MASTER PLAN 2050

Final - March 2021

CVG
CINCINNATI/NORTHERN KENTUCKY
INTERNATIONAL AIRPORT

L&B
TEAM

Contents

List of Tables

List of Exhibits

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MASTER PLAN 2050

Chapter 1 | Introduction

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1 Introduction

An airport master plan is a comprehensive study of an airport, describing the short-, mid-, and long-term development plans to meet future aviation demand at an airport; it is a tool which provides the framework necessary to guide potential airport development, while considering both internal and external impacts. The last Master Plan Update for the Cincinnati/Northern Kentucky International Airport (CVG or Airport) was completed in 2013. Since then, a number of changes have occurred that require a fresh look at the long-term planning and development of CVG. Major operational changes since the completion of the previous study include (1) a shift from hub-based activity to increased local traffic, (2) the return and growth of air cargo operations, and (3) an increased demand for aeronautical and non-aeronautical land development. Another major near-term consideration for CVG and as a result, a major element of this Master Plan, is the age, condition, availability, and sustainability of existing passenger terminal facilities. Near-term (2020) expiration of many long-term passenger facility leases, which will require the renegotiation of use and lease agreements, are also a focus of this Master Plan.

The Master Plan 2050 for CVG provides the Kenton County Airport Board (KCAB) with a guide for facility development that will efficiently and economically meet future aviation needs through 2050, while preserving the flexibility to respond to the changing and dynamic aviation industry conditions. This Master Plan:

- Addresses all CVG functional areas, including the airfield, terminal, support, ground access, and people mover facilities,
- Provides a development framework for the long-term planning horizon (2050),
- Identifies future facility requirements for all Airport users, including travelers, airlines, cargo, and general aviation,
- Graphically presents the preferred CVG development projects,
- Defines the purpose and need for the proposed development projects,
- Complies with Federal Aviation Administration (FAA) planning and environmental regulations,
- Enables CVG to achieve its long-term mission, and
- Supports the financial health of one of the region’s most powerful economic engines.

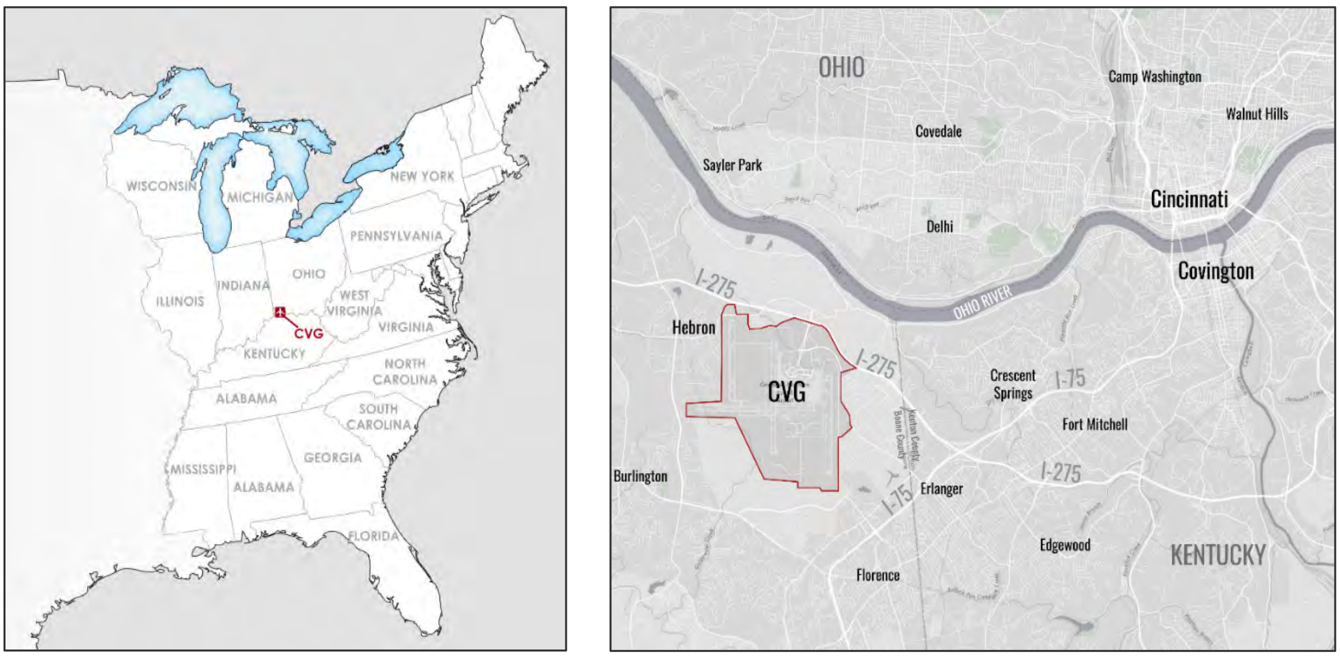
In particular, the CVG Master Plan 2050 focuses on providing a concourse redevelopment strategy, evaluating opportunities to improve airfield capacity and efficiencies, supporting the passenger airlines, supporting the cargo airlines (DHL, Amazon, and other cargo development potential/plans), and identifying landside improvements to support the increase in local passengers and the Consolidated Rental Car Facility (CONRAC).

1.1 Airport Location

CVG is located in Boone County, Kentucky near the City of Hebron, approximately 8.5 nautical miles southwest of downtown Cincinnati, Ohio. KCAB operates the Airport, which occupies approximately 7,000 acres just south of Interstate 275 (I-275) and west of the I-75/I-275 interchange. As depicted on **Exhibit 1.1-1, *Airport Location***, CVG is located approximately one mile south of the Ohio River.

According to the 2010 census, the City of Cincinnati has a population of 301,301 within its city limits and a population of 2,172,191 within its metropolitan area (known as the Cincinnati-Middletown-Wilmington Metropolitan Statistical Area), which CVG serves. Cincinnati is the third largest city in Ohio, the 65th largest city in the U.S., and is the fastest growing economic power in the Midwestern U.S. (based on percentages).

EXHIBIT 1.1-1 AIRPORT LOCATION



Source: Landrum & Brown analysis

1.2 Airport History

CVG has been serving commercial passengers since 1947. Prior to 1947, the Cincinnati area was served by Lunken Airport (LUK), located on the City of Cincinnati's eastern border. Due to consistent flooding and limited growth opportunities at LUK, the federal government recommended a new hilltop airport be constructed within the city limits. However, due to severe terrain issues, the cost to build an airport proved to be too expensive. As a result, the federal government selected a site in Northern Kentucky for the new airport.

The newly established Airport was completed in 1944 with four 5,500-foot runways. CVG was initially utilized as a training field for B-17 Bombers during World War II, but the military relinquished control of the Airport to Kenton County upon the conclusion of the war.

In October of 1946, an American Airlines DC-3 from Cleveland, Ohio became the first commercial aircraft to land at CVG. A brand new three-story terminal building was constructed, and CVG was officially open for business.

The first scheduled jet flight at CVG was a Delta Air Lines Convair 880 from Miami. The jet age had begun in Cincinnati and soon the terminal building was expanded as passenger demand grew. By 1974, CVG had constructed two additional terminals, most recently known as Terminals 2 and 3, to accommodate the growth in commercial service. The original 1974 Terminal 3 was replaced by the current Terminal 3 in 1993.

After airline deregulation in 1979, Delta Air Lines began a hub operation at CVG, expanding the number of their gates to 22, giving CVG 40 total gates. In addition to commercial passenger growth, CVG also experienced cargo growth, beginning with DHL's package-sorting hub in 1984. As cargo continued to grow at CVG, DHL completed a $220 million expansion on the south side of the airfield in 2003. The 150-acre DHL site allowed enough apron space to park 60 aircraft. With this expansion, CVG was required to provide DHL with support infrastructure, accessibility, and pavement improvements. A direct result of this required expansion was the extension of Runway 09/27 to 12,000 feet.

In 2005, a third north-south runway was constructed (18R-36L), making CVG one of the most efficient airports in the nation. Shortly thereafter, traffic began to decline as a result of merger between Delta Air Lines and Northwest Airlines, the rightsizing of Delta's operation at CVG, DHL's decision to relocate its hub to Wilmington, Ohio, and other economic factors. However, by 2009, cargo operations started rebounding as DHL decided to move its operation back to CVG and have since continued to grow and show a strong international cargo presence at CVG. The CVG DHL hub is considered one of three global "Super Hubs" from which DHL Express serves 220 countries.

In 2010, the FAA's ranking of U.S. airports by enplanements showed CVG ranked 48th, just behind San Antonio International Airport and just ahead of Dallas Love Field. A neighboring airport, Indianapolis International Airport, was ranked 50th. In late 2011, CVG averaged 185 daily commercial departures serving 53 markets, comparable to activity in the early 1990s.

In October 2012, Frontier Airlines began service from CVG – becoming the first modern attempt to bring a low-cost carrier into CVG. Following this success, Allegiant Air began service in February 2014, and in July 2015 announced plans to make CVG its midwestern base of operations with four Airbus A319s. Since 2015, there has been significant growth in both legacy and low-cost carrier service at CVG. Delta also began expanding at CVG for the first time since it began capacity cuts in 2005.

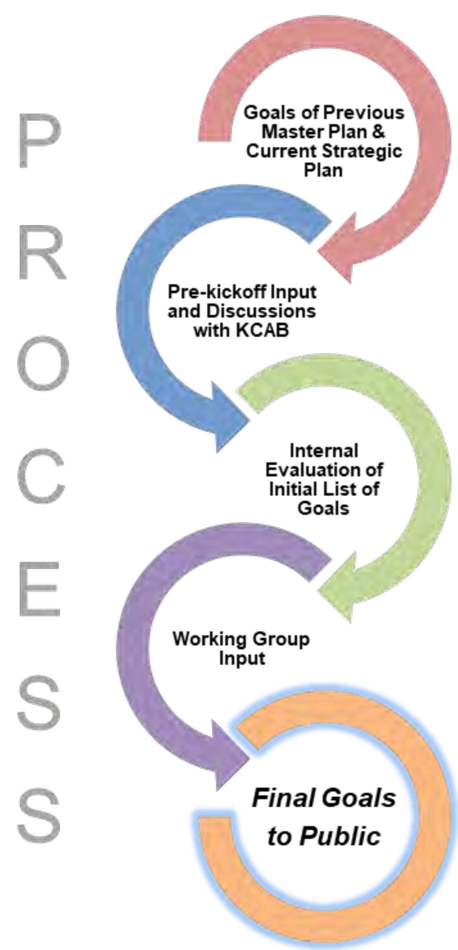
Between 2016 and 2017, Terminals 1 and 2, Concourse C, and miscellaneous other facilities were demolished to make room for new development projects, including the CONRAC and terminal curb improvement projects. The CONRAC is anticipated to be complete and open for business in 2021.

CVG is currently the premier passenger airport for the Tri-State region, as well as the fastest-growing cargo airport in the U.S. In January 2017, Amazon announced its plans to build its global hub on the south side of CVG's airfield. The Amazon Air Hub Development is a $1.5 billion facility that will lease about 650 acres of CVG land (with an option for an additional 475 acres) for 50+ years and add more than 2,000 jobs to CVG's existing base of 10,000.[1]

As one of the top-growing airports in the country, CVG is serving more local passengers than ever before. In 2019, CVG served 9.1 million annual passengers (MAP) and added nine new flights. CVG experienced 64 consecutive months of local passenger growth as of December 2019. This record-breaking growth has also been accompanied by an increase in nonstop destinations and the lowest fares in the region.

1.3 Master Plan Vision, Goals and Objectives

The CVG Master Plan 2050 visioning task established the overall goals and objectives for the Master Plan based on input from the KCAB and CVG stakeholders. The process started with a review of the goals and objectives from the previous 2013 CVG Master Plan and current CVG Strategic Plan 2016-2020, and then gathered input from the KCAB through multiple visioning sessions/discussions. These goals/objectives served as a starting point for a series of meetings that were conducted with CVG's airlines, tenants, FAA, and other stakeholder groups to solicit input on what direction CVG should be going and specific areas that should be addressed in this Master Plan. The results of these meetings produced the following goals and objectives (in alphabetical order), which were used to help guide the Master Plan, and ultimately, the study's results:



- Build community support for future airport development,
- Develop landside roadway & parking to support the CONRAC, terminal, and cargo facilities,
- Ensure financial sustainability,
- Identify actions to meet/exceed safety & security best practices,
- Optimize terminal/concourse facilities for a multi-airline Origin and Destination (O&D) airport with transient capabilities,
- Support and enhance cargo development,
- Support and enhance non-aeronautical development, and

1 https://www.cvgairport.com/about/next/amazon-and-cvg/amazonatcvg

- Support use agreement renegotiation (2020).

Exhibit 1.3-1, *Master Plan Goals*, summarizes how the goals and objectives established for the CVG Master Plan 2050 relate back to the current CVG Strategic Plan 2016-2020.

EXHIBIT 1.3-1 MASTER PLAN GOALS

Sources: KCAB; Landrum & Brown analysis

1.3.1 Build Community Support for Future Airport Development

To have a successful airport it is important that it have the support of its community. Several steps were identified to help make this goal a reality, including:

- Ensure the Master Plan engages stakeholders
- Minimize noise impacts while ensuring efficient operations
- Promote the recycling plan at CVG
- Define sustainability guidelines
- Improve partnerships with local groups:
  - Universities
  - Local businesses

1.3.2 Develop Landside Roadway and Parking to Support the CONRAC, Terminal, and Cargo Facilities

One of the important focuses of the Master Plan is to recommend improvement and expansion of the landside roadways and parking that support and are compatible with the development of the CONRAC and the increase in local passengers. Additional consideration will be given to protecting for the future development of multi-modal transportation connections.

1.3.3 Ensure Financial Sustainability

To be financially sustainable, the Master Plan recommendations must be financially feasible by ensuring the phasing of capital projects is aligned with the ability to secure available funds. The goal of financial sustainability can be achieved by diversifying revenue streams, continuing to develop CVG property for revenue generation, and enhancing concessions revenue.

1.3.4 Identify Actions to Meet/Exceed Safety and Security Best Practices

As part of the visioning task for the Master Plan, the KCAB and CVG stakeholders identified actions that would meet and/or exceed safety and security best practices. It was determined that this goal could best be accomplished by implementing the following actions:

- Improve airfield security
  - Limit access points
  - Provide separate employee screening location
  - Improve access roads to avoid hot spots
- Implement new technology
  - Improve terminal front door security
  - Separate and harden the Airport Communications Center (ACC), Emergency Operations Center (EOC), and Police Department (PD)
- Improve stakeholder involvement
  - Ensure stakeholder review of recommended plan
- Improve airfield standards compliance

1.3.5 Optimize the Terminal/Concourse Facilities for a Multi-Airline Origin & Destination (O&D) Airport with Transient Capabilities

One of the most important aspects of terminal optimization is the customer experience. Traveling through the terminal must be intuitive and walkable. This Master Plan strives to provide a plan that considers the customer experience by enhancing wayfinding and walkability using benchmarking and best practices, as well as providing more concession options prior to entering through security.

Another aspect of terminal optimization is improving the actual terminal and concourses. To provide a more efficient and enjoyable airport experience, this Master Plan strives to improve both the international arrival process and the Baggage Handling System (BHS). The Master Plan also provides for the implementation of new technologies within the terminal, such as common use terminal facilities and self-serve passenger processing capabilities, both of which support a more efficient multi-airline O&D terminal/airport with transient capabilities. The following is a summary of the factors required to meet this goal.

- Improve customer experience
  - Wayfinding and walkability
  - Benchmarking and best practices
  - More concessions pre-security
  - Consolidating concessions post-security
- Implement terminal/concourse improvements
  - Improve international arrival process
  - Improve BHS
- Implement new technology
  - Common use terminal systems
  - Self-serve processing

1.3.6 Support/Enhance Cargo Development

CVG is currently experiencing the fastest growing cargo traffic in the country. This Master Plan recognizes the importance of this growth and the need to support and enhance cargo development well into its future. To support and enhance the cargo development at CVG, the Master Plan identifies and preserves land for cargo expansion. One of the most important aspects to supporting and enhancing cargo development is to ensure adequate airfield connectivity (taxiway, aprons, etc.). This can best be accomplished by planning to accommodate the largest cargo aircraft in use at CVG, providing for efficient deicing facilities, ground run-up pads, and other needed support facilities.

1.3.7 Support/Enhance Non-Aeronautical Development

Non-aeronautical development at an airport is a relatively new concept that many airports are gravitating towards as it allows an airport to diversify revenue per passenger. In 2012, non-aeronautical revenue accounted for 44.8 percent of total airport revenue in the U.S. To support and enhance non-aeronautical development, the available Airport-owned property was identified and the highest and best use for land development was determined, while simultaneously minimizing community impacts to the extent possible. The Master Plan also provides for an infrastructure development plan that will support growth and enhance revenue. The following is a summary of the factors required to support/enhance non-aeronautical development at CVG:

- Identify available on-airport land
- Enhance airport revenue
- Develop infrastructure to support growth
- Minimize community impacts
- Determine highest and best use for land development

1.3.8 Support Use-Agreement Renegotiation (2020)

Rather than giving airlines proprietary use of certain gates, over the past decade, airports in the U.S. have increasingly adopted a “common-use strategy” — meaning any carrier may use any gate, as well as share check-in kiosks, ticket counters and baggage carousels. This allows airports to accommodate more airlines without a costly expansion, move carriers around more easily after flight cuts and additions, and respond quickly to schedule changes caused by mechanical problems and weather delays. Two main benefits of shared resources are operational efficiencies and cost savings.
A common-use gate strategy can be hard to implement because long-term airline leases often give dominant carriers’ preferential rights to a terminal or set of gates, and those airlines are reluctant to change that arrangement. However, as leases expire (as at CVG) or new terminals are built, airports have an opportunity to renegotiate their operations. Therefore, in light of the use-agreement renegotiation happening in 2020, the CVG Master Plan 2050 was developed around increased but not complete common-use policies, which will provide flexibility for future expansion.

1.4 Public and Stakeholder Involvement Program

The goal of a public and stakeholder involvement program is to provide appropriate information to the public and obtain meaningful input from key stakeholder groups and the public that may be affected by any proposed airport development, expansion, or enhancement.

Throughout the CVG Master Plan 2050 process, the KCAB executed a public/stakeholder involvement plan designed to inform, educate, and engage residents, CVG users and related businesses, local and federal agencies, and city planners. This included, but was not limited to, CVG tenants, the public, and community leaders (elected and others) in the vicinity of CVG, as well as other active members of the CVG community and aviation industry. Wherever possible, the CVG staff and consultants designed and facilitated interactive meeting formats to ensure a balanced and fair discussion of issues from all perspectives.

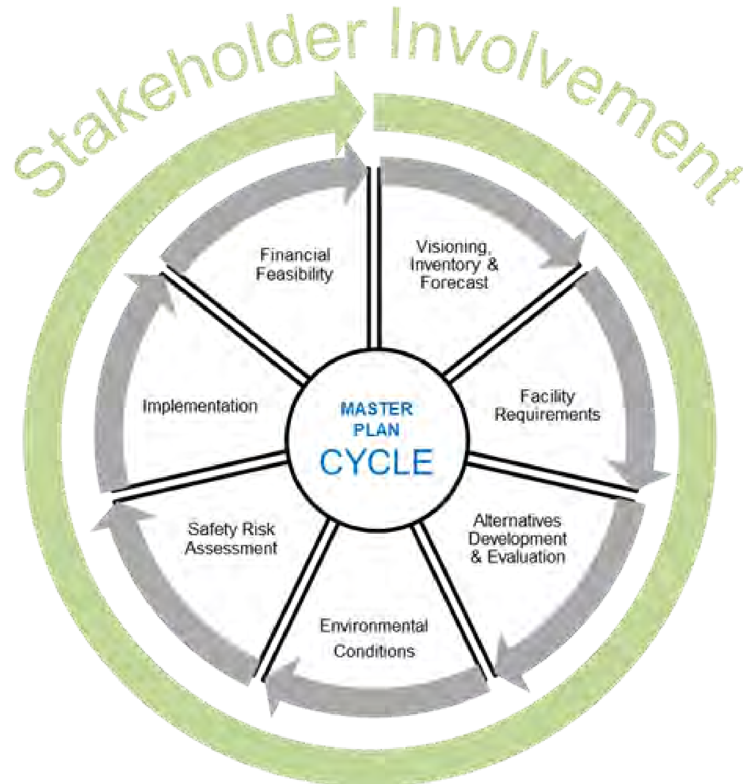
Stakeholders were organized and mobilized into the following groups:

- **Project Coordination Team (PCT)**: The PCT was comprised of various CVG and Landrum & Brown (L&B) staff. Bi-weekly teleconference coordination calls and regular progress meetings were conducted throughout the Master Plan to solicit input, feedback, and direction on each stage of the Master Plan 2050.
- **Project Advisory Committee (PAC)**: The PAC was formed to provide the KCAB with visioning/ideas for the expansion of the CVG facilities and services, as well as detailed technical input into the Master Plan 2050 process and recommendations, by both key internal and external stakeholders. The PAC included CVG staff, federal and state agencies (i.e. FAA, Kentucky Transportation Cabinet, etc.), airlines, CVG tenants, Kentucky government, Ohio government, Indiana government, local planning agencies, area business leaders, and other partners. The CVG Master Plan 2050 was also coordinated with local planning studies, including the Boone County Transportation Plan and Our Boone County Plan 2040. The PAC was consulted for input on each stage of the Master Plan 2050.
- **Public Outreach**: Two publicly posted outreach meetings (i.e. public workshops) on the proposed CVG Master Plan 2050 were held during the study period to provide information about the preliminary visioning and potential community impacts, as well as to solicit public comments, feedback, and suggestions. These public workshops served to provide the public an opportunity to comment and participate in the master plan process. A public website was also created with details about the CVG Master Plan 2050.

Additional details of each meeting, dates, members, meeting attendees, presentation materials, meeting notes, and feedback are provided in **Appendix 1-A, *Public and Stakeholder Involvement Program***.

1.5 Master Plan Process

The Master Plan provides a detailed description of individual development projects that are based on the outputs of the technical planning analysis and consultative process. It encompasses seven sequential work elements that describe in more detail the overall CVG vision and how it transforms through the forecast of growth to the future runway and terminal strategies, surface access needs, and the link to financial feasibility and the Capital Improvement Program (CIP).



The relationship between this Master Plan and the CIP affects the implementation of the development strategy. The intent is to provide the purpose and need for the essential capital investments in a logical manner with sufficient detail and justification.

The process used to prepare the Master Plan was open and deliberate, and complied using the guidelines set forth by the FAA in Advisory Circular (AC) 150/5070-6B, *Airport Master Plans*. This process involved extensive opportunities for public involvement and comment, as well as input from all stakeholders, including the airlines, FAA, the Transportation Security Administration (TSA), CVG tenants, the public, and other aviation experts. The steps performed for the Master Plan resulted in the overall recommended plan which is presented in the next section.

Features of a successful master plan that have been adopted into this process include the following elements:

- **Financially Feasible**: The phasing of capital projects is aligned with the ability to secure available funding.
- **Environmentally Compatible**: The plan strives for environmental stewardship in accordance with CVG guidelines.
- **Balanced**: The plan maintains a balance between CVG development needs and community impacts.
- **Technically Sound**: The plan complies with federal, state, and local requirements and can be constructed efficiently and cost effectively.
- **Responsive**: The plan addresses the physical and operational needs of all stakeholders.

This Master Plan provides the framework needed to guide future development at CVG that will cost-effectively satisfy aviation demand, while also addressing relevant environmental and socioeconomic issues.

1.6 Executive Summary

The forecast is the basis of any master plan – it defines the level of activity that an airport should plan to accommodate. This Master Plan includes a forecast of aviation demand for CVG through the year 2050 (see Chapter 3). Passenger activity, air cargo throughput, and aircraft operations were projected on an annual and peak period basis. This forecast relies on the historical relationship between socioeconomic factors and aviation activity to project future demand. It was approved by the FAA in 2019.

In addition to the FAA-approved forecast, an alternative forecast was prepared. Rather than using traditional forecasting methods such as those used in the FAA-approved forecast, the alternative forecasts relied on airline/cargo carrier input and assumptions about short-term air service additions. This type of forecast was created because CVG is currently in a unique position and is in the midst of significant changes in a variety of sectors: (1) a market evolution from a connecting hub to an O&D hub, (2) the introduction of low-cost and ultra-low-cost service, and (3) the potential for rapid cargo growth unlike any airport has experienced. Because this combination of events is occurring at the same time, KCAB wanted to create a forecast that would allow it to understand the upper bounds of development that could be needed through the planning period. The alternative forecast is presented in **Appendix 1-B, *Alternative Forecasts***.

Having both the FAA-approved forecast (Chapter 3) and the more aggressive air service-based forecast (Appendix 1-B) available allows CVG officials to be prepared for the maximum potential level of growth, while at the same time understanding a lower end of potential activity. Four Planning Activity Levels (PALs) were identified as planning thresholds. The use of these PALs rather than years provides CVG with flexibility to plan for the implementation of future projects based on actual growth in traffic, rather than an arbitrary year. **Table 1.6-1, *Annual Passenger Forecast***, summarizes the forecast passenger level associated with each PAL, along with the range of years during which that passenger level is expected to be reached based on the two forecasts. **Table 1.6-2, *Annual Cargo Throughput Forecast***, and **Table 1.6-3, *Annual Aircraft Operations Forecast***, provide similar information for cargo throughput and aircraft operations.

TABLE 1.6-1 ANNUAL PASSENGER FORECAST

PAL	MAP	Potential Range of Years
PAL 1	11	2022-2024
PAL 2	13	2027-2030
PAL 3	16	2037-2040
PAL 4	19	2050+

Source: Landrum & Brown analysis

TABLE 1.6-2 ANNUAL CARGO THROUGHPUT FORECAST

PAL	Cargo Throughput (millions of tons)	Potential Range of Years
PAL 1	1.9	2022
PAL 2	2.7	2027
PAL 3	4.5	2037-2050
PAL 4	6.7	2050+

Source: Landrum & Brown analysis

TABLE 1.6-3 ANNUAL AIRCRAFT OPERATIONS FORECAST

PAL	Aircraft Operations	Potential Range of Years
PAL 1	200,000	2022
PAL 2	260,000	2027-2028
PAL 3	350,000	2037-2046
PAL 4	460,000	2050+

Source: Landrum & Brown analysis

Facility requirements were identified for PAL 1 through PAL 4 using FAA standards, established industry planning guidelines, and CVG-specific information and needs. Requirements were identified for the airfield, terminal, landside, cargo, and support facilities at CVG. Alternatives were then developed to meet the PAL 4 facility requirements. These alternatives were evaluated based on a variety of factors including community impacts, operational issues and needs, FAA requirements, passenger convenience/experience, costs, and implementation factors. Based on this analysis, a recommended airport development plan was developed.

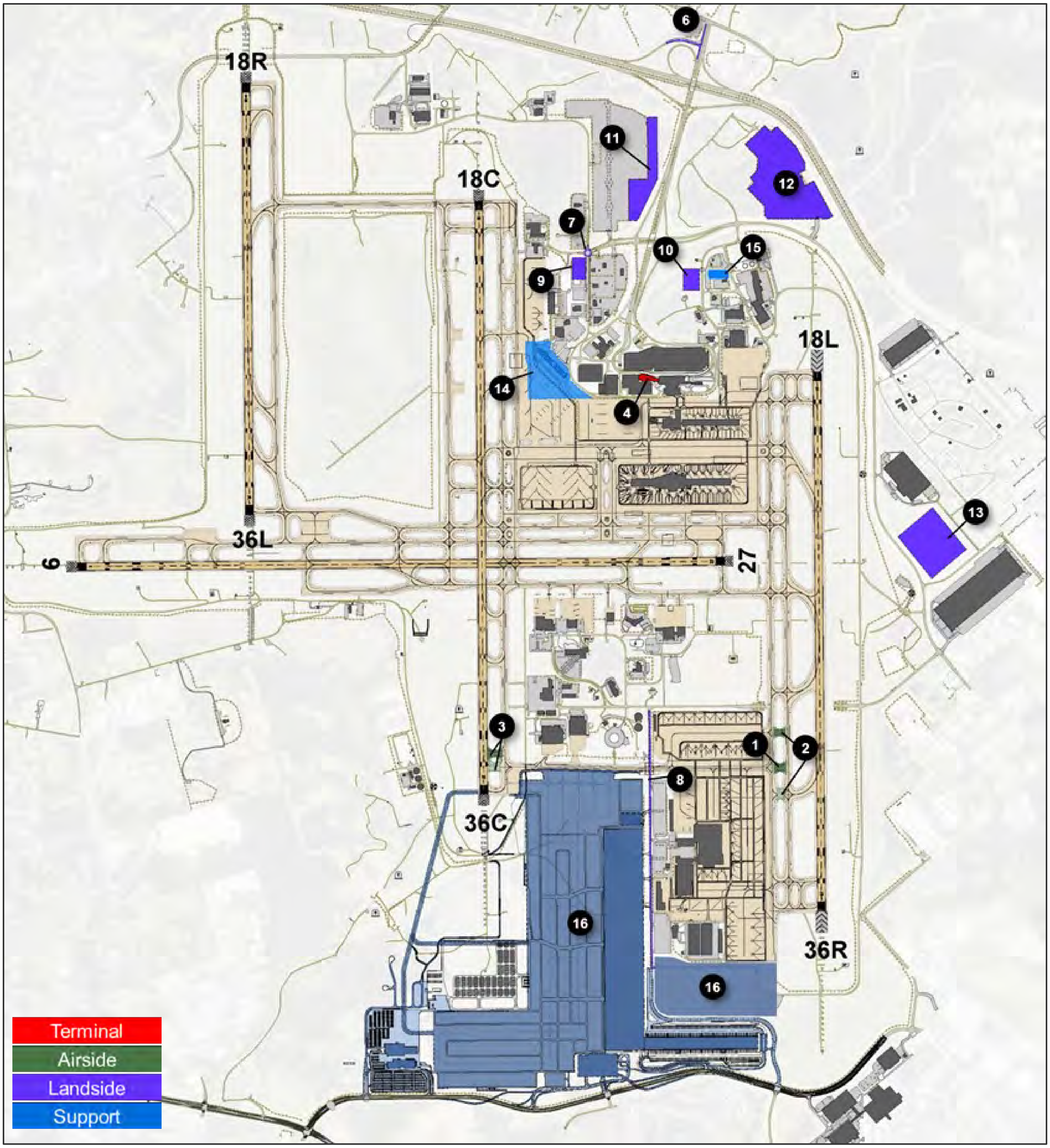
The first phase of the Master Plan recommends several projects to support the projected PAL 1 demand of 11 MAP. A complete list of the PAL 1 projects is shown on **Table 1.6-4, *PAL 1 Recommended Projects***, and their locations are depicted on **Exhibit 1.6-1, *PAL 1 Program***. Major projects in PAL 1 include the expansion of the ticketing lobby into the 3rd floor of the new Customer Servicing Building (CSB); improvements to the Kentucky 212 (KY 212)/I-275 intersection, Loomis Road/Donaldson Road, and Wendell Ford Boulevard; auto parking expansion; and the south airfield cargo expansion that is currently underway.

TABLE 1.6-4 PAL 1 RECOMMENDED PROJECTS

#	PAL 1 Project List
Airfield	
1	Taxiway N Extension
2	Relocation of Taxiway S4 & Demo
3	Relocation of Taxiway D2 & Demo
Terminal	
4	Terminal Expansion
5	Bag Belts from CSB to Terminal (project not shown)
Landside	
6	SB KY 212/I-275 WB Entrance Ramp Improvements
7	Loomis Road/Donaldson Road Improvements – Part 1
8	Wendell Ford Blvd Capacity Improvements & Extension
9	Construction of New Cell Phone Lot
10	Expansion of Taxi Bullpen to add TNC
11	Expansion of ValuPark Parking Lot – Part 1
12	Convert Existing Employee Lot to Long-Term Parking
13	Construction of Replacement Employee Lot
Support Facilities	
14	General Aviation Hangar and Apron
15	Government/Police Facility
16	Cargo Development

Source: Landrum & Brown Team analysis

EXHIBIT 1.6-1 PAL 1 PROGRAM



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

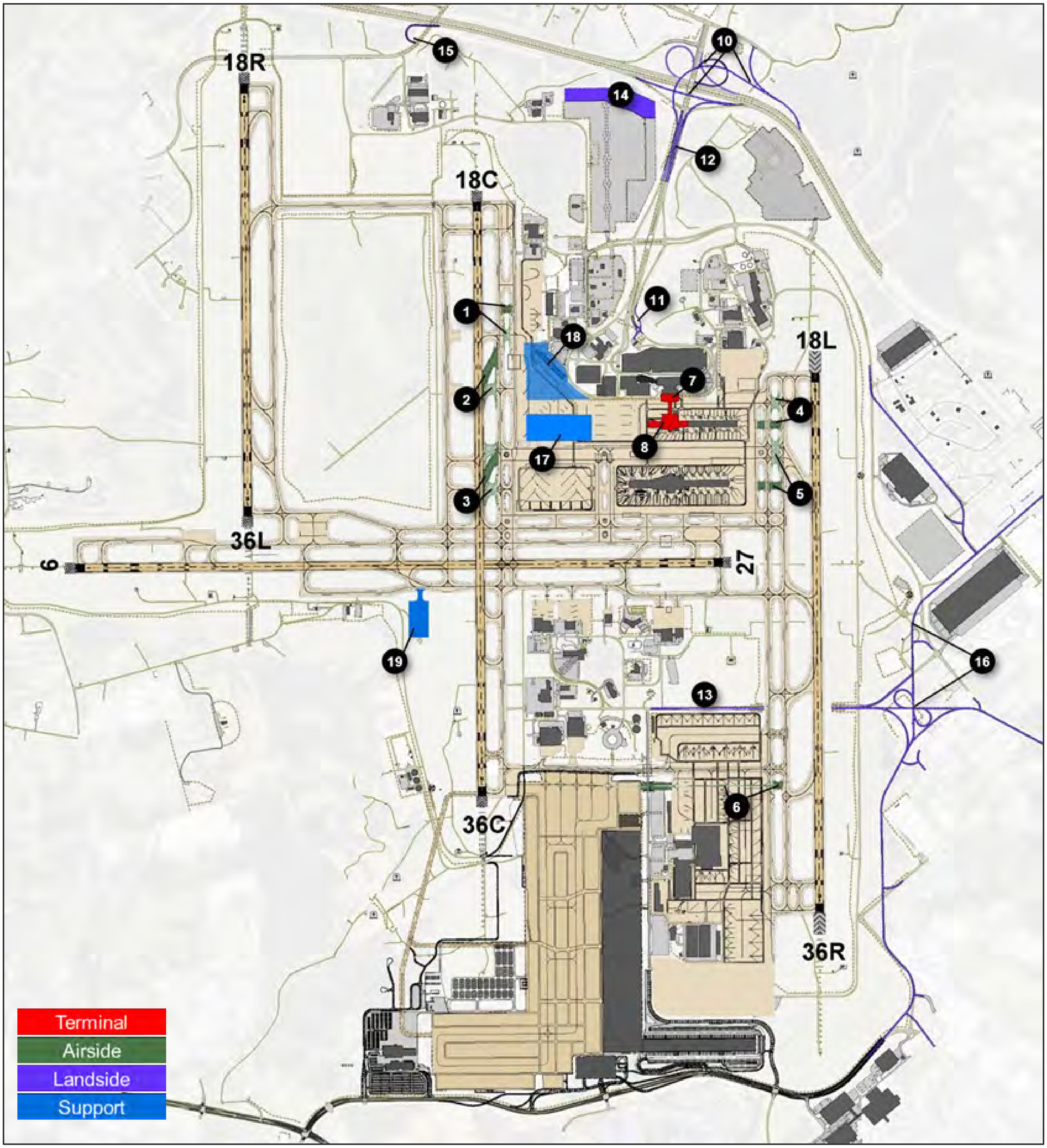
Phase 2 includes projects to support the projected demand of 13 MAP. A list of the PAL 2 projects is shown on **Table 1.6-5, *PAL 2 Recommended Projects***, and their locations are depicted on **Exhibit 1.6-2, *PAL 2 Program***. PAL 2 airfield projects include runway exit improvements and a new crossfield taxilane to support cargo development. Terminal projects include a multi-level expansion to the existing terminal and a connector between the terminal and Concourse A. This expansion includes a new security checkpoint and a relocated international arrivals facility. The PAL 2 improvements also include a west expansion to Concourse A that will provide sterile corridor access to the new international arrivals facility located in the terminal building. Landside projects in the PAL 2 program focus on a reconstruction of the I-275 interchange, entrance road improvements, and auto parking expansion.

TABLE 1.6-5 PAL 2 RECOMMENDED PROJECTS

#	PAL 2 Project List
Airfield	
1	Relocation of Taxiway E9 & Demo
2	Runway 36C High Speed Exit East and D8 Demo
3	Runway 36C High Speed Exit East and D6/D7 Demo
4	Relocation of Taxiway S8 & Demo
5	Relocation of Taxiway S6/S7 & Demo
6	Parallel Crossfield Taxilane
Terminal	
7	Terminal Expansion
8	Concourse A Improvements
9	Bag System Long-Term (project not shown)
Landside	
10	Reconstruct I-275 Interchange
11	Donaldson Road Ramp Improvements – Part 1
12	Terminal Drive Improvements – Part 1
13	Widen South Airfield Drive
14	Expand ValuPark Parking Lot – Part 2
15	KY 20/Petersburg Road Entrance Ramp Improvements
16	Aero Parkway Mineola Park Roadway Improvements
Support Facilities	
17	Deicing Pad
18	Expansion of General Aviation Hangar and Apron
19	Ground Run-up Pad

Source: Landrum & Brown Team analysis

EXHIBIT 1.6-2 PAL 2 PROGRAM



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

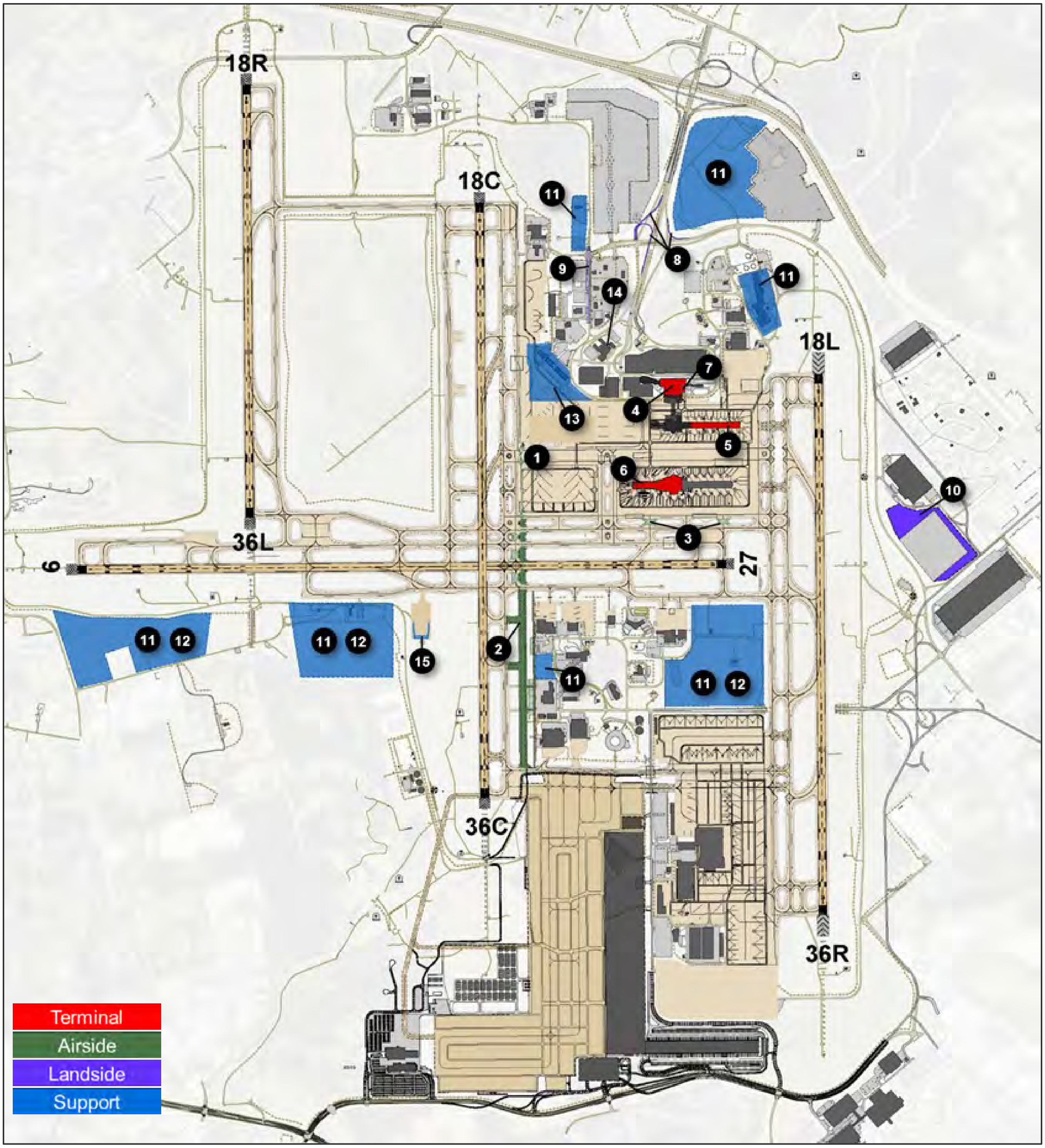
The third phase of the Master Plan recommends several projects to support the projected demand of 16 MAP. A complete list of the PAL 3 projects is shown on **Table 1.6-6, *PAL 3 Recommended Projects***, and their locations are depicted on **Exhibit 1.6-3, *PAL 3 Program***. Major PAL 3 projects include an extension of Taxiway E to the south; an interior reconfiguration of the west side of Concourse B and the east side of Concourse A, as well as a new western gate expansion to Concourse A; a renovation of the main terminal (ticketing areas, offices, and baggage claim level); Donaldson Road and Loomis Road improvements; and auto parking expansion.

TABLE 1.6-6 PAL 3 RECOMMENDED PROJECTS

#	PAL 3 Project List
	Airfield
1	Taxiway E Relocation (north) & Demo
2	Taxiway E Extension South
3	Taxiway J2 & J4 Demo
	Terminal
4	Terminal Improvements
5	Concourse A Improvements
6	Concourse B Improvements
7	KCAB Office Building (if desired)
	Landside
8	Donaldson Road Ramp Improvements – Part 2,3
9	Loomis Road/Donaldson Road Improvements – Part 2
10	Expansion of Replacement Employee Lot
	Support Facilities
11	Airline Support Facility
12	Airport Maintenance Building
13	Expansion of GA Hangar and Apron
14	Expansion of Airport Hotel on Existing Site
15	Ground Run-Up Enclosure

Source: Landrum & Brown Team analysis

EXHIBIT 1.6-3 PAL 3 PROGRAM



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

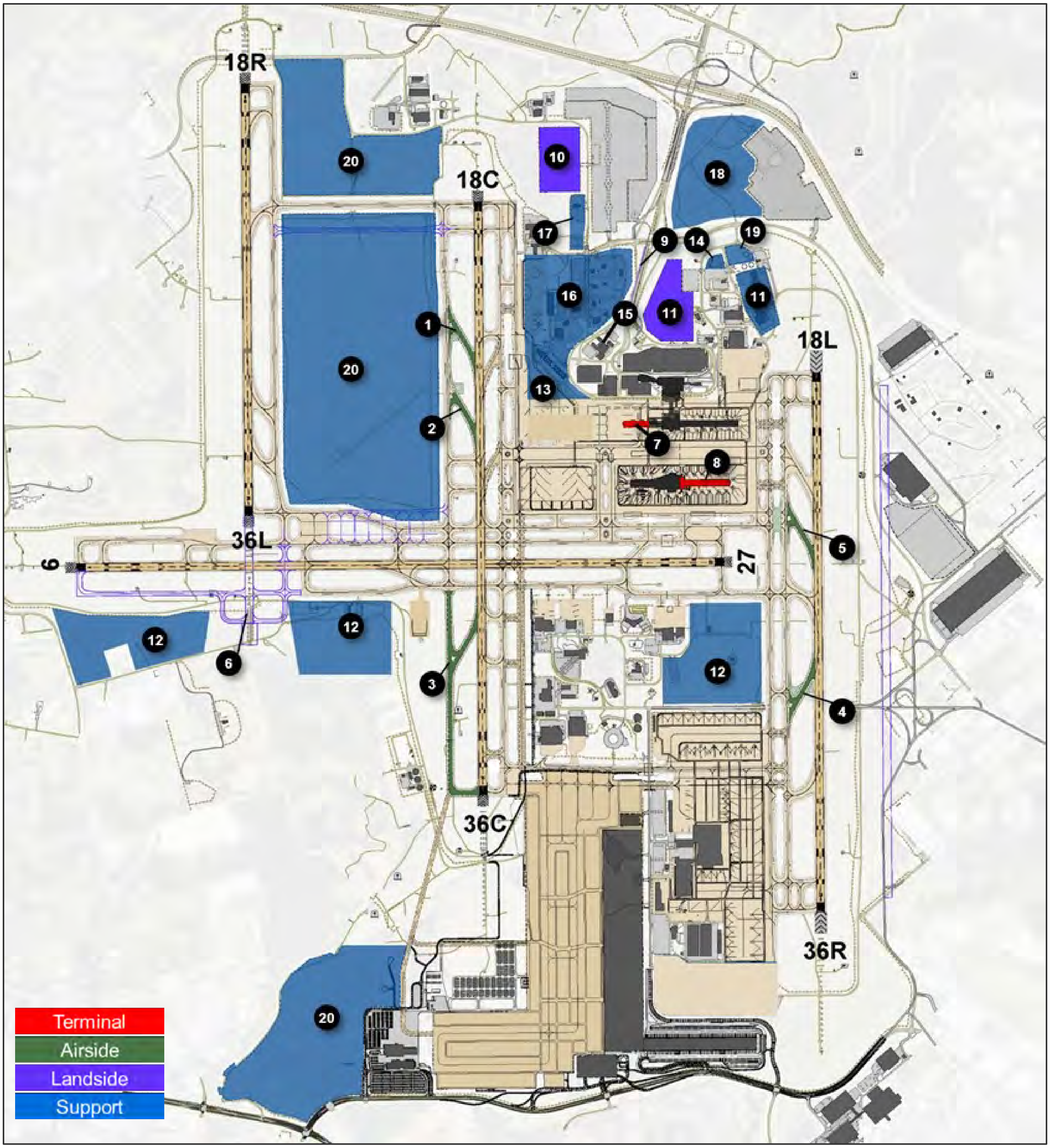
The final phase of the Master Plan includes several projects to support the projected demand beyond 16 MAP, anticipated to occur 20+ years in the future. A complete list of the projects recommended for PAL 4 implementation is shown on **Table 1.6-7, *PAL 4/Post 20-Year Recommended Projects.*** Their locations are depicted on **Exhibit 1.6-4, *PAL 4/Post 20-Year Program***. Major PAL 4 projects include runway exit improvements, an extension to Taxiway C, a 2,000-foot extension to Runway 18R/36L, interior renovations of the east side of Concourse B, additional expansion to the west end of Concourse A, Terminal Drive improvements, and two new auto parking lots.

TABLE 1.6-7 PAL 4 RECOMMENDED PROJECTS

#	PAL 4/ Post 20-Year Expansion Project List
	Airfield
1	Runway 36C High Speed Exit West & Demo
2	Runway 36C High Speed Exit West & Demo
3	Taxiway C Extension and High-Speed Exit
4	Runway 18L High Speed Exit
5	Runway 36R High Speed Exit
6	Runway 18R/36L Extension
	Terminal
7	Concourse A Expansion
8	Concourse B Improvements
	Landside
9	Terminal Drive Improvements – Part 2
10	Construction of New Parking Lot (West of ValuPark)
11	Construction of New Parking Lot (North of Terminal Garage)
	Support Facilities
12	Expansion of Airport Maintenance Building
13	Expansion of GA Hangar and Apron
14	Expansion of Government/Police Facility
15	Expansion of Airport Hotel on Existing Site
16	Land Reserved for Cargo Development
17	Land Reserved for Airline Support
18	Land Reserved for Commercial Development
19	Land Reserved for Fuel Farm
20	Land Reserved for Future Aviation Related Development

Source: Landrum & Brown Team analysis

EXHIBIT 1.6-4 PAL 4/POST-PLANNING PROGRAM



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

While the Master Plan has identified the proposed timing of projects, it is important to note that future airport improvement projects will be undertaken only when demand warrants and actual funding is available, which may differ from the phasing plan presented herein. Factors that can trigger the need to proceed with a particular airport development project can range from tenant demands for landside and support facilities, to airside and terminal capacity requirements that result from increased passenger demand. FAA planning criteria and the need to enhance safety on the airfield must also be considered.

KCAB has incorporated the relevant PAL 1 projects into its CIP to ensure coordination with other projects and funding priorities. Implementation of the PAL 1 and 2 projects will begin with advanced planning studies and pre-design activities. These projects will then go through the appropriate level of environmental review.

A preliminary review of environmental conditions surrounding CVG was included as part of the CVG Master Plan 2050 in order to identify potential environmental impacts associated with the recommended development projects that are expected to occur by 2037. This review found that the following National Environmental Policy Act (NEPA) categories may require additional investigation and coordination as a result of the recommended projects:

- Air quality
- Biological resources
- Climate
- U.S. Department of Transportation (USDOT) Section 4(f) resources (indirect impacts)
- Hazardous materials, pollution prevention, and solid waste
- Historical, architectural, archeological, and cultural resources
- Noise and noise-compatible land use
- Visual effects
- Wetlands
- Surface waters

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MASTER PLAN 2050

Chapter 2 | Inventory of Existing Conditions

CINCINNATI/NORTHERN KENTUCKY INTERNATIONAL AIRPORT

TEAM

2 Inventory of Existing Conditions

2.1 Introduction

The first step of any master planning process is to develop a complete understanding of what exists at an airport today. This chapter, the *Inventory of Existing Conditions*, provides a summary of major facilities at the Cincinnati/Northern Kentucky International Airport (CVG) as they existed at the end of calendar year 2017. This chapter will form the basis of all subsequent facility analyses throughout the CVG Master Plan. The information presented herein was developed through review of existing documentation, multiple site visits, and discussions/feedback with CVG personnel.

The inventory of existing conditions includes the following sections grouped by functional area:

- Existing Facilities Site Location / Land Use
- Airfield & Airspace
- Passenger Terminal Facilities
- Landside Access & Parking
- Air Cargo
- General Aviation (GA)
- Support Facilities
- Utilities
- Safety & Security

2.2 Existing Facilities Site Location / Land Use

This section presents the location, ID number, description, and area of all existing facilities at CVG as well as the general land uses on-airport. Primarily, an airport's role is to facilitate the arrival, departure, and movement of aircraft as well as the movement of passengers to and from their aircraft. Critical facilities for the movement of aircraft include, but are not limited to navigational aids (NAVAIDs), Approach Lighting Systems (ALS), Air Traffic Control Tower (ATCT), passenger terminal(s), access roads, etc. In the case of CVG, the on-airport property has been categorized into one of the following land uses.

- **Airfield**: The area inclusive of all runways, taxiways, movement areas, and their associated safety areas. The airfield land use designation does not include areas that have been designated as "non-movement" areas.
- **Terminal Area**: The area inclusive of the passenger terminal processor building and associated landside facilities (i.e. terminal loop roadway, parking garages, and curbfronts).
- **Apron**: The areas that are primarily designated as non-movement area that are used for aircraft parking positions, and taxilanes used for accessing aircraft parking positions.
- **Air Cargo**: The areas where air cargo processing buildings, taxilanes, and air cargo aprons are located. These areas may or may not be designated as non-movement areas.
- **General Aviation (GA)**: The areas where GA hangars, Fixed-base Operator (FBO) facilities, taxilanes, and aprons are located. These areas may or may not be designated as non-movement areas.
- **Aviation Support**: All areas where facilities that support the overall aviation mission of the airport, but are not directly servicing aircraft, are located, such as fuel farm, airline maintenance, airport maintenance, ATCT, and police/security.
- **Commercial Development**: All non-aviation related land used for commercial related development.
- **Future Aviation Related Development**: Undeveloped areas of CVG property that should be reserved for uses that are related to or in support of the aviation mission of CVG.
- **Future Air Cargo Development**: Undeveloped areas of CVG property that should be reserved specifically for the development of air cargo facilities.
- **Future Non-Aviation Related Development**: Undeveloped areas of CVG property that should be reserved for non-aviation uses.
- **Radar Critical Areas**: Areas that immediately surround the Airport Surveillance Radar (ASR) antennas that must be maintained clear of all obstructions or interfering objects.

The facilities that are located within these general areas will help to determine the overall types of activities that occur within the CVG land use areas. **Exhibit 2.2-1, *CVG Existing Facilities – North***, and **Exhibit 2.2-2, *CVG Existing Facilities - South***, identify the location of all facilities at CVG. **Table 2.2-1, *CVG Existing Facilities Inventory***, presents the respective data for each facility as it exists today. Furthermore, as like facilities typically are clustered together, the general areas of land use are able to be defined and are presented in **Exhibit 2.2-3, *Existing On-Airport Land Use***. In addition, existing off-airport land uses are presented in **Exhibit 2.2-4, *Existing Off-Airport Land Use***. The off-airport land use information was obtained from the Boone County Planning Commission.

EXHIBIT 2.2-1 CVG EXISTING FACILITIES - NORTH

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Sources: Kenton County Airport Board (KCAB); Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 2.2-2 CVG EXISTING FACILITIES - SOUTH

Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

TABLE 2.2-1 CVG EXISTING FACILITIES INVENTORY

ID	Description	Building Elevation (MSL ft.)
3	Sign Shop Building	907.6'
4	KCAB Cargo Building	889.0'
9	ARFF Station North	914.3'
10	Main Terminal	945.7'
11	Concourse A	970.4'
12	Concourse B	1,020.1'
14	Parking Garage One	903.6'
15	Parking Garage Two	921.7'
16	Terminal Parking Garage Toll Plaza	N/A
16A	Terminal Parking Garage Offices	N/A
17	Parking Garage Three	948.7'
18	Double Tree Hotel	894.8'
19	Electrical Vault (North) Switchgear	869.1'
20	Airport Police Department	900.8'
21	Electrical Vault East High Voltage Distribution Building	884.6'
22	Delta Maintenance Hangar	984.7'
22A	Delta Maintenance Hangar Pump Station	928.0'
23	Aircraft Deicing Control Building	895.1'
24	Gate Gourmet Building	895.4'
25	Delta Warehouse/Cargo	918.2'
26	KCAB Triturator/Wash Area	900.8'
27	Delta Air Cargo Building	915.5'
28	KCAB GT Bus Maintenance Building	892.4'
29	ASI Support Building	900.2'
30	ASI Fuel Dock	896.4'
31	Delta Fuel Storage Tanks - Fuel Farm	909.7'
32	Terminal Water Pumping House	878.3'
33	Long Term Parking Toll Plaza	N/A
34	Budget Car Rental	868.0'
35	Sewage Lift Station (North)	N/A

ID	Description	Building Elevation (MSL ft.)
36	Alamo / National Car Rental	859.9'
37	Avis Car Rental	859.8'
38	Hertz Car Rental	858.6'
39	Loomis Road Electrical Vault (West) Switchgear	862.0'
41	Old Post Office	887.2'
42	Pannco Air Freight	877.3'
43	Emery Air Freight	861.7'
46	Indian Burial Ground	N/A
47	Northwest Stormwater Detention Pond West & Dam	N/A
48	Northwest Stormwater Detention Pond East & Dam	N/A
51	Employee Parking Lot Toll Plaza	N/A
52	General Electric Facility	958.8'
53	ASR-8 Antenna	914.5'
54	RTR Antenna	884.0'
55	ARFF Station South	895.3'
56	ATCT and TRACON Facility	907.7'
58	Delta Private Jets MRO Corp. Hangar	903.2'
60	Delta Private Jets - Endeavor Tech Ops	922.6'
61	CVG Centre	943.7'
62	Electrical Vault (12) (South)	870.3'
63	RTT Antenna	888.9'
64	Sewage Lift Station (South)	842.7'
65	Glycol Processing / Recycling Facility	N/A
66	Airfield Maintenance Building #3	880.3'
67	Facility Maintenance Building	870.3'
68	Stormwater Treatment Compound	861.2'
69	ARFF Training Facility Burn Pit / ARFF Trainer Plane	N/A
70	Police Gun Range Canopy	N/A
71	ASR-9 Antenna	988.3'
72	Cincinnati Bell Telephone Building (North)	876.0'
73	Glycol Storage Tanks (2 - UST)	N/A

ID	Description	Building Elevation (MSL ft.)
74	Dollar / Thrifty Car Rental	862.1'
75	Airfield Maintenance Building #2 - Sand Storage	878.8'
76	Airfield Maintenance Building #1 - Storage Building	872.7'
78	Police Storage Explosive Bunker	879.6'
79	Hangar - American Airlines	898.0'
80	Cincinnati Bell Telephone Building (South)	853.8'
81	Flight Safety Building	886.6'
82	FBO Aircraft Hangar - Delta Air Elite Jet Center	911.5'
82A	General Aviation Facility (GAF) Building	911.5'
83	Corporate Hangar - Meyer Tool	917.6'
84	Ameriflight Building	894.8'
85A	3 Mil South Glycol Holding Tank 1 - South	864.2'
85B	3 Mil South Glycol Holding Tank 2 - North	864.2'
86	KCAB Outdoor Events Building	899.2'
87	Gate NE-23 Ramp Building	887.6'
88	U.S. Postal Service	895.4'
89	Gun Range Storage Building	879.1'
91A	Firearms Training Building	882.5'
92	DHL Main Sort Facility - Building 2	954.2'
93	DHL Truck / Administration Building - Building 1	960.6'
95	DHL GSE / Line Maintenance - Building 3	949.5'
98	Electrical Vault (West)	894.7'
99	Airfield Viewing Area	N/A
100	Southwest Stormwater Detention Facility	N/A
101	Mulch Building	867.7'
102	Central Receiving	865.9'
103	Airfield Maintenance Building #4 Fleet Maintenance	876.1'
104	Airfield Maintenance Building #5 Storage Building	870.6'
105	Salt Storage	863.4'
106	Airport Beacon (Roof of Doubletree Hotel)	951.2'
107	Employee Parking Lot	N/A

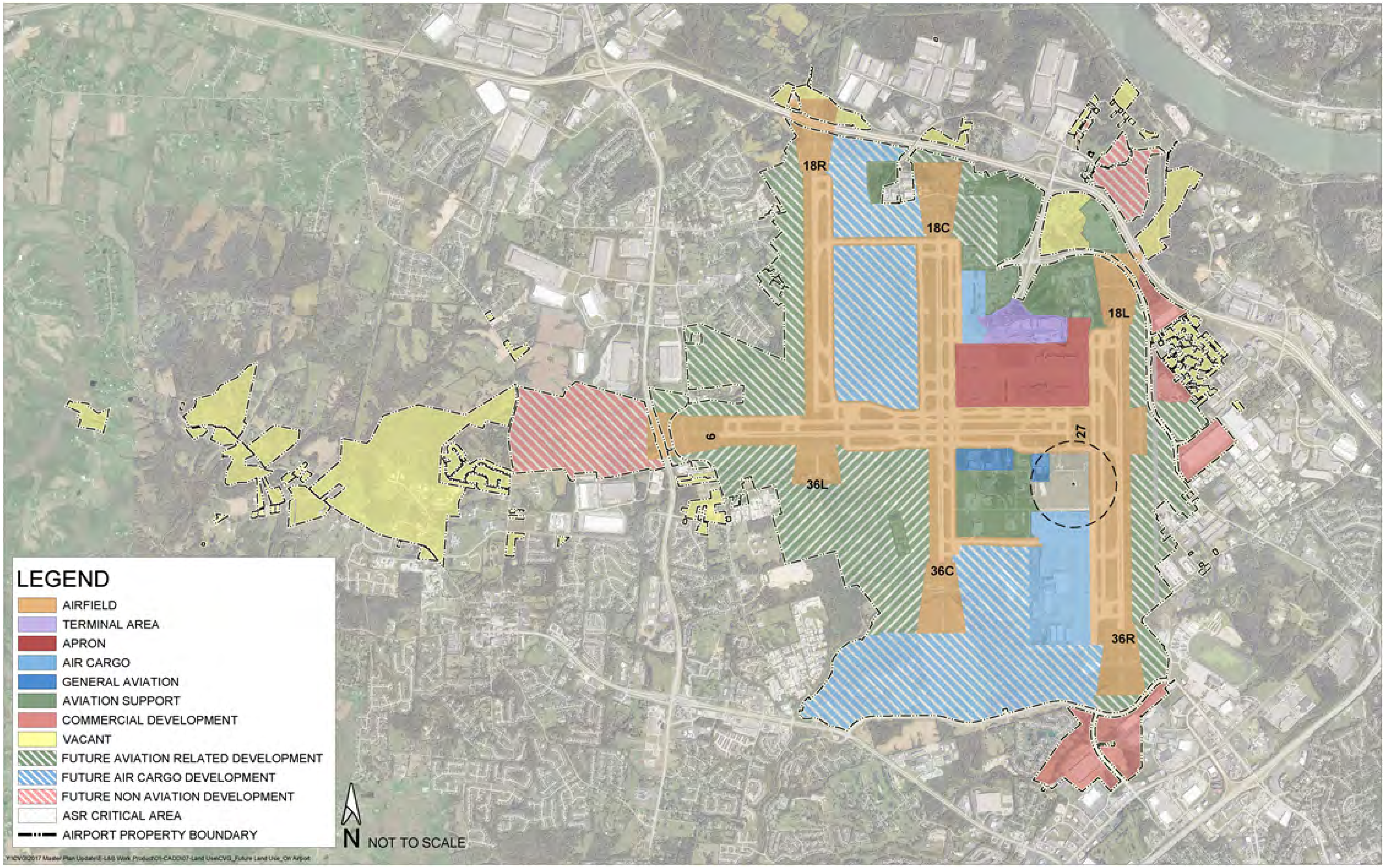
ID	Description	Building Elevation (MSL ft.)
108	Long Term Parking Lot (ValuPark)	N/A
109	MALSR	N/A
110	ALSF2	N/A
111	PAPI	N/A
112	VASI	N/A
113	RVR	N/A
114	Localizer / DME	N/A
115	Glide Slope	N/A
116	Wind Cone	N/A
117	Middle Marker	N/A
118	Inner Marker	N/A
119	LOC / DME Equipment Building	876.0'
120	DHL Facility Fuel Island	904.1'
121	DHL Facility Fuel Farm Glycol Island	N/A
122	ASOS	N/A
123	DHL Facility Generator Building 4 & Pump House	915.0'
124	ARFF Training Center	872.8'
125	Holscher Park Pavilion	N/A
126	DHL Facility Non-Conveyable Freight Sort Building 5	939.5'
127	DHL Facility Pilot Support Building 6	912.5'
128	Delta Fuel Building	
129	Delta Fuel Island	
130	Contractor Staging and Storage	N/A
131	Zinn Cemetery	N/A
132	Weaver Cemetery	N/A
133	Limaburg Cemetery	N/A
134	Baker-Rouse Cemetery	N/A
135	Cristy, Simon, Brown Cemetery	N/A
136	Ann Popham Cemetery – Removed 2019	N/A
137	ALSF Equipment Building	882.8'
138	Popham 2 Cemetery – Removed 2019	N/A

ID	Description	Building Elevation (MSL ft.)
139	Barlow-Airport Cemetery – Removed 2019	N/A
140	Glycol Test Point	N/A
141	McNeal Cemetery	N/A
142	Masters Cemetery	N/A
143	Masters 2 Cemetery	N/A
144	Bosch Automotive Building	943.2'
145	Bosch Automotive Building	936.2'
146	Joseph Brown Cemetery	N/A
147	Old Pad 7 Pump Pit Building	
148	Terminal Parking Garage Toll Plaza	
153	Peeno's Barn - Field Maintenance Storage	
154	Victory Place Pump Station	N/A
155	Limo Lot / Courtesy Vehicles	N/A
156	Feam Hangar	
157	Fuel Farm - Delta Jet Center (FBO)	
158	Fuel Farm - Field Maintenance Facility	
162	Site 3A - WAYFAIR	954.50'
165	Site 3C - AMAZON	948.08'
166	Taxi Bullpen	N/A
167	West Security Gate NE-3	N/A
168	East Security Gate NE-23	N/A
169	Triturator – Removed 2019	
170	South Airfield Road Tunnel	N/A
171	Ky 20 Road Tunnel	N/A
172	TW 'A' Tunnel	N/A
173	TW 'N' Tunnel	N/A
174	DHL ULD Shed West #7	946.5'
175	DHL ULD Shed East #8	947.5'
176	DHL GSE Building South #9	909.2'
177	DHL GSE Building North #10	905.8'
178	DHL North Apron Utility Building #11	898.7'

ID	Description	Building Elevation (MSL ft.)
189	Southeast Security Gate SE-20	N/A
190	Field Maintenance Security Gate SE-26	N/A
191	East Security Gate NE-20	N/A
192	DHL Truck Transfer Building 12	
193	Escort Guard Shack (Northwest Gate)	

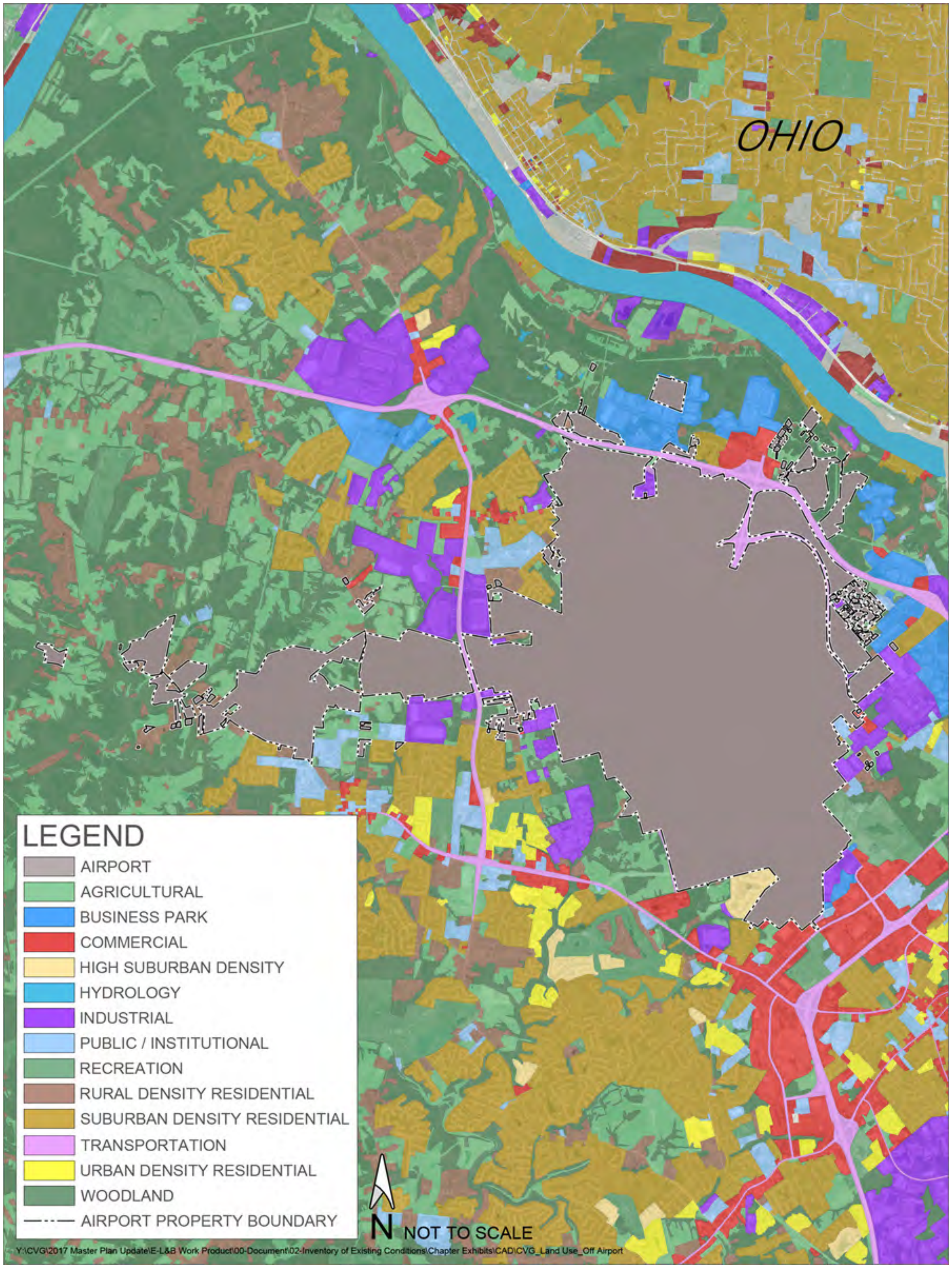
Note: Not all ID numbers are used.
Source: KCAB

EXHIBIT 2.2-3 EXISTING ON-AIRPORT LAND USE



Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 2.2-4 EXISTING OFF-AIRPORT LAND USE



Sources: Boone County Planning Commission 2016; Hamilton County CAGIS 2016; Woolpert Photography dated September 23, 2017

2.3 Airfield & Airspace

This section provides an overview of the CVG airfield, airspace, and NAVAIDS and will serve as the baseline conditions. The airfield is the largest of all facilities on an airport and requires the largest amount of property as it provides for the safe and efficient movement of aircraft into, out of, and around an airport. Therefore, it is often critical to understand both the existing and future needs of the airfield to determine what remains of the airport property to develop and use for other functions. This section will discuss each of the following airfield & airspace facilities:

- Existing Airport Reference Point and Elevation
- Existing Airport Reference Code (ARC)
- Runways
- Meteorological Conditions
- Taxiways
- Hot Spots
- Aprons Areas
- Aircraft Deicing
- Airspace
- ATCT
- Navigational and Visual Aids
- Instrument Approaches

2.3.1 Existing Airport Reference Point and Elevation

The Airport Reference Point (ARP) as defined by the Federal Aviation Administration (FAA) is the approximate geometric center of all usable runways at an airport. In the case of CVG with four runways, the ARP is located at N39° 02' 55.8120" latitude and W084° 40' 04.1600" longitude. **Exhibit 2.3-1, *Airport Reference Point Location***, identifies the location of the ARP on the airfield at CVG. The airport elevation is the surveyed highest point on an airport's usable runways expressed in feet above Mean Sea Level (MSL). The elevation of CVG is 896.2 feet MSL.

2.3.2 Existing Airport Reference Code

The ARC is an airport designation that is used to help categorize an airport's existing airfield capability as determined by a set of design standards prescribed by the FAA. The ARC consists of two components; the first is a letter (A through E) that indicates the Aircraft Approach Category (AAC), the second is a roman numeral that indicates the Airplane Design Group (ADG). **Table 2.3-1, *Airport Reference Codes***, presents the various levels of the ARC as defined in FAA Advisory Circular (AC) 150/5300-13A, *Airport Design*.

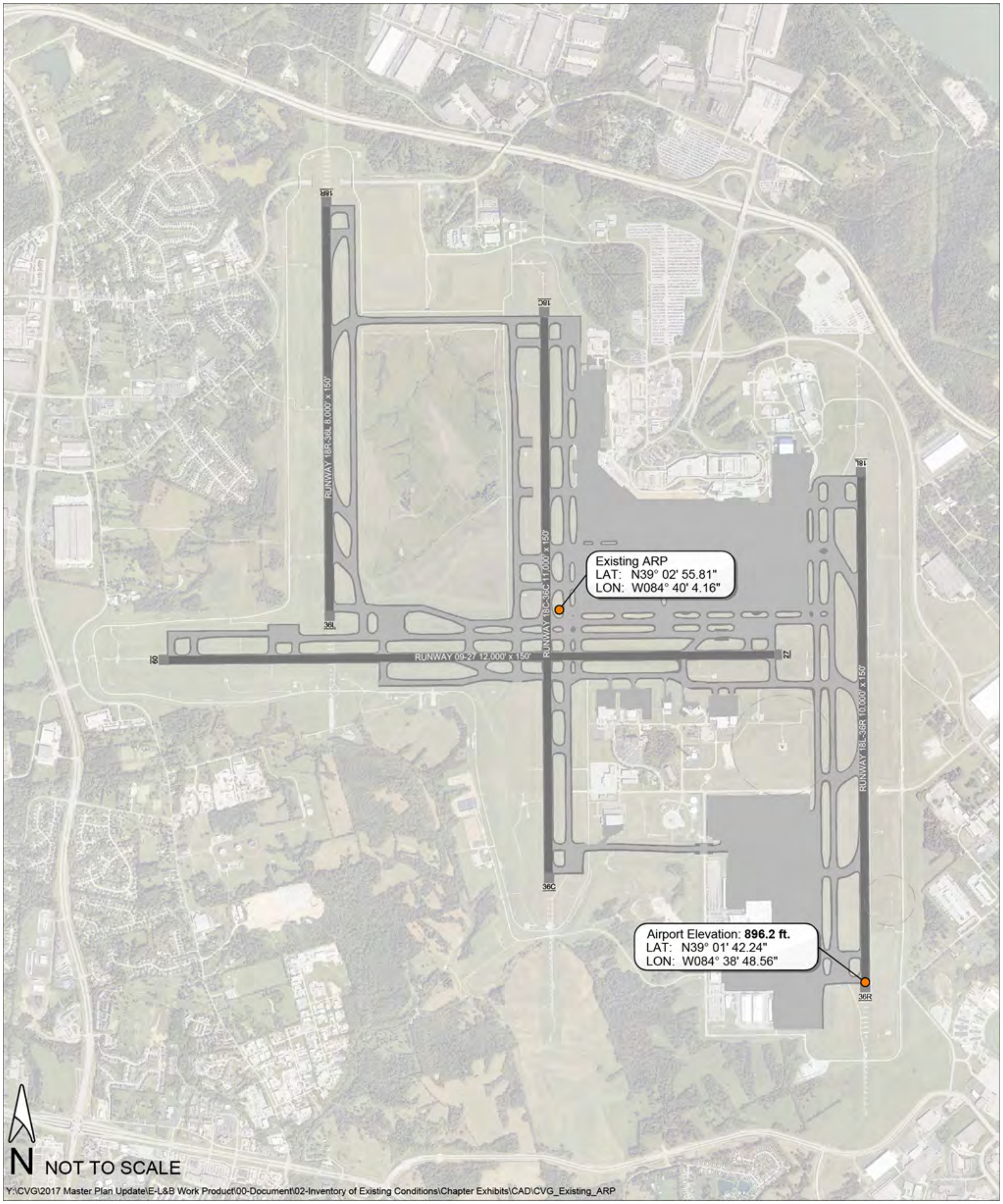
TABLE 2.3-1 AIRPORT REFERENCE CODES

Aircraft Approach Category		Airplane Design Group		
AAC	Approach Speed (knots)	ADG	Tail Height (ft)	Wingspan (ft)
A	< 91	I	< 20	< 49
B	91 to < 121	II	20 to < 30	49 to < 79
C	121 to < 141	III	30 to < 45	79 to < 118
D	141 to < 166	IV	45 to < 60	118 to < 171
E	166 or more	V	60 to < 66	171 to < 214
		VI	66 to < 80	214 to < 262

Source: FAA AC 150/5300-13A, *Airport Design*, September 28, 2012, Chg. 1

The existing ARC at CVG is D-V. The vast majority of airfield facilities at CVG meet the standards prescribed by the FAA to accommodate D-V aircraft. Examples of D-V aircraft include the Boeing 747-400 and the Airbus A340 600.

EXHIBIT 2.3-1 AIRPORT REFERENCE POINT LOCATION



Sources: FAA; KCAB; Woolpert Photography dated September 23, 2017

2.3.3 Runways

The geometry and configuration of runways at an airport are primarily driven by five factors:

- The aircraft that use them
- Environmental factors such as prevailing winds
- Airport elevation
- Temperatures
- The size, shape and terrain of the land envelope available

The existing airfield at CVG consists of four runways – three north-south parallel runways and one east-west runway. Usage of the runways varies by time of day, type of operation (landing and takeoff), as well as weather conditions at the time the operation takes place. **Table 2.3-2, *Runway Usage***, presents a summary of runway usage data.

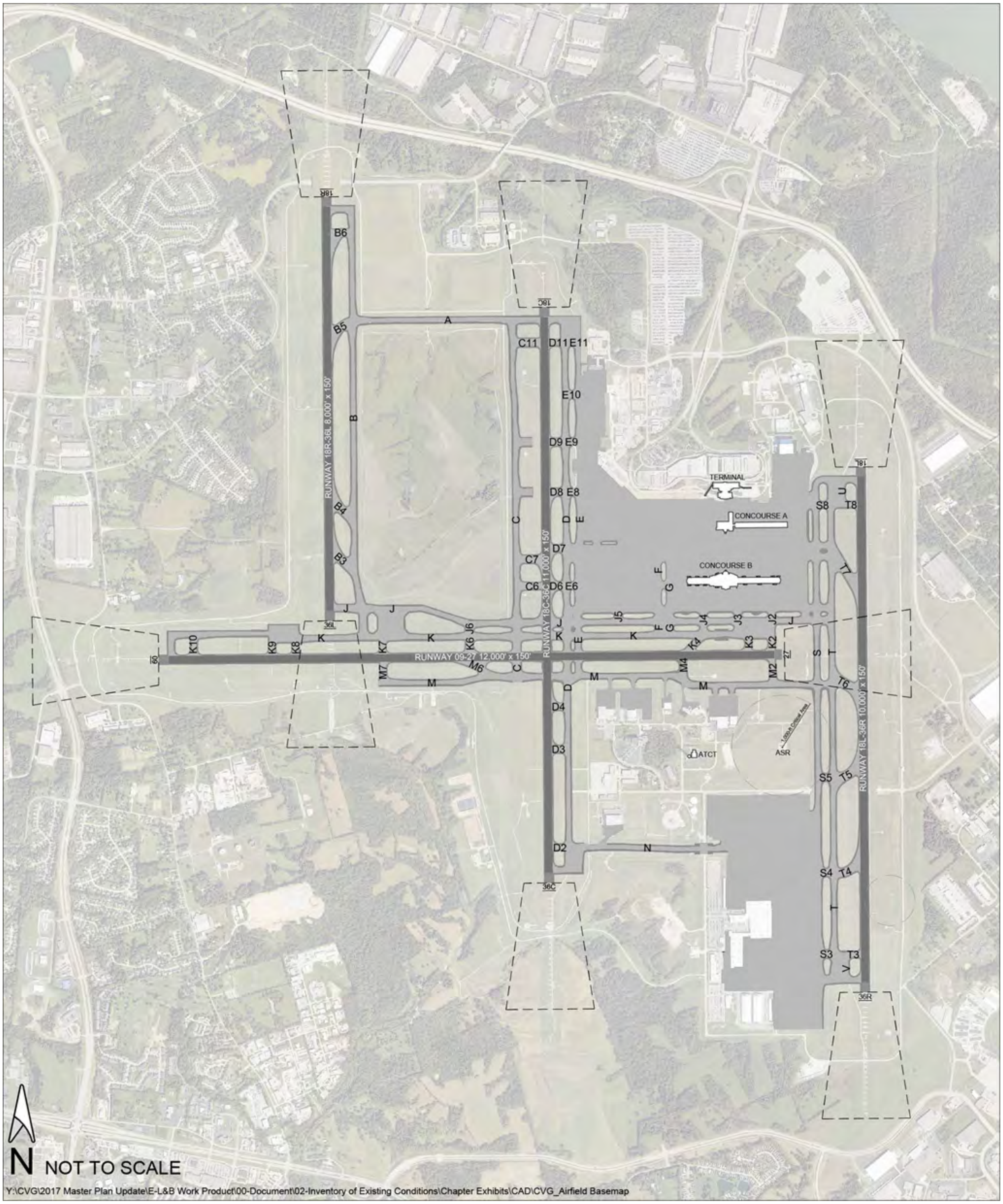
TABLE 2.3-2 RUNWAY USAGE

Runway	Total Arrivals	Total Departures	Total Operations
Runway 09	13.2%	0.0%	6.6%
Runway 27	10.4%	64.0%	37.2%
Runway 18L	31.6%	19.4%	25.5%
Runway 18C	21.3%	3.0%	12.1%
Runway 18R	0.5%	0.1%	0.3%
Runway 36L	0.1%	0.1%	0.1%
Runway 36C	8.2%	2.8%	5.5%
Runway 36R	14.8%	10.5%	12.7%
Total	**100.0%**	**100.0%**	**100.0%**

Source: CVG Airport Operations Management (AOM) System - June 1, 2016 to May 31, 2017

Table 2.3-3, *Runway Data*, presents detailed technical information about each runway as of the end of year 2017. **Exhibit 2.3-2, *CVG Airfield Configuration***, presents the existing configuration (runway and taxiways) of the airfield at CVG in graphical form. Runways are identified by their numbers (i.e. 18L) which refers to the corresponding runway end. Taxiways are identified with a letter designation and pronounced using the phonic alphabet (i.e. Taxiway “A” is pronounced “Alpha”).

EXHIBIT 2.3-2 CVG AIRFIELD CONFIGURATION



Sources: FAA CVG Airport Diagram October 12, 2017; KCAB; Woolpert Photography dated September 23, 2017

TABLE 2.3-3 RUNWAY DATA

Runway		9	27	18L	36R	18C	36C	18R	36L
Runway Length		12,000’		10,000’		11,000’		8,000’	
Runway Width		150’		150’		150’		150’	
Pavement Type		Asphalt/Concrete - Grooved		Concrete – Grooved		Asphalt/Concrete – Grooved		Concrete - Grooved	
Runway End Elevation (MSL)		883’	875’	886’	896’	875’	841’	865’	873’
FAR Part 77 Approach Category		Precision	Precision	Precision	Precision	Precision	Precision	Precision	Precision
Pavement Design Strength (lbs)	SW	120,000		120,000		120,000		120,000	
	DW	250,000		250,000		250,000		250,000	
	DT	550,000		550,000		550,000		550,000	
	DDT	835,000		835,000		835,000		835,000	
Effective Runway Gradient		-0.3%	+0.3%	0.0%	0.0%				
Runway Lighting		HIRL		HIRL		HIRL		HIRL	
Centerline Lights		Yes		Yes		Yes		Yes	
Touchdown Zone Lighting		Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Runway Markings		Precision	Precision	Precision	Precision	Precision	Precision	Precision	Precision
Approach Lighting		MALSR	MALSR	MALSR	ALSF2	MALSR	ALSF2	ALSF2	ALSF2
Visual Approach Aids		P4L	P4L	P4L	P4R	P4R	P4L	-	-
Instrument Approach Aids		LOC, GS, GPS, RNAV, DME	LOC, GS, GPS, RNAV, DME	LOC, GS, GPS, RNAV, DME, RVR	LOC, GS, GPS, RNAV, DME, IM	LOC, GS, GPS, RNAV, DME, RVR	LOC, GS, GPS, RNAV, DME, RVR, IM, MM	LOC, GS, GPS, RNAV, DME, RVR, IM	LOC, GS, GPS, RNAV, DME, RVR, IM
Instrument Approach Procedures		ILS (CAT I) RNAV (RNP) RNAV (GPS)	ILS (CAT I) RNAV (RNP) RNAV (GPS)	ILS (CAT I) RNAV (RNP) RNAV (GPS)	ILS (CAT I, II, III) RNAV (RNP) RNAV (GPS)	ILS (CAT I) RNAV (RNP) RNAV (GPS)	ILS (CAT I, II, III) RNAV (RNP) RNAV (GPS)	ILS (CAT I, II) RNAV (RNP) RNAV (GPS)	ILS (CAT I, II) RNAV (RNP) RNAV (GPS)
Approach Visibility Minimums		<1/2 mile (RVR 1,800’)	<1/2 mile (RVR 2,400’)	<1/2 mile (RVR 1,800’)	<1/2 mile (RVR 0’)	<1/2 mile (RVR 1,800’)	<1/2 mile (RVR 0’)	<1/2 mile (RVR 1,200’)	<1/2 mile (RVR 1,200’)
Part 77 Approach Surface Slope		50:1	50:1	50:1	50:1	50:1	50:1	50:1	50:1
Approach Reference Code (APRC)		D-V	D-V	D-V	D-V	D-V	D-V	D-V	D-V
Departure Reference Code (DPRC)		D-V	D-V	D-V	D-V	D-V	D-V	D-V	D-V
Critical Design Aircraft		Boeing 747-400		Boeing 747-400		Boeing 747-400		Boeing 747-400	
Runway Safety Area Width		500’	500’	500’	500’	500’	500’	500’	500’
Runway Safety Area Length Beyond End		1,000’	1,000’	1,000’	1,000’	1,000’	1,000’	1,000’	1,000’
Runway Object Free Area Width		800’	800’	800’	800’	800’	800’	800’	800’
Runway Object Free Area Length Beyond End		1,000’	1,000’	1,000’	1,000’	1,000’	1,000’	1,000’	1,000’
Takeoff Run Available (TORA)		12,000’	12,000’	10,000’	10,000’	11,000’	11,000’	8,000’	8,000’
Takeoff Distance Available (TODA)		12,000’	12,000’	10,000’	10,000’	11,000’	11,000’	8,000’	8,000’
Accelerate-Stop Distance Available (ASDA)		11,640’	12,000’	10,000’	10,000’	11,000’	11,000’	8,000’	8,000’
Landing Distance Available (LDA)		11,640’	12,000	10,000’	10,000’	11,000’	11,000’	8,000’	8,000’

Sources: FAA CVG Instrument Approach Procedures - October 5, 2017; www.aeronav.faa.gov; FAA Form 5010

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2.3.3.1 *Runway 09/27*

Runway 09/27 is one of the original two runways at CVG and is today the longest of all four at 12,000 feet. This runway serves as the primary crosswind runway as well as the primary runway for use during nighttime departure and noise abatement operations. The 12,000-foot length of Runway 09/27 makes it the preferred departure runway for long-haul aircraft departures. Runway 09/27 is constructed of both asphalt and concrete pavement and is grooved. The concrete portions of the runway include approximately the first 4,200 feet from the Runway 09 threshold (west end) as well as the first 725 feet from the Runway 27 threshold (east end).

2.3.3.2 *Runway 18C/36C*

Runway 18C/36C is the second of the two original runways at CVG and is the second longest at CVG at 11,000 feet. This runway is constructed of both asphalt and concrete pavement and is grooved. The concrete portions of the runway include approximately the first 3,900 feet from the Runway 18C threshold (north end) as well as the first 900 feet from the Runway 36C threshold (south end).

2.3.3.3 *Runway 18L/36R*

Runway 18L/36R was constructed in 1991 and is currently the easternmost north/south parallel runway at CVG. This runway is 10,000 feet long and is constructed completely of grooved concrete.

2.3.3.4 *Runway 18R/36L*

Runway 18R/36L is the newest of all runways at CVG, having been constructed in 2005, and is currently the westernmost north/south parallel runway at CVG. This runway is 8,000 feet long and is constructed completely of grooved concrete.

2.3.4 Meteorological Conditions

Meteorological conditions at an airport are an integral part of the airfield operational strategy. Wind and weather can sometimes dictate the operating configuration of the airfield as well as play a significant part in determining the amount of traffic that can be safely and efficiently handled. The direction and velocity of prevailing winds can be significant factors in the orientation of runways that accommodate aircraft activity and can influence airfield operational performance. Cloud ceiling height and horizontal visibility determine the type of flight rules that are used, and precipitation (rain, snow or ice) can increase runway occupancy times, all of which affect the runway and overall airfield capacity.

A wind and weather analysis was conducted to identify the meteorological conditions and to determine how often wind and weather conditions favor the use of each of the runway directions at CVG. The analysis was conducted using the Landrum & Brown WIND36 wind analysis computer program and the application of 11 consecutive years of weather data obtained from the National Climatic Data Center (NCDC) for the period of January 1, 2006 to December 31, 2016.

2.3.4.1 *Meteorological Condition Categories*

Weather conditions such as low cloud ceiling and poor visibility can impact the capacity of an airport by closing the airport for operations, restricting the use of certain runways, or by increasing the aircraft separation requirement during landing and takeoff operations, thus reducing the number of operations that can occur in a given time period. Weather conditions are typically divided into three categories: all weather, visual meteorological conditions (VMC), and instrument meteorological conditions (IMC). All weather refers to any and all weather conditions regardless of cloud ceiling height or surface horizontal visibility. By definition, all weather has a 100 percent occurrence and includes both VMC and IMC. Visual Flight Rules (VFR) apply when VMC exists and similarly, Instrument Flight Rules (IFR) apply when IMC exists. The distinction between IFR and VFR is important because the separation distance required between aircraft arriving and departing during IMC conditions is greater than that required during VMC conditions. Consequently, given the same runway configuration, fewer aircraft operations can typically be accommodated during IMC conditions than during VMC conditions. In addition, specific navigational and visual aid equipment is required during each of these operating conditions in order to conduce landing and takeoff operations.

Typically, IMC is further divided into subsets, CAT I, CAT II, and CAT III. The occurrence of these meteorological conditions was calculated as described in **Table 2.3-4, *Definition of Meteorological Conditions***.

TABLE 2.3-4 DEFINITION OF METEOROLOGICAL CONDITIONS

Weather Category	Cloud Ceiling Base (feet AGL)				Horizontal Surface Visibility		
All Weather	No restrictions				No restrictions		
VMC	≥ 1,000			and	≥ 3 miles		
IMC[1]	≥ 0	and	< 1,000	or	≥ 0 miles	and	< 3 miles
CAT I	≥ 200	and	< 1,000	or	1/2 to <3 miles (at least 2,400 feet RVR or 1,800 feet RVR with touchdown zone and centerline lighting)[2]		
CAT II	≥ 100	and	< 200	or	At least 1,200 feet RVR but no more than 2,400 feet RVR		
CAT III	≥ 0	and	< 100	or	Less than 1,200 feet RVR		

[1] CAT I, CAT II, CAT III represent divisions of IMC.
[2] All runway ends at CVG have touchdown zone lighting except Runway end 27
Note: AGL – Above Ground Level; RVR – Runway Visual Range
Sources: FAA, *Instrument Procedures Handbook* (FAA-H-8083-16B), September 14, 2017; Landrum & Brown analysis

2.3.4.2 *Historical Occurrence of Meteorological Conditions*

A summary of the historical occurrence for each meteorological condition at CVG is presented in **Table 2.3-5, *Percent Occurrence of Meteorological Conditions***.

TABLE 2.3-5 PERCENT OCCURRENCE OF METEOROLOGICAL CONDITIONS

Conditions	Occurrence
VMC	92.82%
IMC	7.18%
IMC CAT I	6.64%
IMC CAT II[1]	0.32%
IMC CAT III	0.21%

[1] CAT II defined as 1,800-foot RVR and 200-foot Decision Height.
Note: Percent occurrence does not add to 100 percent due to rounding
Sources: National Climatic Data Center (NCDC), station WBAN 93814, data recorded at CVG for the period 01/01/2006-12/31/2016; Landrum & Brown analysis

2.3.4.3 *Wind Coverage by Runway End*

Wind coverage refers to the percent of time crosswind and tailwind components are below an acceptable velocity. In accordance with FAA AC 150/5300 13A, *Airport Design*, the crosswind should not exceed specified the velocities by ARC presented in **Table 2.3-6, *Allowable Crosswind Components*.**

TABLE 2.3-6 ALLOWABLE CROSSWIND COMPONENTS

ARC	Allowable Crosswind Component
A-I and B-I	10.5 knots
A-II and B-II	13.0 knots
A-III and B-III C-I through D-III D-I through D-III	16.0 knots
A-IV and B-IV C-IV through C-VI D-IV through D-VI	20.0 knots
E-I through E-VI	20.0 knots

Source: FAA AC 150/5300-13A, *Airport Design*, September 28, 2012, Chg. 1

Additionally, the analysis allowed for a maximum tailwind component of three knots on each runway end.[1] The results of the analysis indicate the percent of time wind conditions would be favorable for arrival and departure operations in each runway direction, given the established crosswind and tailwind restrictions. To determine the percent wind coverage for individual runway headings and all runways combined at CVG, each crosswind limit component (10.5, 13, 16, and 20 knots) was used for each runway direction for a total of four crosswind conditions.

CVG typically operates in one of six runway configurations depending upon wind, weather and operational conditions. **Table 2.3-7, *Percent Wind Coverage by Traffic Flow (All Weather Conditions) at CVG***, shows the percentage of time each runway configuration is available for each crosswind limit component, based on the analysis. In addition, the column labeled "Total Runway Coverage" shows the total percent coverage provided by the two runway directions at CVG. Total runway coverage is defined as when at least one runway direction (but not necessarily both) is available. Both runway directions combined provide a higher percent coverage than each runway individually.

TABLE 2.3-7 PERCENT WIND COVERAGE BY TRAFFIC FLOW (ALL WEATHER CONDITIONS) AT CVG

Traffic Flows (Runways)	Crosswind (knots)			
	10.5	13.0	16.0	20.0
South and West (18 & 27)	55.97%	59.85%	61.92%	62.59%
North and West (27 & 36)	44.99%	48.42%	50.57%	51.36%
South (18)	71.10%	73.52%	74.64%	73.05%
North (36)	59.85%	62.89%	64.70%	65.35%
West (27)	75.88%	79.37%	80.99%	81.49%
East (9)	61.80%	64.36%	65.49%	65.82%
Total Runway Coverage	**99.49%**	**99.91%**	**99.98%**	**99.99%**

Sources: National Climatic Data Center (NCDC), station WBAN 93814, data recorded at CVG for the period 01/01/2006-12/31/2016; Landrum & Brown analysis

Further analysis indicates the percent of time wind conditions would be favorable for arrival and departure operations for each runway direction and for each weather category, given the established crosswind and tailwind restrictions. The results of this analysis are summarized in **Table 2.3-8, *Percent Wind Coverage by Runway End at CVG***. The wind and weather analysis results did not take into consideration the actual capability of each runway end to accommodate aircraft operations during these specific conditions. Actual runway end usage is dependent on the runway instrumentation, aircraft fleet mix, flight destination, and in some cases the use of surrounding airspace.

[1] FAA Order 8400.9

TABLE 2.3-8 PERCENT WIND COVERAGE BY RUNWAY END AT CVG

Weather Categories	Runway 18				Runway 36				Runway 09				Runway 27				Total Combined (At Least One Runway Available)			
	10.5 kts	13.0 kts	16.0 kts	20.0 kts	10.5 kts	13.0 kts	16.0 kts	20.0 kts	10.5 kts	13.0 kts	16.0 kts	20.0 kts	10.5 kts	13.0 kts	16.0 kts	20.0 kts	10.5 kts	13.0 kts	16.0 kts	20.0 kts
All Weather	71.10%	73.52%	74.64%	75.05%	59.85%	62.89%	64.70%	65.35%	61.80%	64.36%	65.49%	65.82%	75.88%	79.37%	81.03%	81.49%	99.49%	99.91%	99.98%	99.99%
VMC	71.82%	74.23%	75.32%	75.73%	59.51%	62.47%	64.25%	64.88%	61.97%	64.44%	65.52%	65.82%	76.61%	80.03%	81.66%	82.11%	99.50%	99.91%	99.98%	99.99%
IMC	61.78%	64.41%	65.79%	66.24%	64.34%	68.25%	70.58%	71.43%	59.55%	63.40%	65.09%	65.84%	66.37%	70.81%	72.89%	73.40%	99.39%	99.90%	99.97%	100.00%
CAT I	60.70%	63.49%	64.98%	65.46%	63.18%	67.33%	69.75%	70.64%	58.14%	62.23%	64.04%	64.82%	65.76%	70.47%	72.69%	73.24%	99.38%	99.91%	99.97%	100.00%
CAT II1	70.61%	71.57%	71.88%	71.88%	77.96%	79.55%	81.47%	82.11%	75.72%	76.04%	76.36%	77.00%	69.97%	70.61%	71.25%	71.25%	99.36%	99.68%	100.00%	100.00%
CAT III	82.27%	82.27%	82.27%	82.27%	79.80%	79.80%	79.80%	79.80%	79.31%	80.79%	80.79%	80.79%	80.30%	81.77%	81.77%	81.77%	100.00%	100.00%	100.00%	100.00%

Sources: National Climatic Data Center (NCDC), station WBAN 93814, data recorded at CVG for the period 01/01/2006-12/31/2016; Landrum & Brown analysis

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2.3.4.4 *Windrose*

A windrose provides a graphical presentation of the average wind direction and velocity observed at an airport over a period of time compared to the existing runway headings. Three windrose diagrams were created for CVG per FAA AC 150/5300-13A, *Airport Design*, Appendix 1, *Wind Analysis*:

- VMC conditions
- IMC conditions
- All weather conditions

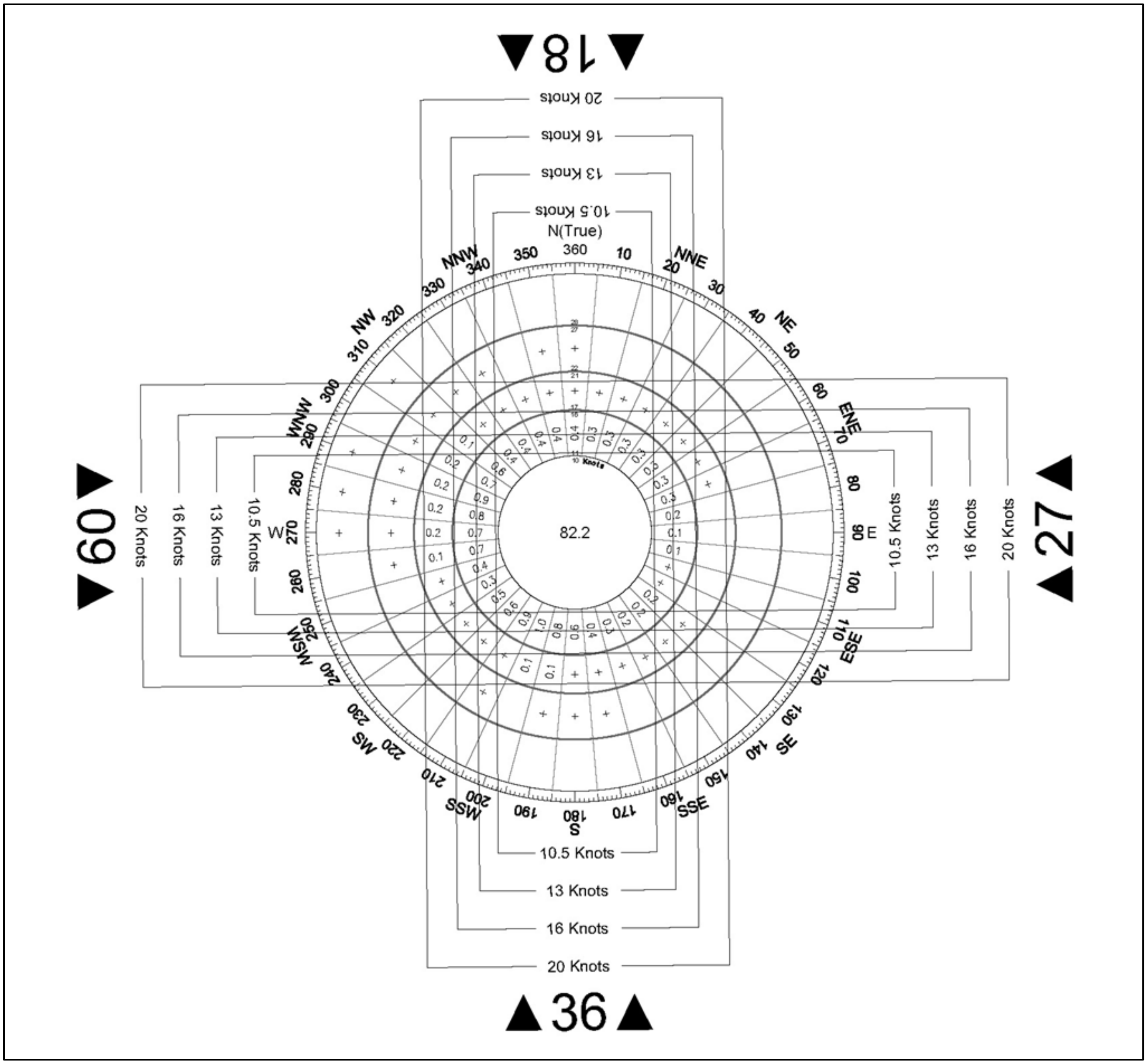
Hourly weather data required to create the windroses was obtained from the NCDC for the period January 1, 2006 through December 31, 2016. This data includes wind direction, wind speed, cloud ceiling base height, and horizontal visibility.

The three windrose diagrams are depicted on **Exhibits 2.3-3 through 2.3-5**. The wind direction, which is measured at ten-degree intervals between zero and 360 degrees, is displayed by radial lines, with the directions labeled along the outer ring. The wind velocity is shown within the concentric circles at: zero to 10 knots, 11 to 16 knots, 17 to 21 knots, 22 to 27 knots, and 28 knots or greater.

Each segment of the windrose represents the percent occurrence of wind observations at the given direction and velocity range. Note that the center circle of the windrose displays the percent occurrence of wind observations at zero to 10 knots regardless of wind direction. Percentages were calculated and rounded to the nearest one tenth of one percent and entered in the appropriate segment of the windrose. Plus (+) symbols are used to indicate direction and velocity combinations which occur less than one tenth of one percent of the time, but greater than zero percent of the time.

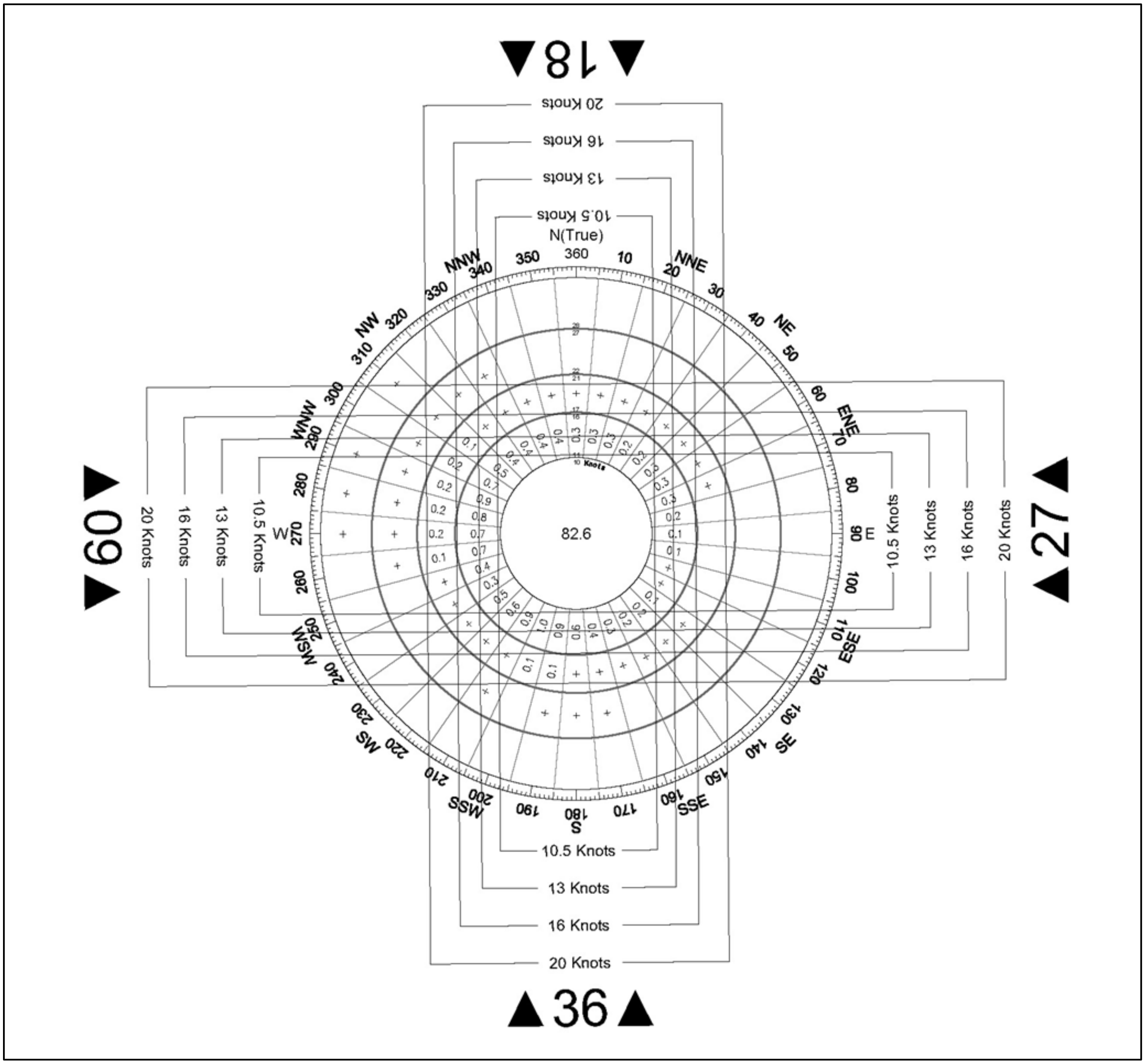
A crosswind template is overlaid on each windrose as parallel lines that show the existing runway end directions and crosswind limits, which for this analysis are 10.5, 13.0, 16.0, and 20.0 knots. This crosswind template is used to calculate the percent coverage offered by the runway orientation at each crosswind limit. By adding the sum of the percentages that fall within each crosswind limit for all runways, the percent coverage can be calculated. The desirable wind coverage for an airport is 95 percent. This 95 percent coverage takes into account various factors influencing operations and the economics of providing the coverage. Based on the weather observations presented in the windroses for all weather, VMC, and IMC conditions, CVG provides at least 99.36 percent coverage under the existing runway configuration.

EXHIBIT 2.3-3 ALL WEATHER WINDROSE



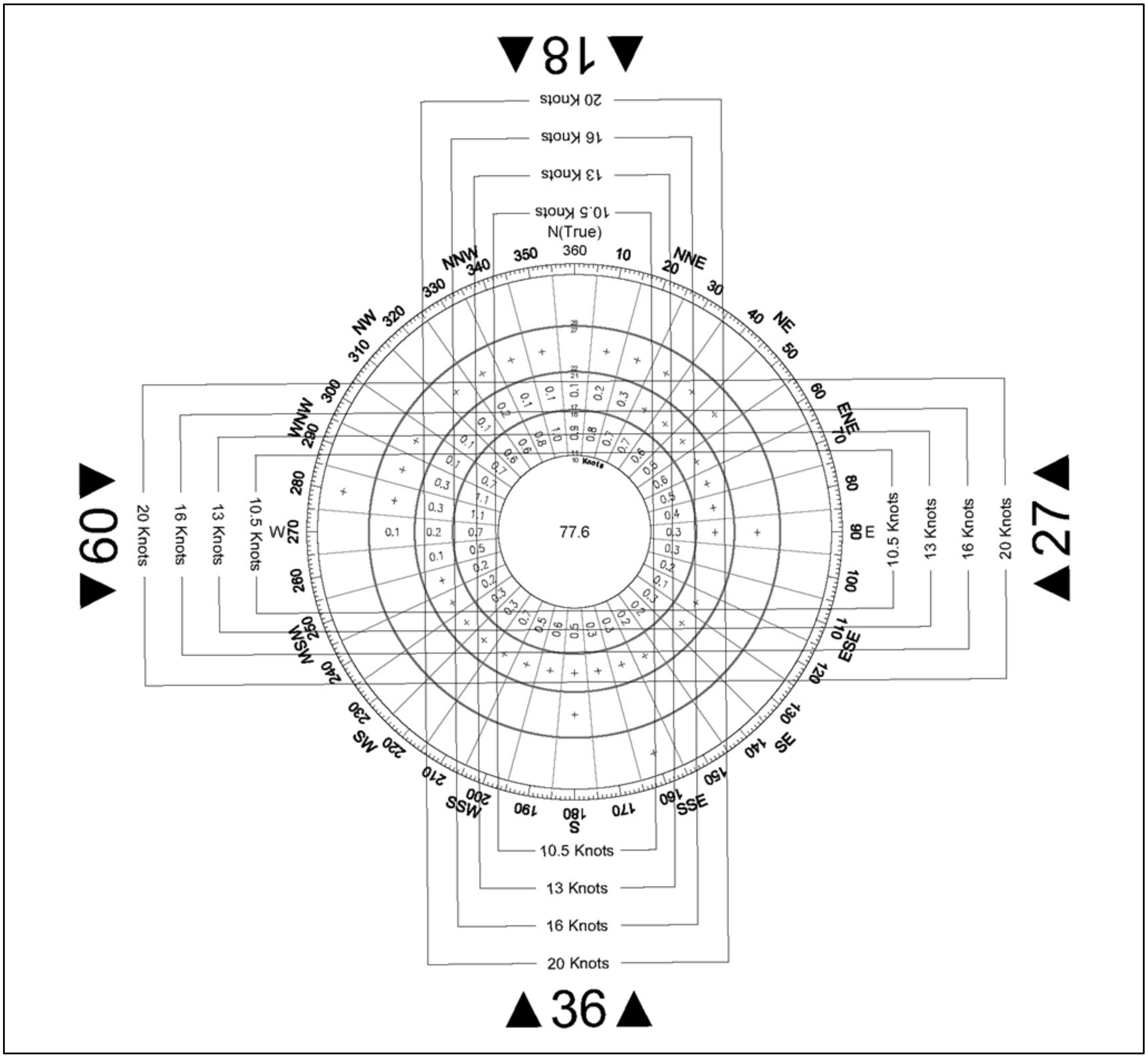
Source: Landrum & Brown analysis

EXHIBIT 2.3-4 VMC WINDROSE



Source: Landrum & Brown analysis

EXHIBIT 2.3-5 IMC WINDROSE



Source: Landrum & Brown analysis

2.3.5 Taxiways

The taxiway system at CVG allows for the safe and efficient movement of aircraft between the runways, passenger terminal areas, GA areas, air cargo, and other aircraft parking/service areas. The airfield at CVG is served by an expansive system of taxiways. All runways at CVG are served by at least one full-length parallel taxiway and in some cases by full-length dual parallel taxiways. **Table 2.3-9, *Parallel Taxiways***, presents the characteristics of all runway parallel taxiways at CVG. **Exhibit 2.3-6, *Taxiway Restrictions***, depicts the areas of the taxiway system that have restrictions pertaining to what category or type of aircraft may operate on them. These restrictions are typically based on meeting certain airfield design standard criteria based on ADG or have an FAA approved Modification to Standard (MOS).

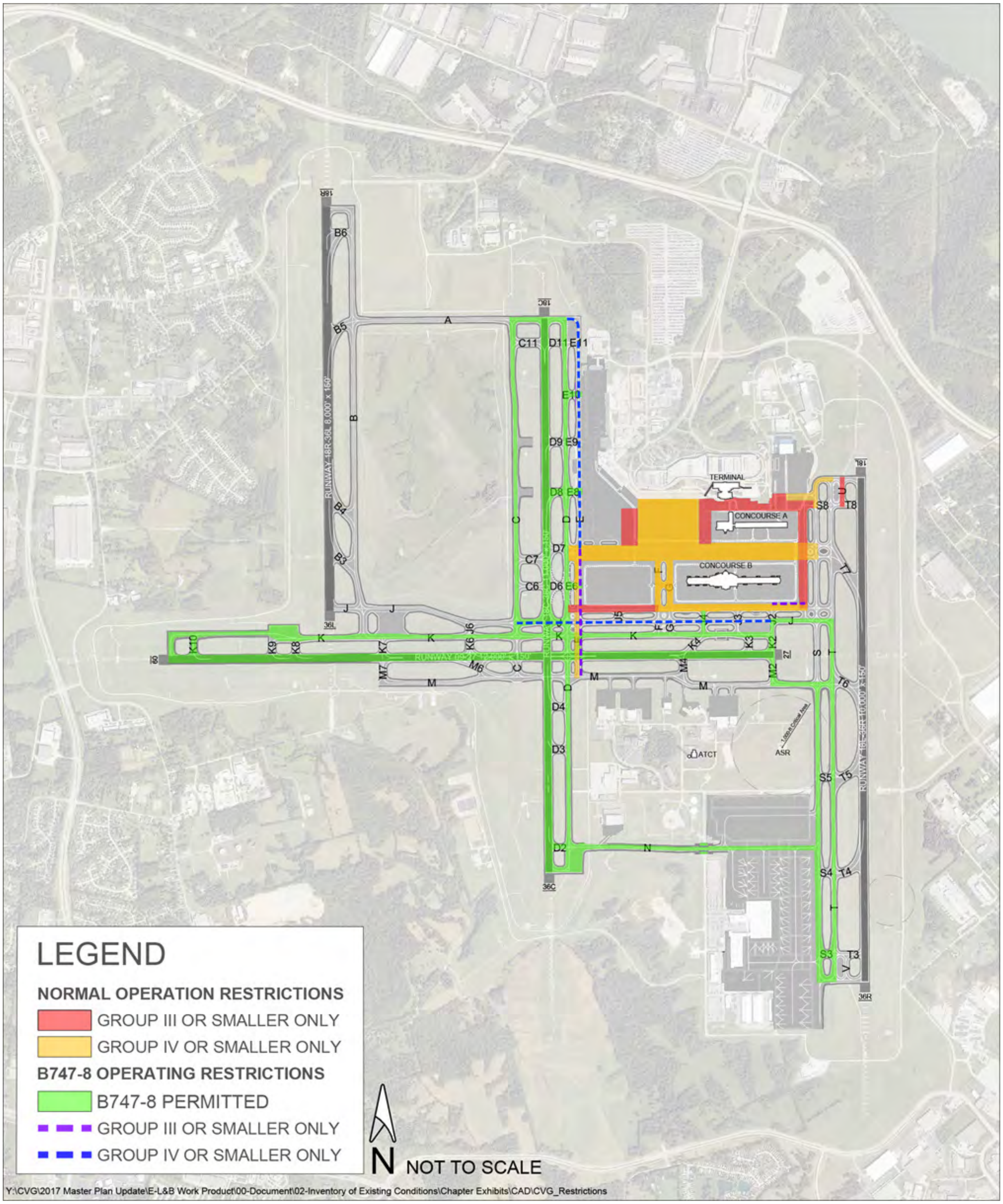
Operationally, not all taxiways/taxilanes are considered to be in the movement area and therefore are not controlled by air traffic controllers. In the case of CVG, the taxilanes around Concourses A and B are not in the movement area. These “non-movement” areas are typically on or around aircraft parking aprons and are usually controlled by ramp towers. **Exhibit 2.3-7, *Non-Movement Areas***, depicts where these non-movement areas exist. In the case at CVG, these non-movement areas are controlled by the Concourse B ramp tower and the DHL ramp tower, which are operated by Delta Air Lines and DHL respectively.

TABLE 2.3-9 PARALLEL TAXIWAYS

Airfield Element	Runway 09/27			Runway 18C/36C		Runway 18L/36R		Runway 18R/36L
Taxiway Name	“K”	“J”	“M”	“C”	“D”	“T”	“S”	“B”
Taxiway Length	Full	Partial	Partial	Partial	Full	Full	Full	Full
Taxiway Width (feet)	75	75	75	75	75	75	75	75
Runway to Taxiway Separation (feet)	400	667	400	600	400	600	900	500
Number of 90º Entrance/Exit Taxiways[1]	11	-	6	7	13	4	-	2
Number of High Speed Exit Taxiways	1	-	1	0	0	4	-	4

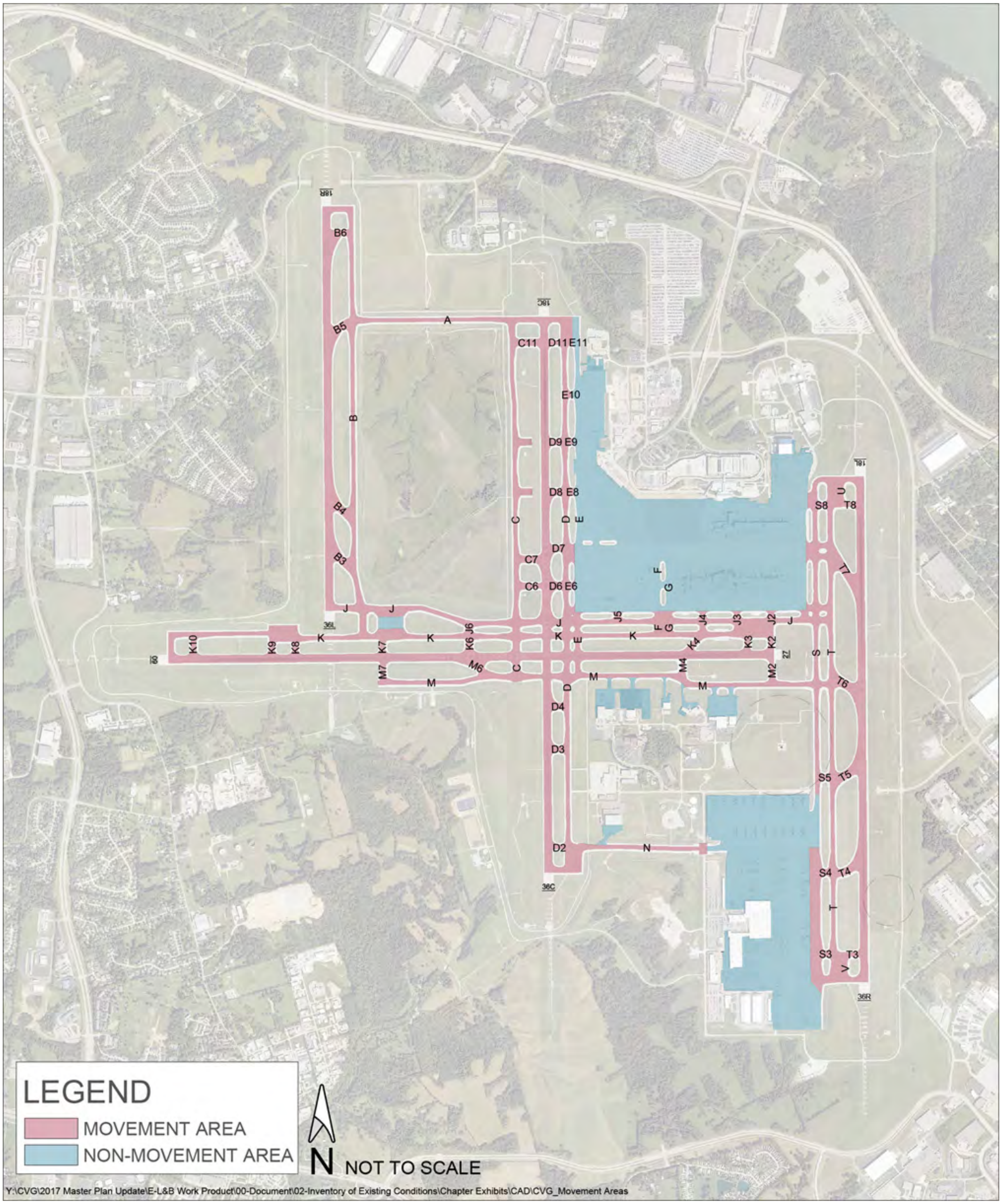
[1] Includes the taxiways at either end of the runway.
Source: Landrum & Brown analysis

EXHIBIT 2.3-6 TAXIWAY RESTRICTIONS



Sources: BF&S - Analysis of Pavement Geometrics, Marking and Signage, August 2018; KCAB; Woolpert Photography dated September 23, 2017

EXHIBIT 2.3-7 NON-MOVEMENT AREAS



Sources: KCAB, Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

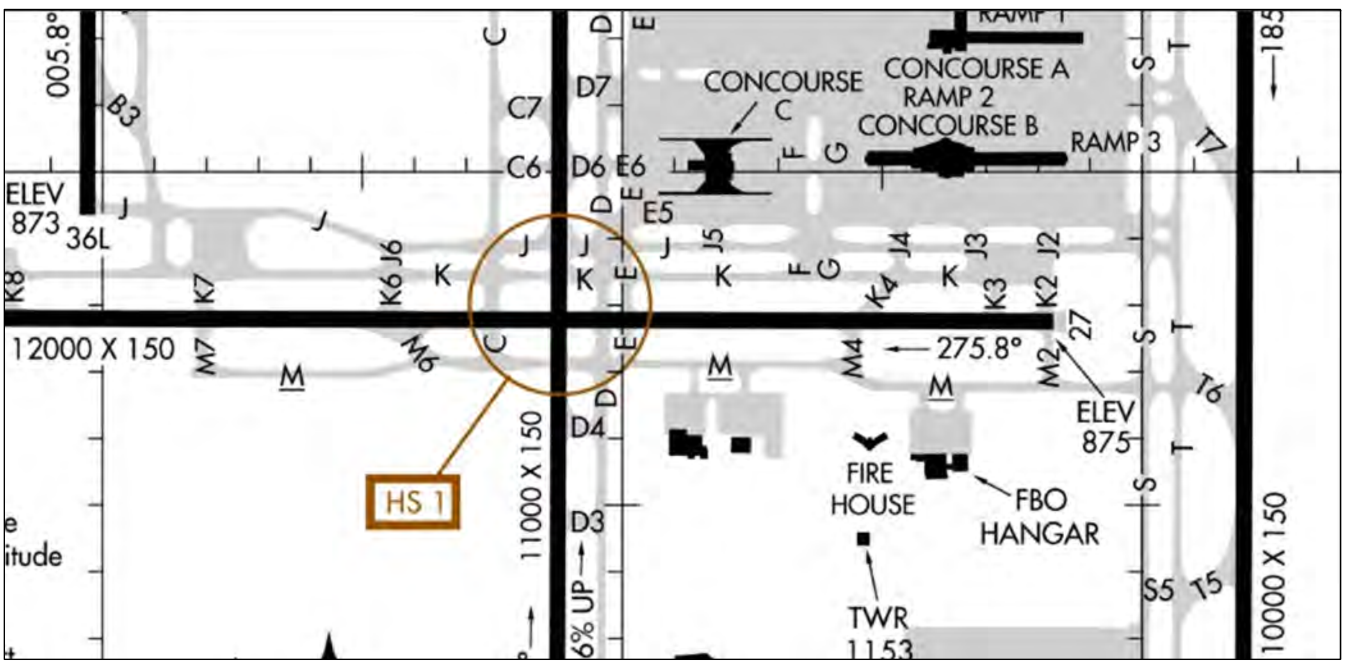
2.3.6 Hot Spots

The FAA defines a hot spot as a runway safety related problem area or intersection on an airport.[2] Typically, it is a complex or confusing taxiway/taxiway or taxiway/runway intersection. A confusing condition may be compounded by miscommunication between the ground controller and a pilot, which might result in a runway incursion or close encounter to another taxiing aircraft. The hot spot might have a history of surface incidents or the potential for surface incidents. This may be due to any mix of causes such as:

- Airport geometry
- Ground traffic flow
- Markings, signage, or lighting
- Human factors

The FAA has identified one hot spot at CVG, designated as "HS-1". The FAA describes HS-1 as, "Be alert to multiple taxiway crossing points surrounding the intersection of Runway 18C/36C and Runway 09/27."[3] **Exhibit 2.3-8, *CVG Hot Spot HS-1***, presents a graphical depiction of HS-1 as published in the CVG Airport Diagram.

EXHIBIT 2.3-8 CVG HOT SPOT HS-1



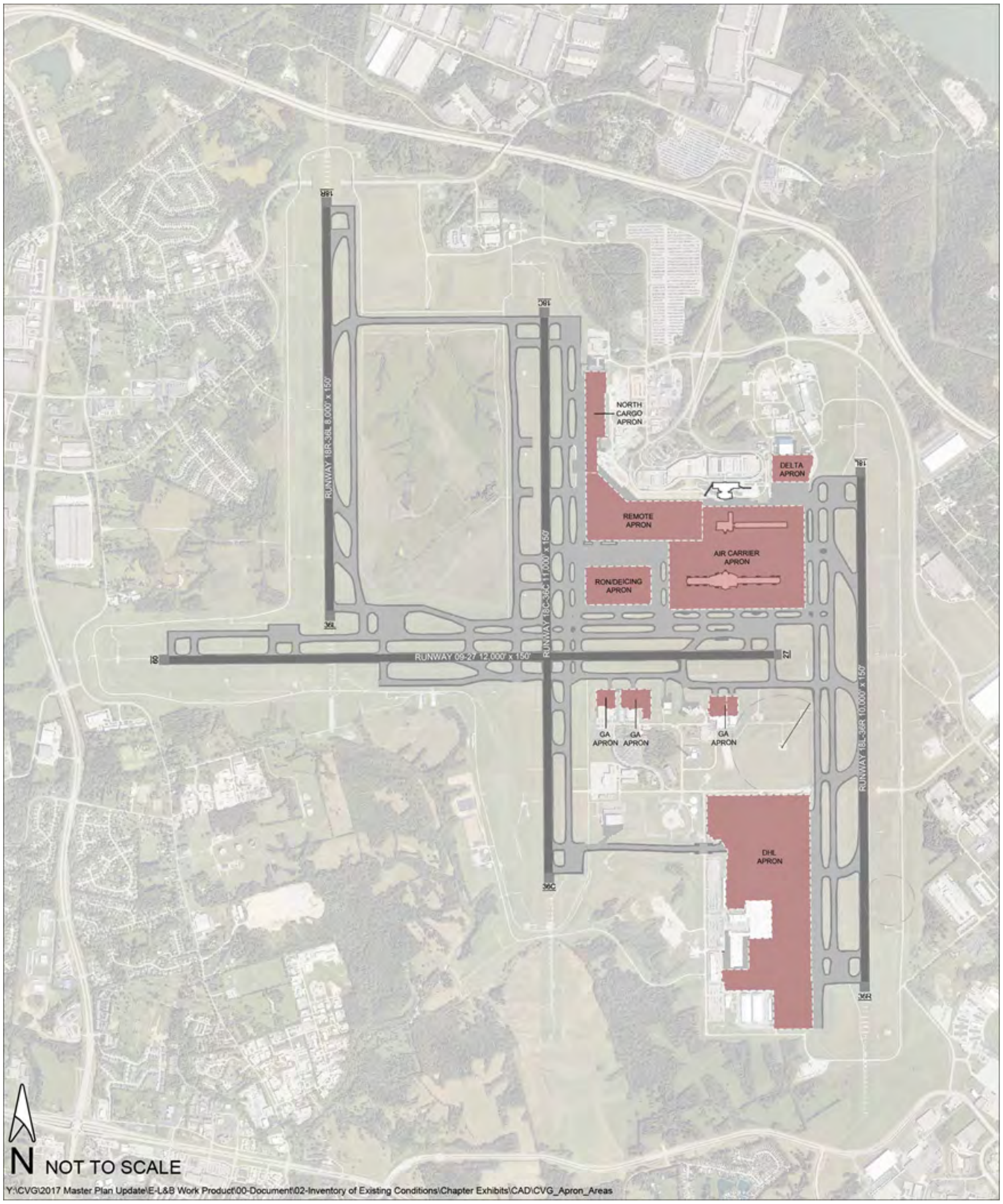
Source: FAA CVG Airport Diagram, October 12, 2017

2 FAA Brochure OK-09-3619, *Focus on Hot Spots – Prevent Runway Incursions*
3 FAA Chart Supplement SE, 12 October 2017 to 7 December 2017

2.3.7 Apron Areas

There are seven different types of apron areas at CVG. The uses of these aprons range from air carrier to GA and air cargo. **Exhibit 2.3-9, *Apron Areas***, identifies each of the apron areas at CVG. Each of these apron areas is discussed in further detail in the following subsections.

EXHIBIT 2.3-9 APRON AREAS



Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

2.3.7.1 *Air Carrier Apron*

The air carrier apron is located north of Runway 09/27 and between Runways 18C/36C and 18L/36R. It encompasses an area of approximately 9.2 million square feet of pavement. This apron is located around Concourses A and B. This apron includes all contact positions that are used by air carrier aircraft, as well as the on-apron taxilanes that are required for the circulation of aircraft. **Table 2.3-10, *Air Carrier Aircraft Parking Positions – Concourse A***, and **Table 2.3-11, *Air Carrier Aircraft Parking Positions – Concourse B***, present an inventory of each aircraft parking position on the air carrier apron and the capacity of each. **Exhibit 2.3 10, *Aircraft Parking Positions – Concourse A***, and **Exhibit 2.3-11, *Aircraft Parking Positions – Concourse B***, identify the location of each of these aircraft positions on the air carrier apron.

TABLE 2.3-10 AIR CARRIER AIRCRAFT PARKING POSITIONS – CONCOURSE A

Position	Max Aircraft Size
A1	Narrow-body
A2	Narrow-body
A3	Narrow-body
A4	B767
A5	Narrow-body
A6	A321
A7	B757
A8	A321
A9	B757
A10	A321
A11	B757-200W/300W
A12	A321
A13	B767-400
A14	A321
A15	B757
A16	A321
A17	B757
A18	A321
A19	B757
A21	B757
A22	B747

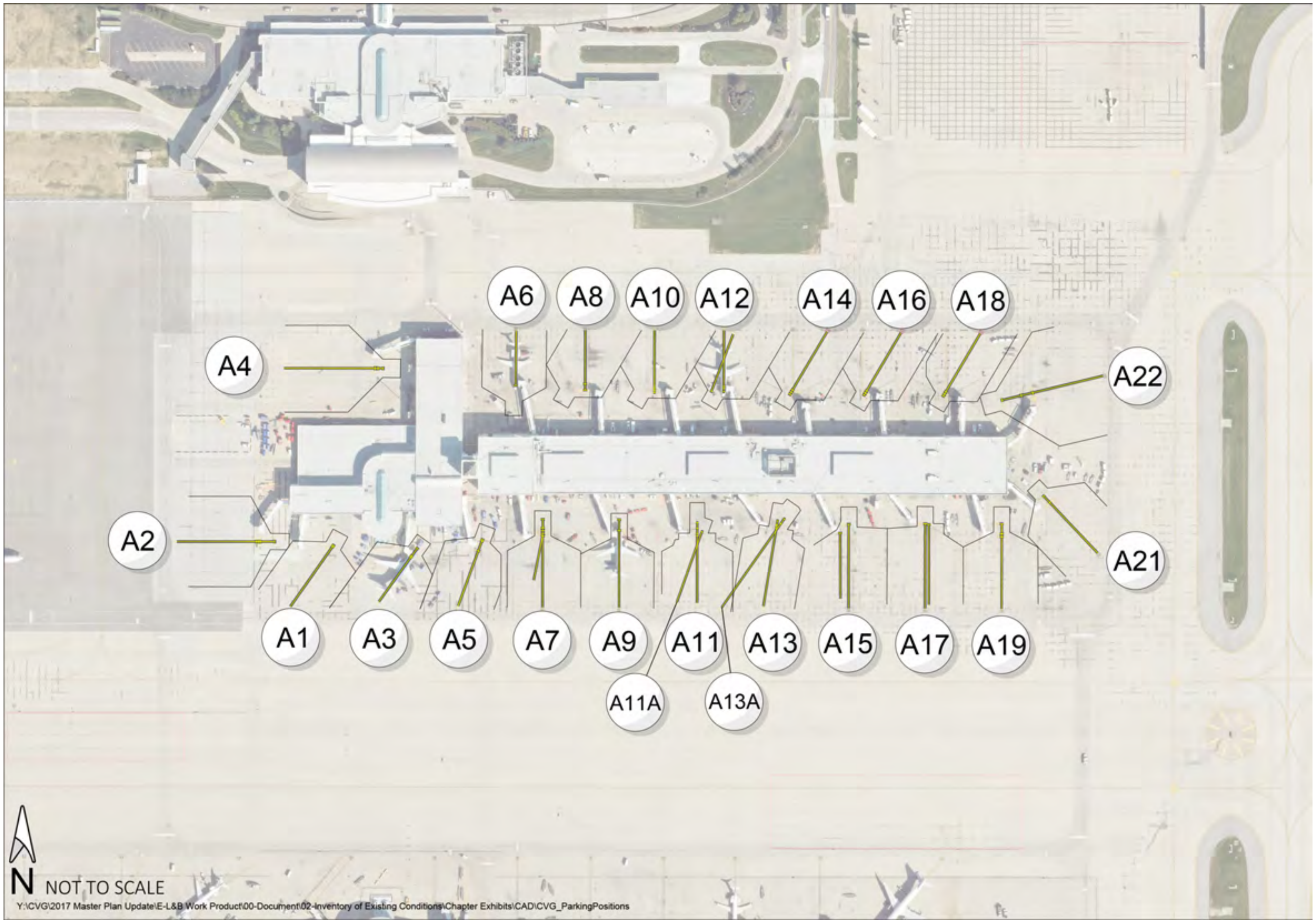
Source: KCAB

TABLE 2.3-11 AIR CARRIER AIRCRAFT PARKING POSITIONS – CONCOURSE B

Position	Max Aircraft Size	Notes
B1	B767-300	International arrival gate
B2	B767-300	International arrival gate
B3	B767-400	International arrival gate
B4	B767-300	International arrival gate
B5	B747-400	International arrival gate
B6	B767-400	International arrival gate
B7	B767-300	International arrival gate
B8	B767-400	International arrival gate
B9	B767-400	International arrival gate
B10	B767-300	International arrival gate
B11	B757-300	
B12	B737-900	
B13	B757-300	
B14	EMB-170	
B15	B737-900	
B16	B737-900	
B17	B757-300	
B18	B757-300	
B19	B757-300	
B20	B737-900	
B21	B737-900	
B22	B757-300	
B23	B737-900	
B24	B757-300	
B25	B767-400	
B26	B757-300	
B27	B767-400	
B28	B767-400	

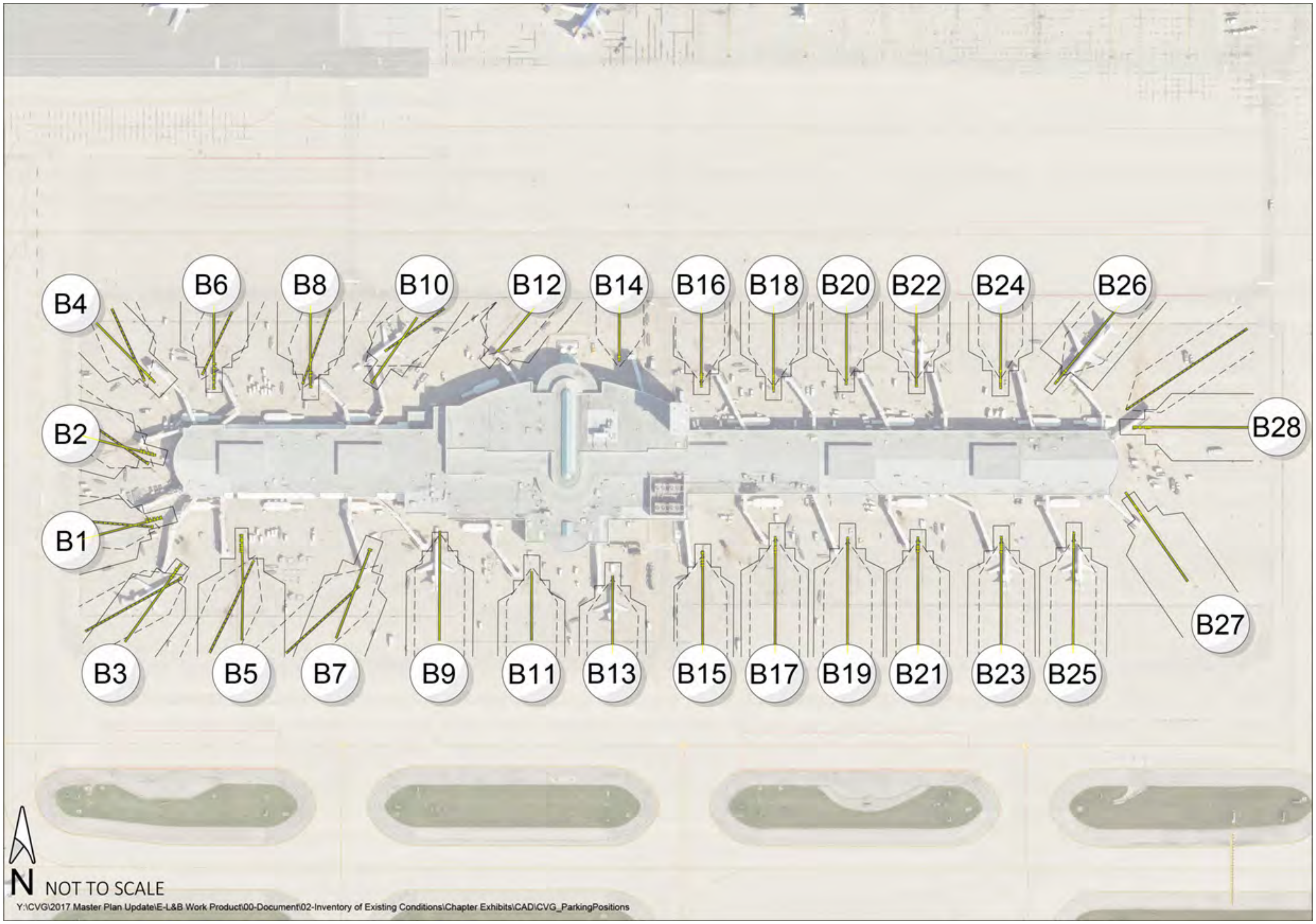
Sources: 2007 CVG Master Plan Update; KCAB

EXHIBIT 2.3-10 AIRCRAFT PARKING POSITIONS – CONCOURSE A



Sources: KCAB; Woolpert Photography dated September 23, 2017

EXHIBIT 2.3-11 AIRCRAFT PARKING POSITIONS – CONCOURSE B



Sources: KCAB; Woolpert Photography dated September 23, 2017

2.3.7.2 *Remote Apron*

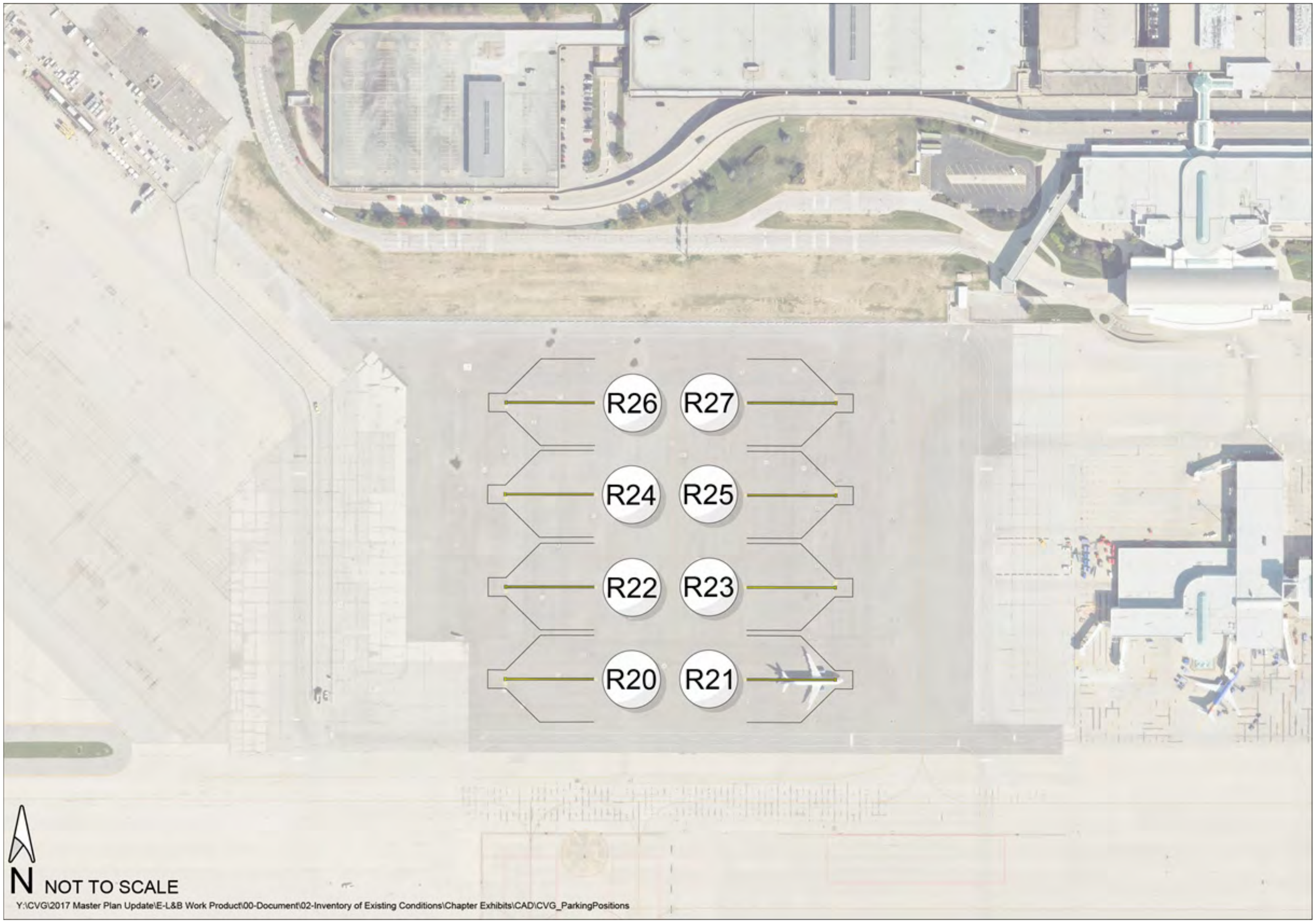
The remote apron is located immediately west of the air carrier apron in the area of the previous Terminals 1 and 2 facilities. This area encompasses approximately one million square feet of pavement. This apron provides eight remote aircraft parking positions to be used by aircraft remaining overnight (RON). **Table 2.3-12, *Remote Apron Aircraft Parking Positions***, presents an inventory of each aircraft parking position on the remote apron and the capacity of each. **Exhibit 2.3-12, *Aircraft Parking Positions – Remote Apron***, identifies the location of each of these aircraft positions on the remote apron.

TABLE 2.3-12 REMOTE APRON AIRCRAFT PARKING POSITIONS

Position	Max Aircraft Size
R20	B767-300
R21	B767-300
R22	B767-300
R23	B767-300
R24	B767-300
R25	B767-300
R26	B767-300
R27	B767-300

Sources: KCAB; Landrum & Brown analysis

EXHIBIT 2.3-12 AIRCRAFT PARKING POSITIONS – REMOTE APRON



Sources: KCAB; Woolpert Photography dated September 23, 2017

2.3.7.3 *Deicing/RON Apron*

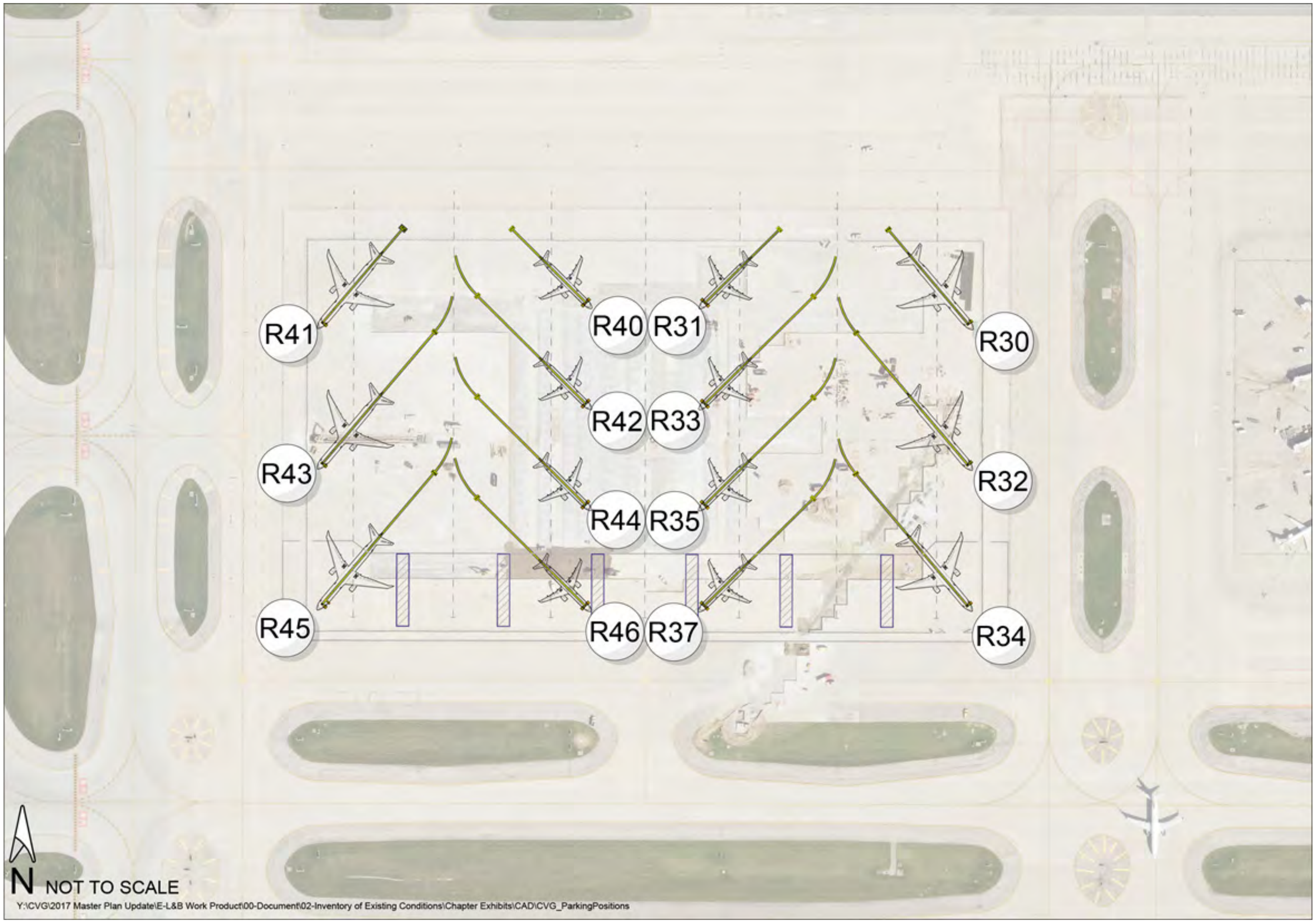
With the recent demolition of Concourse C in the summer of 2017, the area that had immediately surrounded the former concourse building is planned to be developed for an aircraft deicing/RON apron. The intent of this apron is for it to be used for either RON aircraft parking or aircraft deicing operations. The two configurations allow for the apron to be utilized for either purpose, however not simultaneously. **Table 2.3-13, *Deicing/RON Apron Positions (RON)***, presents an inventory listing of each position for RON purposes. **Exhibit 2.3-13, *Deicing/RON Apron Layout (RON)***, presents the RON layout as it was planned in 2017. The deicing capabilities of this apron are described in Section 2.3.8, *Aircraft Deicing*.

TABLE 2.3-13 DEICING/RON APRON POSITIONS (RON)

Position	Max Aircraft Size
R30	B767-300
R31	A321 NEO
R32	B767-300
R33	A321 NEO
R34	B767-300
R35	A321 NEO
R37	A321 NEO
R40	A321 NEO
R41	B767-300
R42	A321 NEO
R43	B767-300
R44	A321 NEO
R45	B767-300
R46	A321 NEO

Sources: KCAB; Landrum & Brown analysis

EXHIBIT 2.3-13 DEICING/RON APRON LAYOUT (RON)



Sources: KCAB; Woolpert Photography dated September 23, 2017

2.3.7.4 *DHL Apron*

The DHL apron is located immediately south of Airfield Drive, and west of Runway 18L/36R. This apron encompasses an area of approximately 7.1 million square feet of pavement. This apron provides a total of 65 aircraft hard stand parking positions that are used exclusively by air cargo aircraft. **Table 2.3-14, *DHL Apron Aircraft Parking Positions***, presents an inventory of each aircraft parking position on the remote apron and the capability of each. **Exhibit 2.3-14, *DHL Apron Aircraft Parking Positions***, identifies the location of each of these aircraft positions on the remote apron.

TABLE 2.3-14 DHL APRON AIRCRAFT PARKING POSITIONS

Position	Max Aircraft Size	Deice	Notes
1	B747-400	Yes	
2	B747-400	Yes	
3	B767-300	Yes	No aircraft at Position 3A
3A	B767-400ER	Yes	No aircraft at Positions 3 and 4
4	B767-300	Yes	No aircraft at Positions 3A and 4A
4A	B767-400ER	Yes	No aircraft at Positions 4 and 5
5	B767-300	Yes	
6	B767-300	Yes	
7	B767-300	Yes	
8	B767-300	Yes	
9	B767-300	Yes	
10	B767-300	Yes	
11	B767-300	Yes	
12	B747-400	Yes	
13	B747-400	Yes	
14	B747-400	Yes	
15	B747-400	Yes	
16	B767-300	Yes	
17	B767-300	Yes	
18	B767-300	Yes	
19	B767-300	Yes	
20	B767-300	Yes	
21	B767-300	Yes	
22	B767-300	Yes	
23	B767-300	Yes	
24	B767-300	Yes	

Position	Max Aircraft Size	Deice	Notes
25	A300-600	Yes	
26	A300-600	Yes	
27	A300-600	Yes	
28	A300-600	Yes	
29	A300-600	Yes	
30	A300-600	Yes	
31	A300-600	Yes	
32	A300-600	Yes	
33	A300-600	Yes	
34	A300-600	Yes	
35	B767-300	No	No aircraft at Positions 35A and 35B
35A	B737-300W	No	No aircraft at Position 35
35B	B737-300W	No	No aircraft at Positions 35 and 36
36	B767-300	No	No aircraft at Positions 35B, 36A, and 36B
36A	B737-300W	No	No aircraft at Position 36
36B	B737-300W	No	No aircraft at Positions 36 and 37
37	B767-300	No	No aircraft at Positions 36B and 37A
37A	B737-300W	No	No aircraft at Positions 37 and 38
38	B767-300	No	No aircraft at Position 37A
39	B767-300	No	No aircraft at Positions 39A and 39B
39A	B737-300W	No	No aircraft at Position 39
39B	B737-300W	No	No aircraft at Positions 39 and 40
40	B767-300	No	No aircraft at Positions 39B, 40A, and 40B
40A	B737-300W	No	No aircraft at Position 40
40B	B737-300W	No	No aircraft at Positions 40 and 41
41	B767-300	No	No aircraft at Positions 40B and 41A
41A	B737-300W	No	No aircraft at Positions 41 and 42
42	B767-300	No	No aircraft at Position 41A
43	Narrow-body	No	
43A	Regional Aircraft	No	
44	Narrow-body	No	
44A	Regional Aircraft	No	
44B	Regional Aircraft	No	
45	Narrow-body	No	

Position	Max Aircraft Size	Deice	Notes
45A	Regional Aircraft	No	
45B	Regional Aircraft	No	
46	Narrow-body	No	
46A	Regional Aircraft	No	
47	Not Used	No	
48	Not Used	No	
49	Not Used	No	
50	B747-8	Yes	
51	B747-8	Yes	
52	B747-8	Yes	
53	B747-8	Yes	
54	B747-8	Yes	
55	B747-8	Yes	
56	B767-300ER	Yes	
57	B767-300ER	Yes	
58	B767-300ER	Yes	
59	B767-300ER	Yes	
60	B767-300ER	Yes	
61	B767-300ER	Yes	
62	B767-300ER	Yes	
63	B767-300ER	Yes	
64	B767-300ER	Yes	
65	B767-300ER	Yes	

Sources: KCAB; Landrum & Brown analysis

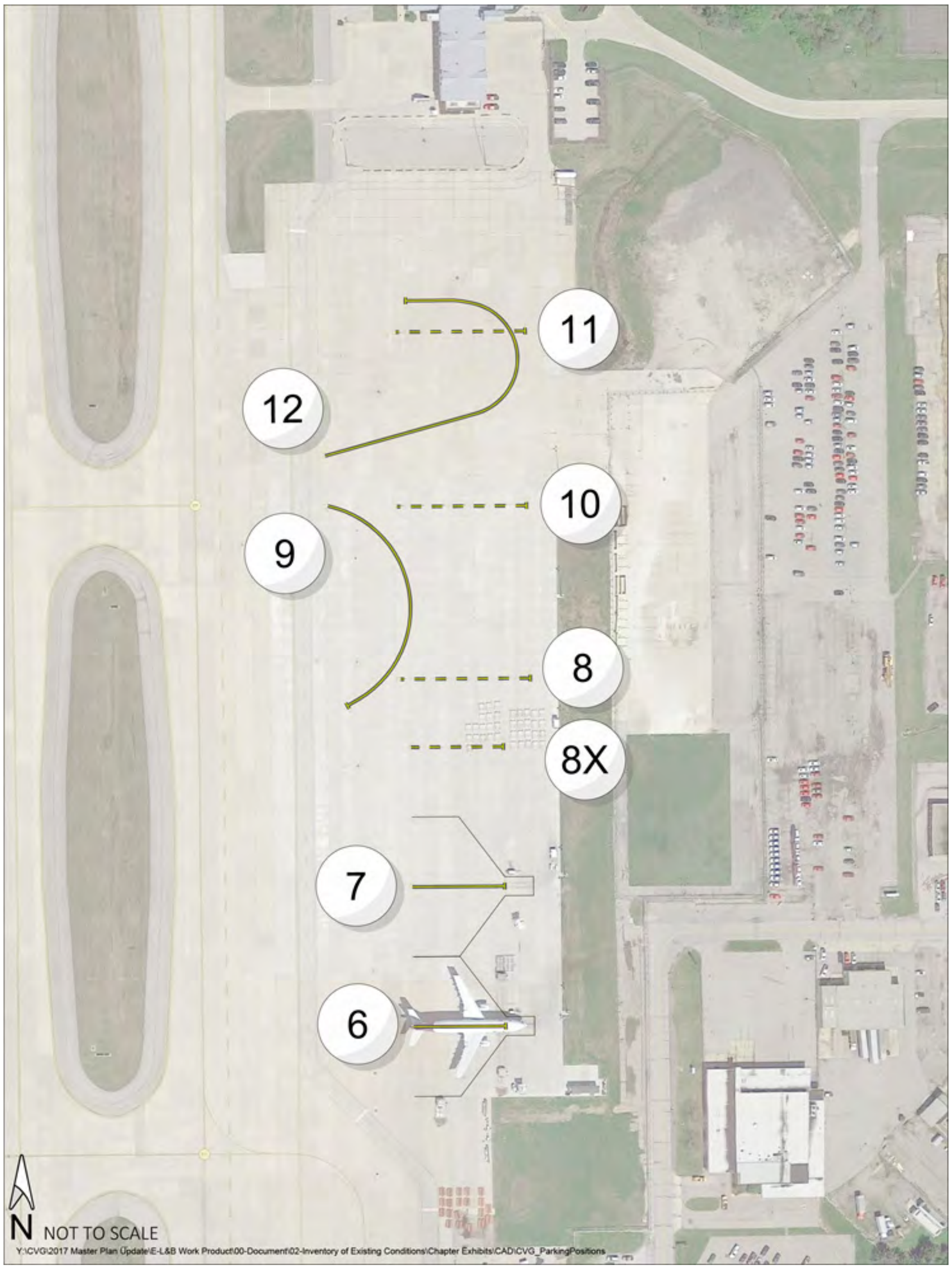
EXHIBIT 2.3-14 DHL APRON AIRCRAFT PARKING POSITIONS

Sources: KCAB; Woolpert Photography dated September 23, 2017

2.3.7.5 *North Cargo Apron*

The north cargo apron is located immediately east of Runway 18C/36C and north of the remote apron. This apron encompasses an area of approximately 1.4 million square feet of pavement. This apron provides a maximum of five simultaneous aircraft parking positions that are primarily used by air cargo aircraft. **Exhibit 2.3-15, *North Cargo Apron Aircraft Parking Positions***, identifies the location of each of these aircraft positions on the remote apron.

EXHIBIT 2.3-15 NORTH CARGO APRON AIRCRAFT PARKING POSITIONS

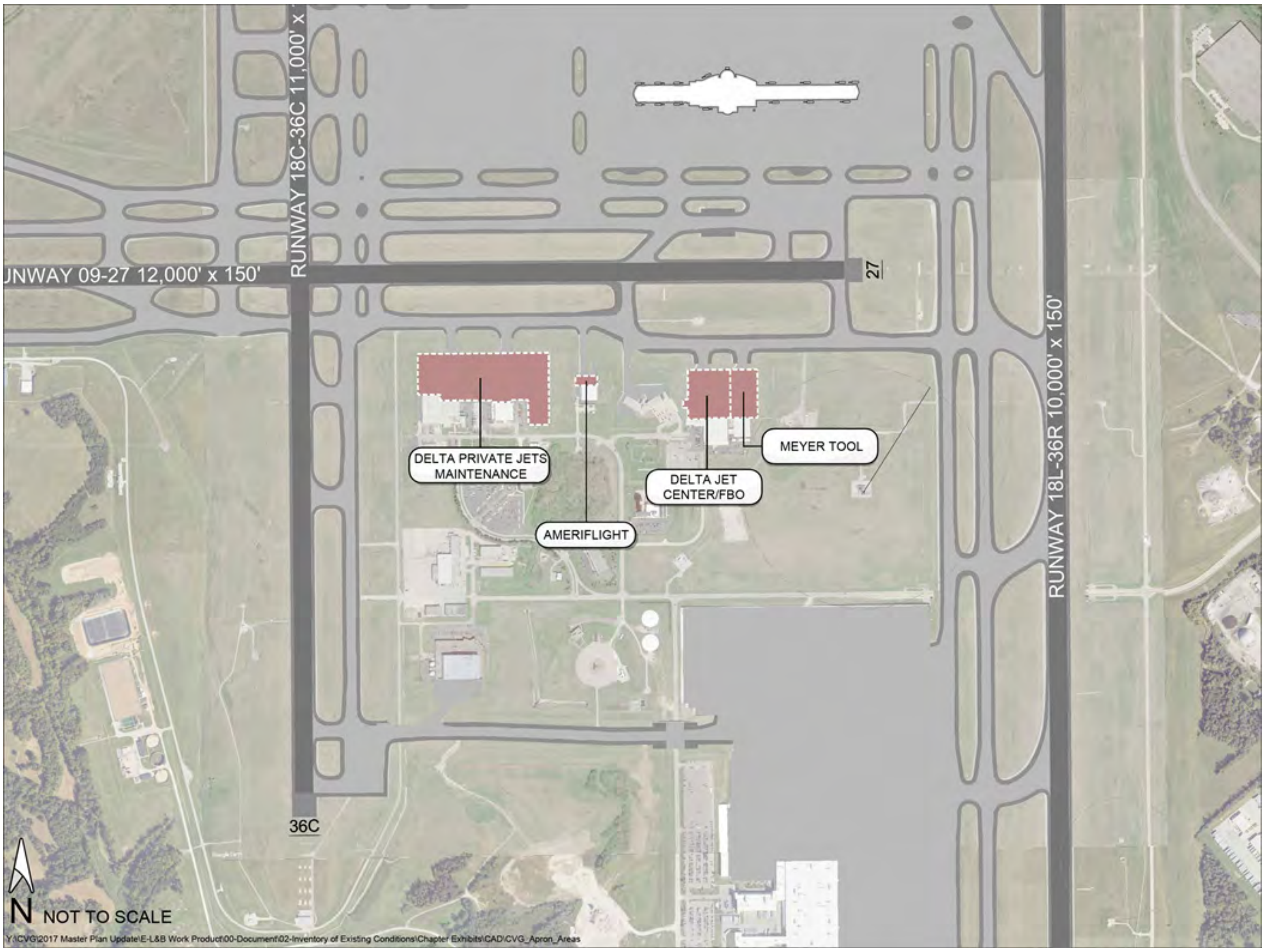


Sources: KCAB; Woolpert Photography dated September 23, 2017

2.3.7.6 *GA Aprons*

There are currently three separate aprons at CVG serving GA activity. All three are located just south of Taxiway M between Runways 18L/36R and 18C/36C. **Exhibit 2.3-16, *GA Aprons***, identifies the location of each GA apron. The primary apron for itinerant and FBO operations is the Delta Private Jets facility located farthest to the east. These three aprons combine for a total of over one half million square feet of apron area.

EXHIBIT 2.3-16 GA APRONS

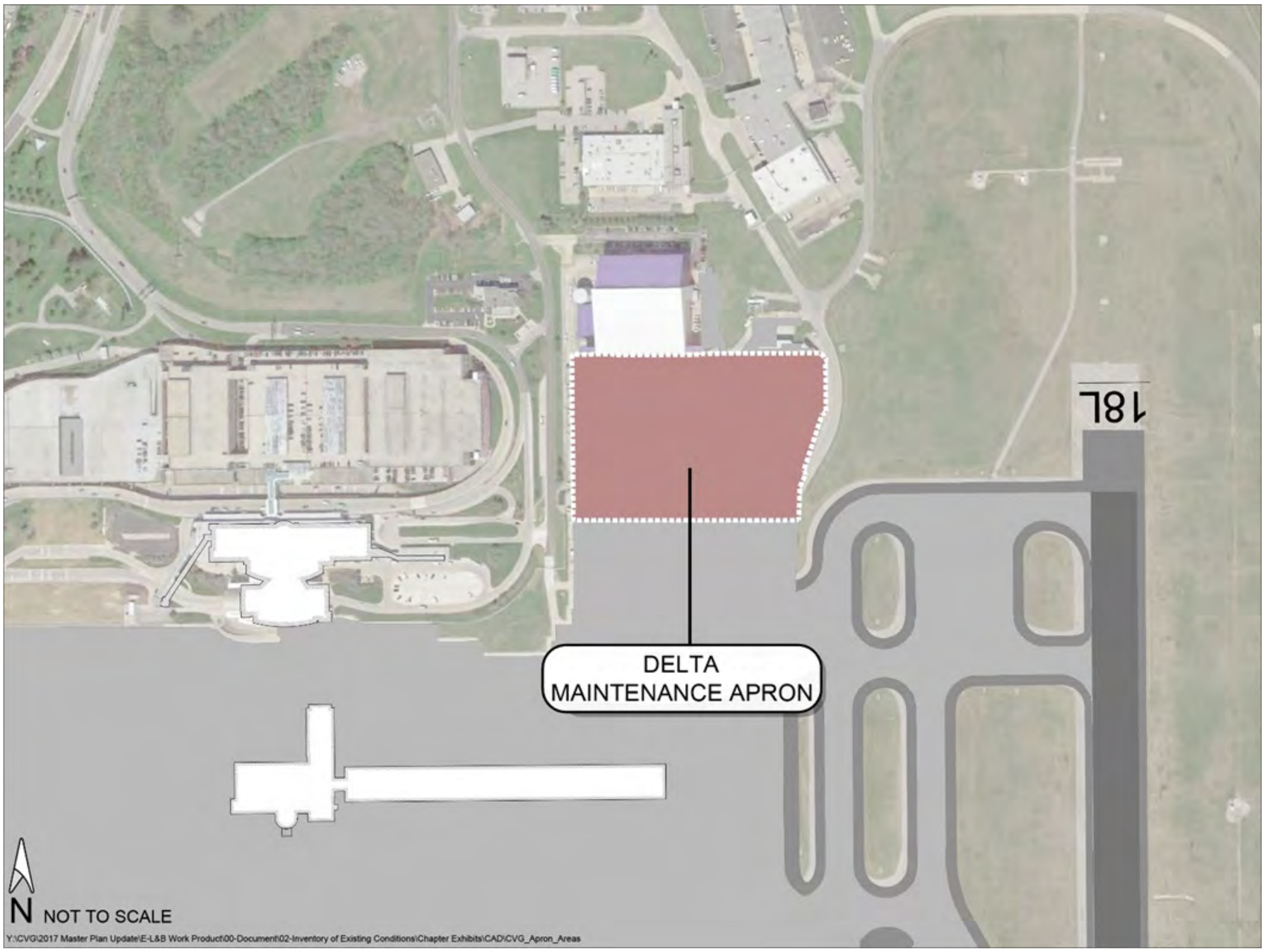


Sources: KCAB; Woolpert Photography dated September 23, 2017

2.3.7.7 *Delta Maintenance Apron*

Delta (DL) currently operates a small maintenance base at CVG, which has a dedicated apron adjacent to its hangar. This maintenance base and its associated apron is located immediately west of the Runway 18L threshold and east of the main terminal parking garages as shown on **Exhibit 2.3-17, *Delta Maintenance Apron***. This apron is capable of accommodating Group IV aircraft and deicing operations. The overall size of the Delta Apron is approximately 600,000 square feet.

EXHIBIT 2.3-17 DELTA MAINTENANCE APRON



Sources: KCAB; Woolpert Photography dated September 23, 2017

2.3.8 Aircraft Deicing

The deicing positions that were available in 2017 are shown on **Exhibit 2.3-18, *2017 Aircraft Deicing Positions***. DHL and the GA operators deiced on their respective aprons (Positions 30 through 45 for DHL and Pad 12 for GA aircraft). The passenger airlines and FedEx used several different locations on the taxiways and aprons near the passenger terminal (Pads 1 through 13). Many of these sites allow for the "flow through" of aircraft on their way from the apron areas to a runway end for departure.

As discussed in Section 2.3.7, *Apron Areas*, the planned deicing/RON apron that is being developed at the site of former Concourse C is anticipated to be the primary location for aircraft deicing for the passenger airlines and FedEx. This site replaces Deicing Pad 13. The deicing capacity of the planned deicing/RON apron is listed in **Table 2.3-15, *Deicing/RON Apron Positions (Deicing)***. The configuration of the planned deicing/RON apron for deicing is shown on **Exhibit 2.3-19, *Deicing/RON Apron Layout (Deicing)***.

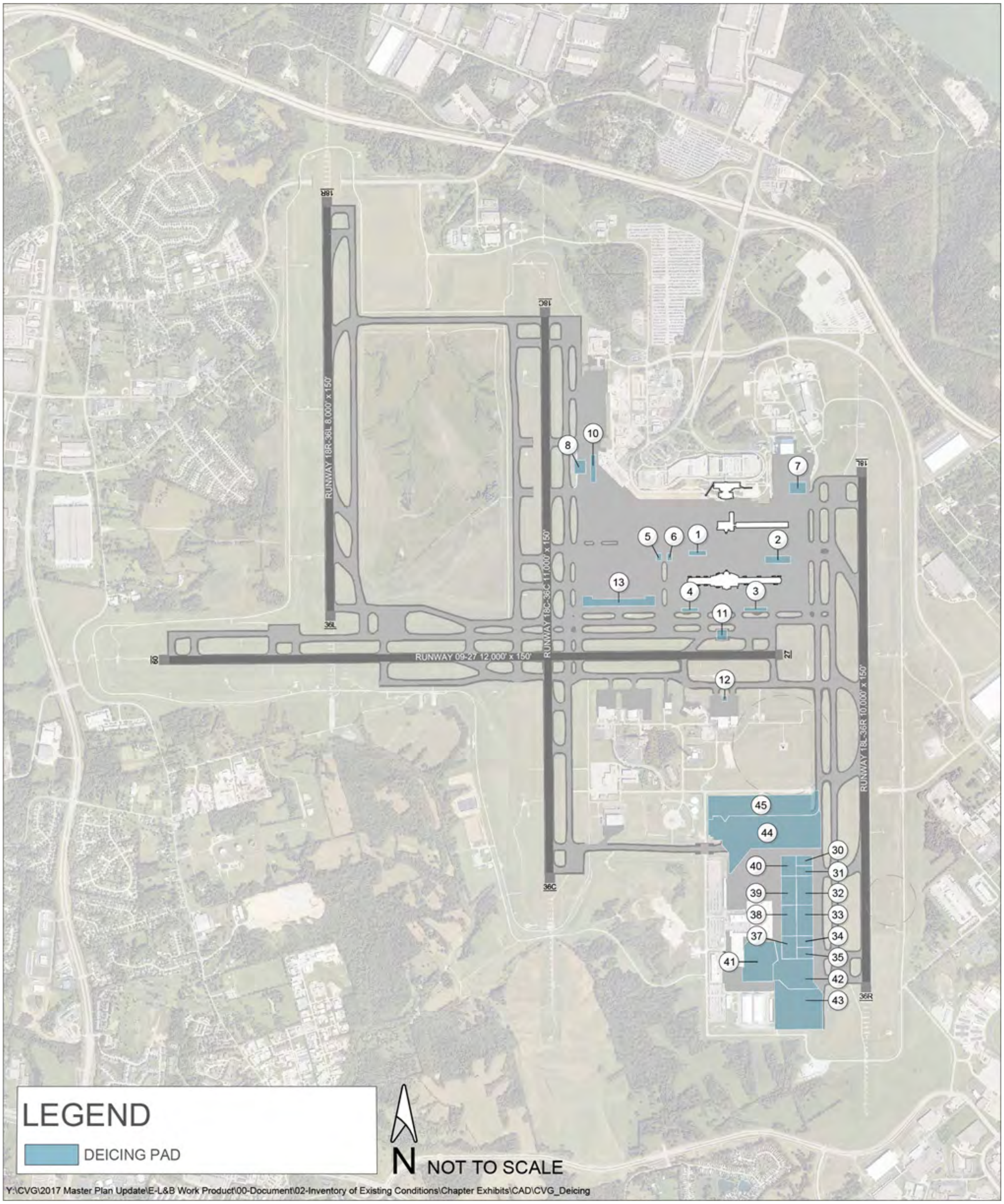
Once the new deicing/RON apron is opened, Pads 1 through 12 will no longer be used as the primary locations for aircraft deicing; however, these locations will be maintained in the event they are required.

TABLE 2.3-15 DEICING/RON APRON POSITIONS (DEICING)

Position	Max Aircraft Size
13A	A321 NEO
13B	A321 NEO
13C	A321 NEO
13D	A321 NEO
13E	A321 NEO
13F	A321 NEO
13G	A321 NEO

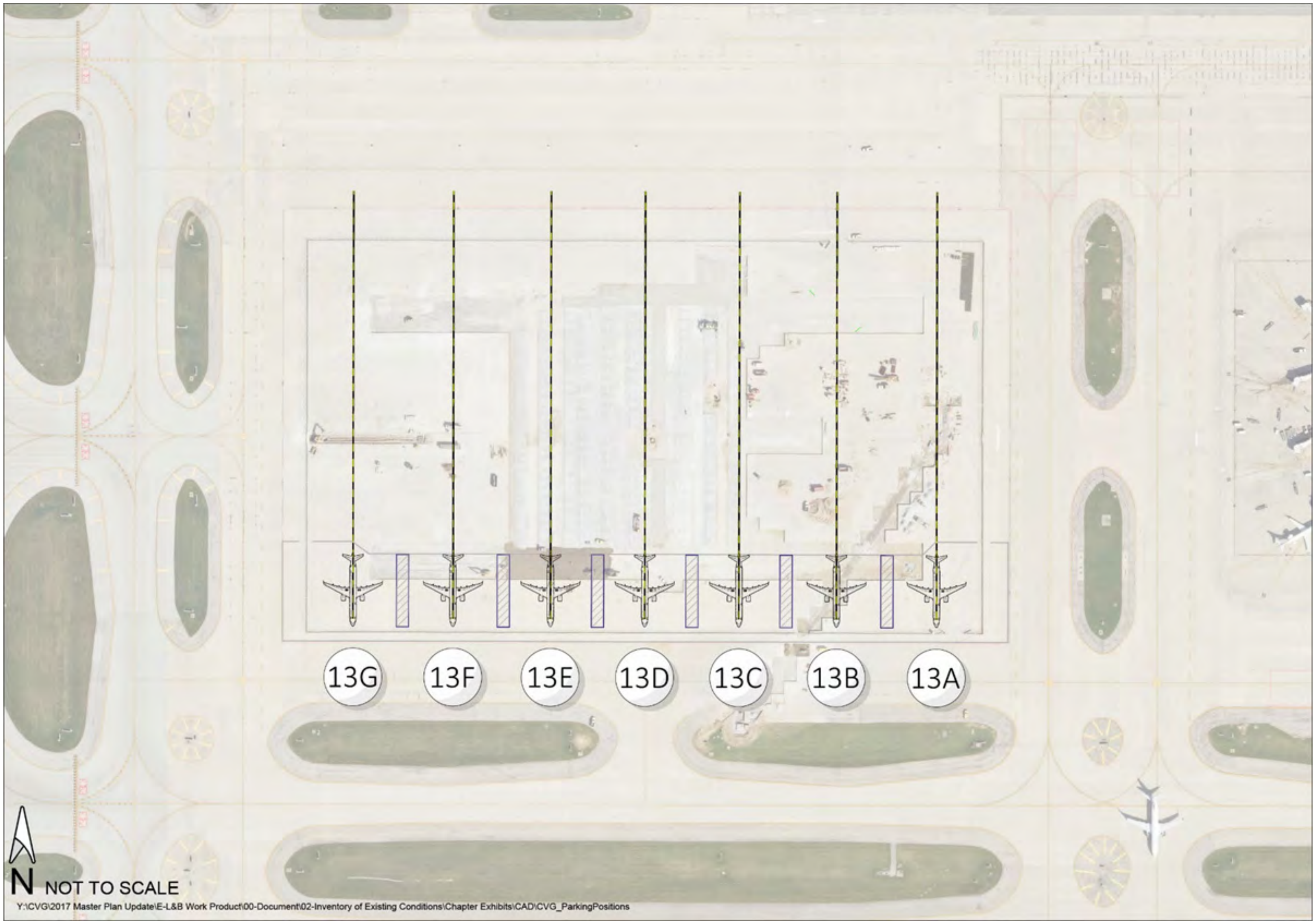
Sources: KCAB; Landrum & Brown analysis

EXHIBIT 2.3-18 2017 AIRCRAFT DEICING POSITIONS



Sources: KCAB; Woolpert Photography dated September 23, 2017

EXHIBIT 2.3-19 DEICING/RON APRON LAYOUT (DEICING)



Sources: KCAB; Woolpert Photography dated September 23, 2017

2.3.9 Airspace

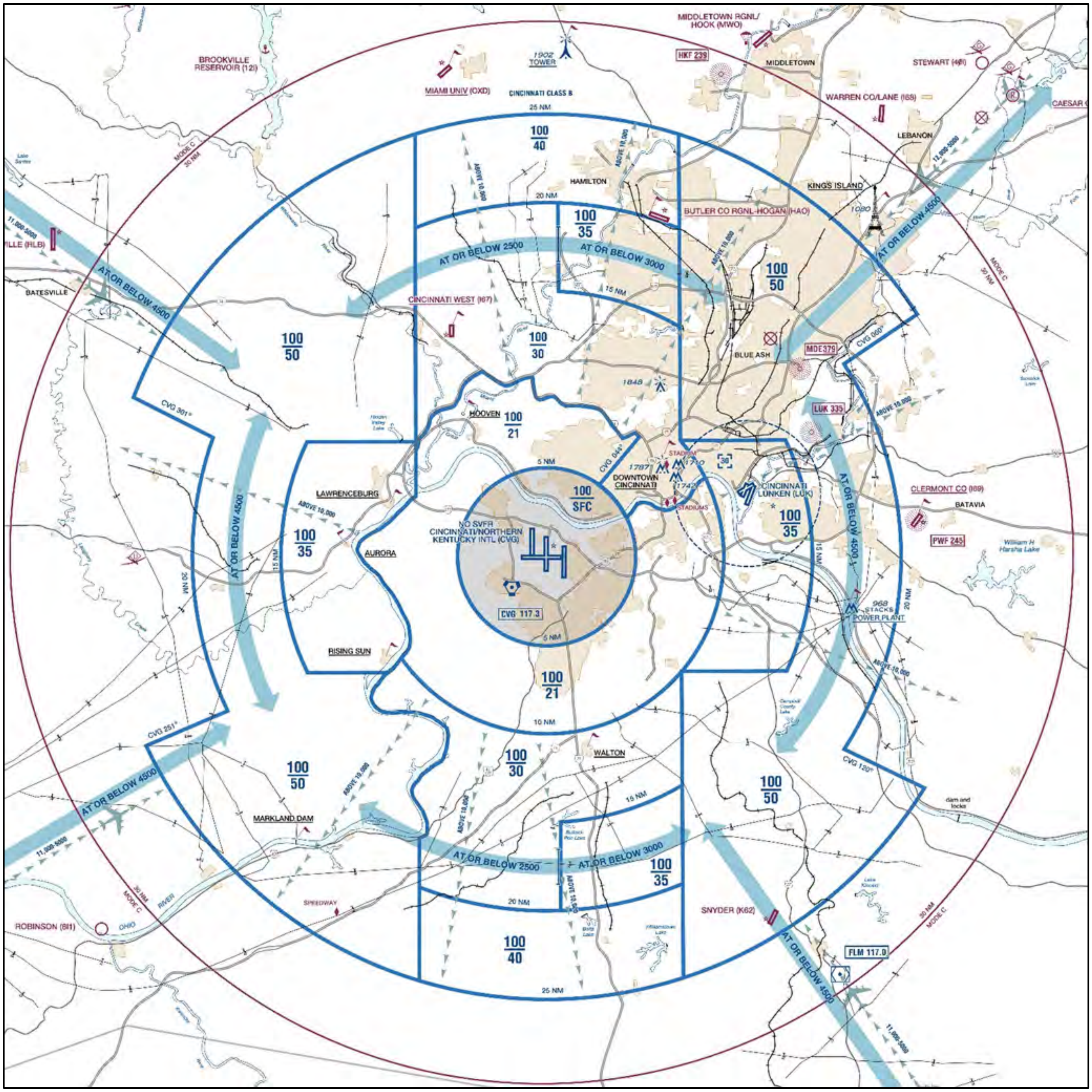
The airspace within the U.S. is made up of several levels (Class A, B, C, D, E, and G) as defined by the FAA. These levels of classification are necessary to ensure the safety and separation of all airplane traffic and passengers utilizing the nation's airports and airspace. The area of airspace that CVG lies within has been classified as Class B Airspace. Class B airspace has been established around the nation's busiest airports. Generally, this airspace will extend from the ground level to 10,000 feet MSL with the core extending for a five nautical mile radius around an airport. Beyond the core, Class B airspace is customized to conform to the surrounding area to allow for air traffic flows into and out of other near-by airports. **Exhibit 2.3-20, *CVG Class B Airspace***, presents a graphical depiction of the Class B airspace around CVG.

Also within the CVG Class B airspace lies Cincinnati Municipal Airport – Lunken Field (LUK), which is 12 nautical miles east/northeast of CVG. LUK lies beneath several of CVG's Class B airspace "tiers". During the hours in which the ATCT is in operation, the airspace around LUK is Class D and extends from the ground level to the floor of the CVG Class B airspace above. When the LUK ATCT is not in operation, this airspace reverts to Class E, and LUK operations are then monitored by Cincinnati Approach, Departure, and Clearance Delivery.

2.3.10 Air Traffic Control Tower (ATCT)

The FAA ATCT and Terminal Radar Approach Control (TRACON) are located south of Taxiway M between Runways 18L/36R and 18C/36C. The ATCT was constructed in 1997 and the tower cab has an eye-level elevation of 1,127 feet MSL. The TRACON building is located adjacent to and east of the ATCT. These two facilities provide Air Traffic Control (ATC) services for the entirety of CVG and surrounding airspace.

EXHIBIT 2.3-20 CVG CLASS B AIRSPACE



Source: CVG Terminal Area Chart (TAC) October 24, 2017

2.3.11 Navigational & Visual Aids

NAVAIDs are both ground and satellite based transmission facilities that are received and interpreted by on-board instruments to assist the pilot with enroute navigation as well as instrument approach procedures to an airport. CVG is equipped with several types of NAVAIDs that are discussed in the following sections. In addition to radio based NAVAIDs, CVG is also equipped several types of visual aids. The intent of these visual aids is to assist the pilot in their transition from an instrument only operating environment to a visual/instrument operating environment (i.e. breaking through a cloud ceiling and coming into sight of the airport/runway). The location of these facilities and their associated critical areas are presented in **Exhibit 2.3-21, *CVG Navigational & Visual Aids***.

2.3.11.1 *Instrument Landing System (ILS)*

The Instrument Landing System (ILS) is a precision approach navigational aid which provides highly accurate course, glide slope, and distance guidance to a given runway end. An ILS is made up of three components and each runway end at CVG is equipped with all three. These components include:

- **Localizer Antenna (LOC)**: A ground based antenna that provides lateral guidance left or right of the runway centerline.
- **Glide Slope Antenna (GS)**: A ground based antenna that provides vertical guidance above or below a prescribed glide path to a runway threshold.
- **Distance Measuring Equipment (DME)**: Ground based transmitter that provides the pilot with accurate distance measurements from the transmitter.

2.3.11.2 *Runway Visual Range (RVR)*

The Runway Visual Range (RVR) is an instrumentally derived horizontal distance a pilot should see down the runway from the approach end based on the sighting of high intensity runway centerline/edge lights.

2.3.11.3 *Lighted Wind Cone*

A wind cone is a truncated cloth cone open at both runway ends and mounted on a freewheeling pivot to indicate the direction the wind is blowing. These wind cones are typically located at or near the runway ends to enable pilots to visually verify that the wind direction at the time of operation favors the runway being used. Each runway end at CVG is equipped with a lighted wind cone.

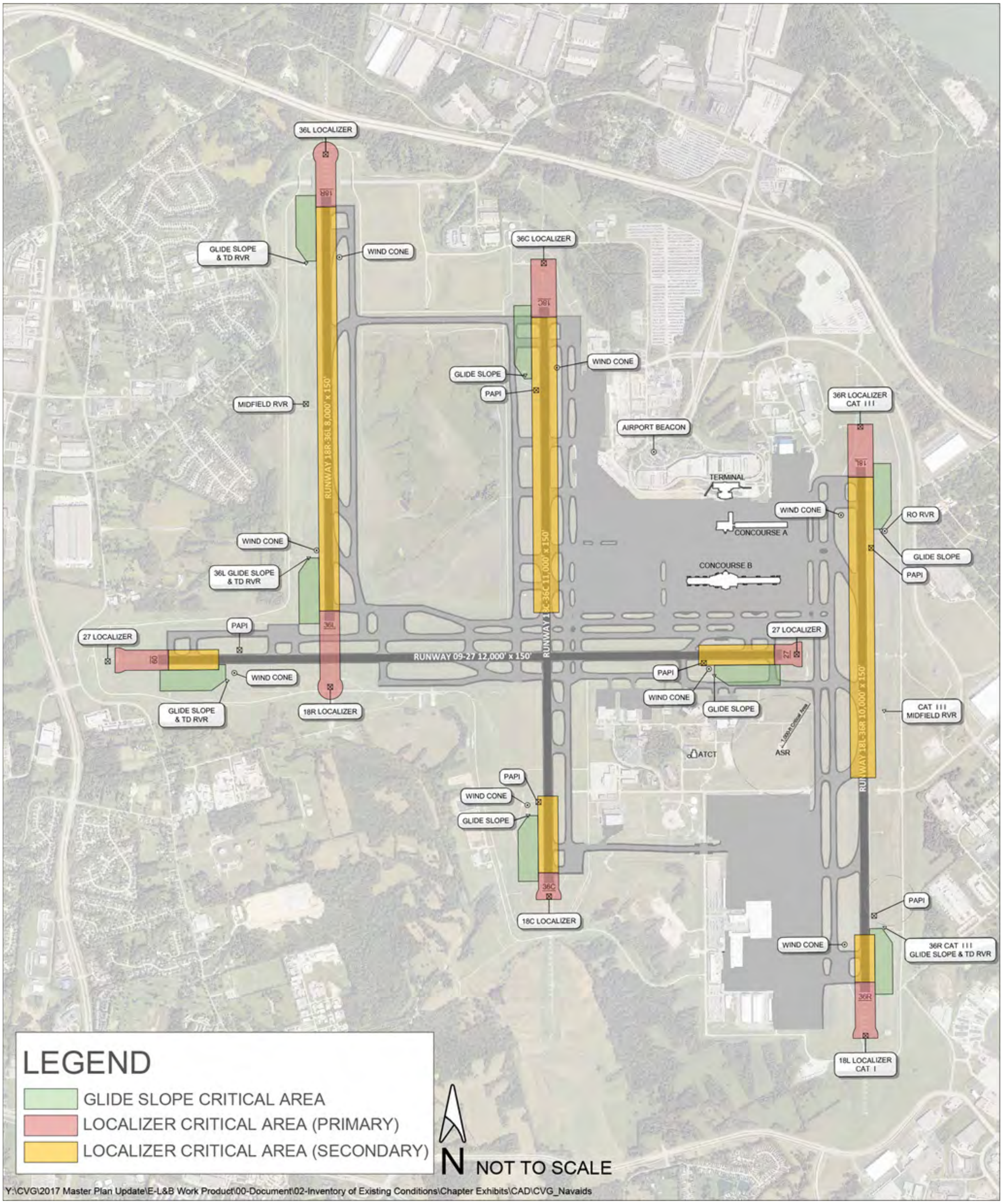
2.3.11.4 *Precision Approach Path Indicator (PAPI)*

The Precision Approach Path Indicator (PAPI) is a series of lights whose purpose is to provide a clear visual means to determine if an aircraft on approach to a runway end is too high, too low, or on the correct glide path. Each runway end at CVG is equipped with a PAPI, except Runways 18R and 36L.

2.3.11.5 *Airport Beacon*

The rotating airport beacon is a basic visual NAVAID that is operated at most airports. At civil airports (such as CVG), the airport beacon consists of alternating white and green flashes to indicate the location of an airport at night and during times of lower visibility.

EXHIBIT 2.3-21 CVG NAVIGATIONAL & VISUAL AIDS

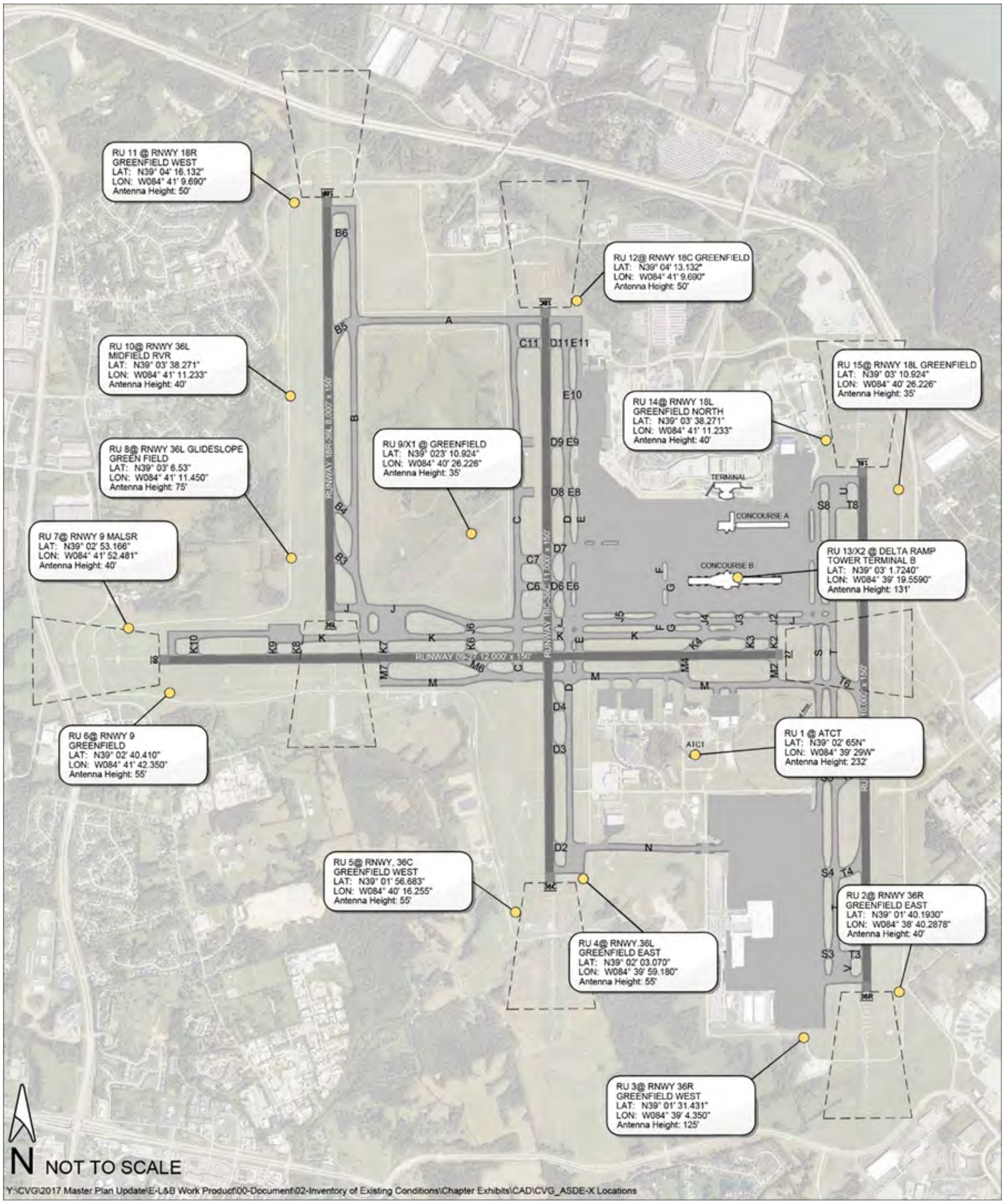


Sources: KCAB; Woolpert Photography dated September 23, 2017

2.3.11.6 *Airport Surface Detection Equipment, Model X (ASDE-X)*

ASDE-X is used by controllers to track vehicles and aircraft on airport surfaces in order to detect potential conflicts. The ASDE-X locations are shown on **Exhibit 2.3-22, *CVG ASDE-X Locations***.

EXHIBIT 2.3-22 CVG ASDE-X LOCATIONS



Sources: KCAB; Woolpert Photography dated September 23, 2017

2.3.12 Instrument Approaches

During times of inclement weather and poor visibility, pilots depend on instrument approach procedures to guide them into/out of an airport environment, and all the way down to the approach end of the runway surface. These procedures can include standard terminal arrivals, departure procedures, or instrument approach procedures. **Table 2.3-16, *CVG Instrument Approach Procedures***, presents an inventory and classification of the instrument approach procedures available at CVG by runway end and their best-case minima (ceiling/visibility).

TABLE 2.3-16 CVG INSTRUMENT APPROACH PROCEDURES

Runway	Non-Precision	Precision – Ground Based			Satellite Based	
	LOC DA/RVR	ILS–CAT I DA/RVR	ILS–CAT II RA/RVR	ILS-CAT III RVR	RNAV-GPS DA/RVR	RNAV-RNP DA/RVR
Runway 09	1,220/24	1,083/18			1,083/18	1,199/24
Runway 27	1,420/24	1,075/24			1,075/24	1,296/50
Runway 18C	1,460/1 mile	1,075/18			1,075/18	1,321/50
Runway 36C	1,260/24	1,051/18	RA 134/12	RVR 06	1,051/18	1,295/50
Runway 18L	1,300/24	1,089/18			1,089/18	1,272/40
Runway 36R	1,360/24	1,096/18	RA 98/12	RVR 06	1,096/24	1,284/40
Runway 18R	1300/24	1,068/18	RA 113/12		1,068/18	1,243/40
Runway 36L	1,220/24	1,073/18	RA 98/12		1,073/18	1,261/40

Notes: RVR – Runway Visual Range, measured in feet
DA – Decision Altitude, measured in feet above ground level
RA – Radio Altimeter, measured in feet above ground level
Source: FAA CVG Terminal Approach Procedures - October 5, 2017

2.4 Passenger Terminal Facilities

This section describes the passenger terminal and concourses at CVG and provides a comprehensive summary of the square footage by space classification throughout these facilities. The descriptions of the passenger areas include all major processing areas for departing and arriving passengers, including the check-in lobby, security screening checkpoint, baggage claim and the Customs and Border Protection (CBP) international arrivals facility.

2.4.1 Terminal and Concourse Overview

CVG has a single passenger terminal designated as the main terminal, previously known as Terminal 3, and two satellites named Concourse A and Concourse B, as shown on **Exhibit 2.4-1, *Terminal Overview***. These facilities serve all commercial passenger activity at CVG. A passenger tunnel connects the main terminal to Concourses A and B utilizing moving walkways and an Automated People Mover (APM), also referred to as an Automated Guideway Transit System (AGTS).

EXHIBIT 2.4-1 TERMINAL OVERVIEW

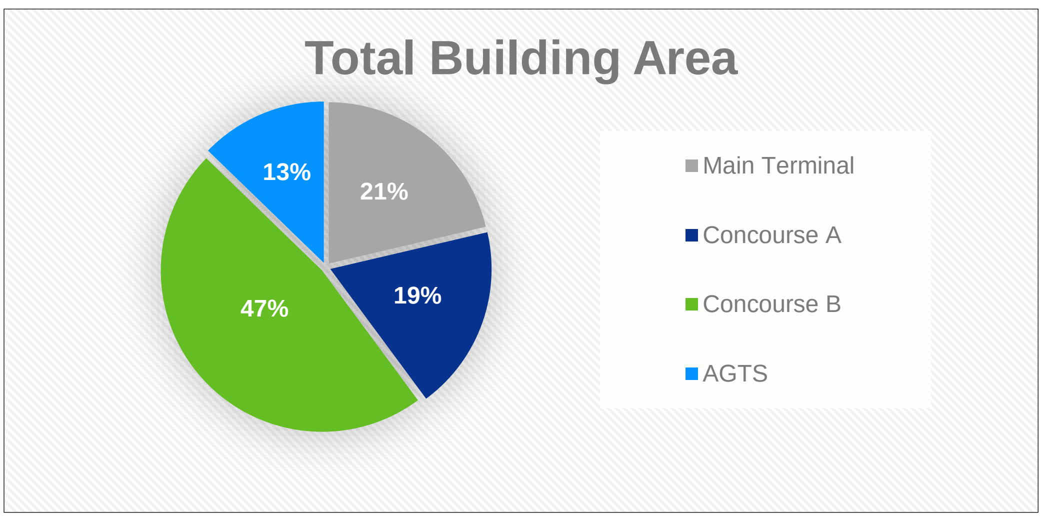
Sources: KCAB; Google Earth-Photography dated April 11, 2017

Since the bankruptcy of Delta Air Lines in 2005 and the subsequent merger of Northwest Airlines into Delta Air Lines in 2008, CVG has transitioned from being a major hub facility into primarily an origin and destination (O&D) airport. Terminal 1 was built in 1947 but ceased serving commercial airline passengers in 2007. In 2008, Concourse C, built to meet the burgeoning demand of regional jet travel in 1994, was closed as airlines like Delta reduced the number of regional jets in their fleets in favor of more fuel-efficient aircraft. In 2012, Terminal 2 was no longer used to support airline passenger activity and all commercial passenger activity was relocated into Concourses A and B and served from the main terminal. With Terminals 1, 2 and Concourse C empty of activity, KCAB directed the demolition of Terminals 1 and 2 in 2016 and then Concourse C in early 2017 in an effort to reduce ongoing maintenance costs. With the land once occupied by Terminals 1 and 2 vacant, this opened a development area for a future Consolidated Rental Car facility (CONRAC).

The main terminal houses the majority of passenger processing facilities with the exception of the CBP international arrivals facility, which is located in Concourse B. The main terminal supports all other passenger processing functions, including passenger check-in, the security screening checkpoint, and baggage claim. All passenger aircraft gates and holdrooms are located on Concourse A and B.

Exhibit 2.4-2, *Terminal Area Breakdown*, provides a square footage inventory by functional area for the main terminal, Concourse A, Concourse B, and the AGTS Tunnel. The combined area of all buildings is 1,889,164 square feet.

EXHIBIT 2.4-2 TERMINAL AREA BREAKDOWN



Sources: KCAB; Landrum & Brown analysis

2.4.2 The Main Terminal

The total square footage for the main terminal is 403,163 square feet. The inventory of terminal areas includes five main space classifications, of which four are found in the main terminal. The summary of these area classifications and the total square footage of the main terminal is summarized in **Table 2.4-1, *Main Terminal Areas by Function***.

TABLE 2.4-1 MAIN TERMINAL AREAS BY FUNCTION

Space Category	Area (ft^2)
Airline Functions	
Curbside Check-in	547
Full Service Check-in & Bag Drop	5,000
Self Service Kiosk/Queuing	11,000
Airline Ticket Offices	2,768
Outbound Baggage	58,055
Domestic Bag Claim Hall	39,801
Inbound Baggage Drop-off	14,176
Baggage Service Offices	5,263
Club/Lounge	578
Airline Operations	183
Subtotal Airline Functions	**137,371**
Secure Public Area	
Check-in Lobby Circulation	10,305
Arrivals Greeter Hall	15,569
Rest Rooms	2,739
Passenger Security Screening	20,101
Queue & Lobby	13,813
Support Areas	919
Circulation	30,548
Subtotal Secure Public Area	**93,994**
Concessions	
Food & Beverage	1,790
Specialty Retail	4,662
Concessions Support	2,080
Subtotal Concessions	**8,532**
Terminal Support	
Terminal Support	163,266
Subtotal Non-Public Area	**163,266**
Total Area	**403,163**

Sources: KCAB; Landrum & Brown analysis

2.4.2.1 *Check-in Lobby*

The main terminal check-in lobby is divided into an east side and a west side by a circulation corridor that accesses the security checkpoint and the escalators down to the baggage claim level and the tunnel level. There are 360 linear feet of check-in counter space allocated equally to each side of the check-in lobby. Delta Air Lines occupies the east side and other airlines, including American, United, Southwest, Allegiant, Frontier, and OneJet occupy the west side. While there is the same linear check-in counter frontage in both the east and west check-in lobbies, the check-in counter configurations differ. Counter configuration preferences will vary depending on airline needs and preferred millwork styles. There are 70 full service check-in and bag drop positions currently. CVG also has 43 self-service kiosks in the check-in lobby.

The overall lobby depth is approximately 50 feet from the front of the check-in counter positions to the entry vestibules at the front of the terminal. Assuming a 20-foot path for cross-circulation, the check-in lobbies have up to 30 feet of space for passenger queuing and self-service kiosk positions.

2.4.2.2 *Baggage Claim Hall*

The baggage claim hall is located on the ground level of the main terminal and is divided into an east section and a west section. The west section primarily serves Delta Air Lines while the east section of the baggage claim hall is shared by all of the other airlines. Four vestibules provide curbside access for arriving passengers and access to the parking facilities. Arriving passengers escalate up from the tunnel level into the baggage claim hall where there are four sloped claim devices, one large and one small on the east and west sides. Immediately to the east there are restroom facilities as well as heating, ventilation, and air conditioning (HVAC) systems and the main terminal loading dock. To the west are the Delta Air Lines baggage service offices, Southwest bag storage and additional HVAC support systems. Along the north wall adjacent to the entry/exit vestibules are the United Airlines and American Airlines baggage service offices as well as ground transportation and rental car information.

The large claim devices each have 255 linear feet of claim frontage and the small claim devices have 145 linear feet of frontage totaling 800 linear feet between all four devices. High-speed conveyors from Concourse A and Concourse B feed the claim devices.

2.4.2.3 *Baggage System*

High-speed conveyors from Concourse A and Concourse B feed inbound baggage to the four sloped claim devices located on the ground level of the main terminal. The load conveyors feed the tunnel level high-speed conveyor system, which delivers bags to the baggage claim devices in the main terminal.

While the main terminal does have outbound baggage screening capability for oversize items, the majority of baggage is screened and sorted in Concourse B. Checked bags are transported via high-speed conveyors from the main terminal to the Transportation Security Administration (TSA) in-line screening matrix in Concourse B for checked baggage inspection and resolution. Checked bags are then sorted and transported via conveyor to baggage makeup devices in Concourse A and Concourse B. Bags are then collected and delivered to aircraft via tug and cart.

2.4.2.4 *Security Checkpoint*

The main terminal operates a single centrally located 10-lane security checkpoint located south of the check-in lobby. The checkpoint lane area currently utilizes 20,101 square feet including a recompose area at the back of the checkpoint and an area at the front of the checkpoint lanes for Travel Document Check (TDC) podiums. The checkpoint queue area is approximately 7,800 square feet with an additional 6,000 square feet of queue overflow area located to the east and west of the checkpoint lanes. The allocation of regular and TSA Pre✓® lanes depends on time of day. Typically, two dedicated TSA Pre✓® lanes are allocated along with eight regular screening lanes.

2.4.2.5 *Concessions and Restrooms*

As passengers proceed to the security checkpoint from the check-in hall, there are three landside concessions. There are landside restrooms located on the west side of the lobby prior to the security checkpoint. Landside concession programs are typically limited in size and offerings, most passengers choose to make their purchases on the airside near their departure gate. These landside concessions also serve CVG staff, TSA staff, and meters, greeters, or well-wishers that may be accompanying arriving/departing passengers.

2.4.3 AGTS and Baggage Tunnel

Passengers and baggage are connected to Concourse A and Concourse B via a tunnel connection. Passengers access the tunnel via elevators and escalators located directly beyond the security checkpoint. Adjacent to the respective train platforms, additional vertical circulation (elevators and escalators) provides access to and from Concourse A and Concourse B. The total area of the AGTS and Baggage Tunnel is 240,891 square feet.

The AGTS has two trains serving three locations that consist of shared boarding platforms for loading/unloading at the main terminal, Concourse A and Concourse B. The overall AGTS and pedestrian tunnel width is approximately 75 feet. This includes the train right-of-way and a 32-foot circulation corridor with bi-directional moving walkways. The unassisted walking distance in the tunnel is approximately 700 feet to Concourse A and 1,400 feet to Concourse B.

The end of the tunnel nearest to the main terminal includes a public meeter/greeter area and vertical circulation up to the baggage claim and check-in levels of the terminal. The tunnel also extends further allowing passengers to directly access the parking garage by passing under the upper level roadways.

The AGTS train maintenance area is located just beyond the Concourse B platform. This area also accommodates the machine rooms for the AGTS pulley driven system along with the respective control room, electrical systems and a breakroom located at the second level. The high-speed conveyor systems are located at the baggage level of the tunnel. The summary of these functions and the total square footage of the AGTS is listed in **Table 2.4-2, *AGTS Areas by Function***.

TABLE 2.4-2 AGTS AREAS BY FUNCTION

Space Category	Grand Total
Airline Functions	
Airline Operations	121,749
Subtotal Airline Functions	**121,749**
Secure Public Area	
Circulation	107,170
Subtotal Secure Public Area	**107,170**
Terminal Support	
Terminal Support	11,972
Subtotal Terminal Support	**11,972**
Total Area	**240,891**

Sources: KCAB; Landrum & Brown analysis

2.4.4 Concourse A

Concourse A, originally constructed in 1974, is located closest to the main terminal. Concourse A was last renovated in 2012 to handle the transition of airlines from Terminal 2 into Concourse A following the consolidation of commercial airlines into the main terminal. The footprint of Concourse A is 100 feet wide and 1,400 feet long with a total building area of approximately 350,108 square feet. Concourse A, which is shared by six airlines including Air Canada, Allegiant, Apple Vacations, Frontier, Southwest, and United, has 23 gates. The inventory of the Concourse A areas includes four main space classifications. The summary of these functions can be found in **Table 2.4-3, *Concourse A Areas by Function***.

TABLE 2.4-3 CONCOURSE A AREAS BY FUNCTION

Space Category	Area (ft^2)
Airline Functions	
Outbound Baggage	30,445
Contact Gate Holdrooms	54,680
Club/Lounge	14,566
Airline Operations	100,367
Subtotal Airline Functions	**200,058**
Secure Public Area	
Concourse Central Circulation	55,947
Rest Rooms	6,711
Subtotal Secure Public Area	**62,658**
Concessions	
Food & Beverage	12,256
Specialty Retail	5,192
News & Gifts	2,341
Concessions Support	2,859
Subtotal Concessions	**22,648**
Terminal Support	
Terminal Support	64,744
Subtotal Non-Public Area	**64,744**
Total Area	**350,108**

Sources: KCAB; Landrum & Brown analysis

2.4.4.1 *Baggage System and Support Facilities*

The ramp level of Concourse A includes baggage facilities, tenant offices, mechanical/electrical/ plumbing (MEP) systems and other support spaces. The baggage facilities at Concourse A include an outbound baggage make-up carousel and inbound baggage conveyors. Outbound checked baggage is transported from the TSA checked baggage inspection facilities in Concourse B and is delivered to Concourse A via a tunnel level conveyor. Inbound baggage is delivered via tug and cart from the Concourse A gates to the baggage load conveyors to be delivered to the main terminal baggage claim. The majority of tenant offices and support spaces on the ramp level are currently vacant.

2.4.4.2 *Passenger Areas and Concessions*

The departures level of Concourse A includes the majority of secure public areas including over 54,000 square feet of holdroom space and over 22,000 square feet of area dedicated to con cessions. Three moving walkways facilitate passenger movement to the gate positions. Airline club space occupies over 14,000 square feet. Concourse A only accommodates domestic arrivals and pre-cleared international arrivals; all international arriving passengers requiring immigration processing must arrive through the CBP facility in Concourse B.

2.4.5 Concourse B

Concourse B, constructed in 1994, is about 1,100 feet south of Concourse A and has 28 gate positions. The footprint of Concourse B is 125 feet wide and 1,850 feet long with a total building area of 895,002 square feet. This concourse is shared by Delta and American. Concourse B provides the only active CBP international arrivals facility at CVG. Concourse B also houses the TSA checked baggage screening and inspection facilities that process all checked baggage for both Concourse A and Concourse B. The summary of functional areas is shown in **Table 2.4-4, *Concourse B Areas by Function***.

TABLE 2.4-4 CONCOURSE B AREAS BY FUNCTION

Space Category	Grand Total
Airline Functions	
Outbound Baggage	136,174
Hold Baggage Screening	17,310
Inbound Baggage Drop-off	30,826
Contact Gate Holdrooms	79,935
Club/Lounge	31,204
Airline Operations	123,576
Subtotal Airline Functions	**419,0285**
Secure Public Area	
Concourse Central Circulation	98,755
Concourse Sterile Corridor	5,442
Rest Rooms	10,905
Circulation	3,192
Subtotal Concessions	**118,294**
Concessions	
Food & Beverage	32,591
Specialty Retail	20,071
Duty Free	6,364
Concessions Support	13,066
Subtotal Concessions	**72,092**
CBP	
CBP	126,241
Subtotal CBP	**126,241**
Terminal Support	
Terminal Support	159,350
Subtotal Terminal Support	**159,350**
Total Area	**895,002**

Sources: KCAB; Landrum & Brown analysis

2.4.5.1 *Baggage System and Support Facilities*

The basement level of Concourse B accommodates the TSA in-line bag screening matrix where the majority of checked baggage at CVG is screened and inspected. This area includes the Checked Baggage Inspection System (CBIS) and the Checked Baggage Reconciliation Area (CBRA). After screening, checked baggage is delivered to make-up devices in Concourse A and Concourse B via conveyor. Checked bags are then distributed to aircraft via tug and cart. The spaces that support Concourse B are concentrated on the basement level. The ramp level houses tenant offices, the CBP international arrivals facility, and other support spaces.

2.4.5.2 *Passenger Areas and Concessions*

Concourse B provides more spacious passenger areas than Concourse A with a wider concourse footprint, allowing for larger holdrooms and circulation areas. The center of Concourse B concentrates numerous food/beverage, news/gifts, and other specialty concessions. Concourse B has dedicated international arrivals gates on the west end of the course, allowing sterile arriving passengers access to the CBP international arrivals facility on the ramp level.

2.4.5.3 *CBP International Arrivals Facility*

The CBP international arrivals facility is located on the ramp level of Concourse B and provides immigration and customs screening for re-entry into the U.S. The CBP facility at Concourse B has a capacity to process up to 600 peak hour passengers based on the 2017 CBP *Airport Technical Design Standards* (ATDS). After arriving into the sterile corridors via international gates located on the west end of Concourse B, passengers process through six piggyback immigration booths and then collect their baggage at one of three claim devices. Following baggage claim, passengers process through customs and then re-check their baggage. Since the CBP is located on Concourse B, which is a secured airside concourse accessible to other outbound flights, passengers must process through security re-screening before entering the secure area of Concourse B and the AGTS Tunnel.

The location of the CVG international arrivals facility is unique amongst other U.S. airports because it is situated on a secure passenger concourse away from the main terminal. While this CBP location was once at the heart of Delta Air Lines connecting hub flights, CVG has transitioned to primarily O&D passenger activity and this airside location has become an operational disadvantage for CVG.

Most international arrivals facilities are located near terminals and curbside roadways, exiting passengers into public or non-secure spaces. Due to the airside location of Concourse B, there is no direct access to a public or non-secure exit for international arriving passengers. All international arriving passengers require re-screening at a dedicated security checkpoint in order to exit into Concourse B or the AGTS Tunnel. Additionally, large checked baggage that cannot fit through the checkpoint X-Ray machines must be re-checked. Checked baggage is then reclaimed at the main terminal. This applies to passengers whose final destination is CVG and passengers who are connecting to another flight.

2.5 Landside Access & Parking

The following section describes in detail the existing landside access network and auto parking facilities at CVG. In addition, detailed traffic counts at specific roadway intersections around CVG have been collected. While these traffic counts are summarized and referred to in this section, the detailed data is presented in **Appendix 2-A, *Study Area Traffic Counts***.

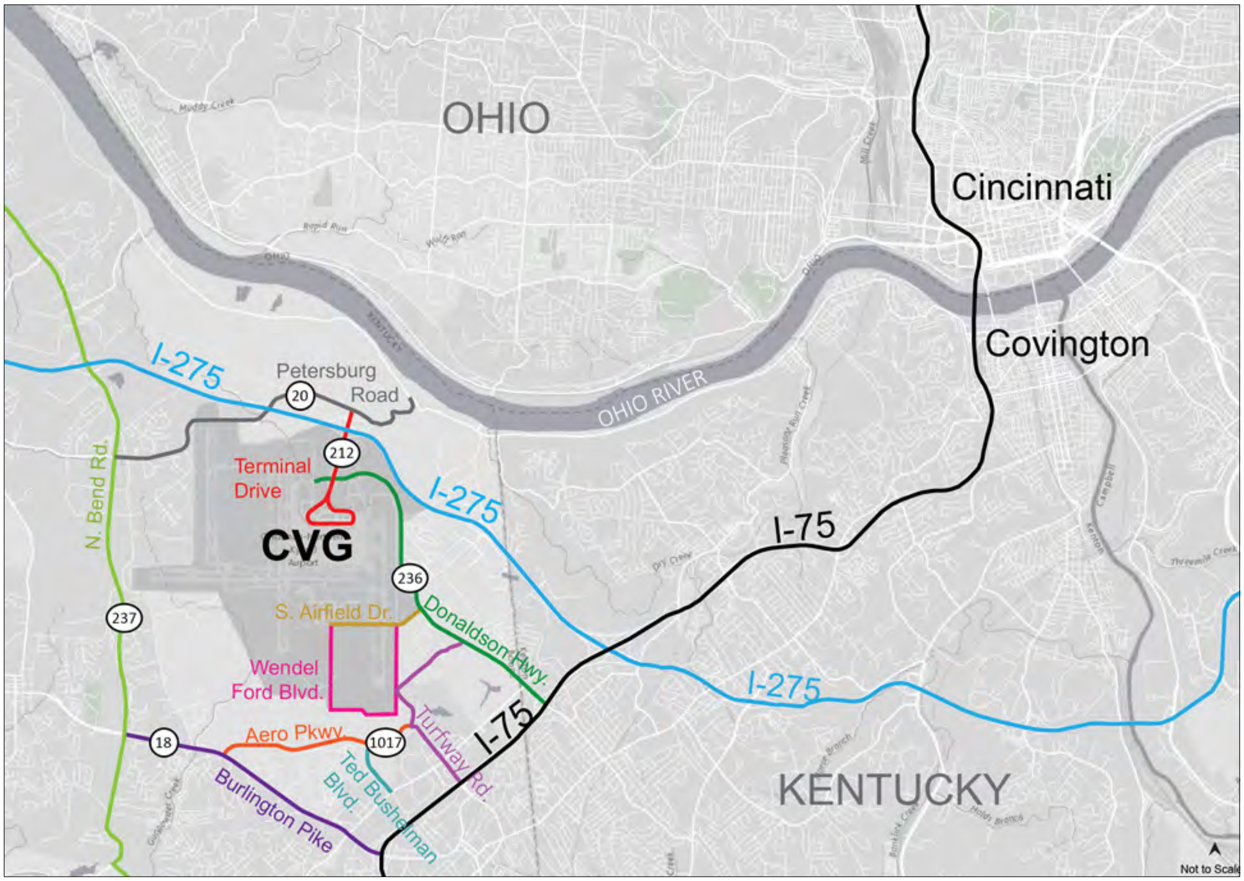
2.5.1 Regional Roadway and Airport Access

CVG is surrounded by four major roadways that pass either directly adjacent to, or nearby CVG. Approximately one mile north of the terminal area is Interstate 275 (I-275), a six-lane highway that circumnavigates the Cincinnati metro area, connecting Ohio, Kentucky and Indiana. The southern portion of CVG is bordered by the east/west-running Aero Parkway and Burlington Pike (KY 18). North Bend Road is a four-lane road running north south along the western extents of CVG. Donaldson Highway (KY 236) begins adjacent to the existing cargo complex on the north side of CVG and continues east and then south, wrapping around the eastern portion of CVG, before intersecting I-71/I-75 just southeast of CVG property.

Terminal Drive (KY 212) is located just north of the Terminal Area and serves as the primary public access roadway to CVG. This road runs south from Petersburg Road (KY 20) to the terminal campus, with connections to I-275 and Donaldson Highway. A majority of the traffic heading into CVG utilizes I-275 before exiting onto Terminal Drive. The counter-clockwise loop through the terminal campus begins approximately ¾ mile south of I-275.

Donaldson Highway is the primary access road for service vehicles (air freight delivery trucks, airport and airline service vehicles, etc.). The South Service Area is also well-served by a network of South Airfield Drive, Donaldson Highway, Turfway Road, Wendell H. Ford Boulevard, and Ted Bushelman Boulevard. **Exhibit 2.5-1, *Regional Roadway Map***, presents a map of the roadways near CVG.

EXHIBIT 2.5-1 REGIONAL ROADWAY MAP

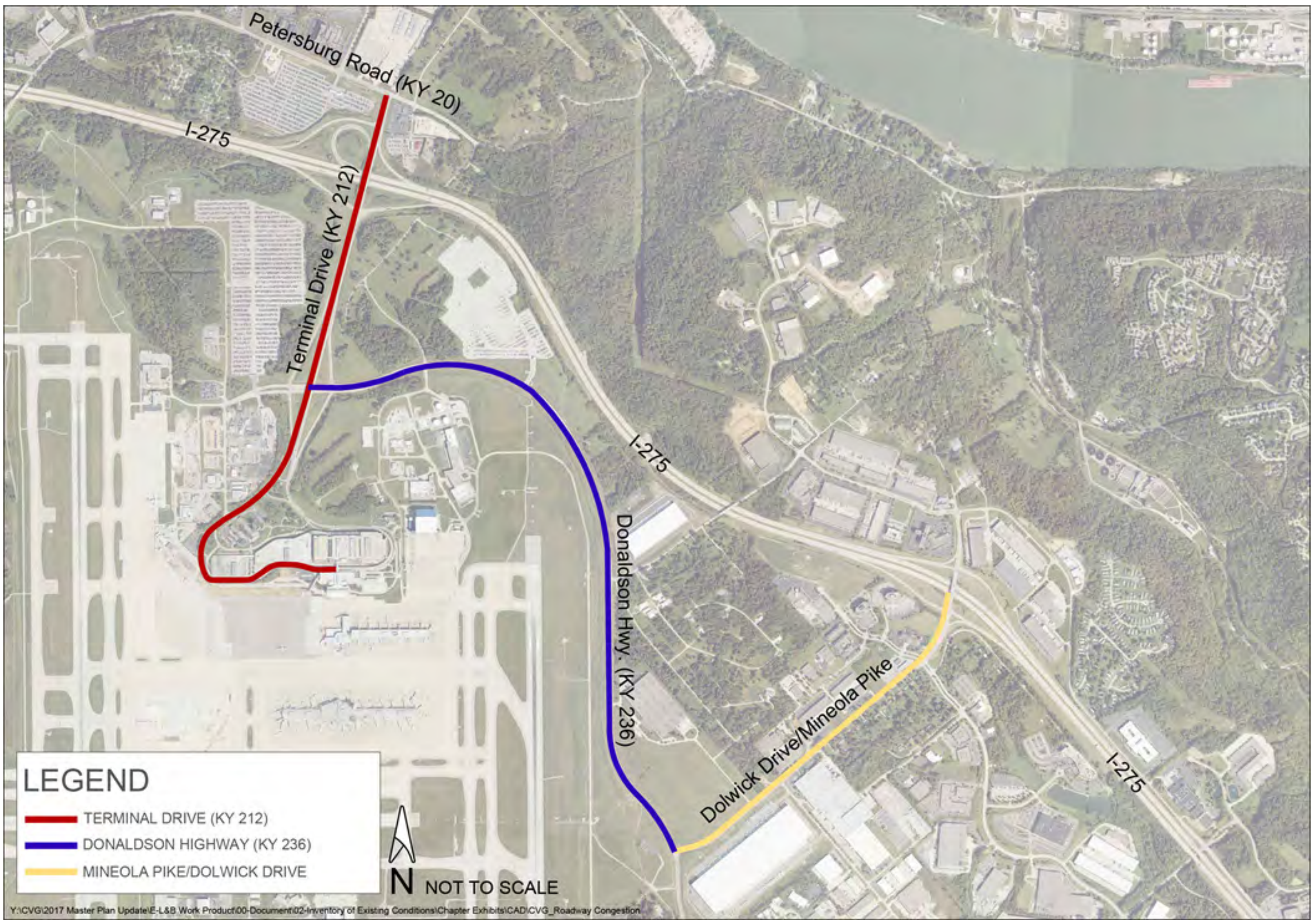


Sources: ESRI; Landrum & Brown analysis

The Boone County Transportation Plan[4] has noted that the proportion of trucks to standard vehicles has increased along major Boone County corridors. This increase varies from six percent to ten percent on roadways that were examined. Several roadways near CVG have been identified as having traffic with greater than ten percent truck volumes, which highlights the increased need to accommodate these trucks. These roadways are presented on **Exhibit 2.5-2, *High Truck Traffic Roads***, and include:

- Terminal Drive (KY 212) from Petersburg Road (KY 20) to CVG
- Donaldson Highway (KY 236) from Terminal Drive (KY 212) to Mineola Pike (KY 3076)
- Mineola Pike (KY 3076)/Dolwick Drive from Donaldson Highway (KY 236) to Boone County Line

EXHIBIT 2.5-2 HIGH TRUCK TRAFFIC ROADS



Sources: Boone County Transportation Plan; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

4 Boone County Transportation Plan – *Existing and Future Conditions Report*, Draft October 12, 2017

2.5.2 Existing Traffic Counts

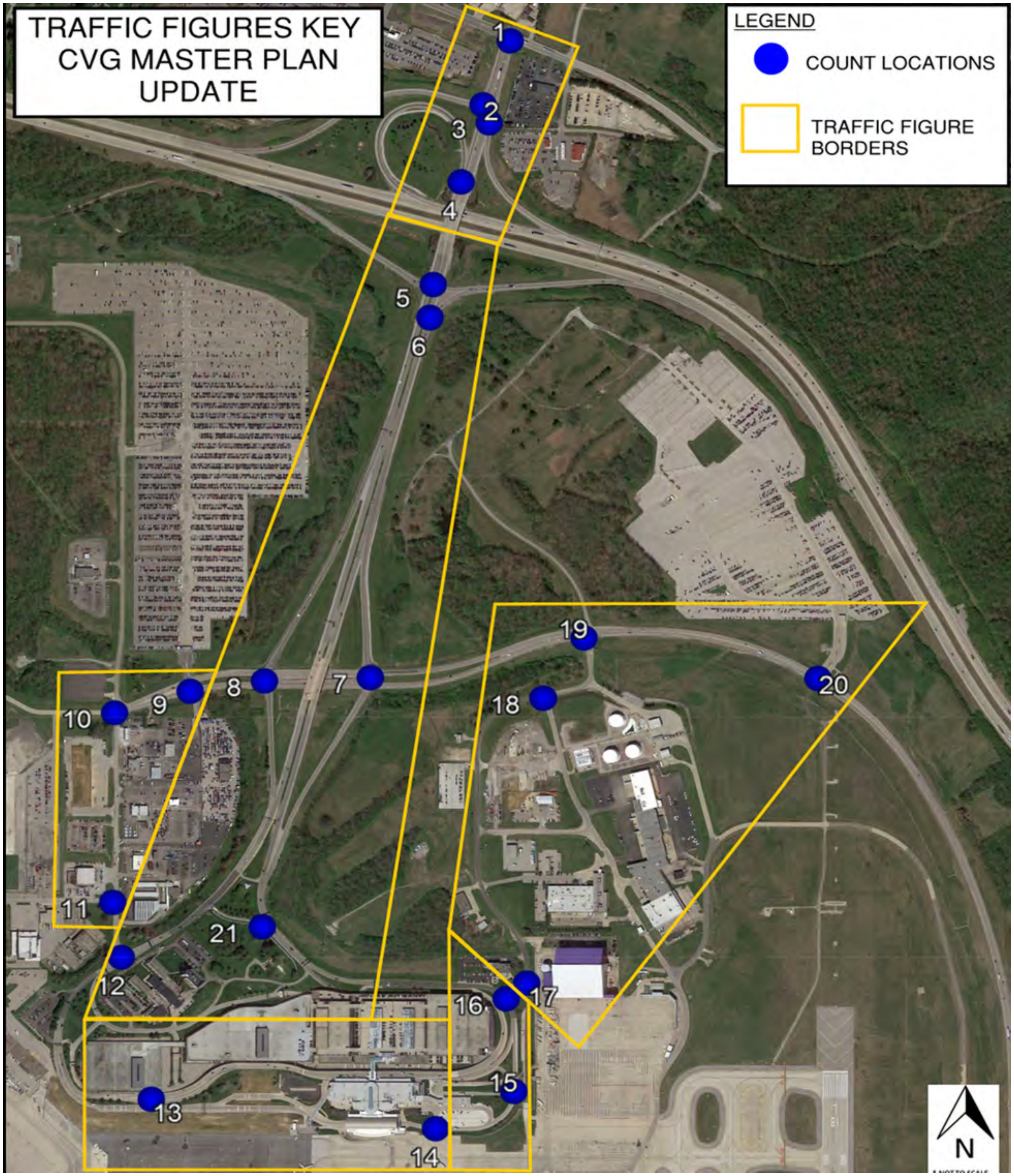
Video turning movement counts were conducted for use in this Master Plan. The video turning movement counts were conducted at 21 intersections for varying hours and days depending on the location and direction from KCAB. **Table 2.5-1, *Traffic Count Summary***, describes the intersections counted, the processed hours, and the day each was counted. **Exhibit 2.5-3, *Traffic Count Locations***, identifies the location of each point where traffic counts were conducted as part of this effort.

TABLE 2.5-1 TRAFFIC COUNT SUMMARY

Int #	Intersection	Processing Hours	Day of Count
1	Petersburg Road (KY 20) at Terminal Drive (KY 212)	24 hours	Thursday; October 26, 2017
2	I-275 Westbound Entry Ramp from Terminal Drive (KY 212)	24 hours	Thursday; October 26, 2017
3	I-275 Westbound Exit Ramp to Terminal Drive North (KY 212)	24 hours	Thursday; October 26, 2017
4	I-275 Westbound Exit Ramp to Terminal Drive South (KY 212)	24 hours	Thursday; October 26, 2017
5	I-275 Eastbound Exit Ramp to Terminal Drive South (KY 212)	24 hours	Thursday; October 26, 2017
6	I-275 Eastbound Entry Ramp from Terminal Drive North (KY 212)	24 hours	Thursday; October 26, 2017
7	Donaldson Highway (KY 236) at Terminal Drive Ramp (East Ramp)	24 hours	Thursday; August 3, 2017
8	Donaldson Highway (KY 236) at Terminal Drive Ramp (West Ramp)	24 hours	Thursday; August 3, 2017
9	Donaldson Highway at ValuPark Intersection	12 hours; 6am-6pm	Thursday; August 3, 2017
10	Donaldson Highway at Loomis Road/Clay Drive	24 hours	Thursday; August 3, 2017
11	Loomis Road at Barkley Drive	24 hours	Thursday; August 3, 2017
12	Loomis Road at Terminal Drive	12 hours; 6am-6pm	Thursday; August 3, 2017
13	Terminal Drive Split to Upper and Lower Roadway	12 hours; 5am-5pm	Friday; October 27, 2017
14	Lincoln Road at Limo Lot	12 hours; 5am-5pm	Friday; October 27, 2017
15	Lincoln Road at Taxi Pickup	12 hours; 5am-5pm	Friday; October 27, 2017
16	Lincoln Road at PD1	12 hours; 5am-5pm	Friday; October 27, 2017
17	Lincoln Road at PD2	12 hours; 5am-5pm	Friday; October 27, 2017
18	Lincoln Road at Kenton Road	12 hours; 5am-5pm	Friday; October 27, 2017
19	Lincoln Road at Donaldson Highway	12 hours; 6am-6pm	Thursday; August 3, 2017
20	Donaldson Road at Employee Lot	12 hours; 6am-6pm	Thursday; August 3, 2017
21	Terminal Drive Turnaround	24 hours	Thursday; August 3, 2017

Source: Woolpert

EXHIBIT 2.5-3 TRAFFIC COUNT LOCATIONS



Source: Woolpert

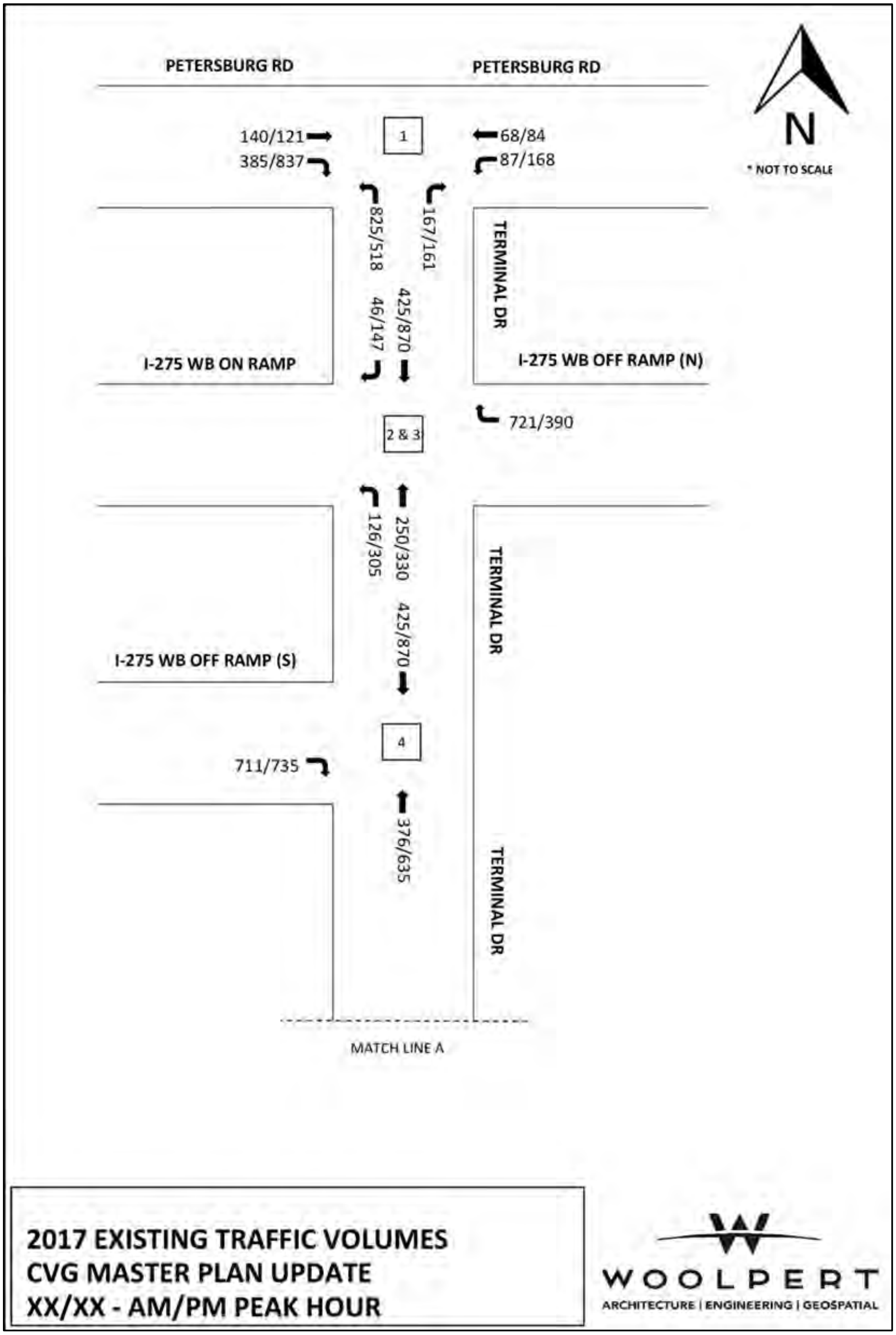
Table 2.5-2, *Intersection Peak Hours*, lists both the morning and afternoon peak hours for each location where traffic was counted. The results for each location are presented in graphical form in **Exhibits 2.5-4 through 2.5-9**.

TABLE 2.5-2 INTERSECTION PEAK HOURS

Int #	Intersection	AM Peak	PM Peak
1	Petersburg Road (KY 20) at Terminal Drive (KY 212)	7:15-8:15 AM	4:30-5:30 PM
2	I-275 Westbound Entry Ramp from Terminal Drive (KY 212)	7:15-8:15 AM	4:30-5:30 PM
3	I-275 Westbound Exit Ramp to Terminal Drive North (KY 212)	6:30-7:30 AM	5:00-6:00 PM
4	I-275 Westbound Exit Ramp to Terminal Drive South (KY 212)	5:15-6:15 AM	3:15-4:15 PM
5	I-275 Eastbound Exit Ramp to Terminal Drive South (KY 212)	6:45-7:45 AM	3:00-4:00 PM
6	I-275 Eastbound Entry Ramp from Terminal Drive North (KY 212)	6:45-7:45 AM	3:00-4:00 PM
7	Donaldson Highway (KY 236) at Terminal Drive Ramp (East Ramp)	7:30-8:30 AM	3:30-4:30 PM
8	Donaldson Highway (KY 236) at Terminal Drive Ramp (West Ramp)	6:45-7:45 AM	3:15-4:15 PM
9	Donaldson Highway at ValuPark Intersection	6:30-7:30 AM	2:00-3:00 PM
10	Donaldson Highway at Loomis Road/Clay Drive	7:30-8:30 AM	2:45-3:45 PM
11	Loomis Road at Barkley Drive	9:00-10:00 AM	2:45-3:45 PM
12	Loomis Road at Terminal Drive	9:00-10:00 AM	1:30-2:30 PM
13	Terminal Drive Split to Upper and Lower Roadway	10:15-11:15 AM/ 9:45-10:45 AM	2:45-3:45 PM/ 2:15-3:15 PM
14	Lincoln Road at Limo Lot	9:00-10:00 AM	2:15-3:15 PM
15	Lincoln Road at Taxi Pickup	9:00-10:00 AM	2:30-3:30 PM
16	Lincoln Road at PD1	9:00-10:00 AM	2:45-3:45 PM
17	Lincoln Road at PD2	9:00-10:00 AM	2:30-3:30 PM
18	Lincoln Road at Kenton Road	8:00-9:00 AM	2:00-3:00 PM
19	Lincoln Road at Donaldson Highway	7:30-8:30 AM	3:15-4:15 PM
20	Donaldson Road at Employee Lot	7:30-8:30 AM	3:15-4:15 PM
21	Terminal Drive Turnaround	5:30-6:30 AM	1:45-2:45 PM

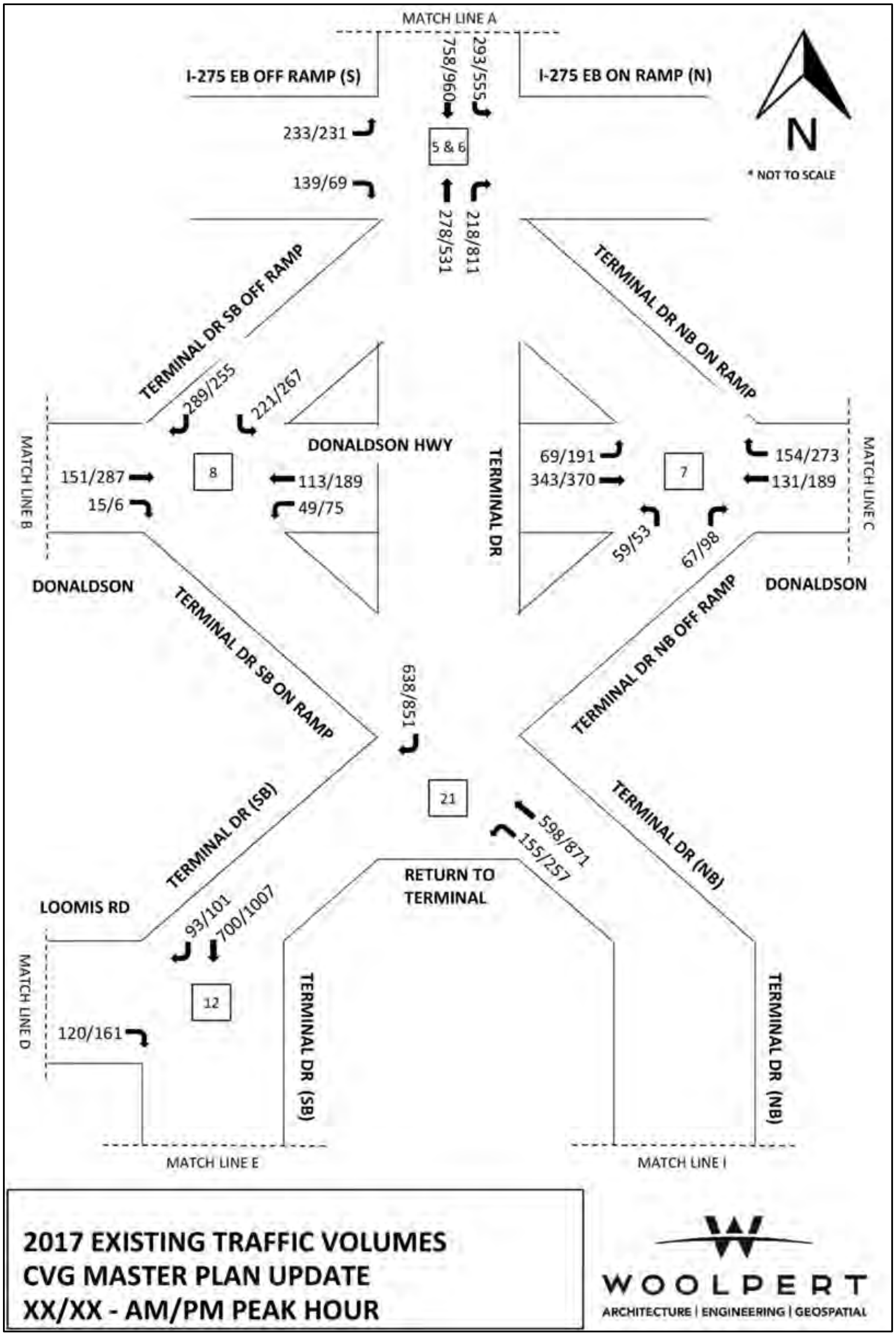
Source: Woolpert

EXHIBIT 2.5-4 TRAFFIC COUNTS – LOCATIONS 1 THROUGH 4



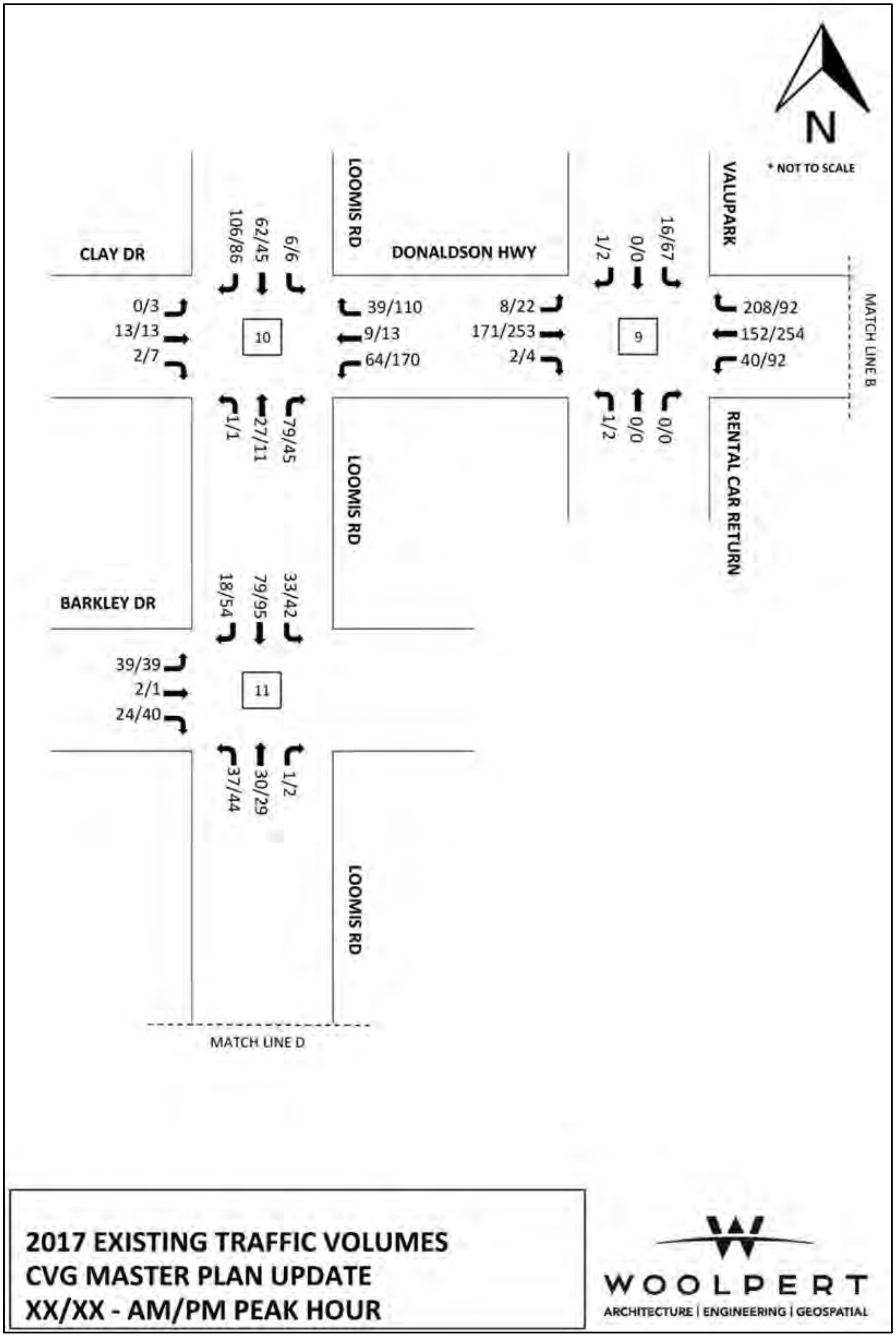
Source: Woolpert

EXHIBIT 2.5-5 TRAFFIC COUNTS – LOCATIONS 5 THROUGH 8, 12, AND 21



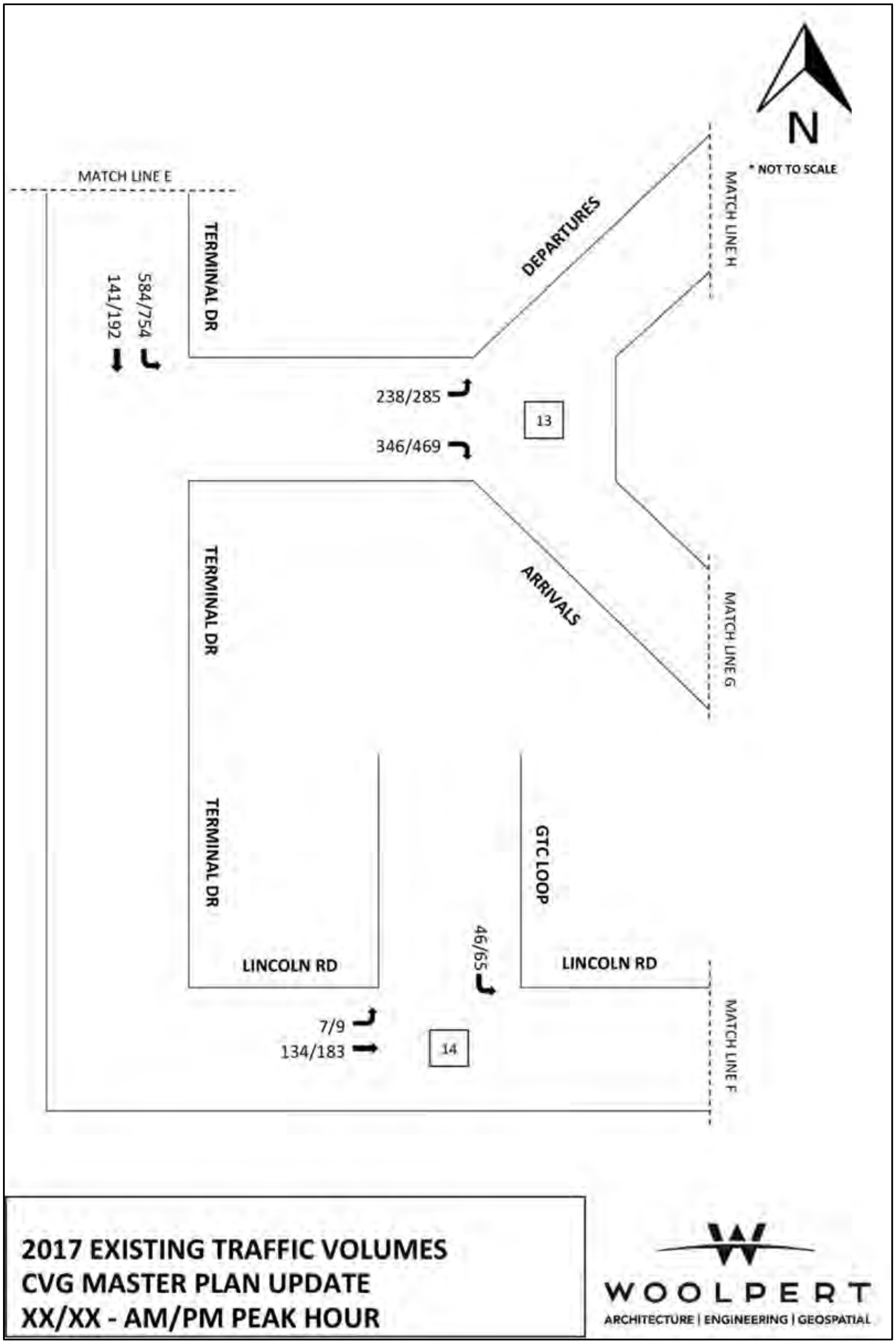
Source: Woolpert

EXHIBIT 2.5-6 TRAFFIC COUNTS – LOCATIONS 9 THROUGH 11



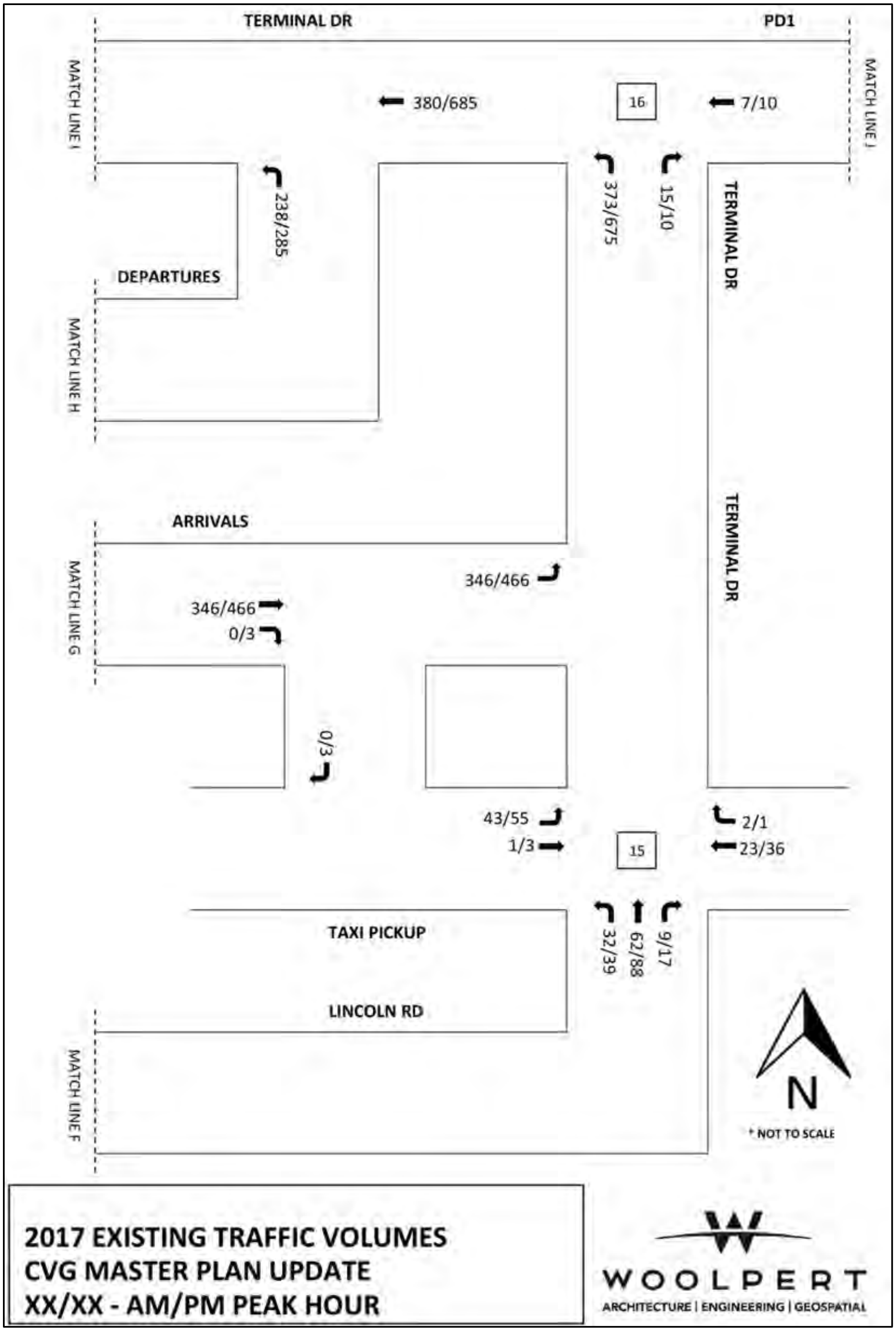
Source: Woolpert

EXHIBIT 2.5-7 TRAFFIC COUNTS – LOCATIONS 13 AND 14



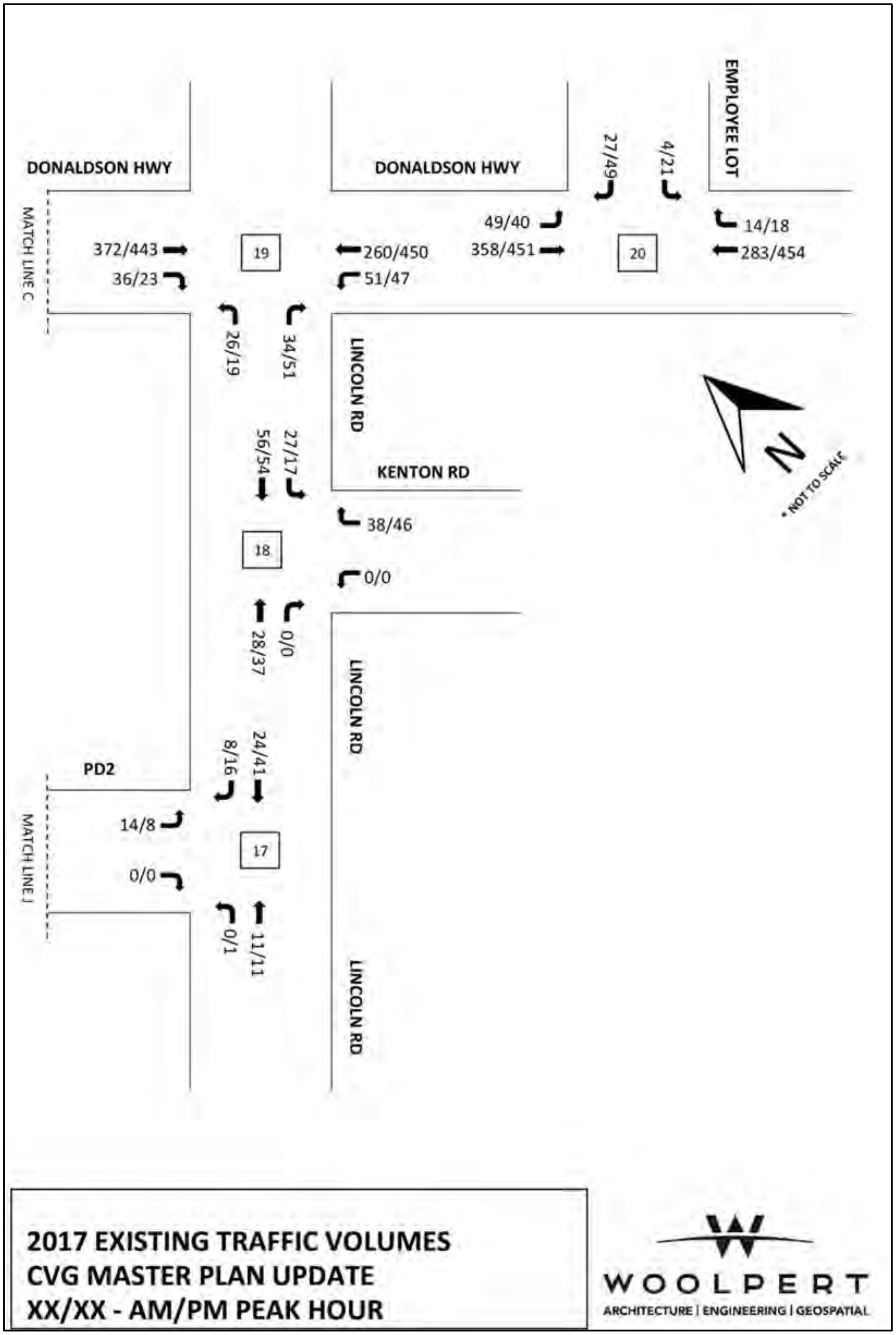
Source: Woolpert

EXHIBIT 2.5-8 TRAFFIC COUNTS – LOCATIONS 15 AND 16



Source: Woolpert

EXHIBIT 2.5-9 TRAFFIC COUNTS – LOCATIONS 17 , 19, AND 20



Source: Woolpert

The roadways and intersections that were studied for 24 hours can be summarized as an Annual Daily Traffic (ADT) volume. **Table 2.5-3, *Traffic Count ADT Summary***, presents the results of these ADT counts. **Exhibit 2.5-10, *ADT Counts Locations 1 through 6***, and **Exhibit 2.5-11, *ADT Counts Locations 7 through 12 and 21***, present theses ADT counts in graphical form.

TABLE 2.5-3 TRAFFIC COUNT ADT SUMMARY

Location	ADT
Petersburg Road West of Terminal Drive	17,820
Petersburg Road East of Terminal Drive	5,970
Terminal Drive South of Petersburg and North of I-275 Westbound Entry Ramp	19,957
Terminal Drive between I-275 Ramps (on bridge)	25,395
Terminal Drive South of I-275 and North of Donaldson Ramps	31,512
Terminal Drive between Donaldson Ramps (on bridge)	19,060
Terminal Drive South of Donaldson and North of Terminal Drive Turnaround	22,427
Donaldson Highway West of Terminal Drive	10,302
Donaldson Highway East of Terminal Drive	11,230
Terminal Drive Turnaround	3,318
Loomis Drive South of Donaldson Highway	5,482

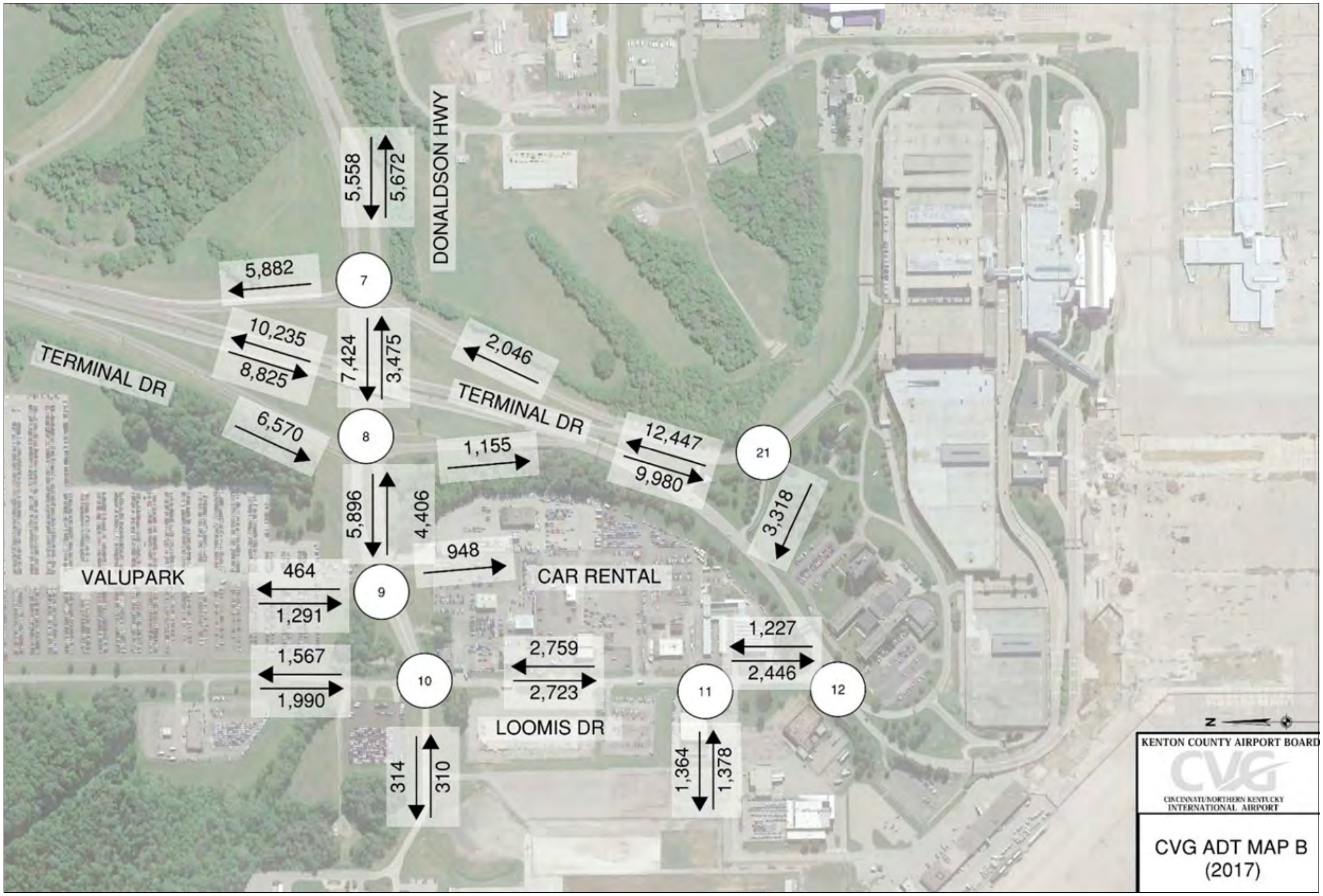
Source: Woolpert

Truck percentages within the study area ranged from as high as 12 percent to as low as one percent. The higher percentages are seen in the northern part of the study area with I-275 while the lower percentages were located along the south side of the terminal in the Ground Transportation Center (GTC) area.

EXHIBIT 2.5-10 ADT COUNTS – LOCATIONS 1 THROUGH 6

Source: Woolpert

EXHIBIT 2.5-11 ADT COUNTS – LOCATIONS 7 THROUGH 12 AND 21



Source: Woolpert

2.5.3 Vehicle Parking Facilities

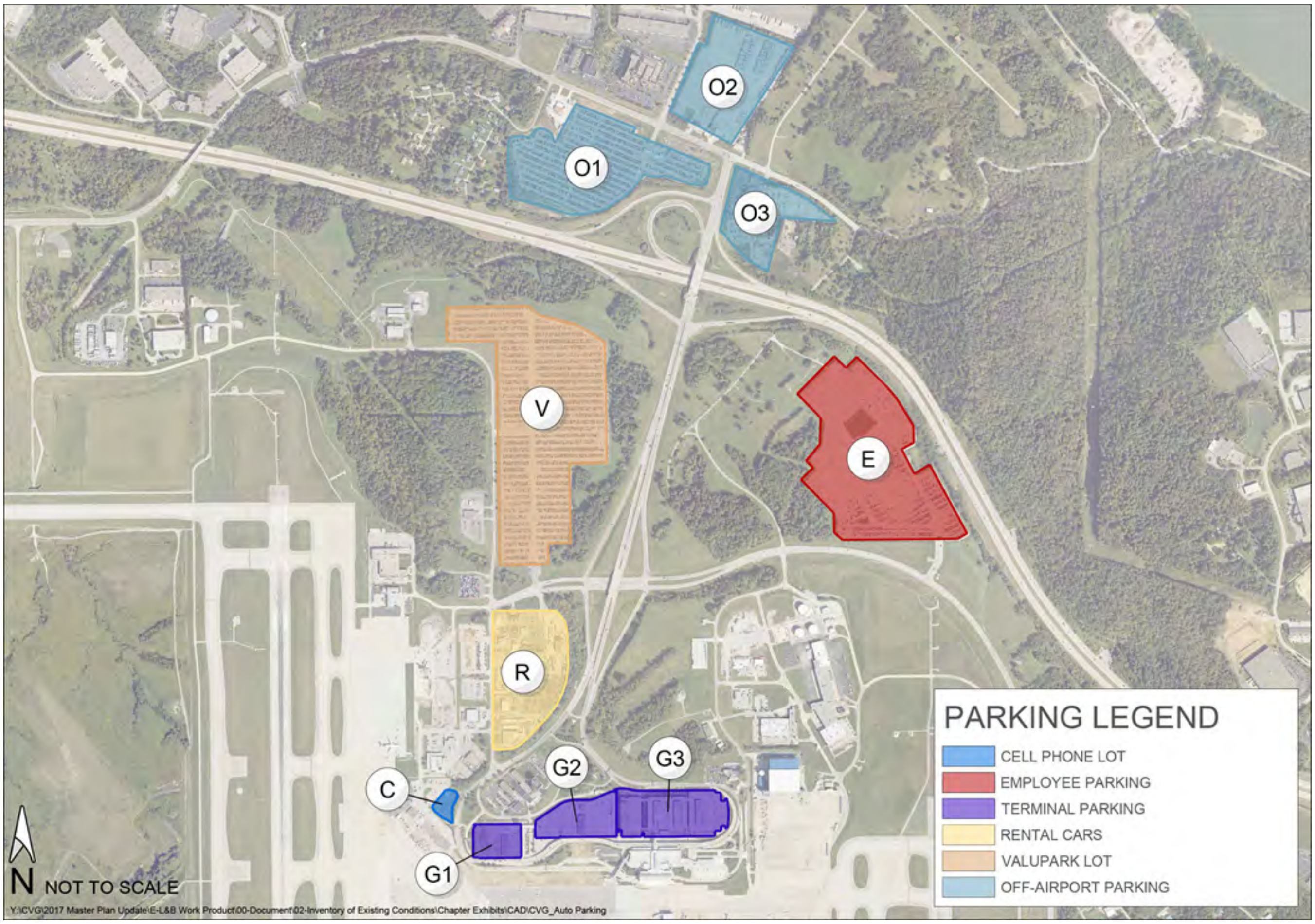
There are currently various vehicle-parking facilities at CVG providing multiple levels of product to passengers, employees, and rental car companies alike. **Table 2.5-4, *CVG Vehicle Parking Facilities***, presents an inventory of each facility, the product provided, and its capacity. **Exhibit 2.5-12, *CVG Vehicle Parking Facilities***, presents the location of each of these facilities.

TABLE 2.5-4 CVG VEHICLE PARKING FACILITIES

Facility	Map ID	Capacity (spaces)	Product	Airport Owned/ Operated	Access to Terminal	Average Occupancy	Peak Occupancy
T1 Garage	G1	500	Employee	Yes	Direct	60%	75%
T2 Garage	G2	1,616	Hourly/ Short-Term	Yes	Direct		
T3 Garage	G3	5,200	Hourly/ Short-Term	Yes	Direct		
Cell Phone Lot	C	370	Free Waiting Area	Yes	-		
ValuPark	V	6,200	Long Term	Yes	Shuttle		
Employee Lot	E	4,400	Employee	Yes	Shuttle		
FastPark & Relax	O1	2,677	Long Term	No	Shuttle		
Vacant	O2	2,109	Long Term	No	Shuttle		
Xpress Park and Ride	O3	706	Long Term	No	Shuttle		

Sources: KCAB; Google Earth; Woolpert; Landrum & Brown analysis

EXHIBIT 2.5-12 CVG VEHICLE PARKING FACILITIES



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

2.5.3.1 *Terminal Parking Garages*

North of the terminal area is a series of three multi-level public parking garages identified as G1, G2, and G3 on the exhibit. Originally, these garages were directly associated with Terminals 1, 2, and 3 respectively. However, with the demolition of Terminals 1 and 2, all three garages now serve the main terminal. These garages are all located adjacent to one another, with connecting ramps allowing for vehicular movement between each garage. All vehicles exit the garages through a parking toll plaza located between Garages 2 and 3.

Garage 1 is the oldest of the three garages and was constructed in 1979. It provides 731 parking spaces on two levels. Garage 2, which is located immediately to the east of Garage 1, is three levels and provides 1,616 parking spaces. Garage 2 is equipped with two access ramps to the upper levels and two bridges providing connection points to Garages 1 and 3. Pedestrians can access Terminal 3 directly by sidewalk at ground level.

Garage 3 is a five-level parking structure located immediately north and adjacent to the main terminal building. Garage 3 provides 5,200 parking spaces. Garage 3 was constructed in three phases. The first phase completed the central portion of the garage in 1988. A western expansion phase was completed in 1995, and an eastern expansion was completed in 2000. Passengers can directly access the main terminal building via a walking bridge connection on Level 3 to the ticketing level of the terminal or at ground level via a crosswalk to the baggage claim level of the terminal.

2.5.3.2 *Remote Parking*

There are three types of remote parking provided on and off-airport at CVG. These include long-term parking, employee parking, and privately owned off-airport parking.

CVG provides public long-term parking with a large surface lot located north of Donaldson Highway and west of Terminal Drive (KY 212). This lot is approximately two million square feet in size and provides 6,200 vehicle parking spaces. CVG has branded this parking product ValuPark. Access to the ValuPark lot is via Donaldson Highway from Terminal Drive (KY 212) and I-275. CVG provides public parking in the ValuPark lot with continual shuttle service between the lot and the main terminal building.

In addition to public parking, CVG also provides a separate lot for employees working at the Airport. This employee parking lot is located between Donaldson Highway and I-275. The employee lot covers approximately 1.6 million square feet of area and provides 4,400 vehicle parking spaces. Access to the employee parking lot is via Donaldson Highway east of Airpark Drive. CVG provides employees with dedicated shuttle service between the employee lot and the main terminal building.

Multiple private operators provide public parking immediately off-airport north of I-275, both east and west of Terminal Drive (KY 212). In the past, there have been three operators; today only two remain in operation, FastPark & Relax, and Xpress Park & Ride. These operators are not affiliated with CVG in any way but do provide continuous shuttle service between their lots and the main terminal building for passengers parking their vehicles in these lots. Combined these parking lots provide approximately 5,500 parking spaces.

2.5.3.3 *Cell Phone Lot*

For people travelling to CVG to pick up arriving passengers that do not wish to fully park their vehicles, the Airport provides a Cell Phone Lot. This Cell Phone Lot allows these meeters/greeters to park while remaining with their vehicle at all times. This prevents these vehicles from needing to re-circulate on Terminal Drive past the terminal curb while they wait for the arriving passenger to get to the curbfront. The existing Cell Phone Lot at CVG is located immediately adjacent to Terminal Drive northwest of Garage 1. The lot is approximately 39,000 square feet in area.

2.5.3.4 *Rental Car Lots*

Rental car companies at CVG currently operate their own independent facilities. The majority of these facilities are located on-airport along Loomis Road northwest of the main terminal building. These rental car facilities accommodate vehicle storage, ready/return lots, customer service buildings, and service/maintenance buildings. The current on-airport rental car operators include; Alamo/National, Avis, Budget, Dollar/Thrifty, and Hertz. In addition, Enterprise and Advantage each have off-airport facilities. Each rental car company operates their own independent shuttle service between their respective facilities and the main terminal building.

CVG is currently in the design process of a CONRAC that is to be located immediately west and adjacent to the main terminal building. This facility is intended to accommodate all rent-a-car functions as well as a ground transportation center and Airport administration offices. In addition to rental cars, hotel shuttles, parking lot shuttles, public transportation, and ride share services will utilize the ground transportation center. This facility is planned to be completed and opened in calendar year 2020.

2.5.4 Terminal Curbfront

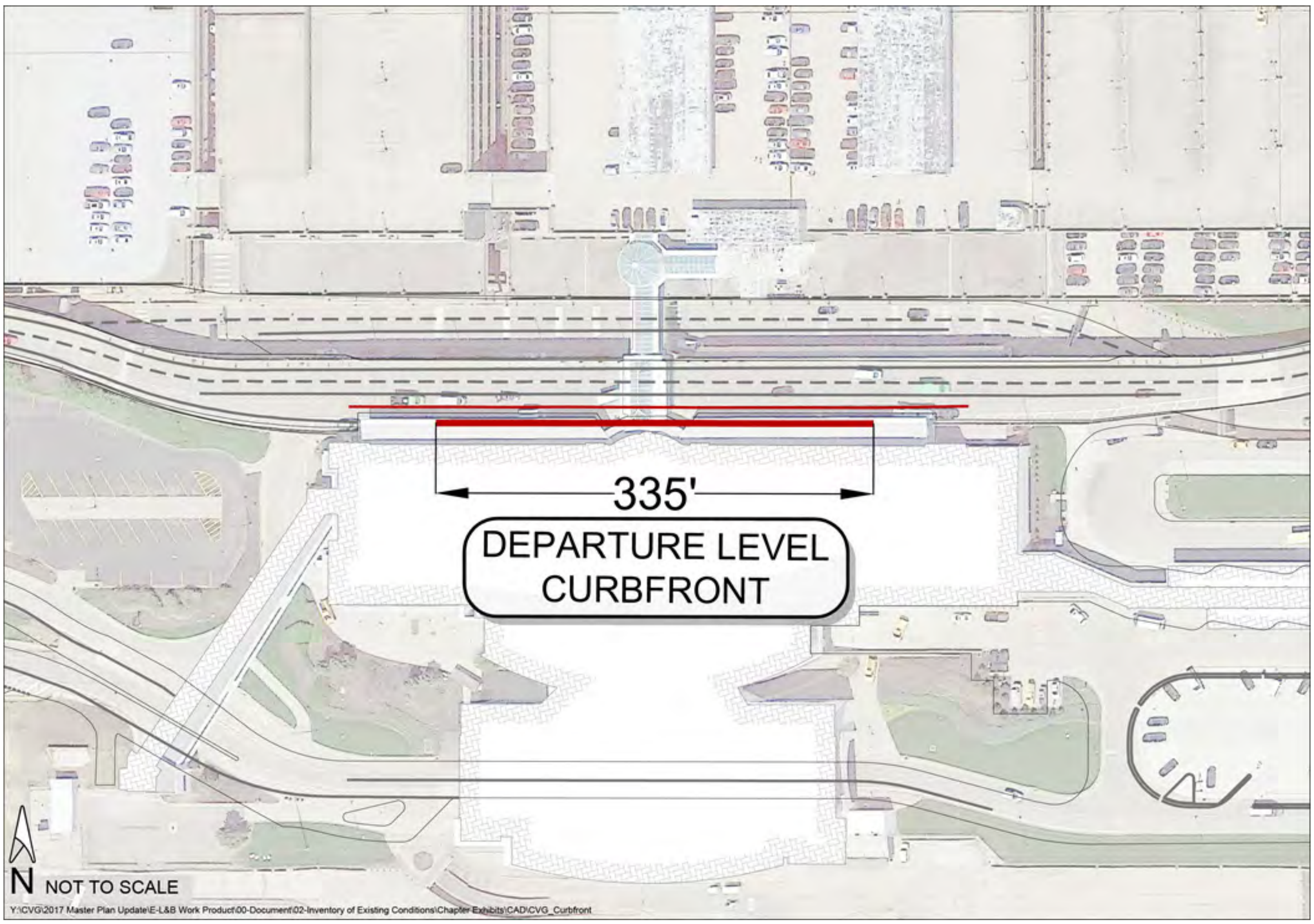
The terminal curbfront on an airport is a complex operating environment. Many different vehicles pass through the terminal loop, such as private automobiles, shuttles, taxis, and buses. When it comes to an airport curbfront, a certain amount of capacity is necessary to allow vehicles sufficient space to stop at the curb to unload/load passengers and luggage, and then pull away from the curb and merge into the traffic flow. Most terminal curbfronts can be separated into two sections: pedestrian amenities and commercial vehicle amenities.

At CVG, three separate curbfronts serve the main terminal building. A single curbfront that is 335 feet in length serves the upper departures level. This departures curbfront is used by departing passengers being dropped off at CVG by another person to catch a departing flight. This curbfront is also used by passengers who are utilizing CVG's valet parking service and passengers arriving to the main terminal building via a shuttle bus of some kind, taxis, and ride-share services. Passengers arriving and departing by public bus are dropped off at the existing ground transportation center immediately east of the main terminal building.

On the lower arrivals level of the main terminal building there are two curbfronts in use. The inner (closest to the façade of the building) curbfront is 460 feet in length and is reserved for commercial vehicles and shuttle busses that are picking up arriving passengers. It is also used by valet for parking and staging. These vehicles tend to dwell at the curbfront for longer periods than public vehicles and therefore require a separate curbfront. The outer (island) curbfront on the arrivals level is to serve passengers being picked up by private car or ride share service (i.e. Uber or Lyft). This outer curbfront is 560 feet in length; the first third of which is reserved for ride share pickups.

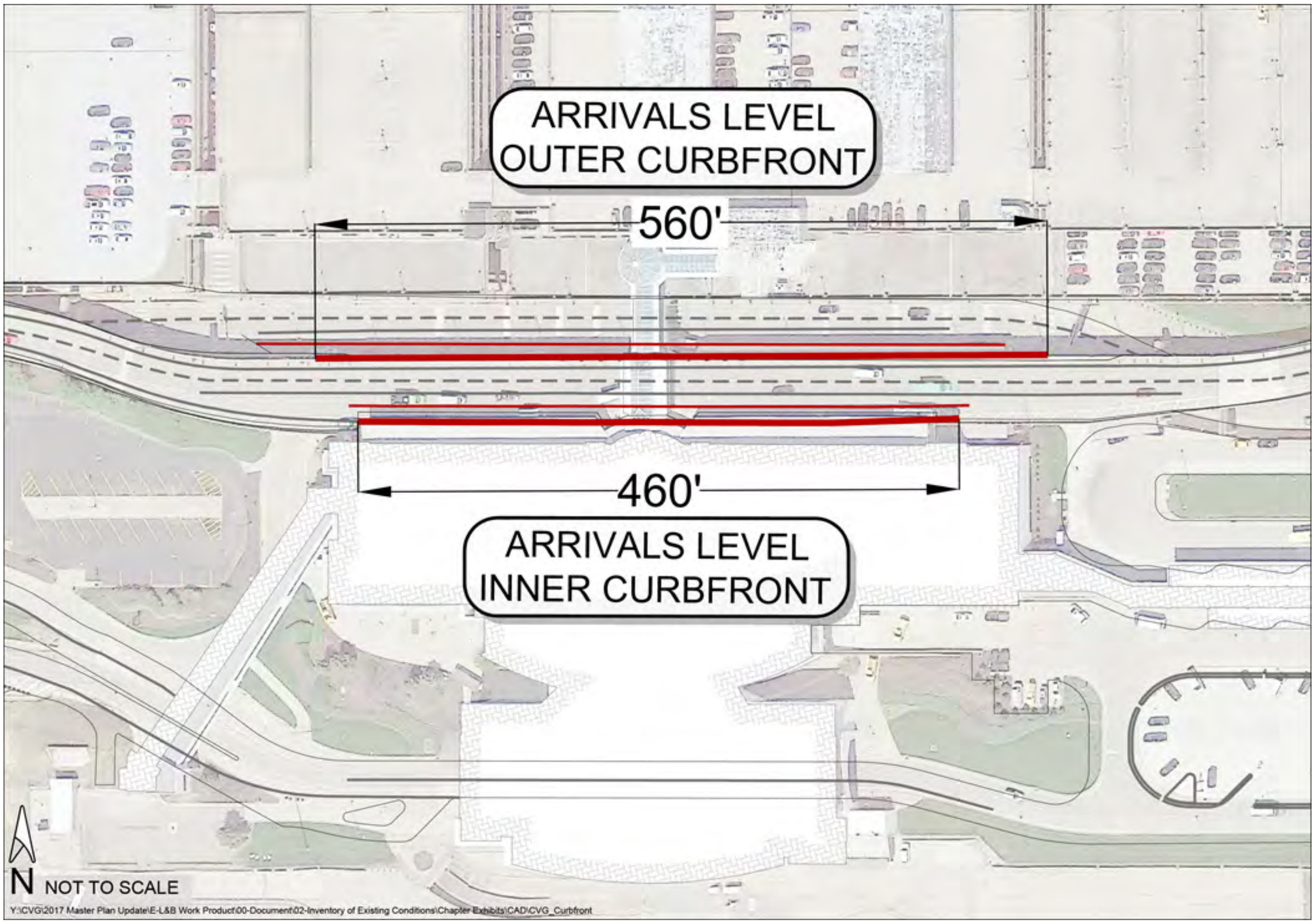
Exhibit 2.5-13, *CVG Departures Curbfront*, presents the configuration of the departures curbfront. **Exhibit 2.5 14, *CVG Arrivals Curbfront***, presents the configuration of the arrivals curbfront. Each curbfront at CVG with the exception of the inner arrivals curb has four total lanes; a curb lane, a transition lane, and two flow through lanes. The inner arrivals curb only has three total lanes.

EXHIBIT 2.5-13 CVG DEPARTURES CURBFRONT



Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 2.5-14 CVG ARRIVALS CURBFRONT



Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

2.6 Air Cargo

Air cargo activity makes up a significant portion of aircraft operations at CVG. Accordingly, the air cargo facilities at CVG are substantial in order to accommodate this level of activity. Air cargo facilities are located in two general locations, the south airfield, and the north cargo area. The following subsections present detailed information regarding the air cargo facilities in these two areas.

2.6.1 South Airfield Air Cargo Facilities

The largest concentration of active air cargo facilities is located in the south airfield area. The general boundaries of this area are south of Runway 09/27, west of Runway 18L/36R and east of Runway 18C/36C. The largest cargo tenant currently is the DHL facility that serves as their North American hub, which is the busiest of DHLs three hubs worldwide. The main DHL cargo hub was constructed in 2009 and has multiple buildings on approximately 150 acres of land. The following facilities comprise the DHL cargo hub:

- Main sort building
- Truck/administration building
- Ground Service Equipment (GSE)/line maintenance building

The first expansion of the DHL facility was completed in 2012 on a 50-acre site to the south of the main DHL hub site. This expansion included the following additional facilities.

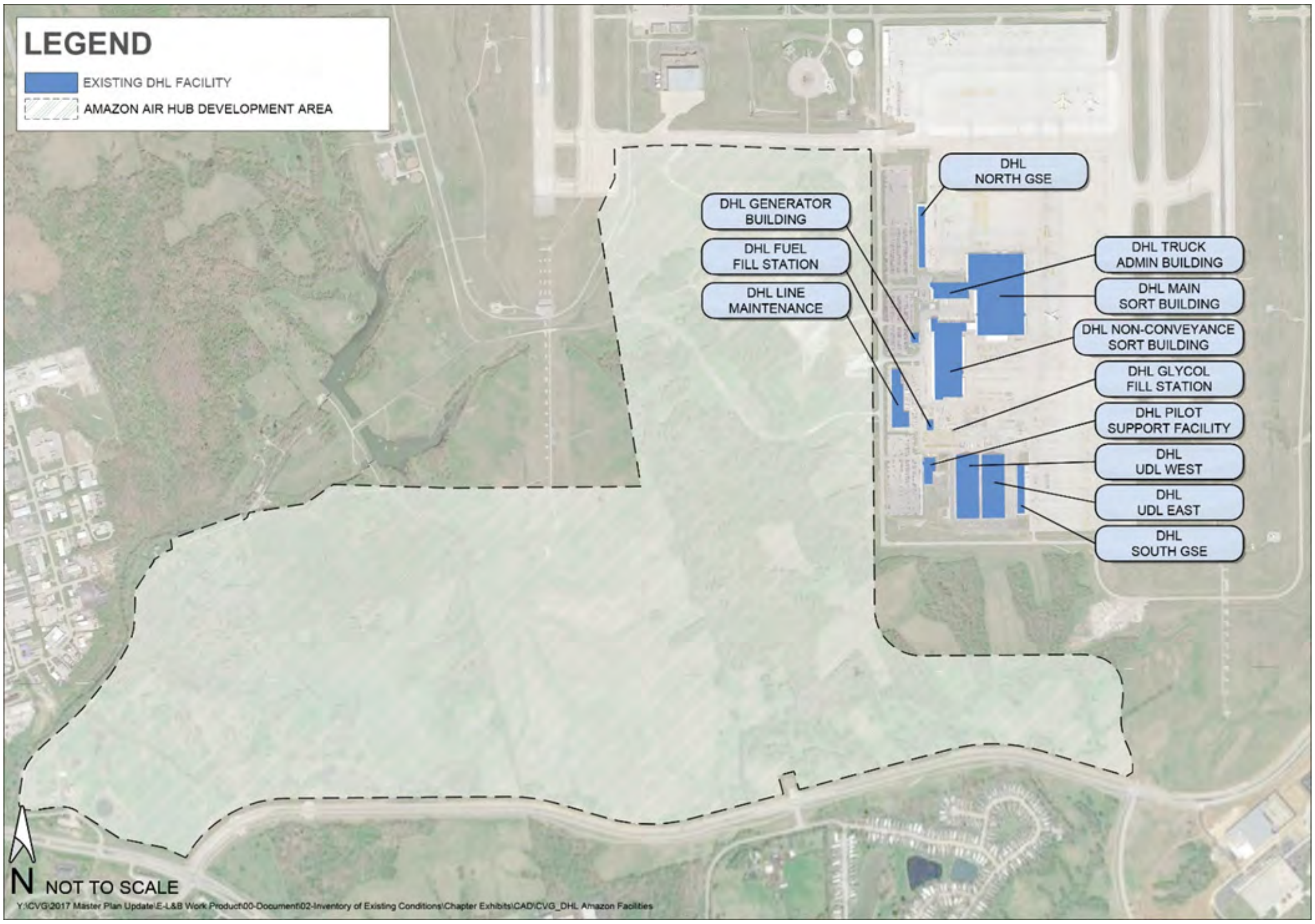
- Non-conveyable freight sort building
- Pilot’s quarters
- Additional aircraft parking for nine widebody aircraft
- GSE & tug parking
- Paved employee parking
- Unpaved (stone) employee parking

A second expansion of the DHL facility was completed in the summer of 2016. This latest expansion consisted primarily of new apron that provides six ADG-V aircraft parking positions and 10 ADG-IV aircraft parking positions. In addition, a Unit Load Device (ULD) storage building was also added.

The majority of the south airfield area remains undeveloped at this time. However, the Amazon Prime Air hub will be developed in this area.

Exhibit 2.6-1, *South Airfield Cargo Facilities*, identifies the location of the existing DHL facilities as well as the planned development site for the Amazon Prime Air hub.

EXHIBIT 2.6-1 SOUTH AIRFIELD CARGO FACILITIES



Sources: KCAB; Amazon; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

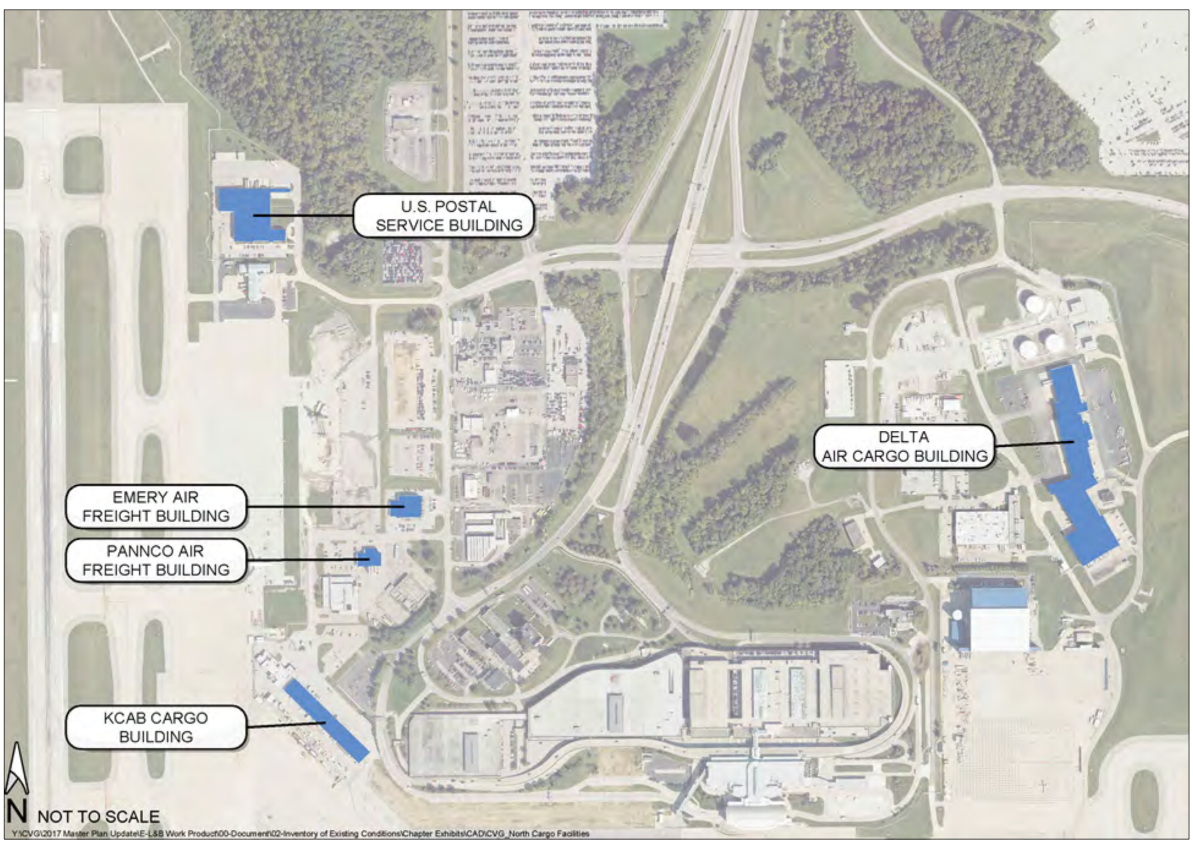
2.6.2 North Air Cargo Facilities

The north cargo area is home to various cargo companies, or DHL contracted air cargo operators at CVG. This includes airline belly-haul cargo operations and FedEx operations among others. These operations are spread out among several existing buildings in the area. These buildings include:

- KCAB Cargo Building
- Delta Air Cargo Building
- PANNCO Air Freight Building
- Emery Air Freight Building
- U.S. Postal Service Building

Exhibit 2.6-2, *North Cargo Area Facilities*, identifies the location of the existing cargo facilities in the north cargo area. Current plans call for the demolition of these buildings and replacement with a consolidated multi-user cargo facility. This facility is currently under contract with Aeroterm for development and will consist of up to 132,000 square feet of building space, with an adjacent apron of 120 feet in depth capable of accommodating five Boeing 747-8 aircraft. This facility makes up the first phase in the ultimate development of an air cargo campus in the north cargo area.

EXHIBIT 2.6-2 NORTH CARGO AREA FACILITIES



Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

2.7 General Aviation

GA facilities includes facilities that support aviation that is not considered commercial or military. The GA facilities at CVG are located south of Runway 09/27, and between Runways 18C/36C and 18L/36R. The GA facilities are provided with access to the airfield via the eastern portion of Taxiway M. The GA facilities are located along Tower Drive and accessible via South Airfield Drive. These facilities are depicted in **Exhibit 2.7-1, *CVG GA Facilities***.

EXHIBIT 2.7-1 CVG GA FACILITIES

Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

FBO services at CVG are provided by Delta Private Jets via their Jet Center/FBO operation. An FBO at an airport will typically function as the “terminal” for GA operations. These functions include, but are not limited to the following:

- Customer/passenger lounge
- Flight crew facilities
- Flight planning facilities
- Fuel service (Jet-A and AvGas)
- Ground handling
- Lavatory service
- Water and fluids service
- Deicing
- Hangar/office rental
- Aircraft maintenance
- Catering
- Ground transportation
- Concierge services

In addition to offering FBO services, Delta Private Jets is an on-demand jet charter service that is a wholly owned subsidiary of Delta Air Lines. CVG serves as the headquarters and base of operations for Delta Private Jets. The hangars associated with the FBO facility are primarily used to accommodate the Delta Private Jets fleet of aircraft with approximately 57,000 square feet of hangar space. In addition, the facility offers over 18,000 square feet of office and mezzanine space used to service customers and flight crews.

Delta Private Jets also operates a maintenance, repair, and overhaul (MRO) facility on the west side of the GA area along Comair Boulevard. This facility occupies the former Comair maintenance facility in Buildings 58 and 60, which offer approximately 27,000 and 76,000 square feet of operational space, respectively.

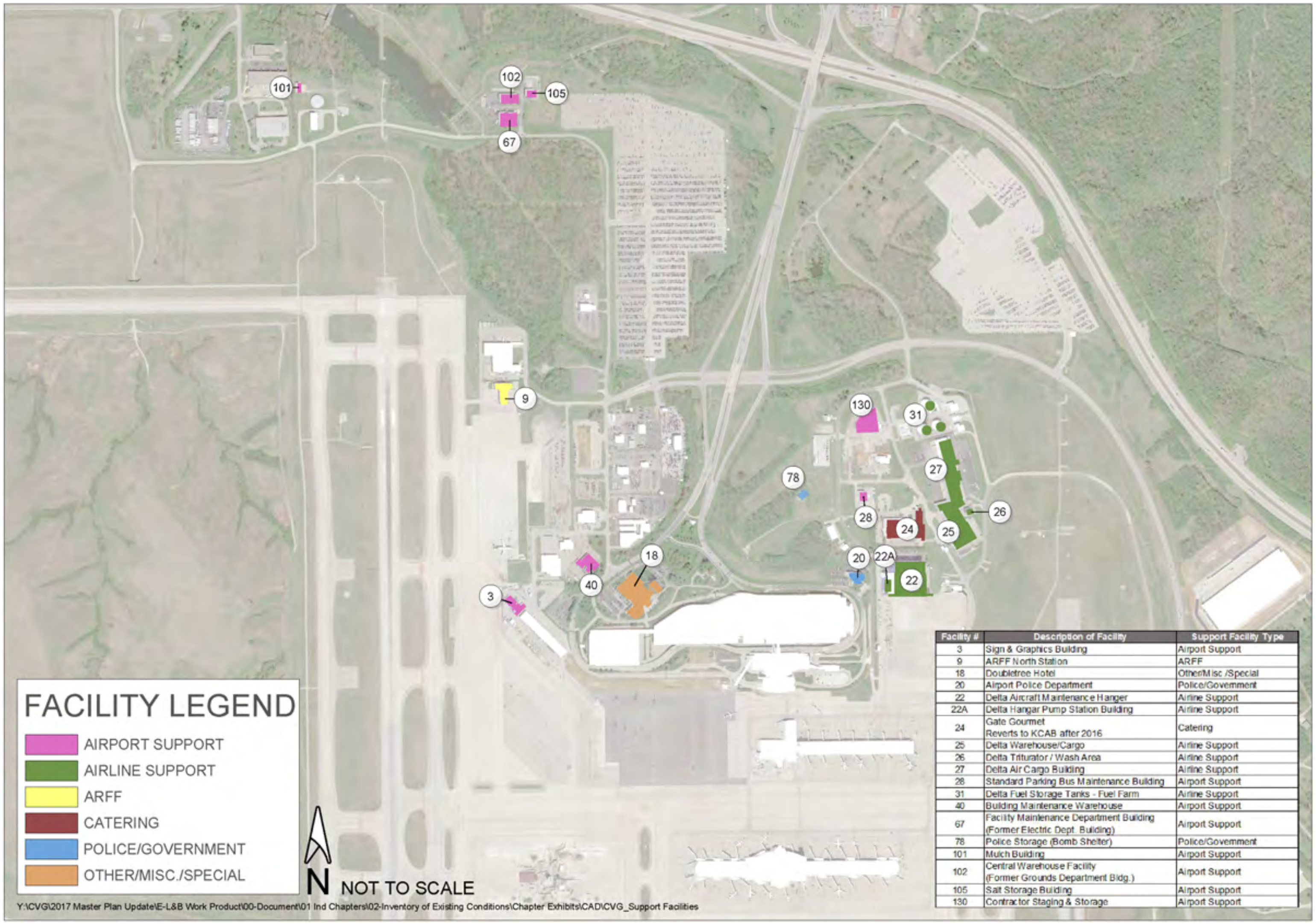
Ameriflight (Building 84) is located between the Delta Jet Center/FBO and the Delta Private Jets maintenance base and provides over 20,000 square feet of operational space. Ameriflight is a Part 135 air carrier that offers full service, on-demand aircraft chartering, specifically catering to freight.

2.8 Support Facilities

Support facilities include any facilities at an airport that provide services contributing to the functional operation of that airport. Support facilities can be comprised of landside and/or airside uses. The support facilities at CVG are located throughout the CVG campus based on their respective function. The support facilities have been categorized based upon their role at CVG and the entities that they support. The classification of each support facility is color coded and presented in **Exhibit 2.8-1, *CVG Support Facilities – North***, and **Exhibit 2.8-2, *CVG Support Facilities – South***. Data relative to the size of both the building footprint and total building area of each facility is presented in Section 2.2, *Existing Facilities Site Location / Land Use*. The support facilities are categorized based on the following facility uses:

- **Aircraft Rescue and Firefighting (ARFF)**: Includes facilities that support the response, hazmat mitigation, evacuation, and possible rescue of passengers and crew of an aircraft involved in an incident at CVG. At CVG, ARFF personnel also respond to on-airport structural fires and Emergency Medical Service (EMS) calls in the terminal.
- **Airline Support**: Includes any facilities associated with airline administration, aircraft maintenance, training, GSE and storage, and other miscellaneous airline support functions.
- **Airport Support**: Includes any facilities owned and operated by the Airport that support airport operations. Such facilities typically include airport maintenance, administration, shuttle transportation, vehicle maintenance, fueling (aircraft and vehicles), aircraft deicing, and storage.
- **Catering**: Includes facilities that support flight-catering operations. These operations supply commercial/charter flights with food, beverages, snacks, aircraft waste disposal, and similar services.
- **Government**: Includes government facilities located on the Airfield Operations Area (AOA). These include ATC and police facilities. The ATC facilities are further discussed in Section 2.3.10.
- **Other**: Includes facilities used for other purposes at an airport. At CVG, this includes a hotel, airport viewing area, and park pavilion.

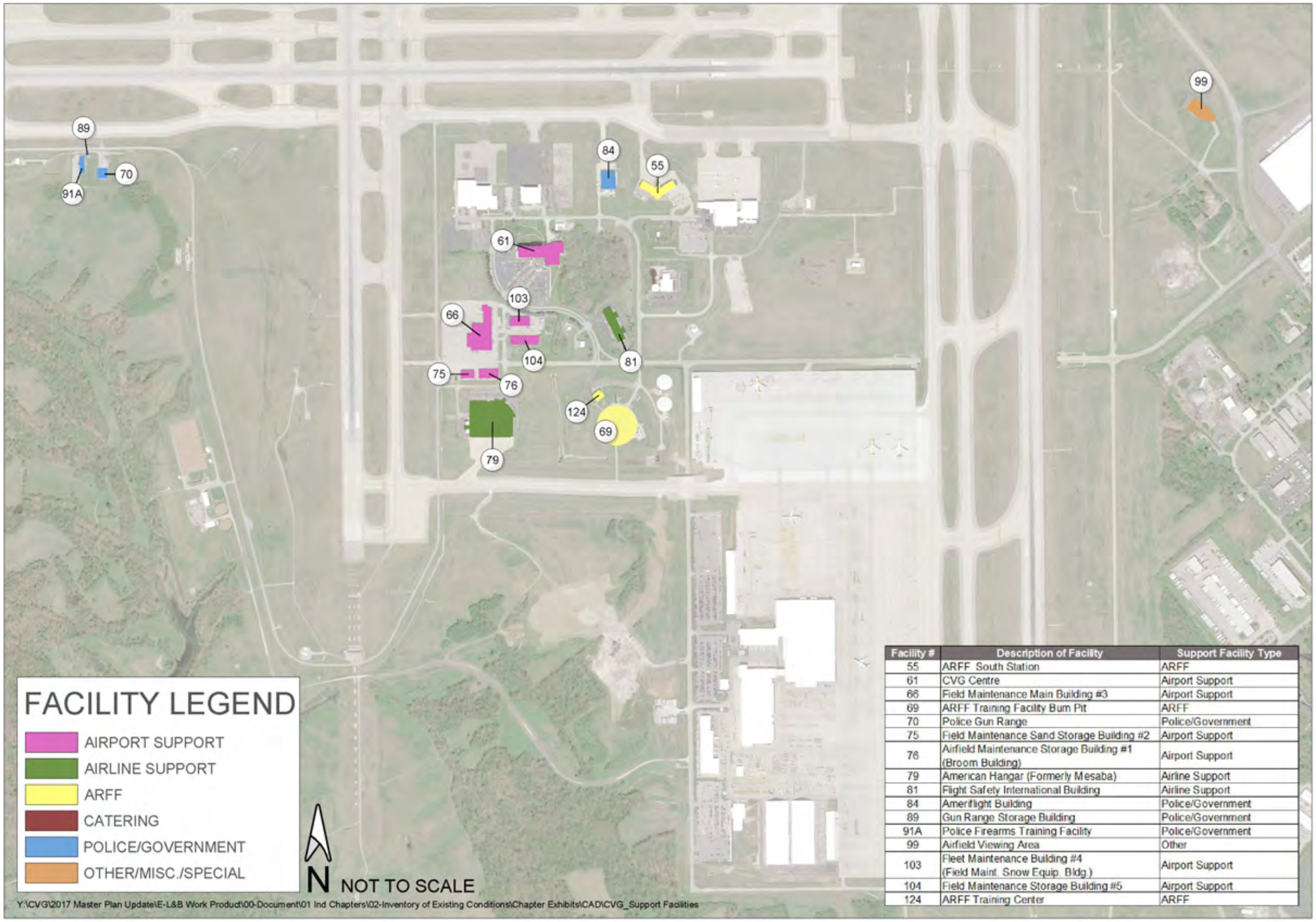
EXHIBIT 2.8-1 CVG SUPPORT FACILITIES - NORTH



Facility #	Description of Facility	Support Facility Type
3	Sign & Graphics Building	Airport Support
9	ARFF North Station	ARFF
18	Doubletree Hotel	Other/Misc./Special
20	Airport Police Department	Police/Government
22	Delta Aircraft Maintenance Hanger	Airline Support
22A	Delta Hangar Pump Station Building	Airline Support
24	Gate Gourmet Reverts to KCAB after 2016	Catering
25	Delta Warehouse/Cargo	Airline Support
26	Delta Triturator / Wash Area	Airline Support
27	Delta Air Cargo Building	Airline Support
28	Standard Parking Bus Maintenance Building	Airport Support
31	Delta Fuel Storage Tanks - Fuel Farm	Airline Support
40	Building Maintenance Warehouse	Airport Support
67	Facility Maintenance Department Building (Former Electric Dept. Building)	Airport Support
78	Police Storage (Bomb Shelter)	Police/Government
101	Mulch Building	Airport Support
102	Central Warehouse Facility (Former Grounds Department Bldg.)	Airport Support
105	Salt Storage Building	Airport Support
130	Contractor Staging & Storage	Airport Support

Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 2.8-2 CVG SUPPORT FACILITIES - SOUTH



Facility #	Description of Facility	Support Facility Type
55	ARFF South Station	ARFF
61	CVG Centre	Airport Support
66	Field Maintenance Main Building #3	Airport Support
69	ARFF Training Facility Burn Pit	ARFF
70	Police Gun Range	Police/Government
75	Field Maintenance Sand Storage Building #2	Airport Support
76	Airfield Maintenance Storage Building #1 (Broom Building)	Airport Support
79	American Hangar (Formerly Mesaba)	Airline Support
81	Flight Safety International Building	Airline Support
84	Ameriflight Building	Police/Government
89	Gun Range Storage Building	Police/Government
91A	Police Firearms Training Facility	Police/Government
99	Airfield Viewing Area	Other
103	Fleet Maintenance Building #4 (Field Maint. Snow Equip. Bldg.)	Airport Support
104	Field Maintenance Storage Building #5	Airport Support
124	ARFF Training Center	ARFF

Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

2.8.1 Aircraft Rescue and Firefighting (ARFF)

ARFF facilities include facilities associated with aircraft and structure firefighting, which include pump houses, storage areas, fire stations, and staff training. CVG has a North and South ARFF station on the airside. The North Station (Building 9) is located east of the Runway 18C end and maintains six drive-thru vehicle bays. This building is approximately 25,000 square feet and serves the terminal facilities providing EMS and structural unit response if a fire breaks out. The South Station (Building 55) is located east of the GA facilities south of the Taxiway M and M4 intersection. This station is approximately 22,000 square feet and has ten vehicle bays that predominantly serve the south side of the airfield.

Two ARFF training facilities are collocated on the airfield southeast of the ATCT along South Airfield Drive and north of Taxiway N. These training facilities include the ARFF Training Center (Building 124) and ARFF Training Facility Burn Pit (Building 69). These facilities are used for ARFF incident reenactment and other training purposes.

Title 14, Code of Federal Regulations (CFR), Part 139, Subpart D states that the amount of ARFF equipment required at an airport is determined by an index based on the size of the largest aircraft operating at that airport. CVG is currently an Index C airport. The equipment owned by the Airport is listed in **Table 2.8-1, *CVG ARFF Equipment***.

TABLE 2.8-1 CVG ARFF EQUIPMENT

Vehicle	Station Location	Year Purchased
Oshkosh 3,000 Gallon Snozzle	South	2014
Oshkosh 3,000 Gallon Crash	South	2001
Oshkosh 3,000 Gallon Crash	North	2007
Rosenbauer 3,000 Gallon Crash	North	2005
Rosenbauer 3,000 Gallon Crash	South	2005
Rosenbauer QRV	North	2006
Ferrara QRV	South	2005

Source: KCAB

2.8.2 Airline Support

The airline support facilities at CVG consist of mainly aircraft maintenance, fueling, and storage facilities. Delta has a large maintenance hangar (Building 22) located northwest of the Runway 18L threshold. The hangar has approximately 132,000 square feet of maintenance area along with an adjacent apron and hangar pump station facility (Building 22A). Additional airline support facilities reside northeast of the Delta Maintenance Hangar (Buildings 25, 26, and 27). These facilities house the KCAB triturator, wash area for GSE, and warehouse space.

Delta maintains its own aircraft fuel storage tanks (Building 31), which are collocated with the airline support facilities (Buildings 25, 26, and 27). The three fuel tanks contain approximately five million gallons of Jet A that serve not only Delta but also other air carriers at CVG. Delta holds a lease on the fuel farm through 2020.

Other airline support facilities include the American Hangar (Building 79), which houses American Airlines support services within a 126,000 square-foot hangar. The facility is located east of Taxiway D and north of Taxiway N near the Runway 36C end.

A new airline maintenance hangar (the Lynx Hangar) has been approved and is under development, located east of the American Hangar (Building 79). The development consists of an aircraft maintenance hangar, associated apron, 19,000 square feet of office space, and 35,000 square feet of vehicle parking. The airside portion of the development is capable of accommodating one Boeing 747-8F aircraft inside and a second on the apron.

Additionally, the Flight Safety International facility (Building 81) is a training facility located south of Taxiway M along Comair Boulevard. The training facility offers advance flight training for pilots, technicians, flight attendants, and dispatchers.

2.8.3 Airport Support

The Airport operates and maintains about 400,000 square feet of airport support building space throughout the north and south sides of the airfield. These support buildings are listed in **Table 2.8-2, *CVG Airport Support Facilities***. In addition to the buildings listed, there are numerous glycol facilities, storm water treatment facilities, pump houses, and electrical buildings located on CVG property.

TABLE 2.8-2 CVG AIRPORT SUPPORT FACILITIES

Building Number	Facility Name
3	Sign Shop Building
28	Standard Parking Bus Maintenance Building
40	Building Maintenance Warehouse
61	CVG Centre
66	Field Maintenance Main Building #3
67	Facility Maintenance Department Building (Former Electric Dept. Building)
75	Field Maintenance Sand Storage Building #2
76	Airfield Maintenance Storage Building #1 (Broom Building)
101	Mulch Building
102	Central Warehouse Facility (Former Grounds Department Bldg.)
103	Fleet Maintenance Building #4 (Field Maintenance Snow Equipment Building)
104	Field Maintenance Storage Building #5
105	Salt Storage Building
130	Contractor Staging

Note: N/A means building number is not available
Source: 2017 CVG Building Report

About 188,000 square feet of the airport support facilities are used for airport and airfield maintenance and storage of equipment. CVG Centre (Building 61) is home to the KCAB offices and is located along Comair Boulevard. The facility offers over 200,000 square feet of operational building space.

2.8.4 Catering

Catering is provided to air carrier and charter flights at CVG via Gate Gourmet (Building 24). This facility is located north of Ramp 1N and northwest of the Runway 18L end adjacent to the Delta Maintenance Hangar. Gate Gourmet prepares and stores the food in this facility prior to delivering it to each aircraft via security Gate NE-23 just east of the main terminal building.

2.8.5 Government/Police

Government owned and/or operated facilities at CVG consist of the ATCT and police department building. The ATCT is further discussed in a separate section, Section 2.3.10. The Airport Police Department operates from six facilities on-airport property. The Airport Police Department (Building 20) is located northeast of the passenger terminal facilities along Terminal Drive. This facility provides nearly 19,000 square feet of space for operations and personnel. A call center is located in the Police Building. Additionally, on the northeast side of CVG is Police Storage (Building 78), which is also used as a bomb shelter. The bomb shelter must contain a 300-foot safety radius around the facility.

Police training facilities are located along Taxiway M nearest Taxiway M7. These facilities include the Police Gun Range (Building 70), Gun Range Storage Facility (Building 89), Police Firearms Training Facility (Building 91A), and the K-9 Training (currently operating in the Ameriflight Hangar, Building 84).

2.8.6 Other

Other support facilities at CVG include a hotel, viewing area for aviation enthusiasts, and a park pavilion.

2.8.6.1 *The Doubletree Hotel*

The Doubletree Hotel (Building 18) is located along Terminal Drive immediately north of the Parking Garage 1. The hotel shuttles passengers to and from the terminal and provides nearly 96,000 square feet of operational space.

2.8.6.2 *Aircraft Viewing Area*

An Aircraft Viewing Area (Building 99) is not actually a physical structure, but an outdoor viewing area for aviation enthusiasts to view aircraft operating at CVG. This space is located east of the Runway 27 approach and can be accessed via Donaldson Drive.

2.8.6.3 *Holscher Park*

Named in honor of CVG's former Chief Executive Officer (CEO), Holscher Park and Pavilion (Building 125) offers educational walking paths and recreational use of airport lands for the local community.

2.9 Utilities

The following section serves to outline the various utilities infrastructure and providers at CVG. The purpose of this information is to understand possible constraints to various Master Plan recommendations, and not the capacity of the utilities themselves. The following utility companies provide services to CVG:

- **Water**: Northern Kentucky Water District (NKWD), Boone County Water District, City of Florence Water
- **Stormwater Sewer**: Sanitation District #1
- **Sanitary Sewer**: Sanitation District #2
- **Natural Gas**: Duke Energy
- **Electric**: Duke Energy & Owen Electric
- **Telecom**: Cincinnati Bell

2.9.1 Water Utilities

CVG is currently provided with bulk potable water through a Master Agreement with the Northern Kentucky Water District (NKWD). The primary feed for this is via a 24-inch iron main along Donaldson Highway and a 12-inch iron main off Mineola Pike. The current feed has sufficient capacity to accommodate future demands of CVG. The master meter is located at the intersection of Donaldson Highway and South Airfield Drive. The southern airfield is provided potable water from the Boone County Water District and the City of Florence Water Department. **Exhibit 2.9-1, *Water Utilities***, depicts the current location of known water utilities at CVG.

2.9.2 Sanitary Sewer

Sanitary sewer service to the main terminal, Concourse A, and other facilities in the north terminal area is provided by a network of gravity mains that feed northward to a central wet well and lift station. This lift station feeds into a 12-inch sanitary sewer force main to the east and south along Donaldson Highway and ultimately to Sanitation District #1. Facilities in the south airfield area and Concourse B are served by a network of sanitary sewer lines that are gravity fed and flow to the east where they are joined with the feeds coming from the north along Donaldson Highway. **Exhibit 2.9-2, *Sanitary Sewer***, depicts the location of these sanitary sewer lines at CVG.

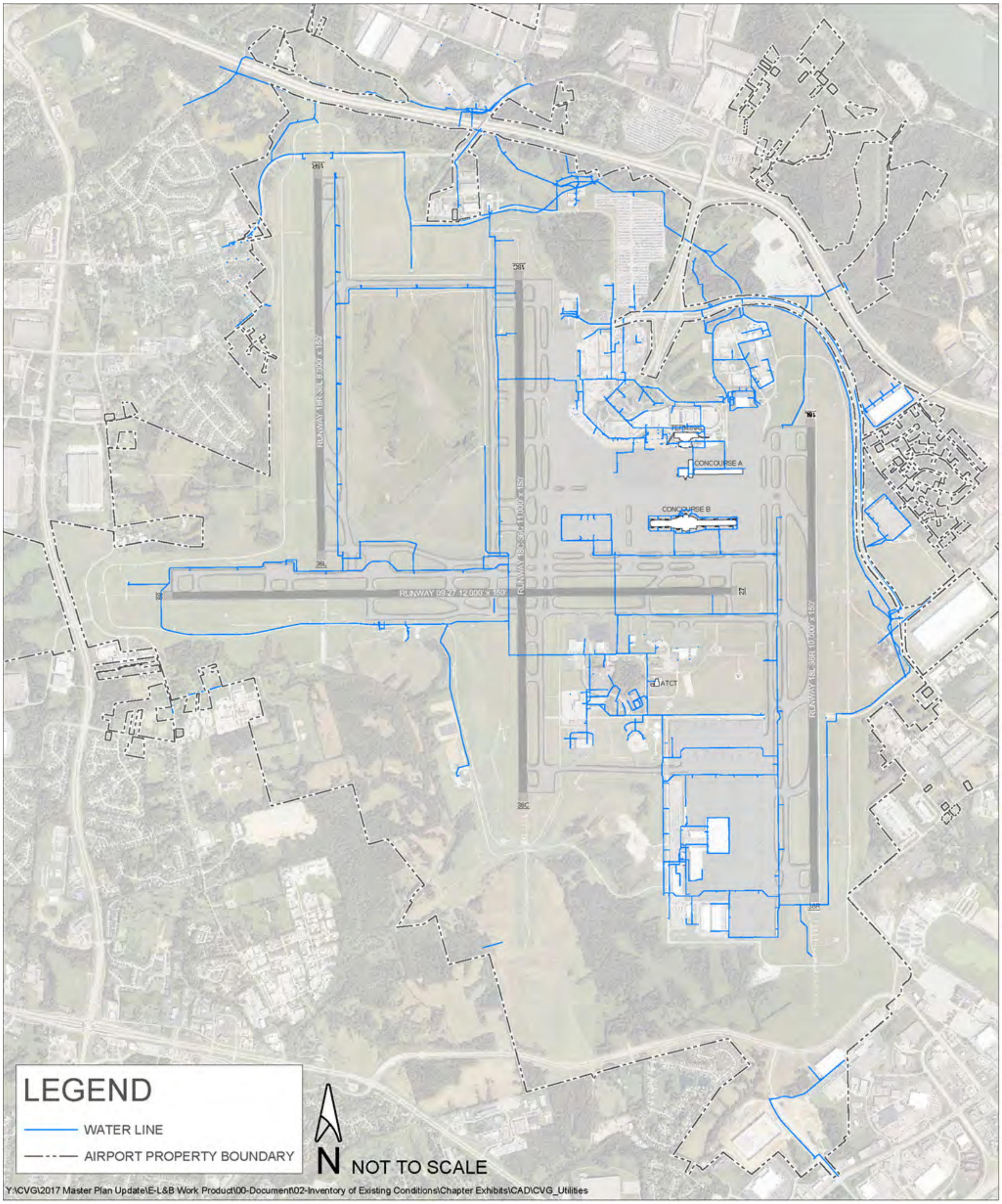
2.9.3 Stormwater Sewer

The Northern Kentucky Regional Storm Water Management Program – Rules and Regulations, dated August 2011, requires that all new developed areas be capable of detaining stormwater so as to not increase the outflow of stormwater from the site. These regulations stipulate that any new development at CVG be required to meet these guidelines. **Exhibit 2.9-3, *Stormwater Sewer***, depicts the location of existing stormwater sewer facilities at CVG.

2.9.4 Other Utilities

Other utilities at CVG include electric, natural gas, and aviation fuel. These utilities are shown on **Exhibits 2.9-4 through 2.9-6**.

EXHIBIT 2.9-1 WATER UTILITIES

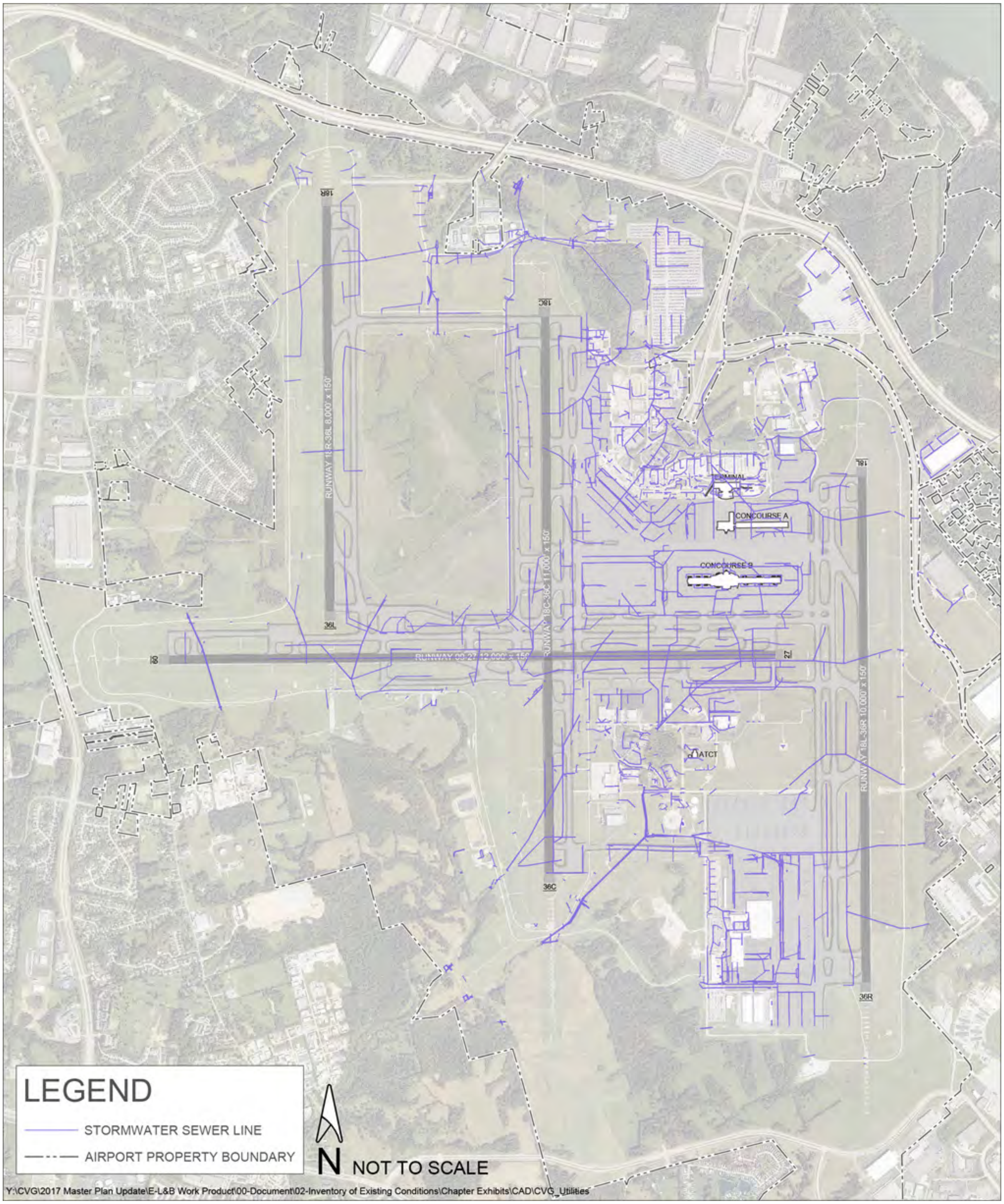


Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 2.9-2 SANITARY SEWER

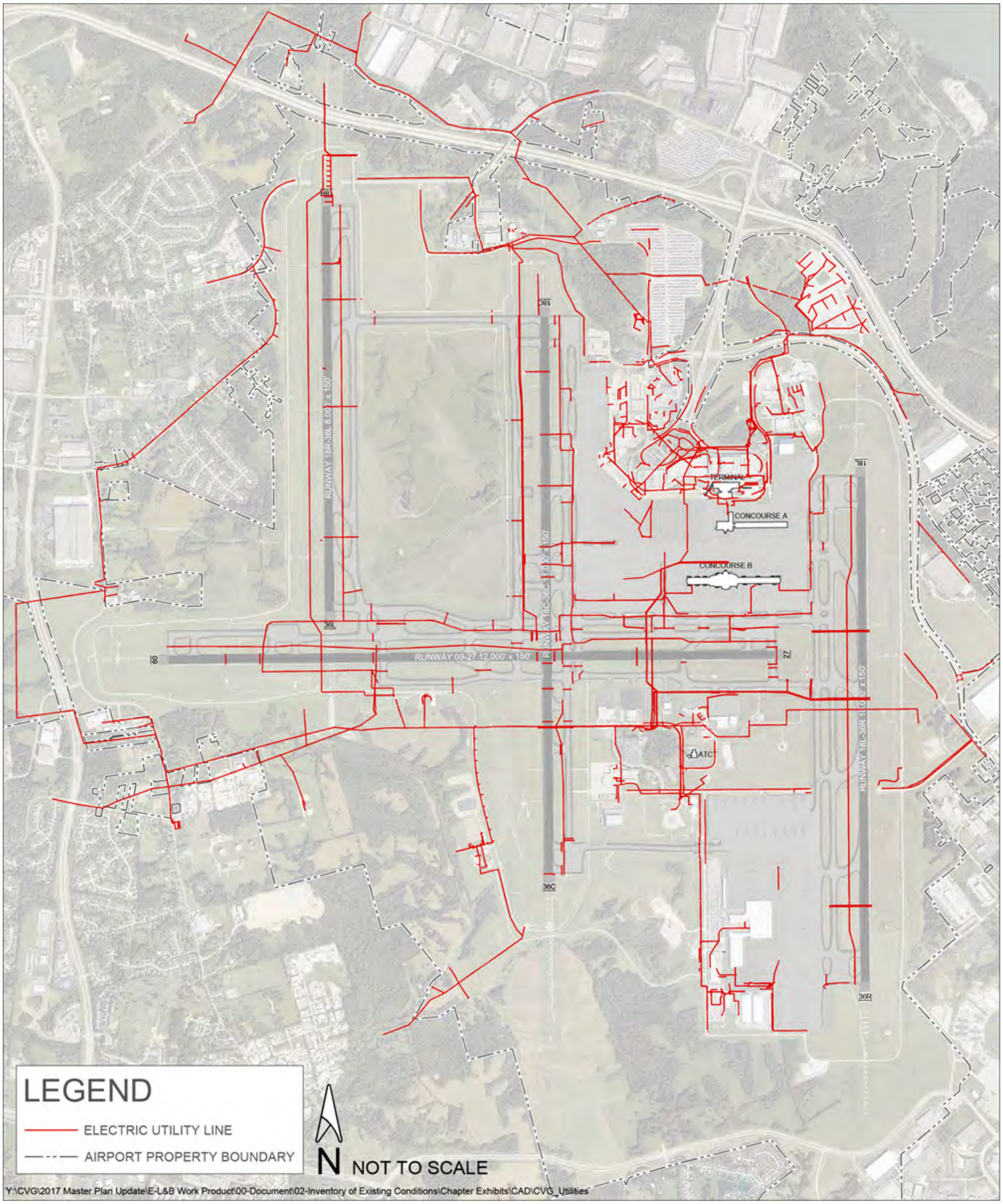
Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 2.9-3 STORMWATER SEWER



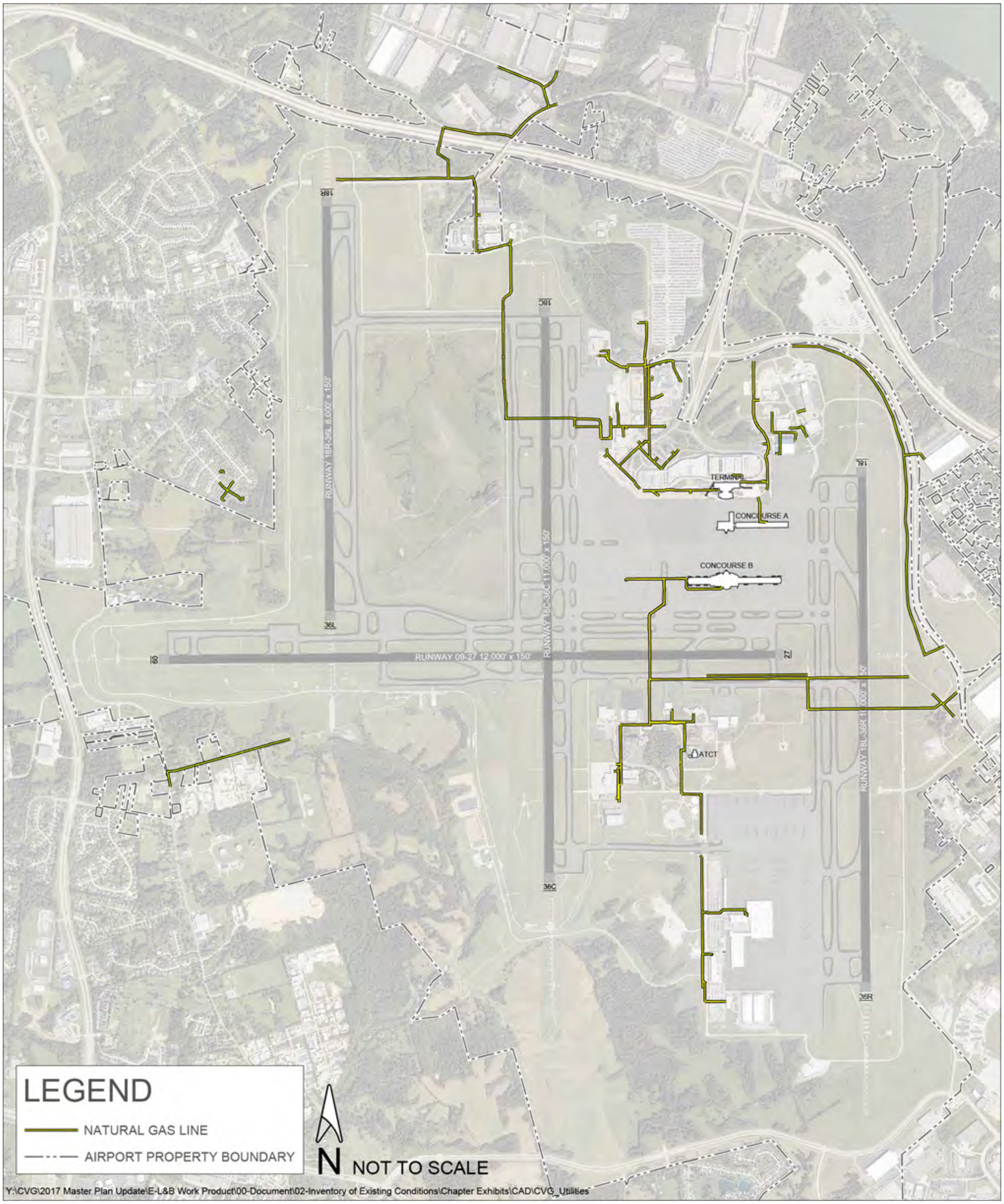
Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 2.9-4 ELECTRIC UTILITIES



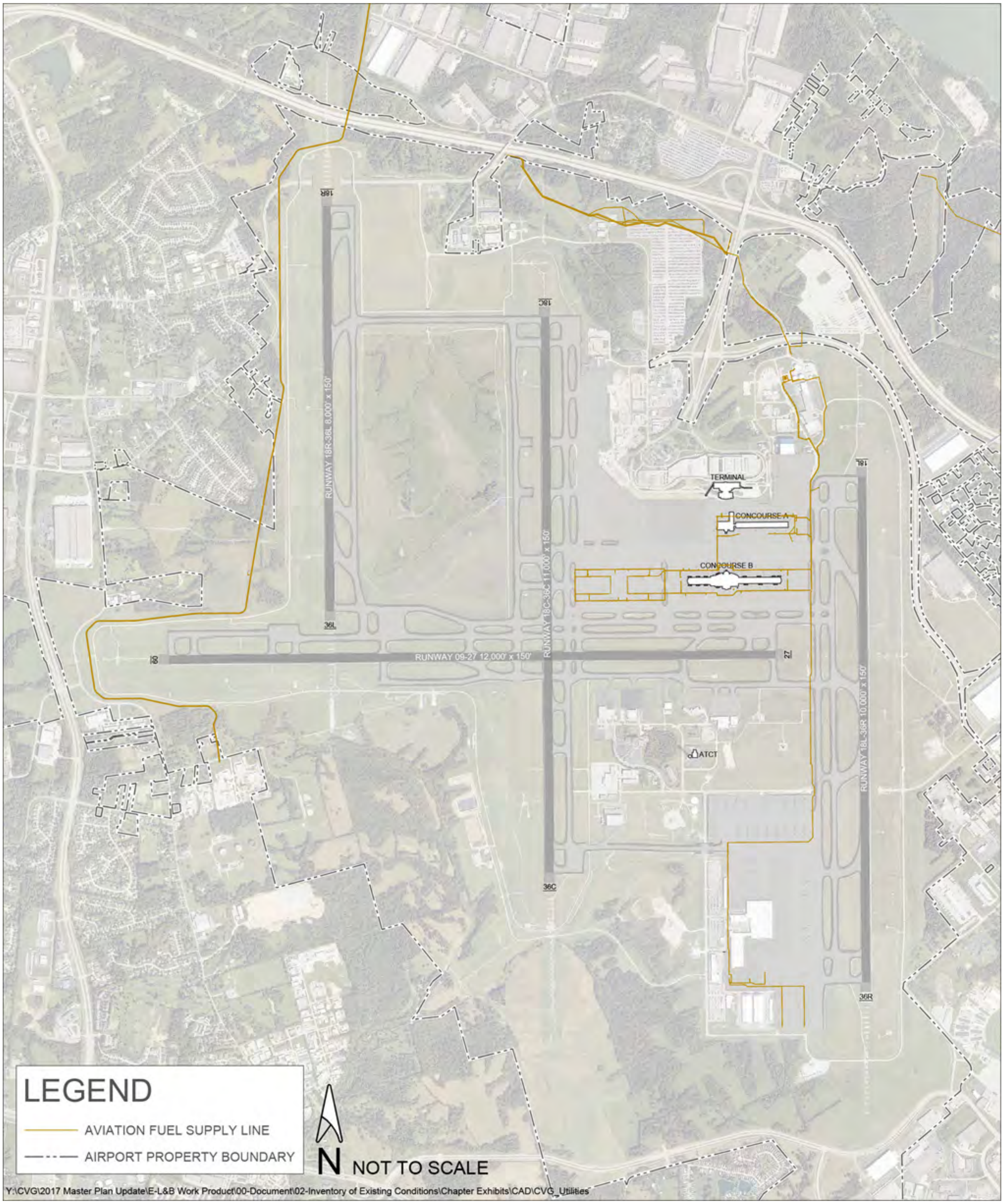
Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 2.9-5 NATURAL GAS UTILITIES



Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 2.9-6 AVIATION FUEL SUPPLY & DISTRIBUTION



Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

2.10 Safety & Security

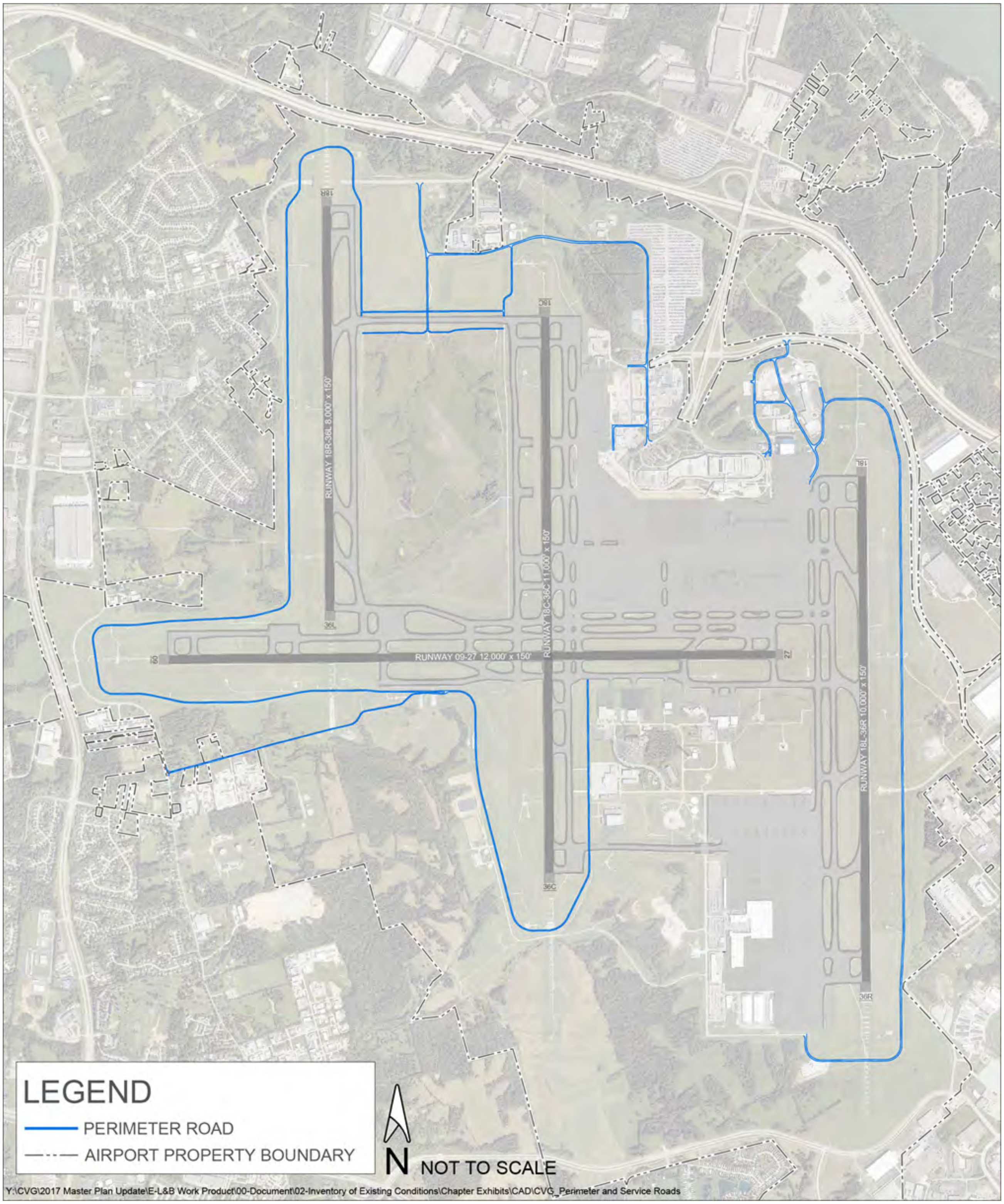
2.10.1 Airfield Security Fence

CVG is protected by a network of security fencing, gates, and walls that provides a completely enclosed barrier around the airfield and secure areas. This network of fencing was upgraded in 2002 to comply with FAA standards to include the following:

- Upgraded height and strength
- General repair and replacement
- Extended concrete barrier terminal area fence line
- Intelikeys installed at fence line gates
- Bollards installed at terminal curbfronts

An extensive network of fencing and gates exists around CVG today. In addition to the fencing, there is a network of airside perimeter roadways. These roadways are intended to provide access to airport vehicles for maintenance and security inspections. **Exhibit 2.10-1, *CVG Airside Perimeter Roadway Network***, depicts the location of this perimeter roadway network.

EXHIBIT 2.10-1 CVG AIRSIDE PERIMETER ROADWAY NETWORK



Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

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MASTER PLAN 2050

Chapter 3 | Aviation Activity Forecast

CVG
CINCINNATI/NORTHERN KENTUCKY
INTERNATIONAL AIRPORT

L&B
TEAM

3 Aviation Activity Forecast

3.1 Background

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

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

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

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

3.1.1 Historical Aviation Activity

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

3.1.1.1 *Passenger Activity*

Passenger Activity Trends

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

- **2003-2005**: Passenger traffic increases naturally as the local demand and connecting traffic both increase due to Delta Air Lines strong presence at CVG. In 2005, CVG reported a peak of 22.8 million passengers.
- **2006-2007**: On September 14, 2005, Delta Air Lines filed for reorganization under Chapter 11 bankruptcy. As a result, the airline cut more than a quarter of its flights at the CVG hub which equated to a 28.7 percent decline in passenger traffic the following calendar year. Passenger traffic continued to decline through 2007 as a result of the continued restructuring of Delta Air Lines.
- **2008-2012**: On April 14, 2008, Delta Air Lines and Northwest Airlines announced plans to merge under the Delta name. On September 26, 2008, the merger was approved by the respective airlines' shareholders and was subsequently approved by the U.S. Department of Justice in October 29, 2008. In December 2009, the operating certificates were merged. Delta Air Lines' post-merger strategy included plans to significantly downsize its CVG hub operation. As a result, connecting passengers declined substantially, from 4.6 million in 2008 to less than a million in 2012. It should be noted that during this period, local traffic remained relatively constant.

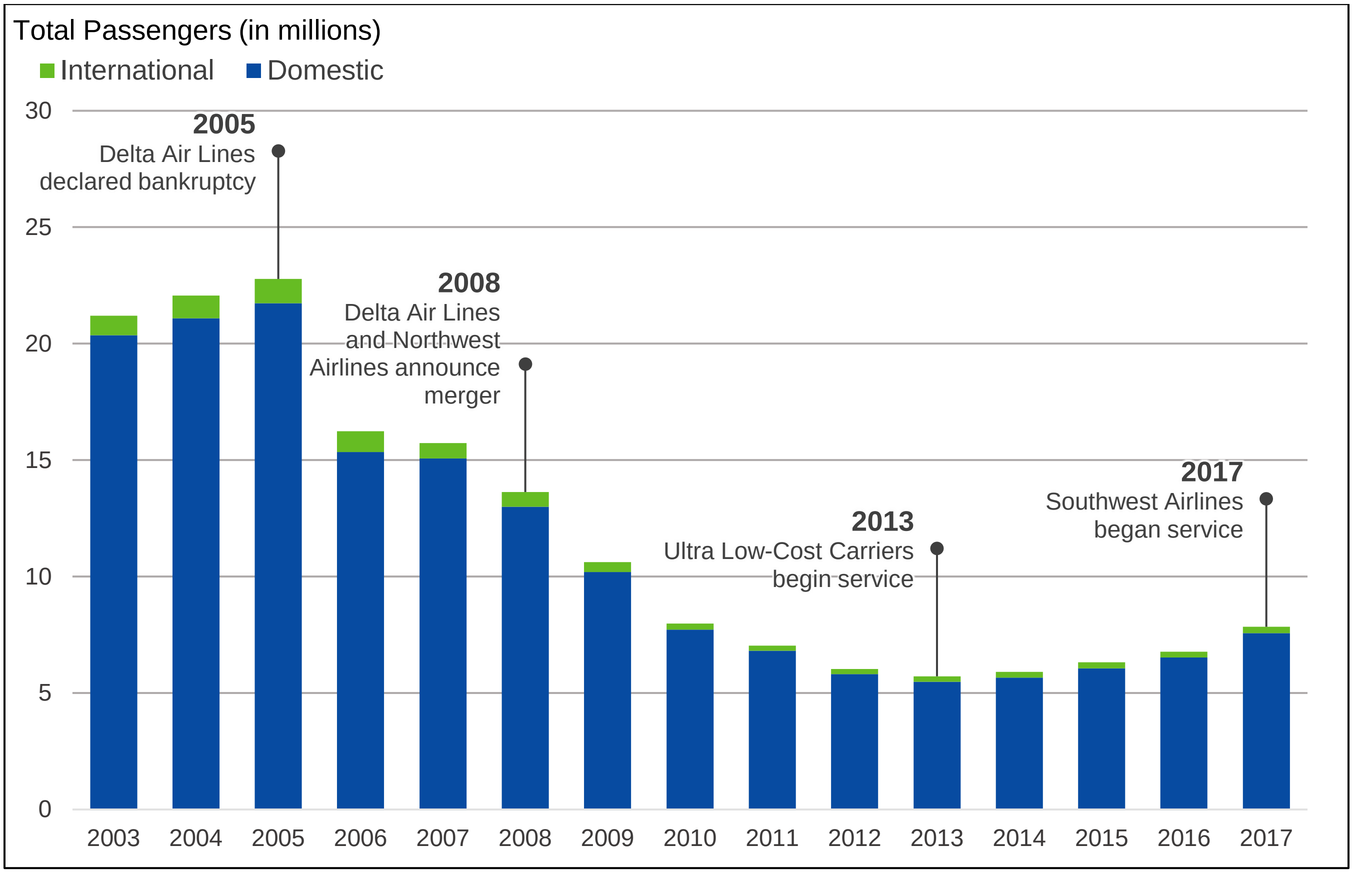
1 Federal Aviation Administration, *Report to Congress: National Plan of Integrated Airport Systems (NPIAS) 2017-2021*, September 30, 2016.

2 To be classified as a medium-hub airport, the airport must have at least 0.25 percent but less than 1 percent of the national annual enplaned passengers.

3 On March 26, 2001, Comair's pilots officially went on strike. At the time, Comair was Delta Air Lines exclusive provider for regional connections at CVG.

- **2013-2017**: In May 2013, Frontier Airlines became CVG's first low-cost carrier (LCC) since the late 1990s when the airline launched service to Denver International Airport (DEN). The following year, another LCC, Allegiant Air, began service. These carriers helped to spur growth in local traffic at CVG. Meanwhile, traditional full-service carriers, American Airlines and United Airlines, also increased their capacity to their major hubs. Southwest Airlines began commercial service in June of 2017 with service to Baltimore-Washington International Thurgood Marshall Airport (BWI) and Chicago Midway International Airport (MDW). From 2013 through 2017, passenger traffic increased from 5.7 million to 7.8 million, representing an average annual growth rate (AAGR) of 8.2 percent.

EXHIBIT 3.1-1 HISTORICAL PASSENGER THROUGHPUT



Source: Kenton County Airport Board (KCAB)

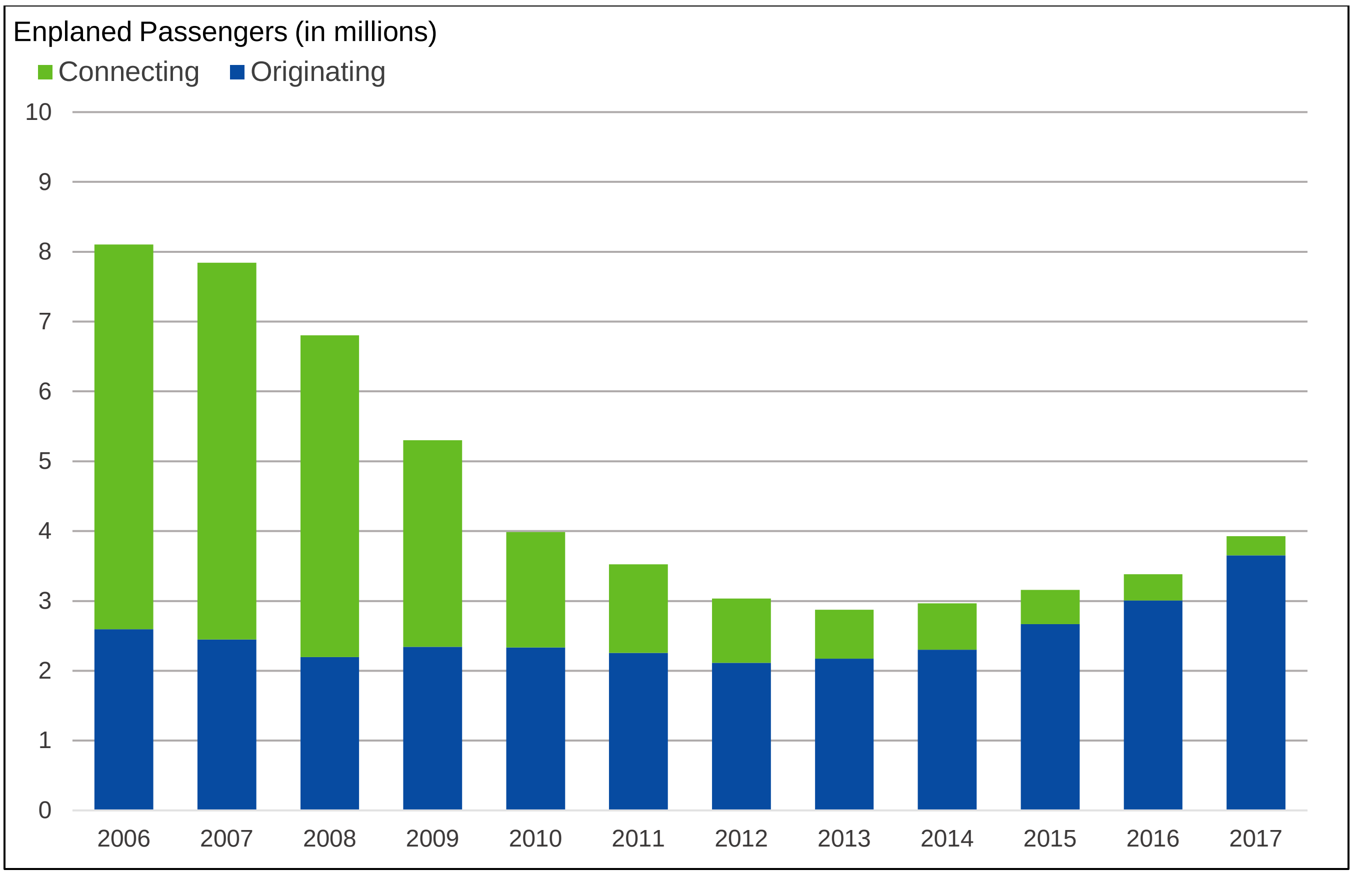
TABLE 3.1-1 HISTORICAL PASSENGER THROUGHPUT

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

Source: KCAB

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

EXHIBIT 3.1-2 HISTORICAL ENPLANED PASSENGERS BY TYPE



Source: KCAB

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

TABLE 3.1-2 HISTORICAL ENPLANED PASSENGER MARKET SHARE

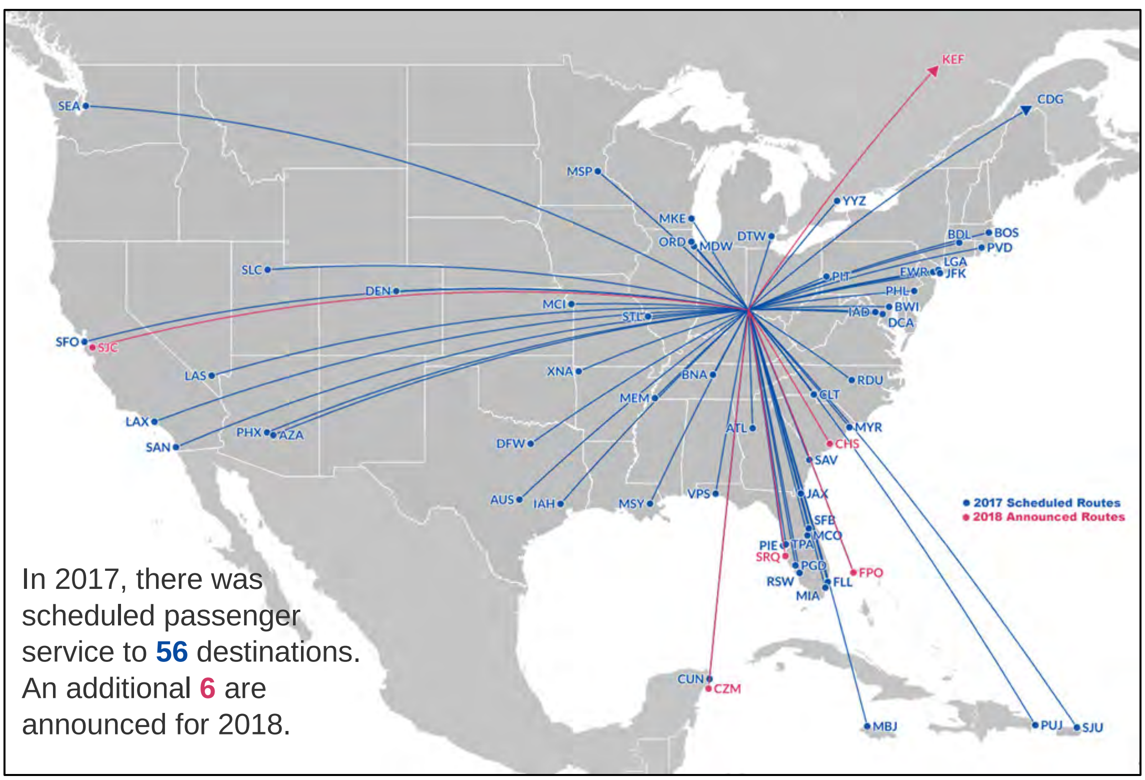
Year	Market Share				
	Delta Air Lines	Other Legacy Carriers	LCC & ULCC	Other Airlines	Grand Total
2007	91.4%	7.8%	0.0%	0.7%	100.0%
2008	90.8%	8.4%	0.0%	0.8%	100.0%
2009	89.5%	9.8%	0.0%	0.7%	100.0%
2010	84.5%	14.8%	0.0%	0.7%	100.0%
2011	82.0%	17.5%	0.0%	0.5%	100.0%
2012	78.3%	21.0%	0.0%	0.7%	100.0%
2013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

Source: KCAB

Passenger Air Service

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

EXHIBIT 3.1-3 MAP OF NONSTOP DESTINATIONS



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

4 These destinations include year-round and seasonal service.

Top Passenger Markets

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

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

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

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

3.1.1.2 *Cargo Activity*

Air Cargo Throughput

Air cargo at airports is comprised of two segments: air mail and air freight. Air mail refers to parcels that are carried by aircraft as part of a contract with the U.S. Postal Service. Air freight refers to all air cargo that is not air mail. Since 2011, less than one percent of the total air cargo processed at CVG was air mail.

Prior to 2004, air cargo increased at a steady pace. However, in 2005, DHL moved its sorting operations from CVG to Airborne Air Park in Wilmington Ohio (ILN) upon entering the US domestic express business. The impact to air cargo throughput was dramatic as only 47,728 tons of cargo were processed at CVG in 2006, almost a tenth of the throughput in 2004. DHL's operation at the Airborne Air Park was relatively short lived. In 2009, DHL refocused its U.S. operations on handling international business and moved its operation back to CVG. Since returning to CVG, DHL has invested $275 million in its facilities at CVG and has a total of 505 million dollars invested in its hub facilities that were relocated to the south airfield area in 2002. In 2013, DHL designated CVG, one of just three global "super hubs" in the world. The latest expansion to the hub was completed in 2016 and added 16 wide-body parking positions. This investment has resulted in significant growth in cargo activity. Since DHL's first full year after returning to CVG, air cargo has increased at an AAGR of 14.0 percent.

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

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

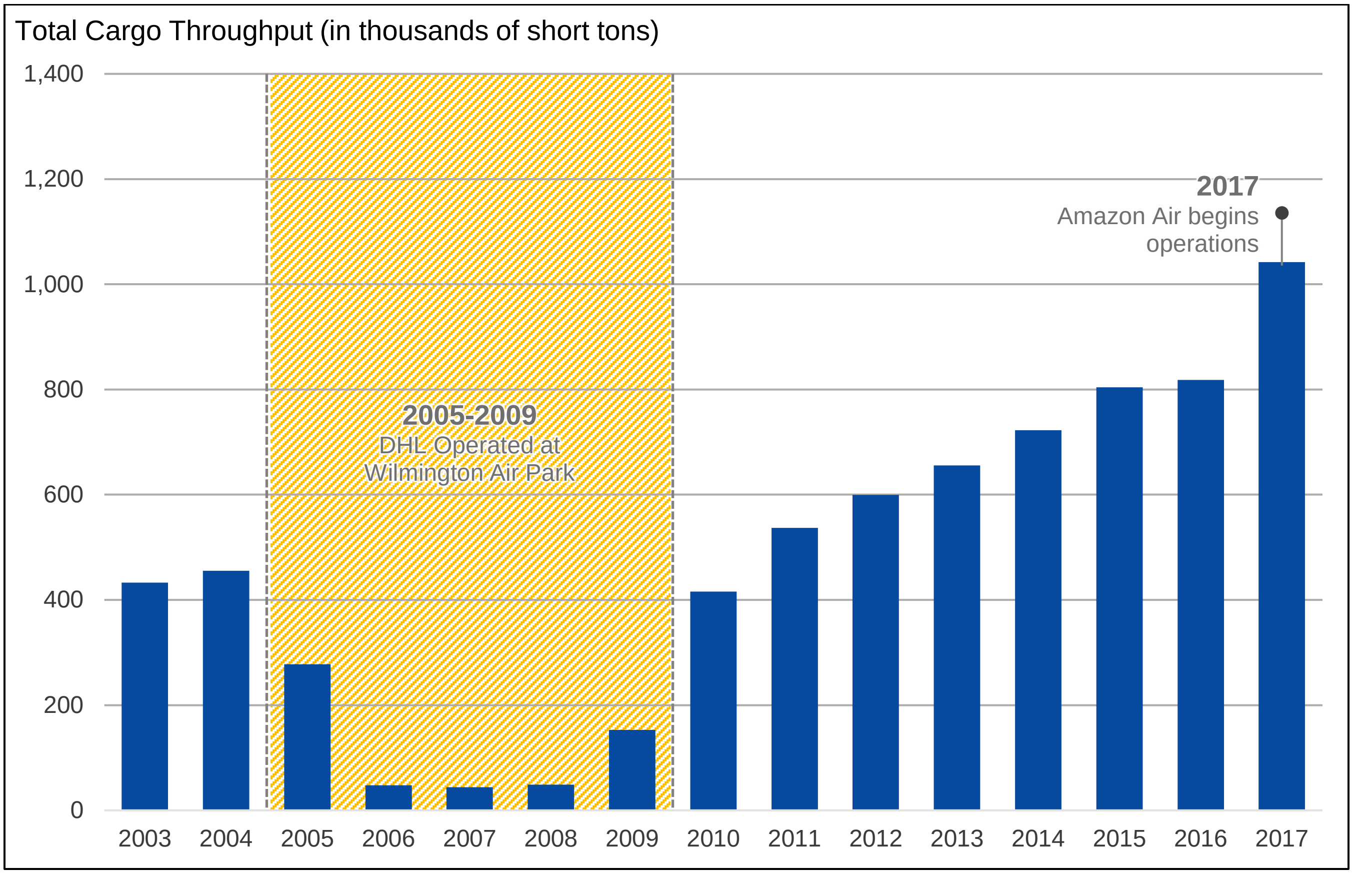
Mode of Transportation

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

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

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

EXHIBIT 3.1-4 HISTORICAL AIR CARGO THROUGHPUT



Source: KCAB

3.1.1.3 *Aircraft Operations*

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

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

5 14 Code of Federal Regulations Part 121

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

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

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

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

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

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

6 14 Code of Federal Regulations Part 91

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

TABLE 3.1-4 HISTORICAL AIRCRAFT OPERATIONS

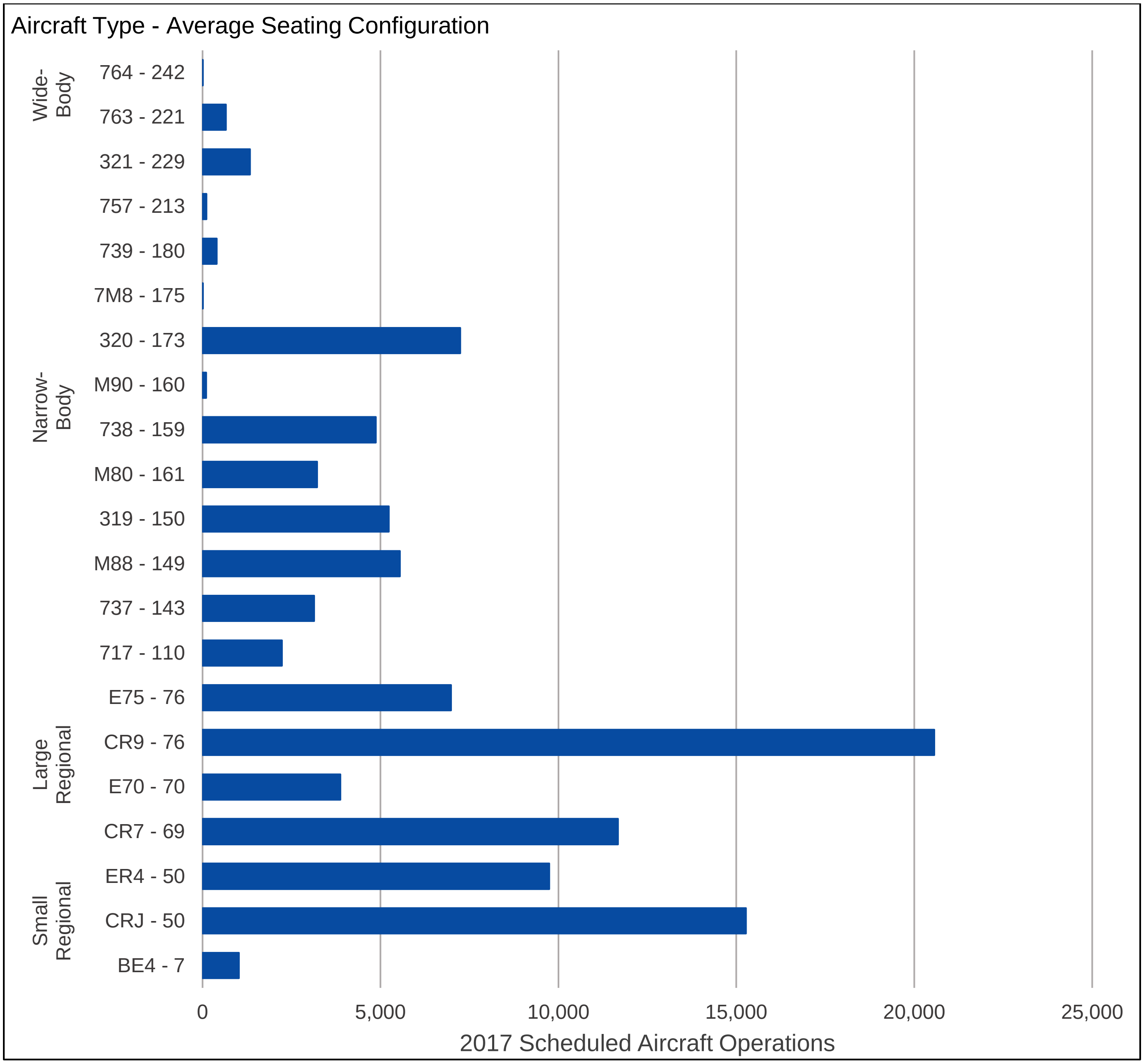
Year	Aircraft Operations						Grand Total
	Passenger		Cargo	Air Taxi	General Aviation	Military	
	Domestic	International					
2007	296,400	8,574	7,938	8,506	6,499	152	**328,069**
2008	258,512	7,900	5,452	7,926	5,531	163	**285,484**
2009	196,772	5,384	10,820	5,335	4,205	161	**222,677**
2010	142,442	4,052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

Source: KCAB

3.1.1.4 *Aircraft Fleet Mix*

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

EXHIBIT 3.1-5 SCHEDULED PASSENGER AIRCRAFT OPERATIONS BY AIRCRAFT TYPE



Source: OAG Aviation Worldwide Ltd, OAG Schedules Analyzer

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

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

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

3.1.1.5 *Based Aircraft*

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

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

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

3.1.2 Prior Forecast

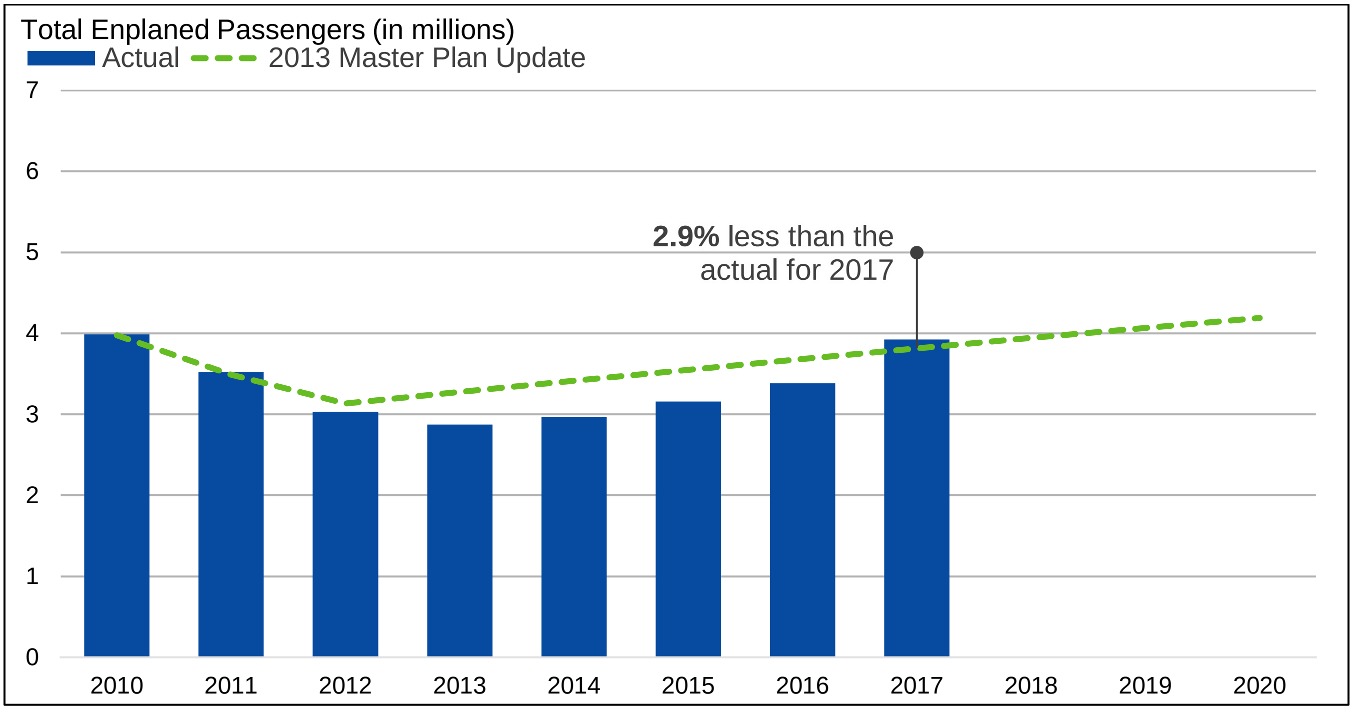
The most recent forecast of aviation activity at CVG was prepared as part of the Master Plan Update completed in 2013 (2013 Master Plan). The 2013 Master Plan used 2010 as the base year and provided projections of passenger enplanements, passenger operations, cargo operations, and cargo landed weights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

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

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

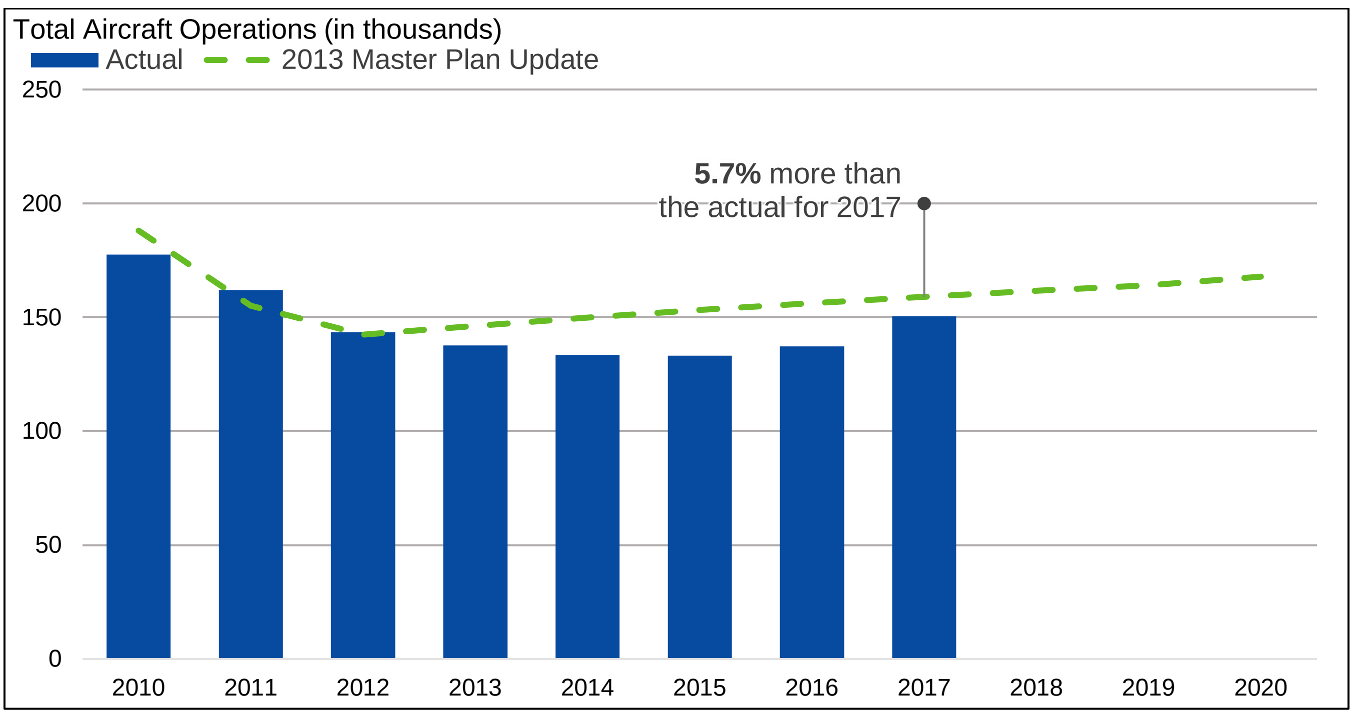
The 2013 Master Plan estimated that aircraft operations would first decrease from 188,064 in 2010 to 142,419 in 2012 and then increase to 192,660 in 2035. The forecast estimated 158,994 aircraft operations in 2017. The actual number of aircraft operations at CVG in 2017 was 150,463, 5.4 percent lower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

EXHIBIT 3.1-6 2013 MASTER PLAN ENPLANED PASSENGER FORECAST COMPARISON



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

EXHIBIT 3.1-7 2013 MASTER PLAN AIRCRAFT OPERATIONS FORECAST COMPARISON



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

3.2 Drivers of Air Traffic

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

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

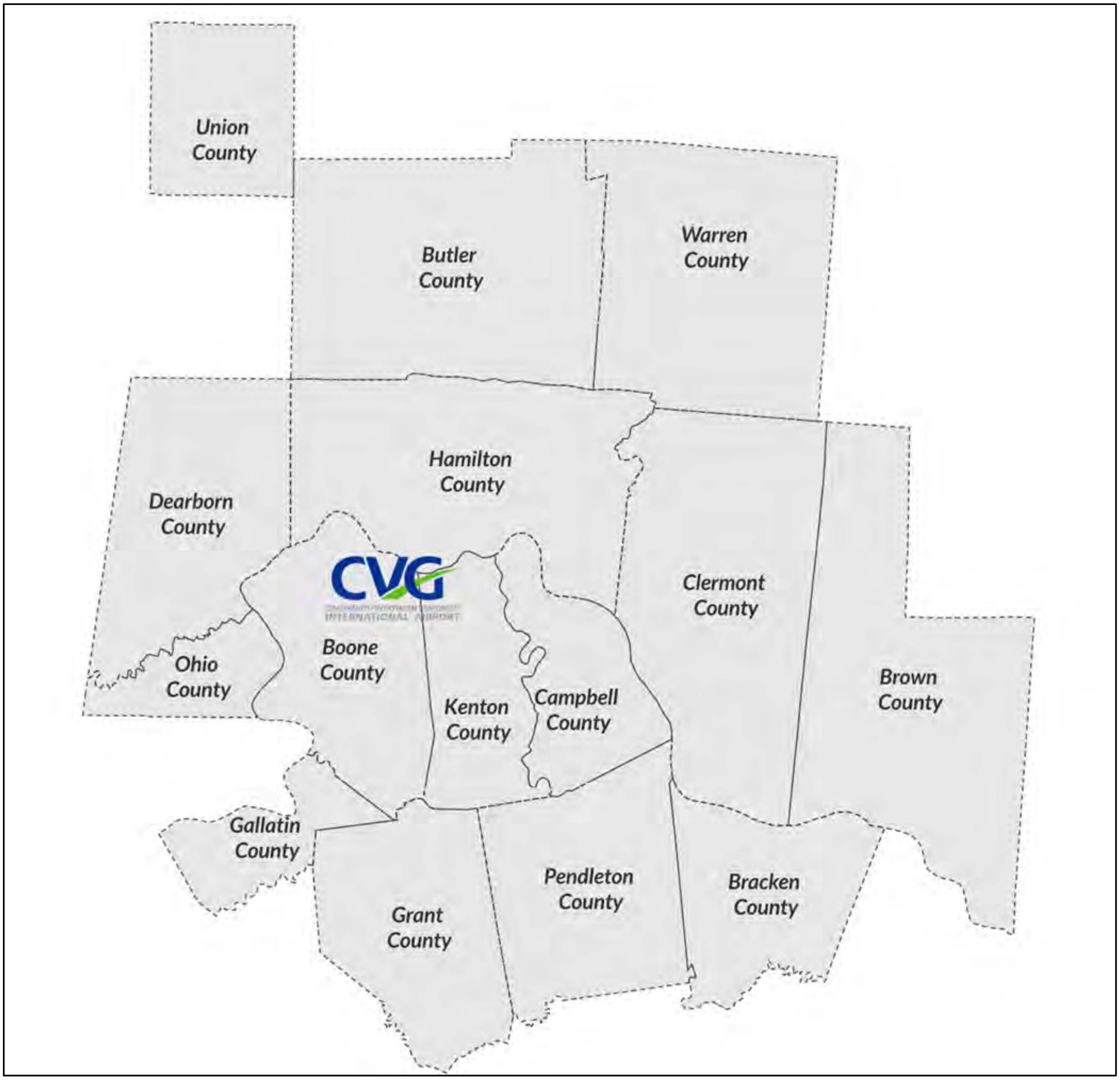
3.2.1 Air Service Area

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

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

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

EXHIBIT 3.2-1 CINCINNATI MSA MAP



Source: Landrum & Brown analysis

3.2.2 Economic Base for Air Travel

3.2.2.1 *United States Economy*

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

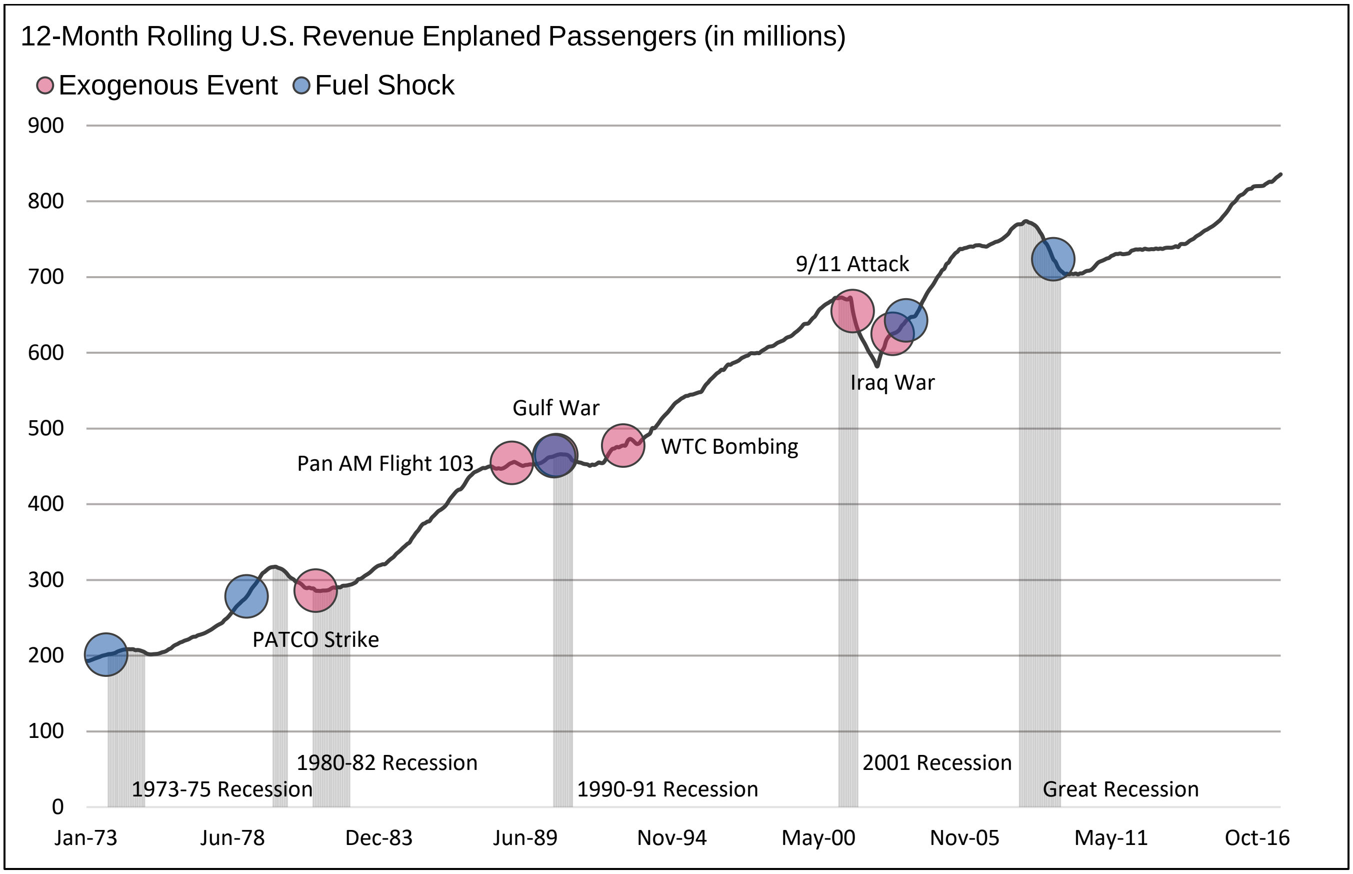
There have been two official economic recessions in the U.S. thus far in the 21st century. The first occurred between March and November of 2001 and was compounded by the September 11, 2001 terrorist attacks. The negative impact of these events on the airline industry is well documented. The recession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

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

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

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

EXHIBIT 3.2-2 UNITED STATES AVIATION SYSTEM SHOCKS & RECOVERIES

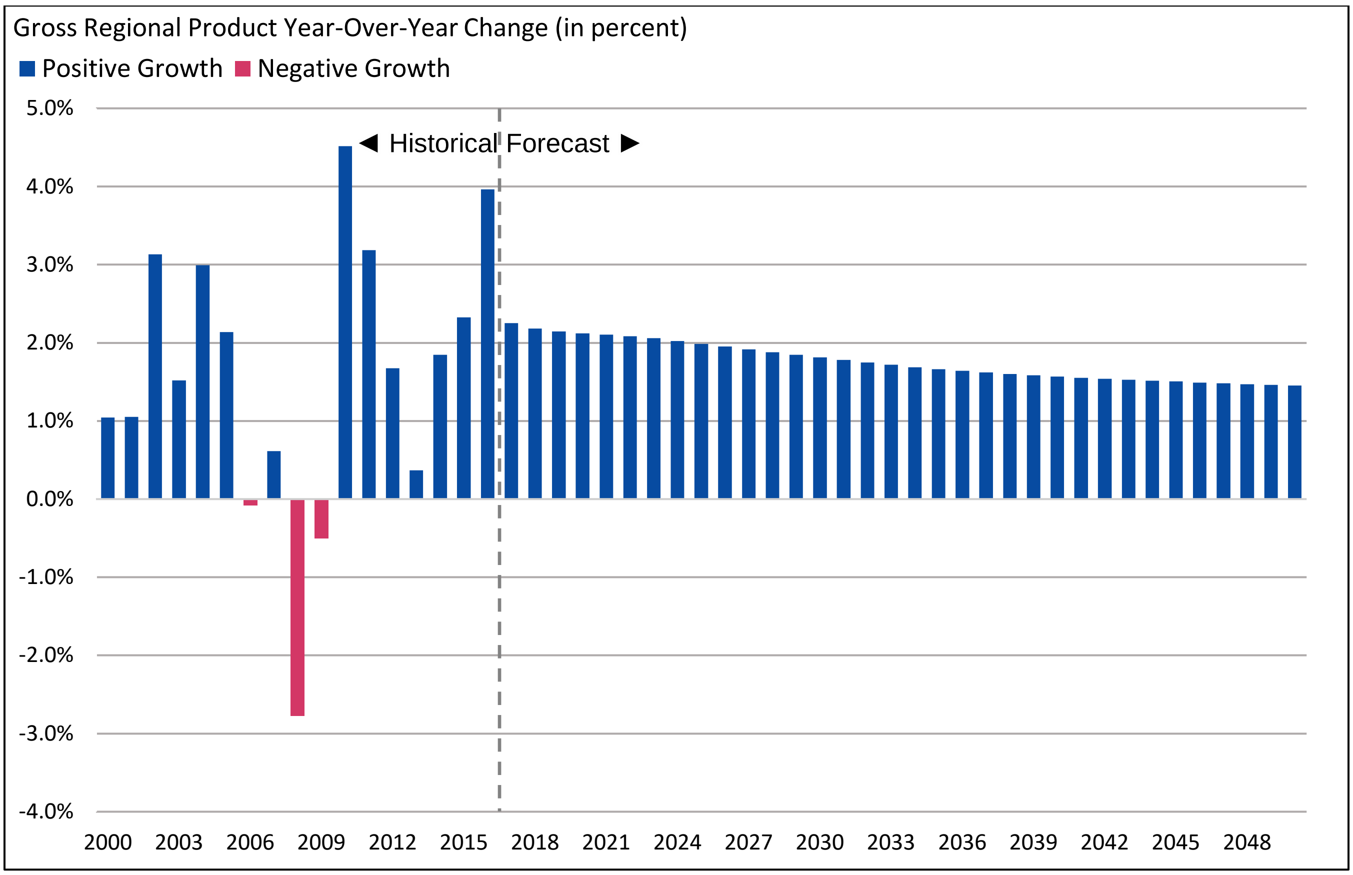


Source: U.S. Bureau of Transportation Statistics, *U.S. Air Carrier Traffic Statistics*

3.2.2.2 *Regional Economy*

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

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

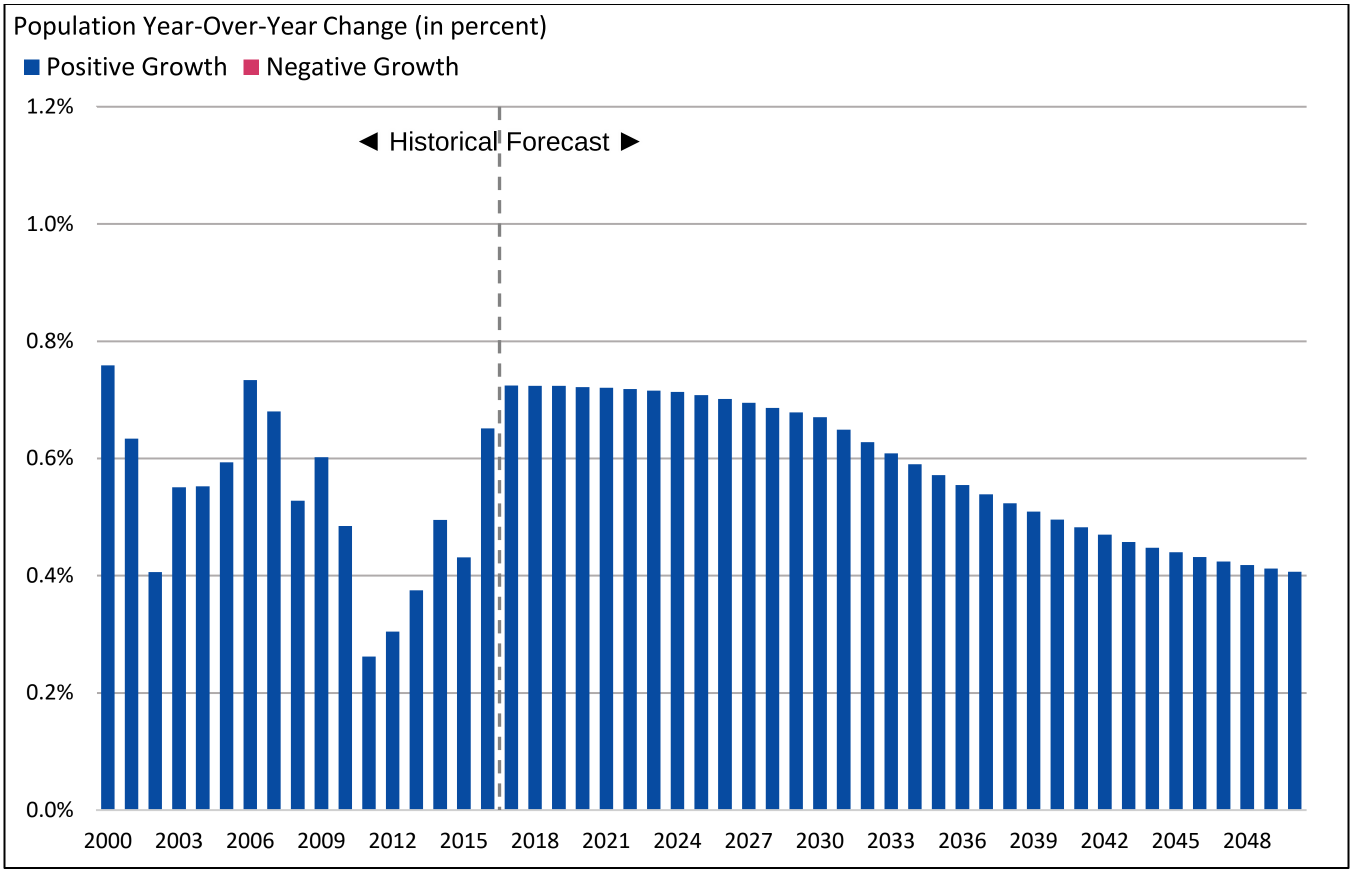


Note: Growth rates reflect real GDP.
Source: Woods & Poole, *The Complete Economic and Demographic Data Source (CEDDS) 2017*

3.2.3 Population Growth

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

EXHIBIT 3.2-4 HISTORICAL AND FORECAST POPULATION – CINCINNATI MSA



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

3.2.4 Employment

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

3.2.4.1 *Major Employers*

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

TABLE 3.2-1 CINCINNATI MSA LARGEST EMPLOYERS

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

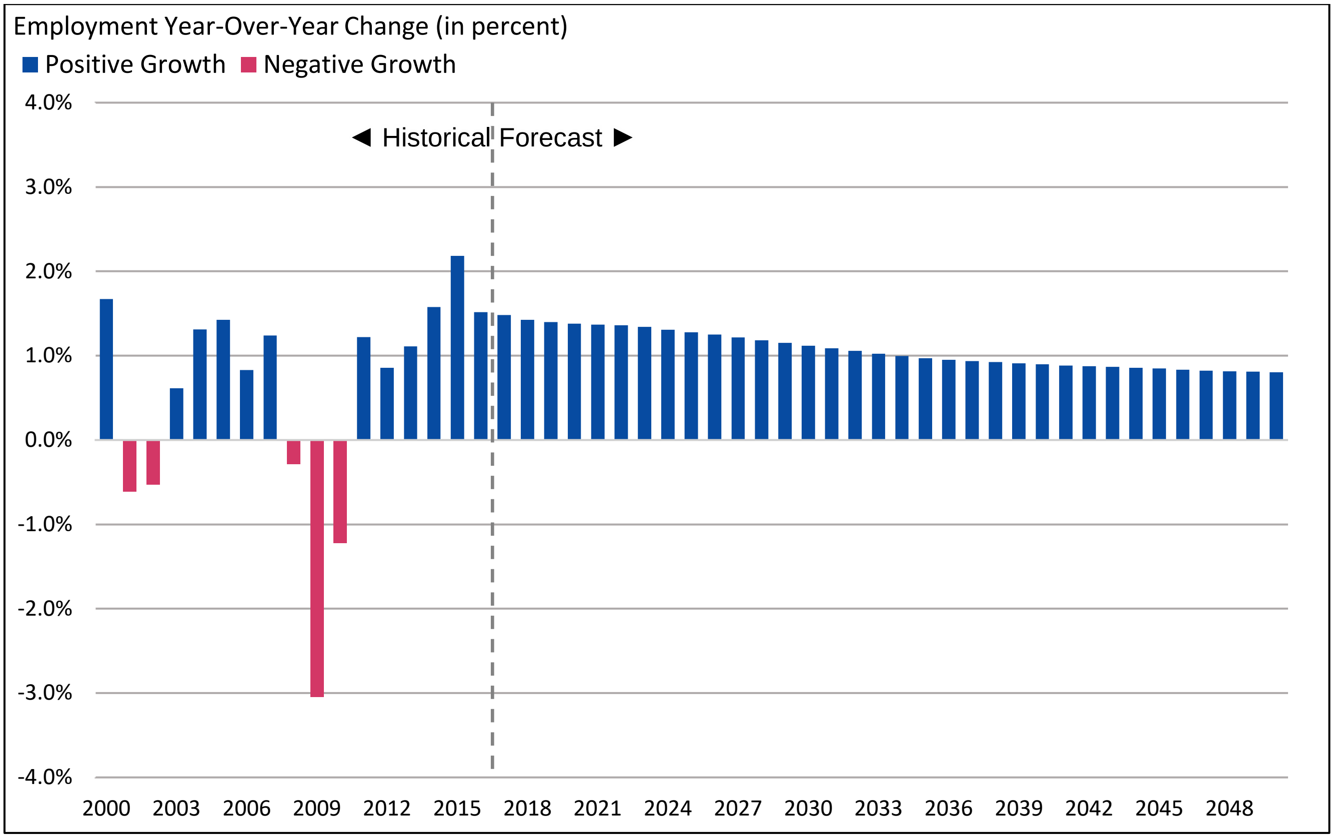
Source: Cincinnati Business Courier, *Book of Lists*, 2017

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

3.2.4.2 *Employment Growth*

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

EXHIBIT 3.2-5 HISTORICAL AND FORECAST EMPLOYMENT – CINCINNATI MSA



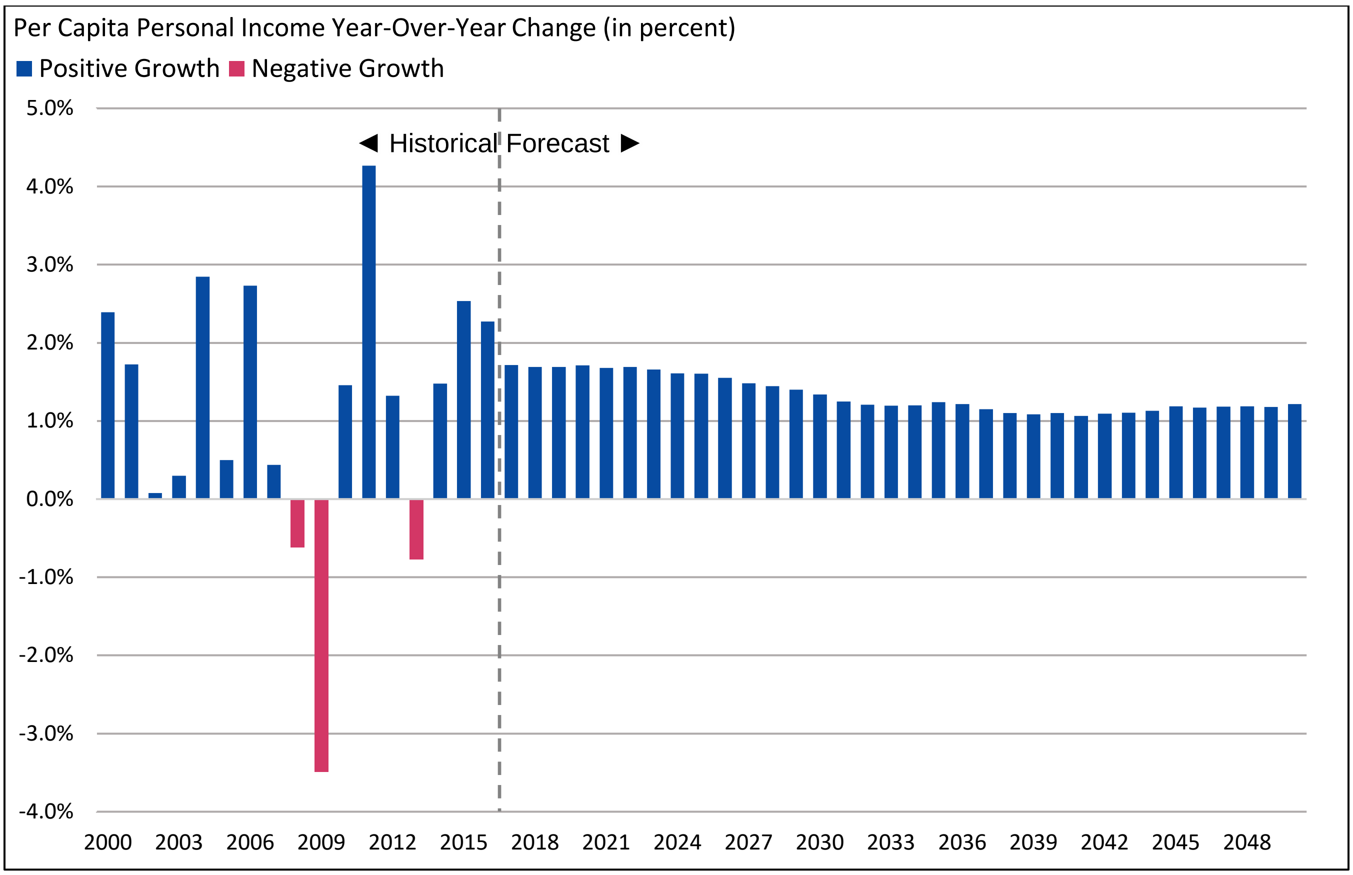
Source: Woods & Poole, *The Complete Economic and Demographic Data Source (CEDDS) 2017*

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

3.2.5 Personal Income

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

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



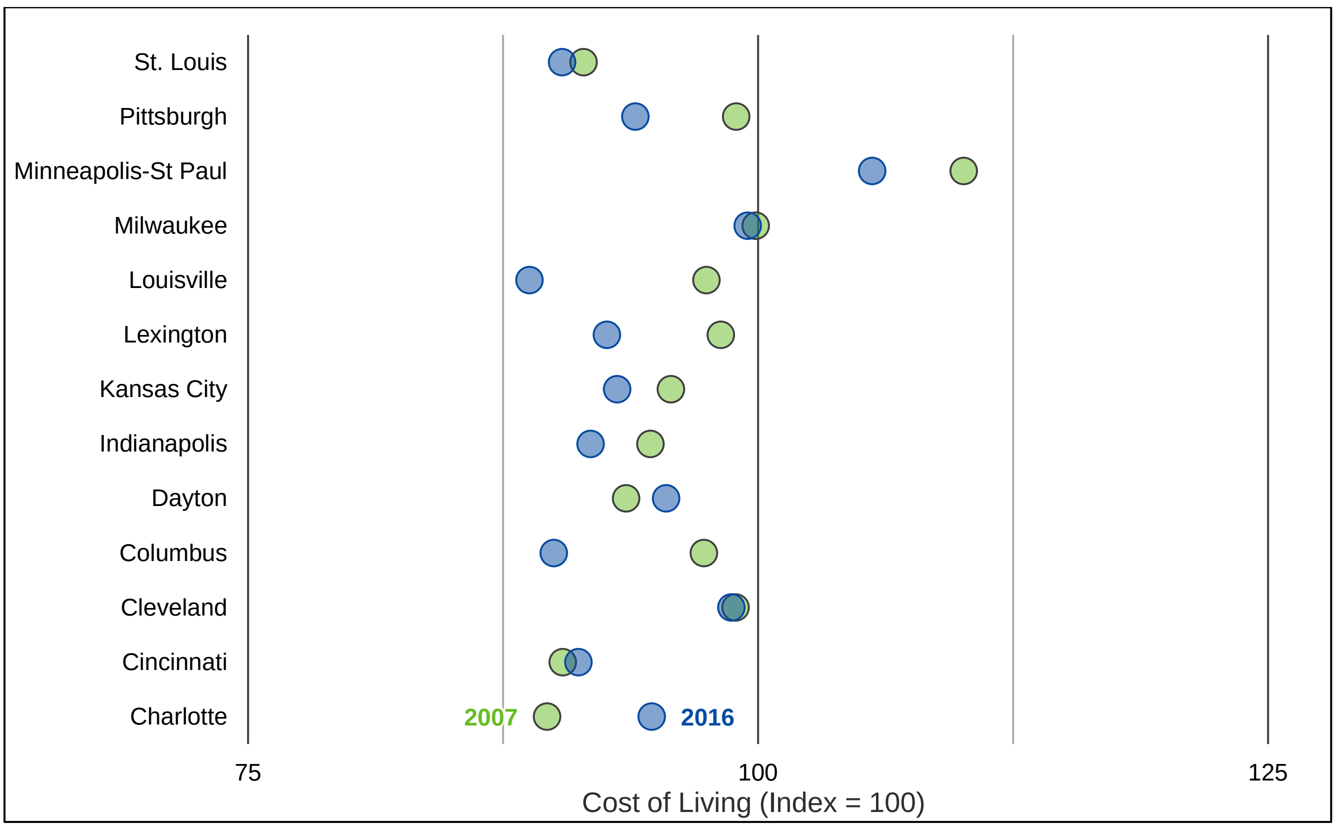
Source: Woods & Poole, *The Complete Economic and Demographic Data Source (CEDDS) 2017*

3.2.6 Cost of Living

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

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

EXHIBIT 3.2-7 COST OF LIVING INDEX



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

3.2.7 Tourism

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

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

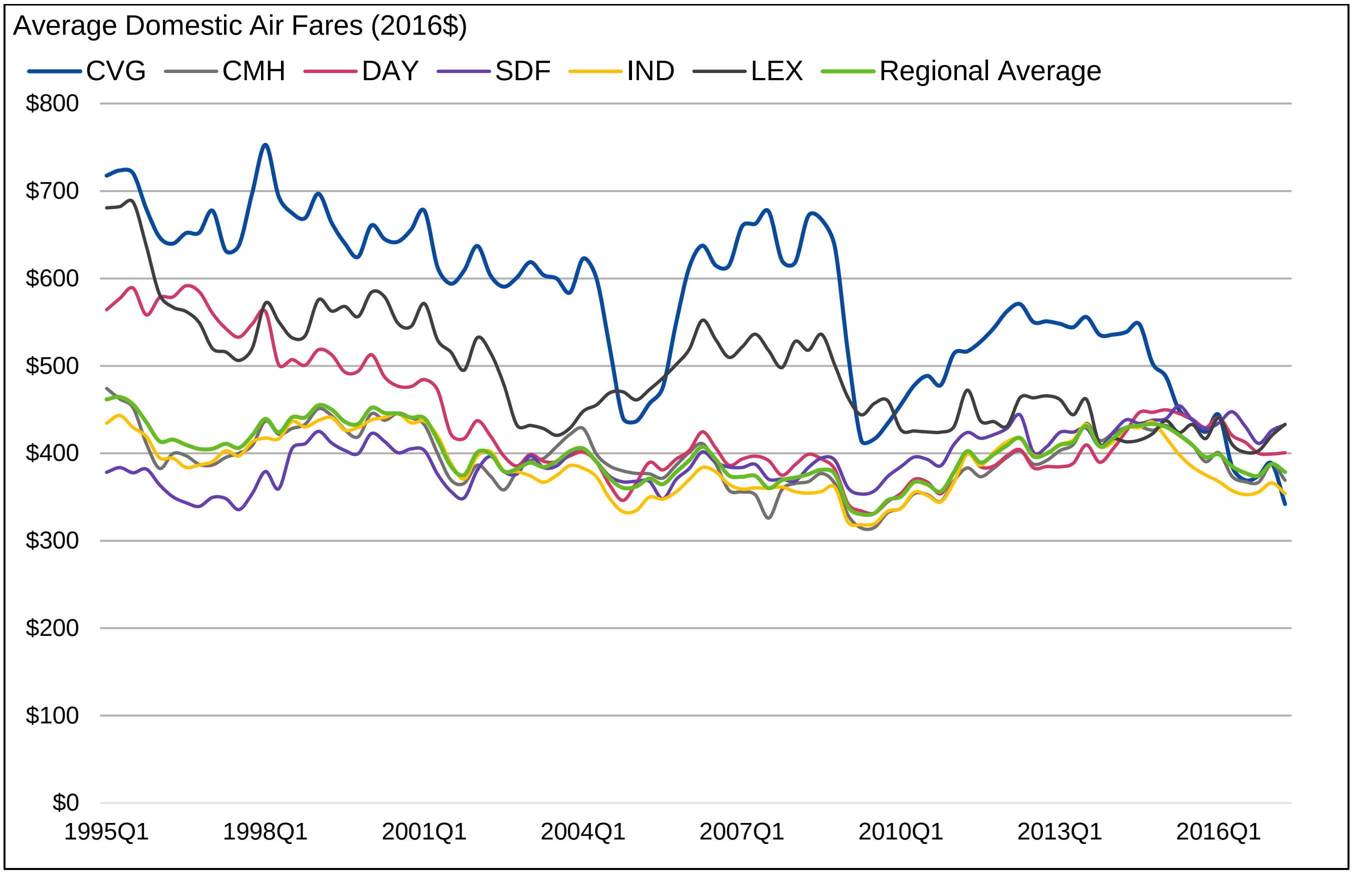
3.2.8 Price of Air Travel

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

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

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

EXHIBIT 3.2-8 AVERAGE AIRFARES AT REGIONAL AIRPORTS



Notes: Airfares are inflation-adjusted using dollars for the 2016 fare release. Regional average is a weighted average of CMH, DAY, SDF, IND, and LEX.

Sources: U.S. DOT, *Average Domestic Airline Itinerary Fares by Origin City*; U.S. DOT, *Air Passenger Origin-Destination Survey*

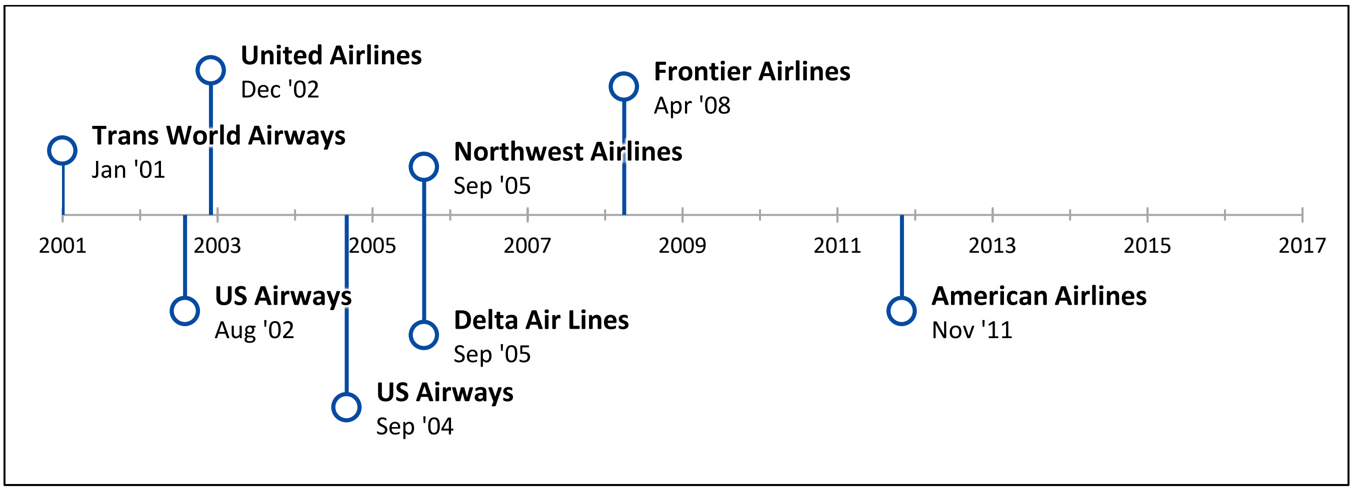
3.2.9 Airline Industry Strategies

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

3.2.9.1 *Airline Bankruptcies*

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

TABLE 3.2-2 AIRLINE BANKRUPTCY STATUS



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

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

3.2.9.2 *Airline Mergers*

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

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

3.2.10 Domestic Capacity

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

3.2.11 New Scheduled Service

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

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

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

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

3.2.12 Price of Fuel

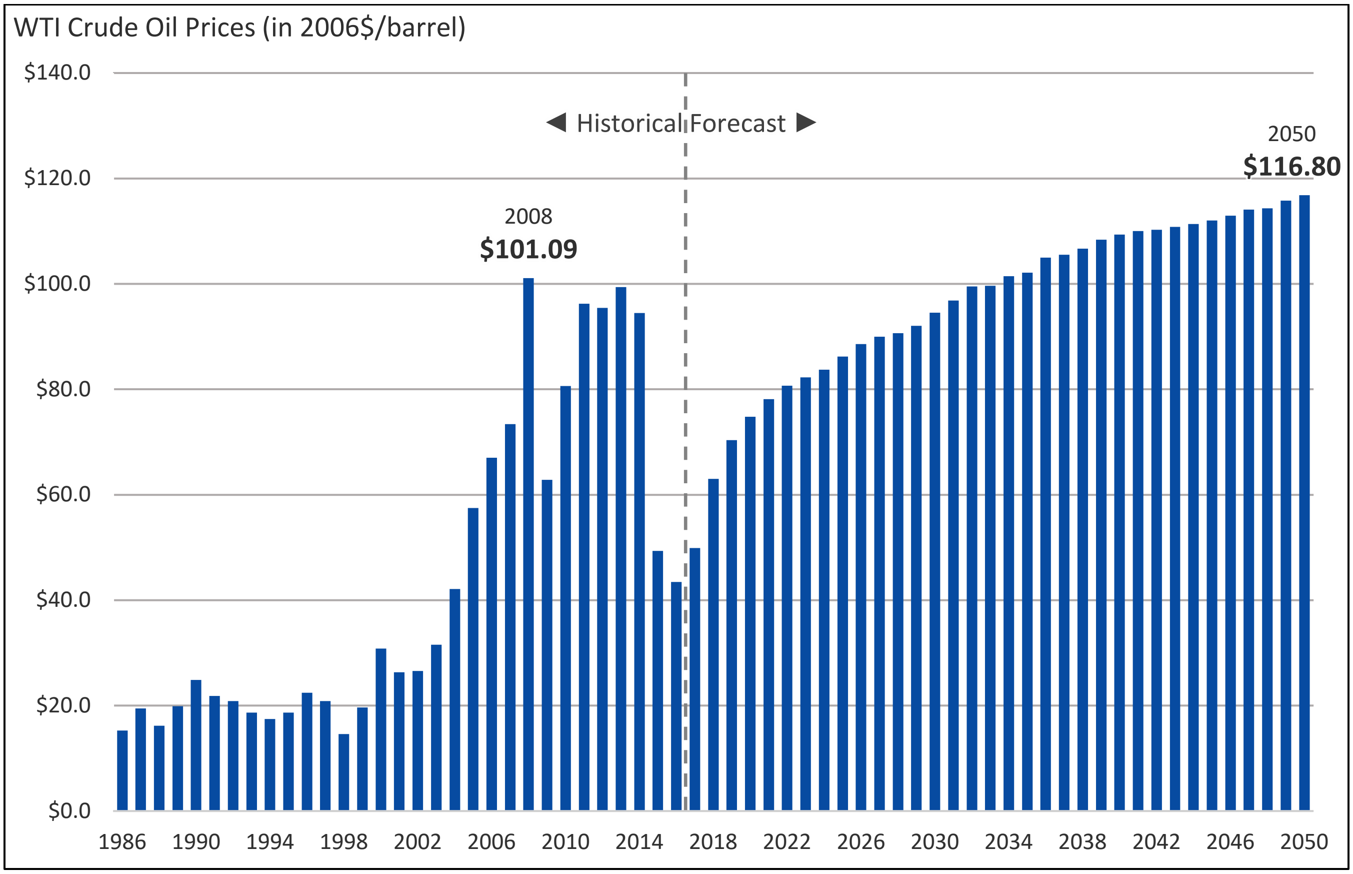
The price of oil and the associated cost of jet fuel is the largest single cost affecting the airline industry. The price of West Texas Intermediate (WTI) crude oil increased dramatically, posting a 290 percent increase in June 2008 when compared to January 2004. After averaging between $20 and $30 per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

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

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

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

EXHIBIT 3.2-9 CRUDE OIL PRICES



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

3.2.13 Aircraft Trends

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

3.2.14 The Rise in E-Commerce

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

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

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

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

3.2.15 FAA Aerospace Forecast

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

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

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

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

3.3 Passenger Activity Forecast

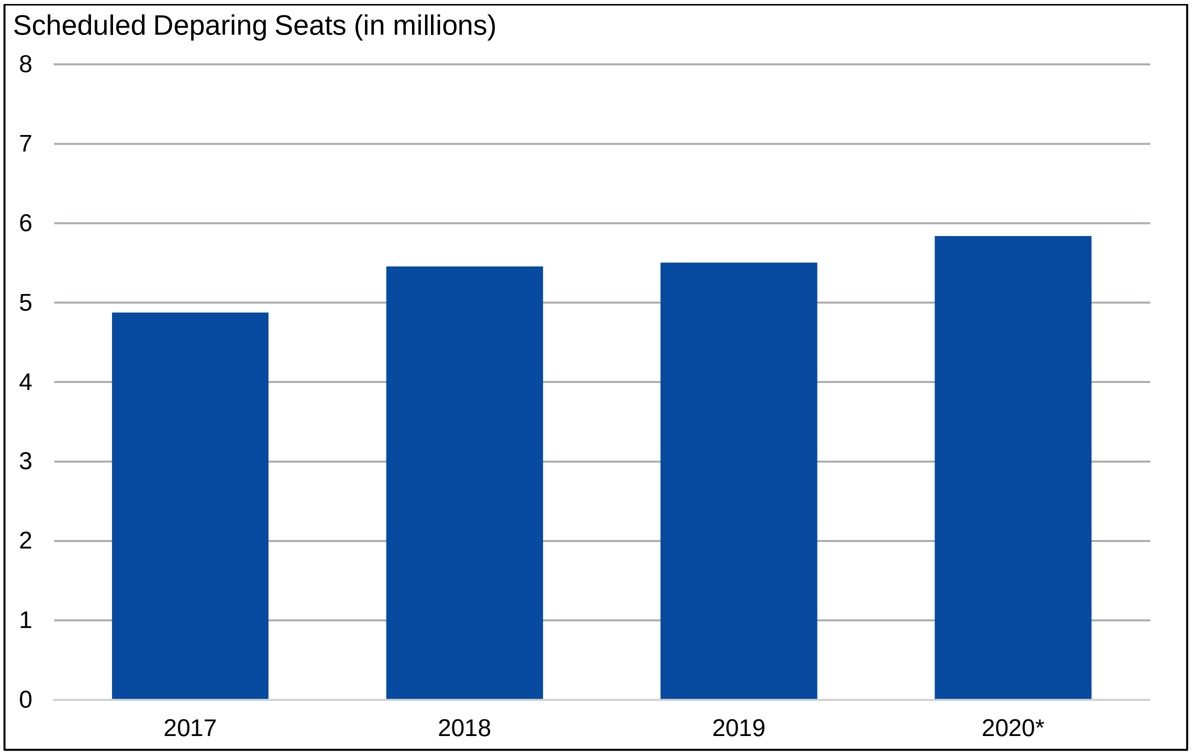
This section presents the forecast of enplaned passengers for CVG through the forecast period as well as a discussion of the methodology used. The enplaned passenger forecast reflects the historical airline activity trends, the economic base for air travel demand, and other factors that may affect the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

3.3.1 Short-Term Forecast Methodology (2017-2020)

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

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

EXHIBIT 3.3-1 GROWTH IN SCHEDULED PASSENGER SEATING



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

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

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

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

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

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

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

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

TABLE 3.3-1 REGRESSION MODEL INPUTS

Year	O&D Enplaned Passengers	Employment (in thousands of jobs)	Airport Yield (in 2016$ cents)
2007	2,448,118	1,288	24.37
2008	2,196,391	1,285	24.26
2009	2,343,094	1,246	18.88
2010	2,335,172	1,230	20.44
2011	2,257,934	1,245	21.59
2012	2,112,322	1,256	23.40
2013	2,171,371	1,270	23.20
2014	2,299,489	1,290	22.54
2015	2,669,588	1,318	20.45
2016	3,007,532	1,338	18.43
2017	3,652,270	1,358	15.77
2018		1,378	15.74
2019		1,397	15.79
2020		1,416	15.86
2021		1,435	15.90
2022		1,455	15.93
2023		1,474	15.93
2024		1,494	15.91
2025		1,513	15.87
2026		1,532	15.81
2027		1,550	15.74
2028		1,569	15.65
2029		1,587	15.55
2030		1,605	15.46
2031		1,622	15.36
2032		1,639	15.27
2033		1,656	15.18
2034		1,673	15.08
2035		1,689	14.99
2036		1,705	14.90
2037		1,721	14.81
2038		1,737	14.78

Year	O&D Enplaned Passengers	Employment (in thousands of jobs)	Airport Yield (in 2016$ cents)
2039		1,753	14.75
2040		1,768	14.72
2041		1,784	14.69
2042		1,799	14.66
2043		1,815	14.64
2044		1,831	14.62
2045		1,846	14.60
2046		1,862	14.58
2047		1,877	14.56
2048		1,892	14.54
2049		1,908	14.52
2050		1,923	14.51

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

3.3.3 Connecting Passenger Forecast Methodology

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

3.3.4 Long-Term International Forecast Methodology

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

According to the FAA's Airline Origin and Destination Survey (O&D Survey), European O&D demand has increased at an average rate of 2.4 percent since 2009. In 2017, there were approximately 114,000

O&D enplaned passengers flying to Europe from CVG but there were fewer than 72,000 departing seats on direct flights to Europe from CVG. Therefore, it was assumed that there is already pent up demand that is not being currently served by direct service. As such, it was assumed that a new daily European service would begin by 2022 using a 214-seat Boeing 787-800. Beyond 2022, it was assumed that European demand would increase at the same rate as total O&D passengers. When demand exceeds an average of 160 daily O&D passengers each way, based on an average 214-seat aircraft operating at a 75 percent load factor, a new flight was assumed to be added.

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

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

3.3.5 Passenger Activity Forecast Summary

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

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

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

TABLE 3.3-2 ENPLANED PASSENGER FORECAST RESULTS

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

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

3.4 Air Cargo Throughput Forecast

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

3.4.1 Methodology

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

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

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

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

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

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

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

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

TABLE 3.3-3 REGRESSION MODEL INPUTS

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

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

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

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

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

TABLE 3.4-1 SHARE OF AIRCRAFT

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

Source: Amazon

3.4.2 Cargo Throughput Forecast Summary

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

TABLE 3.4-2 AIR CARGO THROUGHPUT FORECAST RESULTS

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

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

3.5 Aircraft Operations Forecast

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

3.5.1 Passenger Aircraft Operations

3.5.1.1 *Methodology*

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

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

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

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

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

TABLE 3.5-1 ENPLANED PASSENGER FORECAST BY CLASSIFICATION

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

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

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

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

3.5.1.2 *Passengers Per Operation*

Domestic

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

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

- **Frontier Airlines**: Frontier Airlines uses a mix of Airbus A319, Airbus A320, and Airbus A321 aircraft at CVG. Frontier Airlines has a number of Airbus A320 Neo and Airbus A319 aircraft on order. It is expected the Airbus A320 Neo will handle some of the flights at CVG currently being operated by the current model Airbus A320.
- **Allegiant Air**: Allegiant Air currently uses a mix of McDonnell Douglas MD-80 and Airbus A319 aircraft at CVG. The McDonnell Douglas MD-80 is expected to be replaced by the end of 2018 with the Airbus A320 aircraft.

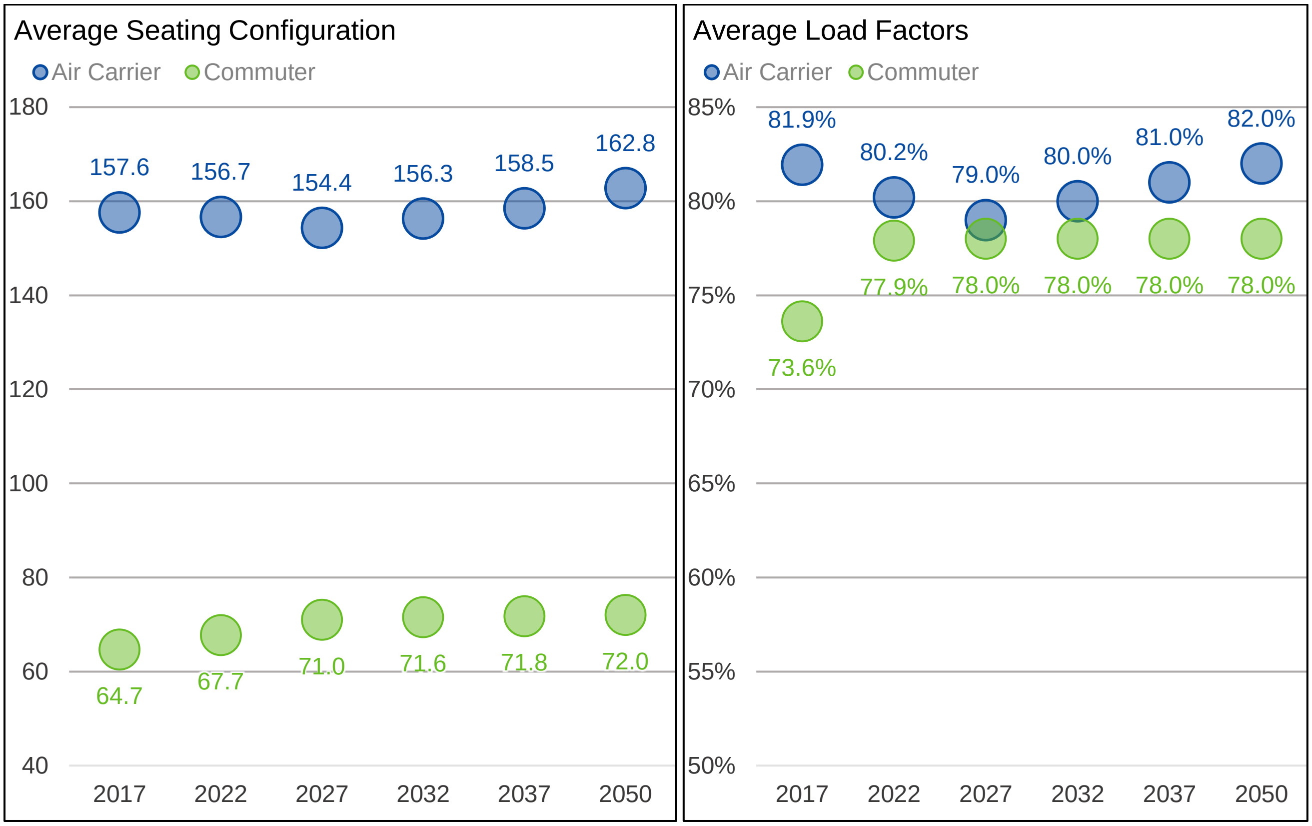
Delta Air Lines, United Airlines, and American Airlines all use regional affiliates to accommodate a majority of their passenger traffic. These regional airlines exclusively use aircraft with fewer than 76 seats, which are called regional jets. Small regional jets (aircraft with 50 or fewer seats) are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

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

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

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

EXHIBIT 3.5-1 DOMESTIC PASSENGERS PER OPERATION ASSUMPTIONS



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

International

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

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

3.5.1.3 *Passenger Aircraft Operations Forecast Summary*

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

3.5.1.4 *Fleet Mix*

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

TABLE 3.5-2 PASSENGER AIRCRAFT OPERATIONS

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

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

TABLE 3.5-3 DOMESTIC PASSENGER FLEET MIX

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

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

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

TABLE 3.5-4 INTERNATIONAL PASSENGER FLEET MIX

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

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

3.5.2 Freighter Aircraft Operations

3.5.2.1 *Methodology*

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

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

3.5.2.2 *Tons Per Operation*

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

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

3.5.2.3 *Freighter Aircraft Operations Forecast Summary*

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

TABLE 3.5-5 FREIGHTER AIRCRAFT OPERATIONS FORECAST

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

Sources: KCAB; Landrum & Brown analysis

3.5.2.4 *Fleet Mix*

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

TABLE 3.5-6 FREIGHTER FLEET MIX

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

Sources: KCAB; Landrum & Brown analysis

3.5.3 Other Aircraft Operations

3.5.3.1 *Air Taxi and General Aviation*

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

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

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

TABLE 3.5-7 AIR TAXI AND GENERAL AVIATION FLEET MIX

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

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

3.5.3.2 *Based Aircraft Forecast*

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

TABLE 3.5-8 BASED AIRCRAFT FORECAST

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

Sources: FAA Form 5010; Landrum & Brown analysis

3.5.3.3 *Military*

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

3.5.4 Total Aircraft Operations

The total aircraft operations forecast is the aggregation of the passenger, freighter, air taxi/GA, and military aircraft operations forecasts. Total aircraft operations are projected to increase from 150,463 in 2017 to 372,443 in 2050, representing an AAGR of 2.8 percent. **Table 3.5-9, *Total Aircraft Operations Forecast***, presents the aircraft operations forecast by segment through the forecast period.

TABLE 3.5-9 TOTAL AIRCRAFT OPERATIONS FORECAST

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

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

3.5.5 Critical Aircraft Determination

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

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

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

3.6 Peak Period Forecasts

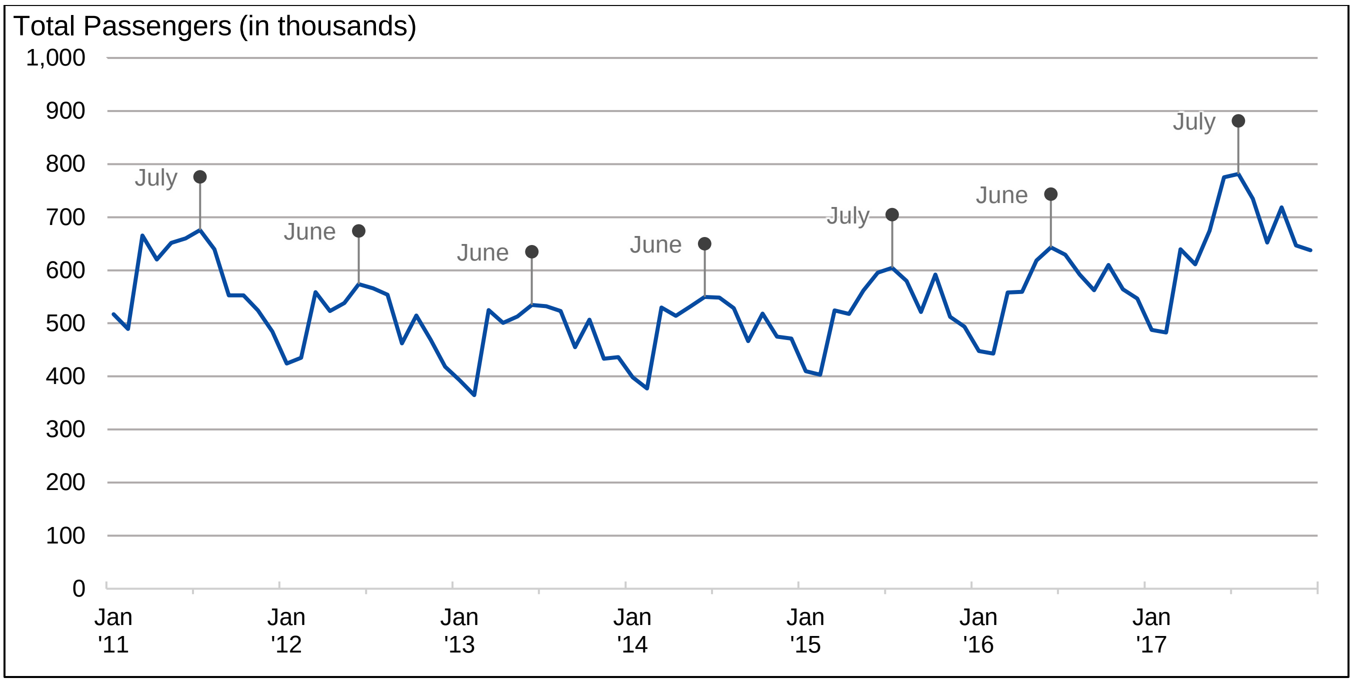
The traffic demand patterns imposed upon an airport are subject to seasonal, monthly, daily, and hourly variations. Peaking characteristics are critical in the assessment of existing facilities and airfield components to determine their ability to accommodate forecast increases in passenger and operational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

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

3.6.1 Monthly Seasonality

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

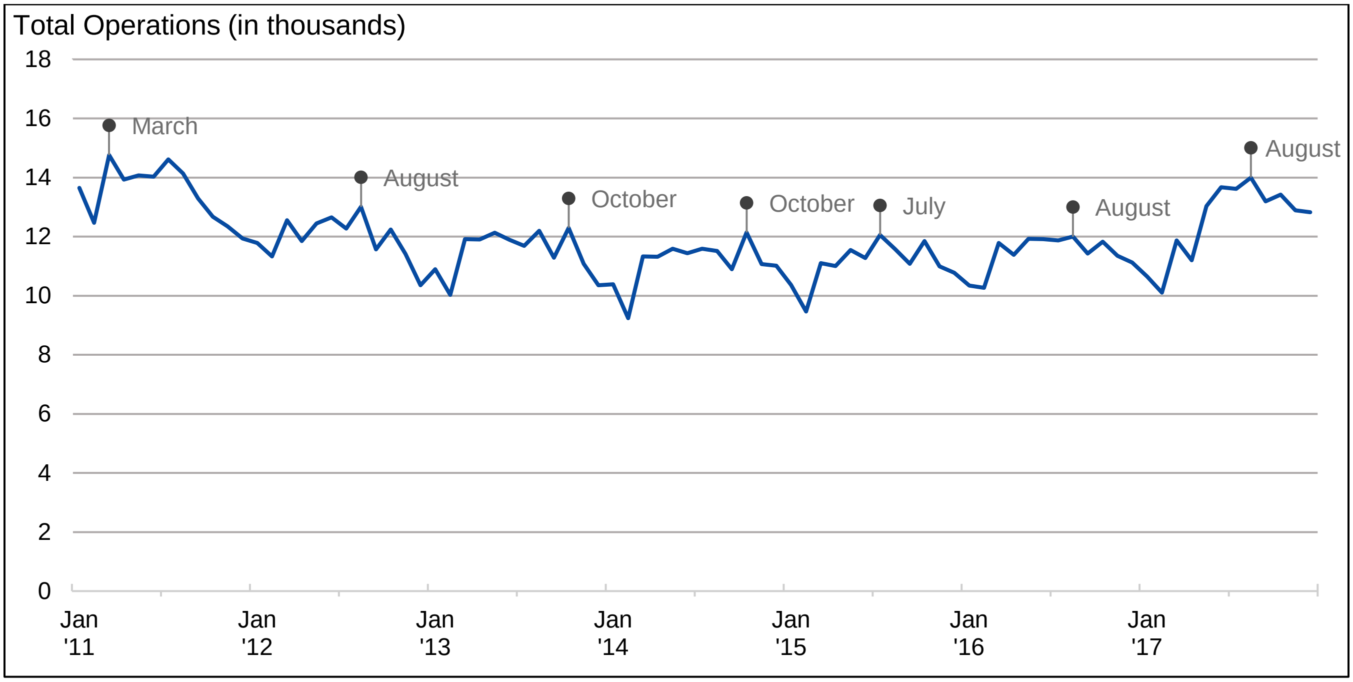
EXHIBIT 3.6-1 MONTHLY ENPLANED PASSENGERS



Source: KCAB

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

EXHIBIT 3.6-2 MONTHLY AIRCRAFT OPERATIONS



Source: KCAB

3.6.2 Daily Patterns

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

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

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

3.6.3 Design Day Flight Schedules

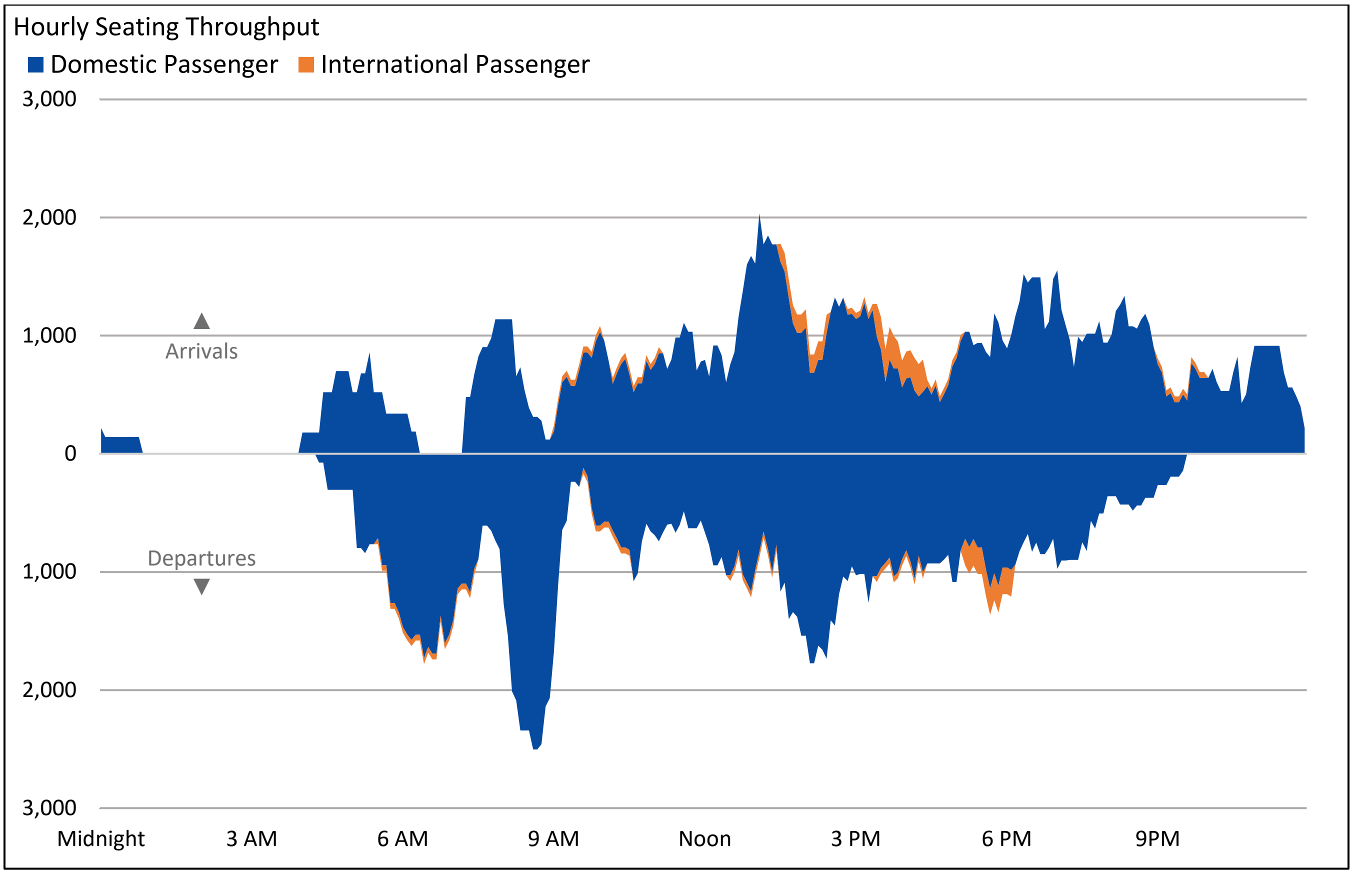
A design day flight schedule (DDFS) for 2017 was developed to determine the hourly profile of traffic at CVG. In order to develop a DDFS that was representative of the traffic CVG to include scheduled and unscheduled service, a combination of OAG schedules and historical radar data was used.

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

3.6.4 Hourly Profiles

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

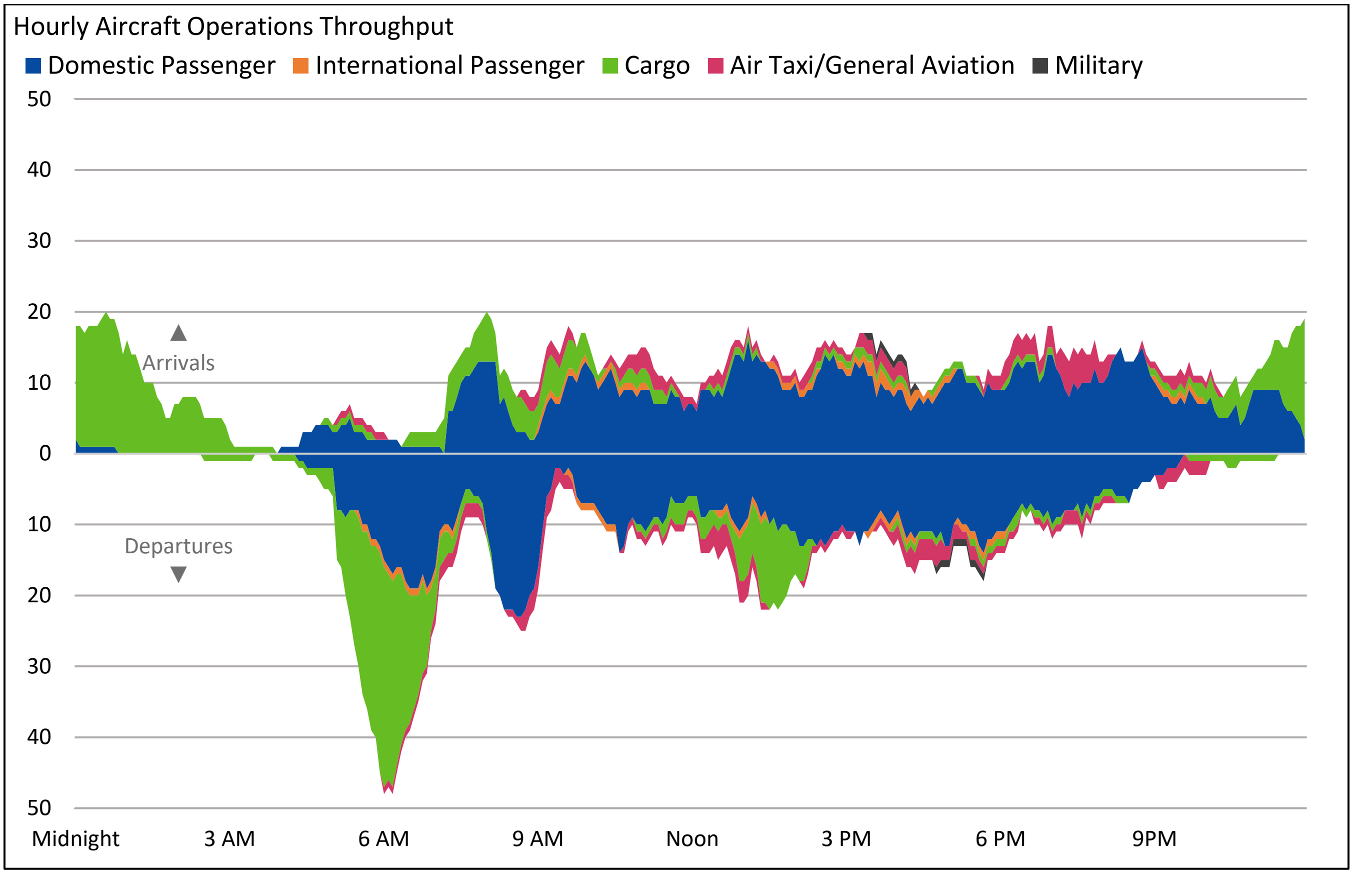
EXHIBIT 3.6-3 ROLLING 60-MINUTE SEATING PROFILE, JULY 19, 2017



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

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

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



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

3.6.5 Derivative Forecast

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

3.6.5.1 *Aircraft Operations Forecast*

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

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

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

3.6.5.2 *Passenger Forecast*

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

TABLE 3.6-1 PEAK PERIOD AIRCRAFT OPERATIONS FACTORS

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

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

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

TABLE 3.6-2 PEAK PERIOD AIRCRAFT OPERATIONS FORECAST

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

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

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

TABLE 3.6-3 PEAK PERIOD PASSENGERS FACTORS

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

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

TABLE 3.6-4 PEAK PERIOD PASSENGER FORECAST

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

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

3.7 Comparison to the TAF

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

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

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

If the Sponsor Forecast is not consistent with the TAF, differences must be resolved before proceeding.

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

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

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

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

According to the 2018 TAF, enplaned passengers at CVG increased from 2.8 million in FY2013 to an estimated 3.7 million in FY2017, representing an AAGR of 7.0 percent. During this span, enplaned passengers provided in the 2018 TAF have been on average within 4.9 percent of CVG's records.

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

There are two reasons for this difference. The data provided in the TAF is on a fiscal year basis. Additionally, the enplaned passengers provided in the TAF exclude non-revenue passengers and military charter passengers. In 2017, there were 3.9 million enplaned passengers at CVG, which is 6.8 percent higher than the 3.7 million for FY2017 in the 2018 TAF. The 2018 TAF projects that enplaned passengers will increase from an estimated 3.7 million in FY2017 to 5.1 million in FY2027, representing an AAGR of 3.4 percent.

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

TABLE 3.7-1 FAA TAF FORECAST COMPARISON – APPENDIX B

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

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

Sources: FAA, *2018 Terminal Area Forecast*; Landrum & Brown analysis

TABLE 3.7-2 FAA TAF FORECAST COMPARISON – APPENDIX C

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

[1] Commercial operations include operations by passenger airlines, all-cargo airlines, and air taxi operators.

Notes: Sponsor forecast has been adjusted so that variance in the base year would be zero to account for differences in reporting.

Sources: FAA, *2018 Terminal Area Forecast*; Landrum & Brown analysis

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MASTER PLAN 2050

Chapter 4 | Facility Requirements

CINCINNATI/NORTHERN KENTUCKY INTERNATIONAL AIRPORT

TEAM

4 Facility Requirements

4.1 Introduction

This chapter presents the future planning requirements for Airport facilities that will be needed in order to provide sufficient capacity to meet the projected demand throughout the planning period at the Cincinnati/Northern Kentucky International Airport (CVG). In addition to providing sufficient capacity, consideration has been given throughout to providing acceptable levels of service for all Airport users. The requirements were calculated using Federal Aviation Administration (FAA) standards where applicable as well as established industry planning standards.

For the purposes of master planning, the requirements presented herein are tied to four Planning Activity Levels (PALs). The use of PALs rather than years provides CVG with flexibility to plan for the implementation of future projects based on actual growth in traffic, rather than a point in time. The associated activity levels for each PAL are shown in **Table 4.1-1, *Planning Activity Levels***. These PALs were selected based on the activity levels presented in **Appendix 1-B, *Alternative Forecasts***, Section 6, *Recommended Forecast*.[1]

TABLE 4.1-1 PLANNING ACTIVITY LEVELS

PAL	Million Annual Passengers (MAP)	Total Annual Operations	Total Peak Hour Passengers	Total Peak Hour Operations
Existing	8	150,000	2,620	46
PAL 1	11	200,000	3,210	56
PAL 2	13	260,000	4,100	71
PAL 3	16	350,000	5,340	102
PAL 4	19	460,000	5,790	136

Sources: Kenton County Airport Board (KCAB); OAG Aviation Worldwide Ltd, *OAG Schedules Analyzer*; *Flight Track Data for 2017*; Landrum & Brown analysis

[1] The forecast demand levels associated with PAL 1 through 4 and the associated design day flight schedules were used to develop the requirements presented in this chapter.

4.2 Airfield

The determination of airfield facility requirements falls into five broad categories:

- **Runway Demand/Capacity**: Defines the ability of the existing runways to accommodate future demand and identifies the improvements required to accommodate those volumes.
- **Runway Length**: Calculates the runway length needed to accommodate the existing and future fleet mix.
- **Runway Exits**: Identifies the exits needed by the current and projected fleet in order to minimize Runway Occupancy Time (ROT) and improve the efficiency of the runways.
- **Taxiway Demand/Capacity**: Identifies taxiway needs that will improve the operational efficiency of the airfield.
- **Airfield Design Standards**: Compares the existing airfield geometry to the current FAA design standards to identify where changes may be necessary.

4.2.1 Runway Demand/Capacity

The purpose of the CVG airfield demand/capacity analysis was to determine the capacity of the airfield in terms of the maximum number of operations that can be accommodated. This capacity was compared to projected demand through PAL 4 to identify when additional airfield capacity may be needed.

4.2.1.1 *Methodology*

The FAA Airfield Capacity Model (ACM) was used to assess airfield capacity for the CVG Master Plan. The ACM is a spreadsheet-based model that calculates hourly runway capacity based on federal Air Traffic Control (ATC) guidelines included in FAA JO 7110.65X, *Air Traffic Control,* as well as airport-specific input parameters. The ACM uses the hourly capacity results and demand profiles to calculate an airport's annual capacity, referred to as Annual Service Volume (ASV).

Capacity was assessed separately for daytime (7:00 AM – 9:59 PM) and nighttime (10:00 PM – 6:59 AM) operations due to traffic and runway use differences. Daytime operations consist primarily of commercial passenger operations, with one cargo operations bank (Amazon Air) occurring during daytime hours. Nighttime operations are made up mostly of cargo activity, overlapping with passenger departures from 6:00 AM to 7:00 AM. The different types of activity (passenger during the day, cargo at night) result in different peaking patterns and fleet mix. In addition, runway use differs at night due to noise restrictions.

4.2.1.2 *Additional Capacity Need Determination*

The CVG Master Plan airfield analysis used the ACM to determine the number of operations that can be processed by the runway system in an hour. The ACM does not consider delays; therefore, the ACM assumes a zero delay condition. An airport does not need to add additional capacity immediately when demand exceeds capacity, as delays should be considered. Delay is defined as the difference between the actual and the normal or unimpeded time required for an aircraft to traverse the airfield or airspace. Delays occur when demand exceeds capacity. The greater the differential in demand versus capacity, the higher the delays will be. Most airports operate with delays, especially in their peak hours. The determination of when an airport needs a new runway is typically based on a delay threshold. Airport officials determine a maximum delay threshold that will trigger the need to add runway capacity. This definition of “acceptable” delays differs by airport. Typically, a new runway can be justified when delays reach an average of six to ten minutes per operation.

In the case of CVG, the analysis presented herein identifies when demand exceeds capacity so that CVG officials can determine when to initiate a delay study and start planning for additional runway capacity. It can take a minimum of 15 years to plan for a new runway, conduct the appropriate environmental studies, and design and construct a new runway. As a general industry rule of thumb, a delay study should be initiated when actual operations reach 60 percent to 80 percent of capacity to allow sufficient time to build a new runway.

4.2.1.3 *Daytime Demand/Capacity Analysis*

The ACM was used to calculate peak hour capacity and ASV for daytime operations, which consist primarily of commercial passenger operations. Capacity was assessed for 2017 (for calibration purposes) and future conditions. Capacity is partially a function of the demand characteristics such as peaking patterns and fleet mix. For purposes of this analysis, the PAL 3 peaking factors and fleet mix were used in the future capacity calculations. PAL 3 was used instead of PAL 4 because the design day flight schedules (DDFSs), and the detailed information they provide, were not available for PAL 4. Instead, PAL 4 capacity was assumed to be equivalent to PAL 3 capacity because the peaking patterns and fleet mix are similar between the two activity levels.

Daytime Assumptions

The ACM was run with standard aircraft separations, runway occupancy times, and approach speeds. Airport-specific inputs to the ACM include operational peaking characteristics, fleet mix, historical weather conditions, and runway use. These inputs are described in the subsections that follow.

Daytime Aircraft Operations

The ACM requires that aircraft operations factors be defined in order to calculate ASV from peak hour capacity (referred to as D-Factor and H-Factor). These factors provide an indication of peaking characteristics. The D-Factor is defined as annual operations divided by design day operations. The H-Factor equals design day operations divided by peak hour operations.

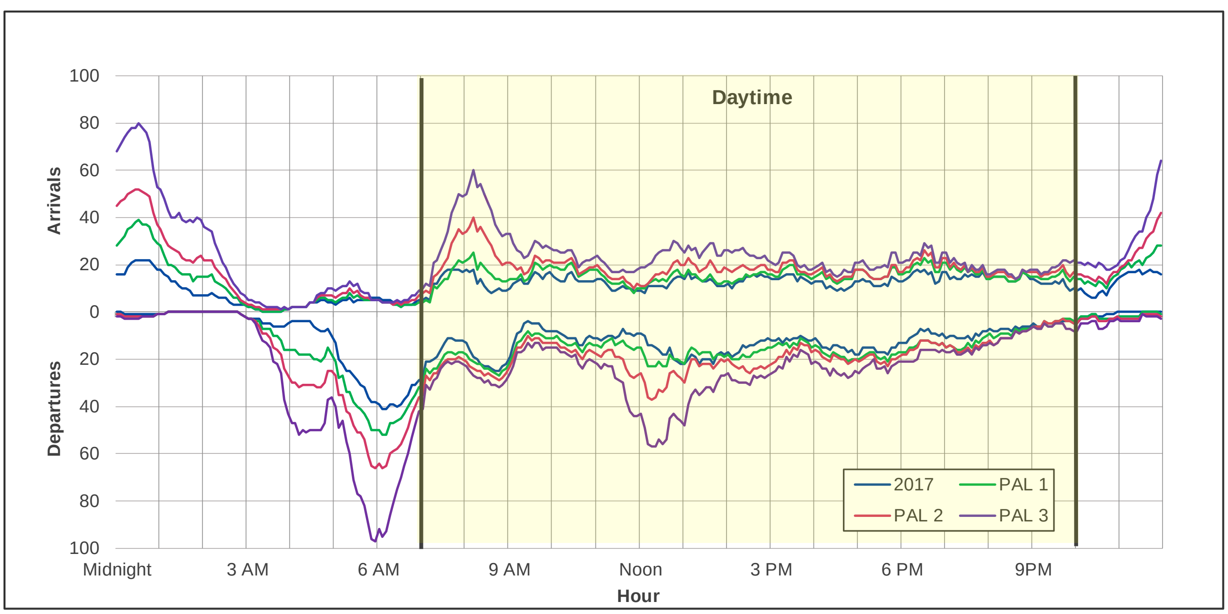
The resulting factors for PAL 3 are compared to the 2017 factors in **Table 4.2-1, *Daytime Peaking Patterns***. The D-Factor is projected to increase from 287.7 to 306.2, indicating that daily activity will become less peaked in the future. Conversely, the H-Factor is expected to decrease from 10.1 in 2017 to 8.4 in PAL 3. This increase indicates that the peak hour will become more peaked in the future than it was in 2017. The hourly pattern of operations is presented in **Exhibit 4.2-1, *Hourly Operations***.

TABLE 4.2-1 DAYTIME PEAKING PATTERNS

Parameter	2017	PAL 3
Daytime Annual Operations	110,741	222,933
Daytime Design Day Operations	385	728
Daytime Peak Hour Operations	38	87
D-Factor	287.7	306.2
H-Factor	10.1	8.4

Source: Landrum & Brown analysis

EXHIBIT 4.2-1 HOURLY OPERATIONS



Source: Landrum & Brown analysis

Daytime Aircraft Fleet Mix

The mix of aircraft is a critical input for the ACM. The fleet mix, organized by aircraft wake category, is presented in **Table 4.2-2, *Daytime Aircraft Fleet Mix***. The proportion of Category B and D aircraft (such as B747, A330, B767, etc.) are expected to increase from 2017 to PAL 3, while the smaller Category E and F aircraft (regional jets and general aviation aircraft) are expected to decline in share.

TABLE 4.2-2 DAYTIME AIRCRAFT FLEET MIX

Category	Maximum Takeoff Weight (lbs)	Wingspan (ft)	Percent of Operations	
			2017	PAL 3
Category A	>= 300,000	> 245	0.0%	0.0%
Category B	>= 300,000	<= 245 and >175	0.5%	11.4%
Category C	>= 300,000	<= 175 and > 125	10.4%	11.4%
Category D	< 300,000	<= 175 and > 90	25.0%	33.9%
Category E	> 41,000	<= 90 and > 65	51.1%	33.6%
Category F	< 41,000	<= 125	13.0%	9.7%

Source: Landrum & Brown analysis

Weather Conditions

ASV is partially a function of local weather conditions. In particular, the ASV calculation requires as input the occurrence of Visual Meteorological Conditions (VMC) versus Instrument Meteorological Conditions (IMC). VMC is defined as conditions where visibility is greater than or equal to three miles and the cloud ceiling is greater than or equal to 1,000 feet. Visual Flight Rules (VFR) apply during VMC; similarly, Instrument Flight Rules (IFR) apply during IMC. The distinction between IMC and VMC is important because the separation distance required between aircraft arriving and departing during IMC conditions is greater than that required during VMC conditions. Consequently, given the same runway configuration, fewer aircraft operations can typically be accommodated during IMC conditions than during VMC conditions. At CVG, VMC occurs 93 percent of the time whereas IMC occurs 7 percent of the time.[2]

[2] Chapter 1, *Inventory of Existing Conditions*, Section 2.3.4, *Meteorological Conditions*

Daytime Runway Use

As presented on **Exhibit 4.2-2, *CVG Existing Runways***, CVG has four runways – three parallel runways (18R/36L, 18C/36C, and 18L/36R) and one crosswind runway (09/27). Runway 18R/36L is the shortest runway and is not currently used on a regular basis. During daytime hours, CVG is typically operated in a North or South Flow configuration with arrivals and departures on Runways 18C/36C and 18L/36R. Runway 27 is used by departures when winds and weather conditions permit.

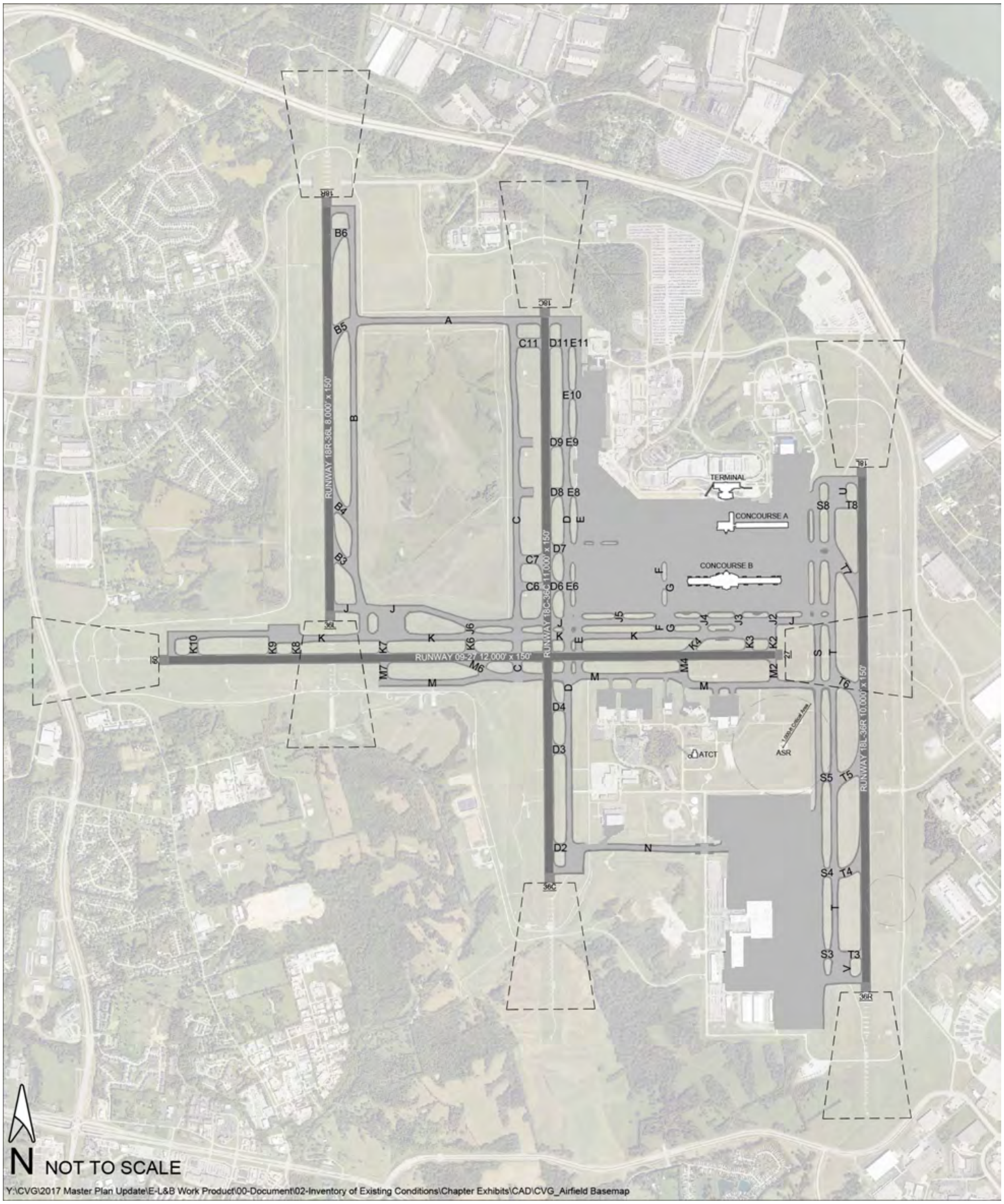
Model Calibration

Calibration of the ACM is an important step in the airfield demand/capacity analysis. This process ensures that the model accurately reflects CVG operations. The 2017 VMC capacity rate from the ACM was calibrated to the facility call rate listed in the FAA Aviation System Performance Metrics (ASPM) database of 88 operations per hour.

The predominant operating configuration used today at CVG is operations on Runways 18C/36C and 18L/36R with departures on Runway 27. This configuration was run in the ACM, yielding an hourly capacity of 89 operations in VMC and 74 operations in IMC. The VMC rate is consistent with the call rate listed in ASPM. In addition, these rates were reviewed with Air Traffic Control Tower (ATCT) officials, and they indicated the rates are representative of actual conditions.[3]

[3] ATCT officials validated the results in a meeting on June 21, 2018.

EXHIBIT 4.2-2 CVG EXISTING RUNWAYS



Sources: FAA CVG Airport Diagram October 12, 2017; KCAB; Woolpert Photography dated September 23, 2017

Daytime Capacity Results

The ACM was run for PAL 3 to determine the future capacity of (1) dual parallel runways with Runway 27 departures and (2) triple parallel runways. The dual parallels with Runway 27 results are presented in **Table 4.2-3, *PAL 3 Peak Hour Capacity and ASV for Dual Parallel Runways + Runway 27***. Dual parallel runways with departures on Runway 27 have an ASV of 213,500 at PAL 3. As presented in **Table 4.2-4, *PAL 3 Peak Hour Capacity and ASV for Triple Parallel Runways***, triple parallel runways have an ASV of 302,000 at PAL 3 (the use of Runway 27 is not available during the operation of triple parallel runways due to runway intersections and coordination of operations that would be required).

TABLE 4.2-3 PAL 3 PEAK HOUR CAPACITY AND ASV FOR DUAL PARALLEL RUNWAYS + RUNWAY 27

Configuration	Capacity
Peak Hour Capacity (Operations/Hour)	
VMC – with Runway 27	90
IMC – with Runway 27	75
VMC – no Runway 27	88
IMC – no Runway 27	70
All-Weather Average	89
ASV (operations)	213,500

Source: Landrum & Brown analysis

TABLE 4.2-4 PAL 3 PEAK HOUR CAPACITY AND ASV FOR TRIPLE PARALLEL RUNWAYS

Configuration	Capacity
Peak Hour Capacity (Operations/Hour)	
VMC	132
IMC	105
All-Weather Average	130
ASV (operations)	302,000

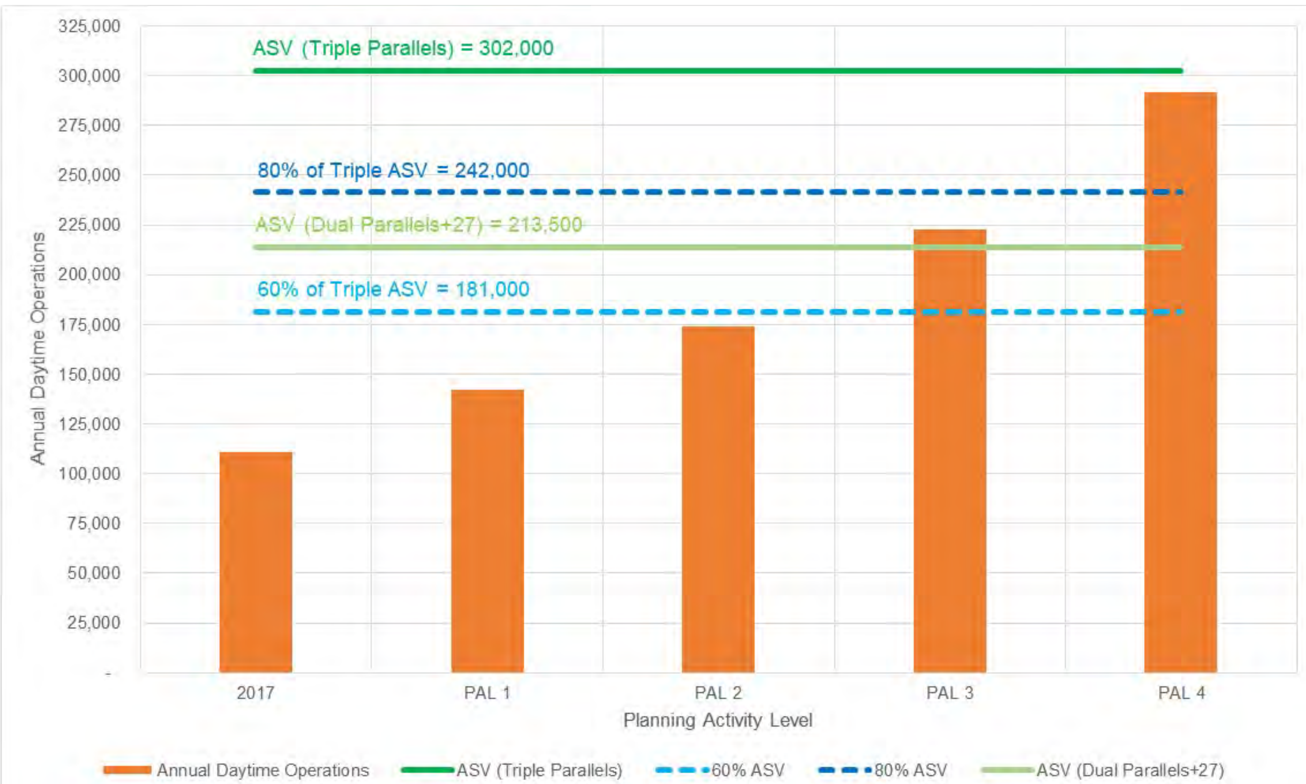
Source: Landrum & Brown analysis

Daytime Demand/Capacity

The two ASV values were compared to PAL 1 through 4 daytime operations in **Exhibit 4.2-3, *Daytime Demand vs Capacity***. Demand will exceed the capacity of the current runway use configuration (Runways 18C/36C and 18L/36R with departures on Runway 27) just prior to PAL 3.

The daytime demand is projected to remain below the capacity of triple parallel runways through PAL 4. The two graphs also show the 60 percent and 80 percent capacity thresholds for the triple parallel runway capacity. The 60 percent triple parallel runway capacity threshold will be reached at 181,000 annual daytime operations, whereas the 80 percent threshold equates to 242,000 annual daytime operations. The 60 percent threshold will occur shortly after PAL 2 and the 80 percent threshold will occur after PAL 3. Based on these results, CVG should monitor operations levels over the next decade, and be ready to initiate a delay study when operating levels approach approximately 60 percent of ASV.

EXHIBIT 4.2-3 DAYTIME DEMAND VS CAPACITY



Source: Landrum & Brown analysis

4.2.1.4 *Nighttime Demand/Capacity Analysis*

Similar to the daytime demand/capacity analysis, the nighttime analysis used the ACM, although with a different approach. Instead of calculating peak hour total operations capacity, the nighttime analysis calculated peak hour arrival capacity and peak hour departure capacity independently. Arrivals and departures were evaluated separately because:

- Departure demand is higher than arrival demand
- Arrival capacity is lower than departure capacity

ASV was not calculated for nighttime operations due to these peaking patterns and capacity differences. In addition, the analysis focused on VMC capacity only, rather than the all-weather average. As with the daytime analysis, capacity was calculated based on the PAL 3 peaking characteristics and fleet mix.

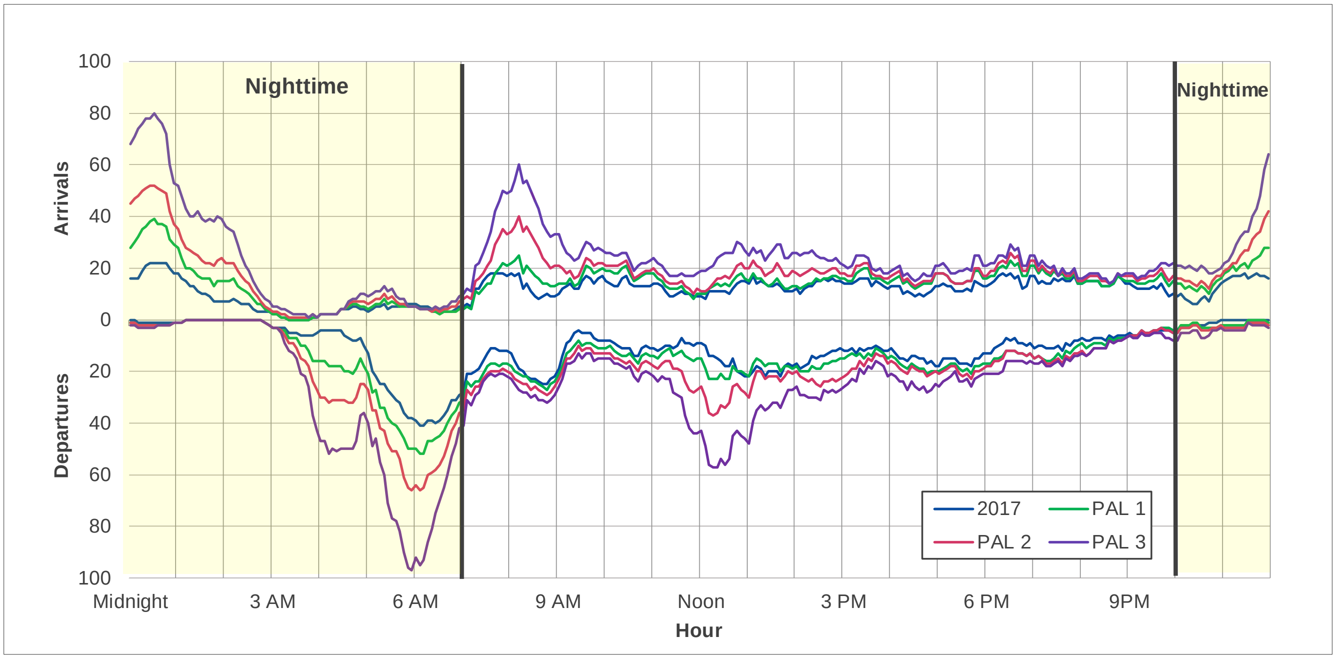
Nighttime Assumptions

The ACM was run with standard aircraft separations, runway occupancy times, and approach speeds. Airport-specific inputs to the ACM nighttime analysis include aircraft operations, aircraft fleet mix, weather conditions, and runway use. These inputs are described in the subsections that follow.

Nighttime Aircraft Operations

The nighttime activity (made up primarily of cargo traffic) is expected to arrive and depart in one distinct arrival bank and one distinct departure bank, rather than operating more uniformly throughout the night, as presented in **Exhibit 4.2-4, *Hourly Operations***. In addition, the departure bank overlaps with the early morning departure push of the commercial passenger traffic. As a result, the departure bank has higher activity than the arrival bank.

EXHIBIT 4.2-4 HOURLY OPERATIONS



Source: Landrum & Brown analysis

Nighttime Aircraft Fleet Mix

The mix of aircraft is a critical input for the ACM. The fleet mix is presented in **Table 4.2-5, *Nighttime Aircraft Fleet Mix*** by category. The percentage of Category B aircraft is projected to increase from 2017 to PAL 3 while the smaller Category E and F aircraft are expected to decline in share.

TABLE 4.2-5 NIGHTTIME AIRCRAFT FLEET MIX

Category	Maximum Takeoff Weight (lbs)	Wingspan (ft)	Percent of Operations	
			2017	PAL 3
Category A	>= 300,000	> 245	0.0%	0.0%
Category B	>= 300,000	<= 245 and >175	9.6%	25.9%
Category C	>= 300,000	<= 175 and > 125	31.5%	32.3%
Category D	< 300,000	<= 175 and > 90	32.9%	31.8%
Category E	> 41,000	<= 90 and > 65	16.4%	7.7%
Category F	< 41,000	<= 125	9.6%	2.3%

Sources: FAA Advisory Circular (AC) 90-23G, *Aircraft Wake Turbulence*; Landrum & Brown analysis

Nighttime Runway Use

Although CVG has four runways, not all are used during nighttime hours due to the noise abatement runway use program. According to Order CVG 7110.28M, *Cincinnati/Northern Kentucky International Airport Runway Use Program*, 11/22/2011, Runway 27 is the preferred runway for departures during nighttime hours. If an aircraft cannot use Runway 27, traffic shall be assigned in the following order: 36C, then 09, then 18C. Runway 09 is the preferred runway for arrivals. If an aircraft cannot use Runway 09, traffic should be assigned in the following order: 27, then 36C, then 18C.[4]

Due to increased delays, flight schedule changes by the passenger and cargo carriers, and the inability to operate “contra-flow” procedures (arrivals on Runway 09 with departures on Runway 27), the ATCT has been authorized to use Runway 36R in addition to Runway 09/27 at night on a limited basis since 2014. The FAA is in the process of conducting an environmental analysis for unlimited use of Runway 18L/36R during nighttime hours.

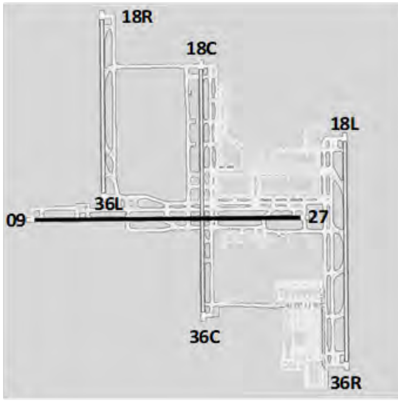
Given today’s runway use, and the expected need to begin using additional runways more often in the future as nighttime demand increases, various runway use scenarios were evaluated for arrivals and departures. The arrival runway use scenarios are presented in **Exhibit 4.2-5, *Arrival Runway Use Scenarios***, and described as follows:

- **Single Runway (09)**: The Runway 09 single-runway operation is currently the preferred mode for nighttime arrivals.
- **Two Runways (09 and 18L/36R)**: During visual approaches in VMC, arrivals on Runway 09 are independent of operations on Runway 18L/36R. During IMC, arrivals on Runway 09 must be coordinated with operations on Runway 18L/36R.
- **Dual Parallel Runways (18C/36C and 18L/36R)**: Runways 18C/36C and 18L/36R have sufficient spacing to be operated as independent runways in all weather conditions.
- **Triple Parallel Runways (18R/36L, 18C/36C, and 18L/36R)**: The three parallel runways have sufficient spacing to be operated as independent runways in all weather conditions.

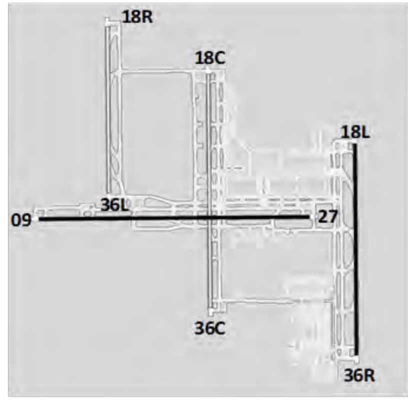
4 Runway use program applies to turbojet aircraft weighing 75,000 pounds or more whenever wind, weather, and field conditions permit.

EXHIBIT 4.2-5 ARRIVAL RUNWAY USE SCENARIOS

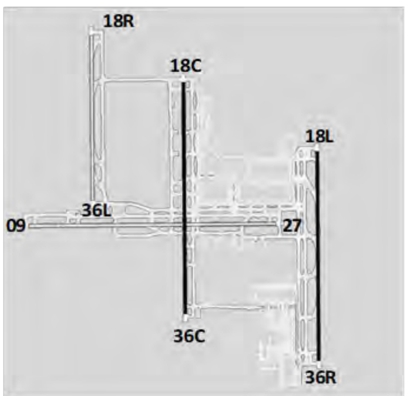
Single Runway (09)



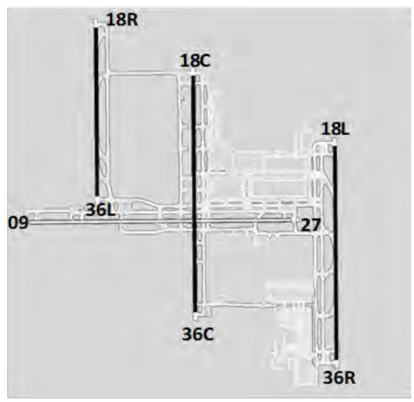
Two Runways (27 & 18L/36R)



Dual Parallel Runways (18C/36C & 18L/36R)



Triple Parallel Runways (18R/36L, 18C/36C & 18L/36R)

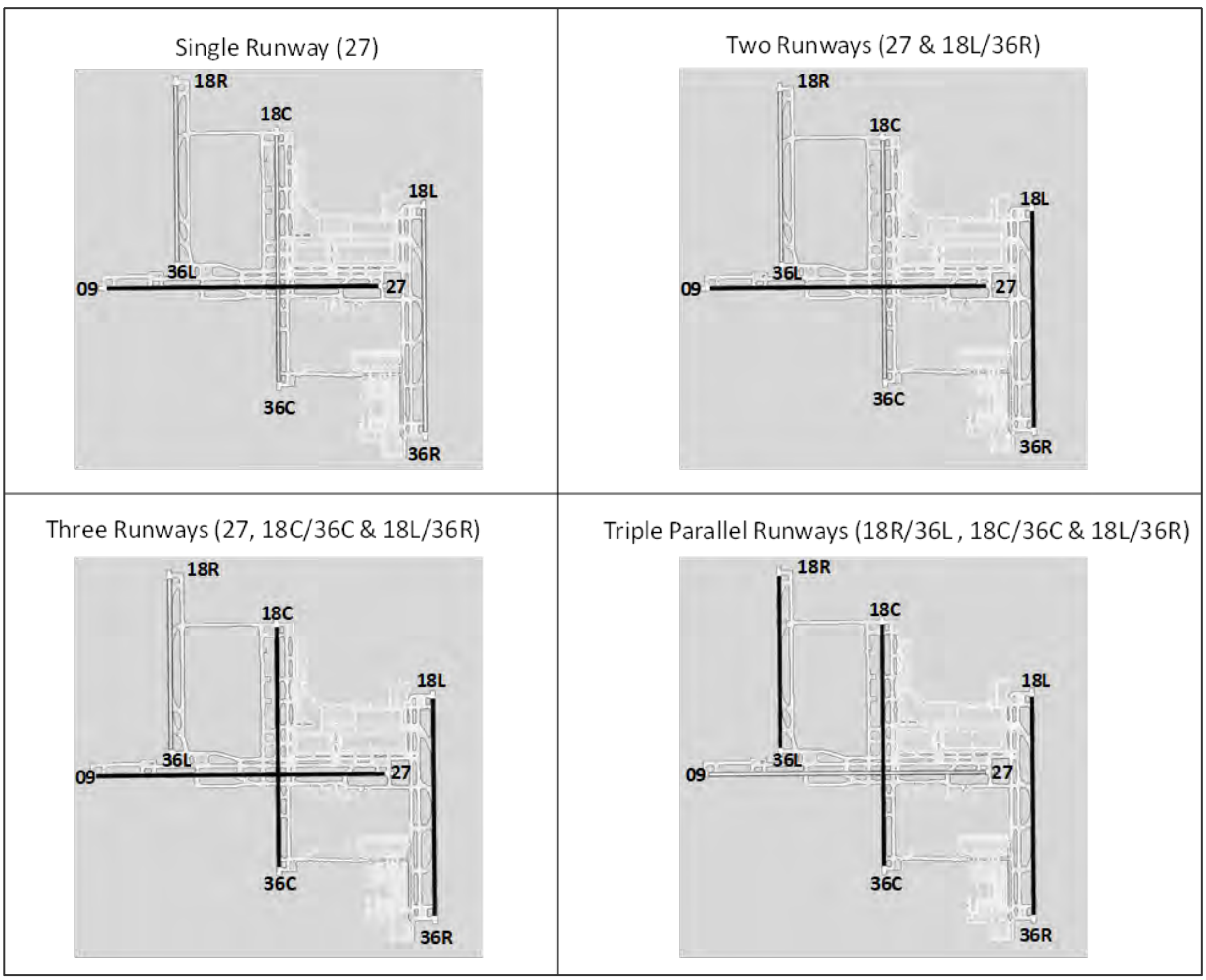


Source: Landrum & Brown analysis

The departure runway use scenarios are presented in **Exhibit 4.2-6, *Departure Runway Use Scenarios*** and described as follows:

- **Single Runway (27)**: The Runway 27 single-runway operation is currently the preferred mode for nighttime departures.
- **Two Runways (27 and 18L/36R)**: Departures on Runway 27 can operate independently of operations on Runway 18L/36R because the flight paths do not intersect.
- **Three Runways (27, 18C/36C, and 18L/36R)**: Runways 09/27 and 18C/36C intersect so operations on these two runways are dependent and must be coordinated; Runway 18L/36R operations are independent of operations on Runway 18C/36C and departures on Runway 27.
- **Triple Parallel Runways (18R/36L, 18C/36C, and 18L/36R)**: The three parallel runways have sufficient spacing to be operated as independent runways in all weather conditions.

EXHIBIT 4.2-6 DEPARTURE RUNWAY USE SCENARIOS



Source: Landrum & Brown analysis

Nighttime Capacity Results

The ACM was run for PAL 3 for the runway use scenarios described in the previous section. The arrival capacity results are presented in **Table 4.2-6, *Nighttime Capacity Results – Arrivals***. A single runway generates an hourly capacity of 34 arrivals in VMC. This capacity was doubled to determine the two-runway and dual parallel runway VMC capacity and tripled to obtain the triple runway VMC capacity.

TABLE 4.2-6 NIGHTTIME CAPACITY RESULTS – ARRIVALS

Runway Use Scenario	Arrival Capacity (Arrivals/Hour)	
	VMC	IMC
Single Runway (09)	34	27
Two Runways (09 and 18L/36R)	68	30
Dual Parallel Runways (18C/36C, and 18L/36R)	68	54
Triple Parallel Runways (18R/36L, 18C/36C, and 18L/36R)	102	81

Source: Landrum & Brown analysis

The IMC capacity for a single runway is 27 arrivals per hour. This capacity was doubled to determine the dual parallel runway IMC capacity, and tripled to obtain the triple runway IMC capacity. The IMC capacity for two runways (Runway 09 and 18L/36R) is 30 arrivals, much lower than that obtained for dual parallels (54). The two-runway IMC capacity is lower because Runway 09 arrivals must be coordinated with operations on Runway 18L/36R in IMC, thereby reducing the capacity to just over that of a single runway.

The departure results from the ACM are presented in **Table 4.2-7, *Nighttime Capacity Results – Departures*.** The ACM results in a single runway capacity of 37 departures in VMC and 32 departures in IMC. These capacities were doubled to determine the two-runway capacity and tripled to obtain the triple parallel runway capacity. The three-runway operation results in a VMC capacity of 98 departures, and an IMC capacity of 90 departures. The capacity of this configuration is not as high as triple parallels because Runway 27 intersects Runway 18C/36C.

TABLE 4.2-7 NIGHTTIME CAPACITY RESULTS – DEPARTURES

Runway Use Scenario	Departure Capacity (Departures/Hour)	
	VMC	IMC
Single Runway (27)	37	32
Two Runways (27 and 18L/36R)	74	64
Three Runways (27, 18C/36C, and 18L/36R)	98	90
Triple Parallel Runways (18R/36L, 18C/36C, and 18L/36R)	111	96

Source: Landrum & Brown analysis

The capacity rates shown for three runways and triple parallel runways are not currently achievable for three reasons: (1) nighttime noise abatement runway use program, (2) nighttime departure heading restrictions, and (3) runway length.

- **Runway Use**: The nighttime noise abatement runway use program at CVG limits which runways can be used at night, as discussed previously. In order to achieve the maximum capacity rates shown in the table for three runways and triple parallel runways, the runway use restrictions would have to be lifted.
- **Departure Headings**: FAA limits the departure headings in North Flow from the parallel runways. All departures from the parallel runways must fly the same heading along the Ohio River to minimize the impact of overflights over incompatible land uses. In terms of capacity, this restriction limits the capacity of the three parallel runways to approximately a single runway. In order to achieve the maximum capacity rates shown in the table for three runways and triple parallel runways, the departure heading restrictions would have to be lifted.
- **Runway Length**: The capacity calculation assumes runway length is not a restriction, which is not currently the case at CVG. Runway 18L/36R is 10,000 feet long, Runway 18C/36C is 11,000 feet long, and Runway 18R/36L is 8,000 feet long. The three parallel runways are not as long as Runway 09/27, which is 12,000 feet long. As presented in *Section 4.3.3, Runway Length Analysis Summary*, 12,000 feet of runway length is needed to accommodate 100 percent of PAL 4 projected departures. Because the lengths of the three parallel runways are uneven, and none are 12,000 feet long, some aircraft would be restricted from using their preferred runway from an airspace standpoint. If an aircraft is forced to use a less optimal parallel runway, it may have to cross the departure flight path of another runway(s). Aircraft that require more than 11,000 feet of runway would have to use Runway 27, which intersects two of the parallel runways. Both of these instances would reduce the throughput of the runway system for departures. In order to achieve the maximum capacity rates shown in the table, Runway 18R/36L would have to be extended to a length that is more consistent with the other two parallel runways (10,000 to 11,000 feet long). Additionally, at least one of the parallel runways would have to be extended to 12,000 feet long to replace the length of Runway 27. These runway length increases are only needed when aircraft must depart on all three parallel runways.

The need to lift runway use restrictions, lift departure heading restrictions, and provide additional runway length for the parallel runways is predicated on demand increasing as projected.

Nighttime Demand/Capacity – Arrivals

The VMC peak hour arrival capacity was compared to the PALs. The results are summarized in **Table 4.2-8, *Nighttime Arrival Demand vs Capacity***, and graphically depicted on **Exhibit 4.2-7, *Nighttime Arrival Demand vs Capacity***. Current (2017) arrival demand is below the VMC arrival capacity of a single runway; demand will exceed capacity just after PAL 1. The arrival demand is projected to exceed the VMC capacity of dual parallel runways between PAL 2 and PAL 3, and of triple parallel runways two years before PAL 4.

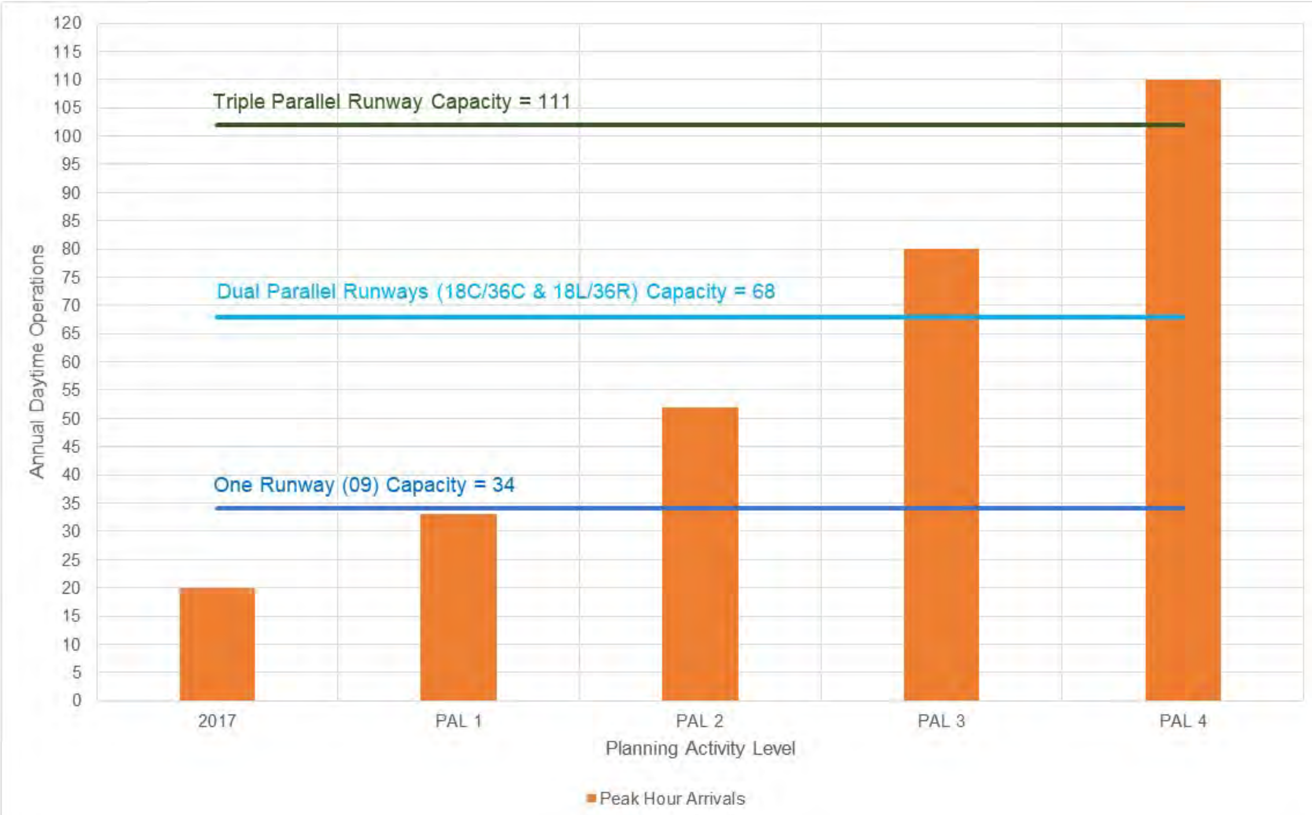
When ATC determines that arrival operations need to occur on two runways, there are two choices of runway use in VMC. The first involves arrivals on Runways 09 and 18L/36R. As discussed in the Nighttime Runway Use Section, this operation is independent in VMC but not IMC. This runway use scenario has the same VMC capacity as dual parallel runways and demand would not exceed capacity until after PAL 2. In IMC, however, the Runway 09 and 18L/36R scenario would not provide much more capacity than a single runway; dual parallels would be needed before PAL 2.

TABLE 4.2-8 NIGHTTIME ARRIVAL DEMAND VS CAPACITY

Runway Use Scenario	VMC Peak Hour Arrival Capacity	Demand Exceeds VMC Capacity
Single Runway (09)	34	One Year After PAL 1
Dual Parallel Runways (18C/36C and 18L/36R)	68	PAL 2 – PAL 3
Triple Parallel Runways (18R/36L, 18C/36C, and 18L/36R)	102	Two Years Before PAL 4

Source: Landrum & Brown analysis

EXHIBIT 4.2-7 NIGHTTIME ARRIVAL DEMAND VS CAPACITY



Notes: Capacity values reflect VMC arrival capacity rates.
The VMC capacity of the two runway scenario (arrivals on Runways 09 and 18L/36R) is the same as dual parallel runways (Runways 18C/36C and 18L/36R). However, the IMC capacity is only three operations higher than a single runway because arrivals on Runway 09 have to be coordinated with operations on Runway 18L/36R in IMC.

Source: Landrum & Brown analysis

Nighttime Demand/Capacity – Departures

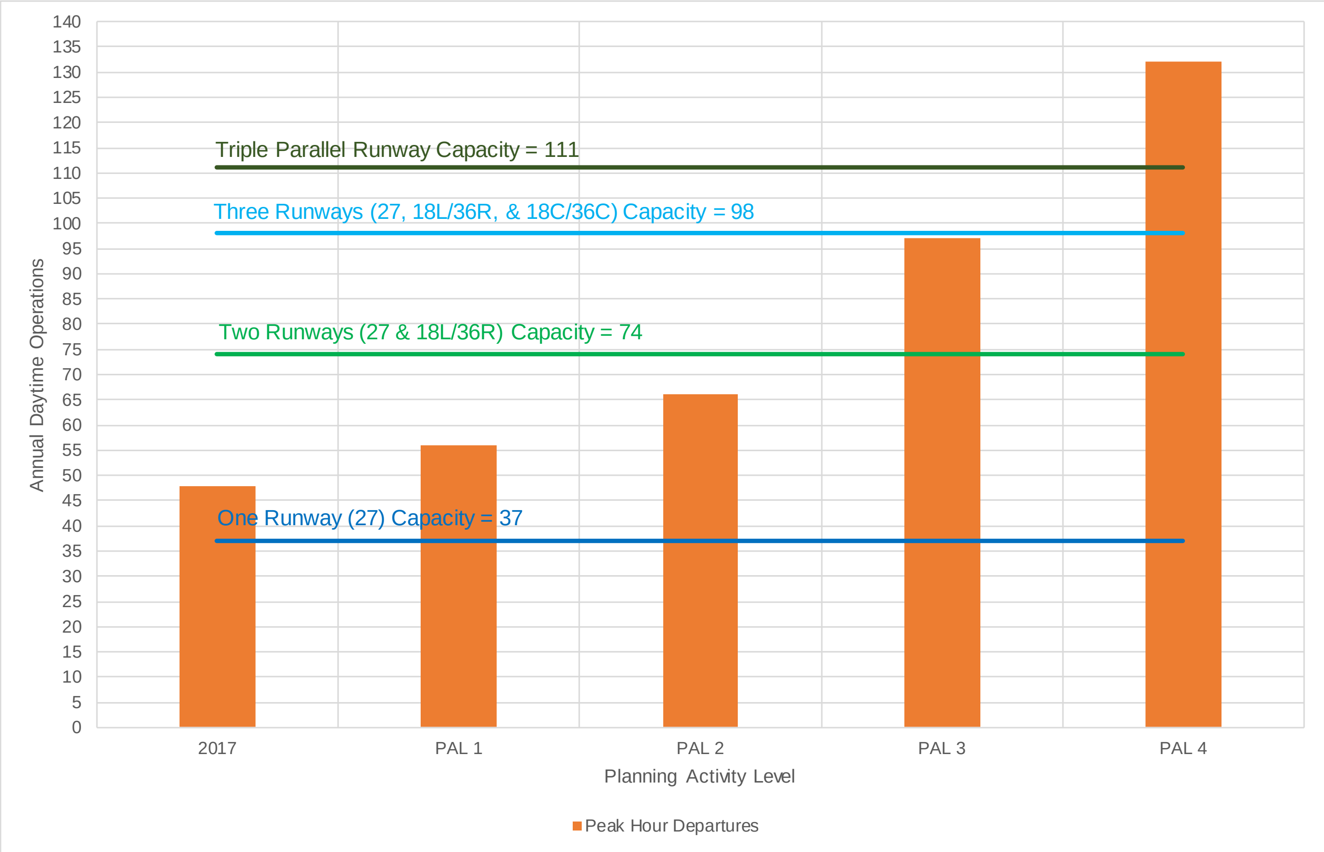
The VMC peak hour departure capacity was compared to the PALs. The results are summarized in **Table 4.2-9, *Nighttime Departure Demand vs Capacity***, and graphically depicted on **Exhibit 4.2-8, *Nighttime Departure Demand vs Capacity*.** Current (2017) demand already exceeds the departure capacity of a single runway. This conclusion has been validated by ATCT officials who indicated that the departure push is experiencing delays now. The two-runway configuration (Runways 27 and 18L/36R) capacity will be exceeded between PAL 2 and PAL 3. Departure demand is projected to exceed the capacity of three runways (27, 18C/36C, and 18L/36R) one year after PAL 3, and of triple parallel runways between PAL 3 and PAL 4.

TABLE 4.2-9 NIGHTTIME DEPARTURE DEMAND VS CAPACITY

Runway Use Scenario	VMC Peak Hour Departure Capacity	Demand Exceeds VMC Capacity
One Runway (27)	37	Currently
Two Runways (27 and 18L/36R)	74	PAL 2 – PAL 3
Three Runways (27, 18C/36C, and 18L/36R)	98	One Year After PAL 3
Triple Parallel Runways (18R/36L, 18C/36C, and 18L/36R)	111	PAL 3 – PAL 4

Source: Landrum & Brown analysis

EXHIBIT 4.2-8 NIGHTTIME DEPARTURE DEMAND VS CAPACITY



Note: Capacity values reflect VMC departure capacity rates.
Source: Landrum & Brown analysis

Nighttime Runway Use Recommendations

The demand/capacity analysis demonstrates that nighttime demand will exceed existing capacity one year after PAL 1 for arrivals, and between PAL 2 and PAL 3 for departures. However, as discussed in Section 4.2.2, *Additional Capacity Need Determination*, an airport does not necessarily need to add additional capacity immediately when demand exceeds capacity – an acceptable amount of delay should be considered. An analysis of delay at CVG may defer the need to use an additional runway during nighttime hours by several years. CVG officials should begin monitoring delays over the next several years.

The demand/capacity analysis also demonstrates that nighttime demand will exceed the capacity of the triple parallel runways towards the end of the planning period. A delay analysis would likely defer this need past 2050 so a new runway should not be planned for at this time. As with the daytime analysis, CVG should begin monitoring operations levels over the next decade, and be ready to initiate a delay study when operating levels reach approximately 60 percent of the peak hour capacity (shortly after PAL 2).

4.2.1.5 *Conclusions*

The demand/capacity analysis for CVG reached the following conclusions:

- The capacity of the existing runway system is likely to be sufficient to accommodate daytime demand through PAL 4 (a delay study is needed to confirm this finding). An additional runway will be needed after PAL 4 if demand continues to grow.
  - CVG officials should monitor actual operations and delays and be prepared to initiate a delay study when annual daytime operations reach 181,000.
- Nighttime runway use will need to change as follows:
  - The arrival cargo push will require the use of dual parallel runways between PAL 1 and PAL 2, and triple parallel runways between PAL 2 and PAL 3.
  - The departure cargo push currently requires the use of two runways. The use of three runways (one independent and two dependent) will be required between PAL 2 and PAL 3; the use of triple independent parallel runways will be required between PAL 3 and PAL 4.
- If it becomes necessary to operate departures on triple parallel runways (projected to occur between PAL 3 and PAL 4):
  - One of the parallel runways should be extended to 12,000 feet long.
  - Runway 18R/36L should be extended to a minimum of 10,000 feet long.

4.2.2 Runway Length

In order to understand the adequacy of the runway lengths at CVG, a runway length analysis was performed. The future fleet mix was used to evaluate the runway length needs for the CVG runway system. The use of this projected future fleet ensures that the runway system will be capable of accommodating the aircraft users of CVG through PAL 4.

Takeoff and landing length requirements were calculated following the recommended guidance in FAA Advisory Circular (AC) 150/5325-4b, Runway Length Requirements for Airport Design. These guidelines establish the process and considerations to assess existing runways and determine adequate runway length recommendations at a planning level. It should be noted that the results of these calculations can differ from more detailed analysis that aircraft operators are capable of performing. These more detailed calculations are often based on aircraft operational manuals and specific airline procedures.

4.2.2.1 *Runway Length Analysis Methodology*

The aircraft manufacturers' airport planning manuals were utilized in conjunction with the future fleet mix to calculate the future runway length requirements specific to unique conditions at CVG. Aircraft runway length requirements are determined using many factors including:

- Density Altitude (temperature and elevation)
- Aircraft Fleet
- Runway Characteristics

Density Altitude

Density altitude is a natural phenomenon that results in decreased aircraft and engine performance as density altitude increases. It is a function of the combination of an airport's elevation and temperature. The higher the elevation and/or temperature, the higher the density altitude and its effects will be. Because higher density altitude decreases an aircraft's operational performance, longer runway distances are required for takeoffs and landings at airports with a higher elevation.

The aircraft manufacturers' manuals contain charts to calculate takeoff runway length requirements based on temperature. Takeoff length requirements may be calculated based on "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. Typically, these "hot day" charts present conditions that range from approximately 84 to 87 degrees Fahrenheit.

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 CVG is 86 degrees Fahrenheit,[5] making the hot day charts most appropriate.

[5] National Climatic Data Center (NCDC), station WBAN 93814, data recorded at CVG for the period 01/01/2006-12/31/2016

The aircraft manufacturers' performance manuals for landing requirements only contain charts for standard day. The FAA does not require CVG to incorporate the mean daily maximum temperature when calculating landing length requirements as landing operations are not susceptible to engine performance degradation. Therefore, landing length requirements were assessed at standard day temperatures.

Airfield elevation is the second component to density altitude. It is used as an input factor on the takeoff and landing charts from the aircraft manufacturers' airport planning manuals to determine accurate takeoff and landing requirements. The higher the elevation of an airport, the less efficient an aircraft wing is at producing lift, thus requiring higher airspeeds to produce a comparable amount of lift. Longer runways are required to accommodate aircraft traveling at higher airspeeds. The elevation at CVG is 896.2 feet above Mean Sea Level (MSL).[6]

Aircraft Fleet

The aircraft fleet operating at an airport in the future is a critical component to determining future runway length requirements for that airport. The fleet mix used for runway length consisted of the most critical domestic and international passenger aircraft and cargo aircraft. From the entire forecast fleet mix, the aircraft used for analysis was condensed down to the 12 most demanding aircraft in the fleet in terms of runway length. This condensed fleet is depicted in **Table 4.2-10, *CVG Forecast Fleet for Runway Length***. This aircraft fleet was analyzed for runway length requirements using the furthest existing or proposed destination for each aircraft type.

[6] FAA Aeronautical Information Services- National Flight Data Center (NFDC), 2018.

TABLE 4.2-10 CVG FORECAST FLEET FOR RUNWAY LENGTH

Type	Aircraft	Furthest Destination	Distance from CVG (NM)
Domestic Passenger	Airbus A319neo	Minneapolis, MN (MSP)	519
Domestic Passenger	Airbus A320neo	San Francisco, CA (SFO)	1,770
International Passenger	Airbus A321	Reykjavik, Iceland (KEF)	2,616
International Passenger	Airbus A330-900neo (used -300)	Paris, France (CDG)	3,611
Domestic Passenger	Boeing 737-900 Passenger	San Francisco, CA (SFO)	1,770
Domestic Passenger	Boeing 737MAX 8 Passenger	San José, CA (SJC)	1,753
Cargo	Boeing 747-400 Freighter	Leipzig, Germany (LEJ)	3,869
Cargo	Boeing 747-8 Freighter	Seoul, South Korea (ICN)	5,916
Cargo	Boeing 767-300 Freighter	East Midlands, UK (EMA)	3,383
Cargo	Boeing 777-200LR Freighter	Hong Kong, China (HKG)	6,989
International Passenger	Boeing 787-8	London, UK (LHR)	3,444
International Passenger	Boeing 787-9	Tokyo, Japan (NRT)	5,682
Domestic Passenger	Bombardier CS100	Denver, CO (DEN)	930

Note: Airbus has not released the takeoff and landing charts for the A330-900neo so the A330-300 was used as a comparable substitute.
Source: FAA Aeronautical Information Services-National Flight Data Center (NFDC), 2018

Runway Characteristics

Runway characteristics such as surface contamination and runway gradients are also an important part of the inputs used to determine runway length requirements for an airport. Runways that are plagued by surface contaminants such as rain and snow often require longer landing lengths than dry surfaces. Some aircraft manufacturers have designated landing length charts for contaminated surfaces, while others do not. For those manufacturers that do not offer these charts, a standard 15 percent was added to dry landing length requirements to account for contaminated surface conditions, per FAA AC 5325-4b, Runway Length Requirements for Airport Design. Boeing landing charts offer contaminated landing length charts, while Airbus and Bombardier typically do not. In this analysis, 15 percent was added to each dry landing length calculation for aircraft produced by these manufacturers.

The runway length charts in the aircraft manuals are based on a runway slope of zero. An aircraft taking off on an uphill gradient requires more runway length than it does on a flat or downhill slope. FAA AC 5325-4b recommends an adjustment for non-zero effective runway gradients.[7] This adjustment was not necessary for the CVG runways because they do not have significant gradients.

4.2.2.2 *Runway Length Requirements*

Runway length requirements were calculated using a payload/range analysis for takeoff and a maximum landing weight analysis in wet (contaminated) conditions for landings.

Takeoff Length Requirements

Takeoff lengths were calculated using 100 percent payload, where possible, to the furthest destination for each aircraft in the fleet mix. The analysis shows that three of the 12 aircraft analyzed are unable to takeoff with maximum payload due to the distance to the critical destination. This means that those aircraft would have to sacrifice payload in order to fly to that destination regardless of runway length. Aircraft requiring decreased payloads included the following:

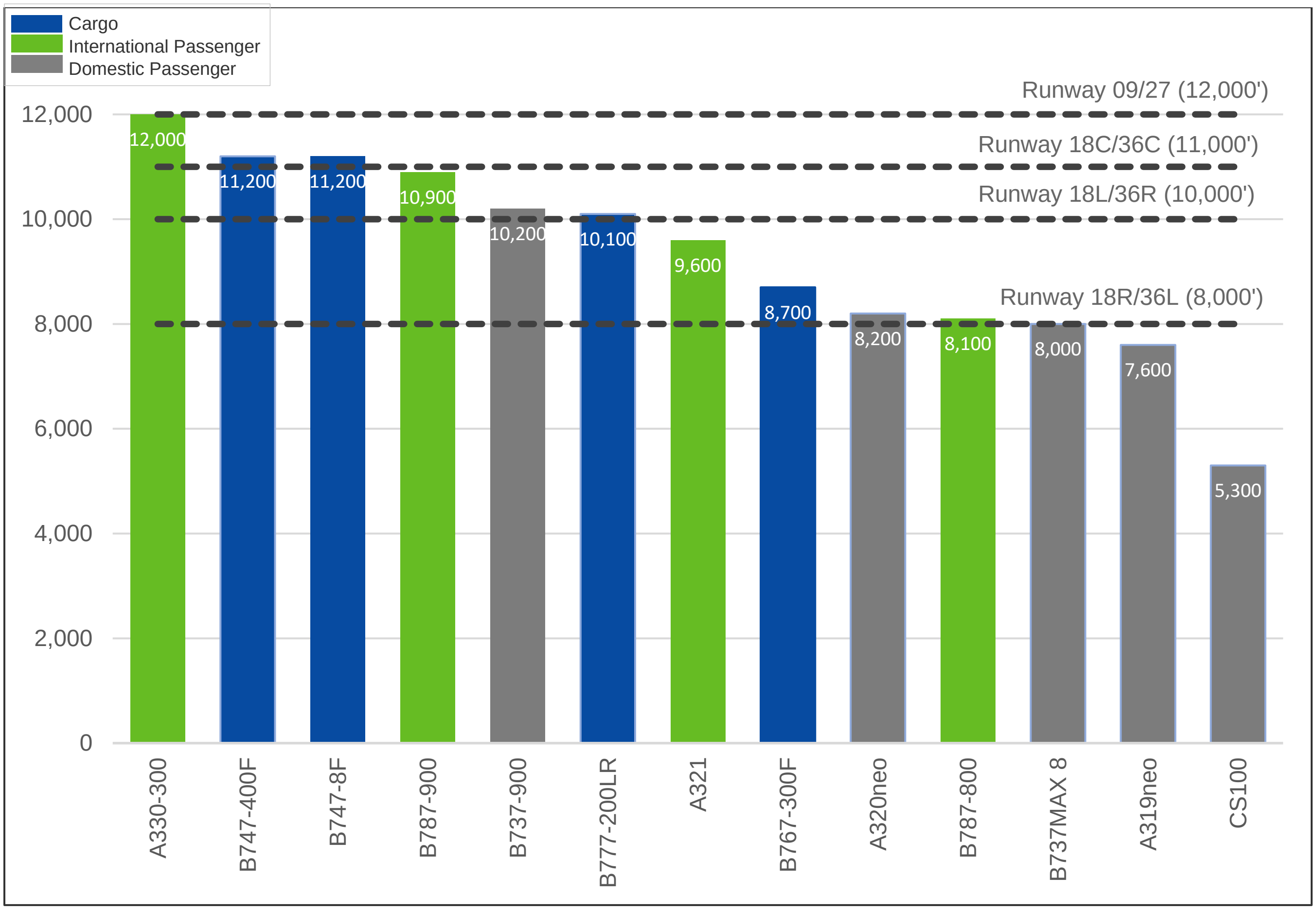
- **B747-8 Freighter to ICN (5,916 nautical miles (NM))**: 73 percent of maximum available payload
- **B787-900 passenger aircraft to NRT (5,682NM)**: 93 percent of maximum available payload
- **A321 passenger aircraft to KEF (2,616NM)**: 94 percent of maximum available payload

All other aircraft analyzed were found to be able to depart with maximum payloads to the furthest destination identified for each aircraft type.

Takeoff length requirements ranged from 5,300 feet (CS100) to 12,000 feet (A330-300). The second longest takeoff requirement is 11,200 feet and is required by the B747-400 Freighter to LEJ (3,869NM) and the B747-8F to ICN (5,916NM). All takeoff length requirements are presented in **Exhibit 4.2-9, *CVG Takeoff Length Requirements***.

7 The difference between the highest and lowest elevations of the runway centerline divided by the runway length.

EXHIBIT 4.2-9 CVG TAKEOFF LENGTH REQUIREMENTS



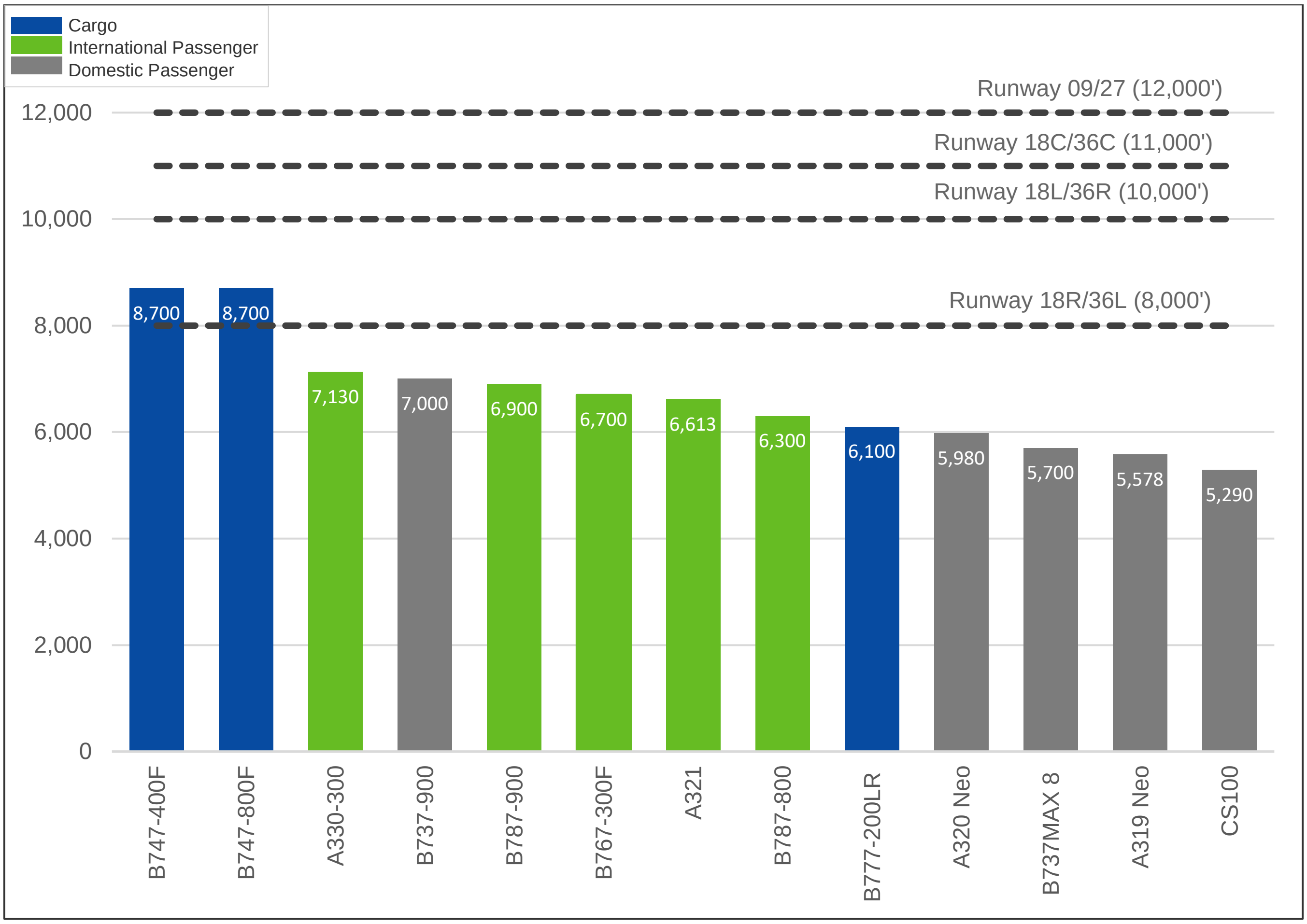
Notes: A330-900neo manufacturer planning data is not available. The A330-300 was used as a viable substitute in the runway length analysis.
Takeoff lengths were calculated for hot-day takeoffs.

Sources: *Aircraft Manufacturers' Airport Planning Manuals*; Landrum & Brown analysis

Landing Length Requirements

Landing lengths were calculated using maximum landing weights with contaminated surface conditions to approximate a worst case scenario. Landing length requirements ranged from 5,290 feet (CS100) to 8,700 feet (B747-400 and -8 freighters). All aircraft in the forecast fleet are able to safely land on any runway at CVG without weight penalties with the exception of the B747-400 and -8 freighters. With an 8,700-foot landing length requirement, the aircraft would be limited on weight when landing on Runway 18R/36L. More likely, these aircraft would arrive on one of the other three runways at CVG, which provide a longer runway length. The landing length requirements are presented in **Exhibit 4.2-10, *CVG Landing Length Requirements***.

EXHIBIT 4.2-10 CVG LANDING LENGTH REQUIREMENTS



Notes: A330-900neo manufacturer planning data is not available. The A330-300 was used as a viable substitute in the runway length analysis.
Landing length requirements were calculated using contaminated runway input (wet charts where available and additional 15 percent where only dry charts were available).

Sources: *Aircraft Manufacturers' Airport Planning Manuals*; Landrum & Brown analysis

4.2.2.3 *Runway Length Analysis Summary*

The existing runway system at CVG is capable, in terms of runway length, of accommodating all aircraft projected to operate at CVG through PAL 4. In addition, these aircraft would be able to depart to their respective critical destinations without takeoff weight penalties so long as Runway 09/27 is available for the more demanding aircraft. In the event that Runway 09/27 is unavailable, certain aircraft will begin to experience payload restrictions. **Table 4.2-11, *CVG Runway Length Analysis Summary***, presents a summary of these results.

TABLE 4.2-11 CVG RUNWAY LENGTH ANALYSIS SUMMARY

Runway	Takeoff Operations	Landing Operations
Runway 09/27	No issues	No issues
Runway 18C/36C	Payload reduction required to certain destinations for: A330-300 B747-400F B747-8F	No issues
Runway 18L/36R	Payload reduction required to certain destinations for: A330-300 B747-400F B747-8F B777-200LR B787-9	No issues
Runway 18R/36L	Payload reduction required to certain destinations for: A320neo A321 A330-300 B737-900 B747-400F B747-8F B767-300F B777-200LR B787-8 B787-9	Reduced landing weight required for: B747-400F B747-8F

Sources: *Aircraft Manufacturers Aircraft Characteristics for Airport Planning Manuals*; Landrum & Brown analysis

4.2.3 Runway Exits

Entrance/exit taxiways, also referred to as runway exits, connect runways to the taxiway system. These taxiways provide a path for aircraft to enter the runway for departure or exit the runway after arrival. The placement and type of runway exits depend on many factors including the type of aircraft using the runway, airport specific environmental data, surface conditions, and other factors such as human factors.

4.2.3.1 *Runway Exit Analysis Input and Methodology*

The FAA's Runway Exit Design Interactive Model (REDIM) was used to analyze the projected fleet mix at CVG on the existing runway system through PAL 4 in order to determine average ROT for each runway. ROT is influenced by the number, type, and location of the runway exits.

The FAA has defined the optimum average ROT as 50 seconds or less. This threshold allows for the minimum 2.5 mile in-trail separation for arriving aircraft to a runway. Achieving this minimum separation allows the capacity of a runway to be maximized. ATCT officials at CVG have expressed that the configuration of the existing exit taxiways on Runway 18L/36R provides sufficient capacity. Runway 18L/36R was analyzed in REDIM to determine the existing average ROT to use as a target threshold in the analysis of the other runways at CVG. The existing results indicated an average ROT of 52 to 53 seconds.

Fleet Mix and Demand Level

The CVG fleet mix was condensed in this analysis due to limitations on aircraft type within REDIM. This fleet is called the REDIM adjusted fleet and was used for the remainder of the runway exit analysis. Due to the location of the passenger and cargo aprons, passenger and FedEx aircraft primarily exit Runway 09/27 to the north and Runway 18C/36C to the east. DHL and Amazon aircraft primarily exit Runway 09/27 to the south. Once taxiway infrastructure is provided on the west side of Runway 18C/36C, DHL and Amazon aircraft will exit both sides of Runway 18C/36C. As a result of this exit usage, the north exits for Runway 09/27 and the east exits of Runway 18C/36C were analyzed using both the passenger and cargo fleet. The south exits for Runway 09/27 and the west exits of Runway 18C/36C were analyzed using the cargo fleet only. The full fleet and cargo-only fleets used in the analysis are depicted in **Table 4.2-12, *CVG Future REDIM Adjusted Fleet Mix (Passenger and Cargo)*** and **Table 4.2-13, *CVG Future REDIM Adjusted Fleet Mix (Cargo Only).***

TABLE 4.2-12 CVG FUTURE REDIM ADJUSTED FLEET MIX (PASSENGER AND CARGO)

#	REDIM Adjusted Fleet	Percentage of Fleet
1	Airbus A300-600	1%
2	A320-200	12%
3	A330-300	14%
4	B727-200	1%
5	B737-300	7%
6	B737-800	11%
7	B747-400	2%
8	Boeing 757-200 Freighter	2%
9	B767-300	19%
10	B777-200	1%
11	B787	1%
12	B717	1%
13	CRX	15%
14	EMB 145	10%
15	C208	1%
16	BE 300	1%
17	Shorts 330	1%
Total		**100%**

Note: Adjustments to the future fleet mix were made to satisfy aircraft fleet parameters within the REDIM program. If an aircraft type was not available in REDIM, a similar performing aircraft was substituted within the program.
Sources: KCAB and Landrum & Brown analysis

TABLE 4.2-13 CVG FUTURE REDIM ADJUSTED FLEET MIX (CARGO ONLY)

#	REDIM Adjusted Fleet	Representation of Fleet
1	A300-600	1%
2	A320-200	8%
3	A330-300	29%
4	B727-200	1%
5	B737-300	3%
6	B737-800	6%
7	B747-400	4%
8	B757-200	4%
9	B767-300	39%
10	B777-200	1%
11	BE300	2%
12	C208	1%
13	Shorts 330	1%
Total Adjusted		**100%**

Note: Adjustments to the future fleet mix were made to satisfy aircraft fleet parameters within REDIM. If an aircraft type was not available in REDIM, a similar performing aircraft was substituted within the program.
Sources: KCAB and Landrum & Brown analysis

Airport Inputs

Amongst many standard inputs used in the program, airport specific data was needed to conduct the analysis. The CVG-specific datum are considered fixed inputs and were applied to each runway end analysis in REDIM. The CVG-specific input included the fixed inputs presented in **Table 4.2-14, *REDIM Airport Inputs***.

TABLE 4.2-14 REDIM AIRPORT INPUTS

Input	Value
Wind Speed	5 knots
Wind Direction	Headwinds
Airport Elevation	896.2 ft
Airport Temperature	86 °F
Surface Condition	80% dry condition and 20% wet condition on runways

Sources: KCAB; *FAA Form 5010*, National Climatic Data Center (NCDC), station WBAN 93814, data recorded at CVG for the period 01/01/2006-12/31/2016; Landrum & Brown analysis

Runway Inputs

Additionally, many inputs are specific to the runway being analyzed. The specific runway inputs and associated values are presented in **Table 4.2-15, *REDIM Runway Inputs***.

TABLE 4.2-15 REDIM RUNWAY INPUTS

Input	RWY 09	RWY 27	RWY 18L	RWY 36R	RWY 18C	RWY 36C	RWY 18R	RWY 36L
Runway Orientation	90°	270°	180°	0°	180°	0°	180°	0°
Wind Direction	270°	90°	0°	180°	0°	180°	0°	180°
Runway Length	12,000’		10,000’		11,000’		8,000’	
Runway Width	150’							
Runway Gradient	0.07%	-0.07%	-0.10%	0.10%	0.31%	-0.31%	-0.10%	0.10%

Sources: KCAB and Landrum & Brown analysis

4.2.3.2 *Runway Exit Analysis Results*

Each runway with an ROT that exceeds or is close to 52 to 53 seconds was run through an optimization process in REDIM to determine if additional exits could reduce the ROT to be below the target. Runways 09, 27, 18C, and 36C have ROTs that are near or above the target. The optimization of these runways is presented in the sections that follow. In addition, Runways 18L and 36R, which ATCT indicated were operating effectively, were analyzed to determine if they could be optimized further. The alternatives analysis will evaluate the potential exit modifications for all runways to determine if they are necessary and justified.

Runway 09

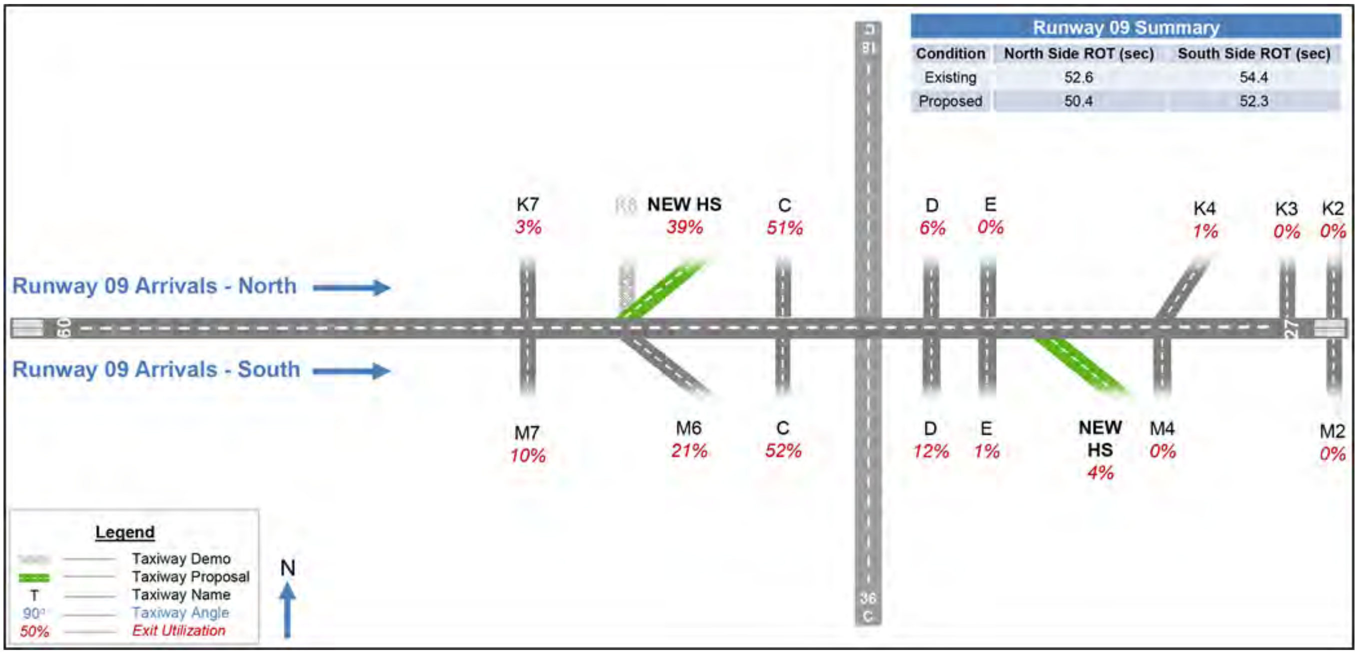
Different fleets of aircraft were assumed to exit on different sides of Runway 09. It was assumed that aircraft exiting to the north would consist of the entire fleet (passenger and air cargo). Aircraft exiting to the south would primarily consist of only air cargo aircraft. For aircraft exiting Runway 09 to the north, the runway has an existing ROT of 52.7 seconds. This ROT is near the high end of the ATCT-recommended target.

The analysis of the runway indicates that a reduction in the average ROT is possible if Taxiway K6 is converted from a 90-degree exit to a high speed exit. The new high-speed exit decreases the overall average ROT on Runway 09 by approximately 2 seconds to 50.4 seconds. This new high-speed exit replacing Taxiway K6 now captures nearly 40 percent of the operations arriving on Runway 09 exiting to the north.

The existing ROT for Runway 09 exiting to the south exceeded the 52 to 53 second ATCT recommendation at 54.4 seconds. The addition of a high speed exit beyond the Taxiway E intersection would yield a benefit. The average ROT on Runway 09 on the south side would be 52.3 seconds after the addition of the new high-speed exit (a 2 second decrease in ROT).

The potential runway exit improvements for Runway 09 are presented in **Exhibit 4.2-11, *Runway 09 Potential Exit Improvements*.**

EXHIBIT 4.2-11 RUNWAY 09 POTENTIAL EXIT IMPROVEMENTS



Source: Landrum & Brown analysis

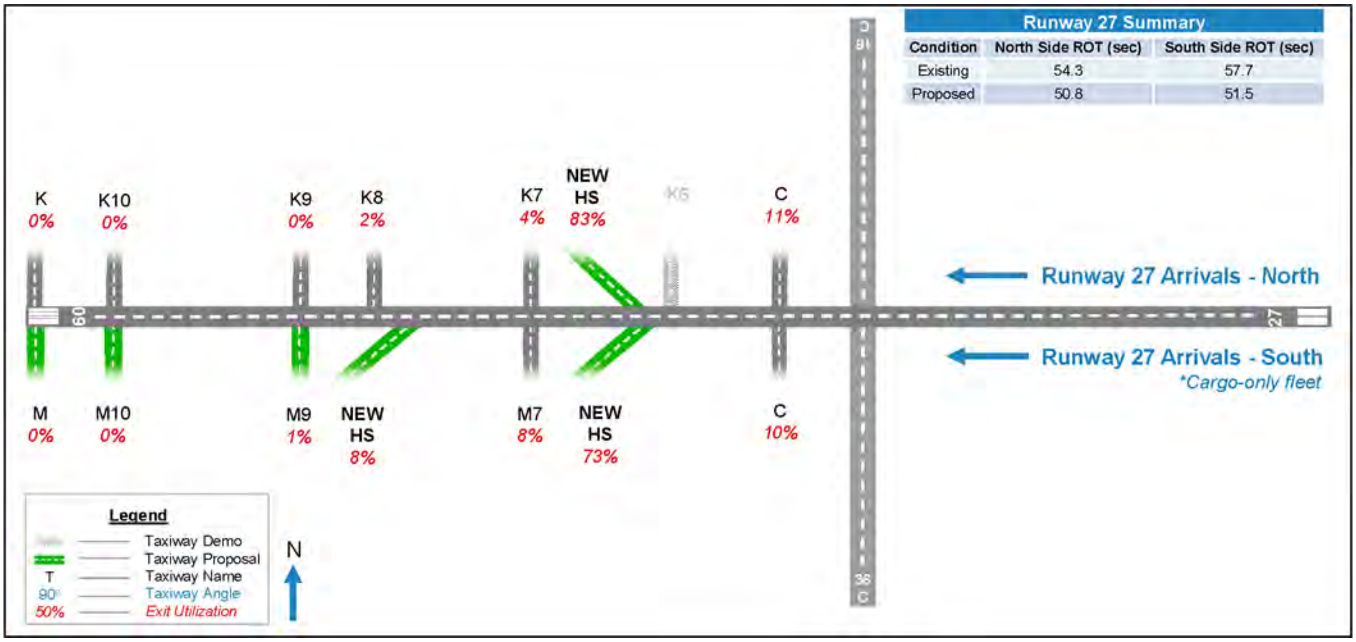
Runway 27

Different fleets of aircraft were assumed to exit on different sides of Runway 27. It was assumed that aircraft exiting the runway to the north would consist of the entire fleet (passenger and air cargo). Aircraft exiting to the south would primarily consist of only air cargo aircraft. For aircraft arriving on Runway 27 and exiting to the north side of the runway, Runway 27 has existing average ROT of 54.3 seconds. To achieve an optimum ROT, a new high-speed exit can be added to replace Taxiway K6, an existing 90-degree exit. This new high-speed exit would decrease the overall average ROT on Runway 27 by approximately 3.5 seconds to 50.8 seconds. Over 80 percent of aircraft arriving on Runway 27 exiting to the north would use this new exit.

For aircraft arriving on Runway 27 and exiting to the south side of the runway, Runway 27 has an existing average ROT of 57.7 seconds. Two new high-speed exits can be added to increase the overall operational efficiency of the runway, as well as three 90-degree connectors (Taxiways M9, M10, and M). The addition of these five exits would decrease the average ROT to 51.5 seconds, an overall savings of approximately 6 seconds. However, it should be noted that the additional exits beyond the existing western end of Taxiway M are only necessary if/when Taxiway M is extended to the full-length of Runway 09/27.

The potential runway exit improvements for Runway 27 are presented in **Exhibit 4.2-12, *Runway 27 Potential Exit Improvements***.

EXHIBIT 4.2-12 RUNWAY 27 POTENTIAL EXIT IMPROVEMENTS



Source: Landrum & Brown analysis

Runway 18C

Similar to Runway 09/27, different fleets of aircraft were assumed to exit on different sides of Runway 18C. It was assumed that aircraft exiting the runway to the east would consist of the entire fleet (passenger and air cargo). Aircraft exiting to the west would primarily consist of only air cargo aircraft. For aircraft exiting Runway 18C to the east, the runway has an existing ROT of 51.0 seconds. This average ROT is below the recommended objective of 52 to 53 seconds, therefore no additional exits are needed for aircraft exiting Runway 18C to the east.

For aircraft exiting Runway 18C to the west side, the runway has an existing ROT of over 60 seconds. In order to optimize the operation of Runway 18C for aircraft exiting to the west, a new high-speed exit should be added south of the existing Taxiway M intersection. This new exit would capture approximately 32 percent of the arriving aircraft on Runway 18C that are exiting to the west. In addition, a second runway end connector could be added near Taxiway C on the west side, capturing 4 percent of the fleet. With these two additional exists, the average ROT would be decreased from over 60 seconds to 51.2 seconds. However, it should be noted that each of these new exits are dependent on an extension of Taxiway C south of Runway 09/27 to the Runway 36C end. In addition, the development of future exits on the west side of Runway 18C would be dependent on the development of other airfield facilities on that side of the runway. Currently, no aircraft need to exit to the west as all existing airport facilities are located to the east of this runway.

The potential runway exit improvements for Runway 18C are presented in **Exhibit 4.2-13, *Runway 18C Potential Exit Improvements***.

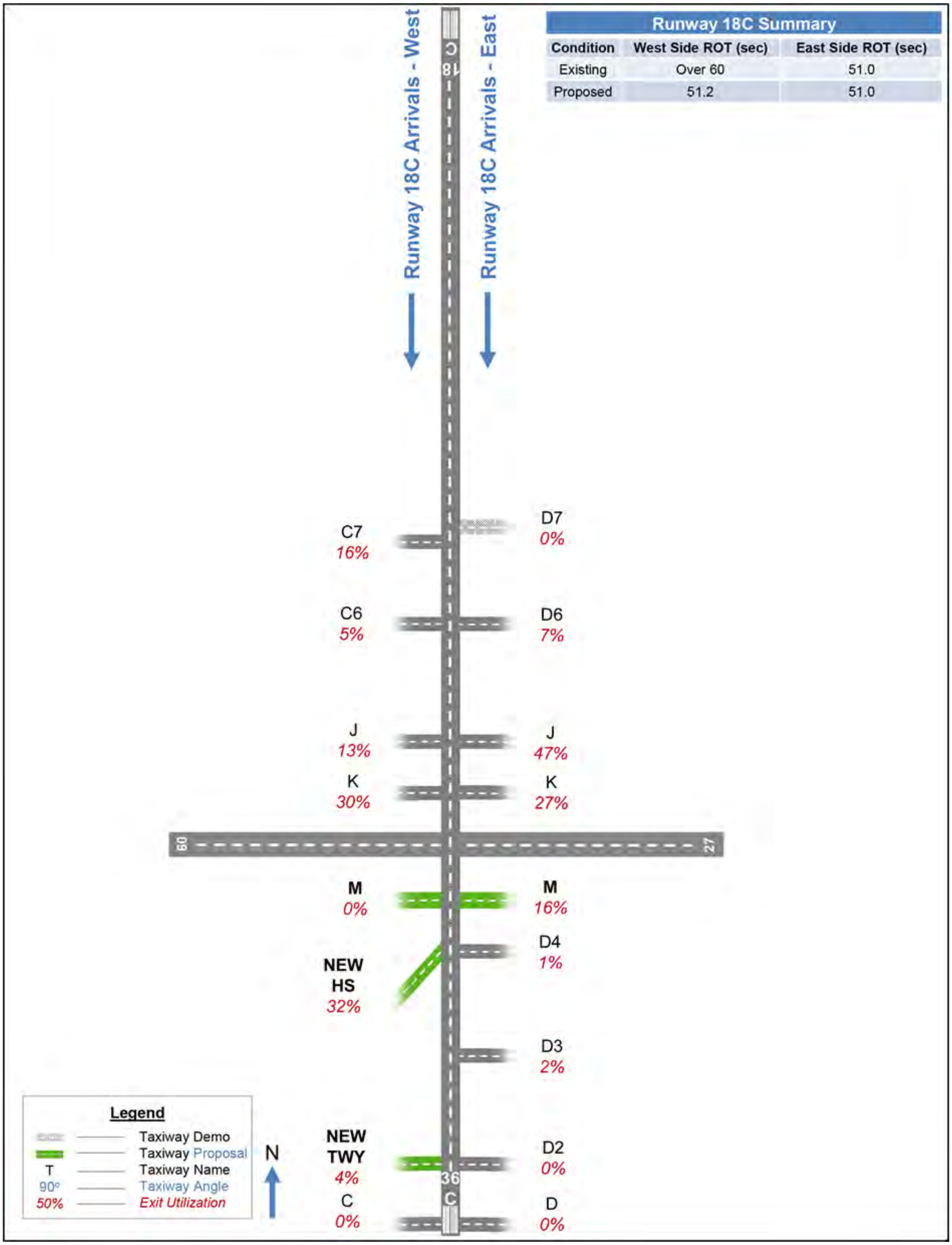
Runway 36C

Similar to Runway 09/27, different fleets of aircraft were assumed to exit on different sides of the Runway 36C. It was assumed that aircraft exiting the runway to the east would consist of the entire fleet (passenger and air cargo). Aircraft exiting to the west would primarily consist of only air cargo aircraft. For aircraft existing Runway 36C to the west side, the runway has an existing ROT of over 60 seconds. The analysis indicated that it may be possible to decrease the average ROT on this side of the runway with the addition of two high speed exits. The first high-speed exit should be located north of Taxiway C7 and would be used by approximately 54 percent of arriving aircraft exiting the runway to the west. The second additional high-speed exit should be located approximately 1,300 feet north of the first high-speed exit and would be used by approximately 19 percent of aircraft arriving and exiting the runway to the west. The addition of these two exits could reduce the average ROT by approximately 10 seconds to 50.8 seconds on the west side.

Aircraft arriving on Runway 36C and exiting the runway to the east have an average ROT of nearly 53 seconds. This ROT result is near the high-end of the ATCT recommended target. The analysis of the runway indicates that a reduction in the average ROT is possible through reconfiguration of two existing exit taxiways. The first is a conversion of existing Taxiway D6 from a 90 degree exit to a high-speed 30 degree exit. This would also require the removal of Taxiway D7 in order to comply with taxiway geometry design standards. With the reconfiguration, this exit would be used by approximately 47 percent of arriving aircraft that exit the runway to the east. The second improvement would come in the form of a reconfiguration of Taxiway D8 from a 90 degree exit to a 30 degree high speed exit. This reconfigured exit would be used by approximately 47 percent of arriving aircraft exiting the runway to the east. These two new high-speed exits would be used by over 90 percent of arriving aircraft exiting to the east of Runway 36C and could result in reducing the average ROT to 49.5 seconds.

The potential runway exit improvements for Runway 36C are presented in **Exhibit 4.2-14, *Runway 36C Potential Exit Improvements***.

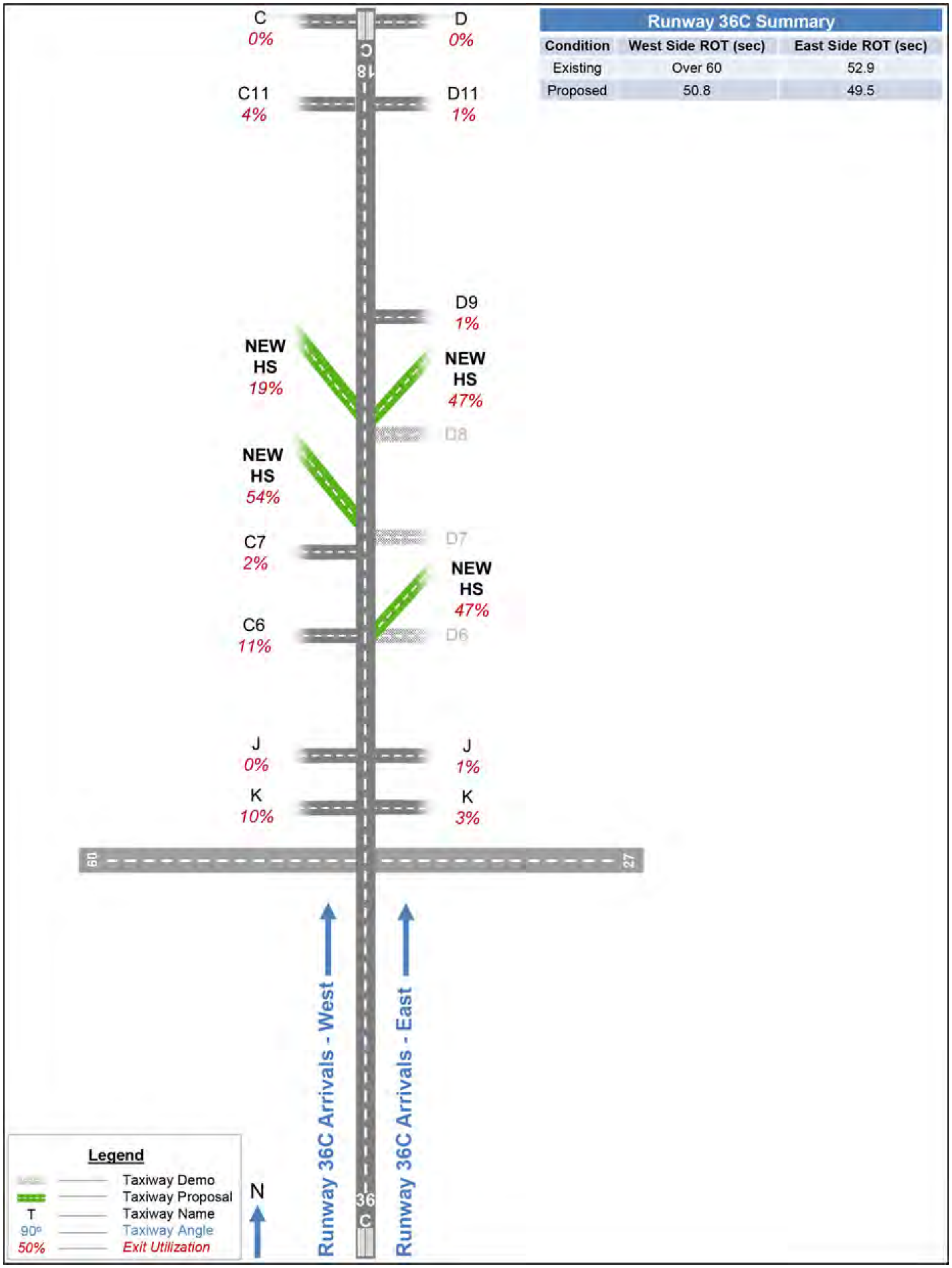
EXHIBIT 4.2-13 RUNWAY 18C POTENTIAL EXIT IMPROVEMENTS



Condition	West Side ROT (sec)	East Side ROT (sec)
Existing	Over 60	51.0
Proposed	51.2	51.0

Source: Landrum & Brown analysis

EXHIBIT 4.2-14 RUNWAY 36C POTENTIAL EXIT IMPROVEMENTS



Runway 36C Summary

Condition	West Side ROT (sec)	East Side ROT (sec)
Existing	Over 60	52.9
Proposed	50.8	49.5

Source: Landrum & Brown analysis

Runway 18L

Runway 18L arrivals were analyzed using the entire cargo and passenger fleet for CVG since there are only exits on the west side of the runway. Both cargo and passenger aircraft exit the same side of the runway. The ROT for 18L averaged 52.2 seconds, which is below the recommended objective of 52 to 53 seconds, however, it was analyzed using the REDIM optimization tool to determine if the runway could achieve an average ROT of 50 seconds or less.

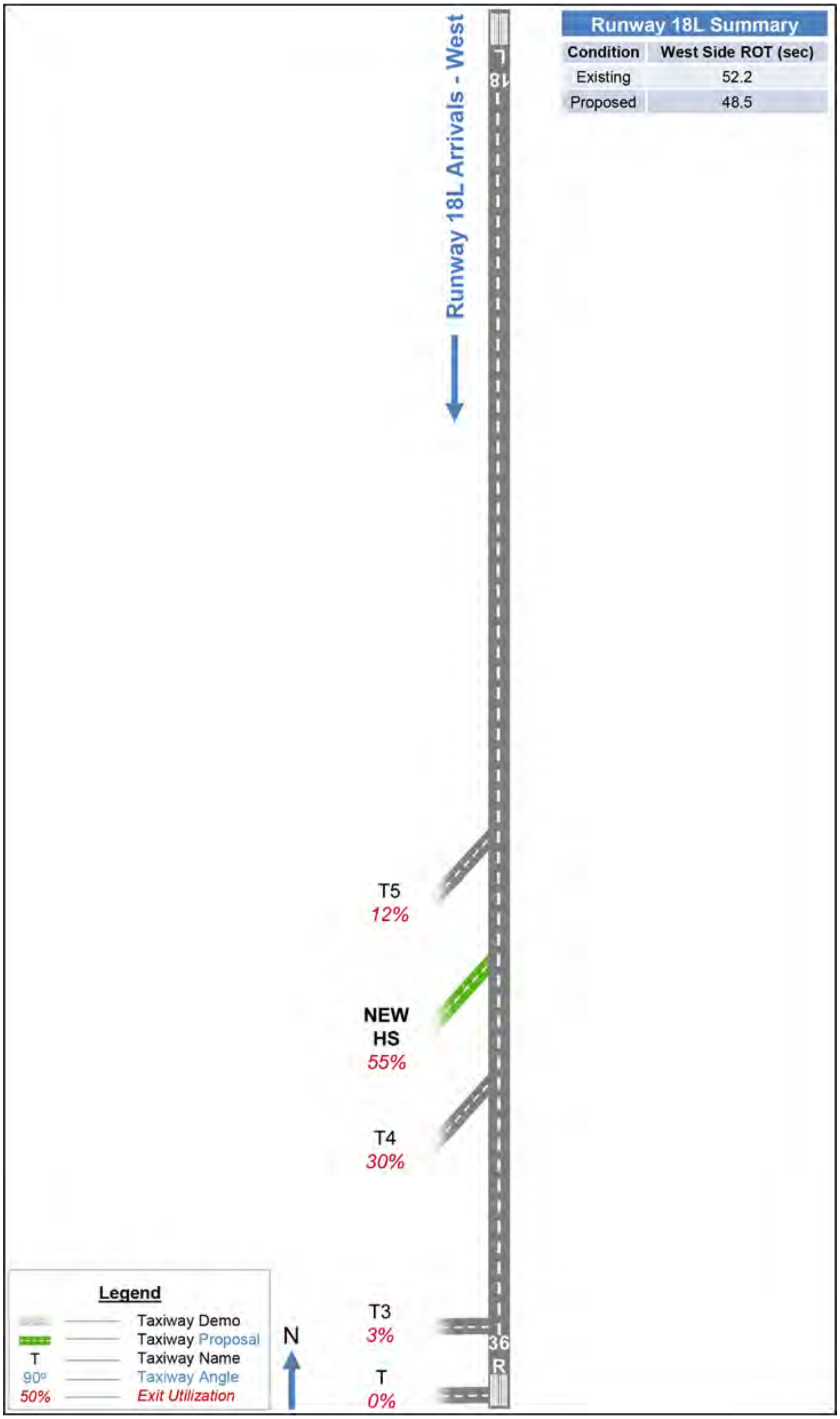
The REDIM analysis indicated that in order to optimize Runway 18L arrivals, a third high-speed exit should be added between Taxiway T5 and T4 which could achieve an average ROT of 48.5 seconds, approximately a four second improvement. The potential runway exit improvements for Runway 18L are presented **in Exhibit 4.2-15, *Runway 18L Potential Exit Improvements***.

Runway 36R

Similar to Runway 18L, Runway 36R arrivals were analyzed using the entire cargo and passenger fleet for CVG since there are only exits on the west side of the runway. Both cargo and passenger aircraft exit the same side of the runway. The ROT for 36R averaged 53.4 seconds, which is equal to the recommended objective of 52 to 53 seconds, however, it was analyzed using the REDIM optimization tool to see if the runway could achieve an average ROT of 50 seconds or less.

Similar to Runway 18L, REDIM determined that in order to optimize Runway 36R arrivals a third high-speed exit should be added between Taxiway T6 and T7 reducing the average ROT to 48.4 seconds, a five second savings. The potential runway exit improvements for Runway 36R are presented in **Exhibit 4.2-16, *Runway 36R Potential Exit Improvements***.

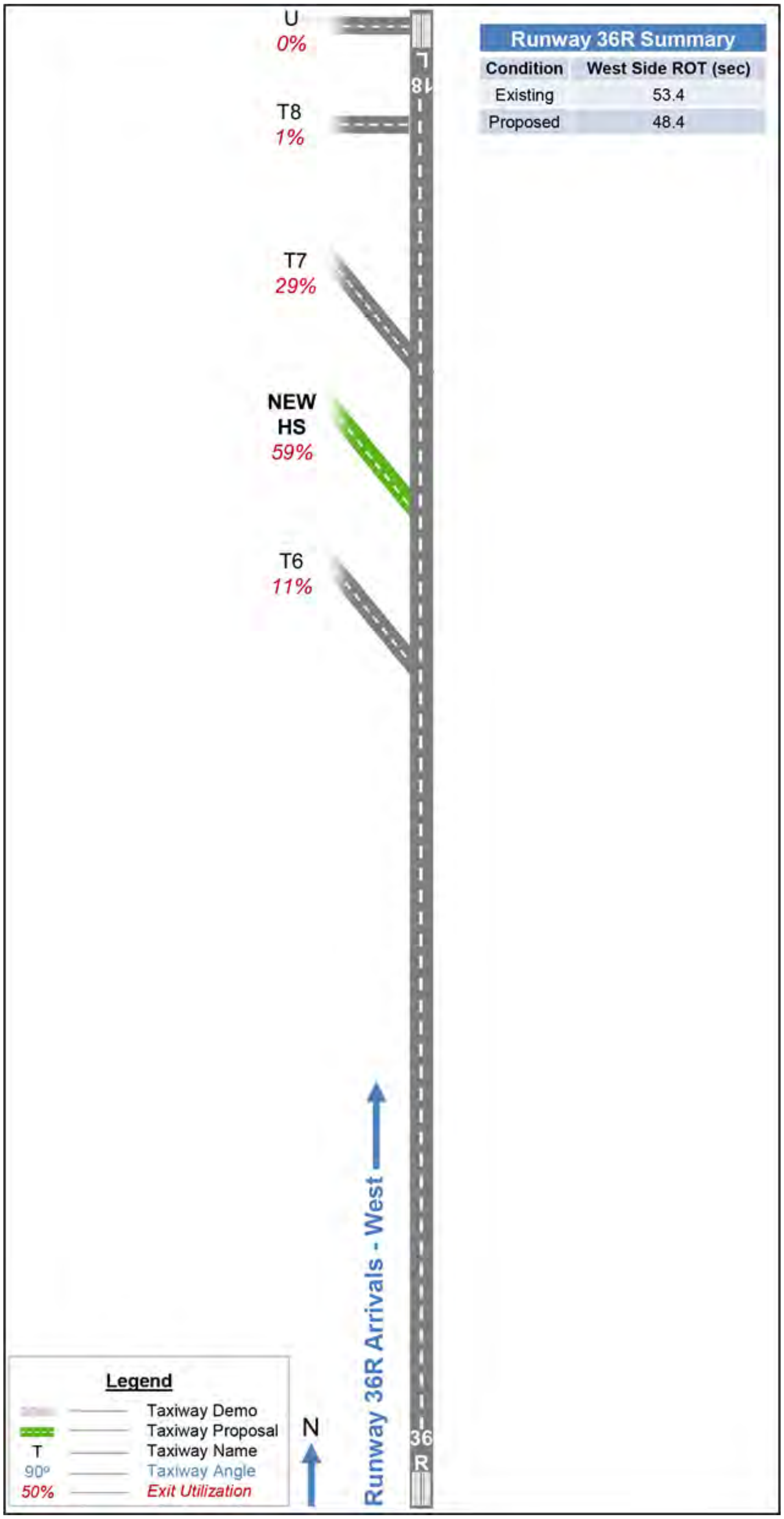
EXHIBIT 4.2-15 RUNWAY 18L POTENTIAL EXIT IMPROVEMENTS



Runway 18L Summary	
Condition	West Side ROT (sec)
Existing	52.2
Proposed	48.5

Source: Landrum & Brown analysis

EXHIBIT 4.2-16 RUNWAY 36R POTENTIAL EXIT IMPROVEMENTS



Runway 36R Summary	
Condition	West Side ROT (sec)
Existing	53.4
Proposed	48.4

Source: Landrum & Brown analysis

4.2.4 Taxiway Demand/Capacity

Amazon initiated operations at CVG in 2017. They intend to build a sort facility to the west of DHL's facility. In order to identify taxiway needs that may result from the increased activity by air cargo operators at CVG, a taxi flow analysis for the south airfield was completed. It should be noted that none of the taxiway improvements considered herein are directly tied to any specific development on the airfield. All needs identified result from increased traffic levels regardless of source.

4.2.4.1 *Assumptions*

The taxi flows were evaluated for North and South Flows as follows:

- Aircraft were routed based on use of the most efficient (lowest distance) routes, without consideration of delays or conflicts. Aircraft were not rerouted to avoid conflicts as rerouting aircraft results in increased taxi distances.
- Departing cargo aircraft can use all available runways. In other words, runway assignments were not made based on the operator in an effort to reduce congestion (for example, sending all DHL departures to Runway 36L to avoid conflicts with Amazon operations). Rerouting aircraft based on their taxi route reduces the capacity of the runway system because it creates flight path crossings in the air.

Taxi flows were evaluated for the arrival push, departure push, and mixed operations. The peak cargo arrival push begins shortly after midnight and lasts through approximately 3:00 am. The peak cargo departure push begins at approximately 4:00 am and lasts until approximately 7:00 am. Mixed operations flows were evaluated because departures occur during the arrival push and vice versa. In addition, in high delay situations (due to inclement weather, for example), the arrival push can be delayed, overlapping with the departure push.

Taxi flows were evaluated for two runway use scenarios. Scenario 1 consists of operations on Runway 09/27 and Runway 18R/36L. Scenario 2 assumes the use of Runway 18C/36C in addition to Runways 09/27 and 18R/36L, as discussed in earlier Section 4.2.1, *Runway Demand/Capacity*.

The taxi flows are presented in a series of exhibits in the following sections. Arrival flows are shown in red, departure flows in green, and mixed operations are shown in blue. Conflicts are identified in sequential numerical order.

4.2.4.2 *Taxi Flow Analysis – Scenario 1 North Flow*

Exhibits 4.2-17 through 4.2-19, present the Scenario 1 North Flow taxi flows for departures, arrivals, and mixed operations. The departure push consists of departures on Runways 36R and 27. One conflict was identified for this flow:

1. **Taxiway S**: conflict between departures coming out of Taxilane N traveling south on Taxiway S to Runway 36R and departures coming from the southern DHL taxilane traveling north on Taxiway S to reach Runway 27.

This conflict will be exacerbated if Taxiway S4 is removed for safety reasons as discussed in Section 4.2.5. Currently, aircraft headed for Runway 36R can use Taxiway S4 to cross over to Taxiway T, minimizing the amount of time aircraft spend traveling in the opposite direction on Taxiway S. Removal of Taxiway S4 would increase the amount of time the southbound aircraft would have to remain on Taxiway S.

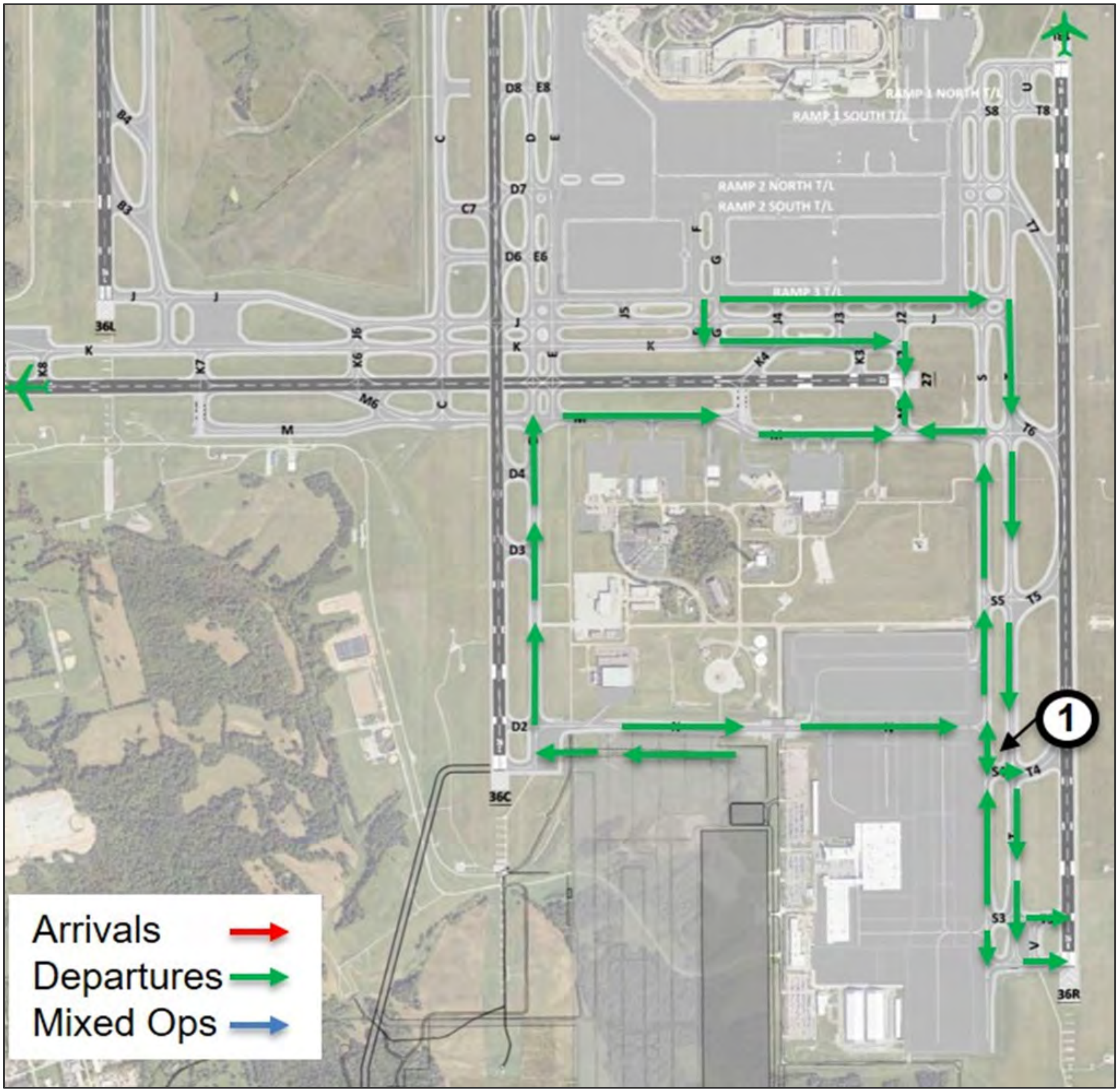
The arrival push consists of arrivals on Runways 09 and 36R. One conflict was identified:

2. **Taxilane N**: conflict between Runway 36R arrivals traveling west and Runway 09 arrivals traveling east.

Mixed operations consist of arrivals on Runway 36R with departures on Runways 36R and 27. In addition to the previously identified conflicts that occur in the departure and arrival pushes, two conflicts were identified for mixed operations:

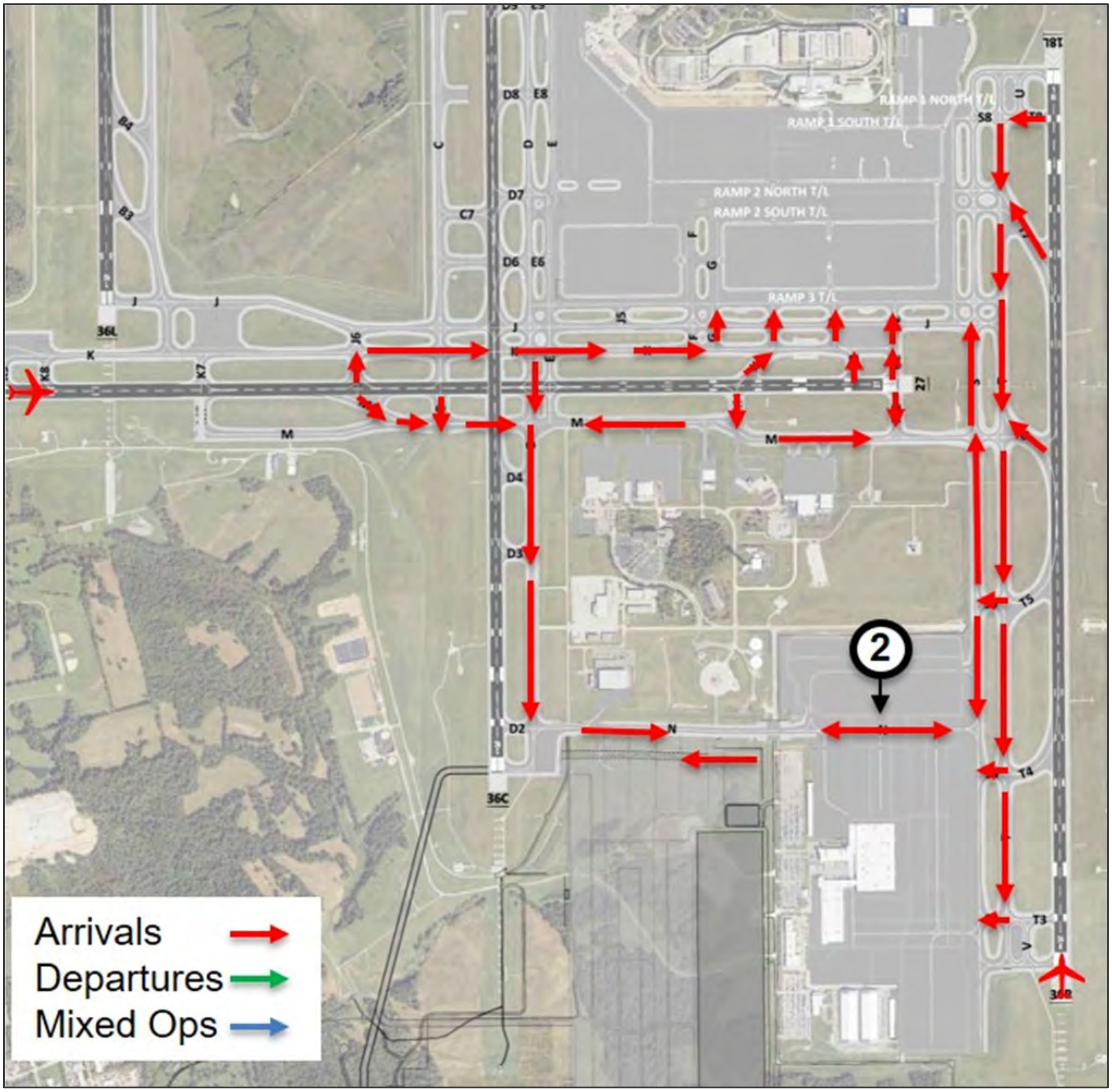
3. **Taxilane N**: conflict between Runway 36R arrivals traveling west and Runway 36R departures traveling east.
4. **Taxiway S**: conflict between Runway 27 departures traveling north and Runway 36R arrivals traveling south.

EXHIBIT 4.2-17 SCENARIO 1 NORTH FLOW DEPARTURES



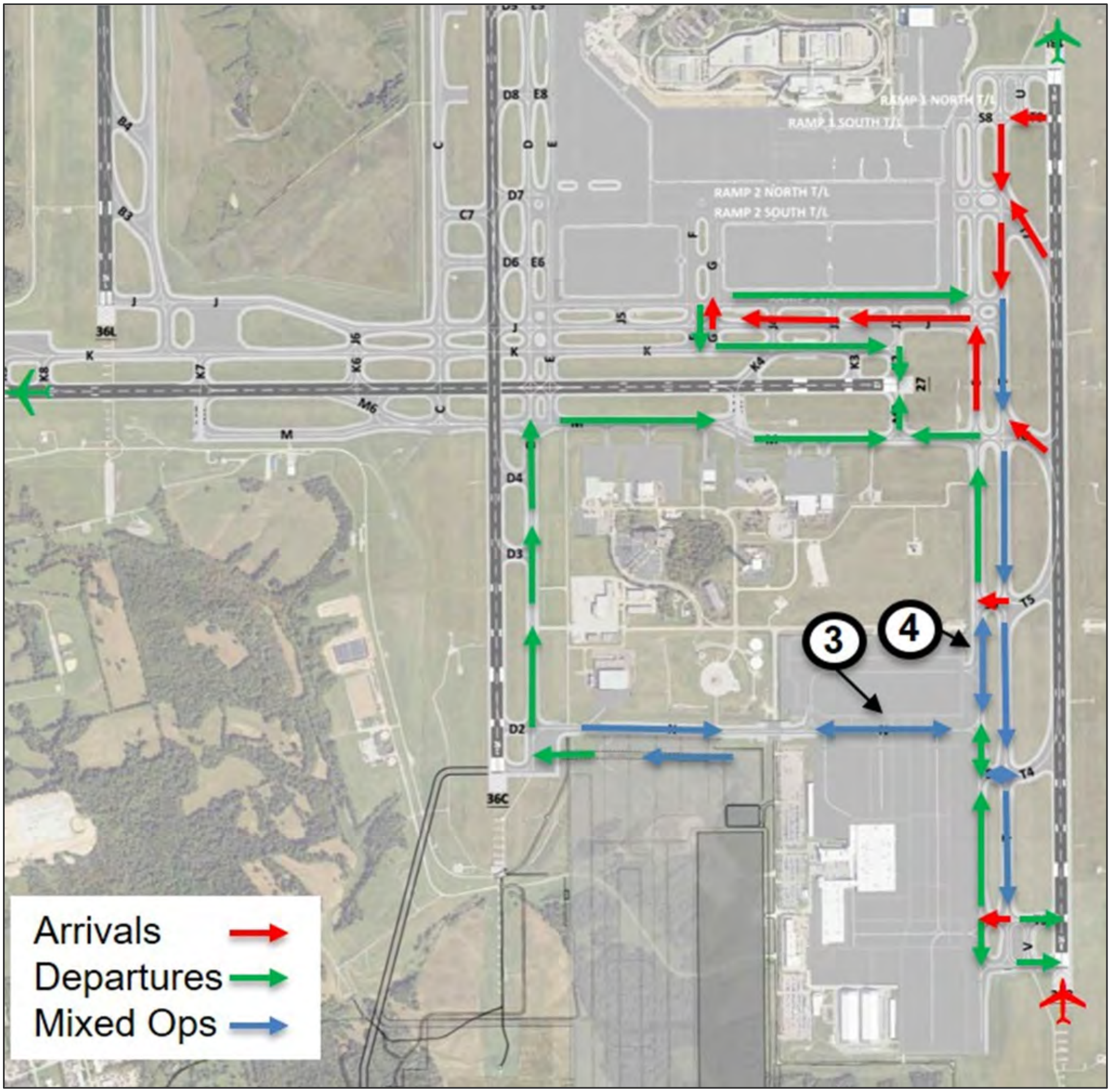
Sources: CVG officials; ATCT officials; Landrum & Brown analysis

EXHIBIT 4.2-18 SCENARIO 1 NORTH FLOW ARRIVALS



Sources: CVG officials; ATCT officials; Landrum & Brown analysis

EXHIBIT 4.2-19 SCENARIO 1 NORTH FLOW MIXED OPERATIONS



Sources: CVG officials; ATCT officials; Landrum & Brown analysis

4.2.4.3 *Taxi Flow Analysis – Scenario 1 South Flow*

Exhibits 4.2-20 through 4.2-22 present the Scenario 1 South Flow taxi flows for departures, arrivals, and mixed operations. The departure push consists of departures on Runways 18L and 27. No conflicts were identified for this flow.

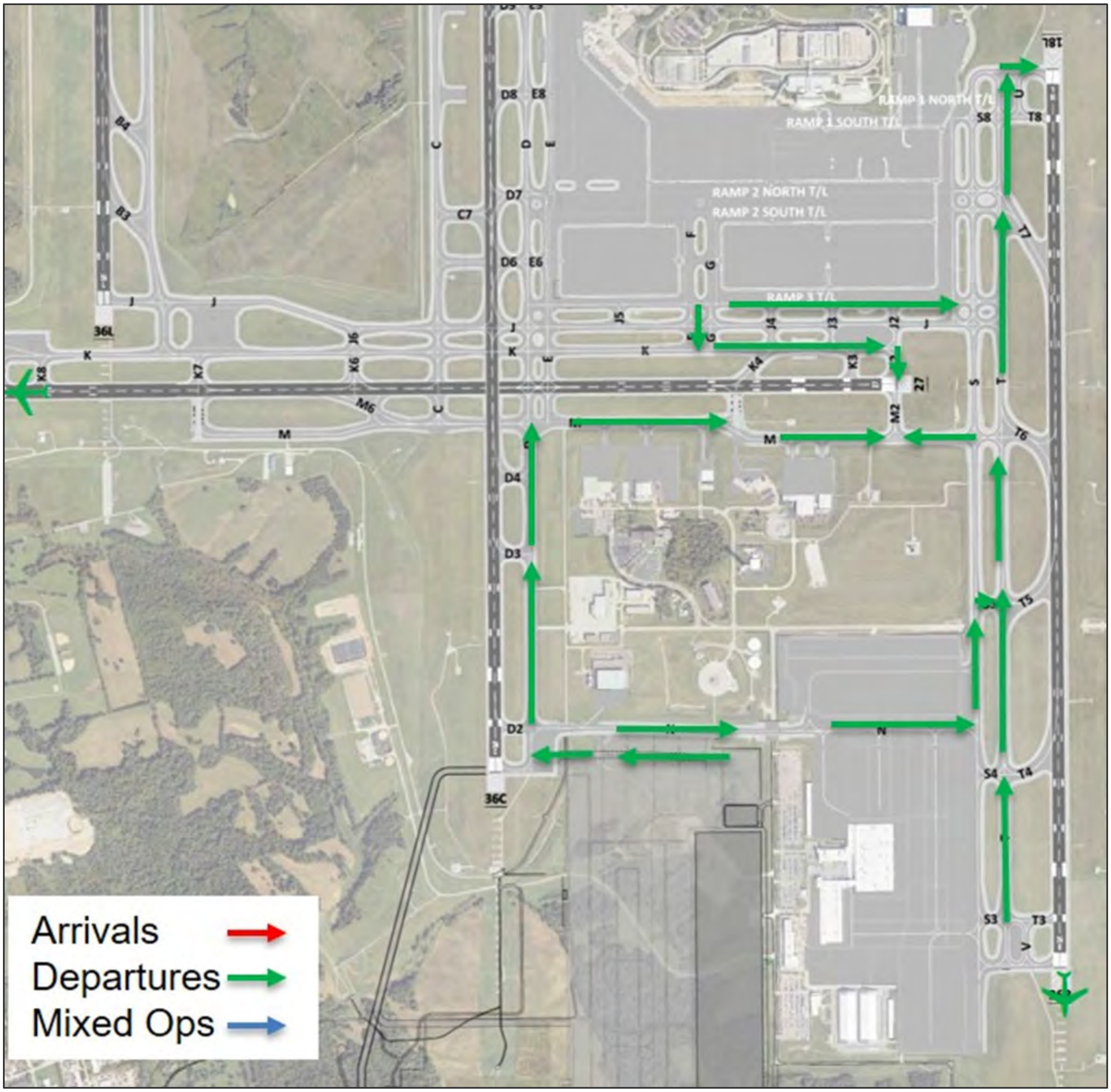
The arrival push consists of arrivals on Runways 09 and 18L. Two conflicts were identified:

5. **Taxiway S**: conflict between Runway 18L arrivals exiting at Taxiway T4 headed north and Runway 18L arrivals headed south to southern DHL taxilane.
6. **Taxilane N**: conflict between Runway 18L arrivals traveling west and Runway 09 arrivals traveling east.

Mixed operations consist of arrivals on Runway 18L with departures on Runways 18L and 27. In addition to the previously identified conflicts that occur in the departure and arrival pushes, two conflicts were identified for mixed operations:

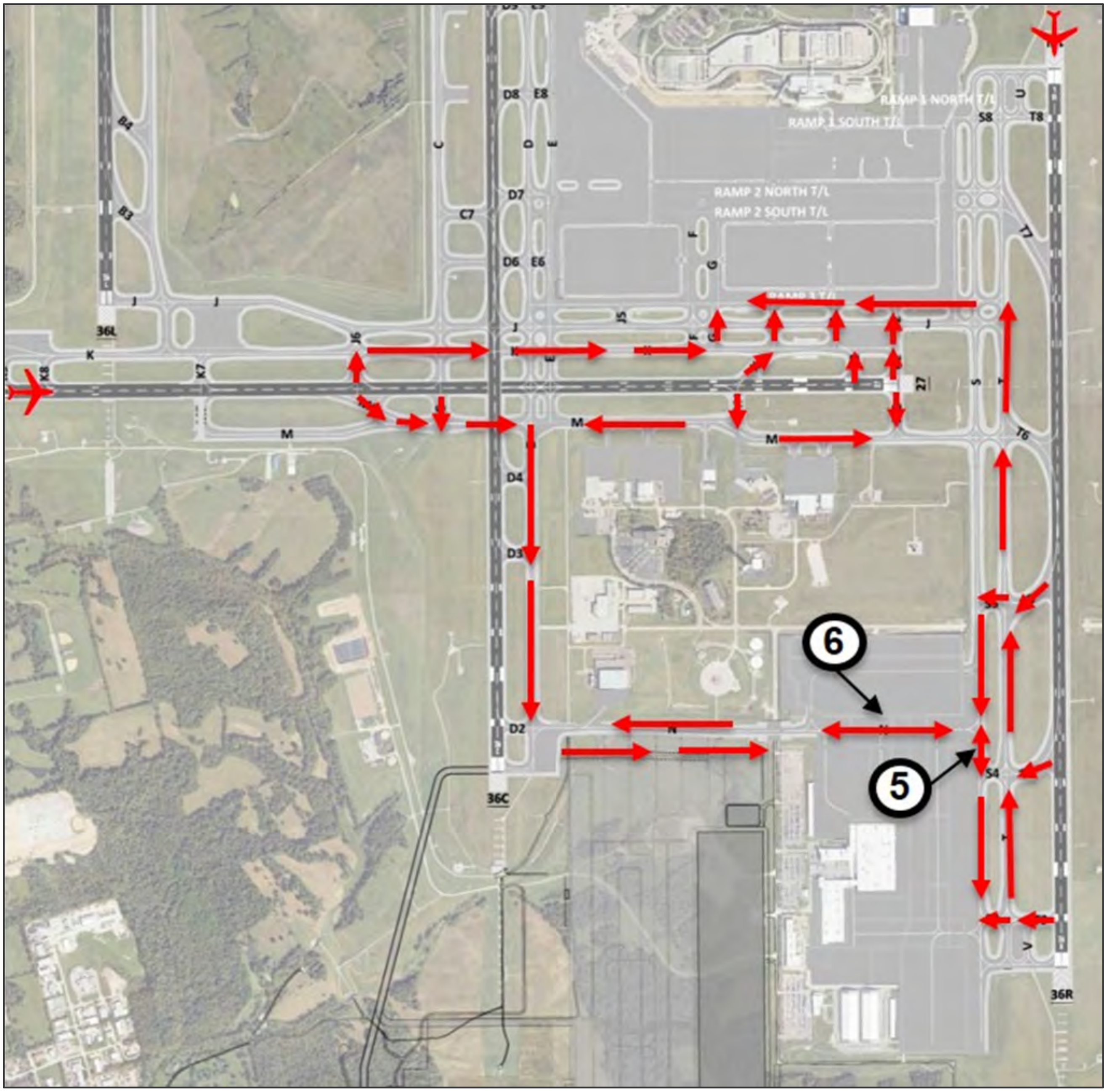
7. **Taxilane N**: conflict between Runway 18L arrivals and departing traffic.
8. **Taxiway S**: conflict between Runway 18L arrivals exiting at Taxiway T4 headed south and departures headed north.

EXHIBIT 4.2-20 SCENARIO 1 SOUTH FLOW DEPARTURES



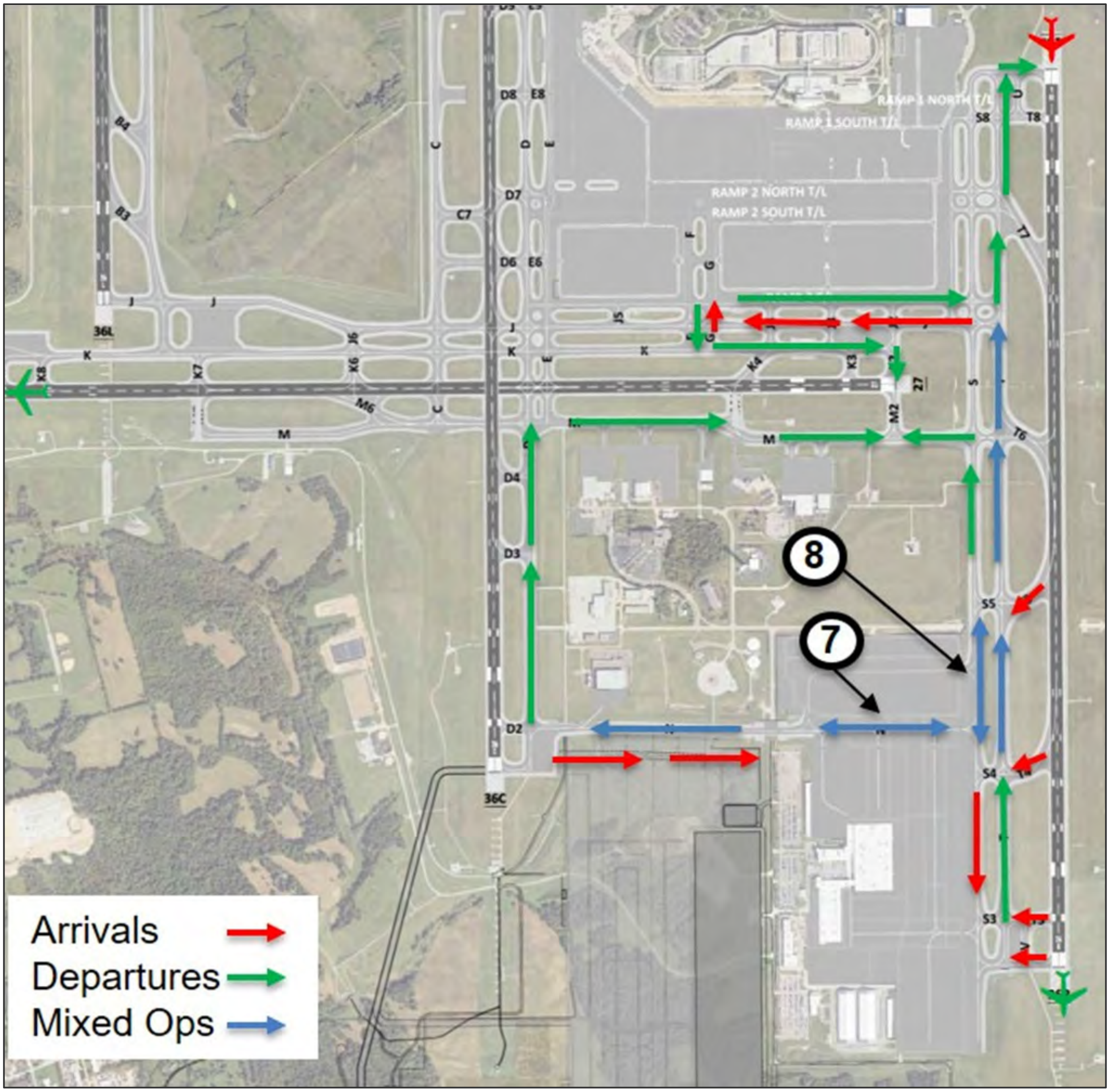
Sources: CVG officials; ATCT officials; Landrum & Brown analysis

EXHIBIT 4.2-21 SCENARIO 1 SOUTH FLOW ARRIVALS



Sources: CVG officials; ATCT officials; Landrum & Brown analysis

EXHIBIT 4.2-22 SCENARIO 1 SOUTH FLOW MIXED OPERATIONS



Sources: CVG officials; ATCT officials; Landrum & Brown analysis

4.2.4.4 *Taxi Flow Analysis – Scenario 2 North Flow*

Exhibits 4.2-23 through 4.2-25 present the Scenario 2 North Flow taxi flows for departures, arrivals, and mixed operations. The departure push consists of departures on Runways 36R, 36C, and 27. Three conflicts were identified:

9. **Runway 36R Departure Queue**: there is no room to queue for departure on Runway 36C, especially as the number of operations increases in the future. It is estimated that there will be 76 peak hour cargo departures at the PAL 3 demand level.[8] Assuming an even split between operations on the departure runways, there will be 38 departures queueing to depart on Runway 36R in a single hour. This queue will likely back up into the south cargo area, blocking other aircraft.
10. **Taxilane N**: conflict between Runway 36C departures traveling west and Runway 36R departures traveling east.
11. **Taxiway S**: conflict between departures coming out of Taxilane N traveling south on Taxiway S to Runway 36R and departures coming from the southern DHL taxilane traveling north on Taxiway S to reach Runways 27 and 36C.

The arrival push consists of arrivals on Runways 36C and 36R. One conflict was identified:

12. **Taxilane N**: conflict between Runway 36C arrivals traveling east and Runway 36R arrivals traveling west.

Mixed operations consist of arrivals and departures on Runway 36C and 36R with departures on Runway 27. In addition to the previously identified conflicts that occur in the departure and arrival pushes, three conflicts were identified for mixed operations:

13. **Taxiway D**: conflict between Runway 27 departures traveling north and Runway 36C arrivals headed south.
14. **Taxiway N**: conflict between arrivals and departures
15. **Taxiway S**: conflict between departures coming out of Taxilane N traveling south on Taxiway S to Runway 36R and departures coming from the southern DHL taxilane traveling north on Taxiway S to reach Runways 27 and 36C.

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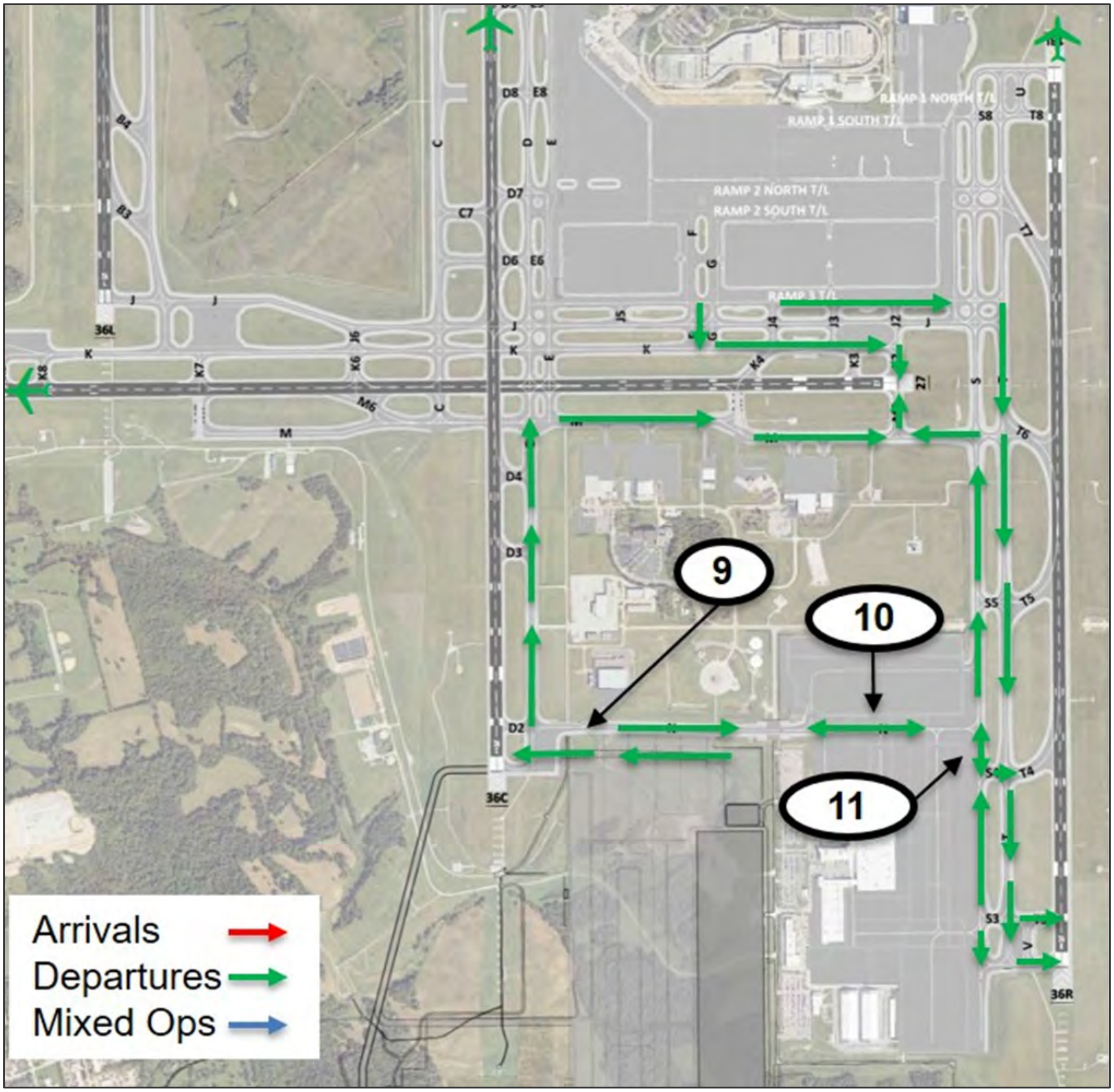
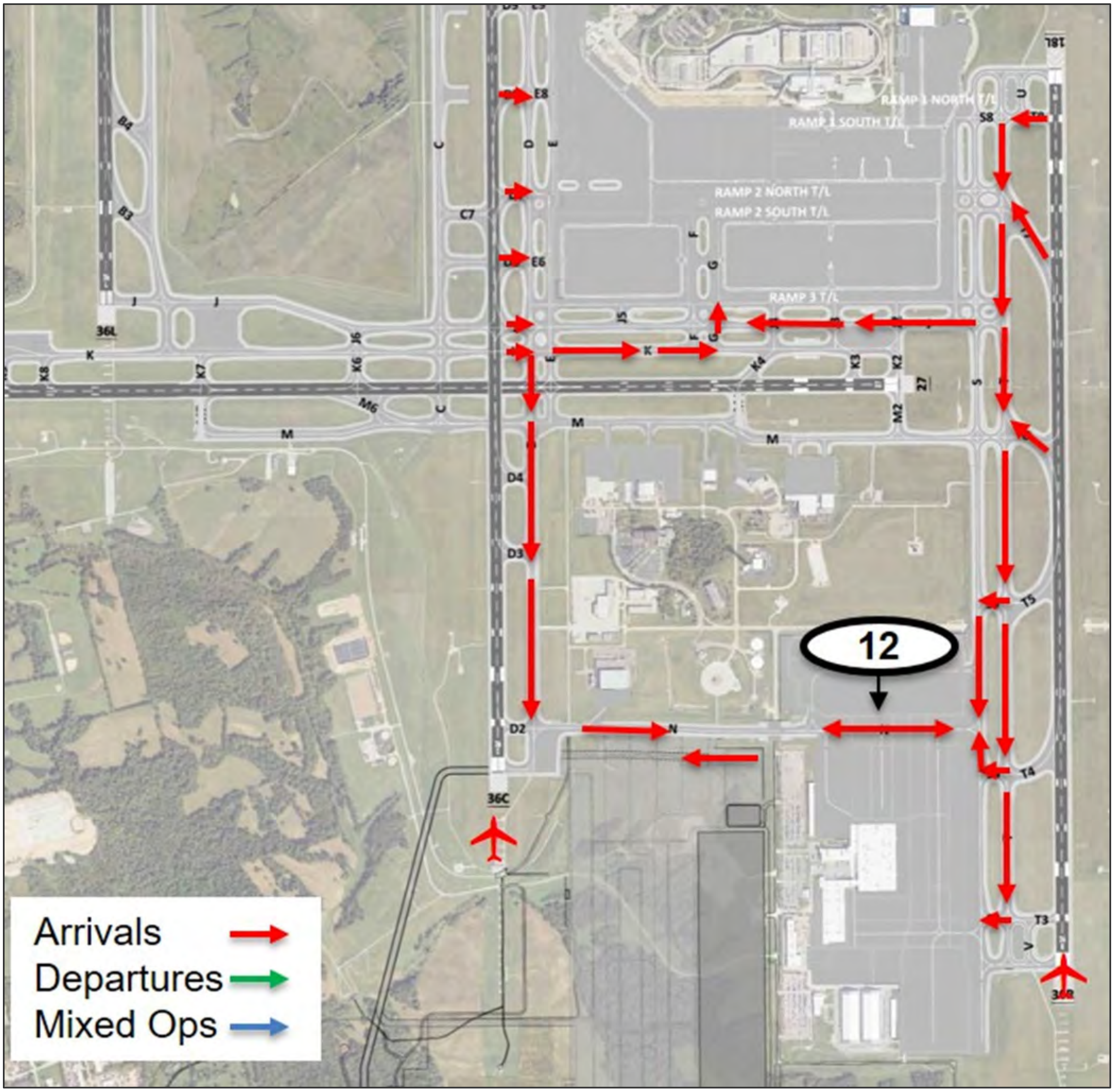
8 Appendix 1-B, Alternative Forecasts

EXHIBIT 4.2-23 SCENARIO 2 NORTH FLOW DEPARTURES



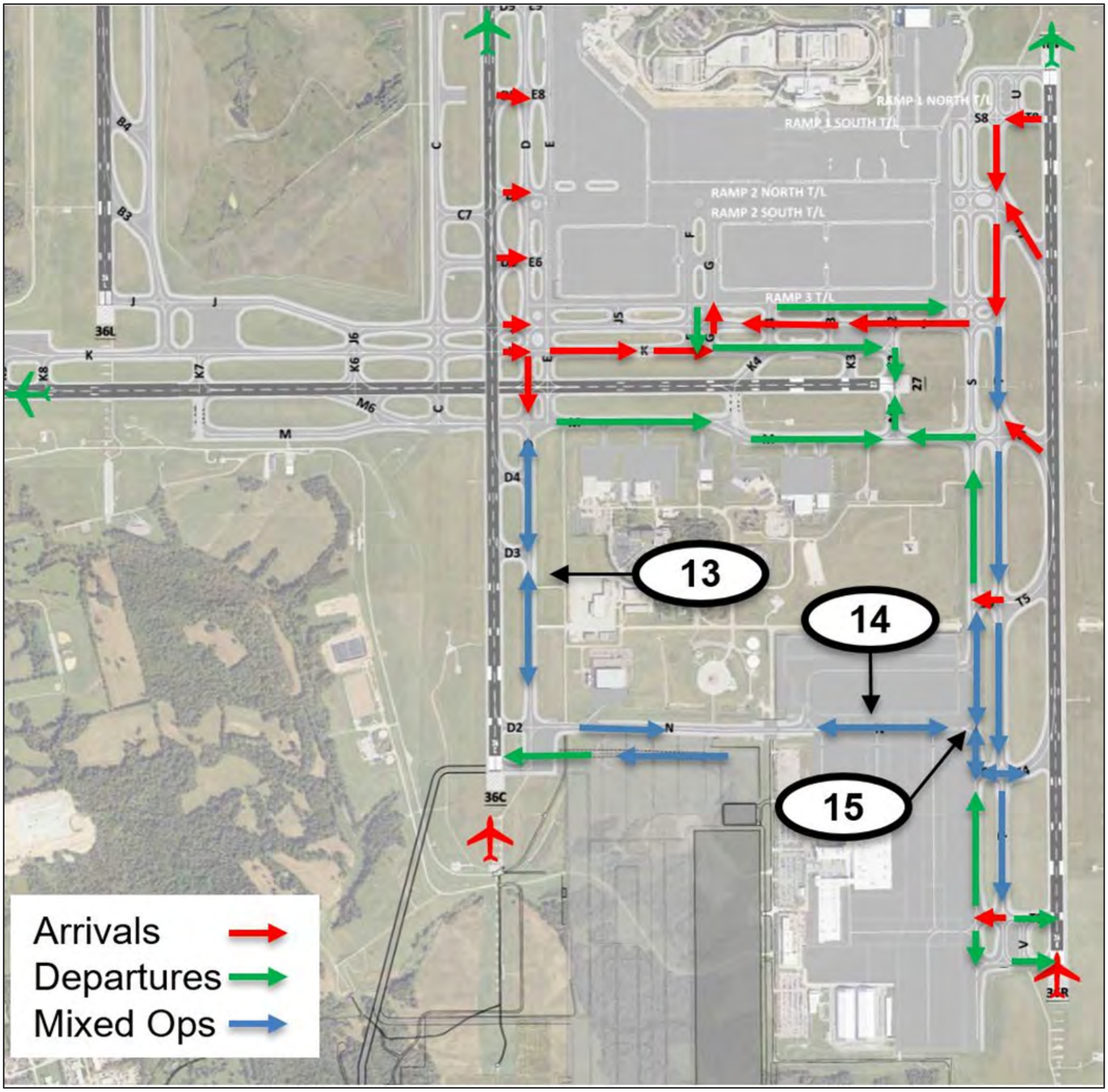
Sources: CVG officials; ATCT officials; Landrum & Brown analysis

EXHIBIT 4.2-24 SCENARIO 2 NORTH FLOW ARRIVALS



Sources: CVG officials; ATCT officials; Landrum & Brown analysis

EXHIBIT 4.2-25 SCENARIO 2 NORTH FLOW MIXED OPERATIONS



Sources: CVG officials; ATCT officials; Landrum & Brown analysis

4.2.4.5 *Taxi Flow Analysis – Scenario 2 South Flow*

Exhibits 4.2-26 through 4.2-28 present the Scenario 2 South Flow taxi flows for departures, arrivals, and mixed operations. The departure push consists of departures on Runways 18C, 18L, and 27. No conflicts were identified for this flow.

The arrival push consists of arrivals on Runways 09, 18C, and 18L. Two conflicts were identified:

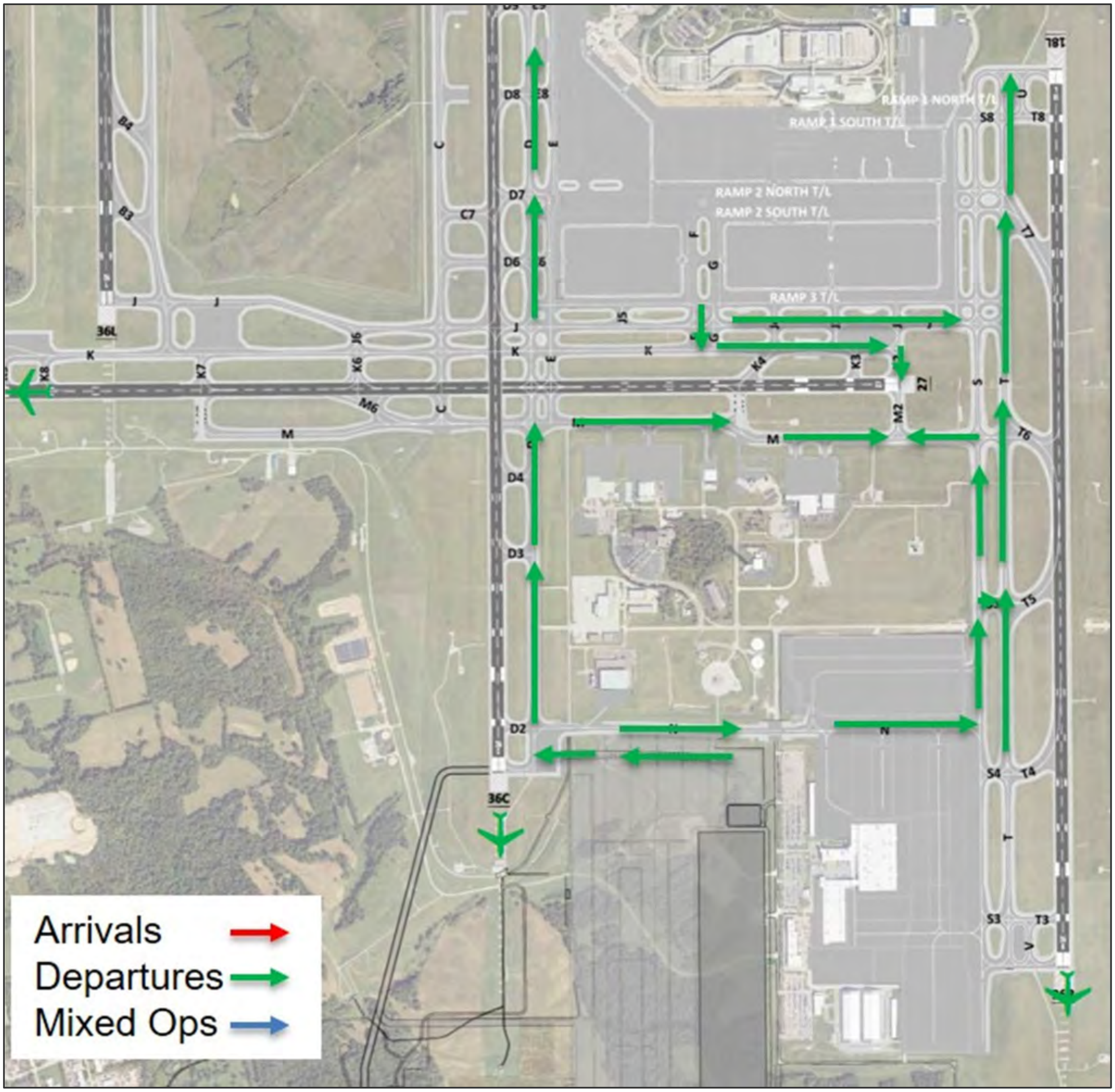
16. **Taxiway S**: conflict between Runway 18L arrivals exiting at Taxiway T4 headed north and Runway 18L and 18C arrivals headed south to southern DHL taxilane.
17. **Taxilane N**: conflict between Runway 18L arrivals traveling west and Runway 18C arrivals traveling east.

Mixed operations consist of arrivals and departures on Runway 18C and 18L with departures on Runway 27. In addition to the previously identified conflicts that occur in the departure and arrival pushes, three conflicts were identified for mixed operations:

18. **Taxiway D**: conflict between Runway 27 departures traveling north and Runway 18C arrivals headed south.
19. **Taxilane N**: conflict between Runway 36R arrivals and departing traffic.
20. **Taxiway S**: conflict between Runway 18L arrivals exiting at Taxiway T4 headed south and departures headed north.

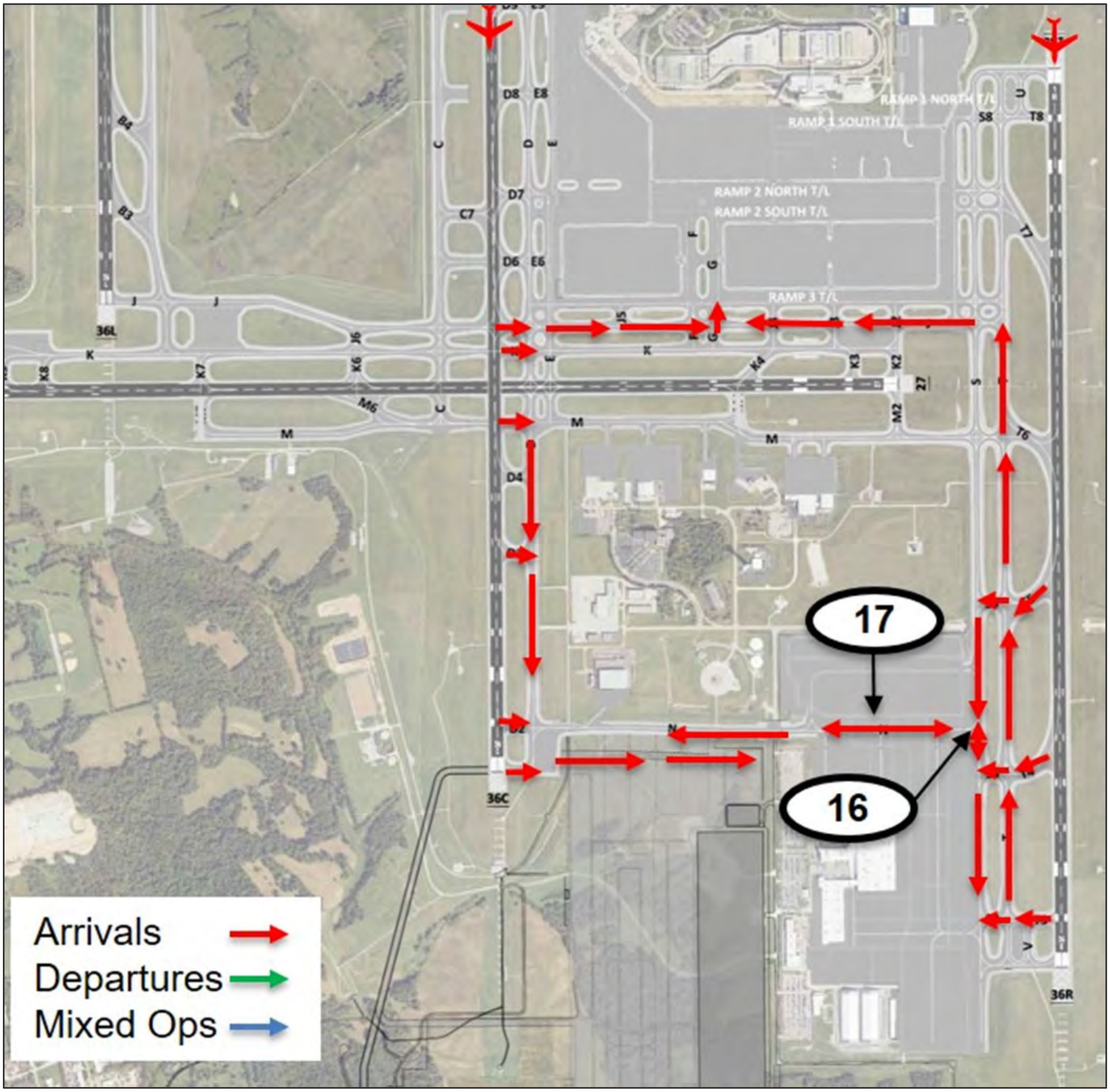
In addition to these conflicts, an issue was identified for Runway 18C operations. Runway 18C/36C's western parallel taxiway (Taxiway C) does not extend to the south of Runway 09/27. As a result, all arrivals on Runway 18C must exit to the east to reach the south cargo aprons. Allowing aircraft to exit to the west instead would reduce the amount of traffic on Taxiway D in South Flow.

EXHIBIT 4.2-26 SCENARIO 2 SOUTH FLOW DEPARTURES



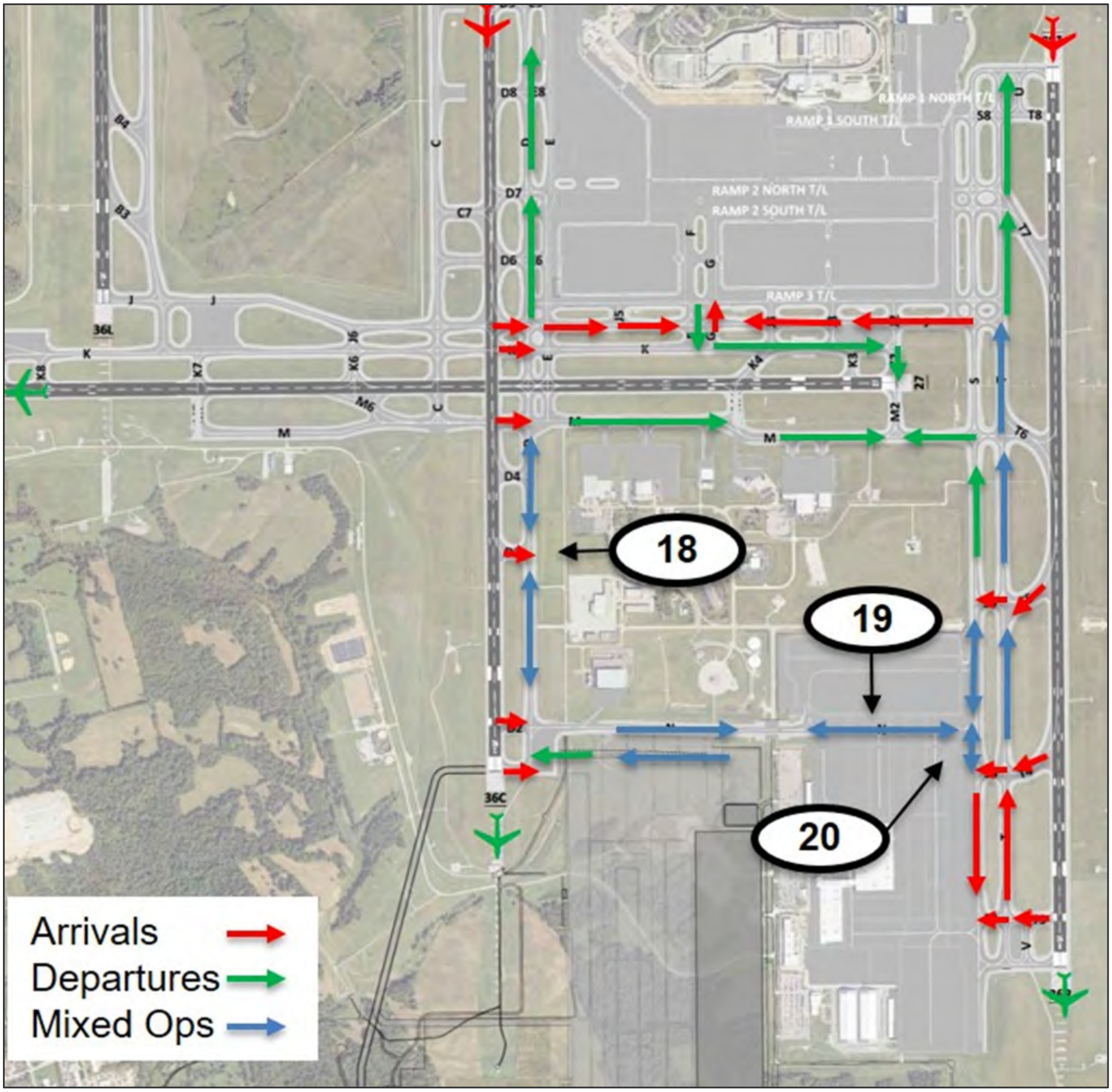
Sources: CVG officials; ATCT officials; Landrum & Brown analysis

EXHIBIT 4.2-27 SCENARIO 2 SOUTH FLOW ARRIVALS



Sources: CVG officials; ATCT officials; Landrum & Brown analysis

EXHIBIT 4.2-28 SCENARIO 2 SOUTH FLOW MIXED OPERATIONS



Sources: CVG officials; ATCT officials; Landrum & Brown analysis

4.2.4.6 *Taxi Flow Analysis – Runway 27 Arrivals*

In addition to the more common North and South Flows, the Runway 27 flow (which occurs when winds do not allow the use of the north/south runways) was evaluated for potential conflicts and inefficiencies. One such issue was identified related to Taxiway M. Runway 27 arrivals that exit past Taxiway M7 must exit to the north and cross Runway 27 to reach the cargo aprons because Taxiway M does not extend to the Runway 09 end. An extension to Taxiway M would allow those aircraft to exit to the south and avoid crossing the active runway. Runway crossings are important because they reduce runway capacity. However, Runway 27 arrivals are rare and will likely occur even less often in the future once Runway 18C/36C is used more frequently. Therefore, an extension of Taxiway M is not recommended unless it is needed to support aeronautical development south of Runway 09/27 and west of Runway 18C/36C.

4.2.4.7 *Taxiway Recommendations*

The following taxiway improvements are recommended for consideration in the alternatives analysis:

- Second eastern parallel taxiway for the east side of Runway 18C/36C, south of Runway 09/27
  - Allows arriving and departing traffic to be segregated, thereby reducing conflicts and delays
  - Provides queue space for Runway 36C departures
- Parallel taxilane for Taxilane N
  - Allows arriving and departing traffic to be segregated, thereby reducing conflicts and delays
- Additional connectors between Taxiways S and T at Taxilane N
  - Reduces conflicts on Taxiway S
- Parallel taxiway for west side of Runway 18C/36C, south of Runway 09/27
  - Allows Runway 18C arrivals to exit west

4.2.5 Airfield Design Standards

Ideally any airfield is designed in accordance with the current FAA guidelines and requirements at the time of construction. These guidelines will stipulate the runway and taxiway design standards, and assist with identifying any airfield constraints that require modification. The following sections present the airfield compliance and constraints at CVG based on FAA AC *150/5300-13A Change 1, Airport Design* and FAA AC *150/5000-17, Critical Aircraft and Regular Use Determination*.

Critical Aircraft

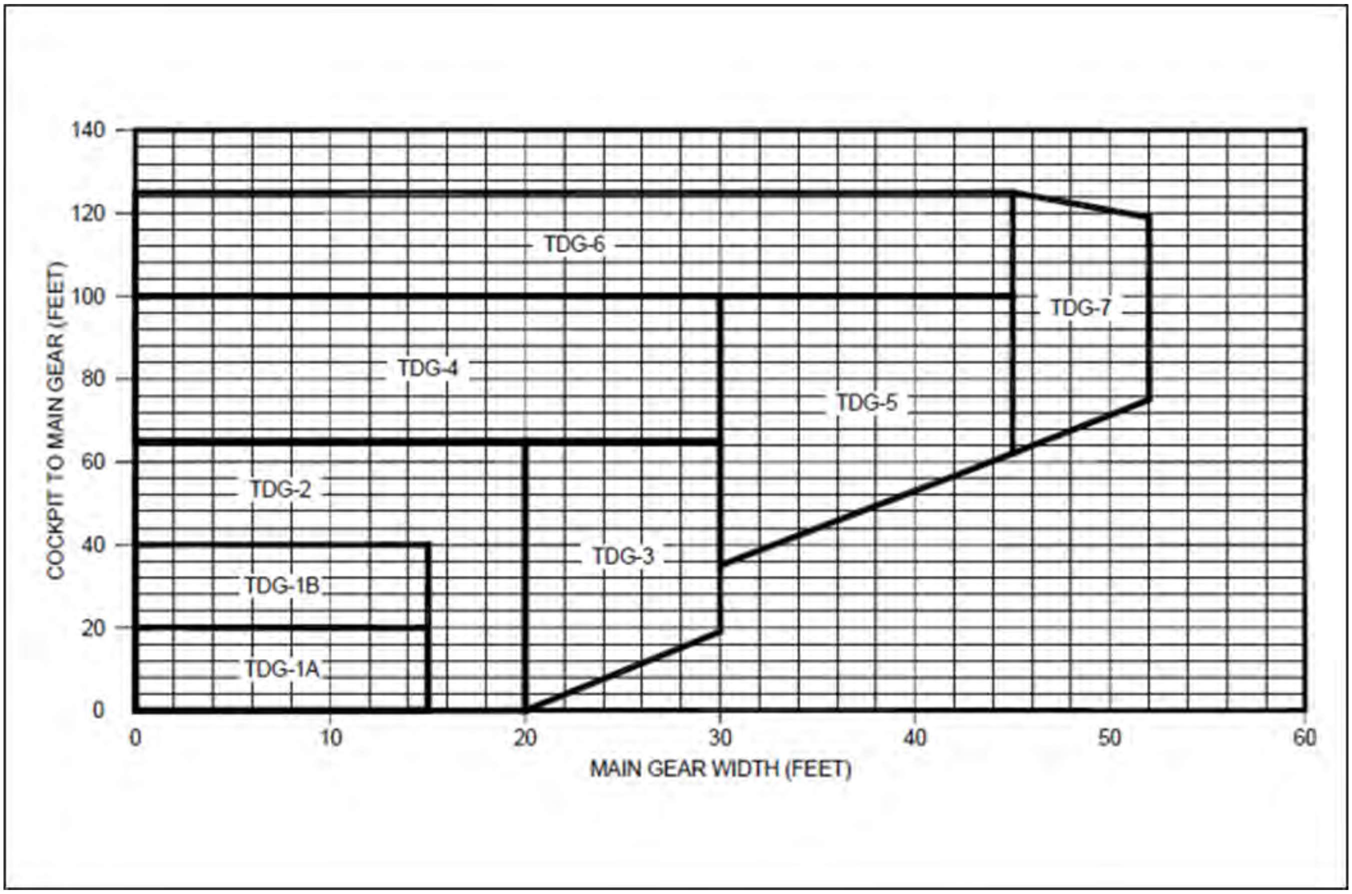
The specific set of guidelines to which an airfield is to comply is determined by the size and needs of the largest aircraft which operates at an airport, or the “critical aircraft.” FAA AC 150/5000-17, Critical Aircraft and Regular Use Determination, defines a critical aircraft as the most demanding aircraft type, or grouping of aircraft with similar characteristics, that make regular use of an airport. Regular use of an airport is defined as 500 annual operations, including both itinerant and local operations, but excluding touch-and-go operations. One landing is considered an operation, as is one takeoff.

FAA AC 150/5300-13A Change 1, Airport Design, uses a coding system to relate airport design criteria to the operational and physical characteristics of the critical aircraft at an airport. The FAA classifies critical aircraft by three parameters for the purpose of airport geometric design:

- **Aircraft Approach Category (AAC)**: classified according to aircraft approach speeds. See Chapter 2, Inventory of Existing Conditions, Section 2.3.2, *Existing Airport Reference Code*, for definitions of the AAC categories.
- **Airplane Design Group (ADG)**: defined by its wingspan and tail height, whichever is most restrictive. See Chapter 2, Inventory of Existing Conditions, Section 2.3.2, *Existing Airport Reference Code*, for definitions of the ADG categories.
- **Taxiway Design Group (TDG)**: based on the dimensions of the aircraft undercarriage. The determining factors are (1) the width of its main gear[9] and (2) the distance between the cockpit and the main gear.[10] **Exhibit 4.2-29, *TDG Chart***, shows how an aircraft’s dimensions (relating to its main gear) determine its TDG.

9 The distance from the outer edge to outer edge of the widest set of main gear tires.
10 The distance from the pilot’s eye to the main gear turn center.

EXHIBIT 4.2-29 TDG CHART



Source: FAA AC 150/5300-13A Change 1, Airport Design

The current Airport Layout Plan (ALP) for CVG identifies that the existing critical aircraft at CVG is the B747-400. This aircraft has an AAC of D, an ADG of V, and a TDG of 5. The existing Airport Reference Code (ARC), which is made up of the AAC and ADG, is therefore D-V . Since the last ALP was prepared, the B747-8, which has an AAC of D, ADG of VI, and a TDG of 6, has reached more than 500 operations by the cargo carriers at CVG. Because it was not previously identified as the critical aircraft, CVG has Modifications of Standards (MOS) and operational procedures in place which allow this aircraft to operate safely. Additional details on the MOS at CVG are found in a later subsection titled, Modifications of Standards. The operational restrictions are described in Section 2.3.5, *Taxiways*, of Chapter 2, Inventory of Existing Conditions. Looking into the Master Plan horizon, the B747-8 will continue to have greater than 500 operations through PAL 4, making it the future critical aircraft for the purposes of this Master Plan. The future ARC is therefore D-VI and the future TDG is 6. **Table 4.2-16, *Critical Aircraft Information***, summarizes the critical aircraft information.

TABLE 4.2-16 CRITICAL AIRCRAFT INFORMATION

FAA Parameter	ALP	Existing	PAL 4
Critical Aircraft	B747-400	B747-8	B747-8
AAC	D	D	D
ADG	V	VI	VI
ARC	D-V	D-VI	D-VI
TDG	5	6	6

Source: FAA AC 150/5000-17, Critical Aircraft and Regular Use Determination; FAA AC 150/5300-13A Change 1, *Airport Design*

The CVG airfield is for the most part designed for ARC D-V and TDG 5 aircraft, with some taxiways designed to ARC D-VI and TDG 6 standards, particularly to the south of Runway 09/27 in the areas where the B747-8 predominately operates. The designation of the CVG ARC as D-VI does not mean that CVG has to upgrade all of its airfield facilities to meet the higher standard. According to FAA AC 150/5000-17, *Critical Aircraft and Regular Use Determination,* "once the critical aircraft has been identified…. this should be reflected on the ALP as the Critical Aircraft regardless of whether the Airport meets that standard and regardless of whether the sponsor plans to reconfigure the Airport to meet the standard."

CVG officials do not intend to reconfigure the entire airfield to meet the higher standards of this aircraft as it would be cost prohibitive, disruptive, and unnecessary. A total of 4,212 B747-8 annual operations (three to four per day) are projected for PAL 4,[11] making up just 0.27 percent of total projected aircraft operations. With this low number of operations, MOS and operational restrictions can continue to be used to ensure that the B747-8 can operate safely at CVG. However, new taxiways should be designed to D-VI and TDG 6 standards if possible. Consideration should be given to upgrading existing airfield facilities only when such a change would have a sufficient Benefit/Cost Analysis (BCA) justification and minimal operational disruption.

4.2.5.2 *Compliance with Design Standards*

The following section presents the evaluation of the CVG runways and taxiways against FAA standards. This assessment was completed for the ADG V, ADG VI, TDG 5, and TDG 6 categories.

Runway Geometry

A runway width of 200 feet is required for D-VI aircraft whereas a width of 150 feet is needed for D-V aircraft. All of the runways at CVG are 150 feet wide, meeting D-V standards, but not D-VI. However, the International Civil Aviation Organization (ICAO) has recently published updated design standards with a reduction in runway width requirements for the largest aircraft (Code F, which corresponds to ADG VI). It is anticipated that the FAA will follow suit in the future, suggesting the width of the CVG runways could be compliant with D-VI standards. Therefore widening of the runways at CVG is not recommended at this time.

Runway to Parallel Taxiway Centerline Separation

Runway to parallel taxiway centerline separation requirements are determined by the ADG in combination with the visibility minima. If the visibility minimum is less than a half mile, the separation requirement increases. All of the runways at CVG have visibility minima that are less than a half mile on at least one runway end so the higher ADG separation requirement applies. In cases where reverse turns from a runway to a parallel taxiway are required, the separation requirement is determined by the TDG. **Table 4.2-17, *Runway to Parallel Taxiway Centerline Separation Requirements***, presents the runway to parallel taxiway centerline separation requirements.

TABLE 4.2-17 RUNWAY TO PARALLEL TAXIWAY CENTERLINE SEPARATION REQUIREMENTS

ADG	TDG	Runway-Taxiway Separation (ft)			
		ADG (Visibility >= ½ Mile)	ADG (Visibility < ½ Mile)	TDG (Minimum)	TDG (Recommended)
V	5	400	500	427	450
VI	6	500	550	584	600

Source: FAA AC 150/5300-13A, Change1, *Airport Design*

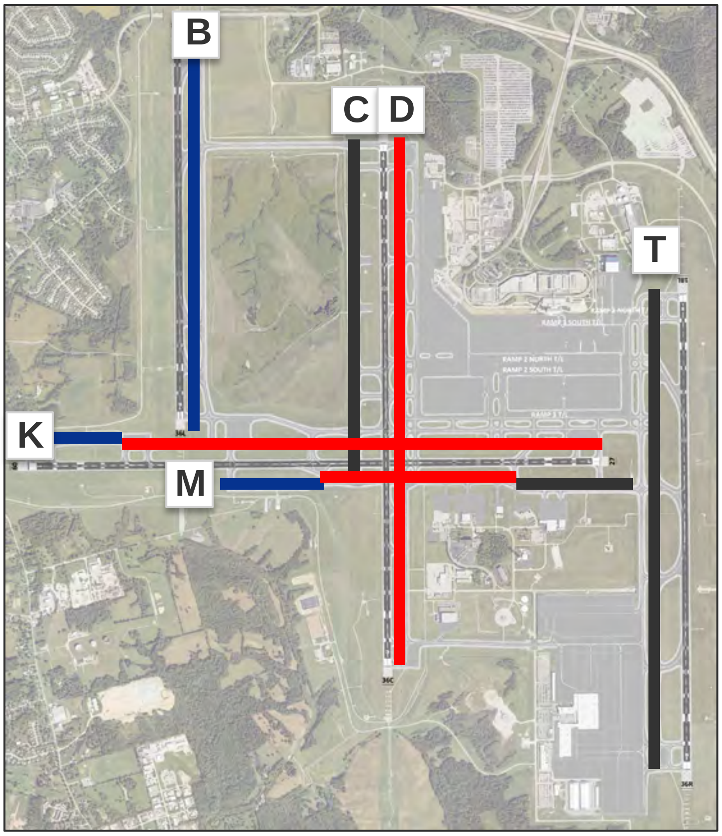
11 Appendix 1-B, *Alternative Forecasts*

Exhibit 4.2-30*, Existing Runway to Taxiway Centerline Separations*, presents a comparison of the CVG runway to taxiway centerline separations to the FAA requirement. Taxiways C, T, and the eastern portion of Taxiway M each have 600 feet of separation to their respective parallel runways, which meets ADG VI and TDG 6 standards. No changes are needed to these taxiways.

Taxiway B, the western portion of Taxiway K, and the western portion of Taxiway M each have 500 feet of separation to their parallel runways. These taxiways meet ADG V and TDG 5 requirements, but fall short of meeting ADG VI and TDG 6 requirements. Increasing these separations to meet TDG 6 standards is not recommended given the location of these sections of taxiway and the small likelihood of ADG VI operations occurring at these locations.

Taxiway D, the majority of Taxiway K, and the center portion of Taxiway M each have 400 feet of separation from their respective parallel runways. This width meets ADG V requirements for runways with visibility minima of greater than or equal to a half mile, but does not meet ADG V requirements for runways with visibility minima less than a half mile, ADG VI, TDG 5 or TDG 6 requirements. The alternatives analysis will analyze the desirability of upgrading the runway to parallel taxiway separations.

EXHIBIT 4.2-30 EXISTING RUNWAY TO TAXIWAY CENTERLINE SEPARATIONS



Runway – Taxiway	Existing Separation (ft)	Does the Existing Separation Meet Requirements for:			
		ADG V (< ½ mile)	TDG 5	ADG VI (< ½ mile)	TDG 6
18R/36L – B	500	Yes	Yes	No	No
18C/36C – C	600	Yes	Yes	Yes	Yes
18C/36C – D	400	No	No	No	No
18L/36R – T	600	Yes	Yes	Yes	Yes
09/27 – K (eastern portion)	400	No	No	No	No
09/27 – K (western portion)	500	Yes	Yes	No	No
09/27 – M (western portion)	500	Yes	Yes	No	No
09/27 – M (center portion)	400	No	No	No	No
09/27 – M (eastern portion)	600	Yes	Yes	Yes	Yes

ADG VI (< ½ mile) / TDG 6
ADG V (< ½ mile) / TDG 5
ADG V (>= ½ mile); no reverse turns for TDG 5 or 6

Sources: FAA AC 150/5300-13A, Change 1, *Airport Design;* Landrum & Brown analysis

Taxiway Pavement Geometry

The taxiway geometry at CVG was evaluated to identify the pavement geometrics that do not currently meet the FAA design parameters, are part of recent proposed airfield configuration changes, or are considered existing complex geometries. Observed non-standard pavement geometrics have initiated comments from multiple parties including the FAA Part 139 inspector. The following sections summarize the findings of a detailed airfield wide analysis performed by Master Plan Team member Butler, Fairman, & Seufert (BF&S). The complete report of their findings is presented in **Appendix 4-A, *Analysis of Pavement Geometrics, Marking and Signage***.

FAA AC 150/5300-13A, Change 1, *Airport Design,* is considered the design criteria for the airfield at CVG and was consulted during the evaluation of the airfield pavement. The majority of the airfield is designed for TDG 5 aircraft. A few locations were evaluated for a different critical aircraft group as depicted in **Exhibit 4.2-31, *Taxiway Restrictions.*** These locations are mainly the taxilanes surrounding the terminal and taxi routes to and from the DHL cargo apron. For the scope of this analysis, TDG 5 is the critical design aircraft, with the exception of specific taxiways as depicted. For example, there exist several approved MOS for the Boeing 747-8 aircraft, the sole TDG 6 aircraft regularly operating at CVG. These routes (identified in green) were evaluated to TDG 6 standards.

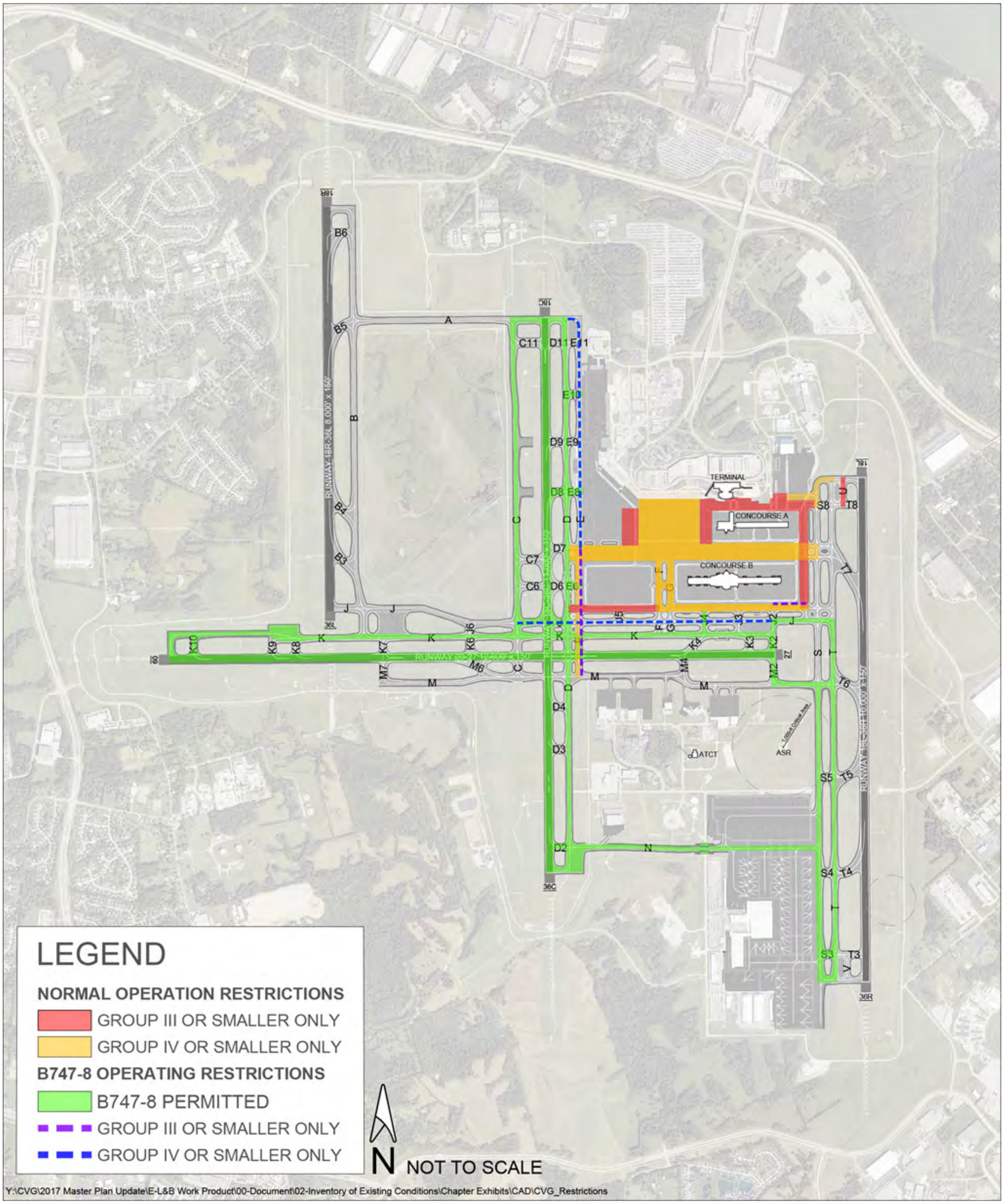
Findings from the complete analysis reveal that additional full strength pavement is required to meet geometric fillet standards in a significant number of locations across the airfield. Furthermore, it was determined during the analysis that several existing high speed exit taxiways are not within standard for true high-speed angled taxiway exits. It is recommended that these angled connectors be corrected to standard at the next best opportunity. **Exhibits 4.2-32, *Summary of Taxiway Pavement Geometry Improvements – East,*** and **Exhibit 4.2-33, *Summary of Taxiway Pavement Geometry Improvements – West***, present an airfield-wide summary of taxiway pavement geometry improvements that have been identified by this analysis.

Taxiway to Taxiway Centerline Separation

Taxiway to parallel taxiway/taxilane centerline separation requirements are determined by the ADG.[12] ADG V aircraft require 267 feet of spacing between taxiways while ADG VI aircraft require 324 feet. **Exhibit 4.2-34, *Existing Taxiway to Taxiway Centerline Separations***, presents a comparison of the CVG taxiway to taxiway/taxilane centerline separations to the FAA requirements. The centerline separation between Taxiway K and J (western portion) meets ADG VI standards but no other taxiways do. Reconfiguration of the taxiways to meet ADG VI standards is not recommended due to low expected usage. Taxiway K to J (eastern portion), and Taxiway T to S centerline separations meet ADG V standards. The Taxiway D to E centerline separation meets ADG V standards to the north of Taxiway D7 but does not to the south of Taxiway D7. The alternatives analysis will analyze the desirability of upgrading the separation between Taxiways D and E (south of Taxiway D7) to meet ADG V standards.

12 Taxiway to taxiway centerline separation requirements can also be determined by the TDG. However, the TDG requirement for TDG 5 and 6 aircraft is lower than the corresponding ADG requirement, therefore the ADG requirement was used.

EXHIBIT 4.2-31 TAXIWAY RESTRICTIONS

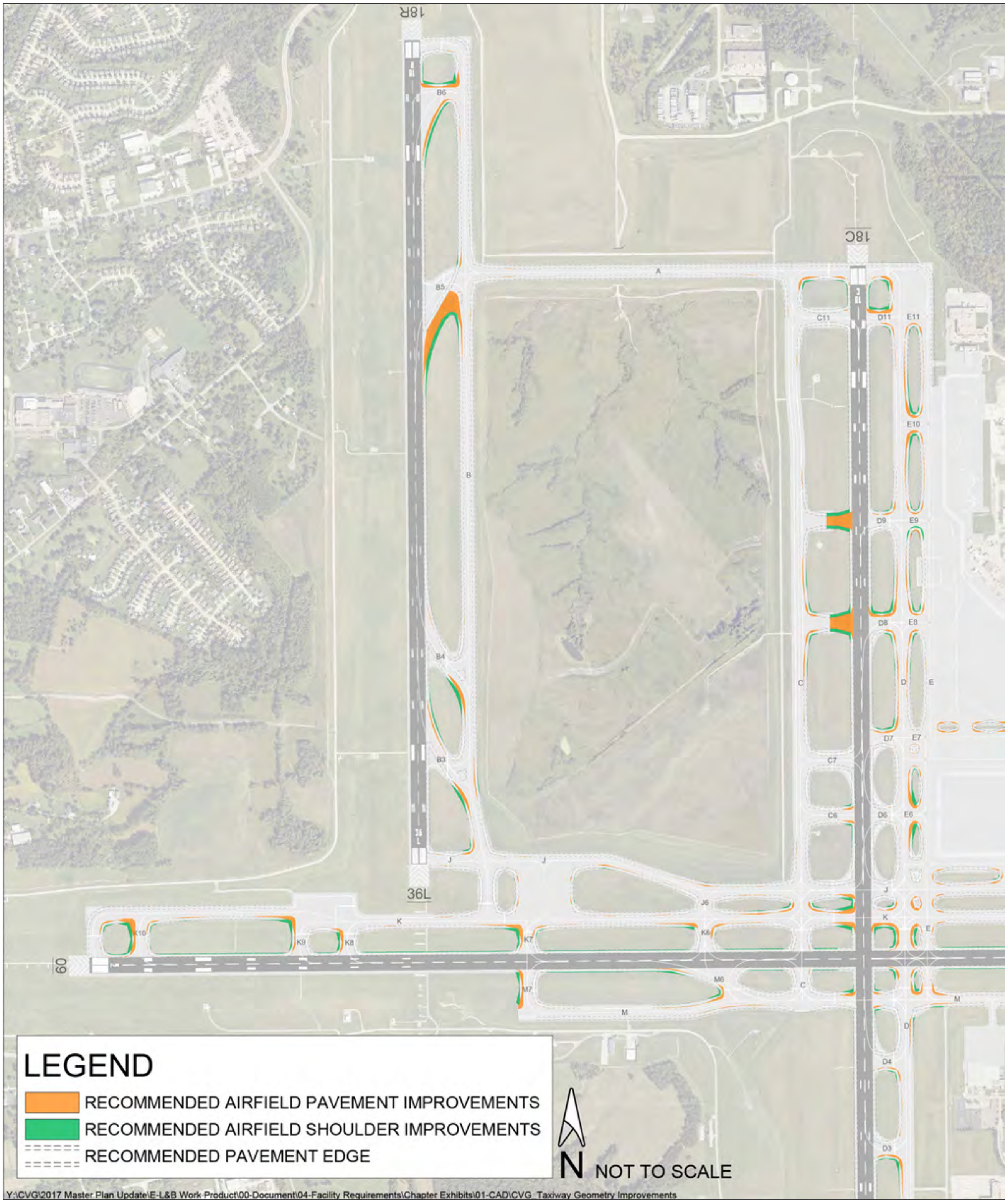


Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 4.2-32 SUMMARY OF TAXIWAY PAVEMENT GEOMETRY IMPROVEMENTS – EAST

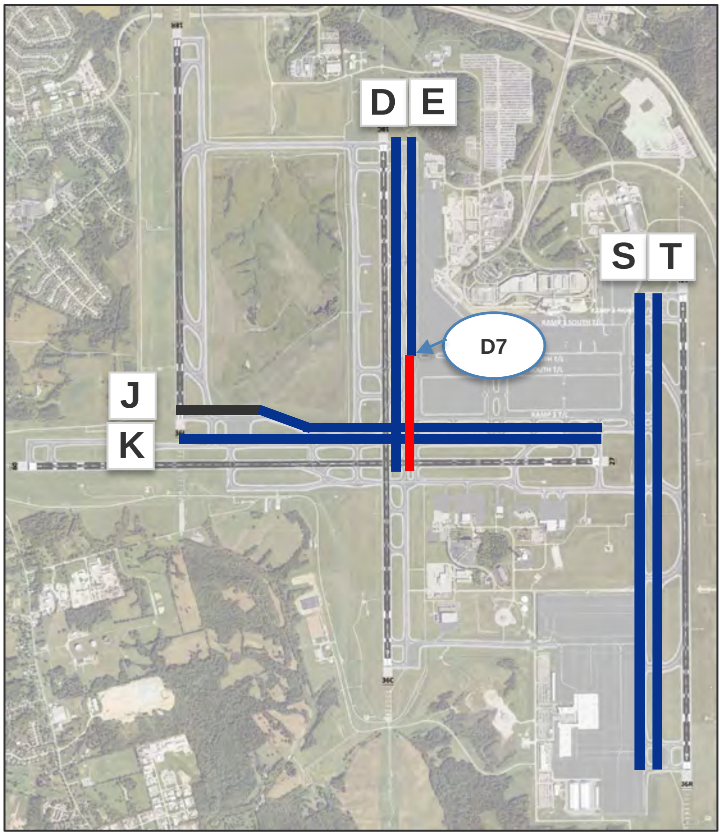
Sources: Woolpert Photography dated September 23, 2017; BF&S

EXHIBIT 4.2-33 SUMMARY OF TAXIWAY PAVEMENT GEOMETRY IMPROVEMENTS – WEST



Sources: Woolpert Photography dated September 23, 2017; BF&S

EXHIBIT 4.2-34 EXISTING TAXIWAY TO TAXIWAY CENTERLINE SEPARATIONS



Taxiway – Taxiway/Taxilane	Existing Separation (ft)	Does the Existing Separation Meet Requirements for:	
		ADG V	ADG VI
K – J (western portion) (09/27)	575	Yes	Yes
K – J (eastern portion (09/27)	270	Yes	No
D – E (North of D7) (18C/36C)	267	Yes	No
D – E (South of D7) (18C/36C)	215	No	No
T – S (18L/36R)	300	Yes	No

ADG VI
ADG V
ADG IV

Sources: FAA AC 150/5300-13A, Change 1, *Airport Design;* Landrum & Brown analysis

4.2.5.3 *Lighting and Navigational Aids (NAVAIDs)*

The level of instrumentation and lighting associated with a runway determines the minimum weather conditions in which an aircraft can safely and legally land. Obstacles in the area surrounding an airport also play a part in determining the approach minimums of a particular runway.

Instrument Approach Procedures

The runways at CVG are served by a variety of approaches utilizing both ground based and satellite-based approach systems. The type and level of accuracy of each approach will play a part in determining the ceiling and visibility minima. **Table 4.2-18, *CVG Approach Capabilities by Runway End***, presents a summary of the landing approaches at CVG by runway end, approach type, ceiling, and visibility minima. For approach procedures where the minima vary by aircraft type operating, the data listed are for approach category D aircraft, which is the largest category listed on the FAA approach charts at CVG.

All runways have a conventional ILS system in place with at least CAT I capabilities. Additionally, Runways 18R and 36L offer CAT II ILS approach procedures, and Runways 36R and 36C offer CAT III ILS approach procedures. Given the level of service provided by the existing approach procedures at CVG, no upgrades or improvements to the NAVAIDs are necessary through the planning period. It is envisioned that over the long-term the approach procedures will be modernized to rely more heavily on satellite based navigational systems in line with the FAA's NextGen strategy.

TABLE 4.2-18 CVG APPROACH CAPABILITIES BY RUNWAY END

Runway End	Type of Approach[1]	Ceiling (ft)	Visibility Minimum[2]
09	ILS CAT I	**200**	**18 RVR**
	RNAV (GPS) Y- LPV	**200**	**18 RVR**
	RNAV (GPS) Z- RNP 0.18	316	24 RVR
	LOC	337	40 RVR
	RNAV (GPS) Z- RNP 0.30	350	40 RVR
	RNAV (GPS) Y-LNAV MDA	377	50 RVR
	RNAV (GPS) Y- LNAV/VNAV	414	50 RVR
27	ILS CAT I	**200**	**24 RVR**
	RNAV (GPS) Y-LPV	200	24 RVR
	RNAV (RNP) Z- RNP 0.15	421	50 RVR
	RNAV (GPS) Y- LNAV/VNAV	474	60 RVR
	RNAV (RNP) Z- RNP 0.23	503	60 RVR
	RNAV (GPS) Y- LNAV MDA	545	60 RVR
	LOC	545	60 RVR
	RNAV (RNP) Z- RNP 0.30	570	1 ½ miles
18L	ILS CAT I	**200**	**18 RVR**
	RNAV (GPS) Y- LPV	**200**	**18 RVR**
	RNAV (RNP) Z- RNP 0.21	383	40 RVR
	RNAV (RNP) Z- RNP 0.25	394	50 RVR
	LOC	411	40 RVR
	RNAV (GPS) Y- LNAV MDA	471	50 RVR
	RNAV (GPS) Y- LNAV/VNAV	506	60 RVR
	RNAV (RNP) Z- RNP 0.30	583	1 ½ miles
36R	ILS CAT III a/b/c	**0/0/0**	**7/6/0 RVR**
	ILS CAT II	100	12 RVR
	ILS CAT I	200	18 RVR
	RNAV (GPS) Y- LPV	200	18 RVR
	RNAV (RNP) Z- RNP 0.16	388	40 RVR
	RNAV (RNP) Z- RNP 0.20	399	50 RVR
	RNAV (RNP) Z- RNP 0.30	433	50 RVR
	RNAV (GPS) Y- LNAV/VNAV	444	50 RVR
	LOC	464	50 RVR
	RNAV (GPS) Y- LNAV MDA	464	50 RVR
18C	ILS CAT I	**200**	**18 RVR**
	RNAV (GPS) Y- LPV	**200**	**18 RVR**
	LOC	385	40 RVR
	RNAV (RNP) Z- RNP 0.15	446	50 RVR
	RNAV (GPS) Y- LNAV MDA	485	50 RVR
	RNAV (RNP) Z- RNP 0.30	514	60 RVR

Runway End	Type of Approach[1]	Ceiling (ft)	Visibility Minimum[2]
	RNAV (GPS) Y- LNAV/VNAV	523	60 RVR
36 C	ILS CAT III a/b/c	**0/0/0**	**7/6/0 RVR**
	ILS CAT II	100	12 RVR
	ILS CAT I	200	18 RVR
	RNAV (GPS) Y- LPV	200	18 RVR
	LOC- TABBO FIX	409	40 RVR
	RNAV (RNP) Z- RNP 0.24	444	50 RVR
	RNAV (RNP) Z- RNP 0.30	467	60 RVR
	LOC	489	50 RVR
	RNAV (GPS) Y- LNAV/VNAV	549	60 RVR
	RNAV (GPS) Y- LNAV MDA	664	2 miles
18R	ILS CAT II	**100**	**12 RVR**
	ILS CAT I	200	18 RVR
	RNAV (GPS) Y- LPV	200	18 RVR
	RNAV (RNP) Z- RNP 0.29	375	40 RVR
	RNAV (RNP) Z- RNP 0.30	413	50 RVR
	LOC	432	50 RVR
	RNAV (GPS) Y- LNAV MDA	452	50 RVR
	RNAV (GPS) Y- LNAV/VNAV	453	50 RVR
36L	ILS CAT II	**100**	**12 RVR**
	ILS CAT I	200	18 RVR
	RNAV (GPS) Y- LPV	200	18 RVR
	LOC- JIMUR FIX	347	30 RVR
	RNAV (RNP) Z- RNP 0.29	388	40 RVR
	RNAV (RNP) Z- RNP 0.30	391	50 RVR
	RNAV (GPS) Y- LNAV MDA	427	50 RVR
	RNAV (GPS) Y- LNAV/VNAV	510	60 RVR
	LOC	567	60 RVR

[1] The most critical type of approach and minimums are bolded for each runway end.
[2] Visibility is depicted in Runway Visual Range (RVR) or miles depending on how it is listed in the FAA chart.
Source: *FAA Digital Terminal Procedures Publication (d-TPP)/Airport Diagrams*, May 24, 2018 through June 21, 2018; Landrum & Brown analysis

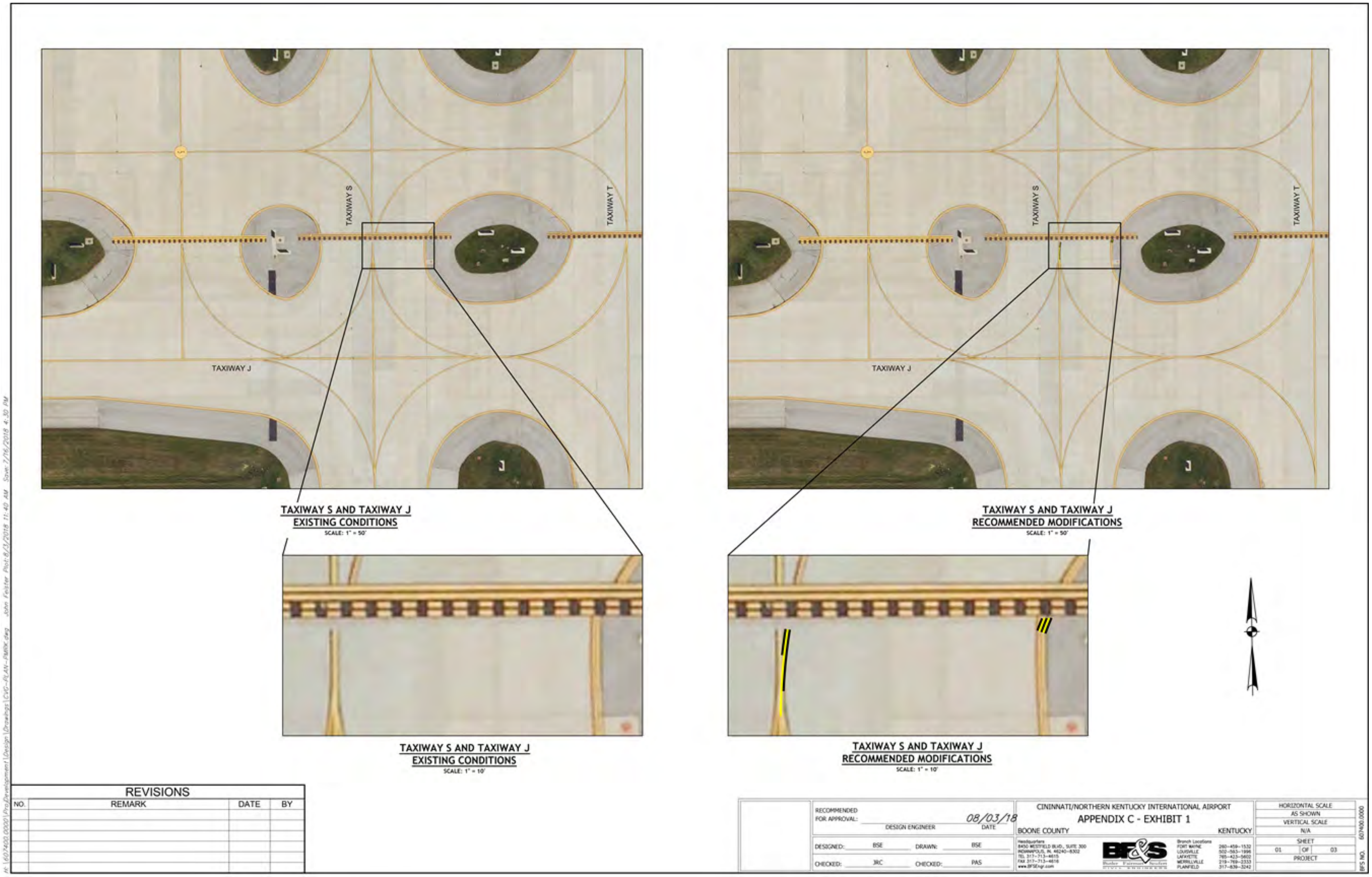
Airfield Signage and Pavement Markings

For the consideration of existing non-standard airfield markings and signage with current pavement geometry, five specific locations on the airfield at CVG were identified as being non-standard:

- The taxiway edge lines do not match on either side of the approach hold bar to Runway 27 on Taxiway S north of the intersection with Taxiway J.
- The taxiway centerline on the southeast radius from Taxiway T to Taxiway S does not continue south of the approach hold bar to Runway 27 on Taxiway S north of the intersection with Taxiway J.
- At Taxiway K3 there are two enhanced taxiway centerlines that merge at the runway hold bar, but only one taxiway centerline continues on the other side of hold bar.
- The eastern side of the Taxiway M intersection with Runway 18C/36C has only one mandatory hold position sign.
- Pilots are missing the turn off onto Taxiway M when landing on Runway 18C.

A detailed report of the Airfield Signage and Pavement Marking findings has been included in Appendix 4-A. **Exhibits 4.2-35 through 4.2-37** present the existing conditions and the proposed corrections required to bring the marking and signage to standard. These corrections assume no change to pavement geometry.

EXHIBIT 4.2-35 TAXIWAYS S AND J

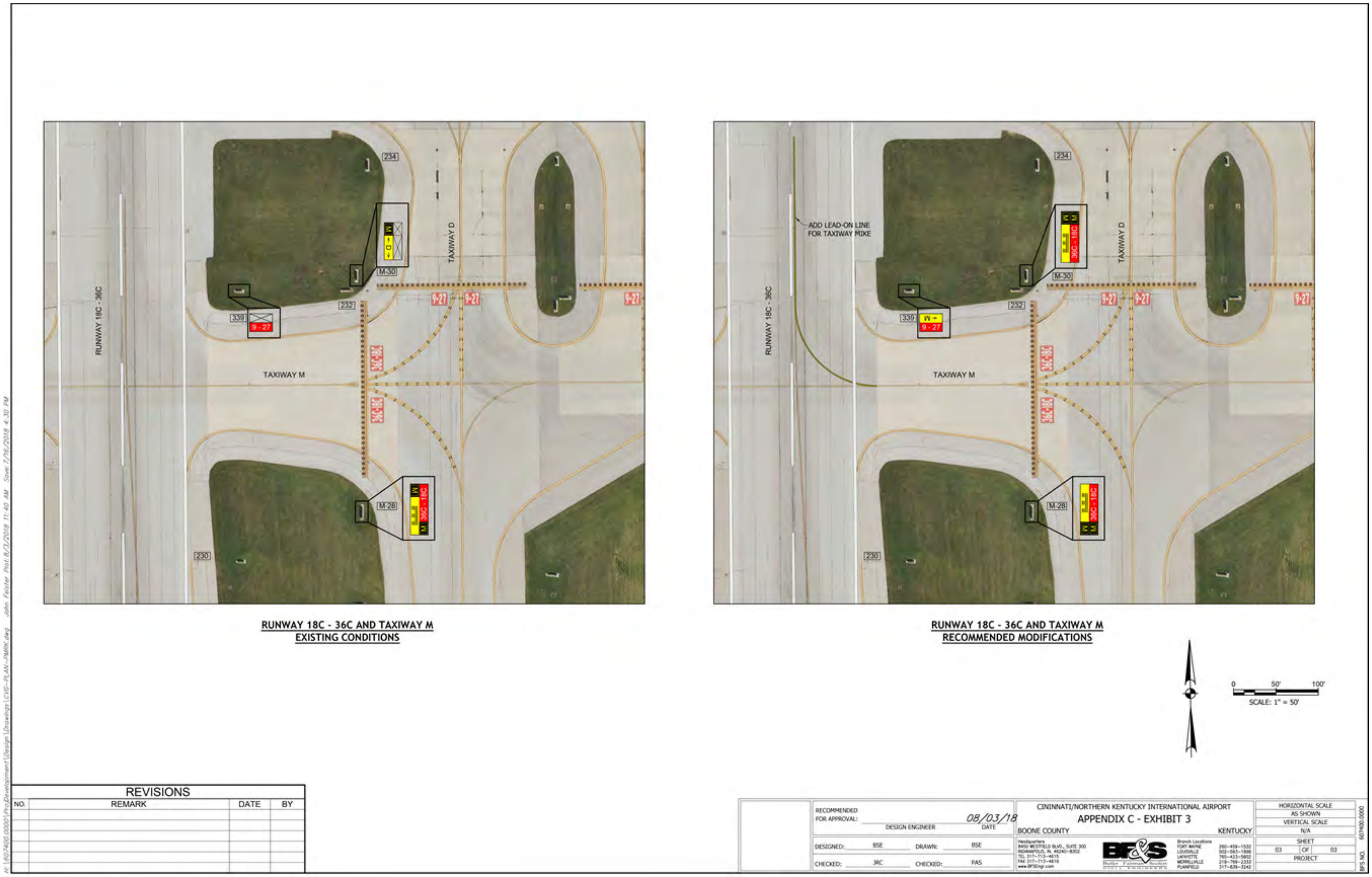


Source: BF&S

EXHIBIT 4.2-36 TAXIWAY M AT RUNWAY 09/27

Source: BF&S

EXHIBIT 4.2-37 TAXIWAY M AT RUNWAY 18C/36C



Source: BF&S

4.2.5.4 *Airfield Safety Areas*

There are three primary safety areas that provide for the safety of aircraft arriving and departing from the runways at an airport. These safety areas include the Runway Protection Zone (RPZ), Runway Safety Area (RSA), and Runway Object Free Area (ROFA). The FAA prescribes the criteria to which each safety area must be maintained clear and what uses/objects are and are not allowed to exist within each. The following subsections evaluate each at CVG.

Runway Protection Zones (RPZ)

The RPZ's function is to enhance the protection of people and property on the ground. This is best achieved through airport owner control over RPZs. Control is preferably exercised through the acquisition of sufficient property interest in the RPZ and includes clearing the RPZ areas (and maintaining them clear) of incompatible objects and activities.[13]

For the purposes of this analysis, the evaluation of the RPZs were broken into two segments, the central portion of the RPZ and the outer portion of the RPZ. The reason for this segmentation was to identify the incompatibilities that affect the more critical central portion of the RPZ versus those found in the outer portion of the RPZ. The following section is simply meant to identify incompatibilities that exist within each portion the RPZ, not that mitigation is immediately required. It is advisable for CVG to address any incompatibilities if/when the opportunity arises.

Of the eight RPZs at CVG (one for each runway end), five are completely on Airport property. These are the RPZ at the ends of Runways 27, 36L, 18C, 36C, and 36R. Of the remaining three RPZs, at least a small portion of each occupies land which is not currently owned or controlled by CVG. Accordingly, in the future CVG should make every effort to purchase/control in some way any property or right-of-way identified within the RPZ as it becomes available. In the following sections and exhibits, airport service roadways that are within the Airport Operations Area (AOA) fence line are not identified as they are considered an allowable land-use within an RPZ because they exist within a controlled environment.

Runway 09

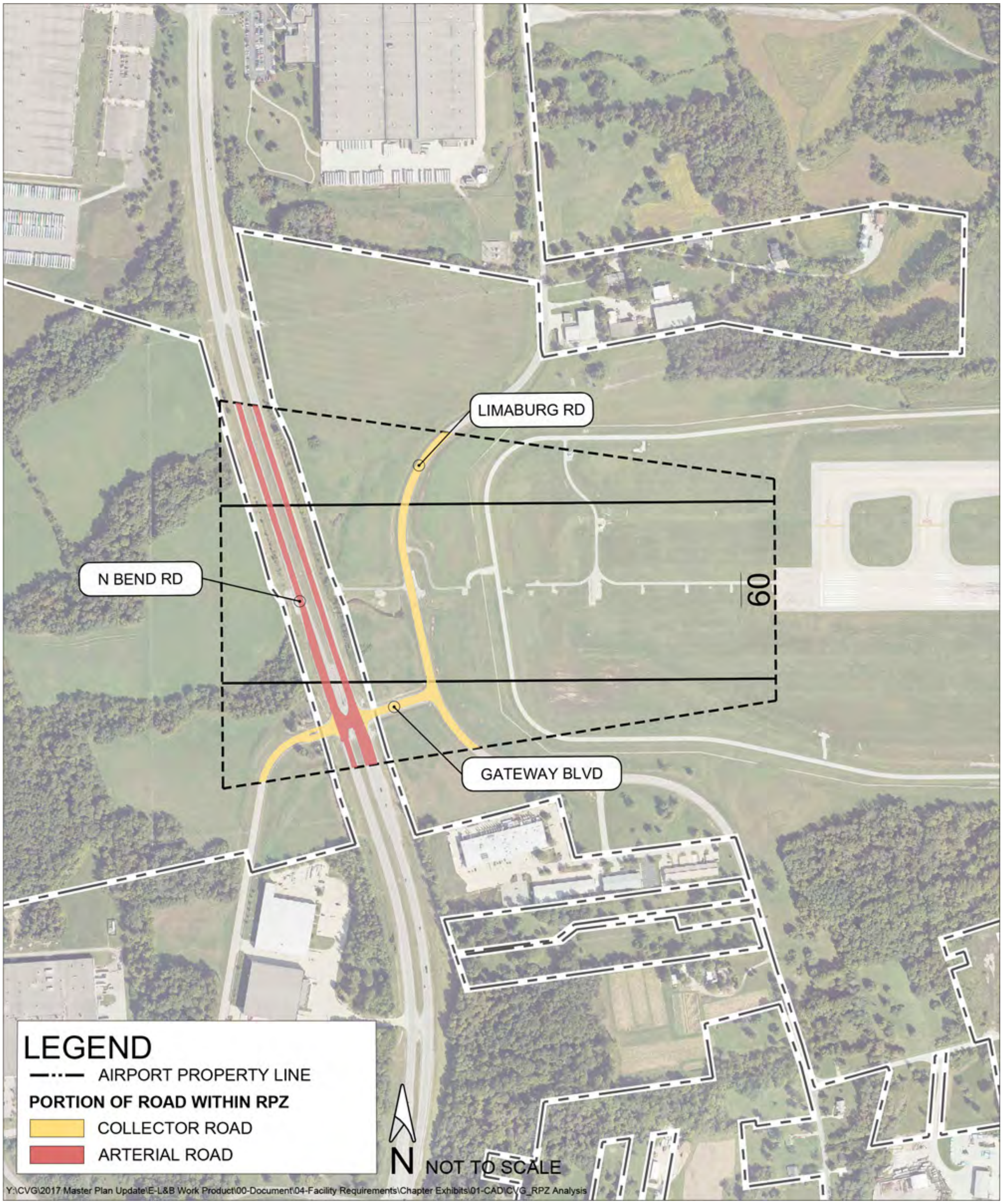
With the exception of three public access roadways, the RPZ on the Runway 09 end is compatible with RPZ guidance and mostly under the control of CVG. The three roadways are:

- Limaburg Road
- North Bend Road
- Gateway Boulevard

Limaburg Road and North Bend Road cross both the central and outer portions of the RPZ. Gateway Boulevard only lies within the outer portion along the southern side of the RPZ. **Exhibit 4.2-38, *Runway 09 RPZ***, depicts the incompatibilities within the Runway 09 RPZ.

13 FAA AC 150/5300-13A, *Airport Design*, paragraph 310.

EXHIBIT 4.2-38 RUNWAY 09 RPZ



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Runway 27

The entirety of the Runway 27 RPZ lies within CVG property boundary and within the secure perimeter of the airfield. Therefore, there are no incompatible land uses within the Runway 27 RPZ. **Exhibit 4.2-39, *Runway 27 RPZ***, depicts the boundaries of the Runway 27 RPZ.

Runway 18R

The majority of the Runway 18R RPZ is under the control of CVG. This equates to 85 percent of the central portion and 71 percent of the outer portions of the RPZ being Airport owned land. The remainder of the RPZ accommodates the following land uses:

- I-275
- Petersburg Rd
- Elijah Creek Rd

In addition to the three public-use roadways mentioned, one industrial building currently exists within the RPZ. This building, which is identified on **Exhibit 4.2-40, *Runway 18R RPZ***, lies approximately 2,600 feet north/northwest of the Runway 18R arrival threshold.

Runway 36L

The Runway 36L RPZ lies completely within the CVG property boundary and is therefore 100 percent under control of CVG. The only exception to the compliance of this RPZ is the section of Youell Road that crosses the RPZ approximately 2,300 feet from the Runway 36L arrival threshold. The location and limits of the Runway 36L RPZ are depicted on **Exhibit 4.2-41, *Runway 36L RPZ***.

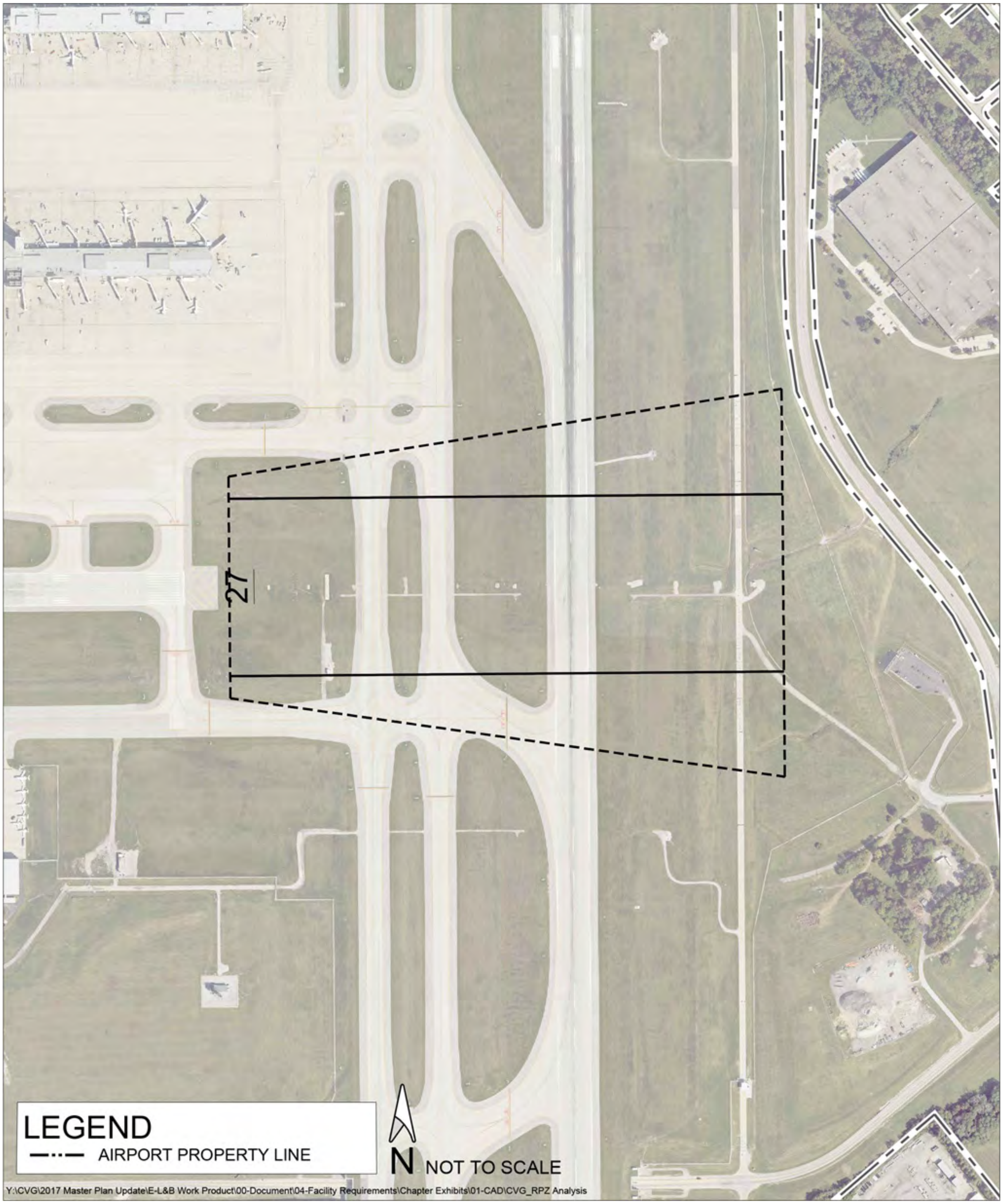
Runway 18C

The Runway 18C RPZ lies completely within CVG property boundary and is therefore 100 percent under the control of CVG. The only exception to the compliance of this RPZ is the section of Loomis Road that crosses the RPZ approximately 1,500 feet from the Runway 18C arrival threshold. The location and limits of the Runway 18C RPZ are depicted on **Exhibit 4.2-42, *Runway 18C RPZ***. In addition to the section of Loomis Road that crosses the RPZ, the Glycol Storage Building is located within the Runway 18C RPZ.

Runway 36C

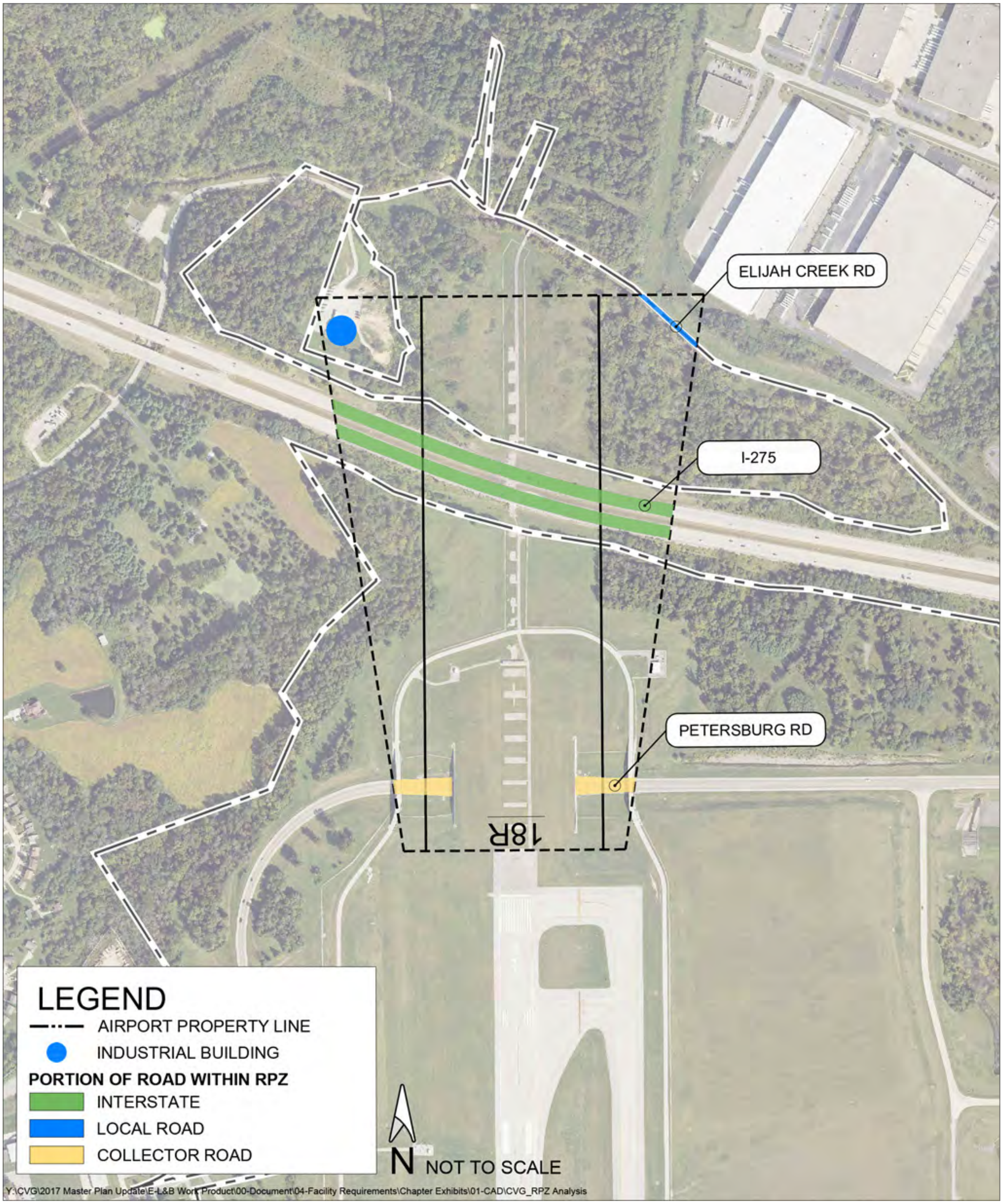
The Runway 36C RPZ lies completely within the CVG property boundary and is therefore 100 percent under the control of CVG. The only exception to the compliance of this RPZ is the section of landside service road that crosses the RPZ approximately 1,300 feet from the Runway 36C arrival threshold. While this roadway is exterior to the AOA perimeter fence, CVG does maintain access control to this service road which is not available for use by the public. Therefore, this roadway is considered an allowable land-use. The location and limits of the Runway 36C RPZ are depicted on **Exhibit 4.2-43*, Runway 36C RPZ***.

EXHIBIT 4.2-39 RUNWAY 27 RPZ



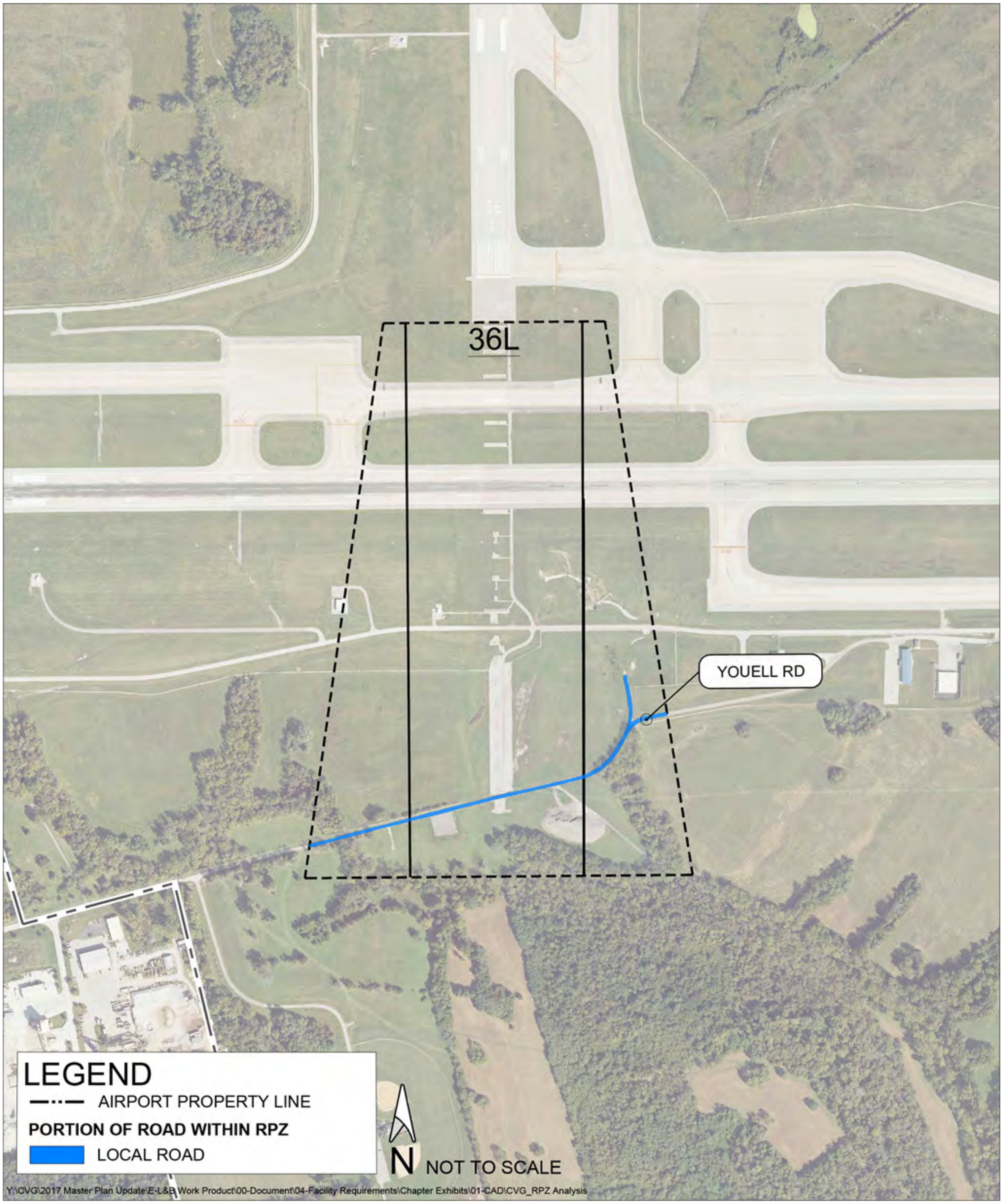
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 4.2-40 RUNWAY 18R RPZ



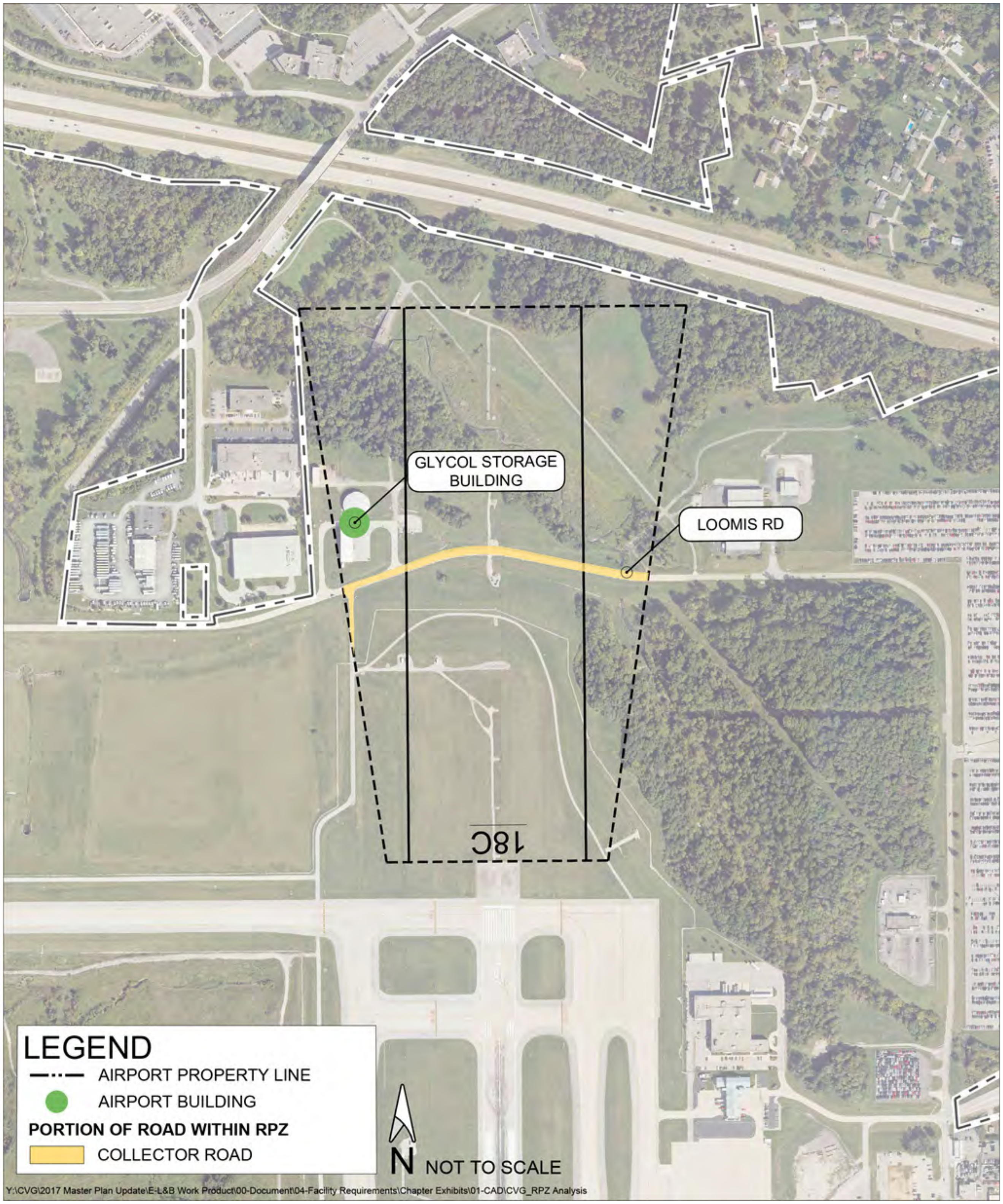
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 4.2-41 RUNWAY 36L RPZ



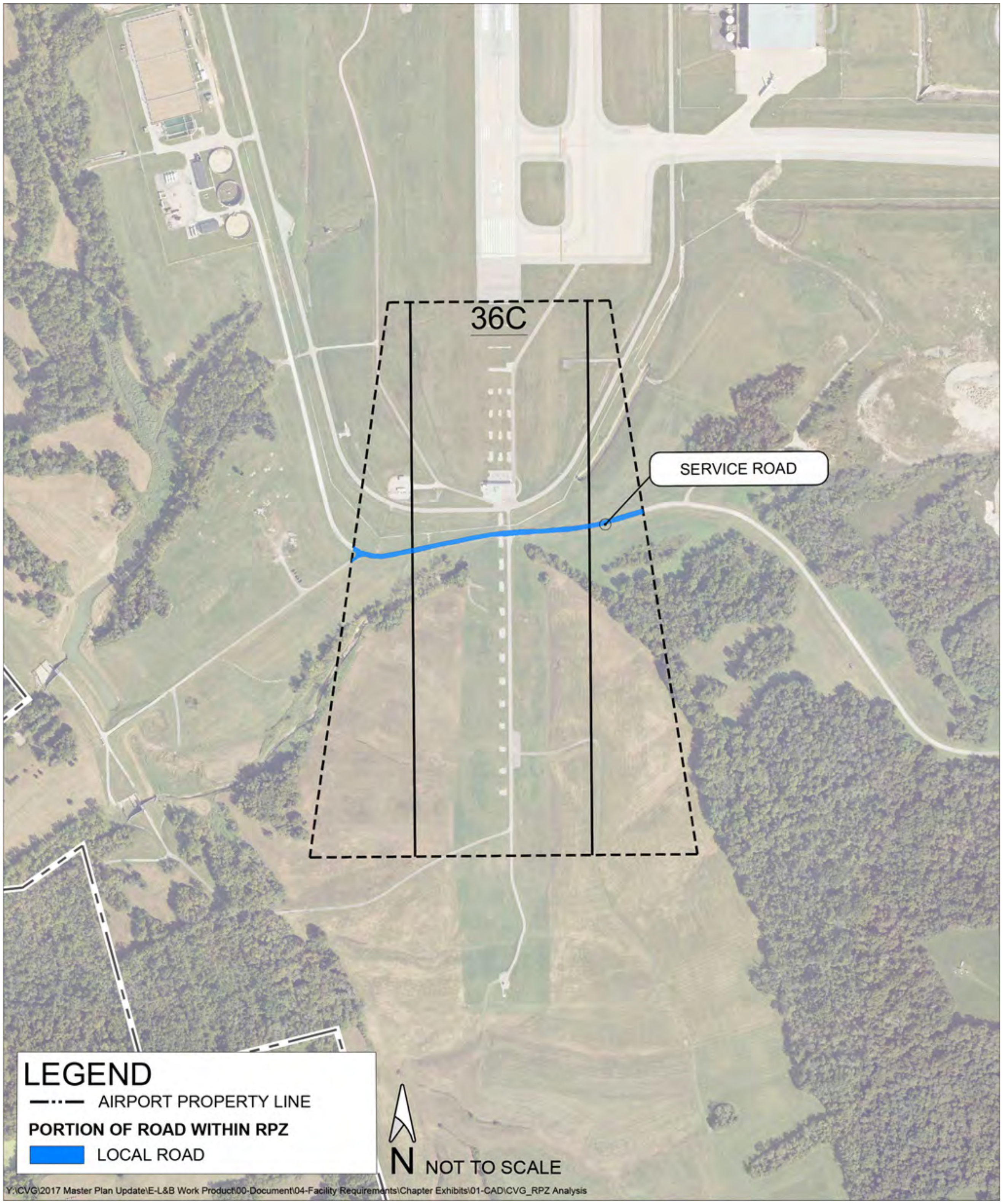
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 4.2-42 RUNWAY 18C RPZ



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 4.2-43 RUNWAY 36C RPZ



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Runway 18L

The majority of the Runway 18L RPZ is under the control of CVG. This equates to 92 percent of the central portion and 83 percent of the outer portions of the RPZ being airport owned land. The remainder of the RPZ accommodates the right-of-ways for the following public roadways:

- I-275
- Donaldson Highway
- Parking Entrance Road (Employee/Economy Lot)

The location and limits of the Runway 18L RPZ are identified on **Exhibit 4.2-44, *Runway 18L RPZ*.**

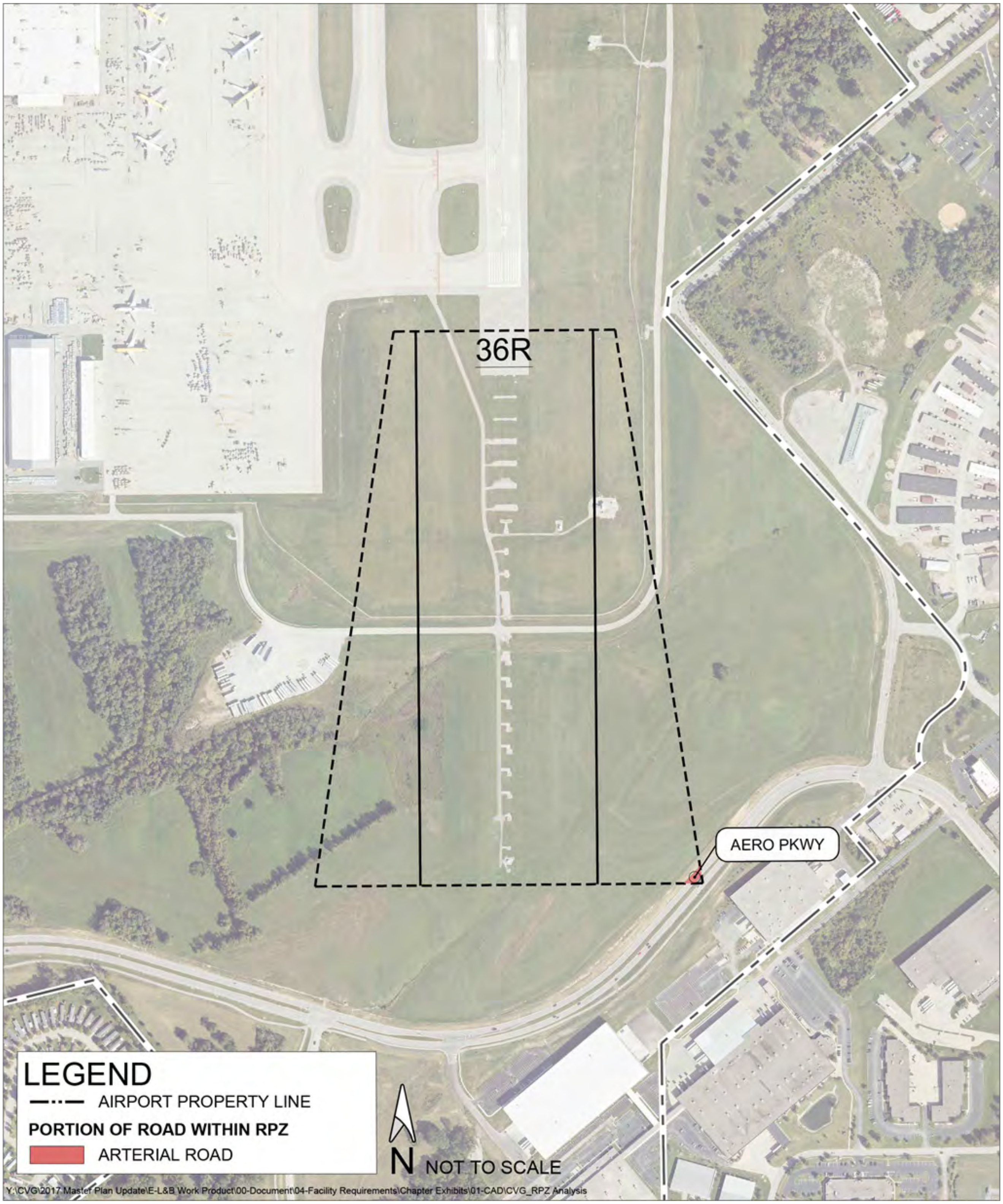
Runway 36R

The Runway 36R RPZ lies completely within the CVG property boundary and is therefore 100 percent under the control of CVG. The only exception to the compliance of this RPZ is a small section of Aero Parkway that clips the southeastern corner of the RPZ. The location and limits of the Runway 36R RPZ are depicted on **Exhibit 4.2 45, *Runway 36R RPZ***.

EXHIBIT 4.2-44 RUNWAY 18L RPZ

Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 4.2-45 RUNWAY 36R RPZ



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

RPZ Summary

Table 4.2-19, *RPZ Land Ownership*, and **Table 4.2-20, *Roadways in RPZs***, present a summary comparison of the RPZs at CVG.

TABLE 4.2-19 RPZ LAND OWNERSHIP

Runway End	Central RPZ		Outer RPZ	
	Owned by Airport	Not Owned by Airport	Owned by Airport	Not Owned by Airport
Runway 09	89%	11%	84%	16%
Runway 27	100%	0%	100%	0%
Runway 18R	85%	15%	71%	29%
Runway 36L	100%	0%	100%	0%
Runway 18C	100%	0%	100%	0%
Runway 36C	100%	0%	100%	0%
Runway 18L	92%	8%	83%	17%
Runway 36R	100%	0%	100%	0%

Source: Landrum & Brown analysis

TABLE 4.2-20 ROADWAYS IN RPZS

Runway End	Central RPZ				Outer RPZ			
	Interstate (LF)	Local Rd (LF)	Collector Rd (LF)	Arterial Rd (LF)	Interstate (LF)	Local Rd (LF)	Collector Rd (LF)	Arterial Rd (LF)
Runway 09	-	-	814	838	-	-	1531	879
Runway 27	-	-	243	-	-	-	-	-
Runway 18R	841	0	753	-	753	335	288	-
Runway 36L	-	809	-	-	-	1196	-	-
Runway 18C	-	0	820	-	-	-	844	-
Runway 36C	-	809	-	-	-	580	-	-
Runway 18L	-	249	1041	-	288	-	856	-
Runway 36R	-	-	-	-	-	-	-	75

Notes: LF = Linear Feet
Airport Service Roads are not considered incompatible land uses and therefore are not included in this table.
Source: Landrum & Brown analysis

RSAs and ROFAs

FAA AC 150/5300-13A Change 1, *Airport Design*, prescribes the geometric standards for RSAs and ROFAs at airports in the U.S. Based on the capabilities of the runways at CVG, the RSA width should be 250 feet from each side of the runway centerline and have a length that is at least 600 feet prior to the arrival threshold and 1,000 feet beyond the far end of the runway. The ROFA should have a width of 400 feet from each side of the runway centerline and a length equal to that of the RSA.

While the RSAs and ROFAs at CVG are dimensionally compliant, there are several instances of incompatible object(s) within each of these safety areas. Mitigation of these objects may be achievable through one or a combination of operational restrictions, frangible mounting, or removal. In the instances where removal may be necessary, CVG should evaluate the feasibility of doing so during the next upgrade or modification to the respective runway. NAVAIDS typically should not be in the RSA and ROFA, unless they are required to be in a specific location in order to function or “fixed-by-function”.[14]

Runway 09/27

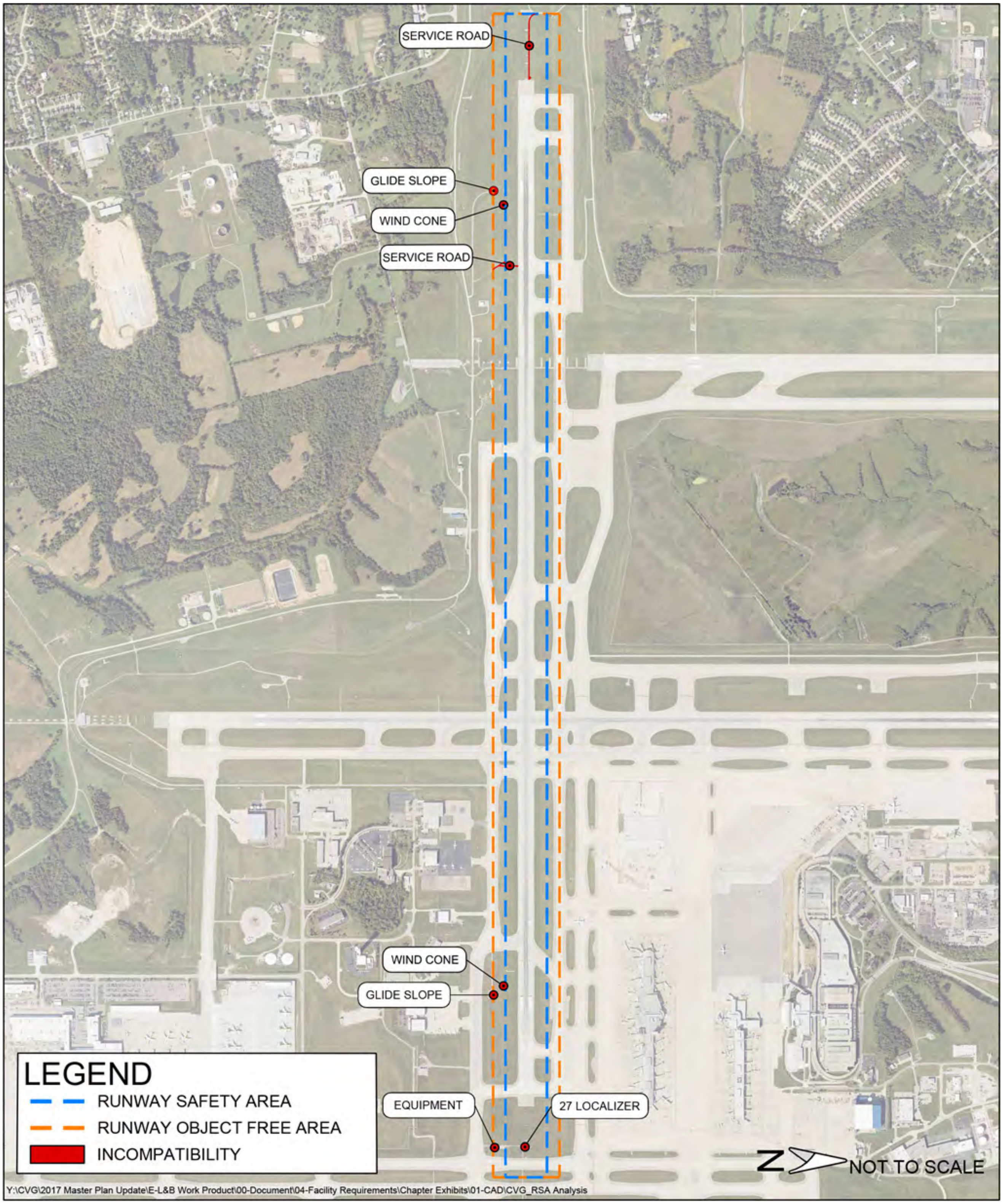
While Runway 09/27 has a standard dimension RSA and ROFA, there are several instances of incompatible objects within these safety areas. **Exhibit 4.2-46, *Runway 09/27 RSA & ROFA***, identifies the location of the following objects within the Runway 09/27 RSA and ROFA:

- Two service roads – these service roads have restricted access and are mitigated via operational restrictions. (RSA and ROFA)
- Two Glide slopes (ROFA only)
- Two wind cones (ROFA only)
- Runway 27 localizer – The location of Taxiway S forces the localizer antenna to be within the Runway 27 end RSA. Relocation of this NAVAID is not possible and therefore has a frangible mounting. (RSA and ROFA)
- Equipment shack (ROFA only)

In the case of Runway 09/27, all identified objects and service roads should be mitigated through continued controlled access/coordination with the ATCT, and frangible mounting.

[14] FAA, AC 150/5300-13A, Change 1, *Airport Design*, Paragraph 605a.

EXHIBIT 4.2-46 RUNWAY 09/27 RSA & ROFA



Source: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Runway 18R/36L

While Runway 18R/36L has a standard dimension RSA and ROFA, there are several instances of incompatible objects within these safety areas. **Exhibit 4.2-47, *Runway 18R/36L RSA & ROFA***, identifies the location of the following objects within the Runway 18R/36L RSA and ROFA:

- Two wind cones (RSA and ROFA)
- Three airport service roads – these service roads have restricted access and are mitigated via operational restrictions. (RSA and ROFA)
- Glide slope (ROFA only)

In the case of Runway 18R/36L, all identified objects and service roads should be mitigated through continued controlled access/coordination with the ATCT, and frangible mounting.

Runway 18C/36C

While Runway 18C/36C has a standard dimension RSA and ROFA, there are several instances of incompatible objects within these safety areas. **Exhibit 4.2-48**, Runway 18C/36C RSA & ROFA, identifies the location of the following objects within the Runway 18C/36C RSA and ROFA:

- Two wind cones (RSA and ROFA)
- Three airport service roads – these service roads have restricted access and are mitigated via operational restrictions. (RSA and ROFA)
- Two airport roads (ROFA only) – these roads have restricted access and are mitigated via operational restrictions.
- Two glide slopes (ROFA only)

In the case of Runway 18C/36C, all identified objects and service roads should be mitigated through continued controlled access/coordination with the ATCT, and frangible mounting.

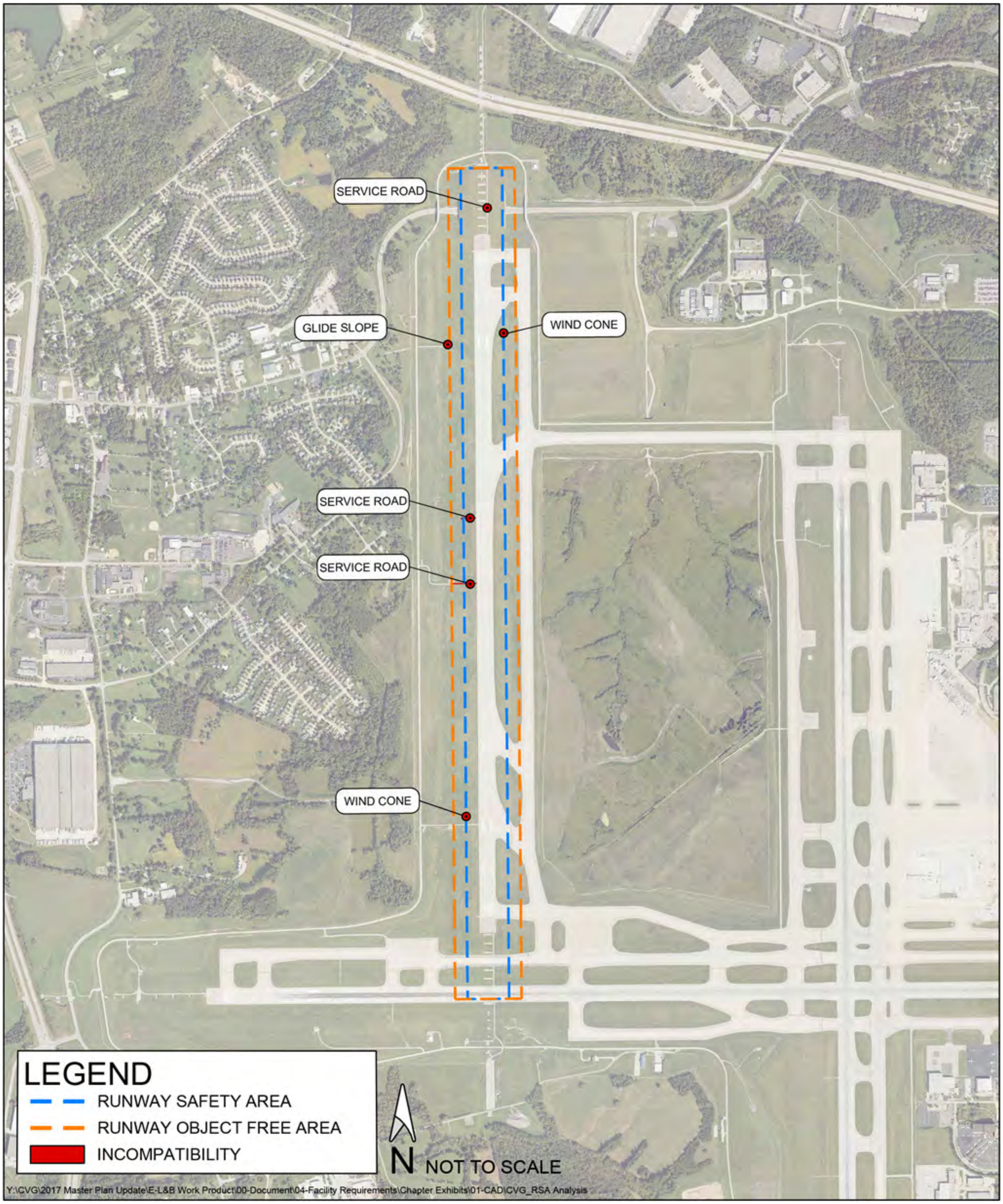
Runway 18L/36R

While Runway 18L/36R has a standard dimension RSA and ROFA, there are several instances of incompatible objects within these safety areas. **Exhibit 4.2-49, *Runway 18L/36R RSA & ROFA***, identifies the location of the following objects within the Runway 18L/36R RSA and ROFA:

- Three service roads – these service roads have restricted access and are mitigated via operational restrictions. (RSA and ROFA)
- Two glide slopes (ROFA only)
- Two wind cones (ROFA only)

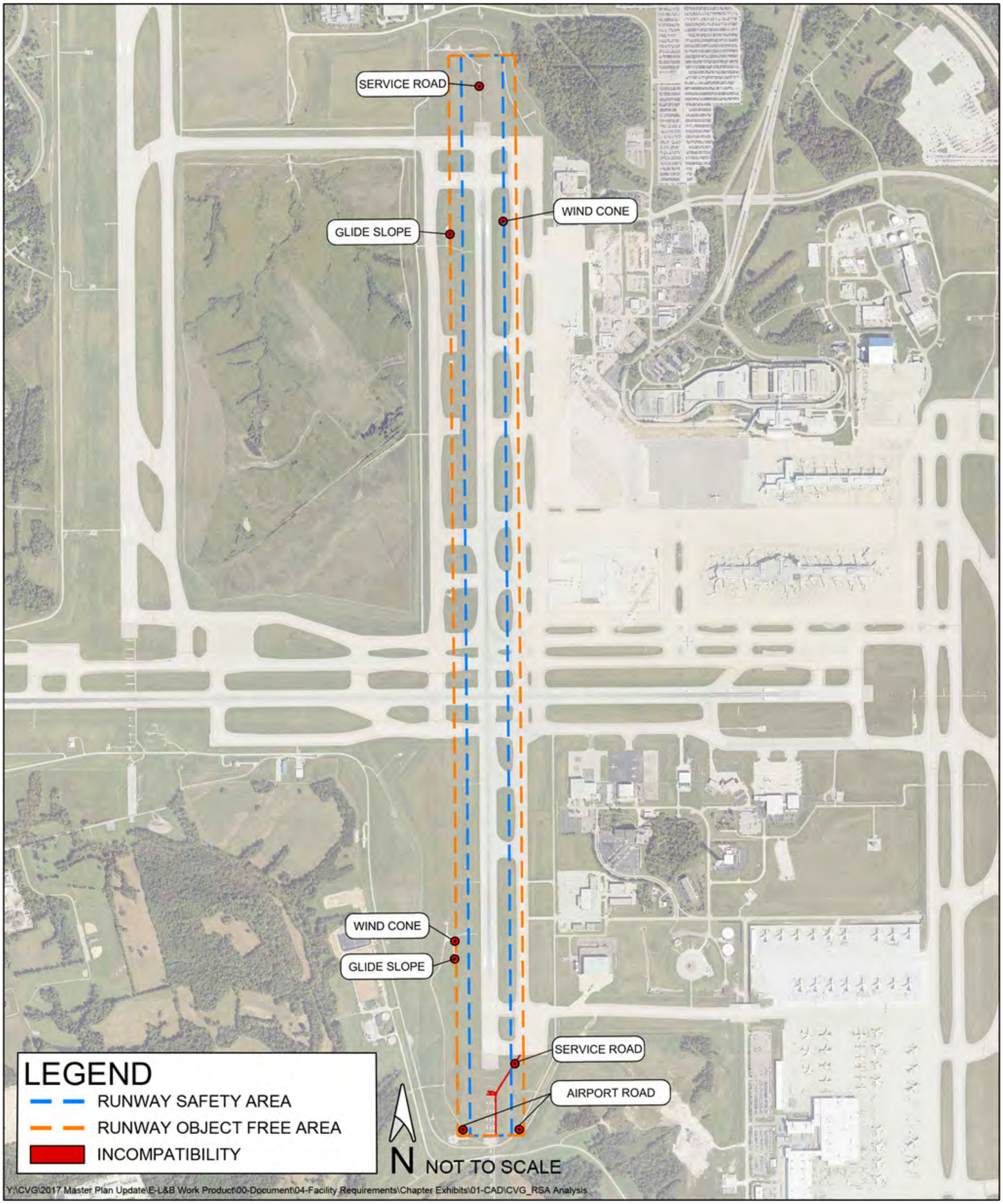
In the case of Runway 18L/36L, all identified objects and service roads should be mitigated through continued controlled access/coordination with the ATCT, and frangible mounting.

EXHIBIT 4.2-47 RUNWAY 18R/36L RSA & ROFA



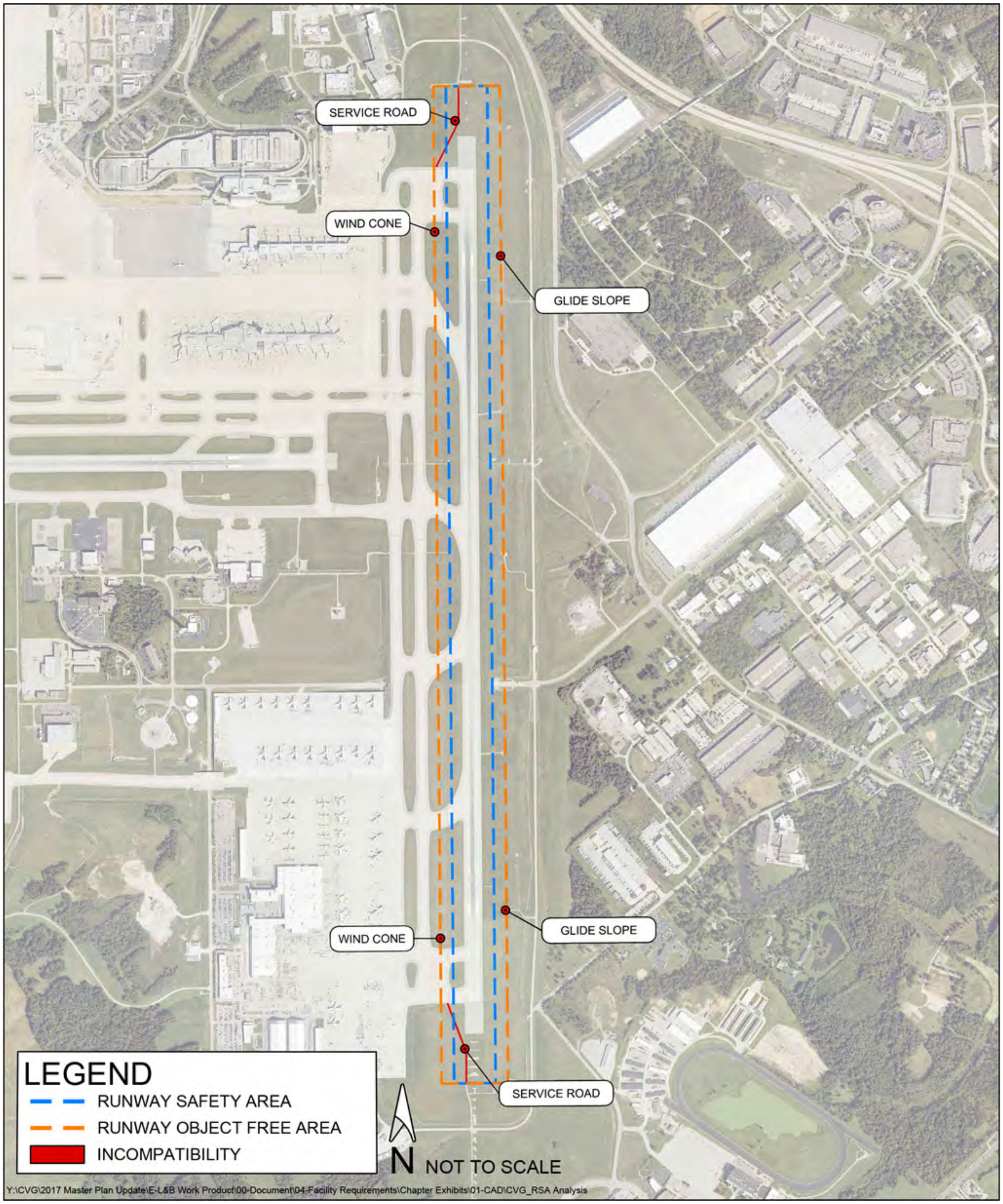
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 4.2-48 RUNWAY 18C/36C RSA & ROFA



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 4.2-49 RUNWAY 18L/36R RSA & ROFA



Source: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

4.2.5.5 *Modifications of Standards (MOS)*

As a condition of receiving federal grants for airport improvements, airports must comply with design standards adopted by the FAA. These standards are necessary for the safety, efficiency, and economy of the national airport system and its users. However, when local conditions do not allow an airport to meet standards, the FAA provides a process for airport sponsors to apply for a MOS for airport design standards to maintain an adequate level of safety.

MOS enhance or maintain airfield capacity and efficiency by assuring that aircraft can safely operate when current standards are not met. There are currently two MOS at CVG, which include:

- B747-8 Operations with Non-Standard Taxiway Object Free Area (TOFA)[15]
  - Taxiway S centerline to DHL vehicle service road (VSR) and movement/non-movement line does not meet ADG VI standards of being 193 feet from centerline by only providing 160 feet from the taxiway centerline. MOS allows B747-8 (ADG VI) operations on Taxiway S with ADG V TOFA standards (160' from centerline) based on Engineering Brief (EB) #78 using taxilane criteria.
  - Taxiway S centerline to AOA fence does not meet ADG VI standards of 193 feet from the centerline by only providing 185 feet of clearance from the taxiway centerline. MOS allows B747-8 (ADG VI) operations on Taxiway S with ADG V TOFA (160' from centerline) based on EB #78 using taxilane criteria.
  - The existing Taxiway S bridge has required fencing, delineators, etc. on top of the bridge within the TOFA. MOS allows objects (i.e. fencing, delineators, etc.) required for the taxiway bridge inside the reduced TOFA based on aircraft to object horizontal and vertical clearances.
  - Wingspans on Taxiway S are be restricted to 225 feet.
- B747-8 Operations 300-foot Taxiway to Taxiway Separation[16]
  - Standard taxiway to taxiway separation for B747-8 (ADG-VI) is 324 feet centerline to centerline. Portions of Taxiway S and T do not meet this standard. MOS allows simultaneous B747-8 (ADG VI) operations on Taxiway S and Taxiway T (from Taxiway J to DHL ramp) with current 300-foot separation between Taxiway S and T based on EB #78. Aircraft wingspan is restricted to 225 feet on Taxiway S and T. Operation on Taxiway T was approved in 2012.

MOS will be further reviewed and potentially addressed, in the alternatives process, to maintain an adequate level of safety at CVG and comply with FAA design standards.

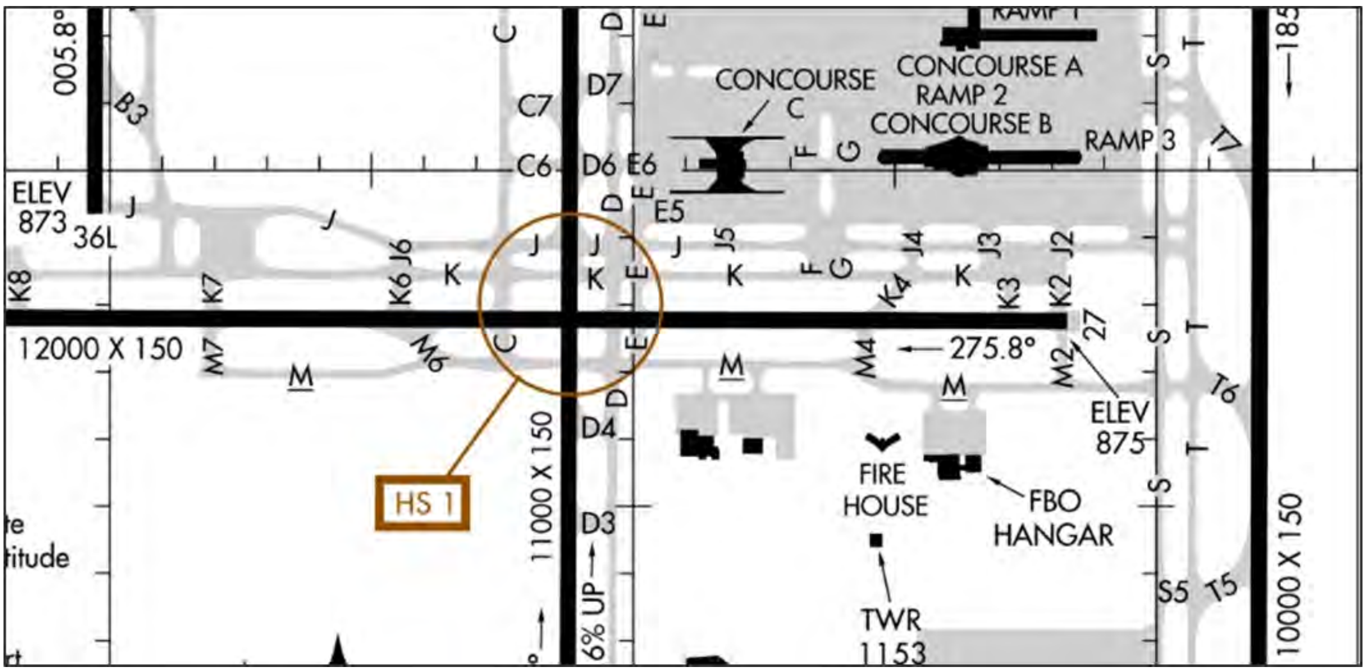
[15] FAA Southern Region, Modification of Airport Standards for B747-8 Operations with 300-foot Taxiway-Taxiway Separation with start date of January 12th, 2018 and end date of January 12th, 2023.

[16] FAA Southern Region, Modification of Airport Standards for B747-8 Operations with Non-Standard TOFA with start date of February 27th, 2018 and end date of February 27th , 2023.

4.2.5.6 *Hot Spots*

The FAA defines a hot spot as a location on an AOA where collisions or runway incursions have occurred or are likely to occur. Air Traffic Control (ATC), pilots, and vehicle drivers must be alert when operating in these areas. There is currently one hot spot location identified by the FAA on the CVG airfield. The hotspot is found at the intersection of Runway 18C/36C and Runway 09/27 in conjunction with the multiple taxiway crossings in this area. It encompasses the runway intersection, as well as Taxiways C, D, E, J, K, and M. The location of the hotspot is identified in the FAA airport diagram in **Exhibit 4.2-50, *CVG Hot Spot***.

EXHIBIT 4.2-50 CVG HOT SPOT



Source: FAA Terminal Procedures, *Airport Diagram*, CVG effective April 26 through May 23, 2018

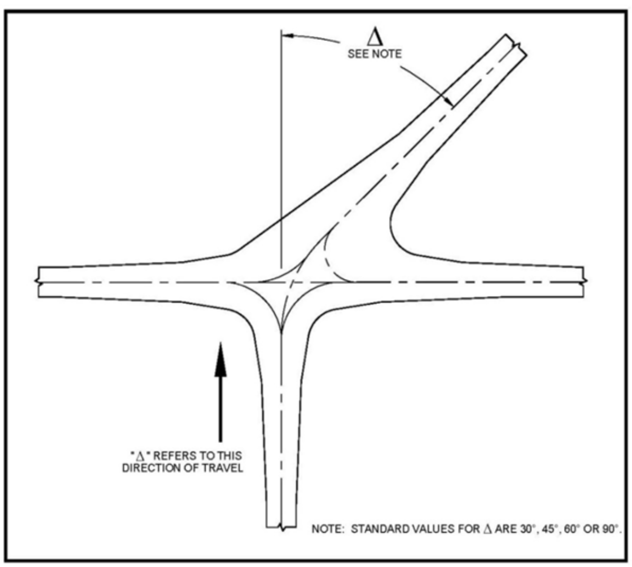
FAA guidance for the mitigation of runway/taxiway intersection crossings suggests simplification of pavement geometry to only 90-degree crossings and/or relocation of the crossings out of the "high energy area" (middle 1/3) of the runway. Given the existing geometry is configured to only 90-degree crossings and the airfield configuration does not allow for the relocation of these crossings, removal is the only remaining option to completely mitigate this hot spot. However, because of the airfield configuration and the resulting aircraft congestion and resulting delays, removal of these crossings is not recommended.

4.2.5.7 *Prevention of Runway Incursions*

The FAA defines a runway incursion as "any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and takeoff of aircraft."[17] FAA AC 150/5300-13A Change 1, Airport Design, provides the following guidance on how to design taxiways and taxilanes in a way that enhances safety by reducing the probability of runway incursions:

- Keep taxiway systems simple by using the three-node concept. As illustrated in **Exhibit 4.2-51, *Three Node Concept***, the three-node concept means a pilot should have no more than three choices at an intersection (preferably left turn, right turn, and straight).
- Avoid wide expanses of pavement with taxiway-to-runway interfaces. For example, an aircraft parking apron should not be directly connected to a runway by a taxiway.
- Reduce the need for aircraft to cross runways.
- Avoid "high-energy" intersections. High-energy intersections are intersections in the middle third of the runway.
- Provide right angle intersections (between two taxiways and between a taxiway and a runway). Do not use acute angle runway exits as a runway entrance point or as a runway crossing.
- Avoid dual-purpose pavements. Do not use runways as taxiways and vice versa.
- Do not construct taxiways that lead directly from an aircraft parking apron to a runway.

EXHIBIT 4.2-51 THREE NODE CONCEPT



Source: FAA AC 150/5300-13A Change 1, *Airport Design*

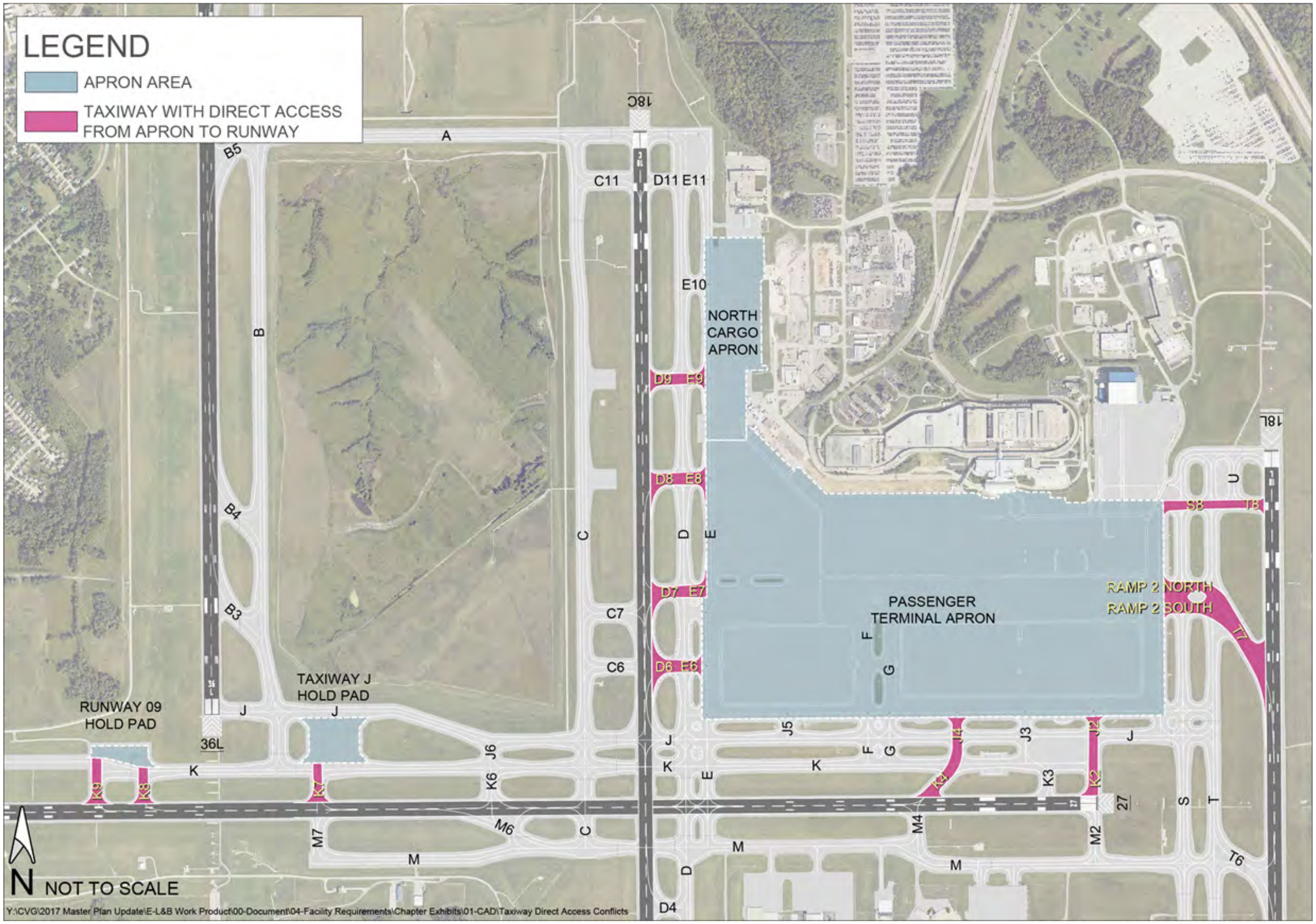
17 https://www.faa.gov/airports/runway_safety/news/runway_incursions/

CVG's taxiway system meets most of these criteria, with the exception of having several taxiways that connect aircraft parking aprons directly to a runway without requiring the aircraft to perform a turn. These instances are described as follows and presented in **Exhibit 4.2-52, *North Airfield Taxiways*** and **Exhibit 4.2-53, *South Airfield Taxiways***:

- Taxiways D9/E9, D8/E8, D7/E7, D6/E6 lead from the passenger terminal apron to Runway 18C/36C
- Taxiways S8/T8 and Ramp 2 North/Ramp 2 South/T7 connect the passenger terminal apron to Runway 18L/36R
- Taxiways K4/J4 and K2/J2 lead from the passenger terminal apron to Runway 09/27
- Taxiway K7 connects the Taxiway J hold pad to Runway 09/27
- Taxiways K8 and K9 connect the Runway 09 hold pad to Runway 09/27
- Taxiway D2/N connects the cargo aprons to Runway 18C/36C
- Taxiways T4/S4 lead from the DHL cargo apron to Runway 18L/36R

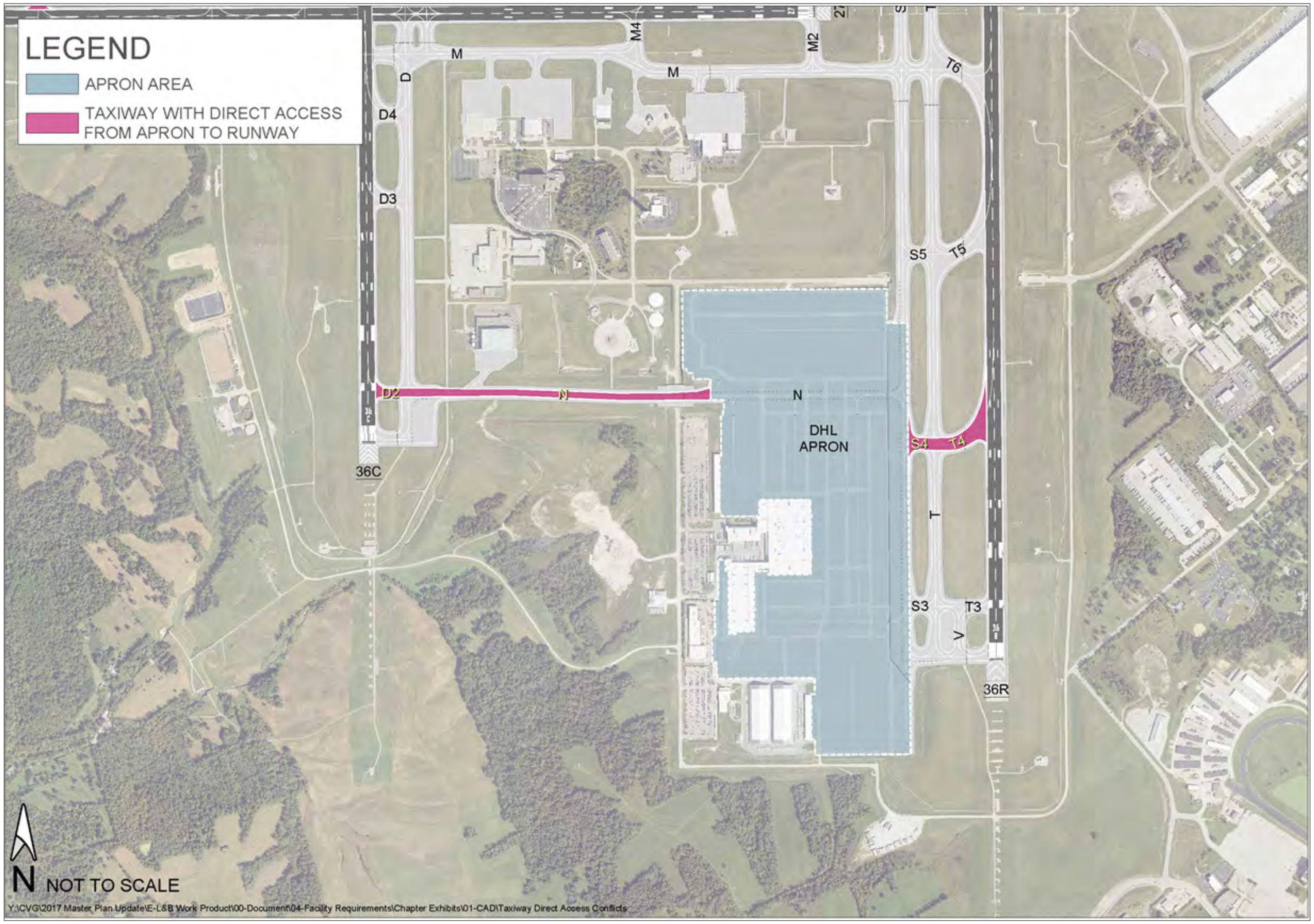
The alternatives analysis will assess ways to correct these issues.

EXHIBIT 4.2-52 NORTH AIRFIELD TAXIWAYS



Source: Landrum & Brown analysis

EXHIBIT 4.2-53 SOUTH AIRFIELD TAXIWAYS



Source: Landrum & Brown analysis

4.3 Passenger Terminal Facilities

The term “passenger terminal facilities” encompasses the aircraft gates along with the main terminal and concourses. Adequate passenger terminal facilities are essential to meeting projected aviation activity and ensuring acceptable levels of service and operational reliability for passengers, airlines, and other airport stakeholders. This section describes the calculation of the facility requirements for the aircraft gates and passenger terminal building at CVG. **Exhibit 4.3-1, *Existing Passenger Terminal Facilities***, depicts the existing terminal facilities at CVG.

EXHIBIT 4.3-1 EXISTING PASSENGER TERMINAL FACILITIES

Sources: KCAB; Google Earth-Photography dated April 11, 2017

4.3.1 Passenger Aircraft Gate Requirements

CVG has a total of 49 gates available on two concourses. There are 21 gates at Concourse A and 28 at Concourse B. Ten of the gates on Concourse B are capable of serving international arrivals; the remainder of CVG's gates can serve domestic flights and international departures.[18] Gate requirements were calculated to determine if the existing gates will be sufficient through PAL 4 or if additional gates will be needed.

The development of projected requirements for the number of passenger aircraft parking requirements involved an Aircraft on Ground (AOG) analysis of the DDFS developed for each PAL. An AOG analysis uses the DDFS to develop a running count of the number of aircraft on the ground throughout the design day by aircraft type, airline, and whether they are actively loading or unloading passengers.

All passenger loading and unloading was assumed to occur at contact gate positions with a Passenger Loading Bridge (PLB). Aircraft with long ground times were assumed to be towed off of the gate to a remote parking position in this analysis. Towing aircraft off of the contact gates allows other aircraft to use a contact position for passenger loading/unloading, which maximizes the utilization of the gates and reduces the need for additional gates. Aircraft were only eligible to be towed if they were at the gate longer than it takes to load and unload passengers and if the gate was needed by another aircraft. An aircraft cannot be towed off a gate during the first 30 minutes after arrival and must be towed back to a gate 45 minutes prior to its departure time.

Domestic and international gate requirements were developed separately using different assumptions due to the different nature of the activity and how the gates are operated.

4.3.1.1 *Domestic Gate Requirements*

In order to accurately consider the range of requirements in the future, minimum and maximum gate demand scenarios were developed for domestic gate usage. Scenario 1 considers the minimum gate demand by assuming a maximum utilization or efficiency of gate use at CVG. In order to achieve this, a primary assumption is that 100 percent of gates at CVG would be considered common-use. Under a 100 percent common-use scenario, any arriving aircraft could be assigned to any available position at any time, regardless of the airline and gate adjacencies. This scenario yields the least number of gates required.

To determine the maximum gate demand, Scenario 2 assumed an airline would lease a gate when that airline would utilize a gate at least three times per day, thereby making that gate a preferential-use gate. Preferential-use gates are preferred by airlines so they can locate their gates adjacent to one another to take advantage of efficiencies in ground operations. This preferential-use scenario results in the most gates required of the two scenarios.

18 International arriving passengers must be kept separate from other passengers until they have cleared all Customs and Border Protection (CBP) inspections. Therefore, separate sterile corridors are used to transfer passengers from the aircraft gate to the CBP facilities. International arrivals can only use gates that have such a separate corridor system. International departures and domestic flights do not require separate corridors.

Table 4.3-1, *Scenario 1 Domestic Gate Requirements*, and **Table 4.3-2, *Scenario 2 Domestic Gate Requirements***, present the gate requirements for each PAL throughout the planning period of this Master Plan. All future gates should be ADG III based on the fleet mix that is expected to operate at CVG. A total of 51 gates will be required by PAL 4 under Scenario 1 (deficit of 12 gates). Scenario 2 results in a requirement for 63 gates by PAL 4 (deficit of 24 gates). CVG will begin to experience a gate deficit by PAL 3 in Scenario 1, and by PAL 1 with Scenario 2. Scenario 2 was chosen as the preferred scenario because it most accurately represents how the airlines operate today, and how they are expected to operate in the future.

It is important to note that 21 of the existing gates are larger (ADG IV or V) than what is needed in the future (ADG III). As a result, the existing terminal frontage could be reconfigured to accommodate more gate positions than are available today. Plans for future gates should take this into consideration in order to maximize the capacity of the existing concourses.

TABLE 4.3-1 SCENARIO 1 DOMESTIC GATE REQUIREMENTS

Aircraft Size	Existing Gates	Number of Gates Required					Surplus/(Deficit)				
		2017	PAL 1	PAL 2	PAL 3	PAL 4	2017	PAL 1	PAL 2	PAL 3	PAL 4
ADG V	1	0	0	0	0	0	1	1	1	1	1
ADG IV	20	0	0	0	0	0	20	20	20	20	20
ADG III	17	30	35	39	44	51	(13)	(18)	(22)	(27)	(34)
ADG II&III	1	0	0	0	0	0	1	1	1	1	1
Total	**39**	**30**	**35**	**39**	**44**	**51**	**9**	**4**	**0**	**(5)**	**(12)**

Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

TABLE 4.3-2 SCENARIO 2 DOMESTIC GATE REQUIREMENTS

Aircraft Size	Existing Gates	Number of Gates Required					Surplus/(Deficit)				
		2017	PAL 1	PAL 2	PAL 3	PAL 4	2017	PAL 1	PAL 2	PAL 3	PAL 4
ADG V	1	0	0	0	0	0	1	1	1	1	1
ADG IV	20	0	0	0	0	0	20	20	20	20	20
ADG III	17	36	45	48	54	63	(19)	(28)	(31)	(37)	(46)
ADG II&III	1	0	0	0	0	0	1	1	1	1	1
Total	**39**	**36**	**45**	**48**	**54**	**63**	**3**	**(6)**	**(9)**	**(15)**	**(24)**

Sources: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

4.3.1.2 *International Gate Requirements*

The international gates operate as common use gates today. This is expected to continue in the future. Thus, the international gates were assumed to be common-use for this analysis. The international gate requirements are presented in **Table 4.3-3, *International Gate Requirements***. CVG is projected to have a surplus of international gates through PAL 4. While the total number of international gates is expected to be sufficient, the size of those gates is not. One additional ADG V gate will be needed in PAL 3 and PAL 4.

TABLE 4.3-3 INTERNATIONAL GATE REQUIREMENTS

Aircraft Size	Existing Gates	Number of Gates Required					Surplus/(Deficit)				
		2017	PAL 1	PAL 2	PAL 3	PAL 4	2017	PAL 1	PAL 2	PAL 3	PAL 4
ADG V	1	0	1	1	2	2	1	0	0	(1)	(1)
ADG IV	9	1	1	1	0	0	8	8	8	9	9
ADG III	0	1	1	1	2	4	(1)	(1)	(1)	(2)	(4)
Total	**10**	**2**	**3**	**3**	**4**	**6**	**8**	**7**	**7**	**6**	**4**

Source: KCAB; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

The preceding tables provide gate requirements by aircraft size. Gate capacity can be more easily compared and analyzed by measuring different gate mixes through a standard index. Two indices are typically used in terminal planning:

- **Narrow-Body Equivalent Gate (NBEG) Index**: Converts the gate requirements of diverse aircraft so they are equivalent to the apron capacity of a narrow-body aircraft gate.
- **Equivalent Aircraft (EQA) Index**: Converts the gate requirements of diverse aircraft so they are equivalent to a 145-seat aircraft.

The NBEG and EQA requirements are shown in **Table 4.3-4, *Scenario 2 Gate Index Requirements***.

TABLE 4.3-4 SCENARIO 2 GATE INDEX REQUIREMENTS

Index	Requirement				
	2017	PAL 1	PAL 2	PAL 3	PAL 4
Total Gates	38	48	51	58	69
NBEG	38.4	49.2	52.2	59.6	70.6
EQA	38.9	50.7	53.7	61.6	72.6

Source: Landrum & Brown analysis

4.3.2 Passenger Terminal Building Requirements

CVG has a single passenger terminal building (main terminal) and two satellite concourses. Future requirements for the main terminal and concourses were prepared individually for airline space, public space, concessions, U.S. Customs & Border Protection (CBP), and terminal support spaces.

4.3.2.1 *Methodology and Assumptions*

Terminal facility requirements were developed using the Terminal Space Program (TSP) model developed by Landrum & Brown. The TSP is based upon the planning guidelines published in the International Air Transport Association (IATA) Airport Development Reference Manual (ADRM). The TSP is supplemented with information about facilities provided at comparable airports (benchmarks) and a knowledge of industry-wide trends in construction of passenger terminals. The TSP also takes into account planning and operational input provided by CVG and site observations of existing conditions.

The requirements were based on the volume of activity (e.g., passengers or baggage) to be accommodated during peak periods and/or industry-accepted standards and allowances. Requirements based on activity were derived by mathematically relating the projected peak volume of activity to a number of other variables, including:

- Passenger dwell times and flow rates
- Baggage volumes and flow rates
- Processor sizes
- Maximum allowable queue sizes or times
- Space required per unit of queue
- Space required per unit volume

Assumptions for processing rates, queue length, and spatial requirements were based on IATA Level of Service (LoS) “optimum” standards. LoS is a measure of the quality of service provided inside the terminal in terms of ease of flow and propensity for delays. Optimum LoS corresponds to an overall good level of service, where flows are stable, delay levels are acceptable and a good level of comfort is provided. Professional judgment was employed throughout the TSP to reflect conditions local to CVG.

4.3.2.2 *Airline Space*

The airline spaces analyzed for the CVG Master Plan are:

- Check-in Lobby
- Baggage Facilities
- Gate Holdrooms
- Club/Lounge Space
- Airline Operations Space

Check-in Lobby

The check-in lobby includes passenger check-in, baggage check-in, and passenger queuing space. This area also includes Airline Ticket Offices (ATO). CVG currently has 8 curbside check-in positions, 70 full-service check-in and bag drop positions, and 43 self-service kiosks in its ticketing lobby. The curbside check-in positions take up 547 square feet of space on the curb. A total of 16,000 square feet of space is allocated to the full-service check-in and bag drop positions, self-service kiosks, and ticketing counter queue.[19] The ATO makes up 2,768 square feet of space.

The requirements for check-in positions and check-in lobby space were calculated in the TSP. A hybrid of common use and exclusive use check-in facilities were assumed in the calculation of future check-in requirements, depending on each airline's peak period. The inputs to the TSP for the check-in positions and check-in space requirements are:

- Average processing time
- Maximum queuing times deemed acceptable to the airlines and Airport
- Distribution of passengers to the different types of check-in facilities

The input assumptions that were used in the calculation of check-in lobby requirements in the TSP are presented in **Table 4.3-5 *Check-in Lobby Assumptions***. The different types of check-in facilities have different average processing times. Curb check-in facilities tend to have longer processing times per passenger (210 seconds) than other types of check-in facilities (130 to 175 seconds). The maximum queuing times assumed in this analysis vary by check-in facility type as well. The queue times assumed for curbside check-in and first-class passengers at full-service counters are the lowest at two minutes. Economy class check-in at full-service positions has the highest maximum queue time at 20 minutes. Assumptions were also made regarding the distribution of passengers to each type of check-in facility. About 5 percent of passengers use the curb check-in facilities, 30 percent use full-service counters, 30 percent use bag drop counters, and 50 percent use self-service kiosks.

ATO space was also calculated in the TSP. It was assumed that 58 square feet of ATO space should be provided per EQA gate position.

[19] This area is inclusive of the behind the counter space (staff space and the baggage belts that convey baggage from the counters to the baggage make-up areas).

TABLE 4.3-5 CHECK-IN LOBBY ASSUMPTIONS

Parameters	Value
Curb Check-in	
Process (throughput) time per passenger (in seconds)	210
Maximum queuing time (in minutes)	2
Full-service Check-in	
Process (throughput) time per passenger (in seconds)	175
Maximum queuing time economy class (in minutes)	20
Maximum queuing time business class (in minutes)	5
Maximum queuing time first class (in minutes)	2
Bag-drop	
Process (throughput) time per passenger (in seconds)	136
Maximum queuing time (in minutes)	10
Self-service Kiosks	
Process (throughput) time per passenger (in seconds)	130
Maximum queuing time (in minutes)	5
Passenger Allocations	
Percent of passengers in first class	0%
Percent of passengers in business class	15%
Percent of passengers in economy class	85%
Percent of passengers using curb check-in facilities	5%
Percent of passengers using full-service check-in facilities	30%
Percent of passengers using bag-drop	30%
Percent of passengers using self-service kiosks	50%

Source: Landrum & Brown analysis

Table 4.3-6, *Check-in Lobby Requirements*, presents the check-in positions and space requirements based on the previously presented assumptions. CVG has a total of 121 check-in positions today. By PAL 4, an additional 20 positions will be required. The TSP indicates that the curbside check-in space and full-service check-in and bag drop space is deficient now, whereas the self-service kiosks, ticketing lobby and ATO space will be deficient by PAL 1.

TABLE 4.3-6 CHECK-IN LOBBY REQUIREMENTS

Check-in Position Type	Number of Check-in Positions					
	Existing	2017	PAL 1	PAL 2	PAL 3	PAL 4
Requirement						
Curbside Check-in	8	6	6	7	8	9
Full-service Check-in & Bag Drop	70	52	65	71	81	87
Self-Service Kiosk	43	21	26	30	38	45
Total	**121**	**79**	**97**	**108**	**127**	**141**
Surplus/(Deficit)						
Curbside Check-in		2	2	1	0	(1)
Full-service Check-in & Bag Drop		18	5	(1)	(11)	(17)
Self-Service Kiosk		22	17	13	5	(2)
Total		**42**	**24**	**13**	**(6)**	**(20)**

Check-in Position Type	Check-in Lobby (ft2)					
	Existing	2017	PAL 1	PAL 2	PAL 3	PAL 4
Requirement						
Curbside Check-in	547	1,000	1,000	1,200	1,400	1,500
Full-service Check-in & Bag Drop	5,000	5,200	6,600	7,100	8,200	8,800
Self-Service Kiosk & Ticket Counter Queue	11,000	9,800	12,200	13,300	15,400	16,800
ATO	2,768	2,300	3,000	3,200	3,600	4,300
Total	**19,315**	**18,300**	**22,800**	**24,800**	**28,600**	**31,400**
Surplus/(Deficit)						
Curbside Check-in		(453)	(453)	(653)	(853)	(953)
Full-service Check-in & Bag Drop		(200)	(1,600)	(2,100)	(3,200)	(3,800)
Self-Service Kiosk & Ticket Counter Queue		1,200	(1,200)	(2,300)	(4,400)	(5,800)
ATO		468	(232)	(432)	(832)	(1,532)
Total		**1,015**	**(3,485)**	**(11,085)**	**(9,285)**	**(12,085)**

Source: Landrum & Brown analysis

Baggage Facilities

The baggage facilities consist of the following components:

- **Checked Baggage Inspection System (CBIS)**: The area where outbound checked baggage is screened through an automated process. The CBIS currently makes up 224,674 square feet of space at CVG. CBIS space requirements were calculated based on the industry standard assumptions of 12 baggage carts per baggage make-up unit, 160 linear feet of frontage per baggage make-up unit, 3,000 square feet per Inline Screening Device (ISD) unit, and 6,000 square feet of CBIS area per baggage make-up unit.
- **Checked Baggage Reconciliation Area (CBRA)**: The area where outbound checked baggage that has been processed by the CBIS and flagged for additional manual screening is reconciled back into the general baggage population after being cleared. It is then sorted by flight to be loaded onto baggage carts in this area. This area is comprised of 17,310 square feet of space. Future requirements were calculated based on the industry standard assumptions of 180 square feet per station.
- **Domestic Baggage Claim**: The area where arriving domestic passengers reclaim their checked baggage upon arrival at CVG. This area is not considered to be secure or sterile and is accessible by the public. CVG has four claim units with 795 linear feet of claim frontage. The domestic baggage claim hall is made up of 39,801 square feet of space. Future requirements were determined by applying the industry standard assumptions of two flights per baggage claim unit, 1.38 linear feet of claim frontage per passenger, and 17.2 square feet per inbound passenger.
- **Inbound Baggage Drop-off area**: The area where inbound checked baggage is unloaded from baggage carts onto takeaway belts to be conveyed to the baggage claim units. This area is made up of 45,002 square feet of space at CVG. Future requirements were calculated based on the industry standard ratio of 2,000 square feet per inbound drop.
- **Baggage Services Offices**: This area is where passengers must go if their luggage is lost. This area is comprised of 5,263 square feet of space. Future requirements were calculated by assuming 1.5 square feet of baggage office space per terminating peak hour passenger.

The resulting requirements are shown in **Table 4.3-7, *Baggage Facility Requirements***. The analysis shows that all of the baggage areas will have sufficient space through PAL 4, with the exception of the CBRA space. An additional 2,190 square feet of space will be needed for CBRA functions by PAL 4.

TABLE 4.3-7 BAGGAGE FACILITY REQUIREMENTS

Units	Unit Requirements				
	2017	PAL 1	PAL 2	PAL 3	PAL 4
CBIS Make-up Units	4	4	5	6	8
CBIS ISD Units	3	3	4	4	5
CBRA Stations	13	13	19	19	25
Domestic Baggage Claim Units	8	9	11	13	15
Domestic Baggage Claim Frontage (LF)	640	740	830	1,080	1,260

Baggage Area	Baggage Facility Space (ft2)					
	Existing	2017	PAL 1	PAL 2	PAL 3	PAL 4
Requirement						
CBIS	224,674	24,000	24,000	30,000	36,000	48,000
CBRA	17,310	11,300	11,300	15,400	15,400	19,500
Domestic Baggage Claim	39,801	14,700	17,000	19,000	24,900	29,000
Inbound Baggage Drop-off	45,002	18,000	20,000	26,000	28,000	36,000
Baggage Services Offices	5,263	2,500	2,600	3,600	4,100	4,700
Total	**33,2050**	**70,500**	**74,900**	**94,000**	**108,400**	**137,200**
Surplus/(Deficit)						
CBIS		200,674	200,674	194,674	188,674	176,674
CBRA		6,010	6,010	1,910	1,910	(2,190)
Domestic Baggage Claim		25,101	22,801	20,801	14,901	10,801
Inbound Baggage Drop-off		27,002	25,002	19,002	17,002	9,002
Baggage Services Offices		2,763	2,663	1,663	1,163	563
Total		**261,550**	**257,150**	**238,050**	**223,650**	**194,850**

Source: Vic Thompson Company analysis

4.3.2.3 *Gate Holdrooms*

The gate holdrooms serve as an assembly area for passengers waiting to board a particular flight. CVG currently has 134,615 square feet of holdroom space in Concourses A and B.

Average holdroom size requirements were calculated in the TSP based on the following assumptions:

- Number of passengers based on the maximum size aircraft that each gate can accommodate at a 90 percent load factor based on the Scenario 2 gate requirements presented in Section 4.3.1, *Passenger Aircraft Gate Requirements*
- One holdroom per gate
- Seats for 80 percent of boarding passengers, space for airline processing, and passenger boarding queues

Table 4.3-8, *Holdroom Size Assumptions by Aircraft Size*, shows the holdroom sizes that result from these assumptions.

TABLE 4.3-8 HOLDROOM SIZE ASSUMPTIONS BY AIRCRAFT SIZE

Gate Size	Holdroom Size (ft^2)
ADG VI	6,500
ADG V	5,000
ADG IV	3,700
ADG III	2,500
ADG I&II	900

Source: Landrum & Brown analysis

Table 4.3-9, *Total Holdroom Requirements*, presents the resulting total holdroom requirements. The existing holdroom space is expected to be sufficient through PAL 2. An additional 42,885 square feet of holdroom space will be needed in PAL 4.

TABLE 4.3-9 TOTAL HOLDROOM REQUIREMENTS

	Holdroom Space (ft^2)				
	2017	PAL 1	PAL 2	PAL 3	PAL 4
Existing	134,615				
Requirement	96,200	123,700	131,200	150,000	177,500
Surplus/(Deficit)	38,415	10,915	3,415	(15,385)	(42,885)

Source: Landrum & Brown analysis

Club/Lounge Space

Club/lounge space makes up 46,348 square feet of space in the main terminal and two concourses. The majority of the club/lounge space is in the two concourses, with 578 square feet in the main terminal. Future requirements were calculated based on the industry standard assumption of 23,000 square feet per lounge and the need for two lounges (one per concourse) throughout the planning period. This results in a requirement for 46,000 square feet of lounge space through PAL 4, as shown in **Table 4.3-10, *Club/Lounge Space Requirements***. The CVG lounges are therefore sufficient through the planning period.

TABLE 4.3-10 CLUB/LOUNGE SPACE REQUIREMENTS

	Club/Lounge Space (ft^2)
	2017 – PAL 4
Existing	46,348
Requirement	46,000
Surplus/(Deficit)	348

Source: Landrum & Brown analysis

Airline Operations Space

Airline operations space makes up 345,875 square feet of space in the main terminal and two concourses. Future requirements were calculated based on an industry standard assumption that 4,700 square feet of airline operations space should be provided per EQA gate position. The resulting requirements are shown in **Table 4.3-11, *Airline Operations Space Requirements***. The existing airline operations space is expected to be sufficient through PAL 4.

TABLE 4.3-11 AIRLINE OPERATIONS SPACE REQUIREMENTS

	Airline Operations Space (ft^2)				
	2017	PAL 1	PAL 2	PAL 3	PAL 4
Existing	345,875				
Requirement	182,900	238,300	252,400	289,600	341,300
Surplus/(Deficit)	162,975	107,575	93,475	56,275	4,575

Source: Landrum & Brown analysis

4.3.2.4 *Public Space*

The public spaces analyzed for the CVG Master Plan are:

- Check-in Lobby Circulation
- Arrivals Greeter Hall
- Concourse Central Circulation
- Concourse Sterile Corridor
- Rest Rooms
- Passenger Security Screening

Check-in Lobby Circulation

The check-in lobby in the main terminal currently has 10,305 square feet of cross-circulation space to allow passengers to travel between the check-in lobby and other parts of the terminal. Requirements for this area were determined based on an industry standard width of 30 feet. The resulting requirements are shown in **Table 4.3-12, *Check-in Lobby Circulation Requirements***. The analysis shows that the check-in lobby space is currently deficient by almost 2,700 square feet. By PAL 4, a deficit of about 11,500 square feet is projected.

TABLE 4.3-12 CHECK-IN LOBBY CIRCULATION REQUIREMENTS

	Check-in Lobby Circulation Space (ft^2)				
	2017	PAL 1	PAL 2	PAL 3	PAL 4
Existing	10,305				
Requirement	13,000	16,300	17,600	20,100	21,800
Surplus/(Deficit)	(2,695)	(5,995)	(7,295)	(9,795)	(11,495)

Source: Landrum & Brown analysis

Arrivals Greeter Hall

An arrivals greeter hall is where passengers can meet family and friends after their flight arrives. At CVG, this space makes up 15,569 square feet on the lower level of the Main Terminal, just beyond the security screening area. Requirements for this space were calculated based on the following assumptions:

- Even distribution of peak hour passengers throughout peak hour
- Number of visitors per person = 1
- Average occupancy time per passenger (AOP) = 5 minutes
- Average occupancy time per visitor (AOV) = 30 minutes
- Average amount of space per occupant = 18 square feet

The arrivals greeter hall requirements are shown in **Table 4.3-13, *Arrivals Greeter Hall Requirements***. The analysis shows that the existing arrivals greeter hall space is deficient. By PAL 4, over 17,000 square feet of additional space will be required.

TABLE 4.3-13 ARRIVALS GREETER HALL REQUIREMENTS

	Arrivals Greeter Hall Space (ft^2)				
	2017	PAL 1	PAL 2	PAL 3	PAL 4
Existing	15,569				
Requirement	17,000	18,200	24,800	28,500	32,700
Surplus/(Deficit)	(1,431)	(2,631)	(9,231)	(12,931)	(17,131)

Source: Landrum & Brown analysis

Concourse Central Circulation

The concourse central circulation corridor space consists of the main corridor of Concourses A and B. These corridors are considered "secure" because passengers must go through security to reach them. Concourse A's secure corridor is made up of 55,947 square feet of space, while Concourse B has 98,755 square feet of secure corridor, for a total area of 154,702 square feet.

The following assumptions were made regarding the length and width of the concourse central circulation corridors:

- Double-loaded concourses (same as today)[20]
- Corridor width of 36 feet (30 feet for walking and 6 feet for moving sidewalks)
- Width increased by a factor of 15 percent to account for additional circulation needs
- Length based on the number of required NBEG

The resulting concourse central circulation corridor requirements are shown in **Table 4.3-14, *Concourse Central Circulation Corridor Requirements***. The analysis shows that the existing secure corridors are sufficient but there will be a need for additional space by PAL 1. By PAL 4, there is expected to be a deficit of over 120,000 square feet.

TABLE 4.3-14 CONCOURSE CENTRAL CIRCULATION CORRIDOR REQUIREMENTS

	Concourse Departure Corridor Space (ft^2)				
	2017	PAL 1	PAL 2	PAL 3	PAL 4
Existing	154,702				
Requirement	149,500	191,500	203,200	232,000	274,800
Surplus/(Deficit)	5,202	(36,798)	(48,498)	(77,298)	(120,098)

Source: Landrum & Brown analysis

20 Double loaded concourses refer to concourses that have holdrooms and gates on both sides of the concourse.

Concourse Sterile Corridor

International arriving passengers must be kept separate from other passengers until they have cleared all federal inspections. Therefore, separate sterile corridors are used to transfer passengers from the aircraft gate to the CBP facilities. CVG has 5,442 square feet of sterile corridors (this number includes vertical circulation).

The following assumptions were made regarding the length and width of the concourse departure corridors:

- Double loaded concourse
- Corridor width of 22 feet
- Length based on the number of NBEG
- Width increased by a factor of 100 percent to account for additional circulation (non-concourse area) needs

In addition, area was added to the sterile corridor requirement to accommodate fixed bridge connectors and vertical circulation. The TSP assumed one gateper sterile vertical circulation and 2,900 square feet per fixed bridge. The resulting requirements for concourse sterile corridors are shown in **Table 4.3-15, *Concourse Sterile Corridor Requirements***. The sterile corridor is currently deficient. By PAL 4, almost 36,000 square feet of sterile corridor will be needed.

TABLE 4.3-15 CONCOURSE STERILE CORRIDOR REQUIREMENTS

	Concourse Sterile Corridor Space (ft^2)				
	2017	PAL 1	PAL 2	PAL 3	PAL 4
Existing	5,442				
Requirement	13,300	21,800	21,800	29,000	41,000
Surplus/(Deficit)	(7,858)	(5,958)	(16,358)	(23,558)	(35,558)

Source: Landrum & Brown analysis

Rest Rooms

CVG provides public rest rooms in the check-in lobby (1,726 square feet), concourses (17,286 square feet), sterile corridor (330 square feet), and baggage claim (1,013 square feet) for a total of 20,355 square feet. There are no rest rooms in international baggage claim or the arrivals greeter hall. The TSP calculates rest room requirements based on the number of peak hour passengers and assumptions regarding occupancy ratios, square foot per fixture, employee/visitor ratios, and rest room modules per gate ratios, all of which vary by where the rest rooms are located. The resulting rest room requirements are shown in **Table 4.3-16, *Public Rest Room Requirements***. The analysis shows that the check-in lobby, baggage claim areas, and arrivals greeter hall are all deficient in rest room space today. The concourses have excess rest room space today; this surplus will continue through PAL 4. The sterile corridor has excess rest room space today but additional space will be needed by PAL 1. An overall deficit of about 14,500 square feet of rest room space is projected for PAL 4.

TABLE 4.3-16 PUBLIC REST ROOM REQUIREMENTS

Rest Room Location	Rest Rooms (ft2)					
	Existing	2017	PAL 1	PAL 2	PAL 3	PAL 4
Requirement						
Check-in Lobby	1,726	3,400	3,600	4,000	4,400	5,000
Concourses	17,286	9,500	11,400	13,300	15,200	17,100
Sterile Corridor	330	1,900	1,900	1,900	1,900	1,900
Baggage Claim - Domestic	1,013	2,800	3,000	3,200	3,600	4,000
Baggage Claim – International	0	1,400	1,600	1,600	1,600	2,000
Arrivals Greeter Hall	0	3,100	3,100	4,000	4,400	4,800
Total	**20,355**	**22,100**	**24,600**	**28,000**	**31,100**	**34,800**
Surplus/(Deficit)						
Check-in Lobby		(1,674)	(1,874)	(2,274)	(2,674)	(3,274)
Concourses		7,786	5,886	3,986	2,086	186
Sterile Corridor		(1,570)	(1,570)	(1,570)	(1,570)	(1,570)
Baggage Claim - Domestic		(1,787)	(1,987)	(2,187)	(2,587)	(2,987)
Baggage Claim – International		(1,400)	(1,600)	(1,600)	(1,600)	(2,000)
Arrivals Greeter Hall		(3,100)	(3,100)	(4,000)	(4,400)	(4,800)
Total		**(1,745)**	**(4,245)**	**(7,645)**	**(10,745)**	**(14,445)**

Source: Landrum & Brown analysis

Passenger Security Screening

All outbound passengers must pass through a security screening checkpoint. The Transportation Security Administration (TSA) is responsible for screening airport passengers, employees, and flight crews. CVG currently has 10 screening units, comprising 20,101 square feet. There is also a 13,813-square foot screening queue and lobby area and 919 square feet of support areas.

Requirements for the number of security screening checkpoint units were calculated in the TSP based on the assumptions shown in **Table 4.3-17, *Passenger Security Screening Checkpoint Assumptions***. Assumptions are shown for the two types of passenger security screening processes – standard and pre-check. Pre-check is a TSA expedited screening program for pre-screened passengers. Passengers who have not been pre-screened go through standard screening. About 75 percent of passengers use standard screening. The remainder use pre-check, as do employees and airline crews. The average number of passengers processed per lane per hour is higher for pre-check versus standard screening while the maximum queuing time is shorter.

TABLE 4.3-17 PASSENGER SECURITY SCREENING CHECKPOINT ASSUMPTIONS

Factor	Standard Screening Assumption	Pre-check Assumption
Percent of Traffic	75%	25%
Percent Additional Traffic (employees, crew)	0%	5%
Passengers/Lane/Hour (in seconds)	150	210
Maximum Queueing Time	10	5

Sources: TSA; Landrum & Brown analysis

Requirements for security screening unit space, queue/lobby space, and support areas were calculated based on the following assumptions:

- Security lane footprint of 1,050 square feet (supports security screening equipment such as the magnetometer, body scanner, and X-ray)
- Queue area per security lane of 450 square feet
- Support area as percent of security screening area = 17 percent

The resulting requirements for passenger security screening based on the preceding assumptions are shown in **Table 4.3-18, *Passenger Security Screening Requirements***. The analysis shows that additional security screening units will be required beginning at PAL 1, with seven additional units required in PAL 4. The space allocated for security screening units was found to be sufficient through PAL 2. By PAL 4, about 2,900 square feet of additional space will be required. The queue and lobby area is projected to be sufficient through PAL 4. The support area is currently deficient; about 4,300 square feet of support space will be required by PAL 4.

TABLE 4.3-18 PASSENGER SECURITY SCREENING REQUIREMENTS

Area	Security Screening Space					
	Existing	2017	PAL 1	PAL 2	PAL 3	PAL 4
Requirement						
Number of Units	10	10	11	13	15	17
Security Unit Space (ft^2)	20,101	13,600	14,900	17,600	20,300	23,000
Queue & Lobby (ft^2)	13,813	4,600	5,000	5,900	6,800	7,700
Support Areas (ft^2)	919	3,100	3,400	4,000	4,600	5,200
Total Area (ft^2)	**34,833**	**21,300**	**23,300**	**27,500**	**31,700**	**35,900**
Surplus/(Deficit)						
Number of Units		0	(1)	(3)	(5)	(7)
Security Unit Space (ft^2)		6,501	5,201	2,501	(199)	(2,899)
Queue & Lobby (ft^2)		9,213	8,813	7,913	7,013	6,113
Support Areas (ft^2)		(2,181)	(2,481)	(3,081)	(3,681)	(4,281)
Total Area (ft^2)		**13,533**	**11,533**	**7,333**	**3,133**	**(1,067)**

Source: Landrum & Brown analysis

4.3.2.5 *Concessions Space*

CVG has concessionaires in the main terminal and both concourses, which include food & beverage, specialty retail, news & gifts, and duty free stores. Concessions space comprises 85,267 square feet, with an additional 18,005 square feet of space for concessions support. Concession space requirements were calculated by applying the following ratios:

- **Food & Beverage**: 4.5 square feet per 1,000 enplanements
- **Specialty Retail**: 2.6 square feet per 1,000 enplanements
- **News & Gifts:** 1.1 square feet per 1,000 enplanements
- **Duty Free**: 4.9 square feet per 1,000 enplanements

In addition, concession support areas were assumed to require 20 percent of total concessions space.

The resulting concessions requirements are shown in **Table 4.3-19, *Concessions Space Requirements***. Food & beverage and specialty retail concessions space are projected to have sufficient space to serve demand through PAL 4. News & gifts and duty free concessions spaces are currently deficient. Concession support space is sufficient through PAL 2. The facility requirements analysis shows that over 47,000 square feet of concessions space will be needed by PAL 4.

TABLE 4.3-19 CONCESSIONS SPACE REQUIREMENTS

Area	Concessions Space (ft^2)					
	Existing	2017	PAL 1	PAL 2	PAL 3	PAL 4
Requirement						
Food & Beverage	46,637	17,600	24,900	28,900	35,300	43,100
Specialty Retail	29,925	10,200	14,400	16,700	20,400	24,900
News & Gifts	2,341	4,300	6,100	7,100	8,600	10,500
Duty Free	6,364	19,200	27,200	31,400	38,500	47,000
Subtotal	85,267	51,300	72,600	84,100	102,800	125,500
Concessions Support	18,005	10,300	14,500	16,800	20,600	25,100
Total	**103,272**	**61,600**	**87,100**	**100,900**	**123,400**	**150,600**
Surplus/(Deficit)						
Food & Beverage		29,037	21,737	17,737	11,337	3,537
Specialty Retail		19,725	15,525	13,225	9,525	5,025
News & Gifts		(1,959)	(3,759)	(4,759)	(6,259)	(8,159)
Duty Free		(12,836)	(20,836)	(25,036)	(32,136)	(40,636)
Subtotal		33,967	12,667	1,167	(17,533)	(40,233)
Concessions Support		7,705	3,505	1,205	(2,595)	(7,095)
Total		**41,672**	**16,172**	**2,372**	**(20,128)**	**(47,328)**

Source: Landrum & Brown analysis

4.3.2.6 *CBP Space*

The purpose of the CBP facilities is to screen passengers arriving on international flights. This space includes primary and secondary inspection areas, baggage claim, and transfer bag re-check areas. The CVG CBP facilities currently makes up 126,241 square feet of space in Concourse B. Requirements for the overall space were estimated based on the U.S. CBP's manual: *Airport Technical Design Standards*, November 2017 and industry standards. The resulting CBP requirements are shown in **Table 4.3-20, *CBP Space Requirements***. CVG is estimated to require 45,700 square feet of CBP space by PAL 4, which equates to a surplus of over 80,500 square feet.

TABLE 4.3-20 CBP SPACE REQUIREMENTS

	CBP Space (ft^2)				
	2017	**PAL 1**	**PAL 2**	**PAL 3**	**PAL 4**
Existing	126,241				
Requirement	20,900	24,100	27,800	29,300	38,400
Surplus/(Deficit)	105,341	102,141	98,441	96,941	87,841

Sources: U.S. CBP's manual: *Airport Technical Design Standards, November 2017*; Landrum & Brown analysis

4.3.2.7 *Terminal Support Spaces*

Terminal support spaces include airport operations space (such as non-public rest rooms and circulation), maintenance space, mechanical/electrical/plumbing space, and vertical circulation. These spaces at CVG currently total 399,332 square feet. Requirements for future terminal support space were developed based on the following assumptions:

- 4,687 square feet per EQA for airport operations space
- 2 percent of programmed terminal space for maintenance space
- 12 percent of programmed terminal space for mechanical/electrical/plumbing space
- 3 percent of programmed terminal space for vertical circulation

The resulting terminal support space requirements are shown in **Table 4.3-21, *Terminal Support Space Requirements***. The analysis shows that additional terminal support space will be needed by PAL 1. A deficit of over 266,000 square feet of terminal support space is projected for PAL 4.

TABLE 4.3-21 TERMINAL SUPPORT SPACE REQUIREMENTS

	Terminal Support Space (ft2)				
	2017	PAL 1	PAL 2	PAL 3	PAL 4
Existing	339,332				
Requirement	325,200	415,700	446,800	512,600	606,100
Surplus/(Deficit)	74,132	(16,368)	(47,468)	(113,268)	(206,768)

Sources: U.S. CBP's manual: *Airport Technical Design Standards, November 2017*; Landrum & Brown analysis

4.3.3 Terminal Space Program Summary

The requirements from the previous sections are summarized in **Table 4.3-22, *Terminal Space Program Summary***. This table adds an industry standard circulation allowance of 15 percent to the airline space, public space, and concessions requirements presented in the preceding sections. Circulation was already included in the CBP and terminal support requirements so no additional allowance for these spaces was added in the summary table.

The gross floor areas presented in the table represent the principal target values and planning requirements provided to meet the projected demand for the entire planning period. The requirements are pure programmatic results, based on projected peak hour volumes at defined stages during the planning period. As mentioned previously, these parameters constitute guidance to define facility needs, but the ability to accommodate site-specific information provides for the best assessment of future needs. It is important to note that the particular configuration of the facility can have considerable impact on future space needs beyond that which can be determined by analyzing the volumes of activity. A team of airport terminal specialists (planners and architects) must properly assess and recognize the organizational and functional flows, the physical distribution of spaces and passenger processing areas, as well as the support facilities within the passenger terminal building and the implications and interactions of each area in order to effectively use the programmatic results in a useful manner.

TABLE 4.3-22 TERMINAL SPACE PROGRAM SUMMARY

Functional Area	Space Requirement (ft^2)					
	Existing	2017	PAL 1	PAL 2	PAL 3	PAL 4
Airline Spaces						
Check-in						
Curbside Check-in	547	1,000	1,000	1,200	1,400	1,500
Full Service Check-in & Bag Drop	5,000	5,200	6,600	7,100	8,200	8,800
Self-Service Kiosk	11,000	9,800	12,200	13,300	15,400	16,800
ATO	2,768	2,300	3,000	3,200	3,600	4,300
Outbound Baggage Sorting	224,674	24,000	24,000	30,000	36,000	48,000
Baggage Screening	17,310	11,300	11,300	15,400	15,400	19,500
Domestic Baggage Claim	39,801	14,700	17,000	19,000	24,900	29,000
Inbound Baggage Drop Off	45,002	18,000	20,000	26,000	28,000	36,000
Baggage Service Offices	5,263	2,500	2,600	3,600	4,100	4,700
Contact Gate Holdrooms	134,615	96,200	123,700	131,200	150,000	177,500
Club/Lounge	46,348	46,000	46,000	46,000	46,000	46,000
Airline Operations	345,875	182,900	238,300	252,400	289,600	341,300
Subtotal Airline Space	878,203	413,900	505,700	548,400	622,600	733,400
Circulation	0	62,100	75,900	82,300	93,400	110,100
Total Airline Spaces	**878,203**	**476,000**	**581,600**	**635,700**	**716,000**	**843,500**
Public Space						
Check-in Lobby Circulation	10,305	13,000	16,300	17,600	20,100	21,800
Arrivals Greeter Hall	15,569	17,000	18,200	24,800	28,500	32,700
Concourse Central Circulation	154,702	149,500	191,500	203,200	232,000	274,800
Concourse Sterile Corridor	5,442	13,300	21,800	21,800	29,000	41,000
Rest Rooms	20,355	22,100	24,600	28,000	31,100	34,800
Passenger Security Screening	34,833	21,300	23,300	27,500	31,700	35,900
Subtotal Public Spaces	241,206	236,200	295,700	322,900	372,400	441,000

Functional Area	Space Requirement (ft²)					
	Existing	2017	PAL 1	PAL 2	PAL 3	PAL 4
Circulation	140,910	35,500	44,400	48,500	55,900	66,200
Total Public Spaces	**382,116**	**271,700**	**340,100**	**371,400**	**428,300**	**507,200**
Concession Spaces						
Food & Beverage	46,637	17,600	24,900	28,900	35,300	43,100
Specialty Retail	29,925	10,200	14,400	16,700	20,400	24,900
News & Gifts	2,341	4,300	6,100	7,100	8,600	10,500
Duty Free	6,364	19,200	27,200	31,400	38,500	47,000
Concessions Support	18,005	10,300	14,500	16,800	20,600	25,100
Subtotal Concessions Space	103,272	61,600	87,100	100,800	123,500	150,700
Circulation	0	9,300	13,100	15,200	18,600	22,600
Total Concessions Spaces	**103,272**	**70,900**	**100,200**	**116,000**	**142,100**	**173,300**
Total CBP Space	**126,241**	**20,900**	**24,100**	**27,800**	**29,300**	**38,400**
Total Terminal Support Space	**339,332**	**325,200**	**415,700**	**446,800**	**512,600**	**606,100**
Total Building Area	**1,889,164**	**1,164,700**	**1,461,700**	**1,592,700**	**1,828,300**	**2,168,500**

Sources: KCAB; Vic Thompson Company; Landrum & Brown analysis

4.4 Landside Access and Parking

The determination of landside access and parking requirements falls into three main categories:

- **Landside Access Roadways**: Projects the demand that is anticipated to be placed on the roadways that serve as the primary access routes for vehicles entering and exiting CVG, as well as defines the improvements that may be required to accommodate the projected demand.
- **Vehicle Parking**: Projects the demand that is anticipated to be placed on both the public parking facilities as well as employee parking facilities and quantifies the amount of additional (if any) parking facilities required to accommodate this demand. This analysis includes both on-airport and off-airport parking facilities.
- **Main Terminal Curbfront**: Projects the demand that is anticipated to be placed on the main terminal curbfronts and quantifies the additional curbfront length (if any) required to accommodate the projected demand.

4.4.1 Landside Access Roadways

Traffic volumes were projected on an average daily and peak hourly basis for the existing and planned conditions under the proposed Consolidated Rent-a-car Facility (CONRAC) and associated developments within the study area. Observed traffic volumes using traffic counts developed in the fall of 2017 were used in the landside access analysis. The traffic volumes were increased for each PAL based on passenger growth rates presented in Appendix 1-B, Alternative Forecasts, for the recommended forecast. Annual enplanement growth rates were applied to the future average daily traffic (ADT) levels and peak hour enplanement growth rates were applied to the peak hour traffic counts.

The following conditions were assumed based on the proposed CONRAC development and were applied to the traffic projections through the planning period:

- The difference between the northbound exiting movements at the south end of Loomis and the northbound entering movements at Loomis and Donaldson Roads equaled the number of vehicles entering or exiting from the rental car driveways on Loomis Road.
- Trip generation for a proposed site at the existing rental car facility was not added until PAL 3.
- Trip generation for a proposed Aeroterm site west of Loomis was added in PAL 1.
- Any rental car shuttle trips were removed from the network. It was assumed that approximately 60 percent of the shuttles at the Ground Transportation Center (GTC) were rental car shuttles.
- For existing intersections with movements proposed to be removed under the CONRAC changes, the net movement volume following the CONRAC adjustment was corrected to zero out the movement.
- The ValuPark shuttle peak hour volume was calculated using the bus counts at the entrance to the ValuPark lot.
- The employee lot shuttle peak hour volume was calculated using the bus counts at the entrance to the employee lot.
- From daily data for hotel shuttle operations provided by CVG, the peak hour volumes were approximated based on existing conditions and volumes.
- It was assumed that because of the nature of the EconoLot as an overflow lot for ValuPark, approximately a third of the lot would be filled on average, or 333 spaces, in 2017. A ratio of the volumes at the entrance to the ValuPark lot to the available spaces was applied to the 333 EconoLot spaces in the employee lot to approximate the expected new trips at the employee lot entrance. Overflows will continue to increase during peak flows as passenger volumes grow.
- The T1 Garage has 500 spaces which are currently used by employees; it was assumed that all of the T1 spaces will be used by employees in the future.

For the purposes of this Master Plan analysis, the landside roadway network was divided into a series of segments and identified using a unique segment identifier, as shown on **Exhibit 4.4-1, *Landside Roadway Segments***. Projected traffic volumes for the morning and afternoon peak hours were compared to existing capacity for each segment to determine an hourly flow rate per lane, and the resulting LoS. Industry standards generally consider LoS D acceptable for urban roadway environments. Roadway improvements target LoS C or D for future operations.

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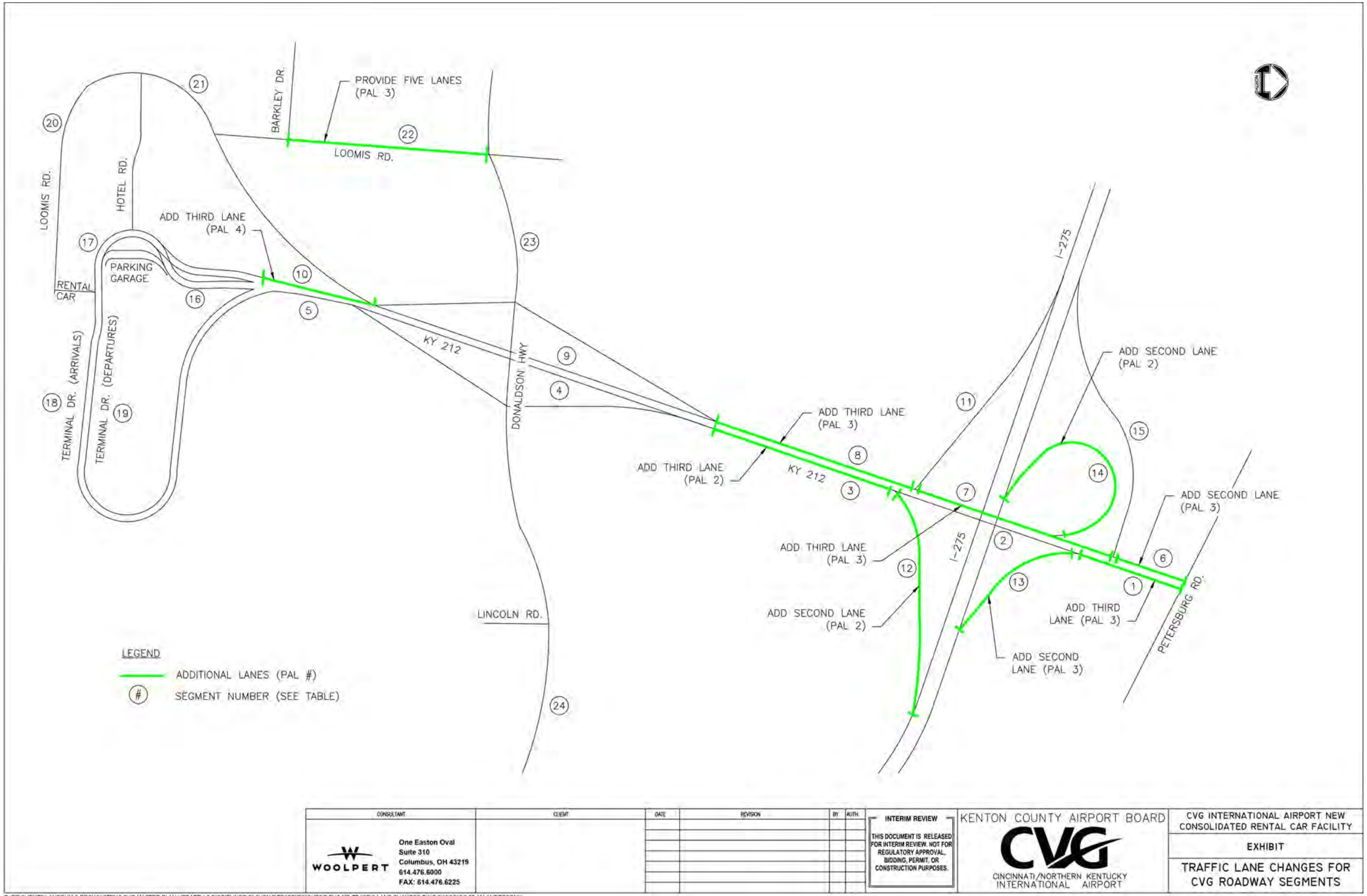
EXHIBIT 4.4-1 LANDSIDE ROADWAY SEGMENTS



Source: Woolpert analysis

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Table 4.4-1, *Traffic Volumes and LoS of Roadway Segments – 2017*, presents the LoS for each segment for 2017. In 2017, all segments were found to operate at a LoS of D or better.

TABLE 4.4-1 TRAFFIC VOLUMES AND LOS OF ROADWAY SEGMENTS – 2017

Segment Number	Speed Limit	ADT[1]	DHV[1]	LOS[1]	Existing Lanes	Proposed Lanes	Change
1	45 mph	10,122	992	B	2	2	-
2	45 mph	6,122	600	A	2	2	-
3	45 mph	16,987	1,342	B	2	2	-
4	45 mph	7,347	720	A	2	2	-
5	45 mph	10,369	871	A	2	2	-
6	45 mph	10,255	1,005	C	1	1	-
7	45 mph	15,459	1,515	C	2	2	-
8	45 mph	12,153	1,191	B	2	2	-
9	45 mph	7,347	720	A	2	2	-
10	45 mph	8,327	816	A	2	2	-
11	45 mph	3,796	372	A	1	1	-
12	65 mph	13,939	1,366	D	1	1	-
13	45 mph	7,357	721	B	1	1	-
14	30 mph	7,500	735	C	1	1	-
15	65 mph	2,786	273	A	1	1	-
16	30 mph	3,276	321	A	2	2	-
17	30 mph	8,684	851	A	2	2	-
18	30 mph	5,051	495	B	2	2	-
19	30 mph	3,276	321	B	2	2	-
20	30 mph	11,918	1,168	B	2	2	-
21	30 mph	2,143	210	A	2	2	-
22	30 mph	4,286	420	A	2	2	-
23	30 mph	7,520	737	A	4	4	-
24	30 mph	9,490	930	A	4	4	-

[1] ADT = average daily traffic; DHV = design hourly vehicle; LoS = level of service.
Source: Woolpert analysis

Table 4.4-2, *Traffic Volumes and LoS of Roadway Segments – PAL 1*, presents the LoS for each segment for PAL 1. All segments are projected to operate at a LoS of D or better in PAL 1. No improvements were therefore identified for PAL 1.

TABLE 4.4-2 PROJECTED TRAFFIC VOLUMES AND LOS OF ROADWAY SEGMENTS – PAL 1

Segment Number	Speed Limit	ADT[1]	DHV[1]	LOS[1]	Existing Lanes	Proposed Lanes	Change in # of Lanes
1	45 mph	12,459	1,221	B	2	2	-
2	45 mph	7,735	758	A	2	2	-
3	45 mph	21,456	1,695	C	2	2	-
4	45 mph	8,673	850	A	2	2	-
5	45 mph	13,988	1,175	B	2	2	-
6	45 mph	12,633	1,238	D	1	1	-
7	45 mph	19,153	1,877	C	2	2	-
8	45 mph	15,133	1,483	C	2	2	-
9	45 mph	8,673	850	A	2	2	-
10	45 mph	15,459	1,515	C	2	2	-
11	45 mph	4,847	475	B	1	1	-
12	65 mph	17,388	1,704	D	1	1	-
13	45 mph	9,041	886	C	1	1	-
14	30 mph	9,367	918	D	1	1	-
15	65 mph	3,469	340	A	1	1	-
16	30 mph	11,439	1,121	C	2	2	-
17	30 mph	12,633	1,238	C	2	2	-
18	30 mph	5,918	580	B	2	2	-
19	30 mph	4,020	394	B	2	2	-
20	30 mph	765	75	B	2	2	-
21	30 mph	3,786	371	B	2	2	-
22	30 mph	4,133	405	B	2	2	-
23	30 mph	6,510	638	B	4	4	-
24	30 mph	11,969	1,173	B	4	4	-

[1] ADT = average daily traffic; DHV = design hourly vehicle; LoS = level of service.
Source: Woolpert analysis

Table 4.4-3, *Traffic Volumes and LoS of Roadway Segments – PAL 2*, presents the LoS for each segment for PAL 2. The LoS shown reflects improvements to Segments 3, 6, 12, and 14 (widening to provide an additional lane for each segment as shown in the last column of the table). The noted deficiencies and recommended improvements for these three segments are described as follows:

- Southbound KY 212 from Petersburg Road to I-275 ramp (Segment 6) is projected to degrade to LoS E without improvements. Widening to two lanes would provide LoS C.
- Operations on the entrance ramp from northbound KY 212 to eastbound I-275 (Segment 12) are projected to degrade to LoS E without improvements. Widening to a two-lane entrance ramp would restore operations to LoS C. With the limited weaving length between Donaldson Highway (KY 236) and the entrance ramp (Segment 12), this improvement should include an auxiliary weaving lane between the entrance ramp from Donaldson to the I-275 ramp (Segment 3), improving LoS on Segment 3 to B.
- The westbound I-275 exit ramp (loop ramp – Segment 14) to southbound KY 212 is projected to degrade to LoS E without improvements. Widening to a two-lane ramp would provide an LoS of C.

Table 4.4-4, *Traffic Volumes and LoS of Roadway Segments – PAL 3*, presents the LoS for each segment for PAL 3. The LoS shown reflects the PAL 2 improvements to Segments 3, 6, 12, and 14 shown in Table 4.4-3 in addition to improvements to Segments 1, 6-8, 13, and 22 (widening to provide additional lane(s) for each segment as shown in the last column of the table) that are recommended for PAL 3 to avoid unacceptable LoS. The noted deficiencies and recommended improvements for Segments 1, 6-8, 13, and 22 include the following:

- Operations on northbound KY 212 from the I-275 exit ramp to Petersburg Road (Segment 1) are projected to degrade to LoS D/E without improvements. Widening to a third northbound lane on KY 212 would provide an LoS of B/C. This is a short (500-foot long) segment that should be included in the PAL 3 exit ramp widening to improve weaving operations approaching Petersburg Road.
- Operations on southbound KY 212 from Petersburg Road through the I-275 interchange to Donaldson Highway (Segments 6, 7, and 8) are projected to degrade to LoS E/F without improvements. Widening to an additional southbound lane on KY 212 is projected to provide LoS C.
- The westbound I-275 exit ramp to northbound KY 212 (Segment 13) is projected to degrade to LoS E without improvements. Widening to a two-lane ramp would provide an LoS of C.
- Projected traffic volumes on Loomis Road between Barkley and Donaldson (Segment 22) would require five lanes (two through lanes in each direction).

TABLE 4.4-3 PROJECTED TRAFFIC VOLUMES AND LOS OF ROADWAY SEGMENTS – PAL 2

Segment Number	Speed Limit	ADT[1]	DHV[1]	LoS[1]	Existing Lanes	Proposed Lanes	Change in # of Lanes
1	45 mph	15,898	1,558	C	2	2	-
2	45 mph	9,816	962	B	2	2	-
3	45 mph	27,241	2,152	B[2]	2	3	+1
4	45 mph	11,071	1,085	B	2	2	-
5	45 mph	17,857	1,500	C	2	2	-
6	45 mph	16,112	1,579	B[2]	1	2	+1
7	45 mph	24,408	2,392	D	2	2	-
8	45 mph	19,276	1,889	C	2	2	-
9	45 mph	11,071	1,085	B	2	2	-
10	45 mph	15,306	1,500	C	2	2	-
11	45 mph	6,143	602	B	1	1	-
12	65 mph	22,122	2,168	C[2]	1	2	+1
13	45 mph	11,541	1,131	D	1	1	-
14	30 mph	11,888	1,165	C[2]	1	2	+1
15	65 mph	4,418	433	A	1	1	-
16	30 mph	14,602	1,431	D	2	2	-
17	30 mph	16,122	1,580	D	2	2	-
18	30 mph	7,551	740	B	2	2	-
19	30 mph	5,133	503	B	2	2	-
20	30 mph	969	95	B	2	2	-
21	30 mph	4,837	474	B	2	2	-
22	30 mph	5,204	510	B	2	2	-
23	30 mph	8,102	794	B	4	4	-
24	30 mph	15,235	1,493	B	4	4	-

1 ADT = average daily traffic; DHV = design hourly vehicle; LoS = level of service.
2 The LoS shown reflects the improvements discussed in the text (added lanes).
Source: Woolpert analysis

TABLE 4.4-4 PROJECTED TRAFFIC VOLUMES AND LOS OF ROADWAY SEGMENTS – PAL 3

Segment Number	Speed Limit	ADT[1]	DHV[1]	LoS[1]	Existing Lanes	Proposed Lanes	Change in # of Lanes
1	45 mph	20,765	2,035	B[2]	2	3	+1
2	45 mph	12,898	1,264	B	2	2	-
3	45 mph	35,823	2,830	C[2]	2	3	+1
4	45 mph	14,449	1,416	B	2	2	-
5	45 mph	23,310	1,958	C	2	2	-
6	45 mph	21,061	2,064	C[2]	1	2	+1
7	45 mph	31,929	3,129	C[2]	2	3	+1
8	45 mph	25,245	2,474	C[2]	2	3	+1
9	45 mph	14,449	1,416	B	2	2	-
10	45 mph	19,980	1,958	C	2	2	-
11	45 mph	8,041	788	C	1	1	-
12	65 mph	29,010	2,843	C[2]	1	2	+1
13	45 mph	15,061	1,476	C[2]	1	2	+1
14	30 mph	15,561	1,525	D[2]	1	2	+1
15	65 mph	5,786	567	A	1	1	-
16	30 mph	19,061	1,868	D	2	2	-
17	30 mph	21,041	2,062	E	2	2	-
18	30 mph	9,857	966	B	2	2	-
19	30 mph	6,704	657	B	2	2	-
20	30 mph	1,265	124	B	2	2	-
21	30 mph	6,306	618	B	2	2	-
22	30 mph	6,888	675	B[2]	2	4	+2
23	30 mph	10,949	1,073	B	4	4	-
24	30 mph	19,949	1,955	C	4	4	-

1 ADT = average daily traffic; DHV = design hourly vehicle; LoS = level of service.
2 The LoS shown reflects the improvements discussed in the text (added lanes).
Source: Woolpert analysis

Table 4.4-5, *Traffic Volumes and LoS of Roadway Segments – PAL 4*, presents the LoS for each segment for PAL 4. The LoS shown reflects the PAL 2 and PAL 3 improvements shown in Table 4.4-3 and Table 4.4-4 in addition to improvements to Segment 10 (widening to provide an additional lane as shown in the last column of the table) that are recommended for PAL 4 to avoid an unacceptable LoS. Operations on southbound KY 212 from Donaldson Highway south on-ramp through the Terminal Drive Arrivals/Departures split (Segment 10) are projected to degrade to LoS D without improvements due to the short distance for weaving (500 feet). Widening to an additional southbound lane on KY 212 would provide for an LoS of C.

4.4.2 Vehicle Parking

Parking requirements were determined for employee and public parking, for all parking locations (terminal garages, CVG-owned surface lots, and privately-owned off-site parking). Currently, there are 4,900 employee spaces available in two different areas of CVG: T1 Garage (500 spaces) and the remote Employee Lot (4,400 spaces). There are 13,016 Airport-owned parking spaces available to the public: T2 and T3 Garages (6,816 spaces) and ValuPark (6,200 spaces). In addition to the Airport-owned parking products, the public may also choose to park at privately-owned lots off-site. Private operators have the capacity to provide approximately 5,500 off-site spaces near CVG. This parking analyses assumed this offsite parking would remain open, and the utilization balance between off-airport and on-Airport parking would remain relatively stable.

Two projects are currently in implementation that will affect the parking products available at CVG. The first project is a short-term project to convert 1,000 spaces to public use within the remote employee parking lot. This public space – branded as the Economy Lot – will increase the total public parking spaces to 14,016 but reduce the remote employee spaces to 3,400. The CONRAC will remove 350 public parking spaces from Terminal Garage 2 and add 100 public parking spaces in Terminal Garage 3 for a net loss of 250 public parking spaces. After the CONRAC is open in 2021, CVG will provide 13,766 public parking spaces and 3,400 employee parking spaces.

4.4.2.1 *Employee Parking*

Vehicular parking counts provided by KCAB for a typical day in April 2018 indicated a peak employee lot occupancy of 1,252 vehicles, with an additional 113 employees utilizing the T1 garage parking, resulting in a total daily employee parking demand of 1,365 spaces. With changes to terminal parking from the CONRAC development, the T1 garage is anticipated to become an all employee parking facility. Employee parking beyond the T1 garage capacity will be directed to the remote Employee Lot.

Employee vehicle parking requirements were developed by evaluating historic parking demand to determine a planning factor, representing the average number of parking spaces required compared to a given level of activity. This planning factor was then applied to projections of PAL 1 through 4 annual departures.

TABLE 4.4-5 PROJECTED TRAFFIC VOLUMES AND LOS OF ROADWAY SEGMENTS – PAL 4

Segment Number	Speed Limit	ADT[1]	DHV[1]	LoS[1]	Existing Lanes	Proposed Lanes	Change in # of Lanes
1	45 mph	23,327	2,286	C[2]	2	3	+1
2	45 mph	14,449	1,416	B	2	2	-
3	45 mph	40,127	3,170	D[2]	2	3	+1
4	45 mph	16,235	1,591	C	2	2	-
5	45 mph	26,190	2,200	D	2	2	-
6	45 mph	23,663	2,319	D[2]	1	2	+1
7	45 mph	35,837	3,512	D[2]	2	3	+1
8	45 mph	28,327	2,776	C[2]	2	3	+1
9	45 mph	16,235	1,591	C	2	2	-
10	45 mph	22,449	2,200	C[2]	2	3	+1
11	45 mph	9,000	882	C	1	1	-
12	65 mph	32,531	3,188	D[2]	1	2	+1
13	45 mph	16,918	1,658	C[2]	1	2	+1
14	30 mph	17,459	1,711	D[2]	1	2	+1
15	65 mph	6,490	636	A	1	1	-
16	30 mph	21,418	2,099	E	2	2	-
17	30 mph	23,643	2,317	E	2	2	-
18	30 mph	11,071	1,085	C	2	2	-
19	30 mph	7,531	738	B	2	2	-
20	30 mph	1,418	139	B	2	2	-
21	30 mph	7,071	693	B	2	2	-
22	30 mph	7,684	753	B[2]	2	4	+2
23	30 mph	12,133	1,189	B	4	4	-
24	30 mph	22,388	2,194	C	4	4	-

[1] ADT = average daily traffic; DHV = design hourly vehicle; LoS = level of service.
[2] The LoS shown reflects the improvements discussed in the text (added lanes).
Source: Woolpert analysis

A peak demand of 1,365 spaces resulted from 75,453 annual departures; this corresponds to a planning factor of 0.0181 annual departures per employee parking space. This factor is substantially lower than the previous CVG Master Plan, which calculated a planning factor of 0.0315. The decrease in parking demand does appear to be warranted based on changing employment conditions over the past five years and further drawdown of the Delta Air Lines hub. A search factor of 0.90 was applied to the daily parking requirements to account for acceptable times required to search for empty spaces. The projections for future employee parking requirements are presented in **Table 4.4-6, *Employee Parking Requirements***.

TABLE 4.4-6 EMPLOYEE PARKING REQUIREMENTS

Year	Annual Departures	Daily Parking Demand	Search Factor	Requirements (spaces)			Existing Spaces	Surplus/ (Deficit)
				Total	Garage	Remote		
2017	75,453	1,365	0.90	1,517	126	1,391	4,400	3,009
PAL 1	82,977	1,501	0.90	1,668	-	1,668	3,400	1,732
PAL 2	96,606	1,748	0.90	1,942	-	1,942	3,400	1,458
PAL 3	110,835	2,005	0.90	2,228	-	2,228	3,400	1,172
PAL 4	132,394	2,395	0.90	2,661	-	2,661	3,400	739

Note: Search Factor represents how easy it is to find an available parking space. A search factor of 0.9 results in approximately 1.10 spaces available per spaces required.
Source: Woolpert analysis

Based on projected traffic, the employee parking demand is not expected to exceed capacity through the planning period, even with the current re-purposing of 1,000 spaces in the Remote Employee Lot.

4.4.2.2 *Public Parking*

Public parking at CVG is split between the terminal parking garages, remote on-airport parking, and remote off airport parking. It is assumed that the split of public parking between terminal garages and remote parking facilities, both airport owned and private, will remain consistent. Current parking usage data was based on a combination of peak counts provided by KCAB, aerial images from Google Earth, and the professional judgement of the Master Plan Team.

Remote Public Parking

With the current conversion of 1,000 employee parking spaces to public parking, the remote public parking capacity will increase by 1,000 spaces resulting in a total capacity of 7,200 stalls. Vehicular parking counts provided by KCAB indicated a peak ValuPark occupancy of 5,086 vehicles. A planning factor of stalls per local enplaned passenger was established by comparing the existing remote public parking demand to the average day local enplaned passengers for each PAL. The annual local enplaned passenger volume was averaged on a daily basis. For 2017, this resulted in an average of 10,384 daily local enplaned passengers. This results in a planning factor of 0.4898 spaces per daily enplaned passenger.

The 1,000 spaces available in the new Economy Lot are anticipated to come on-line at the end of 2018. The projected remote public parking requirements are presented in **Table 4.4-7, *Remote Public Parking Requirements (On-Airport)***. Demand for remote public parking is projected to exceed existing capacity (including the 1,000 additional spaces re-purposed in the employee lot) sometime before PAL 1.

TABLE 4.4-7 REMOTE PUBLIC PARKING REQUIREMENTS (ON-AIRPORT)

Year	Enplaned Passengers		Daily Parking Demand	Search Factor	Required Spaces	Existing Spaces	Surplus/ (Deficit)
	Annual	Average Daily					
2017	3,790,240	10,384	5,086	0.9	5,651	6,200	549
PAL 1	5,271,600	14,443	7,074	0.9	7,860	7,200	(660)
PAL 2	6,007,290	16,458	8,061	0.9	8,957	7,200	(1,757)
PAL 3	7,164,680	19,629	9,614	0.9	10,682	7,200	(3,482)
PAL 4	8,523,640	23,352	11,438	0.9	12,709	7,200	(5,509)

Note: Search Factor represents how easy it is to find an available parking space. A search factor of 0.9 results in approximately 1.10 spaces available per spaces required.
Source: Woolpert analysis

For off-airport (privately owned) facilities, Google Earth aerial imagery indicated that on average, approximately 80 percent (2,140 spaces) of the FastPark & Relax and approximately 30 percent (215 spaced) of the Xpress Park and Ride is utilized. This results in a total parking demand in 2017 of 7,441 spaces. When corelating both on and off-airport parking demand to passenger demand, this yields a planning factor of 0.7166 spaces per daily enplaned passenger. **Table 4.4-8, *Remote Public Parking Requirements (On-Airport and Off-Airport)***, presents the total projected demand when considering the off-airport parking.

TABLE 4.4-8 REMOTE PUBLIC PARKING REQUIREMENTS (ON-AIRPORT AND OFF-AIRPORT)

Year	Enplaned Passengers		Daily Parking Demand	Search Factor	Required Spaces	Existing Spaces	Surplus/ (Deficit)
	Annual	Average Daily					
2017	3,790,240	10,384	7,441	0.9	8,268	11,692	3,424
PAL 1	5,271,600	14,443	10,350	0.9	11,500	12,692	1,192
PAL 2	6,007,290	16,458	11,794	0.9	13,104	12,692	(412)
PAL 3	7,164,680	19,629	14,066	0.9	15,629	12,692	(2,937)
PAL 4	8,523,640	23,352	16,734	0.9	18,593	12,692	(5,901)

Note: Search Factor represents how easy it is to find an available parking space. A search factor of 0.9 results in approximately 1.10 spaces available per spaces required.
Source: Woolpert analysis

These results indicate that the off-airport parking providers have sufficient capacity to accommodate additional parking demand, especially moving forward if additional on-airport parking facilities are not developed. Demand for on-site, CVG remote parking is expected to exceed the available parking spaces by PAL 1. Factoring in the non CVG remote parking, demand is expected to exceed the combined available parking spaces by PAL 2.

Public Parking Garages

The planned development of the new CONRAC facility will result in the reduction of public parking garage spaces by 350. This reduction in spaces will occur in the T2 Garage. To help mitigate this reduction,100 spaces have recently been added to the T3 Garage with the associated reconfiguration of the exit plaza. The expected public parking garage capacity with the CONRAC changes will total 6,566 spaces.

Vehicular parking counts provided by KCAB indicated a peak garage occupancy of 5,523 vehicles. A planning factor of spaces per local enplaned passenger was established by comparing the existing public parking garage demand to the number of average day enplaned passengers for each PAL. This resulted in a planning factor of 0.5319 spaces per daily enplaned passenger.

The projected public parking garage requirements are presented in **Table 4.4-9, *Public Parking Garage Requirements***.

TABLE 4.4-9 PUBLIC PARKING GARAGE REQUIREMENTS

Year	Enplaned Passengers		Daily Parking Demand	Search Factor	Required Spaces	Existing Spaces	Surplus/ (Deficit)
	Annual	Average Daily					
2017	3,790,240	10,384	5,523	0.9	6,137	6,816	679
PAL 1	5,271,600	14,443	7,682	0.9	8,536	6,566	(1,970)
PAL 2	6,007,290	16,458	8,754	0.9	9,727	6,566	(3,161)
PAL 3	7,164,680	19,629	10,440	0.9	11,600	6,566	(5,034)
PAL 4	8,523,640	23,352	12,420	0.9	13,800	6,566	(7,234)

Note: Search Factor represents how easy it is to find an available parking space. A search factor of 0.9 results in approximately 1.10 spaces available per spaces required.
Source: Woolpert analysis

4.4.2.3 *Potential Effects of Technology*

Surface transportation choices have changed rapidly over the last five years with the introduction of on-demand rides and the infancy of the connected and autonomous vehicles unfolding. Given the rapid changes and use of technology, it is difficult to confidently predict the impact of these technologies, much less technologies that have yet to be developed. The one thing that is clear is that the need for traditional parking capacity that is oriented towards driver-based vehicles is likely to diminish over time and the need for alternative facilities may be realized. The amount of the reduced capacity is debated and therefore is not included in the parking requirements previously presented in this section. It is recommended that future Master Plans continue to research this trend and incorporate recommendations for appropriate physical improvements to accommodate the needs.

4.4.3 Main Terminal Curbfront

Length requirements for the main terminal curbfront were calculated using the methodology prescribed in the Airport Cooperative Research Board (ACRP) Report 40. A base assumption of this analysis is that upon completion of the CONRAC project, the vehicles utilizing the main terminal curbfront will change significantly. The curbfront assignment assumptions are presented in **Table 4.4-10, *Curbfront Assumptions***. These are the assumed assignments of curbfronts between the arrivals curbfront, the departures curbfront, the existing GTC, and the new GTC in the CONRAC. These assumptions are accounted for in the traffic volume projections for the arrival and departure curbfronts presented in **Tables 4.4-11 and 4.4-12, *Curbfront Design Hour Vehicles (DHV)*.** These projections are presented by vehicle type: private vehicle, Transportation Network Company (TNC) vehicles which are Uber and Lyft vehicles, and shuttles.

TABLE 4.4-10 CURBFRONT ASSUMPTIONS

Vehicle Type	2017		PAL 1 – PAL 4	
	Departures	Arrivals	Departures	Arrivals
Private Vehicles	Departures Curbfront	Arrivals Curbfront	Departures Curbfront	Arrivals Curbfront
TNC	Departures Curbfront	Arrivals Curbfront	Departures Curbfront	GTC
Taxis/Limos	Departures Curbfront	GTC	Departures Curbfront	GTC
Hotel Shuttles	Departures Curbfront	GTC	CONRAC GTC	CONRAC GTC
Rental Car Shuttles	Departures Curbfront	GTC	N/A	N/A
Parking Shuttles	Departures Curbfront	Arrivals Curbfront	CONRAC GTC	CONRAC GTC

Source: KCAB

TABLE 4.4-11 CURBFRONT DESIGN HOUR VEHICLES (DHV) – ARRIVALS

Vehicle Type	2017	PAL 1	PAL 2	PAL 3	PAL 4
Private Vehicles	253	310	396	516	580
TNC	217	268	341	446	501
Shuttles	33	30	39	51	57
Total	**503**	**608**	**776**	**1,013**	**1,138**

Source: Woolpert analysis

TABLE 4.4-12 CURBFRONT DESIGN HOUR VEHICLES (DHV) – DEPARTURES

Vehicle Type	2017	PAL 1	PAL 2	PAL 3	PAL 4
Private Vehicles	144	173	222	289	324
TNC	131	173	221	289	325
Shuttles	26	40	50	66	74
Taxis/Limos	10	28	35	46	52
Total	**311**	**394**	**503**	**657**	**738**

Source: Woolpert analysis

These calculations of curbfront requirements are based on assumed vehicle dwell times which are applied to traffic count projections to determine the demand on the curbfront. In order to develop the assumed dwell times, observations were made of both the departures curbfront and the arrivals curbfront during their respective peak hours on Thursday May 31, 2018. The objective of these observations was to document the dwell time and type of all vehicles observed. A total of 251 vehicles were observed on the arrivals curbfront and 346 vehicles on the departures curbfront. From these observations assumptions on future vehicle dwell times were made. The assumed vehicle dwell times are presented in **Table 4.4-13, *Vehicle Dwell Times***.

TABLE 4.4-13 VEHICLE DWELL TIMES

Vehicle Type	Observed Average (minutes)	Observed Average Exclude > 5 min (minutes)	Assumed Dwell Time (minutes)
Arrivals Curbfront			
Private Vehicles	2.26	1.41	1.50
TNC/Taxis	1.25	1.24	1.25
Shuttles	7.69	3.12	5.00
Departures Curbfront			
Private Vehicles	2.05	1.63	1.75
TNC/Taxis	1.11	1.11	1.25
Shuttles	1.17	1.17	2.00
Black Cars/Limos	2.54	1.93	2.00

Source: Landrum & Brown analysis

ACRP Report 40 prescribes a maximum utilization rate of the curbfront to determine the LoS. **Table 4.4-14, *Curbfront LoS Ratios***, presents the utilization thresholds for each LoS. For the purposes of this analysis the assumed objective of CVG is to maintain a LoS C on both curbfronts which means that the curbfront will never exceed 130 percent utilization (i.e. that there will never be more than 30 percent of the curbfront length double parked).

TABLE 4.4-14 CURBFRONT LOS RATIOS

LoS	Maximum Utilization Ratio
LoS A	90%
LoS B	110%
LoS C	130%
LoS D	170%
LoS E	200%

Source: ACRP Report 40

The results of the arrivals curbfront analysis are presented in **Table 4.4-15, *Curbfront Length Requirements – Arrivals***. The results show that the existing arrivals curbfront length will maintain LoS A through the planning period. It is important to note that the calculation of surplus/deficit in PAL 1 through PAL 4 only accounts for the vehicles assumed to be utilizing the curbfront after the opening of the CONRAC. This calculation also assumes that the entirety of the curbfront is available for private vehicles and not used by other functions such as Airport Valet Parking which was assumed to be accommodated in the CONRAC.

TABLE 4.4-15 CURBFRONT LENGTH REQUIREMENTS – ARRIVALS

Vehicle Type	Existing (ft)	Requirement (ft)				
		2017	PAL 1	PAL 2	PAL 3	PAL 4
Private Vehicles	1,020	190	210	260	340	370
TNC/Taxis/Limos		130	0	0	0	0
Shuttles		180	0	0	0	0
Total		**500**	**210**	**260**	**340**	**370**
Surplus/(Deficit)		**520**	**810**	**760**	**680**	**650**

Source: Landrum & Brown analysis

The results of the departures curbfront analysis, which are presented in **Table 4.4-16, *Curbfront Length Requirements – Departures***, indicate that the existing departures curbfront length is currently at capacity to maintain LoS C and will require expansion or a reallocation of vehicles to the GTCs beginning in PAL 1. It is important to note that the calculation of surplus/deficit in PAL 1 through PAL 4 only accounts for the vehicles assumed to be utilizing the curbfront after the opening of the CONRAC.

TABLE 4.4-16 CURBFRONT LENGTH REQUIREMENTS – DEPARTURES

Vehicle Type	Existing (ft)	Requirement (ft)				
		2017	PAL 1	PAL 2	PAL 3	PAL 4
Private Vehicles	335	130	170	190	240	260
TNC/Taxis/Limos		140	180	190	270	270
Shuttles		60	0	0	0	0
Total		**330**	**350**	**380**	**510**	**530**
Surplus/(Deficit)		**5**	**(15)**	**(45)**	**(175)**	**(195)**

Source: Landrum & Brown analysis

4.5 Air Cargo

The CVG cargo facility requirements were prepared as a general set of requirements targeted at understanding the minimum level of cargo building space (warehouse/office) that will be needed based on the annual cargo tonnage for each PAL, minimum parking requirements for employees based on building area, truck dock requirements based on the daily cargo tonnage and peak period traffic, and the minimum apron area requirements (area and parking positions) based on the daily freighter operations and peak period demand.

4.5.1 Air Cargo Aircraft Parking Requirements

Similar to the process that was used to determine the requirements for passenger aircraft parking positions, an aircraft on ground analysis was performed using a DDFS for only air cargo operations. Due to the fact that air cargo aircraft do not utilize contact positions, but park remotely on dedicated cargo aprons, the need to distinguish between active and inactive aircraft was not necessary. **Table 4.5-1, *Air Cargo Aircraft Parking Requirements***, presents the projected demand for air cargo aircraft parking positions throughout the planning period.

TABLE 4.5-1 AIR CARGO AIRCRAFT PARKING REQUIREMENTS

Aircraft	2017	PAL 1	PAL 2	PAL 3	PAL 4
ADG II	4	4	4	5	6
ADG III	6	11	17	27	40
ADG IV	33	45	57	77	107
ADG V	5	16	29	53	78
ADG VI	1	1	1	2	3
Total	**49**	**77**	**108**	**164**	**234**

Note: The required positions by ADG are not necessarily equal the total position requirements as they only indicate the peak number of that aircraft type on the ground at any given time.
Source: Landrum & Brown analysis

4.5.2 Air Cargo Facility Requirements

Cargo building sizing was based on assumptions of throughput or processing rates by type of cargo or specific carrier or segment type. For CVG it was assumed that three main cargo building areas would be required (Amazon, DHL, and a north cargo area for all other cargo entities). **Table 4.5 2, *Air Cargo Planning Assumptions***, presents the various planning assumptions utilized in the determination of air cargo facility requirements for CVG.

TABLE 4.5-2 AIR CARGO PLANNING ASSUMPTIONS

Assumption	Value
Throughput – Amazon Air (annual tons/ft2)	1.5
Throughput – DHL (annual tons/ft2)	1.5
Throughput – Other (annual tons/ft2)	0.5 - 1.0
Security/Storage Areas	+10%
Office Space	+10%
Employee Parking (stalls/10,000 ft2 of warehouse)	5
Employee Parking (stalls/1,000 ft2 of office)	4
Parking Space (ft2/stall inclusive of circulation)	300
Daily Demand in Peak Hour	40%
Turns per Truck Dock	2-4
Truck Dock Courtyard Depth (ft)	125

Source: Landrum & Brown analysis

Combined, the building areas, parking areas for employees, and trucks provide the assumed minimum area necessary for basic cargo facility operations. Additional factors for truck staging, safety offsets, green space and other specific desired function can be applied and added to the minimum facility requirements in estimating the total target area necessary for the dedicated or shared cargo facilities. Much of these additional considerations are determined by the cargo operator developing the facility. It is assumed that the vast majority of the air cargo facility requirements will be met by the independent facilities that are being developed by Amazon and DHL so as to best meet their individual needs.

Table 4.5-3, *Air Cargo Facility Requirements,* presents the projected basic air cargo facility requirements through the planning period.

TABLE 4.5-3 AIR CARGO FACILITY REQUIREMENTS

Requirement	2017	PAL 1	PAL 2	PAL 3	PAL 4
Building					
Warehouse (ft^2)	754,000	1,434,000	1,892,000	3,025,000	4,542,000
Office (ft^2)	75,000	143,000	189,000	303,000	454,000
Security/Storage (ft^2)	75,000	143,000	189,000	303,000	454,000
Total Building (ft^2)	905,000	1,721,000	2,270,000	6,630,000	5,450,000
Auto Parking (stalls)	750	1,430	1,890	3,020	4,530
Auto Parking (ft^2)	225,300	428,700	565,800	905,400	1,358,700
Truck Dock Bays	40	60	80	110	140

Source: Landrum & Brown analysis

4.6 Support Facilities

The support facilities at any airport are an integral part of the system a whole. Without these support facilities, the servicing of aircraft, passengers, and cargo would not be possible. This section identifies the future support facilities requirements throughout the planning period. In addition to providing growth to accommodate projected demand, the support facilities also need to account for other proposed airfield changes.

Factors such as support facility utilization, aircraft size, demand type and peak volumes are key drivers of these facility requirements. The support facilities discussed in this section have been divided up into the following categories:

- Airline Support
- Airport Support
- Catering
- Aircraft Fuel
- General Aviation (GA)
- ATCT
- Government/Police
- Aircraft Rescue and Firefighting (ARFF)
- Airport Hotel

The support facility requirements analysis is a foundation for the development of the support facility alternatives process. The methodology and results of these facility requirements are presented in the following sections. Each of the support facilities was analyzed "holistically" (i.e., the total quantity of each facility category was analyzed, and requirements were calculated accordingly). Facilities were not evaluated on an individual basis or by tenant. In reality, the total amount of site area required in the future may differ depending on the tenant's specific needs/operation, annual growth, or additional tenants coming to CVG. The future support facility needs are based on what is currently operating at CVG and each facility's utilization. Since utilization rates data was unavailable at the time of the analysis, rates were established based on previous studies and changes in overall operational levels. Planning factors were then determined by the existing utilization rates.

4.6.1 Airline Support

Airline support facilities include both airline maintenance and storage of materials that support the airline's operations throughout CVG: staff training, GSE equipment, and other facilities. Requirements for airline support take into account building space (including hangar for airline maintenance), as well as apron and landside areas.

CVG has two main airline support hangars (Buildings 22 and 79). The hangars are currently 40 to 50 percent utilized and offer a combined total of over 257,000 square feet of building area. The two facilities also offer approximately 634,000 square feet of apron area.

Additional airline support buildings at CVG offer storage, office, and support space on the airfield (Buildings 22A, 26, and 81) offering an additional 35,000 square feet of space.

The facility requirements for airline support were calculated using total annual passenger operations. The assumptions used to calculate the requirements are depicted in **Table 4.6-1, *Airline Support Facility Assumptions***.

TABLE 4.6-1 AIRLINE SUPPORT FACILITY ASSUMPTIONS

Facility	Existing	Utilization Assumption	Planning Factor
Hangar	257,080 ft2	40% to 50%	1.10 ft^2/op
Building	34,602 ft2	30% to 75%	0.21 ft^2/op
Apron	633,853 ft2	25% to 75%	1.85 ft^2/op
Vehicle Parking	302 stalls	60% to 80%	0.002 stalls/op

Sources: KCAB Data; Aerial Photography (9/23/17); Landrum & Brown analysis

The results of the airline support facility requirements are presented in **Table 4.6-2, *Airline Support Facility Requirements***. The hangar and aircraft apron areas were found to be sufficient through the planning period; however, additional support buildings will be needed beginning in PAL 3. Additionally, associated vehicle parking should be developed to support any new facilities.

TABLE 4.6-2 AIRLINE SUPPORT FACILITY REQUIREMENTS

PAL	Hangar		Building		Aircraft Apron		Vehicle Parking	
	Required (ft^2)	Surplus/ (Deficit)	Required (ft^2)	Surplus/ (Deficit)	Required (ft^2)	Surplus (Deficit)	Required (Stalls)	Surplus/ (Deficit)
2017	115,390	141,700	22,100	12,500	194,510	439,300	200	102
PAL 1	138,790	118,300	26,590	8,000	233,960	399,900	241	61
PAL 2	157,310	99,800	30,130	4,500	265,180	368,700	273	29
PAL 3	184,700	72,400	35,380	(800)	311,360	322,500	296	6
PAL 4	220,240	36,800	42,190	(7,600)	371,280	262,600	321	(19)

Sources: KCAB and Landrum & Brown analysis

4.6.2 Airport Support

Airport support facilities offer space for administration staff, storage, airport maintenance, deicing equipment, and other similar uses dedicated to keeping CVG in efficient operating condition. There are several airport support facilities at CVG, none of which requires hangar or significant apron space. They make up a total of 391,000 square feet of space and over 500 parking stalls for employees and visitors.

Similar to airline support, the facility requirements for airport support were calculated using annual operations. The assumptions used to calculate the requirements are presented in **Table 4.6-3, *Airport Support Facility Assumptions***.

TABLE 4.6-3 AIRPORT SUPPORT FACILITY ASSUMPTIONS

Facility	Existing	Utilization Assumption	Planning Factor
Administrative Building	202,202 ft2	50% to 60%	0.68 ft2/op
Maintenance Building	188,312 ft2	40% to 60%	0.72 ft2/op
Vehicle Parking	524 stalls	20% to 60%	0.001 stalls/op

Sources: KCAB Data; Woolpert Photography dated September 23, 2017; and Landrum & Brown analysis

The results of the support facility requirements are further presented in **Table 4.6-4, *Airport Support Facility Requirements***. Additional administrative and maintenance building area was found to be required in PAL 3. Additionally, vehicle parking should be developed to support new facilities.

TABLE 4.6-4 AIRPORT SUPPORT FACILITY REQUIREMENTS

PAL	Admin. Building		Maint. Building		Vehicle Parking	
	Required (ft2)	Surplus/ (Deficit)	Required (ft2)	Surplus/ (Deficit)	Required (Stalls)	Surplus/ (Deficit)
2017	102,460	99,700	108,250	80,100	215	309
PAL 1	138,190	64,000	146,010	42,300	290	234
PAL 2	177,980	24,200	188,050	300	373	151
PAL 3	238,760	(36,600)	252,260	(63,900)	501	23
PAL 4	312,600	(110,400)	330,280	(142,000)	655	(131)

Sources: KCAB and Landrum & Brown analysis

4.6.3 Catering

There is currently one catering facility operating at CVG (Building 24). The facility currently has nearly 63,000 square feet of building space and over 87,000 square feet of space (132 parking stalls) for landside parking.

Future catering facility requirements were based upon current number of meals made daily at the facility and growth of enplanements throughout the planning period. The assumptions used to calculate the requirements are presented in **Table 4.6-5, *Catering Facility Assumptions***.

TABLE 4.6-5 CATERING FACILITY ASSUMPTIONS

Facility	Existing	Utilization Assumption	Planning Factor
Daily Meals	1,349 meals	-	0.1 meals/ep
Building	62,623 ft^2	25%	11.60 meals/ft^2
Vehicle Parking	132 stalls	20%	0.02 meals/stall

Note: Daily meals were calculated using 2006 MPU, adjusted for decrease in enplanements.
Sources: KCAB Data; Woolpert Photography dated September 23, 2017; and Landrum & Brown analysis

The results of the catering facility requirements are presented in **Table 4.6-6, *Catering Facility Requirements***. The building and vehicle area are underutilized and therefore sufficient through the planning period. The 2006 Master Plan Update indicated that the building was at 50 percent utilization in 2003, therefore the 2017 building utilization is close to 25 percent based on lower operational levels.

TABLE 4.6-6 CATERING FACILITY REQUIREMENTS

PAL	Daily Meals	Building		Vehicle Parking	
	Required (meals)	Required (ft^2)	Surplus/(Deficit)	Required (Stalls)	Surplus/(Deficit)
2017	1,349	15,656	46,967	26	106
PAL 1	1,882	21,828	40,795	37	95
PAL 2	2,184	25,334	37,289	43	89
PAL 3	2,685	31,153	31,470	53	79
PAL 4	3,292	38,187	24,436	64	68

Source: KCAB and Landrum & Brown analysis

4.6.4 Aircraft Deicing

The deicing of aircraft is critical to ensure safe operations during winter weather, including rain, snow, and ice. According to the FAA's "clean aircraft" concept[21] and associated guidance, the FAA requires that all critical surfaces of an aircraft be free of contamination at takeoff. In order to achieve this clean aircraft concept during winter weather, deicing of aircraft is required, which involves removing frost, snow, and ice. Deicing may sometimes be followed by anti-icing—which then prevents the development of further accumulations for a short period of time, according to Transportation Research Board (TRB) ACRP Report 14, *Deicing Planning Guidelines and Practices for Stormwater Management Systems*. The deicing process is accomplished with a combination of physical removal techniques and the application of specialized deicing and anti-icing products. The deicing and anti-icing applications may occur when freezing precipitation is imminent or occurring.

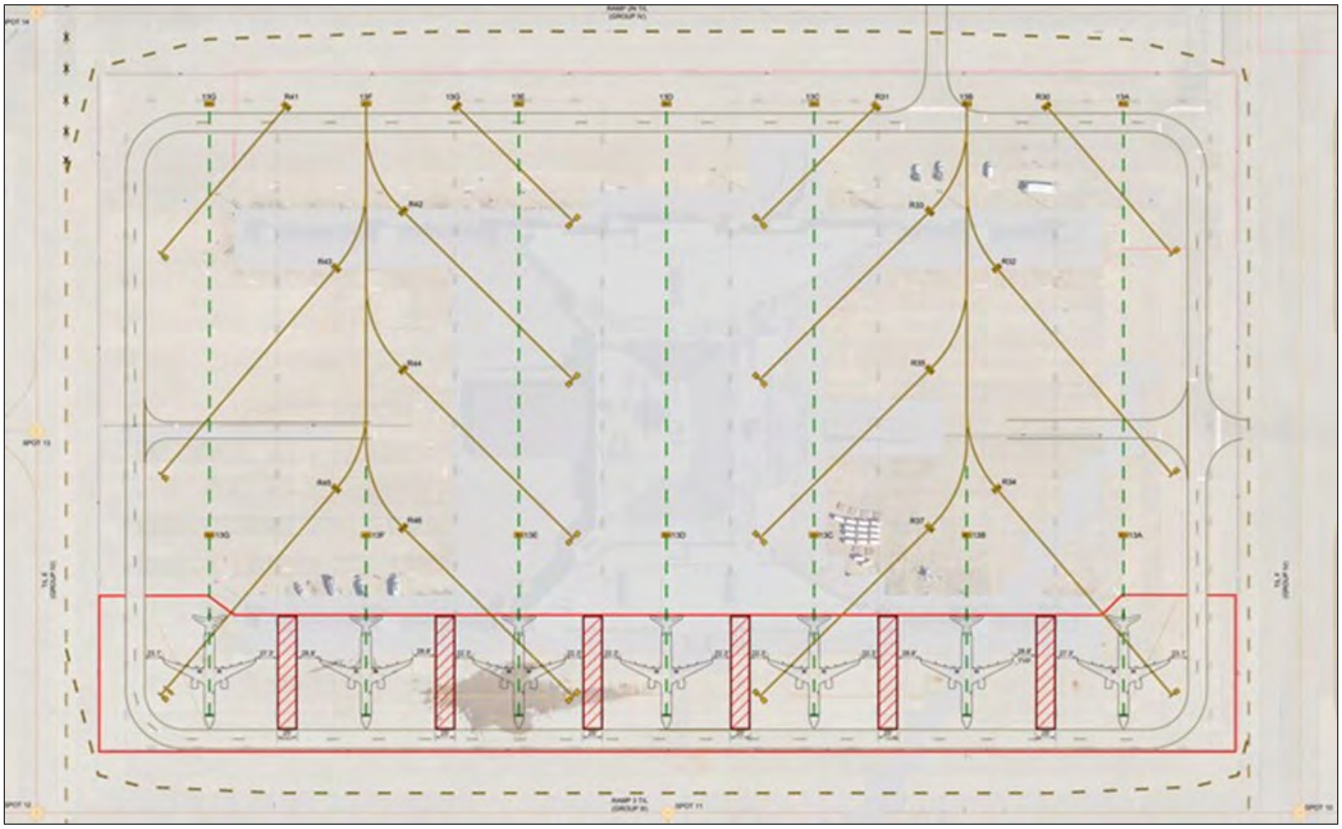
4.6.4.1 *Existing Conditions*

Deicing occurs at several locations around CVG:

- Beginning with the 2018/2019 winter season, the commercial passenger carriers and FedEx will deice at the newly constructed Pad 13, located at the former Concourse C site. Pad 13 has seven deicing positions available, as presented in **Exhibit 4.6-1, *Commercial Passenger and FedEx Deicing Pad (Pad 13)***.
- DHL has 15 deicing positions on their ramp (see **Exhibit 4.6-2, *DHL Deicing Positions***).
- Amazon will have a deicing pad available on their ramp once it is built. Until that time, their aircraft deice on DHL's ramp.
- GA aircraft deice on the GA ramp. One position is available.

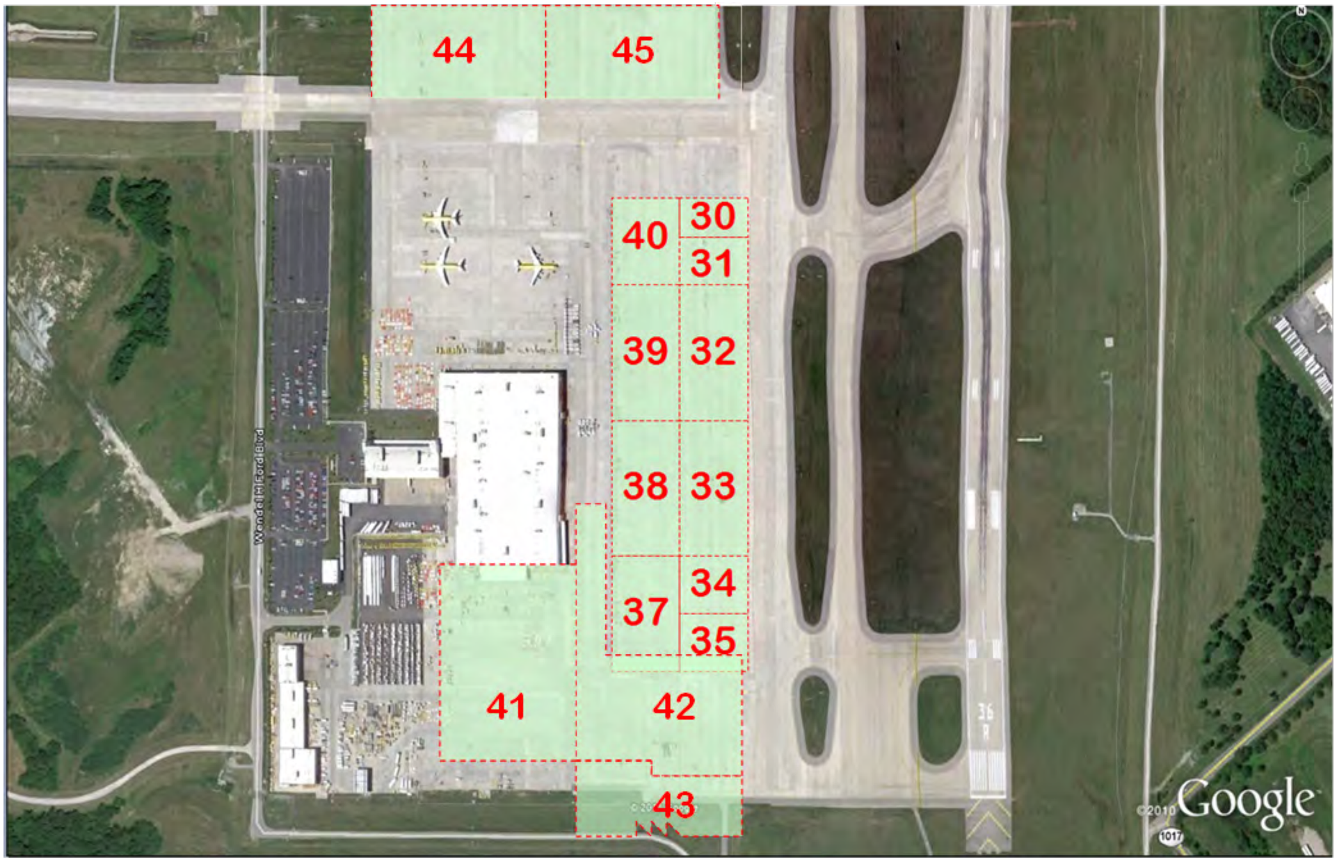
[21] An aircraft cannot depart when frost, ice, or snow is adhering to the wings, control surfaces, or propellers of an aircraft (Federal Aviation Regulation (FAR) Sections 121.629 and 135.227). The presence of even minute amounts of frost, ice, or snow on particular aircraft surfaces can cause potentially dangerous degradation of aircraft performance and unexpected changes in aircraft flight characteristics.

EXHIBIT 4.6-1 COMMERCIAL PASSENGER AND FEDEX DEICING PAD (PAD 13)



Source: KCAB

EXHIBIT 4.6-2 DHL DEICING POSITIONS



Source: KCAB

4.6.4.2 *Deicing Pad Requirements*

The deicing analysis for this Master Plan did not evaluate the GA deicing pad because peak hour GA departures are not expected to increase significantly through PAL 4. The GA peak hour departures associated with each PAL increase from four in 2017 to six in PAL 4, which does not warrant an increase in the deicing pad size. However, should additional GA facilities be developed at CVG, consideration should be given to including the capabilities for deicing associated aircraft.

The required number of deicing positions at CVG is directly related to the number of aircraft that need to be deiced and the average amount of time required to deice each aircraft.

Number of Aircraft

According to recommendations in FAA AC 150/5300-14C, *Design of Aircraft Deicing Facilities*, airport deicing facilities should have a deicing/anti-icing capacity that approximates the peak hour runway departure rate that the ATCT can manage during deicing conditions. The peak hour departure rate for CVG was not used in this analysis for the following reasons:

- The three pads operate independently and there are inefficiencies that occur when using multiple pads. For example, there could be open positions on the DHL pad while Amazon has a queue for its pad.
- The peak departure hours for each pad differ. The peak hours do overlap but are not exactly the same. As a result, the sum of the individual pad peak hour departures is greater than total peak hour departures.
- The demand/capacity analysis found that additional runway capacity may be needed towards the end of the planning period.

Instead, the peak hour departure projections for each pad presented in **Table 4.6-7, *Projected Peak Hour Departures***, were used to determine the required deicing pad capacity for the commercial passenger airlines/FedEx, DHL, and Amazon.

TABLE 4.6-7 PROJECTED PEAK HOUR DEPARTURES

PAL	Peak Hour Departures		
	Commercial Pax/FedEx	DHL	Amazon
2017	23	31	0
PAL 1	23	32	15
PAL 2	27	36	28
PAL 3	31	43	50
PAL 4	36	59	74

Source: Landrum & Brown analysis

Deicing Time per Aircraft

Aircraft deicing is a time-consuming process. The time it takes to deice an aircraft is calculated from when the wheels stop on a pad to when the wheels start moving again. This includes the time to allow the engines to turn off (when applicable), the time to dispense the deicing application, the time to notify the pilot that deicing is complete, and the time to restart the engines (when applicable).

The amount of time spent deicing each aircraft depends on various factors, including:

- Amount of snow/ice accumulated on the aircraft
- Rate at which additional precipitation is falling
- Time needed to position the aircraft and deicing equipment
- Number of deicing trucks dedicated to each aircraft
- Type of deicing trucks operated
- Size of the aircraft

Deicing times for other North American airports were benchmarked for this Master Plan for snow conditions and are presented in **Table 4.6-8, *Deicing Times Benchmarking Analysis***. The average deicing time for these benchmarked airports is 22 minutes for wide-body aircraft, 19 minutes for narrow-body aircraft, and 15 minutes for regional jets.

TABLE 4.6-8 DEICING TIMES BENCHMARKING ANALYSIS

Airport	Deicing Times (in minutes)		
	Wide-body	Narrow-body	Regional Jet
Cleveland Hopkins (CLE)	18.0	12.0	7.0
Baltimore-Washington (BWI)	28.0	20.0	18.5
Denver (DEN)	23.0	15.0	12.0
Kansas City (MCI)	n/a	25.0	n/a
Ottawa (YOW)	n/a	n/a	17.5
MSP (Delta)	23.0	20.0	15.5
ORD (United)	17.5	16.5	n/a
Average	**22.0**	**19.0**	**15.0**

Source: Landrum & Brown analysis

Based on the CVG fleet mix data and the benchmarked deicing times, an average deicing time of 17 minutes per aircraft was applied for the passenger carriers, and 21 minutes was used for the cargo carriers. These times result in a deicing rate of 3.5 aircraft per position per hour for the passenger carriers (60 minutes divided by 17 minutes = 3.5). The corresponding rate for the cargo carriers is 2.9 aircraft per position per aircraft (60 minutes divided by 21 minutes = 2.9).

Commercial Passenger/FedEx Deicing Pad Position Requirements

The number of deicing positions required at CVG was calculated by dividing the number of peak hour departures in each year by the number of aircraft that can be processed by a position in one hour. The results for the commercial passenger airlines/FedEx, DHL, and Amazon are presented in **Tables 4.6-9 through 4.6-11**. This methodology shows that the passenger airlines/FedEx and DHL have a sufficient number of deicing positions currently. The passenger airlines/FedEx will require 11 positions by PAL 4 (four additional) and DHL will require 21 positions (six more than are currently available). Amazon will require six positions in PAL 1 and 26 by PAL 4.

TABLE 4.6-9 DEICING PAD POSITION REQUIREMENTS – COMMERCIAL PASSENGER AND FEDEX

PAL	Peak Hour Departures	Number of Aircraft Processed in One Hour	Deicing Positions Required	2018/2019 Season Positions Available	Surplus/(Deficit)
2017	23	3.5	7	7	0
PAL 1	23		7		0
PAL 2	27		8		(1)
PAL 3	31		9		(2)
PAL 4	36		11		(4)

Note: The number of deicing positions required was rounded up to the nearest whole number.
Source: Landrum & Brown analysis

TABLE 4.6-10 DEICING PAD POSITION REQUIREMENTS – DHL

PAL	Peak Hour Departures	Number of Aircraft Processed in One Hour1	Deicing Positions Required	2018/2019 Season Positions Available	Surplus/(Deficit)
2017	31	2.9	11	15	4
PAL 1	32		12		3
PAL 2	36		13		2
PAL 3	43		16		(1)
PAL 4	59		21		(6)

Note: The number of deicing positions required was rounded up to the nearest whole number.
Source: Landrum & Brown analysis

TABLE 4.6-11 DEICING PAD POSITION REQUIREMENTS – AMAZON

PAL	Peak Hour Departures	Number of Aircraft Processed in One Hour1	Deicing Positions Required	2018/2019 Season Positions Available	Surplus/(Deficit)
2017	0	2.9	0	0	0
PAL 1	15		6		(6)
PAL 2	28		10		(10)
PAL 3	50		18		(18)
PAL 4	74		26		(26)

Note: The number of deicing positions required was rounded up to the nearest whole number.
Source: Landrum & Brown analysis

Summary of Deicing Pad Requirements

The total number of deicing pad positions required is presented in **Table 4.6-12, *Deicing Pad Position Requirements – Total***. Eighteen were required in 2017, with 58 required at PAL 4.

TABLE 4.6-12 DEICING PAD POSITION REQUIREMENTS – TOTAL

PAL	Number of Required Deicing Positions			
	Commercial Passenger/FedEx	DHL	Amazon	Total
2017	7	11	0	**18**
PAL 1	7	12	6	**25**
PAL 2	8	13	10	**31**
PAL 3	9	16	18	**43**
PAL 4	11	21	26	**58**

Source: Landrum & Brown analysis

4.6.5 Aircraft Fuel

The aircraft fuel facilities at CVG currently support an existing capacity of five million gallons of Jet-A aircraft fuel, which equates to just under a four-day supply. This currently exceeds the industry planning standard of maintaining a three-day fuel supply on-airport. The fuel requirements for CVG assumes a 50 percent average fuel uplift per operation. The results of the fuel facility requirements are presented in **Table 4.6-13, *Aircraft Fuel Facility Requirements***. The majority of the fuel storage needs are driven by the increase in cargo operators on the south side of the airfield. The proposed Amazon Air facility is anticipated to include a fuel farm capable of providing this additional demand.

TABLE 4.6-13 AIRCRAFT FUEL FACILITY REQUIREMENTS

PAL	3 Day Supply (million gal.)	Surplus/(Deficit) (million gal.)
2017	3.8	1.2
PAL 1	5.9	(0.9)
PAL 2	8.3	(3.3)
PAL 3	12.4	(7.4)
PAL 4	23.5	(18.5)

Source: KCAB and Landrum & Brown analysis

4.6.6 General Aviation

The GA facilities consist of five separate facilities. The Fixed-Base Operator (FBO) occupies the Delta Jet Center, Building 82. In addition, there are four other GA hangars (Buildings 58, 60, 83, and 84). These facilities combined provide over 212,000 square feet of hangar space and over 657,000 square feet of apron area. The FBO consists of a nearly 9,000 square-foot GA terminal. In total the GA facilities have a landside area of nearly 364,000 square feet. This area is predominantly allocated to automobile parking, providing a combined total of 757 parking stalls.

The GA facility requirements at CVG were calculated using the annual GA operations and existing facility utilization assumptions. The assumptions used to calculate the requirements are presented in **Table 4.6-14, *GA Facility Assumptions***.

TABLE 4.6-14 GA FACILITY ASSUMPTIONS

Facility	Existing	Utilization Assumption	Planning Factor
Hangar	212,381 ft2	90% to 100%	20 to 25 ft2/op
FBO/GA Terminal	8,511 ft2	80%	.75 ft2/op
Apron	657,484 ft2	100%	70 ft2/op
Vehicle Parking	797 stalls	35%[1]	25 ops/stall

[1] FBO vehicle parking utilization assumption is 85 percent; all others are 35 percent.
Source: KCAB Data; Woolpert Photography dated September 23, 2017; and Landrum & Brown analysis

The results of the GA facility requirements are presented in **Table 4.6-15, *GA Facility Requirements***. The FBO terminal and landside parking areas are sufficient through the planning period, however additional hangar and apron area are anticipated to be needed beginning in PAL 1. Additionally, although there is a surplus of vehicle parking associated with the existing GA facilities, additional vehicle parking should be developed to support each new facility, if demand for these additional facilities materializes according to market conditions.

TABLE 4.6-15 GA FACILITY REQUIREMENTS

PAL	Hangar		FBO/GA Terminal		Aircraft Apron		Vehicle Parking	
	Required (ft^2)	Surplus/ (Deficit)	Required (ft^2)	Surplus/ (Deficit)	Required (ft^2)	Surplus/ (Deficit)	Required (Stalls)	Surplus/ (Deficit)
2017	209,700	2,700	6,810	1,700	657,500	0	400	357
PAL 1	219,800	(7,400)	7,140	1,400	689,200	(31,700)	420	337
PAL 2	230,200	(17,800)	7,470	1,000	721,500	(64,000)	440	317
PAL 3	252,600	(40,200)	8,200	300	791,800	(134,300)	480	277
PAL 4	285,300	(72,900)	9,260	(800)	894,500	(237,000)	540	217

Source: KCAB and Landrum & Brown analysis

4.6.7 Airport Traffic Control Tower

The ATCT at CVG is located to the south of Runway 09/27, between Runways 18C/36C and 18L/36R. The ATCT consists of the tower cab with an eye elevation of 1,127 feet MSL, Terminal Radar Approach Control (TRACON), and supporting offices totaling 23,840 square feet. The facility was considered fully utilized in 2003. The number of operations has since dropped at CVG and the facility is considered underutilized. The assumptions used to calculate the requirements are presented in **Table 4.6-16, *ATCT Facility Assumptions***.

TABLE 4.6-16 ATCT FACILITY ASSUMPTIONS

Facility	Facility Area (ft^2)	Utilization Assumption	Planning Factor
2017 ATCT Building	48,168	30%	0.10 ft2/op
2017 ATCT Vehicle Parking	33,154	30%	0.07 ft2/op

Source: *2025 Master Plan Update*, February 2007 and Landrum & Brown analysis

The results of the ATCT facility requirements are presented in **Table 4.6-17, *ATCT Facility Requirements***. The ATCT facilities are projected to be sufficient to accommodate demand through the planning period.

TABLE 4.6-17 ATCT FACILITY REQUIREMENTS

PAL	Building		Vehicle Parking	
	Required (ft^2)	Surplus/ (Deficit)	Required (ft^2)	Surplus/ (Deficit)
2017	15,561	32,607	10,710	22,444
PAL 1	20,988	27,180	14,446	18,708
PAL 2	27,031	21,137	18,606	14,548
PAL 3	36,262	11,906	24,959	8,195
PAL 4	47,476	692	32,678	476

Source: *2025 Master Plan Update, February 2007* and recent Landrum & Brown analysis

4.6.8 Government/Police

The government facilities at CVG consist of the Airport Police Department and their supporting facilities. They currently have three facilities at CVG. The Airport Police Department building (Building 20) is their main facility providing nearly 19,000 square feet of building space. Four other facilities offer storage and training areas (Buildings 70, 78, 89, and 91A). These additional support facilities provide an additional 19,000 square feet of building space for the Police Department. Combined, all five facilities provide nearly 87,000 square feet of landside area that is predominantly allocated to vehicle parking. Additionally, CVG has identified the need for an Airport Operations Center (AOC); no location has been identified at this time.

Future government facility requirements were calculated using annual operations and current facility utilization assumptions. The assumptions used to calculate the requirements are presented in **Table 4.6-18, *Government Facility Assumptions***.

TABLE 4.6-18 GOVERNMENT FACILITY ASSUMPTIONS

Facility	Existing	Utilization Assumption	Planning Factor
Building	37,370 ft^2	60%	0.15 ft^2/op
Vehicle Parking	65 stalls	70%	0.0003 stalls/op

Sources: KCAB Data; Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

The results of the government facility requirements are further depicted in **Table 4.6-19, *Government Facility Requirements***. Additional building area is anticipated to be required by PAL 2. Additionally, vehicle parking should be developed to support these increases in building area.

TABLE 4.6-19 GOVERNMENT FACILITY REQUIREMENTS

PAL	Building		Vehicle Parking	
	Required (ft^2)	Surplus/ (Deficit)	Required (Stalls)	Surplus/ (Deficit)
2017	22,420	15,000	46	20
PAL 1	30,240	7,100	61	4
PAL 2	38,950	(1,600)	79	(14)
PAL 3	52,250	(14,900)	106	(41)
PAL 4	68,410	(31,000)	139	(74)

Sources: KCAB and Landrum & Brown analysis

4.6.9 Aircraft Rescue and Firefighting (ARFF)

There are two ARFF stations at CVG, known as Station 1 (Building 9) and Station 2 (Building 55). Station 1 is approximately 25,400 square feet in size and Station 2 is approximately 22,500 square feet in size. Additionally, an ARFF training center (Building 124) and the ARFF Training Facility Burn Pit are also located at CVG.

4.6.9.1 *ARFF Index*

The level of protection that is required to be provided at an airport is known as the ARFF Index. An ARFF index is defined in 14 Code of Federal Regulations (CFR) Part 139. 315, Paragraph C, and is determined by the longest air carrier passenger aircraft with an average of five or more daily scheduled departures. However, when there are fewer than five average daily departures of the longest air carrier aircraft serving an airport, the Index required for will be the next lower index group than the index group prescribed for the longest aircraft.[22] The requirements for index determination are presented in **Table 4.6-20, *Airport ARFF Index Determinations***.

TABLE 4.6-20 AIRPORT ARFF INDEX DETERMINATIONS

Airport Index	Length of Aircraft (ft)[3]	Vehicles[2]		Extinguishing Agents (gallons)[1]	
		Light-Weight	Self-Propelled	Dry Chemicals	Water[4]
A	Less than 90	1	0	500 or 450	0 or 100
B	90-125.9	1	1	500	1,500
C	126-158.9	1	2	500	3,000
D	159-199.9	1	2	500	4,000
E	200+	1	2	500	6,000

Notes: [1] The protein-based agents may be substituted for aqueous film forming foam (AFFF) and the quantities of water shown increased by a factor of 1.5. Dry chemicals in the ratio of 12.7 pounds per gallon of water may be substituted for up to 30 percent of the water specified for AFFF.
[2]. Light-weight vehicle requirements for Index A are part of the total for Index B-E.
[3]. Length of largest aircraft providing an average of five scheduled departures daily.
[4]. Water for protein foam production.

Source: 14 CFR Part 139.315, *Aircraft Rescue and Firefighting: Index Determination*, 2013

[22] 14 CFR Part 139.315, Aircraft Rescue and Firefighting: Index Determination, 2013.

The longest aircraft in both the existing and future fleets were analyzed to determine the CVG Index. The existing Index for CVG is based upon the Boeing B767-300. The B767-300 has a length of approximately 180 feet (Index D) but only had 337 departures in 2016. Applying the exception previously mentioned, the aircraft does not meet the threshold minimum for daily departures therefore the next lower index group of the longest aircraft can be used. In this case, the next lowest index is Index C.

When considering the projected traffic growth and fleet mix, Index C is not considered to be sufficient through the planning period. The longest aircraft in the fleet by PAL 3 is projected to be the Airbus A330-900neo that has a length of 209 feet (Index E), however, as was the case with the existing condition, the A330-900neo does not meet the minimum threshold of daily departures. Therefore, the next lower index should be used, Index D. This represents an increase in ARFF Index requirement from the existing condition. However, given the existing equipment and facilities, CVG currently meets Index D ARFF requirements.

4.6.9.2 *ARFF Response Time Analysis*

An ARFF response-time analysis was conducted for the CVG airfield. The FAA's 14 CFR Part 139.319, Aircraft Rescue and Firefighting: Operational Requirements, provides guidance on the performance criteria of ARFF vehicles at an airport. According to these guidelines, at least one ARFF vehicle must be able to respond to the midpoint of the farthest runway serving air carrier aircraft at CVG within three minutes from the time of the alarm.

For this analysis, the response times from each of the two ARFF stations were calculated by measuring various routes that the ARFF vehicles would take from each station to the midpoint and end points of each runway at CVG. These routes were then analyzed to determine the respective lengths of the straight-away and curved portions along each route. **Table 4.6-21, *ARFF Response Time Assumptions***, presents the assumptions used for this analysis. The results of the analysis concluded that the current ARFF station locations with the existing airfield configuration are sufficient to meet the three-minute response time required under FAA FAR Part 139 regulations.

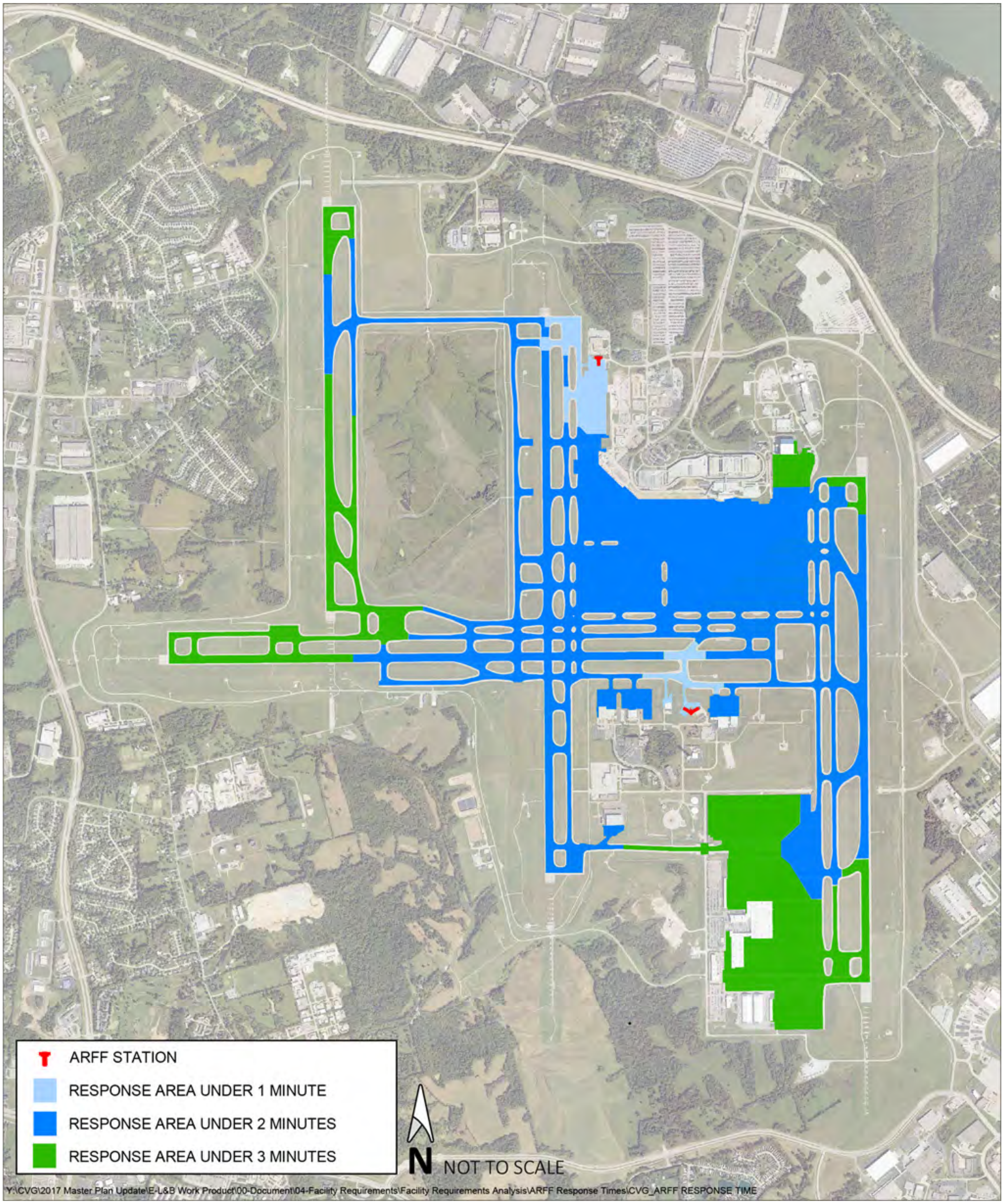
TABLE 4.6-21 ARFF RESPONSE TIME ASSUMPTIONS

Assumption	Value
Initial Turn-out Time	40 seconds
Average Straightaway Speed	69.5 mph
Average Curve Speed	35 mph

Sources: Landrum & Brown analysis; industry guidelines

Exhibit 4.6-3, *ARFF Response Times*, presents the estimated response times for all paved areas of the CVG airfield.

EXHIBIT 4.6-3 ARFF RESPONSE TIMES



Source: Landrum & Brown analysis, 2018

4.6.10 Airport Hotel

The Doubletree Hotel by Hilton (Building 18) is the only on-airport hotel providing lodging to the public. The 96,000 square-foot facility offers passengers and visitors of the area overnight accommodations with convenient Airport access. The hotel provides 200 total rooms.

Future airport hotel requirements were based upon annual passengers and historical facility utilization. The assumptions used to calculate the requirements are depicted in **Table 4.6-22, *Airport Hotel Facility Assumptions***.

TABLE 4.6-22 AIRPORT HOTEL FACILITY ASSUMPTIONS

Facility	Existing	Utilization Assumption	Planning Factor
Rooms	200 rooms	60%	65,351 pax/room
Building	95,749 ft2	60%	136.51 pax/ft2
Vehicle Parking	238 stalls	60%	54,917 pax/stall

Sources: KCAB Data; Woolpert Photography dated September 23, 2017; and Landrum & Brown analysis

The results of the hotel facility requirements are presented in **Table 4.6-23, *Airport Hotel Facility Requirements***. Additional rooms and building area are projected to be needed by PAL 3. Furthermore, vehicle parking should be developed to support the addition of new rooms and space in the facility.

TABLE 4.6-23 AIRPORT HOTEL FACILITY REQUIREMENTS

PAL	Rooms		Building		Vehicle Parking	
	Required (rooms)	Surplus/ (Deficit)	Required (ft^2)	Surplus/ (Deficit)	Required (Stalls)	Surplus/ (Deficit)
2017	120	80	57,400	38,600	140	100
PAL 1	170	30	81,200	14,800	200	40
PAL 2	200	0	93,900	2,100	230	10
PAL 3	240	(40)	115,100	(19,100)	290	(50)
PAL 4	290	(90)	140,400	(44,400)	340	(100)

Sources: KCAB and Landrum & Brown analysis

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MASTER PLAN 2050

Chapter 5 | Alternatives Development and Evaluation

CINCINNATI/NORTHERN KENTUCKY INTERNATIONAL AIRPORT

L&B TEAM

5 Alternatives Development and Evaluation

5.1 Introduction

This chapter explores alternative development concepts for Cincinnati/Northern Kentucky International Airport (CVG) that provide the facilities required to accommodate projected demand through Planning Activity Level (PAL) 4. The requirements presented in Chapter 4, *Facility Requirements*, served as the framework for the development of the alternative concepts presented herein. Specific areas of focus for the development concepts include the following:

- Airfield
- Passenger Terminal Facilities
- Landside Access and Parking
- Air Cargo
- Support Facilities

5.2 Airfield

This section provides an evaluation of alternative ways to meet the airfield requirements identified in Chapter 4, *Facility Requirements*. These requirements include improvements in runway capacity, taxiway capacity, and runway exits. In addition, concepts for improving the portions of the airfield that do not meet Federal Aviation Administration (FAA) standards were considered and recommendations made.

5.2.1 Runway Capacity

CVG has three parallel runways oriented in the north-south direction (18/36), and a crosswind runway in the east-west direction (09/27). The facility requirements analysis identified that the existing runways would be sufficient to accommodate demand through PAL 4. As a result, the need for an additional runway(s) was not investigated in this Master Plan. Although no additional runways are needed, the demand/capacity analysis in Chapter 4, Section 4.2.1, *Runway Demand/Capacity*, identified that the way the runways are used at night would have to change. Currently, Runway 09/27 is the preferred runway at night, with occasional operations on Runways 18C/36C and 18L/36R. As demand grows, triple parallel simultaneous departure runway capability will be needed at night, which means CVG will need to operate on the three parallel runways (18R/36L, 18C/36C, and 18L/36R).[1]

[1] It was assumed that any applicable runway use restrictions and departure heading restrictions would be amended to allow triple simultaneous departures on the three parallel runways.

The three parallel runways do not provide the necessary departure runway length to serve the fleet mix at CVG (arrival lengths are sufficient). Chapter 4, Section 4.2.2, *Runway Length Analysis*, identified that 12,000 feet of runway length is needed to serve 100 percent of the PAL 4 fleet. Runway 18L/36R is 10,000 feet long, Runway 18C/36C is 11,000 feet long, and Runway 18R/36L is 8,000 feet long. Because the lengths of the three parallel runways are uneven, and none is 12,000 feet long, some aircraft would be restricted from using their preferred runway from an airspace standpoint. If an aircraft is forced to use a less optimal parallel runway, it may have to cross the departure flight path of another runway(s). Aircraft that require more than 11,000 feet of runway would have to use the 12,000-foot long Runway 27 for departure, which intersects two of the parallel runways. Both of these instances would reduce the throughput of the runway system for departures. To avoid this capacity reduction, Chapter 4 recommended the following runway lengths:

- At least 12,000 feet of runway length on one of the north/south runways.
- A minimum of 10,000 feet of runway length on Runway 18R/36L, which is currently 8,000 feet long. According to the runway length analysis in Chapter 4, an 8,000-foot long runway is not able to serve the larger aircraft that operate at CVG at night. A runway of this length is generally restricted to serving narrow-body aircraft; only 30 percent of the PAL 4 cargo fleet could use Runway 18R/36L. On the other hand, a 10,000-foot long runway could serve 78 percent of the PAL 4 fleet.

Runway extension alternatives that meet the 12,000-foot length requirement were developed for each of the parallel north-south runways. If Runway 18R/36L is extended to 12,000 feet, both needs would be met with a single runway extension. If Runway 18C/36C or 18L/36R were extended to 12,000 feet to meet the first need, Runway 18R/36L would still need to be extended to 10,000 feet to meet the second need. Therefore, alternatives were also developed that increase the length of Runway 18R/36L to 10,000 feet.

5.2.1.1 Methodology

Runway Design Code (RDC) D-VI-1200 standards were applied in the development of the runway extension alternatives. The approach and departure capability (visibility and minima) of each runway were assumed to remain unchanged from today.

Some of the runway extension alternatives include the application of declared distances and/or displaced thresholds in order to comply with FAA standards, while minimizing impacts/costs and maximize the usable runway length. Declared distances are the maximum usable lengths of a runway that are declared available to meet performance requirements for turbine-powered aircraft. The declared distances are:

- Takeoff Run Available (TORA)
- Takeoff Distance Available (TODA)
- Landing Distance Available (LDA)
- Accelerate Stop Distance Available (ASDA)

Declared distances can be used to obtain a full Runway Safety Area (RSA) and/or Object Free Area (OFA) length, mitigate incompatible land uses within the Runway Protection Zone (RPZ), and meet approach and departure surface clearance requirements.

A displaced threshold is a threshold that is located at a point on the runway other than the designated end of the physical runway pavement. A displaced threshold is applied to arriving aircraft and reduces the length of the runway available for landings (LDA). The physical runway end can be used for departing aircraft, so a displaced threshold does not affect the TORA, TODA, or ASDA.

The runway extension alternatives were evaluated based on the following criteria:

- Objects within the RSA and OFA
- Land Uses within the RPZ
- Relocation of Navigational Aids (NAVAIDs)

Objects within the RSA and OFA

The FAA requires all RSAs to be cleared of all objects, except for objects that need to be in the RSA due to their aviation function (such as: NAVAIDS, approach lighting systems, airside service roads, etc.). The OFA must be cleared of objects that are considered non-essential for air navigation or aircraft maneuvering purposes. Structures and public roads that would require relocation out of the RSAs and OFAs were identified for each alternative.

Land uses within the RPZ

An RPZ is a two-dimensional trapezoid centered on the extended runway centerline. The RPZ is divided into two components: 1) central portion and 2) controlled activity area. The reason for this segmentation is to identify the more critical “central portion” of the RPZ versus the less critical “outer portion” for clearing of objects. No differentiation was made between these two areas in the alternatives analysis but the two RPZ components are identified in the alternatives for informational purposes.

The RPZ’s function is to enhance the protection and safety of people and property on the ground. FAA Advisory Circular (AC) 150/5300-13A Change 1, *Airport Design*, indicates that this protection can be best achieved through airport owner control over the property within the RPZ and by clearing RPZs of incompatible objects and activities. The September 27, 2012 FAA Memorandum, *Interim Guidance on Land Uses within a Runway Protection Zone*, provides a listing of potentially incompatible land uses that require FAA coordination. These include buildings and structures (residence, schools, churches, hospitals, commercial/industrial, etc.), recreational land uses, transportation facilities (rail, roads/highways, auto parking facilities), fuel storage facilities (above and below ground), hazardous material storage (above and below ground), wastewater treatment facilities, and above ground utility infrastructure.

The amount of RPZ area (acres) that would be located on and off CVG property was determined for each alternative. In addition, non-compatible land uses within the relocated RPZs were identified for the purpose of comparing alternatives. However, no decisions regarding acquisition or relocations have been made at this time. The evaluation of concepts performed for this analysis assumed that if a runway end is extended or modified, the RPZ on both runway ends would need to be addressed for FAA compliance.

Relocation of NAVAIDs

Each of the runway extension alternatives has NAVAIDS that will require relocation. The alternatives evaluation identified these NAVAIDS, which include:

- Approach Light Systems (ALS)
- Glide Slope Antennas (GS)
- Localizer Antennas (LOC)
- Distance Measuring Equipment (DME)
- Marker Beacons (Middle and Outer Markers)
- Runway Visual Range (RVR)
- Precision Approach Path Indicator (PAPI)

5.2.1.2 12,000-Foot Runway Analysis

Alternatives were developed and evaluated that extend each of the parallel runways to 12,000 feet. A preferred alternative was selected for each runway; these three alternatives were then evaluated against each other to identify the preferred runway extension alternative.

Runway 18R/36L Extension Alternatives

Three alternatives were developed for the extension of 8,000-foot long Runway 18R/36L to a length of 12,000 feet:

- **Alternative 1**: Extend Runway 18R/36L to the north by 4,000 feet
- **Alternative 2**: Extend Runway 18R/36L to the south by 4,000 feet
- **Alternative 3**: Extend Runway 18R/36L to the north by 2,000 feet and to the south by 2,000 feet

These alternatives are illustrated on **Exhibit 5.2-1** through **Exhibit 5.2-3**. **Table 5.2-1, *12,000-Foot Long Runway 18R/36L Evaluation***, presents the evaluation of the three extension alternatives.

<u>Runway 18R/36L Alternative 1 Impacts:</u>

Alternative 1 roadway impacts include Interstate 275 (I-275), Elijah Creek Road, and Petersburg Road on the north end. In addition, there are three houses within the Runway 18R RPZ and RSA/OFA. A total of 77 acres of off-airport land is within the Runway 18R RPZ. This alternative requires NAVAID relocations on the Runway 18R end. On the south end, the Runway 36R RPZ is entirely on CVG property but does include Youell Road, a controlled access roadway owned by CVG.

<u>Runway 18R/36L Alternative 2 Impacts:</u>

Alternative 2 roadway impacts include I-275 and Elijah Creek Road within the Runway 18R RPZ. Petersburg Road is located within the Runway 18R RSA/OFA and RPZ. There is also an industrial building in the Runway 18R RPZ. The Runway 18R RPZ encompasses 17 acres of off-airport land.

On the Runway 36L end, Youell Road is under the runway extension pavement and a portion of the Kenton County Airport Board (KCAB) ball fields are within the RSA/OFA and RPZ. Also within the RPZ, is a new commercial business parking lot on Timber Lane. The Runway 36L RPZ encompasses 53 acres of off-airport land. NAVAID relocations are required on the Runway 36L end only.

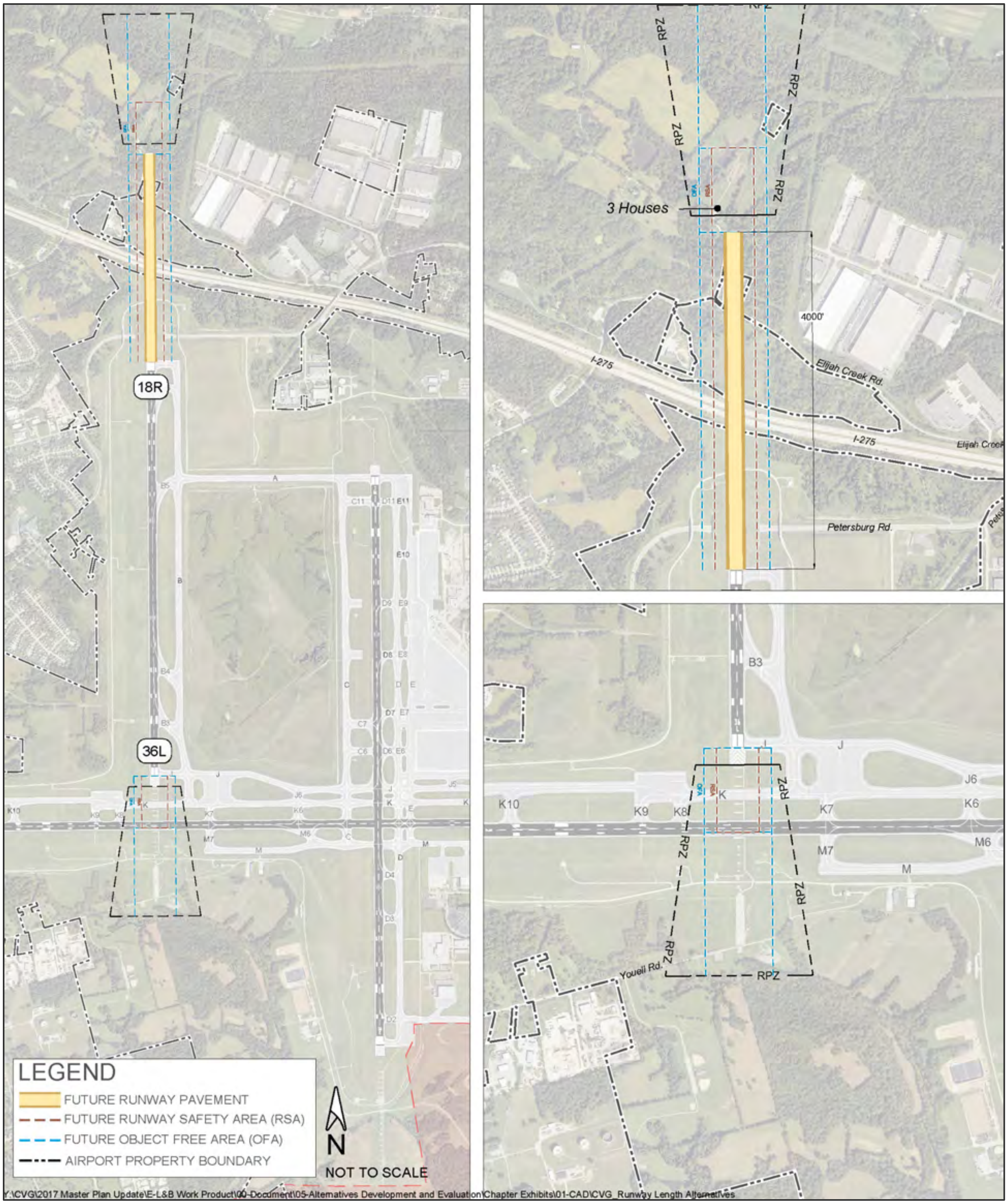
Runway 18R/36L Alternative 3 Impacts:

Runway 18R end impacts include I-275 located under the runway extension pavement and in the RSA/OFA. Elijah Creek road is within the Runway 18R RSA/OFA and RPZ. Petersburg Road is within the Runway 18R RSA/OFA. The Runway 18R RPZ encompasses 55 acres of off-airport land area, including three houses and the property associated with an industrial building. Runway 36L impacts include Youell Road within the RSA/OFA and central portion of the RPZ. While the entire Runway 36L RPZ is entirely on CVG property, it does encompass the KCAB ball fields and access road. NAVAID relocations are required on both runway ends.

Runway 18R/36L Alternatives Evaluation and Recommendation

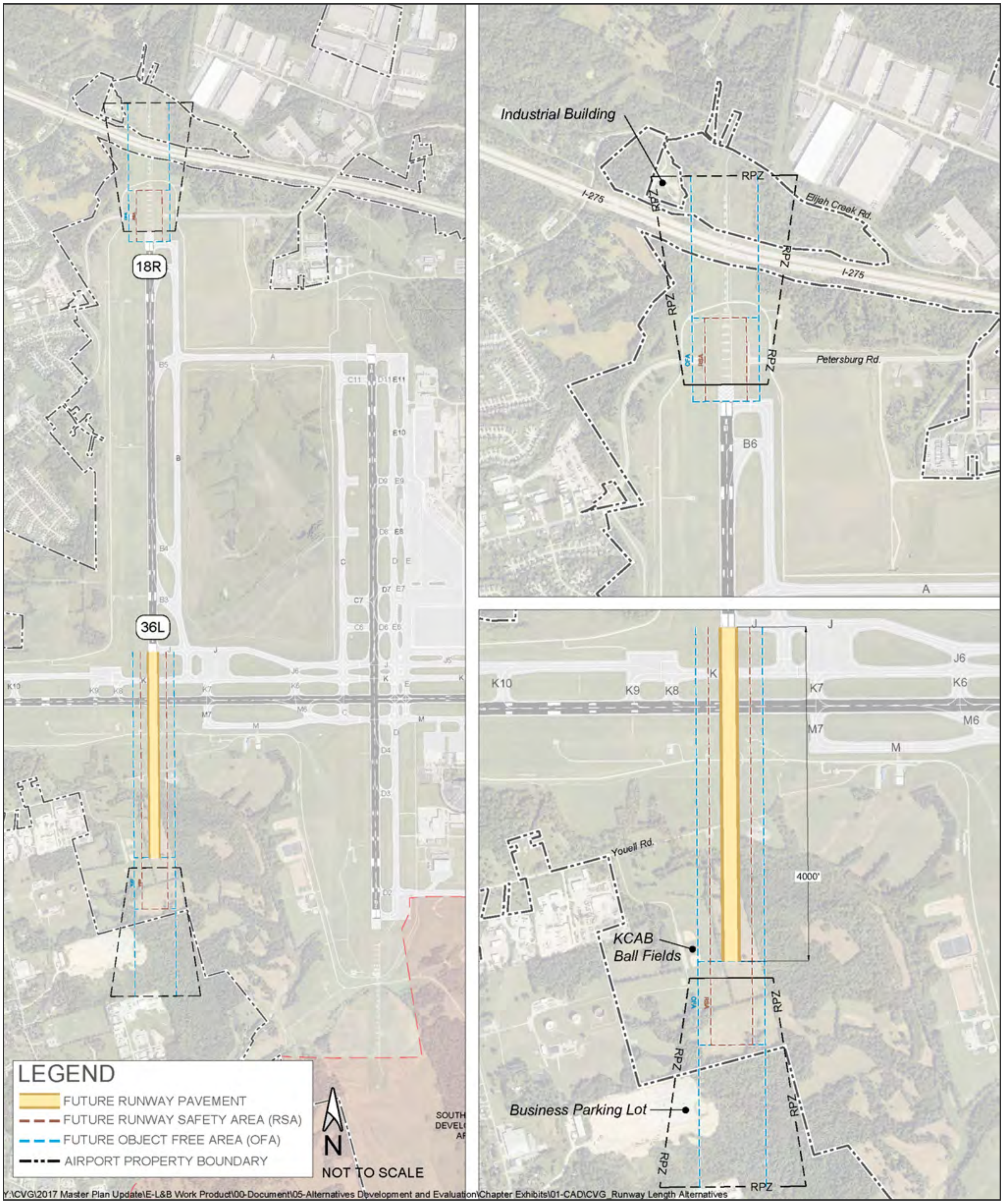
The evaluation of the three Runway 18R/36L alternatives indicates that the majority of potential impacts exist on the north end of Runway 18R/36L. While Alternative 3 attempts to limit the magnitude of these northern impacts, they still exist to a degree that is most likely very costly and prohibitive. Alternative 2 does not modify the north end because the full extension is to the south. FAA may allow the north end to remain untouched because there is no change on that end. Therefore, it is recommended that Alternative 2 be taken forward for further evaluation. This south extension maintains all proposed airfield infrastructure on existing CVG property, while maintaining the least amount of off-airport property within the RPZ.

EXHIBIT 5.2-1 12,000 FOOT RUNWAY 18R/36L – ALTERNATIVE 1



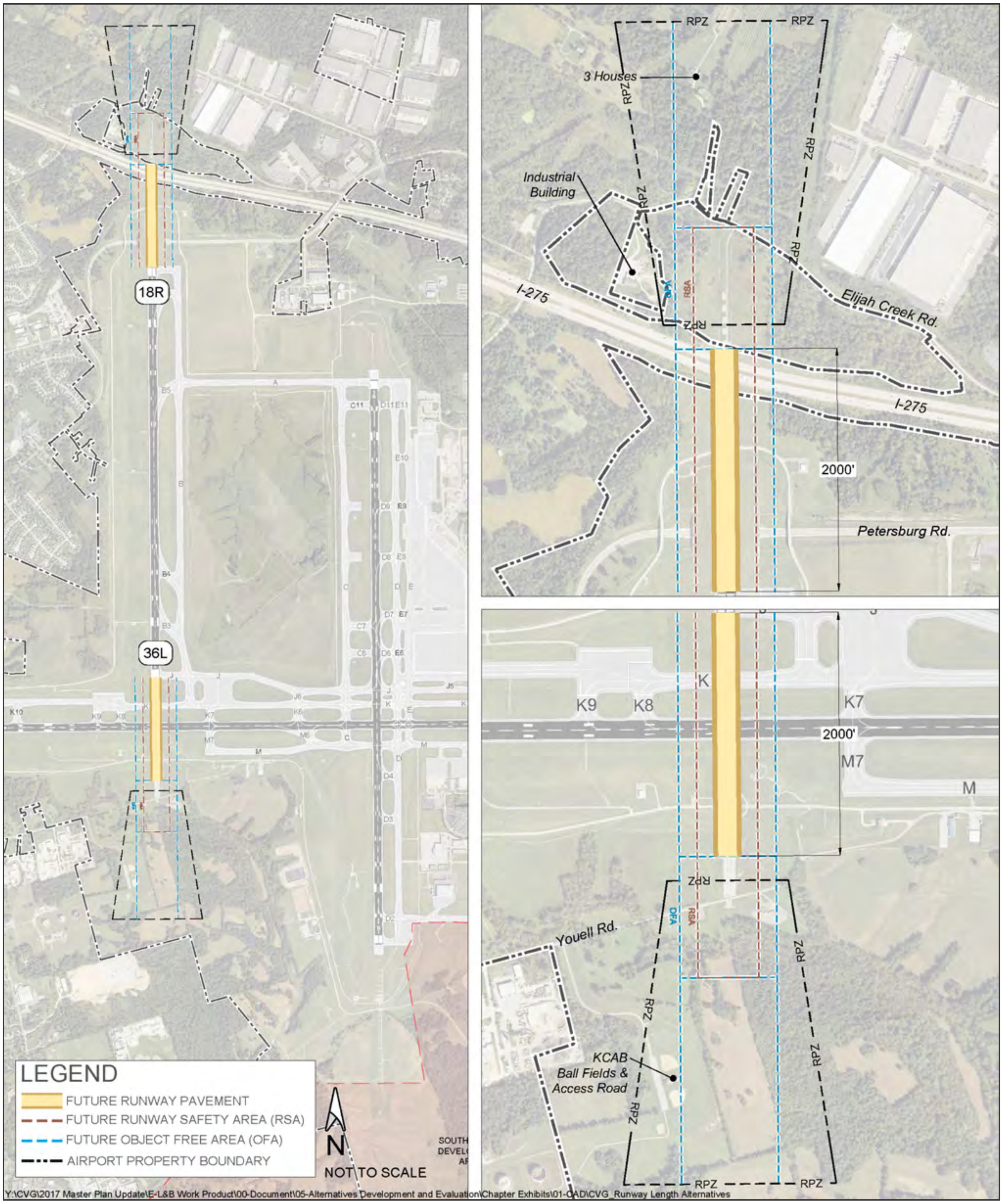
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-2 12,000 FOOT RUNWAY 18R/36L – ALTERNATIVE 2



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-3 12,000 FOOT RUNWAY 18R/36L – ALTERNATIVE 3



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

TABLE 5.2-1 12,000-FOOT LONG RUNWAY 18R/36L EVALUATION

Evaluation Criteria	Alternative		
	1	2	3
Extension Description			
Extension Length & Direction	4,000' North	4,000' South	2,000' North 2,000' South
Takeoff Run Available	12,000'	12,000'	12,000'
Runway 18R End Impacts			
Public Roads/Structures Under Runway or in RSA/OFA	I-275 Elijah Creek Road Petersburg Road 3 Houses	Petersburg Road	I-275 Elijah Creek Road (NE Corner) Petersburg Road
Public Roads in RPZ	None	I-275 Elijah Creek Road (NE Corner) Petersburg Road	Elijah Creek Road Petersburg Road
Structures/Areas in RPZ	3 Houses	Industrial Building	3 Houses Industrial Building
Off-Airport RPZ	77 Acres	17 Acres	55 Acres
NAVAID Relocations	18R ALS 18R GS 18R RVR 18R DME 18R PAPI 18R Marker Beacons 36L LOC	None	18R ALS 18R GS 18R RVR 18R DME 18R PAPI 18R Marker Beacons 36L LOC
Runway 36L End Impacts			
Public Roads/Structures Under Runway or in RSA/OFA	None	Youell Rd KCAB Ball Fields	Youell Rd
Public Roads in RPZ	Youell Rd	None	Youell Rd

Evaluation Criteria	Alternative		
	1	2	3
Structures/Areas in RPZ	None	Business Parking Lot KCAB Ball Fields	KCAB Ball Fields & Access Road
Off-Airport RPZ	None	53 Acres	None
NAVAID Relocations	None	36L ALS 36L GS 36L RVR 36L DME 36L PAPI 36L Marker Beacons 18R LOC	36L ALS 36L GS 36L RVR 36L DME 36L PAPI 36L Marker Beacons 18R LOC

Source: Landrum & Brown analysis

Runway 18C/36C Extension Alternatives

Two alternatives were developed for the extension of 11,000-foot long Runway 18C/36C to a length of 12,000 feet.

- **Alternative 4**: Extend Runway 18C/36C to the north by 1,000 feet. Implement declared distance criteria (1,000-foot displaced threshold) to mitigate impacts to the north.
- **Alternative 5**: Extend Runway 18C/36C to the south by 1,000 feet.

These alternatives are illustrated on **Exhibits 5.2-4** and **Exhibit 5.2-5**. **Table 5.2-2, *12,000-Foot Long Runway 18C/36C Evaluation***, presents the evaluation of these three extension alternatives.

<u>Runway 18C/36C Alternative 4 Impacts:</u>

In order to minimize impacts on the north end, the Runway 18C arrival threshold is displaced 1,000 feet in Alternative 4. This displacement keeps the arrival threshold in its current location even though the runway is extended 1,000 feet. The approach RPZ also remains in the same location as today, however, the departure RPZ shifts to the north, starting 200 feet beyond the physical runway end. The displacement of the arrival threshold avoids impacts to I-275, Petersburg Road, and Elijah Creek Road.

Implementing a displaced threshold reduces the LDA by 1,000 feet but does not affect TORA, TODA, or ASDA. The physical runway length is 12,000 feet; the full length is available for departures in each direction and for arrivals in the Runway 36C direction. A reduced length of 11,000 feet is available for landings in the Runway 18C direction.

North end impacts include Loomis Road in the Runway 18C RSA/OFA and RPZ. In addition, the glycol processing building and tank are within the Runway 18C approach RPZ. The approach and departure RPZs are located entirely within CVG property. NAVAID relocations are required on the Runway 18C end.

On the south end, there are no structures or public roads within the RSA, OFA, or RPZ. The Runway 36C RPZ is located entirely within CVG property.

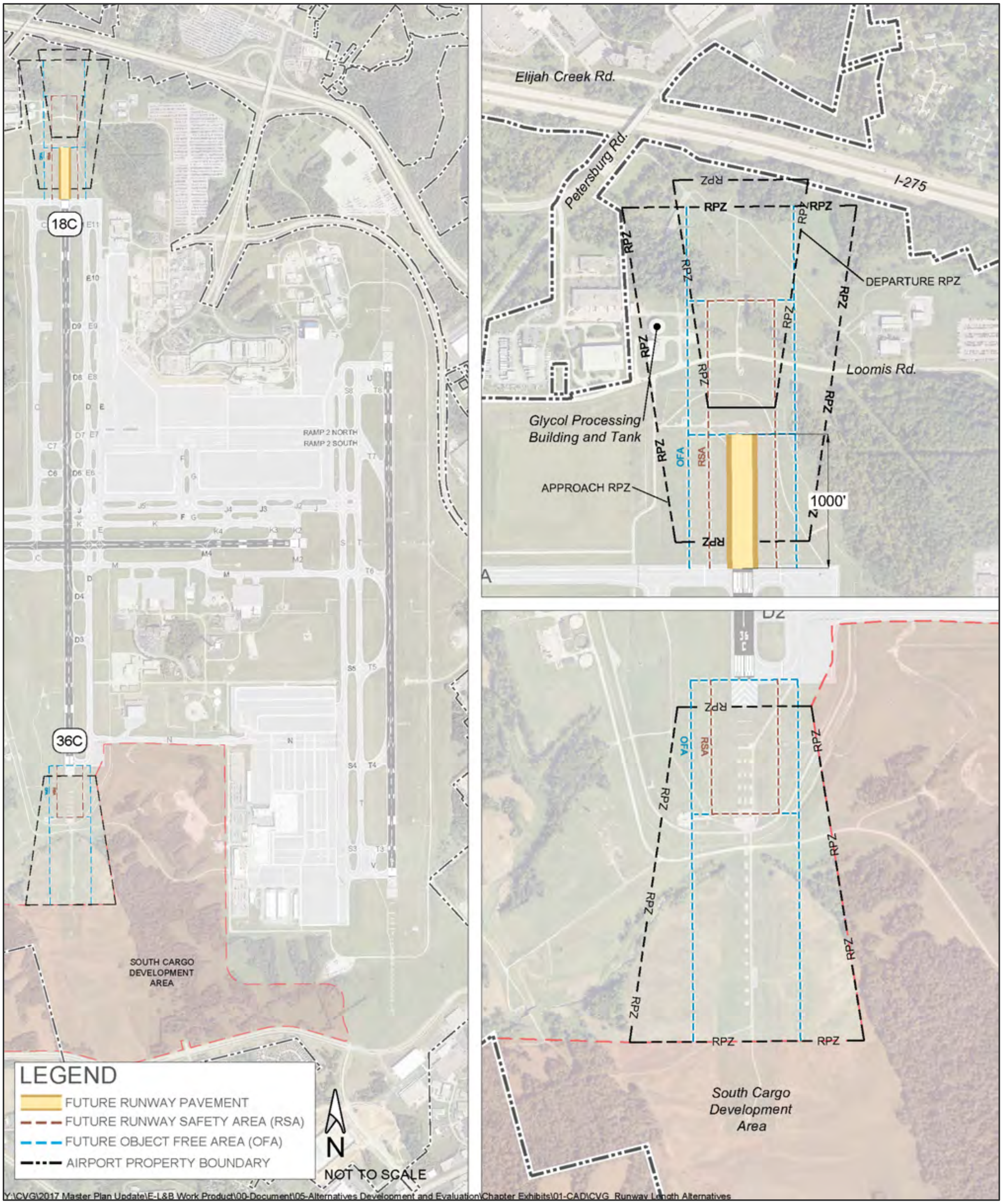
<u>Runway 18C/36C Alternative 5 Impacts:</u>

North end impacts include Loomis Road and the glycol processing building and tank in the 18C RPZ. The north RPZ is entirely within CVG property. South end impacts include the future south cargo development within the Runway 36C RPZ. The Runway 36C RPZ encompasses one acre of off-airport land. NAVAID relocations are required on the Runway 36C end.

Runway 18C/36C Alternatives Evaluation and Recommendation

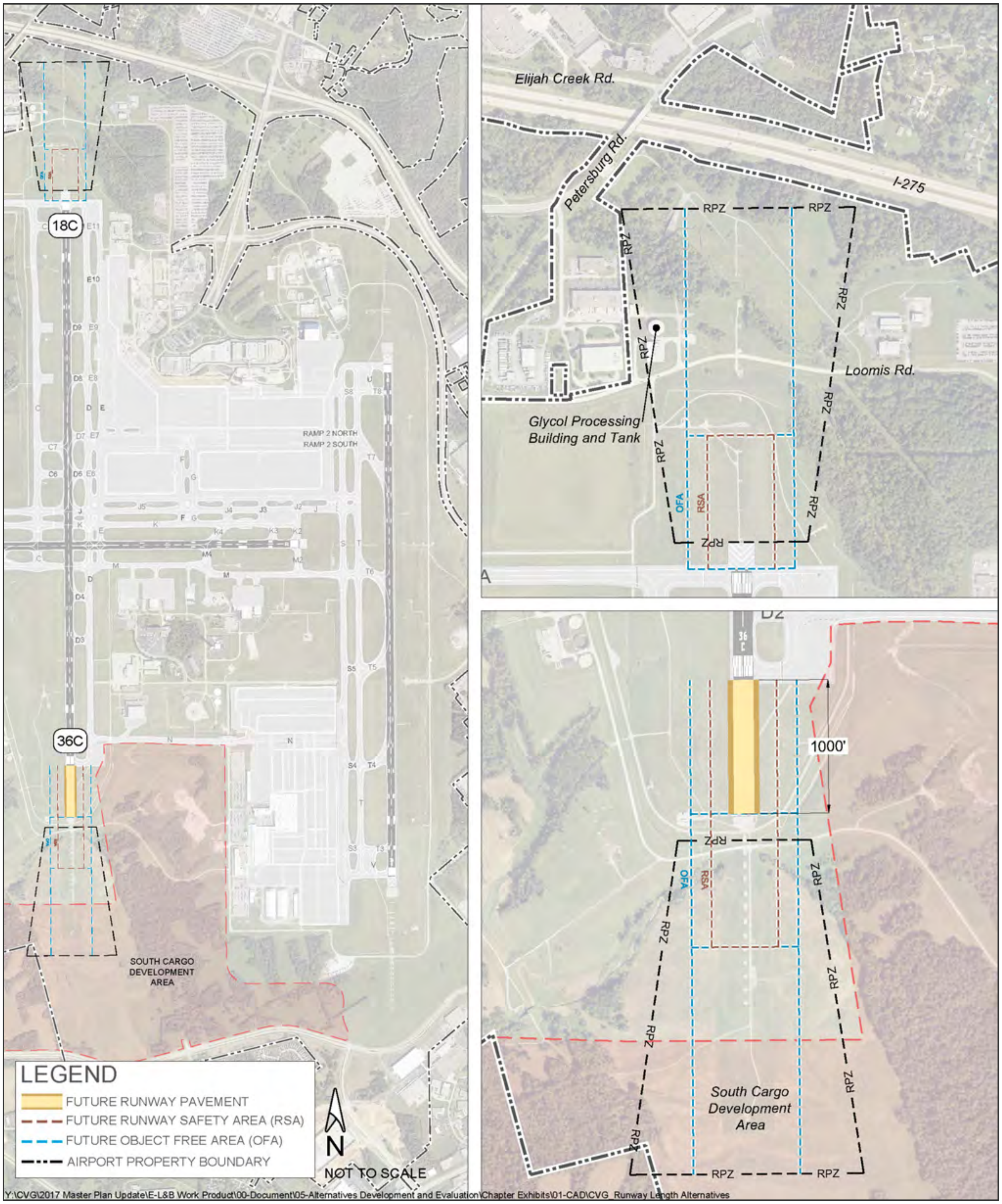
Alternatives 4 and 5 are similar in terms of their impacts to the Runway 18C end and the number of NAVAID relocations. However, they differ in the south cargo development area impact. Alternative 5 would reduce the area available for the south cargo development, whereas Alternative 4 does not. As a result, Alternative 5 was eliminated from further consideration, and Alternative 4 is the recommended for the extension of Runway 18C/36C to be carried forward for further evaluation.

EXHIBIT 5.2-4 12,000 FOOT RUNWAY 18C/36C – ALTERNATIVE 4



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-5 12,000 FOOT RUNWAY 18C/36C – ALTERNATIVE 5



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

TABLE 5.2-2 12,000-FOOT LONG RUNWAY 18C/36C EVALUATION

Evaluation Criteria	Alternative	
	4	5
Extension Description		
Extension Length & Direction	1,000' North 1,000' Displaced Threshold (18C)	1,000' South
Takeoff Run Available	12,000'	12,000'
Runway 18C End Impacts		
Public Roads/Structures Under Runway or in RSA/OFA	Loomis Rd	None
Public Roads in RPZ	Loomis Rd	Loomis Rd
Structures/Areas in RPZ	Glycol Processing Building & Tank	Glycol Processing Building & Tank
Off-Airport RPZ	None	None
NAVAID Relocations	18C ALS 18C GS 18C RVR 18C DME 18C PAPI 36C LOC	None
Runway 36C End Impacts		
Public Roads/Structures Under Runway or in RSA/OFA	None	None
Public Roads in RPZ	None	None
Structures/Areas in RPZ	None	South Cargo Development
Off-Airport RPZ	None	1 Acre
NAVAID Relocations	None	36C ALS 36C GS 36C RVR 36C DME 36C PAPI 18C LOC

Source: Landrum & Brown analysis

Runway 18L/36R Extension Alternatives

Three alternatives were developed for the extension of 10,000-foot long Runway 18L/36R:

- **Alternative 6**: Extend Runway 18L/36R to the north by 2,000 feet to provide a length of 12,000 feet
- **Alternative 7**: Extend Runway 18L/36R to the south by 2,000 feet to provide a length of 12,000 feet
- **Alternative 8**: Extend both ends of Runway 18L/36R by 2,000 feet to provide a physical pavement length of 14,000 and apply declared distances to reduce impacts

These alternatives are illustrated on **Exhibit 5.2-6** through **Exhibit 5.2-8**. **Table 5.2-3**, ***12,000-Foot Long Runway 18L/36R Evaluation***, presents the evaluation of these three extension alternatives.

<u>Runway 18L/36R Alternative 6 Impacts:</u>

North end impacts include Donaldson Highway and a portion of a CVG parking lot within the RSA/OFA. The Donaldson Highway, Interstate 275, and a portion of a CVG parking lot are within the RPZ area. The Runway 18L RPZ encompasses 26 acres of off-airport land area. NAVAID relocations are required on only the Runway 18L end. The Runway 36R RPZ is fully within CVG property boundaries. However, a small portion of Aero Parkway (southeast corner) in the RPZ area.

<u>Runway 18L/36R Alternative 7 Impacts:</u>

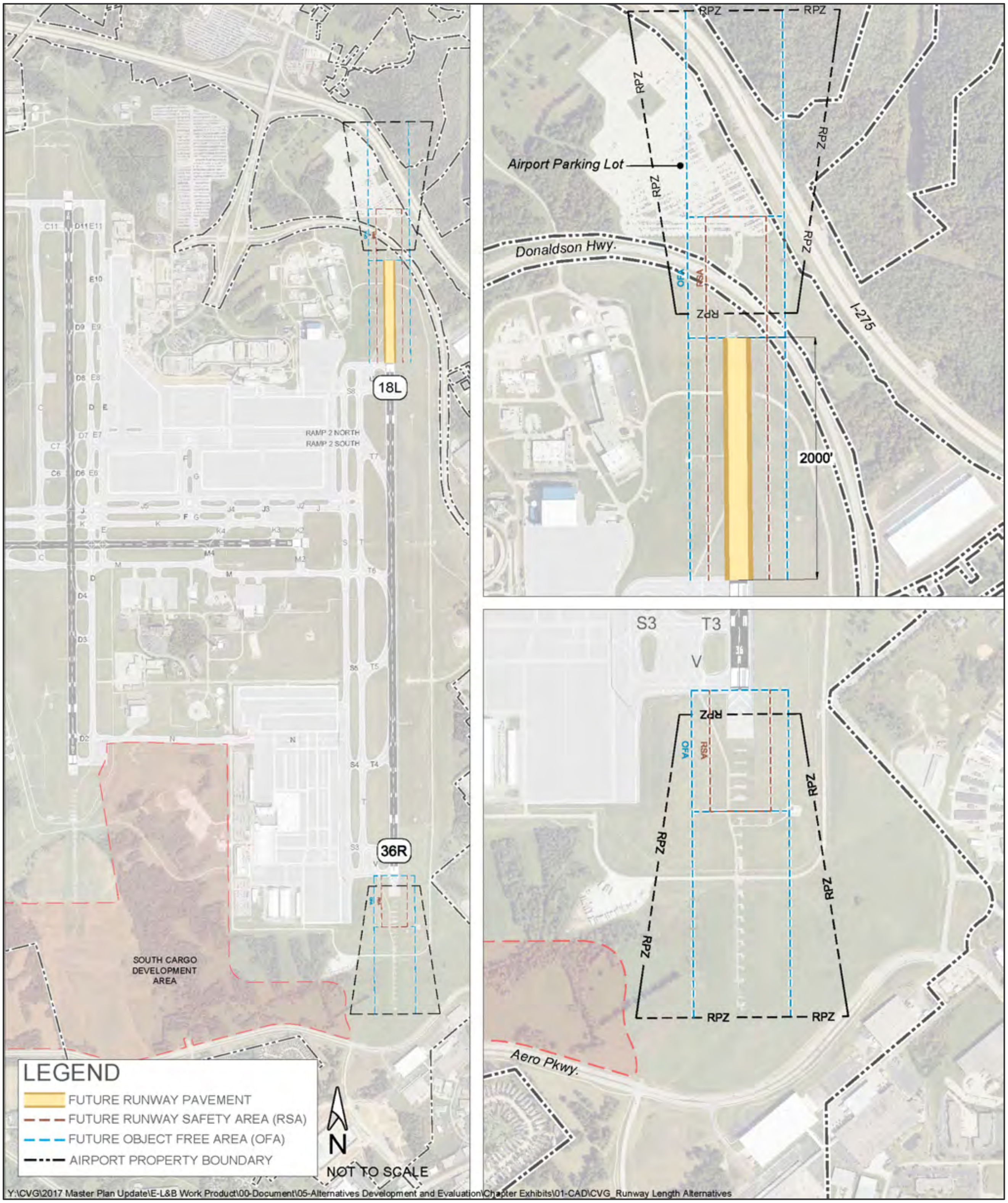
North end impacts include Donaldson Highway and Interstate 275 (NE corner) within the Runway 18L RPZ area. The Runway 18L RPZ encompasses nine acres of off-airport land. South end impacts include Aero Parkway and Ted Bushelman Boulevard (southwest corner) within the Runway 36R RPZ area. In addition, two commercial Bosch Automotive buildings are within the Runway 36R RPZ area. The Runway 36R RPZ encompasses three acres of off-airport land. NAVAID relocations are required on only the Runway 36R end.

<u>Runway 18L/36R Alternative 8 Impacts:</u>

In order to minimize the roadway and parking impacts seen in Alternatives 6 and 7, declared distances were applied in Alternative 8 as depicted on **Exhibit 5.2-9, *Runway 18L/36R Alternative 8 Declared Distances***. The alternative includes displacement of the arrival thresholds by 2,000 feet. In addition, the departure end of runway is declared 2,000 feet prior to the physical end of the extended runway on both ends. These declared distances allow the RSA, OFA, and both RPZs to remain in their current locations, while providing the 12,000-foot departure length in each direction. The physical runway length increases to 14,000 feet, and the runway provides 14,000 feet of TODA, 12,000 feet of TORA and ASDA, and 10,000 feet of LDA in each direction.

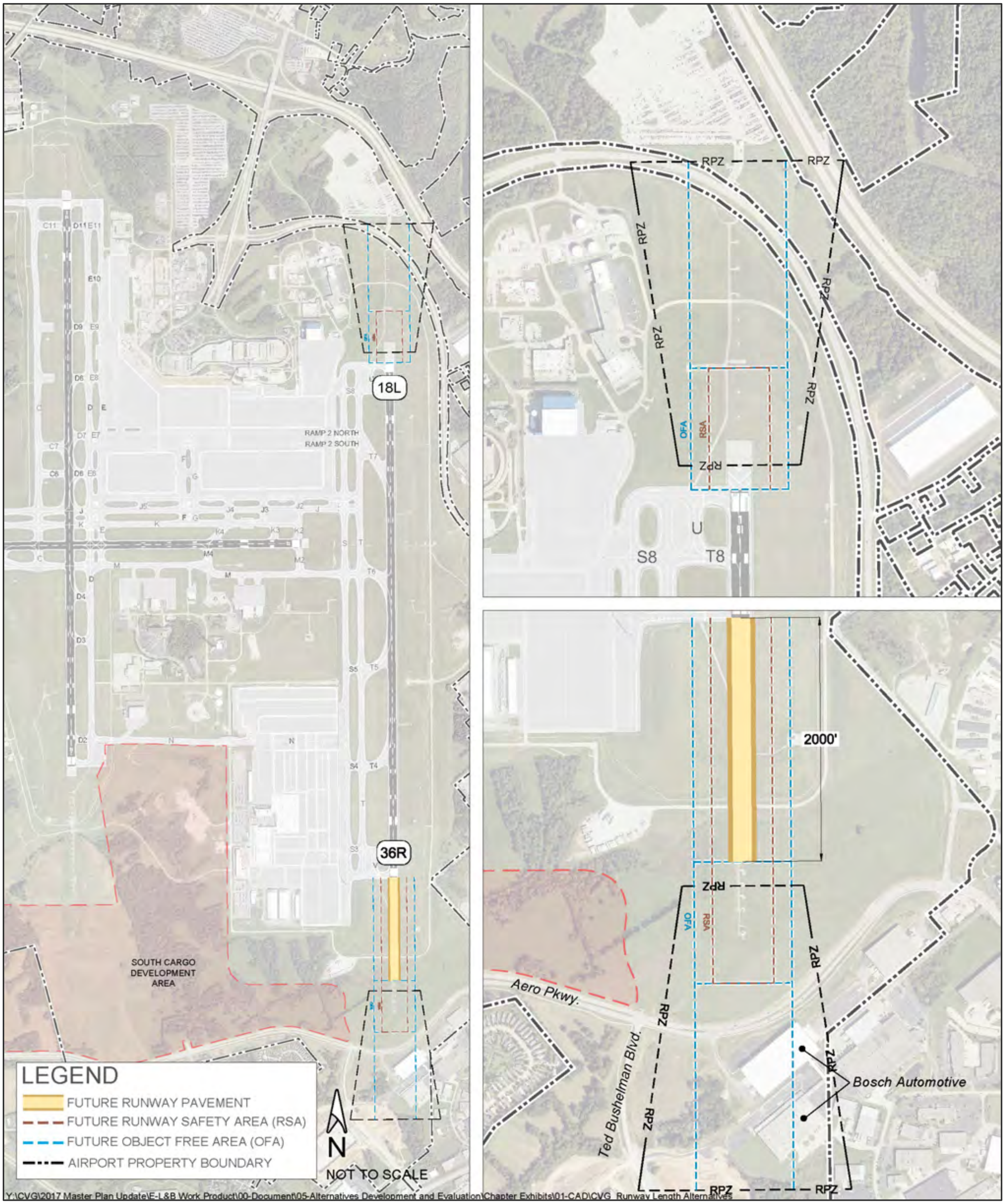
North end impacts include Donaldson Highway and Interstate 275 (northeast corner) within the Runway 18L RPZ area. The Runway 18L RPZ encompasses nine acres of off-airport land. South end impacts include a small portion of Aero Parkway (southeast corner) in the Runway 36R RPZ area. The Runway 36R RPZ is located entirely on CVG property. NAVAID relocations are required on both runway ends with Alternative 8.

EXHIBIT 5.2-6 12,000 FOOT RUNWAY 18L/36R – ALTERNATIVE 6



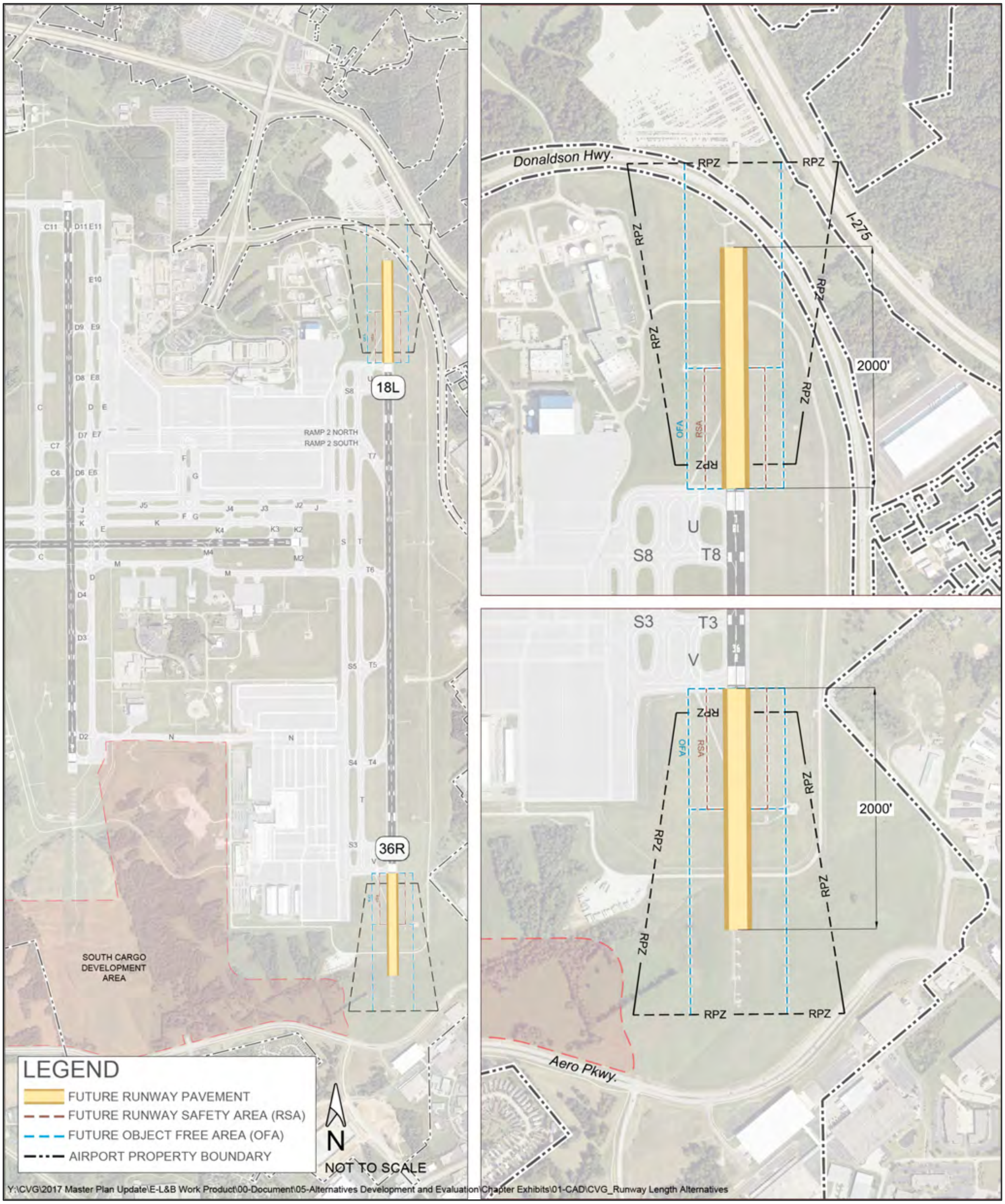
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-7 12,000 FOOT RUNWAY 18L/36R – ALTERNATIVE 7



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-8 12,000 FOOT RUNWAY 18L/36R – ALTERNATIVE 8



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

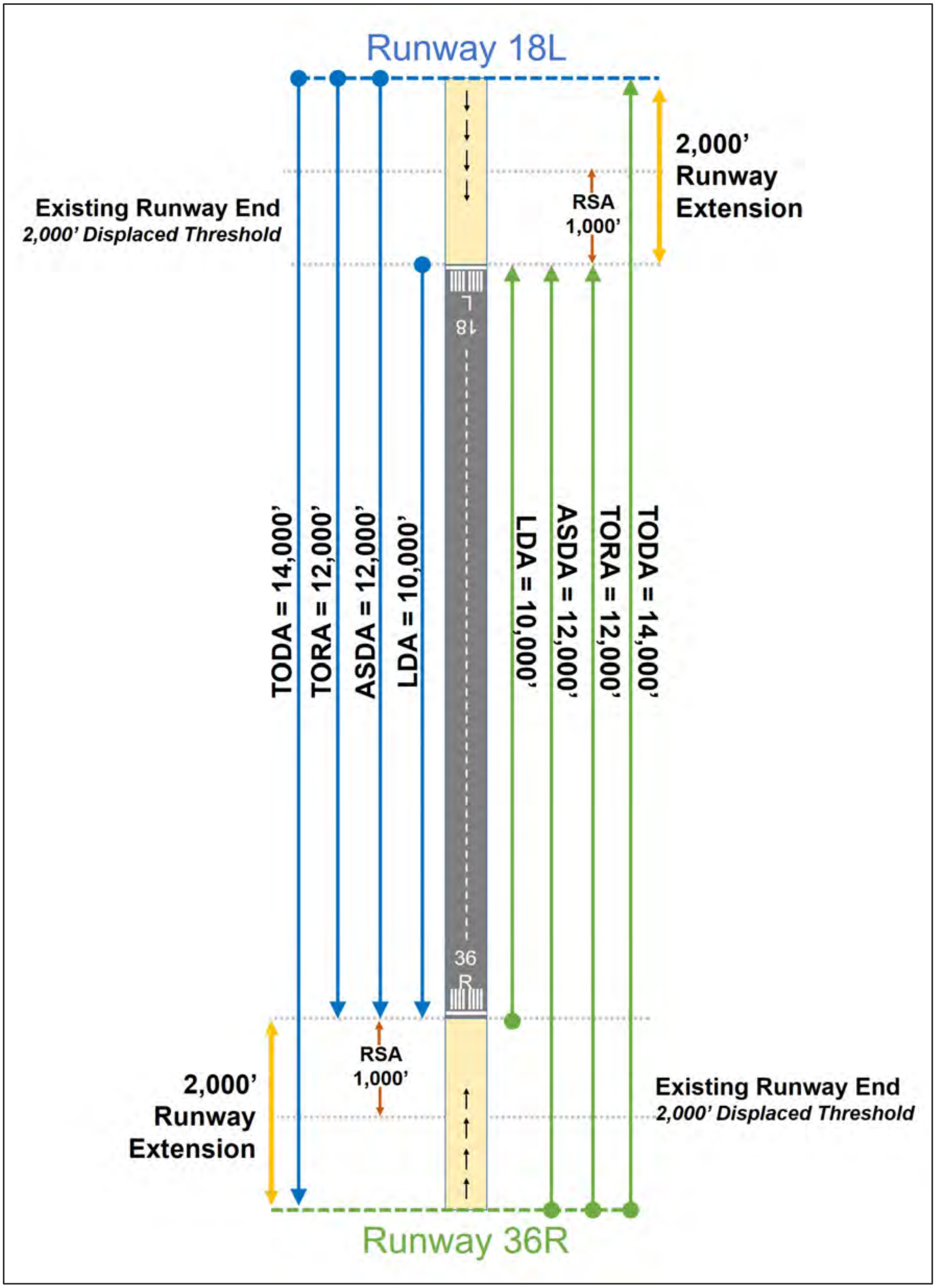
TABLE 5.2-3 12,000-FOOT LONG RUNWAY 18L/36R EVALUATION

Evaluation	Alternative		
	6	7	8
Extension Description			
Extension Length & Direction	2,000’ North	2,000’ South	2,000’ North 2,000’ South Apply Declared Distances
Takeoff Run Available	12,000'	12,000'	12,000'
Runway 18L End Impacts			
Public Roads/Structures Under Runway or in RSA/OFA	Donaldson Hwy. Airport Parking Lot	None	None
Public Roads in RPZ	I-275 Donaldson Hwy.	I-275 (NE Corner) Donaldson Hwy.	I-275 (NE Corner) Donaldson Hwy.
Structures/Areas in RPZ	Airport Parking Lot	None	None
Off-Airport RPZ	26 Acres	9 Acres	9 Acres
NAVAID Relocations	18L ALS 18L GS 18L RVR 18L DME 18L PAPI 36R LOC	None	18L ALS 18L GS 18L RVR 18L DME 18L PAPI 36R LOC
Runway 36R End Impacts			
Public Roads/ Structures Under Runway or in RSA/OFA	None	None	None
Public Roads in RPZ	Aero Pkwy. (SE Corner)	Aero Pkwy. Ted Bushelman Blvd. (SW Corner)	Aero Pkwy. (SE Corner)
Structures/Areas in RPZ	None	2 Bosch Automotive Bldgs.	None

Evaluation	Alternative		
	6	7	8
Off-Airport RPZ	None	3 Acres	None
NAVAID Relocations	None	36R ALS 36R GS 36R RVR 36R DME 36R PAPI 18L LOC	36R ALS 36R GS 36R RVR 36R DME 36R PAPI 18L LOC

Source: Landrum & Brown analysis

EXHIBIT 5.2-9 RUNWAY 18L/36R ALTERNATIVE 8 DECLARED DISTANCES



Source: Landrum & Brown analysis

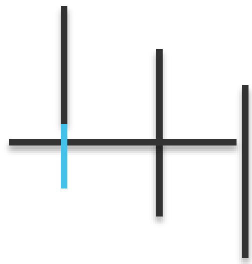
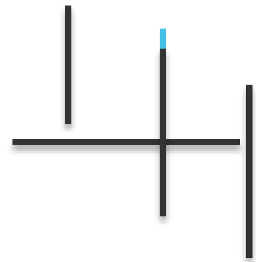
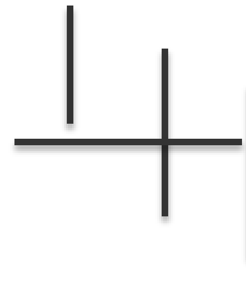
Runway 18L/36R Alternatives Evaluation and Recommendation

The northern extension of Runway 18L/36R in Alternative 6 requires extensive relocation or tunneling of I-275 and has impacts to a CVG parking lot, whereas the southern extension of Runway 18L/36R in Alternative 7 requires an extensive relocation or tunneling of Aero Parkway, which would affect numerous industrial and commercial buildings to the south of CVG. Alternative 8 uses declared distances to minimize extensive impacts to I-275 and Aero Parkway. It has the least amount of roadway impacts of the three alternatives. As a result, Alternative 8 is recommended for the extension of Runway 18L/36R be carried forward for further evaluation.

5.2.1.3 12,000-Foot Runway Recommendation

Exhibit 5.2-10, *12,000-Foot Runway Extension Recommendation* shows a comparison of the three shortlisted alternatives. Alternative 2 (Runway 18R/36L extension) has the least amount of physical impact on and off-airport, although it would require the acquisition of 17 acres of land within the future Runway 36L RPZ area. Alternative 2 would meet both runway length needs at once: (1) provide widebody capability for Runway 18R/36L and (2) provide 12,000 feet of runway length on one of the parallel runways. Conversely, the other two alternatives would require that Runway 18R/36L be extended to 10,000 feet in addition to the runway extension proposed as part of the alternative. Alternative 2 is therefore the preferred alternative for a 12,000 foot runway.

EXHIBIT 5.2-10 12,000-FOOT RUNWAY EXTENSION RECOMMENDATION

Evaluation Criteria	Alternative 2  4,000’ extension south	Alternative 4  1,000’ extension north	Alternative 8  2,000’ extensions north & south with declared distances
Minimizes Runway Extension Pavement	X	✓	X
Minimizes NAVAID Impacts	✓	✓	X
Minimizes Facility Impacts	✓	X	X
Minimizes RPZ Incompatibilities	✓	X	X
Minimizes Affected Runways	✓	✓	X

Note: Alternatives 4 and 8 would require that Runway 18R/36L be extended to 10,000 feet in addition to the runway extension assumed as part of the alternative.

Source: Landrum & Brown analysis

5.2.1.4 10,000-Foot Runway 18R/36L Analysis

This subsection describes the development and evaluation of runway extension alternatives that provide 10,000 feet of departure length on Runway 18R/36L (2,000-foot extension). A length of 10,000 feet on Runway 18R/36L would allow this runway to accommodate 100 percent of arrivals and 78 percent of departures at CVG at PAL 4 demand levels. Three alternatives were developed for the extension of Runway 18R/36L from a length of 8,000 feet to 10,000 feet:

- **Alternative 9**: Extend Runway 18R/36L to the north by 2,000 feet.
- **Alternative 10**: Extend Runway 18R/36L to the south by 2,000 feet.
- **Alternative 11**: Extend Runway 18R/36L to the north by 550 feet and to the south by 1,450 feet. The 550-foot north extension is the longest that can be achieved while keeping the RSA and OFA within existing CVG property.

These three alternatives are illustrated in **Exhibit 5.2-11** through **Exhibit 5.2-13**. **Table 5.2-4, *10,000-Foot Long Runway 18R/36L Evaluation***, presents the evaluation of the three extension alternatives.

<u>Runway 18R/36L Alternative 9 Impacts</u>:

North end impacts include I-275 and Elijah Creek Road located under the runway extension pavement and/or the RSA/OFA. Elijah Creek Road and one industrial building are within the Runway 18R RPZ area. The 18R RPZ encompasses the most off-airport land area at 55 acres. NAVAID relocations are required on only the Runway 18R end. South end impacts include Youell Road within the Runway 36L RPZ. The Runway 36L RPZ is located entirely on CVG property.

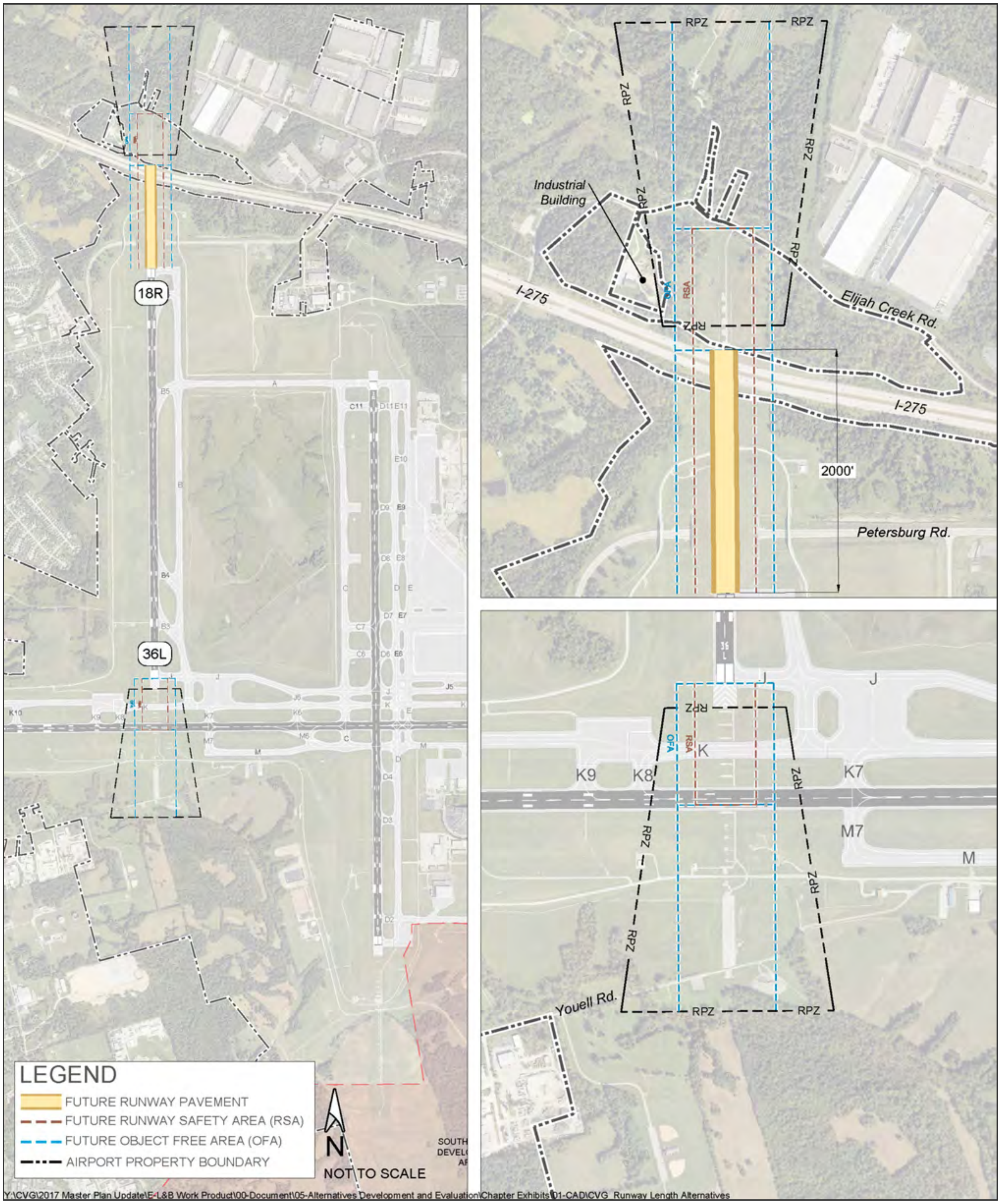
<u>Runway 18R/36L Alternative 10 Impacts</u>:

North end impacts include I-275, Elijah Creek Road and one industrial building within the Runway 18R RPZ area. Petersburg Road is located within the RSA/OFA. The Runway 18R RPZ encompasses 17 acres of off-airport land area. South end impacts include Youell Road, KCAB ball field, and an access road located within the Runway 18R RPZ area. Youell Road is also located within the RSA/OFA. NAVAID relocations are required on only the Runway 36L end. The Runway 36L RPZ is located entirely on CVG property.

<u>Runway 18R/36L Alternative 11 Impacts</u>:

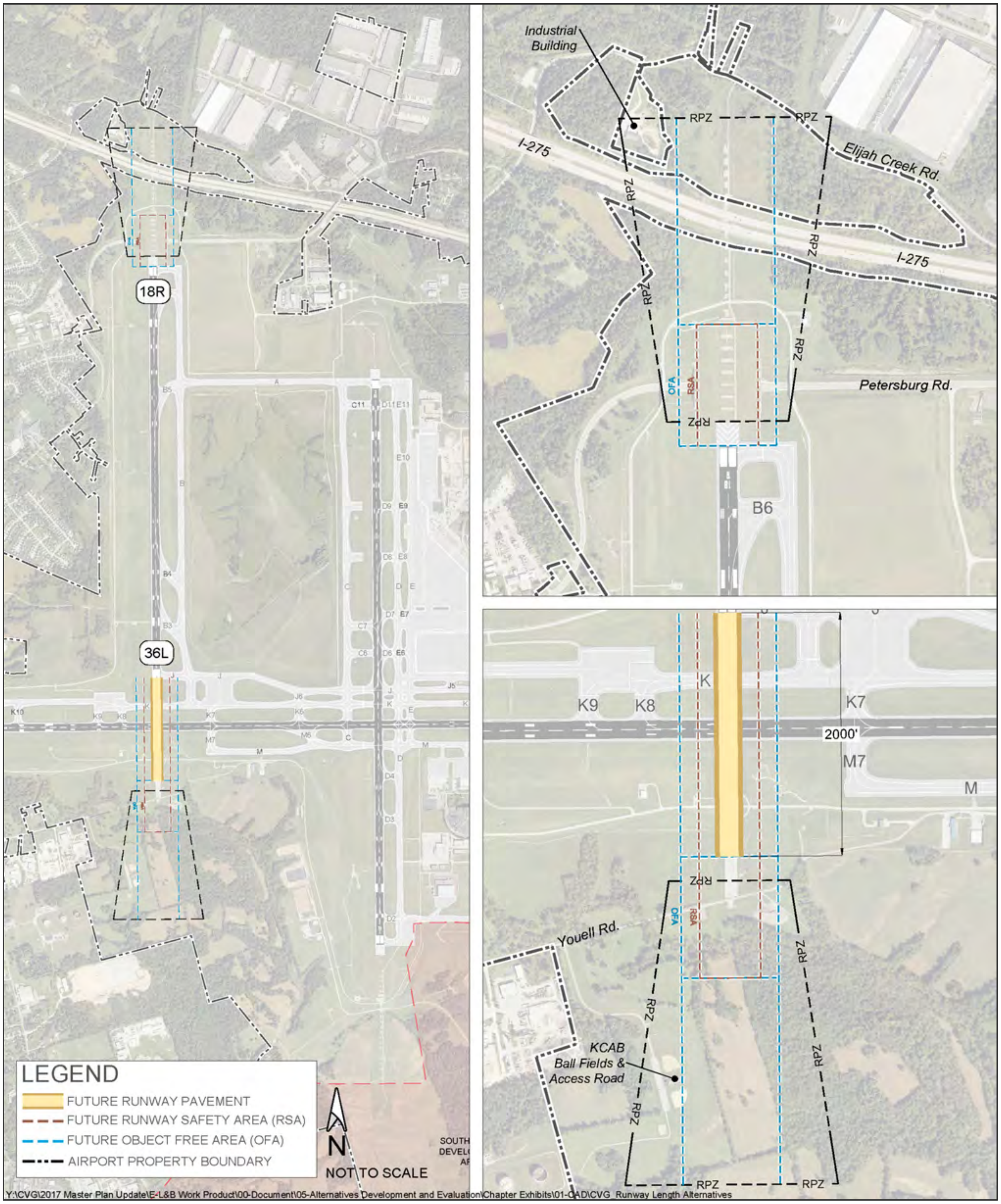
North end impacts include I-275, Elijah Creek Road and one industrial building within the Runway 18R RPZ area. In addition, Petersburg Road is located within the RSA/OFA. The Runway 18R RPZ encompasses 25 acres of off-airport land area. South end impacts include Youell Road, KCAB ball field, and access road located within the Runway 36L RPZ area. Youell Road is also located within the RSA/OFA. The Runway 36L RPZ is located completely on CVG property. NAVAID relocations are required on both runway ends.

EXHIBIT 5.2-11 10,000 FOOT RUNWAY 18R/36L – ALTERNATIVE 9



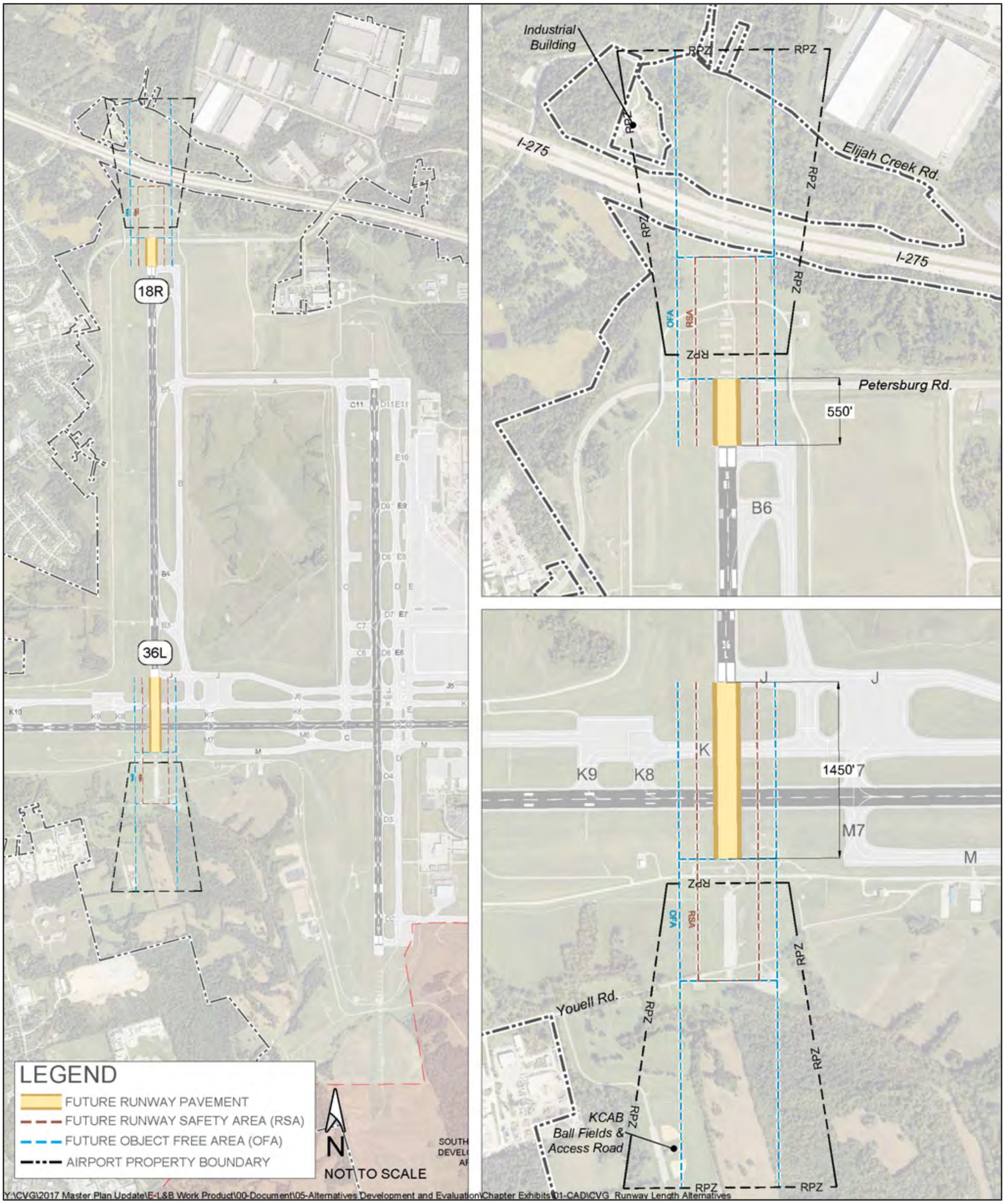
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis.

EXHIBIT 5.2-12 10,000 FOOT RUNWAY 18R/36L – ALTERNATIVE 10



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis.

EXHIBIT 5.2-13 10,000 FOOT RUNWAY 18R/36L – ALTERNATIVE 11



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis.

TABLE 5.2-4 10,000-FOOT LONG RUNWAY 18R/36L EVALUATION

Evaluation Criteria	Alternative		
	9	10	11
Extension Description			
Extension Length & Direction	2,000' North	2,000' South	550' North 1,450' South
Takeoff Run Available	10,000'	10,000'	10,000'
Runway 18R End Impacts			
Public Roads/Structures Under Runway or in RSA/OFA	I-275 Elijah Creek Road (NE Corner)	Petersburg Road	Petersburg Road
Public Roads in RPZ	Elijah Creek Rd.	I-275 Elijah Creek Rd. (NE Corner)	I-275 Elijah Creek Rd.
Structures/Areas in RPZ	Industrial Building	Industrial Building	Industrial Building
Off-Airport RPZ Area	55 Acres	17 Acres	25 Acres
NAVAID Relocations	18R ALS 18R GS 18R RVR 18R DME 18R PAPI 18R Marker Beacons 36L LOC	None	18R ALS 18R GS 18R RVR 18R DME 18R PAPI 18R Marker Beacons 36L LOC
Runway 36L End Impacts			
Public Roads/Structures Under Runway or in RSA/OFA	None	Youell Rd.	Youell Rd.
Public Roads in RPZ	Youell Rd.	Youell Rd.	Youell Rd.
Structures/Areas in RPZ	None	KCAB Ball Fields & Access Road	KCAB Ball Fields & Access Road

Evaluation Criteria	Alternative		
	9	10	11
Off-Airport RPZ Area	None	None	None
NAVAID Relocations	None	36L ALS 36L GS 36L RVR 36L DME 36L PAPI 36L Marker Beacons 18R LOC	36L LOC 36L ALS 36L GS 36L RVR 36L DME 36L PAPI 36L Marker Beacons 18R LOC

Source: Landrum & Brown analysis

5.2.1.5 10,000-Foot Runway Recommendation

The evaluation of the three proposed 10,000-foot Runway 18R/36L alternatives indicates that the majority of impacts are on the north end of Runway 18R/36L, in particular roadway impacts. While Alternative 11 attempts to limit the magnitude of these northern impacts, they still exist to a degree that is most likely very costly and prohibitive.

Alternative 10 does not modify the north end because the full extension is to the south. FAA may allow the north end to remain untouched because there is no change on that end. Therefore, Alternative 10 (2,000-foot extension to south) is the preferred alternative to provide 10,000 feet of runway length on Runway 18R/36L. This south extension maintains all proposed airfield infrastructure on existing CVG property while proposing the least amount of off-airport property acquisition. Benefits of the Alternative 10 runway extension include:

- All runway and taxiway extensions are on existing CVG property
- RSA/OFA/RPZ areas are on existing CVG property
- Affected roads/facilities are currently controlled by CVG

5.2.1.6 Runway Extension Recommendation

The preceding analysis determined that extending Runway 18R/36L is the preferred way to meet the need for 12,000 feet of length on one of the parallel runways. The extension of Runway 18R/36L by 4,000 feet to the south (Alternative 2) would result in lengths of 12,000 feet, 11,000 feet, and 10,000 feet on the parallel runways. These lengths would allow 100 percent of the fleet to be accommodated on the parallel runways. As a result, Runway 09/27 would not need to be used when operating on the triple parallel runways, allowing the capacity of the runway system to be maximized.

While the 4,000-foot southern extension would maximize capacity, it does require the purchase of 17 acres of property to the south. Given those impacts, and the costs that would be associated with a 4,000-foot extension, the need for 12,000 feet on the parallel runways was reassessed. If Runway 18R/36L was extended by 2,000 feet to the south (Alternative 10), CVG would have two 10,000-foot long runways and one 11,000-foot long runway in the 18/36 direction. Aircraft that require more than 11,000 feet for departure would have to use Runway 09/27, which would reduce the capacity of the runway system. Only two aircraft in the future fleet (B747-400 and A330-800) were found to require more than 11,000 feet, and only to certain destinations. Therefore, the capacity impact of those aircraft using Runway 09/27 is likely to be minor.

The runway extension is not projected to be needed until after PAL 3. Because this need is most likely 20 years away or more, the 4,000-foot extension to Runway 18R/36L is not recommended at this time. The 2,000-foot extension is recommended instead. The need for 12,000 feet should be assessed as part of future studies.

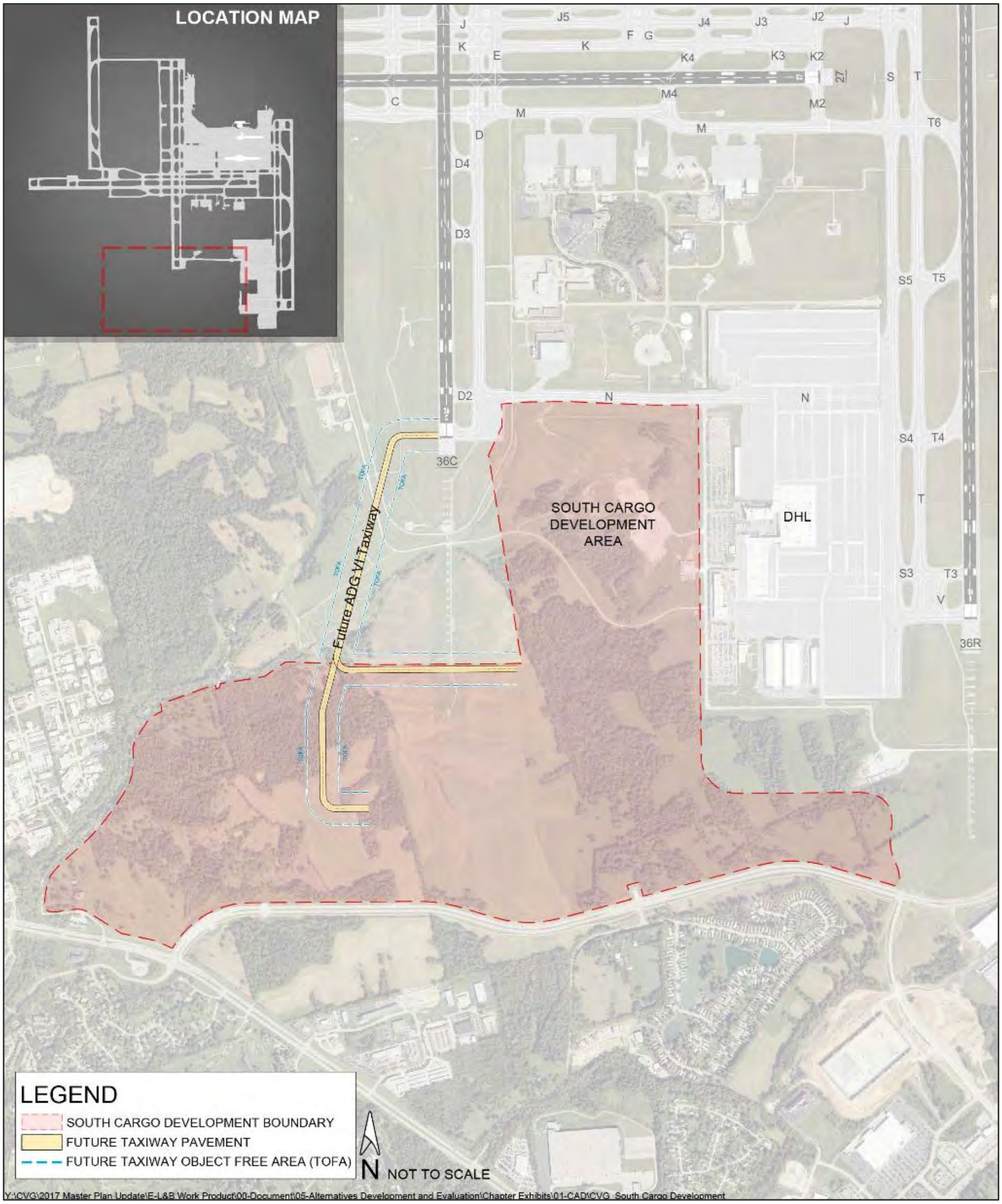
5.2.2 Taxiway Capacity

A taxiway demand/capacity analysis was completed to determine the existing taxiway deficiencies (see Chapter 4 – Facility Requirements, Section 4.2.4, *Taxiway Demand/Capacity*). The analysis focused on the south airfield, to the south of Runway 09/27, where the majority of cargo operations occur. The Chapter 4 analysis assumed that the south cargo development is in place, including an end-around taxiway that connects the southwestern portion of the new ramp to the west side of Runway 36C (see **Exhibit 5.2-14, *South Cargo Development***). This development was assumed to be in place because it is currently under environmental review. No other taxiway improvements were assumed to be in place for the taxiway demand/capacity analysis.

The Chapter 4 analysis identified multiple taxiway capacity requirements; this chapter evaluates alternative ways to meet those requirements. The requirements include:

- Taxiway E extension, south of Runway 09/27
- Taxiway C extension, south of Runway 09/27
- Parallel south crossfield taxilane (parallel to Taxilane N)
- Taxilane N extension

EXHIBIT 5.2-14 SOUTH CARGO DEVELOPMENT



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.2.2.1 Taxiway E Extension

Runway 18C/36C currently has a single parallel taxiway (Taxiway D) on the east side that runs the full length of the runway. North of Runway 09/27, Runway 18C/36C is served by a second parallel taxiway on the east side (Taxiway E). Regular use of Runway 18C/36C by cargo aircraft will require a second parallel taxiway (Taxiway E extension) to the south of Runway 09/27 to allow northbound and southbound traffic to be segregated and to minimize conflicts between aircraft heading in opposite directions.

Taxiway E Extension Concepts

The lateral centerline separation needed between the new Taxiway E and Taxiway D is determined by the size of the aircraft intended to use the taxiway. The future critical aircraft at CVG is the Boeing 747-8. The B747-8 is considered to be an Airplane Design Group (ADG) VI aircraft and a Taxiway Design Group (TDG) 6 aircraft. The B747-8 makes up 4.5 percent of cargo operations in 2018, decreasing to 1.5 percent by PAL 4. Conversely, the majority of cargo operations (68 percent through PAL 4) are ADG V and TDG 5 aircraft and the remainder of the fleet is smaller. Based on this fleet mix, two alternative layouts for the parallel taxiway were developed:

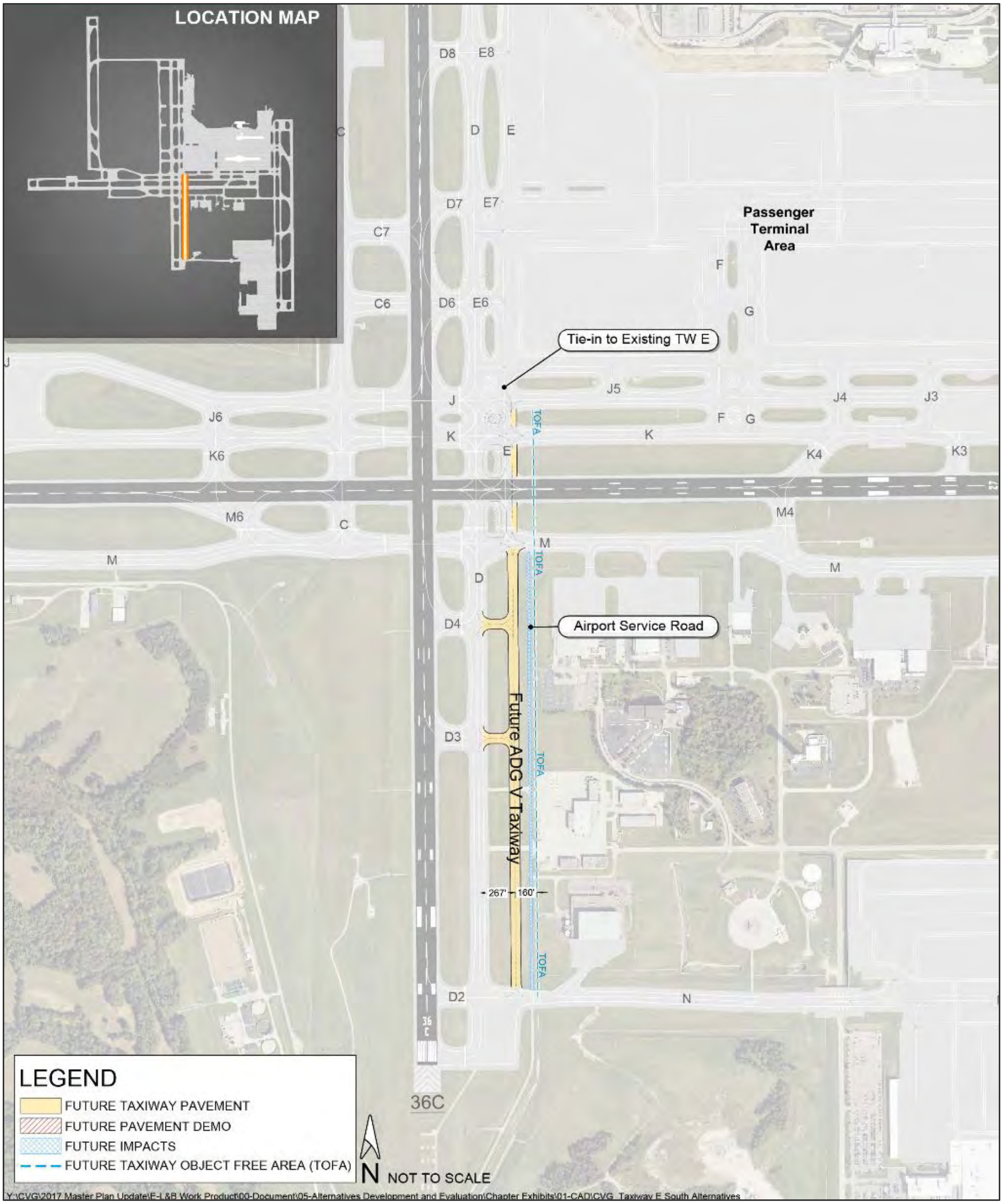
- **Concept 1**: Parallel taxiway with 267 feet of lateral separation from Taxiway D to meet ADG V and TDG 5 standards, presented in **Exhibit 5.2-15, *Taxiway E Extension Concept 1***.
- **Concept 2**: Parallel taxiway with 324 feet of lateral separation from Taxiway D to meet ADG VI and TDG 6 standards, presented in **Exhibit 5.2-16, *Taxiway E Extension Concept 2***.

Both concepts relocate existing Taxiway E between Taxiway J and Runway 09/27 to the same separation from Taxiway D as is depicted in the concepts. These shifts allow the extended Taxiway E to tie into existing Taxiway E.

Evaluation and Recommendation

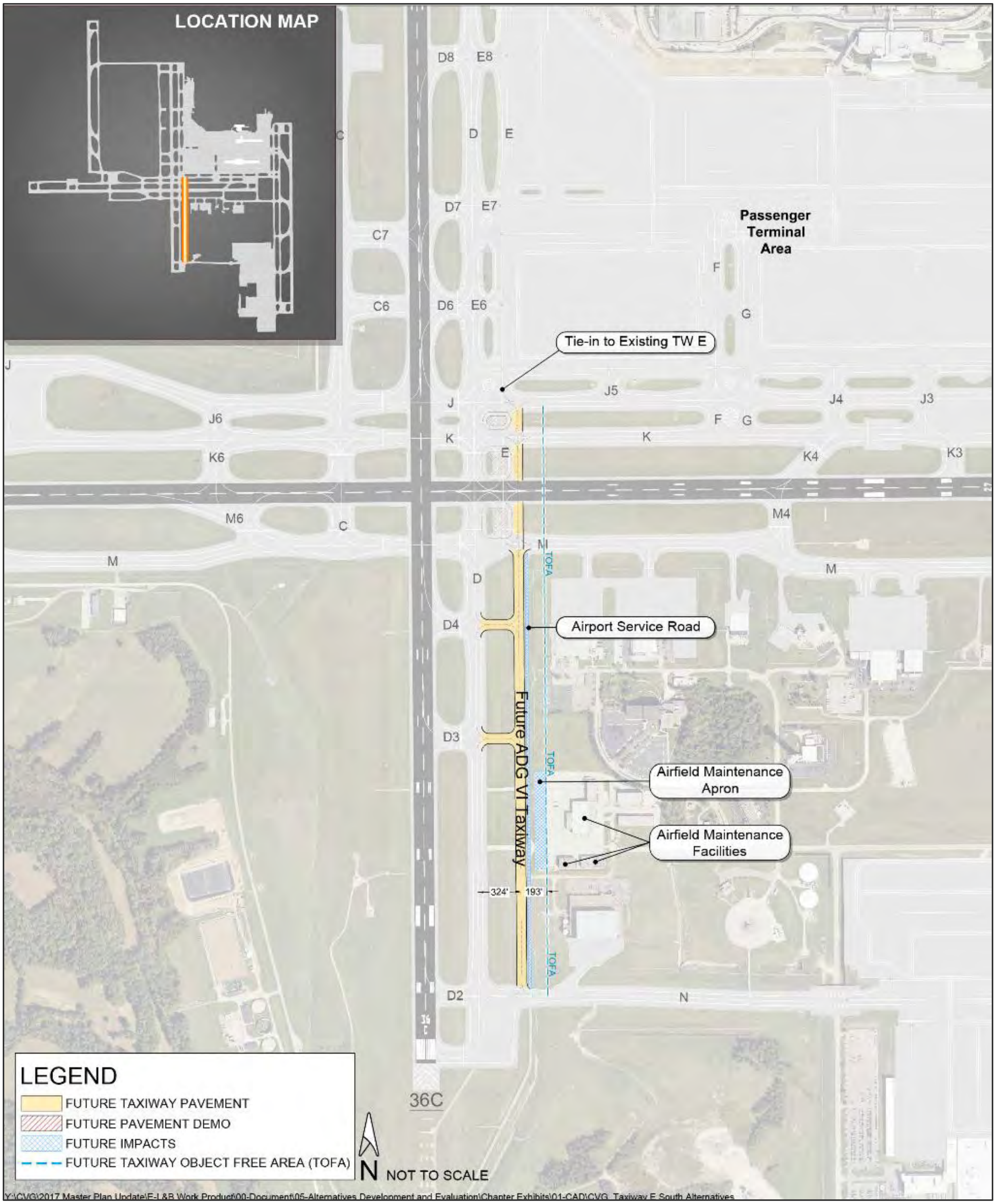
Both concepts would require the relocation of an airport service road. There would be no other facility impacts with Concept 1. Concept 2 would require a reduction in the apron associated with the airfield maintenance facilities by 85 linear feet of apron depth. In spite of the loss of apron area, Concept 2 is recommended because it provides the ability to accommodate the existing and projected fleet without operational restrictions and minimal facility impacts.

EXHIBIT 5.2-15 TAXIWAY E EXTENSION CONCEPT 1



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-16 TAXIWAY E EXTENSION CONCEPT 2



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.2.2.2 Taxiway C Extension

Runway 18C/36C's western parallel taxiway (Taxiway C) extends only to Taxiway M. As a result, all arrivals on Runway 18C not exiting the runway prior to the Runway 09/27 intersection, must exit to the east. By extending Taxiway C to the south of Runway 09/27 arrivals would now be able to exit the runway to the west. This would ultimately be beneficial as additional facilities are developed at CVG west of Runway 18C/36C. Additionally, this Taxiway C extension would have added benefit should an end-around-taxiway (EAT) be developed south of the Runway 36C threshold to reduce the number of runway crossings.

Taxiway C Extension Concepts

The lateral centerline separation needed between Runway 18C/36C and an extended Taxiway C is determined by the visibility minima of the runway, and the size of the aircraft intended to use the taxiway. Using similar assumptions as for the parallel taxiway on the eastern side of Runway 18C/36C, two alternative layouts for the parallel taxiway were developed:

- **Concept 1**: Parallel taxiway with 500 feet of lateral separation from Taxiway D to meet ADG V and TDG 5 standards for runways with visibility minima of less than a half mile, presented in **Exhibit 5.2-17, *Taxiway C Extension Concept 1***.
- **Concept 2**: Parallel taxiway with 600 feet of lateral separation from Taxiway D to meet ADG VI and TDG 6 standards for runways with visibility minima of less than a half mile, presented in **Exhibit 5.2-18, *Taxiway C Extension Concept 2***.

Evaluation and Recommendation

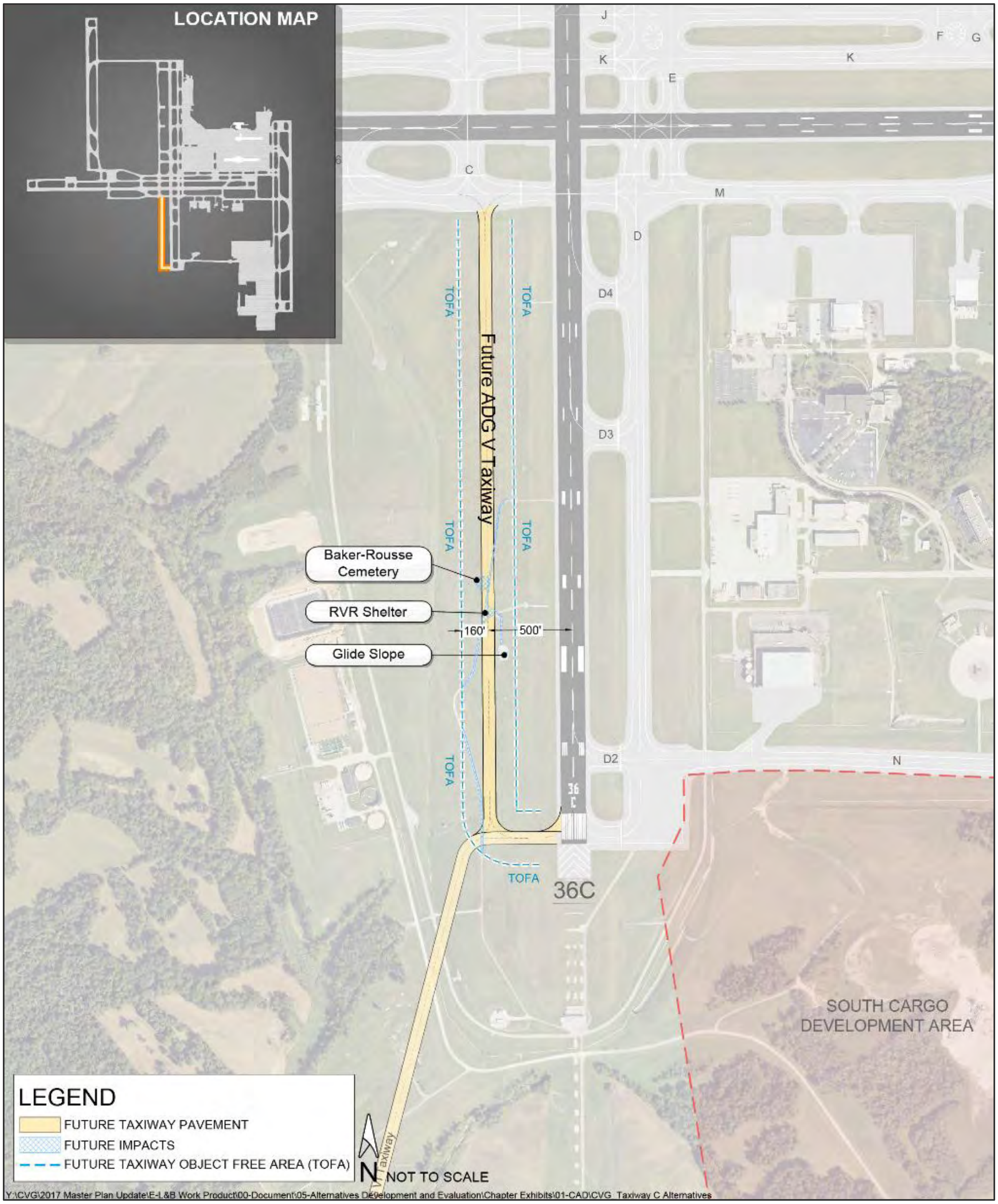
Taxiway C to the north of Runway 09/27 has 600 feet of separation from Runway 18C/36C in order to serve CVG's design aircraft (the B747-8). The Taxiway C extension in Concept 2 would provide the same capability as existing Taxiway C, whereas the Concept 1 taxiway extension could not accommodate B747-8 aircraft without restrictions. Both concepts require the relocation of the glide slope antenna and the Runway Visual Range (RVR) shelter. In addition, the Baker-Rousse Cemetery would be within the Taxiway Object Free Area (TOFA) in both concepts. This cemetery would have to be relocated, which requires environmental evaluation. There is a 10-foot difference in elevation between the ADG V and ADG VI taxiway so the ADG VI taxiway would require more grading than the ADG V taxiway. The grading difference is the only impact that differentiates the two concepts. The likely minor increase in cost due to the grading difference is outweighed by the ability to accommodate the projected fleet mix. Thus, the ADG VI taxiway in Concept 2 is recommended. A comparison of the concepts is shown in **Table 5.2-5, *Taxiway C Evaluation***.

TABLE 5.2-5 TAXIWAY C EVALUATION

Evaluation Criteria	Concept 1	Concept 2
Runway-Taxiway Separation	500’	600’
747-8 Capability	No	Yes
Impacts	Baker –Rousse Cemetery	Baker –Rousse Cemetery
Grading	Less grading required	10’ elevation difference could lead to minor cost increase

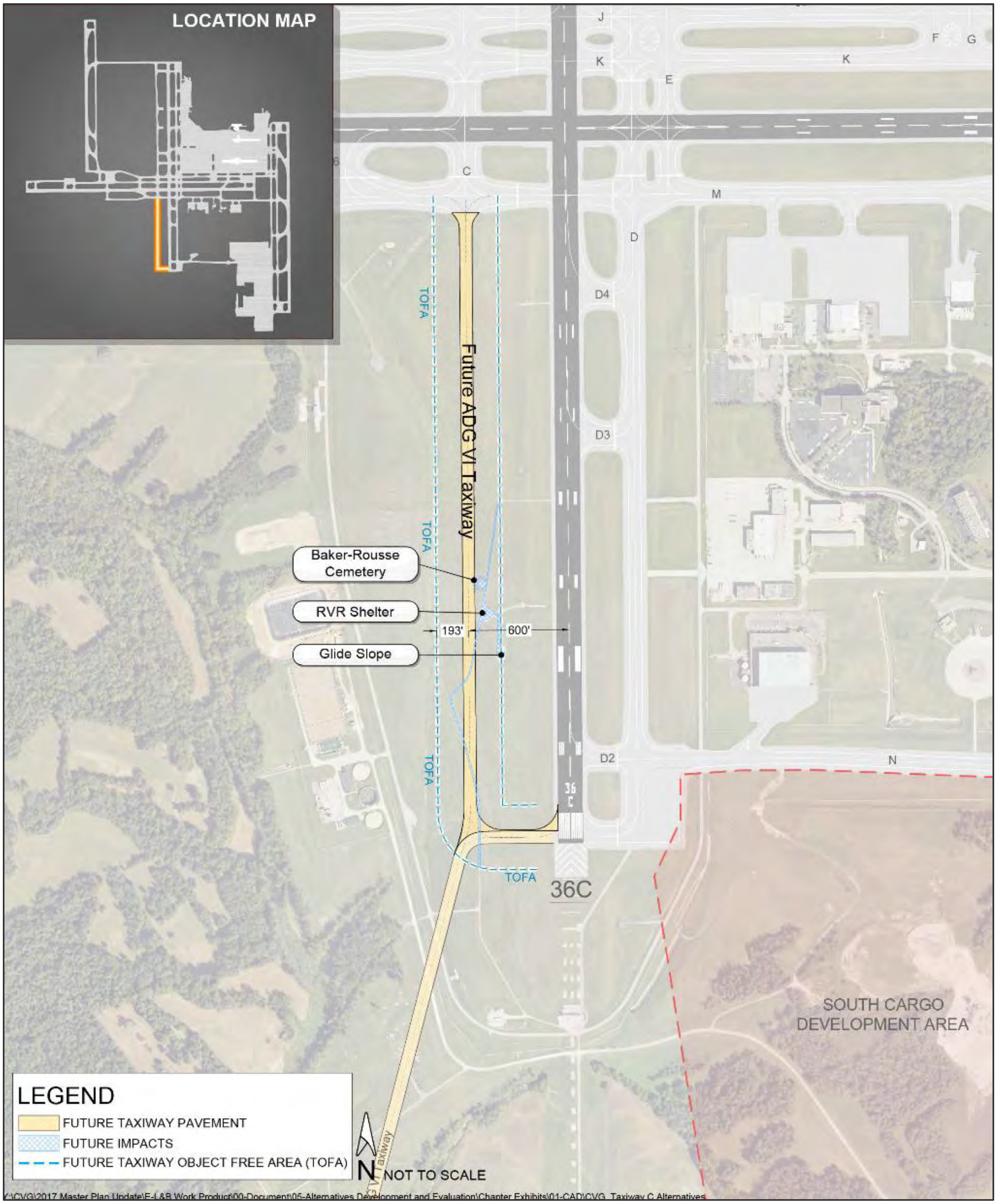
Source: Landrum & Brown analysis

EXHIBIT 5.2-17 TAXIWAY C EXTENSION CONCEPT 1



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-18 TAXIWAY C EXTENSION CONCEPT 2



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.2.2.3 Parallel South Crossfield Taxilane

The existing Crossfield taxilane, Taxilane N, begins at Taxiway S and ends at Taxiway D near the Runway 36C end. Taxilane N is an ADG VI taxilane. This single taxilane is used by cargo departures headed west for Runway 18C/36C, departures headed east for Runways 27 and 18L/36R, arrivals from Runways 09 and 18C/36C headed east, and Runway 18L/36R arrivals headed west. The analysis presented in Section 4.2.4 indicated the high propensity for conflicting aircraft taxi operations on this taxilane. These conflicts would likely result in significant delays, which will only worsen as cargo traffic grows in the future. As a result, a second parallel taxilane is recommended for the DHL and new south cargo ramps.

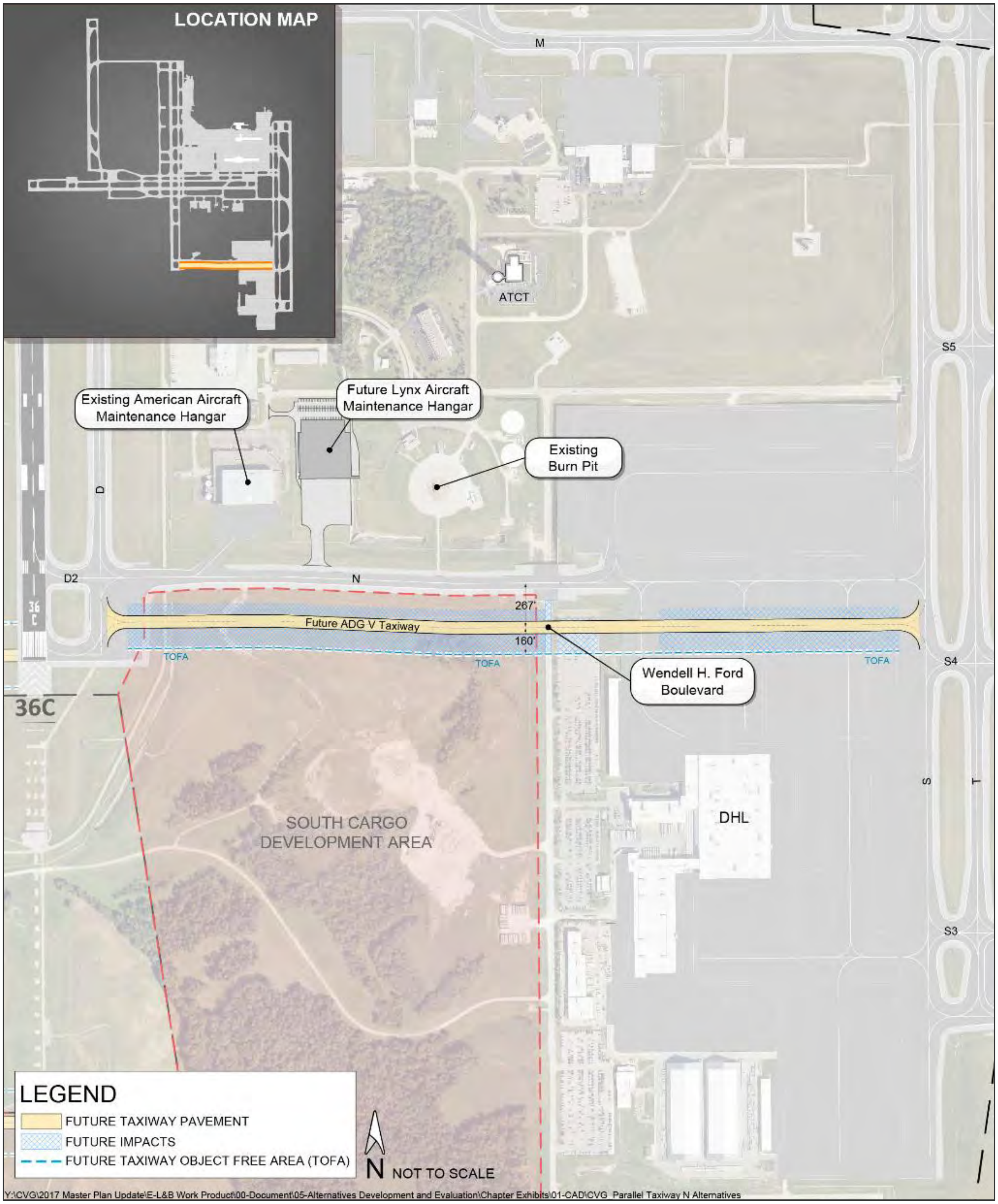
Parallel South Crossfield Taxilane Concepts

Eight taxilane/taxiway concepts were developed:

- **Concept 1**: ADG V taxiway to south of Taxilane N
- **Concept 2**: ADG V taxilane to south of Taxilane N
- **Concept 3**: ADG V taxiway to north of Taxilane N
- **Concept 4**: ADG V taxilane to north of Taxilane N
- **Concept 5**: ADG VI taxiway to south of Taxilane N
- **Concept 6**: ADG VI taxilane to south of Taxilane N
- **Concept 7**: ADG VI taxiway to north of Taxilane N
- **Concept 8**: ADG VI taxilane to north of Taxilane N

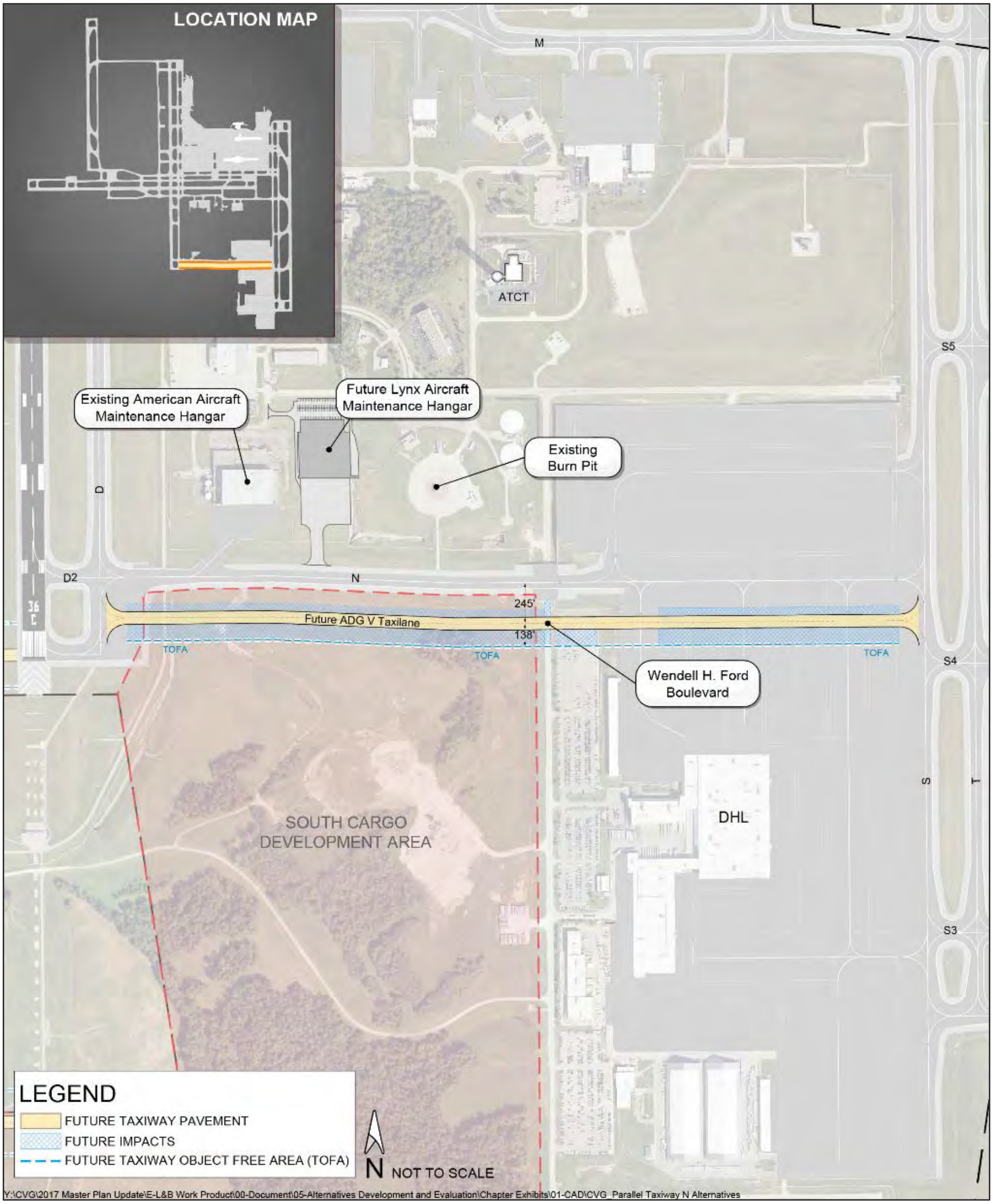
These concepts are presented in **Exhibit 5.2-19** through **Exhibit 5.2-26**.

EXHIBIT 5.2-19 PARALLEL SOUTH CROSSFIELD TAXILANE CONCEPT 1



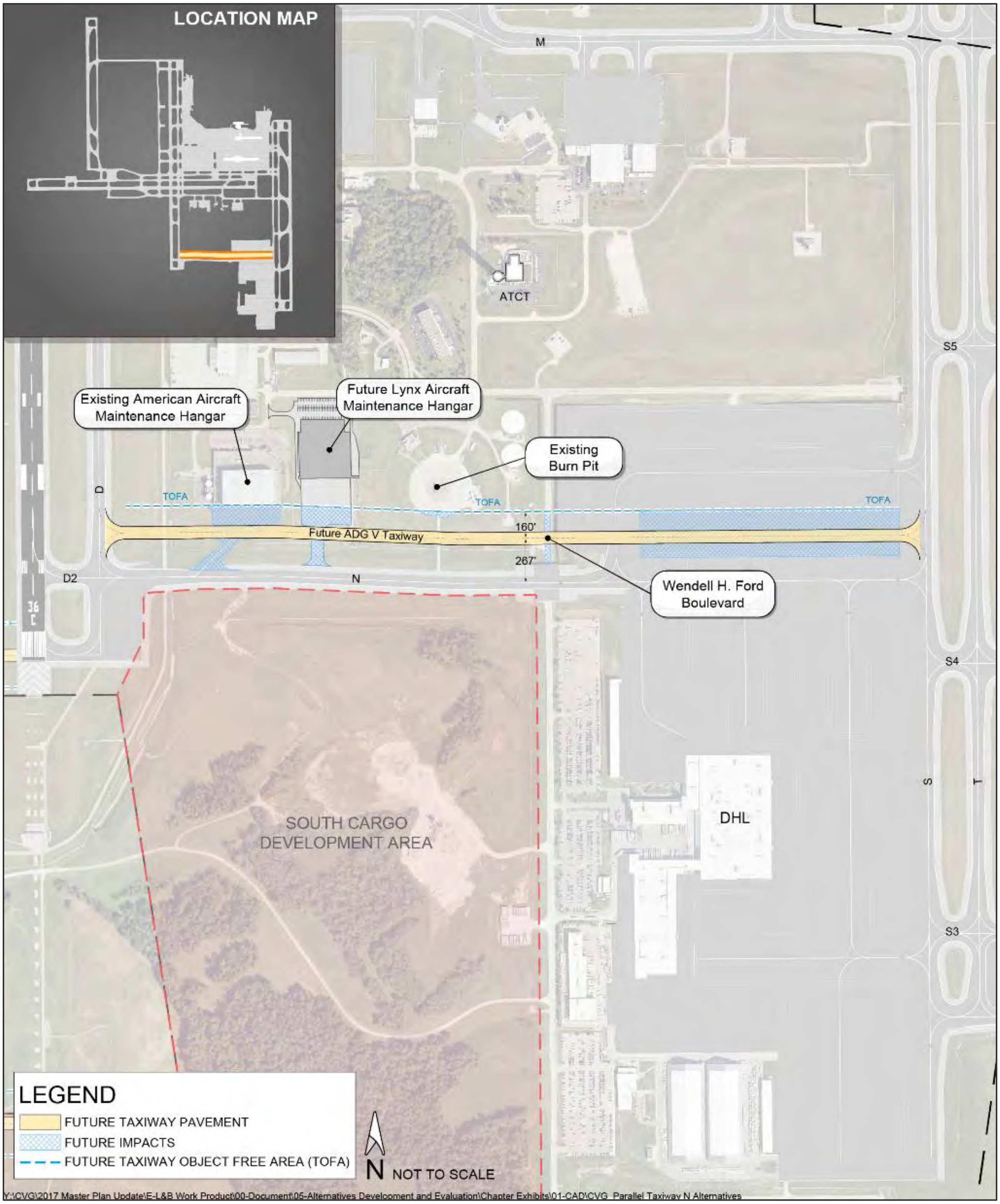
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-20 PARALLEL SOUTH CROSSFIELD TAXILANE CONCEPT 2



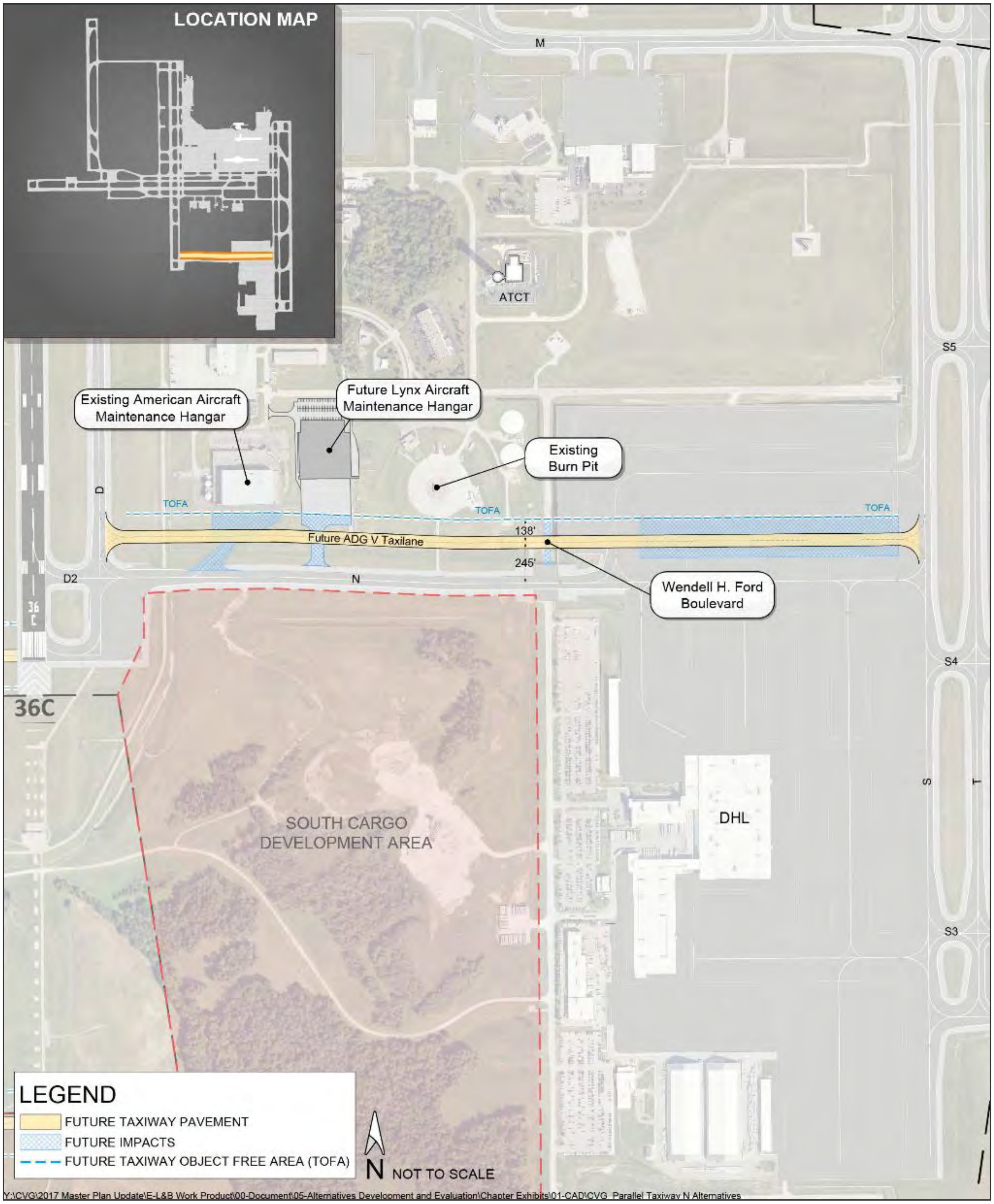
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-21 PARALLEL SOUTH CROSSFIELD TAXILANE CONCEPT 3



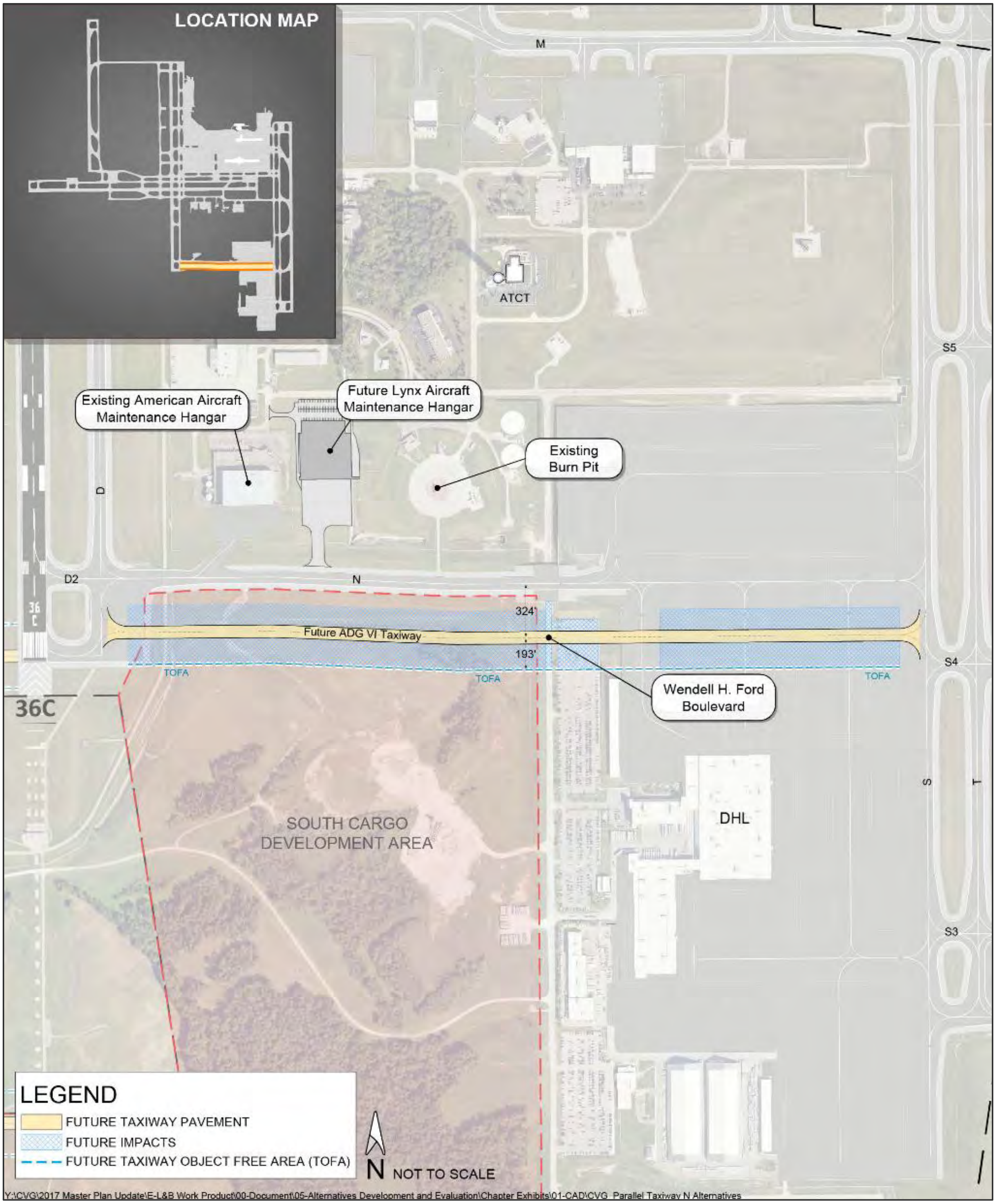
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-22 PARALLEL SOUTH CROSSFIELD TAXILANE CONCEPT 4



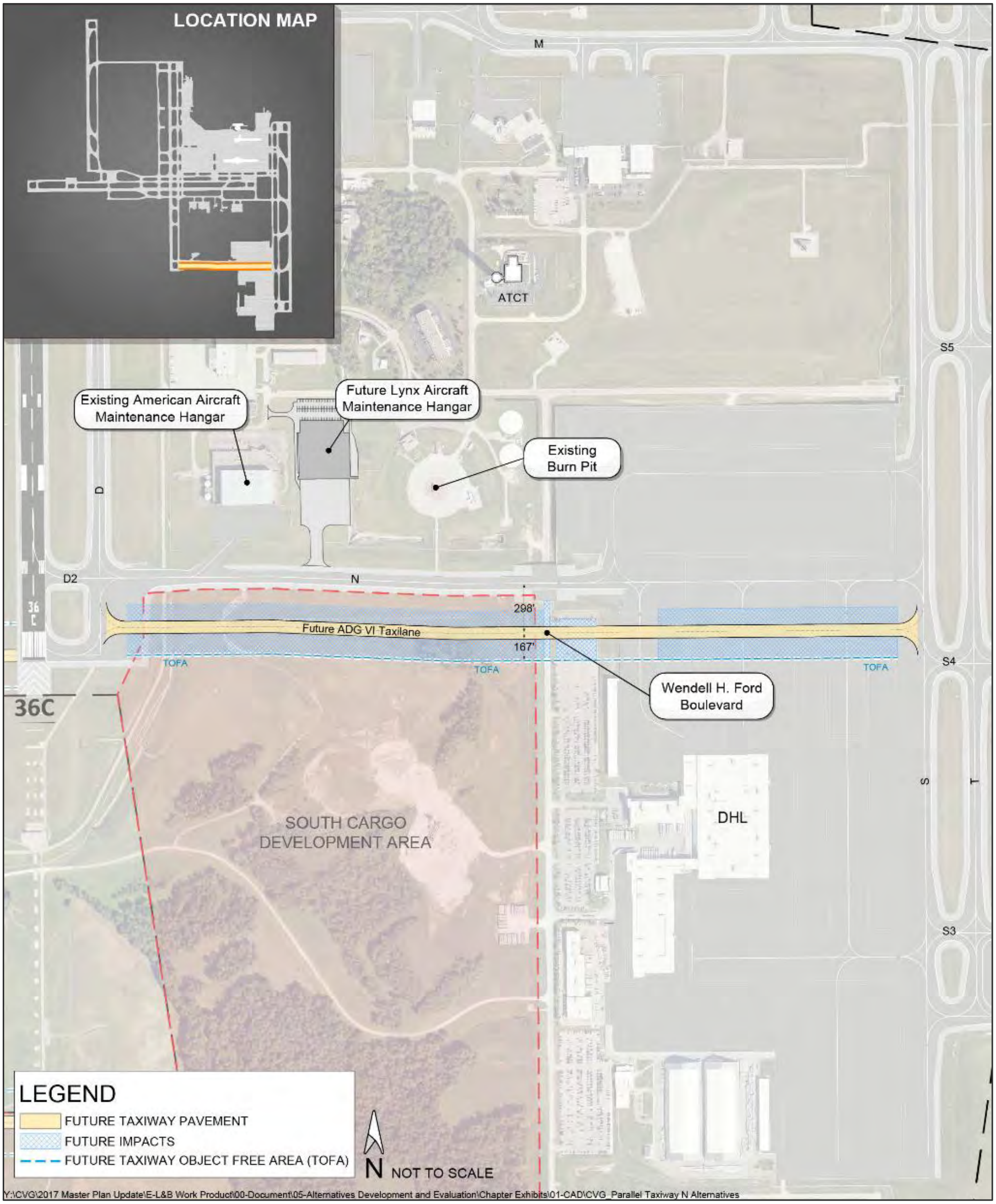
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-23 PARALLEL SOUTH CROSSFIELD TAXILANE CONCEPT 5



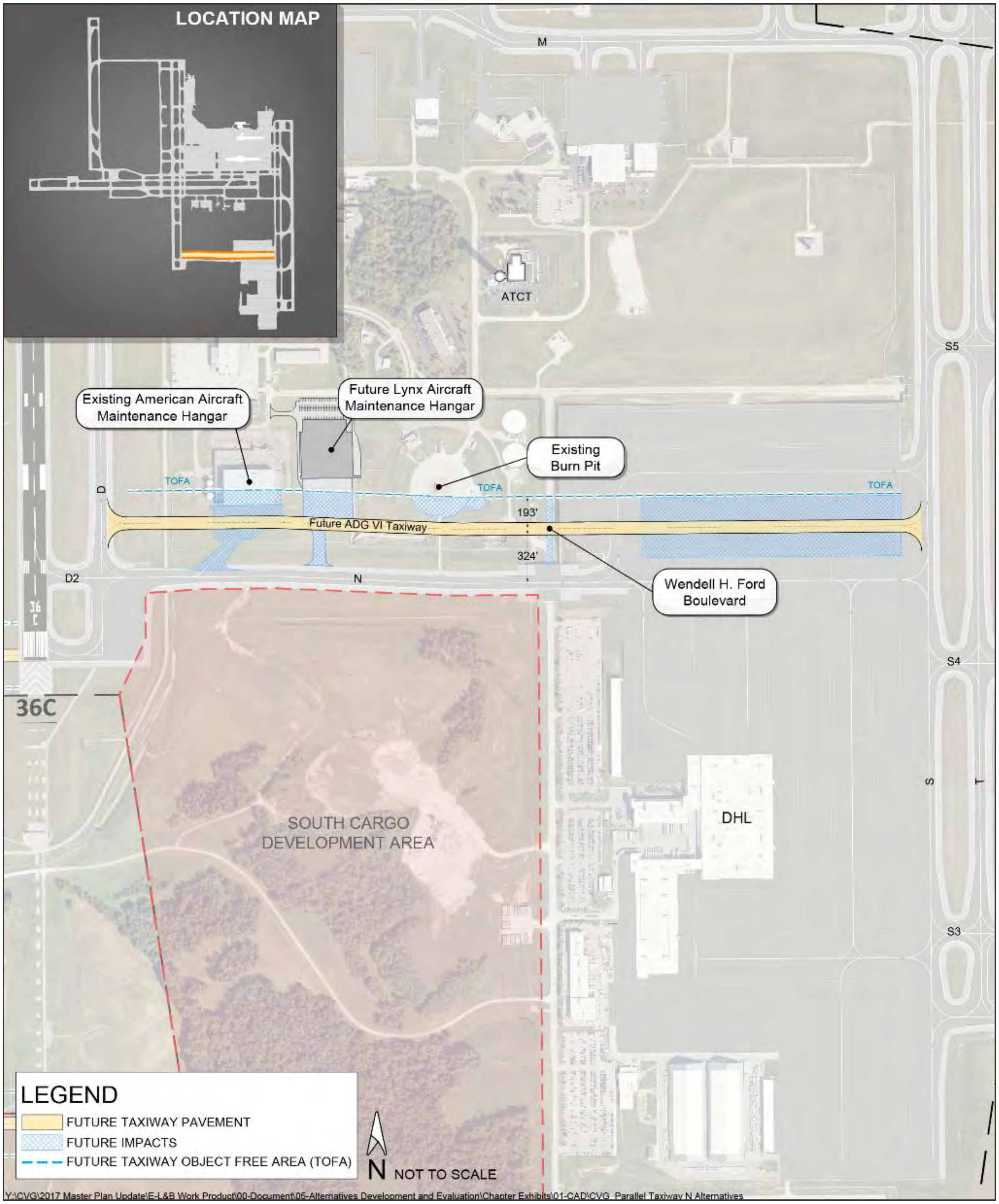
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-24 PARALLEL SOUTH CROSSFIELD TAXILANE CONCEPT 6



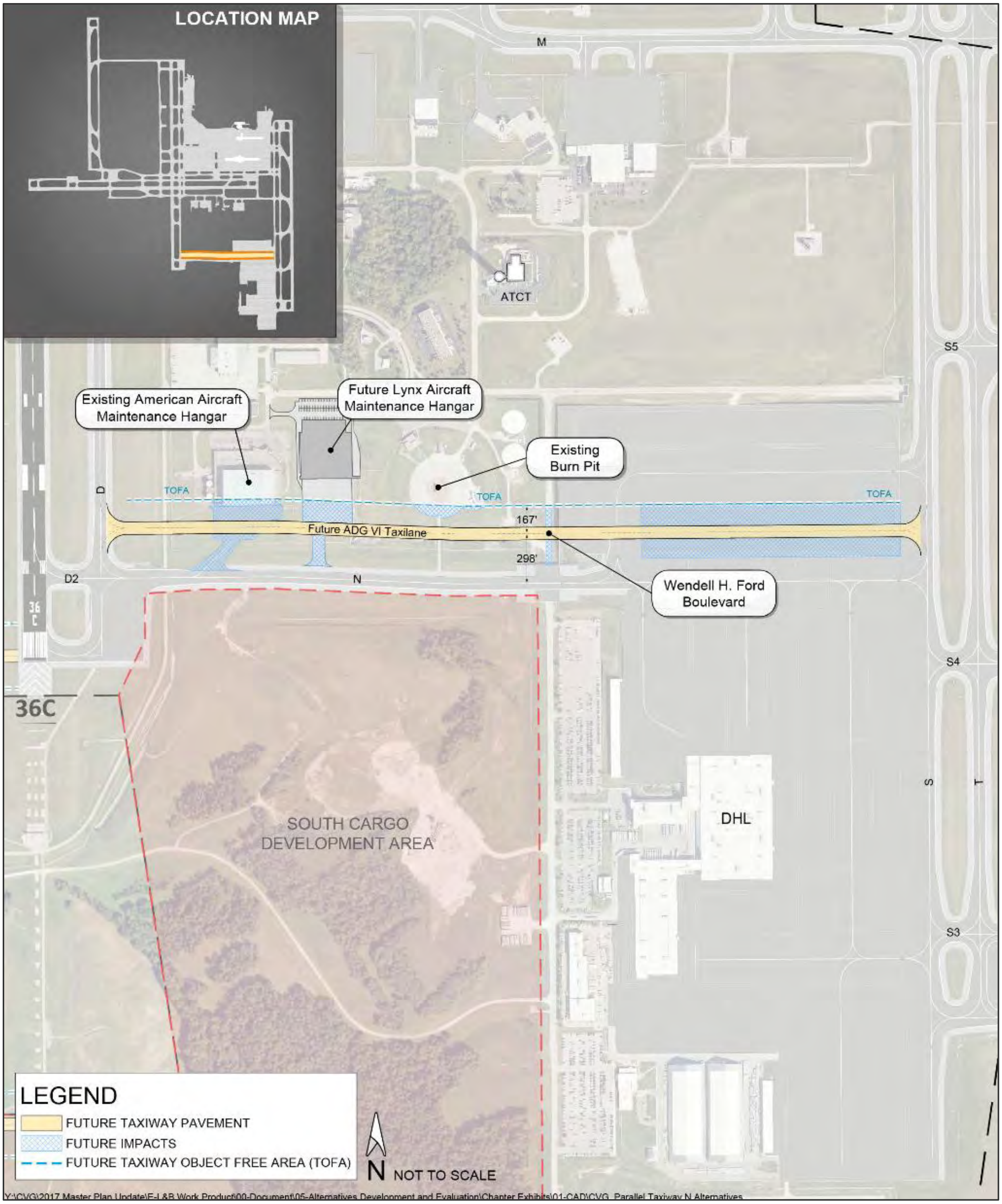
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-25 PARALLEL SOUTH CROSSFIELD TAXILANE CONCEPT 7



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-26 PARALLEL SOUTH CROSSFIELD TAXILANE CONCEPT 8



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Evaluation and Recommendation

All eight concepts require a bridge over Wendell H. Ford Boulevard. The impacts to existing facilities from the proposed taxiways/taxilanes are summarized in **Table 5.2-6, *Parallel South Crossfield Taxiway/Taxilane – Evaluation***. Between the eight concepts, there are three main differences:

- **Taxiway vs. Taxilane**: Determines the volume of facility impacts
- **ADG V vs. ADG VI**: Determines the volume of facility impacts
- **North vs. South Location**: Determines which facilities will require relocation

Concepts 1, 3, 5, and 7 propose the development of a parallel taxiway whereas Concepts 2, 4, 6, and 8 propose the development of a taxilane. The facility impacts would be greater with taxiways due to the greater separation and spacing requirements. There is little to no benefit to providing a taxiway over a taxilane in this area of the airfield, so the higher impacts associated with a taxiway are not justified. Therefore, Concepts 1, 3, 5, and 7 were eliminated from further consideration.

Of the remaining concepts, Concepts 2 and 4 provide an ADG V taxilane while Concepts 6 and 8 provide an ADG VI taxilane. An ADG VI taxilane provides the ability to accommodate the B747-8 without restrictions. The provision of an ADG V taxilane means that the B747-8 would only be able to travel on Taxilane N and only while no aircraft are operating on the new parallel taxiway/lane, which would result in conflicts between aircraft and create delays and congestion. While the facility impacts would be greater with ADG VI capability versus ADG V, the ability to accommodate the existing and projected fleet without restrictions is paramount. Therefore, the concepts with ADG V taxilanes (Concepts 2 and 4) were eliminated from further consideration.

Concept 6 locates the proposed taxiway/taxilane to the south of Taxilane N. This concept would result in the loss of some DHL employee auto parking facilities, DHL apron, DHL deicing pads, and approximately 18 acres of the south cargo development. Concept 8 locates the proposed taxiway/taxilane to the north of Taxilane N. This concept would require the relocation of the burn pit, preclude the planned Lynx aircraft maintenance hangar (currently under construction) from being developed, require the relocation of the American aircraft maintenance hangar, and result in a loss of DHL apron space and a deicing position. The impact to the DHL facilities is smaller with Concept 8, but the affected parking positions in Concept 6 are smaller positions that are easier to replace.

Concept 6 is preferred because the facility impacts would be limited to the users of the proposed taxilane, which would gain the most benefit. Concept 6 would not impact other CVG facilities and would allow the aircraft maintenance development to proceed as planned.

TABLE 5.2-6 PARALLEL SOUTH CROSSFIELD TAXIWAY/TAXILANE – EVALUATION

Evaluation Criteria	Concept							
	1	2	3	4	5	6	7	8
ADG	V	V	V	V	VI	VI	VI	VI
Type	taxiway	taxilane	taxiway	taxilane	taxiway	taxilane	taxiway	taxilane
Location	south	south	north	north	south	south	north	north
Requires Relocation of Burn Pit	no	no	yes	yes	no	no	yes	yes
Lynx Hangar Development Impact	no	no	yes	yes	no	no	yes	yes
Aircraft Maintenance Apron Impact (ft2)	-	-	94,460	76,900	-	-	94,460	94,460
Aircraft Maintenance Building Impact (ft2)	-	-	-	-	-	-	37,160	15,900
DHL Parking Impact (ft2)	51,250	40,680	-	-	72,840	60,360	-	-
DHL Parking Impact (spaces)	168	128	-	-	248	200	-	-
DHL Apron Impact (ft2)	383,340	320,180	436,800	368,660	512,480	437,860	559,590	495,660
DHL Apron Impact (stands)	5 - 7	5	6	6	10	9 - 10	6	6
DHL Deicing Impact (no. of positions)	3	2	1	1	3	3	1	1
South Cargo Development Impact (acres)	15	13	-	-	21	18	-	-

Source: Landrum & Brown analysis

5.2.2.4 Taxilane N Extension

Taxilane N leads directly to Taxiway S but does not continue further east to connect to Taxiway T. Aircraft must travel north or south on Taxiway S to cross over to Taxiway T. These aircraft are oftentimes traveling against the predominant flow on Taxiway S, which results in conflicts and delays. As a result, the facility requirements analysis identified the need to extend Taxilane N to the east to connect to Taxiway T. This project was approved as part of the 2014 Environmental Evaluation (Short Environmental Assessment) for Airport Development Projects. The new taxilane that is proposed to the south of Taxilane N should also extend to Taxiway T. **Exhibit 5.2-27, *Taxilane N Extension***, presents the proposed taxiway extension with a second parallel taxilane extending to Taxiway T (assumes the development of the Parallel South Crossfield Taxilane). There are no alternative locations for these taxiway connectors.

5.2.3 Taxiway Design Standards

Chapter 4 – *Facility Requirements,* Section 4.2.5, *Airfield Design Standards,* identified areas of the CVG airfield that do not comply with modern FAA design standards. The sections that follow present alternative ways to address these deficiencies.

5.2.3.1 Runway to Taxiway Separation

The lateral centerline separation needed between a runway and a taxiway is determined by the visibility minima of the runway and the size of the aircraft intended to use the taxiway. The 400-foot lateral separation from Taxiway D, Taxiway K, and a portion of Taxiway M to their respective parallel runways does not meet the FAA standard for the aircraft that use the runways or weather conditions in which the runway is capable of being used. The capabilities of a runway are determined by the instrument approach minima for each respective runway. The separation requirements are:

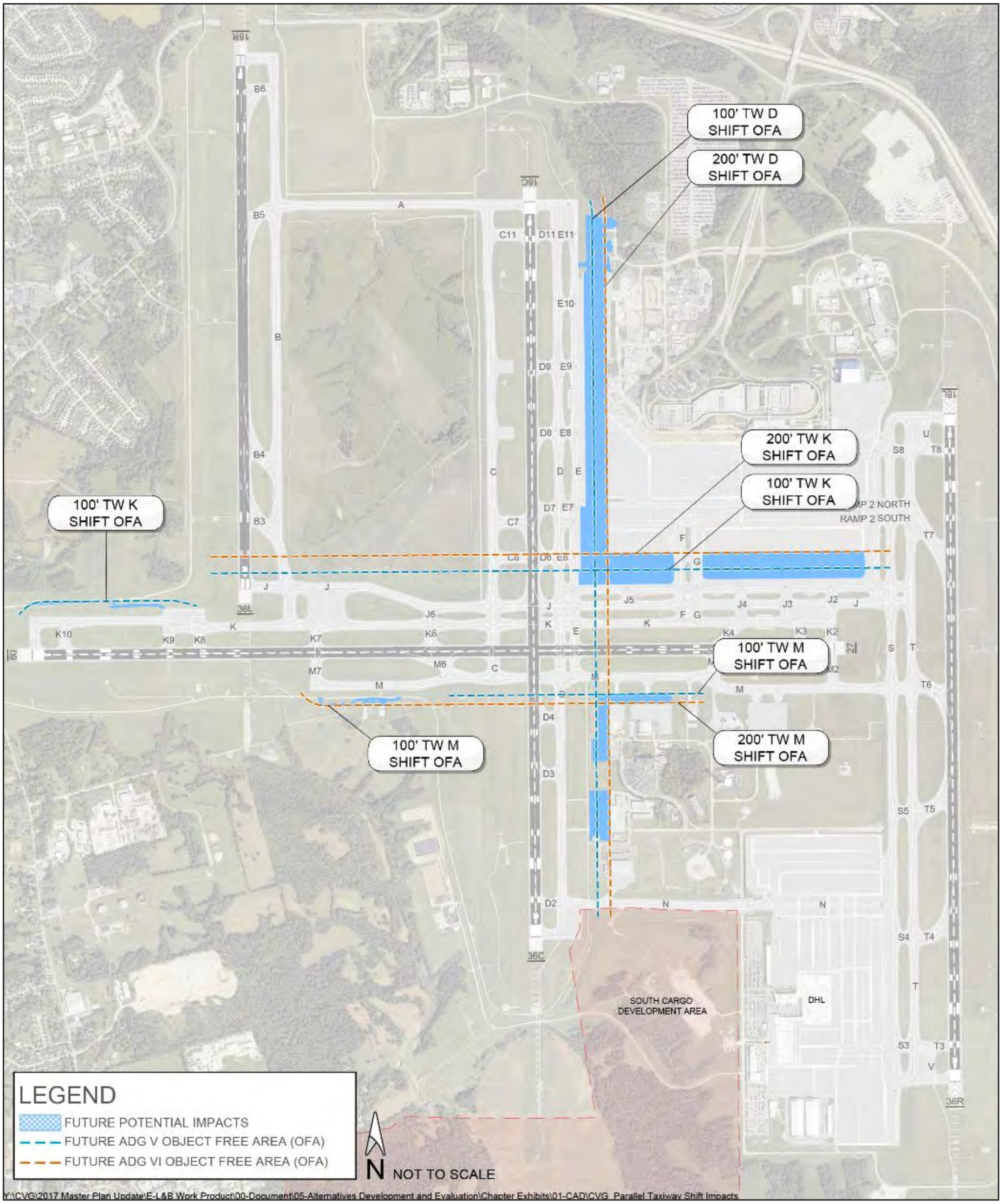
- 500 feet from runway centerline to taxiway centerline to meet ADG V standards for runways with visibility minima less than a ½ mile and TDG 5 standards
- 600 feet from runway centerline to taxiway centerline to meet ADG VI standards for runways with visibility minima less than a ½ mile and TDG 6 standards

The potential impacts of relocating Taxiways D, K, and M are depicted on **Exhibit 5.2-28, *Potential Taxiway Relocation Impacts***. Taxiways D and K have associated parallel taxiways; these parallel taxiways would require relocation as well to accommodate the increased separation between Taxiways D and K and their respective runways. The exhibit does not depict the actual taxiway relocations; rather it shows the relocated OFA for each potential taxiway shift.

EXHIBIT 5.2-27 TAXILANE N EXTENSION

Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-28 POTENTIAL TAXIWAY RELOCATION IMPACTS



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Taxiway D

The Taxiway D lateral separation to Runway 18C/36C meets ADG V standards when visibility is greater than a ½ mile. In order to accommodate ADG V aircraft without restrictions when visibility is below ½ mile, the Taxiway D centerline (and its associated OFA) would need to be shifted by 100 feet to the east. The amount of time when conditions exist with visibility that is less than or equal to a ½ mile occur less than one percent of the time.[2] It would be necessary to shift Taxiway D by 200 feet to the east to meet ADG VI standards. In both cases, Taxiway E would have to be shifted as well.

Shifting the taxiway centerline by 100 feet would result in one deicing pad position on Pad 13, the Pad 8 and 10 remote parking positions, 185 linear feet of terminal area envelope, and 130 linear feet of apron area in the North Cargo Area being within the OFA. The 200-foot shift would result in two deicing pad positions on Pad 13, the Pad 8 and 10 remote parking positions, 345 linear feet of terminal area envelope, and 294 linear feet of apron area in the North Cargo Area being within the OFA. Both concepts would require the relocation of the Sign Building, Post Office Building, and the North Aircraft Rescue and Firefighting (ARFF) Station.

Upgrading existing facilities to higher standards is only necessary if there is no other taxi path available for aircraft to travel to and from the runways, or if the benefits outweigh the impacts. ADG V and ADG VI aircraft can travel along Taxiway E to reach the runway during times when visibility conditions are less than or equal to ½ mile. Because this alternate path is available, it is not necessary for Taxiway D to be upgraded with the resulting shift of Taxiway E. The facility impacts of shifting Taxiway D to either 500- or 600-foot separation would likely outweigh the benefits in this case. Therefore, upgrading the taxiway to higher standards is not recommended.

Taxiway K

Taxiway K (between the Runway 09 end and Taxiway K9) has 500 feet of separation between the taxiway centerline and the centerline of Runway 09/27. This portion of the taxiway meets ADG V standards. To meet ADG VI standards a shift of 100 feet to the north would be required. This shift would require that 1,500 linear feet of the CVG perimeter service road be relocated and would eliminate the Taxiway K Hold Pad. This portion of Taxiway K is rarely used by ADG VI aircraft because Runway 27 arrivals and Runway 09 departures only occur when required by wind speed and direction (less than two percent of the time). As a result, upgrading this portion of Taxiway K to ADG VI standards is not recommended.

The remainder of Taxiway K has 400 feet of separation to the runway. As with Taxiway D, this portion of the taxiway meets ADG V standards when visibility is greater than a ½ mile. In order to accommodate ADG V aircraft without restrictions when visibility is below ½ mile, the Taxiway K centerline (and its associated OFA) would need to be shifted by 100 feet to the north, and by 200 feet to meet ADG VI standards. Visibility conditions less than or equal to ½ mile occur at CVG less than one percent of the time. In both cases, a northward shift of Taxiway K would require an associated shift of Taxiway J as well.

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[2] National Climatic Data Center (NCDC), station WBAN 93814, data recorded at Cincinnati/Northern Kentucky International Airport (CVG) for the period 01/01/2006-12/31/2016 and Landrum & Brown analysis

The facility impacts of the 100-foot shift would result in 205 linear feet of terminal area envelope being within the OFA. The facility impacts of the 200-foot shift would include 450 linear feet of terminal area envelope being within the OFA. The Taxiway J hold pad would be eliminated with both concepts.

Upgrading existing facilities to higher standards is only necessary if there is no other taxi path available for aircraft to travel to and from the runways, or if the benefits outweigh the impacts. ADG V and ADG VI aircraft can travel along Taxiway J to reach the runway end; therefore, it is not necessary for Taxiway K to be upgraded. The facility impacts of shifting Taxiway K to either 500- or 600-foot separation would likely outweigh the benefits in this case. Upgrading the taxiway to higher standards is not recommended.

Taxiway M

The western portion of Taxiway M between Taxiway M6 and M7 has 500 feet of lateral separation to the Runway 09/27 centerline. This portion of the taxiway meets ADG V standards. It (and its associated OFA) would have to be shifted 100 feet further south to meet ADG VI standards. This shift would require the relocation of the police facilities. This portion of Taxiway M is only used when Runway 27 is being used for arrivals, which occurs rarely. As a result, upgrading this portion of Taxiway K to ADG VI standards is not recommended.

The portion of Taxiway M between Taxiways M4 and M6 has 400 feet of lateral separation to Runway 09/27. As with Taxiways D and K, this portion of the taxiway meets ADG V standards when visibility is greater than a ½ mile. It (and its associated OFA) would need to be shifted by 100 feet to the south in order to be able to meet ADG V standards when visibility is less than or equal to ½ mile (occurs less than one percent of the time), and by 200 feet to meet ADG VI standards. There would be no facility impacts with the 100-foot shift. The impacts of the 200-foot shift would include 130 linear feet of ramp associated with the Endeavor Aviation Hangar, Delta Private Jets Maintenance Base, and the Ameriflight Hangar being within the OFA.

Upgrading existing facilities to higher standards is only necessary if there is no other taxi path available for aircraft to travel to and from the runways, or if the benefits outweigh the impacts. As such, aircraft are able to taxi along Taxiway J when needed; therefore, it is not necessary for Taxiway M to be upgraded. The facility impacts of shifting Taxiway M to either 500- or 600-foot separation would likely outweigh the benefits in this case. Therefore, upgrading the taxiway to higher standards is not recommended.

5.2.3.2 Taxiway to Taxiway Separation

The lateral centerline separation needed between two taxiways is determined by the size of the aircraft intended to use the taxiway. The facility requirements identified that the lateral centerline separation between Taxiway D and E does not meet standards. As discussed in Section 5.2.2, *Taxiway Capacity*, it is recommended that the portion of Taxiway E between Taxiway J and Runway 09/27 be relocated to provide 324 feet of separation to Taxiway D in order to tie into a Taxiway E extension to the south. The analysis in this section therefore focuses on the portion of Taxiway E to the north of Taxiway J. The portion of Taxiway E (between Taxiway J and Taxiway D7) has 215 feet of separation, which meets ADG IV standards, but not ADG V or ADG VI. The northern portion (north of Taxiway D7) has 267 feet of lateral separation to Taxiway D, which meets ADG V standards, but not ADG VI. Existing Taxiway E is shown on **Exhibit 5.2-29, *Existing Taxiway E***. Two concepts were considered:

- **Concept 1**: 267 feet of lateral separation between Taxiways D and E and 160 feet of lateral separation between Taxiway E and the passenger terminal apron to meet ADG V standards, presented in **Exhibit 5.2-30, *Taxiway E Separation Concept 1***.
- **Concept 2**: 324 feet of lateral separation between Taxiways D and E and 193 feet of lateral separation between Taxiway E and the passenger terminal apron to meet ADG VI standards, presented in **Exhibit 5.2-31, *Taxiway E Separation Concept 2.***

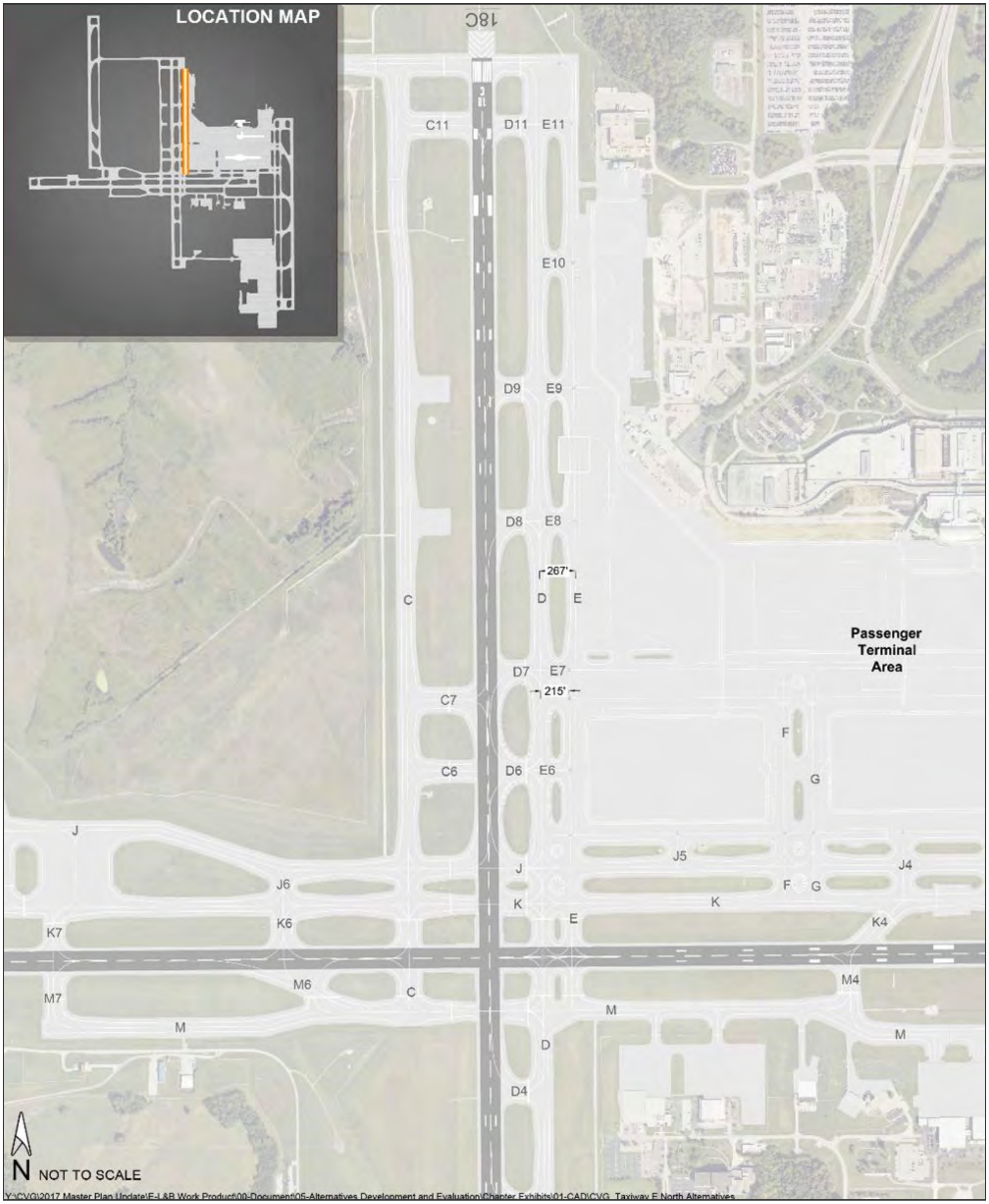
The exhibits do not show the actual taxiway shift; rather they show the associated relocated OFA.

Concept 1 assumes the portion of Taxiway E between Taxiway J and Taxiway D7 is shifted to increase its taxiway to taxiway separation from 215 feet to 267 feet to meet ADG V standards, with no change to the northern portion. This relocation would result in one deicing position on Pad 13 and 85 linear feet of terminal area envelope being within the OFA.

Concept 2 assumes the entire taxiway is upgraded to ADG VI standards by shifting the taxiway east (the portion with 215 feet of separation and the portion with 267 feet of separation are increased to 324 feet). This concept would result in the post office building, 120 linear feet of the North Cargo Area apron (resulting in 250 feet of apron depth), one deicing position on Pad 13, and 175 linear feet of terminal area envelope being within the OFA.

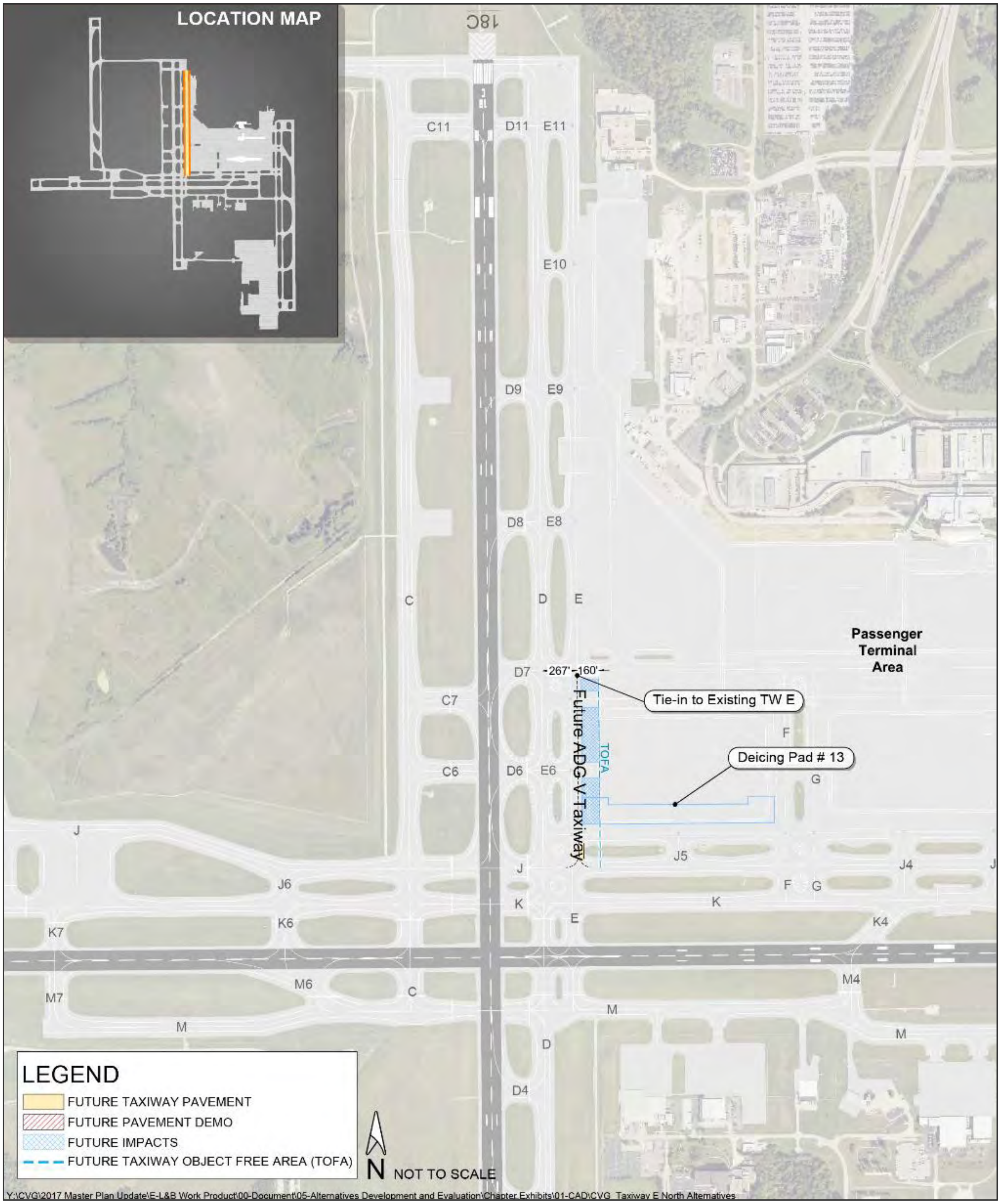
The impact to the North Cargo Apron was found to be an unacceptable impact because the remaining apron depth would be insufficient to serve the aircraft that use the apron. Conversely, the terminal and deicing impact can be recouped when the terminal area is redeveloped. As a result, it is recommended that ADG VI capability be provided from Taxiway J to a point between Taxiways E8 and E9 (see **Exhibit 5.2-32, Taxiway E Separation Recommended Concept**), provided it works with the terminal redevelopment.

EXHIBIT 5.2-29 EXISTING TAXIWAY E



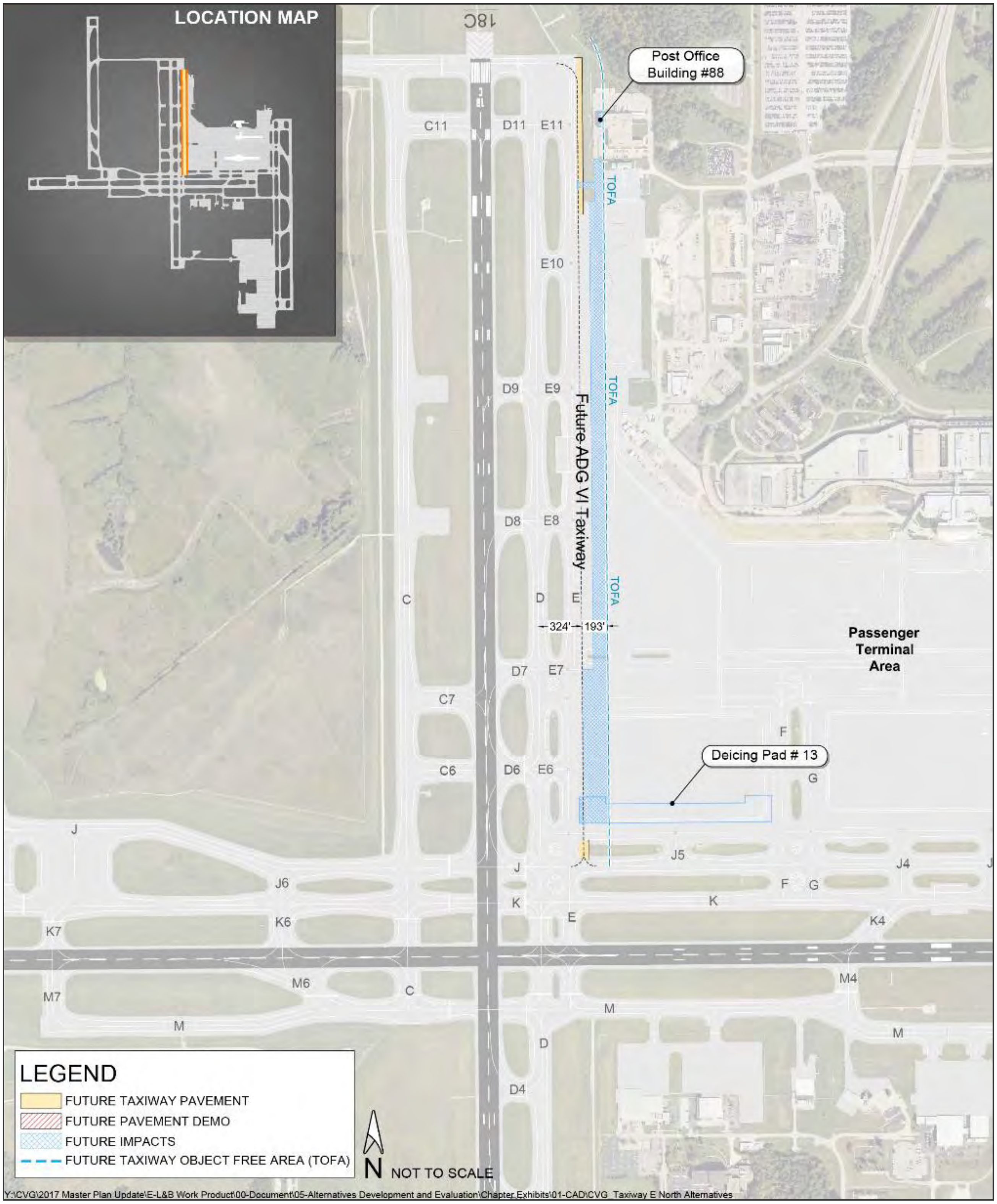
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-30 TAXIWAY E SEPARATION CONCEPT 1



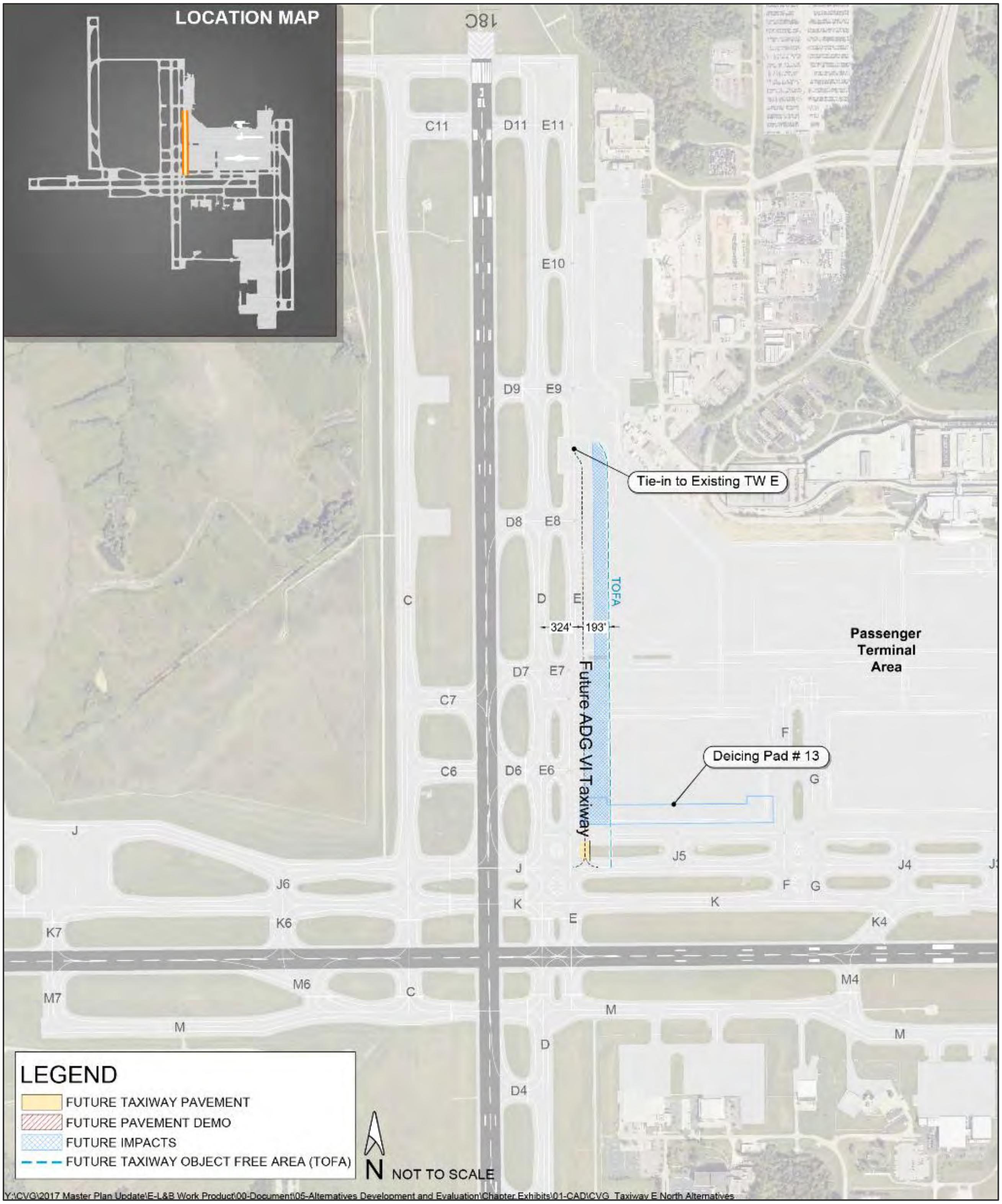
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-31 TAXIWAY E SEPARATION CONCEPT 2



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-32 TAXIWAY E SEPARATION RECOMMENDED CONCEPT



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.2.3.3 Runway Incursion Avoidance

The FAA defines a runway incursion as "any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and takeoff of aircraft."[3] FAA AC 150/5300-13A Change 1, *Airport Design*, provides taxiway design guidance that can help reduce the occurrence of runway incursions. Chapter 4 – *Facility Requirements*, Section 4.2.5, *Airfield Design Standards*, analyzed the CVG airfield against this guidance to determine how the airfield could be improved. This analysis determined that several CVG taxiways connect an apron directly to a runway, which can lead to pilot confusion.

- Taxiways D2/N connect the DHL apron directly to Runway 18C/36C
- Taxiways T4/S4 connect the DHL apron directly to Runway 18L/36R

These issues can be addressed by relocating Taxiways D2 and S4, as presented in **Exhibit 5.2-33, *South Airfield Direct Access Taxiway Mitigation***.

There are also several taxiways that lead directly from the passenger terminal apron to Runways 09/27, 18C/36C, and 18L/36R. Given the relationship the location of these taxiways/taxilanes have with the configuration of the passenger terminal concourses, these issues are addressed in Section 5.3, *Passenger Terminal Facilities*.

5.2.4 Runway Exits

The entrance/exit taxiways that connect a runway to the taxiway system are referred to as runway exits. The placement and type of runway exits influence the operational efficiency and capacity of CVG. Chapter 4 – *Facility Requirements,* Section *4.2.3*, *Runway Exits*, describes the analysis using the Runway Exit Design Interactive Model (REDIM) and the potential runway exit improvements for each of CVG's runways. These potential exits are presented in **Exhibit 5.2-34, *Potential Runway Exit Improvements***, and include:

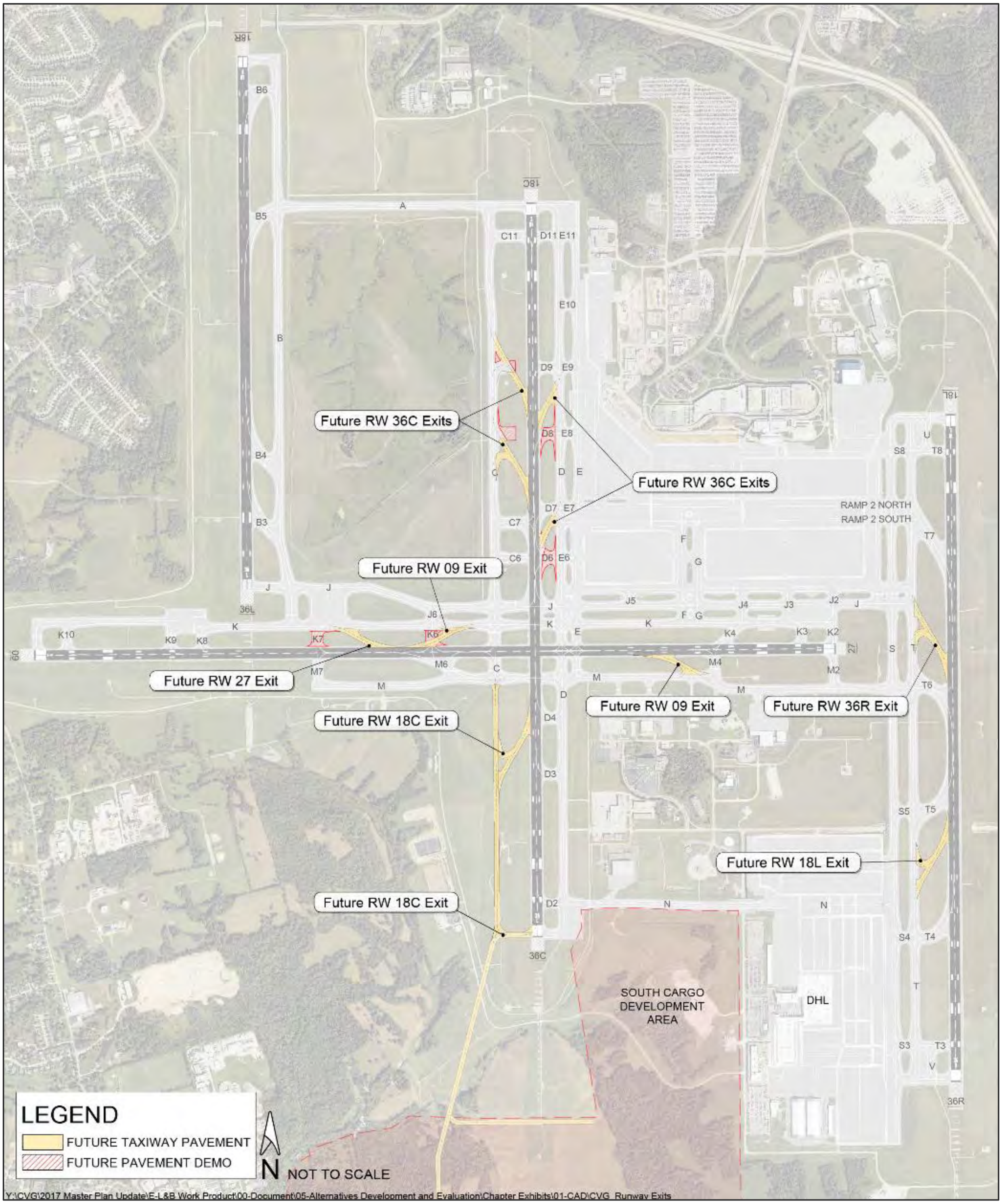
- **Runway 09 (North)**: Replace one 90-degree exit with a high speed exit
- **Runway 09 (South)**: Add one new high speed exit
- **Runway 27 (North)**: Replace one 90-degree exit with a high speed exit
- **Runway 18C (West)**: Add one new high speed exit and one new 90-degree exit (if Taxiway C is extended to the full length of Runway 18C/36C)
- **Runway 36C (West)**: Add two new high speed exits
- **Runway 36C (East)**: Replace two 90-degree exits with two high speed exits
- **Runway 18L (West)**: Add one new high speed exit
- **Runway 36R (West)**: Add one new high speed exit

[3] https://www.faa.gov/airports/runway_safety/news/runway_incursions/

EXHIBIT 5.2-33 SOUTH AIRFIELD DIRECT ACCESS TAXIWAY MITIGATION

Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.2-34 POTENTIAL RUNWAY EXIT IMPROVEMENTS



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.2.4.1 Runway 09 (North)

The REDIM analysis identified that the Runway 09 north Runway Occupancy Time (ROT) could be optimized by converting Taxiway K6 from a 90-degree exit to a high speed exit. This conversion would reduce the average Runway Occupancy Time (ROT) from 52.7 seconds to 50.4 seconds. However, this exit is not recommended because Runway 09 usage by arrivals will continually decrease in the future as demand increases and the use of two parallel runways for arrivals occurs more often. This is estimated to occur between PAL 2 and PAL 3. At this point, the potential runway exit would no longer be used on a regular basis, thus diminishing the realized benefit.

5.2.4.2 Runway 09 (South)

The REDIM analysis identified that the Runway 09 south ROT could be optimized through the addition of a high speed exit between Taxiway E and Taxiway M4. This new exit would reduce the average ROT from 54.4 seconds to 52.3 seconds but would only be used by about 4 percent of operations. This exit is not recommended given the limited usage of this new exit combined with the decreasing utilization of Runway 09 in the future.

5.2.4.3 Runway 27 (North)

The REDIM analysis identified that the replacement of the 90-degree Taxiway K7 with a high speed exit that would be located between Taxiways K6 and K7. This high speed exit would allow the Runway 27 average ROT to be optimized. The high speed exit would decrease the average ROT from 54.3 seconds to 50.8 seconds. Aircraft that exit to the north are primarily passenger aircraft, which do not tend to land on Runway 27. Runway 27 is primarily used by departures during the daytime when passenger operations occur, and for mixed operations at night (mainly cargo aircraft) when Runway 09 is not available. Given the limited use of Runway 27 by arrivals and therefore limited benefit gained, this exit is not recommended.

5.2.4.4 Runway 18C (West)

No exits are currently available on the west side of Runway 18C/36C for Runway 18C arrivals other than the crossings of Taxiways K, J, and M. The REDIM analysis identified that the addition of one high speed exit and one 90-degree exit would optimize the runway, resulting in an average ROT of 51.2 seconds. The extension of Taxiway C to the south of Runway 09/27 (recommended in Section 5.2.2, *Taxiway Capacity*) is necessary for these exits to function. These exits are recommended once the Taxiway C extension is developed.

5.2.4.5 Runway 36C (East)

The REDIM analysis indicated that the Runway 36C ROT could be optimized through the conversion of two 90-degree exits (Taxiways D6 and D8) to high speed exits. These exits would result in the Runway 36C average ROT being reduced from 52.9 seconds to 49.5 seconds. Runway 36C does not currently have any high speed exits. These exits would allow Runway 36C to improve its capacity in North Flow. As a result, the two exits are recommended.

5.2.4.6 Runway 36C (West)

Runway 18C's average ROT is over 60 seconds due to a lack of appropriately placed runway exits. The REDIM analysis demonstrated that the addition of two high speed exits would allow the Runway 36C ROT to be optimized, resulting in a ROT of 50.8 seconds. These exits are recommended once it becomes necessary for aircraft to exit the runway to the west.

5.2.4.7 Runway 18L

Airport Traffic Control Tower (ATCT) officials have indicated that the existing exit taxiways on Runway 18L provide sufficient capacity at current demand levels. However, the REDIM analysis indicated that the Runway 18L ROT could be further optimized by adding a third high speed exit between Taxiways T5 and T4. This exit would allow ROT to be reduced from 52.2 seconds to 48.5 seconds. As demand increases and airfield capacity becomes an issue (between PAL 3 and PAL 4), it will become increasingly important to minimize ROT on this runway. At this time, the additional exit for Runway 18L is not justified; however, the new high-speed exit is recommended for inclusion in the overall plan as a longer-term project. The need for this new exit should be monitored as the projected demand materializes in the future.

5.2.4.8 Runway 36R

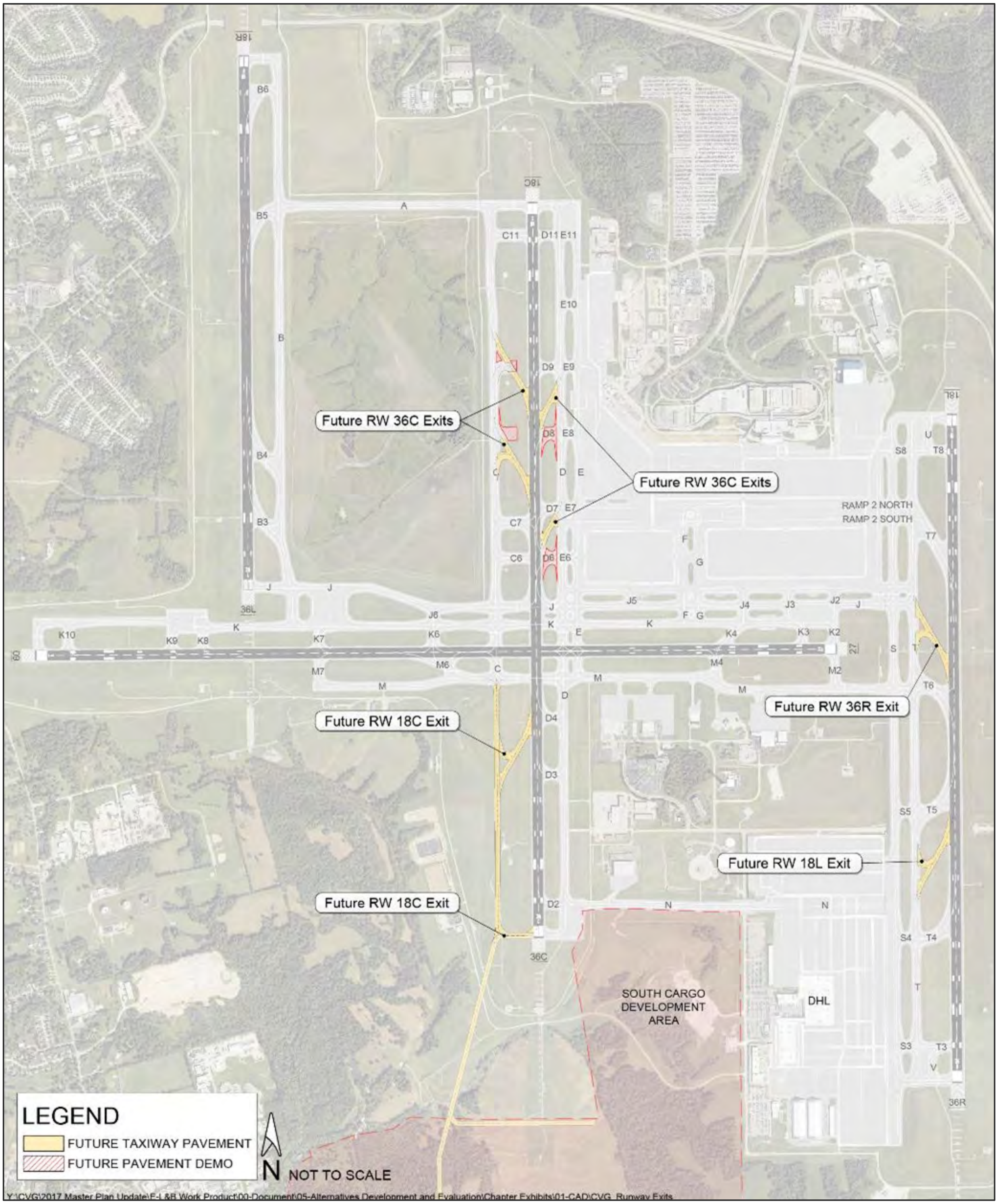
As with Runway 18L, ATCT officials have indicated that the existing exit taxiways on Runway 36R provide sufficient capacity at current demand levels. However, the REDIM analysis indicated that the Runway 36R ROT could be optimized by adding a third high speed exit between Taxiways T6 and T7. This exit would allow ROT to be reduced from 53.4 seconds to 48.4 seconds. As demand increases and airfield capacity becomes an issue (between PAL 3 and PAL 4), it will become increasingly important to minimize ROT on this runway. At this time, the additional exit for Runway 36R is not justified; however, the new high-speed exit is recommended for inclusion in the overall plan as a longer term project. The need for this new exit should be monitored as the projected demand materializes in the future.

5.2.4.9 Recommended Runway Exit Improvements

Based on the preceding analysis, the following runway exit improvements presented in **Exhibit 5.2-35, *Recommended Runway Exit Improvements***, are recommended:

- One high speed exit and one 90-degree exit for Runway 18C (west)
- Two high speed exits for Runway 36C (west)
- Two high speed exits for Runway 36C (east)
- One high speed exit for Runway 18L (west)
- One high speed exit for Runway 36R (west)

EXHIBIT 5.2-35 RECOMMENDED RUNWAY EXIT IMPROVEMENTS



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

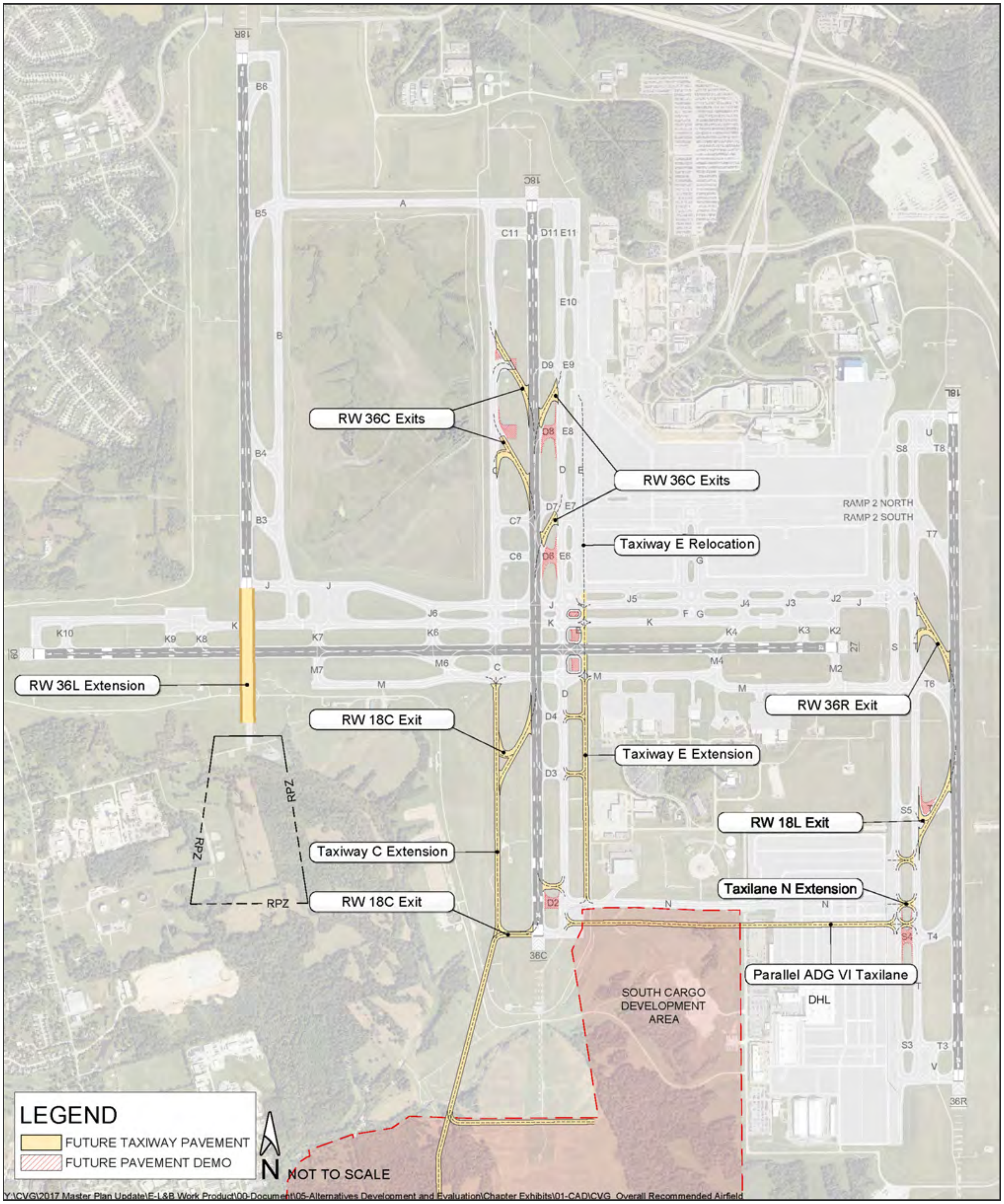
5.2.5 Summary of Airfield Recommendations

Based on the analysis in the preceding sections, the following airfield improvements are recommended by this Master Plan Update to accommodate demand through PAL 4:

- Extend Runway 18R/36L to 10,000 feet
- Extend Taxiway E from Runway 09/27 to the Runway 36C end (ADG VI capable)
- Relocate portion of Taxiway E between Runway 09/27 and a point between Taxiways E8 and E9 to provide ADG VI capability
- Extend Taxiway C to the Runway 36C end (ADG VI capable)
- Provide ADG VI taxilane south and parallel to Taxilane N
- Provide connector taxiway between Taxiways S and T aligned with Taxilane N
- Relocate Taxiways D2 and S4 to resolve direct access between apron and runways
- Provide one high speed exit and one 90-degree exit for Runway 18C (west)
- Provide two high speed exits for Runway 36C (west)
- Provide two high speed exits for Runway 36C (east)
- Provide one high speed exit for Runway 18L (west)
- Provide one high speed exit for Runway 36R (west)

These recommendations are shown on **Exhibit 5.2-36, *Airfield Recommendations*.**

EXHIBIT 5.2-36 AIRFIELD RECOMMENDATIONS



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.3 Passenger Terminal Facilities

The following subsections describe the process that was undertaken to develop the passenger terminal concourse concepts and the evaluation that took place as part of the process to ultimately determine a preferred concept. This section is organized into three primary sections. Each section focuses on one of the three levels of evaluation that resulted in a final recommendation on a terminal development plan. The result of the analysis described herein is the Master Plan recommended terminal development plan. This plan is aimed at accommodating the projected passenger demand through PAL 4 and achieving the major goals and objectives of the terminal portion of this Master Plan Update. The major passenger terminal goals and objectives are:

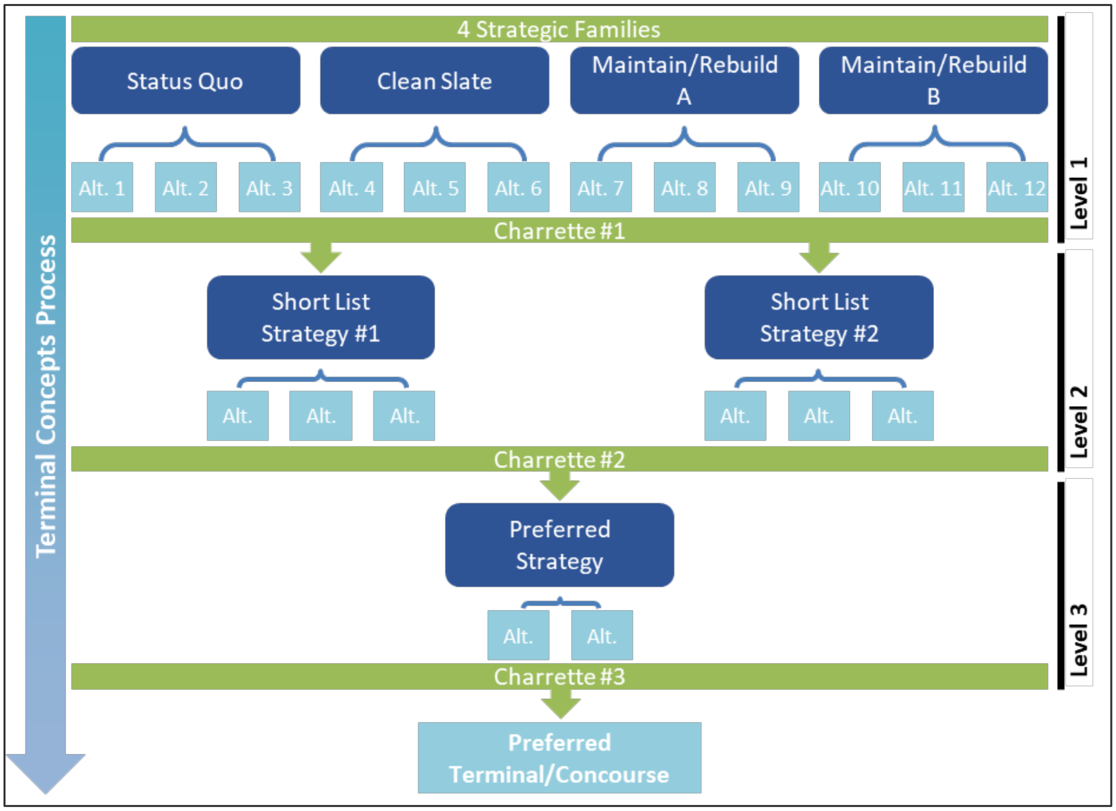
- **International Arrivals**: Improve the international arrivals process for passengers arriving at CVG internationally to eliminate the need to be re-screened and have to re-check baggage to access the non-secure landside curbside.
- **Baggage Handling System**: Facilitate the improvement/replacement of the existing Baggage Handling System (BHS) to allow for a more efficient and reliable operation that eliminates unnecessary complexities.
- **Main Terminal Expansion**: Allow for the logical and incremental expansion of the Main Terminal Building and processors to accommodate the increased levels of origin and destination (O&D) passengers that CVG is currently experiencing and projected to experience in the future.
- **Revenue Enhancement**: Maximize the revenue generation potential of the passenger terminal facilities through passenger routing and the use of centralized concessions.

5.3.1 Passenger Terminal Planning Process

As part of this Master Plan Update, a specific planning process was defined to assess the various concepts/alternatives that CVG could develop to meet the projected passenger demand through PAL 4. This process consists of three levels of evaluation. Each level begins has the objective of eliminating a number of concepts from consideration while selecting fewer concepts to move forward for further refinement and evaluation. **Exhibit 5.3-1, *Terminal/Concourse Evaluation Process***, presents the overall process of the terminal/concourse concept and evaluation process graphically.

Each of the three levels of evaluation are described in detail in the following sections. In general, the process consisted of evaluating an ever-decreasing number of concepts with an increasing level of detail.

EXHIBIT 5.3-1 TERMINAL/CONCOURSE EVALUATION PROCESS

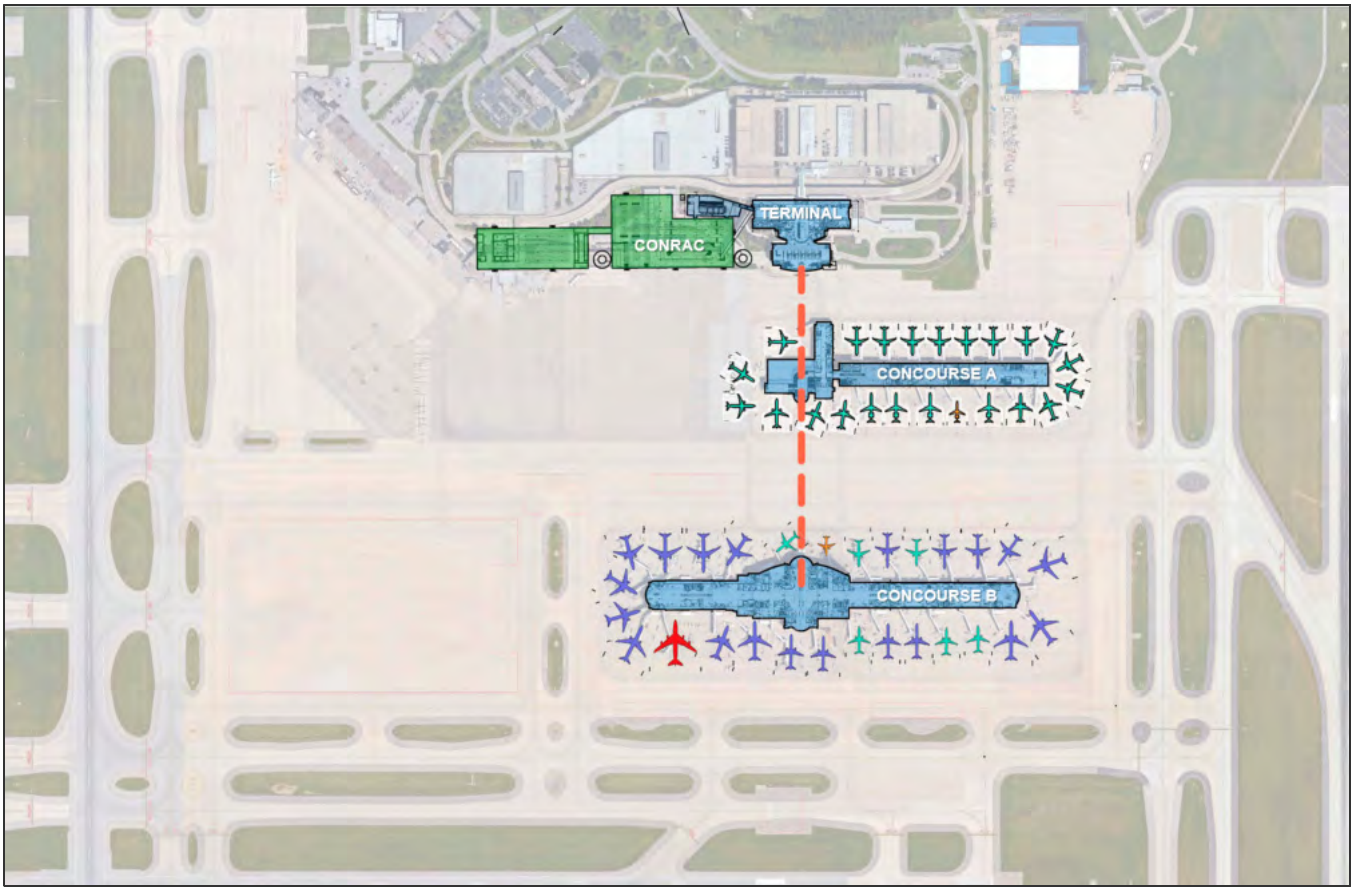


Source: Landrum & Brown analysis

5.3.2 Primarily Concept Families

The configuration of the passenger terminal and concourses today was developed by Delta Air Lines in the early 1990s to serve as their primary hub airport outside of Atlanta Hartsfield/Jackson International Airport (ATL). Because of this role, the terminal complex consists of a main terminal building and two satellite concourses (A & B). Originally there was a third satellite (Concourse C); however, with the eventual drawdown of the Delta hub at CVG it was no longer necessary and was demolished in 2017. **Exhibit 5.3-2, *Existing Terminal and Concourse Configuration***, presents the general layout of the Main Terminal Building, Concourse A, and Concourse B.

EXHIBIT 5.3-2 EXISTING TERMINAL AND CONCOURSE CONFIGURATION



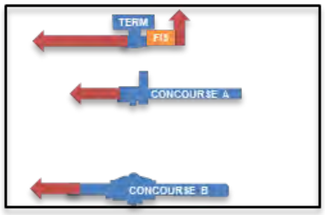
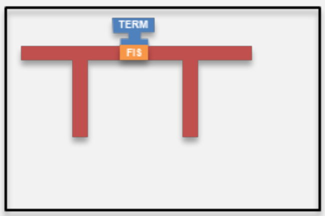
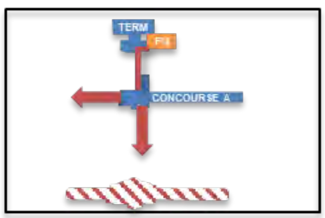
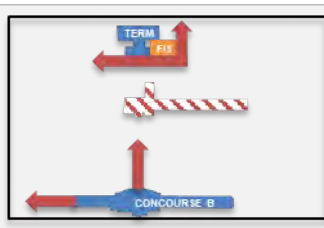
Sources: Woolpert Photography dated September 23, 2017; KCAB; Landrum & Brown analysis

At the beginning of the process of developing the range of concourse development concepts, four primary concept families were considered. No matter what the concept ultimately proposed, each could be categorized into one of these primary families. The four primary concept families are:

- **Family 1 – Status Quo**: The premise of Family 1 is that some version of both Concourses A and B are maintained moving forward. The projected growth in passenger demand would be accommodated through concourse extension(s), developing a new concourse, or a combination of both.
- **Family 2 – Clean Slate**: The premise of Family 2 is that neither Concourse A nor Concourse B are maintained moving forward. The projected growth in passenger demand would be accommodated through the development of entirely new concourse infrastructure, connecting the existing buildings to the Main Terminal Building, or a combination of both.
- **Family 3 – Concourse A**: The premise of Family 3 is that the existing Concourse A or a relocated Concourse A is maintained moving forward and that Concourse B is demolished. The projected growth in passenger demand would be accommodated trough expansion(s) to Concourse A, the development of a new concourse, or a combination of both.
- **Family 4 – Concourse B**: The premise of Family 4 is that the existing Concourse B is maintained moving forward and that Concourse A is demolished. The projected growth in passenger demand would be accommodated through expansion(s) to Concourse B, the development of a new concourse, or a combination of both.

Table 5.3-1, *Primary Concept Families*, presents a generic depiction of each family and some high-level attributes of each. The high-level attributes presented are whether the family of concepts requires an Automated People Mover (APM) or train connection, and whether the family of concepts facilitates the relocation of the Federal Inspection Services (FIS) or Customs and Border Patrol (CBP) facilities.

TABLE 5.3-1 PRIMARY CONCEPT FAMILIES

Family		APM Connection	FIS Relocation
Family 1 – Status Quo		Requires APM	Limited area at Main Terminal to Relocate International Gates
Family 2 – Clean Slate		APM Not Required	Enables New FIS Facility
Family 3 – Concourse A		APM Not Required	Requires New FIS Facility
Family 4 – Concourse B		Requires APM	Enables New FIS Facility

Source: Landrum & Brown analysis

5.3.3 Level 1 Concourse Concepts & Evaluation

The Level 1 concept development and evaluation aimed to develop a series of concepts for each primary concept family and evaluate all concepts against one another. The concepts developed at this point in the process are conceptual and lack many fine details as they are meant to be diagrammatic in nature. Each concept has been sized to accommodate the projected PAL 3 gate demand of 38 to 48 gates.

The evaluation in Level 1 consisted of a qualitative evaluation using a defined set of evaluation criteria. The result of this evaluation was a shortlisted set of six concepts that were carried forward for further refinement and evaluation in Level 2. The following subsections present the 14 concepts, the criteria used for evaluation, and the results of that evaluation.

As part of this analysis, several base assumptions were made in the development of each concept. These assumptions are:

- Each concept, regardless of configuration, is assumed able to be refined to a point to allow for required main terminal building expansion. Therefore, the processing requirements of the main terminal building do not factor into the evaluation of concepts at this level.
- For concepts that propose to maintain existing concourse building, that building is assumed to have undergone major rehabilitation to extend the useful life of the asset and optimize its efficiency to modern standards.
- For concepts that maintain Concourse B, some form of passenger conveyance is required in order to maintain acceptable walking distances.

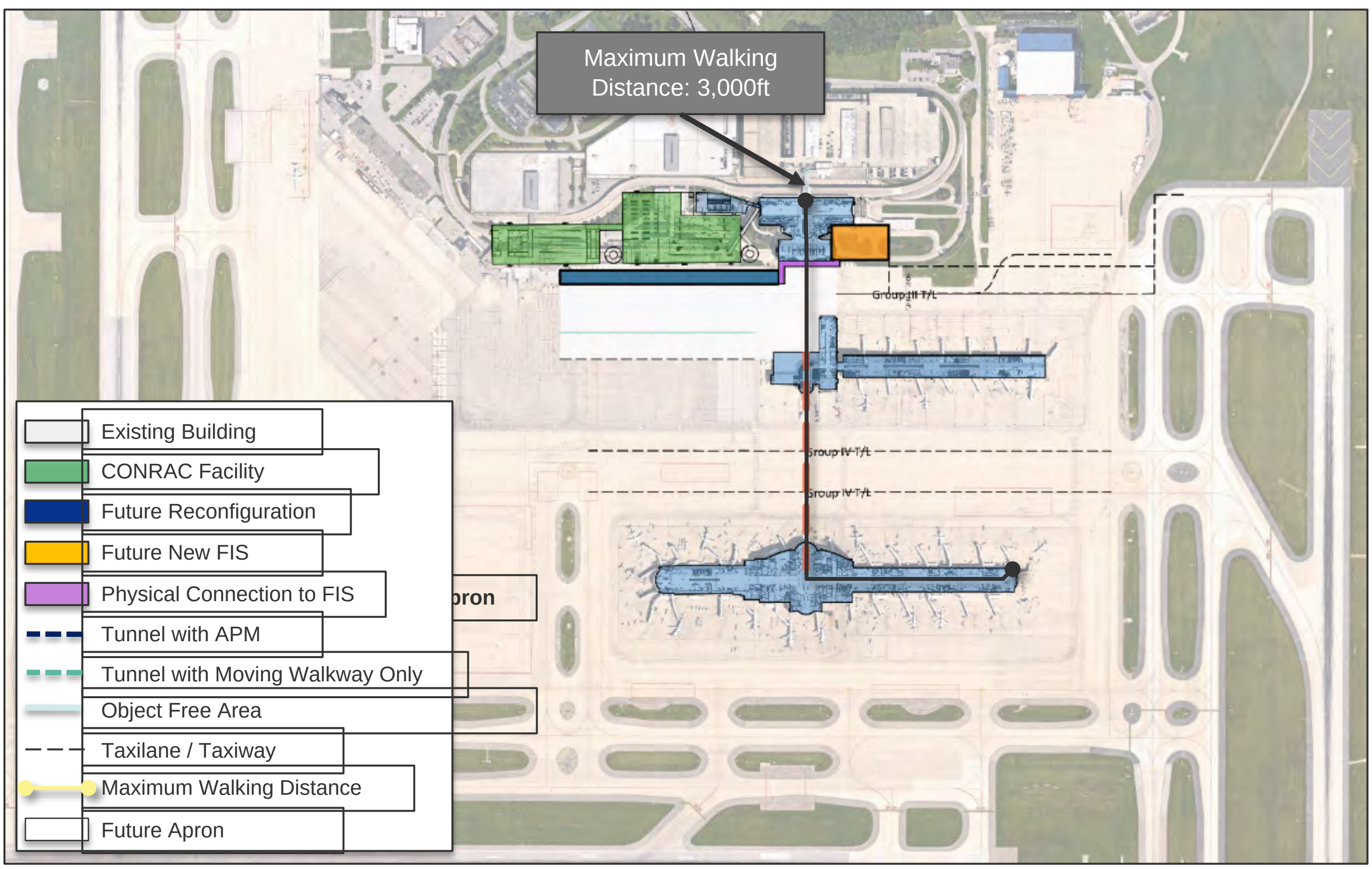
5.3.3.1 Level 1 Concepts

The Level 1 Concepts are presented in order of their primary concept family. Each concept was assigned a two-digit number, the first represents the family and the second is the concept number within that family. For example, Concept 1-1 correlates to Concept 1 of Family 1 (status quo). While there are multiple concepts for each family, not all families have the same number of concepts.

Concept 1-1

Family 1, Concept 1 proposes to maintain both Concourses A and B. Additional gates are provided via a new terminal concourse directly south and adjacent to the new Consolidated Rent-a-car Facility (CONRAC). These new gates are intended to be capable of accommodating international arrivals and connect to a relocated FIS facility that is adjacent to the existing main terminal building. This concept would require the entire length of the APM system be maintained in the existing tunnel to provide passengers reduced walking distances to both Concourses A and B. **Exhibit 5.3-3, *Concept 1-1***, presents the layout of Family 1, Concept 1 in plan view.

EXHIBIT 5.3-3 CONCEPT 1-1

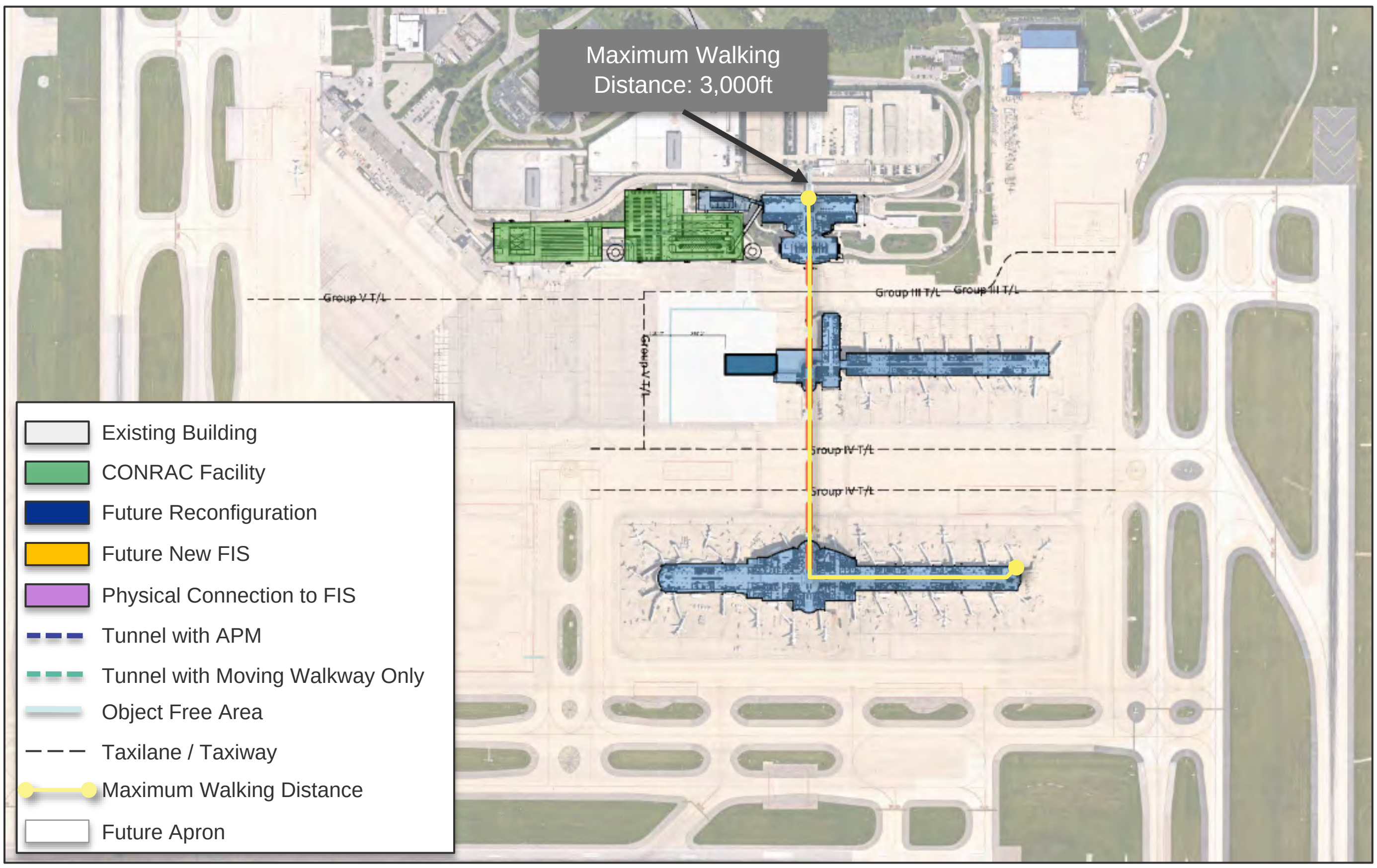


Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Concept 1-2

Family 1, Concept 2 proposes to maintain both Concourses A and B. Additional gates are provided via a concourse expansion on the western end of Concourse A. This new concourse expansion would maintain the existing alignment of Concourse A. Under this concept, the international arrival gates would remain on Concourse B and thereby require the existing passenger re-screen operation to remain in effect. This concept would require the entire length of the APM system be maintained in the existing tunnel to provide passengers reduced walking distances to both Concourses A and B. **Exhibit 5.3-4, *Concept 1-2***, presents the layout of Family 1, Concept 2 in plan view.

EXHIBIT 5.3-4 CONCEPT 1-2



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

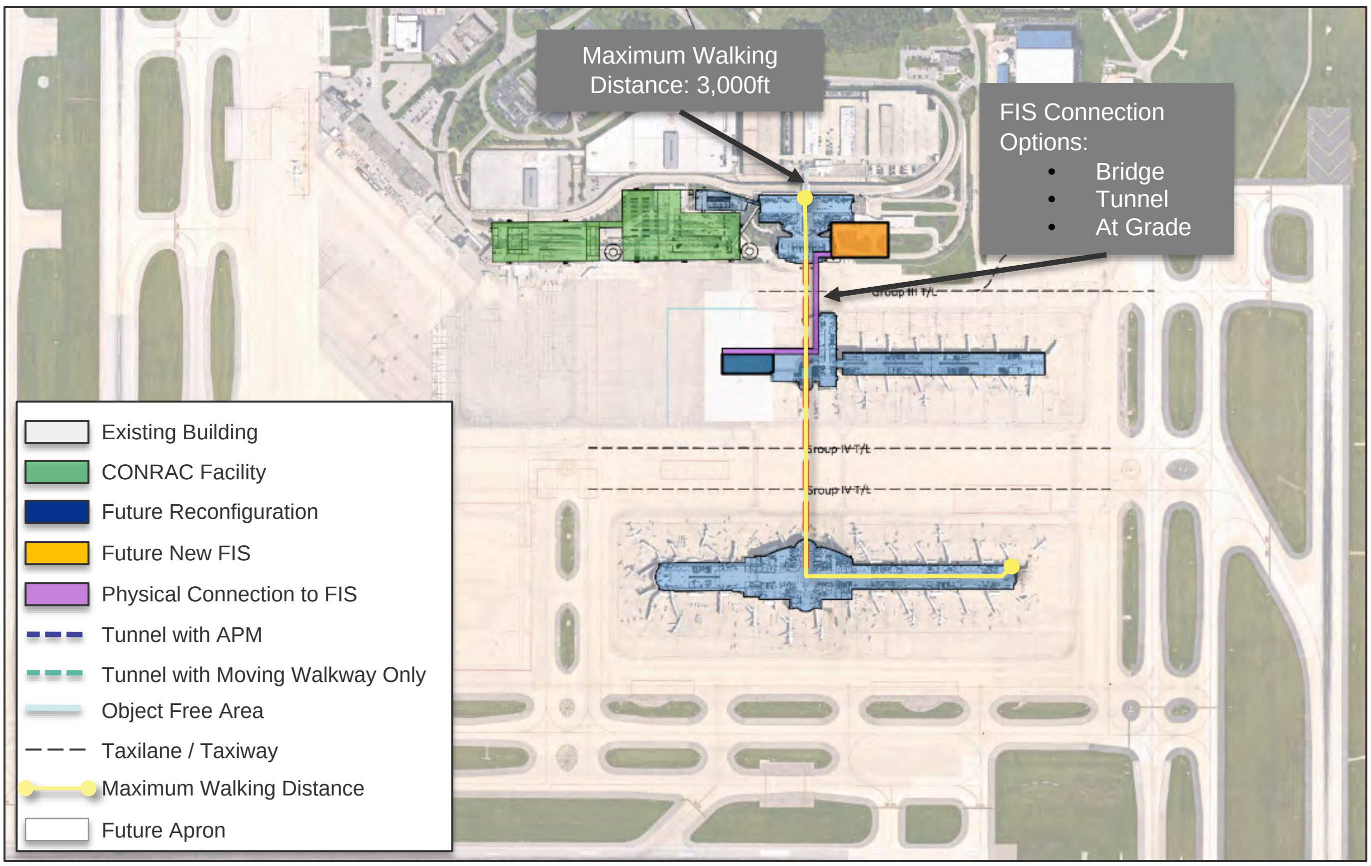
Concept 1-3

Family 1, Concept 3 proposes to maintain both Concourses A and B. Additional gates are provided via a concourse expansion on the western end of Concourse A. This new concourse expansion would maintain the existing alignment of Concourse A. While nearly identical to Concept 1-2, Concept 1-3 proposes that the expansion of Concourse A be able to accommodate international arrivals and connect to a relocated FIS adjacent to the existing main terminal building. This relocation would allow for the elimination of passenger re-screening to reach the main terminal landside. This connection would be accomplished in one of three ways:

- A passenger connector bridge over the north apron taxilane
- An at-grade connector which would block the north apron taxilane
- Sacrifice part of the existing passenger tunnel to accommodate a sterile corridor

This concept would require the entire length of the APM system be maintained in the existing tunnel to provide passengers reduced walking distances to both Concourses A and B. **Exhibit 5.3-5, *Concept 1-3***, presents the layout of Family 1, Concept 3 in plan view.

EXHIBIT 5.3-5 CONCEPT 1-3

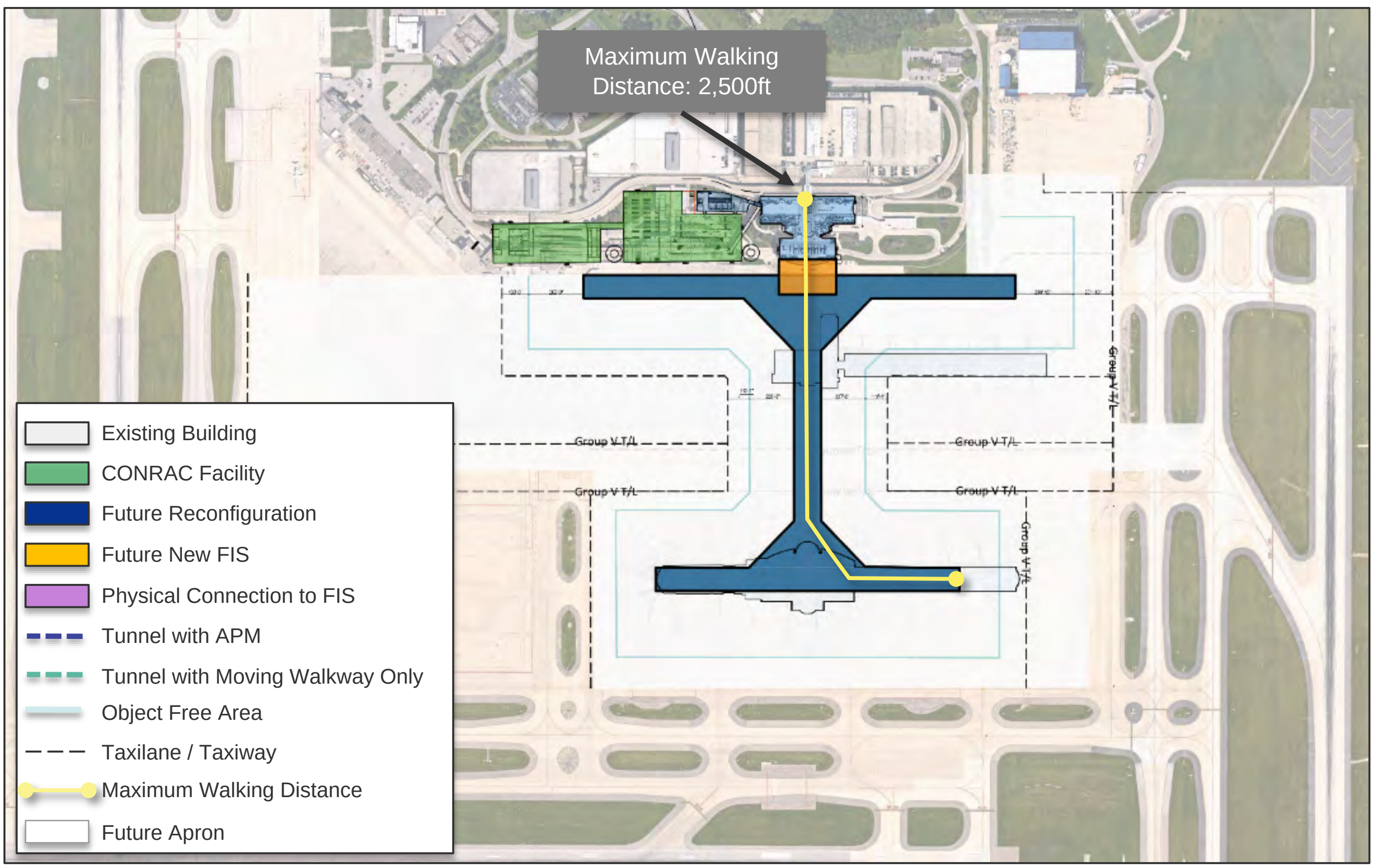


Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Concept 2-1

Family 2, Concept 1 proposes to move away from a satellite concourse configuration. Under this concept, a single-loaded concourse (aircraft park only on one side of the building) is proposed adjacent to the main terminal building and CONRAC which is connected to a second east/west concourse that is roughly aligned with the existing Concourse B. These two proposed concourses are connected via a north/south connector concourse. Under this configuration, passenger flows would move entirely away from the existing tunnel with passengers remaining on the gate/departures level throughout the entirety of the building. This would eliminate the need for an APM system so long as moving walks are utilized throughout the building. This concept enables the elimination of passenger re-screening to reach the main terminal landside for international arrivals. **Exhibit 5.3-6, *Concept 2-1***, presents the layout of Family 2, Concept 1 in plan view.

EXHIBIT 5.3-6 CONCEPT 2-1

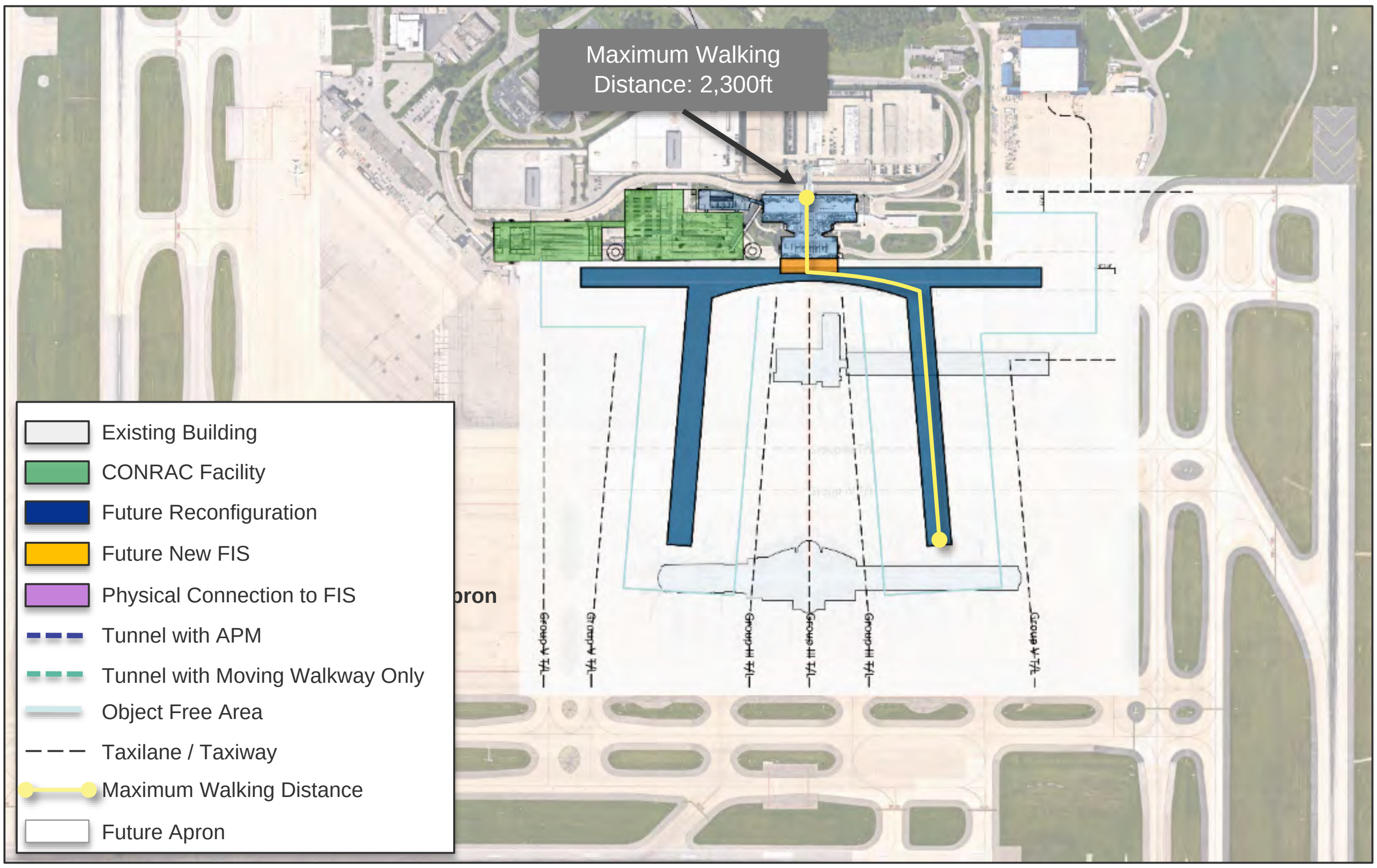


Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Concept 2-2

Family 2, Concept 2 proposes to move away from a satellite concourse configuration. Under this concept, a single-loaded concourse is proposed adjacent to the main terminal building and CONRAC. Extending towards the south from this terminal concourse are approximately perpendicular pier style double loaded concourses. Under this configuration, passenger flows would move entirely away from the existing tunnel with passengers remaining on the gate/departures level throughout the entirety of the building. This would eliminate the need for an APM system and tunnel entirely. This concept enables the elimination of passenger re-screening to reach the main terminal landside for international arrivals. **Exhibit 5.3-7, *Concept 2-2***, presents the layout of Family 2, Concept 2 in plan view.

EXHIBIT 5.3-7 CONCEPT 2-2

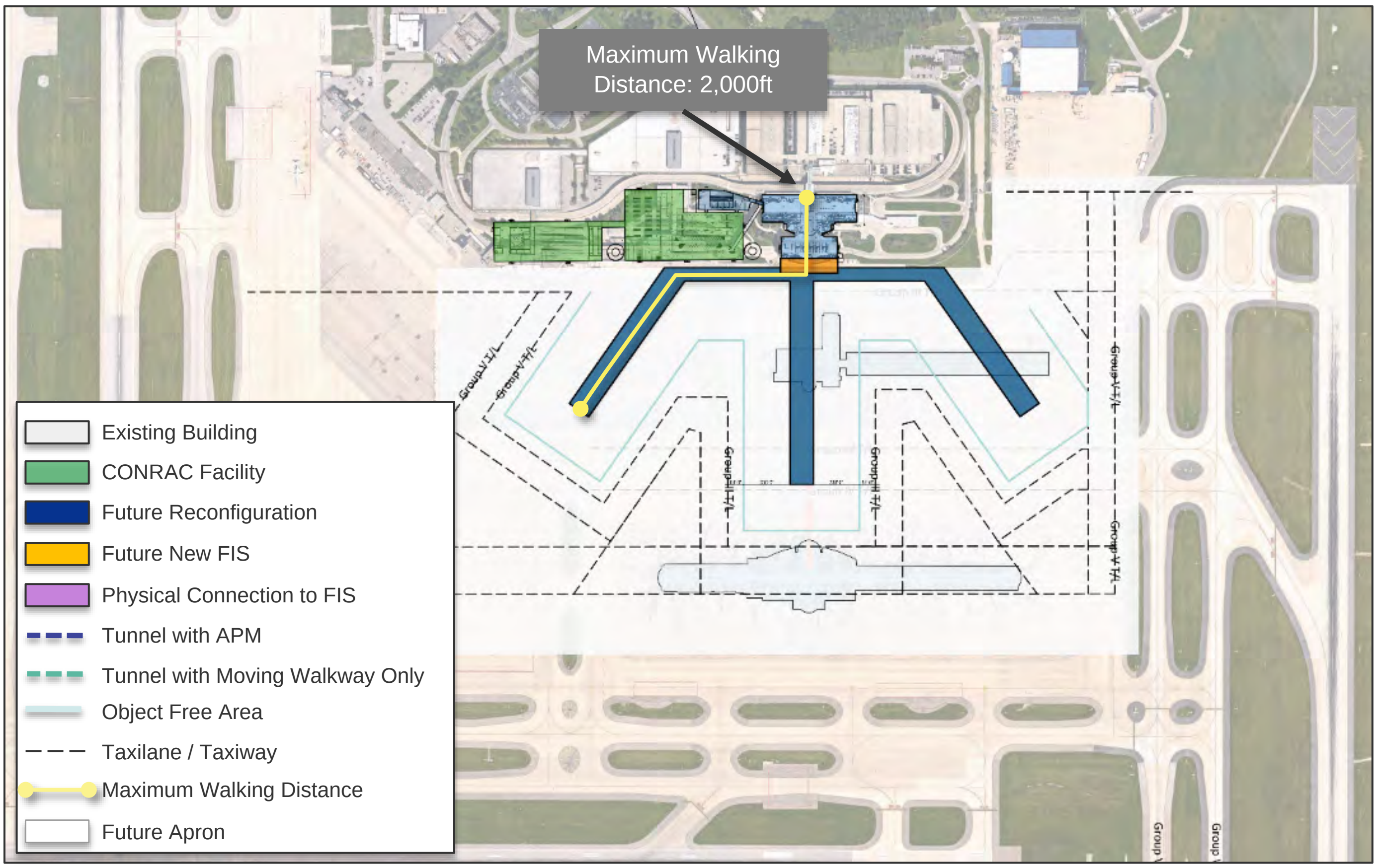


Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Concept 2-3

Family 2, Concept 3 proposes to move away from a satellite concourse configuration. Under this concept, a series of concourses would be developed in the general configuration of a trident. Each of these concourses would extend outward away from the existing Main Terminal Building. Under this configuration, passenger flows would move entirely away from the existing tunnel with passengers remaining on the gate/departures level throughout the entirety of the building. This would eliminate the need for an APM system and tunnel entirely. This concept enables the elimination of passenger re-screening to reach the Main Terminal landside for international arrivals. **Exhibit 5.3-8, *Concept 2-3***, presents the layout of Family 2, Concept 3 in plan view.

EXHIBIT 5.3-8 CONCEPT 2-3

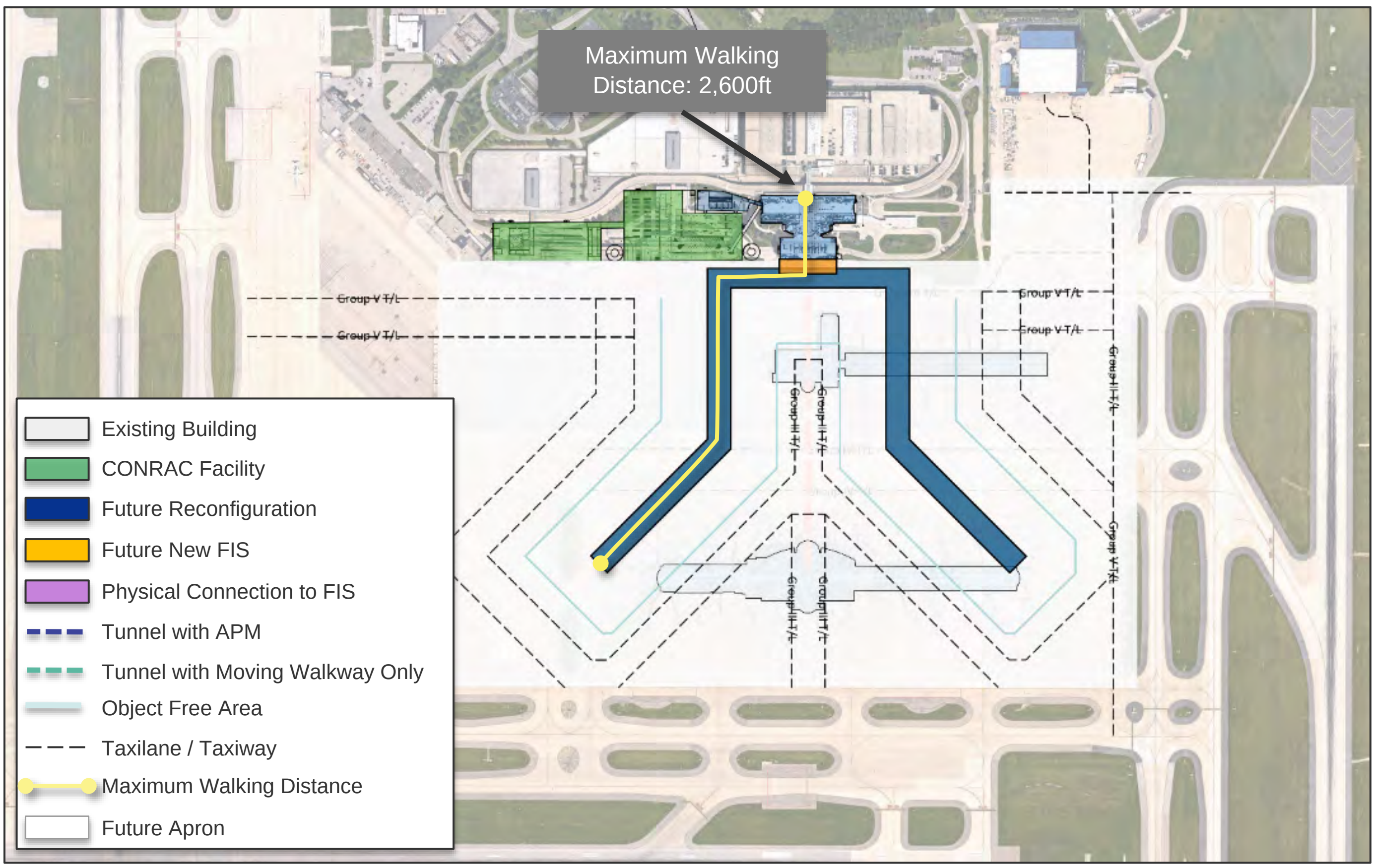


Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Concept 2-4

Family 2, Concept 4 proposes to move away from a satellite concourse configuration. Under this concept, two pier concourses would be developed. The first segments of these two concourses extend due south parallel to each other before turning 45 degrees and diverging in a southeast/southwest direction. Under this configuration, passenger flows would move entirely away from the existing tunnel with passengers remaining on the gate/departures level throughout the entirety of the building. This would eliminate the need for an APM system and tunnel entirely. This concept enables the elimination of passenger re-screening to reach the Main Terminal landside for international arrivals. **Exhibit 5.3-9, *Concept 2-4***, presents the layout of Family 2, Concept 4 in plan view.

EXHIBIT 5.3-9 CONCEPT 2-4

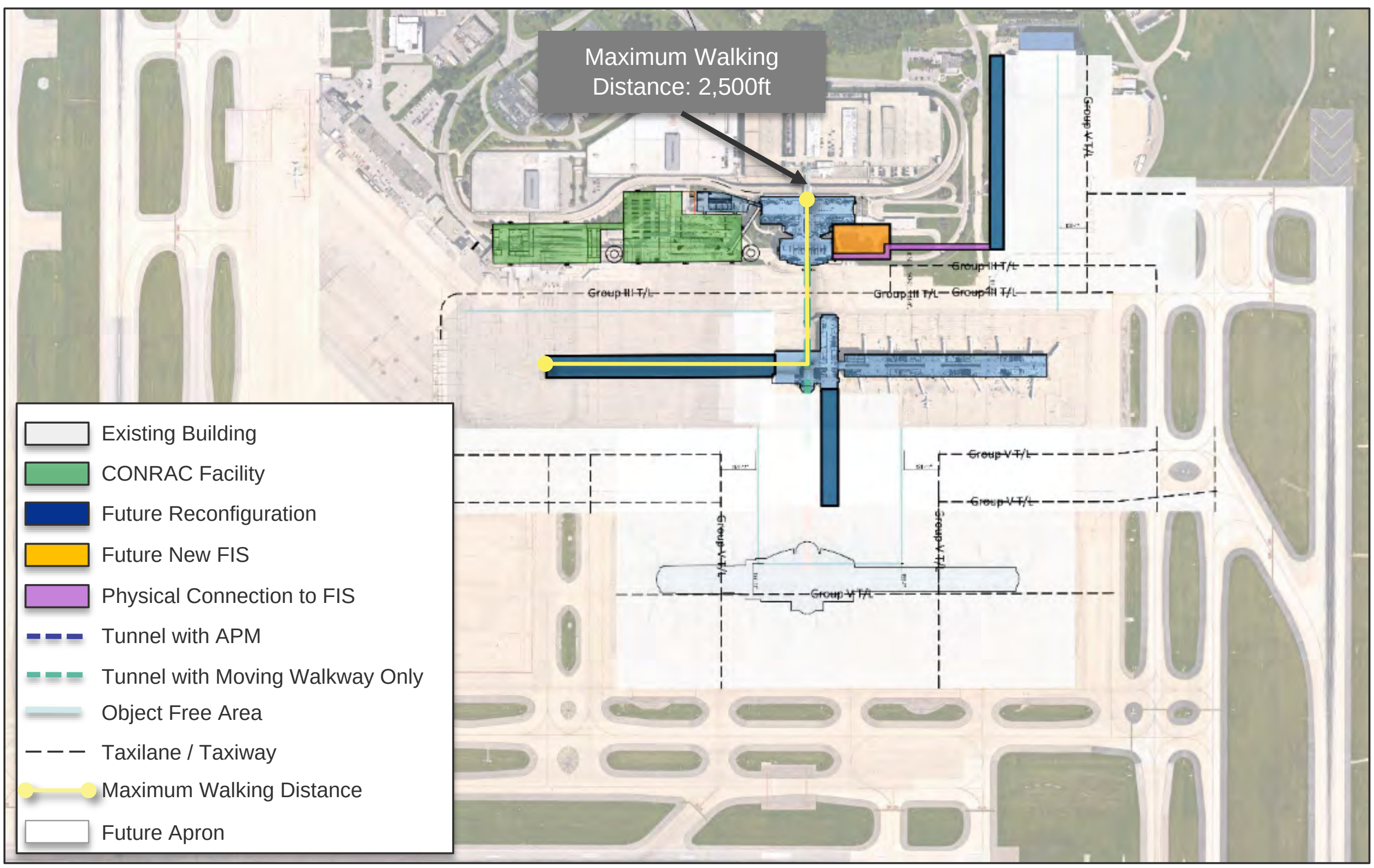


Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Concept 3-1

Family 3, Concept 1 proposes to maintain Concourse A while eliminating Concourse B. Additional gates are provided via extensions to Concourse A. These extensions consist of a southern pier extension extending from the existing node of Concourse A, and an inline western extension that continues the existing alignment of the concourse. In addition, a separate concourse for international arriving flights is proposed beginning due east of the main terminal building and extending to the north into the existing Delta Air Lines maintenance facility. These new gates would connect to a relocated FIS facility that is adjacent to the existing main terminal building. This concept enables the elimination of passenger rescreening to reach the main terminal landside for international arrivals. However, it requires the removal or relocation of the Delta Air Lines maintenance facility. The utilization of the APM is no longer required in this concept as walking distances in the tunnel have been reduced. **Exhibit 5.3-10, *Concept 3-1***, presents the layout of Family 3, Concept 1 in plan view.

EXHIBIT 5.3-10 CONCEPT 3-1

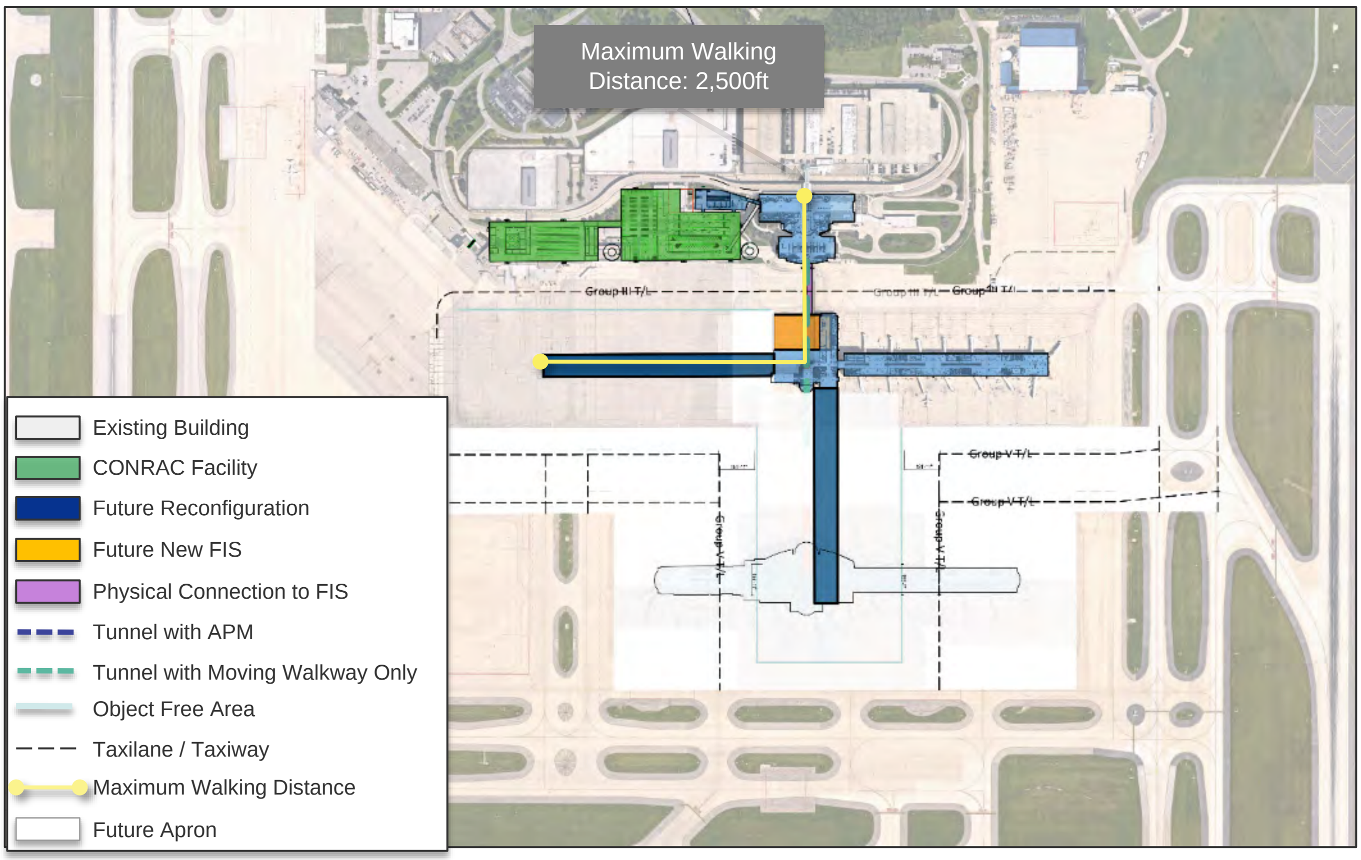


Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Concept 3-2

Family 3, Concept 2 proposes to maintain Concourse A while eliminating Concourse B. Additional gates are provided via extensions to Concourse A. These extensions consist of a southern pier extension extending from the existing node of Concourse A, and an inline western extension that continues the existing alignment of the concourse. In addition to concourse extensions, this concept proposes to relocate the FIS adjacent to the new concourse center point. The relocation of FIS proposed in this concept enables the elimination of passenger re-screening to reach the main terminal landside for international arrivals by connecting to the landside via a portion of the existing tunnel between Concourse A and the main terminal building. The utilization of the APM is no longer required in this concept as walking distances in the tunnel have been reduced. **Exhibit 5.3-11, *Concept 3-2***, presents the layout of Family 3, Concept 2 in plan view.

EXHIBIT 5.3-11 CONCEPT 3-2

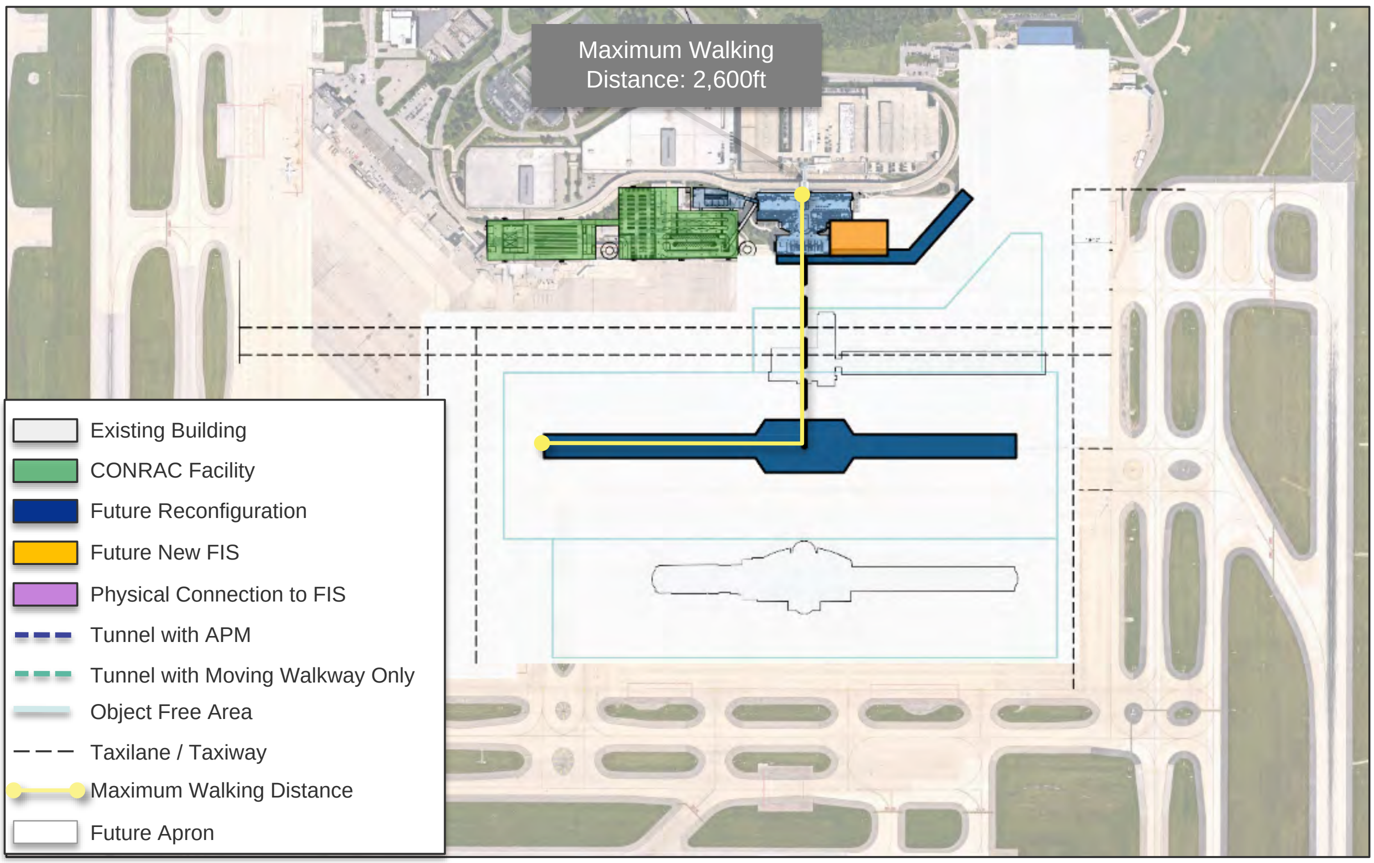


Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Concept 3-3

Family 3, Concept 3 proposes to relocate Concourse A while eliminating Concourse B. The relocated Concourse A has been shifted south from the current alignment to allow for dual-parallel taxilanes to the north of the concourse as well as an additional international-only concourse adjacent to the main terminal building. This new terminal concourse proposes to relocate the FIS and thereby allow for the elimination of passenger re-screening to reach the main terminal landside. The utilization of the APM is no longer required in this concept as walking distances in the tunnel have been reduced. **Exhibit 5.3-12, *Concept 3-3***, presents the layout of Family 3, Concept 3 in plan view. Concept 3-3 is the most similar concept considered to the concourse configuration recommended by the 2012 Master Plan Update.

EXHIBIT 5.3-12 CONCEPT 3-3

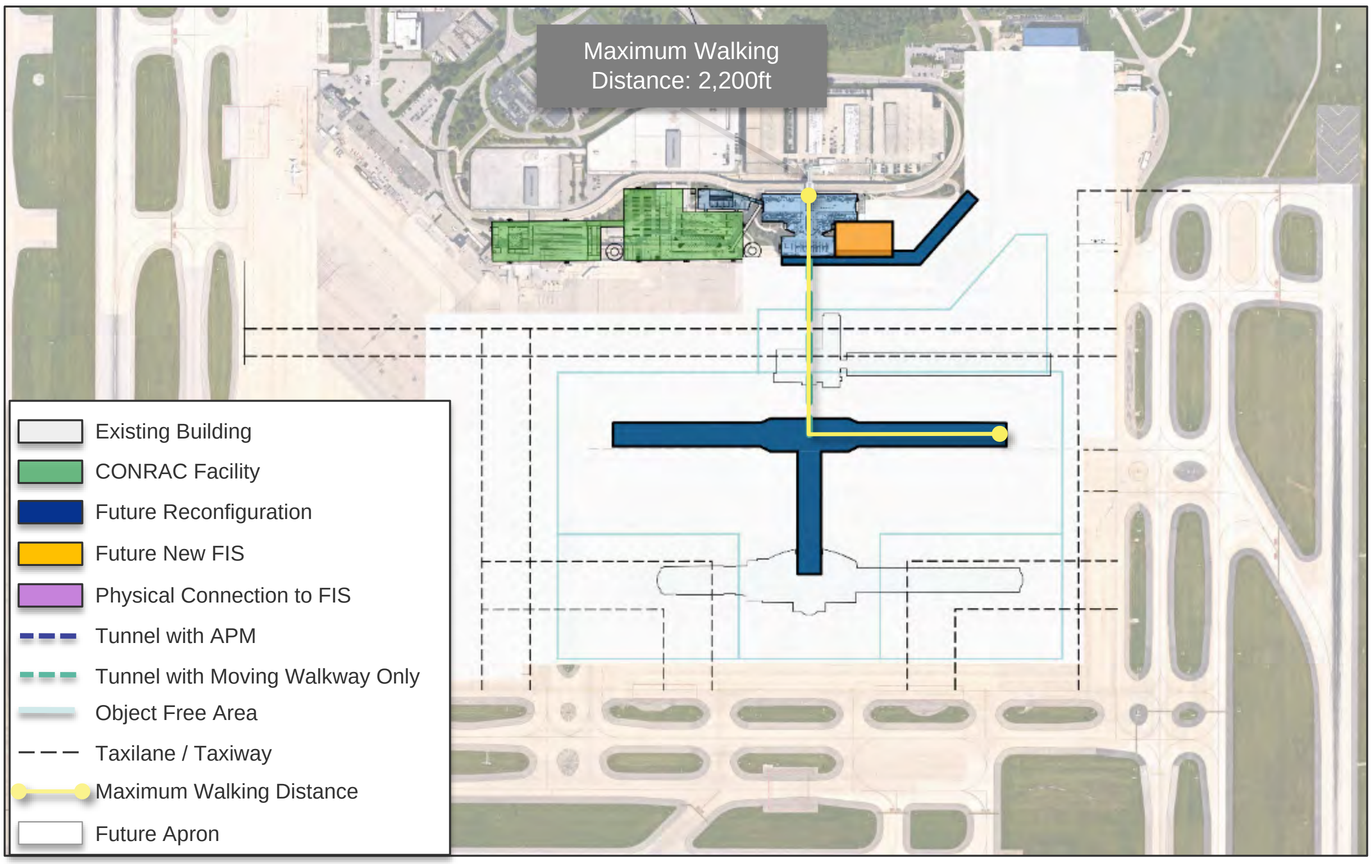


Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Concept 3-4

Family 3, Concept 4 proposes to relocate Concourse A while eliminating Concourse B. The relocated Concourse A has been shifted south from the current alignment to allow for dual-parallel taxilanes to the north of the concourse as well as an additional international only concourse adjacent to the main terminal building. This new terminal concourse proposes to relocate the FIS and thereby allow for the elimination of passenger re-screening to reach the main terminal landside. The utilization of the APM is no longer required in this concept as walking distances in the tunnel have been reduced. The only difference from Concept 3-3 is that a southern concourse pier has been added to the satellite, which reduces the overall east/west span of the concourse. **Exhibit 5.3-13, *Concept 3-4***, presents the layout of Family 3, Concept 4 in plan view.

EXHIBIT 5.3-13 CONCEPT 3-4



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

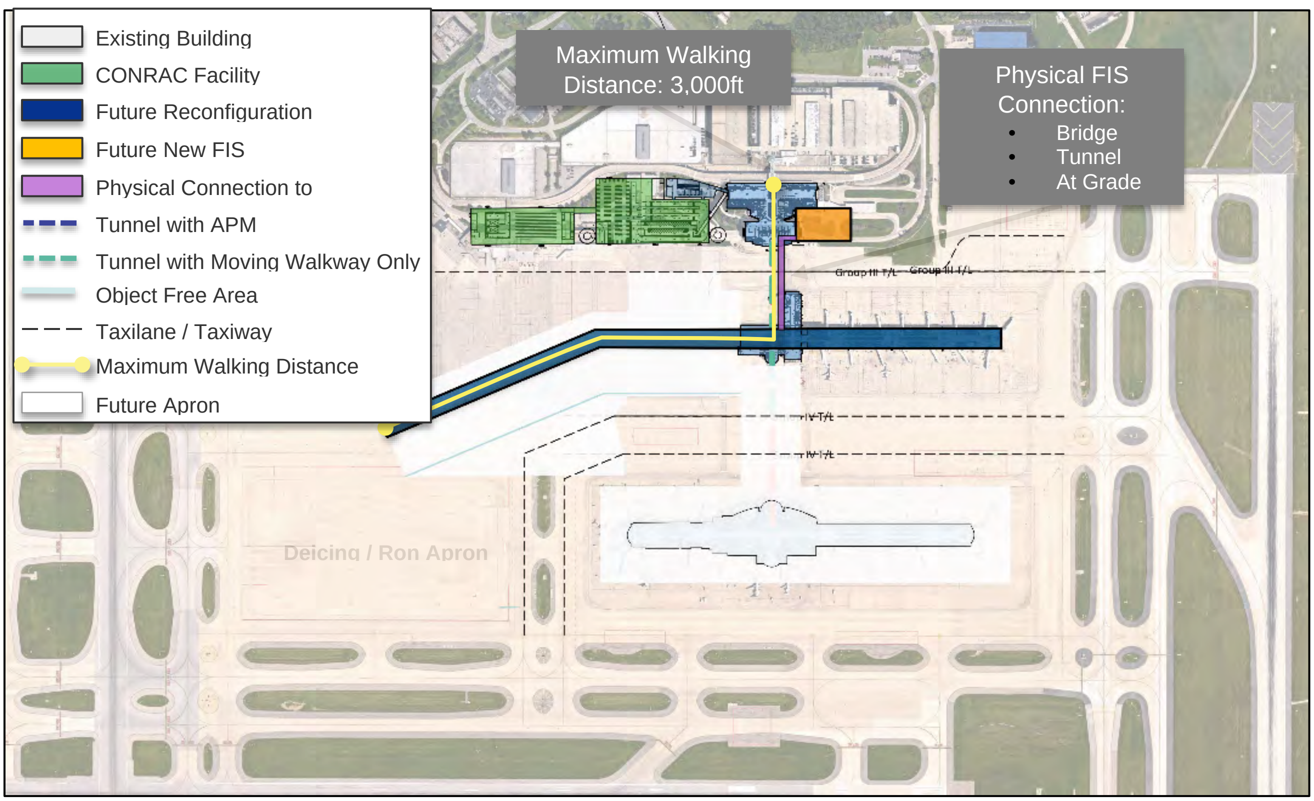
Concept 3-5

Family 3, Concept 5 proposes to expand Concourse A while eliminating Concourse B. The expansion of Concourse A consists of a simple linear expansion of Concourse A to the west. The expansion makes a slight turn to the south at the point that the concourse and associated taxilanes would no longer impact operations on Concourse B. This would allow for easy phasing during construction. Concept 3-5 proposes that the expansion of Concourse A be able to accommodate international arrivals and connect to a relocated FIS adjacent to the existing main terminal building. This relocation would allow for the elimination of passenger re-screening to reach the main terminal landside. This connection would be accomplished one of three ways:

- A passenger connector bridge over the north apron taxilane
- An at-grade connector which would block the north apron taxilane
- Sacrificing part of the existing passenger tunnel to accommodate a sterile corridor

The utilization of the APM is no longer required in this concept as walking distances in the tunnel have been reduced. However, the increased length of the proposed Concourse A is such that an APM system would likely be required within the concourse itself. **Exhibit 5.3-14, *Concept 3-5***, presents the layout of Family 3, Concept 5 in plan view.

EXHIBIT 5.3-14 CONCEPT 3-5

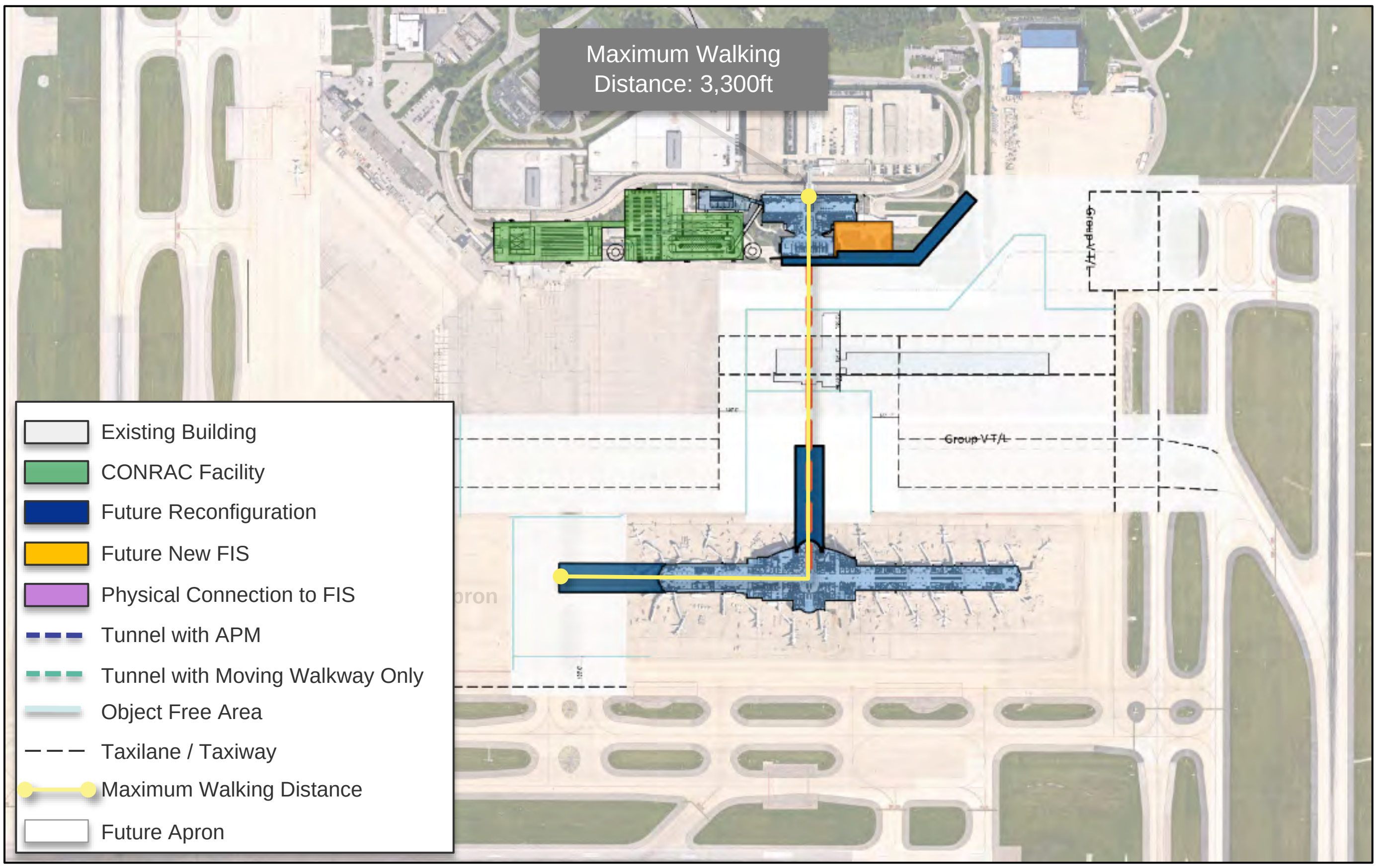


Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Concept 4-1

Family 4, Concept 1, proposes two extensions to Concourse B while removing Concourse A. In addition, a new terminal concourse is proposed that will accommodate international arrival capable gates. This new terminal concourse will be directly adjacent to a relocated FIS facility. This relocation of the FIS facility will allow for the removal of the international passenger re-screening process. Additional gate capacity to accommodate the projected demand is also provided by a western extension to Concourse B and a new concourse pier extending to the north from the center point of Concourse B. The continued operation of the APM system and tunnel would be required in this concept. **Exhibit 5.3-15, *Concept 4-1***, presents the layout of Family 4, Concept 1 in plan view.

EXHIBIT 5.3-15 CONCEPT 4-1

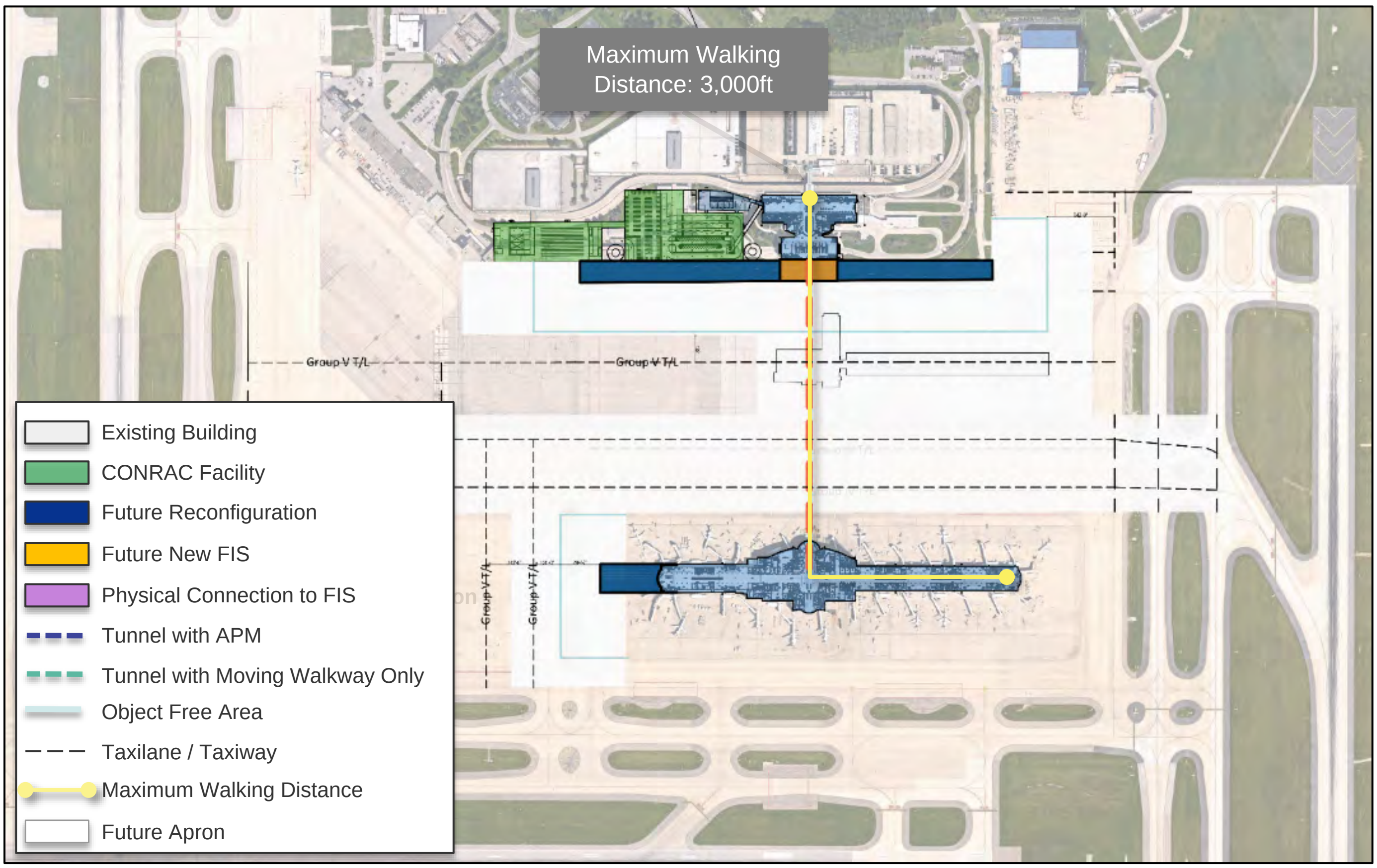


Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Concept 4-2

Family 4, Concept 2, proposes an extension to Concourse B while removing Concourse A. In addition, a new terminal concourse is proposed that will accommodate international arrival capable gates. This new terminal concourse will be directly adjacent to a relocated FIS facility. This relocation of the FIS facility will allow for the removal of the international passenger re-screening process. Additional gate capacity to accommodate the projected demand is also provided by a western extension to Concourse B. However, unlike Concept 4-1, Concept 4-2 does not propose a northward pier extension to Concourse B, but rather a much larger terminal concourse. The continued operation of the APM system and tunnel would be required in this concept. **Exhibit 5.3-16, *Concept 4-2***, presents the layout of Family 4, Concept 2 in plan view.

EXHIBIT 5.3-16 CONCEPT 4-2



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.3.3.2 Level 1 Evaluation

The Level 1 evaluation of the 14 concourse concepts was a process of qualitative evaluation of each concept to a set of evaluation criteria that were defined by the planning team. The objective of this process was to holistically compare the performance of each concept against the other concepts and yield a shortlist of six concepts that performed the best. This shortlist was then carried forward for Level 2 refinement and evaluation.

Level 1 Evaluation Criteria

Through discussions with KCAB personnel and review of the goals and objectives of the Master Plan 2050 presented in Chapter 1, 12 evaluation criteria were defined to evaluate all 14 concourse concepts. These 12 criteria were categorized into four major categories, airside, terminal, implementation, and costs. The evaluation criteria are defined as follows:

- Airside
  - **Airside Circulation/Operations**: Does the configuration of the concourse(s) maintain or improve the taxiing of aircraft from east to west without creating significant numbers of gates that have dependent pushback operations?
- Terminal
  - **Passenger Journey**: The configuration of the concourse(s) minimizes the number of level changes and the potential unassisted walking distance required for passengers to flow from the main terminal to their gate and from their gate to the main terminal.
  - **APM Needed**: Does the concourse configuration eliminate the need for an APM (train/people-mover)?
  - **Baggage Operations**: Does the concourse configuration allow for the implementation of a simplified baggage handling system with consolidated baggage screening?
  - **International Passenger Arrivals**: Does the concourse configuration allow for international arriving passengers to exit the CBP facility directly to the landside without having to be rescreened?
  - **Future Flexibility**: Does the concourse configuration support future hubbing operations while supporting flexibility for O&D operations and gate allocations?
- Implementation
  - **Impact to Existing Facilities**: Does the concourse configuration limit the impact to existing non-passenger related structures?
  - **Infrastructure Re-Use**: Does the concourse configuration reduce the need to construct new facilities by providing the ability to re-use existing concourse/gate infrastructure?
  - **Phasing**: Is it feasible to phase the construction of the concourse configuration in a way that limits the impacts to existing gate operations and does not require the construction of temporary gates?
  - **Project "Off-Ramps"**: Does the concourse concept allow for incremental facility expansion that provides for flexibility in modifying the plan at project milestones? Can the ultimate configuration can be modified over time to adjust to changing conditions at CVG?

- Costs
  - **Capital Costs**: Does the configuration require a large amount of new infrastructure?
  - **O&M Costs**: Does the configuration rely heavily upon the re-use of existing infrastructure which drives a higher O&M cost?

Level 1 Evaluation Weighting

In order to recognize the varying level of importance of each evaluation criteria and to not over-emphasize criteria for which little information was available at this point in the process, a weighting system was applied. This weighting system was developed through extensive coordination with KCAB staff and Master Plan team members. During this coordination, individuals were asked to compare the importance of each criteria to all other criteria. From this process a suggested ranking of the 12 criteria was developed. Using that suggested ranking, a percent of the overall score was applied to the criteria. **Table 5.3-2, *Evaluation Criteria Weighting***, presents the ranking and weighting applied to each criteria in the Level 1 Evaluation process.

TABLE 5.3-2 EVALUATION CRITERIA WEIGHTING

Criteria	Suggested Rank	Weight
Airside Circulation/Operations	1	15%
Project "Off-Ramps"	2	12.5%
Passenger Journey	3	12.5%
International Passenger Arrivals	4	12.5%
Phasing	5	10%
Baggage Operations	6	7.5%
Future Flexibility	7	5%
APM Needed	8	5%
Infrastructure Re-Use	9	5%
Impact to Existing Facilities	10	5%
Operations & Maintenance Costs	11	5%
Capital Costs	12	5%
		100%

Source: Landrum & Brown analysis

Level 1 Evaluation Scoring

This process used what is commonly referred to as a "Red, Amber, Green" (RAG) analysis. Through high-level qualitative evaluation of each concept, this process assigns a value to each evaluation criteria based on how the concept performs. The values assigned are:

- **+1 (Green)**: The concept performs/compares positively or favorably.
- **0 (Amber)**: The concept performs/compares neutrally.
- **-1 (Red)**: The concept performs/compares negatively or unfavorably.

The individual scores for each criteria were totaled for each concept. This total score was then used to determine a suggested ranking of the 14 concourse concepts. This suggested ranking was used to guide the selection of the six concepts to shortlist for Level 2 Refinements and Evaluation. **Table 5.3-3, *Level 1 Evaluation Matrix***, presents the matrix of scoring for all 14 concepts.

Level 1 Shortlisted Concepts

The results of this analysis informed the decision to shortlist six concepts that were to be carried forward for further refinement and evaluation in Level 2 of the Concourse Concepts Evaluation process. The six concepts carried forward were:

- **Family 1**: Concept 1
- **Family 1**: Concept 3
- **Family 2**: Concept 1
- **Family 2**: Concept 2
- **Family 3**: Concept 1
- **Family 4**: Concept 2

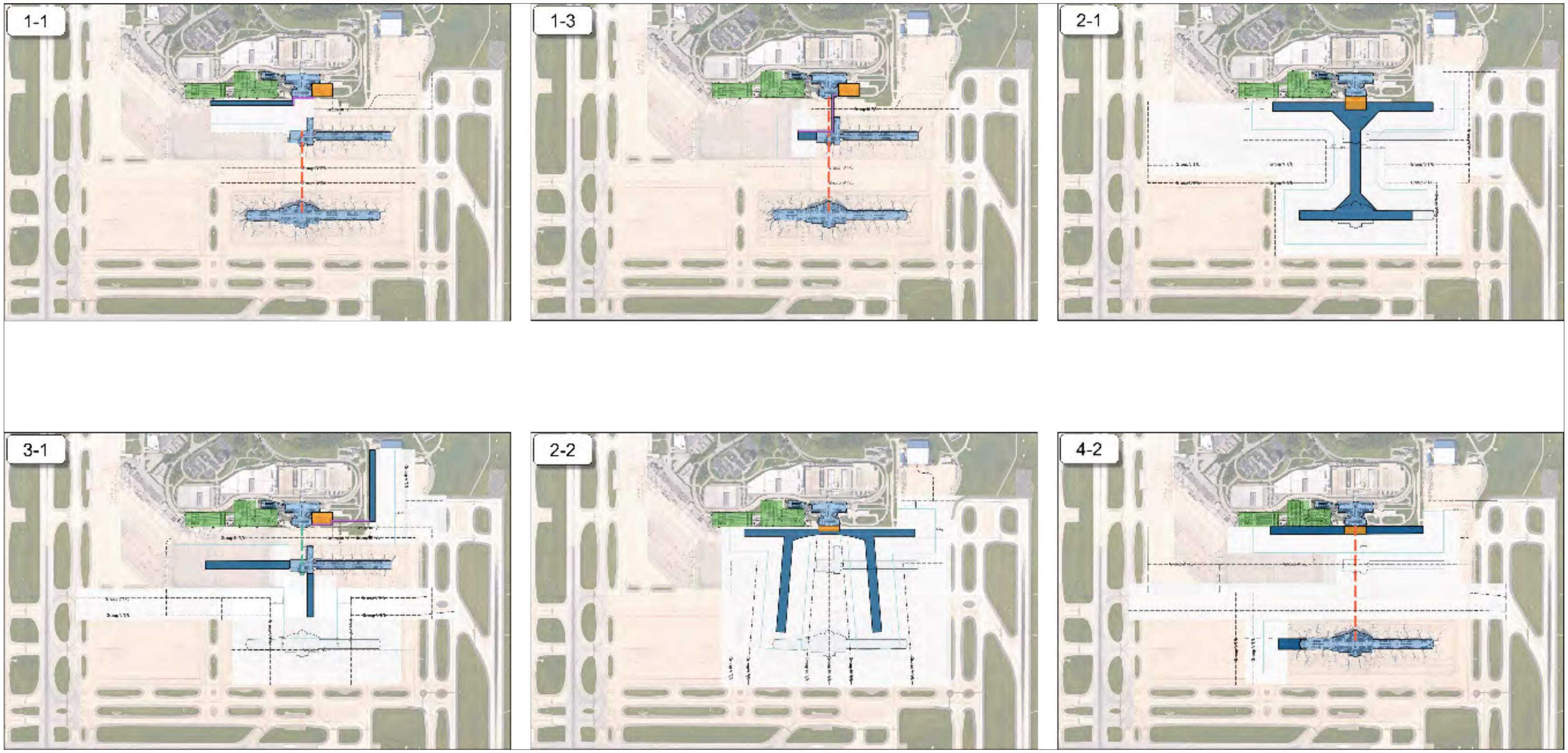
Exhibit 5.3-17, *Level 1 Shortlisted Concepts*, presents an overview of the six shortlisted concepts that were carried forward for Level 2 Refinement and Evaluation.

TABLE 5.3-3 LEVEL 1 EVALUATION MATRIX

Family	Weight	1 – Status Quo			2 – Clean Slate				3 – A Only					4 – B Only	
Concept		**1**	**2**	**3**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**5**	**1**	**2**
Airside															
Airside Circulation/Operations	15%	0	+1	0	-1	-1	-1	-1	0	0	+1	0	-1	0	+1
Terminal															
Passenger Journey	12.5%	0	0	0	+1	+1	+1	+1	0	-1	0	0	-1	0	0
APM Needed	5%	-1	-1	-1	+1	+1	+1	+1	+1	+1	+1	+1	+1	-1	-1
Baggage Operations	7.5%	0	-1	0	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1
International Passenger Arrivals	12.5%	+1	-1	0	+1	+1	+1	+1	+1	0	+1	+1	0	+1	+1
Future Flexibility	5%	-1	0	0	+1	0	0	0	-1	0	-1	-1	-1	0	0
Implementation															
Impact to Existing Facilities	5%	+1	+1	+1	+1	+1	+1	+1	-1	+1	-1	-1	+1	-1	+1
Infrastructure Re-Use	5%	+1	+1	+1	0	-1	-1	-1	0	0	-1	-1	0	+1	+1
Phasing	10%	+1	+1	+1	0	-1	-1	-1	+1	+1	-1	-1	+1	+1	+1
Project “Off-Ramps”	12.5%	+1	+1	+1	+1	-1	-1	-1	+1	0	-1	-1	+1	0	+1
Costs															
Operations & Maintenance	5%	-1	-1	-1	-1	+1	+1	+1	0	0	+1	+1	0	0	0
Capital	5%	+1	+1	+1	+1	-1	-1	-1	0	0	-1	-1	0	0	0
Scoring															
Rank	100%	4	8	5	2	10	10	10	3	7	13	14	9	6	1

Source: Landrum & Brown analysis

EXHIBIT 5.3-17 LEVEL 1 SHORTLISTED CONCEPTS



Source: Landrum & Brown analysis

5.3.4 Level 2 Concept Refinement and Evaluation

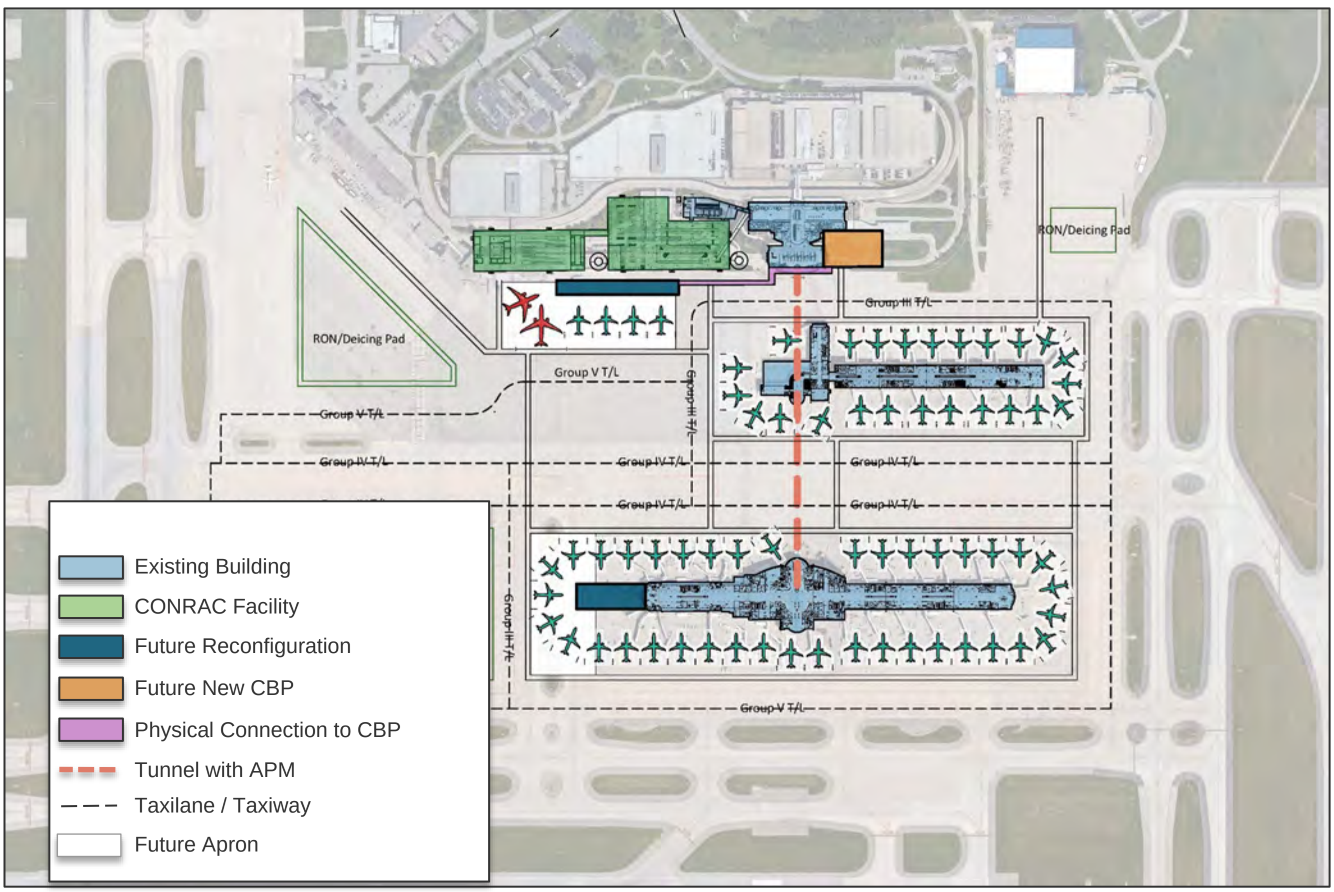
The objective of the Level 2 refinement and evaluations was to add additional detail to the six shortlisted concepts that would allow a quantifiable evaluation to be performed. The end goal of this level of evaluation was to determine the final two concepts to continue on to Level 3 evaluation.

5.3.4.1 Level 2 Concept Refinement

The first step in this refinement process was to adequately size the concepts to a point of being able to accommodate the maximum projected gate demand in PAL 4 (69 gates). This was considered to be the ultimate configuration of each concept. Additional detail was added to each concept to indicate the configuration and capabilities of the taxilanes, general configuration of the aircraft parking area, and remaining apron areas for possible use for deicing or remain overnight parking.

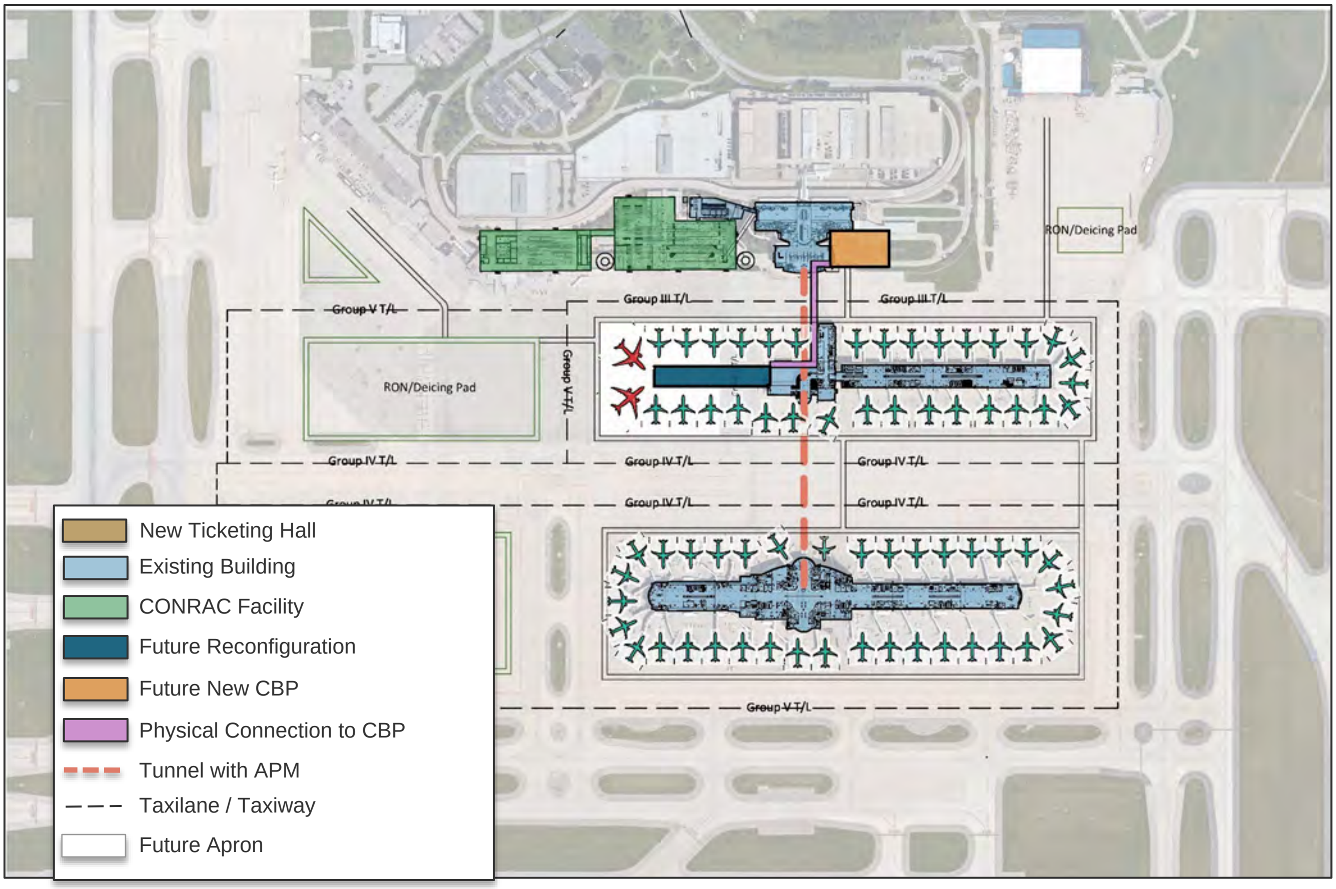
Exhibits 5.3-18 through 5.3-23, present each of the six shortlisted concourse concepts, as they have been refined for the Level 2 evaluation.

EXHIBIT 5.3-18 CONCEPT 1-1



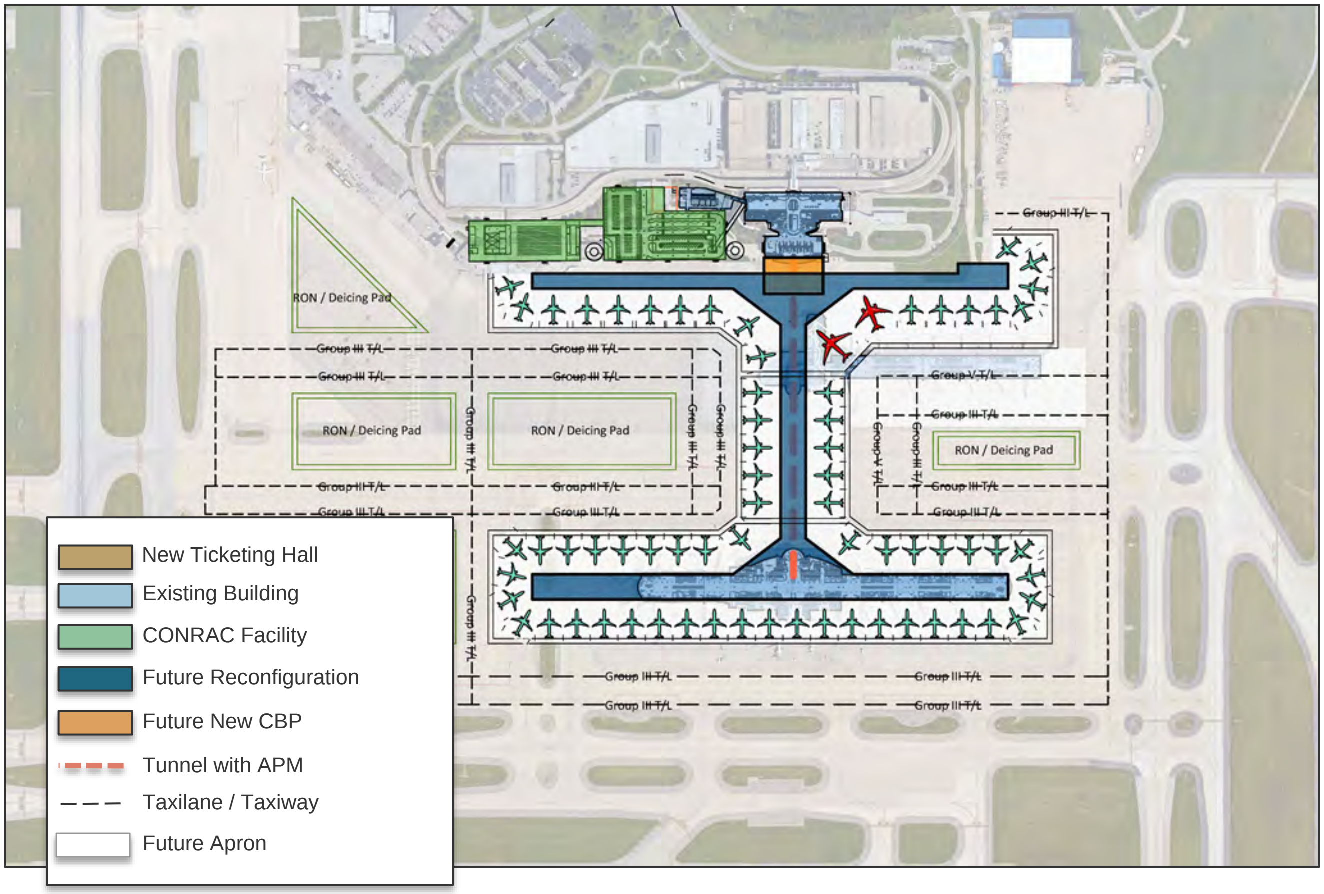
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.3-19 CONCEPT 1-3



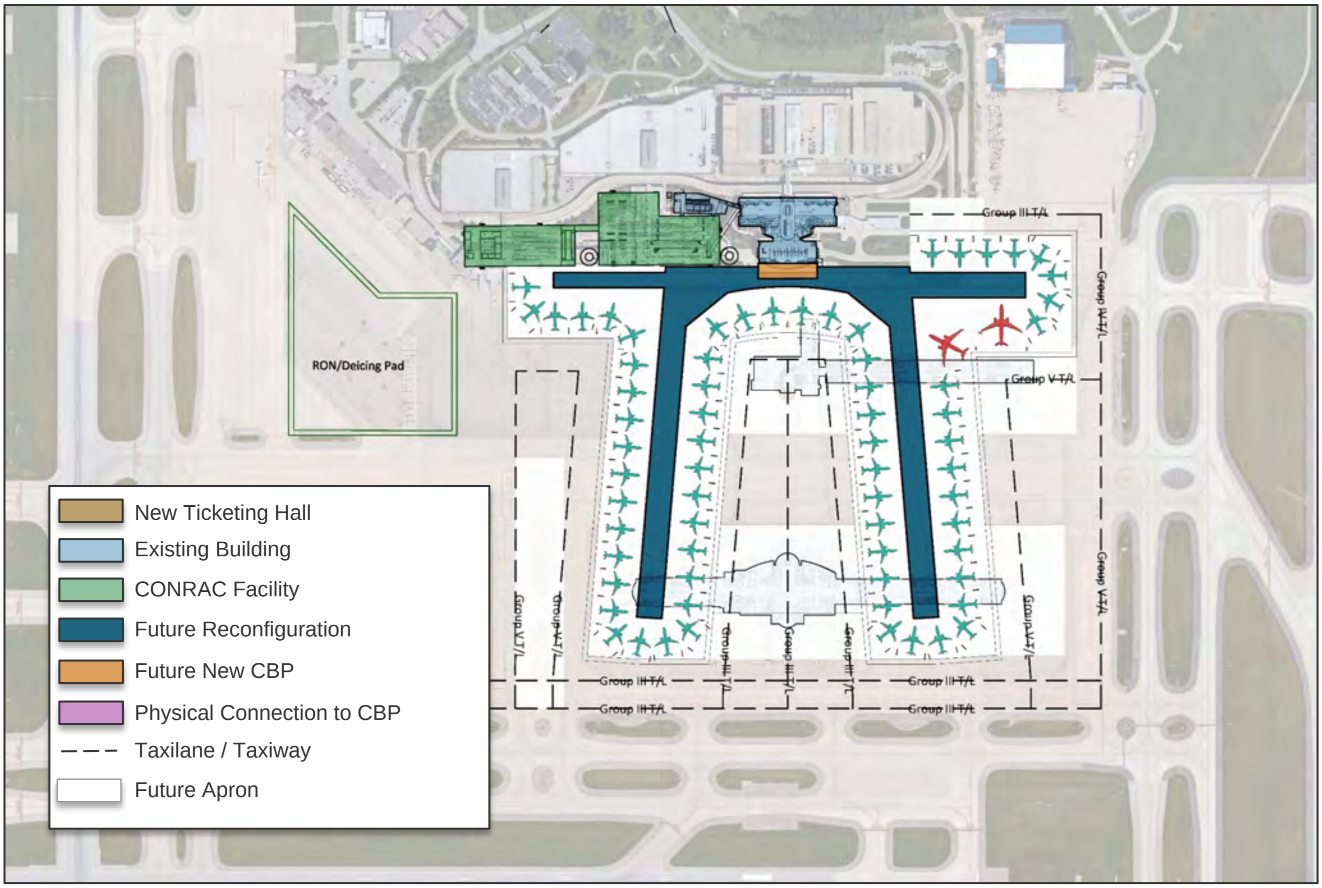
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.3-20 CONCEPT 2-1



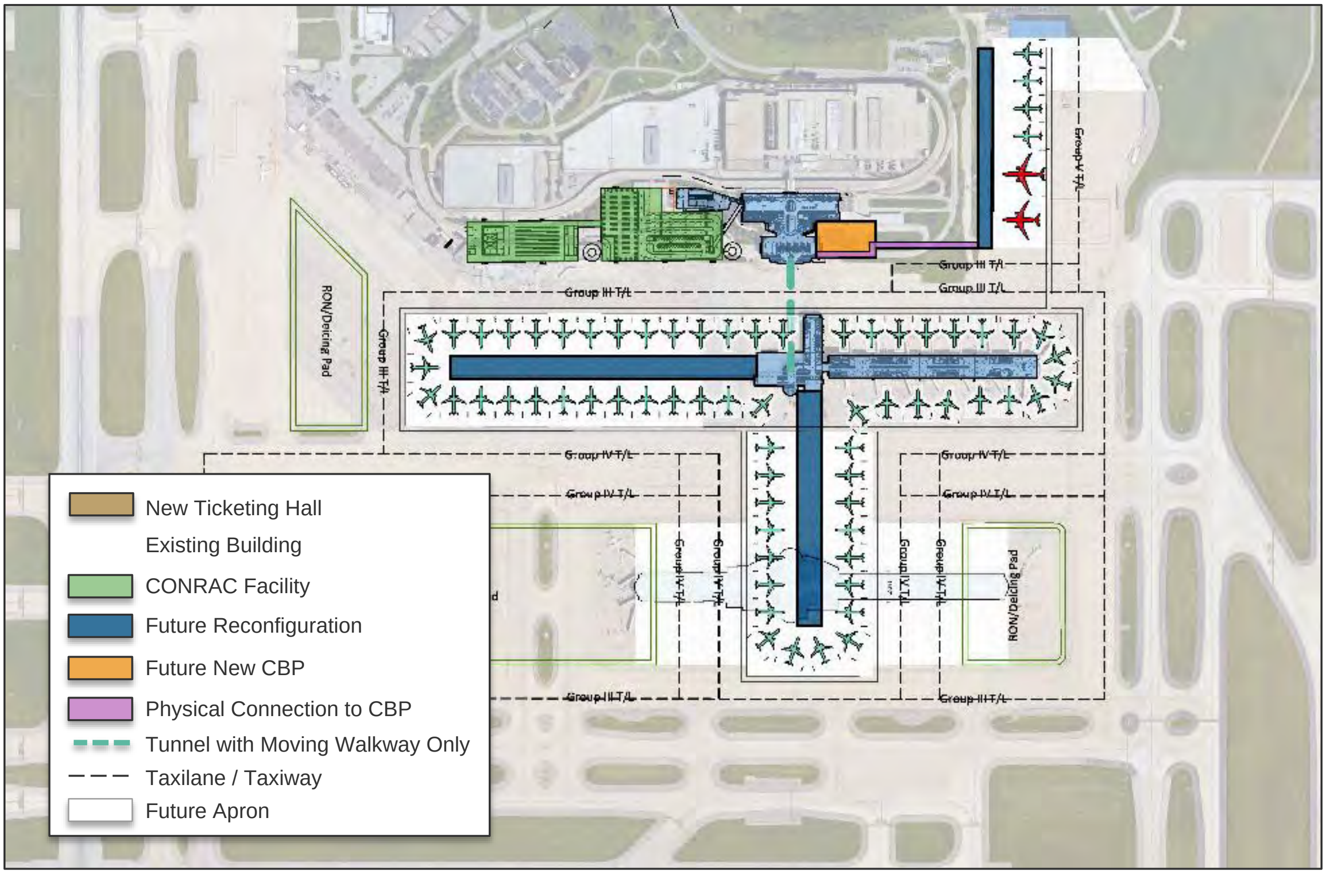
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.3-21 CONCEPT 2-2



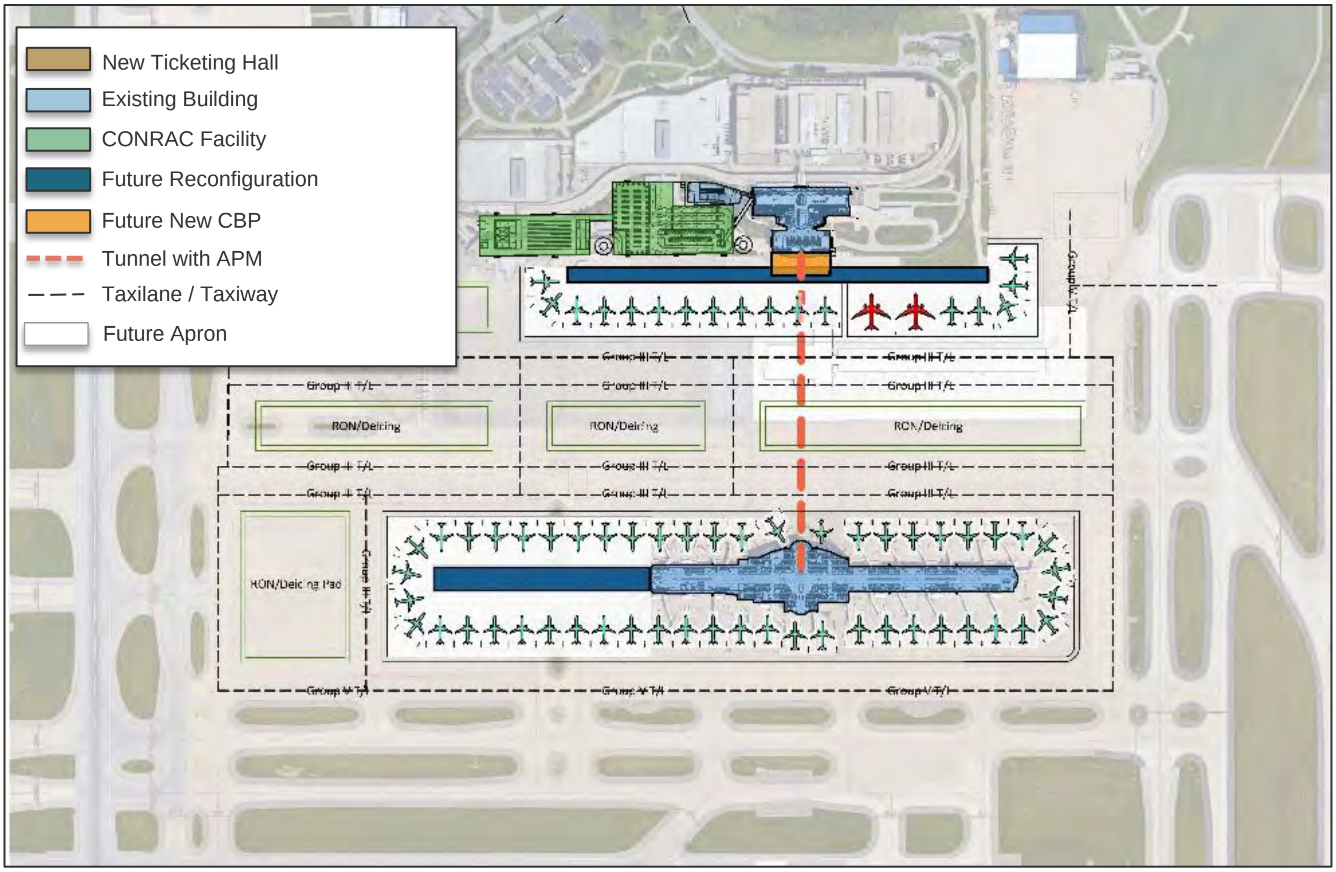
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.3-22 CONCEPT 3-1



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.3-23 CONCEPT 4-2



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.3.4.2 Level 2 Evaluation

The metrics used for the evaluation of the six shortlisted concepts in Level 2 were developed specifically for the Level 2 evaluation process. This set of metrics, while loosely based on criteria established in Level 1, are separate from the evaluation completed in Level 1 and all six concepts were evaluated from an equal starting point. The Level 2 evaluation metrics begin to capture the additional level of detail and understanding that was developed as part of the Level 2 refinements.

Level 2 Evaluation Metrics

All metrics used in the Level 2 evaluation were quantifiable in some manner and were defined as follows:

- Airside
  - **Airside Operations**: The percent of gates with dependent aircraft pushback operations
  - **Pushback Flexibility**: The percent of gates supported by a single taxilane
  - **Airside Circulation**: The number of east/west taxilanes usable for simultaneous ADG III or greater taxi operations

- **Taxi Distance**: The average aircraft taxi distance from gate to departure runway ends
- **RON/Deicing Areas**: The number of RON/deicing positions and distance of RON/deicing from the aircraft parking positions at the concourse

▪ Baggage Handling System

- **BHS System Complexity**: The count of separate baggage make-up location(s), and the baggage conveyor length

▪ Terminal

- **Passenger Journey**: The average and maximum walking distances and the number of level changes required for departing passengers
- **International Passenger Flows**: The maximum walking distance from the international capable gates to the terminal curbfront
- **Future Flexibility**: The largest percentage of the total gates that are directly adjacent to one another on a single concourse

▪ Financial

- **Capital Cost**: The estimated cost based on the square feet of building construction/ refurbishment and the square yards of new apron pavement required (not inclusive of future main terminal expansion)
- **O&M Cost**: Assessment of the number of escalators, the square feet of concourse re-use area, and if the APM is operational
- **Revenue Enhancement**: The maximum number of aircraft gate positions adjacent to or beyond a single concession node such that passenger footfall is concentrated and the maximum number of gate positions within 1,500 feet of a concession node

▪ Implementation

- **Phasing**: The number of replacement gates built during construction and the number of construction phases
- **Project "Off-Ramps"**: The number of compatible ultimate concourse concepts during the first phases of construction and an assessment of the number of potential non-functional gates if the concept is only partially built

Level 2 Evaluation Weighting

Similar to the Level 1 evaluation, the evaluation metrics in Level 2 needed to capture the varying level of importance of each. To that end, a weighting system was applied to each evaluation metric score. This new weighting system, while similar to the system used in Level 1, begins to add additional importance to financial considerations, phasing and overall flexibility. These new weighting values also reflect the additional level of detail understood for each shortlisted concept. **Table 5.3-4, *Level 2 Evaluation Metric Weighting***, presents the weighting applied to each metric in the Level 2 Evaluation process.

TABLE 5.3-4 LEVEL 2 EVALUATION METRIC WEIGHTING

Metric	Weight
Airside	
Airside Operations	2%
Pushback Flexibility	5%
Airside Circulation	5%
Taxi Distance	2%
RON/Deicing	2%
Baggage Handling System	
BHS Complexity	12%
Terminal	
Passenger Journey	10%
International Passenger Flows	10%
Future Flexibility	3%
Financial	
Capital Costs	12%
O&M Costs	12%
Revenue Enhancement	2%
Implementation	
Difficulty of Phasing	8%
Project “Off-Ramps”	15%
	100%

Source: Landrum & Brown analysis

Level 2 Evaluation Scoring

The Level 2 evaluation process began with all six shortlisted concepts being considered equal having not carried over the evaluation results from Level 1. The primary difference beyond the metrics used are that all evaluation at this level was quantifiable. The evaluation of each concept for each metric was also not comparative, but an actual score based on the performance of the concept. Therefore, it is possible for all six concepts to score the same if they perform similarly. Based on the performance of the concept, each concept was given a score ranging from -2 to +2. When it made sense to do so, 0 was centered on existing conditions at CVG. In that case, a concept that improves upon the existing condition will receive a positive score while a concept that degrades from existing conditions will receive a negative score.

To begin the process of the Level 2 evaluation, the Master Plan team began with a holistic evaluation of the six shortlisted concepts. This resulted in the grouping of the six concepts into two basic families: concepts that proposed some kind of a satellite concourse (1-1, 1-3, 3-1, and 4-2), and concepts that moved away from satellite concourses (2-1 and 2-2). The next step in the Level 2 evaluation then aimed to determine which concept from each basic family was the best to carry forward based on the scoring outlined above. To that end, the scores of each concept within each basic family were compared with the highest scoring concept being recommended to continue to Level 3.

Table 5.3-5, *Level 2 Evaluation Matrix*, presents the scoring and results of the Level 2 evaluation. **Exhibits 5.3-24** through **5.3-39** present the quantification of each of the evaluation metrics that resulted in the scoring for the Level 2 evaluation process.

The results of this analysis indicate that Concept 4-2 is the highest scoring satellite option, and that Concept 2-1 is the highest scoring non-satellite option. Both concepts are recommended to be carried forward for Level 3 refinement and evaluation. Concept 4-2 performs well on the airside metrics with the only negative scores being for passenger journey and O&M costs. Concept 2-1 performs better on capital costs and implementation/phasing than Concept 2-2.

TABLE 5.3-5 LEVEL 2 EVALUATION MATRIX

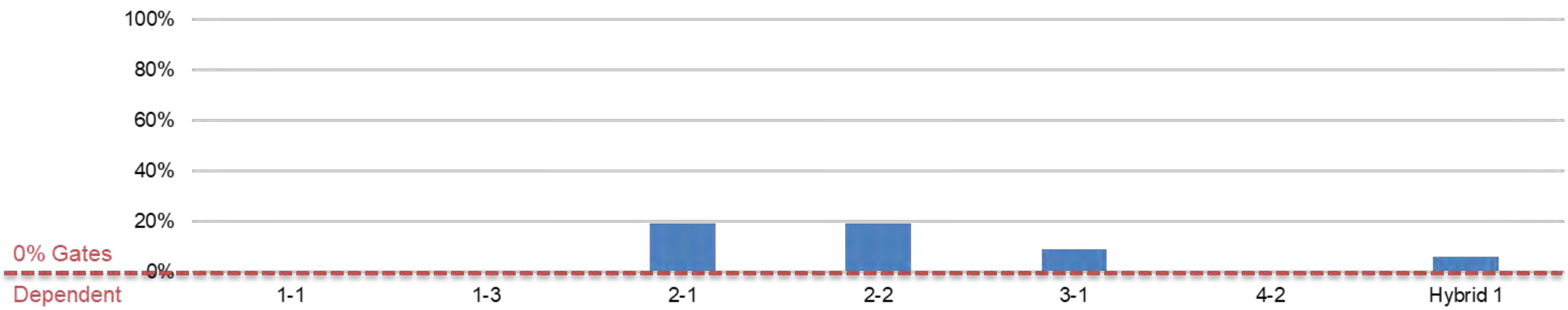
Metric	Satellite Concepts					Non-Satellite Concepts	
	1-1	1-3	3-1	4-2		2-1	2-2
Airside							
Airside Operations	0	0	-1	0		-2	-2
Pushback Flexibility	-1	0	1	1		2	2
Airside Circulation	0	0	-2	1		-2	-2
Taxi Distance	-1	0	-1	0		-2	-2
RON/Deicing	-1	1	0	2		1	-2
Baggage Handling System							
BHS Complexity	0	0	1	1		2	2
Terminal							
Passenger Journey	-1	0	-2	-1		1	0
International Passenger Flows	1	1	1	2		2	2
Future Flexibility	0	0	2	1		2	2
Financial							
Capital Costs	2	2	0	1		-1	-2
O&M Costs	-2	-2	1	-1		-1	2
Revenue Enhancement	0	0	2	1		2	2
Implementation							
Difficulty of Phasing	2	2	1	1		0	-2
Project “Off-Ramps”	1	1	-1	1		1	1
Total Score	**.22**	**.43**	**.08**	**.64**		**.49**	**.41**

Source: Landrum & Brown analysis

EXHIBIT 5.3-24 AIRSIDE OPERATIONS

Dependent Gates

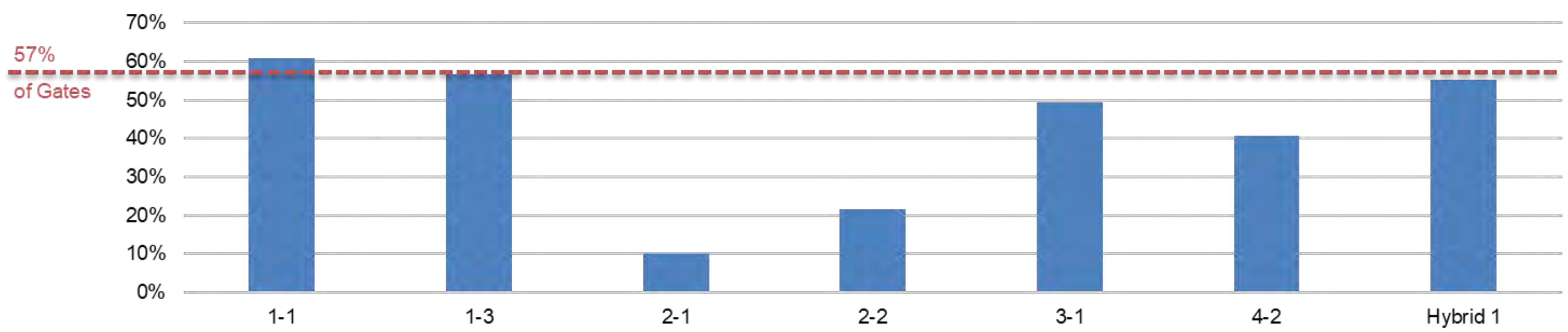
	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
Dependent Gate %	0%	0%	19%	19%	9%	0%	6%



Source: Landrum & Brown analysis

EXHIBIT 5.3-25 PUSHBACK FLEXIBILITY

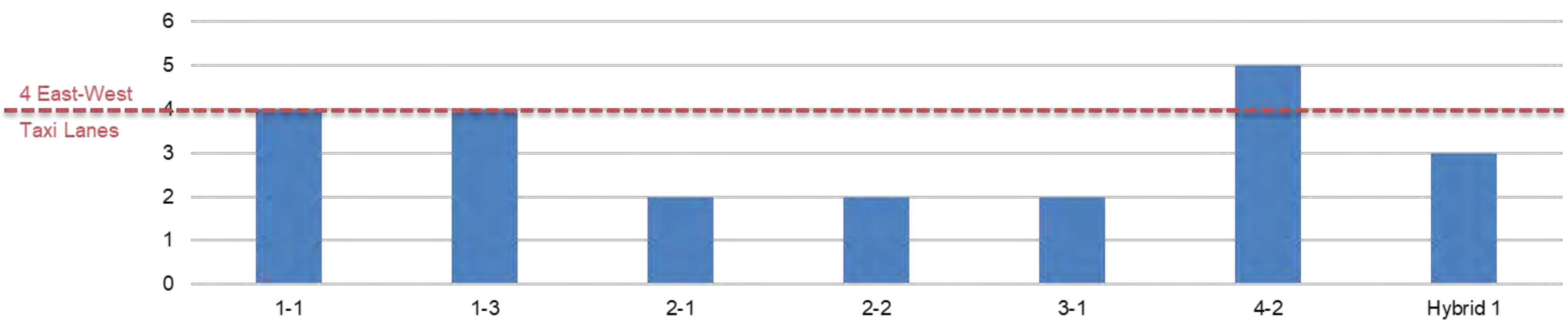
	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
% of Gates with 1 Pushback Taxilane	61%	57%	10%	22%	49%	41%	55%



Source: Landrum & Brown analysis

EXHIBIT 5.3-26 AIRSIDE CIRCULATION

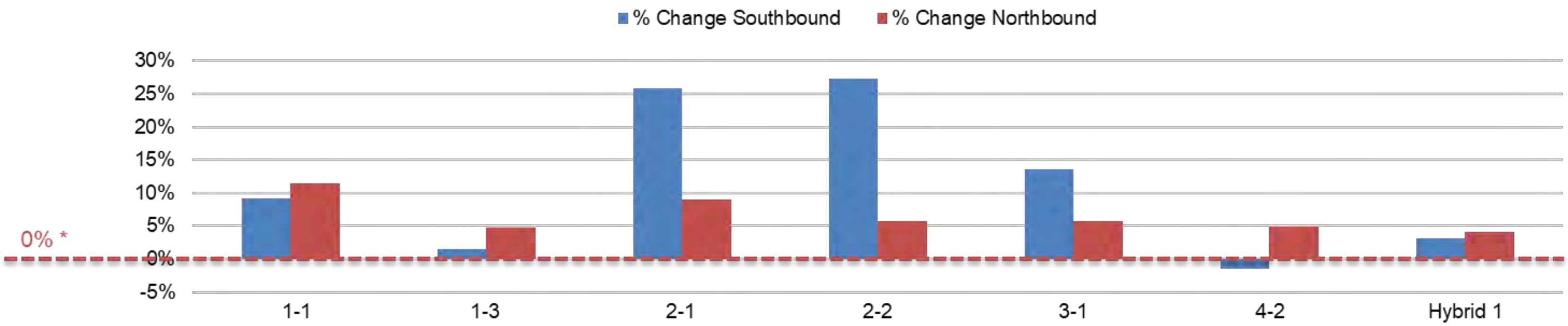
	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
# of East - West Taxi Lanes	4	4	2	2	2	5	3



Source: Landrum & Brown analysis

EXHIBIT 5.3-27 TAXI DISTANCE

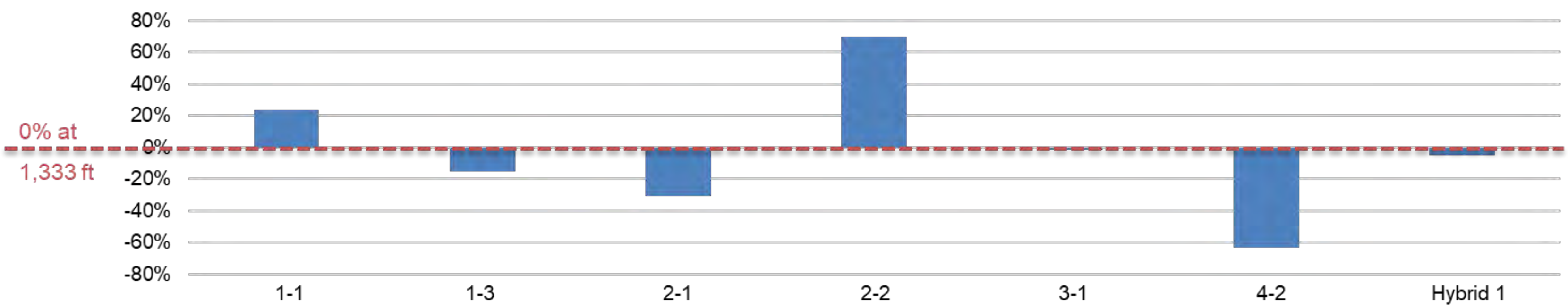
	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
Average 18C/18L	9%	2%	26%	27%	14%	-2%	3%
Average 36C/36R	12%	5%	9%	6%	6%	5%	4%



Source: Landrum & Brown analysis

EXHIBIT 5.3-28 RON/DEICING AREAS

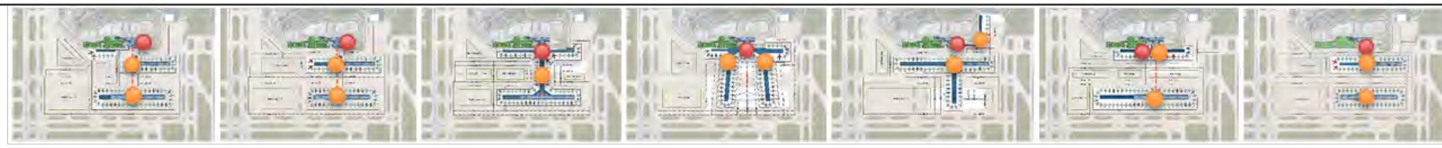
	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
% Change in Average RON Distance to Gate	24%	-24%	-31%	70%	-2%	-63%	1



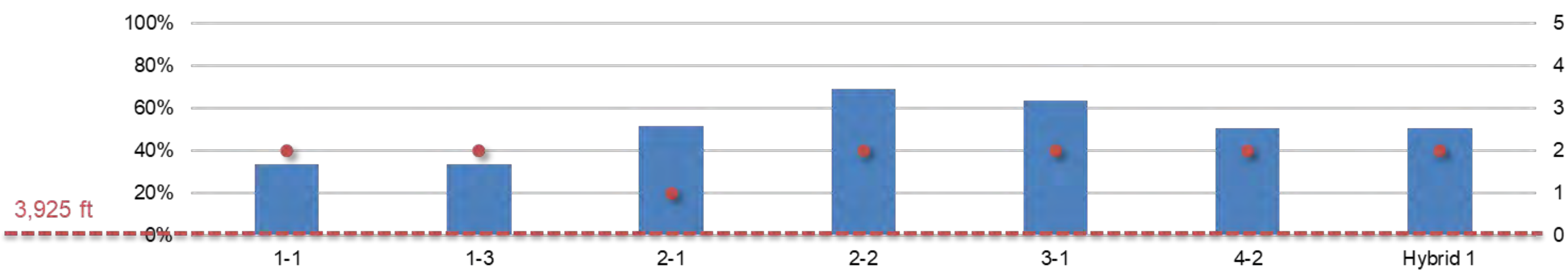
Source: Landrum & Brown analysis

EXHIBIT 5.3-29 BAGGAGE HANDLING SYSTEM

Bag makeup
CBIS

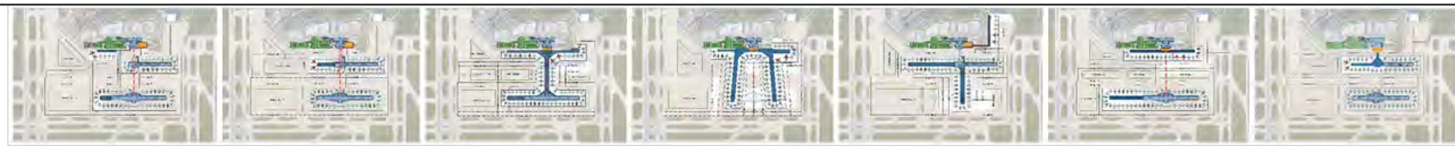


	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
# of Bag Makeup	2	2	1	2	2	2	2
MAX Belt Length	2,610 ft	2,610 ft	1,900 ft	1,230 ft	1,430 ft	1,950 ft	1,950 ft
% Improvement	34%	34%	52%	69%	64%	50%	50%

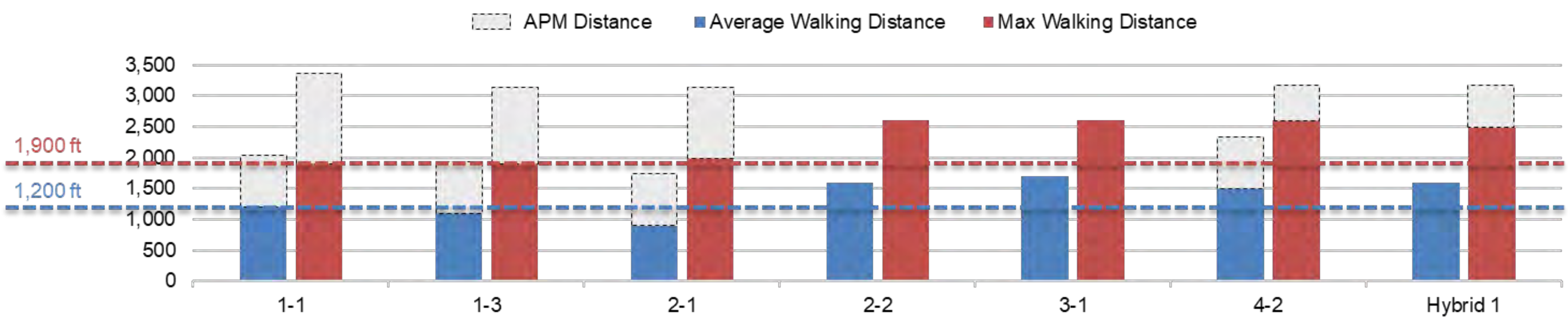


Source: Landrum & Brown analysis

EXHIBIT 5.3-30 PASSENGER JOURNEY – WALKING DISTANCES



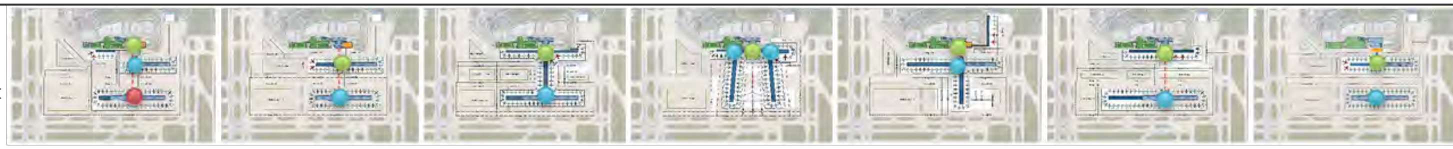
	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
Average Walking Distance	1,200 ft	1,100 ft	900 ft	1,600 ft	1,700 ft	1,500 ft	1,600 ft
Max Walking Distance	1,900 ft	1,900 ft	2,000 ft	2,600 ft	2,600 ft	2,600 ft	2,500 ft



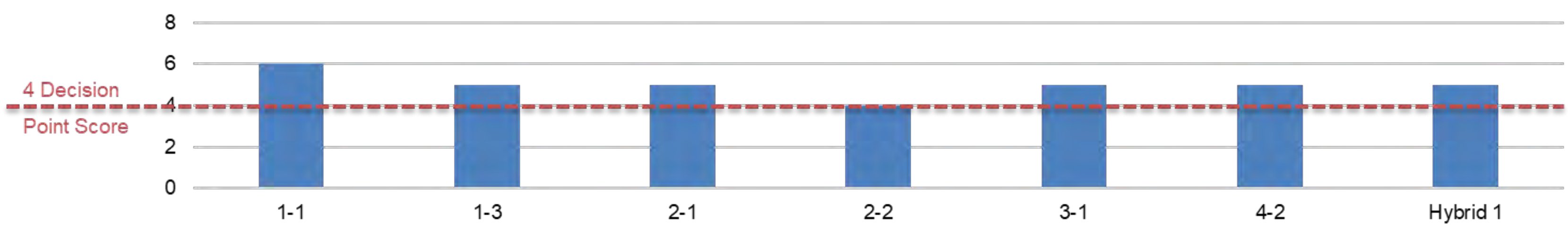
Source: Landrum & Brown analysis

EXHIBIT 5.3-31 PASSENGER JOURNEY – DECISION POINTS

1st Decision Point
2nd Decision Point
3rd Decision Point



	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
# of choices at 1st decision point	2	3	3	2	2	3	3
# of choices at 2nd decision point	2	2	2	2	3	2	2
# of choices at 3rd decision point	2	-	-	-	-	-	-
Decision Point Score	**6**	**5**	**5**	**4**	**5**	**5**	**5**

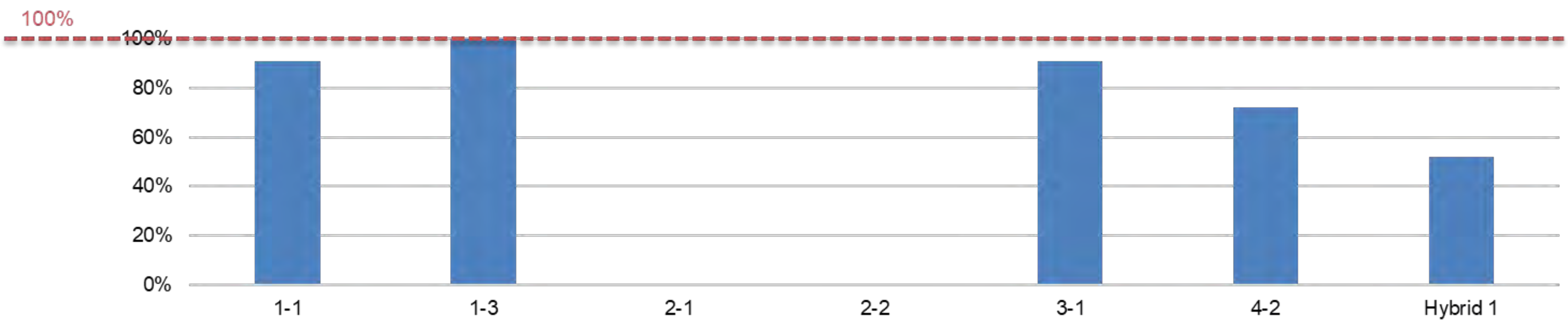


Source: Landrum & Brown analysis

EXHIBIT 5.3-32 PASSENGER JOURNEY – LEVEL CHANGES

Gate with level change

	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
% of Gates with Level change	91%	100%	0%	0%	91%	72%	52%

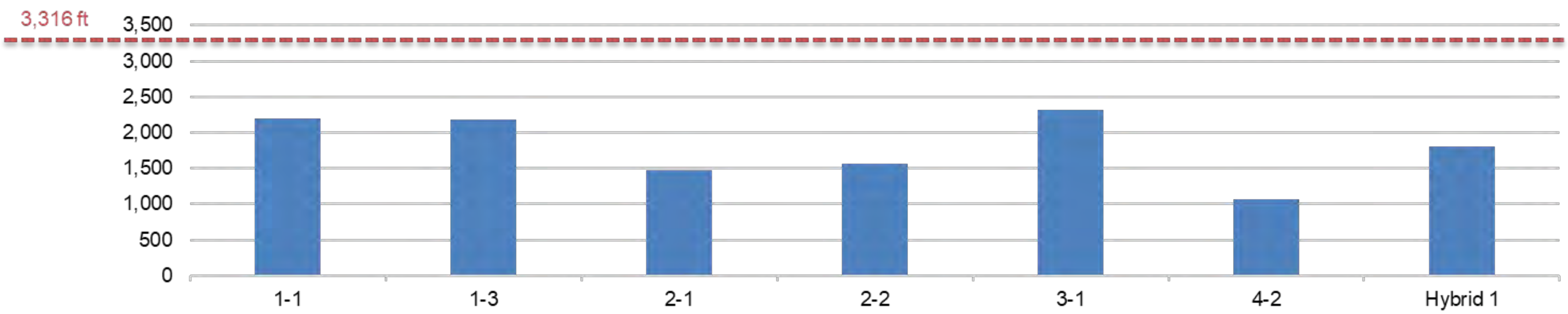


Source: Landrum & Brown analysis

EXHIBIT 5.3-33 INTERNATIONAL PASSENGER FLOWS

Maximum Int'l Arrival Walking Distance

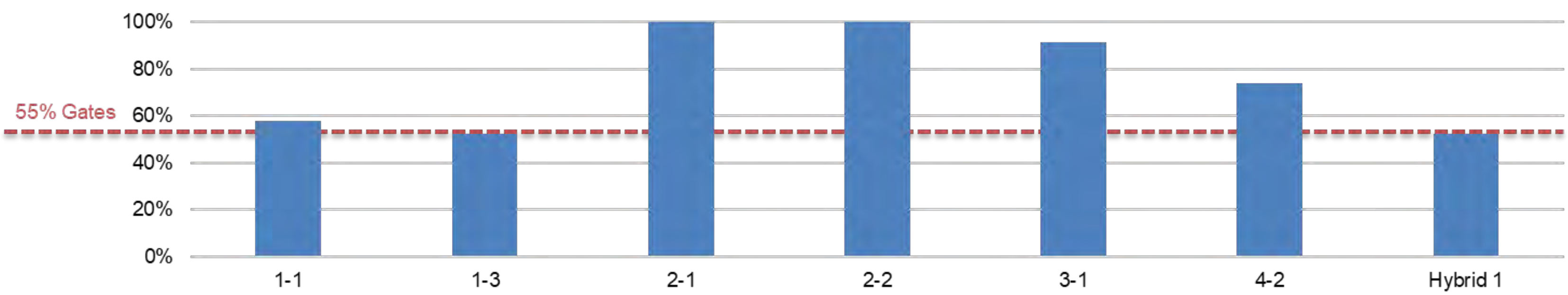
	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
Distance from furthest int'l gate to Curbfront	2,189 ft	2,175 ft	1,477 ft	1,565 ft	2,320 ft	1,058 ft	1,810 ft



Source: Landrum & Brown analysis

EXHIBIT 5.3-34 FUTURE FLEXIBILITY

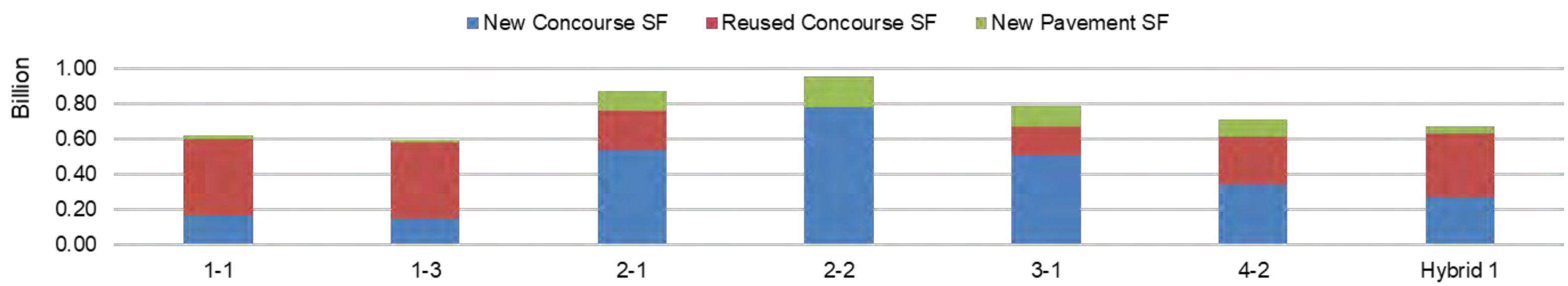
	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
% of contiguous gates	58%	52%	100%	100%	91%	74%	52%



Source: Landrum & Brown analysis

EXHIBIT 5.3-35 CAPITAL COSTS

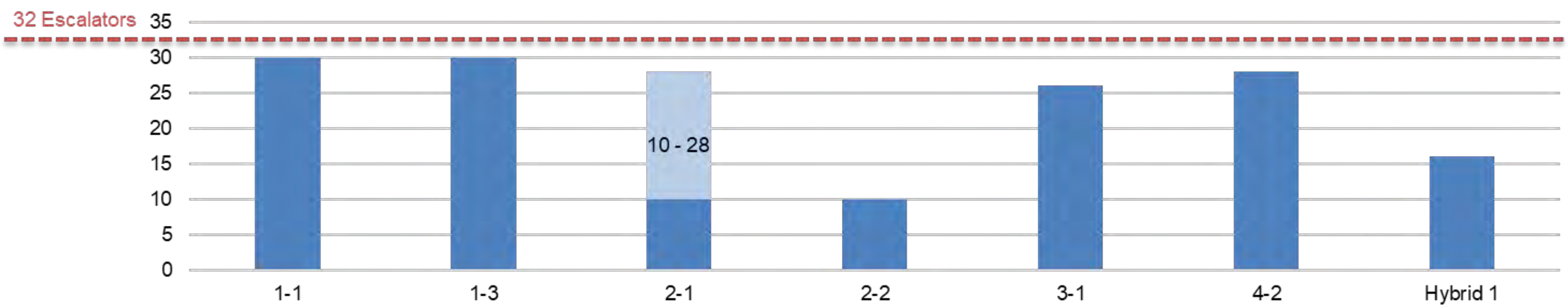
	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
New Concourse	0.17	0.15	0.53	0.78	0.51	0.34	0.27
Reused Concourse	0.43	0.43	0.23	0.00	0.17	0.27	0.36
New Pavement	0.02	0.01	0.11	0.17	0.11	0.10	0.03
Total (Billion)	**0.62**	**0.59**	**0.87**	**0.95**	**0.78**	**0.71**	**0.67**



Source: Landrum & Brown analysis

EXHIBIT 5.3-36 O&M COSTS – ESCALATORS

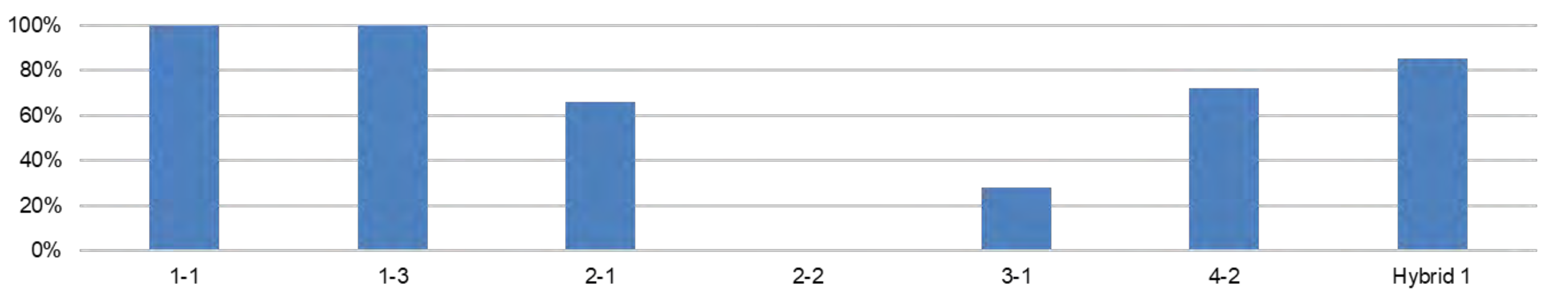
	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
Escalator #	30	30	10 or 28	10	26	28	16



Note: Assumes existing Concourse A/B escalators are still in use (2-1/4-2 will see a reduction in escalators).
Source: Landrum & Brown analysis

EXHIBIT 5.3-37 O&M COSTS – INFRASTRUCTURE RE-USE

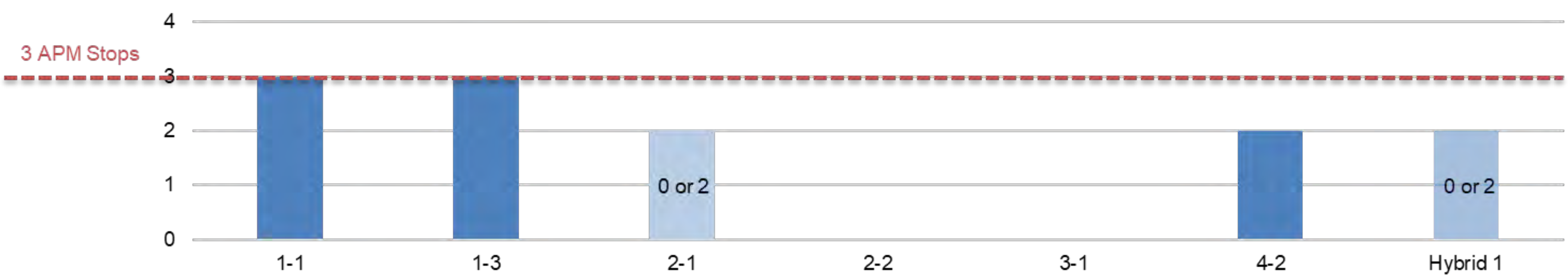
	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
Concourse Re-Use Area (SF)	1,245,000	1,245,000	819,000	0	350,000	895,000	1,059,000
% Re-Use of Existing	**100%**	**100%**	**66%**	**0%**	**28%**	**72%**	**85%**



Source: Landrum & Brown analysis

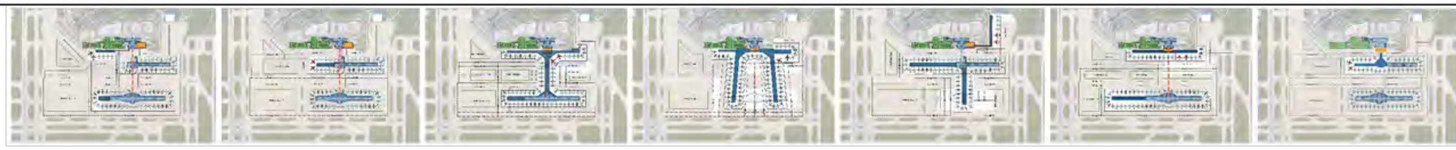
EXHIBIT 5.3-38 O&M COSTS – APM

	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
# of APM Stops	3	3	0 or 2	0	0	2	0 or 2

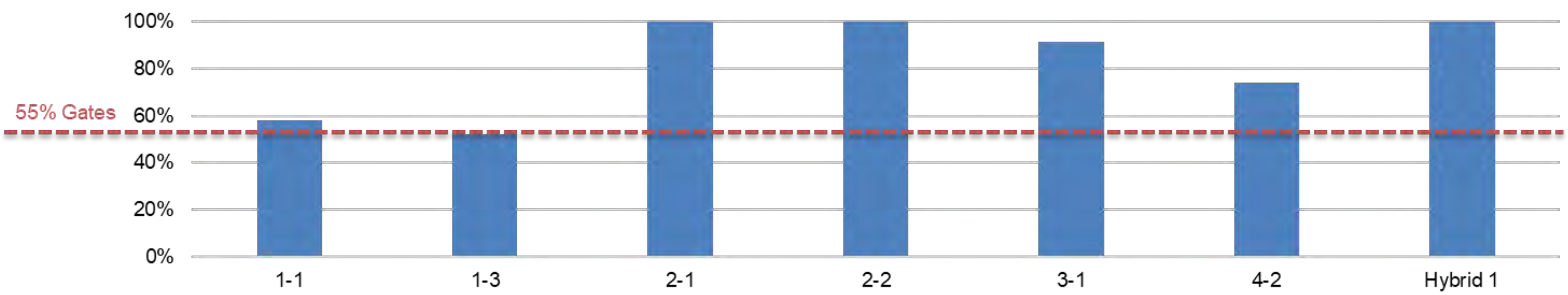


Source: Landrum & Brown analysis

EXHIBIT 5.3-39 REVENUE ENHANCEMENT



	1-1	1-3	2-1	2-2	3-1	4-2	Hybrid 1
Max gate % beyond a concession node	58%	52%	100%	100%	91%	74%	100%



Source: Landrum & Brown analysis

Level 2 Evaluation Recommendation

The objective of Level 2 evaluation was to recommend a pair of concepts to be carried forward for the Level 3 refinement and evaluation. Both Concepts 2-1 and 4-2 are recommended to be carried forward for Level 3 refinements and modeling. In the ultimate configuration, either concept achieves all primary terminal planning objectives:

- **International Arrivals**: Improve the international arrivals process for passengers arriving at CVG internationally to eliminate the need to be re-screened and have to re-check baggage to access the landside curbfront.
- **Baggage Handling System**: Facilitate the improvement/replacement of the existing BHS to allow for a more efficient and reliable operation that eliminates unnecessary complexities.
- **Main Terminal Expansion**: Allow for the logical and incremental expansion of the main terminal building and processors to accommodate the increased levels of O&D passengers that CVG is currently experiencing and projected to experience in the future.
- **Revenue Enhancement**: Maximize the revenue generation potential of the passenger terminal facilities through passenger routing and the use of centralized concessions.

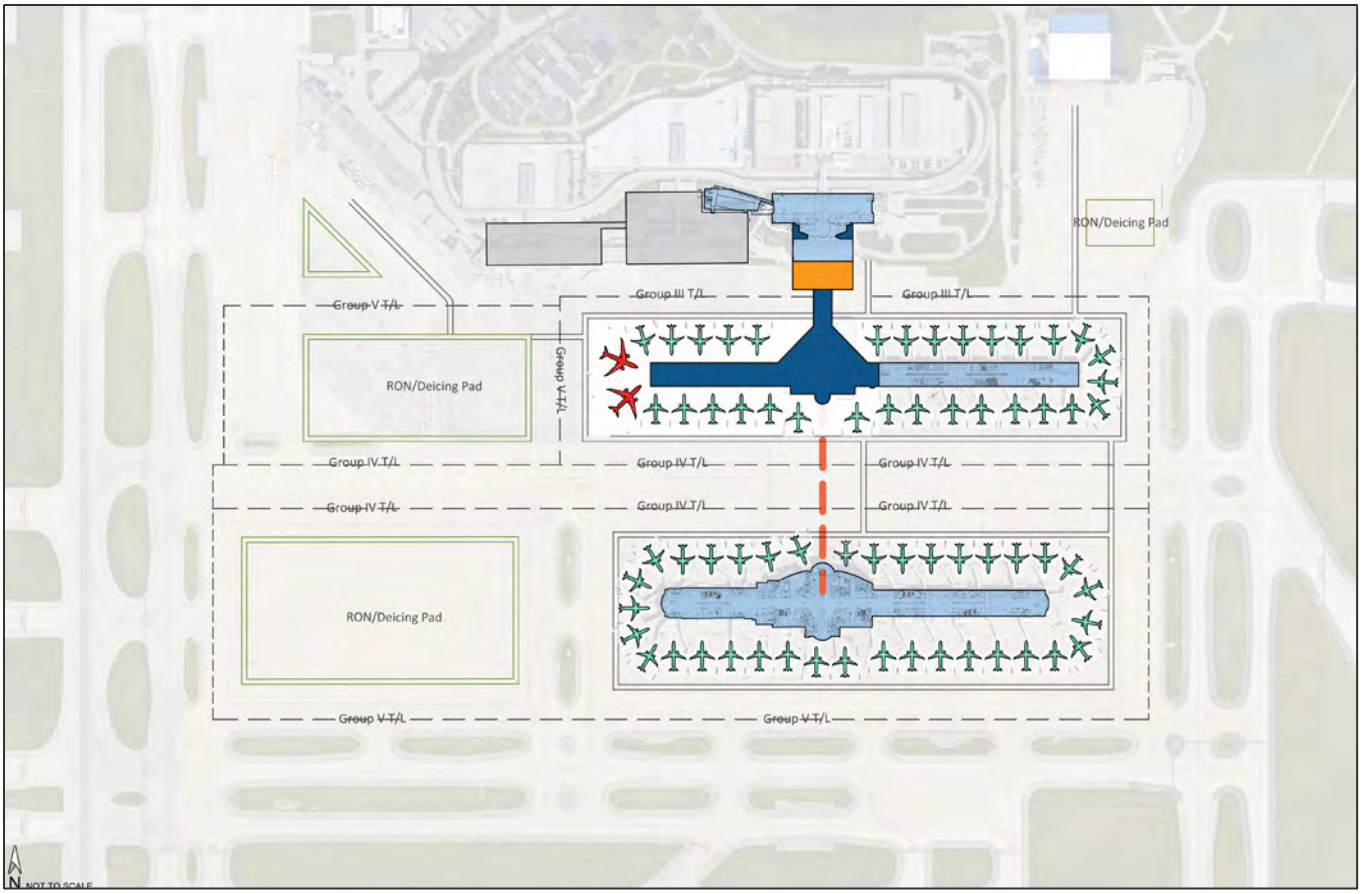
While both concepts facilitate meeting the primary terminal planning objectives in their ultimate configuration, implementation based on gate demand would defer achieving those objectives to later in the planning period. Because of this, the Master Plan team sought to configure the early phases of development to achieve the primary objectives sooner.

A hybrid concept of maintaining the existing alignment of Concourses A and B while connecting Concourse A to the main terminal via a connector structure was developed. **Exhibit 5.3-40, *Hybrid Concept***, present the configuration of the hybrid concept. This concept allows for the each of the primary objectives to be achieved in the first phase of terminal improvement. Accommodated within this connector are areas for reconfigured BHS, relocated FIS facilities, improved and expanded security checkpoints, and relocated KCAB office space.

Additional gate demand is provided through a combination of gate frontage realignment/optimization and a modest concourse extension to the western end of Concourse A. This hybrid concept allows for the double loading of Concourse A (parking aircraft on both sides of the building) which has the effect of minimizing the amount of additional building square footage required and thus reducing the capital cost.

Because of the accelerated timeframe to achieve the primary objectives and the expected reduction in capital costs, the Hybrid Concept was added to the Level 2 evaluation matrix to compare its performance against the six shortlisted concepts. **Table 5.3-6, *Level 2 Evaluation Matrix with Hybrid***, presents the Level 2 Evaluation Matrix with the scoring of the Hybrid Concept added. The results of this analysis indicate that the hybrid concept scores equally high as Concept 4-2. Therefore, the recommendation of the Level 2 evaluation is to carry forward only the Hybrid Concept for Level 3 refinements and evaluation.

EXHIBIT 5.3-40 HYBRID CONCEPT



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

TABLE 5.3-6 LEVEL 2 EVALUATION MATRIX WITH HYBRID

Metric	Satellite Concepts					Non-Satellite Concepts			Hybrid
	1-1	1-3	3-1	4-2		2-1	2-2		
Airside									
Airside Operations	0	0	-1	0		-2	-2		0
Pushback Flexibility	-1	0	1	1		2	2		0
Airside Circulation	0	0	-2	1		-2	-2		-1
Taxi Distance	-1	0	-1	0		-2	-2		0
RON/Deicing	-1	1	0	2		1	-2		0
Baggage Handling System									
BHS Complexity	0	0	1	1		2	2		1
Terminal									
Passenger Journey	-1	0	-2	-1		1	0		-1
International Passenger Flows	1	1	1	2		2	2		2
Future Flexibility	0	0	2	1		2	2		0
Financial									
Capital Costs	2	2	0	1		-1	-2		1
O&M Costs	-2	-2	1	-1		-1	2		0
Revenue Enhancement	0	0	2	1		2	2		2
Implementation									
Difficulty of Phasing	2	2	1	1		0	-2		2
Project “Off-Ramps”	1	1	-1	1		1	1		1
Total Score	**.22**	**.43**	**.08**	**.64**		**.49**	**.41**		**.64**

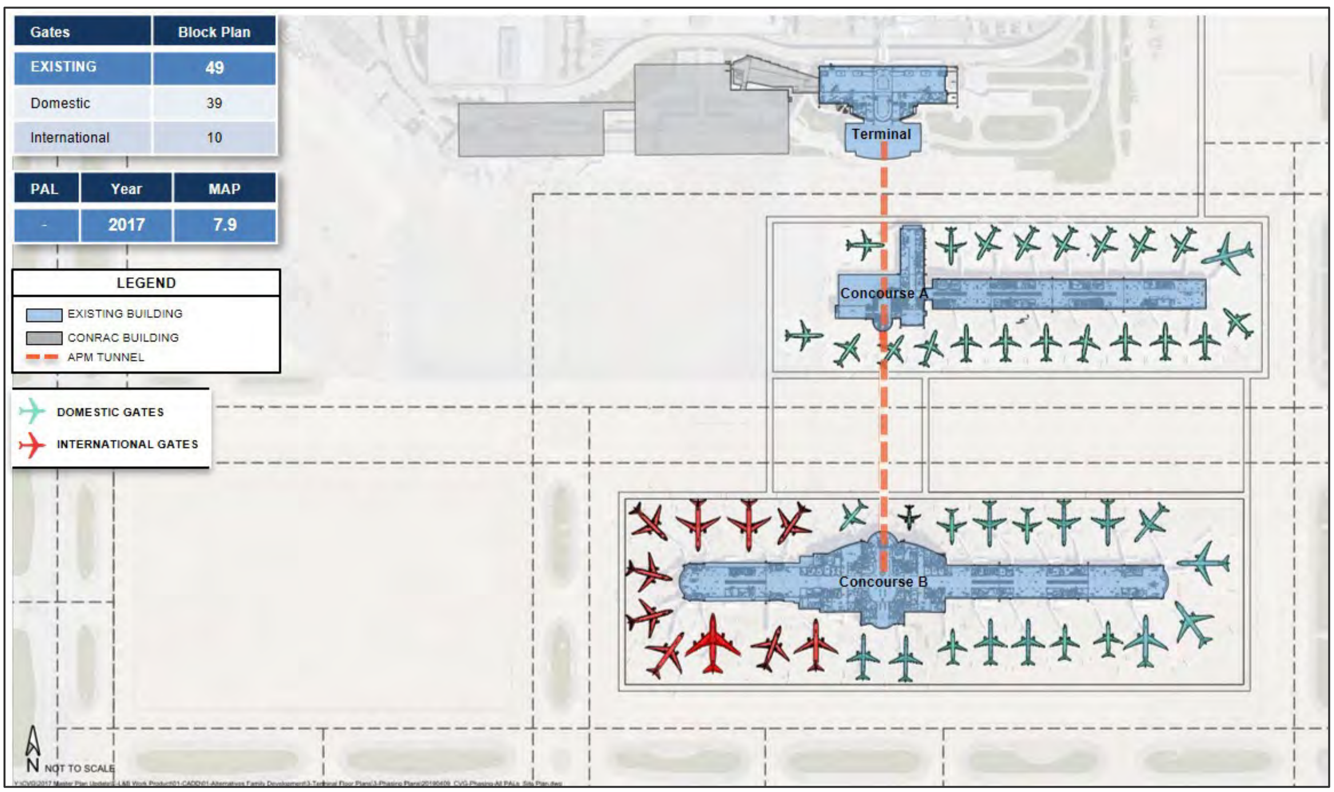
Source: Landrum & Brown analysis

5.3.5 Level 3 Concept Refinement

The objective of the Level 3 refinement was to develop conceptual floorplans for the Hybrid Concept in order to further define the allocation of passenger processing and terminal support functions for each level of the building. This section includes the building floorplans, sections, and passengers flows through the terminal and concourses.

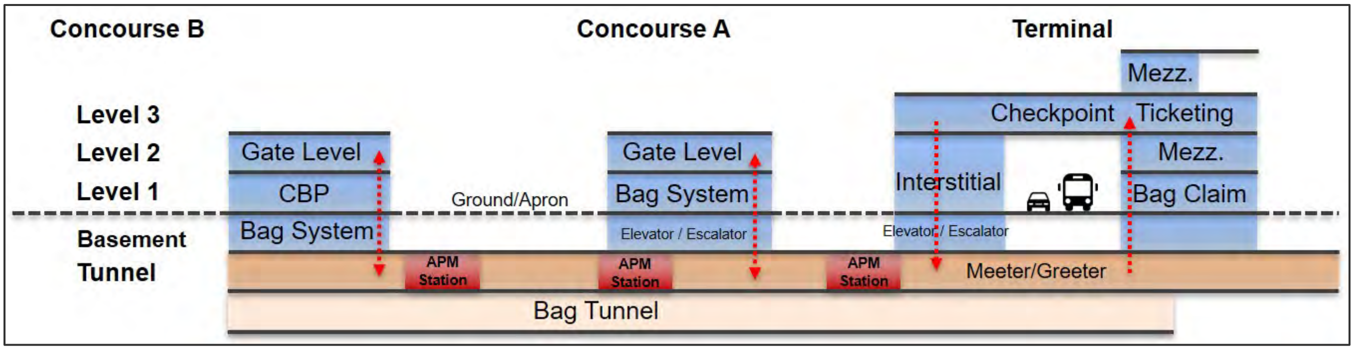
The existing site plan and building section shown on **Exhibit 5.3-41, *Existing Site Plan***, and **Exhibit 5.3-42, *Existing Building Section*,** allow for comparison to the PAL 4 improvements shown later in this section.

EXHIBIT 5.3-41 EXISTING SITE PLAN



Source: Landrum and Brown analysis

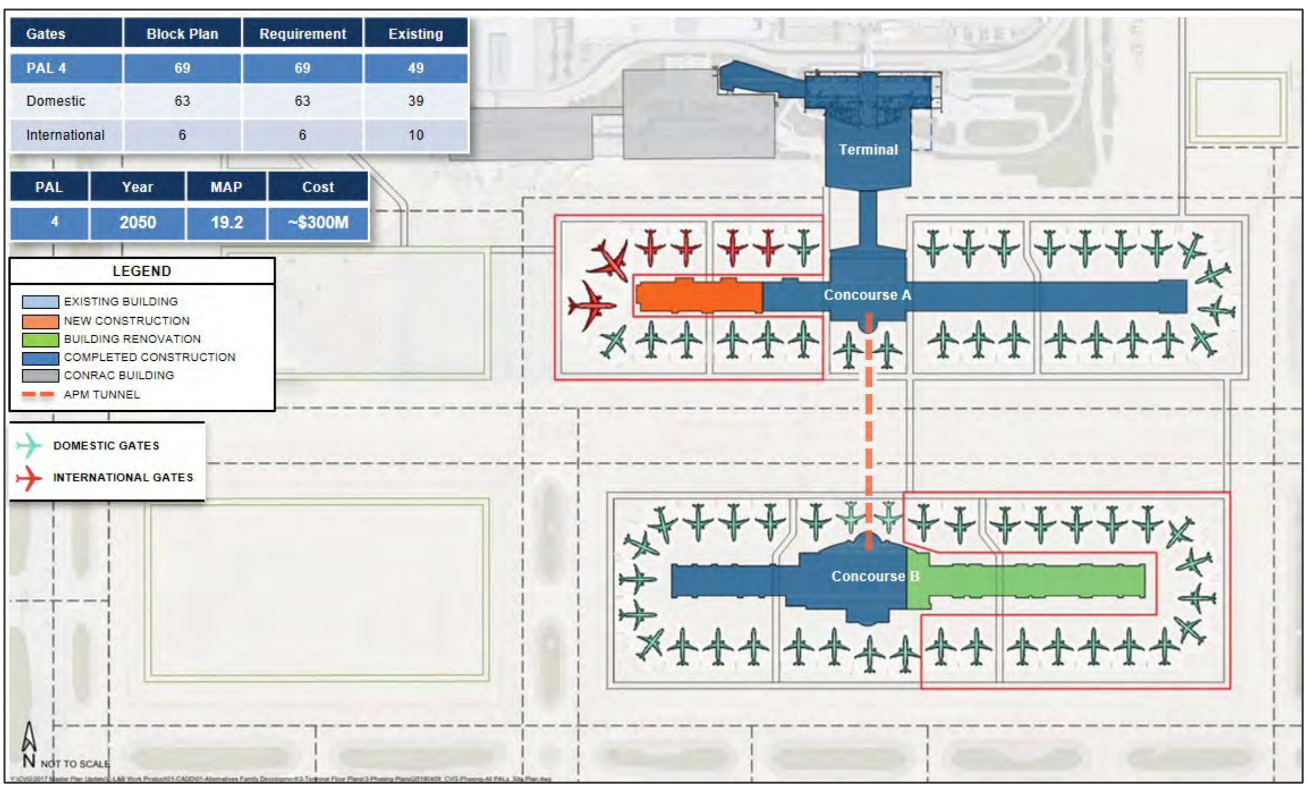
EXHIBIT 5.3-42 EXISTING BUILDING SECTION



Source: Landrum and Brown analysis

The PAL 4 site plan shown in **Exhibit 5.3-43, *PAL 4 Site Plan***, is a refined version of the Hybrid Concept that was selected as part of the evaluation process in the Level 2 evaluation. The site plan has been refined to optimize the building footprint and gate layout while meeting capacity requirements in a phased approach. This PAL 4 site plan is the final phase and represents the ultimate build-out of the terminal and concourses to meet 2050 demand.

EXHIBIT 5.3.43 PAL 4 SITE PLAN



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

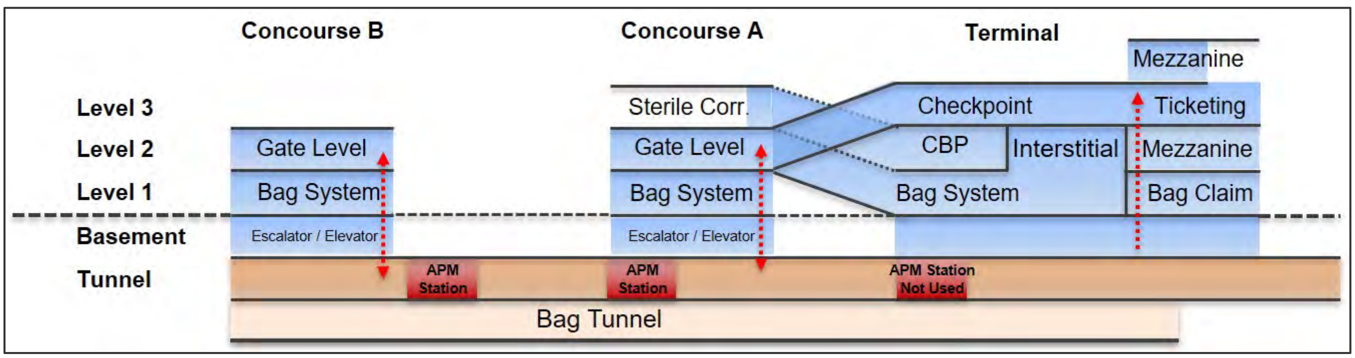
5.3.5.1 Building Section and Enlarged Floor Plans

The building section shown in **Exhibit 5.3-44, *PAL 4 Section***, represents a north to south cross-section through the center of the Main Terminal, Concourse A and Concourse B. This conceptual representation of the building levels shows each functional area of the building and can be compared to the existing building section shown in Exhibit 5.3-42, *Existing Building Section*. The most significant differences in PAL 4 include the following:

- A three-level building expansion to the south of the existing checkpoint
- A connector between the main terminal and Concourse A
- A sterile corridor connection from Concourse A to a new CBP facility

The connector is shown in the section as a series of exaggerated ramps that allow level changes to and from the main terminal and Concourse A for secure and sterile passengers as well as passengers exiting to baggage claim. The ramps will minimize the number of required escalators and elevators while allowing each passenger type to transition to and from the new terminal expansion.

EXHIBIT 5.3.44 PAL 4 SECTION

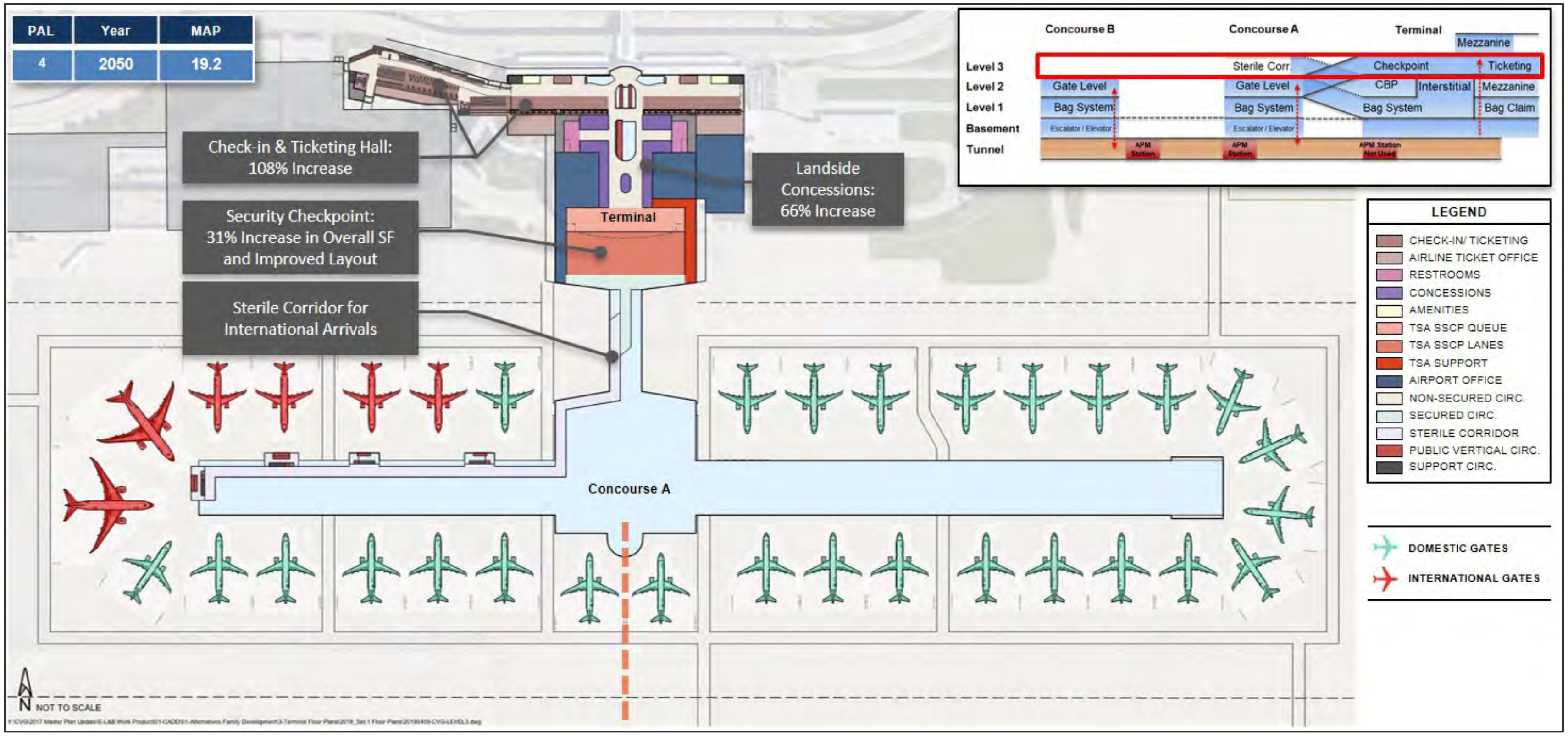


Note: All horizontal and vertical scales have been exaggerated.
Source: Landrum & Brown analysis

The enlarged floorplans shown on **Exhibit 5.3-45** through **Exhibit 5.3-50** show the following configuration of passenger and support functions per level:

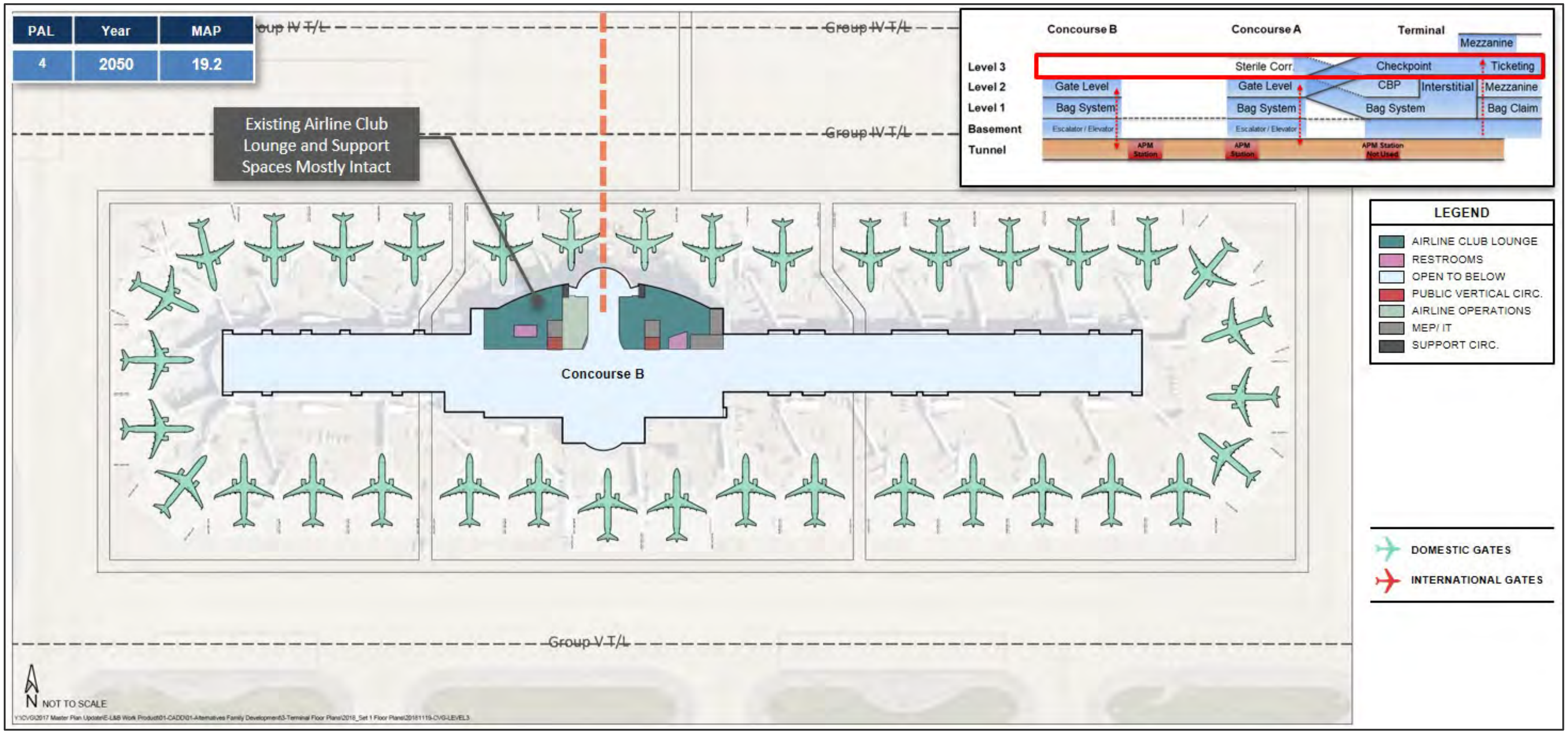
- Level 3 – Terminal and Concourse A
  - Security checkpoint relocated to new terminal expansion building
  - New landside terminal concessions program and new airport offices (repurpose old checkpoint)
  - Expanded ticketing lobbies as part of the CSB
  - New connector and ramp to Concourse A
- Level 3 – Concourse B
  - Total refresh of existing Level 3 functions such as airline clubs or support spaces
- Level 2 – Terminal and Concourse A
  - Relocated CBP international arrivals facility relocated new terminal expansion building
  - International baggage claim devices and sterile corridor access from Level 3 of Concourse B
  - New airport offices (additional building expansion)
  - Concourse A concession new and holdroom reconfiguration
- Level 2 – Concourse B
  - Total refresh of existing Level 2 functions and reconfiguration of holdrooms
- Level 1 – Terminal and Concourse A
  - Expanded domestic baggage claim devices and claim area
  - New inbound bag drop-off area in new terminal building expansion
  - New outbound bag make-up and screening in Concourse A reconfiguration
- Level 1 – Concourse B
  - Total refresh of existing Level 1 functions and reconfiguration of inbound and outbound bag systems
  - Removal of international arrivals processing

EXHIBIT 5.3-45 PAL 4 ENLARGED FLOOR PLAN – LEVEL 3 TERMINAL AND CONCOURSE A



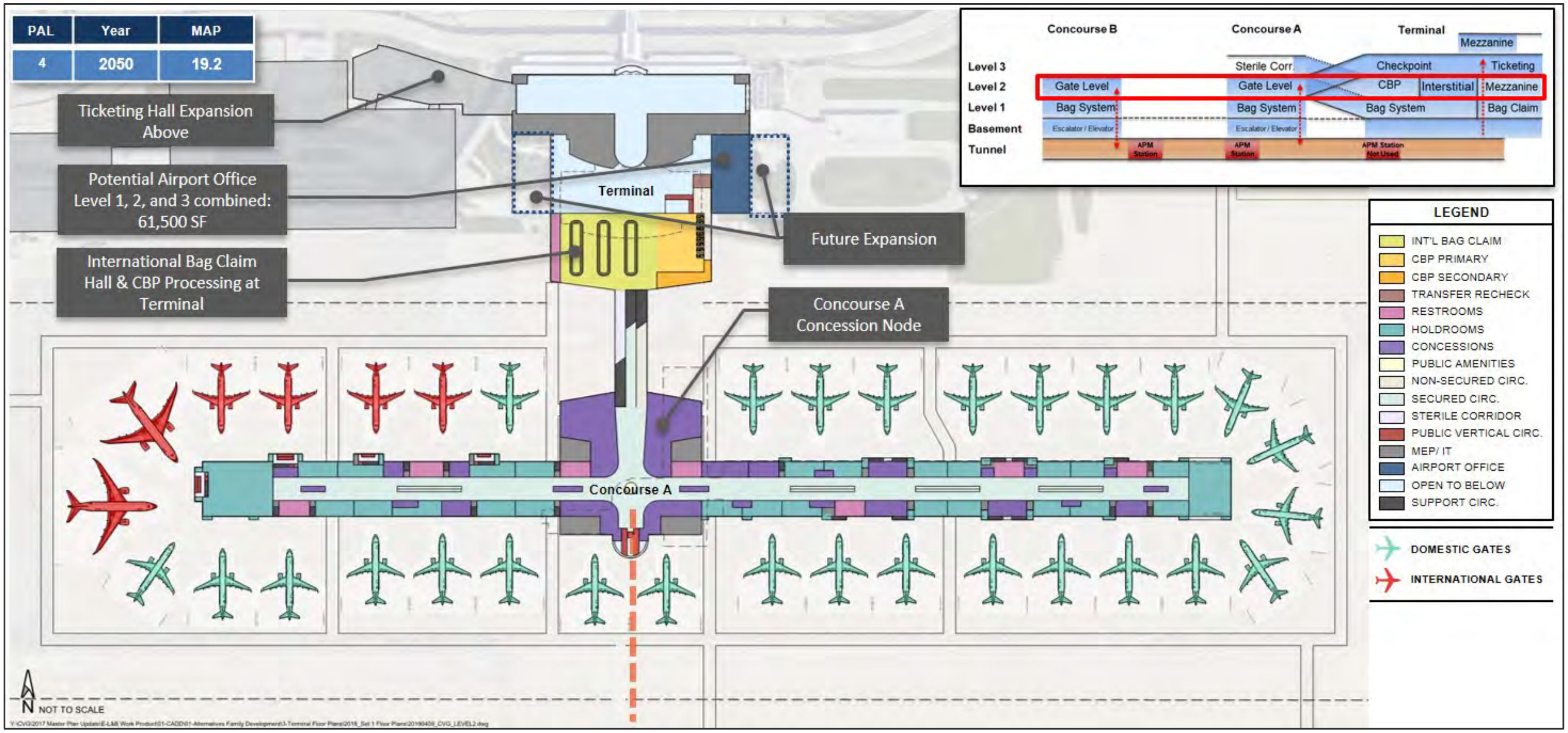
Sources: Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.3-46 PAL 4 ENLARGED FLOOR PLAN – LEVEL 3 CONCOURSE B



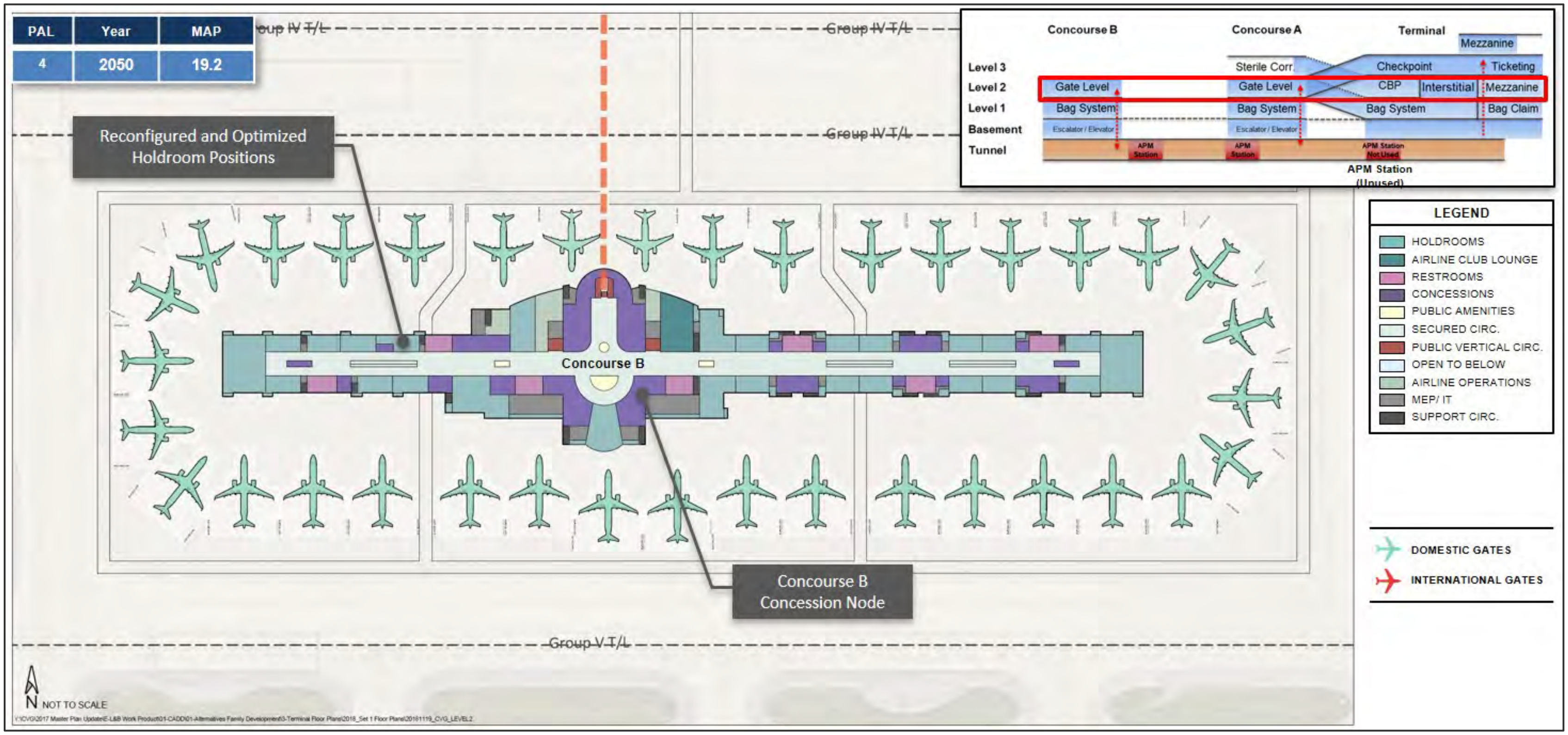
Sources: Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.3-47 PAL 4 ENLARGED FLOOR PLAN – LEVEL 2 TERMINAL AND CONCOURSE A



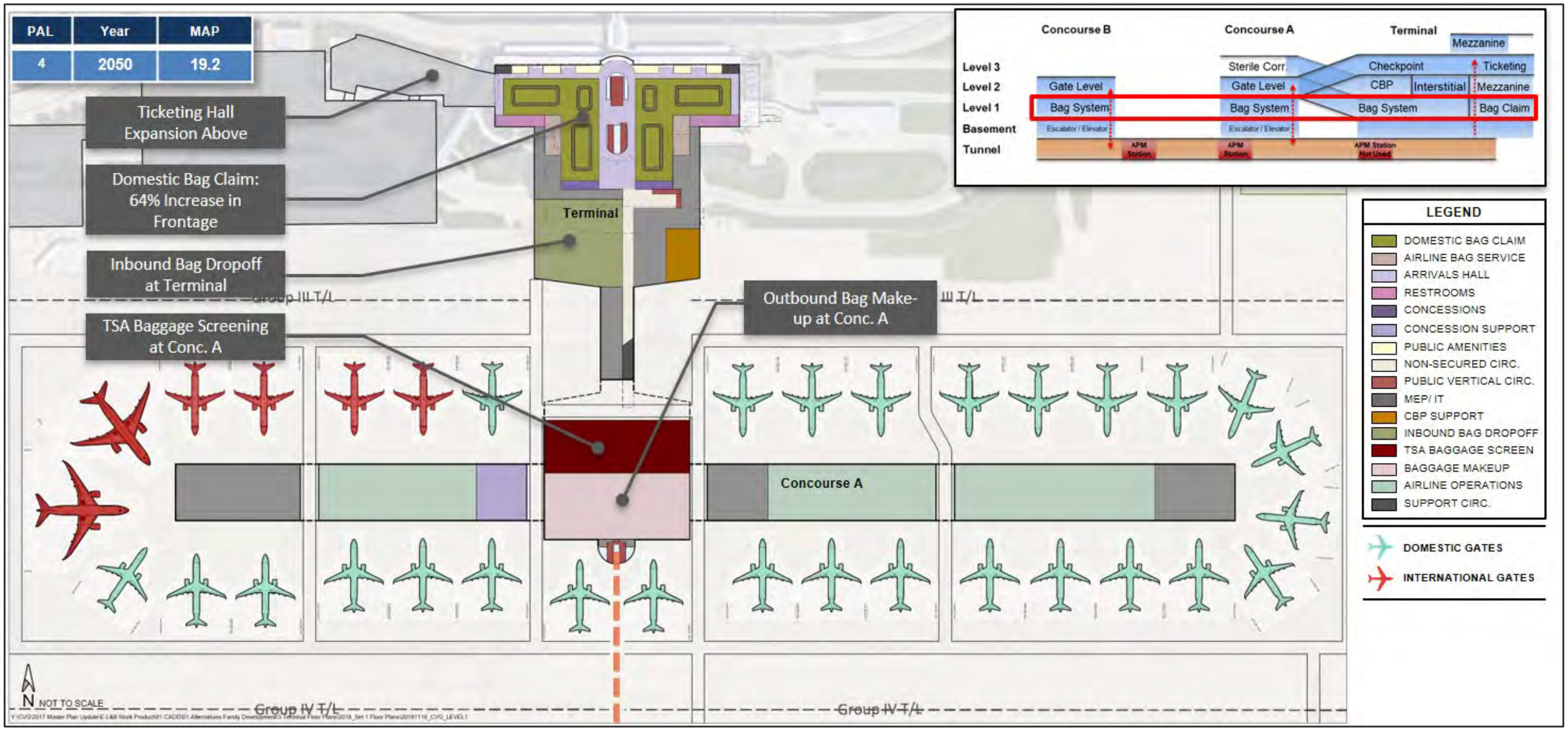
Sources: Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.3-48 PAL 4 ENLARGED FLOOR PLAN – LEVEL 2 CONCOURSE B



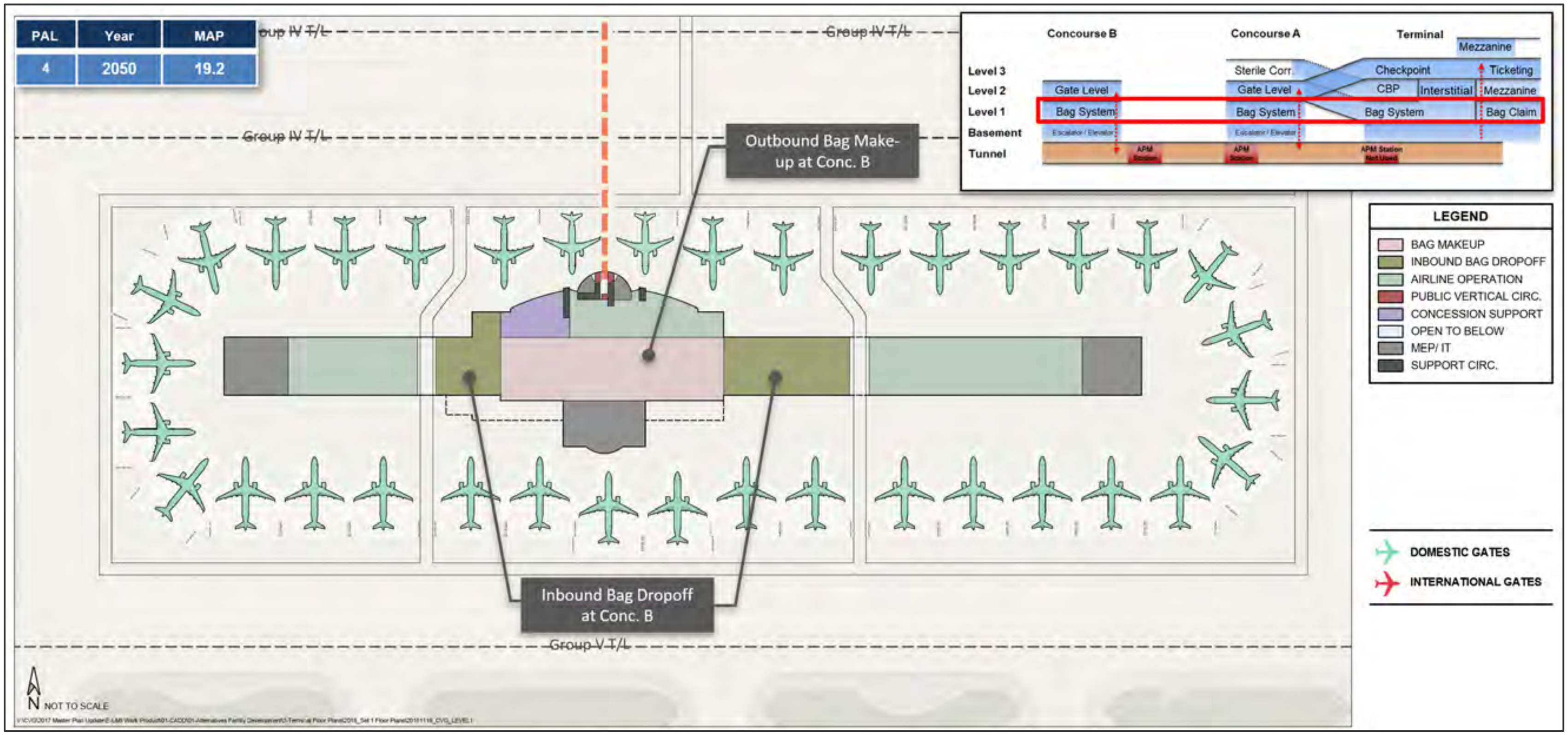
Sources: Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.3-49 PAL 4 ENLARGED FLOOR PLAN – LEVEL 1 TERMINAL AND CONCOURSE A



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.3-50 PAL 4 ENLARGED FLOOR PLAN – LEVEL 1 CONCOURSE B



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

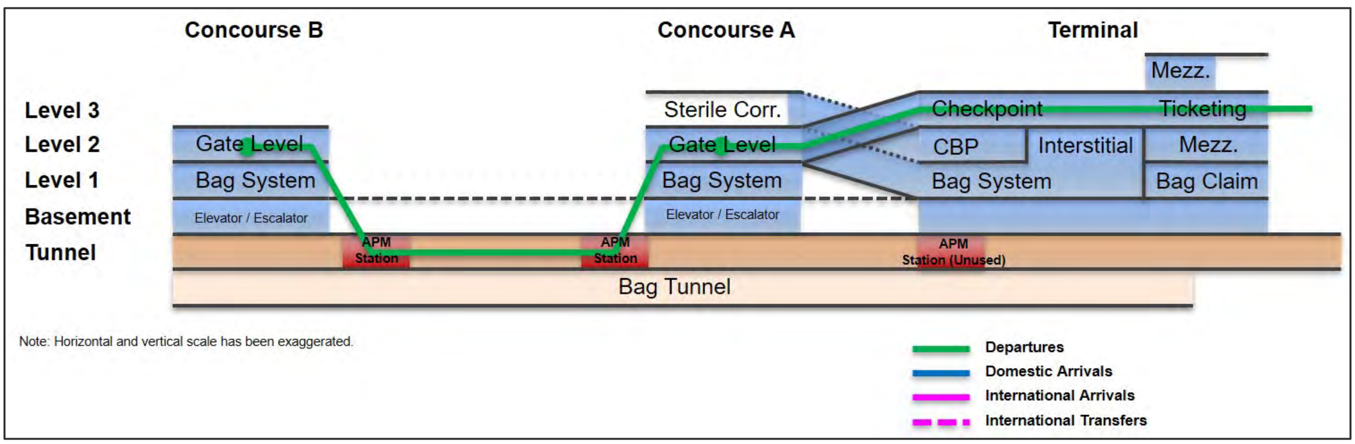
5.3.5.2 Passenger Flows

The following section describes the passenger flows based on the PAL 4 Hybrid Concept. The changes that are most impactful to the passenger flows are the new terminal expansion and the connector to Concourse A due to elevation differences. Supporting exhibits have been developed that show the passenger flows and ramps that connect Concourse A to the new terminal expansion, shown on **Exhibit 5.3-51, *Departing Passenger Flow***, **Exhibit 5.3-52, Domestic *Arriving Passenger Flow,*** and **Exhibit 5.3-53, *International Arriving Passenger Flow*.**

Departing Passenger Flow

All departing passengers flow from ticketing to security on the same level. Once past security, departing passengers circulate down one floor along a gently sloping corridor that connects directly to the Concourse A large central concession node. Passengers departing from Concourse B will flow through the central concession node to a vertical core taking them down to the tunnel where they will take either the APM, use the moving sidewalks, or walk independently to the vertical core at Concourse B. Passengers departing from Concourse A will flow into the central concession node and the turn left or right to access their gate.

EXHIBIT 5.3.51 DEPARTING PASSENGER FLOW



https://landb.sharepoint.com/sites/DFWOn-CallPlanningServices/Shared Documents/Team Management/EATZI's Order_10012019.docx?web=1

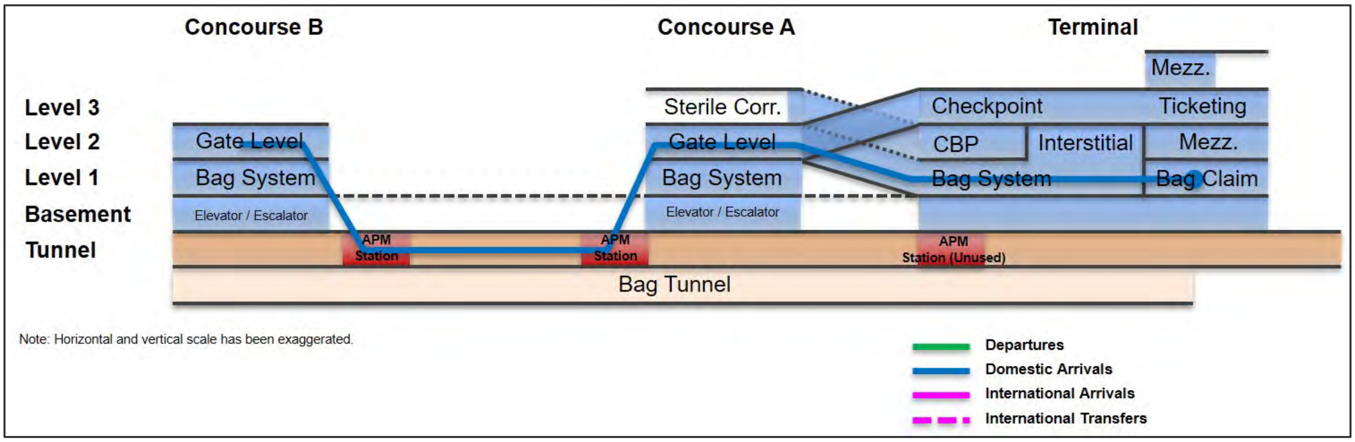
Source: Landrum & Brown analysis

Domestic Arriving Passenger Flow

Passengers arriving at Concourse A will enter the concourse from the passenger boarding bridge (PBB) and circulate from their gate to the central concession node. They will cross through the central concessions node and circulate down one floor along a gently sloping corridor that connects directly to the terminal building and the domestic bag claim hall and then connect with ground transportation.

Passengers arriving at Concourse B will enter the concourse from the PBB and flow to the large center concession node to a vertical core taking them down to the tunnel where they will take either the APM, use the moving sidewalks, or walk independently to the vertical core at Concourse A. At this vertical core they will go up to Level 2 of Concourse A and join with Concourse A domestic arriving passengers.

EXHIBIT 5.3.52 DOMESTIC ARRIVING PASSENGER FLOW

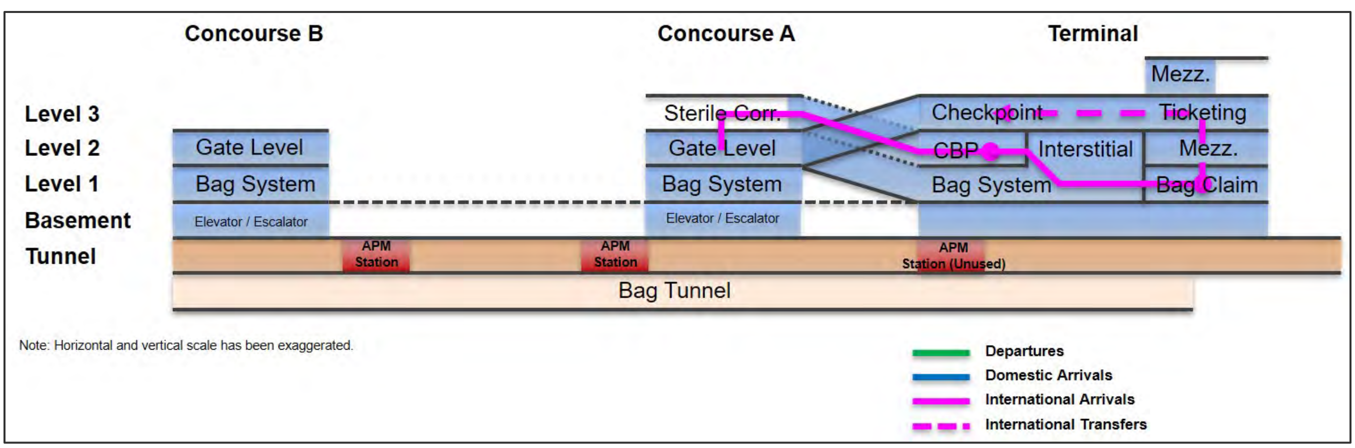


Source: Landrum & Brown analysis

International Arriving Passenger Flow

International arriving passengers will enter a gatehouse at Concourse A from the PBB and flow into the vertical core up to the sterile corridor on Level 3. They will travel along the sterile corridor to a gently sloping corridor that connects directly to the terminal building and the CBP on Level 2. They will pass through the international bag claim and then onto customs primary. Once they are processed by CBP and enter the country they will go down to Level 1 via a vertical core and then connect to ground transportation.

EXHIBIT 5.3.53 INTERNATIONAL ARRIVING PASSENGER FLOW



Source: Landrum & Brown analysis

5.4 Landside Access and Parking

This section describes the evaluation of alternative ways to meet the landside requirements identified in Chapter 4, *Facility Requirements*. These requirements include improvements to local roadways and CVG-owned auto parking facilities.

5.4.1 Roadway Alternatives

Roadway alternatives were considered for the terminal area roadways, the Interstate 275 (I-275) interchange, Terminal Drive, and Loomis Road.

5.4.1.1 Terminal Area

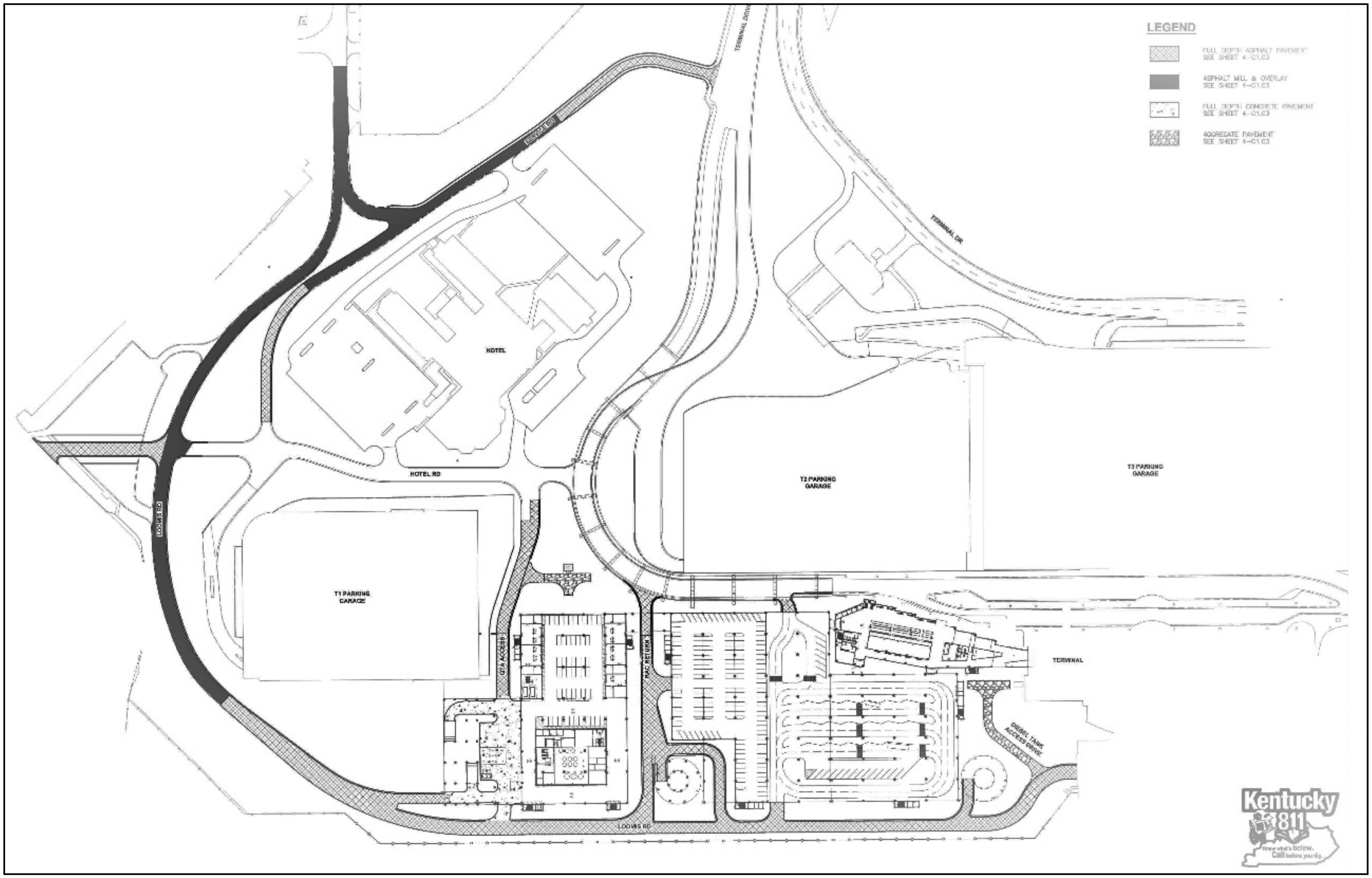
The ongoing construction of the Consolidated Rent-a-car Facility (CONRAC) includes a significant reconstruction of the roadways in and around the terminal area. These changes include an upgraded exit plaza from the terminal garage, a more direct route to the terminal and improved service routes, as shown on **Exhibit 5.4-1, *Terminal Area Roadway Layout***. The plan maintains the familiar flow of the current CVG roadway layout while providing a new rental car facility and Ground Transportation Center (GTC) area within 1,000 feet of the CVG terminal. The plan provides for more efficient entering and exiting times for passengers utilizing both facilities. The overall proposed roadway provides a more seamless flow of traffic (with minimal stopping inbound and outbound) from I-275 to CVG.

Moving rental operations and the new entry route significantly repurposes the roadway network west of the hotel. While still providing access to facilities in this area, this route will also serve as the primary exit from the rear of the CONRAC facility, headed up Loomis. The intersection of Hotel Drive and Loomis Road serves outbound traffic departing the CONRAC facility and provides southern access to the hotel and future Loomis Road development area as well as to the existing cell phone and Transportation Network Company (TNC) lots. Two alternatives for this intersection were evaluated:

- **Concept 1 – Standard Intersection Control Methods**: PAL 1 traffic could be accommodated with a 2-way or 4-way stop control with left turn lanes. Future traffic growth would require a traffic signal by PAL 3.
- **Concept 2 – Roundabout**: A single lane roundabout would meet projected traffic demands and minimize the number of stops. PAL 4 traffic projections would require the addition of a right turn by-pass lane from westbound Hotel Drive to northbound Loomis. A second southbound to westbound by-pass lane could be required, depending on the access plan for PAL 4 development.

Both concepts would meet the needs of traffic operations within the area. Concept 2 is recommended because it results in minimal delay and requires fewer stops for area traffic, improving overall traffic operations. A roundabout would also have lower maintenance costs than a traffic signal.

EXHIBIT 5.4-1 TERMINAL AREA ROADWAY LAYOUT



Sources: CVG CONRAC BP4 Pricing Update; Woolpert analysis

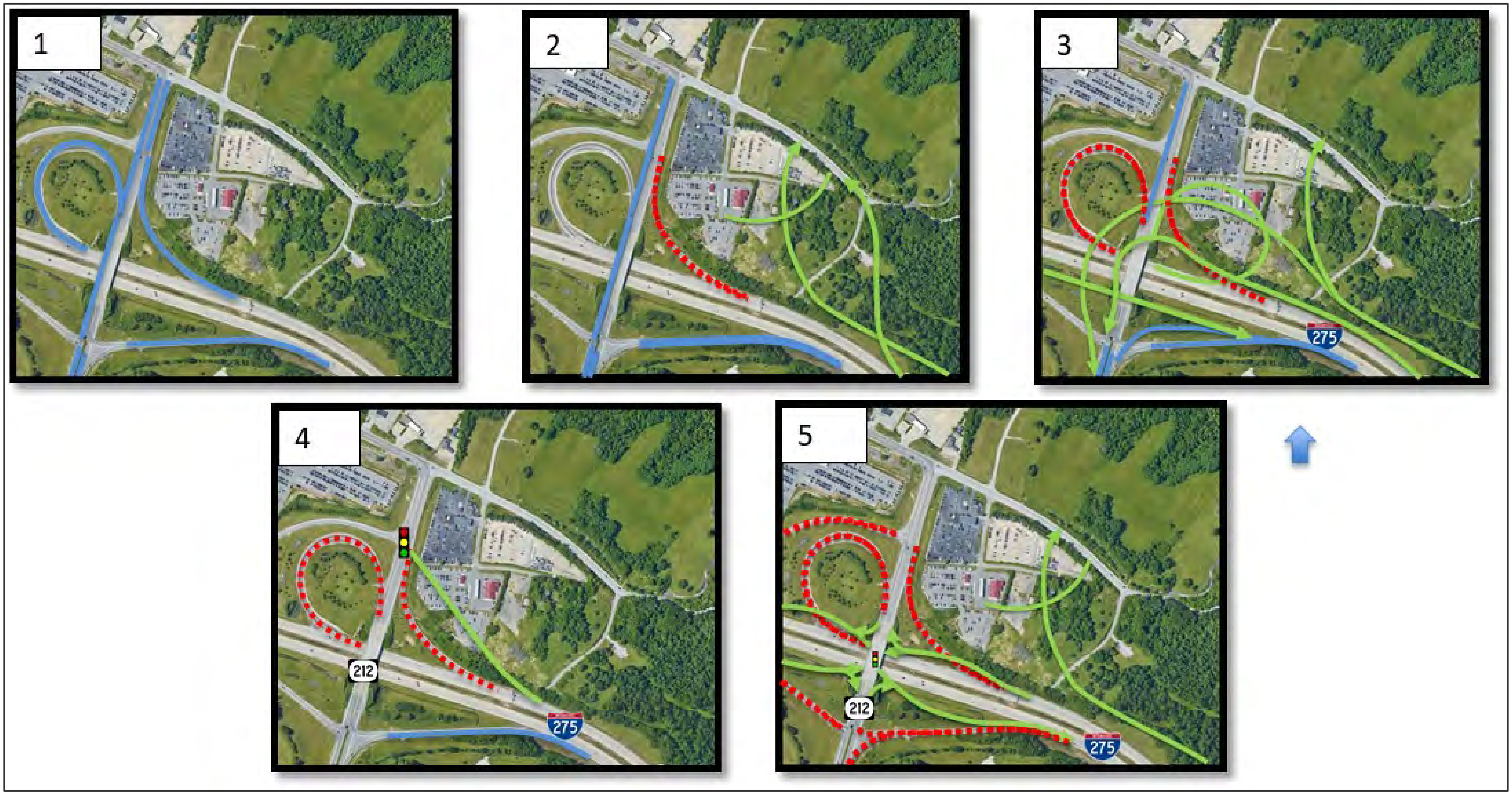
5.4.1.2 I-275 Interchange

The I-275 / Terminal Drive (KY 212) interchange serves as the primary roadway entrance to CVG. It also provides access to a growing area of freight and industrial development to the north of I-275. Development traffic is already beginning to cause minor delays and backups between Petersburg Road (KY 20) and the I-275 westbound entrance ramp. The majority of CVG traffic is accessing the site by way of the westbound exit ramp, a 30-mile per hour (MPH) loop ramp with significant geometric and capacity constraints. Traffic growth is projected to occur as a result of area industrial growth and CVG passenger traffic increases.

With traffic volumes on each segment and ramp of the interchange projected to exceed capacity by PAL 2 or PAL 3, a number of interchange improvements and alternative configurations were evaluated. These concepts are shown on **Exhibit 5.4-2, *I-275 Ramp Concepts***, and are described as follows:

- **Concept 1**: Widen Terminal Drive and appropriate ramps, in the existing configuration. This includes widening Terminal Drive to add an additional through lane in each direction, widening the westbound exit ramp to southbound Terminal Drive to add a second lane, widening the westbound exit ramp to northbound Terminal Drive to add a second lane, and widening the eastbound entrance ramp from Terminal Drive to add a second lane.
- **Concept 2**: Construct a new westbound exit ramp directly to Petersburg Road to replace the existing westbound exit ramps. Widening of Terminal Drive and the eastbound entrance are included.
- **Concept 3**: Reconstruct the interchange to replace both westbound exit ramps, with a ramp directly to Petersburg Road and a flyover to southbound Terminal Drive. Northbound traffic headed west on I-275 would be relocated to a loop ramp, replacing the existing northbound left turn. Eastbound ramps would be widened and moved north, closer to I-275, to allow the flyover to merge to southbound Terminal Drive. This design is very similar to the design concept developed approximately 10 years ago with the Kentucky Transportation Cabinet (KYTC).
- **Concept 4**: Replace both westbound exit ramps with a single ramp directly to Terminal Drive, opposite the westbound entrance ramp. This design could include realigning Petersburg Road from the west to curve directly into Terminal Drive, converting the northbound left and eastbound right turns to through moves.
- **Concept 5**: Reconstruct the interchange as a Single Point Urban Interchange (SPUI)

EXHIBIT 5.4-2 I-275 RAMP CONCEPTS



Source: Woolpert analysis

Concepts 1 and 3 meet capacity needs. Conversely, Concepts 2, 4, and 5 offer benefits but do not fully meet the capacity needs. Concept 1 is not ideal because it exaggerates existing weaving problems by adding lanes and volume without increasing the length of the weaving sections. Widening the westbound loop exit ramp to two lanes in Concept 1 increases safety concerns with its tight radius. As a result, Concepts 1, 2, 4, and 5 were eliminated from further consideration.

Concept 3, full reconstruction of the interchange, is recommended to meet projected capacity, safety and operational needs for the interchange. Concept 3 would provide a more streamlined flow of traffic inbound and outbound from CVG with fewer stops and less delay at the intersections. The revised interchange includes more direct access coming from I-275 (from the east, including I-75) to Petersburg Road and CVG by providing a new flyover ramp from I-275 west to Terminal Drive south and a new ramp to Petersburg Road.

The improvements in Concept 3 are not needed until PAL 2 or PAL 3, although minor deficiencies are already being experienced. Two improvements could be implemented immediately to address these existing deficiencies:

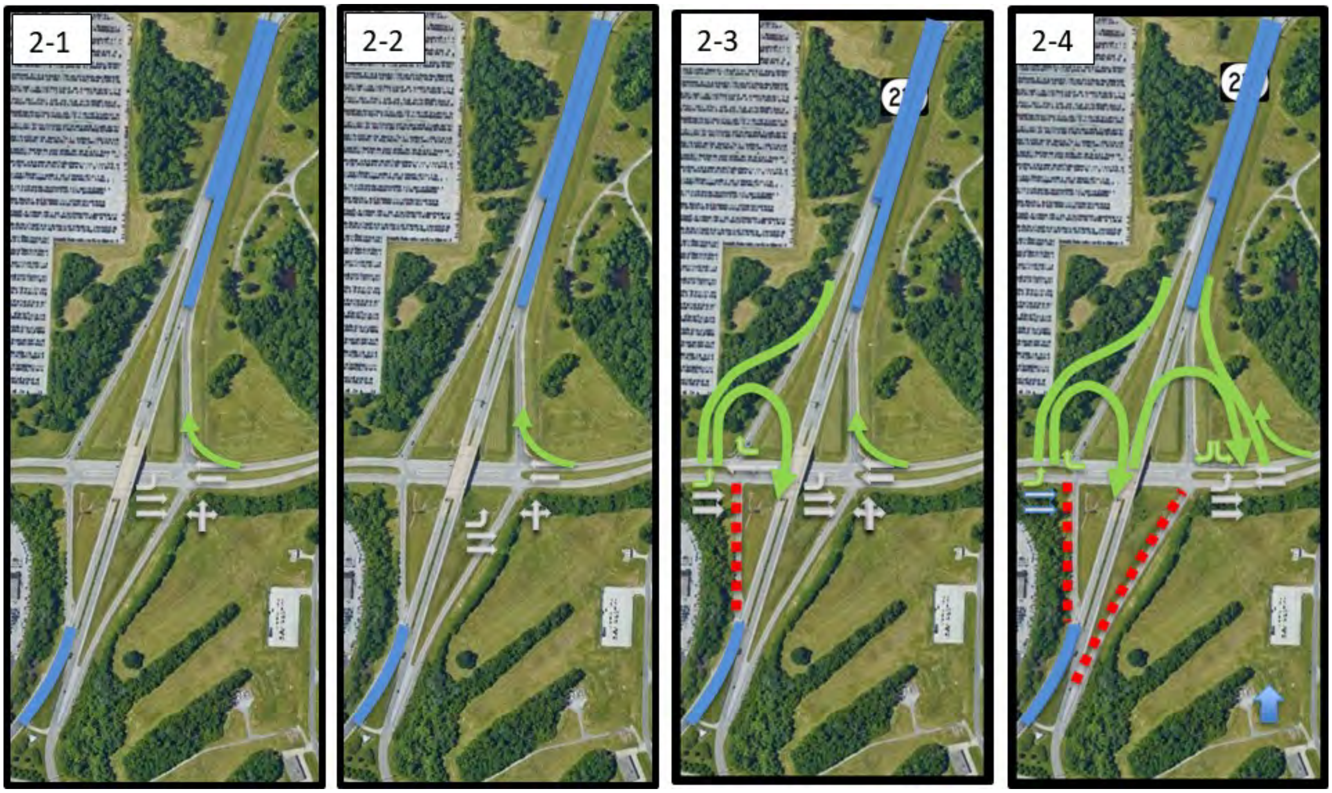
- Widen a portion of southbound Terminal Drive between Petersburg Road and the westbound entrance ramp to mitigate existing development traffic issues.
- Realign the west side of Petersburg Road to connect directly with Terminal Drive, creating an offset T-Intersection for the east side of Petersburg Road. This alternative would streamline traffic at the trucking facilities and parking to the west on Petersburg with more direct access to the I-275 ramps and CVG.

5.4.1.3 Terminal Drive

Terminal Drive serves as the main passenger/vehicle entrance to the CVG. Weaving and capacity issues are projected along Terminal Drive (capacity) and between Donaldson Road and the terminal area (weaving). Reconstruction of the roadways around the Terminal/CONRAC areas has simplified those areas, but it also shortened the sections between the Donaldson Road ramps and the arrival/departure/garage splits.

Improvements to Terminal Drive will be required to mitigate projected capacity and weaving deficiencies caused by projected traffic increases. Two capacity concepts and two weaving concepts were developed as shown on **Exhibit 5.4-3, *Terminal Drive Concepts***.

EXHIBIT 5.4-3 TERMINAL DRIVE CONCEPTS



Source: Woolpert analysis

Terminal Drive Capacity Concepts

Widening Terminal Drive was determined to be the most feasible scenario for improving its capacity. Two concepts were developed for widening Terminal Drive as follows:

- **Concept 1**:
  - Widen Terminal Drive to provide three through lanes in each direction, between the I-275 interchange and the terminal. Added lanes include a third northbound through lane from the Donaldson Ramps to I-275 east, a third southbound through lane from I-275 to the Donaldson ramps, and a third southbound through lane from the Donaldson Ramps to the terminal split. In addition, a westbound slip right turn lane on Donaldson Highway would be added onto the northbound Terminal Drive Entrance Ramp
- **Concept 2**:
  - In addition to the improvements listed for Concept 1, construct a second eastbound left turn lane on Donaldson Highway onto the northbound Terminal Drive entrance ramp. The added left turn lane requires widening Donaldson Highway under the bridge and providing a second lane on the northbound entrance ramp.

Concept 1 is recommended to add through capacity and mitigate weaving issues between I-275 and Donaldson Highway by PAL 3 in both north and southbound directions. The northbound direction between Donaldson and the I-275 eastbound entrance ramp is the most critical segment, requiring widening by PAL 2 to maintain a Level of Service C. Southbound widening is required by PAL 3.

Concept 2 requires widening the northbound entrance ramp to accommodate the dual left turn lanes on Terminal Drive. The added capacity provided by Concept 2 fails to increase traffic flow at the ramp intersections on Donaldson Road, and lowers capacity on Terminal Drive with a multi-lane entrance. As a result, Concept 2 was eliminated from further consideration.

Terminal Drive Weaving Concepts

Two concepts were developed to mitigate the weaving issues on Terminal Drive between the Donaldson Road ramps and the arrival/departure split (southbound) and garage exit facility (northbound). Both concepts require the improvements shown in Concept 1 (widening Terminal Drive) to provide acceptable operations. These concepts are described as follows:

- **Concept 3**:
  - Construct a loop ramp to replace the existing southbound entrance ramp to move the entrance to Terminal Drive north, extending the weave length by approximately 700 feet north. Improvements increase the southbound weaving length by 700 feet. Constructing the loop ramp, though, does require reconstruction of the southbound exit ramp to provide sufficient space to meet geometric requirements for the new loop ramp.
  - Construct a single lane roundabout (with a short-term parking exit slip lane onto Terminal Drive towards I-275), allowing outbound garage traffic headed for Donaldson Highway to merge with traffic from the terminal curbside in a controlled environment (roundabout).
- **Concept 4**:
  - Construct a loop ramp to replace the existing southbound entrance ramp to move the entrance to Terminal Drive north, extending the weave length by approximately 700 feet. This includes relocating the southbound exit ramp to provide enough space to construct the loop ramp.
  - Construct a loop ramp to replace the existing northbound exit ramp from Terminal Drive to Donaldson Highway, extending the weave length by approximately 1,000 feet. This includes relocating the northbound entrance ramp to provide space to construct the loop ramp.

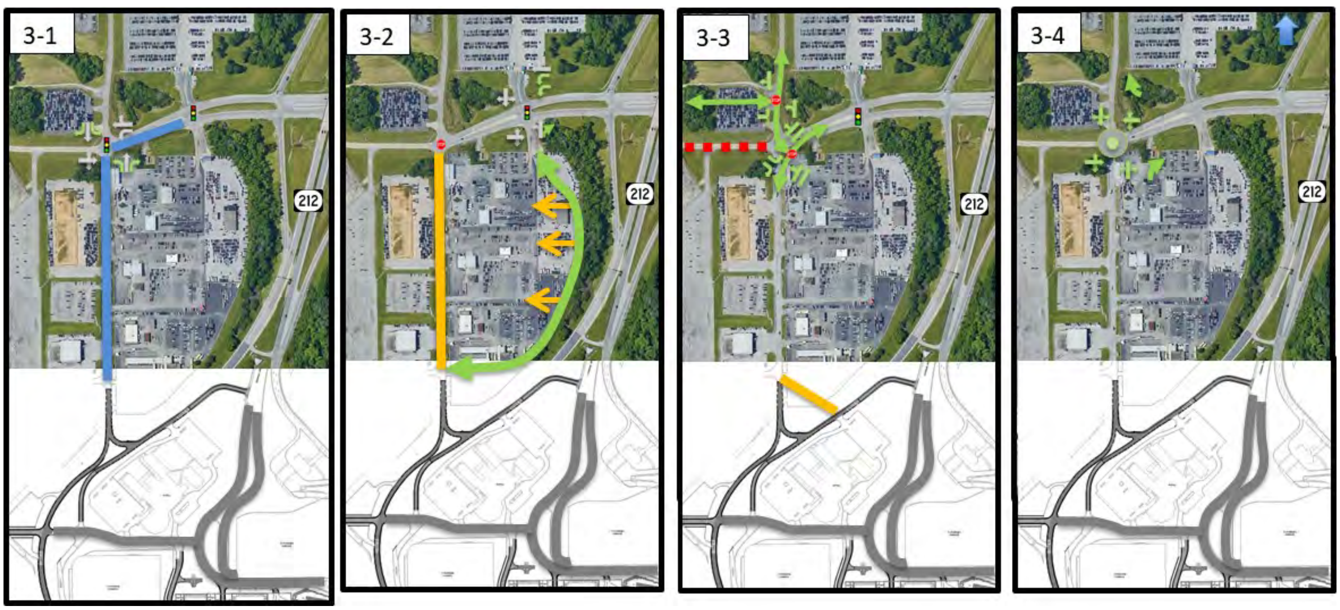
Of the two concepts that address weaving issues between Donaldson Highway and the terminal area (Concepts 3 and 4), Concept 3 has lower costs and provides traffic calming potential for lower speeds on Terminal Drive, especially coming from the terminal. Therefore, Concept 3 is recommended along with Concept 1. These improvements would be needed at PAL 3.

5.4.1.4 Loomis Road

Loomis Road serves the west development area, consisting mostly of the various rental car areas. Minor capacity issues have been noted at the intersection of Loomis Road and Donaldson Highway and the ValuPark entrance. With the CONRAC construction, the rental car operation will change dramatically, though departures from the rental car facilities will still travel northbound on Loomis. Over time, this area will be redeveloped, bringing more traffic to the area.

Four conceptual layouts were evaluated to improve Loomis Road as shown on **Exhibit 5.4-4, *Loomis Road Concepts***.

EXHIBIT 5.4-4 LOOMIS ROAD CONCEPTS



Source: Woolpert analysis

These concepts include:

- **Concept 1**:
  - Construct a traffic signal at Loomis/Donaldson and widen Donaldson at the intersection to provide a second eastbound lane.
  - Widen Loomis Road to five lanes from Barkley Drive to Donaldson Highway.
  - Signalize the ValuPark entrance on Donaldson.
  - Provide two-way access for shuttles from Loomis Road to the CONRAC facilities. These improvements are applied to all concepts.

- **Concept 2**:
  - Relocate Loomis Road around the east side of the existing car rental (future development area) tying into Donaldson Highway at the ValuPark entrance. Signalize the new intersection and provide turn lanes at the intersection. Maintain the existing Loomis Road location as a service road.
- **Concept 3**:
  - Realign Loomis Road to connect directly with Donaldson Highway, creating an offset T-intersection with the converted south Loomis Road to Donaldson Highway as the major free flow movement.
  - Separate the Clay Drive intersection to the north on Loomis Road as a T intersection.
  - Signalize the Donaldson Highway and ValuPark entrance.
  - Widen Loomis to five lanes.
- **Concept 4**:
  - Along with the Concept 1 improvements, construct a roundabout at the Loomis Road and Donaldson Highway intersection with a northbound and westbound slip lane.

All four concepts improve capacity to some extent. Concepts 3 and 4 also minimize the total number of stops and improve traffic flow to and from Loomis Road and Donaldson Highway. Concept 4 is recommended because it improves capacity, streamlines the Donaldson Highway/Loomis Road, and eliminates stops for all traffic. It also avoids a short intersection spacing between the ValuPark and Terminal Drive southbound ramps.

A short-term solution to improve Loomis Road and Donaldson Highway intersection would be to extend the second Donaldson Highway eastbound through lane from Loomis Road to the ValuPark entrance. Providing this improvement would be sufficient in the short-term until the additional improvements are needed at PAL 3.

5.4.2 Auto Parking Alternatives

Alternative sites were considered for the parking garages, Airport-owned remote public parking, employee parking, and cell phone lot/TNC parking.

5.4.2.1 Assumptions

The assumptions used in the development and evaluation of alternatives are described in this section.

Terminal 1 (T1) Garage

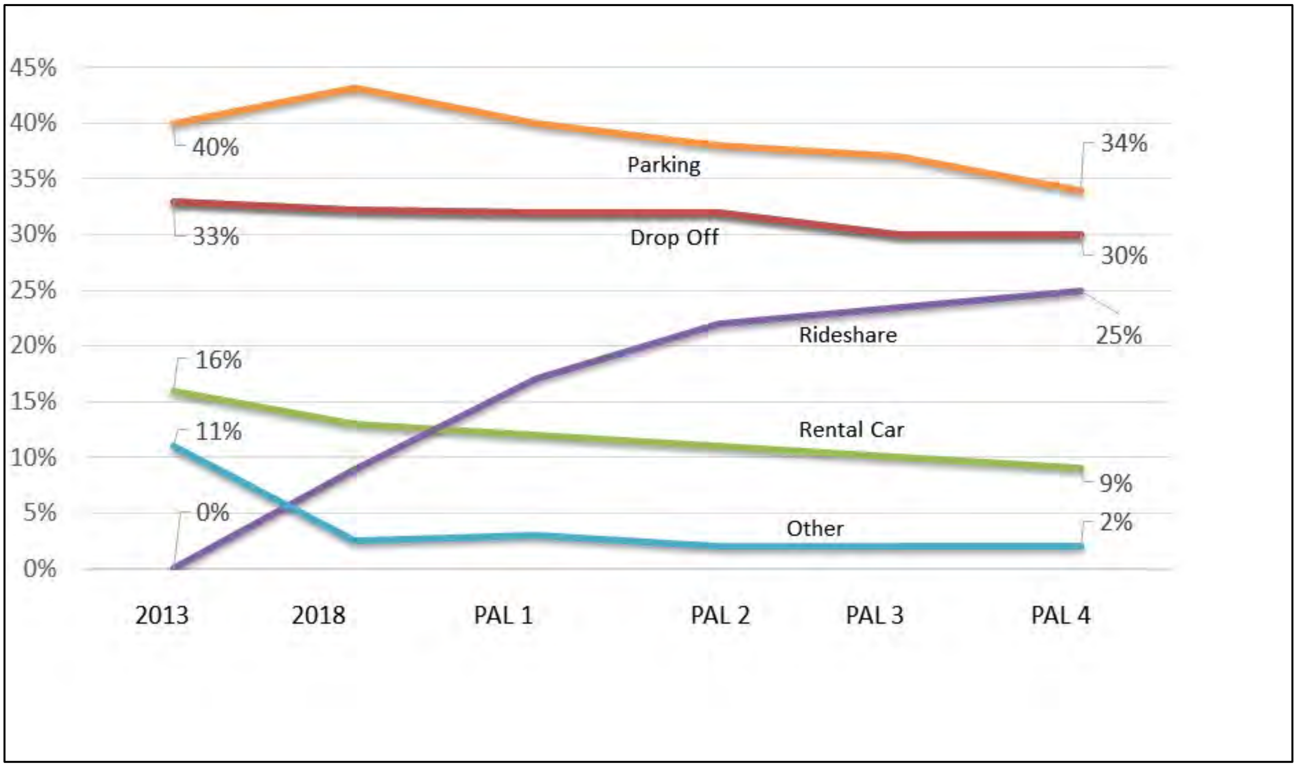
With the removal of Terminals 1 and 2, the 800-space Terminal 1 (T1) garage is at the outer edge of walkability to the terminal but has no suitable walking pathway. The facility is currently used for staff, and construction parking. The T1 garage was considered in both the evaluation of parking garages and employee parking.

Landside Mode Split

An important consideration in the evaluation of alternative sites for parking is landside mode split. Transportation choices across the country are in a period of change, with the rapid rise of TNCs such as Uber and Lyft, and even bigger potential changes in the future such autonomous and connected vehicles (AV/CV). Forecasting future passenger travel modes to and from airports is more challenging – and more important – than ever before. Accommodating projected passenger growth with the current mode split would require the addition of more than 13,000 parking spaces. However, some forecasters predict huge decreases in required airport parking with the dawn of autonomous vehicles.

In the previous five years, rideshare or TNC traffic has grown from non-existent to a nine percent share of the passenger mode choice. Much of this increase has come at the expense of taxi ridership (drop from 11 percent to less than 1 percent), with a lesser decrease in rental car share. Looking to the future, rideshare travel is expected to continue to increase, with corresponding decreases in travel by rental car and private vehicle (parking). While national projections show up to 40 percent TNC use across the travel network, the trip characteristics of the CVG area indicate a more modest 25 percent mode share. The splits shown in **Exhibit 5.4-1**, ***Mode Splits***, have been factored into the alternatives analysis.

EXHIBIT 5.4-5 MODE SPLITS



Source: Woolpert analysis

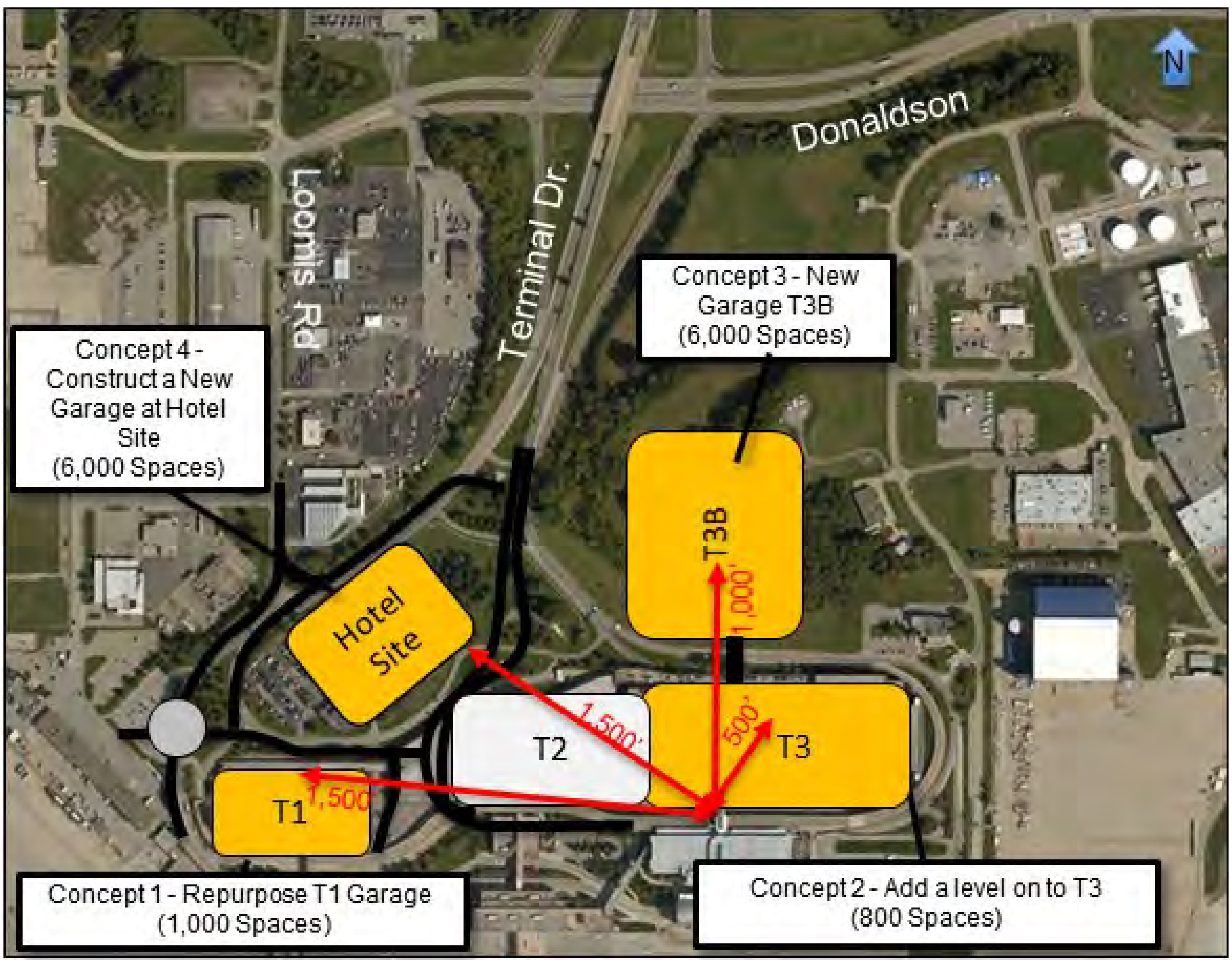
Public Parking Pricing Structure

Preferred locations and sizes were identified individually for parking garages versus remote public parking lots. However, it is important to keep in mind that the type of parking needed in the future may change based on changes in mode splits, pricing structure, and operational strategies. This alternatives analysis assumes that the current pricing structure and operational strategies would remain in place. A focused study on CVG parking strategies and pricing structure is recommended in the near-term to better define parking needs.

5.4.2.2 Parking Garages

The garage parking at CVG is within walking distance to the terminal and serves as the closest and most convenient parking option for passengers. Garage parking demand is already beginning to exceed capacity. Significant deficits are projected beginning in PAL 2 unless additional garage parking is provided. To increase garage parking, four conceptual layouts were evaluated as shown on **Exhibit 5.4-6, *Parking Garage Concepts***.

EXHIBIT 5.4-6 PARKING GARAGE CONCEPTS



Source: Woolpert analysis

The parking garage concepts include:

- **Concept 1**: Reconstruct T1 Garage. The current 800-space structure could be replaced with a new four-level, 1,500-space parking structure, with improved pedestrian access to the terminal. Reserving 500 spaces for employees (especially with the proposed relocation of the administration staff to the terminal), would result in a net increase of over 1,000 spaces. Relocation of Terminal Drive puts access for the T1 Garage off Hotel Drive. A pedestrian pathway along Terminal Drive would be required.
- **Concept 2**: Add a level to T3 garage. The T3 garage was designed with the ability to add a level. Construction would be expensive but would provide 800 spaces within close walking distance to the Terminal.
- **Concept 3**: Construct a new T3B garage. The space adjacent to the T3 garage, north of Terminal Drive, is sufficient to construct a 6,000-space garage. The proposed garage could be built in two phases, adding 3,000 spaces in a first phase (east or west side) with an additional 3,000 spaces added later if demand requires it.
- **Concept 4**: Construct a new garage at the hotel site. A 6,000-space garage could be constructed at the location of the existing hotel. This concept would require relocation of the hotel. A new pedestrian pathway would be required.

Concepts 1, 2, and 3 do not require the relocation of the hotel, whereas Concept 4 does. Concepts 2 and 3 have shorter walking distances than Concepts 1 and 4, providing better passenger service than Concepts 1 and 4. Concepts 3 and 4 provide the most spaces (around 6,000 spaces) compared to around 1,000 spaces with Concepts 1 and 2.

Relocating the hotel is not recommended at this time so Concept 4 was eliminated from further consideration. Concepts 1 through 3 are recommended to be carried forward in this Master Plan. There are concerns about constructing expensive garages at this time and further study is needed to determine the feasibility of doing so and to determine if changes in price structure could mitigate the need for some parking garage construction in the future.

5.4.2.3 Airport-owned Remote Public Parking

The remote Airport-owned public parking facilities provide a cheaper, more remote alternative to serve the CVG parking needs for passengers flying for longer durations or wanting a less expensive option. Shuttle service to the terminal is provided from each lot. Additional remote parking will be needed by PAL 2 unless additional parking is provided. To increase the available remote public parking, five conceptual layouts were evaluated as shown on **Exhibit 4.5-7, *Airport-Owned Remote Public Parking Concepts***.

EXHIBIT 5.4-7 AIRPORT-OWNED REMOTE PUBLIC PARKING CONCEPTS

Source: Woolpert analysis

The remote public parking concepts are described as follows:

- **Concept 1**: Convert 1,000 spaces in the existing employee lot to public parking (Economy Lot), using the excess space in the employee lot.[4]
- **Concept 2**: Convert 3,000 spaces in the existing employee lot to public parking. This would require relocating the entire employee lot.
- **Concept 3**: Construct a new 2,000-space lot west of the existing employee lot, in vacant property off Airpark Drive.
- **Concept 4**: Construct a new 2,000-space lot west of Loomis Road and ValuPark, in the wooded area towards the runway.

4 Conversion of a portion of the employee lot to public parking occurred in 2019, after the alternatives analysis was completed.

- **Concept 5**: Expand the ValuPark lot to the north and east, adding 3,000 spaces. This expansion would increase the size of the facility, but maintain use of current support services (security, revenue, shuttles).

CVG has already begun the process of converting the existing employee lot to public parking as shown in Concepts 1 and 2. Expanding ValuPark (Concept 5) would be more cost-efficient than constructing another public parking lot and associated support services as shown in Concepts 3 and 4. The expansion of ValuPark shown in Concept 5 along with the conversion of the existing employee lot to public parking would provide around 7,000 remote parking spaces, which is sufficient to meet demand through PAL 4.

5.4.2.4 Employee Parking

Employees park at the T1 garage and the employee lot off Donaldson Highway. These facilities provide enough capacity to meet the projected employee parking demand through PAL 4. New employee facilities may be needed, however, with the potential conversion of the existing employee lot to public parking.

Five conceptual layouts for the relocation of employee parking were developed as shown on **Exhibit 5.4-8, *Employee Parking Concepts***.

These concepts include:

- **Concept 1**: Retain the 4,400 spaces in the existing employee lot
- **Concept 2**: Reconstruct a new T1 Garage with four levels to provide added short-term parking spaces, including up to 500 spaces for employees.
- **Concept 3**: Construct a new 3,000-space lot west of Loomis Road and ValuPark in the wooded area.
- **Concept 4**: Construct a new 2,000-space lot west of the existing employee lot in vacant property off Airpark Drive.
- **Concept 5**: Construct a new 3,000-space lot north east of the Donaldson Highway and Mineola Pike intersection.

CVG has already begun the process of converting the existing employee lot to public parking so maintaining employee parking in this area as shown in Concept 1 is not feasible. Concept 2 is not suitable to serve the majority of employee parking needs but would be useful if the CVG administration offices are relocated to the terminal area. As a result, this area should be reserved for parking use. The Concept 3 and 4 sites are close to the terminal area and should be reserved for higher and better uses such as commercial development, public parking, or other airport-related functions. Concept 5 makes use of more distant CVG land without increasing shuttle commute times significantly (shuttle times would increase by less than two minutes). Therefore, Concepts 2 and 5 are recommended as future sites for employee parking expansion.

EXHIBIT 5.4-8 EMPLOYEE PARKING CONCEPTS

Source: Woolpert analysis

5.4.2.5 Cell Phone and TNC Staging Lots

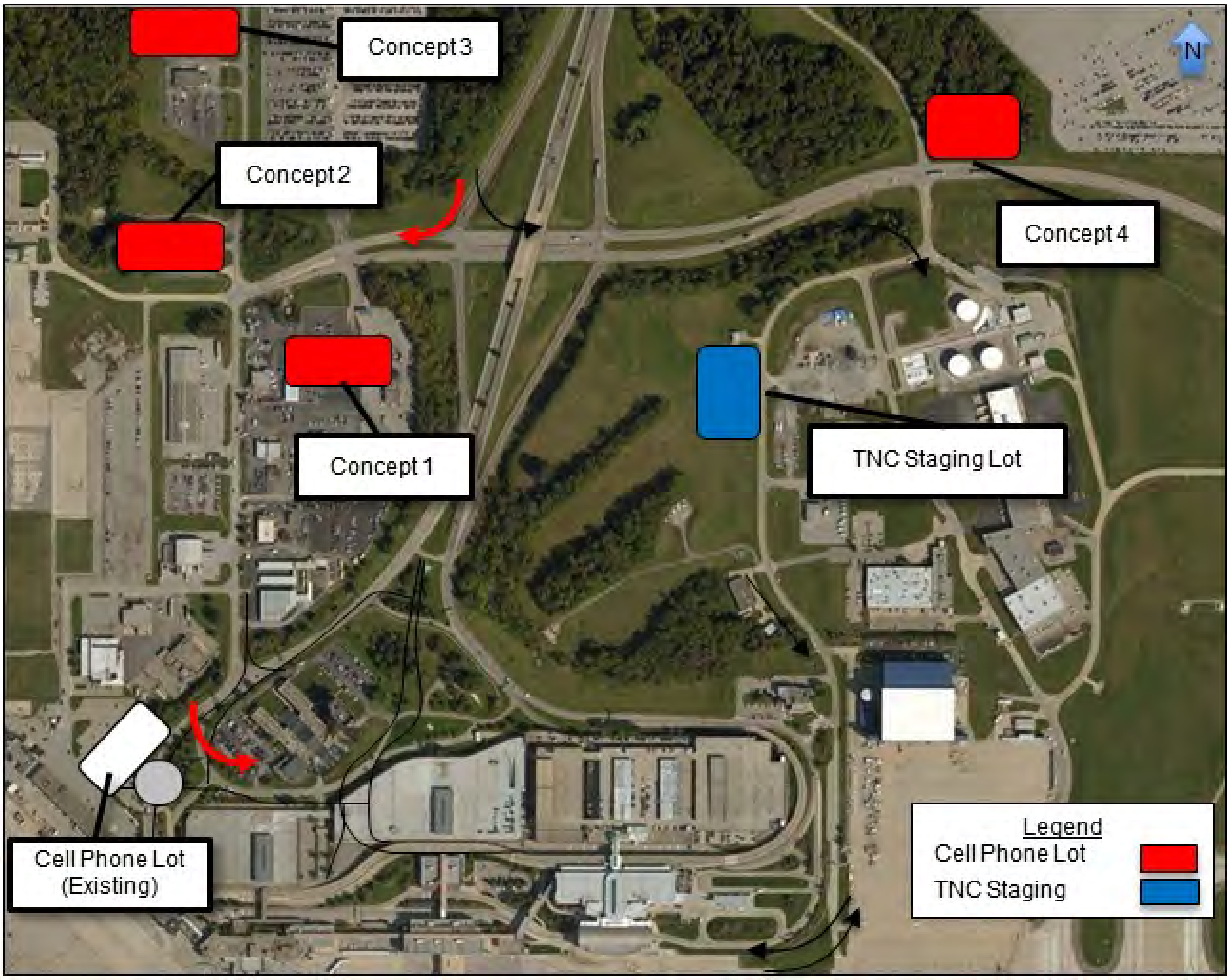
Cell phone and TNC lots function more as staging lots than parking lots, providing a place for vehicles to wait to pick up arriving passengers. As such, these facilities need to be located in an easily accessible location, with direct access to their passengers. **Exhibit 5.4-9, *Cell Phone Lot and TNC Staging Concepts***, shows the alternative sites that could be used for a cell phone lot and TNC lot. Each site shown could accommodate 500 spaces.

The existing cell phone lot is well positioned, west of the terminal, for vehicles to easily access the arrivals curb when summoned. However, its proximity to the terminal results in drivers arriving at the curb earlier than necessary, which increases dwell times at the curb. It has easy access from Terminal Drive, which will be maintained by way of Hotel Drive once the current CONRAC construction is completed. The current lot provides more than 85 spaces, with overflow into the TNC area if needed. The cell phone lot works well in its current location, but it occupies a valuable space for potential future development and does not have capacity to expand as needed.

Several remote locations were considered for a potential cell phone lot based on CVG staff's desire to relocate the lot further away from the terminal to allow for a higher and better use in the current location. Concept 1 is the closest to the curbside of the four sites that were considered. Concepts 2 and 3 are further away from the curbfront than Concept 1 but would provide a streamlined route for vehicles coming to CVG to pick up passengers. Concept 4 would complicate routing to the terminal curbside for pickup. Any of the sites would meet future needs. Therefore, all sites should be reserved for potential auto parking use.

The potential cell phone lot locations were also evaluated for a TNC stating lot, and, while any of the sites would be feasible for TNC staging, the current taxi bullpen on Lincoln Avenue was identified for TNC staging along Lincoln Road. This location provides capacity for a 500-space TNC staging area to meet the growing demand of the TNC operation. It would provide a streamlined route for vehicles coming to CVG to pick up passengers.

EXHIBIT 5.4-9 CELL PHONE LOT AND TNC STAGING CONCEPTS



Source: Woolpert analysis

5.5 Air Cargo

Section 4.5, *Air Cargo*, presented the results of the facilities requirements analysis for Air Cargo facilities at CVG. These results indicated that the demand projected in PAL 4 would require substantial increases in both air cargo aircraft parking positions and total air cargo facility space. PAL 4 requirements indicate a need of:

- 234 total air cargo aircraft parking positions
- 5.5 million square feet of total air cargo facility

Currently the vast majority of air cargo activity at CVG is accommodated at the DHL hub in the south airfield. Plans have been developed to expand this facility in the near future by developing an additional 50 acres to the south. In addition to the DHL hub, the Amazon Prime Air Hub is under development in the south cargo area. These two expansions, combined with the pending Aeroterm cargo development on the north airfield, are expected to provide all projected air cargo facility needs through PAL 4. Given these anticipated developments, this Master Plan recommends preserving the land use envelopes for each; no further development alternatives have been considered.

An Air Cargo Land Use Study was prepared for CVG in 2013. The document reserved nearly 70 acres near the Aeroterm site, east of Runway 18C/36C. This Master Plan reserved this site be designated as Cargo Development on the CVG land use plan and future Airport Layout Plan (ALP), thereby remaining available for development as air cargo facilities should market demand require it.

5.6 Support Facilities

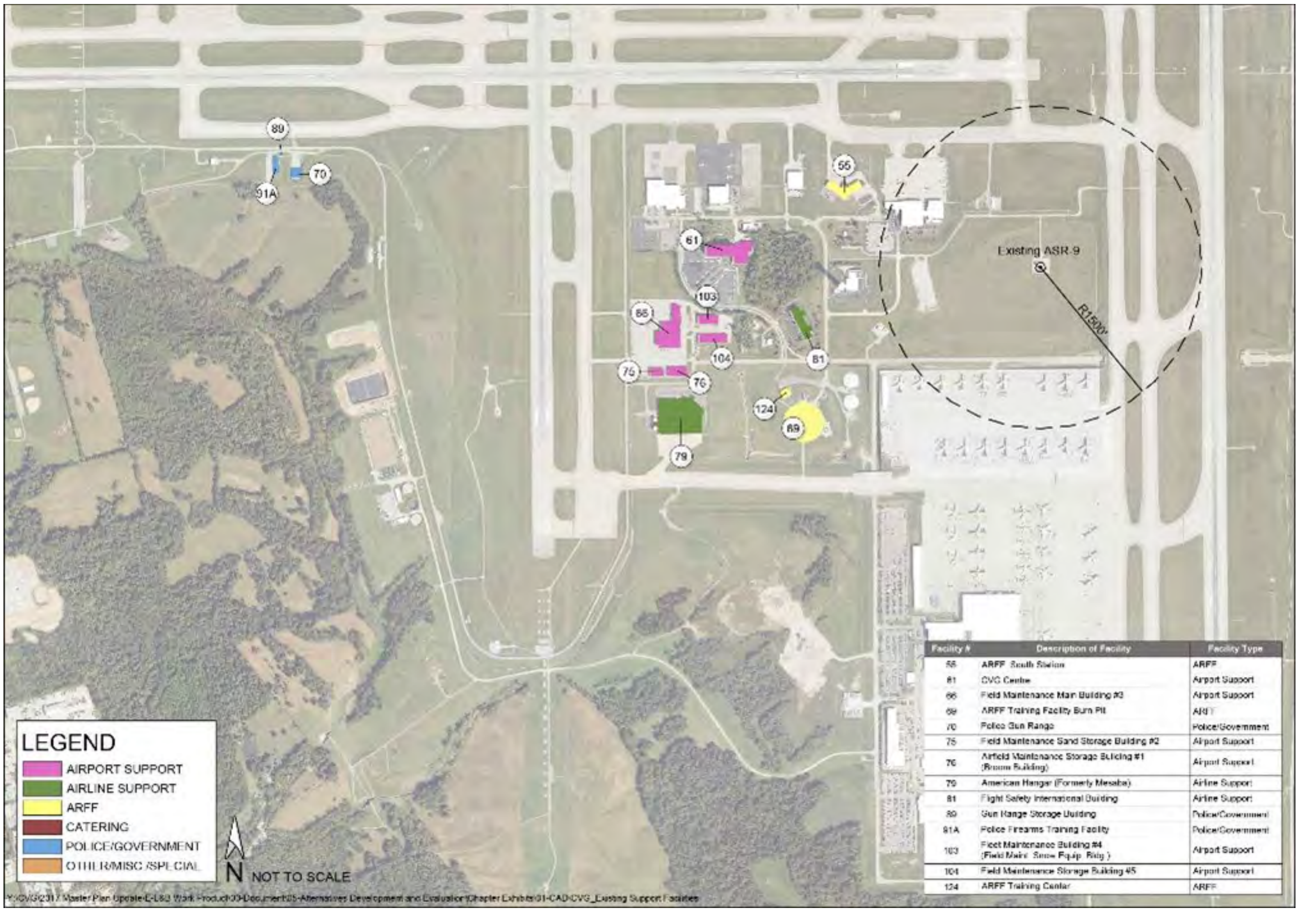
Support facilities serve specific roles at CVG, many of which have specific location requirements based on their respective functions. **Exhibit 5.6-1, *Existing Support Facilities – North***, and **Exhibit 5.6-2, *Existing Support Facilities – South***, provide a summary of the locations of the support facilities analyzed in this Master Plan. Section 4.6, *Support Facilities*, presented the results of the facility requirements analysis for the support facilities at CVG. Support facilities that were found to require expansion include: airline support, airport support, catering, aircraft deicing, aircraft fuel, general aviation (GA), government/police facilities, and the hotel. In some instances where additional needs have been identified, it is possible to grow the existing facilities as needed as opposed to expanding in a separate site.

The subsections that follow present the options to provide the additional capacity identified in Chapter 4. The evaluation of alternative sites for support facilities takes into consideration the potential relocation of the existing Airport Surveillance Radar (ASR) and its associated 1,500-foot critical area, The ASR is currently located in the south airfield and limits potential expansion opportunities. The previous Master Plan recommended that the existing ASR-9 be relocated to the western portion of the airfield north of Runway 09/27 and west of Runway 18R/36L. That recommendation is being maintained by this Master Plan; however, it is subject to FAA funding, as it is a facility maintained by the FAA. For purposes of the Master Plan alternatives analysis, the critical area for the existing ASR-9 is considered to be available for development.

EXHIBIT 5.6-1 EXISTING SUPPORT FACILITIES – NORTH

Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.6-2 EXISTING SUPPORT FACILITIES – SOUTH



Facility #	Description of Facility	Facility Type
55	ARFF South Station	ARFF
61	CVG Centre	Airport Support
66	Field Maintenance Main Building #3	Airport Support
69	ARFF Training Facility Burn Pit	ARFF
70	Police Gun Range	Police/Government
75	Field Maintenance Sand Storage Building #2	Airport Support
76	Airfield Maintenance Storage Building #1 (Broom Building)	Airport Support
79	American Hangar (Formerly Mesaba)	Airline Support
81	Flight Safety International Building	Airline Support
89	Gun Range Storage Building	Police/Government
91A	Police Firearms Training Facility	Police/Government
103	Fleet Maintenance Building #4 (Field Maint. Snow Equip. Bldg.)	Airport Support
104	Field Maintenance Storage Building #5	Airport Support
124	ARFF Training Center	ARFF

Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.6.1 Airline Support

Airline support facilities include both airline maintenance facilities and their associated apron and landside areas. Facility requirements for airline support facilities were developed based on building utilization assumptions and future aircraft operations (see Chapter 4, Facility Requirements, Section 4.6.1, *Airline Support*). The facility requirements for the airline support facilities presented in Chapter 4 indicated that the hangar and aircraft apron areas are sufficient through PAL 3; however, 7,600 square feet of additional support buildings will be needed by PAL 4. Vehicle parking should be developed to support any new facilities. In addition to these requirements, space should be reserved for the potential that an airline(s) may desire to build additional hangars at CVG because airline maintenance is a market-driven demand that cannot be easily predicted.

The development of a new airline maintenance hangar (the Lynx Hangar) has been previously approved and is in the design process. This facility would provide more than enough space to satisfy the PAL 4 requirements identified in Chapter 4. The proposed development area is 16.5 acres and is located on South Airfield Drive between the existing hanger and the ARFF Training Center. The development consists of an aircraft maintenance hangar, associated apron, 19,000 square feet of office space, and 35,000 square feet of vehicle parking. The airside portion of the development is capable of accommodating one Boeing 747-8F aircraft inside and a second on the apron. The planned configuration is presented in **Exhibit 5.6-3, *Lynx Hangar Development***.

With regards to reserving additional space for potential market-driven airline maintenance demand, two sites were identified (see **Exhibit 5.6-4, *Airline Support Site Alternatives***).

5.6.2 Airline Support Site 1

Airline Support Site 1 is located just south of Taxiway M and west of Runway 18C/36C on the CVG airfield. This site provides expansion opportunity and flexibility to meet any additional market-driven demand that may materialize. Due to the location of the ATCT, however, this site would need to be evaluated further for any line of sight issues it may cause to the extended Runway 36L runway end.

5.6.2.1 Airline Support Site 2

Airline Support Site 2 is also located just south of Runway 09/27 and west of extended Runway 18R/36L. As with Site 1, this site would provide flexibility to meet market-driven demand. Site 2 would not present any issues for line of site to the nearby runway end, however, an extension to Taxiway M would be required to support this site development.

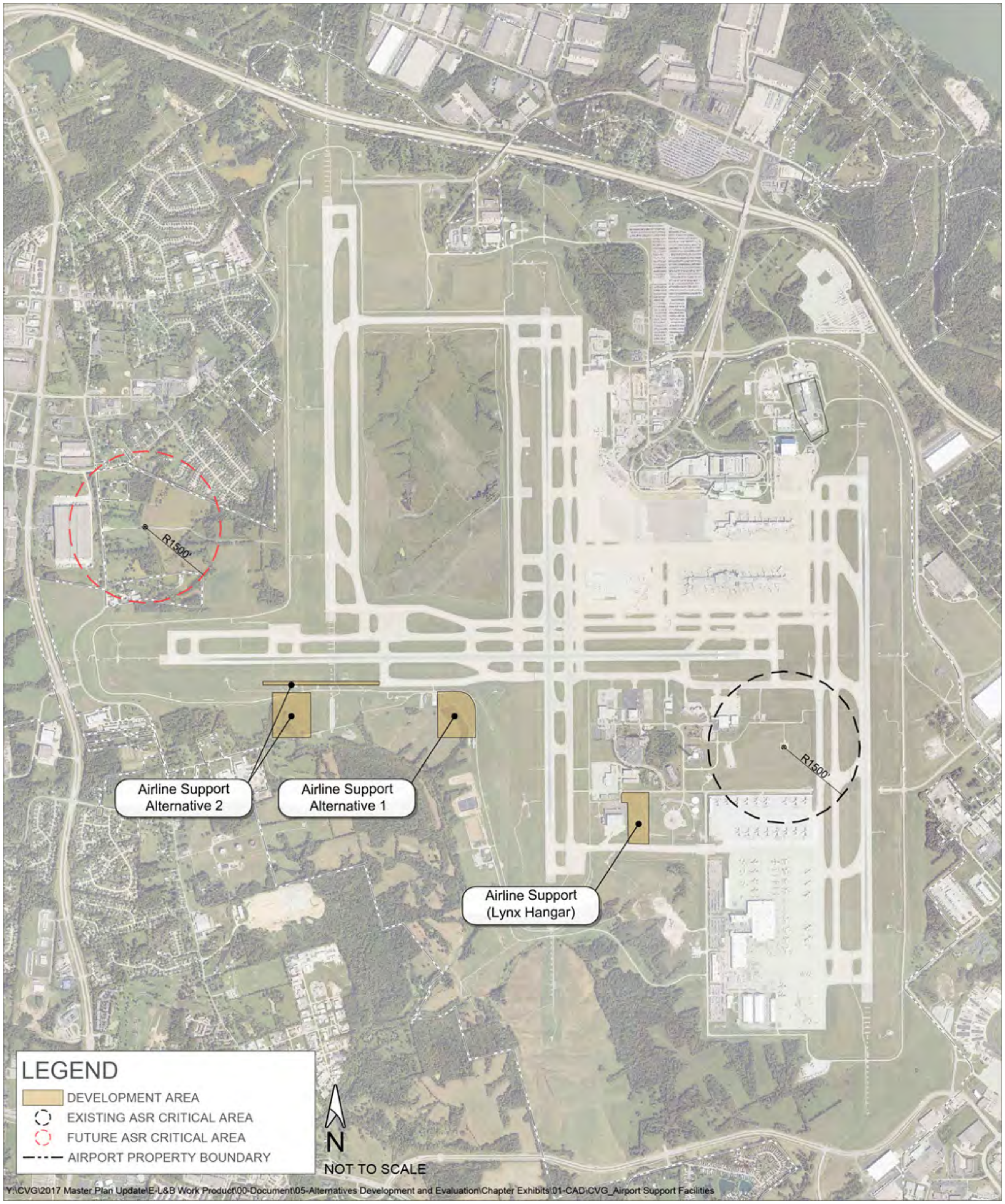
5.6.2.2 Recommendation

Depending on the function of the actual facility being developed, different requirements on configuration and proximity to other facilities or parts of the airfield may exist. Therefore, CVG is best served by maintaining a maximum degree of flexibility to accommodate the need for these additional facilities in the future. For that reason, this Master Plan recommends that both identified sites be designated as Aviation Related Support on the land use plan and future ALP, thereby remaining available for development as airline support facilities should market demand require it.

EXHIBIT 5.6-3 LYNX HANGAR DEVELOPMENT

Sources: Woolpert Photography dated September 23, 2017; KCAB

EXHIBIT 5.6-4 AIRLINE SUPPORT SITE ALTERNATIVES



Sources: Woolpert Photography dated September 23, 2017; KCAB

5.6.2.3 Aircraft Ground Run-Up Site

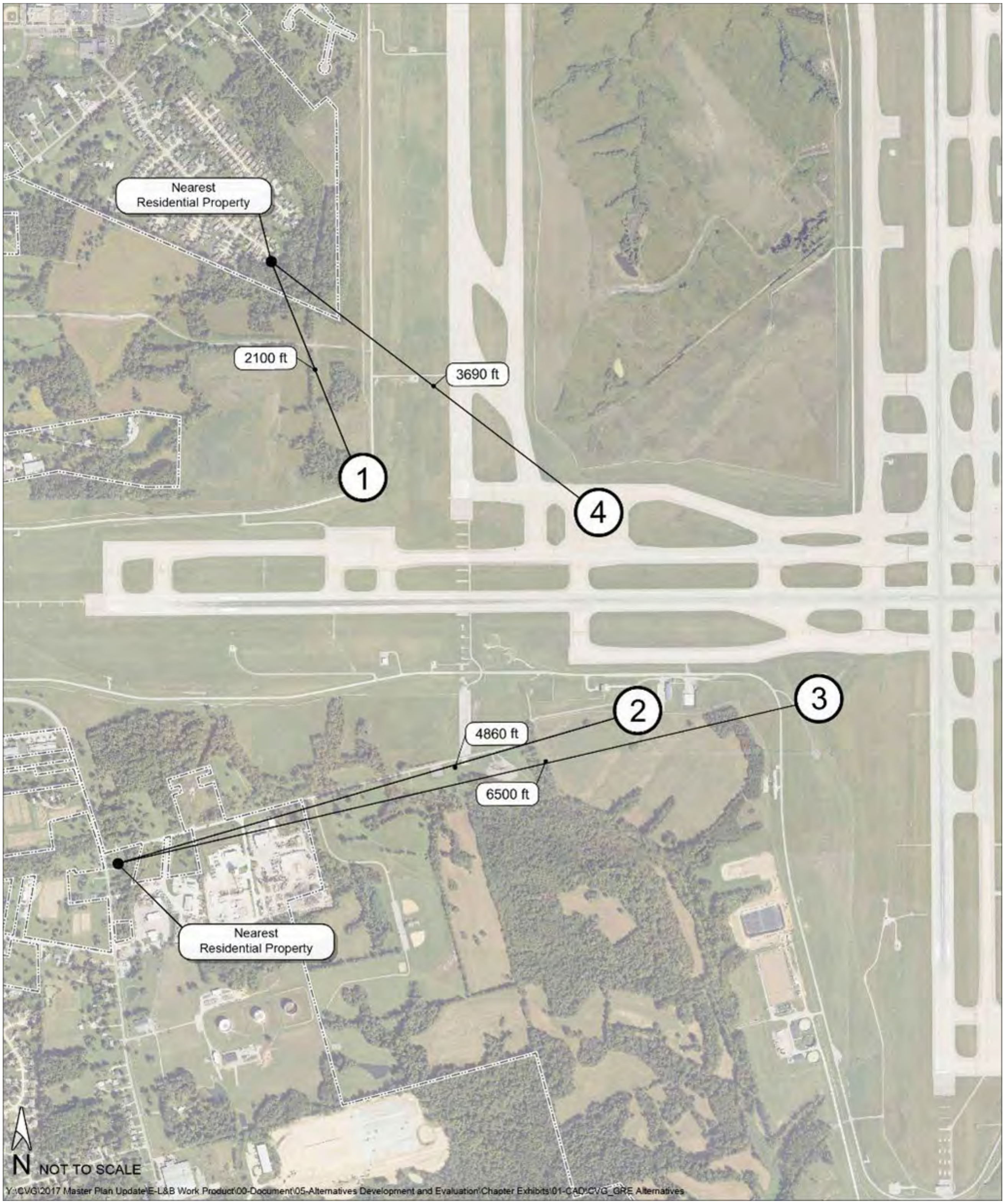
Routine aircraft maintenance activities require engines to be tested at take-off power to ensure the proper operation of the aircraft. These maintenance activities are known as ground run-ups. The location of ground run-up events take place at designated points on the airfield, taking into account take-off power jet blast impacts, impacts to airfield flows, orientation of the aircraft to ensure headwinds are maintained, and the impacts to noise sensitive areas.

Currently aircraft ground run-ups are performed at the far southern end of Taxiway D. In the future as the South Cargo Area is developed, operations at this location will no longer be an option. Therefore, this alternatives analysis has identified four possible locations to perform aircraft ground run-ups in the future. These four alternative sites, along with their respective proximities to existing off-airport development, are identified on **Exhibit 5.6-5, *Ground Run-Up Site Alternatives***. All alternative sites identified are capable of accommodating a Boeing 747-8F ground run-up operation. In some instances, the construction of a Ground Run-up Enclosure (GRE) may be recommended. A GRE has three primary benefits:

- A GRE helps to mitigate the impacts of noise generated by ground run-up operations by directing the noise upward away from the ground where potential noise sensitive areas exist.
- A GRE helps to mitigate the effects of jet blast produced by the ground run-up operations by shielding adjacent areas from the jet blast.
- A GRE helps to shield the aircraft performing the run-up from problematic crosswinds.

A three-sided GRE is the most common type in the U.S. Indianapolis (IND), Portland (PDX), and Chicago-O'Hare (ORD) are prime examples of airports with this type of facility. GREs are constructed of two acoustical paneled sidewalls and one rear acoustical wall with a jet blast deflector. An aircraft has the option of entering the GRE through a tug-in and tug-out operation or a power-in and power-out option depending upon the size of the GRE and type of aircraft performing the run-up.

EXHIBIT 5.6-5 GROUND RUN-UP SITE ALTERNATIVES



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.6.2.4 Ground Run-up Alternative Site 1

Alternative Site 1 is located near the western boundary of CVG north of Runway 09/27. The only existing development occupying the site is an airport service road. Alternative Site 1 is the closest of the four sites under consideration to residential properties at approximately 2,100 feet to the southeast. **Exhibit 5.6-6, *Alternative Site 1 - GRE***, presents the possible development of Alternative Site 1 with a GRE. **Exhibit 5.6-7, *Alternative Site 1 – No GRE***, presents the possible development of Alternative Site 1 without a GRE.

5.6.2.5 Ground Run-up Alternative Site 2

Alternative Site 2 is located south of the far western end of Taxiway M near the Airport Police shooting range and training grounds. The nearest off-airport residential development to Alternative Site 2 is approximately 4,860 feet to the southwest. **Exhibit 5.6-8, *Alternative Site 2 – GRE***, presents the possible development of Alternative Site 2 with a GRE. **Exhibit 5.6-9, *Alternative Site 2 – No GRE,*** presents the possible development of Alternative Site 2 without a GRE.

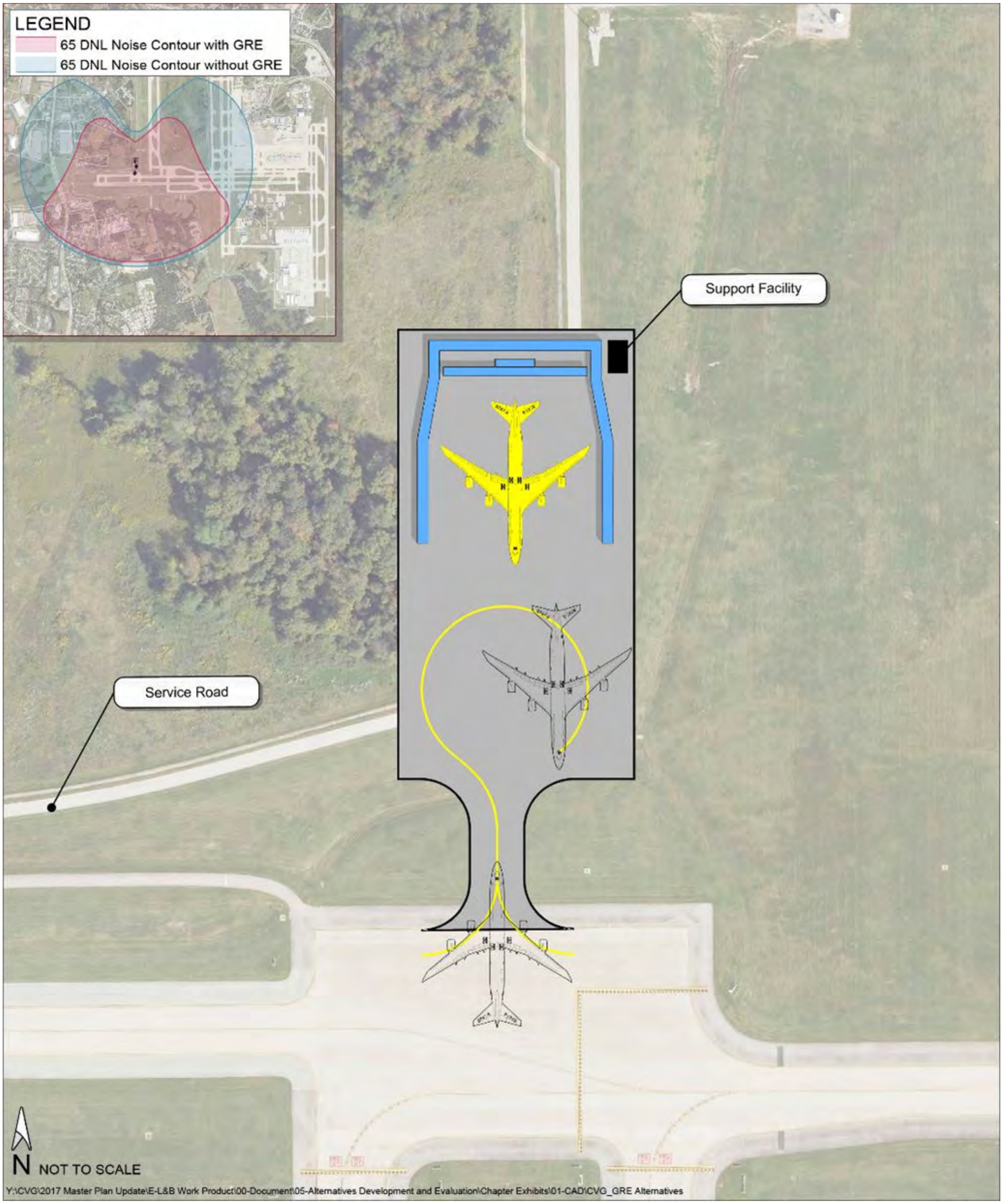
5.6.2.6 Ground Run-Up Alternative Site 3

Alternative Site 3 is located south of Taxiway M just west of the recommended Taxiway C extension. The nearest off-airport residential development to Alternative Site 3 is approximately 6,500 feet to the southwest. **Exhibit 5.6 10, *Alternative Site 3 – GRE***, presents the possible development of Alternative Site 3 with a GRE. **Exhibit 5.6-11, *Alternative Site 3 – No GRE***, presents the possible development of Alternative Site 3 without a GRE.

5.6.2.7 Ground Run-Up Alternative Site 4

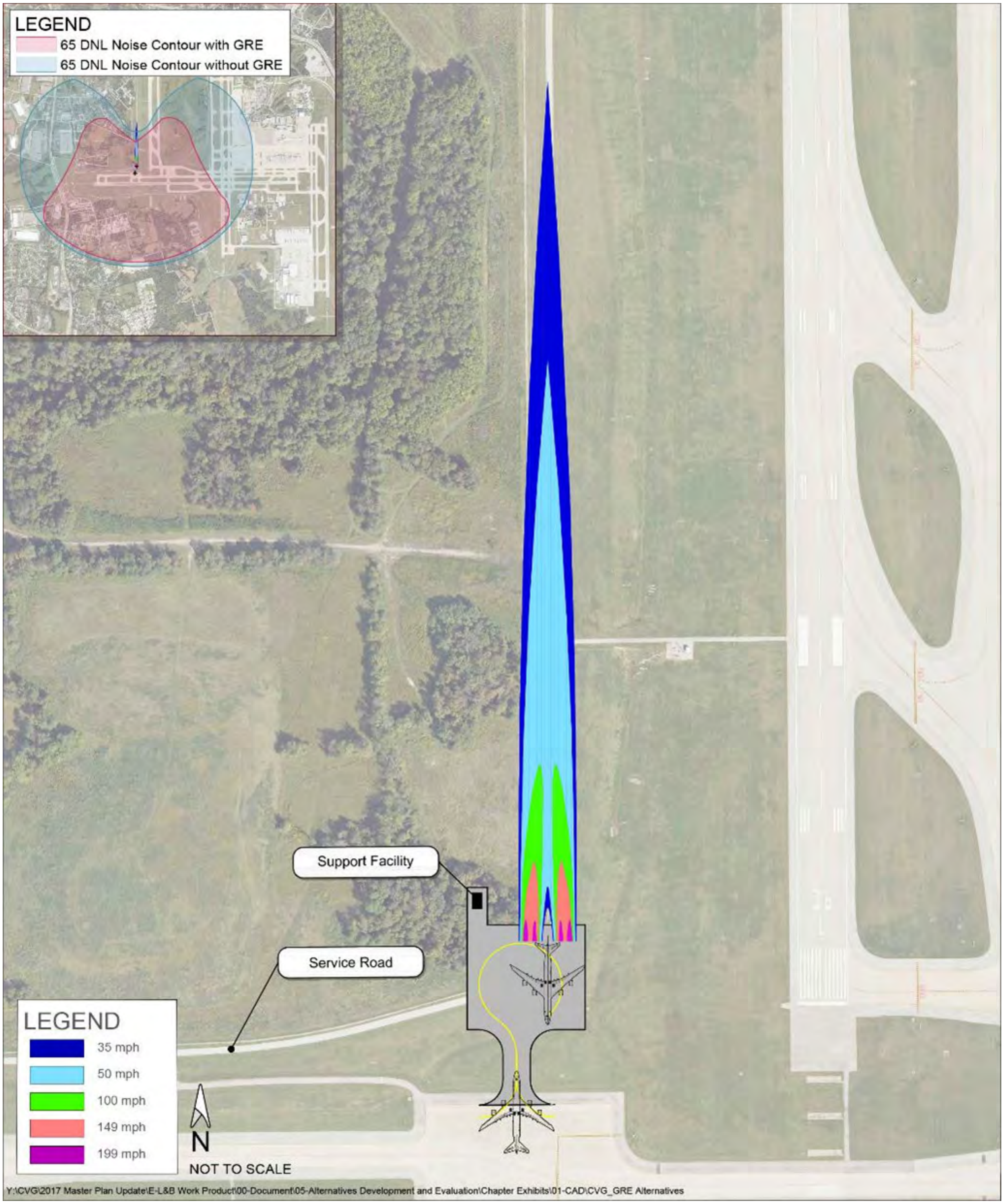
Alternative Site 4 is located on the existing Juliet Holdpad between Taxiways J and K. The nearest off-airport development to Alternative Site 4 is approximately 3,690 feet to the northwest and is a residential development. Given that the location of Alternative Site 4 is an existing holdpad with other operational requirements when not being used for ground run-up operations, the development of a GRE is not feasible at this location. **Exhibit 5.6-12, *Alternative Site 4 – No GRE***, presents the use of the Juliet holdpad for ground run-up operations.

EXHIBIT 5.6-6 ALTERNATIVE SITE 1 – GRE



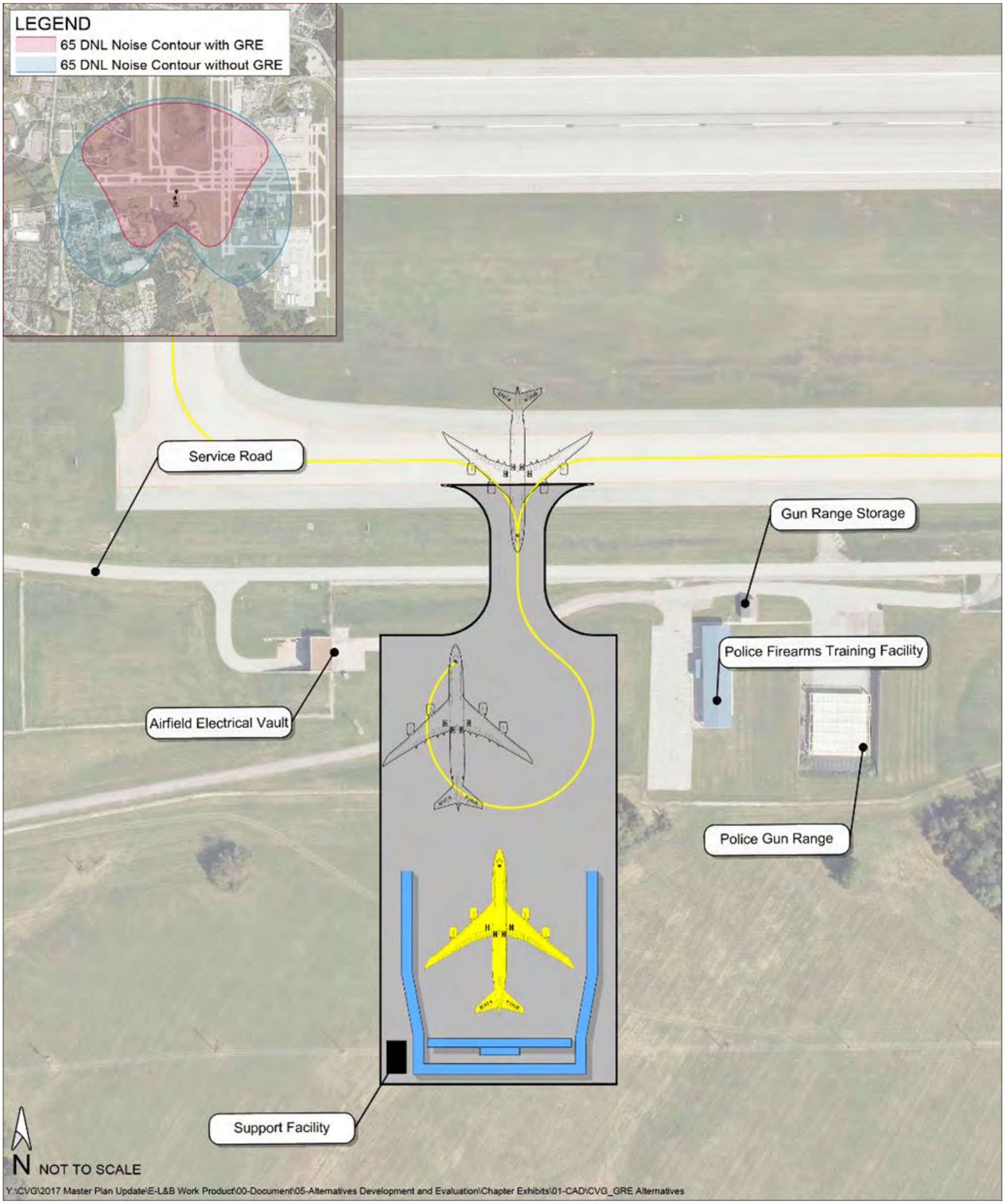
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.6-7 ALTERNATIVE SITE 1 – NO GRE



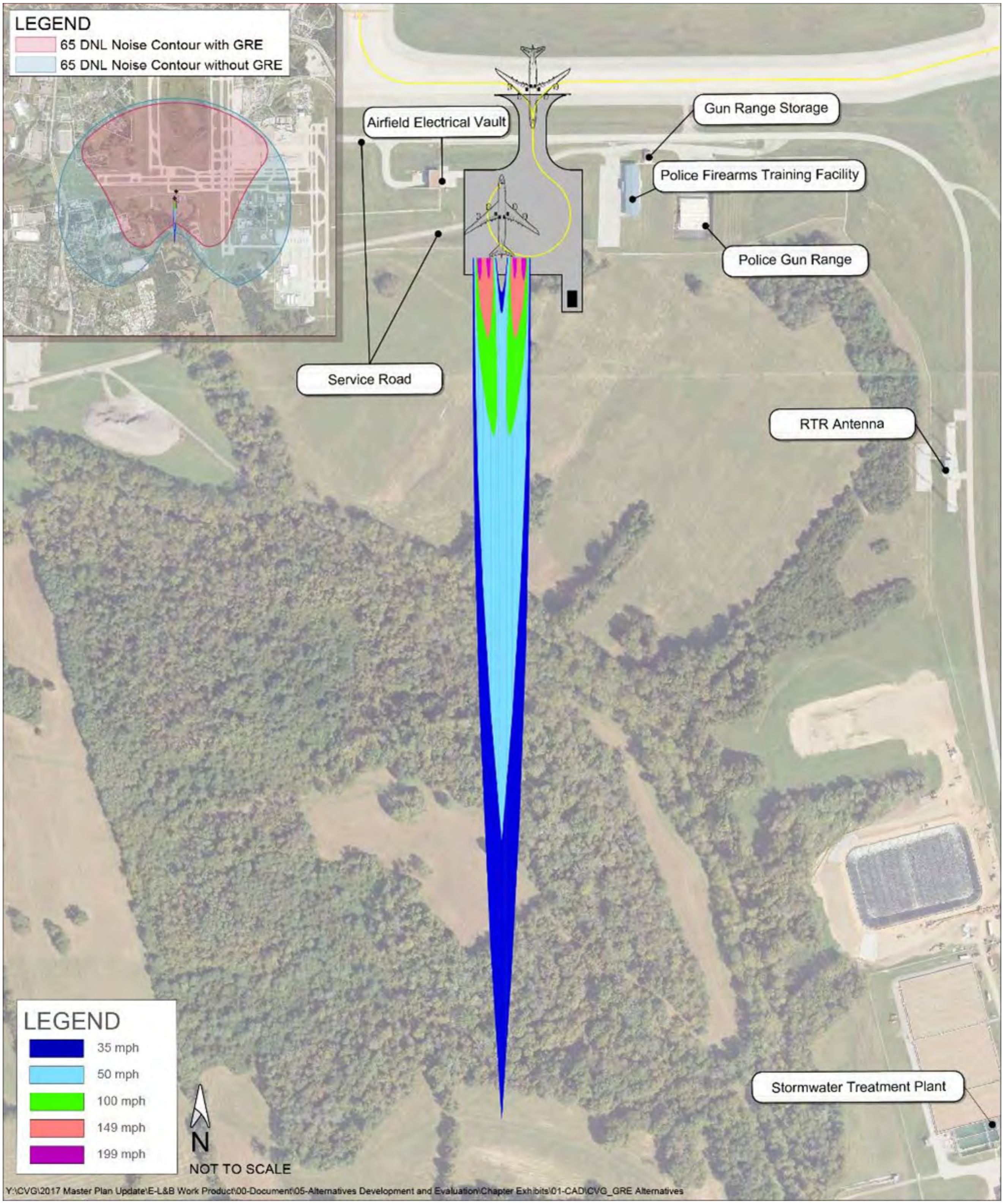
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.6-8 ALTERNATIVE SITE 2 – GRE



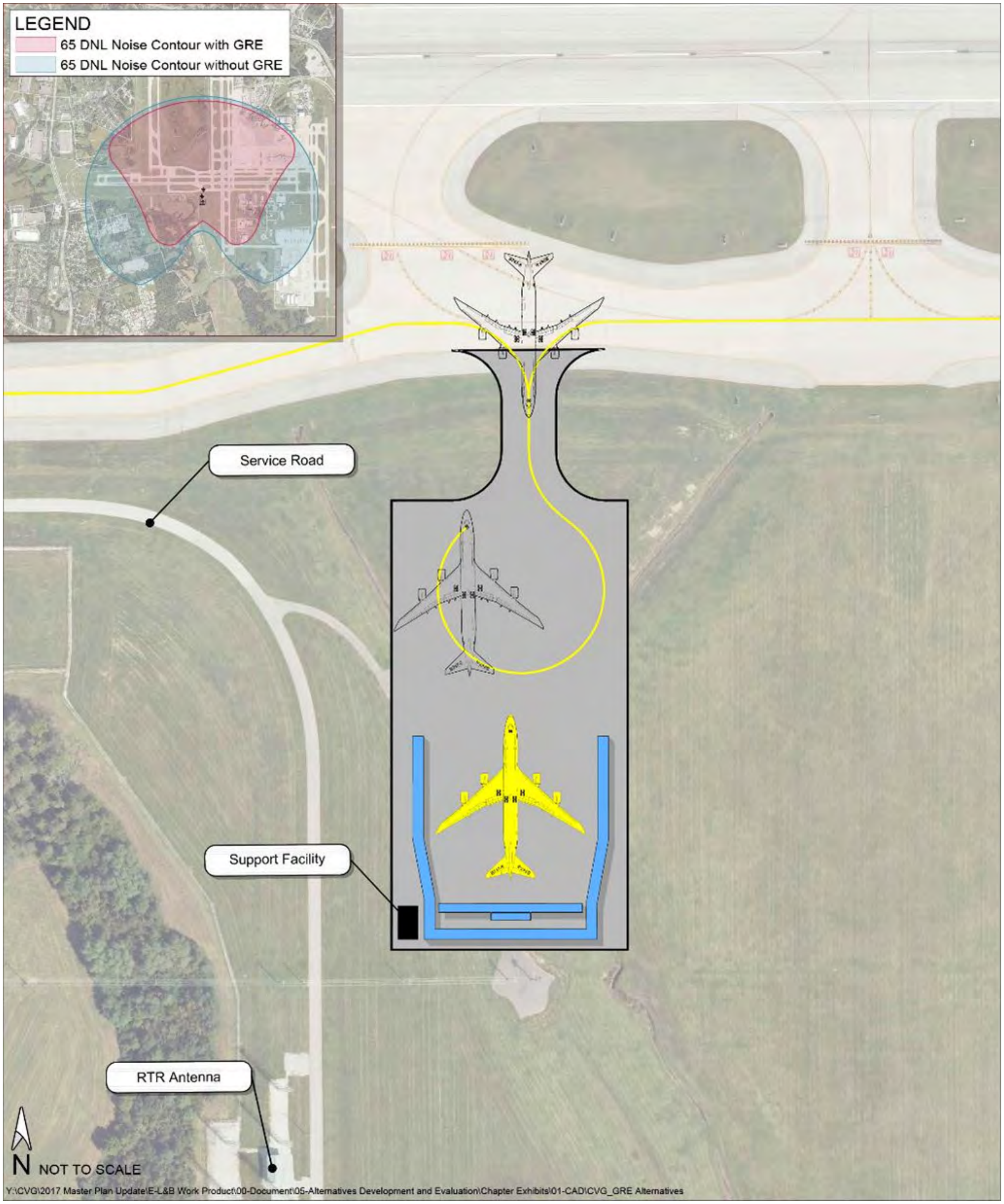
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.6-9 ALTERNATIVE SITE 2 – NO GRE



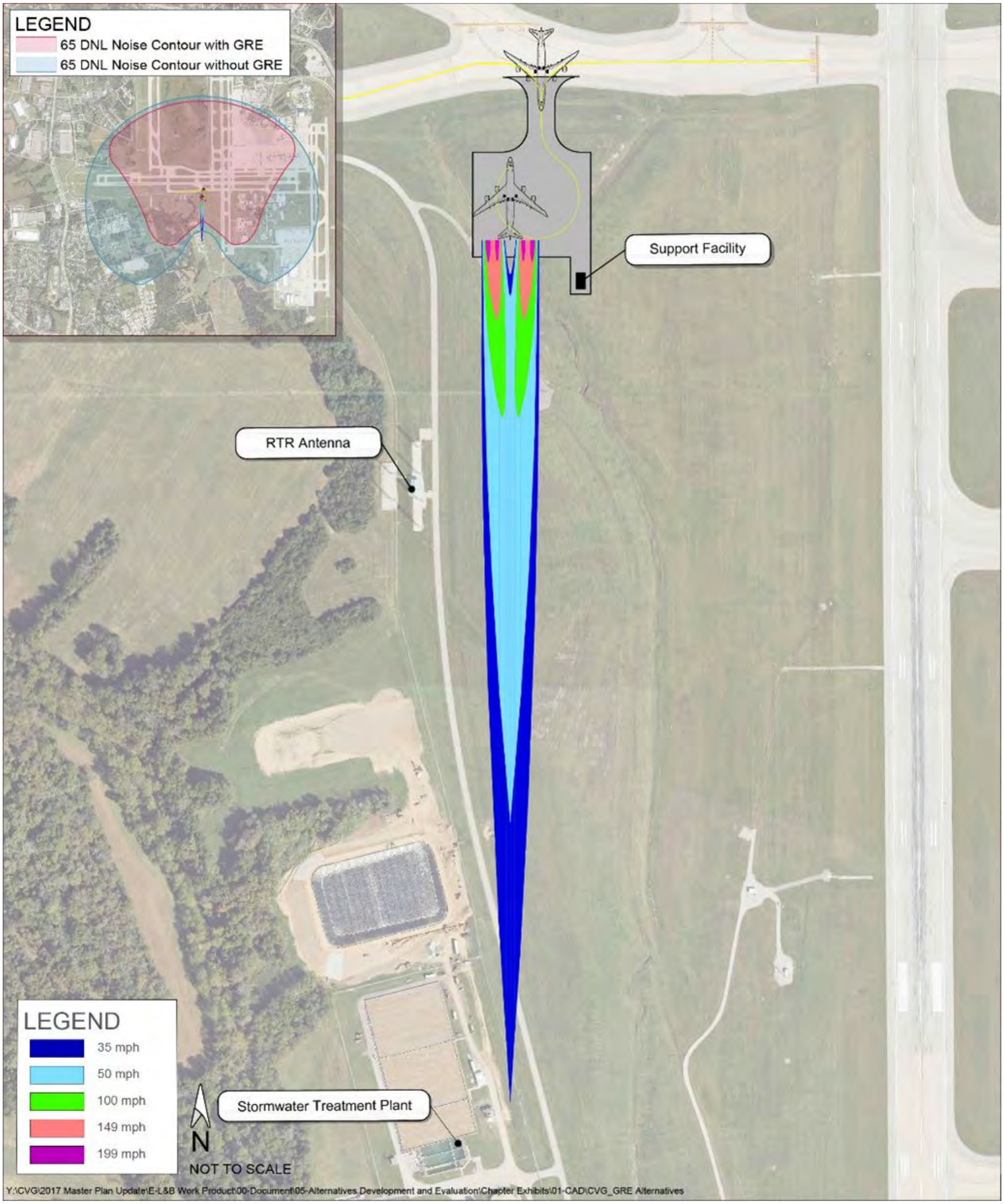
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.6-10 ALTERNATIVE SITE 3 – GRE



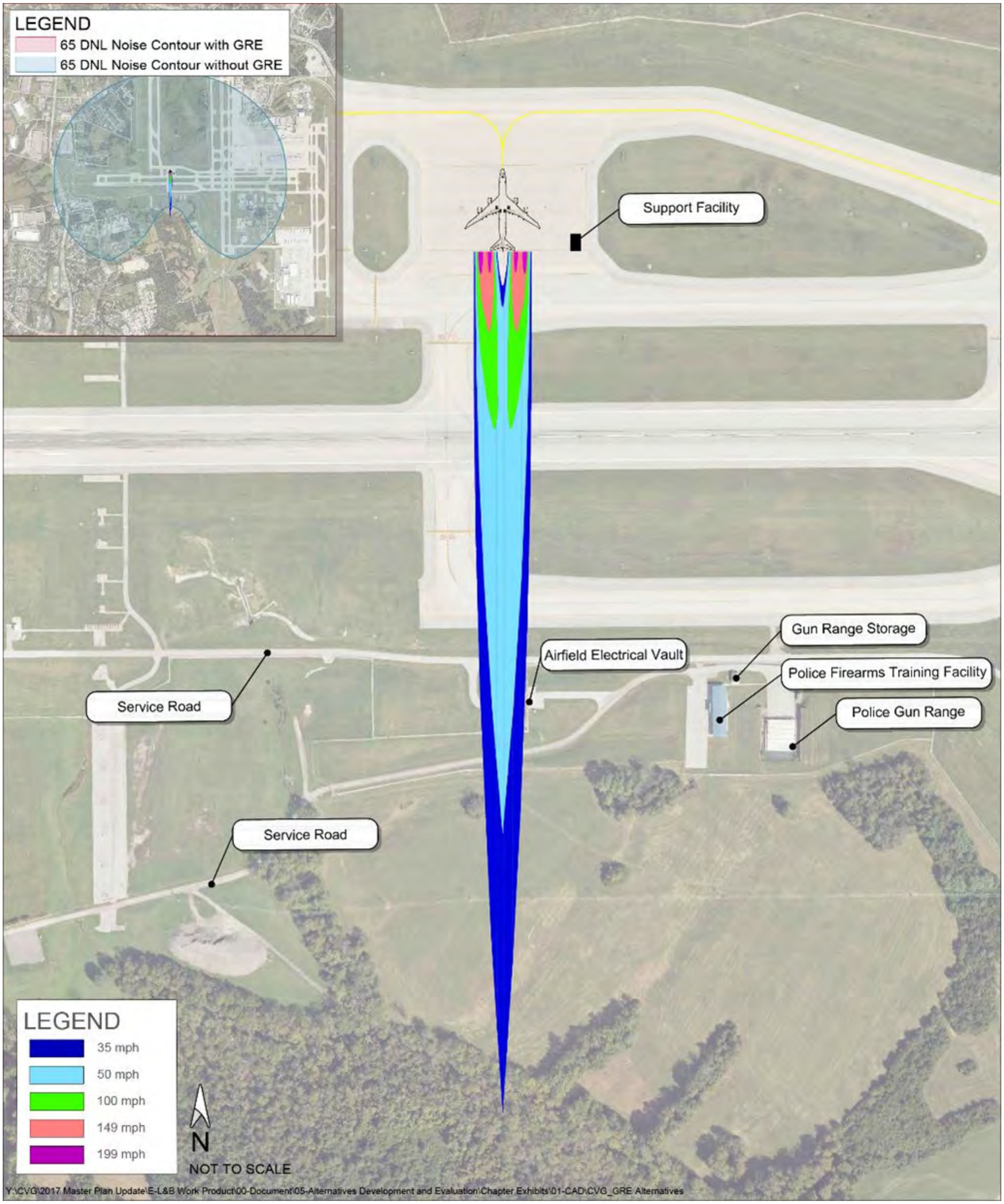
Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.6-11 ALTERNATIVE SITE 3 – NO GRE



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

EXHIBIT 5.6-12 ALTERNATIVE SITE 4 – NO GRE



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

Aircraft Ground Run-up Site Evaluation

Table 5.6-1, *Aircraft Ground Run-up Site Evaluation*, presents a comparison of the four alternative sites for aircraft ground run-up operations at CVG. The factors considered in this evaluation include operational and safety impacts, environmental impacts, land- use considerations, and financial considerations. The evaluation criteria are defined as follows:

- **Impacts to Existing/Planned Facilities**: Does the proposed engine run-up site impact any existing or planned facilities?
- **Proximity**: Does the proposed engine run-up site provide a location that is proximate to the primary users of the facility and offer efficient movements to and from the location?
- **Orientation Flexibility**: Does the proposed engine run-up site offer flexibility in the orientation of the aircraft performing the run-up in order to orient the aircraft into the wind?
- **# of Runway Crossings**: The number of runways an aircraft originating from the primary users (south airfield cargo operators) will be required to cross to reach the proposed engine run-up site.
- **Jet Blast Impacts**: Does the proposed engine run-up site produce adverse jet blast impacts?
- **GRE Required**: Does the proposed engine run-up site require a GRE in order to minimize noise impacts to residential development?
- **New Infrastructure Required**: Does the proposed engine run-up site require the development of new airfield pavement infrastructure?

TABLE 5.6-1 AIRCRAFT GROUND RUN-UP SITE EVALUATION

Evaluation Criteria	Site Alternative			
	1	2	3	4
Impacts to Existing/Planned Facilities	Yes	Yes	No	No
Proximity	Low	Medium	High	Low
Orientation Flexibility	Medium	Medium	Medium	High
# of Runway Crossings	2	1	1	2
Jet Blast Impacts	High	Medium	Medium	Medium
GRE Required	Yes	Yes	No	N/A
New Infrastructure Required	Yes	Yes	Yes	No

Source: Landrum & Brown analysis

When taking into account all considerations mentioned previously, Alternative Site 3 is the recommended site to develop for Aircraft Engine Run-up operations. Site 1 was eliminated for its distance from the primary users, the number of runway crossings, and the potential impacts to existing residential developments to the west of CVG. Site 2 would limit the number of runway crossings required and is closer to the users of the facility, however, development of this site would likely require the relocation of the existing police shooting range and training facility. Site 4 provides the only option that would not require the development of additional airfield pavement infrastructure, but its potential noise impacts and inability to accommodate a GRE eliminate it from being a viable long-term solution. While Site 3 would require new airfield pavement infrastructure, it would provide a facility that is proximate to the primary users, limit the number of runway crossings, and is the least impactful to off-airport development without requiring the development of a GRE. Should a GRE be determined to be necessary in the future, Site 3 is capable of accommodating such a facility.

5.6.3 Airport Support

Airport support facilities provide space for storage, airport maintenance, deicing equipment, and other similar uses dedicated to keeping CVG in efficient operating condition. There are 13 total airport support facilities at CVG. The facility requirements analysis in Chapter 4, Facility Requirements, Section 4.6.2, *Airport Support*, found that 142,000 square feet of additional maintenance support buildings will be needed by PAL 4. Additionally, vehicle parking should be developed to support any new facilities.

The current airport support facilities at CVG are located in the south airfield. It is recommended that airport support facilities be kept in a consolidated area that provides landside and airside access. Two airport support alternative sites were identified. The two overall areas that were considered for airport support facility development are presented in **Exhibit 5.6-13, *Airport Support Alternative Sites.***

EXHIBIT 5.6-13 AIRPORT SUPPORT SITE ALTERNATIVES

Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.6.3.1 Airport Support Site 1

Airport Support Site 1 would allow for additional airport support facilities to be co-located with the majority of existing similar facilities in the south airfield. Because of the existing level of development in that area, it would not be possible to accommodate all new facilities in a contiguous development nor would it be possible to develop much without the recommended relocation of the ASR-9. However, this area would provide the benefit of proximity to other similar facilities at CVG. Site 1 would provide ample opportunities for access to both the existing landside and airside networks. In addition, Site 1 would provide additional areas available for expansion, once the ASR-9 has been relocated as recommended.

5.6.3.2 Airport Support Site 2

Airport Support Site 2 is located in the northeast portion of CVG. This location was previously used as the Delta hangar, but its upcoming vacancy would allow for redevelopment of the site. The site would also provide the benefit of landside and airside access and contiguous site development; however, it does not provide proximity to similar facilities.

5.6.3.3 Recommendation

Depending on the function of the actual facility being developed, different requirements on configuration and proximity to other facilities or parts of the airfield may exist. Therefore, CVG is best served by maintaining a maximum degree of flexibility to accommodate the need for these additional facilities in the future. For that reason, this Master Plan recommends that each of the identified sites be designated as Aviation Related Support on the land use plan and the future ALP, so the sites remain available for development as airport support facilities as needed.

5.6.4 Aircraft Fuel

The fuel facilities at CVG currently provide an existing capacity of 5,000,000 gallons of fuel, resulting in just under a 4-day supply. This currently meets the industry standard of offering a 3-day fuel supply. The facility requirements analysis identified a projected demand of 23.5 million gallons of fuel storage in PAL 4 to maintain a 3-day supply. It is anticipated that the majority of the future fuel storage needs will be provided for by the planned South Cargo Area development, which will provide a second fuel farm at CVG. While no additional fuel tanks are projected to be required at the existing fuel farm, there is sufficient area for expansion if needed. **Exhibit 5.6-14, *Existing Fuel Farm Expansion***, present the possible development of one additional fuel storage tank at the existing fuel farm.

EXHIBIT 5.6-14 EXISTING FUEL FARM EXPANSION

Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.6.5 Aircraft Deicing

Aircraft deice in three different locations at CVG. The passenger airlines and FedEx deice at the newly constructed Pad 13, located at the former Concourse C site (see **Exhibit 5.6-15, *Aircraft Deicing***). DHL deices on their ramp and Amazon will have a deicing pad on their ramp once it is built.

The requirements analysis in Chapter 4, Facility Requirements, Section 4.6.4, *Aircraft Deicing*, identified a need for four additional deicing positions by PAL 4 for the passenger airlines and FedEx. There is currently a hold pad to the north of Pad 13. This site would make an ideal location for deicing. It is adjacent to the existing deicing pad and is centrally located on the airfield.

Requirements for deicing positions were identified for DHL and Amazon. These positions were assumed to continue to be located on the cargo carriers' respective ramps. As a result, no further analysis was conducted for DHL and Amazon deicing facilities.

EXHIBIT 5.6-15 AIRCRAFT DEICING

Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.6.6 General Aviation

The facility requirements for GA facilities presented in Chapter 4, Facility Requirements, Section 4.6.6, *General Aviation*, indicate there is a need for approximately 73,000 square feet of additional hangar space, and 237,000 square feet of additional apron space through PAL 4.

Ideally, GA facilities should be located away from the passenger terminal facilities, but still provide airfield and landside access. It is preferred to keep the general aviation facilities in a consolidated area. Three potential general aviation sites were identified for analysis. The three alternative GA expansion sites are presented in **Exhibit 5.6 16, *General Aviation Site Alternatives***. In addition to these sites, the Ameriflight hangar is no longer occupied and can potentially be reused or expanded for GA purposes.

5.6.6.1 General Aviation Site 1

General Aviation Site 1 provides an area on the west side of CVG, north of Runway 09/27. This area offers adequate space for general aviation hangers with room for expansion. There is sufficient access to the airfield and connectivity through existing Taxiway K. Landside access can be provided for this site, but additional roadways would have to be developed. Site 1 is not adjacent to the existing GA facilities.

5.6.6.2 General Aviation Site 2

General Aviation Site 2 provides an area in the south airfield along existing Taxiway M. This area offers adequate space for general aviation hangers but would not allow for a lot of expansion. The site offers sufficient access to the airfield and connectivity through current Taxiway M. This site would be able to tie into the existing roadway network without the development of additional landside network. This site is adjacent to the current general aviation sites.

5.6.6.3 General Aviation Site 3

General Aviation Site 3 provides an area in the North Airfield along existing Taxilane E, near the CVG Cargo Building (Building 4) and Sign and Graphics Building. This area offers adequate space for general aviation hangers with direct access from Loomis Road and Logan Drive. The site offers sufficient access to the airfield and connectivity through current Taxilane E. This site provides adequate apron space for any corporate or GA maintenance hangar needs.

5.6.6.4 Recommendation

Due to the landside access issues and ,lack of adjacency to similar uses, Site is not recommended. Sites 2 and 3 offers sufficient space to meet the GA requirements and provide excellent airfield and landside access, however, Site 2 is dependent on relocating the ASR. For that reason, this Master Plan recommends that Site 3 be designated as General Aviation on the land use plan and future ALP, thereby remaining available for development as a GA facility.

EXHIBIT 5.6-16 GENERAL AVIATION SITE ALTERNATIVES

Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.6.7 Government/Police

The facility requirements analysis presented in Chapter 4, Requirements, Section 4.6.8, *Government/Police*, identified a requirement of approximately 31,000 square feet of additional general facility building to accommodate PAL 4 demand. Additionally, vehicle parking should be developed to support all new facilities. The current government/police facilities at CVG are located in the south airfield and north of the main terminal building. **Exhibit 5.6-17, *Government/Police Facilities Alternatives***, presents the three site alternatives identified as part of this analysis.

5.6.7.1 Government/Police Facilities Site 1

Site 1 is located north of the main terminal, west of the Delta Air Cargo building. This area provides easy landside access to current roads, currently serves as a contractor staging lot. It is also located near the main government building at CVG, the Airport police department building. Once developed, this site has additional room for expansion.

5.6.7.2 Government/Police Facilities Site 2

Site 2 is located south of the western end of Taxiway M. This area provides easy landside access to the existing airport service road network and is located adjacent to other existing government facilities. Development of new police facilities here would enable further consolidation. Once developed, this site has additional room for expansion.

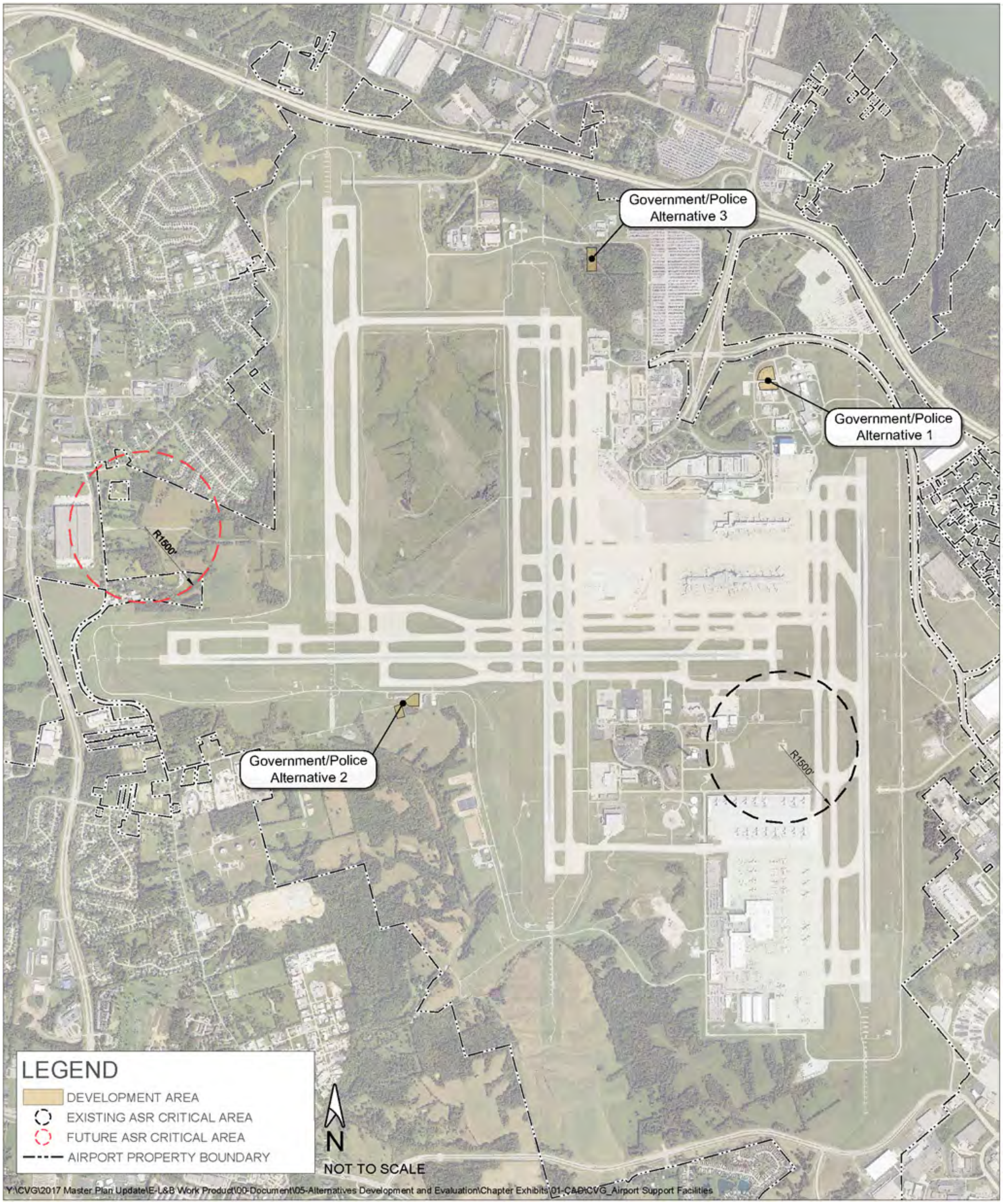
5.6.7.3 Government/Police Facilities Site 3

Site 3 is located in the North Airfield along Loomis Road. This area provides easy landside access via existing roads. This site is not located near any current police facilities but does have room for expansion.

5.6.7.4 Recommendation

The Site 2 area is most suitable for the develop of facilities benefiting from direct access to the airfield and should not be reserved for the development government/police facilities. Site 3 provides a site connected to landside facilities, however, offers no connection to nearby police facilities. For that reason, this Master Plan recommends that Site 1 be designated as Aviation Related Support on the land use plan and the future ALP.

EXHIBIT 5.6-17 GOVERNMENT/POLICE FACILITIES ALTERNATIVES



Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.6.8 Airport Hotel

The Doubletree Hotel by Hilton is located north of the main terminal and the Terminal 1 Garage, as shown on **Exhibit 5.6-18, *Airport Hotel Site***. Chapter 4, Facility Requirements, Section 4.6.10, *Airport Hotel*, determined that hotel expansion may be needed based on forecast passenger growth. The analysis identified a potential need for an additional 45,000 square feet of hotel space by PAL 4. The existing hotel site has available land to develop additional hotel rooms and auto parking to accommodate the PAL 4 demand. Should further expansion be needed, a second hotel site should occur in any land reserved for commercial development on the land use plan.

EXHIBIT 5.6-18 AIRPORT HOTEL SITE

Sources: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

5.6.9 Summary of Recommendations

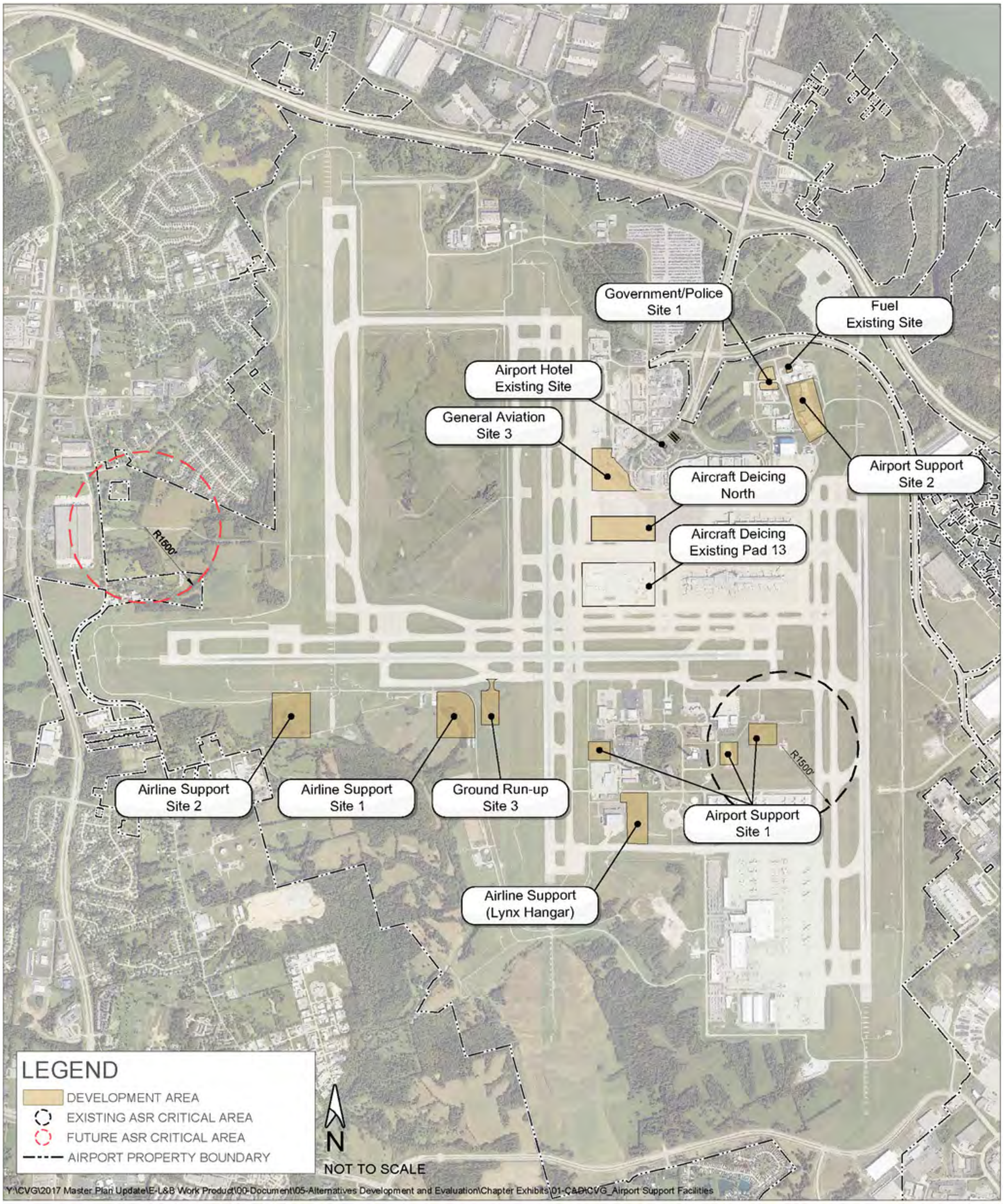
The facility requirements analysis presented in Chapter 4 identified requirements for CVG's support facilities. **Table 5.6-2, *Summary of Support Facility Recommendations***, and **Exhibit 5.6-19, *Summary of Support Facility Site Recommendations***, present the recommendations proposed by this Master Plan Update.

TABLE 5.6-2 SUMMARY OF SUPPORT FACILITY RECOMMENDATIONS

Facility	Additional Space Required – PAL 4	Potential Development Sites
Airline Support	7,600 ft^2	Site 1 (south of 09/27, east of 18R/36L) Site 2 (south of 09/27, west of 18R/36L) Lynx Hangar (South Airfield)
Ground Run-Up Pad/GRE	One pad	Site 3 (south of 09/27, west of 18C/36C)
Airport Support	142,000 ft^2	Site 1 (South Airfield) Site 2 (Delta Cargo Hangar)
Aircraft Deicing – North	4 positions	North of Pad 13
Aircraft Deicing – South	6 positions (DHL) 26 positions (Amazon)	Existing DHL apron Planned Amazon apron
Aircraft Fuel	18.5 million gallons	Add fuel tank on existing site if needed
General Aviation	310,700 ft^2	Site 3 (east of 18C/36C)
Government/Police	31,000 ft^2	Site 1 (North Airfield)
Airport Hotel	45,000 ft^2	Expand on existing site

Note: Not all sites are needed to meet the forecast requirements, however CVG should reserve all sites to allow for flexibility in future development.
Source: Landrum & Brown analysis

EXHIBIT 5.6-19 SUMMARY OF SUPPORT FACILITY SITE RECOMMENDATIONS



Source: Woolpert Photography dated September 23, 2017; Landrum & Brown analysis

MASTER PLAN 2050

Chapter 6 | Implementation Planning

CVG
CINCINNATI/NORTHERN KENTUCKY
INTERNATIONAL AIRPORT

L&B
TEAM

6 Implementation Planning

6.1 Introduction

The previous chapters of the Cincinnati/Northern Kentucky International Airport (CVG) Master Plan evaluated the existing facilities, projected future activity levels, identified potential facility needs, evaluated alternatives, and made recommendations for addressing those facility needs. This chapter presents the initial recommended Master Plan projects, an assessment of financial feasibility, and the final recommended implementation plan based on the financial analysis. Because actual aviation activity rarely occurs as forecast, especially over a 20+ year planning horizon, this recommended implementation plan should only be used as a general guide for project timing; projects should not be implemented until actual activity justifies the project and funds are available.

The recommended Master Plan projects were grouped into four phases that correspond to the Planning Activity Levels (PALs) presented in Chapter 4, *Facility Requirements*. The requirements are tied to activity levels, not specific years. The annual forecast activity levels that correspond to each PAL are shown in **Table 6.1-1, *Planning Activity Levels***.

TABLE 6.1-1 PLANNING ACTIVITY LEVELS

PAL	Million Annual Passengers (MAP)	Total Annual Operations
PAL 1	11	200,000
PAL 2	13	260,000
PAL 3	16	350,000
PAL 4	19	460,000

Source: Chapter 4, *Facility Requirements*

6.2 Initial Recommended Projects and Phasing

This section provides the initial list of recommended projects that resulted from the Chapter 4, *Facility Requirements*, and Chapter 5, *Alternatives Development and Evaluation*, analyses. The recommended projects were categized by development type (airfield, terminal, landside, and support facilities) as shown in **Table 6.2-1, *Initial Recommended Projects and Phases***. Each of the projects shown in the table was assigned a phase (PAL 1 through PAL 4) based on the timing identified in the Chapter 4 facility requirements analysis.

Some projects have multiple PALs listed because they were assumed to be implemented incrementally throughput the planning period based on forecast demand. For example, terminal expansion is shown in PALs 1, 2, and 3 because the Chapter 4 facility requirements analysis identified a need for expansion of different terminal facilities at each of these PALs.

TABLE 6.2-1 INITIAL RECOMMENDED PROJECTS AND PHASE

Project	PAL
Airfield	
Taxiway N Extension	1
Relocation of Taxiway S4 & Demo	1
Parallel Crossfield Taxilane	1
Relocation of Taxiway D2 & Demo	1
Relocation of Taxiway E9 & Demo	2
Runway 36C High Speed Exit East and D8 Demo	2
Runway 36C High Speed Exit East and D6/D7 Demo	2
Relocation of Taxiway S8 & Demo	2
Relocation of Taxiway S6/S7 & Demo	2
Taxiway E Relocation (north) & Demo	3
Taxiway E Extension South	3
Taxiway J2 & J4 Demo	3
Runway 18R/36L Extension	3
Runway 36C High Speed Exit West & Demo	4
Runway 36C High Speed Exit West & Demo	4
Taxiway C Extension and High Speed Exit	4
Runway 18L High Speed Exit	4
Runway 36R High Speed Exit	4
Terminal	
Terminal Expansion	1,2,3
Bag Belts from CSB to Terminal	1
Bag System Long-Term	2
KCAB Office Building (if desired)	3
Concourse A Improvements	2,3,4
Concourse B Improvements	3,4
Landside	
SB KY 212/I-275 WB Entrance Ramp Improvements	1
Loomis Road/Donaldson Road Improvements 0Part 1	1
Wendell Ford Blvd Capacity Improvements & Extension	1
Construction of New T1 Parking Garage	1
Construction of New Cell Phone Lot	1
Expansion of Taxi Bullpen to add TNC	1

Project	PAL
Expansion of T3 Parking Garage	1
Reconstruct I-275 Interchange – Part 1,2,3,4	2
Donaldson Road Ramp Improvements – Part 1	2
Widen South Airfield Drive	2
Terminal Drive Improvements – Part 1	2
Construction of Replacement Employee Lot	2
Construction of New T3B Parking Garage	2
Convert Existing Employee Lot to Long-Term Parking	2
Loomis Road/Donaldson Road Improvements – Part 2	3
Donaldson Road Ramp Improvements – Part 2,3	3
Expansion of T3B Parking Garage	3
Terminal Drive Improvements – Part 2	4
Expand ValuPark Parking Lot	4
Support Facilities	
General Aviation Hangar and Apron	1,2,3,4
Ground Run-up Pad	1
Ground Run-up Enclosure	1
Deicing Pad	2
Government/Police Facility	2,4
Airline Support Facility	3
Airport Maintenance Building	3,4
Airport Hotel	3,4

Source: Landrum & Brown Team analysis

6.3 Financial Plan

Section 6.2, *Initial Recommended Projects and Phasing*, identified an initial list of projects and their timing based on forecast demand. This section addresses the financial implications of the proposed projects. The purpose of this financial analysis is to determine if the development program is financially feasible. Regardless of the identified need for improvements, the ability to fund the capital program will ultimately determine when projects are implemented.

The estimated cost implications and anticipated timing of each project is discussed in the following sections. The findings are meant to inform CVG of the financial implications of each project and to inform the decisions that will ultimately decide the final recommended implementation program.

6.3.1 Forecast of Future Aviation Activity

A key input to the financial plan is the forecast of future activity. The forecast determines the timing of projects and the potential revenues that can be assumed. The most conservative approach to the financial plan is to use a lower forecast for Passenger Facility Charges (PFC) revenue projections and a higher forecast for the project implementation schedule. The Master Plan prepared several different forecasts based on different methodologies and assumptions.[1] The CVG financial plan assumed the use of the Low Case Scenario forecast from Appendix 1-B, *Alternative Forecasts,* for PFC projections and the Appendix 1-B Recommended Forecast for the project implementation schedule. This conservative approach, rather than using the FAA-approved forecast, assures that the CVG Master Plan development program is financially feasible.

The financial forecast used in this analysis is shown in **Table 6.3-1*, Financial Forecast.***

[1] The Federal Aviation Administration (FAA)-approved forecast is described in Chapter 3, *Aviation Activity Forecast.* The other forecasts that were prepared can be found in Appendix 1-B, *Alternative Forecasts*.

TABLE 6.3-1 FINANCIAL FORECAST

Master Plan Financial Affordability Analysis (For the Fiscal Years Ending December 31)											
	PAL 1				PAL 2					PAL 3	PAL 4
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2037	2050
Enplaned Passengers											
By Itinerary Type											
Resident	2,570,018	2,673,696	2,801,323	2,965,012	3,038,539	3,113,098	3,188,396	3,265,516	3,344,500	3,859,803	4,452,064
Visitor	1,575,323	1,637,969	1,717,396	1,817,083	1,861,612	1,908,116	1,954,269	2,001,538	2,049,950	2,365,796	2,728,811
Subtotal O&D Enplaned Passengers	4,145,341	4,311,665	4,518,719	4,782,095	4,900,151	5,021,214	5,142,665	5,267,054	5,394,451	6,225,598	7,180,876
Connecting Enplaned Passengers	359,359	372,835	376,481	387,705	394,694	401,700	411,416	421,367	431,559	498,052	574,474
Total Enplaned Passengers	**4,504,700**	**4,684,500**	**4,895,200**	**5,169,800**	**5,294,845**	**5,422,914**	**5,554,081**	**5,688,421**	**5,826,010**	**6,723,650**	**7,755,350**
Landed Weight (1,000 Pounds)											
Passenger Airlines	5,085,806	5,288,801	5,526,681	5,836,704	5,977,880	6,122,470	6,270,558	6,422,227	6,577,565	7,591,001	8,755,790
Cargo Airlines	7,383,802	7,810,067	8,046,267	8,765,423	9,249,038	9,759,336	10,297,788	10,865,948	11,465,456	14,978,911	19,005,111
Charter / Cargo Other	26,208	27,721	28,560	31,112	32,829	34,640	36,551	38,568	40,696	53,167	67,458
Total Landed Weight (1,000 lbs)	**12,495,817**	**13,126,589**	**13,601,508**	**14,633,239**	**15,259,747**	**15,916,446**	**16,604,897**	**17,326,744**	**18,083,717**	**22,623,078**	**27,828,358**
Total Aircraft Operations	**169,076**	**179,498**	**190,759**	**202,940**	**212,547**	**222,769**	**233,655**	**245,253**	**257,620**	**312,380**	**378,520**

Sources: KCAB; Appendix 1-B, *Alternative Forecasts*; and LeighFisher analysis

6.3.2 Baseline Financial Metrics

Fitch Ratings (Fitch) prepares an annual Airport Medians Report that is used as a basis for certain peer comparisons. The findings of this report are presented in part in **Table 6.3-2, *Comparison of Key Metrics*.** The findings are compared to CVG on **Exhibit 6.3-1, *Comparison of Key Metrics***. In November 2019, Fitch rated the Kenton County Airport Board (KCAB) outstanding Airport Revenue Bonds A+ with a Stable Outlook. Additional information or considerations relative to the bond rating can be obtained from Fitch Ratings.

CVG is required to maintain annual debt service coverage of 1.25x annually and currently sets appropriate airline fees and charges pursuant to the Airport Use Agreement and within the requirements of the General Bond Resolution. In 2018, CVG's debt service coverage ratio was 5.52, well above their requirement as well as peer airport medians. CVG had cash on hand of approximately 541 days in 2018, in line with its peers. The Cost per Enplanement (CPE) level at CVG was 5.33 dollars in 2018, significantly below peer airport medians. Lastly, CVG has relatively low levels of outstanding debt/principal, compared to median airports measured in terms of debt per passenger. Debt per passenger was 10 dollars in 2018, much lower than comparable airport medians. Taken together, these currently robust financial metrics show CVG is well positioned to undertake a new capital program.

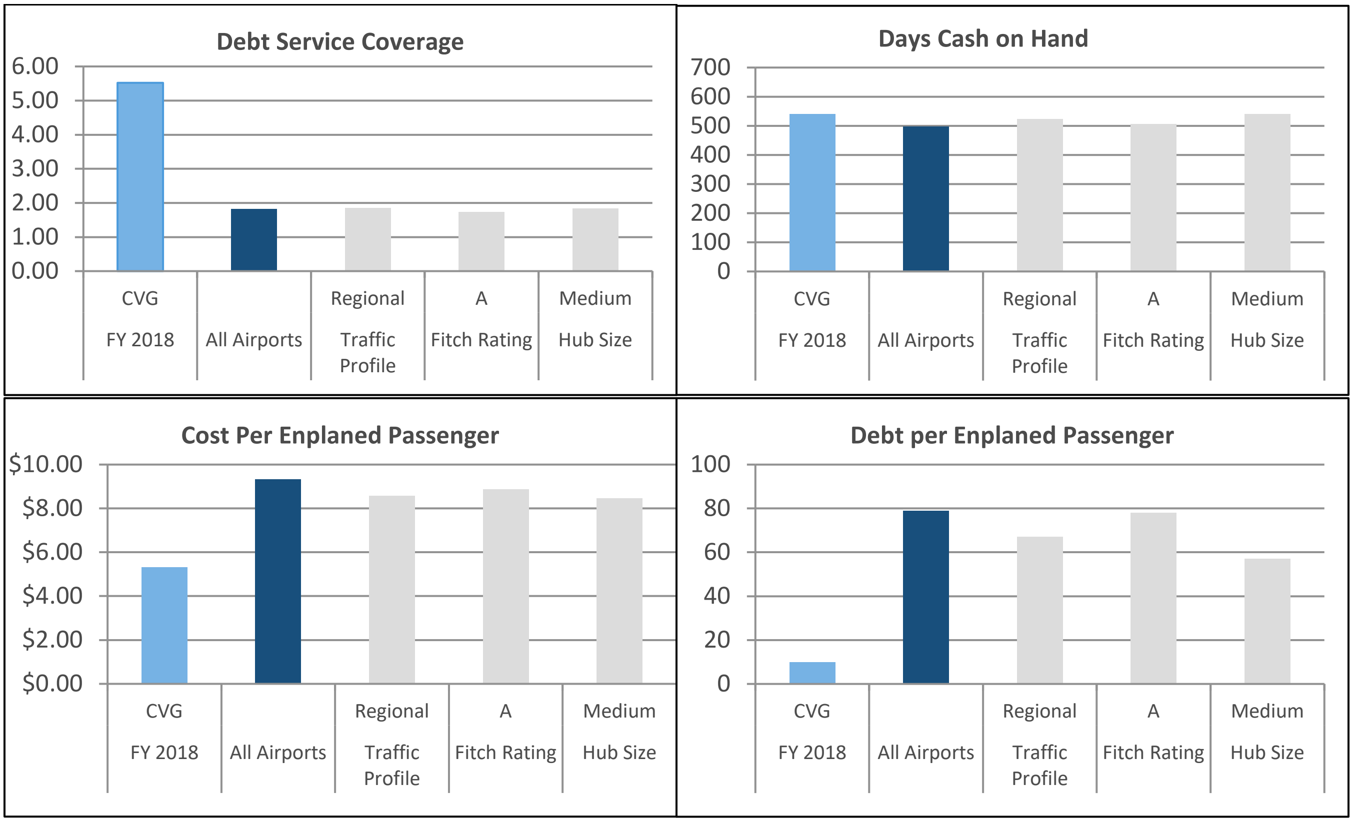
In analyzing the affordability of the future Master Plan program, financial targets were set to assess the financial impact of the projects to be undertaken and determine the optimal financing sources (see **Table 6.3-3, *Master Plan Financial Targets***). These targets include a Debt Service Coverage Ratio (DSCR) of 1.50 for all years analyzed, PFC leveraging not to exceed 70 percent, PFC fund balance not to fall below 10 million dollars, and a competitive CPE when compared to peer airports.

TABLE 6.3-2 COMPARISON OF KEY METRICS

Metric	2018 CVG	Fitch U.S. Airport Medians for FY 2018					
		Fitch Portfolio	Airport Size (FAA)		Traffic Profile		Rating
			Large	Medium	Hub	Regional	A Rated
General Information							
Enplaned Passengers (000's)	**4,449**	5,865	23,075	4,662	23,075	3,471	4,834
Primary Carrier as % of Total	**43%**	40%	45%	42%	72%	36%	45%
% O&D Passengers	**92%**	95%	71%	96%	58%	96%	95%
Core Metrics							
Days Cash on Hand	541	497	468	541	568	524	506
Airline Payments per Enplaned Passenger (CPE)	$5.33	$9.33	$10.64	$8.47	$10.05	$8.58	$8.88
Debt per Enplaned Pass.	$10	$79	$113	$57	$113	$ 67	$ 78
Debt Service Coverage	5.52	1.83	1.72	1.84	1.74	1.86	1.73

Source: *Fitch Ratings Peer Review of U.S. Airports*, November 14, 2019.

EXHIBIT 6.3-1 COMPARISON OF KEY METRICS



Source: *Fitch Ratings Peer Review of U.S. Airports*, November 14, 2019

TABLE 6.3-3 MASTER PLAN FINANCIAL TARGETS

Metric	Targets
Debt Service Coverage Ratio (DSCR) (Revenue Method)	1.50x
PFC Leveraging	65%-70% of Annual Collections Remainder available for paygo and Airport Improvement Program (AIP) match
PFC Fund Balance	>= $10 million
CPE	Maintain competitive CPE as compared to similarly situated airports

Source: LeighFisher analysis

6.3.3 Outstanding Bonds and Bond Resolution

The General Bond Resolution is an integral part of CVG's financial operations. The Resolution applies to all bonds outstanding and obligates CVG to meet certain terms and conditions so long as the bonds remain outstanding. Currently, the Series 2016 and Series 2019 Bonds are outstanding.

In Section 8.03(b), *Rate Covenant, of the General Bond Resolution*, the KCAB covenants to meet a requirement defined for the purposes of this Report as a "Coverage Requirement." That section states:

The Board shall, while any Bonds remain Outstanding, charge and collect rates, fees, rentals and charges in connection with the ownership and operation of the Airport and for services rendered in connection therewith and shall revise such rates, fees, rentals and charges as often as may be necessary or appropriate, so that for each Fiscal Year the sum of (i) the Net Revenues plus (ii) the Carryover Amount, if any, for such Fiscal Year will be equal to at least 125% of Principal and Interest Requirements on all Outstanding Bonds for that Fiscal Year.

The amount of revenue bonds outstanding at the dates indicated is presented in **Table 6.3-4, *Outstanding Bonds***.

TABLE 6.3-4 OUTSTANDING BONDS

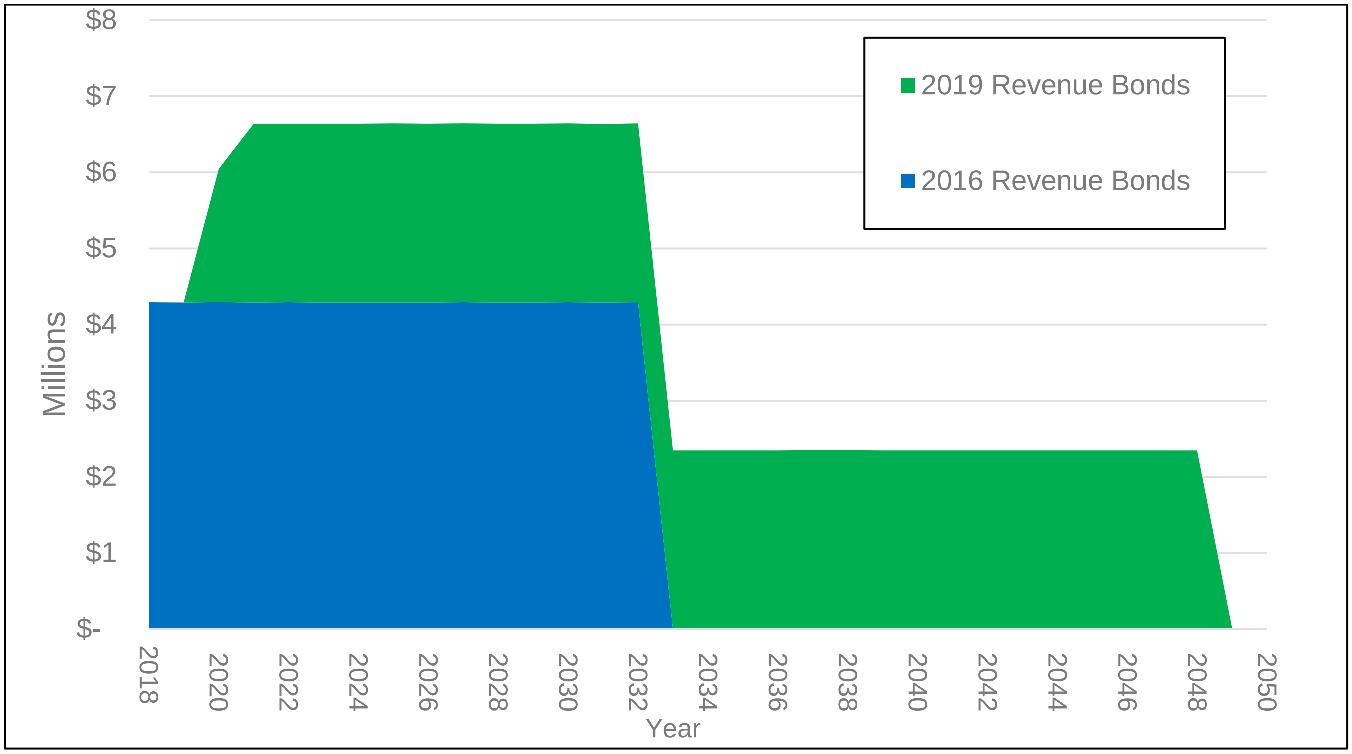
	12/31/2018	12/31/2019[1]	Interest Rates
General Airport Revenue Bonds (GARBs)			
2016	$42,485,000	$40,320,000	5.00%
2019	$0	$32,935,000	5.00%
Total GARBs	$42,485,000	$73,255,000	
Customer Facility Charge (CFC) Bonds			
2019	$0	$ 103,130,000	3.08% to 4.69%
Total CFC Bonds	$0	$ 103,130,000	
Total All Bonds	**$ 42,485,000**	**$ 176,385,000**	

[1] Projected
Source: KCAB

Under the General Bond Resolution, before any bonds are issued, KCAB is to adopt a Series Resolution authorizing the issuance of such bonds, fixing the amount and the details thereof, and describing in brief and general terms the purposes for which the bonds are to be issued. Pursuant to Section 6.15 of the General Bond Resolution, a Series Resolution may specify other available revenues that may be available to secure a series of bonds. Other available revenues means, for any period of time, all designated PFC revenues, designated Customer Facility Charge (CFC) revenues, and designated grant revenues that KCAB irrevocably commits to pay principal and interest requirements as provided in Section 6.15, in any Series Resolution, or by any other action adopted by KCAB.

Principal payments for respective maturities of all bond series are due January 1. Interest payments are due semi-annually on July 1 and January 1. The Series 2016 Bonds and a portion of the Series 2019 Bonds were issued to fund the costs of PFC-eligible projects; therefore, KCAB has the option to pay the debt service requirements of these bonds with PFC revenues. Deposits for debt service are made by KCAB into the Sinking Fund on a monthly basis. Principal and interest payments are then paid from the accumulated amounts in the Sinking Fund when due. Existing annual debt service payments are approximated in **Exhibit 6.3-2, *Existing Annual Debt Service Obligations***.

EXHIBIT 6.3-2 EXISTING ANNUAL DEBT SERVICE OBLIGATIONS



Source: KCAB

6.3.4 Airline Agreements

Airport Use Agreement and Lease of Terminal Facilities.

The Airport Use Agreement (AUA) is closely linked to the General Bond Resolution. The current AUA became effective on January 1, 2016 and expires on December 31, 2020. This agreement replaced a prior agreement that was entered into by KCAB in 1972 and which expired on December 31, 2015. Allegiant, American, Delta, DHL, Federal Express, Frontier, Southwest, and United are signatories to the AUA.

The AUA provides for the use of CVG and establishes landing fees. Each passenger airline that is a signatory leases airport facilities under separate terminal lease agreements. The AUA also establishes the methodology for calculating the various terminal related rates and charges used to calculate terminal rentals to be paid under the terminal lease agreements.

The AUA currently employs a hybrid rate setting methodology with an airfield residual and a terminal commercial compensatory rate setting methodology. The AUA also establishes cost centers to which KCAB's costs are assigned and allocated. Several airline cost centers are established, which include: airfield, terminal, and loading bridge. In addition, a Board cost center is established, which is comprised of several sub-cost centers: commercial property, parking and ground transportation, and rental car.

Under the AUA, the landing fee rate and the terminal related rates and charges are calculated based on the costs allocated to the applicable airline cost centers (the cost center requirement) less certain offsets. These revenue offsets include a reduction in the terminal rental rate based on terminal concession revenues and a share of Net Remaining Revenues (NRR) that serves to reduce the landing fee rate and terminal rentals.

The landing fees and terminal rentals are established annually during the budget process and therefore are based on projected airline activity, revenues, and cost. Under the AUA, KCAB may make adjustments to landing fees and terminal rentals once during the fiscal year to account for changes in activity levels and budget changes, which result in a required adjustment of 10 percent or more to the landing fees and terminal rentals. Additionally, after the close of each fiscal year, the landing fee rate, terminal rentals and the NRR adjustment to terminal rentals shall be recalculated using audited financial data. The airline revenues as recorded are net of the applicable NRR adjustments.

Under Section 5.9 of the AUA, KCAB may charge the signatory airlines Extraordinary Coverage Protection payments (ECP) in any fiscal year in which the amount of revenues less Operating and Maintenance (O&M) expenses is, or is forecast to be, less than 125 percent of the principal and interest requirements on all outstanding bonds. Any amounts collected for such ECP from the signatories shall be allocated to the airfield cost center requirement.

Future AUA and Terminal Lease Agreement Assumptions for Forecast.

The expiration date of the AUA is December 31, 2020. Upon the expiration of the AUA, KCAB may enter into extensions of such agreements with the airlines, enter into new agreements with the airlines, or impose rates and charges upon the airlines. KCAB has covenanted in its Bond Resolution (which extends beyond the expiration of the AUA) to establish rentals, rates and other charges for the use and operation of CVG such that revenues (including rentals, fees and charges imposed on the airlines), together with certain other moneys deposited in accounts and funds pursuant to the Resolution, are sufficient to satisfy the coverage requirements contained in the Resolution.

The Master Plan financial analysis assumes that the provisions of the AUA will continue in a substantially similar manner through 2020, with a renegotiation and change in terms beginning in 2021. The assumed structure for 2021 and beyond is a hybrid residual method and includes a revenue sharing methodology with the airlines similar to the one currently in place. With regards to O&M expenses, further changes are assumed related primarily to KCAB assuming the operation and maintenance of certain facilities currently operated by Delta beginning in 2021.

6.3.5 Other Agreements

KCAB has agreements with the company who operates the parking facilities, rental car companies, and other services.

Parking

KCAB has a management agreement with SP+ under which all parking revenues are paid to KCAB and KCAB pays SP+ a monthly fee to provide operation, management, and maintenance of on-Airport parking facilities. Parking revenue at CVG is a function of parking rates and passenger traffic, specifically passengers originating their travel at CVG.

Rental Car

Revenue from rental cars includes concessions fees from rental car companies; leases for counter space in the terminal building are included in other revenues as non-airline terminal rentals. KCAB collects a percentage of revenues from the rental car companies operating at CVG. CFCs are not included in rental car revenue and are excluded from the definition of revenues in the General Bond Resolution.

Other

Other revenues are generated from ground transportation services including commercial vehicles, most notably taxicabs, limos, and hotel/motel shuttles, as well as the recent (2015) introduction of Transportation Network Companies (TNCs) such as Uber and Lyft into the CVG market. TNCs, like taxicabs, are charged a fee for operating at CVG, currently set at 3.00 dollars per pickup.

6.3.6 Financial Plan

The financial plan was developed using information and assumptions that provide a reasonable basis for analysis at a master plan-appropriate level of detail. Some of the assumptions may not be realized, and unanticipated events and circumstances may occur. Therefore, actual results may vary from those projected, and such variations could be material.

The financial plan is not intended to be used to support the sale of bonds or to obtain any other forms of financing. More detailed cost estimates and financial analysis will be required if and when KCAB decides to pursue the sale of bonds or other forms of financing. Some projects included in the Master Plan development plan may be postponed or eliminated if forecast aviation demand is not achieved, construction costs rise significantly, or if projected funding is not available. Similarly, projects may be undertaken earlier than indicated if demand or other considerations require earlier implementation and funding is available.

6.3.6.1 Cost Estimates

Rough order of magnitude cost estimates were developed for the Master Plan projects using cost per square foot models based on similar projects at CVG and other airports in the area. The following assumptions were applied:

- The base construction cost for each project was increased as shown in **Table 6.3-5, *Project Markups***:
  - **Estimating Design Evolution**: Accounts for unforeseen work and final detailing.
  - **General Contractor Markup**: Accounts for general requirements, phasing and temporary construction, general conditions, general contractor overhead and profit, insurance, and payment and performance bonds.
  - **Owner's Soft Cost Allowance**: Accounts for a construction manager; planning and preconstruction; architectural and engineering design; architectural and engineering construction administration; airport staff; materials testing, inspection, and commissioning; plan check services; cost estimates and scheduling; miscellaneous owner costs; artwork; and owner's construction contingency.
  - **Project Contingency**: Provides a contingency to account for unforeseen changes.
- All costs are shown in first quarter 2019 dollars. The project cost estimates evaluated in the financial plan were not adjusted to include inflationary increases to the anticipated year of project implementation due to the application of the markups described previously.

TABLE 6.3-5 PROJECT MARKUPS

Markup Category	Civil/Site Construction	New Building Construction	Building Rehab
Estimating Design Evolution	15%	20%	25%
General Contractor Markup	17%	21%	24%
Owner's Soft Costs	27%	35%	42%
Project Contingency	10%	10%	10%
Total Markup	**88%**	**116%**	**142%**

Source: KCAB

6.3.6.2 Projects Analyzed

The initial implementation program presented in Section 3.2, *Initial Recommended Projects and Phasing*, was used as the input into the financial analysis. One project was removed – the Terminal 3 parking garage expansion – due to its high cost relative to the number of spaces provided. In addition, the other garage projects (T1 garage, T3 garage part 1, and T3 garage part 2) were each deferred to the next phase due to the high cost of these projects. All other projects remained the same as in the initial plan.

In addition to the Master Plan projects, the financial plan includes KCAB's five-year Capital Improvement Program (CIP) and various renewal and replacement projects. The total set of projects analyzed in the financial plan is summarized by category in **Table 6.3-6, *Master Plan Capital Improvement Program (CIP)***. In total, the CIP program total 3,589 million dollars. The Amazon development that is occurring on the south airfield is not reflected in the financial plan because it is underway and being built with 3rd party funding.

TABLE 6.3-6 MASTER PLAN CAPITAL IMPROVEMENT PROGRAM (CIP)

Project	Cost (in thousands)
5-Year CIP Program	**$428,289**
Master Plan Projects	
Runway and Taxiway Improvements	$255,794
Apron & Ramp Rehabilitation	$97,099
Main Terminal Improvements	$1,280,553
Terminal Joint Use Equipment	$140,849
Parking Garages	$363,678
Parking Lot Improvements	$105,526
Commercial Development	$138,885
General Aviation	$183,493
KCAB Office	$53,125
Maintenance Facilities	$110,053
Roadways External	$85,218
Roadways Amazon	$10,221
Subtotal Master Plan Projects	**$2,824,493**
Other Projects	**$336,585**
Total Capital Improvements Program	**$3,589,367**

Note: Project costs shown in 2019 dollars.
Sources: KCAB; Master Plan Team analysis

The distribution of project costs over the estimated construction periods to determine annual cash outflows is summarized graphically by year in **Exhibit 6.3-3, *Master Plan Projects by Year***.

EXHIBIT 6.3-3 MASTER PLAN PROJECTS BY YEAR

Master Plan		PAL 1			PAL 2					PAL 3										PAL 4												
	Pro Forma	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Major Projects																																
Parallel Crossfield Taxilane	$62,112,592																															
New T1 Garage	$94,112,129																															
PAL 2 Terminal Expansion	$100,086,642																															
PAL 2 Concourse A Improvements	$340,730,464																															
Bag System Long-Term	$139,348,965																															
Replacement Employee Lot	$42,653,492																															
New T3B Garage	$137,333,290																															
PAL 2 Deicing Pad	$91,406,891																															
PAL 3 Terminal Improvements	$149,054,636																															
KCAB Office Building (if desired)	$53,124,685																															
Expand T3B Garage	$132,232,550																															
PAL 3 Concourse A Improvements	$138,450,004																															
Runway 18R/36L Extension	$63,298,565																															
PAL 3 Concourse B Improvements	$235,444,512																															
PAL 4 Concourse A Improvements	$142,035,672																															
PAL 4 Concourse B Improvements	$160,166,998																															
Other Master Plan Projects																																
Relocation of Taxiway S4 & Demo	$1,826,265																															
Relocation of Taxiway D2 & Demo	$2,858,931																															
Relocation of Taxiway E9 & Demo	$2,995,094																															
Rwy 36C High Speed Exit East and D8 Demo	$5,090,385																															
Rwy 36C High Speed Exit East and D6/D7 Demo	$5,605,670																															
Relocation of Taxiway S8 & Demo	$4,000,138																															
Relocation of Taxiway S6/S7 & Demo	$4,792,601																															
Taxiway E Relocation (north) & Demo	$8,015,405																															
Taxiway E Extension	$29,316,821																															
Taxiway J2 & J4 Demo	$411,018																															
Rwy 36C High Speed Exit West & Demo A14	$9,419,598																															
Rwy 36C High Speed Exit West & Demo A15	$7,717,706																															
Taxiway C Extension and High Speed Exit	$29,273,190																															
Rwy 18L High Speed Exit	$9,778,517																															
Rwy 36R High Speed Exit	$9,281,027																															
PAL 1 Terminal Expansion	$14,584,486																															

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Master Plan		PAL 1			PAL 2					PAL 3										PAL 4												
	Pro Forma	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Bag Belts from CSB to Terminal	$1,500,000																															
SB KY 212/I-275 WB Entrance Ramp Improvements	$2,147,450																															
Reconstruct I-275 Interchange Part 1	$6,316,855																															
Reconstruct I-275 Interchange Part 2	$36,691,698																															
Reconstruct I-275 interchange Part 3	$3,961,436																															
Reconstruct I-275 Interchange Part 4	$9,742,211																															
Donaldson Road Ramp Improvements Part 1	$3,313,344																															
Donaldson Road Ramp Improvements Part 2	$3,766,449																															
Donaldson Road Ramp Improvements Part 3	$1,090,462																															
Terminal Drive Improvements Part 1	$3,661,980																															
Terminal Drive Improvements Part 2	$6,326,964																															
Loomis Road/Donaldson Road Improvements Part 1	$2,121,521																															
Loomis Road/Donaldson Road Improvements Part 2	$6,077,192																															
Wendell Ford Blvd Capacity Improvements & Extension	$6,560,000																															
Widen South Airfield Drive	$3,661,146																															
New Cell Phone Lot	$7,097,665																															
Expand Taxi Bullpen to add TNC	$7,935,901																															
Convert Existing Employee Lot to Long-Term Parking	$15,498,886																															
Expand ValuPark Lot	$40,275,889																															
PAL 3 Airline Support Facility	$19,101,343																															
PAL 3 Airport Maintenance Building	$63,692,822																															
PAL 4 Airport Maintenance Building	$46,360,040																															
PAL 1 GA Hangar and Apron	$36,647,855																															
PAL 2 GA Hangar and Apron	$37,337,047																															
PAL 3 GA Hangar and Apron	$30,027,320																															
PAL 4 GA Hangar and Apron	$79,480,751																															
PAL 2 Government Facility	$14,708,451																															
PAL 4 Government Facility	$15,599,154																															
Ground Run-up Pad	$5,691,946																															
PAL 3 Airport Hotel	$26,284,735																															
PAL 4 Airport Hotel	$25,666,624																															
GRE (Enclosure)	$29,589,226																															
All Other Projects																																
New AGTS (Train)	$70,000,000																															
Terminal A Apron	$10,000,000																															
Concourse B Roof	$2,500,000																															

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Master Plan		PAL 1			PAL 2					PAL 3										PAL 4												
	Pro Forma	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Concourse B Apron Rehab	$66,424,863																															
Vehicles Ongoing	$26,000,000																															
Equipment Ongoing	$33,800,000																															
Utilities Ongoing	$19,500,000																															
Loading Bridge Ongoing	$105,000,000																															
Main Terminal Roof	$1,360,000																															
Concourse A Roof	$2,000,000																															

Note: Project costs shown in 2019 dollars.
Sources: KCAB; Master Plan Team analysis

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Five-Year CIP and Master Plan Projects

KCAB has several ongoing or planned projects that occur in the 2019-2024 timeframe in its existing five-year CIP plan. The remaining five-year CIP projects are projected to total 428 million dollars, with all other Master Plan projects totaling 2,824 million dollars through 2050.

Renovation and Renewal Projects

KCAB developed cost and funding assumptions for a set of additional projects that are not demand driven from the Master Plan but represent ongoing expenses at CVG. Such projects are related to the normal operation and maintenance of existing facilities (e.g., terminal roof replacement, replacement and/or repairs to loading bridges, IT systems, and various equipment replacements). In developing the assumptions for renovation and renewal projects, KCAB reviewed historical capital spending, the existing condition of facilities, and available studies evaluating the condition of facilities.

6.3.6.3 Funding Sources

The following sources of funding were considered for the financial plan:

Passenger Facility Charge

The authority for airport operators to impose a PFC was granted by Congress in the Aviation Safety and Expansion Act of 1990 and the Wendell H. Ford Aviation Investment and Reform Act of 2000. An airport must apply to the FAA for the authority to impose a PFC and for the authority to use the PFC revenues collected for specific FAA-approved projects. KCAB currently collects a PFC at the maximum allowable level of 4.50 dollars per eligible enplaned passenger. For the purposes of this financial plan analysis, it was assumed that KCAB would continue to collect a PFC at a level of 4.50 dollars per eligible enplaned passenger and apply those revenues toward eligible projects contained in the near-term capital projects or renovation and renewal projects.

Federal Airport Improvement Program.

Federal grants in-aid under the Airport Improvement Program (AIP) can be used to fund eligible airport improvements, particularly airfield capacity enhancement projects. There are three types of federal AIP grants:

- **AIP Passenger Entitlement Grants**: Annual amounts calculated based on the number of enplaned passengers and a legislated per passenger formula.
- **AIP Cargo Entitlement Grants**: Similar grants calculated based on the landed weight of all-cargo aircraft and each airport's proportion of landed weight to the total cargo landed weight at all qualifying airports.
- **AIP Discretionary Grants**: Awarded at the discretion of the FAA based on its determination of priorities for projects at tan airport in relation to funding priorities for the national airport system.

For federal fiscal year (FFY) 2018, ending September 30, 2018, KCAB was eligible to receive approximately 1.7 million dollars in AIP passenger entitlement grants and 3.0 million dollars in AIP cargo entitlement grants. Subject to certain limitations, apportioned funds, if unspent from previous years, can be carried over in future years. AIP passenger entitlement grants are reduced for certain airports that impose a PFC. At the current 4.50 dollars PFC level, KCAB's AIP passenger entitlements grants are reduced 75 percent. The financial plan assumes AIP will continue to be appropriated at the federal level, KCAB will continue to receive AIP passenger and cargo entitlements through the program at or above historical levels in accordance with the prescribed formulas, and KCAB will pursue and compete for discretionary funding where appropriate. Discretionary AIP funds have been projected in years when AIP needs exceed projected entitlements; it is assumed that any project unable to gain discretionary AIP funding is not considered a high priority by the FAA or is not time-sensitive and can be delayed until a time when such AIP funding becomes available to KCAB.

State Grants

The Kentucky Revised Statutes authorize state financial assistance by grant or loan for the development of airports. KCAB has from time to time received grant funds from the Commonwealth of Kentucky. The financial plan presented herein does not anticipate any receipt of state grants.

Customer Facility Charge

Revenues from CFCs are derived by the imposition of charges on rental car customers and provide funding to certain eligible and approved rental car projects. Pursuant to an ordinance passed by KCAB, the collection of CFCs began in 2006. Currently, a CFC is levied at a rate of 7.50 dollars per rental car transaction day. Per the ordinance, CFCs may be used for costs related to planning, constructing, or operating and maintaining consolidated transportation facilities. As it relates to construction, CFCs have been pledged as security for a new CONRAC facility (identified as "The 2019 Project") in the Series 2019 CFC Bonds issued by the KCAB. CFC funds are otherwise not projected to be used for any Master Plan projects or other related projects other than the CONRAC project.

Internal KCAB Funds (including GARBs)

KCAB retains certain defined cash flows under the existing airline agreement. In the future, KCAB may consider various options for the next Airline Agreement in 2021, including (1) negotiation of an extended "residual" rate methodology and agreement, (2) negotiation of a revised alternative agreement, which could potentially utilize a "hybrid" rate methodology, or (3) setting rates by ordinance or through agreement utilizing a "compensatory" rate methodology.

Other and Third-Party Funding

Other funding may include receipts from other governmental or private entities such as "third-party" funding. The financial plan assumes KCAB will find third-party and/or state funding for most roadway projects (only 80 percent for Donaldson Road improvements), as well as for many commercial development projects. Any commercial development projects not funded by third party sources are assumed to return revenues to offset the amortization costs from said projects.

Application of Funding Sources

This section describes the application of funding sources to the Master Plan projects and renovation and renewal projects. Since certain sources of funds, such as PFC revenues, AIP grants and CFC revenues, have restrictions on how they can be used, aligning the source of capital funds with allowable and optimal uses is essential for maximizing financial capacity. In general, specific funding sources for projects were determined considering the following:

- The five-year CIP projects (projected 2019-2024) were reviewed to confirm that existing funding commitments were accounted for and that these commitments did not conflict with the funding assumptions for projects in the Master Plan projects or renovation and renewal projects.

All other Master Plan projects and the renovation and renewal projects were reviewed to consider and match each funding source to the best use in a given year, taking into consideration debt coverage requirements, fund balance requirements, and future funding needs. **Table 6.3-7, *Capital Improvement Program Estimated Costs and Cash Flow***, presents the sources and uses of funds by year through 2050 for all related projects. The amount of funding available from the various funding sources and the application of that funding to specific projects is summarized in the following sections.

Table 6.3-8, *Capital Improvement Program – Funding by Source,* presents the estimated funding sources for projects included in this financial projection. Estimated project costs total 428 million dollars for the 5-Year CIP program, 2,824 million dollars for the Master Plan Projects, and 337 million dollars for other projects, totaling 3,589 million dollars together.

TABLE 6.3-7 CAPITAL IMPROVEMENT PROGRAM ESTIMATED COSTS AND CASH FLOW (IN THOUSANDS)

Capital Improvement Program	Total	PAL 1 2019-2022	PAL 2 2023-2027	PAL 3 2028-2037	PAL 4 2038+
Subtotal 5-Year CIP Program	$428,289	$393,676	$34,613	$0	$0
Master Plan Projects					
Runway and Taxiway Improvements	$255,794	$34,312	$64,303	$91,709	$65,470
Apron & Ramp Rehabilitation	97,099	5,692	8,310	83,097	0
Main Terminal Improvements	1,280,553	14,584	490,502	414,403	361,064
Terminal Joint Use Equipment	140,849	1,500	139,349	0	0
Parking Garages	363,678	0	0	231,445	132,233
Parking Lot Improvements	105,526	3,549	61,701	0	40,276
Commercial Development	108,578	22,731	14,795	45,386	25,667
General Aviation	183,493	36,648	37,337	30,027	79,481
KCAB Office	53,125	0	0	53,125	0
Maintenance Facilities	110,053	0	0	63,693	46,360
Government Facilities	30,308	0	14,708	0	15,599
Roadways External	85,218	18,515	49,441	10,934	6,32
Roadways Amazon	10,221	3,280	6,941	0	0
Subtotal MP Projects	$2,824,493	$140,811	$887,387	$1,023,819	$772,476
Other Projects					
Apron & Ramp Rehabilitation	$76,425	$0	$66,425	$10,000	$0
Main Terminal Improvements	180,860	0	0	113,360	67,500
Utilities	19,500	0	2,250	7,500	9,750
Vehicles & Equipment	59,800	0	6,900	23,000	29,900
Other	0	0	0	0	0
Subtotal Other Projects	$336,585	$0	$75,575	$153,860	$107,150
Subtotal MP & Other Projects	$3,161,078	$140,811	$962,962	$1,177,679	$879,626
Total Capital Improvement Program	**$3,589,367**	**$534,487**	**$997,575**	**$1,177,679**	**$879,626**

Sources: KCAB; LeighFisher analysis

TABLE 6.3-8 CAPITAL IMPROVEMENT PROGRAM – FUNDING BY SOURCE (IN THOUSANDS)

Capital Improvement Program	Total	PFC Paygo	PFC Bonds	GARB Bonds[1]	Board Funds	AIP Grants	Local Grants	3rd Party	CFC Paygo	Series 2019 CFC Bonds	Other
Subtotal 5-Year CIP Program	$428,289	$90,426	$0	$16,013	$90,432	$37,322	$6,461	$32,605	$62,216	$89,686	$3,127
Master Plan Projects											
Runway and Taxiway Improvements	$255,794	$0	$0	$31,353	$32,596	$191,845	$0	$0	$0	$0	$0
Apron & Ramp Rehabilitation	97,099	0	0	28,544	0	68,555	0	0	0	0	0
Main Terminal Improvements	1,280,553	182,271	172,852	729,033	196,397	0	0	0	0	0	0
Terminal Joint Use Equipment	140,849	1,050	0	77,092	62,707	0	0	0	0	0	0
Parking Garages	363,678	0	0	228,895	134,783	0	0	0	0	0	0
Parking Lot Improvements	105,526	7,749	0	50,403	47,374	0	0	0	0	0	0
Commercial Development	108,578	14,795	0	7,936	0	14,795	0	71,053	0	0	0
General Aviation	183,493	0	0	0	0	0	0	183,493	0	0	0
KCAB Office	53,125	0	0	53,125	0	0	0	0	0	0	0
Maintenance Facilities	110,053	0	0	0	110,053	0	0	0	0	0	0
Government Facilities	30,308	0	0	14,708	15,599	0	0	0	0	0	0
Roadways 0External	85,218	18,188	0	0	1,634	0	65,396	0	0	0	0
Roadways 0Amazon	10,221	0	0	0	0	0	0	10,221	0	0	0
Subtotal MP Projects	$2,824,493	$224,053	$172,852	$1,221,088	$601,143	$275,195	$65,396	$264,767	$0	$0	$0
Other Projects											
Apron & Ramp Rehabilitation	$76,425	$0	$0	$16,606	$2,500	$57,319	$0	$0	0	0	0
Main Terminal Improvements	180,860	35,000	0	0	145,860	0	0	0	0	0	0
Utilities	19,500	0	0	0	19,500	0	0	0	0	0	0
Vehicles & Equipment	59,800	0	0	0	59,800	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0
Subtotal Other Projects	$336,585	$35,000	$0	$16,606	$227,660	$57,319	$0	$0	$0	$0	$0
Subtotal MP & Other Projects	$3,161,078	$259,053	$172,852	$1,237,694	$828,803	$332,514	$65,396	$264,767	$0	$0	$0
Total Capital Improvement Program	**$3,589,367**	**$349,479**	**$172,852**	**$1,253,707**	**$ 919,235**	**$369,836**	**$71,857**	**$297,372**	**$62,216**	**$89,686**	**$3,127**

Sources: KCAB; LeighFisher analysis

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6.3.6.4 *Consideration of Costs and Revenues*

The following subsections summarize the costs and revenues associated with implementation of the Master Plan projects and the renovation and renewal projects.

Debt Service Requirements

The debt service requirement represents the scheduled annual principal and interest payments on the outstanding bonds and the additional bonds to be issued by KCAB to finance the projects. Requirements for debt service are based on the following assumptions (the actual structure and sizing of future bond issues will depend on municipal market conditions at the time of issuance):

- A bond term of 30 years
- Level annual debt service for each issue during the amortization period
- A coupon rate of 6.0 percent for GARB Bonds and 6.5 percent for PFC bonds
- An issuance cost of 2 percent of proceeds, and one-year debt service reserve

The annual debt service requirement is reflected in **Table 6.3-9, *Annual Debt Service (in Thousands)***, and excludes any CFC-related debt and CFC revenues, which are assumed to be deposited annually to separate bond funds to pay interest and principal on those respective bonds. The annual debt service requirement for PFC bonds and PFC cash flow are shown in **Table 6.3-10, *Passenger Facility Charge Funds (in Thousands)***.

As a result of the projected bond issues, the annual debt service requirement is projected to increase during the planning period, which all things being equal, will also result in increases to airline costs. Eventually, future annual debt service requirements and airline costs will be offset, to some extent, by the maturity of existing bonds. Projections for future debt service coverage levels is shown in **Table 6.3-11, *Net Revenues, Cash Balances, and Debt Service Coverage (in Thousands).***

O&M Costs

O&M costs were projected by analyzing historical trends in expenses by line item. O&M costs were projected using the 2019-2024 projected results from the Report of the Airport Consultant of the Series 2019 Revenue Bonds as a base, taking into account management plans, facility development plans, and other assumptions. From this baseline, O&M costs were assumed to increase based on projected changes in enplaned passengers. Projections of future O&M expenses are summarized in **Table 6.3-12, *O&M Expenses (in Thousands)***. Incremental operations and maintenance costs were assumed beginning in 2021 due to multiple airport systems changing from Delta's control and maintenance responsibility to KCAB's control.

Future Revenues

Future revenues must be sufficient to provide for payment of the (1) cost of O&M; (2) required reserve transfers; (3) debt service requirement on the outstanding bonds and additional bonds; and (4) if applicable, other subordinated indebtedness. KCAB received 109.0 million dollars of revenues in 2018 and is projected to earn 112.1 million dollars of revenues in 2019 (excluding PFCs and CFCs). Sources of airline and non-airline revenues and key assumptions are summarized in **Table 6.3-13, *Operating Revenues (in Thousands)***.

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TABLE 6.3-9 ANNUAL DEBT SERVICE (IN THOUSANDS)

Gross Debt Service	PAL 1					PAL 2					PAL 3	PAL 4
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2037	2050
Annual Debt Service by Bond Series												
Existing Bonds												
Series 2016 Bonds	$4,293	$4,289	$4,296	$4,292	$4,293	$4,292	$4,290	$4,292	$4,292	$4,294	$0	$0
Series 2019 Bonds	$0	$1,285	$1,647	$2,212	$2,209	$2,209	$2,213	$2,210	$2,211	$2,210	$2,209	$0
Future Bonds												
KCAB Bonds	$0	$0	$193	$1,560	$2,099	$13,649	$26,541	$34,610	$41,780	$41,963	$86,003	$99,636
Total Annual GARB Debt Service	**$4,293**	**$5,575**	**$6,136**	**$8,064**	**$8,600**	**$20,150**	**$33,044**	**$41,112**	**$48,283**	**$48,467**	**$88,212**	**$99,636**
Total Annual PFCs Applied to Debt Service	**$0**	**$5,433**	**$5,762**	**$6,260**	**$6,258**	**$8,424**	**$10,592**	**$12,757**	**$14,924**	**$14,926**	**$15,121**	**$14,652**
Total Net Annual Debt Service	**$0**	**$141**	**$374**	**$1,804**	**$2,342**	**$13,892**	**$26,785**	**$34,853**	**$42,023**	**$42,206**	**$86,246**	**$99,636**

Sources: KCAB; LeighFisher analysis

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TABLE 6.3-10 PASSENGER FACILITY CHARGE FUNDS (IN THOUSANDS)

PFC Revenues		PAL 1				PAL 2					PAL 3	PAL 4
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2037	2050
Eligible Enplaned Passengers												
Enplaned Passengers		4,505	4,685	4,895	5,170	5,295	5,423	5,554	5,688	5,826	6,724	7,755
Eligibility %		88.5%	88.5%	88.5%	88.5%	88.5%	88.5%	88.5%	88.5%	88.5%	88.5%	88.5%
Total PFC Eligible Enplaned Passengers		**3,987**	**4,146**	**4,332**	**4,575**	**4,686**	**4,799**	**4,915**	**5,034**	**5,156**	**5,950**	**6,863**
PFC Net Charge per Eligible Enplaned Passenger												
Gross PFC Charge		$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50
Less: Airline Collection Fee		(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
PFC Net Charge per Eligible Enplaned Passenger		$4.39	$4.39	$4.39	$4.39	$4.39	$4.39	$4.39	$4.39	$4.39	$4.39	$4.39
Total PFC Collections		**$17,501**	**$18,200**	**$19,019**	**$20,085**	**$20,571**	**$21,069**	**$21,578**	**$22,100**	**$22,635**	**$26,122**	**$30,131**
Starting PFC Account Balance		$84,836	$85,690	$76,113	$56,646	$47,123	$25,768	$10,502	$15,811	$23,251	$94,947	$117,175
PFC Collections		17,501	18,200	19,019	20,085	20,571	21,069	21,578	22,100	22,635	26,122	30,131
PFC Interest Earnings		1,697	1,705	1,618	1,328	1,038	729	363	263	391	1,763	2,173
Total Sources of PFCs/Available PFCs		**$104,035**	**$105,595**	**$96,750**	**$78,059**	**$68,732**	**$47,566**	**$32,444**	**$38,175**	**$46,276**	**$122,832**	**$149,479**
Uses of PFC Revenues	**Total**											
CIP Paygo	$(90,426)	$(12,912)	$(17,030)	$(27,153)	$(9,884)	$(17,696)	$(5,753)	$0	$0	$0	$ 0	$0
Master Plan and Other Projects Paygo	(259,053)	0	(6,690)	(6,690)	(14,795)	(16,844)	(20,719)	(3,875)	0	0	0	0
Master Plan PFC Bonds	(316,422)	0	0	0	0	(2,166)	(4,332)	(6,498)	(8,664)	(8,664)	(13,155)	(14,652)
Existing PFC Bonds	(117,785)	(5,433)	(5,762)	(6,260)	(6,258)	(6,258)	(6,260)	(6,259)	(6,260)	(6,261)	(1,966)	0
Total Uses of PFC Revenues	**$(783,686)**	**$(18,345)**	**$(29,482)**	**$(40,104)**	**$(30,936)**	**$(42,964)**	**$(37,064)**	**$(16,632)**	**$(14,924)**	**$(14,926)**	**$(15,121)**	**$(14,652)**
Ending PFC Account Balance/Available PFCs		**$85,690**	**$76,113**	**$56,646**	**$47,123**	**$25,768**	**$10,502**	**$15,811**	**$23,251**	**$31,351**	**$107,711**	**$134,827**

Sources: KCAB; LeighFisher analysis

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TABLE 6.3-11 NET REVENUES, CASH BALANCES, AND DEBT SERVICE COVERAGE (IN THOUSANDS)

Net Revenues		PAL 1				PAL 2					PAL 3	PAL 4
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2037	2050
Revenues		$112,052	$116,529	$141,348	$144,055	$158,301	$174,905	$188,078	$198,983	$210,527	$321,281	$443,874
Non-operating Revenues		2,789	2,859	2,930	3,001	3,073	3,073	3,073	3,073	3,073	3,073	3,073
PFC Revenues to Pay Debt Service	[A]	5,433	5,762	6,260	6,258	8,424	10,592	12,757	14,924	14,926	15,121	14,652
Subtotal Revenues		**$120,274**	**$125,149**	**$150,539**	**$153,314**	**$169,798**	**$188,569**	**$203,908**	**$216,980**	**$228,526**	**$339,475**	**$461,599**
Less Operating and Maintenance (O&M) Expenses		(98,669)	(101,785)	(116,383)	(120,237)	(124,044)	(127,570)	(131,397)	(135,339)	(139,399)	(187,341)	(275,116)
Net Revenues	[B]	**$21,605**	**$23,364**	**$34,155**	**$33,077**	**$45,754**	**$60,999**	**$72,511**	**$81,641**	**$89,127**	**$152,134**	**$186,482**
KCAB General Fund + O&M Reserve +R&R Reserve		**$99,368**	**$88,880**	**$100,696**	**$109,225**	**$112,401**	**$118,735**	**$127,366**	**$137,085**	**$163,322**	**$234,004**	**$659,592**
Days Cash on Hand (with O&M Reserve)		**368**	**319**	**316**	**332**	**331**	**340**	**354**	**370**	**428**	**456**	**875**
PFC 25% coverage	[C =A* 25%]	1,358	1,440	1,565	1,565	2,106	2,648	3,189	3,731	3,731	3,780	3,663
Net Revenue for DSC Calculation	[D= B+C]	**$22,964**	**$24,805**	**$35,720**	**$34,642**	**$47,860**	**$63,648**	**$75,700**	**$85,372**	**$92,858**	**$155,914**	**$190,145**
Revenue Bond Debt Service	[E]	**$5,575**	**$6,136**	**$8,064**	**$8,600**	**$22,316**	**$37,377**	**$47,611**	**$56,947**	**$57,132**	**$101,367**	**$114,288**
Debt Service Coverage Ratio	[D/C]	**4.12**	**4.04**	**4.43**	**4.03**	**2.14**	**1.70**	**1.59**	**1.50**	**1.63**	**1.54**	**1.66**

Sources: KCAB; LeighFisher analysis

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TABLE 6.3-12 O&M EXPENSES (IN THOUSANDS)

O&M Expenses by Line Item	PAL 1				PAL 2					PAL 3	PAL 4
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2037	2050
Salaries & Benefits	$32,406	$34,467	$36,401	$37,839	$39,346	$40,519	$41,734	$42,986	$44,276	$59,503	$87,383
Employee Insurance	6,236	6,548	6,875	7,219	7,580	7,959	8,198	8,444	8,697	11,688	17,164
Pension	8,159	9,414	10,862	11,749	12,709	13,092	13,485	13,889	14,306	19,226	28,234
Salaries Other	2,435	2,508	2,584	2,661	2,741	2,823	2,908	2,995	3,085	4,146	6,089
Outside Contractors	21,432	22,172	32,112	32,372	32,308	33,081	34,073	35,095	36,148	48,580	71,341
Equipment & Facilities	1,122	1,150	1,179	1,208	1,237	1,267	1,305	1,344	1,384	1,861	2,732
Supplies & Materials	4,966	5,090	5,278	5,469	5,667	5,803	5,977	6,156	6,341	8,521	12,514
Utilities	8,455	8,763	9,478	9,970	10,331	10,704	11,025	11,356	11,696	15,719	23,084
Other	8,354	8,563	8,778	8,995	9,215	9,435	9,718	10,010	10,310	13,856	20,347
Subtotal Allocable Expenses	**$93,564**	**$98,674**	**$113,547**	**$117,483**	**$121,133**	**$124,682**	**$128,423**	**$132,275**	**$136,243**	**$183,100**	**$268,888**
Expensed Capital Outlays	2,557	2,621	2,837	2,753	2,820	2,888	2,975	3,064	3,156	4,241	6,228
Additional from CIP	2,547	489	0	0	91	-	-	-	-	-	-
Total O&M Expenses	**$98,669**	**$101,785**	**$116,383**	**$120,237**	**$124,044**	**$127,570**	**$131,397**	**$135,339**	**$139,399**	**$187,341**	**$275,116**
Annual Growth Rate		*3.2%*	*14.3%*	*3.3%*	*3.2%*	*2.8%*	*3.0%*	*3.0%*	*3.0%*	*3.0%*	*3.0%*

Sources: KCAB; LeighFisher analysis

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TABLE 6.3-13 OPERATING REVENUES (IN THOUSANDS)

Revenues	PAL 1				PAL 2					PAL 3	PAL 4
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2037	2050
Airline Revenues (Net of Adjustments)											
Landing Fees	$22,918	$24,779	$30,960	$31,302	$32,887	$34,829	$36,860	$38,588	$39,663	$58,068	$81,351
Terminal and Ramp Rentals and Use Charges	19,394	21,098	33,814	31,967	43,149	53,162	62,030	68,848	72,925	120,643	153,819
Miscellaneous Airline Revenues	173	173	0	0	0	0	0	0	0	0	0
Subtotal Airline Revenues	**$42,486**	**$46,050**	**$64,774**	**$63,269**	**$76,036**	**$87,991**	**$98,890**	**$107,436**	**$112,588**	**$178,711**	**$235,169**
Estimated Airline Cost per Enplaned Passenger (CPE)											
Subtotal Airline Revenues	$42,486	$46,050	$64,774	$63,269	$76,036	$87,991	$98,890	$107,436	$112,588	$178,711	$235,169
Less: Estimated Cargo and Other Adjustments	(15,222)	(16,368)	(18,433)	(18,865)	(20,045)	(21,466)	(22,969)	(24,310)	(25,257)	(38,557)	(55,668)
Passenger Airline Revenues	$27,264	$29,682	$46,340	$44,404	$55,990	$66,525	$75,921	$83,126	$87,330	$140,154	$179,502
Divided By: Enplaned Passengers	4,505	4,685	4,895	5,170	5,295	5,423	5,554	5,688	5,826	6,724	7,755
Estimated CPE	$6.05	$6.34	$9.47	$8.59	$10.57	$12.27	$13.67	$14.61	$14.99	$20.84	$23.15
Non-airline Revenues											
Parking	$43,296	$43,683	$47,975	$49,246	$49,446	$53,224	$54,201	$55,202	$60,171	$89,244	$125,619
Rental Cars	8,315	8,515	8,735	8,929	9,107	9,316	9,821	10,353	10,914	16,857	28,436
Terminal Concessions	6,183	6,479	6,780	7,078	7,382	7,715	8,133	8,574	9,038	13,960	23,550
Commercial Development	6,207	6,103	6,178	8,464	9,076	9,208	9,484	9,769	10,062	13,522	19,858
Recovery of Commercial Development	-	-	635	635	635	635	635	635	635	635	635
Reimbursed O&M Expenses	2,839	2,921	3,006	3,094	3,185	3,279	3,378	3,479	3,583	4,816	7,072
Other Non-airline Revenues	2,726	2,779	3,265	3,339	3,433	3,536	3,536	3,536	3,536	3,536	3,536
Subtotal Non-airline Revenues	**$69,566**	**$70,479**	**$76,575**	**$80,786**	**$82,266**	**$86,913**	**$89,188**	**$91,547**	**$97,940**	**$142,570**	**$208,705**
Total Operating Revenue	**$112,052**	**$116,529**	**$141,348**	**$144,055**	**$158,301**	**$174,905**	**$188,078**	**$198,983**	**$210,527**	**$321,281**	**$443,874**

Sources: KCAB; LeighFisher analysis

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The principal sources of non-airline revenues include parking fees, rental cars, concessions, non-airline rents, and interest on KCAB fund balances. Non-airline revenues were projected by analyzing the trend in revenue by line item and comparing those revenues to passenger activity. Parking revenues have been projected based on the growth rate of O&D passengers, as well as projected growth in parking prices at CVG, in addition to an estimated positive impact when additional parking garages are built. Commercial revenues have been projected to equal 100 percent of the annual debt service or amortization charges related to any KCAB-funded commercial project, under the assumption that such projects will return no worse than a return at 100 percent of cost to CVG. All other non-airline revenues have been held consistent with the projected (conservative) revenues from the Report of the Airport Consultant of the Series 2019 Revenue Bonds through 2024. From 2025 forward, these categories of non-airline revenues are projected to grow correlated to changes in enplaned passengers and a base 3.0 percent annual inflation rate.

Existing airline revenues are generated primarily through landing fees and terminal rents and through the rate methodology as defined in the current AUA. As described earlier, for the purpose of this analysis, it was assumed that under any future rate methodology, KCAB would continue to generate internal cash flow sufficient to fund the Master Plan projects and other ongoing capital projects, or KCAB could otherwise fund projects using a combination of surplus generated from cash or the issuance of General Airport Revenue Bonds (GARBs).

6.3.6.5 Conclusions

The financial feasibility specifically considers the effects of the capital program on CVG's financial operations, including airline CPE, DSCR, and cash balances. In general, the analysis presented herein indicates that funding the Master Plan CIP results in key metrics remaining within the goals set by CVG and is therefore affordable. Although changes in key assumptions could affect this conclusion, CVG does have the flexibility to adjust the timing of projects, and to develop alternative financing plans, which would allow a similar development plan to progress under various changed assumptions.

6.4 Implementation Plan

In practice, future airport improvement projects will be undertaken only when demand warrants and actual funding is available, rather than in accordance with a specific projected scheduled timeframe. Factors that can trigger the need to proceed with a particular airport development project can range from tenant demands for landside and support facilities, to airside and terminal capacity requirements (passenger demand). FAA planning criteria and the need to enhance safety on the airfield must also be considered.

The following section presents the recommended implementation plan for the CVG Master Plan. The phasing was adjusted from that which was analyzed in Section 6.3, *Financial Plan*. The phasing was modified as follows:

- Parking garages were removed from the plan due to the high cost of construction. Future garage development was replaced with surface lot parking until KCAB can further study the feasibility of parking garage construction.
- Some projects were deferred or accelerated as needed based on updated funding priorities and tenant needs. Examples include the deferral of a south airfield crossfield taxilane and a ground run-up pad/enclosure and the acceleration of police facilities.

All changes from the financial analysis phasing plan is detailed in the sections that follow.

6.4.1 PAL 1

The first phase of the Master Plan implementation strategy recommends several projects to support the projected PAL 1 demand of 11 Million Annual Passengers (MAP).

6.4.1.1 Airfield

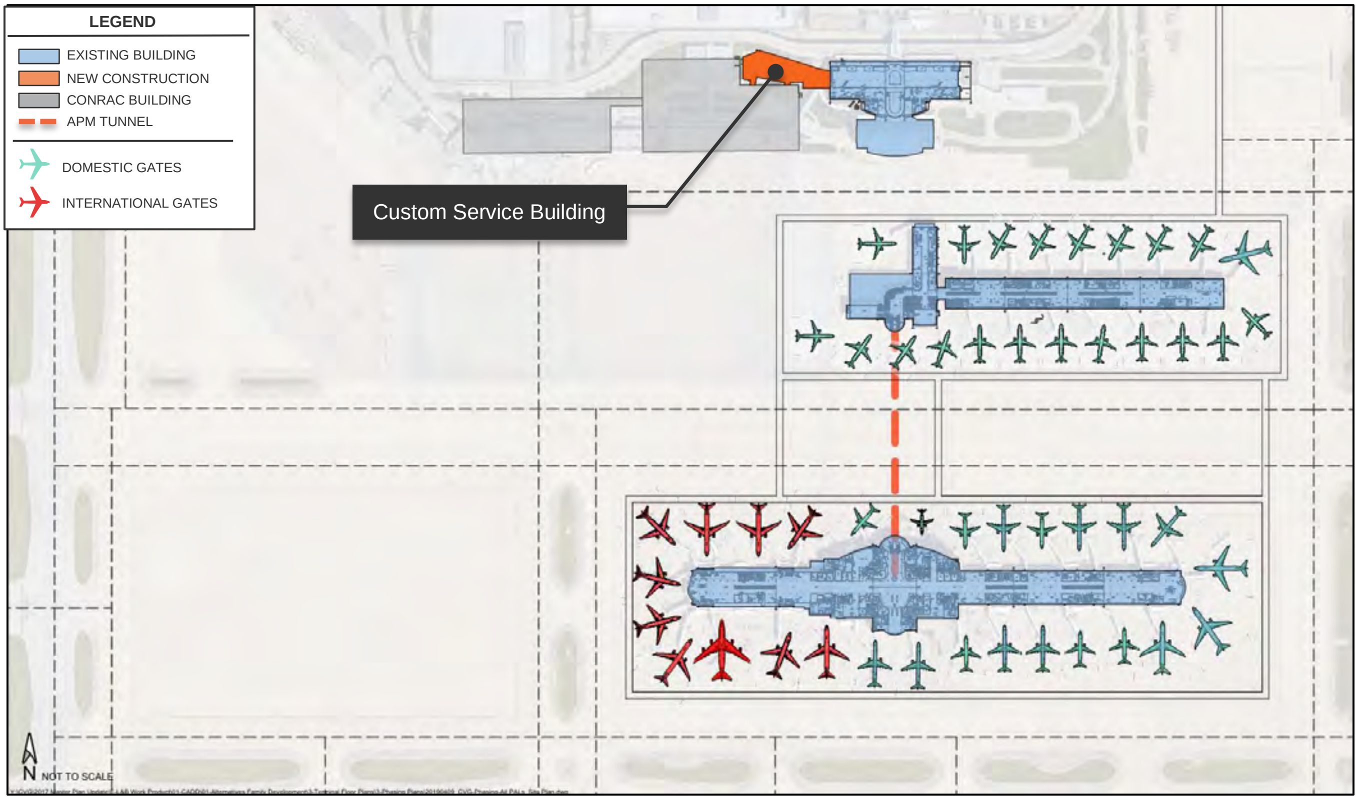
Airfield projects in the PAL 1 program are designed to improve safety and enhance capacity in the near-term. These projects include the extension of Taxilane N and the realignment of two taxiways with direct access from the cargo aprons to Runways 18C/36C and 18L/36R (Taxiways S4 and D2). The development of the parallel crossfield taxiway was initially recommended in PAL 1. This project has been deferred to PAL 2 for financial reasons based on discussions with KCAB staff. Independent of the recommended Master Plan projects, the Runway 09/27 rehabilitation project is currently in the design phase and scheduled to occur in the near-term.

6.4.1.2 Terminal

Terminal projects in the PAL 1 program include a new Customer Service Building (CSB) that will connect the adjacent CONRAC facility to the main terminal and provide passengers direct access to rental car pick-up and drop-off and a new ground transportation curb. The CSB will include rental car counters at the baggage claim level and the departure levels will include bag-drop counters and kiosks. The CSB will operate as an extension to the existing main terminal check-in hall. Details of the PAL 1 terminal projects are shown on **Exhibit 6.4-1, *PAL 1 Terminal Plan Detail***.

No new gates are provided in PAL 1 because there are currently sufficient gates to accommodate PAL 1 demand. The current gate count exceeds the PAL 1 gate requirements by one gate as shown in **Table 6.4-1, *PAL 1 Terminal Gates***. The PAL 1 plan provides 10 international swing gate positions that can accommodate both international and domestic operations.

EXHIBIT 6.4-1 PAL 1 TERMINAL PLAN DETAIL



Source: Photography dated September 23, 2017, Landrum & Brown analysis

TABLE 6.4-1 PAL 1 TERMINAL GATES

Gates	PAL 1 Plan	PAL 1 Requirement
Domestic	39	45
International	10	3
Total Gates	**49**	**48**

Source: Landrum & Brown analysis

6.4.1.3 Landside

Landside projects in the PAL 1 program focus on airport road improvements and several auto parking enhancements. Improvements to the Southbound KY 212/I-275 Westbound entrance ramp and Loomis Road/Donaldson Road (part 1), capacity improvements and extension to Wendell Ford Boulevard, and the construction on a new cell phone lot (West of Loomis Road) are consistent with the initial PAL 1 recommended projects.

Compared to the initial list of recommended projects, the timing and type of several auto parking facilities have changed. The construction of a new T1 parking garage and an expansion of the T3 parking garage were included in the initial list of recommend PAL 1 projects. The projects are required to meet the public parking demand needs of PAL 1 based on a continuation of the current parking pricing structure. Due to the high cost of adding parking garages and the fact that there are several unknowns with regards to future parking demand (how demand for garages will change based on pricing changes, increased use of TNCs, and the advent of driverless cars), KCAB made the decision to not include parking garages in the Master Plan development plan. Rather, surface lots were assumed to be built, which increases the space needed for parking but decreases the price.

Because the new T1 garage will not be built and the T3 parking garage will not be expanded, other surface parking projects initially planned for later phases have been moved up to support the PAL 1 needs. PAL 1 includes expansion of the ValuPark parking lot (part 1) and the conversion of the entire existing employee lot (along Donaldson Road) into a long-term public parking lot. The construction of a replacement employee surface parking lot is included off of Mineola Pike on the east side of CVG.

6.4.1.4 Support Facilities

The PAL 1 support facility projects include the development of a General Aviation (GA) hangar and apron, a government facility, and the development of the Amazon Prime Air Cargo site. The implementation plan reserves land for GA facilities south of the new AeroTerm building (near the existing CVG Sign Shop). The exact timing and size of these facilities will be determined as demand warrants. At the request of KCAB, the development of government/police facilities were moved up from PAL 2 to PAL 1. Land is reserved west of the fuel farm to accommodate the government/police facilities.

The development of the ground run-up enclosure and pad was initially recommended for PAL 1. This project has been deferred to a later phase for financial reasons based on discussions with the KCAB staff.

A 50-acre expansion off the DHL existing site to south is anticipated to occur during this phase.

6.4.1.5 Summary of PAL 1 Program

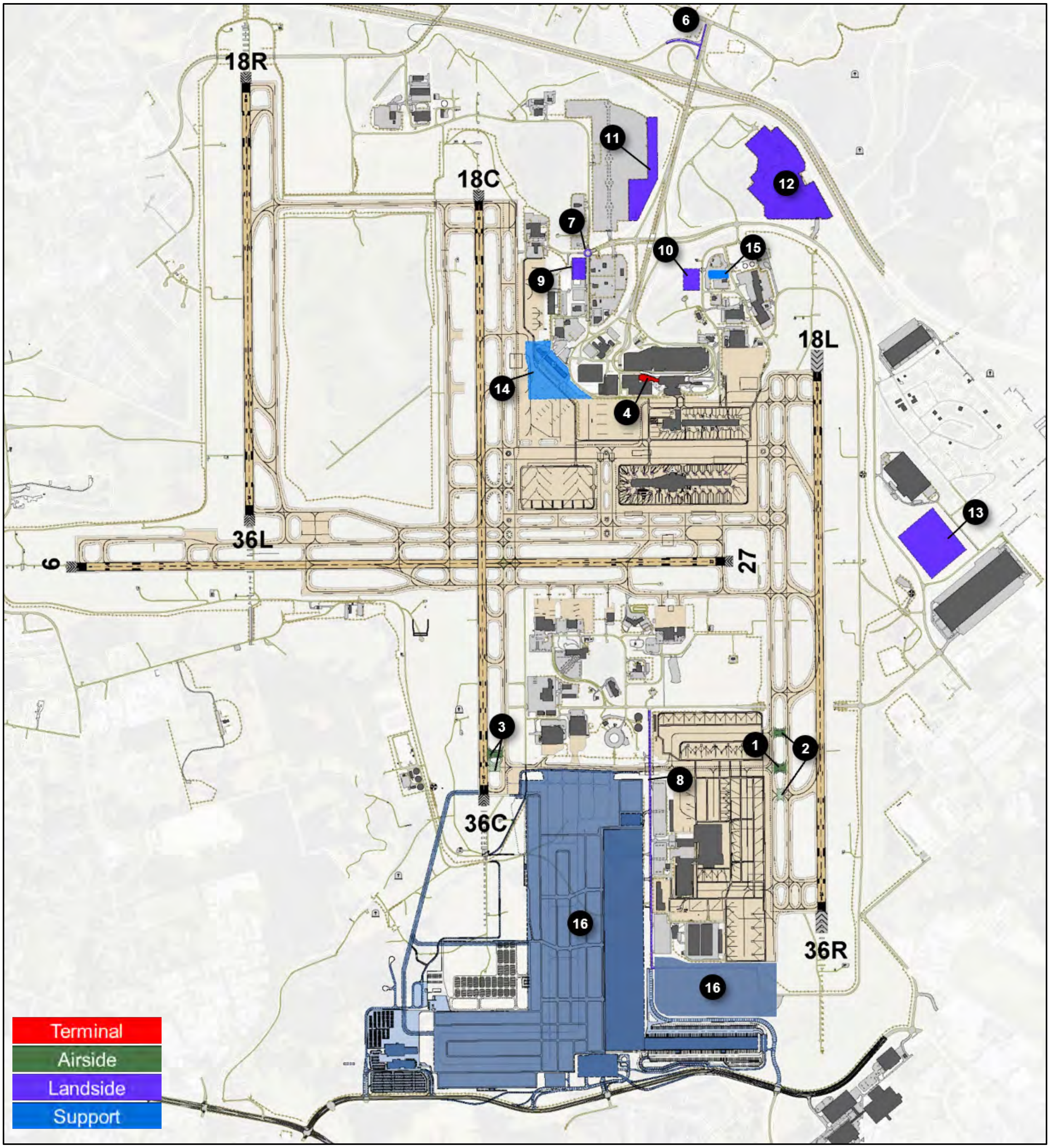
A complete list of the projects recommend for PAL 1 implementation is shown on **Table 6.4-2, *PAL 1 Recommended Projects***, and their locations are depicted on **Exhibit 6.4-2, *PAL 1 Program***.

TABLE 6.4-2 PAL 1 RECOMMENDED PROJECTS

#	PAL 1 Project List
	Airfield
1	Taxiway N Extension
2	Relocation of Taxiway S4 & Demo
3	Relocation of Taxiway D2 & Demo
	Terminal
4	Terminal Expansion
5	Bag Belts from CSB to Terminal (project not shown)
	Landside
6	SB KY 212/I-275 WB Entrance Ramp Improvements
7	Loomis Road/Donaldson Road Improvements – Part 1
8	Wendell Ford Blvd Capacity Improvements & Extension
9	Construction of New Cell Phone Lot
10	Expansion of Taxi Bullpen to add TNC
11	Expansion of ValuPark Parking Lot – Part 1
12	Convert Existing Employee Lot to Long-Term Parking
13	Construction of Replacement Employee Lot
	Support Facilities
14	General Aviation Hangar and Apron
15	Government/Police Facility
16	Cargo Development[1]

[1] Not included in Table 6.2-1. These projects are funded by third parties and were added at the request of KCAB staff.
Source: Landrum & Brown Team analysis

EXHIBIT 6.4-2 PAL 1 PROGRAM



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

6.4.2 PAL 2

The second phase of the Master Plan implementation strategy recommends several projects to support the projected demand of 13 MAP.

6.4.2.1 Airfield

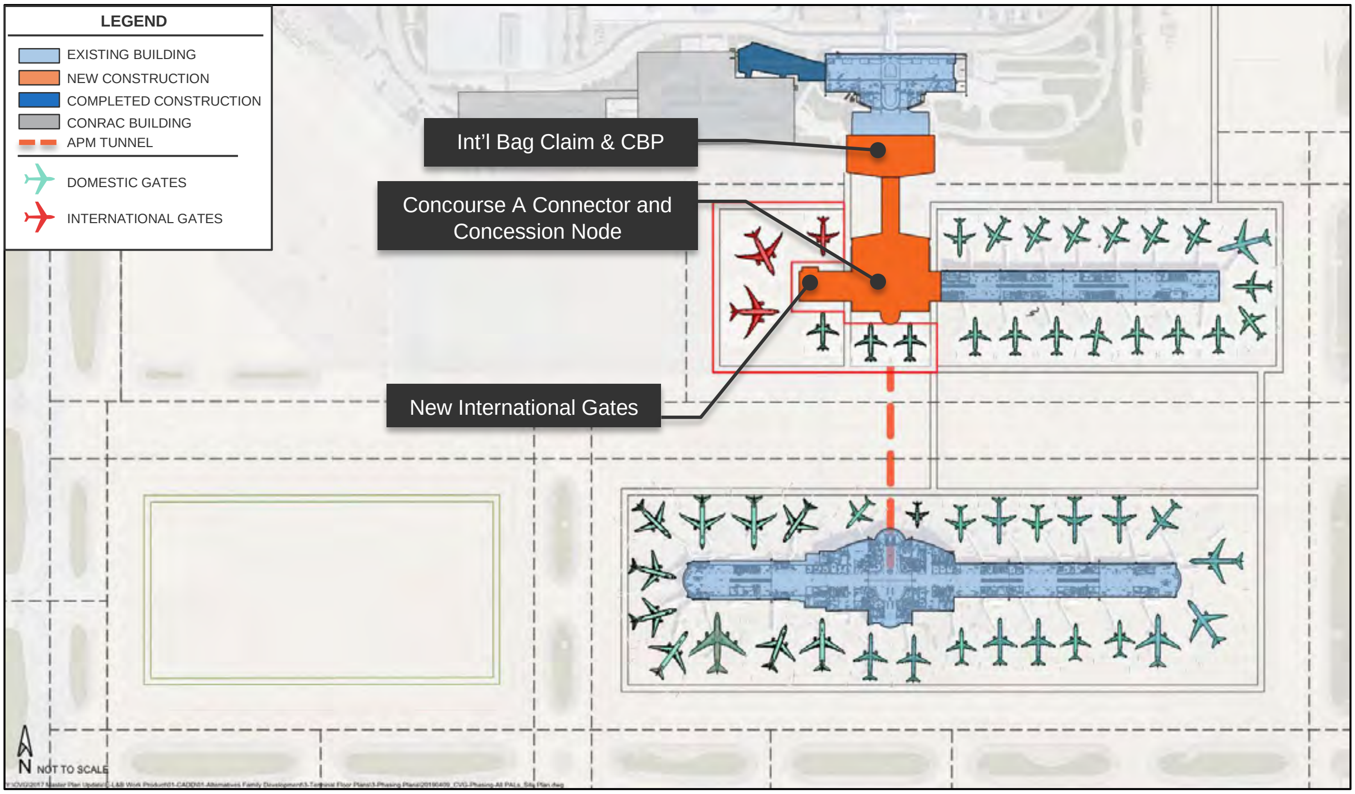
Airfield projects in the PAL 2 program are consistent with the initial recommended projects. Similar to the previous airfield projects, the PAL 2 program is designed to improve safety and enhance capacity. These projects include the realignment of four taxiways with direct access to runways (Taxiways S6, S7, S8, and E9). Additional projects are designed to improve Runway Occupancy Time (ROT) for Runway 36C arriving aircraft. These include the conversion of 90-degree runway exits into high-speed exit taxiways. These exits result in the demolition of Taxiways D8, D6, and D7 (east of Runway 18C/36C). PAL 2 also includes the development of a parallel crossfield Airplane Design Group (ADG) VI taxilane (parallel to Taxiway N). This project was initially included in PAL 1.

6.4.2.2 Terminal

The recommended terminal projects in the PAL 2 program include a multi-level expansion to the existing terminal and a connector that will allow passengers to walk directly to Concourse A without changing levels. This expansion includes a new security checkpoint and a relocated international arrivals facility. The PAL 2 improvements also include a west expansion to Concourse A that will provide relocated international gate positions with sterile corridor access to the new international arrivals facility located in the adjacent terminal building expansion.

The additional gates required to meet the PAL 2 requirements are located in the new west expansion to Concourse A and are intended to operate as international swing gates. Following the construction of a new international arrivals facility as part of the proposed terminal expansion, the original international swing gates located in Concourse B will transition to domestic arrivals and departures only. Details of the PAL 1 terminal projects are shown on **Exhibit 6.4-3, *PAL 2 Terminal Plan Detail,*** and **Table 6.4-3, *PAL 1 Terminal Gates*.**

EXHIBIT 6.4-3 PAL 2 TERMINAL PLAN DETAIL



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

TABLE 6.4-3 PAL 2 TERMINAL GATES

Gates	PAL 2 Plan	PAL 2 Requirement
Domestic	48	48
International	3	3
Total Gates	**51**	**51**

Source: Landrum & Brown analysis

6.4.2.3 Landside

Landside projects in the PAL 2 program focus on a major reconstruction of the I-275 interchange into CVG, various entrance road improvements, and auto parking enhancements. The four-part reconstruction of the I-275 interchange, improvements to the Donaldson Road ramp (part 1), Terminal Drive improvements (part 1), and the widening of South Airfield Drive are consistent with the initial PAL 2 recommended projects. At the request of KCAB staff, the construction of a KY 20/Petersburg Road entrance ramp and the Aero Parkway Mineola Pike improvements were also included in the PAL 2 landside program.

Incremental capacity expansion to support the projected PAL 2 public parking demand is included in PAL 2. This phase includes a second phase expansion of the ValuPark parking lot; ValuPark expansion was originally shown in PAL 4.

6.4.2.4 Support Facilities

The PAL 2 support facility projects include the development of a deicing pad west of the terminal apron, expansion of the PAL 1 GA hangar and apron (as demand warrants), and the development of a ground run-up pad south of Taxiway M, which was originally shown in PAL 1. The sizing and timing of the PAL 2 deicing pad is based on the requirements presented in Chapter 4.

6.4.2.5 Summary of PAL 2 Program

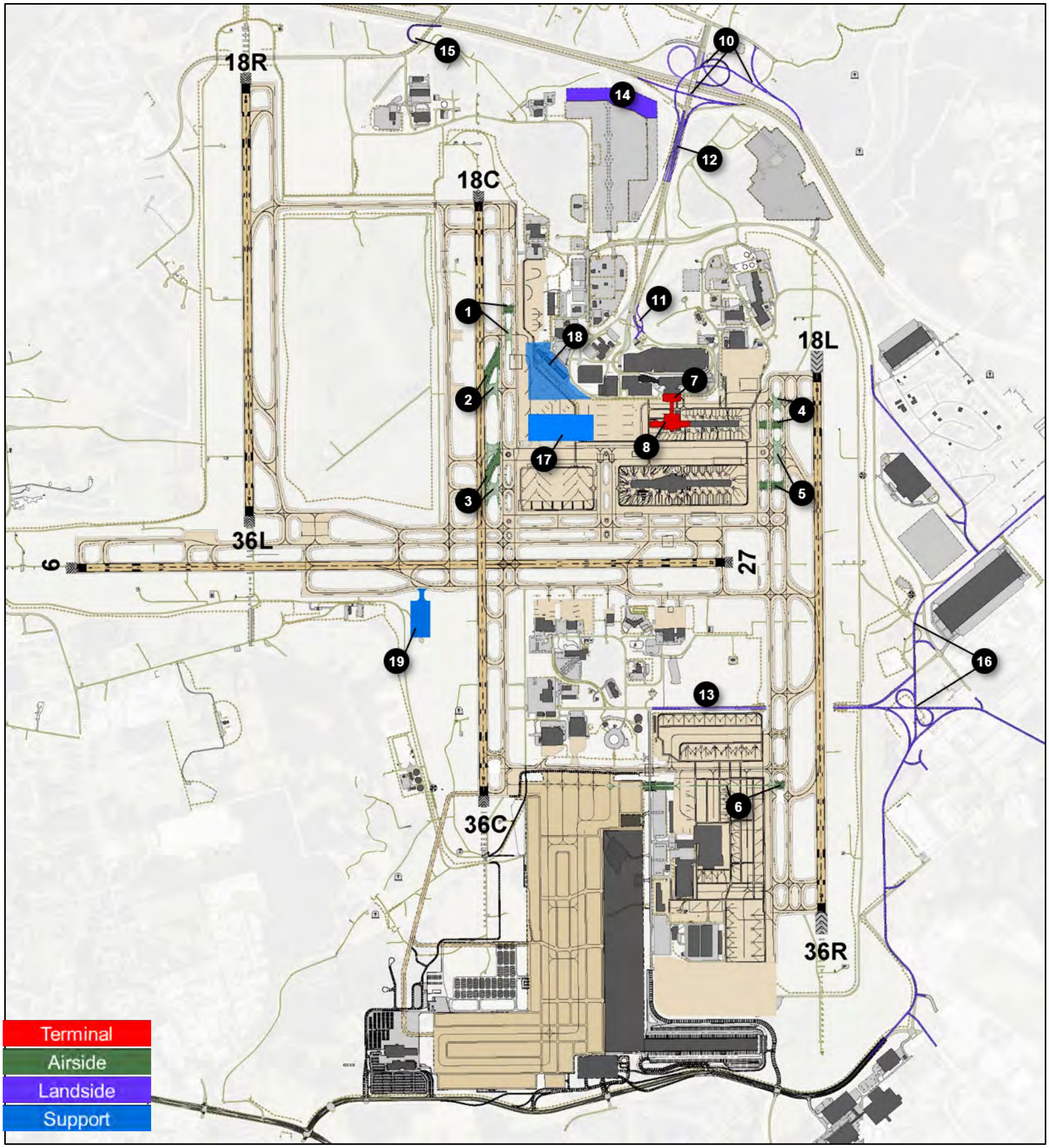
A complete list of the projects recommend for PAL 2 implementation is shown on **Table 6.4-4, *PAL 2 Recommended Projects***, and their locations are depicted on **Exhibit 6.4-4, *PAL 2 Program***.

TABLE 6.4-4 PAL 2 RECOMMENDED PROJECTS

#	PAL 2 Project List
Airfield	
1	Relocation of Taxiway E9 & Demo
2	Runway 36C High Speed Exit East and D8 Demo
3	Runway 36C High Speed Exit East and D6/D7 Demo
4	Relocation of Taxiway S8 & Demo
5	Relocation of Taxiway S6/S7 & Demo
6	Parallel Crossfield Taxilane
Terminal	
7	Terminal Expansion
8	Concourse A Improvements
9	Bag System Long-Term (project not shown)
Landside	
10	Reconstruct I-275 Interchange
11	Donaldson Road Ramp Improvements – Part 1
12	Terminal Drive Improvements – Part 1
13	Widen South Airfield Drive
14	Expand ValuPark Parking Lot – Part 2
15	KY 20/Petersburg Road Entrance Ramp Improvements[1]
16	Aero Parkway Mineola Park Roadway Improvements[1]
Support Facilities	
17	Deicing Pad
18	Expansion of General Aviation Hangar and Apron
19	Ground Run-up Pad

1 Not included in Table 6.2-1. These projects are funded by third parties and were added at the request of KCAB staff.
Source: Landrum & Brown Team analysis

EXHIBIT 6.4-4 PAL 2 PROGRAM



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

6.4.3 PAL 3

The third phase of the Master Plan implementation strategy recommends several projects to support the projected demand of 16 MAP.

6.4.3.1 Airfield

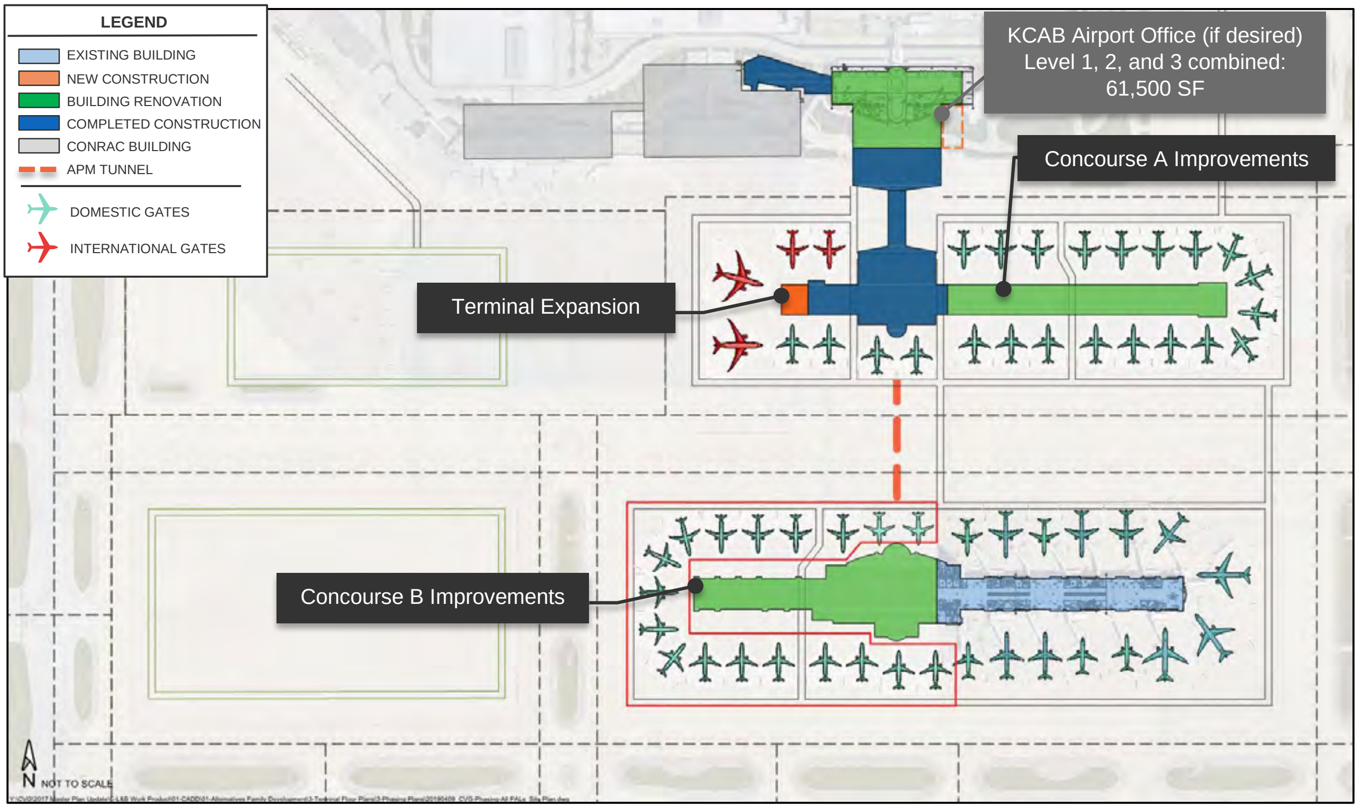
Airfield projects in the PAL 3 include the relocation of Taxiway E to the east to provide ADG-VI capability, removal of two direct access taxiways (Taxiway J2 and J4) south of the terminal area, and the extension of Taxiway E to the south to provide dual parallel taxiways to the Runway 36C end.

6.4.3.2 Terminal

The PAL 3 terminal improvements include an interior reconfiguration of the west side of Concourse B and the east side of Concourse A as well as a new western gate expansion to Concourse A that provides additional international gate positions. PAL 3 also includes a complete renovation of the main terminal. The renovation includes the ticketing areas, existing offices, and baggage claim level. The new security screening checkpoint area that is included as part of PAL 2 is an enabling project for portions of the proposed PAL 3 renovations in the main terminal. If desired, a KCAB office building could be constructed in PAL 3.

The intent of the Concourse A and B reconfigurations is to both modernize the facilities and allow for the relocation of holdrooms and jet bridges to correspond to a more efficient gate parking configuration. The gate reconfiguration will optimize the width of the existing aircraft parking position width for ADG III aircraft and improve the gate frontage utilization. The optimization of parking positions will increase the total number of gates. Details of the PAL 3 terminal projects are shown on **Exhibit 6.4-5, *PAL 3 Terminal Plan Detail,*** and **Table 6.4-5, *PAL 3 Terminal Gates***.

EXHIBIT 6.4-5 PAL 3 TERMINAL PLAN DETAIL



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

TABLE 6.4-5 PAL 3 TERMINAL GATES

Gates	PAL 3 Plan	PAL 3 Requirement
Domestic	54	54
International	4	4
Total Gates	**58**	**58**

Source: Landrum & Brown analysis

6.4.3.3 Landside

The PAL 3 landside projects include parts 2 and 3 of the Donaldson Road ramp improvements and part 2 of the Loomis Road/Donaldson Road improvements. The initial list of recommended projects included the construction of a new T3B parking garage. Because the development plan focuses on surface lots rather than garages, the PAL 3 landside implementation plan now includes an expansion to the PAL 1 replacement employee surface parking lot to meet the parking demand needs.

6.4.3.4 Support Facilities

The PAL 3 support facility program includes the development of airline support and airport maintenance facilities to support the anticipated demand. Several areas are identified in the implementation plan that could accommodate this development. Additionally, the expansion of the PAL 1 GA hangar and apron (as demand warrants) is likely to occur in this phase. Expansion of the airport hotel space is anticipated to occur in PAL 3. As demand warrants, the existing Hilton Double Tree hotel (located along the airport entrance road) could accommodate the additional hotel space by expanding their existing facilities. PAL 3 also includes the ground run-up enclosure structure that was originally shown in PAL 1.

6.4.3.5 Summary of PAL 3 Program

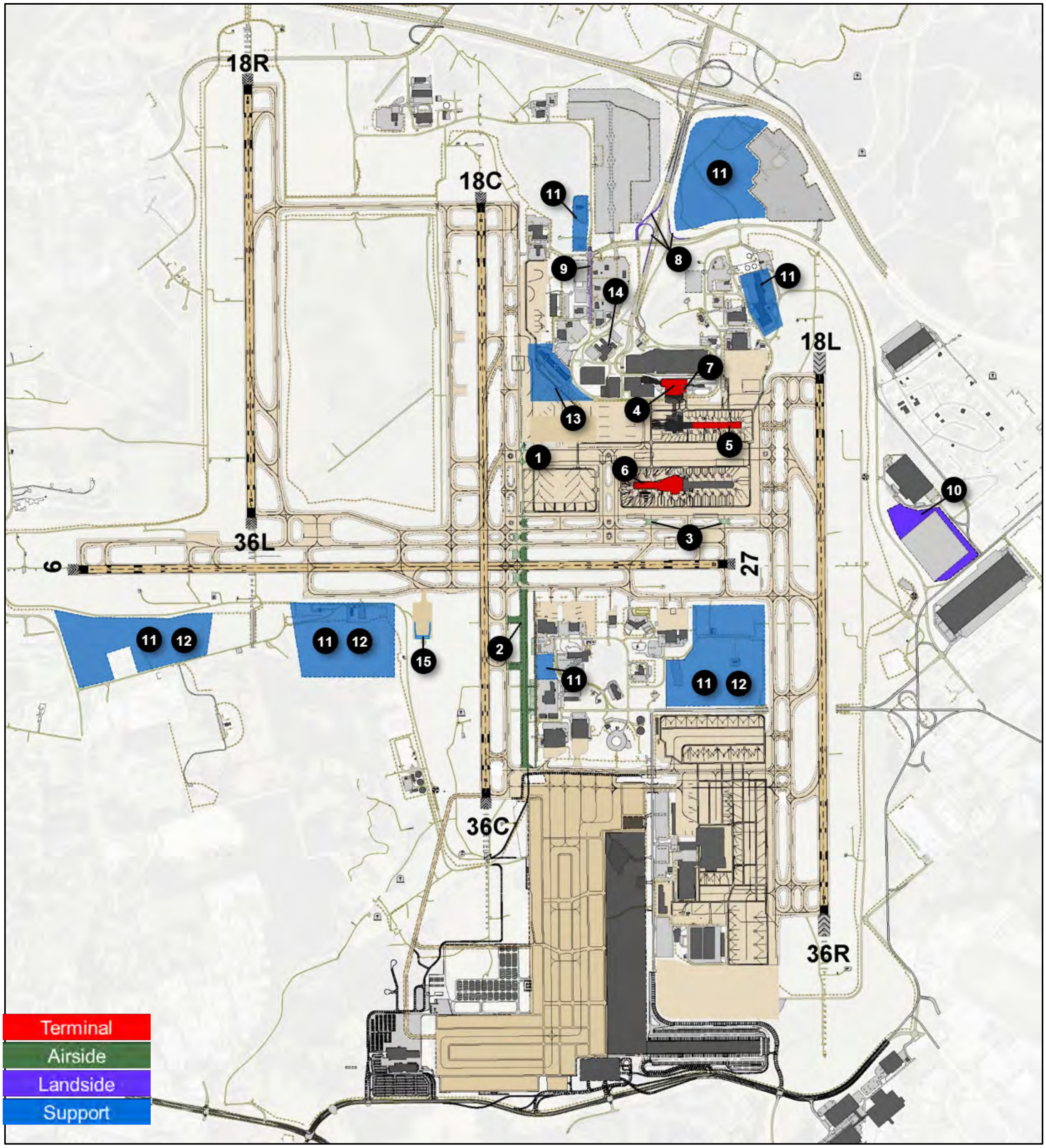
A complete list of the projects recommended for PAL 3 implementation is shown on **Table 6.4-6, *PAL 3 Recommended Projects***, and their locations are depicted on **Exhibit 6.4-6, *PAL 3 Program***.

TABLE 6.4-6 PAL 3 RECOMMENDED PROJECTS

#	PAL 3 Project List
	Airfield
1	Taxiway E Relocation (north) & Demo
2	Taxiway E Extension South
3	Taxiway J2 & J4 Demo
	Terminal
4	Terminal Improvements
5	Concourse A Improvements
6	Concourse B Improvements
7	KCAB Office Building (if desired)
	Landside
8	Donaldson Road Ramp Improvements – Part 2,3
9	Loomis Road/Donaldson Road Improvements – Part 2
10	Expansion of Replacement Employee Lot
	Support Facilities
11	Airline Support Facility Expansion
12	Airport Maintenance Building Expansion
13	Expansion of GA Hangar and Apron
14	Expansion of Airport Hotel on Existing Site
15	Ground Run-Up Enclosure

Source: Landrum & Brown Team analysis

EXHIBIT 6.4-6 PAL 3 PROGRAM



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

6.4.4 PAL 4/Post 20-Year Expansion Plan

The final phase of the Master Plan implementation strategy recommends several projects to support the projected demand beyond 16 MAP, anticipated to occur 20+ years in the future.

6.4.4.1 Airfield

Airfield projects in the PAL 4 are designed to improve safety and enhance capacity. These projects include several runway exit improvements for Runway 18C/36C and 18L/36R. Two high-speed exits are included on the west side of Runway 18L/36R designed to improve Runway Occupancy Time (ROT) in both flows. Additionally, a total of three high-speed runway exits (west side) are recommended for Runway 18C/36C; two for Runway 36C arriving aircraft and one for Runway 18C arrivals. To help support operations to and from the Runway 36C end, an extension of Taxiway C to the south is recommended to provide a full-length parallel taxiway to the west of Runway 18C/36C.

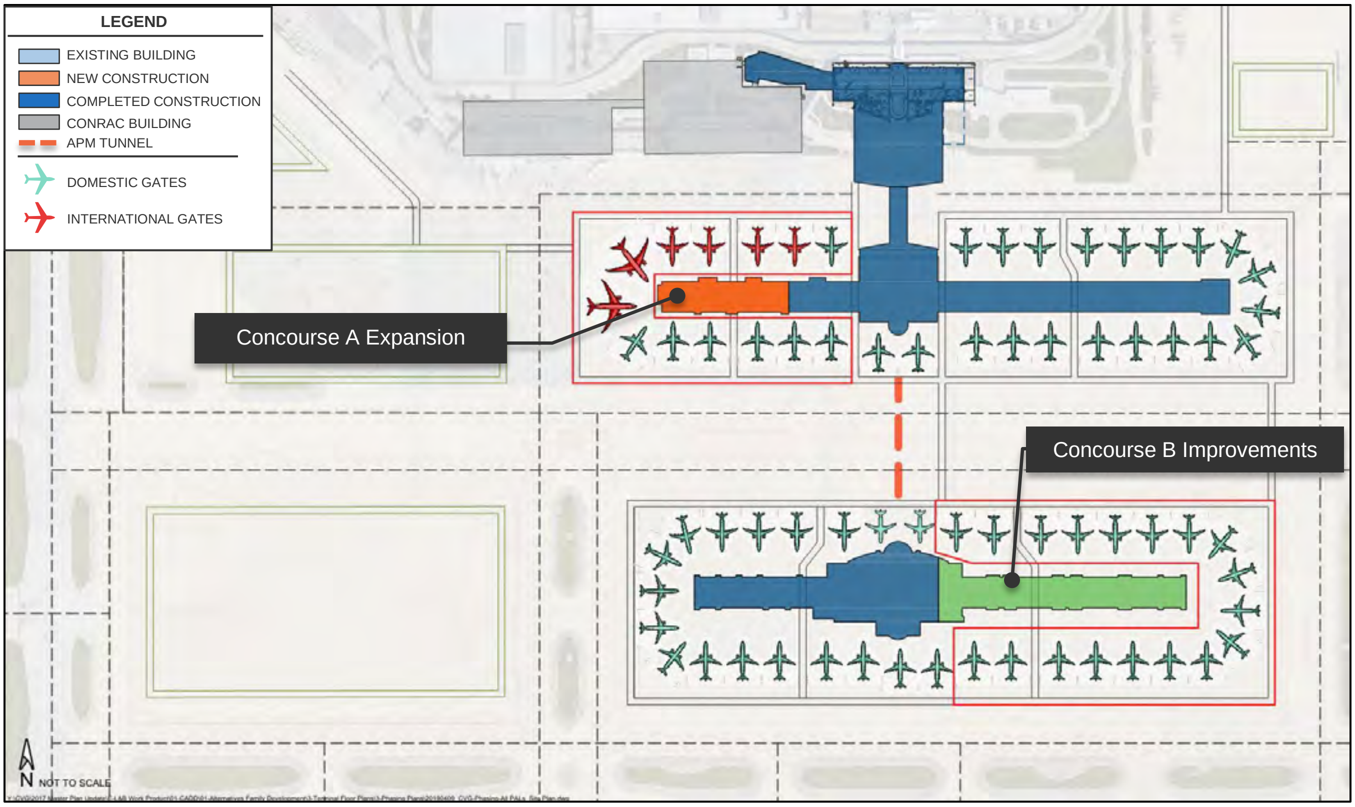
The final development phase also recommends a 2,000-foot extension of Runway 18R/36L to the south, resulting in a total runway length of 10,000 feet. Associated taxiway improvements are recommended to support operations to the new runway threshold. This runway extension was originally included in PAL 3.

Finally, the Master Plan preserves an ultimate parallel runway east of Runway 18L/36R. The ultimate length and location will require additional analysis, is not anticipated to be needed within the long-term planning horizon and was not included in the financial plan.

6.4.4.2 Terminal

The PAL 4 terminal improvements complete the east portion of the Concourse B interior renovations and gate optimization that began in PAL 3. Similar to the PAL 3, these improvements provide additional gate positions. PAL 4 also includes additional expansion to the west end of Concourse A. This expansion provides both additional international swing gates and domestic gates. Combined with the Concourse B gate optimization the new gates provided in the west Concourse A expansion meet the PAL 4 gate requirements. Details of the PAL 4 terminal projects are shown on **Exhibit 6.4-7, *PAL 4 Terminal Plan Detail,*** and **Table 6.4-7, *PAL 4 Terminal Gates***.

EXHIBIT 6.4-7 PAL 4 TERMINAL PLAN DETAIL



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

TABLE 6.4-7 PAL 4 TERMINAL GATES

Gates	PAL 4 Plan	PAL 4 Requirement
Domestic	63	63
International	6	6
Total Gates	**69**	**69**

Source: Landrum & Brown analysis

6.4.4.3 Landside

The PAL 4 landside projects include part 2 of the Terminal Drive improvements, as well as the construction of two parking lots in the north. The initial list of recommended projects included an incremental expansion of ValuPark parking, but this was moved up to PALs 1 and 2 because KCAB does not want to include new garage parking at this time. In order to accommodate the PAL 4 parking demand in surface lots, two new parking lots are included in PAL 4 – one north of the terminal building and one west of the ValuPark parking lot.

6.4.4.4 Support Facilities

The PAL 4 support facility implementation plan is designed to preserve land for the development of several facilities needed to support the future airport. As discussed in Chapter 4, a few support facilities are anticipated to require incremental expansions in the beginning of PAL 4. These facilities include airport maintenance, GA, government/police, and the Airport hotel.

Additionally, several areas are reserved in the implementation plan that could accommodate the following support facility developments:

- Cargo Development
- Airline Support
- Commercial Development
- Fuel Farm
- Future Aviation Related Development.

6.4.4.5 Summary of PAL 4/Post 20-Year Program

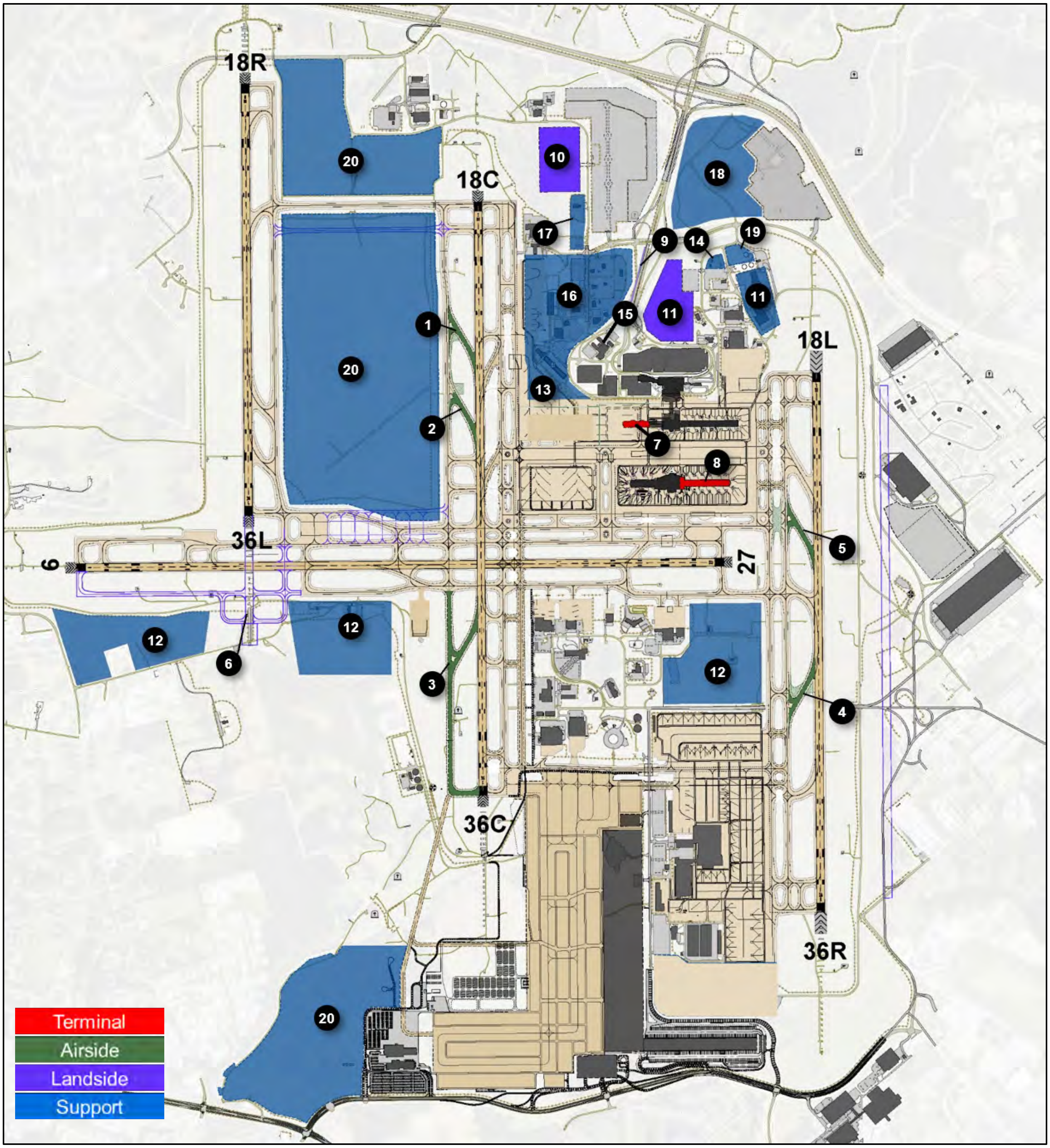
A complete list of the projects recommended for the PAL 4 implementation is shown on **Table 6.4-8, *PAL 4/Post 20-Year Recommended Projects.*** Their locations are depicted on **Exhibit 6.4-8, *PAL 4/Post 20-Year Program***.

TABLE 6.4-8 PAL 4/POST 20-YEAR RECOMMENDED PROJECTS

#	PAL 4/ Post 20-Year Expansion Project List
Airfield	
1	Runway 36C High Speed Exit West & Demo
2	Runway 36C High Speed Exit West & Demo
3	Taxiway C Extension and High-Speed Exit
4	Runway 18L High Speed Exit
5	Runway 36R High Speed Exit
6	Runway 18R/36L Extension
Terminal	
7	Concourse A Expansion
8	Concourse B Improvements
Landside	
9	Terminal Drive Improvements – Part 2
10	Construction of New Parking Lot (West of ValuPark)
11	Construction of New Parking Lot (North of Terminal Garage)
Support Facilities	
12	Expansion of Airport Maintenance Building
13	Expansion of GA Hangar and Apron
14	Expansion of Government/Police Facility
15	Expansion of Airport Hotel on Existing Site
16	Land Reserved for Cargo Development
17	Land Reserved for Airline Support
18	Land Reserved for Commercial Development
19	Land Reserved for Fuel Farm
20	Land Reserved for Future Aviation Related Development

Source: Landrum & Brown Team analysis

EXHIBIT 6.4-8 PAL 4/POST 20-YEAR PROGRAM



Sources: Photography dated September 23, 2017; Landrum & Brown analysis

MASTER PLAN 2050

Chapter 7 | Airport Layout Plans

CVG
CINCINNATI/NORTHERN KENTUCKY
INTERNATIONAL AIRPORT

L&B
TEAM

7 Airport Layout Plans

7.1 Introduction

The Cincinnati/Northern Kentucky International Airport (CVG) Master Plan 2050 has evolved through the analytical efforts described in previous chapters. The information in Chapter 6, *Implementation Planning*, presents the development plan for the CVG that accommodates the forecast demand through 2050.

This chapter presents the preferred CVG development plan in a set of detailed drawings, referred to as the Airport Layout Plan (ALP) set. These drawings depict the recommendations for airfield layout, disposition of obstructions, and future use of land at CVG. This set of plans includes the following drawings that are presented in reduced format at the end of this chapter:

- **Sheet 1**: Cover Sheet
- **Sheet 2**: Existing Airport Layout Plan (ALP)
- **Sheet 3**: Future Airport Layout Plan (ALP) Overall
- **Sheet 4**: Future Airport Layout Plan - North
- **Sheet 5**: Future Airport Layout Plan – South
- **Sheet 6**: Data Sheet
- **Sheet 07**: Airspace Overall (Part77)
- **Sheet 08**: Airspace Conical (Part 77)
- **Sheet 09**: Runway Centerline Profiles
- **Sheet 10**: Part 77 Runway Approach Profiles
- **Sheet 11**: 50:1 Part 77 Runway Approach Profiles
- **Sheet 12**: 40:1 Part 77 Runway Approach Profiles - Runway 09/27
- **Sheet 13**: 40:1 Part 77 Runway Approach Profiles - Runway 18R/36L
- **Sheet 14**: 40:1 Part 77 Runway Approach Profiles - Runway 18C/36C
- **Sheet 15**: 40:1 Part 77 Runway Approach Profiles - Runway 18L/36R
- **Sheet 16**: Inner Portion of the Approach Surface - Runway 09/27
- **Sheet 17**: Inner Portion of the Approach Surface - Runway18R/36L
- **Sheet 18**: Inner Portion of the Approach Surface - Runway 18C/36C
- **Sheet 19**: Inner Portion of the Approach Surface - Runway 18L/36R
- **Sheet 20**: Runway Departure Surface - Runways 09/27 & 18R/36L
- **Sheet 21**: Runway Departure Surface - Runways 18C/36C & 18L/36R
- **Sheet 22**: On Airport Land Use
- **Sheet 23**: Off Airport Land Use

- **Sheet 24**: Exhibit A Property Map
- **Sheet 25**: Exhibit A Property Map Details
- **Sheet 26**: Exhibit A Property Map – Bearing and Distance

The ALP set has been prepared in accordance with Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5300-13A, *Airport Design*, and the FAA Standard Operating Procedure (SOP) 2.00, *Standard Procedure for FAA Review and Approval of Airport Layout Plans (ALPs)*.

7.2 Airport Layout Plan Drawings Set

The following subsections describe the major components of the ALP set. The ALP set is a planning tool for the FAA's review of airport development grant applications under the Airport Improvement Program (AIP). The FAA refers to the ALP set in its review of proposed construction projects that may affect navigable airspace. The ALP set also serves as a planning tool for use by surrounding jurisdictions to address land use, zoning, and resource planning issues.

7.2.1 Sheet 1: Cover Sheet

The Cover Sheet serves as an introduction to the CVG plans set. It includes the following:

- Name of the Airport
- Name of the Study
- Period of the Study
- Index of the Included Drawings
- Approval Blocks

7.2.2 Sheets 2 through 5: Airport Layout Plans

The ALP drawings graphically present the existing and future airport facility layout. These sheets depict the recommended improvements that will enable CVG to meet the forecast demand through the 20-year planning period.

The Existing ALP (Sheet 2) is a base drawing that depicts the existing airport facilities anticipated to be operational by the end of 2019. The Future ALP (Sheets 3, 4, and 5) depicts the proposed airport improvements for both the airside and landside areas "on top of" the existing airport facilities. The entire airport is shown on Sheet 3. Sheet 4 and Sheet 5 show zoomed-in portions of the north and south areas, respectively.

Sheets 3, 4, and 5 show the proposed phasing for the future projects. These phases are described as Planning Activity Levels (PALs):

- PAL 1 = short-term projects
- PAL 2 = medium-term projects
- PAL 3 = long-term projects
- PAL 4 = post planning period

7.2.3 Sheet 6: Airport Data Sheet

This sheet provides basic airport and runway data tables associated with the existing and future airport layout. The Airport Data Sheet includes the following information:

- Existing Taxiway Data
- Proposed Taxiway Data
- Airport Data
- Runway Data
- Declared Distance Data
- Acronym Table
- Wind Coverage Table

7.2.4 Sheet 7 and 8: Federal Aviation Regulation (FAR) Part 77 Airspace Plan and Obstruction Data Tables

Federal Aviation Regulation (FAR) Part 77, *Objects Affecting Navigable Airspace*, prescribes airspace standards that establish criteria for evaluating navigable airspace around airports. This sheet presents FAR Part 77 standards and their relationship to the physical features and terrain on and around CVG. The FAR Part 77 surfaces and limiting heights and evaluations for future development adjacent to CVG are shown on this sheet.

The intent of FAR Part 77 is to protect the airspace and approaches to each runway from hazards that could affect the safe and efficient operation of aircraft. These federal criteria have also been established for use by local jurisdictions to control the height of objects in an airport vicinity. For example, FAR Part 77 can be utilized in zoning ordinances to enhance area land use compatibility.

These drawings are also used to identify potential obstructions that are located within the imaginary surfaces of an airport. Ideally, an obstruction should be removed or lowered beneath the imaginary Part 77 surfaces. In some cases, it is appropriate to mark and light the obstruction in accordance with FAA AC 70/7460-1K, *Obstruction Marking and Lighting*. All obstructions must be reviewed by the FAA to determine if they are a hazard to air navigation and to determine which course of action is appropriate. Sheet 7 shows the entire Part 77 surfaces, while Sheet 8 zooms in to show more detail.

The FAR Part 77 imaginary surfaces are established relative to an airport and its runway system. The size of each imaginary surface is based on the runway approach category (visual, non-precision, or precision). Each of the Part 77 surfaces is described as follows:

- **Primary Surface**: The primary surface is located closest to the runway environment. It is a rectangular area symmetrically located about each runway centerline and extends a distance of 200 feet beyond each runway threshold. Its elevation is the same as the runway centerline at a point perpendicular to the runway centerline. The width of the primary surface depends on the type of runway approach capability (visual, non-precision, or precision). All existing CVG runways have precision approach capability.

The primary surface must remain clear of most objects to allow unobstructed passage of aircraft. Objects are only permitted if they are no taller than two feet above the ground, and if they are constructed on frangible (breakaway) mounts. The only exception to this rule is for objects for which location is “fixed by function,” such as navigational and visual aid facilities (glide slope, precision approach path indicator, windsock, etc.).

- **Approach Surface**: An approach surface is also established for each runway end. The approach surface has the same inner width as the primary surface, and then flares (gets wider) as it rises upward and outward along the extended runway centerline. The approach surface begins 200 feet beyond the runway end. The slope of the rise and the length of the approach surface is dictated by the type of approach available to the runway (visual, non-precision or precision), and by the approach category of the aircraft for which the runway is designed. All existing CVG runways have precision approach capability.
- **Transitional Surface**: Each runway has a transitional surface that begins at the outside edge of the primary surface, and at the same elevation as the runway centerline. There are three transitional surfaces: the first is off the sides of the primary surface, the second is off the sides of the approach surface, and the third is outside the conical surface and pertains to precision runways only. The transitional surface rises at a slope of one foot vertically for each seven feet of horizontal distance (7:1) up to a height which is 150 feet above the highest runway elevation.
- **Horizontal Surface**: The horizontal surface is established at 150 feet above the published airport elevation. This is an oval-shaped flat surface that connects the transitional and approach surfaces to the conical surface at a distance of 10,000 feet from the primary surface.
- **Conical Surface**: The conical surface begins at the outer edge of the horizontal surface. The conical surface continues for a distance of 4,000 feet horizontally at a slope of a one foot rise for each 20 feet of horizontal distance (20:1).

7.2.5 Sheet 9: Runway Centerline Profiles

This sheet shows the centerline profiles for the four existing runways at CVG, including elevations along the entire length of each runway.

7.2.6 Sheets 10 through 15: Part 77 Runway Approach Profiles

These Runway Approach sheets show profile views of the Part 77 approaches to each of the existing runways.

7.2.7 Sheets 16 through 19: Inner Portion of the Approach Surface Plan and Profiles

These sheets show the inner portion of the approach surface plan and profile views of the approaches to each of the existing runways. The plan and profile views facilitate identification of obstructions located within the areas that should be void of objects that may endanger safe aircraft flight during takeoff and landing. A database of obstruction analysis tables and tree cluster information is provided in a separate Microsoft Excel spreadsheet.

7.2.8 Sheets 20 and 21: 40:1 Departure Surface Drawings

The 40:1 Runway Departure Surface drawings show both the plan and profile views for each of the runway departures as shown on the ALP. Departure surfaces, when clear, allow pilots to follow standard departure procedures. It is important for airports to identify and remove these obstacles whenever possible when takeoff procedures can be enhanced, and also to prevent new obstacles. A database of obstruction analysis tables and tree cluster information is provided in a separate Microsoft Excel spreadsheet.

7.2.9 Sheets 22 and 23: On and Off-Airport Land Use Plans - Existing & Future

The purpose of developing the on-airport land use plan shown on Sheet 22 is to achieve an arrangement of land uses within an airport's boundary that best utilizes available property for existing and future airport needs. It should be compatible with the surrounding environment. The Future Airport Land Use Plan for CVG provides adequate growth for all airport functions and provides for the potential to develop non-aviation related development that could generate additional revenue for CVG.

Sheet 23 of this plan set presents the off-airport land use plan with the aircraft noise contours overlaid. The purpose of the off-airport land use plan is to guide the future development of the property in the vicinity of CVG so as to ensure that incompatible uses are not developed in areas that are potentially affected by airport operations. This plan should be used by municipal planners to develop the appropriate zoning regulations and for the approval of future off-airport development proposals.

7.2.10 Sheet 24, 25, and 26: Exhibit A Property Map

The purpose of an Exhibit A Airport Property Inventory Map is to represent all real property currently owned and previously owned by an airport. Specific data is maintained for each numbered parcel presented in the Exhibit A. The data includes physical description of parcel, grantee information, type of interest acquired, and public land record references. The Exhibit A also includes information such as project number, specific to FAA funded projects. The Exhibit A is maintained by CVG and must be provided to the FAA to receive funding for airport projects. A database of the Exhibit A Property Map information is provided in a separate Microsoft Excel spreadsheet.

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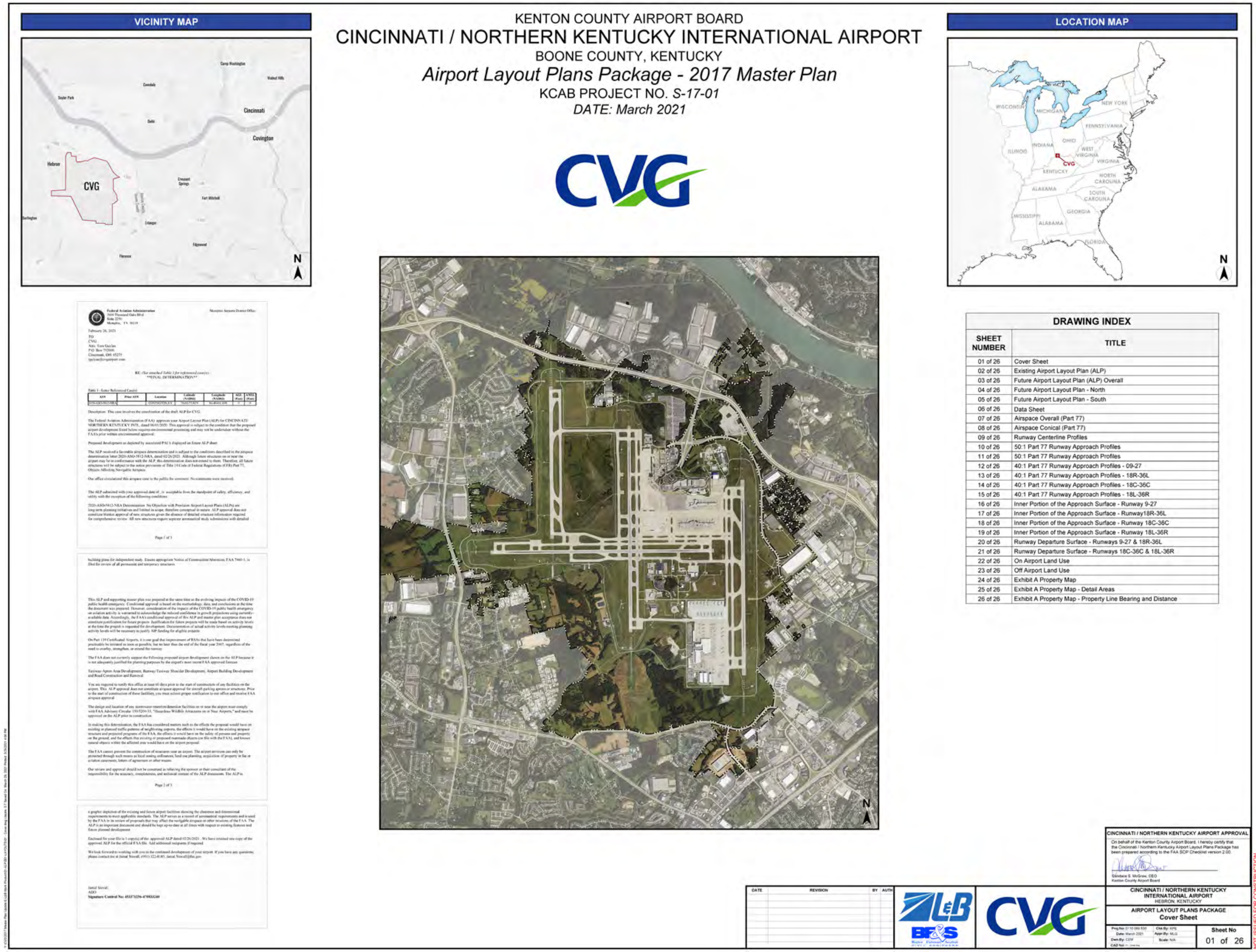
EXHIBIT 7.2-1 SHEET 01: COVER SHEET



Source: Landrum & Brown Team analysis

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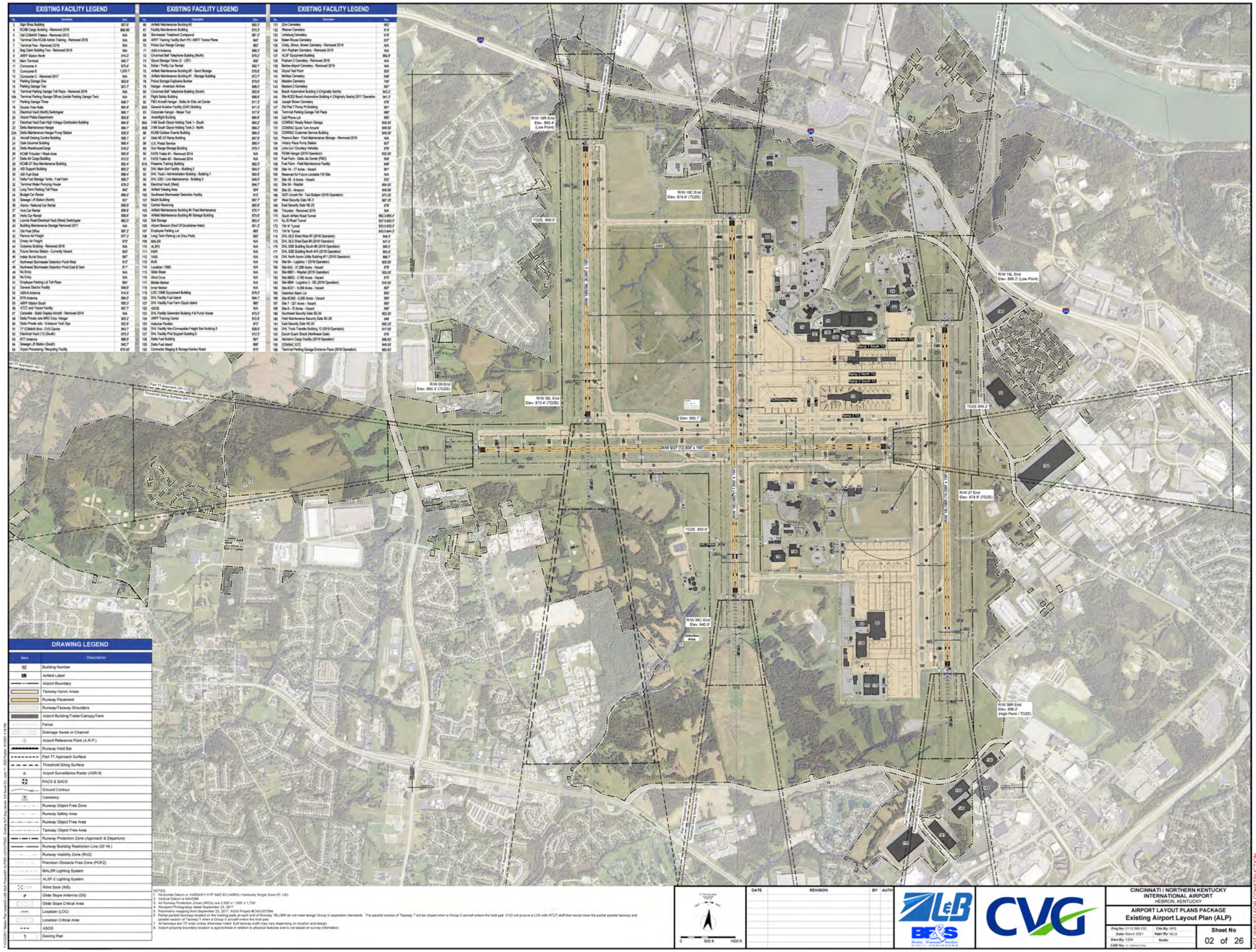
EXHIBIT 7.2-2 SHEET 02: EXISTING AIRPORT LAYOUT PLAN (ALP)



Source: Landrum & Brown Team analysis

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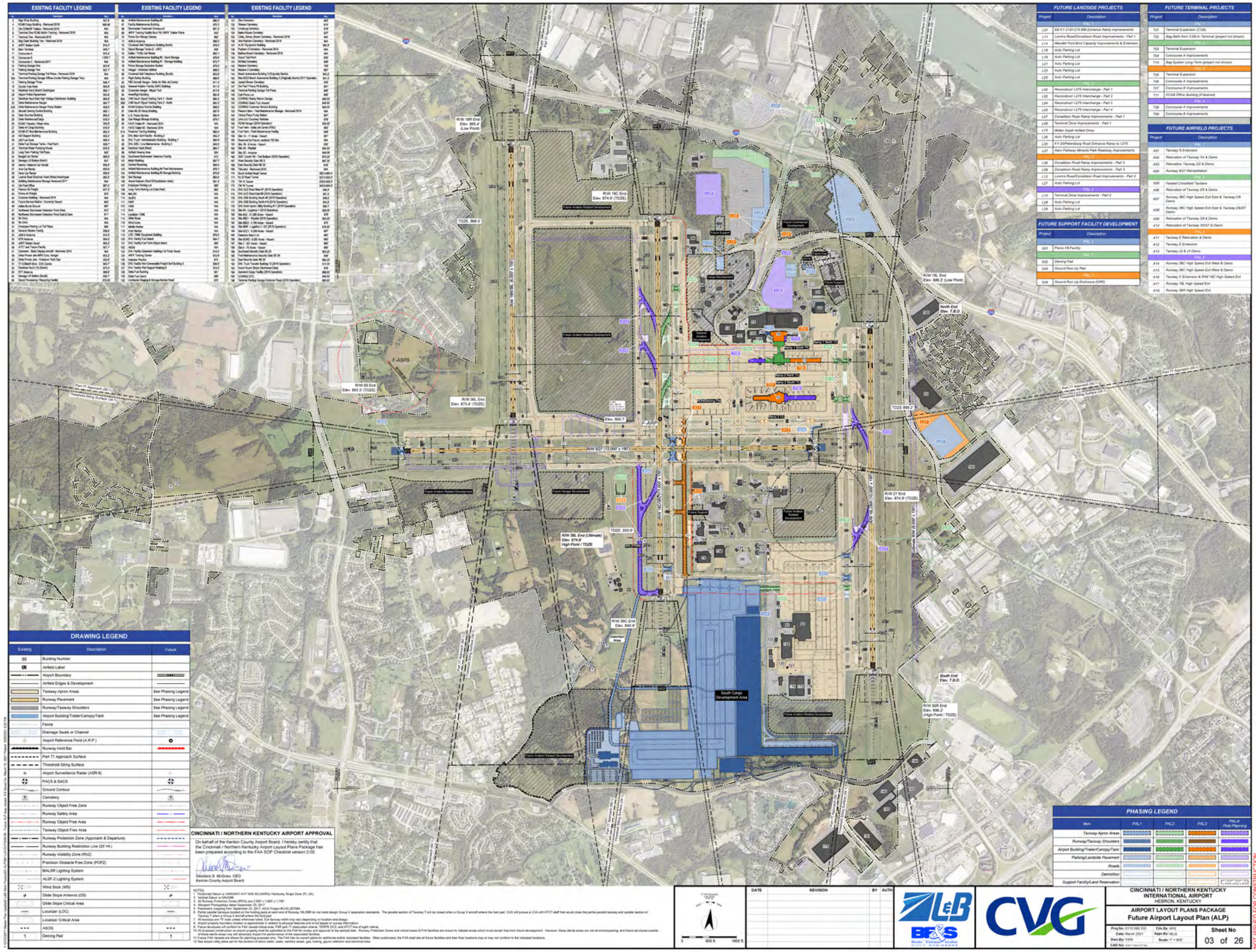
EXHIBIT 7.2-3 SHEET 03: FUTURE AIRPORT LAYOUT PLAN (ALP) OVERALL



Source: Landrum & Brown Team analysis

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EXHIBIT 7.2-4 SHEET 04: FUTURE AIRPORT LAYOUT PLAN - NORTH

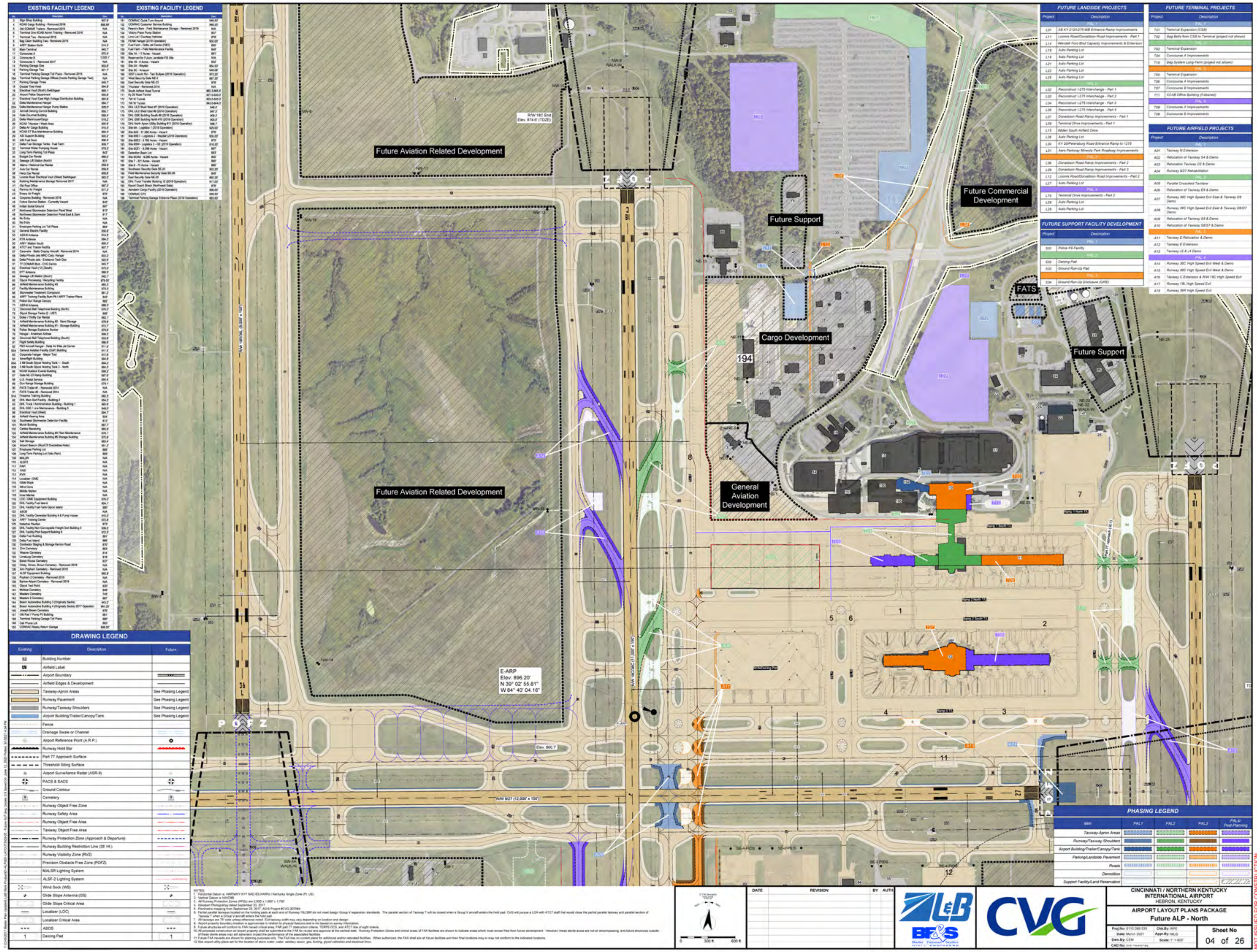

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EXHIBIT 7.2-5 SHEET 05: FUTURE AIRPORT LAYOUT PLAN – SOUTH

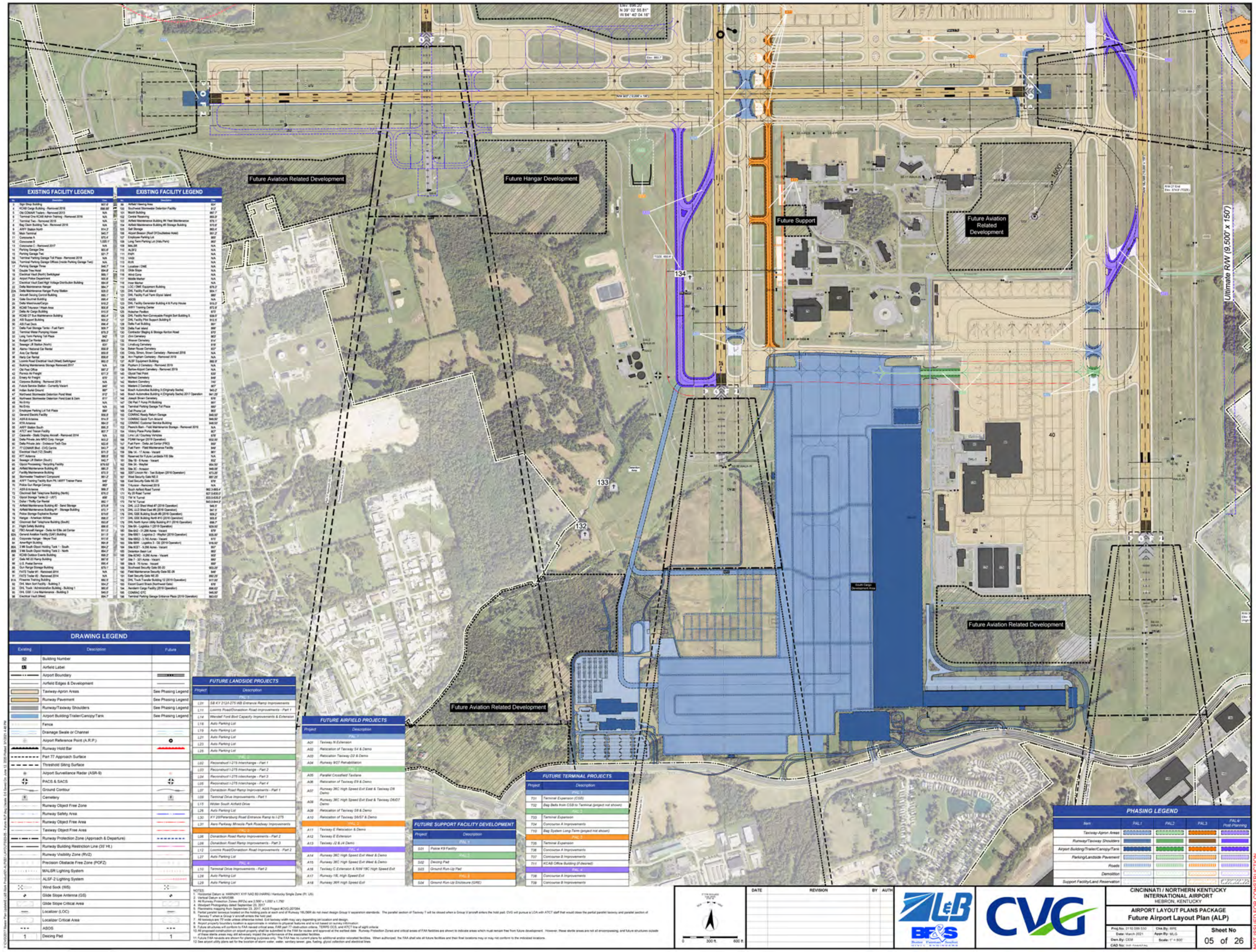

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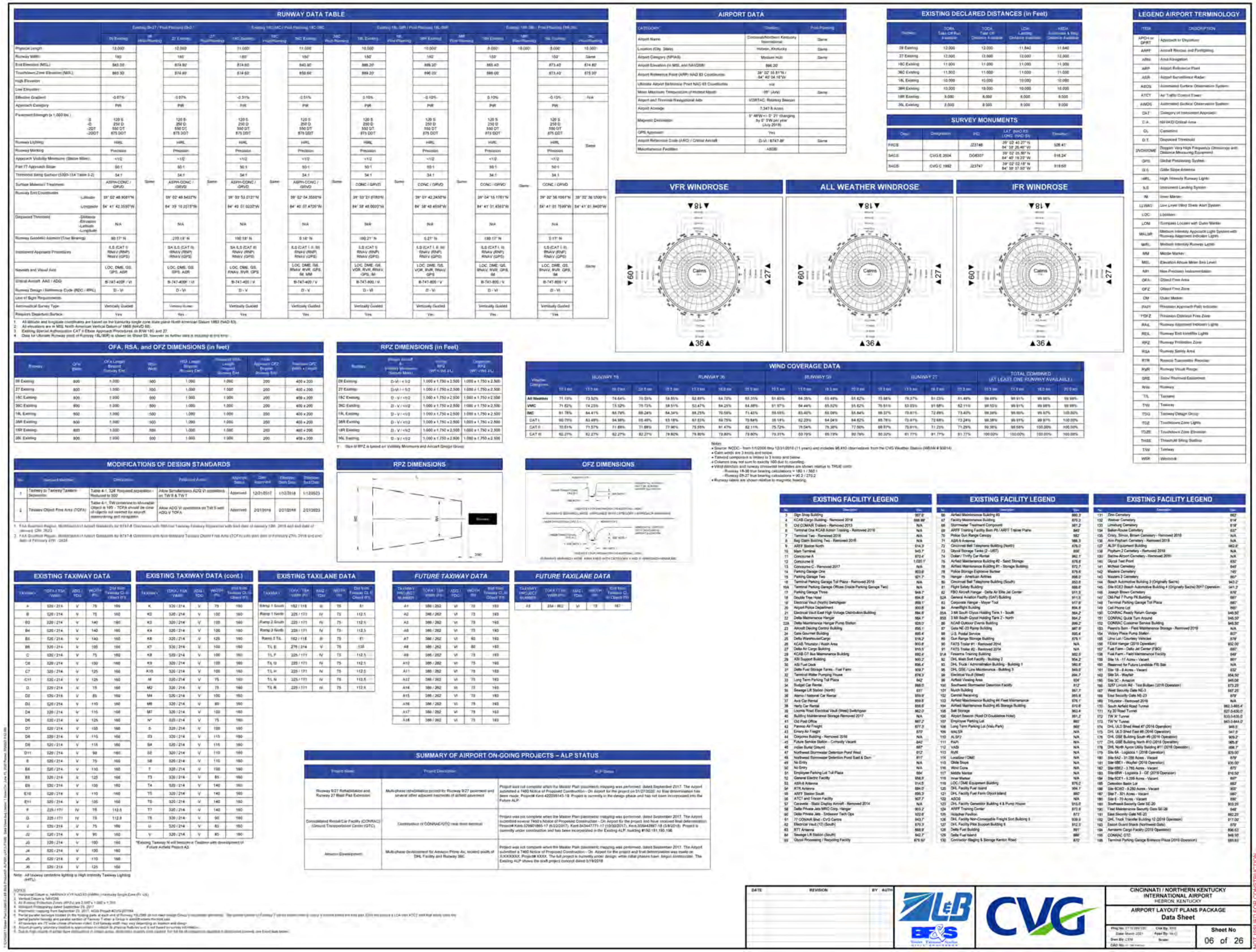
EXHIBIT 7.2-6 SHEET 06: DATA SHEET



Source: Landrum & Brown Team analysis

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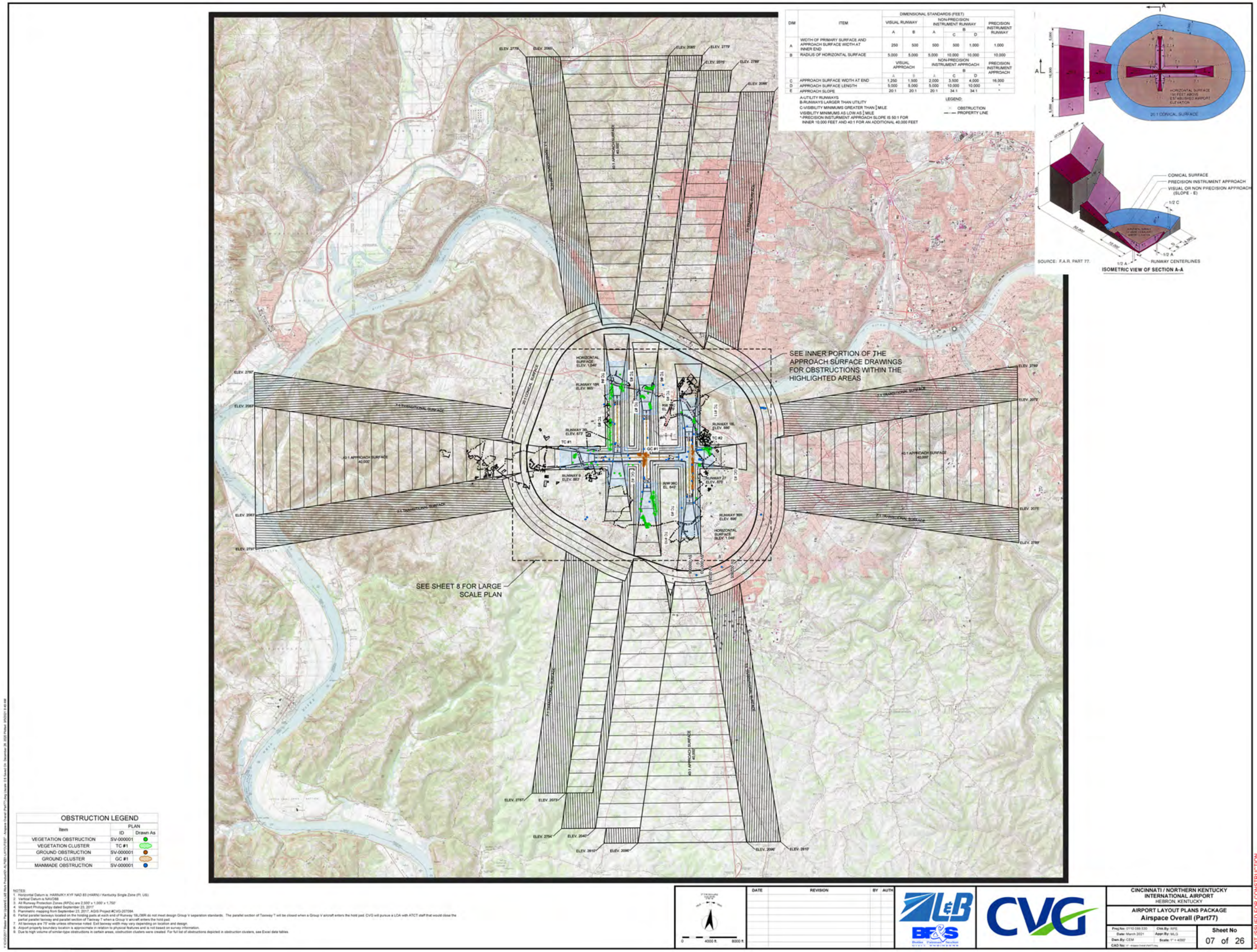
EXHIBIT 7.2-7 SHEET 07: AIRSPACE OVERALL (PART 77)



Source: Landrum & Brown Team analysis

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EXHIBIT 7.2-8 SHEET 08: AIRSPACE CONICAL (PART 77)

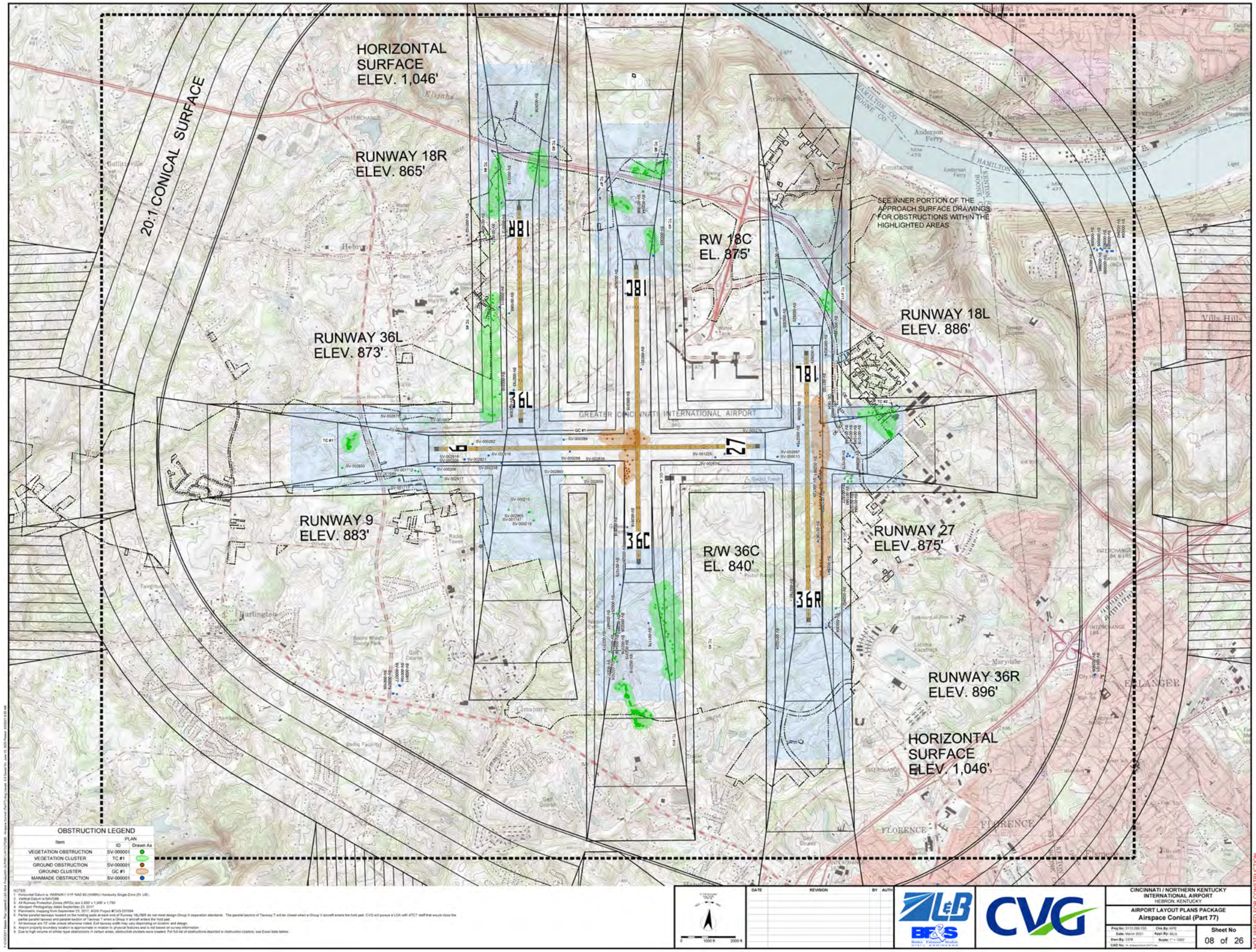

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EXHIBIT 7.2-9 SHEET 09: RUNWAY CENTERLINE PROFILES

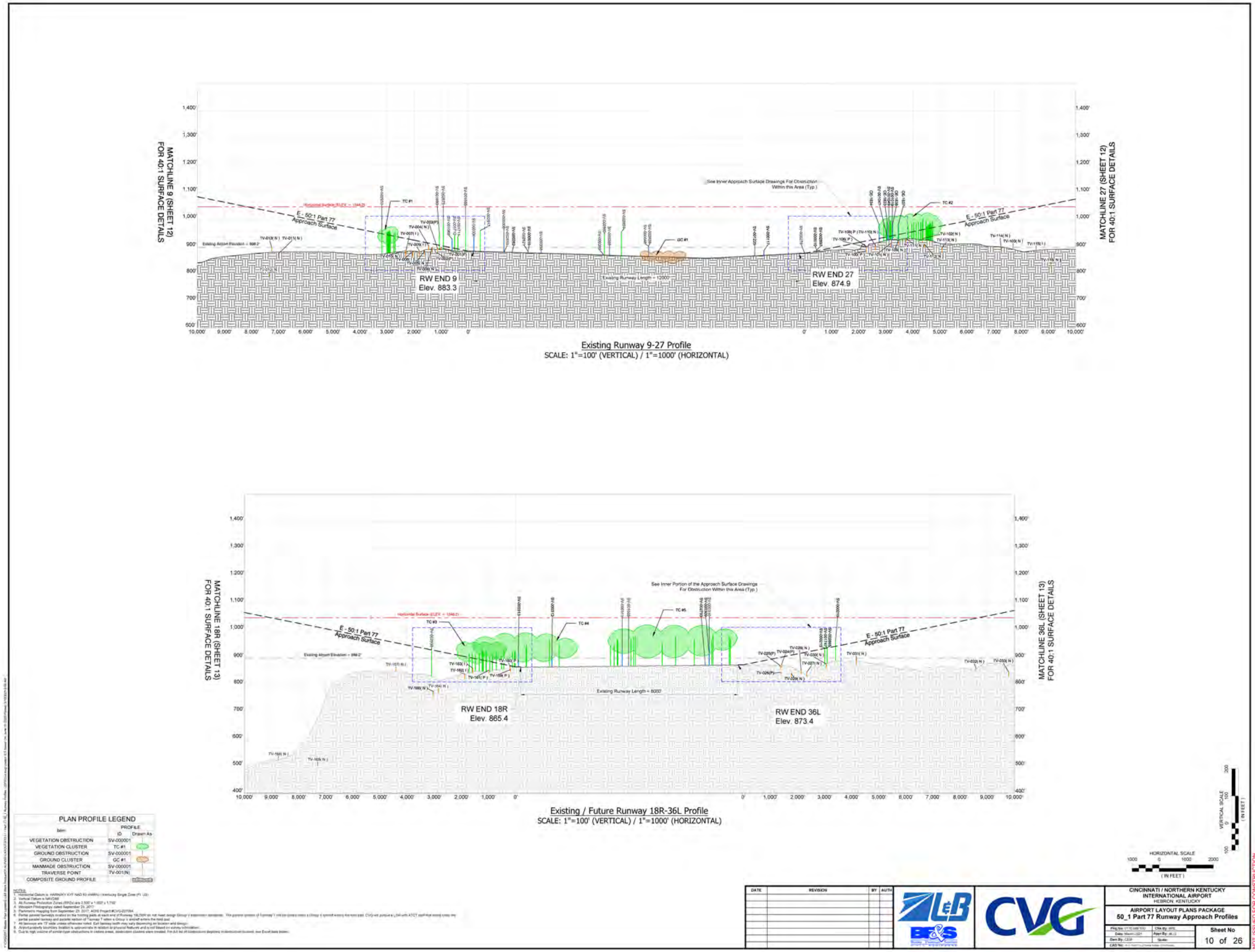

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EXHIBIT 7.2-10 SHEET 10: PART 77 RUNWAY APPROACH PROFILES

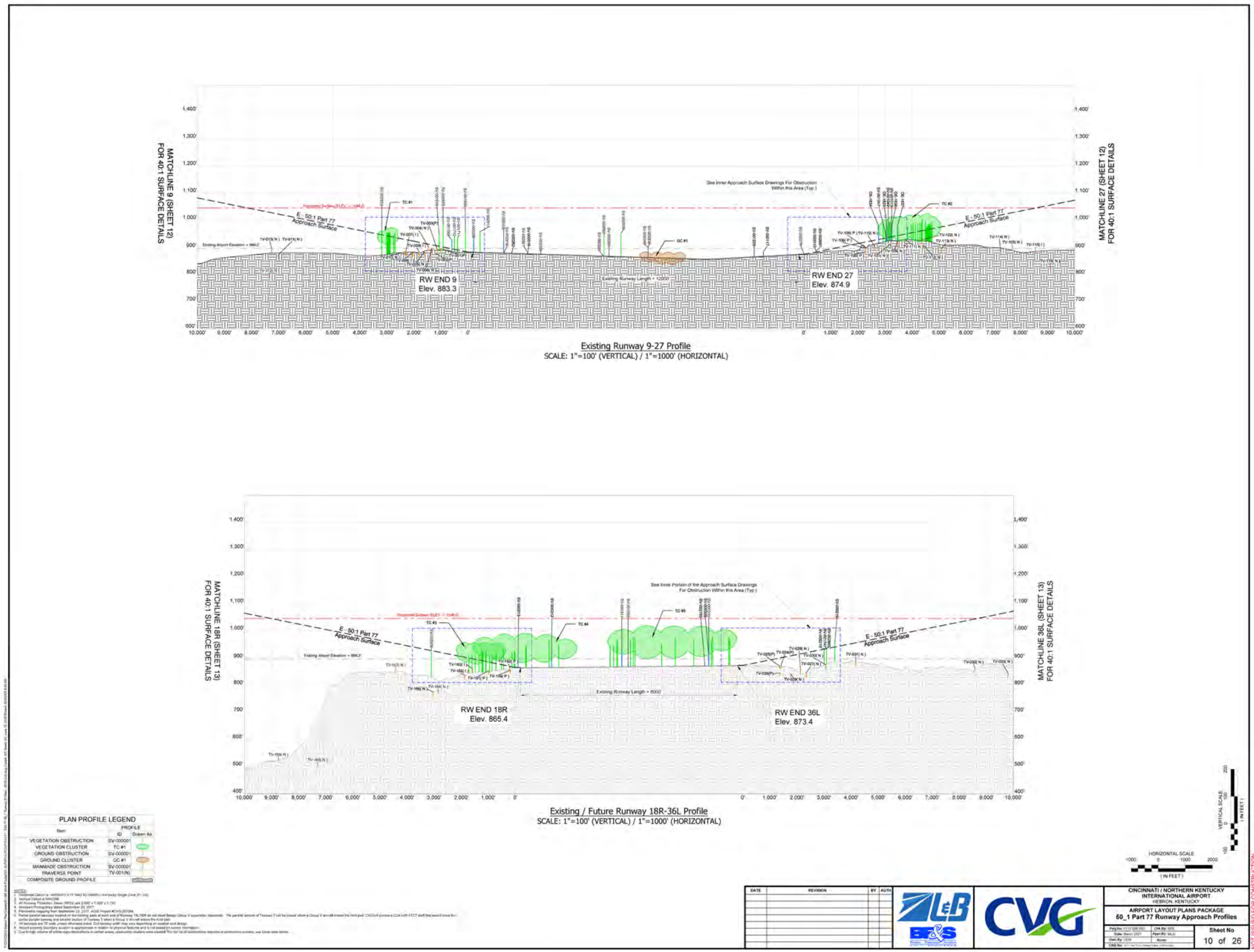

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EXHIBIT 7.2-11 SHEET 11: 50:1 PART 77 RUNWAY APPROACH PROFILES

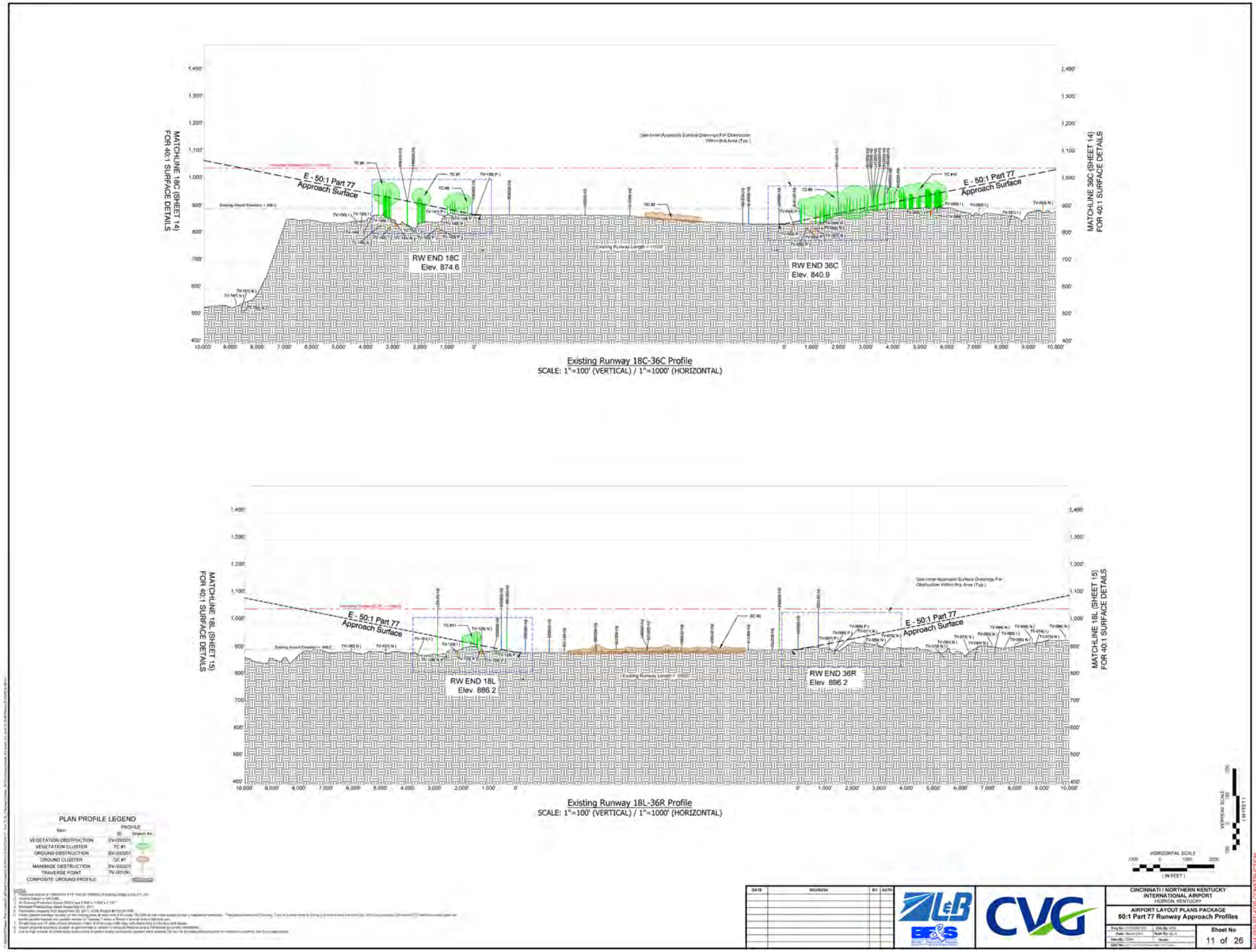

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EXHIBIT 7.2-12 SHEET 12: 40:1 PART 77 RUNWAY APPROACH PROFILES - RUNWAY 09/27

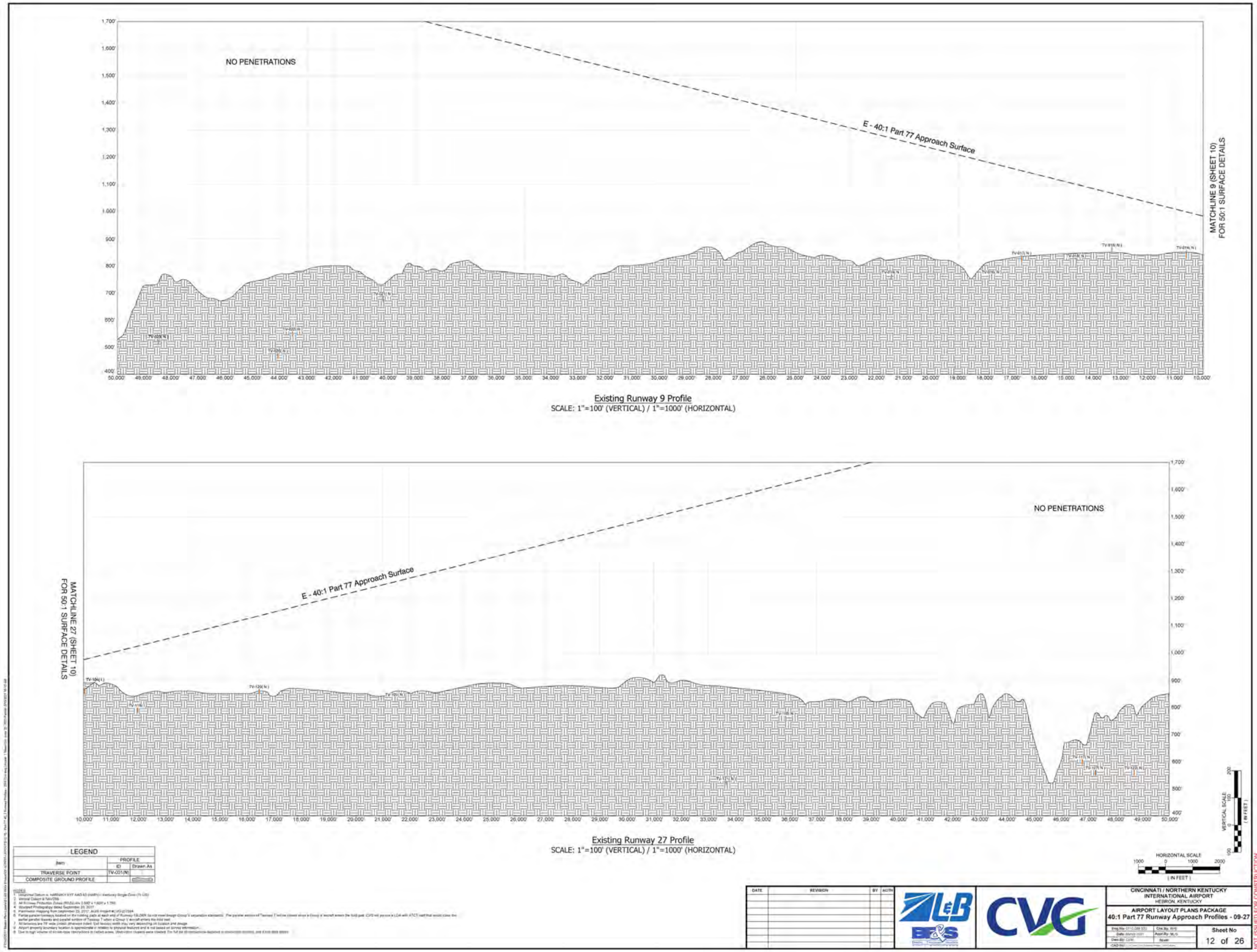

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EXHIBIT 7.2-13 SHEET 13: 40:1 PART 77 RUNWAY APPROACH PROFILES - RUNWAY 18R/36L

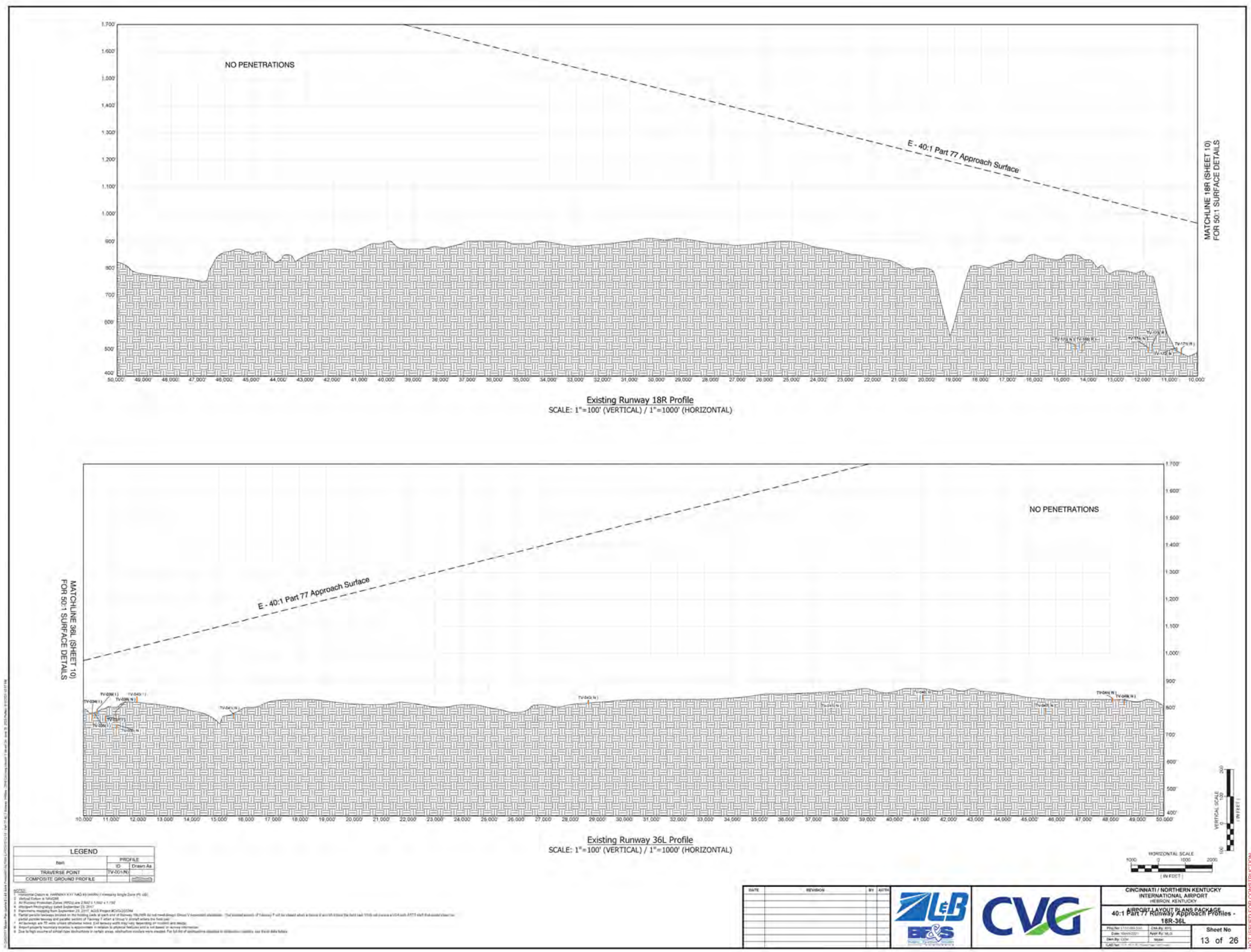

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EXHIBIT 7.2-14 SHEET 14: 40:1 PART 77 RUNWAY APPROACH PROFILES - RUNWAY 18C/36C

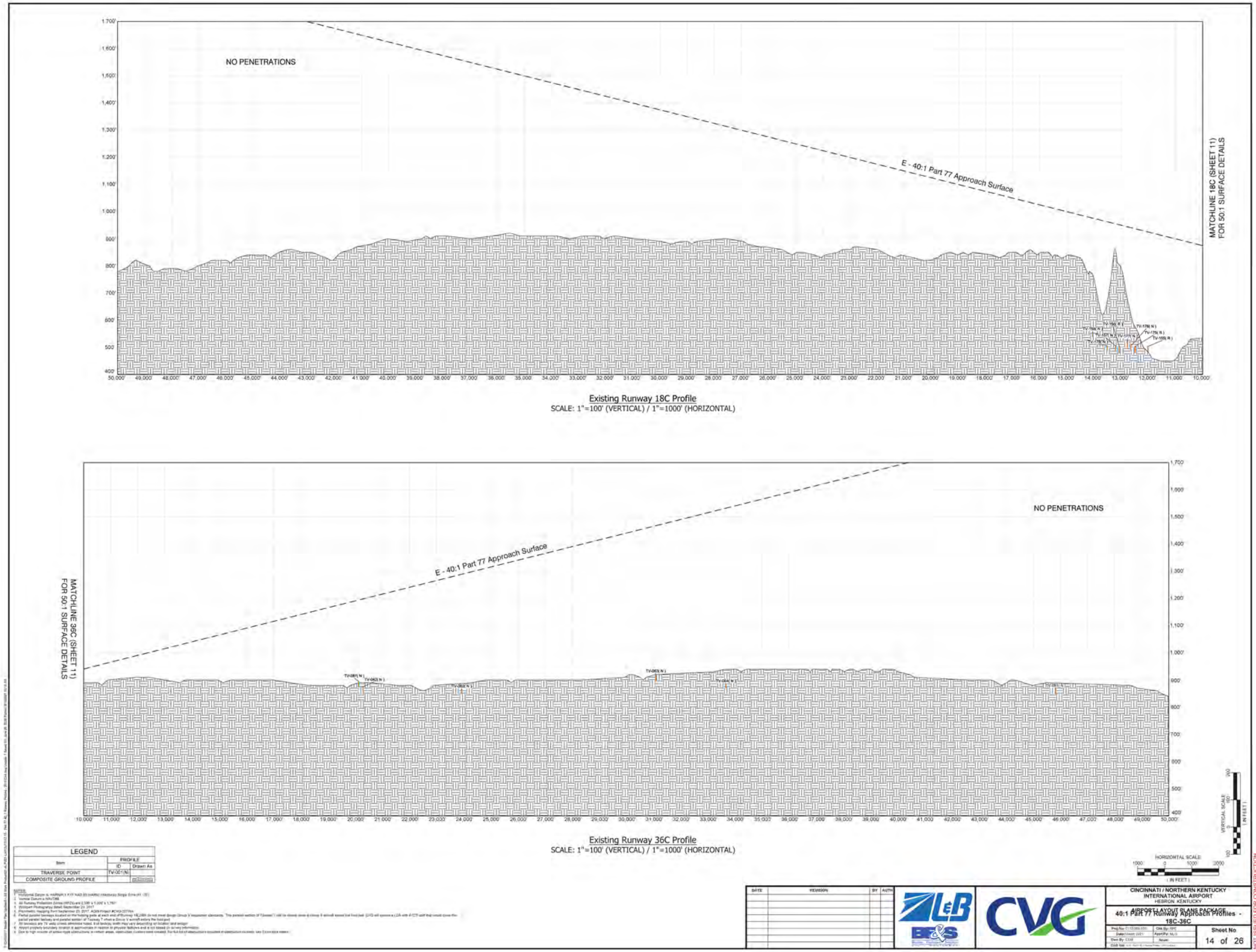

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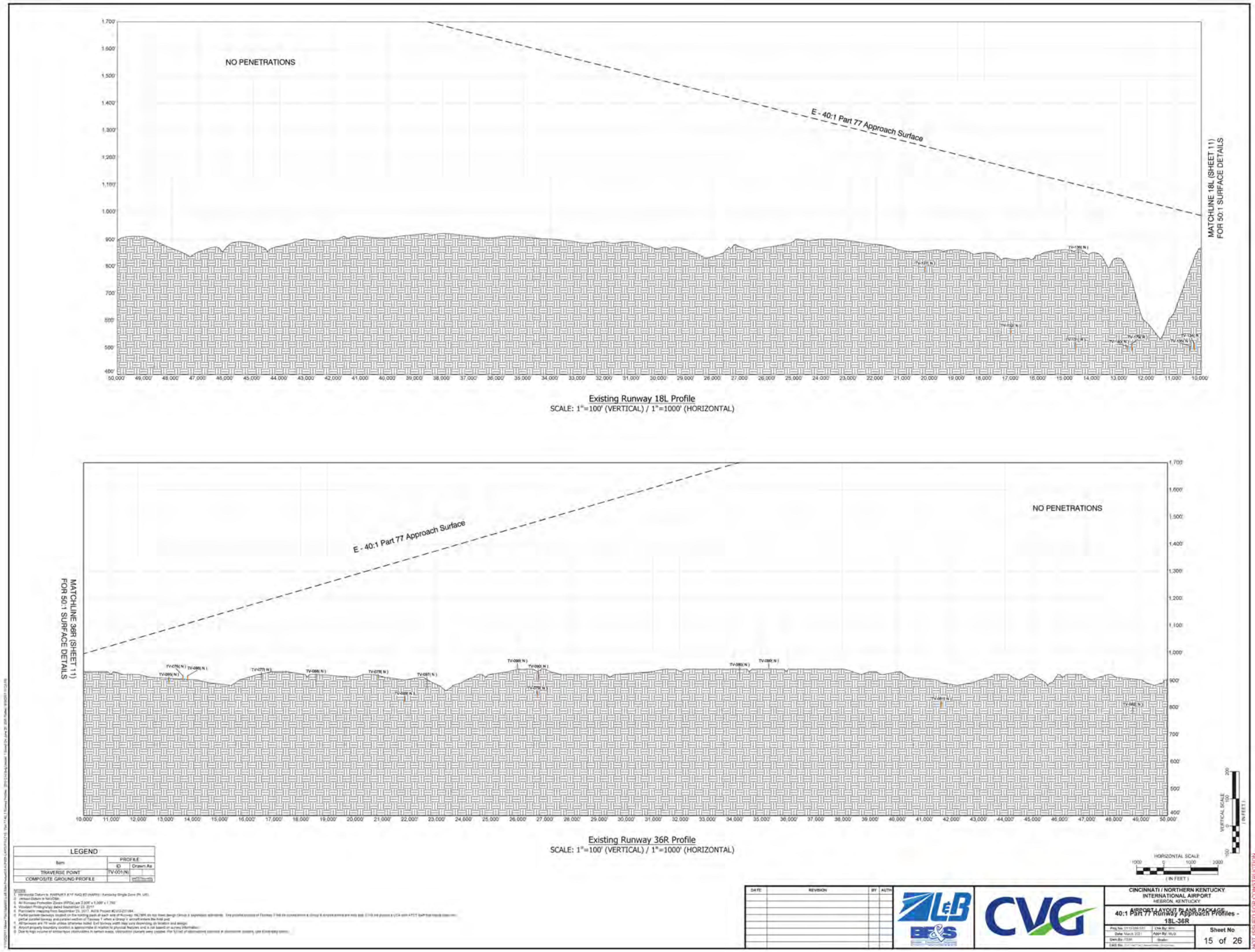
EXHIBIT 7.2-15 SHEET 15: 40:1 PART 77 RUNWAY APPROACH PROFILES - RUNWAY 18L/36R



Source: Landrum & Brown Team analysis

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EXHIBIT 7.2-16 SHEET 16: INNER PORTION OF THE APPROACH SURFACE - RUNWAY 09/27

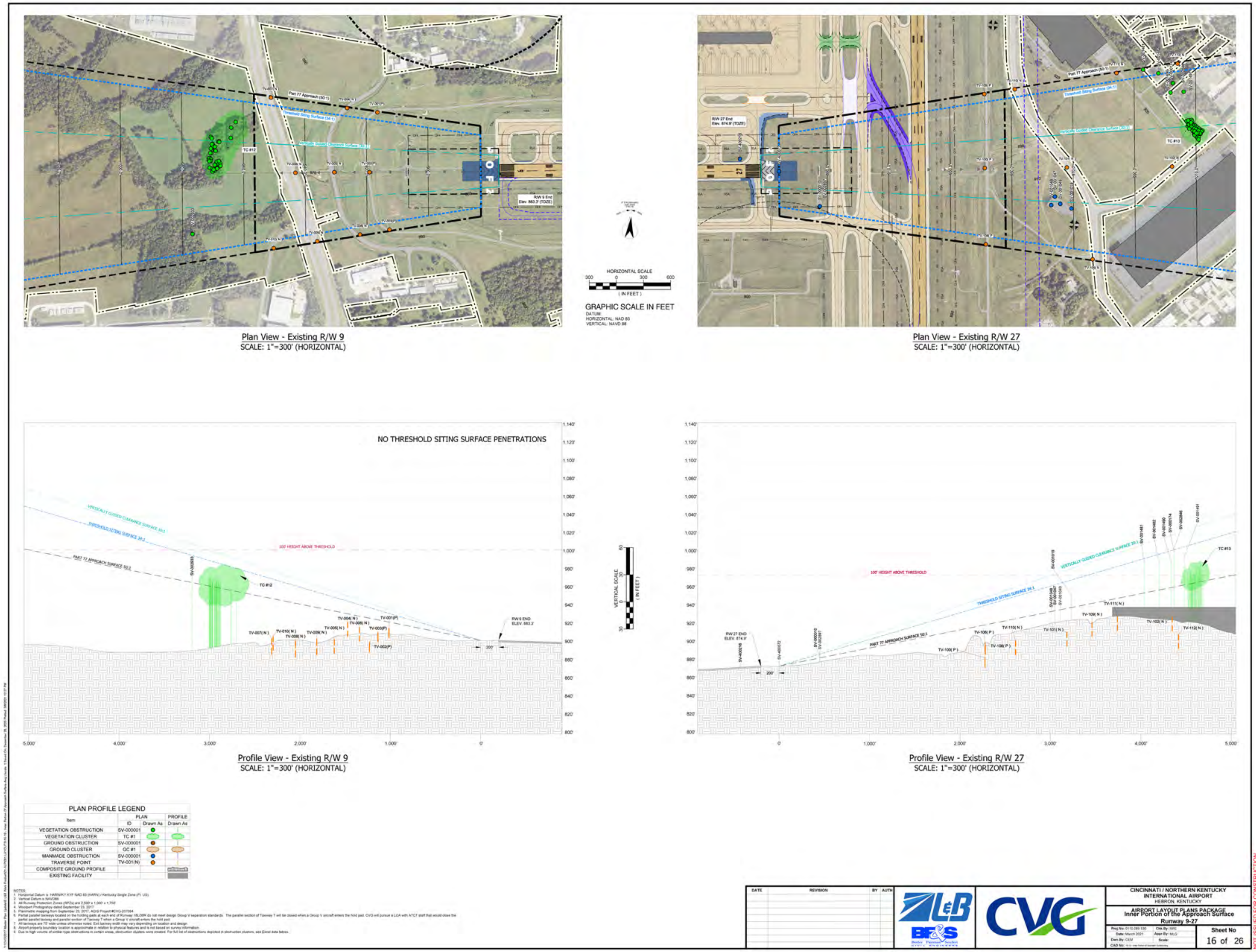

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EXHIBIT 7.2-17 SHEET 17: INNER PORTION OF THE APPROACH SURFACE - RUNWAY18R/36L

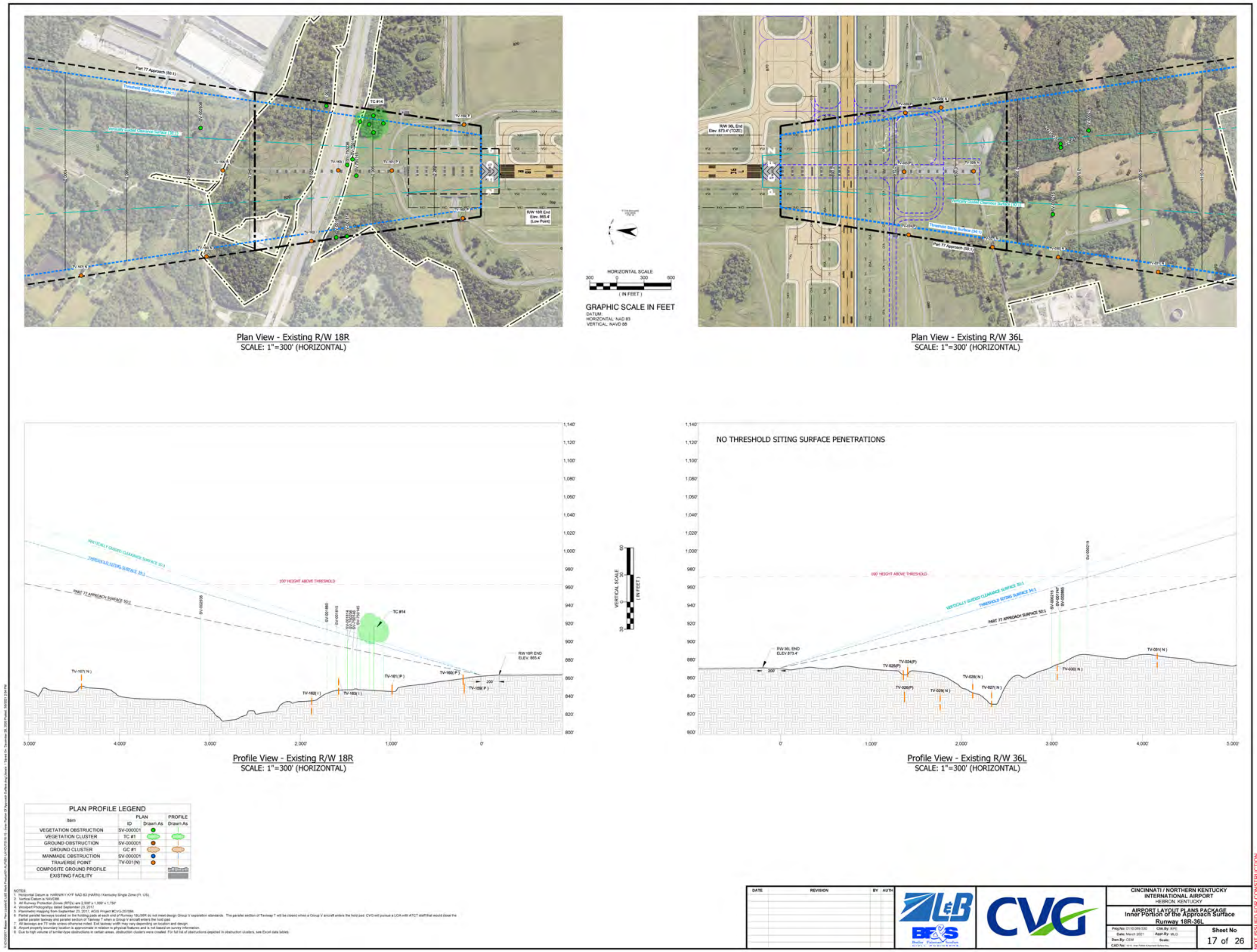

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EXHIBIT 7.2-18 SHEET 18: INNER PORTION OF THE APPROACH SURFACE - RUNWAY 18C/36C

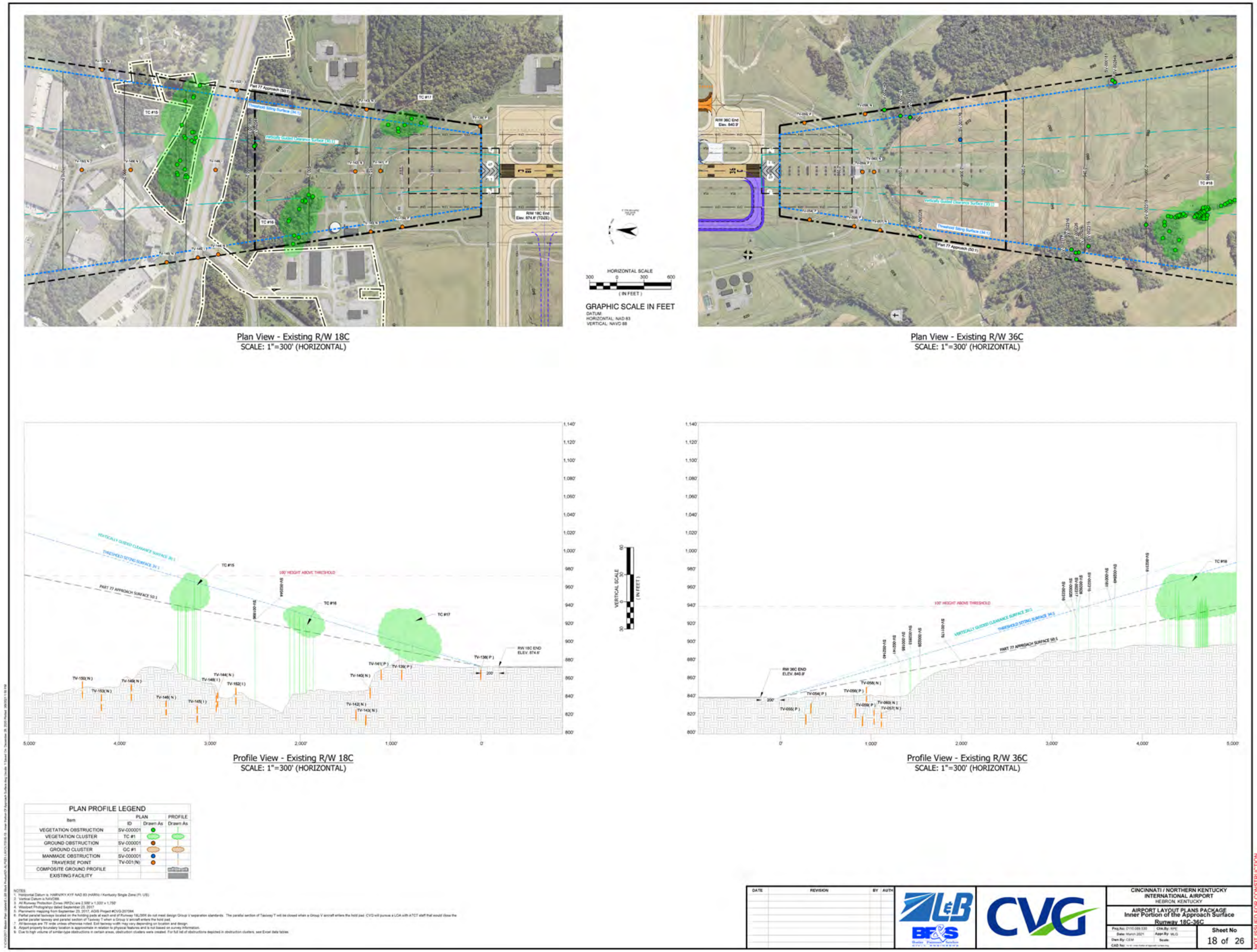

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EXHIBIT 7.2-19 SHEET 19: INNER PORTION OF THE APPROACH SURFACE - RUNWAY 18L/36R

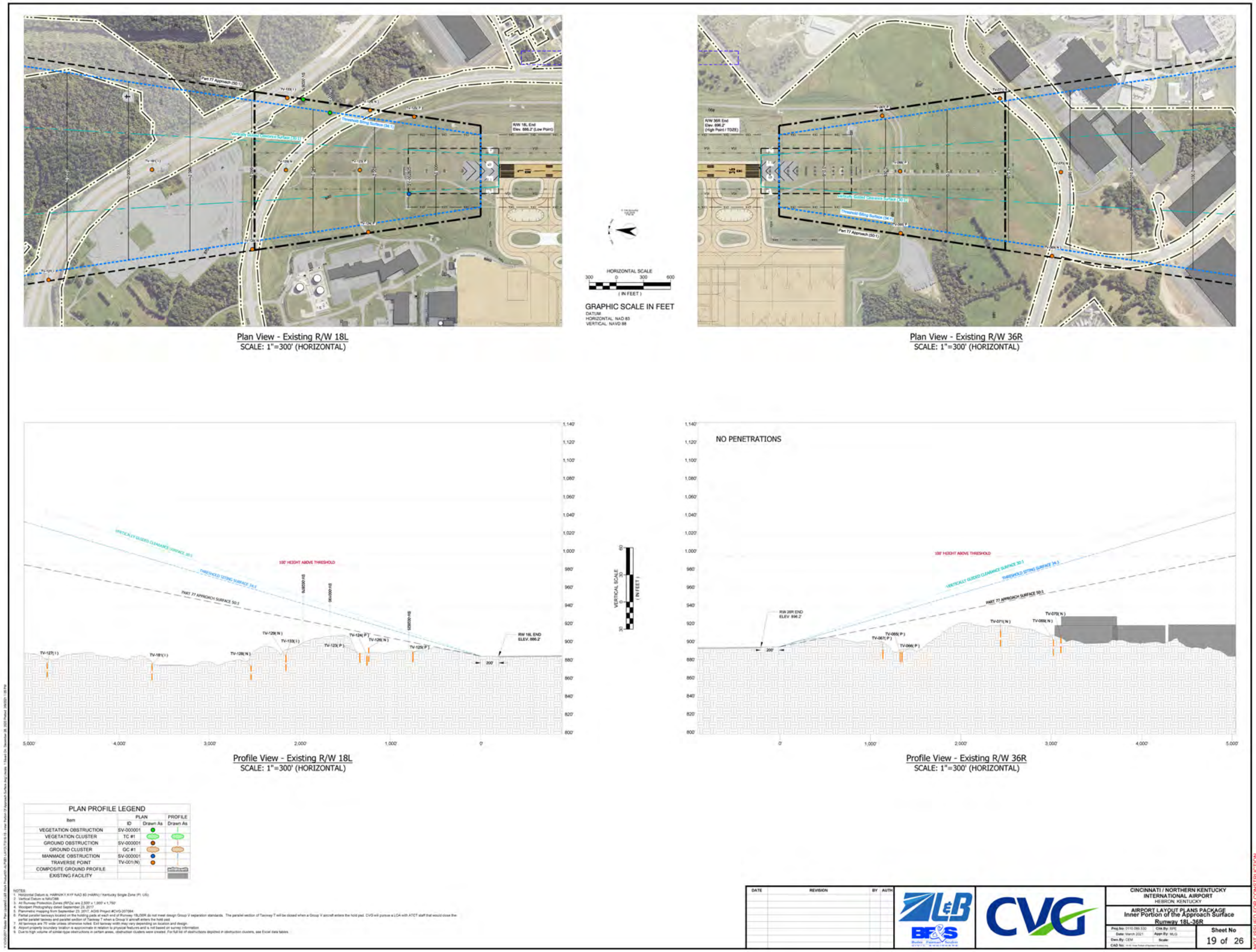

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EXHIBIT 7.2-20 SHEET 20: RUNWAY DEPARTURE SURFACE - RUNWAYS 09/27 & 18R/36L

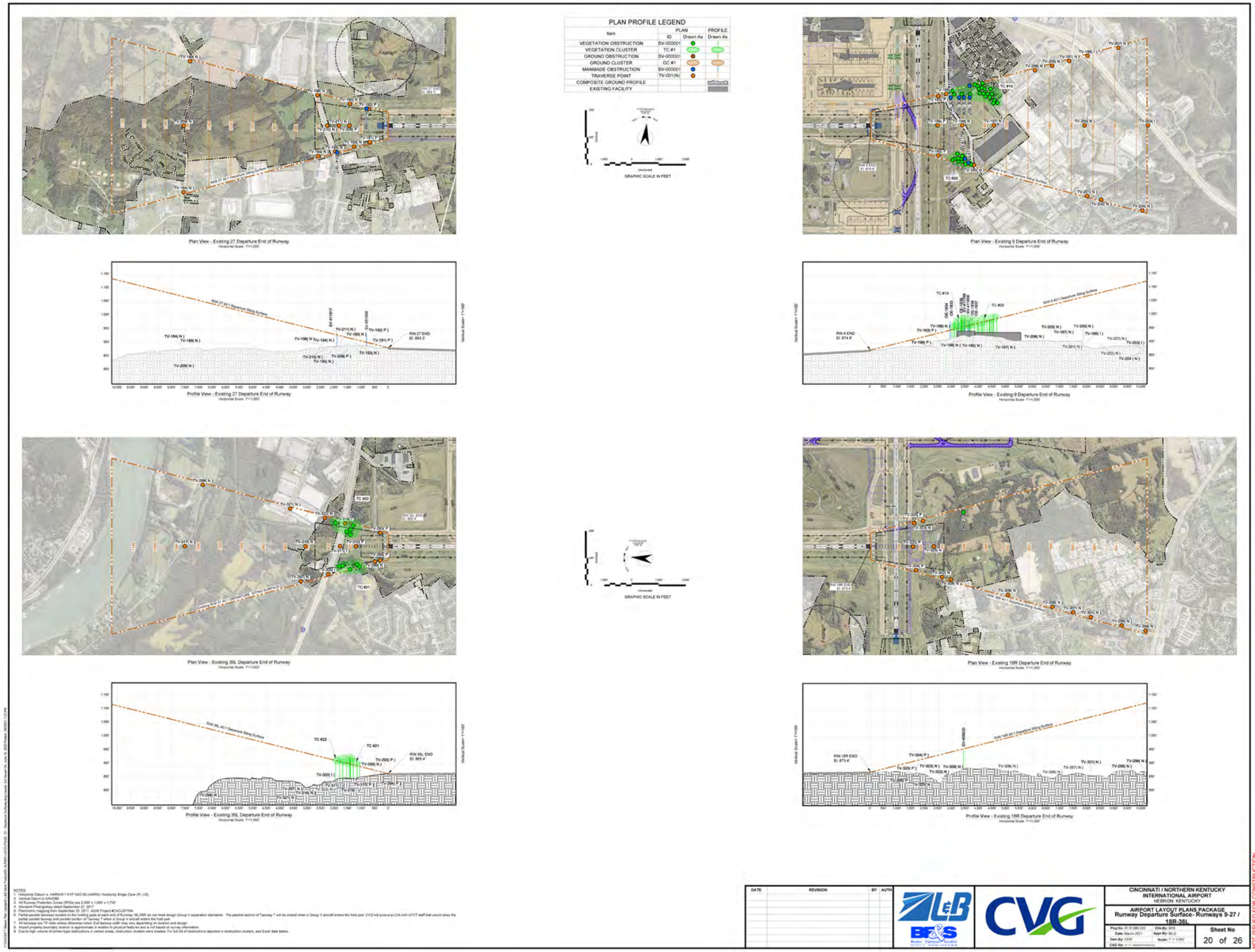

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EXHIBIT 7.2-21 SHEET 21: RUNWAY DEPARTURE SURFACE - RUNWAYS 18C/36C & 18L/36R

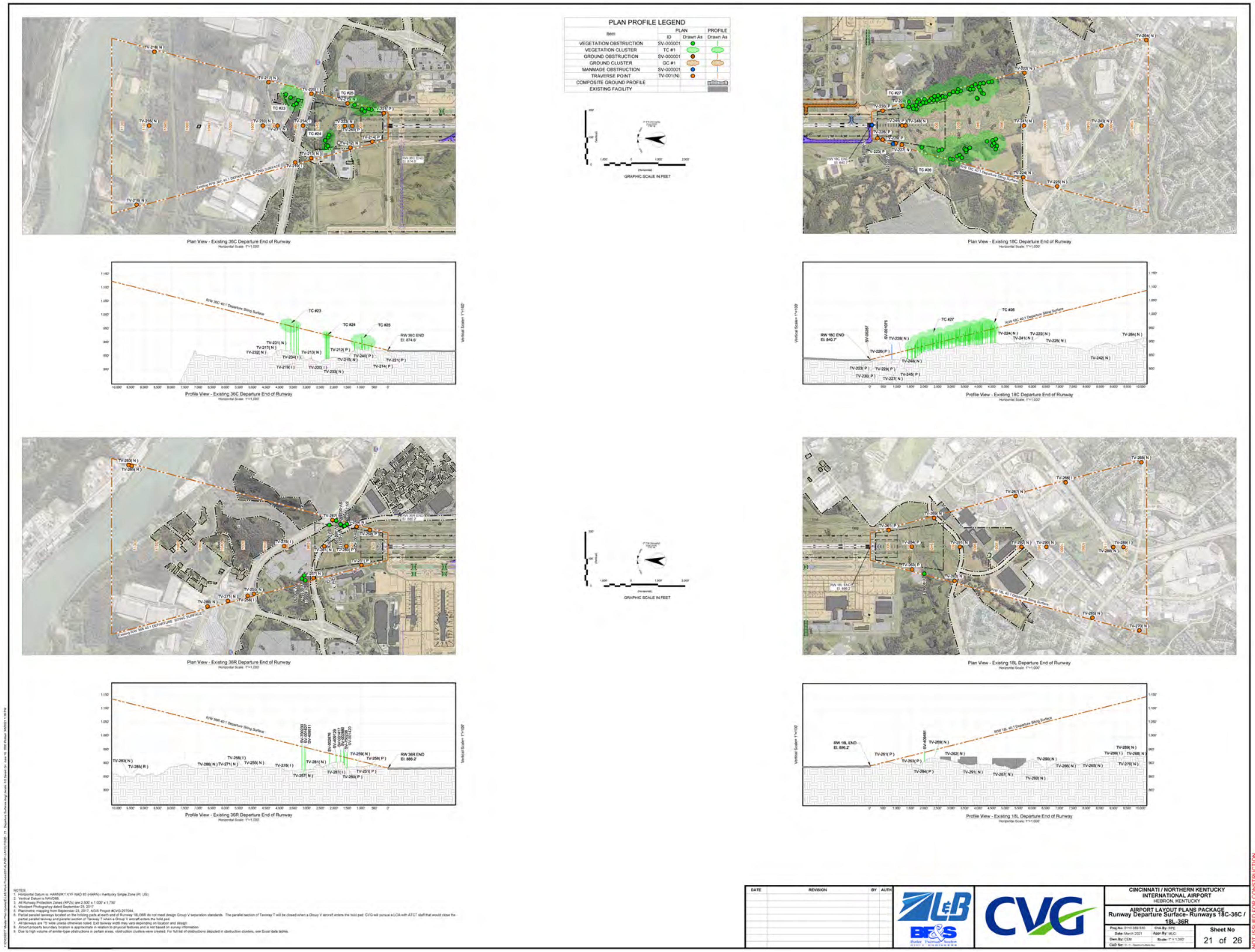

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EXHIBIT 7.2-22 SHEET 22: ON AIRPORT LAND USE

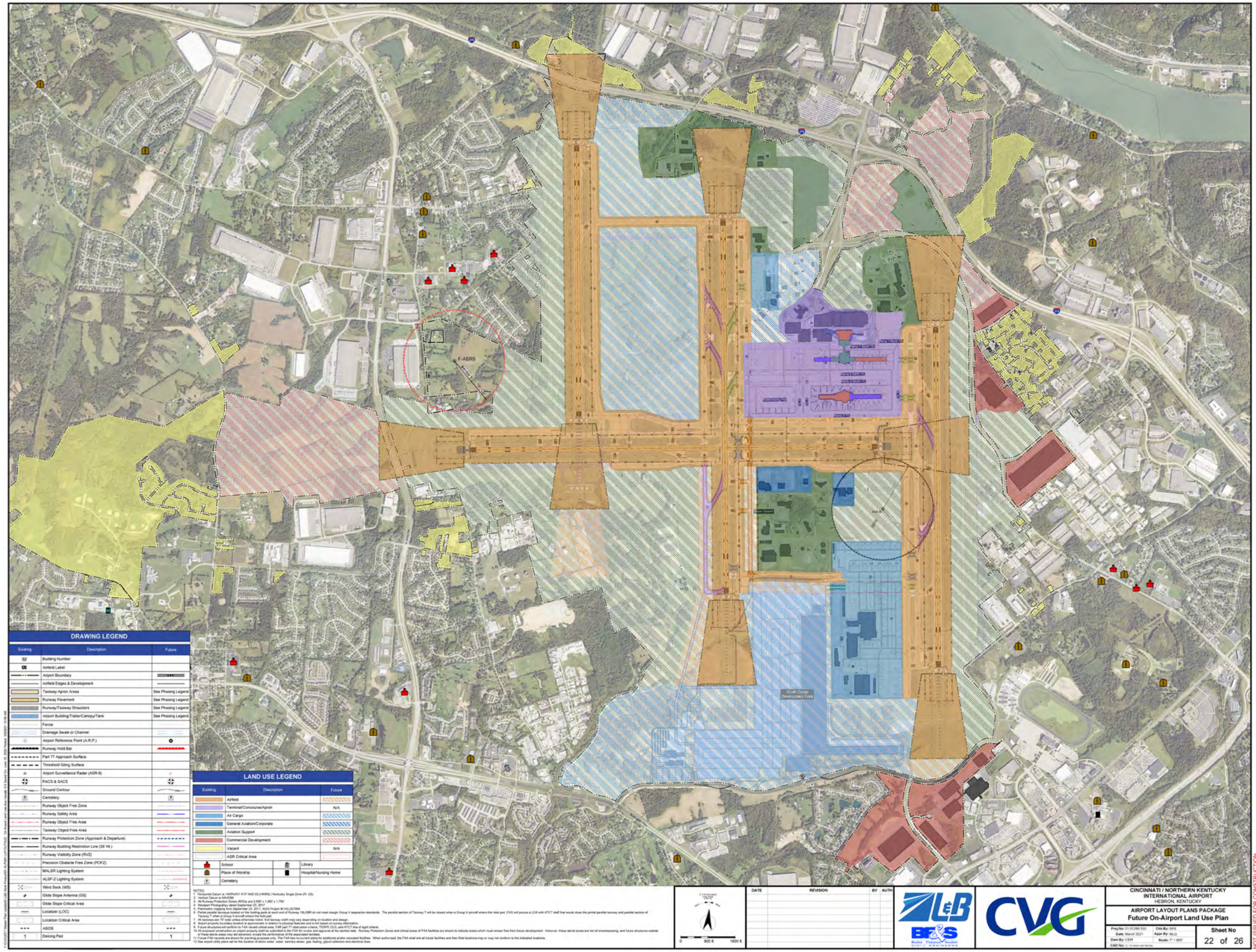

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EXHIBIT 7.2-23 SHEET 23: OFF AIRPORT LAND USE

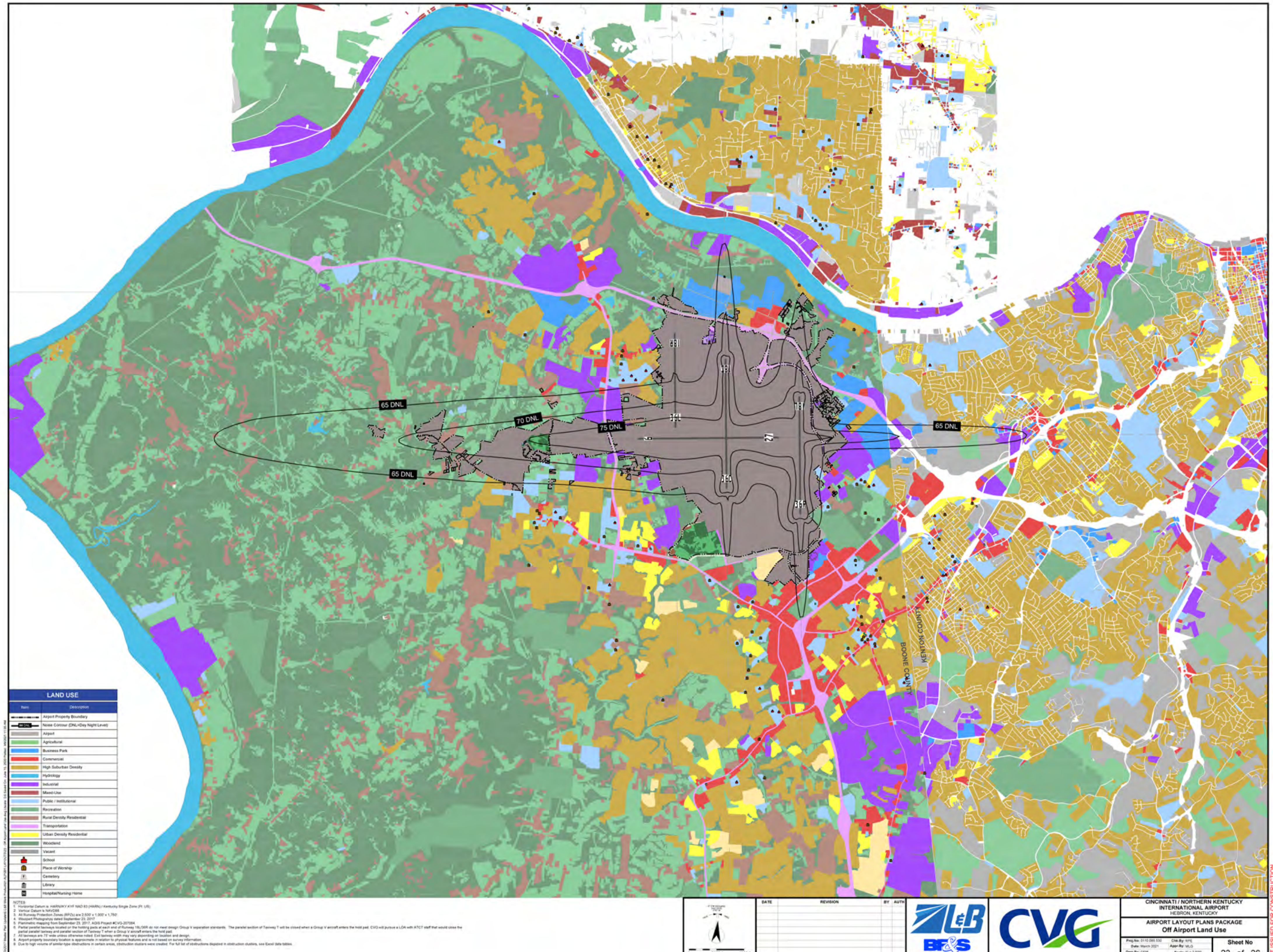

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EXHIBIT 7.2-24 SHEET 24: EXHIBIT A PROPERTY MAP

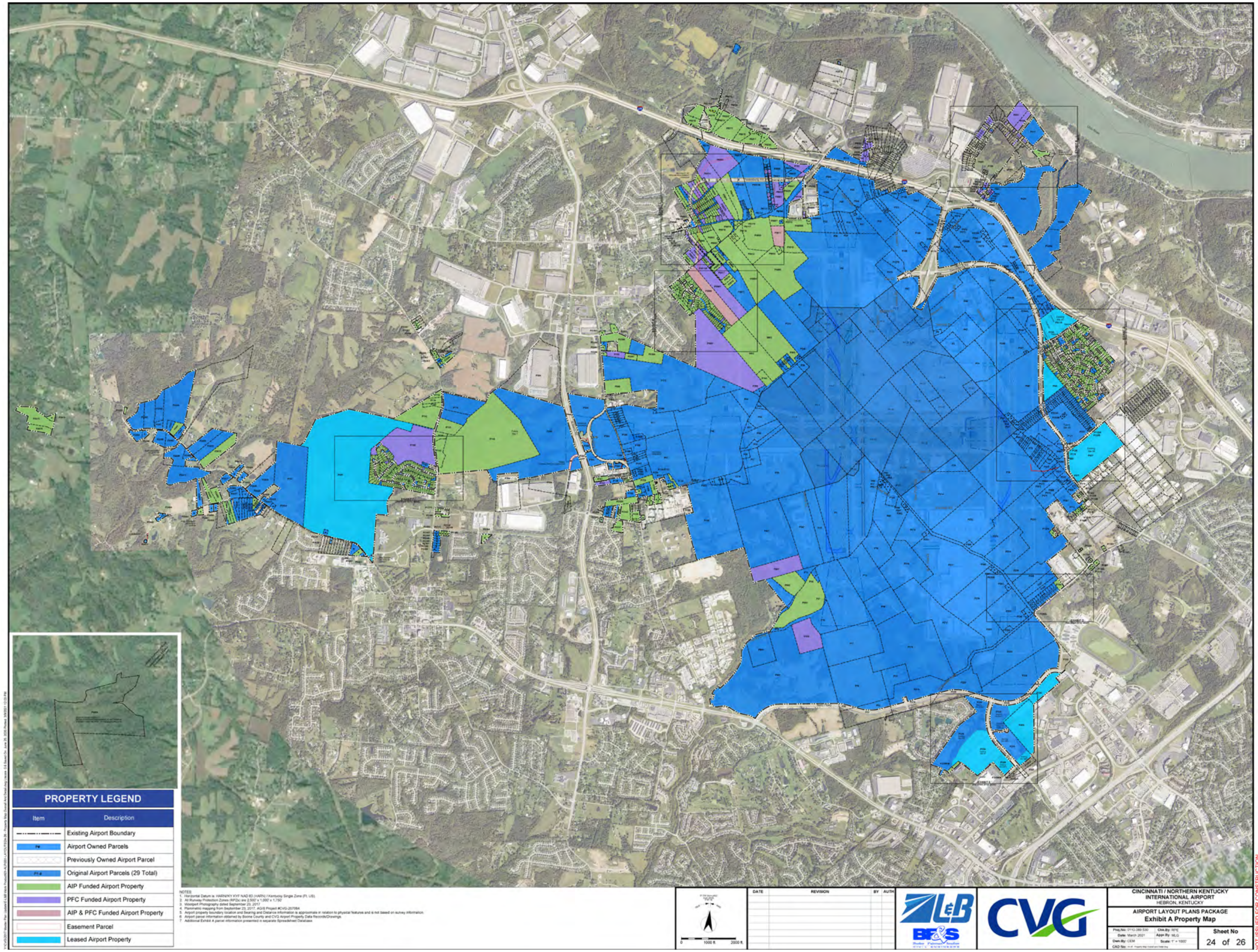

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EXHIBIT 7.2-25 SHEET 25: EXHIBIT A PROPERTY MAP DETAILS

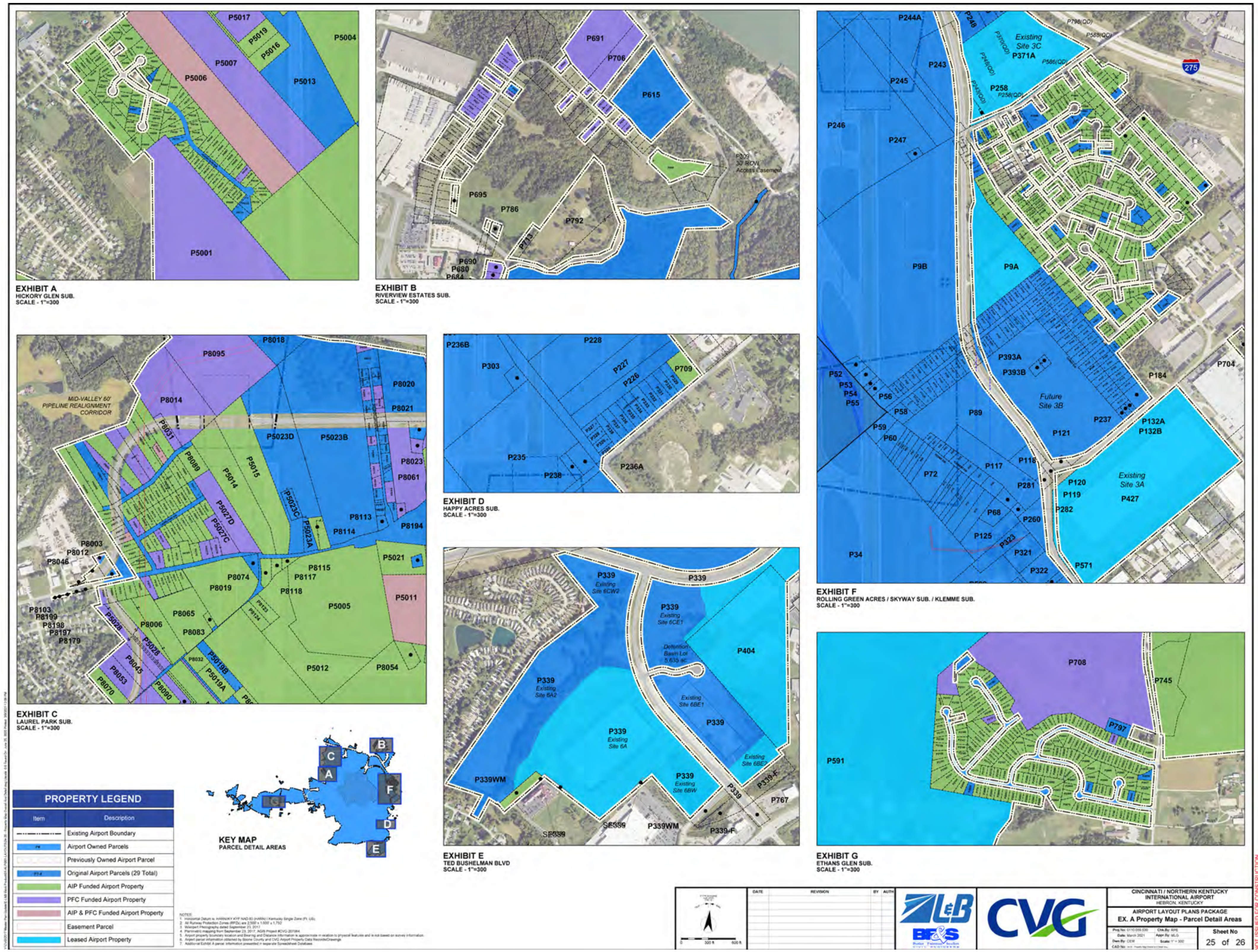

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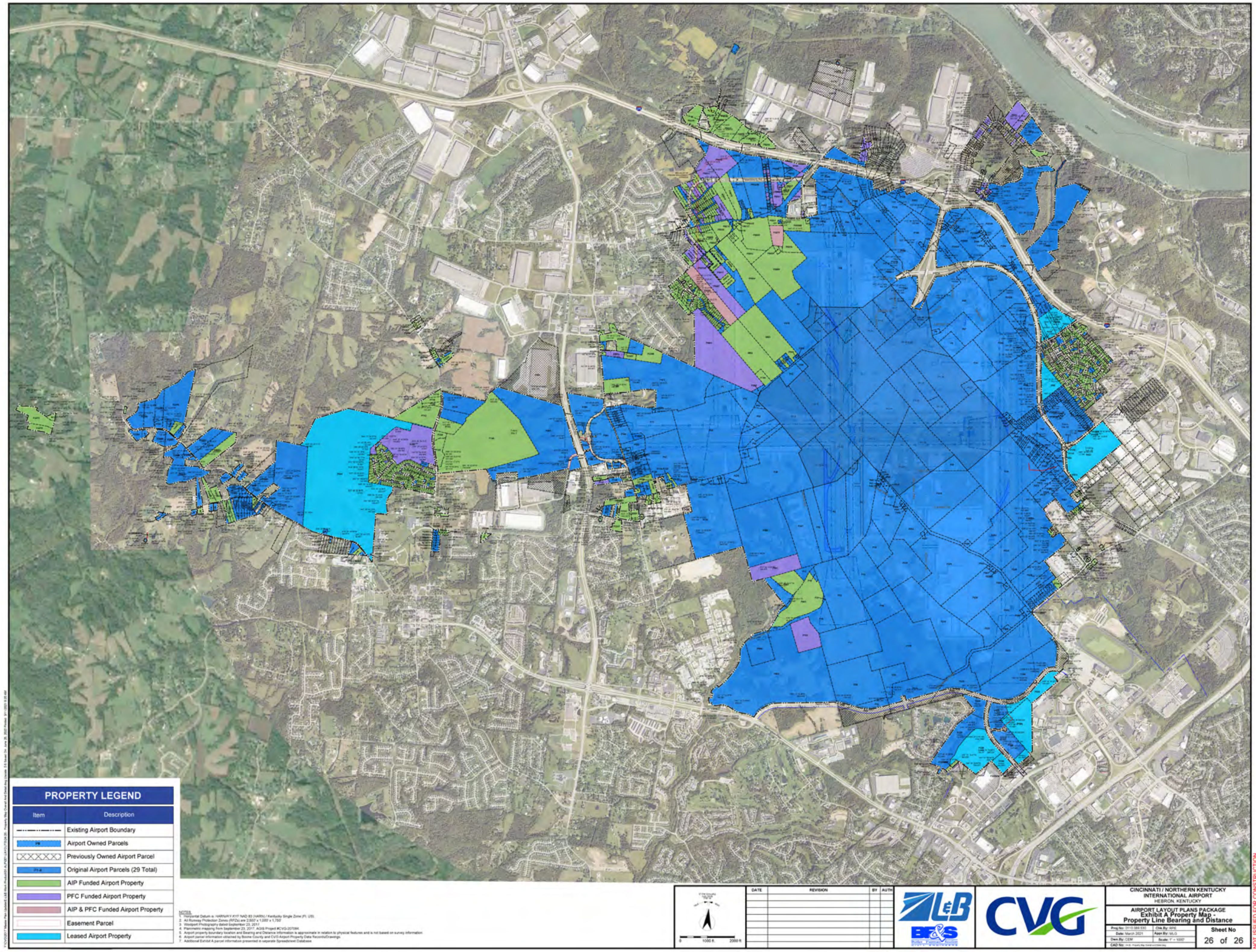
EXHIBIT 7.2-26 SHEET 26: EXHIBIT A PROPERTY MAP - BEARING AND DISTANCE



Source: Landrum & Brown Team analysis

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MASTER PLAN 2050

Chapter 8 | Environmental Considerations

CVG
CINCINNATI/NORTHERN KENTUCKY
INTERNATIONAL AIRPORT

L&B TEAM

8 Environmental Considerations

8.1 Introduction

This chapter provides a preliminary review of the environmental conditions surrounding the Cincinnati/Northern Kentucky International Airport (CVG) to identify potential environmental impacts associated with the recommended development projects discussed in Chapter 6, *Implementation Planning*. The purpose of considering environmental factors in airport master planning is to help the sponsor thoroughly evaluate airport development alternatives and to provide information that will help expedite subsequent environmental processing.[1]

8.2 Environmental Requirements

The National Environmental Policy Act (NEPA) significantly affects airport planning by requiring that environmental impacts of proposed airport development be considered early and throughout the planning process. Environmental feasibility is as important as economic or engineering feasibility in determining how an airport will be developed. This environmental considerations chapter identifies the potential impacts that may occur with the development of the recommended Master Plan projects. This information serves to support the decision-making process and to aid future NEPA reviews. The analysis of environmental impacts would be prepared pursuant to Federal Aviation Administration (FAA) Order 1050.1F, *Environmental Impacts: Policies and Procedures*, and FAA Order 5050.4B, *NEPA Implementing Instructions for Airport Actions*.

FAA Order 1050.1F states that, unless otherwise exempted, proposed actions and decisions by FAA officials are subject to NEPA review. Specific FAA actions subject to NEPA review can include, but are not limited to, grants, loans, contracts, leases, construction and installation actions, procedural actions, research activities, rulemaking and regulatory actions, certifications, licensing, permits, plans submitted to the FAA that require the FAA's approval, and legislation proposed by the FAA. As such, the development projects recommended in this Master Plan would be required to undergo an environmental review in accordance with NEPA prior to implementation.

Federal regulations outline three major levels of NEPA review relevant to airport development:

- **Categorical Exclusion**: Applies to those actions that have been found (under normal circumstances) to have no potential for significant environmental impact.
- **Environmental Assessment (EA)**: Applies to those actions that have been found by experience to sometimes have significant environmental impacts. The list of actions normally requiring an EA can be found in Chapter Four of FAA Order 1050.1E. The purpose of an EA is to determine whether the proposed project will have significant impacts. Upon review of the EA findings, the FAA either issues project approval in the form of a Finding of No Significant Impact (FONSI) or directs the preparation of an Environmental Impact Statement (EIS) to further investigate potential environmental impacts in detail before project approval can be granted.

1 U.S. Department of Transportation (USDOT), Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5070-6B, *Change 1*; May 1, 2007

- **Environmental Impact Statement (EIS)**: Applies to those actions that have been found by experience to usually have significant environmental impacts. The FAA may issue a Record of Decision (ROD) after the Final EIS has been released.

8.3 Purpose and Need

Each proposed project within the Master Plan must have an acceptable "purpose and need," for the FAA to issue an environmental finding. The Master Plan development projects described in Chapter 6, *Implementation Planning*, have been developed to meet the following needs:

- Airfield Projects
  - The need to improve the safety and efficiency of the airfield
- Terminal Projects
  - The need to provide sufficient terminal capacity to accommodate projected operating levels
- Landside Projects
  - The need to provide sufficient parking capacity to accommodate projected passenger levels
  - The need to provide for efficient automobile circulation within the CVG access roadways and parking facilities
- Support Facilities
  - The need to provide adequate facilities, including hangar space, apron space, maintenance facilities, ground run-up locations, and space for administrative functions

The need to encourage economic development on unused or underutilized property.

8.4 Environmental Impact Categories

This preliminary review identifies potential environmental impacts associated with the development alternatives that are recommended in this Master Plan study. The FAA examines the NEPA environmental impact categories to determine applicability for its actions. As identified in FAA Order 1050.1F, the NEPA environmental impact categories are:

- Air Quality
- Biological Resources
- Climate
- Coastal Resources (Coastal Barriers and Coastal Zones)
- Department of Transportation Act Section 4(f) Resources
- Farmlands
- Hazardous Materials, Solid Waste, and Pollution Prevention
- Historical, Architectural, Archeological, and Cultural Resources
- Land Use
- Natural Resources and Energy Supply
- Noise and Noise-Compatible Land Use
- Socioeconomics, Environmental Justice, and Children's Environmental Health and Safety Risks
- Visual Effects
- Water Resources
  - Floodplains
  - Groundwater
  - Surface Water
  - Wetlands
  - Wild and Scenic Rivers

8.4.1 Air Quality

8.4.1.1 Existing Conditions

CVG is located within Boone County, Kentucky, which is included in the Metropolitan Cincinnati Interstate Air Quality Region. The U.S. Environmental Protection Agency (USEPA) previously determined that Boone County's levels of the eight-hour concentration of ozone exceeded the federal standards defining healthful air quality. On July 5, 2017, the USEPA determined the area had attained the 2008 eight-hour standard for ozone. However, in 2018, the area was designated as marginal nonattainment for the 2015 eight-hour standard for ozone.

8.4.1.2 Significance Threshold

The air quality significance threshold from FAA Order 1050.1F is if the action would cause pollutant concentrations to exceed one or more of the National Ambient Air Quality Standards (NAAQS), as established by the USEPA under the Clean Air Act (CAA), for any of the time periods analyzed, or to increase the frequency or severity of any such existing violations.

8.4.1.3 Summary of Air Quality Considerations

Two primary laws apply to air quality: NEPA and the CAA, including the 1990 Amendments.

Any assessment of air quality associated with a federal action would need to be prepared in accordance with the guidelines provided in the FAA's *Air Quality Procedures for Civilian Airports & Air Force Bases,*[2] and pursuant to FAA Order 5050.4B and FAA Order 1050.1F. An air quality assessment prepared pursuant to these orders and guidelines would be compliant with all the relevant provisions of NEPA, the CAA, and the Kentucky State Implementation Plan (SIP).

To determine the net emissions resulting from construction and operation of proposed Master Plan development projects, an emissions inventory would need to be prepared for each alternative, including the no-build alternative. A General Conformity evaluation would be required to determine net emissions from construction and implementation. The emissions inventory would be compared to the relevant *de minimis* thresholds for the pollutants of concern. If emissions exceed applicable *de minimis* thresholds, dispersion analysis may be required for the air quality assessment of any of the Master Plan study alternatives at CVG. Additional coordination with the FAA and other regulatory agencies may be required.

8.4.2 Biological Resources

8.4.2.1 Existing Conditions

Biological resources include fish, wildlife, plants, and their respective habitats. A biotic community is an assemblage of living things residing together, including both plants and animals. The Endangered Species Act of 1973 (ESA),[3] as amended, provides for the protection of certain plants and animals, as well as the habitats in which they are found.

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2 FAA and United States Air Force (USAF), *Air Quality Procedures for Civilian Airports & Air Force Bases*, April 1997

3 16 U.S.C. §1531 et seq. (1973)

Information from the U.S. Fish and Wildlife Service (USFWS) Information, Planning, and Conservation (IPaC) system was obtained to determine the species list that could be affected by the Master Plan alternatives. According to the USFWS, there are 14 federal and state listed species of plants and animals found in Boone County as shown in **Table 8.4-1, *List of Threatened, Endangered and Candidate Species***. It should be noted that the bald eagle is no longer protected under the ESA; however, the species remains protected under the Bald and Golden Eagle Protection Act, which prohibits the disturbance of a bald or golden eagle or its nest. Information collected from the USFWS website indicated that no designated critical habitats for threatened/endangered species was known to exist on CVG property.

TABLE 8.4-1 LIST OF THREATENED, ENDANGERED AND CANDIDATE SPECIES

Taxonomic Group	Common Name	Scientific Name	Federal Status
Mammal	Gray bat	Myotis grisescens	Endangered
Mammal	Indiana bat	Myotis sodalis	Endangered
Mammal	Northern long-eared bat	Myotis septentrionalis	Threatened
Clams	Clubshell	Pleurobema clava	Endangered
Clams	Fanshell	Cyprogenia stegaria	Endangered
Clams	Northern Riffleshell	Epioblasma torulosa rangiana	Endangered
Clams	Orangefoot Pimpleback (Pearlymussel)	Plethobasus cooperianus	Endangered
Clams	Purple Cat’s Paw (Purple Cat’s Paw Pearlymussel)	Epioblasma obliquata	Endangered
Clams	Rabbitsfoot	Quadrula cylindrica cylindrica	Threatened
Clams	Ring Pink (mussel)	Obovaria retusa	Endangered
Clams	Rough Pigtoe	Pleurobema plenum	Endangered
Clams	Sheepnose Mussel	Plethobasus cyphyus	Endangered
Clams	Spectaclecase (mussel)	Cumberlandia monodonta	Endangered
Plants	Running Buffalo Clover	Trifolium stoloniferum	Endangered

Source: USFWS Information for Planning and Conservation (IPaC) website, https://ecos.fws.gov/ipac/location/VAPSFAGLSJD5VPV73NP7GASRQY/resources#endangered-species, accessed December 11, 2019

Pursuant to 14 Code of Federal Regulations (CFR) Part 139.337(e), the Kenton County Airport Board (KCAB) has a Wildlife Hazard Management Plan (WHMP) in cooperation with the U.S. Department of Agriculture (USDA) Wildlife Services program. The WHMP was approved by the FAA in October 2010.[4] The WHMP establishes the responsibilities, policies, resources, and procedures to reduce wildlife hazards at CVG, including habitat management plans. Habitat management includes, but is not limited to, the removal of food sources attractive to birds or wildlife; the removal of brush, woodlands and undergrowth where possible; and even physical removal of birds and waterfowl from the airfield and terminal areas. The ultimate goal is to make the environment fairly uniform and unattractive to the species that are considered the greatest hazard to aviation. The Airport Operations Supervisor is responsible for all wildlife management activities at CVG. Two full time USDA Wildlife Services Specialists are also under contract on an annual basis.

8.4.2.2 Significance Threshold

FAA Order 1050.1F states that a significant impact to biological resources would occur when the USFWS or the National Marine Fisheries Service (NMFS) determines that the action would be likely to jeopardize the continued existence of a federally-listed threatened or endangered species or would result in the destruction or adverse modification of federally-designated critical habitat. The FAA has not established a significance threshold for non-listed species. When determining if there is a significant impact to biological resources, the FAA considers if the action would have the potential for:

- A long-term or permanent loss of unlisted plant or wildlife, i.e., extirpation of the species from a large project area;
- Adverse impacts to special status species or their habitats;
- Substantial loss, reduction, degradation, disturbance, or fragmentation of native species' habitats or their populations; or
- Adverse impacts on a species' reproductive success rates, natural mortality rates, non-natural mortality, or ability to sustain the minimum populations levels required for population maintenance.

8.4.2.3 Summary of Biological Resources Considerations

Coordination with the USFWS and the Kentucky Department of Fish and Game should be initiated upon the commencement of any environmental review to confirm that no records of rare or endangered species or their habitat occur within the boundaries of the proposed Master Plan development projects.[5]

4 KCAB; *Section 139.337 Wildlife Hazard Management Plan*; approved by the FAA on October 8, 2010; (14 CFR Part 139, Section 139.337 – Wildlife hazard management)

5 Field Supervisor, U.S. Fish and Wildlife Service, Kentucky Field Supervisor, 30 West Broadway, Suite 265 Frankfort, Kentucky 40601

Impacts to endangered species is unlikely for Master Plan alternatives that will occur on previously disturbed land. Construction planning efforts should include actions to limit stormwater runoff during construction that could impact aquatic species. For any Master Plan alternatives that include the clearing of vegetation and tree removal, field surveys would be required to investigate the existence of summer roost trees for protected bat species. If summer roost trees are found in areas that may be cleared, potential mitigation may recommend that tree removal only occur within the dates established by the USFWS, which is generally between September 15 to April 15; although dates are subject to change.

The Master Plan alternatives are not expected to create permanent standing water or any new attractive wildlife habitat. Therefore, it is expected that all the Master Plan alternatives would conform to the existing WHMP and FAA guidelines including FAA AC 150-5200-33B, *Hazardous Wildlife Attractants on or Near Airports*.[6]

8.4.3 Climate

8.4.3.1 Existing Conditions

Research has shown there is a direct correlation between fuel combustion and Greenhouse Gas (GHG) emissions. In terms of U.S. contributions, the General Accounting Office (GAO) reports that "domestic aviation contributes about three percent of total carbon dioxide emissions, according to USEPA data," compared with other industrial sources including the remainder of the transportation sector (20 percent) and power generation (41 percent). The International Civil Aviation Organization (ICAO) estimates that GHG emissions from aircraft account for roughly three percent of all anthropogenic GHG emissions globally.

8.4.3.2 Significance Threshold

The FAA has not established a significance threshold for climate.

8.4.3.3 Summary of Climate Considerations

Per FAA Order 1050.1F, the discussion of potential climate impacts should be documented in a separate section of the NEPA document, distinct from air quality. Where the proposed action or alternative(s) would result in an increase in GHG emissions, the emissions should be assessed either qualitatively or quantitatively.

Changes in GHG emissions may occur due to the proposed Master Plan alternatives due to emissions from construction vehicles and any changes in aircraft, automobile traffic, or ground support equipment that may occur. The net change in GHG emissions should be calculated and disclosed in the relevant NEPA document either qualitatively or quantitatively. There is currently no threshold of significance for GHG emissions per FAA requirements.

6 FAA AC 150/5200-33B, *Hazardous Wildlife Attractants on or Near Airports*, May 1, 1997

8.4.4 Coastal Resources

8.4.4.1 Existing Conditions

The state of Kentucky is landlocked, there are no areas designated as being protected by the Coastal Zone Management Act or the Coastal Barrier Resources Act.

8.4.4.2 Significance Threshold

The FAA has not established a significance threshold for coastal resources, however, FAA Order 1050.1F does list factors to consider when determining if there is a significant impact to coastal resources. These factors are if the action would have the potential to:

- Be inconsistent with the relevant state coastal zone management plan(s);
- Impact a coastal barrier resources system unit (and the degree to which the resource would be impacted);
- Pose an impact to coral reef ecosystems (and the degree to which the resource would be impacted);
- Cause an unacceptable risk to human safety or property; or
- Cause adverse impacts to the coastal environment that cannot be satisfactorily mitigated.

8.4.4.3 Summary of Coastal Resources Considerations

Because of the location of CVG, no significant adverse coastal resource impacts are expected with the construction and implementation of any of the Master Plan alternatives.

8.4.5 Department of Transportation Act Section 4(f) Resources

8.4.5.1 Existing Conditions

The federal statute that governs impacts in this category is commonly known as the Department of Transportation (DOT) Act of 1966, Section 4(f) provisions. Section 4(f) of the DOT Act was recodified and renumbered as Section 303(c) of U.S. Code Title 49 (49 USC). FAA Orders 5050.4B and 1050.1F continue to refer to this statute as Section 4(f) to avoid confusion. Section 4(f) provides that the "Secretary of Transportation will not approve any program or project that requires the use of any publicly-owned land such as a public park, recreation area, or wildlife/waterfowl refuge of national, state, or local significance or land from an historic site of national, state, or local significance as determined by the officials having jurisdiction thereof, unless there is no feasible and prudent alternative to the use of such land and such program, and the project includes all possible planning to minimize harm resulting from the use."[7] A direct taking of land occurs when land from a 4(f) site is permanently incorporated into a transportation facility. A constructive taking occurs when proximity impacts of a project on a 4(f) property are so severe that the activities, features, or attributes that qualify the property or resources for protection under Section 4(f) are substantially impaired.

[7] FAA Order 1050.1E, *Environmental Impacts: Policies and Procedures*. Appendix A, *Analysis of Environmental Impact Categories*, Section 6.1a, March 20, 2006

Section 6(f) of the Land and Water Conservation Act (LWCA) is also pertinent to Section 4(f) lands. Section 6(f) prohibits recreational facilities funded under the LWCA from being converted to non-recreational use unless approval is received from the director of the grantor agency.

A review of records maintained by the National Park Service (NPS), the Kentucky Heritage Council (KHC), Boone County, and the Northern Kentucky Area Planning Commission (NKAPC) was conducted to identify known Section 4(f) resources around CVG property. Potential Section 4(f) properties around CVG are listed in **Table 8.4-2, *Potential Section 4(F) Resources*** and shown on **Exhibit 8.4-1, Potential Section 4(F) Resources**. No LWCA lands are located around CVG.

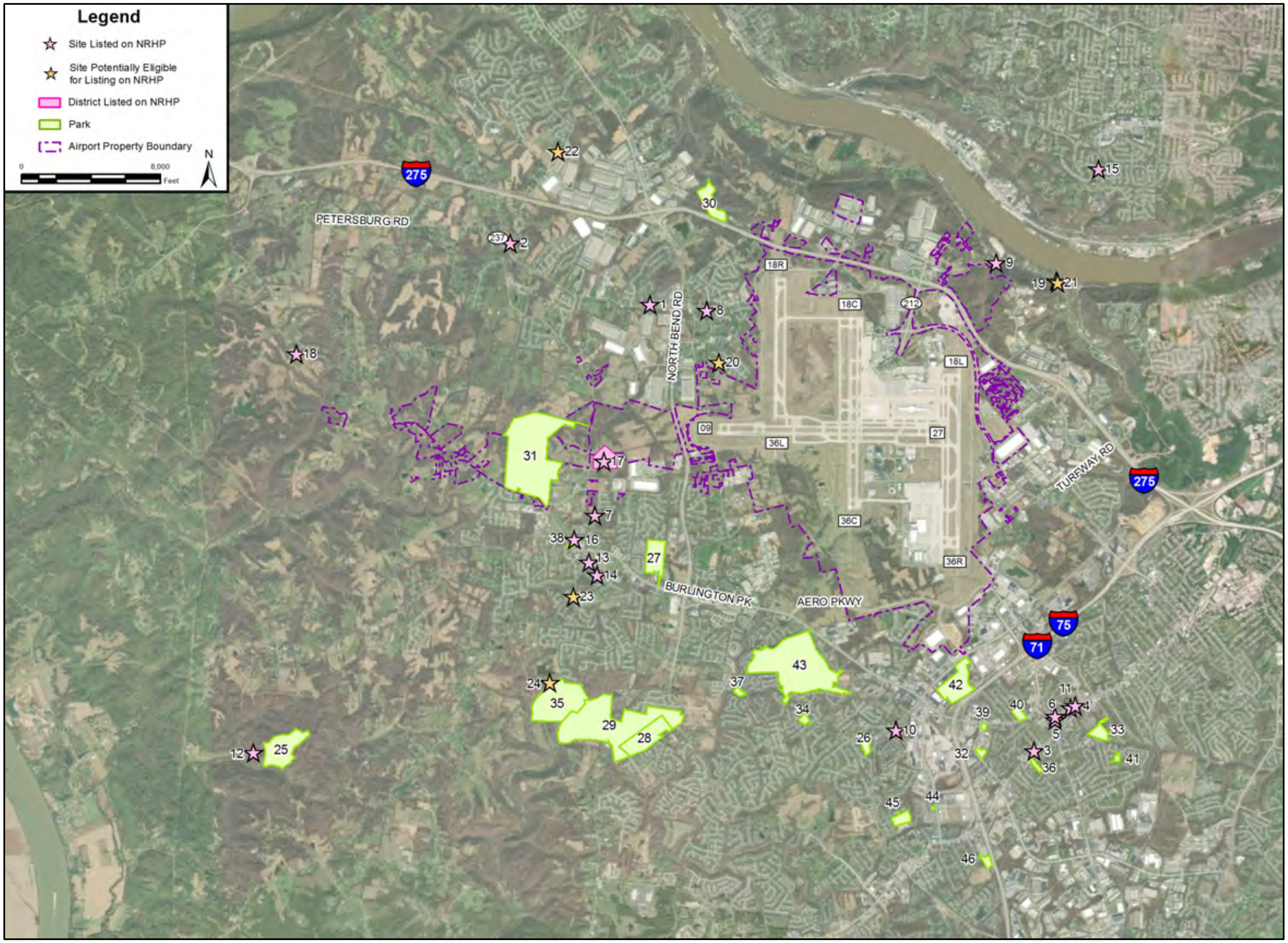
TABLE 8.4-2 POTENTIAL SECTION 4(F) RESOURCES

Map ID	Name	Resource Type
1	A.J. Aylor House	Historic Structure
2	Allie Corn House	Historic Structure
3	Clinton Blankenbeker House	Historic Structure
4	Dr. Gladys Rouse Office and House	Historic Structure
5	Florence Fire Station	Historic Structure
6	Florence Hotel	Historic Structure
7	Frank S. Milburn Machine Shop	Historic Structure
8	Hebron Deposit Bank	Historic Structure
9	Henry and Agnes Rolsen House	Historic Structure
10	Hopeful Lutheran Church	Historic Structure
11	John Delehunty House	Historic Structure
12	Roberts, Thomas Zane, House and Workshop	Historic Structure
13	W.F. and Florence McKim House	Historic Structure
14	W.T. Delph House	Historic Structure
15	Williams, W.L., House	Historic Structure
16	Burlington Historic District	Historic District
17	Ephraim Utz House	Historic District
18	Gaines, Benjamin R., Farm	Historic District
19	Anderson Ferry House	Historic Structure
20	Joel Garnett House	Historic Structure
21	Kottmeyer House	Historic Structure
22	Marietta Graves House	Historic Structure
23	Robert Chambers House	Historic Structure

Map ID	Name	Resource Type
24	Sperti Farm	Historic Structure
25	Boone Cliffs	Park / Recreation
26	Boone County Pee Wee Football	Park / Recreation
27	Boone Woods Park	Park / Recreation
28	Camp Ernst Lake	Park / Recreation
29	Camp Ernst YMCA	Park / Recreation
30	Carder Dolwick Nature Preserve	Park / Recreation
31	England Idlewild Park	Park / Recreation
32	Florence Family Aquatic Center	Park / Recreation
33	Florence Nature Park	Park / Recreation
34	Fox Run Park	Park / Recreation
35	Gunpowder Creek Nature Park	Park / Recreation
36	Niblack Memorial Park	Park / Recreation
37	Oakbrook Park	Park / Recreation
38	Pete’s Park	Park / Recreation
39	Skate Park	Park / Recreation
40	Stringtown Park	Park / Recreation
41	Walnut Creek Park	Park / Recreation
42	World of Golf	Park / Recreation
43	Boone Links Golf Course	Park / Recreation
44	Florence Community Plaza	Park / Recreation
45	Lincoln Woods Park	Park / Recreation
46	Florence Lions Park	Park / Recreation

Sources: U.S. National Park Service, *National Register of Historic Places*; Kentucky Heritage Council; Boone County; Landrum & Brown analysis

EXHIBIT 8.4-1 POTENTIAL SECTION 4(F) RESOURCES



Sources: U.S. National Park Service, *National Register of Historic Places*; Boon County Planning Commission, 2019

8.4.5.2 Significance Threshold

FAA Order 1050.1F states that a significant impaction to Section 4(f) resources would occur when the action involves more than a minimal physical use of a Section 4(f) resource or constitutes a constructive use based on an FAA determination that the aviation project would substantially impair the Section 4(f) resource. Resources that are protected by Section 4(f) are public owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, state, or local significance; and publicly or privately-owned land from an historic site of national, state, or local significance. Substantial impairment occurs when the activities, features, or attributes of the resource that contribute to its significance or enjoyment are substantially diminished.

A physical use would occur if the proposed action or alternative(s) would involve an actual physical taking of Section 4(f) property through purchase of land or a permanent easement, physical occupation of a portion or all of the property, or alteration of structures or facilities on the property. A constructive use would occur when the impacts of a project on a Section 4(f) property are so severe that the activities, features, or attributes that qualify the property for protection under Section 4(f) are substantially impaired. The concept of constructive use is that a project that does not physically use the resource, may still, by means of noise, air pollution, water pollution, or other impacts, dissipate its aesthetic value, harm its wildlife, restrict its access, and take it in every practical sense.

8.4.5.3 Summary of Department of Transportation Act Section 4(f) Resources Considerations

It is anticipated that no direct use or taking of land from any Section 4(f) or 6(f) resources would occur with the implementation of the Master Plan development projects; and no changes to noise exposure patterns, runway use, or flight procedures are anticipated. Therefore, it is anticipated that no direct impacts to any Section 4(f) or 6(f) resources would result from any of the Master Plan alternatives. The environmental review and NEPA documentation should include a review of potential visual impacts to confirm no indirect impacts (i.e. constructive taking) of any Section 4(f) or 6(f) resources would occur.

8.4.6 Farmlands

8.4.6.1 Existing Conditions

The Farmland Protection Policy Act (FPPA) of 1981 was enacted to minimize the extent to which federal actions and programs contribute to unnecessary and irreversible conversion of farmland to non-agricultural uses. The Council on Environmental Quality (CEQ) Memorandum on the Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing NEPA also urges the FAA to analyze the effects of a proposed action on any prime or unique farmland within the NEPA analysis. Here, the land making up the airfield and terminal areas has been highly disturbed by past development activity. Additionally, there are no areas on CVG property or in the area of investigation currently being used for agriculture.

8.4.6.2 Significance Threshold

FAA Order 1050.1F states the significance threshold for farmlands is if the total combined score on Form AD-1006, *Farmland Conversion Impact Rating*, ranges between 200 and 260 points. The FAA considers whether the action would have the potential to convert important farmlands to nonagricultural uses. Important farmlands include pastureland, cropland, and forest considered to be prime, unique, or statewide or locally important land.

8.4.6.3 Summary of Farmland Considerations

According to the Order 1050.1F Desk Reference, the study area for farmlands is typically limited to the construction footprint of the project, however, indirect impacts could occur if access to important farmland is lost due to construction of a new airport, runway extension, commercial space launch site, or other facility. Since no CVG property is currently being used as farmland, no impacts to prime or unique farmland are expected to occur under any of the proposed alternatives. For any proposed alternative that includes development on unpaved surfaces, the FAA may require coordination with the USDA National Resources Conservation Service (NRCS). As part of this agency coordination, Form AD-1006, *Farmland Conversion Impact Rating*, may be required to document that no impacts to prime or unique farmland will occur.

8.4.7 Hazardous Materials, Pollution Prevention, and Solid Waste

8.4.7.1 Existing Conditions

The potential impacts resulting from hazardous materials, solid waste collection, control, and disposal due to airport projects must be assessed. The following four primary laws govern the handling and disposal of hazardous materials, chemicals, substances, and wastes:

- Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), (as amended by the Superfund Amendments and Reauthorization Act of 1986 and the Community Environmental Response Facilitation Act of 1992);[8]
- Pollution Prevention Act of 1990;[9]
- Toxic Substances Control Act of 1976 (TSCA), as amended;[10] and
- Resource Conservation and Recovery Act of 1976 (RCRA), (as amended by the Superfund Amendments and Reauthorization Act of 1986 and the Community Environmental Response Facilitation Act of 1992).[11]

The two statutes of most importance to the FAA for actions to construct and operate airport facilities and navigational aids are RCRA and CERCLA. RCRA governs the generation, treatment, storage, and disposal of hazardous wastes. CERCLA provides for consultation with natural resources' trustees and cleanup of any release of a hazardous substance (excluding petroleum) into the environment.

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[8] 42 U.S.C. 9601-9675
[9] 42 U.S.C. 1310-1319
[10] 15 U.S.C. 2601-2692
[11] 42 U.S.C. 6901-6992(k)

Due to past hazardous waste generating activities at and around CVG, it is necessary to evaluate the potential hazardous waste impacts from any of the proposed Master Plan development projects, including the potential to disturb contaminated soil, existing underground storage tanks (USTs), or the underground hydrant fueling system at Concourse A. Once design plans are known for the Master Plan development projects, potential impacts to specific hazardous materials can be determined.

8.4.7.2 Significance Threshold

The FAA has not established a significance threshold for hazardous materials, pollution prevention, and solid waste, however, FAA Order 1050.1F does list factors to consider when determining if there is a significant impact to hazardous materials and solid waste. These factors are if the action would have the potential to:

- Violate applicable federal, state, tribal, or local laws or regulations regarding hazardous materials and/or solid waste management;
- Involve a contaminated site (including but not limited to a site listed on the National Priorities List);
- Produce an appreciably different quantity or type of hazardous waste;
- Generate an appreciably different quantity or type of solid waste or use a different method of collection or disposal and/or would exceed local capacity; or
- Adversely affect human health and the environment.

8.4.7.3 Summary of Hazardous Materials, Pollution Prevention, and Solid Waste Considerations

The potential impacts from hazardous materials would be evaluated as part of the environmental documentation preparation process for each of the specific development projects. Additional analysis for the proposed development areas such as environmental due diligence audits or environmental site assessments may need to be performed due to the potential to disturb any possible soil contaminants from past uses. Coordination with the Kentucky Environmental Protection Cabinet and other agencies may be necessary prior to design of the Master Plan development projects.

Some of the Master Plan development projects may also include demolition activities. Demolition activities will likely require coordination with the Kentucky Environmental Protection Cabinet and Boone County to ensure proper assessments are conducted and abatement practices are followed, if necessary, prior to demolition.

It is not anticipated that the Master Plan development projects would generate an unmanageable volume of solid waste or affect the existing solid waste management program at CVG. The environmental review should include a review of solid waste, such as demolition debris that may be generated, and identify appropriate facilities for disposal.

8.4.8 Historical, Architectural, Archeological, and Cultural Resources

8.4.8.1 Existing Conditions

The *National Historic Preservation Act* of 1966 (NHPA)[12] and the *Archeological and Historic Preservation Act* of 1974[13] are the primary federal laws governing the preservation of historic and prehistoric resources, encompassing art, architecture, archaeological, and other cultural resources. Section 106 of the NHPA requires that, prior to approval of a federal or federally-assisted project, or before the issuance of a license, permit, or other similar approval, federal agencies take into account the effect of the project on properties that are on or eligible for listing on the National Register of Historic Places (NRHP).

The NRHP has established criteria for determining historic significance. These criteria require a property to have integrity of location, design, setting, materials, workmanship, feeling, and association. Additionally, properties must be at least 50 years old, remain fairly unaltered, and meet one or more of the following National Register criteria for significance, identified as Criterion A through D:

A. Property is associated with events that have made a significant contribution to the broad patterns of our history.
B. Property is associated with the lives of persons significant in our past.
C. Property embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.
D. Property has yielded, or is likely to yield, information on prehistory or history.

8.4.8.2 Significance Threshold

The FAA has not established a significance threshold for historical, architectural, archeological, and cultural resources, however, when determining if there is a significant impact it considers if the action would result in a finding of Adverse Effect through the Section 106 process. However, an adverse effect finding does not automatically trigger preparation of an EIS (i.e., a significant impact).

[12] Public Law 89-665; 16 U.S.C. 470 et seq.
[13] Public Law 86-523, 16 U.S.C. 469-469c-2

8.4.8.3 Summary of Historical, Architectural, Archeological, And Cultural Resources Considerations

Known historic properties in the vicinity of CVG are shown on Exhibit 8.4-1. There are no known archaeological resources that would be directly impacted by any of the Master Plan alternatives. None of the Master Plan alternatives would directly or indirectly impact any structures listed on the NRHP. However, it may be necessary to make a determination of NRHP eligibility for any structures in the area of potential effect that are greater than 50 years old. Coordination with the State Historic Preservation Officer (SHPO) would be required to confirm a finding of no historic properties affected.

An assessment would be included in the environmental documentation on whether the Master Plan development projects would physically destroy or alter any historic properties; require removal of any properties from its historic location; introduce an atmospheric, audible or visual feature to the area that would diminish the integrity of any property’s setting; or through transfer, sale, or lease, diminish the long-term preservation of any property’s historic significance that federal ownership or control would otherwise ensure. A determination in accordance with 36 CFR 800.4 and 36 CFR 800.5 would need to be included in the environmental documentation.

8.4.9 Land Use

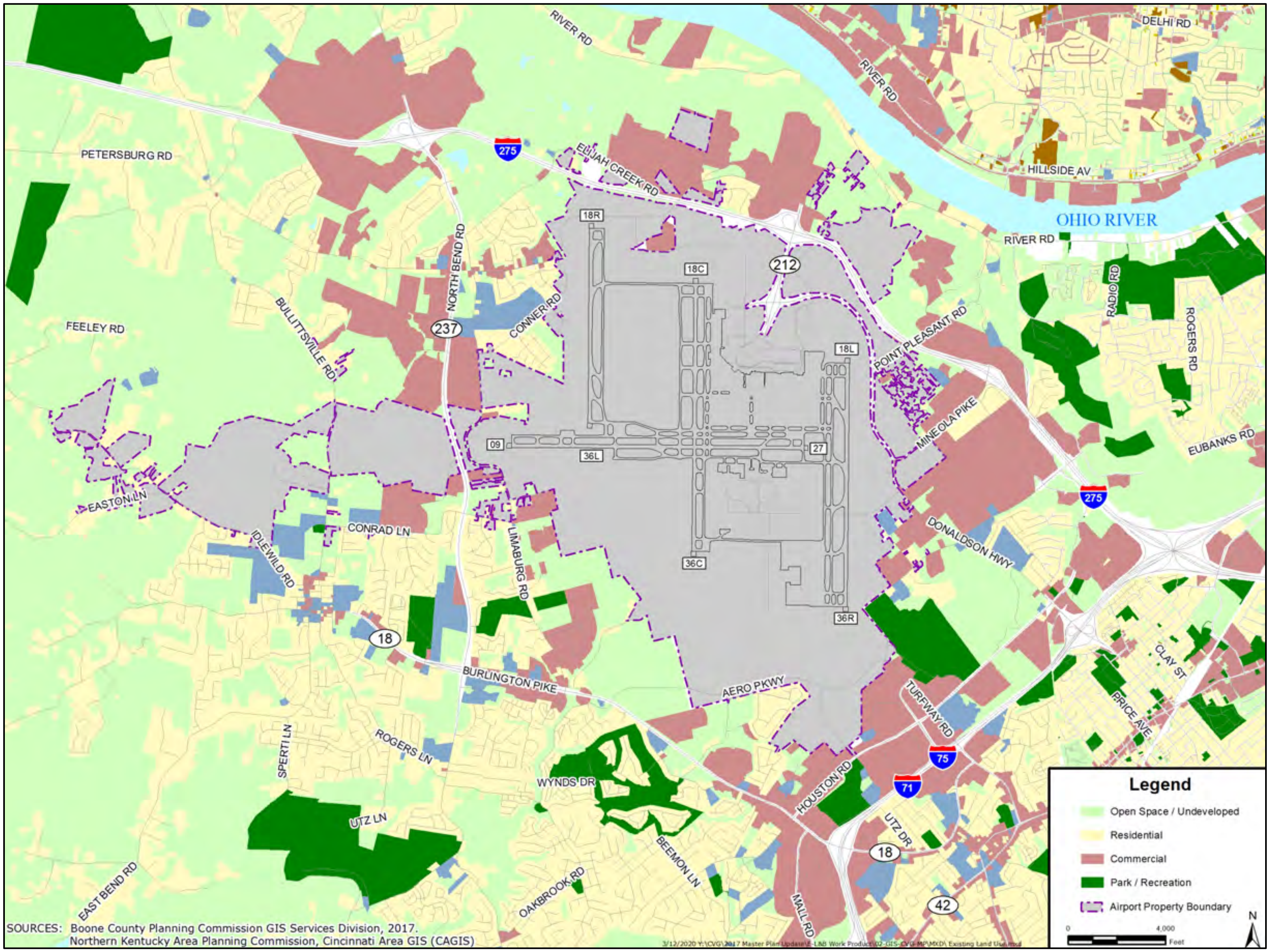
8.4.9.1 Existing Conditions

CVG is located in a suburban area and is immediately surrounded by commercial, industrial, and residential land uses. All of the land areas proposed for the Master Plan development projects are owned by CVG and surrounded by similar airport uses, shown on **Exhibit 8.4-2, *Existing Land Use***.

8.4.9.2 Significance Threshold

The FAA has not established a significance threshold for land use. The determination that significant land use impacts exist is normally dependent on the significance of other impact categories.

EXHIBIT 8.4-2 EXISTING LAND USE



Sources: Boone County Planning Commission GIS Services Division, 2017; Northern Kentucky Area Planning Commission; Cincinnati Area GIS (CAGIS)

8.4.9.3 Summary of Land Use Consideration

No changes to noise exposure patterns, runway use, or flight procedures are anticipated as a result of implementing any of the Master Plan development projects; therefore, no noise new impacts would occur and it is unlikely that the Master Plan alternatives would have a significant adverse impact on compatible land use.

While the KCAB has no jurisdiction over the adoption or enforcement of local zoning regulations, as the Airport Sponsor/Owner it is required to provide written assurance to the FAA that appropriate action has been or will be taken to the extent reasonable to restrict the use of land adjacent to, or in the immediate vicinity of CVG, to activities and purposes compatible with normal airport operations, including landing and takeoff of aircraft.[14] Land use and zoning for land use compatibility is the responsibility of the local jurisdictions around CVG and the KCAB has undertaken all efforts to ensure that these local jurisdictions will undertake such actions to the extent reasonable, as documented in its 14 CFR Part 150 Noise Compatibility Program for CVG.

8.4.10 Natural Resources and Energy Supply

8.4.10.1 Existing Conditions

CVG is located in Boone County, approximately 12 miles southeast of downtown Cincinnati. The City of Cincinnati and surrounding region has adequate access to natural resources and energy for development of the Master Plan alternatives.

8.4.10.2 Significance Threshold

The FAA has not established a significance threshold for natural resources and energy supply; however, FAA Order 1050.1F directs that the use of natural resources needs to be examined if the action would have the potential to cause demand to exceed available or future supplies of these resources. For most airport actions, natural resource consumption will not exceed available or future supplies.

8.4.10.3 Summary of Natural Resources and Energy Supply Considerations

It is unlikely that energy use for construction and implementation of any of the Master Plan development projects would have a significant adverse impact to natural resources and energy supply. Construction of the proposed projects is not likely to cause a substantial demand for natural resources or energy that cannot be met by the local supply. It is not anticipated that scarce or unusual materials would be required to construct any of the proposed projects. Projected demand on electricity and natural gas providers should be assessed and confirmation should be sought that capacity exists to meet the demand.

[14] FAA Order 1050.1E, *Environmental Impacts: Policies and Procedures*; Appendix A, *Analysis of Environmental Impact Categories*, Section 4.1b, March 20, 2006; as set forth in the Aviation Safety and Noise Abatement Act of 1979, as amended (49 U.S.C. 47501-47507)

8.4.11 Noise and Noise-Compatible Land Use

8.4.11.1 Existing Conditions

A review of past environmental studies, previous noise contours prepared for CVG, recent aerial photographs, and local government websites was conducted to identify noise-sensitive land uses within the Master Plan area of investigation and the extent that future noise may impact the area. There were no residences, public schools, nursing homes, hospitals, libraries, or religious institutions within the Master Plan area of investigation.

8.4.11.2 Significance Threshold

FAA Order 1050.1F states the significance threshold for noise and noise compatible land use is if the action would increase noise by Day Night Average Sound Level (DNL) 1.5 dB or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB noise exposure level, or that will be exposed at or above the DNL 65 dB level due to a DNL 1.5 dB or greater increase, when compared to the no action alternative for the same timeframe. Additionally, the FAA gives special consideration to the evaluation of the significance of noise impacts on noise sensitive areas within Section 4(f) properties where the land use compatibility guidelines in 14 CFR part 150 are not relevant to the value, significance, and enjoyment of the area in question.

The FAA has identified land use compatibility guidelines relating types of land use to airport sound levels as shown in **Table 8.4-3, *Land Use Compatibility Guidelines – 14 CFR Part 150***. These guidelines, which are codified in 14 CFR Part 150, show the compatibility parameters for residential, public (schools, churches, nursing homes, hospitals, and libraries), commercial, manufacturing and production, and recreational land uses. All land uses within areas below 65 DNL are considered compatible with airport operations.

As part of the NEPA process a noise analysis would need to be conducted to determine the potential impacts due to any projects under consideration. If a noise increase was determined to be a significant impact, as defined in FAA Order 1050.1F, to any of the surrounding properties, mitigation would need to be provided.

TABLE 8.4-3 LAND USE COMPATIBILITY GUIDELINES – 14 CFR PART 150

Land Use Yearly Day – Night Average Sound – Level (DNL) in Decibels	Below 65	65-70	70-75	75-80	80-85	Over 85
Residential						
Residential, other than mobile homes and transient lodgings	Y	N1	N1	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N1	N1	N1	N	N
Public Use						
Schools, hospitals, nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Governmental services	Y	Y	25	30	N	N
Transportation	Y	Y	Y2	Y3	Y4	N4
Parking	Y	Y	Y2	Y3	Y4	N
Commercial Use						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail -- building materials, Hardware, and farm equipment	Y	Y	Y2	Y3	Y4	N
Retail trade, general	Y	Y	25	30	N	N
Utilities	Y	Y	Y2	Y3	Y4	N
Communication	Y	Y	25	30	N	N
Manufacturing and Production						
Manufacturing, general	Y	Y	Y2	Y3	Y4	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y6	Y7	Y8	Y8	Y8
Livestock farming and breeding	Y	Y6	Y7	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y	Y5	N5	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

The designations contained in this table do not constitute a federal determination that any use of land covered by the program is acceptable under federal, state, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.
Key to Table

- Y (Yes) Land Use and related structures compatible without restrictions.
- N (No) Land Use and related structures are not compatible and should be prohibited.

- NLR Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure
- 25/30/35 Land Use and related structures generally compatible; measures to achieve or NLR of 25, 30, or 35dB must be incorporated into design and construction of structure.

Notes:

1. Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25dB and 30dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide an NLR of 20dB, thus, the reduction requirements are often stated as 5, 10, or 15dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.
2. Measures to achieve NLR of 25dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
3. Measures to achieve NLR of 30dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
4. Measures to achieve NLR of 35dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
5. Land use compatible provided special sound reinforcement systems are installed.
6. Residential buildings require an NLR of 25.
7. Residential buildings require an NLR of 30.
8. Residential buildings not permitted.

Source: *14 CFR Part 150 Airport Noise Compatibility Planning*, Appendix A, Table 1

8.4.11.3 Summary of Noise and Noise-Compatible Land Use Considerations

No alternatives are being recommended that would cause a change in the number of aircraft operations, fleet mix, runway use, flight corridors, or flight profiles. Therefore, a future (2037) noise contour was prepared to reflect the future conditions of this Master Plan timeframe. The future (2037) noise contour is based on the aviation activity forecast prepared for this Master Plan. It is anticipated that existing runway use patterns and flight procedures will continue for the future conditions.

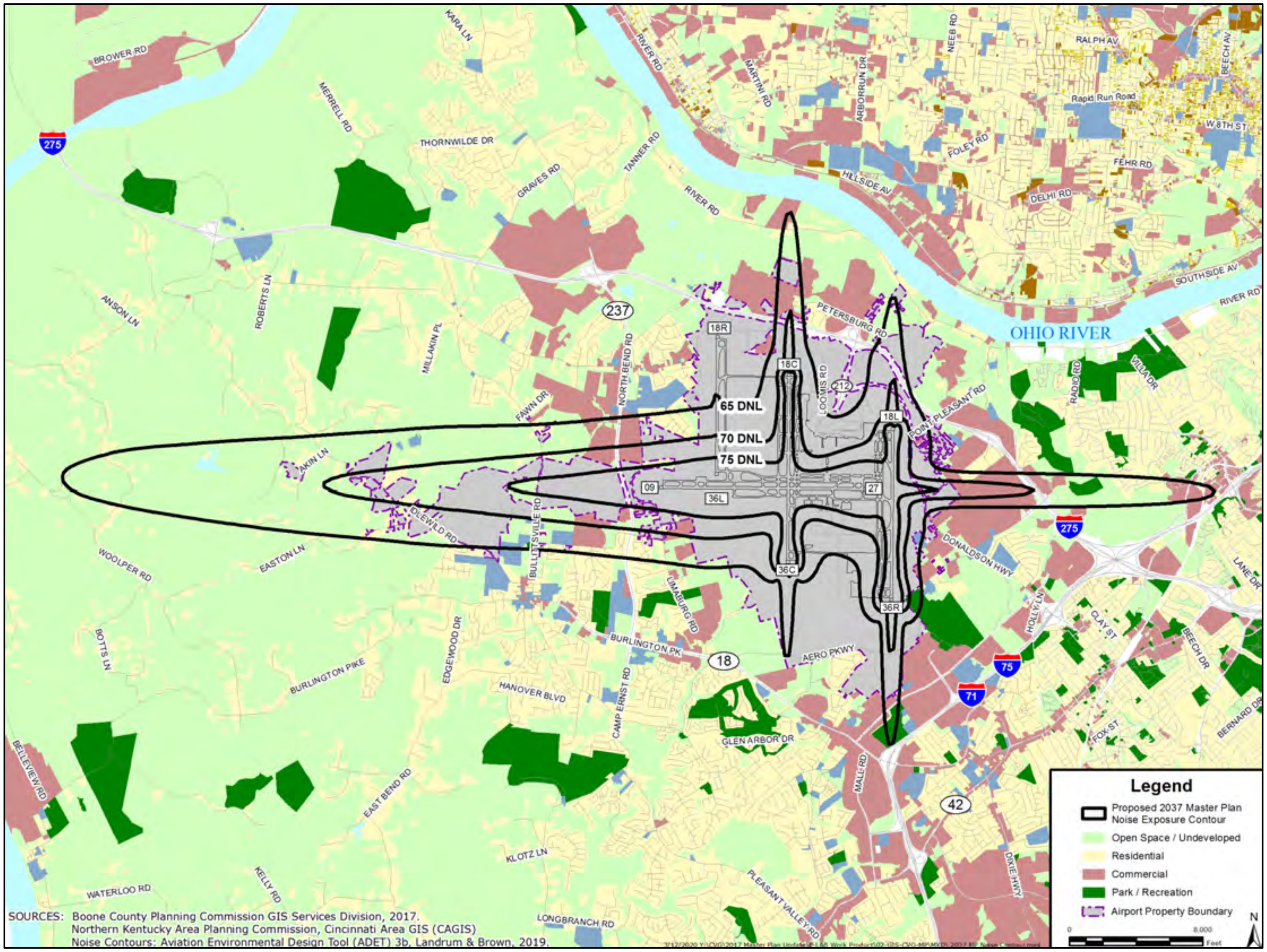
Exhibit 8.4-3, ***Future (2037) Master Plan Noise Exposure Contours*** presents the future (2037) noise contours. **Table 8.4-4**, ***Area (in Square Miles) Within Noise Contour Bands***, summarizes the area within each noise contour level. The information is presented in five-increment DNL noise levels (65, 70, and 75). A technical report detailing the development of the noise contours can be found in **Appendix 8-A,** ***Noise Technical Report***.

TABLE 8.4-4 AREA (IN SQUARE MILES) WITHIN NOISE CONTOUR BANDS

Contour Range (DNL)	2037 Master Plan Noise Exposure Contour Area (Square Miles)
65-70	9.8
70-75	3.8
75+	2.6
65+	16.2

Note: Figures are rounded to the nearest tenth of a square mile.
Source: Landrum & Brown analysis

EXHIBIT 8.4-3 FUTURE (2037) MASTER PLAN NOISE EXPOSURE CONTOURS



Sources: Boone County Planning Commission GIS Services Division, 2017; Northern Kentucky Area Planning Commission; Cincinnati Area GIS (CAGIS), Noise Contour;: Aviation Environmental Design Tool (ADET) 3b; Landrum & Brown analysis

8.4.12 Socioeconomics, Environmental Justice, and Children's Environmental Health and Safety Risks

8.4.12.1 Existing Conditions

CVG functions as the largest airport in the Greater Cincinnati and Northern Kentucky area and is the eighth largest cargo airport in the U.S. by tonnage. The economic activity that CVG generates is a major contributor to the region's economy, contributing nearly 4.4 billion dollars in annual total economic impact to the region.[15]

In addition to serving the Metropolitan Statistical Area (MSA) as a hub for passenger air transportation and air cargo shipping, CVG contributes to the regional economy through its operations and the operations of supporting industries. Employers who maintain staff on-site have nearly 13,500 workers, including airlines, tenants, other businesses and the KCAB.[16] Additionally, more than 31,100 jobs in the region are directly or indirectly related to CVG and its services. Those workers earn 1.3 billion dollars in wages and salaries. CVG's state and local tax contribution is approximately $25 million.

8.4.12.2 Significance Threshold

The FAA has not established a significance threshold for socioeconomic impacts, environmental justice, and children's environmental health and safety risks. However, factors to consider when reviewing a potential action include:

- The potential to induce substantial economic growth in the area, either directly or indirectly;
- Disruption or division of the physical arrangement of an established community;
- Extensive relocation when sufficient replacement housing is unavailable;
- Extensive relocation of community businesses that would cause severe economic hardship for affected communities;
- Disruption to local traffic patterns and substantial reduction in the levels of service of roads serving an airport and its surrounding communities;
- Produces a substantial change in the community tax base;
- Impacts to the physical or natural environment that affect an environmental justice population in a way that the FAA determines are unique to the environmental justice population and significant to that population; or
- Lead to a disproportionate health or safety risk to children.

15 https://www.cvgairport.com/docs/default-source/stats/cvg-facts---january-2020.pdf
16 Ibid

8.4.12.3 Summary of Socioeconomics, Environmental Justice, and Children's Environmental Health and Safety Risks Considerations

The Master Plan development projects are not expected to exceed any of the socioeconomic, environmental justice, and children's environmental health and safety risk factors listed previously. Per FAA Order 1050.1F, prior to construction of the proposed Master Plan development projects, a screening of minority or low-income populations potentially affected would need to occur, and if minority or low-income populations would be affected by the proposed project, meaningful involvement of those populations would be required.[17] Because all of the proposed Master Plan development projects would occur on CVG property, there is not expected to be any risks to environmental justice populations.

CVG has been and continues to be a major factor in attracting business to the MSA. Any new development is likely to produce positive socioeconomic benefits associated with new jobs and increased tax revenues.

8.4.13 Visual Effects

8.4.13.1 Existing Conditions

CVG is currently illuminated by various types of lighting on the airfield and landside facilities. Lighting that emanates from the airfield includes runway, apron, and navigational lighting such as, hold position lights, stop-bar lights, and runway and taxiway signage. Airfield lighting is located along taxiways and ramps for guidance during periods of low visibility, and to assist aircraft movement on the airfield. Aircraft lighting, such as landing lights, position and navigation lights, beacon lights, and vehicle lighting are other types of light sources on the airfield. Lights for landside facilities include buildings, roadways, and parking facilities. CVG is located in an urbanized area which is comprised of other development that is also lighted and contributes to the overall light emissions in the area.

As previously discussed, CVG is located in a suburban area and is immediately surrounded by commercial, industrial, and residential land uses. All of the land areas proposed for the Master Plan development projects are surrounded by similar airport uses, so they would not change the visual character of the area.

[17] USDOT, FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures,* §2-5.2.b. July 16, 2015

8.4.13.2 Significance Threshold

The FAA has not established a significance threshold for light emissions or visual character. However, factors to consider when reviewing a potential action include, whether the proposed action would have the potential to:

- Create annoyance or interfere with normal activities from light emissions;
- Affect the visual character of the area due to the light emissions;
- Affect the nature of the visual character of the area;
- Contrast with the visual resources and/or visual character in the study area; or
- Block or obstruct the views of visual resources.

8.4.13.3 Summary of Visual Effects Considerations

Although there are no federal special purpose laws or requirements specific to light emissions and visual effects, there are special purpose laws and requirements that may be relevant. In addition to NEPA, laws protecting resources that may be affected by visual effects include sensitive wildlife species, Section 106 of the NHPA, Section 4(f) of the DOT Act, and Section 6(f) of the LWCF Act.

The proposed Master Plan development projects are similar to existing airport uses, so it is unlikely that they would have an impact on visual character. Additionally, any additional lighting from these projects would be located on CVG property and would not impact uses off-Airport property. However, the NEPA documentation would need to determine if any additional lights or lighting systems would have an impact on human activity or on the use or characteristics of any protected properties. The NEPA document would also need to determine if construction and operation of any of the proposed Master Plan development projects would have an impact on visual character.

8.4.14 Water Resources

8.4.14.1 Wetlands

Existing Conditions

Section 404 of the Clean Water Act (CWA) governs the dredging and filling of navigable waters of the U.S. The term, “navigable waters of the U.S.” includes wetlands connected or adjacent to navigable waters of the U.S, or jurisdictional wetlands. Non-jurisdictional wetlands do not involve navigable waters, and dredge and fill activities in these wetlands do not require U.S. Army Corps of Engineers approvals, but these wetlands are natural resources FAA must assess under NEPA.

The CVG property encompasses several areas that are considered wetlands. The quality and character of the various areas of wetlands varies.

Significance Threshold

FAA Order 1050.1F states the significance threshold for wetlands is if the action would:

- Adversely affect a wetland's function to protect the quality or quantity of municipal water supplies, including surface waters and sole source and other aquifers;
- Substantially alter the hydrology needed to sustain the affected wetland system's values and functions or those of a wetland to which it is connected;
- Substantially reduce the affected wetland's ability to retain floodwaters or storm runoff, thereby threatening public health, safety, or welfare (the term welfare includes cultural, recreational, and scientific resources or property important to the public);
- Adversely affect the maintenance of natural systems supporting wildlife and fish habitat or economically important timber, food, or fiber resources of the affected or surrounding wetlands;
- Promote development of secondary activities or services that would case the circumstances listed above to occur; or
- Be inconsistent with applicable state wetland strategies.

Summary of Wetland Considerations

The FAA typically requires mitigation for non-jurisdictional streams under Executive Order 11990 which lays out the federal government's "no net loss" policy for wetlands. Executive Order 11990 requires the FAA to make a written finding that an airport did not construct on a wetland unless, "(1) there is no practicable alternative to such construction, and (2) that the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use." This finding must be made either in the FONSI or ROD, and the documentation necessary to support the finding must be contained in the NEPA document.

For projects that would occur on unpaved surfaces, a field survey should be conducted by a qualified wetland specialist to determine the presence or absence of wetlands and/or streams. Coordination and consultation shall be conducted with the U.S. Army Corps of Engineers and the Kentucky Energy and Environment Cabinet, Division of Water (DOW) should any impacts to wetland areas or streams be expected as a result of the proposed Master Plan development projects.

8.4.14.2 Floodplains

Existing Conditions

Floodplains are defined by Executive Order 11988, *Floodplain Management*,[18] as "the lowland and relatively flat areas adjoining inland and coastal waters including flood-prone areas of offshore islands, including at a minimum, that area subject to a one-percent or greater chance of flooding in any given year" (i.e., area inundated by a 100-year flood).[19] U.S. Department of Transportation (U.S. DOT) Order 5650.2 defines the beneficial values served by floodplains to include "natural moderation of floods, water quality maintenance, groundwater recharge, fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, and forestry." Federal Emergency Management Agency (FEMA) maps are the primary reference for determining the extent of the base floodplain.

The 100-year flood has been adopted by FEMA as the base flood for floodplain management purposes. There are no areas of the 100-year floodplain that occur on CVG property, as shown on **Exhibit 8.4-4, *Floodplains and Streams***. According to FEMA, CVG is located on Flood Insurance Rate Maps (FIRM) Panel 21015C0120C, 21015C0115C, and 21015C0110C.

Significance Threshold

FAA Order 1050.1F states the significance threshold for floodplains is the action would cause notable adverse impacts on natural and beneficial floodplain values. Natural and beneficial floodplain values are defined in Paragraph 4.k of U.S. DOT Order 5650.2, *Floodplain Management and Protection*.

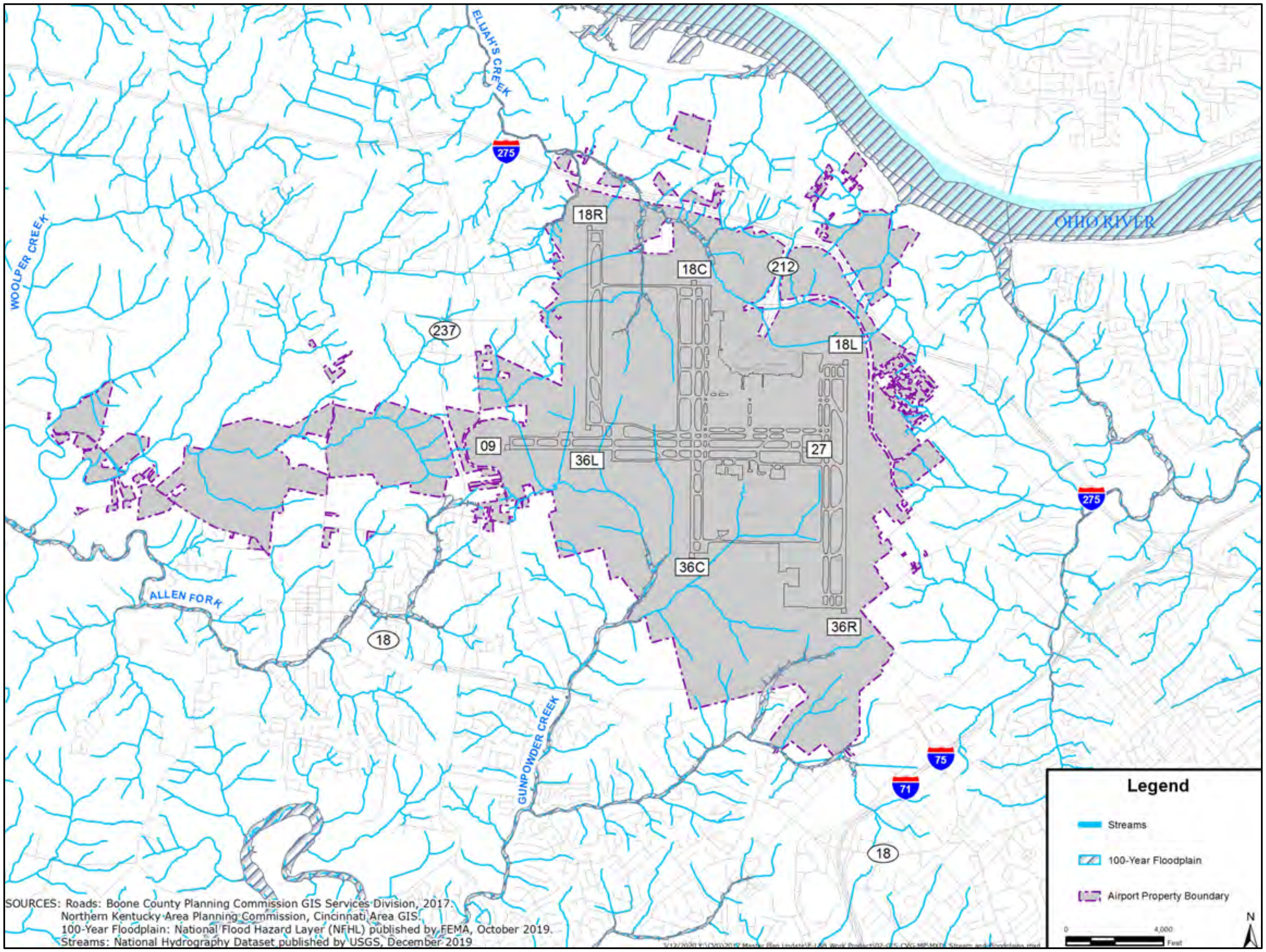
Summary of Floodplain Considerations for All Alternatives

None of the Master Plan proposed projects or its alternatives encroach upon a mapped floodplain. Floodplain impacts would only be considered significant relative to NEPA if a proposed federal action results in one or more of the following impacts:

- A high likelihood of loss of human life;
- Substantial encroachment-associated costs or damage, including adversely affecting safe airport operations or interrupting aircraft services (e.g., interrupting runway or taxiway use, placing another facility such as a navigational aid out of service, placing utilities out of service, etc.); or
- A notable adverse impact on the floodplain's natural and beneficial floodplain values.

[18] Code of Federal Regulations, Title 43, Part 6030 (43 CFR 6030)
[19] FAA Order 5050.4B, *NEPA Implementing Instructions for Airport Actions*, April 28, 2006

EXHIBIT 8.4-4 FLOODPLAINS AND STREAMS



Sources: Boone County Planning Commission GIS Services Division, 2017; Northern Kentucky Area Planning Commission; Cincinnati Area GIS (CAGIS); National Flood Hazard Layer (NFHL) published by FEMA, October 2019; National Hydrography Dataset published by USGS, December 2019

8.4.14.3 Surface Waters

Existing Conditions

The main source of hydrology on CVG property is precipitation, surface runoff from adjacent properties, and various streams. In general, surface water is migrated across CVG property in an east to west direction.

The two primary sources of drinking water in Kenton County are the Ohio River and the Licking River. Water is pumped from the rivers to one of three treatment plants where the water is cleaned, tested, and pumped into the distribution system. The Ohio River is located to the north and west of CVG and several tributaries flow from CVG property into the Ohio River.

In Kentucky, stormwater discharges are regulated by the Kentucky Pollutant Discharge Elimination System (KPDES) as administered by the DOW. CVG currently holds an individual KPDES Permit (Permit No. KY0083864) for industrial activity.

Significance Threshold

FAA Order 1050.1F states that a significant impact on surface waters exist if the action would:

- Exceed water quality standards established by federal, state, local, and tribal regulatory agencies; or
- Contaminate public drinking water supply such that public health may be adversely affected.

Additional factors to be considered when evaluating whether this is a significant impact on surface water include whether the proposed action would have the potential to:

- Adversely affect natural and beneficial water resource values to a degree that substantially diminishes or destroys such values;
- Adversely affect surface waters such that the beneficial uses and values of such waters are appreciably diminished or can no longer be maintained and such impairment cannot be avoided or satisfactorily mitigated; or
- Present difficulties based on water quality impacts when obtaining a permit or authorization.

Summary of Surface Waters Considerations

Potential future surface water impacts associated with the creation of additional impervious surfaces could occur due to the construction of the proposed Master Plan development projects. Several permits, approvals, or certifications associated with surface water may be required prior to development of the proposed projects, such as a NPDES Construction Stormwater General Permit.

Coordination with U.S. Army Corps of Engineers and the DOW would need to be conducted to confirm any potential impacts and mitigation measures.

8.4.14.4 Groundwater

Existing Conditions

The geology of CVG is predominantly limestone which yields 100 to 500 gallons of water per day from wells in valleys or on broad ridges, but almost no water from drilled wells on narrow ridges or hilltops.[20] There are no public or private drinking water wells or wells used for agricultural purposes on CVG property.[21]

Significance Threshold

FAA Order 1050.1F states the significance threshold for groundwater is an action that would:

- Exceed water quality standards established by federal, state, local, and tribal regulatory agencies; or
- Contaminate public drinking water supply such that public health may be adversely affected.

Factors to be considered in this analysis are whether the action would have the potential to:

- Adversely affect natural and beneficial groundwater values to a degree that substantially diminishes or destroys such values;
- Adversely affect groundwater quantities such that the beneficial uses and values of such groundwater are appreciably diminished or can no longer be maintained and such impairment cannot be avoided or satisfactorily mitigated; or
- Present difficulties based on water quality impacts when obtaining a permit or authorization.

Summary of Groundwater Considerations

It is unlikely that any of the proposed Master Plan development projects would exceed groundwater quality standards or contaminate a public water supply. If a significant impact from any proposed projects is identified, coordination with the DOW must occur to create a Groundwater Protection Plan.

[20] Kentucky Geological Survey; *Groundwater Resources of Boone County*, Kentucky; 2004

[21] Kentucky Geological Survey; *Water Well Records Search Results*, Kentucky Groundwater Data Repository; Online at: http://kgs.uky.edu/kgsweb/datasearching/water/waterwellsearch.asp; accessed: December 13, 2019

8.4.14.5 Wild and Scenic Rivers

Existing Conditions

The Wild and Scenic Rivers Act of 1968 provides protection for certain free-flowing rivers, which have "outstanding or remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values." The 1979 Environmental Message Directive on Wild and Scenic Rivers (August 2, 1979) from the President, directs federal agencies to avoid or mitigate adverse effects on rivers identified in the Nationwide Rivers Inventory (NRI) as having potential for designation under the Wild and Scenic Rivers Act. The NRI is a listing of more than 3,400 free-flowing river segments that are believed to possess one or more outstanding remarkable natural or cultural values judged to be of more than local or regional significance.

According to the NRI database accessed on the U.S. Department of the Interior, NPS website, there are no NRI river segments or rivers designated as part of the National Wild and Scenic River System within Kenton County.

Significance Threshold

The FAA has not established a significance threshold for wild and scenic rivers, however, FAA Order 1050.1F does list factors to consider when determining if there is a significant impact to wild and scenic rivers. These factors are if the action would have an adverse impact on the values for which a river was designated through:

- Destroying or altering a river's free-flowing nature;
- A direct and adverse effect on the values for which a river was designated;
- Introducing a visual, audible, or other type of intrusion that is out of character with the river or would alter outstanding features of the river's setting;
- Causing the river's water quality to deteriorate;
- Allowing the transfer or sale of property interests without restrictions needed to protect the river or the river corridor; or
- Any of the above impacts preventing a river on the NRI or a Section 5(d) river that is not included in the NRI from being included in the Wild and Scenic River System or causing a downgrade in its classification.

Summary of Wild and Scenic Rivers Considerations

Construction and operation of any of the proposed Master Plan development projects is not anticipated to impact a wild or scenic river, or river segment under study for inclusion in the Wild and Scenic River System, an NRI river segment, or an otherwise eligible river.

8.5 Findings and Environmental Strategy

FAA AC 150/5070-6b[22] states, "The purpose of considering environmental factors in airport master planning is to help the sponsor thoroughly evaluate airport development alternatives and to provide information that will help expedite subsequent environmental processing. By using existing maps of the airport area, prior environmental documents, and the Internet, planners and environmental specialists can get an excellent overview of sensitive environmental resources in and around the airport."

8.5.1 NEPA Requirements

The projects proposed in this Master Plan would require an update to the CVG Airport Layout Plan (ALP). Updates to the ALP may require FAA approval. The current FAA reauthorization bill requires that the FAA "review and approve or dis-approve only those portions of the plan (or any subsequent revision to the plan) that materially impact the safe and efficient operation of aircraft at, to, or from the airport or that would adversely affect the safety of people or property on the ground adjacent to the airport as a result of aircraft operations, or that adversely affect the value of prior federal investments to a significant extent."[23] Such review and approval would constitute a federal action that would be subject to NEPA. As such, a NEPA environmental review would be required prior to the development of these Master Plan proposed projects in order to identify and quantify the potential adverse environmental impacts. This NEPA review should include a determination of purpose and need, identification of alternatives for evaluation, and a discussion of potential environmental impacts for the project(s).

For those projects that are ripe for decision and would require FAA approval and NEPA review, coordination with the FAA will determine the appropriate type of environmental documentation as required by NEPA. For this environmental overview, a summary of potential NEPA processing requirements has been undertaken for projects proposed within the Planning Activity Level (PAL) 1 timeframe. These projects are listed in **Table 8.5-1, *PAL 1 Recommended Projects*** and shown in **Exhibit 8.5-1, *PAL 1 Program***. Of these projects, the cargo development shown on the south side of the airfield has already received environmental approval per NEPA. Other projects that would affect federally obligated land and/or materially impact the safe and efficient operation of aircraft would be required to undergo NEPA analysis. Several of the projects within the PAL 1 timeframe may impact unpaved areas with little or no previous development. These projects, including the proposed replacement employee parking lot and the expansion of the ValuPark parking lot, may impact resources which typically have required an EA. Other minor development on previously disturbed land that would be subject to ALP approval could potentially be processed as a Categorical Exclusion. Individual projects that may have independent utility but may occur in the same timeframe and/or physical location may be combined into the same NEPA review process for expediency, where appropriate. Initiating a formal coordination process with the FAA Memphis Airports District Office (ADO) will determine which type of environmental documentation would be required for each project.

22 FAA AC 150 5070-6b, Change 2, *Airport Master Plans*, Chapter 5, *Environmental Considerations*, 501 General (a). January 27, 2017
23 H.R. 301, Section 163, FAA Reauthorization Act of 2018 P.L. 115-254

Each project would need to demonstrate independent utility according to the regulatory requirements under NEPA prior to processing. It is recommended that KCAB staff discuss the individual development projects with the FAA as early as possible to make certain there is sufficient time to obtain the necessary environmental approval(s) and permit(s) before construction needs to begin. The time to prepare an EA can take six months to a year to obtain FAA approval. Other timing considerations may include the potential need to conduct surveys for protected species which have seasonal restrictions, such as running buffalo clover and Indiana and northern long-eared bats, that may delay approvals. **Table 8.5-1, *PAL 1 Recommended Projects*** shows the potential level of NEPA processing for each project based on preliminary review of existing information. Additionally, environmental permits and mitigation may be required by other federal and state agencies as described in Section 8.5.2.

TABLE 8.5-1 PAL 1 RECOMMENDED PROJECTS

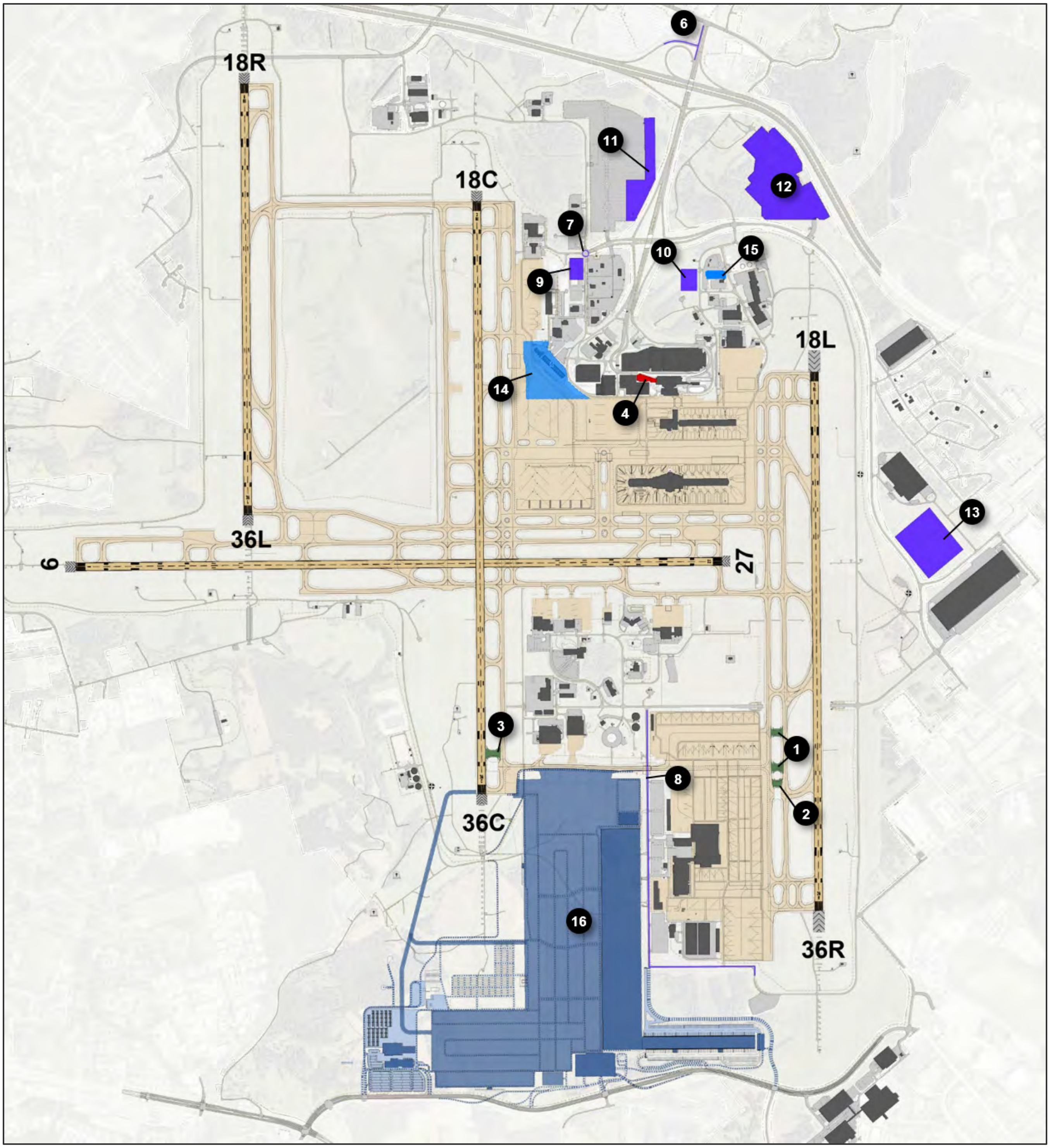
PAL 1 Project List		
#	Project Description	Potential NEPA Processing
Airfield		
1	Taxiway N Extension	Categorical Exclusion
2	Relocation of Taxiway S4 & Demo	Categorical Exclusion
3	Relocation of Taxiway D2 & Demo	Categorical Exclusion
Terminal		
4	Terminal Expansion	Environmental Assessment
5	Bag Belts from CSB to Terminal (project not shown)	
Landside		
6	SB KY 212/I-275 WB Entrance Ramp Improvements	Categorical Exclusion
7	Loomis Road/Donaldson Road Improvements - Part 1	Categorical Exclusion
8	Wendell Ford Blvd Capacity Improvements & Extension	Categorical Exclusion
9	Construction of New Cell Phone Lot	Categorical Exclusion
10	Expansion Taxi Bullpen to add TNC	Categorical Exclusion[1]
11	Expand ValuPark Parking Lot – Part 1	Categorical Exclusion[1]
12	Convert Existing Employee Lot to Long-Term Parking	Categorical Exclusion or Environmental Assessment[1]
13	Construction of Replacement Employee Lot	
Support Facilities		
14	General Aviation Hangar and Apron	Categorical Exclusion or Environmental Assessment[2]
15	Government/Police Facility	Categorical Exclusion
16	Cargo Development	NEPA Processing Complete

1 If trees are impacted, project may require coordination with USFWS due to potential habitat for protected bat species. Disturbance of previously-disturbed ground would require coordination with KHC for determination of potential impacts to archaeological resources. Wetland surveys should be conducted to confirm presence/absence of wetlands. Potential wetland impacts would require coordination with USACE and impacts exceeding 0.5 acres would trigger an EA.

2 Project may require an EA if hangar supports new aircraft activity at CVG.

Source: Landrum & Brown analysis

EXHIBIT 8.5-1 PAL 1 PROGRAM



Source: Landrum & Brown analysis

8.5.2 Major Environmental Permitting Requirements

The environmental categories that may require environmental surveys, approvals, and permitting are listed in this section. In some cases, these processes would occur simultaneously with the NEPA process. Coordination with appropriate environmental regulatory agencies would also need to take place.

- Air Quality
  - General Conformity Determination
  - Coordination with the USEPA if necessary
  - Appropriate measures recommended to reduce construction air quality impacts on surrounding communities
- Biological Resources
  - Coordination with the USFWS to determine impacts to threatened and endangered species
- Cultural Resources
  - Coordination with the Kentucky Heritage Council to determine impacts to historic, architectural, archaeological, and cultural resources
- Hazardous Waste
  - Coordination with Kentucky Department for Environmental Protection, Division of Waste Management, to obtain a permit for the disposal of hazardous waste if necessary
- Water Quality
  - Update to current NPDES Permit
  - Section 404 Dredge and Fill Permit required for dredge and fill activities involving Waters of the U.S.
  - Coordination with the U.S. Army Corps of Engineers and the Kentucky Department for Environmental Protection, Division of Water
- Wetlands
  - Wetland Use Permit and mitigation could be required for construction; however, it is unlikely due to the minimal amount of wetlands and streams that are located on CVG property and the low potential of either being impacted by the development of any of the Master Plan alternatives.

MASTER PLAN 2050

Chapter 9 | Sustainability

CINCINNATI/NORTHERN KENTUCKY INTERNATIONAL AIRPORT

L&B TEAM

9 Sustainability

9.1 Introduction

Airport sustainability is a broad term that encompasses a wide variety of practices applicable to the operation and management of airports. The term refers to practices that ensure airport operational efficiencies; financial benefits, including maintenance of high and stable levels of economic growth and employment; no impact, or benefits to the natural environment; and social progress that recognizes the needs of all stakeholders.

This chapter is designed to provide a framework for a future Sustainability Plan for the Cincinnati/Northern Kentucky International Airport (CVG). Included are recommended sustainability initiatives that support and advance CVG and Kenton County Airport Board (KCAB) goals and targets for sustainability.

9.2 Definition of Sustainability

The common definition of sustainability is the "Triple Bottom Line," or balance of environmental, financial, and social goals. In an airport environment, it is important to also consider the critical fourth category of operational efficiency, as shown on **Exhibit 9.2-1, *EONS Approach to Airport Sustainability***.

This approach was developed by Airports Council International (ACI) and is commonly referred to as "EONS,"[1] which stands for a balance of:

- Economic viability
- Operational efficiency
- Natural resource considerations (benefits or no impact)
- Social responsibility

Sustainable practices are measures incorporated into projects that are designed to produce balanced operational, environmental, social, and financial benefits. Sustainable practices reduce impact on the environment by reducing the use of raw or material resources (materials, fossil fuels, energy consumption, etc.), reducing air emissions, reducing waste, and reducing water pollution, as key examples. Thoughtful and early planning to incorporate green and sustainable practices helps to reduce impacts while also creating financial and operational benefits.

[1] Airports Council International – North America (ACI-NA) Sustainability Working Group, 2008.

EXHIBIT 9.2-1 EONS APPROACH TO AIRPORT SUSTAINABILITY

9.3 Sustainability within the Airport Industry

Airports today are challenged to look ahead and plan to meet projected increases in demands for capacity and service, while also preserving economic viability and addressing potentially formidable constraints to growth. To meet this challenge, airports need strategies that allow for sustained aviation growth while controlling costs and pursuing a goal of reducing environmental impacts over time.

Managing operating costs and capacity, reducing environmental risks and liability, and ensuring customer and employee satisfaction, while demonstrating a commitment to the health and vitality of their communities is the new order of business. Sustainability programs combine operational, ecological, social, and economic concerns into a balanced approach to meeting the unique challenges facing airports today.

9.4 Sustainability Benefits

Sustainability goals and strategies have achieved priority at global levels as more airports in more countries are realizing the benefits of striving for, and achieving, efficiency in all aspects of airport management and operations. Airports at the forefront of sustainability are given a prominent place on the “aviation global stage” and are viewed as world leaders in operational efficiency. Efficient operating practices and reduced operations costs are major attractants to airline partners.

There are opportunities for applying principles of sustainability in all areas of airport operations - airside, landside, terminals, and hangars, just to name a few. New buildings, runways and taxiways, and maintenance facilities should be designed with sustainable principles in mind. Sustainability can also be applied as a component of retrofit and repair activities. The most beneficial opportunities for employing sustainable principles is during the initial planning and design phases of an airport development project, but there are potentially even more opportunities to consider in facility replacement and maintenance.

There are challenges to implementing sustainable initiatives beyond identifying appropriate processes or technologies. Throughout a facility’s design and construction phases, decisions are made based on the goals of the project team, usually total cost and time to completion. Once the facility is turned over to begin routine operations, however, the operating department has different cost concerns and goals driving its decisions, usually monthly or yearly operating costs. In most cases, the majority of the cost of facility ownership occurs after design and construction and the operating departments must live with decisions made by the capital project team.

To ensure their success, sustainability programs must begin during planning and design and continue through construction and operation/maintenance, as well as decommissioning and demolition. This approach takes into account the lifetime impacts of processes and equipment and minimizes not only total costs but also lifetime environmental impacts. The expense of “green” technologies, which may often be perceived as a detriment to implementation due to higher upfront costs compared to traditional systems, often produce lower life-cycle costs as compared to traditional systems; and in some cases, significant cost savings can be generated when sustainable practices are incorporated instead of traditional practices.

Sustainability programs make good business sense by providing:

- Greater asset utilization
- Reduced costs of asset management and asset development
- Reduced life-cycle costs
- Optimization of new and better technologies
- Improved work environment for employees leading to higher productivity
- Benefits to local communities and the environment
  - Reduced environmental footprint
  - Improved benefits to and greater support from the community

9.5 Current Airport Sustainability Best Practices

A core value of the KCAB is to minimize CVG's impact on its surroundings while still ensuring safety and operating efficiency. The current sustainability practices at CVG are in keeping with the goals of the CVG's board and leadership, which are to be innovative, efficient and mindful of the CVG's surroundings. This section provides a summary of the existing sustainability best practices at CVG; as well as programs that are currently in development.

9.5.1 Existing Programs and Initiatives

9.5.1.1 *Management of Waste*[2]

The recycling program at CVG includes airfield materials, building materials, electronics, and passenger items in the terminals. On the airfield, demolished concrete and asphalt are ground-up and stored on site for use in other projects. In employee office areas, computers, light bulbs, and all types of batteries are collected and recycled. In passenger terminal areas, paper, bottles, and cans are collected and recycled. In addition, liquid collection stations are located pre-security, which serves to reduce the amount of liquid waste disposed of in trash containers.

9.5.1.2 *Water Quality*[3]

In order to safeguard the environment from chemicals used during deicing operations, CVG has installed a system designed to capture the majority of stormwater runoff and snowmelt occurring within in a 4.5 square-mile area of the airfield. CVG reports that over 400 million gallons of runoff water are treated each year by this system. The bio-treatment system operates year-round and uses microorganisms to consume the deicing chemicals present in the collected stormwater. Runoff is collected in creeks, which are then pumped into treatment basins, and then into reservoirs, before being gradually released back into the creeks. Weekly stream samplings are performed at over fifteen locations to ensure compliance with environmental regulations.

9.5.1.3 *Emissions Reduction*[4]

CVG's efficient airfield assists airlines in lowering aircraft emissions by decreasing the amount of fuel burned by aircraft when taxiing. CVG has also begun to reduce reliance on traditionally-fueled vehicles by adding hybrid vehicles to the maintenance fleet. In regard to building efficiencies, CVG has replaced older boilers with high efficiency units that use less energy and emit less emissions into the atmosphere. In addition, the Aircraft Rescue and Firefighting (ARFF) facility uses cleaner burning propane and Tek Flame at their CVG training facility. CVG's transportation center creates a dedicated space for rental car buses to park and wait for passengers. It also improves traffic flow, reduces pollution, and saves fuel.

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2 Discussions with CVG Environment Department Staff and online content at: http://www.cvgairport.com/about/enviro.
3 Discussions with CVG Environment Department Staff and online content at: http://www.cvgairport.com/about/enviro.
4 Discussions with CVG Environment Department Staff and online content at: http://www.cvgairport.com/about/enviro; CVG Building our Future, online at: http://www.cvgairport.com/about/next/Build/.

9.5.2 Programs and Initiatives Currently in Development

9.5.2.1 *Consolidated Rental Car Facility*[5]

As CVG continues to grow and enhance its facilities to better serve customers, construction began in 2018 to improve and modernize the terminal and roadways to make way for a new Consolidated Rental Car Facility (CONRAC). The purpose of this facility is to elevate the customer experience, eliminate emissions from shuttles circling back and forth from rental car lots and terminal, continue to make CVG competitive, and provide a new front door to the terminal. The overall project includes a new entrance road to CVG, a customer service building for rental cars, facility for pick-up and returns of rental cars, and vehicle maintenance and fueling facilities. The project also includes both a temporary construction bridge and a permanent bridge largely constructed with reusable materials. The Consolidated Rental Car Facility will cover approximately 12 acres (1 million square feet for the complete facility) and is being constructed in the space where former Terminals 1 and 2 were located. The facility will open in 2021.

9.5.2.2 *Compost Pilot Program*[6]

CVG Environment and Innovation Department staff are working with the Airport Master Concessionaire and other CVG tenants to develop a pilot program for collection and compost of used coffee grounds. Although there is adequate space for storage of the collected materials until pick-up would occur, staffing is yet to be determined. Additional items to be vetted include potential community partnerships with local farms and/or other facilities that would receive and use the coffee grounds as compost material.

9.5.2.3 *Food Rescue and Donation*[7]

CVG Environment and Innovation Department staff are working together to develop programs to "rescue" safe, edible food from both the CVG employee cafeteria and terminal concessionaires for donation. As recipients of the food donations, local food banks and charities could distribute the food for immediate as-is consumption or could use the donations as ingredients for new meals served to those in need within surrounding local communities.

9.5.2.4 *Reduced Water Pollution-Potential due to Deicing*[8]

As CVG continues to strive for the best and most current technology for environmental management, CVG staff are exploring partnerships with local universities to study techniques to reduce water pollution potential of deicing materials during the winter season. The results of this study will assist in reducing overall pollution potential from stormwater runoff into local and regional waterways.

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5 Discussions with CVG Environment Department Staff and online content at: http://www.cvgairport.com/about/enviro; CVG Building our Future, online at: http://www.cvgairport.com/about/next/Build/.

6 Discussions with CVG Environment Department Staff.

7 Discussions with CVG Environment Department Staff.

8 Discussions with CVG Environment Department Staff.

9.5.2.5 *Additional Considerations*[9]

In addition to all initiatives and programs currently in development, CVG staff are also researching and implementing use of electric ground support equipment (GSE), researching development and implementation of a potential hydrogen farm, and researching potential use of reclaimed water.

CVG is also hiring a sustainability intern who will be dedicated to supporting the senior leadership of Customer Experience and Innovation. The intern will work within four verticals: Clean, Secure, Connect and Transport. The focal point of this internship is the research, pre-development and implementation of the Clean vertical with leanings towards existing environmental sustainability efforts and innovative concepts in early-stage development and/or entering the market. This includes gathering data, defining best practices and convening partners as needed to assist CVG in advancing its sustainability efforts and improving its environmental impact potion in both the community and industry.

9.6 Airport Sustainability Recommendations

The following are sustainability recommendations appropriate for an airport environment. These recommendations offer a framework for consideration, which is to be refined and revised through coordination with KCAB in order to develop a future Sustainability Plan for CVG.

The methodology to develop airport sustainability recommendations for CVG includes the integration of three principle lines of research: 1) an assessment of CVG's current sustainability initiatives, 2) a review of airport sustainability frameworks developed by the Airport Cooperative Research Program (ACRP) and the Federal Aviation Administration (FAA),[10] and 3) a review of global airport best practices.

The sustainability recommendations are presented in the following categories:

- Solid Waste Management
- Energy and Atmosphere Optimization
- Sustainable Site Management
- Water Efficiency
- Airport Design and Construction Practices
- Construction Waste Management: Designing for Use and Reuse of Materials and Resources

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9 Discussions with CVG Environment Department Staff.
10 Sources: ACRP Synthesis 77, *Airport Sustainability Practices*; ACRP Report 80, *Guidebook for Incorporating Sustainability into Traditional Airport Projects*; FAA Synthesis, *Recycling, Reuse and Waste Reduction at Airports, 2013.*

9.6.1 Solid Waste Management

Sustainable initiatives for consideration at CVG, related to solid waste management include, but are not limited to those listed below.

- Solid Waste Management
  - Waste Stream Audit
    - Conduct a waste stream audit of passenger terminal areas and CVG facilities to in order to establish a baseline for types/amounts of waste by weight or volume
    - Use the baseline assessment to identify opportunities for increased recycling and waste diversion
  - If needed, enhance existing system for Storage and Collection of Recyclables and Compostable Materials
    - Designate an area for recyclable collection and storage that is appropriately sized and located in a convenient area
      - These areas would likely be designed and sized differently depending on the ultimate use and waste stream of the facility (e.g., terminal, airfield, office, airlines, concessionaires, cargo, hangar, etc.)
      - Identify local waste handlers and buyers for glass, plastic, office paper, e-waste, newspaper, cardboard, metals, fluids, fixtures, and organic wastes
      - Instruct occupants, employees and contractors on the recycling procedures
      - Consider employing cardboard balers, aluminum can crushers, recycling chutes and other waste strategies to further enhance the recycling program
      - Recycle the following waste, whenever feasible:
        - Aluminum
        - Glass
        - Paper, newspapers, magazines and cardboard
        - Carpet
        - Wood (pallets/crates, etc.)
        - Food waste/grease and compostables
        - Organic waste and compostables
        - Gas & oil filters
        - Motor oil and anti-freeze
        - Scrap metal
        - Batteries
        - Light bulbs
        - Toner cartridges
        - Tires
        - Electrical wiring
        - Electronics including monitors
        - Foreign Object Debris (FOD)
  - Develop a waste tracking system and establish a designated sort area for all recyclable and reusable items
- Local/Regional Materials

- The intent of using local and regional materials and resources is to increase demand for products that are extracted, harvested or recovered, or manufactured within the local region (within a 500 mile radius), thereby supporting the local economy and the use of indigenous resources, as well as reducing the environmental impacts resulting from transportation of such products

9.6.2 Energy and Atmosphere Optimization

The goal of energy reduction is to reduce lifetime energy consumption of airport facilities. Energy reduction techniques have been proven to provide long-term, post-construction operational and maintenance benefits that will result in a net savings in energy usage. The following sustainable practices are examples of energy reduction strategies and best management practices that exemplify green and sustainable technologies applicable for facilities and roadway systems at airports.

- Energy Optimization
  - Energy optimization is achieved by reducing, wherever possible, levels of energy consumed. This can be achieved through:
    - Master Lighting Plan
      - Design lighting to provide luminance for safety, while limiting light pollution and reducing or conserving energy
      - Design lighting systems to reduce lifetime energy consumption for facilities, parking lots, and roadways
        - Install luminaires that meet or exceed the Energy Star standard
        - Use alternative and/or high efficiency energy sources to power street lighting, warning signs, and other lighted components in order to reduce grid power consumption. High efficiency street lighting sources include (but are not limited to):
          - Light Emitting Diodes (LED)
          - Induction Lamps
          - High Intensity Discharge (HID) Lamp and Ballast combinations
          - Solar power
        - Replace traditional lighted signs with retro-reflective signs to eliminate both power consumption and light pollution associated with sign-lighting
        - Provide lamps that are Dark-Sky compliant or equivalent. A list of Dark-Sky approved fixtures is available at: www.DarkSky.org
        - Install lighting sensors and controls
        - Provide for the ongoing accountability of lighting energy consumption over time through development and implementation of a Measurement and Verification (M&V) Plan

- Design electrical-powered systems to reduce lifetime energy consumption for occupied or non-occupied structures:
  - For all structures (occupied and non-occupied):
    - HVAC components
    - Establish goal of zero use of chlorofluorocarbon (CFC)-based refrigerants in new systems
    - When reusing existing equipment, complete a comprehensive CFC phase-out conversion prior to project completion
    - Install vegetated or white-roof systems to reduce overall building energy consumption
    - Provide high-efficiency motors and variable-speed pumping systems
    - Continue to use LED lighting, wherever applicable
    - Implement renewable energy strategies, as applicable including solar (photovoltaic and thermal), wind, geothermal
    - Begin the commissioning process early in the design process and execute additional activities after systems performance verification is completed
    - Provide for the ongoing accountability of a structure's energy consumption over time through development and implementation of an M&V Plan covering a period of no less than one year of post-construction
  - For occupied buildings:
    - Refrigerant Management
      - Eliminate use of CFC-based refrigerants in Heating, Ventilation, Air Conditioning, and Refrigeration (HVAC&R) systems.
    - Heating, Ventilation, Air Conditioning (HVAC) components
      - Establish goal of zero use of CFC-based refrigerants in new systems
      - When reusing existing equipment, complete a comprehensive CFC phase-out conversion prior to project completion
    - Install vegetated or white-roof systems to reduce overall building energy consumption
    - Provide high-efficiency motors and variable-speed pumping systems
    - Provide energy efficient lighting systems including LED, fluorescent lighting, solar lighting and the use of lighting sensors or timers
    - Organize circuiting of lighting and building systems so that individual areas may be separately controlled relative to daylight and heating/cooling zones
    - Install electrochromic glass

        - Orient building to optimize passive solar and/or daylight penetration
        - Optimize architectural features for daylighting and glare control. Consider light shelves, ceiling design, window placement, and window treatments
        - Provide Energy Star compliant equipment and appliances
        - Control air infiltration through all exterior openings
        - Evaluate appropriate levels of insulation for building envelope
        - Verify that energy related systems are installed, calibrated and perform according to project requirements, basis of design, and construction documents
    - Commissioning of existing buildings
        - Existing building commissioning is achieved through conducting an Energy Audit to document a building's or facility's energy use, implementing no or low-cost improvements immediately, and budgeting for future capital improvements to address major system upgrades, as necessary, to optimize
- On-site and Off-site Renewable Energy
    - Consider the following renewable energy initiatives, as appropriate:
        - Electricity generation using bio-fuels (untreated wood waste, agricultural crops or waste, landfill gas)
        - Electricity generating wind turbines
        - Solar-thermal water or air heating
        - Geothermal heating and/or electrical systems
        - Co-gen systems
        - Micro-turbines
        - Hydroelectricity
        - Purchase of green power
- Emissions Reduction
    - Emissions can typically be reduced by the following activities:
        - Increase energy efficiency, including use of renewable energy
        - Promoting use of public transportation or commuting
        - Establish an anti-idling policy on airport property
            - Require that vehicles dropping or loading passengers for departures or arrivals shut off their engines while vehicles are stopped
            - Designate and encourage use of a cell phone lot
            - Provide premium parking spots for alternative fuel passenger vehicles
            - Install public-use electric vehicle charging stations

    - Continue to convert airport fleet vehicles to alternative fueled vehicles, such as compressed natural gas (CNG), ethanol, biodiesel, propane, ultra-low sulfur diesel (ULSD), hydrogen, or electric; encourage tenants to do the same

- Airport Carbon Accreditation[11]
  - Created and ultimately managed by ACI
  - Unique framework and tool for active carbon management at airports, with measurable results
    - Covers the operational activities that contribute most to carbon emissions
    - Site-specific
    - Can also be used at any airport as part of daily environmental management activity and long-term strategy to guide and support airport environmental management
    - Provides a process of continual improvement and partnership for an airport with its stakeholders
  - Four levels of certification
    - Mapping: carbon footprint measurement
    - Reduction: reduction of the airport operator's carbon footprint
    - Optimization: engaging others on the airport site to reduce Carbon Dioxide (CO_2) emissions
    - Neutrality: offsetting any residual CO_2 emissions from the airport operator
  - To apply for certification at one of the four levels of the program, airports must first have their carbon footprints independently verified in accordance with ISO14064 (Greenhouse Gas Accounting)
    - Evidence of this must be provided along with all claims regarding carbon management processes, which must also be independently verified
  - Sample ways for airports to address their CO_2 emissions:
    - Better insulation and energy efficiency
    - Investing in renewable energy sources
    - Investing in hybrid, electric or gas-powered service vehicles
    - Encouraging employees, passengers & visitors to use public transport
    - Working with airline partners to reduce emissions of GSE and other airline-owned equipment operated at the airport
    - Working with air traffic management to reduce runway taxiing times
    - Implement green landing processes

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11 Sources: https://www.airportcarbonaccreditation.org/ ; https://airportco2.org/.

- There are currently 262 airports in the program, representing 70 countries (as of March 2019)
  - 54 global airports have achieved Level 3 Reduction to-date
  - 49 global airports have achieved Level 4 Neutrality to-date

9.6.2.1 *Energy Reduction Example Program – Green or Vegetated Roof*

The expense of green technologies, which may often be perceived as a detriment to implementation due to higher upfront costs than traditional systems, often produce lower life-cycle costs as compared to traditional systems; and in some cases, significant cost savings can be generated when sustainable practices are incorporated instead of traditional practices. As an example, comparison of sustainable and conventional design concepts and technologies, **Table 9.6-1, *Typical 31 Year Cost/Benefit Comparison: Green Roof vs. Conventional Roof***, shows a 31-year cost/benefit comparison for a 25,000 square-foot green roof vs. a conventional roof of the same size.

TABLE 9.6-1 TYPICAL 31 YEAR COST/BENEFIT COMPARISON: GREEN ROOF VS. CONVENTIONAL ROOF

Comparison Element	Green Roof 25,000 sq. ft. vegetated surface	Conventional Roof 25,000 sq. ft. asphalt surface
Initial Capital Expense	$300,000 USD	$225,000 USD
Cost per Square Foot	$12 USD/square foot	$9 USD/square foot
Average Life Expectancy	40 years	10 years
Capital Expense/Inflation in year 31	$300,000 USD (original roof)	$1,154,595 USD (replaced twice)
Maintenance Costs/Inflation in year 31	$26,607 USD	$26,607 USD
Life Cycle Costs in year 31	$270,447 USD	$359,682 USD
Energy Cost Reduction/ Thermal Insulation	Approximately 30% reduction of air conditioning requirements and 25% reduction of heating requirements (with a 3-7 degree interior temperature reduction in the summer and increase in the winter)	None
Sound Insulation	Green roof with a 5 inch substrate layer can reduce sound by 40 decibels	Minimal
Air Quality Improvement	100 square feet of grass roof can remove 4.5 pounds/year of airborne particulates; 25,000 sq. ft. equates to approximately 1,125 pounds/year reduction of airborne particulates	None
Stormwater Retention	In summer, green roofs retain 70-90% of the precipitation that falls on them; in winter they retain between 25-40%.	None
Temperature Regulation	Moderation of the Urban Heat Island Effect: roughly 10.76 sq. ft. of foliage can evaporate 0.13 gallons of water per day and 47.5 gallons of water per year	Minimal
Visibility of Environmental Commitment	Enhances public image and emphasizes commitment to environmental stewardship	None
Conclusions: Initial expenses incurred with a conventional roof are $75,000 less than a green roof. However, after 31 years, the conventional roof had to be replaced twice, while the green roof did not yet need replacement. The cost savings in capital expenses associated with the green roof are estimated to be nearly $850,000. Maintenance costs for both roofs are the same. While the conventional roof is the least expensive initially, it also offers the shortest life cycle of 10 years and the highest capital expenses, having to be replaced two times in 31 years. Although the green roof has a higher initial capital expense, it offers the most benefits over time, offering a life cycle of 40 years, four times longer than a conventional roof. The green roof has no additional capital expenses after 31 years because it did not need to be replaced. In addition to cost savings, green roofs offer advantages in sound insulation, air quality improvements, stormwater management, temperature regulation, and public relations opportunities.		

Source: Chicago Department of Aviation, 2009

O'Hare has been undergoing a major runway and airfield reconfiguration program since 2005. This has required several facilities to be relocated to make way for airfield improvements. In so doing, and in keeping with O'Hare's goal to be one of the greenest airports in the world, O'Hare now has more green roofs than any airport in the world (521,971 square feet on 17 facilities), and the largest green roof of any airport in the U.S., which is located atop the new FedEx Sort Facility.

The green roof at the FedEx Sort Facility is the size of 3 ½ football fields, or 201,242 square feet and is shown in the images below.

With the green roof on the relocated facility, FedEx is reporting a 30 percent cost savings for energy use (heating and cooling), as compared to the previous facility. Green roofs reduce the heating and cooling demand for facilities and decrease the overall Urban Heat Island Effect of the Airport.

In accordance with the Chicago Department of Aviation's Sustainable Airport Landscaping Specification, the plant materials used in the green roofs must be:

- Drought resistant (no irrigation required)
- Maintenance-free (no mowing, no weeding, designed to grow to a short height)
- Perennials
- Non-Wildlife Attractants (no flowers or berries)

9.6.2.2 *Energy Efficiency Example Program: Smart Glass*[12]

When considering options for energy efficiency in passenger terminals, for example, which typically incorporate significant amounts of glass, and therefore experience heat gain due to sunlight, is it helpful to know the benefits of smart glass, (also known as dynamic glass or electrochromic glass) as compared to traditional window glass, as listed in the sections that follow.

12 *Smart Glass Makes Waiting At The Airport More Tolerable: Study*, Forbes, April 17, 2018, online at: https://www.forbes.com/sites/jeffkart/2018/04/17/smart-glass-makes-waiting-at-the-airport-more-tolerable-study/#2a66b7e61b0c; *Dynamic Glass Offers Innovative Occupant Experience Solution*, Forbes, May 13, 2019, online at: https://www.forbes.com/sites/pikeresearch/2019/05/13/dynamic-glass-offers-innovative-occupant-experience-solution/#ce462ce3f98d

Benefits of Smart Glass

The inclusion of natural daylight in occupied spaces has become a focal point in improved occupant health and well-being. Daylighting is a lighting control strategy that reduces energy use through the dimming of electrical lighting when natural light is present. However, the incorporation of daylight can also create unintended issues, such as sunlight that is too bright, creates a glare, and causes heat gain and uncomfortably warm temperatures. Smart glass offers solutions that can reduce lighting and HVAC expenses by up to 20 percent, while simultaneously increasing well-being and thermal comfort.

Smart Glass is electronically tintable glass, which can be directly controlled by building occupants to improve occupant comfort, maximize access to daylight and outdoor views, and reduce energy costs.

Applications of Smart Glass at Airports

A recent study[13] in an airport setting found that terminal windows fitted with smart glass overwhelmingly improved passenger comfort over conventional glass, resulting in an 83 percent increase in passenger dwell time at a preferred gate seat and a 102 percent increase in concession spending (in alcohol sales at a terminal restaurant). The study was conducted at Dallas Fort Worth International Airport (DFW) in October 2017 by a manufacturer of smart glass, the Department of Design and Environmental Analysis at Cornell University, and an independent aviation market research group, in conjunction with the U.S. Green Building Council's Advisory Council.

The study concluded that smart glass can reduce cooling costs and have a positive effect on customer experience and behavior from less glare and cooler temperatures. Infrared imaging showed that smart glass reduced surface temps to 10-15 degrees compared to conventional glass, reducing the need for air conditioning with HVAC systems.

At left is smart glass installed at DFW alongside conventional glass during the 2017 pilot study referenced above.

To date, smart glass has been installed at major U.S. airports including DFW, Boston Logan International (BOS), San Francisco International (SFO), Seattle-Tacoma International (SEA), and Charlotte-Douglas International (CLT).

13 *A First Class Airport Experience: Improve passenger comfort and employee productivity with View Dynamic Glass*, online at: https://view.com/solutions/buildings-types/airports/

9.6.3 Sustainable Site Management

Sustainable initiatives for consideration at an airport that are related to sustainable site management/land management/natural resources management include, but are not limited to the following, which can be incorporated into everyday airport operations and activities.

- Equipment Maintenance
  - Minimize the environmental impact of maintenance equipment and associated maintenance activities by establishing Best Management Practices (BMPs) outlining procedures for vehicle washing, maintenance, fueling, chemical storage, and spill control
- Exterior Facilities Management
  - Encourage environmentally sensitive building exterior practices by developing and implementing a low-impact building/facility exterior plan, designed to discourage surrounding wildlife habitat, while sustaining ecological and environmental integrity. The plan should employ BMPs that significantly reduce harmful chemical use, energy waste, water waste, air pollution, solid waste, and/or chemical runoff (e.g., gasoline, oil, antifreeze, salts) compared with standard practices. The plan should also address operational elements that occur on the building and grounds, as applicable, such as cleaning of building exterior and paints and sealants used on the building exterior.
- Hardscape Grounds Management as related to snow and ice removal and anti-ice/de-ice applications
  - Use environmentally sensitive, low-impact snow and ice removal methods that utilize innovative and ecologically friendly chemicals and/or employ BMPs that significantly reduce harmful chemical use, thereby reducing energy waste, water waste, air pollution, solid waste, and/or chemical runoff (e.g., gasoline, oil, antifreeze, salts)
    - Airside ground anti-icing and deicing fluids that are environmentally friendly, include, but are not limited to:
      - Solid: Sodium Formate and Sodium Acetate
      - Liquid: Potassium Acetate
      - Biochemical Oxygen Demands (BOD)
  - Develop a landside policy for optimal road salt usage balancing environmental and safety concerns
  - Investigate non-electrified snowmelt procedures, including hydronic runway pavement for snowmelt and Epoxy overcoat with glycol for controlling snow on runways
  - Use fossil fueled equipment only as frequently as needed to maintain site appearance and safety, or use low-impact alternatives such as, but not limited to:
    - Electric powered equipment
    - Low-noise equipment
    - Hand raking or sweeping
  - Use more environmentally friendly deicing chemicals, such as but not limited to:
    - Magnesium Chloride
    - Potassium Chloride
    - Potassium Acetate

- Administer eco-training, such as chemical use and eco-driving to personnel to ensure appropriate use/applications, and to reduce fuel consumption, greenhouse gas emissions, and accident rate
- Consider use of the following innovations:
  - Infrared Radiant Deicing Technology
  - Forced air/hybrid deicing which adds deicing fluid to the airstream to aid in removing ice and snow
  - Tempered steam technology

- Wildlife Hazard Assessment/Wildlife Hazard Management Plan
  - Evaluate the potential safety risks due to wildlife activity at that airport and identify specific actions the airport will take to mitigate the risk of wildlife strikes on or near the airport

- Integrated Pest Management and Wildlife Deterrence
  - In an effort to preserve environmental integrity, while discouraging the presence of pests/wildlife, implement methods that use Integrated Pest Management (IPM) Techniques, such as:
    - Control dirt, moisture, clutter, foodstuffs, harborage, and building penetrations
    - Use baits and traps rather than pesticide sprays where possible
    - Avoid pesticide applications for prevention of pests
    - Use pesticides only where pests are located
    - Use pesticide specifically formulated for targeted pest
  - In addition, it is recommended that the following BMPs be put in place:
    - Apply pesticides only during unoccupied hours
    - Ventilate building with significant quantities of outside air during and after applications
    - Completely flush building prior to occupancy
    - Use more than normal outside air ventilation for some period after occupancy
    - Notify occupants prior to occupation
    - If applying outside keep away from air intake
    - Administer eco-training, such as chemical use, eco-driving, to personnel to ensure appropriate use/applications, and to reduce fuel consumption, greenhouse gas emissions, and accident rates

- Erosion Control
  - Develop and implement a maintenance plan and BMPs that address overall site management and control. Examples of such methods include, but are not limited to:
    - Mulching
    - Structural control methods, such as: earthen dike, silt fence, sediment traps and sediment basins
    - Buffer strips
    - Ditch liners
    - Limit the use of fertilizer, as necessary
    - Removing and/or not installing invasive plants
    - Identify problems
    - Perform periodic checks
    - Dispose of loose debris

    - Maintain ground cover
    - Clean major sediment sources on paved surfaces
    - Install rolled mats (organic, biodegradable mulch mats used to reduce erosion) and ensure that they conform to site contours
    - Use natural fiber geotextiles (permeable fabrics) that are biodegradable
    - Install permeable paving materials to reduce stormwater runoff and allow rainwater to infiltrate into the ground and replenish groundwater

- Landscape Management
  - Consider grazing herd to replace traditional mowing systems
  - Have in place a low-impact plan that addresses overall site management, chemicals, fertilizers, and landscape waste, including green landscape management practices such as the following:
    - Provide proper training methods to current employees
    - Reduction of the use of power equipment
    - Discourage wildlife habitat
    - Remove or do not install invasive plants
    - Use mulching mowers to significantly reduce landscape waste generation, fertilizer needs, and water consumption through retention of organic matter
  - Do not apply pesticides or fertilizers before an expected rainfall, unless specified within the manufacturers' recommendations
  - Conduct soil testing, as necessary to determine the amount of nutrients needed for a healthy landscape
  - Do not wash spilled chemicals into streets of storm drains
  - Do not store chemicals in a manner that allows exposure to storm water
  - Do not apply chemicals within 25 feet (at a minimum) of a body of water
  - Use organic and natural products
  - Use non-potable hot water for weed control to eliminate vegetation in pavement cracks in place of herbicides
  - Use mulching and/or electric mowers
  - Eliminate fertilizer and herbicide use completely or to the greatest extent possible
  - Install rolled organic, biodegradable mulch mats used to reduce erosion, and ensure that they conform to site contours
  - Use natural fiber geotextiles/permeable fabrics that are biodegradable
  - Specify non-toxic, non-chemical organic or bio-based materials for landscape planting and fertilization
  - Top-dress soil with compost to decrease fertilizer and irrigation needs, to control erosion, and to retain moisture
  - When applying landscape fertilizers, pesticides, and other chemicals as necessary, specify organic or bio-based fertilizers and pesticides
  - Spot treat landscape problem areas instead of chemically treating a larger area than necessary
  - Use electric lawn mowers to reduce the level of noise and air pollution generated by traditional gasoline-powered mowers
  - Use propane and/or natural gas-powered string trimmers, blowers, and push mowers

- Specify that all diesel-powered equipment is to use biodiesel with a minimum 20 percent blend
- Install cisterns and other water recycling infrastructure to use stormwater and/or graywater for irrigation
- Install high-efficiency irrigation systems (if irrigation is a necessity) with a slow-drip, sub-soil irrigation and automated linkages to meteorological data
- Administer eco-training, such as chemical use, eco-driving, to personnel to ensure appropriate use/applications, and to reduce fuel consumption, greenhouse gas emissions, and accident rates
- Consider use of the following innovations:
  - Establish a centralized landscaping composting facility
  - Utilize a solar or propane mower

- Water Quality
  - Sustainable practices for protecting water quality provide benefits of water conservation, as well as reduced water pollution through minimization of impacts from flooding and stormwater runoff. The following sustainable practices serve to improve water quality and control stormwater runoff with a list of BMPs that exemplify green and sustainable technologies:
    - Complete a low-impact development (LID) hydrologic analysis for use in project decision-making for stormwater management. LID describes engineered controls, stormwater management facilities, and other land development BMPs that attempt to mimic pre-development hydrologic conditions by emphasizing infiltration, evapotranspiration, or stormwater reuse for long-term flow control and runoff treatment
    - Develop a site drainage design report that includes, at minimum, the following:
      - Statement of initial and design conditions for flow rate, time of concentration and runoff volume
      - Supporting calculations for runoff areas, flow rate, times of concentration and runoff volumes
      - List of BMPs and their expected flow control performance criteria, such as:
        - Stormwater detention/retention facilities, including catch basins, rain gardens, sand filters, and sediment traps and forebays
        - Infiltration basin or trench allowing stormwater to filter/drain through the bottom of the basin or trench
        - Permeable and porous pavements in mostly non- or low-traffic areas, e.g., parking areas, roadway shoulders, maintenance roads, etc.
        - Vegetative swale/bio-swale – a stormwater conveyance system that effectively removes water contaminants prior to reaching surface or ground waters
        - Bioretention - a low lying area either natural or manmade which is heavily vegetated for the purpose of retaining stormwater and naturally treating pollutant content
        - Vegetative filter strips – a narrow strip of vegetation usually adjacent to an imperious runoff area that attenuates flows prior to reaching manmade or natural drainage ways
        - Construction of wetlands to double as a naturalized stormwater detention area(s)

    - Develop policy to reduce or optimize the use of pavement de-icers
  - Landside Stormwater Management
    - Replace impervious surfaces with permeable surfaces, including, but not limited to:
      - Permeable asphalt / concrete
      - Open grid pavers
      - Aggregate materials
      - Turf or landscaped area
    - Harvest rainwater and develop a use for it, such as landscape irrigation
    - Install rain gardens, vegetated swales, disconnection of imperviousness, and rainwater recycling
    - Install cisterns or rain barrels
    - Install landscaping to reduce runoff
    - Evaluate curb breaks and drainage ditches, and/or bioswales
    - Install high-efficiency irrigation systems (if irrigation is a necessity) with a slow-drip, sub-soil irrigation
    - Install permeable paving materials to reduce stormwater runoff and allow rainwater to infiltrate into the ground and replenish groundwater
  - Stormwater cost analysis
    - Determine lifecycle costs and savings associated with low impact development techniques and best management practices for stormwater utilities
    - The results must show, at minimum, that these criteria have been addressed: 1) expected service life, 2) construction costs, 3) maintenance costs, 4) interest rate, 5) salvage value, and 6) estimated annual cost of the stormwater management system
  - Design site vegetation to the following parameters, to the greatest extent possible:
    - Include vegetation types that do not need irrigation
    - Consider opportunities for rainwater harvesting through use of above ground or below ground storage systems with latter use for irrigation
    - Incorporate vegetated green roofs on facilities
    - Use only native, non-invasive plant species
    - Maintain and/or enhance natural features, such as wetlands, riparian areas, floodplains, woodlands, and similar
    - Maintain and/or enhance riparian and forested buffers so as not to adversely affect natural attenuation of runoff to streams, ponds, and wetlands

- Heat Island Reduction, including Green/Vegetated Roofs, White Roofs, or Similar
  - Minimize impacts of existing roofs and pavements that cause the heat island effect, which is caused by thermal gradient differences between developed and undeveloped areas
    - Provide shade from an existing tree canopy or within five years of landscape installation
    - Use paving materials with a Solar Reflective Index (SRI) of at least 29 and implement a maintenance program that ensures these surfaces are cleaned at least every two years to maintain good reflectance and minimums
    - Use an open-grid pavement system (that consists of at least 50 percent open area)
    - Install a vegetated green roof atop occupied or unoccupied structures
    - Employ strategies, materials and landscaping techniques that reduce heat absorption of exterior materials

      - Use shade from native or adapted trees and large shrubs, vegetated trellises or other exterior structures supporting vegetation
        - Vegetation is recommended for landside projects only and should not attract wildlife
      - Consider the use of new coatings and integral colorants for asphalt to achieve light-colored surfaces instead of blacktop
      - Position photovoltaic cells to shade impervious surfaces
      - Consider installing high-albedo roofs to reduce heat absorption
      - Install open grid pavement for surface lots and site pavement
      - Install light-colored permeable pavers and concrete
      - Install “green walls” or “living walls” for building façade

- Light Pollution Reduction
  - Eliminate light trespass from building interiors and outdoor areas, thereby improving night sky access and reducing development impact on nocturnal environments
  - For Interior Lighting
    - Automatically control all non-emergency built-in interior/indoor lighting to turn off during all after-hours periods
    - Implement a program to ensure that the lighting control system is being properly used to adjust lighting levels during all after-hours periods
  - For Exterior Lighting
    - Partially or fully shield all fixtures so that they do not directly emit light to the night sky

- Alternative Commuting Transportation for Employees
  - To reduce pollution and land development impacts from conventional automobile use for commuting trips. Alternative transportation includes, but is not limited to:
    - Telecommuting
    - Compressed work weeks
    - Mass/public transit
    - Walking
    - Bicycles or other human-powered conveyances
    - Carpools
    - Vanpools
    - Low-emitting, fuel-efficient or alternative-fuel vehicles

- Water-Efficient Landscaping
  - Proper landscaping techniques not only create beautiful landscapes, but also ben fit the environment and save water. Water-efficient landscaping produces attractive landscapes because it utilizes designs and plants suited to local conditions. Water-efficient landscaping offers many economic and environmental benefits, including:
    - Reduced landscaping labor and maintenance
    - Lower water bills from reduced water use
    - Extended life for water resources infrastructure (e.g., reservoirs, treatment plants, groundwater aquifers), thus reduced taxpayer costs
    - Decreased energy use (and air pollution associated with its generation) because less pumping and treatment of water is required.
    - Reduced runoff of stormwater and irrigation water that carries topsoil, fertilizers, and pesticides into local receiving bodies
    - Reduced heating and cooling costs through the careful placement of trees
    - Fewer trimmings to be managed or land-filled
    - Reduced landscaping labor and maintenance costs
    - Coupled with a rainwater collection system, water for future irrigation can be stored on-site

9.6.3.1 *Sustainable Sites Example Program: Grounds Maintenance Program*[14]

Pacific Northwest National Laboratory (PNNL) operates an award-winning grounds maintenance program that comprises a comprehensive landscape and irrigation management program. The program has helped the laboratory reduce its water use for irrigation by 30 percent. The program began in 2000, and at the time, was implemented with their 35-year old landscape. PNNL has more than 4,200 staff members, sits on 600 acres, and houses 2 million square feet of facilities. The Program encompasses sound landscape design and maintenance of the plants and efficient application of water to these plants.

The PNNL landscape and irrigation management program has resulted in the following annual savings:

- 30 percent reduction in water consumption for turf irrigation
- 15 million gallons of water reclaimed from the cooling ponds for irrigation
- $30,000 in reduced wastewater fees from reclaiming cooling pond water instead of sending it to the wastewater treatment plant
- 200,000 kilowatt-hours (kWh) of electricity saved from reducing water pumping from the Columbia River

9.6.4 Water Efficiency

The goal of developing sustainable initiatives related to increased water efficiency is to reduce the burden on local municipal water supply and wastewater systems.

- Establish a water baseline by tracking water usage for one full year

[14] U.S. Environmental Protection Agency (EPA), 2012.

  - Use this baseline to establish goals and targets to increase indoor and outdoor water efficiency, thereby reducing future water use

- Initiatives to increase indoor water efficiency include, but are not limited to
  - Upgrade to high-efficiency fixtures and valves
  - Utilize fixtures such as dual flush toilets and waterless urinals to reduce wastewater volumes
  - Evaluate reusing stormwater for non-potable uses
- Increase Outdoor Water Efficiency
  - Landscaping
    - Remove or do not install irrigation systems
    - Install drought tolerant plants
    - Utilize native and/or low maintenance vegetation that does not require excessive watering
    - Minimize use of high maintenance grass areas, lawns and annual plants
    - Establish areas of high and low landscape maintenance areas
      - Group plants with similar water-use needs by determining those areas of the site that should receive a higher level of care than others and, during drought periods, more irrigation. Lower maintenance areas should be located on low traffic areas, buffer zones and service areas
    - If an irrigation system is installed:
      - Also install a soil moisture monitoring system reduce reliance on timed devices (so as not to water during natural rain events) and to detect system leaks
      - Incorporate the use of recycled and treated wastewater for the use of irrigation
      - Evaluate use of graywater cisterns for capturing runoff from roofs, vehicle washing, aircraft washing, and/or irrigation for reuse
    - Rain Harvesting: Evaluate use of stormwater cisterns for capturing natural rainwater for reuse
- Innovative Wastewater Management
  - Reduce wastewater generation and potable water demand in order to increase local aquifer recharge. This can be accomplished through implementation of a system or technology that:
    - Reduces potable water use for building sewage conveyance through the use of water conserving fixtures, such as water closets, urinals
      - Specify high-efficiency fixtures and fittings and dry fixtures, such as composting toilet systems and non-water using urinals to reduce wastewater volumes
    - Increases available amounts of non-potable water, such as captured rainwater, recycled graywater, and on-site or municipally treated wastewater
      - Consider reusing stormwater or graywater for sewage conveyance or on-site mechanical and/or natural wastewater treatment systems
      - Options for on-site wastewater treatment include packaged biological nutrient removal systems and high-efficiency filtration systems

9.6.4.1 *Indoor Water Efficiency: Example Program*

U.S. EPA's Water Sense Program: Saving Water Saves Energy[15]

With climate change concerns, pervasive droughts, and high-energy prices across the country, nearly everyone is looking for ways to conserve resources and cut costs. The good news is that by using a little "water sense" we can all use water and energy more efficiently, save money, and preserve energy supplies and water for future generations.

Although many know about the importance of saving energy, and many know about the importance of saving water, few know about the direct connection between saving both. It takes water to create energy. Vast amounts of water are used to cool the power plants that generate electricity. In fact, it takes 3,000 to 6,000 gallons of water to power a 60-watt incandescent bulb for 12 hours per day over the course of one year. Approximately 4 percent of the electricity consumption in the U.S. is used for moving or treating water and wastewater. Given how closely related saving water is to saving energy, one of the best ways to save energy across the country is to use water more efficiently. One of the simplest ways to save both water and energy is to install water-efficient plumbing fixtures, including toilets, sink faucets, and faucet accessories.

The U.S. EPA certifies "WaterSense" toilets, bathroom sink faucets, and faucet accessories that save resources. WaterSense labeled products must achieve independent, third-party testing and certification to prove they meet EPA's rigorous criteria for both efficiency and performance before they can earn the label.

9.6.5 Airport Design and Construction Practices

Sustainable initiatives for consideration at an airport that are related to design and construction practices include, but are not limited to the following:

- Specify Certification
  - Specify a minimum certification level for new facilities at the airport, both airport owned-operated, and tenant facilities, such as Leadership in Energy and Environmental Design (LEED), Envision, Green Globes, or similar
- Warm-Mix Asphalt
  - To reduce the level of energy consumption, the FAA has approved the use of warm-mix asphalt (WMA) to replace traditional hot-mix asphalt (HMA).[16] Besides the fact that WMA is produced at a lower temperature, it also induces great improvement of working conditions by less exposure to heat and fumes
  - Runway construction requires high levels of energy for the production of asphalt and cement paving materials and excavating materials. Asphalt is produced at high temperatures (160 – 180°C). Per ton of asphalt, 275 MJoule is needed, which implies a consumption of 76 billion Mjoule in Europe. Therefore, asphalt production turns out to be one of the most energy consuming activities and as a consequence, generates large quantities of CO_2.[17]

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15 U.S. Environmental Protection Agency (EPA), 2012.
16 Source: FAA, www.airporttech.tc.faa.gov
17 Source: European Asphalt Pavement Association, www.eapa.org

- Clean Fuel Construction Vehicles
  - The intent is to minimize air quality impacts during construction
  - Specify that all off-road construction vehicles over 50 hp use Ultra-low Sulfur Diesel (ULSD) fuel
  - Restrict idling times
  - Require all contractors to report fuel usage on a monthly basis
  - Encourage contractors to identify and incorporate any other measures that may assist in reducing air quality emissions as a result of construction, examples include:
    - Encouraging cleaner vehicle options for employee shuttle buses and Light Duty Vehicles (LDVs), such as compressed natural gas (CNG), hybrid (fuel/electric), flex fuel, and demand on displacement
- Construction Equipment Maintenance
  - The intent is to minimize the environmental impact of construction equipment maintenance activities
  - Develop and implement a BMP Manual that includes the following, at a minimum, and require contractors to comply with the BMP Manual:
    - Equipment Vehicle Washing Restrictions
    - Equipment Vehicle Fueling Controls
    - Equipment Vehicle Maintenance Requirements
    - Above Ground Storage Tank Equipment Requirements/Spills
    - Mobile Tank Trucks (petroleum) Requirements
    - Chemical Handling/Storage Requirements
    - Drum Storage Procedures
    - Battery Storage Procedures
    - Truck Loading/Unloading Procedures/Spill Control
    - Spill Control Kits and Spill Response
    - Good Housekeeping Procedures/Waste Storage
    - Storm Drain Protection/Identification
- Construction Activity Pollution Prevention
  - Create and implement an Erosion and Sedimentation Control (ESC) Plan for all construction activities to describe the measures to be implemented to accomplish the following objectives:
    - Prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse
    - Prevent sedimentation of storm sewer or receiving streams
    - Prevent pollution of the air with dust and particulate matter using BMPs
  - Incorporate temporary sedimentation basins, temporary ditch checks, diversion dikes, temporary ditches, pipe slope drains into the construction plans
  - For dust control: tarp truckloads, sweep streets as needed, stabilize construction entrances, spray site as necessary to minimize fugitive dust
  - Establish temporary and permanent seeding plans consistent with direction received by an FAA-certified airport biologist to ensure the plants will not attract wildlife
  - Monitor water quality impacts before and during construction

  - Develop an inventory of topsoil for potential re-use
  - Develop a policy to chip or compost all vegetation for re-use on site
- Low-Emission Construction Vehicles
  - The intent is to minimize air quality impacts during construction
  - Encourage contractors to purchase new equipment or retrofit existing equipment to low-emission vehicles, such as:
    - Biodiesel (especially regionally derived biofuels)
    - Other regionally preferred alternative fuels
    - Diesel-electric hybrid vehicles
    - Where approved and appropriate, consider the use of WMA for paving, which reduces energy usage and emissions
    - Global Positioning System (GPS) for optimizing haul routes and work activities
    - Stricter idling controls, including use of idling restrictors
    - Newest technology equipment and retrofits
- Alternative Transportation During Construction
  - Staging Area
    - Reduce emissions due to construction vehicles by minimizing the amount of traffic to the construction site
    - Have a staging area where employees congregate prior to entering the project site
    - Use multiple occupancy vehicles to access the project site from the centralized staging area
    - Establish procedures and make vehicles available for employee car-pooling to the project site
      - For maximum benefit, specify that shuttle buses or vans are preferred over lower occupancy vehicles such as pick-up trucks
  - Low-Emitting and Fuel-Efficient Vehicles
    - The intent is to reduce emissions from on-road construction vehicles, such as foreman pickups or shuttle buses
    - Specify that the contractor must use fuel efficient and low emitting vehicles for at least a minimum percentage of all on-road, contractor-owned construction vehicles that access the project site more than five calendar days per month
- Construction Material Conveyance
  - Reduce emissions from construction activities by minimizing the amount of on-road and off-road vehicle traffic traveling to/from the construction site
  - Use an automatic materials conveyance system as a method for transporting materials to or from a construction site
  - The primary focus of a conveyance system would be in those projects in which there is a large area requiring significant grading changes
  - Construct Batch Plants as needed on- or near-site or utilize rail transport where available or appropriate

- Construction Noise and Acoustical Quality
  - Improve the exterior noise quality during construction affecting residential areas or other noise sensitive areas
  - Implement a noise abatement or noise mitigation plan that identifies site specific, mechanical, structural or operational measures to reduce noise disturbances in noise sensitive areas adjacent to the project site
  - Require contractors to abide by the noise abatement or noise mitigation plan

9.6.6 Construction Waste Management: Designing for Use and Reuse of Materials and Resources

The goal of designing for use and reuse of sustainable materials and resources in airport construction activities, as well as every-day airport activities, is to reduce the amount of ongoing waste and toxins generated on a daily basis that are hauled to and disposed of in landfills or incineration facilities. Sustainable initiatives for consideration at an airport that are related to materials and resources include, but are not limited to the following:

- Building and Infrastructure Reuse
  - Consider reuse of existing, previously occupied buildings, including structure, envelope and elements and infrastructure.
    - Remove elements that pose contamination risk and upgrade components that would improve energy and water efficiency such as windows, mechanical systems, and plumbing fixtures
    - Upgrade outdated components
  - Evaluate relocation of existing structures for reuse (with special consideration of historical components)
  - Consider adaptive reuse of building(s)/structure(s) and potential relocation for the same program use
  - Evaluate maximizing reuse of existing runway and other infrastructure (e.g., utilities, lighting, etc.)
  - Evaluate opportunities for application of deconstruction techniques
- Construction Waste Management
  - Divert construction and demolition debris from disposal in landfills and incineration facilities.
  - Redirect recyclable recovered resources back to the manufacturing process and reusable materials to appropriate sites.
  - Recycle and/or salvage non-hazardous construction and demolition debris.
  - Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site
  - Specify minimum percentage debris to be recycled or salvaged
  - Consider recycling cardboard, metal, brick, mineral fiber panel, concrete, plastic, wood, glass, gypsum wallboard, carpet and insulation
  - Keep in mind that construction debris processed into a recycled content may be a commodity with an open market value

- Designate specific area(s) on the construction site for segregated collection and labeling of recyclable materials, and track recycling efforts throughout the construction process
- Identify construction haulers and recyclers to handle the designated materials. Note that diversion may include donation of materials to charitable organizations and salvage of materials on-site
- Implement deconstruction planning and techniques into all demolition activities. Careful and planned deconstruction of a facility can provide sustainable benefits related to disposal, reuse of materials, etc.
- Ensure that employees are aware of waste management and recycling procedures and are trained periodically
- Evaluate use, as appropriate, of pre-cast or pre-fabricated units whenever possible, to reduce on-site waste generation during construction

▪ Balanced Earthwork
  - Divert soils from landfills, reduce transportation of soil to off-site locations, and maintain or make soil available for reuse on other on-airport projects, which can reduce the amount of transportation and disposal costs (both financial and environmental)
  - Evaluate opportunities for on-site soil management, which may include infrastructure elevation changes, development of noise berms, considerations for landscaping needs, etc.
  - Use GPS systems during large-scale grading and earthwork operations
  - Identify stockpile areas, as well as the potential reuse on concurrent projects

▪ Aggregate Reuse
  - Continue to promote the reuse of aggregate from on-airport property sources
    - ▪ Continue to identify aggregates present on-site that can be incorporated into the final development of a project
    - ▪ Continue to identify possible uses of recycled aggregates within each project
  - Where approved and appropriate, consider the use of WMA for paving, which allows for the use of higher quantities of Recycled Asphalt Pavement (RAP), also known as asphalt grindings.

▪ Material Reuse
  - Continue to reuse building materials and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources
  - Continue to identify opportunities to incorporate salvaged materials into the building design, and research potential material suppliers
  - Continue to consider salvaged materials such as beams and posts, flooring, paneling, doors and frames, masonry, fencing, metal railing, manhole frames, lids, and catch basins inlets
  - Use a “virtual warehouse” to maintain a current listing of materials available for reuse on other projects

▪ Specify Recycled Content of Materials
  - By project, establish a goal for recycled content materials
  - Consider the following major building components for specifying maximum recycled content:
    - ▪ Aggregate in cast-in-place concrete

- Fly-ash in cast-in-place concrete
- Aggregate in pre-cast concrete including site work and infrastructure piping
- Fly-ash in pre-cast concrete including site work and infrastructure piping
- Bituminous concrete pavement
- Unit pavers
- Steel reinforcement
- Structural steel
- Miscellaneous steel
- Steel fencing and furnishings
- Unit masonry
- Ductile iron pipe
- Aluminum products
- Site generated broken concrete for gabions
- Railroad rails
- Railroad ties
- Railroad track base material
- Steel doors and frames
- Aluminum doors and windows
- Plaster
- Terrazo
- Acoustical ceilings
- Drywall
- Finish flooring including carpet, resilient flooring and terrazzo
- Toilet and shower compartments
- Special finishes

– During construction, ensure that the specified recycled content materials are installed and quantify the total percentage of recycled content materials installed

– Encourage aggressive use of permeable pavement with high-recycled content, where applicable, such as recycled Ground Tire Rubber (GTR) for permeable asphalt

- Specify Use of Local/Regional Materials

– The intent of using local and regional materials and resources is to increase demand for products that are extracted, harvested/recovered, or manufactured within the local region (within a 500 mile radius), thereby supporting the local economy and the use of indigenous resources, as well as reducing the environmental impacts resulting from transportation of such products

– Establish a project goal for locally sourced materials, and identify materials and material suppliers that can achieve this goal

- Materials that may contribute toward this goal include, but are not limited to: concrete, aggregate, asphaltic products, structural steel, masonry, gypsum wallboard, utility structures (manholes, conduit, catch basins, culverts, sewer piping, stormwater piping, etc.), gas and water piping, landscaping materials. (Note: Piping used indoors for building systems should not be included.) Reused and salvaged materials also qualify.
- Note that due to sole sourcing and limited availability, specialty equipment and items sometimes cannot meet the 500 mile criterion

  - During construction, ensure that the specified local materials are installed and quantify the total percentage of local materials installed
  - Consider a range of environmental, economic, and performance attributes when selecting products and materials

- Specify Use of Rapidly Renewable Materials
  - Establish a project goal for rapidly renewable materials and identify products and suppliers that can support achievement of this goal
  - Consider materials such as:
    - Poplar oriented strand board
    - Straw board or “agriboard”
    - Bamboo flooring
    - Cork
    - Wool carpets and fabrics
    - Cotton-batt insulation
    - Linoleum flooring
    - Sunflower seed board
    - Wheat grass or Straw board cabinetry and others.
    - Rice husks for concrete

- Specify Use of Certified Wood
  - Establish a project goal for certified wood products in order to encourage environmentally responsible forest management
  - During construction, ensure that the certified wood products are installed and quantify the total percentage of certified wood products installed

- Equipment Salvage and Reuse
  - Promote the reuse of equipment and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources
  - Identify opportunities to incorporate salvaged materials into the project design. Consider salvaged materials, such as cabinetry and furniture, pumps, motors, electrical panels, fixtures and tanks
  - Explore and encourage the development of a virtual warehouse for salvaged and reusable items

9.6.6.1 *Construction Waste Management Example Program: Balanced Earthwork Plan*

The expense of green construction practices, which may often be perceived as a detriment to implementation due to higher upfront costs than traditional systems, often produce lower life-cycle costs as compared to traditional systems; and in some cases, significant cost savings can be generated when sustainable practices are incorporated instead of traditional practices. As an example, **Table 9.6-2, *Chicago Department of Aviation – O'Hare International Airport – Balanced Earthwork Plan – Benefits Analysis*** shows the benefits of a Balanced Earthwork Plan as part of an airport construction project, courtesy of the Chicago Department of Aviation.

TABLE 9.6-2 CHICAGO DEPARTMENT OF AVIATION - O'HARE INTERNATIONAL AIRPORT - BALANCED EARTHWORK PLAN – BENEFITS ANALYSIS

Quantities to Date	Description
28.8 MCY	Cubic yards of Soil Moved
28.5 MCY	Cubic yards of Excess Soil Kept On-site
over 2.5 million	Haul Trips Saved
over 4.8 million	Hours of Roadway Travel Saved
over 194 million	Vehicle Miles Traveled (VMT) Saved
over 29 million	Gallons of Diesel Fuel Saved
over $1.4 billion	Dollars Saved
over 297,000	Tons of CO2 Saved

Sources: Chicago Department of Aviation – O'Hare International Airport, *Key Quantities as of September 30, 2018*; L&B analysis

Through September 21, 2018, the Chicago Department of Aviation (CDA) has managed over 28 million cubic yards of soil material on-site, with only 250,000 cubic yards disposed off-site, at a savings of over $1.4 billion, as compared to traditional construction disposal practices. Additional benefits are shown in the table below.

9.7 Airport Sustainability Case Studies

The following airport case studies are presented across a wide range of sustainability focus-areas. They are provided as background information relative to sustainability programs and procedures in place at other major airports.

9.7.1 Sustainable Airport Manual at Chicago O'Hare International Airport (ORD)[18]

In 2003, under the O'Hare Modernization Program (OMP), the CDA introduced the Sustainable Design Manual to ensure that sustainable initiatives and measurements were implemented during the design and construction of the modernized airfield at ORD. With this development, the city became the first in the nation to develop LEED-based sustainability guidelines for design and construction at airports. In 2009, that document evolved into the Chicago Department of Aviation's Sustainable Airport Manual (SAM) as a means of an integrating more environmentally sustainable initiatives across all airport activities in Chicago at both O'Hare and Midway International Airports.

The SAM is a comprehensive guidance manual to incorporate and track sustainability in administrative procedures, planning, design and construction, operations and maintenance, and concessions and tenants' activities, with minimal impact to project schedules or budgets. The CDA's SAM Rating System measures each the ability of each project/program to incorporate sustainability guidance. To-date, over 230 ratings have been issued by the CDA. The CDA encourages other airports around the world to use this industry standard for sustainability planning and development and apply it to their own unique operating environments.

With the SAM, CDA's major sustainability accomplishments include the installation of more green-roof square footage at O'Hare than any other airport in the U.S; a comprehensive Green Concessions Policy; an indoor aeroponic garden that is accessible to passengers; a grazing herd for hard-to-mow areas; the first apiary at any airport in the U.S.; and the development of the annual Airports Going Green Conference, which is the aviation industry's premier forum for the active discussion of sustainability programs, practices, and innovations.

Through its sustainability programs, the CDA has implemented numerous airport industry-leading initiatives to improve operational efficiency, social responsibility, economic benefits, and economic viability of O'Hare and Midway International Airports. The CDA continues to seek creative ways to reduce emissions and energy use, conserve water and natural resources, salvage and recycle materials, reduce waste, and educate passengers and the local community.

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18 Chicago Department of Aviation, Environment, https://www.flychicago.com/community/environment/Pages/default.aspx

9.7.2 Carbon Neutrality at Dallas-Fort Worth International Airport (DFW)[19,20]

In 2016, Dallas Fort Worth International Airport (DFW) became the first airport in North America to achieve carbon neutrality under the Airport Carbon Accreditation Program administered by ACI. Carbon neutrality is achieved by an airport when the net carbon dioxide emissions over an entire year is zero (i.e. the airport absorbs the same amount of carbon dioxide as it produces).

The path to carbon neutrality for DFW began in the late 1990s when it began switching its buses to compressed natural gas fuel, a process that finished in 2011. DFW also focused on its rental car operations, consolidating two major rental car areas and their associated bus operations into one. By consolidating into one facility and having only one bus fleet, rental car providers reduced their miles driven by over 50 percent.

Various other sustainability measures have been achieved over the years including retooling DFW's central energy plant to be more efficient and adopting a process known as "continuous commissioning," which constantly adjusts heating and cooling systems in the terminals to account for the time of day and passenger flows. The net effect has been an 18 percent reduction in carbon emissions, despite a 15 percent increase in passenger traffic, according to figures from DFW and the Airport Carbon Accreditation Program. Altogether, DFW says it has reduced its carbon emissions by 31,000 metric tons since 2010, with more than half of the savings coming from the switch to purchasing only renewable wind energy - despite DFW's electricity contract with the Texas General Land Office only requiring 40 percent renewable energy from Texas wind farms. At the same time, DFW's annual energy bill has fallen from $32 million in 2006 to just under $18 million in the most recent fiscal year. DFW still produces 146,000 metric tons of carbon emissions annually, which it offsets with renewable energy certificates and carbon offsets from emissions reduction projects at Texas landfills and wastewater treatment plants.

The takeaway, according to DFW's Vice President of Environmental Affairs, Robert Horton, is that there is no single solution to reaching carbon neutral status. He said; "About 70 percent of our (carbon) footprint comes from electricity use. The other 30 percent comes from energy to heat facilities, as well as fuels we use for fleet vehicles. That's why a lot of initiatives centered around efficiency. We took a balanced approach focused on all the different components." DFW is also looking at new types of natural gas with even lower emissions for its fleet of buses and is committed to designing new building additions to have no net effect on its emissions.

19 https://www.dallasnews.com/business/dfw-airport/2016/10/11/dfw-airport-became-north-americas-first-carbon-neutral-airport

20 ACI Airport Carbon Accreditation Program: https://www.airportcarbonaccreditation.org/airport/4-levels-of-accreditation/neutrality.html

9.7.3 Solar Energy at Indianapolis International Airport (IND)[21]

While a number of airports across the country have installed solar photovoltaic panels, the Indianapolis International Airport (IND) stands out for the size of its program. IND is home to the largest airport-based solar farm in the world. The farm spans 183 acres and houses 87,478 solar panels, located in two sites, one to the northeast and one to the southwest of the terminal. The combined output of the farm generates enough energy to power approximately 3,675 average American homes for a year and lowers IND's operating costs.

The solar farm was built in two phases, with Phase 1 beginning in 2013 and Phase II completed in 2015. Energy produced onsite is sold to Indianapolis Power & Light Co. (IPL) and feeds into the existing grid of surface transmission lines that connect IND to an IPL substation close by. IPL and IND entered into a 15-year power purchase agreement at the completion of the solar farm's expansion in 2015. IPL purchases power from the farm at three to four times the cost at which it can be sold and subsidizes the cost through federal tax credits and by raising rates to its customers by several cents per month.

Siting of solar panels was crucial for the program in order to ensure the efficiency and safety of IND was not impacted. Solar panels have a high albedo and the radiant heat they create can cause unstable air currents, which can cause problems for takeoff and landing. The panels were sited far enough away from runways to specifically avoid this issue. IND, developers, and the FAA also collaborated to conduct reflectivity and glare analyses to ensure approaching aircraft and air traffic control would not experience any adverse glare effects from the installation of the panels. IND's commitment to sustainability also extends past its solar farm; IND is the first airport in the country to be awarded LEED certification for an entire terminal campus.

9.7.4 Waste Processing at London Gatwick Airport (LGW)[22]

London's Gatwick Airport has set a new standard in how airports process their waste with a pioneering processing facility that began operations in 2017. The $4.7 million facility not only makes Gatwick the only airport in the world able to process Category 1 waste onsite, which includes the most hazardous of animal-waste byproducts, but also converts it and other organic waste into biomass energy to heat Gatwick's waste management site, power the site's water recovery system, and heat the airport's North Terminal.

Processing Category 1 waste, which ranges from potentially disease-infected animal carcasses to common food waste, is particularly challenging at airports, which typically include hundreds of waste streams scattered throughout the facilities. Bringing these waste streams together is further complicated by security restrictions and strict rules governing the separation of different types of waste.

21 *Sustainability*, Indianapolis Airport Authority, https://www.indianapolisairport.com/community/sustainability

22 Gatwick Media Centre Press Release, March 23, 2017, http://www.mediacentre.gatwickairport.com/press-releases/2017/17_03_24_waste_plant.aspx

Gatwick's project was developed through a unique collaboration with its new waste handling contractor DHL, with food waste technology specialists, Tidy Planet, providing the biomass combustion and preparation systems. While DHL brought significant experience in developing innovative waste processing strategies, the impetus for the project came from more commonplace needs. According to Simon Duggan, senior logistics & waste manager at Gatwick Airport, "In terms of recycling, like many organizations, we found that our rates plateaued, and we struggled to move the needle above the 50 percent mark. The strategy drove us to constantly look at how we can improve our targets… when the scheme is fully up and running we expect our recycling rates to jump to 60 percent in 2017, 70 percent in 2018 and then up to 85 percent in its fifth full year of operation."

9.7.5 Lowering Emissions in Ground Transportation at Seattle-Tacoma International Airport (SEA)[23]

The Port of Seattle, which operates SEA, determined that focusing on ground transportation was crucial to lowering the overall carbon emissions. In 2006, the Port of Seattle reported that the total emissions of ground transportation were 380,000 metric tons annually.

As part of a pilot agreement with rideshare companies starting in 2016, SEA negotiated a weighted 45 miles per gallon (mpg) requirement for all rideshare cars servicing SEA; the same environmental standard that had been in place for their contracted taxi company since 2012. The agreement allows for the 45 mpg requirement to be met through utilizing cars that meet or exceed that mileage, or through a combination of other efficiency means. These include increasing carpooling among passengers, as well as reducing "deadheading," which refers to the practice when a rideshare or taxi company drops off passengers at an airport and then returns to the city without a new fare, or vice versa. SEA takes information reported from rideshare companies about each ride - including the make, model and year of the car, the number of passengers, if it was a pooled ride, etc. - in order to determine the operational average mpg of each rideshare company for a given period of time. If a rideshare company became out of compliance with the 45 mpg target, they would need to pay an additional $5 per ride, in addition to the current fee of 5 dollar per ride as part of their operational agreement, until they are able to demonstrate they are meeting the 45 mpg benchmark.

23 *Sea-Tac Airport Greener Transportation Options*, https://www.portseattle.org/environment/climate-air-quality

9.7.6 Equity-Driven Initiatives at Los Angeles International Airport (LAX)[24]

The $11 billion Los Angeles International Airport (LAX) modernization and expansion project was initiated in 2004 with a community benefits agreement (CBA) between Los Angeles World Airports (LAWA), the City of Los Angeles, and a coalition of community groups. At the time, the CBA was the largest in the U.S., and served as a legally binding contract between Los Angeles World Airports (LAWA), the governmental entity that operates LAX, and the LAX Coalition for Economic, Environmental, and Educational Justice, an organization created to represent the many stakeholder communities that would be impacted by the project. The benefits obtained through this CBA have been valued at half a billion dollars. The bulk of these benefits are set forth in the CBA itself, but LAX also committed funding to two area school districts through side agreements that were negotiated during the same process as the CBA. The CBA has been hailed by both local policy-makers and the FAA as a model for future airport development nationally.

The CBA was comprehensive and included provisions for job training, first-source hiring, disadvantaged business and minority- and women-owned business participation, and a living-wage provision in accordance with local policy. The job training component featured the additional benefit of paid work experience programs to connect unskilled residents to job opportunities. The first-source hiring provision prioritized low-income residents. And the minority-and-women-owned business participation provision included a bonding assistance and capacity-building program. Progress reports indicate that as of December 2012 the agency had achieved 996 confirmed job placements including both construction and permanent job opportunities at LAX.

The agreement also provided for significant community health benefits including funds for soundproofing affected schools and residences; retrofitting diesel construction vehicles and diesel vehicles operating on the tarmac with the intent of curbing dangerous air pollutants by up to 90 percent; electrifying airplane gates to eliminate pollution from jet engine idling; and funds for studying the health impacts of airport operations on surrounding communities.

One of the substantive practices emerging from the CBA is the requirement that the airport authority incorporate the provisions of the agreement into all airport contracts and lease agreements. As such, the CBA for Los Angeles International has equitable economic development and outcomes institutionalized into ongoing airport operations.

To further ensure the retention and success of disadvantaged and minority- and women-owned businesses, LAX established a coordination center early on that houses program staff, consultants, and a Surety Bond Liaison to help small and disadvantaged businesses participate on capital and infrastructure projects. The center serves as a clearinghouse for information on business, employment, and educational opportunities. Additionally, the CBA requires coordination of the airport authority and the City of Los Angeles, which has responsibility for the agency's small, minority and disadvantaged business utilization programs.

[24] *LAWA Community Benefits Agreement*, https://www.lawa.org/en/lawa-our-lax/community-benefits-agreement

9.7.7 Human-Centered Design at Minneapolis-St. Paul International Airport[25]

At Minneapolis-St. Paul International Airport (MSP), the Metropolitan Airport Council (MAC) is taking proactive steps to make flying more accessible to passengers with disabilities through a number of innovative programs. MAC recently launched a pilot project for GPS-enabled wayfinding for visually-impaired travelers. The goal is to create a smartphone app that will provide auditory directions, distances to amenities, and information about a passenger's immediate surroundings based on their current location.

MAC has also convened a Travelers with Disabilities Advisory Committee (TDAC) comprised of local disability advocates and organizations, as well as airport and Transportation Security Administration (TSA) employees, which works to identify accessibility issues and help design solutions for special-needs passengers. The committee recently influenced the design of new restroom facilities, ensuring adequate lighting to help the visually impaired, as well as updating braille signs for restrooms to include layouts of restroom facilities. The committee also works with TSA and airport personnel to address airport processes and policies that may unintentionally hinder or deter travelers. Cliff Van Leuven, Federal Security Director, TSA, notes that "TDAC has become a very important part of our outreach to ensure those who may be concerned about security protocols at MSP, and thus may be hesitant to travel, have their concerns allayed prior to their travel date."

In 2013, MSP implemented the Navigating MSP program, which allows travelers with disabilities to familiarize themselves with airport and security processes and facilities through a guided visit to the terminal prior to a scheduled flight. Originally targeted at families of children with autism, the program has since expanded to serve any persons for whom a "test run" might result in a smoother, less stressful travel experience. Between 2013 and 2017, the program has served 1,616 individuals and 448 families.

9.8 Next Steps

This chapter is designed to provide a framework for a future Sustainability Plan for CVG that will support and advance KCAB's goals for sustainability. It is anticipated that the objective of developing a Sustainability Plan for CVG will be to integrate sustainable practices into all phases of airport project development and their associated activities (from inception through planning, design, construction, and then to everyday operations and maintenance activities) in order to reduce environmental impacts while also creating operational, financial, and social benefits.

This future effort will result in a long-lasting, living, comprehensive guidance document outlining the overall sustainability mission statement for CVG, as well as specific guidance for all phases of airport management, including planning, design, construction, operations and maintenance, for airport projects, as well as those of its concessionaires and tenants. These actions will benefit CVG's passengers and tenants, and the community it is proud to serve.

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[25] *Aviation Insight, Summer 2018*, HNTB: http://www.hntb.com/HNTB/media/HNTBMediaLibrary/ThoughtLeadership/Publications/AviationInsight_EnhancingThePassengerExperience.pdf

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