4. Demand/Capacity Analysis and Requirements

Airside and landside facility requirements for Dallas Love Field are discussed in this section. Facility requirements for the planning activity levels (PALs) identified in Section 4.1 are based on several factors, including the relationship between demand and capacity for various Airport systems/facilities, deficiencies identified through comparison of existing conditions with applicable planning/design standards, and functional/operational deficiencies identified through discussions with Airport management, tenants, and users.

The methodologies used to determine facility requirements and capacities of various Airport systems, as described in this section, generally follow industry standards, with adjustments made, as appropriate, to reflect use characteristics specific to the Airport. Facility requirements were determined based on information presented in Sections 2 and 3, as well as any additional information that more accurately reflects existing or expected future conditions at the Airport.

Following the discussion of PALs, the remainder of this section discusses the requirements for functional Airport systems, as follows:

- **Airfield facilities:** Includes the runway and taxiway system, lighting, markings, navigational aids, and related safety and protection areas. The ability of the airfield system to accommodate forecast demand was evaluated in terms of runway capacity and design standards.
- **Passenger terminal facilities:** Includes the terminal building, where enplaned and deplaned passenger demand defines the need for various functional areas, such as ticketing, baggage claim, security screening, and holdrooms, among other building spaces.
- **Parking and access facilities:** Includes vehicular parking areas and on-Airport ground transportation and circulation systems, such as access roadways and terminal curbsides.
- **Taxicab and Commercial Vehicle Staging Areas:** Includes the taxi staging area and the commercial vehicle staging area.
- **Rental Car Facilities:** Includes the customer service area, rental car ready/return area, onsite vehicle storage area, and service site.
- **Tenant and support facilities:** Tenant facilities include FBO facilities; corporate aviation facilities; and maintenance, repair, and overhaul (MRO) facilities. Support facilities include Airport maintenance

facilities, ARFF facilities, and facilities related to aircraft fueling operations, provisioning, belly cargo, and GSE.

4.1 Planning Activity Levels

The Master Plan Update forecasts were adopted by the Department of Aviation during the Master Plan Update process and hereinafter are referred to as the Airport Forecast. Because of the disparity between the Airport Forecast and the FAA TAF for the Airport, PALs were derived to analyze the operational and facility requirements to accommodate demand at specific thresholds rather than specific calendar years. The use of PALs facilitates the analytical process associated with the demand/capacity analysis, facility requirements determination, and alternatives development and evaluation by reducing the demand scenarios to a finite number. PALs were defined to correspond with particular demand thresholds identified as part of the demand scenarios. The demand thresholds (and PALs) are expressed in terms of annual enplaned passengers and aircraft operations.

Typically, a single PAL is used to characterize both numbers of enplaned passengers and aircraft operations. However, because of the variance between the Airport Forecast and the 2013 FAA TAF for the Airport, Ricondo & Associates, Inc. (R&A) developed individual PALs for enplaned passengers and for aircraft operations. The activity variance resulted from an assumption made in the Airport Forecast for faster growth by Southwest Airlines upon expiration of Wright Amendment restrictions compared to the TAF. This accelerated growth in the Airport Forecast is the primary driver of both higher numbers of enplaned passengers and aircraft operations versus TAF numbers forecast for the Airport in 2015. However, the Airport Forecast also reflects the constraints of the terminal's 20-gate limit beyond 2015 while the TAF forecast is unconstrained by the operational limits of a 20-gate terminal. These differences result in higher growth rates in passenger airline aircraft operations forecast in the TAF throughout the balance of the planning period, leading to a greater number of enplaned passengers in the TAF compared with the Airport Forecast in the latter stages of the planning period.

The PALs for enplaned passengers and aircraft operations are set forth in **Table 4-1**. The use of PALs allows demand to trigger the implementation of specific improvements, rather than predicted calendar years. For instance, improvements linked to PAL O2 will be triggered when the number of annual aircraft operations reaches 210,000, which may happen in, earlier than, or later than 2032 (the end of the planning period for this Master Plan Update).

Exhibits 4-1 and **4-2** illustrate the variances in forecasts of enplaned passengers and aircraft operations through 2032. The demand/capacity analyses and requirements associated with each facility are based on the PALs identified.

Table 4-1: Planning Activity Levels

ENPLANED PASSENGERS

PLANNING ACTIVITY LEVEL	MILLION ANNUAL ENPLANED PASSENGERS	YEAR FORECAST	
		2013 TAF	MASTER PLAN UPDATE
PAL E1	5.5	2018	2014/2015
PAL E2	6.2	2032	2015
PAL E3	7.0	NA	2032

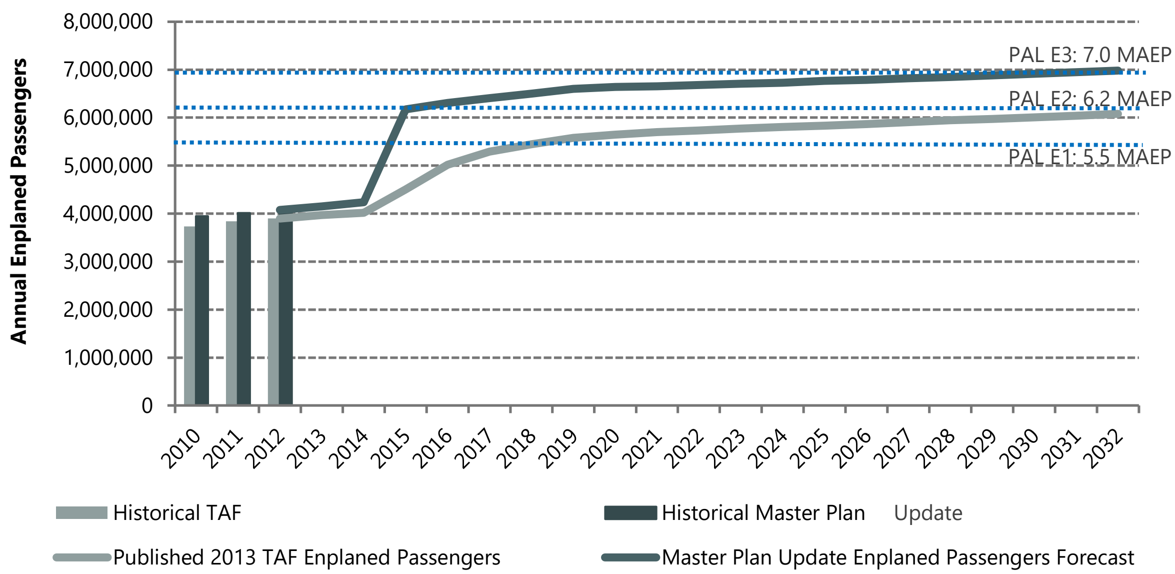
AIRCRAFT OPERATIONS

PLANNING ACTIVITY LEVEL	TOTAL ANNUAL OPERATIONS	YEAR FORECAST	
		2013 TAF	MASTER PLAN UPDATE
PAL O1	200,000	2016/2017	2015
PAL O2	210,000	2018/2019	2032
PAL O3	245,000	2027/2028	NA

NOTE: NA = Not Applicable

SOURCES: Federal Aviation Administration, *Terminal Area Forecast* 2012-2040, March 2013; Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

Exhibit 4-1: Planning Activity Levels – Enplaned Passengers



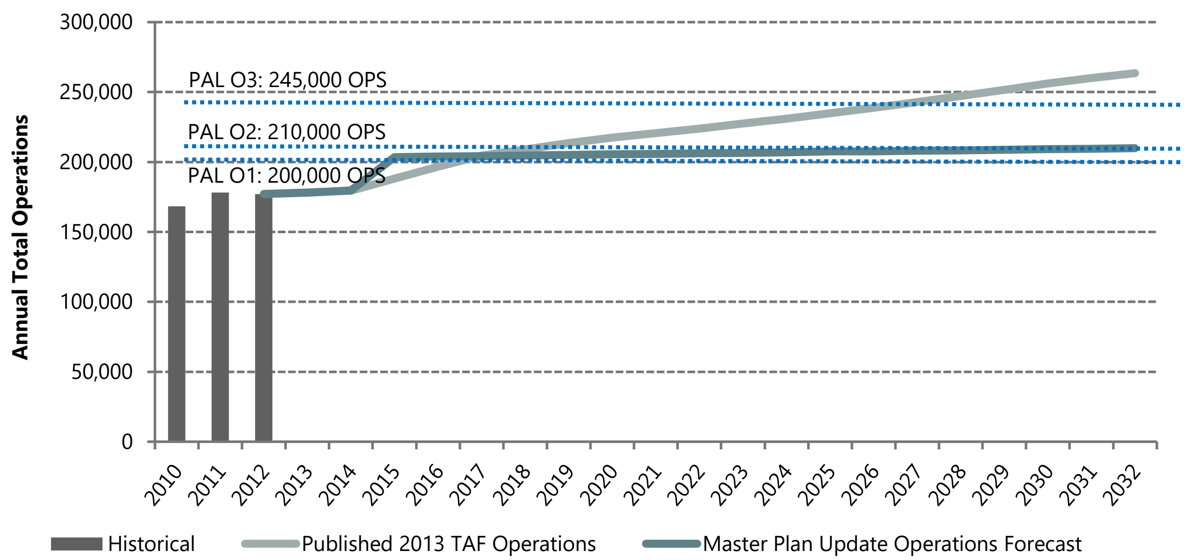
NOTES:

1/ MAEP = Million Annual Enplaned Passengers

2/ Two sets of historical data have been used for enplaned passengers because the historical TAF do not include non-revenue passengers and the historical Master Plan Update takes into account these passengers.

SOURCES: Federal Aviation Administration, *Terminal Area Forecast* 2012-2040, March 2013; City of Dallas Department of Aviation, March 2013; Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

Exhibit 4-2: Planning Activity Levels – Aircraft Operations



NOTE: OPS = Operations

SOURCES: Federal Aviation Administration, *Terminal Area Forecast* 2012-2040, March 2013; Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

4.2 Airfield Facility Requirements

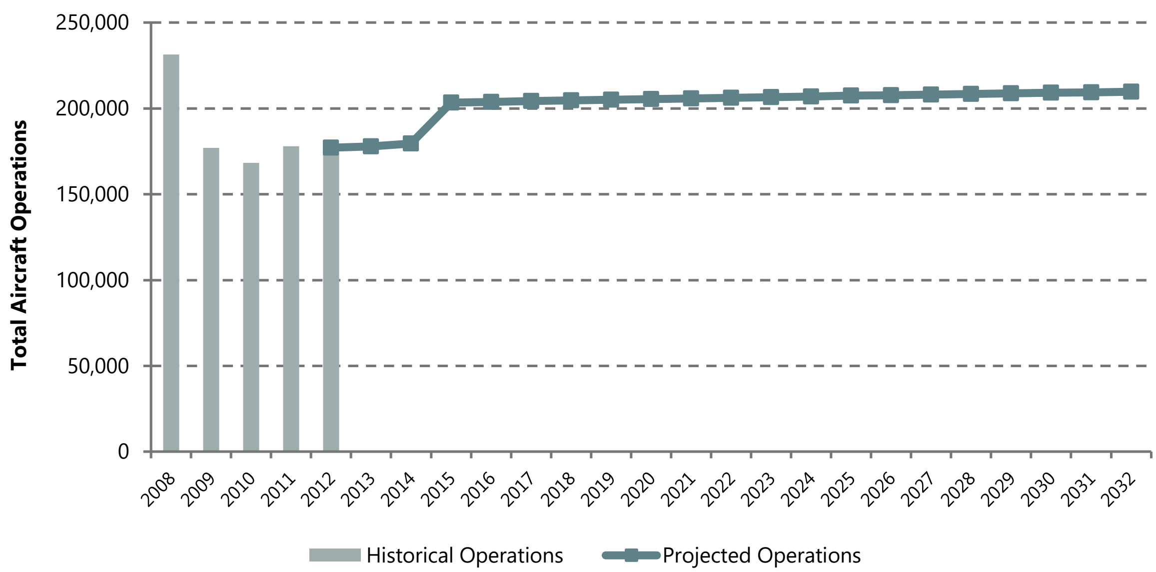
As described in the following subsections, the existing airfield facilities at the Airport were evaluated to determine whether they would be able to adequately accommodate forecast demand, and if they are appropriately sized and configured in accordance with FAA design standards.

4.2.1 AIRFIELD DEMAND/CAPACITY ANALYSIS

The purpose of the airfield demand/capacity analysis is to assess the ability of airfield facilities to accommodate existing and forecast aircraft operations. The analysis establishes the hourly throughput capacity, annual service volume (ASV), and estimated delay per aircraft operation. When compared with the operational demand associated with each PAL, these metrics are used to determine if the capacity of the airfield would be exceeded within the planning period (through 2032) and if airfield capacity enhancements would be required during the planning period.

Exhibit 4-3 shows forecast aircraft operations throughout the planning period, while Table 4-1, presented earlier, shows the relationship between forecast aircraft operations and the PALs.

Exhibit 4-3: Forecast Aircraft Operations



SOURCES: City of Dallas Department of Aviation, March 2013; Ricondo & Associates, Inc., May 2013.
PREPARED BY: Ricondo & Associates, Inc., May 2013.

As shown in Table 4-1, in accordance with the Airport Forecast prepared for this Master Plan Update, PAL O1 and PAL O2 represent the operational demand forecast to occur in 2015 and 2032, respectively. However, the FAA 2013 TAF forecasts annual aircraft operations at the Airport to number 263,514 in 2032, approximately 53,000 operations more than the forecast number of operations presented in this Master Plan Update at PAL O2. As the FAA recommends that Master Plan forecasts be within 10 percent of the TAF in the 5-year forecast, PAL O1 was established to correspond with 200,000 annual aircraft operations. PALs O2 and O3 correspond with 210,000 and 245,000 annual operations, respectively. In evaluating the ability of the airfield to accommodate this demand, airfield/runway capacity and aircraft delay were calculated using the methodologies set forth in FAA AC 150/5060-5 (Change 2), *Airport Capacity and Delay*.

Airfield capacity, sometimes referred to as throughput, is defined as the maximum number of aircraft operations that an airfield can accommodate during a specific period of time without incurring an unacceptable level of aircraft delay. Airfield capacity varies according to weather conditions, types of aircraft, airfield configuration, and ATC procedures. The number and location of runway exits and the share of touch-and-go operations also influence airfield capacity. Aircraft delay increases exponentially as the number of aircraft operations (demand) nears or exceeds airfield capacity under a specific operating condition. The following terms, as defined by the FAA, are used in describing the analyses conducted for the Master Plan Update:

- **Annual service volume:** As defined in the *Airport Capacity and Delay* advisory circular, ASV "is a reasonable estimate of an airport's annual capacity." In estimating ASV, the hourly, daily, and seasonal variations in aircraft demand associated with the airfield are considered, as well as the occurrence of low visibility and cloud ceiling heights in which ATC procedures are modified to maintain operational safety.

- **Average annual delay per operation:** This is an estimate of the average delay, expressed in minutes, that each aircraft operation would experience in a given year. Some aircraft operations, such as those occurring during peak demand hours, would likely experience higher delays while other operations, such as nighttime operations, may experience little or no delay. Average annual aircraft delay is associated with the runway component and does not include consideration of any gate, taxiway, or airspace delay.
- **Total annual hours of aircraft delay:** This is an estimate of the total hours of aircraft delay experienced annually at the Airport (i.e., the annual number of aircraft operations multiplied by the average annual delay per aircraft operation).

4.2.1.1 Factors Affecting Airfield Capacity

The capacity of an airfield system, including the runways and associated runway exits, is not constant over time. A variety of factors can affect airfield capacity at an airport, as discussed in the remainder of this subsection. These include:

- Airfield configuration
- Percentage of time the airport experiences poor weather conditions (i.e., low cloud ceilings or low visibility)
- Types of aircraft operating at the airport (aircraft fleet mix)
- Frequency of touch-and-go operations
- Runway use restrictions (airfield operating configurations)

Airfield Configuration

The number of runways, their orientation, the locations of runway intersections, and the lateral separation between parallel runways are primary factors affecting airfield capacity. The number, location, and type (e.g., angled, perpendicular) of runway exits also affect the capacity of the airfield.

Aircraft operations on intersecting runways are typically considered "dependent" operations. In-trail aircraft separation, or spacing, must be increased to allow adequate time for aircraft operations on the intersecting runway to occur safely. The amount of in-trail separation between aircraft is largely dependent on the type of operation (arrival/departure) and the distance between the runway intersection and the approach ends of the runways. As the distance between the end of the runway and the intersection increases, the amount of in-trail separation required may also increase because of the greater amount of time an aircraft requires to clear the runway intersection, thus allowing an operation on the intersecting runway to commence. As in-trail separations increase, airfield capacity decreases.

When an airfield configuration includes parallel runways, the lateral spacing between the runways also affects airfield capacity. Parallel runways with a lateral separation of 2,500 feet or more can operate as independent runways during visual meteorological conditions (VMC). These conditions enable aircraft to arrive or depart on each parallel runway simultaneously. As the separation between Runways 13R-31L and 13L-31R is 3,000 feet, simultaneous arrivals and simultaneous departures are independent operations in VMC.

During instrument meteorological conditions (IMC) in a radar-controlled environment, the minimum lateral separation between parallel runways is 2,500 feet for dependent arrivals. At this separation, simultaneous departures may occur independently in IMC. However, dependent staggered approaches to the parallel runways are typically conducted maintaining a minimum separation of 1.5-miles diagonally between successive aircraft on adjacent runways. Increasing the lateral separation of the runways to 4,300 feet or more would enable independent simultaneous arrivals and/or simultaneous departures or simultaneous arrivals and departures on the parallel runways during IMC, provided that both runways have instrument approach procedures. If the airport is equipped with a precision runway monitor, simultaneous arrivals and/or simultaneous departures can occur during IMC with a separation of 3,400 feet between parallel runways. As the separation between the two parallel runways at the Airport is approximately 3,000 feet, simultaneous departures are independent and simultaneous arrivals are dependent in IMC. These dependencies require an increase in in-trail aircraft separations, thus reducing airfield capacity.

Another factor affecting airfield capacity is the amount of time an aircraft occupies a runway. Runway occupancy time for arriving aircraft is a function of the number, type, and location of runway exits, as well as aircraft performance. Typically, lighter aircraft require shorter runway distances for landing and, therefore, have shorter runway occupancy times. However, if a runway exit is not available once the aircraft has decelerated to a speed that allows for safe maneuvering off the runway, airfield capacity is reduced because of the increased time the aircraft occupies the runway, delaying the subsequent arriving or departing aircraft operating on that runway.

Angled runway exits, when properly located along a runway, can be more effective at reducing runway occupancy times than 90-degree runway exits. Approximately located angled runway exits are typically aligned at 30 to 45 degrees relative to the runway orientation. This angle allows landing aircraft to exit more expeditiously than standard runway exits perpendicular to the runway. Angled exit taxiways result in lower runway occupancy times, increasing airfield capacity.

Weather Conditions

Airfield capacity can vary significantly depending on the weather conditions at an airport. Prevailing winds (direction and speed) dictate which runways can be used for aircraft arrivals and departures. Aircraft typically land and take off into the wind, and can accommodate a limited amount of crosswind and tailwind. If the maximum crosswind or tailwind is exceeded, the aircraft may not safely operate on that particular runway. Therefore, wind conditions may prevent the use of a higher-capacity runway operating configuration, thus increasing aircraft delays.

Other meteorological conditions affecting airfield capacity include cloud ceiling height and visibility. Low cloud ceilings and poor visibility conditions result in increased spacing between aircraft in the airspace surrounding the airport. These conditions may also restrict which runways can be used, as arrivals in these conditions require instrument landing systems.

Visual flight rules govern the procedures used to conduct flight operations in VMC and marginal VMC (MVMC). Similarly, instrument flight rules govern the procedures used to conduct flight operations in IMC. The criteria for establishing the two operating conditions are summarized in **Table 4-2**.

Table 4-2: Operating Conditions for Airfield Capacity and Aircraft Delay Analysis

	WEATHER CONDITIONS		
CLASSIFICATION	VISIBILITY		CLOUD CEILING
Visual Meteorological Conditions	Greater than or equal to 3 statute miles	and	Greater than or equal to 1,000 feet above ground level
Marginal Visual Meteorological Conditions	Between 3 and 5 statute miles	and/or	Between 1,000 feet and 3,000 feet above ground level
Instrument Meteorological Conditions	Less than 3 statute miles	and/or	Less than 1,000 feet above ground level

SOURCE: Federal Aviation Administration, Advisory Circular 150/5060-5 (Change 2), *Airport Capacity and Delay,* December 1, 1995.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

During IMC, in-trail separations for arrivals and departures are increased, thus reducing the hourly capacity of the airfield and limiting procedures for aircraft arrivals and departures on parallel runways.

Aircraft Fleet Mix

Aircraft fleet mix is an important factor in determining an airport's airfield capacity. As the diversity of approach speeds and aircraft weights increases, airfield capacity decreases because increased in-trail separation is required to avoid wake vortices or wake turbulence. Turbulence is created behind an aircraft as a result of its movement through the air. Heavier aircraft produce more severe wake turbulence than smaller aircraft. Although more prevalent during departures than arrivals, wake vortices are considered a significant safety hazard during any airborne operation.

To alleviate the hazards of wake vortices, aircraft are spaced according to the differences in air speed and weight. Lighter aircraft are more susceptible to wake vortices than heavy aircraft. Therefore, pilots of light aircraft are typically required to wait up to 2 minutes before operating on a runway following a heavy aircraft. This delay results in decreased airfield capacity. The greater the size and weight differential of the aircraft fleet using a specific runway, the greater the separation required between successive aircraft operations on that runway.

The FAA's *Airport Capacity and Delay* Advisory Circular incorporates a factor referred to as the "mix index" to account for aircraft fleet composition. The mix index is represented as a percentage to quantify the share of large aircraft in the fleet mix. To establish the mix index, aircraft are assigned to one of five classifications based on the maximum certificated takeoff weight (MTOW) of the aircraft. Based on the number of operations in each classification, a percentage is established to quantify the share of total aircraft operations by aircraft types that result in wake turbulence hazards. **Table 4-3** summarizes the weight classifications of the five aircraft categories considered in defining an airport's mix index.

Table 4-3: Aircraft Classifications for Establishing Aircraft Mix Index

AIRCRAFT CLASSIFICATION	MAXIMUM CERTIFICATED TAKEOFF WEIGHT (POUNDS)	REPRESENTATIVE AIRCRAFT
Small	12,500 or less	Piper P23, Cessna C-180, Cessna C-207, King Air
Small+	12,501 to 41,000	Lear 25, Cessna Citation, Grumman G-1
Large	41,001 to 300,000	Gulfstream IV, F-28, Dash 8, Boeing 737, Airbus A320
B757	N/A	Boeing 757-200/300
Heavy	300,001 or more	Airbus A300, Boeing 767, DC-10, Airbus A380, Boeing 747-8

NOTE: NA = Not applicable.

SOURCE: Federal Aviation Administration, Advisory Circular 150/5060-5 (Change 2), *Airport Capacity and Delay*, December 1, 1995.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

Touch-and-Go Operations

Touch-and-go operations are defined as operations by a single aircraft that touches down and departs without stopping on or exiting the runway. Pilots conducting touch-and-go operations are usually conducting training exercises and, thus, stay in the airport traffic pattern. Airfield capacity, in terms of the number of aircraft operations, typically increases as the level of touch-and-go operations increases because aircraft continually approach and depart without incurring significant runway occupancy time. A touch-and-go operation is counted as two operations: one arrival and one departure. However, continuous touch-and-go operations reduce the availability of the runway for other non-training operations or may impede aircraft operations on nearby or intersecting runways. Touch-and-go operations are not common at Dallas Love Field, where the majority of GA activity consists of corporate flights rather than training flights.

Airfield Operating Configurations

As previously discussed, the configuration of the runways can result in a variety of airfield operating configurations. Weather is a primary factor in dictating which operating configuration is used. However, other factors may influence the operating configuration, including the runway length required for departure and arrival and the proximity of obstructions (structures and terrain), other airports, and related airspace.

Aircraft performance characteristics may restrict operations on a runway. For departures, the available runway length must exceed the runway length required for the departing aircraft type. This required runway length includes that required for the takeoff ground roll, to clear an obstruction of a specified height (typically 35 feet above ground level [AGL]), and accelerate-stop distance (to accommodate an aborted takeoff roll). If the available runway length is not adequate, it would be necessary for the aircraft to depart on a runway that provides adequate departure length or reduce its payload. Similarly, the available landing distance on the runway must exceed the landing distance requirements prescribed for the aircraft type and pavement conditions. Otherwise, the aircraft would be required to land on a longer runway.

Aircraft departures may also be restricted by the presence of obstacles. These restrictions are based on the climb performance of the aircraft and the location of the obstacles relative to the departure route of the aircraft. Potential obstructions to the aircraft takeoff and initial departure climb are of particular importance. Aircraft operations conducted under Title 14, Code of Federal Regulations, Part 121 (14 CFR Part 121), *Operating Requirements: Domestic, Flag, and Supplemental Operations*, or under 14 CFR Part 135, *Operating Requirements: Commuter and On-Demand Operations and Rules Governing Persons on Board Such Aircraft,* are subject to the limitations defined by airport obstacle analysis. If an obstacle is identified that would not allow a departing aircraft to meet the minimum obstacle clearance requirements prescribed by the FAA, the departure would not be permitted, restricting the use of the runway and affecting the airfield's operating configuration.

Runway use may also be predicated on regional ATC procedures associated with nearby airports. Neighboring airports often require the shared use of navigational facilities and approach/departure fixes. Strict coordination is required between ATC facilities, and could restrict the capacity of the overall regional airspace system. In some instances, specific operating configurations at one airport may take precedence over the operating configurations at the other, thereby restricting the use of certain operating configurations at the airport that has lower priority. As Dallas Love Field is located 11 miles east of DFW, both airports operate as dictated by the Dallas-Fort Worth TRACON. DAL and DFW usually operate in the same directional flow, but a "reverse flow" situation sometimes occurs to avoid tailwinds at both airports. Although DFW is the larger airport, no constraining dependencies were identified by DAL ATC and, as such, DAL is considered to operate independently of DFW.

4.2.1.2 Existing Airfield Demand/Capacity and Delay Relationships

The estimated existing airfield capacity is expressed in terms of hourly capacity, and hourly capacity and ASV were used to evaluate PALs O1, O2, and O3. For each runway use configuration, hourly capacities were established for operations during VMC, MVMC, and IMC. Historical weather data obtained from the National Climatic Data Center were used to determine the annual runway use configuration during IMC, MVMC, and VMC. A weighted hourly capacity was then established based on the occurrence rate of each runway use configuration/weather condition and the respective hourly capacities. The weighted hourly capacity forms the basis for determining the airfield's ASV.

ASV represents an estimate of the annual number of aircraft operations the Airport can efficiently accommodate taking hourly, daily, and monthly operational patterns into consideration. The formula for calculating ASV consists of three variables: weighted hourly capacity, the ratio of annual demand to average daily demand in the peak month, and the ratio of average daily demand to average peak hour demand during the peak month. These variables are multiplied together to obtain the ASV for the Airport.

FAA AC 150/5060-5 presents the methodology for calculating hourly aircraft delays for a number of conditions that represent the seasonal and daily variations in demand, weather conditions, runway use, and capacity. It is assumed in the methodology that the variations in demand over the year can be characterized by a number of representative daily demands. Different weather conditions and runway uses, as well as hourly runway capacity parameters corresponding to these conditions and uses, are provided as variables in the calculation. Delays are established for each hour of the year using delay curves. The average annual delay per aircraft operation is computed by aggregating the estimated hourly delays.

4.2.1.3 Hourly Airfield Capacity

When hourly demand begins to reach hourly capacity, aircraft delays increase. These delays take the form of extended arrival traffic patterns and departure queue delays in VMC and MVMC, or holding patterns and flow control delays in IMC. As aircraft delays are most prevalent during peak demand periods, the hourly throughput of the airfield was compared with peak hour demand. Peak hour demand that meets or exceeds hourly capacity is likely to result in delays during the peak demand periods. The rate at which an airfield can "recover" from peak period delays depends on the operational profile of activity throughout the day.

4.2.1.4 Current Air Traffic Control Airfield Operating Configurations

In estimating the hourly capacity of the existing airfield, the various runway use configurations and their utilization rates, aircraft fleet mix projections, and probable weather conditions based on historical weather data were considered. As the aircraft fleet mix is expected to evolve throughout the planning period, the hourly capacities associated with existing (2012) operational demand, as well as those estimated for PALs O1, O2, and O3, were identified. These capacities were then compared to the projected peak hour demand to assist in identifying potential operational delays during peak demand periods.

To provide an understanding of the various airfield operating configurations used by ATC, the existing runway configuration at the Airport must be considered. As shown in Section 2, the airfield consists of two parallel runways, Runways 13L-31R and 13R-31L, and one crosswind runway, Runway 18-36, which is currently used as a taxiway. It should be noted that, in this runway demand/capacity analysis, Runway 18-36 is considered decommissioned and was not considered in the capacity calculations. The parallel runways have a lateral centerline-to-centerline separation of approximately 3,000 feet.

With overall lengths of 7,752 feet and 8,800 feet, respectively, Runways 13L-31R and 13R-31L can accommodate any aircraft identified in the current aircraft fleet serving the Airport. The parallel runways primarily accommodate air carrier, regional jet, and corporate general aviation operations.

Exhibit 4-4 shows the percentage of time that each runway operating configuration occurs at the Airport during VMC, MVMC, and IMC, as identified by ATC. The exhibit also shows the prevailing wind direction under which each airfield operating configuration is typically used. The occurrence rate (percent of time) of each operating configuration is based on historical weather observations for the 10-year period between January 1, 2003, and December 31, 2012.

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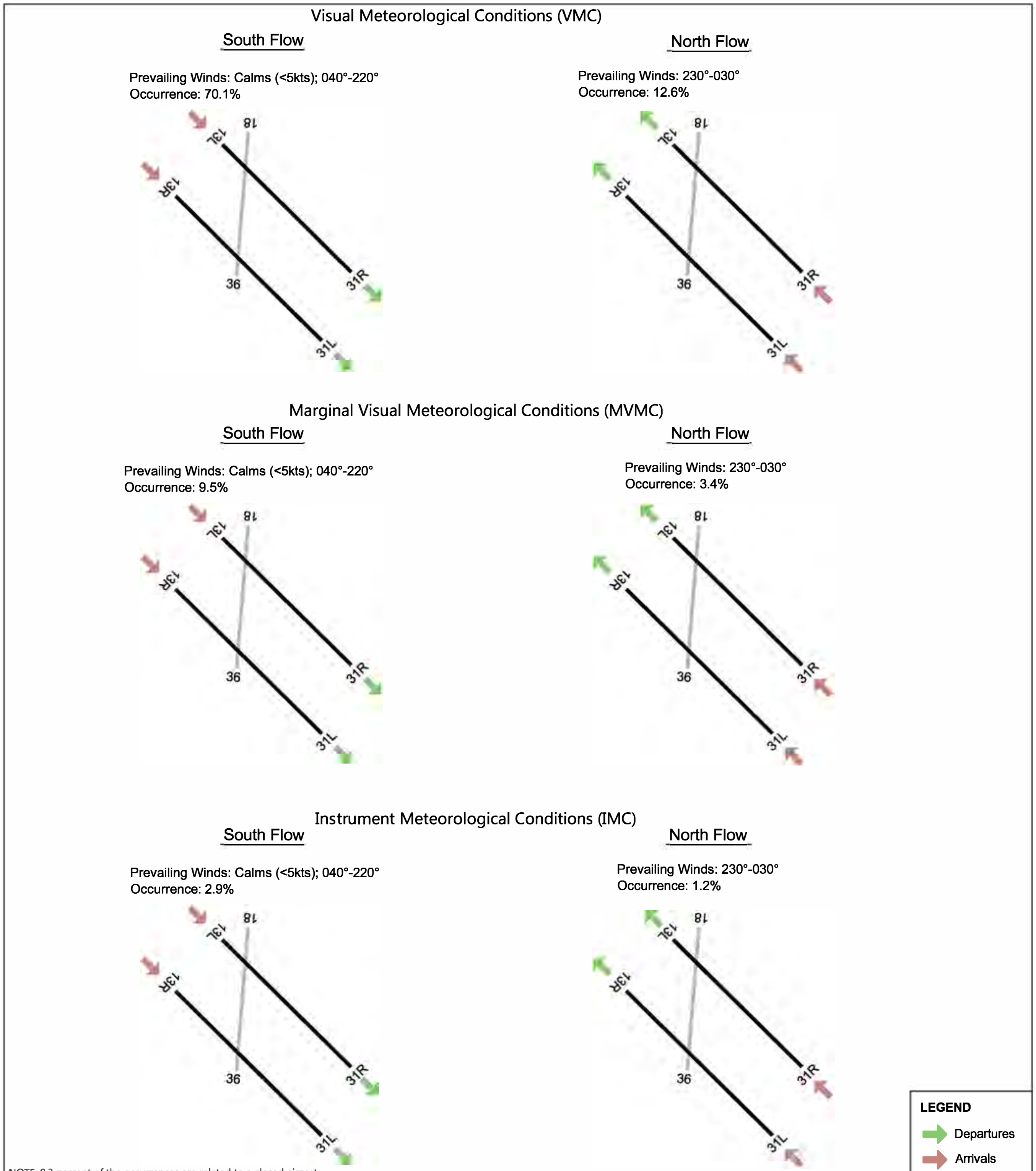

SOURCES: DMJM Aviation, *Dallas Love Field Airport Impact Analysis and Master Plan*, 2001; Ricondo & Associates, Inc., October 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 4-4

NORTH 0 Not to Scale

Runway Use Configurations under Various Weather Conditions

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As illustrated on Exhibit 4-4, two operating configurations are currently used during VMC, MVMC, and IMC. These operating configurations are briefly described below.

- **South Flow:** ATC has identified south flow as the preferred operating configuration at the Airport. This configuration currently yields the greatest airfield capacity, and produces limited airspace impacts with DFW operations.

  During VMC and MVMC, Runways 13L and 13R provide simultaneous arrival and departure capability in South Flow and all operations are independent. The south flow configuration during IMC is similar to its operation during VMC and MVMC. Both runways have a published instrument approach procedure and simultaneous arrivals and departures are permitted. However, arrivals are dependent (i.e., a minimum separation must be maintained between arrivals on both runways during IMC).

  The south flow operating configuration in VMC, MVMC, and IMC is typically used when the prevailing winds are reported from a heading of 040 degrees through 220 degrees. ATC also prefers to use this configuration during calm wind conditions (less than 5 knots) because it yields the greatest capacity and reduces interaction with DFW when DFW is operated in the South Flow configuration. During IMC, the instrument landing system approach procedure for Runway 13R requires a minimum cloud ceiling[1] of 200 feet AGL and a minimum visibility of ¾ mile, while the ILS approach procedure for Runway 13L requires a minimum cloud ceiling of 200 feet AGL and a minimum RVR of 1,800 feet. On that basis, it was estimated that the VMC, MVMC, and IMC South Flow operating configurations occur approximately 70.1 percent, 9.5 percent, and 2.9 percent of the time, respectively.

  It should be noted, however, that during south flow operations, aircraft arrivals on Runways 13R and 13L at DAL require coordination between DAL ATC and DFW ATC to provide adequate separation from DFW aircraft departures. Aircraft departures on DAL Runways 13R and 13L do not require coordination with DFW ATC.

- **North Flow:** When the prevailing winds are reported between 230 degrees and 030 degrees, the north flow operating configuration is used at DAL by ATC during VMC, MVMC, and IMC. During VMC and MVMC, simultaneous arrivals and departures can be accommodated on Runways 31R and 31L. During IMC, similar to the south flow configuration, arrivals are dependent and departures are independent in north flow. The Runway 31L ILS procedure provides the capability to serve aircraft arrivals with a cloud ceiling of 200 feet AGL or greater and an RVR of 1,800 feet, while the Runway 31R ILS procedure provides the capability to serve aircraft arrivals with a cloud ceiling of 200 feet AGL or greater and visibility of ½ mile. On that basis, it was estimated that the VMC, MVMC, and IMC north flow operating configurations occur approximately 12.6 percent, 3.4 percent, and 1.2 percent of the time, respectively.

[1] The minimum cloud ceiling height for an ILS approach is relative to the touchdown zone elevation of the associated runway. This elevation is defined as the highest centerline elevation within the initial 3,000 feet of the landing portion of the runway.

Consistent with Exhibit 4-4, **Table 4-4** provides a summary of the historical occurrence rates associated with the various airfield operating configurations at the Airport.[2] As indicated, VMC, MVMC, and IMC had occurrence rates of 82.7 percent, 12.9 percent, and 4.1 percent, respectively. The remaining 0.3 percent consists of weather conditions in which the cloud ceiling and/or visibility minimums were below those prescribed for the current instrument approach procedures for the Airport, thus requiring that aircraft operations be discontinued until weather conditions improve.

Table 4-4: Historical Hourly Occurrence of Runway Use Configurations

RUNWAY USE CONFIGURATIONS	VMC	MVMC	IMC	CLOSED
South Flow	70.1%	9.5%	2.9%	NA
North Flow	12.6%	3.4%	1.2%	NA
Airport Closed	NA	NA	NA	0.3%
Total	**82.7%**	**12.9%**	**4.1%**	**0.3%**
			Total Observations:	100.0%

NOTE: NA = Not applicable.

SOURCES: National Climatic Data Center, DAL Surface Hourly Weather Observations (January 1, 2003 – December 31, 2012; 6:00 a.m. to 10:00 p.m.), September 2013; Ricondo & Associates, Inc., September 2013.

PREPARED BY: Ricondo & Associates, Inc., October 2013.

4.2.1.5 Aircraft Fleet Mix Assumptions

Table 4-5 summarizes the VMC/MVMC aircraft fleet mix composition serving the Airport in 2012, and the projected fleet mix throughout the planning period. The table also presents the resulting mix index that formed the basis for estimating the throughput of the airfield. The fleet mix data for 2012 were estimated by evaluating the fleet composition of air carrier, commuter, general aviation, and military aircraft operations. The 2012 fleet mix data were obtained from the DAL Airport Noise and Operations Monitoring System (ANOMS) database for January 1, 2012, through December 31, 2012. The fleet mix data for PALs O1, O2, and O3 were derived from the 2012 design day flight schedule and the forecast of total aircraft operations at each PAL. The increase in operations from one PAL to another was assumed to result from increases in corporate and commercial jet operations. The numbers of other types of aircraft operations were assumed to remain constant.

[2] National Climatic Data Center, DAL Surface Hourly Weather Observations (January 1, 2003 – December 31, 2012; 6:00 a.m. to 10:00 pm), September 2013.

Table 4-5: Aircraft Fleet Mix Composition during Visual and Marginal Visual Meteorological Conditions

	SMALL	SMALL+	LARGE	BOEING 757	HEAVY	TOTAL	MIX INDEX 1/
2012	18.5%	18.9%	62.4%	0.1%	0.1%	100.0%	81.8%
PAL O1	17.0%	19.2%	63.6%	0.1%	0.1%	100.0%	83.3%
PAL O2	16.8%	19.2%	63.8%	0.1%	0.1%	100.0%	83.5%
PAL O3	15.3%	19.6%	64.9%	0.1%	0.1%	100.0%	85.0%

NOTE:

1/ Mix Index = (Percent of "Small+" Aircraft) + (Percent of Large Aircraft) + (2 * Percent of Boeing 757 Aircraft) + (3 * Percent of Heavy Aircraft).

SOURCES: Dallas Love Field, Airport Noise and Operations Monitoring System Database, January 1, 2012 - December 31, 2012 (accessed in September 2013); Ricondo & Associates, Inc., September 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

As shown in Table 4-5, the mix index associated with 2012 operations was estimated at 81.8 percent under VMC/MVMC. Only small variations in the fleet mix are anticipated throughout the planning period, resulting in a PAL O3 mix index of 85.0 percent.

Similarly, **Table 4-6** presents the IMC aircraft fleet mix composition serving the Airport in 2012 and the projected aircraft fleet mix at PALs O1, O2, and O3. The IMC aircraft fleet mix composition was derived from the VMC fleet mix composition, assuming a 50 percent reduction in small piston and turboprop aircraft operations during IMC. Accordingly, the IMC mix index is projected to increase from its 2012 level of 86.5 percent to 88.5 percent at PAL O3.

Table 4-6: Aircraft Fleet Mix Composition during Instrument Meteorological Conditions

	SMALL	SMALL+	LARGE	BOEING 757	HEAVY	TOTAL	MIX INDEX 1/
2012	13.8%	20.0%	66.0%	0.1%	0.1%	100.0%	86.5%
PAL O1	12.9%	20.2%	66.7%	0.1%	0.1%	100.0%	87.4%
PAL O2	12.7%	20.2%	66.9%	0.1%	0.1%	100.0%	87.6%
PAL O3	10.9%	20.5%	67.5%	0.1%	0.1%	99.1% 2/	88.5%

NOTES:

1/ Mix Index = (Percent of "Small+" Aircraft) + (Percent of Large Aircraft) + (2 * Percent of Boeing 757 Aircraft) + (3 * Percent of Heavy Aircraft).

2/ Because of rounding, the percentages do not add to 100 percent.

SOURCES: Dallas Love Field, Airport Noise and Operations Monitoring System Database, January 1, 2012 - December 31, 2012 (accessed in September 2013); Ricondo & Associates, Inc., September 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

4.2.1.6 Hourly Capacity

Table 4-7 presents the VMC/MVMC and IMC hourly capacity estimates for the operating configurations considered (existing airfield during South Flow and North Flow). It should be noted that, for the purpose of evaluating airfield capacity, the demand/capacity analysis was focused on the hourly capacity estimates for 50 percent arrivals and 50 percent departures. This split is reasonable for airfields, such as Dallas Love Field, that accommodate balanced and sustained activity at peak times.

Table 4-7: Existing and Projected Airfield Configuration Hourly Capacity

	VMC/MVMC		IMC	
SOUTH AND NORTH FLOW CONFIGURATIONS	MIX INDEX	HOURLY CAPACITY (50% ARRIVALS)	MIX INDEX	HOURLY CAPACITY (50% ARRIVALS)
Existing (2012)	81.8%	108	86.5%	83
PAL O1	83.3%	105	87.4%	83
PAL O2	83.5%	104	87.6%	84
PAL O3	85.0%	103	88.5%	85

SOURCES: Federal Aviation Administration, Advisory Circular 150/5060-5, *Airport Capacity and Delay*, December 1, 1995; Ricondo & Associates, Inc., October 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

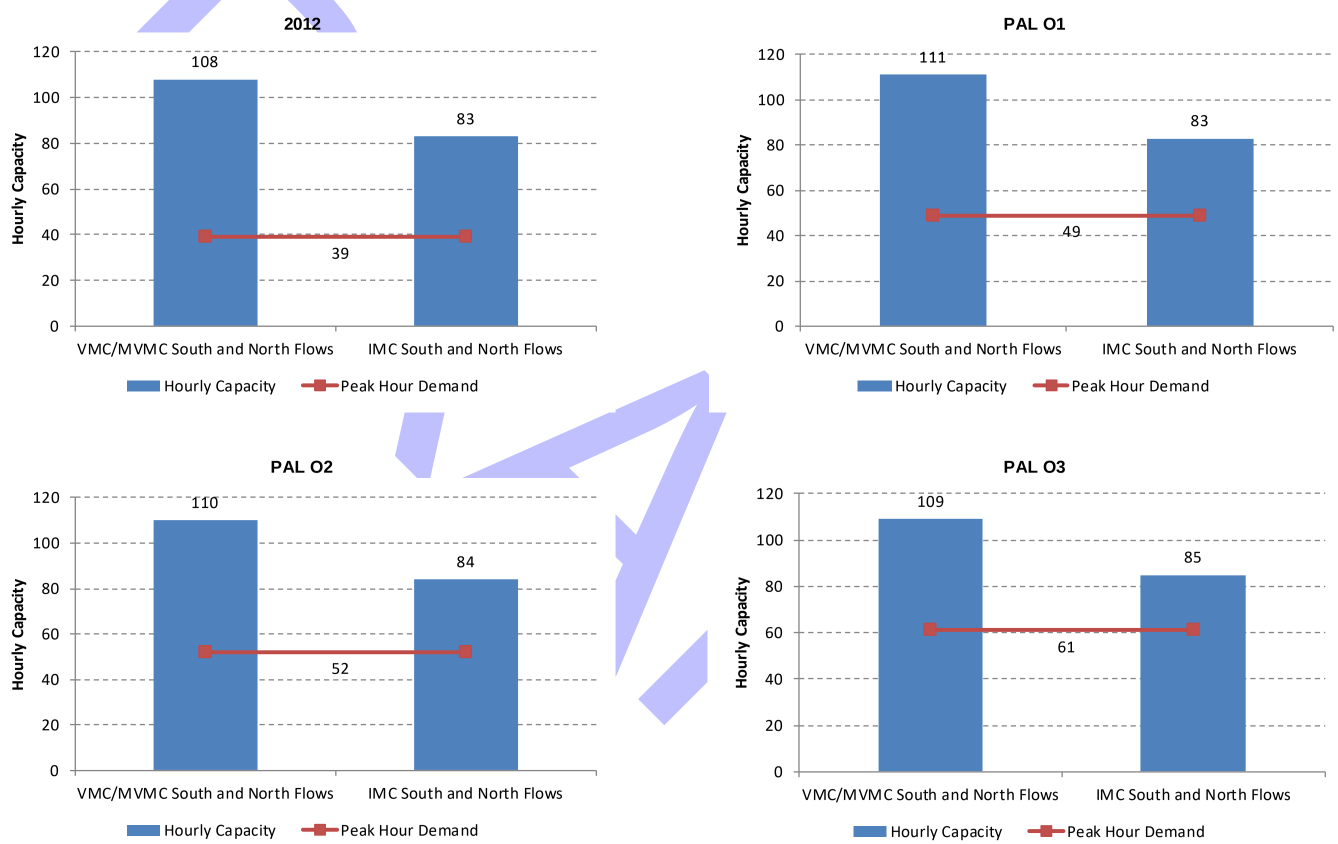
Assuming a 50 percent arrivals mix, the existing (2012) VMC/MVMC hourly capacity was 108 operations for South Flow and North Flow configurations. Although the mix index is projected to increase from 81.8 percent in 2012 to 85.0 percent at PAL O3, it would have a negligible effect on the airfield's hourly capacity.

As expected, the IMC hourly capacity is lower than the VMC/MVMC hourly capacity. This reduction is caused by a variety of factors, including (1) an increase in the mix index, (2) increased separation requirements between successive aircraft operations, and (3) the dependency of simultaneous arrivals on the parallel runways in IMC. Assuming a 50 percent arrivals mix, the IMC hourly capacity was 83 operations in 2012 for South Flow and North Flow operations. Similar to the results for VMC/MVMC conditions, the IMC hourly capacity is projected to remain relatively constant, numbering 85 operations at PAL O3, as the mix index increases from 86.5 percent to 88.5 percent.

4.2.1.7 Hourly Demand/Capacity Comparisons

Exhibit 4-5 presents a comparison of the hourly capacity estimates at the Airport associated with VMC/MVMC and IMC for 2012 and PALs O1, O2, and O3 assuming an arrivals mix of 50 percent. As shown on Exhibit 4-5, the peak hour aircraft demand is projected to increase from 39 operations in 2012 to 49, 52, and 61 operations at PALs O1, O2, and O3, respectively. The peak hour demand would not exceed the hourly airfield capacity in any of the runway operating configurations at any PAL considered in this analysis.

Exhibit 4-5: Hourly Airfield Demand/Capacity Comparison – Existing Airfield



NOTES:

1/ The peak hour demand is the average number of operations during the peak hour of the peak month.

2/ The analysis assumes 50 percent arrivals.

SOURCES: Federal Aviation Administration, Advisory Circular 150/5060-5, *Airport Capacity and Delay*, December 1, 1995; Ricondo & Associates, Inc., October 2013
PREPARED BY: Ricondo & Associates, Inc., October 2013.

Annual Service Volume

The peak hour airfield capacity for the Airport forms the basis for establishing the ASV of the current airfield. The ASV is then compared with the annual aircraft operational demand associated with PALs O1, O2, and O3. If annual demand exceeds the ASV of the airfield, delays would increase exponentially. To minimize aircraft delays, the FAA recommends that planning for additional airfield capacity commence when the airfield's annual demand reaches 60 to 75 percent of the ASV.[3] Identification of the demand level at which this would occur requires the quantification of annual demand expressed as a share (percent) of ASV. **Table 4-8** presents this comparison for the operational demand experienced in 2012, and for demand projected at PALs O1, O2, and O3. The table also presents annual demand expressed as a percentage of ASV, as well as estimated peak hour demand.

Table 4-8: Comparison of Annual Demand (Operations) and Annual Service Volume

	AIRFIELD CAPACITY AND DEMAND CHARACTERISTICS (NUMBER OF OPERATIONS)			
CAPACITY/DEMAND METRIC	**2012**	**PAL O1**	**PAL O2**	**PAL O3**
Estimated Peak Hour Demand	39	49	52	61
Annual Service Volume	404,000	366,000	364,000	364,000
Annual Demand	177,067	200,000	210,000	245,000
Annual Demand/Annual Service Volume	43.8%	54.6%	57.7%	67.3%

SOURCES: Federal Aviation Administration, Advisory Circular 150/5060-5, *Airport Capacity and Delay*, December 1, 1995; Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

As shown, the ASV at the Airport in 2012 was estimated at 404,000 operations, while actual annual demand was 177,067 operations. As a result, annual demand in 2012 accounted for 43.8 percent of the ASV. Annual demand is anticipated to be lower than 60 percent of the ASV at PALs O1 and O2; therefore, planning for additional airfield capacity is not anticipated to be required during the planning period for this Master Plan Update. At PAL O3, annual demand is anticipated to account for 67.3 percent of the ASV; therefore, planning for additional airfield capacity may be warranted between PALs O2 and O3.

Airfield Delay

For long-range planning, FAA AC 150/5060-5 uses a general demand versus capacity comparison to estimate average delay associated with an airfield. For purposes of this analysis, the ratio of annual demand to the airfield's ASV serves as the basis for developing these delay estimates. The delay estimates provide the basis for justifying capacity improvements, as they demonstrate the true operational consequences associated with

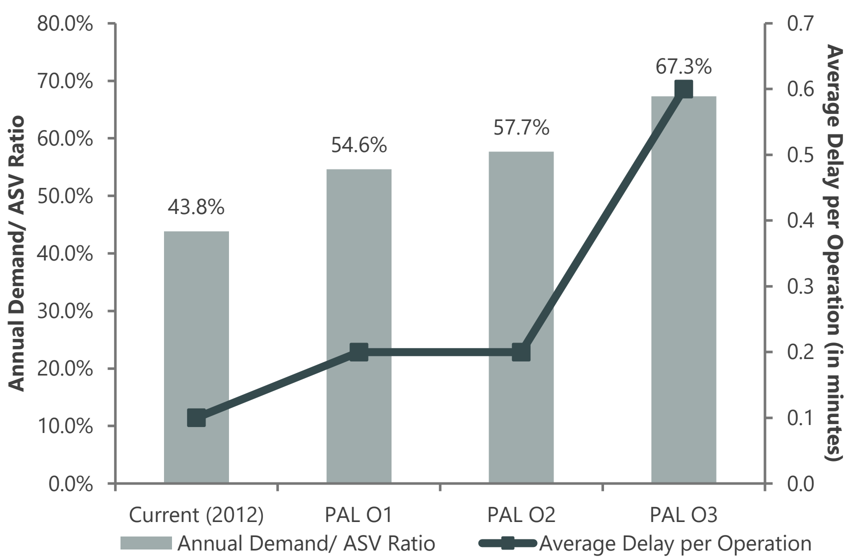
[3] Federal Aviation Administration, Order 5090.3C, *Field Formulation of the National Plan of Integrated Airport Systems (NPIAS)*, December 4, 2000.

demand exceeding airfield capacity.

It should be noted that the delay estimates contained in AC 150/5060-5 reflect delays associated with runways only. Additional delays associated with local airspace constraints, aircraft taxiing operations, and gate occupancies are not considered. These other components of delay cannot be reasonably quantified without the use of advanced airfield and airspace simulation tools. As the delay estimates presented herein reflect delay associated with the runway components exclusively, the generally accepted maximum allowable delay per operation is 4.0 minutes. On that basis, airfield capacity enhancements should be implemented prior to reaching or exceeding this delay threshold.

Exhibit 4-6 graphically presents this relationship for demand forecast through PAL O3. The forecast increase in annual demand is compared with the ASV projections through PAL O3, and the resulting delay values, in terms of average delay per aircraft operation, are superimposed. As shown, the average aircraft delay experienced in 2012 was approximately 0.1 minute per operation, which is well below the FAA criterion for generally accepted delay of 4.0 minutes per operation (runway component only). As annual demand increases and the ASV decreases, the average delay per aircraft operation would increase to 0.6 minute per operation at PAL O3. Therefore, no additional airfield capacity would be required between 2012 and PAL O3.

Exhibit 4-6: Relationships of Demand, Capacity, and Delay



SOURCES: Federal Aviation Administration, Advisory Circular, 150/5060-5, *Airport Capacity and Delay*, December 1, 1995; Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

Existing Airfield Demand/Capacity Conclusions

The demand/capacity analysis for the airfield determined that the existing runway configuration is adequate to accommodate current and forecast operational demand at the Airport, even during peak demand periods. Average delay in 2012 was estimated to be 0.1 minute (6 seconds) per aircraft operation. This delay is expected to increase to nearly 0.6 minute (36 seconds) per aircraft operation at PAL O3. As DAL is a medium-hub airport, an average delay of 4.0 minutes per aircraft operation is typically the threshold of unacceptable delay throughout the airline industry. On that basis, the capacity of the existing airfield is adequate to accommodate forecast demand through PAL O3; therefore, no airfield capacity enhancements nor planning for additional airfield capacity are necessary within the planning period for this Master Plan Update.

4.2.2 AIRFIELD REQUIREMENTS

Although the airfield demand/capacity analysis concluded that the current airfield is adequate to accommodate operational demand forecast through the planning period, enhancements to the airfield may be warranted to ensure safe and efficient operations. The overall airfield was assessed to determine its ability to accommodate the projected aircraft fleet mix, while also complying with the FAA's airfield design standards. The following airfield components were assessed:

- **Runway system:** In addition to the physical configuration of the runways (pavement length and width), the various runway protection surfaces were reviewed. These protection areas include the RSA, ROFA, obstacle free zone (OFZ), and runway protection zone (RPZ).
- **Taxiway system:** The lateral separations from adjacent runways, taxiways, and taxilanes; pavement geometry; and taxiway OFAs were evaluated. Particular emphasis was placed on the FAA's latest guidelines intended to enhance situational awareness and reduce the potential for runway incursions.
- **Airfield lighting and signage systems:** Runway and taxiway edge lighting, approach lighting systems, visual approach guidance systems, and airfield signage were reviewed.

The airfield assessment was based on the airfield design standards prescribed under FAA AC 150/5300-13A (Change 1), *Airport Design*, as well as other supporting ACs and interim FAA guidance. Potential enhancements identified by ATC and Department of Aviation staff were also considered. However, the local airspace structure was not assessed to determine potential obstructions or hazards to air navigation.

4.2.2.1 Airfield Design Standards

The planning and design of an airport and its airfield facilities are predicated on the aircraft types using the airport. Airfield facilities must comply with planning and design standards, such as those set forth in FAA AC 150/5300-13A (Change 1), for runway and taxiway widths and clearances to ensure that the range of aircraft projected to operate at the Airport can be accommodated. These airfield standards are typically dictated by the physical and operational characteristics of the aircraft that operate at the airport in terms of wingspan, approach speed, weight, and configuration of the landing gear. To facilitate the appropriate correlation of airfield design standards with the physical and operational characteristics of the aircraft fleet, the FAA has established the design classifications discussed in the paragraphs below.

Airport Reference Code

The Airport Reference Code is used to relate airport design criteria to the operational and physical characteristics of the aircraft intended to operate at an airport, and is calculated based on specifications in AC 150/5300-13A. The ARC has two components: the first component, represented by a letter, is the Aircraft Approach Category, which is defined by aircraft approach speed,[4] as follows:

- **AAC A:** Approach speed less than 91 knots.
- **AAC B:** Approach speed of 91 knots or greater, but less than 121 knots.
- **AAC C:** Approach speed of 121 knots or greater, but less than 141 knots.
- **AAC D:** Approach speed of 141 knots or greater, but less than 166 knots.
- **AAC E:** Approach speed of 166 knots or greater.

The second component of the ARC, represented by a Roman numeral, is the Airplane Design Group, which is determined by aircraft wingspan, as follows:

- **ADG I:** Wingspan less than 49 feet (e.g., Piper PA-48, Learjet 35).
- **ADG II:** Wingspan of 49 feet up to, but not including, 79 feet (e.g., Cessna Citation II, Saab 340).
- **ADG III:** Wingspan of 79 feet up to, but not including, 118 feet (e.g., Boeing 737, MD-80, Airbus A320 family).
- **ADG IV:** Wingspan of 118 feet up to, but not including, 171 feet (e.g., A300, Boeing 757, A310).
- **ADG V:** Wingspan of 171 feet up to, but not including, 214 feet (e.g., Boeing 747, Boeing 777, A330, A340).
- **ADG VI:** Wingspan of 214 feet up to, but not including, 262 feet (e.g., A380).

An aircraft's approach speed translates into time and distance factors, which identify criteria for runways and runway dimensional clearances. The aircraft's wingspan is indicative of an aircraft's weight and physical size. These factors dictate requirements for pavement strength and separation from other pavement or structures.

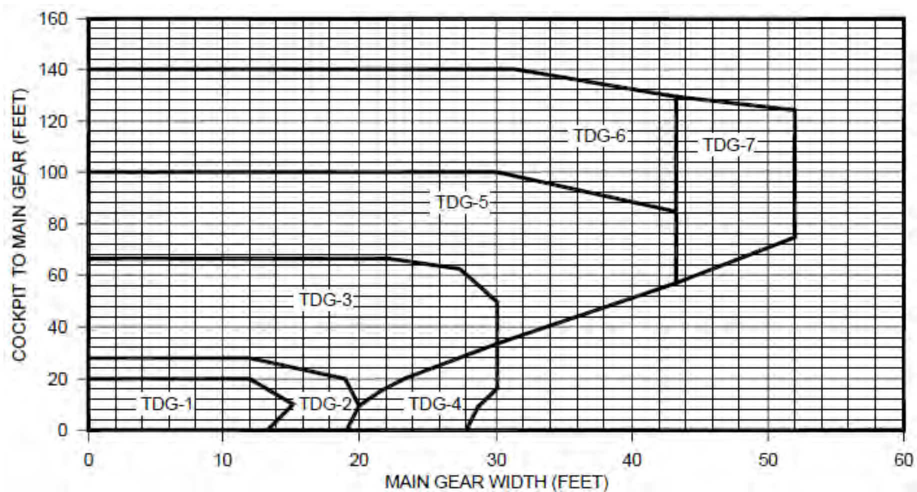
Runway Design Codes and Taxiway Design Groups

The FAA recently established a Runway Design Code (RDC) and a Taxiway Design Group (TDG), which establish the design standards for specific runways and taxiways, respectively. The RDC is described by the same parameters as the ARC (AAC and ADG) and serves to establish the same runway design criteria as the ARC. The TDG is a classification of aircraft based on the configuration of landing gear. The TDG is dependent on the width of the main landing gear and the distance from the cockpit to the main landing gear. Whereas

[4] AC 150/5300-13A, *Airport Design*, defines an aircraft's approach speed as 1.3 times its stall speed at that aircraft's maximum certificated landing weight.

the ADG establishes criteria for taxiway separations and OFA dimensions, the TDG determines taxiway pavement geometry. There are seven TDGs, which are described graphically on **Exhibit 4-7**.

Exhibit 4-7: Taxiway Design Groups



SOURCE: Federal Aviation Administration, Advisory Circular 150/5300-13A, *Airport Design* (Change 1), February 2014.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

Dallas Love Field Application

The ARC for DAL is currently C-III, indicating that Runways 13L-31R and 13R-31L, their associated taxiways, and their safety areas should meet ARC C-III FAA design standards to adequately accommodate regular operations of aircraft with approach speeds between 121 and 141 knots and wingspans up to, but not including, 118 feet. The crosswind runway (Runway 18-36) is designated as RDC B-II, but is currently used as a taxiway. All taxiways, except Taxiways E, G, and W, which are classified as TDG 4, are designated TDG 5 and should meet TDG 5 FAA design standards. TDG 5 is the largest TDG associated with ADG III aircraft.

The Airport currently accommodates a wide variety of aircraft operations. Based and itinerant general aviation aircraft include small single-engine and multi-engine aircraft (ARCs A-I and B-I) and corporate turboprops and jets (ARCs B-II, C-I, and C-II). Most commercial operations are currently provided by air carrier jet aircraft, such as the Boeing 737-700, 737-300, and 737-500, which are all ARC C-III. Additionally, one Boeing 767 (ARC D-IV[5]) and two Boeing 757s (ARC D-IV[6]) are based at the Airport. Other large aircraft operate at the Airport infrequently and include some widebody aircraft, such as Boeing 747 (ARC D-V).

5 Applies to the version of the Boeing 767 with the highest ARC.

6 Applies to the version of the Boeing 757 with the highest ARC.

As part of the Master Plan Update planning process, the current ARC for the Airport was re-evaluated pursuant to FAA guidance specifying that airport dimensional standards should be selected for the critical (or design) aircraft, defined as the most demanding aircraft, in terms of size and approach speed, that will make substantial use of the Airport during the planning period. According to FAA Order 5090.3C, *Field Formulation of the National Plan of Integrated Airport System (NPIAS)*, "substantial use" means either 500 or more annual itinerant operations or scheduled commercial service. The most demanding aircraft in terms of size and approach speed that is currently making substantial use of the Airport is the Boeing 737-700, which is ARC C-III. However, based on the recent orders of Boeing 737-800 aircraft by Southwest Airlines and on the long-term design day flight schedule developed for the Master Plan Update, the most demanding aircraft, in terms of design standards, projected to make substantial use of the Airport over the planning period is the Boeing 737-800, or equivalent (ARC D-III). Although other larger aircraft operate at DAL, such as the Boeing 757 and Boeing 767 (ARC D-IV for their most demanding versions), their operational demand is limited and projected to remain under 500 annual operations. Therefore, it is recommended that the Airport's ARC be changed from C-III to D-III to account for the projected increase in Boeing 737-800 operations over the planning period. To accommodate ARC D-IV aircraft without operational restrictions, the airfield would need to be configured to meet ARC D-IV dimensional and design standards. However, the limited number of operations of this aircraft type does not warrant an ARC change to D-IV. Therefore, in subsequent assessments of facility requirements, the current airfield's ability to comply with ARC D-III standards will be assessed and protection of the taxiway OFA requirements to support ARC D-IV aircraft will be considered along the typical taxiing routes used by ARC D-IV aircraft.

4.2.2.2 Runway System

The ability of the existing runway system at DAL to accommodate the projected aircraft fleet mix is discussed in this subsection. The runway system consists of the runway pavement, shoulders, blast pads, RSA, OFA, OFZ, and RPZ. As the City plans to permanently decommission Runway 18-36 and convert it to a taxiway, the evaluation of DAL's runway system was focused exclusively on Runways 13L-31R and 13R-31L.

Runway Length and Width

Runway 13L-31R is 7,752 feet long and Runway 13R-31L is 8,800 feet long. Based on current performance capabilities of the most common large aircraft operating at the Airport (Boeing 737-700/800), the current runway lengths are adequate to serve all domestic U.S. markets. If international service is initiated at DAL, extended range versions of these aircraft types have the capability to serve all of Central America, the Caribbean, and Canada when departing on Runway 13R-31L. The northern extents of South America, such as Colombia, Venezuela, and Ecuador, could be served nonstop with the Boeing 737-700 and Boeing 737-800 aircraft. Therefore, the extension of Runway 13L-31R or 13R-31L is not warranted to serve the current and potential destination markets from the Airport.

Runway Design Criteria

The FAA-recommended runway design criteria for RDC D-III and D-IV are presented in **Table 4-9**, along with existing runway characteristics at the Airport. With the exception of the blast pads associated with Runways 13L, 13R, and 31L, the existing runways at the Airport comply with recommended design criteria for RDC D-III and D-IV. Although there is no record of any modifications to design standards associated with the blast pads, they are respectively 15 feet, 3 feet, and 2 feet shorter than the minimum length of 200 feet prescribed in FAA's design standards for an RDC D-III runway.

Table 4-9: FAA Runway Design Criteria Compliance Summary

RUNWAY DESIGN ELEMENTS	CURRENT CONFIGURATION (FEET)	RDC D-III / D-IV DESIGN CRITERIA (FEET)
Runway Width	150	150
Runway Shoulder Width	25	25
Runway Blast Pad (width/length)		
Runway 13L	200 / 185	200 / 200
Runway 31R	200 / 197	200 / 200
Runway 13R	200 / 200	200 / 200
Runway 31L	198 / 200	200 / 200

NOTE: RDC = Runway Design Code.

SOURCE: Federal Aviation Administration, Advisory Circular 150/5300-13A, *Airport Design* (Change 1), February 2014.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

Lateral Runway Separation Criteria

As shown in **Table 4-10**, the lateral separations between the runways and their associated taxiways meet or exceed the lateral separation requirements for both ARC D-III and D-IV. The lateral separation between the runways and the adjacent apron areas is also adequate.

Table 4-10: FAA Lateral Runway Separation Compliance Summary

RUNWAY DESIGN ELEMENTS	CURRENT CONFIGURATION (FEET)	ARC D-III /D-IV (FEET)
Runway Centerline to Taxiway Centerline between:		
Runway 13R-31L and Taxiway C	400	400
Runway 13L-31R and Taxiway B	552 [1/]	400
Runway 13L-31R and Taxiway A	400	400
Aircraft Parking Area between:		
Runway 13L-31R and the Apron East of Taxiway A	550 [2/]	500
Runway 13L-31R and the Apron West of Taxiway B	645 [3/]	500

NOTES: ARC = Airport Reference Code.

1/ At the closest point on Taxiway B to Runway 13L-31R

2/ At the closest point on the western edge of the vehicle service road of the apron east of Taxiway A.

3/ At the closest point on the eastern edge of the vehicle service road of the apron west of Taxiway B.

SOURCE: Federal Aviation Administration, Advisory Circular 150/5300-13A, *Airport Design* (Change 1), February 2014.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

Pavement Strength

In accordance with FAA AC 150/5320-6D, *Airport Pavement Design and Evaluation*, the runway pavement must be able to support frequent operations of the aircraft types that currently operate at the Airport, as well as aircraft projected to operate at the Airport in future years. In general, runway pavement strength can be expressed in terms of its load-bearing capacity under single wheel, dual wheel, dual tandem wheel, and double dual tandem wheel loading. The aircraft landing gear type and configuration dictate how aircraft weight is distributed on the pavement and determine pavement response to loading. Examination of gear configuration, tire contact areas, and tire pressure indicates that pavement strength is related to aircraft MTOW.

The load bearing capacities of Runways 13L-31R and 13R-31L are 100,000 pounds for aircraft equipped with single wheel landing gear, 200,000 pounds for aircraft equipped with dual wheel landing gear, and 350,000 pounds for aircraft equipped with dual tandem wheel landing gear. Aircraft with single wheel landing gear projected to use the Airport on a regular basis include primarily single- and multi-engine GA aircraft, including some business jets. These aircraft generally have an MTOW of less than 60,000 pounds, which is less than the load bearing capacity of Runways 13R-31L and 13L-31R for single wheel landing gear.

The largest aircraft with dual wheel landing gear projected to use the Airport on a regular basis through the planning period is the Boeing 737 (or equivalent). This landing gear configuration is common for other narrowbody aircraft, such as all variants of the A319 and A320. Nearly all aircraft in this group have an MTOW of less than 200,000 pounds; both Runways 13R-31L and 13L-31R can support the pavement loading imposed by aircraft currently using and projected to use the runways throughout the planning period. No aircraft with dual tandem landing gear are projected to use the Airport on a regular basis through the planning period.

No enhancement of pavement strength should be required for either runway through the planning period, given the aircraft types projected to operate at the Airport. It should be noted that pavement design typically allows for aircraft weighing more than the design pavement strength to operate occasionally on the pavement. This is of particular importance for large fire-fighting tankers or other aircraft that occasionally use the Airport with weight and gear configurations that exceed the identified load bearing capacity of the runway.

4.2.3 RUNWAY PROTECTION AREA CRITERIA

The FAA's design standards for the various airfield safety and protection areas, as they relate to the Airport, are presented in this subsection. These areas were introduced in Section 2 and are illustrated on the Airport Layout Plan (ALP) set. Airfield safety and protection areas evaluated for the Airport include RSAs, ROFAs, OFZs and RPZs.

4.2.3.1 Runway Safety Areas

RSAs are rectangular areas centered on runway centerlines, which, under normal (dry) conditions, are capable of supporting the occasional passage of an aircraft without causing structural damage to the aircraft or injury to its occupants if an aircraft were to inadvertently leave the paved runway surface. To serve this function, the FAA requires RSAs to be (1) cleared and graded, (2) drained by grading or storm sewers to prevent water accumulation, (3) capable, under dry conditions, of supporting snow removal and ARFF equipment, and (4) free of objects, except those that need to be located in the RSA because of their function (e.g., approach lighting).

Based on FAA design criteria for RDC D-III, the RSAs for Runways 13L-31R and 13R-31L should be 500 feet wide (i.e., 250 feet on either side of the runway centerline) and extend 1,000 feet beyond the runway ends. These criteria are also applicable to runways with an RDC of D-IV. Currently, the RSAs for both runways meet the applicable design criteria.

4.2.3.2 Runway Object Free Areas

ROFAs are rectangular areas centered on runway centerlines that are required to be clear of objects protruding above the RSA edge elevation, with the exception of those objects that are essential to air navigation or aircraft ground maneuvering.

For ARC D-III runways (Runways 13L-31R and 13R-31L), ROFAs must be 800 feet wide (i.e., extending 400 feet on either side of the runway centerline) and extend 1,000 feet beyond the runway ends. The ROFA length beyond the end of the runway does not exceed the standard RSA length beyond the runway end. All runways at the Airport meet the ROFA design criteria. These criteria are also applicable to runways with an RDC of D-IV.

4.2.3.3 Obstacle Free Zones

An OFZ is a volume of airspace centered on a runway centerline below 150 feet above the established airport elevation that is required to be clear of all objects, except for frangible navigational aids that need to be located in the OFZ because of their function. The OFZ provides clearance protection for aircraft arrivals, departures, and missed approaches.

The OFZ is intended to protect an aircraft's transition from the ground to airborne operations (and vice versa). Airports with non-precision instrument approach procedures are only required to comply with the runway component of the OFZ criteria, while airports with precision instrument approach procedures or approach lighting systems are required to comply with additional requirements. FAA criteria prohibit taxiing, parked aircraft, and object penetrations within OFZs, except for frangible navigational aids with fixed locations. Applicable elements of the Airport's OFZ are described as follows:

- **Runway OFZ:** In general, the required runway OFZ is typically 400 feet wide for runways serving large aircraft, and all OFZs extend 200 feet beyond the runway ends. All runways at the Airport meet these runway OFZ design criteria.
- **Inner-approach OFZ:** The inner-approach OFZ is a volume of airspace centered on the approach area that applies only to runways equipped with approach lighting. Therefore, the inner-approach OFZ applies to Runways 13L, 31R, and 31L. The inner-approach begins 200 feet from the runway threshold and extends 200 feet beyond the last unit in the approach lighting system. It has the same width as the runway OFZ and rises at a slope of 50:1 away from the runway end. Any objects that penetrate the inner-approach OFZ are listed on the Airport Obstruction Chart.

- **Inner-transitional OFZ:** The inner-transitional OFZ is a defined volume of airspace along the sides of the runway and inner-approach OFZ. It applies only to runways with lower than ¾ statute-mile approach visibility minimums. Runways 13L, 31R, and 31L have approaches with visibility minimums lower than ¾ statute mile. Therefore, these runways are subject to inner-transitional OFZ object clearance restrictions. Any objects that penetrate the inner-transitional OFZ are listed on the Airport Obstruction Chart.

Analysis of the runway OFZ, inner-approach OFZ, and inner-transitional OFZ, which constitute the OFZ, did not reveal any penetrations of the OFZ surfaces or other OFZ impacts. Therefore, the Airport currently meets the OFZ requirements for both ARC D-III and D-IV.

4.2.3.4 Runway Protection Zones

The RPZ is a trapezoidal area centered on the extended runway centerline. The length and width of the RPZ are contingent on the size of aircraft operating on the runway, as well as the type of approach (i.e., visual or instrument) and the available approach minimums. RPZs are designed to enhance the protection of people and property on the ground. To achieve this goal, the FAA recommends that the airport operator own or otherwise control the property in the RPZ. This area should be free of land uses that create glare and smoke. Additionally, the FAA recommends that airport operators keep the RPZs clear of incompatible land uses, specifically residences, fuel storage facilities, and places of public assembly (e.g., churches, schools, office buildings, and shopping centers). Typically, a single RPZ is associated with each runway end. However, the FAA has suggested that separate approach and departure RPZs be defined for any runway end with a displaced arrival threshold. Runways 13L and 13R have displaced thresholds of 400 feet and 490 feet, respectively. Therefore, both approach and departures RPZs were evaluated for these two runway ends.

The FAA provides dimensional criteria for RPZs that are based on the lowest runway approach visibility minimums and the AAC associated with each runway. Approach and departure RPZ dimensions, respectively, for each runway end are presented in **Table 4-11** and **Table 4-12**.

Table 4-11: Approach Runway Protection Zone Dimensions

RUNWAY	VISIBILITY MINUMUMS	INNER WIDTH (FEET)	OUTER WIDTH (FEET)	LENGTH (FEET)	DISTANCE FROM THRESHOLD (FEET)
13L	1,800 feet	1,000	1,750	2,500	200
31R	½ mile	1,000	1,750	2,500	200
13R	¾ mile	1,000	1,510	1,700	200
31L	1,800 feet	1,000	1,750	2,500	200

SOURCE: Federal Aviation Administration, Advisory Circular 150/5300-13A, *Airport Design* (Change 1), February 2014.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

Table 4-12: Departure Runway Protection Zone Dimensions

RUNWAY	VISIBILITY MINIMUMS	INNER WIDTH (FEET)	OUTER WIDTH (FEET)	LENGTH (FEET)	DISTANCE FROM THRESHOLD (FEET)
13L	1,800 feet	500	1,010	1,700	200
13R	¾ mile	500	1,010	1,700	200

SOURCE: Federal Aviation Administration, Advisory Circular 150/5300-13A, *Airport Design* (Change 1), February 2014.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

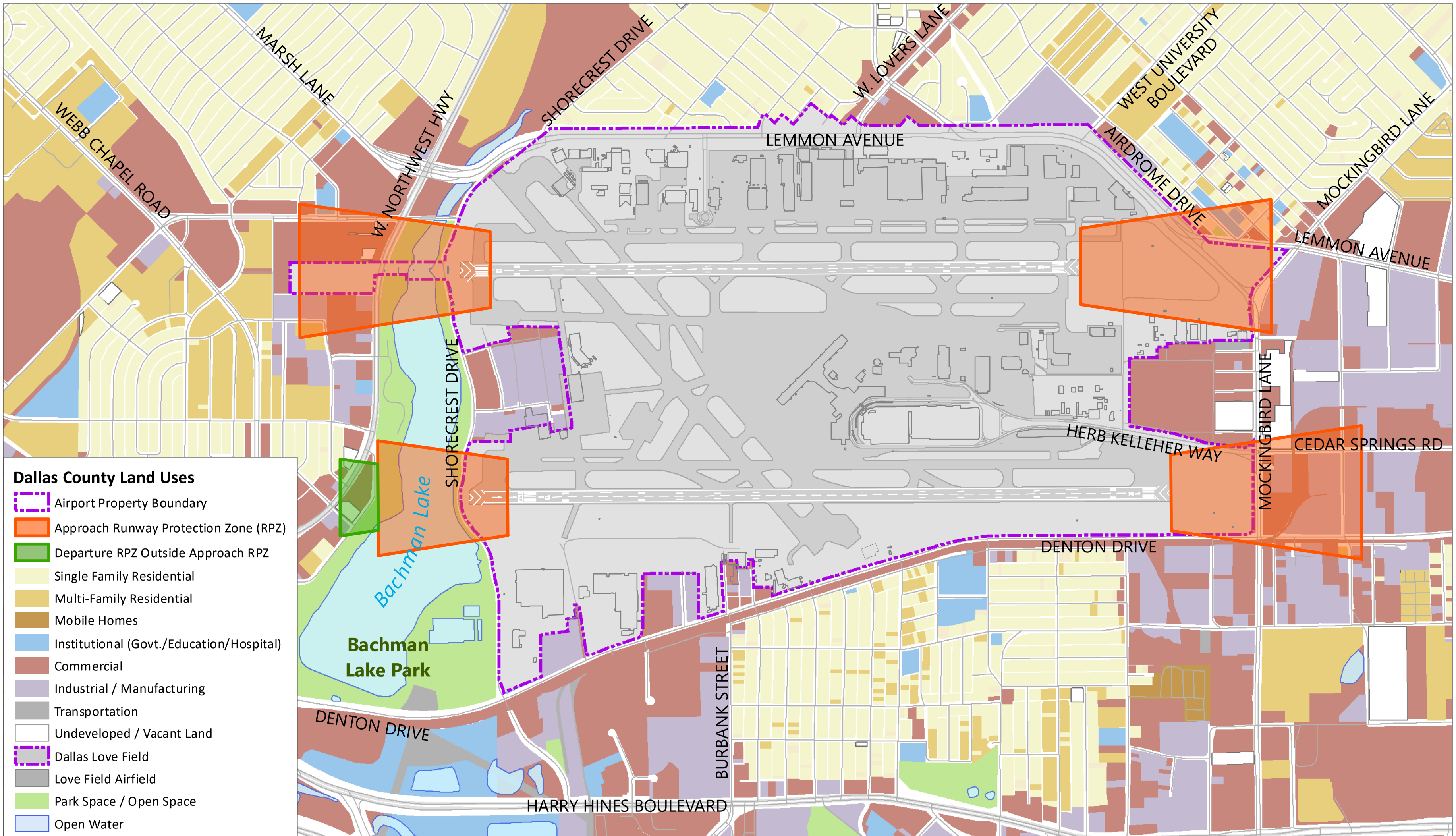
Currently, the RPZs do not fall within the Airport property boundary and these areas have noncompatible land uses. As shown in **Table 4-13** and on **Exhibit 4-8**, commercial development is located within the boundaries of all four RPZs. Additionally, residential properties are located within the RPZs for Runways 13R and 31R, while some industrial land use is located within the RPZ for Runway 31L. In addition, several roads encroach on these RPZs. An avigation easement has been granted for the Runway 13R medium intensity approach lighting system with runway alignment indicator lights (MALSR), but most of the property within the RPZs is currently not controlled by the Department of Aviation. According to the FAA's *Memorandum regarding Interim Guidance on Land Uses within a Runway Protection Zone*,[7] public roads, residential areas, and buildings, such as industrial buildings, should not be located within an RPZ and the FAA recommends that "airport sponsors take all possible measures to protect against and remove or mitigate incompatible land uses."

Table 4-13: Roads and Area Uses Located within the Runway Protection Zones

RUNWAY END	ROADS ENCROACHING ON RPZ	USE OF AREA WITHIN RPZ
13L	Northwest Highway, Shorecrest Drive, Bachman Lake Park	Mostly commercial
31R	Airdrome Drive, Lemmon Avenue, and Mockingbird Lane	Residential and commercial
13R	Bachman Lake Park, Shorecrest Drive	Residential and commercial
31L	Mockingbird Lane, Herb Kelleher Way/Cedar Springs Road, Denton Drive	Mostly commercial and industrial

SOURCES: Google Earth Pro (accessed January 2014); AirOps, LLC, January 2014.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

7 Memorandum published by the FAA Office of Airport Planning and Programming on September 27, 2012.



SOURCE: North Central Texas Council of Governments, GIS Clearinghouse, June 2010; City of Dallas, GIS Services, 2013 Certified Tax Parcel Coverage, accessed online: http://gis.dallascityhall.com/EnterpriseGIS, August 2014.
PREPARED BY: Ricondo & Associates, Inc., January 2015.

EXHIBIT 4-8

Developments within Runway Protection Zones

Z:\Love Field\GIS\Environmental Overview MXD\DAL_EO_Land_Use_Airfield_20150403.mxd

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4.2.4 TAXIWAY SYSTEM

This section documents the ability of the taxiway system at DAL to accommodate the existing and projected aircraft fleet mix. The airfield's taxiway system consists of the taxiway pavement shoulders, taxiway safety area, and taxiway OFA. A review of runway exit taxiways and other runway crossings to ensure compliance with the FAA's runway incursion mitigation initiatives set forth in AC 150-5300-13A is also discussed.

4.2.4.1 Taxiway Design Criteria

As previously discussed, taxiway pavement widths and fillet geometry standards are dictated by TDG standards. The most common aircraft operating at the Airport is the Boeing 737, which dictates TDG 3 standards. However, several other ADG III aircraft types operate at DAL and are classified as TDG 5. Among those aircraft, the MD-87 and MD-90 are classified as TDG 5. TDG 5 also applies to some ADG IV aircraft, including the Boeing 757 and Boeing 767, which are the two ADG IV aircraft based at the Airport. Therefore, this analysis was focused on TDG 5 design standards and evaluation of the existing airfield for compliance with those standards.

With the exception of Taxiways E, G, and W, which are 50 feet wide, all other taxiways at DAL are 75 feet wide and meet FAA width requirement for TDG 5. The lateral separation between the Taxiway P and Q centerlines of 152 feet meets ADG III standards, but is less than ADG IV requirements (lateral separation of 215 feet between parallel taxiways). All 75-foot-wide taxiways comply with TDG 5 edge safety margin requirements and shoulder requirements. Further analysis would be required to determine if all taxiways comply with TDG 5 pavement fillet requirements.

Taxiway protection and separation standards, such as the taxiway OFA and lateral separation to parallel taxiways/taxilanes, are based on ADG, not TDG. All 75-foot-wide taxiways at the Airport meet the requirements for ADG III: taxiway safety area width of 118 feet and the taxiway OFA width of 186 feet. ADG IV design standards for taxiway safety areas and taxiway OFAs are more demanding than ADG III standards. The width requirements for the taxiway safety area and taxiway OFA for ADG IV aircraft are 171 feet and 259 feet, respectively. With the exception of Taxiways P and Q, all taxiways at the Airport that comply with ADG III standards also comply with ADG IV standards. The limitation of Taxiway P results from the location of the remain overnight (RON) "B" area, with a boundary 93 feet from the Taxiway P centerline.

4.2.4.2 Runway Exit/Entrance Taxiways

FAA AC 150/5300-13A presents updated standards for taxiway/runway intersections to reduce the risk of runway incursions. The geometry of several taxiway intersections at the Airport does not comply with FAA design standards and needs to be improved to be in compliance. In particular, confusing and complex intersections should be avoided and taxiways should not lead directly from an apron to a runway. **Exhibit 4-9** presents the intersections that are not in compliance with FAA standards and **Table 4-14** lists these intersections and the reasons they are not compliant with FAA design standards.

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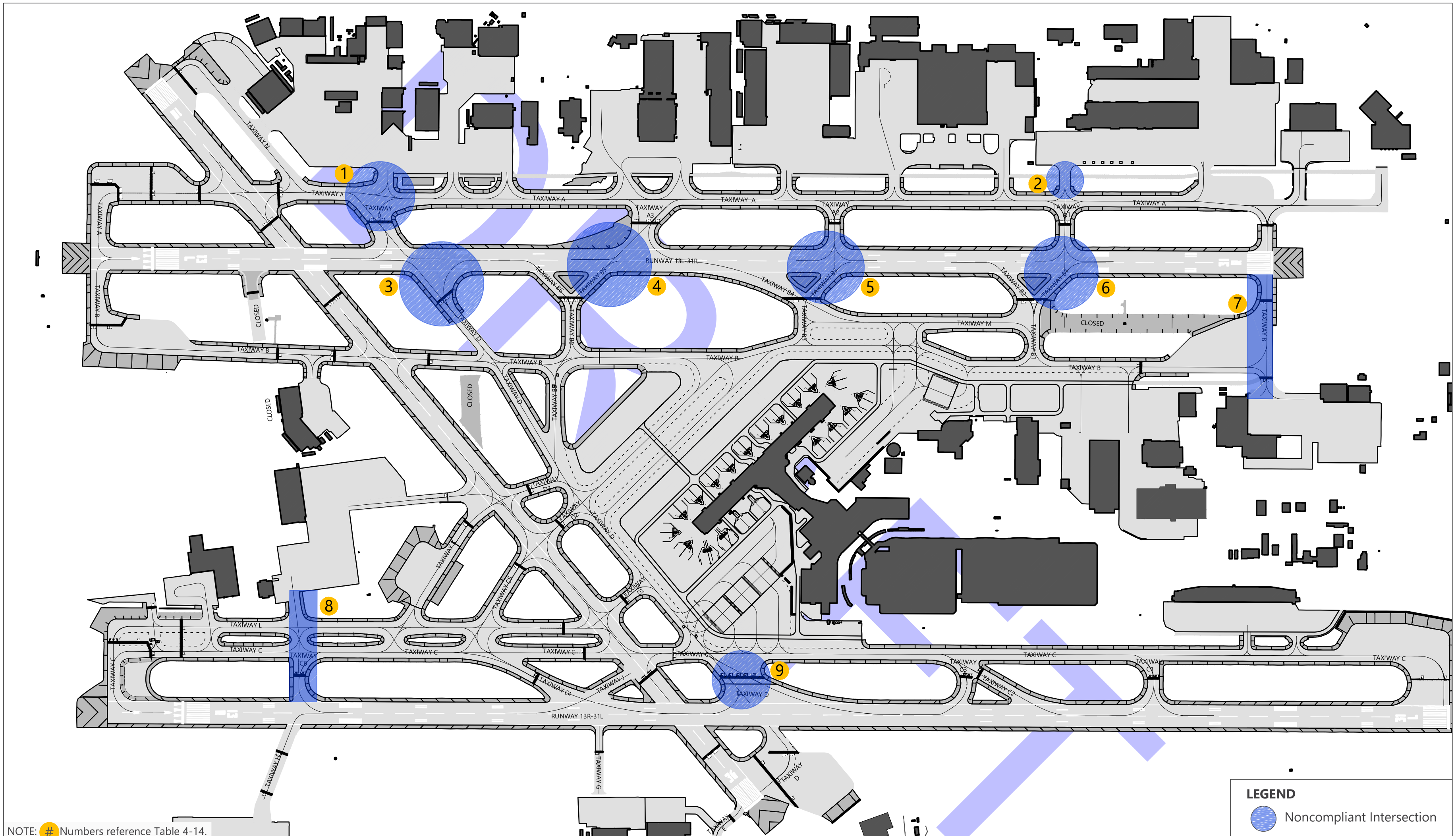

NOTE: # Numbers reference Table 4-14.

SOURCES: Dallas Love Field Airport Layout Plan, 2001; Ricondo & Associates, Inc., February 2014.
PREPARED BY: Ricondo & Associates, Inc., September 2014.

EXHIBIT 4-9

NORTH 0 1,000 ft.

Noncompliant Intersections

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Table 4-14: Noncompliant Runway Exits

RUNWAY EXIT	LOCATION	WHY IS IT NONCOMPLIANT?
1	Taxiway D and Runway 13L-31R Intersection East of Runway 13L-31R	Direct access from apron to runway
2	Runway 13L-31R and Taxiway A1 Intersection	Direct access from apron to runway
3	Runway 13L-31R and Taxiway D Intersection West of Runway 13L-31R	Geometry limits pilot visibility.
4	Runway 13L-31R and Taxiways B5/A3 Intersection	Nonperpendicular runway crossing
5	Runway 13L-31R and Taxiways B3/A2 Intersection	Nonperpendicular runway crossing and runway crossing point in the middle third of the runway
6	Runway 13L-31R and Taxiways B1/A1 Intersection	Nonperpendicular runway crossing
7	Runway 13L-31R and Taxiway B Intersection	Direct access from GA apron to runway
8	Runway 13R-31L and Taxiway C6/H Intersection	Direct access from apron to runway
9	Runway 13R-31L and Taxiway D Intersection	Direct access from terminal apron to runway; crossing in the middle third of the runway

SOURCE: Federal Aviation Administration, Advisory Circular 150/5300-13A (Change 1), *Airport Design*, February 2014.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

4.2.4.3 Runway Exit Analysis

To develop runway exit improvements, as discussed in Section 5, it is necessary to understand the current runway exits used to minimize the effects of the recommended improvements on aircraft operations.

The runway exit analysis was focused on the taxiways serving Runways 13L-31R and 13R-31L. The aircraft fleet mix associated with the two parallel runways differs. Approximately 63 percent of the GA tenant facilities are located northeast of Runway 13L-31R; therefore, a majority of GA aircraft operations at the Airport are accommodated on this runway. To determine the mix of aircraft using the various runway exits, operational data from the ANOMS were reviewed.

The purpose of this analysis was to determine if the existing runway exit locations are optimal to minimize runway occupancy times. The Runway Exit Design Interactive Model (REDIM) was used to consider specific airfield variables that affect the landing performance of aircraft, as well as important operational constraints (e.g., aircraft mix) that have a direct effect on exit locations and geometries.

Runway 13R-31L and Associated Exits

Runway 13R-31L primarily serves air carrier aircraft, as most GA facilities are located on the opposite side of the airfield. Aircraft landing on Runway 13R can exit at five locations: Taxiways J, D, C3, and C1 and at the end of the runway. Aircraft arriving on Runway 31L can also exit at five locations: Taxiways C2, D, C4, and C6 and at the end of the runway. Taxiway C1 is not considered an exit for aircraft arriving on Runway 31L because the taxiway is located less than 800 feet from the touchdown markings. Runway exits on Taxiways C2, C4, and D are classified as angled exits, as they are acute-angle runway exit taxiways that form a 30-degree angle with the runway centerline.

Runway 13L-31R and Associated Exits

Runway 13L-31R is the primary runway for GA traffic because of its proximity to GA facilities and FBOs located on the northeast side of the airfield. This runway is expected to continue to remain the primary runway for GA activity, while also continuing to serve air carrier aircraft.

Air carrier aircraft arriving on Runway 13L can exit at four locations to reach the gates located southwest of the runway: Taxiways B6, B4, and B2 and at the end of the runway. Taxiway D is located too close to the runway touchdown markings to be considered a runway exit. Taxiways B2 and B4 are the only angled exit taxiways available for arrivals on Runway 13L. To reach the GA facilities on the northeast side of the airfield, GA traffic can exit at four locations: Taxiways A3, A2, and A1 and at the end of the runway; all of these exits are right-angled.

Runway 31R has four exits for aircraft that require access to the midfield area: Taxiways B3, B5, and D and at the end of the runway. None of these are angled exit taxiways. Taxiway B1 is not considered an exit for aircraft arriving on Runway 31R given its distance from the runway touchdown markings. GA aircraft use four exits: Taxiways A2, A3, and D and at the end of the runway. None of these exits are high-speed exit taxiways.

Planning Considerations

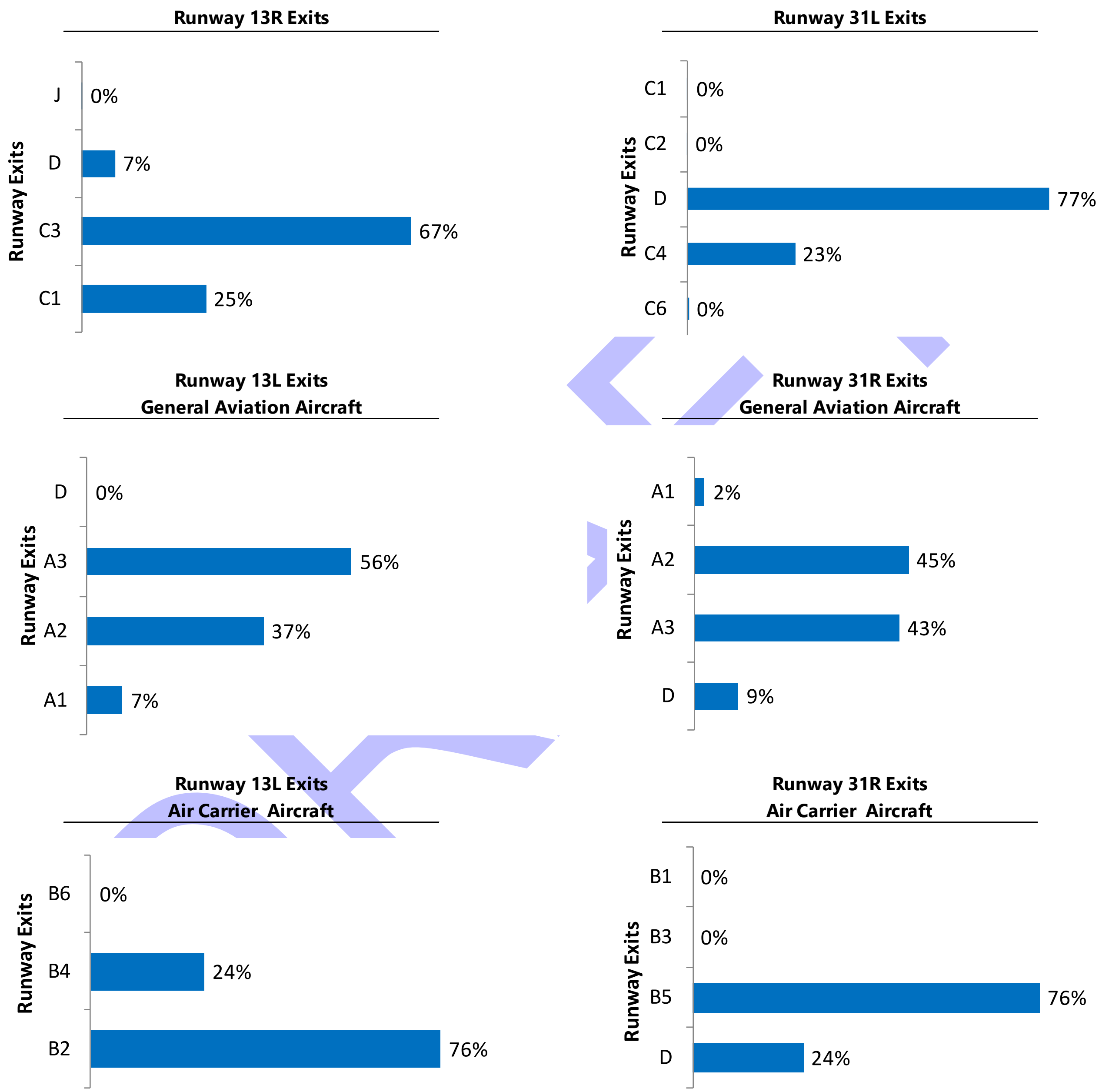
In the runway exit analysis, the following were considered:

- **Aircraft fleet mix:** The 2012 ANOMS database was used to determine the number and share of operations per aircraft type and the fleet mix using each runway. The same aircraft fleet mix was considered for Runways 13L and 31R; similarly, the same fleet mix was used for Runways 13R and 31L.
- **Wet pavement conditions:** In accordance with historical occurrences of precipitation at DAL, wet pavement conditions, which occur at least 10 percent of the time, were considered.
- **Runway 18-36**: This runway is considered decommissioned and its use as a taxiway for Runways 13L-31R and 13R-31L exits was not evaluated because the geometry and location of the runway intersections would not benefit arrivals on the parallel runways.

Results

Exhibit 4-10 shows the results of the analysis for each runway end. The results for air carrier aircraft and general aviation aircraft were combined for Runways 13R and 31L, as most aircraft exit the runways to the northeast side of the airfield onto Taxiway C or L. Separate analyses for landings on Runways 13L and 31R, however, are warranted, as most general aviation aircraft exit onto Taxiway A, while air carrier aircraft exit onto Taxiway B to access the terminal area.

Exhibit 4-10: Runway Exit Use Results



SOURCES: Runway Exit Design Interactive Model, March 2014; Airport Layout Plan Base Map, March 2014; Ricondo & Associates, Inc., March 2014.
PREPARED BY: Ricondo & Associates, Inc., March 2014.

The results and conclusions of the runway exit analysis are summarized as follows:

- **Runway 13R:** Taxiway J is rarely used and could be closed. Most aircraft arriving on Runway 13R use Taxiways C3 and C1 to exit the runway.
- **Runway 31L:** Taxiways C2 and C6 are rarely used by aircraft arriving on Runway 31L. However, Taxiway C6 is the only taxiway leading to Taxiway H, which provides access for aircraft taxiing to the Southwest Airlines maintenance base; therefore, it must remain open. Most arrivals use Taxiway D.
- **Runway 13L:** It may be possible to further reduce runway occupancy times by reconfiguring Taxiway A3 as a high speed taxiway exit.
- **Runway 31R:** Taxiways A1 and B3 are rarely used by aircraft landing on Runway 31R, but Taxiways B5, A2, A3, and D are frequently used.

4.2.4.4 Other Taxiway Enhancements

Additionally, during discussions with DAL ATC representatives, it was suggested that the geometry of angled taxiway exits off Runway 13R be enhanced to reduce runway occupancy times and, therefore, increase the capacity of the runway.

4.2.5 AIRFIELD LIGHTING, MARKING AND SIGNAGE, AND NAVIGATIONAL AIDS

4.2.5.1 Airfield Lighting

Airfield lighting systems generally include runway lighting, taxiway/taxilane lighting, and airport identification lighting (beacon).

The MALSRs installed off the approach ends of Runways 13L, 31R, and 31L are appropriate to support the ILS precision instrument approaches published for these runways and no lighting improvements are necessary, except to maintain the effectiveness and efficiency of the systems through routine maintenance and technology upgrades, or to support any future airfield development. Runway 13R is not equipped with an approach lighting system, but is equipped with high intensity runway lights (HIRL) and runway centerline lights that make it usable at night. However, ATC representatives at the Airport suggested that the Runway 13R approach lighting be improved and that a MALSR be added to Runway 13R to enhance airfield flexibility and reliability at night and in poor weather conditions.

Existing taxiway/taxilane lighting is adequate to guide aircraft between runways and aircraft parking areas. Additionally, the rotating beacon located on top of the ATCT above the main terminal and within 5,000 feet of the runways provides an unobstructed beam sweep and is, therefore, appropriately positioned.

4.2.5.2 Airfield Marking and Signage

According to FAA AC 150/5340-1K, *Standards for Airport Markings*, Runway 13L, 13R, and 31L markings are appropriate for the designated ILS precision approach procedures and all markings are reported to be in good condition. All other markings on the airfield, such as Runway 31R markings, taxiway markings, hold position markings, and other required markings, comply with FAA guidance. According to FAA AC 150/5340-18, *Standards for Airport Sign Systems*, no signage deficiency has been identified. However, changes to the airfield marking and signage may be necessary to support future airfield improvements.

4.2.5.3 Navigational Aids

Navigational aids at the Airport include visual navigational aids, electronic navigational aids, and weather reporting equipment.

The lighted wind cones located at each end of Runways 13L-31R and 13R-31L, the PAPIs installed on the approach ends of the two runways, and the existing instrument approach procedures published for the Airport are appropriate and no issue has been reported. Therefore, no additional visual or electronic navigational aids should be required at the Airport through the planning period. Any future instrument approach procedures developed for the Airport will likely be based on satellite technology, which may not require the installation of physical equipment at the Airport.

Weather equipment installed on the airfield consists of an Automated Surface Observing System (ASOS)[8] located in the same equipment area as the Runway 13R glideslope antenna and a Low Level Windshear Alert System (LLWAS) located east of Runway 18-36 and north of Taxiway B. These two pieces of equipment meet siting standards and function properly. No additional weather reporting equipment is likely to be required through the planning period, except as required to upgrade or replace existing systems.

4.3 Passenger Terminal Facility Requirements

The methodologies used to program the individual areas of the passenger terminal were identified in the Love Field Modernization Program. The terminal facility requirements identified in the LFMP are assumed to be adequate to meet forecast demand based on the LFMP planning process and conclusions. Therefore, a traditional demand/capacity analysis of terminal facilities was determined to be unnecessary for the Master Plan Update. Also, given that the terminal is a new structure completed in October 2014, this section summarizes the way and the levels of demand for which the modernized terminal was initially planned. Each major area of the terminal building was programmed and designed based on a variety of studies, analyses, and simulation modeling runs. Legislative requirements set limits on the number of gates the terminal should ultimately include, thereby constraining terminal demand and affecting its future design. Airport space programming and design are typically predicated on numbers of enplaned passengers and/or aircraft operations derived for a peak hour, peak month average day, or annual basis. The space requirements for many other components of the terminal, such as the ticketing hall, baggage claim areas, security screening checkpoint, aircraft gates, and concessions space, are typically calculated from these numbers.

8 http://www.faa.gov/air_traffic/weather/asos/?airportId=KDAL.

4.3.1 TICKETING HALL

The ticketing hall space program was developed using the number of peak hour originating passengers from the activity forecasts. The number of originating passengers in the peak hour was adopted from the future flight schedule developed for the LFMP project, which was based on the TARPS. The LFMP documentation of the Ticketing Hall Simulation, included in **Appendix G**, discussed a potential 15 percent reduction in the ticketing hall space program from the original design for potential cost savings. To ensure that the potential reduction would not affect passenger level of service, in April 2010, TransSolutions conducted a simulation to determine the level of service for a variety of design options (also included in Appendix G). Ultimately, a reduction with a 'Modified Three Pod" design was recommended for the ticketing hall.

4.3.2 BAGGAGE CLAIM AREAS

Baggage claim areas, similar to the ticketing hall, aircraft gates, and concession space, are typically planned using the information from aviation activity forecasts. From this information, a design day activity analysis with peak 20-minute periods was derived and used to size baggage claim facilities. In the case of the new terminal at DAL, the TARPS and the projected 2014 flight schedule were used to develop baggage volumes. This information is set forth in the *Inline Checked Baggage Inspection System* design report prepared by Vic Thompson Company, dated April 15, 2011.

It should be noted that, because of the limit of 20 gates in the new terminal, the peak period of 20 minutes was modified to 10 minutes to size the required system and spaces as described in the above-mentioned report.

4.3.3 SECURITY SCREENING CHECKPOINT

The design of an SSCP can be complex as a result of several factors. These include defining sufficient space for the screening equipment, providing a sufficient number of SSCP lanes to minimize passenger waiting times, providing a adequate amount of queuing space, and including sufficient support space for supervisors and daily operations, such as break rooms. The guidance for designing SSCPs to meet these needs for airports nationwide (and specifically at DAL) is included in the TSA's *Checkpoint Design Guide* (CDG).[9] The SSCP at DAL was programmed and designed using CDG Revision 3.0, dated March 10, 2011.

Included in **Appendix H** is an extract of the results of the TSA's REGAL model of the SSCP. The model uses inputs determined by the number of checkpoint lanes available, the amount of security/scanning equipment used, the projected number of passengers per hour, and passenger wait time goals to achieve an output of average delay and to ultimately determine if the number of checkpoints is sufficient. For the model shown in Appendix H, 16 lanes and four explosives detection system (EDS) machines were used as inputs. The output was a weekly maximum average wait time of 10 minutes, 27 seconds.

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9 Transportation Security Administration, Revision 4.0, August 29, 2012. Leo A Daly (Author) http://www.aci-na.org/sites/default/files/Checkpoint_Design_Guide_%28CDG%29_Rev_4_0.pdf

4.3.4 AIRCRAFT GATES

The number of required gates for the new terminal was developed from an analysis of previous Master Plan analyses and the Five Party Agreement TARPS. As previously noted, the Five Party Agreement and TARPS required the City of Dallas to reduce the number of gates available for commercial air service at DAL to no more than 20. The executive summary of the Five Party Agreement TARPS is included as **Appendix I**.

4.3.5 CONCESSIONS SPACE

Appendix J documents discussions regarding the programming of concessions space at DAL. In a memorandum issued by Unison Consulting to the Department of Aviation, dated January 12, 2009, the concessions space requirements for the LFMP are noted as 9.0 square feet for 1,000 annual enplaned passengers. According to Unison's analysis, the terminal would have adequately sized concessions in the near term; however, concessions spaces would be insufficient to meet long-term demand. Also included in Appendix J is an email from Gresham Smith and Partners noting agreement with the short-term concessions program, but expressing concern regarding the long-term approach.

4.4 Airport Parking Facility Requirements

Automobile parking for DAL passengers and other users of the Airport can be categorized as on-Airport and off-Airport. On-Airport facilities are managed by the Parking Company of America (PCA) under contract with the City. Off-Airport facilities are privately owned and operated. The City also maintains a cell phone waiting lot, as well as several parking facilities for employees at the Airport. **Exhibit 4-11** shows the various on-Airport public and employee parking facilities addressed in this Master Plan Update. Other parking facilities on Airport property are privately operated and managed by tenants and were not evaluated as part of the Master Plan Update parking analysis.

Space requirements for all on-Airport parking facilities maintained by the City are discussed in this section. Requirements were determined by estimating parking demand and rounding up to the nearest 10 spaces. Future requirements were determined by applying growth factors derived from forecast aviation activity. Requirements were compared to available capacity to identify surpluses and deficiencies. Design day requirements were estimated to correspond with spaces that would be needed to meet demand on a typical busy day. Peak day requirements were estimated to accommodate demand during very busy holiday periods or other special events. Some peak day demand could be accommodated in temporary overflow facilities that are only opened during peak periods rather than in more costly permanent facilities, as desired.

Exhibit 4-11: On-Airport Parking Facilities and Capacities

SOURCES: Google Earth Pro, March 2013; Ricondo & Associates, Inc., March 2013.
PREPARED BY: Ricondo & Associates, Inc., May 2013.

4.4.1 ON-AIRPORT PUBLIC PARKING

Dallas Love Field has two garages that serve all public parking needs. Garage A, closest to the terminal entrance, contains 2,980 parking spaces and serves more short-term parkers. The rate charged in Garage A is incremental, up to a maximum of $17 per day. Garage B is immediately adjacent to Garage A, slightly further from the terminal, and serves more long-term parkers; it contains 4,000 parking spaces. The rate charged in Garage B is also incremental, up to a maximum of $13 per day.

A parking analysis was completed in 2008 based on 2006 data.[10] The same methodology as used in the 2008 analysis was used in the Master Plan Update analysis, updating relevant data to appropriately reflect more current conditions.

10 Ricondo & Associates, Inc., *Dallas Love Field Public Parking Assessment*, Technical Memorandum issued to Roddy L. Boggus, Senior Vice President, Parsons Brinkerhoff, January 4, 2008.

4.4.1.1 Data Collection and Demand/Capacity Analysis

Prior to conducting the parking analysis, various parking data were obtained from the City, assuming calendar year 2012 as a base for estimating existing conditions. The 2012 data obtained included:

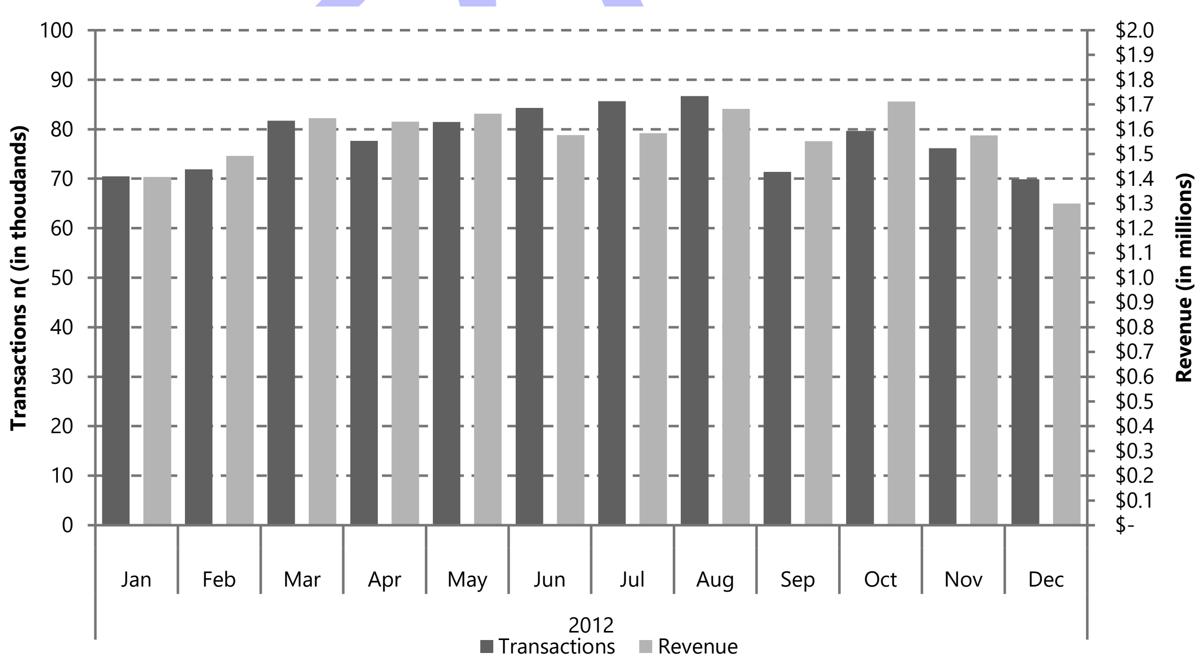
- Total parking spaces by facility
- Combined monthly total transactions and revenue collected by the parking revenue control system (PRCS) from TollTags and from other parking facility access modes (e.g., employee access cards)
- Daily TollTag transactions by facility
- Daily PRCS transactions by facility and parking duration
- Daily overnight occupancy counts by facility

Other qualitative and anecdotal information was obtained to supplement the quantitative data. The raw data were processed, analyzed, and organized to illustrate how the on-Airport public parking system operates, establish 2012 conditions and demand, and identify trends used to determine future requirements.

Transactions and Revenue

Exhibit 4-12 shows monthly transactions and revenue data for calendar year 2012, which indicate that October is the peak month for parking revenue. The data include all sources of transactions and revenue.

Exhibit 4-12: On-Airport Public Parking Transactions and Revenue



NOTE: Excludes TollTag data, which were not available.

SOURCES: Parking Company of America, April 2013; Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., May 2013.

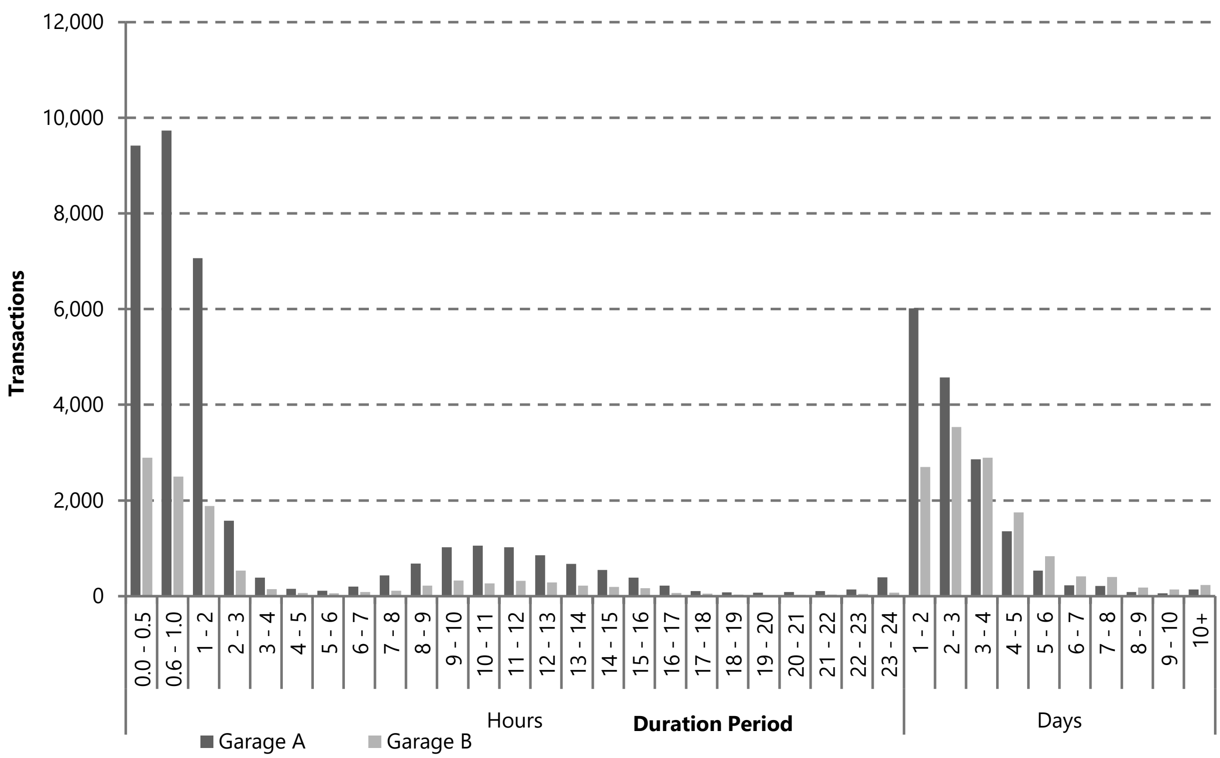
Duration Reports

Exhibit 4-13 shows transactions by duration for both garages. The operational differences between Garages A and B are most evident in these data. Garage A had more transactions for all parking durations up to 3 days. Garage B had more transactions for durations longer than 3 days.

The duration reports as received only provided data for transactions from PRCS ticket receipts and did not account for TollTag transactions, but it was assumed that the TollTag transaction profile would be similar to that produced by PRCS users.

Supplemental information provided by PCA indicated that, on typical busy days, Garage A fills to near capacity, causing staff to close it and forcing additional short-term parkers into Garage B. This may account for the significant number of short-duration (less than 3 hours) transactions occurring in Garage B. Also, more closures of Garage A occurred in October than in any other month of 2012 because of the high use of the garage without any holiday events, supporting the selection of October 2012 to represent typical busy demand.

Exhibit 4-13: On-Airport Parking Revenue Control System Transactions by Duration

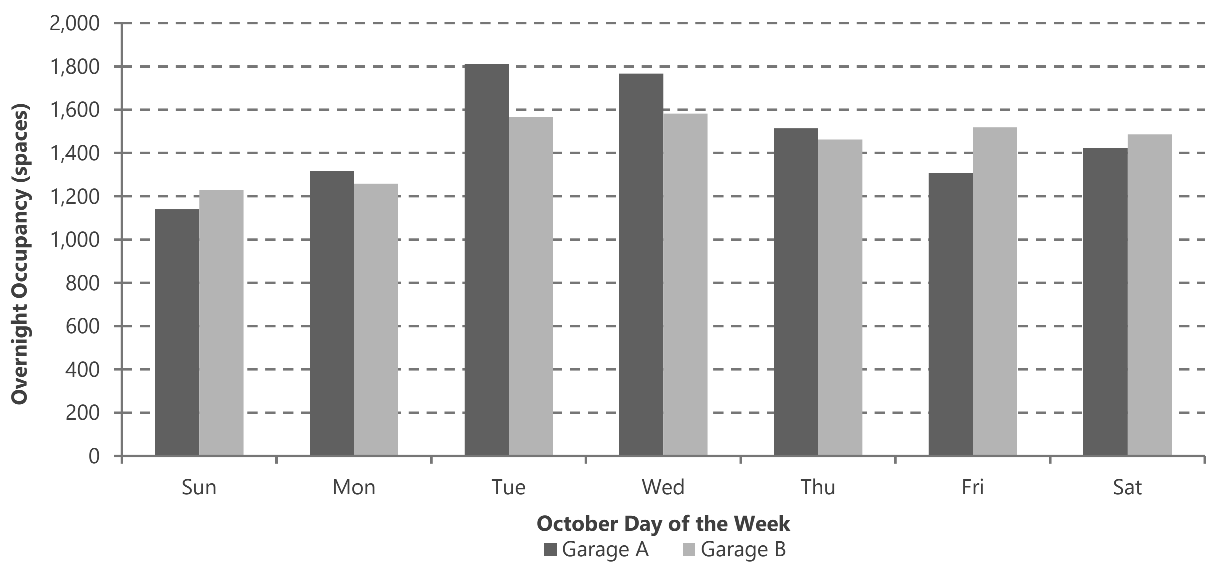


SOURCES: Parking Company of America, April 2013; Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., May 2013.

Overnight Occupancy Counts

Exhibit 4-14 shows a weekly profile of daily overnight occupancy levels in Garages A and B in October 2012. These data represent non-short-term parkers (i.e., some portion of parkers staying more than 9 hours and all parkers staying longer than 1 day). The use of Garage A, which is potentially used by a higher proportion of business travelers, peaks in the middle of the week. The use of Garage B also peaks in the middle of the week, but is more sustained toward the end of the week and over the weekend than the use of Garage A, possibly because of a higher proportion of leisure traveler use.

Exhibit 4-14: On-Airport Public Parking Overnight Occupancy



SOURCES: Parking Company of America, April 2013; Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., May 2013.

4.4.1.2 Estimating 2012 Demand

Passenger activity at the Airport is largely business in nature and parking trends reflect this. It was known that the daily occupancies in Garages A and B reach their peaks in the middle of the week during the busy months of the year. At such times, Garage A fills completely and overflow demand is accommodated in Garage B, which becomes a little more than half-full. The significant number of customers parking for multiple days in Garage A is potentially due to the predominance of business travelers at the Airport. Demand in the garages does not reach capacity at other times during the year, including holidays, although demand in long-term Garage B is higher than in Garage A during holiday periods. This holiday profile could be attributed to a decrease in business travelers, but also to an increase in leisure travelers who are more sensitive to the cost of parking.

Daily peak occupancies can be analyzed to determine demand for parking spaces, but because daily peak occupancies were not available from the PRCS, another method was used to estimate demand. Transaction data from the October 2012 duration report were used as the basis for estimating demand.

Daily transaction and revenue data for October 2012 were used to calculate average transactions, peak transactions, and the surge in transactions from the average to the peak. The peak days in October 2012 for Garages A and B, respectively, had 39.1 percent and 37.5 percent more transactions than the average day. These data were used to adjust estimates of demand from the average to the busy day. **Table 4-15** summarizes the calculations used to estimate demand in Garages A and B. See **Appendix K** for a more detailed table supporting the summarized calculations in Table 4-15. The actual calculations supporting this table were based on the shortest duration periods possible (as reported in the raw data) to maintain fidelity. The numbers in the table were aggregated for reporting purposes.

Table 4-15: 2012 On-Airport Public Parking Space Demand

		GARAGE A			GARAGE B				
		TRANSACTIONS			TRANSACTIONS				
FROM	TO	MONTHLY [1/]	BUSY DAY	BUSY DAY DEMAND	MONTHLY [1/]	BUSY DAY	BUSY DAY DEMAND	TOTAL BUSY DAY DEMAND	DURATION DISTRIBUTION
0 hour	3 hours	9,645	433	179	3,000	133	147	326	6.7%
3 hours	24 hours	4,493	202	1,370	1,436	64	1,127	2,497	51.4%
24 hours	∞	9,090	408	1,061	6,763	300	972	2,033	41.9%
	Total	**23,228**		**2,610**	**11,199**		**2,246**	**4,856**	**100.0%**
		% Full:		87.6%			56.2%		
		Estimated Overnight:		1,811			1,583	3,394	
		% Full:		60.8%			39.6%	48.6%	
		Actual Overnight:		1,812			1,583	3,395	
		% Full:		60.8%			39.6%	48.6%	
		% Different from Estimated:		0.0%			0.0%	0.0%	
		Capacity:		2,980			4,000	6,980	

NOTE:

1/ Parking revenue control system only.

SOURCES: City of Dallas, 2012; Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., May 2013.

An estimated turnover rate for each duration period was calculated based on a few assumptions. For those periods longer than 1 day, the turnover rate is simply the inverse of the average number of days for that period (e.g., for the 2 to 3 day period, the turnover rate would be 1/2.5). For shorter periods, the turnover rate was calculated based on the average parking duration, the assumed number of busy operational Airport hours per day (17), and an additional calibration factor.

The number of October 2012 transactions was divided by the number of days in the month (31) and then increased by the average-to-peak-day surges to estimate the number of busy day transactions. Busy day demand was then calculated by dividing the estimated number of busy day transactions by the estimated turnover rate to determine the required number of spaces.

To validate the calculations, the statistics provided at the bottom of Table 4-15 were calculated and compared. The estimated overnight demand was the summation of the estimated busy day demand for durations longer than 1 day and 70 percent of the demand for durations between 10 and 24 hours. The actual overnight demand represents the average overnight occupancy recorded in October 2012. Calibration factors for each facility were adjusted so that the estimated overnight demand matched actual demand.

When comparing demand to capacity, a practical capacity was used. To account for the inability to completely fill a facility, a level of service factor was applied. It was assumed that Garage A would fill to 90 percent before it would have to be closed and that Garage B would be closed when its occupancy approached 95 percent. Such closures are a customer service feature that prevent customers from spending excessive time searching for the few remaining unoccupied spaces, assuming that users of Garage A require a slightly higher level of service than users of Garage B.

It is understood from information received from Airport staff that, on a typical busy day, Garage A fills (approaching 90 percent full, at which point it is closed) and overflow demand is accommodated in Garage B, which only reaches a little over half-full. These results are reflected in the estimated demand shown in Table 4-15 for each garage. These statistics verify that the estimates of demand are reasonable.

Prior to this analysis, some employees had been issued cards providing them access to Garage B. These employees were estimated to require almost 500 spaces in 2006. It was assumed for this analysis that these employees would be accommodated in a separate dedicated facility in the future and would no longer occupy spaces accessible to the public. For this reason, no employee demand was accounted for in this updated analysis.

4.4.1.3 Forecasting Future Demand and Requirements

The increase in originating passengers was used to estimate future parking requirements. The numbers of enplaned passengers in 2012 and forecast through 2032, as provided in the Airport activity forecasts, were used to calculate expected growth in public parking demand at the Airport. Exhibit 3-2 in the previous section depicts forecast changes in passenger activity.

Based on transaction data, total 2012 design day demand was estimated to be 4,856 spaces. Similarly, total overnight occupancy in 2012 was estimated to be 3,394 spaces (approximately 70 percent of design demand). The relationship between daily peak and overnight demand was assumed to be constant over the planning period and was applied to the maximum observed October 2012 overnight occupancy (3,818 spaces) to estimate a total peak day demand of 5,462 spaces. The level of service factors were then applied to design day demand and both design and peak day demands were rounded up to the nearest 10 spaces to estimate 2012 requirements, as shown in **Table 4-16**, highlighting a need for 5,240 spaces on the design day and 5,470 spaces on the peak day, both below the total capacity of 6,980 spaces.

Table 4-16: Forecast On-Airport Public Parking Space Requirements

	EXISTING (2012)			PAL E1	PAL E2	PAL E3
Enplaned Passengers (millions)	4.1			5.5	6.2	7.0
Originating Passengers (millions)	2.7			3.2	3.4	4.5
	CAPACITY	**DEMAND**	**REQUIREMENTS [1/]**	**REQUIREMENTS [1/]**		
DESIGN DAY [2/]						
Garage A	2,980	2,609	2,880	3,360	3,510	4,680
Garage B	4,000	2,246	2,360	2,760	2,890	3,840
Total	**6,980**	**4,855**	**5,240**	**6,612**	**6,400**	**8,520**
Surplus/(Deficit)			1,740	860	580	(1,540)
PEAK DAY						
Total	**6,980**	**5,462**	**5,470**	**6,380**	**6,680**	**8,900**
Surplus/(Deficit)			1,510	600	300	(1,920)

NOTES:

1/ Requirement rounded up to nearest 10 spaces.

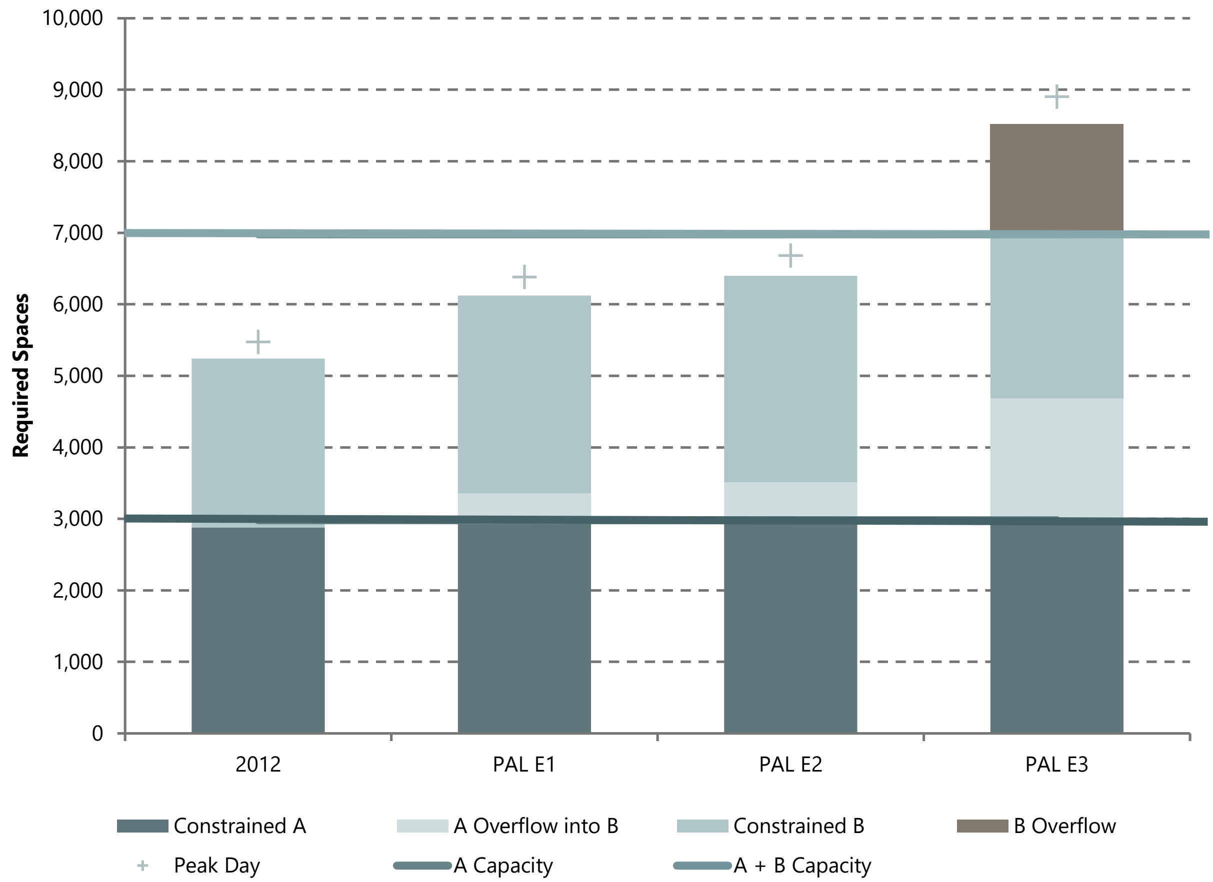
2/ Level of service factors of 10 percent and 5 percent were applied to Garages A and B, respectively.

SOURCE: Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., May 2013.

Applying the proportional changes in passenger activity to the 2012 total design and peak day demand produced future total demand. Applying the same level of service factors and rounding as for 2012 requirements produced estimated future design and peak day requirements, as depicted on **Exhibit 4-15**.

As shown in Table 4-16, the existing garages would be unable to accommodate all demand on typically busy days at the activity levels forecast through the planning period. Capacity could be expected to be insufficient on typical busy and peak days between PAL E2 and PAL E3. By PAL E3, an additional 1,540 spaces could be required to consistently accommodate demand throughout the year. On the absolute peak day at PAL E3, 1,920 additional spaces would be required to accommodate all demand.

Exhibit 4-15: Forecast Public Parking Requirements



SOURCE: Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., May 2013.

4.4.1.4 Conclusions

Garages A and B are more than sufficient to accommodate existing demand, but are not expected to be sufficient to accommodate future design day or peak day demand. One or both garages would need to be expanded or additional spaces provided to supplement the garages to accommodate parking demand forecast in this analysis. The timing of the need for new spaces will depend upon the rate at which demand increases, which is, in turn, dependent on the rate at which activity (specifically originating passenger activity) increases at the Airport. Future demand is also dependent on other factors, such as the split between different types of travel (i.e., business vs. leisure) and economic factors (e.g., parking rates, airfares) that may or may not change the profile of demand in the future.

In the interim, increasing the capacity of Garage A could increase revenues and potentially customer convenience by eliminating the overflow to the less expensive and remote Garage B. Increasing the capacity of Garage A for this purpose could also delay the need to increase the capacity of Garage B or build additional facilities as overall demand increases.

4.4.2 ON-AIRPORT EMPLOYEE PARKING

The On-Airport employee parking facilities maintained by the City and considered in this analysis are located in the terminal area, as depicted on Exhibit 4-11. Other on-Airport parking facilities not considered in this analysis are reserved for and managed by Airport tenants. Total on-Airport employee parking capacity is 497 spaces.

Estimated 2012 on-Airport employee parking demand was provided by the City, as determined through a survey of tenants and users requiring parking in Airport-operated facilities. These demands are summarized in **Table 4-17**.

Table 4-17: 2012 On-Airport Employee Parking Demand 1/

TENANT	DEMAND (SPACES)
Department of Aviation	175
Department of Aviation Employee Parking	159
Communications Center	5
Badging	3
Additional	8
Federal Aviation Administration	55
Transportation Security Administration	42
Southwest Airlines	15
Other Airlines	40
Concessionaires	40
Other	70
Dallas Police Department	30
Taxicab Starters	5
Diamond Security	6
FOFM/AWO 2/	4
Visitor	25
Total	437

NOTES:

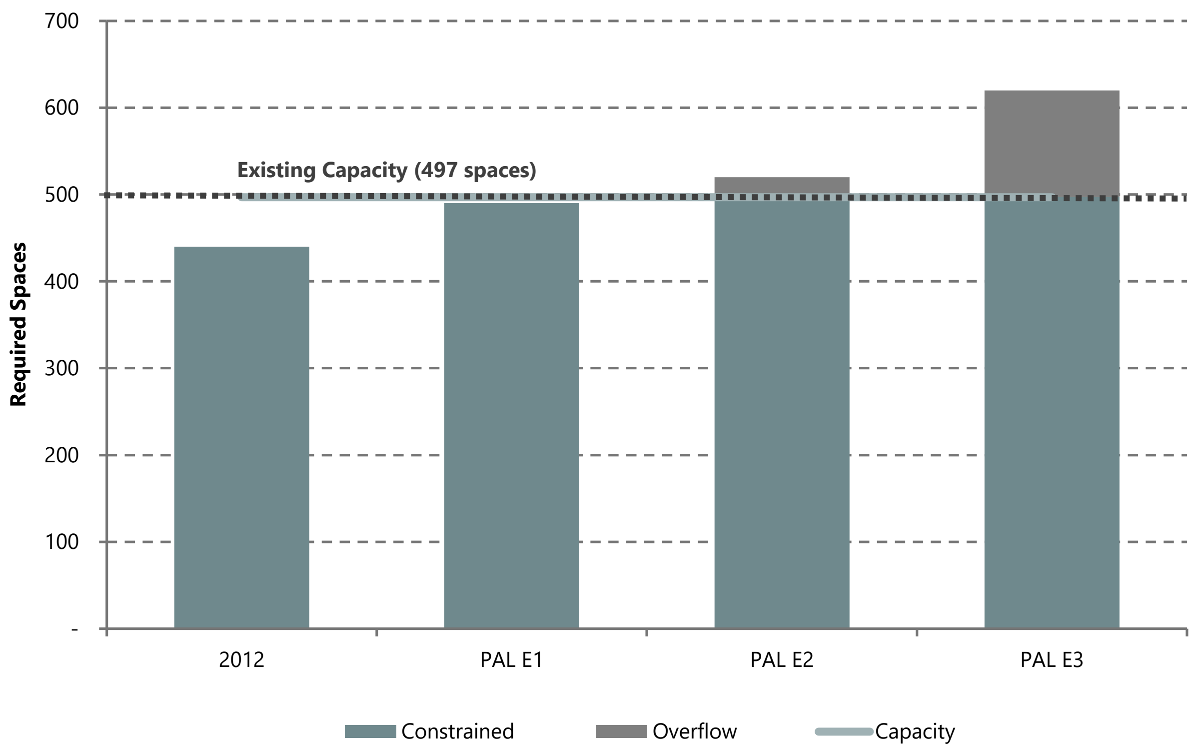
1/ Employee parking spaces are intended to encompass DOA provided parking only.

2/ Contract group providing weather staffing at the Airport.

SOURCE: City of Dallas, 2012.
PREPARED BY: Ricondo & Associates, Inc., May 2013.

Changes in employee parking demand are caused by changes in staffing related, in part, to changes in passenger activity (e.g., concessionaires) and, in part, to changes in the number of aircraft operations (e.g., maintenance) at the Airport. For this reason, changes in employee parking demand were forecast based on the average change in rates of passenger activity and aircraft operations, as depicted in the previous section on Exhibits 3-2 and 3-3, respectively. Employee parking demands were converted to requirements by rounding up to the nearest 10 spaces. Forecast employee parking requirements are depicted on **Exhibit 4-16** and summarized in **Table 4-18**. As a result of the forecast increase in aviation activity at the Airport in 2015, an additional 123 employee spaces would be required by PAL E3.

Exhibit 4-16: Forecast Employee Parking Requirements



SOURCE: Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., May 2013.

Table 4-18: Forecast On-Airport Employee Parking Space Requirements

YEAR	EXISTING (2012)	PAL E1	PAL E2	PAL E3
Enplaned Passengers (millions)	4.1	5.5	6.2	7.0
Originating Passengers (millions)	2.7	3.2	3.4	4.5
Aircraft Operations (thousands) [1/]	177.9	187.9	203.8	209.9
Requirements [3/]	**440**	**490**	**520**	**620**
Average Growth[2/]	-	11.2%	6.6%	18.1%
Surplus/(Deficit)	57	7	(23)	(123)

NOTES:

1/ Aircraft operations are in alignment with the Airport Forecast and correlate to the number of enplanements

2/ From 2012

3/ Rounded up to the nearest 10 spaces.

SOURCE: Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., May 2013.

4.5 Airport Access Requirements

Ricondo & Associates, Inc., conducted a demand/capacity analysis for the Airport access and ground support system components at the Airport. This analysis included a review of previous demand/capacity analyses and incorporates the results of the forecasts prepared by R&A for the Master Plan Update.

4.5.1 NONTERMINAL AREA ROADWAYS

A demand/capacity and requirements analysis of the nonterminal area roadways was not conducted for the Landside Master Plan Section of the LFMP (December 2008). To conduct such an analysis, intersection turning movement counts and 7-day automatic traffic recorder (ATR) counts were collected along Mockingbird Lane by GRAM Traffic of North Texas, Inc., during February 2014.

Two 7-day, 24-hour ATRs were placed midblock at two locations on Mockingbird Lane between:

- Airdrome Drive and Cedar Springs Road/Herb Kelleher Way
- Cedar Springs Road/Herb Kelleher Way and Denton Drive

Exhibit 4-17 presents the rolling-hour counts for traffic heading northeast and southwest on Mockingbird Lane between Cedar Springs Road/Herb Kelleher Way and Airdrome Drive to the northeast, and **Exhibit 4-18** presents the rolling hour counts for traffic heading northeast and southwest on Mockingbird Lane between Cedar Springs Road/Herb Kelleher Way and Denton Drive to the southwest. The ATR data were collected from Thursday, February 20, 2014, through Wednesday, February 26, 2014. From both sets of data, it was determined that Mockingbird Lane serves not only as an access road to Dallas Love Field, but also as a commuter route for many local residents.

The a.m. peak traffic flow is primarily in the southwest direction on Mockingbird Lane, peaking at approximately 2,400 vehicles per hour between 7:30 a.m. and 8:30 a.m. on weekday mornings, with approximately 1,400 vehicles per hour in the nonpeak northeast direction during the same hour. Conversely, the traffic peak direction reverses during the p.m. peak hour (5:00 p.m. to 6:00 p.m.) with approximately 2,750 vehicles per hour in the northeast direction and approximately 1,350 vehicles per hour in the nonpeak southwest direction.

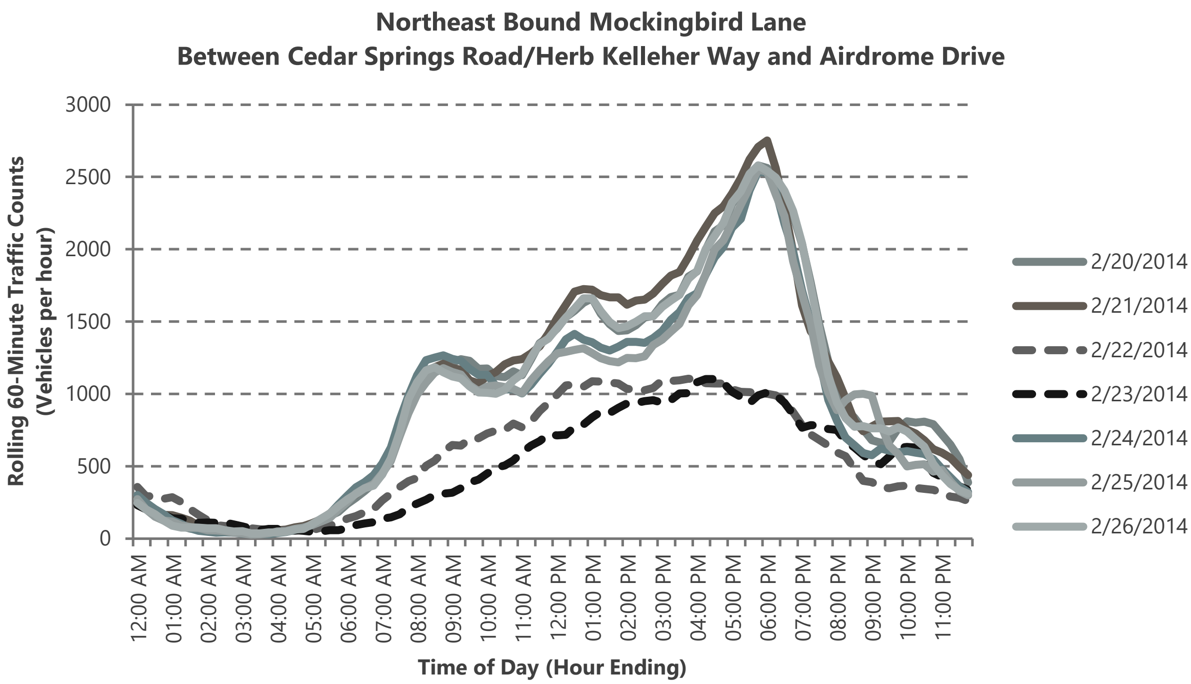
The intersection turning movement counts were collected on Friday, February 21, 2014, and Monday, February 24, 2014, during the a.m. peak (6:00 a.m. to 8:30 a.m.) and p.m. peak (4:30 p.m. to 8:00 p.m.) at the following intersections:

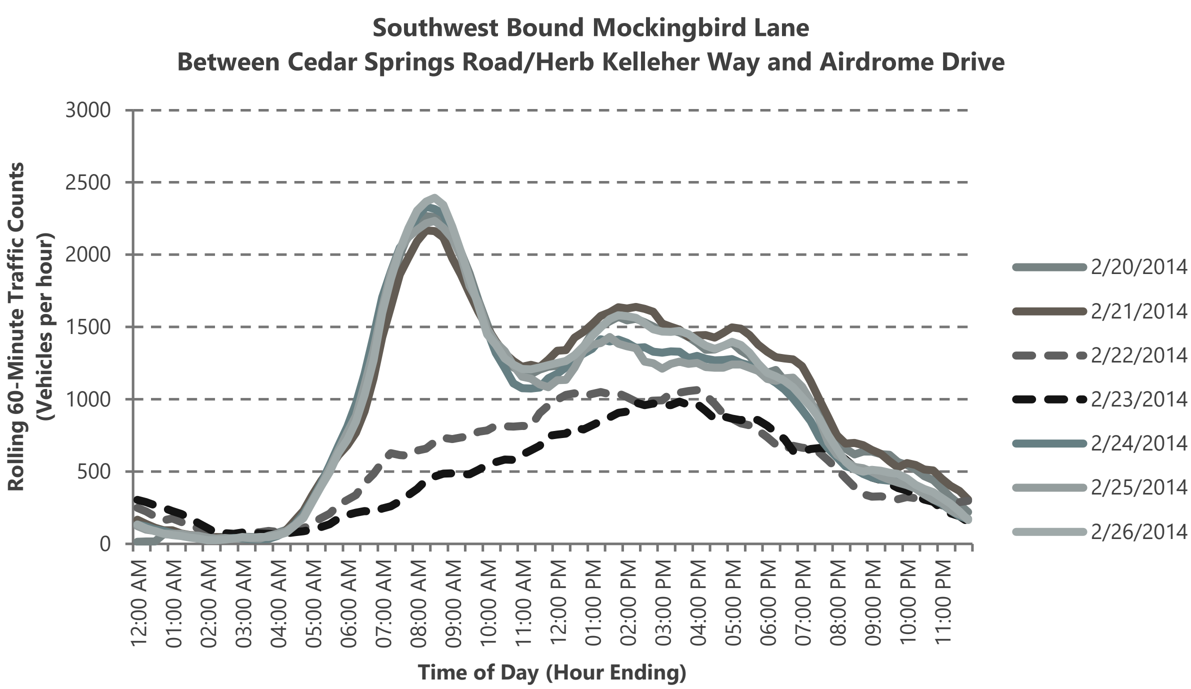
- Airdrome Drive at Lemmon Avenue
- Mockingbird Lane at Lemmon Avenue
- Mockingbird Lane at Airdrome Drive
- Mockingbird Lane at Cedar Springs Road/Herb Kelleher Way
- Mockingbird Lane at Denton Drive

From the ATR intersection turning movement counts, the a.m. and p.m. rolling 60-minute peak hours were identified for each intersection. The a.m. peak hour was identified as 7:30 a.m. to 8:30 a.m. and the p.m. peak hour was identified as 4:30 p.m. to 5:30 p.m. To analyze intersection demand/capacity performance, the peak hour turning movement counts, along with intersection geometry and signal phasing and timing, were input into Synchro® 7, traffic signal simulation and optimization software developed by Trafficware. The turning movement counts, as well as the intersection levels of service computed using Synchro® 7 and based on *Highway Capacity Manual* procedures, are presented on **Exhibits 4-19** and **4-20** for the a.m. and p.m. peak periods, respectively.

With traffic volumes for the nonterminal roadways identified for the data collection period in February 2014, the roadway volumes were then factored to baseline 2013 values based on passenger activity from the gated baseline airline schedule. Intersection levels of service were established for baseline 2013 volumes, and then a spreadsheet trip generation model was prepared to segment traffic by activity type (e.g., airline passenger traffic, other Airport traffic, and non-Airport background traffic). Different growth rates for all three traffic components were developed using the following assumptions:

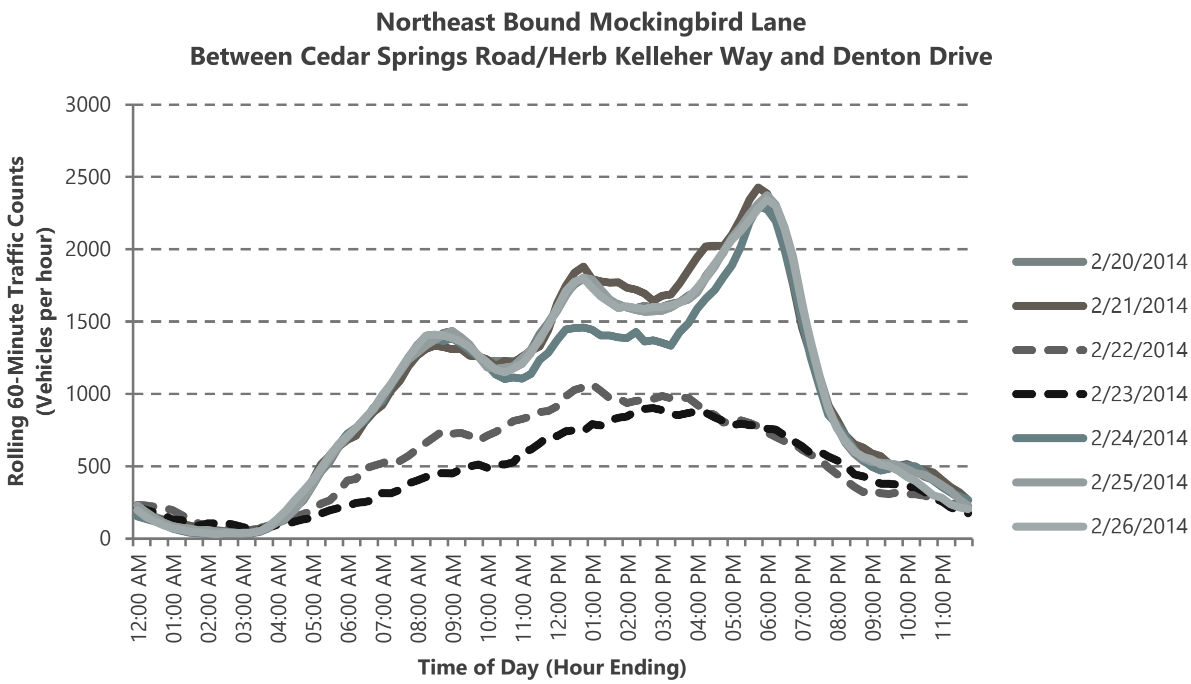
Exhibit 4-17: 7-day Automatic Traffic Recorder Counts on Mockingbird Lane (Cedar Springs Road/Herb Kelleher Way and Airdrome Drive)

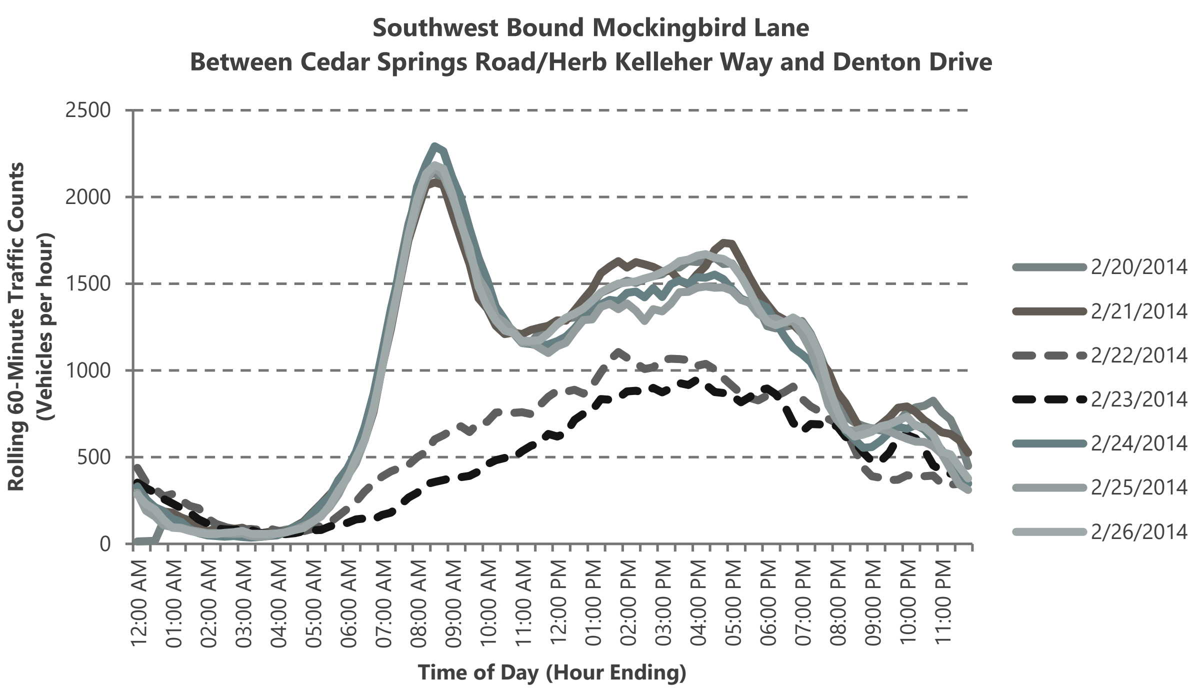




SOURCES: GRAM Traffic of North Texas, Inc., February 2014; Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

Exhibit 4-18: 7-day Automatic Traffic Recorder Counts on Mockingbird Lane (Cedar Springs Road/Herb Kelleher Way and Denton Drive)





SOURCES: GRAM Traffic of North Texas, Inc., February 2014; Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

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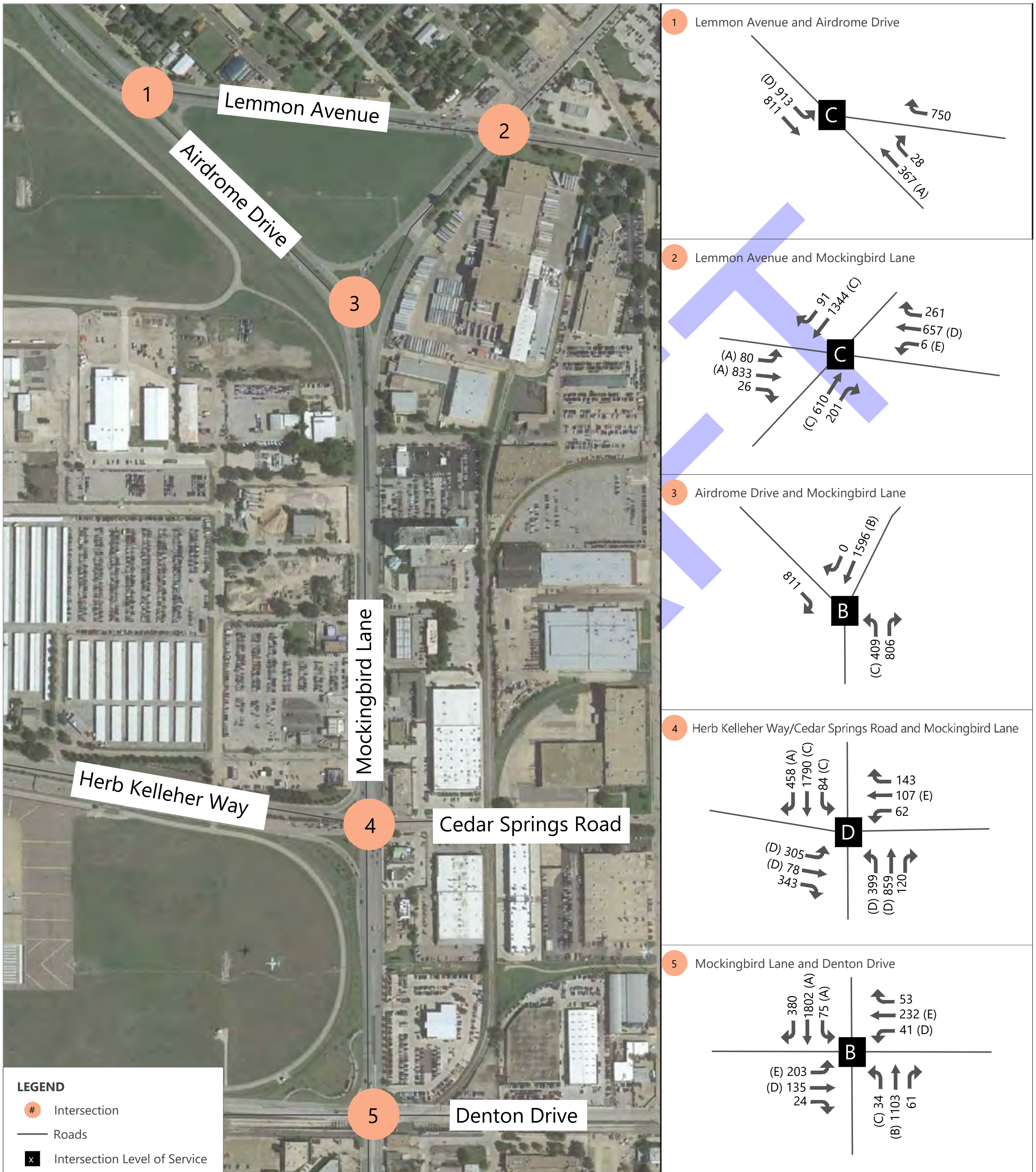

SOURCES: Google Earth Pro, February 2014; GRAM Traffic of North Texas, Inc., February 2014; Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

EXHIBIT 4-19

Turning Movement Counts and Intersection Level of Service Existing a.m. Peak Hour

Drawing: N:\Love Field\08 Master Plan Update 2013\02 Demand Capacity Analysis\05 CAD\new_Off_Airport_Intersections_ALL 8 SCENARIOS.dwg_Layout: Baseline 2014 AM_May 19, 2015, 5:37pm

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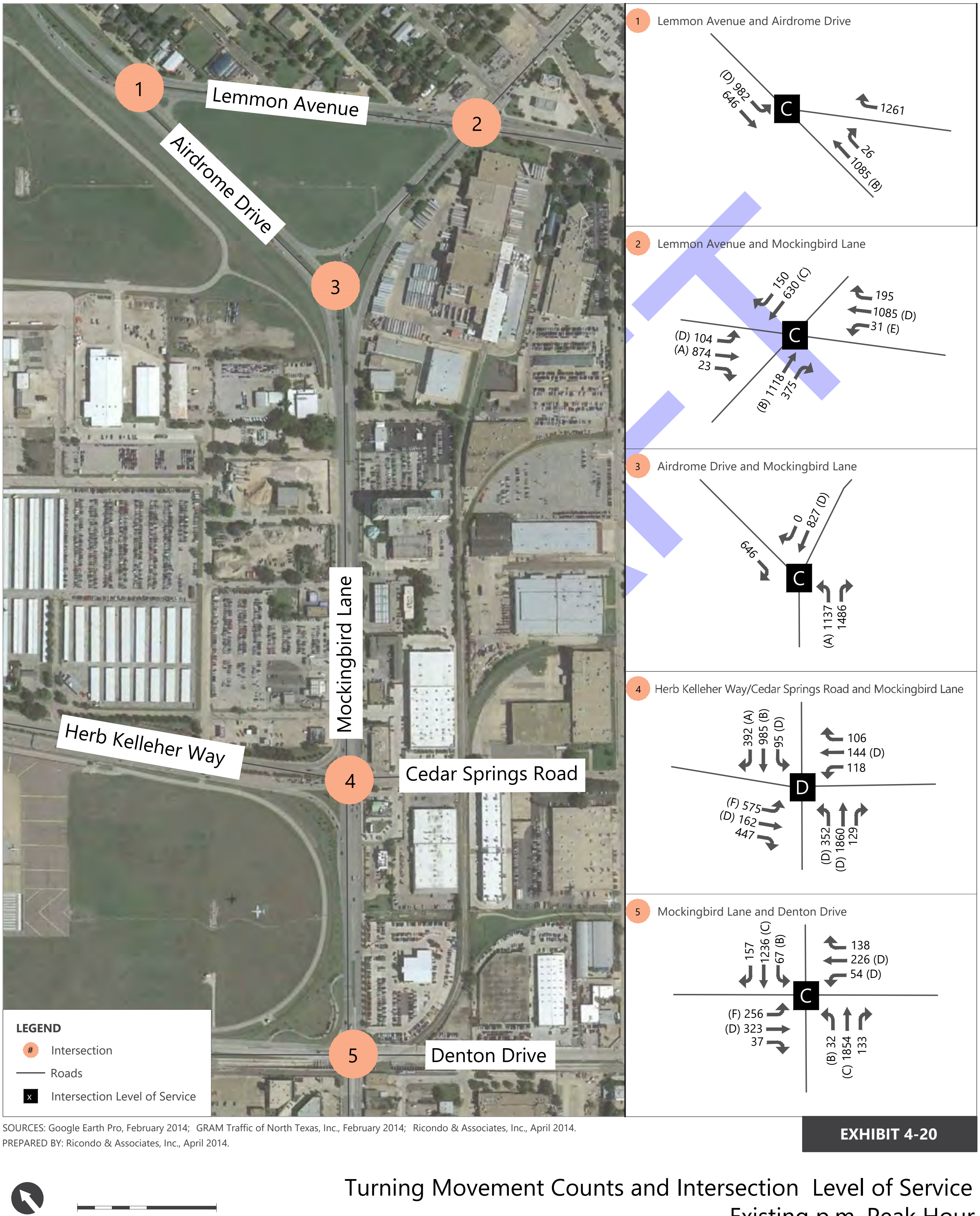

SOURCES: Google Earth Pro, February 2014; GRAM Traffic of North Texas, Inc., February 2014; Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

EXHIBIT 4-20

Turning Movement Counts and Intersection Level of Service Existing p.m. Peak Hour

Drawing: N:\Love Field\08 Master Plan Update 2013\02 Demand Capacity Analysis\05 CAD\new_Off_Airport_Intersections_ALL 8 SCENARIOS.dwg_Layout: Baseline 2014 PM_May 19, 2015, 5:40pm

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- Airline passenger traffic will increase based on increases in numbers of enplaned passengers at the various PALs.
- Other Airport service and employee traffic activity will increase in proportion to the blended averages of the growth rates for annual originating passengers and annual aircraft operations.
- Non-Airport background traffic will increase based on regional traffic growth rates, as reported by the North Central Texas Council of Governments (NCTCOG) model, and historical economic growth rate for Gross Metropolitan Product as reported for Dallas-Fort Worth-Arlington, Texas in *U.S. Metro Economies Outlook - Gross Metropolitan Product, and Critical Role of Transportation Infrastructure,* The United States Conference of Mayors, July 2012.

New intersection turning movement volumes based on the three growth rates for enplaned passengers at PAL E1, PAL E2, and PAL E3 were produced by the spreadsheet trip generation model. Each PAL scenario was then modeled in the Synchro® version 7 based on Highway Capacity Manual procedures. This traffic signal simulation and optimization program was used to determine the level of service at each intersection. The Highway Capacity Manual utilizes control delay as the measure of effectiveness for signalized intersections. Control delay represents the average amount of travel time per vehicle added to a trip as a result of the traffic signal. **Table 4-19** summarizes the LOS criteria for signalized intersections. The results of the PAL E1 a.m. peak hour scenario are presented on **Exhibit 4-21**. According to the model results, the additional traffic generated by the Airport would result in a minimum of one movement on each approach to the Cedar Springs Road/Herb Kelleher Way at Mockingbird Lane intersection being at Level of Service (LOS) E or worse, and the intersection as a whole operating at LOS E. Additionally, the left turn traffic on the eastbound Denton Drive approach at Mockingbird Lane would also decrease to LOS F. The PAL E1 p.m. peak hour scenario results are displayed on **Exhibit 4-22**. The outbound traffic at the Cedar Springs Road/Herb Kelleher Way and Mockingbird Lane intersection would increase beyond the left-turn capacity of the dual left-turn lanes, affecting this movement as well as degrading the other approaches. However, this intersection as a whole would still operate at an overall LOS D. The level of service at the intersection of Denton Drive at Mockingbird Lane would degrade to an overall LOS D at PAL E1.

Table 4-19: LOS Criteria for Signalized Intersections

LOS	CONTROL DELAY PER VEHICLE (SECONDS/VEHICLE)
A	< 10
B	> 10-20
C	> 20-35
D	> 35-55
E	> 55-80
F	> 80

SOURCE: Transportation Research Board, *Highway Capacity Manual*, 2010.
PREPARED BY: Ricondo & Associates, Inc., January 2015.

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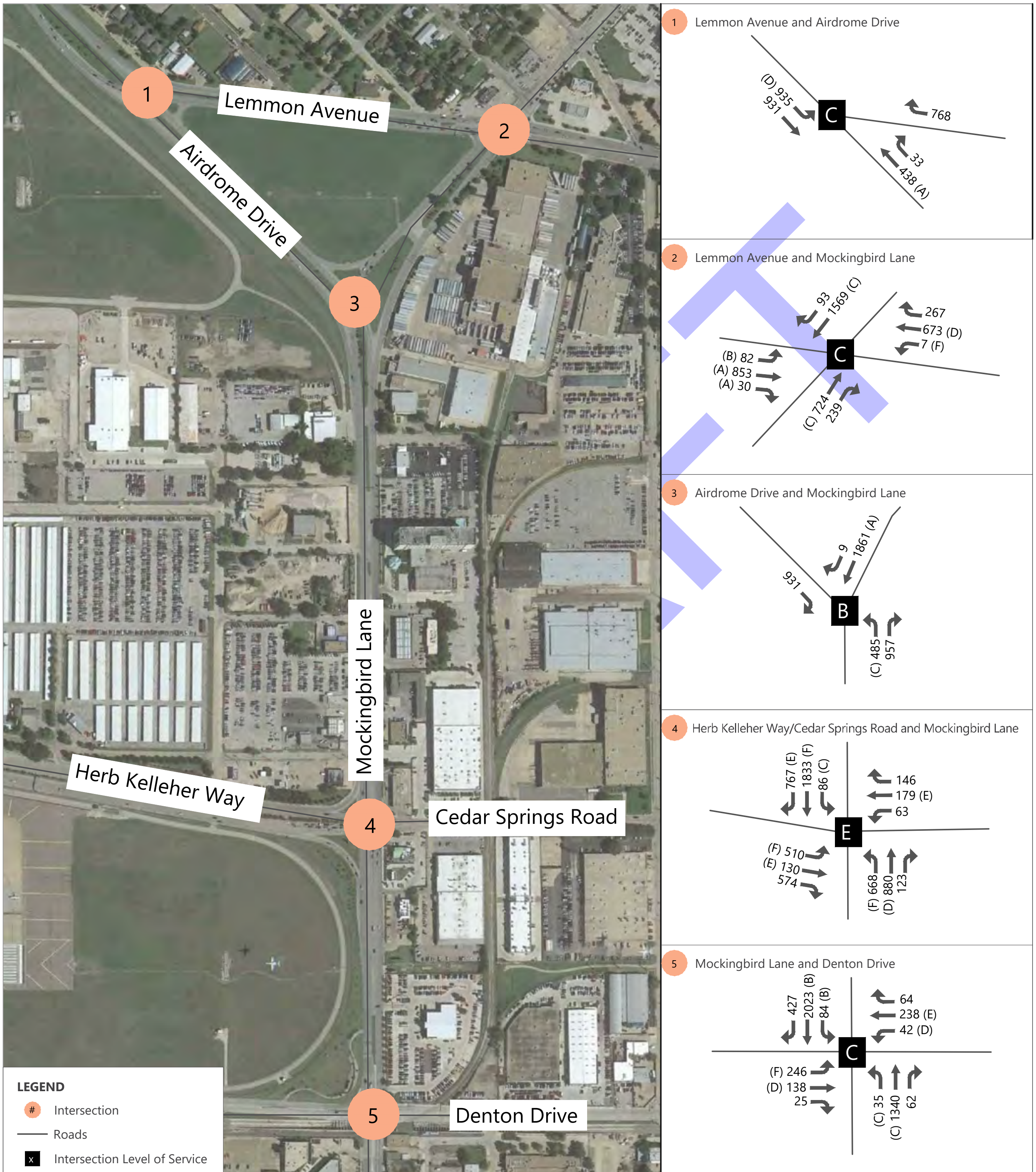

SOURCES: Google Earth Pro, February 2014; North Central Texas Council of Governments, December 2012; Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

EXHIBIT 4-21

NORTH 0 600 ft.

Turning Movement Counts and Intersection Level of Service PAL E1 a.m. Peak Hour

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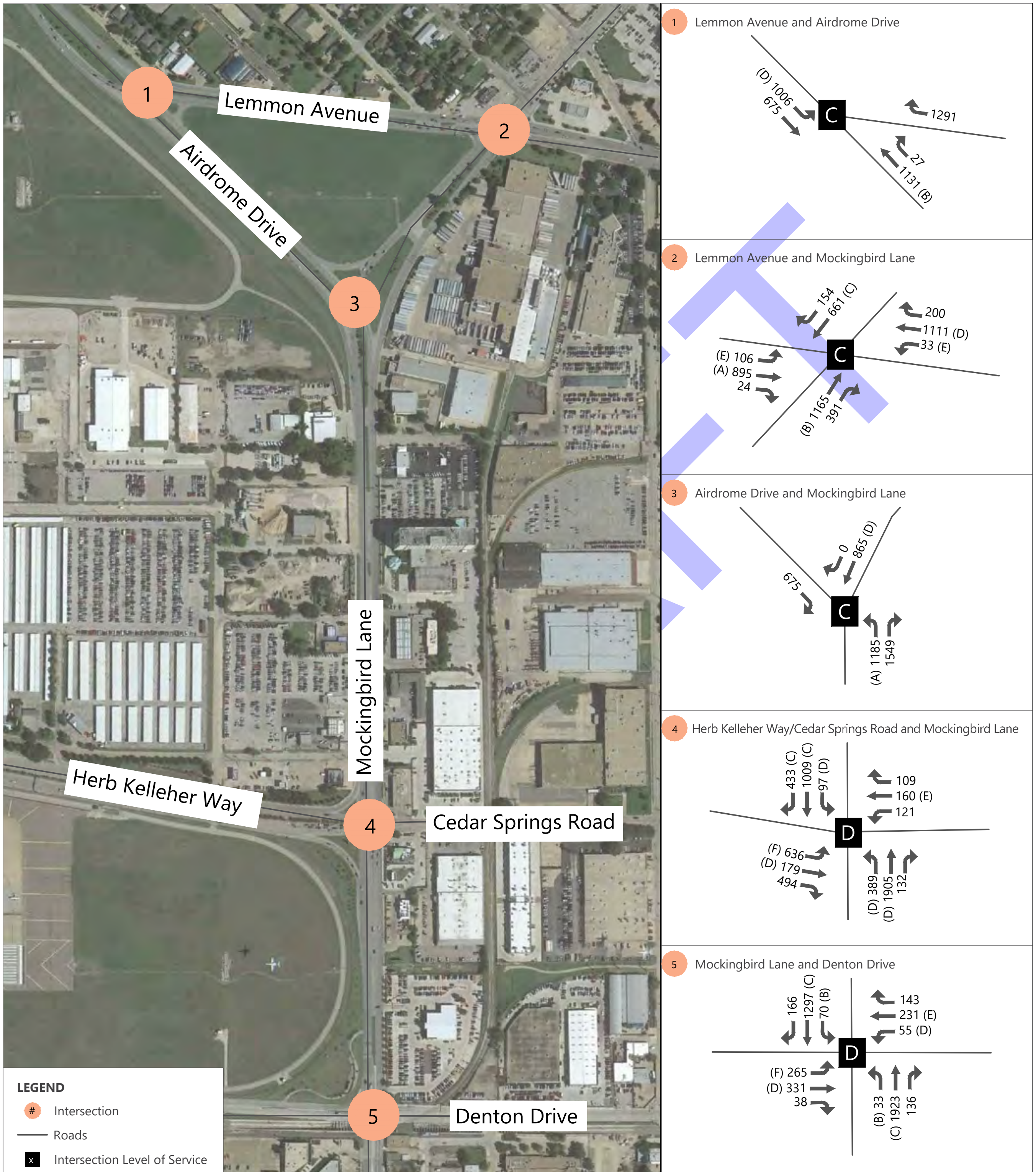

SOURCES: Google Earth Pro, February 2014; North Central Texas Council of Governments, December 2012; Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

EXHIBIT 4-22

NORTH 0 600 ft.

Turning Movement Counts and Intersection Level of Service PAL E1 p.m. Peak Hour

Drawing: N:\Love Field\08 Master Plan Update 2013\02 Demand Capacity Analysis\05 CAD\new_Off_Airport_Intersections_ALL 8 SCENARIOS.dwg_Layout: PAL E1 PM_May 19, 2015, 5:41pm

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PAL E2, representing 6.2 million annual enplaned passengers in approximately 2016, traffic analysis results are presented on **Exhibit 4-23** and **Exhibit 4-24** for the a.m. and p.m. peak hours, respectively. During the a.m. peak hour, all approaches would have at least one movement at LOS F at the Cedar Springs Road/Herb Kelleher Way at Mockingbird Lane intersection, even though overall intersection performance would be at LOS E. During the p.m. peak hour, the level of service at the Cedar Springs Road/Herb Kelleher Way and Mockingbird Lane intersection would deteriorate from LOS D to an overall LOS E.

PAL E3, representing 7.0 million annual enplaned passengers in approximately 2032, traffic analysis results are presented on **Exhibit 4-25** and **Exhibit 4-26** for the a.m. and p.m. peak hours, respectively. With the Cedar Springs Road/Herb Kelleher Way at Mockingbird Lane intersection operating at LOS F, the intersection would not be able to accommodate the Airport traffic demand and heavy southbound commuter traffic. Therefore, traffic from the Cedar Springs Road/Herb Kelleher Way at Mockingbird Lane intersection would affect other intersections, and create gridlock during the a.m. peak hour. Similar traffic would occur during the p.m. peak hour, but the heavy Airport traffic and northbound commuter Mockingbird Lane traffic would be most heavily affected.

4.5.2 TERMINAL AREA ROADWAYS

Terminal area roadway demand/capacity and requirements were determined by evaluating curbside requirements, conducting a link-by-link analysis of on-Airport roadways from the terminal area to Mockingbird Lane, and analyzing the level of service at all major intersections on Airport property.

4.5.2.1 Data Collection

As the terminal roadway demand/capacity analysis is an update of the analysis conducted for the LFMP, only limited roadway network traffic counts were collected. To effectively recalibrate the roadway data collected in 2008 for the LFMP, new vehicle classification counts were collected on the inbound roadways at the start of the upper level and lower level roadways. These new classification counts were necessary because many of the curbside vehicle assignments have changed since implementation of the LFMP, but the remainder of the inbound roadway system has remained the same. The current terminal curbside configuration consists of the lower level roadway accommodating all commercial vehicle activity, while the upper level roadway is primarily used for departing passenger private vehicle dropoff and taxicab unloading, and arriving passenger private vehicle loading. The new classification counts reflect these changes in vehicle paths. The change in combined vehicle counts for the upper level and lower level peak hours for the inbound roadways enabled the inbound and outbound roadway link volumes to be factored up accordingly. The classification counts were collected on Monday, August 12, 2013, during the a.m. departures peak between 5:30 a.m. and 8:30 a.m., and on Thursday August 15, 2013, during the p.m. arrivals peak between 5:30 p.m. and 8:30 p.m. Garage A and Garage B entry traffic volumes were also collected during the classification counts and garage exit volumes for the same time periods were obtained from the PRCS database. It should be noted that the ticketing hall section of the new terminal was under construction during the data collection periods and the curbside in front of the ticketing hall was closed; however, passenger pickup via private vehicles was still accommodated at the upper level curbside directly in front of the main terminal building entrance at this time, and should have no effect on the route allocation and classification data collected.

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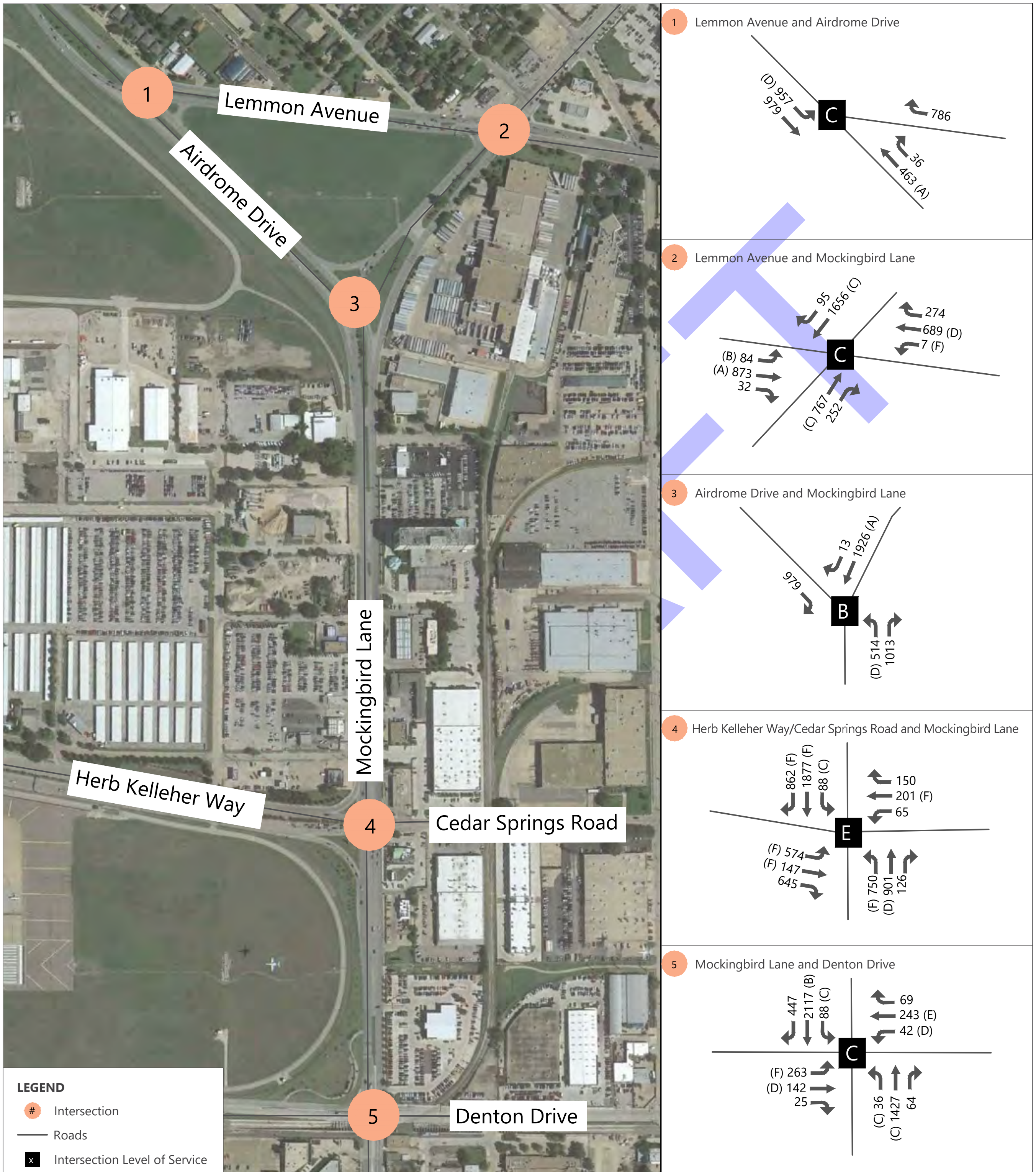

SOURCES: Google Earth Pro, February 2014; North Central Texas Council of Governments, December 2012; Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

EXHIBIT 4-23

Turning Movement Counts and Intersection Level of Service PAL E2 a.m. Peak Hour

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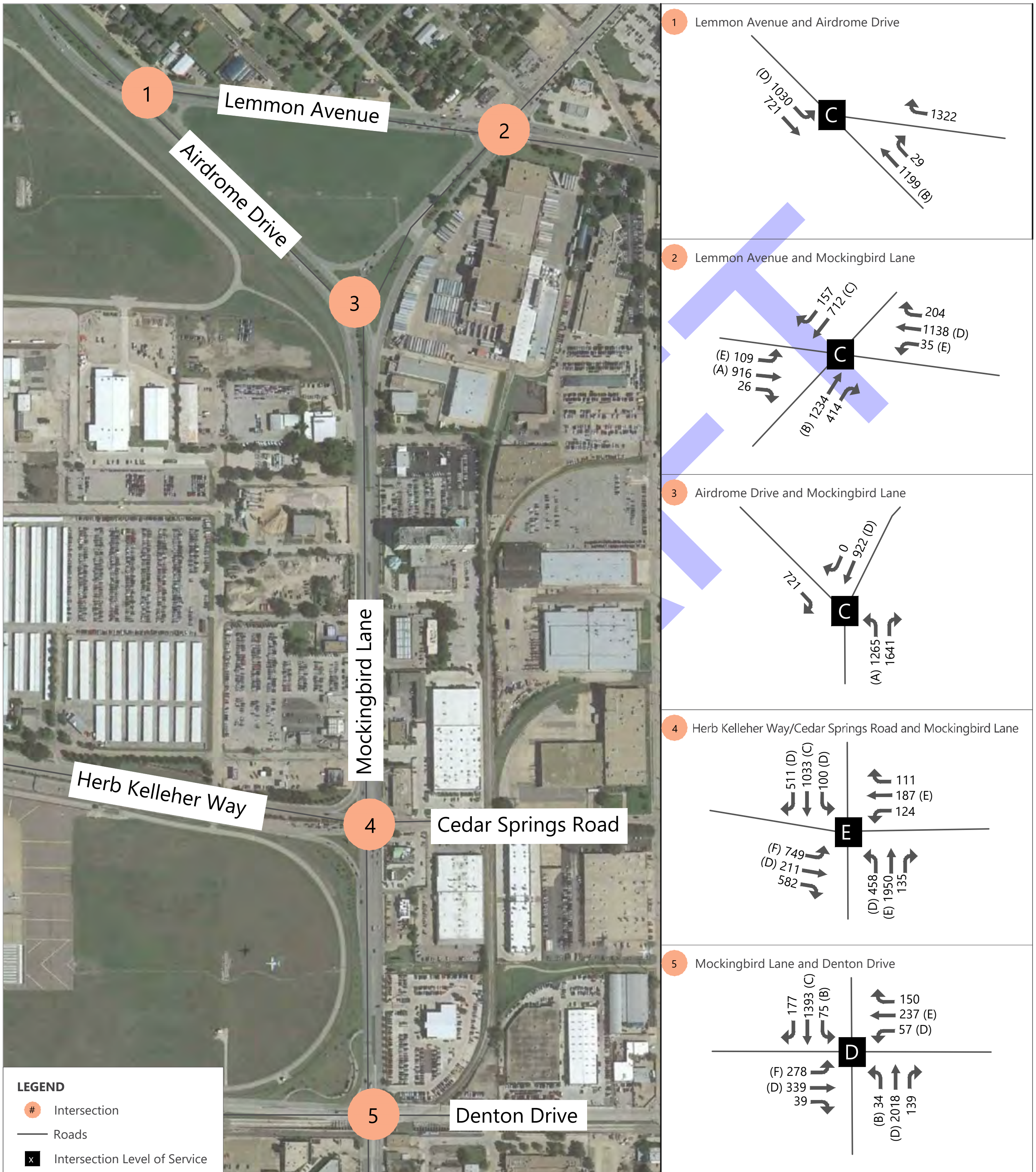

SOURCES: Google Earth Pro, February 2014; North Central Texas Council of Governments, December 2012; Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

EXHIBIT 4-24

NORTH 0 600 ft.

Turning Movement Counts and Intersection Level of Service
PAL E2 p.m. Peak Hour

Drawing: N:\Love Field\08 Master Plan Update 2013\02 Demand Capacity Analysis\05 CAD\new_Off_Airport_Intersections_ALL 8 SCENARIOS.dwg_Layout: PAL E2 PM_May 19, 2015, 5:42pm

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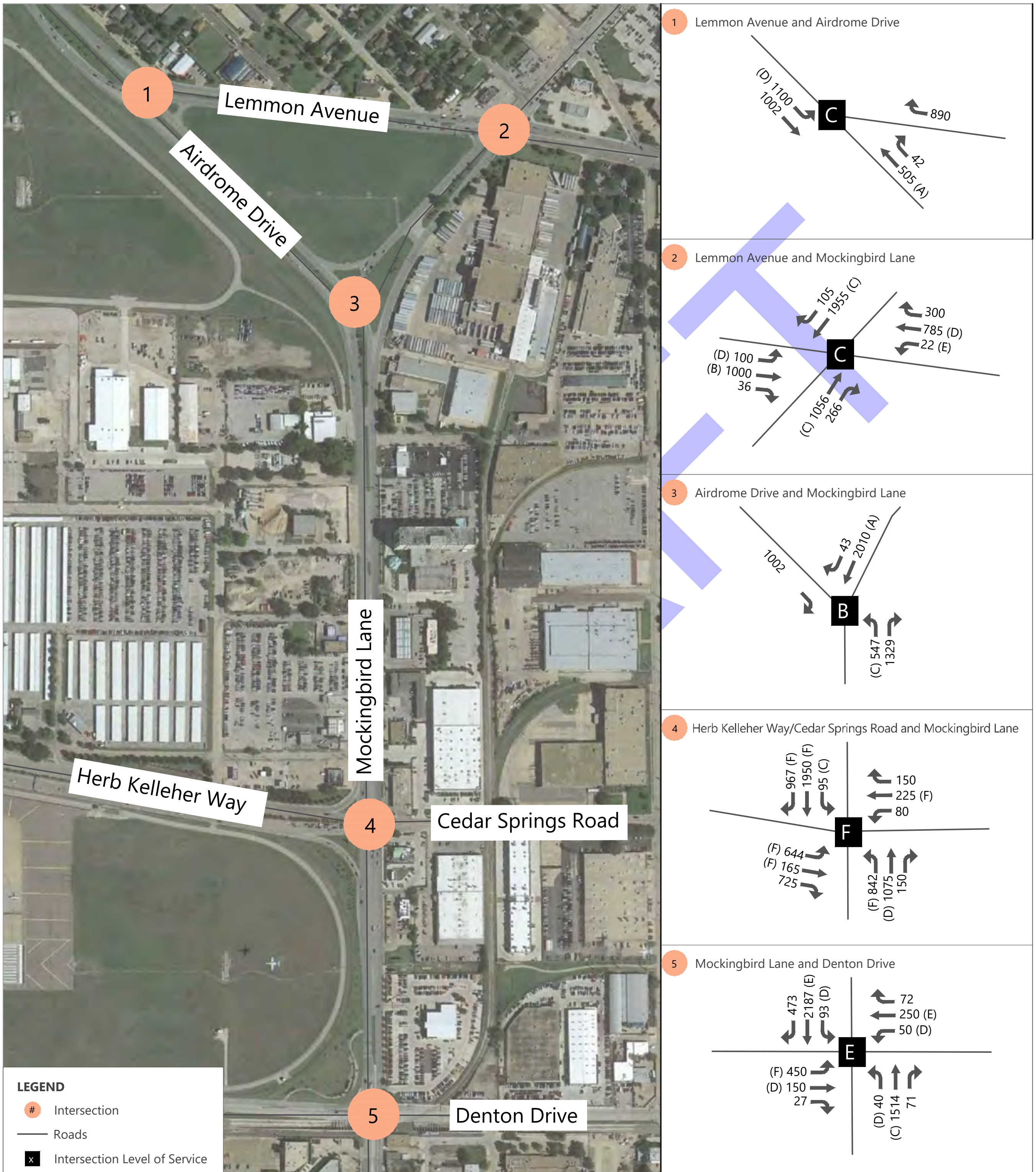

SOURCES: Google Earth Pro, February 2014; North Central Texas Council of Governments, December 2012; Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

EXHIBIT 4-25

NORTH 0 600 ft.

Turning Movement Counts and Intersection Level of Service
PAL E3 a.m. Peak Hour

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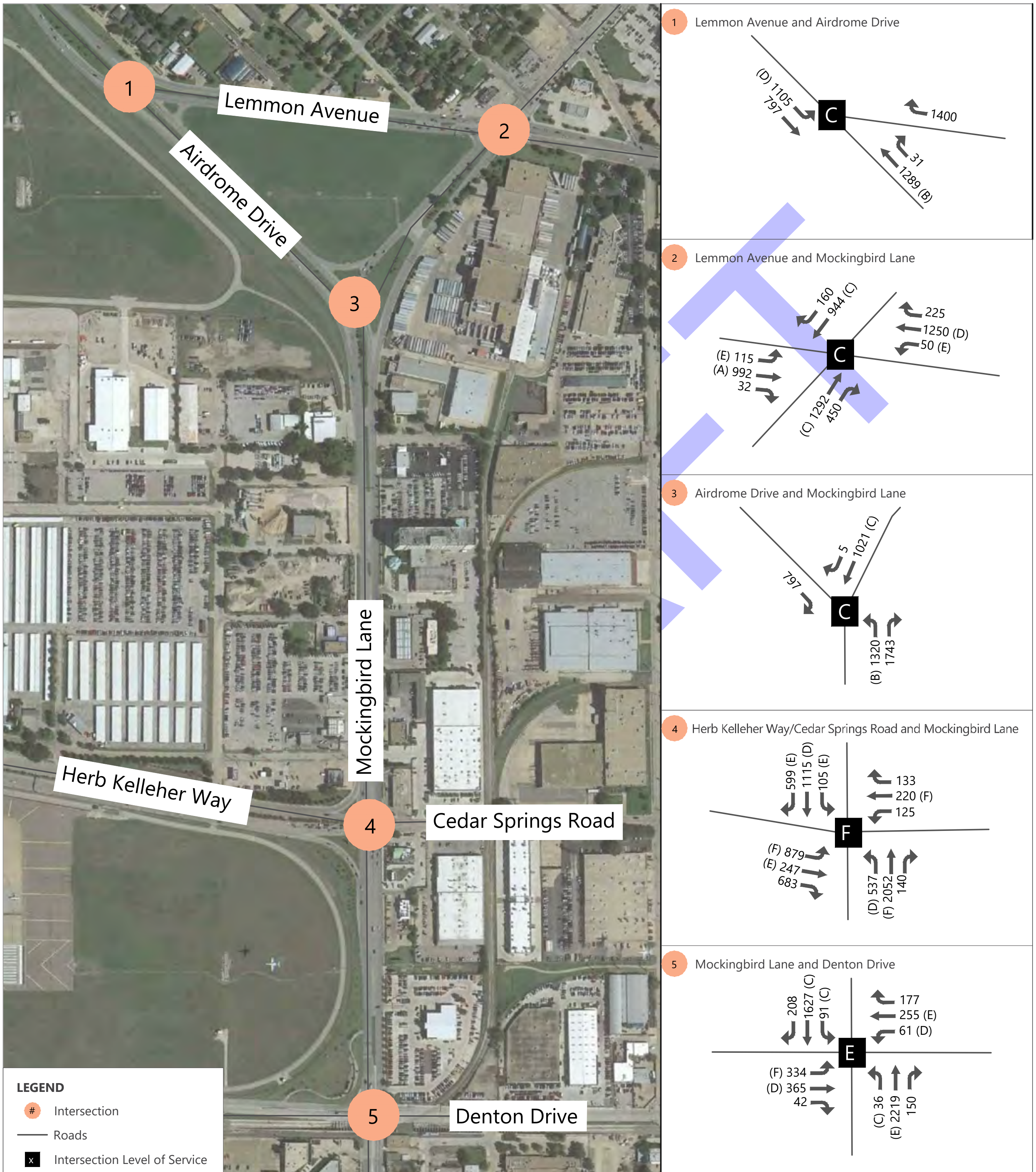

SOURCES: Google Earth Pro, February 2014; North Central Texas Council of Governments, December 2012; Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

EXHIBIT 4-26

NORTH 0 600 ft.

Turning Movement Counts and Intersection Level of Service
PAL E3 p.m. Peak Hour

Drawing: N:\Love Field\08 Master Plan Update 2013\02 Demand Capacity Analysis\05 CAD\new_Off_Airport_Intersections_ALL 8 SCENARIOS.dwg_Layout: PAL E3 PM_May 19, 2015, 5:44pm

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From the new classification counts, the a.m. peak hour occurred between 6:30 a.m. and 7:30 a.m. with a total of 979 vehicles entering the terminal area. The p.m. peak hour occurred between 6:00 p.m. and 7:00 p.m. with 971 vehicles entering the terminal area. The vehicle classification peak hour totals by vehicle mode are presented in **Table 4-20**.

Table 4-20: Vehicle Classification Summary

	A.M. PEAK (6:30 - 7:30 A.M.)		P.M. PEAK (6:00 - 7:00 P.M.)	
	NUMBER OF VEHICLES	**PERCENT OF TOTAL**	**NUMBER OF VEHICLES**	**PERCENT OF TOTAL**
UPPER LEVEL CURB				
Private Vehicles	356	83.6%	638	91.9%
Taxicabs	35	8.2%	39	5.6%
Hotel/Motel Shuttles	8	1.9%	0	0.0%
On-Airport Rental Car Shuttles	3	0.7%	4	0.6%
Shared Ride Vans	3	0.7%	1	0.1%
Limousines	14	3.3%	6	0.9%
Other	7	1.6%	6	0.9%
Upper Level Total	**426**	**100.0%**	**694**	**100.0%**
LOWER LEVEL CURB				
Private Vehicles	16	13.7%	70	36.3%
Taxicabs	2	1.7%	20	10.4%
Hotel/Motel Shuttles	2	1.7%	3	1.6%
Airport-operated Shuttles	89	76.1%	86	44.6%
Shared Ride Vans	2	1.7%	2	1.0%
Limousines	0	0.0%	5	2.6%
City Buses	3	2.6%	4	2.1%
Other	3	2.6%	3	1.6%
Lower Level Total	**117**	**100.0%**	**193**	**100.0%**
TERMINAL PARKING				
Valet	4	0.9%	0	0.0%
Garage A Entrance	278	63.8%	57	67.9%
Garage B Entrance	154	35.3%	27	32.1%
Parking Total	**436**	**100.0%**	**84**	**100.0%**
TERMINAL AREA TOTALS	**979**		**971**	

NOTE: Columns may not sum to 100 percent because of rounding.

SOURCE: Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

4.5.2.2 Planning Activity Levels and Forecasts

From the updated curbside classification data collection, an on-Airport balanced roadway network of vehicle counts was developed. This vehicle roadway network represents the baseline 2013 vehicle counts. All roadway counts were then factored up to PAL E1, PAL E2, and PAL E3 based on the peak hour growth in numbers of arriving and departing passengers at the terminal curbsides. The growth factors between the 2013 baseline and the three PALs are presented in **Table 4-21** and were used for all on-Airport roadway demand/capacity and requirements analyses.

Table 4-21: Departures and Arrivals Peak Hour Passengers

		PAL E1		PAL E2		PAL E3	
	2013 PASSENGERS	PASSENGERS	PERCENT INCREASE	PASSENGERS	PERCENT INCREASE	PASSENGERS	PERCENT INCREASE
Departures Peak Hour	851	1,444	69.7%	1,626	91.1%	1,828	114.8%
Arrivals Peak Hour	1,391	1,537	10.5%	1,820	30.9%	2,143	54.0%

SOURCE: Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

4.5.2.3 Curbsides

Curbsides consist of two primary components that have measurable capacity: available curbside frontage for the loading and unloading of passengers to/from vehicles and throughput capacity of the adjacent travel lanes. The length of available curbside frontage for a given vehicle mode will affect passenger level of service and safety. Furthermore, crowded curbside frontage areas will directly affect the throughput of adjacent travel lanes. The curbside demand/capacity analysis was conducted for the 2013 baseline and PAL E1, PAL E2, and PAL E3 scenarios to determine the surplus/deficit of available curbside frontage and the throughput capacity of adjacent travel lanes.

The curbside spreadsheet model developed to estimate peak-hour terminal curbside requirements uses peak hour vehicle counts combined with average dwell times by vehicle mode to determine the linear length of curbside required. To account for nonuniform arrival rates and varying vehicle dwell times at the curbside during the peak hour, the model applies a statistical "surge" factor based on a Poisson arrivals distribution to estimate the maximum number of occupied parking spaces during the peak hour. The estimated space requirements are multiplied by the average length of one vehicle (including a buffer to represent the empty space between two parked vehicles) to determine the demand for curbside frontage in linear feet.

Curbside frontage demand is a theoretical measurement of the peak accumulation of vehicles waiting at the curbside if they were aligned nose-to-tail in a single queue. For existing conditions, a utilization factor can be derived, which is the calculated ratio of curbside demand in linear feet divided by the existing curbside length. The utilization factor provides an indication of the amount of double and triple parking that would result for a given level of demand, and the level of service associated with a given utilization rate recognizes that vehicles do not park uniformly along the curbside. For example, a very low utilization factor indicates that vehicles are easily accommodated along the inner curb without the need to double park. This utilization factor equates to an excellent level of service (e.g., LOS A). Conversely, a very high utilization factor equates to double and triple parking along the entire curbside, restricting vehicle movements and resulting in a poor level of service.

In this analysis, the upper level arrivals and departures curbsides accommodate private vehicles picking up and dropping off passengers in multiple lanes while the lower level curbsides are all assigned to commercial vehicle passenger loading/unloading, which is restricted to the lane directly adjacent to the curbside. **Table 4-22** describes the levels of service for various utilization ranges for multiple-lane passenger loading/unloading, which occurs on the upper level curbside used primarily by private vehicles.

For private vehicle curbsides with multiple-lane passenger loading/unloading, LOS C is generally a desirable condition during peak activity periods at major airports and DAL on most days of the year. LOS C represents an acceptable condition in which double parking is common, especially near terminal entrances, with some intermittent triple parking. LOS D conditions may be acceptable during peak seasonal periods.

Table 4-22: Level of Service and Utilization Ranges for Curbsides with Multiple-Lane Passenger Loading/Unloading

LOS	UTILIZATION RANGES	DESCRIPTION
A	0% - 90%	**Excellent**: Drivers experience no interference from pedestrians or other motorists
B	91% - 110%	**Very Good**: Relatively free-flow conditions with limited double parking
C	111% - 130%	**Good**: Double parking near doors is common with some intermittent triple parking
D	131% - 170%	**Fair**: Vehicle maneuverability is restricted due to frequent double/triple parking
E	171% - 200%	**Poor**: Significant delays and queues; double/triple parking throughout curbside
F	> 200%	**Failure**: Motorists unable to access/depart curbside; significant queuing along entry road

NOTE: Utilization is the ratio of curbside demand divided by available curbside length.

SOURCE: Ricondo & Associates, Inc., April 2014, based on information published in Airport Cooperative Research Program, ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*, July 2010.

PREPARED BY: Ricondo & Associates, Inc., April 2014.

Table 4-23 describes the utilization ranges for single-lane passenger loading/unloading that typically occurs at curbsides that accommodate commercial vehicles. For commercial vehicle curbsides with single-lane passenger loading/unloading, LOS C is generally a desirable condition during peak activity periods at major airports and DAL for most days of the year. LOS D conditions may be acceptable during peak seasonal periods. Curbsides with single-lane loading are not considered to be operating at a poor level of service when all available curbside is being used (100 percent utilization). When a single lane is fully utilized, parked vehicles are still able to depart and access the curbside, and are not generally blocked by vehicles in a second parking lane. For curbsides with single-lane passenger loading/unloading, double or triple parking or queuing along 30 percent or more of the adjacent travel lane constitutes a failed level of service (i.e., LOS F).

Table 4-23: Level of Service and Utilization Ranges for Curbsides with Single-Lane Passenger Loading/Unloading

LOS	UTILIZATION RANGES	DESCRIPTION
A	0% - 70%	**Excellent:** Drivers experience no interference from pedestrians or other motorists
B	71% - 85%	**Very Good**: Relatively free-flow conditions with no double parking
C	86% - 100%	**Good**: Curbside utilization is approaching full capacity, but maneuverability is adequate
D	101% - 115%	**Fair**: Vehicle maneuverability is becoming restricted due to double parking or queuing
E	116% - 130%	**Poor**: Vehicle maneuverability is restricted due to double parking or queuing
F	> 130%	**Failure**: Delays and queues and/or double parking exceeds desired utilization

NOTE: Utilization is the ratio of curbside demand divided by available curbside length.

SOURCE: Ricondo & Associates, Inc., April 2014, based on information published in Airport Cooperative Research Program, ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*, July 2010.

PREPARED BY: Ricondo & Associates, Inc., April 2014.

Table 4-24 provides a summary of the estimated demand and requirements for the upper level and lower level curbsides at DAL during the PAL E1, PAL E2, and PAL E3 a.m. peak hour. As shown in the table, the analysis was based on the assumption that 477 linear feet would be allocated for the departures curbside (passenger dropoff) and 318 linear feet would be allocated for the arrivals curbside (passenger pickup). In estimating the total amount of usable curb, an overlap area of approximately 162 feet was considered. This overlap area is the area between the arrivals curbside and the departures curbside. It was assumed that this area would be used for passenger dropoff during the departures peak hour and for passenger pickup during the arrivals peak hour. The functional upper level curbside would, therefore, consist of a total of 795 linear feet. As shown in the table, it is anticipated that the departures curbside would operate at LOS E at PALs E1 and E2 and at LOS F at PAL E3 during the a.m. peak hour, while the upper level arrivals and lower level commercial staging areas would operate at LOS A or LOS B during the same period. The level of service estimates for the upper level curbside were based on multiple-lane utilization, and the level of service for the lower level curbside was based on single-lane utilization, as described previously.

Table 4-24: Master Plan Curbside Allocations (a.m. Peak Hour)

A.M. PEAK	CURB LENGTH AVAILABLE (FEET)	PAL E1 REQUIRED CURB LENGTH (FEET)	PAL E1 CURBSIDE LEVEL OF SERVICE	PAL E2 REQUIRED CURB LENGTH (FEET)	PAL E2 CURBSIDE LEVEL OF SERVICE	PAL E3 REQUIRED CURB LENGTH (FEET)	PAL E3 CURBSIDE LEVEL OF SERVICE
				UPPER LEVEL			
Arrivals Curbside	318	100	A	100	A	125	A
Departures Curbside	477	840	E	915	E	990	F
				LOWER LEVEL			
Taxicabs	227	25	A	50	A	50	A
Limousines	92	30	A	30	A	30	A
Shared Ride/Door-to-Door Vehicles	80	30	A	30	A	30	A
Rental Car Shuttles	197	30	A	30	A	30	A
Hotel/Motel/Parking Shuttles Dropoff	244	120	A	150	A	180	B
Hotel/Motel/Parking Shuttles Pickup	192	60	A	60	A	60	A
Dallas Area Rapid Transit Buses	60	40	A	40	A	40	A
Lower Level Totals	**1,092**	**335**	**A**	**390**	**A**	**420**	**A**

SOURCE: Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

Table 4-25 provides a summary of the estimated demand and requirements for the upper level and lower level curbsides during the PAL E1, PAL E2, and PAL E3 p.m. peak hour. As shown in the table, the analysis was based on the assumption that 428 linear feet would be allocated for the departures curbside (passenger dropoff) and 367 feet would be allocated for the arrivals curbside (passenger pickup). The total amount of usable curbside, similar to the analysis of the upper level curbside, was assumed to include an approximate 162-foot overlap area between the arrivals and departures curbsides. Use of this area would be shared between arrivals and departures during the respective peak hours to accommodate curbside demand. It was assumed that 70 percent of the overlap area would be utilized by people accessing the departures curbside, and that 30 percent would be utilized by people accessing the arrivals curbside. As shown in the table, it is estimated that the departures curbside would operate at LOS D at PAL E1, LOS E at PAL E2, and LOS F at PAL E3 during the p.m. peak hour and the arrivals curbside would operate at LOS C at PAL E1 and at LOS D at PALs E2 and E3. The lower level commercial staging areas would operate at LOS A during the same period. The level of service estimates for the upper level curbside were based on multiple-lane utilization and the level of service for the lower level curbside was based on single-lane utilization, as previously discussed. Therefore, the capacity of the departure curbside needs to be improved to avoid severe congestion and delay during a.m. and p.m. peak hours. Because no additional linear curbside is planned for the recently renovated terminal area, operational curbside improvements are required to improve the efficiency of the upper level departures and arrivals areas. Potential improvements include: improved signage, additional pavement markings delineating the loading lanes and by-pass lanes, improved enforcement by police to reduce excessive dwell times and expansion/relocation of cellphone lots to reduce the number of recirculating vehicles.

Table 4-25: Master Plan Curbside Allocations (p.m. Peak Hour)

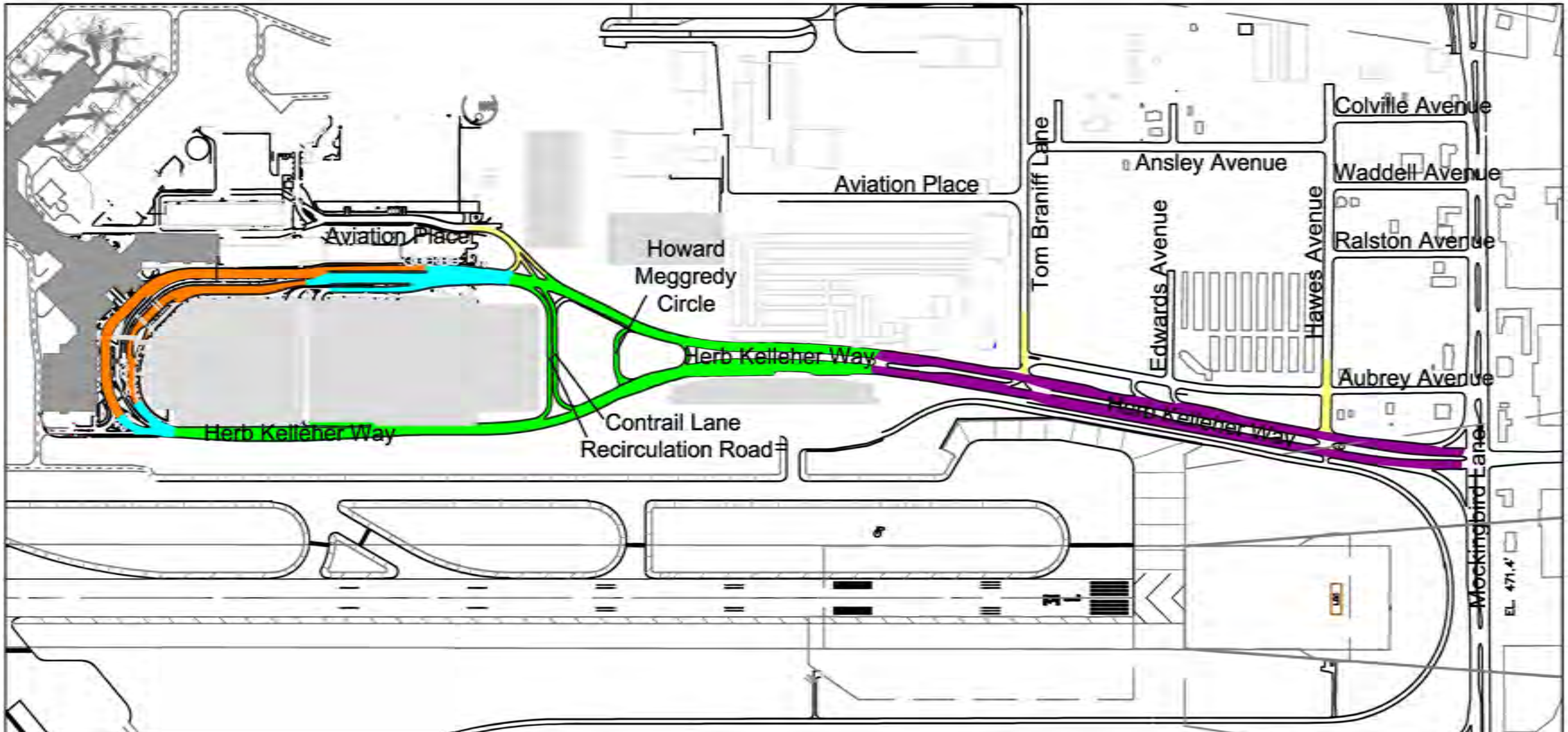
		PAL E1		PAL E2		PAL E3	
P.M. PEAK	CURB LENGTH AVAILABLE (FEET)	REQUIRED CURB LENGTH (FEET)	CURBSIDE LEVEL OF SERVICE	REQUIRED CURB LENGTH (FEET)	CURBSIDE LEVEL OF SERVICE	REQUIRED CURB LENGTH (FEET)	CURBSIDE LEVEL OF SERVICE
				UPPER LEVEL			
Arrivals Curbside	367	450	C	500	D	525	D
Departures Curbside	428	685	D	760	E	885	F
				LOWER LEVEL			
Taxicabs	227	100	A	100	A	100	A
Limousines	92	30	A	60	A	30	A
Shared Ride/Door-to-Door Vehicles	80	30	A	30	A	30	A
Rental Car Shuttles	197	60	A	60	A	60	A
Hotel/Motel/Parking Shuttles Drop-off	244	60	A	90	A	90	A
Hotel/Motel/Parking Shuttles Pickup	192	90	A	90	A	90	A
Dallas Area Rapid Transit Buses	60	40	A	40	A	40	A
Lower Level Totals	**1,092**	**410**	**A**	**470**	**A**	**440**	**A**

SOURCE: Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

4.5.2.4 On-Airport Roadways

The on-Airport roadway demand/capacity analysis conducted for the Master Plan Update consisted of updating the trip generation and trip assignment model developed for the LFMP. This spreadsheet demand/capacity model was used to calculate the capacity of the roadway system on a link-by-link basis. The terminal area roadways are classified based on speed flow rate tables applicable to airport roads, as developed in conformance with the guidelines in Airport Cooperative Research Program (ACRP) Report 40, *Airport Curbside and Terminal Area Roadway Operations*. The capacity and level of service ranges for terminal area roadways are summarized on **Exhibit 4-27**. Roadways at Dallas Love Field range from entry/exit roadways with speeds of 30 miles per hour to curbside roadways with speeds below 20 miles per hour. For the ease of identifying links, each link was given a letter designation. **Exhibit 4-28** provides a map of the roadway links considered in this demand/capacity analysis.

The link-by-link demand/capacity analysis was conducted for PAL E1, PAL E2, and PAL E3 for both the a.m. and p.m. peak periods based on the growth factors for enplaned passengers provided earlier in Table 4-20. The resulting demand volumes and level of service for each link are presented in **Table 4-26**. LOS A represents the optimal operating condition, characterized by uninterrupted free flow operations. LOS F represents the worst operating condition, characterized by severe roadway congestion and delay. LOS C is generally a desirable operating condition for the design of new facilities; however, LOS D conditions may be acceptable at some larger airports such as DAL during peak periods. For purposes of analyzing existing facilities and the need to provide improvements, it was assumed that LOS D conditions would be the "trigger point" at which capacity enhancements or demand reduction measures would be implemented before LOS E or F conditions occur.



Roadway Classification	Speed (mph)	A	B	C	D	E
		Maximum Capacity Ranges Level of Service				
Entry/Exit Roadway	40	360	600	860	1,130	1,410
Terminal Loop Road	30	300	480	700	930	1,170
Terminal Access Road	20	250	400	600	800	1,010
Curbside	20	250	400	600	800	1,010
Service Road	20	250	400	600	800	1,010

Capacity = number of vehicles per hour per lane

SOURCES: Transportation Research Board, ACRP Report 40, July 2010, Ricondo & Associates Inc, April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

EXHIBIT 4-27

NORTH 0 NTS

Roadway Link Capacities

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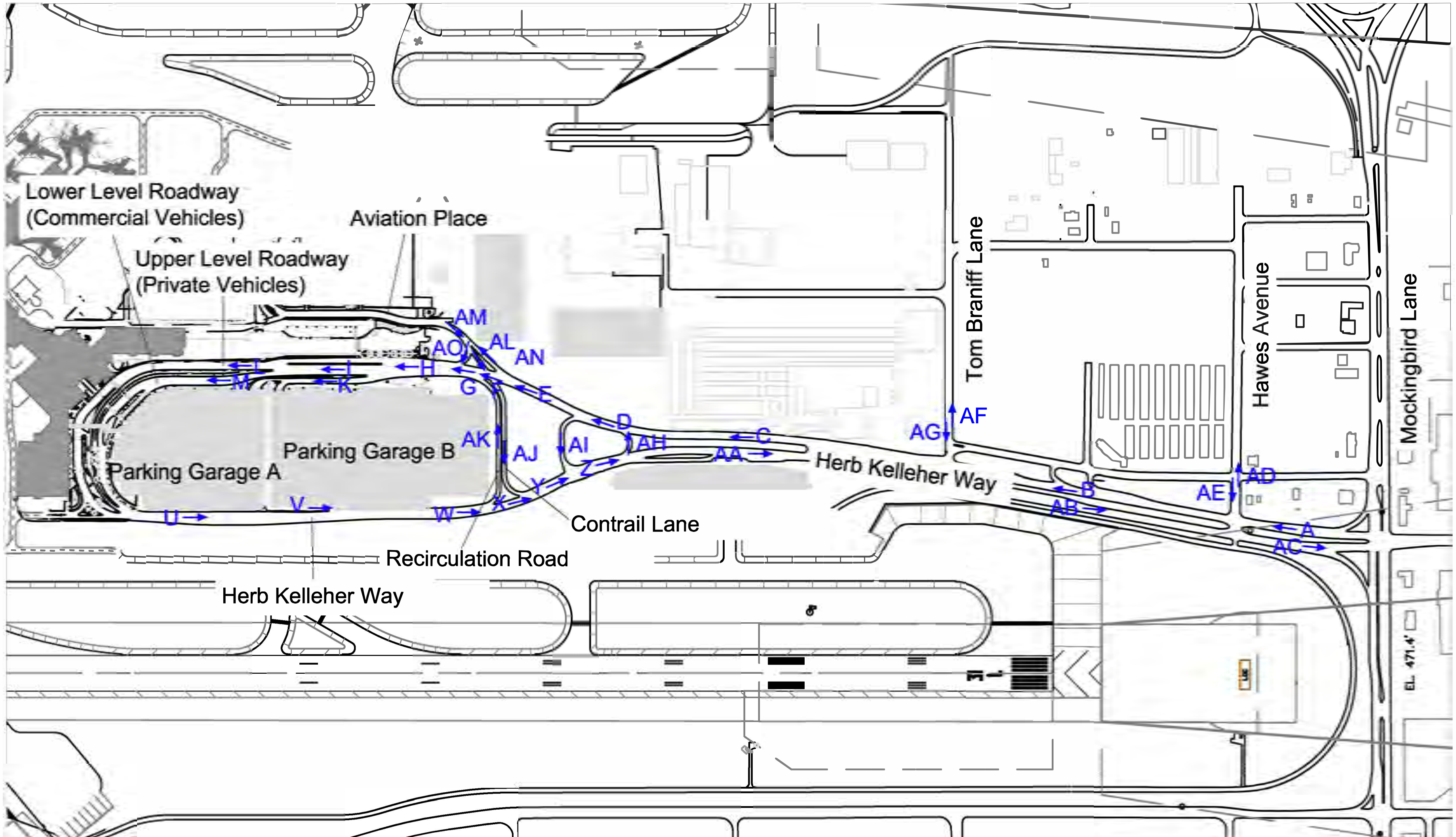

EXHIBIT 4-28

SOURCE: Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

NORTH 0 NTS

Roadway Network Link Designations

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Table 4-26: Terminal Area Roadway Demand/Capacity Analysis

				BASELINE CAPACITY		PAL E1				PAL E2				PAL E3			
						A.M. PEAK		P.M. PEAK		A.M. PEAK		P.M. PEAK		A.M. PEAK		P.M. PEAK	
LINK	LOCATION	NUMBER OF LANES	LINK SPEED	VEHICLES PER LANE PER HOUR	LINK CAPACITY (VEHICLES/ HOUR)	NUMBER OF VEHICLES	LEVEL OF SERVICE	NUMBER OF VEHICLES	LEVEL OF SERVICE	NUMBER OF VEHICLES	LEVEL OF SERVICE	NUMBER OF VEHICLES	LEVEL OF SERVICE	NUMBER OF VEHICLES	LEVEL OF SERVICE	NUMBER OF VEHICLES	LEVEL OF SERVICE
A	Herb Kelleher Way, Inbound between Mockingbird Lane and Hawes Avenue	4	40	1,410	5,640	1,852	B	1,064	A	2,085	B	1,260	A	2,344	B	1,483	B
B	Herb Kelleher Way, Inbound between Hawes Avenue and Tom Braniff Lane	4	40	1,410	5,640	1,842	B	1,058	A	2,075	B	1,253	A	2,332	B	1,475	B
C	Herb Kelleher Way, Inbound between Tom Braniff Lane and 2nd Recirculation Road	3	40	1,410	4,320	1,976	C	1,059	A	2,225	C	1,255	B	2,501	C	1,477	B
D	Herb Kelleher Way, Inbound between 2nd Recirculation Road and Outbound Recirculation Road	4	30	1,170	4,680	2,008	C	1,109	A	2,261	C	1,313	B	2,542	C	1,546	B
E	Herb Kelleher Way, Inbound between Outbound Recirculation Road and Aviation Place Exit	4	30	1,170	4,680	1,935	C	1,041	A	2,179	C	1,234	B	2,449	C	1,452	B
F	Herb Kelleher Way, Inbound between Aviation Place Exit and Aviation Place Outbound Road	3	30	1,170	3,510	1,626	C	1,006	B	1,831	C	1,192	B	2,058	C	1,403	B
G	Herb Kelleher Way, Inbound between Aviation Place Exit and Aviation Place Inbound to Terminal	4	30	1,170	4,680	1,660	B	1,073	A	1,869	B	1,272	B	2,101	C	1,497	B
H	Herb Kelleher Way, Inbound between Aviation Place Inbound and Terminal/Cell Phone Lot/Garage Split	6	20	1,010	6,060	1,660	B	1,073	A	1,869	B	1,272	A	2,101	B	1,497	A
I	Herb Kelleher Way, Inbound between Garages A and B Split and Upper/Lower Level Terminal Split	6	20	1,010	6,060	927	A	981	A	1,044	A	1,162	A	1,173	A	1,367	A
K	Entrances to Garages A and B	1	20	1,010	1,010	733	D	93	A	826	E	110	A	928	E	129	A
L	Upper Level Curbside (Private Vehicles)	4	20	1,010	4,040	726	A	767	A	818	A	909	A	920	A	1,070	B
M	Lower Level Curbside (Courtesy Vehicles)	2	20	1,010	2,020	200	A	213	A	226	A	252	A	254	A	297	A
U	Herb Kelleher Way, Outbound between Terminal Exit and Garages A and B Exit Road	3	30	1,170	3,510	927	B	981	B	1,044	B	1,162	B	1,173	B	1,367	B
V	Garages A and B Exit Road	2	30	1,170	2,340	46	A	412	A	52	A	488	A	58	A	574	A
W	Herb Kelleher Way, Outbound between Garages A and B Exit and 1st Recirculation Road	4	30	1,170	4,680	973	A	1,393	B	1,095	A	1,650	B	1,231	B	1,942	C
X	Herb Kelleher Way, Outbound between 1st Recirculation Road and Aviation Place	4	30	1,170	4,680	939	A	1,325	B	1,057	A	1,570	B	1,188	A	1,848	B
Y	Herb Kelleher Way, Outbound between Aviation Place and Outbound Recirculation Road	4	30	1,170	4,680	1,137	A	1,433	B	1,281	B	1,698	B	1,439	B	1,999	C
Z	Herb Kelleher Way, Outbound between Outbound Recirculation Road and 2nd Recirculation Road	4	30	1,170	4,680	1,210	B	1,501	B	1,363	B	1,778	B	1,532	B	2,093	C
AA	Herb Kelleher Way, Outbound between 2nd Recirculation Road and Tom Braniff Lane	3	40	1,410	4,230	1,178	B	1,451	B	1,327	B	1,719	B	1,491	B	2,023	C
AB	Herb Kelleher Way, Outbound between Tom Braniff Lane and Hawes Avenue	4	40	1,410	5,640	1,147	A	1,436	A	1,292	A	1,702	B	1,452	B	2,003	B
AC	Herb Kelleher Way, Outbound between Hawes Avenue and Mockingbird Lane	4	40	1,410	5,640	1,094	A	1,414	A	1,232	A	1,675	B	1,384	A	1,971	B
AD	Hawes Avenue, Northbound	1	30	1,170	1,170	74	A	114	A	85	A	131	A	103	A	160	A
AE	Hawes Avenue, Southbound	1	30	1,170	1,170	34	A	86	A	39	A	99	A	48	A	121	A
AF	Tom Braniff Lane, Northbound	1	20	1,010	1,010	51	A	96	A	59	A	110	A	71	A	134	A
AG	Tom Braniff Lane, Southbound	1	20	1,010	1,010	141	A	112	A	163	A	129	A	198	A	157	A
AH	2nd Recirculation Road	1	30	1,170	1,170	32	A	50	A	36	A	59	A	41	A	69	A
AI	Outbound Recirculation Road	1	30	1,170	1,170	73	A	67	A	82	A	80	A	92	A	94	A
AJ	Aviation Place, Outbound Adjacent to 1st Recirculation Road	1	20	1,010	1,010	199	A	108	A	224	A	128	A	251	B	151	A
AK	1st Recirculation Road	1	20	1,010	1,010	34	A	67	A	38	A	80	A	43	A	94	A
AL	Aviation Place, Northbound Exit Road	1	20	1,010	1,010	309	B	15	A	348	B	18	A	391	B	22	A
AM	Aviation Place, Southbound Prior to Intersection with Herb Kelleher Way	1	20	1,010	1,010	199	A	88	A	224	A	105	A	251	B	123	A
AN	Aviation Place, Southbound Outbound lanes through Intersection at Herb Kelleher Way	1	20	1,010	1,010	199	A	88	A	224	A	105	A	251	B	123	A
AO	Aviation Place, Inbound Exit toward Terminal	1	20	1,010	1,010	0	A	0	A	0	A	0	A	0	A	0	A

SOURCE: Ricondo & Associates, Inc., April 2014.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

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The a.m. peak resulted in the highest roadway volumes, with the single-lane ramp to the entrance to Garages A and B (Link K) experiencing LOS D at PAL E1, and LOS E at PALs E2 and E3. The p.m. peak link-by-link analysis did not produce any roadway deficiencies (LOS D or worse) at any PAL.

4.5.2.5 On-Airport Intersection Level-of-Service Analysis

Intersection level-of-service analysis provides a quantitative means of determining the operation of signalized and unsignalized intersections. This analysis was conducted at two signalized intersections: the Herb Kelleher Way with Aviation Place intersection and the Herb Kelleher Way with Tom Braniff Lane intersection. The intersection of Herb Kelleher Way and Hawes Avenue is a stop-controlled intersection that was analyzed using a different process. In all cases, Synchro® version 7 was used to analyze the intersections based on *Highway Capacity Manual* procedures.

The existing signal timings at the two signalized intersections were obtained from the City of Dallas, Department of Public Works and Transportation, and incorporated within a Synchro signal timing network model that was created to analyze the terminal area roadway and traffic signal network. **Table 4-27** presents the estimated vehicle delay, volume/capacity ratio (V/C), and level of service during the a.m. departures peak and the p.m. arrivals peak for the intersections at PAL E1, PAL E2, and PAL E3. It is anticipated that both signalized intersections would operate at LOS B or better through PAL E3.

As shown in the table, it is estimated that the stop-controlled intersection at Herb Kelleher Way and Hawes Avenue would operate at LOS B or better at PAL E1, but would deteriorate to LOS F at PAL E2, as left-turning vehicles traveling south on Hawes Avenue would have a difficult movement across four inbound lanes on Herb Kelleher Way onto outbound Herb Kelleher Way, which currently backs up past Hawes Avenue during peak periods. While it could be assumed that signalization would improve the level of service at this intersection, its proximity to the Cedar Springs Road/Herb Kelleher Way and Mockingbird Lane intersection, and the long queuing on outbound Cedar Springs Road/Herb Kelleher Way suggest that this intersection would operate better if reconfigured as a right turn-in/right turn-out for the inbound Cedar Springs Road/Herb Kelleher Way traffic.

Table 4-27: Intersection Level of Service Analysis

		HERB KELLEHER WAY AT AVIATION PLACE (SIGNALIZED)		HERB KELLEHER WAY AT TOM BRANIFF LANE (SIGNALIZED)		HERB KELLEHER WAY AT HAWES AVENUE (STOP-CONTROLLED)	
		DEPARTURES PEAK	ARRIVALS PEAK	DEPARTURES PEAK	ARRIVALS PEAK	DEPARTURES PEAK	ARRIVALS PEAK
PAL E1	Delay (seconds)	5.5	3.3	9.4	9.4	3.2	10.3
	V/C 1/	0.53	0.31	0.53	0.33	0.89	1.28
	LOS 2/	A	A	A	A	A	B
PAL E2	Delay (seconds)	6.1	3.5	9.6	9.1	7.4	23.6
	V/C 1/	0.59	0.36	0.59	0.38	1.68	2.32
	LOS 2/	A	A	A	A	F	F
PAL E3	Delay (seconds)	5.6	3.7	13.1	10.4	124.2	333.8
	V/C 1/	0.67	0.43	0.68	0.46	5.70	7.44
	LOS 2/	A	A	B	B	F	F

NOTES:

1/ V/C = Volume to capacity ratio: if this value is greater than 1.0, there is more traffic demand than the roadway can handle, and delays are imminent.

2/ Intersection level of service is a function of delay attributed to the traffic control device, either a traffic signal or a stop sign, and is expressed in seconds per vehicle based on the following criteria:

Signalized Intersection Level of Service

LOS	Control Delay (seconds/vehicle)
A	<10.0
B	>10.0 and < 20.0
C	>20.0 and < 35.0
D	>35.0 and < 55.0
E	>55.0 and < 80.0
F	>80.0

Stop Controlled Level of Service

LOS	Control Delay (seconds/vehicle)
A	<10.0
B	>10.0 and < 15.0
C	>15.0 and < 25.0
D	>25.0 and < 35.0
E	>35.0 and < 50.0
F	>50.0

SOURCES: Ricondo & Associates, Inc.; Transportation Research Board, *Highway Capacity Manual*, 2010.
PREPARED BY: Ricondo & Associates, Inc., April 2014.

4.6 Taxicab and Commercial Vehicle Staging Area Requirements

Other ground transportation facilities considered for the Master Plan Update include the taxicab staging area and commercial vehicle staging area, as discussed below.

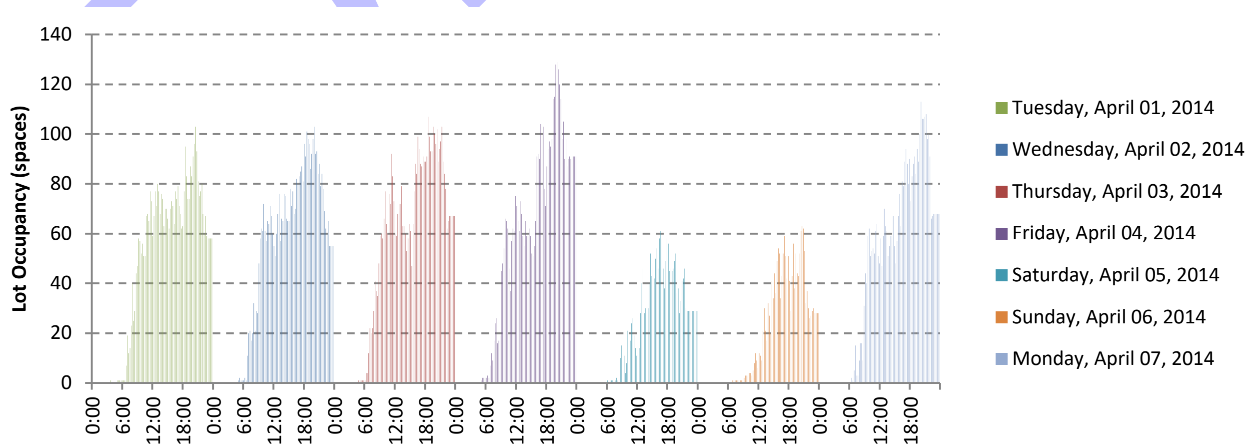
4.6.1 TAXICAB STAGING AREA

Only taxicabs with approved City of Dallas Department of Public Works and Transportation decals and North Texas Tollway Authority (NTTA) TollTag transponders are permitted to stage and load passengers at the Airport. The staging procedure requires taxicabs to process in sequence through the remote holding area, terminal staging/queuing area, and curbside loading area. All taxicab drivers must first check in at the remote holding area located at the old National/Alamo/Enterprise rental car site located between Tom Braniff Lane, Edwards Avenue, and Ansley Avenue. As taxicabs are needed at the terminal curbside loading area, the curbside taxicab starter calls for additional taxicabs from the terminal staging/queuing area located on the left-side lane of the lower level roadway adjacent to Garage A. The number of taxicabs requested by the starter is then released from the remote holding area to the terminal staging/queuing area. A maximum of nine taxicabs can be accommodated at the curbside loading area. The maximum capacity of the terminal staging/queuing area is approximately 12 taxicabs. The taxicab remote holding area (former rental car lot) has been restriped with linear taxicab queue lanes for taxicab staging, and has a marked capacity of 160 spaces, but would have a much higher capacity if the lot were to be cleared of some existing buildings and restriped for optimal taxicab staging. The ultimate capacity of the approximate 100,000-square-foot taxicab remote holding area has the potential to accommodate 225 to 275 taxicab spaces.

The curbside loading area, terminal staging/queuing area, and remote holding area are equipped with NTTA automated vehicle identification (AVI) receivers to monitor taxicab vehicle movements. The AVI data were obtained from the NTTA to process the daily demand profile for taxicabs and other commercial vehicles at Dallas Love Field.

The entry and exit AVI data from the NTTA were processed in 15-minute increments over a period of one week to develop a lot occupancy chart. **Exhibit 4-29** provides a summary of the estimated taxicab staging area occupancy for the week of April 1 through April 7, 2014. The taxicab staging area data indicate that taxicab demand is highest during weekdays, especially on Mondays and Fridays, and significantly lower on weekends. Taxicab demand by arriving passengers typically tends to be higher early in the week, as the demand is often driven by the arrival of out-of-town business travelers, and on Friday evening by out-of-town leisure travelers arriving for weekend visits or returning business travelers who elect not to use a private vehicle and park at the Airport.

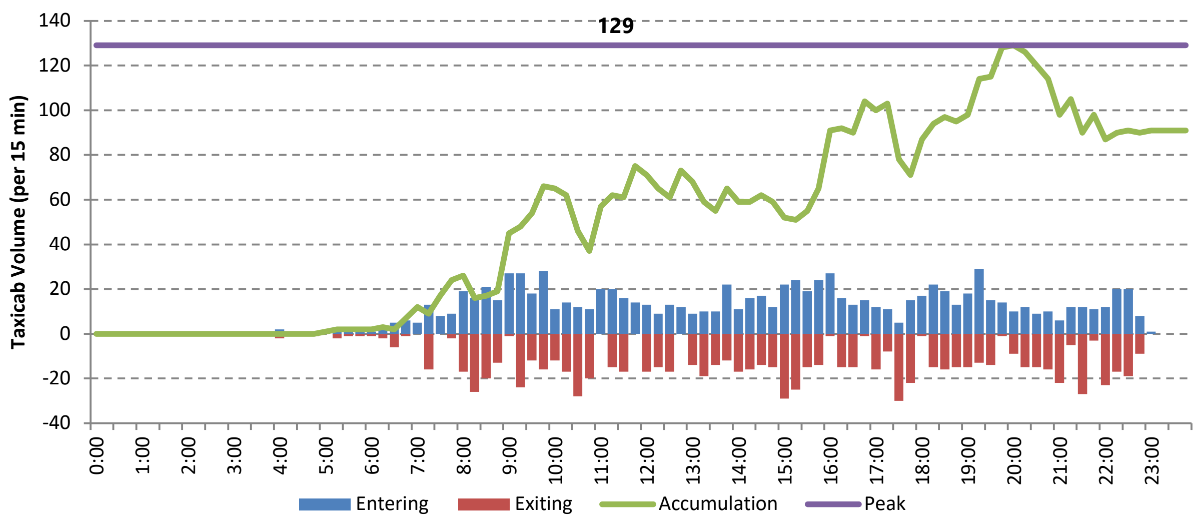
Exhibit 4-29: Existing Taxicab Staging Area Vehicle Occupancy



SOURCES: North Texas Tollway Authority, April 2014; Ricondo & Associates, Inc., May 2014.
PREPARED BY: Ricondo & Associates, Inc., May 2014.

The bar graph presented on **Exhibit 4-30** shows a comparison of the taxicab staging area entries and exits to the taxicab staging area on the peak day, Friday, April 4, 2014; the line graph on the same exhibit illustrates the resulting taxicab accumulation within the staging area, which peaks at 129 taxicabs between 7:00 p.m. and 8:00 p.m. The overall accumulation total within the staging area provides an indication of actual staging area occupancy based on procedures followed by the taxicab starter. Consequently, the overall area accumulation over the course of the day typically includes an excess supply of taxicabs waiting in the lot for excessive periods.

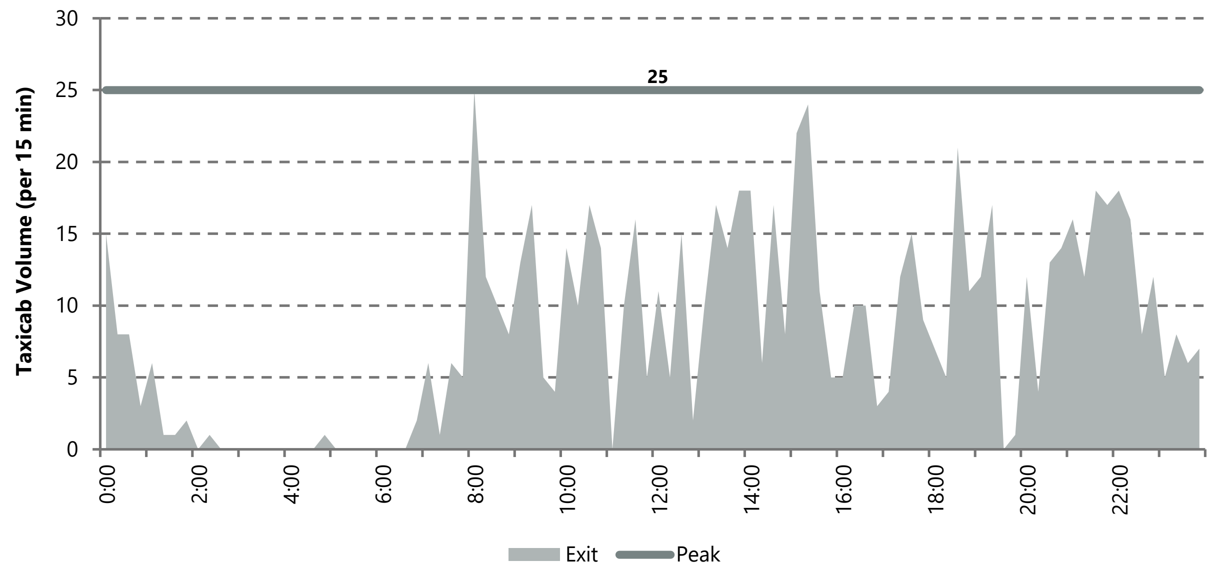
Exhibit 4-30: Comparison of Peak Day Taxicab Staging Area Vehicle Accumulation with Taxicab Entries and Exits



SOURCES: North Texas Tollway Authority, April 2014; Ricondo & Associates, Inc., May 2014.
PREPARED BY: Ricondo & Associates, Inc., May 2014.

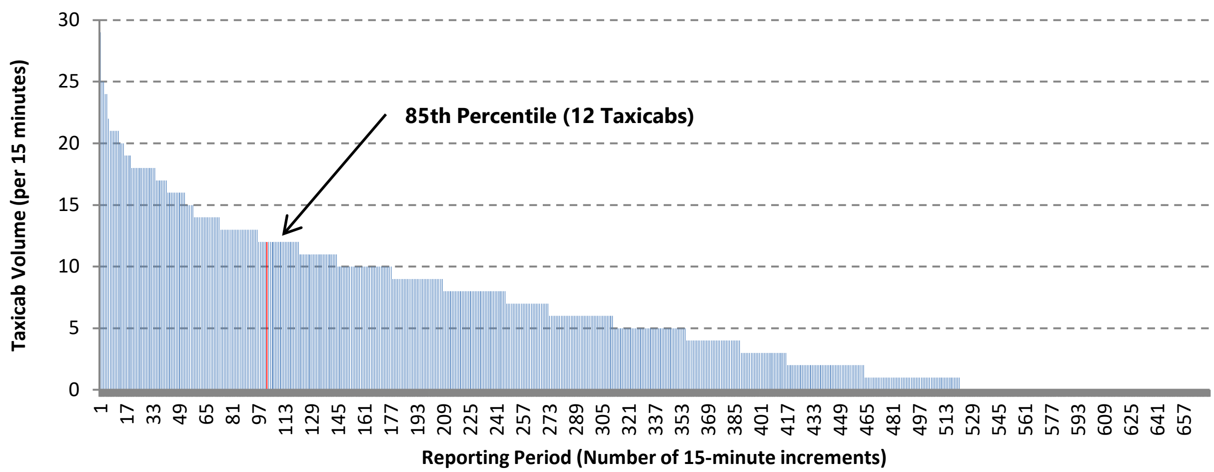
For purposes of estimating facility requirements for a taxicab staging area, it is important to balance overall demand with the number of taxicabs required to serve actual demand at curbside. This analysis was based on a review of the number of taxicabs dispatched from the taxicab staging area in 15-minute increments to serve arriving passengers at curbside. **Exhibit 4-31** shows that, except for a single 15-minute demand spike of 25 vehicles, the 15-minute demand for taxicabs at the terminal curbside exceeded 18 taxicabs during only four periods of the day. To understand the overall demand characteristics throughout the day, **Exhibit 4-32** was prepared to show the 15-minute demand for the week in decreasing order of magnitude. As shown on the exhibit, the 85th percentile taxicab demand was equal to 12 taxicabs, which represents approximately 41 percent of the overall peak 15-minute demand for 29 taxicabs at the arrivals curbside. It is important to note that the 15-minute demand for taxicabs represents an efficient operation where drivers dwell in the staging area for relatively short durations before being dispatched to the curbside.

Exhibit 4-31: Peak Day Taxicab Demand at Curbside



SOURCES: North Texas Tollway Authority, April 2014; Ricondo & Associates, Inc., May 2014.
PREPARED BY: Ricondo & Associates, Inc., May 2014.

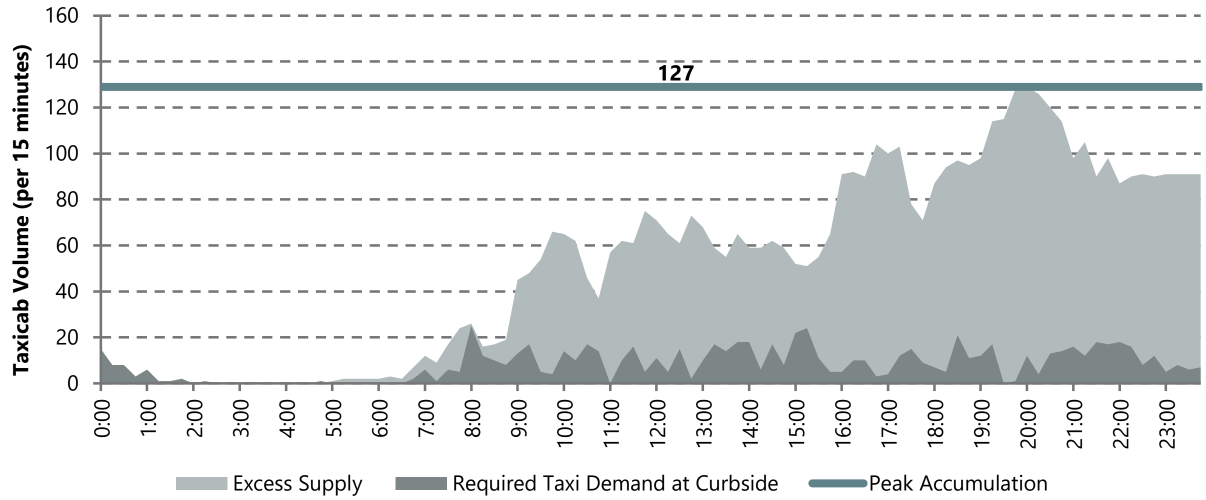
Exhibit 4-32: Taxicab Demand at Curbside in Decreasing Order of Magnitude for April 1 through April 7, 2014



SOURCES: North Texas Tollway Authority, April 2014; Ricondo & Associates, Inc., May 2014.
PREPARED BY: Ricondo & Associates, Inc., May 2014.

Exhibit 4-33 illustrates the estimated excess supply of taxicabs dwelling in the staging area throughout the day, which is calculated as the difference between the total number of taxicabs in the staging area less the number of taxicabs needed to serve the demand for taxicabs at curbside. As shown on the exhibit, the excess supply is estimated to reach a maximum of 127 taxicabs between 7:45 and 8:00 p.m. Furthermore, the data suggest that the existing taxicab staging area capacity of approximately 160 taxicabs is sufficient to serve existing demand.

Exhibit 4-33: Comparison of Peak Day Taxicab Demand versus Excess Supply



SOURCES: North Texas Tollway Authority, April 2014; Ricondo & Associates, Inc., May 2014.
PREPARED BY: Ricondo & Associates, Inc., May 2014.

Future taxicab staging area requirements were computed based on factoring the current peak day maximum 15-minute taxicab curbside demand plus a reasonable supply of additional taxicabs in the staging area. Both the curbside demand and additional supply values were assumed to be directly related to the increase in passenger activity, as well as possible changes in other factors, such as vehicle mode split. For purposes of this analysis, future taxicab demands and requirements were estimated using the following assumptions:

- Taxicab demand will increase at the same rate as forecast growth in the number of O&D passengers annual
- The proportion of airline passengers using taxicabs (i.e., mode split) in the future will remain the same as in the year 2012
- The taxicab operation will be managed to maintain a reasonable supply in the staging area as required to meet anticipated demand

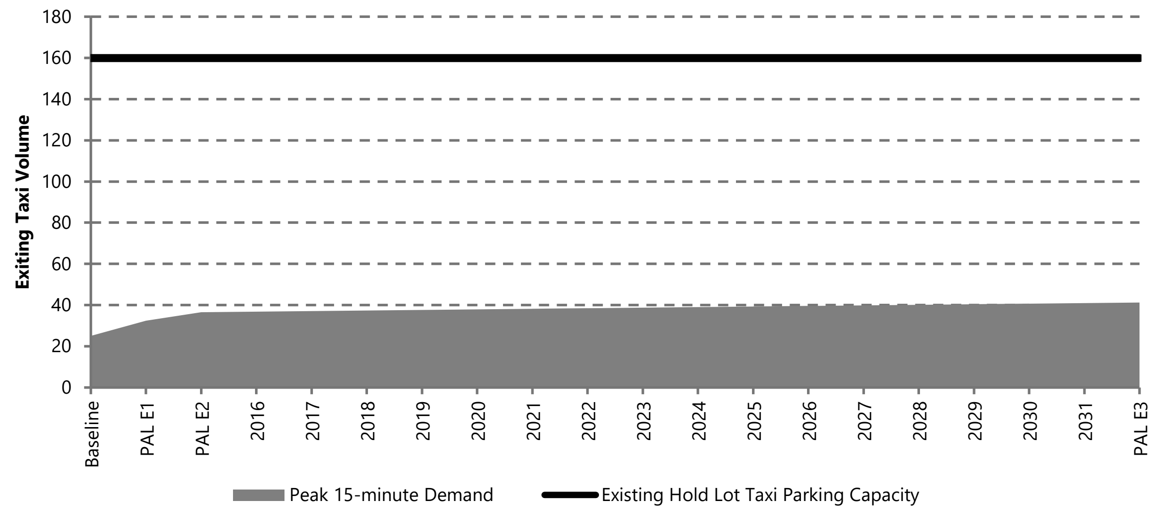
The taxicab companies have the ability to control the arrival or supply of taxicabs in the staging area to minimize excessive dwell times and the potential overflow of the staging area. However, it is important to acknowledge that minimizing supply to respond to curbside demand on a "just-in-time" basis is not a reasonable operating parameter. As a result, an excess supply of taxicabs beyond the immediate short-term demand is required to ensure that taxicabs are available to accommodate unanticipated surges and maintain an acceptable level of customer service. **Exhibit 4-34** illustrates the forecast growth in the peak 15-minute taxicab demand at the terminal based on the forecast growth in the number of O&D passengers provided in Section 3. However, because taxicab supply cannot be managed on a just-in-time basis, **Exhibit 4-35** was prepared to depict the additional supply needed to maintain a larger reserve within the staging area. The supply calculations depicted on the exhibit are provided in **Table 4-28**. The information in the table and on the exhibit illustrate the forecast peak 15-minute taxicab demand plus the additional taxicab supply that would be required to serve the peak demand occurring over 60, 90, and 120 minutes based on the assumption that all vehicles required to accommodate demand are queued within the staging area and that no additional supply would enter the area during that period.

The information on the exhibit illustrates the importance of managing the taxicab supply and the length of time drivers dwell in the staging area. For example, if a taxicab supply capable of accommodating either the peak 60- or 90-minute demand were staged in the area, it is estimated that the existing 160 space lot would be sufficient to meet demand through the end of the planning period for this Master Plan Update (2032). However, maintaining a supply of taxicabs to meet the 120-minute demand would exceed staging area capacity by 2017. The exhibit shows the importance of managing the supply of taxicabs in the lot to eliminate vehicle queuing and congestion that may exceed the capacity of the lot. The supply of taxicabs available in the staging area is assigned at the discretion of Airport management. Consideration should also be given to the additional 12 taxicabs that are routinely staged in the terminal staging/queuing area located on the left-side lane of the lower level roadway adjacent to Garage A.

4.6.2 COMMERCIAL VEHICLE STAGING AREA

There is no formal staging area on Airport property for commercial vehicles other than taxicabs. Rental car companies, off-airport parking companies and hotels all run their shuttles continuously between the airport curbside and their respective properties on a fixed schedule or headway and can stage their vehicles at their respective properties and have no need to stage on-airport other than the curbside. The remaining commercial vehicle modes;, shared ride vans, limousines, buses, and other courtesy shuttles, have no space to stage at the Airport. Peak day activity from the NTTA for the remaining commercial vehicles on the lower level, as reported by the AVI data in 15-minute increments, is presented on **Exhibit 4-36**. These data indicate that the activity of the other commercial vehicle modes is much less than that of taxicabs. Existing demand for limousines reached a maximum of eight per 15-minute period, while both shared ride and courtesy shuttles had maximum demands of six per 15-minute period, and typically only one to two buses were required per 15-minute period throughout the peak day. Since current and future level of activity of these remaining commercial vehicles is LOS B or better, the curbside staging appears adequate and off-airport staging of these commercial vehicles appears to be adequate as well, wherever their current staging location may be, as long as they do not stage in the cell phone lot or Spirit of Flight fountain areas.

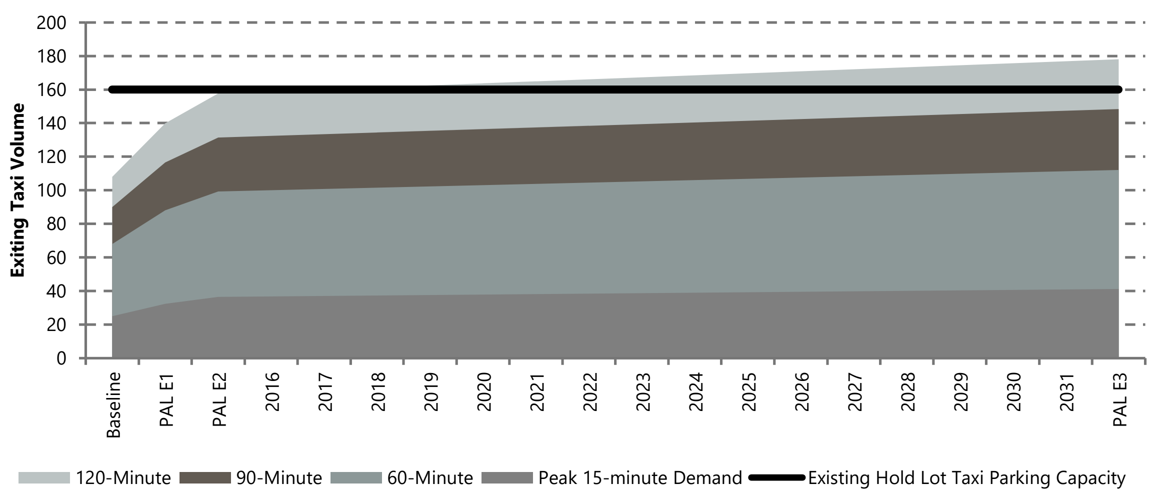
Exhibit 4-34: Forecast Peak Day Taxicab Demand at Curbside (Peak 15-Minute Supply)



NOTE: Future Demand based on forecast number of O&D passengers

SOURCE: Ricondo & Associates, Inc., May 2014.
PREPARED BY: Ricondo & Associates, Inc., May 2014.

Exhibit 4-35: Forecast Peak Day Taxicab Demand for Alternative Levels of Supply



NOTE: Future Demand based on forecast number of O&D passengers

SOURCE: Ricondo & Associates, Inc., May 2014.
PREPARED BY: Ricondo & Associates, Inc., May 2014.

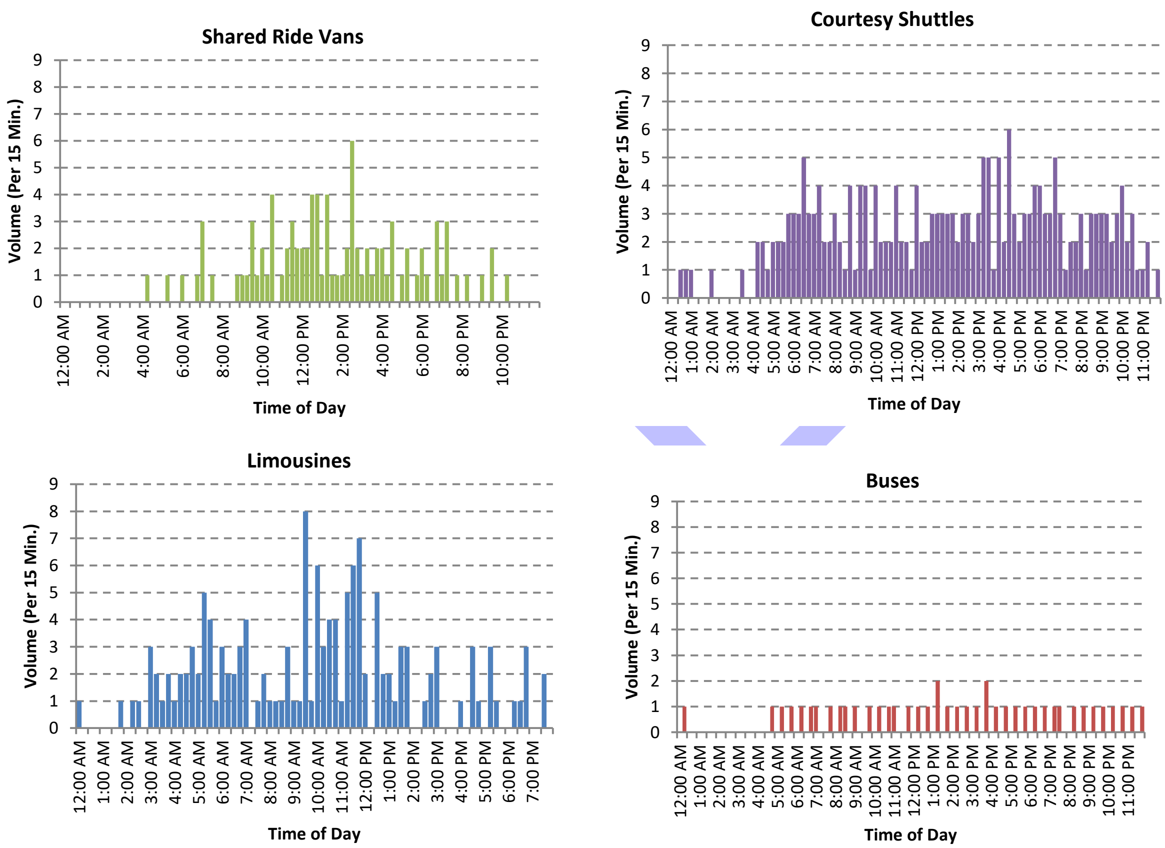
Table 4-28: Future Taxicab Staging Lot Occupancy – Peak 15-Minute Demand Period

YEAR	ANNUAL ENPLANED PASSENGERS	ANNUAL GROWTH RATE	PEAK 15-MINUTE DEMAND	STAGING LOT OCCUPANCY WITH ADDITIONAL SUPPLY		
				60-MINUTE	90-MINUTE	120-MINUTE
Baseline	4,245,996		25	68	90	108
2014 (PAL E1)	5,500,000	29.5%	32	88	117	140
2015 (PAL E2)	6,200,000	12.7%	37	99	131	158
2016	6,247,000	0.8%	37	100	132	159
2017	6,294,000	0.8%	37	101	133	160
2018	6,341,000	0.7%	37	102	134	161
2019	6,388,000	0.7%	38	102	135	162
2020	6,435,000	0.7%	38	103	136	164
2021	6,482,000	0.7%	38	104	137	165
2022	6,529,000	0.7%	38	105	138	166
2023	6,576,000	0.7%	39	105	139	167
2024	6,624,000	0.7%	39	106	140	168
2025	6,671,000	0.7%	39	107	141	170
2026	6,718,000	0.7%	40	108	142	171
2027	6,765,000	0.7%	40	108	143	172
2028	6,812,000	0.7%	40	109	144	173
2029	6,859,000	0.7%	40	110	145	174
2030	6,906,000	0.7%	41	111	146	176
2031	6,953,000	0.7%	41	111	147	177
2032 (PAL E3)	7,000,000	0.7%	41	112	148	178

NOTE: Capacity of existing taxicab staging area is approximately 160 taxicab queuing spaces in the remote holding area plus approximately 12 taxicab spaces in the terminal staging/queuing area adjacent to Garage A.

SOURCES: Federal Aviation Administration, *Terminal Area Forecast* 2012-2040, March 2013; Ricondo & Associates, Inc., May 2014.
PREPARED BY: Ricondo & Associates, Inc., May 2014.

Exhibit 4-36: Peak Day Lower Level Commercial Vehicle Activity



SOURCES: North Texas Tollway Authority, April 2014; Ricondo & Associates, Inc., May 2014.
PREPARED BY: Ricondo & Associates, Inc., May 2014.

4.7 Rental Car Facility Requirements

Rental car companies representing nine national brands operate on Airport property in exclusive use leaseholds. Advantage, Alamo, Avis, Budget, Enterprise, Hertz, and National operate along the northeast side of Herb Kelleher Way. Dollar and Thrifty operate southeast of the terminals on the northwest side of West Mockingbird Lane, northeast of Herb Kelleher Way. Each company's leasehold includes a rental car ready/return area, vehicle storage parking area, employee parking area, fueling facilities, wash bays, light maintenance bays, administrative area, and vehicle stacking/staging spaces. All companies transport their customers between the terminal building and their facilities via shuttle bus.

Specific requirements for each of the following rental car facility components are discussed after the discussion on the methodology used to determine requirements:

- Customer Service Area
- Rental Car Ready/Return Area and Onsite Vehicle Storage Area
- Service Sites
  - Fueling Positions
  - Wash Bays
  - Vehicle Light Maintenance Bays
  - Vehicle Stacking/Staging Spaces

4.7.1 METHODOLOGY

The rental car facility requirements were developed using DAL-specific facility utilization rates based on hourly rental car transactions during a peak rental day. A peak rental day (based on individual company questionnaire responses) was selected as the design day because ready vehicles occupy more space than the same number of return vehicles and, therefore, represent the maximum space required during a peak period. R&A sent a questionnaire requesting hourly transaction information, as well as the size, configuration, and use of existing facilities to each of the nine on-Airport rental car companies in September 2013. All nine on-Airport companies returned a completed questionnaire. A summary of their responses is presented in **Table 4-29**. Planning hour activity was defined as the peak hour number of returns or rentals. For forecasting purposes, existing (2013), PAL E1, PAL E2, and PAL E3 demand was based on forecast growth in numbers of originating passengers.

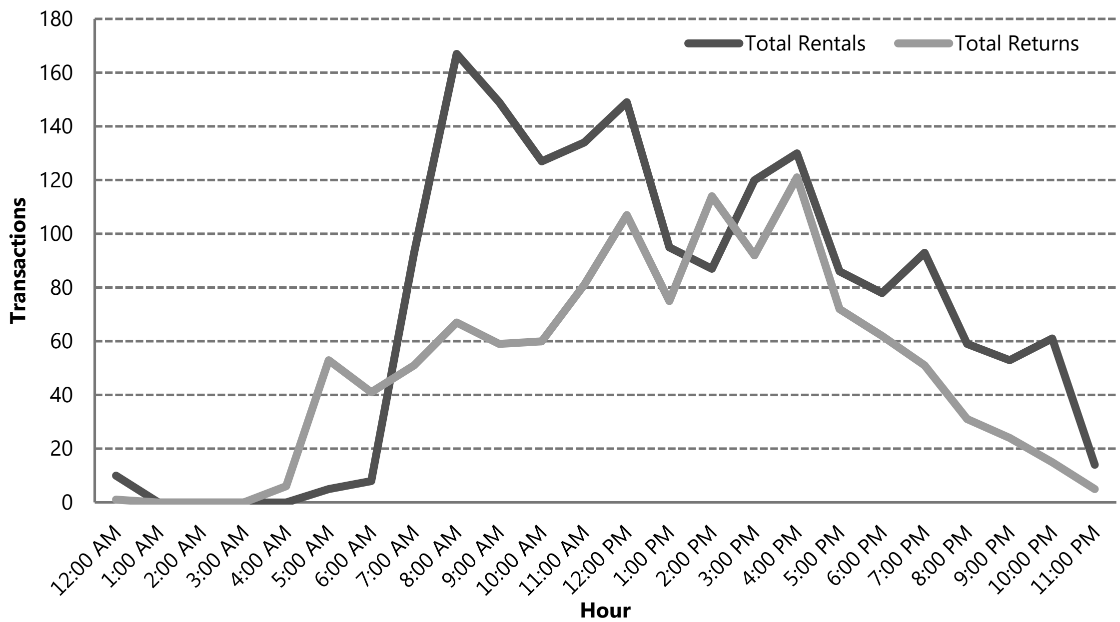
Exhibit 4-37 presents the hourly rentals and returns during the peak rental day, which was a Monday. It was assumed that rental car activity would increase at the same rate as the number of originating passengers. Therefore, existing (2013) requirements were determined based on the passenger forecasts completed in October 2013.

Table 4-29: Summary of Rental Car Company Questionnaire Responses

COMPONENT	HAVE (2013)	NEED (2013)	2015	2022	2032
Customer Service Area					
Regular Customer Service Positions	50	57	66	80	95
Kiosk Positions	5	6	10	19	24
Preferred Customer Service Positions	3	6	10	12	14
Ready/Return Area					
Regular Ready Spaces	506	723	907	1,172	1,487
Premium Ready Spaces	118	270	310	470	615
Total Ready Spaces	**624**	**993**	**1,217**	**1,642**	**2,102**
Return Spaces	332	473	553	740	915
Total Ready/Return Spaces	**956**	**1,466**	**1,770**	**2,382**	**3,017**
Service Area					
Vehicle Fueling Positions (nozzles)	24	32	42	58	74
Car Wash Bays	5	9	10	12	17
Vehicle Light Maintenance Bays	9	9	8	8	11
Administrative Area - Service Facility (square feet)	5,243	7,593	7,873	9,573	10,673
Overflow Vehicle Storage Spaces	606	1,406	1,610	2,015	2,370
Stacking/Staging Spaces	95	235	280	425	550
Employee Parking Spaces	72	153	193	255	330

SOURCE: Ricondo & Associates, Inc., January 2014.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

Exhibit 4-37: Peak Rental Car Day Transactions and Returns by Hour



SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

4.7.2 CUSTOMER SERVICE AREA

The customer service area is used to process arriving rental car customers. The required number of counter positions is the primary factor that determines the size of the customer service area. The peak rental day's peak hour number of rental car transactions at the customer service counter was used to determine customer service counter requirements.

During the peak rental day, the peak hour number of rental car transactions was 167. Of the 167 peak hour transactions, 57 percent, or 96, were regular counter transactions and 43 percent, or 71, were preferred area transactions. A preferred area is where the customer is able to bypass the customer service counter and proceed directly to the rental car ready area. Based on R&A experience at similar airports with rental car customer business/leisure splits that are similar to those of the Airport market, it was assumed that a typical rental car counter transaction takes approximately 10 minutes, which translates to six transactions per hour. With 96 regular counter transactions during the peak hour, six transactions per hour per position, and an assumed additional 30 percent surge factor, 21 regular customer service positions would be needed today. **Table 4-30** presents the customer service counter requirements for existing (2013) demand and for each PAL. Note that for each PAL, there would be a surplus of customer service positions.

Table 4-30: Customer Service Counter Requirements

COMPONENT	EXISTING (2013)	PAL E1	PAL E2	PAL E3
Customer Service Counter Position Requirements	21	28	32	36
Existing Customer Service Position Counters	50	50	50	50
Surplus/(Deficiency)	29	22	18	14

SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

4.7.3 RENTAL CAR READY/RETURN AREA AND ONSITE VEHICLE STORAGE AREA

Customers pick up and return rental cars in the ready/return areas. Ready vehicles are parked in a 90-degree configuration with traffic lanes, similar to the configuration of a conventional public parking lot. Return vehicles are parked in a nose-to-tail configuration. As previously mentioned, the peak rental day at the Airport, Monday, was selected as the design day because ready vehicles occupy more space than the same number of return vehicles and would represent the maximum space required during a peak period. The key utilization rate, or hours of available parking capacity, used to determine ready and return space requirements was the peak hour number of rentals (167) and returns (121) and the number of hours of peak activity that the spaces would be required to accommodate during the peak rental day.

Rental car companies prefer to maintain a sufficient supply of ready spaces and vehicles to accommodate the planned number of vehicles to be rented during the next hour's expected transactions. In addition, rental car companies prefer to have additional ready spaces available in case unplanned operational challenges occur, such as delayed flights. When flights are delayed, delayed customers are added to the next hour's planned rentals, potentially creating a shortfall of available vehicles. To alleviate this potential shortfall and avoid customer delays, the rental car companies prefer to have a buffer of ready vehicles available to provide more than one hour of capacity.

Therefore, the rental car companies typically prefer to have 2 to 3 hours of capacity for rental car ready and return vehicles (i.e., spaces). According to responses regarding the number of existing spaces and transaction information collected from the questionnaire, the rental car companies at the Airport have approximately 3.7 hours of ready space capacity and 2.7 hours of return space capacity during peak periods. Based on this information, an average of 3.0 hours of rental car ready and return capacity was used to develop the facility requirements. **Table 4-31** presents the rental car ready/return area requirements for existing (2013) demand and for each PAL. Note that for each PAL, there would be a deficiency of ready/return spaces.

Table 4-31: Rental Car Ready/Return Area Requirements

COMPONENT	EXISTING (2013)	PAL E1	PAL E2	PAL E3
Ready Space Requirement	501	676	762	861
Return Space Requirement	363	490	552	624
Total Space Requirement	**864**	**1,166**	**1,314**	**1,485**
Existing Rental Car Ready/Return Spaces	956	956	956	956
Surplus/(Deficiency)	**92**	**(210)**	**(358)**	**(529)**

SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

Also included in the vehicle space requirements is the onsite vehicle storage requirement during a peak week. This represents the number of spaces the rental car companies need to store vehicles that are not being rented or parked in a ready or return space. The utilization rate was calculated using the difference of rental and return transactions during the 2013 peak rental week, which, according to the questionnaire responses, nets 923 peak rentals and returns. It is assumed that ready/return spaces are not used to store vehicles. **Table 4-32** presents the onsite vehicle storage facility requirements for existing (2013) demand and for each PAL. Note that, for each PAL, there would be a deficiency of onsite vehicle storage spaces.

Table 4-32: Rental Car Onsite Vehicle Storage Facility Requirements

COMPONENT	EXISTING (2013)	PAL 1	PAL 2	PAL 3
Onsite Vehicle Storage Space Requirements	923	1,246	1,405	1,586
Existing Onsite Vehicle Storage Spaces	606	606	606	606
Surplus/(Deficiency)	**(317)**	**(640)**	**(799)**	**(980)**

SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

Area required for exit booths was also calculated. Exit booths would house the personnel responsible for checking the credentials of the drivers of the rented vehicles exiting the facility. It was assumed that each booth could process 30 vehicles per hour, at approximately 2.0 minutes per vehicle. **Table 4-33** presents the exit booth requirements.

Table 4-33: Exit Booth Requirements

COMPONENT	EXISTING (2013)	PAL E1	PAL E2	PAL E3
Planning hour rentals	167	225	254	287
Vehicles Processed Per Hour	30	30	30	30
Total Exit Booths Required	**6**	**8**	**8**	**10**

SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

Note: Some columns may not total due to rounding.

4.7.4 SERVICE SITES

The service sites are designed to accommodate vehicle support functions, such as fueling, washing, maintenance, and stacking/staging. After being processed through the service sites, the vehicle is parked in either a stacking space located at the service site, or in a ready space for the next customer. Parking (stacking/staging) lanes are provided for queuing vehicles at each stage of the process. Thus, vehicles may be staged in lanes waiting for fuel, staged in lanes after fueling waiting for washing, staged in lanes after washing waiting for an available ready stall, or parked in the onsite vehicle storage area.

4.7.4.1 Fueling Positions

The number of fueling positions required to accommodate future demand was based on the number of vehicles that can be fueled within the peak hour. The number of peak hour returns is 121. Assuming that 15 minutes are required to fuel one vehicle, 4 vehicles can be fueled per hour per position. This results in a requirement of 30 fueling positions for existing (2013) conditions and a forecast requirement of 52 fueling positions for PAL E3. **Table 4-34** presents the fueling position requirements for existing (2013) demand and for each PAL. Note that, for existing conditions and for each PAL, there is/would be a deficiency in fueling positions.

Table 4-34: Fueling Position Requirements

COMPONENT	EXISTING (2013)	PAL E1	PAL E2	PAL E3
Fueling Position Requirements	30	41	46	52
Existing Fueling Positions	24	24	24	24
Surplus/(Deficiency)	**(6)**	**(17)**	**(22)**	**(28)**

SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

4.7.4.2 Wash Bays

The number of wash bays required to accommodate future demand was based on the number of vehicles that can be washed in the peak hour. The number of peak hour returns is 121. Assuming that 3 minutes are required to wash a vehicle, a metric of 17 vehicles washed per hour per wash bay was used to calculate the requirements. This results in a requirement of 7 wash bays for existing (2013) conditions and a forecast requirement of 12 wash bays at PAL E3. **Table 4-35** presents the wash bay requirements for existing (2013) demand and for each PAL. Note that, for existing conditions and each PAL, there is/would be a deficiency in wash bays.

Table 4-35: Wash Bay Requirements

COMPONENT	EXISTING (2013)	PAL E1	PAL E2	PAL E3
Wash Bay Facility Requirements	7	10	11	12
Existing Wash Bays	5	5	5	5
Surplus/(Deficiency)	**(2)**	**(5)**	**(6)**	**(7)**

SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

4.7.4.3 Vehicle Light Maintenance Bays

Vehicle light maintenance bays are located adjacent to the wash bays. Maintenance bays and functions include vehicle lifts, parts storage, tool lockers, vehicle records storage, administrative support, employee break and locker areas, and employee parking area. Light maintenance bays are used to change oil, align wheels, or replace minor parts, such as interior, head, or tail lights. Requirements for employee administrative support and employee parking areas were also developed. Because of the often unscheduled nature of vehicle maintenance, no utilization rate was developed for the maintenance bays. Instead, the requirements for maintenance bays, administrative area, and employee parking area were developed by increasing the existing quantity by the passenger forecast rate. Based on the questionnaire responses, there were nine light maintenance bays at the Airport in 2013; therefore, this number was used as the baseline for facility requirements. Increasing the nine maintenance bays by the passenger forecast rate results in a requirement for 15 maintenance bays at PAL E3. **Table 4-36** presents the requirements for light maintenance bays, employee administrative area, and employee parking spaces for existing (2013) demand and for each PAL.

Table 4-36: Light Maintenance Bay Requirements

COMPONENT	EXISTING (2013)	PAL E1	PAL E2	PAL E3
Light Maintenance Bay Requirements	9	12	14	15
Administrative Area Requirements (square feet)	7,593	10,250	11,554	13,045
Employee Parking Requirements (spaces)	**153**	**207**	**233**	**263**

SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

4.7.4.4 Vehicle Stacking/Staging Spaces

Overflow parking areas are provided near the service sites for the staging of clean vehicles for peak rental periods and for the stacking of return vehicles. A metric of 6 stalls per fueling nozzle (10 minutes per vehicle per hour) was used to calculate the requirements. The utilization rate used to size the stacking area is based on the number of required fueling positions in 2013 (30) multiplied by the aforementioned metric (6). This results in a requirement of 180 vehicle stacking spaces for existing (2013) conditions. Returned vehicles are positioned in the stacking areas prior to the fueling positions before being serviced. In some cases, clean vehicles may be stored in this area prior to being returned to a ready stall. Depending on the number of fueling positions on each fuel island, two, four, or six spaces would be provided on each island to stack clean or dirty vehicles (based on experience and an understanding of similar airport rental car facilities). **Table 4-37** presents the facility requirements for vehicle stacking and staging spaces for existing (2013) demand and for each PAL.

Table 4-37: Vehicle Stacking/Staging Space Requirements

COMPONENT	EXISTING (2013)	PAL E1	PAL E2	PAL E3
Vehicle Stacking Space Requirements	180	245	276	312
Existing Vehicle Stacking Spaces	95	95	95	95
Surplus/(Deficiency)	**(85)**	**(150)**	**(181)**	**(217)**

SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

4.7.5 FACILITY REQUIREMENTS SUMMARY

A summary of the requirements for the rental car facility components described above is presented in **Table 4-38** for existing (2013) demand and for each PAL.

Table 4-38: Rental Car Facility Requirements Summary

COMPONENT	EXISTING (2013)	PAL E1	PAL E2	PAL E3
Customer Service Area				
Regular Customer Service Positions	21	28	32	36
Ready/Return Spaces and Onsite Vehicle Storage Area				
Ready Spaces	501	676	762	861
Return Spaces	363	490	552	624
Storage Spaces	923	1,246	1,405	1,586
Service Sites				
Fueling Positions	30	41	46	52
Wash Bays	7	10	11	12
Vehicle Light Maintenance Bays	9	12	14	15
Vehicle Stacking/Staging Spaces	180	245	276	312
Administrative Area Requirements (square feet)	7,593	10,250	11,554	13,045
Employee Parking Requirements (spaces)	153	207	233	263

SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

A summary of the surplus or deficiency in the requirements for the rental car facility components described above is presented in **Table 4-39** for existing (2013) demand and for each PAL. Those components that would be operating at a deficiency are shown in parentheses.

Table 4-39: Requirements Surplus/(Deficiency) Summary

COMPONENT	EXISTING (2013)	PAL 1	PAL 2	PAL 3
Regular Customer Service Positions	29	22	18	14
Ready/Return Spaces and Onsite Vehicle Storage Area				
Total Ready/Return Spaces	92	(210)	(358)	(529)
Onsite Vehicle Storage Spaces	(317)	(640)	(799)	(980)
Service Sites				
Fueling Positions	(6)	(17)	(22)	(28)
Wash Bays	(2)	(5)	(6)	(7)
Vehicle Light Maintenance Bays	0	(3)	(5)	(6)
Vehicle Stacking/Staging Spaces	(85)	(150)	(181)	(217)

SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

A summary of the total requirements for each rental car facility component described above is presented in **Table 4-40** for existing (2013) demand and for each PAL. Also included in the total requirements summary is an allowance for circulation and landscaping, which were calculated as percentages of the total area.

Table 4-40 (1 of 2): Rental Car Facility Requirements Program – Total Area

	EXISTING (2013) SPACE PROGRAM			PAL E1 SPACE PROGRAM			PAL E2 SPACE PROGRAM			PAL E3 SPACE PROGRAM		
	QUANTITY	SQUARE FEET	TOTAL SQUARE FEET	QUANTITY	SQUARE FEET	TOTAL SQUARE FEET	QUANTITY	SQUARE FEET	TOTAL SQUARE FEET	QUANTITY	SQUARE FEET	TOTAL SQUARE FEEET
Customer Service Areas												
Counter Positions	21	300	6,200	28	300	8,400	32	300	9,500	36	300	10,700
Circulation (percent of total Customer Service Area)	25%		1,600	25%		2,100	25%		2,400	25%		2,700
Subtotal			**7,800**			**10,500**			**11,900**			**13,400**
Ready/Return/Storage Areas												
Ready Spaces	501	300	150,300	676	300	202,900	762	300	228,700	861	300	258,200
Return Spaces	363	200	72,600	490	200	98,000	552	200	110,500	624	200	124,700
Storage Spaces	923	170	156,900	1,246	170	211,800	1,405	170	238,800	1,586	170	269,600
Total Spaces	**1,787**			**2,412**			**2,719**			**3,070**		
Exit Booths	6	20	100	8	20	200	8	20	200	10	20	200
Circulation (percent of total Ready/Return/Storage Area)	20%		76,000	20%		102,600	20%		115,600	20%		130,500
Subtotal			**455,900**			**615,500**			**693,800**			**783,200**
Service Sites												
Fueling Positions	30	300	9,100	41	300	12,300	46	300	13,800	52	300	15,600
Wash Bays	7	2,000	14,200	10	2,000	19,200	11	2,000	21,700	12	2,000	24,500
Stacking and Staging Spaces	182	200	36,300	245	200	49,000	276	200	55,200	312	200	62,400
Vehicle Light Maintenance Bays	9	810	7,300	12	810	9,800	14	810	11,100	15	810	12,500
Administrative Area			7,593			10,250			11,554			13,045
Employee Parking Spaces	153	250	38,300	207	250	51,600	233	250	58,200	263	250	65,700

Table 4-40 (2 of 2): Rental Car Facility Requirements Program – Total Area

	EXISTING (2013) SPACE PROGRAM			PAL E1 SPACE PROGRAM			PAL E2 SPACE PROGRAM			PAL E3 SPACE PROGRAM		
	QUANTITY	SQUARE FEET	TOTAL SQUARE FEET	QUANTITY	SQUARE FEET	TOTAL SQUARE FEET	QUANTITY	SQUARE FEET	TOTAL SQUARE FEET	QUANTITY	SQUARE FEET	TOTAL SQUARE FEET
Circulation (percent of total Service Site area)	20%		22,600	20%		30,400	20%		34,300	20%		38,700
Subtotal			**135,393**			**182,550**			**205,854**			**232,445**
Small Market Entrant (2 percent of total area)			12,000			16,200			18,200			20,600
Total Facility (with small market entrant)			611,100			824,700			929,800			1,049,600
Landscaping/Circulation (15 percent of Total Facility area)			91,700			123,700			139,500			157,400
Total Requirement			**702,800 (16 acres)**			**948,400 (22 acres)**			**1,069,300 (25 acres)**			**1,207,000 (28 acres)**

NOTE: Some columns may not total due to rounding.

SOURCE: Ricondo & Associates, Inc., *Dallas Love Field Rental Car Industry Questionnaire*, October 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

4.8 Airport Tenant and Airport Support Facility Requirements

4.8.1 GENERAL AVIATION FACILITIES

This section presents the requirements for general aviation facilities, which include facilities dedicated to FBOs, corporate leased hangars, and MRO facilities. Currently, five FBOs operate at the Airport. In addition, four entities lease corporate hangars and seven tenants operate aircraft MRO/finish-out facilities.

The analyses documented in this section are organized by functional system. For clarity, each system was analyzed separately. Ultimately, however, the facility requirements for each system were combined to provide gross facility requirements for Airport tenant and support functions.

The PALs for aircraft operations described in Section 3 were used for these facilities. Growth rates were derived from numbers of annual based aircraft and aircraft operations. PALs, operations targets, and growth rates for based aircraft and aircraft operations are listed in **Table 4-41**.

Table 4-41: Planning Activity Levels and Growth Rates for Based Aircraft and Aircraft Operations

	ANNUAL AIRCRAFT OPERATIONS TARGET	ANTICIPATED YEAR OF ACHIEVEMENT 1/	BASED AIRCRAFT GROWTH RATE	AIRCRAFT OPERATIONS GROWTH RATE	BLENDED GROWTH RATE 2/
PAL O1	200,000	2015	4.5% 3/	13.0% 3/	10.4%
PAL O2	210,000	2032	21.9% 4/	3.0% 4/	8.7%
PAL O3	245,000	-	14.4% 5/	14.4% 5/	14.4%

NOTES:

1/ Based on the Master Plan Update forecasts presented in Section 3.

2/ A blended growth rate of 70 percent operations and 30 percent based aircraft was used.

3/ Growth rate between 2012 and PAL O1.

4/ Growth rate between PAL O1 and PAL O2.

5/ Growth rate between PAL O2 and PAL O3.

SOURCE: Ricondo & Associates, Inc., February 2014.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

To determine gross facility requirements, existing conditions were inventoried and used to form the baseline condition. Growth rates derived for each PAL were applied across the functional areas for each tenant to determine facility requirements. A growth rate was established for PAL O1 and tenant interviews were conducted to determine immediate needs given the aviation activity forecast for 2015. Tenants provided a range of near-term needs, such as individual hangars, increases in ramp space, and the need for additional passenger vehicle parking. Facility requirements for PAL O2 and PAL O3 were calculated using a mix of based aircraft and operations growth to accommodate forecast growth in aviation activity.

The methodologies used to determine demand/capacity relationships and facility requirements are in accordance with industry standards, with planning factors adjusted, as appropriate, to reflect actual Airport use characteristics. In calculating demand/capacity, the information presented in the inventory section of this Master Plan Update (Section 2) was used, along with any additional information, inclusive of tenant interviews or planning/expansion data provided by facility operators, that more accurately reflects existing or future conditions. This approach ensured that demand calculations would be sensitive to the specific requirements at the Airport, and reflective of industry standard practices.

The tables in the subsections below account for the following functional area requirements:

- **Buildings:** Building requirements were limited to hangar space with space allowed for offices and administrative facilities located within the hangar footprint. No additional support buildings or administrative offices, outside of the envelope of the hangar footprint, were considered as part of the building requirements.
- **Apron Areas:** These areas are considered suitable for aircraft parking and storage, maintenance, and the guided or towed movement of aircraft. These areas do not include taxilanes or other Airport movement areas.
- **Automobile Parking:** These areas include parking lots, entrance and exit areas, and circulation space for personal or tenant vehicles.
- **Vacant/Open Areas:** The gross facility requirements include consideration for general landscaping, grassed areas, and other pervious or impervious areas that facilitate storage and treatment of stormwater runoff. These areas may include drainage swales, small retention areas, and sidewalks.

4.8.1.1 Fixed Base Operator Requirements

For the purposes of this analysis, a facility was classified as an FBO facility if aircraft handling, parking, storage, fueling, and maintenance for both based and itinerant aircraft were available. Existing FBO facilities are depicted on **Exhibit 4-38.** A list of current FBOs at the Airport and their respective functional areas are listed in **Table 4-42.**

FBO facilities typically service more aircraft operations than MRO or corporate aviation facilities. FBO tenant telephone interviews were conducted in July 2013 as part of a Department of Aviation Tenant Community Outreach study to determine if their facilities were adequate to satisfy existing and future operational demand at PAL O1. Responses to these interviews were mixed, ranging from "adequate space today with little perceived need to expand" to "an immediate need to expand given constrained facilities." As FBOs serve both itinerant and based aircraft, a blended growth rate of both operations and based aircraft was used to calculate facility requirements at PAL O2 and PAL O3 (see Table 4-40). The resulting facility requirements are presented in **Table 4-43.**

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SOURCE: Dallas Love Field Airport Layout Plan, Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., April 2013.

EXHIBIT 4-38

Fixed Base Operators

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Table 4-42: Existing Fixed Base Operators and Their Functional Areas (in square feet)

	BUILDING AREA	APRON AREA	AUTOMOBILE PARKING AND CIRCULATION AREA	TOTAL FUNCTIONAL AREA
BUSINESS JET CENTER				
Business Jet Center Facilities Lease 1	218,000	690,000	161,000	1,069,000
Business Jet Center Facilities Lease 2	43,000	69,000	43,000	155,000
Subtotal (Business Jet Center) 1/	**261,000**	**759,000**	**204,000**	**1,224,000**
SIGNATURE FLIGHT SUPPORT				
Signature Flight Support Hangar Lease 1	26,000	59,000	67,000	151,000
Signature Flight Support Hangars Lease 2	191,000	486,000	106,000	783,000
Signature Flight Support Hangars Lease DalFort Fueling	344,000	783,000	322,000	1,449,000
Subtotal (Signature Flight Support) 2/	**561,000**	**1,328,000**	**495,000**	**2,383,000**
OTHER FBOs				
Landmark Aviation	33,000	160,000	10,000	203,000
Jet Aviation	76,000	155,000	30,000	261,000
Textar Aviation	112,000	397,000	171,000	679,000
TOTAL	**1,043,000**	**2,799,000**	**910,000**	**4,750,000**

NOTES:

1/ Business Jet Center holds leases for two facilities on Airport. One is located in the northwest corner of the airfield, and one is located along Denton Drive, south of the Runway 36 end.

2/ Signature Flight Support maintains buildings in three areas to the west and one to the east of the DalFort facility and one hangar located in the northwest corner of the airfield, adjacent to Business Jet Center facilities.

SOURCES: Dallas Love Field records, June 2013 (Leasehold and AutoCAD base map); Fixed Base Operator Tenant Telephone Interviews, July 2013.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

Table 4-43: Fixed Base Operator Gross Facility Requirements (in square feet, except as noted)

		REQUIREMENTS		
	EXISTING AREA (2013)	PAL O1	PAL O2	PAL O3
Hangars	1,043,000	1,133,000	1,229,000	1,407,000
Aprons	2,799,000	3,019,000	3,281,000	3,752,000
Automobile Parking and Circulation	910,000	919,000	999,000	1,141,000
Subtotal (Functional Areas)	**4,752,000**	**5,071,000**	**5,509,000**	**6,300,000**
Vacant/Open Areas	593,000	626,000	666,000	726,000
Subtotal	**5,345,000**	**5,697,000**	**6,175,000**	**7,026,000**
Subtotal (acres)	**122.7**	**130.8**	**141.8**	**161.3**
Cumulative Net Increase	-	6.20%	13.40%	23.90%
Surplus/(Deficiency)	-	**-352,000**	**-830,000**	**-1,681,000**
Surplus/(Deficiency) (acres)	-	**-8.1**	**-19.1**	**-38.6**

SOURCES: Dallas Love Field records, June 2013 (Leasehold and AutoCAD base map); Fixed Base Operator Tenant Telephone Interviews, July 2013; Ricondo & Associates, Inc., February 2014.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

4.8.1.2 Corporate Aviation Facilities

Corporate aviation at the Airport relates to tenants with aircraft storage (including open hangar space) and light maintenance capability. These tenants do not typically service aircraft requiring major repairs or refurbishing. **Table 4-44** identifies the tenants and existing corporate aviation functional areas. **Exhibit 4-39** depicts the existing corporate hangar areas at the Airport.

Table 4-44: Existing Corporate Hangar Facilities (in square feet)

	BUILDING AREA	APRON AREA	AUTOMOBILE PARKING AND CIRCULATION AREA	TOTAL FUNCTIONAL AREA
Trinity Industries	15,000	89,000	16,000	121,000
Reeves Street, LLC Hangar	38,000	98,000	19,000	155,000
MLT Development Co.	25,000	50,000	45,000	120,000
Holly Frontier Aviation	17,000	64,000	24,000	104,000
Total	**95,000**	**301,000**	**104,000**	**500,000**

SOURCES: Dallas Love Field records, June 2013 (Leasehold and AutoCAD base map); Corporate Tenant Telephone Interviews, January 2013.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

SOURCE: Dallas Love Field Airport Layout Plan, Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., April 2013.

EXHIBIT 4-39

NORTH 0 1000 ft.

Corporate Aviation Hangars

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Operations at corporate hangar facilities are generally limited to aircraft parking and storage, light maintenance, and on-demand fueling. Additionally, a lower number of aircraft access corporate hangar facilities than FBO or MRO facilities. Therefore, based aircraft growth rates were applied to estimate future facility requirements. During the tenant interviews, no increase in near-term capacity was requested by corporate hangar operators. Corporate hangar gross facility requirements are listed in **Table 4-45.**

Table 4-45: Corporate Hangar Gross Facility Requirements (in square feet, except as noted)

	EXISTING (2013)	PAL O1	PAL O2	PAL O3
Hangars	95,000	95,000	118,000	132,000
Aprons	301,000	301,000	367,000	420,000
Automobile Parking and Circulation	104,000	104,000	127,000	145,000
Subtotal (Functional Areas)	500,000	500,000	612,000	697,000
Vacant/Open Areas	50,000	50,000	61,200	69,700
Subtotal	**550,000**	**550,000**	**673,200**	**766,700**
Subtotal (acres)	**12.6**	**12.6**	**15.5**	**17.6**
Cumulative Net Increase	-	0.00%	22.40%	39.40%
Surplus/(Deficiency)		**0**	**-123,200**	**-216,700**
Surplus/(Deficiency) (acres)		**0**	**-2.8**	**-5**

SOURCES: Dallas Love Field records, June 2013 (Leasehold and AutoCAD base map); Corporate Tenant Telephone Interviews, January 2013.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

4.8.1.3 Maintenance, Repair, and Overhaul Facilities

Major and recurring aircraft maintenance and aircraft testing are typically performed at MRO facilities, which include facilities in which complete interior finishing is performed on aircraft prior to delivery to a customer. Other MRO operators test equipment and conduct field checks. These facilities typically accommodate fewer recurring aircraft patronage than FBO facilities, as little day-to-day aircraft servicing is performed. The MRO facilities at the Airport are clustered in the north-central and eastern portions of the airfield. Existing MRO facilities are depicted on **Exhibit 4-40**. Existing functional areas for these facilities are listed in **Table 4-46**.

As aircraft typically remain at MRO facilities for scheduled maintenance and regularly occurring light maintenance, the need for maintenance facilities can be tied to a mix of airport arrivals and departures and based aircraft. The blended growth rate presented in Table 4-40 was used to calculate requirements for MRO facilities. **Table 4-47** presents the existing (2013) and PAL O1, O2, and O3 facility requirements for maintenance, repair, and overhaul facilities.

Table 4-46: Existing Maintenance, Repair, and Overhaul Facilities (in square feet)

	BUILDING AREA	APRON AREA	AUTOMOBILE PARKING AND CIRCULATION AREA	TOTAL FUNCTIONAL AREA
Learjet Inc.	**20,000**	**90,000**	**12,000**	**122,000**
Raytheon Aircraft Services Lease 1	42,000	70,000	44,000	156,000
Raytheon Aircraft Services Lease 2	112,000	129,000	46,000	287,000
Subtotal (Raytheon Aircraft Services)	**154,000**	**199,000**	**90,000**	**443,000**
Associated Air Center Facilities Lease 1	156,000	165,000	130,000	451,000
Associated Air Center Facilities Lease 2	72,000	89,000	181,000	342,000
Subtotal (Associated Air Center)	**228,000**	**254,000**	**311,000**	**793,000**
Gulfstream Aerospace Services Hangar Lease 1	50,000	58,000	77,000	185,000
Gulfstream Aerospace Services Hangars Lease 2	212,000	492,000	60,000	765,000
Subtotal (Gulfstream Aerospace Services)	**262,000**	**550,000**	**137,000**	**950,000**
Bombardier Aerospace Services Lease 1	41,000	75,000	40,000	156,000
Bombardier Aerospace Services Lease 2	91,000	125,000	92,000	308,000
Subtotal (Bombardier Aerospace Services)	**132,000**	**200,000**	**132,000**	**464,000**
Total	**796,000**	**1,293,000**	**682,000**	**2,772,000**

SOURCES: Dallas Love Field records, June 2013 (Leasehold and AutoCAD base map); Maintenance, Repair and Overhaul (MRO) Tenant Telephone Interviews, January 2013.

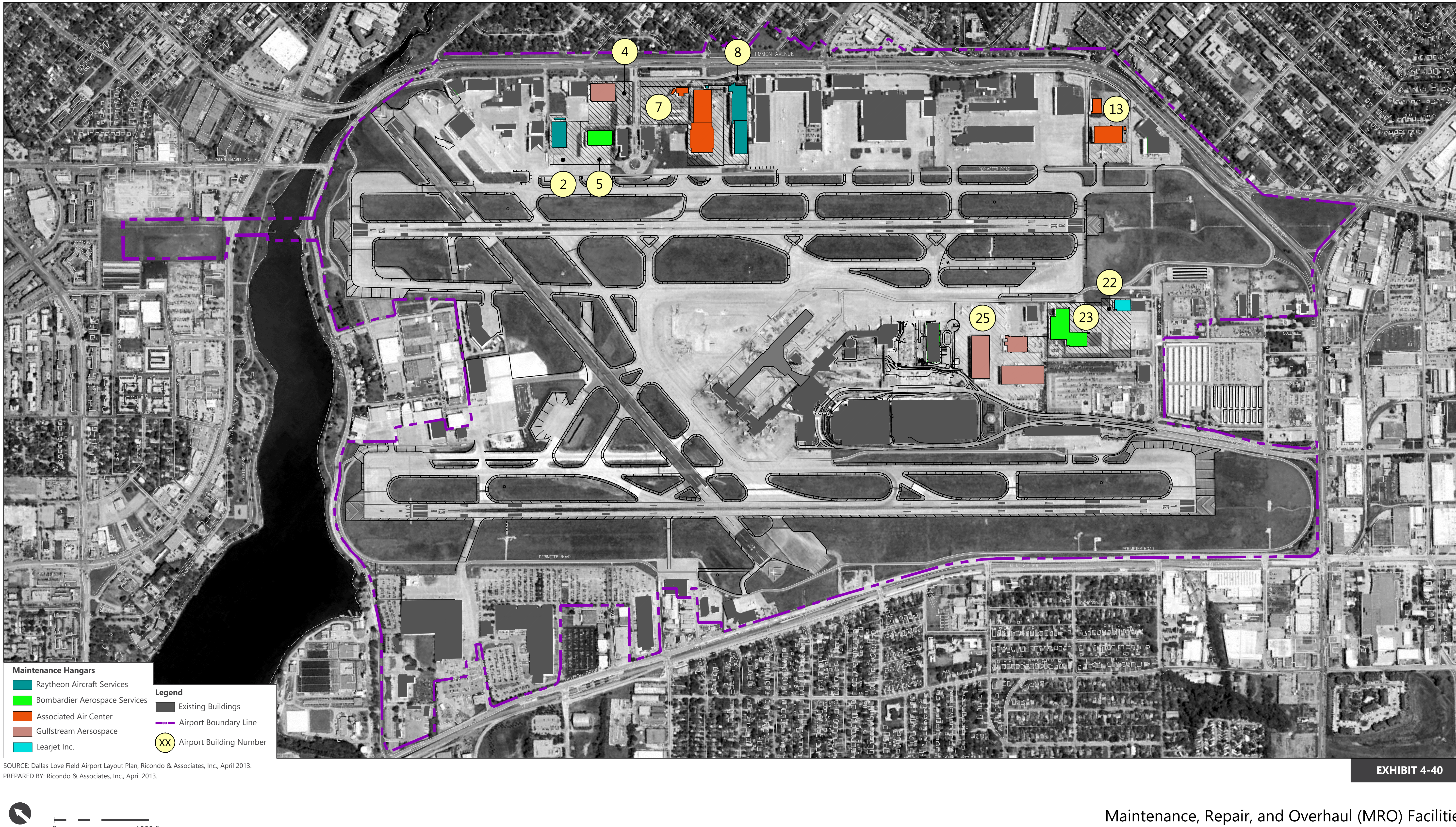
PREPARED BY: Ricondo & Associates, Inc., February 2014.

Table 4-47: Maintenance, Repair, and Overhaul Gross Facility Requirements (in square feet, except as noted)

	EXISTING (2013)	PAL O1	PAL O2	PAL O3
Hangars	796,000	796,000	972,000	1,111,000
Aprons	1,293,000	1,293,000	1,576,000	1,804,000
Automobile Parking and Circulation	682,000	682,000	833,000	951,000
Subtotal (Functional Areas)	**2,771,000**	**2,771,000**	**3,381,000**	**3,866,000**
Vacant/Open Areas	277,100	277,100	338,100	386,600
Subtotal	**3,048,100**	**3,048,100**	**3,719,100**	**4,252,600**
Subtotal (acres)	70.0	70.0	85.4	97.6
Cumulative Net Increase	-	0.0%	22.0%	39.5%
Surplus/(Deficiency)	**-**	**0**	**(671,000)**	**(1,204,500)**
Surplus/(Deficiency) (acres)	**-**	**0.0**	**(15.4)**	**(27.7)**

SOURCES: Dallas Love Field records, June 2013 (Leasehold and AutoCAD base map); Maintenance, Repair, and Overhaul Tenant Telephone Interviews, January 2013; Ricondo & Associates, Inc., February 2014.

PREPARED BY: Ricondo & Associates, Inc., February 2014.



SOURCE: Dallas Love Field Airport Layout Plan, Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., April 2013.

EXHIBIT 4-40

Maintenance, Repair, and Overhaul (MRO) Facilities

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4.8.1.4 Summary and Conclusions

Gross facility requirements for FBO, MRO, and corporate hangar areas are presented in **Table 4-48**. The table summarizes the gross facility requirements for general aviation facilities through PAL O3.

Table 4-48: Total Gross Facility Requirements (in square feet, except as noted)

		REQUIREMENTS		
	EXISTING AREAS (2013)	PAL O1	PAL O2	PAL O3
Hangars	1,934,000	2,024,000	2,319,000	2,650,000
Aprons	4,393,000	4,613,000	5,224,000	5,976,000
Automobile Parking and Circulation	1,696,000	1,705,000	1,959,000	2,237,000
Subtotal (Functional Areas)	**8,023,000**	**8,342,000**	**9,502,000**	**10,863,000**
Vacant/Open Areas	882,700	834,200	950,200	1,086,300
Subtotal	**8,905,700**	**9,176,200**	**10,452,200**	**11,949,300**
Subtotal (acres)	204.4	210.7	239.9	274.3
Cumulative Net Increase	NA	3.0%	17.2%	34%
Surplus/(Deficiency)	NA	**(270,500)**	**(1,546,500)**	**(3,043,600)**
Surplus/(Deficiency) (acres)	NA	**(6.2)**	**(35.5)**	**(69.9)**

NA = Not Applicable

SOURCE: Ricondo & Associates, Inc., February 2014.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

The overall land area required to support FBO, MRO, and corporate hangars is forecast to increase from approximately 204 acres in 2013 to approximately 211 total acres at PAL O1 (a net increase of 7 acres) to approximately 240 acres at PAL O2 (a net increase of 29 acres from PAL O1 and 35.5 acres from existing) and to approximately 274 acres at PAL O3 (a net increase of 34 acres from PAL O2 and approximately 70 acres from existing).

4.8.2 AIRPORT AND AIRLINE SUPPORT FACILITIES

Airport support facilities include Airport administration and maintenance buildings and ARFF facilities. Airline support facilities accommodate GSE maintenance, belly cargo handling, provisioning, and aircraft fuel farm facilities. The belly cargo, provisioning, and fuel farm facilities at Dallas Love Field are primarily operated by Southwest Airlines.

Other support facilities include those facilities not dedicated to serving the needs of aircraft operators. These facilities include an aeronautical museum, a Dallas Police Department's K-9 training area, and the DalFort site. Indication that these facilities do not require expansion over the planning period was provided by Department of Aviation staff. Therefore, these facilities were not considered in this analysis. An Environmental Assessment is currently being prepared for the DalFort facility and future use of the site will be determined following completion of this Master Plan Update.

4.8.2.1 Airport Maintenance Complex

The Airport maintenance complex is located on the northeast side of the airfield, immediately north of the off-airport parking lots. The existing complex was recently constructed and is designed to accommodate some additional growth. Airport staff indicated that no additional expansion of this facility was required over the planning horizon.

4.8.2.2 Aircraft Fueling Operations

Fueling operations at the Airport are split, with Southwest Airlines fueling aircraft from a dedicated fuel farm on the south side of the Airport while the other airlines serving the Airport are serviced by various other fueling facilities. Current Southwest Airlines fueling facilities consist of three 420,000 gallon tanks, for a total capacity of 1,260,000 gallons.

Conversations with Southwest Airlines representatives identified no current need for fuel farm expansion. As no monthly or annual fuel flowage reports were provided to assess demand, no expansion of the fuel farm is recommended over the planning period. However, adjacent properties are currently undeveloped and may be able to accommodate future growth should the need arise.

On-Airport fueling facilities are located on individual leaseholds and fuel a mix of general aviation aircraft and passenger airline aircraft. Tenant telephone interviews were conducted to assess the need for expanded fuel facilities. The existing facilities were deemed adequate to meet existing and anticipated future needs. **Table 4-49** lists the existing on-Airport fuel tanks and their capacities. If additional capacity is requested, further analysis should be conducted to determine the need and location for the added capacity.

Table 4-49: On-Airport Fueling Facilities

FACILITY	NUMBER OF TANKS	TOTAL GALLONS
Landmark Aviation	3	36,000
Business Jet Center	3	76,000
Ambassador Aviation (formerly Dallas Aircraft Services)	3	21,000
Jet Aviation	9	114,000
Jet Center of Dallas	2	25,000
MLT Development Co. (North Fuel Farm)	6	110,000
Signature Flight Support	17	433,000
Business Jet Access (formerly TXI Aviation)	3	25,000
Total	**46**	**840,000**

SOURCES: Dallas Love Field records, June 2013 (Fuel tank counts and capacities); Fixed Base Operator Tenant Telephone Interviews, January 2013.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

4.8.2.3 Aircraft Rescue and Firefighting Facilities

Operators of airports with daily scheduled airline service are required to provide ARFF services. The required number of firefighting vehicles and amounts of extinguishing agents are determined by the standards prescribed in 14 CFR Part 139, and are based on the length of the aircraft (expressed in relation to ADG), and the number of average daily departures by the most demanding aircraft that serves the airport. Air carrier aircraft are grouped as follows into ARFF indices:

- Index A: Aircraft less than 90 feet long (e.g., Beech 1900D and CRJ200)
- Index B: Aircraft at least 90 feet long, but less than 126 feet long (e.g., ERJ 145 and Boeing 737-300)
- Index C: Aircraft at least 126 feet long, but less than 159 feet long (e.g., Boeing 757-200 and MD-88)
- Index D: Aircraft at least 159 feet long , but less than 200 feet long (e.g., Boeing 757-300 and Airbus A330-200)
- Index E: Aircraft at least 200 feet long (e.g., Airbus A340-600 and Boeing 747-200)

Currently, the Airport has two ARFF stations that house a variety of rescue and firefighting equipment. One station is located on the east side of the airfield, adjacent to Mockingbird Lane, southeast of the Runway 31R end. The second station is located on the west side of the airfield, north of Taxiway L and west of Taxiway C6. No facility modification or expansion requirements were identified by Airport or Fire Department staff.

4.8.2.4 Provisioning, Belly Cargo, and Ground Support Equipment

Existing provisioning, belly cargo, and GSE facilities are housed at General Use Building #1 (GUB-1). This building is subdivided into three approximately equal and separate sections, one for each function. GUB-1 is approximately 55,250 square feet in area with 18 total truck docks and approximately 281 vehicle parking spaces and is depicted on **Exhibit 4-41**.

None of the current airlines serving the Airport has identified an immediate need for additional facilities to support their belly cargo or provisioning storage requirements. Southwest Airlines did, however, indicate a desire to expand the GUB or add a facility similar to the existing GUB to accommodate expanded operations if necessary. Expansion alternatives are discussed in the following section of this Master Plan Update.

4.5.2.5 Summary

Airport and airline support facilities are estimated to be sufficient through the planning period, with the exception of the need for 50,000 square feet of additional space as identified by the Department of Aviation for airline general use purposes.

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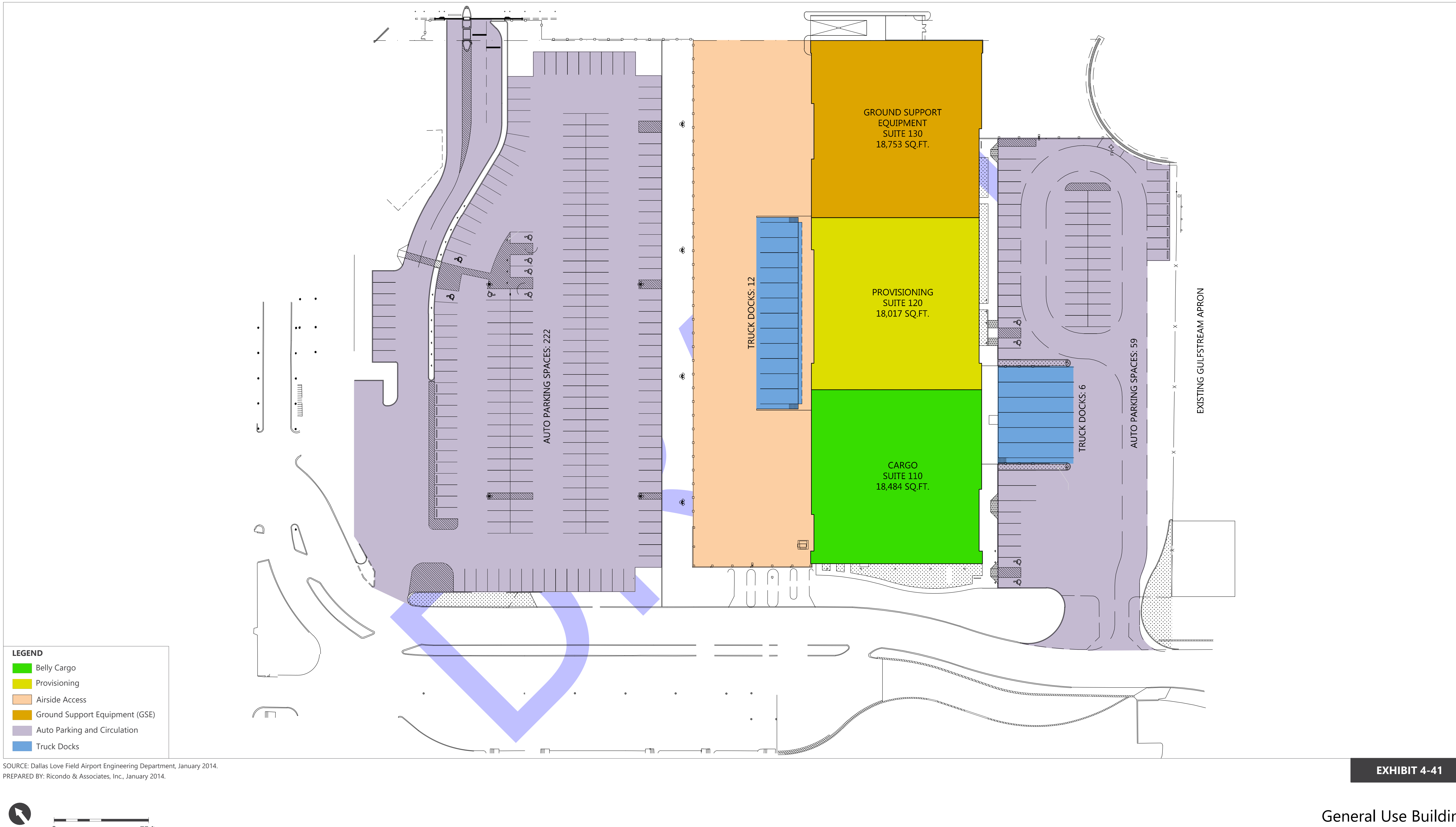

SOURCE: Dallas Love Field Airport Engineering Department, January 2014.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

EXHIBIT 4-41

General Use Building

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