## **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**

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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.

<sup>1</sup> 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				Compound Annual Growth 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%	
<b>Total Operations</b>	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).<sup>2</sup> 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.

#### Figure 2-1 CLT Catchment Area 1

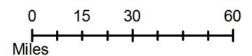




Charlotte-Gastonia-Salisbury Combined Statistical Area (CSA)

Charlotte-Gastonia-Salisbury, NC-SC Economic Area

Highways



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%	

<sup>9</sup> 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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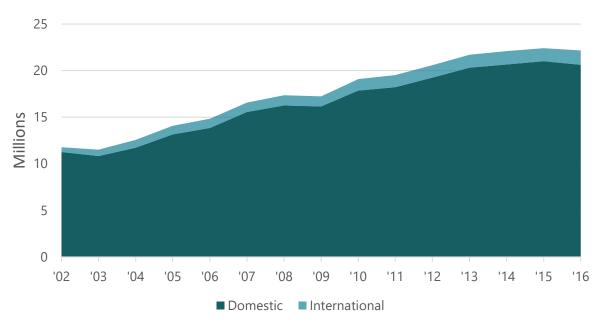
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Since 2002, the Airport has grown 4.6 percent annually on average in terms of enplaned passengers, reaching 22.2 million in 2016. During this period, average international growth (8.1 percent) almost doubled that of domestic growth (4.4 percent). As 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.<sup>3</sup> 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;<sup>4</sup> 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.

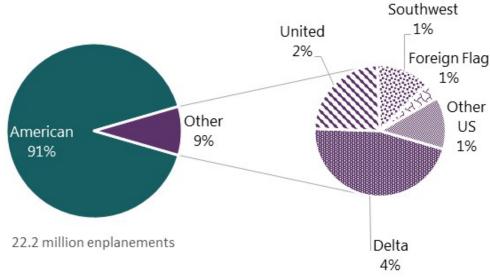
**Table 2-7 Charlotte Passenger Traffic CY 2016** 

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**).<sup>5</sup> 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,<sup>6</sup> 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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<sup>5</sup> Innovata schedule data via Flight Global's Diio Mi database.

<sup>6</sup> 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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Overview of Capacity at American Airlines Hubs, CY 2016 Table 2-8

American Airlines' largest Caribbean gateway, Miami (Figure 2-4).

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

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

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.

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.

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#### 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 flights<sup>7</sup> 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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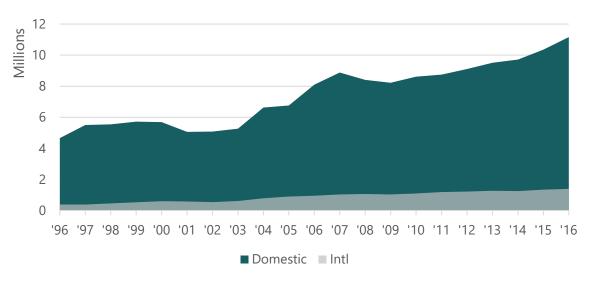
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OAG schedules as shown in the ACEP

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.

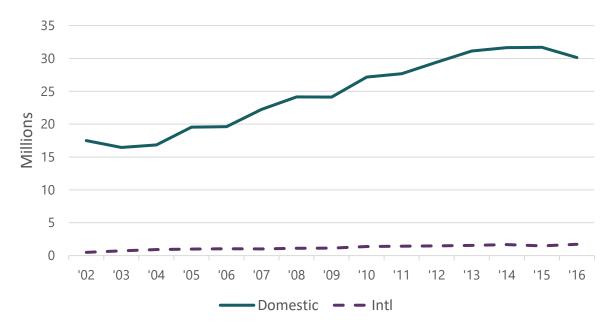
CAGR - Compound Annual Growth Rate

## 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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<sup>&</sup>quot;International" here includes U.S.-Transatlantic, U.S.-Latin American, and U.S.-Canadian markets

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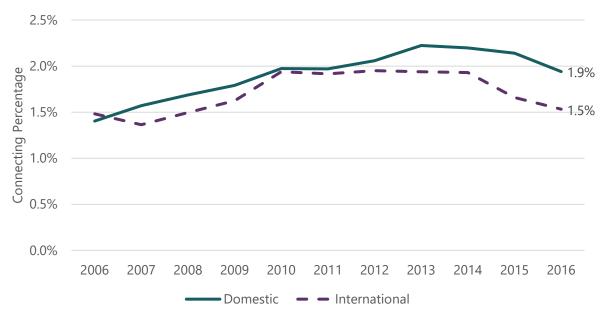
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Source: U.S. DOT O&D Survey via Flight Global's Diio Mi database, FAA

## 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" <sup>10</sup>
  - 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

<sup>10</sup> FAA TAF, Appendix A: Description of Activity Measures, page 26.

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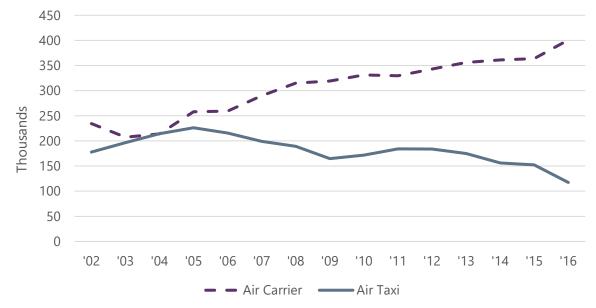
#### 2. Non-commercial operations

- a. **General Aviation (GA) "**all civil aviation aircraft takeoffs and landings not classified as commercial or military"<sup>11</sup>
- 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.<sup>13</sup>

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

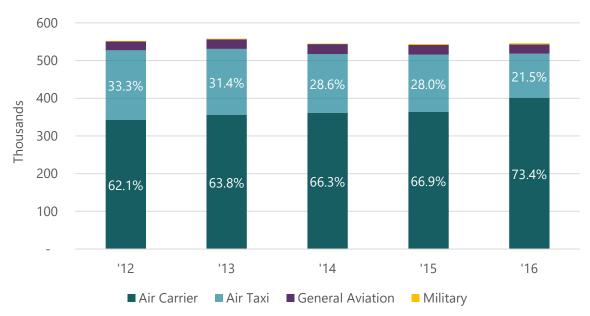
<sup>11</sup> FAA TAF, Appendix A: Description of Activity Measures, page 26.

<sup>12</sup> Ibid.

<sup>13</sup> 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** 



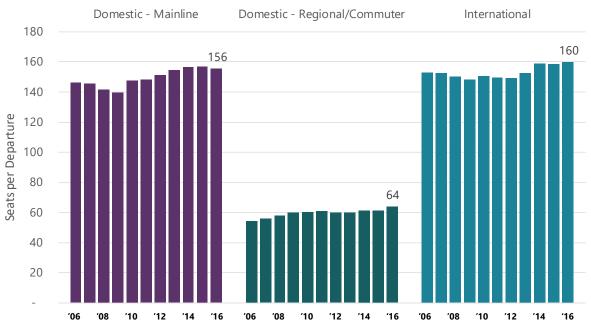
8 Source: FAA OPSNET

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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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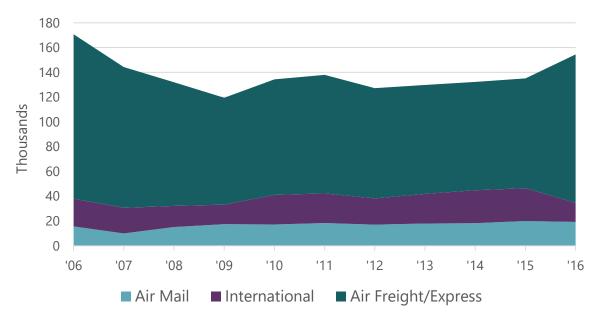
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## 2.5 Air Cargo

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.

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 & Poole<sup>15</sup> for Charlotte GDP and the U.S. Department of Agriculture Economic Research Service.<sup>16</sup>

### 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.

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

<sup>16</sup> 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 & Poole<sup>17</sup> 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.

<sup>17</sup> 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.

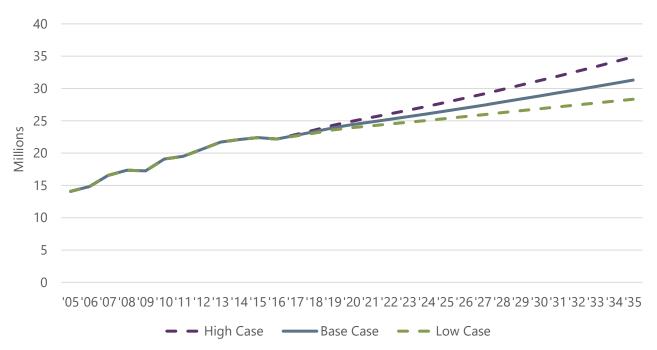
Note: Data is reflected in calendar years

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.<sup>20</sup> 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.

<sup>18</sup> FAA, Approval of Local Forecasts, 2008, page 1.

<sup>19</sup> CLT is a large hub airport.

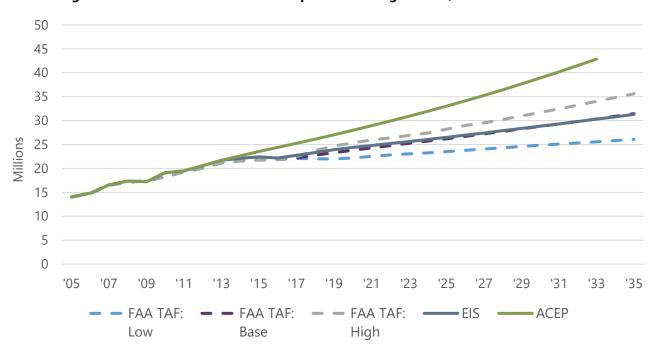
The TAF forecast has been converted into calendar years for comparison purposes. Calendar year figures were determined by assuming 75 percent of operations in the base fiscal year and 25 percent of operations in the following fiscal year (i.e., for CY 2016: 75 percent of FY 2016 and 25 percent of FY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

<sup>21</sup> CLT Master Plan Update: Phase 1, Airport Capacity Enhancement Plan

<sup>22</sup> Ibid.

<sup>23</sup> Ibid.

<sup>24</sup> 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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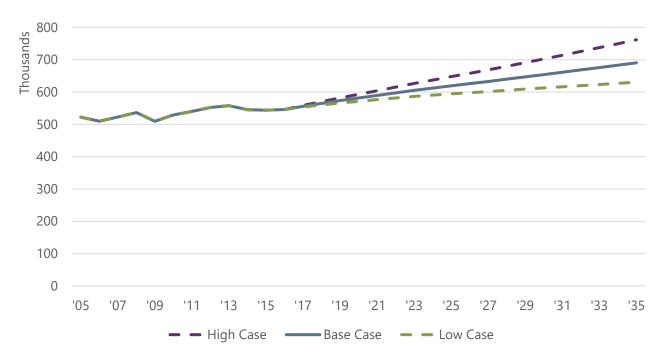
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Figure 3-3 Operations Forecast – Base, High, Low Cases – Charlotte Douglas International Airport



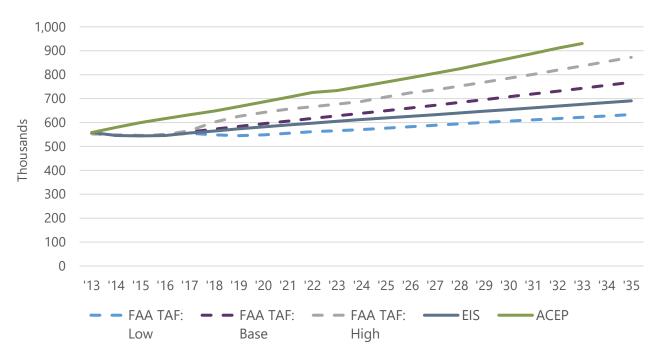
Source: Airport Statistics data for historical; U.S. DOT T100; InterVISTAS analysis for forecasts.

### **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.<sup>25</sup>

<sup>25</sup> 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: <a href="https://www.faa.gov/data\_research/aviation/taf/">https://www.faa.gov/data\_research/aviation/taf/</a>

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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.

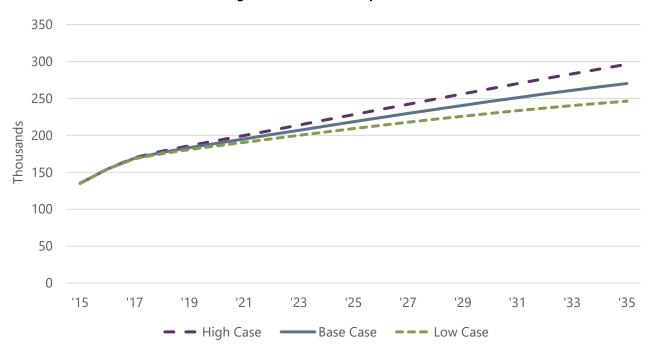
#### 3.5.1.3 Low Case

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 <sup>2</sup>	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 <sup>2</sup>	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 <sup>2</sup>	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 <sup>2</sup>	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 <sup>2</sup>	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 <sup>2</sup>	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 <sup>2</sup>	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 <sup>2</sup>	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 <sup>2</sup>	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 <sup>2</sup>	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 <sup>2</sup>	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		<b>CLT International</b>
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

<sup>\*</sup> 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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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
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### **Gating Analysis Approach and Assumptions**

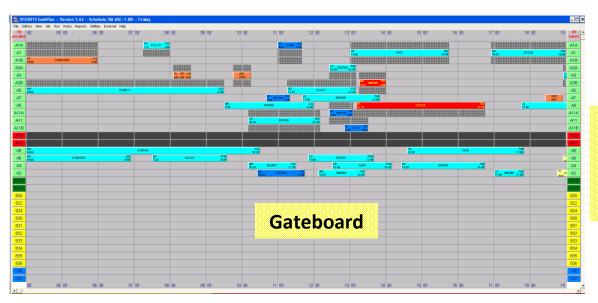
The objectives of this study were to quantify the gate requirements for the CLT EIS flight schedule forecasts for 2016, 2028 and 2033 and to verify if the number of gates identified in the Airport Capital Enhancement Program (ACEP) is still valid. This memo documents the assumptions and approach used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

2016 Arr - 2016 Dep -

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

assumed there are no adjacency constraints between nearby gates.

Time of Day (hr)

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.

To quantify the number of gates required to accommodate the flight schedules, the analysis

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

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).

-2028 Arr - 2028 Dep - 2033 Arr -

eparture

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Figure 1-2 **Rolling 60-Minute Commercial Passenger Flight Profile** 150 100 50 Number of Flights 0

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-150

1.3 Assumptions

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1-3 Gating Analysis Approach and Assumptions

(DUB), and Montreal (YUL).

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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.<sup>1</sup>

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

	Domest	ic Flights	International 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	<b>√</b>	<b>√</b>	2028 2033
Scenario 3: All Gates Dedicated (Dedicated airlines – domestic or international operations)	<b>√</b>	<b>√</b>	✓	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 Gates								
	International			Domestic				Internation	al						
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 Gates										
		Internation	al	Domestic				Internation	al								
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	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	<ul> <li>OAIN – OA International</li> </ul>
2	HS - Hardstands
3	For the individual flight pucks, the following color scheme applies
4	<ul> <li>Blue – Regional Jets + Turbo props</li> </ul>
5	<ul> <li>Green – Narrow body</li> </ul>
6	<ul><li>Orange – Widebody</li></ul>

#### 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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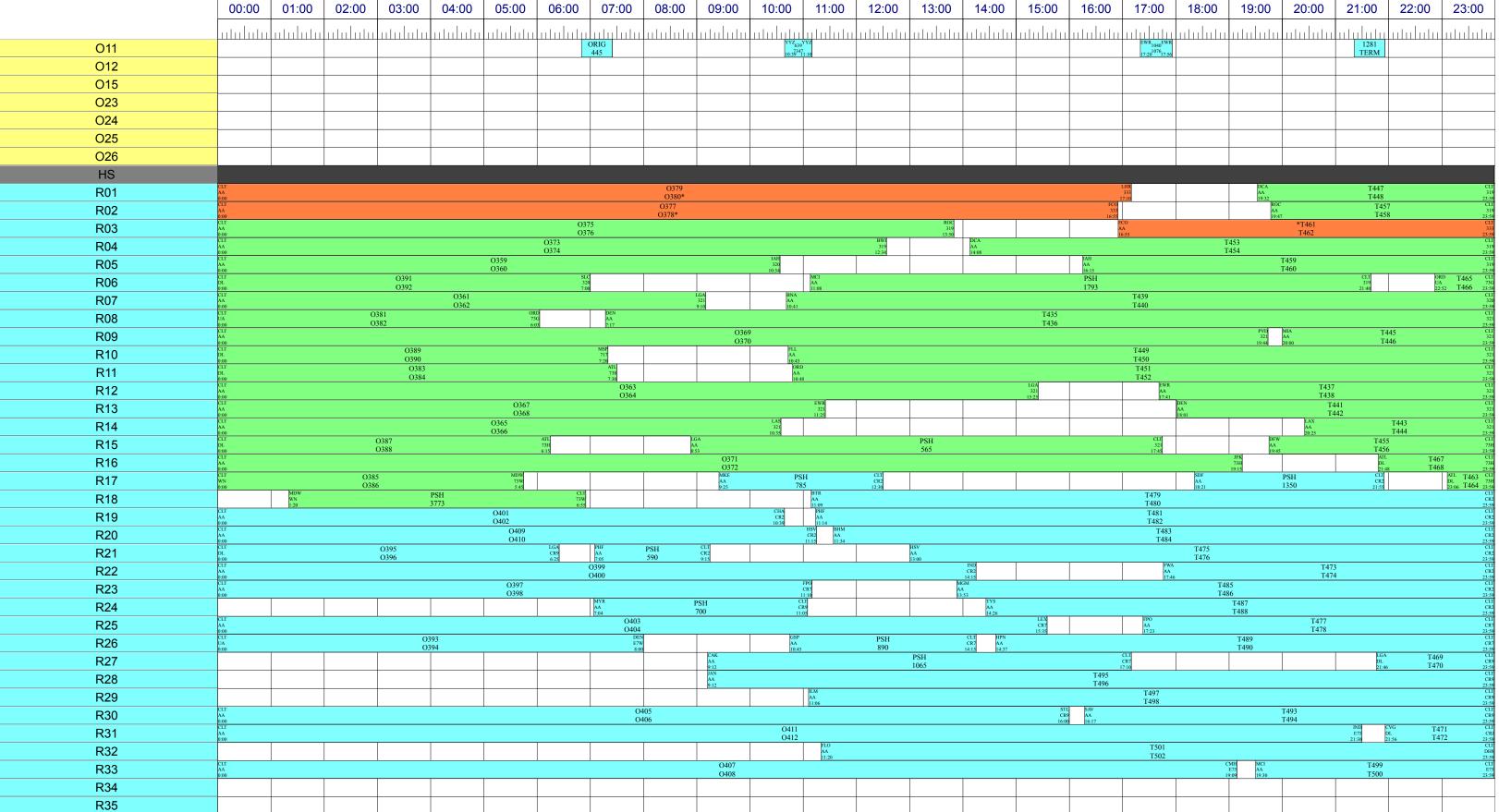
# **Appendix A: Gateboard Scenarios**

# CLT 2016 Gating Scenario 2

Date:04/11/2019 1IIIIe:15:00							Cl	LT 2016-S	cenario 2												Page # 10
	00:00 01:00	02:00	03:00 04	:00 05:00	06:00	07:00	08:00	09:00	10:00	11:00 1:	2:00 1:	3:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00 23:0
													1								
AADO																					
A21					BWI AA	396 JFK 320 450 7:30	EWR 475 AA 560	PBI 320	MSY AA 10:24 710	STT TPA 320 AA	726 BOS 321 790 13:10	TPA 808 AA 890	B MSP FI 320 A 14:50 1:	LL 905 ATL A 320 5:05 959 15:59			BWI AA	1119 1220	FLL 320		
A22					6:36	450 7:30		9:20 508 FLL 320 590 9:50	CLTSC4 IA ORIG IA	11:50 12:06 H	790 13:10	PHL 798	PBI 320	5:05 959 15:59	RS A	SW 1015 BWI 320	18:39	1220	20:20	MSP 1264 PVD 320	
A23					CLI	TSC4 DFW ORIG DFW	8:28 BWI 500 AA 575		ATL 612	19 GCM ATL 320 AA	722 LGA 792 320 792 13:12	BWI 810	14:25 FLL 320		16	6:55 1065 17:45		ATL 1142	SAT 320	AA 1325 320 21:04 1325 22:05 ATL 1276 IAH 320	1349
A24					6:4:	450 7:30	CLTSC4 ORIG	MSY	BWI 620 AA 690*	1:25 12:02 AUA	JFK 750 C	13:30 870	14:30 832 BWI 890 320 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 MIA 800 13:20	3:30 13:52	890 14:50 SF	15:25 985 0 903	16:25 TPA LGA	17:15 <sup>1070</sup> 17:50	LGA 1082 MSY	8:54 1205 20 FLL 1152 AA 1200		79 21:19 21:50 13 LAS 1286 1 21:26 1796 2:	65 22:45 HIL
A25					LAS	370 L.	8:28 41 AS ATL 501	MSP	10:11 663 11:03 DCA 63	12:04 32 RSW	800 13:20	MIA 81	15 ORD	TPA 921 AA 725 15:27 725	16:24 16:44 7 LAX P	1065 17:45 TT 1017	18:02 1135 320 18:02 1135 18:55	19:12 1220	20:20	SEA 1286 F	1:25 1:SW
					6:10 SEA	658 8: 375 SAN	8:21 560 TPA	521 BWI	LGA 600		723 TPA	ORD 803	80 14:50 PHX	MCO 92	5 LAS	6:57 1100 TPA 10	18:20 140 LGA	RDU 1135 RS	W .	21:26 1346 <sub>2</sub> FLL 1281 LA	321 2:26 X
A27					6:15	470 7:50 669 MCO	493	580 9:40 CLTSC4 LGA ORIG 595 0:55	LGA AA 10:00 700*		723 TPA 321 782 13:02 717 PHX	13:23 875	14:35	15:25 63	7 16:45	17:20 11	20 18:40 1 C4 DFW ORD PULL AA 565 18:20 18:45	1125 1200 32 1125	AS SJU	1223 DFW	0
A28					6:09 40	160 7:40	PUSH 481	9.10 9.33	10:38 690	11:30 AA 11:57 MIA PHX	780 321 726 PIT	LGA 81	7 MCO LGA	A 900 P	нх	17:45	565 18:30 18:45	; 643 <sub>20</sub>	321 AA 0:05 20:23 PHL	1330 321 22:10 1240 PHX	
A29				CLTSC4 D	6:14 LAX	374 TPA 321 7:45 386 ORD 321	8:01 585 ORD 50	9:45	BOS 619 AA 705 PHL 605	321 AA 11:45 12:06 MBJ	726 PIT 321 789 13:09	13:37 88		900 P 00 975 16 X 900 PHL	321 :15	1006 ORE		PHL 1145	DFW T.	472 321 PA 1252 BOS	
A1				CLTSC4 ORIG 5:15 360 6	:00 AA 6:26 SMF 362	475 7:55	8:20 68		10:05 690*	321 11:30 35 FLL MI	A 734 DFW	13:45 8	85 321 AA 15:0	00 559 16:05	AA 16:46 PIT A	1908 321 18:00 TL 1017	LAS	19:05 844		A 1335 321 0:52 1335 22:15 JFK 1262 DTV	v <mark>i</mark>
A3					SMF AA 6:02 408 SAN 364		RDU 482 8:02 565*	321 9:25 02 SEA			734 DFW 321 1878 13:15 DFW 747 ATL	13:52	895 321	DEN 924 15:24 995 DFW 920	321 A 16:35 1 FLL MI	6:57 1090 1 IA 1014 SI	321 8:10 FO SAT	N 1129 C	PRD	AA 21:02 1340 32 LGA 1264 SF	0
A5					AA 6:04 450 SLC 37	7:30	8:22 58	321 80 9:40 514 SJU	PVD AA 10:32 710 MIA AA 629	321 11:50 DEN MCO	AA 321 12:27 804 321 724 MCO 321	21 24 LAX	830 TPA	AA 15:20 984 PHX 93	321 AA 16:24 16	3 :54 1085 18: BOS 1020	21 AA 05 18:4	49 1205 <sub>20</sub>	321 0:05	AA 1204 32 21:04 557 22:2	1 0 EN
A7						993 321 7:35	AA 8:34 LAS 490	590 321 590 9:50	DTW 611	11:45	781 13:01	AA 13:50 DEN 801 M	890 321 890 14:50	AA 7- 15:35 70 LAS 908 BOX		AA 1020 17:00 1090 1 FLL 1020	321 8:10 SEA	AS 1135	MSP	AA 1276 21:16 1345 2: MCO 1263 BDL	321 125
A9					MO	CO 404 LG	AA 8:10 565*	321 9:25	10:11 685* 1 BDL 631		725 CLE 319 785 13:05	AA 801 3 13:21 860 14 BOS 810	321 :20 DFW	AA 908 32 15:08 970 16:10 BOS 909 DFV	DFW	AA 1020 17:00 1090 1	321 8:10	8:55 2075 SFO 115	321 20:10 4 BOS	AA 1263 321 21:03 1329 22:09 SFO 1273 MCC	
A11					AA 6:44 CLTSC4 M	404 3: 4 479 7::	59 8:31 5	75 9:35 CUN	10:31 705	11:45	718 AUS	13:30 865 I	321 14:25	AA 909 32 15:09 970 16:10 RD 905 MCO		060 321	DEN	19:14 122	9 20:29	21:13 1339 22:1 LAX 1269 FLL	9
A13					CLTSC4 M 6:15 420 7:	7:00	PHL 490 8:10 565* MCO 490	321 9:25 SEO	RSW 613 10:13 685 1	PHX BNA 321 AA 1:25 11:58 PA IAH	74 12:54	PHX AA 811 13:31 866	321 A 14:26 1:	5:05 960 16:00	ORD	MCO AA 17:16 1105	18:25	PHX AA 19:14 1975	20:20	21:09 1330 321 21:09 23:10	
A12							8:10 564 PHX 491	321 9:24 MCO	MCO 613 TI AA 2053 11:	21 AA 20 12:1	731 JFK 73H 100 13:19 EWR 743 EWI	VR DTW 00	DE STIL IN	MIA 916 15:16 1453 WR 905	73H 16:25	PHY 1022	DFW 1091 18:11 1150	19:10 19:35	1175 LGA 321 1240 20:40	1270 TERM PVD 1280 DCA	
A10						207	AA 8:11 559	321 9:19	TPA 618 0 AA 685 1	321 1:25	AA 731 12:23 806 13:2 729 RDU	VR DTW 82 3H AA 88 26 13:45 88	319 30 14:40 A	A 985	73H 16:25	PHX 1033 AA 17:13 678	321 18:16	LGA 1160 AA 1220 19:20 1220	321 ) 20:20	21:20 1334 22:14	
A8						397 ERM	AA 8:43	523 BOS 321 585 9:45	MSP 626 AA 690	11:30 12:05	784 13:04	MCI 807 AA 875	319 14:35	CLTSC4 LG/ ORIG 15:25 16:1		050 17:30		TPA 1147 AA 1205 20	321	DFW 1272 MSP AA 321 21:12 1330 22:10	
A6						lerr e		SC4 ORD ORIG 575 9:35	DFW AA 637 10:37 700	321 11:40	LL 739 DCA 319 2:19 1950 13:15	AA 14:00	840 EW 2249 73 25:	VR IND 93 3H AA 15:30 100	0 319 00 16:40	1021 TERM		MCO 1139 PHX AA 321 18:59 1195 19:55		DEN 1278 TPA AA 1335 22:15	
A4					Table 1	ATL 412 A AA 480 8:	ORF 509 AA 555 8:29 555	9:15	601 TERM	ud bo	PVD 748 IAH AA 319 12:28 800 13:20	MEM 819 AA 880	9 SAI 319 0 14:40		president	1041 TERM			1185 TERM	MIA 1273 EWR 73H 21:13 1384 22:15	
A2					AA 6:17	377 MCI 319 470 7:50	AA 8:46	526 DFW 569 321 569 9:29	CLTSC4 ORIG 10:35 680 11:	AS DCA 71: AA 71: 20 11:52 76:		PIT 811 13:31 870		902 02 990	319 16:30	les sec		1160 TERM		ORD 1287 AA 1277 21:27 1277	73H 22:30
B1									10:35 11: CLTSC4 MC ORIG 10:35 680 11:		CHS 745 JAX AA 795 319 12:25 795 13:15	CLE 817 AA 870	14:30 AA	SW 903 1.03 990	319 16:30	IND AA 17:11 1105	STL 319 18:25	1132 TERM	EWR AA 20:36	1236 JFK 73H 1608 22:10	
B3					TP. AA 6:4	PA 406 RDU A 470 7:50	JFK 51 8:30 14	0 MIA 73H 9:30	603 TERM	CLTSC4 EWR ORIG 11:25 730 12:10			831 PIT 319 895 14:55					19:4	1185 STL 319 5 1233 20:33	SYR AA 21:04 1336 ROC 319 22:16	_
B5						DCA 422 P AA 479 3 7:02 479 7::	EWR 496 JE AA 2529 9:0	FK 5H 06	608 TERM		ORF 743 IND AA 792 319 12:23 792 13:12	RDU AA 13:56	836 IAH 895 14:55	BWI 915 AA 980	BDL 319 16:20	AUS AA 17:15 1105	BDL 319 18:25	19.4	ORIG PVD 1229 20:29	RDU 1257 C AA 1345 22	TLE 319 :25
B7					RIC AA 6:34	394 BDL 450 7:30	DTW 488 E 8:08 550 g	319 9:10	JFK AA 10:42 330		GA 737 ORD A 319 1:17 785 13:05	CHS AA 14:0:	842 DCA 319 2 895 14:55	DCA 913 M AA 975 16	ICI 319 :15	MCI AA 17:13 1100	MIA 319 18:20	JFK 1149 AA 1390	FWR BWI 73H AA 20:10 20:38	1238 1360	RIC 319 22:40
B9							MIA AA 8:47	527 EWR 73H 595 9:55	MDT AA 10:33 710			BUF 806 BOS AA 315 13:26 855 14:15	5	RDU AA 15:44	944 BWI 319 16:45	ALB 1021 DT AA 1085 18:		EWR 1156 19:16 2483	IAH PIT 73H AA 20:10 20:39	1239 1355	ORD 319 22:35
B11					EV A.ª 6:4	WR 407 EWR A 465 7:45	BDL AA 8:21 58	01 CLE 319 9:40	EWR AA 602 73H 10:02 1458 11:05					JAX 920 AA 979 1	SYR 319 16:19	BWI 1027 AA 1090 1		.115 SFO .170 321 .170 19:30		PBI 1275 SY AA 1340 31 21:15 1340 22:2	R 9 0
B13							PVD AA 8:12 565*	320 9:25	LGA 64 AA 70	4 BNA 319 0 11:40		808 TERM		BNA 914 RIC AA 319 15:14 969 16:09			ORD 1 AA 1 18:04 1	084 IL 200 20:0	M 9 10	1299 TERM	
B15					SFO AA 6:14 4:	74 DEN 321 7:35	RIC 495 8:15 570*		BUF 614 AA 690	NAS 319 11:30				PHL 937 AA 990	7 PBI 319 16:30	RDU 1024 PW AA 1085 18:	M 19 05	1145 TERM		BUF 1258 ALB AA 1335 319 20:58 1335 22:15	
B16						BOS 432 BN AA 480 8:		9:30	JAX 619 AA 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 1282 AA 1360	ATL 319 22:40
B14					PIT AA 6:42	402 PVD 319 455 7:35	MEM AA 8:43	523 RSW 319 595 9:55	628 PUSH						·			1147 TERM		CLTSC <sub>4</sub> PULL 21:40 1793 22	PIT ::25
B12				CLTSC4 ORIG 5:20 365			BUF 488 8:08 559	DTW 319 9:19	AUS AA 10:39 7	39 ALB 319 115 11:55				DTW 93 AA 15:39 99	9 MSY DO 319 AA 0 16:30 16	CA 1014 IAH A 319 :54 1074 17:54		STL 1150 ME AA 1200 20:0	M 9 10	RIC 1255 AUS AA 1330 319 20:55 1330 22:10	
B10					CLTSC4 PHL ORIG 995 :50 395 6:35		IND AA 8:44	524 BDL 319 590 9:50	PWM 633 AA 699	ATL PHL 319 AA 11:39 11:59	719 PHL E90 2054 13:00					CLE 1019 RIC AA 319 16:59 1074 17:54	PIT AA 18:44	1124 PIT 319 1194 19:54		DTW 1255 LGA AA 319 20:55 1324 22:04	1350 TERM
B8						TSC4 PHL ORIG PHL 450 7:30		8 CHS 319 0 9:30	PBI 610 PHL AA 319 10:10 675 11:15					RIC 941 AA 15:41 984	ALB 319 16:24	PHL 1036 17:16 1733	MCO 752 18:20	IAH 11 AA 12 19:25 12	65 RIC 319 230 20:30	1285 TERM	
B6					CL1 6:4:	TSC4 DCA ORIG DCA 450 7:30	IAH AA 8:38	518 NAS 319 580 9:40	STL 627 AA 690	DCA 319 11:30				935 TERM		NAS 1024 AA 1095	PIT 319 18:15	MSY 1154 AA 1215	JAX	DCA 1289 AA 1355	JAX 319 22:35
B4					6	ORIG 455 7:35	PIT 4 AA 8:35	515 IAH 319 575 9:35	SAT AA 10:39 700	MCI 319 11:40				MSY 930 BNA AA 966 319 15:30 16:06 NAS 910 AA 15:10 989	_			RIC 1151	TPA 319	1272 TERM	
B2							ILM 484 PHL AA 1820 319	7.0.	ROC 614 CHS AA 319 10:14 674 11:14		CLTSC4 BWI ORIG 799 13:19			NAS 910 AA 989	BUF 319 16:29			JAX 1155 AA 1210	RDU 319 20:10	MSY 1280 F AA 1345 22	BUF 319 :25
C2							8:04 1839 9:00 CLE 510 AA 564	0 MEM 319 4 9:24	PIT 620 DT AA 10:20 680 11:	W 19 20		CLTSC4 OR 13:50	IG ROC 75 14:35					BDL 1147 MG AA 1200 20:0	9	IAH 1270 PBI AA 1331 22:11	
C4						CLTSC4 BOS ORIG 7:05 470 7:50	STL AA 9-51	531 PIT 319 585 9:45	ALB 623 RE AA 680 11:	DU 19 20		23.50						BNA 1164 AA 1215	L BUF	MCI AA 21:40 1360	ORF 319 22:40
C6						7.50	3.31	7.43	<u> </u>	_								67.24 1211		2.30	
C8																					
C10																					
C12																					
C14																					
C16																					
AAIN																					
I1						CLTSC4 MBJ 6:55 465* 7:45									MBJ AA	*1010 TPA 321 0 1073 17:53	GCM *1	1094 BNA 320 189 19:49	CUN *122	GLTSC4	
12						6:55 465* 7:45 CLTSC4 PUI ORIG 475* 7:55							MBJ A A	*893 RDI	16:5 CUN 0 AA	0 1073 17:53 *1000 BOS 321 1075 17:55	18:14 1 SXM AA	189 19:49 *1120 DCA 320 1185 19:45	PUJ *1216 *1216 *1216		
12						7:05 475* 7:55							14:53	970 32 16:10	0 16:40	1075 17:55	18:40	1185 19:45	20:16 TERM 21:0	01	

	00.00	01.00 02.00 03.00		07.00		10.00		2.00 13.00	14.00		16.00		.00 19.00	20.00 21.00		
	<u>ulululu</u>										لتتلييل					
13						10:35 61	RIG SAM 13* 11:25				AA 16:21	*981 EWR 320 1711 18:05	PLS AA 18:55 *1135 1215	MCO 321 AA *1250 20:15 20:50 1350	320 22:30	
14													MBJ AA 18:56 1215	MIA 321 20:15		
l5												PUJ <sub>*1062</sub> SAN 17:42 <sup>109</sup> 18:15	CUN *1120 PI AA 1195 33 18:40 1195 19:	SXM *1224 1 20:24 TERM 21:09		
I6													MEX *1115 MDT AA 319 18:35 1189 19:49			
17													1000			
18																
I10											LHR AA	*975 732*		LHR 333		
l11									CDG AA	*83 1100	16:15	CDG 332		20:15		
I12								DUB AA	785 704*		FRA CI 332 A/	TSC4 ORIG FCO A ORIG 333 :55 1105* 18:25				
I13								13:05	704*	MAD A A	16:35 16 *95 724		LHR *1110 CLTSC4 AA *18:30 TERM 19:30			
l14								FRA	*780	15:50	724 MAD	4 18:05 CLTSC4 ORIG AA 117:10 1120*	18:30 TERM 19:30			
								13:00	*780 748*	FCO	*955 CLTSC4	17:10 1120* BC	8:40 N *1100	BCN		
I15										15:55	*955 CLTSC4 333 TERM 16:55	18:3	*1100 1245*	BCN 332 20:45		
OADO	ATL	22	ATL CLTSC4 <sub>TAC</sub> ORD	CLTSC4	O ATL DTW_DTW		ATL 676 ATL	ATL 752 ATL ATL	822 ATL D	EN 897	DEN MSP 100	atl 1070	ATL 1149	ATL ORD 1243 ORD	1346	14
01	DL 0:22	22 823	M90 S:30 ORIG 408 6:48 CLTSC4 MDW C	7:30 ORI- 7:30 BWI	8.13	JFK 601 JFK	ATL 676 ATL 717 11:162251 12:00	ALL 753 ALL DL DL 13:42	822 ATL 320 U. 2597 14:30 II4	EN 897 A 1:57 1199 1 DTW 940	320 DL 10 6:22 16:40 15:	00 320 DL 10/0 24 17:20 17:50 826	ATL M88 DL 1149 DL 19:09 1407	ATL M88 F9 1243 ORD 520-20-5 20:42 1290 21:30 TTN 1225 TTN	1346 TERM	TE 1297
O2	40 PU	SH	CLTSC4 IAH CLTSC4 ATI	PULL 3773 7:40		JFK 601 JFK B6 601 E90 10:01 218 10:40	BOS BOS INTERV	F9	HL 830 MCO 321 321 349 890 14:49	DTW 940 DL 15:40 1793	319 16:30 16:50	V <sub>1010</sub> MDW HOU <sub>1075</sub> HOU 101045 17:25 17:25 17:35 18:30	1135 344 18:55 1721 18:55 19:30	TTN 1225 TTN F9 20:25 932 21:10	1332 TERM	1387 TERM
O3			CLTSC4 <sub>ORIG</sub> IAH CLTSC4 <sub>ORIG</sub> ATI  5:05 350 5:50 6:15 420 7:00	CLTSC4 ORIG 7:20 485	MSP ORD 566 UA 9:26 521	73G 10:15	BOS 659 BOS DTW 7 DL 7 10:59 696 11:36 DTW 7 12:07 16	727 DTW 629 12:50	MSP 864 MSP 1503 14:24 14:59		ATL 978 ATL DL 978 M88 16:18 2651 17:00	BOS B6 1038 E90 17:18 1446 18:00	DTW <sub>1120</sub> DTW 1155 18:40 19:15	1268 TERM		1399 TERM 1400 TERM
O4			DEN 310 F9 200	319 7:20	BWI 575 9:35 <sup>3055</sup>	10:10		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 1168 19:28			1400 TERM
O5			CLTSC4 <sub>RIG</sub> DTW 5:15 360 6:00	CLTSC4 SLC ORIG 7:00 465 7:45		ATL 603 ATL M90 10:03 1454 10:45	M PS 12	4CO 743 PHL 9 321 2:22 805 13:24								
O6																
O13																
O14																
O18																
O19																
O20																
O27																
O28																
O29																
O30																
O31																
O32																
OAIN				T.							MUC	tooo Mi	<b>7</b>			
l21											LH 16:20	*980 M 1115* 3	46 35			
l22																
AEDO																
D13					ORIG 530 510 PUSH		ORIG 5593	PULL AA 13:4:	823 ORF CR2 3 880 14:40	ORF 907 AA 985	GSP CR2 16:25	1066 PUSH			PULL 1350	
D12			390 PUSH		PULL 590	LEX AA 10:40	640 780	BHM BT CR2 AA 13:00 13:	R 827 DAY CR2 47 881 14:41	SDF 917 AA 995	MKE TI CR2 A/ 16:35 16	H 1015 AVI A 17015 CR2 155 1110 18:30	HSV AA 19:21	1161 HPN AVL AVL AAA 125 1240 20:40 20:55 136		
D10			GSP 357 DCA AA 357 CR2 5:57 392 6:32	PHL 418 CAE AA 465 7:45	BHM 51 AA 8:30 68	0	FAY TY CR2 AA 11:20 12:	YS 740 A 870	BHM CR2 14:30	FAY 926 AA 990	IND AVI CR2 AA 16:30 16:4	1012 CAE CR2 1080 18:00	VPS 1118 PHF AA 1190 CR2 18:38 1190 19:50	AGS AA 20:38 1340	CAE CR2 22:20	
D8			CHO AA 6-23	383 549	BTR DCA	564 674	AGS CR2 AA 11:14 12:15	735 FWA CR2 AA 5 790 13:10 13:4	825 TYS CR2 875 14:35	MLB 94 AA 99	4 JAN CR2 5 16:35	TYS 1030 CAK AA 17:10 1084 18:04	CAK 11 AA 12		6 AGS CR2 0 22:30	
D6			N.22		TLH AA 0.52	533 695	EVV PGV AA ,	725 LEX MOB CR2 AA 13:42	822 LEX CR2 865 14:25	LEX	OFF VPS	CAE 1023 AGS AA 1075 17:55	ORF AA 1123 AGS CR2 18:43 5398 19:45	LGA 1200 BTV AA 1200 E75 AA 1240 20:40 20:58 1335	BTR CR2 22:15	
D4			CA	E 410 BHM CR2 0 455 7:35	8:53 HPN 502 AGS AA CR2 8:22 585 9:45	YUL 606 AA 695	GSP GSP	P 737 TLH	ORIG 890	OAJ 933 MG AA 979 16	iM P2	PHF 1042 LEX AA 17:22 1094 18:14	BHM 1 19:23 1		22:15 280 LEX CR2 355 22:35	
E1			6:51	ORIG	MOB 522 GSI	CAE 621	MYR CLE 72	25 GNV	CHA 841 VPS AA 840 CR2 14:01 880 14:40	HSV 920 BHM	17	FAY 1025 GNV	GSP 1129 MKE	FAY 1199 HSV 1275		
E2			Gr AA	455 NV412 LEX CR2	R42   599   9:55     PGV   491   PGV   AA   CR2   S:11   559   9:19	VPS AA 10:06 678	11:19 12:05 7 TYS OAJ 7	70 12:50 25 CHO	MYR 841 AVL AA 880 14:40 14:01 880 14:40	CHO 930 CAE		LEX 1045 CHO	18:49 1184 19:44 YYZ 1157		1291 EVV	
E3			6:2	DAY 434 CLE AA 470 CR2	AGS 501 OAJ	EVV 623	11:18   12:05 /C	69 12:49 8 736 OAJ	PGV 847 FAY AA CR2	15:30 970 16:10 CAE 922 HSV AA 960 16:00		17:25 1095 18:15 BHM 1065 CHA AA 1105 CR2	19:17 1210 EWN 1145 FAY AA CR2	MEM 1205 MLB CHO 1268	1360 22:40 TLH	
E5				7:14 470 7:50 CAK 428 CHA	8:21 566 9:26 LEX 510 MOB	10:23 680 MKE	11:20 12:10 648 SDF CR2	16 780 13:00 AA 742 FAY AA AA CR2 2:22 785 13:05 13	GS 829 CR2	15:22 960 16:00 EVV 923 CAK		17:45 18:25 MOB 1030 MOB ATL AA 1030 CR2 AA 108.	19:05 1190 19:50 DSM CRW 1145 FWA	20:05 1243 20:45 21:08 1335 CAE 1259	22:15 MKE CR2	
				7:08 463 7:43 384 GSP	8:30 575 9:35	10:48 ORI	IG	2:22 785 13:05 13 BHM 750 MOB VI	:49 865 14:25	EVV 923 CAK AA 923 CR2 15:23 16:00 TYS 937 CP		17:10 <sup>1069</sup> 17:49 18:05 112:	CR9 AA 11-45 CR2 18:45 19:05 1189 19:49 MGI	20:59 1325	1295 MOB	
E7			6:24  CHS 378	465 7:45	CAE 501 HSV CR2 8:21 549 9:09 FWA 529 MGM	674	4	AA CR2 12:30 790 13:10 13 GNV 745 TYS	PS 829 PHF A 829 CR2 i:49 865 14:25 GSP YYZ AA 834 CR2	15:37 PA 16:1-	NV 969 BTR	TERM CHA 1041 TYS	MSN 1123 OAJ	0 1220 CK2 AA 21:35 MKE	1360 CR2 22:40 1297 GSP	
E9			6:18 450	) 7:30	AA CR2 8:49 585 9:45	BTV 621 R AA E 10:21 665 11:	646 PGV	12:25 <sup>780</sup> 13:00	13:54 870 14:30	JAN CRV	6:09 <sup>1005</sup> 16:45	AA 1041 CR7 17:21 1095 18:15	AA 1125 CR7 18:43 1185 19:45 MLB 1132 MS	AA 21:37 CAK	1360 CR2 1295 CR9	
E11			ILM AA 6:41	401 SAV CR9 465 7:45	MGM 518 TYS AA CR2 8:38 575 9:35	10:46	690 11:30	TLH 740 MSN L	311 HSV CR7 365 14:25	JAN 940 CRV 15:40 975 16:1		ERM DAY	18:52 1194 19:5	7 AA 21:35	1355 22:35	
E13					ORIG 550	634 TERN	Л	12:28 814 13:34	3:51 885 <sub>14:45</sub>	AA 15:13	913 1080	CR7 18:00	OAJ 1133 SDF AA 1189 CR7 18:53 1189 19:49	HPN 1250 ORF AA 3904 CR2 20:50 3904 21:30	1321 TERM	
E15				and	ORIG 585	639 TER		732 AVL 785 CR7 AA 13:05 13:37	817 CHA CR7 867 14:27	CHA 94 AA 15:40 100	0 GPT CR7 00 16:40	HSV 1058 PHF AA CR7 17:38 1100 18:20	IND 1138 CAK AA CR7 18:58 5306 19:45	21:363	25 22:05	
E17			ORF 38 AA 6:27 44	7 CVG CR9 4 7:24	CRW 496 GNV AA 555 GSO AA 555 DH3 8:16 540 9:00 9:15 595 9:55		659 TERM		PULL 890			SAV 1029 ILM AA 17:09 1105 CR9 17:09 1105 18:25		TYS AA 20:59 1345	AVL CR7 22:25	
			1 10-7		7.50					'		- 5,720				

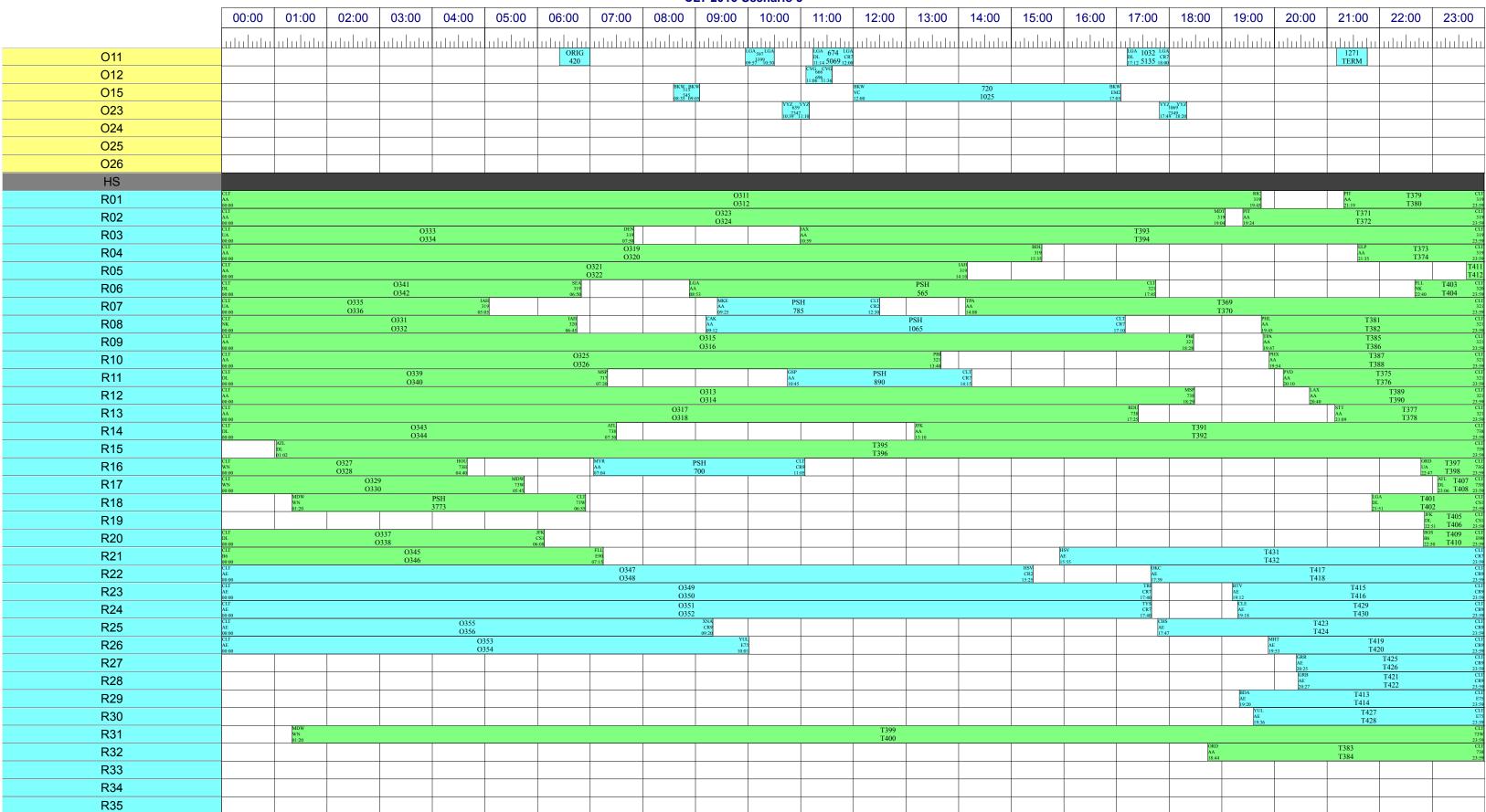
E10	GPT   1270   SRQ   CRY   CRY
E19    Full   Fu	GPT   1270   SRQ   CRY   CRY
E19	Cap
E18	PHF   1286   PHF   1286   PHF   1280   PHF   1280   1350   2230
E16	1300   TERM
E14	SSP
E12	1166
E10    ROA 424 GNO   AND 112   AND 113   AND 114   AND 114   AND 114   AND 115   AND 1	No.   No.
E21	1270   TERM     1265   TERM     1265   TERM     1270   TERM   1270   T
E23  ORIG   SRQ 484   T.H   SBY 555 AVL   AA 500 H3   SRQ 484   T.H   SBY 555 AVL   AA 500 H3   SRQ 485   SRQ 484   T.H   SBY 555 AVL   AA 500 H3   SRQ 485	1265   TERM       1265
F25    TRI 399 HHH   TYS 502 LIT   TUL 620 DAY   MYR 735 MYR   GSO 813 CR9   AA 813 CR9   AA 914 SDF   PVD 1011 SRO DAB 1080 CR9   AA 1080 CR9	1230 2030   2125   1360   2246
639 455 735 822 555 915 1020 695 1135 1215 79 1259 1333 864 1424 1515 4965 1605 1651 1060 1700 1800 1125 1845 1935	21:09 1340 CR9 22:20
E27	ceol bue part
E29    AA 396   CR9   AA 62621   MI 3738 AUS   AA 625   CR9   AA 636   CR9   AA 6	9 GSO PNS 1255 DAY CR9 0 20:10 20:55 1325 22:05
E31  ORIG 455  R  ORIG 455  R  ORIG 489  MYR  OMA 641  PII EWN 749 GR9 AA AO GR9 AB GR9 AB GR9 AB GR9 AB AO GR9 AB GR	21:05 1335 CRS 22:15
E33 ORIG 460 S36 590 9.50 OKC 642 IAD 680 738 TRI AA 870 LTS 1145 CR9 1452 CR9 1452 CR9 13.56 885 LTS 145 CR9 15.16	
CRIG AD 523 ND AV 618 AV 618 OR9 AA 625 ND AV 618 OR9 AA 625 ND AV 618 OR9 AA 625 OR9	215 CR9
E38   S   S   S   S   S   S   S   S   S	21:00 1350 22:30
E36    Hill 416 ROA   BINA   529   DAB   AA   639   CVG   AA   639   CVG   AA   641   PNS   AA   649   CR9   AA   640   CR9	BHM 1292 MEM AA 1292 CR9 21:32 1355 22:35
E34   SAV 496 ME	520:05 21:34 1355 22:35
HA TH E7S AA SL (RE) A	AA 1299 LITI AA 200 CR9 21:39 1355 22:35
559   1054 710 1150   1222 785 13305   1330 865 1425   995   1726 1110 1830   1928 1211	1020:10 21:28 1360 22:40
E28   SRQ 610 OR1   SRQ 610 OR2   SRQ 610 OR	155 EWN AA 1281 TYS 230 2030 E121 1329 2200  LVH SRQ 1299 SDF
8:49 580 9:40 [10:28 680 11:20 [12:23 790 13:10 [13:50 875 14:35 [15:06 970 16:10 [17:24 1095 18:15 [18:59 1210	20:10 21:39 1340 22:20
6.46 470 750 835 564 924 [1030 680 1120 [1538 990 1630 [1718 1085 1805] [842 1189 19.48]	21:22 1350 22:30
CZZ	TRI JAX 1292CMH DH3 21:33 13292:09  MDT 1289 APP
8:16 540 9:00 9:19 599 9:59 10:27 676 11:16 13:28 845 14:05 15:20 965 16:05 17:20 10:57:35 188:43 1184 19:44	21:29 1340 22:20
8:45 5089 9:30   10:22 670 11:10   13:42 5 <sup>509</sup> 14:19   15:33 976 16:16   19:09 1209	
AA   CK9   AA   DH3   BN3   S50   CK9   AA   DH3   BN3   S50   S51   S51   S79   BN3   B	1180 HTS IND 1299 MDT
F1   AA 50 (R9   A	AA 1230 DHS
	121:24 1350 22:30 LYH 1286 ROA AA 1325 BH3 21:36 1325 22:35
CVG 416 MYR CHO 495 LYM HHH 647 CRW ORIG	TRI 1253 TRI AAA 1253 DH8 20:53 4925 22:25
F4	20:53 4925 22:25   HHH 1275 HHH AA 1275 DH8 21:15 1340 22:20
F5	21:15 13:40 22:20 YYZ 1282 MSY AZ 1282 ETS 21:22 1355 22:35
F6   530   p <sub>10</sub> -30-348   710	22:25   CMH 1274 YYZ   AA 1274 YZZ   AA 1330 22:10
F7	ORIG 1325
F8	1323
F9	
F10	
F11	
F12	
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F17	
F18	
F19	GA
ORIG ORIG S15 S S S S S S S S S S S S S S S S S S	
ORIG 369 420 8538409:15 160 1025 1705 1075 1075 1135 14D 1020 1025 1705 1075 1075 1135 14D 1020 1025 1025 1705 1025 1025 1025 1025 1025 1025 1025 10	1379 TERM 1281 1379
ORIG   State	1281 1379 TERM TERM
O10  ORIG 460  S35 <sup>545</sup> 905  O10  ORIG 460  S35 <sup>645</sup> 905  O10  ORIG 460  ORIG	



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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 2	23:00
										1												
AADO																						
A21					BWI 2 AA 06:36	396 JFK EV	VR 475 A 550 560	PBI 320	MSY AA	624 s 710 11	TPA 726 AA 790	BOS 321 AA	808 MSP 320 890 14:50	FLL 905 ATL AA 959 320 15:05 959 15:59			BWI AA	1119 1220	FLL 320	MCI AA 21:40 1360	ORF 319	
A22					06:36	450 07:30 07		09:20 508 FLL 320 590 09:50	DCA AA	632 2 715	50 12:06 790 RSW 320	13:10   13:28 PHL 798 AA 798	PBI	15:05 959 15:59	R	SW 1015 BWI A 320 6:55 1065 17:45	18:39	1220	20:20	MSP AA 1264 PVD 320 21:04 1325 22:05	22:40	
A23					CLTS	C4 DFW ORIG 450 07-30	08:28 BWI AA 08:20 575		ATL 6	2 715 612 GCM 320 11:25	ATL 722 AA 792 12:02 792		810 FLL		10	PHL 1036	MCO 752	ATL 1142	SAT 320	ATL 1276 IAH	1349	
A24					06:45	450 07:30	CLTSC4 ORIG	MSY		620 AUA 690* 11:30	JFK	750 CUN P	870 14:30 BI 832 BWI	MSP 925 AA 985	RSW	17:16 1733 IAH 1035 ATL	18:20	AA 1225 BI 1134 PI 134	20:25 HL STT 122	AA 22:10 320 21:16 1330 22:10 9 ATL PHX 13	TERM 310 RDU 321	
A25							08:29 554 ( RSW 50	08 ATL	SYR 611	MSY	BOS 724	810* 13:30 A	3:52 890 320 3:52 890 14:50	SFO 903	16:25 TPA LGA	1004 PHX	LGA 1082 MSY AA 1082 320	8:54 1205 20 FLL 1152	200 AA 20:29 127	LAS 1286	365 22:45 PHI	
					LAS	370 LAS	08:28 41	MSP	10:11 663 CLTS	11:03 SC4 IAH ORIG 679	ORD 717 P	13:20 HX MIA	815 ORD 321 2080 14:50	15:03 984 TPA 9:	16:24 16:44 27 LAX	1065 321 107 1017	18:02 1135 320 18:02 1135 18:55	19:12 1220 MSY 1154	JAX	21:26 1796 2: SEA 1286 1 AA 1346 2	225 8SW	
A26					06:10 SEA 3	658 08:00 375 SAN	08:21 560 PVD 492	09:20 SXM			DEN 723	321 AA 1:00 13:35 TPA ORD 8	2080 14:50 03 PHX	MCO 9	27 LAX 321 25 16:40	16:57 1100 TPA 10	18:20 140 LGA	AA 1134 19:14 1215 RDU 1135 RSW	20:15	21:26 1346 <sub>2</sub> FLL 1281 LA	321 2:26	
A27					PHX 369	470 07:50	AA 08:12 565* 493	09:25 CLTSC4 <sub>RIG</sub> LGA		600 PLS 321 700* 11:40	DEN 723 12:03 782 1	321 AA 3:02 13:23 8	75 14:35	15:25 6	37 321 16:45	17:20 11	20 18:40	8:55 1200 320:00	AS SJU	1223 DFW	<u>.</u>	
A28					06:09 460	0 321 07:40 74 TPA	PUSH 481	ORIG LGA 09:10 595 09:55 LAX	BOS	1:38 690 11:30	PHX 726	PIT LGA	817 MCO	LGA 900	PHX	17:45	C4 DFW ORD PULL AA 565 18:30 18:45	1125 L 643 20	21 AA 05 20:23 PA PHL	1330 321 22:10 1240 PHX		
A29				CLTSC4 <sub>DAG</sub> DFW	06:14 40	65 07:45	AA 585 ORD 50	09:45	AA 10:19 PHL 6	619 MI/ 705 32 11:4:	PHX AA 726 12:06 789	321 AA 13:09 13:37 MCC	885 14:45	LGA 900 15:00 975 LAX 900 PH	321 6:15 SFO	1006 ORI		PHL 1145	19 AA :06 20:40 DFW TF	472 22:15		
A1				OS:15 OFW 05:05 OFW 05:05 OFW 05:05 OFW 06:00	AA 06:26 SMF 362	386 ORD 321 475 07:55	AA 50 08:20 68		10:05 69	505 MBJ 321 90* 11:30	FLU MIA 724	AA 13:4 DFW	825 PHL 321 5 885 14:45	15:00 559 16:0	AA 16:46	1908 321 1908 18:00	LAS	AA 1143 19:05 844 JAX 1155	321 A/ 20:27 20	1252 BOS 321 52 1335 22:15 JFK 1262 DT	w	
A3					06:02 408	321 07:30 SFO	08:02 565*	321 09:25	AA 10:3	635 715	FLL MIA 734 321 AA 1878 UJ DFW 7	321 A 13:15 1	FW 832 JFK A 321 3:52 895 14:55	DEN 92- AA 99- DEW 920	321 16:35	16:57 1090 i	321 8:10	19:15 1210 g	319 0:10	21:02 1340 32 21:02 22:2	100	
A5					SAN 06:04 364 450	07:30		321	AA 10:32	632 F 2 710* 11	50 12:27 8	321 304 13:24	X P20 TBA	DFW 920 AA 984	321 A. 16:24 16	IIA 1014 S A 1085 18:	21 AA 05 18:4	N 1129 OI 49 1205 20	21 05	LGA 1264 SF AA 32 21:04 557 22:2	1 0 0	
A7					SLC AA 06:10 1993	321 3 07:35	08:34	514 SJU 321 590 09:50	AA 10:29	629 DEN 32 521 11:4:	AA 724 12:04 781 13	321 3:01 A	XX 830 TPA 321 :50 890 14:50	15:35	935 SFO 321 705 16:40	BOS 1020 17:00 1090	321 8:10	BDL 1147 MC AA 319 19:07 1200 20:00	MSP	PHX 1276 I AA 1345 2:	521 2:25	
A9					ham	16.1	LAS 490 AA 565*	321 09:25	AA 68	511 CUN 321 85* 11:25	PIT 725 AA 785	CLE 319 AA 801 13:05 13:21 860	14:20	LAS 908 B AA 970 16	21 10	FLL 1020 17:00 1090	321 8:10	AS 1135 8:55 2075 :	321 0:10	MCO 1263 BDL 321 21:03 1329 22:09		
A11					MCO AA 06:44	404 LGA 321 479 07:59	08:31 5	11 DEN 321 75 09:35	BDL AA 10:31	631 SJU 705 11:4:	DNA	BOS AA 13:30 8	65 14:25	BOS 909 D AA 970 16		991 DFW 321 1060 17:40	DES	SFO 1154 19:14 1229	20:29	SFO 1273 MCC AA 1339 32 21:13 1339 22:1		
A13					Of:15 420 07:00		PHL 490 08:10 565*	321 09:25	10:13	613 PHX 321 685 11:25	BNA 718 AUS AA 718 319 11:58 774 12:54	10.51	11 LGA 321 66 14:26	ORD 905 MCO 321 15:05 960 16:00	one	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 AA 06:17	377 MCI 319 470 07:50	MCO 490 AA 564	SFO 321 09:24	10:13 20	053 TPA 321 053 11:20	IAH AA 12:11 100	13:19		MIA AA 15:16 1453	ORD 73H 16:25		DFW 1091 18:11 1150	321 AA 19:10 19:35	1240 20:40	1270 TERM		
A10								MCO 321 09:19	TPA AA 10:18	618 ORD 685 321 11:25	12:23 8		825 STL 319 5 880 14:40	EWR 905 AA 15:05 985	MIA 73H 16:25	PHX AA 17:13 678	321 18:16	LGA 1160 AA 19:20 1220	DEN 321 20:20	PVD 1280 DCA AA 319 21:20 1334 22:14		
A8					39 TEF	RM	LAX AA 08:43	523 BOS 321 585 09:45	MSP AA 10:26	626 BOS 690 321 11:30	AA 729 12:09 784	319 AA 13:04 13:27	807 MSY 319 875 14:35	CLTSC4 L ORIG L 15:25 970 16	10.57	1050 17:30		TPA 1147 S AA 1205 20	LC 21 05	DFW 1272 MSP AA 1330 321 21:12 1330 22:10		
A6							08:50	ORIG ORD 0 575 09:35	DF <sup>1</sup> AA 10::	W 637 LGA 321 37 700 11:40	FLL 739 AA 12:19 195	O DCA 319 0 13:15	JFK 840 AA 2249	73H AA 15:15 15:30 10	30 DCA 319 16:40	1021 TERM		MCO 1139 PHX AA 321 18:59 1195 19:55		DEN 1278 TPA AA 1335 321 21:18 1335 22:15		
A4					AT A.A 06:	TL 412 ATL 320 A 480 08:00	ORF 509 AA 555	ORF 319 09:15	601 TERM		PVD 7 AA 12:28 8	48 IAH MEM 319 AA 13:20 13:39	819 SAT 319 880 14:40			1041 TERM	SJU 1 AA 1 18:35 1	115 SFO 321 170 19:30 T	185 ERM	MIA 1273 EWR AA 1384 22:15		
A2							MSP AA 08:46	526 DFW 321 569 09:29		ORIG LAS	DCA 712 RIC AA 319 11:52 765 12:45	PIT	311 BDL 319 370 14:30	BDL 902 AA 990	DTW 319 16:30			1160 TERM		ORD 1287 AA 1277	MIA 73H 22:30	
B1							50.10	07.27	CLT	rsc4 MCO ORIG MCO	CHS 74 AA 79	5 JAX CLE	817 RDU 319 870 14:30	RSW 903 AA 990	PVD 319 16-30	IND AA 17:11 1105	STL 319	1132 TERM	EWR AA 20:36	1236 JFK 73H 1608 22:10	2.50	
В3					TPA AA	406 RDU 319 470 07:50	JFK 51 08:30 14	0 MIA 73H	603 TERM	CLTSC	RIG EWR	M A	SY 831 PIT A 895 14:55	13.03	10.50		10.25	BOS	1185 STL 1233 20:33	SYR 1264 ROC AA 1336 319 21:04 1336 22:16	1	
B5					00340	DCA 422 PIT AA 422 319 07:02 479 07:59	EWR 496 JF AA 2529 09:0	K	608 TERM	11.23	ORF 743 12:23 792	3 IND 319	RDU 836 IAH AA 895 14:55	BWI 915 AA 980	BDL 319	AUS AA 17:15 1105	BDL 319	CLTS	ORIG 1229 20:20	RDU 1257 (AA 1345 2:	ILE 319	
B7					RIC 3	394 BDL 319 450 07:30	DTW 488 B AA 550 09	BUF	JI A	FK 642 DFW AA 330 73H 10:42 330 11:35	LGA 737 AA 785		CHS 842 DCA AA 319 14:02 895 14:55	DCA 913 AA 975	MCI 319	MCI 1033 AA 1100		JFK 1149 AA 1390	20.29 EWR BWI 73H AA	1238 1360	RIC 319	
B9					06:34	07:30	08:08 330 09 MIA AA	527 EWR 73H 595 09:55	MDT AA	10:42 330 11:38 1 633 J. 3 710 11		BUF AA 13:26 855	BOS	RDU AA	944 BWI 1005 16:45	ALB 1021 DT	18:20 W 19	EWR 1156 AA 2483	0:10 20:38 IAH PIT 73H AA	1239 1355	ORD 319	
B11					EWR AA	R 407 EWR 73H 7 465 07:45	BDL 50		EWR 602 AA 1458			4 BWI CI	14:15 TSC4 ROC ORIG 875	JAX 920 AA 979	SYR 319	AA 1021 3 17:01 1085 18: BWI 1027 AA 1090 1	05 RDU 319	BNA 1164 AA 1215	0:10 20:39 BUF 319	PBI 1275 SY AA 1340 22:15	22:35 R 19	
B13					06:47	7 403 07:45	TPA			11:05 LGA 644 BNA AA 319 10:44 700 11:40	12:34	13:19   13 808 TERM	.30 14.33	BNA 914 BAA 969 16	16:19 IC 19	17:07 1090	8:10 ORD 1 AA 1	084 ILN 200 20:00	20:15	1299 TERM		
B15					SFO 374		RIC 495 AA 570*		BUF	614 NAS	PHL 719 P AA 11:59 2054 13	PHL E90		PHL 9		RDU 1024 PW AA 17:04 1085 18:	18:04   1   M   19	1145		BUF 1258 ALB		
B16				CLI	06:14 455 SC4 PHL ORIG PHL 10 395 06:35	BOS 432 BNA	JAX 497	DCA	JAX AA	690 11:30 619 BWI 319	11:59 2054 13	::00		ATL 908 JAX AA 959 319 15:08 959 15:59	00 16:30 JAN AA	1010 DCA 319 50 1070 17:50	05	TERM  CLTSC4 ORIG  19:15  12:00  20:00		AAA 1282 AAA 1360	ATL 319	
B14				05::	PIT	402 PVD 319	08:17 570 MEM AA 08:43	523 RSW 595 09:55	10:19 MCI AA	695 11:35				15:08 959 15:59	628	50 1070 17:50		19:15 1200 20:00		21:22 1360	22:40 PIT 319	
B12				CLTSC4 LC ORIG LC 05:20 365 06:	06:42 6A	455 07:35	BUF 488 AA 559		10:28 At	US 639 A 715	ALB 319			DTW 9 AA 15:39 9	1793 39 MSY D	CA 1014 IAH A 319 5:54 1074 17:54		STL 1150 MEM AA 1150 319 19:10 1200 20:00	R	IC AUS A 1255 AUS 319 0:55 1330 22:10	25	14 TEI
B10				05:20 365 06:	05	CLTSC4 BOS ORIG 07:05 470 07:50	08:08 559 IND AA 08:44	524 BDL 590 09:50	PWM AA	M 633 ATL	1:55			MSY 930 BN AA 930 31	90 16:30 16	CLE 1019 RIC	PIT	1124 PIT	2 E	TW 1255 LGA	1350	TE
B8					CLTS	07:05 470 07:50 C4 PHL ORIG 450 07:30	DCA 50	8 CHS	PBI 610	3 699 11:39 0 PHL 319				MSY 930 BN AA 966 31 15:30 RIC 92	1 ALB 319	1074 17:54	18:44	1194 19:54 IAH 110 AA 19:25 12	55 RIC 319	1324 22:04 1285 TERM	TERM	
B6						450 07:30 C4 ORIG DCA 450 07:30	08:28 570 IAH AA 08:38	0 09:30 518 NAS 319	10:10 67: STL AA	627 DCA 690 11:30		+		NAS 910	4 16:24 BUF 319	NAS 1024 AA 1095	PIT 319	19:25 12	20:30	DCA 1289	JAX 319	
B4					06:45 CLT	450 07:30 FSC4 ORIG FLL ORIG 455 07:35	PIT 5	15 IAH	10:27 SA	AT 630 MCI		+		15:10 989	16:29	17:04 1095	18:15			21:29 1355 1272 TERM	22:35	
B2					06::		ILM 484 PHL	575 09:35	ROC 61	A 700 319 0:39 700 11:40 14 CHS 319										TERM  MSY 1280 AA 1345 2:	3UF 319	
C2							AA 1839 319 08:04 1839 09:00 CLE 510 08:30 564	) MEM		74 11:14 620 DTW 680 11:20				935						IAH 1270 PBI	25	
C4							STL	531 PIT	ALB	623 RDU				TERM	1			1147		21:10 1331 22:11		
							08:5	1 585 09:45	10:23	680 11:20								TERM				
C6																						
C8																						
C10																						
C12																						
C14																						
C16																						
AAIN																			lan-			
l1					0	ORIG MBJ 6:55 465* 07:45									MB AA 16:	J *1010 TPA 321 50 1073 17:53	18:14 1	189 BNA 320 19:49	CUN *1229 20:29 TERM			
l2						CLTSC4 ORIG 07:05 475* 07:55							M A	BJ *893 R A :53 970 16	OU CUN 20 AA 10 16:40	*1000 BOS 321 1075 17:55	SXM AA 18:40	*1120 DCA 320 1185 19:45	AU AA 20:	*1250 1350	320 22:30	
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13		1111111111						<del>                                      </del>	<del>                                     </del>	<del>                                     </del>	CLTSC4 <sub>OR</sub>	RIG SXM			<del>                                     </del>		PUJ	*981 EWR 320 1711 18:05		PLS AA 18:55 1215	MCO 221	<del>                                      </del>	<del>111111111</del>	
14											10:35	11:25					16:21	1711 18:05		18:55 1215 MBJ *1136 AA 1215	20:15 MIA			
15																		PUJ <sub>*1062</sub> SA 17:42 <sup>109</sup> §8:	N CUN	*1120 PBI *1120 321 1195 19:55	20:15 SXM *1224 TERM 21:09			
																		17:42 18:1		1195 19:55 *1115 MDT 319 1189 19:49	20:24 TERM 21:09 PUJ *1216 20:16 TERM 21:01			
16																			18:35	1189 19:49	20:16 TERM 21:01			
17																								
18																	LHR	*	975		LHR			
l10															CDG		AA 16:15 *835	7	*975 732* CDG		333 20:15			
<u>                                      </u>														DUB	AA 13:55 78:		*835 100*	CLTSC4 ORIG	332 8:20 FCO					
I12														AA 13:05	78: 704	* MA	332 16:35 D *O	CLTSC4 ORIG AA 1105*	333 18:25 LHR *:	1110 CLTSC4				
I13														FRA	*79	AA 15:5	0 *9 0 72 MAD		AA 18:30 TI LHRI	1110 CLTSC4 333 ERM 19:30				
l14														AA 13:00	*78 748	V *	332 16:40	CLTSC4 ORIG AA 17:10 1120*	333 18:40	*1100	BCN			
I15																A 1:	20 *955 CLTSC4 A 333 5:55 TERM 16:55		AA 18:20	*1100 1245*	BCN 332 20:45			
OADO																								
O1	ATL DL 00:22		22 823			M90 05:30	O6:15 420 07:00	0 07:20 485 08	3:05	09:04 <sup>579</sup> 09:39		ATL 676 ATL 717 11:162251 12:00	ATL 753 DL 753 12:33 109:	ATL ATL DL 5 13:15 13:42	822 ATL 320 2597 14:30	DL 904 M88 15:04213315:45	MSP DL 1 16:40	000 DTW ATL 524 DL 17:20 17:50	1070 ATL M88 18:45	ATL 1149 DL 119:09 1407 2	ATL M88 20:05	1268 TERM	1346 TERM	14 TE
O2						ORIG OC: 05:15 OC: 05:15 OC: 05:15 OC: 05:05	W 00	CLTSC4 SLC ORIG 07:00 465 07:45	AT DI 08	TL 528 ATL L 528 M88 3:48 2422 09:30			DTW 727 DTW DL 319 12:07 1629 12:50		MSP 864 M 14:24 1503 14:	DTW DL 15:40 1	940 MSP 793 16:30							1387 TERM
O3								CLTSC4 ORIO 07:30	G ATL 08:15		ATL 603 ATL M90 10:03 1454 10:45						ATL 978 ATI DL 978 M8 16:18 2651 17:0	1. 8 0	DTW <sub>11</sub> 18:40	DTW 120 155 19:15				1400 TERM
O4						CLTSC4 IAH ORIG OS:05 350 05:50				ORD 566 UA 521	ORD 73G 10:15			ORD 780 ORD UA 319 13:00 1140 13:45		DEN 897 UA 11:57 1199	DEN 320 16:22		,					1399 TERM
O5							CLTSC4 ORD ORIG 408																1332 TERM	
O6	4 PU	40 USH				CLT 05:4	SC4 MDW ORIG MDW 5 390 06:30	CLTSC4 BWI PULL BWI 06:55 3773 07:40		BWI 575 09:35 <sup>3055</sup>	DAL						MI 16-	DW <sub>1010</sub> MDW HOU <sub>1</sub> 50 <sup>1045</sup> 17:25	075 HOU 493	DAL 1135 BWI				
O13						0334	5 00.50j p	07.40		07.33	JFK 601 JFK B6 E90 10:01 218 10:40	BOS BOS B6 659 E90					10.	BOS 1038 BOS B6 1446 18:00	JFI B6	K 1130 FK 5 1168 E90				
O14											10.01 10.40	10.39 11.30						[17.18 18.00	110	19.28				
O18						DEN F9	310 200	DEN 319					MCO 743 F9 1688	PHL PHI 321 F9	HL 830 MCO 321 321 1029 14:49						ORD 124 F9 120:42 120	13 ORD 320		
O19						05:10	200	07:20					12:22 1086	13:24 13:	:49 1029 14:49						TTN 1225 TTN F9 932 21:10	21:30		
O20																					20:25 932 21:10			
O27																								
O28																								
O29																								
O30																								
O31																								
O32																								
OAIN																								
																	MUC	*980	MUC					
121																	LH 16:20	1115*	346 18:35					
122																								
AEDO									ORIG	530		659	PULL	DAY	823 ORF	ORF 907	GSP	SDF			1066		СНО	
D13							PHF		510 390	PUSH	LEX	TERM 640	PULL 785	AA 13:43 BTF	823 ORF CR2 880 14:40	ORF AA 907 15:07 985 SDF 91	CR2 16:25 7 MKE I	AA 17:46	AVL	HSV	1066 1350 1161 HPN AVL	1255	CR2 22:30 MGM	
D12							AA 06:30 GSP 357 DCA	PHL 418 CAE	590 BHM	VPS CR2 09:50	AA 10:40	780 FAY	BHM CR2 13:00		47 881 14:41 BHM	15:17 99:	16:35 I	TLH 1015 AA 1110 /L 1012 CAE	AVL CR2 18:30	1118 PHF	1161 HPN CR2 AA 1240 20:40 20:55	1361	CR2 22:41 CAE	
D10							05:57 <sup>392</sup> 06:32 CHO	PHL 418 CAE AA 465 CR2 06:58 465 07:45	AA 08:30	510 680 BTR DCA		CR2 11:20 AGS	AA 12:20 CRW 72.5	740 870 FWA FAY	CR2 14:30 825 TYS	FAY 92 AA 92 15:26 99 MLB	O CR2 O 16:30 16 Q44 JAN	/L 1012 CAE A 1080 CR2 1:52 1080 18:00	AA 18:38	1118 PHF CR2 1190 19:50		1340	CR2 22:20 AGS	
D8							AA 06:23	549		BTR DCA CR2 AA 09:09 09:24 TLH	564 674 533	CR2 11:14 EVV	CRW 735 AA 790 1 PGV 725 LEX	CR2 AA 13:10 13:45 MOR	825 TYS CR2 875 14:35	AA 15:44	944 JAN 995 CR2 995 16:35 EX 955 VPS	TYS 1030 CAK AA 1020 CR2 17:10 1084 18:04	ORF	AA 122	25 CR2 25 20:25 ZO	VPS 1266 AA 1350	CR2 22:30 BTR	
D6							loa.	E 410 BHM	HPN	AA 08:53 502 AGS	695	CR2 11:35 GSP	PGV 725 LEX AA 725 CR2 12:05 779 12:59 GSP 737	AA 13:42 TLH	822 LEX CR2 865 14:25		EX 955 VPS A 1005 16:45 2 MGM	AA 1023 CR2 17:03 1075 17:55	AA 18:43	1123 AGS CR2 5398 19:45	AA 1240 E75 AA 20:00 20:5	8 1333 2: GNV 1290	CR2 12:15	
D4							AA 06:	410 BHM CR2 50 455 07:35	AA 08:22	502 AGS CR2 585 09:45	AA 10:06 695	11:35	12:17 790 I	CR2  3:10	ORIG 890	OAJ 933 AA 979 15:33 979	) 16:19	17:22 1094 18:1	32 14	BHM 11 19:23 12	25 20:25	AA 1250 21:20 1355	) LEX CR2 22:35	
E1							las.	ORIG 455	MOE AA 08:42				CLE 725 GNV AA 770 CR2 12:05 770 12:50		CHA 841 VPS AA 880 CR2 14:01 880 14:40	HSV 920 BH AA CI 15:20 965 16:	22 05	FAY 1025 GNV CR2 17:05 1075 17:55	AA 18:		FAY 1199 HSV AA 1199 CR7 19:59 1240 <sub>20:40</sub>	1275 TERM	not mad	
E2							G1 Az 06	NV 412 LEX A CR2 6:52 450 07:30	PGV 491 08:11 559		VPS 606 AA 678		OAJ 725 CHO AA 769 12:49		MYR 841 AVL AA 880 CR2 14:01 880 14:40	CHO 930 AA 15:30 970 1	CR2 6:10	LEX 1045 CH 17:25 1095 18:1	R2	YYZ 1157 AA 1210		DAY AA 12 21:31 13		
E3								DAY CLE AA 434 CR2 07:14 07:50	AGS 50 AA 56 08:21 56		EVV 623 AA 680	11:20	AGS 736 OAI AA CR2 12:16 780 13:00		PGV 847 FAY AA CR2 14:07 885 14:45	CAE 922 HSV AA 920 CR2 15:22 960 16:00		BHM AA 1065 17:45	CHA CR2 18:25	EWN 1145 FAY AA CR2 19:05 1190 19:50	MEM 1205 CR9 1245 CR9 20:05 20:45	21:08 1335 2	TLH CR2 2:15	
E5								CAK 428 CHA 07:08 463 07:43	LEX AA 08:30	510 MOB CR2 575 09:35	10:48	648 SDF CR2 8 700 11:40	CAE 742 FAAA 785 12	AY AG R2 AA (05 13)	GS 829 SDF A 829 CR2 :49 865 14:25	EVV 923 CAK AA 960 16:00 TYS		MOB 1030 MOB AT	TL 1085 DSM A 1085 CR9 3:05 18:45	CRW 1145 FWA AA CR2 19:05 1189 19:49		1259 MKE CR2 59 1325 22:05		
E7								384 GSP CR7 465 07:45	MGM AA 08:38	518 TYS CR2 575 09:35	ORI 674	4	BHM 750? AA 12:30 790 1	MOB VP: CR2 AA (3:10 13:	PS PHF A 829 CR2 :49 865 14:25	TYS AA 937 15:37	16:14	1031 TERM		MGM AA 19:40	1180 VPS 1220 CR2 1220 20:20	BTR 12 AA 12 21:35 13	295 MOB CR2 360 22:40	
E9							CHS 378 AA 450	8 AUS CR9 0 07:30	F	WA 529 MGM A 585 09:45	BTV 621 R AA E 10:21 665 11:	RIC 275	GNV 745 TYS	S	AA 870 CR2	10.07	GNV 969 BTR 16:09 <sup>1005</sup> 16:45	CHA 1041 TY AA 1095 18:	YS MSN R7 AA 15 18:42	1123 OAJ CR7 1185 19:45		MKE 12 AA 21:37 1	297 GSP CR2 360 22:40	
E11							ILM AA	401 SAV CR9 465 07:45	CAE 501 AA 549		CHA	646 PGV CR2 690 11:30	GNV <sub>745</sub> TYS 12:25 <sup>780</sup> 13:00 745 TERM	CVG 8	13:54 14:30 B11 HSV CR7 G65 14:25	JAN 94:	CRW	1008 TERM		ILB 1132 MSN A 1194 CR7 8:52 1194 19:54			295 CRW CR2 255 22:35	
E13							ĮJO:41	07:43	OR 55	.IG	634 TERN		TLH 7 AA 12:28 8	48 MSN LI CR7 A/	IT 831 AUS A CR9	PHF AA	913 1080	DAY CR7	C A	DAJ 1133 SDF NA 1189 CR7 8:53 1189 19:49	<u>'                                     </u>	1265 TERM		
E15									33	ORIG 585	639 TER	9	CHO 732 A AA 785 13:12	VL GPT AA	817 CHA CR7 867 14:27	CHA AA	940 GPT CR7 1000 16:40	HSV 1058 AA 17:38 1100 1	PHF CR7	IND 1138 CAK AA CR7 18:58 5306 19:45		LEX <sub>129</sub> CAK 1325 21:36 22:05		
E17							ORF AA 06:27 44	7 CVG CR9	CRW 496 GN AA CI 08:16 540 09:			ORIG 5593	12:12 763 13:	usj [13:37	PULL 890	[15:40	16:40	SAV 1029	8:20 ILM CR9	18:58 3300 19:45	TYS	21:36 22:05 8 1259 1345	AVI. CR7	
						<u> </u>	06:27 44	07:24	08:16 540 09:	[09:15 393 09:55]	PUSH	3393			890			17:09 1105	18:25		20:5	1343	22:25	

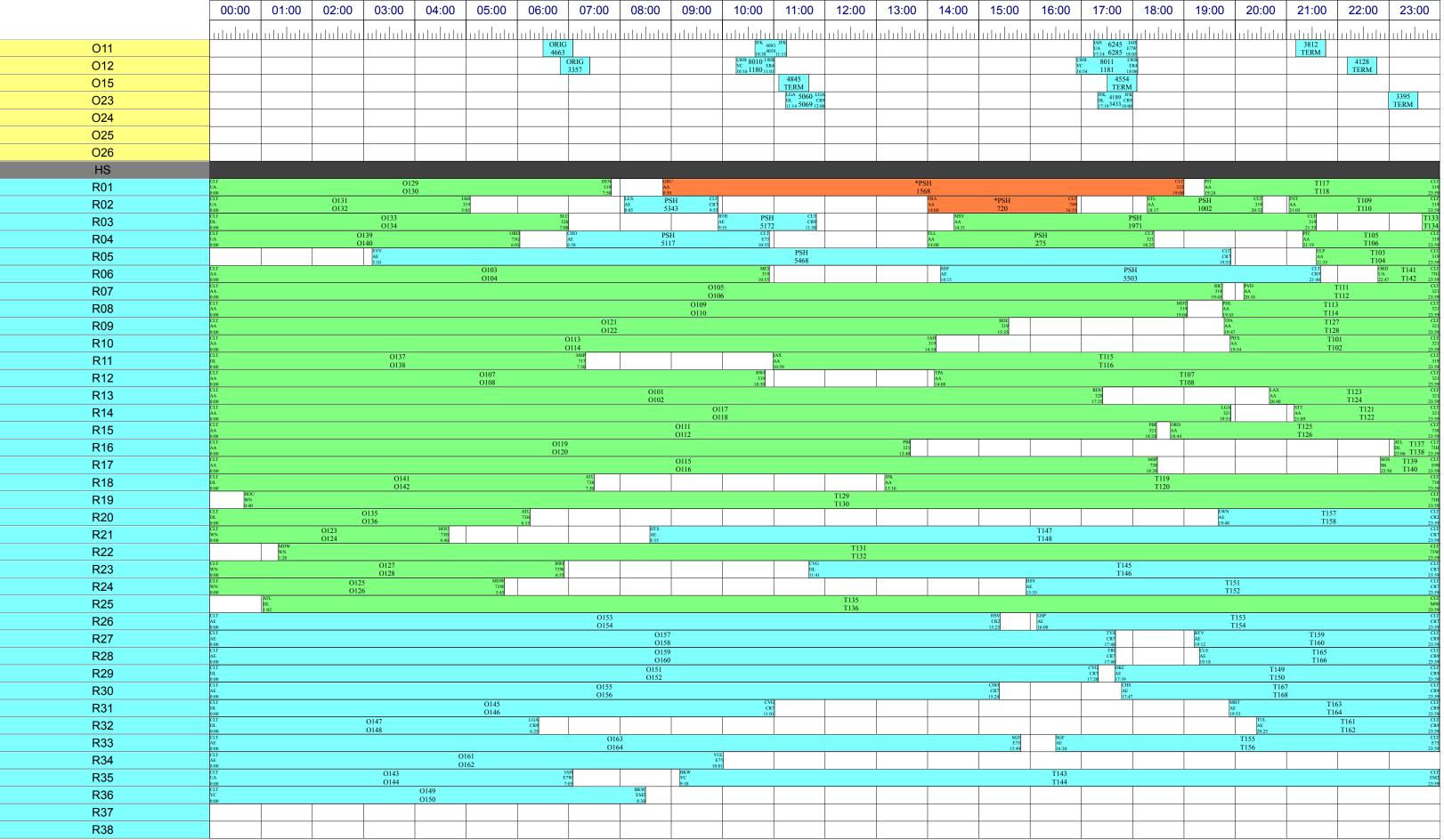
Date:04/11/2019 Time:12:51						CI	_T 2016-S	Scenario 3										Pag	je # 3 of 4
	00:00 01:00	02:00	03:00 04:00	05:00	06:00 07:00		09:00	10:00 11:00	12:00	13:00	14:00 1	5:00 16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
									1			1							1
E19				4	IAD 404 CHS AA CR9 06:44 460 07:40	FAY 52 08:40 56	0 CRW CR2	SGF 609 SGF AA 650 ER4 10:09 650 10:50 11:05 700 11:40	JAX 730 DTW AA 780 CR9 12:10 780 13:00	798 TERM		AVL 929 OAJ AA 929 CR7 15:29 974 16:14	OMA AA 17:06 1100	SAV CR9	LEX TYS AA 1156 CR7 19:16 5221 19:56		GPT 1270 SRC AA 1334 22:1.	7	
E18					GSO 412 RIC AA 460 07:40	PHF 490 AA 560	GPT CR7	10:09 030 10:50	RDU 739 AA 795	CAK	831 TERM	PIT 924 LIT AA CR9 15:24 990 16:30	DTW 10		19:16 19:56		PHF 1286 21:26 1350	PHF CR7	
E16					ORIG 440	517 PUSI	09:20 H	OAJ 646 FLO AA 0H3 10:46 693 11:33	12:19 773	13:15	LKW	CMH 921 ILM AA 969 16:09	PULL 1065		1120 CVG CR9 1185 19:45		1300 TERM	22:30	
E14					LYH 382 OAJ AA DH3 06:22 460 07:40	OAJ AA 08:13 560	CVG CR7	IND 646 CMH AA 705 11:45		JAN AA	827 HPN CR7 873 14:33	ORIG 970	SYR 1036 17:16 1100		1130 CHS 1184 CR9 1184 19:44	GSP AA	1199 1365	GSO CR9	
E12					EWN 395 FAY AA 460 07:40	AVL 501 AA 559	CHO CR7	ROA 621 HHH	IAD 749 AA 800	BNA	842 TERM	STL 943 PNS AA 15:43 1004 16:44	ILM 1034 G AA 1085 IS	ORF	IAD 110 AA 12:26 12	66 MSY GSO AA AA 20:45	1245 1350	SAV CR9	
E10					ROA 424 GSO AA DH3 07:04 470 07:50	SDF 51		GSO 630 EW AA 715 DH 10:30 715 11:5:			312 ILM CR9 A.	AY 914 SAV CR9 5:14 974 16:14	CAK 1013 GSP AA 1070 CR9 16:53 1070 17:50	S.A.	AV 1140 ORI A 1200 CRS	20.30 20.43	ILM 1263 AA 1355	CHS CR9 22:35	
E21						HSV 51 08:33 57		SAV AA 10:38 779	ILM	DAB		902 TLH CR9 959 15:59	DSM 1018 CLE AA CR9 16:58 1070 17:50		1130 GRR CR9 1185 19:45		1270 TERM		
E23					ORIG 449	SRQ 484 TLH AA 540 CR7 08:04 540 09:00	SBY 555 AVL 09:15 590 09:50	BHM 613 BHM AA CR9 10:13 695 11:35	FAY 730 CHS AA CR9 12:10 774 12:54	CAK 808 AA 865	8 IAD MDT CR9 AA 5 14:25 15:07	907 CMH CR9 7 959 15:59	RIC 1039 AA 1090		YS 1141 SAV A 1195 19:55	HP. AA 20:	N 1250 ORF 50 3904 CR2 21:30 T	1321 ERM	
E25					TRI 399 HHH AA 06:39 455 07:35	TYS 502 AA 555	LIT CR9 09:15	TUL 620 DAY AA 620 CR9 10:20 695 11:35	MYR 735 MYR AA CR9 12:15 779 12:59		3 CMH CR9 4 14:24	CR9 A 965 16:05	PVD 1011 SRQ AA CR9 16:51 1060 17:40	DAB 1080 OKC AA CR9 18:00 1125 18:45	DAB 1 AA 19:36 1	176 CLE CR9 230 20:30	SDF AA 21:25 1360	MYR CR9 22:40	
E27					389 PUSH	MDT 488 C AA 550 09	MH E75 9:10	PULL 700	MEM 727 SYR AA CR9 12:07 770 12:50	SRQ 8 AA 13:37 8	17 SAV BHI CR9 AA	M 910 IAD CR9 10 960 16:00	TUL 1028 IAD AA 1075 CR9 17:08 1075 17:55	GSO AA 18:49	1129 DAY 1180 CR9 1180 19:40		21:09 1340 22	HA CR9 2:20	
E29					SAV AA 06:36	396 565	GRR CR9 09:25	CLE 621 MDT AA 685 CR9 10:21 685 11:25	HTS 738 AGS AA DH3 12:18 781 13:01	AUS AA 1 13:45	825 CHS CR9 875 14:35	ILM 935 GSO AA 985 CR9 15:35 985 16:25	XNA 1024 CVG AA CR9 17:04 1070 17:50		TLH 1159 AA 1210 2	GSO P CR9 A 0:10 2	NS 1255 DAY (A 1325 CR9 0:55 1325 22:05		
E31					ORIG 455	CHS AA 08:09 570	MYR CR9 09:30	OMA 641 PIT AA 705 11:45	EWN 749 AA 12:29 792	GSP DH3 13:12	GRR 845 ATL AA 845 CR9 14:05 895 14:55	AD 915 DAB AA CR9 5:15 964 16:04	MYR 1039 B AA 17:19 1085 18	3HM M CR9 A. 8:05 19	YR 1140 PNS A CR9 9:00 1190 19:50		AUS 1265 CR 21:05 1335 22:1	D 9 5	
E33					ORIG 460	GSO AA 08:36	516 JAX CR9 590 09:50	OKC 642 IAD AA CR9 10:42 705 11:45	GSO 738 TRI AA DH3 12:18 779 12:59	Pi A 1:	NS 836 DTW A CR9 3:56 885 14:45	CLE 925 CVG AA CR9 15:25 974 16:14	PWM 1030 SDF AA CR9 17:10 1074 17:54		CMH 1156 MI AA 1205 C 19:16 1205 20:	11 R9 D5	CHS AA 21:00 1350	XNA CR9 22:30	
E35					ORIG 465	IAD AA 08:43	523 IND CR9 595 09:55	AVP 618 AVP AA 680 11:20	AVL 732 LYH AA 770 DH3 12:12 770 12:50	1:	RF 836 MYR CR9 3:56 885 14:45	CHS 930 TYS AA CR9 15:30 979 16:19	16:45 17:25 AA 17:4	1066 TUL CR9 46 1110 18:30	CVG 1166 AA 19:26 1215	ABE CR9 20:15	XNA AA 21:33 136	3 BNA CR9 0 22:40	
E38						MSY AA 08:46	590 CR9 09:50	DSM 619 GSO CR9 10:19 680 11:20	TRI 743 ROA AA 743 DH3 12:23 781 13:01	M A A	KE 836 ABE A CR9 3:56 885 14:45	AVP 936 XNA AA CR9 15:36 985 16:25	CHS 1032 MDT AA 1075 CR9 17:12 1075 17:55		CHS 1143 SRQ AA 179:03 1190 19:50		ROA AA 1260 21:00 1350	LYH DH3 22:30	
E36					HHH 416 ROA 06:56 07:30	BNA AA 08:45	590 CR9	ABE 639 CVG AA CR9 10:39 700 11:40	LYH 752 FI 12:32 786 13:32 13:	:06	IND 841 PNS AA CR9 14:01 890 14:50	MYR 933 CHS AA CR9 15:33 980 16:20	CMH AA 17:41	1061 MYR 1100 CR9 18:20	DTW 1144 GSP AA CR9 19:04 1190 19:50	D	BHM 1292 21:32 1355	22:35	
E34					CMH 398 IN E 06:38 475 07:30	ND SAV 496 AA 496 355 08:16 554	MKE CR9 09:14	CVG 649 XNA AA 710 11:50	CMH 747 AA 12:27 804	7 MCI ILM E75 AA 4 13:24 13:	4 832 MKE CR9 52 880 14:40 LS	VG 914 MEM CR9 5:14 960 16:00			MKE 1161 L AA 1161 C 19:21 1205 20:	39 05	BNA 1294 21:34 1355	22:35	
E32					ND 411 DTW AA 465 07:45	08:47	09.45	CMH 650 PWM AA CR9 10:50 710 11:50	SAV 727 CHA AA CR7 12:07 770 12:50	ione.	YYZ 859 LGA AA E75 14:19 915 15:15	MEM 935 MYR AA CR9 15:35 980 16:20	hos		ABE 1146 OMA AA 1189 CR9 19:06 1189 19:49 SDF 1168	DAD	CLE 129 21:39 135	5 22:35	
E30					lace and epit	55	RIG 59	DAY 654 PVD CR9 10:54 710 11:50	IND 732 GS AA 785 E1 12:12 785 13:0	75 AA 8 13:40 8	20 DAB CR9 65 14:25	ORIG 995	ROA AA 103 17:16 111		19:28 1210	0:10	CHA 1288 21:28 1360	CR2 22:40	
E28					AGS 391 SDF AA 450 CR2 06:31 450 07:30	GSP 498 I AA C 08:18 549 09	529 RDU CR9	SRQ 610 ORF AA 662 11:02	DTW N	13:5	830 RIC 830 RIC CR9 0870 14:30	942 TERM	CRW 10 AA 17:30 11	105 18:25	PGV AA 19:15 1230	DH3 20:30	IAD 1281 TYS AA 1329 CR9 21:21 1329 22:09	erori.	
E26					SDE 40 C MEN	08:45	580 <sub>09:40</sub>	XNA 628 OMA AA CR9 10:28 680 11:20	DTW 743 M AA 790 1		A 830 ROA DH3 AA 15:06	970 DH3	EWN 1044 AA 1095	5 18:15 AA	H 1139 A 1210 2	DH3 0:10	SRQ 1299 S AA 1340 22	CR9 2:20	
E24					SDF 406 MEM AA 470 CRS 06:46 470 07:50	DAB 51 AA 51 08:35 56	4 09:24	MHT 630 STL AA 680 CR9 10:30 680 11:20		13:39 85	9 CRW DH3 9 14:19	TRI 938 TRI DH3 15:38 990 16:30	HTS 1038 H AA 1085 I 17:18 1085 I	DH8 AA 8:05 18:42	1122 CHO DH3 1189 19:49	TDI	CVG AA 21:22 1350	CR9 22:30	
E22					CHA 389 IAD AA CR9 06:29 450 07:30	AA 08:00	480 685	DH8 11:25		13:48	828 DH3 865 14:25	LYH 935 AVL AA DH3 15:35 984 16:24	CHO FLO	ROA	CHO 1150 AA 1215	DH3 20:15	JAX 1293 CMH 21:33 1329 22:09	AVP	
E20						ORIG 530	CVG 550 CAK 09:10 <sup>585</sup> 09:45	CHS 627 ILM AA CR9 10:27 676 11:16		CRW 805 HT AA DE 13:25 845 14:0	18 05 CHO	FLO 920 ROA AA DH3 15:20 965 16:05 GSP 933 PGV	CHO <sub>1021</sub> FLO 17:01 <sup>1055</sup> 17:35	18:43	1123 ROA 1184 DH3 19:44	10	MDT 1289 ( 21:29 1340 22	CR9 2:20	
E8						08:45 -	525 MHT CR9 5089 <sub>09:30</sub>	MYR 622 SAV AA CR9 10:22 670 11:10		AA 8: 13:42 8:	22 DH8 59 14:19	AA 933 DH3 15:33 976 16:16 ROA 941 AGS	MDT 1016 IND		AGS 1149 AA 1209 2	DH3 D:09	LIT 1278 AA 1355 MYR 1250 CVG	CR9 22:35	
E6						08:38 56	8 OKC CR9 0 09:20	FAY 607 ROA AA 674 H1:14 ORF 647 MEM		II.	1.00 HHH 836 HHH 3:56 870 14:30	AA 941 DH3 15:41 979 16:19	MDT 1016 IND AA 1070 17:50 GSO 1019 CMH	A. 19	RI 1140 SBY A DH3 9:00 1190 19:50	100 HTS	MYR AA 1259 CVG CR9 20:59 1325 22:05 IND 1299 M	IDT	
E4						08:5	1 580 <sub>09:40</sub>	AA 647 CR9 10:47685 11:25 MEM 40 DSM		AA 13:42		959	16:59 1070 17:50	.X II.M		180 HTS DH8 230 20:30	21:39 134022	E75 E:20 EWN	
F1						517 TERM	M TRI	AA 680 CR9 10:43 680 11:20			RIC 842 OMA AA E75 14:02 895 14:55	GSO 930 YYZ AA 987 E75 15:30 987 16:27	MSY 1028 E7 17:08 1079 17:5	51 TRI	1130 IND E75 1185 19:45			DH3 22:30	
F2					CVG 416 MYR	LYH 492 08:12 580 CHO 495	DH3 09:40 LYH	631 TERM HHH <sub>64</sub> -CRW					17:31 109	95 <sub>18:15</sub>	ORIG	п	LYH AA 1286 DH3 21:26 1325 22:05	TRI	
F3					CVG 416 MYR AA CR9 06:56 460 07:40	CHO 495 08:15 575 EWN 512	DH3 09:35 SBY	HHH <sub>647</sub> CRW 10:4 <sup>679</sup> 11:19 RIC <b>645</b> CLE					SGF 1011 SGF		1184	A. 20	4925 HHH 1275 H	DH8 22:25 HH	
F4						EWN 512 08:32 560 TRI 496 HTS	OH3 09:20 YYZ 559 BNA	RIC 645 CLE CR9 10:45 695 11:35 ORIG					SGF 1011 SGF AA 1070 ER4 16:51 1070 17:50	T	TERM		AA 1273 II 21:15 1340 22 YYZ 1282	DH8 2:20 MSY	
F5						TRI 496 HTS AA 540 09:00 FLO 5	AA E75 09:19 599 09:59 23 EWN	710									21:22 1355	22:35	
F6						08:43 5 CMH 51 AA 08:36 50	23 EWN 64 09:24 16 YYZ	645 TERM AA 670 SA 11:10 715 11:5	ı e								CMH 1274 YYZ AA 1330 22:10 ORIG		
F7 F8						08:36 50	67 09:27	11:10 715 11:5:	5								1325		
F9																			
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F18																			
F19																			
07				ORIG 360	ORIG 445		IAD UA	582 IAD 582 CR7 5150 10:22	EWR 712 EWR		EWR 864 IAH UA 3315 E70		ORD <sub>1006</sub> ORD 16:4 <sup>4843</sup> 17:21	IAD	1135 IAD 55 19:30				1410 TERM
O8				ORIG	G ORIG	EWR <sub>514</sub> EV 08:34 <sup>3648</sup> 09	09:42 <sup>6</sup>	10:22	11:52 12:27		14:24 <sup>3315</sup> 15:02 IAH <sub>849</sub> IAD 14:09 <sup>6120</sup> 14:44		16:46 <sup>4843</sup> 17:21 EWR <sub>1040</sub> EWR 17:20 <sup>1076</sup> 17:56	18:5	55,1019:30				1379 TERM
O9				369	460	ORIG	:09				14:09 14:44		17:20 <sup>1076</sup> 17:56 IAH 1034 E 17:14 6285 18	IAH E7W			1281 TERM		1379 TERM
O10					ORIG 425	515 LGA DL 515 DL 3840	LGA CR9	MSP 632 MSP		LGA 794 LGA DL CR9 13:14 3642 14:00	LGA DL	906 LGA CR7 5 5099 16:00	1050 1075	8:05	LGA 1158 LGA DL CR7 19:18 6227 20:00		1281 TERM		IEKM
0.10					425	08:35 3840	09:15	10:32 <sup>667</sup> 11:07		13:14 3642 14:00	15:06	5 5099 16:00	1075		19:18 6227 20:00		TERM		



	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	<u>lutulutu</u>		<u>utulutu</u>	<u></u>	<u>lutulutu</u>				<u>liitiiliiti</u>		<u>.l</u>	<u>liitiiliitii</u>		<u></u>						<u></u>	<u>ntulutu</u>
AADO							-															There		
A21						CLTSC4 DF ORIG 5:15 2451 6:0	W 00		AA 865* 8:12	320 9:25	BNA AA 10:01 876*	AUA 320 11:30	BOS AA 2044 12:04	MIA 321 13:20	SA A	N 823 LAS 321 :51 65 15:49		favor.	mga	MSY 732 AA 19:14 1885	319 20:15	MSP AA 21:04 1998	320 22:30	18 TEI
A22						CLTSC4 ORIG 5:20 2060			AA 1770 8:29	319 9:15	10:24	833 320 11:50	new		1789 MSP 321 1855 14:50	No	1.40	BWI 1915 AA 2038	320 18:15	1976 TERM		AA 1717 21:09 2:	7LL 2005 321 TERM	
A23						5::	ORIG 2010 6:35		AA 1 8:28	1709 321 9:50	BWI 876 AA 821	5 GCM * 320 * 11:25	AA 12:00	445 580	DEN 321 14:20	AA 6	537 321 16:45	CLTSC4 ORIG 17:25 1915 18	8:10	EWR 1598 AA 2483 2	738 0:10	21:29	922 319 22:40	
A24							CLTSC4 ML ORIG 6:15 1877 7:0	A 00	JFK AA 148 8:30	MIA 738 9:30	AA 1909 3 10:11 11:	SY 19 03		ORD AA 13:23	695 TPA 321 1810 14:50		LGA AA 16:44	436 PHX 321 17:45	AA 1809 320 18:02 18:55	STL 1768 PIT AA 319 19:10 1747 19:54	AA 20:23	753 2039 <sub>2</sub>	4SP 321 1:10 TERM	
A25							0.45	ORIG PHL 1956 7:30	AA 1839 319 8:04 9:00			CLTSC4 ORIG MCI 10:55 1964 11:40	AA 629 12:06		1154 SAN 1583 321 14:45	LGA AA 494 15:00	PHX 321 AA 72 16:15 16:31 83	20 PHL P 321 A 30 17:30 1	PDX AA 7:58 660 <sub>1</sub>	SJC BNA 194 320 AA 733 19:09 19:24 733	5 SAT 319 20:25	2035 TERM		
A26								ORIG 868 7:30	MSY 5. AA 8:46 5	330 MHT 319 5089 9:30	ORD 1' AA 10:08 19	729 PUJ 321 67* 11:50	AA 893 12:17 1	738 3:05 1051 PUSH					CLTSC4 PULL 18:25	PVD DFW 56 AA 19:10 19:35 61	0 DEN 321 6 20:20	ALB AA 2070 21:22	22:25	
A27								SC4 RSW ORIG 928 7:30	ORD AA 680 8:20	O 321 9:40	LGA AA 879* 10:00	11:40	ORD PH AA 628 3: 11:57 13:0	1X MIA 21 AA 00 13:35	2080 ORD 321 14:50	BWI AA 15:15		1889 1798		PI 3 20:	H. 21 05	277 TERM	783 TERM	
A28							6:45	SC4 SAT ORIG 1727 7:30	FLL AA 191 8:22	SEA 321 9:40	RDU AA 10:38	1977 1936	321 12:10	LGA AA 13:37	581 MCO 321 14:45		PBI AA 16:00	294 1673		19:11 19:45	793 319 20:33	1971 TERM		
A29							C1 6:5	TSC4 LAX ORIG 1993 7:35	SFO 1944 AA 1946	ORD 321 9:35	FLL AA 10:03 826*	MBJ 321 11:30	AA 1842 12:06	PIT BWI 321 AA 17 13:09 13:30	760 321 14:30	1AH AA 15:35 184	15 ALB 319 13 16:24	MSP AA 17:40	1836 1841	FLL CLTS 321 19:12 19:45	C4 RIC ORIG 2006 20:30	LGA AA 557 21:04	SFO 321 22:20	
A1							C1 6:5	TSC4 FLL A ORIG 525 7:35 7	NA 1866	PBI 321 9:20	DCA AA 10:32	1837 RS' 11:5	MIA 21 AA 1878 12:14	13:15	91 321 14:25	SFO 704 L AA 2050 16	GA 321 6:10	CLE RIC AA 2028 319 16:59 17:54	BWI AA 18:39	416	FLL 321 20:20	PHX AA 21:16 1865	321 22:25	
A3								CLTSC4 MCO ORIG MCO 6:55 1725 7:40	AA 1772 8:13	321 9:29	1AH AA 10:35	1961 32 11:5	AA 1970	0 321 AA 13:19 13:	1810 PHL 321 2055 14:45	LAX 724 PHI AA 32 15:00 559 16:0:	1 AA 1 16:46	1908 SF 1799 18:0	O P 21 A 05	PBI 1798 NA 8:54 844	321 20:27	AA 1857 21:13	321 22:19	
A5								CLTSC4 MCI ORIG 7:05 1906 7:50	AA 8:34	835 321 9:50	AA 858 10:14	NAS 321 11:30	AA 1808 3 12:03 13	PA DEN 321 AA 2059 13:21	14:20	AA 1992 15:03	319 AA 16:30 16:	A 673 319 17:54		AA 1921 19:07	319 20:15 T	724 BOS AA 21:39	.788 321 22:35	
A7								CLTSC4 RDU ORIG 7:05 2011 7:50	PHL AA 883* 8:10	321 9:25	10:29	521 DEN 321 11:45	MCO 1725 MC 3 12:04 691 13:	DI D	FW 2091 JFK A 321 3:52 1972 14:55		1899 SFO A 321 A 705 16:40 1	ATL 786 AA 6:57 678	18:16 ORD 18:45	747	MCO 321 20:15	AA 1812 21:12	BOS 321 22:15	
A9								CLTSC4 ORD ORIG 7:10 7:55	AA 1925 8:20	5 321 9:35	PHL 826 10:05 1735	321 11:20	DFW AA 87 12:27	73 321 AA 13:24 13	A 2063 321 3:52 14:50	SEA AA 15:16 443	321 16:20	TPA 73 AA 17:20 174	30 I.GA 321 40 18:40	AA 1820 321 19:02 20:00		AA 186 21:26	22:26	
A11									CLTSC4 ORIG 8:29	9:14	AA 885* 10:11	11:25	AA 2066 12:02	13:12 13:31	068 321 14:26	AA 1719 15:20	321 16:24		SAF AA 18:4	N 487 SI 49 451 20:	21 05	ATL 199 AA 189 21:16 189	8 AIL 738 7 22:40	
A13									han	DTW 925 FNT AA 319 9:06 1109 9:52	10	ORIG BWI 1924 11:35	IAH AA 12:11 100	13:19	LAS 1458 SMF AA 1917 14:50	LAS 748 B AA 15:08 1999 16	321 AA 5:10 16:39	622 TPA 321 731 17:53		AA 2075 18:55 2	321 0:10	AA 1704 21:03 22	DL 321 :09	
A12							l av	The	MSP AA 8:46	1910 321 9:55	AUS AA 10:39	nund	1964 1849		2055 PHX 321 5 695 14:35	AA 1775 : 15:09 16	321 5:10	AA 470	321 18:15	MIA AA 19:20 199	6 20:29	AA 1873 21:18	321 22:15	
A10							6:26	696 TPA 321 7:45	AA 461 8:10	321 9:24	AA 679	11:25	PHL 1882 PH AA 2054 3:	1855 TERM	1	DEN 428 15:24 1791	321 16:24	FLL 609 F AA 17:00 1787 18	321 8:10	AA 1769 315 19:11 20:00	AA 20:40	892 472	321 22:15	
A8							AA 6:14	20	98 057	321 9:45	MCO AA 10:13 2053	321 11:20	EWR AA 16 12:23 14			AA 2046	321 16:25	BOS 1787 S AA 17:00 609 18	321 8:10	LGA AA 19:20 178	3 321 3 20:29	AA 179	5 321 22:25	
A6							LAS AA 6:10 428	8 7:35	AA 44 8:31	15 321 9:35	AA 186	2 321 11:25	AA 12:19	1907 ELP 319 254 13:45	nod	AA 1715 31 15:02 16:0	9 06	AA 651	321 18:25	SEA AA 19:12 541	321 20:20	PA 2039 E AA 890 2:	321 1:10	
A4							SAN 579 AA 662		AA 8:43	1982 321 9:45	AA 10:31	752 321 11:45	AA 1973	3 319 AA 1: 13:12 13:27	860 319 14:35	ORD 1999 MCO AA 321 15:05 1899 16:00		DEN 1811 AA 565	1 321 18:30	AA 1920 19:12	20:20	AA 1774 21:02	321 22:20	
A2								1930 SAN 321 487 7:50	8:41	1960 321 9:40	AA 19 10:26	)37 321 11:30	AA 2078 12:05 1	319 AA 2 3:05 13:28	.045 319 14:35	AA 504 321 15:05 15:59	est ve	PHX AA 767 17:13 466	321 18:20	SFO 662 19:14 1975		AA 1737 21:21	321 22:20	
B1							SJC 661 P 6:00 1872 7	320 7:05	RSW 413 8:28 713	321 9:20	10:37	2064 321 11:40	AA 653 319 11:58 12:54	AA 13:39	1827 319 14:40	SRQ 1130 D AA 15:20 184 16	321 AA	IA 1799 ORD A 1799 321 554 1908 18:00	MCO	AA 1871 3 19:07 20	PA 334 121 TERM	AA 127 21:27	77 738 22:30	
B3							AA 6:37	1980 321 7:50	LAS AA 8:10 1905	321 9:19	BOS AA 10:19 1729		AA 1914 12:09 13	319 3:04	JFK 2530 AA 2249	738 / 15:15 1	AA 819 SJU AA 972 321 16:00 972 16:50	PHL 799 17:16 1733	321 18:20	AA 19:15	1861 2043	2	319 2:11	
B5							AA 6:47	1364 738 7 7:45	AA 8:47	1496 738 9:55	A./ 10	1376 SRQ 321 50 1404 11:40	AA 65 12:28	57 319 13:20		AA 379 15:05	738 A/ 16:25 16	A 703 321 5:55 17:45		CLTSC4 MDT ORIG 19:04 19:49	EWP	AA 2038 73 20:57 22:0	8	
B7							AA 6:46	IEV	20 179	97 DTW	ATI	321 11:20		CAT	1 622	MIA AA 15:16 1453	738 A 16:25	PIT 1829 DFW AA 321 6:57 721 17:40		MCO 746 PHX AA 321 18:59 463 19:55	AA 20:36	1245 1608 2:	738 1:10	
B9							AA 2 6:36	7:30	BUF 829 8:08 1941	319 9:19	AA 2065 10:12 EWR 1451 E		CHS 104	AA 13:4	1633 48 296	319 15:11	20 141	TAH FW	AA 18:35 (	836 SFO 321 619 19:30 766		AA 1384 21:13 RSW 1805	738 22:15	
B11							AA 6:02	476 840*	l DTW BI	321 9:25	10:02 1458 11	1:05	12:25 1950	9 DCA PIT 319 AA 1' 0 13:15 13:31	/00 319 14:30	15:27 72	39 LAX 321 25 16:40	IAH EW AA 1711 73 17:15 18:0	088 05 18:28 1530	19:13 TERM	1	21:10 745 2:	321 1:10 ALB	
B13							RDU	DCA	AA 1942 3 8:08 9: FNT 1751	119 :10 SLC	10:42	330 738 11:35 DEN	AA 2077 319 11:52 12:45	AA 13:45	756 319 5 14:40	ATL AA 15:08 1821		AA 1701 17:13	738 18:20	844 TERM		AA 1940 20:58	319 22:15 US	
B15							AA 173 6:17 2020	7:30	8:03 97	319 9:30 CLE	1924 TERM	AA 11:15 MIA	1446 LA 652 13:1	21	RDU 2069 PIT AA 319 13:56 2084 14:55	AA 18	843 DCA 319 864 16:40	AA 2067 31 17:04 18:0	19 05	2084 ERM	BWI	AA 1893 20:55 2:	319 1:10 JAX	
B16							AA 2020 6:09 2091 SLC 2014	7:30	AA 178 8:21	9:40	10:32 STL	1831 321 11:45	887 TER	M CLE	AA 14:30 RDU	I DCA	1974 1242 MCI	319 18:00 ALB PW1	M SLC	DFW AA 2648 738 19:05 20:00	78	864 2035	319 22:35	
B14							AA 2014 6:10 408	7:30 BOS BNA		978 NAS 319 352 9:40	AA 192 10:27 MDT	11:20 IAX		AA 1 13:37 BUF	14:30 POS	AA 1653 15:13	319 16:15	AA 2052 31 17:01 18:0 NAS	19 AA 05 18:40	JFK 101	881	319 22:00 BDL	BUF	
B12								AA 1817 319 7:12 8:00	RIC 9 8:15 1941 829* PHX 423	9:30 PUJ	AA 10:33 LGA	1753 319 11:50 AL	B	AA 2002 13:26	14.13	RDU	BWI	AA 859 17:04 IND	319 18:15 STL R	JFK 101 1 AA 1390 2		AA 1952 21:12 5563	22:25	
B10							MCO	) LGA	8:11 1965*	321 9:25 DCA	AA 10:44 PIT	1988 31 11:5 DCA M	19 55 CI 1267 BUF AI	LB 1756 ALB	CHS DCA AA 1938 319 14:02 14:55	15:44 IAX	1962 319 16:45	AA 765 17:11	319 18:25 1 BUF	18:55	861	21:19 TERM MCI PHX	A BOUL	
B8							AA 6:44 RIC	2062 321 7:59	AA 1722 8:17 MEM	9:30 RSW	AA 17: 10:20	30 319 A 11:30 11 ELP 281 ELP AA 281 319 11:07 1870 11:50	A 751 319 A.	LB 1756 ALB 319 1753 13:50	CLTSC4 IAH	AA 2036 15:20 RIC 1	16:19	DCA 1750 319	AA 18:00 CLTSC4 OPIG	584 170	LTSC4 LGA ORIG 1954	319 AA 21:30 21:5 SAT	22:45	
B6							6:34 PIT	1654 319 7:30 PVD	8:43 STL	1853 319 9:55	PWM	ATT			CLTSC4 IAH ORIG 14:10 2069 14:55	PHI	1864 PIT JAX 319 AA 1745 16:35 16:50	1 / 50 319 i0 17:50	DFW 1752		9.55 20.40	AA 1870 SYR AA 1987	22:16 DCA	
B4							SEA	1903 319 7:35 624 LAS 658 8:00	8:51 IND	1677 319 9:45 BDL 1756 319	PBI AA 1847	1814 319 11:39 PHL				AA 20 15:37 MSY 1821 R	16:30 RIC	AUS	AA 1752 18:11 DC 319 AA	DFW 321 19:10 19:25 1861 2 CA ILM A 1979 315	0:10	DTW LG. AA 1981 31	22:14	
B2 C2							6:15	658 8:00 DCA PIT AA 1904 319	DCA AA 179:	9:50 CHS	10:10 ALB 170	11:15 07 SXM			2017 PUSH	BNA 1886 JAX AA 1886 JAX	BUF	AA 1840 17:15	18:25 A 422 524	3:52 20:00 FSD	808 TER	20:55 22:0	SYR	
C4								7:02 7:59	8:28 IAH 8	9:30 352 IAH	10:23 613 MCI 1'	797 IND		CLTSC	PUSH ORIG PBI	15:14 2032 15:59 MCI	16:20	422 1540	524	19:54 ELP	1954	M 21:35 197 MSY AA 1793	pre	
C6									EWR 2531 JFK	978 9:35 K FSD 784 8 AA 9:23 993	10:28 19	977 11:30 850 319		13:40	1789 14:25	15:35 DTW AA 18	MSY 202 319	1540 106 PUS	i5 N	19:15 NAS 605 PLS NA 1029* 20:00	TERM CLTSC4	21:20	22:25 ORF 1785 319	
C6							A	TL ATI A 469 321	8:16 2529 9:06 CLE AA 1784	MEM	10:15 10:39 ROC AA 1868	CHS 11:40				15:39 CLTSC4 ORIC 1889	16:30	PUS	1692 TERM	8:54 1029* 20:00 451 TERM	20:32	21:17 21:40	973	
C10							6:	52 8:00	ATL 713	9:24 ATL	10:14 BI	11:14 DA 1840 N	MEX 319			NAS AA 853	BUE EI	LP A	1891 736	TERM		2043	TERM	
C12									8:21 413	9:35	10	1434* 1	2:00			15:10	16:29	5:55	736	20:00		TERM		
C12																								
C14																								
AAIN																								
I1													CLTSC	C4 CUN ORIG 887* 13:30			МВЈ	y *869 <sup>1</sup>	LAS 321	MBJ *827 AA 1919	MIA 321	SJ	O *1850 *1850 *1850 TERM 22:40	
12								CLTSC4 PUJ 7:05 1963* 7:55	G	GCM *860 HAV IA 319 :00 1615* 9:45		PAP AA	*368 1826	NAS 319	N.	IBJ *843 R A 2056 16	DU CUN 321 AA	*884 BOS 1806 321 17:55	8:10 P	18:56 1919 PLS *880 OF AA 18:55 1851 20:	20:15 RD A	UA *877 CLTSC4	:55 TERM 22:40	
12								7:05 1963* 7:55	9:	:00 1615* 9:45		11:00	1826	13:15	1	4:53 2056 16	:10 16:40	1806 17:55	1	18:55 1851 <sub>20:</sub>	05 2	0:50 TERM 21:35		

Date:04/11/2019 Time:12:58					С	LT 2028-S	Scenario 2	2											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
				Latadada	la ta la ta	la la la la la			andana.	artarlartar	antantantan	antarlantar		and and and an	la ta la ta	llll.	la l			
13				ORIG CUN	T		PLS *8 AA 10:00 104	42 KIN 319 40* 13:00					PUJ *	1963 ATL 738 787 17:50	CUN AA 18:40	*886 PBI 321 2061 19:55	*1968 TERM	1		
14				CLTSC4 MBJ ORIG 843* 7:45			10.00	12.00					10.21	17.50	SXM AA 18:40	*866 BNA 320 1867 19:49	CUN *888 20:29 TERM	LTSC4		
15				7.40				MEX *1844 SDQ AA 1853* 319 11:00 1853* 12:00					HAV AA 16:05 1028	BDA 319 17:30	SDQ *639 AA 18:00 1865*		SXM *613 20:24 TERM 2	SC4		
l6						K A	IN *854 PAP A 319 55 1647* 10:50	12.00					10.03	PUJ AA 17-42	*19 64		LAS 321 0:05			
17						2.	CUN AA 10:5	*1283 SJO 321 0 1087* 11:55						17.42		822 DCA 320 356 19:44	UVF AA 20:15	*1342 SDC 874* 32 22:00		
18					SDQ *183 AA 982°	39 UVF * 321 9:45	10.2	11.55							MEX AA 18:35	*828 ME 1768 3	M 19			
I10				GF A# 7:5	*1062 CLTSC4 332 PUSH 8:50					FRA *705 CLTSC4 AA 789 13:00 PUSH 14:00			LHR AA 16:15	*731 730*	LHR 789 18:40	CLTSC4 PULL AA 19:00 1568*	GRU 332 20:30			
l11												P A I:	CO *721 CLTSC4 A 789 5:55 TERM 16:55							
l12												F) A	CO *721 MAD A 789 5:55 748* 16:40		BCN AA 18:20	*745 744*	BCN 332 20:45			
l13												MA AA 15:	*7. 50 72	49 DU 3 4 18:	UB LHR 332 AA :05 18:30	*733 732*	LHR 789 20:15			
l14										C A	DG A 3:55	*787 704*	FRA C 332 A 16:35 1	LTSC4 PULL A 720*	FCO 789 18:25					
l15										DUB AA 13:05		725 786*			CDG 332 18:20					
OADO																				
01	1078 TERM		CLTSC4 <sub>ORIG</sub> HOU CLTSC4 <sub>ORIG</sub> MDW 643 5:25 5:45 1010 6:30	CLTSC4 BWI ORIG 5:55 3773 7:40		BWI 1 3055 9:35 1	DAL 0:10	BOS <sub>1245</sub> BOS 10:59 <sup>1246</sup> 11:36					BOS 8021 BOS E90 16:00 8016 17:00	H	10U <sub>1747</sub> HOU 7:55 <sup>1493</sup> 18:30	DAL BWI 1721 18:55 19:30		2808 TERM		
O2	TE		DEN 201 F9 200	DEN CL 319 7:20 7:5	ORIG DEN 5290 8:35		JFK 219 JFK B6 218 E90 10:01 218 10:40	ISP F9 354 ISP 11:20 353 12:05			BNA 5136 BNA WN 738 14:00 684 14:45	PHL F9 1689 15:21 1	MD 320 5:09 16::	W <sub>853</sub> MDW 50 <sup>1748</sup> 17:25						5812 TERM
O3	1441 TERM		CLTSC4 ORIG 5:05 1191 5:50	CLTSC4 SLC ORIG 7:00 521 7:45	ATL DL 8:48	2422 73H 9:30	ATL ATL DL 1454 M90 10:03 10:45		DTW DTW DL 1629 319 12:07 12:50		MSP MSP 1503 14:24 14:59		ATL 602 ATI DL 73F 16:18 2651 17:00	ATI DL 17::	L ATL 826 73H 50 18:45	DL 1407 19:09 2	ATL 73H 0:05		1076 TERM	19 TE
O4			CLTSC4 <sub>RIG</sub> DTW CLTSC4 <sub>ORIG</sub> AT 5:15 1366 6:00 6:15 2488 7:0	CLTSC4 N ORIG 7:20 2266 8	1SP 1:05	DTW DTW 2292 9:04 9:39	MCO PHL F9 1028 320 10:11 10:59	ATL ATL DL 2251 717 11:16 12:00	ATL DL 1095 12:33	ATL 5 717 13:15		ATL ATL DL 2133 73H 15:04 15:45	MSP DL 1: 16:40	DTW 322 320 324 17:20	18:40	DTW 057 19:15			8017 TERM	522 TERM
O5			CLTSC4RIG ATL CLTSC4RIG ORD 4:45 823 5:30 6:03 1712 6:48	SFO 1704 UA 1969	1 SFO 739 8:20		8025 BOS 8020 E90 10:51			13:42	2597 320 14:30	DTW DL 15:40 1	603 MSP 793 16:30	BOS 1445 BOS B6 1446 E90 17:18 1446 18:00	5 JF. D B6	K JFK 6 1119 E90 1:50 1118 19:28				876 TERM
O6			CLTSC4 BOS 5:33 8022 6:18	CLTSC4 ORIO 7:30	3 ATL 1 8:15	ORD 425 UA 9:26 521	ORD 73G 10:15			ORD 1484 ORD UA 319 13:00 1140 13:45		DEN 1711 UA 15:10 1199	DEN 320 16:22	SFO 11 UA 17:31 16	176 SFO 739 598 18:30		TTN 933 F9 932 20:25 932	320 21:10	1286 TERM	1974 TERM
O13																				
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O31																				
O32																				
OAIN											ı		MUC	*420	MUC			I		
l21													LH 16:20	*428 429*	359 18:35					
122																				
AEDO			PHF	5100 PHF	PGV 5234	PGV	EVV 50	MLB 0	OAJ 5176 OAJ	MGM 5441	SDF	FAY 29	1 IND	FAY	5486		GNV A	VL 5326 C.	AK MGM, AEX	
D13			AE 6:30	5190 PHF CR2 7:35	PGV AE 8:11 5187 MGM	CR2 9:19 5293 MGM	EVV AE 10:23 51	32 CR2 32 11:40 A	DAJ 5176 CR2 12:05 5314 13:00 509		CR2 14:25 IND	FAY 38: AE 40: EVV 5032		AE 17:05 TYS AE	5172 5119	FAY	CR2 20:25 20:25 20:25 20:25	VL 5326 C. E 5124 C DAY	:05 22:27 22:59	
D12			ja j	NV 5228 LEX	8:38	5440 CR2 5440 9:45	СНА	AE 11:05 5277 EVV	532	23	CR7 14:50	15:23 5366 GPT 5005 CID	16:14	17:10	5256	CR2 19:50 CRW 5148 FWA	20:15 20:50 MEM MLB	AE 21:31 LEX	5156 PGV CR2 5118 22:40 5264 MGM	
D10			A 6:	5228 CR2 52 5039 CR2 52 7:30 CAK 5355 CHA	8:40	5297 9:35	10:46	5032 11:35	CRW 5237 BHM AE 12:15 5164 13:00 HSV 3906 CA AE 3960 CF 12:25 13:00	AE 13:43	5120 PHF CR2 5052 14:25	15:05 5096 15:50 OAJ 531	4 MGM	5063 CA 5259 18:1 L 4011 CAE	04	19:05 5405 19:49 CHS SRO	20:05 5141 CR9 20:05 20:45	AE 21:36 TLH 5211 LFT	5264 MGM CR2 5298 22:41	
D8				7:08 <sup>5277</sup> 7:43 5058	GSP 5235 AE 5509 MLE	B 5175 HPN	PULL	39 FAY 63 CR2 11:20	AE 3960 CF 12:25 13:0 BHM 5142	05 TLH	AE 4011 CR2 14:01 14:40 PGV FAY	15:33 522 ORIG	2 16:19 AE	52 3775 18:00 PHF 5052	LEX SHV 5514	AE 5227 CR9 19:03 19:50		21:15 <sup>276</sup> 21:46 5222	МОВ	
D6			5279	PUSH	AE 8:47	5384 9:30	5343	PULL	12:30 5218	3:10 GPT	14:07 <sup>5486</sup> CR2 14:07 <sup>5486</sup> 14:45	3973	OAJ	AE 17:22 5264 FWA 5135 DAY AE 683	CR2 18:14 18:30 5254 AVL	9:05 19:40	TRI	5304	CR7 22:40	
D4			5279 PUSH		CRW 5347		MSN	PULL 5117	GNV <sub>5371</sub> TYS 12:25 <sup>3305</sup> 13:00 5231	AE 13:37	532 522 HPN CR7	MGM 5366	16:14 LFT	AE CR2 17:11 5156 18:00 BHM	311 CHA 5311 CPA	4895 TRI 4786	20:15 EWN	5099	-	
E1		5006	CRW	<u>'</u>	8:16 5142 5263		VPS 5157	CHA RAP 5514	5104		14:33	0RF 3773 BH	16:20 M	GSO IND	5186 CR2 18:25	AE 19:00 4755	20:30 PULL	TERM TYS 5037	AVI	
E2		PUSH	AE 6:45		5335	9:36 ORIG	10:06 5179 PHF	CHA RAP 5514 AE 5514 11:14 11:40 5255 1	CMH 453		S 5294 TYS	15:07 3865 16: SDF 379	8 MKE	GSO IND AE 4522 E75 16:59 17:50			5468 892	AE 20:59 5100	22:25 TRI	
E3 E5				738 OAJ	4935 DA	5452	5122	0/ CR2 04 11:18 PHF CR7	AGS 5396 F	5 13:24 AE	51 5119 14:35 CAE 53	15:17 395 327 EVV	9 16:35	17:31 CHA	5508		925	JAN 5257	22:25 BTR CR7	
<u> </u>				889 7:40 4921 GSO CR7	TERM 8:5	533	5364 7	11:45 JAN CR7	12:16 5135 1 AVL 4751 LYI	3:10 H LFT	14:03 52 5110	204 16:00 GNV HPN CR7 AE	5526 HPN CR: 5166 17:00	ROA 4829	5233 9 LYH	19:45 BHM	20:00 5523 20:40 3865 HPN CR7	20:58 5407 CAE 3775 M	22:15 KE	
E9			6:35 AGS 5	4826 7:50 296 SDF	8:30	551- 53	<u>4</u> 390	11:20 CAE CR7	12:12 4804 13:0 TYS 5297 M	3 13:5 MOB FAY	5463 VPS X	15:15 15:44 NA 5569 ICT VPS AE 4:55 <sup>5196</sup> 15:32 15:4	5138 HTS	17:16 4798 CRW 474	8 18:30 49 OAJ ROA	4842 SBY	1023 CR7	20:59 4056 22 OAJ 49	31 LYH	
E9			6:31 5	093 7:30 4867 HHH	TRI 485	52 LYH	MOB AF	11:19	12:20 5512 1	CR7 3:10 13:45 SHV CR7 AE 540 CR7 AE 53 13:15 13:31 53	5453 14:40	EWN 4773	5200 CR 17:00 LYH T	LH 5218 GNV	31 18:25 AE 18:43 BTR 5500 F	4835 19:50 HSV HSV 397		ROA 4807 ROA	22 22:30 OA	
E13			6:39	4942 CR7 7:35 ROA 4776 FAY	8:16 482 HPN 51	20 9:35 150 MOB	AE 10:45 SHV	5514 5546		AGS	5 5263 DAY	15:06 4779 1 CHA	5582 GPT CR7	6:55 5202 17:55 CID 5456 CI	18:30 <sup>5505</sup> 19 ID MSN	9:05 19:21 391 5437 CAK		AE 21:00 4799 22 HHH AE 4943	:05	
E15				AE 4934 CR7 7:04 7:40 HHH <sub>4915</sub> ROA 4763	MDT 4669 8:08 4538	251 CR7 9:35 ML1	5111 5514	GRR CR9	CR7 13:00 SAV 5185 CHA AE CR7	AE 13:4	9 5123 CR/ 14:41 HPN 5384 MLB		5083 CR7 16:40	17:04 5429 18:0 5431	04 18:43 ORF	5209 AGS	20:00 4582 20:40	21:15 BTR	5074 EVV	
E17			CHS 5	246 SAV	LYH 4886	9:10 9:40 SBY CR7		11:30 II 320 CID CR7 123 11:45	AE 5183 CR7 12:07 5582 12:50 HTS 4866 AGS AE 4866 CR7	13:14 13:46 FLO	4904 ROA	MLB	5132 JAN CR7	TERM EWN 4939	ROA M	5398 19:45 MLB MSN ME 5230 CR7		21:35 GPT 5083	5038 22:40 SRQ	
L17			6:18 5	295 CR9 7:45	8:12 4831	9:20	10:18 54	11:45	12:18 4805 13:01	13:4:	8 4829 14:35	15:44	5257 CR7 16:35	17:24 4807	18:15	8:52 19:54		AE 5005 21:10 5393	22:14	

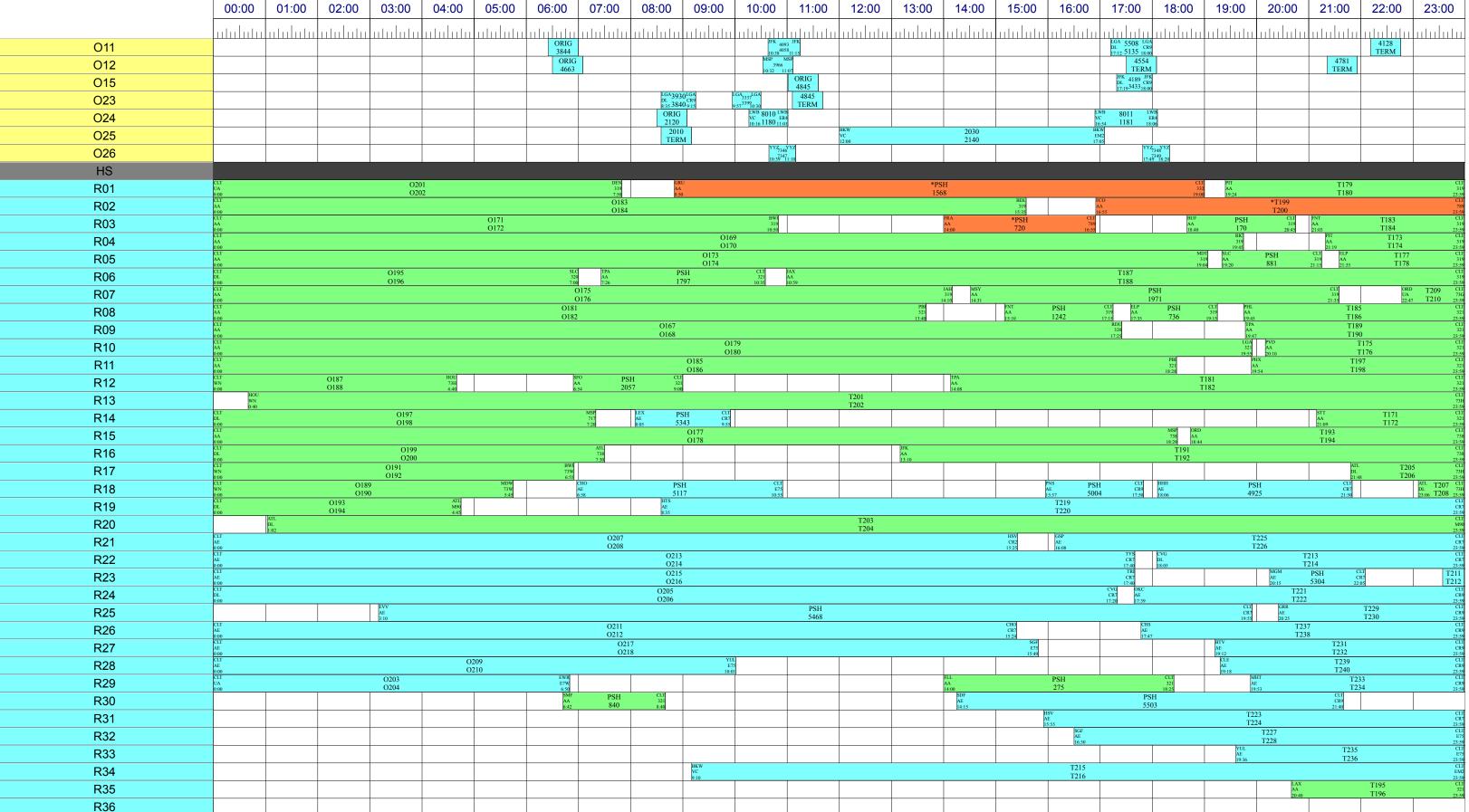
	0:00 01:00	02:00	03:00 04:00	05:00	06:00 07:00	08:00	09:00	10:00 11:00	12:00	13:00	14:00	15:00	16:00 1	7.00 10.0	00   19:00	20:00	21:00 22:0	00 23:00
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E19					MYR 5357 CHS AE 5309 CR9 6:29 5309 7:40	EWN 488 AE 484	1 TRI CR7 1 9:40	FAY 4934 FLO AE CR7 10:07 4904 11:33	GSP 5067 LEX AE 5067 CR7 12:17 5153 12:59		78 14:25	PWM 5572 GRR AE 5567 CR9 15:10 15:50		AE 4759 HHH CR7 17:18 4813 18:05	CAK 50 AE 19:18 51		LYH 4798 EWN AE 4744 CR7 21:26 4744 22:30	
E18					SAV 5452 MYR AE 5389 CR9 6:36 5389 7:40	OAJ 5113 AE 5466	CR7 9:20	OAJ 4889 EWN AE 4773 11:55		AE 13:47	5225 BHM 5311 CR7 5311 14:30	TRI 4765 AE 15:38 4769 16	AVI. FPO 507 CR7 AE 510 5:24 16:48 510	)5 17:45	AGS 4907 AE 4870	20:09	MDT 5180 PHF AE 5556 CR7 21:29 5556 22:30	
E16					GSO MEM AE 5026 CR9 6:52 7:50	0.42	278 AGS CR7 396 9:45	PIA 5349 PIA AE CR7 10:26 5431 11:19	LYH 4820 ( AE 4933 12:32 4933 12:32	3:12 13:39	CRW CR7 14:19	ORIG 4809	LIT AE 16:20	5513 5147	1	GRB MLB 5 CR9 AE 5 20:30 5	207 21:30 AE 22:01 5112 2	GSO CR9 2:45
E14					ORF 5460 CVG AE 5268 CR9 6:27 5268 7:24	AVL 5365 AE 5152		GSO 4826 ROA AE CR7 10:30 4879 11:14	TRI 4841 ROA AE 4926 CR7 12:23 13:01	CRW 4824 HTS AE 4759 CRT 13:25 14:05	MSN 5204 CF 7 AE 5272 CF 14:25 15:0	FLO 4862 ROA AE CR7 15:20 4842 16:05		ORIG 5037	GSP 3833 MKE AE 3889 CR7 18:49 3889 19:44		MOB 5060 LEX AE 5520 CR7 21:40 5520 22:35	
E12						5	RIG 129	BTR 5507 AGS AE 5507 CR7 10:34 11:14	EWN <sub>4936</sub> FLO 12:29 <sup>4862</sup> 13:0	O JAN AE 5 13:47	5071 CHA 5508 CR7 14:27	LYH 4804 AE 4786 15:47	TRI CR7 AE 50 16:30 16:58 53	64 MLB 76 CR7 76 17:40 DAB 5315 AE 18:00 5258 1	19:15 478			
E10					SDF 5342 STL AE 5073 7:40	8:04 5091 9:00	ROA 4790 GSO AE 4903 CR7 9:15 4903 9:55	LIT 5183 EYW AE CR9 11:00 5220 11:45	TLH 509 AE 12:28 543	91 MSN CR9 37 13:34	CHA 5179 ORF AE 5179 CR7 14:01 14:40	CHO 5048 CR7 15:30 16:10		HSV 5319 PHF AE CR7 17:38 5361 18:20	LYH 4779 CHC AE 18:59 4885 19:49		GNV 5202 ČHO AE 5287 E75 21:20 5287 22:30	
E21					IAD 5399 IAD CR9 6:44 5373 7:30	8:50	3850 CAE CR7 3814 9:45	MKE 3896 SDF AE CR7 10:48 3798 11:40	RDU 5415 AE 5288	BNA CR9 13:20 AVL 480 13:42	0 <sup>CHO</sup> 3 14:19	ROA 4926 AG AE 4907 CR 15:41 16:1	S 7 9	ORIG 4796	FL AE 19:	O 4777 HTS CR7 40 4767 20:30	MKE 3959 CAE AE 3959 CR7 21:37 4010 22:20	
E23					DAY CLE AE 5328 CR2 7:14 7:50	8:51	5232 MSN CR7 5060 9:45	CAK 5468 GPT AE 5462 CR7 10:50 5462 11:40	CHO 5152 AVI AE 5086 CR6 12:12 5086 13:0:	TL ROA 19 15 13:50	4879 <sup>EWN</sup> 4939 14:25	PIA 5186 AE 15:43 <sup>5310</sup> 16:	AEX AE 17:05	5060 FWA 5324 CR7 17:45	AE 5283 (19:16 5221 19	YS HI CR7 AI 1:56 20	PN 3945 ORF E 3904 CR7 :50 21:30	
E25					PHL 3899 CAE AE E75 6:58 3908 7:45	CAK 524. AE 507		CAE 3908 MYR AE E75 10:21 3777 11:19	ILM 5107 AVE AE 5189 13:04		ин 4844 56 <sup>4892</sup> 14:30	AGS 4805 PGV 15:40 <sup>4869</sup> 16:16	17:1	5512 MOB 5512 CR7 0 17:49	OAJ 5226 SDI AE CR: 18:53 5477 19:49		HSV 5050 PIA AE 5050 CR7 21:06 21:45	
E27					CMH 4544 DTW AE 4542 E75 6:38 4542 7:45	AGS 5439 BTR AE 5225 9:09	5260 9:24 9:59	ROA <sub>4763</sub> HHH 10:21 <sup>4844</sup> 0:55 IAD 5373 SAT AE 5373 CR9 11:10 5210 11:55		5458 5087	CMH CR9 14:24	JAN <sub>5514</sub> CRW 15:40 <sup>5148</sup> 16:15	CHO <sub>49</sub> : 17:01 <sup>47</sup>	77.10.0	CHO <sub>4809</sub> ROA 19:10 <sup>4810</sup> 19:44	GSP AE 19:59	5214 BN CI 5336 22:	AA R9 40
E29					IND 4661 INI AE 4531 7.5	HSV 5329 AE 8:33 5185		RIC 5290 CLE AE CR9 10:45 5436 11:35	AE 5073 ILM CR9 12:10 5345 12:59	AE 13:28	5245 PNS CR9 5212 14:50	3909 TERM	DSM AE 16:58	5276 <sub>1</sub>	OSM GNV_BTI 5252 19:18 19:5		MYR 5449 CHS AE CR9 20:59 5114 22:35	
E31					CAE DUM	ORIG 5573	YYZ 4464 BNA AE 4684 E75 9:19 4684 9:59	HHH <sub>494</sub> 2RW 10:4 <sup>481</sup> \(\hat{1}:19	IAD 5509 AE 12:29 5243	CR9 AE 5: 13:15 13:33 54	372 MEM CR9 494 14:40	4933 TERM	AE 16:56		253 421	CR9 AE 20:22 20:40	5530 GPT 5090 5491 21:30 TERM	
E33					CAE 3967 BHM AE 275 6:50 3819 7:35	CAE 3826 HSV AE 3906 9:09	EWN	ORF AE 10:47	5252 5285	ltay -	CR9 14:35	CVG 5166 CF AE 5229 16:		4662 CMH E75 34506 17:50	MCI 4675 CMH AE E75 18:55 4624 19:44	CAT	OMA 4556 IND AE E75 21:05 4495 22:05	
E35					ORIG 5261	FLO 4914 AE 4936 8:43 4936	9:24	OMA 525 AE 526		JAX 524 AE 531 13:32 531	5 14:25	TER	M 16:45	5378 5036		SAT CR9 20:00	CHO 5552 CRW CR7 21:08 5177 22:35	
E38					ORIG 5547	1C Ai 9:0	5316 5164	CMH FLO AVL CR9 AE 4850 CR7 10:30 10:45 11:25	DTW 4542 M AE 12:23 4510 13	3:10 13:37 51:	51 14:27	GRR AE 15:50	lkan	5043 5236	BHM CR9 19:30	5077 TERM	CAK 5350 ACC	
E36					AE 6:56	5116	9:20	TUL TUL AE 5054 CR9 10:50 11:40	PGV 5187 CHO AE E75 12:05 5048 12:49	13:45	5433 CHS CR9 5181 14:35	MHT TLH AE 5072 CR9 15:02 15:59	17:03	3957 AGS E75 4001 17:55	III VV2 s	4 CAE JACO	CAK 5259 AGS AE CR2 21:35 5438 22:30	Sh Sh
E34					ORIG 5082	BHM 5346 6 8:30 5237	CR2 9:20	IND 4484 CMH AE E75 10:46 4457 11:45	AUS 5171 LIT AE 12:05 5395 12:50	13:10 13:44	GRR 5533 ATL AE CR9 14:05 5192 14:55	AE 15:30	546 505	3	LIT YYZ 383 AE 386 19:00 19:17 396	8 20:10 AE 20:38	4001 G 3795 22:	R7 40
E32					ORIG 5290	AE 8:49	cvg	5117 VPS CR9 5502 11:50	FAY 5487 CHS AE CR9 12:10 5084 12:54	5092 PUS		CMH 4457 ILM AE E75 15:21 4674 16:09		LEX 5078 CHO AE 575 17:25 5552 18:15		5502 MSY CR9 5232 20:30	AE 4476 E75 21:39 22:35	
E30					CHA 5165 AE 5457	CHO 4876 HTS	AE 9:10 SGF	5128 OMA CR9 5504 11:20	MYR 5289 MYR AE CR9 12:15 5053 12:59 MEM SYR	UT	SYR 5223 AE 14:30 5349	CR9 AE 15:20 15:39		267 514	CR9 AE 19:03 19:30	53	335 CHA CR9 238 22:20 MEM	
E28					ORIG 5252	AE 48/6 CR7 8:15 4866 9:00 ORIG	AE 9:15	5177 TVC CR9 5037 11:24	AE 5184 CR9 12:07 12:50	AE 13:51	5033 MKE CR9 5098 14:40	AE 15:30	5200 5456		CR9 18:50	GSO	AE 5301 CR9 21:05 5299 22:35	
E26					ODIC	5531	AE 9:15 E LNK	5204 OKC CR9 5033 11:20 PNS	CLE 5282 GNV AE 5282 CR2 12:05 5063 12:50	AE 13:5: OR		886 CVG CR9 244 16:14	16:56	4510 JAX 4662 E75 4662 17:59	AE 542	0 CR9 20:10 ICT GSO	5069 TERM	
E24					ORIG 5432 ORIG	SAV 5130 MK AE 5267 9:	AE 14 9:33	5415 PNS CR9 5575 11:25	IND 4470 GSC AE 12:12 4537 13:0:	15 AE 15 13:	5081 MYR CR9 56 5313 14:45 CE 5267 ABE	STL 53° AE 15:43 509		53! 504		CR9 AE 20:06 20:4	5121 DAY CR9 5 5374 22:05 PNS 5094 CVG	
E22					5079	CHS 5207 AE 5289 ORIG AVP 529	CR9 9:30	AE 5556 CR9 10:13 5474 11:50	AE 3814 E7: 12:22 3831 13:0:	5 AE 13:	5267 CR9 56 5140 14:45 S 5255 DTW	AE 15:22 AVL	5592 5004 5086	AUS CR9 18:25	SAT 5210 AE 5335 DTW 5435		20:55 5109 22:05 CHS TYS	
E20					ILM 5006 CMH	4850 AE 8:47 552		5632 10:54 5193 11:50	DITT	13:	56 5434 14:45	AE 15:29 MYR	5180	CR9 17:55	19:04 5169	CR9 20:15	AE 5138 CR9 21:00 22:09	
E8					ILM 5096 CMH AE CR9 6:41 5061 7:29		5194 IND CR9 5568 9:55		PULL 5172	AE 53 13:40 50.	17 CR9 31 <sub>14:25</sub> ND 5568 AUS	AE 15:33 CHS 5084	5053 LC 5066 17:	25 18:05	5276 GRR CR9 5553 19:45	ORE	JAX 4636 YYZ 21:33 <sup>4554</sup> 22:10	
E6						SDF 54 AE 52 8:32 52	55 CR9 55 9:45 5431 SYR	MHT 5162 CVG CR9 10:30 5166 11:40 XNA 5350 BHM		ABE 51	AE CR9 14:01 5301 14:45	AE 5084 15:30 5088 CLE 5436 MY	CR9 AE 16:30 17:1	5034 ILM CR9 5070 18:25	AE 5056 19:00 PNS 5212 CVG	CR9 20:00	CVG 5281 BHM AE CR9 21:22 5211 22:30	TRI
E4						AE 8:47	5260 CR9	10:28 5178 11:35		AE 13:4450	)35 <sub>14:25</sub>	AE 5430 CF 15:25 5170 16:2 GSO 4537	R9 AE 17:06 YYZ BNA 52	5131 CR9 18:20	AE 5212 CR9 18:50 5303 19:45 MEM 5494 CHS	FAY 5105 HSV	XNA 5236 MY CI 21:33 5161 22:	R9 40
F1						8:36 52	117 CAR CR9 9:45 9:45 5158 SDF	MEM 5474 PWM AE 10:43 5034 11:50  CLE MDT		AE 13:50 OKC, MYR	5051 CR9 5372 14:30 GRB ABE	AE 4337 15:30 4498 SAV 5266	10.45	YR CHS	18:50 5318 CR9	AE 19:59 5224 CR7 20:40	AE 5088 CR9 21:18 5334 22:20 SRQ 5161 JAN	
F2				G	GSP DCA	AE 8:45 PNS 53	5330 9:50	AE 5080 CR9 10:21 11:25 OKC IAD		AE 5527 CR9 13:18 5527 13:57	14:22 <sup>5286</sup> 14:59	15:42 5069 MDT CMH	CR9 A 16:35 1	E 5377 CR9 7:16 18:20 DTW MYR	AE 5144 C 19:01 19 IND 5189 GS	R9 :55	AE 21:39 5333 22:35 CLE 5331 ILM	
F3				5	SSP DCA 3802 :57 6:32	AE 8:38 54 ORIG	87 9:40	AE 5510 CR9 10:42 11:45 AVP 5160 STU		AE 3 13:48	14:26 ICT 5102 MHT	AE 5064 CR9 15:07 15:59 OKC 5116 SDF	CAK 5	AE 5249 CR9 17:22 18:20	18:58 5155 19:5 GSO 5418 DAY		ORF 5455 AVP	
F4					TYS GSP	5136 TYS 5344 L		AVP 5160 STL CR9 10:18 5370 11:20 DSM 5129 ILM AE CP9		C	AE 5103 CR9 14:07 5565 14:45 CMH_5414 TUL	OKC 5116 SDF AE 5300 16:05 BHM 5178 IAD	AE 16:53 53	243 CLE CR9 331 17:50 M 5285 ORF	AE 5416 CR9 18:49 5101 19:40 MYR 5170 PN	ş	21:09 5099 CR9	
F5					AE 5354 CR7 6:24 7:45	8:22 5033 9: CMH 4547		AE 5270 CR9 10:19 5270 11:16  ABE 5134 MEM AE 5134 CR9		VPS	4:05 <sup>5542</sup> 14:35 5183	15:10 5502 16:00	17 17	M 5285 ORF CR9 :14 5455 18:05	19:00 5103 19:5	0	IAD 5286 SAV CR9 21:21 5451 22:30 CMH 4554 CMH	
F6						8:36 4546	9:27	AE CR9 10:39 5058 11:25 SAV 5504 DAY		AE 13:49	5223	16:00 PIT SAV		AE 12 CR7 17:46532618:30	AE 4572 E75 18:50 CMH AE 5047	MHT	21:14 4579 E75 22:09	
F7						FWA 544 AE 547 8:49 GRR 5		10:38 5115 CK9 10:38 5115 11:35 CMH 5061 PIT		BNA	4695 OMA	AE 5043 CR9 15:24 16:14	GSO IAD	17:19 5563 18:10	5366	20:05	VPS 5065 TLH E75 21:06 5349 22:15 5049	
F8						DAB 5352	\$415 CR9 SRQ SRQ	10:50 5522 CR9		AE 13:42	4556 E75 14:55	IAD DAB AE 5035 CR9	6:25	5286 CR9 17:55	TERM  MKE 509  AE 19:21 512	8 IAD	5182	
F9						8:35 5139 ORIG	9:24 SBY 4770 AVI	CHS 5309 GSO CR9 10:27 5350 11:20 GSP 5467 FPO CP2			14:02 4695 14:45 YYZ 4546	LGA AVP 5322	(NA	SRQ 5 CR9 17:40 CMH 5087 GSO AE CR9	CVG 51	69 DAB	TERM 5451 LIT	
F10 F11						5371 IAD 532 8:43 553:	9:15 4751 GR/ 9:15 9:50	10:10 5593 11:45 BHM 3819 HSV		GSI	AE 14:19 4566 2 3989 YYZ 54 3834 14:30	15:15   15:36 5236 1	6:25	AE CR9 17:41 5121 18:30	ABE 5140 OMA AE 5140 CRS 19:06 5248 19:46	0720:10	AE 21:03 5200 CR9 22:35 5361 TERM	
F11						BNA	5325 DAB	ILM 5082 DSM		13:5	54 <sup>3834</sup> 14:30	AE 5115 CR9 15:14 5265 16:00 MEM 5058 TY AE CR	S XNA	5193 CVG CR9 5281 17:50	5546 TERM	5382	PULL	
F12						8:49 ORIO	5317 9:50	SGF 3706 SGF AE 255 10:09 3213 10:50				15:35 5208 16:1	9 AE 17:04 153 BTR CR7 074 16:45	5281 17:50 MYR 5313 BHM AE CR9 17:19 5182 18:05	TERM	TERM 5	5503 XNA	
F13						5071 ORIG	3	cvg 52	268 DTW			OMA 5431 CR9	074 16:45	IAD 5031 TUL	19:28 5163	5076	219 CR9 22:30	
F14						5509 TLH	5213 VPS	MYR 5389 SAV AF 5389 SAV	58 CR9			ORIC	SAV	17:465271 18:30	5307 TERM	5337 TERM		
F15							5183 9:50 ORIG	10:22 5051 11:10 BTV 4649 RIC AE 875				3190 TYS AE 15:37 506	17:0	5181	TERM  VPS PH AE 5385 E7	TERM	YYZ 4498 MDT AE 575	
F17							5294 ORIG	10:214618 11:05 TUL 5196 ORF AE CR9 10:205081 11:02				CAE 3960		5543 YOW E75	18:38 19:5	ol	21:22 4636 22:20	
F18						PHF 5383 AE 5320	5247 GPT CR7	YUL 3916 CR7 10:06 3989 U:35				15:22 3833 1 SAT AE	6:25 17:06	5587	TERM LNK		4796	
F19						8:10 5320	9:20	10:06 3989 11:35				16:00		5553	19:45		TERM	
07				ORIG	ORIG	EWR <sub>3697</sub> EWR 8:34 <sup>3648</sup> 9:09	IAD UA 615	IAD YYZ 7346 10 CR7 10-7347		LGA 3888 LGA DL CR9 13:14 3642 14:00	EWR 36	42 EWR E7W 56 15:30	ORD <sub>4823</sub> ORI 16:46 <sup>4843</sup> 17:21	YYZ <sub>7348</sub> 17:4 <sup>7349</sup> 8:20	IAD IAD 6160			6234
O8				6238	6113	2010	9:42	ORIG	EWR <sub>3367</sub> EWR	13:14 3642 14:00	EWR 3314 E70 14:24 3315 15:02	56 15:30	LG	A 5508 LGA	18:55 19:30 LGA 6224	LGA CR9	6302 TERM	TERM
O9					ORIG	TERM LGA3930LC DL 8:35 3840 9:	GA LG.	A3337 LGA IAH 6165 IAH 73399 0:30 11:04 <sup>6310</sup> 11:41	11:52 <sup>3311</sup> 12:27			LGA 5096 LGA DL CR9 15:06 5099 16:00	17:	12 5135 18:00 EWR <sub>3401</sub> EWR	DL 19:18 6227	20:00	TERM	
O10				ORIG	3612 G ORIG	ORIG	15 9:5	7 <sup>3399</sup> 10:30 11:04 <sup>6310</sup> 11:41 MSP MSP MSP 3966	BKW VC		2030	15:06 5099 16:00	BKW EM2 17:05	17:20 <sup>3343</sup> 17:56 ORIG			4781	
010				3312	3844	2120		10:32 11:07	12:00		2140		17:05	4554			TERM	



	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
	minhata		utulutu	lutulutu	mhhh		Intulutu	lutulutu			ntuluti	<u> </u>			liitiiliitii		ntulutu	ntulutu	ntulutu	lutulutu			ntulutu	<u>lutulutu</u>
AADO				,		auraci na			I myra	eya d	Texas.		L bos	VIII	,							Lycn	DAVI.	
A21						5:15 2451 6:0	O GA		AA 865* 8:12	320 9:25	BNA 821 10:01 876*	320 11:30	AA 2044 12:04	13:20	LTDO MSP			RWI 1015	A. 18	1979 31: 52 20:0		MSP AA 21:04 1998	320 22:30	TEI
A22						CLTSC4 DRIG 5:20 2060 6	5:05 TSC4 PHL		AA 1770 8:29 BOS	9:15 FLL	AA 10:24 BWI 07	833 3: 11::	20 50 RSW	13:18	1789 MSP 321 1855 14:50	MCO	LAS	BWI 1915 AA 2038		78 JSH EWR 1598	IAH PAR	AA 1717 21:09 DCA	7LL 2005 321 TERM	1
A23						5:5	ORIG 2010 6:35 CLTSC4 MI/	N .	AA 8:28	1709 321 9:50 CLTSC4 LAX	BWI 87 AA 82 10:20 82		AA 12:00	445 580	321 14:20 695 TPA	AA 15:25	537 321 16:45 LGA	CLTSC4 ORIG 17:25 1915 PHX	8:10 LGA MSY	1598 19:16 2483 STL 1768 PIT	738 0:10	753 AA 19	922 319 22:40 1SP 550	
A24							CLTSC4 MI/ ORIG 1877 7:00 CLTS	OCATIG PHL	9	9:00 <sup>2057</sup> 9:45	AA 1909 10:11 1 CLTSQ	319 1:03 4 RDU	TPA	13:23	1810 321 1154 SAN	LGA	AA 16:44 PHX DFW 77	436 321 17:45 20 PHL	AA 1809 320 18:02 18:55 PDX 1853	AA 1708 319 19:10 1747 19:54 SJC BNA 194	AA 20:23 5 SAT	2039 22	321 :10 TERM	
A25							6:45	1956 7:30 C4 ROC	MSY 4	DTW 925 FNT AA 319 9:06 1109 9:52 5330 MHT	10.55	4 <sub>ULL</sub> RDU 1797 11:20 1729 PI	AA 629 12:06 LGA 002	321 AA 13:10 13:28 ORD 1051	1583 321 14:45	AA 494 15:00 LAS AN 823 LAS	321 AA 72 16:15 16:31 83	30 321 30 17:30 1891	AA 17:58 660 1 CLTSC4 PULL	320 AA 73	20:25	TERM	973	
A26							6:45	868 7:30 CC4 RSW 928 7:30	8:46 -	5089 9:30 PHX	10:08 1 LGA	967* 11:	21 AA 893 12:17 1 ORD PH	738 3:05 PUSH MIA	ORD ORD	A 321 :51 65 15:49		PUSH	18:25	19:10 AA 19:35 61 FLL 321 19:12 TERM	6 <sub>20:20</sub> TE	24 RM 277	TERM 783	
A27 A28								C4 SAT	8:20 FLL	9:40 SEA 321	AA 879 10:00 RDU	11:40	AA 628 3: 11:57 13:0 EWR	00 13:35 LGA	2080 321 14:50 MCO 581 321		PBI	17:40 294	1836 1841	EWR BOS	1 STL 793 319	TERM 1971	TERM	
A28							6:45 CL	1727 7:30 TSC4 LAX ORIG LAX	8:22 SFO 1944	9:40 ORD	10:38 FLL 1735	1936 5 MBJ 321	12:10 PHX AA 1842	13:37 PIT BWI 321 AA 1	760 321 760 321	BWI	16:00	1673 1889		19:11 19:45 P	20:33 HL	TERM LGA AA 557	SFO 321	
A1							6:5 CE	0 1993 7:35 TSC4 FLL FL ORIG 525 7:35	8:01 1946 WR A 1866	9:35 PBI 321	10:03 826* DCA AA	11:30 1837	12:06 RSW MIA 321 AA 1878	13:09 13:30 DFW BOS	14:30 DFW 321	SFO 704 1 AA 2050 1	.GA 321	1798 CLE RIC AA 2028 319	BWI AA	416	95 FLL 321	PHX 499	22:20 DEN 321	
A3							6:5	0 525 7:35 7 CLTSC4 MCO ORIG MCO	LGA AA 1772	9:20 DFW 321	IO:32 IAH AA	1961	1:55 12:14 FLL FLL 321 AA 1970	13:15 13:30 BWI LA	X 1810 PHL	LAX 724 PF AA 3: 15:00 559 16:	5:10 IL SFO 21 AA	16:59 17:54 1908 SI	18:39 P 21 A	ы 1798	20:20 DFW 321	21:16 1865 SFO AA 1857	22:25 MCO 321	
A5							6	CLTSC4 MCI ORIG 7:05 1906 7:50	8:13 DFW	9:29 835 321	BUF AA 85	NAS 1	DEN T AA 1808 3	13:19 13 TPA DEN 321 AA 2059	2055 14:45 MIA 321	15:00 559 16:0 RSW AA 1992	PVD DC 319 AA	1799 18: CA IAH A 673 319		8:54 844 2084 CLTS	20:27 C4 RIC ORIG 2006 20:30	21:13 BOS AA 1	22:19 788 ORD 321	
A7								7:05 7:50 CLTSC4 RDU ORIG 2011 7:50	PHL AA 883*	9:50 CUN 321	MIA AA	11:30 DEN 521 321	MCO 1725 MC AA 12:04 691 13:	13:21	14:20 FW 2091 JFK A 321 1:52 1972 14:55	15:03 PHX	16:30 16 1899 SFO A 321 A 705 16:40 1	:54 17:54 GTL 786 AA 6:57 678	LAX ORD 321 AA	ERM 19:45	20:30 MCO 321	DFW AA 1812	22:35 BOS 321	
A9								7:05 7:50 CLTSC4 ORD ORIG 1916 7:55	8:10 BWI AA 192	9:25 TPA 321	PHL 826 10:05 1735	11:45 LAS 321	DFW AA 87	73 321 A	HS 1972 14:55 BI BWI A 2063 321	SEA 2107 AA 443	705 16:40 1 SEA 321	TPA 7:	18:16 18:45 30 LGA 321 40 18:40	ATL RSV AA 1820 32	20:15	21:12 SEA AA 186.	RSW 3 321	
A11								7:10 7:55	CLTSC4 ORIG 1957	9:35 MSY	DTW AA 885	CUN	ATL AA 2066	13:24   1: LGA   PHX 738   AA   20	14:50 168 321	DFW AA 1719	16:20 FLL 321	[17:20 17	40 18:40 SAI AA	N 487 S 49 451 20	.C 21	ATL 199 AA 189		
A13									STL AA 8:51	1677 PIT 1677 319	[10:11 C	CLTSC4 BWI ORIG 1924 11:35	IAH 382 AA 12:11 100	JFK 738	LAS 1458 SMF AA 1258 321 13:58 1917 14:50	LAS 748 AA 15:08 1999 1	16:24 30S ORD 321 AA 6:10 16:39	622 TPA 321 731 17:53	[183	AS AA 2075	MSP 321	MCO B AA 1704 3	7 22:40j DL 121	
A12									16.31	9.43		CLTSC4 MCI ORIG MCI	12.11		2055 PHX 321 695 14:35	BOS 1775	321 6:10	EWR AA 470	SAN 321 18:15	MIA 760	0.10 PVD 321 6 20-29	DEN AA 1873	TPA 321 22:15	
A10							LAX AA 6:26	696 TPA 321 1813 7:45	MCO AA 461 8:10	SFO 321 9:24	RSW AA 679 10:13	9 321 11:25	PHL 1882 PH AA 2054 3:	HL 1855 19 00 TERN		DEN 428 AA 15:24 1791		FLL 609 AA 17:00 1787 1	PDX 321 8:10	RIC MC AA 1769 31: 19:11 20:00	PHL AA 20:40	892 472	PHX 321 22:15	
A8							898 PUSH		MSP AA 8:46	1910 LGA 1910 321 9:55	MCO AA 10:13 2053	TPA 321 311:20		47 13:26		MSP AA 204 15:25	6 321 16:25	BOS 1787 AA 609 1	SEA 321 8:10	LGA AA 19:20 178		LAS AA 1790 21:26	PHI. 321 22:25	
A6							LAS AA 6:10 428	7:35	PBI AA 4- 8:31	45 DEN 321 9:35	TPA AA 180 10:18	ORD 321 11:25	ROC AA 12:19	1907 ELP 319 254 319 13:45		BDL BN AA 1715 3 15:02 16:	IA 19 06	MCO AA 651 17:16	18:25	SEA AA 19:12 541	SEA TF 321 A/ 20:20 20	A 2039 D A 2039 D 52 890 22	FW 321 :10	
A4							SAN 579 AA 6:04 662	7:30	LAX AA 8:43	1982 321 9:45	BDL AA 10:31	752 321 11:45	ORF AA 1973	IND MCI 3 319 AA 1 13:12 13:27	860 319 14:35	ORD 1999 MCO AA 321 15:05 1899 16:00		DEN 181 AA 565	1 DFW 321 5 18:30	FLL AA 1920 19:12	321 20:20	JFK AA 1774 21:02	321 22:20	
A2							6:14 <sup>2</sup>	930 SAN 321 487 7:50	8:41	1960 321 9:40	AA 1 10:26	1937 321 11:30	AA 2078	319 AA 2 3:05 13:28	045 319 14:35	AA 504 321 15:05 15:59	nen M	PHX AA 17:13 466	321 18:20	SFO 662 19:14 1975		AA 1737 21:21	321 22:20	
B1							SJC 661 PI AA 1872 7	520 :05	RSW 413 8:28 713	321 9:20	AA 10:37	2064 321 11:40	AA 653 319 11:58 12:54	AA 13:39	1827 319 14:40	SRQ 1130 I 15:20 184 1	321 AA 6:10 16	1799 ORD 321 54 1908 18:00	MCO	AA 1871 19:07 20	PA 334 121 TERM	AA 127 21:27	7 738 22:30	
B3							AA 6:37	1980 321 7:50 R EWR	LAS AA 8:10 1905	321 9:19	BOS AA 10:19 172	29 11:20	AA 1914 12:09 13	319 3:04	JFK AA 14:00 2249	738 15:15	AA 819 SJU AA 972 321 16:00 972 16:50	PHL 799 AA 17:16 1733	321 18:20	AA 19:15 CLTSC4 MDT	1861 2043	22 RDU PVI	319 2:11	
B5							AA 6:47	1364 738 7:45	AA 8:47 JFK	1496 738 9:55	AUS	AA 1376 SRQ AA 321 0:50 1404 11:40	AA 65 12:28	57 319 13:20 JAX		AA 379 15:05 MIA 2448	738 A. 16:25 16 ORD P	A 703 321 5:55 17:45 TT 1829 DFW		CLTSC4 MDT 19:04 1720 19:49 MCO 746 PHX	EWR	AA 2038 73 20:57 22:0	8 5 IFK	
B7							BWI	PUSH	AA 14 8:30 EWR 2531 JF	738 9:30	AA 10:39 ATL	IAH	1849	319 13:15 SA	1633	AA 2446 15:16 1453		6:57 721 17:40	/R SJU	AA 740 321 18:59 463 19:55 836 SFO 321	AA 20:36	1608 22	738 :10 EWR	
B9							6:36	7:30	8:16 2529 9:0		AA 2065 EWR 1451	738 11:19 EWR	CHS 184	9 DCA PIT	8 296 BDI	319 15:11 TPA 5	39 LAX	AA 1711 7 17:15 18:	38 AA 05 18:35	519 19:30		AA 1384 21:13 CLTSC4	738 22:15 SYR	
B11 B13							476 PUSH		AIL 713 AA 8:21 413 DTW E	3 9:35 BUF	1451 10:02 1458	738 11:05 DFW 330 738	DCA RIC AA 2077 319	9 DCA PIT 319 AA 1 0 13:15 13:31	700 319 14:30 STL 756 319	ATL AA 15:08 1821	25 16:40 DTW	MCI AA 1701	MIA	1065 1002 844		FNT 319 CLTSC4 PUL. 197: BUF AA 1940	22:20 ALB	
B15							RDU AA 173	DCA 2 319	FNT 1751	9:10 SLC 319	1924	2 11:35 DEN	11:52 12:45 1446 LA 652 13:0	13:4: AX 21	RDU 2069 PIT AA 319 13:56 2084 14:55		QA2 DCA	17:13 RDU DT AA 2067 3	18:20 W	TERM 451	R	20:58 IC A A 1893	22:15 .US	
B16							6:17 PHX AA 6:09 2091	7:30	8:03 97 BDL AA 17	9:30 CLE 80 319	TERM PVD AA	11:15 MIA 1831 321	887	7	1974	IAH 17	45 ALB	17:04 18: CLTSC4 BUF PULL 17:15 1242 18:00	05	DFW JFF AA 2648 733	BWI AA	0:55 22 864	JAX 319	
B14							SLC 2014	PHX	8:21 PIT 1	9:40 1978 NAS	10:32 STL AA 19	DTW 023 319	TER	CLE AA	PUSI 1934 319	DCA AA 1653	4.3 16:24 MCI 319	ALB PW AA 2052 3	M 19	ROC AA 1921	JAX 319	2035 2043 TERM	22:35	
B12							6:10 408	7:30 BOS BN/ AA 1817 31	RIC AA 8:15 829*	852 9:40 MEX 319	MDT AA	11:20 JA 1753 3	.X 19	BUF AA 2002	14:30 POS	NAS AA 853	16:15 BUF 321	17:01 18: NAS AA 859	PIT 319	JFK 101 AA 19:09 1390	20:15 EWR 738	BDL AA 1952	BUF 319	
B10								7:12 8:0	PHX AA 8:11 1965*	PUJ	LG. AA	A 1988	ALB 319	13:26	14:15 CHS DCA AA 1938 319	15:10 RDU	16:29 BWI 1962 319	IND AA 765	STL 519	DU	0:10 861	ATL 738 21:19  5563 TERM	1	
B8							MCO AA 6:44	2062 LGA 2062 321 7:59	JAX AA 1722	DCA	PIT AA 11	730 DCA 730 319	MCI 1267 BUF AA 319 11:45 751 12:30	LB 1756 ALB A 319 2:50 1753 13:50	14:55	JAX AA 2036	SYR 319 16:19	prod	1692 TERM	MSY 732 AA 19:14 1885	BUF 319 20:15	ALB AA 2070 21:22	CLE	
B6							RIC AA 1 6:34	654 BDL 7:30	MEM AA 8:43	1853 RSW 1853 319 9:55	10.20	ELP 281 SI AA 1870 11:	P 19 500	13.30	CLTSC4 IAH ORIG 2069 14:55	RIC AA 15:41	1864 PIT JAX 319 1745 16:35 16:5	DCA 1750 319 0 17:50	CLTSC4 ORIG 18:29	MSP 19:14	20:13 LTSC4 LGA ORIG 1954 20:40	SAT AA 1870 21:25	ROC 319 22:16	
B4							PIT AA 6:42	PVD 1903 319 7:35	BUF 829 8:08 1941	DTW 319 9:19	PWM AA 10:33	1814 ATL 1814 319 11:39				DITI	PBI 047 319 16:30		DFW AA 1752 18:11	DFW 321 AA 744 19:10 19:25 1861	RDU 319 0:10	SYR AA 1987 21:04	DCA 319 22:14	
B2			-			_	SEA AA 6:15	624 LAS 658 8:00	IND AA 8:44	1756 BDL 319 9:50	PBI AA 1847 10:10	11:15				MSY AA 1821 15:30 1886	RIC 319 6:09		584 PUSH	CLTSC4 DTV PULL 19:15 736 20:00	E. A 2	TW LG/ A 1981 31' 0:55 22:0	1	
C2								DCA PIT AA 1904 319 7:02 7:59	DCA AA 179 8:28	9:30	ALB AA 17 10:23 61	13* 11:25			2017 PUSH	BNA 1886 JAX AA 319 15:14 2032 15:59		AUS AA 1840 17:15	BDL N 319 A 18:25 1	AS 605 PL: A 1029* 319 8:54 1029* 20:00		RSW 1805 1 21:10 745 22	AH 321 ::10	
C4									IAH 8 AA 8:38 1	852 IAH 319 1978 9:35	10:28	1797 IND 319 1977 11:30		13:40	PBI ORIG 1789 14:25	MCI AA 15:35	Movi	422 1540		ELP 319 19:15	1954 TERM	MSY AA 1793 21:20	22:25	
C6							late of the state	Y ATT	AA 1839 319 8:04 9:00	FSD 784 9:23 993	MCI SAI 319 AA 10:15 10:39	850 319 11:40				AA 1 15:39	802 319 16:30		100	1976 TERM	юте	21:40	1785 319 22:40	
C8							A) 6:	A 469 32 52 8:00	AA 178- 8:30	4 319 9:24	AA 1868 10:14	11:14	MEX			CITSC4	AA 16:20		422 524	319 19:54	20:45	C4 MC1 PHX PULL AA 170 21:30 21:50	1854 321 22:45	
C10												BDA 1840 AA 1434*	319 12:00			CLTSC4 ORI 15:35	9 16:20		CLTSC4 ORIG 18:28	19:13		CLTSC4 STL 21:15 881 22:00		
C12																								
C14																								
C16 AAIN																								
													CLTSC	C4 <sub>ORIG</sub> CUN			MBJ	*869	LAS	MBJ *827	MIA	SJ	CLTSC4	
<u>                                    </u>								CLTSC4 PUJ ORIG 7:05 1963* 7:55		GCM *860 HAV AA 319 9:00 1615* 9:45		PAP	*368 1826	C4 ORIG 887* 13:30 NAS	N	HBJ *843 F A 2056 10	AA 16:5 CUN	*869 0 749 1 *884 BOS 321 1806 17:55	8:10 F	MBJ *827 18:56 1919 PLS *880 0 1A 1851 20	20:15 RD	21	CLTSC4 *1850 55 TERM 22:40	
12							<u> </u>	7:05 1963* 7:55		9:00 1615* 9:45		11:00	1826	13:15	<u> </u>	4:53 2056 1	5:10 AA 16:40	1806 17:55	<u> </u>	8:55 1851 <sub>20</sub>	05			

Date:04/11/2019 Time:12:46					CLT 2028-S	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
				n tududu		la ta la ta				lutulutu.	ndadada		ntulutu	la la la la la		n Indiada.		ntulutu
13			C	CUN ORIG CUN 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 *1968 *1968 *TERM 21:1	24		
14				7.40	SDQ *1839 UVF AA 321 8:00 982* 9:45		N *1283 SJO 50 1087* 11:55				HAV *1074 AA 1028	4 BDA	SXM AA 18:40	*866 BNA 320 1867 19:49	CUN *888 20:29 TERM	LTSC4		
15			C	ORIG MBJ	2.43	100	MEX *1844 SDQ AA 1853* 12:00				10.03	17.50	SDQ *639 AA 18:00 1865*	GCM 319 19:30		*1342 SDC 321 874* 22:00		
l6				7.40	CLTSC4 MBJ 8-35 840* 9-25	KIN *854 PAP AA 319 9:55 1647* 10:50	12.00					PUJ AA 17:42	*196 643	66 <sup>1</sup>	LAS AU 321 0:05 20	JA *87CLTSC4 -50 TERM 21:35		
17					[6.52 7.23]	9.55						17.42		822 DCA 320 356 19:44	SXM *613 20-24 TERM			
18													MEX AA 18:35	*828 MEI 31 1768 20:0	M 19			
I10				GF A.A. 7::	RU *1062 CLTSC4 332 50 PUSH 8:50			FRA *705 CLTSO AA 75 13:00 PUSH 14:1	24 89 00		LHR AA 16:15	*731 730*	LHR 789 18:40					
I11										F A	CO *721 CLTSC4 A 789 5:55 TERM 16:55		BCN AA 18:20	*745 744*	BCN 332 20:45			
l12										F A	CO *721 MAD A 789 5:55 748* 16:40			CLTSC4 PULL AA 19:00 1568*	GRU 332 20:30			
I13										MA AA 15::	D *7	749 DU 24 33	B LHR 2 AA 18:30	*733 732*	LHR 789 20:15			
l14									CDG AA 13:55	*787 704*	FRA 332 16:35	CLTSC4 PULL AA 720*	FCO 789 18:25					
l15								DUB AA 13:05		725 786*			CDG 332 18:20					
OADO																		
O1	1078 TERM		CLTSC4 HOU CLTSC4 MDW C 4:40 643 5:25 5:45 1010 6:30 6:	ORIG 3773 7:40	BWI 305: 9:35	DAL 5 10:10			BNA 5136 BNA WN 738 14:00 684 14:45		M 16	DW <sub>853</sub> MDW H0 5:50 <sup>1748</sup> 17:25	DU <sub>1747</sub> HOU I :55 <sup>1493</sup> 18:30 1	DAL BWI 1721 18:55 19:30				
O2	9 TEI	RM																
O3	1441 TERM		CLTSC4 ORIG 4:45 823 5:30	CLTSC4 ORIG 7:00 521 7:45	ATL DL 2422 73H 8:48 9:30	ATL ATL DL 1454 M90 10:03 10:45	DTW DTW DL 1629 319 12:07 12:50		MSP MSI 1503 14:24 14:5	P 9	ATL 602 AT DL 73 16:18 2651 17:0	FL ATL 5H DL 00 17:5	826 73H 0 18:45	DL 1407 19:09 20	ATL 73H 0:05	2808 TERM	1076 TERM	19 TE
O4			CLTSC4 ORIG 5:15 1366 6:00	CLTSC4 ORIG 7:20 2266 8	MSP DTW DTW 2292 9:04 9:39		ATL DL 2251 717 DL 10 11:16 12:00 12:33	ATL 095 717 13:15		ATL ATL DL 2133 73H 15:04 15:45	MSP DL 16:40	1322 DTW 1524 17:20	DTW 10 18:40	DTW 057 19:15				522 TERM
O5			CLTSC4 ATL ORIG 6:15 2488 7:00	CLTSC4 ORIO 7:30				13:42	2597 320 14:30	15:40	603 MSP 319 1793 16:30	6						876 TERM
O6			CLTSCARIG IAH 5:05 1191 5:50	SFO 1704 UA 1969		73G 10:15		ORD 1484 ORD UA 319 13:00 1140 13:45		DEN 1711 UA 1199	DEN 320 16:22	SFO 11 UA 17:31 16	76 SFO 739 98 18:30				1286 TERM	1974 TERM
O13					BOS B6 9:24	8025 BOS 8020 E90 10:51							I					
O14			CLTSC4 BOS 5:33 8022 6:18		Tool Pry	JFK 219 JFK B6 218 E90 10:01 218 10:40	BOS <sub>1245</sub> BOS <sub>10:59</sub> 1246 <sub>11:36</sub>				BOS 8021 BOS 8021 ES 16:00 8016 17:0	BOS 1445 BOS B6 E90 17:18 1446 18:00	B6 18:	K JFK 5 1119 E90 :50 1118 19:28			8017 TERM	
O18			CLTSC4 6:03 1712 6:48	7.:	TSC4 ORIG DEN 50 5290 8:35	hico nu				laur .					hrm			5812 TERM
O19			DEN 201 F9 200	319 7:20		MCO PHL F9 1028 320 10:11 10:59	ISP F9 354 ISP 11:20 353 12:05			F9 1689	320 6:09				TTN 933 F9 932	320 21:10		
O20																		
O27																		
O28																		
O29																		
O30																		
O31																		
O32																		
OAIN				I							MUC	*420	MUC					
121											LH 16:20	*428 429*	359 18:35					
122																		
AEDO			PHF 5	190 PHF	PGV 5234 PGV	EVV 5	241 MLB OAJ 5176 C	OAJ MGM 544	1 SDF	FAY 38	31 IND	FAY	5486		GNV	GNV 520	2 СНО	
D13			6:30 5.	190 PHF CR2 7:35	PGV 5234 PGV CR2 8:11 5187 9:19 MGM AF 5293 MGM GR2		241 MLB CR2 132 11:40 OAJ 5176 CR2 12:05 5314 13	5093	1 SDF CR2 4 14:25	FAY 38 AE 15:26 40 EVV 5032	EWN	AE 17:05 TYS AE	5486 5172 5119	FAY	CR2 20:25 HTS 5461 <sup>CRW</sup>	GNV AE 520 21:20 528		
D12			GN GN	NV 5228 LEX 5228 CR2 5039 7320	8:38 5440 9:45 FAY 5273 TYS	SGF 3706 SGF AE 275 10:09 3213 10:50	5277 EVV CRW 5237 B	5323	CR7 14:50 5120 PHF 5120 CR2	GPT 5095 CID AE 15:05 5096 15:50	16:14 GNV	17:10	5256	CR2 19:50 CRW 5148 FWA	HTS 5461 CRW 20:15 5049 20:50 MEM AE 5265 MLB	LEX	5156 PGV CR2 5118 22:40 5264 MGM	
D10 D8			6:5	CAK <sub>5355</sub> CHA	8:40 5297 9:35 CRW 5347 BHM	10:46	5 5032 CR2   AE   12:15 5164 13   13:5   13:5   14:3   14:	3:00 13:43 CAE	5120 PHF CR2 35052 14:25 MYR 3777 AVL	OAJ 531	16:09 4 MGM	5063 CAI 5259 18:00 WL 4011 CAE 40:52 3775 18:00	4	AE 5140 CR2 19:05 5405 19:49 CHS SRQ AE 5227 CR9	20:05 5141 CR9 20:05 5141 20:45	21:36 4796	5298 CR2 5298 22:41	
D6				7:08 5277 7:43	8:16 5142 9:10 CAE 3826 HSV AE E75	BTR AE 5507 AE 5263		13:05 TLH 42 CR2	14:01 4011 14:40 PGV AF 5117 FAY	ORIG 3973	2 16:19	PHF 5052	LEX SHV 5514 T	TLH 52	222	TERM TLH_5211LFT	PULL 5304	
D4					8:21 3906 E/S 8:21 906 9:09 FWA 5406 OAJ AE 5406 CR2 8:49 5176 9:26	GSP 54	67 FPO GNV 5371	18 13:10	14:07 <sup>5486</sup> CR2 14:07 <sup>5486</sup> 14:45		OAJ CR7	TWA 5135 DAY	18:14 18:30 <sup>5254</sup> 19 AVL AE	9:05 PU 4769	JSH	21:15 <sup>276</sup> 21:15 <sup>27</sup> 21:46 PN ORF 3945 CR7 21:30	5304	
E1				5058	IAD 5327 GRR	PULL MSN	5231			MGM 5366	16:14 LFT CP7	17:11 5156 18:00 BHM	18:42 311 CHA	4895	20:15	5186		
E2		5006	CRW AF	PUSF	5263 LFT	5343 10:45 VPS 5157 AE 5170	CHA RAP 5514 DAB E75 AE 5255 12:20		14:33 YS 5294 TYS	ORF 3773 BE AE 15:07 3865 16:	16:20 IM 75		087 GSO		PULL	TERM TYS 5037	AVI. CR7	
E2		PUSH	5279		5335 9:36 MLB 5175 HPN AE CR7	10:06 5179 PHF AE 55 10:39 52	57 TYS CMH 4		3:51 5119 14:35	SDF 379	8 MKE	4892		TRI 4786		20:59 5100 5049	22:25	
E5			PUSH LYH 47 AE		8:47 5384 9:30 4935 DAY AE	5122	PHF AGS 5396		CAE 5	15:17 395 327 EVV		CHA AE	5508	19:00 4755 OAJ CR7	20:30 LFT SHV AE 5411 CR7	JAN 5257	BTR CR7	
E7			EWN	4921 GSO GRO	TERM 8:51	5364	JAN AVL 4751	LYH LI	FT 5110	5204 16:00 GNV HPN CR7 AE	5526 HP 5166 17:0	17:21 PN ROA 4829 AE 4829	5233 LYH CR7	19:45 BHM 3	20:00 20:40 B865 HPN	20:58 5407 CAE 3775 MI AE C	22:15 CE R7	
E9			AGS 52	4826 7:50 296 SDF CR7	8:30 55 LFT 5 AE 5	390	11:20 12:12 4804 1 CAE 17YS 5297 AE 5297		5459 5463 VPS CR7 5453 14:40	15:15 15:44 XNA 5569 ICT VPS 5196, 539	5138 HT	00 17:16 4798 CRW 474	18:30 9 OAJ ROA	19:23 4 4842 SBY CR7 4835 19:50	1023 20:40	OAJ 491	31 LYH	
E11			TRI	93 7:30 4867 HHH CR7	R:42 5	MOB AE	11:19 AE 12:20 5512 5506	2 13:10 13:4 SHV CVG 54 CR7 AF 54	15 5453 14:40 466 HSV 319 14:25	14:55 <sup>5196</sup> 15:32   15:: EWN 4773 AE 4779 1	50 5200 CF LYH CR7	TLH 5218 GNV AE 5202 17:55	1 18:25 18:43 BTR 5500 H	HSV HSV 397		ROA 4807 RO	22 CR7 22:30 DA R7	
E13			6:39	4942 7:35 ROA 4776 FAY AE 4034 CR7	8:16 4820 935 HPN 5150 MOB AE CR7	10:45 SHV AF	5514 5546	AL AL	5263 DAI		5582 GPT CR7 5083 16:40	16:55 5202 17:55 CID 5456 CII	18:30 <sup>5505</sup> 19 MSN AE	9:05 19:21 391 5437 CAK	5 20:25 LGA 4460 BTV AE 4582 E75	AE 21:00 4799 22:	HHH CR7	
E15			H H	7:04 4934 7:40 HHH <sub>4915</sub> ROA	8:22 5251 9:35 GSP 5235 IAD AE CR9 8:18 5509 9:09	ORIG	5364 10 LIT 5183 EYW SAV 5185 CHA AE 5000 CR9 AE 5000 CR7	AEX <sub>5375</sub> AEX	HPN 5384 MLB AE 5202 CR7	PHF 5364	LEX	AE CR 17:04 5429 18:0	18:43 ORF AE	5306 <sub>19:45</sub> 5209 AGS	20:00 4582 20:40	21:15 BTR	5074 EVV	
E17			CHS 52	5:56 4763 7:30 246 SAV CR9 295 7:45	LYH 4886 SBY	5632 CID AE 51	11:00 5220 11:45   12:07 5582 12:50   HTS 4866 4	13:1 <sup>3</sup> 144 AGS FL CR7 AE	0 4904 ROA CR7	15:13 5283 I	5132 JAN	EWN 4939 AE 1997	ROA M CR7 A1	5398 19:45 ILB MSN E 5230 CR7		21:35 GPT 5083	5038 22:40 SRQ CR7	
Lii			6:18 52	295 7:45	8:12 4831 CR7 9:20	10:18 54	423 CR7 AE 12:18 4805 1	3:01 13:	48 4829 14:35	15:44	5257 16:35	AE 17:24 4807	18:15	8:52 19:54		21:10 5393	22:14	

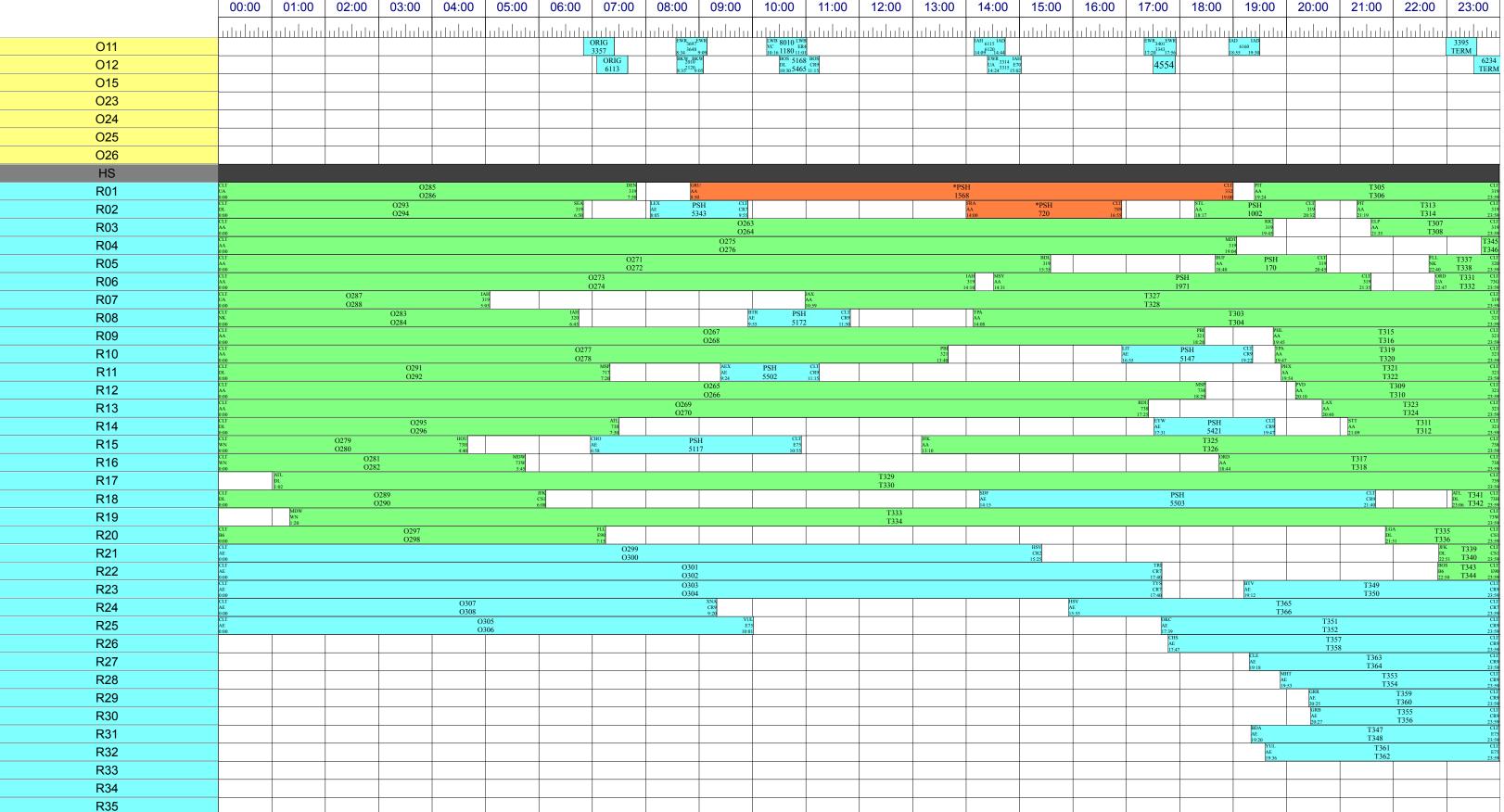
Date:04/11/2019 Time:12:46						CI	LT 2028-S	Scenario 3											Page # 3 of 4
	00:00 01:00	02:00	03:00 04:00	05:00	06:00 07:00	08:00	09:00	10:00 11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00 22	2:00 23:00
		1 1 1		, , ,			1 1 1			1 1 1	, , ,	1 1 1	1 1 1	, , ,	1				
E19			<del></del>		MYR 5357 CHS		1884 TRI CR7 1841 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 5567 CR9 15:10 15:50	шшшш	HTS 4759 H AE 17:18 4813 18	IHH CR7	CAK 5036 AE 5143	VPS CR7	LYH 4798 EW AE 4744 CH 21:26 4744 22:	
E18					6:29 5309 7:40 SAV 5452 MYR GR9	OAJ 5113	CVG CR7	OAJ 4889 EWN	GSO 4903 TRI AE CR7 12:184765 12:59	BTR	5078 14:25 5225 BHM CR7	TRI 476	5 AVL	5431	8:05	AGS 4907	20:20 FLO CR7	MDT 5180 PF	30 HF 27
E16					6:36 5389 7:40 GSO MEN AE 5026 CR	8:13 5466 MOB	9:20 5278 AGS	PIA 5349 PIA	12:18 4765 12:59 LYH AE 4820	GSP SBY 48	7 5311 14:30 31 CRW 49 14:19	ORIG	9 16:24	TERM	5154 AVL 0.	19:09 4870 PAJ 5226 SDF	20:09 MLB 5	431 MOB LGA 500	30 56 GSO CP0
E14					0RF 5460 CVG	AVL 5365	5396 9:45	GSO 4826 ROA AE 10:30 4879 11:14	12:32 4933 1	13:12 13:39 47   CRW 4824 H AE 4759 14:	49 14:19 TS MSN 5204 CAR	4809 FLO 4862 ROA OBZ			465326 <sub>18:30</sub> Is	P 3833 MKE CR7	20:30 5		
					6:27 5268 7:24 ILM 5096 CMH	8:21 5152 MDT 4669 C	9:19 MH MLI	5111 GRR	TRI 4841 ROA AE 4841 CR7 12:23 13:01 EWN 4936 FL	AE 4759 C 13:25 4759 14: JAN	05 14:25 5272 CR. 05 14:25 5272 15:05 5071 CHA 5071 CR7 7508 14:27	AE CR/ 15:20 4842 16:05	804 TRI		RIG   GSI   AE   18:4	49 3889 <sub>19:44</sub>	LYH FWA 5	MOB 5060 AE 5520 2 476 LEX 5256	2:35
E12					6:41 5061 CR9	8:08 4538	POA 4790 GSO	5514 (11:30)	EWN <sub>4936</sub> FL 12:29 <sup>4862</sup> 13:		7 5508 CR7 14:27 CHA 5179 ORF	AE 15:47 4	786 16:30	16:58 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 STIL AE 6:46 5073 7:40 IAD 5399 IAD	SRQ 5390 TLH AE 5091 CR7 8:04 5091 9:00	ROA 4790 GSO AE 4903 9:55 E 3850 CAE	PULL 5117 MKE 3896 SDF	RDU 5415	37 13:34	AE 5110 CR7 14:01 14:40	CHO 5048 CA AE 5239 CI 15:30 16:	AGS	17:38 5	361 CR7 RIG	18:59 4885 19:49	4777 HTS	HSV 5050 PIA AE 5050 CR7 21:06 21:45 MKE 3050 CAE	
E21					AE CR9 6:44 5373 7:30 DAY 5328 CB	8:50	3814 CR7 3814 9:45 5232 MSN	AE 3798 CR7 10:48 3798 11:40 CAK 5468 GPT	AE 5115 12:19 5288 CHO 5152 AV	CR9 13:20 13:42 L RO.	CHO 743 14:19 A <sub>487</sub> EWN	ROA AE 4907 15:41 PIA 518	CR7 16:19 AEX	47	796	19:40	4767 <sub>20:30</sub> CR7	MKE 3959 CAE AE 3959 CR7 21:37 4010 22:20	
E23					AE 5326 CR 7:14 5282 7:5 PHL 3899 CAE	8:51	5060 9:45 242 JAN	AE 10:50 5462 CR7	12:12 5086 13:0	13:: P F	A <sub>4879</sub> EWN 50 <sup>4939</sup> 14:25 IHH <sub>404</sub> HHH	PIA 518 15:43 <sup>531</sup> AGS 4005		AEX 5060 FWA AE 5060 CR7 17:05 17:45 MOB 5513 MOB		AE 5283 CR7 19:16 5221 19:56	FAY 5105 HSV	21:05 4495 22:05	MGM, AEX
E25					AE 3679 E75 6:58 3908 7:45 CMH 4544 DTW		071 9:30	CAE 3908 MYR AE E75 10:21 3777 11:19 ROA. HHH   IAD 5272 SAI	AE 1107 CR 12:13 5189 13:0	9 14 1	14:23 14:42 14:44 3:56 14:30 CMH	AGS 4805 15:40 <sup>4869</sup> JAN	6:16 RW	AE 5060 CR7 17:10 17:49 CHO 5060 TR:49		CHO, ROA	FAY 5105 HSV AE 5105 CR7 19:59 5224 20:40	AVL 5326 CAK AE 5124 CR2 20:55 5124 22:05	MGM <sub>491</sub> AEX 22:2 <sup>7</sup> 22:59 BNA
E27					AE 4544 E75 6:38 4542 7:45 IND 4661	8:21 5225 g	9:09 9:24 9:59	ROA <sub>4763</sub> HHH IAD 5373 SAT AE 5373 SAT AE 5210 11:55	AE 12:10 STL 5072 ILM	5458 5087	CMH CR9 14:24	JAN 5514 15:40 <sup>5148</sup> 13909	6:15	CHO <sub>4918</sub> FLO 17:01 17:35 DSM 505	DSM	CHO <sub>4809</sub> ROA 19:10 19:44 GNVBTR	AE 19:59	5336	CR9 22:40 CHS
E29					AE 4661 1 6:51 4531 7	ND HSV 532 AE 533 518 ORIG	5 9:19	RIC 5290 CLE AE 5290 CR9 10:45 5436 11:35	STL 5073 ILM AE 5345 CR9 12:10 5345 12:59	AE 13:28 GSO	5245 PNS CR9 5212 14:50 5372 MEM CR9	TERM	/ 1	DSM AE 16:58 527	6 18:45	GNV <sub>5252</sub> BTR 19:18 19:50	MU	AE 3449 20:59 5114 2	CR9 2:35
E31					CAE 2007 BHM	5573	9:20	5292 5172	CR9 12:25	AE 13:33	5494 CR9 14:40	4933 TERM	A 16	6:56	5253 5421	MCL 46775 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			5252 5285 SAV	IAY 52	CR9 14:35	CVG AE 15:14 5229	CR9 16:20	MSY 4662 CMH AE 4506 E75 17:08 4506 17:50		MCI 4675 CMH AE E75 18:55 4624 19:44		5099 TERM	TPMI
E35						0.45	936 9:24	OMA 5253 AE 5266		JAX 52 AE 13:32 53		Т	3190 DSM AE ERM 16:45	50.12	5378 5036	CR 20:0	5077	21:08 31// 2	CRW CR7 2:35
E38					love		ICT 5316 9:03 5164	CMH CR9 AE 4850 CR7 10:30 10:45 4800 11:25	DTW 4542 M AE 12:23 4510 1:	3:10 AE 13:37 5	151 14:27	GRR AE 15:50	lur	5043 5236	5512	19:30	5077 TERM	CAK 5259 AC CE 21:35 5438 22:3	33 30
E36					CVG AE 6:56	5341 5116	CR9 9:20	TUL TUL AE 5054 CR9 10:50 11:40	PGV 5187 CHO AE E75 12:05 5048 12:49	13:45	5433 CHS CR9 5181 14:35	MHT TLH AE 5072 CR9 15:02 15:59	AE 16:20		5513 5147	GRB CR9 19:57	20:40	5530 GPT CR7 5491 21:30	CSD
E34						BHM 5340 8:30 523°	6 CRW CR2 7 9:20	IND 4484 CMH AE 4457 11:45	AUS 5171 LIT AE 12:05 5395 12:50	13:10 13:44	GRR 5533 ATL AE CR9 14:05 5192 14:55	DAB AE 15:30		5460 5053	LII 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 CR9 12:10 5084 12:54	509 PU:	SH	CMH 4457 IL. AE E7 15:21 4674 16:0	M 55 9	LEX 5078 AE 17:25 5552	8 CHO E75 2 18:15	IAD 55 AE 19:26 52	502 MSY CR9 232 20:30	PULL 5503	
E30					CHA 5165 AE 5457 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 CF 19:0	AP DAB R9 AE 03 19:36	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	LП АЕ 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 521:05 5299 2	1EM CR9 2:35
E26						ORIG 5531	BHM AE 9:15	5204 OKC CR9 5033 11:20	CLE 5282 GNV AE CR2 12:05 5063 12:50	ILI AE 13	53 52 52	86 G	VG M CR9 A 5:14 16	MDT 4510 JA: 6:56 4662 E7	X 75 59			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 13:15	ORF 5081 MYR AE CR9 3:56 5313 14:45	STL AE 15:43	5370 PNS CR9 5094 16:44	CVG AE 17:00	5398 5040	2	ICT GSO CR9 AE 0:06 20:4	5121 DAY CR9 5374 22:05	
E22						CHS 5207 AE 5289	MYR CR9 9:30	BHM 5356 PVD AE CR9 10:13 5474 11:50	CAE 3814 FA AE 3831 E7 12:22 3831 13:0	Y N 75 A	MKE 5267 ABE AE CR9 3:56 5140 14:45	5592 PUSH			PULL SAT 5004 SAT 18:40	5210 5335	CLE CR9 20:30	PNS 5094 CVG AE CR9 20:55 5109 22:05	
E20						AVP AE 8:47	5294 ILM CR9 5525 9:25	DAY 5042 XNA AE 10:54 5193 11:50		F	NS 5255 DTW AE 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 CR9 10-10 5322 11-20	IND 4470 GS AE 4537 E7	O DAB 5 75 AE 13:40 5	317 IAD CR9 031 14:25	MYR AE	5053 5066	LGA CR9	ATL 527 AE 555	15101	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	15.40	IND 5568 AUS AE CR9 14:01530114:45	CHS 508- AE 508- 15:30 508	4 LIT	PWM AE 17:10 5070		SAV OR AE 5056 CR	F 9	CVG 5281 BH AE 521:22 5211 CF 21:22 5211 22:	M 89
E4					ORIG 5261	MYR AE	5431 SYR CR9 5260 10:00	XNA 5350 BHM AE CR9 10:28 5178 11:35		ABE AE	5191 CVG CR9 5035 <sub>14-25</sub>	CLE 5436 AE 5170		OMA AE 5131	SAV PN:	S 5212 CVG CR9 50 5303 19:45		XNA 5236 AE 21:33 5161	MYR CR9
F1					ORIG 5079	GSO AE	5417 CAK CR9 5245 9:45	MEM 5474 PWM AE 5034 11:50		SAV AE	7 5051 RIC 5051 CR9 5372 14-20	GSO 4537 AE 15:30 4498	7 YYZ BNA E75 AE	5288 SDF CR9 5049 17:54	ME AE	5494 CHS CR9 50 5318 19:44		LIT 5088 SDF AE 5334 CR9 21:18 5334 22:20	22.40
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 5	266 STL CR9 069 1635	SYR AE 5377	Cue	TYS SAV AE 5144 CR9		SRQ 5161 AE 5333 2	JAN CR9
F3				C	GSP DCA 3802		5343 FAY CR9 5487 9:40	OKC IAD AE 5510 CR9		SAT AE	5046 MLI 5265 CR9	MDT CMH AE 5064 CR9	16.53	DTW AE 524	MYR 9 CR9	IND 5189 GSP AE 5155 19:50		CLE 5331 AE 5250 2	ILM CR9
F4				P	6:32	OR 513	IG	AVP 5160 STL AE 5370 11:20		1314	ICT MHT AE 5103 CR9	OKC 5116 SDF AE 5300 16:05	CA AE	AK 5243 CLE CR9 :53 5331 17:50	AE	O 5418 DAY CR9 49 5101 19:40		ORF 5455 AVP AE 5099 22:20	255
F5					TYS GSP AE 5354 CR7	TYS 5344 AE 5033	LIT	DSM 5129 ILM AE 6270 IL16			CMH 5414 TUL 14:00 <sup>5542</sup> 4:35	BHM 5178 IAD AE 5502 16:00	[16:	ILM 5285 (AE 17:14 5455 18	ORF CR9	MYR 5170 PNS AE 5170 CR9 19:00 5103 19:50		IAD 5286 SA AE 21:21 5451 22:	W 29
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			GSO IND AE 4522 E75 16:59 17:50	ILN AE	M IND 4572 E75		CMH 4554 CMH AE E75 21:14 4579 22:09	30
F7					ORIG 5290	PHF AE 8:10 5320	GPT CR7	SAV 5504 DAY AE CR9 10:38 5115 11:35		13:4	9 3223	PIT AE 5043 (15:24 16	SAV CR9	RIC AE 17:19 5563	BNA CR9	CMH N AE 5047 C	IHT CR9	VPS 5065 TLH AE 575 21:06 5349 22:15	
F8					ORIG 5082	GRR	9:20 5534 RDU CR9 5415 9:40	10:38 5115 11:35 CMH 5061 PIT AE 5061 CR9 10:50 5522 11:45		BNA AE	4695 OMA E75 4556 14:55	ILM 534 AE 15:35 541	5 GSO	IAD IAD AE 5286 CR9	18:10	19:16 20 5366 TERM	202	21:06 3349 22:15	
F9					ORIG 5547	DAB 53:	52 SRQ	CHS 5309 GSO AE 5309 CR9 10:27 5350 11:20		13:42	4556 14:55 RIC 4618 GSO AE 4618 E75 14:02 4695 14:45	IAD DAB AE 5035 CR9	PVI AE	17:05 17:55 D SRQ 5125 CR9		MKE 5098 AE 19:21512720	I IAD CR9	5182 TERM	
F10					5547	ORIG	SBY 4770 AVL AE 4751 CR7	YUL 3916 GSP AE 3916 CR7 10:06 3989 11:35			YYZ 4546	15:15 16:04 LGA AVP 532	2 XNA	CAE 3957 AGS		CVG 5169	DAB	ILM 5451	LIT CR9 2:35
F11						5371	9:15 <sup>4751</sup> 9:50 ORIG	10:06 3989 11:35 HHH4942 RW 10:448101:19		G	SP 3989 YYZ 35:54 <sup>3834</sup> 14:30	DAY 5115 MEM AE CR9 15:14 5265 16:00	0 16:25	17:03 4001 17:55 IAD AE	2 5031 TUL CR9 46 5271 18:30	ABE 5140 OMA AE 5140 CR9 19:06 5248 19:49	20:10	21:03 5200 2 5361 TERM	2:35
F12						ORIG BNA	5452 5325 DAB CR9	10:4 <sup>‡81</sup> 1:19 ILM 5082 DSM AE CR9 10:31 5055 11:20		1.5	3:54 14:30	15:14 5265 16:00 MEM 5058 AE 15:35 5208	TYS CR9	XNA 5193 CVG	46 5271 <sub>18:30</sub> 554 TER		5382	IERM	
F13						4850 8:49 OI	5317 9:50 RIG	BHM 3819 HSV AE CR2 10:59 3909 11:50				LEX	16:19 5153 BTR CR7 5 5074 16:45	17:04 5281 17:50 MYR 5313 B AE 17:19 5182 18	НМ	SDF AE	TERM 5.	300 XN	IA 39
F14						OI	071 RIG	CVG 526	8 DTW CR9			OMA 5431 DSM AE 5431 CR9 15:20 5165 16:00		17:19 5182 18 5077 FAY CR7 8 5105 17:45	8:05	19:28 5163	5:	219 22:	30
F15						TL	509 H 5213 VPS CR7	MYR 5389 SAV AE 5389 CR9	8 13:00			OI	RIG	SAV 5070 GSP AE 5070 CR9 17:09 5214 17:50			5337	4925	
F16						8:5	3 5183 9:50 ORIG	10:22 5051 11:10 BTV 4649 RIC AE E75					90 5305 VPS 5065 16:45	5181	VPS AF	5385 PHF E75	TERM	IND NAE 4476	MSY E75
F17							5294 ORIG	10:21461811:05 TUL 5196 ORF AE CR9 10:20 5081 11:02				CAE 3960		TERM YOW 5543		307		YYZ 4498 MDT	2:35
F17							ORIG 5247	10:20 5081 11:02				15:22 3833 SA	16:25 XT	17:06 5265 558	18:10 TE	ERM LNK CR9	5076	21:22 4636 E/5	
							5129					10	:00	555		19:45	TERM		
F19				ORIG	ORIG	EWR <sub>360-</sub> E	WR IAD	IAD IAH 6165 IAH			EWR 364	42 EWR	ORD <sub>4</sub>	4823 <sup>ORD</sup>	ļi.	AD IAD			6234
07				ORIG 6238 ORIG	ORIG 3357	EWR <sub>3697</sub> E 8:34 <sup>3648</sup> 9	UA 6 9:42	1AD 6150 CR7 10:22 11:04 <sup>6310</sup> 11:41	VR <sub>3367</sub> EWR		EWR 364 14:33 335 EWR 3314 IAH	56 E7W 15:30	16:46	4823 <sup>ORD</sup> 4843 <sub>17:21</sub> EWR <sub>3401</sub> EWR	<u> </u>	6160 18:55 19:30			6234 TERM
O8				3312	ORIG			11:	3367 -52 <sup>3311</sup> 12:27		UA 3314 E70 14:24 3315 15:02 IAH 6115 IAD			17:20 <sup>3343</sup> 17:56	IAH			6302	TERM
O9					6113			LGA EDGO LGA		LGA 2000 LGA	6115 14:09 14:44	LGA 5006 LGA		UA 6243 17:14 6285 18 ORIG	8:05	LGA coat LG	A	3812 3812	
O10					ORIG 3612			LGA 5060 LGA DL CR9 11:14 5069 12:00		LGA 3888 LGA DL CRS 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	



AADO A21 A22 A23 A24 A25 A26 A27 A28 A29 A1 A3 A5	CLTSC4 <sub>GRIG</sub> DF 5:15 <sup>2451</sup> 6:	W ITPA AA 2011 AA 1797	RDI ORD PHX HI.		
A21 A22 A23 A24 A25 A26 A27 A28 A29 A1	CLTSC4 <sub>RIG</sub> DF 5:15 <sup>2451</sup> 6:	W IPA 2011	RDU ORD PHX FLL		
A22 A23 A24 A25 A26 A27 A28 A29 A1 A3	5:15 2451 6:	W 2011 AA 2007	RDU ORD PHX FLL		
A23 A24 A25 A26 A27 A28 A29 A1 A3			321 AA 628 321 AA 11:20 11:57 13:00 13:20	1051 PVD 321 275 19:10	CLISC3 RIC DEN TPA ORIG AA 1873 321 19:45 2006 20:30 21:18 22:15
A24 A25 A26 A27 A28 A29 A1 A3		SFO 898 LAX AA 321 6:14 2057 9:45	LGA PLS RSW 445 AA 879* 321 AA 580 10:00 11:40 12:00 580	DEN BWI 1889 321 AA 1820 15:15 1798	PHI PHI 892 PHX 321 AA 472 22:15
A25 A26 A27 A28 A29 A1 A3		SMF 476 MB3 AA 321 602 840* 9.25	SVR MSY PHL AA 1909 319 AA 10:11 11:03 13:18	1789 MSB PBI 294 EWR AA 321 1855 1459 16:00 1673 19:11	EWR 1245 JFK AA 738 2036 1608 22:10
A26 A27 A28 A29 A1 A3		SEA 624 LAS BOS FLL AA 624 321 AA 1709 321 6:15 658 8:00 8:28 9:50		855 RSW BW F F RSW BW A T BW A	US AS 2 TUS IPA 2039 DFW AA 9.010 843 20.10 20.52 890 321 22.10
A27 A28 A29 A1 A3		SAN 579 SFO AA 321 AA 319 6:04 662 7:30 DTW 925 FNT AA 319 9:06 1109 9:52	RDU 1977 EWR AA 321 AA 10:38 1936 12:10 13:23	695 TPA MCO LAS EWR SAN BWI 1810 14:50 15:25 16:45 17:01 18:15 18:39	FLL DFK DTW 514 416 321 AA 1774 321 20:20 21:02 22:20
A28 A29 A1 A3		CLTSC4 PHL ORD PHX AA 680 321 6.45 1956 7.30 8.20 9.40	FLL 1735 MBJ PHX PTT SMF AA 826* 321 AA 1842 321 AA 12:06 13:09 13:28	1154 SAN DEW 720 PHI AA 321 AA 1583 1445 1631 830 1730 1854	1798 DFW LGA SFG 321 AA 557 321 21:04 20:27 21:04
A29 A1 A3		LAS 431 DEN SFO 1944 ORD AA 1921 AA 1946 9:35 6:10 428 7:35 8:01 1946 9:35	AA 1837 321 AA 1878 321 AA 1878 1321 AA 1878 1321 AA 1878 321 AA 1878	FLI MSP 1836 FLI 1760 321 AA 1841 19:12	PHX 499 DEN AA 321 21:16 1865 22:25
A1 A3		PHX   2020   DFW   EWR   PBI   AA   A   2020   321   AA   1866   321   AB   AB   AB   AB   AB   AB   AB   A	AA 1961 321 AA 1970 321 AA 1035 11:55 12:19 13:19 13:35	A ORD SEA 2107 SEA SFO 1908 SFO ORD AA 2107 SEA SFO 1908 SFO AA 321 AA 321 AA 1520 1646 1799 18:05 18:45	747 321 AA 1704 321 20:15 21:03 22:09
A3		SLC 2014 PHX FLL SEA AA 1912 321 AA 1912 321 8.22 9.40	AA 858 321 AA 2044 321 AA 10:14 11:30 DESI DESI TESI		TL 1768 PH A 1768 A 1857 321 A 1857
		LAX 696 TPA LGA DFW AA 1772 321 AA 1772 321 S13 C MCO LGAI DFW SJU	AA 521 321 AA 1808 321 10:29 11:45 12:03 13:02 18:0	DFW   2091   JFK   TPA   539   LAX   ATL   786   LAX   SAN   AX   212   AX   232   AX   AX   AX   AX   AX   AX   AX   A	487 SLC DFW BOS 321 AA 1812 321 451 20:05 21:12 22:15
Δ5	KITGA	AA 2062 321 AA 835 321 6:44 7:59 8:34 9:50	PHI	2059 321 AA 704 1321 2084 TERM	1 AA 1717 321 21.09 22:10
	CLISC-GRIG ORIG 5-20 <sup>2060</sup>	ATI ATI RWI TPA	AA 885* 321 AA 873 321 10:11 11:25 11:27 13:24	LAX 1810 PHI LAX 724 PHIL ORD 622 TRA AA 321	SFO BOS STI 277 973 321 AA 793 319 TERM TERM 1930 1945 29-33 TERM PSWI
A7	KIISC4 ATII	AA 469 321 AA 1925 321 6.52 8.00 8.20 9.35 DEN BOS MCO SFO	AA 752 321 10:31 11:45 PVD MIA BOS	13:52 14:50 15:35 /US 16:40 17:00 6U9 18:10 1	NA 1769 319 AA 1863 321 9:11 20:00
A9	CLTSC4RIG ATI 4.45 823 530	AA 1980 321 AA 461 321 AA 321 527 AA 461 321 524 524 524 524 524 524 524 524 524 524	10:32	891 321   AA 1719 321   AA 321   AA 1425   1520   1624   17:90 1787   18:10   19:02	1820 - 321   KA 1737 - 321   22-20
A11		6:45 928 7:30 8:11 1965* 9:25	10:13 11:25 12:02 13:12 13:31	14:26 15:08 1999 16:10 17:16 18:25	19:20 1783 20:29 20:58 22:15
A13		6:15 1877 7:00 8:21 413 9:35	MCO 790 TPA AA 382 JFK 10:13 2053 11:20 I2:11 100 13:19 TPA ORD EWR 1615 EWR	13:58 1917 14:50 15:09 16:10 17:21 565 18:30	FLL BWI RSW 1805 IAH 550 AAA 321 TERM 1912 2020 21:10 745 22:10 TERM
A12		CLISCÓRIG SAT LAS 1955 MCO AA 1905 9:19 CLISCÓRIG MCO MSP LOLD LGA	10:18 11:25 12:23 1447 13:26 L	AA 321 AA	NFO 662 LAX 783
A10 A8		CLTSCORIG MCO AA 1910 321 6.55 1725 7.40  CLTSCORIG PU PBI PBI DEN AA 445 321 7.05 1963* 7.55 831 935	AA 833 320 AA 893 738 10:24 11:50 12:17 13:05	15:25 16:25 16:54 1908 18:00	AA 273 321 TERM  1914 1975 2020 TERM  1871 1794 ORD MA  1871 3221 AA 1277 738
A6		CLTSC4 MCI LAX BOS	10:26 11:30 12:19 254 13:45	AA   321	07 20.06 21.27 22:30 MSP 1897 BWI
A4		ORIG   AA   1982   321	Disput   Color   Col	A 1827 738 AA 1999 321 AA 436 321 AA 1752 321 AA 339 14:40 FLL ATT AA 504 321 ATT AA 504 321 AA 1752 A	1925   1861   20:10    21:04   1998   22:30
A4 A2		CLTSCA BWI RSW 413 MSP	10:19 1/29 11:20   12:05 13:05	SRQ 1130 DEN MCO	746 PHX 2043
B1		6.55 3773 7-40 R28 713 9-20 CLISGRIG FILL CLE MEM 5.55 AA 1784 319	AA   1458   11:05	AA 321   AA 1518   AA 1518   AA 1701   AA 1701	463   19:55     TERM
B3	, c	6.50   525   7.35   8.30   9.24     LTSC4   PHL   DCA   PHT   JAX   DCA     AA   1904   319   AA   1722   738     For 2010   6.35   7.35   PHT	10:50 1404 11:40   11:58		1724 5563
B5	<u>s</u> :	SIC 661 PDX MIA EWR	130   1312   1327   1312   1327   1312   1327   1312   1327   1312   1327   1312   1327   1312   1327   1312   1327   1312   1327   1312   1327   1312   1327   1312   1		TERM   TERM
B7		BWI   JFK   AA   2042   738   AA   148   738	10:12   11:19   12:09   13:04		TERM 2126 2228  451 DTW 167A 758  TERM 2055 2204
B9		RDU DCA EWR 2531 JFK	SAT BNA DCA	199 AA 278 15:00 16:10 278 15:00 16:09 AUS BDL AA 1840 319	1976 SJU 753 MSP
B11		6:17 7:30 8:16 2329 9:06 CLTSC4 LAX MSY 5330 MHT MSY 5330 MHT	10-39	14.35	TERM 2023 2039 2210 2010 2010 2010 2010 2010 2010 201
B13		6.50 1993 7.35 AA 5089 9:30 CLTSC4 RDU AA 1942 319 AA 1942 319 8:08 9:30 CLTSC4 RDU AA 1942 319 8:08 9:30 RDU AA 1942 319 8:08 9:30 RDU AA 1942 319 8:08 RDU AA 1942 319 RDU A	10:42   11:35   11:52   12:45     13:31	14:30	1948 TERM 21.13 1304 22.18 861 AL MCI ORE 18 861 738 AA 1785 319 21.19 21.40 TEJ
B15		7:05 - 7:50 8:08 9:10 CLE	AUS 1964 319 10-39 1849 13-15	RDU 2069 PIT RDU BWI RIC 5321 BNA SJC	786 ABQ 21:19 21:40 22:40 TEJ 786 738 628 585 20:05 TERM
B16		RIC BDLI MEM RSW AA 1853 319	IAD 5373 SAT    AA 5373 SAT    AA 5173 SAT    AA		303 20:03 EILENVI BUF AN 1945 SAT BDL BUF AN 1954 738 AN 1952 738 1954 733 20:25 21:12 22:25
B14		PDX 1930 SAN STL PTT AA 1677 319 8-45 9-45 8-51	MDT JAX AA 1753 319 AA 657 319 AA	1345   1448	Solution
B12		PIT PVD   ILM PHIL FSD 784   AA 1903 319   AA 1839 319   AA 0.00   AA 1839 319   AA 18	1130	14:39	799 130 20:10 20:38 22:38 22:38
B10		CLISC GRIG ROC FN 1751 SLC AA 1751 319 6:45 868 7:30 8:03 97 9:30	DIT DCA MCL to CE DIE	DOS BOS BDL BNA JAX DCA DFV AA 1715 319 AA 1750 319 AA 1751 319 AA 1750 319 AA 1750 319 AA AA 1750 319 AA	W JFK 2035 2648 738 D5 2000 TERM
B8		BOS BNA AA 1817 319 AA 1917 112 8:00 8:15 829* 9:30	1924 PBI 2754 PBI TERM II:15 2845 12:15	14:30 1242 18:00	EWR 1598 AH AA 283 738 AA 1893 319 19:16 2483 20:10 20:55 22:10
B6		BUF 829 DTW AA 319 8:08 1941 9:19	PWM ATL AA 1814 319 10:33 11:39	CHS DCA AA 1938 319 L4-52 L5-53 1889 16-20 L70 18:08	JAX 1861 PBI AA 319 19:15 2043 22:11
B4		IND BDI AA 1756 319 8:44 9:50	PBI PHI AA 1847 319 10:10 11:15	CLISCÁRIG IAH DCA MCI NND STL SAT AA 1653 319 AA 765 319 II-11 1513 I6-15 II-71 II-71 II-71 II-71 II-72 II-74 II-75 II-74 II-75 II-74 II-75 II-74 II-75 II-74 II-75 II-7	5210 CLE SYR DCA 319 AA 1987 319 5335 2030 2104 22.14
B2		PIT 1978 NAS AA 1978 319 8:35 852 9:40	OKC IAD AA 5510 319 10:42 11:45	STL 5370 PNS CLE RIC AA 319 AA 2028 319 15:43 5094 16:44 16:59 17:54	SCA <sub>RIG</sub> MDT MSY PIT AA 1793 319 41720 19:49 21:20 22:25
C2		CLISCA MSY MSY 8:29 1957 9:14	ALB 1707 SXM AA 319 10:23 613* 11:25	15:39 16:30 17:07 2038 18:15 18:52	1979 319 334 TERM
C4		DCA CHS AA 1795 319 8:28 9:30	MCI 1797 IND AA 1797 319 10:28 1977 11:30	MCI 422 EIP AA 319 15:35 1540 19:15	DFW 560 DFN ALB CLE AA 2070 319 19:35 616 2020 21:22 22:25
C6		IAH 852 IAH AA 819 IAH	ROC CHS AA 1868 319 10:14 11:14	LAH 1745 ALB AA 139 1065 1535 1843 1624 PUSH	MIA 760 PVD BOS ORD AA 1788 321 19:20 1996 20:28 21:39 22:35
C8		ORF AA 1770 319 8:29 9:15	BWI 876 GCM AA 320 10:20 821* 11:25		605 PLS SAT ROC 319 1029* 20:00 21:25 22:16
C10		PVD SXM AA 865* 320 8:12 9.25	12:00	PBI PBI PBI AA 2047 319 SV61 PDIS PS SV61 PD	07 20:15 20:45 170 21:30 21:50 22:45
C12		CLTSCARG JAX 9.05 <sup>5247</sup> 9.50	DEN 1446 LAX AA 321 11:15 652 13:00	AA 2036 319 AA 2067 319 AA 15:20 16:19 17:04 18:05 18:40	78 STL 2005 319 TERM
C14			CLISCARIG MCI 10-55 1964 11-40 CLISCA BWI	RIC 1864 PT ELP 1891 AA 319 AA 736 1541 1745 1633 1655 736	319 AA 2038 738 20:00 CLISCA FYI CLISCA SYR
C16			CLTSC4 BWI 10:50 1924 11:35	BUF 422 AA 1620 524	FSD
AAIN		SDQ *1839 UVF	MEX *1844 SDQ	HAV *1074 BDA MEX *.	828 MEM AUA *87ÇLTSC4
l1		8:00 982* 9:45	11:00 1853* 12:00	16:05 1028 17:30 18:35 1	768 20:50 TERM 21:35
12		CLTSC-ORIG MBJ GCM *860 HAV AA AA 319 9:00 1615* 9:48	CUN *1283 SJO AA 321 10:50 1087* 11:55	PU *1963 ATL GCM *822 AA 16:21 787 17:50 18:14 856	DCA 320 *1968 Sio *1850LTSCd 19.44 1954 21.55 TERM 22.40

ŗ						CLI 20	33-Scena	1110 4												
	00:00	01:00 02:00 03:00	04:00 05:00	06:00	07:00	08:00 09:0	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
										Lutulutu	lutulutu.		ndududu.						atadaata	lll
13									CLTSC	ORIG CUN 887* 13:30	SJO AA	*672 AUA	A 1		SXM AA	*866 BNA 320 1867 19:49	SXM *613 TERM 21:	C4		
14								PAP AA	*368 1826	13:30 NAS 319	[14:35 MI AA	BJ *843 RI A 2056 16	5  DU MB. 321 AA	J *869 LA 50 749 18:1	1 18:40 N	MBJ *827 AA 1919	MIA 321	:09		
15				CLI	ORIG CUN 804* 7:45		PLS AA	*842 KII 1040* 12:0	1820 IN 19	13:15	14	KIN :	*644 KIN 319	50 /49 18:1 PUJ AA	9 <u>  1</u> *196 643	66 <sup>1</sup>	20:15 LAS CUN *888 321 70:05 TERM	TSC4		
I6				6:55	7:45		10:00 KIN *854 AA	PAP	00	AUA AA	*1542 625*	15:40 2 SJO 738	2456* 16:40 PAP *2364 AA 2541*	PAP SD 738 AA	*639 1865*			21:14 1342 SDQ 321 374* 22:00		
17							9:55 1647*	10:50		13:30	625*	15:40	16:15 2541* CUN AA	*884 BOS 321 1806 17:55	00 1865* CUN AA	*886 PBI	20:15	374* 22:00		
18													16:40	1806 17:55	18:40 P	2061 19:55 PLS *880 O	ORD 321			
l10										FRA *705 CLTSC4	4	FC	O *721 MAD 789 55 748* 16:40		BCN AA	*745 744*	0:05 BCN 332			
I11										13:00 PUSH 14:00	ó	I5: MAD	*74		18:20 LHR	744* *733 732*	20:45 LHR 780			
					GRU	*1062 CLTSC4						15:50 FC	72 0 *721 CLTSC4	4 18:05	18:30	732*	20:15			
l12					7:50	*1062 CLTSC4 332 PUSH 8:50				C	CDG	*787	*721 CLTSC4 789 TERM 16:55 FRA C	LTSC4 PULL	FCO					
l13										A 1	AA 13:55	*787 704*	332 A 16:35 10 LHR	LTSC4 PULL A 720* *731	789 18:25 LHR					
114										DUB		725	AA 16:15	*731 730*	789 18:40 CDG	CLTSC4 PIII I	GRU			
I15										AA 13:05		725 786*			332 18:20	CLTSC4 PULL AA 19:00 1568*	332 20:30			
OADO	1441		CITSC4 HOLD CITSCS	4 MDW CLTSC4	IAH CIT	SC4 DEN		lek lek			BNA 5126 BNA		SEA 5	SEA HOL	HOL				1207	
O1	1441 TERM		CLISCA HOU CLISCA 4:40 643 5:25 5:45 1   CLISCA LAH	ORIG 1010 6:30 6:45	7:50 7:50	ORIG 5290 8:35		10:38 4058 11:15	74		BNA 5136 BNA WN 738 14:00 684 14:45 MSP MSP		SEA AS 16:30 52	26 17:30 17:55	1747 1493 18:30	DTW		2012	1286 TERM	Т
O2	TEF	RM	5:05 IAH  5:05 S 5:50	6:08 ORIG JFR 6:08 6:53	7:20 2266 8:0	DL CS1 B:35 3840 9:15	HUN	LGA 5060 LG/ DL CS 11:14 5069 12:0	S1 00		MSP MSP 1503 14:24 14:59	ATI ATI	DL 13 16:40	322 320 324 17:20	DTW 105 18:40	19:15 19:15		3812 TERM	257	876 TERM
O3			CLTSC4 ORIG 5:15 612 6:00	LAS NK 6:45	165 MCO 320 864 8:00	ATL ATL DL 2422 73H 8:48 9:30	JFK 219 10:01 218	DL 2231 /1	17			ATL ATL DL 2133 73H 15:04 15:45	16:45	135 FLL 386 <sub>17:30</sub>	D 11	1721 18:55 19:30			357 TERM	614 TERM
O4			CLTSC4 DTW ORIG 5:15 1366 6:00	6:50	ORIG 681 7:35	2292 9:04 9:3	9	11716 12:0 ISP 354 F9 353 12				15:04 15:45 LGA 5096 LGA DL CS1 15:06 5099 16:00	MD 16:5	W <sub>853</sub> MDW 50 <sup>1748</sup> 17:25		DL 1407 19:09 20	ATL TTN 933 T F9 20:25 932 21	321 :10	4128 TERM	19 TE
O5			5::	ORIG ORD 58 1712 6:48	SFO 1704 UA 1969	8:20 9:20	DEN 1685 738 10:00		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 CS DL 6227 CS 19:18 6227 20:0	A 51 00		1076 TERM	
O6				CLTSC4 LGA ORIG 6:15 3844 7:00	CLTSC4 ORIG 7:30	ATL ORI UA 8:15 9:26	O 425 ORD 73G 521 10:15	BOS <sub>1245</sub> BOS 10:59 <sup>1246</sup> 11:36	ATL DL 109 12:33	ATL 95 717 13:15		PHL MC F9 1689 3 15:21 16:	CO 320 :09	JFK 4189 JFK DL 3433 CS1 17:19 3433 18:00	JFK B6 18:5	K JFK 1119 E90 :50 19:28	MCO 344 LAS NK 320 20:00 541 20:50		8017 TERM	1974 TERM
O13																				
O14			CLTSC4 ORIG 5:33	BOS 6:18	CLTSC4 FLL ORIG 7:15 8104 8:00	BOS B6 9:24	8025 8020	BOS E90 B6 10:51 FLL B6 11:30 8	3101 FLL E90 12:30			E E	BOS 8021 BOS E90 16:00 8016 17:00	BOS 1445 BOS B6 E90 17:18 1446 18:00					8103 TERM	
O18				CLTSC4 ATL ORIG 2488 7:00	PDX AS 7:15	625 PDX 73H 626 9:00	BWI DAL 3055 9:35 10:10			ORD 1484 ORD UA 319 13:00 1140 13:45		DTW 6 DL 15:40 17	503 MSP 319 793 16:30	BNA 2465 BN. WN 73V 17:20 3113 18:1	A V		CLE 486 F9 489	CLE 320 21:20		522 TERM
O19				C. 7.	LTSC4 SLC ORIG 521 7:45	7.50	ATL DL 1454	ATL 1 739 10:45		LGA 3888 LGA DL CS1 13:14 3642 14:00	A 1	13.10	ATL 602 ATL DL 73H	SFO 1176 UA 1698	5 SFO 739		10.20	21,20		5812 TERM
O20			DEN F9	201 200	DEN 319		MCO F9 1	PHL 028 320		I IATI.	ATL 2597 320		DEN MCO WN 1362 738	ATI.	826 73H			2808 TERM		
O27			5.10	200	7.20		10.11	10.39		13.42	14.50		16.20 17.00	17.30	10.43			TEACH		
O28																				
O29																				
O30																				
O31																				
O32																				
OAIN																				
121													MUC LH	*428 429*	MUC 359			LGW *77 DY 775	51 LGW 788	V 8
122													16:20	429* KEF *: WW 17:40 20	18:35 201 KEF 321			21:05 775	2* 23:05	5
AEDO														17:40 2	02* 18:40					
D13				PHF 519 AE 555	90 PHF CR2	LEX AE	5337	JAN CR7	OAJ 5176 OA AE 12:05 5314 13:00	MGM 5441 2 AE 5154	1 SDF CR2	FAY 383 AE 407	1 IND CR2	TYS AE	5119 5256	FAY CR2 19:50	HTS 5461 CRW 20:15 5049 20:50	DAY 51 AE 21:31 51	56 PGV CR2	
D13				6:30 555	7:35	8:30 MGM 5293 M AE 8:38 5440	5514 GM CR2	BHM 3819 HSV AE 10:59 3909 11:50	CLE 5282 GNV AE 5282 GR2 12:05 5063 12:50	TY	rs 5294 TYS	GPT 5095 CID AE 5096 CR7 15:05 5096 15:50		17:10 5063 CAK CR2 5259 18:04	5256 SHV <sub>5514</sub> TI 18:30 <sup>5254</sup> 19:		20:15 20:50	LEX 52	264 MGM	
D10			GS	SP DCA GNV 3802 AE	5228 LEX CP2	FAY 5273 TYS	9:45	CHA 5277 EVV	CRW 5237 BHN		5120 PHF 5052 14:25	EVV 5032	EWN	PHF 5052 L	EX	5366		21:36 52	298 CR2 22:41	
D8			5:5	57 6:32 6:52 LYH 473	8 OAJ	8:40 5297 9:35 FWA 5406 CR2 8:49 5176 CR2 8:49 9:26		LEX 5039 FAY AE 5039 CR2 10:40 5463 11:20	AE 12:15 5164 13:00  HSV 3906 C AE 3960 C	0 13:43 -	5052 14:25 PGV 5117 FAY AE 5117 CP2	OAJ 5314	4 MGM	FWA 5135 DAY AE 5135 DAY CR2	:14 AVL	TERM 4769	TRI AGS	4001	GSP CR7	
D6				6:22 488	O 7:40 CAK <sub>5355</sub> CHA	TRI 4852 LYH		10:40 5463 11:20 PHF 5557 TYS AE 5597 CR2 10:39 5294 11:18	12:25 3960 13 BHM 5142		14:07 5486 CR2 14:07 14:45 VPS CR7	15:33 5222 ORIG	2 16:19	17:11 5156 18:00 BHM 531	18:42 1 CHA	4895 TRI 4786 AE 4755	20:15 20:38 EWN	3795 CHO 5552 AE 5177	22:40 CRW CR7	
				TYS	7:08 <sup>5277</sup> 7:43 GSP	8:16 4820 9:35	5122 5364		GNV <sub>5371</sub> TY		5 5453 14:40	3973	OAJ	FAY	16 CR2 18:25 5486		GNV	YS 5037	22:35 AVI	
D4				AE 53 6:24 CRW	54 CR7 7:45	HTS FLO DAY AE 8:00 <sup>4850</sup> 8:30 8:51 LFT CP2	5364	MOB 55	GNV <sub>5371</sub> TY: 12:25 <sup>5305</sup> 13:00	0 AE 13:37 SHV	532 522 CAE 53	26 1 327 EVV CR7	CR7 16:14 5513	AE 17:05	5172 31 TUL		CR2 20:25 2	AN 5257 E	22:25 BTR	
E1				AE 6:45 EWN		5335 9:36	SGF 270	10:45 5:	514	13:15 LF1	AE 14:03 52	327 EVV CR7 204 16:00 GNV HPN CR7 AE	5526 HPN	ROA 4829	271 18:30 LYH	PULL 5147 HSV 397	A 20 73 YUL AV	DE 5257 0:58 5407 22 CL 5326 CAK	2:15	
E2				AE 6:35	4921 GSO CR7 4826 7:50 5058	AE 5234 CR2 8:11 5187 9:19	SGF 370 AE 370 10:09 321	LIT 5183 EYW	RAP CR9 12:10 AVL 4751 LY	AE 13::	50 5459	CR7 15:15 AE 15:44 MGM 5366	5166 17:00 LFT AV	17:16 4798	CR7 18:30	AE 397 19:21 391 2344	5 CR7 AE 5 20:25 20:	5320 CR7 555 5124 22:05	MGM <sub>5491</sub> AEX 22:27 22:59	
E3				TRI 48	PUSH		PULL 5343	AE 5183 CR9 11:00 5220 11:45	12:12 4804 13:	13:31 53	19 14:25 1 8 5263 DAY	14:57 5096	CR7 AE 16:20 16: 2 MKE T	LH 5218 GNV	TE	5209 AGS	AE 5411 CR7 20:00 20:40 MEM CALLED	OAJ 4931	LYH	
E5				6:39 49	942 7:35	8:22 5251 9:35	KISP	10:44 5364	54 13:01	0 13:4	49 5123 14:41	SDF AE 15:17 3959 VPS		6:55 5202 17:55	18:43	5398 19:45	AE 5265 CR9 20:05 141 20:45 LGA BTV	21:24 4922	22:30	
E7					ROA FAY AE 4776 CR7 7:04 7:40	PHF 5383 GPT CR7 8:10 5320 9:20	AE 10:10	5467 FPO CR7 5593 11:45	TYS 5297 AE 12:20 5512	13:10	HPN 5384 MLB AE CR7 14:02 5302 14:50	AE 15:50	5138 HTS CR7 5200 17:00	CRW 4749 AE 4931		5437 CAK CR7 5306 19:45	AE 4460 E75 20:00 4582 20:40 2	AE CR7 21:00 4799 22:05	ннн	
E9					AE 5328 CR2 7:14 7:50	LYH 4886 SBY AE CR7 8:12 4831 9:20	AE 10:2	3908 MYR E75 21 3777 11:19	SAV 5185 CHA AE 5185 CR7 12:07 5582 12:50	AE 13:4	4904 ROA CR7 48 4829 14:35	EWN 4773 L AE 4779 C 15:06 4779 16	CR7 :10	CID 5456 CID CR7 17:04 5429 18:04	AE 18:	E 5230 CR7 3:52 CAK 5036	VDS	21:15	CR7 22:20	
E11					H <sub>4915</sub> ROA 6 <sup>4763</sup> 7:30	TLH 5213 AE 5183	VPS CID CR7 AE 9:50 10:18	5320 CID CR7 5423 11:45	HTS 4866 AG AE 4805 13:0		1800 CHO 1743 14:19		5582 GPT CR7 5083 16:40	EWN 4939 R AE 4807 18		CAK AE 19:18 5143	CR7 20:20	AE 30 21:35 50	074 EVV CR7 038 22:40	
E13				CHS 524 AE 529	16 SAV CR9 7:45	EWN 4884 CR 8:32 4841 9:4	FAY AE 10 10:07	4934 FLO CR7 4904 11:33	GSP 5067 LEX AE 5153 12:55	AEX 5375AEX 13:14 13:46		PHF 5364 L AE 5283 16	EA FPO CR7 AE :10 16:41	8 5105 CR7 17:45 18	AB 5315 OKC CR9 :00 5258 18:45	AGS 4907 AE 4870	CR7 20:09	GPT 5083 S AE 5393 22	:R7 :14	
E15						MOB 5278 AE 5396	AGS CR7 9:45	OAJ 4889 EWN AE 4773 11:55	GSO 4903 TRI AE CR7 12:18 4765 12:59	MOB 4 7 AE 13:42	5251 LEX CR7 5078 14:25		5257 16:35	HTS 4759 HHH AE CR7 17:18 4813 18:05	O/ AE 18	AJ 5226 SDF .E CR7 8:53 5477 19:49		LYH 4798 AE 4744	22:30	
E17				MYR 53 AE 53 6:29 53	57 CHS CR9 7:40	OAJ 5113 CVG AE CR7 8:13 5466 9:20	PI Al	IA 5349 PIA CR7 0:26 5431 11:19	LYH AE 4820 12:32	GSP BTR	S 5225 BHM CR7 17 5311 14:30 14	NA 5569 ICT AE 4:55 <sup>5196</sup> 15:32 15:	X 5153 BTR CR7 55 5074 16:45	ORIG 4796	GSP AE 18:4	P 3833 MKE CR7 49 3889 19:44	FAY 5105 HSV AE CR7 19:59 5224 20:40	MDT 5180 AE 5156	PHF CR7 22:30	
				p.22	7.30	7.20	1 10		(2.32	p3.4.	. 4.50	13.	10.40		10.4		20.10	2.2		

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E19			шшшщ		шшшшш	SAV 5.	3452 MYR CR9 7:40	AVL AE 8:21 5152	CHO CP3		MKE 3896 SDF AE 3798 11:40	TRI ROA	CRW 4824 HT AE 4759 14:	S MSN CAK	TRI 4765	AVL	OF	RIG 037	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	col conv	CDU	15:38 4769 FLO 4862 ROA	16:24 DSM	50	5378	19:15 4780 SA CR	T FWA 5	476 LEX	
E18						AGS 529 AE 509 6:31 GSO	MEM	8:18 5509 CR CRW 5347 BH	DCA GSP 5260 99 9:24 9:59		AE 10:50 5462 CR7 10:50 5462 11:40 IND 4484 CMH	EWN <sub>4936</sub> F 12:29 <sup>4862</sup> 13 RDU 5415	15:39	11 CR7 19 CR7 14:19	AE 15:20 4842 16:05 LYH 480	AE 16:45	LFT 5064 MLB	5036	20:0	4777 HTS	235 21:30	50 LEX
E16						AE 6:52 ORF 5460	5026 CR9 7:50	AE 5347 CF 8:16 5142 9:1 AGS 5439 BT	R7 10	A I BTR	AE 4457 E75 10:46 4457 11:45	12:19 5288		4879 <sup>EWN</sup> 4939 0 14:25 MYR 3777 AVL	15:47 478		LFT 5064 MLB AE 5064 CR7 16:58 5376 17:40	PHE	19:40	4767 CR7 20:30	MOB 506 AE 21:40 552	CR7 20 22:35 A 5066 GSO
E14						AE 6:27 5268	7:24	8:21 5225 9:0		AE 10:34	5507 CR7 5263 11:14	TLH 50 AE 12:28 54	137 CR9	AE 4011 CR7 14:01 14:40	CHO 5048 CAE AE 5048 CR7 15:30 16:10	ce	17:38 5.	319 CR7 361 <sub>18:20</sub>	AE 5283 CR7 19:16 5221 19:56	CAE	21:15 21:46 22:0	01511222:45
E12						6:46	5342 STL 5073 CR9 7:40		5232 MSN CR7 5060 9:45	A 10	AE 4850 CR7 10:45 11:25	GRB 5674 AE 5036	PNS CR9 13:15	AE 5179 CR7 14:01 14:40	ROA AE 4926 ( 15:41 10	CR7 5:19	AEX 5060 FWA AE 5324 CR7 17:05 17:45		YYZ 3834 AE 3968		CAK 5259 AE 5438	CR2 22:30
E10						ILM 50 AE 6:41 50	061 7:29	CAK AE 8:37 500		A I	MSN AE 10:45	5231 5104		HPN CR7 14:33	PIA 5186 <sup>4</sup> 15:43 <sup>5310</sup> 1	6:20	MOB AE 5512 CR7 17:10 17:49		MGM AE 19:40		5222 5304	MOB CR7 22:40
E21						IAD 53 AE 53 6:44 53	399 IAD CR9 373 7:30	BHM 5346 8:30 5237	9:20	ORIG 5632	SDF AE 11:05	50° 53°	93 23	IND CR7 14:50	AGS 4805 PC 15:40 <sup>4869</sup> 16:	16	HHH AE 17:31		48 49	392 925		TRI CR7 22:25
E23						CMH AE	4544 DTW E75 4542 7:45	MKE AE 8:50	3850 CAE CR7 3814 9:45	GSO 4: AE 10:30 4	826 ROA CR7 879 11:14	STL 5073 ILM AE 5345 12:59	H	нн <sub>4844</sub> ннн 3:5 <sup>4892</sup> 14:30	ORF 3773 BHM AE 275 15:07 3865 16:05		CHO <sub>4918</sub> FLO 17:01 <sup>4777</sup> 17:35		GNV <sub>5252</sub> BTR 19:18 <sup>5024</sup> 19:50		CHS TYS AE 5138 CR9	
E25						PH	HL 3899 CAE E E E75 58 3908 7:45	HSV 5329 8:33 5185	SAV	10.50	HHH CRW 4942	JAX AE	5458 5087	CMH CR9	JAN 5514 15:40 <sup>5148</sup> 16:	W	CHA AE	5508 5233	OAJ CR7	H A	PN 3945 ORF E 3904 CR7	
E27						0.2	38 3700 7.43	6.33 5105	ORIG 5294	BTV 4649 AE 10:214618		XNA AE	5388 TV 5158 CI	C GRB 5531 ABE	4933 4809		DSM 505 AE 527	5 DSM	LIT AE	5440 TUL 5880 CR9 5880 20:40	CAE 3775 MKE AE 4056 CR7 20:59 4056 22:05	
E29							3967 BHM 3819 7:35	CHO 4876 HTS AE CR7 8:15 4866 9:00	SBY 4770 AVL AE 4751 CR7	0M AE		253 SAV CR9 266 12:59		5245 PNS CR9 5212 14:50	AVL AE	5086 5180	16:58 327 MDT CR9	BTR 5500 F	HSV IAD 55	502 MSY CR9 232 20:30	5361 TERM	
E31						(	ORIG	MLB 5	9:15 9:50 175 HPN CR7	10:	CVG	5268 DTW	I3:28 ILM AE	5212 14:50 1 538 52 524	15:29 6 CV	5180 9	PWM 5034 AE 5070		9:05 19:26 52 SAV OR AE 5056 CR	LF.	5049	
E33						T	5432	FLO 491	384 9:30 14 EWN MLI AE	5111	10:49 GRR CR9	5458 13:00 IAD 5509 AE 5509	CAK GSO AF	52 524 5372 MEM CR9 5494 14:40	MYR AE	5053	17:10 5070 LGA TVC CR9 AE	5216 DAB CR9 5480 18:50	19:00 20:0 DAB AE	5:	TERM 335	CHA CR9
E35						CV		8:43 493 5341	36 9:24 9:40 OKC CR9	5514 BHM AE	5356 PV 5474 11:50	D AUS 5171 LIT		TUL 5357 GRB AE CR9 14:00 5227 14:55	CVG 5166 AE 5229 1	5066 CHS	17:25 17:40 OMA AE 5131		19:36 EM 5494 CHS CR9	GSP AE	238 <sub>2</sub> 5214	2:20 BNA CR9
E38						CHA	5165	5116 JAX CR9	9:20 CVG	10.13	5474 11:5 OMA CR9	PULL	13:10 <sup>5314</sup> 13:44	14:00 5227 14:55 17 DAB	CHS 5084	LIT BNA	17:06 SDF CR9 5 5049 17:54	18:20	NS 5212 CVG	19:59	5336 MYR 5449	22:40 CHS
						AE 6:29	5457	8:50 SRQ 5390 TLH	9:10 SGF	5128 5504 5177	11:20 TVC	5172 FAY 5487 CHS	JAX 524 AE 13:32 53 SRQ 51	39 SAV	15:30 5088	CR9 AE 16:30 16:45	SYR	CHS	1:50 5303 19:45		20:59 5114 ILM 5451	22:35 LIT
E36								AE 8:04 5091 CR7 8:04 5091 9:00 BDA	AE 9:15 BHM	5037 5204	CR9 11:24 OKC CR9	AE CR9 12:10508412:54 MYR 5289 MYR	13:37 51	51 14:27 A 5433 CHS	5072 CR9 15:59 CLE 5436 M	ſYR	AE 5377 17:16 DTW	18:20 MVR	AE 5144 CR9 19:01 19:55 IND 5189 GR9		AE 21:03 5200 AUS 5301 AE 5301	22:35 MEM
E34								8:15 682 9:00	AE 9:15 MKE LNK	5033	CR9 11:20 PNS	12:15 5053 12:59	AE 13:45	5181 14:35	AE 5430 15:25 5170 1 SAV 520	6:20	AE 5249 17:22 CAK 5243 CLE	9 CR9 18:20 GS	18:58 5155 19:50 50 5418 DAY	GSC	AE 21:05 5299 DAY CPR	CR9 22:35
E32						IND	AGC1 IND	8:16 5267 S	0KE LNK CR9 AE 9:14 9:33	5575	CR9 11:25 CHA	MEM SYR AE 5184 CR9 12:07 12:50		GRR 5533 ATL AE CR9 14:05 5192 14:55	15:42 500 MDT CMH	OO CR9 A	6:53 5331 17:50	AE 18:	:49 5101 19:40	AE 20:4	5 5374 22:05	AVP
E30						AE 6:51	4661 IND E75 4531 7:55	0.110	27 GRR CR9 33 9:25	VPS 5157 AE 5179	11:14	MSN 550 AE 12:25 53:	27 E75 AE 13:30 13:	5033 MKE CR9 1 5098 14:40	AE 5064 CR9 15:07 15:59			5291 EYW CR9 5271 18:30	AE 5420 19:19 PNS	CR9 20:10	ORF 5455 AE 5099 2	CR9 2:20
E28								CHS 5207 AE 5289	CR9 9:30	SRQ AE 10:10 532	22 11:20 11	5514 CR9 :40 5255 12:20	A I	KE 5267 ABE CR9 3:56 5140 14:45	OKC 5116 SDF AE 5300 16:05	cso	ILM 5285 (AE 17:14 5455 18	CR9 8:05	MYR 5170 PNS AE 5103 CR9 19:00 5103 19:50		PNS 5094 CVG AE CR9 20:55 5109 22:05	
E26									5194 IND CR9 5568 9:55	MH1 AE 10:30	5162 CVG CR9 5166 11:40	PGV 5187 CHO AE E75 12:05 5048 12:49	OKC 5504 MYR AE 5504 CR9 13:18 13:57	SYR 5223 AE 5349	CLE ILM 5345 CR9 AE 5418	16:25	AE 5286 CR9 17:05 17:55		AE 5047 0 19:16 20	1H 1 CR9 0:05	4796 TERM	
E24								SDF 54 AE 52 52	495 PNS CR9 255 9:45	XNA AE 10:28	5350 BHM CR9 5178 11:35	ILM 5107 AV AE 5189 13:		NS 5255 DTW E 5256 CR9 5:56 5434 14:45	BHM 5178 IAD AE CR9 15:10 5502 16:00	AF 16	VD SRQ E 5125 CR9 6:51 17:40		CHS SRQ AE 5227 CR9 19:03 19:50		IAD 5286 AE 5451	SAV CR9 22:30
E22								MYR AE 8:47	5431 SYR CR9 5260 10:00	AI 10	E 5474 PWI E 5034 CR 11:5		32 BMI O E75 A 131 13:30 1:	RF 5081 MYR E 5313 CR9 3:56 5313 14:45	PIT SA AE 5043 CR 15:24 16:1	V 9 4	CMH AE 17:41	5087 GSO 5121 18:30	CVG 5169 AE 19:265307	DAB CR9 20:10	CVG 5281 21:22 5211	BHM CR9 22:30
E20								GSO 5 AE 8:36 5	5417 CAK CR9 5245 9:45	CLE AE 5 10:21	MDT 5080 CR9 11:25	CMH 453 12:27 467	8 MCI DAB 5: 5 13:24 DAB 5: 13:40 50	317 IAD CR9 031 14:25	IAD DAB AE 5035 CR9 15:15 16:04		XNA 5193 CVG AE CR9 17:04 5281 17:50		CHO <sub>4809</sub> ROA 19:10 19:44		XNA AE 21:33 516	6 MYR CR9 11 22:40
E8								LIT AE 8:45	5158 SDF CR9 5330 9:50	AVP 51 AE 53	370 11:20	DTW 4542 1 AE 12:23 4510			AE 5035 CR9 15:15 16:04 AVP 5322 AE 15:36 5236	XNA CR9 16:25	MYR 5313 B AE 17:19 5182 18	BHM CR9 8:05	DTW 5435 AE 5169	ABE CR9 20:15	LIT 5088 AE 5334 2	SDF CR9 2:20
E6									343 FAY CR9 9:40	DSM 512 AE 522	29 ILM FV CR9 AI	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			5154 AVL CR7 465326 <sub>18:30</sub>	LYH 4779 CHO AE CR7 18:59 4885 19:49		SRQ 516 AE 21:39 533	1 JAN CR9 13 22:35
E4								BNA	5325 DAB CR9 5317 9:50	SAV	5504 DAY CR9 5115 11:35	IND 4470 G AE 4537 I3:		191 CVG CR9 035 <sub>14-25</sub>	NK 5084 LIT LE CR9 5:05 5100 15:50		MDT 4510 JAX AE 4662 E7 16:56 4662 17:5	X 75	BHM 3	3865 HPN CR7 4023 20:40	CLE 533 AE 525 21:39 525	1 ILM
F1								<u>[8.49]</u>	ICT 5316 AE 5164		DAY 5042 XN AE 5193 11:5	A CAE 3814 F. AE 12:22 3831 13	75 AE	5051 RIC 5072 CR9	MEM 5058 7 AE 15:35 5208 10	YS CR9	SAV 5070 GSP AE CR9 17:09 5214 17:50	554 TEF	46 EV	VV 5006 MGM E 5468 CR7	PULL 5503	
F2								ORIG 5531	5292 PUSH	10.30	CMH 5061 PIT AE 5061 CR9 10:50 5522 11:45	AGS 5396 AE 5135	FWA SAT CR7 AE	5046 CR9 5265 14:26	PWM 5572 GRR AE 5567 CR9 15:10 5567 15:50	5.19	CVG AE	5398 5040	19	ICT CR9	MKE 3959 AE 21:37 4010 2	CAE
F3								GRR	5534 RDU 5415 CR9 5415 9:40	CHS 5	5309 GSO CR9 5350 11:20	CHO 5152 A AE 5086 13		ICT MHT AE 5103 CR9	OMA 5431 DSM AE 5165 CR9	SHV AE	5815 SHV 5379 E75 5379 17:35	1 10	M IND E 4572 E75	0:06	GNV 5202 AE 5287	CHO E75
F4								DAB 5352 AE 5139	2 SRQ	YUL 39 AE 26	916 GSP CR7 989 11:35	12:12 3080 13:	509 PUS	14:07 14:45	15:20 16:00 PNS AE	559 500			ABE 5140 OMA AE 5140 CR9 19:06 5248 19:49		VPS 5065 TL AE 5349 22:	22:30 H 75
F5								ORIG	ROA 4790 GSO	10:06 35	TUL TUL AE 5054 CR9			CMH <sub>5414</sub> TUL	DAB AE	300	5460 5053	18:25 LI CR	19:06 3248 19:49 TT SDF R9 AE	5	300	XNA CR9
F6								5371 CMH 454 8:36 454	9:15 4903 9:55 17 YYZ E75	EVV AE	10:50 11:40 5241 MLB CR2		BNA AE	14:00 <sup>7542</sup> 14:35 4695 OMA E75	15:30 CMH 4457 ILM AE 457 E75		5431 TERM	19:0	JAN 5315 AE 5315	LAN E75	219 CMH 4554 CMH AE 4554 E75	22:30
F7							ORIG	CAE 3826 HS AE 3906 9:0	40 9:27 5V 75	ILM 4	5132 CR2 11:40 5082 DSM CR9		13:42	4556 14:55	AE 15:21 4674 16:09 AUS AE		5200 5456	SGF CR9 18:50	AE 18:55 5732 5163	20:10	21:14 4579 22:09 5186 TERM	
F8							5547	(	ORIG	MYR 538	5055 11:20 89 SAV CR9			RIC AE 4618 GSO 14:02 4695 14:45	15:30 MLI AE		5456 5267 5514	18:50 R.	TERM  AP AE 19:21512720	IAD CR9	5256	
F9								ORI	5129 IG	ABI	CR9 51 11:10 E 5134 MEM CR9		SHV JAN AE 5767 E75 13:15 5326 13:55	14:02 4695 14:45	15:39 GRR		5514 5043 5236	19:	BHM	PULL	5182 TERM	<u>/                                    </u>
F10						OR	dG	LFT	53	90	39 5058 11:25 CAE CR7			P 3989 YYZ :54 <sup>3834</sup> 14:30	15:50 SAT		558	37	19:30 LNK CR9	5421	HSV 5050 PIA AE 5041 CR7 21:06 5041 21:45	
F10						520	ORIG ORIG	MDT 4669 CM	500	SBN 5586 SF AE 5328 10:	11:19		13	:54 <sup>3834</sup> 14:30	AE 16:0 SBY	5851 MSN	555 LEX 5078	8 CHO 1	19:45 MCI 4675 CMH		5099	
						5279	5082	AE 4009 E: 8:08 4538 9:1	ORIG	10:05 5328 E			VPS	5183	CAK	0 5321 16:45	17:25 5552		18:55 4624 19:44 PHF	CID	TERM 5530 GPT CR7 5491 21:30 TER	0
F12						5279 PUSH	ORIG		5452 LAN 5864 SBI	TUL 5106	PULL 5117		AE 13:4 JAN	5223 5071 CHA	BMI 4867	BTV	5253 PUSH	AE 18:38 BMI 468	5385 E75 19:50	5337 AE 20:40	5491 21:30 TER	M
F13							5079	ORIG	9:20 5378 10:0 YYZ 4464 BNA	TUL 5196 AE 5196 10:20 5081 ROA <sub>4763</sub> HF			AE 13:47	5508 14:27 ECP 4627	15:25 4837	16:40	AE 5757 E75 17:03 4001 17:55 5181		85 19:20 CRW 51.48 FWA	TERM	JAX 4636 4636 21:33 <sup>4554</sup> 22:10	
F14							ORIG	5573	9:19 4684 9:59	10:21 4844 10:				AE 4027 14:25 4373	MDT TYS 53 E75 AE 50 15:37 50 CAE 3960	65 E75 16:45	TERM	RAP 5126 YN	19:05 5405 19:49	5077	OMA 4556 IND	
F15							5252 ORIG		294 ILM 525 9:25 117	EYW 5579 LN AE CI 10:10 5331 10:				SBN 5485 F	15:22 3833		GSO IND AE 4522 E75 16:59 17:50	RAP 5126 XN. AE 5321 19:0 584 SBN F36	5814	TERM	OMA 4556 IND AE 21:05 4495 22:05	MSY
F16							5290	PU	JSH	A	RIC 5290 CLE AE CR9 10:45 5436 11:35	*****		14:30 5926 15	15 AE 15:30 4378	16:30	17:35 57	584 SBIN E75 783 18:20	TERM	5055	AE 447 21:39	MSY 26 E75 22:35
F17								ORIO 5136	6	leen	AE 10:47	5252 5285		CR9 14:35	GSO 4537 AE 4498	16:27	MSY 4662 CMH AE 4506 E75 17:08 4506 17:50	AE 18:43	4842 SBY CR7 4835 19:50	5076 TERM		
F18								OR) 550	IG 09	ECP 4839 AE 4781	ECF E75 11:05			YYZ 4546 L AE 4566 15	15 15:55	90 16:24	YOW 5543 AE 5265		307 ERM	5382 TERM		
F19															3909 TERM						YYZ 4498 M AE 4636 <sub>2</sub>	4DT E75 2:20
07					ORIG 6238						CVG CVG 4845 11:06 11:36			EWR 364. UA 335	EWR E7W 15:30		6 <sup>4843</sup> 17:21	YZ YYZ EWR 7348 UA (349 18:20 18:45	R 3368 EWR E7W 5 3365 19:30		6302 TERM	
O8					ORIG 3312				IAD UA 61 9:42	IAD YYZ 150 CR7 10:22 10:3	Z <sub>7346</sub> YYZ 3 <sup>734</sup> 71:10	EWR <sub>3367</sub> EWR 11:52 <sup>3311</sup> 12:27					WB 8011 I	LWB ER4 8:06				
O9						•			L	.GA <sub>3337</sub> LGA	IAH 6165 IAH 11:04 <sup>6310</sup> 11:41				TUL <sub>7350</sub> YUL 5:05 <sup>7351</sup> 15:40		IAH 6245 E	IAH E7W 8:05				
O10						ORIG 4663			J.	MSP 39	MSP 966 11:07	BKW VC		2030 2140	13.40	BI	KW EM2 7:05				4781 TERM	
						1003				10:32	11.07	12.00		2170		17	7.03	1	1	1	LINIVI	l



# **CLT 2033 Gating Scenario 3**

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	111111111	<u>utulutu</u>	minimin	111111111		ndududu	ntulutu	lutulutu	lutulutu					Intoloto				Intulutu	lutulutu	lutulutu				
AADO						CUTCOL DELL						NO.	(opp.							nurs curre	COL DIO	DEN. TRA		
A21						CLTSC4 ORIG DFW 5:15 2451 6:00	AA 6:46		1	2011 1797	t CA	321 11:20	AA 628 32 11:57 13:0	1 AA 0 13:20	pest	bwa	1051 275		1	321 19:10 19:45	ORIG RIC ORIG 5 20:30	AA 1873 321 21:18 22:15		
A22							AA 6:14	8 20	98 )57	321 9:45	AA 879	11:40	AA 12:00	445 580	321 14:20	AA 15:15	torw -	1889 1798	1	20	321 AA 0:05 20:40	892 PHX 321 472 22:15		
A23							AA 6:02	476 840*	d loos	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 0 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	NCO	LAC	AA 703 321 16:55 17:45	AA 1809 320 18:02 18:55	TUS AA 19:10 843	319 A. 20:10 20	PA 2039 DFW 321 22:10	SVI	
A25							SAN 579 6:04 662	7:30	(ORD	DTW 925 FNT AA 319 9:06 1109 9:52	AA 10:38	1977 1936	321 12:10		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	21	
A26							6:45	ORIG PHL 1956 7:30	8:20	580 321 9:40	FLL 173 AA 826	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 22:1	21 20	
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	CEAL CEO	AA 17:40	1836 1841	321 19:12	MCO	PHX 499 I AA 1865 2:	321 2:25	
A28							PHX AA 2020 6:09 2091	7:30	AA 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 3 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 8:	58 321 11:30	AA 2044 12:04	321 AA 13:20 13:37	581 321 14:45	AA 494 15:00 1	321 6:15		30 LGA 321 740 18:40	STL 1768 PIT AA 1747 19:54		AA 1857 32 21:13 22:1	9	
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	25 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:	21 10	C22 TPA	CLTSC4 ORIG 18:29	19:14	STIL	AA 1717 321 21:09 22:10	702	
A5						CLTSC4 LG ORIG 5:20 2060 6:	AA 6:47	1364 738 7:45	AA 883* 8:10	9:25 TPA	AA 885	11:25	AA 87 12:27	3 321 AA 13:24 13:	1810 PHL 321 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 619 19:30 19:45	793 319 5 20:33	TERM TI	783 ERM	
A7					lej re-	C4 ATI	A. 6:	A 469 32 52 8:00	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	899 SFO 321 705 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 2	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	21	
A11							0.43	C4 ORIG 928 7:30	AA 423 8:11 1965*	9:25	AA 67 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:	21 10 W	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	Corig SAT	8:21 4	13 9:35	10:13 205	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 DEN 428	21 10 TPA	AA 181 17:21 565 PHX 767	321 5 18:30 SMF	AA 1920 19:12 SEA 633	321 20:20 SEA	AA 745 321 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	321 11:25 STT	12:23 144	17 13:26 AA 13:45	5 695 14:35	15:24 1791 MSP	RSW	AA 767 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 LAS	321 16:25	AA 1775 321 16:54 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 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 19	2064 321 11:40	11:59 2054 13:0	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 W 808	21:04 1998	320 22:30 973	
A4								CLTSC4 ORD ORIG 7:10 1916 7:55	AA 8:41	1960 321 9:40	BOS 190 AA 172	29 11:20 CLTSC4 BWI	AA 2078 13	319		AA 504 321 15:05 15:59 SRQ 1130 DI	EN .	BWI 1915 AA 2038	320 18:15	AA 1820 32 19:02 20:0 MCO 746 PHX	TERN	1 TI	ERM	
A2							CL	rsc4 FLL	RSW 41:	3 MSP		10:50 1924 11:35	BNA AUS			AA 1130 3 15:20 184 16:	21 10 AX 819 SJU A 221	MCI	MIA I.	AS 463 321 18:59 463 19:55	MSP	TERM 1998	ATL	
B1						си	SC4 PHL	0 525 7:35 DCA PIT	8:28 71	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	EWR	A 972 321 5:00 972 16:50 MIA	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 821 10:01 876	IAH	AA 1973 12:23 BDL RI	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	16:57 721 321 16:57 721 17:40	CLTSC4 ORIG 18:28		TE	RM TERM	PHL	
B5							6:00 1872 7	738 :05 JFK	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 15:30 18 MSY 1821 RI		17:25 1915	1692 T	2084 ERM 451		AA 1796 21:26 2: DTW LGA	321 2:25	
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	19 09 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 1954	2039 22:10 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 2448 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 178:	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 A	<sup>7K</sup> 1577 SNA A 1577 738 5:00 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	10:35	) 1	1849	13:15 DTW	756 319 756 319	BNA 1886 JAX AA 319 15:14 2032 15:59	A 5:00	1673	PDX 1853	321 19:11 TERM SJC BNA 194 738 AA 19:24 73		BDL 1952	BUF	
B14							6:34	7:30	8:43 CLTSC4 ORIC 9:29	9:55	MDT	1753 34 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 <sub>1</sub>	JFK 101	3 20:25 EWR BWI	21:12 2: 864 2035	2:25 JAX	
B12							PIT	1903 PVD	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 I	NAS AA 859	PIT 319	MSY 732	20:10 20:38 BUF 738	1971	22:35	
B10							6:42	7:35 C4 <sub>RIG</sub> ROC 868 7:30	8:04 9:0 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 DCA A 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 AA 1909	11:30 11 MSY	245 751 12:30 CLTSC	13:26 4 ORIG 887* 13:30	14:15	15:02 16:00 RDU	1962 BWI 1962 319	CLTSC4 BUF		ROC AA 1921	JAX 319	TERM AUS AA 1893 319	2005 TERM	
B6							(	7:05 2011 7:50 CLTSC4 BWI ORIG 3773 7:40	8:15 829 BUF AA 829 8:08 1941	9:30 DTW 319	10:11 PWM	11:03 ATL 1814 319	12:40	13:30	CHS DCA AA 1938 319	15:44 CLTSC4 ORIG 15:35	16:45	17:15 1242 18:00 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	8:44 PIT AA	1978 NAS	10:10 OK 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	21:04 22:14 MSY AA 1793	PIT 319	
C2									8:35 DTW AA 1942	852 9:40 BUF 319	ALB 1	42 11:45			2017 PUSH	DTW	5094 16:44 02 319	RIC 5321 AA 5563 1	BNA DO	19:04 1720 19:49 CA ILM A 1979 31	334 TERM	21:20 2:	2:25	
C4									8:08	9:10 CHS 795 319	MCI	1797 IND		CLTSC	PUSH ORIG PBI 1789 14:25	MCI AA	16:30	422	18:10 18	ELP DFW 50	60 DEN	ALB AA 2070	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 194	5 ALB 319	1540 106 PUS	65	1976	16 20:20 CLTSC4 PUL 20:32 100	21:22 2:	ORD 321	
C8									8:38 ORF AA 1770	OPE	10:14	76 GCM				15:35 184	D 16:24 BUF AA		422 524	TERM FSD 319	20:32	21:17 21:39 SAT ROC AA 1870 319	22:35	
C10							Ċ	CLTSC4 CUN ORIG 804* 745	8:29 CLE AA 17	9:15	10:20 82 STL AA 19	DTW				PHL AA 20	PBI 47 319		584 PUSH	844 TERM	CLTS	21:25 22:16	RDU 354 321	
C12							<u> </u>	2.55 7:45 2LTSC4 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							6	7:45	8:	9:45	+	CLTSC4 MCI ORIG 10:55 1964 11:40	12:15			15:20 RIC 1	16:19 864 PIT 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:	4EX 319			15:41	143 16:35	AUS AA 1840	RDI N	AAS 605 PL AA 1029* 20:0	0 S 9	20:57 22:05 CLTSC4 SY PULL SY	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		
I1									SDQ *183 AA 9820	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 *1	CLTSC4 850 ERM 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 8J *843 RI 353 2056 16:	1028 DU MI 21 A/	17:30 BJ *869 A 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>10</u> 16	30 749 1	18:40	1007 19:49	1934			

		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
10		ntulutul			ntulutu		1111111111		ntulutu	lutulutu	hitaliiti	lutulutu	ntulutu	Intulutu	lutulutu	lutulutu	lu lu lu lu	datalata	ntulutu	ntulutu
H	13						KIN *854 PAP AA 319 9:55 1647* 10:50				SJO AA 14:35	*672 AU 617* 32 616:0	A 11 55		GCM *: AA 18:14 8	822 DCA 320 356 19:44	CUN *88 20:29 TERI	CLTSC4		
16	14						PLS * AA 10:00 10	842 KIN 319 340* 12:00					PUJ * AA 16:21	*1963 ATL 738 787 17:50		MBJ *827 AA 18:56 1919	MIA 321 20:15 20	UA *877 0:50 TERM 21:35		
17 18 19 19 19 19 19 19 19 19 19 19 19 19 19												KIN AA 15:40		PUJ AA 17:42	*19 64	66 1 3 20	.AS 321 0:05			
10							CU AA 10	UN *1283 SJO A 321 1:50 1087* 11:55					PAP *2364 16:15 2541*		SDQ AA 18:00 *639		UVF AA 20:15	*1342 SD0 874* 32 22:0		
110 111 113 115 116 117 117 118 119 119 119 119 119 119 119 119 119													CUN AA 16:40	*884 BOS 321 1806 17:55	CUN AA 18:40	*886 PBI 321 2061 19:55	20:24 TERM	21:09		
101 102 103 103 104 105 105 105 107 107 108 109 109 109 109 109 109 109 109 109 109						N. CUTSON				CLTCC			l III			PLS *880 O AA 18:55 1851 20	RD 321 3:05			
112 113 114 115 00-00 00 00 00 00 00 00 00 00 00 00 00					AA 7:5	*1062 CLISC4 A 908H 332 PUSH 8:50				*705 CLISCS AA 705 CLISCS 789 13:00 PUSH 14:00	9		AA 16:15	*731 730*	789 18:40					
H4 H5 OAFD O71 O72 O73 O74 O75 O77 O77 O78 O79												A.			N.B. K.HB		Lup			
H4 H5 OAFD O71 O72 O73 O74 O75 O77 O77 O78 O79												AA 15:5	*7. 0 72	24 18	332 AA 8:05 18:30	*733 732*	789 20:15			
15											'ng	A. 15	*721 CLI 3C4 789 :55 TERM 16:55	CLTSCA BANK	AA 18:20	*745 744*	332 20:45			
OADO O1 O2 O3 O4 O5 O5 O6 O6 O7										DUB.	AA 3:55		332 A 16:35 1	AA 720*	789 18:25	AA 19:00 1568*	332 20:30			
01										AA 13:05		725 786*			332 18:20					
03		1441		CITSC4 DTW CITSC4 ATI	CLTSC4 M	MSP.	IFK	IFK	DTW DTW			DTW	O2 MSP	IGA SEOR IG	iA	I.GA can I.G	A			522
04		TERM			7:20 ORIG 2266 8	7.00	10.58	11.10	ATI	ATL	MSP MS	DL 15:40 1	793 16:30 MSP	DL 5308 CS 17:12 5135 18:0	DTW	DTW	0	3812		TERM 876
O4 O5 O6 O7					CLTSC4	DL 3730 CS1 8:35 3840 9:15	DL 1454 739 10:03 10:45	Temp cont	DL 109: 12:33	13:15	1503 14:24 14:5	9 ATL ATL	DL 1: 16:40	524 320 524 17:20	18:40	057 19:15		TERM	1076	TERM
O6 O6 O73 O74 O74 O78 O79 O79 O70				ORIG 3844 6:15	/:30	DL 2422 73H 8:48 9:30 DTW DTW		DL 2251 717 11:16 12:00		ATI.	ATL		DL 002 73F 16:18 2651 17:00	DI. 0 17: JFK #190 JFI	7:50 18:45	ATL A	NTL		TERM	10
O6 O7				ku		9:04 9:39				DL 13:42	2597 320 14:30	DL CS1 15:06 5099 16:00		DL 4189 CS 17:193433 18:0	S1 00	DL 1407 1	73H 0:05	2808	TERM	TE
O13 O14 O18 O19 O20 C27 C28 O29 O30 O31						4 SFO ORD 42	5 ORD			ORD 1484 ORD		DEN 1711	DEN	SFO 1	176 SFO			TERM	1286	1974
O14 O18 O19 O20 O27 O28 O30 O30 O31 O31 O32 O41 O52 O53 O53 O53 O53 O54 O55 O55 O55 O55 O55 O55 O55 O55 O55					TA 1969	9 739 9 8:20 UA 9:26 52 BOS		FLL 81	01 FLL	UA 13:00 1140 13:45		UA 15:10 1199	739 16:22 BOS 8021 BOS	UA 17:31 10 8 BOS 1445 BO	739 18:30 JF	K 1119 JFK			TERM 8017	TERM
018 019 020 027 028 030 030 031 031 032 0AN 121 122 AEDO D13 D13 D12 D19 D10				5:33 8022 6:18	CLTSC4 FLI	B6 9:24	8020 E90 10:51 JFK 219 JFK	B6 11:30 81 BOS 1245 BOS	02 12:30				B6 E90 16:00 8016 17:00	0 B6 E9 0 17:18 1446 18:0	90 B6 00 18	:50 1118 E90 :50 19:28			TERM 8103	
019				CLTSC4 <sub>ORIG</sub> ORD		O TSC4 <sub>RIG</sub> DEN	B6 E90 10:01 218 10:40	10:59 1246 11:36											TERM	5812
O27 O28 O29 O30 O30 O31 O32 O31 O32 O31 O32 O48 O51		9	)		7:5	BWI	DAL						ME	DW <sub>853</sub> MDW						TERM
O27 O28 O29 O30 O31 O32 O37 O38 O37 O39		TEF	RM	5.40		9:35 MCO D	10:10				BNA 5136 BNA		DEN MCC	50 <sup>1748</sup> 17:25	HOU <sub>1747</sub> HOU	DAL BWI				614
C28 C29 C30 C31 C31 C31 C32						9:20 10	:00				14:00 684 14:45		16:20 17:00	BNA 2465	17:55 <sup>1493</sup> 18:30 BNA	18:55 19:30				TERM
O29 O31 O32 O32 O31 D12 D22 AEDO D33 D33 D34 D35 D37 D37 D37 D38 D39					DEN 310		MCO PHI	ISP 354 ISP	SP			PHL M	CO	17:20 3113	18:10		CLE 486	5 CLE		
O30 O31 O32 O32 O39 O39 O31 O31 O31 O31 O31 O32 O31 O31 O32 O32 O33 O34 O35 O35 O36 O37 O37 O38 O38 O39				5:10 200	7:20		10:11 10:5	9 11:20 353 12:0	05			15:21	:09				TTN 933	21:20 TTN 321		
031 032 038 039 039 039 039 039 039 039 039 039 039				LAS NK	165 MCC	0							IAH NK	135 FLL 320			20:25 932 MCO 344 LAS NK 320	21:10	357	
OAIN    121				6:45 CLTS		10							16:45	5 386 17:30			20:00 541 20:50		TERM	
OAIN  121  AEDO  D13  D14  D15  D16  D17  D17  D18  D19  D19  D19  D19  D19  D19  D19				6:45	PDX	625 PDX 73H							SEA 5.	525 SEA 737						
122  AEDO  D13  D12  D17  D18  D19  D19  D19  D19  D19  D19  D19					7:15	9:00							16:30	17:30						
AEDO  D13  D14  D15  D16  D17  D17  D18  D19  D19  D19  D19  D19  D19  D19													MUC LH	*428 429*	MUC 359			LGW S	7751 LG <sup>7</sup>	W 88
AEDO  D13  D14  D15  D17  D19  D19  D19  D19  D10  D10  D10  D10													p 0.20		*201 KEF 202* 321 202* 18:40			E1.03	23:0	
D13  D12  D10  D10  D10  D10  D10  D10  D10														17.40	10:40					
D12    15	D13			PHF 5 AE 6:30 5	190 PHF CR2 7:35	8:30 55	337 514	JAN CR7 11:20		MGM 5441 2 AE 5154	SDF CR2 14:25			TYS AE 17:10	5119 5256	FAY CR2 19:50	HTS 5461 CRW 20:15 5049 20:50	DAY AE 21:31	5156 PGV CR2 5118 22:40	
D10	D12			AE 48	389 CK/	MGM 5293 MGM AE 5293 CR2 8:38 5440 9:45		10:59 3909 11:50	CLE 5282 GNV AE CR2 12:05 5063 12:50	TY AE 13:	S 5294 TYS CR2 515119 14:35			5063 C 5259 18	CAK SHV 5514 TCR2 18:30 19:30	FLH 9:05	PULL 5172	LEX AE 21:36	5264 MGM CR2 5298 22:41	
D6	D10			GSP DCA GN 3802 AE 5:57 6:32 6:5	5228 CR2 5039 CR2 2 7:30	FAY 5273 TYS AE 5297 CR2 8:40 5297 9:35			CRW 5237 BHM AE CR2 12:15 5164 13:00	DAY DAY AE 13:43	5120 PHF 5052 CR2 5052 14:25	EVV 5032 AE 5366	EWN CR2 16:14	PHF 5052	LEX	5366 TERM	FAY 5105 HSV	CAK 5 AE 21:35	259 AGS	
D4						0.13 9.00 9.13		CR9 11:20	AE 3906 C 12:25 3960 I3:	RE CR2 :05	14:07 14:45	15:33 522	4 MGM FPO CR2 AE 2 16:19 16:4	5077 FAY CR7 5105 17:45	AVL AE 18:42	4895	TRI AGS CR7 AE 20:15 20:38	3795	GSP CR7 22:40	
E1					7:08 5277 7:43	8:16 4820 9:35	10.39	557 TYS 294 CR2 11:18	BHM AE 5142 12:30 5218	TLH FAY CR2 AE 13:10 13:45	5453 14:40	3973		BHM AE 17:45	5311 CHA 5186 CR2 5 18:25		EWN CR7 20:30		CRW CR7 22:35	
E2   S35   S48   S55   S48   S55   S48   S55   S				6:24	GSP CR7 7:45		5122 5364	11:45	12.23 15.00	GPT AE 0 13:37	52	26	CR7 16:14	PUSH	18:10 5321 19:0	19:23 4	023 20:40	20:59 5100	AVL CR7 22:25	
E3				AE 6:45		5335 9:36	MOE AE 10:4:	5 55	514	SHV CR7 13:15	14:03 <sup>4</sup>	5204 16:00	PUSH	AE 17:21	5233	19:45	AE 5411 CR7 20:00 5523 20:40	20:58 5407	22:15	
E5   Fig.   Fig.				EWN AE 6:35	4921 GSO CR7 4826 7:50	8:11 5187 9:19			12:10	LFI AE 13:	50 5459	15:15 15:44	5526 HPN CRT 5166 17:00	7 AE 479	29 CR7 98 18:30	19:21 391	5 20:25	20.55 5124 22	R7 5491 05 22:27 22:59	
E7    BOA 476 FAX   APP   5383   GP   APP   5384   ME   540   FX   APP   5384   ME   APP				l len	40.7	9:03 5164	CR9 1 10:30	11:00 5220 11:45	12:12 4804 13:0	03 13:31 53	19 14:25	14:57 5096	16:20	5:52 3775 18:0	ROA R7 AE 00 18:43	4835 19:50	MEM MED	21:33 4636	22:10	
E9				1R1 AE 6:39	4942 7:35		GSP SHV	5364	1 13:00	7 AE 0 13:4	5263 DAT CR7 49 5123 14:41		9 16:35 1	6:55 5202 17:55	18:43	5398 19:45	AE 5265 CR9 20:05 5141 20:45			
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					AE 4776 CR7 7:04 7:40	8:10 5320 CK7	10:10 55	593 CR7	12:20 5512 <sub>1</sub>	13:10	14:02 5302 14:50	AE 15:5	3130 CD	0 17:30 49		5306 19:45	AE 4460 E75 20:00 4582 20:40	AE 21:00 4799 22	05 HHH	
E13				h	AE 5328 CR2 7:14 5282 7:50	8:12 4831 CR7 9:20	AE 3908 10:21 3777	7 11:19		AE 13:4	4904 CR7 CR7 14:35	15:06 4779 1	CR7 5:10 5:592 GPT	17:04 5429 18:	8:04	8:52 19:54	VPS	21:15	22:20	
				(CHS -	.30 7.30	8:53 5183 CR7			12:18 4805 CR	AEXAEX		15:40	5083 CR7 16:40		7 18:15		CR7 20:20 FLO	21:35	5038 22:40	
1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				6:18 52	295 CR9 7:45	8:32 4841 9:40		4 11:33	12:17 5153 CR7		5251 LEX	15:13 5283 1	CR7 5:10 5.132 JAN	HTS 4750 H	18:00 5258 CR9	19:09 4870	CR7 20:09	21:10 5393	22:14	
MYR 5357 CHS OAJ 5113 CVG PIA 5349 PIA LYH 4920 GSP BTR 5225 BHM NNA 5500 ICT LEX 5153 BTR ORIG GSP 3833 MKE MDT 5180 PHE	E15			PUSH	357 CHS	MOB 5278 AGS AE 5396 CR7 8:42 5396 9:45	PIA 524	PULL 5117	12:18 4765 12:59	13:42 -	5078 14:25	XNA SS60 ICT LI	X 5153 BTR	HTS 4759 H AE 17:18 4813 18		DAJ 5226 SDF AE 5477 19:49 SP 3833 MKE		21:26 47	44 22:30	
E17    Myr 5357 Crs   Az 5357 Crs   Cr7   Cr7   Az 5369 PA   Cr7	E17				309 CR9 7:40	AE 8:13 5466 CR7 8:13 5466 9:20	AE 5344 10:26 543	CR7 11:19	AE 4820 12:32	CR7 AE 13:12 13:4	7 5311 CR7	5569 AI 5196 14:55 15:32 15	5133 CR7 :55 5074 16:45	47	796 AE	3889 CR7		AE 5.	56 CR7 22:30	

Date:04/11/2019 Time:12:43									С	LT 2033-S	Scenario	3											ı a	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
	1 1 1			- I I		, , ,	1 1 1			1 , , ,	1	1	1			, , ,			- I - I		1	1		
E19								5452 MYR CR9 5389 7:40	AVL 5365 8:21 5152	5 CHO CR7		KE 3896 SDF	TRI 4841 RO.	A CRW 4824	HTS MSN 5204 CR7	TRI 476 AE 15:38 476	5 AVL CR7	ORI	G	PGV 4869 AE 19:15 4780	LYH MLB CR7 AE	5431 MOB CR7 5207 21:30		
E18							6:36 AGS 52 AE 50 6:31 50		8:21 5152 GSP 5235 AE 5509		10  C  A	248 3798 11:40 CAK 5468 GPT E CR7	EWN <sub>4936</sub> F 12:29 <sup>4862</sup> 13	13:25 4759 14 FLO SBY AE 4	4:05 14:25 <sup>3272</sup> 15:05 831 CRV CR7	FLO 4862 ROA	9 16:24	SDF AE	5154 AVL	LYH 4779 CHO AE CR7 18:59 4885 19:49	20:10 20:30 FWA AE	5207 21:30 5476 LEX CR7 5235 21:30		
E16							6:31 50 GS AF	093 7:30 50 MEM 5026 CR9	CRW 5347	9.09 9.24 9.39 BHM	INI AE	0:50 5462 11:40 D 4484 CMH	RDU 5415 AE 5288	3:06 13:39 4 BNA RO	OA <sub>4879</sub> EWN :50 <sup>4939</sup> 14:25	15:20 4842 16:05 LYH 4	804 TRI 1804 CR7 786 16:30	LFT 5064 MLB AE 5764 CR7 16:58 5376 17:40	532618:30	FLO	4777 HTS	5235 21:30 5186 TERM		
E14							ORF 546 AE 527 526	52 7:50	8:16 5142 AGS 5439	BTR	BTR 55	46 4457 11:45 607 AGS 163 11:14	12:19 5288 TLH 50 AE 12:28 50	091 MSN	:50 <sup>4939</sup> 14:25 MYR AF 3777 CP7	CHO CA AE 5048 CA AE 5239 CE		HSV 531		LEX TYS	4767 <sub>20:30</sub> CID	5530 GPT CR7 5491 21:30	LGA 5066 GSO	
							SDF	5342 STL	AE 5437 8:21 5225	PT 5232 MSN	10:34 52 FLC	163 CR7 11:14 0 4850 AVL 4850 CR7 4800 11:25	GRB 5674	PNS	14:01 14:40 CHA ORF	15:30 5239 16:1 ROA 4926 AE 4907 15:41		AEX 5060 FWA AE 5060 FWA 25 5324 CR7	51 18:20	19:16 5221 CRV 19:16 5221 19:56 CRW 5148 FWA	20:4	5491 21:30 HPN 3945 ORF AE 3904 CR7 20:50 3904 21:30	22:01 5112 22:45 5090 ERM	
E12								5073 7:40 5096 CMH	CAK	51 5060 9:45 5242 JAN	MSI	4800 CR7 45 11:25 N	5231 5104	13:15	AE 5110 CR7 14:01 14:40 HPN			17:05 5324 CR7 17:45 17:45 MOB MOB		19:05 5405 19:49 52		TLH 5211LFT	ERM PULL	
E10							IAD	5061 7:29 5399 IAD	BHM 534	5071 9:30 46 CRW	ORIG ORIG	45 SDF	50	193	CR7 14:33 IND	PIA 518i 15:43 <sup>5310</sup> AGS 4805		17:10 5060 CR7 17:49 HHH			222 JSH 892	21:15 21:46	5304 TRI	
E21							AE 6:44	5373 CR9 7:30 DTW	8:30 523	37 9:20 KE 3850 CAE	ORIG 5632	11:05 26 ROA	53	23	CR7 14:50 HHH <sub>4844</sub> HHH	AGS 4805 15:40 <sup>4869</sup> 1	6:16	AE 17:31 CHO <sub>4918</sub> FLO	PULI	49	925	CHS	22:25 TYS	
E23							AE 6:38	4542 7:45 PHL 3899 CAE	8:5	29 SAV CR7	10:30 487	79 <sub>11:14</sub>	STL 5073 ILM AE 12:10 5345 12:59 JAX		HHH <sub>4844</sub> HHH 13:56 <sup>4892</sup> 14:30 CMH	3909 TERM JAN 5514	RW	CHO <sub>4918</sub> FLO 17:01 <sup>4777</sup> 17:35	PULI 5514	GNV <sub>5252</sub> BTR 19:18 <sup>024</sup> 19:50 DTW 5435	ABE	21.00 Z	CR9 22:09 MSY	
E25								AE 3908 E75 6:58 3908 7:45	AE 8:33 51	85 9:19 ORIG	BTV 4649	H <sub>4942</sub> CRW :4 <sup>4816</sup> 11:19 RIC	AE 12:10 XNA	5458 5087	CR9 14:24 FVC GRB 5521 ABE	15:40 <sup>5148</sup> 10 4933	6:15 I	DSM 5055	DSM	19:04 5169	CR9 20:15 5440 TUL CR9	CAE 3775 M	4476 E75 22:35	
E27							CAI	E 2067 BHM	CHO 4876 HT	5294 S SBY AVI.	AE 4049 10:21 4618 1	11:05	AE 12:30 52 SAV	5388 5158 1	GRB 5531 ABE 5531 4:05 14:22 5286 14:59 PNS	4809	5096	DSM 5055 AE 5276 MDT		19:30	5880 20:40	20:59 4056 22	R7 :05	
E29								3967 BHM E75 3819 7:35 ORIG	8:15 4866 9:0	9:15 4731 9:50	AE 10:41	52 52 VG	.66 CRS	9 AE 9 13:28	5245 PNS CR9 5212 14:50	AE 15:29	5086 5180	MDT CR9 17:55	BTR 5500 18:30 <sup>5505</sup> 1	HSV IAD 55 19:05 19:26 52 ISAV OR	232 CR9 20:30	5361 TERM 5049		
E31								5432	8:47	B 5175 HPN 7 5384 9:30	A1		268 DTV CRI 458 13:01	9 A 0 CAK GSO	531 E 5272 MEM	14 16	CR9	AE 5034 17:10 5070	CR9 18:25	AE 5056 CR 19:00 20:0	19 00	TERM	СНА	
E33							-	nuc.		4914 CR7 AE 4936 9:24 9:40	5111 5514	GRR CR9 11:30	IAD 5509 12:29 5243	CR9 AE 13:33	5372 MEM CR9 5494 14:40	AE 15:33	5053 5066	LGA TVC CR9 AE 17:25 17:40	5216 DAB CR9 5480 18:50	AE 19:36	koon	5335 5238	CR9 22:20	
E35							A 6	i:56	5341 5116	OKC CR9 9:20		5356 PVD CR9 5474 11:50		13:10 13:44	TUL 5357 GRB AE 5227 CR9 14:00 5227 14:55	CVG 5166 AE 5229	CHS CR9 16:20	OMA AE 5131 17:06	18:20 A	MEM 5494 CHS ME CR9 8:50 5318 19:44	GSP AE 19:59	5214 5336	BNA 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	13:32 5	247 DAB CR9 315 14:25	CHS 508- AE 508- 15:30 508-		5288 SDF CR9 5049 17:54	P1 A 18	NS 5212 CVG LE CR9 8:50 5303 19:45		MYR AE 20:59 5114	22:35	
E36									SRQ 5390 TLI AE 5091 CR 8:04 5091 9:0	H SGF .7 AE .0 9:15	5177 5037	TVC CR9 11:24	FAY 5487 CHS AE CR9 12:10508412:54	13:37	5139 SAV 5151 <sub>14:27</sub> 1	MHT TLH AE 5072 CR9 5:02 15:59		SYR AE 5377 17:16	CHS CR9 18:20	TYS SAV AE 5144 CR9 19:01 19:55		ILM AE 21:03 5200	LIT CR9 22:35	
E34									8:4	R 5534 RDU CR9 9 5415 9:40	LEX AE 10:40	5039 FAY 5463 CR2 11:20	MYR 5289 MYR AE CRS 12:15 5053 12:59		5433 CHS CR9 5 5181 14:35	CLE 5436 AE 5170	16:20	DTW AE 5249 17:22	18:20	IND 5189 GSP AE CR9 18:58 5155 19:50		AUS 5301 AE 5299	MEM CR9 22:35	
E32									SAV AE 8:16 5267	MKE LNK CR9 AE 9:14 9:33	5415 5575	PNS CR9 11:25	MEM SYR AE 5184 CR9 12:07 12:50		GRR 5533 ATL AE CR9 14:05 5192 14:55	SAV 5: AE 15:42 5	266 STL CA CR9 AE 069 16:35 16:	AK 5243 CLE E CR9 5:53 5331 17:50	G: Al 18	SO 5418 DAY E CR9 8:49 5101 19:40	GS AF 20	O 5121 D C 45 5374 22	AY R9 :05	
E30							INI AE 6:5	D 4661 IND E75 1 4531 7:55		5327 GRR CR9 5533 9:25	VPS 5157 AE 5179	CHA E75 11:14	MSN 55 AE 12:25 53	665 SBY LI 627 E75 A	TT 5033 MKE E CR9 3:51 5098 14:40	MDT CMH AE 5064 CR9 15:07 15:59		PNS 52 AE 52 17:35 52	291 EYW CR9 271 18:30	TLH AE 5420 19:19	GSO CR9 20:10	ORF 5455 AE 5099	AVP CR9 22:20	
E28								,	CHS 5207 AE 5289	7 MYR CR9 9:30	SRQ AE 10:10 5322	AVP RAP CR9 AE 11:20 11:4	5514 DAB 5514 CR9 5255 12:20		MKE 5267 ABE AE CR9 13:56 5140 14:45	OKC 5116 SDF AE 15:14 5300 16:05		ILM 5285 OR AE 5455 18:0	F 9	MYR 5170 PNS AE CR9 19:00 5103 19:50		PNS 5094 C AE 5109 22	VG R9 -05	
E26									JAN AE 8:37	5194 IND CR9 5568 9:55		5162 CVG CR9 5166 11:40	PGV 5187 CHO AE E75 12:05 5048 12:49	OKC 5504 MYR AE 5504 CRS	SYR 5223 AE 5349	CLE ILM 534:	GSO CR9	IAD IAD AE 5286 CR9	-	CMH M AE 5047 C 19:16 20	OHT	CVG 528 AE 521:22 52	81 BHM CR9 11 22:30	
E24									SDF AE	5495 PNS CR9 5255 9:45	XNA	5350 BHM CR9 5178 11:35	12.05	15.10	PNS 5255 DTW AE 5434 1445	BHM 5178 IAD AE CR9 15:10 5502 16:00		D SRQ 5125 CR9		CHS SRQ AE 5227 CR9		IAD 528 AE 545	36 SAV	
E22									MY AE	R 5431 SYI 7 5260 10:00		M 5474 PWM CR9	MDT 49 AE 47	932 BMI F75 731 13:30	ORF 5081 MYR AE 5313 14:45	PIT AE 5043 C	AV R9	CMH 5 AE	087 GSO 121 18:30	PULL 5236	5382 TERM	21.21	22.50	
E20									GSO AE	5417 CAK CR9 5245 9:45	CLE AE 500	MDT 80 CR9	CMH 453 AE 453 12:27 467		5317 IAD CR9 5031 14:25	IAD DAB AE 5035 CR9 15:15 16:04	014	XNA 5193 CVG AE CR9 17:04 5281 17:50	12.16.30	CHO <sub>4809</sub> ROA 19:10 19:44		XNA AE	5236 MYR CR9 5161 22:40	
E8									8:36 LIT AE	5158 SDF CR9 5330 9:50	AVP 5160 AE 5370	0 STL CR9	DTW 4542 AE 12:23 4510	MDT	5051 14:25	AVP 532 AE 15:36 523	XNA CR9	MYR 5313 BHI AE 17:19 5182 18:0	M 19	PULL 5147	5076 TERM	LIT 5088 AE 5334	SDF	
E6									PNS AE	5343 FAY 5487 CR9 5487 9:40	DSM 5129 AE 5270	ILM FWA	A 5645 MKE E75 0 5983 12:25	13:10	IND 5568 AUS AE CR9 14:01 5301 14:45	DAY 5115 MEM AE CR9 15:14 5265 16:00	7 16:25	IAD	5031 TUL 5031 CR9 5271 18:30	LM IND	ILKWI	SRQ	5161 JAN 5333 CR9 5333 22:35	
E4									8:38 BN AE	A 5325 DAB CR9 9:50	SAV	5504 DAY 5115 CR9 5115 11:35	IND 4470 G AE 4537 I		5191 CVG CR9 15035 14-25	15:14 3203 16:00 S/	T .	5587 5553		8:50 19:45 LNK CR9		CLE	5331 ILM CR9 5250 22:35	
F1								LEX AE	51	058		DAY 5042 XNA AE CR9 10:54 5193 11:50			4303314:25 W RIC E 5051 CR9	MEM 5058 AE 15:35 5208	TYS CR9	SAV 5070 GSP AE 5070 CR9 17:09 5214 17:50	55	19:45 546 EV AE	/V 5006 MGM E 5469 CR7		LL 03	
F2								7:30	ORIG 5531	5292 PUSH	10:30 C A	MH 5061 PIT LE 5522 11:45	CHO 5152 A AE 5086 13	8:05   13 AVL   SA CR9   AE	14:30 F MLI 5046 CR9 48 14:26	PWM 5572 GRR AE 5567 CR9 15:10 5567 15:50	16:19	[17:09-52-14-17:50] CVG AE	5398 5040	RM 19:	E50 20:30 ICT CR9	OMA 4556 II AE 4495 22	ND ::75	
F3									TYS 5344	LIT	CHS 53	09 GSO	ILM 5107 A	8:05   13: VP :R9	14:26 ICT MHT AE 5103 CR9	OMA DSM AE 5165 CR9	SHV AE	5815 SHV 5270 E75	VPS AE	5385 PHF 5385 E75	0:06	GNV 520 AE 21:20 528	2 CHO E75	
F4									8:22 5033 DAB 5: AE 5:	352 SRQ	RIC	50 11:20 5290 CLE CR9	AGS 5396 AE 5125	FWA 50	14:07 3303 14:45	15:20 16:00 PNS AE	5592	5379 17:35	AUS CR9 18:25	ABE 5140 OMA AE 5140 CR9 19:06 5248 19:49		VPS 5065 AE 21:06 5349	TLH E75	
F5									0RIG 5371	139 9:24 ROA 4790 GSO AE 4790 CR7 9:15 4903 9:55	l Ir	45 5436 11:35 UL TUL LE 5054 CR9	12:16 5135	13:10 PU	JSH CMH <sub>5414</sub> TUL 14:00 <sup>5542</sup> 14:35	DAB AE	5004	5460 5053	18:25 L Cl	19:06 5248 19:49 JT SDF R9 AE		5300	22:15 XNA CR9	
F6									CMH 4	547 YYZ	EVV	5241 MLB		BNA AE	4695 OMA	15:30 CMH 4457 IL1 AE E7	4	5053 FWA 5135 DAY AE 5135 CR2 17:11 5156 18:00	193	JAN 5315 AE 5315	LAN E75	CMH 4554 C	22:30 CMH E75	
F7								ORIG	CAE 3826 AE 3906	546 9:27 HSV E75	ILM 50	5132 CR2 082 DSM CR9		13:42 AVL	4556 14:55 4800 CHO 4743 14:19	15:21 4674 16:0 AUS AE		5200	SGF CR9	18:55 5732 CVG 5169	20:10 DAB CR9	21:14 4579 2 5182		
F8								5079	8:21 3906	ORIG	MYR 5389	055 11:20 SAV CR9		13:42	RIC 4618 GSO	15:30 5267 PUSE		5456	5378	19:26 5307 SA CR	20:10 T	TERM 5	256 ERM	
F9										5129 DRIG	10:22 5051 ABE	11:10 5134 MEM CR9 5058 11:25		SHV JAN AE 5767 E75 13:15 13:55	14:02 4695 14:45	FWA 50	16:45 143 ISH	5431 TERM	5036	5163 TERM	00	YYZ 4498	MDT	
F10								ORIG	LFT	5071	390 002	5058 11:25 CAE CR7		13:15 5326 13:55	GSP 3989 YYZ	LNK 5084 LIT	SH N	TERM  MDT 4510 JAX AE 4662 E75 16:56 4662 17:59		MKE 5098 I	IAD CR9	HSV 5050 PIA AE 5050 CR7 21:06 5041 21:45	22:20	
F10								5547 ORIG	MDT 4669	CMH E75	002 SBN 5586 SHV AE 5328 10:55	11:19			13:54 <sup>3834</sup> 14:30	ORF 3773 BHM AE 3773 BHM E75	1	LEX 5078	CHO E75	MCI 4675 CMH AE 4675 CMH	0:05	5099		
F12								5082	8:08 4538	9:10 ORIG	AE 10:05 5328 10:55 ROA <sub>4763</sub> HHH 10:21 <sup>4844</sup> 10:55	5502		VF	S 5183	15:07 3865 E75 CAK	E	17:25 5552 EYW	18:15	AE 4675 E75 18:55 4624 19:44	MLI	TERM  MKE 39 21:37 40	59 CAE	
									ORIG	5452 LAN 5864 S	10:21 <sup>4844</sup> 10:55	DRF		I3 JAN	49 5223		7 BTV	AE 16:56 CAE 3957 AGS	5421	587 ECP	CR9 20:22 5337	MOB	5060 LEX	
F13							O	RIG	5573	9:20 5378 10 YYZ 4464 BNA	BN TUL 5196 C E75 AE 5196 C 10:20 5081 11	J 4889 EW	'N	AE 13:	5071 CR7 47 5508 14:27	15:25 483	7 16:40 305 VPS	17:03 4001 17:55 5181			TERM	4796 AE 21:40	5520 CR7 22:35	
F14							5:	261 ORIG	AVE	AE 4464 E75 9:19 4684 9:59 5294 ILM	EYW 5579 LNK	46 4773 11:5	55		ECP 4627 AE 14:25 4373	15:20 AE 15:37 5	065 16:45	TERM		19:17 3968		TERM		
F15								5252 ORIG	8:47	5525 CR9 5525 9:25	EYW 5579 LNK AE CR9 10:10 5331 10:55	RF	5252		ILM CR9	CAE 3960 AE 3833 BTV 432		AE 4522 E75 16:59 17:50 MKE 568	4 SBN	5814	TERM			
F16								5290		PUSH RIG	YUL 391	6 GSP	5252 5285		CR9 14:35	AE 432 15:30 4373 GSO 4537	3 16:30	17:25 578	3 18:20	TERM				
F17									51	136 DRIG	AE 391 10:06 398 ECP 4839				YYZ 4546	15:30 4498 LGA SGF	16:27 SGF	MSY 4662 CMH AE E75 17:08 4506 17:50 YOW 5543 YO	ow T	2344 FERM 5307				
F18									5	5509	AE 4839 10:10 4781 1	E75 11:05			AE 4546 1	E75 5:15 15:5	190 5 16:24	YOW 5543 YOU 5265 18	E75 3:10	ERM				
F19						OPTO	- I	ODIC	AE 8:4	A 5406 CR2 9 5176 9:26	IADI	IAH IAH			IAH IAD	Al 16	5851 MSN E75 :00 5321 16:45	ORD	lpw-	R 22 CO EWR				2205
O7						ORIG 6238		ORIG 3357	EWR <sub>3697</sub> 8:34	9:09 UA (	6150 CR7 10:22	11:04 <sup>6310</sup> 11:41	EWR EWD		1AH 6115 IAD 14:09 14:44		16:46	4823 ORD 4843 17:21	UA 18:4	45 3368 EWR E7W 45 3365 19:30				3395 TERM
O8						ORIG 3312							EWR <sub>3367</sub> EWR 11:52 <sup>3311</sup> 12:27		UA 3314 E70 14:24 15:02	- EMB		IAH 6245 IAI UA 6285 I8:0	W OS	1AD IAD 6160 18:55 19:30				6234 TERM
O9								ORIG 6113							EWR 364 UA 335	66 15:30		EWR <sub>3401</sub> EWR 17:20 <sup>3343</sup> 17:56				6302 TERM		
O10							ORIG 4663				BOS 510 DL 10:30 540	68 BOS CR9 65 11:15						4554				4781 TERM		
													-						_					

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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 -150Arr 2028 Arr 2033 Arr2016 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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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 90<sup>th</sup> 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 <sup>th</sup> 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 95<sup>th</sup> 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.<sup>5</sup>

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 effort<sup>6</sup>, 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,

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

<sup>6</sup> 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** 

	ACEP		E	IS
Year	Number of Daily Operations	Delay per Operation (minutes)	Number of Daily Operations	Delay per Operation (minutes)
<b>Existing</b> (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 Project<sup>7</sup> (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
- Observed<sup>8</sup> 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.

<sup>8</sup> 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.

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

<sup>10</sup> 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)<sup>11</sup> 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.

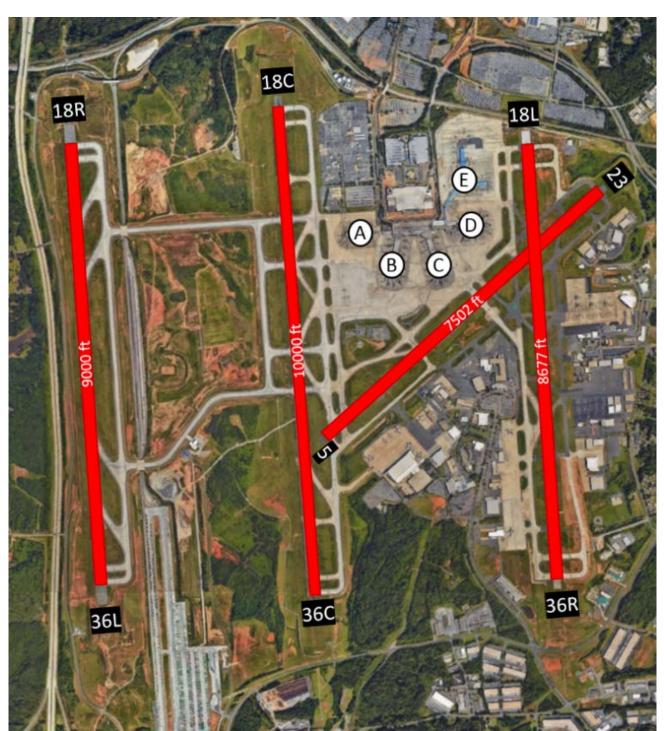
<sup>11</sup> Relevant sections of the ACEP "Chapter 3 Airside Demand/Capacity" include the Existing Airport Operating Assumptions.

<sup>12</sup> 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		<ul> <li>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.</li> </ul>
4 5		Teleconference interview conducted with American Airlines CLT Ramp Tower Operations Manager and personnel on January 29 <sup>th</sup> , 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 <b>Figure 2-1</b> .
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%
	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%
South	18C	11.9%	46.6%	29.1%
	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:

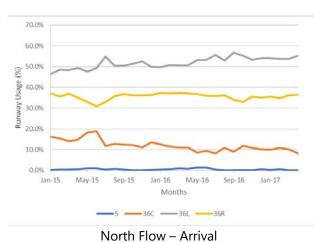
- The percentage of arrivals on Runway 18R has been steadily increasing.
- > The percentage of arrivals on Runway 23 has been steadily decreasing. This is likely due to:
  - Runway 23 arrivals constrain Runway 18C departures with the current Converging Runway Operations (CRO) and Arrival Departure Window (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.

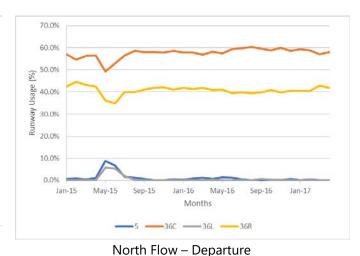
During peak departure times, more departure capacity is needed than can be achieved during CRO conditions, whereas the airport then switches to an all parallel runway configuration to

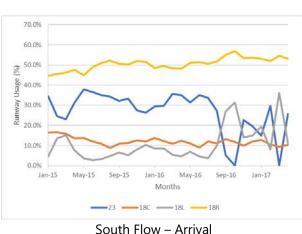
<sup>13</sup> Data was analyzed for all hours (24), including noise abatement periods (2300-0700 local time).

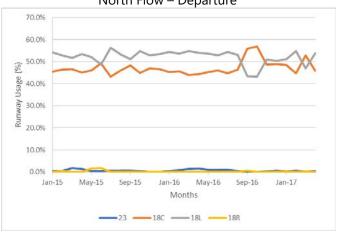
achieve more efficiency. The Runway 23 arrivals are then assigned to other runways so that departures can be better accommodated on Runway 18C.

## Figure 2-2 Historical Runway Usage at CLT









South Flow – Departure

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

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.

### Figure 2-3 Arrival and Departure Runway Configurations

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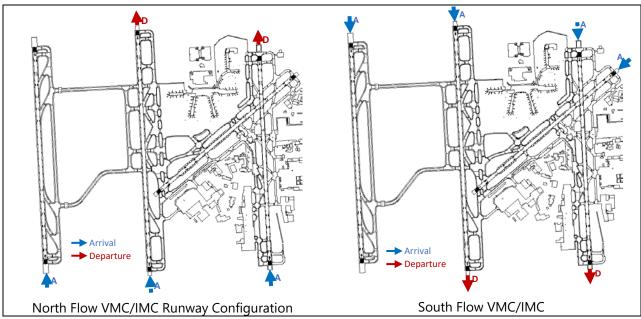
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Source: ACEP Final Report, Exhibits 3-2 and 3-3, February 2016

# 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.<sup>14</sup>

## 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.<sup>15</sup>

### 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

<sup>14</sup> TransSolutions analysis of Aerobahn® data

<sup>15</sup> TransSolutions analysis of Aerobahn® data

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

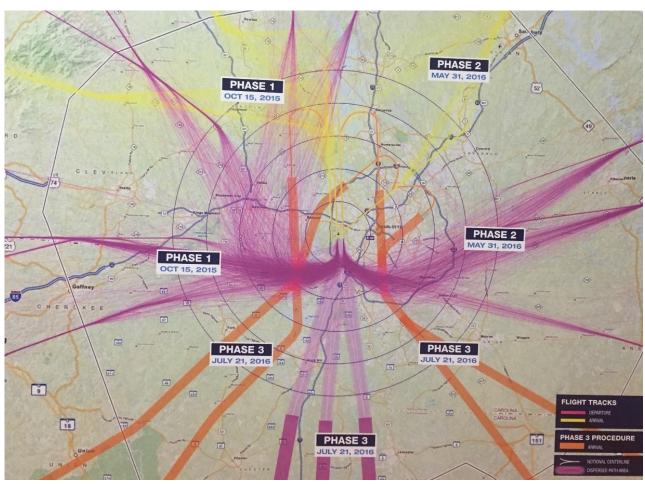
The Charlotte Metroplex includes CLT as well as Columbia Metropolitan Airport(CAE), Piedmont Triad International Airport (GSO), Greenville-Spartanburg International Airport(GSP), Concord Regional (JQF) Airport, and Raleigh-Durham International Airport (RDU). The Metroplex airspace includes new arrival 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).<sup>16</sup> The airspace changes are described in detail in the FAA's Environmental Assessment (EA) of the Charlotte Metroplex.<sup>17</sup>

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.

<sup>16</sup> 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

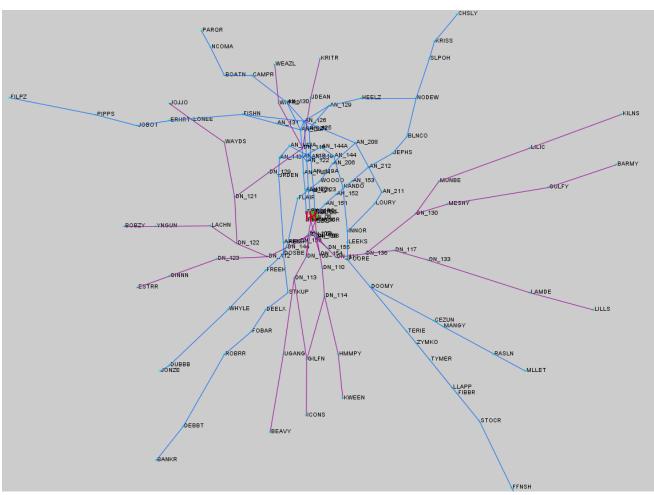
<sup>17</sup> Draft Environmental Assessment for Charlotte Optimization of Airspace and Procedures in the Metroplex, FAA, December 2014.

#### 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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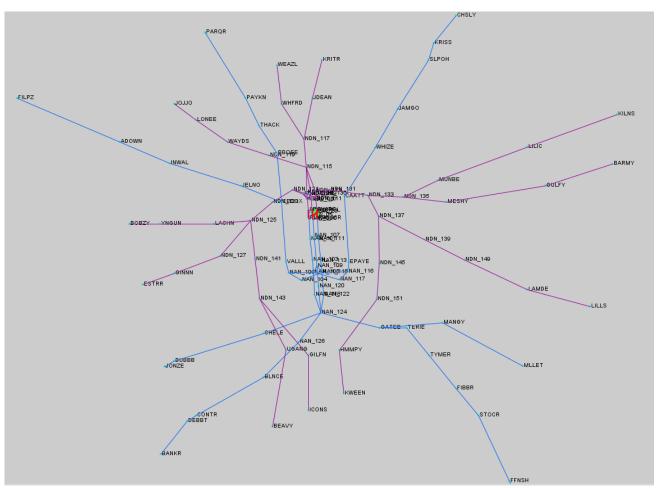
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Source: TransSolutions SIMMOD model

### 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	
<b>L</b> e	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	<sup>1</sup> 60/72	<sup>1</sup> 60/72	<sup>1</sup> 60/72	<sup>1</sup> 60/72
Small	<sup>1</sup> 60/72	<sup>1</sup> 60/72	<sup>1</sup> 60/72	<sup>1</sup> 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	<b>Departure Route</b>
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)	E	MILLET	BARMY
Philadelphia, PA (PHL)	E	MILLET	BARMY
Washington, DC (DCA)	E	MILLET	BARMY
Wilmington, NC (ILM)	ESE	MILLET	LILLS

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 <sup>th</sup> 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 <sup>1</sup>	140
Lower Heavy <sup>2</sup>	140
Upper Medium³	130
Lower Medium <sup>4</sup>	110
Small <sup>5</sup>	105

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

<sup>1</sup>Includes: 332, 333, 346, 359, 788, 789 <sup>2</sup>Includes: A300F, A306, DC10, DC10F

<sup>3</sup>Includes: 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

<sup>5</sup>Includes: 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.

<sup>\*</sup> 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



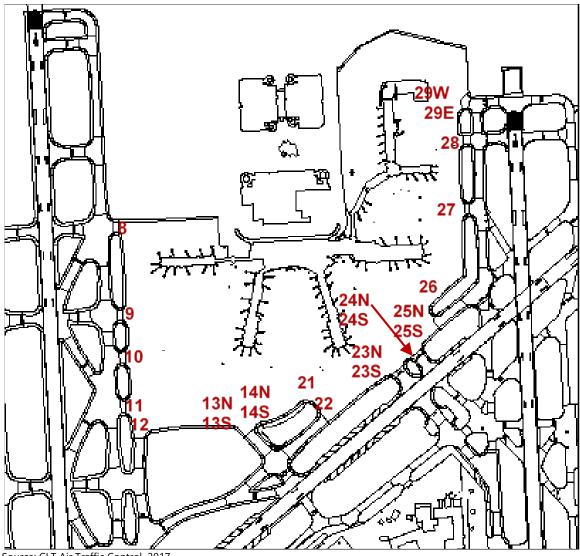
Source: TransSolutions, LLC

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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%	

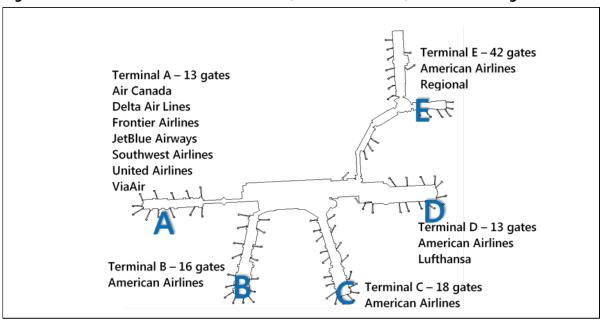
Source: Aerobahn®, February 2016 – April 2017

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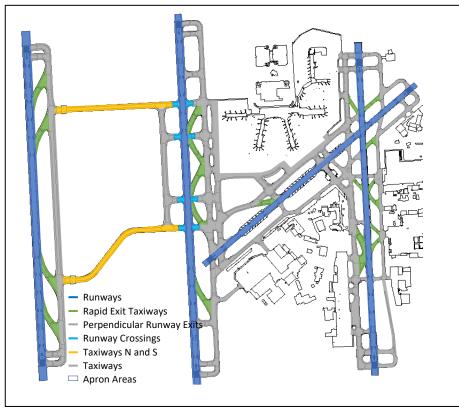
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The Existing Conditions and future No-Action Baseline used a combination of the ACEP and the onsite observations of taxi speeds collected at CLT on June 14-15, 2017, as shown in Table 2-11 and illustrated in Figure 2-8.

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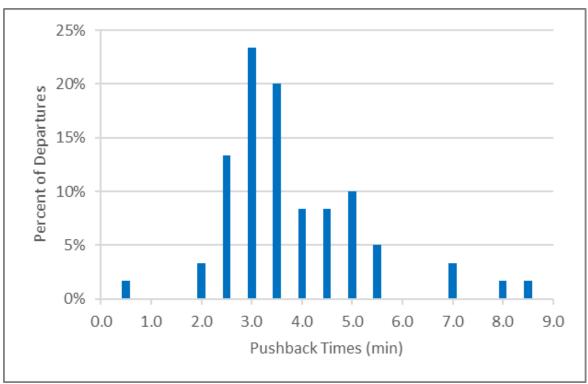
6 7 The same pushback distribution will be used for all commercial passenger aircraft types as they are not significantly different across different aircraft types.

**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

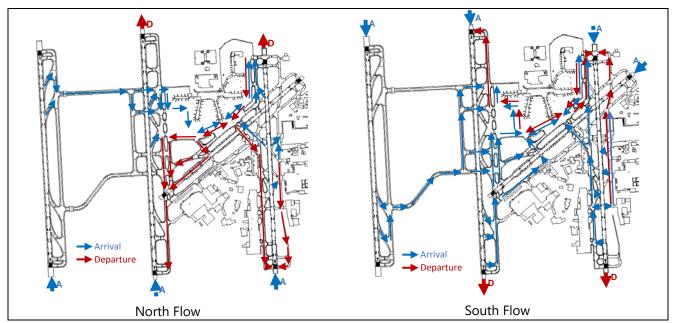


Source: Data collected at CLT, June 14-15, 2017

## 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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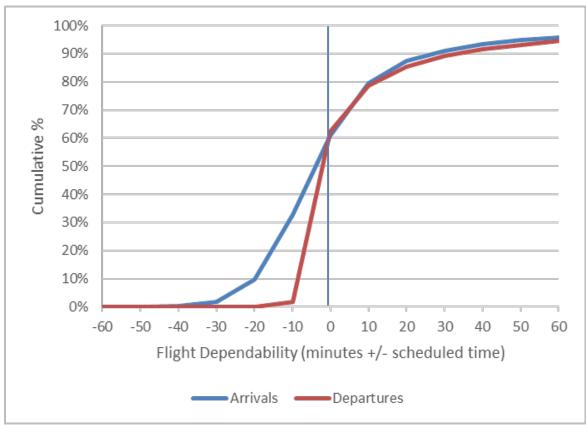
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Source: Aerobahn®, January 2015 - April 2017

### 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

<sup>18</sup> 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 <sup>1</sup>		Simul	ation <sup>2</sup>	ACEP <sup>3</sup>		
Flow	Operations	Called Rate*	Maximum Operations*	95 <sup>th</sup> % Operations*	Maximum Operations	95 <sup>th</sup> % 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 95<sup>th</sup> percentiles.

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

**Table 2-15 VMC Hourly Throughput Calibration – Total Operations** 

ASPM	Simulation
90 <sup>th</sup> %	90 <sup>th</sup> %
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® <sup>1</sup>	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

<sup>1</sup> 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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<sup>1</sup> Analysis of Aerobahn® data, May 2016

the ASPM hourly counts, especially for the 95<sup>th</sup> percentiles.

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**Table 2-18 IMC Hourly Throughput Calibration by Operation Type** 

		ASPM <sup>1</sup>		Simu	ACEP <sup>3</sup>		
Flow	Operations	Called Rate*	Maximum Operations*	95 <sup>th</sup> % Operations*	Maximum Operations	95 <sup>th</sup> % 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 90<sup>th</sup> percentile.

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

Flow	90 <sup>th</sup> %	90 <sup>th</sup> %
South	112	114
North	114	116
	112	

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.

<sup>1</sup> Analysis of ASPM data, 2016-2017

<sup>2</sup> 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 90<sup>th</sup> 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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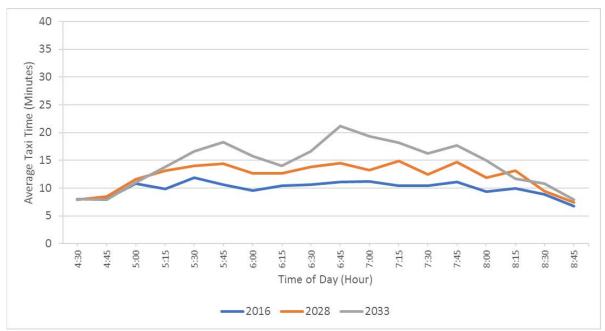
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Taxi times increase with higher demand from 2016 to 2033; average taxi-in time increases by 50 percent, while taxi-out time increases by 9 percent.

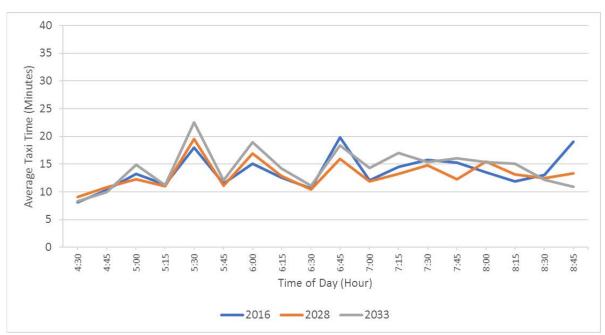
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Figure 3-1 illustrates the average taxi times in hourly increments for South Flow VMC.

### 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)** 

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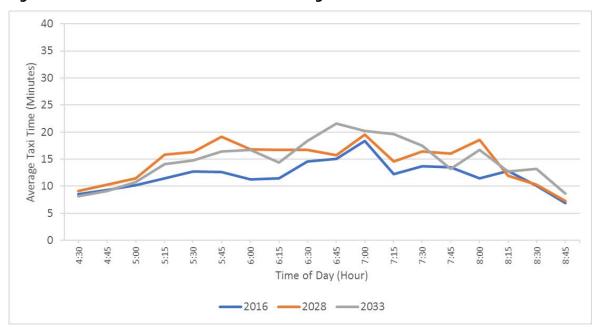
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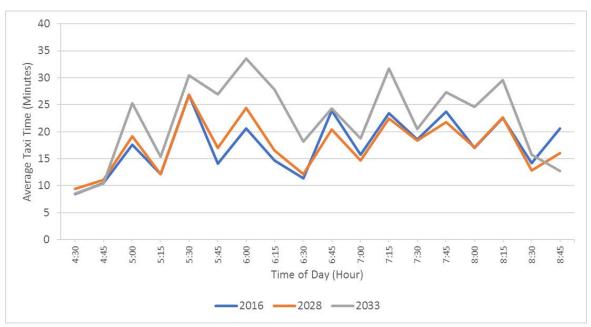
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### Figure 3-2 South Flow IMC Quarter-Hour Average Taxi Times



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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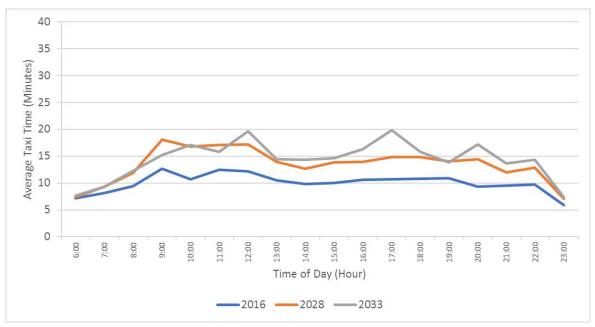
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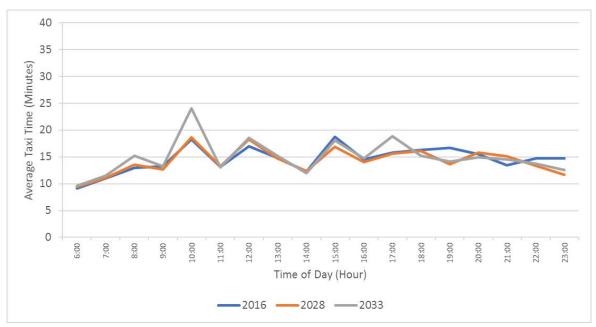
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### Figure 3-3 North Flow VMC Hourly Average Taxi Times



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.

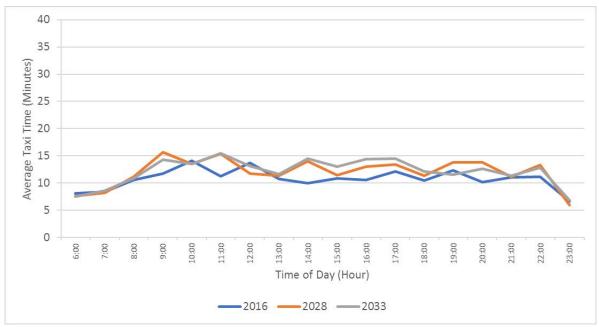
10 11 > Average departure ground delay doubles from 2016 to 2033.

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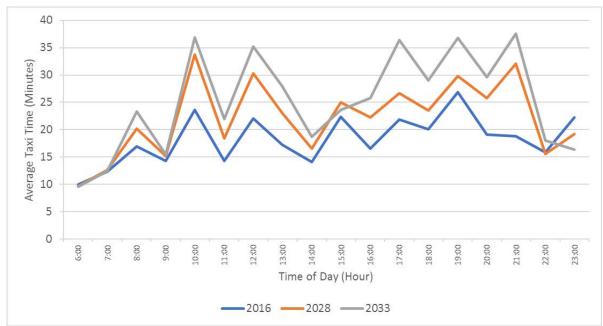
Average taxi-out time increases by 25 percent from 2016 to 2028, and by 43 percent from 2016 to 2033.

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** 

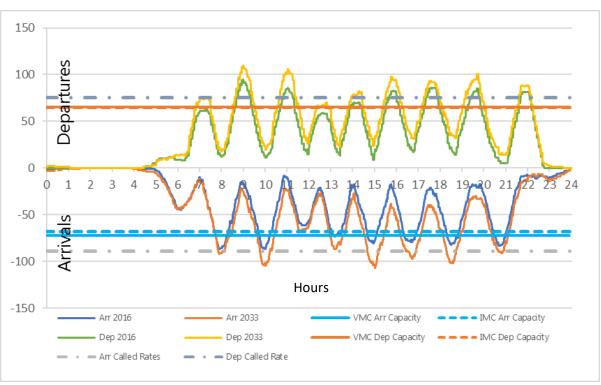
Flow /	Arri	vals	Departures		Total Operations	
Weather	Maximum	Capacity	Maximum	Capacity	Maximum	Capacity
South VMC	84	72	78	65	141	130
South IMC	74	68	69	66	134	130
North VMC	77	68	78	65	138	131
North IMC	76	68	68	63	137	127

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 <sup>th</sup> 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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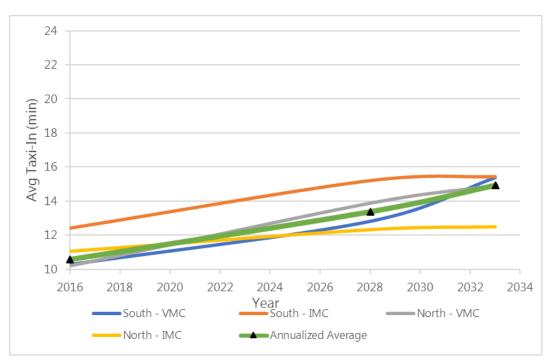
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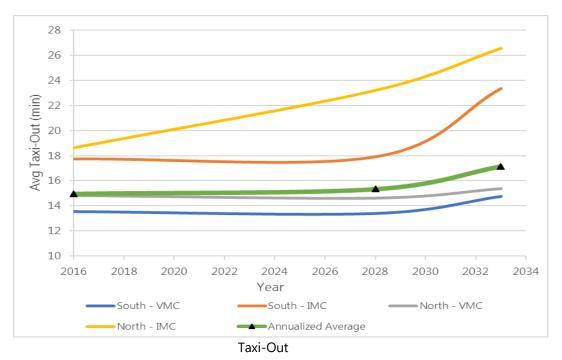
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<sup>19</sup> Note that ACEP included configuration use for 2013 only, resulting in slightly different percentage use.

### Figure 3-6 Average Taxi Times



2 Taxi-In



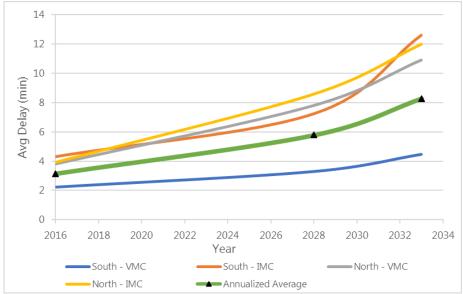
Source: TransSolutions, LLC; Simmod PLUS!

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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.

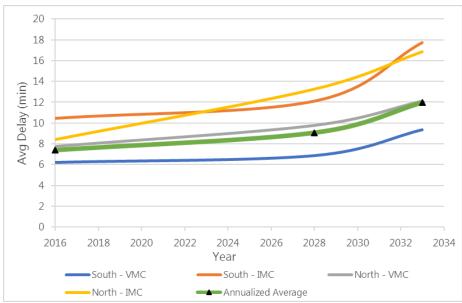
Figure 3-7 Average Airspace Delays



Source: TransSolutions, LLC; Simmod PLUS!

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

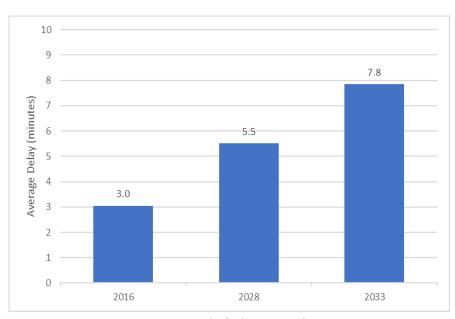
## Figure 3-8 Average Delay per Operation (in minutes)



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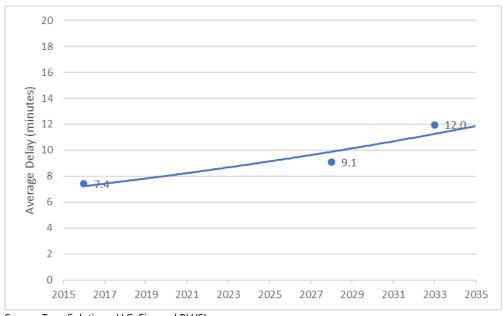
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The annualized average delays per operation, depicted in **Figure 3-10**, increase over 60 percent from 2016 to 2033.

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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, <sup>1</sup> 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.<sup>2</sup> 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

<sup>2017</sup> 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.<sup>3</sup> 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

Rolling Hour Arrival and Departure Demand 120 100 80 60 40 20 20 40 Departures 2016 60 2019 80 2028 100 2033 120 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 Local Time (Hour)

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 Type	2016		2019		2028		2033	
	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		20	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%	
11	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.<sup>4</sup> Arrivals tend to have more variability than departures and are more likely to be early.

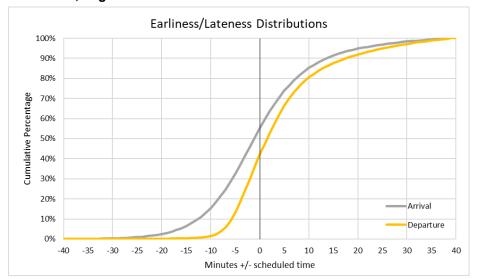


Exhibit 2-2, Flight Earliness/Lateness Distributions

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.

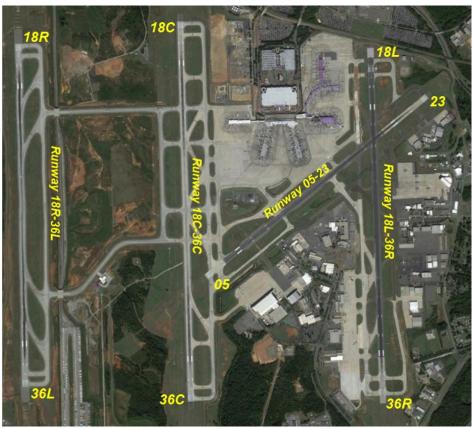
# 3.1 Airfield and Aircraft Apron Layouts

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.

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

<sup>4 |</sup> Landrum & Brown

Exhibit 3-1, 2016 CLT Airfield



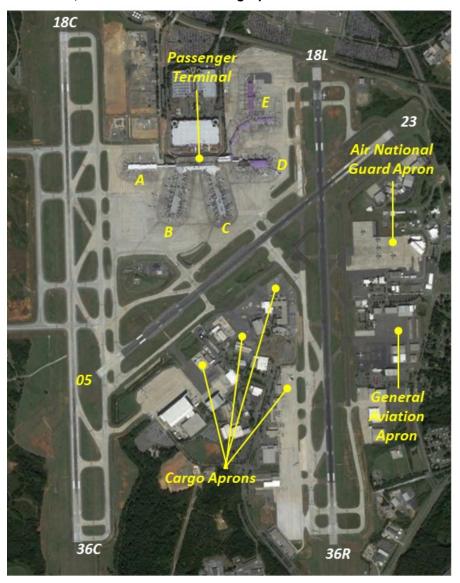
Source: ESRI ArcMap aerial imagery

**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 times<sup>5</sup>. 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.

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

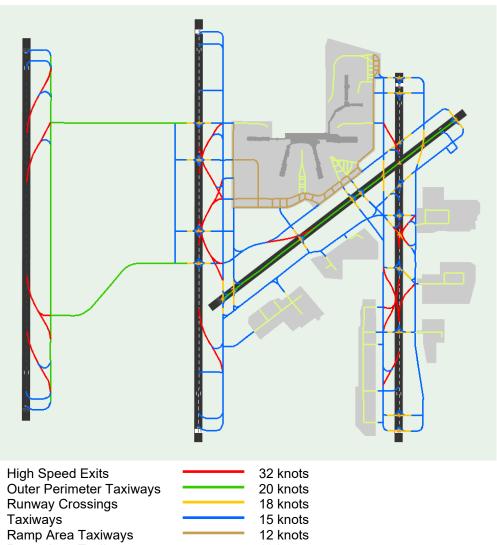
Source: ESRI ArcMap aerial imagery; Landrum & Brown, 2020

<sup>5</sup> 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



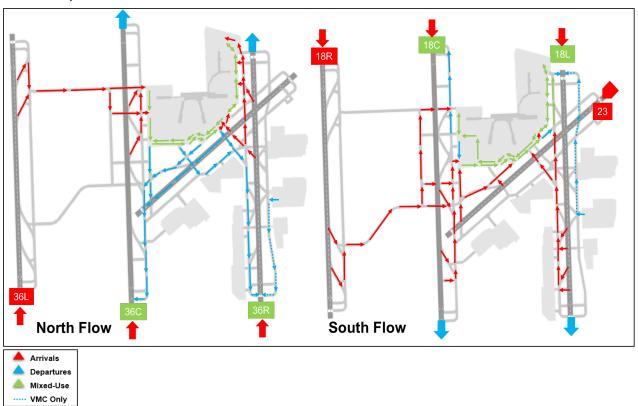
Ramp Area Taxilanes 10 knots

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

#### 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)		
<b>Upper Heavy</b>	3.3/3.81	4.3	5.3	5.3	7.3		
Lower Heavy	3.3/3.8 <sup>1</sup>	$3.3/3.8^{1}$	3.8	3.8	6.3		
<b>Upper Medium</b>	3.3/3.8 <sup>1</sup>	$3.3/3.8^{1}$	3.3/3.81	3.3/3.8 <sup>1</sup>	4.3		
Lower Medium	3.3/3.81	3.3/3.81	3.3/3.81	3.3/3.8 <sup>1</sup>	$3.3/3.8^{1}$		
Small	$3.3/3.8^{1}$	$3.3/3.8^{1}$	3.3/3.8 <sup>1</sup>	3.3/3.8 <sup>1</sup>	$3.3/3.8^{1}$		

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		
<b>Upper Medium</b>	60/72 <sup>1</sup>	60/72 <sup>1</sup>	60/72 <sup>1</sup>	60/72 <sup>1</sup>	60/72 <sup>1</sup>		
Lower Medium	60/72 <sup>1</sup>	60/72 <sup>1</sup>	60/72 <sup>1</sup>	60/72 <sup>1</sup>	60/72 <sup>1</sup>		
Small	60/72 <sup>1</sup>	60/72 <sup>1</sup>	60/72 <sup>1</sup>	60/72 <sup>1</sup>	60/72 <sup>1</sup>		

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.

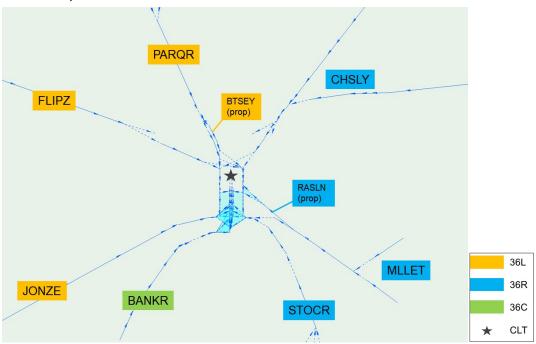
Table 3-4, Sample Origins by Arrival Routing

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. Source: EIS and Landrum & Brown analysis, 2020

**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

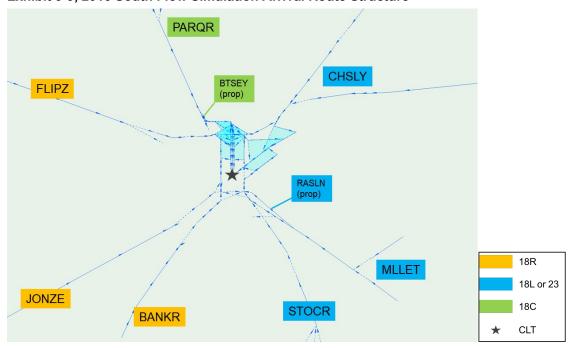


Exhibit 3-9, 2016 South Flow Simulation Arrival Route Structure

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.

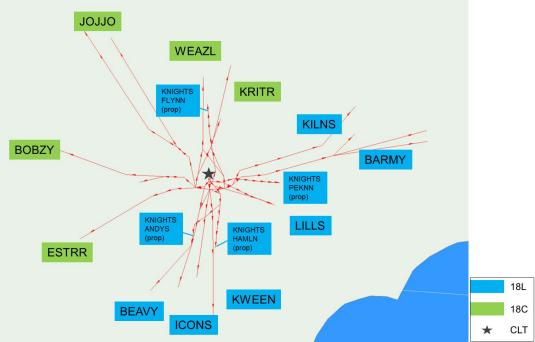
JOJJO WEAZL KRITR **KILNS BARMY** KNIGHTS PEKNN **BOBZY** KNIGHTS ANDYS (prop) **LILLS** KNIGHTS HAMLN **ESTRR** 36R KWEEN 36C **BEAVY ICONS** CLT

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

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

FAA terminal procedures Source:

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



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

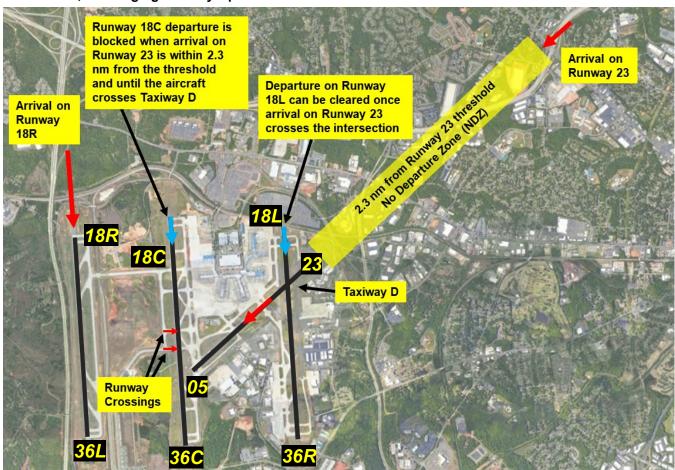
Source: FAA terminal procedures

#### 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 <sup>th</sup> 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 90<sup>th</sup> 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 90<sup>th</sup> 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 <sup>1</sup>	ASPM Max	ASPM 90 <sup>th</sup>	EIS Max <sup>2</sup>	AirTOp Max	AirTOp 90 <sup>th</sup>	
North VMC	Arrival	92	79	63	73	76	67	
NOTHI 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	
South INC	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** 

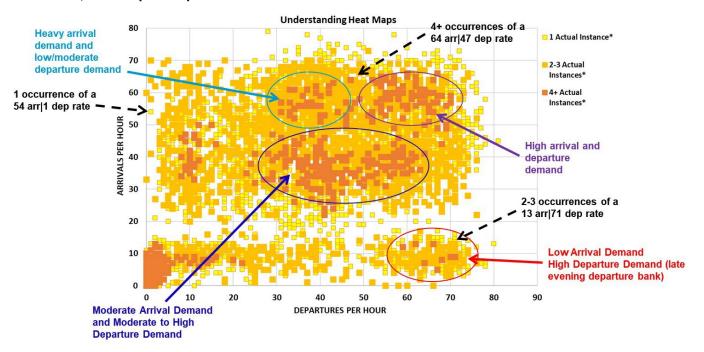
	Operation	Runway	Aerobahn – 90th	EIS - 90th	AirTOp – 90th
	Arrival	36L	35	32	34
North VMC	Departure	36C	38	37	39
	Departure	36R	29	28	27
	Arrival	36L	35	32	32
North IMC	Departure	36C	35	35	36
	Departure	36R	27	26	26
	Arrival	18R	33	33	33
South VMC	Departure	18C	32	31	32
	Departure	18L	38	35	37
	Arrival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

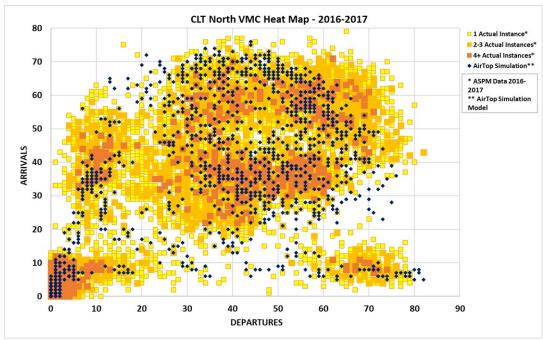
Exhibit 4-1, Heat Map Example



Source: Landrum & Brown analysis, 2020

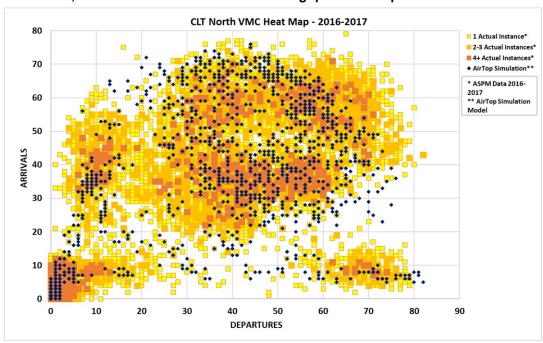
**Exhibit 4-2** and **Exhibit 4-3** present the throughput rate heat map based on 2016-2017 ASPM data for the North Flow VMC and South Flow VMC operation respectively. In both flows, the simulated throughputs correlate well to the actual data.

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



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

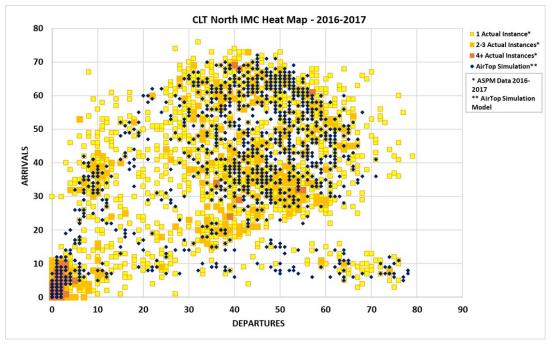
Exhibit 4-3, Calibration South Flow VMC Throughput Heat Map - Actual Data



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

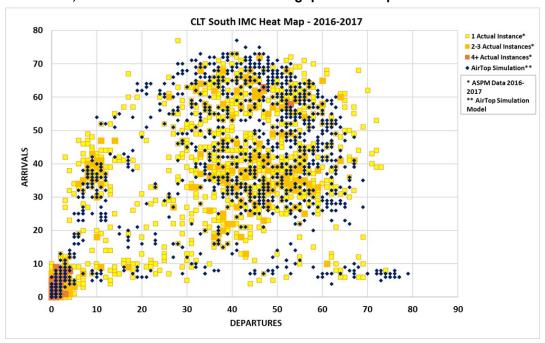
**Exhibit 4-4** and **Exhibit 4-5** present the throughput rate heat map based on 2016-2017 ASPM data for the North Flow VMC and South Flow IMC operation respectively. In both flows, the simulated throughputs correlate well to the actual data.

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



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

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** 

	Minutes per Operation						
Metric	North VMC	North IMC	South VMC	South IMC	All-Weather Annualization		
Runway Use <sup>1</sup>	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

#### 2019 Baseline Operating Assumptions 5

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

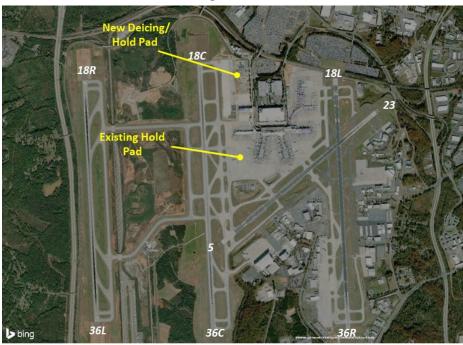
Concourse	Airline Assignments	Number of Gates
Α	American, Delta	13
A Phase I Pier	Other Airlines (OALs)	9
В	American Mainline	16
С	American Mainline	18
D	American Mainline, Lufthansa	13
E	American Regional	44

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

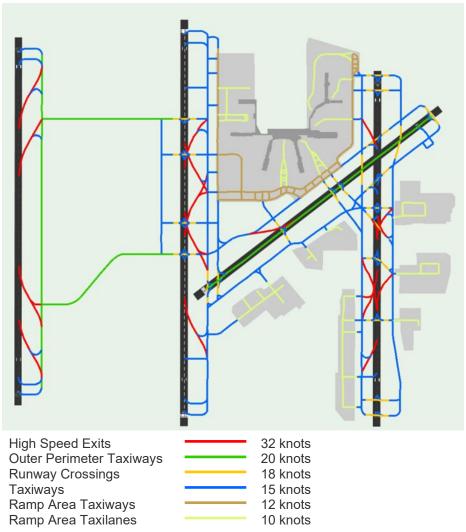


Source: 2020 Bing Maps imagery; Landrum & Brown, 2020

#### 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.

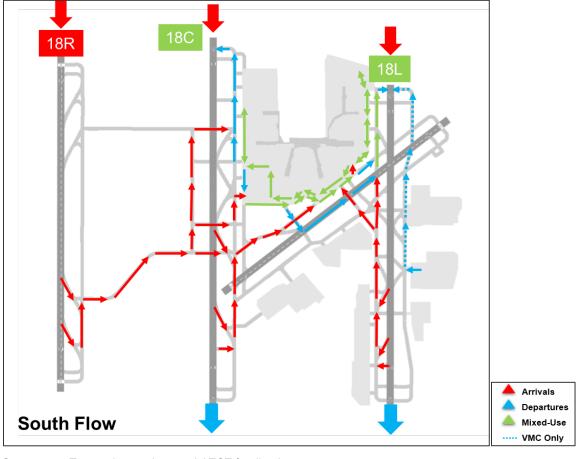


Exhibit 5-5, 2019 Baseline Taxi Routes

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 90<sup>th</sup> percentile throughputs are within 10 percent of the ASPM rates.

Table 6-1, 2019 Baseline Total Operations Throughput Comparison

Case	90 <sup>th</sup> 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 90<sup>th</sup> 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 <sup>1</sup>	ASPM Max	ASPM 90 <sup>th</sup>	AirTOp Max	AirTOp 90 <sup>th</sup>
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

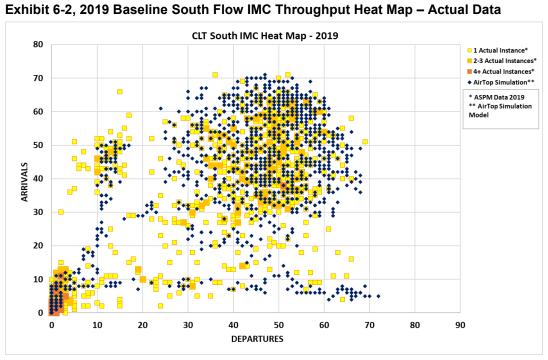
Source: Aerobahn data, January-April 2019; Landrum & Brown analysis, 2020

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 Model 50 ARRIVALS 30 20 0 10 30 40 50 70 80 90 **DEPARTURES** 

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

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



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

Coop	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

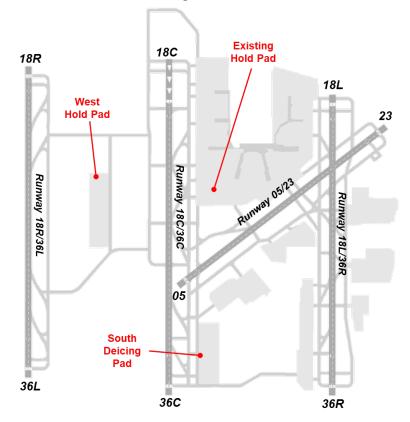
Concourse	No Action Airline Assignments	Number of Gates
Α	American	9
A Phase I Pier	Other Airlines (OALs)	9
A Phase II Pier	Other Airlines (OALs)	10
В	American Mainline	16
С	American Mainline	18
D	American Mainline, Lufthansa	13
E	American Regional	44

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

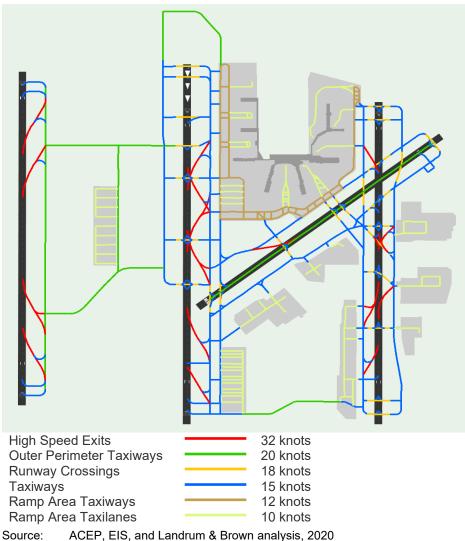
# 7.3 Runway Operating Configurations

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.

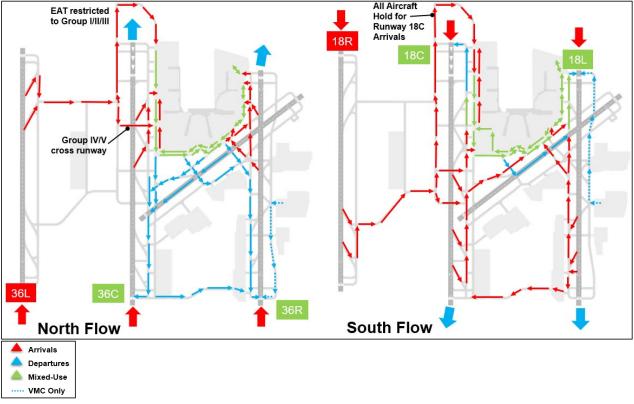
Exhibit 7-3, No Action Airfield Ground Speed Assumptions



#### 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,<sup>6</sup> 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.

<sup>6</sup> 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	;	Н	
Super	Upper Heavy	Lower Heavy	Non-Pai Hea		B757	Upper Large		Lower	Lower Large		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

14	To the Alexander											
ln-t			Trailing Aircraft									
Separa	ations											
(nau	tical	Α	В	С	D	E	F	G	Н			
` mil												
	Α	2.5/3.8 <sup>1</sup>	4.8	6.3	6.3	7.3	7.3	7.3	7.3	8.3		
#	В	2.5/3.8 <sup>1</sup>	3.3	4.3	4.3	5.3	5.3	5.3	5.3	6.3		
Cra	С	2.5/3.8 <sup>1</sup>	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	3.8	3.8	3.8	5.3	6.3		
į	D	2.5/3.8 <sup>1</sup>	3.3	4.3	4.3	5.3	5.3	5.3	6.3	6.3		
9	E	2.5/3.8 <sup>1</sup>	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	4.3		
Ë	F	2.5/3.8 <sup>1</sup>	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	4.3		
Leading Aircraft	G	2.5/3.8 <sup>1</sup>	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	2.5/3.81	$2.5/3.8^{1}$	2.5/3.81	$2.5/3.8^{1}$		
تّ	Н	2.5/3.8 <sup>1</sup>	2.5/3.81	2.5/3.81	2.5/3.81	2.5/3.81	2.5/3.81	2.5/3.81	2.5/3.81	$2.5/3.8^{1}$		
	I	2.5/3.8 <sup>1</sup>	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$	$2.5/3.8^{1}$		

VMC/IMC in-trail separations

Note: Arrival separations include a 0.3 nautical mile buffer

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

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 <sup>1</sup>	180	180	180	180	180	180	180	180		
#	В	60/72 <sup>1</sup>	120	120	120	120	120	120	120	120		
Aircraft	С	60/72 <sup>1</sup>	60/72 <sup>1</sup>	60/72 <sup>1</sup>	60/72 <sup>1</sup>	120	120	120	120	120		
i	D	60/72 <sup>1</sup>	120	120	120	120	120	120	120	120		
	E	60/72 <sup>1</sup>	120									
Leading	F	60/72 <sup>1</sup>	60/721	60/721	60/72 <sup>1</sup>							
eac	G	60/72 <sup>1</sup>										
Ĭ	Н	60/72 <sup>1</sup>										
	ı	60/72 <sup>1</sup>										

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.

Annual Use of Configurations (2012-2019) 70% 60% South VMC North VMC 50% 40% 30%

**Exhibit 8-1, Annual Use of Airport Configurations** 

Source: ASPM data, 2012-2019

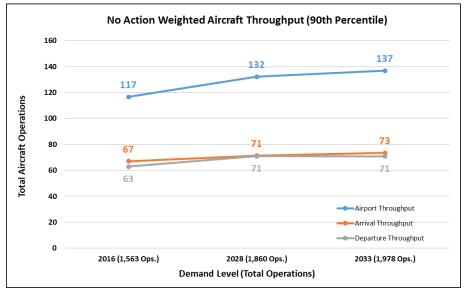
#### Percent of Operations 20% South IMC North IMC 10% 0% 2012 2013 2014 2015 2016 2017 2018 2019 Year

#### 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 sustainable 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 90<sup>th</sup> 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

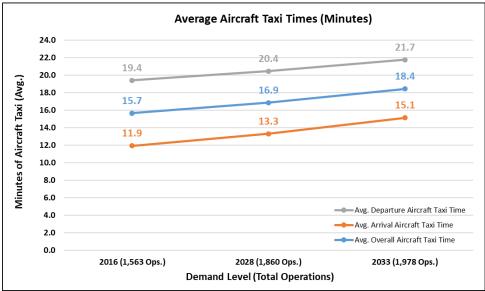
·		0.							
90th Percentile	2	2028 Future	e No Action	ı	2033 Future No Action				
Simulated	North	North	South	South	North	North	South	South	
Throughput	VMC	IMC	VMC	IMC	VMC	IMC	VMC	IMC	
Airport	134	128	132	128	139	131	137	132	
Arrival	73	70	70	69	75	72	72	71	
Departure	72	65	73	67	71	67	73	68	
18R/36L 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.

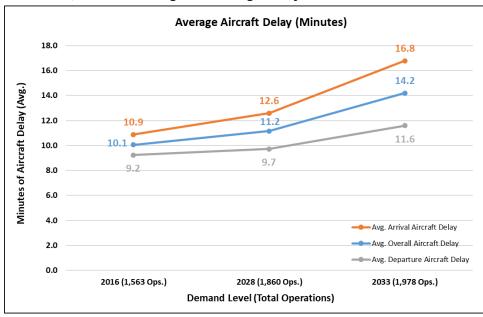
Exhibit 8-3, No Action Weighted Average Taxi Times



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.

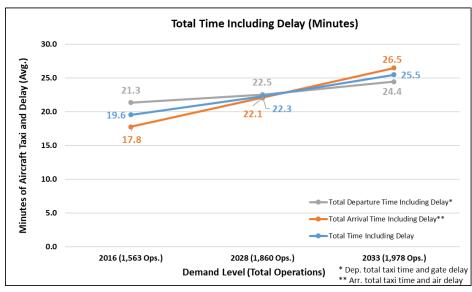
Exhibit 8-4, No Action Weighted Average Delay



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.

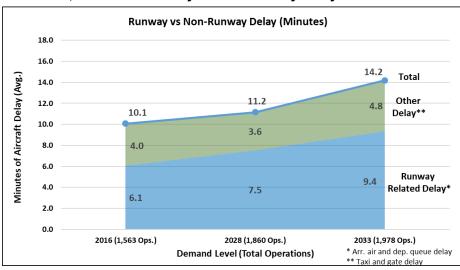
Exhibit 8-5, No Action Total Time Including Delay



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

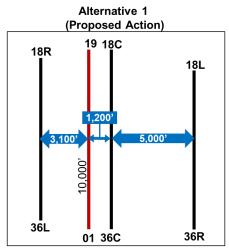


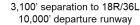
Source: Landrum & Brown analysis, 2020

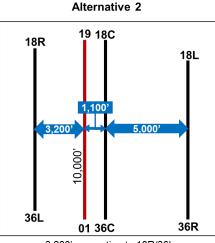
# 9 Airfield Alternatives Operating Assumptions

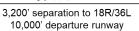
Three alternatives were developed and evaluated to meet the purpose and need identified in the EA process. Alternative 1 assumes the construction of a new 10,000 feet runway (designated as Runway 01/19 for the purposes of the EA) that is located 1,200 feet to the west of existing Runway 18C/36C. Under 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.

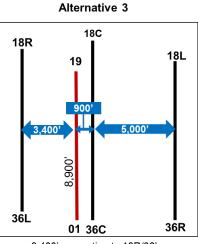
**Exhibit 9-1, Alternatives Overview** 











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 cpansion Runway 18R/36L Runway Runway 18C/36C 01/19 Additional Taxiway/Taxilane Infrastructure 36L 36C 36R

Exhibit 9-2, Alternative 1 Airfield Layout

Source: CLT airport and Landrum & Brown, 2020

Full South EAT

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

**Exhibit 9-3, Alternative 3 Airfield Layout** 

Source: CLT airport and Landrum & Brown, 2020

**EAT** 

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

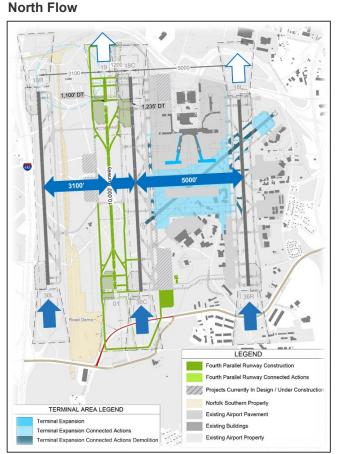
The addition of the fourth runway allows for greater flexibility in runway operating configurations. For the purposes of this study, one main set of runway configuration was assumed and simulated for each alternative. Other runway configurations and procedures can be developed based on the needs of future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

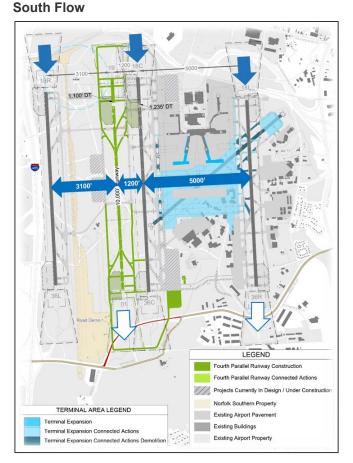
In Alternative 1, the new runway does not have sufficient spacing between it and either of its two adjacent runways to allow for triple simultaneous independent straight-in approaches, so it is intended to be used primarily by departures. Therefore, Runways 18R/36L, 18C/36C, and 18L/36R would be used 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

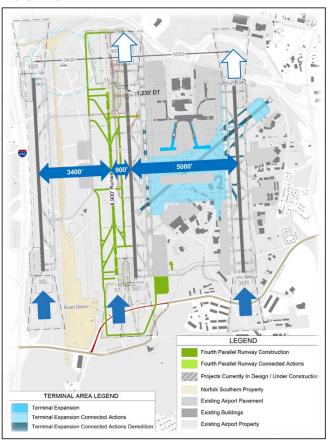




Source: Landrum & Brown, 2020

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

#### North Flow South Flow



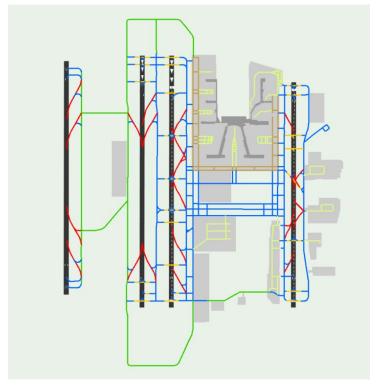


Source: Landrum & Brown, 2020

# 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

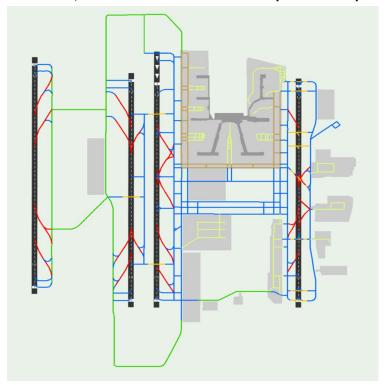


High Speed Exits
Outer Perimeter Taxiways
Runway Crossings
Taxiways
Ramp Area Taxiways
Ramp Area Taxilanes

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

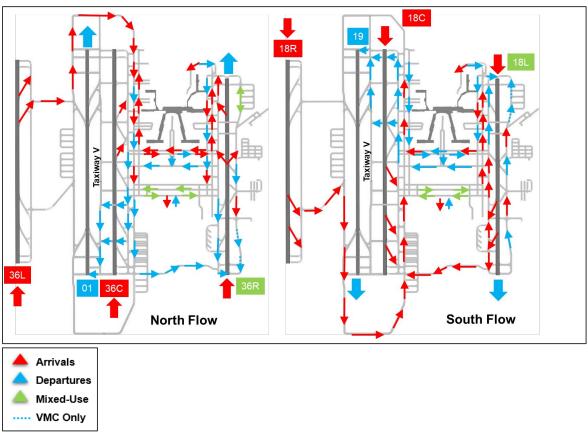
High Speed Exits
Outer Perimeter Taxiways
Runway Crossings
Taxiways
Ramp Area Taxiways
Ramp Area Taxilanes

32 knots
20 knots
18 knots
115 knots
12 knots
10 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

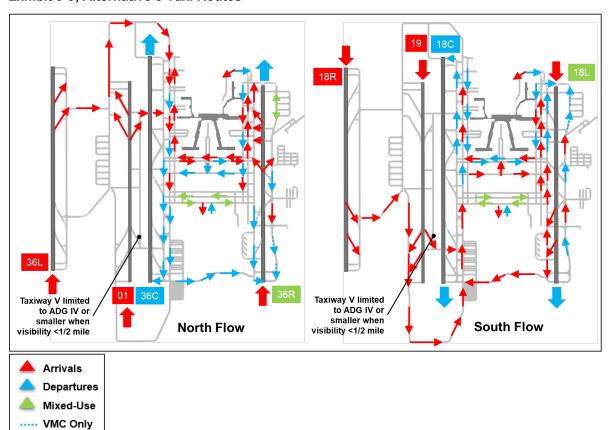


Exhibit 9-9, Alternative 3 Taxi Routes

Source: Landrum & Brown analysis and ATCT feedback, 2020

#### 9.5 Airspace Assumptions

**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)

RASLN
(prop)

RUNway 36L

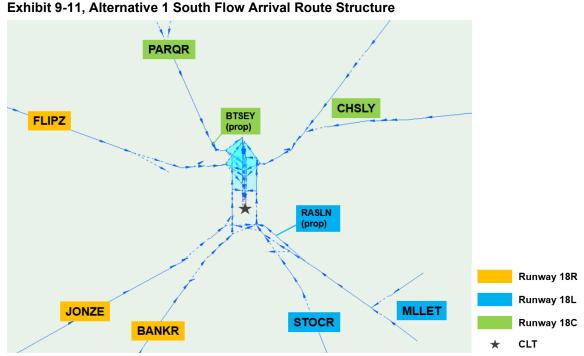
Runway 36C

Runway 36C

CHSLY

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



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.

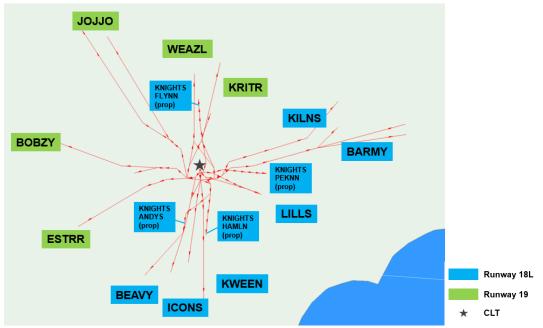
JOJJO **WEAZL** KRITR **KILNS BARMY BOBZY LILLS ESTRR** Runway 36R **KWEEN** Runway 01 **BEAVY ICONS** 

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

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

CLT

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 90<sup>th</sup> 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 Arrival Throughput Weighted Total Throughput Weighted Departure Throughput (90th Percentile) (90th Percentile) (90th Percentile) 160 160 160 153 **3**151 Number of Aircraft Operations 08 001 051 140 140 137 132 120 120 100 100 82 82 80 79 **8**2 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 90<sup>th</sup> 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 90<sup>th</sup> 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 Alte	ernative 1		2033 Alter			rnative 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.

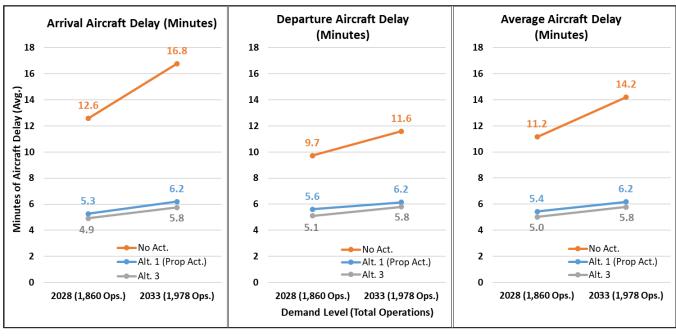
**Arrival Taxi Time (Minutes)** Departure Taxi Time (Minutes) Overall Taxi Time (Minutes) 22 22 22 **21.7** 20.4 20 20 20 **•19.3** 18.4 (Avg.) 18.7 18 18 16.9 18.2 و ا 16 17.5 15.1 16 16 Taxi 14.6 13.3 14.9 ზ 14 14 14 14.5 Minutes 12 12.1 11.8 12 12 10.4 10.2 10 10 10 No Act. No Act. Alt. 1 (Prop Act.) -Alt. 1 (Prop Act.) -Alt. 1 (Prop Act.) -Alt. 3 —Alt. 3 ——Alt. 3 2033 (1,978 Ops.) 2033 (1,978 Ops.) 2028 (1,860 Ops.) 2033 (1,978 Ops.) 2028 (1,860 Ops.) 2028 (1,860 Ops.) **Demand Level (Total Operations)** 

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

Landrum & Brown analysis, 2021 Source:

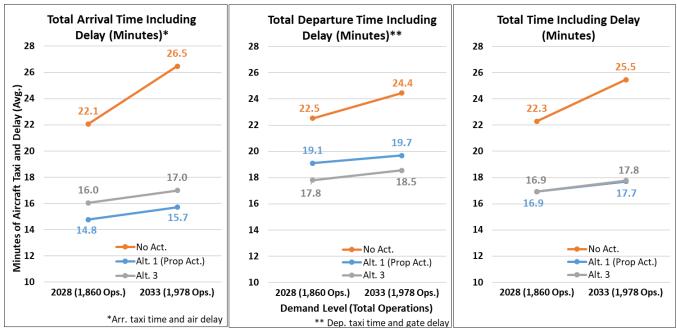
The average arrival, departure, and overall aircraft delays are shown in Exhibit 10-3. Both arrival and departure delays are slightly higher in Alternative 1 than Alternative 3 due to Runway 01/19 departures needing to cross Runway 18C/36C to reach the departure gueue on Taxiway V. The departures experience 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. Runway-related 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

#### 11 Conclusions

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

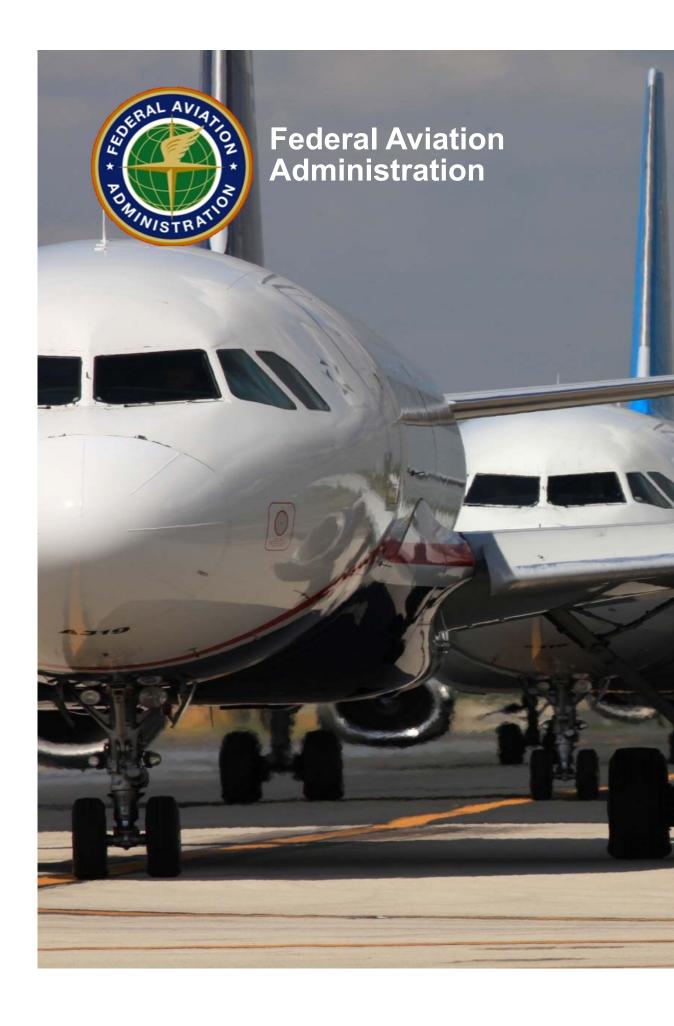
## **DORA Process**

# 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

2/1/2016

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)

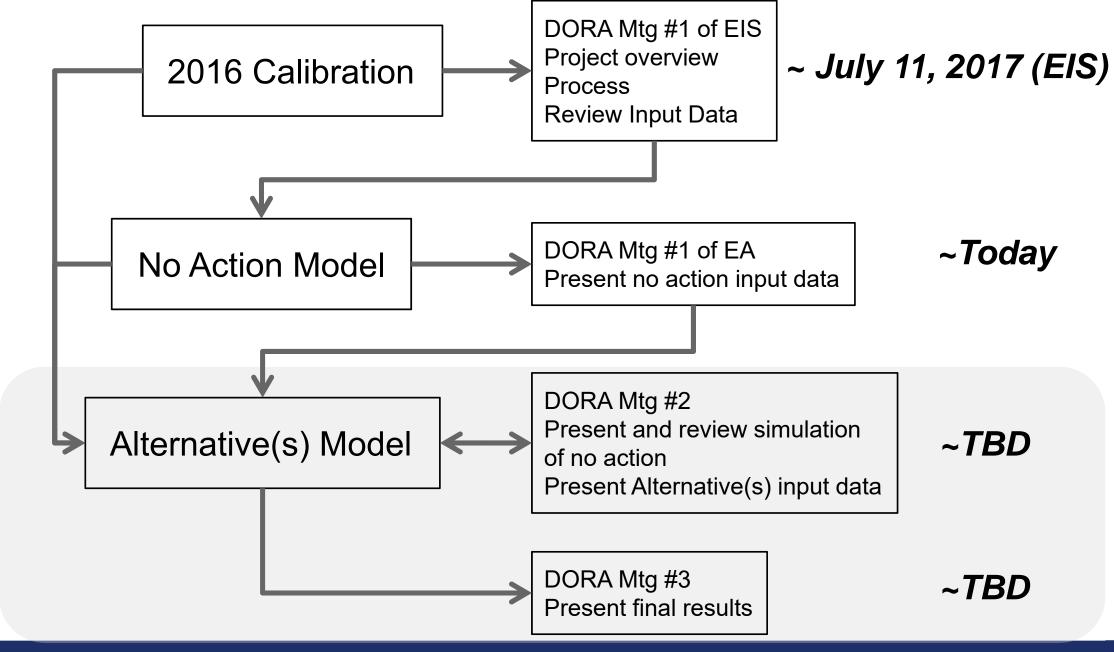
#### Desired Result: 2<sup>nd</sup> DORA Letter

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



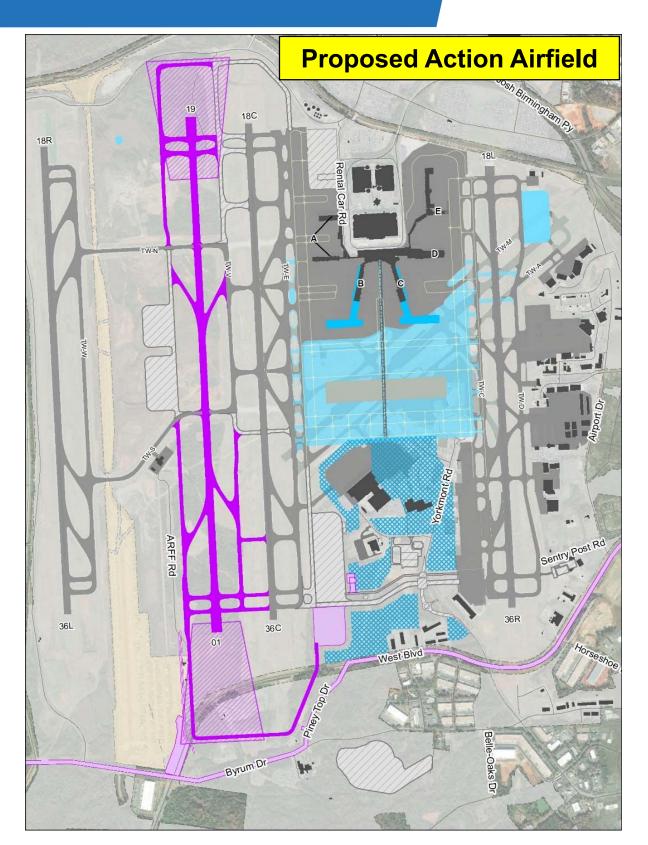
#### **EA Process Overview**

#### 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

- -4<sup>th</sup> 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

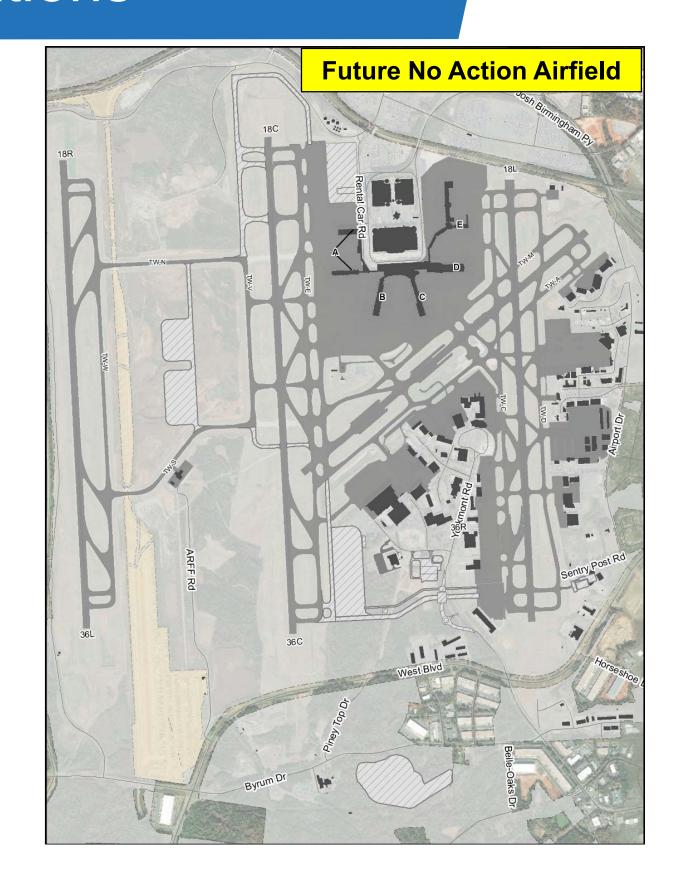


#### **EA Process Overview**

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 90<sup>th</sup> 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						
ASPM – 90 <sup>th</sup> * EIS – 90 <sup>th</sup> * AirTOp – 90 <sup>th</sup>						
North VMC	121	118	117			
North IMC	114	116	114			
South VMC	121	121	117			
South IMC	112	116	115			

<sup>\*</sup> Source: Capacity/Delay Analysis and Airfield Modeling Technical Memorandum, CLT EIS ASPM data, 2016-2017

## Arrival and Departure Throughput

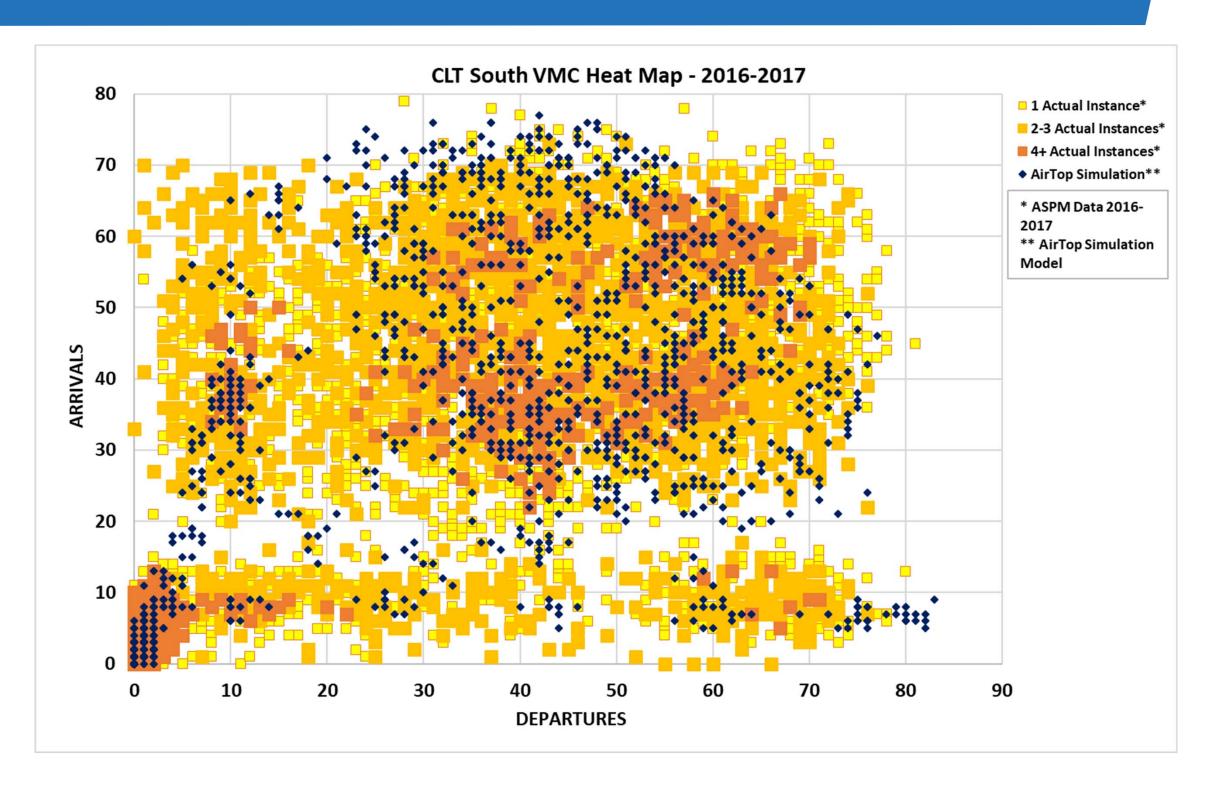
- Simulated hourly arrival and departure throughput match closely with ASPM and results of EIS simulation effort
- The FAA's Capacity Airport Arrival Rates or called arrival rates in VMC are much higher than actual hourly counts

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
NOITH VIVIC	Dep	69	82	67	78	82	63
North IMC	Arr	75	76	64	73	72	64
NOI III IIVIC	Dep	65	79	62	68	78	59
South VMC	Arr	92	78	63	77	77	68
South vivic	Dep	82	81	66	78	83	64
South IMC	Arr	75	77	64	74	77	66
South livic	Dep	65	74	58	68	79	61

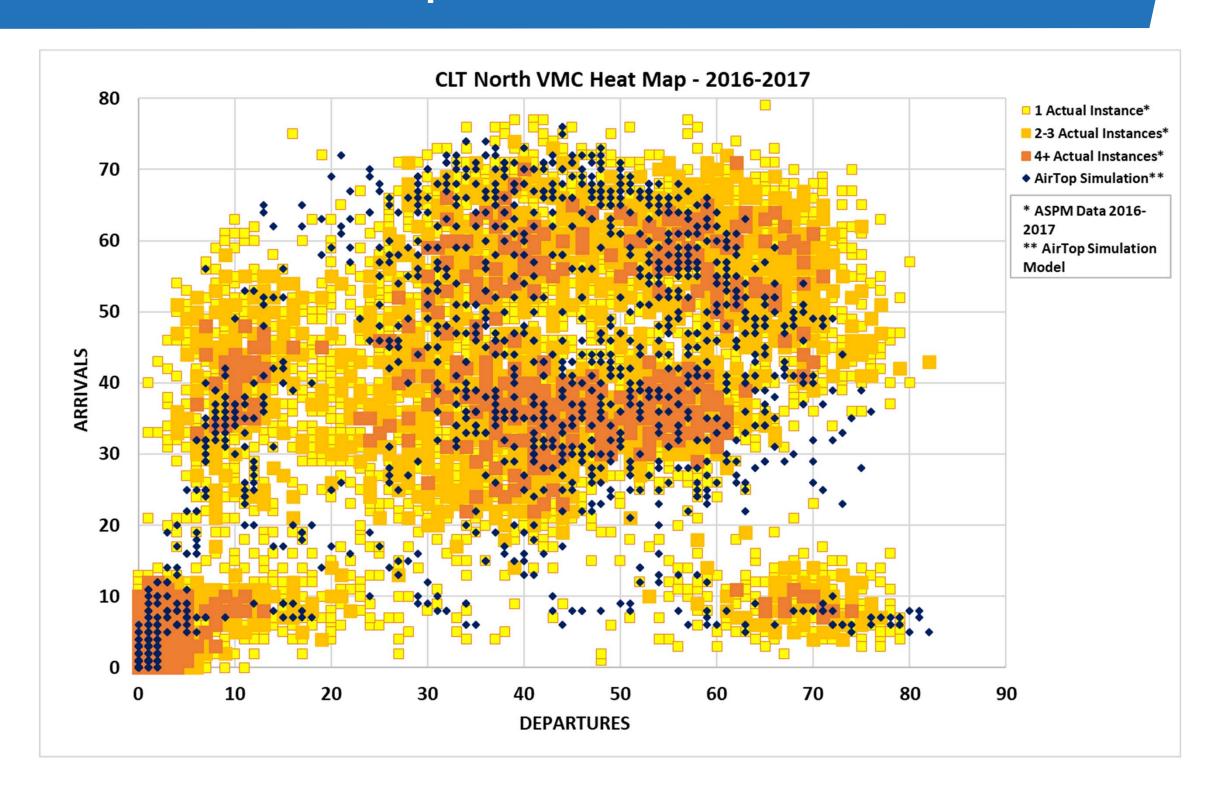
<sup>\*</sup> Source: Capacity/Delay Analysis and Airfield Modeling Technical Memorandum, CLT EIS ASPM data, 2016-2017

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 90<sup>th</sup> percentile data was not provided in the EIS calibration report

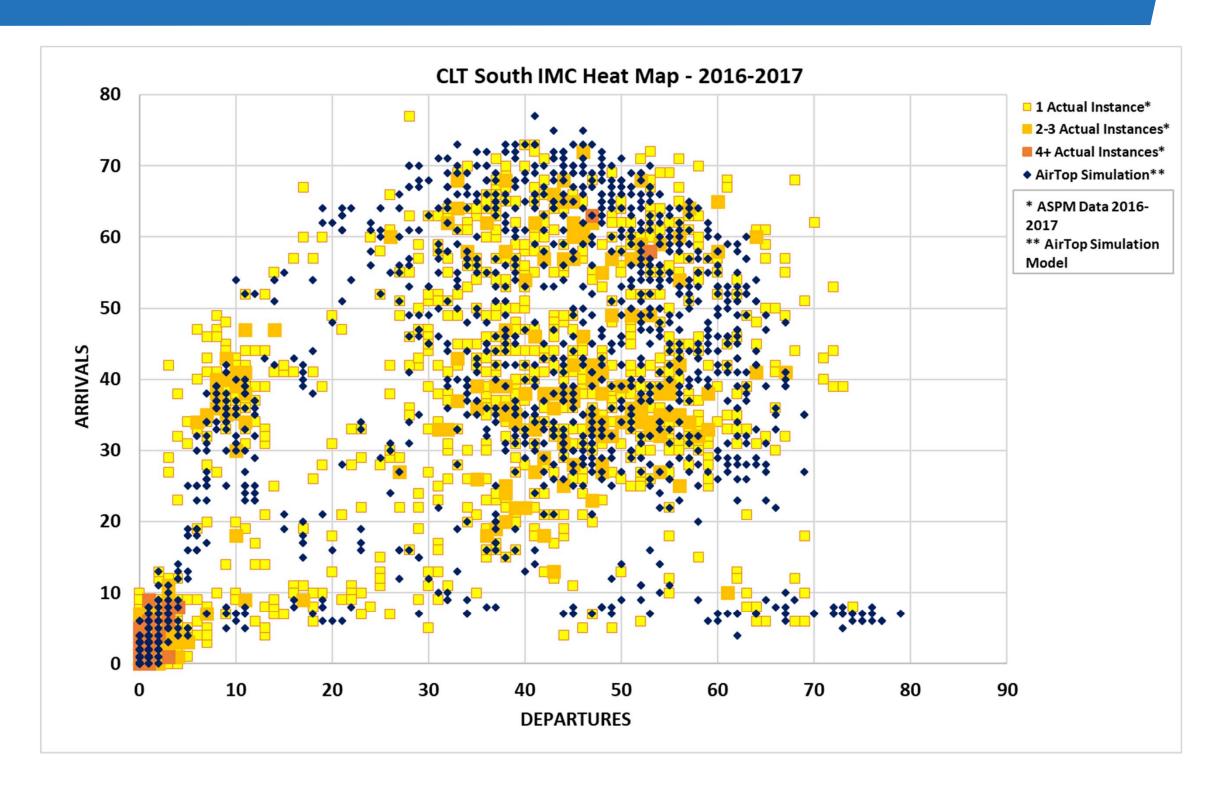
# South VMC Heat Map



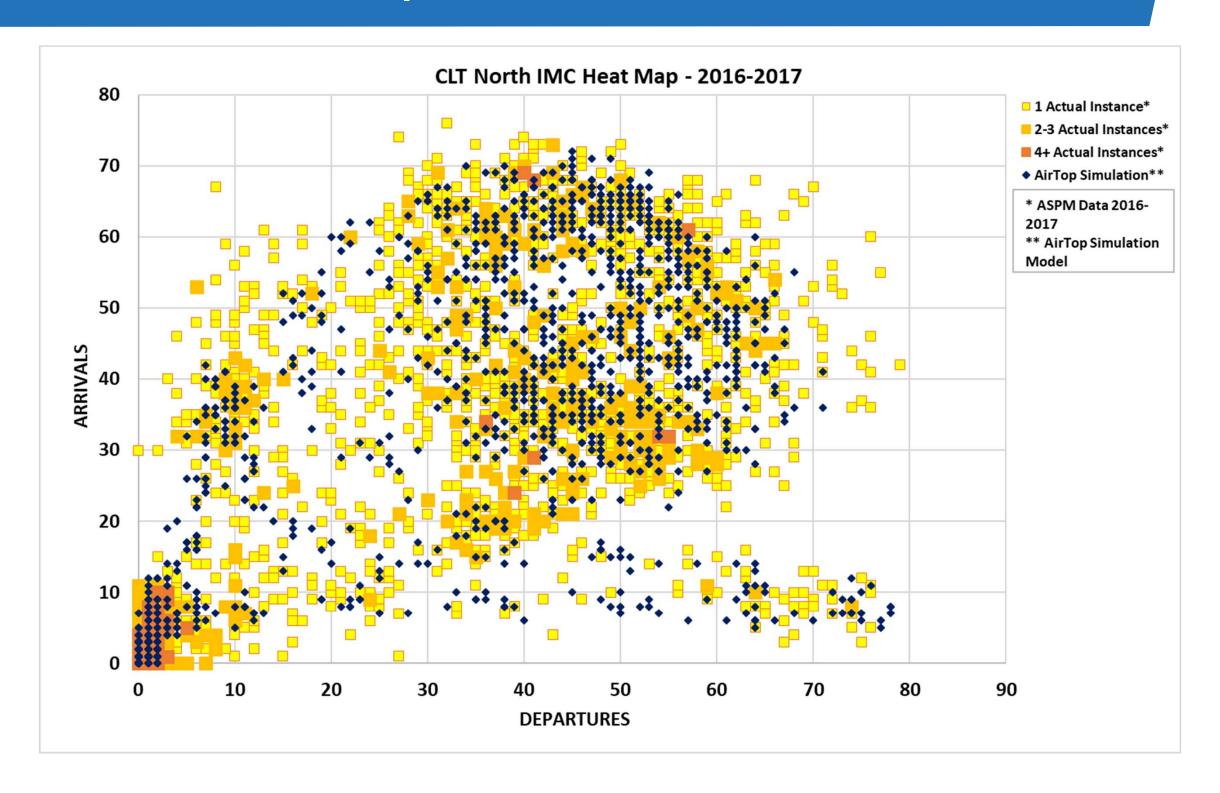
# North VMC Heat Map



# 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 Time				
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

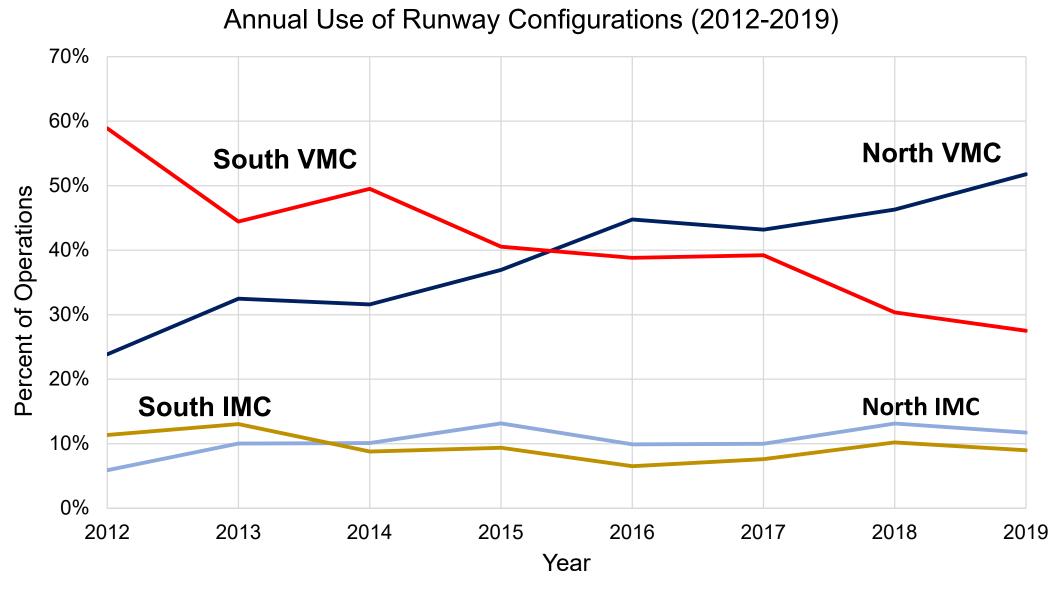
- Taxi time and delay metrics are presented for each runway configuration
- Annualization is calculated by averaging the metrics using the runway configuration use percentage

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%			

<sup>\*</sup> 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

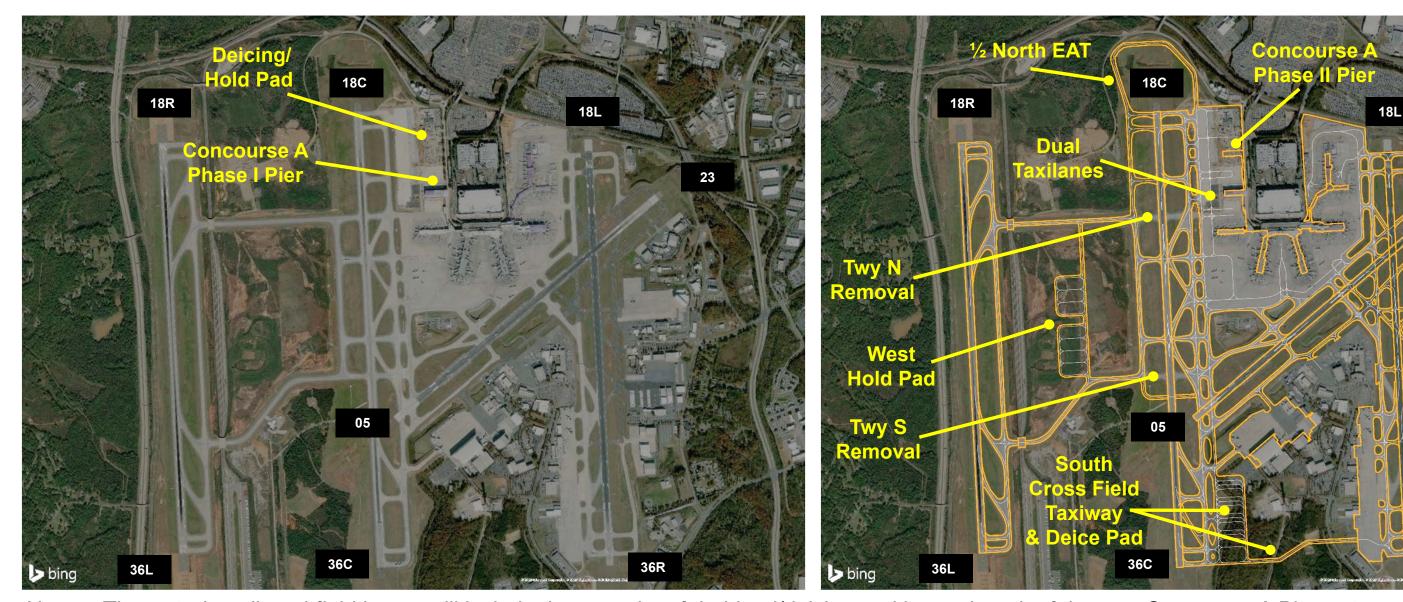
## 2019 Baseline and Future No Action Summary of Experiments

- 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

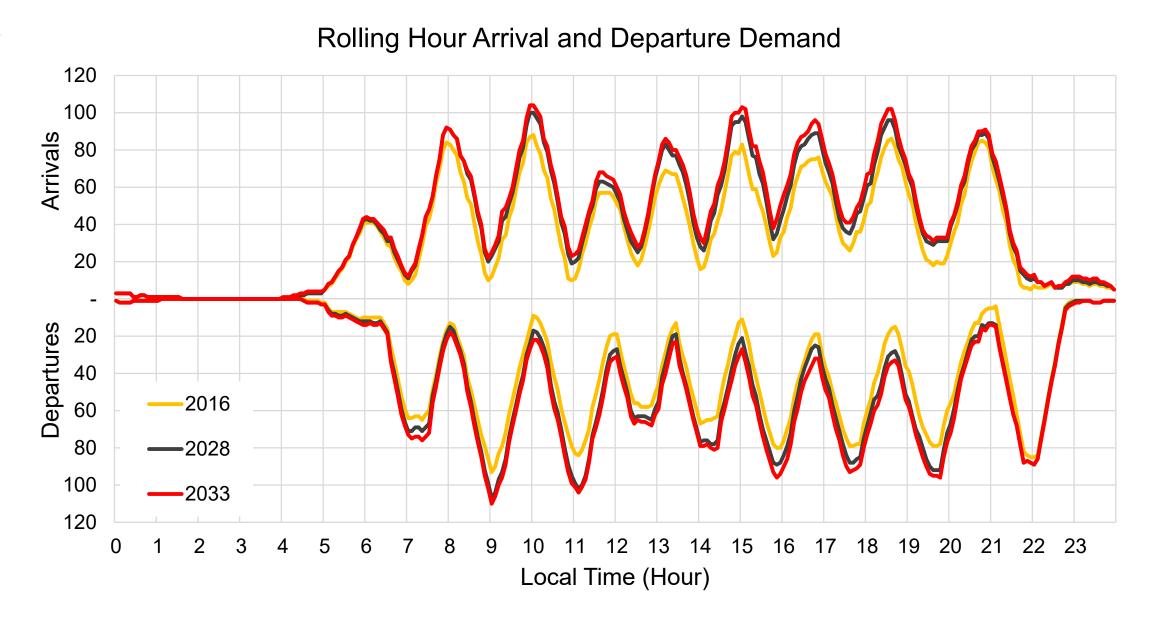
**- 2016: 1,563** 

**- 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

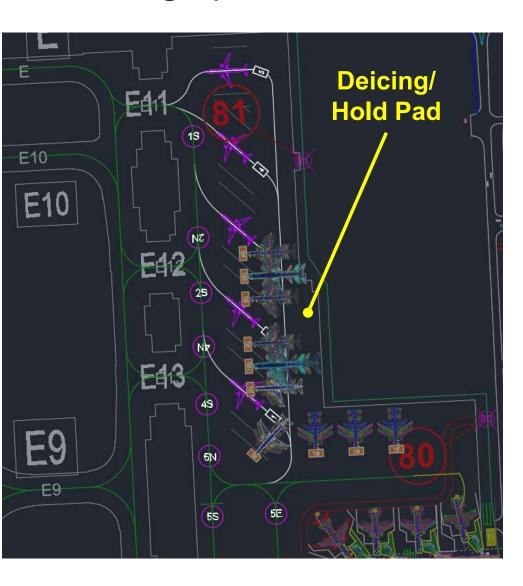
- Aircraft gate layouts will be input into AirTOp and will include airline assignment and aircraft size restrictions to simulate actual gate usage
- General Aviation and Cargo (FDX/UPS) operations were simulated and parked at their primary facility located on the existing airfield
- Aircraft holdpad and towing areas simulated
- Modeling of future gate capacity

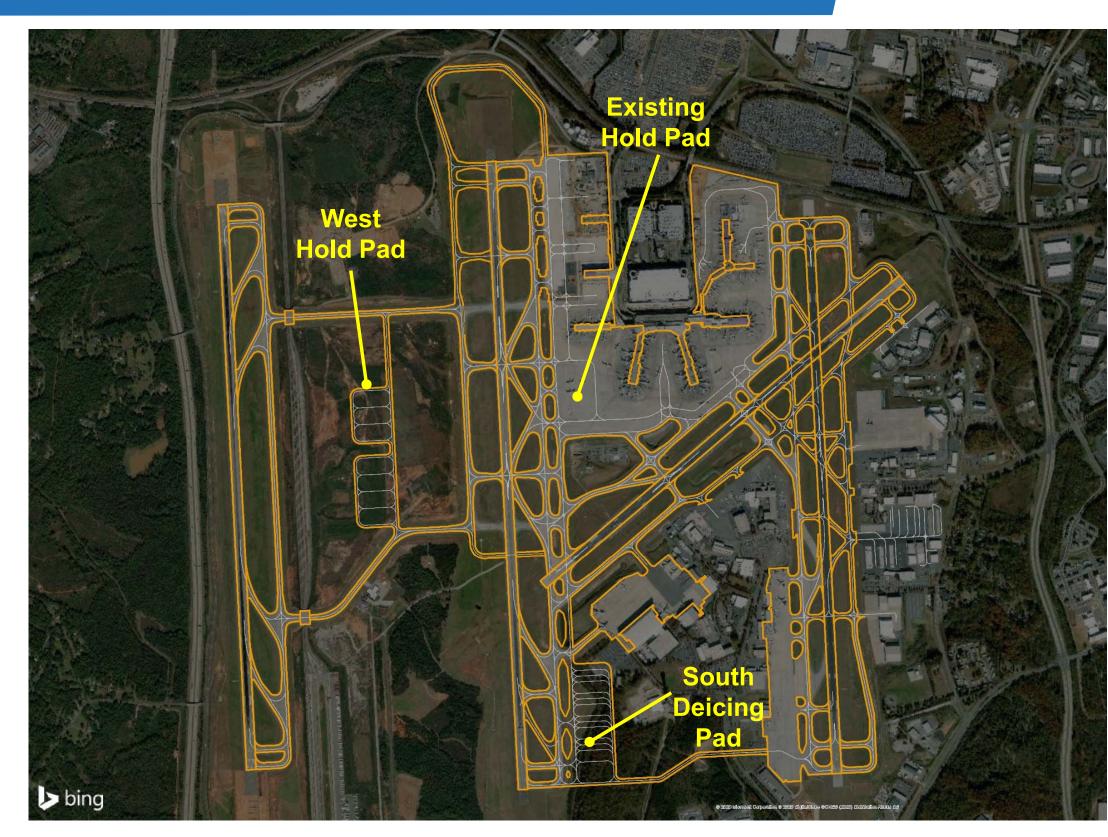
Airline Gating Assignment Assumptions (2019 Baseline)					
Concourse A	AA, DL				
Concourse A (Phase 1 Expansion)	OALs				
Concourse B & C	AA Mainline				
Concourse D	AA Mainline, LH				
Concourse E	AA Regional				

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

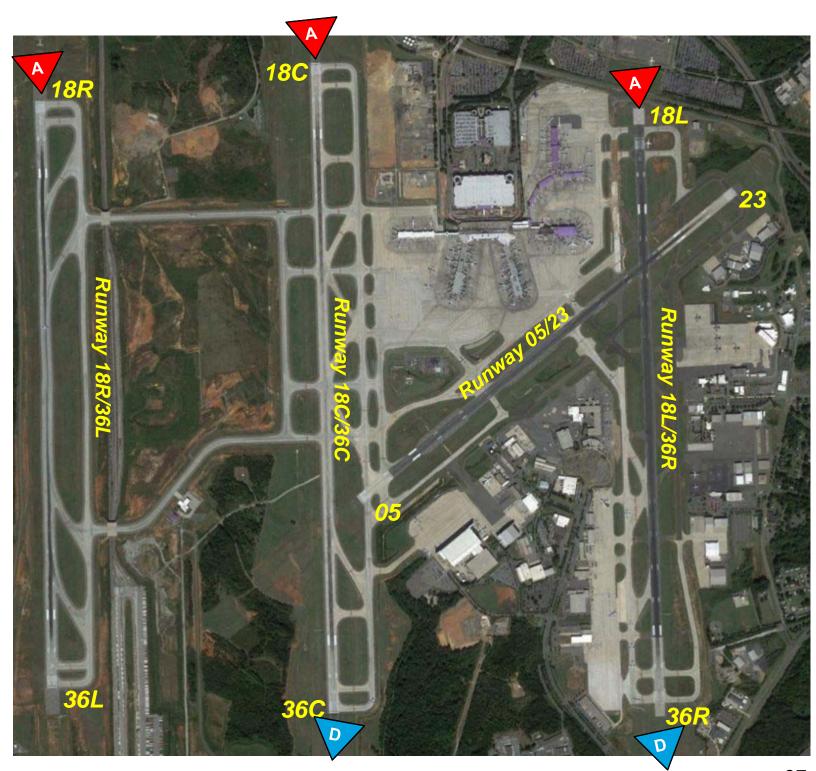
 Airfield deicing/hold pads will be simulated to accommodate arrivals waiting for gates, RON operations and aircraft towing operations





#### 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°

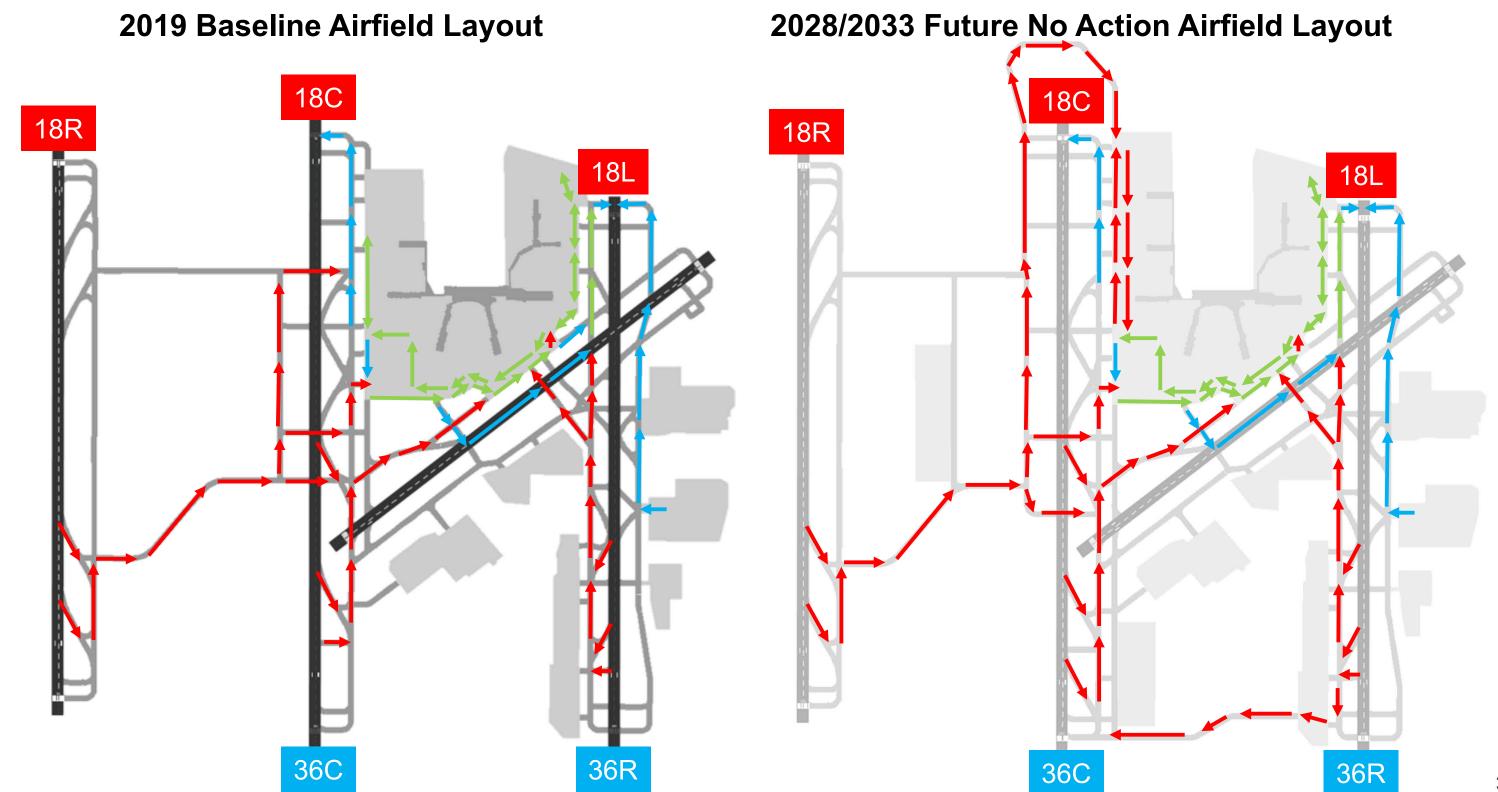
#### North VMC/IMC Runway Configuration

- 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



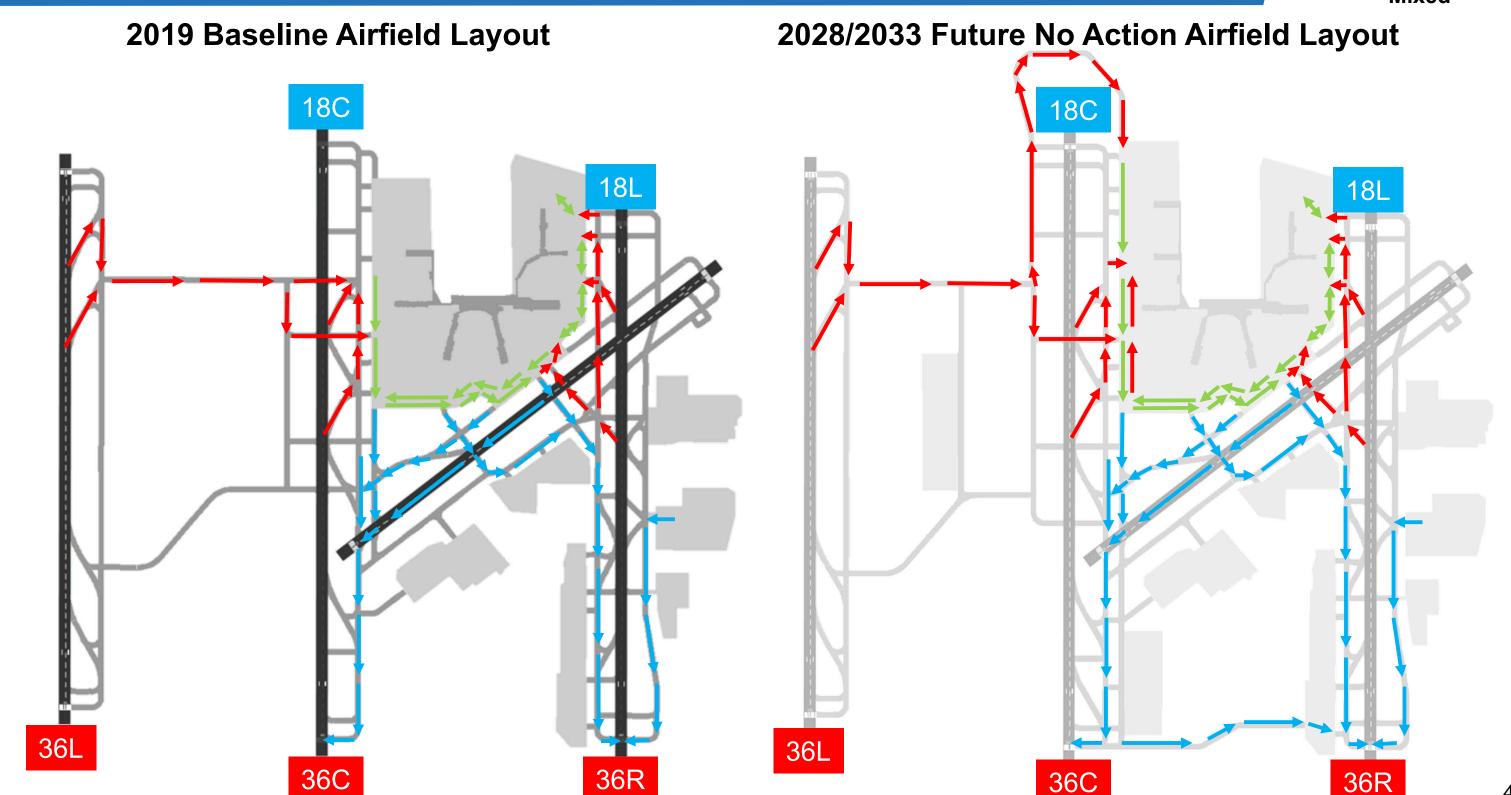
#### South Flow Aircraft Taxi Flows



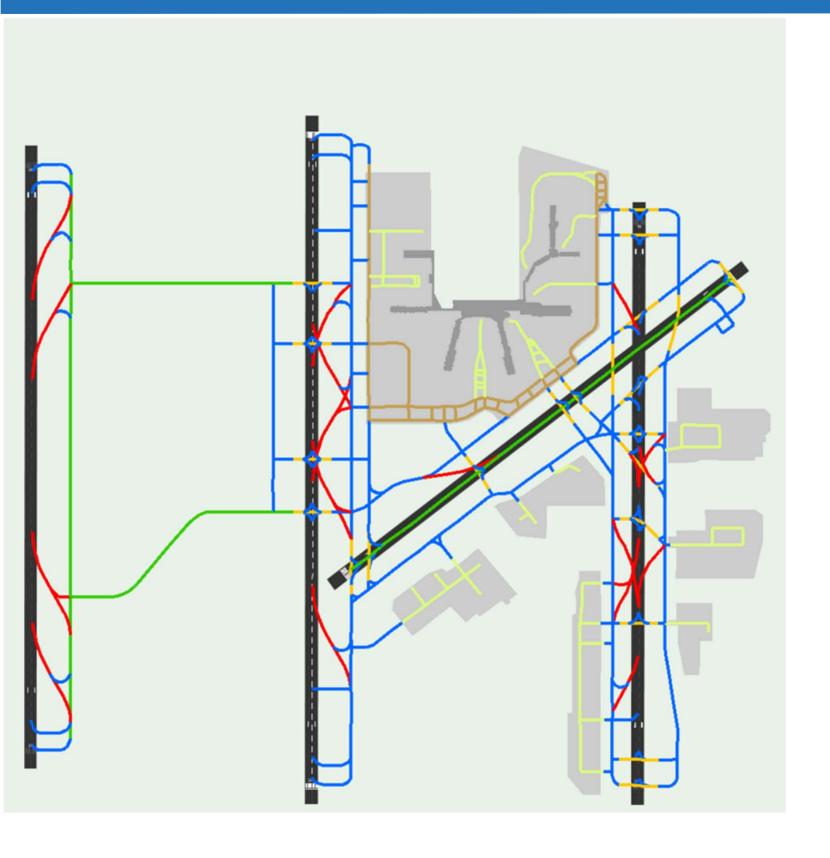


#### North Flow Aircraft Taxi Flows



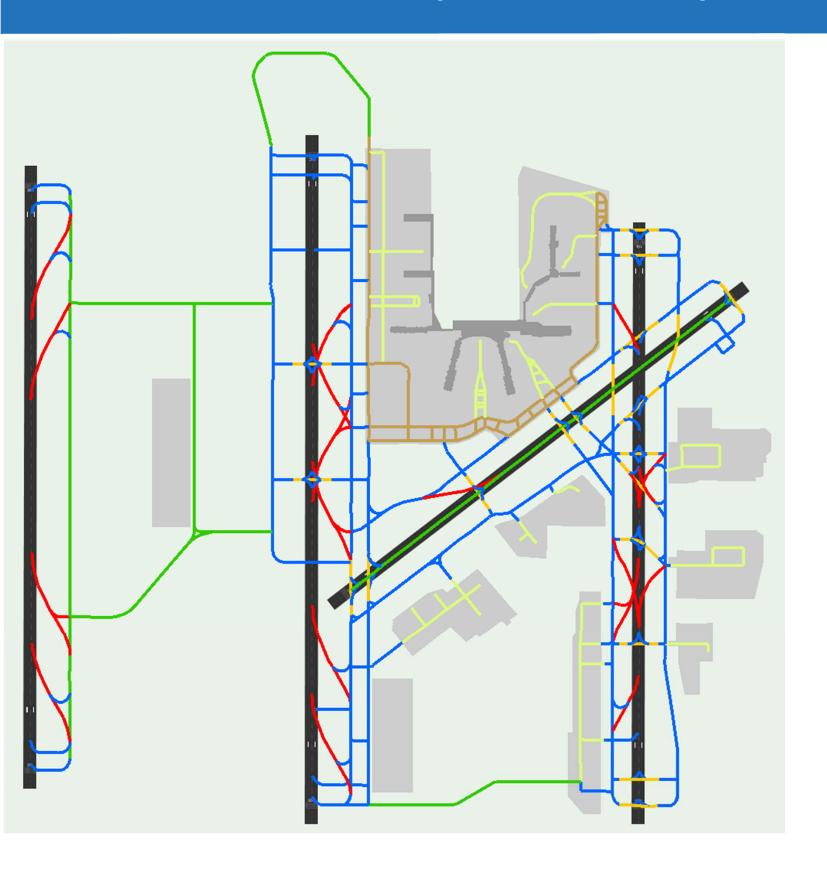


#### Airfield Ground Speed Assumptions – Baseline



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

<sup>\*</sup>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
	C					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									

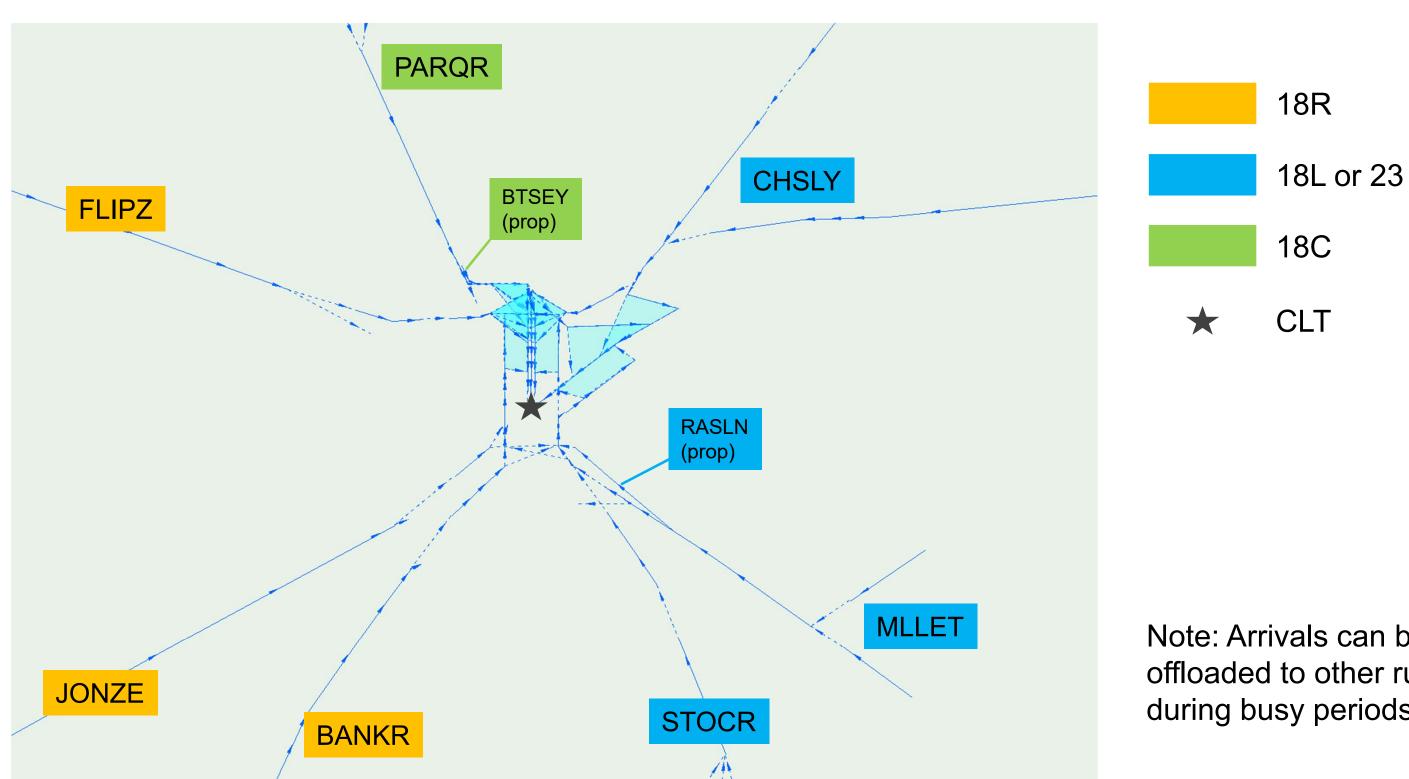
TBL 5-5-2 Wake Turbulence Separation for On Approach

		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

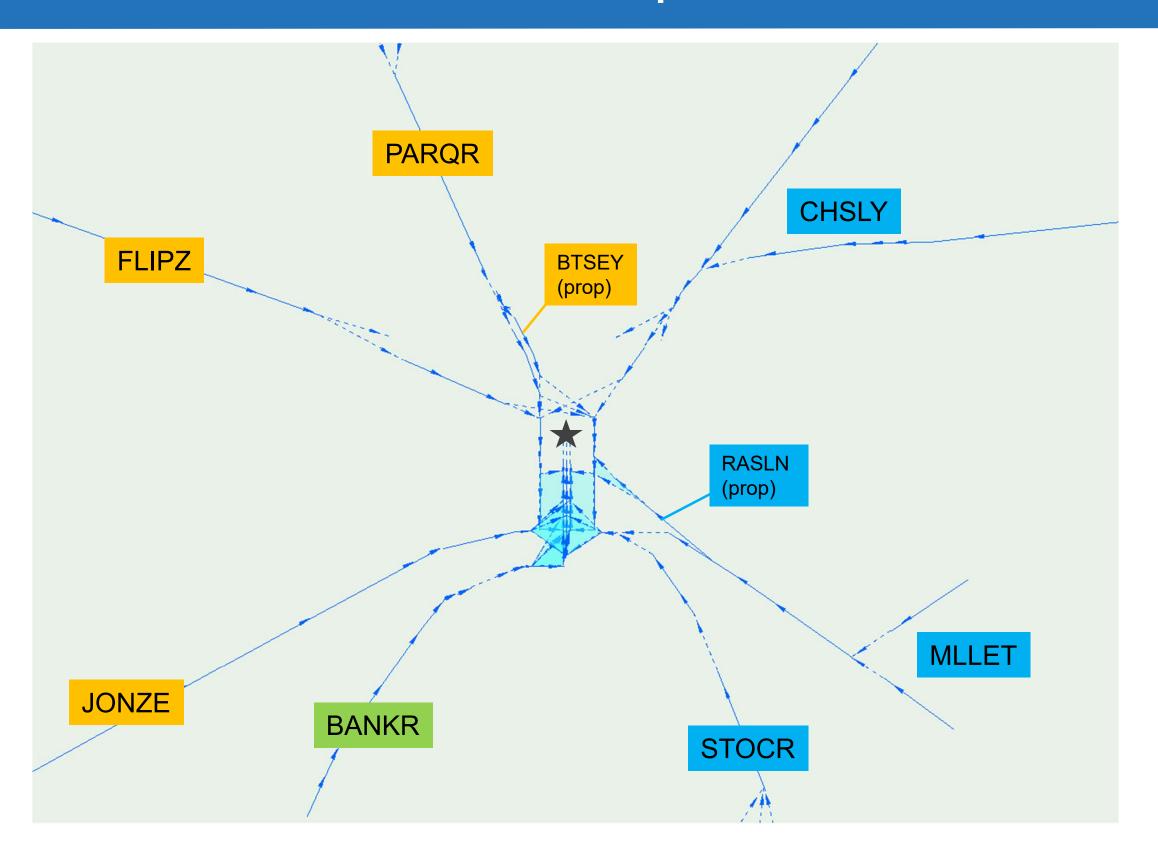
Effective Date: September 28, 2019

### South Flow Arrival Airspace



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

#### North Flow Arrival Airspace



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

36L

36R

36C

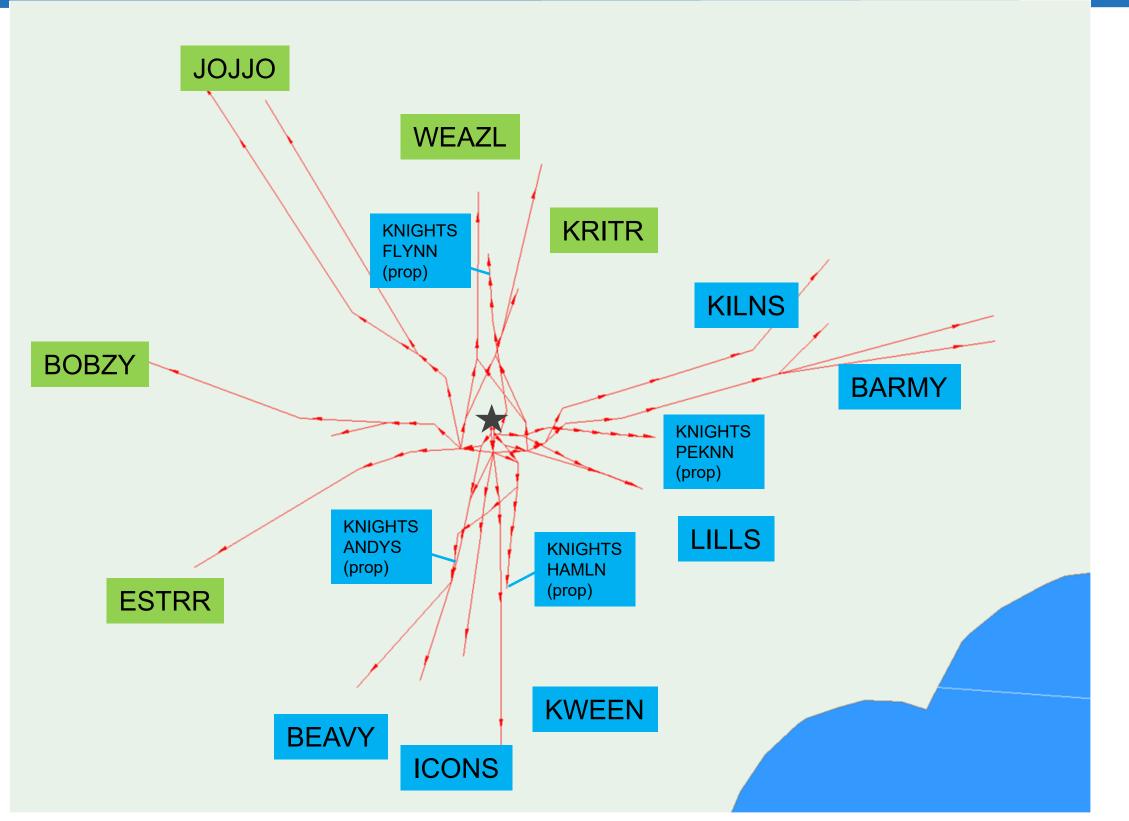
CLT

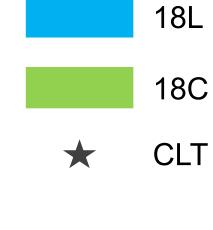
#### Sample Origins by Arrival Routing

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				

<sup>\*</sup>Note that these lists are not all-inclusive. They merely contain examples of some of the major airports that use each route.

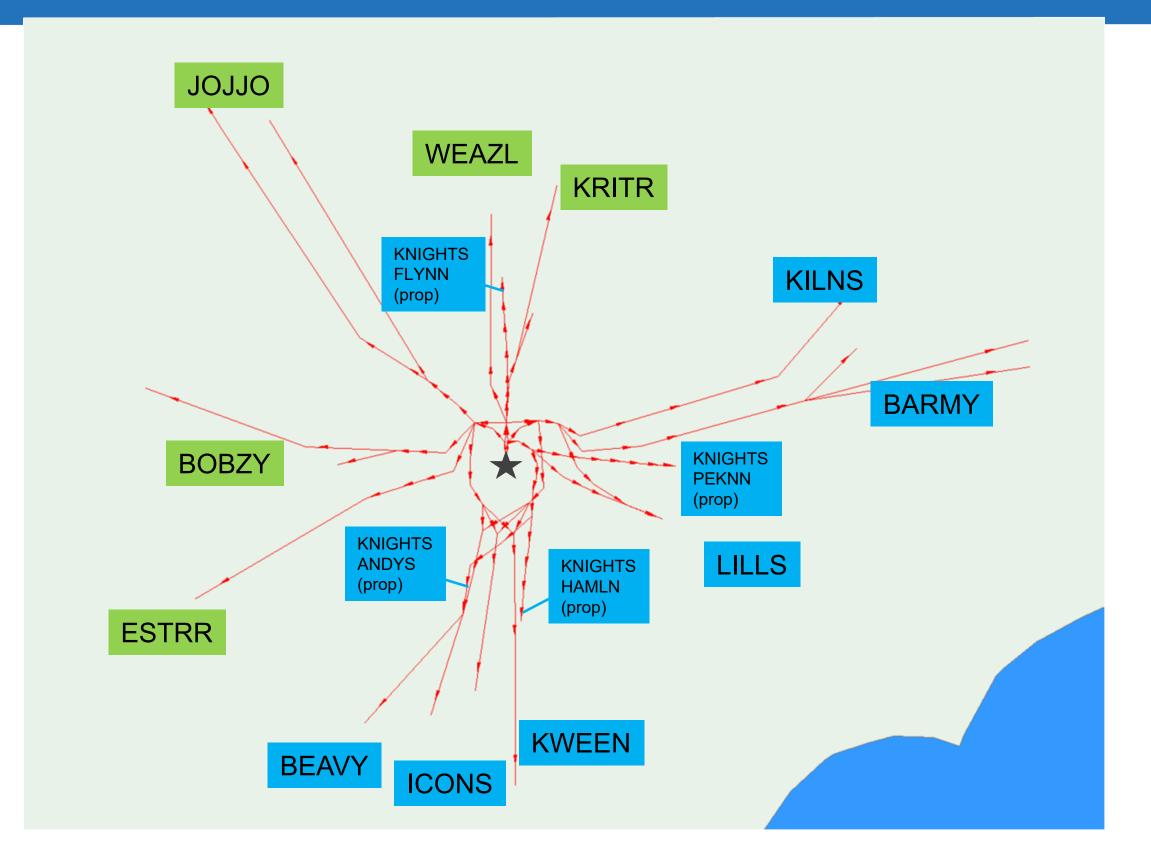
#### South Flow Departure Airspace





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				

<sup>\*</sup>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 3<sup>rd</sup> week of April (week of the 20<sup>th</sup>)
- 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

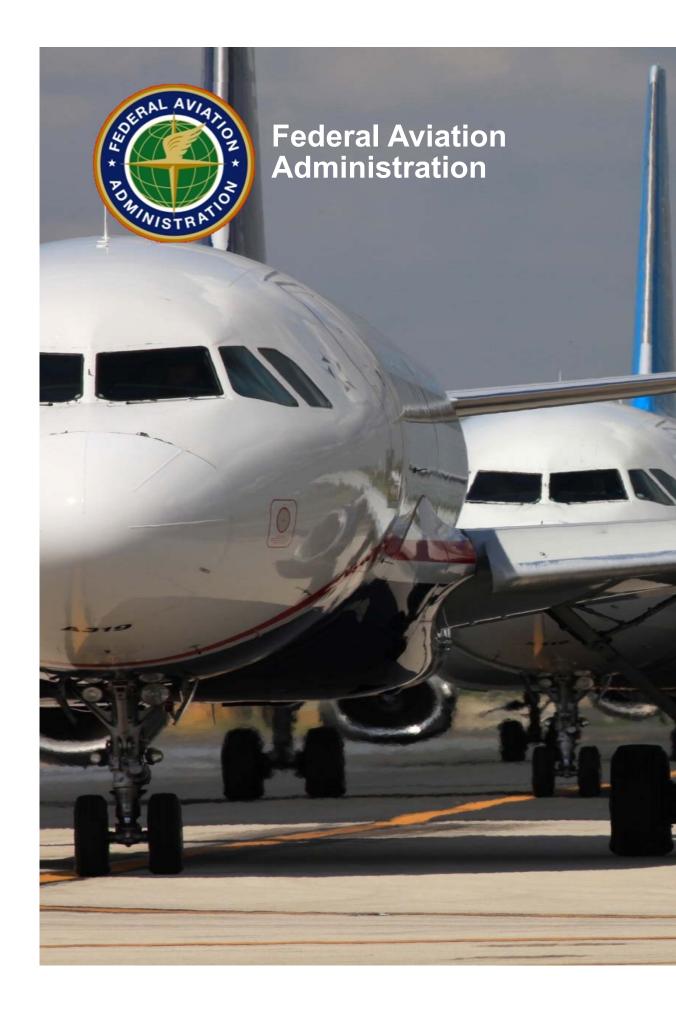
#### **DORA Process**

# 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.

Vinsome A. Lenfert

ome A. Lenfert

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Date

FAA, Division Manager Airports Southern Region

Prostell Thomas,

CLT Air Traffic Manager

2/1/2016

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)

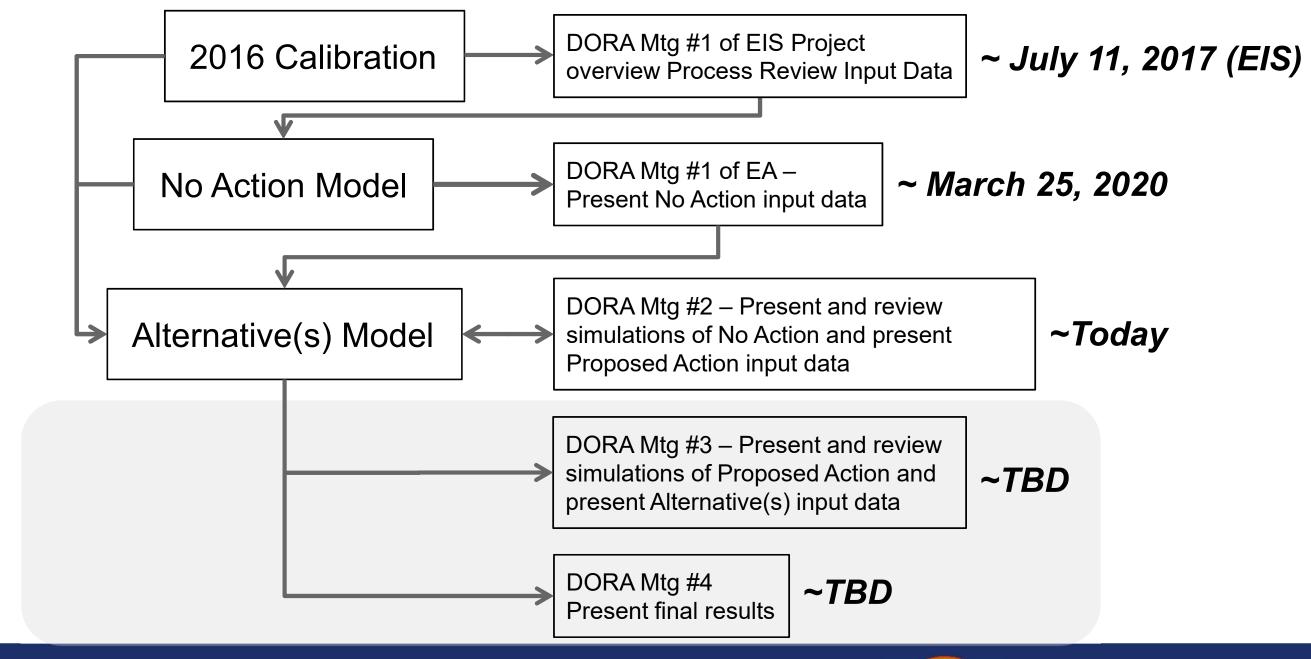
#### Desired Result: 2<sup>nd</sup> DORA Letter

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**



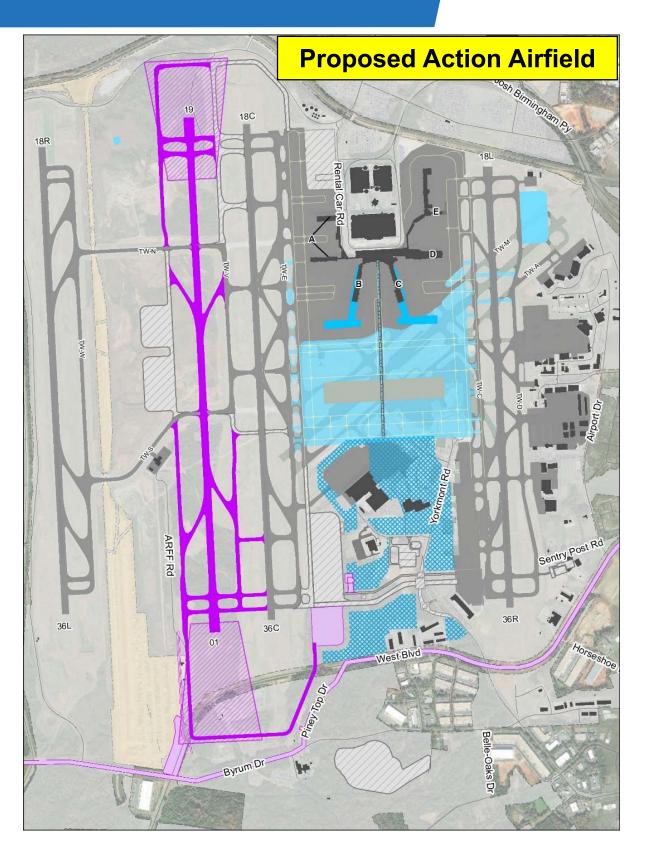
#### **EA Process Overview**

#### 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

- -4<sup>th</sup> 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

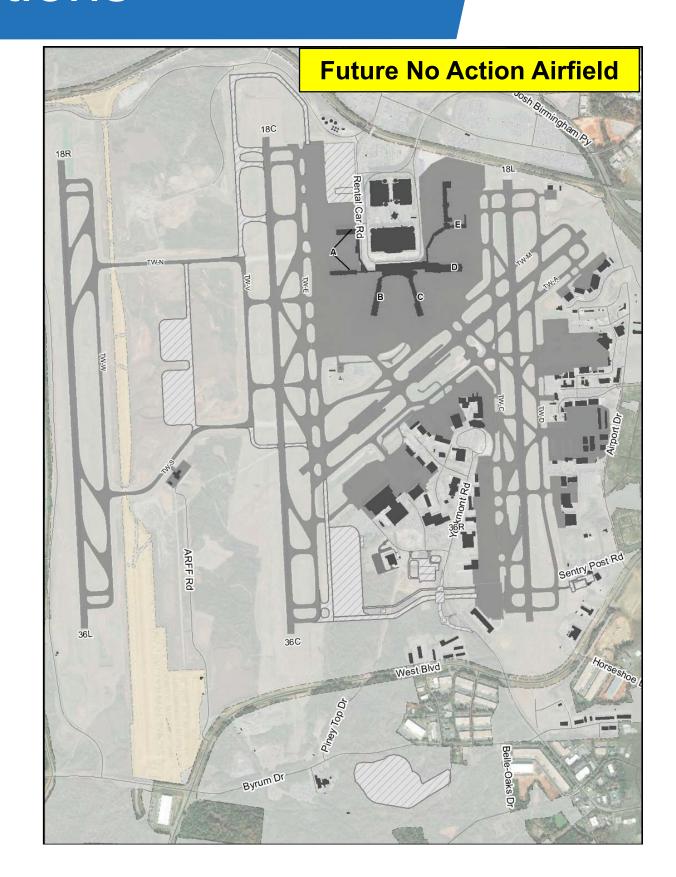


#### **EA Process Overview**

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).

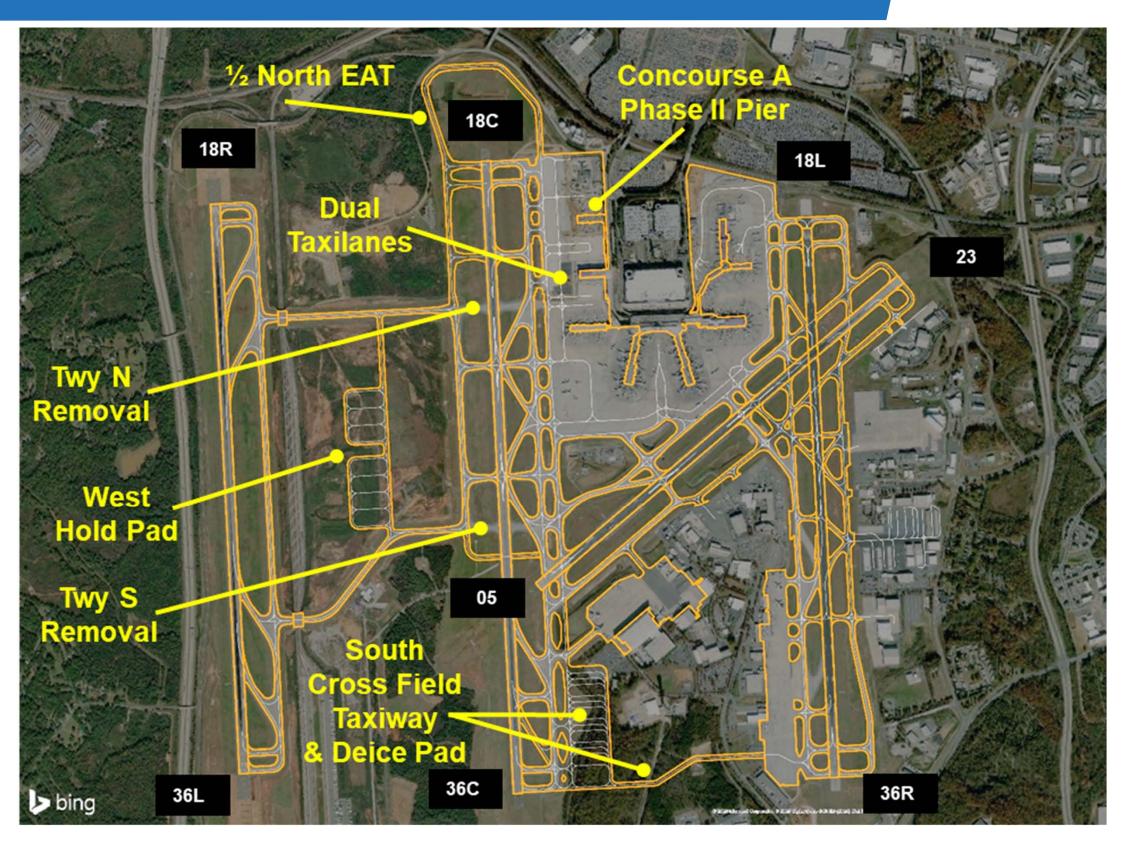
#### No Action Airfield Layout for Simulation

## South FlowExperiments

- 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

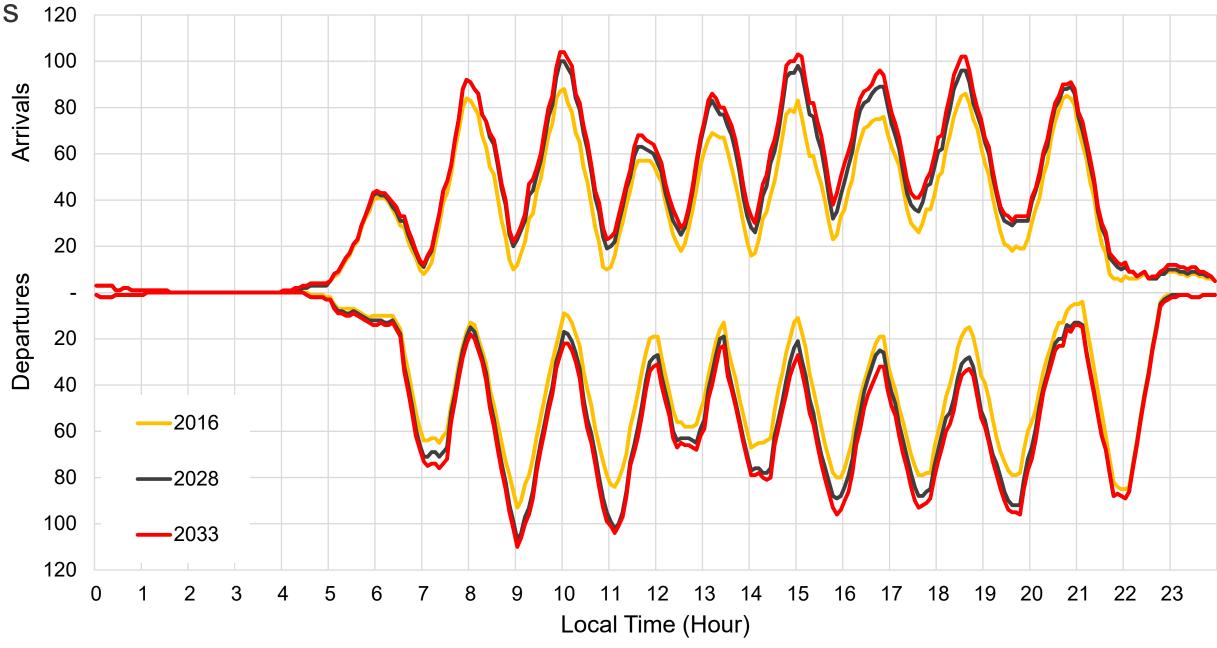
#### Rolling Hour Arrival and Departure Demand



**- 2016: 1,563** 

**- 2028: 1,860** 

**- 2033: 1,978** 



#### Terminal/Concourse Layout Assumptions

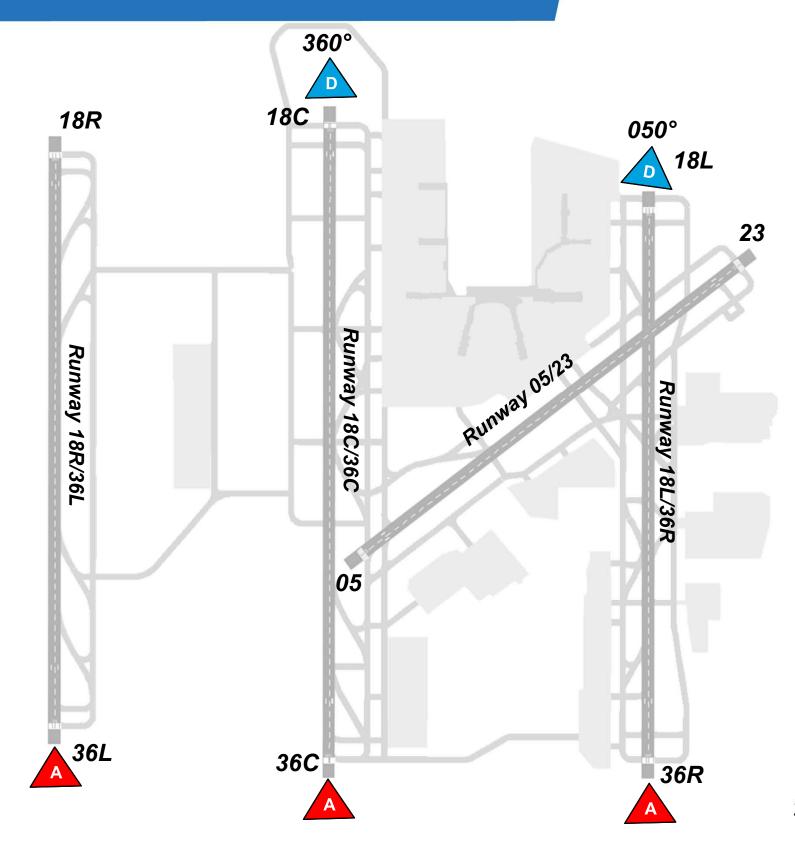
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Airline Gating Assignment Assumptions (2028/2033 Future No Action)					
Concourse A	AA				
Concourse A (Phase 1 Expansion)	OALs				
Concourse A (Phase 2 Expansion)	OALs				
Concourse B & C	AA Mainline				
Concourse D	AA Mainline, LH				
Concourse E	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

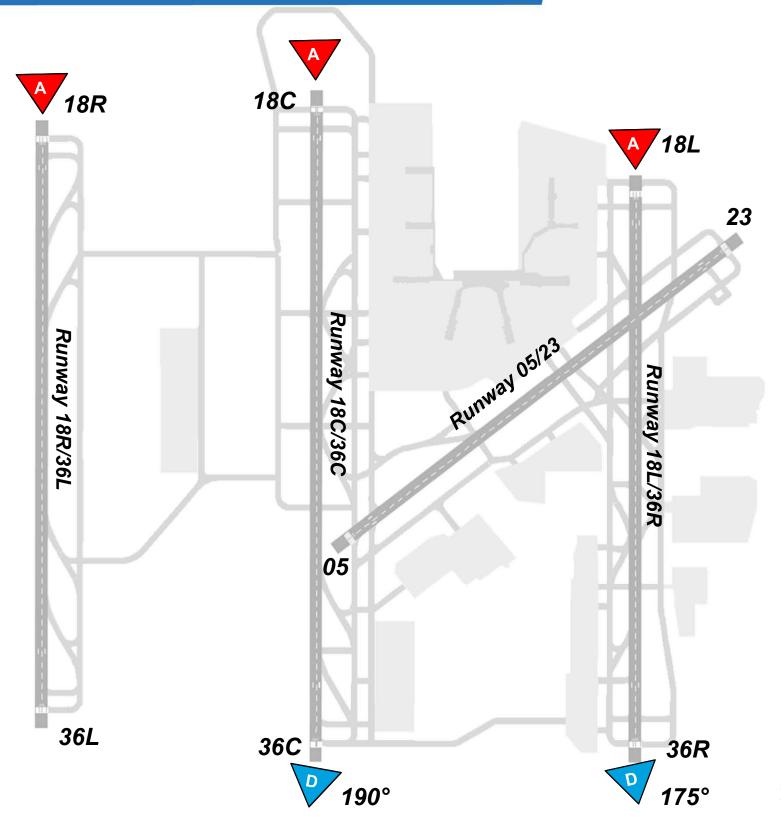
Configuration	36L, 36C, 36R	36C, 36R
	AAR	ADR
VMC	87	69
IMC	80	69



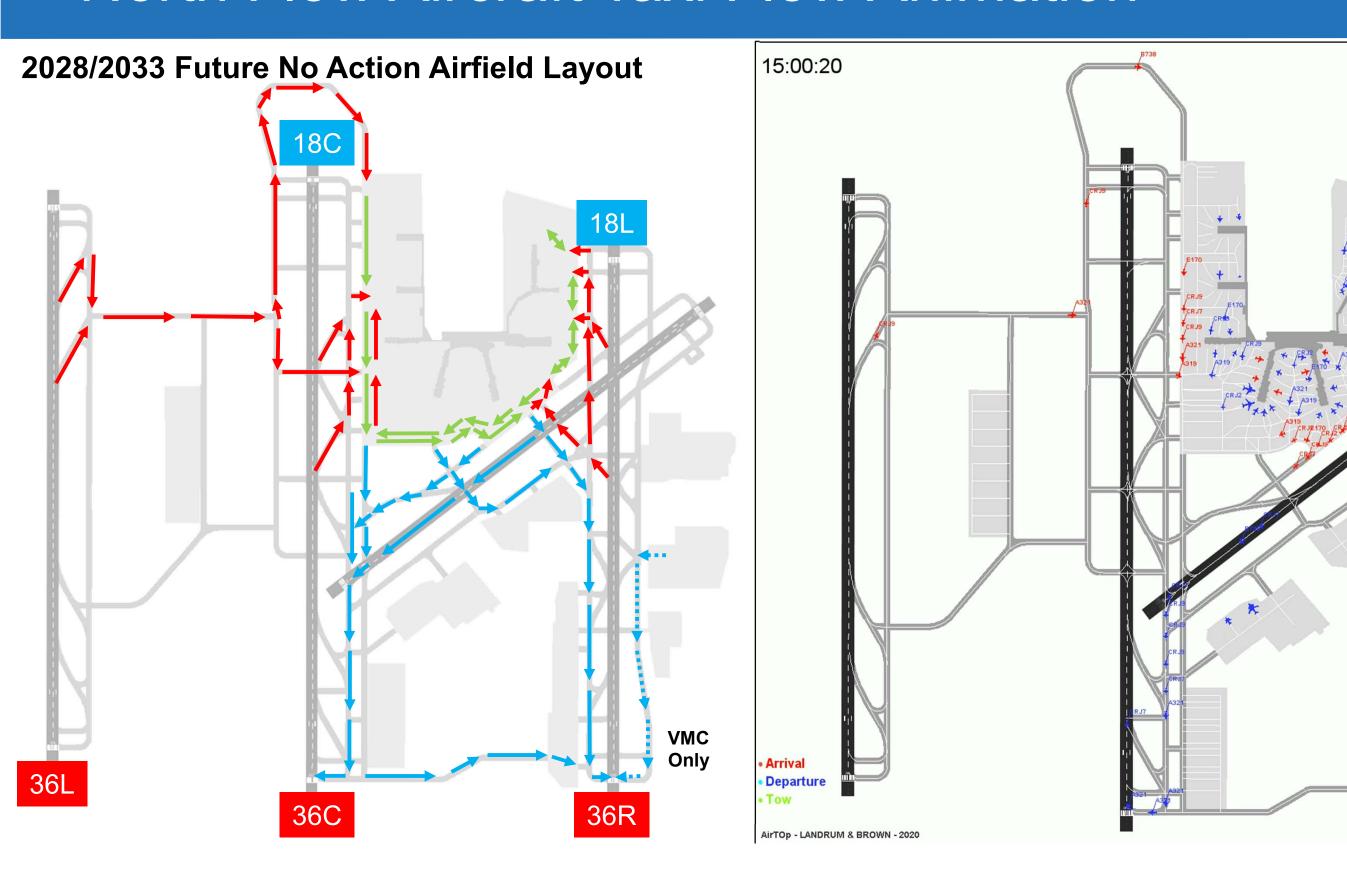
#### South VMC/IMC Runway Configuration

- 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

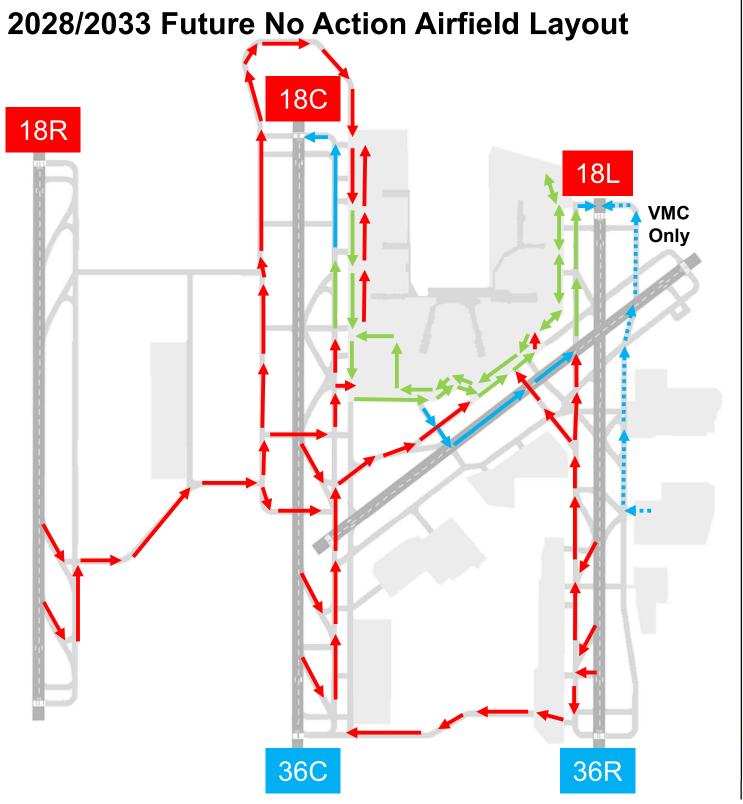


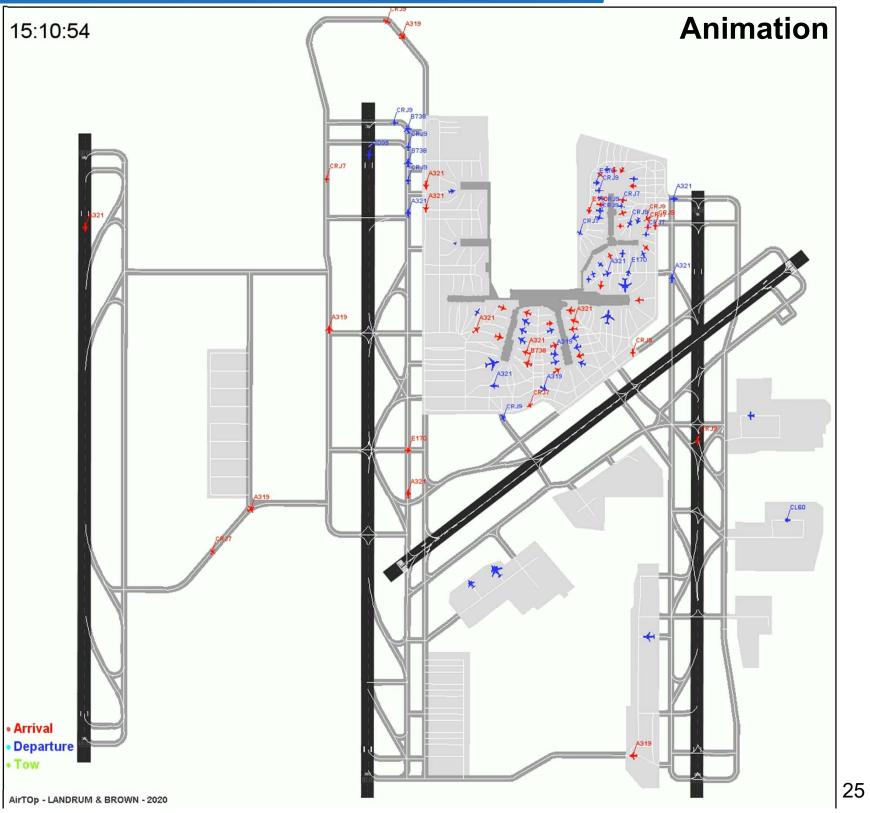
#### North Flow Aircraft Taxi Flow Animation



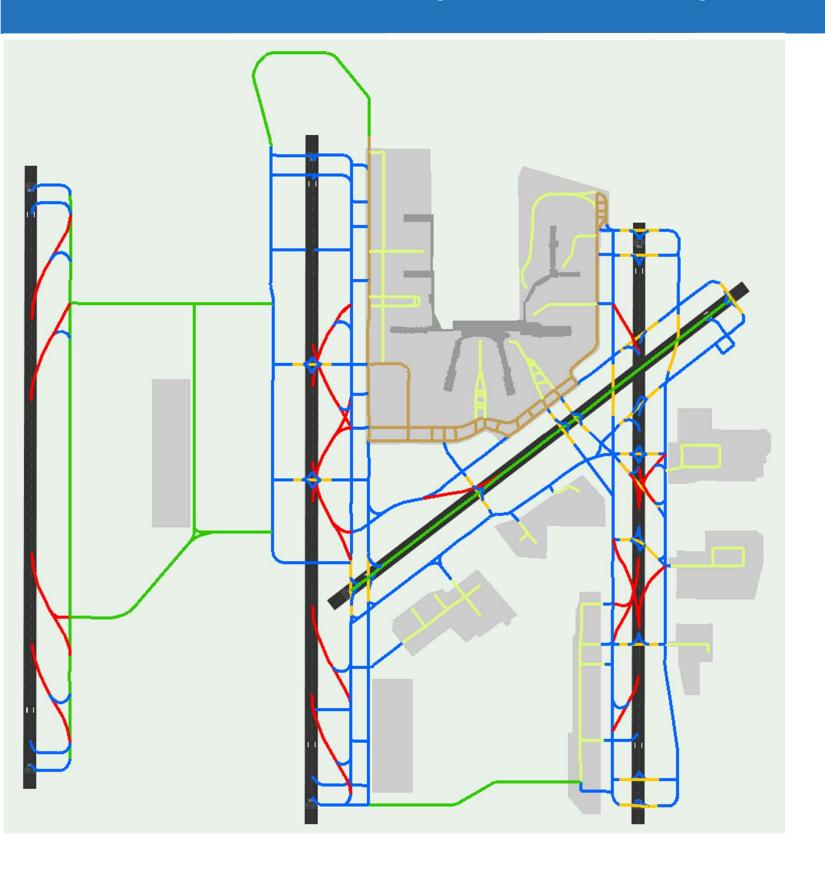
**Animation** 

#### 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

<sup>\*</sup>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	C	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
	C					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
Le l	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

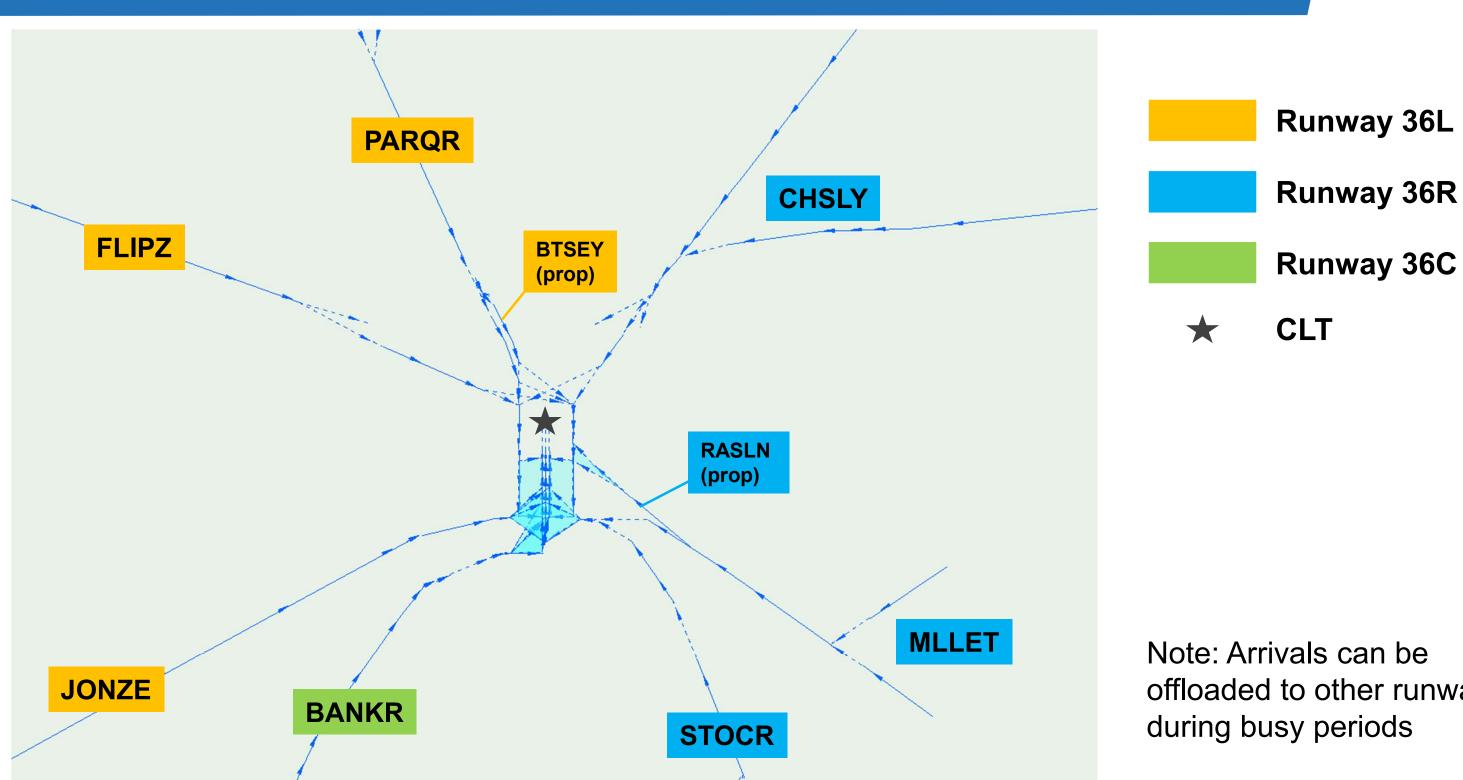
#### Sample Airport Route/City Pairs

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

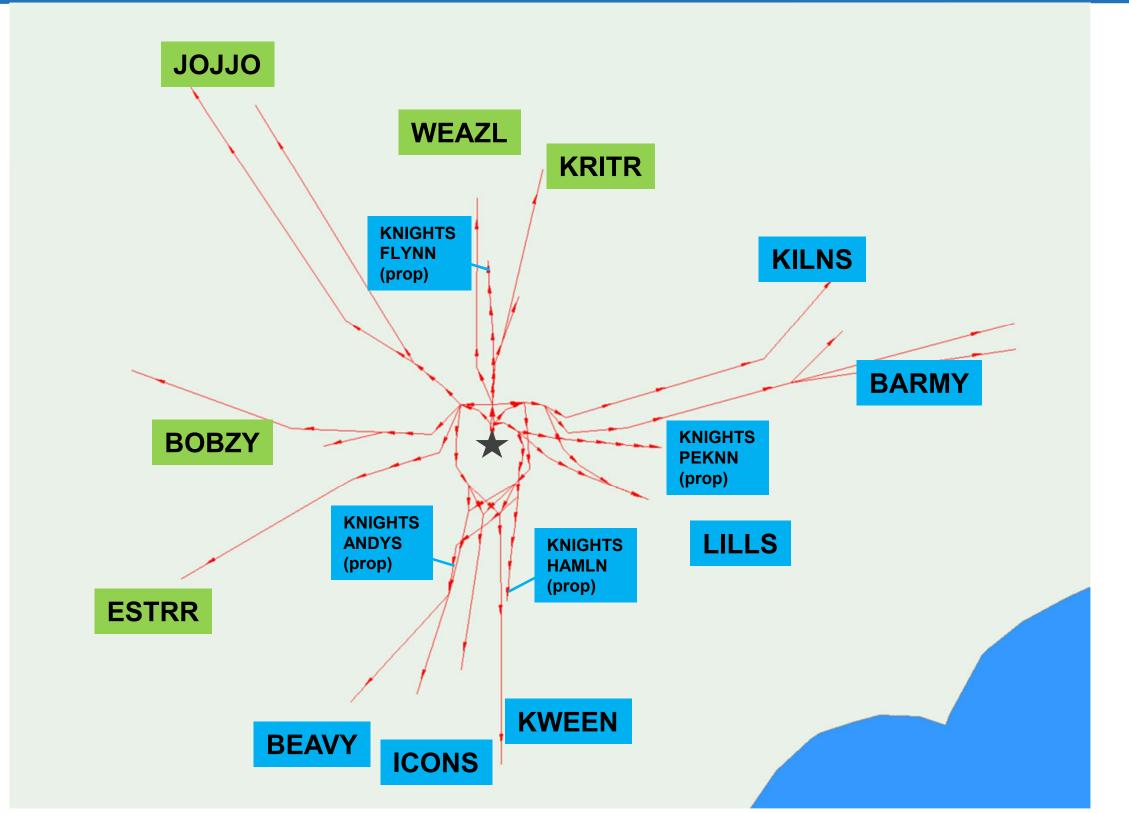
<sup>\*</sup>Note that these lists are not all-inclusive. They merely contain examples of some of the major airports that use each route.

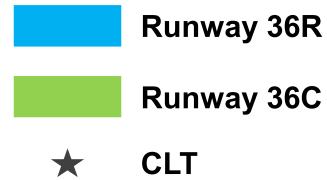
#### North Flow Arrival Airspace



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

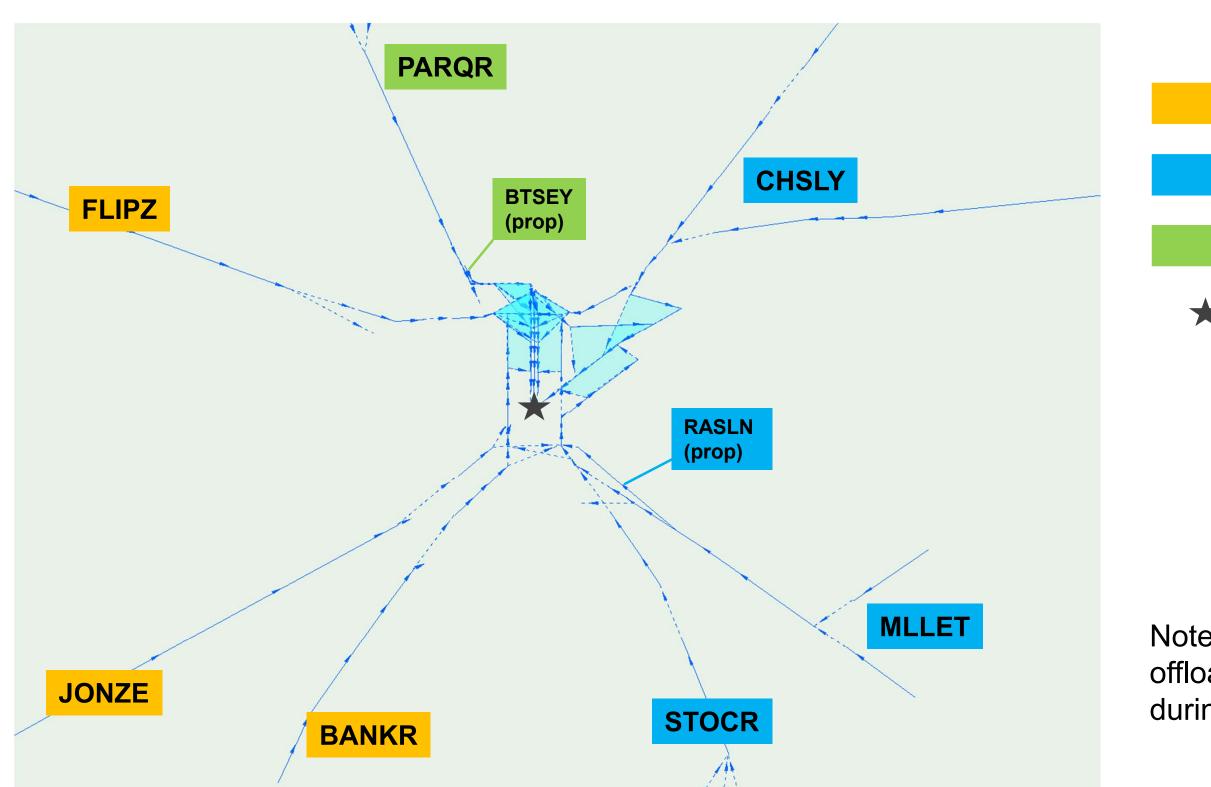
#### North Flow Departure Airspace





Note: BEAVY and ICONS departures can be offloaded to 36C during busy periods

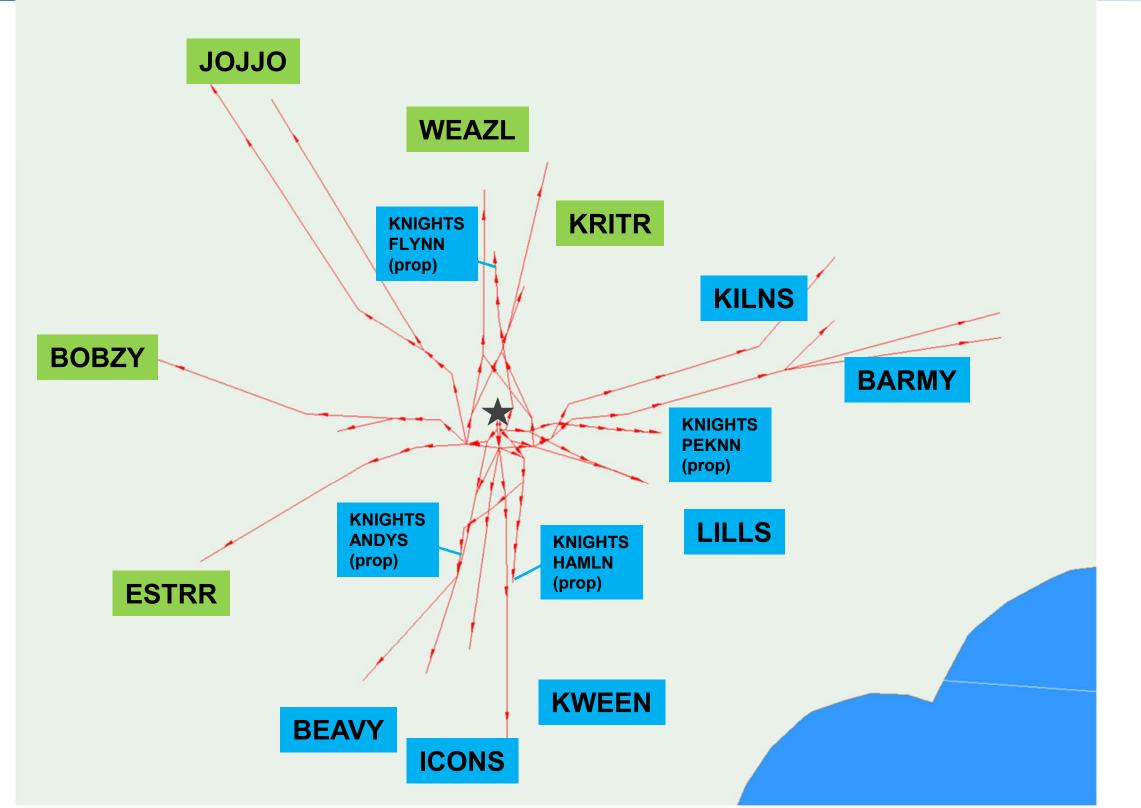
#### South Flow Arrival Airspace

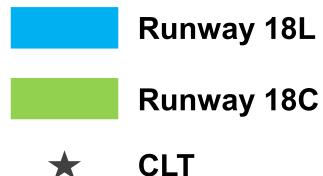




Note: Arrivals can be offloaded to other runways during busy periods

#### South Flow Departure Airspace





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

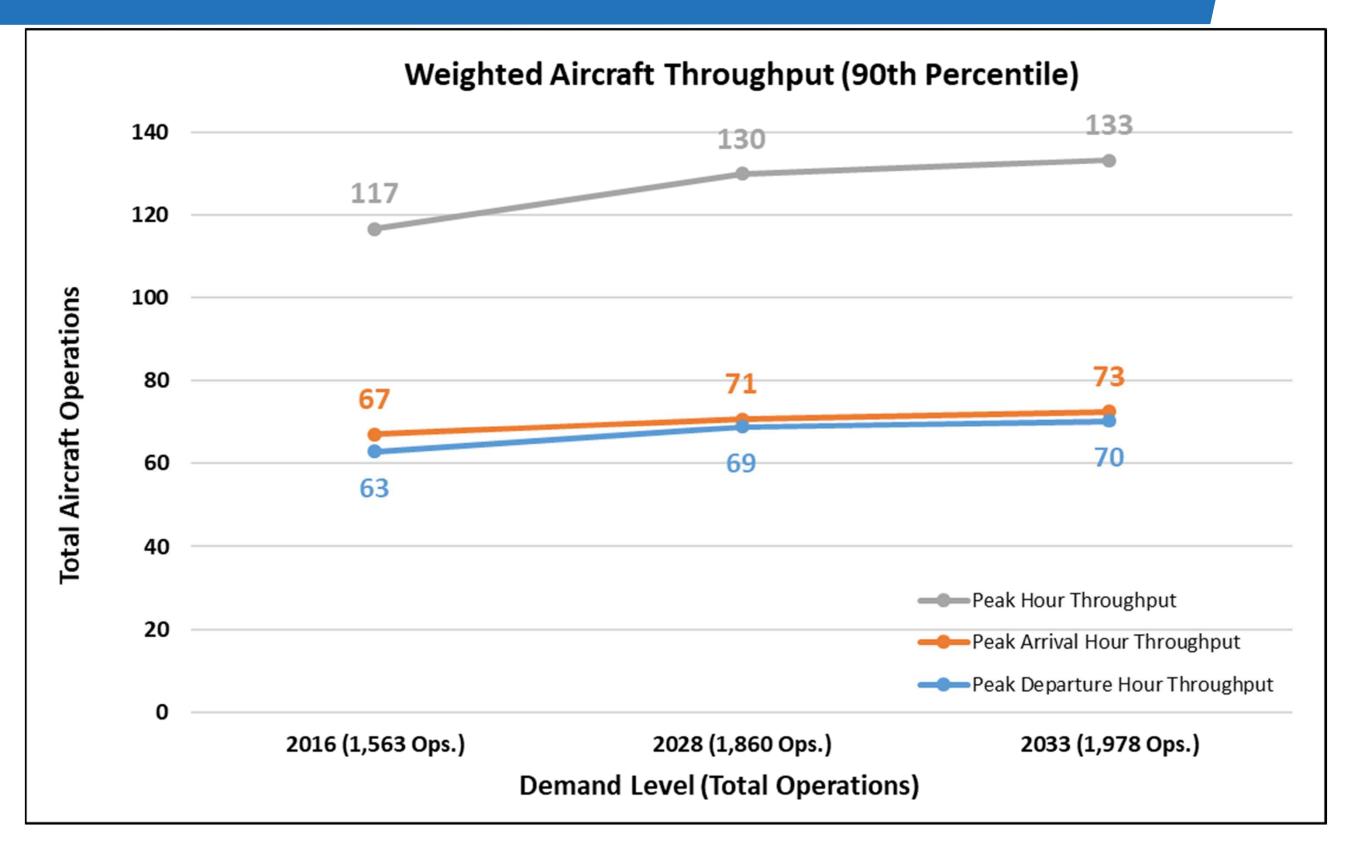
90th Percentile Simulated Throughput						
	2016 (1,563 ops.)	2028 (1,860 ops.)	2033 (1,978 ops.)			
Peak Hour (Arr. & Deps.)	117	130	133			
Peak Hour Arrival	67	71	73			
Peak Hour Departure	63	69	70			

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				

<sup>\*</sup> 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%

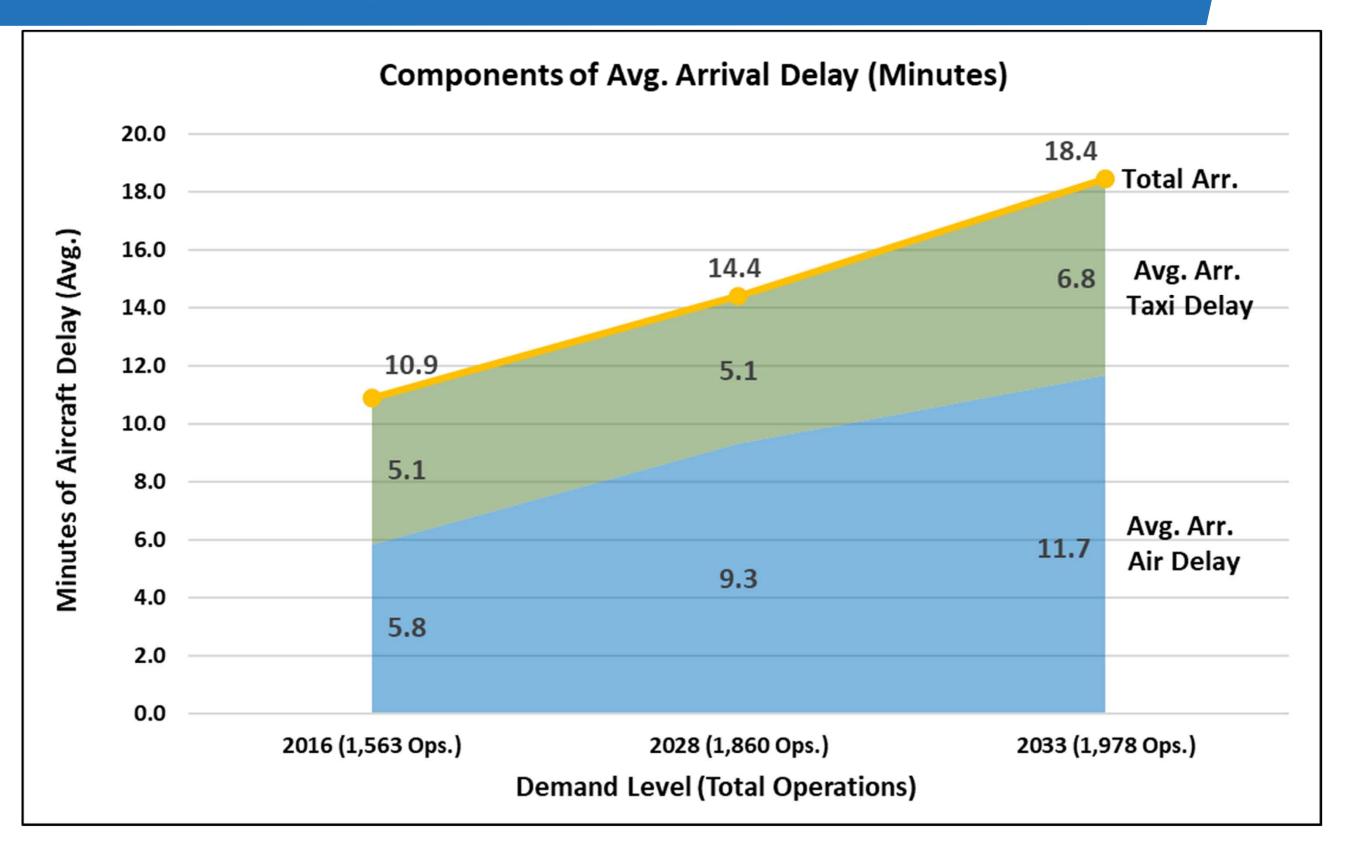
- South VMC: 27.5%

- South IMC: 9.0%

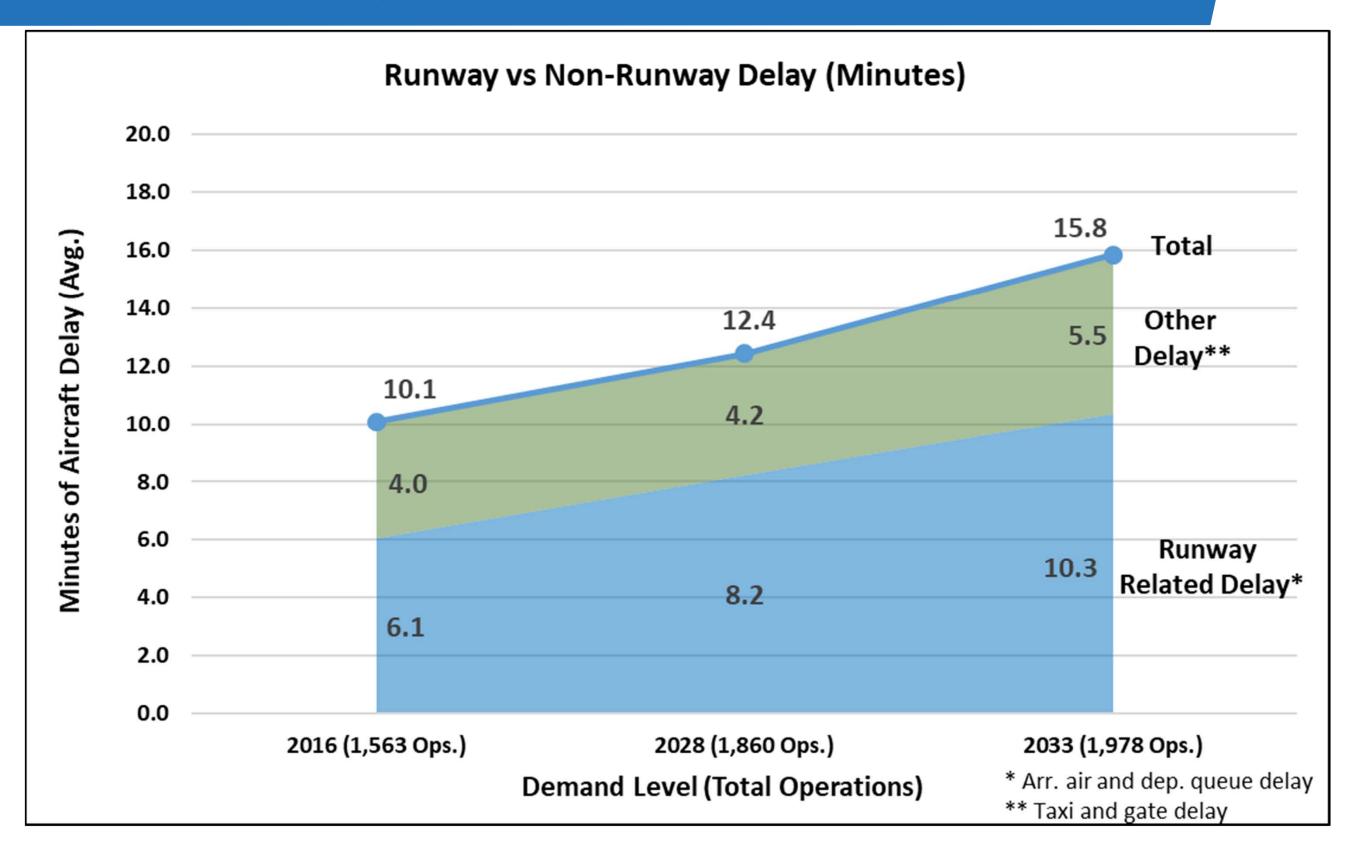
	20	028 Dema	nd Level (	1,860 Dail	ly Ops.)
	North	North	South	South	
Metrics	VMC	IMC	VMC	IMC	Annualization
Avg. arrival taxi time (total)	13.7	14.6	15.0	15.8	14.4
Avg. arrival taxi time (unimpeded)	8.7	8.6	10.4	10.4	9.3
Avg. arrival taxi delay	5.1	6.0	4.6	5.4	5.1
Avg. departure taxi time (total)	21.5	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	y Ops.)
	North	North	South	South	
Metrics	VMC	IMC	VMC	IMC	Annualization
A ' 11 '1' /1 1 N		IIII			
Avg. arrival taxi time (total)	15.4	15.8	17.6	17.9	
Avg. arrival taxi time (total)  Avg. arrival taxi time (unimpeded)	8.9	15.8 8.8	17.6 10.7	17.9 10.7	16.3 9.5
		15.8	17.6	17.9	16.3 9.5
Avg. arrival taxi time (unimpeded)	8.9	15.8 8.8	17.6 10.7	17.9 10.7	16.3 9.5 6.8 23.3
Avg. arrival taxi time (unimpeded) Avg. arrival taxi delay	8.9 6.6	15.8 8.8 7.0	17.6 10.7 6.9	17.9 10.7 7.3	16.3 9.5 6.8
Avg. arrival taxi time (unimpeded)  Avg. arrival taxi delay  Avg. departure taxi time (total)	8.9 6.6 23.6	15.8 8.8 7.0 28.7	17.6 10.7 6.9 19.8	17.9 10.7 7.3 25.0	16.3 9.5 6.8 23.3
Avg. arrival taxi time (unimpeded)  Avg. arrival taxi delay  Avg. departure taxi time (total)  Avg. departure taxi time (unimpeded)	8.9 6.6 23.6 13.5	15.8 8.8 7.0 28.7 13.7	17.6 10.7 6.9 19.8 11.6	17.9 10.7 7.3 25.0 11.8	16.3 9.5 6.8 23.3 12.9
Avg. arrival taxi time (unimpeded)  Avg. arrival taxi delay  Avg. departure taxi time (total)  Avg. departure taxi time (unimpeded)  Avg. departure taxi delay	8.9 6.6 23.6 13.5 10.1	15.8 8.8 7.0 28.7 13.7 14.9	17.6 10.7 6.9 19.8 11.6 8.1	17.9 10.7 7.3 25.0 11.8 13.2	16.3 9.5 6.8 23.3 12.9 10.4
Avg. arrival taxi time (unimpeded)  Avg. arrival taxi delay  Avg. departure taxi time (total)  Avg. departure taxi time (unimpeded)  Avg. departure taxi delay  Avg. taxi time	8.9 6.6 23.6 13.5 10.1 <b>19.5</b>	15.8 8.8 7.0 28.7 13.7 14.9 <b>22.2</b>	17.6 10.7 6.9 19.8 11.6 8.1 <b>18.7</b>	17.9 10.7 7.3 25.0 11.8 13.2 <b>21.5</b> 14.5 21.7	16.3 9.5 6.8 23.3 12.9 10.4 <b>19.8</b> 11.7 18.4
Avg. arrival taxi time (unimpeded)  Avg. arrival taxi delay  Avg. departure taxi time (total)  Avg. departure taxi time (unimpeded)  Avg. departure taxi delay  Avg. taxi time  Avg. arrival air delay	8.9 6.6 23.6 13.5 10.1 <b>19.5</b> 9.8	15.8 8.8 7.0 28.7 13.7 14.9 <b>22.2</b> 15.1	17.6 10.7 6.9 19.8 11.6 8.1 <b>18.7</b>	17.9 10.7 7.3 25.0 11.8 13.2 <b>21.5</b>	16.3 9.5 6.8 23.3 12.9 10.4 <b>19.8</b>

<sup>\*</sup> Based on ASPM configurations and called rates

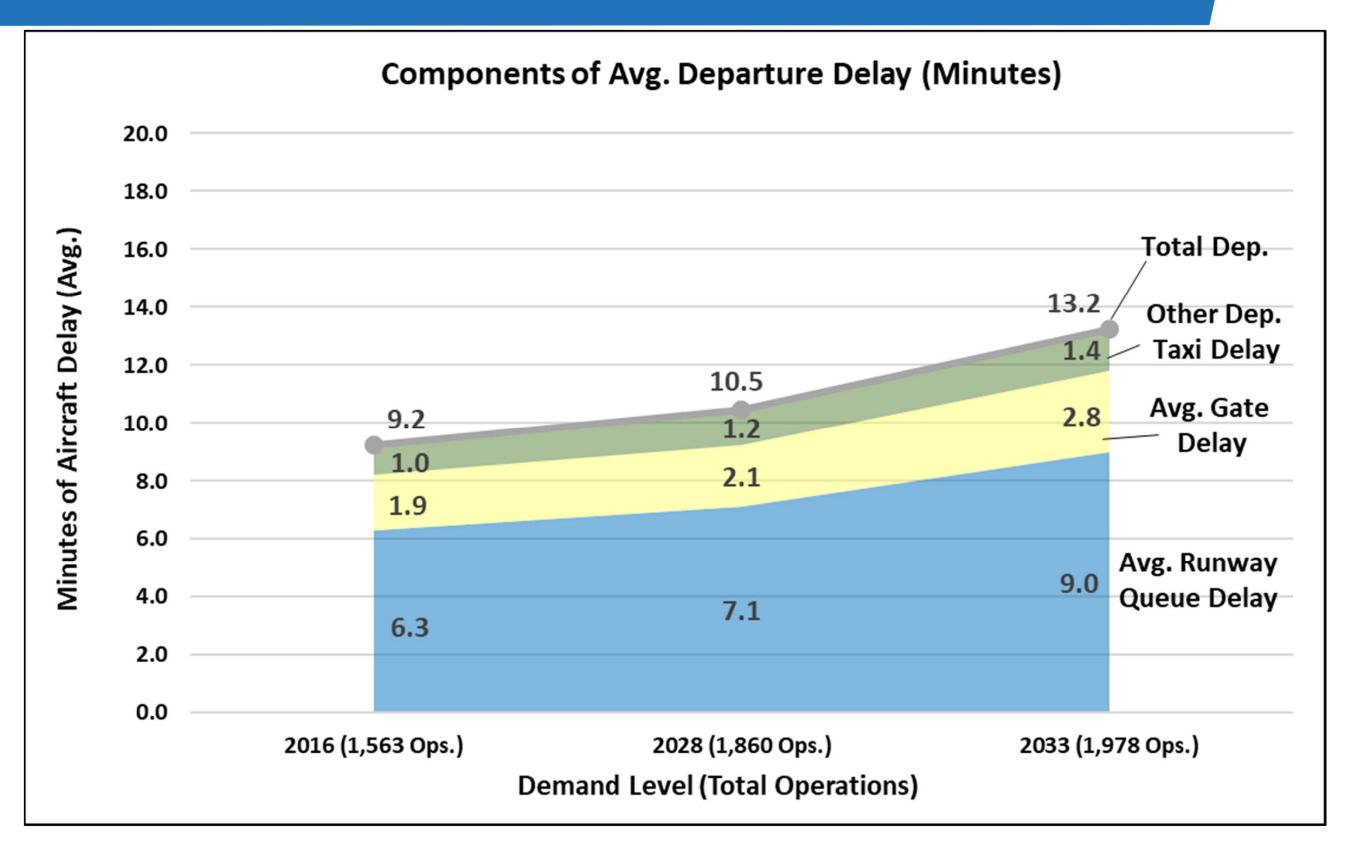
#### No Action Average Arrival Delay



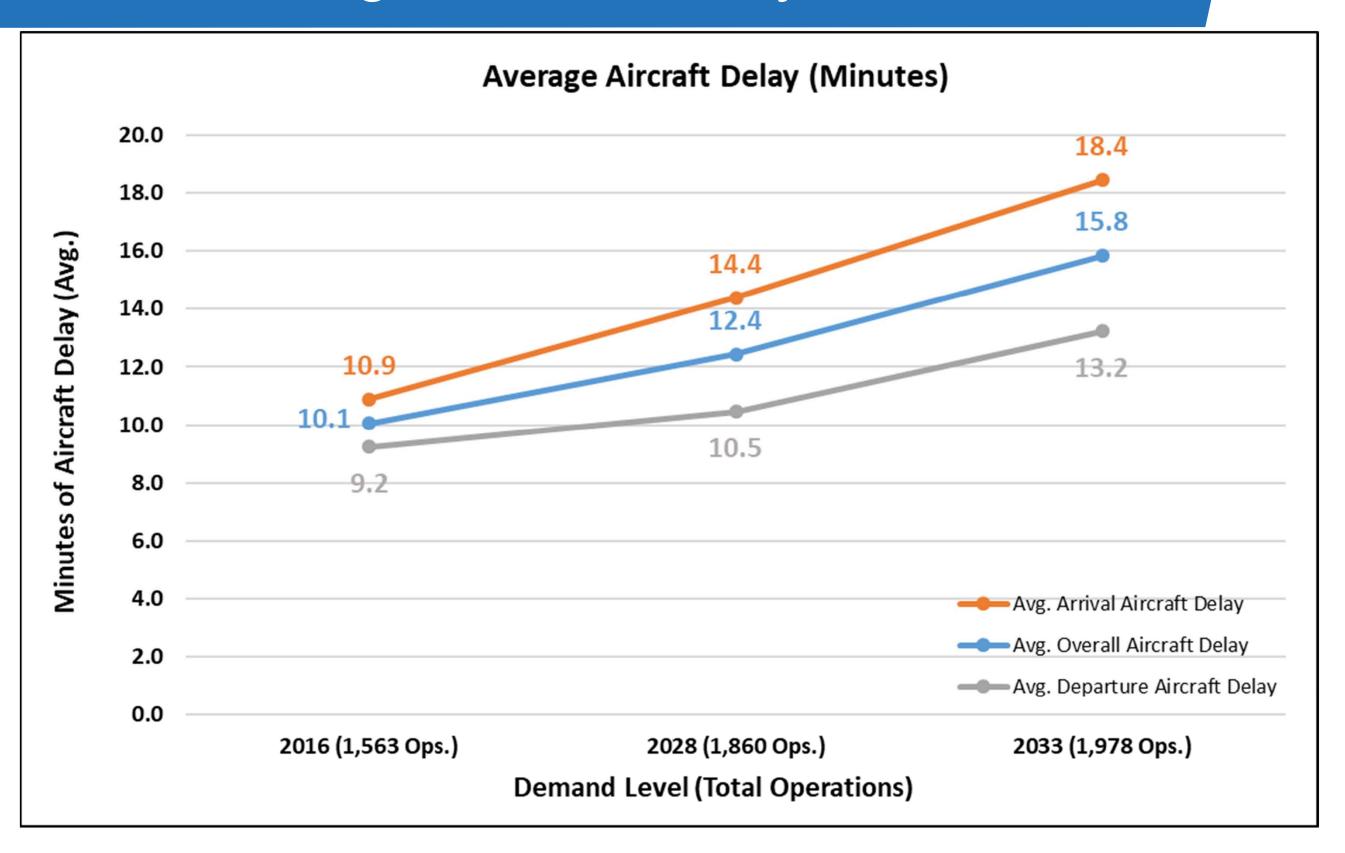
### No Action Average Aircraft Delay



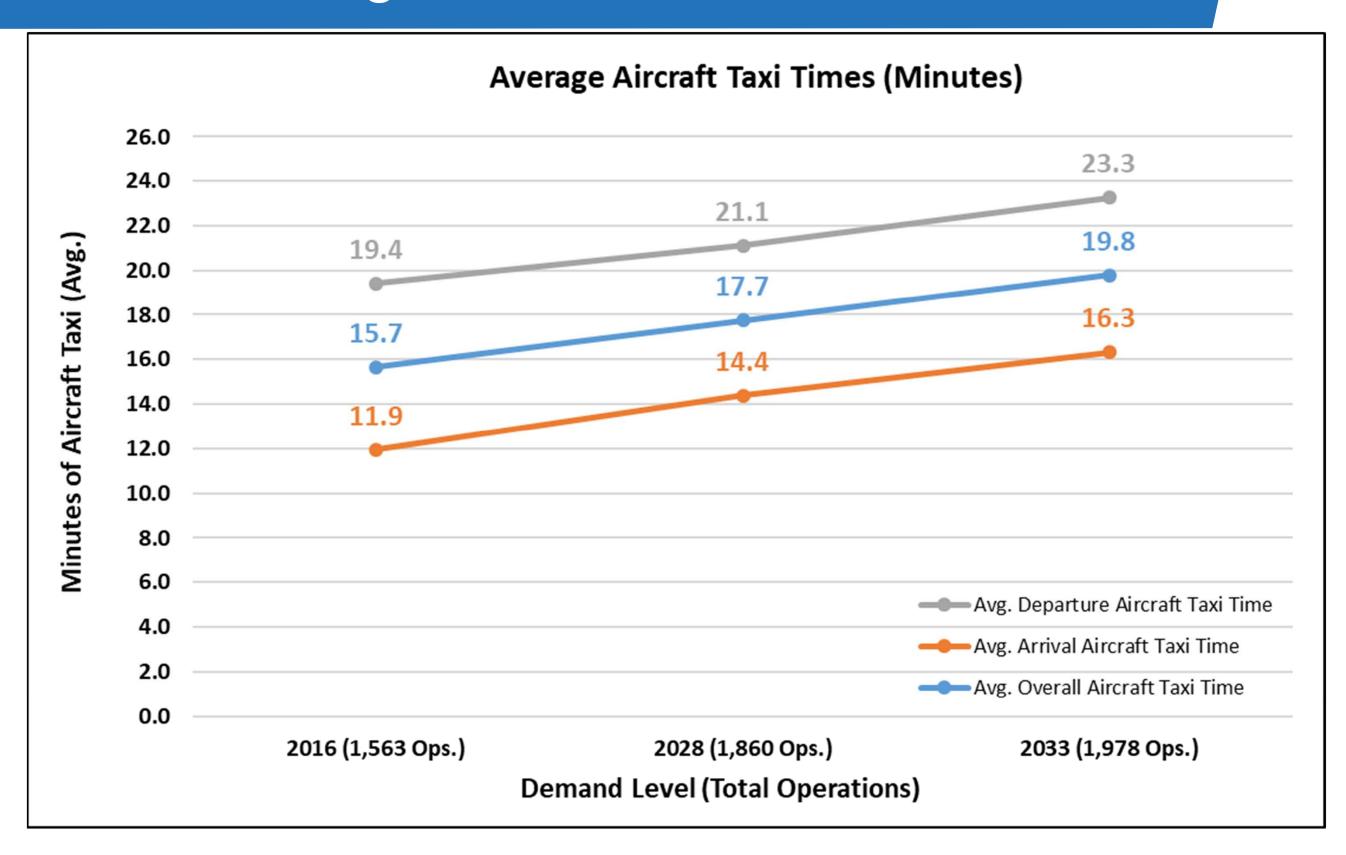
#### No Action Average Departure Delay



#### No Action Average Aircraft Delay



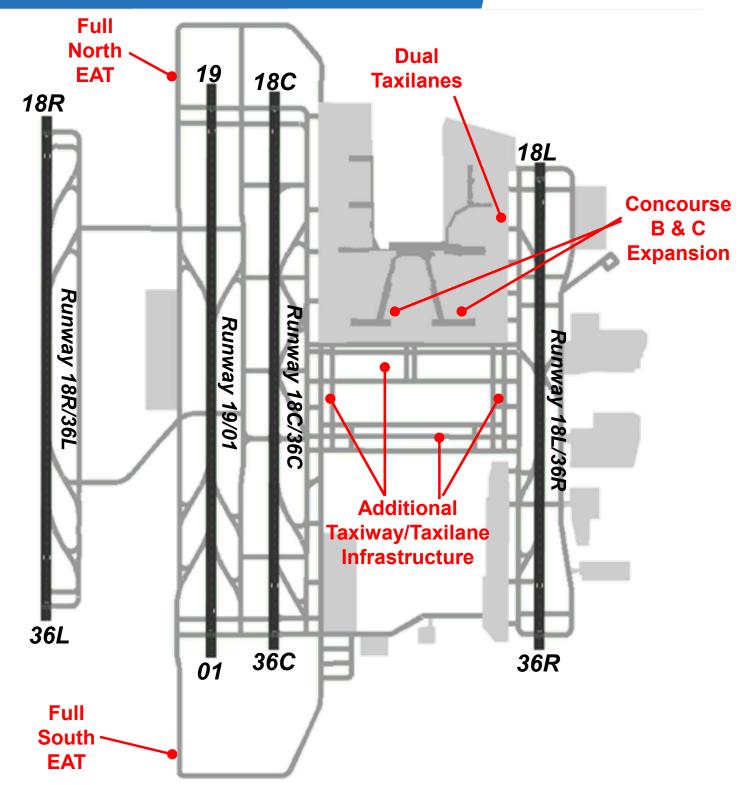
#### No Action Average Aircraft Taxi Times



# Proposed Action Modeling Assumptions

#### Proposed Action Airfield Layout

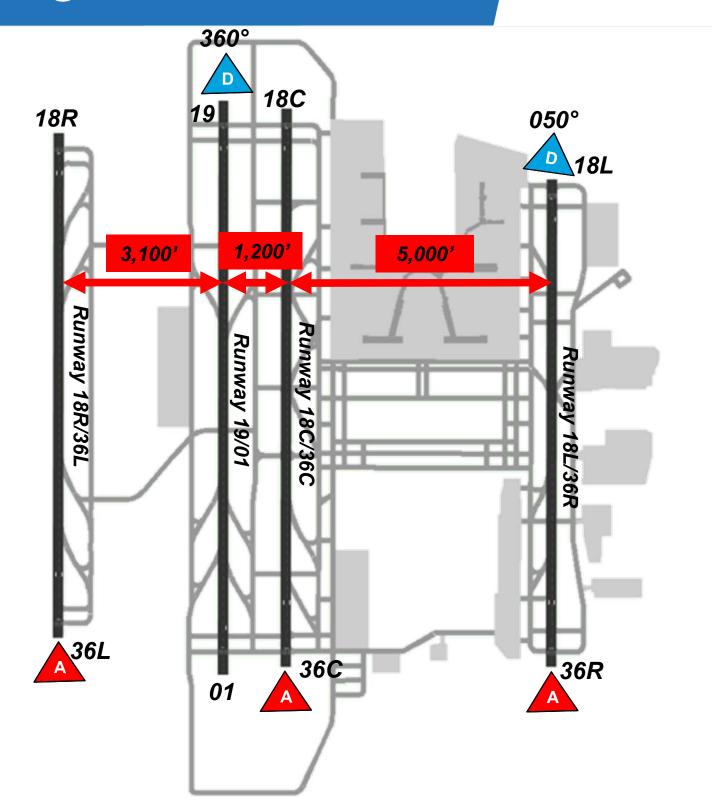
- Proposed Action Airfield includes all facilities in the No Action airfield as well as new facilities including:
  - Proposed Runway 01/19
  - Full End-Around Taxiway (EAT)
  - Removal of existing Runway 05/23
  - Additional aircraft gates
  - Additional taxilanes/taxiways
- EAT usage assumes that arrivals 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



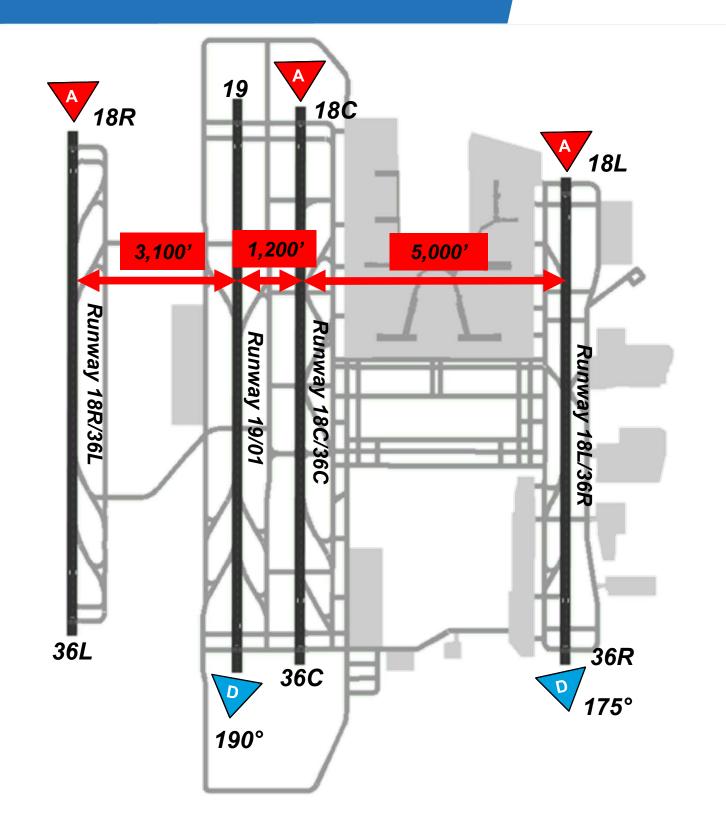
- Primary Arrival Runways:
  - Runways 36L, 36C & 36R
- Primary Departure Runways:
  - Runway 01 North & West
  - Runway 01 International Heavy Eastbound
  - Runway 36R East & South
- Maintain current departure headings



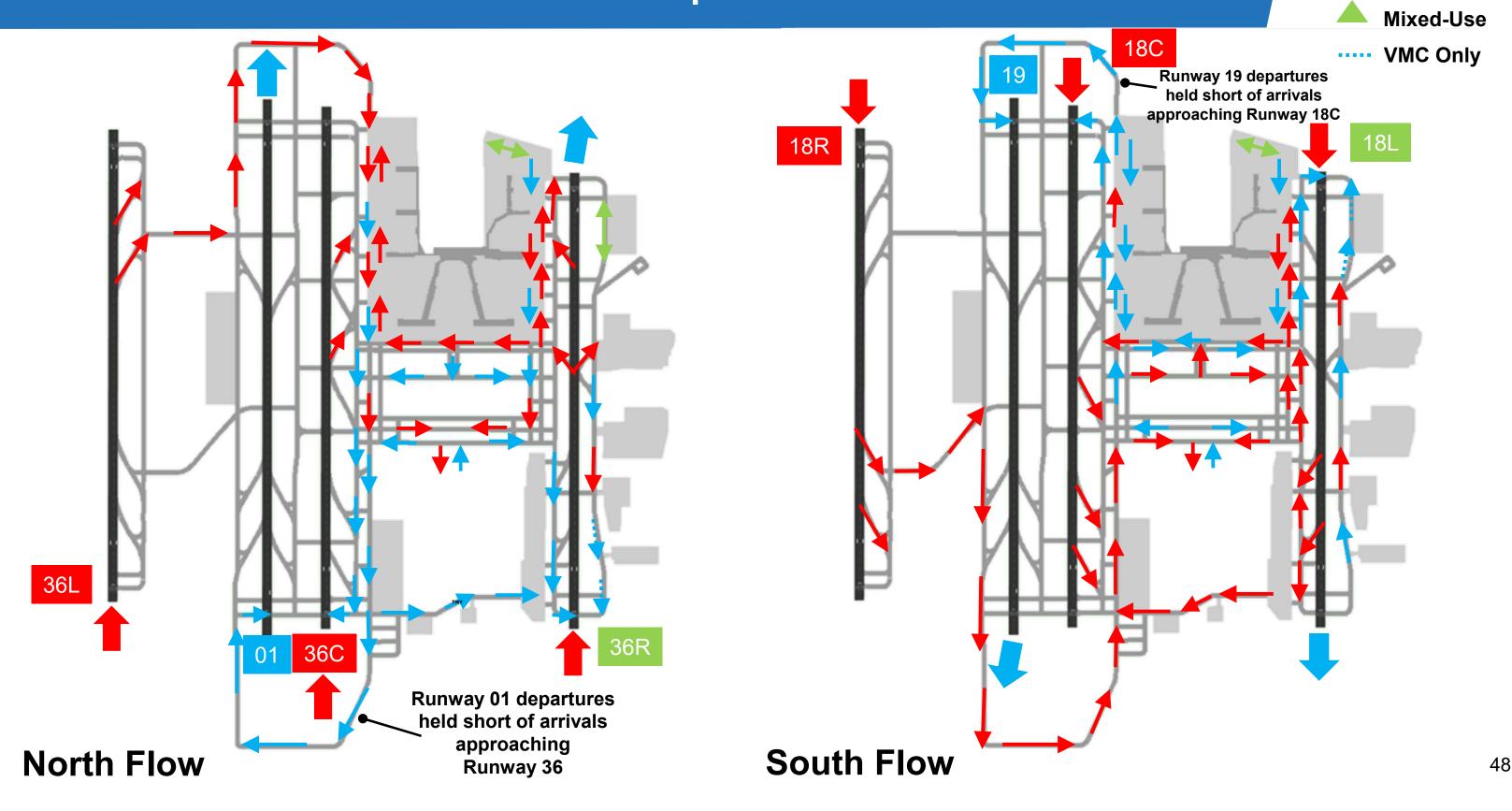
## South VMC/IMC Runway Configuration



- 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	C	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

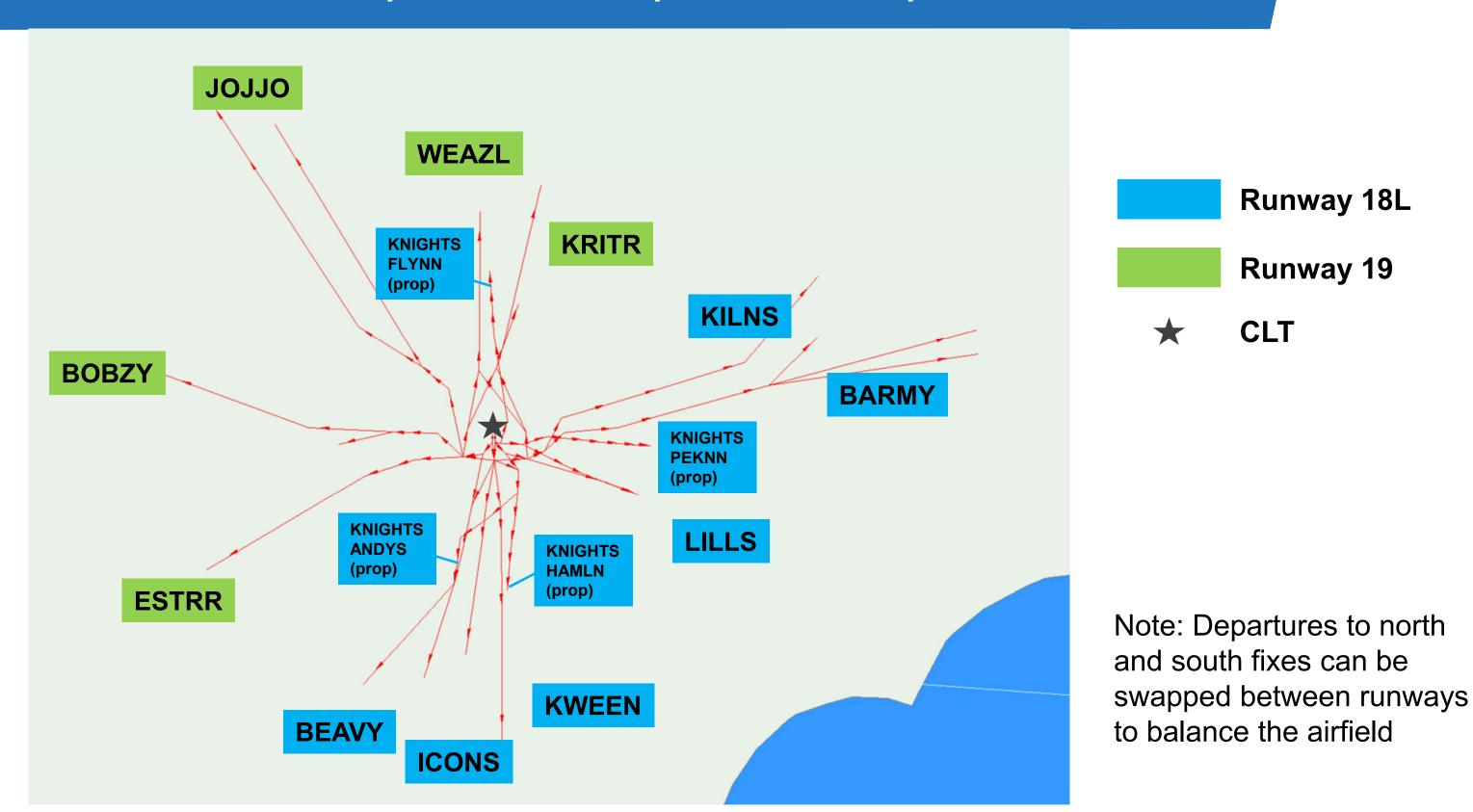
## Sample Airport Route/City Pairs

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					

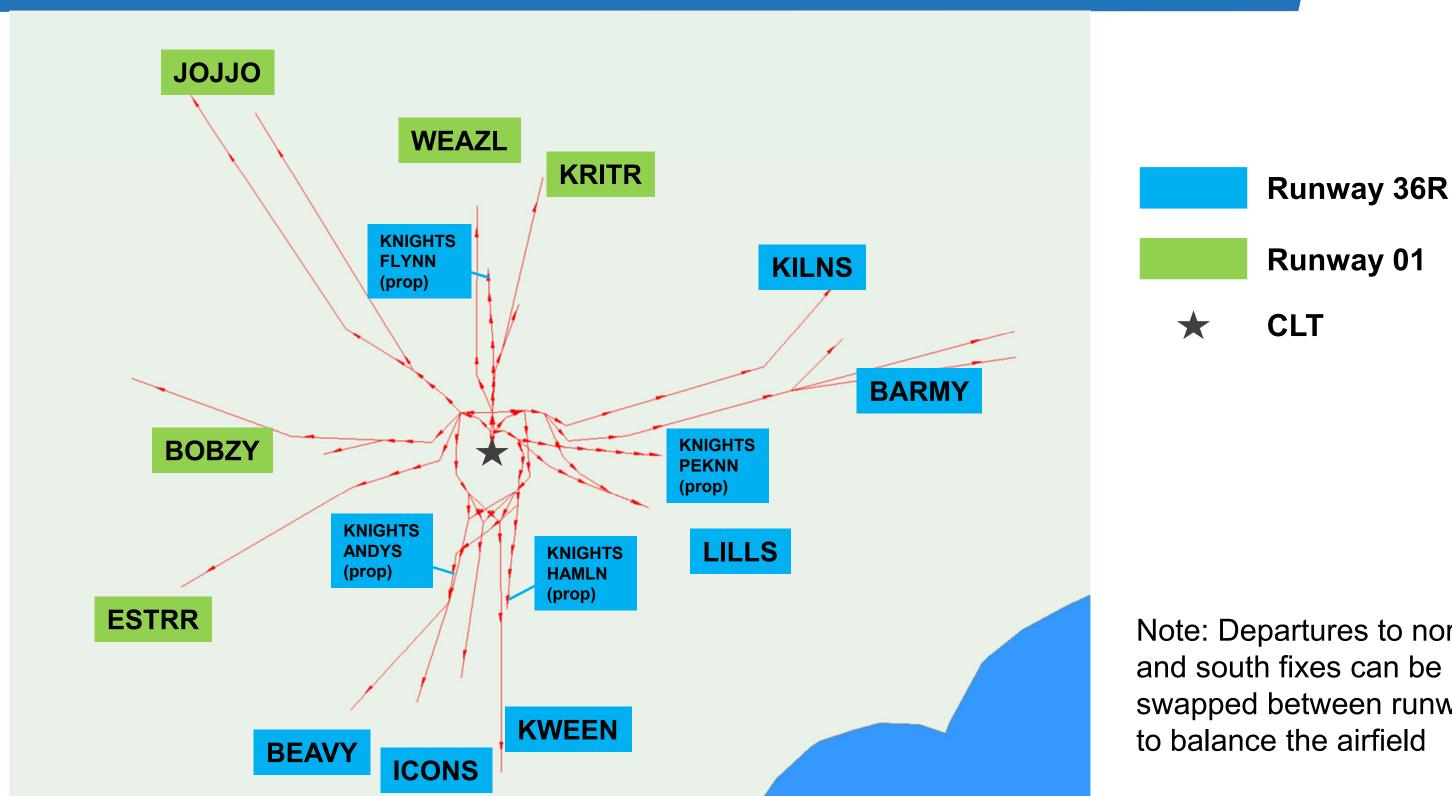
Departure Route	Destination Examples*					
<u>North</u>						
JOJJO DODGE	MDW, ORD, PDX, SEA					
KRITR FILDS	BUF, PIT, YYZ					
<u>East</u>						
KILNS	BWI, IAD, EWR, PHL					
BARMY RDU	BOS, FRA, LGA					
<u>South</u>						
ICONS	JAX, MIA					
<u>West</u>						
ESTRR	AUS, DAL, IAH, MEX					
BOBZY BNA	DEN, DFW, LAX, PHX, SFO					

<sup>\*</sup>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

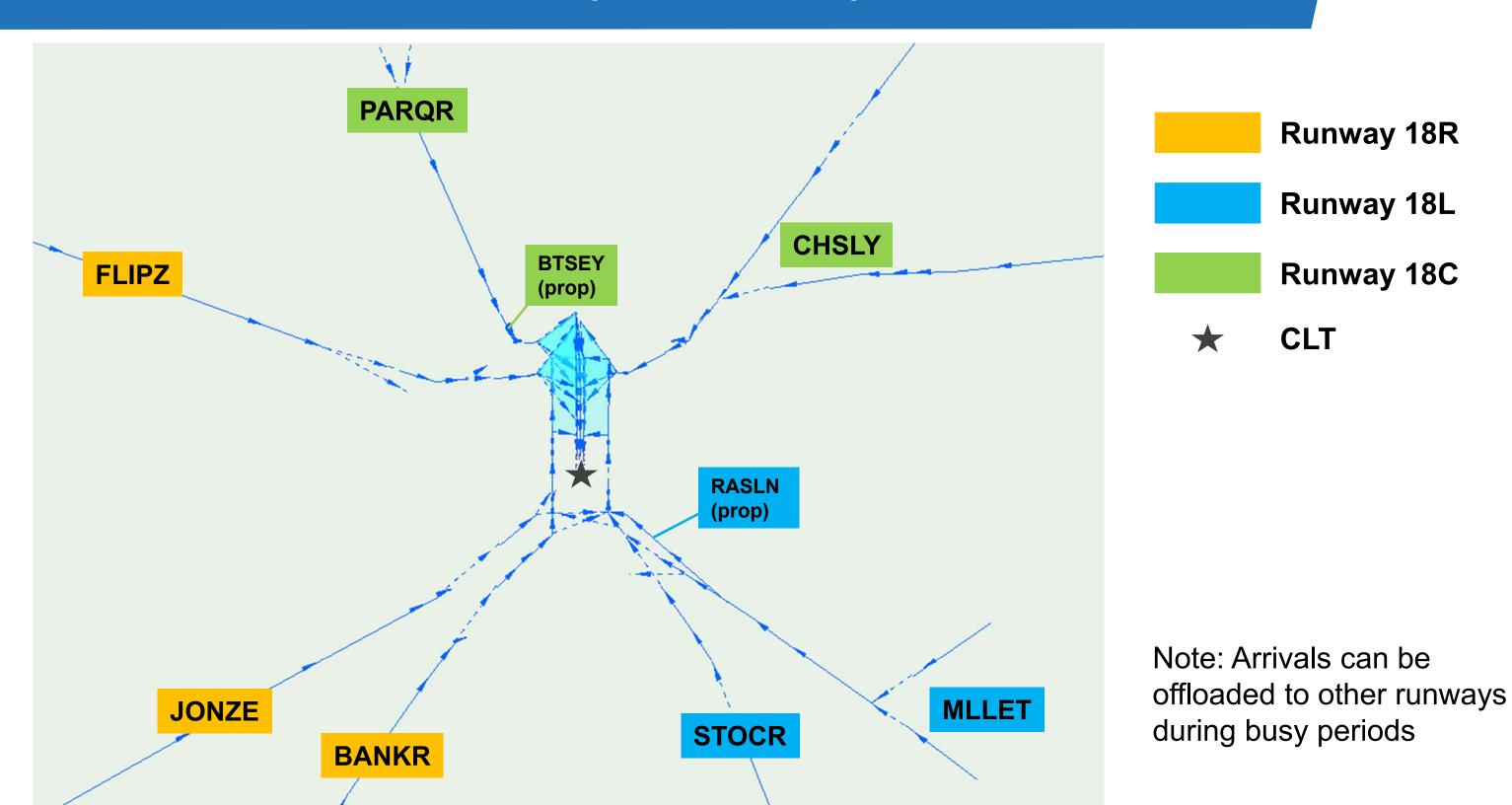


## North Flow Departure Airspace – Proposed Action

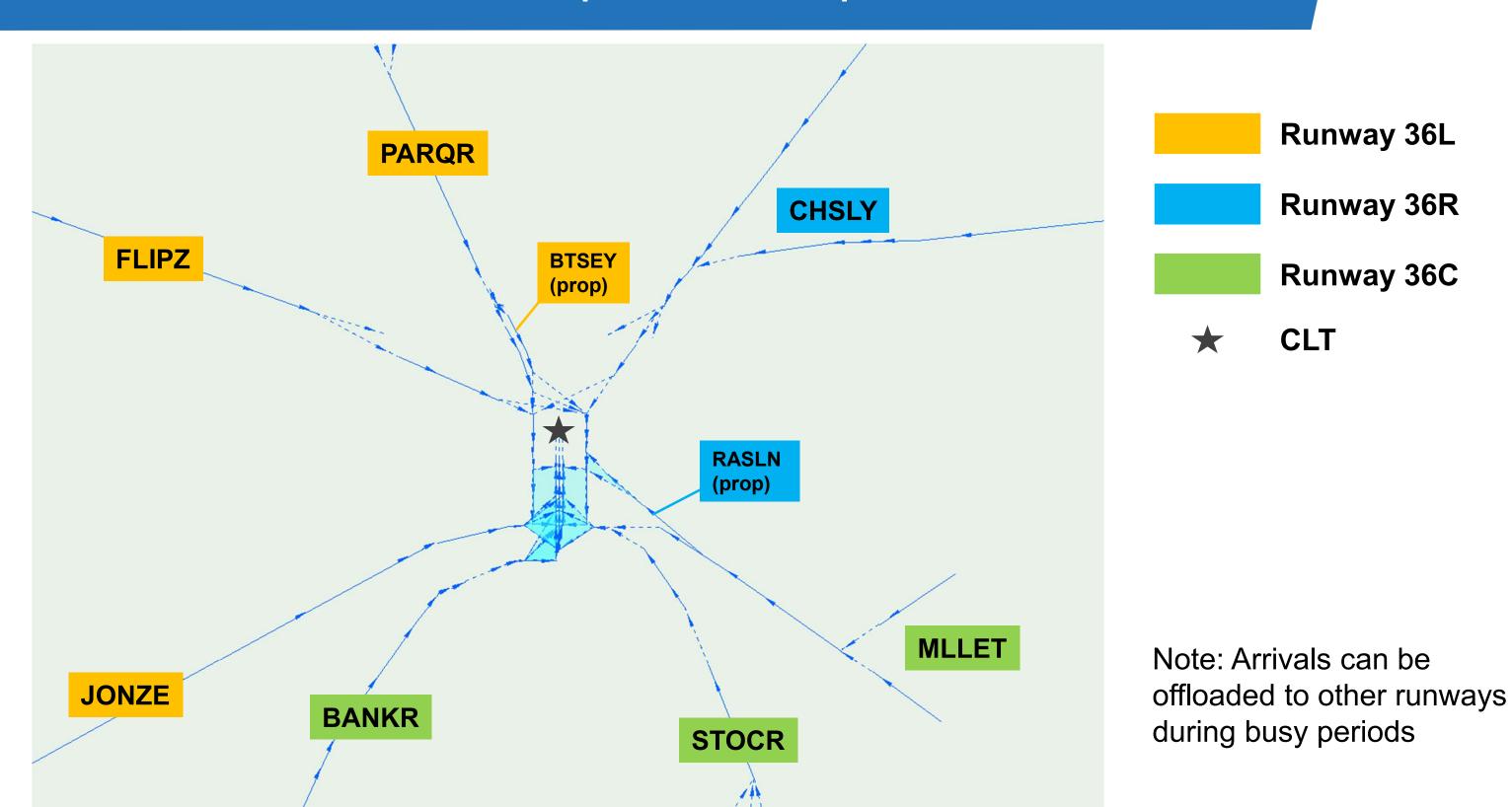


Note: Departures to north and south fixes can be swapped between runways

## South Flow Arrival Airspace – Proposed Action



## 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

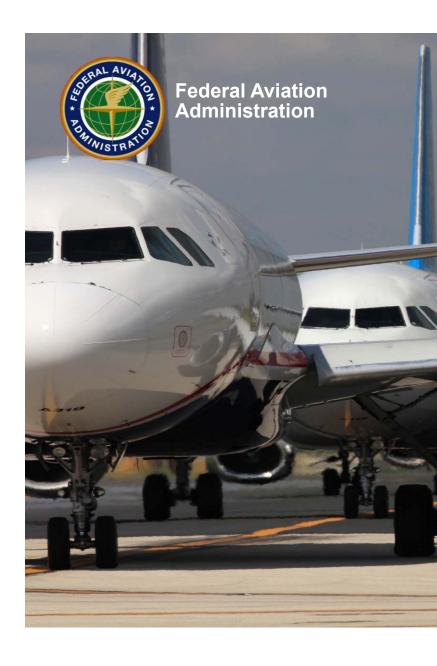
#### **DORA Process**

## 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 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

Jate

11/2016

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)



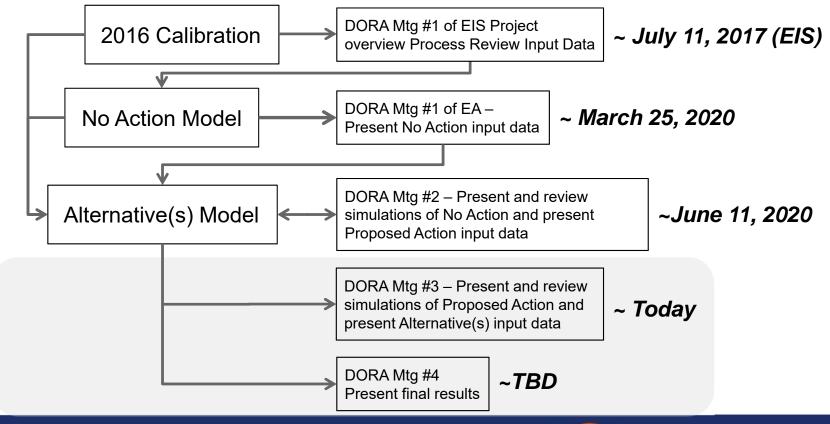
#### Desired Result: 2<sup>nd</sup> DORA Letter

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**

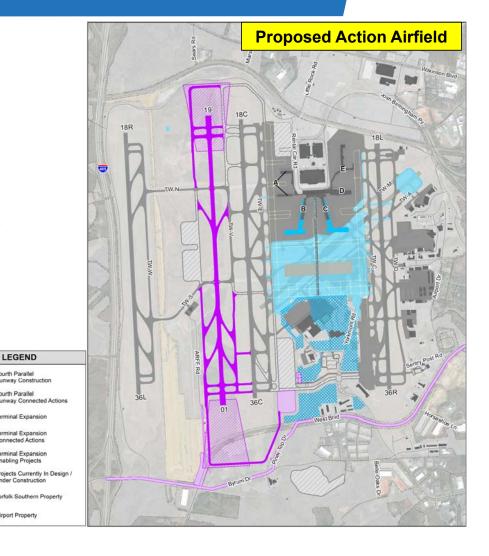
#### EA Process Overview - Background

- 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

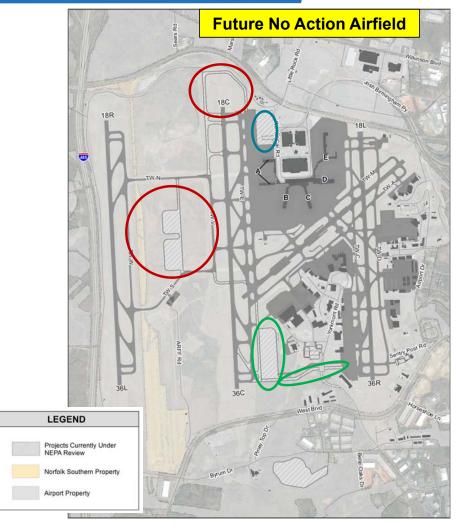
Fourth Parallel

- -4<sup>th</sup> 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



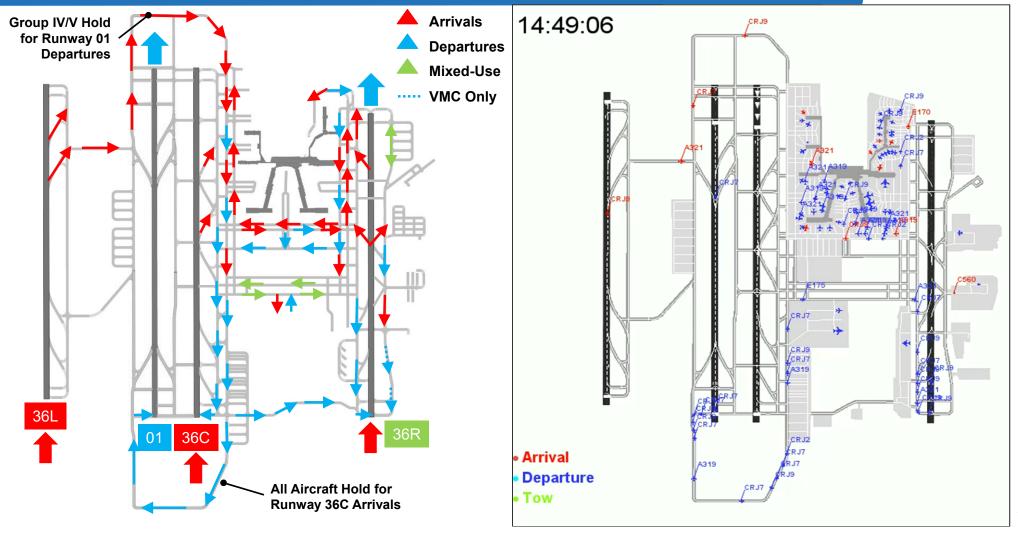
## Proposed Action Simulation Modeling Results

#### Proposed Action EAT Usage Assumption

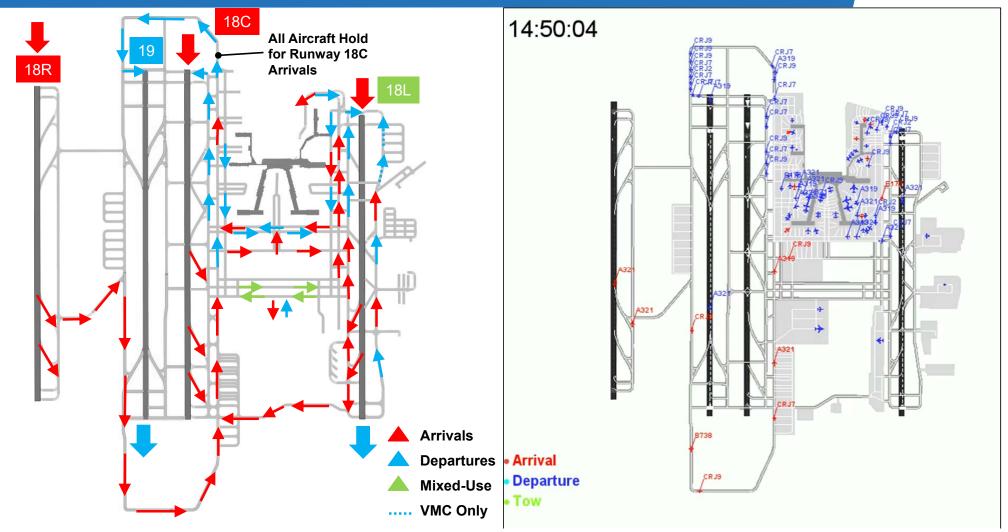
- Aircraft taxiing on the North and South EATs require large arrival gaps on Runway 18C/36C approach
  - 8nm gap for NEAT
  - 9nm gap for SEAT
- Arrival gap requirement may hinder efficient operations
  - Reduced arrival capacity on Runway 18C/36C
  - Increased ground holding times for aircraft holding 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	<ul><li>Long departure taxi distance</li><li>Departures on EAT hold short of approach</li><li>Gap needed in arrival stream</li></ul>		
Scenario 2	Short departure taxi distance	<ul> <li>Runway crossings</li> <li>Queue for crossing extends into apron area during peak in south flow</li> </ul>		

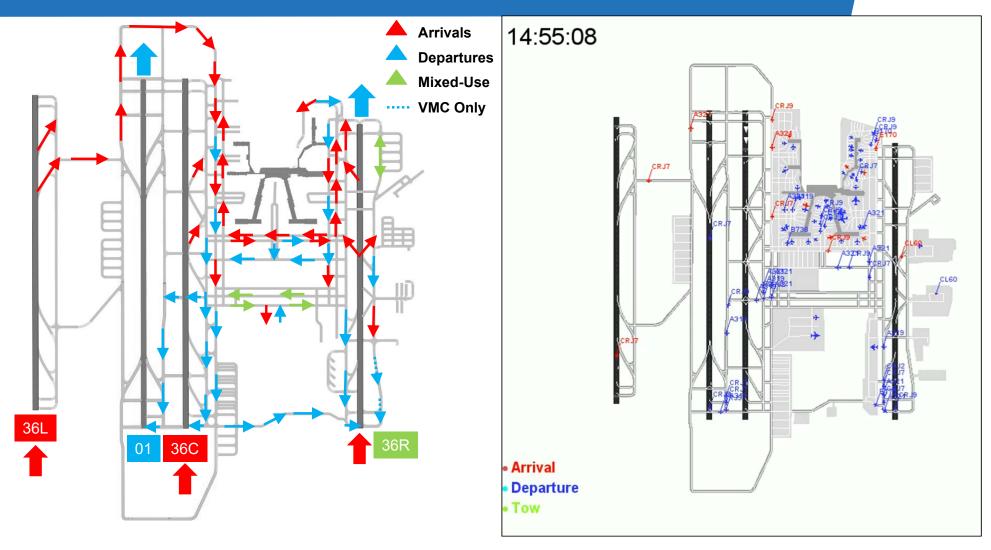
#### Proposed Action – North Flow, Scenario 1



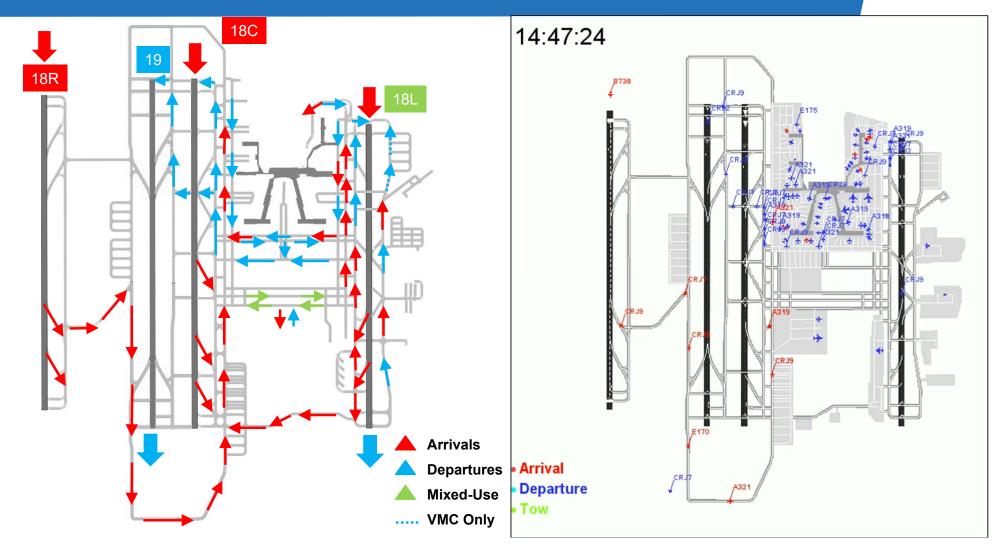
#### Proposed Action – South Flow, Scenario 1



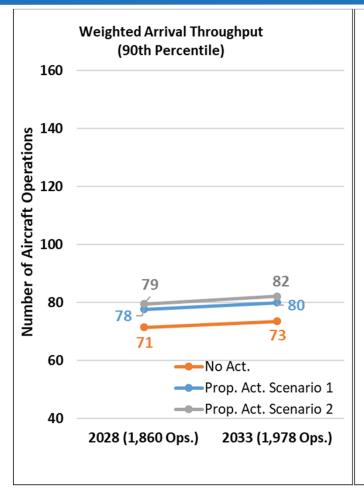
#### Proposed Action – North Flow, Scenario 2

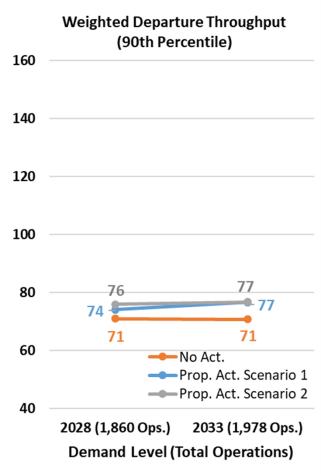


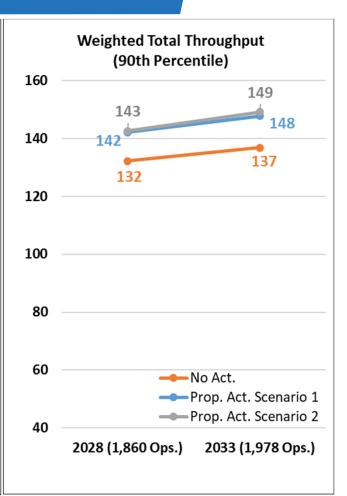
#### Proposed Action – South Flow, Scenario 2



#### Proposed Action Weighted Aircraft Throughput

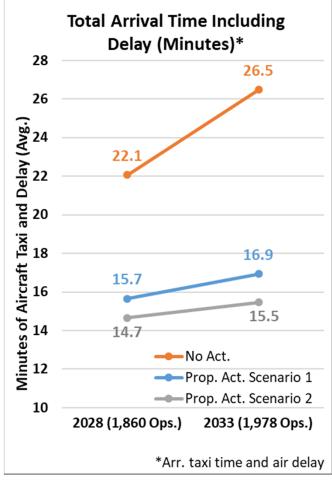


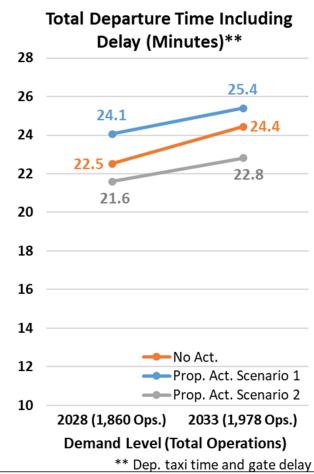


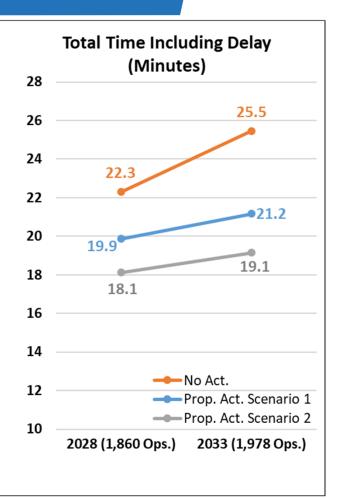


Prop. Act. Scenario 1: All operations use EATs (no runway crossings)
Prop. Act. Scenario 2: Departures use Taxiway V and arrivals use EATs

#### Proposed Action Total Time Including Delay

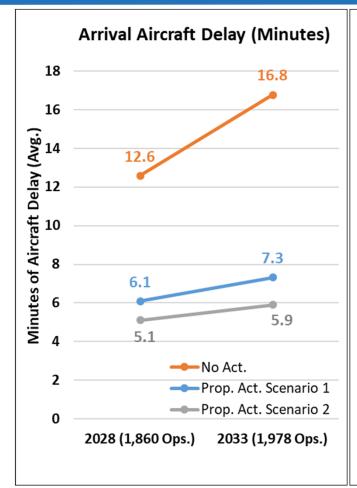


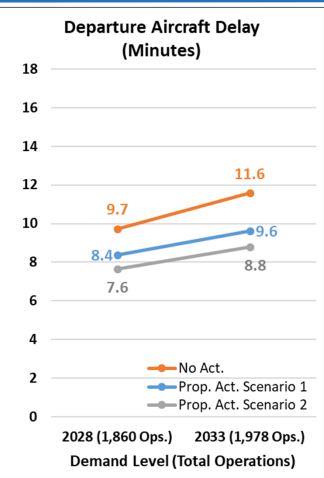


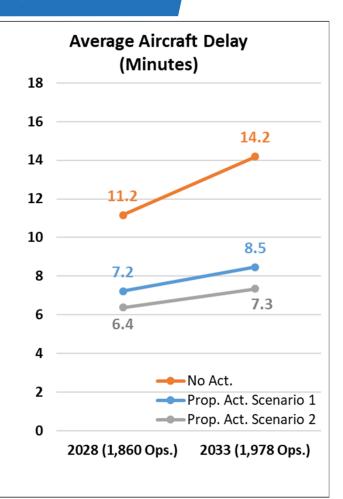


Prop. Act. Scenario 1: All operations use EATs (no runway crossings)
Prop. Act. Scenario 2: Departures use Taxiway V and arrivals use EATs

#### Proposed Action Average Aircraft Delay

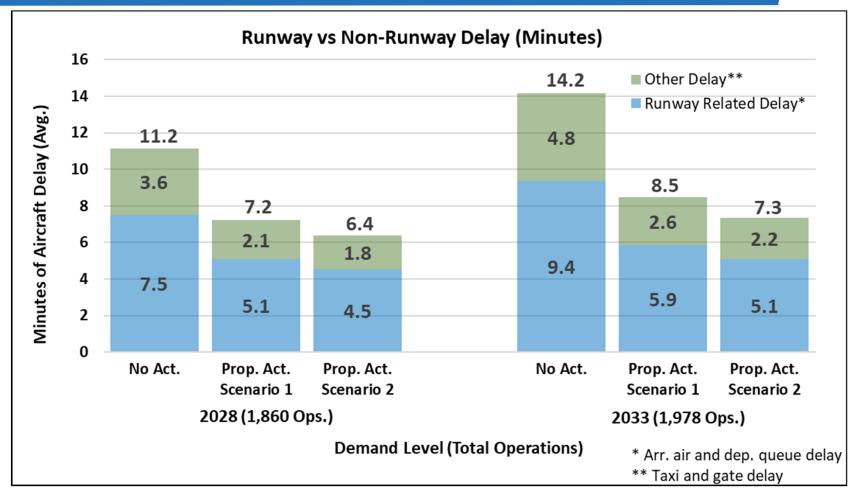






Prop. Act. Scenario 1: All operations use EATs (no runway crossings)
Prop. Act. Scenario 2: Departures use Taxiway V and arrivals use EATs

#### Proposed Action Average Aircraft Delay

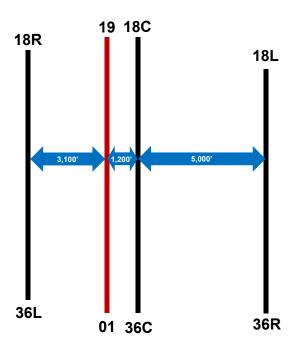


Prop. Act. Scenario 1: All operations use EATs (no runway crossings)
Prop. Act. Scenario 2: Departures use Taxiway V and arrivals use EATs

#### **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

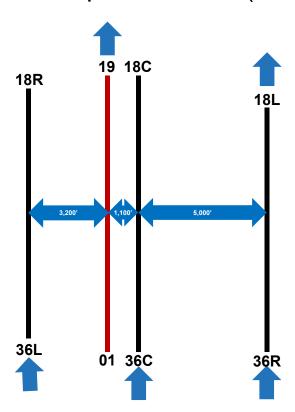


#### New FAA Rules for Parallel Runways

- 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)



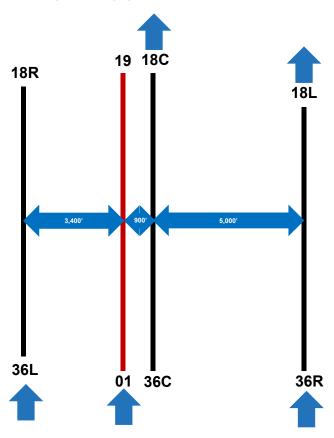
Notes:

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:

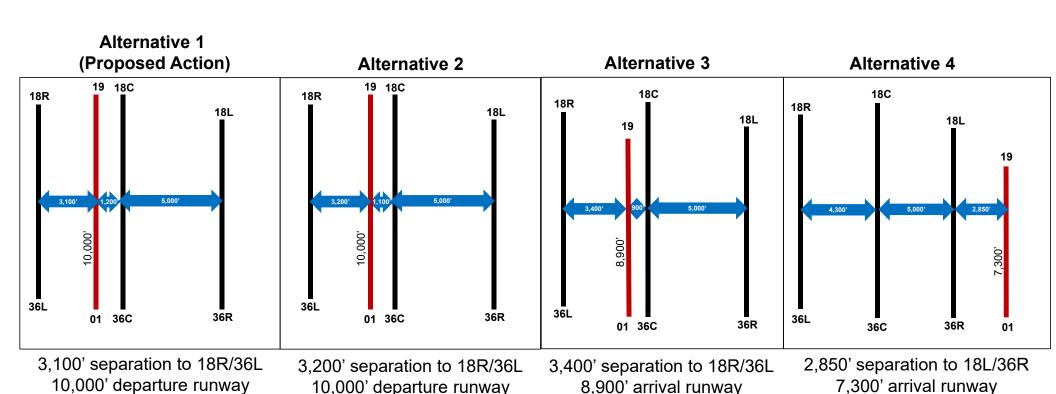
Diagram is not to scale.

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?	ive Carried Forward for	
1		Yes	Yes	Yes	
2		Yes	Yes	Yes	
3		Yes	Yes	Yes	
4		Yes	No	No	

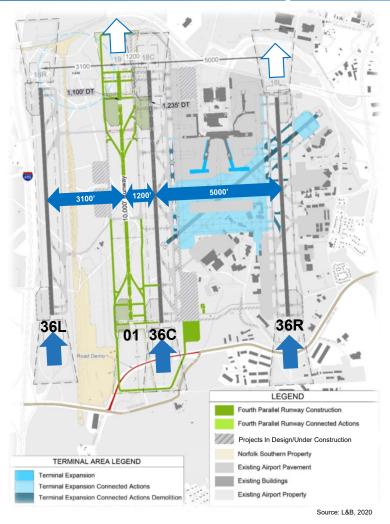
Note: Diagrams are not to scale.

#### **Alternatives Airspace Assumptions**

#### Alternatives Airspace Assumptions

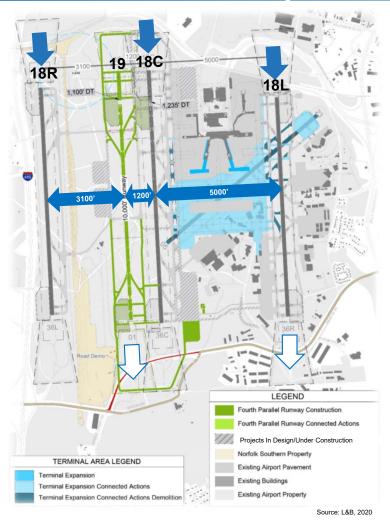
- Alternatives will use same assumptions as Proposed Action:
  - Apply FAA Wake RECAT separation criteria
  - Minimum arrival separations on final approach 2.5 nautical miles (VMC) and 3.8 nautical miles (IMC)
  - Allocation of city pairs to airport routes
  - Allocation of fixes to runways
  - Straight out departure headings

## Alternative 1 (Proposed Action) – North Flow 10,000' Runway / 3,100' Separation to 18R/36L



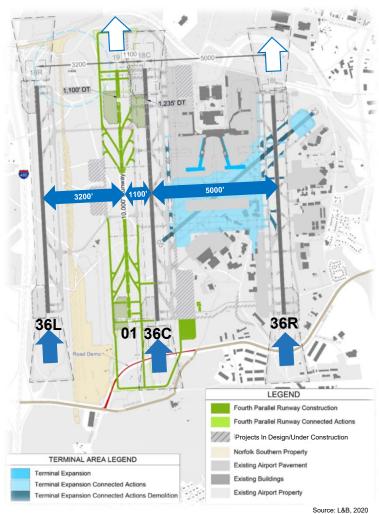
- Proposed Action
- 3,100 feet of separation between new midfield runway and Runway 18R/36L
- Arrivals:
  - Runways: 36L, 36C, 36R
  - Simultaneous triple independent approaches permissible in all weather conditions
- Departures:
  - Runways 01 and 36R
  - 10,000-foot long Runway 01/19
- Runway capacity:
  - Simultaneous triple approaches

## Alternative 1 (Proposed Action) – South Flow 10,000' Runway / 3,100' Separation to 18R/36L



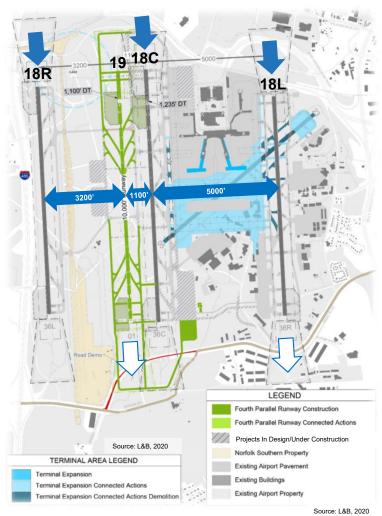
- Proposed Action
- 3,100 feet of separation between new midfield runway and Runway 18R/36L
- Arrivals:
  - Runways: 18R, 18C, 18L
  - Simultaneous triple independent approaches permissible to RVR 4500
- Departures:
  - Runways 19 and 18L
  - 10,000-foot long Runway 19
- Runway capacity:
  - Simultaneous triple approaches

# Alternative 2 – North Flow 10,000' Runway / 3,200' Separation to 18R/36L



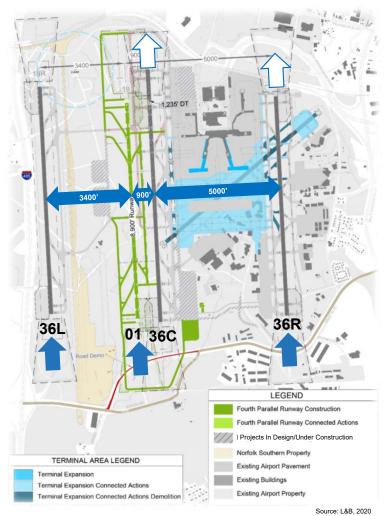
- Opportunity for "future proofing" for possible additional reductions in triple runway spacing requirements
- 3,200 feet of separation between new midfield runway and Runway 18R/36L
- Arrivals (same as Alt. 1):
  - Runways: 36L, 36C, 36R
  - Simultaneous triple independent approaches permissible in 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



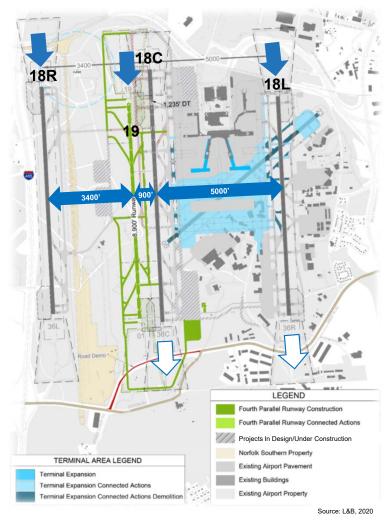
- Opportunity for "future proofing" for possible additional reductions in triple runway spacing requirements
- 3,200 feet of separation between new midfield runway and Runway 18R/36L
- Arrivals (same as Alt. 1):
  - Runways: 18R, 18C, 18L
  - Simultaneous triple independent approaches permissible to 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



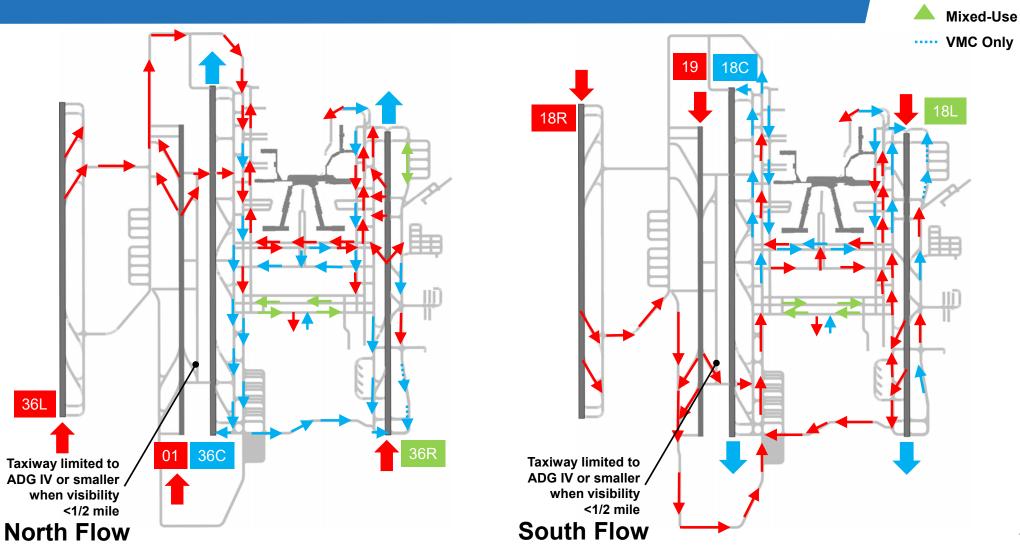
- Opportunity to change runway use through the use of proposed runway spacing criteria
- 3,400 feet of separation between new midfield runway and Runway 18R/36L
- Arrivals:
  - Runways 18R, 19, and 18L
  - 8,900-foot long Runway 01/19.
  - Simultaneous triple independent approaches permissible (assumes 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

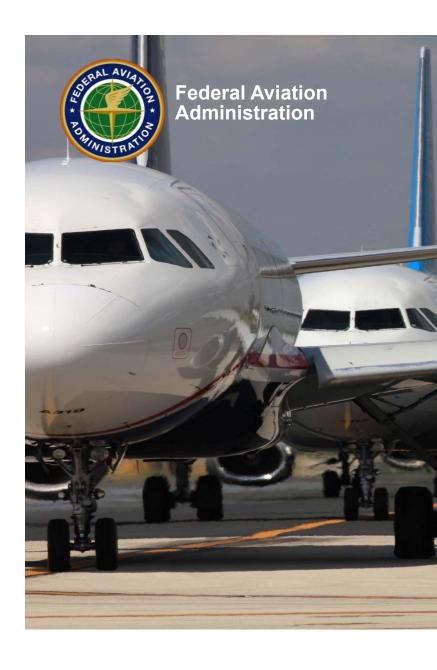
#### **DORA Process**

# 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 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

·

11/2016

Prostell Thomas,

CLT Air Traffic Manager

Ke:

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)



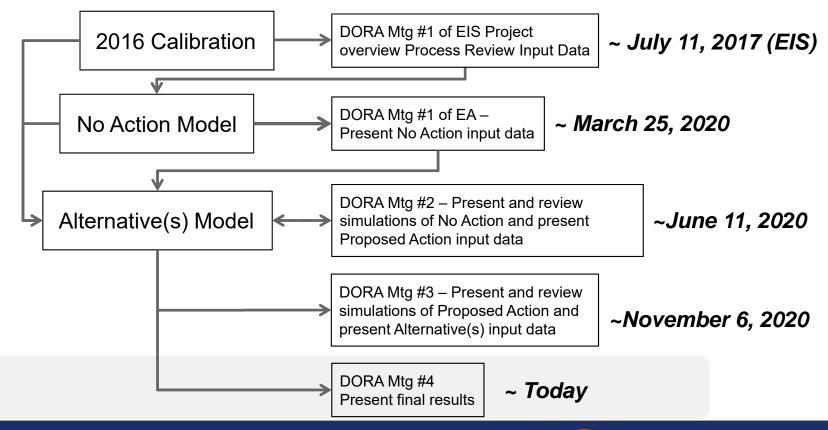
#### Desired Result: 2<sup>nd</sup> DORA Letter

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

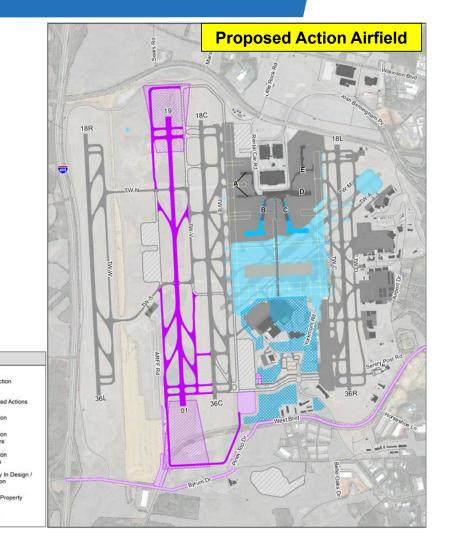
- The CLT Environmental Impact Statement (EIS) that the Federal Aviation Administration (FAA) began was cancelled on February 27, 2019.
- The FAA cancelled the EIS because a runway length analysis determined only a 10,000 foot runway is required to meet the purpose and need.
- The FAA determined that 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** 

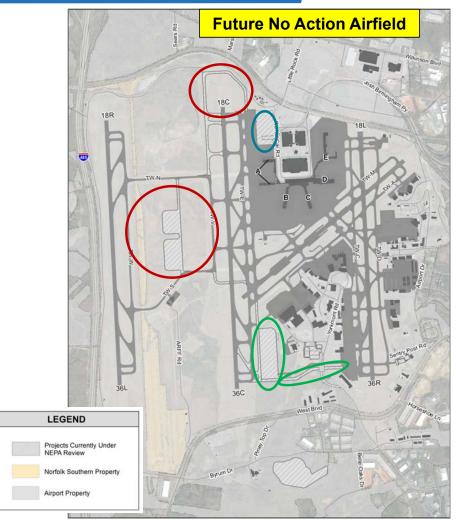
Fourth Parallel

- -4<sup>th</sup> 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**

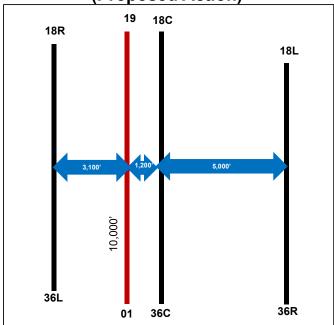
- Simulations will:
  - Be used in developing the Purpose and Need, noise modeling, and air quality modeling.
  - Conducted for the following scenarios:
    - 2016 Calibration Complete
    - 2019 Baseline Complete
    - 2028 Future No Action Complete
    - 2033 Future No Action Complete
    - 2028 Alternative(s) 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**

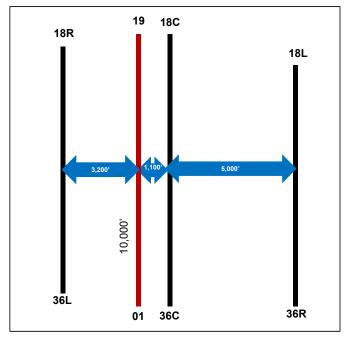
#### **Alternatives Overview**

#### Alternative 1 (Proposed Action)



3,100' separation to 18R/36L 10,000' departure runway

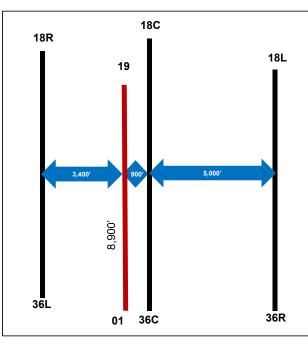
#### **Alternative 2**



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

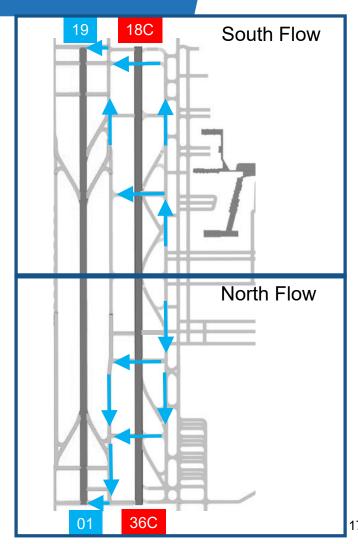
Note: Diagrams are not to scale.

### 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' 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'  006' 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

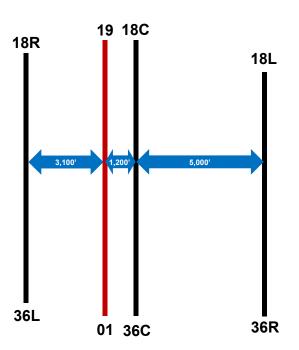
- Added runway crossing points to let two departing aircraft cross Runway 18C/36C simultaneously
  - Reduces Runway 01/19 departure delay
  - Allow more arrivals on Runway 18C/36C
- Rebalanced runway usage to optimize delay and throughput
  - Offload arrivals from Runway 18L/36R to Runway 18C/36C
  - Balance departures between Runway 01/19 and Runway 18L/36R



# Alternative 1 (Proposed Action)/Alternative 2

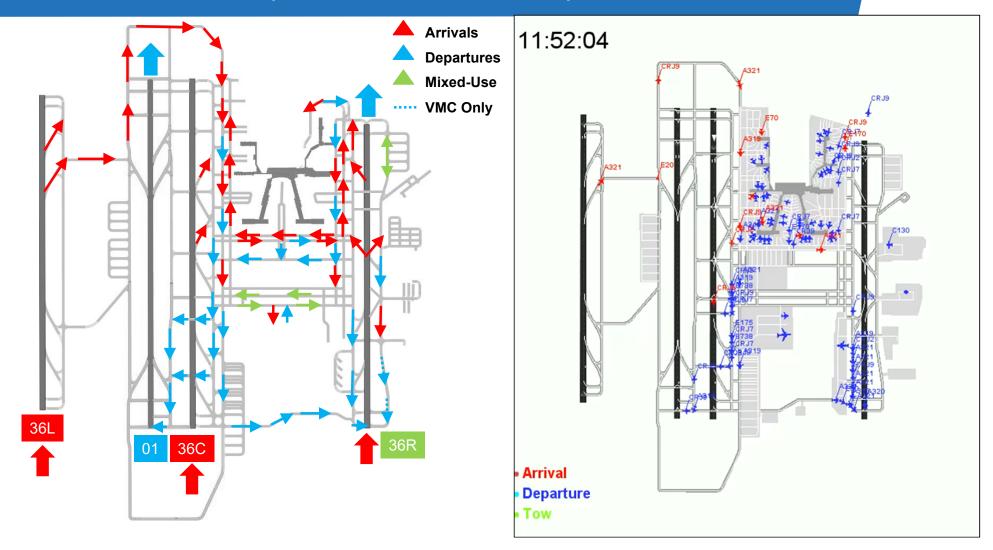
## - Alternatives 1 and 2

- 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

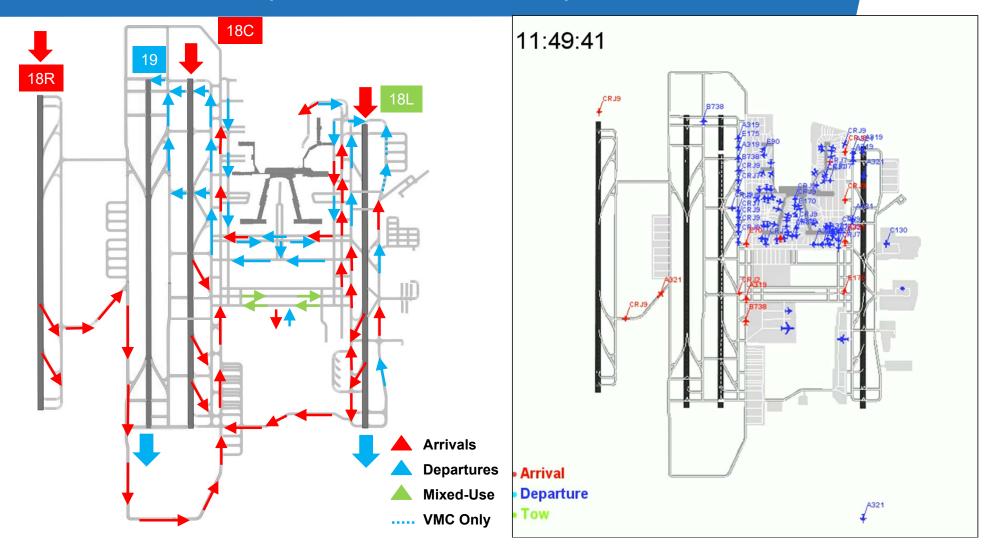


Note: Diagram is not to scale.

# Alternative 1 (Proposed Action) – North Flow

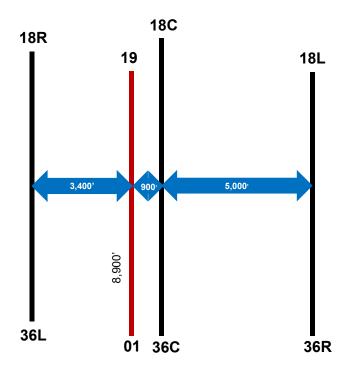


# Alternative 1 (Proposed Action) – South Flow



# Alternative 3

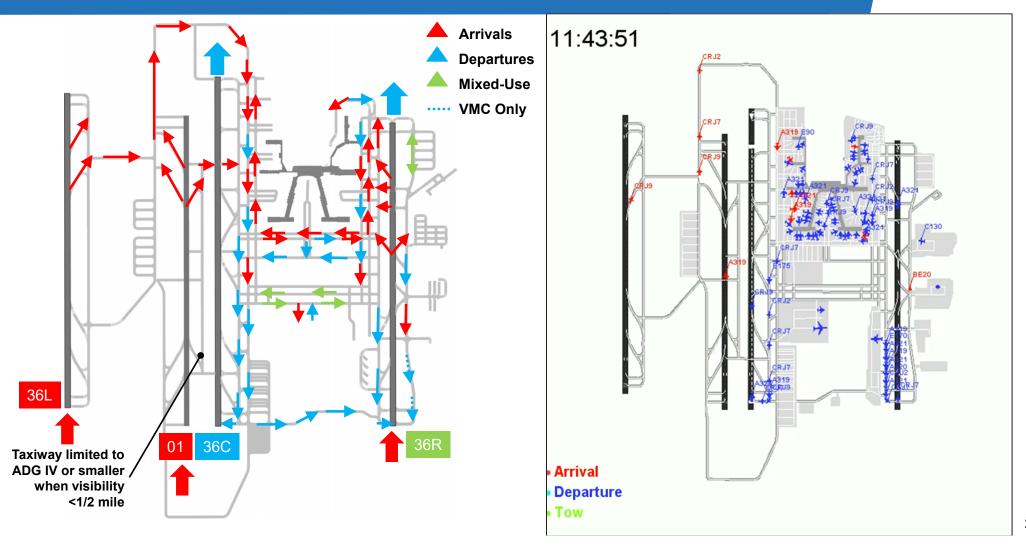
- Assumes that new FAA rules for parallel runways allow simultaneous triple approaches to new runway
- Alternative 3 will use same the airspace assumptions and procedures as Alternative 1 (Proposed Action)



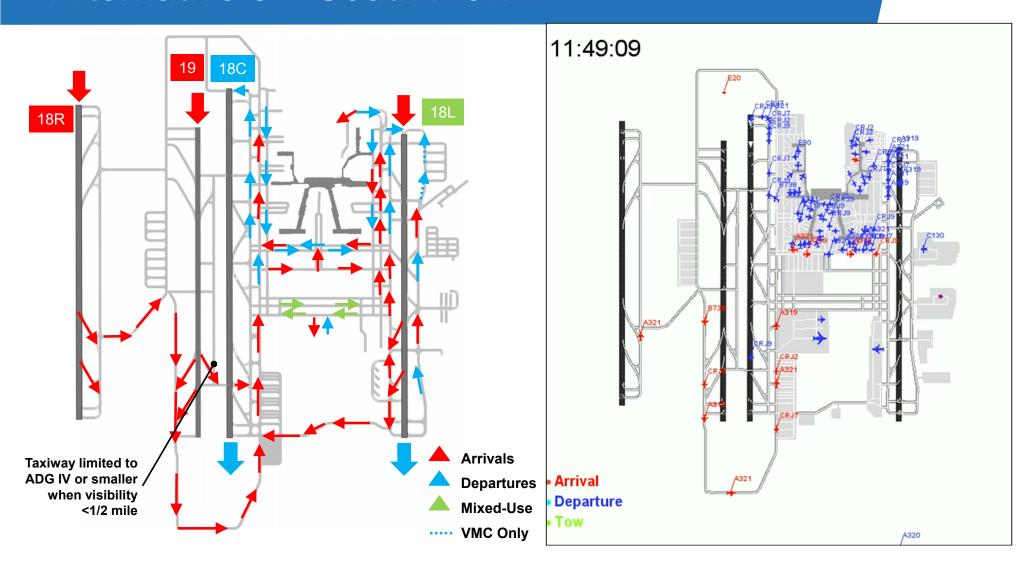
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Note: Diagram is not to scale.

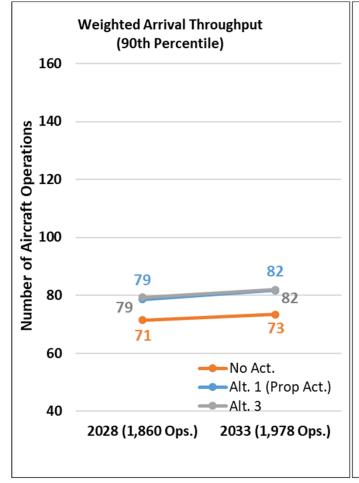
# Alternative 3 – North Flow

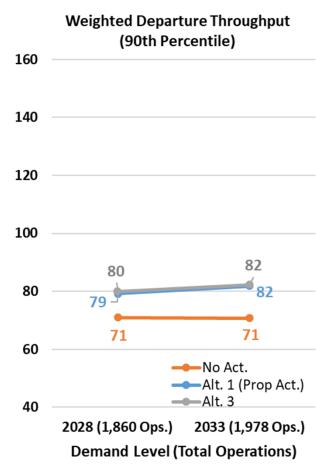


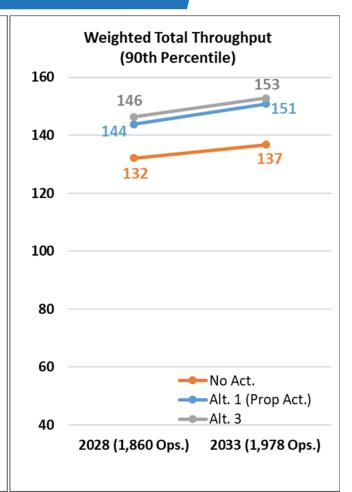
# Alternative 3 – South Flow



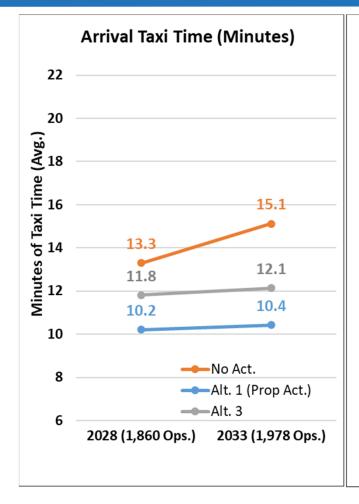
# Alternatives Weighted Aircraft Throughput

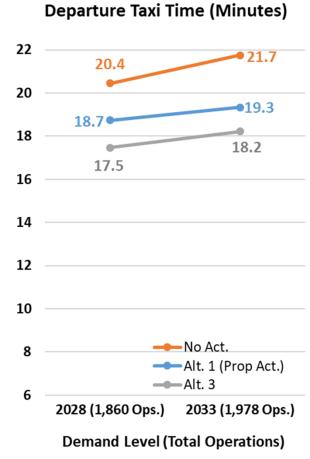


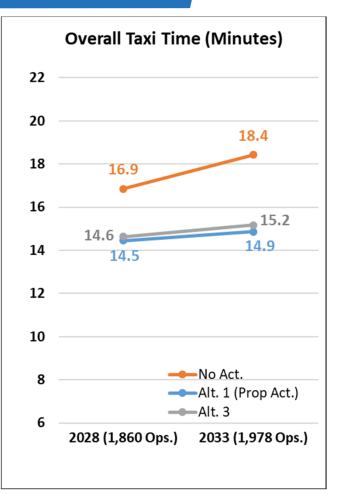




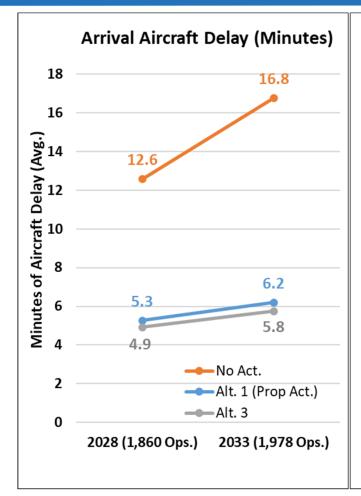
# Alternatives Taxi Time (Including Delay)

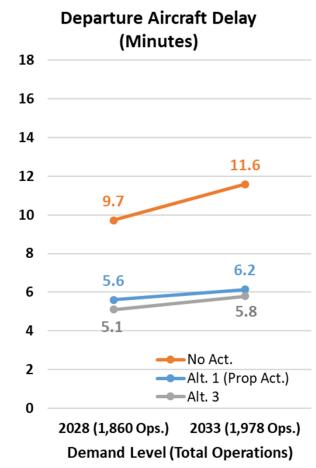


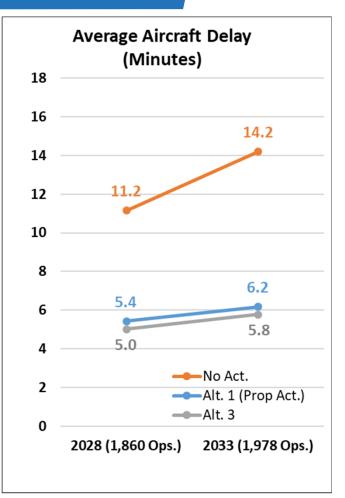




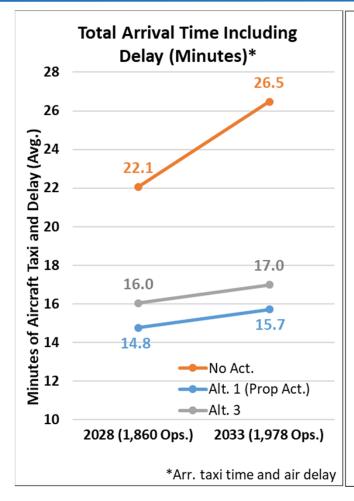
# Alternatives Average Aircraft Delay

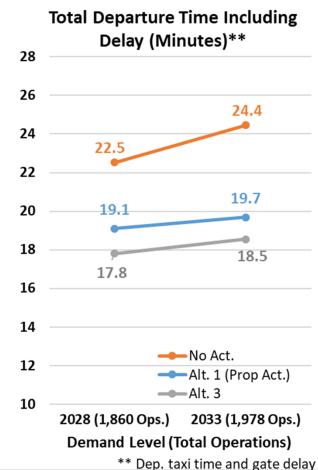


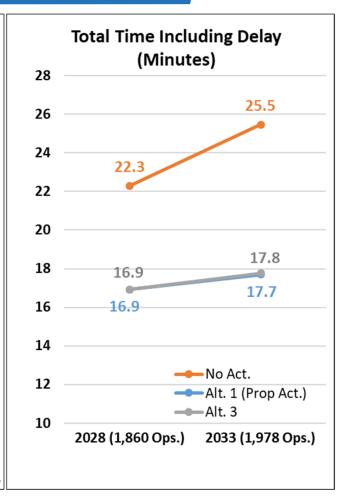




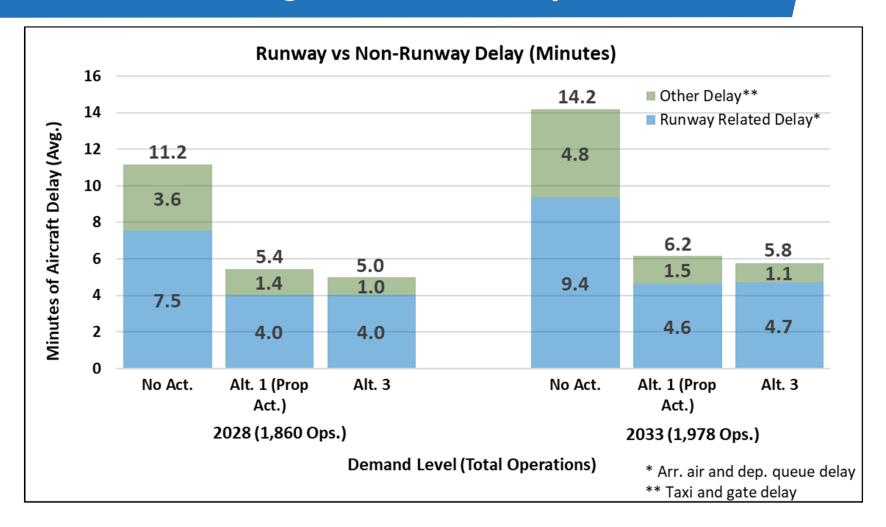
# Alternatives Total Time Including Delay







# 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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	Farmer, Alexandra
	Pilarski, Michael
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	Rustemov, Mirza
	Perry, Jeffrey
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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 feet1
Simultaneous IFR Departures	2,500 feet <sup>1</sup>
Dual Simultaneous Independent IFR Approaches	3,600 feet <sup>2</sup>
Triple Simultaneous Independent IFR Approaches	3,900 feet <sup>2</sup>

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.

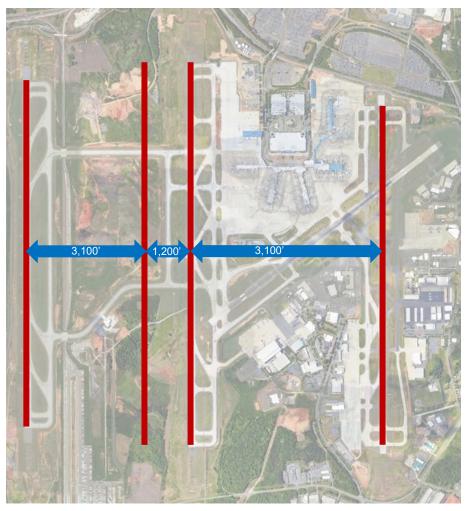
Source: FAA Order 7110.65Z, Air Traffic Control; FAA Headquarters office

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.<sup>1</sup>

**EXHIBIT 2-1, PROPOSED ACTION RUNWAYS** 



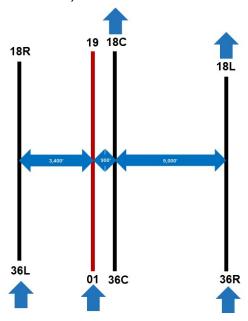
Source: Landrum & Brown, 2020

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 straight-in 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 flexibility<sup>2</sup> and position CLT to take advantage of any potential future reductions in runway separation requirements.<sup>3</sup> 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.

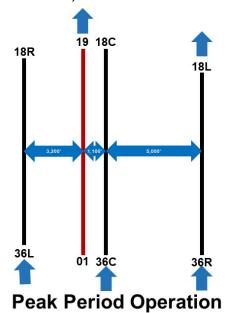
Source: Landrum & Brown analysis, 2021

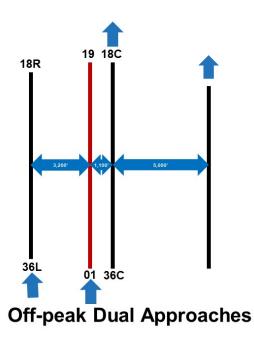
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The 3,200-foot separation between the new runway and Runway 18R/36L would allow these runways to be used by arrivals, with departures on the two eastern most runways, during off-peak periods when triple approaches are not required. The operational 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.<sup>4</sup>

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).<sup>5</sup>

<sup>4</sup> https://www.aopa.org/training-and-safety/active-pilots/safety-and-technique/weather/density-altitude#WIDA

<sup>&</sup>lt;sup>5</sup> FAA Airport Data and Information Portal (ADIP) 2020

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
	Frankfurt (FRA)	1	16:00
A 220, 200	Paris (CDG)	1	18:00
A330-200	Brazil (GRU)	1	20:00
	Barcelona (BCN)	1	20:00
B787-900	Rome (FCO)	1	18:00
B737-900	Seattle (SEA)	1	17:00

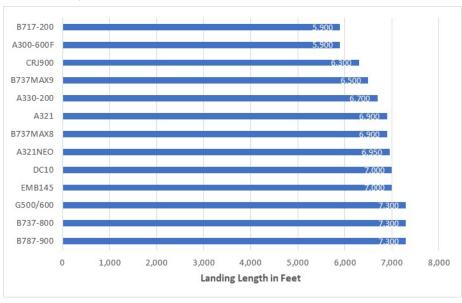
Source: 2033 design day flight schedule; Landrum & Brown analysis, 2020

## 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.<sup>7</sup> 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) <sup>1</sup>	427
TDG 5 (Recommended) <sup>1</sup>	450
ADG V with Visibility < ½ 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.<sup>8</sup> 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 <sup>1</sup>
Airport Temperature	87°F <sup>2</sup>
Surface Conditions	90% Dry, 10% Wet <sup>3</sup>

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	Exit Angle	Exit Usage	
EXIL	from Threshold	Exit Aligie	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

Ewi4	Exit Distance	Evit Angle	Exit Usage		
Exit	from Threshold	Exit Angle	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	Evit Anglo	Exit Usage		
EXIL	from Threshold	Exit Angle	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

Exit	Exit Distance	Exit Angle	Exit Usage		
EXIL	from Threshold		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		

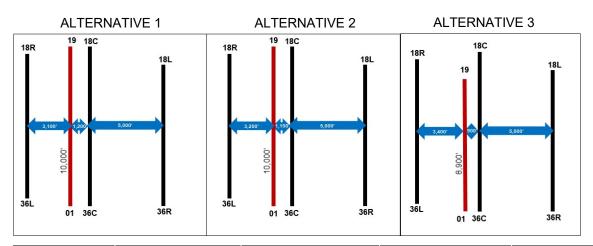
Source: REDIM V3 analysis

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

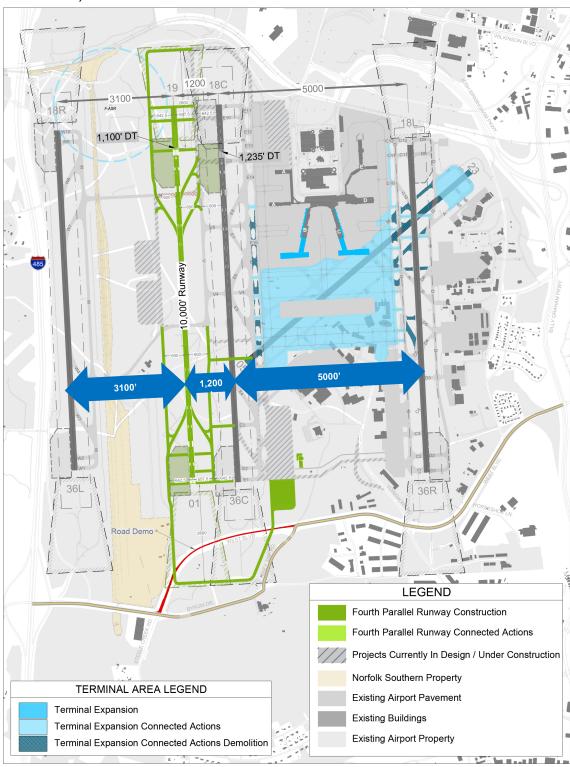
### 6.1 Alternative 1

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.

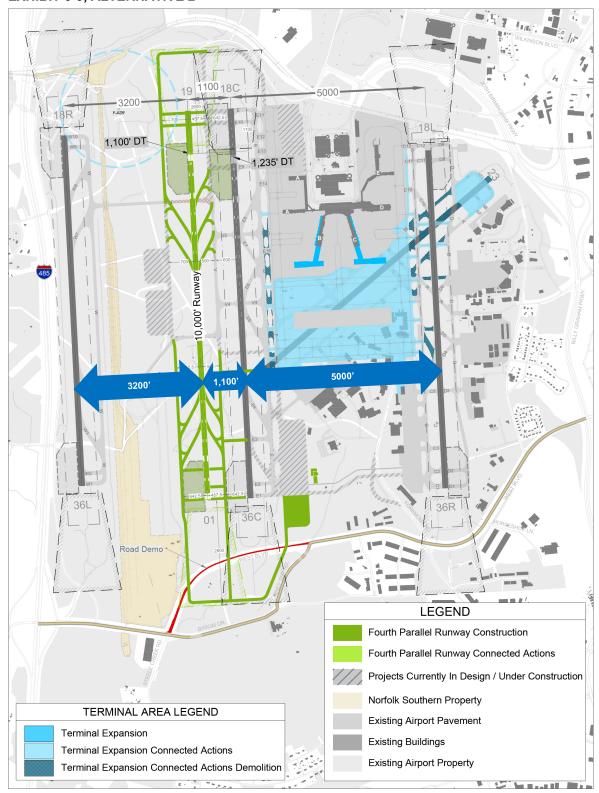
Runway 01/19 is intended for departure use so it is not necessary to optimize ROT in this alternative. As a result, two high-speed exits are provided in north flow and one is provided in south flow. The locations of the exits differ from that shown in Section 5, *Runway Exit Geometry*, due to the location 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.

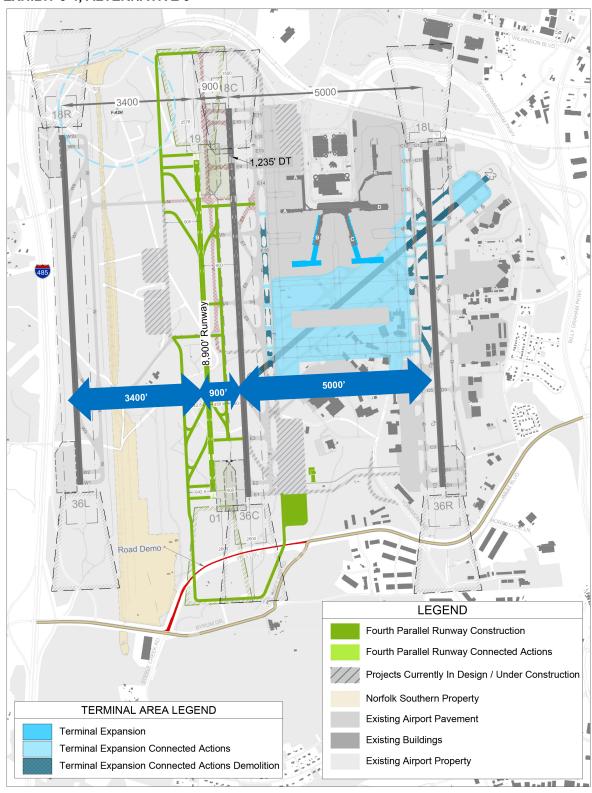
### **EXHIBIT 6-2, ALTERNATIVE 1**



### **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.<sup>9</sup>

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. <sup>10</sup>

### 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.

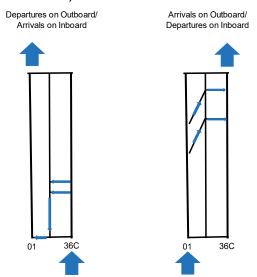
### 7.1.2 North EAT Holding Requirements

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. To 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:

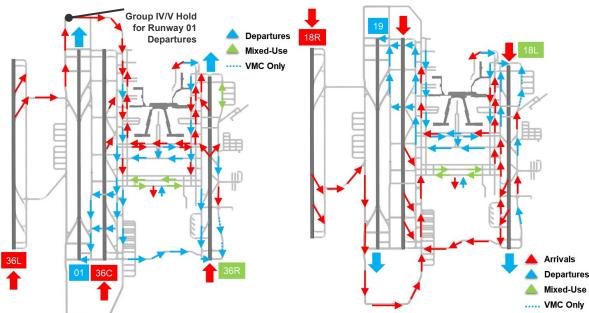
- FAA air traffic officials indicated they would rather cross Runway 18C/36C than taxi on the EATs due to the amount of time it would take for aircraft to taxi through the approach surface.<sup>13</sup>
- Participants at the Safety Assessment Workshop (October 16, 2020) identified a hazard with a high 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.

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.<sup>14</sup>

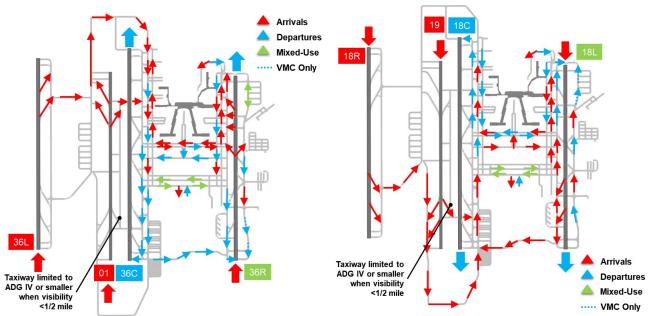
<sup>&</sup>lt;sup>14</sup> FAA AC 150/5300-13A, Airport Design

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.

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	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.



U.S. Department of Transportation

Federal Aviation Administration

July 23, 2021

Mr. Jack Christine Chief Operating Officer Charlotte-Douglas International Airport 5601 Wilkinson Boulevard Charlotte, NC 28208

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) Environmental Assessment (EA) for the Capacity Enhancement Projects. The Direction, Oversight, Review, and Agree (DORA) process described in this letter has been successfully applied to other large-scale airport and airspace modernization efforts.

The target years of analysis for the capacity enhance projects are through 2033. This letter documents the second stage of a multi-year planning, design, and analysis process, which builds on the prior analysis conducted for the Airfield Capacity Enhancement Plan (ACEP) as is documented in a February 2016 letter. The purpose of the DORA process during the conduct of the EA is to provide current operational input on the feasibility and reasonability of the No-Action and other potential alternatives. The operational input is a crucial component to validate the modeling conducted using AirTOP. AirTOP is a modern airspace and airport simulation model that is used to test and analyze the performance of various airport development scenarios.

The DORA work group was comprised of representatives from the FAA, CLT, airlines serving the airport including American Airlines, and the Landrum & Brown team (consultant to CLT). FAA membership included both ARP and ATO participants, including:

- Air Traffic Management, Traffic Flow Management, and National Air Traffic Controller Association (NATCA) representatives from Charlotte Air Traffic Control Tower and Terminal Radar Approach Control (TRACON).
- ARP representatives from the Memphis Airport Districts Office (ADO) and the Office of Airport Planning and Programming (APP).

The CLT DORA process consisted of a simple present>feedback>incorporate cycle, which proceeded as follows: Airfield alternatives and airspace utilization were presented by Landrum & Brown. Operational input and feedback on use of the alternative designs was then solicited from ATO and airline subject matter experts. Prior to the next DORA meeting, Landrum & Brown incorporated the collected information into the modeling.

A total of five DORA meetings were held starting in 2017 and concluding in 2021. These meetings are summarized below:

- <u>July 2017</u>: CLT ACEP project overview, introduction to DORA process and protocols, review collected No Action input data.
- March 2020: Present and review revised No Action input data.
- <u>June 2020</u>: Present and review simulation results for No Action, present and review input data for Proposed Action.
- <u>November 2020</u>: Present and review simulation results for Proposed Action, present and review input data for Alternatives.
- <u>January 2021</u>: Present and review simulation results for Alternatives, synthesize overall simulation results, and close-out of the DORA process.

The DORA process ensured that the appropriate operational expertise and experience, from both airlines and controllers, informed and influenced the design, analysis, and decision-making for the CLT capacity enhancement effort. In particular, ATC's operational input was vital to the DORA process. As applicable and relevant to the simulation tool, the operational input was incorporated into the AirTOP simulation model. For this second phase of analysis, ARP and ATO are satisfied that the modeling approach was reasonable, that the modeling assumptions accurately reflected operational perspectives, and the capacity, throughput, and delay results derived from the DORA process are reasonable representations of the performance expected with the potential airfield designs.

Going forward, subsequent analysis will be needed during implementation phases to:

- Define dependent procedures between aircraft departing from a new runway while
  an aircraft is landing on Runway 18C/36C, and vice versa, in order to ensure
  aircraft separation in the event of a missed approach per FAA Order 7110.65
  paragraph 5-8-5. It is expected that the tower simulator available at the CLT
  ATCT/TRACON will be effective in developing the specific procedures needed
  for incorporation into the facility's Standard Operating Procedures.
- Evaluate possible TCAS interactions and mitigations through coordination with the Flight Technologies and Procedures Division, Flight Operations Group, AFS-410. The TCAS analysis is recommended in order to evaluate if the planned parallel final approach courses to a new runway, using either Established on RNP

- (EoR) RNAV transitions or traditional 1000-feet vertical separations, could result in recurring TCAS alerts between aircraft on simultaneous approach courses.
- A future Part 150 study is expected to investigate the efficiency benefits, operational viability, and community acceptance of divergent departure headings from CLTs runways (as well as other recommendations advocated by the Airport Community Roundtable).

The additional analysis identified above is part of the normal maturation process for large-scale airport capacity initiatives. The FAA considers the results of the simulation evaluation conducted for the EA to be reasonable given the information that is currently available.

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