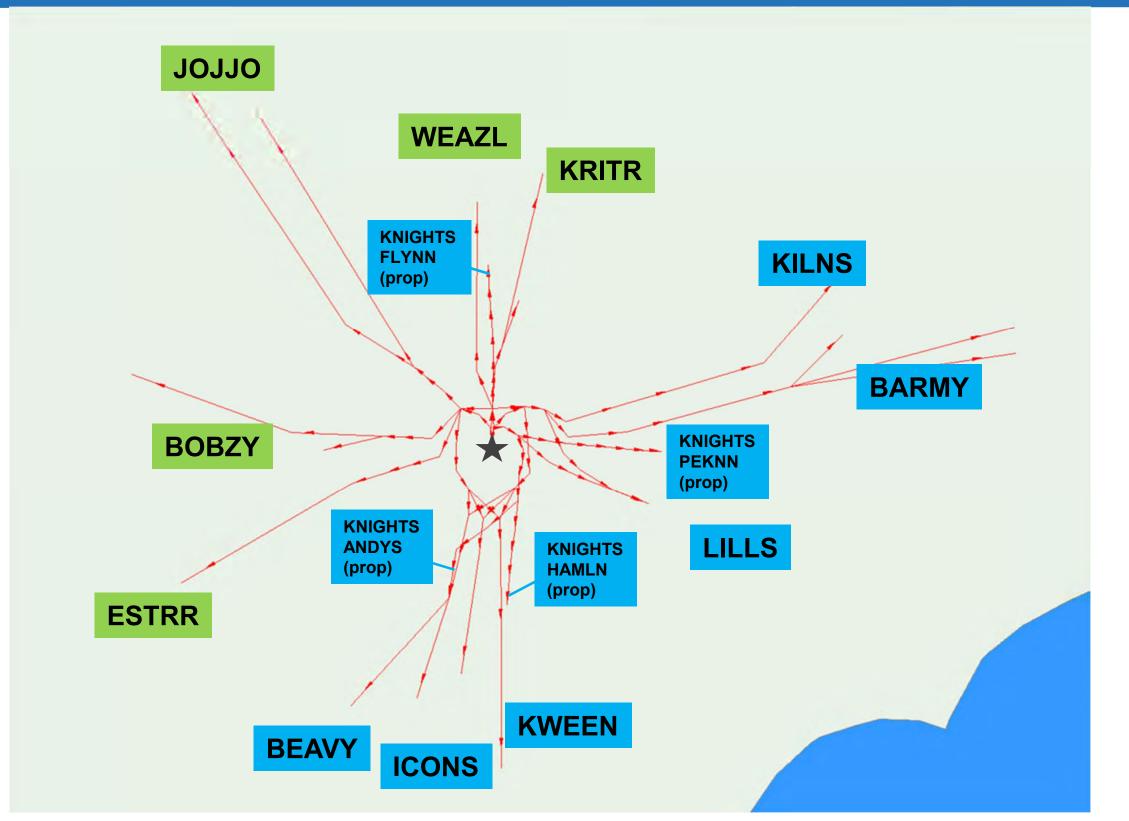
^{*}Note that these lists are not all-inclusive. They merely contain examples of some of the major airports that use each route.

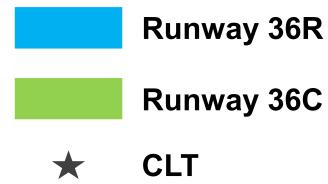
North Flow Arrival Airspace



Note: Arrivals can be offloaded to other runways during busy periods

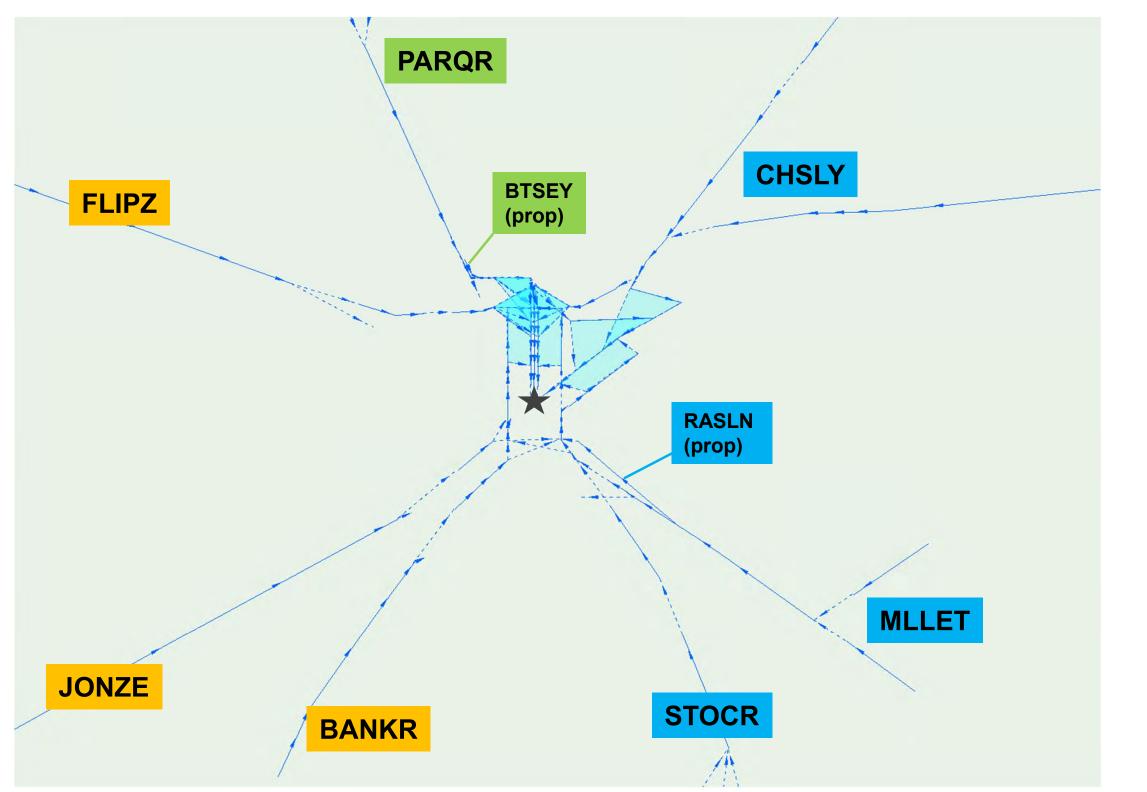
North Flow Departure Airspace

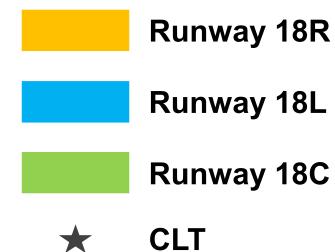




Note: BEAVY and ICONS departures can be offloaded to 36C during busy periods

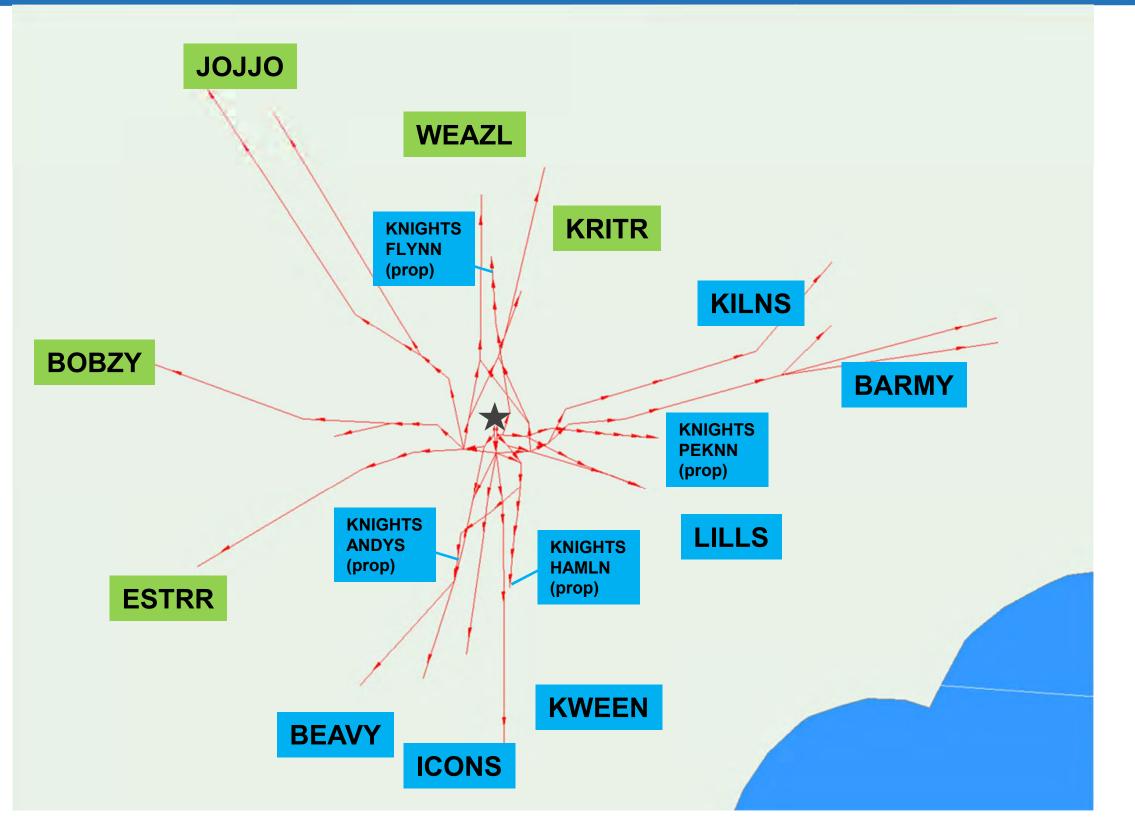
South Flow Arrival Airspace





Note: Arrivals can be offloaded to other runways during busy periods

South Flow Departure Airspace



Runway 18L

Runway 18C

CLT

Note: BEAVY and ICONS departures can be offloaded to 18C during busy periods

No Action Simulation Modeling Results

No Action Simulated Airport Throughput

- A key metric in the simulation analysis is an assessment of the peak hour and total airport throughput achieved in each scenario simulated
- While the maximum throughput is achievable under certain circumstances, it is not a good indication of capacity. Therefore, the 90th percentile hourly rates is used as a measure of capacity per previous DORA stakeholder group recommendations

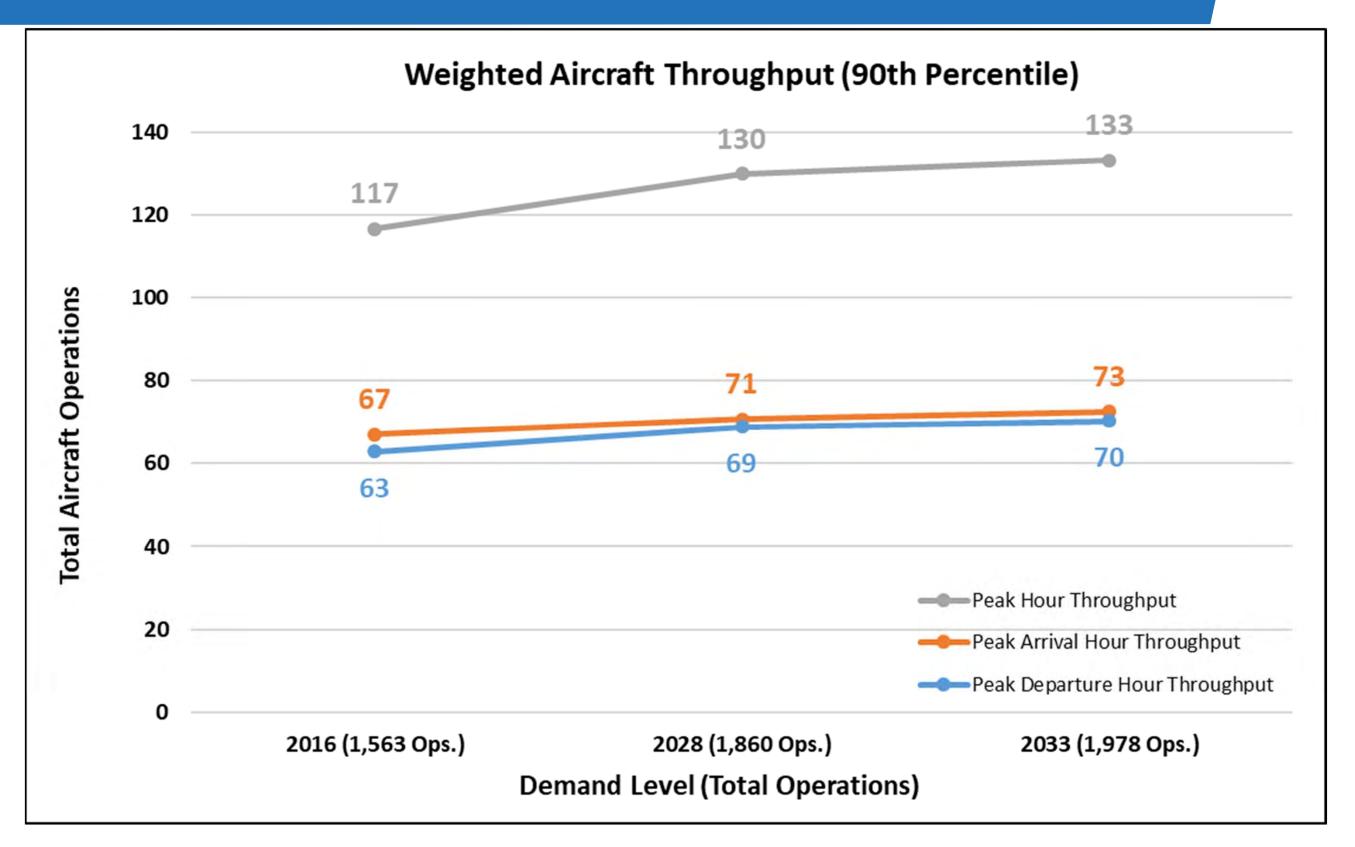
90th Percentile Simulated Throughput							
2016 2028 2033 (1,563 ops.) (1,860 ops.) (1,978 ops.)							
Peak Hour (Arr. & Deps.)	117	130	133				
Peak Hour Arrival	67	71	73				
Peak Hour Departure	63	69	70				

Maximum Simulated Throughput								
2016 2028 2033								
Peak Hour (Arr. & Deps.)	127	140	140					
Peak Hour Arrival	76	78	79					
Peak Hour Departure	82	85	86					

Annualized Call Rates*					
AAR 86					
ADR	69				

^{*} Annualized based on the most frequent called rate for each ASPM configurations and configuration use percentage for 2019

No Action Weighted Aircraft Throughput



No Action Simulation Modeling Results

- Aircraft delay and taxi time metrics are presented for each simulated demand level and runway configuration
- Annualization is calculated by averaging the metrics using the runway configuration use percentage for 2019

- North VMC: 51.8%

- North IMC: 11.7%

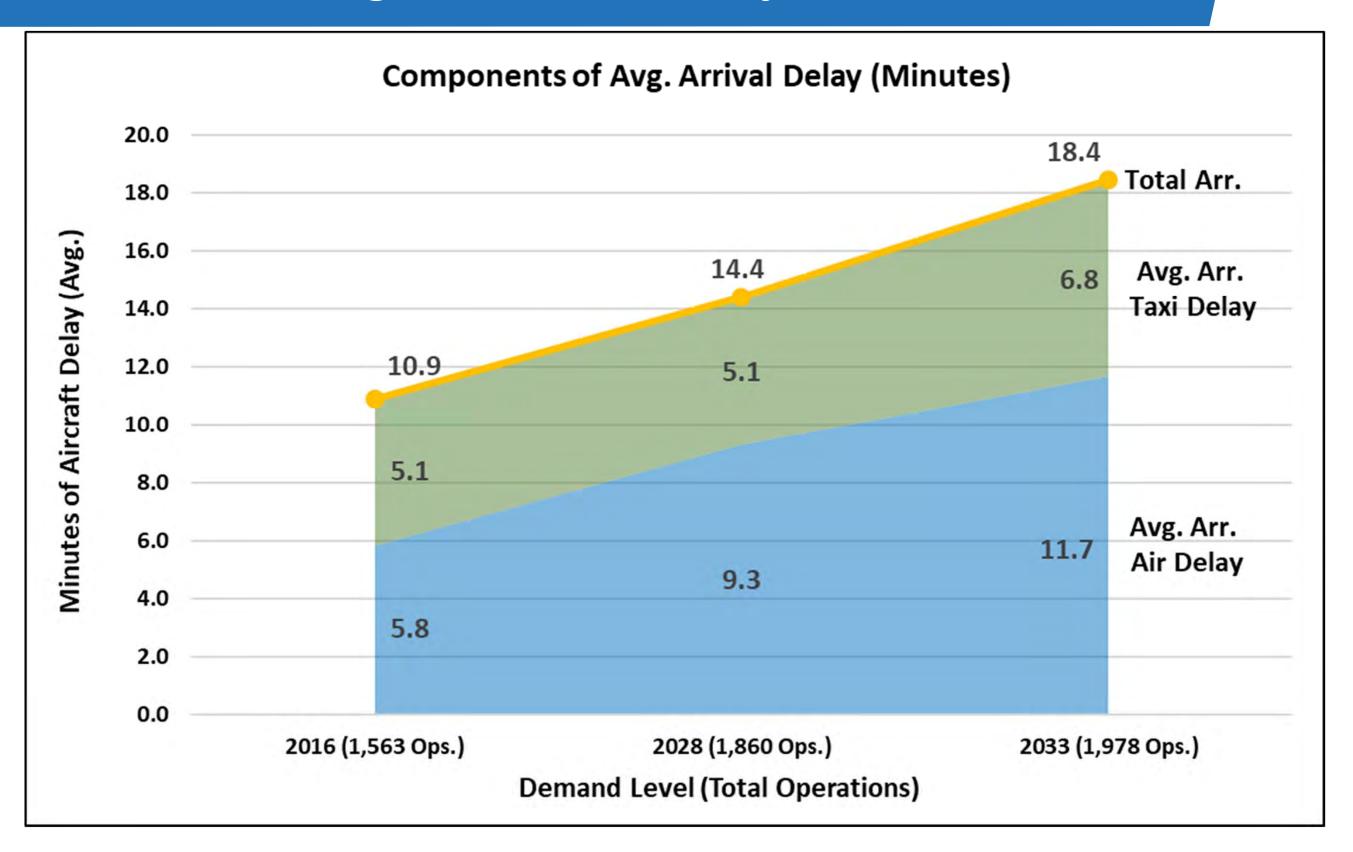
- South VMC: 27.5%

- South IMC: 9.0%

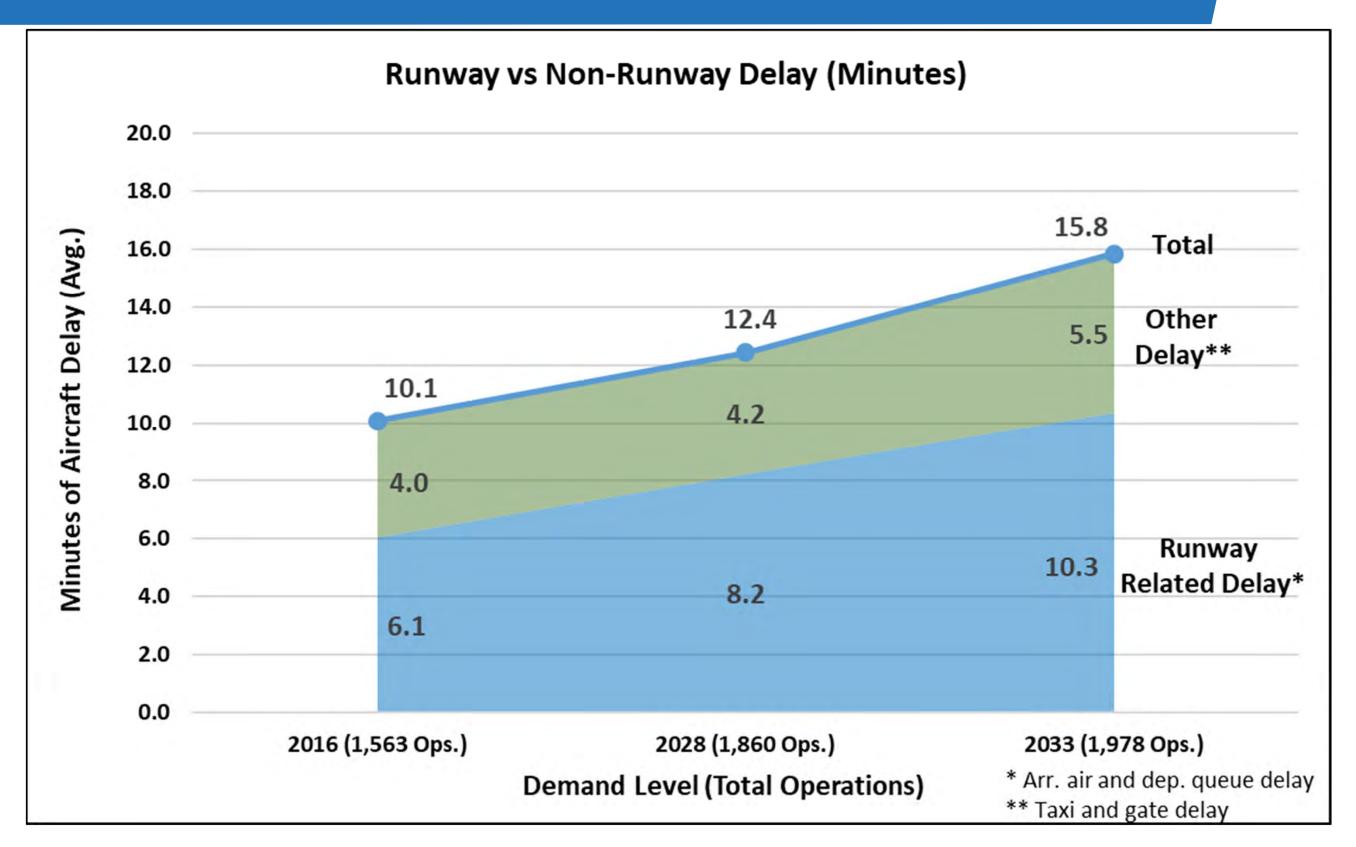
	20	2028 Demand Level (1,860 Daily Ops.)							
	North	North	South	South					
Metrics	VMC	IMC	VMC	IMC	Annualization				
Avg. arrival taxi time (total)	13.7	14.6	15.0	15.8	14.4				
Avg. arrival taxi time (unimpeded)	8.7	8.6	10.4	10.4	9.3				
Avg. arrival taxi delay	5.1	6.0	4.6	5.4	5.1				
Avg. departure taxi time (total)	21.5	25.6	18.3	21.8	21.1				
Avg. departure taxi time (unimpeded)	13.5	13.6	11.5	11.6	12.8				
Avg. departure taxi delay	8.0	12.0	6.8	10.1	8.3				
Avg. taxi time	17.6	20.1	16.6	18.8	17.7				
Avg. arrival air delay	8.4	10.7	10.1	10.6	9.3				
Avg. arrival delay	13.5	16.8	14.6	16.0	14.4				
Avg. departure ground delay	9.8	14.3	9.3	12.8	10.5				
Avg. aircraft delay	11.6	15.5	12.0	14.4	12.4				
	20	033 Dema	nd Level (1,978 Dail	ly Ops.)				
	North	North	South	South					
Metrics	VMC	IMC	VMC	IMC	Annualization				
Avg. arrival taxi time (total)	15.4	15.8	17.6	17.9	16.3				
Avg. arrival taxi time (unimpeded)	8.9	8.8	10.7	10.7	9.5				
Avg. arrival taxi delay	6.6	7.0	6.9	7.3	6.8				
Avg. departure taxi time (total)	23.6	28.7	19.8	25.0	23.3				
Avg. departure taxi time (unimpeded)	13.5	13.7	11.6	11.8	12.9				
Avg. departure taxi delay	10.1	14.9	8.1	13.2	10.4				
Avg. taxi time	19.5	22.2	18.7	21.5	19.8				
Avg. arrival air delay	9.8	15.1	12.7	14.5	11.7				
Avg. arrival delay	16.4	22.1	19.7	21.7	18.4				
Avg. departure ground delay	12.5	17.9	11.4	17.1	13.2				
Avg. aircraft delay	14.5	20.0	15.5	19.4	15.8				

^{*} Based on ASPM configurations and called rates

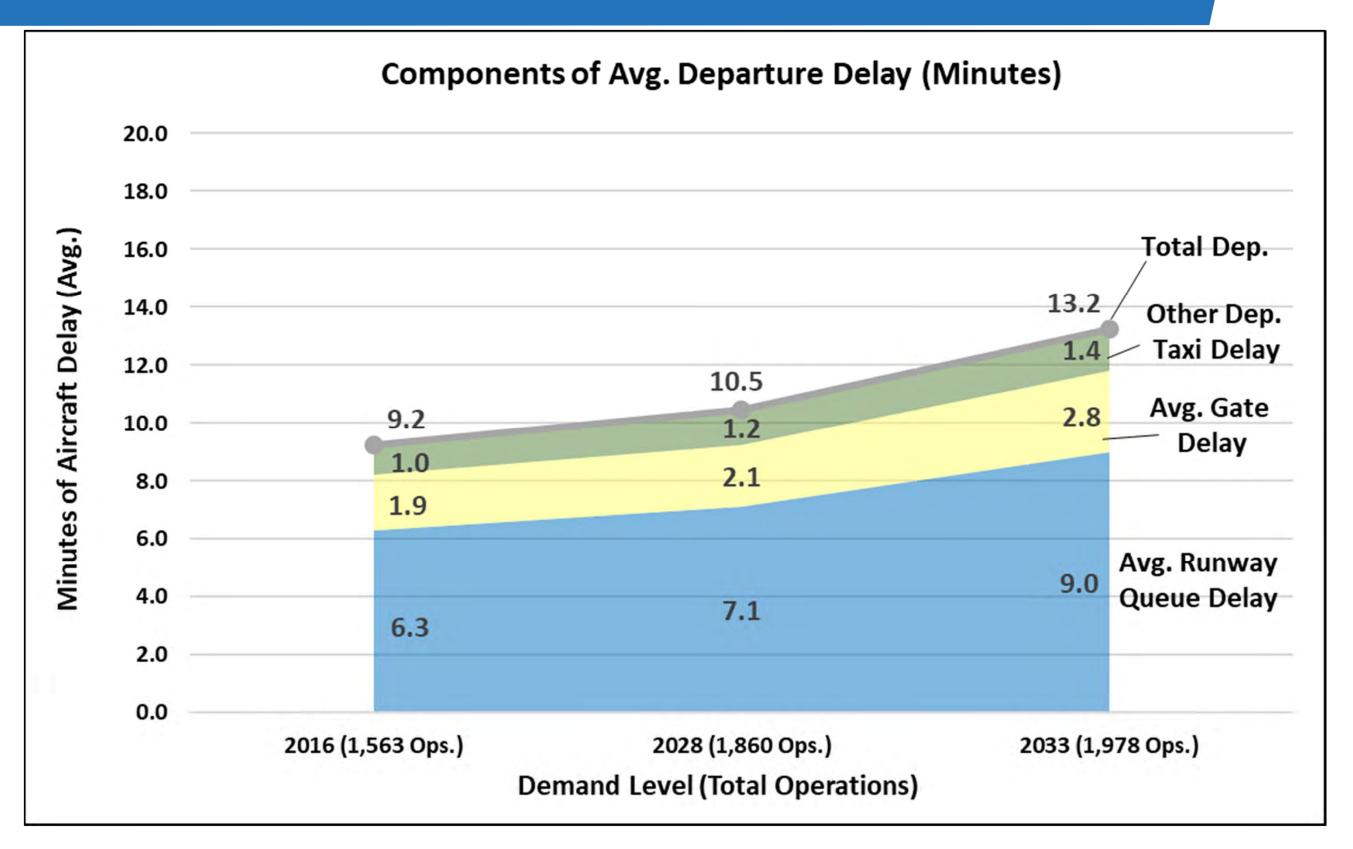
No Action Average Arrival Delay



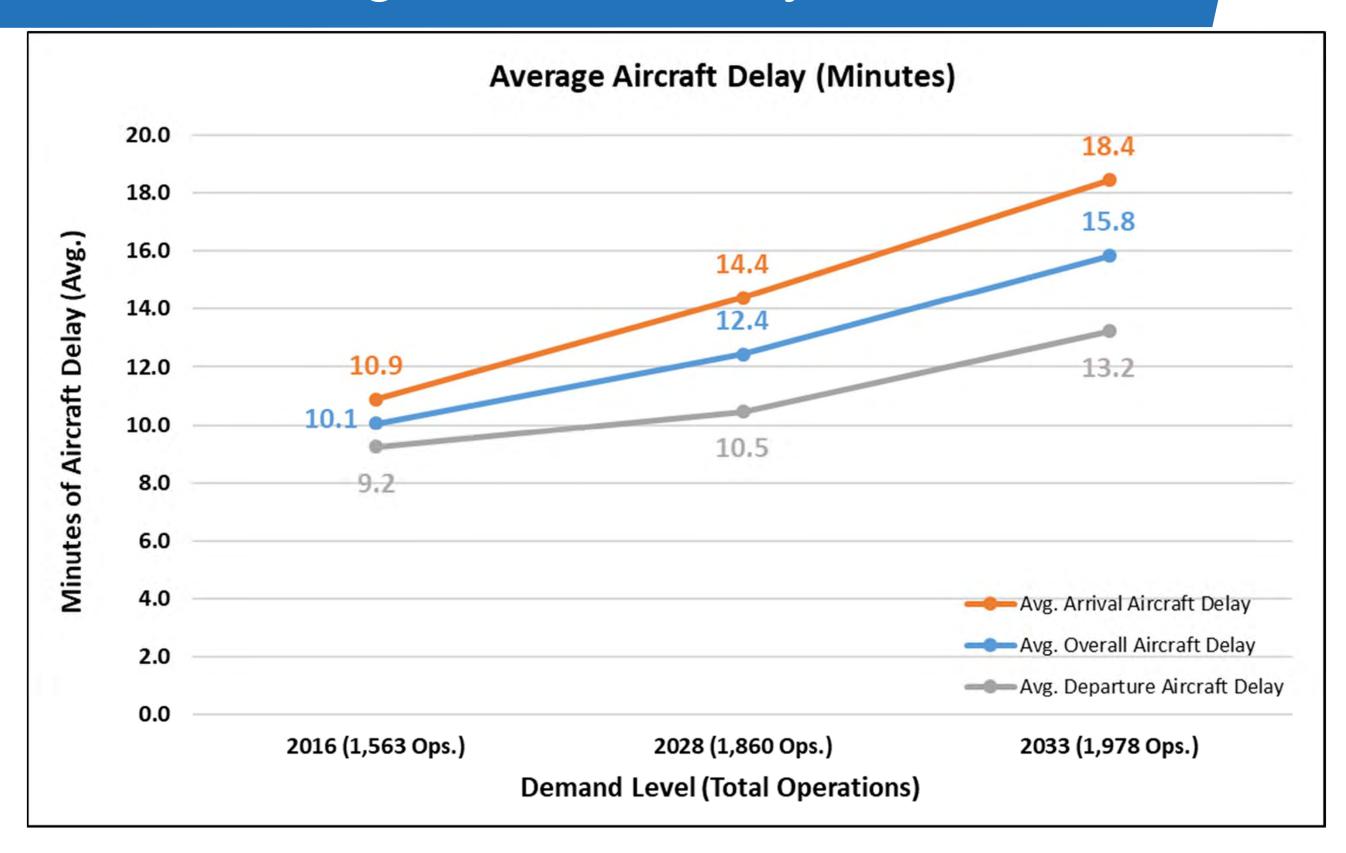
No Action Average Aircraft Delay



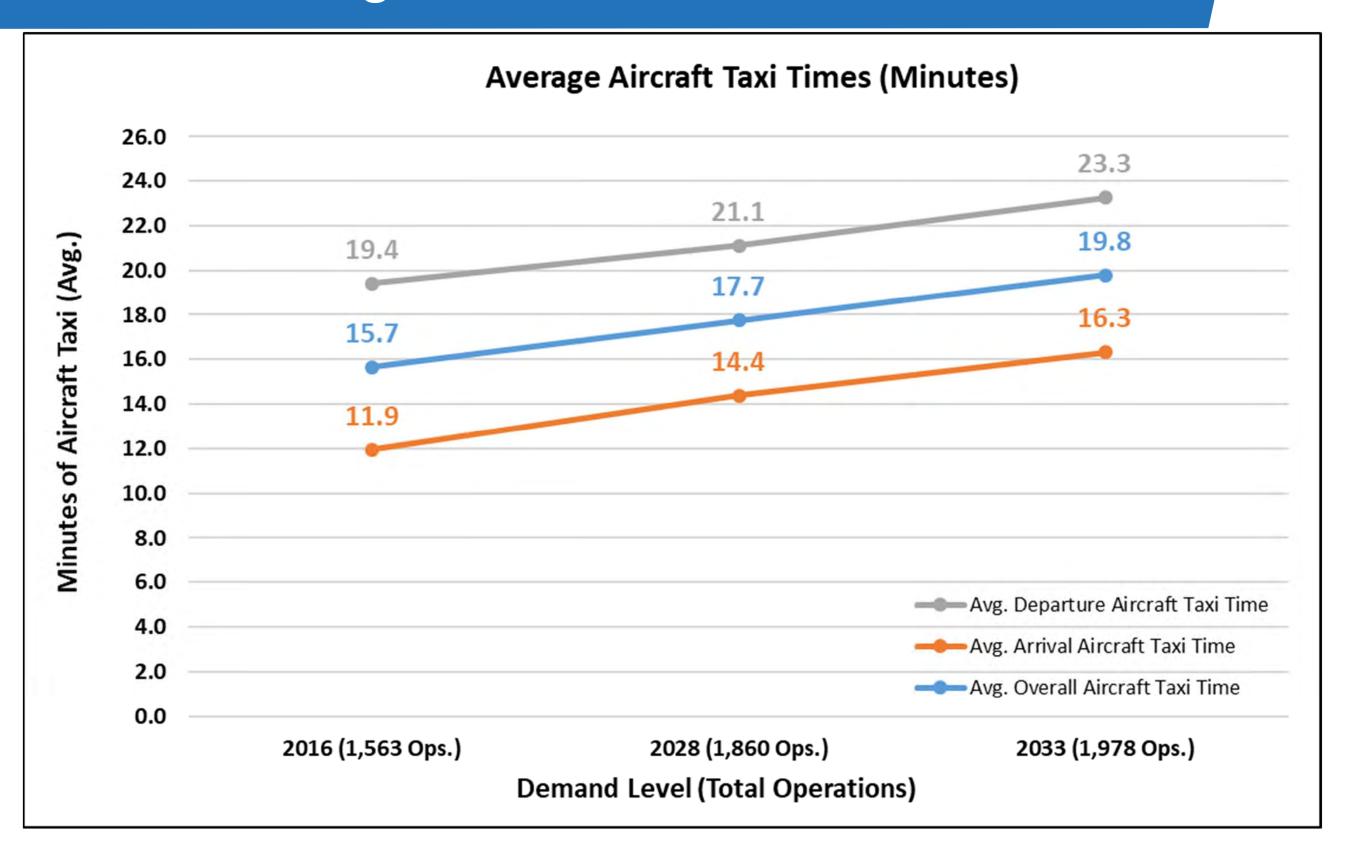
No Action Average Departure Delay



No Action Average Aircraft Delay



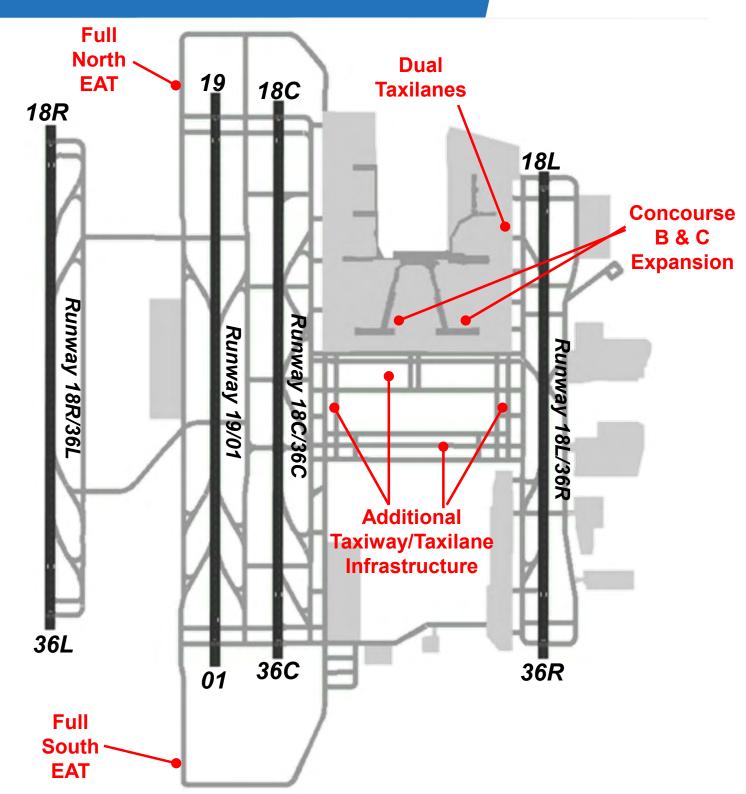
No Action Average Aircraft Taxi Times



Proposed Action Modeling Assumptions

Proposed Action Airfield Layout

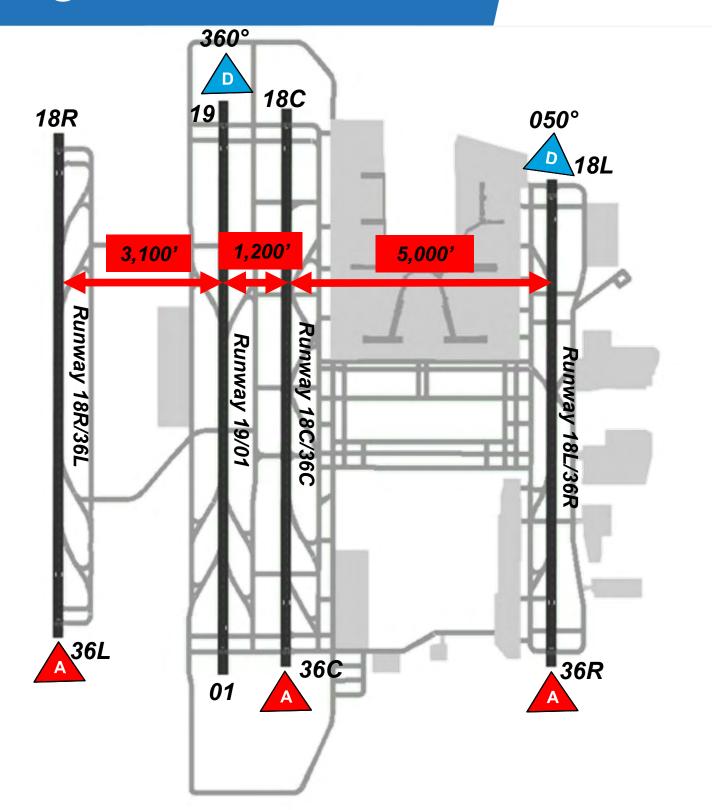
- Proposed Action Airfield includes all facilities in the No Action airfield as well as new facilities including:
 - Proposed Runway 01/19
 - Full End-Around Taxiway (EAT)
 - Removal of existing Runway 05/23
 - Additional aircraft gates
 - Additional taxilanes/taxiways
- EAT usage assumes that arrivals overthe-top of departures is not permitted
- The 2028 and 2033 demand levels will be simulated for the four airport operating configurations



North VMC/IMC Runway Configuration



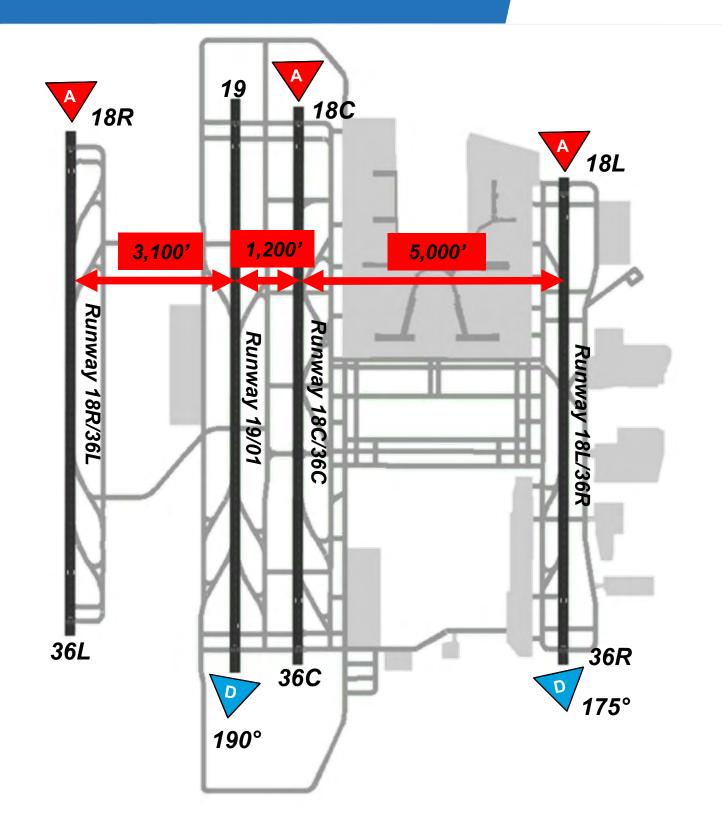
- Primary Arrival Runways:
 - Runways 36L, 36C & 36R
- Primary Departure Runways:
 - Runway 01 North & West
 - Runway 01 International Heavy Eastbound
 - Runway 36R East & South
- Maintain current departure headings



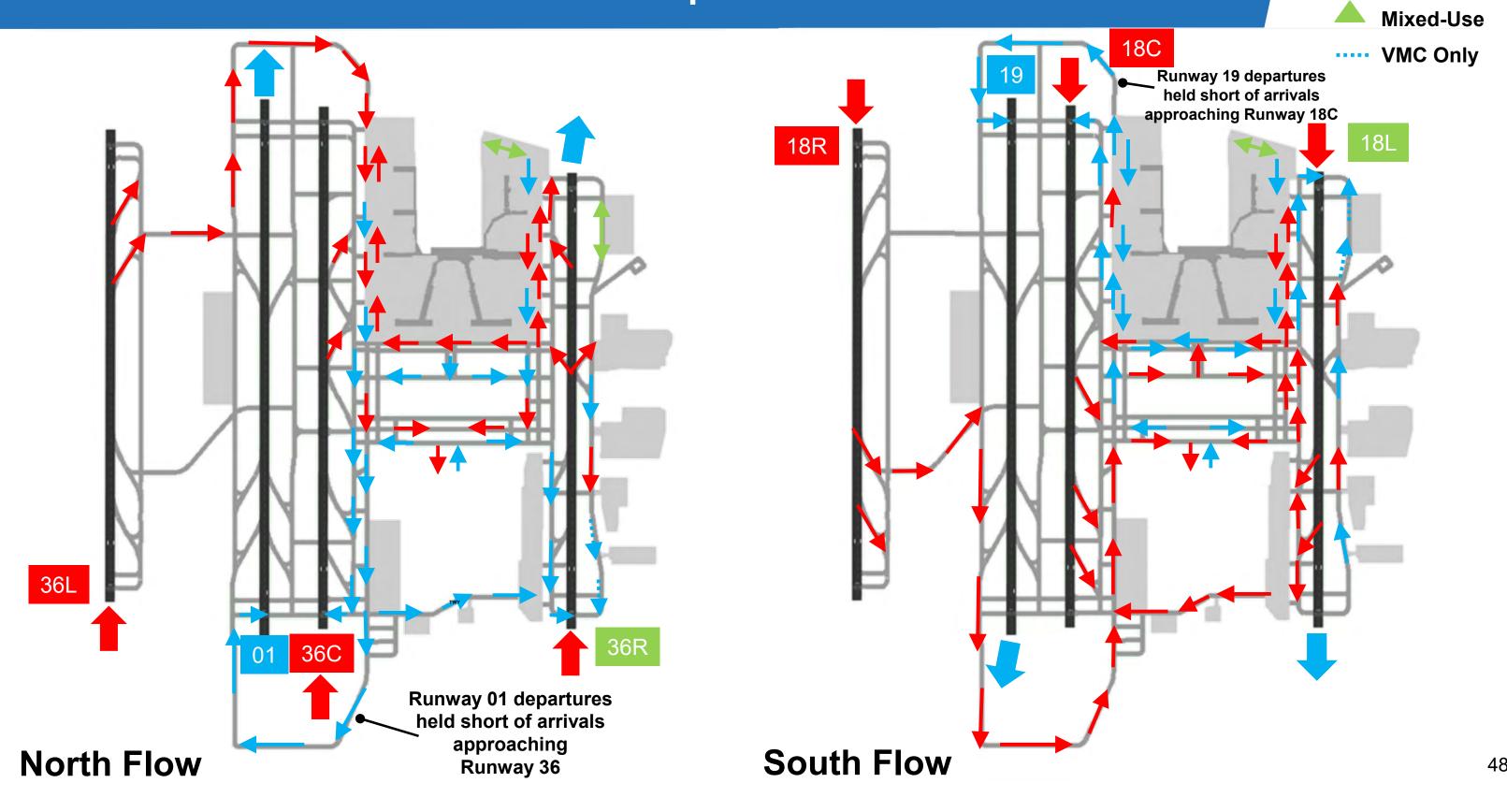
South VMC/IMC Runway Configuration



- Primary Arrival Runways:
 - Runways 18L, 18C & 18R
- Primary Departure Runways:
 - Runway 19 North & West
 - Runway 19 International Heavy Eastbound
 - Runway 18L East & South
- Maintain current departure headings



Aircraft Taxi Flows – Proposed Action



Arrivals

Departures

Proposed Action Airspace Modeling Assumptions

Intrail Separation Minimums – Wake RECAT

- Simulation of FAA Wake RECAT separation criteria will be applied to the Baseline and Future No Action scenarios
- Previous simulation modeling and intrail separation analyses indicate minimum arrival separations on final approach range between 3.3nm (VMC) and 3.8nm (IMC)

TBL 5-5-1
Wake Turbulence Separation for Directly Behind

		Follower								
		Α	В	С	D	E	F	G	Н	I
Leader	Α		4.5 NM	6 NM	6 NM	7 NM	7 NM	7 NM	7 NM	8 NM
	В		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	5 NM	5 NM
	С					3.5 NM	3.5 NM	3.5 NM	5 NM	5 NM
	D		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	5 NM	5 NM
	E									4 NM
	F									
	G									
	Н									
	I									

 $TBL\ 5-5-2$ Wake Turbulence Separation for On Approach

		Follower								
		Α	В	С	D	E	F	G	Н	ı
Leader	Α		4.5 NM	6 NM	6 NM	7 NM	7 NM	7 NM	7 NM	8 NM
	В		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	5 NM	6 NM
	С					3.5 NM	3.5 NM	3.5 NM	5 NM	6 NM
	D		3 NM	4 NM	4 NM	5 NM	5 NM	5 NM	6 NM	6 NM
	E									4 NM
	F									4 NM
	G									
	Н									
	I									

Source: JO 7110.126A - Consolidated Wake Turbulence (CWT) Separation Standards

Effective Date: September 28, 2019

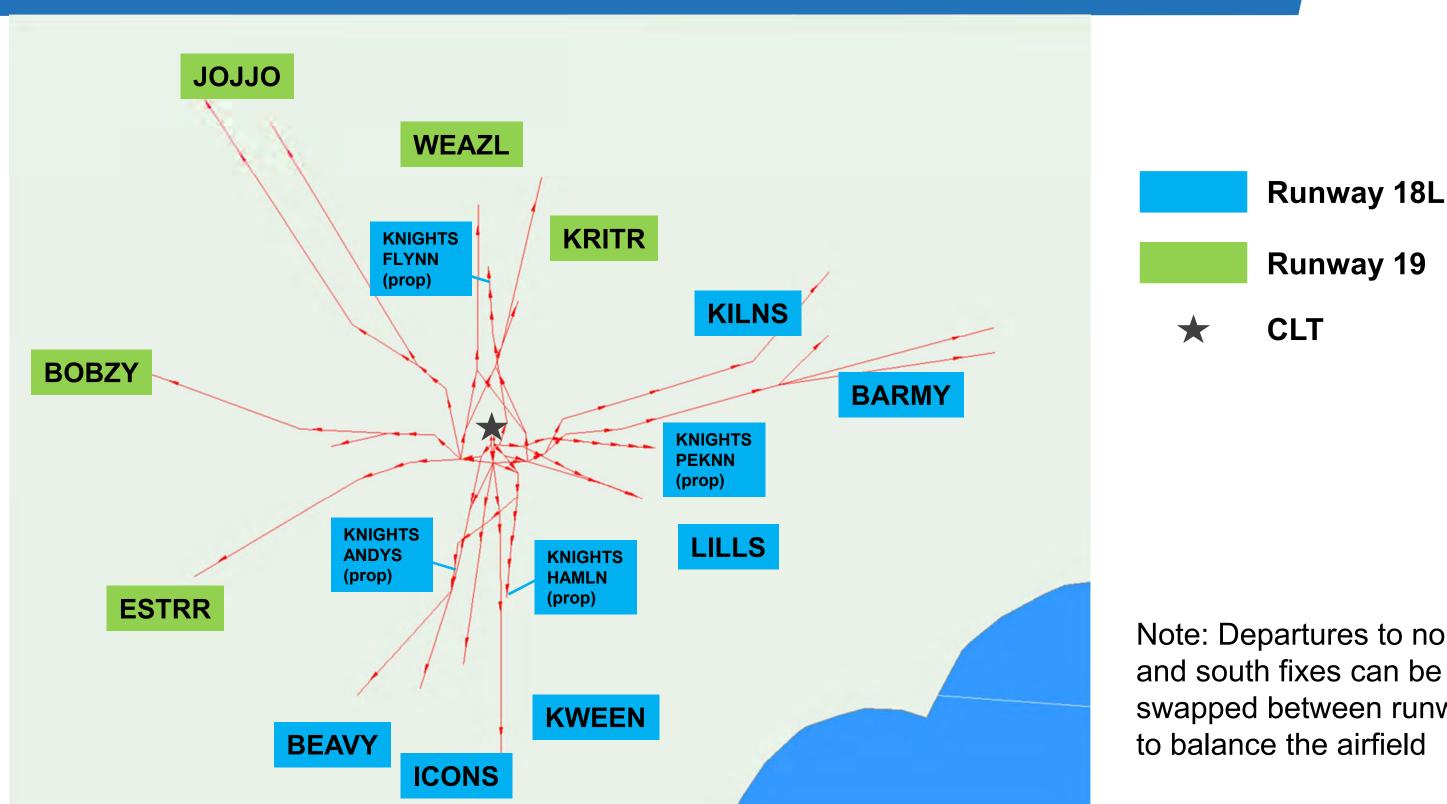
Sample Airport Route/City Pairs

Arrival Route	Origin Examples*					
<u>North</u>						
PARQR TAFTT	MDW, CLE, MSP, ORD, SEA					
	<u>East</u>					
CHSLY LYH	BOS, EWR, FRA, JFK, LHR					
<u>South</u>						
BANKR	JAX, MIA					
<u>West</u>						
JONZE BESTT	ATL, IAH, MEX					
FLIPZ COMDY	DEN, DFW, LAX, PDX, SFO					

Departure Route	Destination Examples*					
<u>North</u>						
JOJJO DODGE	MDW, ORD, PDX, SEA					
KRITR FILDS	BUF, PIT, YYZ					
<u>East</u>						
KILNS	BWI, IAD, EWR, PHL					
BARMY RDU	BOS, FRA, LGA					
<u>South</u>						
ICONS	JAX, MIA					
<u>West</u>						
ESTRR	AUS, DAL, IAH, MEX					
BOBZY BNA	DEN, DFW, LAX, PHX, SFO					

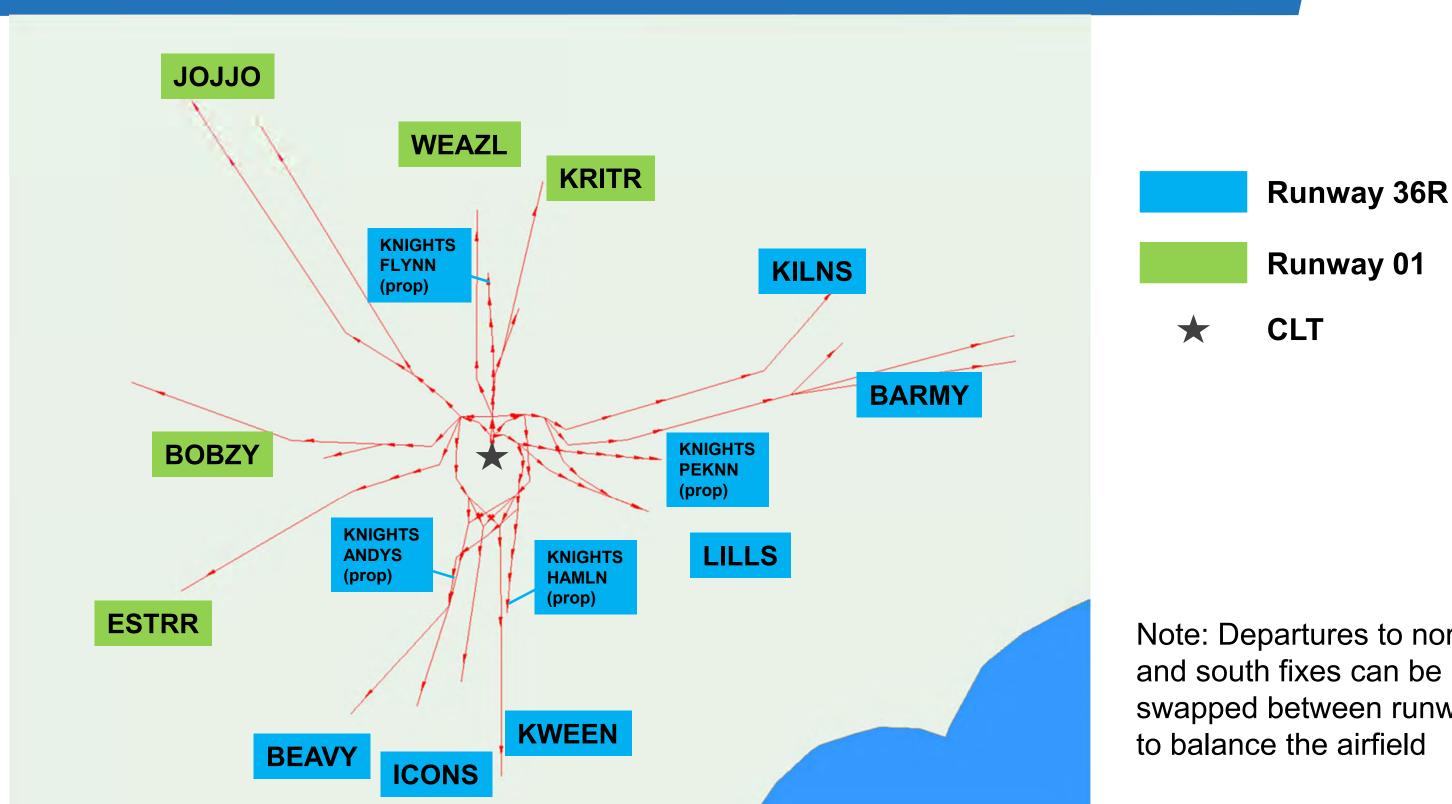
^{*}Note that these lists are not all-inclusive. They merely contain examples of some of the major airports that use each route.

South Flow Departure Airspace – Proposed Action



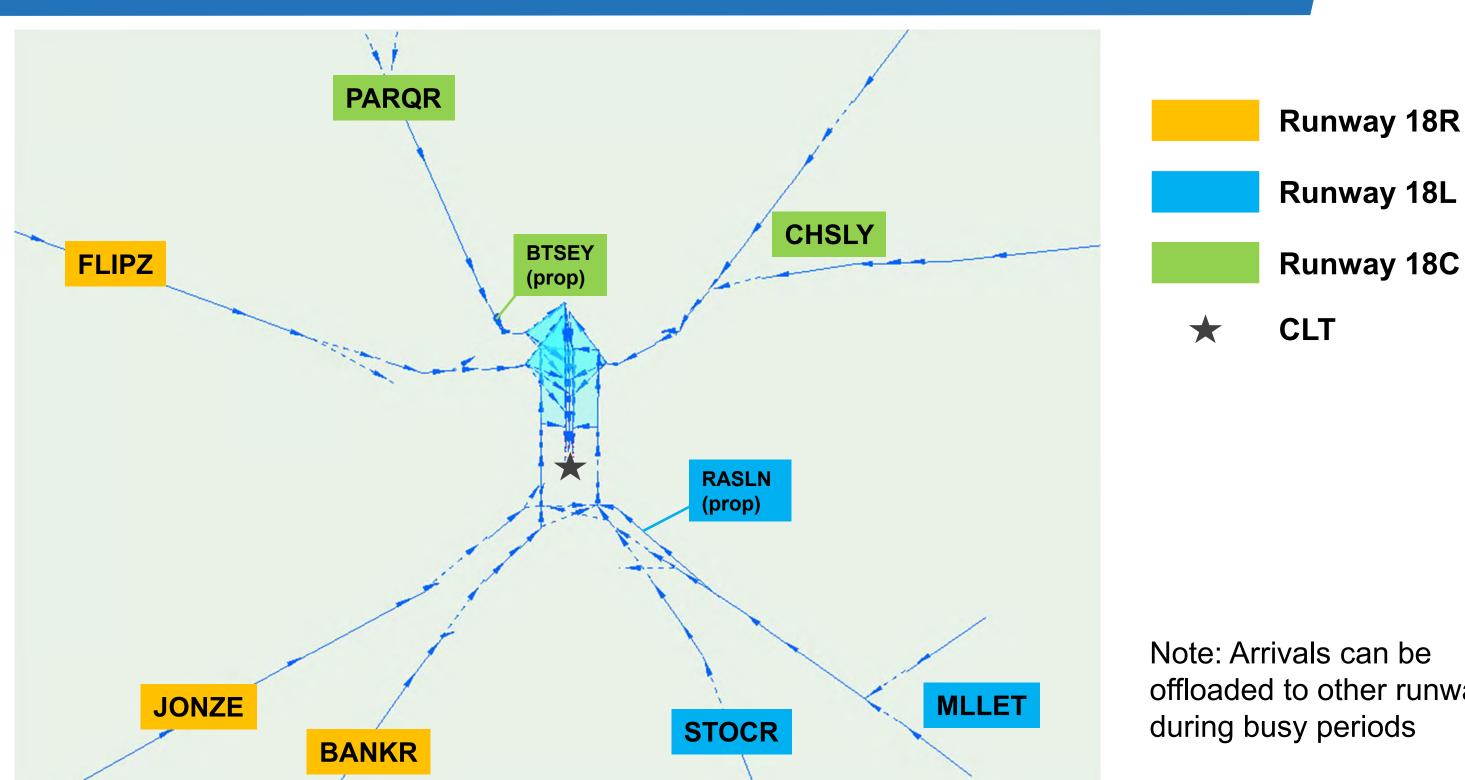
Note: Departures to north and south fixes can be swapped between runways

North Flow Departure Airspace – Proposed Action



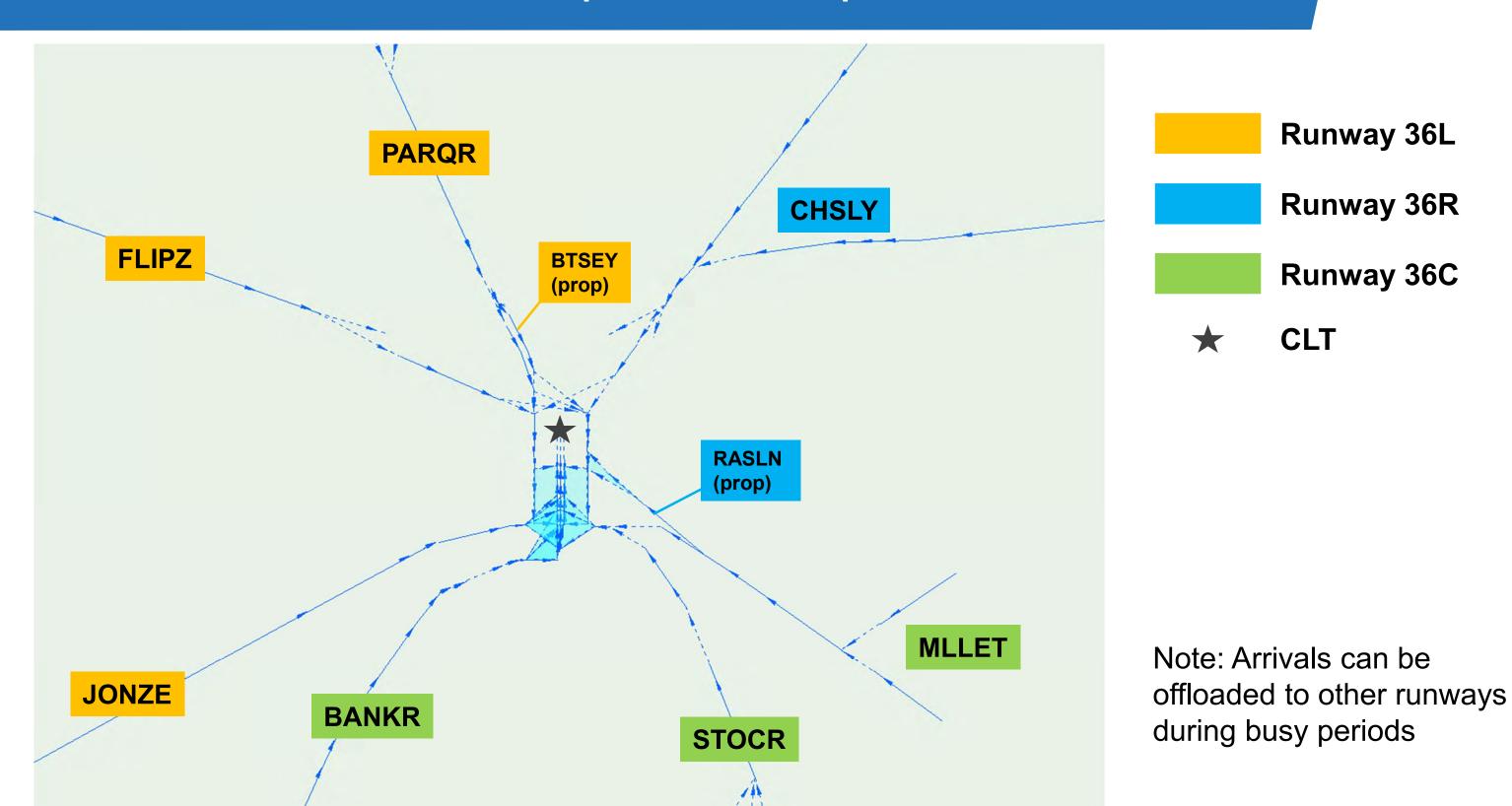
Note: Departures to north and south fixes can be swapped between runways

South Flow Arrival Airspace – Proposed Action



Note: Arrivals can be offloaded to other runways during busy periods

North Flow Arrival Airspace – Proposed Action



Next Steps

- Provide comments to EA Team by June 18th, 2020
 - Send comments to spotter@landrum-brown.com
- Incorporate comments from DORA Team
- Conduct the Proposed Action modeling analysis
- Conduct alternatives evaluation
- DORA Meeting #3 present results of the Proposed Action and Alternatives modeling analysis (tentative mid-July 2020)
- Continue preparation of the Draft EA



CLT DORA (Direction, Oversight, Review & Agree) Meeting #3

November 6, 2020



Agenda

- Role Call
- Meeting Objectives
- DORA Process
- EA Process Overview
- Proposed Action Modeling Results
- Alternatives Modeling Assumptions
 - Alternatives Development and Screening
 - Alternatives Airspace Assumptions
 - Alternatives Taxi Flow Assumptions
- Next Steps

Meeting Objectives

Meeting Objectives

- To present the Proposed Action simulation modeling results
- To present the alternatives modeling assumptions
- To present the next steps in the overall project

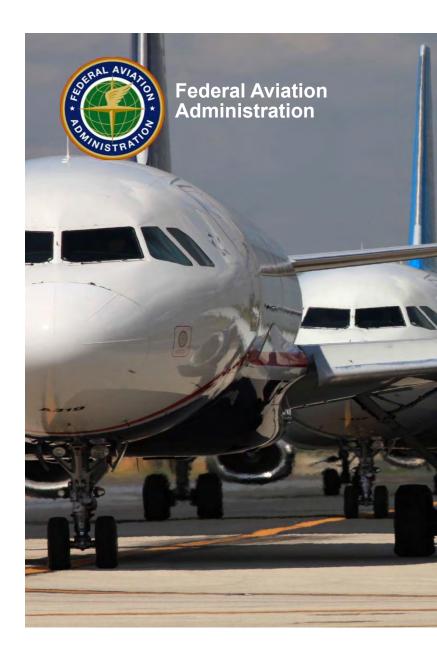
DORA Process

Charlotte Douglas International Airport EA DORA Process Overview

Prepared for: CLT EA DORA Meeting #3

By: Kent Duffy

Date: November 6, 2020



What is DORA?

- DORA =
 Direction, Oversight, Review and Agree
- Obtaining and understanding controller input on operational issues and viability of proposed alternatives is a key to airport capacity development
- DORA has been applied successfully to other large-scale airport and airspace modernization efforts (e.g., O'Hare Modernization Program)



Objectives: Why are we here?

- Ensure collaboration w/ATO on simulation activities as needed to complete EA
 - Obtain input development of the simulation model
 - Revise and refine simulation model, rather than develop new alternatives
- Build from successful process used during planning phase
 - Update with recent changes: forecast trends, CRO, metroplex, heading usage, Atlantic coast routes, etc.
 - Validate operating assumptions used in the simulation model
 - Airspace flows and procedures, Runway usage and balancing, Aircraft separation and buffers, Taxiflows and ground movement, etc.
 - Review and validate airspace's ability to accommodate new runway throughput
- Collaboration ensures the simulation results can be used in the EA analyses with confidence



Planning Phase DORA Letter



U.S. Department of Transportation

Federal Aviation

February 1, 2016

Mr. Jack Christine
Deputy Aviation Director
Charlotte-Douglas International Airport
5601 Wilkinson Boulevard
Charlotte, NC 28208

The additional analysis identified above is part of the normal maturation process as the potential airfield alternatives are further refined and assessed. The FAA considers the results of the first phase of the ACEP to be reasonable given the information that is currently available.

Winsome A. Lenfert

FAA, Division Manager Airports Southern Region

Prostell Thomas, CLT Air Traffic Manager $\frac{\sqrt{2}}{2}$

2/1/2011

Re: Documentation of DORA Process, Charlotte-Douglas International Airport Airfield Capacity Enhancement Plan

This letter summarizes the process used by the Federal Aviation Administration (FAA) Office of Airports (ARP) and Air Traffic Organization (ATO) to obtain necessary input on operational feasibility of potential design alternatives considered as part of the Charlotte-Douglas International Airport (CLT) Airfield Capacity Enhancement Plan (ACEP). The ACEP is the first step of a long-term modernization effort to add significant capacity to CLT. The Direction, Oversight, Review, and Agree (DORA)



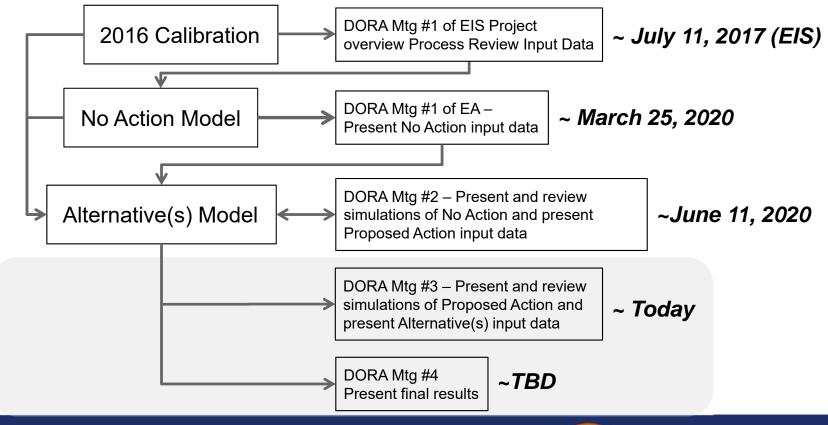
Desired Result: 2nd DORA Letter

Active ATC participation

- FAA Letter signed by ATO and ARP
- Explains process and summarizes meetings
- Identifies further analyses required in subsequent phases (e.g., design/ implementation), as needed
- Desired findings:
 - Modeling approach is <u>reasonable</u>
 - Modeling assumptions accurately reflects operational perspectives
 - Subsequent capacity, throughput and delay <u>results are reasonable</u> representations of the proposed airfield and airspace designs



DORA Process Relationship to Modeling



EA Process Overview

EA Process Overview - Background

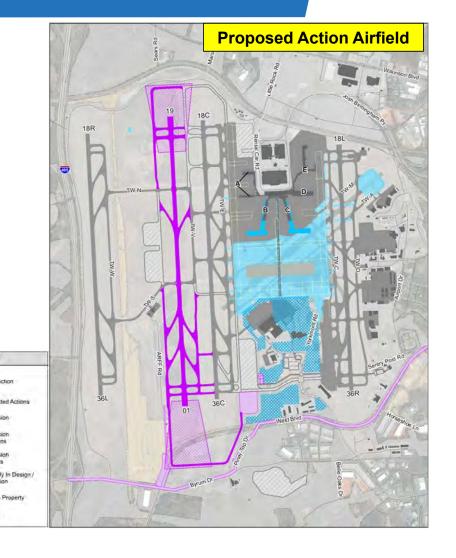
- The CLT Environmental Impact Statement (EIS) that the Federal Aviation Administration (FAA) began was cancelled on February 27, 2019.
- The FAA cancelled the EIS because a runway length analysis determined only a 10,000 foot runway is required to meet the purpose and need.
- The FAA determined that this was a sufficient change to warrant cancellation of the EIS and conversion to an Environmental Assessment (EA).
- The City of Charlotte (Airport Sponsor) is responsible for preparing the EA.
- FAA is still the lead agency.
- Similar to the EIS, the EA will evaluate the potential direct, indirect, and cumulative environmental impacts that may result from the Proposed Action.

EA Process Overview – Proposed Action

LEGEND

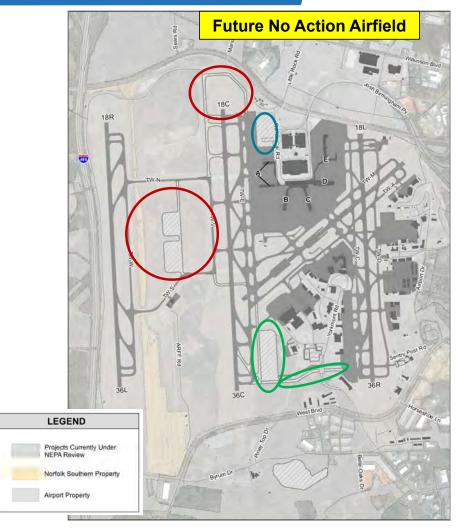
Fourth Parallel

- -4th Parallel Runway (10,000 feet long)
 - North and South End Around Taxiways
- Extensions of Concourse B and C
 - Decommissioning Runway 5/23
- Dual Taxilanes Around Ramp
 - Requires the removal of gates off the end of Concourse D and E
- Crossfield Corridors



EA Process Overview - Simulations

- Simulations will:
 - Be used in developing the Purpose and Need, noise modeling, and air quality modeling.
 - Conducted for the following scenarios:
 - 2016 Calibration Complete
 - 2019 Baseline Complete
 - 2028 Future No Action Complete
 - 2033 Future No Action Complete
 - 2028 Alternative(s) Underway
 - 2033 Alternative(s) Underway
 - Use forecast of operations approved by the FAA.
 - Include 3 independent projects as part of the Future No Action.
 - Deice Pad and crossfield taxiway
 - North End Around Taxiway around Runway 18C/36C, hold pads and threshold displacement (1,235 feet)
 - Concourse A Phase II



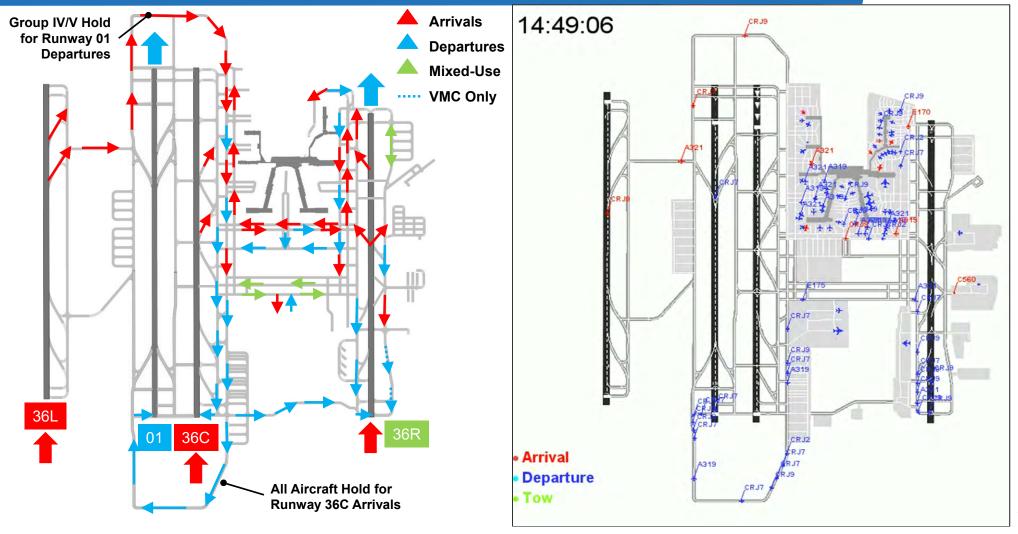
Proposed Action Simulation Modeling Results

Proposed Action EAT Usage Assumption

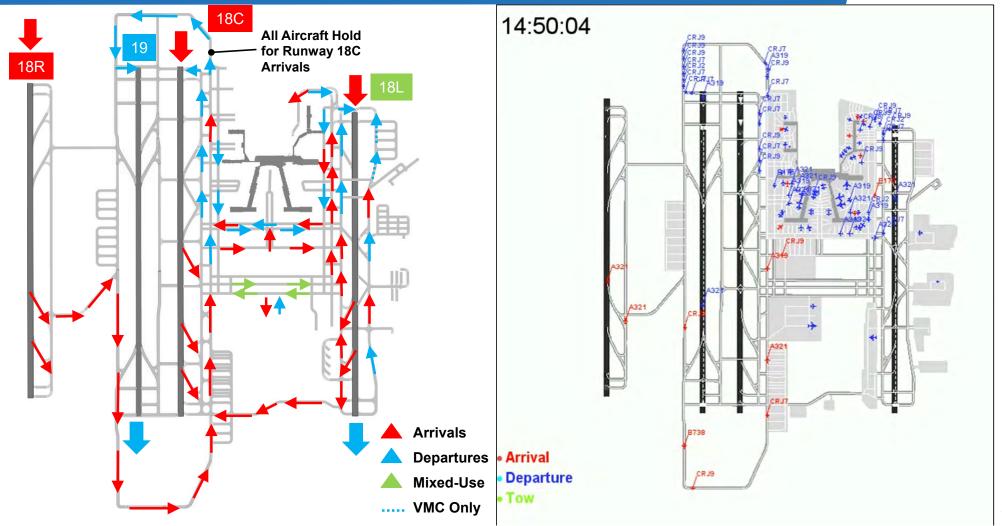
- Aircraft taxiing on the North and South EATs require large arrival gaps on Runway 18C/36C approach
 - 8nm gap for NEAT
 - 9nm gap for SEAT
- Arrival gap requirement may hinder efficient operations
 - Reduced arrival capacity on Runway 18C/36C
 - Increased ground holding times for aircraft holding short of the EAT as arrivals over-thetop of taxiing aircraft is not currently permitted
- Therefore, two EAT scenarios were evaluated
 - Scenario 1: All operations use EATs (no runway crossings)
 - Scenario 2: Departures use Taxiway V and arrivals use EATs

Proposed Action Scenario	Advantages	Disadvantages		
Scenario 1	Avoid runway crossings	Long departure taxi distanceDepartures on EAT hold short of approachGap needed in arrival stream		
Scenario 2	Short departure taxi distance	 Runway crossings Queue for crossing extends into apron area during peak in south flow 		

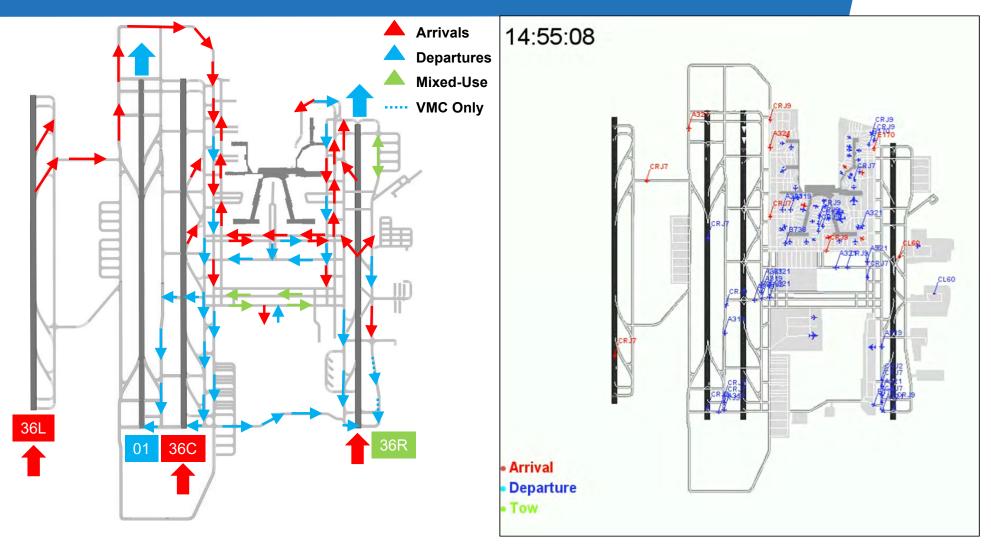
Proposed Action – North Flow, Scenario 1



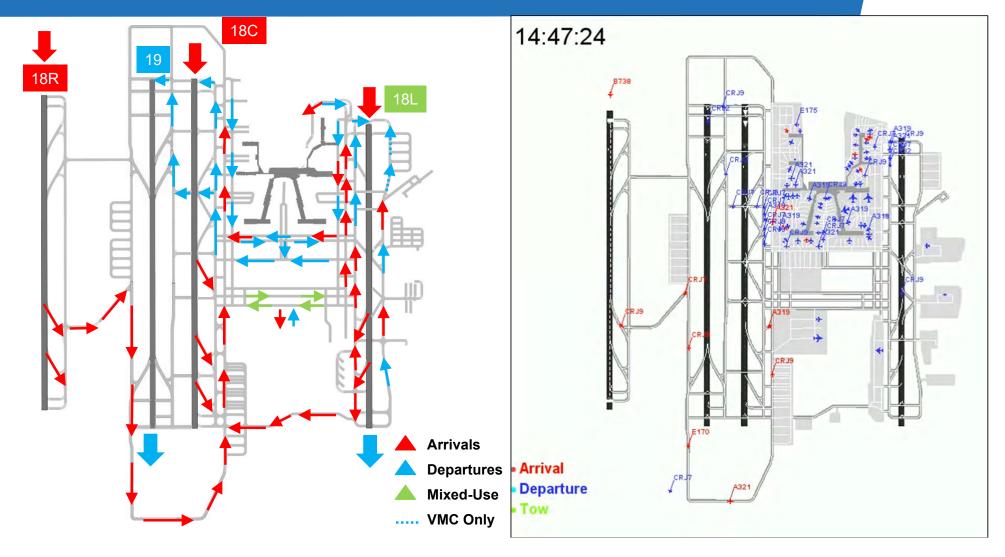
Proposed Action – South Flow, Scenario 1



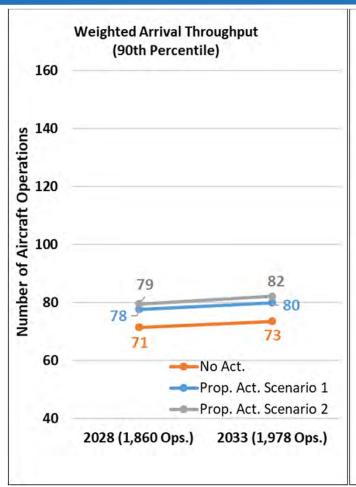
Proposed Action – North Flow, Scenario 2

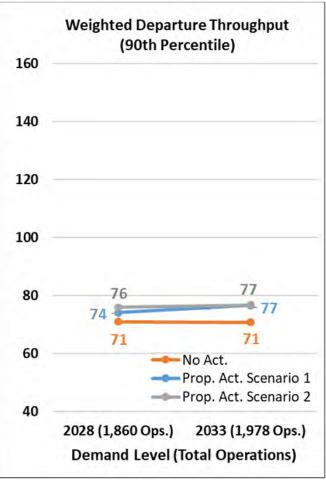


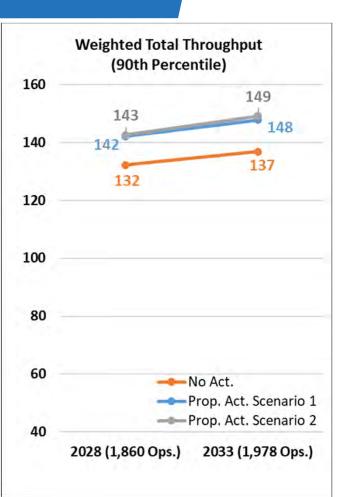
Proposed Action – South Flow, Scenario 2



Proposed Action Weighted Aircraft Throughput

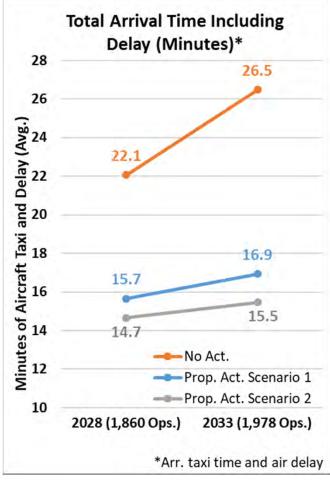


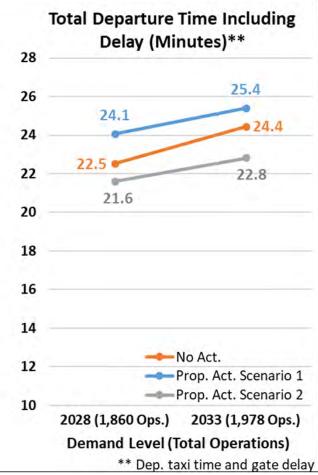


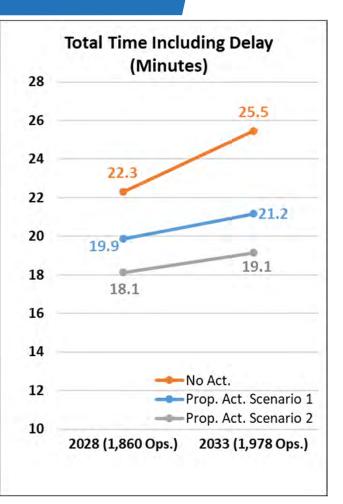


Prop. Act. Scenario 1: All operations use EATs (no runway crossings)
Prop. Act. Scenario 2: Departures use Taxiway V and arrivals use EATs

Proposed Action Total Time Including Delay

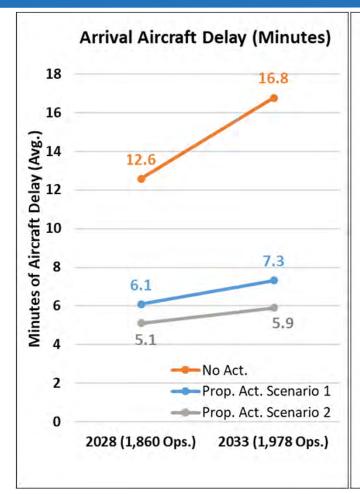


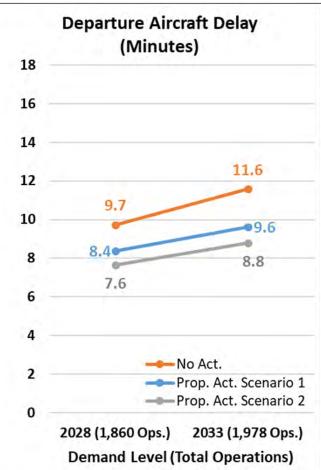


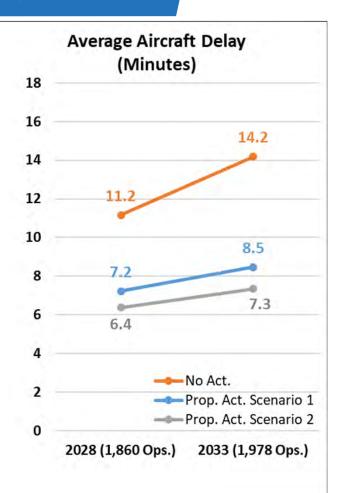


Prop. Act. Scenario 1: All operations use EATs (no runway crossings)
Prop. Act. Scenario 2: Departures use Taxiway V and arrivals use EATs

Proposed Action Average Aircraft Delay

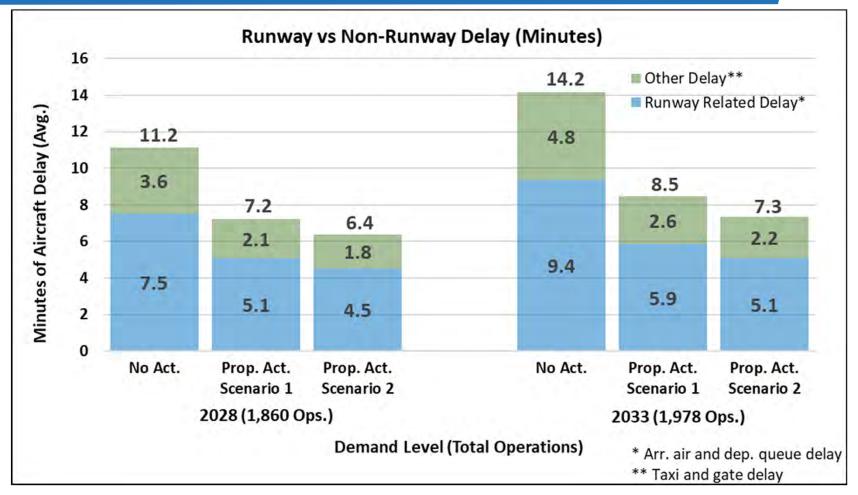






Prop. Act. Scenario 1: All operations use EATs (no runway crossings)
Prop. Act. Scenario 2: Departures use Taxiway V and arrivals use EATs

Proposed Action Average Aircraft Delay

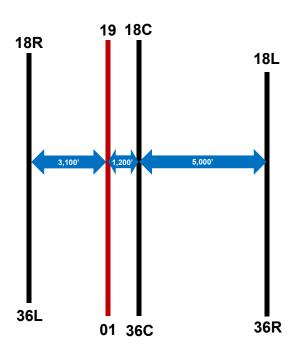


Prop. Act. Scenario 1: All operations use EATs (no runway crossings)
Prop. Act. Scenario 2: Departures use Taxiway V and arrivals use EATs

Alternatives Development and Screening

Proposed Action

- Proposed action alternative developed based on existing FAA Order 7110.65 criteria for parallel runways:
 - 3,900' of separation required for simultaneous triple approaches
 - 700'-1,200' of separation required for simultaneous VFR operations by ADG V aircraft
- -4,300' of separation exists between 18L/36R and 18C/36C
 - Insufficient to allow triple approaches to new runway
 - New runway sited to provide 1,200' of separation to Runway 18C/36C
- New runway would therefore be used for departures and arrivals would occur on Runway 18C/36C
 - Results in arrivals on runway to "inboard" runway and departures to "outboard" – not a typical operation

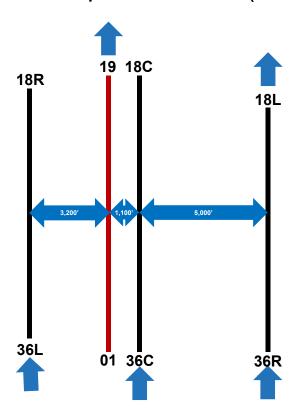


New FAA Rules for Parallel Runways

- New FAA operating rules for lateral separation between parallel runways expected in spring 2021 revision for FAA Order 7110.65
 - Allow 3,200 feet for simultaneous dual approaches (vs current 3,600 feet)
 - Allow 3,400 feet for simultaneous triple approaches (vs current 3,900 feet)
- Allows for different runway separations to be considered between CLT's new runway and Runway 18R/36L
 - Affects intended runway use (primary departure or arrival)
 - Which in turn affects runway length requirements

3,200' Between Runways 18R/36L and 01/19

- Same runway use as the Proposed Action
- Potential for simultaneous triples in future (would require rule change)



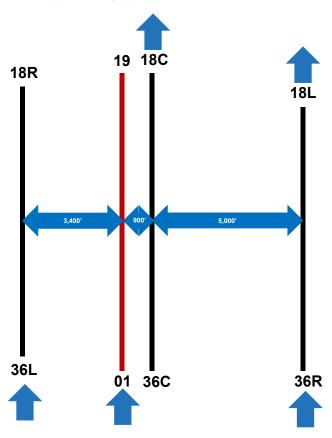
Notes:

Diagram is not to scale.

Runway length may vary depending on the use of the runway.

3,400' Between Runways 18R/36L and 01/19

- Allows simultaneous triple approaches to new runway



Notes:

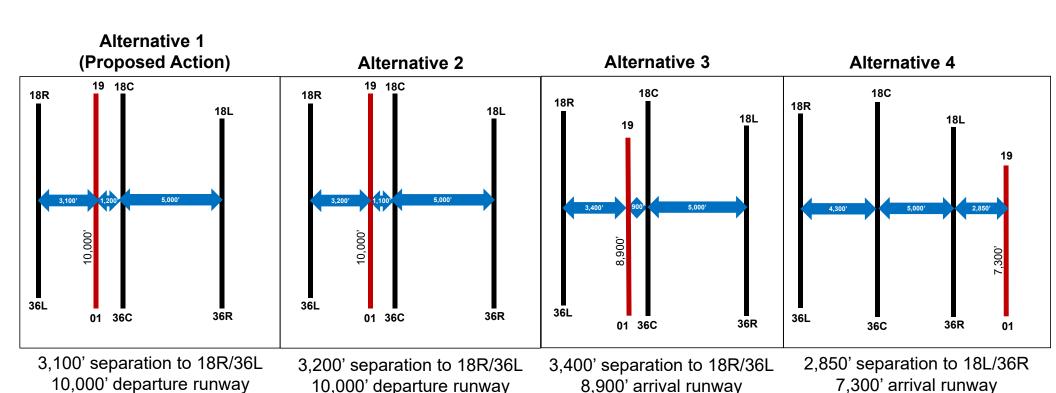
Diagram is not to scale.

Runway length may vary depending on the use of the runway.

Runway Length Requirements

- Runway length will vary depending on how the runway is being used
- Conducted a runway length requirements analysis based on
 - CLT future fleet
 - FAA guidelines
 - Airline input
- Length requirements:
 - Departures: 10,000 feet
 - Arrivals: 7,300 feet
- Lengths can be longer if required for other operational reasons

Alternatives with Alternative Runway Separations



Note: Diagrams are not to scale.

Runway Alternatives Screening Process

	Alternative	Meet Purpose and Need (< 7 Minutes Average Runway Delay)?	Reasonable and Feasible Alternative Based on Timeframe and Cost?	Carried Forward for Further Analysis?
1		Yes	Yes	Yes
2		Yes	Yes	Yes
3		Yes	Yes	Yes
4		Yes	No	No

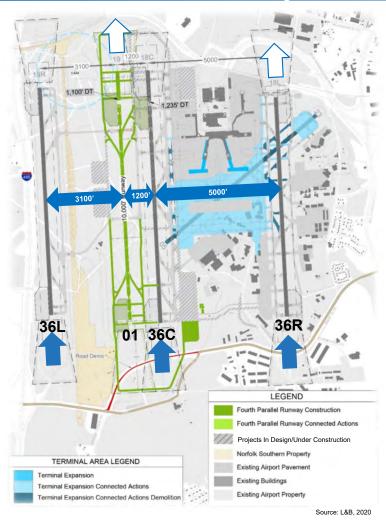
Note: Diagrams are not to scale.

Alternatives Airspace Assumptions

Alternatives Airspace Assumptions

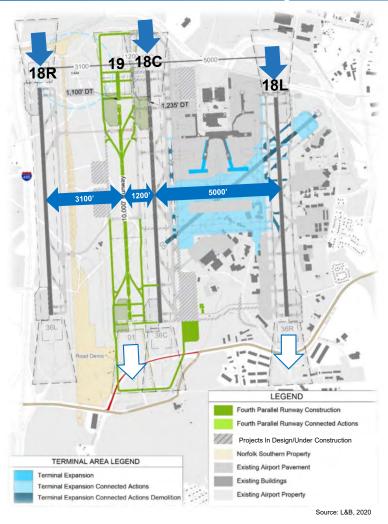
- Alternatives will use same assumptions as Proposed Action:
 - Apply FAA Wake RECAT separation criteria
 - Minimum arrival separations on final approach 2.5 nautical miles (VMC) and 3.8 nautical miles (IMC)
 - Allocation of city pairs to airport routes
 - Allocation of fixes to runways
 - Straight out departure headings

Alternative 1 (Proposed Action) – North Flow 10,000' Runway / 3,100' Separation to 18R/36L



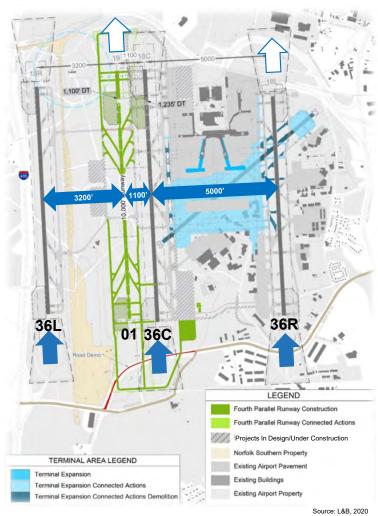
- Proposed Action
- 3,100 feet of separation between new midfield runway and Runway 18R/36L
- Arrivals:
 - Runways: 36L, 36C, 36R
 - Simultaneous triple independent approaches permissible in all weather conditions
- Departures:
 - Runways 01 and 36R
 - 10,000-foot long Runway 01/19
- Runway capacity:
 - Simultaneous triple approaches

Alternative 1 (Proposed Action) – South Flow 10,000' Runway / 3,100' Separation to 18R/36L



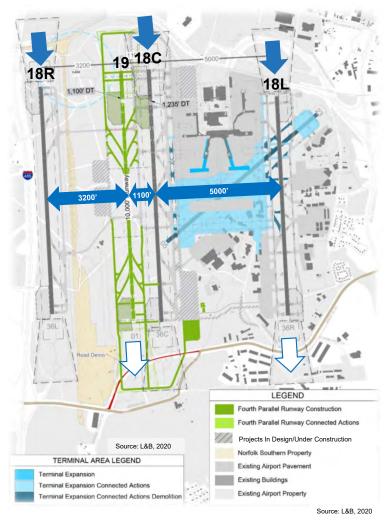
- Proposed Action
- 3,100 feet of separation between new midfield runway and Runway 18R/36L
- Arrivals:
 - Runways: 18R, 18C, 18L
 - Simultaneous triple independent approaches permissible to RVR 4500
- Departures:
 - Runways 19 and 18L
 - 10,000-foot long Runway 19
- Runway capacity:
 - Simultaneous triple approaches

Alternative 2 – North Flow 10,000' Runway / 3,200' Separation to 18R/36L



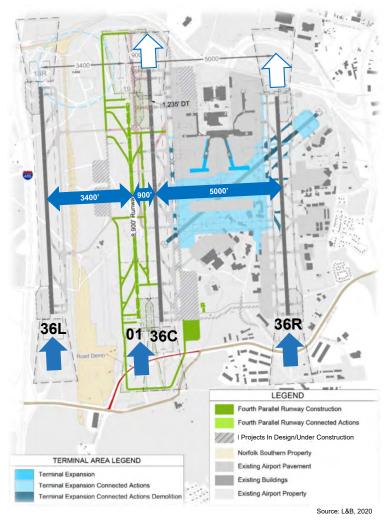
- Opportunity for "future proofing" for possible additional reductions in triple runway spacing requirements
- 3,200 feet of separation between new midfield runway and Runway 18R/36L
- Arrivals (same as Alt. 1):
 - Runways: 36L, 36C, 36R
 - Simultaneous triple independent approaches permissible in all weather conditions
- Departures (same as Alt. 1):
 - Runways 01 and 36R
 - 10,000-foot long Runway 01/19
- Runway capacity:
 - Simultaneous triple approaches

Alternative 2 – South Flow 10,000' Runway / 3,200' Separation to 18R/36L



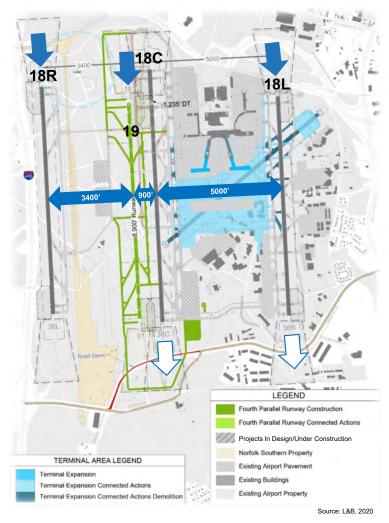
- Opportunity for "future proofing" for possible additional reductions in triple runway spacing requirements
- 3,200 feet of separation between new midfield runway and Runway 18R/36L
- Arrivals (same as Alt. 1):
 - Runways: 18R, 18C, 18L
 - Simultaneous triple independent approaches permissible to RVR 4500
- Departures (same as Alt. 1):
 - Runways 19 and 18L
 - 10,000-foot long Runway 01/19
- Runway capacity:
 - Simultaneous triple approaches

Alternative 3 – North Flow 8,900' Runway / 3,400' Separation to 18R/36L



- Opportunity to change runway use through the use of proposed runway spacing criteria
- 3,400 feet of separation between new midfield runway and Runway 18R/36L
- Arrivals:
 - Runways 36L, **01**, and 36R
 - 8,900-foot long Runway 01/19
 - Simultaneous triple independent approaches permissible in all weather conditions (assumes CAT II/III on Rwy 01)
- Departures:
 - Runways 36C and 36R
- Runway capacity:
 - Simultaneous triple approaches
- Does not allow for a full taxiway between Runway 01/19 and 18C/36C

Alternative 3 – South Flow 8,900' Runway / 3,400' Separation to 18R/36L



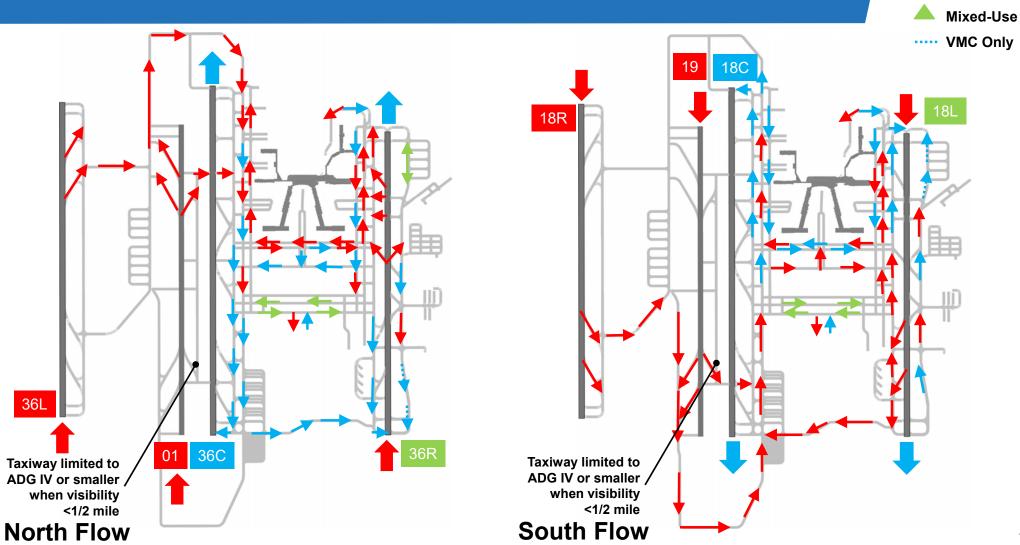
- Opportunity to change runway use through the use of proposed runway spacing criteria
- 3,400 feet of separation between new midfield runway and Runway 18R/36L
- Arrivals:
 - Runways 18R, 19, and 18L
 - **8,900**-foot long Runway 01/19.
 - Simultaneous triple independent approaches permissible (assumes CAT II/III on Rwy 19) to RVR 4500
- Departures:
 - Runways <u>18C</u> and 18L
- Runway capacity:
 - Simultaneous triple approaches
- Does not allow for a full taxiway between Runway 01/19 and 18C/36C

Alternatives Taxi Flow Assumptions

Aircraft Taxi Flows – Alternatives 1 and 2

- Taxi flows for the Proposed Action (Alternative 1) were presented earlier
- Taxi flows for Alternative 2 will be identical to the Proposed Action with one exception
 - Taxiway V cannot be used by ADG V aircraft when visibility is less than a half mile due to the 1,100-foot separation between Runways 01/19 and 18C/36C

Aircraft Taxi Flows – Alternative 3



Arrivals

Departures

Next Steps

Next Steps

- Provide comments to EA Team by November 20, 2020
 - Send comments to spotter@landrum-brown.com
- Incorporate comments from DORA Team
- Conduct alternatives modeling analysis
- DORA Meeting #4
- Continue preparation of the Draft EA



CLT DORA (Direction, Oversight, Review & Agree) Meeting #4
January 27, 2021



Agenda

- Role Call
- Meeting Objectives
- DORA Process
- EA Process Overview
- Present Alternatives Modeling Results
- Next Steps

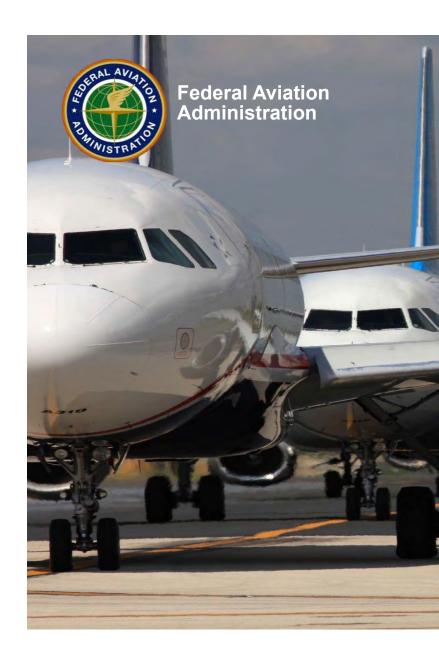
DORA Process

Charlotte Douglas International Airport EA DORA Process Overview

Prepared for: CLT EA DORA Meeting #4

By: Kent Duffy

Date: January 27, 2021



What is DORA?

- DORA =
 Direction, Oversight, Review and Agree
- Obtaining and understanding controller input on operational issues and viability of proposed alternatives is a key to airport capacity development
- DORA has been applied successfully to other large-scale airport and airspace modernization efforts (e.g., O'Hare Modernization Program)



Objectives: Why are we here?

- Ensure collaboration w/ATO on simulation activities as needed to complete EA
 - Obtain input development of the simulation model
 - Revise and refine simulation model, rather than develop new alternatives
- Build from successful process used during planning phase
 - Update with recent changes: forecast trends, CRO, metroplex, heading usage, Atlantic coast routes, etc.
 - Validate operating assumptions used in the simulation model
 - Airspace flows and procedures, Runway usage and balancing, Aircraft separation and buffers, Taxiflows and ground movement, etc.
 - Review and validate airspace's ability to accommodate new runway throughput
- Collaboration ensures the simulation results can be used in the EA analyses with confidence



Planning Phase DORA Letter



U.S. Department of Transportation

Federal Aviation

February 1, 2016

Mr. Jack Christine
Deputy Aviation Director
Charlotte-Douglas International Airport
5601 Wilkinson Boulevard
Charlotte, NC 28208

The additional analysis identified above is part of the normal maturation process as the potential airfield alternatives are further refined and assessed. The FAA considers the results of the first phase of the ACEP to be reasonable given the information that is currently available.

Winsome A. Lenfert

FAA, Division Manager Airports Southern Region

Prostell Thomas.

CLT Air Traffic Manager

Duic

Date

Re: Documentation of DORA Process, Charlotte-Douglas International Airport Airfield Capacity Enhancement Plan

This letter summarizes the process used by the Federal Aviation Administration (FAA) Office of Airports (ARP) and Air Traffic Organization (ATO) to obtain necessary input on operational feasibility of potential design alternatives considered as part of the Charlotte-Douglas International Airport (CLT) Airfield Capacity Enhancement Plan (ACEP). The ACEP is the first step of a long-term modernization effort to add significant capacity to CLT. The Direction, Oversight, Review, and Agree (DORA)



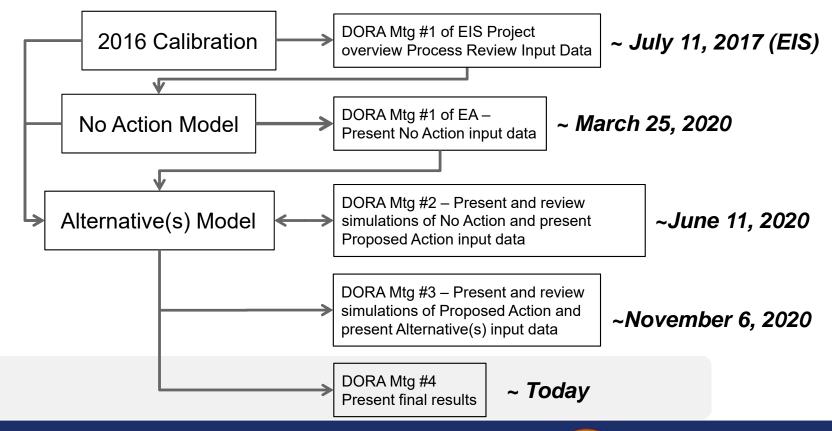
Desired Result: 2nd DORA Letter

Active ATC participation

- FAA Letter signed by ATO and ARP
- Explains process and summarizes meetings
- Identifies further analyses required in subsequent phases (e.g., design/ implementation), as needed
- Desired findings:
 - Modeling approach is <u>reasonable</u>
 - Modeling assumptions accurately reflects operational perspectives
 - Subsequent capacity, throughput and delay <u>results are reasonable</u> representations of the proposed airfield and airspace designs



DORA Process Relationship to Modeling





EA Process Overview

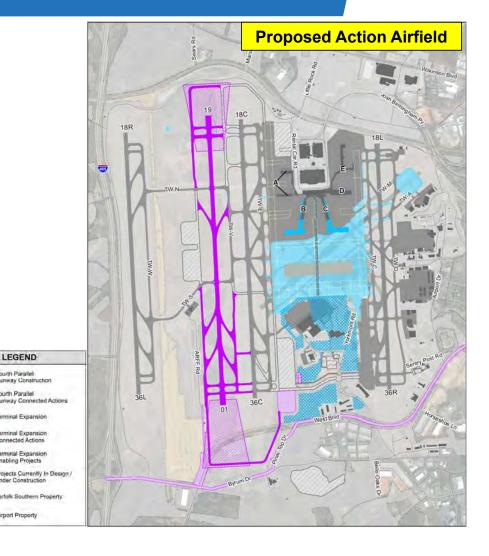
EA Process Overview - Background

- The CLT Environmental Impact Statement (EIS) that the Federal Aviation Administration (FAA) began was cancelled on February 27, 2019.
- The FAA cancelled the EIS because a runway length analysis determined only a 10,000 foot runway is required to meet the purpose and need.
- The FAA determined that this was a sufficient change to warrant cancellation of the EIS and conversion to an Environmental Assessment (EA).
- The City of Charlotte (Airport Sponsor) is responsible for preparing the EA.
- FAA is still the lead agency.
- Similar to the EIS, the EA will evaluate the potential direct, indirect, and cumulative environmental impacts that may result from the Proposed Action.

EA Process Overview – Proposed Action

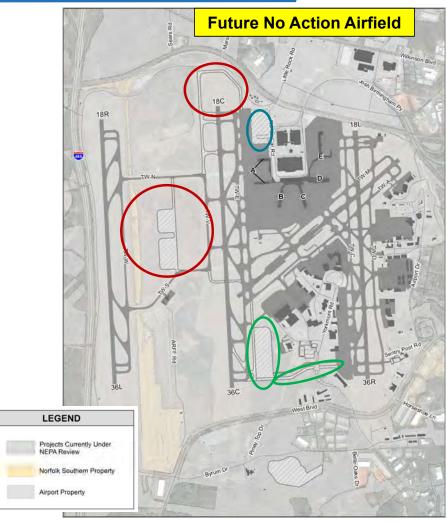
Fourth Parallel

- -4th Parallel Runway (10,000 feet long)
 - North and South End Around Taxiways
- Extensions of Concourse B and C
 - Decommissioning Runway 5/23
- Dual Taxilanes Around Ramp
 - Requires the removal of gates off the end of Concourse D and E
- Crossfield Corridors



EA Process Overview - Simulations

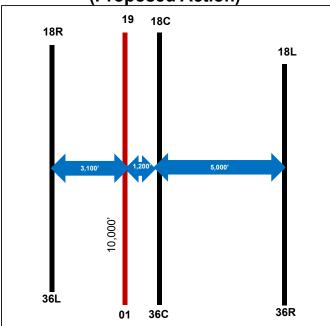
- Simulations will:
 - Be used in developing the Purpose and Need, noise modeling, and air quality modeling.
 - Conducted for the following scenarios:
 - 2016 Calibration Complete
 - 2019 Baseline Complete
 - 2028 Future No Action Complete
 - 2033 Future No Action Complete
 - 2028 Alternative(s) Complete
 - 2033 Alternative(s) Complete
 - Use forecast of operations approved by the FAA.
 - Include 3 independent projects as part of the Future No Action.
 - Deice Pad and crossfield taxiway
 - North End Around Taxiway around Runway 18C/36C, hold pads and threshold displacement (1,235 feet)
 - Concourse A Phase II



Alternatives Simulation Modeling Results

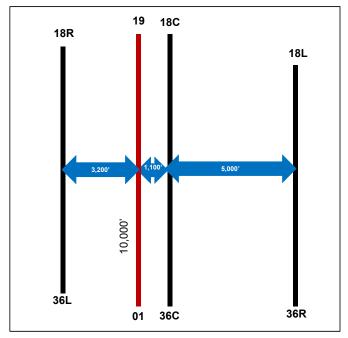
Alternatives Overview

Alternative 1 (Proposed Action)



3,100' separation to 18R/36L 10,000' departure runway

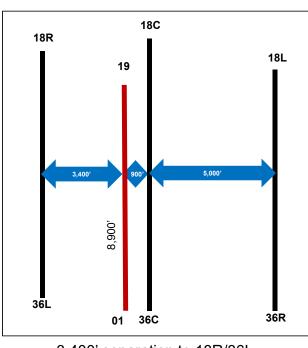
Alternative 2



3,200' separation to 18R/36L 10,000' departure runway

Alternative 2 simulation results are assumed to be same as Alternative 1, with only slight taxi time differences

Alternative 3



3,400' separation to 18R/36L 8,900' arrival runway

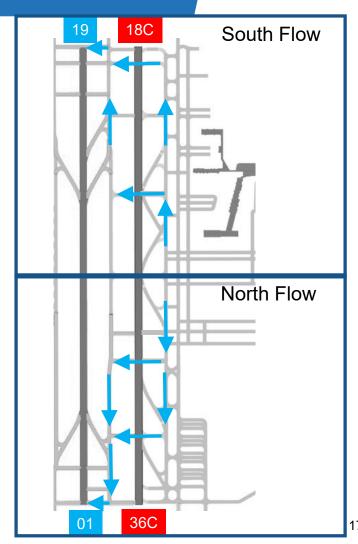
Note: Diagrams are not to scale.

Comparison of Alternatives

Alternative		Future Flexibility	Taxiway V Capability	Navigational Aid Placement	Runway Use	Crossings of Rwy 18C/36C
1 Proposed Action	18R 19 18C 18L 3,100° ,000° 36L 01 36C 36R	No	Full length; unrestricted	Standard placement	Arrivals on inboard runway	More than Alternative 3
2	18R 19 18C 18L 3,200' .000' 01 36L 01 36C 36R	Potential for Rwy 01/19 to be part of simultaneous triples if rules changed in future	Full length; minor restrictions	Standard placement	Arrivals on inboard runway	More than Alternative 3
3	18R 18C 19 18L 3,400' 000' 8 36L 01 36C 36R	n/a	Partial taxiway; minor restrictions	Co-located glideslopes (Rwy 18C/19 and 36C/01)	Arrivals on outboard runway	Fewer than Alternatives 1 & 2

Alternative 1 (Proposed Action) Refinement

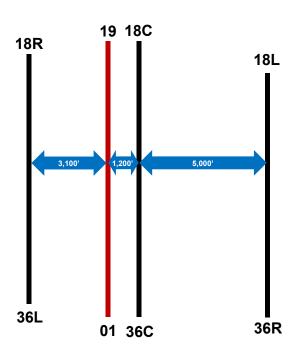
- Added runway crossing points to let two departing aircraft cross Runway 18C/36C simultaneously
 - Reduces Runway 01/19 departure delay
 - Allow more arrivals on Runway 18C/36C
- Rebalanced runway usage to optimize delay and throughput
 - Offload arrivals from Runway 18L/36R to Runway 18C/36C
 - Balance departures between Runway 01/19 and Runway 18L/36R



Alternative 1 (Proposed Action)/Alternative 2

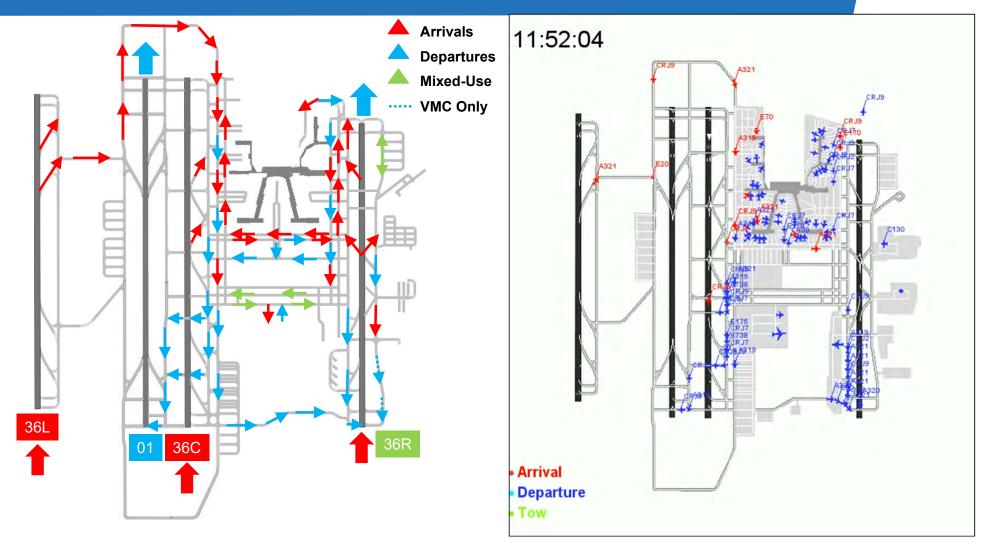
- Alternatives 1 and 2

- Same runway use and procedures
- Same performance with the exception of slight differences in taxi times
- Closely spaced parallel runways:
 - Runways are dependent in IMC
 - Arrivals block departures 2 miles out

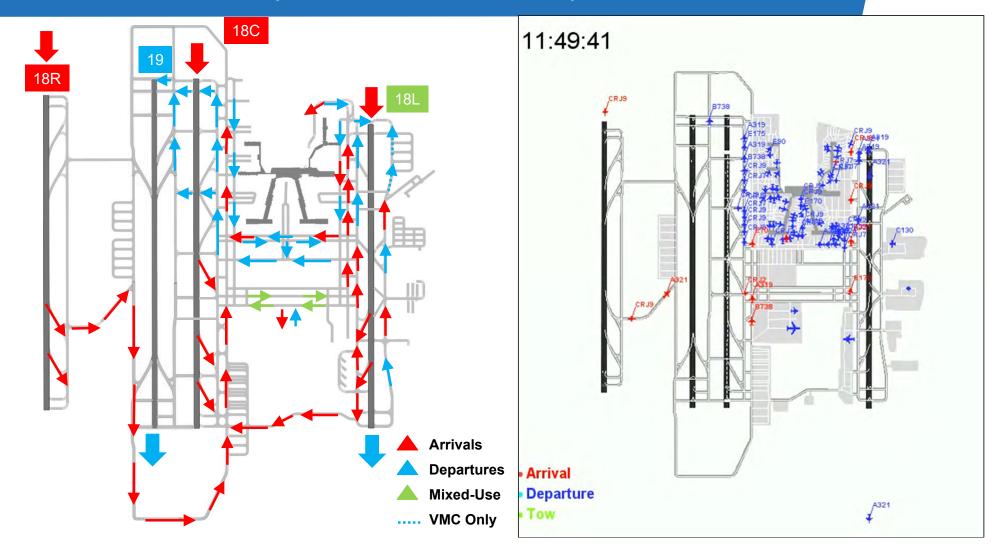


Note: Diagram is not to scale.

Alternative 1 (Proposed Action) – North Flow

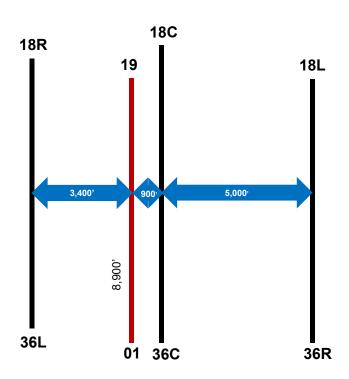


Alternative 1 (Proposed Action) – South Flow



Alternative 3

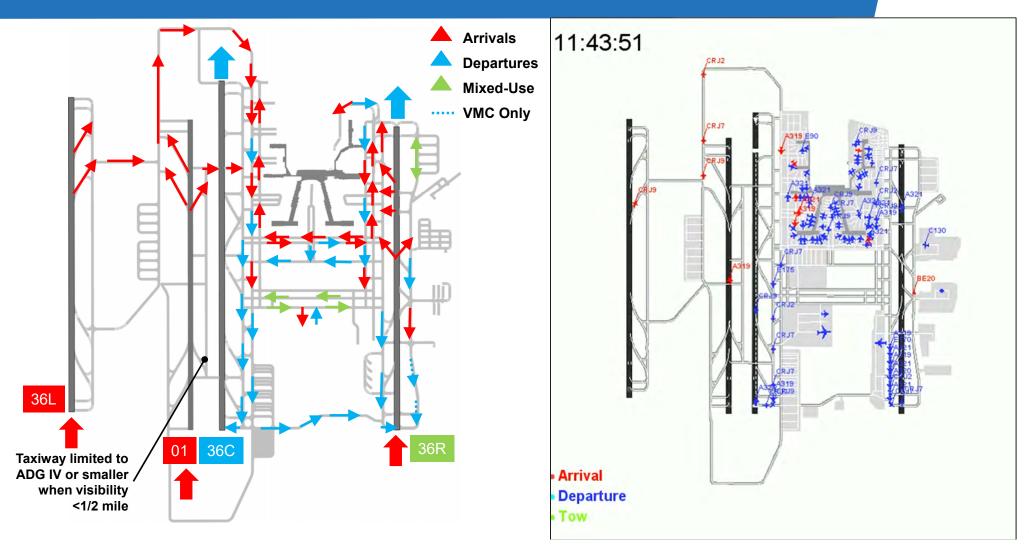
- Assumes that new FAA rules for parallel runways allow simultaneous triple approaches to new runway
- Alternative 3 will use same the airspace assumptions and procedures as Alternative 1 (Proposed Action)



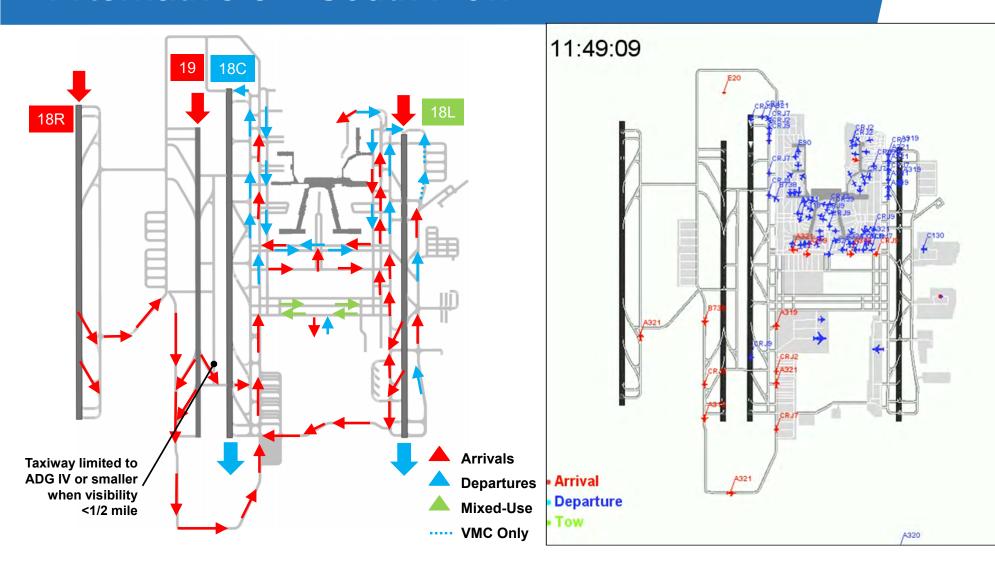
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Note: Diagram is not to scale.

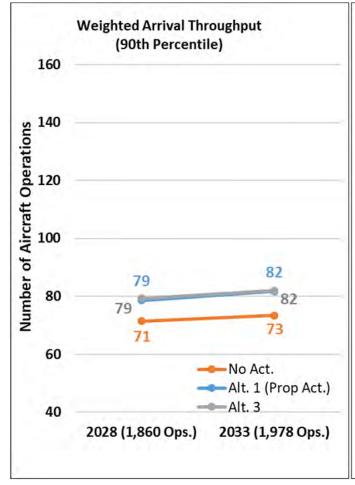
Alternative 3 – North Flow

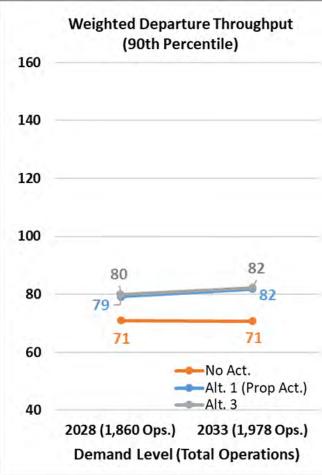


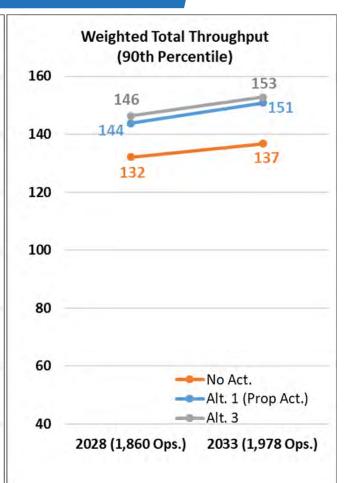
Alternative 3 – South Flow



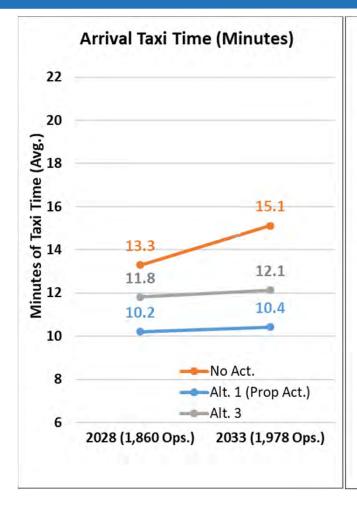
Alternatives Weighted Aircraft Throughput

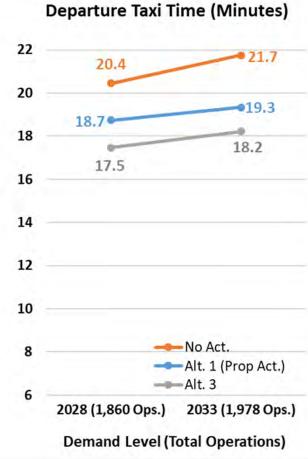


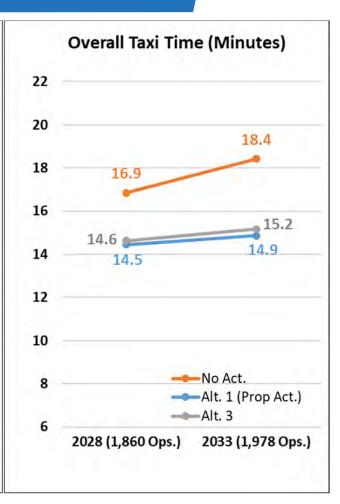




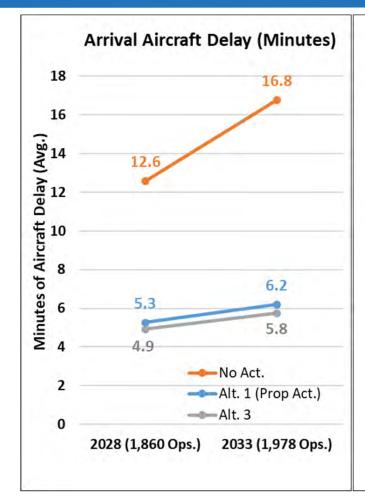
Alternatives Taxi Time (Including Delay)

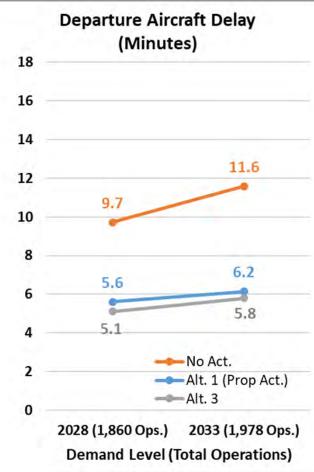


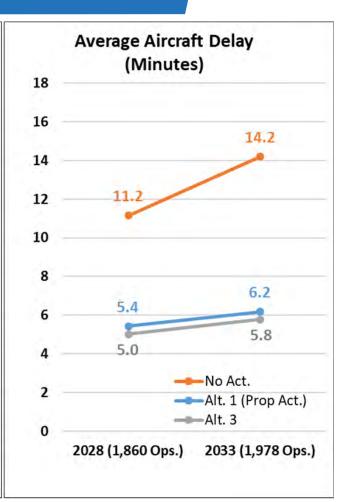




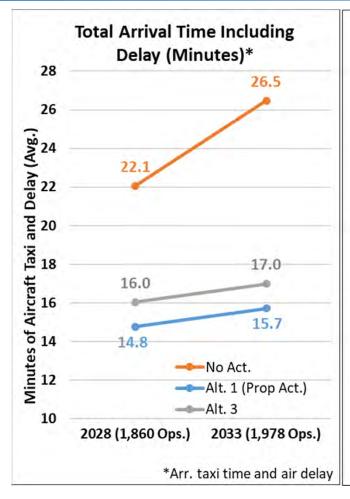
Alternatives Average Aircraft Delay

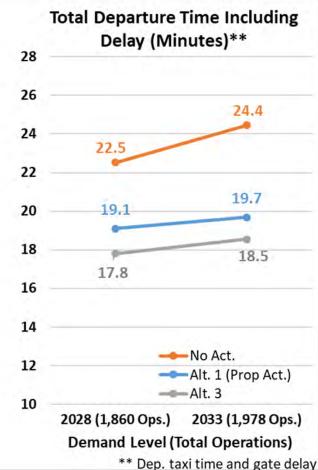


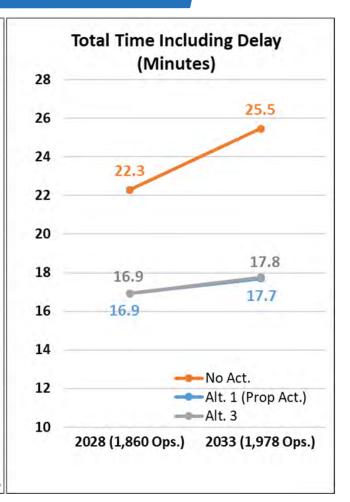




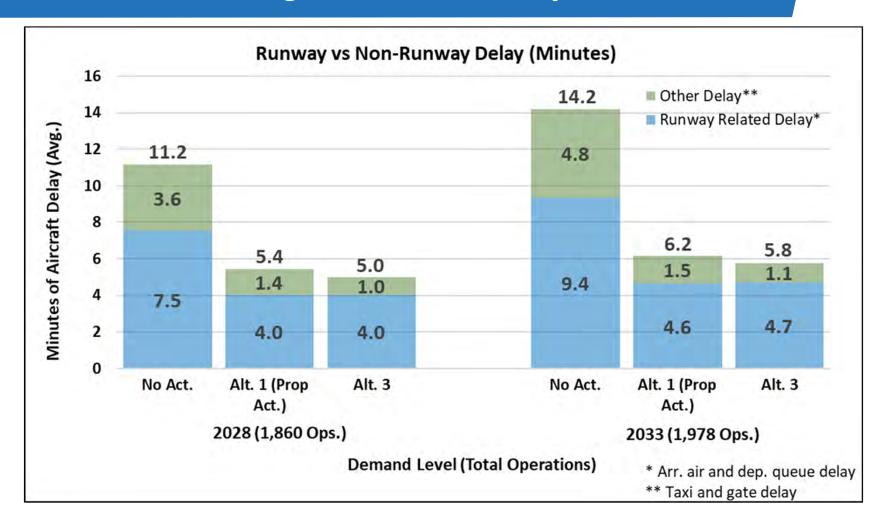
Alternatives Total Time Including Delay







Alternatives Average Aircraft Delay



Next Steps

Next Steps

- Send questions to <u>sarah.potter@landrumbrown.com</u>
- Complete DORA compliance letter
- Continue preparation of the Draft EA

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	Johnson, Duane- Memphis ADO Program Manager	
	Alexander, Timothy L- Memphis ADO EPS	
	Green, Bernard- Memphis ADO Airport Planner	
FAA - Other	Sweat-Essick, Jackie- Environmental Program Manager	
	Fineman, Michael- Senior Attorney	
	Duffy, Kent- FAA Airports Planning and Environmental Division (APP-400)	
	Walker, Jon- Flight Procedures Team / AJV-E24	
	Gendoes, Brett- Charlotte Group Technical Operations Manager	
	Fowler, John - Lead Planner for the Carolinas, AJV-E34	
ANG	Billy Prather	
Charlotte Fire Dept	Field, Justin	

Proposed Capacity Enhancements at Charlotte Douglas International Airport

National Environmental Policy Act Environmental Assessment

Alternatives Analysis

August 2021

PREPARED FOR
Charlotte Douglas International
Airport

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1 Introduction

The Federal Aviation Administration (FAA) notified Charlotte Douglas International Airport (CLT) in April of 2020 of an upcoming modification to the lateral runway separation requirements for dual and triple simultaneous independent approaches that were specified in FAA Order 7110.65Y, *Air Traffic Control*. This rule change had the potential to affect the placement of the new runway under consideration in the Environmental Assessment (EA) for the Capacity Enhancement Projects. As a result, alternatives with different separations from CLT's existing runways were studied. This appendix discusses the development and evaluation of those runway separation alternatives for the CLT EA based on the FAA rule change, which has since become final (FAA issued the revised FAA Order 7110.65Z, *Air Traffic Control*, in June of 2021).

Each of the alternatives includes a new runway which is referred to as Runway 01/19 for purposes of the analysis in this EA. If the new runway is implemented in the future, the proper nomenclature will be determined at that time.

2 Runway Separation

The separation provided between parallel runways is the primary factor that determines the air traffic procedures that must be followed, which in turn determines the capacity of the runways. The FAA runway separation requirements based on FAA Order 7110.65Y, *Air Traffic Control*, that are relevant to the CLT analysis are shown in **Table 2-1**.

TABLE 2-1, LATERAL RUNWAY SEPARATION REQUIREMENTS

Type of Operation	Lateral Runway Separation (in feet)
Simultaneous VFR Operations – Standard	700 feet
Simultaneous VFR Operations – Recommended for ADG V and VI Runways	1,200 feet
Simultaneous IFR Approaches and Departures	2,500 feet ¹
Simultaneous IFR Departures	2,500 feet ¹
Dual Simultaneous Independent IFR Approaches	3,600 feet ²
Triple Simultaneous Independent IFR Approaches	3,900 feet ²

When thresholds are not staggered.

Note: VFR = Visual Flight Rules; IFR = Instrument Flight Rules; ADG = Airplane Design Group

Source: FAA Order 7110.65Y, Air Traffic Control

The FAA's updated lateral runway separation requirements for the dual and triple simultaneous independent approaches that were published in June of 2021 (FAA Order 7110.65Z, *Air Traffic Control*) are compared to the previous lateral runway separation requirements in **Table 2-2**.

TABLE 2-2, RUNWAY SEPARATION REQUIREMENTS COMPARISON

Type of Approach	Order 7110.65Y Runway Separation Requirement	Order 7110.65Z Runway Separation Requirement
Dual Simultaneous Independent	3,600 feet	3,200 feet
Triple Simultaneous Independent	3,900 feet	3,400 feet

Note: Assumes straight-in approaches.

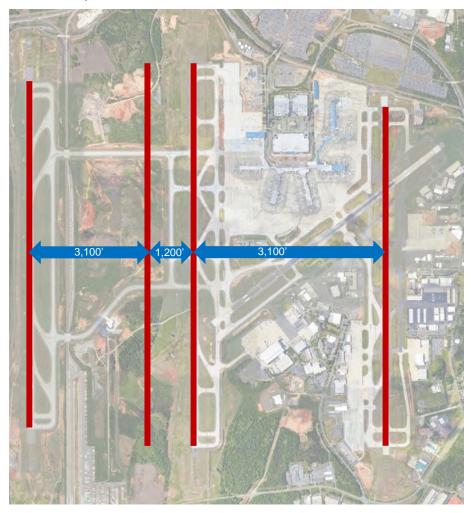
Source: FAA Order 7110.65Z, Air Traffic Control; FAA Headquarters office

This rule change is relevant at CLT because the new runway location and intended runway use in the Proposed Action Alternative were chosen based on the runway separation requirements in FAA Order 7110.65Y, *Air Traffic Control*. As shown on **Exhibit 2-1**, the Proposed Action includes a new "midfield" runway located on the west side of the airfield between Runways 18R/36L and 18C/36C, which are separated by 4,300 feet. Based on the current FAA separation requirements, it is not possible to meet the separation requirement for simultaneous Visual Flight Rules (VFR) operations between Runways 01/19 and 18C/36C (700 to 1,200 feet) while also meeting the 3,900-

Assumes straight-in approaches.

foot separation requirement for triple approaches between Runway 01/19 and 18R/36L. Therefore, the new runway in the Proposed Action alternative was sited so that it provides 1,200 feet of separation to Runway 18C/36C (the recommended separation for ADG V and VI aircraft), leaving 3,100 feet between it and Runway 18R/36L. Because Runway 01/19 does not have the necessary separation between it and the other runways to allow for triple simultaneous independent straight-in approaches, the new runway in the Proposed Action Alternative is intended primarily for departure use (with limited use for arrivals), with Runway 18C/36C intended primarily for arrival use.¹

EXHIBIT 2-1, PROPOSED ACTION RUNWAYS



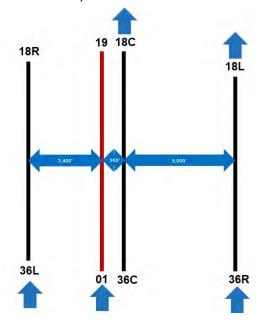
Source: Landrum & Brown, 2020

The reduction in separation requirements for triple simultaneous independent straight-in approaches, results in two possible alternative locations for the new runway in the midfield. The first is placement of Runway 01/19 so that it provides 3,400 of separation to Runway 18R/36L and 900 feet of separation to Runway 18C/36C (see **Exhibit 2-2**). The 3,400-foot separation to Runway 18R/36L would allow triple simultaneous independent straightin approaches to Runways 18R/36L, 01/19, and 18L/36R. Another possible location for Runway 01/19 is to place

It is important that air traffic controllers have the flexibility to use Runway 01/19 and Runway 18C/36C for both arrivals and departures to maximize capacity and operational flexibility. While Runway 01/19 is primarily assumed to be used by departures and Runway 18C/36C is primarily assumed to be used by arrivals, limited use of Runway 01/19 can be expected for arrivals. For example, during off-peak periods, air traffic controllers may choose to land on Runways 18R/36L and 18L/36R while departing Runways 01/19 and 18C/36C. Air traffic controllers could also choose to land on Runway 01/19 and depart Runway 18C/36C during visual weather conditions.

Runway 01/19 with 3,200 of separation to Runway 18R/36L and 1,100 feet of separation to Runway 18C/36C (see **Exhibit 2-3**). This option would not allow triple simultaneous independent straight-in approaches to Runways 18R/36L, 01/19, and 18L/36R but would provide operational flexibility² and position CLT to take advantage of any potential future reductions in runway separation requirements.³ Both of these runway separation options meet standards for the separation between Runway 01/19 and Runway 18R/36L but do not provide the recommended separation of 1,200 feet between Runway 01/19 and Runway 18C/36C. The 3,200-foot and 3,400-foot runway separations will be evaluated in the alternatives analysis.

EXHIBIT 2-2, POTENTIAL SEPARATION SCENARIO 1



Notes: Diagram is not to scale. The length of the new runway is shown at 10,000 feet but may vary depending on the use of

the runway.

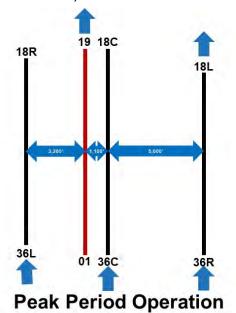
Source: Landrum & Brown analysis, 2021

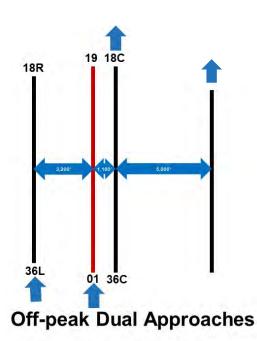
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The 3,200-foot separation between the new runway and Runway 18R/36L would allow these runways to be used by arrivals, with departures on the two eastern most runways, during off-peak periods when triple approaches are not required. The operational benefit of this runway use configuration is the segregation of arrival and departure traffic.

Because dual simultaneous independent approaches would be permitted to Runways 18R/36L and Runway 01/19 if the runways were 3,200 feet apart and because the separation between Runway 01/19 and Runway 18L/36R far exceeds the requirement of 3,400 feet for triple simultaneous independent approaches, it may be possible to obtain a waiver from FAA to operate triple simultaneous independent approaches at CLT in the future. Such an operation would require further study and is not assumed for this EA.

EXHIBIT 2-3, POTENTIAL SEPARATION SCENARIO 2





Notes: Diagram is not to scale. The length of the new runway is shown at 10,000 feet but may vary depending on the use of the runway.

Source: Landrum & Brown analysis, 2021

3 Runway Length Requirements

This section describes the takeoff and landing runway length requirements for CLT.

3.1 Runway Length Methodology

Landing and takeoff requirements were calculated following the recommended guidance in FAA Advisory Circular (AC) 150/5325-4B, *Runway Length Requirements for Airport Design*. As such, the aircraft manufacturers' airport planning manuals from Airbus, Boeing, and Gulfstream were utilized in conjunction with the 2033 forecast fleet mix to calculate runway length requirements. Runway length requirements are a function of the following factors:

- Aircraft Fleet
- Density Altitude
- Runway Contamination (landings only)
- Flap Settings (landings only)

3.1.1 Aircraft Fleet

The CLT 2033 fleet mix was reviewed to determine the most critical aircraft for runway length requirements. Thirteen aircraft were selected for the analysis. All of the analyzed aircraft meet the critical aircraft threshold of maintaining at least 500 operations annually in the 2033 forecast. Landing runway length requirements for these aircraft were assessed at maximum landing weight (MLW). Takeoff requirements were calculated for the furthest destination for each aircraft, assuming 100 percent payload. Each aircraft used in this analysis is depicted in **Table 3-1**.

3.1.2 Density Altitude

Density altitude is pressure altitude corrected for non-standard temperature. It affects an aircraft's performance including how fast it can accelerate, how quickly it can obtain lift, and how fast it can climb. As an airport's elevation and/or temperature increase, air density decreases, which results in decreased aircraft performance and longer runway length requirements.⁴

Airfield elevation is the first component to density altitude. It is used as an input factor on the landing and takeoff charts in the aircraft manufacturers' airport planning manuals to determine accurate takeoff and landing requirements. The elevation at CLT is 747.9 feet above Mean Sea Level (MSL).⁵

⁴ https://www.aopa.org/training-and-safety/active-pilots/safety-and-technique/weather/density-altitude#WIDA

⁵ FAA Airport Data and Information Portal (ADIP) 2020

TABLE 3-1, 2033 AIRCRAFT FLEET FOR RUNWAY LENGTH ANALYSIS

Aircraft	Operator	Critical Destination (distance in NM from CLT)	2033 Annual Operations
Airbus A300-600F	FedEx, UPS	MEM (444)	4092
Airbus A321	American	SFO (1,995)	96,503
Airbus A321NEO	American	KEF (2,711)	21,142
Airbus A330-200	American	GRU (4,018)	3,410
Boeing B717-200	Delta	MSP (808)	4,092
Boeing B737-800	Delta, Southwest	PDX (1,983)	6,138
Boeing B737MAX8	American, Southwest	PDX (1,983)	37,169
Boeing B737MAX9	United	SFO (1,995)	2,046
Boeing B787-900	American	FCO (4,182)	3,069
Bombardier CRJ900	American, Delta	n/a¹	133,672
Embraer 145	American	n/a¹	1,364
Gulfstream G500/600	General Aviation	n/a¹	682
McDonnel Douglas DC10	FedEx	MEM (444)	1,364

Aircraft not assessed for takeoffs. Source: 2033 design day flight schedule

The second component to density altitude is temperature. The effect of temperature on density altitude is greater with takeoffs than landings. As a result, the FAA requires temperature adjustments for takeoffs, but not landings, according to FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*. The aircraft manufacturers' manuals contain charts to calculate takeoff runway length requirements based on temperature. Takeoff length requirements may be calculated based on a "standard day" (defined as 59 degrees Fahrenheit) or a "hot day." The hot day charts in the aircraft manufacturers' manuals vary the conditions of the hot day depending on the aircraft type. The determination of which temperature chart to use depends upon the average or typical weather conditions for a particular region or airport. FAA guidance prescribes the use of an airport's mean-max temperature for use in runway length calculations. The mean-max temperature is defined as the average daily maximum temperature of the hottest month. The mean daily maximum temperature at CLT is approximately 87 degrees Fahrenheit, 6 making the hot day charts most appropriate for use in the CLT takeoff analysis.

3.1.3 Runway Contamination

Landing length requirements should be calculated for wet (contaminated) runways when following FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*. Contaminated runway conditions require longer runways for landing than dry conditions, due to the additional distance needed to decelerate on wet pavement. For those aircraft where the aircraft performance manuals do not specifically show a wet landing length curve, the dry landing length was increased by 15% as specified in the runway length AC. Takeoff runway length requirements do not factor in runway contamination per FAA guidance.

3.1.4 Flap Settings

Flaps are used on landings to produce a slower stall speed (so the pilot can land slower) and more drag (which allows the pilot to fly at a steeper descent angle to the runway). Maximum flap settings allow a pilot to maximize the lift and drag that the aircraft wings produce. All landing analysis was conducted using the highest landing flap settings available. Flap settings are not used in determining takeoff requirements.

3.2 Takeoff Runway Length Requirements

The Runway Length Analysis: Proposed Runway 1-19 Technical Memorandum, April 15, 2019, found that 10,000 feet of runway length is required at CLT to serve departures by the critical aircraft. This analysis was based on

National Centers for Environmental Information, 1981-2010 Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days.

performance engineering data from the airlines, which found that the Boeing 787-9 is the critical aircraft for runway length. This aircraft would require 10,000 feet of runway when departing in north flow.

As a result of critical aircraft runway length requirement, at least one departure runway at CLT should be 10,000 feet long. Runway 18C/36C is 10,000 feet long and currently serves as the primary departure runway. If this runway will continue to be used as a departure runway it meets the 10,000-foot need. For alternatives where Runway 18C/36C is intended primarily for arrival use and the new runway will become the primary departure runway, the new runway should be 10,000 feet long.

Not every departure runway at CLT needs to be 10,000 feet long. Runway 18L/36R is the secondary departure runway and is 8,676 feet long. The ability of this runway to serve the forecast fleet was assessed using a payload/range analysis (see **Table 3-2**) to determine if it needs to be extended. This analysis assumed 100% payload to the furthest destination for 10 aircraft in the 2033 fleet. The analysis determined that 3 of the 10 aircraft analyzed are unable to takeoff with maximum (100%) payload from Runway 18L/36R:

- A330-300 international passenger aircraft to GRU (4,018 nautical miles)
- B787-900 international passenger aircraft to FCO (4,182 nautical miles)
- B737-900 domestic passenger aircraft to SEA (1,980 nautical miles)

All of the other analyzed aircraft were found to be able to depart Runway 18L/36R with maximum payloads to the furthest destination identified for each aircraft type. The aircraft that require more than 8,676 feet for takeoff at 100% payload are noted in the table.

TABLE 3-2, 2033 RUNWAY 18L/36R PAYLOAD-RANGE ANALYSIS

Aircraft	Critical Destination	CLT to Critical Destination (NM)	Payload to Critical Destination (lbs.)	% Payload to Critical Destination
A330-200*	Brazil (GRU)	4,018	90,000	90%
MD-DC10	Memphis (MEM)	444	152,964	100%
B787-900*	Rome (FCO)	4,182	148,000	95%
B737MAX8	Portland (PDX)	1,983	52,040	100%
A321	San Francisco (SFO)	1,995	56,000	100%
A300-600F	Memphis (MEM)	444	102,852	100%
B737-800	Portland (PDX)	1,983	47,000	100%
A321NEO	Keflavik (KEF)	2,711	56,200	100%
B717-200	Minneapolis-St Paul (MSP)	808	32,000	100%
B737MAX9	San Francisco (SFO)	1,995	156,500	100%
B737-900*	Seattle (SEA)	1,980	43,720	96%

Note: * = Aircraft that require more than 8,676 feet of runway for takeoff at 100% payload. Source: Aircraft manufacturer's airport planning manuals; Landrum & Brown analysis, 2020

If any of the three aircraft have full payloads, they must use Runway 18C/36C to depart instead of Runway 18L/36R. If the aircraft are headed eastbound, the departure from Runway 18C/36C results in an airspace crossing, which means aircraft waiting to depart on Runway 18L/36R must hold until the eastbound departure from Runway 18C/36C is clear. This negatively affects the capability of the runways. As a result, the 2033 design day schedule was reviewed to determine how many takeoffs per hour would require use of Runway 18C/36C (see **Table 3-3**). This analysis found that there would be at most two aircraft in any hour that cannot depart from Runway 18L/36R. This level of activity is not sufficient to justify an extension to Runway 18L/36R in any of the alternatives. As a result, none of the CLT EA alternatives will include an extension to Runway 18L/36R.

TABLE 3-3, 2033 DEPARTURES THAT CANNOT TAKEOFF FROM RUNWAY 18L/36R AT FULL PAYLOAD

Aircraft	Destination	Daily Departures	Hours of Operation
A330-200	Frankfurt (FRA)	1	16:00
	Paris (CDG)	1	18:00
	Brazil (GRU)	1	20:00
	Barcelona (BCN)	1	20:00
B787-900	Rome (FCO)	1	18:00
B737-900	Seattle (SEA)	1	17:00

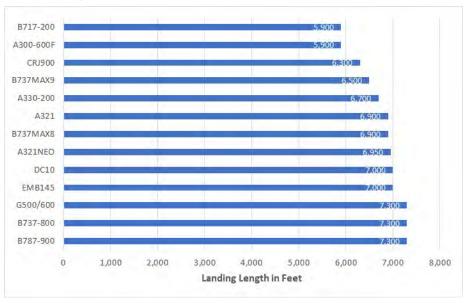
Source: 2033 design day flight schedule; Landrum & Brown analysis, 2020

3.3 Arrival Runway Length Requirements

Given the FAA's rule change for runway separations, it may be possible for CLT's new runway to be a primary arrival runway in some of the EA alternatives. As a result, arrival runway length requirements were determined using the procedures outlined in FAA Advisory Circular (AC) 150/5325-4B, *Runway Length Requirements for Airport Design*. The results of these calculations can differ from the more detailed performance engineering analysis that aircraft operators and airlines are capable of performing. As a result, the airlines at CLT were consulted to validate the runway length conclusions.

The landing length requirements are depicted on **Exhibit 3-1**. The requirements shown for most of the aircraft reflect the results of the aircraft manufacturers' charts. American Airlines provided requirements for the B878-900, B737-800, A321, and B737MAX8; the requirements provided by American are shown instead of the chart results for these aircraft. The B787-900, B737-800, and Gulfstream 500/600 require the most landing length at 7,300 feet. These aircraft combined are forecast to make up 9,889 annual operations in 2033. Therefore, any alternative that considers arrival use for the new runway will include a 7,300-foot long runway, unless there are operational reasons that require a longer length.

EXHIBIT 3-1, 2033 LANDING RUNWAY LENGTH REQUIREMENTS



Notes: Landing lengths based on wet (contaminated) runway conditions at MLW.

Source: Aircraft manufacturer's airport planning manuals; Landrum & Brown analysis, 2020

4 Taxiway Geometry

Taxiway geometry requirements at an airport are dictated by the critical aircraft as specified in FAA AC 150/5000-17, *Critical Aircraft and Regular Use Determination*. CLT's critical aircraft is the Airbus 350-900.⁷ It is the largest aircraft that is forecast to have at least 500 annual operations at CLT in 2033. The A350-900 is classified by FAA as an ADG V and Taxiway Design Group (TDG) 5 aircraft. All of the alternatives should be designed to meet ADG V and TDG 5 standards.

The taxiway geometry should be designed to protect for Category (CAT) II/III approaches in the event CLT decides to provide CAT II/III instrumentation on the new runway. In addition, it is preferable that a full-length parallel taxiway be provided on both sides of Runway 01/19 (between Runways 01/19 and 18R/36L and between Runways 01/19 and 18C/36C) in order to maximize operational flexibility and operational performance.

The key taxiway dimension for the CLT alternatives is the lateral spacing between the new runway and its parallel taxiways. The required spacing can vary based on a number of factors. **Table 4-1** provides the various lateral spacing requirements that apply for Runway 01/19. In order to meet TDG 5 and ADG V standards while protecting for CAT II/III approaches, the minimum separation between the new runway and its parallel taxiways should be 500 feet. Another consideration for runway-taxiway separation is the location of the glideslope antenna and the glideslope critical area. In order to be able to taxi past a glideslope antenna, 560 feet of lateral separation must be provided between the runway and the parallel taxiway. In order to be able to taxi unrestricted around a glideslope critical area, 642.5 feet of lateral separation must be provided between the runway and the parallel taxiway. These spacing requirements will be applied in the alternatives.

TABLE 4-1, RUNWAY TO TAXIWAY LATERAL SEPARATION REQUIREMENTS

Criteria	Runway-Taxiway Lateral Separation Requirement (in feet)
ADG V with Visibility >= ½ mile	400
TDG 5 (Minimum) ¹	427
TDG 5 (Recommended) ¹	450
ADG V with Visibility < 1/2 mile	500
Allow Taxi Past Glideslope Antenna	560
Protect for Glideslope Critical Area	642.5

Separation requirement for reverse turns from a high-speed exit.

Source: FAA AC 150/5300-13A, Airport Design

5 Runway Exit Geometry

The type of runway exits and the location and number of exits on a runway depend on many factors including the separation distance between the runway and its associated parallel taxiways, the length of the runway, any displacement of the arrival threshold, and the types of aircraft using the runway. The time it takes an aircraft to decelerate to a slow enough speed to exit the runway varies depending on the size and performance characteristics of the aircraft and condition of the runway. If exits are not placed at the point(s) where the majority of aircraft using the runway reach their exit speed, the aircraft must continue down the runway at a relatively low rate of speed until it reaches the next available exit taxiway.

Runways with adequate and properly spaced runway exits allow capacity to be optimized by minimizing the runway occupancy times (ROT) of arriving aircraft and reducing the spacing required between sequential landing aircraft. The ROT is the length of time required for an arriving aircraft to proceed from over the runway threshold

The A350-900 is the critical aircraft based on its wingspan and approach speed. The critical aircraft for runway length is the B787-9 based on its landing and takeoff performance characteristics. Per FAA Advisory Circular 150/5000-17, Critical Aircraft and Regular Use Determination, Section 3.1, airports can have "multiple critical aircraft determinations."

to a point clear of the runway. An average ROT of 50 seconds or less is considered high efficiency.⁸ The number, type, and location of runway exits influences the ROT for each runway.

A runway exit analysis was conducted for CLT to identify the best placement of runway exits on Runway 01/19 in the alternatives. The analysis was completed for the 2028 and 2033 fleet mixes. The new Version 3 release of the FAA's Runway Exit Design Interactive Model (REDIM) was used in this analysis. This new version of REDIM uses real aircraft landing data from 30 major U.S. airports to determine typical landing patterns by aircraft type based on runway length. As a result, the ROT results from REDIM V3 are influenced by factors outside of aircraft performance such as the availability of properly placed exits and terminal/parking locations at the analyzed airports. Because this model is new, additional study will be needed to determine the most appropriate number and location of runway exits for the new runway prior to its construction.

5.1 Assumptions

REDIM uses a mix of airport specific fixed and variable inputs to perform its analysis. The main inputs include the following:

- Fleet Mix
- Airport Temperature
- Airport Elevation
- Surface Conditions

Table 5-1 summarizes the 2028 and 2033 forecast fleet mix for CLT.

TABLE 5-1, REDIM AIRCRAFT FLEET MIX

Fleet Mix	2028 % of Fleet	2033 % of Fleet
319 (A319)	14.6%	14.0%
320 (A320)	2.1%	1.7%
321 (A321)	15.2%	14.3%
32N (A320neo)	0.0%	0.3%
332 (A330-200)	0.5%	0.5%
333 (A330-300)	0.0%	0.0%
359 (A350-900)	0.1%	0.1%
A321 Neo	2.9%	3.1%
717 (B717-200)	0.6%	0.6%
733 (B737-300)	0.0%	0.0%
738 (B737-800 Passenger)	0.9%	1.0%
739 (B737-900 Passenger)	0.0%	0.3%
73G (B737-700 Passenger)	0.6%	0.7%
752 (B757-200 Passenger)	0.0%	0.0%
Boeing 787-8	0.0%	0.1%
Boeing 787-9	0.5%	0.5%
7M7 (B737-Max 7 Passenger)	0.1%	0.1%
7M8 (B737-Max 8 Passenger)	3.6%	5.5%
7M9 (B737-Max 9 Passenger)	0.2%	0.3%
A300	0.6%	0.6%
Beech 350 Super King	0.1%	0.1%
Beech 200 Super King	0.4%	0.4%
Beechcraft Baron	0.1%	0.1%
Beech 90 King Air	0.1%	0.1%
Lockheed C-130	0.1%	0.1%
Cessna 525A	0.1%	0.1%

An average 50-second ROT on a runway allows air traffic controllers to authorize 2.5-nautical mile separation between aircraft on final approach within 10 nautical miles of the landing runway. FAA Order 7110.65Z, *Air Traffic Control*.

Fleet Mix	2028 % of Fleet	2033 % of Fleet
Cessna 525B	0.1%	0.1%
Cessna T303 Crussader	0.1%	0.1%
Cessna 550	0.2%	0.2%
Cessna Citation V	0.3%	0.3%
Cessna Citation Excel	0.4%	0.4%
Cessna Citation X	0.2%	0.2%
Bombardier Challenger 300	0.2%	0.2%
Bombardier Challenger 350	0.1%	0.1%
Bombardier Challenger 600	0.1%	0.1%
CR2 (CRJ-200)	4.6%	3.7%
CR7 (CRJ-700)	17.9%	17.3%
CR9 (CRJ-900)	21.7%	19.8%
CR7 (CRJ-700)	0.2%	0.3%
CRJ (CRJ)	0.0%	0.0%
Airbus 220-100	0.0%	1.0%
McDonnell Douglas DC-10	0.1%	0.2%
DH3 (DHC-8-300)	0.0%	0.0%
DH8 (DHC-8)	0.0%	0.0%
Embraer Phenom 300	0.4%	0.4%
E70 (E-170)	0.5%	0.5%
E75 (E-175)	5.5%	7.0%
E7W (E-175 Enhanced Winglets)	0.9%	0.9%
E90 (E-190)	0.8%	0.9%
EM2 (EMB-120 Brasilia)	0.2%	0.2%
ER4 (ERJ-145)	0.2%	0.2%
Dassault Falcon 2000	0.4%	0.4%
Dassault Falcon 900	0.1%	0.1%
DASSAULT Falcon 50	0.1%	0.1%
FRJ (328Jet)	0.1%	0.1%
Gulfstream G100	0.1%	0.1%
Gulfstream G280	0.1%	0.1%
Gulfstream G200	0.1%	0.1%
Bombardier Global Express	0.2%	0.2%
Gulfstream 5	0.1%	0.1%
Gulfstream 6	0.1%	0.1%
Hawker 800	0.1%	0.1%
Learjet 45	0.2%	0.2%
Learjet 60	0.1%	0.1%
M88 (MD-88)	0.0%	0.0%
M90 (MD-90)	0.2%	0.0%
Cirrus SR22	0.1%	0.1%
Socata TBM-800	0.1%	0.1%
Socata TBM-900	0.1%	0.1%

Source: 2028 and 2033 design day flight schedules.

Table 5-2 presents the airport specific assumptions that affect the REDIM output. Higher airport elevation results in higher ground speeds, leading to longer landing distances. Similarly, higher airport temperature leads to lower air density and decreased aircraft performance, resulting in increased ROT. Surface conditions affect the landing performance of aircraft. A wet runway results in increased rolling distances and higher ROT times than dry runway conditions.

TABLE 5-2, AIRPORT SPECIFIC INPUTS

Input	CLT
Airport Elevation	747.9 feet above sea level ¹
Airport Temperature	87°F ²
Surface Conditions	90% Dry, 10% Wet ³

FAA Airport Data and Information Portal (ADIP) 2020

5.2 Runway Exit Analysis Results

REDIM was used to determine the optimal location and number of exits for three runway lengths:

- **10,000 feet**: Based on the runway length analysis presented in Section 1.2, *Runway Length Analysis*, 10,000 feet is the most appropriate length for a departure runway.
- **8,900** feet: The new 10,000-foot long runway in Alternative 1 includes a 1,100-foot long displaced threshold on the Runway 19 end, resulting in 8,900 feet of available landing length. It was assumed that any alternative with a 10,000-foot long runway would have a similar displaced threshold.
- **7,300 feet**: Based on the runway length analysis presented in Section 1.2, *Runway Length Analysis*, 7,300 feet is the most appropriate length for an arrival runway.

Table 5-3 and **Table 5-4** present the results of the REDIM analysis at each of the demand levels for a 10,000-foot runway, with four versus five exits. The ROT for both scenarios is greater than the desired 50 seconds. The higher ROT occurs because the aircraft will use the end-around taxiways (EATs) and so have no incentive to exit the runway quickly.

TABLE 5-3, REDIM RESULTS FOR 10,000-FOOT LONG RUNWAY WITH FOUR EXITS

Exit	Exit Distance from Threshold	Exit Angle	Exit Usage		
			2028	2033	
1	5,800	30°	40%	39%	
2	6,600	30°	35%	35%	
3	7,600	90°	21%	21%	
4	10,000	90°	4%	5%	
Average ROT		54 seconds	54 seconds		

Note: Percentages may not sum to 100% due to rounding.

Source: REDIM V3 analysis

TABLE 5-4, REDIM RESULTS FOR 10,000-FOOT LONG RUNWAY WITH FIVE EXITS

Evit	Exit Distance	Exit Angle	Exit Usage		
Exit	from Threshold		2028	2033	
1	5,500	30°	25%	25%	
2	6,200	30°	34%	33%	
3	7,000	30°	26%	26%	
4	7,900	90°	13%	13%	
5	10,000	90°	3%	3%	
Average ROT		53 seconds	53 seconds		

Note: Percentages may not sum to 100% due to rounding.

Source: REDIM V3 analysis

National Centers for Environmental Information, 1981-2010 Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days

National Centers for Environmental Information, precipitation data from 1/1/2009 to 12/31/2019

Table 5-5 presents the results of the REDIM analysis at each of the demand levels for an 8,900-foot long runway. This 8,900-foot length represents the 1,100-foot long displaced threshold on 10,000-foot long Runway 19, which would be used in south flow. As with the 10,000-foot length, the ROT is higher than 50 seconds. This higher ROT occurs because aircraft in south flow are traveling away from the terminal area when they land so pilots have no incentive to exit the runway early.

TABLE 5-5, REDIM RESULTS FOR 8,900-FOOT LONG RUNWAY

Exit	Exit Distance from Threshold	Exit Angle	Exit Usage		
			2028	2033	
1	5,700	30°	37%	37%	
2	6,500	30°	38%	37%	
3	7,200	90°	20%	22%	
4	8,900	90°	5%	4%	
Average ROT		52 seconds	52 seconds		

Note: Percentages may not sum to 100% due to rounding.

Source: REDIM V3 analysis

Table 5-6 presents the REDIM results for a 7,300-foot long runway. ROT is below 50 seconds due to the shorter length of the runway.

TABLE 5-6, REDIM RESULTS FOR 7,300-FOOT LONG RUNWAY

Evit	Exit	Evit Anglo	Exit Usage		
EXIL		Exit Angle	2028	2033	
1	4,900	30°	51%	50%	
2	5,700	30°	37%	38%	
3	7,300	90°	12%	12%	
	Average ROT		47 seconds	48 seconds	

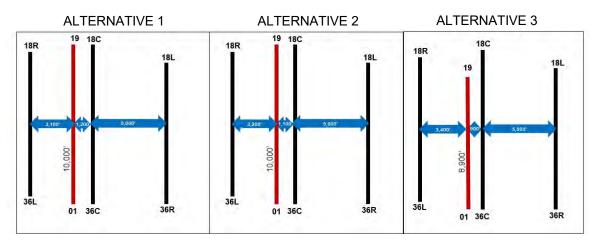
Source: REDIM V3 analysis

This exit location information for the various runway lengths will be used to determine the appropriate placement of exits in the alternatives. The actual locations of the exits may differ slightly due to the location of thresholds, existing exits, and glideslopes.

6 Development of Alternatives

Based on the changes in FAA runway separation requirements and the runway length analysis, three alternatives with new runways in the midfield were developed. The alternatives are summarized in **Exhibit 6-1**. The three alternatives are shown in more detail on **Exhibit 6-2** through **Exhibit 6-4**. This section discusses typical or primary runway use when discussing the alternatives. It is important to note that no new restrictions on runway use are proposed or assumed. The proposed new runway will be usable by arrivals and departures.

EXHIBIT 6-1, MIDFIELD RUNWAY ALTERNATIVES SUMMARY



Alternative	Separation to West Rwy (in feet)	Separation to East Rwy (in feet)	Primary Use of New Runway	Length (in feet)	
1	3,100	1,200	Departure	10,000	
2	3,200	1,100	Departure	10,000	
3	3,400	900	Arrival	8,900	

Source: Landrum & Brown analysis, 2020

6.1 Alternative 1

Alternative 1 includes a 10,000-foot long midfield runway with 3,100 feet of separation to Runway 18R/36L and 1,200 feet of separation to Runway 18C/36C. The new runway does not have sufficient spacing between it and either of its two adjacent runways to allow for triple simultaneous independent straight-in approaches, so it is intended to be used primarily by departures (with limited use for arrivals). As a result of this intended use, the new runway is 10,000 feet long in this alternative. Runways 18R/36L, 18C/36C, and 18L/36R are anticipated to be used for arrivals, providing triple simultaneous independent approach capability. Runways 01/19 and 18L/36R would be used for departures.

Runway 01/19 is intended for departure use so it is not necessary to optimize ROT in this alternative. As a result, two high-speed exits are provided in north flow and one is provided in south flow. The locations of the exits differ from that shown in Section 5, *Runway Exit Geometry*, due to the location of other taxiways and navigational aids.

Alternative 1 includes the construction of a partial north EAT (NEAT), and a full south EAT (SEAT). The alternative also includes the construction of a west parallel taxiway and the extension of Taxiway V (the taxiway between the new runway and Runway 18C/36C) to the Runway 01 threshold. There is 1,200 feet of separation between Runways 01/19 and 18C/36C, so Taxiway V has sufficient spacing to both runways to allow unrestricted taxiing during all weather conditions.

EXHIBIT 6-2, ALTERNATIVE 1

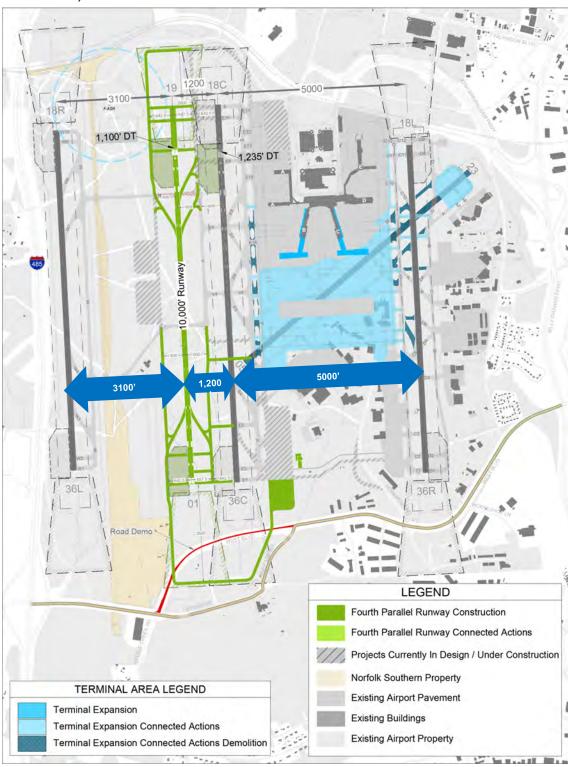
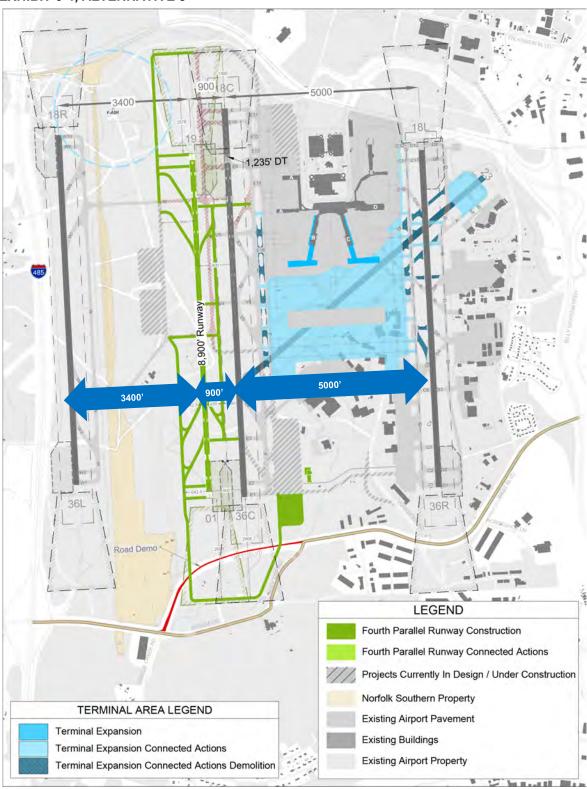


EXHIBIT 6-3, ALTERNATIVE 2



EXHIBIT 6-4, ALTERNATIVE 3



6.2 Alternative 2

As in Alternative 1, Alternative 2 includes a 10,000-foot long midfield runway. The runway is shifted 100 feet to the east in this alternative to provide 3,200 feet of separation to Runway 18R/36L and 1,100 feet of separation to Runway 18C/36C. The new runway does not have sufficient spacing between it and either of its two adjacent runways to allow for triple simultaneous independent straight-in approaches so is intended to be used primarily by departures (with limited use for arrivals). As a result of this intended use, the new runway is 10,000 feet long in this alternative. Runways 18R/36L, 18C/36C, and 18L/36R are anticipated to be used primarily for arrivals, providing triple simultaneous independent approach capability. Runways 01/19 and 18L/36R would be used for departures. This runway use is the same as in Alternative 1.

As discussed in Section 2, *Runway Separation*, the 3,200-foot separation between the new runway and Runway 18R/36L would provide operational flexibility to air traffic controllers because dual simultaneous independent approaches would be permitted to Runways 18R/36L and 01/19. The controllers could opt to run arrivals to these two runways while using Runways 18C/36C and 18L/36R for departures in non-peak arrival periods. This would segregate arriving and departing traffic, possibly providing operational benefits. The 3,200-foot separation would also position CLT to take advantage of any potential future reductions in runway separation requirements.⁹

Runway 01/19 is intended for departure use, however, due to its potential use as an arrival runway during off-peak times, it is important to optimize ROT to the extent possible in this alternative. As a result, three high-speed exits are provided in north flow and two are provided in south flow. The locations of the exits differ from that shown in Section 5, *Runway Exit Geometry*, due to the location of other taxiways and navigational aids.

Alternative 2 includes the construction of a partial NEAT and a full SEAT. The alternative also includes the construction of a west parallel taxiway and the extension of Taxiway V (the taxiway between the new runway and Runway 18C/36C) to the SEAT in order to allow arrivals on Runway 01/19 to access the SEAT. There is 1,100 feet of separation between Runways 01/19 and 18C/36C, which falls short of the recommended separation between closely spaced parallel runways for ADG V aircraft. As a result of having 1,100 feet of separation between the runways and the location of the Runway 36C glideslope, ADG V aircraft cannot taxi on Taxiway V when visibility is less than a half mile.¹⁰

6.3 Alternative 3

Alternative 3 includes a new midfield runway with 3,400 feet of separation to Runway 18R/36L and 900 feet of separation to Runway 18C/36C. The new runway has sufficient spacing between it and Runways 18R/36L and 18L/36R to allow for triple simultaneous independent straight-in approaches. As a result, it is intended to be used primarily by arrivals along with Runways 18R/36L and 18L/36R. Runways 18C/36C and 18L/36R would be used for departures.

Alternative 3 includes the construction of a partial NEAT, and a full SEAT. The 900-foot separation between the proposed runway and Runway 18C/36C allows for a center taxiway with 450 feet separation to both runways, which results in restricted use. ADG V aircraft cannot use this taxiway when visibility is less than a ½ mile. The 900-foot spacing also results in another restriction. The location of the Runway 18C and 36C glideslopes and associated critical areas combined with the 900-foot spacing means Taxiway V cannot extend the full length of Runway 01/19 and cannot connect to the EATs (a minimum of 560 feet of spacing is required between the runways to allow aircraft to taxi past the Runway 18C and 36C glideslope antennas).

Because dual simultaneous independent approaches would be permitted to Runways 18R/36L and Runway 01/19 if the runways were 3,200 feet apart and because the separation between Runway 01/19 and Runway 18L/36R far exceeds the requirement of 3,400 feet for triple simultaneous independent approaches, it may be possible to obtain a waiver from FAA to operate triple simultaneous independent approaches at CLT in the future. This would require further study and consultation with FAA.

A separation of 642.5 feet is required between Runway 36C and Taxiway V on the southern portion of Taxiway V to allow unrestricted taxing past the Runway 36C glideslope critical area. With 1,100 feet of separation between Runways 18C/36C and 01/19, that leaves 457.5 feet of separation between Taxiway V and Runway 01/19, which is not sufficient to allow ADG V aircraft to taxi when visibility is less than a half mile.

It is important that aircraft have the ability to exit Runway 01/19 to both the east and the west. Aircraft exiting to the west can use the EATs to reach the terminal area, avoiding runway crossings. In addition, ADG V aircraft, which cannot use Taxiway V when visibility is less than a half mile, need to be able to exit to the west. According to the runway exit analysis, two high-speed exits are required in order to achieve runway occupancy times of less than 50 seconds. If the two glideslopes for Runway 01/19 were placed on the west side of Runway 01/19 (most typical location), their critical areas would conflict with the optimal location of the runway exits. Because the parallel taxiway to the east of Runway 01/19 has restricted use due to the separation between the proposed runway and Runway 18C/36C, the glideslopes were placed on the east side of Runway 01/19. This placement of the glideslopes allows two high-speed exits to be placed on the west side of the runway in both directions.

The ability to exit to the east Runway 01/19 is needed because it provides a shorter path to the terminal. If the new runway were 7,300 feet long, Taxiway V could only extend from Taxiway E3 to Taxiway V4 due to the location of the Runways 18C, 19, 01, and 36 glideslopes as well as the location of Runway 36C high-speed exits. This distance is 3,500 feet which is not sufficient to allow most aircraft in the CLT fleet to exit to the east. In order for the center taxiway to be long enough to provide the capability for all arrivals to exit east, the runway needs to be longer. A length of 8,900 feet provides 7,303 feet of usable runway length for south flow arrivals exiting east and 7,418 feet of usable runway length for north flow arrivals exiting east. Thus, Runway 01/19 is 8,900 feet long in Alternative 3. It has one high-speed exit in both directions to the east of Runway 01/19.

The location of the runway and exit taxiways requires that a portion of Taxiway N, a portion of the newly constructed Taxiway V, and Taxiway E8 (a high-speed exit for Runway 36C) be removed. The removal of a Runway 36C high-speed taxiway is not expected to cause an increase in ROT for Runway 36C.

7 Alternatives Comparison

There are several key differentiators between the three alternatives: (1) EAT holding requirements, (2) runway use and runway crossings, (3) Taxiway V capability, (4) navigational aid placement, and (5) the ability to provide future flexibility. The alternatives were screened with regards to these factors to identify any fatal flaws.

The alternatives will all result in differing costs, implementation time frames, and operational performance. These factors will be assessed as part of the EA alternatives analysis to determine which ones should be carried forward for detailed environmental analysis.

7.1 End Around Taxiway (EAT) Holding

An EAT is a taxiway that crosses the extended centerline of a runway, on which aircraft do not require clearance from air traffic control (ATC) to cross. EATs can improve efficiency and reduce runway crossings. All three alternatives have full EATs around Runways 19 and 18C on the north end and around Runways 01 and 36C on the south end. These EATs were designed based on the following guidance in FAA AC 150/5300-13A, *Airport Design*:

- The centerline of an EAT must be at least 1,500 feet from the stop end of the runway for a minimum of 500 feet on each side of the extended runway centerline.
- The minimum dimensions are typically increased in order to prevent aircraft tails from being a penetration to the 40:1 departure surface or any other relevant surfaces.
- EATs can be placed at a lower elevation than the stop end of the runway to reduce the distance between the runway end and the EAT that is perpendicular to the extended runway centerline.
- It is not currently possible for aircraft to taxi unrestricted on the EAT in the approach surface of an incoming arrival.

7.1.1 South EAT Holding Requirements

The perpendicular portion of the SEAT is located 2,600 feet from the stop end of Runways 01 and 36C in all three alternatives. This distance allows unrestricted flow on the EATs under departing aircraft because all tail heights for the CLT fleet can clear the 40:1 departure surface.

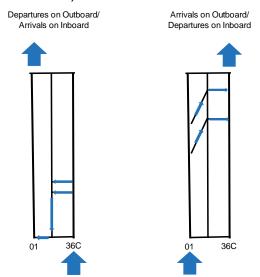
7.1.2 North EAT Holding Requirements

On the north end of Alternatives 1 and 2, the perpendicular portion of the NEAT is located 1,500 feet from the stop end of Runway 19 and 18C. The 1,500-foot distance is the maximum distance that can be achieved without relocating the railroad to the north of the runways. This distance requires that ADG IV and V aircraft hold for ATC clearance before taxiing around the NEAT because the ADG IV and V aircraft tail heights cannot clear the 40:1 departure surface. This restriction is not expected to be significant because there are no commercial ADG IV aircraft forecast for 2028 and 2033 and less than two percent of operations are expected to be ADG V. Air traffic controllers have indicated that they would most likely land ADG V aircraft on one of the other runways to avoid the issue of holding on the NEAT. Tor Alternative 3, the perpendicular portion of the NEAT is located 2,578 feet from the stop end of Runways 19 and 18C. This distance does not require any holding on the EAT under departing aircraft.

7.2 Runway Use and Runway Crossings

When operating on closely spaced runways such as proposed Runway 01/19 and existing Runway 18C/36C, departures typically occur on the "inboard" runway (runway closest to the terminal) and arrivals occur on the outboard runway (runway furthest from the terminal). Alternative 3 would be able to be operated this way but Alternatives 1 and 2 would not. In the case of Alternatives 1 and 2, there is insufficient separation between Runway 01/19 (the outboard runway) and Runway 18R/36L to allow triple simultaneous IFR approaches on Runways 01/19, 18R/36L, and 18L/36R. As a result, in these alternatives, arrivals would typically use the inboard runway (Runway 18C/36C) and departures would typically use the outboard runway (Runway 01/19). An example of both runway use situations is shown on **Exhibit 6-5**.

EXHIBIT 6-5, RUNWAY USE EXAMPLES



Source: Landrum & Brown analysis, 2020

These differences in runway use would result in different EAT usage and runway crossings assumptions, as described in the subsections that follow.

7.2.1 Alternatives 1 and 2

Primary taxi flows for Alternative 1 are shown on **Exhibit 6-6**. The taxi flows for Alternative 2 would be the same as Alternative 1 so they are not shown on an exhibit. In Alternatives 1 and 2, all North Flow arrivals on Runway 36L and 01 would exit to the east and use the NEAT to reach the terminal. Similarly, in South Flow, arrivals on

Direction, Oversight, Review, and Agree (DORA) Meeting #4, January 27, 2021

No restrictions on runway use are proposed or assumed for the new runway. Additionally, no runway use restrictions are proposed for the existing runways.

18R and 19 would exit to the east and use the SEAT to access the terminal. No arrivals would be required to cross a runway to reach the terminal area in these alternatives.

Departing aircraft bound for Runway 01 in North Flow or Runway 19 in South Flow would cross Runway 18C/36C at two locations to reach the departure queue. These departing aircraft were assumed to cross Runway 18C/36C instead of using the EATs for several reasons:

- FAA air traffic officials indicated they would rather cross Runway 18C/36C than taxi on the EATs due to the amount of time it would take for aircraft to taxi through the approach surface.¹³
- Participants at the Safety Assessment Workshop (October 16, 2020) identified a hazard with a high potential risk related to holding on the EATs for the approach surface of Runway 18C/36C.
- Large gaps in the arrival stream (eight to nine nautical miles) would be required in order to allow aircraft on the EATs to taxi through the approach surfaces of Runway 18C/36C. These gaps would result in reduced capacity on Runway 18/36C. If the gaps are not provided, taxiing aircraft would have long ground delays while waiting for a natural gap in the arrival sequence. Crossing the runway was found to take less time and result in a more efficient operation than taxiing on the EATs.

Based on these factors, crossing the runway was identified as preferable over taxiing through the approach surfaces on the EATs.

There would be more runway crossings with Alternatives 1 and 2 versus Alternative 3 because all Runway 01/19 departures would be required to cross a runway to reach their departure queue in Alternatives 1 and 2. Runway 01/19 departures would have to cross an arrival runway (Runway 18C/36C) to access the Runway 01/19 departure queue. This type of operation creates a more complex situation for air traffic controllers to manage than when arrivals are on the outboard runway and departures are on the inboard runway. In general, it is more complicated to cross an arrival runway than a departure runway for two reasons:

- Arrivals restrict the runway from use by crossing aircraft for a longer period of time than departures.
 Arrivals that are less than two miles out "own" the runway until they land and pass the runway crossing point, whereas departures only "own" the runway from the point of takeoff clearance until they pass the runway crossing point.
- Crossing an arrival runway provides less flexibility to manage the flow of aircraft on the ground. Arrivals
 cannot be told to hold in the air for a runway crossing. If separation cannot be assured between arrivals
 due to a slow runway crossing or other reason, the controller must send the arriving aircraft around for a
 missed approach to avoid an operational error. On the other hand, departures on the ground can be told
 to hold for runway crossings, providing flexibility to reduce taxiway congestion.

¹³ Feedback received at DORA Meeting #2 (June 11, 2020).

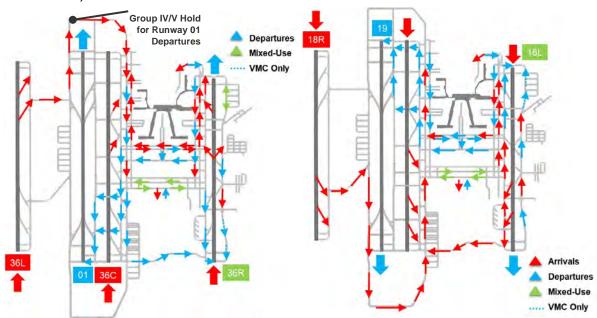


EXHIBIT 6-6, ALTERNATIVE 1 PRIMARY TAXI FLOWS – NORTH FLOW/SOUTH FLOW

Note: Alternative 2 would have identical taxi flows to Alternative 1. Source: Landrum & Brown, 2020

7.2.2 Alternative 3

Primary taxi flows for Alternative 3 are shown on **Exhibit 6-7**. All arrivals on Runways 36L would use the NEAT and all Runway 18R arrivals would use the SEAT. Runway 01/19 arrivals could exit to the east or west. Runway 01 arrivals exiting to the west would use the NEAT and Runway 19 arrivals that exit west would use the SEAT. Runway 01/19 arrivals that exit east would have to cross Runway 18C/36C to reach the terminal area. It was assumed that the Runway 01/19 arrivals would use the EATs during peak periods of activity to reduce the capacity impacts of runway crossings. Exiting to the east (with the associated runway crossing) was assumed to occur in off-peak periods, resulting in fewer runway crossings than Alternatives 1 and 2. Runway 18C/36C would be primarily used by departing aircraft so the Runway 01/19 arrivals that do cross Runway 18C/36C would be crossing a departure runway. Crossing a departure runway is less complex for air traffic controllers to manage than crossings an arrival runway.

7.3 Taxiway V Capability

When constructing a new runway, the supporting taxiway structure is critical. The ability to provide sufficient taxiway capacity and meet all applicable FAA standards to the extent possible is imperative to ensuring that runway capacity can be maximized and in enabling aircraft to transition to/from the terminal area with minimal delay and restrictions. Providing a taxiway between two parallel runways is one key factor in providing sufficient taxiway geometry to support a new runway. A parallel taxiway between two runways provides an alternative location for aircraft to queue for departure that is outside of the terminal area and allows aircraft a place to hold while waiting to cross a runway. FAA recommends 1,200 feet of separation between two parallel runways to allow for proper taxiway geometry.¹⁴

¹⁴ FAA AC 150/5300-13A, Airport Design

All of the CLT alternatives meet all applicable FAA requirements for taxiway design and provide a full parallel taxiway to the west of Runway 01/19. They differ in the capability of the taxiway between Runways 01/19 and 18C/36C. Alternative 1 is the only alternative that provides a full parallel taxiway between the runways, meets FAA recommendations, and is capable of accommodating ADG V aircraft in all weather conditions.

Alternative 2 provides a full parallel taxiway between the runways but ADG V aircraft cannot taxi on it when visibility is less than a half mile because the separation between Runways 18C/36C and 01/19 is 1,100 feet. ADG V aircraft would have to exit Runway 01/19 to the west during these low visibility conditions, resulting in a longer taxi times and less flexibility for air traffic controllers. This restriction is not expected to be significant because less than two percent of operations are expected to be ADG V and the referenced low visibility conditions occur less than one percent of the time.

Alternative 3 has 900 feet of separation between Runways 01/19 and 18C/36C. Similar to Alternative 2, this separation does not allow ADG V aircraft to taxi on Taxiway V when visibility is less than a half mile. ADG V aircraft would have to exit Runway 01/19 to the west during these low visibility conditions, resulting in a longer taxi times and less flexibility for air traffic controllers. As with Alternative 2, this restriction is not expected to be significant. In addition, a full taxiway cannot be provided between Runways 01/19 and 18C/36C due to the location of the Runway 18C/36C glideslopes. The lack of a full length taxiway means that the EAT would not be accessible to aircraft that exit Runway 01/19 to the east. It also means there would be less flexibility for controllers because there would be less space for aircraft to queue for departure and fewer places for aircraft to hold while waiting to cross Runway 18C/36C.

Taxiway limited to ADG IV or smaller when visibility <1/2 mile

EXHIBIT 6-7, ALTERNATIVE 3 PRIMARY TAXI FLOWS – NORTH FLOW/SOUTH FLOW

7.4 Navigational Aid Placement

Glideslopes are located on the sides of runways near the runway ends. They have critical areas that need to be kept free of aircraft when the glideslope is in use. As a result, glideslope placement must be carefully considered so that there are no implications to taxiing aircraft.

For Alternatives 1 and 2, the Runway 01/19 glideslopes were placed on the west side of the runway. There is sufficient separation between the runway and the west parallel taxiway to allow aircraft to taxi unrestricted adjacent to the glideslope critical area. The glideslope and its critical area do not cause restrictions on taxiing aircraft.

Alternative 3 would require that the Runway 01/19 glideslopes be placed between Runways 01/19 and 18C/36C in order to allow for high-speed exits on the west side of the runway. This placement results in the Runway 01 glideslope being co-located with the Runway 36C glideslope. While it is possible to co-locate the glideslopes, there may be issues with the glideslopes and the terminal instrument procedures (TERPS) surfaces – this requires further study. If this glideslope siting is ultimately not possible, the glideslope would have to be placed on the west side of the runway. If the Runway 01 glideslope is located on the west side of the runway, the second high-speed exits in both directions would be in the glideslope critical area which may not be permitted due to signal reflectivity issues. Not having the second high-speed exit in both directions could increase runway occupancy times and ultimately reduce the capacity of the runway.

7.5 Future Flexibility

Alternative 2 provides 3,200 feet of separation between Runways 01/19 and 18C/36C, which meets the minimum requirement for dual simultaneous independent approaches under the FAA's rule change. The separation between Runways 01/19 and 18L/36R in this alternative is 6,100 feet, which is far in excess of the 3,400 feet of separation that will be needed for triple simultaneous independent approaches under the new FAA requirements. The capability to run duals to Runways 18R/36L and 01/19 combined with the excess separation between Runways 01/19 and 18L/36R may make it possible to get approval to run triples to Runway 01/19 in the future. If so, Alternative 2 would be operated with arrivals on Runways 18R/36L, 01/19, and 18L/36R. With regards to the set of closely spaced parallel runways (01/19 and 18C/36C), arrivals would occur on the outboard runway, with departures on the inboard runway. This is a more typical runway use which would result in fewer runway crossings and reduce crossings of an arrival runway. As a result, Alternative 2 could provide future flexibility that may not be available with Alternative 1. It is important to note that this runway use has not been approved and is not assumed as part of this EA. The ability to run triples with 3,200 feet of separation would require future study and consultation with the FAA.

The future flexibility concept is not necessary with Alternative 3 because its 3,400-foot separation takes advantage of the FAA rule change for triple approaches. No additional flexibility would be needed.

7.6 Conclusions

The results of the alternatives screening are summarized in **Table 7-1**. Alternative 1 would have a fully capable taxiway system with no aircraft size restrictions and the glideslope siting is standard. However, this alternative would have more runway crossings than Alternative 3, would require crossings of an arrival runway, would require holding by ADG IV and V aircraft on the NEAT, and would not provide future flexibility with regards to triple approaches to the new runway.

TABLE 7-1, ALTERNATIVES SCREENING SUMMARY

Alternative	Pro/Con	EAT Holding	Runway Crossings	Taxiway V Capability	Navigational Aid Placement	Future Flexibility
1	Con	ADG IV and V aircraft required to hold on NEAT;	Rwy 01/19 departures cross inboard arrival runway	n/a	n/a	No
	Pro	no holding on SEAT	n/a	Full length, unrestricted Taxiway V	Standard placement	n/a
2 Con	Con	ADG IV and V aircraft required to hold on NEAT;	Rwy 01/19 departures cross inboard arrival runway	ADG V cannot use Taxiway V when visibility is less than a half mile	n/a	Yes
	Pro	no holding on SEAT		Full length Taxiway V	Standard placement	n/a
3	Con	n/a	n/a	Partial Taxiway V; ADG V cannot use Taxiway V when visibility is less than a half mile	Requires 18C/19 and 36C/01 glideslopes to be co-located which may have TERPS issues	n/a
	Pro	No holding on NEAT or SEAT	some Rwy 01/19 arrivals cross inboard departure runway	n/a	n/a	n/a

Source: Landrum & Brown analysis, 2021

Alternative 2 would provide a full length Taxiway V, the glideslope siting is standard, and it would provide future flexibility with regards to triple approaches to the new runway. However, this alternative would have an aircraft size restriction on Taxiway V, more runway crossings than Alternative 3, require crossings of an arrival runway, and require holding by ADG IV and V aircraft on the NEAT.

Alternative 3 would not require holding for arriving aircraft on the EATs, would have the least complex runway use, and would have fewer runway crossings than Alternatives 1 and 2. However, it would have the least amount of capability on Taxiway V and would require co-location of glideslopes.

Each of these alternatives has its pros and cons but no fatal flaws. It is therefore recommended that all three alternatives be carried forward into the EA for airfield simulation analysis to determine the best performing alternative from an operational perspective.