DECEMBER 2014 | FINAL

WILLIAM P. HOBBY AIRPORT
Master Plan Update

PHOTOS COURTESY OF HOUSTON AIRPORT SYSTEM

RICONDO® & ASSOCIATES

HOUSTON AIRPORTS

William P. Hobby Airport

Master Plan Update

PREPARED FOR:

Houston Airport System

December 2014

FINAL

PREPARED BY:

RICONDO & ASSOCIATES, INC.

IN ASSOCIATION WITH:

Connico, Inc.

Knudson, LP

Quadrant Consultants, Inc.

UrbanCore Collaborative

Jacobsen/Daniels Associates, LLC

RICONDO®
& ASSOCIATES

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1. Introduction

The Houston Airport System (HAS) owns and operates three airports in the Houston area: William P. Hobby Airport, George Bush Intercontinental Airport/Houston, and Ellington Airport (collectively, the Airport System). Each airport has a unique role within the Airport System, and they collectively provide a full range of aviation activity to serve the Houston region:

- William P. Hobby Airport (hereinafter referred to as the Airport or HOU) is located approximately 7 miles southeast of downtown Houston, as shown on **Exhibit 1-1**. HOU is the airport of choice for many business travelers because of its proximity to downtown Houston and the availability of low-cost airline service to many United States destinations. The Airport is a key airport in Southwest Airlines' route system, and accommodates a significant amount of corporate aviation activity. In 2012, HOU was the 32nd busiest airport in the United States in terms of total numbers of enplaned passengers and the 44th busiest in terms of aircraft operations.[1]
- George Bush Intercontinental Airport/Houston (IAH) is located approximately 23 miles north of downtown Houston, and is the region's primary commercial service airport. IAH is dominated by the hubbing activity of United Airlines, and is the international gateway to Houston for commercial airline traffic. In 2012, IAH was the 11th busiest airport in the United States in terms of total numbers of enplaned passengers.[2]
- Ellington Airport (EFD) is located approximately 15 miles southeast of downtown Houston, and meets a wide range of the region's noncommercial aviation needs. EFD accommodates a significant amount of small general aviation aircraft activity. It is home to the Texas Air National Guard, the U.S. Army National Guard, the U.S. Coast Guard, and the National Aeronautics and Space Administration (NASA). It is also the site of the annual Wings Over Houston Airshow.

The Airport covers more than 1,300 acres of land. It currently includes a 25-gate terminal complex and is home to five fixed base operators (FBOs) and numerous other tenants. A program to modernize the terminal complex was initiated in 2006, when three concourses were torn down and replaced with a new Central Concourse. All airlines now occupy the Central Concourse. After the Central Concourse project was completed, parts of the terminal building were also renovated. In 2012, Southwest Airlines announced its

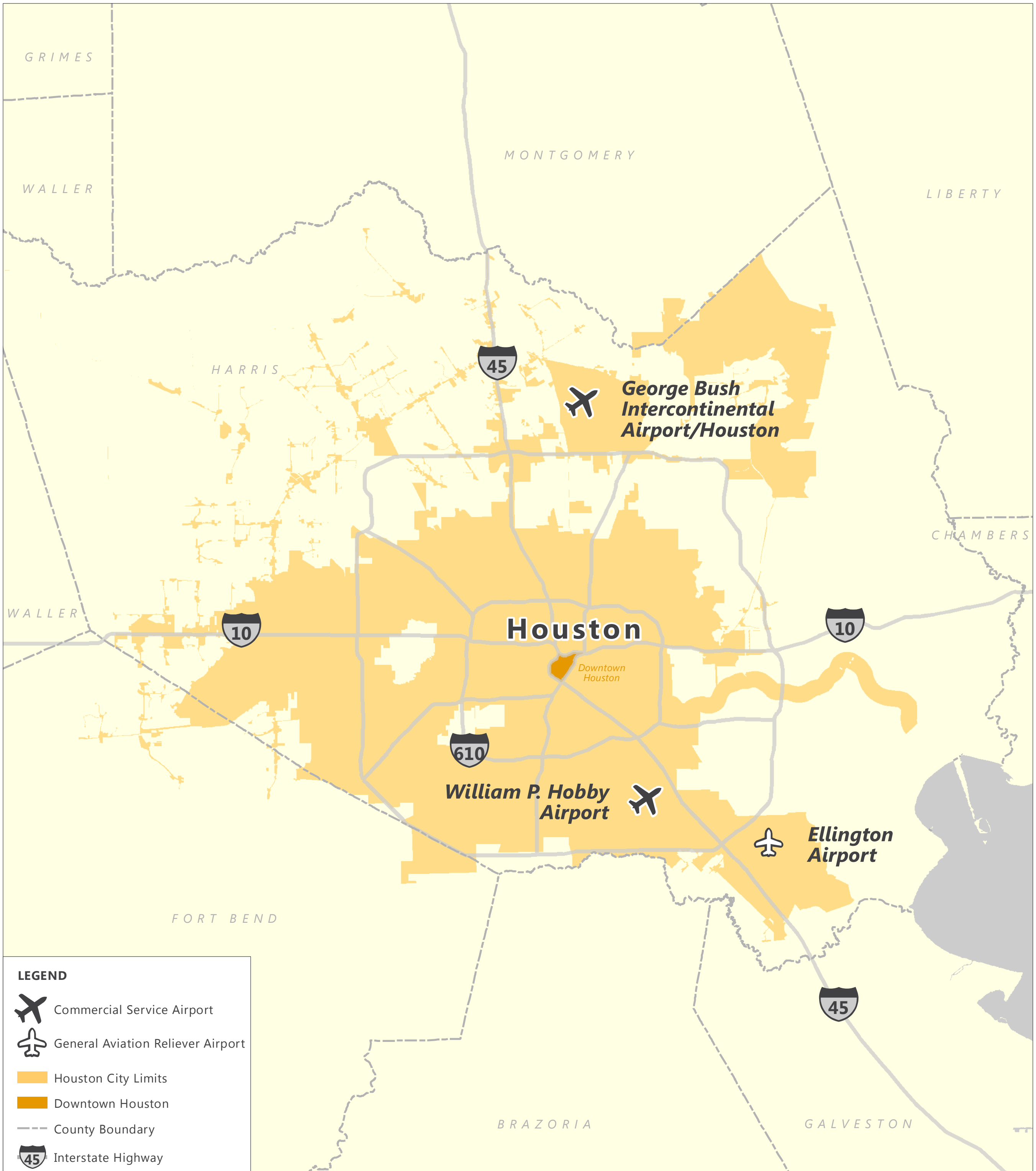
1 Federal Aviation Administration, *Preliminary CY 2012 Passenger Boarding and All-Cargo Data*, http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/, accessed July 9, 2013.

2 Federal Aviation Administration, *Preliminary CY 2012 Passenger Boarding and All-Cargo Data*, http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/, accessed July 9, 2013.

intention to initiate international service from the Airport in 2015. As a result, a major construction project is underway at the Airport, which includes a new five-gate international concourse, terminal expansion, utility modifications (including a second utility plant), roadway realignment, and new parking facilities.

This Master Plan Update builds upon the Airport Master Plan which was completed in 2004, while treating the ongoing construction projects as "existing conditions". This document is organized in 10 sections, and includes summaries of the detailed analyses and assessments associated with the William P. Hobby Airport Master Plan Update. The remainder of this section provides a general statement regarding HAS' vision for the Airport and the goals of the Master Plan Update, as well as a summary of the Master Plan Update. The remaining nine sections present existing conditions at the Airport, including a brief Airport history; the forecasts of aviation demand at the Airport; demand/capacity and facility requirements; a strategy for implementing the recommended improvements; an airport environs development framework plan; an overall Airport development plan; a financial analysis, an environmental overview identifying issues associated with the strategy, as well as an airport layout drawing:

- Section 1 – Introduction
- Section 2 – Inventory of Existing Conditions
- Section 3 – Aviation Demand Forecasts
- Section 4 – Facility Requirements
- Section 5 – Alternatives Development
- Section 6 – Airport Environs (Off-Airport) Development Framework Plan
- Section 7 – Airport Development Plan
- Section 8 – Implementation Plan
- Section 9 – Funding Plan
- Section 10 – Environmental Overview



SOURCES: Environmental Systems Research Institute, 2010 (USA Base Map); City of Houston Planning and Development Department (COHGIS), 2011 (city limits).
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 1-1

NORTH 0 10 miles

Houston Airport System Airports

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1.1 Master Plan Update Goals

The goals for the Airport Master Plan Update were established through various coordination meetings with the HAS Planning Department during the initial stages of the master planning process. These goals were refined as the Master Plan Update was being prepared, and as the planning team and the HAS Planning Department interacted with various tenants and City Departments. Goals from the 2003 Master Plan were also reviewed.

The overarching goal of the Master Plan Update is to ensure that natural market forces are not constrained in the future by facilities or operational limitations. As a result, the role of the Airport within the Houston Airport System would be driven by natural market forces, rather than specific strategic mandates from HAS. This is true for IAH as well, with the exception that between the two airports (IAH and HOU), cargo aircraft operations will be accommodated primarily at IAH. The other notable exception is EFD, where HAS is making intentional efforts to expand its role; the future role of EFD could include Spaceport operations, aircraft manufacturing, or any number of non-traditional aeronautical functions.

Specific goals that were established to guide the HOU Master Plan Update are summarized below:

- The Master Plan Update will identify the facilities and services that are necessary to accommodate unconstrained passenger, cargo, fixed-base operator, and corporate aviation demand through the year 2030.
- The Airport will continue to serve as the Central Business District (CBD) airport that provides service to domestic markets and provides storage and support services for corporate aviation and fractional aircraft owners. (Immediately upon initiation of the master plan update, it was announced that Southwest Airlines would be allowed to inaugurate international service from the Airport beginning in 2015. This announcement underscored HAS' commitment that market forces should be allowed to define the role of the Airport, rather than specific strategic goals set by HAS. The announcement also heightened the need to ensure that the master plan update included facility development concepts that would accommodate high levels of growth in the demand for parking, power, and vehicular access.)
- The Master Plan Update should identify strategies and incentives that could lead to improvement of the image of the Airport and its urban environs.
- The Master Plan Update should accommodate future demand for aircraft operations to the extent possible without requiring a large-scale property expansion program. (This limitation is in contrast to the Airport Master Plan completed in 2003, which included the allowance for significant airport expansion if the need was warranted.)
- The Master Plan Update should accommodate future aviation activity while balancing the capacity of the airfield, the passenger terminal, the ground transportation system, and support facilities at the Airport.

- Airport facilities are to be adequate to accommodate narrowbody aircraft operations (up to Boeing 757 aircraft) to all domestic and short-haul international markets.
- Future development plans must ensure that a high level of airport security is maintained while complying with new government regulations and mandated procedures.
- The plan that emerges from this study should be a plan that:
  - is coordinated with related City and Regional development projects,
  - can be implemented without disrupting the efficient operation of the Airport, and
  - is sensitive to surrounding human and natural environments and wisely utilizes limited resources.

1.2 Summary of Master Plan Update

This Master Plan Update was initiated with a vision setting process at the end of 2011. The technical analysis was started in early 2012 and preliminary conclusions reached in late 2013. A series of workshops were held in 2013 to present analyses methodologies and preliminary findings to stakeholders. Workshop presentation materials are provided in **Appendix B**. Three public meetings were held in March 2014, April 2014 and June 2014 to present findings to and obtain input from the community. Public meetings presentation materials are provided in **Appendix C.** Comments were addressed in included in the Master Plan Update.

This Master Plan Update addressed potential activity and related improvements through 2030. Recommendations included short, intermediate and long-term development to accommodate the growth that could occur. Some elements of airport development, such as new runways, can take 10 to 15 years to put in place once the need is identified. However, it is prudent for an airport to update its master plan periodically to ensure that planning initiatives respond to contemporary market conditions.

This Master Plan Update was designed so that projects could be initiated when demand dictates the need for development. The forecasts identify one timeline in which development could occur, however, if activity does not materialize as quickly as forecast, the development envisioned by this master plan would be delayed accordingly. Conversely, if growth were to accelerate, projects could be initiated prior to the timeline associated with the master plan forecasts. The need for implementation of various projects is based on actual activity reaching specific Planning Activity Levels (PAL) identified in the study. HAS would monitor aviation activity at HOU annually to determine whether activity is tracking as projected and which projects from the master plan should be programmed into the Airport's five-year Capital Improvement Program (CIP) based on that activity.

2. Inventory of Existing Conditions

Developing an inventory of the Airport's physical, operational, and functional characteristics is the basis for identifying improvements to Airport elements for inclusion in the Master Plan Update. The inventory information presented in this section provides the foundation for evaluating existing facilities and understanding future facility needs at the Airport.

The inventory is organized under the following section headings:

- General Airport Information
- Airfield Facilities
- Passenger Terminal Facilities
- Airport Access and Parking Facilities
- Rental Car Facilities
- Airport Tenant Facilities
- Airline Support Facilities
- Airport Support Facilities
- Airspace Environment
- Land Use Data
- Utility Infrastructure
- Environmental Data

2.1 General Airport Information

2.1.1 AIRPORT HISTORY

In 1937, the City of Houston purchased 600 acres of land from the W.T. Carter Lumber Company.[3] The site contained an airstrip and buildings that were suitable for use as a terminal. As such, it became Houston's first public airport. At that time, two airlines served the Airport: Braniff Airways and Eastern Airlines. In its early

[3] Information about the history of the Airport was taken from earlier Master Plans and other technical documents relating to the Airport.

years, the Airport also served the aviation adventures of native Houstonian Howard R. Hughes. Hughes was personally responsible for many improvements to the Airport, including installation of the first airport traffic control tower (ATCT), which was built in 1938. Because of his involvement, the Airport was named Howard Hughes Airport in July 1938.

In the early 1940s, the Airport's first airfield lighting system was installed and the first concrete paved runways and taxiways were completed. By the end of the 1940s, just after World War II, four additional airlines were serving the Airport, which had been renamed the Houston Municipal Airport.

In the 1950s, many facilities at the Airport were constructed or improved. Notable Airport improvements included construction of the passenger terminal complex (which opened in 1955, and served the Airport until 2006); reconstruction of Runways 17-35, 4-22, and 13-31 (now designated as Runway 12R-30L); installation of a high intensity approach lighting system; and extension of Runways 4-22 and 13-31 to a length of 7,600 feet. In addition, private individuals or companies constructed several new hangars at the Airport.

The Airport began accommodating international flights in the 1950s, beginning with Pan American World Airways' first international flight to Mexico City in 1950. By 1957, scheduled international flights were more frequent, and included a flight by KLM Royal Dutch Airlines to Amsterdam. The Airport's growth continued in 1957 with the first scheduled turbojet aircraft operation at the Airport.

In 1967, the Airport was renamed William P. Hobby Airport in honor of the former Texas governor and owner/editor of the *Houston Post* newspaper. Although the name of the Airport has stayed the same since that time, the role of the Airport within the Airport System has undergone several significant changes. The first major change occurred on June 8, 1969, when all scheduled airline operations were moved from the Airport to Houston Intercontinental Airport (now named George Bush Intercontinental Airport/Houston). Almost immediately, the Airport transitioned from its role as the primary commercial-service airport serving the Houston region to being a general aviation airport.

Only a few years after commercial flights were moved to IAH, a new intrastate airline—Southwest Airlines—began serving the Airport. Southwest Airlines inaugurated service between Dallas Love Field, San Antonio International Airport, and William P. Hobby Airport in 1971. Although the airline began by serving only three markets, the arrival of Southwest Airlines' service at HOU marked the Airport's re-entry into commercial aviation. At approximately the same time, Braniff Airways and Texas International Airlines began serving the Airport. Although these airlines did not remain in service at the Airport for a long period of time, the presence of Southwest Airlines and other airlines led to a 34 percent increase in the number of aircraft operations at the Airport between 1963 and 1977.

In 1978, as the airline industry was being deregulated, 12 airlines initiated service at the Airport. Although plans were in place to expand the facilities at Houston Intercontinental Airport, facilities were not sufficient at the time to accommodate all airline traffic demand, thus encouraging growth at HOU. These two factors, combined with the growth of Southwest Airlines as a viable airline, led to a period of significant growth at the Airport and enabled the Airport to regain its role as a significant passenger-service airport. More specifically, from 1978 to 1984, the number of enplaned passengers at the Airport increased an average of 35 percent per year, totaling more than 3.5 million scheduled enplaned passengers in 1984.

From the mid-1980s to 2000, the number of enplaned passengers at the Airport increased an average of 1.5 percent per year. Today, the Airport has a major role in accommodating airline traffic demand in the Houston region. Approximately one-third of all origin and destination (O&D) passengers in the region fly in and out of the Airport. It is the preferred airport of many business travelers because of its proximity to downtown Houston (and other major facilities, such as the Texas Medical Center and NASA facilities), and the fact that Airport parking is readily available very close to the passenger terminal. Nonstop service is provided between the Airport and more than 40 destinations within the United States. In 2012, approximately 5.2 million passengers were enplaned at the Airport, 30 percent of which were connecting between flights.

2.1.2 AIRPORT ACTIVITY DATA AND BASED AIRCRAFT

Approximately 198,000 aircraft operations were conducted at the Airport in 2012, as shown in **Table 2-1**. Approximately 54 percent of those operations were conducted by air carrier aircraft, and approximately 44 percent were conducted by general aviation (GA) aircraft, which includes air taxis. Military operations accounted for 1.3 percent of operations in 2012. As shown in **Table 2-2**, there were 222 GA aircraft based at the Airport in September 2013.

Table 2-1: 2012 Aircraft Operations

	AIR CARRIER	AIR TAXI	GENERAL AVIATION	MILITARY	TOTAL
Number of Aircraft Operations	107,260	34,382	53,451	2,653	197,746
Percentage	54.2%	17.4%	27.0%	1.3%	100.0%

NOTE: Rows may not equal to totals shown because of rounding.

SOURCE: Federal Aviation Administration, Air Traffic Activity Data System (ATADS), *HOU Airport Operations*, Report from January 1, 2012 to December 31, 2012.

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

Table 2-2: Based Aircraft

	2012
FIXED-WING AIRCRAFT	
Single-engine Piston	40
Multi-engine Piston	43
Jet	134
Total Fixed Wing Aircraft	217
HELICOPTERS	5
TOTAL BASED AIRCRAFT	222

SOURCE: Federal Aviation Administration, *Form 5010, Airport Master Record*; http://www.faa.gov/airports/airport_safety/airportdata_5010/ menu/index.cfm, accessed September 19, 2013.

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

2.1.3 AIRPORT REFERENCE CODE

The Airport Reference Code (ARC) is a designation that generally classifies an airport according to its ability to accommodate certain categories of airfield operations. Assigning an ARC does not create limits on the types of operation that can occur at an airport, but rather, it is used to broadly identify various planning and design parameters which will help ensure safe operations at an airport. It is most often determined based upon the Aircraft Approach Category (AAC) and the Airplane Design Group (ADG) of aircraft using or expected to use the airport on a regular basis (at least 500 operations a year); however, the FAA also considers local characteristics when determining an Airport's ARC. The AAC is designated by a letter that represents approach speed, and the ADG is designated by a Roman numeral based on wingspan and tail height. The ARC is written as the combination of the AAC and the ADG.

Based on discussion with HAS and the FAA Airport District Office (ADO), the Boeing 737-700W (with winglets) is the Airport's design aircraft, resulting in an ARC of C-III. The design aircraft is defined as the most demanding aircraft operating at the Airport with more than 500 annual operations. AAC C corresponds to an aircraft approach speed between 121 knots and up to, but not including, 141 knots. ADG III categorizes aircraft with a wingspan range between 79 feet and up to, but not including, 118 feet and a tail height between 30 feet and up to, but not including, 45 feet. Aircraft with larger wingspans may operate at the Airport with advance notification.[4] **Table 2-3** provides examples of aircraft models and corresponding ARCs.

4 National Aeronautical Charting Office, *Airport/Facility Directory*, effective October 17, 2013.

Table 2-3: FAA Airport Reference Code and Airplane Design Group Categories

AIRCRAFT MODEL	AIRPORT REFERENCE CODE	APPROXIMATE APPROACH SPEED (KNOTS PER HOUR)	WINGSPAN (FEET)	TAIL HEIGHT (FEET)
Piper PA-28	A-I	65	35.1	7.2
Cessna 182	B-I	92	36.1	9.2
Beech King Air 100	B-II	111	45.9	15.4
Embraer ERJ145	C-II	135	65.8	22.2
Gulfstream G500	C-III	140	93.5	25.8
Boeing 727-200	C-III	133	108.0	34.9
Boeing 737-700W	C-III	130	117.4	41.6
Boeing 737-800W	D-III	142	117.5	41.4
Boeing 737-900W	D-III	141	117.4	41.4
Boeing 757-200	C-IV	137	124.8	45.1
Airbus A300-600	C-IV	137	147.1	55.0
Douglas DC-8-60	C-IV	137	142.4	42.3
Boeing 767-300	C-IV	140	156.1	52.6
Boeing 757-300	D-IV	143	124.8	44.8
McDonnell Douglas MD-11	D-IV	153	170.5	58.8
Boeing 747-400	D-V	157	213.0	64.0
Airbus A380-800	D-VI	138	261.6	80.0

SOURCE: Federal Aviation Administration, Advisory Circular 150/5300-13A (Change 1), *Airport Design,* February 26, 2014.
PREPARED BY: Ricondo & Associates, Inc., July 2014.

2.1.4 METEOROLOGICAL CONDITIONS

Wind and weather conditions influence airport operations by affecting runway use and the percentage of time aircraft can operate under certain flight rules. Observations of weather conditions, such as wind direction and speed, visibility, and cloud ceiling at HOU were used to evaluate the general weather conditions and runway coverage.

2.1.4.1 General Weather Conditions

Weather conditions are categorized as either Visual Meteorological Conditions (VMC) or Instrument Meteorological Conditions (IMC). VMC occurs when the visibility is greater than or equal to three statute miles *and* the cloud ceilings are 1,000 feet above ground level (AGL) or higher. During VMC conditions, pilots operate under Visual Flight Rules (VFR), essentially using visual means to maintain separation from other aircraft, objects, terrain, etc.

IMC occurs when the prevailing visibility at the airport is less than three statute miles *or* the cloud ceilings are less than 1,000 feet AGL. During IMC conditions, pilots operate under Instrument Flight Rules (IFR), relying on Air Traffic Control (ATC) to provide separation services from other aircraft and terrain. Operating under IFR conditions requires additional pilot training and aircraft certifications beyond those required for operating under VFR conditions.

To evaluate the weather conditions at HOU, meteorological data were obtained from the automated weather station located on Airport property. Data for this station was recorded by the National Climatic Data Center (NCDC) for the 10-year period between January 1, 2004 and December 31, 2013, and consists of 87,958 hourly observations. At HOU, VMC conditions were recorded approximately 93.6 percent of the hourly observations, while IMC conditions were recorded approximately 6.4 percent of the hourly observations.

Wind patterns have a significant effect on runway use at all airports, as aircraft typically take-off and land into the wind in order to minimize the required runway length. When the winds are not directly aligned with the runway(s), pilots calculate a crosswind component to determine if a runway is usable. The Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5300-13A, *Airport Design*, recommends that the runway(s) at an airport achieve at least 95 percent wind coverage and should be evaluated based on a period of at least 10 consecutive years. To evaluate the runway wind coverage at HOU, the weather information retrieved from the NCDC was utilized. All HOU runways were evaluated both independently and together, however, because Runways 12L-20R and 12R-30L are oriented in the same direction, they are considered a single runway for the purposes of runway wind coverage. Crosswind components of 10.5 knots, 13 knots, 16 knots, and 20 knots were evaluated to provide runway coverage percentages for all Runway Design Codes (RDC).

Wind roses prepared as part of the *William P. Hobby Airport Layout Plan (ALP) Set,* and depicted on its *Airport Data Sheet*, show that winds in the Houston area are generally southeasterly. The combined coverage for all runways at HOU provides a 100 percent wind coverage for all weather, VMC, and IMC at all four calculated crosswind components (10.5, 13, 16, and 20 knots), which exceeds the FAA's recommendation of 95 percent. For individual runways, Runways 17-35, 12L-20R and 12R-30L exceed the FAA wind coverage recommendations for all weather, VMC, and IMC at all four crosswind components (10.5, 13, 16, and 20 knots). Runway 4-22 meets the FAA wind coverage recommendations for all weather, VMC, and IMC at crosswind components of 13, 16 and 20 knots; however Runway 4-22 alone does not meet the wind coverage recommendations during all weather, VMC, and IMC conditions with a 10.5 knot crosswind component.

2.2 Airfield Facilities

The Airport has four intersecting runways. Three of the runways (designated 4-22, 12R-30L, and 17-35) accommodate commercial airline traffic at the Airport. The fourth runway (12L-30R) is only 100 feet wide and substantially shorter than the other runways, and therefore is used primarily for general aviation activity. The four runways and the taxiway network, ramp and apron areas, helipads, engine runup areas, and navigational aids and lighting that support airfield operations are described below.

2.2.1 RUNWAYS

The parallel runways (12L-30R and 12R-30L) are separated by approximately 800 feet, centerline to centerline. The HOU airfield layout is shown on **Exhibit 2-1,** and the physical characteristics of each runway, including pavement strength, are summarized in **Table 2-4**.

Runways 12L-30R and 4-22 form an "X" that divides the Airport into four quadrants: the north, east, south and west quadrants, also shown on Exhibit 2-1.

Table 2-4: Runway Characteristics

	RUNWAY			
DESCRIPTION	**4-22**	**12L-30R**	**12R-30L**	**17-35**
Length (feet)	7,602	5,148	7,602	6,000
Width (feet)	150	100	150	150
Runway End Elevation (feet)	4: 42.1 22: 39.0	12L: 44.9 30R: 39.6	12R: 44.6 30L: 41.5	17: 44.8 35: 43.0
Touchdown Zone Elevation (feet)	4: 44.1 22: 41.0	12L: 44.9 30R: 44.0	12R: 46.3 30L: 42.6	17: 45.7 35: 45.6
Shoulder Width (feet)	20 [1/]	15	25	None [2/]
Load Bearing Capacity (pounds in thousands):				
Single Wheel	75	30	75	75
Dual Wheel	200	45	195	121
Dual Tandem Wheel	400	80	220	195
Runway Composition	Grooved Concrete	Grooved Concrete	Grooved Concrete/ Asphalt	Grooved Concrete/Asphalt
Gradient	0.03% Down to the Northeast	0.10% Down to the Southeast	0.04% Down to the Southeast	0.03% Down to the South
Runway Design Code	C-III-1200	B-II-VIS	C-III-4000	B-II-5000

NOTES:

VIS - Visual approach only

1/ Runway design standards for an ADG III runway require 25-foot wide paved shoulders on either side of the runway.

2/ Runway design standards for a B-II runway require 10-foot wide shoulders on either side of the runway. Although Runway 17-35 does not have physical shoulders, the runway is 50 feet wider than required; the additional pavement width provides for adequate shoulders.

SOURCES: National Geodetic Survey, *Aeronautical Data Survey*, June 22, 2000; Federal Aviation Administration, *Airport/Facility Directory*, December 2012; Ricondo & Associates, Inc., *William P. Hobby Airport Layout Plan*, 2004.

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

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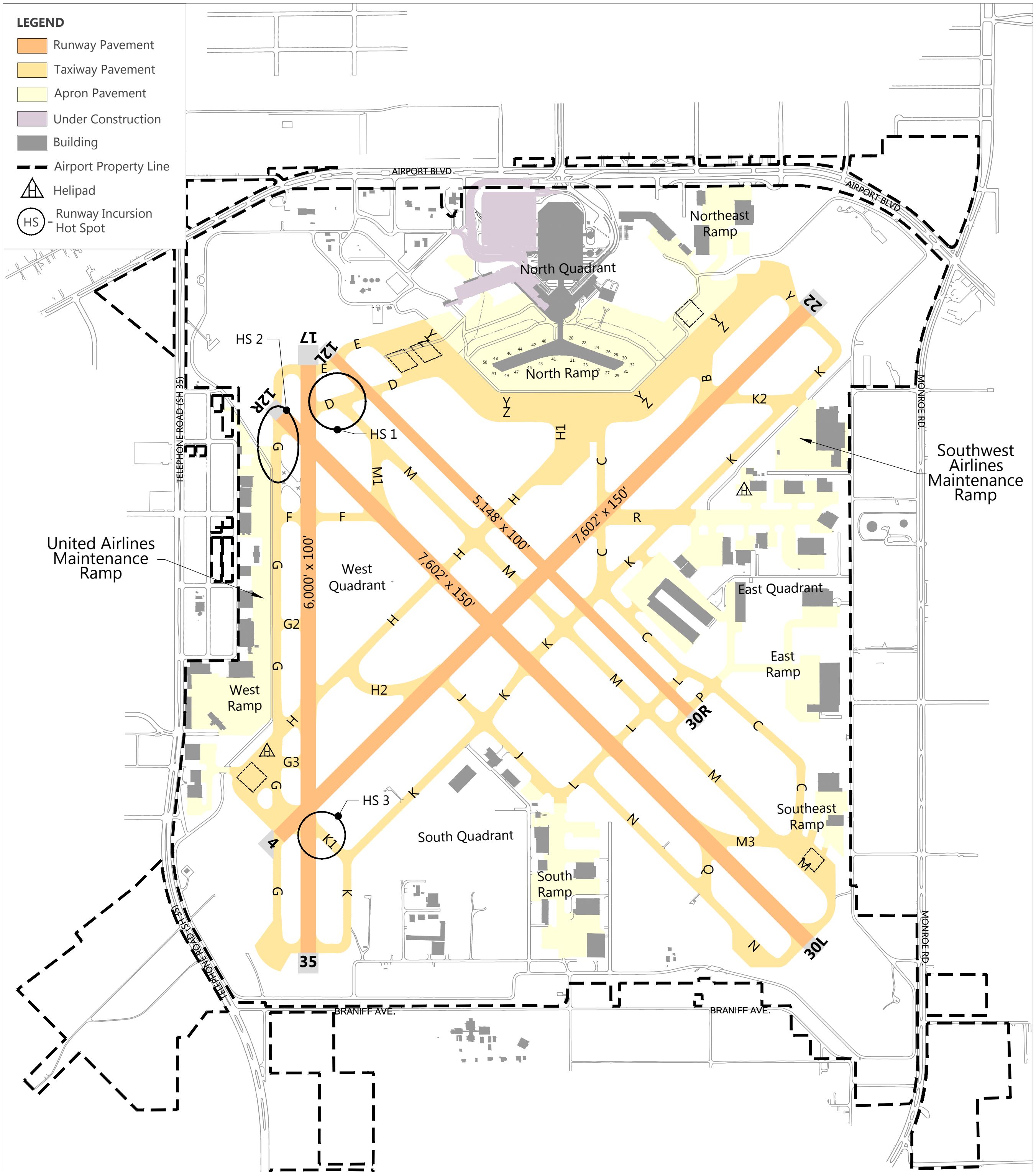

SOURCES: Ricondo & Associates, Inc., William P. Hobby Airport, Draft Airport Layout Plan, 2014; Houston Airport System, Hobby Planimetrics, 2012.
PREPARED BY: Ricondo & Associates, Inc., January 2013.

EXHIBIT 2-1

NORTH 0 1500 ft.

Airfield Layout

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\Exh 2-1 Airfield Layout.dwg_Layout: Ex 2-1_Dec 26, 2014, 10:55am

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2.2.1.1 Runway 4-22

Runway 4-22 is 7,602 feet long and 150 feet wide, with 20-foot wide paved shoulders. The RDC for Runway 4-22 is C-III-1200. In addition to the AAC and the ADG, the approach visibility minimum is also included, which is expressed in Runway Visual Range (RVR) values in feet. The visibility minimum is derived from the runway's instrument approach procedures. Boeing 757 aircraft may operate on Runway 4-22 with advance ATCT and Airport Operations coordination.

The runway safety area (RSA), the runway object free area (ROFA), the obstacle free zone (OFZ) and the runway protection zone (RPZ) for Runway 4-22 are all shown on the *Existing Airport Layout* drawing, in **Appendix D**. Blast pads extend from each runway end to protect the ground from erosion during aircraft departures. Runway 4-22 is constructed with continuously reinforced, grooved concrete and is in good condition. It has a load bearing capacity of 75,000 pounds for single-wheel landing gear, 200,000 pounds for dual-wheel landing gear, and 400,000 pounds for dual-tandem wheel landing gear configurations. A hold pad is located near the north end of the runway for aircraft departing from Runway 22.

Aircraft landing on Runway 4 can exit the runway at eight locations, as shown on Exhibit 2-1. These exits include Taxiways J, M, C, R, B, K2, Y, and K. Taxiway B is located near the end of the runway and is a 45-degree high-speed exit taxiway to the left, which leads directly into the terminal area. This taxiway enables aircraft to exit at higher speeds than typically associated with 90-degree angled taxiways. Other angled exits from Runway 4 include Taxiway C, which also exits to the left into the terminal area, as well as Taxiways K2 and R, which exit to the right off Runway 4. Although these angled exits allow for higher speeds than right-angled exits, they were not designed with the required geometry to allow true high-speed exits from the runway. Taxiways Y and K are located at the north end of the runway and can be used as exits if the full runway length is used for arrivals. General aviation traffic, capable of exiting the runway within a relatively short distance, can also exit the runway at Taxiways J and M.

Arriving aircraft can exit Runway 22 at several locations: Taxiways C and R (which can be used by GA aircraft capable of a short landing), Taxiways M, H2, J, K1 and Taxiway G at the end of the runway.

2.2.1.2 Runway 12L-30R

Runway 12L-30R is 5,148 feet long and 100 feet wide, with 15-foot wide paved shoulders. Runway 12L-30R is used primarily by general aviation aircraft. Both runway ends are approved for visual approaches only. The Runway 12L-30R RSA, ROFA, OFZ and RPZ are shown on the *Existing Airport Layout* drawing, in Appendix D. A blast pad is located beyond each runway end. The surface is grooved concrete and is in poor condition; most of the runway is due for resurfacing within five years. The load bearing capacity of the runway is 30,000 pounds for single-wheel landing gear, 45,000 pounds for dual-wheel landing gear, and 80,000 pounds for dual-tandem wheel landing gear. The RDC for Runway 12L-30R is B-II-VIS (VIS indicates visual approaches only).

Because GA aircraft are typically smaller and slower in speed than air carrier aircraft, they do not require runways designed with high-speed exits. Accordingly, Runway 12L-30R has no high-speed exits. Aircraft arriving on Runway 12L can exit the runway on the right-angled exits created by the four taxiways (Taxiways H, K, L, and P) that cross the runway. Aircraft arriving on Runway 30R can exit the runway using the exits created by the intersections of Taxiways K, H, D and E. Although aircraft may be allowed to exit on the left and right using Taxiway K, they are not typically allowed to exit to the right given the potential interference with aircraft taxiing on Taxiway C from the terminal complex or on Taxiway K from the East Ramp area.

2.2.1.3 Runway 12R-30L

Runway 12R-30L is used primarily for commercial aviation. The runway is 7,602 feet long and 150 feet wide, with 25-foot wide paved shoulders. Similar to Runway 4-22, the RDC for this runway is limited by various design constraints to C-III-4000; however, Boeing 757 aircraft may operate on Runway 12R-30L with advance ATCT and Airport Operations coordination. Blast pads are located beyond each runway end, and a hold pad is located adjacent to the North Ramp near the north end of the runway. The hold pads allow the sorting and queuing of aircraft prior to departures from Runway 12R or 17. Hold pads are also located on each side of the south end of the runway to accommodate Runway 30L departures.

The Runway 12R-30L RSA, ROFA, OFZ and RPZ are shown on the *Existing Airport Layout* drawing, in Appendix D. The surface of Runway 12R-30L is grooved concrete from the blast pad section of Runway 12R through the Runway 17 intersection, then asphalt beyond the intersection; it is in good condition. Its load bearing capacity is 75,000 pounds for single-wheel landing gear, 195,000 pounds for dual-wheel landing gear, and 220,000 pounds for dual-tandem wheel landing gear.

Runway 12R has the following taxiway exits: two 45-degree exits on the right and left near the end of the runway (Taxiways Q and M3); four 90-degree exits (Taxiways K and L); and two runway end exits (Taxiways N and M). Taxiway M3 is defined as a high-speed exit taxiway; Taxiway Q, however, does not have the proper lighting requirements to be classified as a high-speed exit taxiway. The Runway 12R arrival threshold is displaced by 1,034 feet from the physical end of the runway to mitigate obstructions along the approach path.

Runway 30L has the following taxiway exits: two 45-degree high-speed exits on the right (Taxiway M1) and left (Taxiway F); six right-angled exits at the crossovers of Taxiways L, K, and H; and runway-end exits at Taxiways E and G. In the section of the airfield that contains multiple runways and taxiways (Runways 12R, 12L, and 17, as well as Taxiways E, G, and D), the HOU Airfield Operations Department has color-coded the pavement areas to clearly define the taxiways and runways and prevent incursions.

2.2.1.4 Runway 17-35

Runway 17-35 is 6,000 feet long and 150 feet wide, with no shoulders; however, the runway is 50 feet wider than required and the additional pavement width provides for adequate shoulders. Its RDC is limited to B-II-5000 because of RSA constraints on the Runway 35 end.

The Runway 17-35 RSA, ROFA OFZ and RPZ are shown on the *Existing Airport Layout* drawing, in Appendix D. The Runway 17-35 pavement is a combination of grooved concrete and asphalt: the section of the runway between Taxiway F and Runway 4-22 is paved with asphalt, and the remainder of the runway is grooved concrete. The runway is in fair condition and has a load bearing capacity of 75,000 pounds for single-wheel landing gear, 121,000 pounds for double wheel landing gear, and 195,000 pounds for double tandem wheel landing gear. Blast pads are located beyond each runway end. A hold pad is located adjacent to each runway end. One is adjacent to the terminal apron near the north end of the runway, and the other is located on the south end, supporting departures on Runway 35.

Runway 17 is used by a combination of air carrier and GA aircraft, however, it is most commonly used by GA aircraft destined for the west side of the Airport. Air carrier aircraft may use the runway when Runway 4-22 or 12R-30L are being maintained or rehabilitated or when specifically requested by pilots. Pilots of aircraft arriving on Runway 17 have several runway exit options. They can use Taxiway F to the right or left, the right exits to Taxiways G2 and G3, and the 45-degree-angle runway exit to the right (Taxiway H) or to the left (Taxiway K1). Taxiway G is a full-length parallel taxiway; its separation with Runway 17-35 only allows for unrestricted operations by aircraft no larger than B-III or E-II.

Pilots of aircraft arriving on Runway 35 may use the 45-degree-angle Taxiway H exit on the right or additional exits at Taxiway D and Taxiway F, or left-only exits to Taxiways G2 and G3. Taxiway E intersects at the end of the runway and provides an additional exit for aircraft taxiing to the passenger terminal.

2.2.1.5 Land-and-Hold-Short Operations

Operators of airports with intersecting runways can increase airfield capacity through the use of land-and-hold-short operations (LAHSO). With LAHSO, arrival and/or departure operations on one runway can occur independent of aircraft arrivals on the intersecting runway. These operations are only permitted on runways where sufficient landing distance exists prior to the runway intersection. However, LAHSO are not permitted at HOU.

2.2.1.6 Runway Incursions

Runway incursions are incidents that compromise safety on an active runway, and are generally caused by the unauthorized presence of aircraft, vehicles, or individuals on a runway. At HOU, there are three areas of concern known as “hot spots,” where runway incursions are more likely to occur. The runway incursion hot spots are identified on Exhibit 2-1. Hot Spot 1 is located in the northwest quadrant, where Taxiway D intersects Runways 12L and 17. Hot Spot 2 is also in the northwest quadrant, where Taxiway G intersects Runway 12R. Hot Spot 3 is in the south quadrant, where Taxiway K1 intersects both Runways 4 and 35. Airport users need to exercise extreme caution when operating in these hot spots.

To reduce the risk of incursion, HAS painted the triangular fillet between Runways 12R and 17 green and closed that portion of Taxiway D.

2.2.2 RAMP AND APRON AREAS

Airport ramps or aprons are typically used for aircraft parking, unloading, loading, refueling, and deplaning or enplaning passengers. The ramp areas are depicted on Exhibit 2-1, and summarized below:

- The passenger terminal ramp on the north side of the Airport (North Ramp)
- The aircraft maintenance ramps for Southwest Airlines on the east side of the Airport and for United Airlines on the west side of the Airport

- GA ramps located at various sites around the airfield (generally referred to as the West Ramp, South Ramp, Southeast Ramp, East Ramp and Northeast Ramp)

The North Ramp surrounds the Central Concourse and terminal building, thereby providing air carrier aircraft access to and from the taxiways, as shown on Exhibit 2-1. The ramp is approximately 232,000 square yards and is designed to allow the safe maneuvering of air carrier aircraft to and around the 25 gates. The outermost sections of the concrete pavement are designated as movement areas associated with the inner and outer ramp taxiways (Taxiways Y and Z).

The apron maintenance ramps serve the cargo and maintenance facilities for Southwest Airlines and United Airlines. Southwest Airlines is the dominant airline serving the Airport; it also operates an aircraft maintenance facility. United Airlines operates a maintenance facility. The Southwest Airlines maintenance facility, located in the vicinity of the intersection between Taxiways K and K2, includes ramp space in front of its hangar, Building E-320. The ramp is mostly used for staging and maneuvering aircraft.

The United Airlines maintenance facility is located on the west side of the Airport, adjoining Taxiway G. The maintenance hangar is fronted by the ramp space between Taxiways F and G2. The ramp space is used for aircraft parking, staging, and maneuvering and for outdoor aircraft maintenance.

A blast deflection barrier is located on the south end of the Southwest Airlines maintenance facility ramp. The barrier functions as a sound attenuation device for high-power sustained engine run-ups conducted for aircraft maintenance checks. The United Airlines maintenance facility does not have a blast deflection barrier. Rather, United Airlines engine run-ups are coordinated with Airport Operations and performed at designated times and at engine run-up areas on the airfield.

HOU does not have public-use GA ramp space, as all general aviation activities are conducted on ramp space exclusive to tenants, such as fixed base operators or corporate aviation tenants. These corporate aviation and other GA tenants have ramp space for their respective uses and needs. The overall condition of the apron pavement is good.

2.2.3 TAXIWAY NETWORK

As shown on Exhibit 2-1, each runway has at least one associated parallel taxiway, although the parallel taxiways do not extend the full length of the runways in all cases. Runway 4-22 has parallel taxiways on either side: Taxiway H is located approximately 729 feet northwest of the runway,[5] and Taxiway K is offset approximately 545 feet southeast of the runway; this separation increases to 653 feet between Taxiways K1 and J.

Taxiway M serves as a full-length parallel taxiway to Runways 12R-30L and 12L-30R, as it is located between the parallel runways. The Taxiway M centerline is approximately 509 feet north of the Runway 12R-30L

[5] Separation distances refer to the distance from the runway centerline to the taxiway centerline.

centerline and approximately 291 feet south of the Runway 12L-30R centerline. Runway 12R-30L is also served by a partial-length parallel taxiway to the southwest; the Taxiway N centerline is located approximately 404 feet from the Runway 12R-30L centerline and extends from the south end of the runway to its intersection with Taxiway L.

Taxiway C is located on the northeast side of Runway 12L-30R, extending from Taxiway M to Taxiway K, and then into the North Ramp area. The Taxiway C centerline is approximately 250 feet from the Runway 12L-30R centerline.

Runway 17-35 has a full-length parallel taxiway to the west; Taxiway G is located approximately 350 feet from the runway centerline. The majority of Taxiway G is contiguous with the West Ramp. In addition, a short parallel taxiway to the east, Taxiway K, extends from Taxiway K1 to the Runway 35 end. The Taxiway K centerline is 400 feet from the runway centerline.

Other taxiways connect the runways and parallel taxiways with the Central Concourse and tenant facilities. For example, Taxiway F connects aircraft arriving on Runways 12R-30L and 17-35 with the West Ramp, while Taxiway R connects aircraft transiting from the East Ramp apron areas with Runway 4-22. Parallel Taxiways Y and Z extend the full length of the North Ramp area. Taxiway H1 provides an additional connection between the apron edge taxiways and Taxiway H at approximately the midpoint of the North Ramp area.

Most taxiways at the Airport are 75 feet wide, except for Taxiway R which is 150 feet wide (Taxiway R was previously a runway). The taxiways that accommodate air carrier aircraft operations have a 118-foot-wide safety area, supporting ADG III aircraft movements, with the exception of Taxiway G, which serves the West Ramp area. The centerline of Taxiway G is located only 49 feet from the edge of the vehicle service area to the west. According to the criteria defined in FAA AC 150/5300-13A, *Airport Design*, this spacing provides adequate clearance only for aircraft with wingspans less than 83 feet, which includes all ADG II aircraft and a select number of ADG III aircraft (excluding the Boeing 737).

Only Taxiways H, C (between Taxiways Z and K), F B and Y have paved shoulders and as such, meet the latest ADG IV standards. All taxiways edges are equipped with medium intensity taxiway lights (MITL).

2.2.4 HELIPADS

Two designated helipads are located on the airfield: one is located on the Runway 4 end hold pad, west of Taxiway G between Taxiways H and G3; the other is located on the Houston Police Department (HPD) ramp, east of Taxiway K and north of Taxiway R.

2.2.5 ENGINE RUN-UP AREAS

The primary location for engine run-up tests is on the Taxiway G hold pad, abeam the Runway 4 end, with aircraft positioned on a heading between 190 and 220 degrees. A different location may be assigned on a case-by-case basis after consideration has been given to the following variables: day of week, time of day, cloud cover, winds, engine size, duration of test, nature of engine run, and other considerations.[6] Alternate locations include, but are not limited to:

- Taxiway M between Taxiways P and M3
- Taxiway M between Taxiways H and M1
- Taxiway K between Taxiways J and K1

At these alternate locations, aircraft are parallel to the taxiway along the taxiway centerline, and their heading is determined by both the operational and meteorological conditions at the time of the engine run up test. Taxiway R, east of Runway 4, is another alternate engine run-up test location, used only for reciprocating/turboprop engine aircraft. Aircraft at this location are positioned so that the propeller blast is directed to a heading of 040 degrees. The run-up pads at the approach end of the runways may only be used by reciprocating engine aircraft for pre-takeoff engine run checks.

Engine run-up tests are not typically allowed between 10 p.m. and 7 a.m. The HAS Airport Operations Division may grant exceptions to this restriction if a scheduled morning departure would have to be cancelled without the run-up test. The aircraft maintenance supervisor on duty is responsible for coordinating with Airport Operations for this exception. Pilots/mechanics must contact the HOU ATCT on ground control frequency for clearance to the designated area, and radio contact with the ATCT must be maintained at all times.

2.2.6 NAVIGATIONAL AIDS AND LIGHTING

The various types of navigational aids and airport lighting systems in use at the Airport are described in this section. **Exhibit 2-2** depicts the locations of the various navigational aids and lighting systems. **Table 2-5** summarizes this information, and **Table 2-6** lists the various instrument approaches available at the Airport for each runway and provides the associated approach minimums.

2.2.6.1 Very High Frequency Omnidirectional Range Station

A very high frequency omnidirectional range (VOR) station is located on top of the terminal parking garage. The VOR station provides navigational guidance for aircraft transitioning through the area's airspace and for aircraft landing at the Airport. The VOR station also provides nonprecision instrument approach capability for Runways 4, 30L, and 35, allowing aircraft to land at the Airport in poor weather conditions. The VOR critical area is shown Exhibit 2-2.

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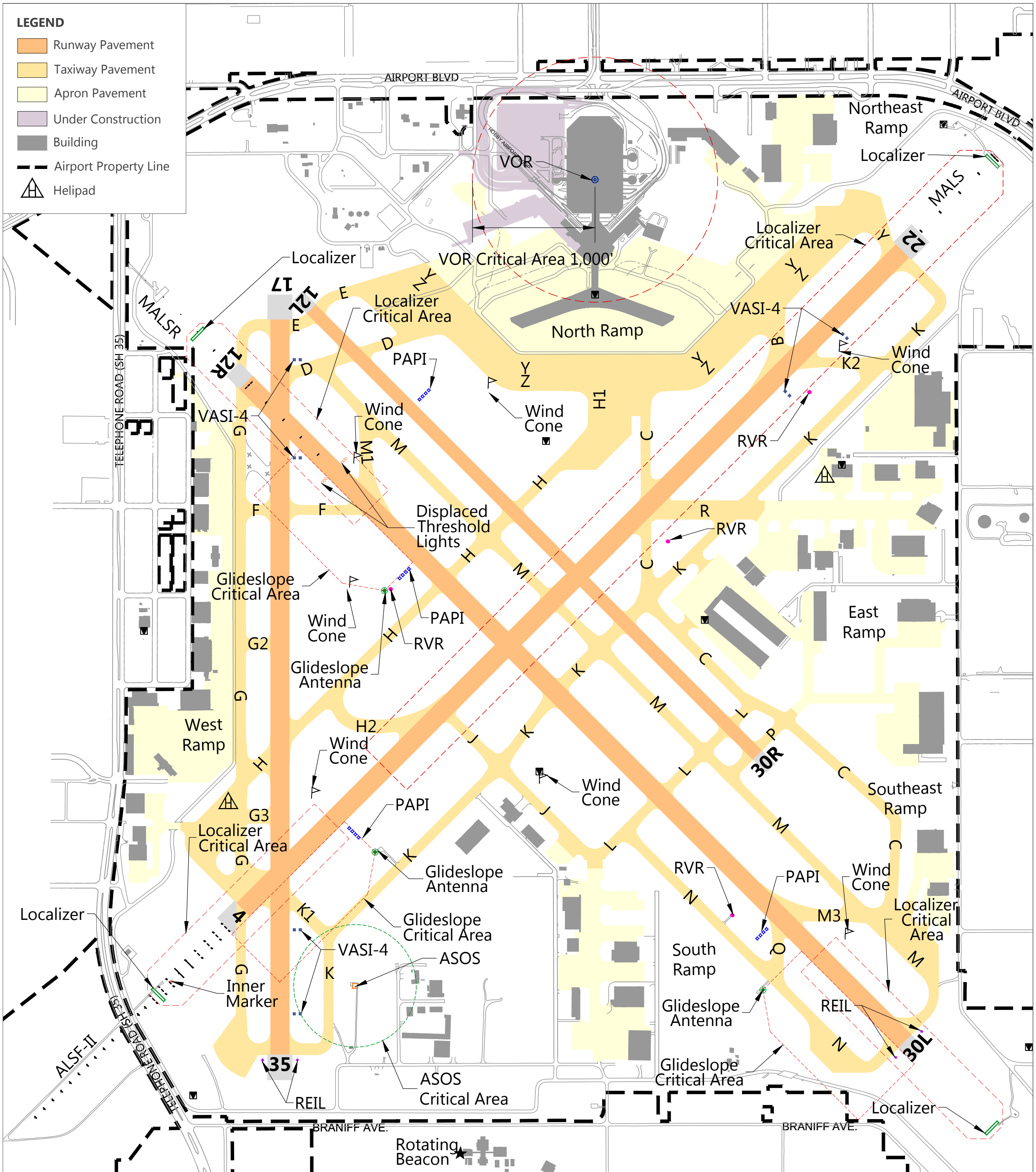
[6] In accordance with the HOU airport traffic control tower standard operating procedures published in *HOU 7110.1W, Houston Hobby Air Traffic Center*, August 15, 2011.



SOURCES: Ricondo & Associates, Inc., William P. Hobby Airport, Draft Airport Layout Plan, 2014; Houston Airport System, Hobby Planimetrics, 2012.
PREPARED BY: Ricondo & Associates, Inc., January 2013.

EXHIBIT 2-2

NORTH 0 1200 ft.

Navigational Aids and Lighting Systems

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\Exh 2-2 Navigational Aids.dwg_Layout: Ex 2-2_Dec 29, 2014, 1:54pm

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Table 2-5: Runway Instrumentation and Lighting Systems

	RUNWAY							
INSTRUMENTATION	**4**	**22**	**12L**	**30R**	**12R**	**30L**	**17**	**35**
APPROACH AIDS								
Localizer	√	√			√	√		
Glide Slope	√				√	√		
Distance Measuring Equipment (DME) 1/	√	√			√	√		
Inner Marker	√							
Runway Visual Range (RVR)	√	√			√	√		
APPROACH LIGHTING SYSTEMS								
Visual Approach Slope Indicator (VASI)		√					√	√
Precision Approach Path Indicator (PAPI)	√		√		√	√		
Medium Intensity Approach Lighting System (MALS)		√						
Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR)					√			
Approach Lighting System with Sequenced Flashing Lights (ALSF-II)	√							
RUNWAY LIGHTING								
High Intensity Runway Lights (HIRL)	√	√			√	√		
Medium Intensity Runway Lights (MIRL)			√	√			√	√
Runway End Identifier Lights (REIL)						√		√
Touchdown Zone Lights (TDZL)	√				√	√		
Runway Centerline Lights	√	√			√	√		

NOTE:

1/ Runways 4 and 22 share the same DME. Runways 12R and 30L share the same DME.

SOURCE: Jeppesen Sandersen, *Airport and Instrument Approach Charts*, accessed November 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 2-6: Runway Approach Specifications

RUNWAY	PUBLISHED INSTRUMENT APPROACH	APPROACH MINIMUMS 1/	DA / MDA
4	ILS CAT I	200 / ½	244
	ILS CAT II	100 / RVR 12	144
	ILS CAT III	0 / 0	0
	RNAV (LPV)	256 / ½	300
	VOR / DME	416 / 1	460
12R	ILS CAT I	250 / ¾	296
	RNAV (LPV)	284/ ¾	330
30L	ILS CAT I	200 / ¾	242
	RNAV (LPV)	200 / ¾	242
	VOR / DME	398 / 1 1/8	440
22	LOC	419 / 1¼	460
	RNAV (LPV)	319 / 1	360
35	VOR / DME	514 / 1¾	560
	RNAV (LNAV)	514 / 1¾	560
17	RNAV (LNAV/VNAV)	434 / 1½	480

NOTES:

CAT - Category

DA - Decision Altitude (in feet above mean sea level)

DME - Distance Measuring Equipment

ILS - Instrument Landing System

LNAV – Lateral Navigation

LOC - Localizer

LPV - Localizer Performance with Vertical Guidance

MDA - Minimum Descent Altitude (feet above mean sea level)

RNAV - Area Navigation (Global Positioning System)

VNAV – Vertical Navigation

VOR - Very High-Frequency Omnidirectional Range

1/ Minimums are lowest available on each runway – Cloud ceiling (feet above ground level) / visibility (statute mile).

SOURCE: Jeppesen Sandersen, *Airport and Instrument Approach Charts*, accessed November 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

2.2.6.2 Distance Measuring Equipment

Distance measuring equipment (DME) provides distance information with a very high degree of accuracy. It can be used both by pilots of aircraft transitioning through the area's airspace and pilots of aircraft landing at the Airport. There are several DME systems at the Airport; one is collocated with the VOR station and is a required component of the VOR/DME instrument approaches to the Airport, and two others are associated with the localizer/ILS approaches and transmit distance information over the localizer frequency.

2.2.6.3 Instrument Landing System

Instrument landing systems (ILS) serve approaches to the Runways 4, 12R, and 30L ends, providing precision instrument approach capability for landings at the Airport in poor weather conditions. An ILS is designed to provide an approach path for exact alignment and descent of an aircraft on final approach to a runway. ILS components provide the following information: lateral and vertical guidance with a localizer and glide slope antenna, respectively; range information with a marker beacon and/or DME; and visual information with approach lighting systems, touchdown zone lights (TDZL), and runway edge and centerline lights.

The Runway 12R and 30L ILSs allow for Category (CAT) I precision approaches, while the Runway 4 ILS allows for CAT II and III precision approaches. If the aircraft is equipped accordingly, a CAT III ILS allows for approaches with a cloud ceiling of 0 feet AGL and a visibility of 0 feet.

Localizer and glide slope critical areas for each ILS are shown on Exhibit 2-2. Dimensions of these areas are based on equipment type and capability; all glide slopes at HOU are of the capture effect type.

2.2.6.4 Approach Lighting Systems

The Runway 4, 22, and 12R ends are equipped with approach lighting systems. These systems provide visual information, runway alignment, height perception, roll guidance, and horizon references to assist in the transition from IMC to VMC for landing. Runway 4 is equipped with an approach lighting system with sequenced flashing lights (ALSF-II), which is typically used on CAT II and III precision approach runways. Runway 22 is equipped with a medium-intensity approach lighting system (MALS), which is typically used for nonprecision approaches. Runway 12R is equipped with a MALS with runway alignment indicator lights (MALSR), which is the FAA standard for CAT I precision runways.

2.2.6.5 Precision Approach Path Indicator

A precision approach path indicator (PAPI) is installed past the Runway 4, 12R, 12L, and 30L ends to provide visual approach slope information during the approach phase. This glide path information not only helps the pilot establish a stabilized approach, but also provides obstacle clearance. PAPI lights are visible from approximately 5 miles during the day and 20 miles or more at night.

2.2.6.6 Visual Approach Slope Indicator

A visual approach slope indicator (VASI) is installed past the Runway 22, 17, and 35 ends to provide visual approach slope information during the approach phase. This glide path information not only helps the pilot establish a stabilized approach, but also provides obstacle clearance. VASI lights are visible from approximately 3 to 5 miles during the day and 20 miles or more at night.

2.2.6.7 Windsock

Seven windsocks are installed in the vicinity of the runway ends and Houston Police Department (HPD) helipads to provide wind direction and speed information to pilots during the landing phase. The windsocks are depicted on Exhibit 2-2. Four of the seven windsocks are lighted.

2.2.6.8 Runway Lights

Runway Edge Lights

Runway edge lights are used to outline the edges of runways during periods of darkness or restricted visibility. These lighting systems are classified according to the intensity or brightness they are capable of producing: high intensity runway lights (HIRL), medium intensity runway lights (MIRL), or low intensity runway lights (LIRL). HIRLs are installed on Runways 4-22 and 12R-30L, while MIRLs are installed on Runways 12L-30R and 17-35.

Runway Centerline Lights

Runway centerline lights are installed on some precision approach runways along the runway centerline to facilitate landing under poor visibility conditions. Both Runways 4-22 and 12R-30L are equipped with centerline lights.

Touchdown Zone Lights

Touchdown zone lights are installed on some precision approach runways to indicate the touchdown zone when landing under poor visibility conditions. They consist of two rows of transverse light bars installed symmetrically along the runway centerline. Runways 4, 12R and 30L are equipped with TDZLs.

Runway End Identifier Lights

Runway end identifier lights (REIL) provide rapid and positive identification of the approach end of a runway. The lighting system consists of a pair of synchronized flashing lights located laterally on each side of the runway threshold. At HOU, REILs are installed on the Runways 30L and 35 ends.

Runway Guard Lights

Runway guard lights are installed at taxiway/runway intersections. They are primarily used to enhance the conspicuity of taxiway/runway intersections during low visibility conditions, but may be used in all weather conditions. Runway guard lights are installed along the low visibility taxiing routes and at taxiway intersections with Runway 4-22.

2.2.6.9 Taxiway Lights

Taxiway Edge Lights

All taxiways at the Airport are equipped with taxiway edge lights, which outline the edges of taxiways during periods of darkness or restricted visibility conditions.

Taxiway Centerline Lights

Taxiway centerline lights are used to facilitate ground traffic under low visibility conditions. At the Airport, centerline lights are installed on the taxiways (H, H1, K, K1, Z and Y) that are part of the low visibility taxiing routes associated with the Surface Movement Guidance and Control System (SMGCS).

2.2.6.10 Airport Surface Detection Equipment

The Airport is also equipped with Airport Surface Detection Equipment – Model X (ASDE-X). ASDE-X is a traffic management system that provides aircraft identification for air traffic controllers; advanced conflict detection and alerting technology alerts controllers of potential aircraft and/or vehicle incursions, improving safety in all weather conditions. This equipment uses information from surface movement radar combined with aircraft and vehicle transponders.

2.2.6.11 Low Level Windshear Alert System

The Airport is equipped with a Low Level Windshear Alert System (LLWAS), which measures wind speed and direction at remote sensor station sites situated around the Airport. Current wind data and warnings are displayed for approach controllers in the FAA Terminal Radar Approach Control (TRACON) facility and for ground controllers in the ATCT. Air traffic controllers relay the LLWAS runway-specific alerts to pilots via voice radio communication. LLWAS alerts assist pilots during critical times when they must determine whether or not to attempt to land or take off in hazardous weather conditions.

2.2.6.12 Transmissometer

A transmissometer measures the RVR, which can be used to determine if visibility conditions permit a certain type of instrument approach. Runways 4-22 and 12R-30L are equipped with several transmissometers along their lengths.

2.2.6.13 Airport Beacon

A rotating beacon, located off-Airport, south of the Airport Maintenance Complex and Braniff Avenue, emits alternating white and green flashes, indicating a lighted land airport. The Airport beacon is a visual navigational aid during nighttime operations. Operation of the beacon during daylight hours may indicate that ground visibility is less than 3 miles and/or the cloud ceiling is less than 1,000 feet.

2.2.7 WEATHER COLLECTION SYSTEMS

An Automated Surface Observing System (ASOS) with Terminal Doppler Weather Radar is located in the south quadrant, between Taxiway K and the Airport Maintenance Complex. The ASOS provides the following basic weather elements: sky condition, visibility, basic present weather information, obstructions to vision, pressure, ambient temperature, dew point temperature, wind, precipitation accumulation, and selected significant remarks. ASOS observations are updated every minute, 24 hours a day, every day of the year.

2.3 Passenger Terminal Facilities

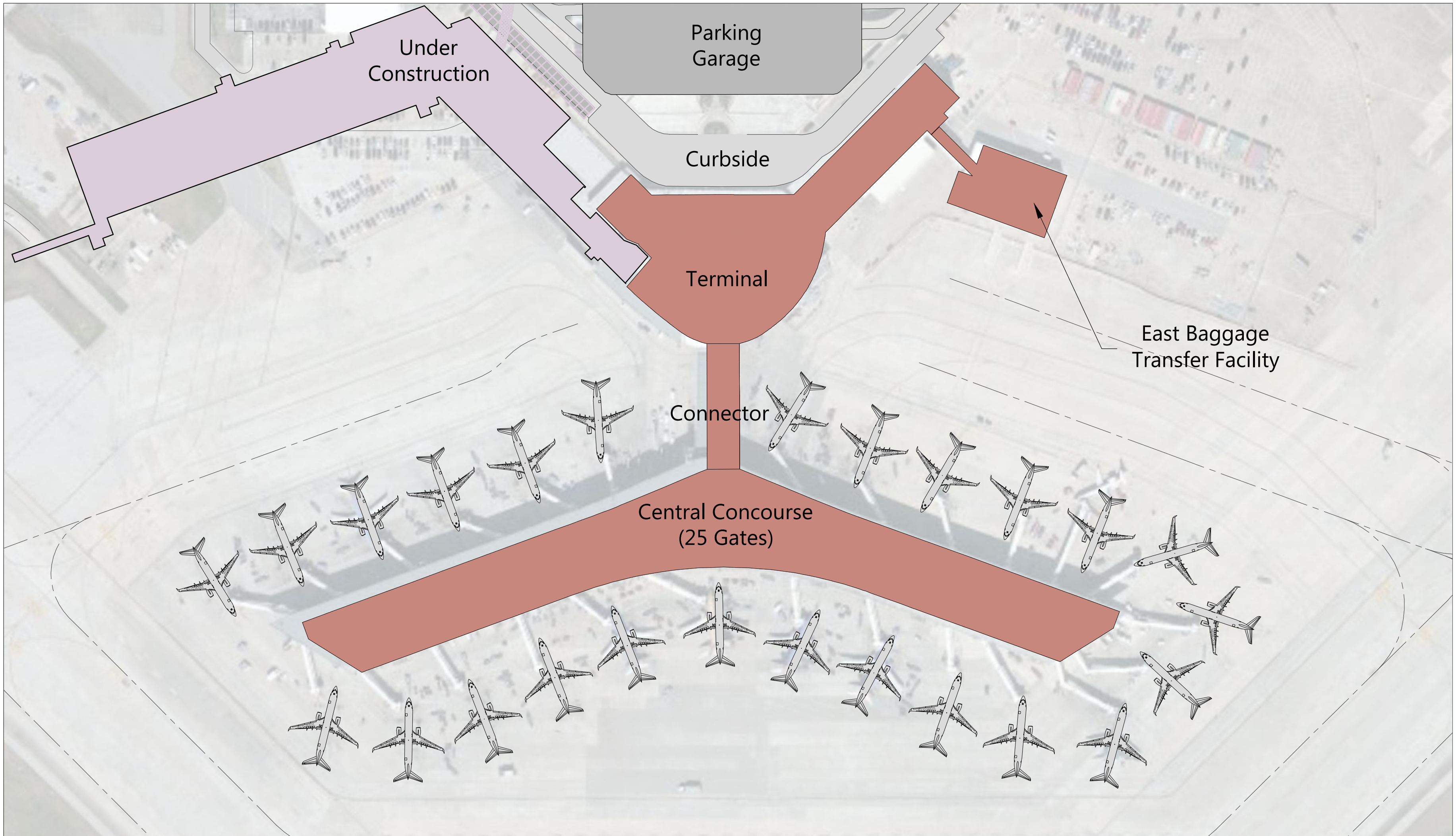
The passenger terminal complex is currently being expanded to accommodate future international operations and is scheduled to open in December 2015. A detailed description of these new facilities is provided in Section 5. The inventory provided in Section 2.3 is representative of conditions as of the writing of this document in December 2013.

Existing passenger terminal facilities encompass an area approximately 80 acres and include the terminal building, aircraft parking apron, curbside access system, and parking structures. Passenger terminal facilities are approximately 650,000 square feet, and consist of three main sections: the Terminal, the Connector, and the Central Concourse, as depicted on **Exhibit 2-3**.

The Terminal has three levels. The Baggage Claim Level (ground floor) primarily serves the baggage claim function, with domestic baggage claim facilities provided in two locations (central and east). This level also provides nonsecure public circulation areas, meeter/greeter areas, and Airport operations space, as well as mechanical, plumbing, and electrical facilities. The Ticketing Level (first floor) provides two airline ticketing areas (i.e., ticketing, baggage check, and airline ticketing offices), one centrally located and one to the east, concession/retail space, a centrally located security screening checkpoint (SSCP), public areas (i.e., restrooms, meeter/greeter areas, and nonsecure circulation areas), as well as nonpublic areas (i.e., mechanical rooms, HAS administrative offices, other secure areas). The Mezzanine Level (second floor) provides a small area used for airline offices and an unused space referred to as the Cloud Room.

The Connector links the Terminal and the Central Concourse. The Connector Apron Level (ground floor) is within the Secure Identification Display Area (SIDA) and is an unenclosed nonpublic area dedicated to airline activities. Baggage transport belts are located overhead the Connector Apron Level and are part of the outbound baggage handling system (BHS) for the Airport. The Connector Upper Level (first floor) provides circulation for screened passengers to move freely between the Terminal and the Central Concourse.

The three-level Central Concourse contains the main airline gate operations area at the Airport. The building accommodates 25 gates serving six airlines, including Southwest Airlines, Delta Air Lines, AirTran Airways, Frontier Airlines, JetBlue Airways, and American Airlines. The Central Concourse Apron Level (ground floor) houses the airline operations areas, Airport spaces, mechanical rooms, and secure nonpublic circulation areas. On the Central Concourse Upper Level (first floor), holdroom areas for the 25 aircraft gates are provided with each gate equipped with a passenger boarding bridge (PBB); a secure circulation corridor connects the holdroom areas. Also on the Central Concourse Upper Level, many passenger amenities are provided, such as retail spaces, news and gift shops, food and beverage concessions, and restrooms. The Central Concourse Mezzanine Level (second floor) primarily serves as airline space.



SOURCES: Ricondo & Associates, Inc., William P. Hobby Airport, Draft Airport Layout Plan, 2014; Houston Airport System, Hobby Planimetrics, 2012; Google Earth Pro, Aerial Photography, October 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2012.

EXHIBIT 2-3

NORTH 0 250 ft.

Overview of Terminal Complex

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\Future Gate Capacity (2020) 250 - Standard\Future Gate Capacity (2020) 250.dwg_Layout: Exhibit 2-3_Dec 26, 2014, 11:11am

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2.3.1 FUNCTIONAL CATEGORIES

The passenger terminal facilities functional categories are defined below and depicted in the following exhibits. In addition, **Table 2-7** provides area takeoffs for the appropriate functional areas:

- Airline Facilities – Areas dedicated to airline functions, including passenger queuing areas, ticketing/check-in counters, airline ticket offices, holdroom areas, clubs/lounges, and baggage claim areas.
- Concessions – Revenue-generating spaces designated for the storage, preparation, and sale of food/beverage and goods throughout the Terminal and Central Concourse.
- Security Screening Checkpoint – Areas in the Terminal dedicated to staffing and security screening functions for the Central Concourse.
- Public Circulation Areas – Areas used as public circulation, including nonsecure areas in the Terminal and secure areas in the Connector and Central Concourse.
- Nonpublic Areas – Areas dedicated to Airport administration offices and mechanical/ electrical/building systems.
- Tug Circulation – Areas dedicated to the movement and distribution of baggage on the Baggage Claim Level of the Terminal.

2.3.2 TERMINAL

The Terminal has three levels: the Baggage Claim Level (ground level), the Ticketing Level (first floor), and the Mezzanine Level (second floor). Each is described below.

2.3.2.1 Baggage Claim Level (Ground Floor)

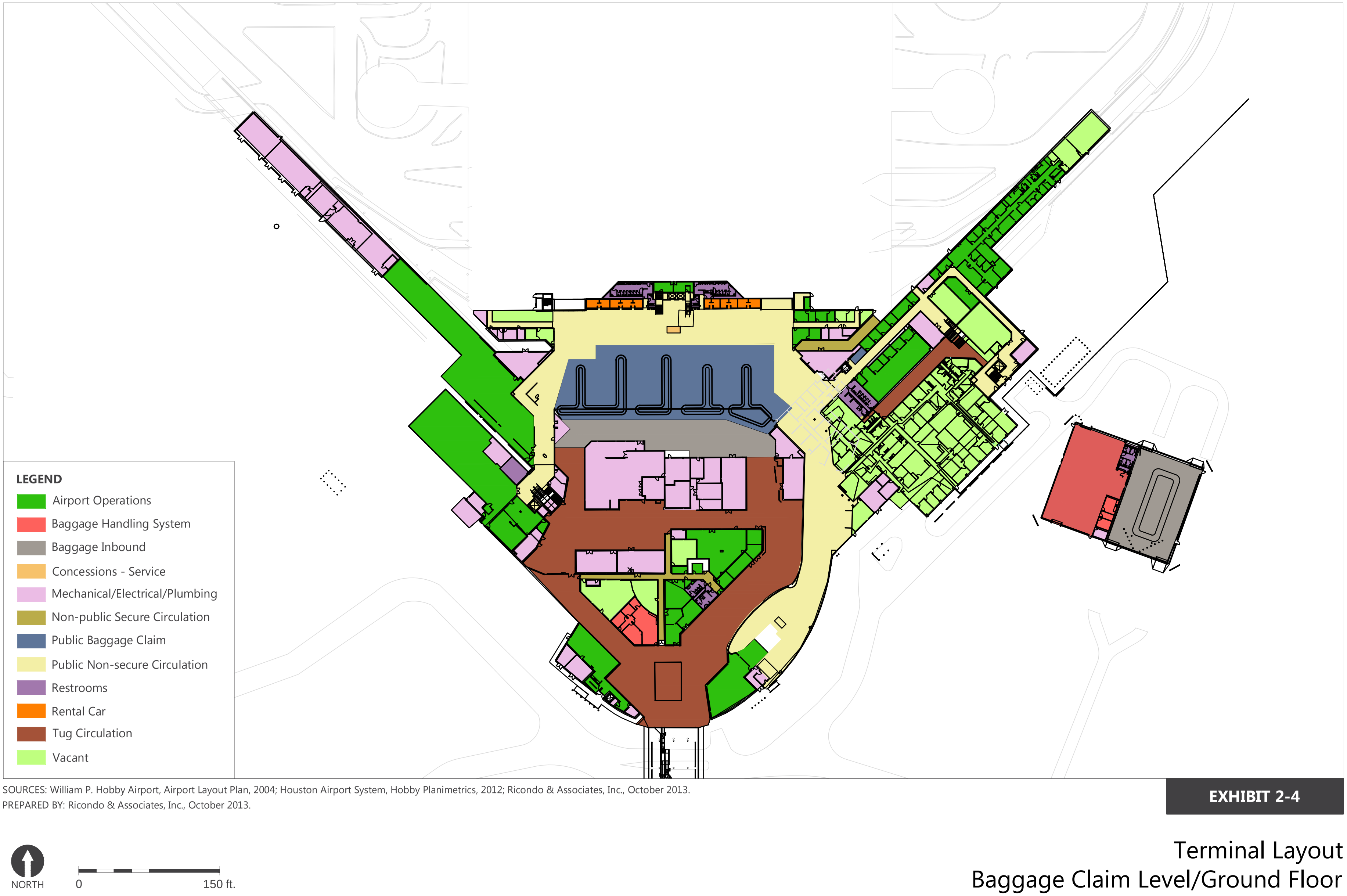
The public areas of the Baggage Claim Level include rental car facilities, all ground transportation (including access to public transportation), public telephones, restrooms, stairwells, elevators, escalators, and an Airport and Public Information service kiosk. The baggage claim area centrally located on the ground floor is used as the main baggage claim area. An additional baggage claim area is located on this level to the east, but is walled off and marked for repurposing.

The nonpublic areas on this level include HAS administration offices, communication rooms, baggage processing space, mechanical rooms, electrical rooms, and vacant spaces. **Exhibit 2-4** shows the layout of these functional areas. Airport Operations Division offices are located on the west side of the ground floor. In addition to housing Airport Operations, they contain the communications center, a conference room, mechanical and electrical rooms, and a larger sign and work tool room. The HOU Badging Office is located in a room abutting the communications center. Several facilities on the west side of the Baggage Claim Level will be relocated as part of the construction of the HIT.

Table 2-7: Summary of Terminal Area

LOCATION		FUNCTIONAL USE	TERMINAL	CENTRAL CONCOURSE	TOTAL
Airline Facilities	1	Ticket Counters (linear feet)	-	-	-
	2	Airline Ticket Offices and Counter Work Area	4,223	-	4,223
	2a	Southwest Skycaps/Baggage Check-in	1,616	-	1,616
	3	Gate Holding Areas	-	60,446	60,446
	4	Passenger Baggage Claim Area	26,878	-	26,878
	5	Number of Baggage Claim Belts	7	-	7
	6	Length of Baggage Claim Belts (linear feet)	-	-	-
	7	Baggage Processing, Conveyor and Tug Lane Areas	24,990	2,486	27,476
	8	Airline Operations, Support, and Storage Areas	1,715	45,534	47,249
		Subtotal	59,422	108,466	167,888
Concessions	9	Food/Beverage	2,239	25,875	28,114
	9a	News/Snack Concession stands	1,998	-	1,998
	10	Retail	-	4,374	4,374
	11	Rental Car	1,863	-	1,863
	12	Visitors Booth	108	675	783
	13	Currency Exchange	69	-	69
	14	Other (Storage and Support Areas)	-	-	-
		Subtotal	6,277	30,924	32,827
Security	15	Security Screening Check Points/Processing Area	14,906	45,310	60,216
		Subtotal	14,906	45,310	60,216
Public Areas	16	Concourse Circulation (Secure Areas)	-	46,967	46,967
	17	General Circulation (Nonsecure Areas)	79,167	-	79,167
	17a	Chapel/USO	347	-	347
	18	Restrooms	2,354	12,030	14,384
		Subtotal	81,868	58,997	140,865
Nonpublic Areas	19	Airport Administration, Operations, Conference rooms, Restrooms, Stairwells, and other Areas	80,577	129,227	209,804
	20	Mechanical/Electrical/Building Systems	1,967	21,137	23,104
	21	Service and Delivery Area	-	-	-
	22	Unenclosed Area	-	7,942	7,942
	23	Vacant space	3,828	-	3,828
		Subtotal	86,372	158,306	244,678
		Total	248,845	402,003	646,474

SOURCE: Houston Airport System, *Hobby Planimetrics*, 2012.
PREPARED BY: Ricondo & Associates, Inc., August 2012.



SOURCES: William P. Hobby Airport, Airport Layout Plan, 2004; Houston Airport System, Hobby Planimetrics, 2012; Ricondo & Associates, Inc., October 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 2-4

Terminal Layout
Baggage Claim Level/Ground Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\HOU_TERMINAL_ALL_20130808 - Standard (09182013)\HOU_TERMINAL_ALL_20130808.dwg_Layout: 02-4_Baggage_Claim_Dec 26, 2014, 11:19am

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2.3.2.2 Ticketing Level (First Floor)

The first floor of the Terminal is the primary processing area for passengers, and is shown on **Exhibit 2-5**. This level includes airline ticket counters, passenger queuing areas, restrooms, and retail/concession facilities. A large central public lobby serves as the primary gateway to the Connector that leads to the Central Concourse. This lobby area contains airline ticket counters and offices for Southwest Airlines, retail/concessions, and the Transportation Security Administration (TSA) screening area. The north façade of the Ticketing Level provides curbside access for the Airport roadway system and curbside passenger check-in services. The nonpublic areas on this level include HAS administrative offices and mechanical and electrical rooms on the east and west ends of the building. Southwest Airlines' check-in counters and offices are located just south of the HOU management offices on the west side.

Ticketing functional spaces and ticket offices for other airlines serving HOU are located on the east side of the Terminal. TSA screening and queuing areas are located in the center core area and, to maximize the length of security screening stations in the central oval space, four full-body screening stations are situated diagonally. Three carry-on baggage/check-in stations are paired with one full body scanner and an employee body scanner.

2.3.2.3 Mezzanine Level (Second Floor)

The Mezzanine Level of the Terminal is highlighted by a clear glass façade that provides natural light, a high ceiling, and an open feel to the floors below. This level contains Southwest Airlines' ticketing offices, which can be accessed from the ticketing area below, and mechanical, communications, and electrical rooms, as depicted on **Exhibit 2-6**. Airport Operations personnel can access a catwalk system on the Mezzanine Level that connects to mechanical and electrical areas above and below. A separate public use section on the Mezzanine Level, referred to as the Cloud Room, overlooks the central lobby. It can be accessed by a stairwell in the central lobby, but is closed.

2.3.2.4 East Baggage Transfer Facility

A secondary outbound baggage handling facility located on the east side of the Terminal was constructed to relieve stress on the primary outbound baggage processing area, which is dominated by Southwest Airlines. Used by other airlines, this facility allows the TSA to screen outbound bags from the eastern ticket counters in the Terminal.

2.3.3 CONNECTOR

The Connector joins the Terminal with the Central Concourse. The Connector Upper Level (first floor) features an open and naturally lit space, and provides a wide central space for passenger circulation and two moving walkways. A passenger information kiosk is provided where the Connector meets the Central Concourse.

At the Apron Level (ground floor), the Connector covers unenclosed nonpublic space dedicated to airline activities. Baggage handling system (BHS) transport belts are located overhead, which deliver checked bags from the Terminal to the Central Concourse baggage makeup area.

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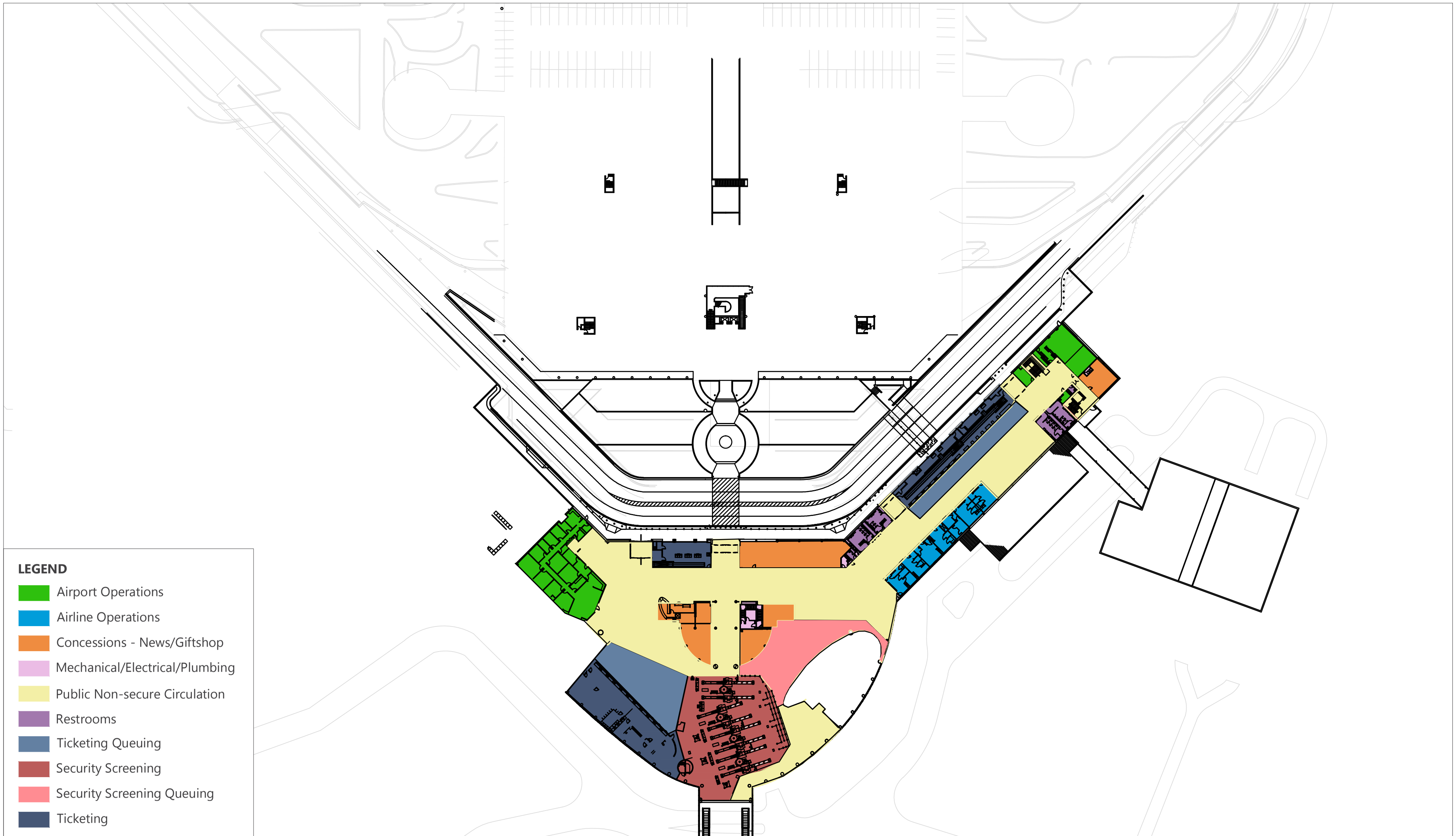

SOURCES: William P. Hobby Airport, Airport Layout Plan, 2004; Houston Airport System, Hobby Planimetrics, 2012; Ricondo & Associates, Inc., October 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 2-5

Terminal Layout
Ticketing Level/First Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\HOU_TERMINAL_ALL_20130808 - Standard (09182013)\HOU_TERMINAL_ALL_20130808.dwg_Layout: 02-5_Ticketing_Dec 26, 2014, 11:21am

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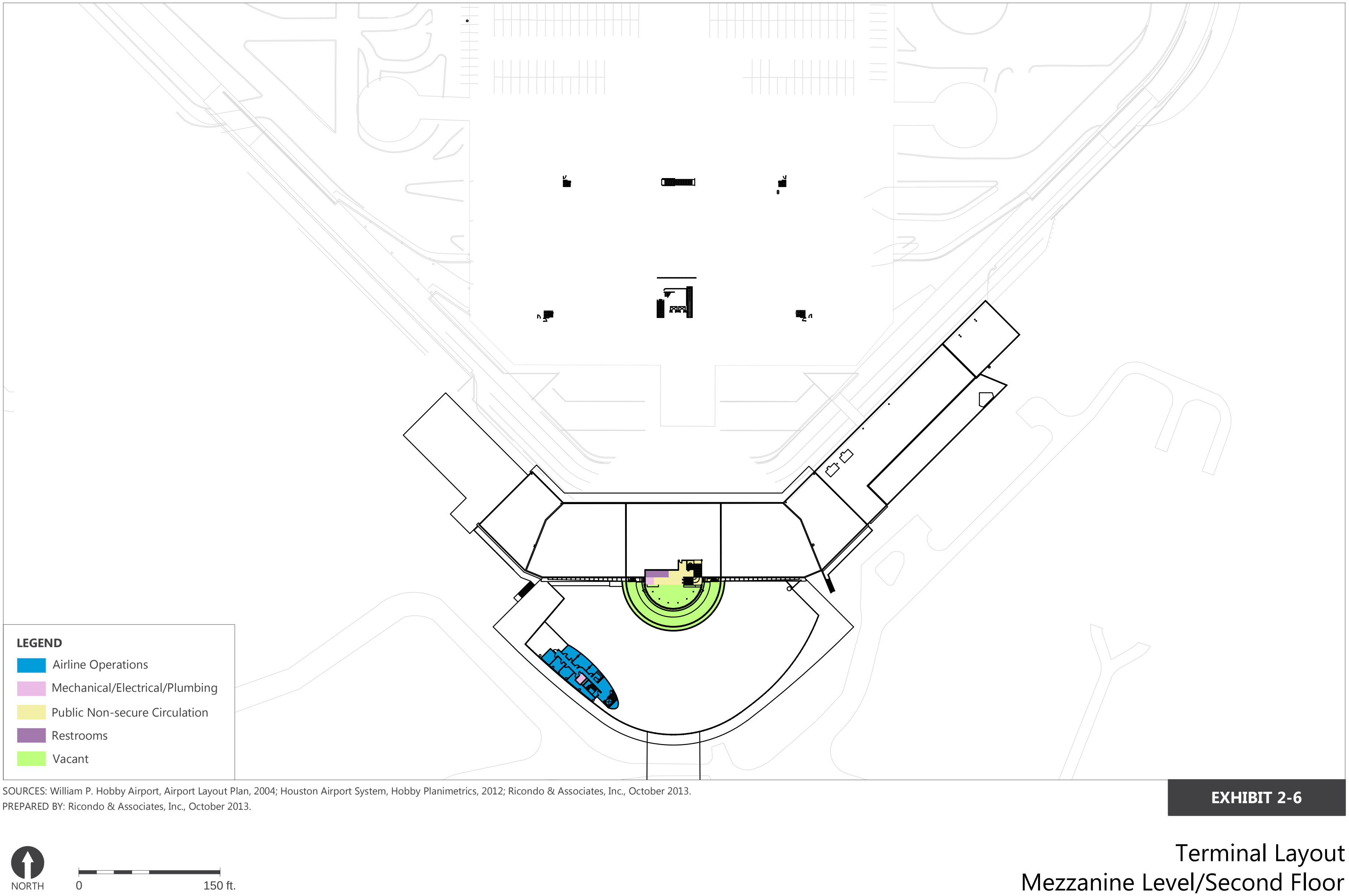

SOURCES: William P. Hobby Airport, Airport Layout Plan, 2004; Houston Airport System, Hobby Planimetrics, 2012; Ricondo & Associates, Inc., October 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 2-6

Terminal Layout
Mezzanine Level/Second Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\HOU_TERMINAL_ALL_20130808 - Standard (09182013)\HOU_TERMINAL_ALL_20130808.dwg_Layout: 02-6_Mezzanine_Dec 26, 2014, 11:24am

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2.3.4 CENTRAL CONCOURSE

The Central Concourse also has three levels: the Apron Level (ground floor), the Upper Level (first floor), and the Mezzanine Level (second floor). The functions on each level are described below.

2.3.5 APRON LEVEL (GROUND FLOOR)

Exhibit 2-7 provides an overview of the layout of the Central Concourse Apron Level. The Apron Level accommodates the airline operations functional areas and is almost completely restricted to Airport, tenant, and airline employees and other authorized personnel. These restricted areas include airline operations offices, mechanical and electrical rooms, stairwells, elevators, airport and concessionaire storage spaces, maintenance rooms, HAS offices, and an employee lounge.

The central area of the Apron Level was expanded to accommodate TSA baggage screening and makeup. Near the end of the east wing, the once unenclosed area is now enclosed and used for airline support operations and offices. In the west wing, a new public area was constructed by HAS to house facilities for the United Service Organizations (USO) and the Airport chapel. It is the only public area on the Apron Level of the Central Concourse, and can only be accessed via a nearby elevator and stairwell from the level above. The remaining space in the west wing is predominantly airline operations and nonpublic areas.

2.3.5.1 Upper Level (First Floor)

Exhibit 2-8 provides an overview of the layout of the Central Concourse Upper Level. This level is the main passenger arrival and departure point. It provides concessions/retail spaces, holdroom areas, gate access, gate check-in counters, information counters, and public restrooms. The central concessions area has a redesigned open concept, displaying an eclectic mix of food and beverage spaces. This area now includes a large common area where passengers can sit, eat, and relax. The newly improved open design also allowed an expansion of the holding areas at the ends of the Central Concourse east and west wings. With no differentiating line between holding areas and central passenger circulation, additional seating is available in the central area, thereby increasing seating capacity. Nonpublic areas on this level include janitorial closets and other Airport maintenance facilities, as well as private offices and support facilities for tenant airlines.

2.3.5.2 Mezzanine Level (Second Floor)

Exhibit 2-9 provides an overview of the layout of the Central Concourse Mezzanine Level. This level accommodates nonpublic spaces, as well as some airline operational functions. Offices, meeting rooms, mechanical, and restroom facilities occupy the central area, while the winged areas consist of heating, ventilation, and air conditioning (HVAC) systems along the length of the concourse.

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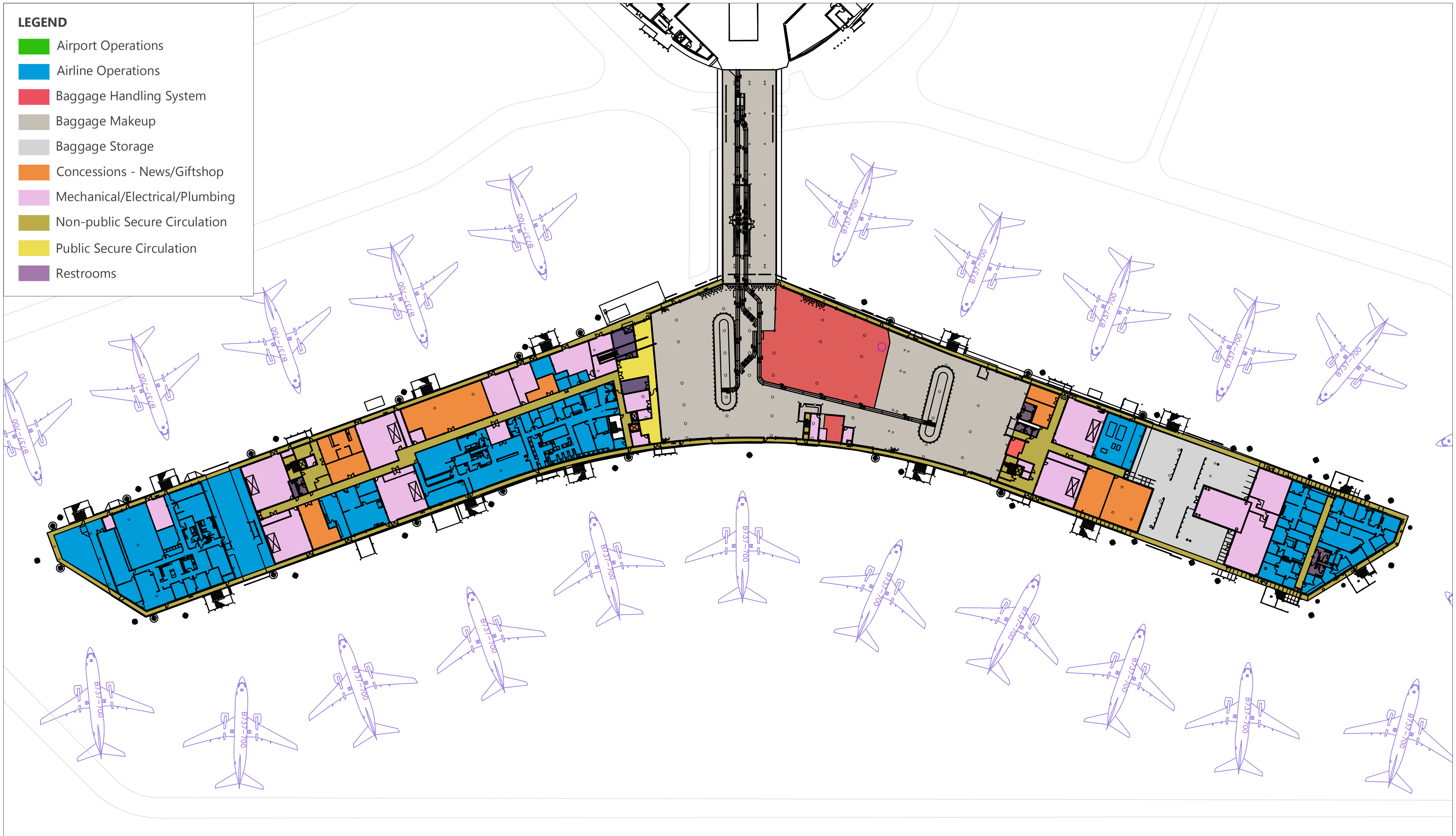

SOURCES: William P. Hobby Airport, Airport Layout Plan, 2004; Houston Airport System, Hobby Planimetrics, 2012; Ricondo & Associates, Inc., October 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 2-7

Connector and Central Concourse Layout
Apron Level/Ground Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\HOU_TERMINAL_ALL_20130808 - Standard (09182013)\HOU_TERMINAL_ALL_20130808.dwg_Layout: 02-7_Apron Level_Dec 26, 2014, 11:25am

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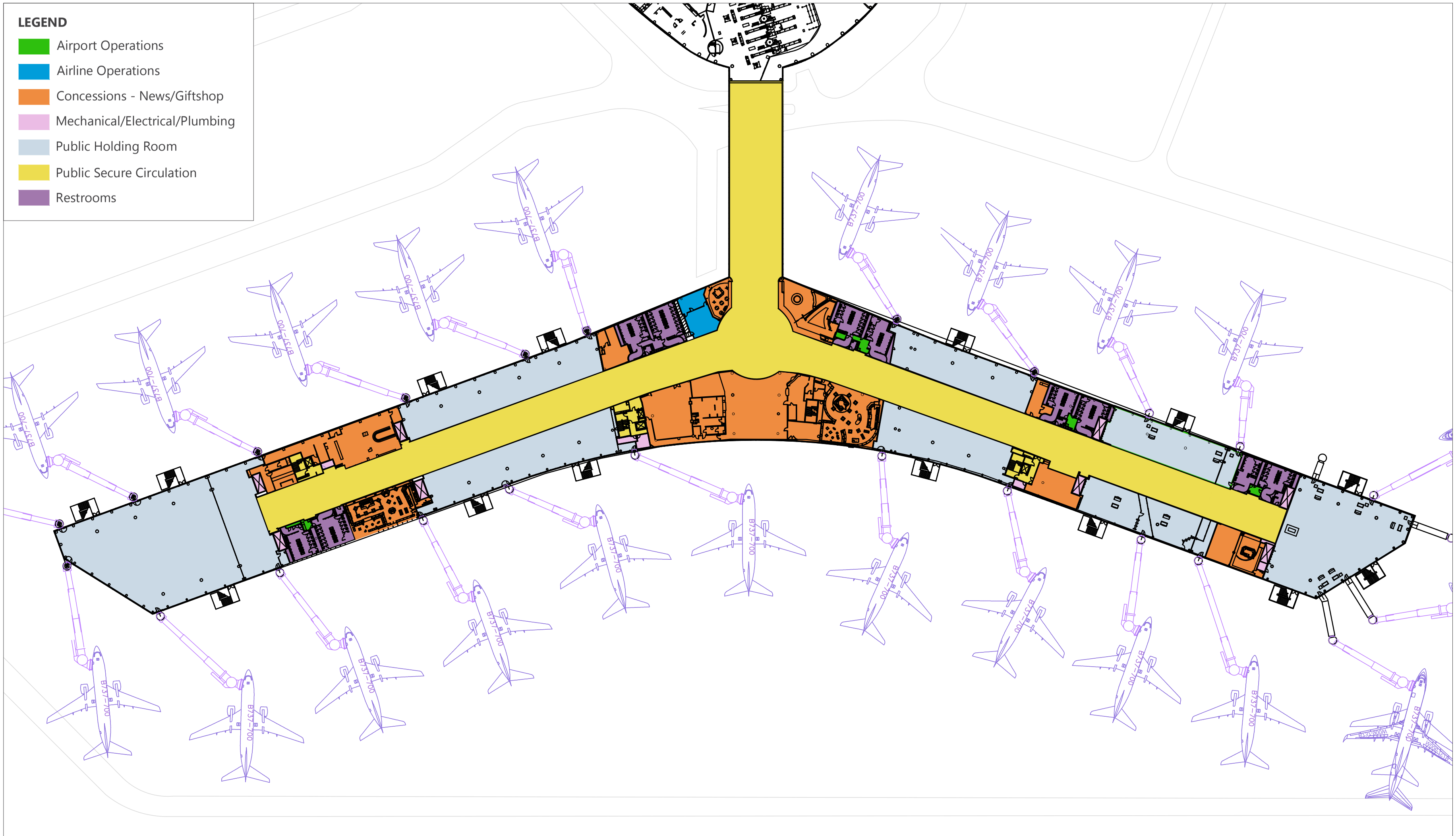

SOURCES: William P. Hobby Airport, Airport Layout Plan, 2004; Houston Airport System, Hobby Planimetrics, 2012; Ricondo & Associates, Inc., October 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 2-8

Connector and Central Concourse Layout
Upper Level/First Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\HOU_TERMINAL_ALL_20130808 - Standard (09182013)\HOU_TERMINAL_ALL_20130808.dwg_Layout: 02-8_Upper_Level_Dec 26, 2014, 11:26am

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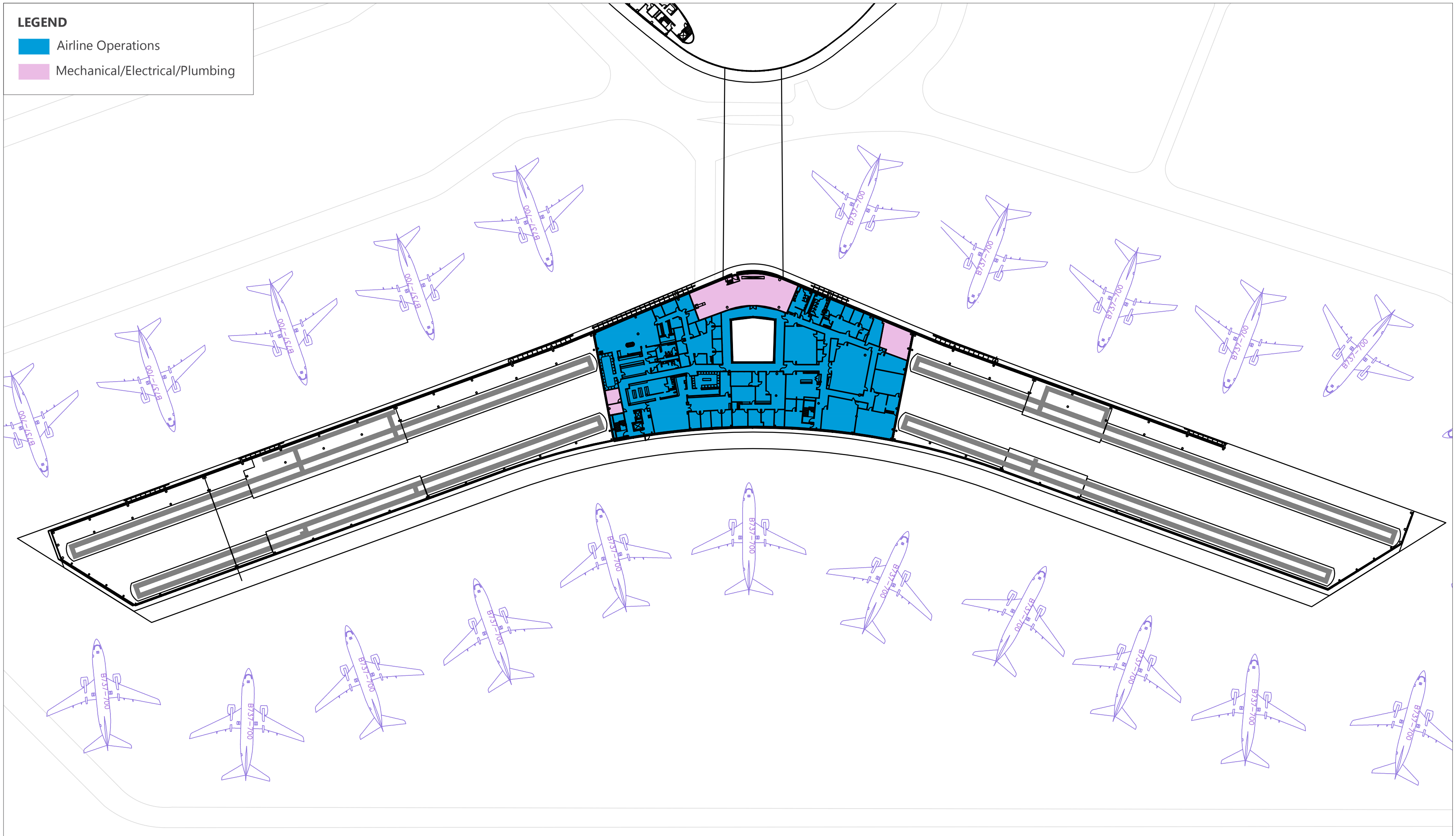

SOURCES: William P. Hobby Airport, Airport Layout Plan, 2004; Houston Airport System, Hobby Planimetrics, 2012; Ricondo & Associates, Inc., October 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 2-9

Connector and Central Concourse Layout
Mezzanine Level/Second Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\HOU_TERMINAL_ALL_20130808 - Standard (09182013)\HOU_TERMINAL_ALL_20130808.dwg_Layout: 02-9_Mezzanine_Dec 26, 2014, 11:27am

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2.4 Airport Access and Parking Facilities

2.4.1 REGIONAL AIRPORT ACCESS

Primary access to the HOU area is provided by three major freeways and a toll road, as depicted on **Exhibit 2-10** and listed in **Table 2-8**. These include Interstate 45 (I-45), Interstate 610 (I-610), Beltway 8 (Sam Houston Toll Road), and State Highway 288. From these major roads, the Airport is accessed via arterial and local roadways. **Table 2-9** lists details regarding the regional roadways used to access the Airport from one of the three major freeways and the toll road.

Table 2-8: Regional Roadways Serving William P. Hobby Airport

MAJOR FREEWAY/TOLL ROAD	REGIONAL ROADWAYS USED FOR AIRPORT ACCESS
Interstate 45	Broadway Street, Monroe Road, Airport Boulevard, Almeda Genoa Road
Interstate 610	State Highway 35 (Telephone Road), Interstate 45
Beltway 8 (Sam Houston Toll Road)	State Highway 35 (Telephone Road), Monroe Road, Interstate 45
State Highway 288	Airport Boulevard

SOURCE: UrbanCore Collaborative, Inc., May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., May 2012.

2.4.2 TERMINAL ACCESS ROADWAYS AND PUBLIC TRANSPORTATION

The local roadways that surround the Airport are Airport Boulevard on the north, Monroe Road on the east, Braniff Avenue on the south, and Telephone Road on the west. The characteristics of these roadways are summarized in Table 2-9. The primary access to the terminal building is provided by Broadway Street and Airport Boulevard. Beyond these primary roads, a series of local roads provide access to FBO, maintenance, cargo, and other Airport facilities.

Table 2-10 lists major and minor intersections around the Airport based on the major thoroughfare classification, traffic volume, and direct accessibility to the Airport.

The City of Houston maintains a traffic count database, which is updated periodically. **Table 2-11** lists the directional average daily traffic (ADT) counts (i.e., number of vehicles) on Airport access roadways. These traffic counts will serve as a baseline for calculating the roadway levels of service for future demand at the Airport.

Exhibit 2-11 identifies major, primary, and secondary arterial access roads connecting the Airport. The exhibit also identifies major and minor intersections around the Airport boundary. These arterial roadways and intersections play a major role in providing efficient access to the Airport; improving these key infrastructure components directly correlates with efficient movement of passengers to and from the Airport.

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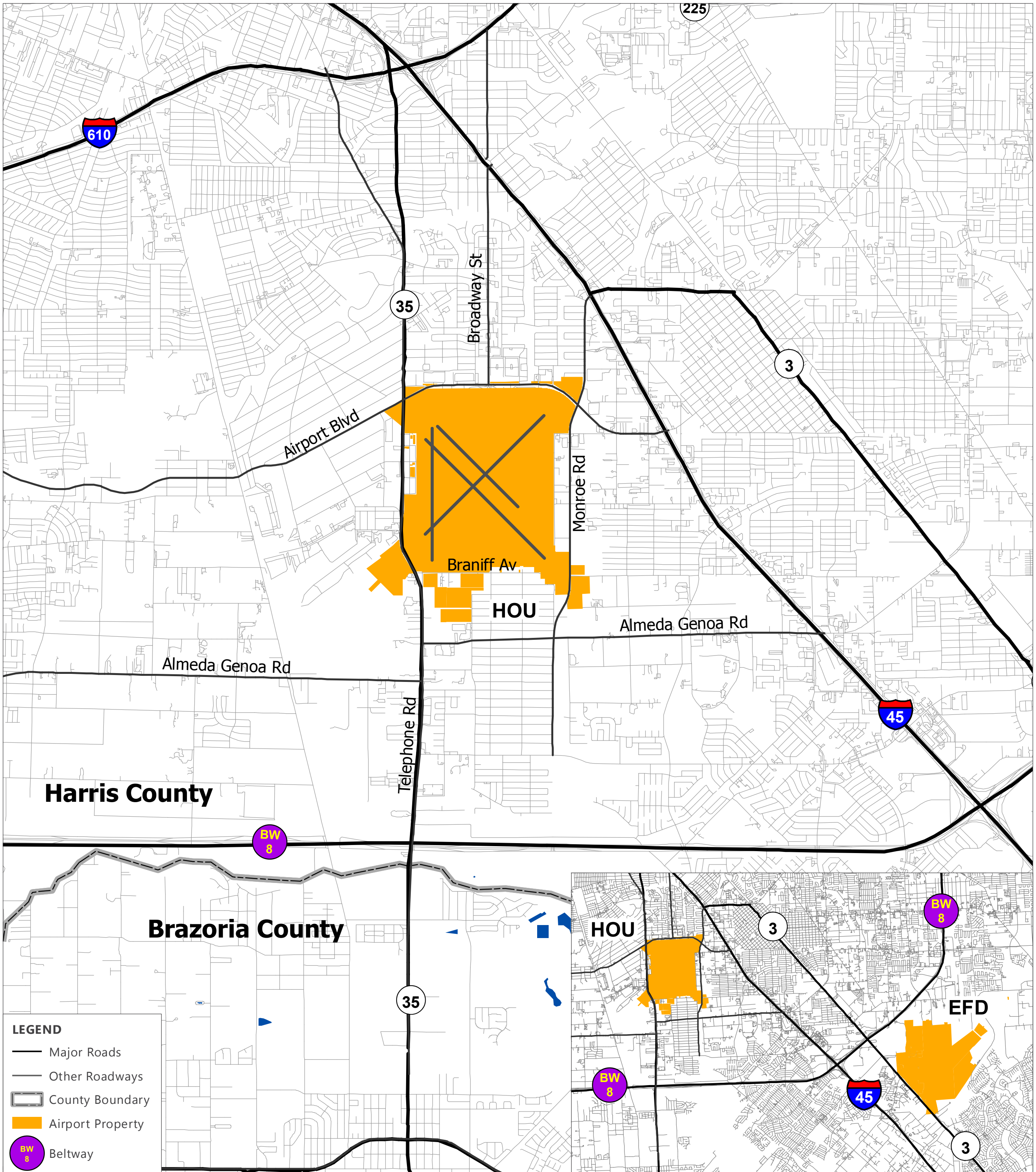

SOURCES: Houston-Galveston Area Council, Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-10

NORTH 0 6,500 Feet

Regional Accessibility

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Table 2-9: Characteristics of Regional Roadways Serving William P. Hobby Airport

ROADWAY	CLASSIFICATION	NUMBER OF LANES	MEDIAN	SIGNAL LOCATIONS	COMMENTS
Airport Boulevard	Major Arterial	6	Yes	Mykawa Road Telephone Road Broadway Street Ruthby Street Monroe Road Hansen Road Mosley Road Interstate 45	Has left turn lanes
Broadway Street	Major Arterial	4	Yes	Airport Boulevard Morley Street Rockhill Street Bellfort Street Santa Elena Drive Dixie Drive Interstate 45	Provides direct access to the Airport
Monroe Road	Major Arterial	4	Yes	Interstate 45 Airport Boulevard Almeda Genoa Road	Has left turn lanes
Telephone Road (State Highway 35)	Major Arterial	6	Yes	Airport Boulevard Brisbane Street Almeda Genoa Road	Has left turn lanes
Braniff Avenue	Local Street	2	No	No	Form south boundary of the Airport and intersects Telephone Road
Brisbane Street	Local Street	2	No	No	Intersects Telephone Road
Convair Street	Local Street	2	No	No	Intersects Telephone Road
Dover Street	Local Street	2	No	No	Intersects Airport Boulevard
Freeland Street	Local Street	2	No	No	Intersects Monroe Road
Hinman Street	Local Street	2	No	No	Intersects Airport Boulevard
Larson Avenue	Local Street	2	No	No	Access to West Ramp and intersects with Telephone Road
Larson Street	Local Street	2	No	No	Access to the East Ramp
Lockheed Street	Local Street	2	No	No	Access to West Ramp and located inside the Airport boundary
Major Street	Local Street	2	No	No	Intersects with Telephone Road
Meldrum Lane	Local Street	2	No	No	Intersects with Monroe Road
Nelms Street	Local Street	2	No	No	Access to West Ramp and intersects with Telephone Road
Nelms Street	Local Street	2	No	No	Access to East Ramp
Newhaus Street	Local Street	2	No	No	Intersects with Telephone Road
Panair Street	Local Street	2	No	No	Intersects with Monroe Road
Paul B. Koonce Street	Local Street	2	No	No	Access to old Airport Traffic Control Tower
Randolph Street	Local Street	2	No	No	Intersects with Braniff Avenue on the south side of the Airport
Ruthby Street	Local Street	2	No	No	Intersects with Airport Boulevard
Scranton Street	Local Street	2	No	No	Intersects with Monroe Road
Travelair Street	Local Street	2	No	No	Access to West Ramp, accommodates on street parking
W Monroe Road	Local Street	2	No	No	East side Airport boundary
Wingtip Drive	Local Street	2	No	No	Intersects Braniff Avenue on the south side of the Airport

SOURCE: UrbanCore Collaborative, Inc., August 2012.
PREPARED BY: UrbanCore Collaborative, Inc., September 2012.

Table 2-10: Major/Minor Intersections around William P. Hobby Airport

ROADWAY	TYPE OF INTERSECTION	SIGNALS
Airport Boulevard and Telephone Road	Major	Yes
Airport Boulevard and Broadway Street	Major	Yes
Airport Boulevard and Monroe Road	Major	Yes
Telephone Road and Almeda Genoa Road	Minor	Yes
Monroe Road and Almeda Genoa Road	Minor	Yes

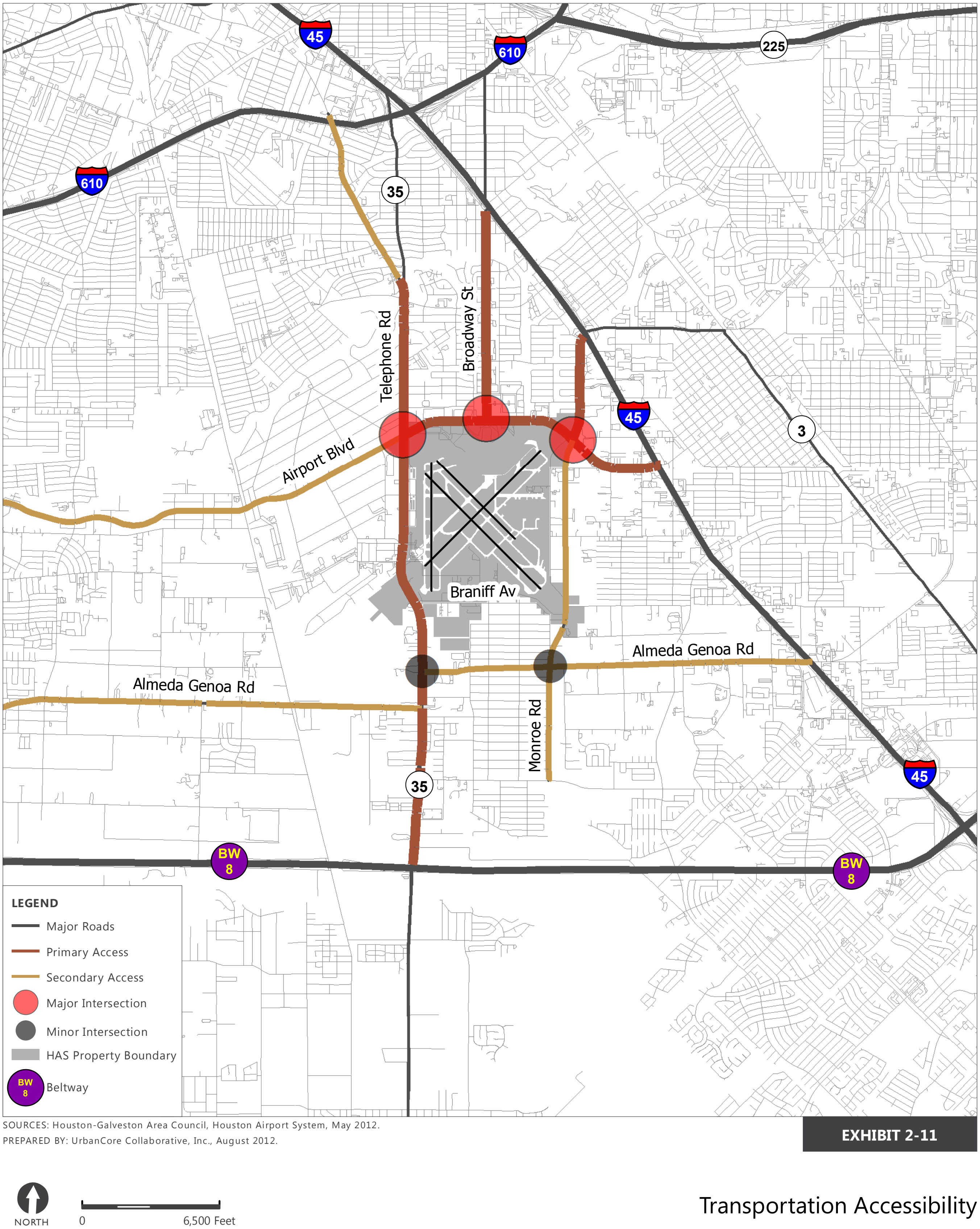
SOURCE: UrbanCore Collaborative, Inc., August 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

Table 2-11: Traffic Counts by Location

ROADWAY	DIRECTION	COUNT (ADT)	TOTAL ADT	LOCATION
Airport Boulevard	Eastbound Westbound	5,751 6,270	12,021	Between Mykawa Road and Telephone Road
Airport Boulevard	Eastbound Westbound	14,095 13,008	27,103	Between Telephone Road and Broadway Street
Airport Boulevard	Eastbound Westbound	17,428 16,667	34,095	Between Broadway Street and Monroe Road
Airport Boulevard	Eastbound Westbound	13,667 12,340	26,007	Between Monroe Road and Interstate 45
Telephone Road	Northbound Southbound	15,289 15,620	30,909	Between Bellfort Street and Airport Boulevard
Telephone Road	Northbound Southbound	13,686 12,473	26,159	Between Airport Boulevard and Almeda Genoa Road
Broadway Street	Northbound Southbound	12,789 13,159	25,948	Between Bellfort Street and Airport Boulevard
Broadway Street	Northbound Southbound	11,833 11,900	23,733	Between Bellfort Street and Interstate 45
Monroe Road	Northbound Southbound	NA NA	17,973	Between Airport Boulevard and Almeda Genoa Road
Almeda Genoa Road	Eastbound Westbound	10,554 9,884	20,438	Between Interstate 45 and Clearwood Drive
Almeda Genoa Road	Eastbound Westbound	8,686 9,131	17,817	Between Clearwood Drive and Monroe Road
Almeda Genoa Road	Eastbound Westbound	8,068 8,039	16,107	Between Monroe Road and Telephone Road
Almeda Genoa Road	Eastbound Westbound	4,969 5,189	10,158	Between Telephone Road and Mykawa Road

NOTES:
ADT - AVERAGE DAILY TRAFFIC

SOURCE: City of Houston Geographic Information System (GIMS), August 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.



SOURCES: Houston-Galveston Area Council, Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-11

Transportation Accessibility

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Table 2-12 provides a list of roadway corridor ADT counts. As shown, southbound Telephone Road, from I-610 to Airport Boulevard, is the busiest roadway section connecting the Airport, followed by Broadway Street and Airport Boulevard.

Table 2-12: Corridor Significance

CORRIDOR	DIRECTION	FROM	TO	TRAFFIC COUNT
Telephone Road	Southbound	Interstate 610	Airport Boulevard	15,620
Telephone Road	Northbound	Beltway 8	Airport Boulevard	13,686
Broadway Street	Southbound	Bellfort Street	Airport Boulevard	13,159
Airport Boulevard	Westbound	Monroe Road	Airport Access Road	13,008
Airport Boulevard	Westbound	Interstate 45	Monroe Road	12,340
Monroe Road	Southbound	Interstate 45	Airport Boulevard	11,663

SOURCE: City of Houston Geographic Information System (GIMS), May 2012.
PREPARED BY: UrbanCore Collaborative, Inc. May 2012.

Exhibit 2-12 shows traffic counts on various roadway sections approaching the Airport, as reported by the City of Houston's GIMS database in October 2013. The traffic counts show that Telephone Road, Airport Boulevard, and Broadway Street are the primary arterial roadways providing access to the terminal building and creating a gateway to the Airport.

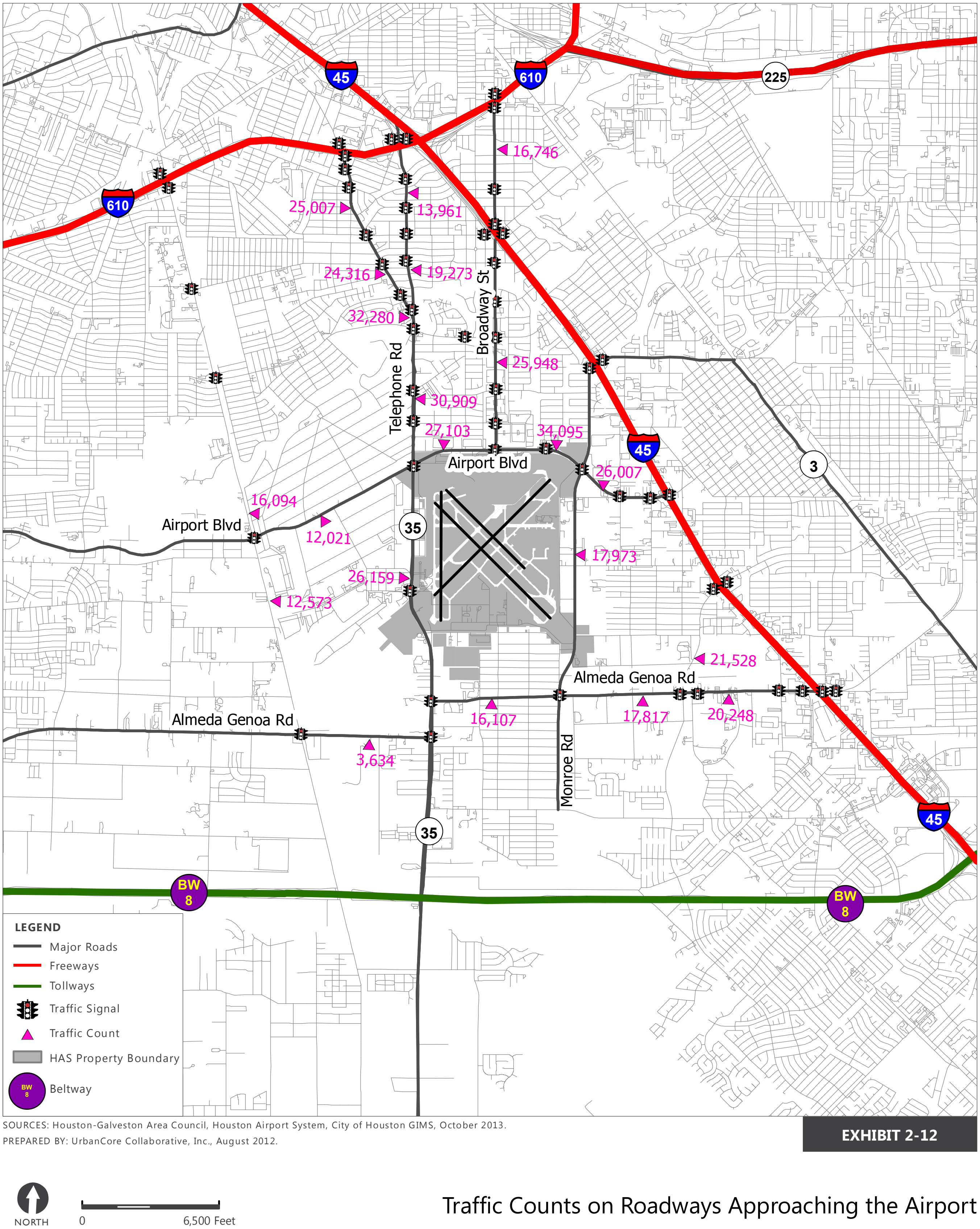
2.4.2.1 Landside Observations

On behalf of HAS, CH2M HILL conducted a Peak Week Survey at the Airport between July 31 and August 7, 2011. The survey report provided a broad analysis of passenger travel characteristics, terminal processes, and landside attributes during the busiest passenger traffic period of the year. Elements of the survey report that pertain to landside operations are summarized below:

- The terminal loop system is a network of one-way traffic roads with the Hobby Airport Loop serving as the main thoroughfare. During the Peak Week Survey, it was documented that the terminal loop system at HOU accommodated approximately 130,000 vehicles accessing the Arrivals and Departures Curbsides, as well as the Airport parking garage and Ecopark - Lot 1 during a typical peak week, with more than 19,400 vehicles accommodated on peak weekdays. It was observed that 90 percent of vehicles using the Hobby Airport Loop system entered and exited from Airport Boulevard and Broadway Street, respectively. The traffic count data were obtained at 19 locations along the terminal loop roadway system over a 48-hour period during peak weekdays, which includes the Hobby Airport Loop and all public ramps and routes leading to the terminal's Arrivals Curbside (lower level), Departures Curbside (upper level), and the Terminal Parking Garage, as well as Ecopark - Lot 1.
- The Peak Week Survey showed that traffic along the terminal loop roadway system was busiest between 11:00 a.m. and 6:00 p.m., with over 900 vehicles accessing the Departures and Arrivals Curbsides each hour.

Key findings from the terminal loop roadway system traffic counts during the Peak Week Survey were as follows:

- A total of 5,177 recirculating vehicle passes were recorded. Of those passes, 24 percent originated from the Arrivals Curbside recirculation ramp, 33 percent originated from the Departures Curbside recirculation ramp, and the remaining 43 percent originated from the recirculation access road.
- Of the 14,267 vehicles entering the terminal loop roadway system on peak weekdays, 42 percent, or 6,017 vehicles per day, originated from the westbound Airport Boulevard entrance ramp. The eastbound Airport Boulevard entrance accommodated 3,388 vehicles per weekday and the southbound Broadway Street entrance ramp accommodated 3,399 vehicles per weekday, collectively accounting for 48 percent of all entering traffic. Approximately 1,463 vehicles entered from South Rental Car Road, accounting for 10 percent of entering traffic.
- Privately owned vehicles commonly circulate several times while waiting to pick up passengers or because stopping space along the curbsides is unavailable, while shuttles typically recirculate once, first destined for the Departures Curbside and then the Arrivals Curbside. Renovation of the Terminal Parking Garage resulted in a net loss of 714 spaces, which may contribute to increased recirculation.
- Approximately 67 percent of all vehicles that enter the terminal loop roadway system (9,424 vehicles) access the Arrivals Curbside, compared with 40 percent that access the Departures Curbside (5,715 vehicles). Approximately 18 percent of all vehicles entering the Airport (92,560 vehicles) access either the parking garage or Ecopark - Lot 1.
- The peak times for traffic along the Departures Curbside are 4:40 a.m., with 405 vehicles per hour recorded, and 5:10 p.m., with 430 vehicles per hour recorded.
- The peak times for traffic along the Arrivals Curbside are 11:20 a.m., with 636 vehicles per hour recorded, and 2:10 p.m., with 669 vehicles per hour recorded. The morning peak hour is part of a larger overall afternoon peak period.
- Approximately 89 percent of traffic exits the Hobby Airport Loop at the intersection of Airport Boulevard and Broadway Street, and the remaining 11 percent exits onto South Rental Car Road.
- Traffic volumes fluctuate moderately from hour to hour, and fluctuate an average of 5 percent every 30 minutes.
- Based on the peak week traffic count survey findings, 14,267 vehicles entered the terminal loop system during the observed peak weekday. Of these, approximately 42 percent entered the system from the westbound Airport Boulevard entrance ramp, approximately 24 percent entered from the eastbound Airport Boulevard entrance ramp, approximately 24 percent entered from the southbound Broadway Street entrance ramp, and the remaining approximately 10 percent entered from the South Rental Car Road entrance ramp. Approximately 89 percent of departing traffic exits the Hobby Airport Loop at the intersection of Airport Boulevard and Broadway Street, and approximately 11 percent departs onto South Rental Car Road.



SOURCES: Houston-Galveston Area Council, Houston Airport System, City of Houston GIMS, October 2013.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-12

Traffic Counts on Roadways Approaching the Airport

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2.4.2.2 Public Transportation

Three primary bus routes provide access to the Airport Transit Center, which is located on the east side of the Arrivals Curbside area. These bus routes are:

- Route 50: Hollister Branch to the Airport
- Route 73: Uptown Galleria to the Airport
- Route 88: Downtown to Southeast Memorial Hospital through the Airport

2.4.3 TERMINAL CURBSIDES

Based on information in the Peak Week Survey report, approximately 15,207 vehicles pass either the Departures Curbside or one of the five Arrivals Curbsides during a typical peak weekday. Curbside vehicles are classified into one of nine categories: (1) private vehicles (including sedans, minivans, sport utility vehicles, and motorcycles), (2) taxicabs, (3) limousines and town cars, (4) hotel shuttles, (5) parking shuttles, (6) rental car shuttles, (7) shared-ride shuttles, (8) commercial buses, and (9) Metropolitan Transit Authority of Harris County (METRO) buses.

The Departures Curbside (upper level) is designated for dropping off departing passengers; additionally, airline skycap podiums are available for baggage check-in. The Arrivals Curbside (lower level) is designated for arriving passenger pickup; it is divided into three zones and three crosswalk locations. **Exhibit 2-13** shows the space allocations for the Departures and Arrivals Curbsides. **Tables 2-13** and **2-14** list the lane configurations and space allocations for the Departures and Arrivals Curbsides, respectively.

As shown in Table 2-13, the Departures Curbside area (upper level) consists of three lanes separated by a median. Lane 1 accommodates all private vehicles with a quick passenger dropoff system. Lane 1 is separated from Lanes 2 and 3 by a median. Lane 2 is also available for passenger dropoff; however, it is more desirably used as a pass-through lane. Lane 3 accommodates all other vehicles, including private vehicles and various types of courtesy shuttles.

Table 2-14 describes the lane configuration of the Arrivals Curbside areas (lower level). The lane configuration of the Arrivals Curbside area is constantly adjusted by the ground transportation staff at the Airport in an effort to provide efficient access to the departures area and the ability to exit the Airport without causing delays. Lane 1 accommodates rental car courtesy shuttles. Lanes 2 and 3 accommodate taxicabs; however, Lane 2 is more desirable for use as a pass-through lane. Lanes 4 and 5 integrate all private vehicles for passenger pickup. Lane 6 is open only to METRO buses (Routes 50, 73, and 88) and Lanes 7 and 8 are reserved for large motor coaches (50+ seats). Lanes 9 and 10 are used for shared-ride shuttle parking. Lane 11 accommodates 19 parking spaces for limousines, which are parked at an angle to maximize the limited space available to accommodate various modes of transportation.

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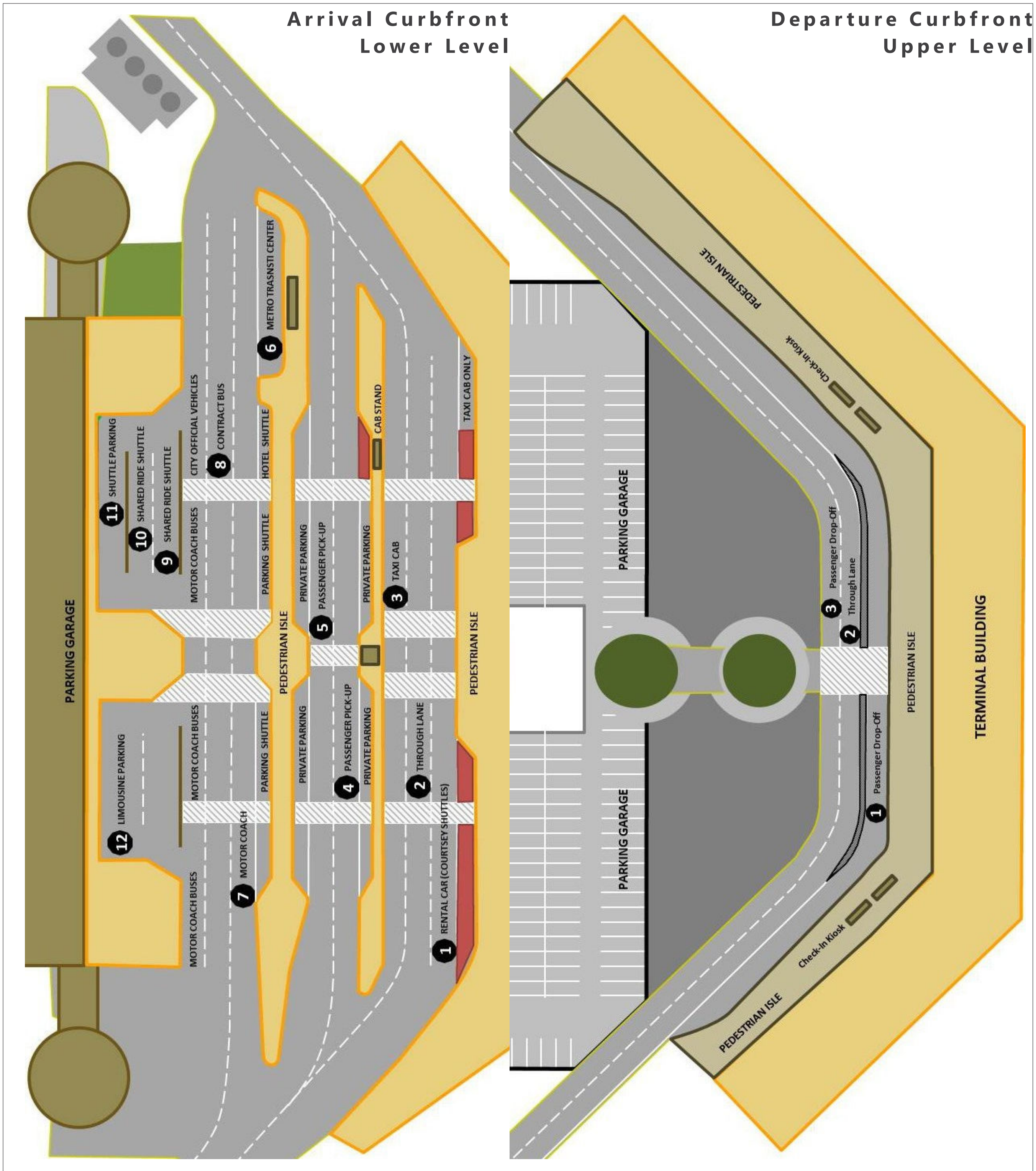

SOURCE: Houston Airport System, August 2012
PREPARED BY: UrbanCore Collaborative, Inc., August 2012

EXHIBIT 2-13

Terminal Curbfronts

NORTH 0 0.4 Miles

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Table 2-13: Departures Curbside Allocation

LANE	PURPOSE	NOTES
1	Private vehicles	Passenger dropoff
2	Private vehicles	Commonly used for pass-through lane
3	All vehicles	Including private vehicles and all types of courtesy shuttles

SOURCE: Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., May 2012.

Table 2-14: Arrivals Curbside Allocation

LANE	PURPOSE	NOTES
1	Rental cars	Courtesy shuttles only
2	Taxicabs	Commonly used for pass-through lane
3	Taxicabs	Taxicab stand nearby in the pedestrian aisle
4 and 5	Passenger pickup	Private vehicles only
6	METRO buses	Airport Transit Center (Routes 50, 73, 88)
7 and 8	Motor coaches	Contract buses (50+ seats)
9 and 10	Shared-ride shuttles	Courtesy shuttles (i.e., SuperShuttle, ground shuttle)
11	Limousines	Angled parking with pass-through lane in the middle

SOURCE: Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., May 2012.

2.4.3.1 Curbside Dwelling Times by Vehicle Classification

Curbside functionality greatly affects vehicular traffic congestion in airport environments. This CH2M HILL Peak Week Survey was used to determine the level of service of existing curbside operations at the Airport; it can also be used as a tool during traffic management decision-making. The findings of the survey encourage future curbside capacity planning, and could serve as a basis for future traffic projections. The findings of the Peak Week Survey are discussed in detail in this section.

The survey of curbside dwelling times was conducted on Wednesday, August 4, 2011. The Departures Curbside was observed between the hours of 8:00 a.m. and 11:00 a.m., and between 3:00 p.m. and 5:40 p.m. The Arrivals Curbside was observed between the hours of 11:00 a.m. and 2:00 p.m., and between 6:00 p.m. and 7:40 p.m. The peak hours were noted as:

- Departures Curbside Peak Hours: 9:30 a.m. to 10:30 a.m. and 3:10 p.m. to 4:10 p.m.
- Arrivals Curbside Peak Hours: 11:20 a.m. to 12:20 a.m. and 6:40 p.m. to 7:40 p.m.

Departures and Arrivals Curbside dwelling vehicle observations are provided in **Table 2-15** and **Table 2-16**, respectively. Vehicles classifications vary more significantly at the Departures Curbside in comparison to the Arrivals Curbside, which accommodates 60 percent more traffic and additional lanes designated for the specific vehicles types. Additionally, parking shuttles, rental car shuttles, and buses provide scheduled service more frequently at the Arrivals Curbsides. Variations between peak hours and the respective observation periods were minimal, indicating a good level of consistency. As reported in the Peak Week Survey, on an average peak weekday, 9,492 vehicles accessed the Arrivals Curbside and 5,715 vehicles accessed the Departures Curbside. Privately owned vehicles were the most common vehicles observed dwelling along the terminal curbsides during the Peak Week Survey. Privately owned vehicles accounted for 45 percent of Arrivals Curbside dwelling vehicles and 60 percent of Departures Curbside dwelling vehicles. The second most common vehicle mode—accounting for 39 percent of dwelling vehicles at the Arrivals Curbside and 22 percent of dwelling vehicles at the Departures Curbside—was courtesy shuttles. On average, across observation periods, taxicabs accounted for 11 percent and 10 percent of dwelling vehicles along the Arrivals Curbside and Departures Curbside, respectively. Limousines and town cars accounted for 5 percent of dwelling vehicles at the Departures Curbside and 1 percent of dwelling vehicles at the Arrivals Curbside. Other vehicles that accounted for 1 percent or less of the total dwelling vehicles at both curbsides include shared-ride shuttles, METRO buses, and Airport service vehicles.

2.4.3.2 Curbside Vehicle Dwell Times

With limited curbside frontage, the amount of time that vehicles dwell along the terminal curbsides to either pick up or drop off passengers causes congestion. According to the Peak Week Survey, during peak hours, approximately 440 vehicles per hour accessed the Departures Curbside and 670 vehicles per hour accessed the Arrivals Curbside. During the Peak Week Survey, dwell times were collected from randomly selected samples during two peak observation periods for the departures and Arrivals Curbsides during the following observation periods:

Departures Curbside	Wednesday, August 4, 2011 – 8:00 a.m. to 11:00 a.m. and 3:00 p.m. to 5:40 p.m.
	Peak Hour: 9:30 a.m. to 10:30 a.m. and 3:10 p.m. to 4:10 p.m.
Arrivals Curbside	Wednesday, August 4, 2011 – 11:00 p.m. to 2:00 p.m. and 6:00 p.m. to 9:00 p.m.
	Peak Hour: 11:20 a.m. to 12:20 a.m. and 6:40 p.m. to 7:40 p.m.

The findings from the Peak Week Survey regarding vehicle dwell times are provided in **Table 2-17**. Vehicle dwell times depend largely on the vehicle type and curbside location. Across all curbsides, 70 percent of vehicles dwelled for 3 minutes or less, while 10 percent of vehicles dwelled in excess of 7 minutes. Shared-ride shuttles are among the longest dwelling vehicle types, but represented a very small portion of dwelling traffic. Fifty percent of taxicabs dwelled in excess of 5 minutes. Parking shuttles and private vehicles dwelled for shorter than average periods overall, with approximately 82 percent of private vehicles and 76 percent of parking shuttles dwelling for less than 2 minutes. METRO buses were the fastest vehicle type with dwelling times less than 1 minute.

Table 2-15: Departures Curbside Dwelling Vehicle Observations Summary (Peak Period)

	WEST CURBSIDE		MAIN ENTRANCE CURB		EAST SIDE CURB		TOTAL DEPARTURES CURB	
VEHICLE CLASSIFICATION	**SAMPLES[1]**	**PERCENT**	**SAMPLES[1]**	**PERCENT**	**SAMPLE[1]**	**PERCENT**	**SAMPLES[1]**	**PERCENT**
Private Vehicle	392	89.7%	73	21.8%	118	57.8%	583	59.4%
Taxicab	16	3.7%	50	14.9%	34	16.7%	100	10.2%
Limousine	20	4.6%	21	6.3%	10	4.9%	51	5.2%
Hotel Shuttle	--	--%	9	2.7%	7	3.4%	16	1.6%
Parking Shuttle	2	0.5%	140	41.8%	7	3.4%	149	15.2%
Rental Car Shuttle	2	0.5%	36	10.7%	13	6.4%	51	5.2%
Commercial Bus	4	0.9%	5	1.5%	1	0.5%	16	1.6%
METRO Bus	--	--%	--	--%	--	--%	--	--%
Service Vehicles	1	0.2%	1	0.3%	14	6.9%	16	1.6%
Departures Curbside Total	**437**	**100.0%**	**335**	**100.0%**	**204**	**100.0%**	**982**	**100.0%**

NOTES:

Columns may not add to totals shown because of rounding.

1/ "Samples" indicates number of randomly selected dwelling vehicles during the peak hour observed.

SOURCE: CH2M HILL, *2011 William P Hobby Airport Peak Week Survey*, 2011.
PREPARED BY: UrbanCore Collaborative, Inc., May 2012.

Table 2-16: Arrivals Curbside Dwelling Vehicle Observations Summary (Peak Period)

	LANES 1 AND 3		LANE 4		LANE 5		LANES 6, 7, AND 8		TOTAL ARRIVALS CURB	
VEHICLE CLASSIFICATION	SAMPLES[1]	PERCENT	SAMPLES[1]	PERCENT	SAMPLE[1]	PERCENT	SAMPLES[1]	PERCENT	SAMPLES[1]	PERCENT
Private Vehicle	457	100.0%	--	--%	5	2.4%	3	1.2%	465	44.9%
Taxicab	--	--%	118	100.0%	--	--%	--	--%	118	11.4%
Limousine	--	--%	--	--%	--	--%	13	5.1%	13	1.3%
Hotel Shuttle	--	--%	--	--%	--	--%	28	11.0%	28	2.7%
Parking Shuttle	--	--%	--	--%	38	18.5%	179	70.2%	217	20.9%
Rental Car Shuttle	--	--%	--	--%	162	79.0%	--	--%	162	15.6%
Commercial Bus	--	--%	--	--%	--	--%	16	6.3%	16	1.5%
METRO Bus	--	--%	--	--%	--	--%	15	5.9%	15	1.4%
Service Vehicle	--	--%	--	--%	--	--%	1	0.4%	2	0.2%
Arrivals Curbside Total	**457**	**100.0%**	**118**	**100.0%**	**205**	**99.9%**	**255**	**100.0%**	**1,036**	**99.9%**

NOTES:

Columns may not add to totals shown because of rounding.

1/ "Samples" indicates numbers of randomly selected dwelling vehicles observed during the peak hour.

SOURCE: CH2M HILL, *2011 William P Hobby Airport Peak Week Survey*, 2011.
PREPARED BY: UrbanCore Collaborative, Inc., May 2012.

Table 2-17: Curbside Vehicle Dwell Time Summary

	EARLY PEAK HOUR		EARLY PEAK PERIOD		LATE PEAK HOUR		LATE PEAK PERIOD	
LOCATION	**AVERAGE**	**ST. DEV.**	**AVERAGE**	**ST. DEV.**	**AVERAGE**	**ST. DEV.**	**AVERAGE**	**ST. DEV.**
Departures Curbside								
West Entrance	02:06	02:20	01:59	02:19	01:21	01:06	01:22	01:17
Main Entrance	01:23	01:05	01:24	01:11	01:14	01:06	01:21	02:24
East Entrance	02:53	04:15	02:18	03:15	01:57	01:41	02:23	02:01
Arrivals Curbside								
Inner – Private	01:04	01:05	01:01	01:08	01:01	01:13	01:09	01:15
Center – Taxicab/Shuttle	16:59	09:02	15.27	10:17	24.10	09:19	18:16	10:01
Center – Shuttles	02:13	01:42	02:44	02:05	06:44	07:00	05:03	05:06
Outer - Buses	02:11	01:57	02.04	01:51	04:23	06:52	07:35	15:17

NOTES:

Time is expressed in minutes and seconds.

ST. DEV. - Standard Deviation

SOURCE: CH2M HILL, *2011 William P Hobby Airport Peak Week Survey*, 2011.
PREPARED BY: UrbanCore Collaborative, Inc., May 2012.

It was observed during the Peak Week Survey that 90 percent of dwell times at the Departures Curbside were shorter than 3.5 minutes, compared with 13.0 minutes at the Arrivals Curbside. The difference in the dwell time distribution results, in part, from passengers typically exiting vehicles immediately after stopping at the Departures Curbside. Picking up passengers, which primarily occurs at the Arrivals Curbside, tends to be more time consuming, as motorists often have to wait for passengers to exit the terminal, or locate them along the curbside.

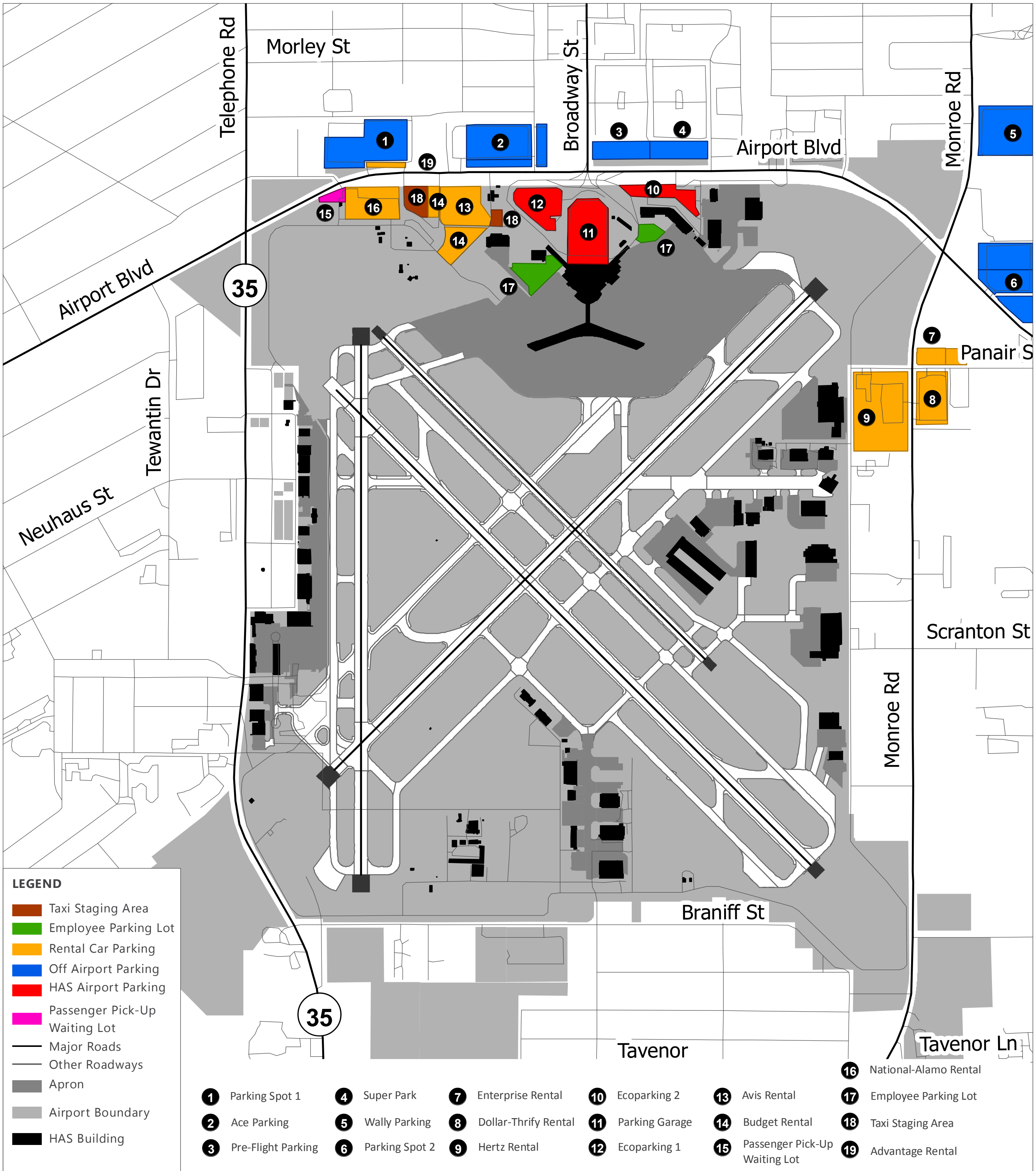
However, this finding did not apply across all vehicle types. For instance, taxicab dwell times, at an average of 2.2 minutes, were similar to the 2.0-minute dwell time average for private vehicles at the Departures Curbside, as the vehicles drop off passengers and immediately move on. At the Arrivals Curbside, however, taxicabs have to wait for arriving passengers, increasing their dwell time average to 20.5 minutes; average dwell times for private vehicles at the Arrivals Curbside is 1.2 minute.

Key findings for curbside vehicle dwell times from the Peak Week Survey are as follows:

- Seventy percent of vehicles along all curbs dwell for 3 minutes or less. Ten percent of vehicles along all curbs dwell in excess of 7 minutes. Shared-ride shuttles and taxicabs dwell for the longest periods, whereas private vehicles and parking shuttles dwell for shorter periods than the overall average. METRO buses have the shortest dwell times.
- Vehicles dwell for significantly shorter periods at the Departures Curbside than at the Arrivals Curbside. Dwell times are shorter along the Departures Curbside partly because shuttles and taxicabs are not allowed to dwell for long periods, unlike at their assigned stopping positions at the Arrivals Curbside. Conversely, dwell times for private vehicles average 2.1 minutes at the Departures Curbside, and 1.0 minute at the Arrivals Curbside.
- The average 1.0 minute dwell time for private vehicles at the Arrivals Curbside reflects congested conditions; two lanes accommodate 669 vehicles during the peak hour. As a result, motorists stopping to pick up passengers impede the flow of traffic.

2.4.4 PARKING FACILITIES

Unless otherwise noted, the parking facilities data provided in this section are current as of May 2012, when this inventory was prepared. Parking facilities are provided by HAS and private companies at both on and off-Airport locations. **Exhibit 2-14** depicts the parking facilities on and near the Airport, which are also summarized in **Table 2-18**. These facilities consist of on-Airport passenger parking areas, off-Airport (private) passenger parking areas, taxicab staging areas, rental cars parking lots, employee parking lots, and a cell phone waiting lot.



SOURCE: Houston-Galveston Area Council, Houston Airport System, May 2012
PREPARED BY: UrbanCore Collaborative, Inc., August 2012

EXHIBIT 2-14

Existing Parking Facilities

NORTH

0 0.4 Miles

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Table 2-18: Parking Inventory (2012)

TYPE	NUMBER OF LOCATIONS	ON OR OFF AIRPORT
Cell Phone Waiting Lot	1	ON
HAS Airport Parking (Includes Ecopark - Lot 1, Ecopark - Lot 2, Terminal Parking Garage)	3	ON
Off-Airport Parking Facilities	6	OFF
Rental Car Parking Lots	7	ON and OFF
Employee Parking Lots	2	ON

SOURCE: Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., May 2012.

2.4.4.1 On-Airport Public Parking Facilities

The three on-Airport public parking areas are owned by HAS and managed by a third party contractor, New South Parking. These areas include two economy surface lots, Ecopark - Lots 1 and 2, and one permanent parking structure, referred to as the Terminal Parking Garage. HAS provides a total of 4,360 vehicle parking spaces in the parking garage, Ecopark - Lot 1, and Ecopark - Lot 2. Ecopark - Lots 1 and 2 are at-grade parking lots that are typically used for short-trip durations. For long-term parking needs, most passengers use the parking garage, a four-level parking structure encircled in the Hobby Airport Loop. A brief description of each facility follows:

- The parking garage is a permanent multilevel structure directly connected to the Terminal. It provides 3,438 parking spaces and is typically fully occupied, as observed during the Peak Week Survey[7] conducted in September 2011. Passengers access the Terminal from the garage through elevators, a garage stairwell, and a direct access connector in the departures area of the Terminal. This garage has an average occupancy rate between 80 percent and 98 percent.
- Ecopark - Lot 1 is the middle-priced on-Airport public parking option. The 566-space surface lot is located to the west of the Terminal Parking Garage, within walking distance to the Terminal. It was formerly known as a “Parking Cents Lot”. Passengers access the Terminal from the parking lot through the garage stairwell and elevators or by crossing the Arrivals Curbside lanes. Ecopark - Lot 1 has an average occupancy rate between 93 percent and 100 percent. Ecopark – Lot 1 was closed in March 2014 to enable construction of the new West Parking Garage.
- Ecopark - Lot 2 opened in December 2010 and is the least expensive on-Airport public parking option. The 356-space surface lot is located northeast of the parking garage. Ecopark - Lot 2 is farthest from the Terminal, although still within walking distance. This lot has an average occupancy rate between 65 percent and 85 percent. The lower occupancy of this parking lot is mainly due to its indirect

[7] CH2M HILL, *2011 William P Hobby Airport Peak Week Survey*, 2011.

accessibility and lower visibility from Airport Boulevard. Passengers access the Terminal from this parking lot via a marked walkway alongside a driveway into a parking area for Airport employees. Ecopark – Lot 2 was expanded south of the Southwest Airlines Cargo and Provisioning facility in November 2013 to a total of 1,022 spaces.

Table 2-19 summarizes the number of parking spaces in each facility as of May 2012.

Table 2-19: On-Airport Parking Capacity (2012)

HAS PARKING FACILITY	NUMBER OF SPACES
Terminal Parking Garage	3,438
Ecopark - Lot 1	566
Ecopark - Lot 2	356
Total on-Airport Parking	**4,360**

SOURCE: Houston Airport System, accessed November 21, 2011.
PREPARED BY: UrbanCore Collaborative, Inc., May 2012.

Table 2-20 illustrates the parking occupancy for 2011 at these on-Airport parking facilities.

Table 2-20: On-Airport Parking Occupancy (2011)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Terminal Parking Garage (3,438)	2,586 (75%)	1,303 (64%)	2,251 (79%)	2,186 (77%)	2,248 (79%)	2,357 (83%)	2,394 (84%)	2,365 (83%)	2,473 (87%)	2,558 (90%)	2,329 (82%)	2,067 (76%)
Ecopark - Lot 1 (566)	506 (89%)	528 (93%)	527 (93%)	543 (96%)	536 (95%)	551 (97%)	551 (97%)	516 (91%)	531 (94%)	546 (96%)	518 (92%)	542 (96%)
Ecopark - Lot 2 (356)	115 (32%)	135 (38%)	223 (63%)	252 (71%)	274 (77%)	259 (73%)	302 (85%)	256 (72%)	272 (77%)	302 (85%)	237 (67%)	263 (74%)
Total Average % Occupancy (4,360)	3,207 (74%)	1,966 (62%)	3,001 (80%)	2,981 (79%)	3,058 (81%)	3,167 (84%)	3,247 (86%)	3,137 (84%)	3,276 (87%)	3,406 (91%)	3,084 (82%)	2,872 (79%)

NOTE: On-Airport parking includes the Terminal Parking Garage, Ecopark - Lot 1, and Ecopark - Lot 2.

SOURCES: Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., May 2012.

Parking Characteristics Based on Peak Week Survey:

The Peak Week Survey also included parking characteristics at the Airport. Based on the survey findings, passengers exhibited a preference for parking for at least one day in the Ecopark lots rather than the Terminal Parking Garage. Almost 25 percent of all vehicles parked at an on-Airport facility remained parked for at least one day. The garage has been found to accommodate more long-term parking (from 3 to 7 days) than the Ecopark lots. From the survey findings, 12 percent of parked vehicles remained parked for 3 to 7 days, while fewer than 3 percent of parked vehicles remained parked for more than 7 days.

The Terminal Parking Garage accommodates most of the shorter-duration parking at HOU, most likely because of its close proximity to the Terminal. Over half of all vehicles parking at HOU remain parked for less than 2 hours. Approximately 38 percent of vehicles park for an hour or less.

2.4.4.2 Off-Airport Parking Facilities

In addition to the on-Airport parking facilities, travelers can also park at one of the five nearby off-Airport parking lots and garages, which provide direct competition to the on-Airport parking products. However, because of the inconvenience of added travel time to take a shuttle between the off-Airport parking facilities and the Terminal, most travelers prefer the convenience of parking on Airport. As a result, the on-Airport parking facilities fill to capacity quickly and contribute to congestion as motorists navigate through multiple facilities in search of spaces.

The off-Airport parking facilities provide a total of 5,701 spaces, accounting for 86 percent of long-term parking capacity; the remaining 14 percent is provided on-Airport in Ecopark products. The locations of off-Airport parking lots are shown on Exhibit 2-14; **Table 2-21** lists the characteristics of each off-Airport parking facility at the time of this inventory, in November 2011.

Table 2-21: Off-Airport Parking Facilities (2011)

FACILITY	NUMBER OF SPACES	COVERED OR UNCOVERED	DISTANCE TO/FROM TERMINAL (MILES)
Ace Park & Ride	323	Covered	0.4
	709	Uncovered	
The Parking Spot 2	1,470	Uncovered	0.8
PreFlight Airport Parking	1,226	Covered	0.8
	307	Uncovered	
Super Park	287	Covered	0.6
The Parking Spot 1	706	Covered	2.0
	673	Uncovered	
Total	**5,701**		

SOURCES: Official websites for the various parking facilities, accessed November 21, 2011.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

2.4.4.3 Employee Parking Lot

At the time of this inventory, in May 2012, employee parking was provided in two access-controlled lots on Airport property within walking distance of the Terminal, as shown on Exhibit 2-14. There were 625 employee parking spaces. Employee parking was consolidated in the Fall of 2013 on the east side of the terminal to enable construction of the new Hobby International Terminal. The new lot consists of 786 spaces.

2.4.4.4 Taxicab and Limousine Staging Areas

Two taxicab staging areas and one limousine staging area are located on-Airport. The main taxicab staging area is accessible from Airport Boulevard and is located on the lot between Fuel Farm Road and Rental Car Road. This lot is equipped with a drivers' lounge area. The other taxicab staging area is south of the Houston Fire Department Station 36 on South Rental Car Road. This staging area is generally for taxicabs that are ready to pick up passengers. Taxicabs are directed to pick up passengers from the taxicab lane located on the arrivals level. Exhibit 2-14 illustrates the location of these staging areas.

The limousine staging area is located at the north side of the Arrivals Curbside, in area 12, as shown on Exhibit 2-13. Approximately 19 angled limousine parking spaces are available.

2.4.4.5 Cell Phone Waiting Lot

The cell phone waiting lot is located in the northwest corner of the Airport, just west of the taxicab staging area. Approximately 50 spaces are available for friends and family wanting to park free of charge until the party they are picking up is ready. HAS also plans to open a second cell phone waiting lot at the intersection of Hinman Street and Airport Boulevard in the northeast corner of the Airport.

2.5 Rental Car Facilities

Unless otherwise noted, the rental car facilities data provided in this section are current as of May 2012, when this inventory was prepared. Additional data describing rental car operational characteristics is also provided in Section 4, Facility Requirements.

Rental car companies representing nine brands operate on- and off-Airport property in exclusive-use leaseholds. The location of each company is depicted on Exhibit 2-14: Avis Rent A Car System, Budget Rent A Car System, National Car Rental, and Alamo Rent A Car operate south of Airport Boulevard between Telephone Road and Broadway Street. Advantage Rent A Car operates north of Airport Boulevard between Telephone Road and Broadway Street, and Enterprise Rent-A-Car, Dollar Rent A Car, Thrifty Car Rental, and Hertz Rent a Car operate at the intersection of Monroe Road and Panair Street. Each company's leasehold includes space for ready and return vehicle parking, vehicle storage, employee parking, fueling facilities, wash bays, light maintenance bays, administrative area, and vehicle stacking (dirty vehicles) and staging (clean vehicles) spaces. All companies transport their customers between the Terminal and their facilities via shuttle bus. Several rental car companies share facilities and shuttle buses with parking providers. **Table 2-22** depicts the acreage leased by each rental car company.

Table 2-22: Rental Car Areas (2012)

RENTAL CAR COMPANY	AREA (ACRES)
Alamo/National	5.01
Advantage	0.86
Avis	4.35
Budget	2.38
Dollar/Thrifty	5.38
Enterprise	2.41
Hertz	12.36
Total	32.75

SOURCE: Jacobs Engineering, Geographic Information System Database for HOU, May 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

Table 2-23 shows the number of customer and employee parking spaces available for each rental car company. Rental car parking spaces are reported as "ready" (passengers picking up vehicles) and "return" (passengers returning vehicles). It should be noted that the number of parking spaces are not directly correlated with the market shares of the rental car companies operating at the Airport.

Table 2-23: Rental Car Parking Space Availability (2012)

RENTAL CAR COMPANY	READY PARKING SPACES	RETURN PARKING SPACES	EMPLOYEE PARKING SPACES	TOTAL PARKING SPACES
Hertz	227	60	40	327
Avis/Budget	321	80	75	476
Enterprise	45	20	15	80
National/Alamo	45	20	15	80
Dollar	88	45	25	158
Thrifty	62	45	12	119
Total	788	270	182	1,240

NOTE: Advantage Rent A Car information not available.
SOURCE: Ricondo & Associates, Inc. rental car companies questionnaire, May 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

2.6 Airport Tenant Facilities

Airport tenants are typically businesses and government agencies that provide a full range of services to meet the operational and safety needs of scheduled commercial, private, and general aviation. **Exhibit 2-15** displays the locations of the various Airport tenant facilities. **Table 2-24** lists the Airport tenants and support facilities, street addresses, business activities, types of facilities, and other general information.

2.6.1 FIXED BASE OPERATORS

Unless otherwise noted, the FBO data provided in this section were current as of January 2013, when this inventory was prepared. FBOs provide general aviation services, such as passenger services, aircraft rentals, aircraft charters, aircraft parking, hangar rentals, refueling, flight instruction, and light maintenance at public-use airports. Five FBOs lease facilities at the Airport: Atlantic Aviation Corporation, Signature Flight Support, Jet Aviation, Wilson Air Center, and Million Air, as described below.

2.6.1.1 Atlantic Aviation Corporation

Atlantic Aviation is located east of the Terminal and west of Runway 4-22, in the northeast quadrant of the Airport. Atlantic Aviation's facilities are accessed from the airfield via Taxiway A and from the landside via Airport Boulevard. The FBO houses 47 based aircraft. Atlantic Aviation has three Jet A fuel storage tanks and one aviation gasoline (avgas) storage tank, which are refueled through trucking operations from the Southwest Airlines Fuel Farm. Atlantic Aviation also provides third party aircraft maintenance.

2.6.1.2 Signature Flight Support

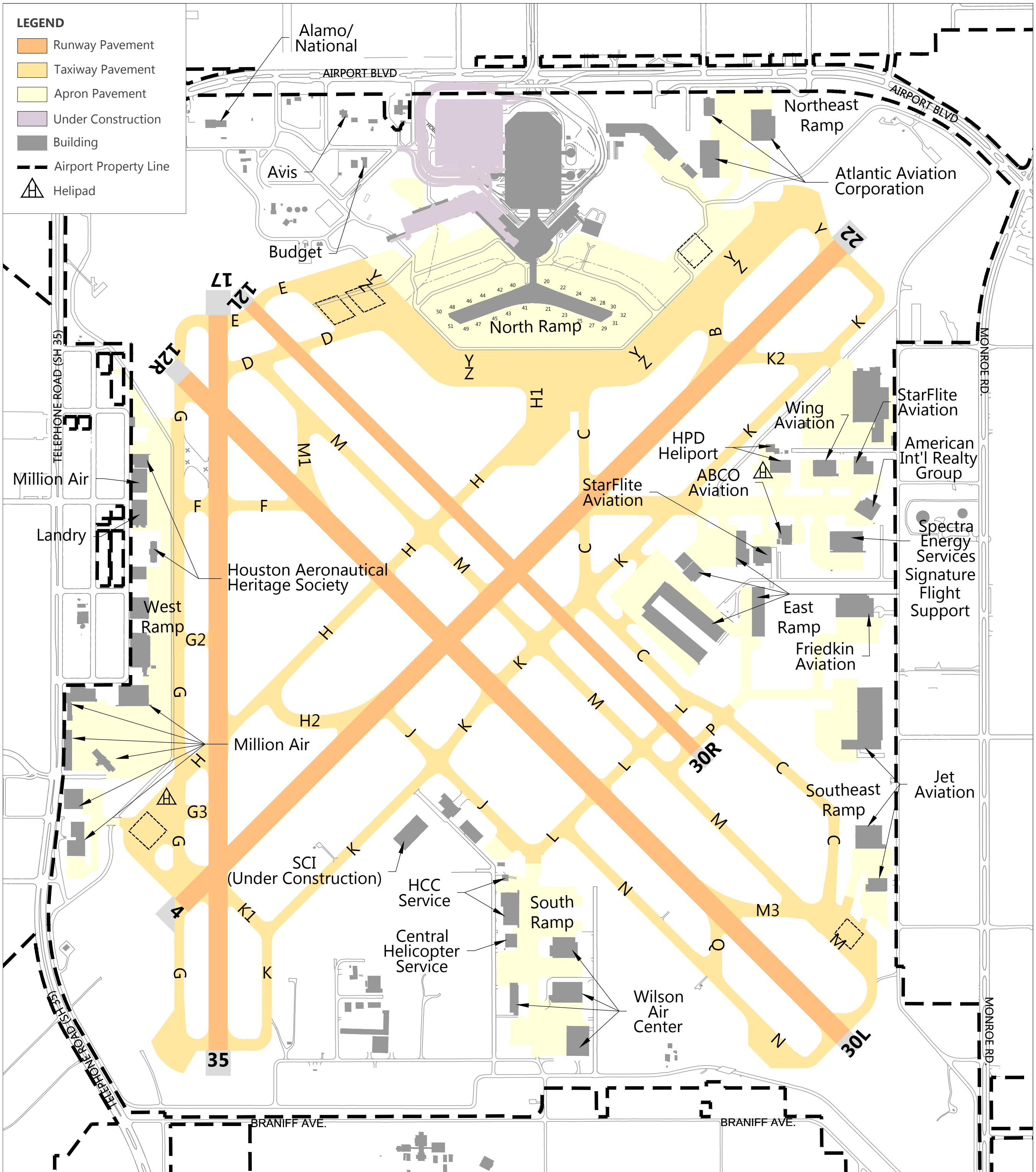
Signature Flight Support is located in the eastern quadrant of the airfield. It houses approximately 55 based aircraft and a Hawker Aircraft Maintenance facility. This FBO has multiple buildings with ramp areas that have access to Taxiways K, R, C, and P. Roadway access is via Nelms Street. Signature Flight Support has three Jet A fuel storage tanks (total of 60,000 gallons) and two avgas storage tanks (total of 30,000 gallons). Aircraft fuel is delivered to the FBO through trucking operations by a third party. Hawker Beechcraft Services is located on the Signature Flight Support leasehold and specializes in Hawker and Beechcraft airframe and power plant services, avionics installations, modifications and repair, quick-turnaround maintenance, and custom interior modifications. Signature Flight Support also offers third party maintenance on-Airport.

Signature Flight Support is planning an expansion of its facilities at the Airport in the near future.

2.6.1.3 Jet Aviation

Jet Aviation is located in the east quadrant of the airfield. Its newer hangar is accessible via Taxiway PP; its two original hangars are served by Taxiways M and C. All three hangars can be accessed from the landside via West Monroe Road. Jet Aviation houses 53 based aircraft. Jet Aviation offers routine aircraft servicing and major inspections and repairs, and specializes in Falcon, Citation, King Air, Hawker, Learjet, and Beechjet aircraft.

Jet Aviation is planning an expansion of its hangar facilities at the Airport in the near future.



SOURCES: Ricondo & Associates, Inc., William P. Hobby Airport, Draft Airport Layout Plan, 2014; Houston Airport System, Hobby Planimetrics, 2012; Jacobs Engineering, HOU GIS Data, May 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2013.

EXHIBIT 2-15

HCC - Houston Casualty Company
HPD - Houston Police Department
SCI - Service Corporation International

NORTH
0 1200 ft.

Airport Tenant Facilities (2013)

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Table 2-24 (1 of 3): Airport Tenants

COMPANY	ADDRESS	PRIMARY LINE OF BUSINESS	BUILDING USE	NEW BUILDING NUMBER	OLD BUILDING NUMBER	LEASEHOLD (SQ FT)	DIRECT ACCESS TO AIRFIELD?
ABCO Aviation	8421 Nelms Street	Corporate	Aircraft Storage	E-240A	ER-8	56,776	Yes
American International Realty Group	8484 West Monroe Road	Corporate	Aircraft Storage, Maintenance	E-340	ER-10	94,855	Yes
Atlantic Aviation Corporation	7930 Airport Boulevard	Fixed Base Operator	Aircraft Storage, Terminal	N-378, N-380, and N-382	NR-11, N-R12, and NR-13	399,726	Yes
Avis Rent A Car System	7714 Airport Boulevard	Automobile Rental	Office, Retail, Automobile Maintenance	N-333A, N-333B, N-335A, N-333B	None	189,365	No
Budget Rent A Car System	7712 Airport Boulevard	Automobile Rental	Office, Retail, Automobile Maintenance	N-332A, N-332B, N-332C	None	84,293	No
Central Helicopter Service	8913 Paul B. Koonce Street	Helicopter Operator	Aircraft Maintenance, Storage, Office	S-352, S-352A	SR-5	51,616	Yes
Southwest Airlines Cargo and Provisioning Facility	7800 and 7900 Airport Boulevard	Cargo/ Provisioning	Office, Storage	N-374A	NR-9	62,399	Yes
Federal Aviation Administration	8800 Paul B. Koonce Street	Office	Office	S-262	SR-2	2,203	No
Friedkin Aviation	8602 West Monroe Road	Corporate	Aircraft Storage, Offices	E-360A	None	377,012	Yes
Houston Aeronautical Heritage Society	Travelair Street	Aircraft Hangar	Aircraft Storage	W-370	WR-4	20,919	Yes
Houston Aeronautical Heritage Society	8325C Travelair Street	Museum	Museum Building	W-352	WR-9	98,406	No
Houston Casualty Company (HCC Service Company)	8909 Paul B. Koonce Street	Corporate	Aircraft Storage	S-350A, S-350B	None	101,799	Yes
Houston Police Department	8402 Larson Street	Government	Aircraft Storage	E-220A, E-230	ER-13, ER-14	134,901	Yes
Hudson Fuel Company	Fuel Farm Road	Fuel Facility	Fuel Pump, Electrical Vault	N-323A	None	1,360	Yes

Table 2-24 (2 of 3): Airport Tenants

COMPANY	ADDRESS	PRIMARY LINE OF BUSINESS	BUILDING USE	NEW BUILDING NUMBER	OLD BUILDING NUMBER	LEASEHOLD (SQ FT)	DIRECT ACCESS TO AIRFIELD?
Jet Aviation	8888 West Monroe Road	Fixed Base Operator	Aircraft Storage, Maintenance, Office	E-392	SER-1	94,853	Yes
Jet Aviation	8850 West Monroe Road	Fixed Base Operator	Aircraft Storage	E-390	SER-2	159,479	Yes
Jet Aviation	8620 West Monroe Road	Fixed Base Operator	Aircraft Storage	E-380	None	816,243	Yes
Million Air	8201 Travelair Street	Fuel Facility	Fuel Tanks	W-384	None	31,674	Yes
Million Air	8249 Travelair Street	Fixed Base Operator	Aircraft Storage	W-362	WR-5	67,969	Yes
Million Air	7542 Major Street	Fixed Base Operator	Aircraft Storage, Office	W-330A	WR-13	130,136	Yes
Million Air	8501 Telephone Road	Fixed Base Operator	Aircraft Storage, Office, Terminal	W-334, W-336, W-338, W-383	WR-14, WR-15, WR-16	251,759	Yes
Million Air	8501 Telephone Road	Fixed Base Operator	Aircraft Storage	None	None	316,813	Yes
Million Air	8703 Telephone Road	Fixed Base Operator	Aircraft Storage	W-322	WR-22	99,079	Yes
Million Air	8901 Telephone Road	Fixed Base Operator	Aircraft Maintenance, Storage	W-320A, W-320B	WR-23, WR-24	117,750	Yes
National Car Rental (Enterprise Holdings)	7600 Airport Boulevard	Automobile Rental	Office, Retail, Automobile Maintenance	N-325A	None	218,332	No
Southwest Airlines East Side Fuel Facility	8376 West Monroe Road	Fuel Facility	Fuel Tanks	E-393A, E-393B	ER-16, ER-17	NA	No
Signature Flight Support	8402 Nelms Street	Fixed Base Operator	Aircraft Storage, Maintenance, Office	E-160, E-170, E-260	ER-1, ER-2, ER-3	761,081	Yes
Signature Flight Support	8401A Nelms Street	Fixed Base Operator	Aircraft Storage	E250, E-260	ER-4, ER-5	142,737	Yes
Signature Flight Support	8401 Nelms Street	Fixed Base Operator	Aircraft Storage	E-254	ER-6	198,897	Yes

Table 2-24 (3 of 3): Airport Tenants

COMPANY	ADDRESS	PRIMARY LINE OF BUSINESS	BUILDING USE	NEW BUILDING NUMBER	OLD BUILDING NUMBER	LEASEHOLD (SQ FT)	DIRECT ACCESS TO AIRFIELD?
Southwest Airlines	8110 West Monroe Road	Maintenance	Maintenance	E-320, E-320C	ER-15	582,990	Yes
Southwest Airlines Fuel Farm	Fuel Farm Road	Fuel Facility	Fuel Tanks, Pump	N-320	NR-14	66,138	Yes
Spectra Energy Services	8502 West Monroe Road	Corporate	Aircraft Storage, Maintenance, Office	E-350	ER-9	259,491	Yes
StarFlite Aviation	8411 Nelms Street	Charter	Aircraft Storage	E-256	ER-7	83,032	Yes
StarFlite Aviation	8430 Larson Street	Charter	Aircraft Storage	E-330	ER-11	90,052	Yes
Summit Sea Food Supply	8251 Travelair Street	Corporate	Aircraft Storage	W-360	WR-6	93,419	Yes
United Airlines Maintenance Base	8323 Travelair Street	Maintenance	Aircraft Maintenance	W-350	WR-10	12,020	Yes
United Airlines Maintenance Base	8401 Travelair Street	Maintenance	Aircraft Maintenance	W-342	WR-11	24,466	Yes
United Airlines Maintenance Base	8451 Travelair Street	Maintenance	Aircraft Maintenance	W-340	WR-12	39,824	Yes
U.S. Customs and Border Protection Service	8800 Paul B. Koonce Street	Government	Office Building	S-262	SR-2	205	No
Wilson Air Center	8909 Paul B. Koonce Street	Fixed Base Operator	Apron, Vacant Space	None	None	53,929	Yes
Wilson Air Center	8919 Paul B. Koonce Street	Fixed Base Operator	Aircraft (Helicopter) Storage	S-354	SR-6	68,119	Yes
Wilson Air Center	8929 Paul B. Koonce Street	Fixed Base Operator	Apron, Vacant Space	None	None	84,643	Yes
Wilson Air Center	8918 Randolph Street	Fixed Base Operator	Aircraft Storage, Maintenance	S-S342	SR-9	120,072	Yes
Wilson Air Center	8910 Randolph Street	Fixed Base Operator	Aircraft Storage, Maintenance	S-S340	SR-10	156,707	Yes
Wilson Air Center	8900 Randolph Street	Fixed Base Operator	Vacant Space	None	None	156,707	Yes
Wilson Air Center	9000 Randolph Street	Fixed Base Operator	Aircraft Storage, Maintenance	S-344	SR-8	143,602	Yes
Wing Aviation	8410 Larson Street	Charter	Hangar	E-232	ER-12	25,572	Yes

SOURCES: Houston Airport System, Hobby Planimetrics, 2012; Jacobs Engineering, HOU Geographical Information System Data, May 2013; Ricondo & Associates, Inc. July 2013.
PREPARED BY: Ricondo & Associates, Inc. January 2014.

2.6.1.4 Wilson Air Center

Wilson Air Center is located in the south quadrant of the airfield and houses approximately 60 based aircraft. It is accessed via Taxiways J and L from the airside and via Randolph Street from the landside. Wilson Air Center has a fuel storage facility consisting of a 12,000-gallon tank of Jet A fuel and a 12,000-gallon tank of avgas. These tanks are supplied through trucking operations from the Southwest Airlines Fuel Farm. Duncan Avionics is located on the Wilson Air Center leasehold and offers full avionics installation, avionics line maintenance, and avionics support services.

Wilson Air Center is planning an expansion of its terminal and hangar facilities at the Airport in the near future.

2.6.1.5 Million Air

Million Air is the sole FBO in the west quadrant of the airfield and houses approximately 60 based aircraft. Million Air facilities are accessed via Taxiway G from the airfield and Telephone Road from the landside. Million Air is undergoing an expansion of its facilities at the Airport: apron space was recently added, a new terminal is under construction, and plans for additional hangar and vehicle parking space are being considered.

Million Air has a fuel storage facility located at the north end of the West Ramp, consisting of two 25,000-gallon tanks of Jet A fuel and one 12,000-gallon tank of avgas. Aircraft fuel is delivered to the FBO through trucking operations by a third party. Million Air supplies some of the other FBOs on the airfield with avgas. Million Air also offers aircraft maintenance, as well as interior and avionics support.

2.6.2 CHARTER COMPANIES

Wing Aviation and Starflite Aviation offer charter services and aircraft management services. Their facilities are adjacent to one another in the east quadrant of the airfield with ramp and apron access via Taxiway R. Larson Street provides landside access.

Central Helicopter Service is located on the South Ramp. Central Helicopter Service provides helicopter transport services, long haul trips, and out of ground hovering for clients in the energy and entertainment industries. Roadway access is via Paul B. Koonce Street.

2.6.3 CORPORATE BUSINESS OPERATORS

Corporate business operator services are offered to meet the personal air travel needs of the business community that desires flexibility, rather than relying on commercial airline travel for conducting business. The corporate aircraft used are not generally available to the public, but typically have a seating capacity between 4 and 19 passengers. At HOU, the corporate tenants are: Service Corporation International (SCI) Management, ABCO Aviation, Summit Seafood Supply, a subsidiary of Landry's Restaurants Inc., Spectra Energy Services, and Houston Casualty Company. These facilities are operated exclusively for their parent companies and maintain and store their own aircraft at the Airport. Some have their own fuel storage facilities, while others use refueling services from an on-Airport FBO.

As of early 2014, SCI Management is temporarily operating at Ellington Airport, while its new aircraft hangar is being built in the south quadrant adjacent to the existing aircraft rescue and firefighting (ARFF) station. The old SCI Management hangar was located inside the footprint of the planned Hobby International Terminal project had to be relocated. ABCO Aviation is located east of the Signature Flight Support facilities and west of the Duke Energy facilities. Its apron and ramp areas are connected to the south side of Taxiway R. Williams Company and Spectra Energy Services facilities are located at the eastern end of Taxiway R. Therefore, their ramp and apron areas are accessible via Taxiway R. Summit Seafood Supply is located on the west side of the airfield with apron and ramp access via Taxiway G.

2.6.4 HOUSTON POLICE DEPARTMENT AIR SUPPORT

The Houston Police Department Air Support unit is located on the east side of the airfield, north of Taxiway R, in Buildings E-220A and E-230. It has a fleet of 12 helicopters (one Bell 412 helicopter, three Schweizer 300C training helicopters, and eight MD500 helicopters) and one fixed-wing aircraft (Cessna 182). Approximately 40 employees (pilots, mechanics, and administrative personnel) support the operation of the unit.

The HPD leasehold includes hangar space for aircraft storage and maintenance, office space, storage space, air conditioned storage space for aircraft parts, two fuel storage tanks, an apron, and landside parking. The apron has taxiway access on the north side of Taxiway R and road access via Larson Street. Helicopter pilots typically aim to land in the grass area west of the facility, and hover east onto the apron. Overall, the facilities are in poor condition (built in the 1970s) and lack the required space. Additionally, the aircraft hangars are not hurricane-proof, requiring the entire fleet to be relocated during hurricane conditions. There have been discussions regarding the relocation of HPD Air Support to Ellington Airport.

2.6.5 HOUSTON AERONAUTICAL HERITAGE SOCIETY

The Houston Aeronautical Heritage Society is an airport museum, located in the 1940 control tower building, on the west side of the Airport.

2.7 Airline Support Facilities

Airline support activities at HOU include air cargo/aircraft provisioning, baggage screening and sortation, airline aircraft maintenance, and ground support equipment (GSE) storage. **Exhibit 2-16** depicts the locations of the facilities where these activities are conducted.

2.7.1 AIR CARGO/AIRCRAFT PROVISIONING FACILITIES

The cargo facility is located in the north quadrant, east of the Hobby Airport Loop; it is referred to as the Southwest Airlines Cargo and Provisioning Facility. The facility is an "L"-shaped, multitenant building serving several airlines. It is primarily used to accept and process belly cargo and provide catering services. The facility encompasses more than 46,000 square feet. A smaller building fronts the facility and supports the air cargo operations at the Airport. Truck docking and loading space at the cargo facility encompasses more than 6,300 square feet. In 2010, more than 12,000 tons of cargo were handled at HOU.

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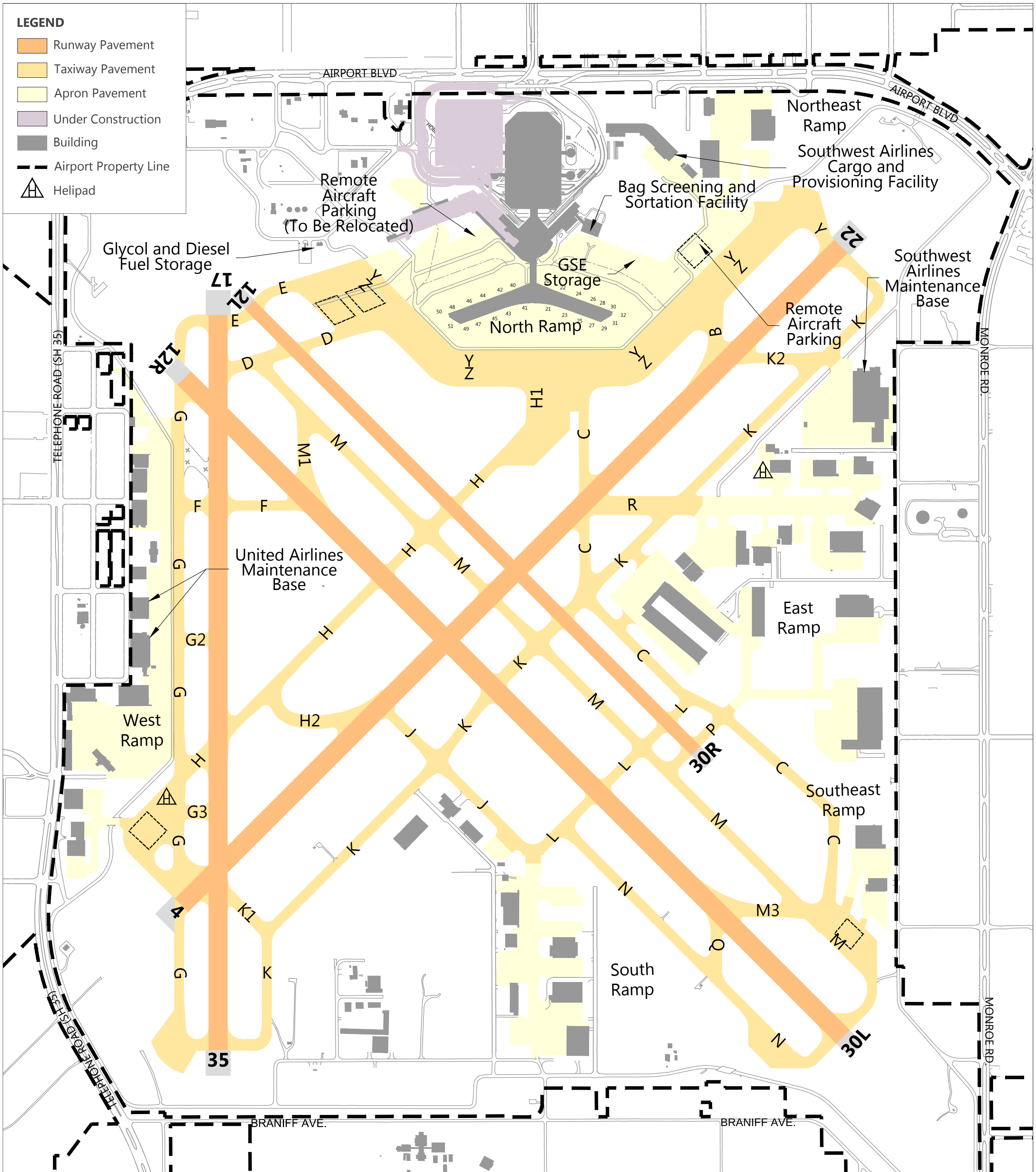

SOURCES: Ricondo & Associates, Inc., William P. Hobby Airport, Draft Airport Layout Plan, 2014; Houston Airport System, Hobby Planimetrics, 2012; Jacobs Engineering, HOU GIS Data, May 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2013.

GSE - Ground Support Equipment

NORTH 0 1200 ft.

EXHIBIT 2-16

Airline Support Facilities

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There is no apron dedicated to serving cargo activity; all cargo at the Airport is carried in the belly compartments of passenger aircraft, and is loaded and unloaded while the aircraft is parked at the gate. The cargo buildings are accessed via Airport Boulevard and several on-Airport roadways.

2.7.3 BAGGAGE SCREENING AND SORTATION BUILDING

This building is used for screening and sorting passenger baggage for all airlines except Southwest Airlines (Southwest Airlines baggage screening and sortation operations are conducted on the Central Concourse Apron Level [ground floor]). The building is adjacent to the east wing of the Terminal. Belts convey baggage from the Ticketing Level (first floor) of the east end of the Terminal to the Baggage Screening and Sortation Building.

2.7.4 AIRLINE AIRCRAFT MAINTENANCE BASES

Southwest Airlines and United Airlines have aircraft maintenance bases on the airfield. The Southwest Airlines maintenance base only services aircraft owned and operated by Southwest Airlines. The maintenance base is located on the east side of the airfield, with ramp and apron access via Taxiway K. West Monroe Road provides landside access to the Southwest Airlines maintenance base. The United Airlines maintenance base is located on the west side of the airfield and is accessed via Taxiway G. Travelair Street provides landside access to the United Airlines maintenance base.

2.7.5 GROUND SUPPORT EQUIPMENT STORAGE

An area on the east side of the North Ramp, adjacent to the employee parking lot, is designated for GSE storage. It is shared by all airlines. A tank with diesel fuel is located south of the Southwest Airlines Fuel Farm to refuel GSE vehicles.

2.8 Airport Support Facilities

Airport support facilities are operated to assist Airport terminal operations and airfield safety procedures and operations. Facilities include the ATCT, an ARFF station, a deicing pad, the Central Utility Plant (CUP), the Airport Maintenance Complex (including vehicle, airfield, and grounds), fuel storage facilities, GSE storage and staging facilities, HAS Airport Administration facilities, Airport Operations facilities, the Houston Police Department-Airport Division, fencing and security gates, and Airport service roads. These facilities and their locations are depicted on **Exhibit 2-17**.

2.8.1 AIRPORT TRAFFIC CONTROL TOWER

The ATCT is located on the west side of the airfield. Air traffic controllers in the ATCT direct pilots to approach or depart the Airport and land or takeoff safely. The ATCT opened in 2000 and is 147 feet high with a 7,300-square-foot building attached at the base. The base building houses electronic equipment and administrative offices. The floor of the ATCT cab is 171.5 feet above mean sea level (MSL). The location and height of the ATCT provide a clear line-of-sight to each runway end and aircraft movement area.

In addition to the current ATCT, one inactive tower is also located at the Airport. The original tower, which is adjacent to the existing ATCT, has historical significance. There are tentative plans to convert the old tower into an aviation museum with an observation deck for visitors.

2.8.2 AIRCRAFT RESCUE AND FIREFIGHTING STATION

The ARFF station (Station 81) is located immediately south of the intersection of Taxiways K and J, and is in good condition. The current ARFF facilities encompasses approximately 1.4 acres. The station is sized to meet Title 14 Code of Federal Regulations Part 139 (14 CFR Part 14) Index C aircraft operations[8], thereby accommodating the required personnel and equipment. The ARFF equipment is operated and maintained by the Houston Fire Department. The ARFF station could accommodate an increase to 14 CFR Part 139 Index D if longer aircraft were to begin regularly scheduled service at the Airport and two full time staff were added per shift. From Station 81, one fire engine can be maneuvered to the midpoint of any runway in 3 minutes, thus meeting the FAA-mandated 3-minute response-time requirement. The ARFF equipment operated at Station 81 is listed in **Table 2-25**. A minimum of seven ARFF personnel are on duty 24-hours per day to provide emergency and medical response on the Airport.

Improvements are planned to the ARFF building to include female quarters. Additionally, the introduction of larger ARFF equipment to the fleet will require widening of the truck bay doors.

2.8.3 DEICING OPERATIONS

Deicing operations are typically conducted on the main deicing pad, located east of the Runway 12L end, between Taxiways E and D. The deicing pad can accommodate two Boeing 737-size aircraft. The deicing pad is equipped to collect aircraft deicing fluid through a network of discrete underground pipes.

A tank with glycol deicing fluid is located south of the Southwest Airlines Fuel Farm. Glycol deicing trucks are staged nearby.

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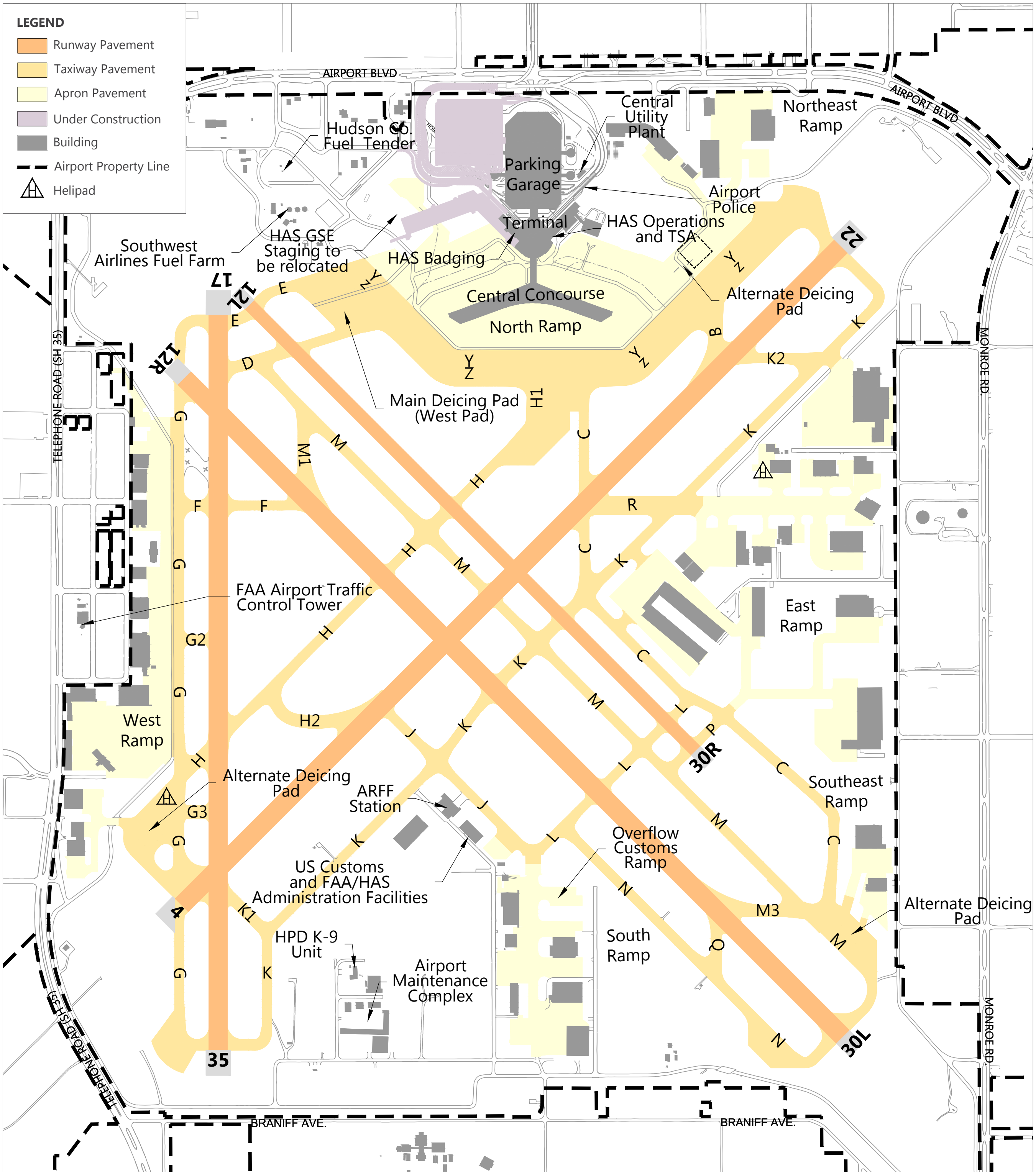
[8] The Index is established in 14 CFR Part 139, *Airport Certification: Airports,* which categorizes airports according to the longest length of aircraft serving the airport. For example, Index C includes aircraft with a length of at least 126 feet but less than 159 feet. Should an airline begin operating aircraft longer than 159 feet (such as a Boeing 767 at 180 feet) at the Airport, providing scheduled service with at least five daily departures, the airport's Index would increase to Index D.



SOURCES: Ricond & Associates, Inc., William P. Hobby Airport, Draft Airport Layout Plan, 2014; Houston Airport System, Hobby Planimetrics, 2012; Jacobs Engineering, HOU GIS Data, May 2013.

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

ATCT - Airport Traffic Control Tower
ARFF - Airport Rescue and Fire Fighting
GSE - Ground Support Equipment
HPD - Houston Police Department

NORTH 0 1200 ft.

EXHIBIT 2-17

Airport Support Facilities

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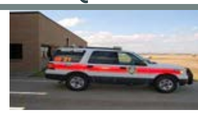
Table 2-25: Aircraft Rescue and Firefighting Vehicles and Capabilities

VEHICLE NUMBER 1/	MODEL	EQUIPMENT	NUMBER OF PERSONNEL ASSIGNED	GALLONS OF WATER	GALLONS OF AFFF 2/	RESPONSE TIME OR PURPOSE
AR1	2005 Ford Expedition		1	NA	NA	Incident Command
AR22	F-550			NA	NA	Emergency Air Stairs
AR24	2007 Ford Expedition		1	NA	NA	Reserve Unit for AR1 and MS81
AR26	Rosenbauer 4x4		2	1,500	200	3 Minutes
AR27	Rosenbauer 6x6		2	3,000	400 460[3]	4 Minutes
AR28	Oshkosh 6x6			3,000	400	Reserve Unit for AR26 and AR27
AR81	Ford		1	NA	NA	Staff Officer
MS81	Chevy		2	NA	NA	Medical First Response
Triage Trailer	Trailer		NA	NA	NA	Triage

NOTES:
NA - Not Applicable
1/ AR denotes Airport Rescue vehicle, MS denotes Medical Safety vehicle
2/ AFFF - Aqueous Film Forming Foam, which is used to extinguish fires.
3/ AR 27 also carries 460 pounds of Halontron 1.

SOURCES: Houston Airport System, Houston Fire Department, June 2012.
PREPARED BY: CHPlanning Ltd., June 2012.

2.8.5 CENTRAL UTILITY PLANT

The CUP is located in the north quadrant, inside the Hobby Airport Loop and east of the existing Parking Garage. The plant provides heating and cooling for the Terminal, Connector and Central Concourse. Not only is the useful life of the CUP limited, but with the opening of the Hobby International Terminal, additional heating and cooling capacity will be required. As part of the Hobby International Terminal project, a new Satellite Utility Plant (SUP) is planned west of the terminal area, which will complement and eventually replace the existing plant.

2.8.6 AIRPORT MAINTENANCE COMPLEX

The HOU Airport Maintenance Complex houses airfield and grounds maintenance facilities: electrical repair and storage, mowing equipment, vehicle maintenance, and fuel storage for vehicles. The facilities are located in the south quadrant of the airfield, as depicted on Exhibit 2-17. HAS has plans to expand the facility to the east.

2.8.7 FUEL STORAGE FACILITIES

The Southwest Airlines Fuel Farm, located west of the North Ramp and south of the northwest rental car area, is owned by Southwest Airlines and operated by Servisair. Although the fuel farm is connected to a pipeline, the pipeline has been repurposed. Aircraft fuel destined for both the Southwest Airlines Fuel Farm and the East Side Fuel Facility are conducted via trucking operations, and are delivered to the East Side Fuel Facility. The fuel farm is connected to the Airport's hydrant fueling system, which consists of a pipeline that encircles the Central Concourse and is connected to hydrant fuel pits at each gate. However, only Southwest Airlines uses the hydrant fuel pits, while the other airlines use refueling trucks. These trucks fill up at the fuel tender located immediately north of the fuel farm. The fuel tender is operated by the Hudson Fuel Company, and receives its fuel supply from underground pipes connected to the fuel farm. Several FBOs on the airfield also receive their fuel supplies from the fuel farm through trucking operations. The Southwest Airlines Fuel Farm consists of three Jet A storage tanks, with capacities of 230,000 gallons each, for a total fuel storage capacity of 690,000 gallons or 2.7 days.[9] The fuel farm also contains a pump system and electrical and control buildings for the system.

Southwest Airlines also owns the East Side Fuel Facility, located off-airport, along the eastern Airport boundary (formerly owned by NuStar). Delivery of aircraft fuel is conducted via trucking operations. This facility provides a Jet A fuel storage capacity of 4,422,600 gallons, or 18.4 days.

Some Airport tenants have fuel storage facilities on their leaseholds. Available information about these facilities is provided in Section 2.6.

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9 Based on a daily fuel consumption of 240,000 gallon, as reported by Southwest Airlines Regional Manager of Fuel Operations in July 31, 2013 email.

2.8.8 GROUND SUPPORT EQUIPMENT STORAGE AND STAGING FACILITIES

GSE is stored on the east side of the North Ramp, adjacent to the employee parking lot. Additionally, a HAS equipment staging area is located west of the North Ramp.

2.8.9 HAS AIRPORT ADMINISTRATION FACILITIES

HAS Airport administration facilities are temporarily located in Building S-262, in the south quadrant of the Airport, during construction of the Hobby International Terminal. These facilities will be permanently relocated inside the HIT upon completion. The HAS Badging office is located on the Baggage Claim level of the Terminal (ground floor), on the west side.

HAS headquarters are located at George Bush Intercontinental Airport/Houston.

2.8.10 AIRPORT OPERATIONS

Airport Operations facilities are located on the Baggage Claim Level (ground floor) of the Terminal's east wing. The HAS Operations Center is located on the Baggage Claim Level (ground floor) of the Terminal's west wing.

2.8.11 HOUSTON POLICE DEPARTMENT – AIRPORT DIVISION

The Houston Police Department–Airport Division offices are located under the Hobby Airport Loop, immediately south of the CUP. The HPD-Airport Division consists of 53 employees, who are also responsible for patrolling Ellington Airport on a daily basis.

The HPD K-9 unit is located north and east of the Airport Maintenance Complex. The unit includes kennels for six dogs, administrative space for the HPD K-9 and narcotics units, storage space, covered outdoor space, and a walled blast area. The HPD stages its operations at the K-9 unit in the event of an airfield incident. The HPD K-9 unit can be expanded within the unit's current footprint if needed.

2.8.12 CUSTOMS AND BORDER PROTECTION

United States Customs and Border Protection (CBP) regulations govern landing requirements and procedures for private aircraft arriving into the United States. The Airport is a customs landing rights airport, where federal inspection services for general aviation aircraft are available on an on-call basis.

The CBP facilities at HOU are located in the south quadrant of the Airport, southeast of the ARFF station. An apron area is adjacent to the facility for aircraft staging during inspections; an additional overflow ramp is located at the north end of the South Ramp. Roadway access is via Paul B. Koonce Street.

2.8.13 FENCING AND SECURITY GATES

The Airport has an FAA-approved Comprehensive Airport Security Plan, which is updated as needed and regularly reviewed by the FAA for compliance with current security regulations.

The Airport is completely fenced, with controlled access to the Air Operations Area (AOA). The fence consists of an 8-foot-high chain link fence with 1 foot of barbed wire at the top facing outward. A clear area of at least

10 feet on each side of the fence line ensures that objects cannot be used as an aid in scaling the fence or obscure the visibility of climbing devices. Appropriate signage, designating restricted access, is posted at intervals of less than 300 feet along the entire perimeter fence line. Tenants are responsible for providing security for their respective facilities. HAS uses closed-circuit television (CCTV) to monitor the airfield.

2.8.14 AIRPORT SERVICE ROADS

The Airport has a network of service roads that can be categorized as public use and airfield use. The public use service roads connect HOU tenant and support facilities with the major thoroughfares of Airport Boulevard, West Monroe Road, Braniff Avenue and Telephone Road. Some minor service roads connect tenant facilities, and several other service roads connect vacant property. These service roads are in fair to good condition.

Airside service roads located in the airfield area are used primarily to access the airfield operational areas. This network of roads can only be accessed through electronic security gates. The airfield service roads provide access to the airfield for personnel to monitor and maintain navigational aids, the airfield, and other grounds and to secure and repair the perimeter fence. All of these roads are of asphalt-textured pavement and are approximately 20 feet to 24 feet wide. The service roads that follow the perimeter of the Airport, as well as those used to access the navigational aids, are in good condition with limited pavement cracking and wear.

2.9 Airspace Environment

The structure of and the procedures to operate in the airspace serving the Airport influence aircraft routings to and from the Airport. This section describes the airspace structure and the procedures used by the various FAA ATC facilities serving the Airport.

2.9.1 AIR TRAFFIC CONTROL FACILITIES

Three facilities provide ATC services for the pilots of aircraft arriving at, departing from, or overflying the immediate area of the Airport. The role of these facilities is to facilitate the safe, efficient, and expeditious movement of air traffic.

The FAA Houston Air Route Traffic Control Center (ARTCC) is located at IAH and provides ATC services to pilots of aircraft operating on IFR flight plans within controlled airspace during the enroute phase of flight. The enroute phase of flight is generally defined as the period when aircraft are operating between departure and destination terminal areas.

The Houston TRACON is also an FAA facility located at IAH. The TRACON provides radar ATC services to pilots of aircraft arriving at and departing from the Airport and other civilian airports in the regional service area and to pilots of aircraft operating under VFR in and around the Class B airspace associated with the Airport.

HOU ATCT staff issue clearances for the movement of aircraft between the surface of the airfield and 4,000 feet above MSL, for an area that ranges from approximately 5 to 8 nautical miles of the Airport. These clearances include authorization to land at or take off from the Airport, move on the airfield, or transit the airspace delegated to the ATCT.

2.9.2 RUNWAY USE CONFIGURATIONS

All runways are available for arrivals and departures; however, the characteristics of the runways, such as length, width, location, and Airport noise abatement procedures, define how the runways are used.

Exhibit 2-18 depicts the eight primary runway use configurations at HOU in all weather conditions. These configurations are designated as: South Flow, East Flow, North Flow, Church Flow, West Flow, MID Flow, SMGCS Flow, and Sunday AM Flow.

Each operation may not occur during a specific flow configuration because of a variety of operational factors, such as wind direction or strength, peak hour demand, the aircraft origin/destination, or the airfield condition.

2.9.2.1 South Flow

When the airfield is operating in South Flow, arriving aircraft are assigned to Runway 12L or 12R, and departing aircraft are typically assigned to Runway 12L, 12R, 17, or 22. Pilots of air carrier aircraft executing the ILS approach are assigned to Runway 12R; GA aircraft, whose tenant facilities are on the east side of the airfield, are assigned to Runway 12L.

Departing aircraft are typically assigned to Runway 12L, 12R, 17, or 22. Aircraft operating under IFR departing for destinations to the east and/or north are assigned to Runway 12L or 12R depending on aircraft performance requirements. Westbound and southbound IFR departures are assigned to Runway 22. GA aircraft that park on the west side of the airfield and depart to the south or west generally use Runway 17.

2.9.2.2 East Flow

When the airfield is operating in East Flow, arriving aircraft are typically assigned to Runway 4 or Runway 35;departing aircraft use Runway 4, 35, 30L, or 30R. Pilots of air carrier and other aircraft executing the ILS approach and pilots of aircraft operating under VFR are assigned to Runway 4; small aircraft operating under VFR are assigned to Runway 35.

Departing aircraft are typically assigned to Runway 4, 35, 30L, or 30R. Aircraft departing for destinations to the north and east are typically assigned to Runway 4; aircraft departing to the west and south are typically assigned to Runway 30R or 30L. Runway 35 is assigned to GA aircraft parked or based on the west side of the airfield and departing for destinations to the west or south.

2.9.2.3 North Flow

When the airfield is operating in North Flow, aircraft arriving at the Airport are typically assigned to Runway 30L or Runway 30R for landing. Aircraft using the ILS approach are typically assigned to Runway 30L, while aircraft operating under VFR are typically assigned to Runway 30R.

Departing aircraft are typically assigned to Runway 30L, 30R, 22 or 35; aircraft with performance characteristics that require a longer runway are assigned to Runway 30L. GA aircraft based or parked on the east side of the airfield are assigned to Runway 30R, and GA aircraft on the west side of the airfield are assigned to Runway 35.

2.9.2.4 Church Flow

When the airfield is operating in Church Flow, arriving aircraft land on Runway 4 or 35. Pilots of air carrier and other aircraft executing the ILS approach and aircraft operating under VFR are assigned to Runway 4; small aircraft operating under VFR are assigned to Runway 35.

Departing aircraft are typically assigned to Runway 4, 35, 12L, or 12R. Aircraft departing for destinations to the north and east are typically assigned to Runway 4 or 35; aircraft departing to the west and south are typically assigned to Runway 12L or 12R.

2.9.2.5 West Flow

When the airfield is operating in West Flow, aircraft arrive and depart on Runway 17 or 22. Air carrier aircraft and those aircraft that require additional runway length are generally assigned to Runway 22; GA aircraft are assigned to Runway 17.

2.9.2.6 MID Flow

When the Airport is operating in MID Flow, arriving aircraft land on Runway 4, and departing aircraft are assigned to Runway 22. MID Flow is typically in effect between 12 a.m. and 6 a.m., weather conditions permitting.

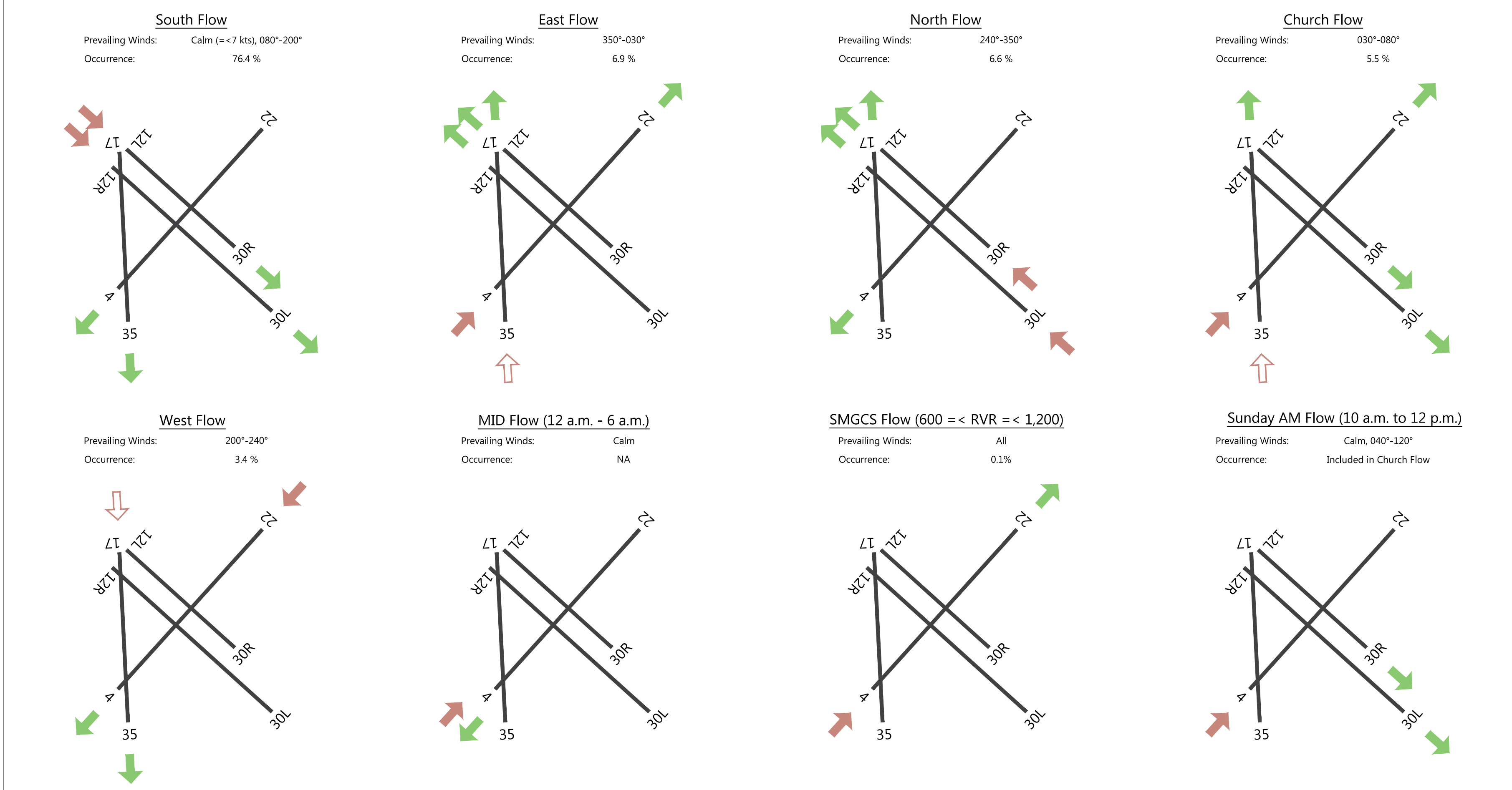
2.9.2.7 SMGCS Flow

SMGCS Flow is in effect during low visibility conditions (visibility 1,200 RVR or lower). During such times, the HOU ATC must terminate all construction activity in movement areas and provide a “follow me service” for all aircraft traveling from runways to parking areas or, vice versa, from the ramp position to a Geographic Position Marking or runway entrance.

When the airfield is operating in SMGCS Flow, aircraft arrive and depart only on Runway 4. All other runways are designated “inactive,” along with Taxiway G south of Runway 4. When the RVR is between 600 and 1,200 feet, the SMGCS lighting is illuminated, and the “follow-me service” is available for aircraft to be escorted. When visibility is below 600 RVR, the Airport is closed.

2.9.2.8 Sunday AM Flow

Given the proximity of churches to the north and east of the Airport, HAS instituted a noise abatement procedure that is in effect between 10:00 a.m. and 12:00 p.m. on Sundays, traffic and weather conditions permitting. The procedure is referred to as “Sunday AM Flow.” When the airfield is operating in Sunday AM Flow, arriving aircraft are assigned to Runway 4. Runway 12R serves air carrier and other higher performance aircraft departures, and Runway 12L serves GA aircraft departures.



NOTES:

1. The reported wind direction is based on prevailing winds during which each airport operating configuration could be operated without experiencing tailwind conditions. Additional consideration was given for preferenc=tial configurations, as identified by ATC staff.
2. As of August 7, 2012, opposite direction operations, such as in MID Flow, are temporarily suspended per the FAA.

SOURCES: National Climatic Data Center, TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009, 6 a.m. to midnight), May 3, 2012; Houston Hobby Air Traffic Control, *Hobby ATCT 7110.1W*, August 15, 2011; Ricondo & Associates, Inc., June 2012.

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

EXHIBIT 2-18

NORTH

0 Not to Scale

LEGEND

Primary Arrivals

Primary Departures

Secondary Arrivals

Runway Use Configurations - All Weather Conditions
Existing Airfield

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\04_Chapter 4_Requirements\02_Airfield Capacity Analysis\CAD\Exh 2-18, 4-2 & 4-3_HOU-Existing Runway Configurations.dwg_Layout: All Weather_Dec 26, 2014, 11:53am

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2.9.3 TAXI ROUTES

HOU ATC is responsible for the safe, efficient, and expeditious flow of surface traffic in the airfield movement areas. The movement areas consist of runways, taxiways, and safety areas of the Airport, which are used for taxiing/hover taxiing, takeoff, and landing of aircraft. Loading ramps and apron parking areas are not considered movement areas; activity in these areas is the responsibility of the tenant and aircraft/vehicle operator. However, specific approval for entry onto the movement areas must be obtained from ATC.

The preferred taxi routes for each runway use configuration are identified in HOU ATCT Order 7110.1W, *Houston Hobby TRACAB Air Traffic Control,* dated August 15, 2011, and summarized below.

2.9.3.1 South Flow Taxi Routes

Exhibit 2-19 illustrates the airfield circulation patterns when the Airport is operating in South Flow. Aircraft landing on Runway 12R exit the runway heading north and proceed along Taxiway H or Taxiways K and C. Other options are to exit on Taxiways M and C or Taxiways L and C. Generally, aircraft landing on Runway 12R are not permitted to turn left onto Taxiway L. Aircraft landing on Runway 12R and destined for the West Ramp use Taxiways H and G or Taxiways K and K1, Runway 4-22, and Taxiway G. Other options are Taxiways L, J, K, and K1, then Runway 4-22 and Taxiway G or Taxiways N, J, K, K1, and G. Aircraft landing on Runway 12R access the South Ramp via Taxiway L or Taxiways K and J or Taxiways N and L. Aircraft landing on Runway 12R and destined for the Southeast Ramp exit the runway to the north on either Taxiway H or K and then proceed along Taxiway M or M3. Aircraft landing on Runway 12R and destined for the East Ramp use Taxiways K, M, and R.

Aircraft landing on Runway 12L exit the runway and proceed to the North Ramp along Taxiway H or Taxiways K and C. Aircraft landing on Runway 12L and destined for the West Ramp use Taxiways H and G or Taxiways L, J, K, and K1, then Runway 4-22 and Taxiway G or Taxiways P, M, N, L, J, K, and K1, then Runway 4-22 and Taxiway G. Aircraft landing on Runway 12L are typically not permitted to turn right onto Taxiway K. Aircraft landing on Runway 12L access the South Ramp via Taxiway L or Taxiways P, M, and L. Aircraft landing on Runway 12L access the Southeast Ramp via Taxiway P or Taxiways L, C, and P. To access the East Ramp, aircraft landing on Runway 12L exit the runway to the north via Taxiway K and proceed along Taxiway R or Taxiways L, C, K, and R.

Aircraft parked at the North Ramp and departing on Runway 22 use Taxiway A. Aircraft departing on Runway 12L or 17 use Taxiways Z and E, and those departing on Runway 12R use Taxiways Z and D. Aircraft parked on the West Ramp and departing on Runway 12R or 17 (including Runway 17 intersection departures) use Taxiways G and E. Aircraft parked at the South Ramp and departing on Runway 12R or 17 (including Runway 17 intersection departures) use Taxiways J, K, and K1, then Runway 4-22 and Taxiway G. Those departing on Runway 22 use Taxiways J and K. Aircraft parked at the East Ramp and departing on Runway 22 use Taxiway K. Aircraft departing on Runway 12R or 17 use Taxiway R, C, Z, and E, and those departing on Runway 12L use Taxiways R, C, Z, E, and D (for intersection departures).

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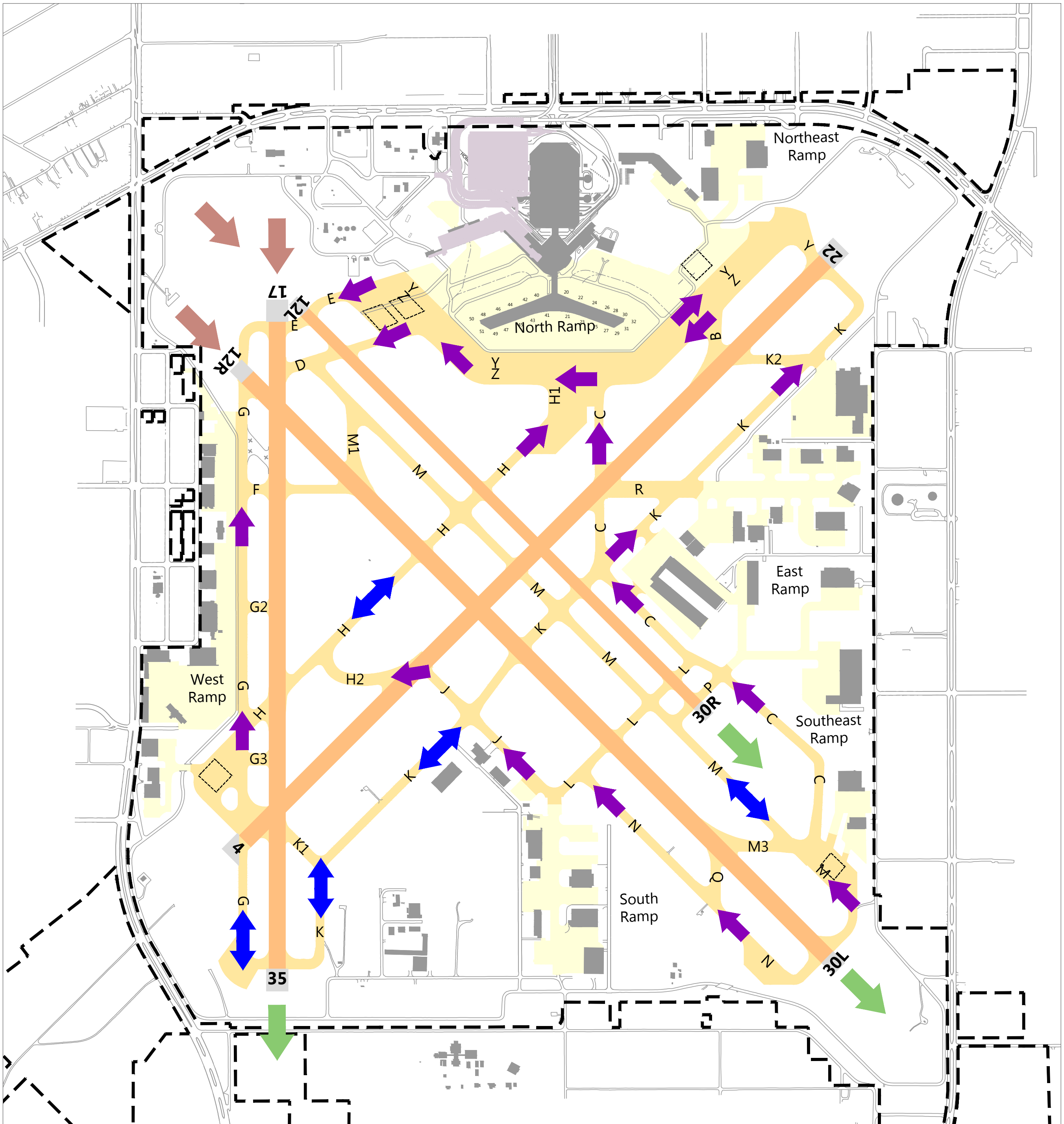

LEGEND

One Way Traffic Taxi Route | Two Way Traffic Taxi Route | Arrival Runway | Departure Runway | Airport Property Line

SOURCE: Federal Aviation Administration, Houston Airport Traffic Control Tower, August 2011.
PREPARED BY: Ricondo & Associates, Inc., February 2013.

EXHIBIT 2-19

NORTH 0 1,400 ft.

South Flow Taxi Routes

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\Exhibit Taxi Routes.dwg_Layout: 2-19_South Flow_Dec 26, 2014, 12:00pm

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2.9.3.2 East Flow Taxi Routes

Exhibit 2-20 shows the airfield circulation patterns when the Airport is operating in an East Flow configuration. Aircraft landing on Runway 35 and destined for the west side of the North Ramp use Taxiways H, M, D, and Z or Taxiways F, M1, M, D, and Z, or Taxiways D and Z. Aircraft landing on Runway 35 and destined for the east side of the North Ramp use Taxiway H or Taxiways F, M1, M, and H or Taxiways D and Z. Aircraft landing on Runway 35 access the West Ramp via Taxiways G1, G2, and G3 and proceed along Taxiway G. Aircraft landing on Runway 35 access the South Ramp via Taxiways G1, G2, G3, and G, then Runway 4-22, and Taxiways K1, K, and J. To access the Southeast Ramp, aircraft landing on Runway 35 proceed via Taxiways H and M. Aircraft destined for the south side of the East Ramp use Taxiways H, M, L, C, and P or Taxiways F, M1, M, L, C, and P. Aircraft destined for the north side of the East Ramp use Taxiways H, M, K, and R or Taxiways F, M1, M, K, and R.

Aircraft landing on Runway 4 access the west side of the North Ramp via Taxiways M and D or Taxiway B or access the east side of the North Ramp via Taxiway A. Aircraft landing on Runway 4 access the South Ramp via Taxiway J or Taxiways K and J. Aircraft landing on Runway 4 access the Southeast Ramp via Taxiways J, L, N, and M or Taxiway M or Taxiway C. Aircraft landing on Runway 4 and destined for the south side of the East Ramp use Taxiways M, L, C, and P or Taxiways C and P or Taxiways A, K, C, and P. Aircraft landing on Runway 4 and destined for north side of the East Ramp use Taxiways M, K and R or Taxiway R or Taxiways J, K, and R.

Aircraft parked at the North Ramp and departing on Runway 30L or 30R use Taxiways Z and C, and aircraft departing on Runway 35 use Taxiways Z, C, and K.

Aircraft departing on Runway 4 use Taxiways Z, H (or H1), and G. Those parked at the West Ramp and departing on Runway 35 or 4 use Taxiway G. Aircraft parked at the South Ramp and departing on Runway 30L use Taxiways L and N, and those departing on Runway 30R use Taxiways L, M, and P. Aircraft parked at the South Ramp and departing on Runway 35 use Taxiways J and K, and those departing on Runway 4 use Taxiways J, K, and K1.

Aircraft parked at the Southeast Ramp and departing on Runway 30L use Taxiways C and M; those departing on Runway 30R use Taxiways M and P. Aircraft departing on Runway 35 use Taxiways M and K, and aircraft departing on Runway 4 use Taxiways M, K, and K1. Aircraft parked at the East Ramp and departing on Runway 30L or 30R use Taxiways R, K, and C. Aircraft departing on Runway 35 use Taxiway K, and those departing on Runway 4 use Taxiways K and K1.

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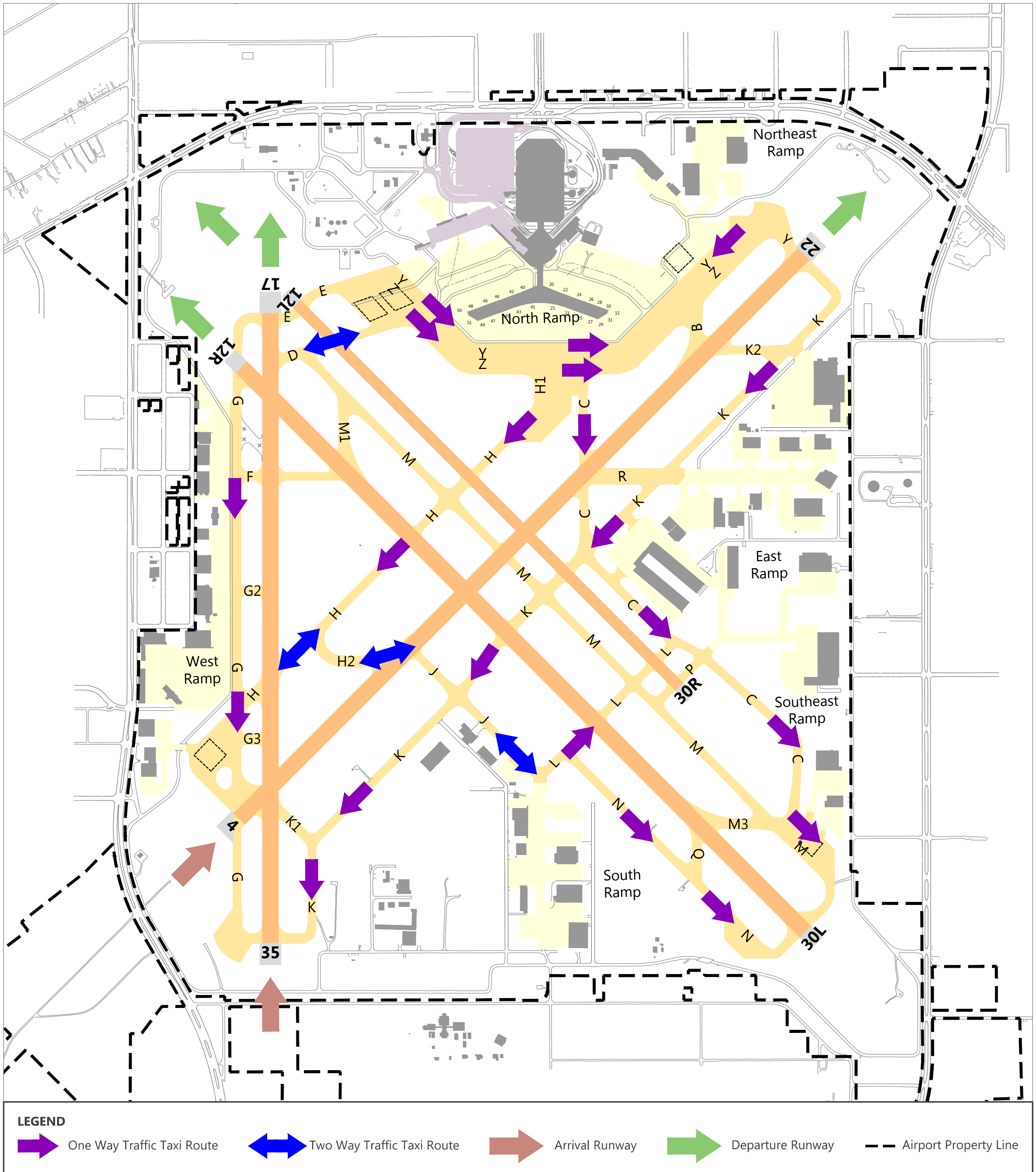

SOURCE: Federal Aviation Administration, Houston Airport Traffic Control Tower, August 2011.
PREPARED BY: Ricondo & Associates, Inc., February 2013.

EXHIBIT 2-20

NORTH 0 1,400 ft.

East Flow Taxi Routes

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\Exhibit Taxi Routes.dwg_Layout: 2-20_East Flow_Dec 26, 2014, 12:01pm

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2.9.3.3 North Flow Taxi Routes

Exhibit 2-21 illustrates the airfield surface circulation patterns when HOU is operating in North Flow. Aircraft landing on Runway 30L exit the runway in a northerly direction by proceeding along Taxiways M, D, and Z toward the Terminal ramp. Aircraft landing on Runway 30L and destined for the West Ramp use Taxiways L and J, Runway 4-22, then Taxiway G. Another option for arriving aircraft is Taxiways K and K1, then onto Taxiway G or exit on Taxiways F and G.

Aircraft landing on Runway 30L access the South Ramp via Taxiway L or Taxiways K and J. Aircraft landing on Runway 30L and destined for the Southeast Ramp exit the runway to the north using Taxiway L, K, or M1 and proceed along Taxiway M toward the Southeast Ramp.

Aircraft landing on Runway 30L and destined for the south side of the East Ramp use Taxiways L, C, and P or Taxiways D, Z, C, and P. Aircraft landing on the north side of the East Ramp use Taxiways K and R or Taxiways D, Z, C, and R.

Aircraft landing on Runway 30R have multiple exit options heading north toward the North Ramp. They can proceed along Runway 4-22 and Taxiways B and Z, or exit on Taxiway H or via Taxiways H, H1, and Z. Another option is to exit on Taxiways D and Z. Aircraft landing on Runway 30R and destined for the West Ramp also have several exit options, such as Taxiway K or K1, or Runway 4-22 and Taxiway G, or Taxiways H and G, or Taxiways D and G.

Aircraft landing on Runway 30R can exit the runway to the south and continue along Taxiways K and J or via Taxiways K, M, and L to access the South Ramp. To access the Southeast Ramp, aircraft landing on Runway 30R exit the runway to the south and proceed along Taxiway M, then Taxiway C, or Taxiways D, Z, and C.

Aircraft landing on Runway 30R can exit the runway to the north and proceed along Taxiway D, Z, C, and R or P toward the East Ramp. These aircraft are typically not permitted to turn right onto Taxiway K.

On departure, aircraft parked at the North Ramp and departing on Runway 30L or 30R use Taxiways Z and C. Aircraft parked at the West Ramp and departing on Runway 30L use Taxiway G, Runway 4, and Taxiways J, L, and N, while aircraft departing on Runway 35 use Taxiway G.

Aircraft parked at the South Ramp and departing on Runway 30L use Taxiways L and N. Aircraft departing on Runway 30R use Taxiways L, M, and P, and aircraft departing on Runway 35 use Taxiways J and K.

Aircraft parked at the Southeast Ramp and departing on Runway 30L use Taxiway P, then Taxiway M, while aircraft departing on Runway 30R use Taxiway P. Aircraft parked at the East Ramp and departing on Runway 30L or 30R use Taxiways R, K, and C.

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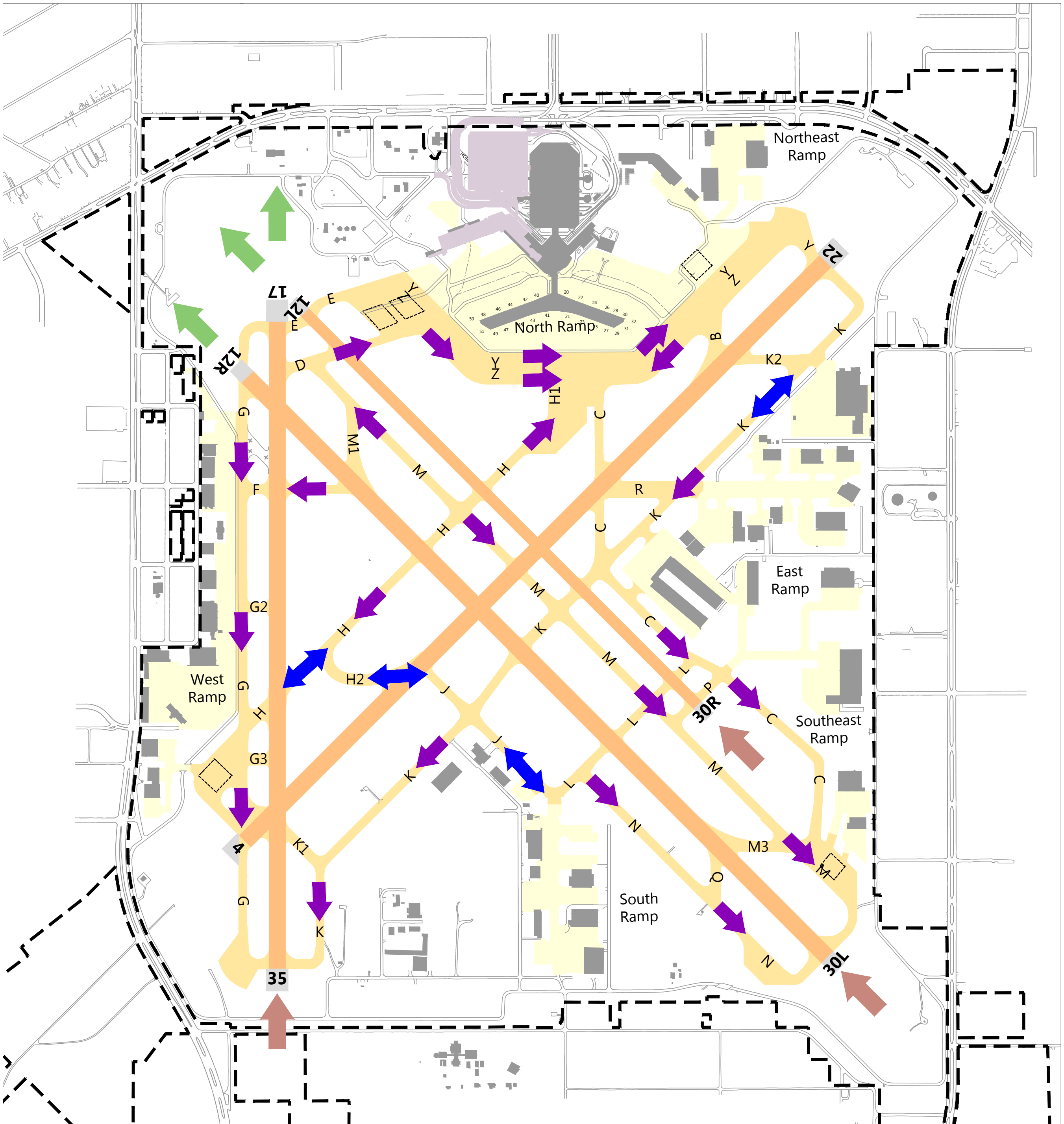

LEGEND

One Way Traffic Taxi Route | Two Way Traffic Taxi Route | Arrival Runway | Departure Runway | Airport Property Line

SOURCE: Federal Aviation Administration, Houston Airport Traffic Control Tower, August 2011.
PREPARED BY: Ricondo & Associates, Inc., February 2013.

EXHIBIT 2-21

NORTH 0 1,400 ft.

North Flow Taxi Routes

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\Exhibit Taxi Routes.dwg_Layout: 2-21_North Flow_Dec 26, 2014, 12:02pm

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2.9.3.4 Church Flow Taxi Routes

Exhibit 2-22 shows the airfield circulation patterns when the Airport is operating in a Church Flow configuration. Aircraft landing on Runway 35 and destined for the west side of the North Ramp use Taxiways H, M, D, and Z or Taxiways M1, M, D, and Z or Taxiways D and Z. Aircraft landing on Runway 35 and destined for the east side of the North Ramp use Taxiway H or Taxiways M1, M, and H or Taxiways D and Z. Aircraft landing on Runway 35 access the West Ramp via Taxiways G1, G2, and G3 and then proceed along Taxiway G. Aircraft landing on Runway 35 access the South Ramp via Taxiways G1, G2, G3, and G, then Runway 4-22 and Taxiways K1, K, and J. To access the Southeast Ramp, aircraft landing on Runway 35 use Taxiways H and M. Aircraft destined for the south side of the East Ramp use Taxiways H, M, L, C, and P or Taxiways F, M, M1, L, C, and P. Aircraft destined for the north side of the East Ramp use Taxiways H, M, K, and R or Taxiways F, M1, M, K, and R.

Aircraft landing on Runway 4 access the west side of the North Ramp via Taxiways M and D or Taxiway B; or access the east side of the North Ramp via Taxiway A. Aircraft landing on Runway 4 access the South Ramp via Taxiway J or Taxiways K and J. Aircraft landing on Runway 4 access the Southeast Ramp via Taxiways J, L, N, and M or Taxiway M or Taxiway C. Aircraft landing on Runway 4 and destined for the south side of the East Ramp use Taxiways M, L, C, and P or Taxiways C and P or Taxiways A, K, C, and P. Aircraft landing on Runway 4 and destined for north side of the East Ramp use Taxiways M, K and R or Taxiway R or Taxiways J, K, and R.

Aircraft parked at the North Ramp and departing on Runway 12L or 12R use Taxiways Z, E, and D. Aircraft parked at the West Ramp and departing on Runway 12R use Taxiways G and E. Aircraft parked at the South Ramp and departing on Runway 12R use Taxiways J, K, and K1, then Runway 4-22 and Taxiway G. Aircraft parked at the East Ramp and departing on Runway 12R use Taxiways R, C, Z, and E, and those departing on Runway 12L use Taxiways R, C, Z, E, and D (for intersection departures).

Aircraft parked at the North Ramp and departing on Runway 35 use Taxiways Z, C, and K, and those departing on Runway 4 use Taxiways Z, H (or H1), and G. Aircraft parked at the West Ramp and departing on Runway 35 or 4 use Taxiway G. Aircraft parked at the South Ramp and departing on Runway 35 use Taxiways J and K, and those departing on Runway 4 use Taxiways J, K, and K1.

Aircraft parked at the Southeast Ramp and departing on Runway 35 use Taxiways M and K, and aircraft departing on Runway 4 use Taxiways M, K, and K1. Aircraft parked at the East Ramp and departing on Runway 35 use Taxiway K, and those departing on Runway 4 use Taxiways K and K1.

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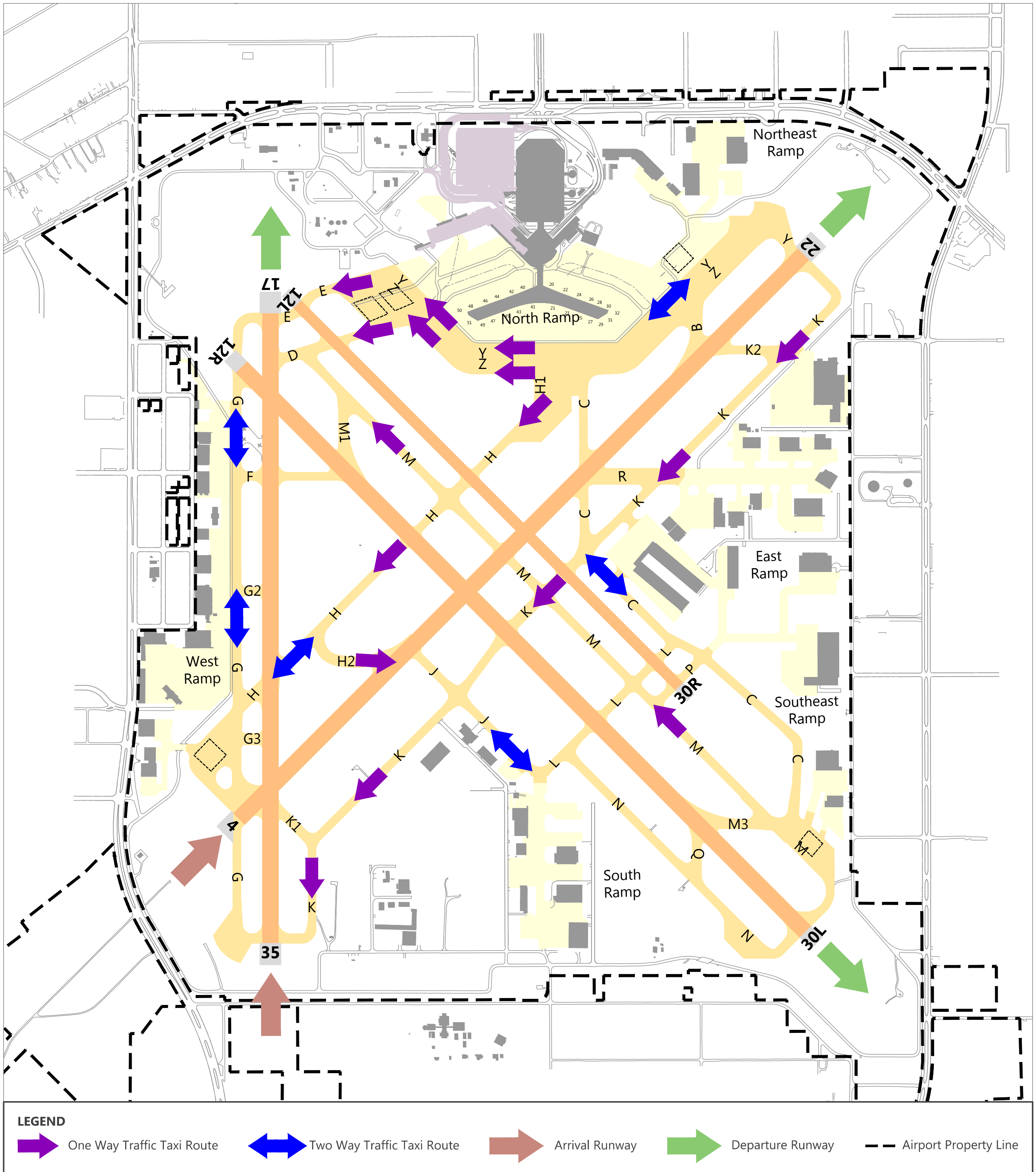

SOURCE: Federal Aviation Administration, Houston Airport Traffic Control Tower, August 2011.
PREPARED BY: Ricondo & Associates, Inc., February 2013.

EXHIBIT 2-22

NORTH 0 1,400 ft.

Church Flow Taxi Routes

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\Exhibit Taxi Routes.dwg_Layout: 2-22_Church Flow_Dec 26, 2014, 12:03pm

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2.9.3.5 West Flow Taxi Routes

Exhibit 2-23 shows the airfield circulation patterns when the Airport is operating in a West Flow configuration. Aircraft landing on Runway 22 and destined for the North Ramp exit the runway via Taxiways H2 and H. Aircraft landing on Runway 22 and destined for the West Ramp use Runway 12R-30L and Taxiways F and G. Aircraft landing on Runway 22 access the South Ramp via Taxiways C and L or Taxiway J or Taxiways K1, K, and J. Aircraft landing on Runway 22 and destined for the Southeast Ramp exit the runway on Taxiway C or Taxiways J, L, N, and M, or Taxiways K1, K, J, L, N, and M. Aircraft landing on Runway 22 and destined for the south side of the East Ramp use Taxiways C and P; and aircraft destined for the north side of the East Ramp use Taxiway R or Taxiways K1, K, and R.

Aircraft landing on Runway 17 and destined for the North Ramp exit the runway via Taxiway H. Aircraft landing on Runway 17 access the West Ramp via Taxiways G1, G2, H, and G3 and then Taxiway G. Aircraft landing on Runway 17 access the South Ramp via Taxiway K or Taxiways K1, K, and J. Aircraft landing on Runway 17 and destined for the Southeast Ramp use Taxiways K1, K, J, L, N, and M. Aircraft landing on Runway 17 and destined for the East Ramp use Taxiways K1, K, and R.

Aircraft parked at the North Ramp and departing on Runway 22 use Taxiway A; those departing on Runway 17 use Taxiways Z and E. Aircraft parked at the West Ramp and departing on Runway 17 use Taxiways G and E. Aircraft parked at the South Ramp and departing on Runway 22 use Taxiways J, K, and A and those departing on Runway 17 use Taxiways J, K, M, and D. Aircraft parked at the Southeast Ramp and departing on Runway 22 use Taxiways C, K, and A and those departing on Runway 17 use Taxiways M and D. Aircraft parked at the East Ramp and departing on Runway 22 use Taxiways K and A, and those departing on Runway 17 use Taxiways C, Z, and D.

2.9.3.6 MID Flow Taxi Routes

Exhibit 2-24 shows the airfield circulation patterns when the Airport is operating in a MID Flow configuration. Aircraft landing on Runway 4 access the west side of North Ramp via Taxiway A and proceed westbound on Taxiway Y. To access the east side of the North Ramp, aircraft exit Runway 4 via Taxiway A, then use the taxilane to the east or west side of the North Ramp. Aircraft landing on Runway 4 and proceeding to the West Ramp exit on Taxiway A, then use Taxiways Y, H1, H, and G. Aircraft landing on Runway 4 and proceeding to the South Ramp use Taxiways A and K, cross Runway 12L-30R when directed by ATC, turn left onto Taxiway M, and hold awaiting ATC clearance. Once clearance is received, aircraft turn right onto Taxiway L and cross Runway 12R-30L proceeding to the South Ramp.

Aircraft landing on Runway 4 access the Southeast Ramp via Taxiways A and K, then cross Runway 12L-30R, turn left onto Taxiway M, and hold awaiting ATC clearance. Once clearance is received, aircraft turn left onto Taxiway P, cross Runway 12L-30R, and proceed to the Southeast Ramp. Aircraft landing on Runway 4 access the East Ramp via Taxiways A and K. Aircraft parked at the North Ramp and departing on Runway 22 use Taxiway Z. Aircraft parked at the West Ramp and departing on Runway 22 use Taxiways G, H, and Z. Aircraft parked at the South Ramp and departing on Runway 22 use Taxiways J and K. Aircraft parked at the Southeast Ramp and departing on Runway 22 use Taxiways C and K. Aircraft parked at the East Ramp and departing on Runway 22 use Taxiways R and K.

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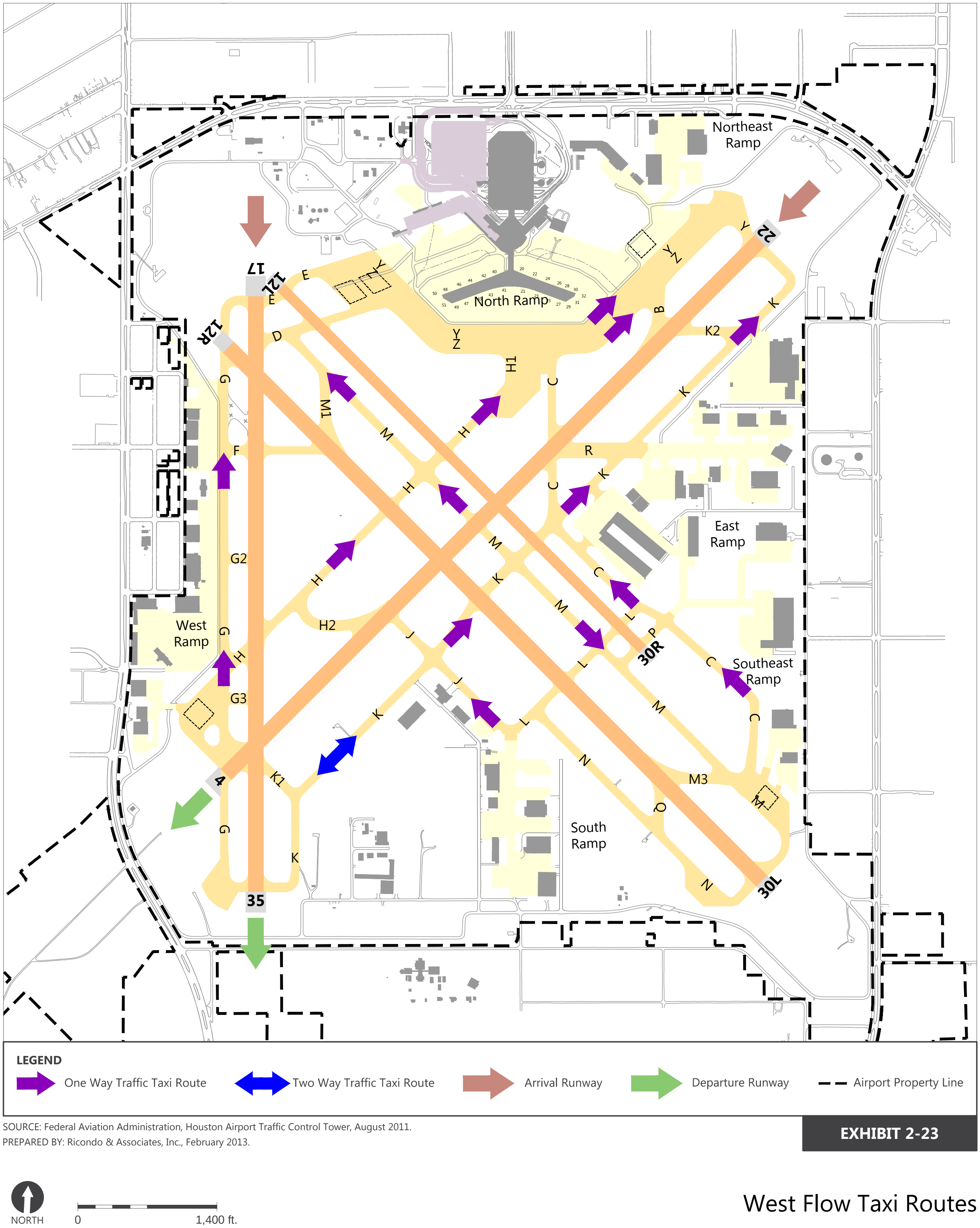

SOURCE: Federal Aviation Administration, Houston Airport Traffic Control Tower, August 2011.
PREPARED BY: Ricondo & Associates, Inc., February 2013.

EXHIBIT 2-23

West Flow Taxi Routes

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\Exhibit Taxi Routes.dwg_Layout: 2-23_West Flow_Dec 26, 2014, 12:04pm

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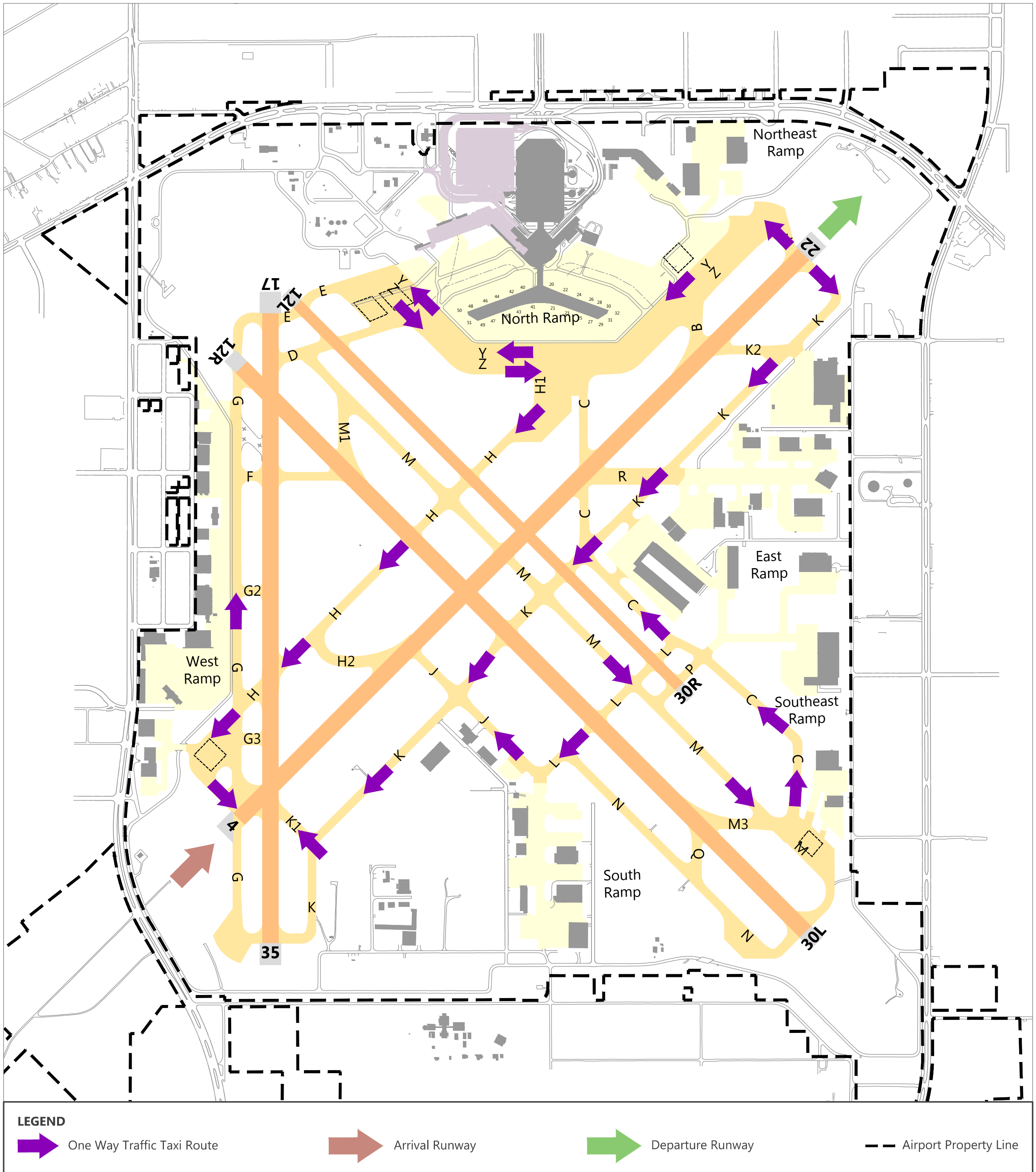

SOURCE: Federal Aviation Administration, Houston Airport Traffic Control Tower, August 2011.
PREPARED BY: Ricondo & Associates, Inc., February 2013.

EXHIBIT 2-24

MID Flow Taxi Routes

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2.9.3.7 SMGCS Flow Taxi Routes

Exhibit 2-25 shows the airfield circulation patterns when the Airport is operating in an SMGCS Flow configuration. Aircraft landing on Runway 4 access the west side of the North Ramp via Taxiway A, then proceed westbound on Taxiway Y; aircraft accessing the east side of the North Ramp use Taxiways A and Y, and then use the taxilane at the east side of the North Ramp. Aircraft landing on Runway 4 access the West Ramp via Taxiway A and then proceed via Taxiways Y, H1, H, and G. Aircraft landing on Runway 4 access the South Ramp via Taxiways A and K, cross Runway 12L-30R when directed by ATC, turn left onto Taxiway M, and hold awaiting ATC clearance. Once clearance is received, aircraft turn right onto Taxiway L and cross Runway 12R-30L to access the South Ramp.

Aircraft landing on Runway 4 access the Southeast Ramp via Taxiways A and K, cross Runway 12L-30R, then turn left onto Taxiway M and hold awaiting ATC clearance. Once clearance is received, aircraft turn left onto Taxiway P, cross Runway 12L-30R, and proceed to the ramp. Aircraft landing on Runway 4 access the East Ramp via Taxiways A and K. Some tenant facilities have entrances on Taxiway K, while others have entrances on Taxiway R.

Aircraft parked on the west side of the North Ramp and departing on Runway 4 await ATC clearance to a Geographic Position Marking and then call Ground Control for clearance to taxi into the movement area. The aircraft then taxi eastward on Taxiways Z, H1, H, to Runway 4. Aircraft parked on the east side of the North Ramp and cleared to depart on Runway 4 taxi westbound on Taxiways Y, H1, and H to Runway 4. Aircraft parked on the West Ramp and departing on Runway 4 await ATC clearance, then proceed southbound on Taxiway G, then turn right onto Taxiway H and hold short of Runway 4.

Aircraft parked on the South Ramp and departing on Runway 4 taxi, with ATC clearance, northwest onto Taxiway J and hold at Taxiway J1 before proceeding onto Taxiway K. Aircraft parked on the Southeast Ramp and departing on Runway 4 exit via Taxiway C. When directed by ATC, aircraft turn left onto Taxiway K (holding short of the ILS critical area), and hold on Taxiway K1 awaiting ATC takeoff clearance. Aircraft parked on the East Ramp and departing on Runway 4 proceed southwest on Taxiway K (holding short on Taxiway K1) until receiving ATC takeoff clearance.

2.9.3.8 Sunday AM Flow Taxi Routes

Exhibit 2-26 illustrates the airfield circulation patterns when the Airport is operating in Sunday AM Flow. Runway 4 is the only runway used for arrivals in this runway use configuration. Aircraft destined for the North Ramp use Taxiways M, D, Z or Taxiways M, H, and Z or Taxiway C or Taxiway B or Taxiway A. Aircraft destined for the West Ramp use Taxiways M, H, and G or Taxiways A, K, K1, Runway 4-22, and Taxiway G.

Aircraft destined for the South Ramp use Taxiway J or Taxiways A, K, and J. Aircraft destined for the Southeast Ramp use Taxiways J, L, N, and M or Taxiway M. Those destined for the south side of the East Ramp use Taxiways M, C, and P or Taxiways C and P. Aircraft destined for the north side of the East Ramp use Taxiways A, K, and R or Taxiway R.

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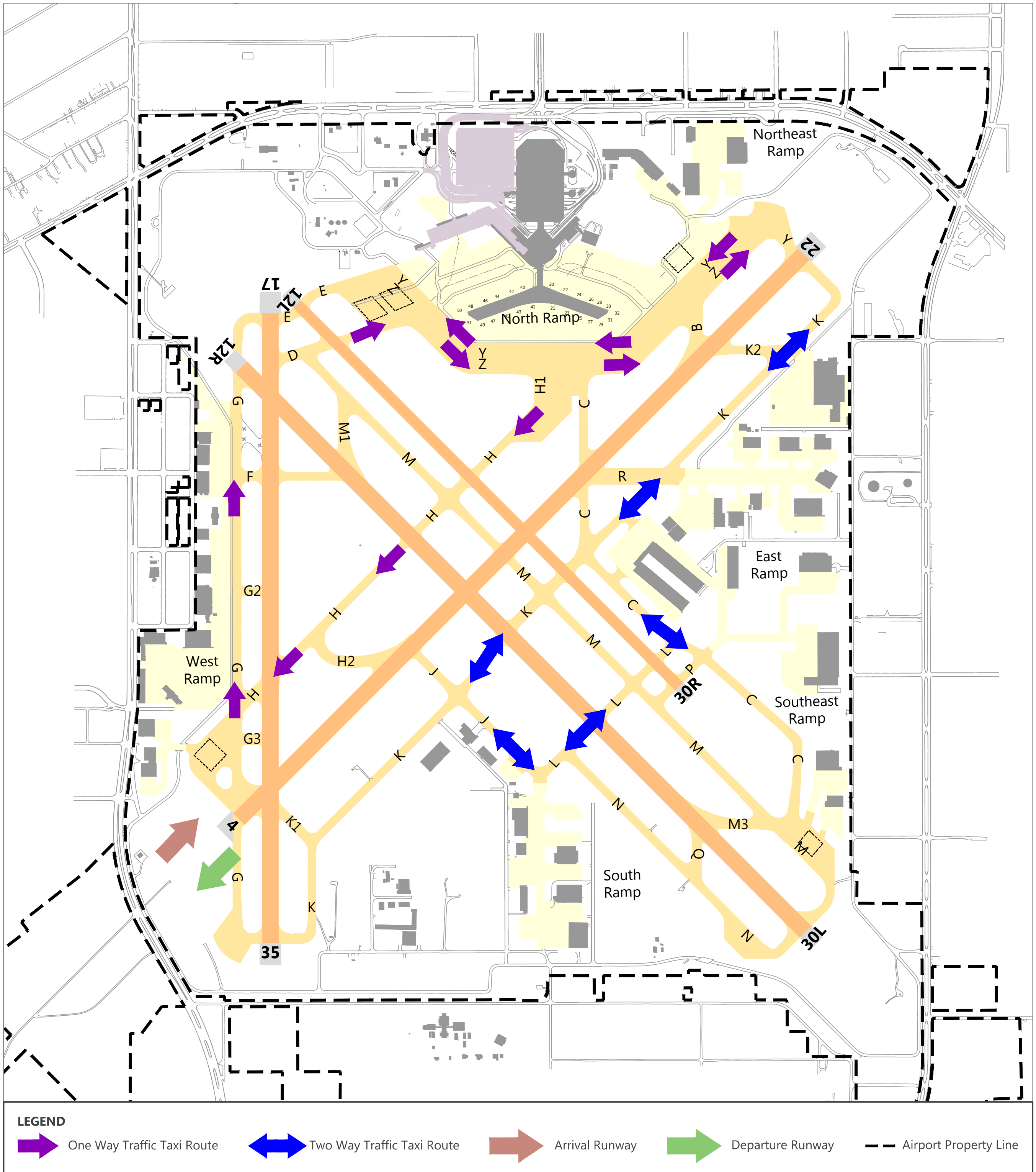

SOURCE: Federal Aviation Administration, Houston Airport Traffic Control Tower, August 2011.
PREPARED BY: Ricondo & Associates, Inc., February 2013.

EXHIBIT 2-25

SMGCS Flow Taxi Routes

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\Exhibit Taxi Routes.dwg_Layout: 2-25_SMGCS_Flow_Dec 26, 2014, 12:06pm

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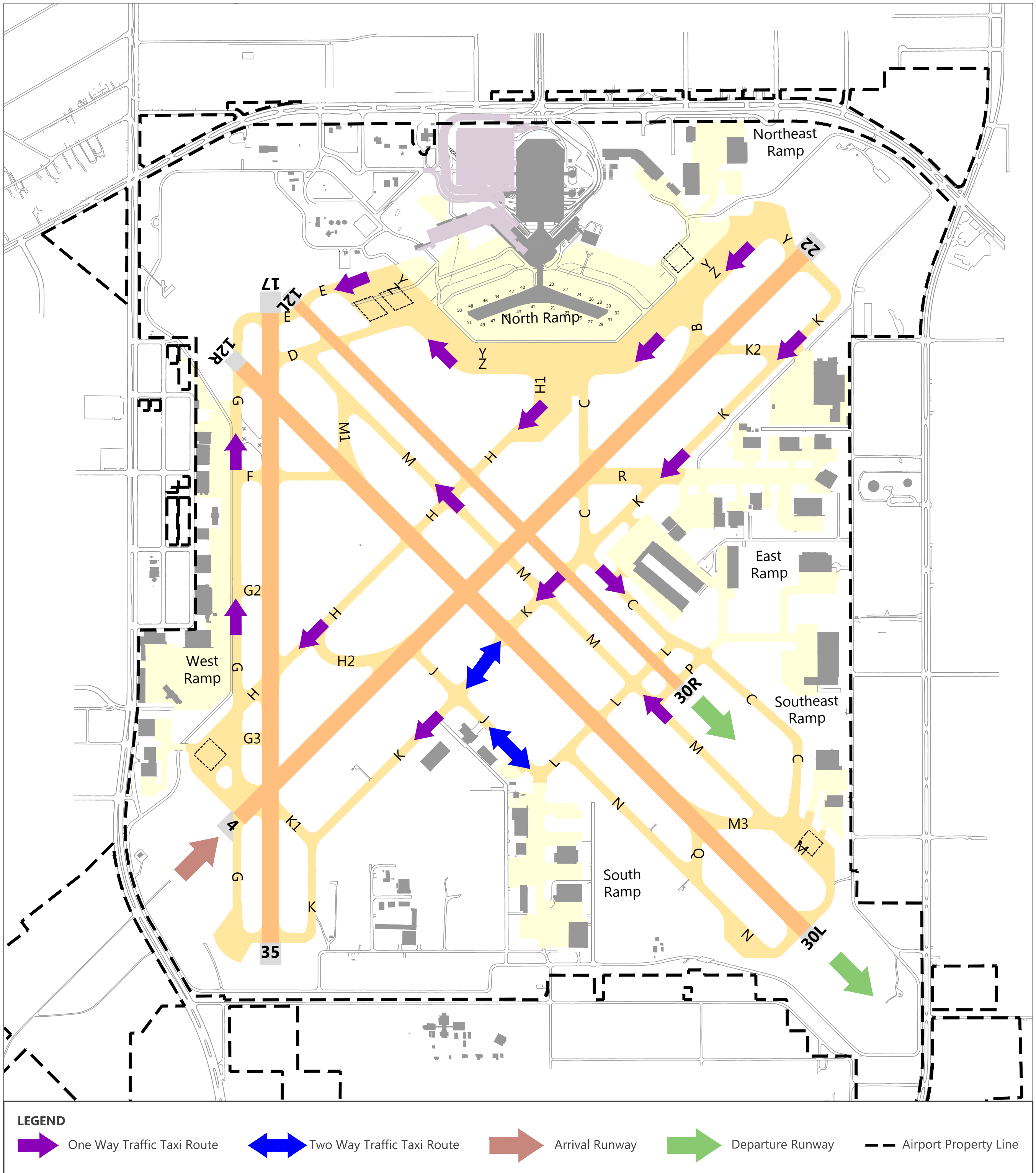

SOURCE: Federal Aviation Administration, Houston Airport Traffic Control Tower, August 2011.
PREPARED BY: Ricondo & Associates, Inc., February 2013.

EXHIBIT 2-26

NORTH 0 1,400 ft.

Sunday AM Flow Taxi Routes

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\02_Chapter 2_Inventory\3-R&A Files\Exhibit Taxi Routes.dwg_Layout: 2-26_Sunday AM Flow_Dec 26, 2014, 12:07pm

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Aircraft parked at the North Ramp and departing on Runway 12R use Taxiways Z and D, and those departing on Runway 12L use Taxiways Z and E. Aircraft parked at the West Ramp and departing on Runway 12R or 12L use Taxiways G and E. Aircraft parked at the South Ramp and departing on Runway 12R or 12L use Taxiways J, K, and K1, then Runway 4-22 and Taxiways G and E. Aircraft parked at the Southeast Ramp and departing on Runway 12R use Taxiways C, Z, and D; those departing on Runway 12L use Taxiways C, Z, and E. Aircraft parked at the East Ramp and departing on Runway 12R use Taxiways R, C, Z, and D; those departing on Runway 12L use Taxiways R, C, Z, and E.

2.9.4 INSTRUMENT FLIGHT RULE ARRIVAL PROCEDURES

HOU is a satellite airport for the purposes of FAA ATC services, as it shares approach control airspace and services with other Houston area airports, including IAH and EFD. Approach control services for the region are provided by the Houston TRACON.

The Houston TRACON airspace is structured so that arriving aircraft can safely and efficiently transition from the enroute environment to the approach control environment. The TRACON airspace is further structured to deliver arriving aircraft from the approach control airspace to the airfield proper. This structure is defined by radio navigation aids known as VOR/VOR Tactical Air Navigation (VORTAC) and airspace intersections. A VOR/VORTAC is a ground-based electronic navigation aid transmitting very high frequency navigation signals. Airspace intersections are geographical positions determined by reference points to one or more radio navigation aids.

The Houston TRACON controls arriving aircraft by issuing instructions, known as radar vectors. A radar vector is a heading issued to an aircraft to provide navigational guidance for the pilot. The Houston TRACON issues radar vectors and altitude clearances to position arriving aircraft in the proper traffic flow prescribed for aircraft landing at the Airport. The usual components of an arrival traffic flow in a radar environment are the downwind leg, base leg, and final approach. These components have the following structure and characteristics:

- Downwind Leg: A flight path parallel to the landing runway in the direction opposite to landing.
- Base Leg: A flight path at right angles to the landing runway off its approach end. The base leg typically extends from the downwind leg to the intersection of the extended runway centerline.
- Final Approach: A flight path in the direction of landing along the extended runway centerline. The final approach typically extends from the base leg to the runway.

The Houston TRACON arrival traffic flows and routings to these flows are discussed in the following sections. External conditions may alter these traffic flows (weather and traffic conditions permitting). ATC will always attempt to deliver arriving aircraft to the Airport via the most expeditious routing possible. The VORs and airspace intersections used for arrival and departure routings are depicted on **Exhibit 2-27**.

Aircraft are transitioned from the enroute phase of flight by Houston ARTCC to the Houston TRACON just prior to reaching the ROKIT intersection, the CLMBA intersection, the STROS intersection, or the TEXNN intersection. Aircraft arriving from Milwaukee, Chicago, Kansas City, and areas in the northeastern United

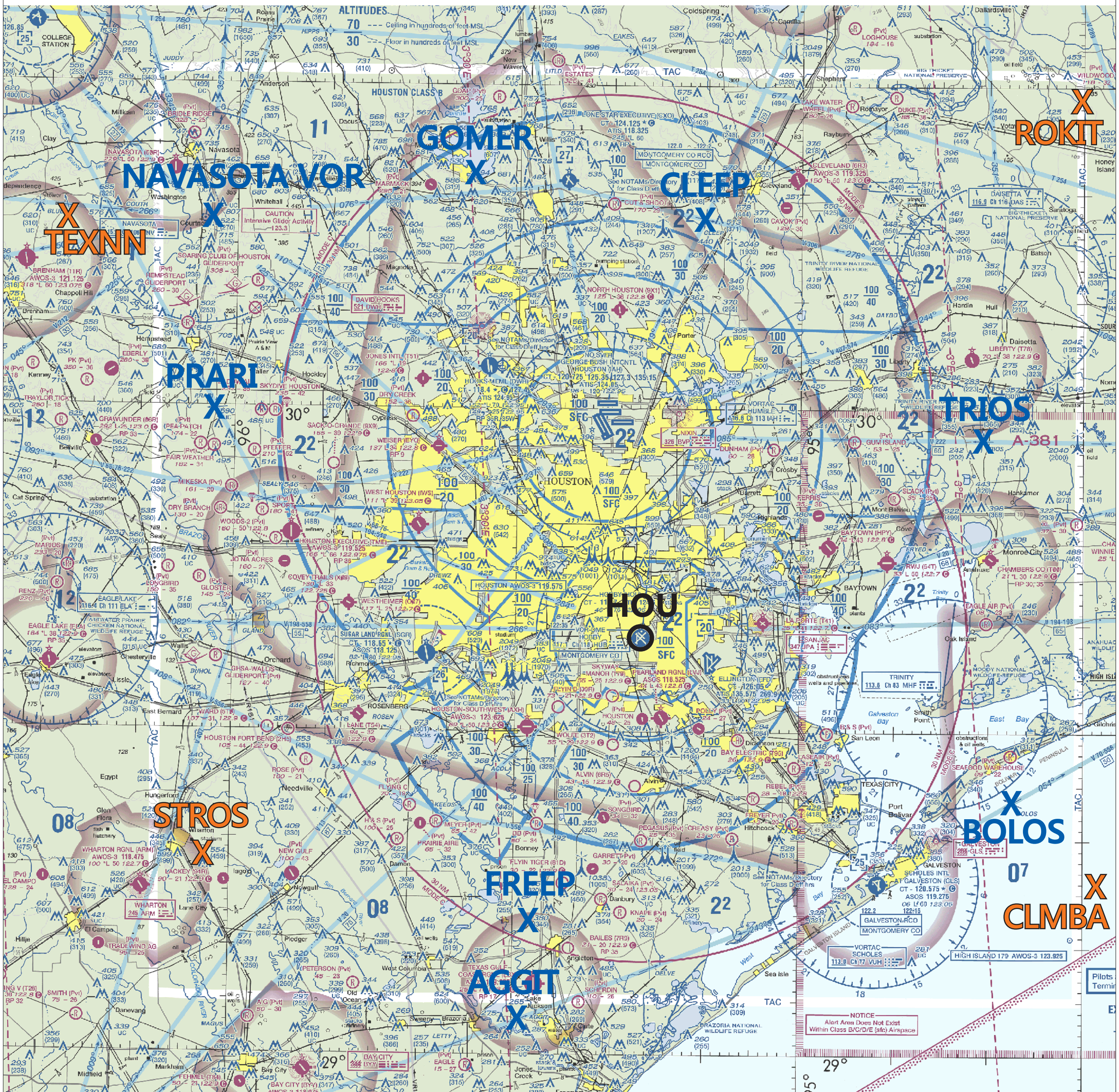
States arrive over the ROKIT intersection. HOU arrivals share this arrival fix with aircraft destined for IAH and EFD. Aircraft destined for these airports cross the ROKIT intersection at least 5 nautical miles in-trail of each other. Turbojets cross the ROKIT intersection at 10,000 feet above MSL. Turboprops and piston-powered aircraft are assigned lower altitudes. HOU arrivals are then vectored toward the southwest for either a visual or instrument approach.

The CLMBA intersection serves aircraft arrivals at HOU from the southeast and Gulf regions of the United States. Aircraft originating flights in cities such as Miami, Jacksonville, and New Orleans arrive at the Airport via the CLMBA intersection. Aircraft destined for the Airport cross the CLMBA intersection at 10,000 feet above MSL and 5 nautical miles in-trail separation. Aircraft are radar vectored to the west for either a visual or instrument approach to the Airport.

Aircraft originating from the southwestern United States, Mexico, or southwest Texas use the arrival stream flying over the STROS intersection. Arrivals from cities such as Los Angeles, Phoenix, and San Antonio use this routing. Turbojet aircraft are assigned an altitude of 10,000 feet above MSL, while turboprops and piston-powered aircraft are assigned lower altitudes. Arriving aircraft are vectored toward the east to the appropriate traffic pattern component for either a visual or instrument approach to the Airport.

Aircraft arriving at the Airport from the Rocky Mountain region, the Pacific Northwest, and North Texas use the TEXNN intersection to enter the Houston TRACON airspace. Aircraft arriving from cities such as Dallas, Denver, and Salt Lake City use this routing. Aircraft destined for the Airport cross the TXNN intersection at 10,000 feet above MSL and 5 nautical miles in-trail separation. Aircraft are radar vectored to the southeast for either a visual or instrument approach to the Airport.

Implementation of the Optimization of Airspace Procedures for the Houston Metroplex (OAPM) took place in June 2014. Improvements include more arrival and departure procedures involving RNAV, routings resulting in less mileage, procedures with fewer level-offs, as well as new arrival and departure gate names (however, the location of these gates will be the same as the existing ones). The OAPM is not anticipated to result in any operational changes at the Airport.



LEGEND

- Airspace DEPARTURE Gates
- Airspace ARRIVAL Gates
- HOU Airport

SOURCE: skyvector.com, 2012.
PREPARED BY: Ricondo & Associates, Inc., CHPlanning, Ltd., May 2012.

EXHIBIT 2-27

NORTH 0 Not to Scale

Airspace Arrivals and Departures Gates

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2.9.5 INSTRUMENT FLIGHT RULE DEPARTURE PROCEDURES

Houston TRACON airspace is also reserved so that aircraft departing from the Airport can transition from the terminal environment to the enroute environment. The departure procedures and airspace are based on radio navigational aids and radar vectors in areas referred to as departure corridors. Four departure corridors serve the Houston TRACON (i.e., the North, South, East and West Corridors, which correspond to the departure control positions in the Houston TRACON). There are preferred departure routings, referred to as departure gates, from the Houston TRACON based on aircraft destination, arrival aircraft traffic flows, and enroute airspace requirements. These departure gates are also depicted on Exhibit 2-27. The Houston TRACON vectors departing aircraft toward these points and provides separation from traffic arriving at and departing from the airports in the Houston area. The Houston TRACON and the Houston ARTCC have mutually agreed to these departure points. Prior to these points, Houston TRACON transfers control of the aircraft to the Houston ARTCC. Aircraft departing from the Airport share departure airspace with aircraft departing from both IAH and EFD. The departure procedures used by the Houston TRACON are discussed in the following sections.

2.9.5.1 North Departure Corridor Procedures

The airspace fixes defining the departure gates for the north departure corridor are the GOMER and CLEEP intersections. Aircraft departing from the Airport and destined for the Dallas/Fort Worth area and midwestern U.S. cities (e.g., Cincinnati, Chicago, and Kansas City) depart through the GOMER gate. Departures from the Airport destined for southeastern U.S. cities, such as Atlanta and Charlotte; mid-Atlantic Coast cities, such as Washington, D.C. and Philadelphia; and northeastern U.S. cities, such as New York and Boston depart through the CLEEP gate.

2.9.5.2 East Departure Corridor Procedures

The airspace fix defining the departure gates for the east departure corridor is the TRIOS intersection. The TRIOS departure gate is used by aircraft departing from the Airport and landing at Gulf Coast airports, such as those in New Orleans and Mobile, or Florida airports, for aircraft that can operate over water for extended periods.

2.9.5.3 South Departure Corridor Procedures

The airspace fixes defining the departure gates for the south departure corridor are the FREEP, BOLOS and AGGIT intersections. Departures routed via the FREEP departure gate are generally destined for cities in the Rio Grande Valley, such as Brownsville and Harlingen, and cities in northern Mexico. Aircraft authorized to operate for extended periods over water and destined for cities such as Miami and Fort Myers or cities in the Caribbean are routed over the BOLOS departure gate. Departures destined for central and southern Mexico, Central America, and South America are vectored by ATC to the AGGIT departure gate.

2.9.5.4 West Departure Corridor Procedures

The PRARI intersections and the Navasota VOR serve as departure gates for the west departure corridor. Aircraft departing from the Airport and destined for Texas cities, such as San Antonio; southern California cities, such as Los Angeles; and southwestern U.S. cities, such as Las Vegas and Phoenix, are vectored over the

PRARI departure gate. The Navasota VOR departure gate serves northern California and Pacific Northwest cities (e.g., Oakland, Portland, and Seattle) and cities in the Rocky Mountain Region (e.g., Denver and Salt Lake City).

2.10 Land Use Data

2.10.1 EXISTING LAND USE

The development of land uses that are not compatible with airports or aircraft noise is a major concern across the country. In addition to aircraft noise, other issues, such as safety and other environmental impacts on land use around airports, need to be considered when addressing the overall issue of land use compatibility. Although several federal grant-in-aid programs include noise standards or guidelines as part of their funding eligibility and performance criteria, the primary responsibility for integrating airport considerations into the local land use planning process rests with local governments. The objectives of compatible land use planning are to encourage land uses that are generally considered to be incompatible with airports (such as residences, schools, and churches) to locate away from airports and to encourage land uses that are more compatible (such as industrial and commercial uses) to locate around airports. The FAA actively supports programs to minimize aircraft noise impacts in airport environments.

To implement effective land use planning and control measures around airports, it is necessary to identify specific planning boundaries. These boundaries define the airport environs for land use planning purposes. It is essential that airport owners/operators, elected officials, land use planners, and developers understand the components of an effective compatible airport land use plan. A land use plan incorporates federal and state airport design criteria, flight safety requirements, and land use provisions unique to the community. HAS recommends that safety zones, standard traffic patterns, overflight areas, noise contours, and 14 CFR Part 77 height restriction criteria be considered as "building blocks" by land use planners when developing zoning ordinances, airport overlay districts, and comprehensive land use plans for their communities. **Table 2-26** lists the land use mix within a 3-mile buffer around the Airport boundary. It should be noted that the primary land use around the Airport is residential (79.03 percent), followed by vacant properties (9.59 percent) and commercial development (5.17 percent).

Table 2-26: Land Use Classification

LAND USE TYPE	PERCENT OF TOTAL	NUMBER OF PARCELS	TOTAL SQUARE FEET	TOTAL ACRES
Residential	79.03%	42.15	63,649,815	7,955
Vacant/Undetermined	9.59%	5,118	37,726	2,636
Commercial	5.17%	2,760	13,404,725	4,375
Industrial	3.59%	1,916	14,795,265	3,678
Transportation/Utilities	0.78%	418	152,050	2,730
Multifamily	0.61%	330	20,136,737	953
Public/Institutional	0.42%	226	2,892,433	1,755
Missing data	0.41%	224	528	1,265
Office	0.23%	125	1,611,628	135
Public Right of Way	0.04%	26	--	14
Agricultural	0.00%	2	--	< 1

SOURCE: Harris County Appraisal District, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., May 2012.

Exhibit 2-28 illustrates the existing land uses in the Airport vicinity.

Many sensitive land uses are located in close proximity to the Airport. **Table 2-27** lists the number of noise-sensitive land uses, such as community centers, hospitals, libraries/universities, schools, and parks, exposed to various levels of aircraft noise.

Table 2-27: Sensitive Land Uses Exposed to Aircraft Noise above 60 dBA

NOISE EXPOSURE LEVEL	COMMUNITY CENTERS	HOSPITALS	LIBRARIES/ UNIVERSITIES	SCHOOLS	PARKS	TOTAL
Lower than 60 dBA – within 3-Mile Buffer	3	2	4	34	37	80
Between 60 dBA and 65 dBA	0	0	1	9	5	15
Between 65 dBA and 70 dBA	1	0	0	2	2	5
Between 70 dBA and 75 dBA	0	0	0	0	0	0
75 dBA	0	0	0	0	0	0

NOTE: DBA - A-WEIGHTED DECIBELS

SOURCE: Harris County Appraisal District, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., May 2012.

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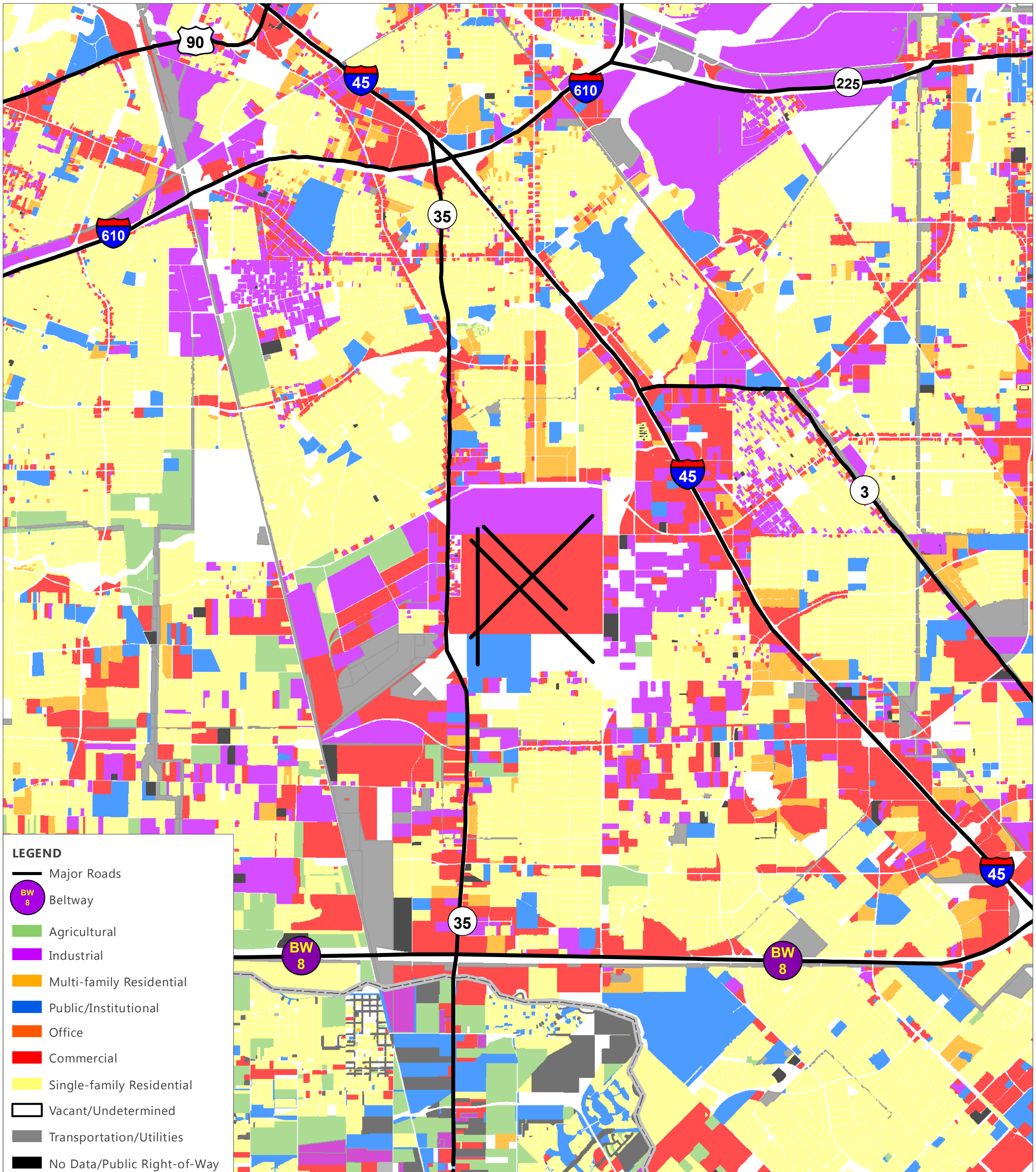

SOURCES: Houston-Galveston Area Council, Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-28

NORTH 0 6,500 Feet

Existing Land Use in the Airport Vicinity

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These land uses are depicted on **Exhibit 2-29**. This information may help define land use planning measures for the areas surrounding the Airport boundaries. Based on 2003 noise contours, there are no noise-sensitive land uses in the Airport vicinity exposed to 70 dBA or higher. Two schools and two parks are exposed to 65 to 70 dBA and one library, nine schools, and five parks are within the area exposed to 60 to 65 dBA.

2.10.2 POPULATION DENSITY AND HOUSEHOLD INCOME CHANGE

Population density and household income changes since the last U.S. Census in 2010 were analyzed. As shown on **Exhibit 2-30,** areas northwest and southeast of the Airport are more densely populated compared with the other areas surrounding Airport property.

2.10.3 HOUSEHOLD INCOME CHANGE

As shown on **Exhibit 2-31,** residents in areas on the west side of the Airport along State Highway 35 and the east side of the Airport along Monroe Road experienced annual household income increases in excess of $10,000, whereas residents in areas north and south of the Airport experienced either annual increases less than $5,000 or significant decreases of $25,000 in household income in the last 10 years (between the 2000 Census and the 2010 Census).

Based on these data, it would be cost efficient to implement future Airport expansion (i.e., new taxiways, runways) in areas northeast and southwest of the Airport based on lower population density and the availability of industrial and vacant land uses.

2.10.4 RESIDENTIAL PARCELS

Exhibit 2-32 shows all single family and multifamily residential parcels around the Airport. Aircraft noise is the single largest generator of Airport-related complaints. Based on the noise exposure pattern, the number of single family residential and multifamily residential units that would be affected by specific noise levels can be identified. It is important that decision-makers and policy makers consider Airport improvements based on land use compatibility around the Airport boundaries.

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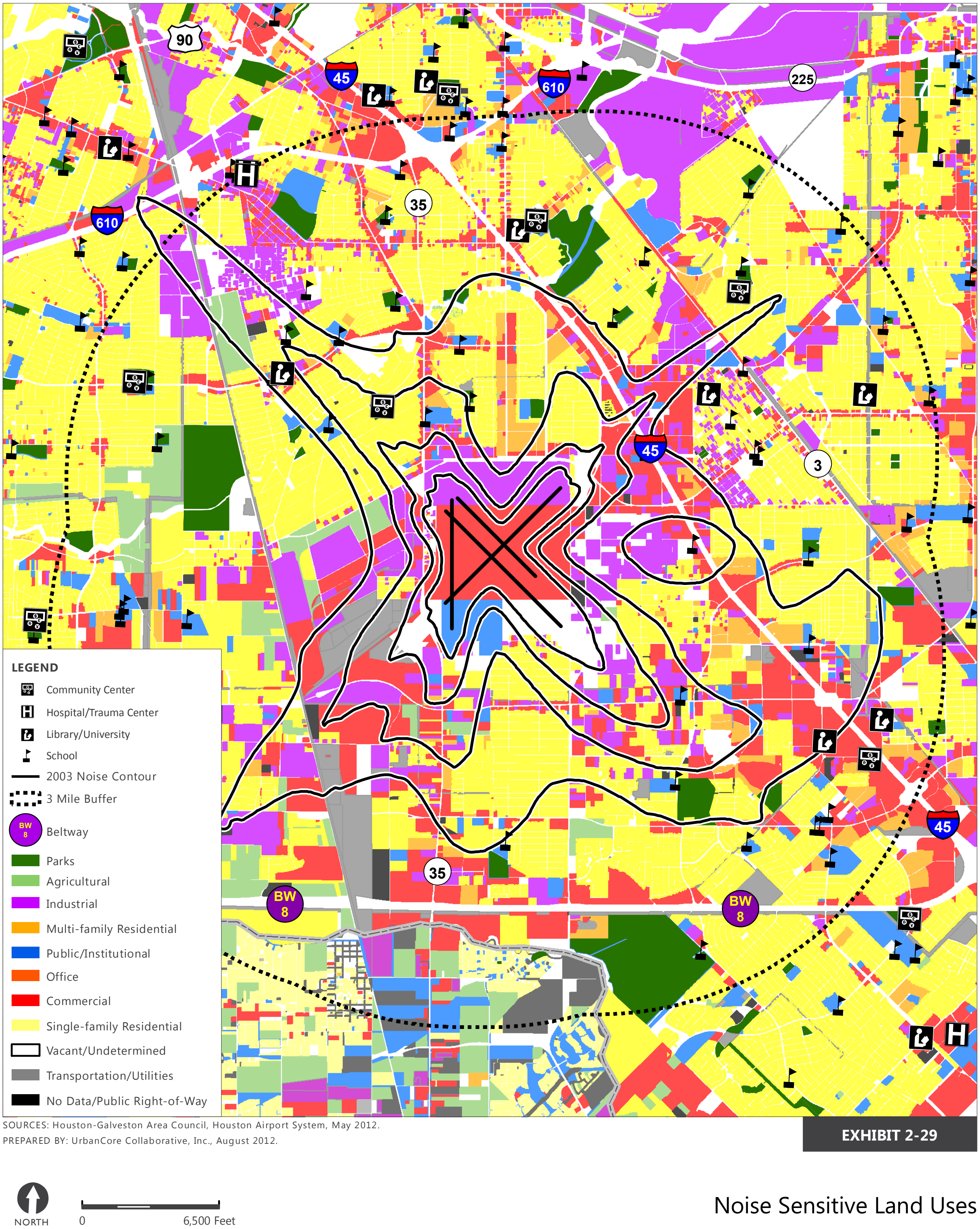

SOURCES: Houston-Galveston Area Council, Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-29

Noise Sensitive Land Uses

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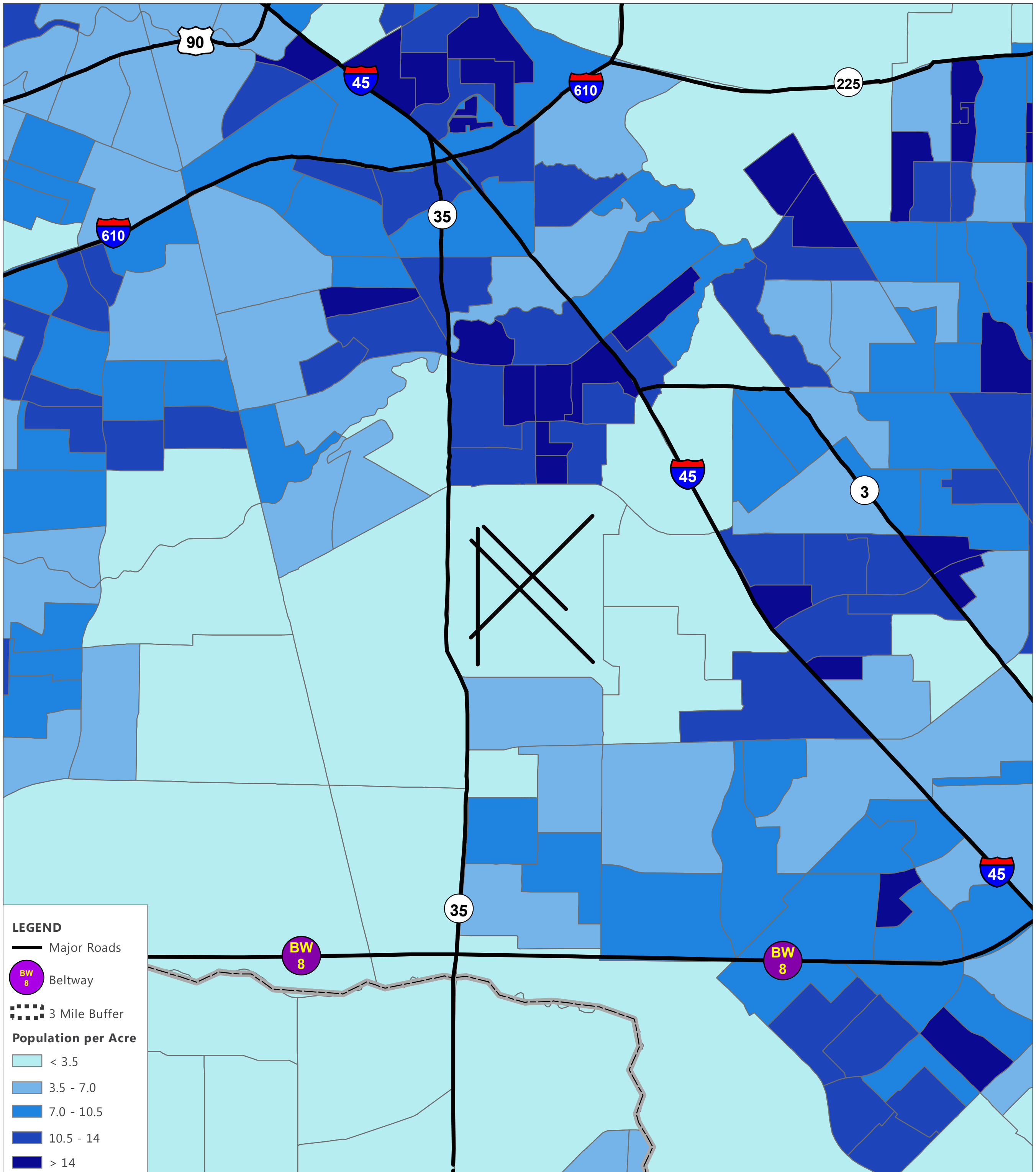

SOURCES: Houston-Galveston Area Council, Houston Airport System, U.S. Census Bureau, 2010 U.S. Decennial Census, Block Groups.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-30

NORTH
0 6,500 Feet

Population Density (2010)

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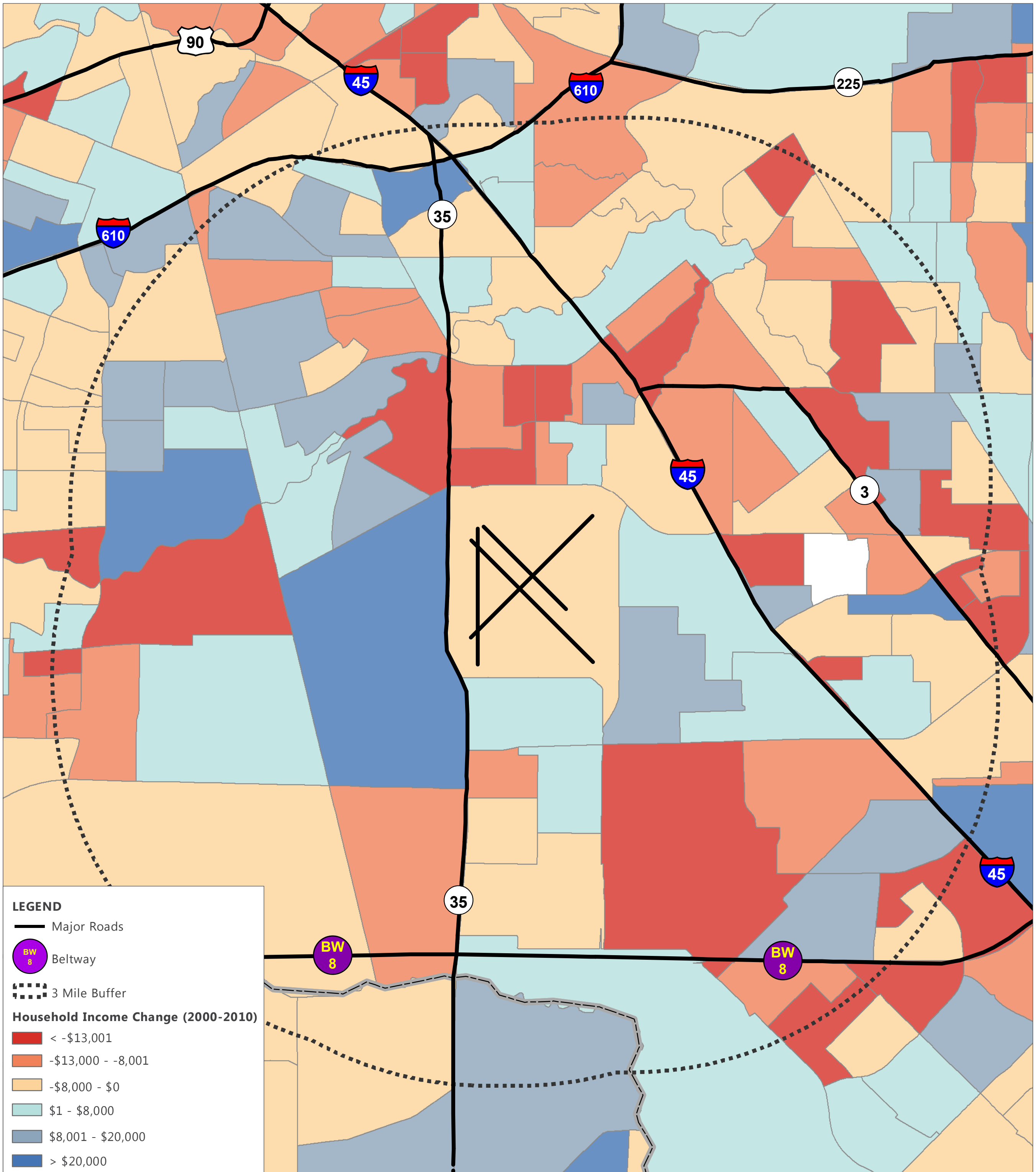

SOURCES: Houston-Galveston Area Council, Houston Airport System, Census Blocks 2010, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-31

NORTH 0 6,500 Feet

Household Income Change (2000-2010)

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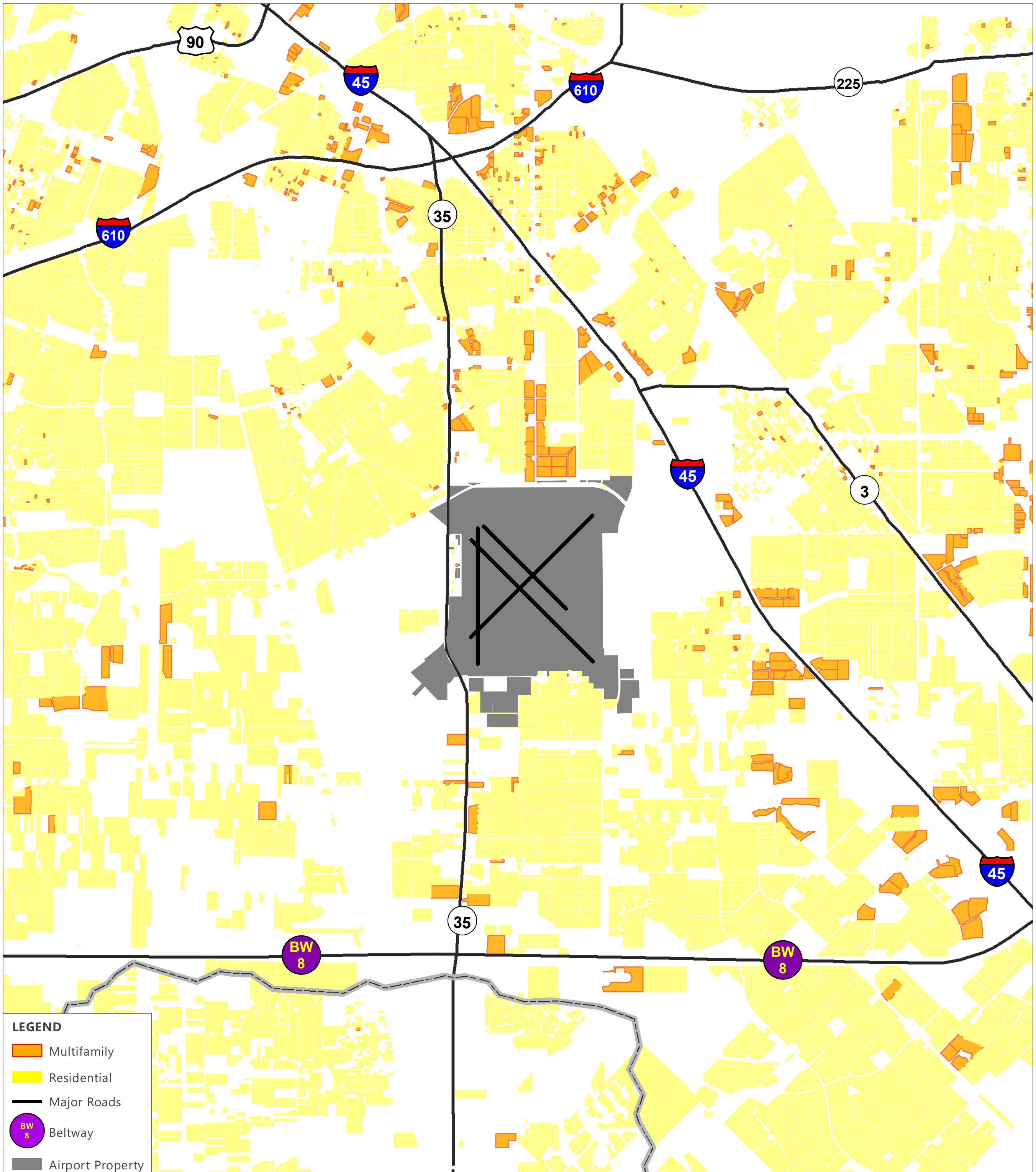

SOURCES: Houston-Galveston Area Council, Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-32

NORTH 0 6,500 Feet

Single Family & Multifamily Residential Parcels in the Airport Environs

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2.11 Utility Infrastructure

The existing utility infrastructure serving the Airport consists of the following six systems: water distribution, storm sewer, sanitary sewer drainage, electrical power distribution, telecommunication lines, and gas line systems, as discussed in the following sections.

2.11.1 WATER DISTRIBUTION SYSTEM

The existing water distribution system for the Airport is shown on **Exhibit 2-33.** This system is part of, and tied into, the larger surface water distribution system serving the Airport area, which is owned and operated by the City of Houston. The Airport receives surface water through surface water transmission lines from the East Water Purification Plant. The water wells in the area have been plugged. A network of interconnected (looped) distribution lines from 8 inches to 24 inches in diameter surrounds the Airport and provides service to the passenger terminal complex and various tenant facilities. Based on conversations with the City of Houston Public Works and Engineering Department, the water distribution system provides potable water in adequate flow and pressure in the event of a fire. A new 66-inch waterline is anticipated to become operational in October 2014 along Monroe Drive, which will provide a second source of water supply from the Southeast Water Purification Plant and provide additional reliability to the Airport.

2.11.2 STORM SEWER SYSTEM

HAS completed a comprehensive Drainage Master Plan (DMP) for the Airport in January 2012. On- and off-site drainage improvements needed to accommodate Airport improvement projects and changes in Airport land uses were identified in the 2003 Airport Master Plan. According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), a portion of the eastern half of the Airport along Monroe Road is in the 100-year floodplain for Berry Creek.

More than 414 acres of Airport property are projected to be in the 100-year floodplain due to lack of drainage improvements along Monroe Road. The HOU DMP identified drainage improvements needed to correct existing drainage system deficiencies at the Airport along with phased improvements that would adequately drain the Airport without increasing the potential for downstream flooding. The final HOU DMP report was coordinated with the Harris County Flood Control District and the City of Houston Floodplain Administrator for acceptance. The existing storm sewer system is illustrated on **Exhibit 2-34**.

2.11.3 SANITARY SEWER DRAINAGE SYSTEM

The existing sanitary sewer drainage system is illustrated on **Exhibit 2-35**. The City constructs sanitary sewer facilities to collect, convey, and treat wastewater from developed properties. A sanitary sewer is a separate underground system specifically designed to transport sewage from houses and commercial buildings to treatment or disposal sites. Sanitary sewers are operated separately and independently of storm drains, which carry runoff from rain and other water that washes into city streets.

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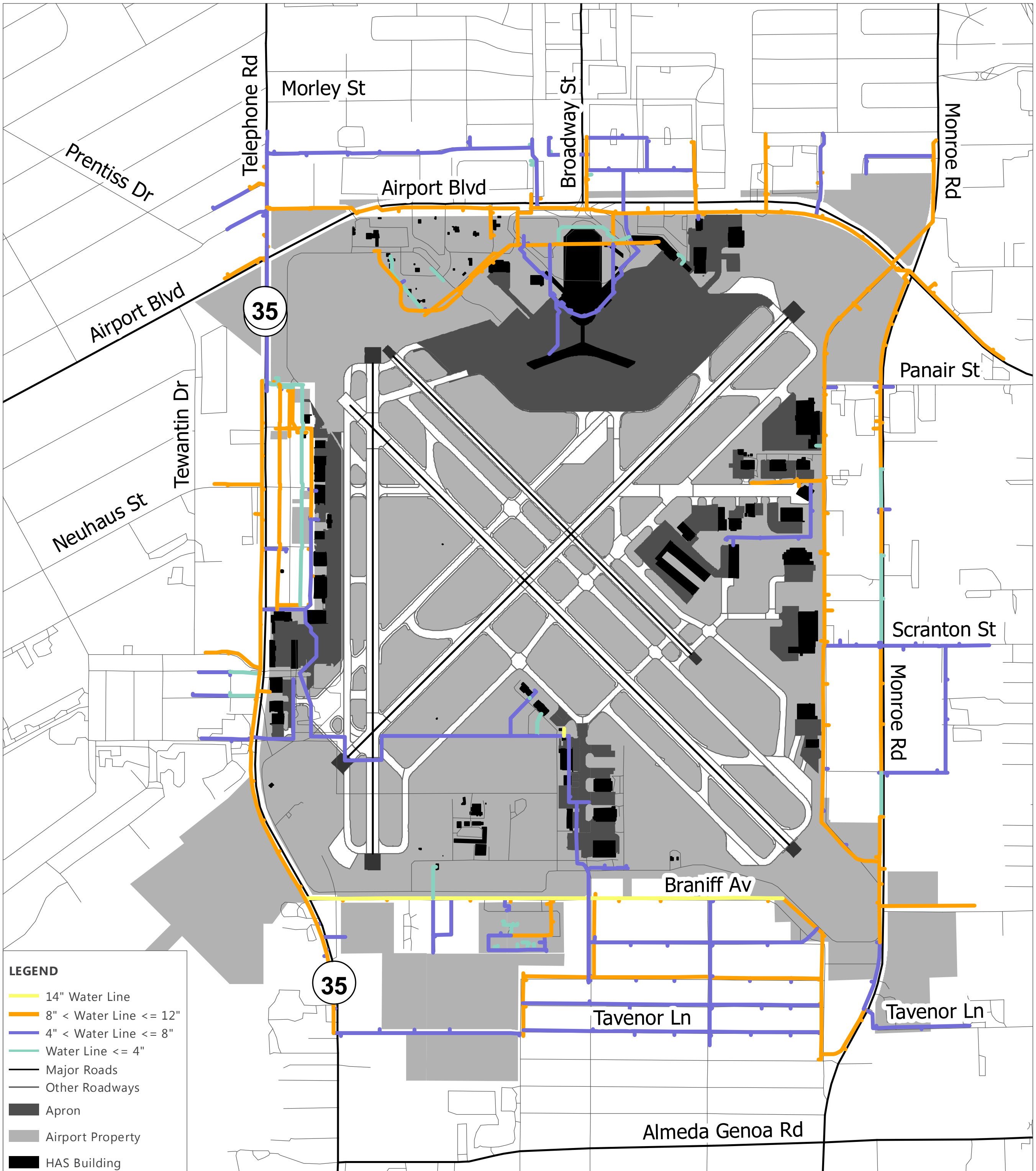

SOURCES: Houston-Galveston Area Council, Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-33

NORTH 0 1,800 Feet

Water Distribution System

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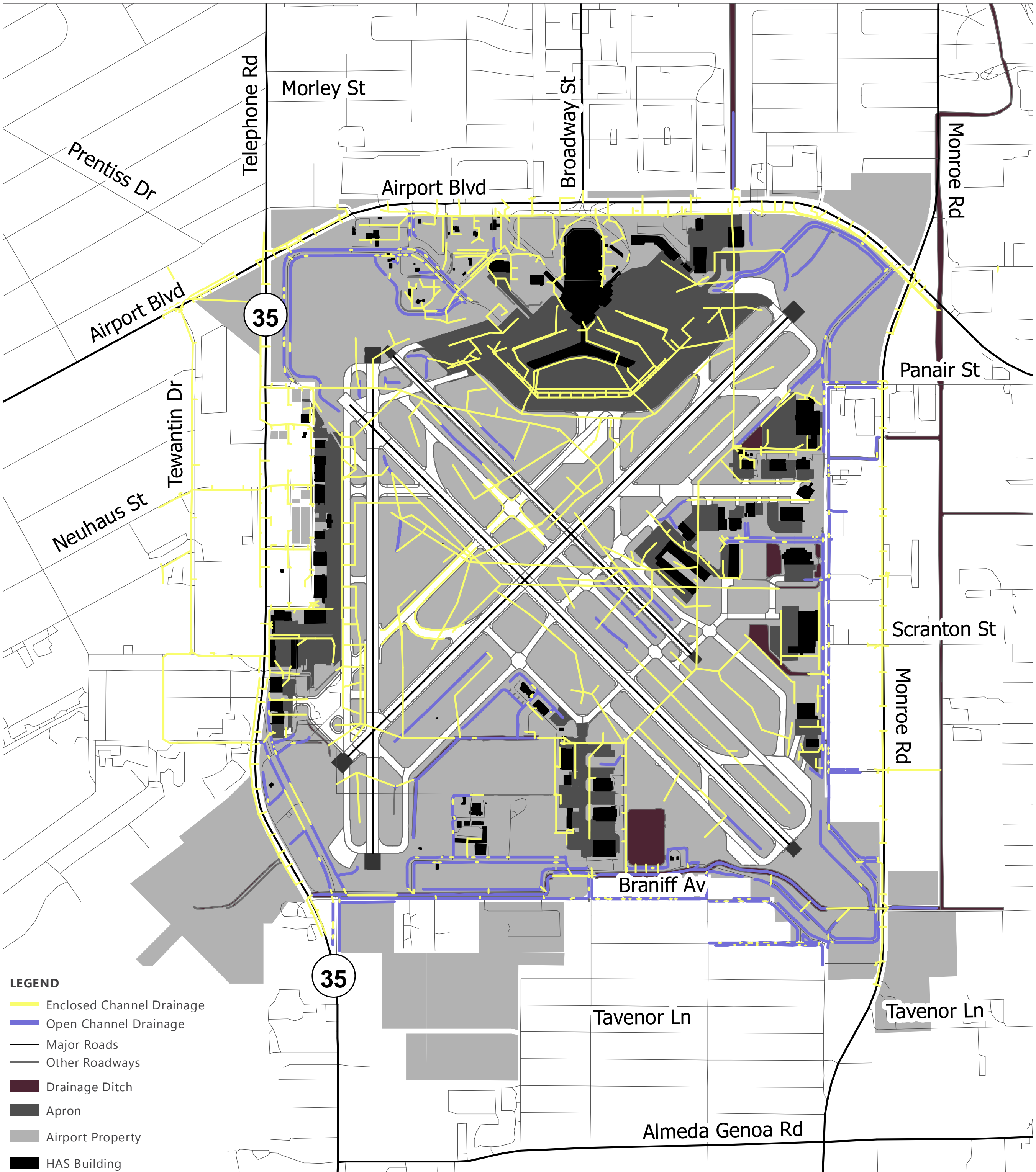

SOURCES: Houston-Galveston Area Council, Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-34

NORTH
0 1,800 Feet

Storm Sewer System

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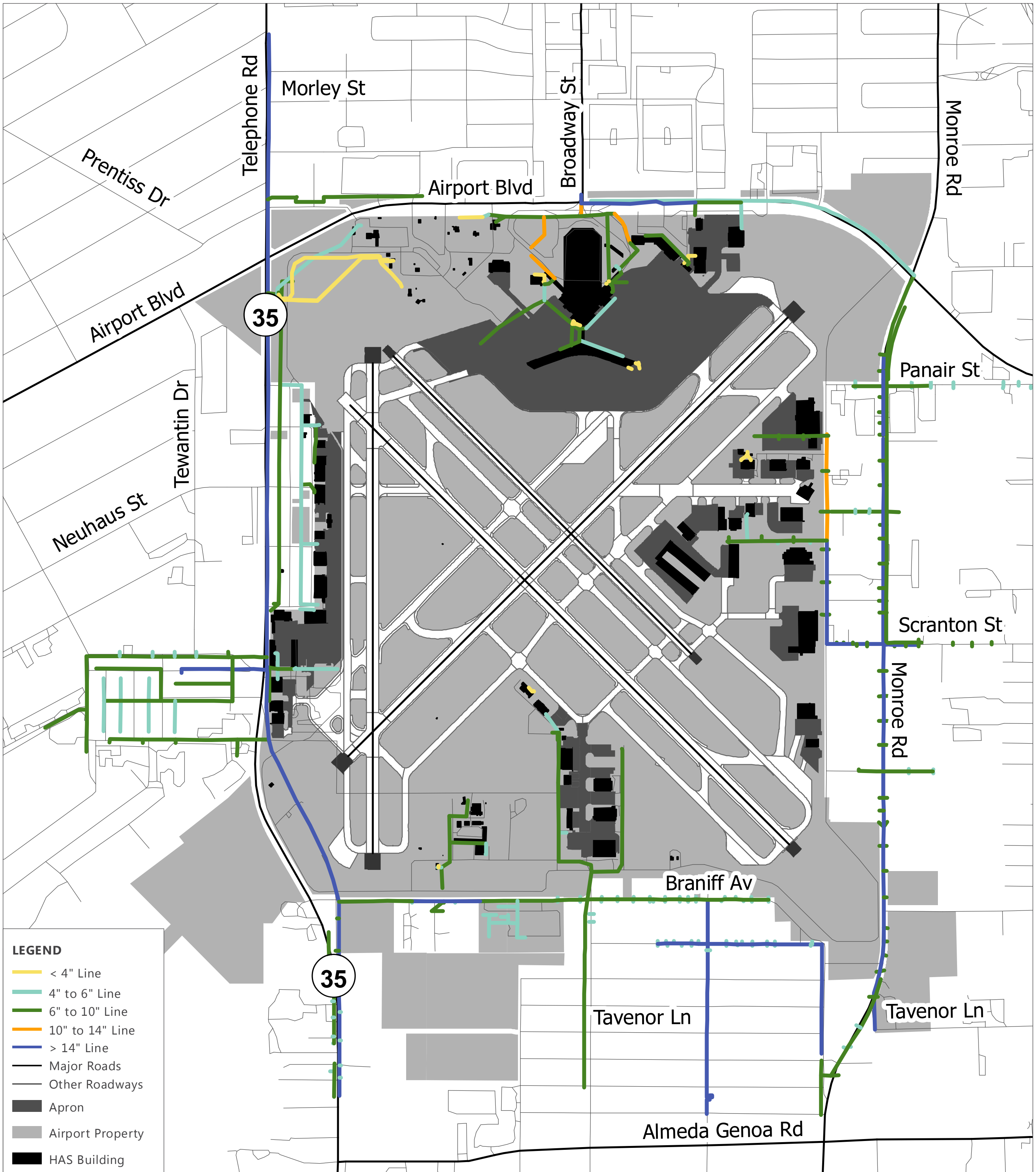

SOURCES: Houston-Galveston Area Council, Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-35

NORTH 0 1,800 Feet

Sanitary Sewer Drainage System

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2.11.4 ELECTRICAL POWER DISTRIBUTION SYSTEM

The electrical power distribution system is shown on **Exhibit 2-36**.

2.11.4.1 Electrical Duct Banks

The electrical duct banks on and around the Airport relay power for roadway lighting, HAS lighting and power, and FAA and HAS communications. Center Point Energy maintains the roadway lighting duct banks on a lease/maintenance contract with HAS. Other duct banks are maintained by HAS. Ducts are located generally parallel and perpendicular to the Airport runways and taxiways for necessary access and maintenance during construction and repairs without adversely affecting Airport operations. Access manholes are provided at 300- to 400-foot intervals in accordance with installation standards. New ducts will have to be provided to accommodate substantial increase in demand.

2.11.4.2 Electrical Substation

An offsite electrical substation serves the Airport and provides voltage and power requirements for all facilities and electrical feeds. Distribution lines are very old and are routed overhead through residential areas. There is only one circuit to the Airport from this substation, connected through a single overhead drop.

CIP projects planned for the Airport indicate a substantial growth requirement for electrical power to serve a new parking garage, maintenance building, passenger terminal expansion, and various airfield support buildings.

2.11.4.3 Electrical Vaults

Two electrical vaults are located on Airport property. The south electrical vault (Building S-250) is located southwest of the intersection of Taxiways J and L, and the north electrical vault (Building N-322) is located south of the triturator and trash compactor sites. Each vault serves a prescribed number of runway and taxiway lights and illuminated signs. These vaults serve as electrical substations and as connecting nodes for Airport facilities.

2.11.5 TELECOMMUNICATION LINES

The telecommunication lines serving the Airport are shown on **Exhibit 2-37**. Telecommunication facilities include all cable infrastructure, pathways, and equipment.

2.11.6 GAS LINE SYSTEM

The existing gas line system serving the Airport is shown on **Exhibit 2-38**. Center Point Energy supplies the Airport with natural gas. The service feeds consist of a 4-inch intermediate pressure gas line on Airport Boulevard that serves the terminal complex and Airport facilities. This gas line is taped into an 8-inch intermediate pressure gas line that runs along Telephone Road from Newhaus Street to north of Airport Boulevard. An 8-inch high-pressure gas line also runs along Airport Boulevard from west of Telephone Road, then turns north on Broadway Street. This 8-inch high pressure gas line does not feed the Airport. However, this line is available for future direct tie-in to Airport facilities if needed. According to discussions with representatives from Center Point Energy, gas distribution capacity is sufficient to accommodate future anticipated requirements. However, distribution lines may need to be expanded to provide additional service.

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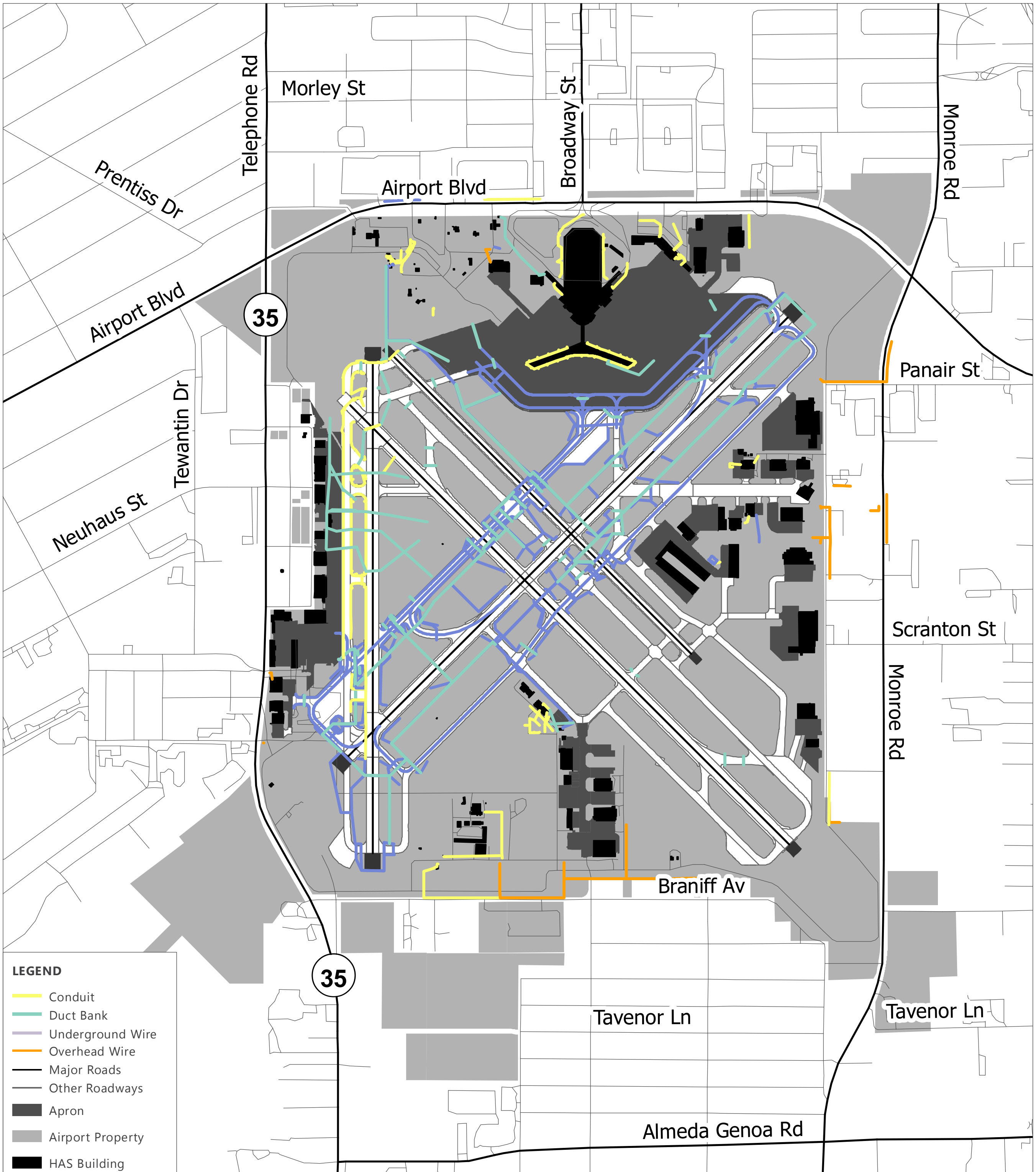

SOURCES: Houston-Galveston Area Council, Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-36

NORTH 0 1,800 Feet

Electrical Power Distribution System

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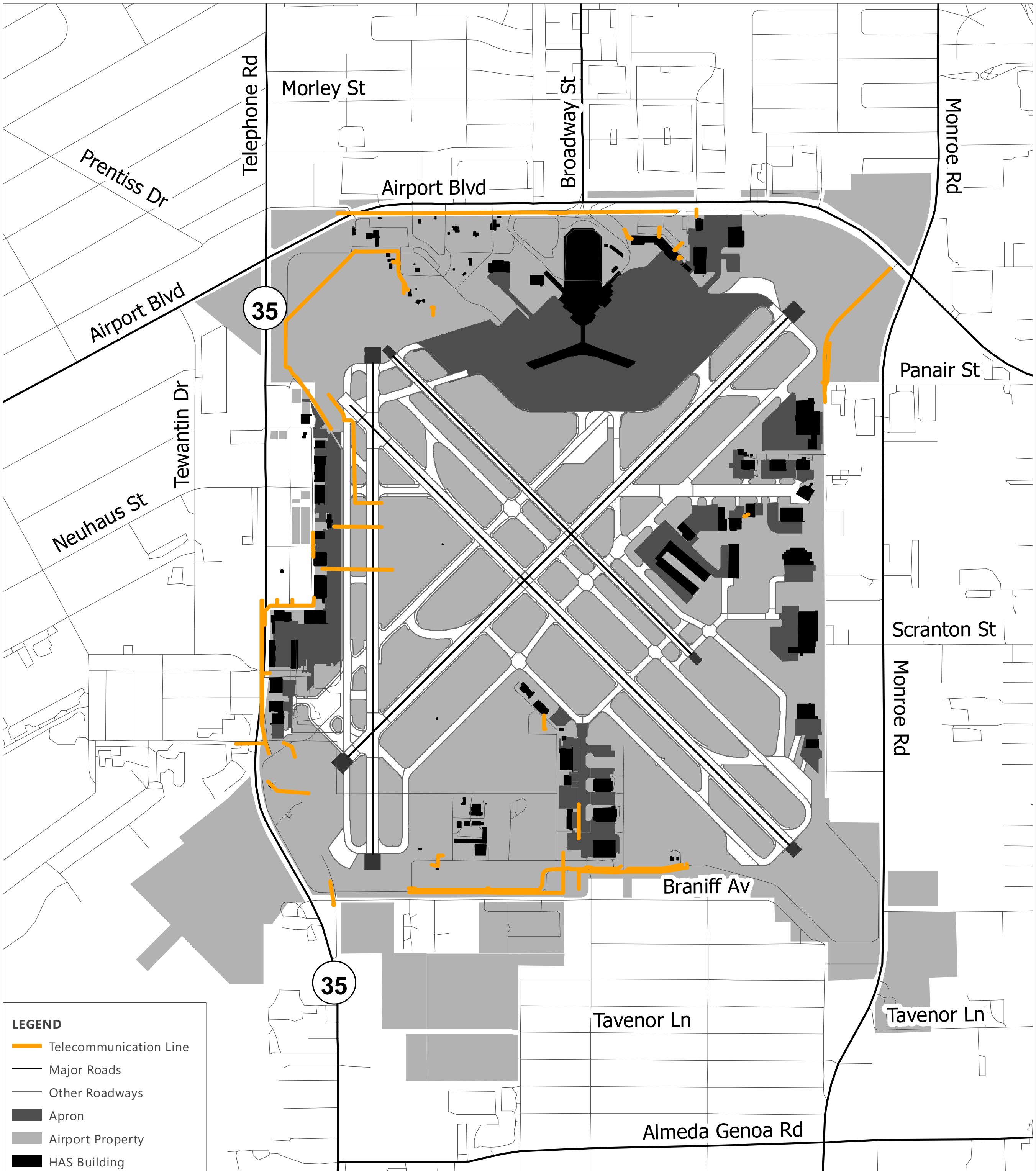

SOURCES: Houston-Galveston Area Council, Houston Airport System, May 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-37

NORTH 0 1,800 Feet

Telecommunication Lines

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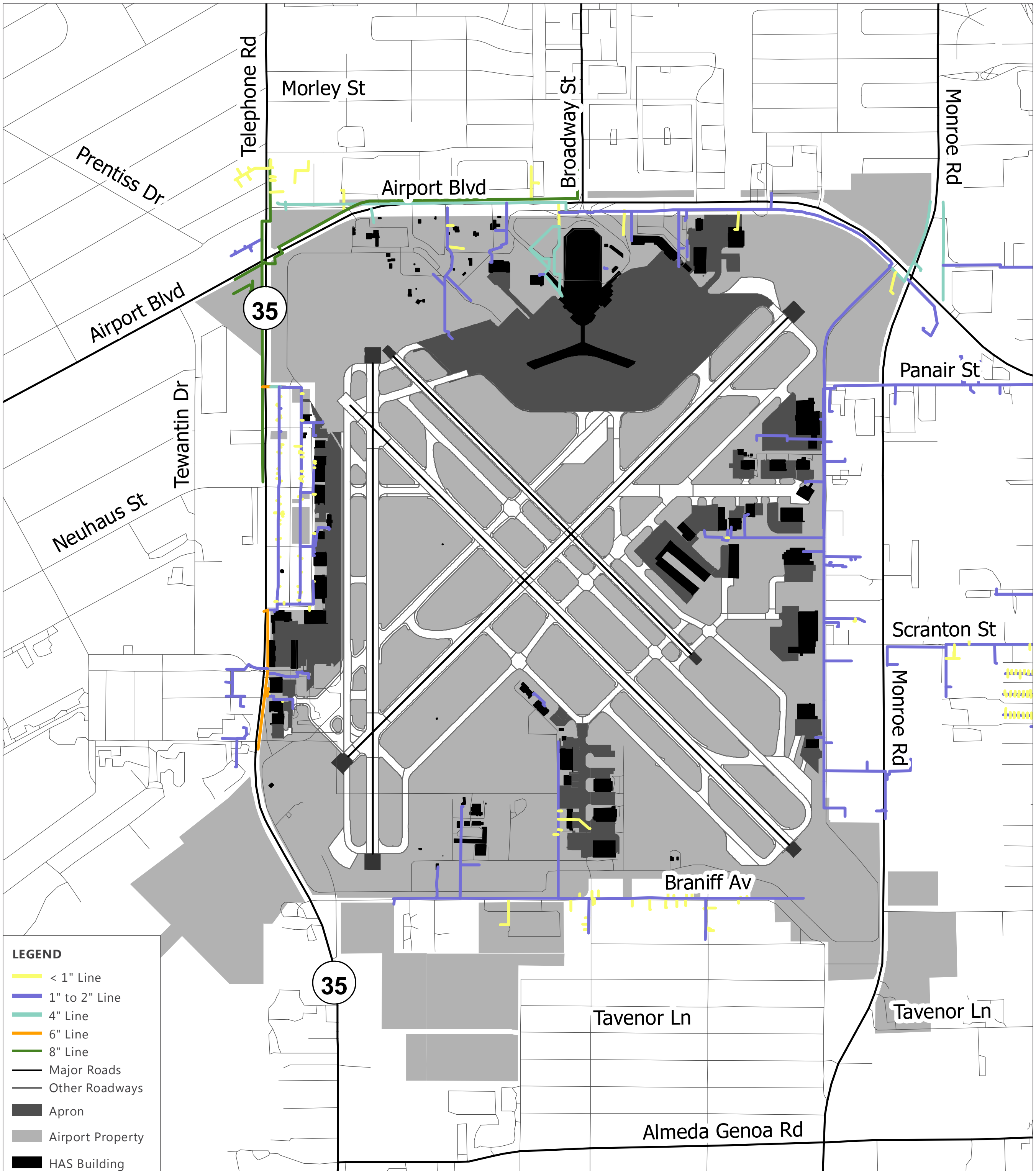

SOURCES: Houston-Galveston Area Council, Houston Airport System, August 2012.
PREPARED BY: UrbanCore Collaborative, Inc., August 2012.

EXHIBIT 2-38

NORTH 0 1,800 Feet

Gas Line System

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2.12 Environmental Data

Major Airport development projects will be recommended for implementation as part of this planning effort. To provide a baseline for the environmental overview, the existing conditions with regard to the environmental status of the Airport environs were inventoried. The following environmental categories were examined; the findings are included in Section 10.

- Aircraft Noise
- Compatible Land Use
- Socio-Economic Impacts and Environmental Justice
- Secondary Impacts
- Air Quality
- Water Quality
- Department of Transportation, Section 4(f)
- Historical, Architectural, Archaeological, and Cultural Resources
- Biotic Communities
- Endangered and Threatened Species of Flora and Fauna
- Wetlands
- Floodplains
- Coastal Management Program
- Coastal Barriers
- Wild and Scenic Rivers
- Farmland
- Energy Supply and Natural Resources
- Light Emissions and Visual Impacts
- Hazardous Materials, Pollution Prevention and Solid Waste
- Construction Impacts

The proposed Airport Development Plan (ADP) may affect the environment status of the Airport environs. An overview of the effects of the proposed projects on the environs of the Airport is presented in Section 10.

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3. Aviation Demand Forecasts

This section presents a discussion of historical aviation demand trends at the Airport, and summarizes forecasts of aviation demand through 2030. Forecasts were developed for enplaned passengers, air carrier and regional/commuter airline aircraft operations, general aviation and based aircraft activity, the aircraft fleet mix expected to operate at the Airport, and air cargo tonnage. The forecasts provide the basis for determining facility requirements and for conducting the environmental, financial, and other analyses necessary for developing this Airport Master Plan Update.

The forecasts were developed in 2012, with a base year of 2011, the last calendar year for which full year data was available before the forecasts were prepared and submitted to the FAA for review and approval. The forecasts presented in this section are based on assumptions about aviation demand in the Houston region and other factors that may affect future aviation demand at the Airport, including:

- National aviation industry trends and factors affecting these trends, including events related to the economy, fuel cost changes and other factors since 2001
- Policy goals and objectives of the Houston Airport System
- The Airport's role in the Houston Airport System
- Historical aviation demand and trends in airline service at the Airport, including comparisons with historical U.S. market shares
- Local socioeconomic and demographic trends, compared with State of Texas and national trends

The forecasts represent estimates of future activity at the Airport. Actual activity at the Airport may vary from the forecasts because of unforeseen events and changes in airline service at the Airport or at competing airports. Because future conditions are, by definition, unknown, future activity may differ from that in the forecasts. Inherent in forecasting is the further uncertainty of how airlines will respond to changes in operating costs and demand. Therefore, the forecasts presented in this section represent a range of possible, not necessarily actual, future airline operations.

In addition to the baseline forecasts (which serve as the basis for facility planning in this master plan update), alternative low and high growth forecast scenarios are presented in this section to account for potential changes in airline service patterns that could emerge during the planning horizon (through 2030). This range of forecasts is intended to guide Airport facility development decisions. The remainder of this section is organized as follows:

- Historical aviation demand and trends
- Factors affecting aviation demand
- Methodology overview and process
- Forecast enplaned passenger results
- Aircraft operations forecast development process
- Peak month and peak month average weekday demand
- Forecast scenarios
- Forecast applications

It should be noted that this Master Plan Update was prepared as Southwest Airlines (the dominant airline serving the Airport) was adjusting to two significant milestones that will have a significant impact on their future passenger services and operations:

(1) the repeal of the Wright Amendment, which governs flight operations at Dallas Love Field (DAL), will eliminate domestic flight restrictions on route stage lengths from DAL in 2014, and;
(2) the introduction of international passenger services at HOU beginning in 2015.

These changes will impact many characteristics of the Airport, including the number of connecting passengers, passenger flows, and gate demand. These changes are reflected in the aviation demand forecasts summarized in the remainder of this section.

3.1 Historical Aviation Demand and Trends

3.1.1 AIRLINES

The FAA classifies the Airport as a medium hub airport. As shown in **Table 3-1**, the Airport accommodated approximately 10.4 million passengers (enplaned and deplaned) in 2012 and almost 200,000 aircraft operations.

Between 2001 and 2012, the number of annual passengers at HOU increased at a compound annual growth rate (CAGR) of 1.7 percent, with more substantial growth of 3.4 percent per year between 2006 and 2012. In comparison, the number of passengers at IAH increased at a 1.3 percent CAGR between 2001 and 2012, but decreased an average of 1.1 percent per year between 2006 and 2012. **Table 3-2** shows historical activity at the three HAS airports from 2001 through 2012. The Airport's share of the region's total scheduled airline passengers decreased from 19.9 percent in 2001 to a low of 16.7 percent in 2006, but recovered over the next 5 years to 20.7 percent in 2012.

Table 3-1: Historical Passengers and Aircraft Operations

YEAR	TOTAL PASSENGERS	AIRCRAFT OPERATIONS
2001	8,637,150	247,173
2002	8,035,727	247,917
2003	7,803,330	244,335
2004	8,290,559	245,102
2005	8,257,506	242,385
2006	8,548,955	237,048
2007	8,819,521	236,742
2008	8,775,798	220,010
2009	8,498,441	201,654
2010	9,054,001	202,096
2011	9,843,302	199,920
2012	10,437,648	197,746
Compound Annual Growth Rate		
2001 - 2012	1.7%	-2.0%

SOURCE: FAA Air Traffic Activity Data System (historical operations); Houston Airport System (historical passengers); January 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

Over a similar period (2001-2011), regional socioeconomic activity in the Houston Galveston-Brazoria Consolidated Metropolitan Statistical Area (CMSA) increased steadily, with population increasing at a 2.3 percent CAGR and per capita personal income increasing at a 3.8 percent CAGR. Gross Domestic Product (GDP) for the CMSA increased at a 3.1 percent CAGR, comparing favorably with the national CAGR of 1.3 percent (see Section 3.2.7). These results indicate that HOU should continue to compare favorably with respect to national and regional aviation activity growth.

As of July 2011, six major/national airlines (including regional/commuter airline affiliates) and no independent regional/commuter airlines served the Airport. Regional/commuter airline passengers accounted for approximately 4.5 percent of total passengers at the Airport in 2011 because of the dominance of Southwest Airlines, which does not have regional/commuter airline affiliates.

Table 3-3 presents the scheduled airlines serving the Airport between 2006 and 2012. The passenger airlines serving the Airport provided nonstop service to approximately 39 domestic destinations in 2011, compared with 36 domestic destinations served in 2006, as presented in **Table 3-4**.

Table 3-2: Historical Total Passengers at Houston Airport System Airports

YEAR	HOU	HOU SHARE	IAH	IAH SHARE	EFD	EFD SHARE	TOTAL	ANNUAL GROWTH RATE
2001	8,637,150	19.9%	34,763,443	80.0%	60,255	0.1%	43,460,848	-
2002	8,035,727	19.1%	33,913,759	80.7%	76,035	0.2%	42,025,521	-3.3%
2003	7,803,330	18.5%	34,208,170	81.3%	80,306	0.2%	42,091,806	0.2%
2004	8,290,559	18.5%	36,513,098	81.4%	53,947	0.1%	44,857,604	6.6%
2005	8,257,506	17.2%	39,716,853	82.8%	-	-	47,974,359	6.9%
2006	8,548,955	16.7%	42,550,432	83.3%	-	-	51,099,387	6.5%
2007	8,819,521	17.0%	42,998,040	83.0%	2	0.0%	51,817,563	1.4%
2008	8,775,798	17.4%	41,708,580	82.6%	-	-	50,484,378	-2.6%
2009	8,498,441	17.5%	40,007,354	82.5%	-	-	48,505,795	-3.9%
2010	9,054,001	18.3%	40,479,569	81.7%	1	0.0%	49,533,571	2.1%
2011	9,843,302	19.7%	40,128,741	80.3%	-	-	49,972,043	0.9%
2012	10,437,648	20.7%	39,890,756	79.3%	-	-	50,328,404	0.7%
Compound Annual Growth Rate								
2001 - 2012	1.7%		1.3%		-100.0%		1.3%	
2006 - 2012	3.4%		-1.1%		-		-0.3%	

NOTE:

EFD = Ellington Airport; HOU = William P. Hobby Airport; and IAH = George Bush Intercontinental Airport/Houston.

SOURCE: Houston Airport System, January 2013.

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

Table 3-3: Passengers Enplaned by the Scheduled Airlines Serving the Airport, 2006 through 2011

AIRLINE	2006	2007	2008	2009	2010	2011	2012	2012 MARKET SHARE
Southwest Airlines[1/]	3,753,739	3,888,254	3,904,843	3,738,312	3,997,436	4,251,394	4,620,990	88.0%
AirTran Airways[1/]	170,219	181,695	175,209	167,412	180,879	222,872	202,181	3.8%
Delta Air Lines and Affiliates	132,059	140,307	144,385	149,595	157,969	179,619	200,246	3.8%
American Airlines and Affiliates	139,102	98,808	98,448	136,924	112,797	101,387	110,562	2.1%
JetBlue Airways	34,157	86,975	76,086	71,188	77,484	70,627	73,578	1.4%
Frontier Airlines	-	-	-	-	14,215	108,285	41,838	0.8%
Others [2/]	72,493	31,295	2,014	3,856	5,917	10,392	2,744	0.1%
Total Enplaned Passengers	4,301,769	4,427,334	4,400,985	4,267,287	4,546,697	4,944,576	5,252,139	100.0%

NOTE:

1/ On May 2, 2011, Southwest announced the closing on its acquisition of AirTran Holdings, Inc., the former parent company of AirTran Airways, Inc. (AirTran). The company plans to operate Southwest and AirTran separately for a period of time to address issues with integration, and expects full integration by the end of 2014. In April 2008, ATA filed for Chapter 11 bankruptcy protection and ceased all services.

2/ Includes ATA, Sun Country, and nonscheduled charter airlines.

SOURCE: Houston Airport System, January 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

Table 3-4: Passenger Markets Served Nonstop from the Airport, 2006 and 2011

		JULY 2006		JULY 2011	
MARKET	AIRLINE(S)	SOUTHWEST	OTHER AIRLINES	SOUTHWEST	OTHER AIRLINES
Albuquerque	Southwest	●		●	
Atlanta	AirTran, Delta		●		●
Austin	Southwest	●		●	
Baltimore	Southwest	●		●	
Birmingham	Southwest	●		●	
Branson	AirTran			●	
Charleston	Southwest			●	
Chicago (Midway)	Southwest	●		●	
Cincinnati	Delta				●
Corpus Christi	Southwest	●		●	
Dallas (Love)	Southwest	●		●	
Dallas-Fort Worth	American		●		●
Denver	Frontier, Southwest	●	●	●	●
El Paso	Southwest	●		●	
Fort Lauderdale	Southwest	●		●	
Fort Myers	Southwest	●			
Greenville-Spartanburg	Southwest			●	
Harlingen	Southwest	●		●	
Jackson	Southwest	●		●	
Jacksonville	Southwest	●		●	
Kansas City	Frontier				●
Las Vegas	Southwest	●		●	
Little Rock	Southwest	●		●	
Los Angeles	Southwest	●		●	
Midland	Southwest	●		●	
Minneapolis-St. Paul	Sun Country		●		
Nashville	Southwest	●		●	
New Orleans	Southwest	●		●	
New York (Kennedy)	Delta, JetBlue		●		●
New York (LaGuardia)	American, ATA		●		
Newark (Liberty)	Southwest			●	
Oakland	Southwest	●		●	
Oklahoma City	Southwest	●		●	
Orlando	Southwest	●		●	
Panama City	Southwest	●		●	
Philadelphia	Southwest	●		●	
Phoenix	Southwest	●		●	
San Antonio	Southwest	●		●	
San Diego	Southwest	●		●	
St. Louis	Southwest	●		●	
Tampa	Southwest	●		●	
Tulsa	Southwest	●		●	

NOTE:

1/ On May 2, 2011, Southwest announced the closing on its acquisition of AirTran Holdings, Inc., the former parent company of AirTran Airways, Inc. (AirTran). The company plans to operate Southwest and AirTran separately for a period of time to address issues with integration, and expects full integration by the end of 2014. In April 2008, ATA filed for Chapter 11 bankruptcy protection and ceased all services.

SOURCE: Diio LLC., November 2012.

PREPARED BY: Ricondo & Associates, Inc., November 2012.

Southwest Airlines has been the dominant airline serving the Airport since 1971, when the airline initiated service at Hobby. In 2012, Southwest Airlines accounted for approximately 88 percent of enplaned passengers and 84 percent of commercial airline aircraft operations at the Airport. In July 2011, Southwest Airlines averaged 137 daily departures from the Airport to the 35 nonstop destinations shown in Table 3-4.

All airlines that currently provide service at the Airport primarily serve short- and medium-haul destinations. As shown in **Table 3-5**, nearly 11 percent – or 383,257 – of the Airport's originating passengers in 2011 traveled between HOU and DAL. HOU primarily serves origin-destination passenger traffic – local passengers who begin or end their trip at the Airport – although the percentage of connecting passengers has been increasing in the recent years. **Table 3-6** lists originating and connecting passenger percentages at the Airport in 2011. Approximately 75 percent of the passengers at the Airport were classified as originating based on the U.S. Department of Transportation *Origin-Destination Passenger Survey*.

Table 3-5: Passengers and Airfares, Top 20 Origin and Destination Markets

		2006		2011		
2011 RANK	MARKET	ORIGINATING PASSENGERS	AVERAGE GROSS AIRFARE	ORIGINATING PASSENGERS	AVERAGE GROSS AIRFARE	NONSTOP SERVICE
1	Dallas (Love)	540,065	$97	383,257	$146	●
2	Denver	24,049	$112	174,525	$146	●
3	New Orleans	159,781	$105	174,447	$135	●
4	Chicago (Midway)	111,924	$142	157,920	$181	●
5	Las Vegas	117,600	$127	136,548	$166	●
6	Atlanta	118,921	$147	133,752	$164	●
7	Los Angeles	91,152	$146	124,489	$193	●
8	Baltimore	84,113	$148	91,845	$203	●
9	Orlando	62,988	$141	89,274	$189	●
10	Harlingen	89,100	$88	84,307	$95	●
11	St. Louis	83,593	$143	82,595	$187	●
12	Oklahoma City	64,569	$121	75,072	$162	●
13	Tulsa	77,759	$125	74,413	$168	●
14	Nashville	69,797	$139	69,711	$192	●
15	Phoenix	70,741	$139	68,392	$186	●
16	New York (Kennedy)	29,407	$119	68,306	$207	●
17	Oakland	44,223	$148	63,446	$202	●
18	Midland	59,597	$120	55,031	$163	●
19	San Diego	27,517	$162	53,387	$194	●
20	Tampa	38,913	$133	50,865	$196	●
	Other Markets	1,173,581		1,258,230		
	Total/Average	3,139,390	$131	3,469,812]	$176	

SOURCE: Diio LLC., November 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 3-6: Historical Originating and Connecting Passengers

YEAR	ORIGINATING	SHARE	CONNECTING	SHARE	TOTAL
2006	3,329,551	77.4%	972,218	22.6%	4,301,769
2007	3,474,075	78.5%	953,259	21.5%	4,427,334
2008	3,521,168	80.0%	879,817	20.0%	4,400,985
2009	3,313,092	77.6%	954,195	22.4%	4,267,287
2010	3,455,227	76.0%	1,091,470	24.0%	4,546,697
2011	3,786,671	76.6%	1,157,905	23.4%	4,944,576
2012	3,938,182	75.0%	1,313,957	25.0%	5,252,139
Compound Annual Growth Rate					
2006 - 2012	2.8%		5.1%		3.4%

SOURCE: Houston Airport System, January 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

It should be noted that the approximately 25 percent connecting passenger share compares with a 60 percent share at IAH. Connecting passengers are more a function of airline route planning than regional socioeconomic conditions. An additional contributing factor to the activity levels at HOU is its relationship with Dallas Love Field. Current Wright Amendment restrictions at DAL inflate connecting passenger activity at HOU. When the Wright Amendment restrictions expire in 2014, many of these HOU connecting passengers will be served nonstop from DAL; however, the proposed initiation of international activity at HOU by Southwest Airlines is expected to provide similar numbers of connecting passengers.

It was assumed that the Airport will continue to primarily accommodate local O&D passenger traffic, and that airlines serving the Airport will continue to provide low-fare, high frequency service to short- and medium-haul destinations.

3.1.2 AIR CARGO

Table 3-7 presents air cargo activity in total tons handled at the Airport between 2006 and 2012. Overall cargo tonnage increased an average of 6.0 percent per year, with Southwest Airlines carrying 99.2 percent of the total in 2012. Other airlines serving the Airport experienced a steady decline in air cargo tonnage handled between 2006 and 2009 before rebounding strongly in 2011, followed by a decrease in 2012. Between 2006 and 2012, cargo carried by the other airlines decreased an average of 12.5 percent per year.

Table 3-7: Air Cargo Carried by Southwest Airlines and Other Airlines

	SOUTHWEST AIRLINES		OTHER AIRLINES		AIRPORT TOTAL
YEAR	TONS	SHARE	TONS	SHARE	
2006	8,226	97.3%	225	2.7%	8,451
2007	7,704	98.4%	122	1.6%	7,826
2008	7,319	98.7%	96	1.3%	7,415
2009	11,462	99.5%	60	0.5%	11,522
2010	11,156	99.4%	66	0.6%	11,222
2011	10,263	97.8%	227	2.2%	10,490
2012	11,881	99.2%	101	0.8%	11,982
Compound Annual Growth Rate					
2006 - 2012	6.3%		-12.5%		6.0%

SOURCE: Houston Airport System, December 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

3.1.3 AIRPORT OPERATIONS

Table 3-8 presents historical aircraft operations at the Airport between 2001 and 2012. Aircraft operations are provided for each category of activity (air carrier, air taxi/commuter, general aviation, and military). Air carrier (mainline) passenger airline aircraft operations decreased an average of 0.9 percent per year between 2001 and 2012. Aircraft operations levels in 2012 for air taxi/commuter are near 2001 levels; however, air taxi/commuter aircraft operations fluctuated greatly over the historical period. Between 2006 and 2012, air carrier aircraft operations increased slightly (0.4 percent per year), whereas air taxi/commuter aircraft operations decreased an average of 6.0 percent per year.

Table 3-9 lists aircraft operations by passenger airline between 2006 and 2012. Overall airline aircraft operations increased over this period from 110,648 in 2006 to 111,610 in 2012. Southwest Airlines had an 84.0 percent market share with 93,710 operations in 2012. Delta Air Lines and affiliates, American Airlines and affiliates, and AirTran Airways followed with market shares of 5.0, 4.7, and 3.9 percent, respectively. **Table 3-10** presents aircraft operations by mainline and regional/commuter operations, with mainline operations accounting for over 90 percent of total airline aircraft operations and total mainline and regional/commuter airline aircraft operations accounted for more than 50 percent of total aircraft operations at the Airport. The total airline share of aircraft operations increased from 46.7 percent in 2006 to 56.4 percent in 2012, primarily as a result of the significant decrease in general aviation aircraft operations.

Table 3-8: Historical Aircraft Operations

YEAR	AIR CARRIER	AIR TAXI / COMMUTER	GENERAL AVIATION	MILITARY	TOTAL	ANNUAL GROWTH RATE
2001	118,976	34,544	93,443	210	247,173	-
2002	112,052	42,286	93,096	483	247,917	0.3%
2003	110,058	44,379	89,566	332	244,335	-1.4%
2004	110,935	46,126	87,750	291	245,102	0.3%
2005	105,759	51,385	84,905	336	242,385	-1.1%
2006	104,590	49,963	82,165	330	237,048	-2.2%
2007	110,151	42,783	83,371	437	236,742	-0.1%
2008	106,643	31,828	80,878	661	220,010	-7.1%
2009	103,419	27,341	69,875	1,019	201,654	-8.3%
2010	99,344	35,468	65,444	1,840	202,096	0.2%
2011	103,780	35,500	57,812	2,828	199,920	-1.1%
2012	107,260	34,382	53,451	2,653	197,746	-1.1%
Compound Annual Growth Rate						
2001 - 2012	-0.9%	0.0%	-5.0%	25.9%	-2.0%	
2006 - 2012	0.4%	-6.0%	-6.9%	41.5%	-3.0%	

SOURCE: FAA Air Traffic Activity Data System, January 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

Table 3-9: Historical Passenger Airline Aircraft Operations

PASSENGER AIRLINE	2006	2007	2008	2009	2010	2011	2012	2012 MARKET SHARE
Southwest Airlines	93,026	96,836	95,168	NA	87,944	89,274	93,710	84.0%
Delta Air Lines and Affiliates	4,548	4,714	4,708	NA	5,012	5,282	5,622	5.0%
American Airlines and Affiliates	7,186	4,792	4,706	NA	5,272	4,712	5,266	4.7%
AirTran Airways	3,816	3,940	3,546	NA	3,454	4,266	4,334	3.9%
JetBlue Airways	690	2,104	1,868	NA	1,400	1,358	1,410	1.3%
Frontier Airlines	-	-	-	NA	242	2,104	894	0.8%
Other	1,382	854	336	NA	470	352	374	0.3%
Total Passenger Airline Aircraft Operations	110,648	113,240	110,332	106,452	103,794	107,348	111,610	100.0%

NOTE: Columns may not add to totals shown because of rounding.

SOURCE: Houston Airport System, January 2013.

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

Table 3-10: Historical Mainline and Regional/Commuter Airline Aircraft Operations

YEAR	MAINLINE	MAINLINE SHARE	REGIONAL/ COMMUTER	REGIONAL/ COMMUTER SHARE	TOTAL	SHARE OF AIRPORT TOTAL	AIRPORT TOTAL
2006	101,108	91.4%	9,540	8.6%	110,648	46.7%	237,048
2007	104,460	92.2%	8,780	7.8%	113,240	47.8%	236,742
2008	101,538	92.0%	8,794	8.0%	110,332	50.1%	220,010
2009	94,720	89.1%	11,586	10.9%	106,306	52.7%	201,654
2010	93,748	90.3%	10,046	9.7%	103,794	51.4%	202,096
2011	98,060	91.3%	9,288	8.7%	107,348	53.7%	199,920
2012	101,954	91.3%	9,656	8.7%	111,610	56.4%	197,746
Compound Annual Growth Rate							
2006 - 2012	0.1%		0.2%		0.1%		-3.0%

SOURCE: Houston Airport System, January 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

Other air taxi and general aviation aircraft operations at the Airport are presented in **Tables 3-11** and **Table 3-12,** respectively. Other air taxi operations include all operations flown for hire, not including scheduled commercial passenger flights. Other air taxi operations decreased an average of 6.2 percent per year between 2006 and 2012 while general aviation operations decreased an average of 6.9 percent per year over the same period. In 2012, all general aviation aircraft operations at the Airport were itinerant. Other air taxi and general aviation aircraft operations accounted for 15.2 percent and 27.0 percent, respectively, of total aircraft operations at the Airport in 2012. In comparison, military aircraft operations increased in each of the last 5 years, numbering 2,653 in 2012, approximately 1.3 percent of the Airport total (see **Table 3-13**).

In 2012, an estimated 307 aircraft were based at the Airport, as summarized in **Table 3-14**. Between 2006 and 2012, the total number of based aircraft decreased 0.2 percent, led by significant decreases in single- and multiengine aircraft. Jets remained the largest category of general aviation aircraft based at the Airport, with an estimated 191 in 2012.

Table 3-11: Historical Other Air Taxi Operations

YEAR	OTHER AIR TAXI	SHARE OF AIRPORT TOTAL	AIRPORT TOTAL
2006	43,905	18.5%	237,048
2007	39,694	16.8%	236,742
2008	28,139	12.8%	220,010
2009	24,454	12.1%	201,654
2010	31,018	15.3%	202,096
2011	31,932	16.0%	199,920
2012	30,032	15.2%	197,746
Compound Annual Growth Rate			
2006 - 2011	-6.1%		-3.0%

SOURCES: Houston Airport System, FAA Air Traffic Activity Data System, January 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

Table 3-12: Historical General Aviation Aircraft Operations

YEAR	ITINERANT	ITINERANT SHARE	LOCAL	LOCAL SHARE	TOTAL	SHARE OF AIRPORT TOTAL	AIRPORT TOTAL
2006	79,553	96.8%	2,612	3.2%	82,165	34.7%	237,048
2007	80,463	96.5%	2,908	3.5%	83,371	35.2%	236,742
2008	80,156	99.1%	722	0.9%	80,878	36.8%	220,010
2009	69,059	98.8%	816	1.2%	69,875	34.7%	201,654
2010	65,104	99.5%	340	0.5%	65,444	32.4%	202,096
2011	57,786	100.0%	26	0.0%	57,812	28.9%	199,920
2012	53,451	100.0%	-	-	53,451	27.0%	197,746
Compound Annual Growth Rate							
2006 - 2012	-6.4%		-100.0%		-6.9%		-3.0%

SOURCE: FAA Air Traffic Activity Data System, January 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

Table 3-13: Historical Military Aircraft Operations

YEAR	ITINERANT	ITINERANT SHARE	LOCAL	LOCAL SHARE	TOTAL	SHARE OF AIRPORT TOTAL	AIRPORT TOTAL
2006	229	69.4%	101	30.6%	330	0.1%	237,048
2007	435	99.5%	2	0.5%	437	0.2%	236,742
2008	661	100.0%	-	-	661	0.3%	220,010
2009	1,019	100.0%	-	-	1,019	0.5%	201,654
2010	1,840	100.0%	-	-	1,840	0.9%	202,096
2011	2,770	97.9%	58	2.1%	2,828	1.4%	199,920
2012	2,653	100.0%	-	-	2,653	1.3%	197,746
Compound Annual Growth Rate							
2006 - 2012	50.4%		-100.0%		41.5%		-3.0%

SOURCE: FAA Air Traffic Activity Data System, January 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

Table 3-14: Historical Based Aircraft

YEAR	SINGLE ENGINE	MULTI-ENGINE	JET	HELICOPTER	TOTAL
2006	60	55	177	19	311
2007	60	55	177	19	311
2008	40	45	165	23	273
2009	35	35	174	25	269
2010	35	35	174	25	269
2011	40	49	187	26	302
2012E	40	50	191	26	307
Compound Annual Growth Rate					
2006 - 2012	-6.5%	-1.6%	1.3%	5.4%	-0.2%

NOTE:

1/ Estimate for 2012 based on FAA *Terminal Area Forecast*..

SOURCE: FAA *Terminal Area Forecast Fiscal Years 2012 - 2040*, December 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

3.1.4 AIRPORT GROWTH COMPARED WITH U.S. GROWTH

Table 3-15 presents a comparison of annual growth rates at the Airport with national growth rates for 2006 through 2012 in the categories discussed above. Except for general aviation operations and based aircraft, the Airport growth rates between 2006 and 2012 were higher (in some cases, less negative) than those for the United States as a whole. In particular, growth in numbers of passengers at the Airport averaged 3.4 percent per year versus an average decrease of 0.3 percent per year for the nation as a whole. Air carrier aircraft operations at the Airport increased 0.4 percent, whereas air carrier aircraft operations in the nation decreased an average of 0.5 percent per year.

Table 3-15: Historical Growth Rate Comparisons

	CAGR 2006-2012	
CATEGORY	**HOU**	**UNITED STATES 1/**
Passengers	3.4%	-0.3%
Air Cargo	6.0%	-1.2%
Air Carrier Aircraft Operations	0.4%	-0.5%
Air Taxi Operations	-6.1%	-4.6%
General Aviation Aircraft Operations	-6.9%	-3.9%
Based Aircraft	-0.2%	-0.1%

NOTES:

1/ Based on 2013 *FAA Aerospace Forecasts, Fiscal Years 2013-2033*.

SOURCES: Houston Airport System, January 2013; FAA *Aerospace Forecasts, Fiscal Years 2013-2033*, February 2013; FAA Air Traffic Activity Data System, January 2013.

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

3.2 Factors Affecting Aviation Demand

There are many factors that affect aviation demand at the Airport. On a national basis, aviation demand is closely tied to the economy. Each segment of the industry (commercial passenger airlines, general aviation, and air cargo) is affected by the strength or weakness of the economy. Similarly, airports are affected by changes in the economy – although the effects vary depending on the type and size of airport, and the type of activity accommodated at the airport. Changes in the industry itself – including the introduction of new aircraft, airline and aviation business practices, and federal aviation policy – also affect aviation demand. Several local factors affect the future of the Airport, including the goals and policies of the Houston Airport System (including defined roles of the airports within the system) and socioeconomic and demographic trends, which affect demand for airline travel in the region. The following subsections describe some of the aviation industry factors and local factors that influence aviation demand at the Airport.

3.2.1 AVIATION INDUSTRY FACTORS

Significant national and international events over the last 12 years have affected aviation demand. Of the several factors that continue to affect the industry and add uncertainty to forecasting, the following four are among the most significant: cost of aviation fuel, economic conditions, airport security, and the threat of terrorism.

3.2.1.1 Cost of Aviation Fuel

The volatile price of aviation fuel is one of the most significant forces affecting the industry today. The average price of jet fuel was $0.81 per gallon in 2000 compared with $2.10 per gallon in 2007. In May 2008, the average price of jet fuel increased to $3.79 per gallon. In December 2011, the price was just below $3.00 per gallon.

According to Airlines for America (formerly, the Air Transport Association of America), every one-cent average annual increase in the price per gallon increases annual airline operating expenses industry-wide by approximately $190 million to $200 million. The organization's reported airline cost index indicates that fuel is the industry's top cost (25.4 percent of industry expenditures for fuel; 24.7 percent for labor in third quarter of 2010).

The significant increases in the cost of jet fuel have contributed to airline capacity reductions, which place downward pressure on activity increases through higher airfares and aircraft load factors.

3.2.1.2 Economic Conditions

In addition to airline costs, the overall state of the economy affects the propensity to travel, and therefore airline revenues. For a medium-hub airport with planned international operations, such as HOU, both domestic and international economic conditions have an effect. Because economic conditions are typically cyclical over time (over longer periods, average changes are more regular and predictable), trends can be extracted from the balance of strong and weak economic years. However, when combined with the uneven growth in the industry and at the Airport over the last 12 years (HOU annual passenger growth rates have varied from -0.6 percent to 8.8 percent over the past 6 years), changing economic conditions can affect the reliability of forecasts of aviation demand by further reducing the correlation between economic conditions and airport activity.

3.2.1.3 Airport Security

The requirements and uncertainties related to airport security and the processes and procedures of the Department of Homeland Security (DHS) can affect the decision to, and the mode choice for, travel. With Congressional enactment of the Aviation and Transportation Security Act (ATSA) in November 2001, the TSA was created, followed by the Homeland Security Act (which created the DHS) in November 2002. The ATSA mandates certain passenger, cargo, and baggage screening requirements, security awareness programs for airport personnel, and deployment of explosives detection devices. These security requirements have increased the time required in the terminal to reach aircraft gates, as well as bag check decisions. Wait time expectations at a particular airport may affect passenger travel mode choice.

3.2.1.4 Threat of Terrorism

As has been the case since September 11, 2001, terrorism incidents directed against either domestic or world aviation, or against other targets that directly affect either domestic or world aviation, remain a risk to achieving aviation demand forecasts. Tighter security measures have restored much of the public's confidence in the integrity of U.S. and world aviation. Any terrorist incident aimed at aviation during the planning period, however, could immediately and significantly affect aviation demand.

3.2.1.5 Summary

The cost of aviation fuel, unpredictable economic conditions, increasing airport security measures, and threats of terrorism could affect the assumptions and skew the results of the Master Plan Update forecasts. Given that these circumstances, along with other unforeseen airline business decisions (such as starting or stopping service to different markets, changes in aircraft fleets, and growth or reduction of capacity at the Airport), could also affect forecast variables, the HOU planning forecasts represent possible rather than predictable results.

It is expected that, in the long term, the Airport will continue to be a medium-hub airport, both in domestic passenger service and as an international gateway. Given the strength of its economic base and leading socioeconomic indicators, the Houston Galveston-Brazoria CMSA is expected to be able to support long-term growth in passenger demand, with regional demand continuing to be predominantly served at the Airport, including international travel and nonstop travel to major medium- and long-haul markets.

3.2.2 SOUTHWEST AIRLINES

Southwest Airlines has traditionally provided point-to-point service from strategic markets – operating at less congested, secondary airports in large metropolitan regions. By offering low fares and operating under a low-cost model that promotes efficient use of aircraft and minimizes overall operating costs (e.g., a common aircraft fleet), the airline has successfully captured market share and competes on a relatively equal basis with other major airlines.

The introduction of service by Southwest Airlines and other low fare airlines in the last four decades has made airline travel generally more affordable and available to a wider number of people. In recent years, Southwest Airlines has developed a network of focus airports in strategically located cities, including Baltimore, Chicago (Midway), Dallas (Love Field), Kansas City, and Las Vegas. Southwest operates more centralized, connecting route structures from these airports, accommodating a high number of connecting passengers, in addition to local passengers. As Southwest Airlines' aircraft fleet has expanded to include long-range Boeing 737-700 aircraft, the airline's ability to serve coast-to-coast and long-haul markets has expanded. It is anticipated that certain airports will naturally become focus locations for the airline. With improved terminal facilities, the Airport is strategically placed (in terms of facilities and geographic location) to remain a key mid-continent focus airport for Southwest Airlines.

Since the development of Dallas/Fort Worth International Airport, flights from DAL have been restricted to nonstop flights to states adjacent to Texas (Mississippi and Kansas were recently added). These restrictions were included in the Wright Amendment, passed by the U.S. Congress in 1979 (subsequently amended in

2006). As a consequence, Southwest Airlines, the dominant airline serving DAL, has served passengers who want to fly to states beyond these limits by routing them through other airports, such as HOU or El Paso International Airport. Congress has determined that the Wright Amendment will expire in 2014. In that year, flight stage lengths from DAL will not be restricted. Passengers desiring to fly beyond the old limits will no longer need to fly to intermediate airports, such as HOU. This change is expected to significantly alter the connecting patterns for passengers on Southwest Airlines at HOU.

Another major change expected in 2015 is the introduction of international service by Southwest Airlines at HOU. Beginning with 10 daily departures to Central American and Caribbean destinations, Southwest Airlines expects to increase the number of daily departures from the Airport to 18 in 2018. No plans have been announced beyond that date. The flights are expected to be operated with Boeing 737-700 and Boeing 737-800 aircraft. Because this will be a new connecting point for new markets in the Southwest system, a significant percentage of connecting passengers is expected on the flights.

Finally, the acquisition of AirTran Airways by Southwest Airlines in 2011 should be noted. In 2011, AirTran Airways was the second busiest airline at HOU, with 222,872 enplaned passengers, approximately 4.5 percent of the market, and four to five flights per day to Atlanta. For this Master Plan Update demand forecasts, AirTran Airways passengers and operations will be incorporated into Southwest Airlines' totals.

3.2.3 AIRLINE AIRCRAFT FLEET MIX

With approximately 88 percent market share of passenger airline operations at the Airport, Southwest Airlines (including AirTran Airways) dominates the aircraft fleet mix. Therefore, it is expected that Boeing 737 aircraft will be the primary aircraft serving the Airport. For other airlines, regional jets are projected to provide a significant portion of aircraft operations. Regional jets with 30 to 90 seats can efficiently serve small markets previously served with turboprop and narrowbody aircraft with passenger comfort and convenience levels associated with jet aircraft. Although demand for these jets escalated in the last two decades, the smaller 30-50-seat models are being phased out. Larger regional jets fly routes up to 1,700 miles, allowing the airlines to serve lower-demand markets with passenger-preferred aircraft.

3.2.4 GENERAL AVIATION, OTHER AIR TAXI, AND MILITARY OPERATIONS

In its *FAA Aerospace Forecasts, Fiscal Years 2012-2032,* the FAA notes that general aviation activity at U.S. airports with FAA or contract ATCTs decreased 2.3 percent in 2011, continuing a decade-long trend. This decrease parallels a decrease in general aviation aircraft fleet size. The changes taking place are primarily in the single engine and multiengine (non-jet) portion of the fleet, where aircraft purchase and maintenance, insurance, and fuel costs drive down the demand for discretionary flying. These trends are not expected to change in the near future.

3.2.5 AIR CARGO

Based on the *FAA Aerospace Forecasts*, *Fiscal Years 2012-2032,* national total domestic and international air cargo revenue-ton-miles (RTMs) increased an average of 2.0 percent per year between 2000 and 2011, led by a 4.6 percent annual increase in international cargo RTMs. Domestic freight/express RTMs decreased an average of 1.8 percent per year over this period.

As relatively low volumes of cargo and mail are shipped by air through the Airport, changes in the air cargo industry, particularly as a result of new security requirements, are not anticipated to have a significant effect on the airlines serving the Airport. The Airport is not served by any all-cargo airlines and none are projected to begin service at the Airport. All cargo is projected to be carried in the belly compartments of passenger airlines serving the Airport.

3.2.6 POLICY ISSUES

As described in the 2004 Master Plan Update, HAS determined goals for the Airport System and its individual airports that guide the development of its airport plans. The results of this goal-setting specific to HOU are summarized below.

- The role of the Airport will be primarily defined by natural market forces, rather than specific mandates set by HAS. That is, HAS desires to focus on providing the facilities needed to accommodate industry demand, rather than focusing on defining the specific role that each system airport will have in the future. The only clearly stated exceptions to this philosophy are that (1) all-cargo aircraft operations will be accommodated primarily at IAH, and (2) the Airport will be developed to serve international operations as demand for such service is realized (it should be noted that, in December 2012, HAS announced that international service would be provided by Southwest Airlines from the Airport. It was further announced that service would commence in 2015).
- This Master Plan Update is intended to document the facilities and services necessary to accommodate unconstrained aviation demand through 2030. Airport facilities are to be adequate to accommodate narrowbody aircraft operations (up to Boeing 757 aircraft) to all domestic and short-haul international markets.
- It is anticipated that the Airport will continue to serve as the Central Business District (CBD) airport that provides O&D service to numerous domestic markets and provides storage and support services for corporate aviation and fractional aircraft owners. These latter characteristics will be addressed in coordination with concurrent planning underway at Ellington Airport.

3.2.7 SOCIOECONOMIC AND DEMOGRAPHIC TRENDS

Airport activity is sensitive to changes in local and national economic conditions. Barring other circumstances that may influence aviation demand, the strength of a local economy – measured by growth in population, per capita income, per capita retail sales, employment, and other economic indicators – typically correlates to the level of aviation activity at an airport. An airport located in a region with a strong economy will typically experience positive growth in aviation activity. The following subsections describe the socioeconomic and demographic trends in the Houston region and serve as the basis for the aviation activity forecasts developed for this Master Plan Update.

Data was considered for the Houston-Galveston-Brazoria CMSA, which includes the counties of Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Matagorda, Montgomery, San Jacinto and Waller. The City of Houston is situated in three counties: Fort Bend, Harris, and Montgomery. The Houston-Galveston-Brazoria CMSA is illustrated on **Exhibit 3-1** and represents the Airport service region.

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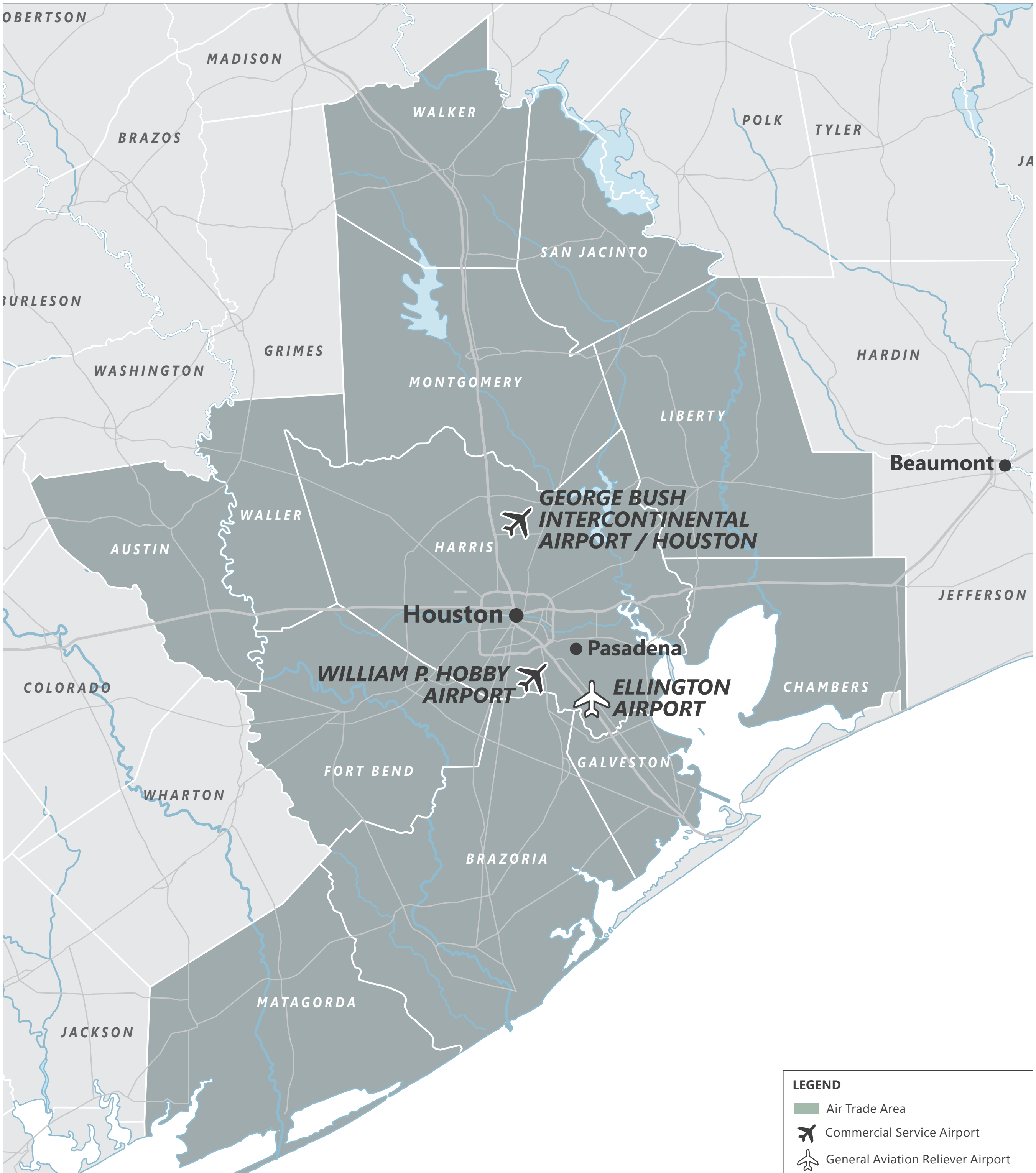

SOURCE: Map Resources, 2007 (vector map graphics); Ricondo & Associates, Inc, November 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

EXHIBIT 3-1

NORTH 0 Not to Scale

Consolidated Metropolitan Statistical Area

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3.2.7.1 Population and Household Trends

The Houston-Galveston-Brazoria CMSA population grew at rates faster than the populations of the State of Texas and the nation, as shown in **Table 3-16**. With 4.9 million people in 2001, the CMSA averaged 2.3 percent population growth per year through 2011, to 6.2 million. In the same period, the population of Texas grew an average of 1.9 percent per year and the population of the nation grew an average of 0.9 percent per year. The fastest growing county during this period was Fort Bend, averaging 5.1 percent growth per year, following by Montgomery County, with an average of 4.3 percent growth per year, and Chambers County, with an average of 3.0 percent growth per year. Harris County experienced strong population growth between 2001 and 2011, increasing from 3.5 million in 2001 to 4.2 million in 2011.

Table 3-16 summarizes the Houston-Galveston-Brazoria CMSA growth in population from 2001 through 2011 and Woods & Poole Economics, Inc., population projections through 2030. The population of the Houston-Galveston-Brazoria CMSA is projected to increase an average of 1.7 percent per year while the population of Texas is projected to increase an average of 1.6 percent per year and the population of the United States is projected to increase an average of 1.0 percent per year.

Approximately 2.2 million households were located in the Houston-Galveston-Brazoria CMSA in 2011. The number of households increased an average of 2.0 percent per year between 2001 and 2011. This rate of increase is projected to slow in future years to 1.5 percent average annual growth between 2020 and 2030, as shown in **Table 3-17**.

3.2.7.2 Employment and Income

The size and growth of the labor force are indications of a region's economic base. Between 2001 and 2011, employment levels in the Houston-Galveston-Brazoria CMSA increased significantly, from 2.9 million to 3.5 million, or an average of 2.0 percent per year, as shown in Table 3-17. Over this same period, income increased an average of 3.9 percent per year.

Per capita personal income in the Houston-Galveston-Brazoria CMSA increased an average of 3.8 percent per year between 2001 and 2011 and is projected to increase at rates averaging between 3.5 percent and 5.1 percent per year throughout the planning period.

3.2.7.3 Houston-Galveston-Brazoria CMSA Gross Domestic Product

Overall, the GDP for the Houston-Galveston-Brazoria CMSA is expected to continue to exceed that of both the State of Texas and the United States, as shown in **Table 3-18**. Between 2001 and 2011, the Houston-Galveston-Brazoria CMSA GDP increased an average of 3.1 percent per year, while the Texas GDP increased an average of 3.0 percent per year and the U.S. GDP increased an average of 1.3 percent per year. Average annual rates projected through 2030 are 2.8 percent for the Houston-Galveston-Brazoria CMSA, 2.8 percent for Texas, and 2.3 percent for the United States.

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Table 3-16: Historical and Projected Houston-Galveston-Brazoria CMSA Population

	HOUSTON-GALVESTON-BRAZORIA CSMA (BY COUNTY)													
YEAR	AUSTIN	BRAZORIA	CHAMBERS	FORT BEND	GALVESTON	HARRIS	LIBERTY	MATAGORDA	MONTGOMERY	SAN JACINTO	WALKER	WALLER	CMSA TOTAL	TEXAS	UNITED STATES
2001	24,341	248,280	26,811	375,708	254,521	3,471,291	71,679	37,804	311,437	22,897	62,444	33,747	4,940,960	21,319,622	284,968,955
2002	24,818	255,246	27,490	397,943	260,096	3,536,682	73,280	37,662	326,466	23,415	62,216	35,060	5,060,374	21,690,325	287,625,193
2003	25,388	261,269	28,021	418,747	265,269	3,586,133	73,734	37,695	341,499	24,100	63,609	36,333	5,161,797	22,030,931	290,107,933
2004	25,976	268,051	28,749	441,139	269,760	3,630,185	74,285	37,388	357,607	24,756	64,551	36,850	5,259,297	22,394,023	292,805,298
2005	26,331	274,336	29,388	462,953	274,806	3,681,829	74,303	37,132	372,541	25,014	65,676	37,242	5,361,551	22,778,123	295,516,599
2006	26,828	284,248	29,980	490,916	279,182	3,807,435	74,269	36,743	392,497	25,151	65,591	38,260	5,551,100	23,359,580	298,379,912
2007	27,454	293,296	30,714	516,564	283,770	3,863,344	74,515	36,452	411,416	25,719	65,517	39,809	5,668,570	23,831,983	301,231,207
2008	27,935	301,336	31,619	542,957	288,643	3,938,580	74,915	36,708	429,818	25,889	65,726	40,578	5,804,704	24,309,039	304,093,966
2009	28,254	309,236	34,230	569,130	287,428	4,034,866	75,041	36,579	445,836	26,086	66,748	42,087	5,955,521	24,801,761	306,771,529
2010	28,443	314,494	35,311	590,350	292,607	4,110,771	75,868	36,751	459,018	26,451	68,185	43,422	6,081,671	25,257,114	309,349,689
2011	29,030	321,961	36,058	615,065	295,200	4,178,478	76,670	36,864	474,619	26,729	68,368	43,930	6,202,972	25,720,680	312,308,189
Projected															
2015	31,441	352,486	39,120	714,929	306,276	4,458,512	80,057	37,410	537,878	27,906	69,274	46,062	6,701,351	27,630,422	324,847,014
2020	34,503	391,151	43,008	840,443	320,704	4,815,964	84,439	38,172	617,576	29,427	70,552	48,810	7,334,749	30,061,787	341,069,539
2030	40,664	468,850	50,829	1,091,675	350,101	5,537,043	93,337	39,772	777,295	32,518	73,254	54,382	8,609,720	34,960,012	373,924,268
Compound Annual Growth Rate															
2001 - 2011	1.8%	2.6%	3.0%	5.1%	1.5%	1.9%	0.7%	-0.3%	4.3%	1.6%	0.9%	2.7%	2.3%	1.9%	0.9%
2011 - 2015	2.0%	2.3%	2.1%	3.8%	0.9%	1.6%	1.1%	0.4%	3.2%	1.1%	0.3%	1.2%	2.0%	1.8%	1.0%
2015 - 2020	1.9%	2.1%	1.9%	3.3%	0.9%	1.6%	1.1%	0.4%	2.8%	1.1%	0.4%	1.2%	1.8%	1.7%	1.0%
2020 - 2030	1.7%	1.8%	1.7%	2.6%	0.9%	1.4%	1.0%	0.4%	2.3%	1.0%	0.4%	1.1%	1.6%	1.5%	0.9%
2011 - 2030	1.8%	2.0%	1.8%	3.1%	0.9%	1.5%	1.0%	0.4%	2.6%	1.0%	0.4%	1.1%	1.7%	1.6%	1.0%

SOURCE: Woods & Poole Economics, Inc., January 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

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Table 3-17: Historical and Projected Houston-Galveston-Brazoria CSMA Socioeconomic Data

YEAR	NUMBER OF HOUSEHOLDS	INCOME (IN MILLIONS)	EMPLOYMENT	PER CAPITA PERSONAL INCOME
Historical				
2001	1,771,758	$188,605	2,916,169	$34,923
2002	1,814,822	$184,287	2,948,136	$33,772
2003	1,866,451	$187,746	2,964,349	$34,429
2004	1,892,610	$198,525	3,015,524	$36,661
2005	1,930,590	$211,824	3,117,080	$39,508
2006	1,989,798	$230,205	3,250,904	$42,599
2007	2,031,909	$239,062	3,413,658	$44,492
2008	2,066,250	$259,679	3,505,495	$48,737
2009	2,099,113	$252,799	3,456,859	$46,340
2010	2,118,134	$261,631	3,504,001	$47,800
2011E	2,169,154	$276,358	3,546,601	$50,603
Projected				
2015	2,387,106	$305,068	3,811,598	$58,032
2020	2,640,198	$355,822	4,172,548	$ 72,250
2030	3,063,737	$490,151	4,978,597	$119,311
Compound Annual Growth Rate				
2001 - 2011	2.0%	3.9%	2.0%	3.8%
2011 - 2015	2.4%	2.5%	1.8%	3.5%
2015 - 2020	2.0%	3.1%	1.8%	4.5%
2020 - 2030	1.5%	3.3%	1.8%	5.1%

SOURCE: Woods & Poole Economics, Inc., January 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 3-18: Historical and Projected Gross Domestic Product Comparison

	GROSS DOMESTIC PRODUCT (IN MILLIONS)		
YEAR	HOUSTON-GALVESTON-BRAZORIA CMSA	TEXAS	UNITED STATES
Historical			
2001	$241,645	$ 836,984	$11,168,696
2002	$238,597	$ 846,957	$11,400,525
2003	$244,050	$ 873,818	$11,692,365
2004	$262,728	$ 933,776	$12,138,374
2005	$274,807	$ 970,997	$12,554,535
2006	$295,307	$1,027,967	$12,958,093
2007	$317,087	$1,088,134	$13,241,193
2008	$323,257	$1,103,425	$13,099,013
2009	$321,025	$1,100,842	$12,701,843
2010	$325,424	$1,115,271	$12,644,089
2011E	$329,434	$1,123,430	$12,679,745
Projected			
2015	$369,309	$1,255,108	$13,895,651
2020	$425,404	$1,438,608	$15,536,576
2030	$561,775	$1,888,741	$19,430,030
Compound Annual Growth Rate			
2001 - 2011	3.1%	3.0%	1.3%
2011 - 2015	2.9%	2.8%	2.3%
2015 - 2020	2.9%	2.8%	2.3%
2020 - 2030	2.8%	2.8%	2.3%

SOURCE: Woods & Poole Economics, Inc., January 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

3.3 Forecast Methodology Overview and Process

Several methodologies were used to forecast enplaned passengers and aircraft operations. These methodologies are described below.

3.3.1 MARKET SHARE ANALYSIS

Historical activity at the Airport was compared with activity in the United States as a whole to determine the Airport's share of the U.S. market in each of the aviation demand categories. As appropriate, these historical shares were used to forecast activity trends at the Airport through the planning period – the Airport's historical share of U.S. enplaned passengers was applied to the U.S. forecast to derive the Airport forecast. The activity forecasts contained in the *FAA Aerospace Forecasts, Fiscal Years 2012-2032* were used as a basis for the market share analysis.

3.3.2 SOCIOECONOMIC REGRESSION ANALYSIS

Regression analysis is used to compare historical relationships between a dependent variable (e.g., enplaned passengers) and one or more independent variables (socioeconomic factors, such as population, employment, per capita personal income, etc.) to forecast future growth in aviation activity. Socioeconomic regression analysis was conducted to determine whether a relationship exists between socioeconomic variables and the Airport's enplaned passengers. Historical and projected socioeconomic data was obtained from Woods & Poole Economics summaries of U.S. government data and analyzed in terms of historical enplaned passenger data from the FAA *Terminal Area Forecast* (TAF) for the Airport and HAS statistics.

3.3.3 TREND ANALYSIS

Trend analysis is used to consider the relative increase or decrease in aviation activity over time. Forecasts derived from a trend analysis suggest that external factors will affect future aviation activity in a manner similar to that experienced in the past. External factors may include the relative strength of the economy, climate, and quality of life.

3.3.4 OTHER CONSIDERATIONS

In addition to the methodologies described above, the forecasts developed were compared with other available forecasts of the particular aviation activity element being analyzed. These other forecasts include the FAA TAF and the Texas Department of Transportation's (DOT) regional aviation forecasts.

3.3.5 FORECAST DEVELOPMENT PROCESS

Typical forecast development involves relating trends in regional socioeconomic data with airport activity. However, over the past decade, activity results have been erratic compared with population and income data, resulting in a relatively low fit between the data using regression analysis. The regression results are summarized in **Table 3-19**. The standard measure of the fit for regressions is the R square. R square results above 0.9 are considered a very good fit. R square results above 0.8 indicate that the predictive qualities are adequate. Single variable regressions for passenger growth using population, income, per capita personal income, or employment produced inappropriately low R square results varying from 0.58 to 0.66, predicting passenger growth rates of 1.2 percent to 2.3 percent.

Table 3-19: Regression Results

VARIABLE	R-SQUARE	2030 FORECAST ENPLANED PASSENGERS	COMPOUND ANNUAL GROWTH, 2011 - 2030
Population	0.60	6,243,074	1.2%
Employment	0.66	6,245,751	1.2%
Per Capita Personal Income	0.58	7,623,383	2.3%
Trend	0.59	6,251,919	1.2%

SOURCES: Woods & Poole Economics, Inc.; Ricondo & Associates, Inc., January 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Therefore, the forecasts were developed based on assumptions about daily flight activity changes for Southwest Airlines and other airlines. The results were then compared with other sources, such as historical trends, the FAA TAF and *FAA Aerospace Forecasts*, *Fiscal Years 2012-2032*, and Texas DOT regional results.

3.3.6 SPECIFIC ASSUMPTIONS AND RESULTS: BASELINE FORECASTS

3.3.6.1 Hubbing Airline

Southwest Airlines will operate only mainline aircraft throughout the planning period. No regional/commuter aircraft operations were assumed for the airline.

Southwest Airline is forecast to average approximately 1.5 additional daily domestic departures through 2015 and 10 additional average daily international departures are forecast to begin in 2015 (based on recent discussions between Southwest Airlines and the HAS. From 2016 through 2030, Southwest Airlines is forecast to average approximately 2.5 additional daily departures with the addition of 9 average daily international departures forecast for 2018.

Average seats per departure are forecast to increase over the planning period from approximately 136.7 in 2011 to 144.3 in 2030, based on Southwest Airlines' announcement of its plan to increase seating capacity on a majority of its fleet from 137 to 143 beginning in 2012 and based on the assumption that Southwest's operation of Boeing 737-800 aircraft will increase to approximately 5 percent of overall activity at the Airport by 2030.

The average load factor for Southwest Airlines is forecast to increase from 69.5 percent in 2011 to 80.2 percent by 2030, reflecting recent trends.

Southwest Airlines' annual enplaned passengers are forecast to increase from 4.2 million in 2011 to 7.9 million in 2030, an average increase of 3.4 percent per year. During this period, the airline's market share of enplaned passengers was assumed to increase from 85.8 percent to 87.6 percent.

In 2012, AirTran Airways operations were combined with Southwest Airlines operations as a result of the acquisition of AirTran Airways by Southwest Airlines; the combined airline was assumed to operate as Southwest Airlines over the planning period.

3.3.6.2 Other Domestic Airlines

Other domestic airlines serving HOU will continue to operate mainline and regional/commuter aircraft over the planning period. The share of mainline operations for other domestic airlines was forecast to decrease over the planning period, while regional/commuter operations were assumed to increase. In 2030, mainline aircraft operations are forecast to account for 35.7 percent of the Airport total and regional/commuter aircraft operations are forecast to account for 64.3 percent of total Airport operations.

These airlines are forecast to average one additional daily departure every 2 years over the planning period.

Mainline aircraft average seats per departure are forecast to increase over the planning period from 120.9 in 2011 to 122.8 in 2030 based on national trends, as shown in the *FAA Aerospace Forecasts, Fiscal Years 2012-2032*. Similarly, regional/commuter aircraft average seats per departure are forecast to increase over the planning period from 65.5 in 2011 to 67.4 in 2030.

The average load factor for these airlines is forecast to increase from 82.7 percent in 2011 to 86.7 percent in 2030.

Other domestic airline enplaned passengers are forecast to increase from approximately 521,800 in 2012 to 791,600 in 2030, an average increase of 2.3 percent per year. In 2030, mainline aircraft enplaned passengers are forecast to account for 50.8 percent of the Airport total and regional/commuter aircraft enplaned passengers are forecast to account for 49.2 percent of the Airport total.

3.3.6.3 Foreign Flag Airlines

Foreign flag airline(s) were assumed to initiate service in 2015 with an average of four daily departures. Foreign flag airline daily departures were assumed to increase to nine in 2018. Aircraft operations by these airlines were assumed to be conducted using only mainline aircraft.

Mainline aircraft average seats per departure were assumed to increase over the planning period from 137.3 in 2015 to 138.7 in 2030.

The average load factor is forecast to increase from 64.0 percent in 2015 to 70.9 percent by 2030.

Foreign flag airline enplaned passengers are forecast to increase from approximately 128,300 in 2015 to 323,100 in 2030, an average increase of 6.4 percent per year.

3.4 Forecast Enplaned Passengers Results

3.4.1 BASELINE FORECASTS OF ENPLANED PASSENGERS

Using the methodology described above, the results of the Baseline forecast of enplaned passengers are 6.1 million in 2015, 7.4 million in 2020, and 9.1 million in 2030, at a CAGR of 3.2 percent for 2011 through 2030. These results are summarized in **Table 3-20**.

Table 3-20: Historical and Forecast Enplaned Passengers

	DOMESTIC SERVICE			INTERNATIONAL SERVICE				
YEAR	MAINLINE	REGIONAL/ COMMUTER	TOTAL	DOMESTIC	FOREIGN FLAG	TOTAL	TOTAL	ANNUAL GROWTH RATE
Historical								
2006	4,112,349	189,420	4,301,769	-	-	-	4,301,769	3.6%
2007	4,223,455	203,879	4,427,334	-	-	-	4,427,334	2.9%
2008	4,187,372	213,613	4,400,985	-	-	-	4,400,985	-0.6%
2009	3,981,672	285,615	4,267,287	-	-	-	4,267,287	-3.0%
2010	4,292,343	254,354	4,546,697	-	-	-	4,546,697	6.5%
2011	4,692,284	252,292	4,944,576	-	-	-	4,944,576	8.8%
Forecast								
2012	4,796,500	244,600	5,041,100	-	-	-	5,041,100	
2013	4,902,800	252,300	5,155,100	-	-	-	5,155,100	
2014	5,044,100	260,000	5,304,100	-	-	-	5,304,100	
2015	5,368,000	271,300	5,639,300	362,100	128,300	490,400	6,129,700	
2020	6,166,000	314,500	6,480,500	641,900	277,500	919,400	7,399,900	
2030	7,563,400	393,500	7,956,900	790,600	323,100	1,113,700	9,070,600	
Compound Annual Growth Rate								
2006 - 2011	2.7%	5.9%	2.8%	-	-	-	2.8%	
2011 - 2012	2.2%	-3.0%	2.0%	-	-	-	2.0%	
2011 - 2015	3.4%	1.8%	3.3%	-	-	-	5.5%	
2015 - 2020	2.8%	3.0%	2.8%	12.1%	16.7%	13.4%	3.8%	
2020 - 2030	2.1%	2.3%	2.1%	2.1%	1.5%	1.9%	2.1%	
2011 - 2030	2.5%	2.4%	2.5%	-	-	-	3.2%	

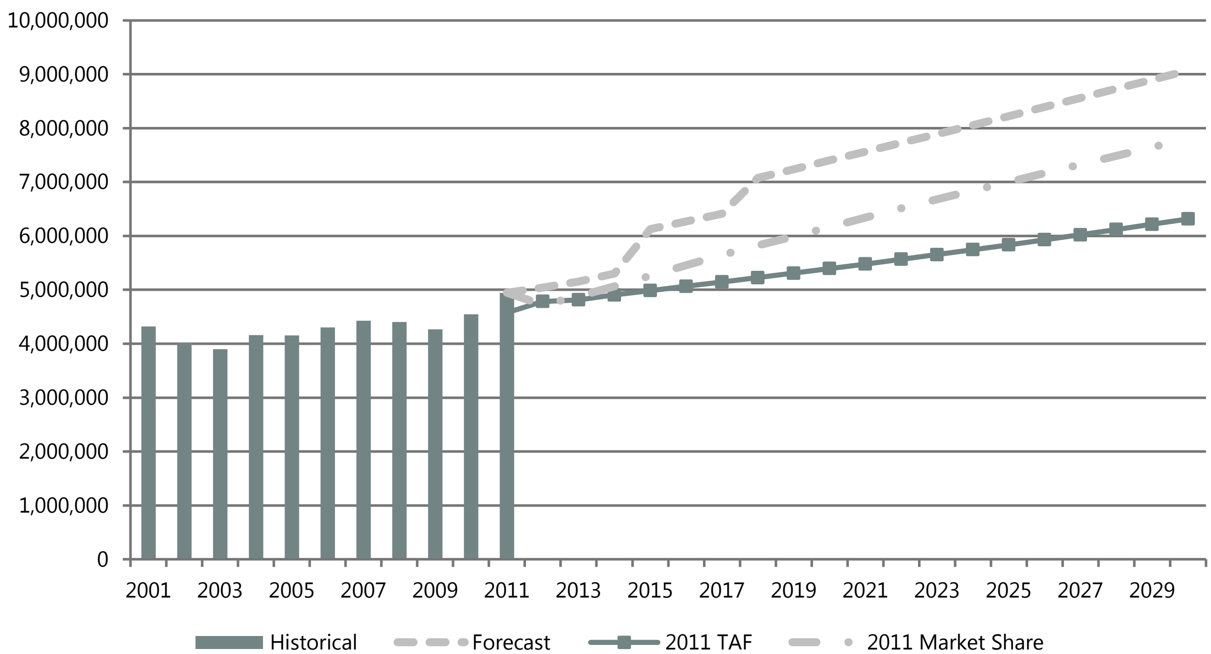
SOURCES: Houston Airport System (Historical), InterVISTAS Consulting (Forecast), Ricondo & Associates, Inc. (Forecast), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

3.4.2 COMPARISON WITH OTHER ENPLANED PASSENGER FORECASTS

- HOU Master Plan Update Baseline CAGR — 3.2 percent
- HOU Master Plan Update CAGR without New International Service — 2.3 percent
- 2011 FAA TAF CAGR — 1.5 to 1.6 percent
- Market Share *FAA Aerospace Forecasts* (2012-2032) — 2.4 percent
- Texas DOT 2010 HOU forecast CAGR — 1.8 percent

The forecast results were compared to the FAA TAF and *FAA Aerospace Forecasts* market shares and are shown graphically on **Exhibit 3-2**.

Exhibit 3-2: Historical and Forecast Enplaned Passengers



SOURCES: Houston Airport System (Historical), InterVISTAS Consulting (Projected), Ricondo & Associates, Inc. (Projected), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

While the total number of enplaned passengers at the Airport grew moderately (2.8 percent annually) between 2006 and 2011, this growth was considerably higher than the nearly flat growth in the number of U.S. enplaned passengers during this period. The number of connecting passengers at the Airport between 2006 and 2011 increased an average of 4.8 percent per year and the number of originating (local) passengers increased an average of 2.1 percent per year. The share of connecting passengers at the Airport increased from 27.0 percent in 2006 to 29.7 percent in 2011, as shown in **Table 3-21**. It was assumed that the increase in connecting passengers that occurred at the Airport during this period will continue throughout the planning period.

Table 3-21: Historical and Forecast Enplaned (Originating and Connecting) Passengers

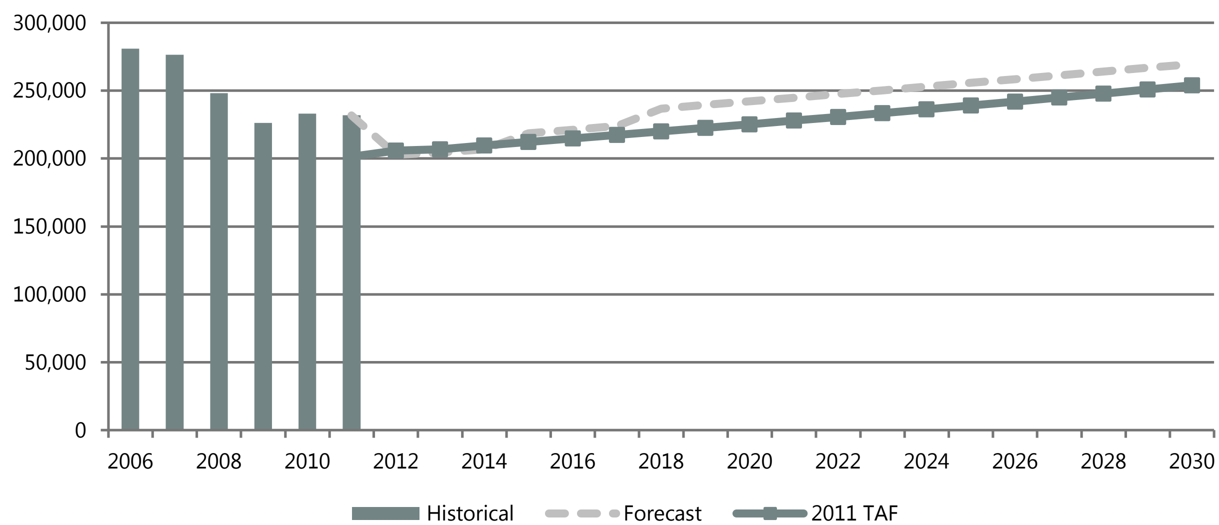
	ENPLANED PASSENGERS				
YEAR	ORIGINATING	SHARE	CONNECTING	SHARE	TOTAL
Historical					
2006	3,140,267	73.0%	1,161,502	27.0%	4,301,769
2007	3,298,738	74.5%	1,128,596	25.5%	4,427,334
2008	3,326,093	75.6%	1,074,892	24.4%	4,400,985
2009	3,060,105	71.7%	1,207,182	28.3%	4,267,287
2010	3,159,532	69.5%	1,387,165	30.5%	4,546,697
2011	3,477,485	70.3%	1,467,091	29.7%	4,944,576
Forecast					
2012	3,534,900	70.1%	1,506,200	29.9%	5,041,100
2013	3,604,200	69.9%	1,550,900	30.1%	5,155,100
2014	3,697,500	69.7%	1,606,600	30.3%	5,304,100
2015	4,260,500	69.5%	1,869,200	30.5%	6,129,700
2020	5,068,100	68.5%	2,331,800	31.5%	7,399,900
2030	6,031,900	66.5%	3,038,700	33.5%	9,070,600
Compound Annual Growth Rate					
2006 - 2011	2.1%		4.8%		2.8%
2011 - 2012	1.7%		2.7%		2.0%
2011 - 2015	5.2%		6.2%		5.5%
2015 - 2020	3.5%		4.5%		3.8%
2020 - 2030	1.8%		2.7%		2.1%
2011 - 2030	2.9%		3.9%		3.2%

SOURCES: Houston Airport System (Historical), InterVISTAS Consulting (Forecast), Ricondo & Associates, Inc. (Forecast), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

3.5 Aircraft Operations Forecast Development Process

The forecasts of aircraft operations at the Airport are presented in **Table 3-22**. The results are shown graphically on **Exhibit 3-3** with a comparison to the 2011 FAA TAF for the Airport. The various components of the forecasts were developed as described in the following subsections.

Exhibit 3-3: Historical and Forecast Aircraft Operations



SOURCES: FAA Air Traffic Activity Data System (Historical), InterVISTAS Consulting (Forecast), Ricondo & Associates, Inc. (Forecast), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

3.5.1 AIR CARRIER AIRCRAFT OPERATIONS

To calculate the number of annual aircraft operations required to accommodate the forecast number of passengers at the Airport, the average flight load factor and number of seats per aircraft must be estimated.

As noted earlier in **Table 3-23,** between 2006 and 2011, the average annual load factor for Southwest Airlines increased from 60.0 percent to 69.5 percent, while that of the other airlines serving the Airport increased from 72.0 percent to 82.7 percent. Trends were carried into the future with the load factor for Southwest Airlines increasing to 80.2 percent in 2030 and the load factor for the other airlines increasing to 86.7 percent.

Because of the relative uniformity of Southwest Airlines' aircraft fleet, its average number of seats per aircraft departure did not change significantly between 2006 and 2011, increasing from 134 to 137. The increase resulted from a reduction in the use of 120-seat Boeing 737-500 aircraft and an increase in the use of the 144-seat Boeing 737-700. In the future, most Southwest Airlines service will be provided using 144-seat aircraft, with some service (estimated at approximately 5 percent) provided using 175-seat Boeing 737-800 aircraft. Southwest Airlines' average number of seats per aircraft departure was estimated to increase to 144 in 2030.

Table 3-22: Historical and Forecast Aircraft Operations

	PASSENGER AIRLINES								
	DOMESTIC								
YEAR	MAINLINE	REGIONAL/ COMMUTER	TOTAL	FOREIGN FLAG	TOTAL	GENERAL AVIATION	MILITARY	OTHER AIR TAXI	AIRPORT TOTAL
Historical									
2006	101,108	9,540	110,648	-	110,648	82,165	330	43,905	237,048
2007	104,460	8,780	113,240	-	113,240	83,371	437	39,694	236,742
2008	101,538	8,794	110,332	-	110,332	80,878	661	28,139	220,010
2009	94,720	11,586	106,306	-	106,306	69,875	1,019	24,454	201,654
2010	93,748	10,046	103,794	-	103,794	65,444	1,840	31,018	202,096
2011	98,060	9,288	107,348	-	107,348	57,812	2,828	31,932	199,920
Forecast									
2012	100,420	9,120	109,540	-	109,540	57,970	2,830	32,330	202,670
2013	101,230	9,360	110,590	-	110,590	58,130	2,830	32,760	204,310
2014	102,730	9,610	112,340	-	112,340	58,290	2,830	33,230	206,690
2015	110,840	9,850	120,690	2,920	123,610	58,450	2,830	33,670	218,560
2020	126,600	11,090	137,690	6,570	144,260	59,300	2,830	35,730	242,120
2030	144,930	13,610	158,540	6,570	165,110	61,100	2,830	40,500	269,540
Compound Annual Growth Rate									
2006 - 2011	-0.6%	-0.5%	-0.6%	-	-0.6%	-6.8%	53.7%	-6.2%	-3.3%
2011 - 2012	2.4%	-1.8%	2.0%	-	2.0%	0.3%	0.1%	1.2%	1.4%
2011 - 2015	3.1%	1.5%	3.0%	-	3.6%	0.3%	0.0%	1.3%	2.3%
2015 - 2020	2.7%	2.4%	2.7%	17.6%	3.1%	0.3%	0.0%	1.2%	2.1%
2020 - 2030	1.4%	2.1%	1.4%	0.0%	1.4%	0.3%	0.0%	1.3%	1.1%
2011 - 2030	2.1%	2.0%	2.1%	-	2.3%	0.3%	0.0%	1.3%	1.6%

SOURCES: FAA Air Traffic Activity Data System (Historical), InterVISTAS Consulting (Forecast), Ricondo & Associates, Inc. (Forecast), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 3-23: Historical and Forecast Load Factors and Average Seats per Aircraft Departure

	LOAD FACTORS				AVERAGE SEATS PER DEPARTURE			
YEAR	SOUTHWEST	OTHER DOMESTIC	FOREIGN FLAG	AIRPORT TOTAL	SOUTHWEST	OTHER DOMESTIC	FOREIGN FLAG	AIRPORT TOTAL
Historical								
2006	60.4%	71.8%	-	61.7%	133.5	86.7	-	126.1
2007	59.9%	77.3%	-	61.6%	134.0	85.0	-	126.9
2008	60.6%	80.1%	-	62.4%	135.3	81.7	-	127.9
2009	61.5%	77.8%	-	63.1%	135.6	81.6	-	127.2
2010	66.9%	83.3%	-	68.5%	136.0	83.2	-	127.9
2011	69.5%	82.7%	-	70.7%	136.7	92.8	-	128.5
Forecast								
2012	68.0%	82.7%	-	69.3%	140.0	86.4	-	132.9
2013	68.5%	83.0%	-	69.8%	141.0	86.4	-	133.6
2014	69.0%	83.2%	-	70.2%	142.0	86.5	-	134.4
2015	72.3%	84.6%	64.0%	73.1%	143.0	86.5	137.3	135.7
2020	75.0%	86.4%	60.9%	75.2%	143.4	86.8	138.7	136.3
2030	80.2%	86.7%	70.9%	80.3%	144.3	87.2	138.7	136.8

SOURCES: Houston Airport System (Historical), FAA Air Traffic Activity Data System (Historical), U.S. Department of Transportation T100 Database (Historical), InterVISTAS Consulting (Forecast), Ricondo & Associates, Inc. (Forecast), March 2012.

PREPARED BY: Ricondo & Associates, Inc., November 2012.

The passenger airline aircraft fleet mix is presented in **Table 3-24**. As shown, the Boeing 737-800 is projected to account for 10.0 percent of total passenger airline aircraft operations in 2030.

Table 3-24: Historical and Projected Passenger Airline Aircraft Fleet Mix

	DEPARTURES							
	2011		2015		2020		2030	
AIRCRAFT	DEPARTURES	PERCENTAGE	DEPARTURES	PERCENTAGE	DEPARTURES	PERCENTAGE	DEPARTURES	PERCENTAGE
Airbus								
A318	18	0.0%	-	-	-	-	-	-
A319	835	1.6%	1,700	2.8%	2,885	4.0%	2,477	3.0%
A320	331	0.6%	618	1.0%	721	1.0%	826	1.0%
A321	-	-	-	-	-	-	413	0.5%
Boeing								
717	1,530	2.9%	309	0.5%	-	-	-	-
737-300	17,221	32.1%	17,614	28.5%	18,754	26.0%	14,447	17.5%
737-400	89	0.2%	62	0.1%	-	-	-	-
737-500	3,874	7.2%	3,863	6.3%	3,607	5.0%	-	-
737-700	24,153	45.0%	30,284	49.0%	36,065	50.0%	47,882	58.0%
737-800	60	0.1%	1,545	2.5%	3,607	5.0%	8,256	10.0%
737-900	-	-	618	1.0%	721	1.0%	1,486	1.8%
DC-9	240	0.4%	-	-	-	-	-	-
MD 80	140	0.3%	62	0.1%	-	-	-	-
MD 90	-	-	185	0.3%	180	0.3%	-	-
Bombardier								
CR7	118	0.2%	155	0.3%	721	1.0%	1,238	1.5%
CR9	2,051	3.8%	2,318	3.8%	2,525	3.5%	3,302	4.0%
CS300	-	-	-	-	180	0.3%	413	0.5%
Embraer								
E70/E75	99	0.2%	155	0.3%	361	0.5%	908	1.1%
E90	495	0.9%	618	1.0%	721	1.0%	908	1.1%
ERJ	585	1.1%	464	0.8%	361	0.5%	-	-
ER4	1,835	3.4%	1,236	2.0%	721	1.0%	-	-
Total	53,674	100.0%	61,805	100.0%	72,130	100.0%	82,555	100.0%

SOURCES: Diio LLC., (Historical), U.S. Department of Transportation T100 Database (Historical), InterVISTAS Consulting (Projected), Ricondo & Associates, Inc. (Projected), March 2012.

PREPARED BY: Ricondo & Associates, Inc., November 2012.

3.5.2 GENERAL AVIATION, OTHER AIR TAXI, AND MILITARY AIRCRAFT OPERATIONS

HOU general aviation activity has been slowly decreasing as a percentage of overall general aviation operations in Texas, as reported in the 2011 FAA TAF. The forecast of general aviation aircraft operations continues this decrease in share through 2030. Combining the HOU forecast with the FAA TAF forecast for Texas resulted in a 0.3 percent CAGR in 2030 for HOU general aviation operations (see **Table 3-25**).

HOU air taxi activity (other than that associated with scheduled air carrier operations) has remained relatively flat with respect to overall national air taxi operations, as reported in the 2011 FAA TAF. The HOU other air taxi forecast maintains this constant percentage share of national air taxi activity.

Military operations at HOU were held constant through the planning period at the number of operations in 2011.

3.5.3 AIRCRAFT OPERATIONS FORECAST SUMMARY

Baseline CAGR results for operations: 2011 to 2030

- Air Carrier 2.3 percent (107,348 in 2011 – 165,110 in 2030)
- General Aviation 0.3 percent (57,812 in 2011 – 61,100 in 2030)
- Other Air Taxi 1.3 percent (31,932 in 2011 – 40,500 in 2030)
- Military 0.0 percent (2,828 in 2011 – 2,830 in 2030)
- Total 1.6 percent (199,920 in 2011 – 269,540 in 2030)

Forecasts of aircraft operations by category were presented in Table 3-22 and on Exhibit 3-3.

3.6 Based Aircraft

As shown in **Table 3-26**, the decline in the number of based aircraft at HOU between 2006 and 2011 is forecast to continue through the planning period, although at lower overall rates. Single- and multi-engine based aircraft have been decreasing at a much higher rate at HOU than nationwide, indicating a migration of the smaller general aviation aircraft to other regional airports. In recent years, the numbers of jet aircraft based at HOU have maintained their approximate position as a percentage of the number in the United States. The *FAA Aerospace Forecasts, Fiscal Years 2012-2032* indicate that based piston aircraft are forecast to decrease an average of 0.1 percent per year, while based jet aircraft are forecast to increase an average of 4.7 percent per year, with an expected total general aviation fleet increase averaging 0.6 percent per year. Based on these results and the trends in the Airport's share of nationwide based aircraft, single- and multiengine based aircraft at HOU are forecast to decrease an average of 0.6 percent per year, while based jet aircraft are forecast to increase an average of 0.6 percent per year. The combined total based aircraft at HOU is forecast to number 293 in 2030.

Table 3-25: Historical and Forecast General Aviation Aircraft Operations

	GENERAL AVIATION AIRCRAFT OPERATIONS				
YEAR	**ITINERANT**	**ITINERANT SHARE**	**LOCAL**	**LOCAL SHARE**	**TOTAL**
Historical					
2006	79,553	96.8%	2,612	3.2%	82,165
2007	80,463	96.5%	2,908	3.5%	83,371
2008	80,156	99.1%	722	0.9%	80,878
2009	69,059	98.8%	816	1.2%	69,875
2010	65,104	99.5%	340	0.5%	65,444
2011	57,786	100.0%	26	0.0%	57,812
Forecast					
2012	57,970	100.0%	-	-	57,970
2013	58,130	100.0%	-	-	58,130
2014	58,290	100.0%	-	-	58,290
2015	58,450	100.0%	-	-	58,450
2020	59,300	100.0%	-	-	59,300
2030	61,100	100.0%	-	-	61,100
Compound Annual Growth Rate					
2006 - 2011	-6.2%		-60.2%		-6.8%
2011 - 2012	0.3%		-100.0%		0.3%
2011 - 2015	0.3%		-100.0%		0.3%
2015 - 2020	0.3%		-		0.3%
2020 - 2030	0.3%		-		0.3%
2011 - 2030	0.3%		-100.0%		0.3%

SOURCES: FAA Air Traffic Activity Data System (Historical), Ricondo & Associates, Inc. (Forecast), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 3-26: Historical and Forecast Based Aircraft

	BASED AIRCRAFT				
YEAR	**SINGLE ENGINE**	**MULTIENGINE**	**JET**	**HELICOPTER**	**TOTAL**
Historical					
2006	60	55	177	19	311
2007	60	55	177	19	311
2008	40	45	165	23	273
2009	35	35	174	25	269
2010	35	35	174	25	269
2011	36	36	178	26	276
Forecast					
2012	36	36	179	26	277
2013	36	36	180	26	278
2014	35	35	181	26	277
2015	35	35	182	27	279
2020	34	34	188	27	283
2030	32	32	200	29	293
Compound Annual Growth Rate					
2006 - 2011	-9.7%	-8.1%	0.1%	6.5%	-2.4%
2011 - 2012	-0.5%	-0.5%	0.6%	0.6%	0.3%
2011 - 2015	-0.5%	-0.5%	0.6%	0.6%	0.3%
2015 - 2020	-0.6%	-0.6%	0.6%	0.6%	0.3%
2020 - 2030	-0.6%	-0.6%	0.6%	0.6%	0.3%
2011 - 2030	-0.6%	-0.6%	0.6%	0.6%	0.3%

SOURCES: FAA *Terminal Area Forecast* (Historical), Ricondo & Associates, Inc. (Forecast), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

3.7 Peak Month and Peak Month Average Weekday Demand

The derivation of peak month and peak month average weekday demand is typically based on average percentages and the historical ratio of peak month activity to annual activity. At HOU, the peak month for passengers differed from the peak month for operations between 2007 and 2011. The peak month for passengers is July, with a share of annual passengers that has varied from 9.1 percent to 9.8 percent. The average of the past 5 years of 9.4 percent was used for this Master Plan Update. The peak month for operations varied between March and May, with 8.8 percent and 9.0 percent shares of operations. March was selected as the peak month for operations, with an 8.9 percent share of annual operations.

Peak month average weekday activity is calculated as the peak month activity on the non-weekend days divided by the number of non-weekend days in the month. Results are shown in **Table 3-27** and **Table 3-28** for the peak month and in **Table 3-29** and **Table 3-30** for the peak month average weekday.

Table 3-27: Historical Peak Month Passengers

	PASSENGERS			
YEAR	PEAK MONTH	TOTAL FOR MONTH	PEAK MONTH % OF AIRPORT TOTAL	AIRPORT TOTAL
2007	July	844,302	9.6%	8,819,521
2008	July	857,330	9.8%	8,775,798
2009	July	816,759	9.6%	8,498,411
2010	July	857,941	9.5%	9,054,011
2011	July	895,209	9.1%	9,810,400
Average			9.4%	

SOURCE: Houston Airport System, January 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 3-28: Historical Peak Month Aircraft Operations

	AIRCRAFT OPERATIONS			
YEAR	PEAK MONTH	TOTAL FOR MONTH	PEAK MONTH % OF AIRPORT TOTAL	AIRPORT TOTAL
2007	March	21,057	8.9%	236,742
2008	May	19,338	8.8%	220,010
2009	May	17,778	8.8%	201,654
2010	March	17,796	8.8%	202,096
2011	March	18,086	9.0%	199,920
Average			8.9%	

SOURCE: FAA Air Traffic Activity Data System, January 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 3-29: Peaking Profile of Enplaned Passengers

	HISTORICAL	FORECAST		
ENPLANED PASSENGERS	**2011**	**2015**	**2020**	**2030**
Annual				
Domestic				
Mainline	4,692,284	5,368,000	6,166,000	7,563,400
Regional/Commuter	252,292	271,300	314,500	393,500
International				
Domestic Airlines	-	362,100	641,900	790,600
Foreign Flag Airlines	-	128,300	277,500	323,100
Total	4,944,576	6,129,700	7,399,900	9,070,600
Peak Month				
Domestic				
Mainline	427,600	504,800	579,840	711,250
Regional/Commuter	23,784	25,510	29,580	37,000
International				
Domestic Airlines	-	34,050	60,360	74,350
Foreign Flag Airlines	-	12,070	26,100	30,380
Total	451,384	576,430	695,880	852,980
Peak Month Average WeekDay				
Domestic				
Mainline	16,040	18,140	20,820	25,650
Regional/Commuter	750	920	1,050	1,300
International				
Domestic Airlines	-	1,010	1,800	2,220
Foreign Flag Airlines	-	360	775	900
Total	16,790	20,430	24,445	30,070

SOURCES: Houston Airport System (Historical), InterVISTAS Consulting (Forecast), Ricondo & Associates, Inc. (Forecast), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 3-30: Peaking Profile of Aircraft Operations

	HISTORICAL	FORECAST		
OPERATIONS	**2011**	**2015**	**2020**	**2030**
Annual				
Mainline	98,060	110,840	126,600	144,930
Regional/Commuter	9,288	9,850	11,090	13,610
Foreign Flag	-	2,920	6,570	6,570
Other Air Taxi	31,932	33,670	35,730	40,500
General Aviation	57,812	58,450	59,300	61,100
Military	2,828	2,830	2,830	2,830
Total	199,920	218,560	242,120	269,540
Peak Month				
Mainline	8,700	9,830	11,230	12,860
Regional/Commuter	820	870	980	1,210
Foreign Flag	-	260	580	580
Other Air Taxi	2,830	2,990	3,170	3,590
General Aviation	5,130	5,180	5,260	5,420
Military	250	250	250	250
Total	17,730	19,380	21,470	23,910
Peak Month Average WeekDay				
Mainline	324	366	419	479
Regional/Commuter	28	32	36	42
Foreign Flag	-	12	28	28
Other Air Taxi	135	142	151	171
General Aviation	244	247	250	258
Military	12	12	12	12
Total	743	812	895	990

NOTE: Columns may not add to totals shown because of rounding.

SOURCES: FAA Air Traffic Activity Data System (Historical), InterVISTAS Consulting (Forecast), Ricondo & Associates, Inc. (Forecast), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

3.8 Forecast Scenarios

To test the sensitivity of the Baseline forecasts to changes in conditions that might affect aviation demand at the Airport, a low growth and a high growth scenario were developed. These scenarios are described below.

3.8.1 LOW GROWTH SCENARIO

The Low Growth Scenario consists of flat Southwest Airlines growth through 2018, followed by the Baseline forecast growth through 2030. This scenario was developed by offsetting the introduction of international operations at HOU in 2014 and 2018 by the elimination of the planned domestic operations growth in the Baseline forecast. No changes were made in other scheduled airline or nonscheduled aircraft operations. The result was a 2.8 percent average annual increase to 8.3 million enplaned passengers in 2030, an 8 percent reduction compared with the Baseline forecast. Low Growth Scenario aircraft operations in 2030 number 244,000, a 9 percent decrease compared with the 269,540 operations in the Baseline forecast. The Low Growth Scenario results are summarized in **Table 3-31**.

3.8.2 HIGH GROWTH SCENARIO

The High Growth Scenario maintains the Baseline forecast growth rates and increased numbers of operations, with additional flights by airlines other than Southwest Airlines to the airlines' secondary hubs. For example, flights were added for American Airlines to Miami, Chicago (O'Hare) and New York (Kennedy) and for Delta Air Lines to Detroit, Minneapolis-St. Paul, and New York (Kennedy). Additional regional airline flights were also added. The result was a 3.9 percent average annual increase to 10.2 million enplaned passengers in 2030, a 12.8 percent increase compared with the Baseline forecast. High Growth Scenario aircraft operations in 2030 increase 13.9 percent to 307,000 from 269,940 in the Baseline forecast. The High Growth Scenario results are summarized in **Table 3-32**.

3.8.3 BASELINE AND SCENARIO FORECAST COMPARISONS

Table 3-33 presents a comparison of the Baseline, Low Growth, and High Growth scenarios with the 2011 FAA TAF and HOU's constant market share results based on the *FAA Aerospace Forecasts, Fiscal Years 2012-2032*. While the TAF and the market share forecasts are significantly lower than the Master Plan Update forecasts, if the 1.1 million international enplaned passengers were added, the TAF would still be lower than the Low Growth Scenario, but HOU's constant Market Share of Aerospace Forecasts would lie between the Low Growth Scenario and the Baseline forecast results. The results are also shown graphically on **Exhibit 3-4**.

3.9 Forecast Applications

The Master Plan Update forecasts were used to develop facility requirements. They were also used to develop the design day flight schedules (DDFS) required as input to analytic models used in preparing airfield and terminal development plans and in assessing operational and environmental impacts. As noted earlier, the forecasts represent estimates of future activity at the Airport. Actual activity may vary from the forecasts because of unforeseen events and changes that may occur in airline service at the Airport or at competing airports. Because future conditions are, by definition, unknown, future activity may be different from that shown in the forecasts. Therefore, the forecasts developed for the Master Plan Update represent a range of possible, not necessarily actual, future activity.

Table 3-31: Historical and Forecast Enplaned Passengers and Aircraft Operations – Low Growth Scenario

	ENPLANED PASSENGERS						
	DOMESTIC		INTERNATIONAL			AIRCRAFT OPERATIONS	
YEAR	SOUTHWEST	OTHER AIRLINES	SOUTHWEST	FOREIGN FLAG AIRLINES	TOTAL	PASSENGER AIRLINES	AIRPORT TOTAL
Historical							
2006	3,753,739	548,030	-	-	4,301,769	110,648	237,048
2007	3,888,254	539,080	-	-	4,427,334	113,240	236,742
2008	3,904,843	496,142	-	-	4,400,985	110,332	220,010
2009	3,738,311	528,976	-	-	4,267,287	106,306	201,654
2010	3,997,436	549,261	-	-	4,546,697	103,794	202,096
2011	4,251,394	693,182	-	-	4,944,576	107,348	199,920
Low Growth Scenario							
2012	4,519,300	521,800	-	-	5,041,100	109,540	202,110
2013	4,585,200	536,700	-	-	5,121,900	109,900	202,470
2014	4,651,300	551,700	-	-	5,203,000	110,280	202,850
2015	4,576,700	566,900	362,100	128,300	5,634,000	113,630	206,200
2020	5,143,600	643,800	641,900	277,500	6,706,800	130,840	223,410
2030	6,418,900	791,600	790,600	323,100	8,324,200	151,690	244,260
Compound Annual Growth Rate							
2006 - 2011	2.5%	4.8%	-	-	2.8%	-0.6%	-3.3%
2011 - 2012	6.3%	-24.7%	-	-	2.0%	2.0%	1.1%
2011 - 2015	1.9%	-4.9%	-	-	3.3%	1.4%	0.8%
2015 - 2020	2.4%	2.6%	12.1%	16.7%	3.5%	2.9%	1.6%
2020 - 2030	2.2%	2.1%	2.1%	1.5%	2.2%	1.5%	0.9%
2011 - 2030	2.2%	0.7%	-	-	2.8%	1.8%	1.1%

SOURCES: Houston Airport System (Historical), Diio LLC., (Historical), InterVISTAS Consulting (Low Growth Scenario), Ricondo & Associates, Inc. (Low Growth Scenario), March 2012.

PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 3-32: Historical and Forecast Enplaned Passengers and Aircraft Operations – High Growth Scenario

	ENPLANED PASSENGERS						
	DOMESTIC		INTERNATIONAL			AIRCRAFT OPERATIONS	
YEAR	SOUTHWEST	OTHER AIRLINES	SOUTHWEST	FOREIGN FLAG AIRLINES	TOTAL	PASSENGER AIRLINES	AIRPORT TOTAL
Historical							
2006	3,753,739	548,030	-	-	4,301,769	110,648	237,048
2007	3,888,254	539,080	-	-	4,427,334	113,240	236,742
2008	3,904,843	496,142	-	-	4,400,985	110,332	220,010
2009	3,738,311	528,976	-	-	4,267,287	106,306	201,654
2010	3,997,436	549,261	-	-	4,546,697	103,794	202,096
2011	4,251,394	693,182	-	-	4,944,576	107,348	199,920
High Growth Scenario							
2012	4,519,300	521,800	-	-	5,041,100	109,540	203,380
2013	4,618,300	538,000	-	-	5,156,300	110,590	205,710
2014	4,752,400	555,200	-	-	5,307,600	112,340	208,750
2015	5,043,000	572,700	362,100	160,400	6,138,200	124,340	222,080
2020	5,892,700	773,800	641,900	339,200	7,647,600	150,350	254,990
2030	7,492,700	1,386,600	790,600	502,600	10,172,500	187,420	307,420
Compound Annual Growth Rate							
2006 - 2011	2.5%	4.8%	-	-	2.8%	-0.6%	-3.3%
2011 - 2012	6.3%	-24.7%	-	-	2.0%	2.0%	1.7%
2011 - 2015	4.4%	-4.7%	-	-	5.6%	3.7%	2.7%
2015 - 2020	3.2%	6.2%	12.1%	16.2%	4.5%	3.9%	2.8%
2020 - 2030	2.4%	6.0%	2.1%	4.0%	2.9%	2.2%	1.9%
2011 - 2030	3.0%	3.7%	-	-	3.9%	3.0%	2.3%

SOURCES: Houston Airport System (Historical), Diio LLC., (Historical), InterVISTAS Consulting (High Growth Scenario), Ricondo & Associates, Inc. (High Growth Scenario), March 2012.

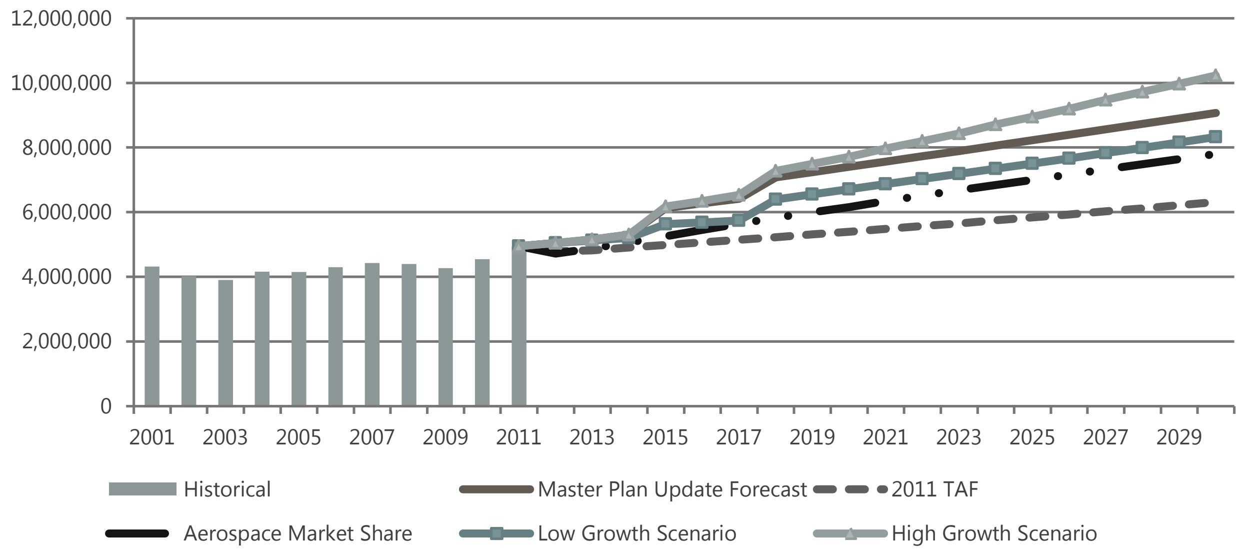
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 3-33: Historical and Forecast Enplaned Passenger Growth Comparison

YEAR	MASTER PLAN UPDATE FORECAST	ANNUAL GROWTH RATE	2011 TAF	MARKET SHARE	LOW GROWTH SCENARIO	HIGH GROWTH SCENARIO
Historical						
2001	4,318,209	-				
2002	4,019,340	-6.9%				
2003	3,901,871	-2.9%				
2004	4,159,769	6.6%				
2005	4,151,983	-0.2%				
2006	4,301,769	3.6%				
2007	4,427,334	2.9%				
2008	4,400,985	-0.6%				
2009	4,267,287	-3.0%				
2010	4,546,697	6.5%				
2011	4,944,576	8.8%	4,573,385	4,944,576	4,944,576	4,944,576
Forecast						
2012	5,041,100		4,784,341	4,719,360	5,041,100	5,041,100
2013	5,155,100		4,814,748	4,878,080	5,121,900	5,156,200
2014	5,304,100		4,905,943	5,064,960	5,203,000	5,307,700
2015	6,129,700		4,985,696	5,258,240	5,634,000	6,138,200
2020	7,399,900		5,394,240	6,160,000	6,706,800	7,647,700
2030	9,070,600		6,315,174	7,804,160	8,324,200	10,172,500
Compound Annual Growth Rate						
2001 - 2011	1.4%					
2006 - 2011	2.8%					
2011 - 2012	2.0%		4.6%	-4.6%	2.0%	2.0%
2011 - 2015	5.5%		2.2%	1.5%	3.3%	5.6%
2015 - 2020	3.8%		1.6%	3.2%	3.5%	4.5%
2020 - 2030	2.1%		1.6%	2.4%	2.2%	2.9%
2011 - 2030	3.2%		1.7%	2.4%	2.8%	3.9%

SOURCES: Houston Airport System (Historical), InterVISTAS Consulting (Forecast), Ricondo & Associates, Inc. (Forecast), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Exhibit 3-4: Historical and Forecast Enplaned Passenger Comparison



SOURCES: Houston Airport System (Historical), InterVISTAS Consulting (Forecast), Ricondo & Associates, Inc. (Forecast), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

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4. Facility Requirements

In this section, the demand forecast at HOU (summarized in Section 3) is compared with the existing capacity of each Airport system. Capacity gaps are identified and used to quantify future facility requirements for the Airport.

The relationship between demand and capacity and how that relationship impacts the planning of future facilities is complex. Numerous issues affect how efficiently a certain level of activity (i.e., demand) can be accommodated within a specific system or facility (i.e., capacity). Acceptable levels of service or convenience vary by user, facility, and airport sponsor.

The purpose of the comparative analyses described in this section is to determine the relationship between demand and capacity in the context of various Airport systems, and to provide general assessments of the ability of existing facilities to accommodate future demand. The assessments were translated into specific facility requirements for a series of PALs based on the forecasts presented in Section 3. In this study, PALs are the baseline demand levels at the increments of 2015, 2020 and 2030. **Table 4-1** summarizes the projected demand level of each PAL.

Table 4-1: Planning Activity Level Characteristics

	PLANNING ACTIVITY LEVELS			
YEAR	**2011**	**2015**	**2020**	**2030**
Enplanements	4,944,576	6,129,700	7,399,900	9,070,600
Million Annual Passengers (MAP)	4.9	6.1	7.4	9.0
Aircraft Operations	199,920	218,560	242,120	269,540

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

The analyses documented in this section are organized by functional system. For clarity, each system was assessed separately. Ultimately, however, the facility requirements for each system have been combined in the Airport Development Plan. Seven functional systems were identified:

- **Airfield facilities** address airfield configuration, including runway orientation and the taxiway system, weather conditions, the aircraft fleet mix, and forecast operations. The ability of the existing airfield to accommodate forecast operational demand, in terms of runway capacity and design standards, was evaluated.

- **Passenger Terminal Facilities** include the terminal from the front interior ticket counters to the gates. Enplaning, deplaning, and connecting passenger demands define the need for various facilities, such as passenger holdrooms, baggage claim facilities, public circulation areas, airline leased space (ticket counters, operations area, baggage makeup area), security space, concessions, and other terminal space (administration, etc.). Terminal gates/aircraft parking requirements were established according to peak hour demand for commercial passenger aircraft serving, and anticipated to serve, the Airport.
- The **Terminal Curbside** includes the size and configuration of the curbside. The ability of the existing terminal curbside configuration to accommodate forecast demand, in terms of numbers and types of vehicles, was evaluated.
- **Airport Ground Access** includes on- and off-Airport vehicular roadway, access, and circulation systems. The demand associated with these systems is driven by passenger demand and the distribution of the various modes of transportation that serve the Airport and operate on the local roadways.
- **Public Parking Facilities** include all on-Airport parking facilities, such as short-term, long-term, and employee parking facilities, as well as off-Airport parking facilities. Parking requirements are based on forecast numbers of originating passengers. The ability of existing parking facilities to accommodate forecast demand for parking spaces was evaluated.
- **Rental Car Facilities** include the customer service area, the ready/return and onsite vehicle storage area, and the quick turnaround area. The rental car facility requirements were developed using Airport-specific facility utilization rates based on hourly rental car transactions during a peak rental day. The ability of existing rental car facilities to accommodate forecast demand was evaluated.
- **General Aviation and Support Facilities** include:
  - FBO facilities
  - Corporate based operator facilities
  - Airline support facilities (aircraft maintenance and belly cargo)
  - Airport support facilities (i.e., Airport maintenance, Airport administration, operations, ARFF station, and fuel storage facility)
  - U.S. Customs and Border Protection facilities

The methodologies used to determine facility requirements and capacity 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 Sections 2 and 3 of this Master Plan Update was used, along with any additional information that more accurately reflects existing or future conditions. Planning experience at, and knowledge of, other airports was also used to estimate capacity. This approach ensured that capacity calculations would be sensitive to the specific requirements at HOU, and reflective of industry standards.

4.1 Airfield Facility Requirements

Planning and design of airport facilities are typically based on the role of the airport and the critical aircraft expected to operate on the airfield. The FAA provides planning and design guidance through published Advisory Circulars, Orders, and other guidelines that are intended to promote airport safety, efficiency, and economy. FAA airfield planning and design standards governing the geometric layout of runways and taxiways are detailed in FAA AC 150/5300-13A, *Airport Design*.

In addition to providing the appropriate geometric parameters for the critical aircraft expected to operate on the airfield, airfield facilities must also be designed to provide capacity to accommodate the activity forecast to occur over the planning period. An airfield demand/capacity analysis is typically conducted to assess the capability of airfield facilities at the airport to accommodate existing and forecast aircraft operations. In analyzing the ability of HOU facilities to accommodate operational demand, airfield demand and capacity and potential aircraft delay were calculated using the methodologies set forth in FAA AC 150/5060-5, *Airport Capacity and Delay* (Change 2).

4.1.1 AIRFIELD LAYOUT CONSIDERATIONS

4.1.1.1 Safety

The existing airfield layout consists of several intersecting runways. Eliminating the intersection of the Runways 12R and 17 ends has been identified as a safety priority by both HAS and the FAA. Indeed, the complex airfield layout in this area causes pilot confusion and increases the risk of runway incursions (two hotspots were identified in that area). Previous recommendations included decoupling the Runways 12R and 17 ends, by shifting Runway 17-35 south. However, this alternative is no longer being considered by HAS, due to the property acquisition requirements and the current leadership goal to not expand the footprint of the Airport. Closure of Runway 17-35 would eliminate two runway intersections and two hotspots; however, runway redundancy and capacity would be impacted. This Master Plan Update should recommend an airfield layout that eliminates confusing runway and taxiway intersections.

4.1.1.2 Redundancy

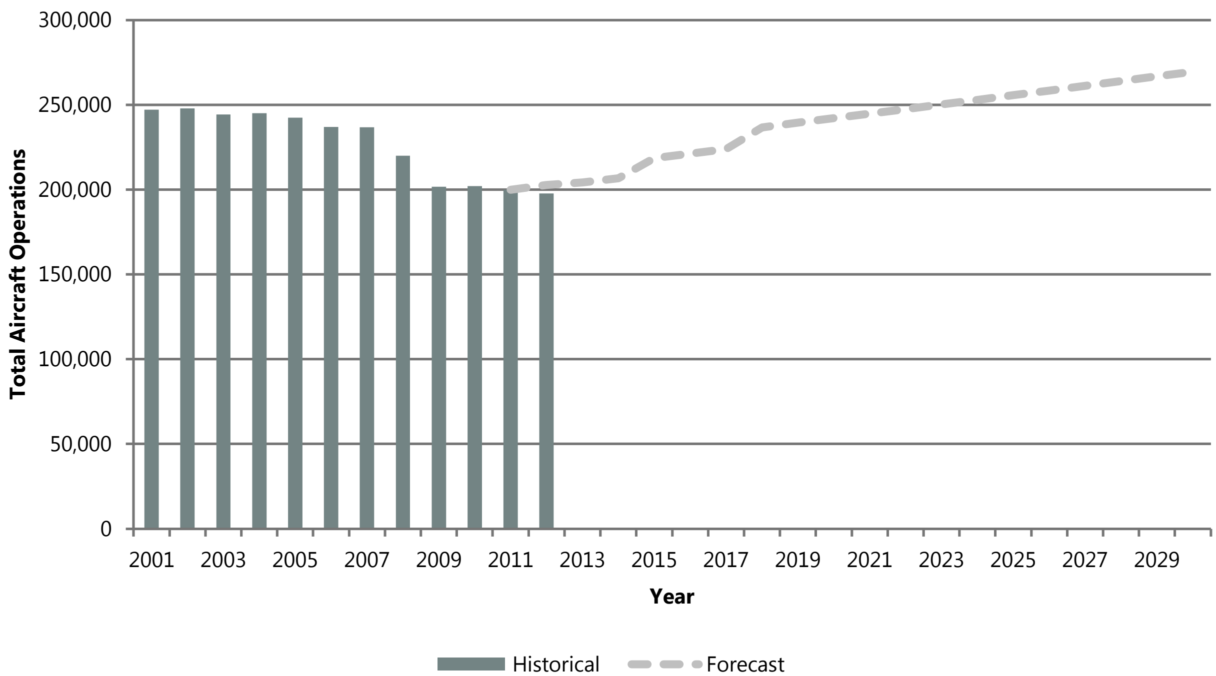
HOU Management is emphasizing the need for a back-up runway should the “iron cross” (the intersection of Runways 12R-30L and 4-22) be closed for maintenance or an incident on either runway. In such a scenario, air carrier aircraft would be required to depart from and land on Runway 17-35, which is shorter than Runways 12R-30L and 4-22 (6,000 feet versus 7,602 feet). A reduction in departure runway length would impose weight limitations on some flights, which may translate into either fewer passengers or less fuel that can be carried onboard the aircraft. On longer flights, where more fuel is required, significant impacts to the number of passengers that can be carried would result. With the introduction of international air service by Southwest Airlines in 2015, the need for runway redundancy is even more pressing, to guarantee uninterrupted runway capability. This Master Plan Update should recommend an airfield layout that provides runway departure length redundancy.

4.1.2 AIRFIELD DEMAND/CAPACITY ANALYSIS

An airfield demand/capacity analysis was conducted to assess the capability of the airfield facilities at HOU to accommodate existing and forecast aircraft operations. Operational demand levels at which aircraft delays would become excessive were identified to help determine the required timing of airfield capacity enhancement measures. **Exhibit 4-1** graphically depicts the forecast aircraft operations throughout the planning period (2030), as set forth in Section 3.

Airfield capacity, also referred to as "throughput," is defined as the maximum number of aircraft operations that can be accommodated on an airfield during a specific period of time without incurring an unacceptable level of delay. Airfield capacity varies according to weather conditions, types of aircraft operating on the airfield, airfield configuration, and ATCT 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 (i.e., demand) nears or exceeds the airfield capacity under a specific operating condition.

Exhibit 4-1: Historical and Forecast Aircraft Operations



SOURCE: Ricondo & Associates, Inc., September 2013.
PREPARED BY: Ricondo & Associates, Inc., September 2013.

The following terms, as defined by the FAA, are used in describing the analysis conducted:

- **Annual Service Volume (ASV).** As defined in FAA AC 150/5060-5, *Airport Capacity and Delay (Change 2)*, 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/or cloud ceiling heights in which ATC procedures are modified to maintain aircraft operational safety.

- **Average annual delay per operation.** This is an estimate of the average delay that each aircraft operation is expected to experience in a given year. Some aircraft operations, such as those occurring during peak operating hours, would likely experience higher delays, while other operations, such as nighttime operations, would likely experience little or no delay.
- **Total annual hours of aircraft delay.** This is an estimate of the total hours of aircraft delay that would be expected to occur annually at the airport (i.e., annual aircraft operations multiplied by the average annual delay per aircraft operation).

4.1.2.1 Factors Affecting Airfield Capacity

The capacity of an airfield, including the runways and associated exit taxiways, is not constant over time. A variety of factors can affect airfield capacity at an airport, each of which is discussed further below. These include:

- Airfield layout
- Percentage of time the airport experiences poor weather conditions (i.e., low cloud ceilings and/or low visibility)
- Aircraft fleet mix (types of aircraft operating at the airport
- Frequency of touch-and-go operations
- Airfield operating configuration (runway use restrictions)
- Existing airfield demand/capacity and delay relationships
- Hourly airfield capacity

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 of runway exits, their locations, and their type (high speed, 90 degree, etc.) also affect the capacity of the airfield.

Aircraft operations on intersecting runways are typically considered “dependent” operations. Aircraft in-trail separations, or spacing, must be increased to allow adequate time for aircraft operations on the intersecting runway to be conducted safely. The amount of in-trail separation between aircraft depends on the type of operations (arrival/departure) and the distance between the runway intersection and the approach end 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 travel beyond the runway intersection, thus allowing an operation on the intersecting runway to begin. As in-trail separations increase, airfield capacity decreases.

At airports with intersecting runways, airfield capacity may be increased through the use of Land-and-Hold-Short Operations (LAHSOs). LAHSOs allow for aircraft arrivals and/or departures on one runway to occur independently of aircraft arrivals on the intersecting runway. These operations are only permitted on runways where sufficient landing distance is available prior to the runway intersection. As stated in *Hobby Air Traffic Control Tower Order HOU 7110.1W* (ATC standard operating procedures), LAHSOs are currently prohibited at the Airport.

When an airfield configuration includes parallel runways, the lateral spacing between the runways also affects airfield capacity. Parallel runways with a lateral centerline-to-centerline separation of 2,500 feet or more can operate as independent runways during VMC. This separation allows aircraft to arrive on or depart from each runway simultaneously. The minimum lateral spacing between parallel runways to support dependent operations during VMC is 700 feet. The separation between the centerlines of Runways 12R-30L and 12L-30R is 800 feet. At this separation, simultaneous arrivals and simultaneous departures become dependent if wake turbulence is a concern during operations in VMC. These dependencies require an increase in in-trail separations, thus reducing airfield capacity.

During IMC in a radar-controlled environment, the minimum lateral spacing between the centerlines of parallel runways is 2,500 feet for dependent arrivals. At this separation, simultaneous departures may occur independently. Dependent staggered approaches to the parallel runways are typically conducted with a minimum of 1.5-mile separation diagonally between successive aircraft on adjacent runways. Increasing the lateral separation of the runways to 4,300 feet or more would allow for simultaneous arrivals and/or simultaneous departures on the parallel runways during IMC, provided that instrument approach procedures are in place for both runways. If the airport is equipped with a precision runway monitor, simultaneous arrivals or simultaneous departures may occur during IMC with a centerline separation of 3,400 feet between parallel runways.

Another factor affecting airfield capacity is the amount of time an aircraft occupies a runway. Runway occupancy time (ROT) 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, occupy the runway for a shorter time. 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.

Angled exit taxiways, when properly located along a runway, can more effectively reduce ROTs than 90-degree exit taxiways. Angled exit taxiways are aligned at an acute angle relative to the runway centerline, typically between 30 and 45 degrees relative to the runway orientation. This angle allows arriving aircraft to exit more expeditiously than standard exit taxiways that are perpendicular to the runway, resulting in lower ROT, and increased airfield capacity.

Weather Conditions

Airfield capacity can vary significantly based 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 operate safely on that particular runway.

Therefore, wind conditions may prevent the use of a higher-capacity runway operating configuration, thereby increasing aircraft delay.

Other meteorological conditions affecting airfield capacity include cloud ceiling height and visibility. Low cloud ceilings and poor visibility 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 the use of instrument landing systems. VFR govern the procedures used to conduct aircraft operations in VMC. Similarly, IFR govern the procedures used to conduct aircraft operations in IMC. The criteria defining 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
VMC	Greater than or equal to 3 statute miles	and	Greater than or equal to 1,000 feet above ground level
IMC	Less than 3 statute miles	and/or	Less than 1,000 feet above ground level

SOURCE: FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay (Change 2)*, December 1, 1995.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

During IMC, in-trail separations for arrivals and departures are increased, thus reducing the hourly capacity of the airfield. At HOU, the restriction of aircraft arrivals to runways with an established instrument approach procedure (e.g., Runways 4, 12R, and 30L) also contributes to diminished airfield capacity during IMC. During IMC, aircraft arrivals and departures on parallel runways are limited.

Aircraft Fleet Mix

The aircraft fleet mix operating at an airport is an important factor in determining airfield capacity. As the diversity of approach speeds and aircraft weights increases, airfield capacity decreases because of the increased in-trail separation 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 vortices than lighter 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 to the in-trail (following) aircraft, aircraft are spaced according to the differences in their airspeed and weight. Light aircraft are more susceptible to upset from wake vortices than heavy aircraft. Therefore, light aircraft are typically required to wait up to 2 minutes before operating on a runway after a heavy aircraft. This delay results in a loss in airfield capacity. The greater the size and weight differential of the aircraft fleet using a specific runway, the greater the increased separation required between successive aircraft operations on that runway.

FAA AC 150/5060-5, *Airport Capacity and Delay* (Change 2) uses 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 categories based on the maximum certificated takeoff weight of the aircraft. Based on the number of operations in each classification, a percentage is established to quantify the share of total aircraft operations at an airport by aircraft type that result in wake turbulence hazards. **Table 4-3** summarizes the five aircraft classifications in accordance with the maximum certificated takeoff weight of the aircraft in the fleet mix.

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, and King Air
Small +	12,501 to 41,000	Lear 25, Cessna Citation, and Grumman G-1
Large	41,001 to 225,000	Gulfstream IV, F-28, Dash 8, Boeing 737, and Boeing 727
B757	225,001- to 300,000	Boeing 757-200/300
Heavy	300,001 or more	300, Boeing 767, DC-10, A380, Boeing 747-8

SOURCE: FAA Advisory Circular 150/5060-5, *Aircraft Capacity and Delay*, December 1, 1995 (Change 2).
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Touch-and-Go Operations

Touch-and-go operations are defined as operations by a single aircraft that lands and departs without stopping or exiting the runway. Pilots conducting touch-and-go operations are usually conducting training exercises and, therefore, stay in the airport traffic pattern. Airfield capacity, in terms of the number of aircraft operations possible, increases as the number of touch-and-go operations increases because aircraft continually land and depart without incurring significant ROT. 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 HOU, as the majority of general aviation activity consists of corporate flights, rather than training flights.

Airfield Operating Configuration

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

Aircraft performance characteristics may restrict aircraft operations on a runway. For departures, the available runway length must equal or exceed the runway length requirements specified for the departing aircraft. These requirements include the runway length needed for the takeoff ground roll, the runway length needed to clear an obstruction of a specified height (typically 35 feet AGL), and the aircraft accelerate-stop distance. If the available runway length is not adequate to accommodate the aircraft, the aircraft is required to depart from a runway that provides adequate departure length or the aircraft payload must be reduced. Similarly, the landing distance available on the runway must exceed the landing distance requirements prescribed for the aircraft. 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 aircraft takeoff and initial departure climb are of particular importance. Aircraft operations conducted under 14 CFR Part 121, *Operating Requirements: Domestic, Flag, and Supplemental Operations,* or 14 CFR Part 135, *Operating Requirements: Commuter and On-Demand Operations and Rules Governing Persons on Board Such Aircraft,* must adhere to an airport obstacle analysis prior to departure. If an obstacle that would not allow the departing aircraft to meet the minimum obstacle clearance requirements prescribed by the FAA is identified, the departure would not be permitted. The presence of this obstacle would restrict the use of the runway, thus affecting the airfield's operating configurations.

Runway use may also be predicated on regional ATCT procedures associated with nearby airports. The presence of neighboring airports often requires the shared use of navigational facilities or approach/departure fixes. In such cases, strict coordination between ATCT facilities is required, and the capacity of the overall regional airspace system could be restricted. In some instances, specific operating configurations at one airport may take precedence over operations at the other airport, which could restrict the use of certain operating configurations at the airport that has lower priority.

Existing Airfield Demand/Capacity and Delay Relationships

The estimated capacity of the existing airfield is presented in this section in terms of hourly capacity and ASV for each one of these PAL: 2011-2012, 2015, 2020, and 2030.

For each runway use configuration, hourly capacities were established for operations during VMC and IMC. Historical weather data obtained from the NCDC were used to establish the availability of each runway use configuration during the two meteorological conditions. A weighted hourly capacity was then established based on the occurrence rate of each runway use configuration/weather condition and their respective hourly capacities. The weighted hourly capacity forms the basis for determining the airfield's ASV.

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

FAA AC 150/5060-5 presents the methodology for calculating hourly delay under a number of conditions that are representative of the seasonal and daily variations in demand, weather, 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. The occurrences of different weather conditions and runway uses, and hourly runway capacity parameters corresponding to these occurrences, are provided as variables in the calculation. Hourly delays are established for each hour of the year using delay curves. The average delay per aircraft operation for the year is computed by aggregating the estimated hourly delays.

Hourly Airfield Capacity

When hourly demand begins to reach hourly capacity, aircraft delays grow at an increasing rate. These delays take the form of extended arrival traffic patterns and departure queue delays in VMC, 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 is compared with peak hour demand in the demand/capacity analysis. Peak hour demand that meets or exceeds hourly capacity is likely to result in delays during the peak demand period. The rate at which an airfield can "recover" from peak period delays is dependent on the operational profile throughout the day.

4.1.2.2 Current ATC Airfield Operating Configurations

In estimating hourly capacity for the existing HOU 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 projected to evolve throughout the planning period, the hourly capacities associated with existing (2011-2012) operational demand, as well as demand forecast for 2015, 2020, and 2030, were identified. In addition, the hourly capacities during VMC and IMC are presented individually for each airfield operating configuration. These capacities are then compared to the forecast peak hour demand to assist in identifying potential operational delays during peak demand periods.

To provide an understanding of the various HOU airfield operating configurations used by ATCT, the existing runway configuration at the Airport must be considered. As previously shown on Exhibit 1-1, the airfield consists of two parallel runways, Runways 12R-30L and 12L-30R, and two crosswind runways, Runways 4-22 and 17-35. The parallel runways have a lateral centerline-to-centerline separation of approximately 800 feet. Runway 4-22 intersects Runways 12R-30L, 12L-30R, and 17-35. Therefore, operations conducted on Runway 4-22 are dependent with operations conducted on all three of the other runways. Similarly, Runway 17-35 intersects Runway 12R-30L, and its extended centerline intersects the extended centerline of Runway 12L-30R. Therefore, operations conducted on Runway 17-35 are also dependent with operations conducted on all three of the other runways.

With overall lengths of 7,602 feet, Runways 12R-30L and 4-22 are the longest runways at the Airport. Although any aircraft in the current aircraft fleet operating at the Airport can use these two runways, the runways primarily serve air carrier, regional jet, and corporate general aviation operations. In comparison, Runways 17-35 and 12L-30R have an overall length of 6,000 feet and 5,148 feet, respectively. Although Runway 17-35 has sufficient length to accommodate air carrier and regional jet aircraft, its use by these aircraft is limited during peak demand periods to minimize the additional taxiing distance from the terminal and unnecessary runway crossings. Additionally, Runway 17-35 can only accommodate B-II aircraft without restrictions, due to runway safety area length limitations beyond the Runway 17 departure end (south end of the runway). Runway 12L-30R is primarily used by general aviation and corporate aircraft because of its limited length and 100-foot width, ATC has determined that the demand for Runway 12L-30R is significantly lower than for the other runways at the Airport.

Exhibit 4-2 and **Exhibit 4-3** illustrate the percentage of time that each runway operating configuration occurs at the Airport during VMC and IMC. The exhibits also present the prevailing wind direction under which each airfield operating configuration is typically used. The likely occurrence (percent of time) of each operating configuration is based on historical weather observations for the 10-year period January 1, 2000, through December 31, 2009. For IMC operating configurations, the cloud ceiling and visibility minimums for published instrument approach procedures associated with the arrival runway are also presented.

As illustrated on Exhibits 4-2 and 4-3, seven operating configurations are used during VMC and IMC, as identified by ATC. In addition, the SMGCS configuration is used during IMC only, when weather minimums are below the ILS CAT I minimums; at this time, only Runway 4 can be used in SMGCS Flow, as it is the only runway equipped with a CAT II/III ILS. The operating configurations are identified below, followed by a brief description of each.

- **South Flow:** ATCT personnel have identified the South Flow operating configuration as the preferred operating condition during both VMC and IMC. This configuration currently yields the greatest airfield capacity, and results in limited airspace impacts with IAH, located approximately 23 miles north of HOU. During VMC, Runways 12L and 12R provide simultaneous arrival and departure capabilities in the South Flow configuration. Because of the combined effects of their close lateral separation and the hazards of wake turbulence, however, simultaneous arrivals/departures on Runway 12L and 12R would be prohibited while wake turbulence hazards exist. In addition, Runways 17 and 22 currently serve aircraft departures during South Flow operations. Operation of the South Flow configuration under IMC is similar to its operation during VMC. As Runway 12L does not have a published instrument approach procedure, the runway is not available for aircraft arrivals in IMC. In addition, its lateral separation from Runway 12R is not adequate to allow simultaneous departures in IMC. Therefore, Runway 12R is used for both arrivals and departures during South Flow IMC, while Runways 17 and 22 accommodate aircraft departures only.

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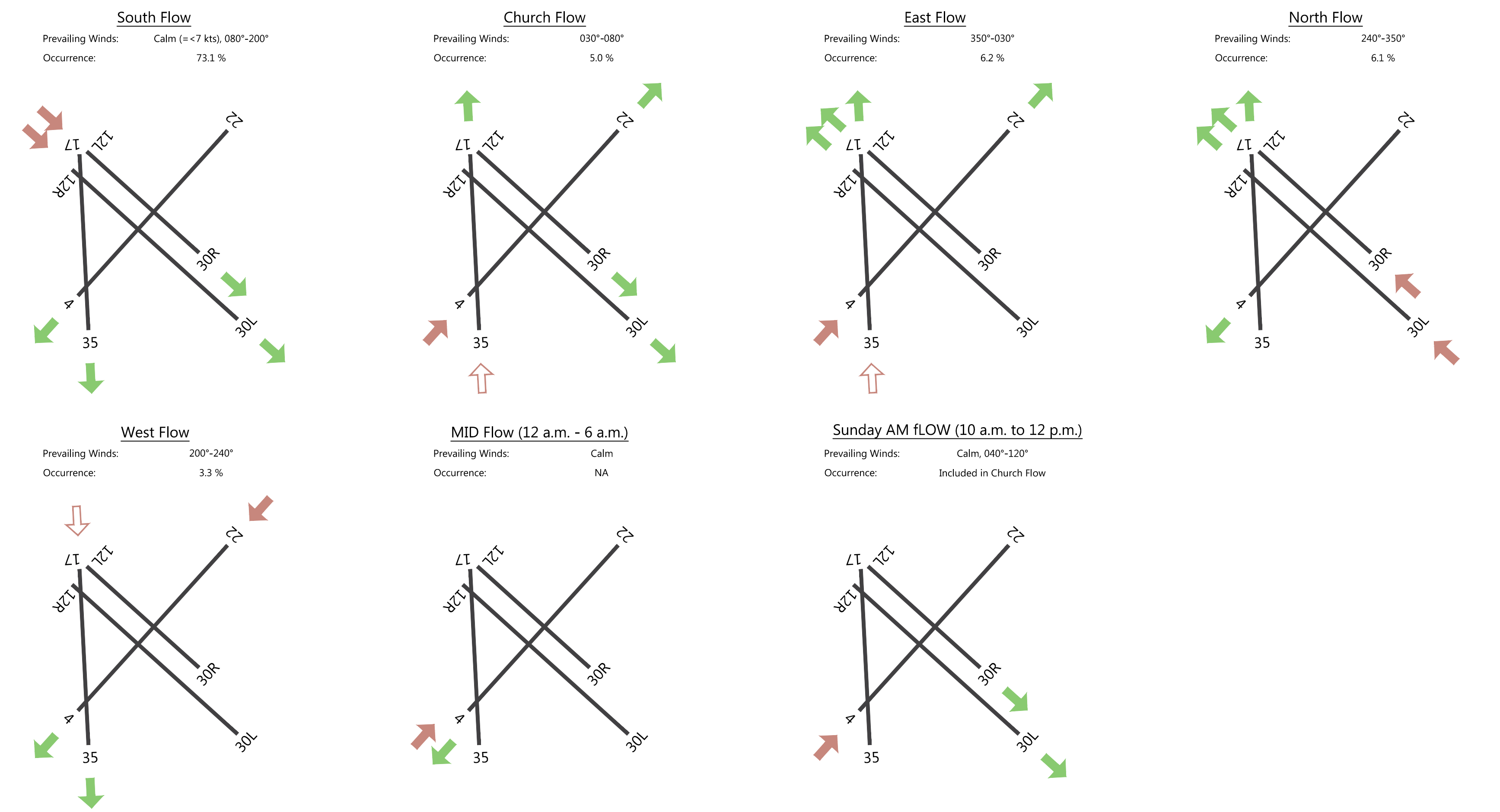

NOTE:
The reported wind direction is based on prevailing winds during which each airport operating configuration could be operated without experiencing tailwind conditions. Additional consideration was given for preferential configurations, as identified by ATC staff.

SOURCES: National Climatic Data Center, TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009, 6 a.m. to midnight), May 3, 2012; Houston Hobby Air Traffic Control, *Hobby ATCT 7110.1W*, August 15, 2011; Ricondo & Associates, Inc., June 2012.
PREPARED BY: Ricondo & Associates, Inc., June 2012.

EXHIBIT 4-2

Runway Use Configurations - VMC Existing Airfield

NORTH 0 Not to Scale

LEGEND
- Primary Arrivals
- Primary Departures
- Secondary Arrivals

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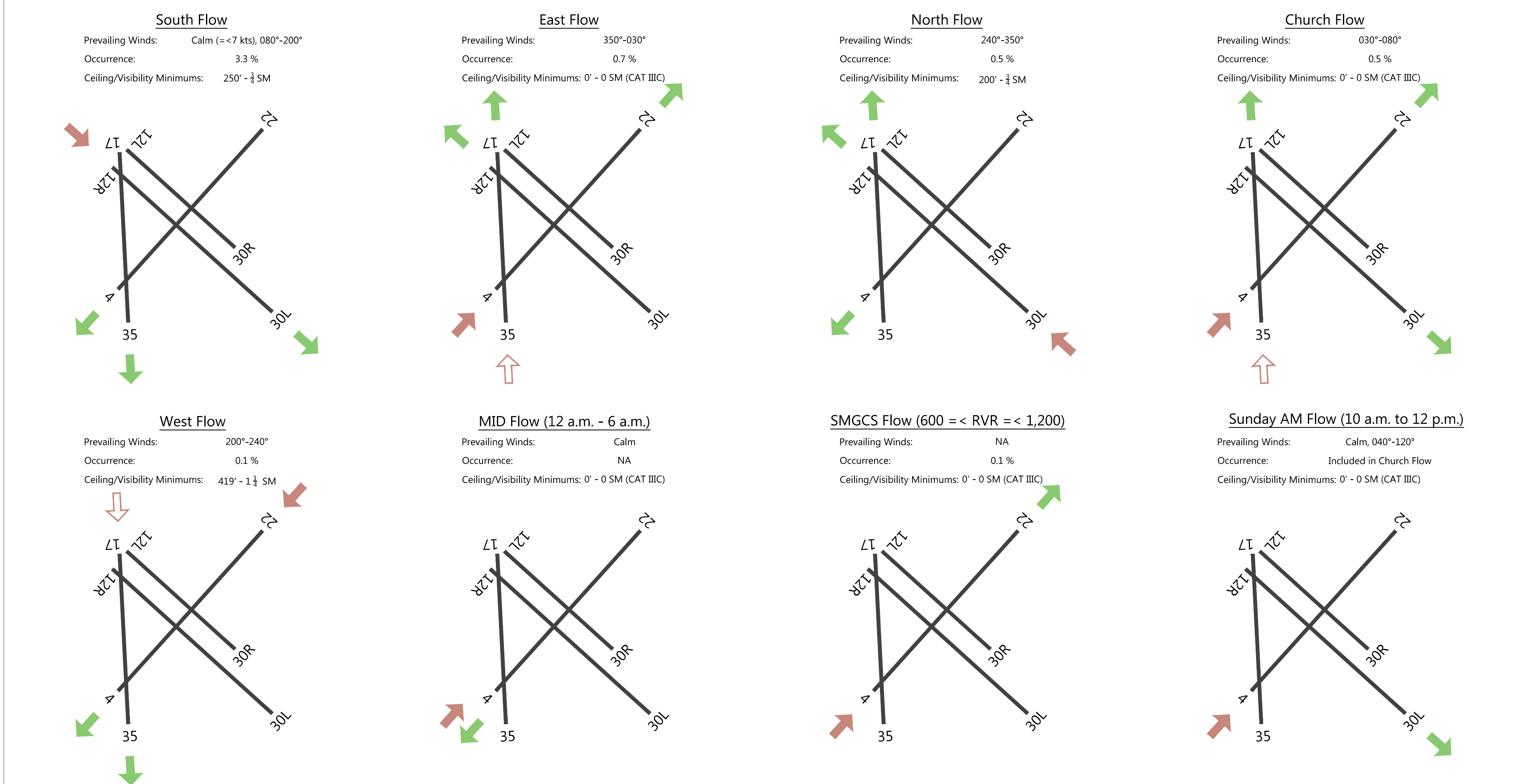

NOTES:
1. The reported wind direction is based on prevailing winds during which each airport operating configuration could be operated without experiencing tailwind conditions. Additional consideration was given for preferential configurations, as identified by ATC staff.
2. Minimum ceiling and visibility are based on the lowest approach minimums prescribed for the arrival runway.
3. SM = statute miles, kts = knots, CAT = category.

SOURCES: National Climatic Data Center, TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009, 6 a.m. to midnight), May 3, 2012; Houston Hobby Air Traffic Control, *Hobby ATCT 7110.1W*, August 15, 2011; Ricondo & Associates, Inc., June 2012.
PREPARED BY: Ricondo & Associates, Inc., June 2012.

EXHIBIT 4-3

NORTH

0 Not to Scale

LEGEND
Primary Arrivals
Primary Departures
Secondary Arrivals

Runway Use Configurations - IMC Existing Airfield

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\04_Chapter 4_Requirements\02_Airfield Capacity Analysis\CAD\Exh 2-18, 4-2 & 4-3_HOU-Existing Runway Configurations.dwg_Layout: IMC_Dec 29, 2014, 2:18pm

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The South Flow configuration in both VMC and IMC is typically operated when prevailing winds are from a heading of 080 degrees through 200 degrees. As this configuration yields the greatest capacity, ATC also prefers to use this configuration during calm wind conditions. During IMC, the ILS serving Runway 12R requires a minimum cloud ceiling[1] of 250 feet AGL and a minimum visibility of ¾ statute mile. Therefore, it was estimated that the VMC and IMC South Flow operating configuration occurs approximately 73.1 percent and 3.3 percent of the time, respectively. It should be noted, however, that aircraft arrivals on Runways 12R and 12L at HOU during South Flow operations require ATC coordination with IAH regarding aircraft departures from Runways 15R and 15L at IAH. Similarly, aircraft departures on Runways 12R and 12L at HOU also require ATC coordination with EFD, located approximately 8 miles southeast of HOU.

- **Church Flow:** During VMC, Runway 4 accommodates both aircraft arrivals and departures, while Runways 12L, 12R, and 35 primarily accommodate aircraft departures. Runway 35 may be operated as a secondary arrivals runway. Although Runways 12L and 12R can support simultaneous departures, wake turbulence hazards may prohibit simultaneous departures on parallel Runway 12L. Similarly, simultaneous departures from Runways 12L and 12R are prohibited under the Church Flow configuration during IMC. Otherwise, operation of the Church Flow configuration under IMC is identical to that during VMC.

  The Church Flow configuration for both VMC and IMC is typically operated when prevailing winds are from a heading of 030 degrees through 080 degrees. During IMC, the ILS serving Runway 4 requires no minimum cloud ceiling or visibility. As these minimums are lower than those for operations on Runway 12R during South Flow, the Church Flow configuration could also be used during calm wind conditions when cloud ceiling and visibility are below the minimums prescribed for the Runway 12R ILS. Therefore, it was estimated that VMC and IMC Church Flow operating configurations have occurrence rates of approximately 5.0 percent and 0.5 percent, respectively. The Church and East Flow configurations are typically operated when IAH is operating in East Flow to avoid interference between approach streams at both airports.

- **East Flow:** During VMC, Runway 4 accommodates both aircraft arrivals and departures, while Runways 30L, 30R, and 35 primarily accommodate aircraft departures. Runway 35 may be operated as a secondary arrivals runway. Although Runways 30L and 30R can support simultaneous departures, such operations may be prohibited when wake turbulence hazards exist. Similarly, simultaneous departures from Runway 30L and 30R are prohibited under the East Flow configuration during IMC. Otherwise, operation of the East Flow configuration under IMC is identical to that under VMC.

  The East Flow configuration for both VMC and IMC is typically operated when prevailing winds are from a heading of 350 degrees through 030 degrees. During IMC, the ILS serving Runway 4 requires no minimum cloud ceiling or visibility. As these minimums are lower than those for operations on Runway 12R during South Flow, the East Flow configuration could also be operated during calm winds

[1] The minimum cloud ceiling 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.

when the weather is below the minimums prescribed for the Runway 12R ILS. Therefore, it was estimated that the VMC and IMC East Flow operating configurations have occurrence rates of approximately 6.2 percent and 0.7 percent, respectively.

- **North Flow:** When the prevailing winds are between 240 degrees and 350 degrees, the North Flow operating configuration is used by ATCT during both VMC and IMC. During VMC, simultaneous arrivals and departures may occur on Runways 30R and 30L, provided that wake turbulence is not a factor. In addition, Runways 22 and 35 accommodate aircraft departures during North Flow operations. During IMC, arrivals and departures on Runway 30R are typically discontinued, and Runways 22, 30L, and 35 remain operational. The ILS for Runway 30L provides the capability to accommodate aircraft arrivals with a cloud ceiling of 200 feet AGL or greater and visibility of ¾ statute mile. Therefore, it was estimated that the VMC and IMC North Flow operating configurations have occurrence rates of approximately 6.1 percent and 0.5 percent, respectively.
- **West Flow:** Because of its limited capacity and airspace interactions with IAH, the West Flow operating configuration at HOU is least preferred by ATC. In West Flow, the same runway operating configuration is used during both VMC and IMC. Runway 22 accommodates both aircraft arrivals and departures, while Runway 17 accommodates aircraft departures and may be used as a secondary arrivals runway. The West Flow operating configuration is used only while the prevailing winds are between 200 degrees and 240 degrees. Runway 22 is served by an Area Navigation (RNAV) global positioning system (GPS) approach with cloud ceiling and visibility requirements of 419 feet AGL and 1 ¼ statute miles, respectively. Therefore, it was estimated that the VMC and IMC West Flow operating configurations have occurrence rates of approximately 3.3 percent and 0.1 percent, respectively.
- **MID Flow:** The MID Flow configuration is the preferred operating configuration between the hours of 12 a.m. and 6 a.m. With this configuration, Runway 4 is used for arrivals and Runway 22 is used for departures. MID Flow is used only when prevailing winds favor its use. During IMC, the ILS serving Runway 4 does not require a minimum cloud ceiling or visibility. The occurrence of MID Flow was not evaluated, as it is only used at night, when there are no capacity issues; the wind occurrence calculations were based on daytime data, between 6 a.m. and midnight.
- **Sunday AM Flow:** Between the hours of 10:00 a.m. and 12:00 p.m. on Sunday mornings, ATC uses the Sunday AM Flow operating configuration, traffic and weather conditions permitting. This configuration is operated to minimize aircraft flights over residential areas and other noise-sensitive land uses immediately north of the Airport. During VMC, under this operating configuration, Runway 4 is used exclusively for arrivals and Runways 12R and 12L are used for departures. During IMC, aircraft departures are restricted to Runway 12R only. The Sunday AM operating configuration can be used only if the prevailing winds are between 040 degrees and 120 degrees, or are calm. During IMC, no approach minimums are associated with the ILS for Runway 4-22. The Sunday AM Flow occurrence rates are included in the Church Flow percentages.
- **SMGCS Flow:** SMGCS Flow is the preferred operating configuration when visibility conditions are below ILS CAT I minimums (i.e., RVR 1,200) but above RVR 600. Under this configuration, Runway 4 is used for arrivals and departures. Therefore, it was estimated that the SMGCS Flow operating configuration has an occurrence rate of approximately 0.1 percent.

Consistent with Exhibits 4-2 and 4-3, **Table 4-4** summarizes the historical occurrence rates associated with the various airfield operating configurations at the Airport. As indicated, VMC and IMC had 10-year occurrence rates of 93.8 percent and 5.2 percent, respectively. The remaining 0.9 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 discontinuation of aircraft operations until weather conditions improve.

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

RUNWAY USE CONFIGURATIONS	VMC	IMC	AIRPORT CLOSED
South Flow	73.1%	3.3%	NA
Church Flow	5.0%	0.5%	NA
East Flow	6.2%	0.7%	NA
North Flow	6.1%	0.5%	NA
West Flow	3.3%	0.1%	NA
SMGCS Flow	NA	0.1%	NA
Airport Closed	NA	NA	0.9%
Total:	93.8%	5.2%	0.9%
		Total Observations:	99.9%

NOTE: NA = Not Applicable

SOURCES: National Climatic Data Center, TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009; 6 a.m. to midnight), May 3, 2012; Ricondo & Associates, Inc., June 2012.

PREPARED BY: Ricondo & Associates, Inc., June 2012.

4.1.2.3 Aircraft Fleet Mix Assumptions

Table 4-5 summarizes the composition of the VMC aircraft fleet mix operating at the Airport during 2011-2012, and the projected fleet mix at the end of the planning period (2030). The table also presents the resulting mix index that formed the basis for estimating the throughput of the airfield. The fleet mix data for 2011-2012 were estimated by evaluating the fleet mix composition of air carrier, commuter, general aviation, and military operations on an individual basis. The fleet mix data were obtained from the HOU Airport Noise and Operations Monitoring System (ANOMS) database for operations between April 1, 2011, and March 31, 2012 (the 12 most recent months of ANOMS data available at the time of this analysis). The fleet mix data for 2030 were derived from the 2030 design day flight schedule. The derived 2030 fleet mix was also used for 2015 and 2020.

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

	SMALL	SMALL+	LARGE	B757	HEAVY	TOTAL	MIX INDEX 1/
2011-2012	14.0%	17.8%	68.2%	0.0%	0.0%	100.0%	86.0%
2030	12.2%	18.8%	69.0%	0.0%	0.0%	100.0%	87.8%

NOTE:

1/ Mix Index = (Percent of "Small+" Aircraft) + (Percent of Large Aircraft) + (2 * Percent of B757 Aircraft) + (3 * Percent of Heavy Aircraft)

SOURCES: Houston Airport System, William P. Hobby Airport, ANOMS Database, April 1, 2011 – March 31, 2012; Ricondo & Associates, Inc., July 2012.
PREPARED BY: Ricondo & Associates, Inc., July 2012.

As shown in Table 4-5, the mix index associated with 2011-2012 operations under VMC was 86.0 percent. Only small variations in the fleet mix are anticipated throughout the planning period, resulting in a 2030 mix index of 87.8 percent.

The mix index reported in the 2004 Master Plan for 2000 was 69.0 percent. The following factors are believed to have caused the 2011-2012 mix index to increase to 86.0 percent:

- General aviation piston aircraft operations decreased, as these operations are being shifted to other GA airports in the area
- Itinerant military operations increased
- Commuter operations, particularly by turboprop aircraft, decreased and are being replaced by regional jet aircraft

Table 4-6 summarizes the IMC aircraft fleet mix composition operating at the Airport during 2011-2012 and the projected aircraft fleet mix in 2030. As indicated by ATC, the IMC fleet mix composition was derived from the VMC fleet mix composition, assuming a 50 percent reduction in small piston aircraft operations during IMC. Accordingly, the IMC mix index is projected to increase from 87.4 percent in 2011-2012 to 89.3 percent in 2030. The derived 2030 fleet mix was also used for 2015 and 2020.

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

	SMALL	SMALL+	LARGE	B757	HEAVY	TOTAL	MIX INDEX 1/
2011-2012	12.6%	18.1%	69.3%	0.0%	0.0%	100.0%	87.4%
2030	10.7%	19.1%	70.2%	0.0%	0.0%	100.0%	89.3%

NOTE:

1/ Mix Index = (Percent of Small+ Aircraft) + (Percent of Large Aircraft) + (2 * Percent of B757 Aircraft) + (3 * Percent of Heavy Aircraft)

SOURCES: Houston Airport System, William P. Hobby Airport, ANOMS Database, April 1, 2011 – March 31, 2012; Ricondo & Associates, Inc., July 2012.
PREPARED BY: Ricondo & Associates, Inc., July 2012.

4.1.2.4 Hourly Capacity Estimates

Table 4-7 presents the VMC and IMC hourly capacity estimates for the operating configurations considered (existing airfield during South Flow, Church Flow, East Flow, North Flow, West Flow, and SMGCS Flow). It should be noted that, for purposes of evaluating airfield capacity, the demand/capacity assessment was focused on the hourly capacity estimates for the condition representative of 50 percent arrivals and 50 percent departures.

Assuming a 50 percent arrivals mix, the existing (2011-2012) VMC hourly capacity ranges from a low of 47 operations in West Flow to a high of 76 operations in South Flow. Although the mix index is projected to increase from 86.0 percent in 2011-2012 to 87.8 percent in 2030, this increase would have a negligible effect on the airfield's hourly capacity.

As expected, the hourly capacity estimates under IMC are lower than the estimates under VMC as a result of a variety of factors: (1) an increase in the mix index, (2) increased separation requirements between successive aircraft operations, and (3) the inability to conduct simultaneous arrivals and simultaneous departures on Runways 12L-30R and 12R-30L during IMC. Assuming a 50 percent arrivals mix, the IMC hourly capacity estimates for 2012 range from a low of 47 operations in West Flow and SMGCS Flow to a high of 57 operations in South Flow and Church Flow. Similar to VMC conditions, the IMC hourly capacity estimates remain relatively constant through 2030 as the mix index is projected to increase from 87.4 percent to 89.3 percent.

4.1.2.5 Hourly Demand/Capacity Comparisons

Exhibit 4-4 through **Exhibit 4-7** present comparisons of the hourly capacity estimates associated with each airfield operating configuration and peak hour demand at the Airport in 2011-2012 (existing) and forecast for 2015, 2020, and 2030. Each exhibit presents a separate comparison for VMC and IMC weather conditions, assuming an arrivals mix of 50 percent. As shown on Exhibit 4-4, during 2011-2012, the VMC and IMC peak hour aircraft demand was typically 42 and 41 operations, respectively,. This demand did not exceed the hourly airfield capacity under any of the runway operating configurations. However, as peak hour demand increases through 2030, aircraft demand is forecast to increasingly exceed airfield capacity under all operating configurations. As shown on Exhibit 4-5, the peak hour IMC demand of 48 operations forecast for 2015 would exceed the hourly airfield capacity under two IMC operating configurations: West Flow and SMGCS Flow.

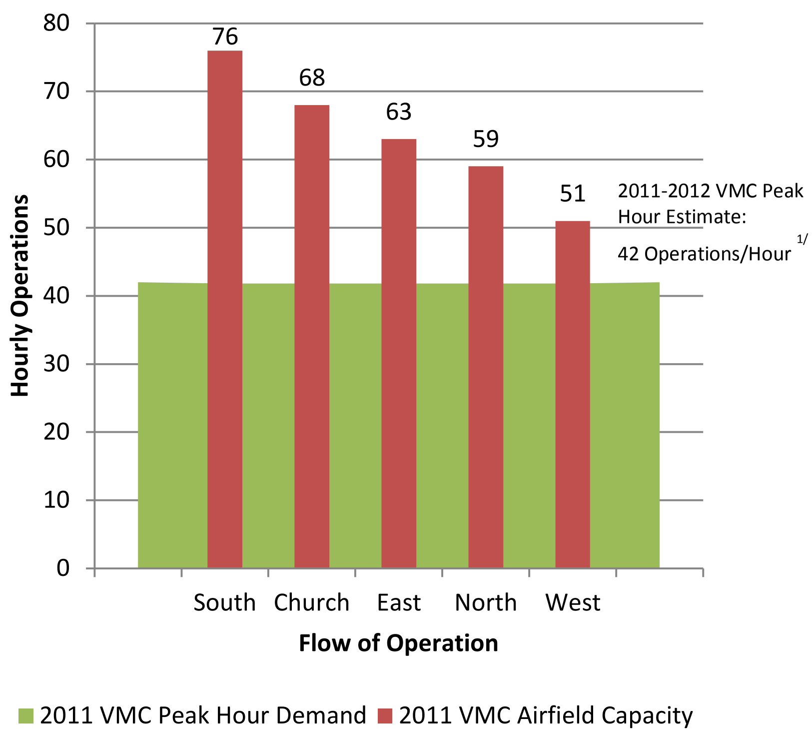
Table 4-7: Estimated Hourly Capacities of the Existing Airfield Configuration

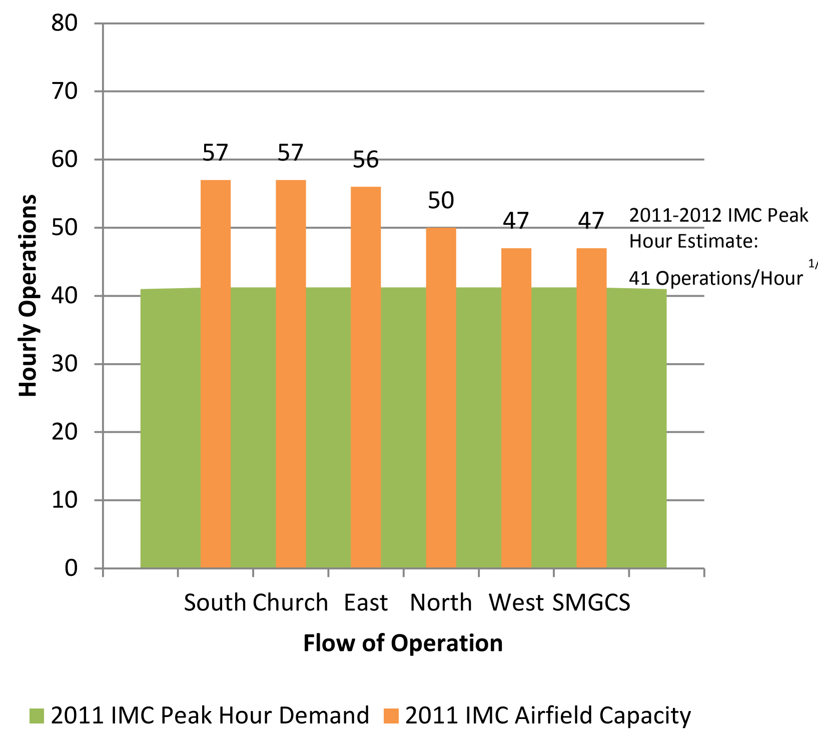
EXISTING AIRFIELD LAYOUT	VISUAL METEOROLOGICAL CONDITIONS		INSTRUMENT METEOROLOGICAL CONDITIONS	
	MIX INDEX	HOURLY CAPACITY (50% ARRIVALS)	MIX INDEX 1/	HOURLY CAPACITY (50% ARRIVALS)
EXISTING (2011/2012)				
South Flow	86.0%	76	87.4%	57
Church Flow	86.0%	68	87.4%	57
East Flow	86.0%	63	87.4%	56
North Flow	86.0%	59	87.4%	50
West Flow	86.0%	51	87.4%	47
SMGCS Flow	NA	NA	87.4%	47
2015				
South Flow	87.8%	76	89.3%	57
Church Flow	87.8%	73	89.3%	57
East Flow	87.8%	69	89.3%	56
North Flow	87.8%	59	89.3%	50
West Flow	87.8%	51	89.3%	47
SMGCS Flow	NA	NA	91.0%	47
2020				
South Flow	87.8%	76	89.3%	57
Church Flow	87.8%	73	89.3%	57
East Flow	87.8%	69	89.3%	56
North Flow	87.8%	59	89.3%	50
West Flow	87.8%	51	89.3%	47
SMGCS Flow	NA	NA	91.0%	47
2030				
South Flow	87.8%	76	89.3%	57
Church Flow	87.8%	73	89.3%	57
East Flow	87.8%	69	89.3%	56
North Flow	87.8%	59	89.3%	50
West Flow	87.8%	51	89.3%	47
SMGCS Flow	NA	NA	91.0%	47

NOTE: Mix Index = (Percent of Small+ Aircraft) + (Percent of Large Aircraft) + (2 * Percent of B757 Aircraft) + (3 * Percent of Heavy Aircraft)

SOURCES: FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay* (Change 2), December 1, 1995; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Exhibit 4-4: 2011-2012 Hourly Airfield Demand/Capacity Comparison – Existing Airfield





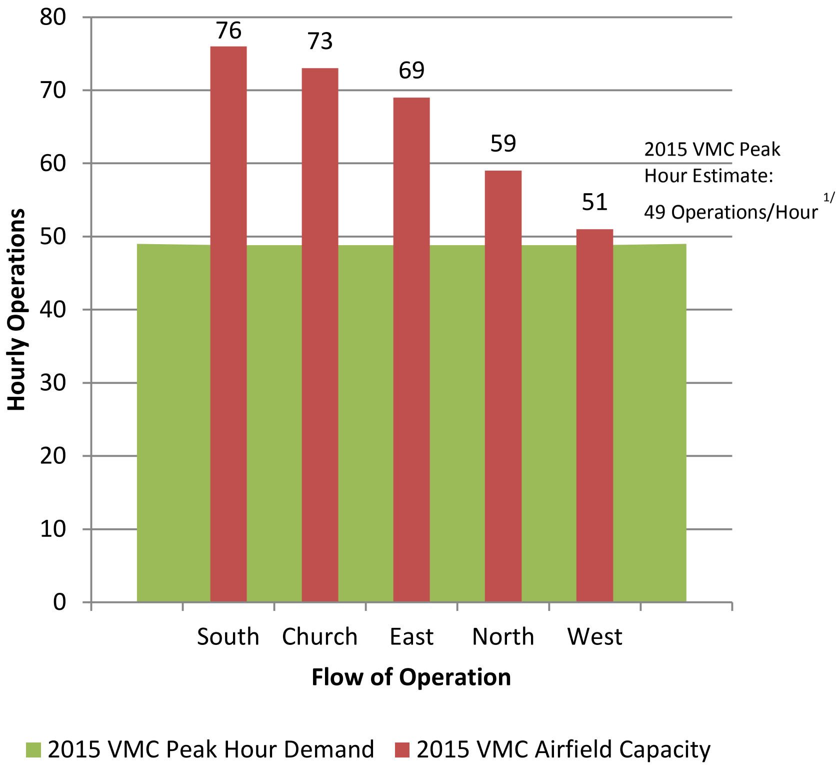
NOTES:

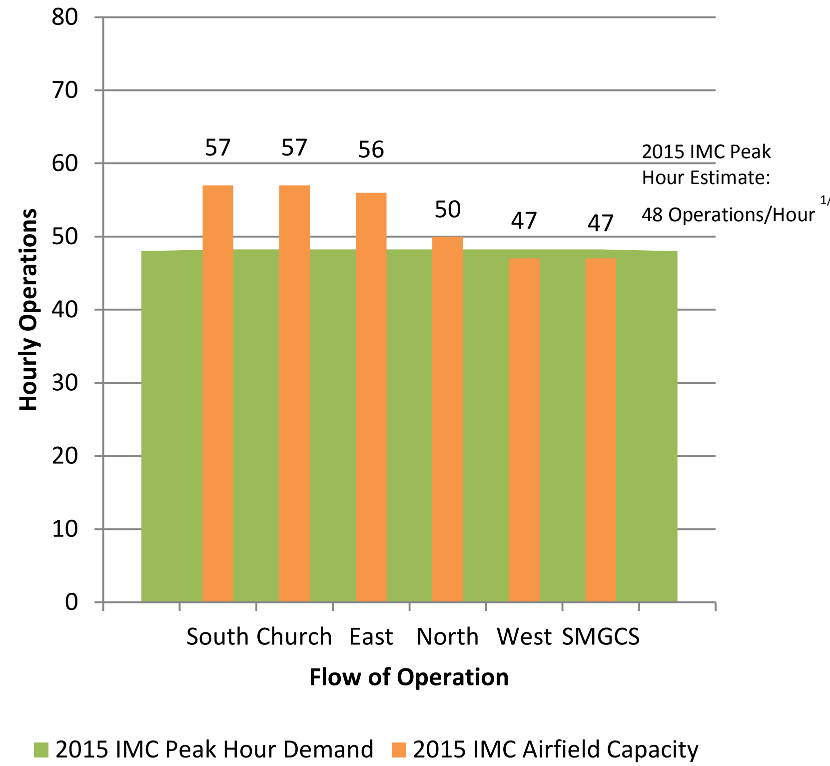
1/ Assuming that peak hour operations occur during the peak hour for commercial operations (air carrier and commuter). During that period, it was assumed that general aviation operational demand would average 66 percent of its peak hour demand during VMC and IMC.

2/ Assuming 50 percent arrivals.

SOURCES: FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*, December 1, 1995 (Change 2); Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Exhibit 4-5: 2015 Hourly Airfield Demand/Capacity Comparison – Existing Airfield





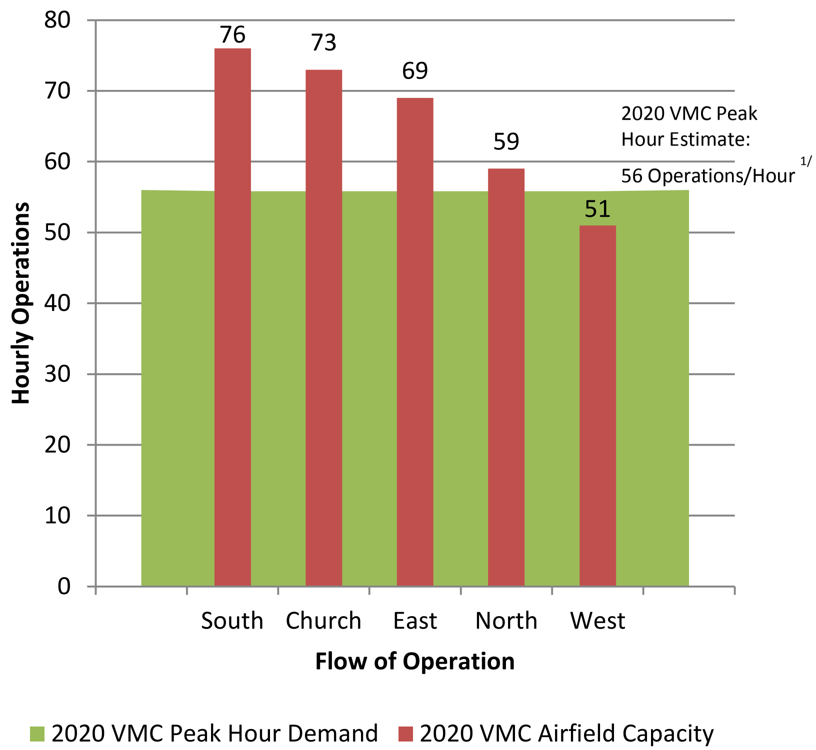
NOTES:

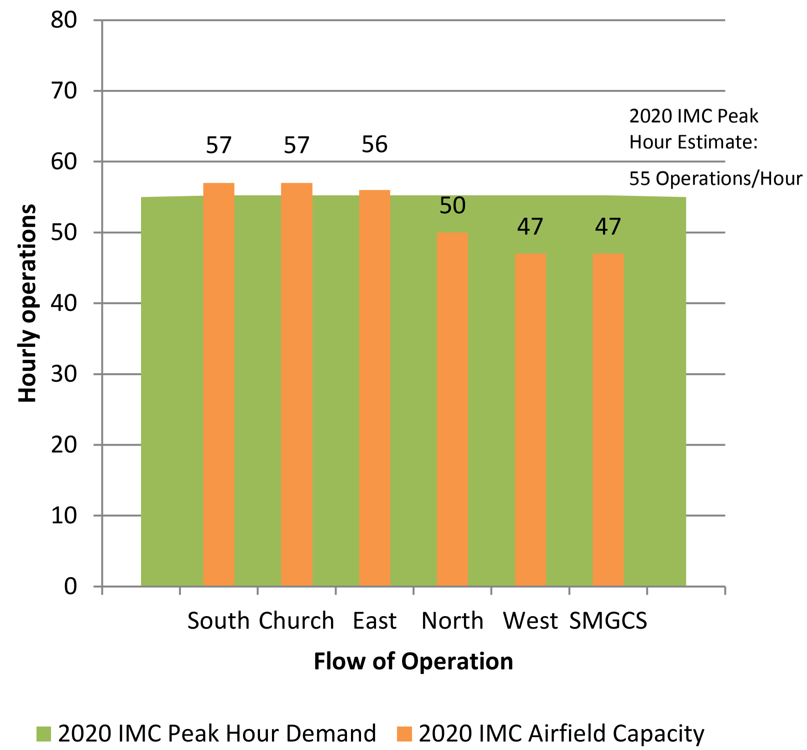
1/ Assuming that peak hour operations occur during the peak hour for commercial operations (air carrier and commuter). During that period, it was assumed that general aviation operational demand would average 66 percent of its peak hour demand during VMC and IMC.

2/ Assuming 50 percent arrivals.

SOURCES: FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*, December 1, 1995 (Change 2); Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Exhibit 4-6: 2020 Hourly Airfield Demand/Capacity Comparison – Existing Airfield





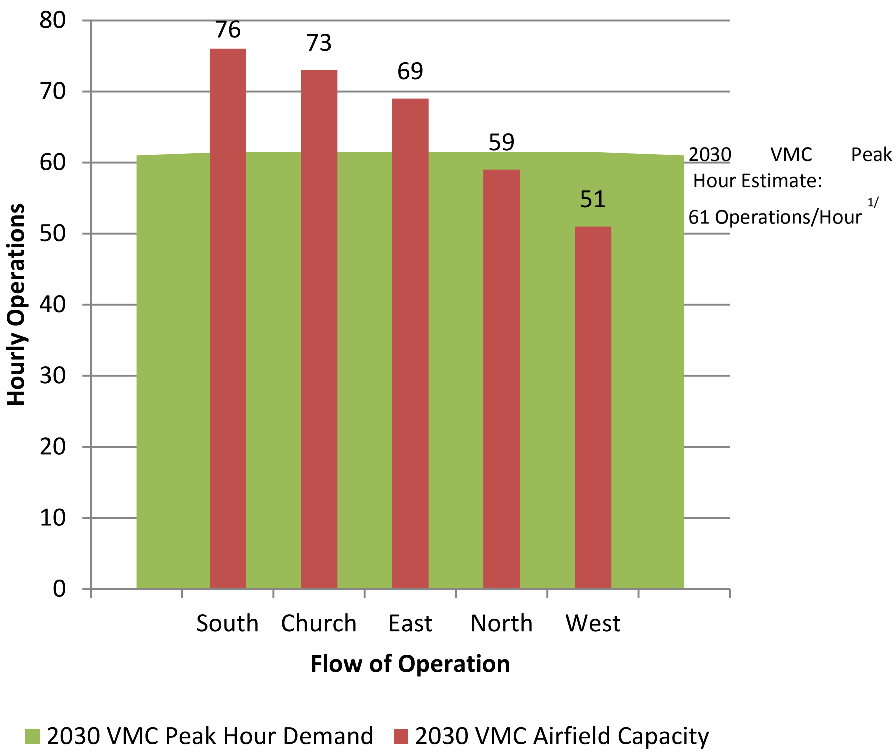
NOTES:

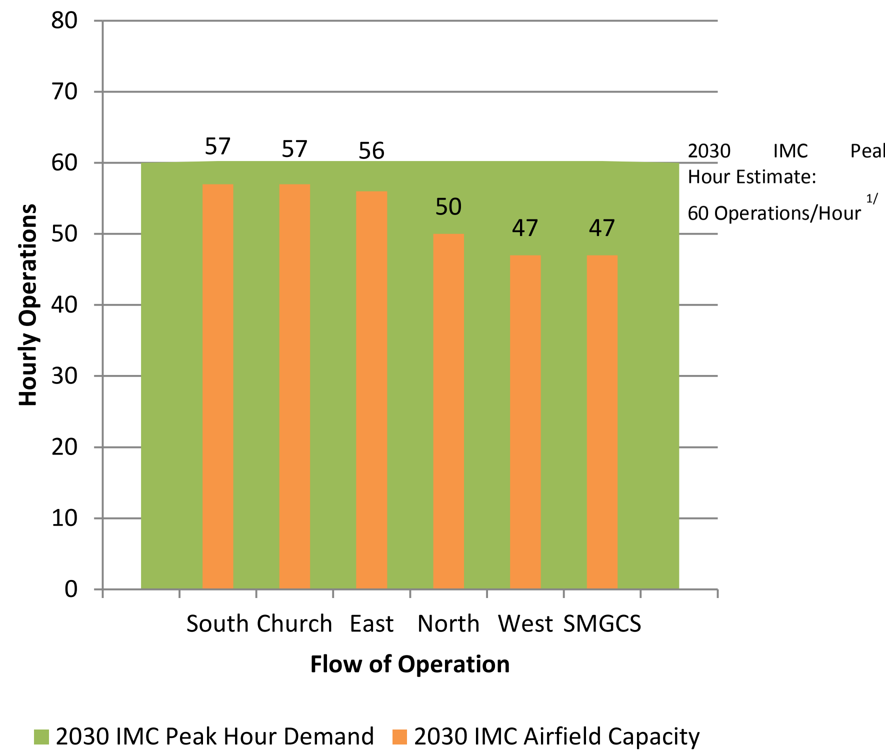
1/ Assuming that peak hour operations occur during the peak hour for commercial operations (air carrier and commuter). During that period, it was assumed that general aviation operational demand would average 66 percent of its peak hour demand during VMC and IMC.

2/ Assuming 50 percent arrivals.

SOURCES: FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*, December 1, 1995 (Change 2); Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Exhibit 4-7: 2030 Hourly Airfield Demand/Capacity Comparison – Existing Airfield





NOTES:

1/ Assuming that peak hour operations occur during the peak hour for commercial operations (air carrier and commuter). During that period, it was assumed that general aviation operational demand would average 66 percent of its peak hour demand during VMC and IMC.

2/ Assuming 50 percent arrivals.

SOURCES: FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*, December 1, 1995 (Change 2); Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Annual Service Volume

The peak hour airfield capacity estimates for the Airport serve as the basis for establishing the ASV of the existing airfield. The ASVs are then compared with annual aircraft operational demand forecast for 2015, 2020, and 2030. As annual demand exceeds the ASV of the airfield, aircraft delay increases exponentially. To minimize aircraft delay, the FAA recommends that planning for additional airfield capacity should begin when the airfield's annual demand reaches 60 percent to 75 percent of its ASV.[2] Identification of the demand level at which this would occur requires quantification of annual demand expressed as a share (percent) of the ASV. **Table 4-8** presents this comparison for the operational demand experienced during 2011-2012, and that forecast for 2015, 2020, and 2030. The table also presents annual demand expressed as a percentage of the ASV, as well as the estimated peak hour demand.

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

CAPACITY/DEMAND METRIC	EXISTING 2011-2012	2015	2020	2030
Estimated Peak Hour Demand:				
Visual Meteorological Conditions	42	49	56	61
Instrument Meteorological Conditions	41	48	55	60
Annual Service Volume	240,000	255,000	255,000	255,000
Annual Demand:				
Aircraft Operations	199,920	218,560	242,120	269,540
Percent of Annual Service Volume	83%	86%	93%	106%

SOURCES: FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay (Change 2)*, December 1, 1995; Ricondo & Associates, Inc., August 2012.
PREPARED BY: Ricondo & Associates, Inc., August 2012.

As shown, the ASV at the Airport during 2011-2012 was estimated at 240,000 operations while actual annual demand numbered 199,920 operations. As a result, the annual demand during 2011-2012 represented 83 percent of the ASV. The fact that this percentage exceeds 60 percent indicates that planning for additional airfield capacity at HOU should be well under way. Annual demand is anticipated to exceed the ASV between 2020 and 2030.

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

Airfield Delay

For long-term planning, FAA AC 150/5060-5, *Airport Capacity and Delay (Change 2),* recommends using a general demand versus capacity comparison to estimate the average delay associated with the airfield. For purposes of this analysis, the ratio of annual demand to the airfield ASV serves as the basis for developing delay estimates. The aircraft delay estimates provide the basis for justifying capacity improvements, as they demonstrate the true operational consequences associated with exceeding the airfield's capacity throughput, or ASV.

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 included. 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 exclusively with the runway components, the recommended 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 4-8 graphically presents this relationship for demand forecast through 2030. The exhibit presents a comparison of the forecast increase in annual demand with the ASV of the existing airfield through 2030, superimposed on the resulting average delay per aircraft operation. As shown, the average aircraft delay currently experienced is approximately 1.5 minutes, which is well below the FAA criterion for acceptable delay of 4.0 minutes per operation (runway component only). However, as annual demand increases, the average delay per aircraft operation would reach 5.5 minutes in 2030 with the existing airfield layout, thereby indicating a need for additional airfield capacity.

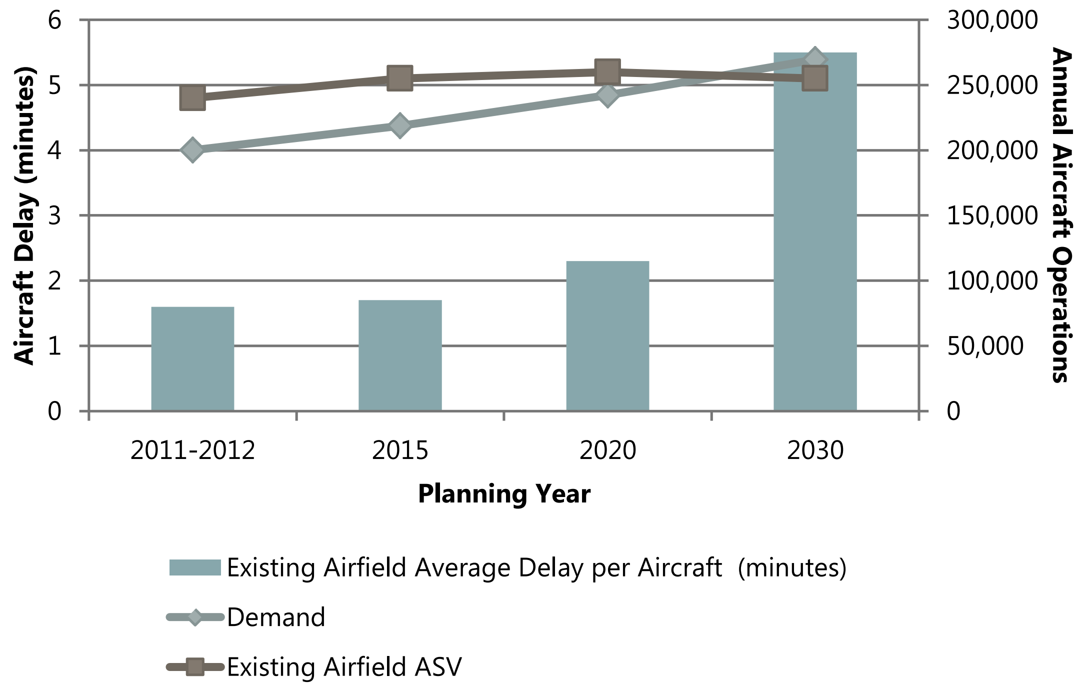
Existing Airfield Demand/Capacity Conclusions

The airfield demand/capacity analysis determined that the existing runway configuration is adequate to accommodate existing (2011-2012) operational demand at the Airport. As demand increases throughout the planning period, however, aircraft demand will exceed airfield capacity during peak demand periods. Inevitably, aircraft delay will increase, thereby increasing operating costs. Currently, the average delay is estimated to be approximately 1.5 minutes per aircraft operation. This delay is expected to increase to nearly 6.0 minutes per operation in 2030. At medium-hub airports, an average delay of 4.0 minutes per operation is the typical threshold of unacceptable delay in the airline industry. Therefore, airfield capacity enhancement opportunities should be considered for implementation prior to 2030.

4.1.3 RUNWAY LENGTH REQUIREMENTS

To assess whether airlines serving the Airport could realize the full operational capabilities associated with new generation aircraft, an aircraft payload and range analysis was conducted. The analysis was conducted to identify the potential need to increase runway length to enable the anticipated air carrier aircraft fleet to serve all domestic markets within the continental United States from the Airport, as well as some international destinations.

Exhibit 4-8: Relationship of Demand, Capacity, and Delay



SOURCES: FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*, December 1, 1995 (Change 2); Ricondo & Associates, Inc., August 2012.
PREPARED BY: Ricondo & Associates, Inc., September 2012

The current air carrier aircraft fleet was evaluated to identify the appropriate aircraft types to be considered in this analysis. The Boeing 737-800, Boeing 737-900, and Boeing 757-300 aircraft were used in the analysis. The Boeing 737-800 is the latest model currently operated by Southwest Airlines, the busiest airline serving HOU; although Southwest Airlines does not currently have any Boeing 737-900 aircraft on order, it is anticipated that this aircraft may enter Southwest's fleet in the near future and, as such, the Boeing 737-900 was included in the analysis. No other airlines currently serving the Airport are operating or planning to introduce larger aircraft.

To conduct an aircraft payload and range analysis, the relationship between runway length, aircraft payload, and range capabilities must be understood. Aircraft range refers to the distance an aircraft could be expected to travel given a specified takeoff weight, weather conditions, and fuel payload. For a given takeoff weight, aircraft range has a direct correlation with the fuel payload capability of the aircraft. A reduction in the aircraft's fuel payload translates into a reduction in its range capability.

As an aircraft is prepared for flight, several tradeoffs in weight may take place. For aircraft departures, available runway length may affect the payload limitations of the aircraft. Limitations on the aircraft's fuel payload may be imposed when insufficient runway length is available for a departing aircraft. The presence of obstructions within the vicinity of the airport may also restrict aircraft range capabilities, resulting in limitations on the weight associated with passengers, cargo, and/or fuel payloads. For air carrier aircraft, a reduction in passenger and cargo payloads is typically not imposed, as they would limit the revenue-generating capability of the flight. Instead, fuel payloads are typically limited, thus reducing the aircraft's range capability. This reduction could result in the inability to provide direct service to certain markets.

The configuration and use of the existing runways at the airport are also considered in an aircraft payload and range analysis. **Table 4-9** summarizes the current runway length and width characteristics at the Airport.

Table 4-9: Existing Runway Length and Width

RUNWAY	LENGTH (FEET)	WIDTH (FEET)
12R-30L	7,602	150
4-22	7,602	150
17-35	6,000	150
12L-30R	5,148	100

SOURCE: Federal Aviation Administration, *Airport/Facility Directory*, December 2012, July 2013.
PREPARED BY: Ricondo & Associates, Inc. July 2013.

As shown, Runways 4-22 and 12R-30L provide the greatest runway length available for departure at the Airport. Both runways currently serve as departure runways for most air carrier aircraft operations. Although Runway 17-35 is an adequate length for air carrier aircraft operations, it is typically used only by general aviation aircraft. Runway 12L-30R also serves general aviation aircraft. Therefore, Runways 12R-30L and 4-22 were the only runways considered in the aircraft payload and range analysis.

Aircraft takeoff performance is greatly influenced by atmospheric conditions, including temperature, barometric pressure, and wind speed and direction. The elevation of the airfield and the effective gradient (slope) of the runway also affect the performance characteristics of an aircraft. Other factors may include engine thrust characteristics, departure flap settings, and pilot technique.

As a result of the ever-changing atmospheric conditions at an airport, the aircraft payload and range analysis is predicated on a set of variables that are representative of the typical operating conditions that can be expected at the airport. In accordance with FAA planning standards, the mean maximum temperature of the hottest month is considered; at HOU, that temperature is 92°F. In addition, the analysis is conducted based on calm wind conditions and standard atmospheric pressure. The FAA defines standard atmospheric pressure as a barometric pressure of 29.92 inches of mercury.

To determine the range capabilities of aircraft departing from Runways 12R-30L and 4-22 at the Airport, the maximum allowable aircraft takeoff weight must be determined. For purposes of this analysis, the maximum allowable takeoff weight is the maximum permitted weight of the aircraft given the available runway length (7,602 feet at HOU). The maximum allowable takeoff weight does not necessarily coincide with the maximum takeoff weight prescribed by the aircraft manufacturer.

Table 4-10 summarizes the performance characteristics of the aircraft selected for this analysis.

Table 4-10: Summary of Aircraft Performance Characteristics

AIRCRAFT	BOEING 737-800	BOEING 737-900	BOEING 757-300
Engine Type	CFM-7B236	CFM-7B236	RB211-535E4B
Maximum Take Off Weight	147,200 pounds	174,200 pounds	270,000 pounds
Runway Length Required for Maximum Range (Standard Day)	7,800 feet	9,800 feet	7,900 feet
Runway Length Required for Maximum Range (Standard Day + 45°F)	10,100 feet	15,000 feet	8,200 feet (STD + 28°F)
Range with Existing Runway Length of 7,602 feet (Standard Day)	2,800 nautical miles	3,100 nautical miles	3,200 nautical miles

SOURCE: Jacobsen/Daniels Associates, LLC, *Houston Hobby Runway Length Analysis*, March 14, 2013.
PREPARED BY: Jacobsen/Daniels Associates, LLC, March 2013.

Exhibit 4-9 and **Exhibit 4-10** present range maps for the three aircraft evaluated. As shown, all three aircraft are capable of reaching destinations within the continental United States from HOU.

Additionally, the distances to the international destinations anticipated to be served from HOU by Southwest Airlines beginning in 2015 were evaluated against the aircraft ranges. The following destinations were considered (distances from HOU are provided in nautical miles [NM]):

- Bogota, Colombia (2,000 NM)
- Liberia, Costa Rica (1,300 NM)
- San Jose, Costa Rica (1,300 NM)
- San Salvador, El Salvador (1,100 NM)
- Cancun, Mexico (700 NM)
- Guadalajara, Mexico (700 NM)
- Los Cabos, Mexico (900 NM)
- Monterrey, Mexico (360 NM)
- Mexico City, Mexico (650 NM)
- Puerto Vallarta, Mexico (770 NM)
- Caracas, Venezuela (1,970 NM)
- Belize City, Belize (900 NM)
- San Luis Potosi, Mexico (537 NM)
- Tegucigalpa, Honduras (1,034 NM)

Exhibit 4-9: Boeing 737-800 Range Map from HOU

NOTE: Aircraft range map shown with a 100 to 200 nautical mile safety buffer to account for fuel consumption during descent/approach.

SOURCE: Jacobsen/Daniels Associates, LLC, *Houston Hobby Runway Length Analysis*, March 14, 2013.

PREPARED BY: Jacobsen/Daniels Associates, LLC, March 2013.

Exhibit 4-10: Boeing 737-900 and Boeing 757-300 Range Map from HOU

NOTE: Aircraft range map shown with a 100 to 200 nautical mile safety buffer to account for fuel consumption during descent/approach.

SOURCE: Jacobsen/Daniels Associates, LLC, *Houston Hobby Runway Length Analysis*, March 14, 2013.

PREPARED BY: Jacobsen/Daniels Associates, LLC, March 2013.

All of these destinations are within 2,000 nautical miles of HOU; therefore, no range limitations would result from the existing/planned runway lengths at HOU for the aircraft evaluated.

In conclusion, no runway extension is anticipated to be required during the planning period. The detailed *Runway Length Requirements Analysis* is provided in **Appendix E**.

4.1.4 AIRFIELD PAVEMENT DESIGN STANDARDS

The appropriate design standards for development of airfield facilities are selected based primarily on the characteristics of the aircraft likely to use the Airport on a regular basis. The most critical characteristics are aircraft approach speed and the physical dimensions of the design aircraft. The aircraft approach speed, tail height, and wing span have a direct effect on runway design criteria, particularly runway length, width, and separation requirements to fixed or movable objects. Similarly, taxiway geometry and separation requirements are dictated by aircraft wing span, tail height, and landing gear configuration.

It is common for an airport to be served by aircraft with performance and/or physical characteristics that exceed the design standards prescribed for the airfield's ARC. Operational restrictions could be necessary while these aircraft are operating on the airfield (as is the case when Boeing 757-200 aircraft land at or depart from the Airport). Reconfiguration of the airfield may also be considered to accommodate the larger or faster aircraft fleet. However, the demand associated with these aircraft types must be consistently high enough to justify reconfiguration. The FAA recommends that airfield reconfiguration be considered for a specific ARC when annual demand by the design aircraft exceeds 500 operations. This demand threshold is for planning purposes only, and a benefit-cost analysis should be performed to verify the feasibility of reconfiguring the airfield.

As mentioned in the *Inventory of Existing Conditions*, the Boeing 737-700W represents the design aircraft at HOU. On that basis, the airfield should be capable of accommodating this aircraft without imposing operational restrictions. Additional analyses outside the scope of this Master Plan Update are required to determine if existing airfield pavement surfaces meet design standards for the B737-700W.

AC 150/5300-13A establishes airport design standards by ARC, RDC, and Taxiway Design Group (TDG). The ARC consists of the AAC and ADG classifications of the design aircraft serving the airport. Similar to the ARC, the RDC is based on the AAC and ADG, and also reflects runway visibility minimums. Each runway has its own RDC. The AAC and the ADG for the Boeing 737-700 aircraft are C and III, respectively. The TDG is based on the outer main gear width and cockpit-to-main-gear distance of the design aircraft; for the Boeing 737-700W, the TDG is 3. **Table 4-11** summarizes the airfield design components based on specific aircraft characteristics.

Table 4-11: Aircraft Characteristics and Design Components

RUNWAY DESIGN CODE		
AIRCRAFT APPROACH CATEGORY	**AIRPLANE DESIGN GROUP**	**TAXIWAY DESIGN GROUP**
Runway Safety Area, Runway Object Free Area, Runway Protection Zone	Taxiway and Apron Object Free Area	Fillet design
Runway width	Parking configuration	Apron area
Runway-to-taxiway separation	Hangar locations	Parking layout
Runway-to-fixed object	Taxiway-to-taxiway separation	Taxiway width
	Runway-to-taxiway separation	Taxiway shoulders
	Runway shoulders	

SOURCE: FAA Advisory Circular 150/5300-13A (Change 1), *Airport Design*, February 26, 2014.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-12 provides the airfield design standards for RDC C-III and TDG 3.

Table 4-12: Recommended FAA Minimum Airfield Design Standards

DESIGN ELEMENT	RUNWAY DESIGN CODE C-III (FEET)	TAXIWAY DESIGN GROUP 3 (FEET)
Runways:		
Runway Pavement Width	150	-
Runway Centerline to Parallel Taxiway/Taxilane Centerline	400	-
Runway Centerline to Aircraft Parking Area	500	-
Runway Shoulders	25	
Runway Object Free Area:		
Overall Width	800	-
Length beyond Runway End	1,000	-
Taxiways:		
Taxiway Pavement Width	-	50
Taxiway Centerline Turning Radius (90 degree turn)	-	60
Taxiway Shoulders		15
Taxiway Edge Safety Margin		10
Taxiway Centerline to Parallel Taxiway/Taxilane Centerline	152	-
Taxiway Centerline to Fixed or Movable Object	93	-
Taxiway Object Free Area Width	186	-
Taxilanes:		
Taxilane Centerline to Parallel Taxilane Centerline	140	-
Taxilane Centerline to Fixed or Movable Object	81	-
Taxilane Object Free Area Width	162	-

SOURCE: FAA Advisory Circular 150/5300-13A (Change 1), *Airport Design*, February 26, 2014.
PREPARED BY: Ricondo & Associates, Inc., July 2014.

An all-encompassing evaluation of airfield pavement surfaces against FAA design standards is not included in the scope of this Master Plan Update. However, when initiating future airfield improvements (rehabilitation or new construction), the latest airport design standards need be applied during design of the improvement. Dimensions specific to AR CC-III and TDG 3, as listed in Table 4-12, should be considered as minimum standards. Although the Boeing 737-700W has been identified as the design aircraft for the Airport, it is not necessary for the entire airfield to be configured to meet the design standards necessary to accommodate that aircraft. Only the airfield components (runways, taxiways, and taxilanes) expected to accommodate the design aircraft on a regular basis need to be in compliance. Therefore, it is necessary to ensure that the runways and taxiways/taxilanes that provide access to and from the terminal area comply with the FAA design standards listed in Table 4-12.

4.1.4.1 Recommended Runway Improvements

Runway Shoulders

Runway 4-22 shoulders are 20 feet wide on either side of the runway. Per FAA standards, a runway serving ADG III aircraft requires 25-foot wide shoulders. It is recommended that the shoulders be widened to 25 feet during the next runway reconstruction or resurfacing.

Runway Intersections

Runway 17-35 intersects both Runways 12R-30L and 4-22, resulting in higher risks for runway incursions, as discussed in Section 2. The FAA recommends mitigating or eliminating these safety issues. Reconfiguration of the airfield layout to eliminate runway intersections or mitigate their risks could be incorporated in an airfield layout that also increases capacity.

4.1.4.2 Recommended Taxiway Improvements

Taxiway Shoulders

The majority of taxiways on the airfield do not have paved shoulders, which are required for taxiways serving ADG IV and higher aircraft, and recommended for taxiways serving ADG III aircraft. It is recommended that the paved shoulders be added during the next taxiway reconstruction or resurfacing.

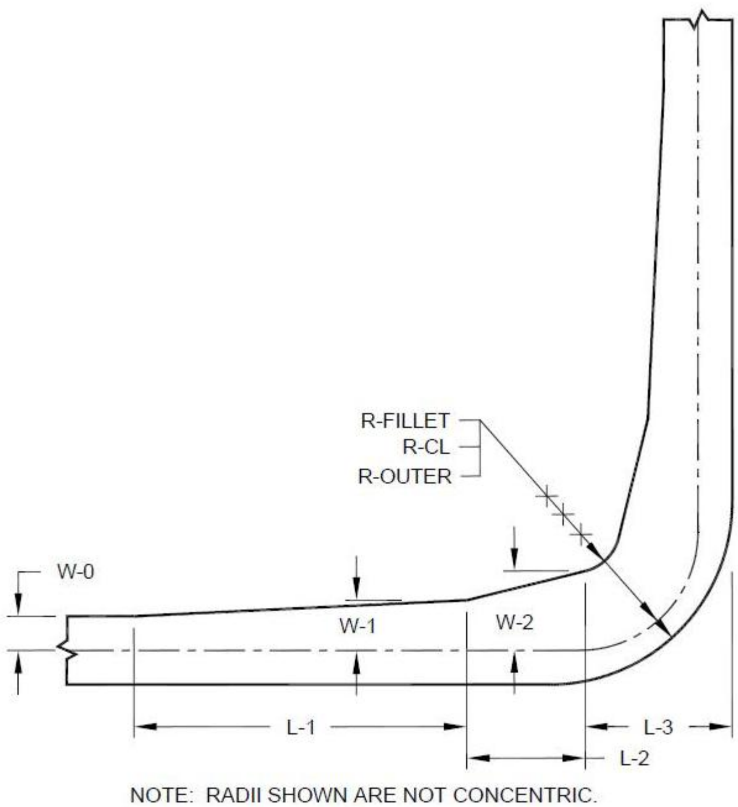
Taxiway Fillets

In addition to the design criteria listed in Table 4-12, consideration should be given to the configuration of airfield pavements associated with taxiway/taxilane intersections, particularly the fillets associated with the taxiways. Fillets are the additional pavement required at a taxiway/taxilane intersection to ensure that the main landing gear of an aircraft does not travel beyond the pavement edge during a taxiing turn. During an aircraft taxiing turn, the main landing gear of the aircraft does not follow the same track as the aircraft's nose wheel. Typically, the pilot will steer so that the nose wheel follows the taxiway/taxilane centerline marking, while the main gear will travel inside the turning radius of the nose wheel, requiring additional taxiway pavement fillet.

Fillet size depends on the landing gear configuration of the most demanding aircraft operating at the airport and the angle of the taxiway/taxilane intersection. Aircraft with the greatest distance between the nose wheel and main gear typically require the largest pavement fillets. This distance is commonly referred to as the wheelbase of the aircraft. The lateral separation between the main landing gear is also a significant factor in determining taxiway fillet design requirements. In addition, as the angle of the required turn increases, the fillet requirements also increase.

AC 150/5300-13A provides guidelines for determining taxiway fillet design requirements based on the most demanding TDG specified for the taxiway/taxilane intersection. The TDG is based on the main gear width and the cockpit-to-main-gear distance. The AC prescribes fillet design criteria based on cockpit-over-centerline steering. During this maneuver, the aircraft's nose-wheel follows the taxiway centerline throughout the entire turn. Although the cockpit-over-centerline steering technique requires the greatest amount of pavement fillet, it provides the greatest margin of safety and facilitates aircraft taxiing movements through the intersection. The Boeing 737-700W is considered a TDG 3 aircraft. Standard intersection fillet dimensions for TDG 3 aircraft are provided in AC 150/5300-13A (Change 1), Table 4-6.[3] **Exhibit 4-11** depicts a typical taxiway fillet design.

Exhibit 4-11: Typical Taxiway Fillet Design



SOURCES: FAA Advisory Circular 150/5300-13A (Change 1), *Airport Design*, February 26, 2014.
PREPARED BY: Ricondo & Associates, Inc., July 2014.

[3] Federal Aviation Administration, AC 150/5300-13A (Change 1), *Airport Design*, February 26, 2014.

The pavement fillets can also be designed for a specific aircraft type, which would require evaluation of the travel of the main gear of the design aircraft as it turns through the taxiway/taxilane intersection. The pavement fillet must then be configured to provide a minimum separation between the track of the main gear and the fillet of the taxiway/taxilane pavement. This separation is referred to as the taxiway edge safety margin (TESM). The TESM varies for each aircraft type, depending on the gear configuration of the aircraft. If the TESM for the design aircraft requires less pavement fillet than required for the TDG, construction and annual maintenance costs could be reduced. In light of the new taxiway fillet criteria set forth in AC 150/5300-13A (Change 1), a taxiway fillet evaluation is recommended to identify pavement areas that would require improvement.

4.1.5 OTHER AIRFIELD RESTRICTIONS

In addition to the design criteria associated with the geometric configuration of runways, taxiways and taxilanes, other restrictions need to be considered for airfield development. These include the establishment of BRLs, RSAs, and RPZs.

4.1.5.1 Building Restriction Lines

BRLs provide the necessary safety clearances between buildings or other fixed objects and the airport's runways and taxiways. FAA criteria require that BRLs be established to identify suitable building area locations on the airport. The BRLs should prevent encroachment of the RPZ, ROFA, the runway visibility zone (RVZ) (if one is required), navigational aid critical areas, imaginary surfaces prescribed under 14 CFR Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace,* and areas required for terminal instrument approach procedures. In some cases, minimum taxiway clearance requirements dictate the locations of the BRLs. The minimum taxiway clearance requirement for a taxiway accommodating ADG III aircraft is 93.0 feet. As previously mentioned, HOU is an ADG III airport.

The locations of the BRLs based on minimum taxiway clearance requirements, navigational aid critical areas, visibility zones, and ATC line-of-sight requirements should be determined on an individual basis. Unless minimum taxiway obstacle clearance or ATC line-of-sight requirements dictate otherwise, the BRL is typically located laterally and parallel to a runway.

As shown on the *Existing Airport Layout* drawing in Appendix D, two buildings penetrate the BRL at HOU: Building S-260, the ARFF station, and Building E-170, a Signature Flight Support aircraft hangar. However, the buildings penetrate the RVZ component of the BRL, which the FAA may allow through a modification of standards, if an acceptable level of safety can be maintained, such as having an ATCT operational 24 hours per day, as is the case at HOU.

4.1.5.2 Runway Safety Areas

RSAs are provided to enhance operational safety for landing or departing aircraft. An RSA is an area surrounding a runway that is cleared, grubbed, and free of objects unless such objects need to be located within the RSA because of their function (e.g., airfield signs, REILs, PAPIs, VASIs). Its purpose is to minimize damage to aircraft that undershoot, overrun, or veer off the runway surface. The size of the RSA is based on the AAC and the ADG of the aircraft types operating on the runway. RSA standards are mandatory and cannot be the object of a FAA modification of standards.

RSAs are shown on the *Existing Airport Layout* drawing, in Appendix D. **Table 4-13** summarizes HOU compliance with FAA RSA criteria. For Runways 12R-30L and 4-22, which serve ARC C-III aircraft, the RSA should be 500 feet wide (250 feet on either side of the runway centerline) and extend 1,000 feet beyond the physical end of the runway. The RSAs for Runways 12L-30R and 17-35, which serve ARC B-II aircraft, should be 150 feet wide and extend 300 feet beyond the ends of the runways. Runway 17-35 was downgraded to an ARC B-II runway to mitigate the proximity of Braniff Road on the south side of the Airport boundary.

Table 4-13: Runway Safety Area Compliance at the Airport

		FAA RUNWAY SAFETY AREA CRITERIA		
RUNWAY	**RUNWAY DESIGN CODE**	**WIDTH (FEET)**	**LENGTH BEYOND RUNWAY END (FEET)**	**MEETS FAA CRITERIA?**
12R-30L	C-III-4000	500	1,000	Yes
12L-30R	B-II-VIS	150	300	Yes
4-22	C-III-1200	500	1,000	Yes
17-35	B-II-5000	150	300	Yes

SOURCES: Ricondo & Associates, Inc., *William P. Hobby DRAFT Airport Layout Plan*, 2014; Houston Airport System, January 2013.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

All RSAs at HOU meet the dimensional criteria established by the FAA, and no RSA improvements are required at this time. Proposed development of either a new runway or extension of existing runways must take into consideration the RSA requirements along the entire runway, including the runway ends.

4.1.5.3 Runway Object Free Areas

ROFAs are provided to enhance the safety of aircraft operations by remaining clear of objects, except for objects that need to be located in the ROFA for air navigation or aircraft ground maneuvering purposes. The size of the ROFA is based on the AAC and the ADG of the aircraft types operating on the runway. ROFA standards may be the object of a FAA modification of standards, allowing objects inside the ROFA on an individual basis.

ROFAs are shown on the *Existing Airport Layout* drawing, in Appendix D. For Runways 12R-30L and 4-22, which serve ARC C-III aircraft, the ROFA should be 800 feet wide (400 feet on either side of the runway centerline) and extend 1,000 feet beyond the physical end of the runway. The ROFAs for Runways 12L-30R and 17-35, which serve ARC B-II aircraft, should be 500 feet wide and extend 300 feet beyond the ends of the runways.

ROFA penetrations were observed northwest of the Runway 12L threshold, where fences and navigational aid shelters are located inside the ROFA. No Modification of Standards (MOS) exists to mitigate this issue.

4.1.5.4 Runway Protection Zones

RPZs are trapezoidal-shaped areas centered on the extended runway centerline and beginning beyond the physical ends of the runway. Although development within the RPZ is not prohibited, the types of development allowed are restricted. Permitted land uses within the RPZ include golf courses and agriculture, as long as they do not attract birds or produce smoke. Parking lots are discouraged, but may be permitted if they remain clear of the extended ROFA (also referred to as the central RPZ). Public roadways, fuel farm facilities, residences, and places of public assembly are prohibited. Places of public assembly include churches, schools, hospitals, office buildings, shopping centers, and the like.

Several public roadways run through the existing RPZs at HOU, as shown on **Exhibit 4-12**. The FAA plans to release further guidance on how to address existing public roadways within an RPZ. Therefore, no resolution regarding the public roadways within the HOU RPZs is provided in this Master Plan Update. Additionally, several other facilities are located within the HOU RPZs, such as the Million Air fuel farm, above-ground utility pipes on Airport property, and several buildings on and off Airport property. No MOS exists to mitigate these issues. However, some may be mitigated upon the planned removal of the Runway 12R displaced threshold.

4.2 Passenger Terminal Facilities Requirements

4.2.1 METHODOLOGY

The terminal and concourse facilities needed to support and safely and efficiently process commercial airline passengers throughout the planning period are discussed in this section. The terminal and concourse facilities are located on three levels (ground, first and second floors), which include public and nonpublic facilities used by passengers, airlines, other tenants, HAS, and other agencies.

Facility requirements described in this section represent the basis for formulating facility program for each PAL for functional areas to develop alternatives as part of the master planning approach to derive a preferred terminal development plan. The terminal space requirements set forth in this section do not, in themselves, constitute a facility program, as they do not comprehensively address program considerations, such as potential constraints imposed by the site, existing facilities, or an implementation strategy. Ultimately, the preferred development alternative will form the basis for developing the facility program for future terminal expansion and development.

Different methodologies, reflecting the unique mission of each terminal function, were used to develop the respective facility requirements, as described in the following subsections.

4.2.1.1 Airline-Operated Facilities

Requirements for airline-operated facilities used to process passengers were developed using methodologies consistent with those in the International Air Transport Association (IATA) *Airport Development Reference Manual*, 9th edition. These facilities include ticketing/check-in lobbies, holdrooms, domestic baggage claim facilities, international recheck lobbies, outbound baggage makeup rooms, and inbound baggage rooms.

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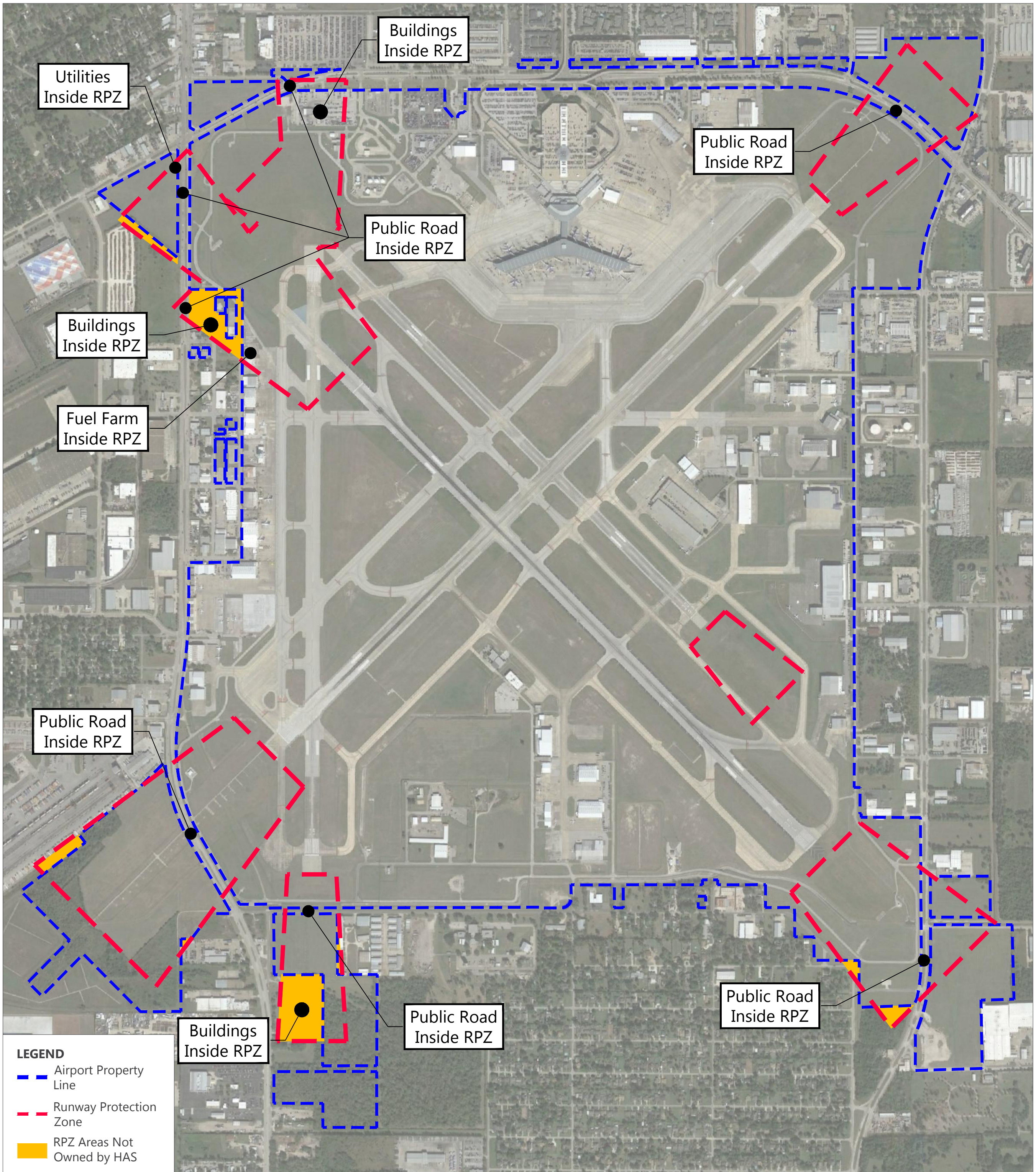

SOURCE: Google Earth Pro, October 2012; TerraMetrics, 2013; Houston Airport System, Hobby Planimetrics, 2012; Ricondo & Associates, Inc., February 2013
PREPARED BY: Ricondo & Associates, Inc., February 2013.

EXHIBIT 4-12

NORTH 0 1,500 ft.

Existing Runway Protection Zones

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\04_Chapter 4_Requirements\02_Airfield Capacity Analysis\CAD\Exh 4-12_Existing RPZs.dwg_Layout: 8.5x11P_Dec 26, 2014, 12:25pm

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Computer modeling was used to generate peak hour demand for passengers and baggage based on the projected design day flight schedules and Airport-specific operational and passenger attributes. The number of equipment units (e.g., check-in counters) represents the number of units required to process passengers within the period of time prescribed by level of service (LOS) standards. Requirements for equipment units were subsequently translated into spatial requirements using facility space templates that define spatial clearances for safe and efficient operations around equipment, as well as relationships between process areas that are part of each facility. Most areas used for processing passengers include holding (queuing) areas for passengers waiting to be processed. Queuing areas were calculated using space per passenger factors prescribed by LOS standards. The IATA LOS framework is discussed in greater detail in Section 4.2.3.

Other airline terminal facility requirements were calculated as follows:

- **Airline Offices:** Requirements for airline support spaces, such as office areas for station managers, customer service agents, and aircraft terminal ground services personnel, were based on factors applied to the forecast numbers of annual enplaned passengers for each PAL. The applied factors were based on the current ratio between aircraft gates, or a processor such as check-in counters, and their corollary support spaces.
- **Internal Circulation and Miscellaneous Support:** Internal circulation within baggage handling areas or other nonpublic airline operational areas is included with the respective space requirements.

4.2.1.2 Department of Homeland Security Facilities

As a result of the enactment of the Aviation and Transportation Security Act in November 2001, the U.S. Department of Homeland Security (DHS) maintains in-terminal facilities related to operating the security screening checkpoints and baggage screening areas, as well as border security. DHS terminal facility requirements were based on three publications:

- *Recommended Security Guidelines for Airport Planning, Design and Construction*, May 2011, prepared for the TSA
- *Checkpoint Design Guide*, Revision 3, March 10, 2011, prepared for the TSA
- U.S. Customs and Border Protection (CBP) facility requirements are guided by the DHS/CBP *Airport Technical Design Standards: Passenger Processing Facilities*, August 2006

Computer modeling was used to develop passenger demand and equipment requirements. Space requirements needed to accommodate equipment and passenger queuing areas were then developed using DHS published facility templates. Support space requirements were developed based on DHS published guidelines. Requirements for other support areas were based on a ratio of existing space to functional items, such as screening lanes or explosives detection system (EDS) space.

4.2.1.3 In-Terminal Nonaeronautical Revenue Program Space

Within the terminal, space associated with the nonaeronautical revenue program includes food and beverage, retail, specialty, and duty free shopping space (i.e., concessions). Future requirements were developed using factors applied to the forecast number of annual enplaned passengers for each PAL. The applied factors are consistent with the current industry ratio for nonaeronautical revenue space per annual enplaned passenger. Support facilities for nonaeronautical revenue program space, such as loading docks and in-terminal concessions breakdown and storage areas, are included under common nonpublic space.

4.2.1.4 In-Terminal Ground Transportation Services Space

Facility and space requirements for ground transportation services include landside vehicle staging areas, loading/unloading areas, and in-terminal spaces. Ground transportation services allocated space within the terminal building includes taxicabs, rental cars, hotel shuttles, local buses, and shuttle vans.

Space requirements for these services were developed giving consideration to the following:

- Rental car areas will be relocated to a consolidated rental car facility (CRCF).
- In-terminal spaces for other ground transportation operations were developed using the current ratio between in-terminal space and passenger volumes.

4.2.1.5 Houston Airport System, Amenities, and Other Agency Space

Requirements for in-terminal facilities supporting Airport administration, Airport operations, police, FAA offices, the USO, and Traveler's Aid were developed using factors applied to the forecast number of enplaned passengers at each PAL. The current ratio between this type of space and terminal functional facilities—such as airline space used to process passengers, DHS space, and nonaeronautical revenue space—was used to define requirements at future PALs.

4.2.1.6 Common Public Terminal Space

Common public terminal space refers to public circulation elements (lobbies, corridors, and vertical conveyance systems) and restrooms. The current ratio between common public terminal space and terminal functional facilities, such as airline space used to process passengers, DHS space, and nonaeronautical revenue space, was used to define requirements at future PALs.

4.2.1.7 Common Nonpublic Building Space

Common nonpublic building space refers to back-of-house circulation and utility spaces, such as mechanical, electrical, and plumbing areas; maintenance, janitorial, and storage areas; receiving areas; and loading docks. The current ratio between this type of space and terminal functional facilities - such as airline space used to process passengers, DHS space, and nonaeronautical revenue space - was used to define the requirements at future PALs.

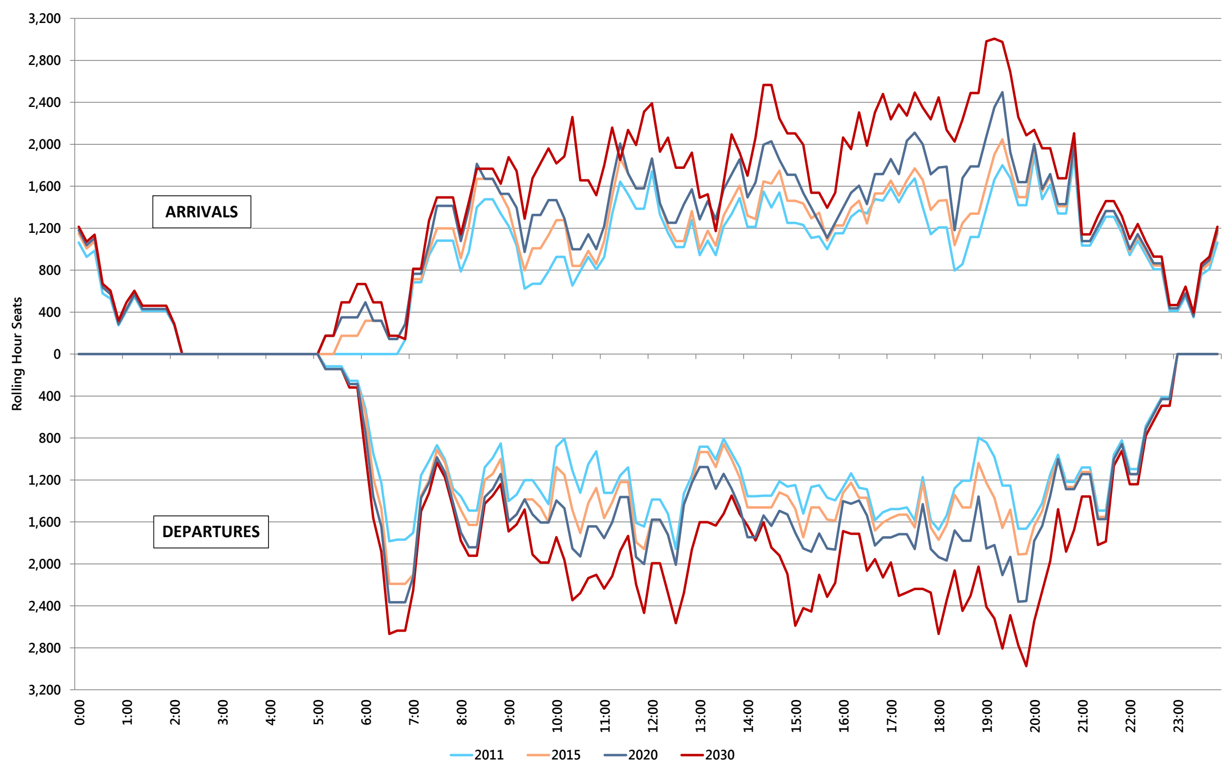
4.2.1.8 Structural and Non-net Terminal Space

The total gross building area requirements for future PALs include a factor equal to 5.0 percent of the preceding functional and support area space requirements that exceed the current building inventory to account for structure and non-net terminal spaces from new building areas such as mechanical, electrical and plumbing (MEP) spaces.

4.2.2 FORECAST PEAK HOUR DEMAND

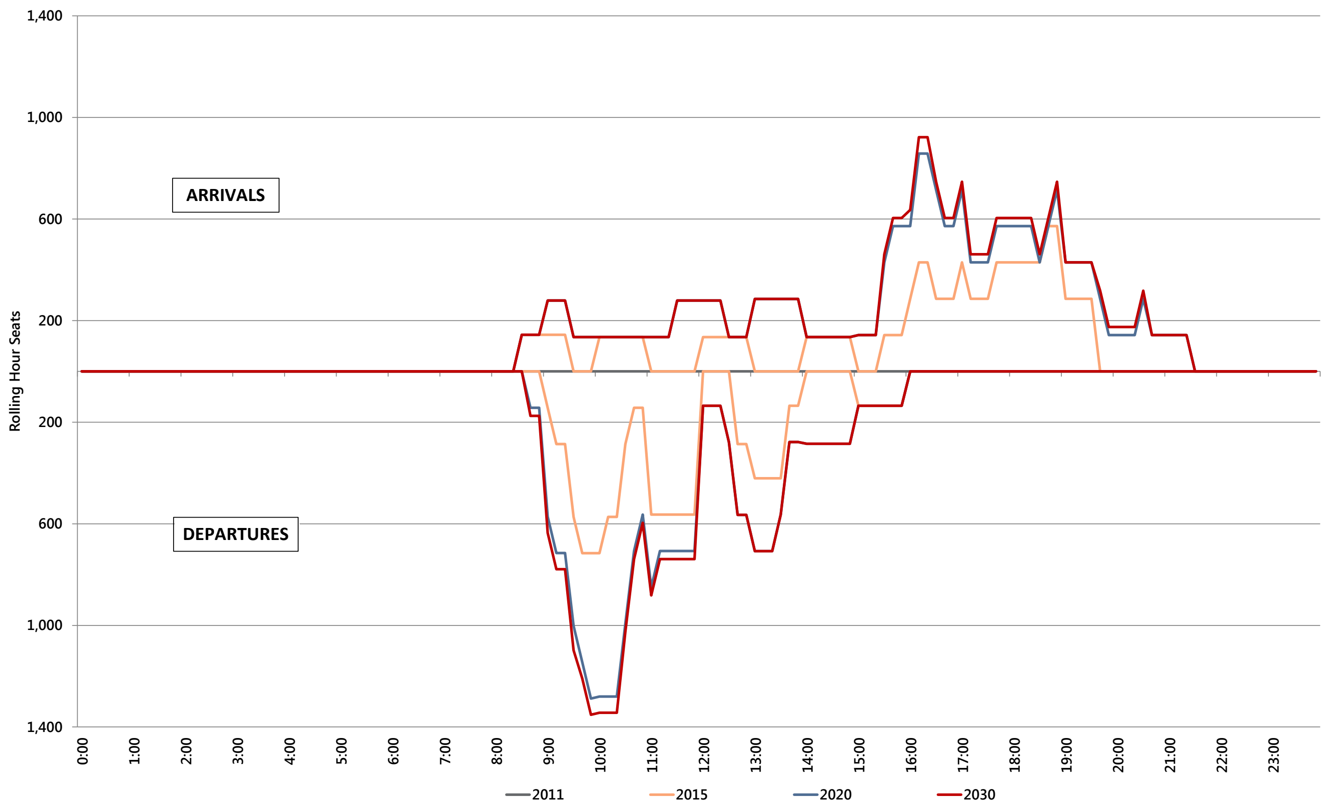
Passenger terminal facility requirements were developed to accommodate forecast peak hour enplaned and deplaned passenger demand. Peak hour demand was calculated using the design day flight schedules that were developed to correlate with the annual passenger forecasts. Design day flight schedules are developed to predict the Airport's daily pattern for airline service on an average weekday of the peak month. Thus, they provide information on a flight-by-flight basis pertaining to time of aircraft arrival or departure, airline, aircraft type, domestic/international designation, origin and destination, seat capacity, load factor, O&D passenger percentages, and numbers of enplaned and deplaned passengers. Other Airport-specific factors that affect demand for facilities include passenger attributes, such as show-up time and check in type, and behavior, operating parameters, and the physical configuration of terminal facilities. **Exhibit 4-13** and **Exhibit 4-14** illustrate forecast departing and arriving domestic and international seats, respectively.

Exhibit 4-13: Departing and Arriving Domestic Seats



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

Exhibit 4-14: Departing and Arriving International Seats



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

Load factors were applied to the numbers of departing and arriving seats on a flight-by-flight basis to derive peak hour enplaned and deplaned passenger numbers. Other factors, representing the percentage of O&D passengers, were used to derive the numbers of passengers originating or terminating their travel at HOU. O&D passengers represent the principal demand for terminal facilities. **Table 4-14** summarizes the peak period metrics for aircraft operations and passengers derived from the design day flight schedules.

For purposes of the Master Plan Update, the design day flight schedule for 2011 was analyzed to develop planning factors for facilities used by the airlines and DHS to process passengers. These planning factors were then applied to peak hour passenger demand for future PALs to derive the corresponding facility requirements.

Table 4-14: Summary of Peak Period Activity Metrics

	2011	2015	2020	2030
Airport Aggregate				
Departures				
Peak 60 Minutes (flights)	11	18	22	25
Daily Operations (flights)	137	188	219	251
Peak 60 Minutes (passengers)	1,243	1,838	2,414	2,973
Daily Enplaned Passengers	14,536	20,433	24,440	30,084
Arrivals				
Peak 60 Minutes (flights)	14	17	21	23
Daily Operations (flights)	164	188	219	251
Peak 60 Minutes (passengers)	1,493	1,943	2,465	2,900
Daily Enplaned Passengers	16,797	20,462	24,470	30,119
SOUTHWEST ACTIVITY				
Departures				
Peak 60 Minutes (flights)	11	12	15	18
Daily Operations (flights)	137	143	158	185
Peak 60 Minutes (Passengers)	1,243	1,411	1,790	2,327
Daily Enplaned Passengers	14,536	16,462	19,044	23,632
Arrivals				
Peak 60 Minutes (flights)	14	14	16	18
Daily Operations (flights)	137	143	158	185
Peak 60 Minutes (passengers)	1,433	1,551	1,981	2,342
Daily Enplaned Passengers	14,592	16,516	19,092	23,676
OTHER AIRLINES ACTIVITY				
Departures				
Peak 60 Minutes (flights)	5	5	6	6
Daily Operations (flights)	27	35	42	47
Peak 60 Minutes (passengers)	477	472	563	619
Daily Enplaned Passengers	2,220	2,959	3,599	4,237
Arrivals				
Peak 60 Minutes (flights)	4	4	4	4
Daily Operations (flights)	27	31	33	38
Peak 60 Minutes (passengers)	333	339	367	393
Daily Enplaned Passengers	2,205	2,933	3,581	4,228

NOTE: Base Year schedule activity reflects data in the Official Airline Guide with applied load factors and O&D percentage.

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

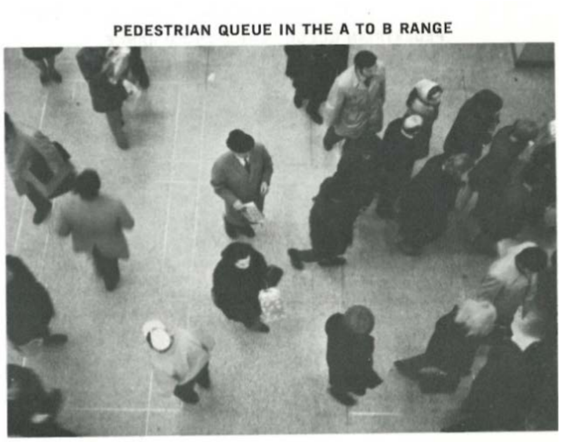
4.2.3 LEVEL-OF-SERVICE FRAMEWORK

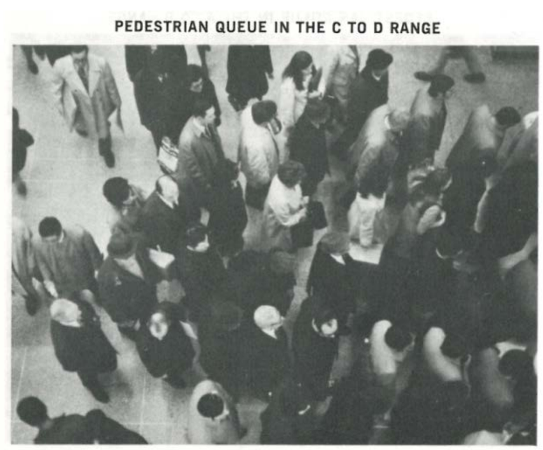
The methodologies used to calculate terminal facility requirements are consistent with those set forth in the IATA reference manual. For the most part, facility requirements were developed to accommodate the demand forecast to occur during the peak 10-minute period of the peak hour of activity on the average weekday of the peak month. Computer simulation was used to derive demand loads and to analyze subsystem performance. Simulation-derived performance data pertaining to numbers of passengers waiting for processing and related wait times were correlated with the IATA-prescribed LOS framework. Desirable wait times and space requirements for passengers were simulated to equate to LOS C unless otherwise indicated. Under the IATA framework, LOS C represents a good level of service characterized by conditions of stable flow, acceptable delays, and a good level of comfort. For most U.S. passenger terminal facilities, LOS C equates to good service at reasonable cost.

Exhibit 4-15 and **Exhibit 4-16** provide representative images of passenger queuing and circulation conditions relative to the IATA framework, which can generally be described as follows:

- **LOS A:** Excellent level of service; condition of free flow; excellent level of comfort
- **LOS B:** High level of service; condition of stable flow; very few delays; high level of comfort
- **LOS C:** Good level of service; condition of stable flow; acceptable delays; good level of comfort
- **LOS D:** Adequate level of service; condition of unstable flow; acceptable delays for short periods of time; adequate level of comfort
- **LOS E:** Inadequate level of service; condition of unstable flow; unacceptable delays; inadequate level of comfort
- **LOS F:** Unacceptable level of service; condition of cross-flows, system breakdown and unacceptable delays; unacceptable level of comfort

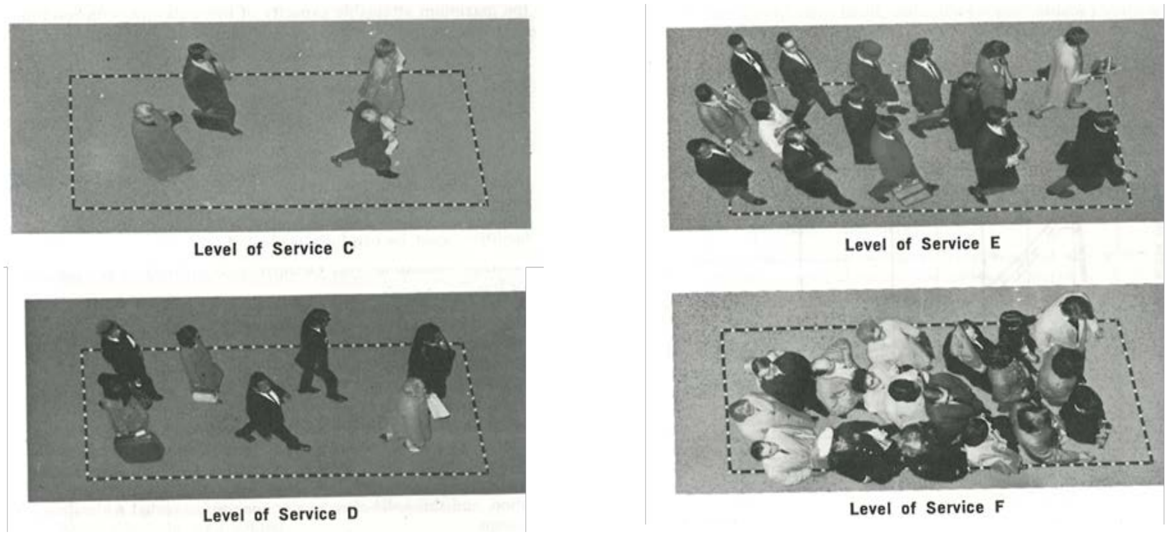
Exhibit 4-15: IATA Level of Service Framework – Passenger Queue





SOURCE: John J. Fruin, *Pedestrian Planning and Design*, 1971.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

Exhibit 4-16: IATA Level of Service Framework – Passenger Circulation



SOURCE: John J. Fruin, *Pedestrian Planning and Design*, 1971.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.4 PASSENGER ATTRIBUTES

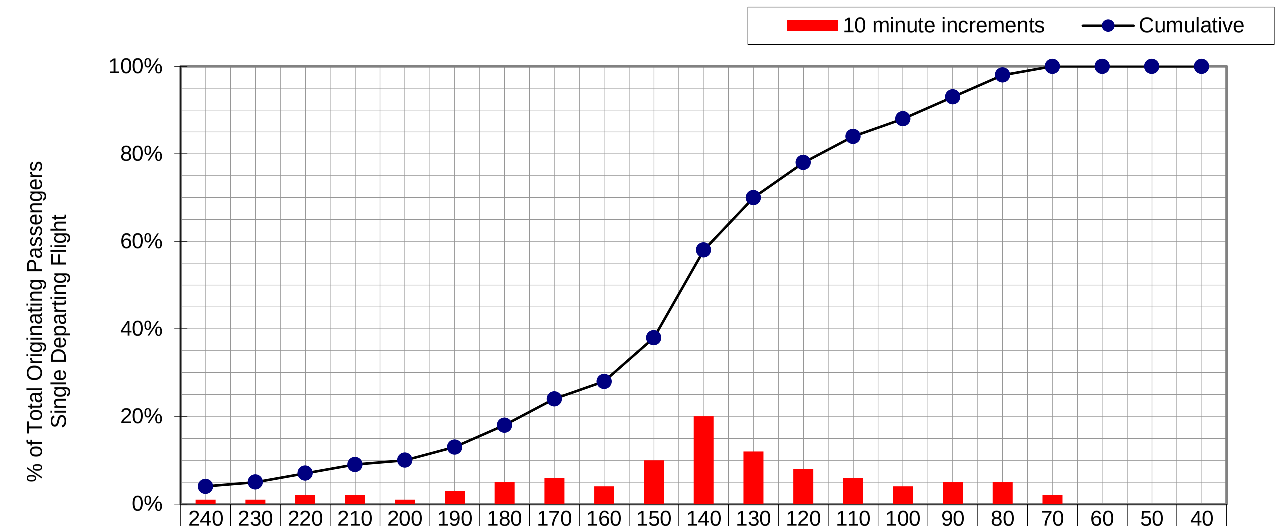
In analyzing passenger activity at HOU, the following passenger attributes were considered: the amount of time before their flight that passengers show up at the terminal to check in for the flight; their mode of ground transportation to the Airport, which determines the floor level and portal used to enter the Terminal; and the percentage of passengers who check baggage. Show-up time is considered for departing (originating) passengers, whereas mode of ground transportation to the Airport and percentage of passengers with checked bags apply to both departing and arriving (destination) passengers.

4.2.4.1 Show-up Profiles

Show-up profiles (**Exhibit 4-17**) represent the amount of time that originating passengers arrive at the Terminal to check in ahead of their scheduled time of departure. Show-up profiles vary depending on the type of travel (domestic or international), class of service, whether or not the passenger is checking baggage, and, sometimes, the time of day. Profiles are affected by airline flight closeout requirements, which pertain to the minimum amount of time that passengers have to complete check-in and baggage check before the scheduled flight departure time. In general, the airlines' published closeout times for the Airport are:

- **Domestic Flights:** 45 minutes before departure time
- **International Flights:** 60 minutes before departure time

Exhibit 4-17: Show-up Profile for Originating Passengers



	240	230	220	210	200	190	180	170	160	150	140	130	120	110	100	90	80	70	60	50	40
10 minute increments	1%	1%	2%	2%	1%	3%	5%	6%	4%	10%	20%	12%	8%	6%	4%	5%	5%	2%	0%	0%	0%
Cumulative	4%	5%	7%	9%	10%	13%	18%	24%	28%	38%	58%	70%	78%	84%	88%	93%	98%	100	100	100	100

Minutes Before Scheduled Time of Departure

SOURCE: CH2M HILL, *2011 William P Hobby Airport Peak Week Survey*, 2011.
PREPARED BY: Ricondo & Associates, Inc., August 2011.

4.2.4.2 Mode Splits

Different modes of transportation are used by passengers to travel to or leave the Airport. The locations where passengers enter or exit the Terminal depend on their mode of transportation, for example:

- Passengers traveling by private vehicle, taxicab, and hotel/offsite rental car or economy shuttles are dropped off at the Departures Curbside (upper level).
- Passengers who park in the garage or have rented cars onsite use vertical circulation on the face of the Terminal.
- All other passengers use the commercial curb and enter the Terminal on Baggage Claim Level (ground floor).

Table 4-15 shows the shares of transportation modes used by daily Airport passengers.

Table 4-15: Passenger Ground Transportation Modes

TRANSPORTATION MODE	PERCENT OF ORIGINATING PASSENGERS
Private Vehicle	74.2%
Rental Car	14.8%
Taxicab	6.6%
Super Shuttle/Van	1.6%
Hotel/Motel Courtesy Vehicle	1.3%
Limousine/Executive Sedan	0.7%
Public Transportation	0.3%
Other	0.5%

SOURCE: CH2M HILL, *2011 William P. Hobby Airport Peak Week Survey*, 2011.
PREPARED BY: Ricondo & Associates, Inc., August 2011.

4.2.4.3 Passengers Checking Bags

Table 4-16 lists the percentages of originating passengers checking bags and the numbers of bags checked based on data from the 2011 passenger survey conducted between July 31 and August 7, 2011. This distribution equates to approximately 60 percent of domestic passengers checking bags at a rate of 1.20 bags per passenger (equivalent to 0.84 bags per enplaned passenger). As the Airport does not currently have international service, numbers of international passengers checking bags were developed based on passenger data from similar markets. This distribution equates to approximately 84 percent of international passengers checking bags at a rate of 1.22 bags per passenger (equivalent to 1.03 bags per enplaned passenger). As many airlines have instituted fees for checked baggage, these rates vary among airlines; airlines not charging baggage fees more closely correlate with the checked baggage rates shown in the table.

Table 4-16: Percentages of Passengers Checking Bags

BAGS	% DOMESTIC	% INTERNATIONAL
0	30%	16%
1	60%	70%
2	7%	9%
3	2%	5%
+4	1%	0%

SOURCES: CH2M HILL, *2011 William P. Hobby Airport Peak Week Survey*, 2011 and Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.4.4 Other Relevant Publications

Industry and Federal Guidelines

- Federal Aviation Administration, Advisory Circular 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities*, April 1988.
- Transportation Research Board, Airport Cooperative Research Program (ACRP) Report 25, *Airport Passenger Terminal Planning and Design,* 2011.

Building, Fire, and Life Safety Codes

The building, fire, and life safety codes adopted by HAS that affect the sizing and arrangement of new terminal construction and the renovation or expansion of existing terminal facilities are as follows:

- International Code Council, *International Building Code*, with City of Houston Amendments.
- National Fire Protection Association (NFPA) 101, *Life Safety Code*, 2006.
- NFPA 220, *Standard on Types of Building Construction*, 2012.
- NFPA 415, Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways, 2008.
- Americans with Disabilities Act Accessibility Guidelines

4.2.5 TERMINAL AND CONCOURSE FACILITY REQUIREMENTS SUMMARY

Table 4-17 summarizes the total gross terminal space requirements for each future PAL, along with a breakdown of space requirements between major space types. The total existing building encompasses approximately 663,800 square feet. It is anticipated that an additional 487,300 square feet of space will be required at 9.0 million annual passengers (MAP), in 2030, which would be a 42 percent increase compared with existing conditions.

Table 4-17: Summary of Total Terminal Space Requirements (in square feet)

	EXISTING BUILDING	2011	2015	2020	2030
Airline Facilities	265,079	282,717	335,143	416,256	459,009
Transportation Security Administration	35,292	44,797	60,445	72,660	84,590
Customs and Border Protection	0	0	84,312	84,312	84,312
Retail, Food and Beverage, Specialty Concessions	50,262	50,300	62,620	74,930	92,370
Ground Transportation	1,287	0	0	0	0
Amenities	1,612	1,620	1,620	1,620	1,620
HAS (Airport)	46,614	27,200	33,300	39,400	49,200
Other Agencies and Contractors		7,100	7,100	7,100	7,100
Circulation	137,039	140,902	199,435	238,533	267,800
Restrooms	18,341	16,550	24,490	32,150	39,600
Building Systems	71,938	73,966	104,692	125,217	140,580
Gross Allowance and Unassigned	36,364	8,606	12,181	14,569	16,356
TOTAL PROGRAM (GROSS AREA)	**663,828**	**646,657**	**833,927**	**1,015,336**	**1,151,125**

NOTE: Values many not equal due to rounding.

SOURCE: Houston Airport System, Composite Space Allocation, December 10, 2010 and Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.6 AIRLINE FACILITIES

Airline facilities include check-in facilities; baggage handling facilities; airline support space, including airline ticket offices (ATO), baggage service offices (BSO), and operations offices; and boarding areas. The methodology, planning criteria, and assumptions used to develop the space requirements for the individual airline facility components are listed in **Table 4-18** and discussed in this section.

Table 4-18: Summary of Airline Space Requirements (in square feet)

	EXISTING	2011	2015	2020	2030
Check-in	10,889	7,106	8,602	11,220	13,277
Baggage Handling	87,347	100,927	115,868	152,535	169,724
Airline Support	62,772	72,140	86,570	101,000	106,770
Boarding Areas	104,071	102,544	124,103	151,502	169,239
TOTAL	**265,079**	**282,717**	**335,143**	**416,256**	**459,009**

NOTE: Values many not equal due to rounding.

SOURCE: Houston Airport System, Composite Space Allocation, December 10, 2010 and Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.6.1 Airline Check-in Facilities

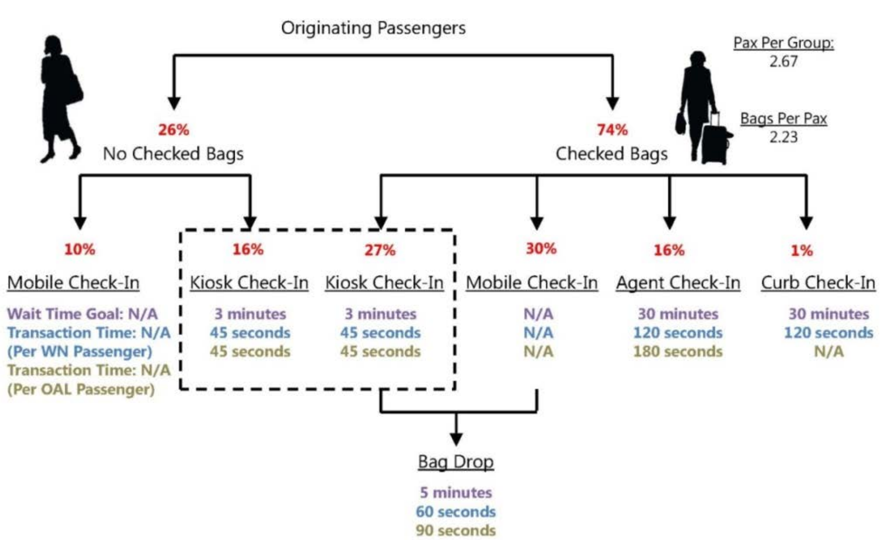
Departing (originating) passengers check in on the Ticketing Level (first floor) of the Terminal. To be consistent with current Airport operating procedures, preferential-use of check-in facilities was used in developing check-in facility requirements.

Five check-in options are generally supported by the airlines, as follows:

- **Bypass (Internet) Check-in:** Passengers who do not check bags may check in remotely prior to arriving at the Airport and, consequently, they do not use check-in facilities at the Airport.
- **Self Service Devices**: In-terminal check-in positions or remote kiosks where passengers acquire boarding passes.
- **Self Service Devices and Bag Drop Positions**: Locations where airline staff tag and accept bags after passengers complete their self-service check-in transactions.
- **Bag Drop Positions**: Locations where airline staff tag and accept bags from passengers who checked in online.
- **Full Service (Agent) Counter Check-in Positions**: Locations where airline staff may assist passengers in acquiring boarding passes and where airline staff accept checked bags.

Passenger check-in preferences depend on their class of service and whether or not they check baggage. **Exhibit 4-18** lists the assumptions regarding passenger check-in preferences, transaction rates, and Airport level-of-service goals.

Exhibit 4-18: Passenger Check-in Options and Service Goals



NOTE: OAL = other airlines

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

Computer simulation was used to analyze the number of check-in positions needed to achieve the level-of-service goals for check-in wait times and to measure the numbers of passengers waiting in queue to check in. The required number of check-in positions for each airline was individually calculated and summed to derive the total requirement.

Table 4-19 provides the peak hour demand basis and the resulting airline check-in requirement for base year 2011. The table also indicates the planning factors derived from this analysis for airline check-in facilities, which were then applied to future PALs to generate future airline requirements at the Airport. The planning factor represents the ratio of check-in facilities needed to achieve the prescribed LOS for wait times and queuing area to peak hour numbers of originating passengers based on detailed analysis of base year 2011 activity. Planning factors for Southwest Airlines and other airlines were calculated separately because of differences in transaction rates.

Table 4-19: Base Year 2011 Passenger Demand and Requirements for Check-in Positions and Queuing

	PLANNING FACTOR	
SOUTHWEST AIRLINES:		
Peak hour at Scheduled Time of Departure	1,243	passengers
Peak hour at Check-in	700	passengers
Peak demand rate	130	passengers/10 minutes
Check-in positions required	30	positions
Wait times for check-in	19	minutes (on average during peak 10-minute demand interval)
Passengers waiting in queue	107	passengers (on average during peak 10-minute demand interval)
Passenger queue area	1,498	square feet (14 square feet per passenger- LOS C)
OTHER AIRLINES (INCLUDES FOREIGN-FLAG AIRLINE CHECK-IN OPERATED BY A U.S.-FLAG AIRLINE):		
Peak hour at Scheduled Time of Departure	477	passengers
Peak hour at Check-in	119	passengers
Peak demand rate	30	passengers/10 minutes
Check-in positions required	8	positions
Wait times for check-in	13	minutes (on average during peak 10-minute demand interval)
Passengers waiting in queue	27	passengers (on average during peak 10-minute demand interval)
Passenger queue area	336	square feet (14 square feet per passenger – LOS C)

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

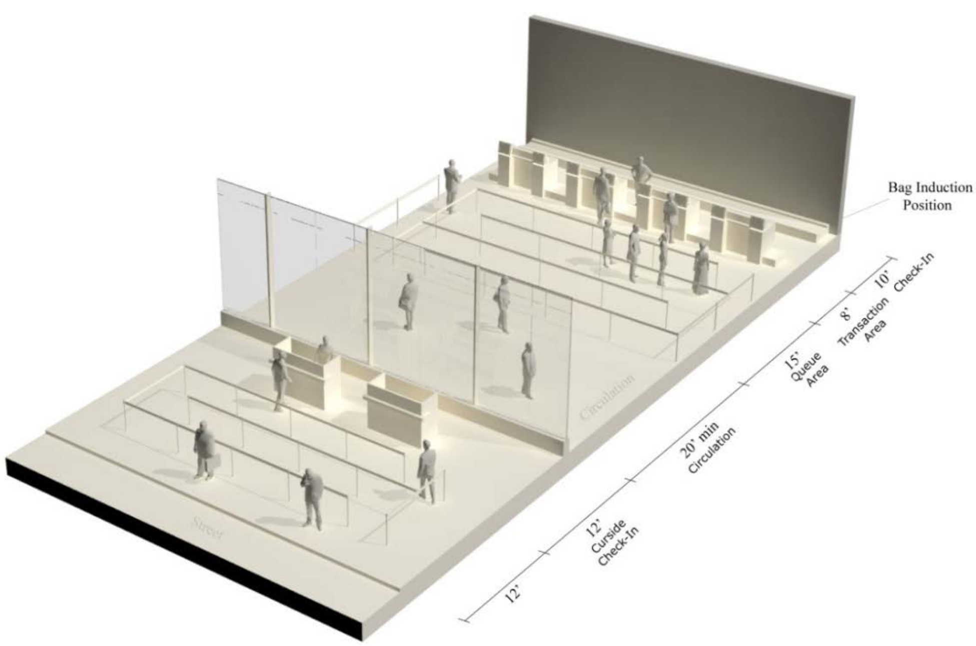
Table 4-20 presents an extrapolation of the total space requirements associated with passenger check-in positions for Southwest Airlines and other airlines based on the check-in space template illustrated on **Exhibit 4-19**. Check-in facilities in airport terminals range in configuration depending on airline operational preferences. The various configurations may include traditional linear-presentation agent counters with or without built-in self-service devices, island counters, and a mix of remote self-service devices and bag tag check-in positions. Space requirements for various check-in configurations may differ slightly depending on equipment. Check-in positions, including self-service devices and curbside check-in, were assumed to be in-line counters for purposes of this analysis.

Table 4-20: Check-in Lobby, Terminal Space Requirements

FACILITY	2011	2015	2020	2030
Southwest Airlines				
Peak Hour Originating Passengers at schedule time of Departure (STD)	429	516	646	797
Check-in Positions	30	36	45	56
Other AIRLINES				
Peak Hour Originating Passengers at STD	111	135	202	210
Check-in Positions	8	10	15	15
TOTAL TERMINAL				
Check-in Positions	38	46	60	71
Total Lobby Length (linear feet)	228	276	360	426
Total Lobby Depth (linear feet)	30.0	30.0	30.0	30.0
Terminal Ticket Lobby (square feet)	6,840	8,280	10,800	12,780
Planning Factors				
Peak Hour Originating Passengers per Position				
Southwest Airlines	14.3	14.3	14.3	14.3
Other Airlines	13.9	13.9	13.9	13.9

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

Exhibit 4-19: Passenger Check-in Space Template



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

- **Check-in Positions:** *Where passengers are checked in by airline staff or at a kiosk in the check-in lobby of the terminal*. Single check-in positions were assumed to be 3-feet wide and 10-feet deep from the check-in counter face to the back wall, which allows for a behind-counter work area and take-away conveyor belts up to 48 inches wide to accommodate large bags. A 15-foot-wide pass-through area for general circulation was assumed between every 16 contiguous check-in positions. Despite the increase in departing passengers from the Baseline scenario to 9.0 MAP (2030), the demand for ticket counters would not significantly increase because of reduced check-in processing times, increased use of Internet check-in, and greater dependence on self-serve kiosks for check-in versus traditional ticket counters.
- **Transaction Area:** Standing area for passengers at the check-in counters and primary cross aisle for passenger circulation between check-in counters. The transaction area is typically 8 feet deep from the face of the check-in counter to the check-in queue boundary.
- **Check-in Queue:** Holding area for passengers waiting to transact at the check-in counters ranges in depth depending on LOS criteria for square footage per passenger in the queue. Exhibit 4-19 shows a 15-foot-deep check-in queue. Check-in queues are typically defined by queue stanchions with serpentine lanes spaced 5-feet apart between each queue stanchion lane.
- **General Circulation:** A main circulation corridor for passengers and others moving between check-in queues and other terminal functions. This area is recommended to be a minimum of 20 feet deep and free of any fixed obstructions to accommodate cross circulation for passengers and others.

4.2.6.2 Airline Baggage Handling Facilities

Airline baggage handling facilities include the outbound baggage makeup areas where bags for departing flights are sorted and placed on baggage carts for delivery to the aircraft. These facilities also include inbound (arriving) areas for passengers to claim their bags and the area needed to transfer the bags from the carts to the baggage claim devices. These facilities only include the domestic baggage claim device area, as the future international baggage claim area is discussed in a later section.

4.2.6.3 Outbound Baggage Makeup Facilities

Airline outbound baggage makeup facilities consist of the baggage makeup equipment, areas for staging and loading baggage carts, and baggage cart drive (circulation) aisles. Outbound baggage makeup devices can be configured to use run-out piers that extend directly from the baggage conveyance and sortation system, or carousel units that allow baggage to continuously circulate and allow for higher storage capacity and greater staging area for carts. Carousels can be flat-plate units or sloped-plate units. Sloped-plate units provide greater capacity; however, flat-plate units are preferred by some airlines because they provide better ergonomics for workers. Carts can be staged either perpendicular to makeup devices or parallel if the aisles between devices have sufficient width. Operating criteria used to calculate the requirements for outbound baggage makeup facilities include the following:

- Makeup units size were calculated using carousel units assigned to airlines on a preferential-use basis. A single unit would be shared (between multiple airlines) when it had 50 percent or greater unused capacity.

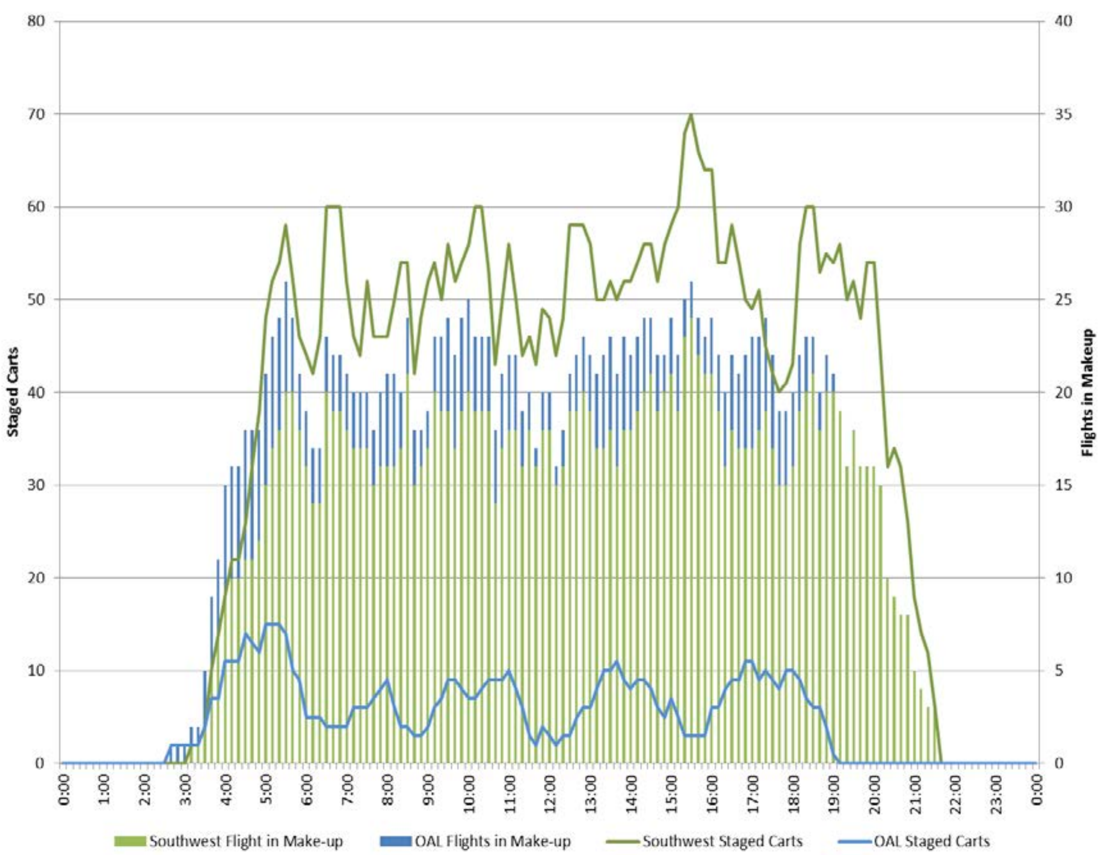
- **Table 4-21** shows the profile used to determine the number of carts to be staged ahead of a flight's scheduled departure time. **Exhibit 4-20** presents graphically the number of carts staged and flights in baggage makeup representing the base year 2011 flight schedule.

Table 4-21: Outbound Baggage Makeup Cart Staging

Minutes Prior to Departure	180	170	160	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10
Percentage of International Flights Carts Staged	50%	50%	50%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	50%	25%	0%	0%	0%
Percentage of Domestic Flights Carts Staged	0%	0%	0%	50%	50%	50%	50%	50%	50%	100%	100%	100%	100%	100%	100%	30%	0%	0%

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

Exhibit 4-20: Airline Outbound Baggage Makeup Activity (Base Year 2011)



NOTE: OAL = other airlines

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

The number of baggage carts staged for a departing flight depends on size of the aircraft and the number of bags checked in for the flight.

Table 4-22 summarizes the peak aggregate domestic and international staged baggage cart requirements through 9.0 MAP (2030) based on the 2011 ratio of staged carts to domestic and international departing flights simultaneously in baggage makeup. The table identifies the factors used to extrapolate space requirements for outbound baggage makeup facilities.

Table 4-22: Outbound Baggage Makeup Cart Staging Requirements

FACILITY	EXISTING BUILDING	2011	2015	2020	2030
Southwest Airlines					
Peak Hour Flights in Makeup		24	29	37	41
Peak Number of Bag Carts Staged		70	76	106	119
Makeup Unit Area (square feet)	26,420	28,000	30,400	42,400	47,600
SUBTOTAL (square feet)	**26,420**	**28,000**	**30,400**	**42,400**	**47,600**
OTHER AIRLINES					
Peak Hour Flights in Makeup		7	9	11	11
Peak Number of Bag Carts Staged		15	19	28	28
Makeup Unit Area (square feet)	7,781	6,000	7,600	11,200	11,200
SUBTOTAL (square feet)	**7,781**	**6,000**	**7,600**	**11,200**	**11,200**
TOTAL (square feet)	**34,201**	**34,000**	**38,000**	**53,600**	**58,800**
Planning Factors					
Makeup Unit Area per Staged Cart (square feet)	400	400	400	400	400

NOTE: Values many not equal due to rounding.

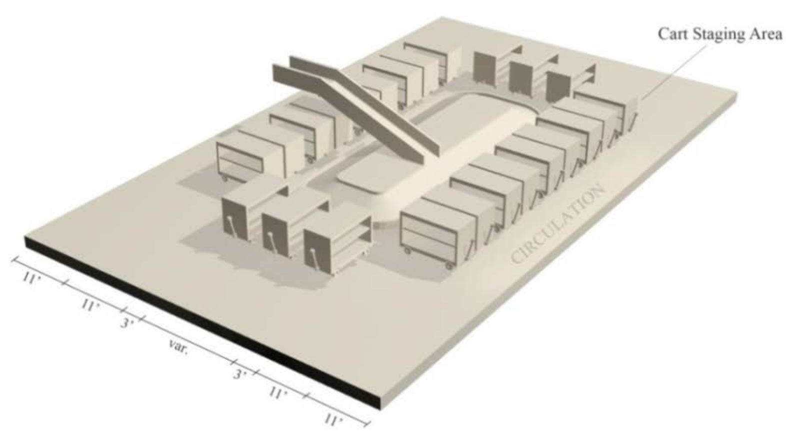
SOURCE: Houston Airport System, Composite Space Allocation, December 10, 2010 and Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

Exhibit 4-21 illustrates the template used to develop space requirements for a typical baggage makeup carousel. The unit length is based on the size of carousels currently in use at the Airport. The makeup unit area includes the carousel equipment, work area, and cart staging clearances. The following assumptions apply to this template:

- **Baggage Carts:** Baggage carts have load capacities of approximately 4,000 pounds, are either 11 feet or 15 feet long (with tow bar down), and weigh up to 1,325 pounds and 1,800 pounds, respectively. The widths of the carts range from approximately 5 feet, 7 inches to 5 feet, 9 inches.

- **Baggage Containers/Dollies:** Containers/dollies are more commonly used for widebody aircraft flights. As no widebody flights are planned at the Airport, containers/dollies were not considered in this analysis.
- **Carousel Dimensions:** The typical dimensions of existing sloped plate carousel devices are 36 feet by 75 feet; up to 24 carts can be staged perpendicular to the carousel.
- **Work Area:** The clearances between the carousel and the staged carts used by workers to load bags should be as follows:
  - Work aisle width: 3 feet
  - Clear height: 7 feet
- **Cart Staging Clearances:** In the area used to stage empty carts for baggage loading, the following clearances from the work aisle to the nearest drive aisle should be maintained:
  - Parallel staging: 7 feet
  - Perpendicular staging: 15 feet
- **Drive Aisle Clearances:** Baggage cart operational clearances should be maintained as follows:
  - One-way drive aisle width: 15 feet
  - Two-way drive aisle width: 25 feet (continuous along the perimeter of the makeup area)
  - Bypass-drive aisle width: 10 feet (one aisle between each device)
  - Drive aisle height clearance: 7 feet, 6 inches (minimum)
  - Drive aisle turning radius: 30 feet
  - Maximum ramp slope: 5 degrees (8.75 percent slope)

Exhibit 4-21: Outbound Baggage Makeup Carousel Space Template



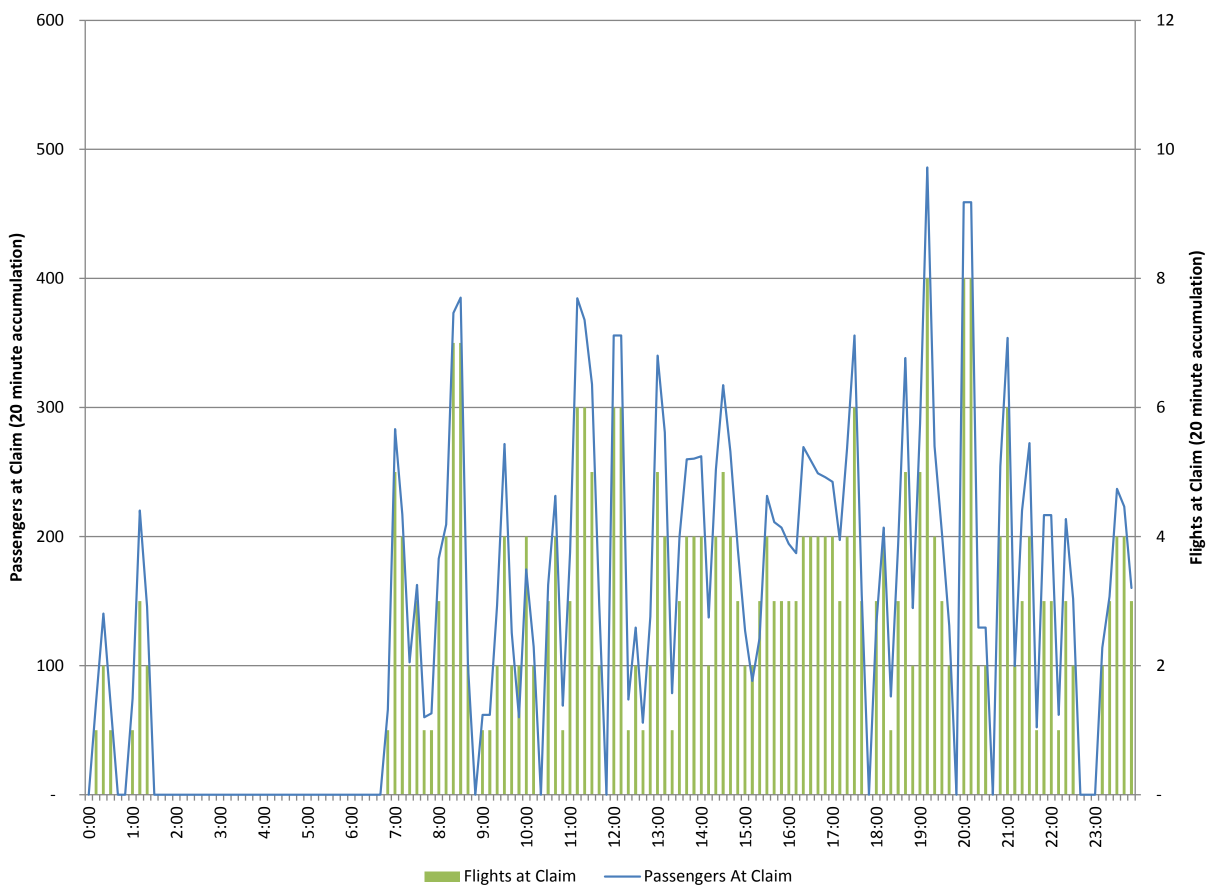
SOURCE: Ricondo & Associates, Inc. August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

Domestic Baggage Claim

Arriving domestic passengers claim their checked baggage on the Baggage Claim Level (ground floor). Facility requirements for domestic baggage claim include the number of claim units, presentation length of claim conveyors, baggage retrieval areas, and a main corridor extending the length of the domestic baggage claim area. Requirements for associated facilities, including airline baggage service offices and baggage offload areas, were addressed separately.

Exhibit 4-22 illustrates the base year 2011 daily number of bags simultaneously in the baggage makeup area for both Southwest Airlines and other airlines, by showing the number of passengers and flights in domestic baggage claim.

Exhibit 4-22: Numbers of Flights and Passengers in Domestic Baggage Claim (Base Year 2011)



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

Level-of-service standards address the amount of space provided for passengers waiting to retrieve bags or in the act of retrieving bags. IATA defines a 12-foot band around the "presentation" face of a claim conveyor as the retrieval area used to determine level of service. The flight schedules associated with forecast demand were analyzed to determine the accumulation of passengers from arriving domestic flights from various concourse gates into the respective domestic baggage claim areas. Exhibit 4-22 correlates the numbers of flights and passengers using domestic baggage claim facilities, assuming a 20-minute accumulation of flight arrivals from the base year 2011 flight schedule.

ADG III aircraft with seating capacity for 175 passengers are projected to be the predominant aircraft in domestic service at the Airport. The following calculation was used to determine the minimum presentation length for a baggage claim unit serving such aircraft:

- Terminating passengers: 158 passengers (90 percent load factor; 100 percent O&D passengers)
- Passengers claiming bags: 120 passengers (75 percent of terminating passengers)
- Required retrieval area at LOS C: 1,680 square feet (based on 14 square feet per passenger)
- Required presentation length: 140 linear feet (based on a 12-foot retrieval band)

Table 4-23 summarizes the demand basis and requirements for domestic baggage claim facilities at future PALs using an average presentation length of 150 linear feet for a single claim unit. Based on IATA LOS framework, 150 feet of presentation length provides 1,800 square feet of retrieval area, which supports 128 passengers waiting to claim bags at 14 square feet per passenger (LOS C, with limited baggage cart use). Claim units were assigned on a common-use basis within the terminal.

Table 4-23: Domestic Bag Claim Space Requirements

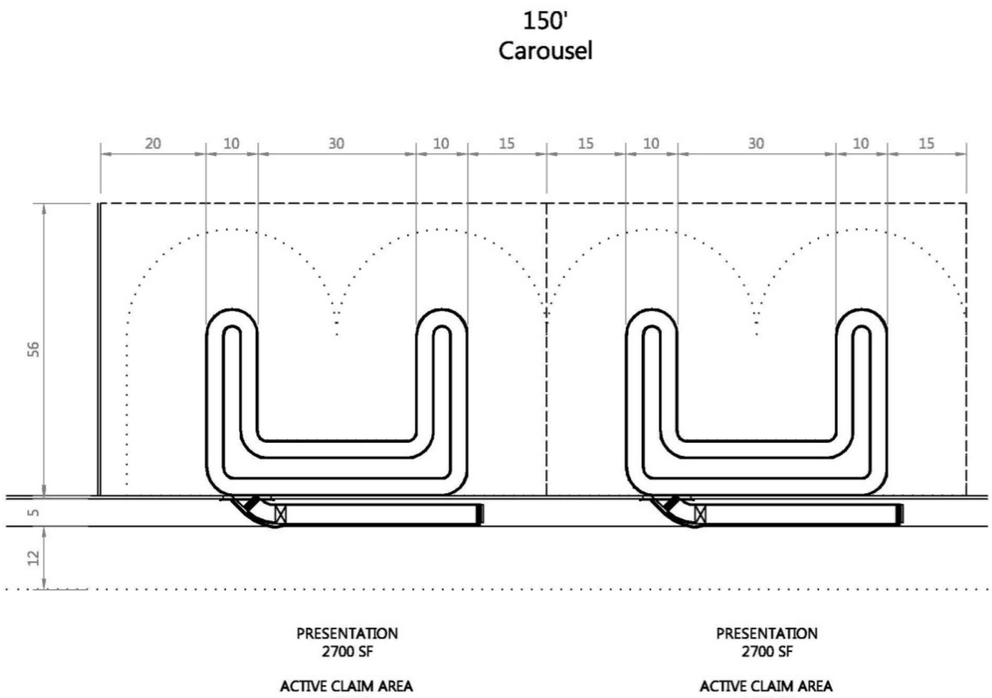
FACILITY		EXISTING	2011	2015	2020	2030
Number of Baggage Claim Units		5	5	6	7	8
Total Baggage Claim Unit Area (square feet)		11,314	22,000	26,400	30,800	35,200
Total Main Corridor Area (square feet)		3,498	8,500	10,200	11,900	13,600
DOMESTIC BAGGAGE CLAIM LOBBY (square feet)		**12,251**	**30,500**	**36,600**	**42,700**	**48,800**
Planning Factors						
Presentation Length per Device	(linear feet)	150	150	150	150	150
Baggage Claim Area per Device	(square feet)	4,400	4,400	4,400	4,400	4,400
Main Corridor Area per Device	(square feet)	2,125	2,125	2,125	2,125	2,125

NOTE: Values many not equal due to rounding.

SOURCE: Houston Airport System, Composite Space Allocation, December 10, 2010 and Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

Overall space requirements to accommodate the required numbers of baggage claim units were based on the space template illustrated on **Exhibit 4-23**.

Exhibit 4-23: Flat Plate Domestic Baggage Claim Unit Space



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

The spatial requirements were based on the flat plate claim devices that were most recently installed at the Airport. These units do not recirculate bags between the nonsecure baggage claim lobby and the SIDA baggage room.

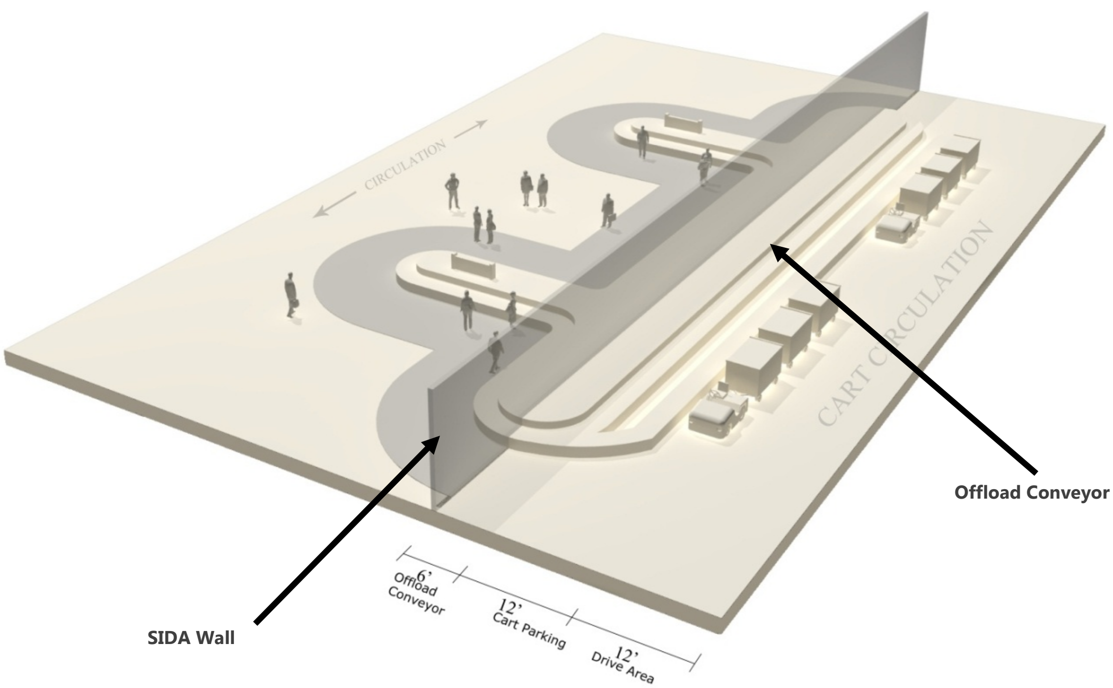
- **Baggage Claim Device and Retrieval Area.** The area allocated for a single baggage claim unit includes the equipment area and clearance between the equipment and the adjoining device, walls, or general circulation corridors. The following clearances were used to calculate a single baggage claim device area:
  - 15 feet between the baggage claim device and the adjacent fixture for a single unit
  - 30 feet between pier extensions, including the retrieval area
- **General Circulation.** Main circulation corridor for passengers and nonpassengers moving between baggage claim devices and other terminal functions. This area is recommended to be a minimum of 20 feet deep and free of any fixed obstructions to accommodate cross-circulation for passengers and

nonpassengers. Additionally, a pass-through area for general circulation was assumed between groupings of three contiguous baggage claim devices.

Domestic Baggage Claim Offload Areas

Each domestic baggage claim device requires an offload area within the SIDA for general baggage cart circulation, parking baggage carts while they are being offloaded, a work aisle, and an offload conveyor. **Exhibit 4-24** illustrates the template used for developing the space requirements for domestic baggage claim offload areas.

Exhibit 4-24: Domestic Baggage Claim Offload Area Space Template



SOURCE: Ricondo & Associates, Inc. June 2010.
PREPARED BY: Ricondo & Associates, Inc., June 2010.

Table 4-24 summarizes the spatial requirements for each PAL.

Table 4-24: Domestic Baggage Claim Offload Space Requirements

FACILITY	EXISTING	2011	2015	2020	2030
Domestic Baggage Claim Units	5	5	6	7	8
Offload Area (square feet)	2,523	3,600	4,320	5,040	5,760
Cart Circulation (square feet)	2,523	3,600	4,320	5,040	5,760
TOTAL (square feet)	**2,523**	**3,600**	**4,320**	**5,040**	**5,760**
Planning Factor					
Offload Area per Device (square feet)	720	720	720	720	720
General Circulation per Device (square feet)	720	720	720	720	720

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010 and Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

The offload area includes the following components:

- **Offload Conveyor.** Conveyor equipment used to transport bags from the baggage carts onto the baggage claim device.
- **Cart Parking.** An area typically the width of a tug road, approximately 10 feet to 12 feet wide, for carts to park and bags to be unloaded, with carts usually parked in parallel with the flat plate device.
- **Work Area.** Area directly between cart staging and flat plate device, typically 3 feet wide, providing a work area for baggage handlers to manually unload bags onto the offload conveyor.
- **Secure Information Display Area Wall.** The wall separating the secure concourse from the nonsecure landside to prevent unauthorized individuals from accessing the SIDA. The configuration of the flat plate conveyor prevents recirculating offloaded bags from re-entering the SIDA.

Baggage Cart Circulation

General cart circulation requires a drive lane and area to provide access to the inbound and outbound baggage areas. The requirement for this area is planned to be at the same ratio of the existing drive area to inbound and outbound baggage areas.

4.2.6.4 Airline Offices

Areas not shown on the check-in space template but associated with check-in functions include ATOs, other airline administrative office spaces, and other check-in support spaces for functions such as skycaps and cart storage. ATOs are usually located immediately behind, or in proximity to, the airlines' check-in counters to accommodate support functions for the airline staff handling check-in. Other office space may include the airline station manager's office or a sales office. As airlines have moved toward more self-service for passenger check-in, the number of customer service agents has decreased, resulting in less demand for ATO space. **Table 4-25** summarizes the requirements for Terminal airline offices at future PALs.

Table 4-25: Airline Office Space Requirements

FACILITY	EXISTING	2011	2015	2020	2030
SOUTHWEST AIRLINES					
Number of check-in positions		38	46	60	71
Check-in position length at 6 feet/ position (linear feet)		228	276	360	426
Airline Ticket Office Area (square feet)	2,800	5,700	6,900	9,000	10,650
Airline Administrative Offices (square feet)	28,390	28,390	34,360	44,820	53,040
OTHER AIRLINES					
Number of check-in positions	-	8	10	15	15
Check-in position length at 6 feet/ position (linear feet)	-	48	60	90	90
Airline Ticket Office Area (square feet)	2,807	1,200	1,500	2,250	2,250
TERMINAL AIRLINE OFFICE SPACE (square feet)	**34,000**	**35,200**	**42,700**	**56,000**	**66,000**
PLANNING FACTORS					
Southwest Airlines					
ATO area per Linear feet of check-in counter		25	25	25	25
Administration space : ATO space		5.97	5.97	5.97	5.97
Other Airlines					
ATO area per Linear feet of check-in counter		25	25	25	25

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010 and Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

The following assumptions apply to Terminal airline offices space requirements:

- **Airline Ticket Offices**. A ratio of 25 square feet per linear foot of check-in positions.
- **Airline Administrative Offices**. Requirements maintain the current ratio between ATO and non-ATO administrative space. This space is currently on the Mezzanine Level (second floor) of the Central Concourse.

- **Other Check-in Support Spaces.** Requirements maintain the current ratio between ATO and other check-in support space.

4.2.6.5 Airline Baggage Service Offices

Baggage service offices include passenger service counters, waiting areas, and storage for delayed or unclaimed bags. Increasingly, airlines are using self-service kiosks that enable passengers to search for delayed bags and, in many instances, determine delivery status. The intent is to limit increases in staff otherwise needed to serve increases in passengers. BSO requirements are summarized in **Table 4-26** and were conservatively developed to maintain the current ratio of total daily terminating passengers to BSO space.

Table 4-26: Domestic Baggage Service Office Space Requirements

FACILITY	EXISTING	2011	2015	2020	2030
Total Daily Terminating Passengers		12,190	14,500	17,330	21,190
Baggage Service Offices (square feet)	**9,412**	**9,410**	**11,200**	**13,390**	**16,360**
Planning Factor					
Total daily terminating passengers : BSO square feet		1.29	1.29	1.29	1.29

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010 and Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc. August 2013.

4.2.6.6 Airline Concourse Facilities

Current and future airline space requirements for concourse or secure spaces are discussed in this section. Airline facilities include holdrooms, customer service counters and offices, and support facilities, including covered unenclosed spaces.

Holdrooms

A holdroom, also referred to as a departure lounge, is located at each aircraft gate. These passenger pre-boarding areas contain seating and standing areas for passengers, airline agent check-in podiums, and boarding/deplaning queuing spaces and aisleways. Holdroom areas are typically sized based on the seating capacity of the largest aircraft using the gate. The number of active gate positions needed to support the design day flight schedule is used to define the number of holdrooms needed. Active gate positions are defined as any aircraft parking position used to board passengers, regardless of the number of arriving aircraft accommodated at the gate. An active gate position by definition requires a passenger pre-boarding area.

Table 4-27 summarizes the space requirements for holdrooms on the Central Concourse based on the number of active gates and fleet mix derived through analyses of the design day flight schedules.

Table 4-27: Central Concourse Holdroom Space Requirements

FACILITY	EXISTING	2011	2015	2020	2030
Total Concourse Holdroom (square feet)	**66,027**	**72,140**	**86,570**	**101,000**	**106,770**
Planning Factors					
ADG III Aircraft Gates	25	25	30	35	37
Aircraft Seat Capacity		175	175	175	175
Holdroom Area Factor (square feet)		16.49	16.49	16.49	16.49

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010 and Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

A factor representing holdroom area to aircraft seat was used to extrapolate overall holdroom space requirements for an ADG III aircraft (i.e., Boeing 737-800 or Airbus 320). Although IATA prescribes a method for calculating LOS standards for holdrooms, it is not uniformly accepted; instead, for purposes of this Master Plan Update, the following parameters were used to derive the holdroom factors:

- **Load Factor:** A 90 percent load factor was applied to the aircraft seat inventory to determine the number of enplaning passengers in the pre-boarding area.
- **Seated vs. Standing Passengers:** A 70 percent factor was used for seated passengers at 17 square feet per passenger; a 30 percent factor was used for standing passengers at 12 square feet per passenger.
- **Common Area Reduction:** A 10 percent reduction in seating area was applied to account for overflow seating between adjoining holdrooms caused by differences in departure times, the estimated passenger arrival time distribution at the holdroom, and boarding time prior to departure.
- **Airline Agent Gate Counter:** An average assumption of three agent counter positions was used. The overall gate counter area per holdroom equals 262.5 square feet (10.5 feet x 25.0 feet).
- **Boarding/Deplaning Aisleway:** An average assumption for the boarding/deplaning aisleway was made per holdroom equal to 180 square feet (6.0 feet x 30.0 feet).

Customer Service Counters and Offices

Airlines require facilities in the Central Concourse for customer service related functions, such as passenger assistance counters or unaccompanied minors waiting areas, agent offices, and break rooms. **Table 4-28** summarizes future space requirements for such facilities, which were calculated to increase at the current ratio of the customer service facility space inventory to the number of peak hour aircraft operations. This factor was applied to every two operations.

Table 4-28: Customer Service Agent Space Requirements in the Central Concourse

FACILITY	EXISTING	2011	2015	2020	2030
Customer Service Agent Offices (square feet)	1,149	1,150	1,900	2,300	2,600
Planning Factors					
Peak Hour Operations	11	11	18	22	25
Increased peak hour operations factor	-	0	7	11	14
Square feet : peak hour operation		105	105	105	105

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010 and Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

Support Facilities

Airlines require facilities located on the Central Concourse Apron Level (ground floor), within the SIDA. Apron level facility requirements usually consist of two types: covered enclosed spaces and covered unenclosed spaces. The latter are used for various types of storage not requiring protection from the environment, such as vehicle and equipment parts storage. Typical uses for covered enclosed spaces include offices; break rooms; lockers and storage areas for terminal service crews; aircraft line maintenance offices, workshops, and storage; pre-flight ready and checkout facilities for flight crews; and airline ramp control centers.

Table 4-29 summarizes future space requirements, which are calculated to increase at the current ratio of the apron level facility space inventory to gates. The factor was applied to every additional gate.

Table 4-29: Concourse Apron Level - Airline Space Requirements

FACILITY	EXISTING	2011	2015	2020	2030
Covered Unenclosed Space (square feet)	42,119	42,119	50,600	59,100	62,500
Covered Enclosed Space (square feet)	32,311	32,311	38,810	45,310	47,910
TOTAL APRON LEVEL AIRLINE SPACE (SQUARE FEET)	**74,430**	**74,430**	**89,410**	**104,410**	**110,410**
Planning Factors Narrow body Equivalents Gates (NBEG)					
NBEG requirements	25	25	30	35	37
Increase of NBEG		0	5	10	12
Covered Unenclosed Spaces - square feet : NBE Gates		1,700	1,700	1,700	1,700
Covered Enclosed Spaces - square feet : NBE Gates		1,300	1,300	1,300	1,300

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010; Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.7 DEPARTMENT OF HOMELAND SECURITY FACILITIES

DHS facilities in the Terminal include passenger security screening checkpoints, baggage screening areas, future international arrivals processing, and support and administrative offices. The methodology, planning criteria, and assumptions used to develop the space requirements for individual DHS facility components are discussed in this section. **Table 4-30** summarizes the DHS space requirements.

Table 4-30: Department of Homeland Security Facilities (square feet)

FACILITY	EXISTING	2011	2015	2020	2030
Passenger Security Screening Checkpoints	16,217	22,287	26,867	29,157	31,447
Baggage Screening	19,075	19,070	28,210	37,050	45,630
Transportation Security Administration Support	0	3,440	5,368	6,453	7,513
Customs and Border Protection	0	0	84,312	84,312	84,312
Total	**35,292**	**44,797**	**144,757**	**156,972**	**168,902**

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010; Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.7.1 Passenger Security Screening

Although the TSA has direct responsibility for determining the size and configuration of passenger security screening checkpoints at the Airport, it typically collaborates with Airport management to plan checkpoint locations and programs. The *Checkpoint Design Guide* (Revision 3, March 10, 2011), provides guidelines for developing the requirements for security screening checkpoints in the Terminal, along with the following criteria:

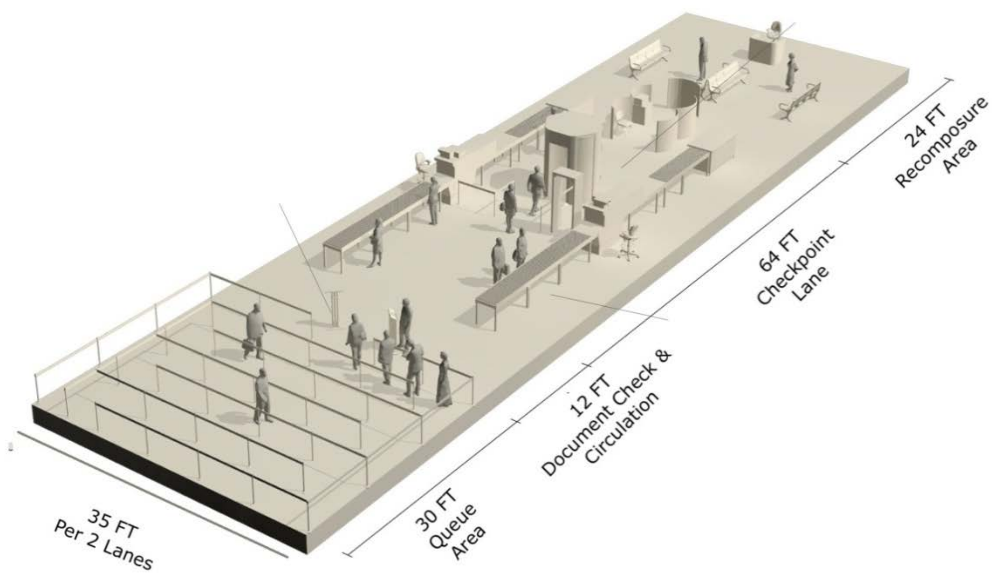
- A screening rate of 150 passengers per hour per lane was used. A sensitivity analysis was conducted using a screening rate of 120 passengers per hour per lane.
- The required number of checkpoint lanes was developed to provide the throughput needed to maintain approximately 10-minute wait times during the peak 20-minute demand interval of the peak hour.
- The area allocated for passenger queuing at the checkpoints provides capacity to accommodate demand equal to a 20-minute maximum wait time. The area assumed for each waiting passenger was 10.8 square feet in accordance with TSA guidelines.

Exhibit 4-25 illustrates the space template for the security screening checkpoints, including a unit for advanced imaging technology (AIT). The template module includes:

- Queue and document check
- Screening area, consisting of divest tables, walk-through metal detectors (WTMD), x-ray equipment, AIT devices, secondary search/examination space, and recomposure area

- Supervisor and Local Enforcement Official stations

Exhibit 4-25: Passenger Security Screening Checkpoint Space Template



SOURCES: Transportation Security Administration, *Checkpoint Design Guide,* Revision 3, March 10, 2011; Ricondo & Associates, Inc., June 2013.
PREPARED BY: Ricondo & Associates, Inc., June 2013.

The template does not include AIT workstations, administrative space, technical support space, or common exit circulation corridors beyond the recomposure area.

Computer simulation was used to analyze the number of checkpoint lanes needed to achieve the service goals for security screening wait times and to measure the numbers of passengers waiting in queue for document check.

Table 4-31 shows the requirements for security screening checkpoints and related queuing space for processing rates of 135 passengers per hour per lane and 150 passengers per hour per lane; 150 passengers per hour per lane was used as the criterion to determine the number of lanes required and queuing area to support the checkpoint. Two more security lanes were added to the requirement for special programs, such as pre-check, and employee screening.

Table 4-31: TSA Security Screening Checkpoint Space Requirements

	2011	2015	2020	2030
Peak 10-Minute Demand (passengers)	180	220	260	320
Peak Hour Demand (passengers)	890	1,080	1,390	1,630
Number of Lanes to Process 135 passengers per hour	8	9	11	12
Number of Lanes to Process 150 passengers per hour	7	9	10	11
Program Lane (Pre-check and Employees)	2	2	2	2
TOTAL LANES	**9**	**11**	**12**	**13**
Lane Area (square feet)	15,750	19,250	21,000	22,750
Queue Area (square feet)	4,860	5,940	6,480	7,020
Total Passenger screening Checkpoint Area	**22,287**	**26,867**	**29,157**	**31,447**
Checkpoint Planning Factors:				
Queue Area per Lane (square feet)	1,750	1,750	1,750	1,750
Checkpoint Screening and Corollary Areas per Lane (square feet)	540	540	540	540

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010 and Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.7.2 Checked Baggage Inspection System

Since enactment of the TSA on November 19, 2001, federal law has mandated that the TSA screen all passengers and property prior to aircraft boarding and loading.

The TSA's *Recommended Security Guidelines for Airport Planning, Design and Construction*, revised May 2011, provides guidelines for determining the most viable configuration for integrating certified EDS into an airport's baggage check operations.

The guidelines describe three configuration options:

- **Category 1 - Fully Integrated Inline System**: This configuration is the current state-of-the-art. These systems incorporate multiplexed EDS technology, complex baggage handling systems, control rooms, on-screen resolution capability, recirculation systems, multiple baggage inputs, and checked baggage resolution rooms. Average throughput rates range between 475 and 500 bags per hour per EDS unit. The TSA has been requiring that Category 1 configurations be designed to support emerging system technology. EDS machines in this category are designed to achieve a throughput of 800+ bags per hour with an improved false alarm rate. These high-speed EDS machines are integrated into pre-existing inline conveyor infrastructure.
- **Category 2 - Dedicated Quasi-Inline System**: Multiple mini-inline systems are dedicated to individual airlines. These systems use a simple point-to point conveyor design and are located closer to the airline's baggage makeup devices, which can help reduce travel time and the likelihood of

improper baggage sortation. The average throughput rate for this installation ranges between 100 and 120 bags per hour per EDS unit. Because of the dedicated and decentralized nature of these systems, more staff and a larger aggregate footprint are required when the totality of multiple dedicated mini-inline systems are considered.

- **Category 3 - Ticket Counter Mounted System**: This system has the lowest capital cost of any inline system on a per machine basis, but is the least efficient in terms of throughput.

For planning purposes, Category 1 - Fully Integrated Inline System, is the recommended configuration for HOU based on the following:

- Surge throughput rates of dedicated quasi-inline systems have reached their technological threshold in large part as a result of the lack of queuing capacity and on-screen resolution capability.
- Lower unit throughput rates resulting from multiple dedicated system configurations and higher staffing levels would require a considerably larger aggregate footprint for multiple quasi-inline systems compared to centralized fully integrated inline systems. Expanding the existing dedicated quasi-inline systems would directly compete with available airline baggage room capacity.

Table 4-32 summarizes the requirements for TSA checked baggage inspection system space. The requirement is based on an inline system and 13.46 square feet of EDS space for each peak hour bag. This factor is based on the current peak hour bags divided by the existing area. A factor has also been used based on the peak number of bags per hour for support spaces for the EDS operations such as on-screen resolution spaces and offices.

Table 4-32: TSA Checked Baggage Inspection System Areas

Facility	Existing	2011	2015	2020	2030
EDS Room (square feet)	**17,231**	**17,230**	**25,480**	**33,470**	**41,220**
Support space (square feet)	1,844	1,840	2,730	3,580	4,410
GRAND TOTAL (square feet)	**19,075**	**19,070**	**28,210**	**37,050**	**45,630**
Planning Factors					
Peak Passengers per Hour	1,243	1,243	1,838	2,414	2,973
Peak Bags per Hour	1,280	1,280	1,893	2,486	3,062
Square Feet EDS : Bags per Hour	13.46	13.46	13.46	13.46	13.46
Square Feet Support : Bags per Hour	1.44	1.44	1.44	1.44	1.44

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010; Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.7.3 TSA Support

TSA offices are located on the Baggage Claim Level (ground floor) of the terminal, on the east end of the temporary baggage claim. These spaces include offices for the Assistant Federal Security Director and supervisors, and for conference and training rooms. The requirement for TSA support space is planned to increase as a factor of the other TSA space within the terminal, as shown in **Table 4-33**.

Table 4-33: TSA Support Space

FACILITY	EXISTING	2011	2015	2020	2030
Support Offices	3,440	3,440	5,368	6,453	7,513
Planning Factor					
Square Feet of TSA space : support space	9.75	9.75	9.75	9.75	9.75

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010; Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.7.4 Federal Inspection Services Facility (International Arrivals)

Federal Inspection Services (FIS) facility requirements were derived from the latest CBP design standards manual. Additionally, the requirements for international baggage claim facilities and space were developed based on the anticipated demand from the design day flight schedule used for overall planning of the terminal expansion and the new West Concourse. The major components of the FIS facility are:

- Primary screening, where passports are checked
- International baggage claim, where passengers from international flights retrieve their baggage
- Secondary screening, where passengers go through additional Customs screening and passport control
- Exit control, which is the final process before passengers exit the FIS facility and enter the United States
- CBP administration, the requirements for which include office space, break rooms, locker rooms, holding facilities, information technology equipment space, conference rooms, and other space pertinent to the FIS mission

Primary Screening

Table 4-34 shows the projected number of peak hour seats, with an 85 percent load factor applied to develop passenger demand. The table shows the number of required agent positions based on the CBP standard of one agent position per 50 peak hour passengers. Typical configurations for primary screening were assumed to consist of piggyback units, providing for two agent positions per security screening unit. The required area was derived from CBP guidelines (U.S. Department of Homeland Security/U.S. Customs and Border Protection, *Airport Technical Design Standards for Passenger Processing Facilities*) based on peak hour international passenger demand.

Table 4-34: Design Basis for Customs and Border Protection Primary Screening

	2015	2020	2030
Number of Seats	572	858	922
Passengers (85% load factor)	486	729	784
Peak Hour Design Level Seats	500	800	800
Number of Agent Positions	10	15	16
Number of Piggyback Units	5	8	8
Area Required (square feet)	7,920	10,560	10,560

SOURCE: Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

International Baggage Claim

The International Baggage Claim Hall was sized to accommodate the anticipated number of peak hour passengers and associated bags. The total linear feet required to store the peak hour bags was translated to baggage claim devices to accommodate peak hour international flights. Baggage storage on the claim units is an important factor, as passengers wait a variable amount of time during the primary screening process before collecting their bags from the claim units; the bags typically arrive at the claim device before the passengers. **Table 4-35** shows the design basis for each baggage claim device planned for international flights. The baggage claim devices were sized for 175-seat passenger aircraft. The assumed bags per passenger ratio is 1.3, and it was assumed that 80 percent of passengers will claim bags; these ratios are consistent with data collected at various international arrivals facilities at U.S. airports at which narrowbody aircraft serve Caribbean and Mexican destinations.

The number of baggage claim devices required is a factor of the number of peak hour flights. For an international flight, because of the different processing times required for primary screening of passengers from domestic and international flights, bags could be stored on a claim device for up to 30 minutes, plus the time required for the bags to be transported to the device. The typical path of baggage from the aircraft to the claim device is as follows: bags are unloaded from the aircraft cargo hold onto a baggage cart or a baggage container pallet, and transported to the inbound baggage unloading area (at this point, the claim device is considered to be occupied); the baggage is then loaded onto the transport conveyor and transported via conveyor lines to the baggage claim device. Each flight essentially occupies the claim device between 40 and 50 minutes after its scheduled time of arrival. Therefore, one device can be used twice an hour, for a ratio of one device for every two peak hour flights. **Table 4-36** shows the number of devices and the total area required during the planning period based on providing queuing space around each device. The area shown does not include general circulation space beyond the claim device queuing space. General circulation space is typically a minimum of 25 feet between the claim device queuing area and any wall or the queuing area for adjacent devices.

Table 4-35: Design Basis for International Baggage Claim

DESIGN BASIS	CRITERIA
Aircraft Seats	175
Load Factor	85%
Deplaning Passengers	149
Percent of Deplaning Passengers Claiming Bags	80%
Bags per Passenger	1.3
Percent of Total Bags at Claim Device	85%
Total Bags	132
Baggage Claim Size Requirement	
Presentation Frontage per Bag (linear feet)	1.5
Claim Device Length (linear feet)	198
Equipment Area (square feet)	1,670
Clearance Area at 18 feet per linear foot (square feet)	3,564
Principal Claim Area (square feet per device)	5,234

SOURCE: Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

Table 4-36: International Baggage Claim Area Requirements

	2015	2020	2030
Peak 10 Minute International Aircraft Operations	2	2	2
Peak Hour International Aircraft Operations	4	6	6
Number of Claim Devices	2	3	3
Total Claim Area Required (square feet)	10,468	15,702	15,702

SOURCE: Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

Secondary Screening, Exit Control, and Customs and Border Protection Administration

Secondary screening, exit control, and CBP administration area requirements are based on the CBP guidelines. Based on those guidelines, the secondary and support areas will require approximately 5,800 square feet of space in 2015. The selected architect/engineer will coordinate with CBP during the design phase of the FIS facilities to finalize the space program to include all CBP-required spaces.

4.2.8 CONCESSIONS

Terminal concessions consist of food and beverage, convenience retail, specialty retail, duty free, advertising, and services, such as automated teller machines, business centers, luggage carts, and spa services. Concession spaces can be divided into three categories: Terminal or nonsecure, Concourse or secure, and support spaces. The amount of concessions public serving areas is summarized in **Table 4-37** and was developed to maintain the 2011 base year ratio of concourse concession area per 1,000 annual enplaned passengers. Additional areas for concession support, including storage rooms, administrative offices, and food-preparation kitchens, but not including common loading docks and trash compactors, were calculated using the current ratio of concession support space to space serving the public.

Table 4-37: Concourse Concession Space Requirements (in square feet, except passengers)

FACILITY	EXISTING	2011	2015	2020	2030
Nonsecure Public Serving/Sales Area	7,094	7,110	8,850	10,590	13,050
Secure Public Serving/ Sales Area	30,041	30,040	37,400	44,750	55,180
Concession Support	13,127	13,150	16,370	19,590	24,140
Total Concourse Concession Space	**50,262**	**50,300**	**62,620**	**74,930**	**92,370**
Planning Factors					
Annual Enplaned Passengers (in million)	4.9	4.9	6.1	7.3	9.0
Nonsecure Public serving/sales area per 1,000 enplaned passengers	1.45	1.45	1.45	1.45	1.45
Secure Public serving/sales area per 1,000 enplaned passengers	-	4.21	4.21	4.21	4.21
Ratio of serving/sales area to concession support	1.85	1.85	1.85	1.85	1.85

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010; Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.9 GROUND TRANSPORTATION SERVICES

Ground transportation services in the terminal area include landside vehicle staging, customer loading/unloading areas, and in-terminal spaces used for customer counters, waiting areas, and staff offices. Ground transportation services inside the Terminal typically include taxicab dispatch, rental car counters, hotel shuttles, and local buses information. **Table 4-38** summarizes the space requirements for tenants and services accommodated in the Terminal. Only rental car spaces were observed, and these are planned to be relocated to a CRCF.

Table 4-38: Terminal Space Requirements for Ground Transportation Services (in square feet)

FACILITY	EXISTING	2011	2015	2020	2030
Rental Cars	1,287	1,287	1,287	Move to CRCF	
Other Ground Transportation Concourse Tenants	0	0	0	0	0
Total Ground Transportation Concourse Facilities	**1,287**	**1,287**	**1,287**	**0**	**0**

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010; Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.10 AIRPORT, AMENITIES, AND OTHER AGENCIES SPACES

4.2.10.1 Airport Nonsecure Spaces

HAS facilities located within the Terminal include staff offices, meeting facilities, and facilities supporting Airport operation and maintenance. Included within these facilities are HAS-managed customer and civic service programs, such as Traveler's Aid and art programs. **Table 4-39** summarizes the requirements for HAS facilities and the factors used to generate future requirements. Facilities maintenance and shops are planned to be moved to a new location outside of the Terminal and are, therefore, not included in future requirements.

HAS terminal space requirements were derived using a ratio equal to the current HAS facility space inventory for every 2.0 million annual passengers. This factor was then applied to every additional 1.0 million passengers over 4.9 MAP (2011).

Table 4-39: HAS Terminal Space Requirements

	UNITS	EXISTING	2011	2015	2020	2030
Administration (square feet)		6,674	6,670	6,670	7,370	8,770
Operations		2,229	3,780	4,580	5,380	6,980
Maintenance and Other Support	(square feet)	37,758	16,790	21,390	25,990	32,790
SUBTOTAL HAS FACILITIES	(square feet)	**46,600**	**27,000**	**33,600**	**39,400**	**49,200**
Planning Factors						
2 Million Annual Passengers (MAP) incremental increase			5	-	1	2
Administration : 2 MAP incremental increase	(square feet)/5 MAP		700	700	700	700
Operations and Maintenance : 2 MAP incremental increase	(square feet)/5 MAP		8,000	8,000	8,000	8,000
Other Support : 2 MAP incremental increase	(square feet)/5 MAP		2,300	2,300	2,300	2,300

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010; Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.10.2 Airport Secure Space

HAS facilities located in the Central Concourse include facilities supporting operation and maintenance of the Airport. Included within this space are HAS-managed customer and civic service programs, such as Traveler's Aid and art programs. **Table 4-40** summarizes the factors used to generate future HAS Central Concourse space requirements. HAS space requirements were derived using a ratio equal to the current HAS facility space inventory to aircraft gate positions. This factor was then applied to every new gate added to the current 4.9 MAP (2011) inventory. Other space requirements were derived similarly using a ratio equal to the other space inventory.

Table 4-40: HAS Central Concourse Space Requirements

FACILITY	EXISTING	2011	2015	2020	2030
Operation and Maintenance	1,120	1,120	2,120	3,120	3,520
Other Support	569	570	1,070	1,570	1,770
Total HAS Concourse Facilities	**1,689**	**1,690**	**3,190**	**4,690**	**5,290**
Planning Factors (number of gates)	25	25	30	35	37
Gates growth (Narrow Body Equivalent)		0	5	10	12
Increase in NBEG requirement		0	5	5	2
Operation and Maintenance : NBEG		200	200	200	200
Other Support : NBEG		100	100	100	100

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010; Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.10.3 Amenities

Other amenities include the USO, interfaith chapel, and general seating in the baggage claim area. The requirements for these spaces are not planned to increase over the planning period, as shown in **Table 4-41**.

Table 4-41: Amenities (in square feet)

FACILITY	EXISTING	2011	2015	2020	2030
USO	928	930	930	930	930
Interfaith Chapel	335	340	340	340	340
General Seating	349	350	350	350	350
Total	**1,612**	**1,620**	**1,620**	**1,620**	**1,620**

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010; Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.10.4 Houston Police Department

The Houston Police Department is located on the Baggage Claim Level (ground floor) of the terminal, on the far east end. HPD does not require all of its space to be in the terminal building; therefore, any future requirements could be located in other buildings in the terminal area. Current HPD requirements are planned to be accommodated in the terminal for future PALs, but any additional growth would not be accommodated in the terminal building and is not included in the requirements shown in **Table 4-42**.

Table 4-42: Houston Police Department (in square feet)

FACILITY	EXISTING	2011	2015	2020	2030
Houston Police Department	0	7,100	7,100	7,100	7,100

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010; Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.11 COMMON PUBLIC SPACE

Common public space principally includes restrooms, public seating areas, meeter/greeter and well-wisher lobbies, circulation corridors, and vertical circulation elements, such as elevators, escalators, and stairs. The ratio is based on the current area of existing restrooms to the peak hour passenger volumes.

- Nonsecure public restrooms are typically provided near check-in facilities, baggage claim, and central concession areas. The space requirements for public restrooms, summarized in **Table 4-43**, were based on a ratio of 4.98 square feet per aggregate (combined) peak hour enplaning and deplaning passengers.
- Secure public restrooms are typically provided near holdrooms and concessions. The space requirements for public restrooms, also summarized in Table 4-43, were based on a ratio of 8.48 square feet per aggregate (combined) peak hour enplaning and deplaning passenger.
- Space requirements for public seating areas, corridors, and vertical circulation elements maintain the current amount of such space as a percentage of total airline, DHS, concessions, ground transportation, HAS, other agency, and public restroom space. Table 4-17 lists these space requirements at each future PAL.

Table 4-43: Public Restroom Space Requirements

FACILITY	EXISTING	2011	2015	2020	2030
Nonsecure Public Restrooms (square feet)	6,186	6,190	9,150	12,020	14,810
Secure Public Restrooms (square feet)	10,542	10,540	15,590	20,470	25,210
Planning Factors					
Aggregate Peak Hour Passengers		1,243	1,838	2,414	2,973
Square Feet per Aggregate Peak Hour Passenger in Nonsecure Space		4.98	4.98	4.98	4.98
Square Feet per Aggregate Peak Hour Passenger in Secure Space		8.48	8.48	8.48	8.48

NOTE: Values many not equal due to rounding.

SOURCES: Houston Airport System, Composite Space Allocation, December 10, 2010; Ricondo & Associates, Inc., August 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.2.12 NONPUBLIC COMMON SPACE

Nonpublic common space, principally include loading docks; receiving and trash storage areas; janitorial spaces; equipment spaces, such as utility rooms and closets; and nonpublic (back-of-house) corridors and vertical circulation elements. The ratio of nonpublic space is based on the current percentage of nonpublic common space to the overall building. Table 4-17 lists these space requirements at each future PAL.

- Requirements for nonpublic common space maintain the current amount of such space as a percentage of total airline, DHS, concessions, ground transportation, HAS, other agency, public restroom, and public common area spaces.
- Non-net space equal to 5.0 percent of the total Terminal space was added to the Terminal space requirement that exceed the Terminal space inventory. Non-net space represents structural and unusable space or inefficiencies inherent in new building areas.

4.2.13 AIRCRAFT GATE REQUIREMENTS

As indicated in **Table 4-44**, 25 gates are currently available to accommodate aircraft arrivals and departures at the Airport. To determine the number of aircraft gates that will be required at each PAL, several ramp charts depicting forecast daily aircraft operations based on the relevant design day flight schedules were developed using VGates, a software program developed by Ricondo & Associates, Inc., and designed specifically to plan gate assignments based on flight schedules.

Table 4-44: Aircraft Gate Requirements

	2011 5 REMOTE POSITIONS	2011 NO REMOTE POSITIONS	2015	2020	2030
Number of International Gates Required	-	-	5	10	12
Total Number of Gates Required	20	25	30	37	37
Number of Remain Overnight or Maintenance Positions Required	5	0	7	7	10
Number of Daily Flights	164	164	188	219	251
Average Turns per Gate (All Airlines)	6.7	5.8	6.2	5.9	6.8

SOURCE: Ricondo & Associates, Inc., September 2013.
PREPARED BY: Ricondo & Associates, Inc., September 2013.

Each ramp chart shows a series of bars representing the time period in which an aircraft is parked, either at a designated gate or at a remote parking position. Each bar is assigned a color and labeled according to the aircraft operator, equipment type, scheduled arrival/departure time, and origin and destination. To the left of the bar, the associated gate or remote parking position is identified, along with the airline(s) using the gate. The following assumptions were used in developing the baseline and each PAL ramp charts:

- Aircraft are only towed off a gate if doing so will result in a reduction in the total number of active gates required and if the aircraft is in a staging capacity (i.e., no loading or unloading of passengers is occurring).
- A minimum of 20 minutes was assumed between a departure and an arrival.
- The Central Concourse can only accommodate domestic flights and the new West Concourse can accommodate international or domestic flights.
- It was assumed that an aircraft is towed out 30 minutes after its arrival time and towed in at the gate 45 minutes before its departure time.
- An airline that has more than five flights at a gate does not share that gate.

Often, for a high volume operation, such as Southwest Airlines' operation at HOU, additional gates are provided as "operational spares." These operational spares or additional parking positions accommodate aircraft that may be subject to mechanical or weather-related delays or other off-schedule activity. Typically, one additional position is provided per eight active gates.

4.3 Terminal Curbside Requirements

This section describes the methodology used to determine future terminal curbside requirements at the Airport and presents the results of the analysis conducted by applying this methodology to the Airport's curbside configurations.

4.3.1 STUDY AREA CONDITIONS

The Airport has a two-level terminal curbside system. The Upper Level is designated for departing passengers, while the Lower Level is designated for arriving passengers and several commercial vehicle modes. For this analysis, the Departures Curbside (upper level) was divided into three sections; west, central, and east. Because of the location of Southwest Airlines' ticket counters, available curbside prior to the central crosswalk was assumed to be allocated for Southwest Airlines' passengers only. For the same reason, the curbside beyond the central crosswalk was assumed to be allocated for the operations of other airlines serving the Airport. It was also assumed that all commercial vehicles accessing the Departures Curbside would use the east section of the curbside only. The Arrivals Curbside (lower level) consists of three curbsides (inner, center, outer) and was assumed to have an even passenger distribution throughout, unlike the allocation split for Southwest Airlines and the other airlines on the Departures Curbside (upper level).

4.3.1.1 Curbside Zones

Exhibit 4-26 depicts the existing curbside allocation plan for the Departures Curbside (upper level). As shown, approximately 160 feet of curbside are available in the west section, 235 feet are available in the central section, and 290 feet are available in the east section. As stated above, because of the location of its ticket counters, Southwest Airlines was assumed to use the entire length of the west section plus half of the central section. The Other Airlines were assumed to use half of the central section plus the entire length of the east section. Commercial vehicles accessing the Departures Curbside (upper level), regardless of airline, are allocated the east section.

Exhibit 4-27 depicts the existing curbside allocation plan for the Arrivals Curbside (lower level). The following allocation lengths were based on current curbside assignments:

- Rental car shuttles (inner curb) = 300 feet
- Taxicabs (inner curb) = 355 feet
- Private vehicles (center curb) = 500 feet
- Parking shuttles (outer curb) = 130 feet
- Hotel shuttles (outer curb) = 75 feet
- METRO buses (outer curb) = 50 feet
- Charter buses (outer curb) = 250 feet
- Shared ride/economy shuttles (outer curb) = 200 feet
- Limousines = dedicated parking spaces (no linear allocation)

4.3.1.2 Roadway Traffic Counts

During the first week of August 2011, CH2M HILL conducted roadway traffic counts at various locations along the Airport's roadway network. The observation period spanned 48 hours for 24 locations around the Airport, as depicted on **Exhibit 4-28**. These data were used to determine average weekday traffic, and peak hour demand at each location. These data represent an average busy day during the peak week. **Table 4-45** summarizes the traffic count data collected by CH2M HILL. For this analysis, Location 6 (Departures Curbside - Upper Level Ramp – Southbound) and Location 9 (Arrivals Curbside - Lower Level) are of particular interest as they represent the number of vehicles destined for both the Departures and Arrivals Curbsides. As shown in the table, the peak hour traffic crossing Location 6 occurs from 3:10 p.m. to 4:10 p.m. with 430 vehicles. The peak hour traffic crossing Location 9 occurs from 2:10 p.m. to 3:10 p.m. with 669 vehicles.

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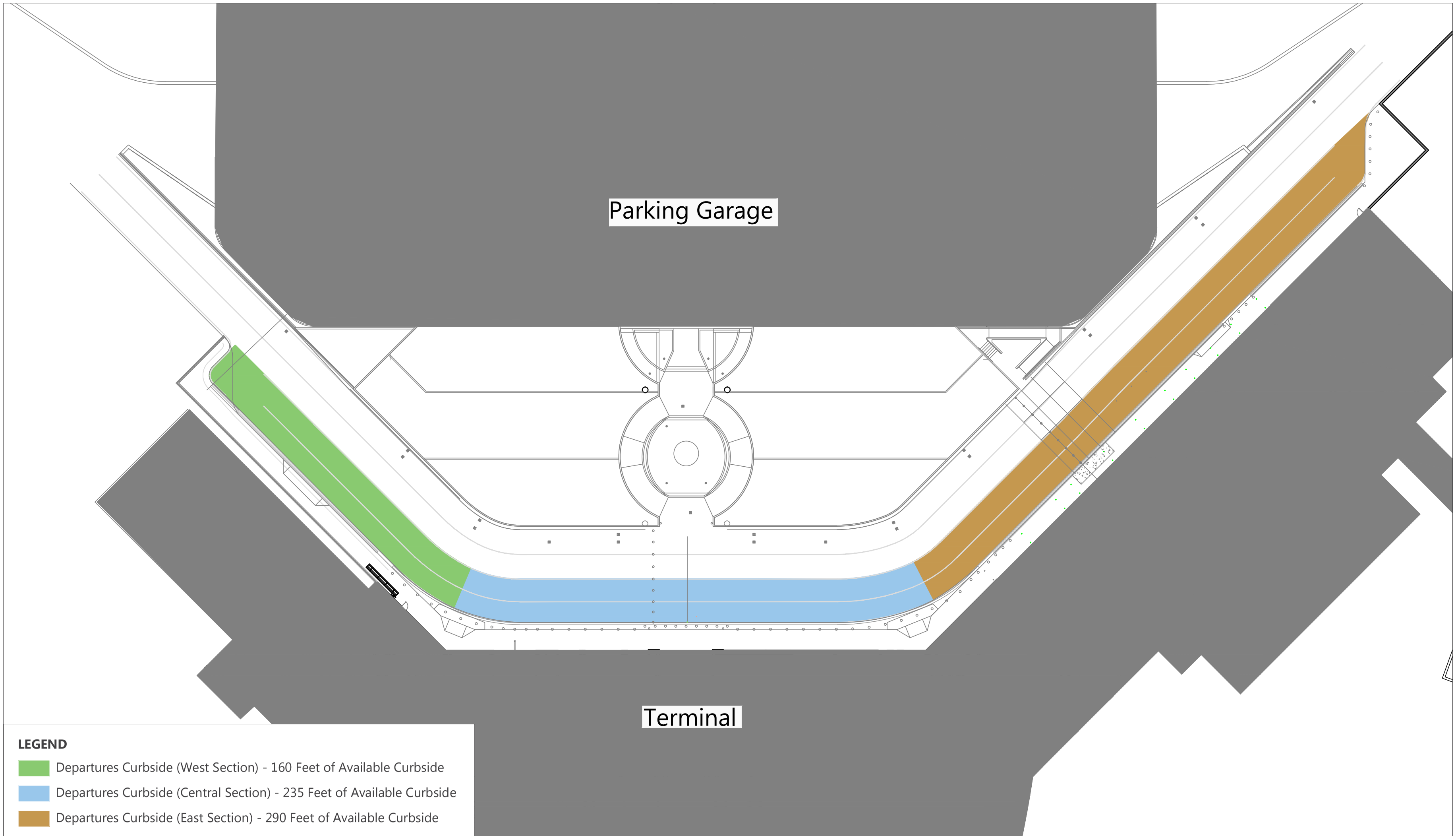

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 4-26

Departures Curbside (Upper Level)
Lanes Allocation

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\04_Chapter 4_Requirements\05_Ground Access\CAD\HOU Departures - Standard\HOU Departures.dwg_Layout: 8.5x11L_Dec 26, 2014, 12:41pm

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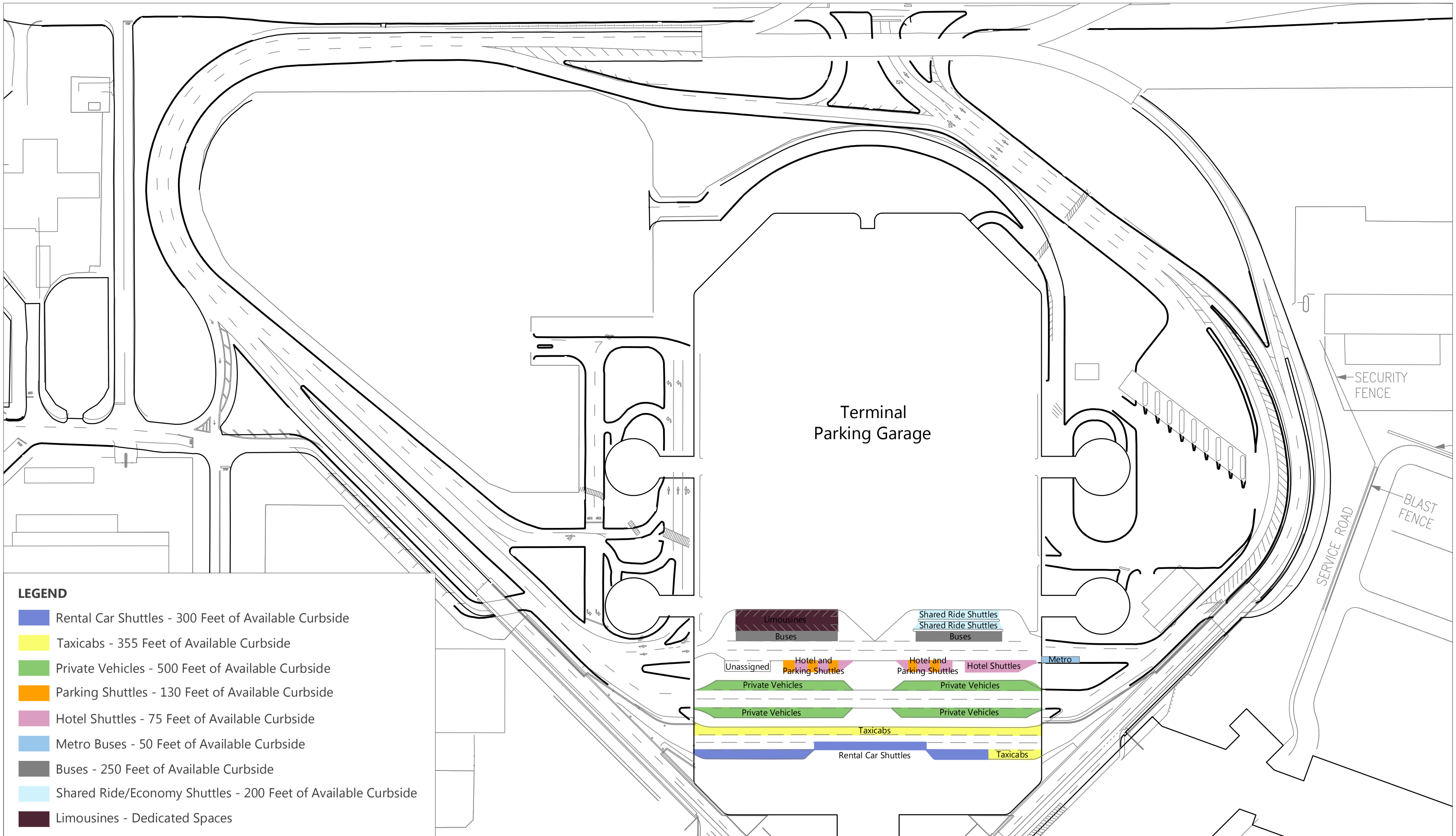

LEGEND

- Rental Car Shuttles - 300 Feet of Available Curbside
- Taxicabs - 355 Feet of Available Curbside
- Private Vehicles - 500 Feet of Available Curbside
- Parking Shuttles - 130 Feet of Available Curbside
- Hotel Shuttles - 75 Feet of Available Curbside
- Metro Buses - 50 Feet of Available Curbside
- Buses - 250 Feet of Available Curbside
- Shared Ride/Economy Shuttles - 200 Feet of Available Curbside
- Limousines - Dedicated Spaces

SOURCE: Houston Airport System; Ricondo & Associates, Inc., August 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 4-27

NORTH

0 Not to Scale

Arrivals Curbside (Lower Level) Lanes Allocation

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\04_Chapter 4_Requirements\05_Ground Access\CAD\HOU Arrivals - Standard\HOU Arrivals.dwg_Layout: 8.5x11L_Dec 26, 2014, 12:37pm

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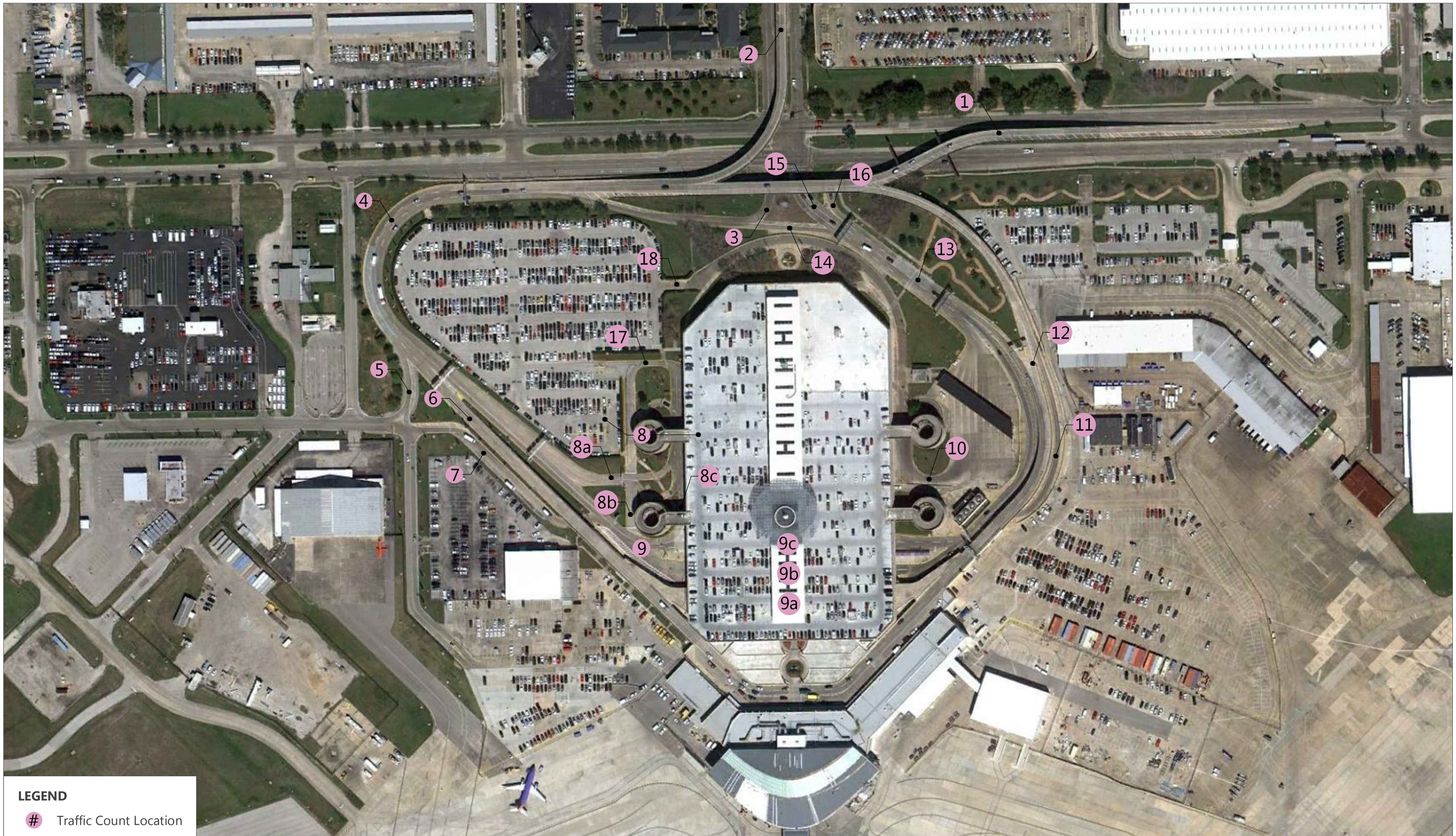

SOURCES: Google Earth Pro 2010; 2011 William P. Hobby Airport Peak Week Survey conducted by CH2M HILL, August 2011; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 4-28

NORTH 0 Not to Scale

Roadway Traffic Count Locations

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Table 4-45: HOU Roadway Traffic Count Averages and Peak Hours

LOCATION/DESCRIPTION		AVERAGE DAILY VEHICLES	AVERAGE A.M. PEAK		AVERAGE P.M. PEAK		AVERAGE WEEKLY VEHICLES 2/
			PEAK HOUR 1/	VEHICLES PER HOUR	PEAK HOUR 1/	VEHICLES PER HOUR	
1.	WB Airport Boulevard Terminal Loop Entrance - WB	6,017	11:40	374	13:50	395	40,113
2.	Broadway Street Terminal Loop Entrance - SB	3,388	11:50	224	13:30	242	22,587
3.	EB Airport Boulevard Terminal Loop Entrance - EB/SB	3,399	11:40	208	17:00	224	22,657
4.	Northwest Hobby Airport Loop Road - SB	17,980	11:50	1,132	14:10	1,226	119,863
5.	Exit Ramp to South Rental Car Road - SB	1,677	11:30	111	12:50	136	11,177
6.	Departures Curbside - Upper Level Ramp - SB	5,715	4:40	405	15:10	430	38,097
7.	South Rental Car Road Terminal Loop Entrance - SB	1,463	7:50	109	12:00	88	9,753
8.	Vehicle Entrances to Parking	2,560	6:00	197	12:00	157	17,067
	8a. Terminal Loop Entrance to Parking - EB	2,094	4:50	173	12:00	131	13,960
	8b. Terminal Loop 2nd Entrance to Parking - NB	1,174	11:50	112	14:00	138	7,823
	8c. Parking Ramp Exit to Terminal Loop - SB	708	11:50	85	13:30	128	4,717
9.	Arrivals Curbside (lower level)	9,492	11:20	636	14:10	669	63,277
	9a. Arrivals Lower Level Inner Curb (Private Vehicles) - EB	5,334	11:20	361	18:40	446	35,560
	9b. Arrivals Lower Level Shuttle (Taxicabs/Shuttles) - EB	2,386	11:30	175	13:00	173	15,903
	9c. Arrivals Lower Level (Busses and Shuttles) - EB	1,772	11:20	106	13:50	120	11,813
10.	Main Parking Exit to Terminal Loop - EB	2,643	11:40	156	19:40	296	17,617
11.	Ramp from Arrivals to Recirculate to Terminal - NB	1,734	11:10	121	18:30	150	11,557
12.	Ramp from Departures to Recirculate to Terminal - NB	1,221	11:40	89	13:50	107	8,140
13.	Northeast Hobby Airport Loop Road - NB	14,894	11:30	948	17:00	1,032	99,293
14.	Recirculation Access Road - EB	2,222	11:00	159	14:10	170	14,810
15.	Exit to Broadway Street / Airport Boulevard - NB	5,565	11:40	342	17:10	413	37,100
16.	Exit to EB Airport Boulevard - NB	7,456	11:30	477	13:10	495	49,703
17.	EcoPark - Lot 1 Entrance - WB	221	4:30	47	15:30	13	1,470
18.	EcoPark- Lot 1 Exit - EB	240	11:50	14	19:40	28	1,600

NOTES:

NB = Northbound, EB = Eastbound, SB = Southbound, and WB = Westbound.

1/ Denotes beginning of the average weekday peak hour. Peak hour based on average weighted peak over 2-day observation period.

2/ Values based on observations from two peak weekday vehicle counts weighted against number of flights. Rows may not add to totals shown because of rounding.

SOURCE: CH2M HILL, *William P. Hobby Peak Week Survey*, August 2011.
PREPARED BY: Ricondo & Associates, Inc., November 2012

4.3.1.3 Recirculating Traffic

Airports often have a significant amount of recirculating traffic at the Arrivals Curbside (lower level), as meeters/greeters choose to circle the terminal roadway while waiting for arriving passengers rather than parking or waiting in the cell phone waiting lot. The amount of recirculating traffic is directly influenced by the level of enforcement at the Arrivals Curbside (lower level). A conservative percentage of 20 percent of private vehicles was assumed to recirculate on the Arrivals Curbside (lower level). It was assumed that zero private vehicles on the Departures Curbside (upper level) would require recirculation.

4.3.1.4 Vehicle Classifications

Table 4-46 and **Table 4-47** summarize the vehicle classification data at the Departures Curbside (upper level) and Arrivals Curbside (lower level), respectively, collected during CH2M HILL's peak week survey in August 2011. The tables present the numbers of vehicles using each designated terminal curbside area. Private vehicles accounted for the largest share (approximately 71 percent) of vehicles accessing both curbsides. Other vehicles including rental car shuttles, taxicabs, parking shuttles, hotel shuttles, buses, economy/super shuttles, and service vehicles, accounted for the remaining vehicles accessing the curbsides during the survey period.

Table 4-46: Departures Curbside (Upper Level) - Level Peak Hour Vehicle Classification

VEHICLE TYPE	CLASSIFICATION PERCENTAGE	NUMBER OF VEHICLES 1/
Rental Car Shuttles	10.0%	43
Taxicabs	6.0%	26
Private Vehicles (Total) 2/	71.0%	---
Private Vehicles (To Curb)	71.0%	305
Private Vehicles (Recirculating)	0.0%	0
Parking Shuttles	10.0%	43
Hotel Shuttles	2.0%	9
METRO Buses	1.4%	6
Economy/Super Shuttles	0.3%	1
Limousines	0.0%	0
Service Vehicles 3/	1.4%	6
Total	**102.1% 4/**	**439**

NOTES:

1/ Departures Curbside (upper level) peak hour numbers based on tube count Location 6, from 3:10 p.m. to 4:10 p.m., 430 vehicles.

2/ Denotes all noncommercial and nongovernment sedans, minivans, pickup trucks, motorcycles, and sports cars.

3/ Includes police cars, fire trucks, tow trucks, etc.

4/ Values do not add to 100% due to rounding.

SOURCE: CH2M HILL, *William P. Hobby Peak Week Survey*, August 2011.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 4-47: Arrivals Curbside (Lower Level) - Peak Hour Vehicle Classification

VEHICLE TYPE	CLASSIFICATION PERCENTAGE	NUMBER OF VEHICLES[1/]
Rental Car Shuttles	10.0%	67
Taxicabs	6.0%	40
Private Vehicles (Total)[2/]	71.0%	---
Private Vehicles (To Curb)	56.8%	380
Private Vehicles (Recirculating)	14.2%	95
Parking Shuttles	10.0%	67
Hotel Shuttles	2.0%	13
METRO Buses	1.4%	9
Economy/Super Shuttles	0.3%	2
Limousines	0.0%	0
Service Vehicles[3/]	1.4%	9
Total	**102.1%** [4/]	**682**

NOTES:

1/ Arrivals Curbside (lower level) peak hour numbers based on tube count Location 9, from 2:10 p.m. to 3:10 p.m., 669 vehicles.

2/ Denotes all noncommercial and nongovernment sedans, minivans, pickup trucks, motorcycles, and sports cars.

3/ Includes police cars, fire trucks, tow trucks, etc.

4/ Values do not add to 100% due to rounding

SOURCE: CH2M HILL, *William P. Hobby Peak Week Survey*, August 2011.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

4.3.1.5 Dwell Times

As part of the data collection by CH2M HILL, the length of time each class of vehicle stopped at the curbsides was recorded. The average dwell times for each class of vehicle are presented in **Table 4-48** and **Table 4-49**. Average dwell times are based on peak hour traffic at the curbsides within the observation period of 8:00 a.m. to 12:00 p.m. and 3:00 p.m. to 5:40 p.m. on the Departures Curbside (upper level), and 11:00 a.m. to 2:00 p.m. and 6:00 p.m. to 9:00 p.m. on the Arrivals Curbside (lower level). Peak hours during the observation period were 9:30 a.m. to 10:30 a.m. and 3:10 p.m. to 4:10 p.m. on the Departures Curbside (upper level) and 11:20 a.m. to 12:20 p.m. and 6:40 p.m. to 7:40 p.m. on the Arrivals Curbside (lower level). As shown in Table 4-49, high dwell times were recorded for taxicabs, limousines, and economy shuttles at the Arrivals Curbside (lower level). Dwell times of this length are not typical; therefore, more typical dwell times for these modes were assumed for this Master Plan Update based on data for various large and medium hub airports in the United States. It was also assumed that, in the future, the higher demand and curbside utilization requirements will lead to enforcement of the curbside and, therefore, lower dwell times are expected.

Table 4-48: Departures Curbside (Upper Level) Average Dwell Times

VEHICLE TYPE	AVERAGE DWELL TIME (MINUTES)
Rental Car Shuttles	5.0
Taxicabs	2.2
Private Vehicles	2.0
Parking Shuttles	0.7
Hotel Shuttles	0.8
METRO Buses	- [1/]
Economy Shuttles	1.6
Limousines	2.3

NOTE:

1/ Buses do not operate on the departures level.

SOURCE: CH2M HILL, *William P. Hobby Peak Week Survey*, August 2011.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Table 4-49: Arrivals Curbside (Lower Level) Average Dwell Times

VEHICLE TYPE	AVERAGE DWELL TIME (MINUTES)
Rental Car Shuttles	5.0
Taxicabs	20.5 [1/]
Private Vehicles	1.0
Parking Shuttles	2.4
Hotel Shuttles	2.9
METRO Buses	0.4
Economy Shuttles	15.4 [2/]
Limousines	12.5 [3/]

NOTES:

1/ Dwell time of 2.0 minutes was used for the analysis.

2/ Dwell time of 5.0 minutes was used for the analysis.

3/ Dwell time of 2.0 minutes was used for analysis.

SOURCE: CH2M HILL, *William P. Hobby Peak Week Survey*, August 2011.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

4.3.2 BASELINE AND FUTURE YEAR AIRLINE PASSENGER ACTIVITY

Airline passenger data were used to develop a 24-hour profile of originating and terminating passengers at the curbsides. Numbers of arriving and departing passengers by flight were estimated for a typical busy day during the peak month. It was determined that 833 passengers landed at the Airport during the peak hour for arrivals and that 909 passengers departed from the Airport during the peak hour for departures. To determine the future peak hour passenger arrivals and departures, the same methodology was applied to future (2015, 2020, 2030) design day airline flight schedules. The estimated numbers of passengers during the respective peak hours are listed below:

- 2015 schedule – 1,024 arriving passengers; 1,062 departing passengers
- 2020 schedule – 1,208 arriving passengers; 1,343 departing passengers
- 2030 schedule – 1,566 arriving passengers; 1,610 departing passengers

Passenger show-up profiles (lead time before a flight departure and lag time after a flight arrival) were used to distribute the passenger data over the 24-hour period in 1-minute increments. Passenger walking distances between the terminal curbsides and the gates, the proportion of passengers checking bags at curbside, and baggage processing times were considered when estimating lead and lag times for passengers to arrive at the curbside.

4.3.3 FUTURE YEAR GROWTH RATES

Existing (2011) peak hour passenger numbers were used to estimate future (2015, 2020, 2030) design day peak hour passenger numbers. A scaling factor to convert from existing to future was calculated by dividing the number of future peak hour passengers by the number of existing peak hour passengers. **Table 4-50** presents the resulting growth rates. The vehicle counts from the existing conditions analysis were scaled by the same percentage of expected increases in Airport passenger arrivals and departures. Commercial vehicle modes were scaled at a lower rate under the assumption that they are higher occupancy vehicles and would require a larger demand before adding vehicles to their service. These vehicles were scaled 5.0 percent, 10.0 percent, and 15.0 percent for 2015, 2020, and 2030, respectively.

Table 4-50: Peak Hour Passengers and Growth Rates

	DEPARTURES		ARRIVALS	
YEAR	PEAK HOUR PASSENGERS	ANNUAL GROWTH RATE	PEAK HOUR PASSENGERS	ANNUAL GROWTH RATE
2011 1/	909	-	833	-
2012	945	4.0%	877	5.3%
2013	982	4.0%	924	5.3%
2014	1,021	4.0%	973	5.3%
2015 1/	1,062	4.0%	1,024	5.2%
2016	1,113	4.8%	1,058	3.4%
2017	1,167	4.8%	1,093	3.4%
2018	1,223	4.8%	1,130	3.4%
2019	1,282	4.8%	1,168	3.4%
2020 1/	1,343	4.8%	1,208	3.4%
2021	1,368	1.8%	1,239	2.6%
2022	1,393	1.8%	1,272	2.6%
2023	1,419	1.8%	1,306	2.6%
2024	1,445	1.8%	1,340	2.6%
2025	1,471	1.8%	1,375	2.6%
2026	1,498	1.8%	1,411	2.6%
2027	1,525	1.8%	1,448	2.6%
2028	1,553	1.8%	1,486	2.6%
2029	1,581	1.8%	1,525	2.6%
2030 1/	1,610	1.9%	1,566	2.7%
	DEPARTURES GROWTH RATES		ARRIVALS GROWTH RATES	
2011 to 2015	16.8%		23.0%	
2015 to 2020	26.5%		17.9%	
2015 to 2030	51.7%		53.0%	

NOTE:

1/ Numbers of passengers based on airline design day flight schedules.

SOURCES: CH2M HILL, *William P. Hobby Airport Peak Week Survey* (distributions), 2011; Ricondo & Associates, Inc. (schedules), November 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

4.3.4 EXISTING TERMINAL CURBSIDE DEMAND

Using the methodology and data presented in the previous sections, a curbside model was developed to estimate peak hour curbside requirements. Peak hour traffic combined with average dwell times by vehicle classification were used to estimate the demand for curbside length at the Departures and Arrivals Curbsides.

To account for non-uniform arrival rates during the peak hour, a statistical surge factor is applied based on a Poisson arrivals distribution. The Poisson distribution is a discrete frequency distribution that derives the probability of a number of independent events occurring in a fixed time. The number of occupied "slots" or space requirements during the peak hour is then estimated. The estimated space requirements are then multiplied by the average length of one vehicle (including a buffer to represent the maneuvering space between two parked vehicles and lost spaces resulting from parking inefficiencies) to determine the demand for curbside frontage in linear feet.

Curbside demand is a theoretical measurement of the peak accumulation of vehicles waiting at the curbside if such vehicles were aligned nose-to-tail in a single queue. A curbside utilization factor is derived for existing conditions, which is the calculated ratio of curbside demand (measured in linear feet) divided by the existing curbside length. The utilization factor provides an indication of the amount of single, double, and triple parking that would result for a given period and demand level. Finally, a level of service associated with a given utilization rate is determined. In calculating the LOS for each curbside area, it is recognized that vehicles are not parked uniformly along the curbside.

The curbside utilization factor is an indicator of the amount of congestion at the curbside as well as the resulting LOS. For example, low utilization indicates that vehicles are easily accommodated along the inner lane without the need to double park. This utilization rate would equate to a desirable curbside operating condition (e.g., LOS A or B). Conversely, a high utilization rate would equate to double and triple parking along the curbside, restricting vehicle movements and resulting in a poor operating condition (e.g., LOS E or F). Each condition is graphically depicted on **Exhibit 4-29**.

There are two variations of utilization ranges: single and double loading curbsides. Single loading consists of one designated loading/unloading lane, with one or more adjacent lanes for bypassing traffic. Double loading consists of one wide lane, or two lanes, designated for loading/unloading, with adjacent lanes for bypassing traffic. For this analysis, the Departures Curbside (upper level) was analyzed using double loading criteria. All Arrivals Curbside (lower level) areas were analyzed using single loading criteria. Curbside LOS for single and double loading utilization ranges are defined in **Table 4-51**.

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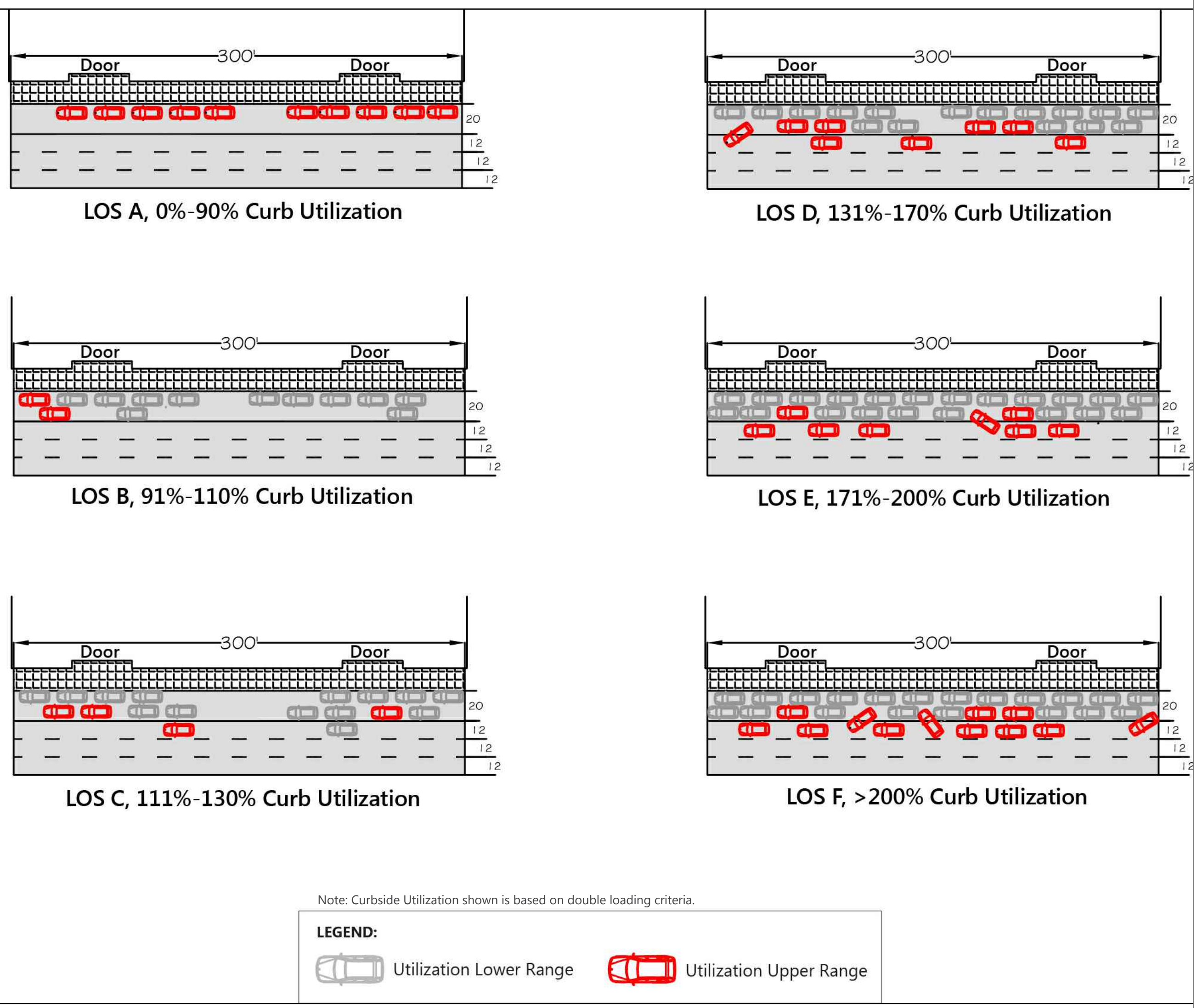

SOURCE: Ricondo & Associates, Inc. based on information published by the Transportation Research Board and Federal Aviation Administration Advisory Circular 150/5360-13, Planning and Design Guidelines for Airport Terminal Facilities, April 22, 1988.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 4-29

NORTH 0 Not to Scale

Curbside Utilization Level of Service Ranges

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Table 4-51: Curbside Level of Service Utilization Ranges

	UTILIZATION RANGES		
LOS	**SINGLE LOADING**	**DOUBLE LOADING**	**DESCRIPTION**
A	0% - 70%	0% - 90%	Excellent: Drivers experience no interference from pedestrians or other motorists
B	71% - 85%	91% - 110%	Very Good: Relatively free flow conditions with limited double parking
C	86% - 100%	111% - 130%	Good: Double parking near doors is common with some intermittent triple parking
D	101% - 115%	131% - 170%	Fair: Vehicle maneuverability restricted due to frequent double/triple parking
E	116% - 130%	171% - 200%	Poor: Significant delays and queues; double/triple parking throughout curbside
F	> 130%	> 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.

SOURCES: Ricondo & Associates, Inc., November 2012 based on information published by the Transportation Research Board and Federal Aviation Administration Advisory Circular 150/5360-13, Planning and Design Guidelines for Airport Terminal Facilities, April 22, 1988.

PREPARED BY: Ricondo & Associates, Inc., November 2012.

LOS C is generally considered acceptable for peak period operations at major airports during most days of the year. LOS D may be acceptable during peak seasonal periods.

Table 4-52 provides a summary of existing (2011) curbside demand, supply, and LOS at the Airport. As shown, all sections of the Departures Curbside (upper level) are estimated to operate at LOS D. The west section, adjacent to Southwest Airlines' ticketing, is estimated to operate at 156 percent utilization during the departures peak hour. The central section, which accommodates both Southwest Airlines and the other airlines, is estimated to operate at 170 percent utilization. The east section, accommodating the other airlines and commercial vehicles, is estimated to operate at 131 percent utilization. As shown in the table, the outer lane of the Arrivals Curbside (lower level), which accommodates parking shuttles (135 percent utilization), is estimated to operate at LOS F during the arrivals peak hour, while the inner roadway, which accommodates rental car shuttles, is estimated to operate at LOS D (105 percent utilization). The outer roadway, which accommodates hotel shuttles (93 percent utilization) and METRO buses (100 percent utilization), is estimated to operate at LOS C. The curbside areas that accommodate the remaining modes—taxicabs (21 percent utilization) on the inner roadway, private vehicles (50 percent utilization) on the center roadway, and shared ride/economy vans on the outer roadway (18 percent utilization)—are estimated to operate at LOS A.

Table 4-52: Existing (2011) Curbside Requirements

	EXISTING AVAILABLE LENGTH (LINEAR FEET)	UTILIZED LENGTH (LINEAR FEET)	UTILIZATION	LOS	OPTIMAL LOS C LENGTH (LINEAR FEET)	SURPLUS/ (DEFICIT) FOR LOS C (LINEAR FEET)
	[A]	[B]	[B]/[A]		[D]	[D]-[A]
Departures Curbside (upper level)						
West Section	160	250	156%	D	192	(32)
Central Section	235	400	170%	D	308	(73)
East Section	290	380	131%	D	292	(2)
Arrivals Curbside (lower level) - Inner Roadway						
Rental Car Shuttles	300	315	105%	D	315	(15)
Taxicabs	355	75	21%	A	75	280
Arrivals Curbside (lower level) - Center Roadway						
Private Vehicles	500	250	50%	A	250	250
Arrivals Curbside (lower level) - Outer Roadway						
Parking Shuttles	130	175	135%	F	175	(45)
Hotel Shuttles	75	70	93%	C	70	5
METRO Buses	50	50	100%	C	50	0
Shared Ride/Economy Vans	200	35	18%	A	35	165

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

4.3.5 FUTURE TERMINAL CURBSIDE DEMAND

Table 4-53 summarizes the curbside requirements at the Airport in 2015. As shown, the west section of the Departures Curbside (upper level) is estimated to operate at LOS E (172 percent utilization) during the departures peak hour. The central section is estimated to operate at LOS D (170 percent utilization), and the east section is also estimated to operate at LOS D (131 percent utilization). Although a slight increase in activity is estimated at the central and east sections, it is not large enough to require additional length along the curbside based on the Poisson distribution model. One area of the Arrivals Curbside (lower level), which would accommodate parking shuttles (162 percent utilization), is estimated to operate at LOS F during the arrivals peak hour. The inner roadway, which would accommodate rental car shuttles (105 percent utilization), is estimated to operate at LOS D, while the outer roadway, which would accommodate hotel shuttles (93 percent utilization) and METRO buses (100 percent utilization), is estimated to operate at LOS C. The curbside areas that would accommodate the remaining modes—taxicabs (28 percent utilization) on the inner roadway, private vehicles (55 percent utilization) on the center roadway, and shared ride/economy vans (18 percent utilization) on the outer roadway—are estimated to operate at LOS A.

Table 4-53: Future (2015) Curbside Requirements

	EXISTING AVAILABLE LENGTH (LINEAR FEET)	UTILIZED LENGTH (LINEAR FEET)	UTILIZATION	LOS	OPTIMAL LOS C LENGTH (LINEAR FEET)	SURPLUS/ (DEFICIT) FOR LOS C (LINEAR FEET)
	[A]	[B]	[B]/[A]		[D]	[D]-[A]
Departures Curbside (upper level)						
West Section	160	275	172%	E	212	(52)
Central Section	235	400	170%	D	308	(73)
East Section	290	380	131%	D	292	(2)
Arrivals Curbside (lower level) - Inner Roadway						
Rental Car Shuttles	300	315	105%	D	315	(15)
Taxicabs	355	100	28%	A	100	255
Arrivals Curbside (lower level) - Center Roadway						
Private Vehicles	500	275	55%	A	275	225
Arrivals Curbside (lower level) - Outer Roadway						
Parking Shuttles	130	210	162%	F	210	(80)
Hotel Shuttles	75	70	93%	C	70	5
METRO Buses	50	50	100%	C	50	0
Shared Ride/Economy Vans	200	35	18%	A	35	165

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

Table 4-54 summarizes the curbside requirements at the Airport in 2020. As shown, the west section of the Departures Curbside (upper level) is estimated to operate at LOS F (219 percent utilization) during the departures peak hour. The central section is estimated to operate at LOS E (191 percent utilization), and the east section is estimated to operate at LOS D (152 percent utilization). The outer roadway on the Arrivals Curbside (lower level), which would accommodate parking shuttles (162 percent utilization), is estimated to operate at LOS F during the arrivals peak hour. The inner roadway, which would accommodate rental car shuttles (117 percent utilization), is estimated to operate at LOS E, and the outer roadway, which would accommodate hotel shuttles (93 percent utilization) and METRO buses (100 percent utilization), is estimated to operate at LOS C. The curbside areas that would accommodate the remaining modes—taxicabs (28 percent utilization) on the inner roadway, private vehicles (70 percent utilization) on the center roadway, and shared ride/economy vans (18 percent utilization) on the outer roadway—are estimated to operate at LOS A. As stated above, curbside utilizations remain similar to that in previous analysis years because of only slight vehicle growth factors used in combination with the Poisson distribution model.

Table 4-54: Future (2020) Curbside Requirements

	EXISTING AVAILABLE LENGTH (LINEAR FEET)	UTILIZED LENGTH (LINEAR FEET)	UTILIZATION	LOS	OPTIMAL LOS C LENGTH (LINEAR FEET)	SURPLUS/ (DEFICIT) FOR LOS C (LINEAR FEET)
	[A]	[B]	[B]/[A]		[D]	[D]-[A]
Departures Curbside (upper level)						
West Section	160	350	219%	F	269	(109)
Central Section	235	450	191%	E	346	(111)
East Section	290	440	152%	D	338	(48)
Arrivals Curbside (lower level) - Inner Roadway						
Rental Car Shuttles	300	350	117%	E	350	(50)
Taxicabs	355	100	28%	A	100	255
Arrivals Curbside (lower level) - Center Roadway						
Private Vehicles	500	350	70%	A	350	150
Arrivals Curbside (lower level) - Outer Roadway						
Parking Shuttles	130	210	162%	F	210	(80)
Hotel Shuttles	75	70	93%	C	70	5
METRO Buses	50	50	100%	C	50	0
Shared Ride/Economy Vans	200	35	18%	A	35	165

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

Table 4-55 summarizes the curbside requirements at the Airport in 2030. As shown, the west and central sections of the Departures Curbside (upper level) are estimated to operate at LOS F (234 percent utilization and 228 percent utilization, respectively) during the departures peak hour. The east section is estimated to operate at LOS E (172 percent utilization). As shown in the table, the outer roadway on the Arrivals Curbside (lower level), which accommodates parking shuttles (162 percent utilization), is estimated to operate at LOS F during the arrivals peak hour in 2030. The inner roadway, which would accommodate rental car shuttles (117 percent utilization), is estimated to operate at LOS E, and the outer roadway, which would accommodate hotel shuttles (93 percent utilization) and METRO buses (100 percent utilization), is estimated to operate at LOS C. The center roadway, which would accommodate private vehicles (80 percent utilization), is estimated to operate at LOS B while the curbside areas that would accommodate the remaining modes—taxicabs (35 percent utilization) on the inner roadway and shared ride/economy vans (18 percent utilization) on the outer roadway—are estimated to operate at LOS A. Similar to previous requirement years, the slight change in activity coinciding with the Poisson distribution model shows that additional curbside length would not be required for certain modes.

Table 4-55: Future (2030) Curbside Requirements

	EXISTING AVAILABLE LENGTH (LINEAR FEET)	UTILIZED LENGTH (LINEAR FEET)	UTILIZATION	LOS	OPTIMAL LOS C LENGTH (LINEAR FEET)	SURPLUS/ (DEFICIT) FOR LOS C (LINEAR FEET)
	[A]	[B]	[B]/[A]		[D]	[D]-[A]
Departures Curbside (upper level)						
West Section	160	375	234%	F	288	(128)
Central Section	235	535	228%	F	412	(177)
East Section	290	500	172%	E	385	(95)
Arrivals Curbside (lower level) - Inner Roadway						
Rental Car Shuttles	300	350	117%	E	350	(50)
Taxicabs	355	125	35%	A	125	230
Arrivals Curbside (lower level) - Center Roadway						
Private Vehicles	500	400	80%	B	400	100
Arrivals Curbside (lower level) - Outer Roadway						
Parking Shuttles	130	210	162%	F	210	(80)
Hotel Shuttles	75	70	93%	C	70	5
METRO Buses	50	50	100%	C	50	0
Shared Ride/Economy Vans	200	35	18%	A	35	165

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

4.3.6 CONCLUSION

Table 4-56 presents a comparison of the utilized lengths and utilization percentages, along with surplus/deficit lengths, for 2011, 2015, 2020, and 2030 in accordance with LOS C criteria. As depicted in the table, the west section of the Departures Curbside (upper level) shows an initial deficit of 32 linear feet in 2011, increasing to a deficit of 128 feet by 2030. The central section is estimated to operate at a deficit of 73 feet in 2011, increasing to a deficit of 177 feet by 2030. The east section is estimated to operate at a deficit of 2 feet in 2011, increasing to a deficit of 95 feet by 2030. The Arrivals Curbsides (lower level) show two areas operating at a deficit in 2011, the inner roadway that accommodates rental car shuttles (15 feet) and the outer roadway that accommodates parking shuttles (45 feet). These deficits are estimated to increase to 50 feet and 80 feet, respectively, by 2030. All curbside areas that would accommodate other modes—taxicabs (inner roadway), private vehicles (center roadway), and hotel shuttles, METRO buses, and shared ride/economy vans (outer roadway)—are estimated to operate at a surplus through 2030.

Table 4-56: Curbside Requirements Summary

	EXISTING AVAILABLE LENGTH (LINEAR FEET)	UTILIZED LENGTH (LINEAR FEET)				UTILIZATION PERCENTAGE (LOS)				OPTIMAL LENGTH FOR LOS C (LINEAR FEET)				SURPLUS/(DEFICIT) FOR LOS C (LINEAR FEET)			
		2011	2015	2020	2030	2011	2015	2020	2030	2011	2015	2020	2030	2011	2015	2020	2030
Departures Curbside (Upper Level)																	
West Section	160	250	275	350	375	156% (D)	172% (E)	219% (F)	234% (F)	192	212	269	288	(32)	(52)	(109)	(128)
Central Section	235	400	400	450	535	170% (D)	170% (D)	191% (E)	228% (F)	308	308	346	412	(73)	(73)	(111)	(177)
East Section	290	380	380	440	500	131% (D)	131% (D)	152% (D)	172% (E)	292	292	338	385	(2)	(2)	(48)	(95)
Arrivals Curbside (Lower Level) -Inner Roadway																	
Rental Car Shuttles	300	315	315	350	350	105% (D)	105% (D)	117% (E)	117% (E)	315	315	350	350	(15)	(15)	(50)	(50)
Taxicabs	355	75	100	100	125	21% (A)	28% (A)	28% (A)	35% (A)	75	100	100	125	280	255	255	230
Arrivals Curbside (Lower Level) - Center Roadway																	
Private Vehicles	500	250	275	350	400	50% (A)	55% (A)	70% (A)	80% (B)	250	275	350	400	250	225	150	100
Arrivals Curbside (Lower Level) - Outer Roadway																	
Parking Shuttles	130	175	210	210	210	135% (F)	162% (F)	162% (F)	162% (F)	175	210	210	210	(45)	(80)	(80)	(80)
Hotel Shuttles	75	70	70	70	70	93% (C)	93% (C)	93% (C)	93% (C)	70	70	70	70	5	5	5	5
METRO Buses	50	50	50	50	50	100% (C)	100% (C)	100% (C)	100% (C)	50	50	50	50	0	0	0	0
Shared Ride/ Economy Vans	200	35	35	35	35	18% (A)	18% (A)	18% (A)	18% (A)	35	35	35	35	165	165	165	165

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

4.4 Airport Ground Access Requirements

4.4.1 STUDY AREA

As shown on **Exhibit 4-30**, the study area for the roadway analysis included the public access roadways on Airport property, as well as selected off-Airport intersections in the immediate vicinity of the Airport. The study area is bounded by Airport Boulevard to the north, Telephone Road to the west, and Monroe Road to the east. The analysis also includes Broadway Street, which provides access to the Airport from the north.

4.4.1.1 Roadways

The study area roadways consist of both off-Airport roadways that provide vehicular access to and from the Airport and on-Airport roadways that provide direct access and egress from the terminal curbsides and parking facilities.

Off-Airport Roadways

Off-Airport roadways included in the study area were limited to the public roadways on the Airport's northern boundary. The principal off-Airport roadways in the study area include the following:

- **Airport Boulevard:** This east/west roadway consists of three lanes in each direction separated by a raised median and generally forms the northern boundary of the Airport.
- **Telephone Road:** This north/south roadway consists of three lanes in each direction separated by a raised median and generally forms the western boundary of the Airport.
- **Monroe Road:** This north/south roadway consists of three lanes in each direction separated by a raised median and generally forms the eastern boundary of the Airport.
- **Broadway Street:** This north/south roadway consists of two lanes in each direction separated by a raised median. Access to the Airport from the north is provided via a grade-separated ramp; egress from the Airport to the north is provided via the intersection of Broadway Street and Airport Boulevard.

On-Airport Roadways

The on-Airport roadways are characterized by an access loop roadway, the Hobby Airport Loop, which serves as a connector to the Airport terminal curbsides, parking facilities, and other Airport facilities from off-Airport roadways. The Hobby Airport Loop splits into the Upper Level roadway, which is grade-separated and serves the Departures Curbside (i.e., upper level), and the Lower Level roadway, which is at grade and serves the Arrivals Curbside (i.e., lower level), as well as the commercial vehicle curbside and parking facilities. The Hobby Airport Loop also serves as the Airport exit and provides two return ramps for recirculation to the terminal and parking facilities.

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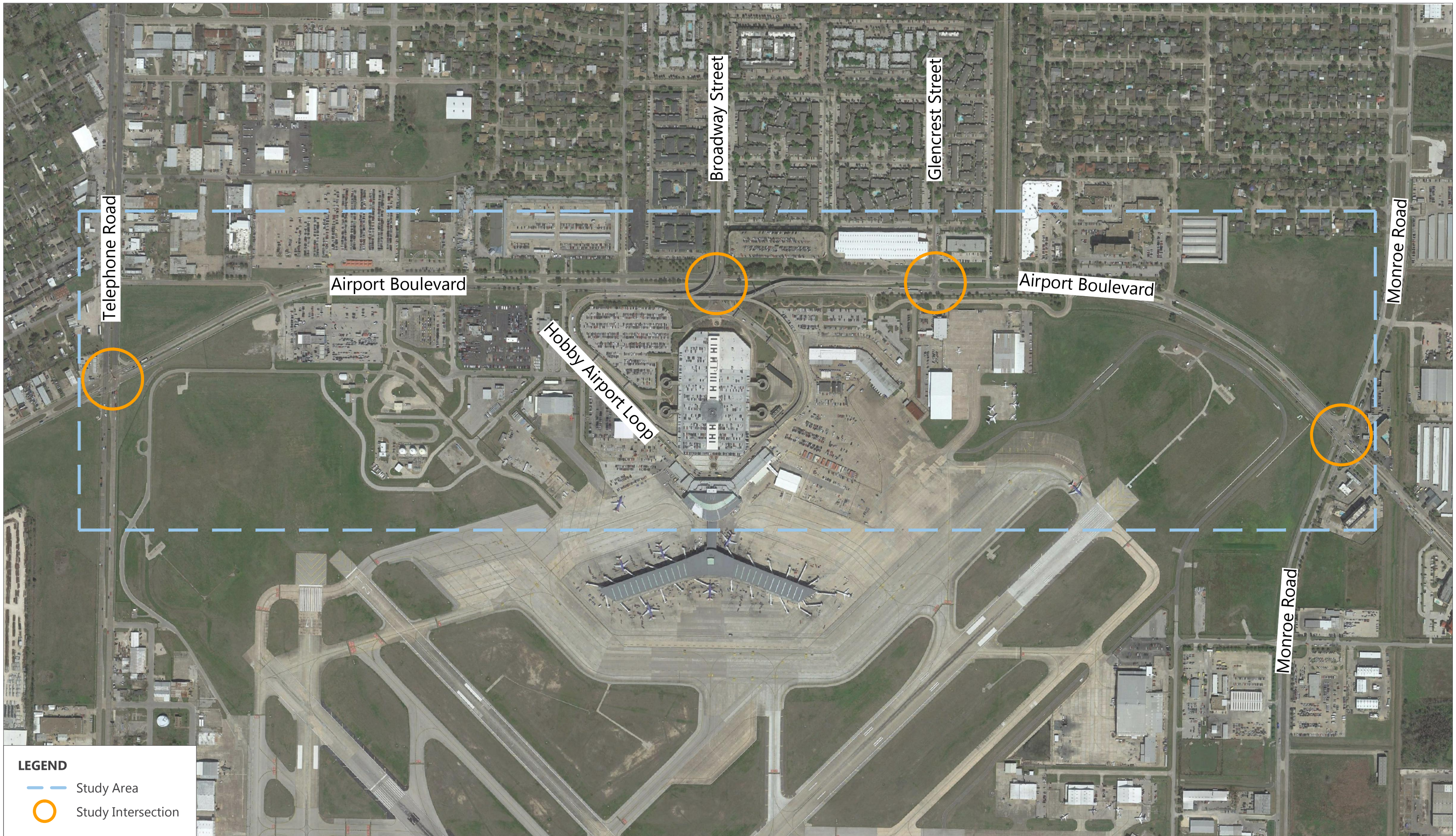

SOURCES: Google Earth Pro 2010; Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 4-30

NORTH 0 Not to Scale

Roadway Network and Study Area

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- **Upper Level Roadway (Departures):** The Upper Level roadway, shown on Exhibit 4-26, consists of four lanes with a striped median separating the two inner lanes from the two outer lanes. The roadway has a posted speed of 15 miles per hour (mph). A 20-foot-wide crosswalk located near the center of the roadway accommodates pedestrians travelling between the terminal and the parking garage. A stop sign located prior to the crosswalk provides added safety for pedestrians using the crosswalk. Available data suggest that some private vehicles dwell (i.e., remain stopped for a short period of time with the driver in the vehicle) in the vicinity of the stop sign while dropping off passengers. For this analysis, this behavior was ignored and all vehicles were assumed to dwell in the lanes adjacent to the curbside, outside of the crosswalk area. During the development of this analysis, HAS enacted a policy change requiring all commercial service vehicles dropping off passengers on the Departures Curbside to stop east of the crosswalk. This operational change was not incorporated into this analysis.

  Southwest Airlines' curbside check-in counters are located on the southern portion of the curbside immediately west of the crosswalk, as depicted on Exhibit 4-26. Observations and data show that most Southwest Airlines passengers are dropped off on the western portion of the curbside because of the easy access to Southwest Airlines' curbside check-in, as well as the check-in counters located in the Terminal. The total usable length of the curbside west of the crosswalk is approximately 250 feet. The eastern portion of the curbside, located after the crosswalk, provides approximately 640 feet of usable length for passengers of all other airlines serving the Airport. Similar to operations on the western portion of the curbside, passengers are typically dropped off in this location because of the proximity to the check-in facilities for Delta Air Lines, American Airlines, AirTran Airways, and JetBlue Airways, located in this area. The eastern portion of the curbside also serves as an overflow for Southwest Airlines' passengers.

  The Departures Curbside serves private vehicles, taxicabs, limousines, parking shuttles, rental car shuttles, commercial buses, and service vehicles. Some commercial vehicles drop passengers off on the Departures Curbside prior to picking up passengers on the Arrivals Curbside. This dual-level commercial vehicle operation was modeled in the analysis to replicate vehicle travel routes and provide a conservative estimate of curbside roadway congestion.

  Vehicles on the Upper Level roadway can use one of the two ramps at the end of the curbside roadway to exit the terminal area. A two-lane exit section forks into two ramps, consisting of one lane each. One exit ramp leads to an at-grade roadway that leads to the intersection of Airport Boulevard and Broadway Street, while the other exit ramp loops around the Airport above grade to provide return access to the terminal. Commercial vehicles dropping off passengers on the Departures Curbside and picking up passengers on the Arrivals Curbside are expected to use the above-grade return ramp. Taxicabs destined for the taxicab staging area along South Rental Car Road are also expected to use this ramp.

- **Lower Level Roadway (Arrivals):** As shown on Exhibit 4-27, the Lower Level roadway consists of three curbsides: inner, middle, and outer. It has a posted speed limit of 15 mph. The inner curbside, located immediately adjacent to the baggage claim facilities, is four lanes wide, with the right-side-loading curbside lane split into two sections. The first section is approximately 100 feet long and allocated to rental car shuttles, while the second section is allocated to taxicabs. The lane furthest from the Terminal is also used by taxicabs and operates with left-side loading. In total, approximately 425 linear feet are allocated for taxicab pickup. Taxicabs are considered a managed mode; the arrival rate of taxicabs is controlled so that the number of taxicabs at the curbside never exceeds the available capacity of the curbside. The middle two lanes are bypass lanes for traffic exiting, or bypassing, the curbsides.

  The middle curbside is designated exclusively for private vehicles picking up passengers. The middle two lanes serve as bypass and maneuvering lanes. The inner and outer lanes, defined as the right-most lane and the left-most lane, are allocated for passenger pickup. These pickup lanes are divided into two sections with a curb protrusion in the midsection. A total of 500 linear feet is allocated for passenger pickup on the inner and outer curbsides.

  The outer curbside is adjacent to the ground level of the parking garage. This roadway consists of two bypass lanes. A pedestrian aisle on the right-hand side of the direction of traffic has curbside cutouts allocated for parking and hotel courtesy shuttles. At the end of the curbside, an area is allocated for METRO buses to pick up passengers. The parking shuttles are allocated 130 linear feet of curb front, the hotel shuttles are allocated 75 linear feet of curb front, and the METRO bus is allocated 50 linear feet of curb front. On the left-hand side, adjacent to the ground level of the parking garage, limousines, charter buses, and shared ride vans are allocated curbside space for passenger pickup.

  Limousines park in pull in/reverse out spaces and shared ride vans park at auxiliary curbsides, as shown on Exhibit 4-27. Charter buses are allocated parking spaces in the aisles adjacent to the limousine area, as well as in the shared ride van spaces at the curbsides. Charter buses are allocated approximately 260 linear feet of curbside. Shared ride vans are allocated approximately 200 linear feet of curbside. A total of 19 positions are available for limousine parking.

  All Lower Level roadway lanes exit into a two-lane exit roadway, which, in turn, splits into two ramps, one lane each. One of the ramps traverses under the Upper Level roadway and joins the Upper Level above-grade return-to-Airport ramp. The other ramp leads to the Airport exit.

4.4.1.2 Off-Airport Roadway Intersections

Discussions with stakeholders at the initiation of the master planning process identified three key roadway intersections to be analyzed. These intersections are all located along the northern boundary of the Airport and are the primary intersections used by vehicles accessing the Airport. The three intersections evaluated are as follows.

- **Airport Boulevard and Broadway Street:** This intersection serves as the primary access to and egress from the Airport. It is a four-legged signalized intersection, with traffic exiting the Airport from the southern leg of the intersection. Vehicles from the north and east use an above-grade flyover to access the Airport, while vehicles from the west access the Airport via a right-turn lane at the western leg of the intersection. The eastern and western legs of the intersection consist of three lanes in each direction separated by a raised median, with a channelized right-turn bay and an auxiliary left-turn lane on the western leg, and two through lanes with a shared through-right lane on the eastern leg of the intersection. The northern leg of the intersection consists of two left-turn lanes and one right-turn lane. The southern leg of the intersection consists of one through lane, one shared through-left lane, and a dedicated left-turn lane in addition to a channelized right-turn lane.

- **Airport Boulevard and Telephone Road:** The intersection of Airport Boulevard and Telephone Road is a four-legged signalized intersection located west of the Airport. The northern and southern legs of the intersection consist of one shared through-right lane, two through lanes, and one auxiliary left-turn lane. The eastern and western legs of the intersection consist of a channelized right-turn lane, two through lanes, and an auxiliary left-turn lane.
- **Airport Boulevard and Monroe Road:** The intersection of Airport Boulevard and Monroe Road is a four-legged signalized intersection located east of the Airport. The southern leg of the intersection consists of one shared through-right lane, two through lanes, and one auxiliary left-turn lane. The northern leg of the intersection consists of a channelized right-turn lane with two through lanes and an auxiliary left-turn lane. The eastern and western legs of the intersection consist of one shared through-right lane, two through lanes, and an auxiliary left-turn lane.

4.4.2 ROADWAY ANALYSIS AND REQUIREMENTS

4.4.2.1 Methodology

General Analysis Methodology

A trip generation and assignment model was developed to represent terminal area roadway traffic and numbers of passengers using the terminal area on a typical Friday in April 2011 (referred to as "existing conditions" for purposes of this analysis). This model includes the terminal area roadways and curbsides. The model development process is generally summarized as follows:

- **Airport Roadway Model:** The first step in the modeling process was to develop a spreadsheet representing the physical layout of the Airport roadway system and features that generate or accommodate ground transportation. Key components of the Airport Roadway Model include the curbsides, all roadway links, parking facilities, rental car facilities, and ground transportation staging areas, among others. The Airport Roadway Model must accurately depict the roadway geometry, including the number of lanes provided under existing and future roadway conditions.
- **Trip Generation:** The next step in the modeling process was to generate ground transportation trips accessing the Airport. This trip generation module was used to convert numbers of airline passengers to vehicular traffic. Using vehicle mode share data obtained from *Methods, Assumptions and Performance Specifications* prepared by TransSolutions in May 2011, the number of vehicles at the curbsides during the Airport peak hour for O&D passengers was computed for each vehicle mode (e.g., private vehicles, taxicabs, limousines, rental car shuttles). Ranges for average vehicle occupancy data in the TransSolutions' report were then multiplied by the peak hour number of airline passengers

by mode to calculate the estimated numbers of vehicles by mode accommodating airline passengers during the peak hour. In addition to vehicle trips generated directly by airline passenger activity, the trip generation process also accounts for vehicles operating on predetermined schedules or headways (e.g., parking shuttles, transit buses) and other nonpassenger-related vehicles using the terminal area roadways (e.g., employee vehicles, employee parking lot shuttles, and other service vehicles).

- **Trip Distribution:** The Airport Roadway Model also contains a trip distribution module used to assign the traffic calculated by the trip generation module to the overall terminal area roadway system. Each vehicle mode using the Airport has unique circulation patterns. For example, a private vehicle containing meeters/greeters may enter the Airport, travel past the arrivals curbside while looking for the arriving passenger(s), recirculate around the terminal loop roadway, return to pick up the passenger(s) on the arrivals curbside, and then exit the Airport. During this step of the modeling process, the trips generated by the Airport's various ground transportation modes were assigned to the roadway network based on the many unique travel paths associated with each vehicle mode. The model was then used to calculate the total and peak hour traffic using the various roadway links throughout the Airport.

  Terminal area routes by mode type were determined based on observed curbside use patterns, known lane restrictions (e.g., the Arrivals Curbside inner lane is restricted to taxicab and rental car shuttle use only), data from automatic traffic recorder counts (i.e., tube counts), lane use patterns, mode share information, and/or the logical path or diversions based on the "path of least resistance."

  Vehicle trips were estimated for all key segments within the terminal area curbside roadway system, corresponding with the balancing of traffic on the roadway network, as derived from the *2011 William P. Hobby Airport Peak Week Survey* by CH2M HILL.

- **Model Calibration:** Prior to using the Airport Roadway Model to estimate vehicle trips and conduct the operational analysis, it is necessary to calibrate the model to ensure that the results reliably predict actual traffic conditions. The Airport Roadway Model was calibrated by adjusting and refining key assumptions pertaining to vehicle occupancy, route assignments, and other variables. The goal of calibrating the Airport Roadway Model is to match traffic on key roadway links within an acceptable level of accuracy (generally +/-10 percent for primary roadway links) compared with the traffic from the balanced roadway network in 2011. This calibration process was performed for both departures peak and arrivals peak conditions in 2011. **Table 4-57** shows the calibration of the model for 2011 Airport peak hour traffic on the roadway links.

Table 4-57: 2011 Airport Peak Hour Traffic Model Calibration for Roadway Links

LINK	TUBE COUNTS	MODEL COUNTS	NUMERICAL DIFFERENCE FROM TUBE COUNTS	PERCENT DIFFERENCE
Entry Ramp from Westbound Airport Boulevard	408	427	19	5%
Entry Ramp from Broadway Street	239	236	-3	-1%
Exit Ramp to Broadway Street and Westbound Airport Boulevard	437	441	4	1%
Exit Ramp to Eastbound Airport Boulevard	354	358	4	1%
Recirculation Ramp	155	138	-17	-11%
Entry Ramp from Eastbound Airport Boulevard	223	228	5	2%
Hobby Airport Loop Road North of Exit to Rental Car Road	1,255	1,255	0	0%
Exit to Rental Car Road	122	110	-12	-10%
Hobby Airport Loop Road South of Exit to Rental Car Road	1,133	1,165	32	3%
Ramp to Departures Curbside (upper level)	370	377	7	2%
Hobby Airport Loop Road to Lower Level and Parking Garage	763	789	26	3%
Entry from Rental Car Road	83	86	3	4%
Entry into Parking Garage	135	120	-15	-11%
Hobby Airport Loop Road North of Rental Car Road	628	614	-14	-2%
Hobby Airport Loop Road South of Rental Car Road	711	700	-11	-2%
Exit from Arrivals Curbside (lower level)	470	489	19	4%
Recirculation Ramp from Arrivals Curbside (lower level)	139	133	-6	-4%
From Departures Curbside (upper level) to Airport Exit	279	274	-5	-2%
Exit Hobby Airport Loop Roadway	889	934	45	5%
Return to Airport Recirculation Road	230	244	14	6%
Exit from Departures Curbside (upper level)	91	101	10	11%
Parking Exits	140	152	12	9%
Arrivals Curbside (lower level)	609	634	25	4%
Departures Curbside (upper level)	370	377	7	2%

SOURCES: CH2M HILL, 2011; Ricondo & Associates, Inc., March 2013.
PREPARED BY: Ricondo & Associates, Inc., June 2013.

Airline Locations

Airline operations at the terminal building are split, with Southwest Airlines on the western section of the building and AirTran Airways, American Airlines, Delta Air Lines, and JetBlue Airways on the eastern section of the building. Each airline was assigned to the appropriate zone according to its location at the time of this analysis. These airline assignments were used in distributing traffic along the curbside frontages. A detailed listing of airline locations by zone is provided in **Table 4-58.**

Table 4-58: Airline Locations

WESTERN SECTION AIRLINE	EASTERN SECTION AIRLINES
Southwest Airlines	AirTran Airways
	American Airlines
	Delta Air Lines
	JetBlue Airways

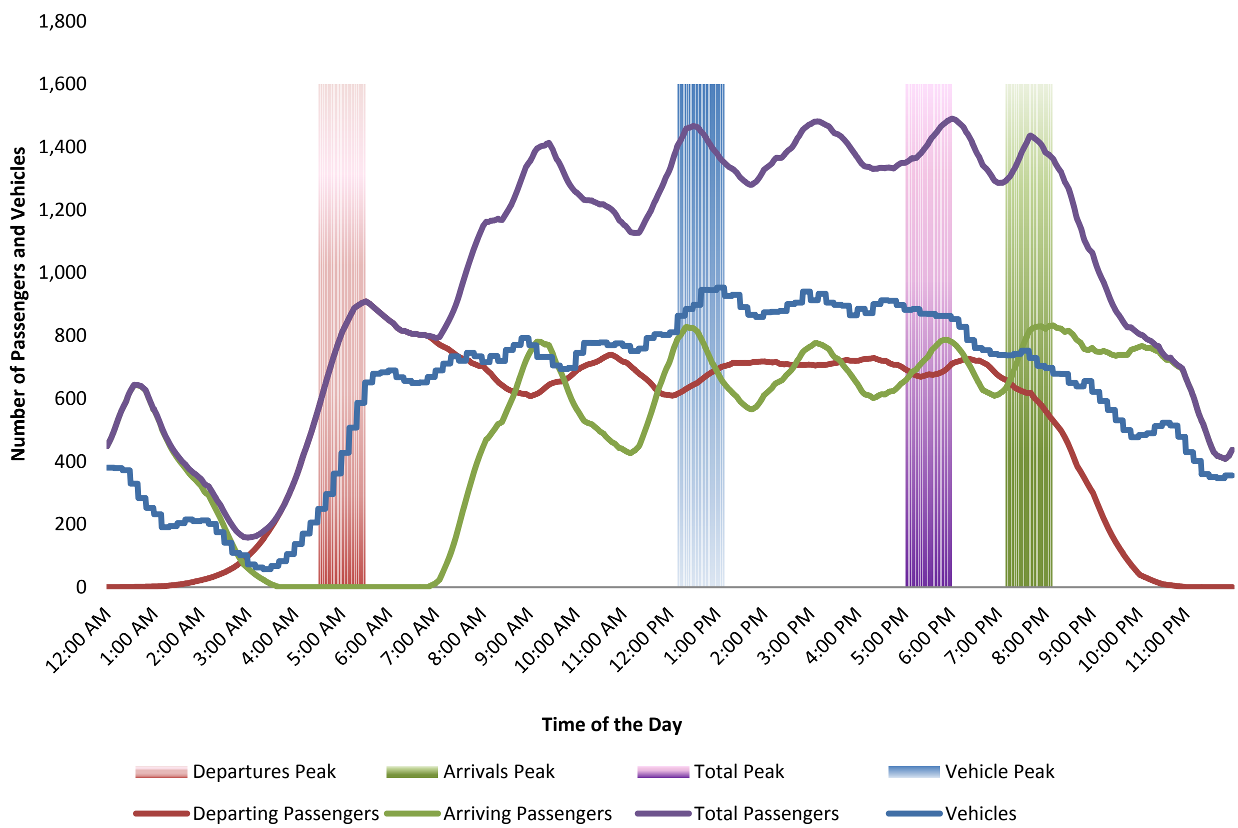
SOURCE: http://www.fly2houston.com/hou-airlines, accessed December 2012.
PREPARED BY: Ricondo & Associates, Inc., February 2013.

Arriving and Departing Passengers

A gated flight schedule was developed by Ricondo & Associates, Inc. for conditions on the design day, which was determined to be a typical Friday in August 2011. Airline-specific aircraft fleet information, aircraft seating configuration, and load factors were applied to the design day flight schedule to develop passenger numbers by airline. Separate show-up profiles were then applied to passengers, representing the distribution of passengers arriving at the curbside prior to their scheduled flight departure (lead time) and after scheduled flight arrival (lag time).

Exhibit 4-31 depicts the rolling hourly numbers of arriving and departing passengers at the curbside. As depicted on Exhibit 4-31, this schedule resulted in 833 peak hour passengers on the Arrivals Curbside (lower level) between 7:10 p.m. and 8:10 p.m., and 909 peak hour passengers on the Departures Curbside (upper level) between 5:00 p.m. and 6:00 p.m. The total Airport peak resulted in approximately 1,490 passengers between 5:00 p.m. and 6:00 p.m.

Exhibit 4-31: 2011 Rolling Hour Arriving and Departing Passengers and Vehicles at Curbside



SOURCES: CH2M HILL, *2011 William P. Hobby Airport Peak Week Survey*, "2011 Tube Counts," August 2011; Ricondo & Associates, Inc. February 2013.
PREPARED BY: Ricondo & Associates, Inc. February 2013.

Vehicle traffic

Existing numbers of vehicles at the curbside were established by data from the August 2011 traffic counts, as reported by CH2M HILL. The profile for the peak day (Wednesday, August 4, 2011) was assumed to represent design day conditions for numbers of vehicles on the Upper and Lower Level roadways. The rolling hourly averages of vehicle traffic arriving at the curbsides are also shown on Exhibit 4-31. Profiles of passenger numbers and vehicle traffic were overlaid in an attempt to determine a correlation between the peaking of the two, and help establish benchmarks for comparing the relationship between numbers of passengers and vehicles in current and future years. It was determined that the peak hour for vehicles was between 12:00 p.m. and 1:00 p.m. and that passenger numbers at this hour were lower than during the absolute Airport peak hour (between 5:00 p.m. and 6:00 p.m.). Passenger numbers during the vehicle peak hour represented about 96 percent of the Airport peak hour passenger numbers. This difference is generally a result of mode choice shift over the day and suggests that more passengers chose to use lower-occupancy vehicles, such as private vehicles, taxicabs, and limousines, rather than higher occupancy vehicles, such as shared ride vans, during the vehicle peak hour.

The resultant peak number of vehicles was 953 between 12:00 p.m. and 1:00 p.m. Calibrating the model to this peak hour number would generate a higher number of vehicles in the future for a given number of passengers than calibrating the model to any other hour. Therefore, this hour was selected as the analysis peak hour.

Dwell Times

Dwell times, as listed in **Table 4-59**, were obtained from the *2011 William P. Hobby Airport Peak Week Survey* by CH2M HILL. The data were collected for the following time periods:

- **Departures Curbside:** Wednesday, August 4, 2011, 8:00 a.m. to 11:00 a.m. and 3:00 p.m. to 5:40 p.m.
- **Arrivals Curbside:** Wednesday, August 4, 2011, 11:00 a.m. to 2:00 p.m. and 6:00 p.m. to 9:00 p.m.

Table 4-59: Vehicle Dwell Times

VEHICLE TYPE	AVERAGE DWELL TIME (SECONDS)
Private Vehicles	98
Taxicabs	112
Hotel/Offsite Parking Shuttles	71
Off-Airport Parking Shuttles	31
Rental Car Shuttles	37
Limousines/Town Cars	83
Shared Ride Vans	85

SOURCES: CH2M HILL, *William P. Hobby Airport Peak Week Survey*, August 2011.
PREPARED BY: Ricondo & Associates, Inc., March 2013.

Mode Shares

Existing mode share data set forth in *Methods, Assumptions and Performance Specifications* prepared by TransSolutions were used to assign numbers of passengers to the appropriate mode choice. The mode choice represents the distribution of types of vehicles used by passengers arriving at the Airport curbsides. Further refinement of these data was necessary to account for the differences in passenger mode share by time of day. The resulting mode share percentages are presented in **Table 4-60.**

Table 4-60: Mode Shares

MODE	SHARE
Private Vehicle Departures	38.0%
Private Vehicle Arrivals	38.0%
Taxicab Departures	6.0%
Taxicab Arrivals	6.0%
Limousine/Town Car Departures	1.0%
Limousine/Town Car Arrivals	1.0%
Hotel Shuttle Departures and Arrivals	2.0%
Rental Car Shuttle Departures and Arrivals	5.0%
Parking Shuttle Departures and Arrivals	22.0%
Shared Ride Van Departures and Arrivals	0.8%
Ecopark - Lot 1	3.0%
Garage Park	19.0%
METRO Bus	0.2%
Ecopark - Lot 2	3.0%

SOURCE: TransSolutions, Methods, Assumptions and Performance Specifications, May 2011.
PREPARED BY: Ricondo & Associates Inc., March 2013.

4.4.2.2 Future Conditions

Access and Circulation Roadways

As shown on **Exhibit 4-32**, the Hobby Airport Loop Road is expected to be reconfigured as a result of the new parking garage to be constructed adjacent to the existing garage. At the time this Master Plan Update was prepared, the future roadway alignment was being refined; however, for purposes of this analysis, the configuration described below was used.

- **Upper Level Roadway:** Construction of a new FIS facility and parking garage, as well as terminal reconfiguration plans, will require reconfiguration of the Upper Level roadway. As shown on **Exhibit 4-33**, the roadway will still consist of four lanes and contain a 20-foot-wide crosswalk near the center of the existing parking garage. Once this future geometry is in place, the usable portion of the Departures Curbside (upper level) is expected to increase by approximately 250 to 300 linear feet.
- **Lower Level Roadway:** Arrivals Curbside facilities are not expected to change in the future and were modeled as currently configured. However, as shown on Exhibit 4-33, the approach roadway to the Arrivals Curbside is planned to be reconfigured.

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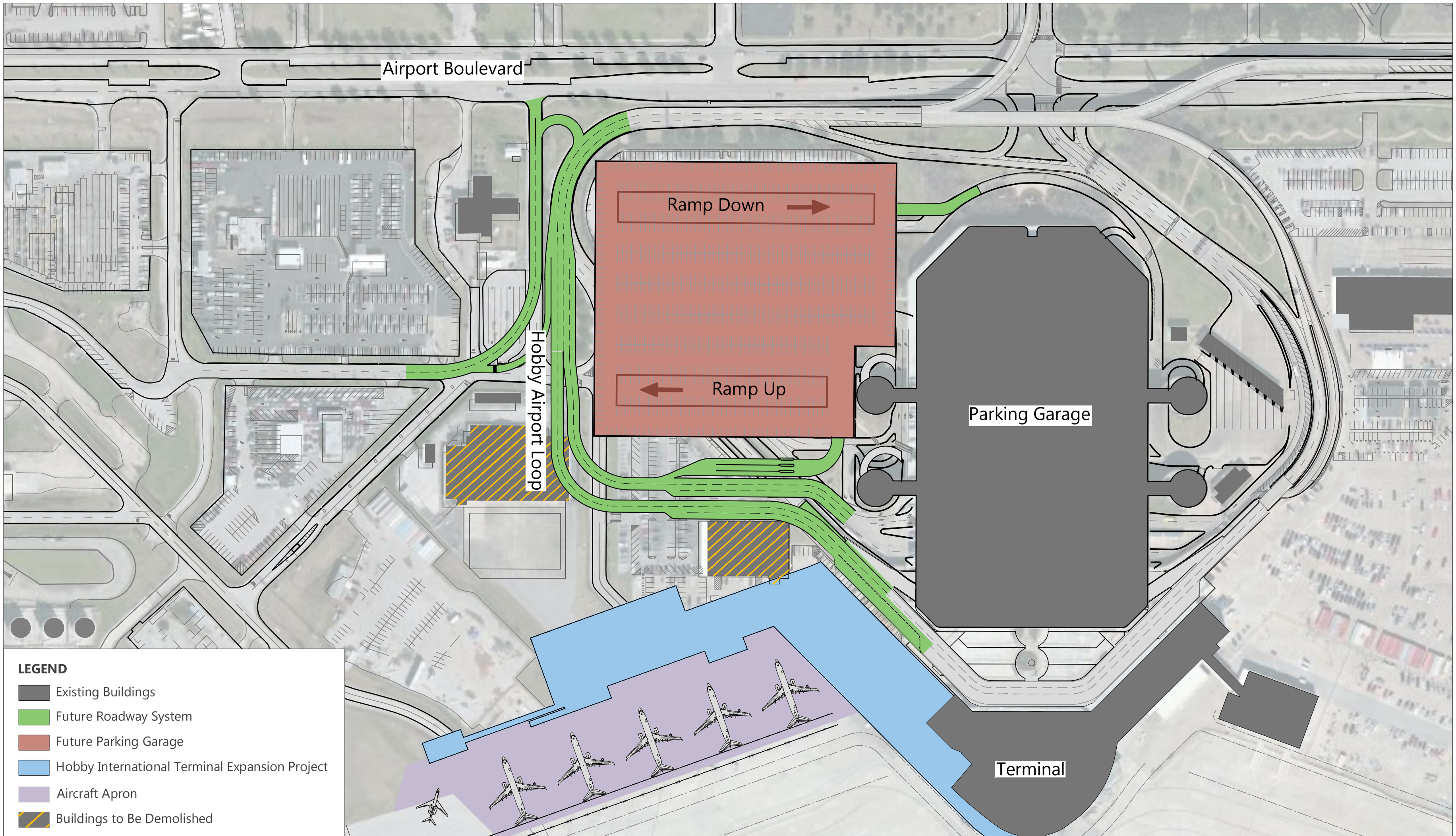

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 4-32

NORTH 0 300 ft.

Future Roadway Network

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\04_Chapter 4_Requirements\05_Ground Access\CAD\Future Roadway Links - Standard\Future Roadway Links.dwg_Layout: 4-32_Future Roadway Network_Dec 26, 2014, 12:55pm

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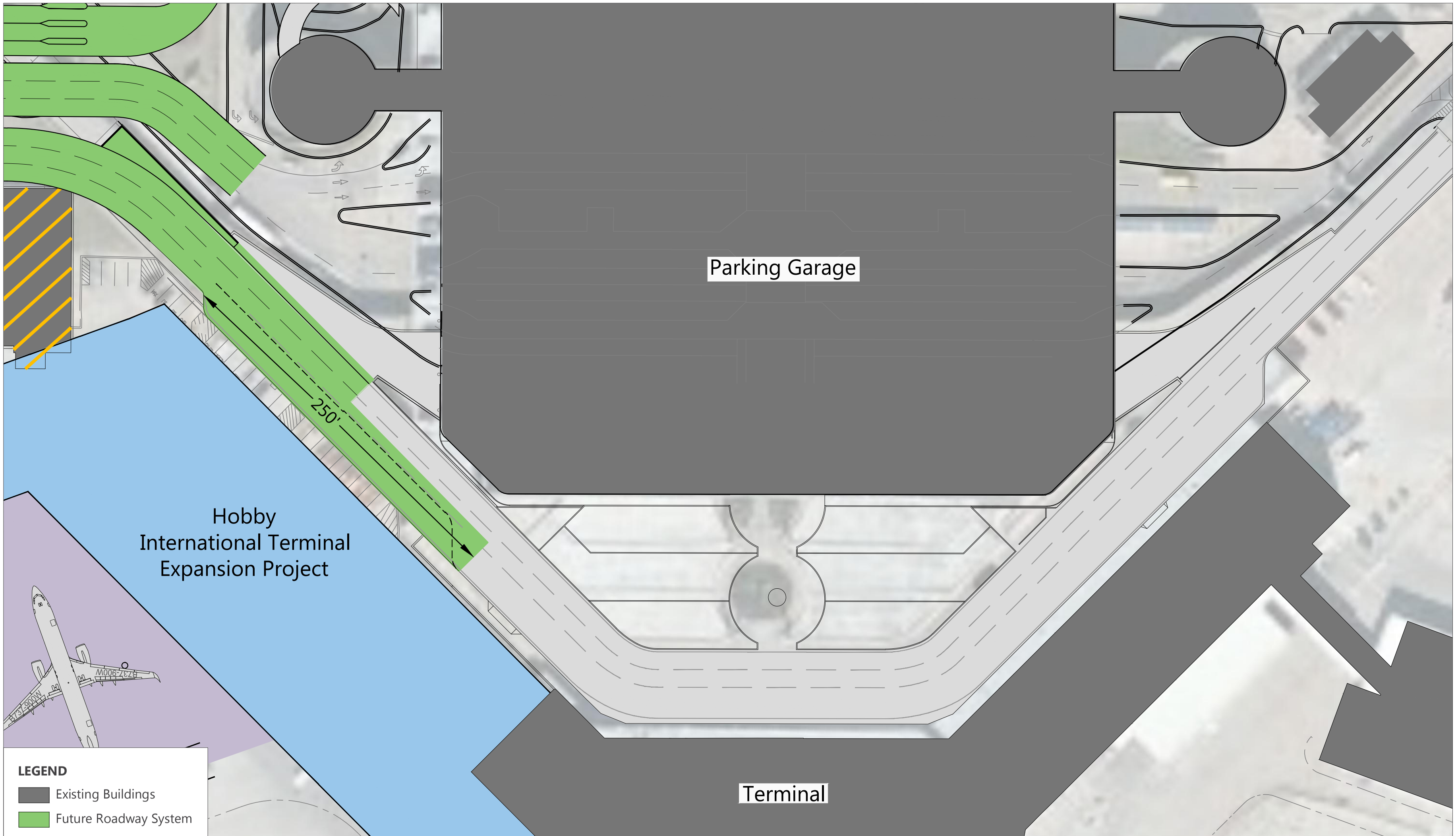

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

NORTH 0 300 ft.

EXHIBIT 4-33

Departures Curbside (Upper Level)
Proposed Roadway Configuration

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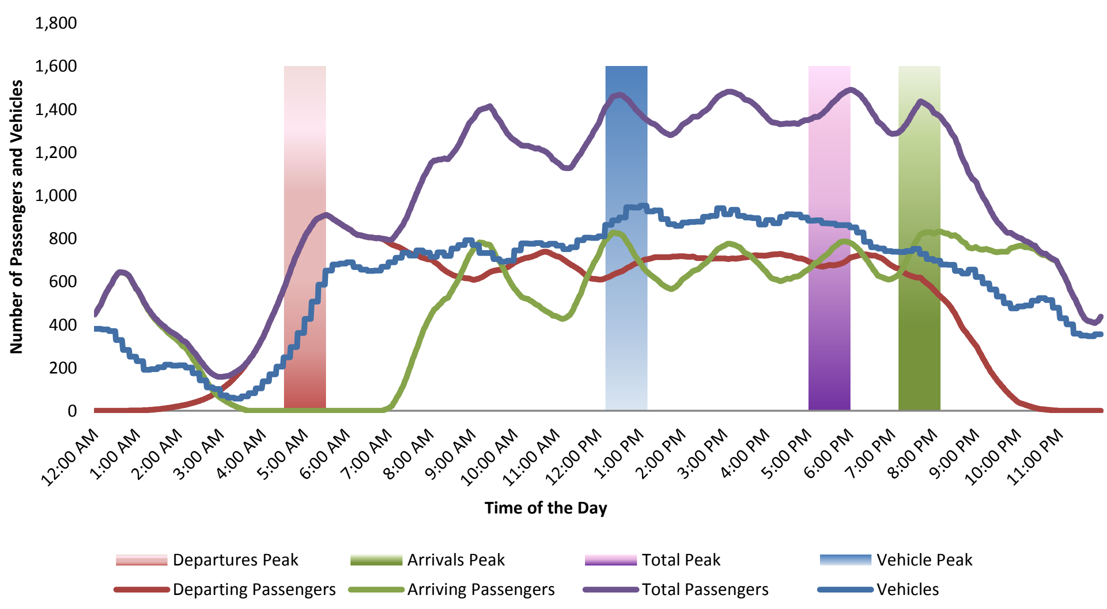
Future Passenger Activities

Design day flight schedules were developed by Ricondo & Associates, Inc. for 2015, 2020, and 2030 to determine future passenger activity at the Airport. These schedules incorporate international flights that would be possible as a result of construction of the FIS facility after the Wright Amendment expires.

After the aviation demand forecasts were developed for 2015, 2020, and 2030, the passenger profile outputs were adjusted with lead and lag time distributions to generate curbside passenger demand. The overall numbers of arriving and departing passengers were selected to represent the busiest design period for the Airport roadways, defined as the period when the number of vehicles on the terminal roadway system is expected to be at its peak. In 2015, the passenger peak hour was determined to be between 9:15 a.m. and 10:15 a.m., with 1,925 total arriving and departing passengers. In 2020, the passenger peak hour was determined to be between 9:10 a.m. and 10:10 a.m., with 2,316 total arriving and departing passengers. In 2030, the passenger peak hour was determined to be between 9:25 a.m. and 10:25 a.m., with 2,728 total arriving and departing passengers.

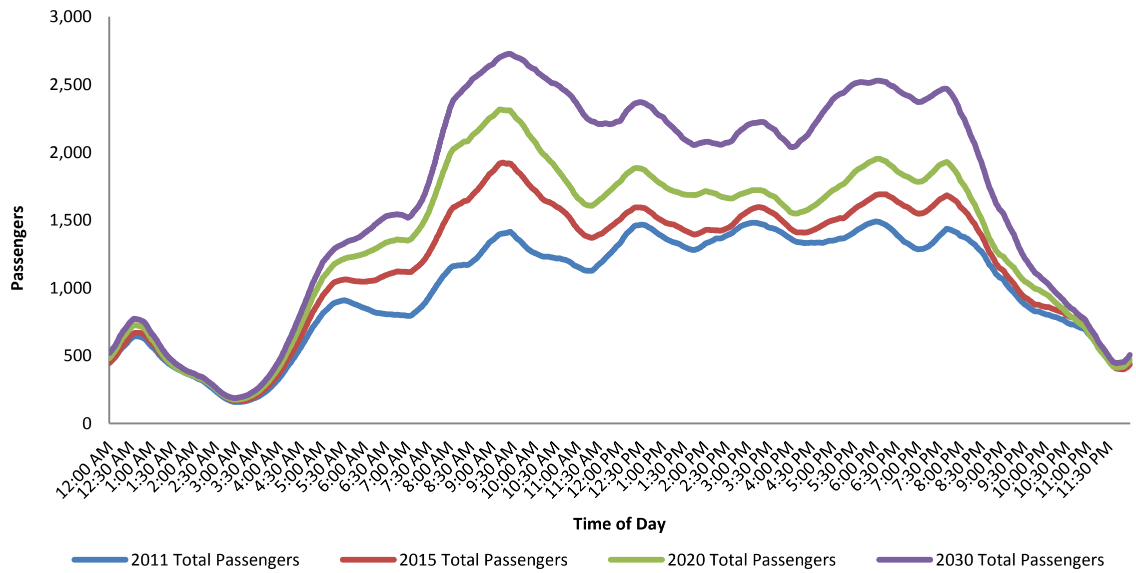
The existing (2011) relationship between numbers of vehicles and numbers of passengers is shown on **Exhibit 4-34**. The number of vehicles between 12:00 p.m. and 1:00 p.m. (the vehicle peak hour) was 18.6 percent higher than the number of vehicles during the total Airport passenger peak hour ending at 6:00 p.m. Therefore, the period between 12:00 p.m. and 1:00 p.m. was selected as the analysis peak hour for the roadway system. **Exhibit 4-35** presents the daily profile of total passengers for each design year considered in this analysis. **Table 4-61** presents the peak hour passenger numbers for each design day flight schedule.

Exhibit 4-34: Existing (2011) Daily Passenger Arrival and Departure Profiles



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

Exhibit 4-35: Future Year Daily Passenger Arrival and Departure Profiles



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

Table 4-61: Forecast Peak Hour Design Day Flight Schedule Passengers

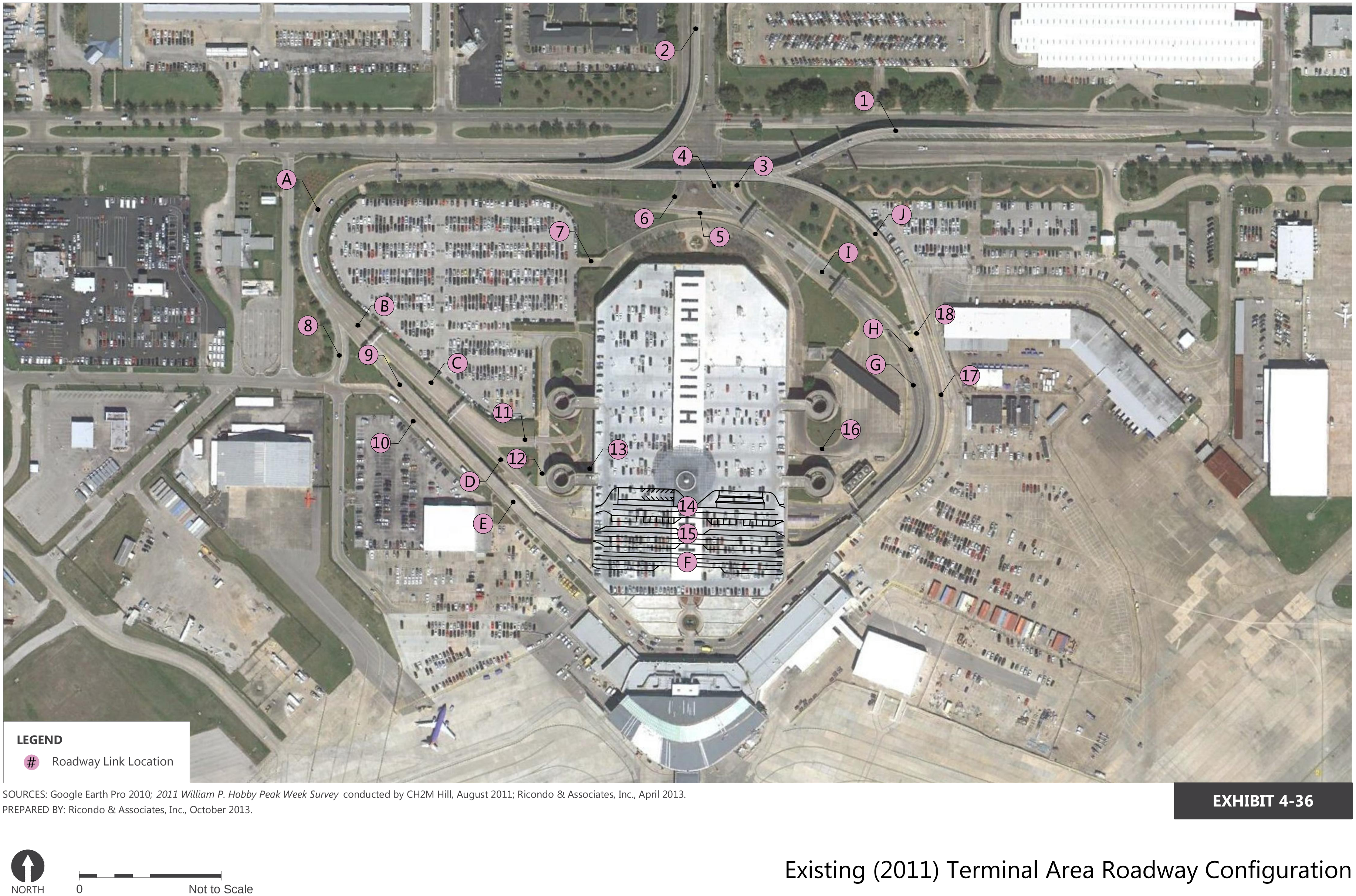
OVERALL AIRPORT PEAK HOUR ACTIVITY (DEPARTURES + ARRIVALS)	EXISTING PASSENGER PEAK 2011	EXISTING VEHICLE PEAK 2011	2015	2020	2030
Peak Hour	5:00 p.m. to 6:00 p.m.	12:00 p.m. to 1:00 p.m.	9:15 a.m. to 10:15 a.m.	9:10 a.m. to 10:10 a.m.	9:25 a.m. to 10:25 a.m.
Peak 60 Minutes for Passengers	1,490	1,467	1,925	2,316	2,728

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

4.4.2.3 Demand/Capacity Analysis and Requirements

A detailed analysis of roadway demand and capacity to determine future requirements was conducted for the terminal area roadway system, as well as the primary intersections serving the Airport, consisting of the intersections of Airport Boulevard with Broadway Street, Telephone Road, and Monroe Road. **Exhibit 4-36** depicts the roadway links analyzed along the terminal area roadways under existing (2011) conditions.

Beyond 2015, the terminal area roadways are expected to be reconfigured in coordination with construction of a new parking garage, as shown on **Exhibit 4-37.** The roadway links included in this analysis are identified on Exhibit 4-28.



SOURCES: Google Earth Pro 2010; *2011 William P. Hobby Peak Week Survey* conducted by CH2M Hill, August 2011; Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 4-36

Existing (2011) Terminal Area Roadway Configuration

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\04_Chapter 4_Requirements\05_Ground Access\CAD\Existing Roadway Links - Standard\Existing Roadway Links.dwg_Layout: Existing Roadway Links_Dec 26, 2014, 1:01pm

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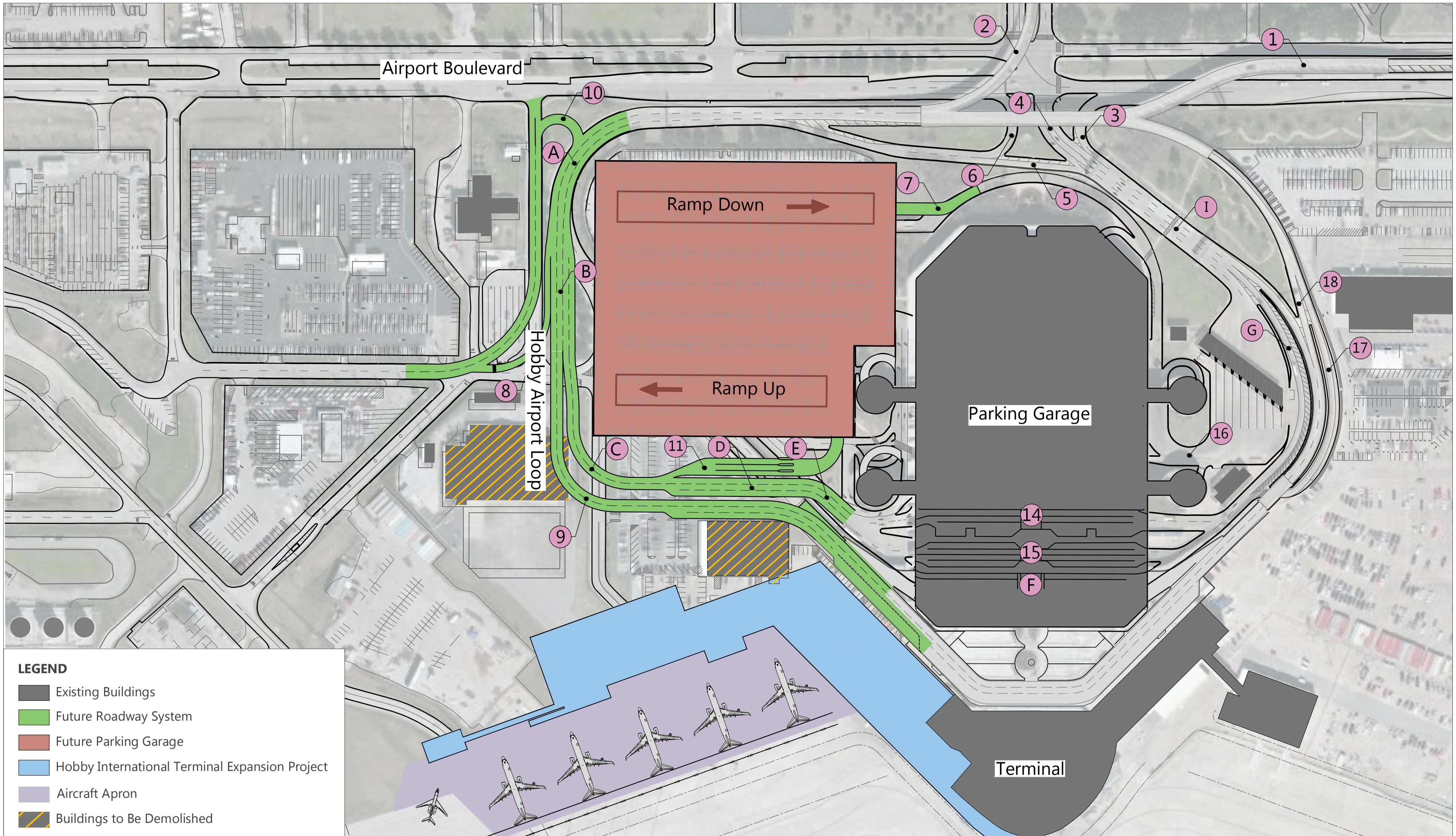

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 4-37

NORTH 0 300 ft.

Terminal Area Roadways Future Configuration

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\04_Chapter 4_Requirements\05_Ground Access\CAD\Future Roadway Links - Standard\Future Roadway Links.dwg_Layout: 4-37_Terminal Area Roadways_Future Configuration_Dec 26, 2014, 12:53pm

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Key Assumptions

The roadway analysis was conducted using data obtained from the *2011 William P. Hobby Airport Peak Week Survey* prepared by CH2M HILL and from *Methods, Assumptions and Performance Specifications* prepared by TransSolutions. The data reflect a typical busy day for vehicle traffic at the Airport; therefore, no seasonal adjustments were required. The maximum hourly vehicle count from the weeklong data recorded was used to represent 2011 peak-period traffic. Traffic on the area roadways was factored up from the 2011 peak traffic for future years based on forecast growth rates using peak 60-minute passenger numbers and background traffic parameters.

This analysis was based on unconstrained demand for each curbside and roadway link, which results in unconstrained future growth related to congestion on off-Airport roadways. By using this conservative approach, the resulting facility requirements ensure that forecast demand can be accommodated on an unencumbered roadway network. Simulation modeling of these curbsides and roadways was then used to validate the results of a spreadsheet-based Airport Roadway Model to identify upstream constraints on the Airport and to assess the order of magnitude of potential constraints. The off-Airport intersections were modeled during the peak traffic period at the Airport, which, in 2011, occurred in the midday between 12:00 p.m. and 1:00 p.m. when non-Airport-related traffic was lower than during commuter peak hours. Therefore, off-Airport upstream constraints that may have occurred during the commuter peak hours were not captured in the modeling.

As previously discussed, peak hour traffic at the Airport under existing (2011) conditions occurs between 11:00 a.m. and 12:00 p.m., and passenger traffic peaks between 5:00 p.m. and 6:00 p.m. Therefore, during the midday traffic peak at the Airport, fewer passengers generate a higher number of vehicles. This relationship between passengers and vehicles during the midday peak hour was used to establish trip generations for future years. The future peak hour passenger numbers for each year (9:15 a.m. to 10:15 a.m. for 2015, 9:10 a.m. to 10:10 a.m. for 2020, and 9:25 a.m. to 10:25 a.m. for 2030) were used to generate future trips, resulting in a more conservative analysis. For off-Airport traffic, the analysis was not conducted for the commuter peak hour because of a lack of data in the morning peak hour. Furthermore, such an analysis would require the development of commuter peak hour trip generation and simulation models for each planning year under two different scenarios, which was beyond the scope of the analysis for this Master Plan Update.

Approach

The roadway analysis was conducted as a starting point in determining future roadway requirements and constraints. A trip generation and assignment model was calibrated using data described in Section 4.4.2 and was used to forecast future traffic volumes at the Airport. As described previously, the trip generation model was used to forecast traffic at the Airport by vehicle mode based on passenger activity. Roadway parameters, such as speed limits, lane configurations, and traffic, were then coded into the simulation models. The outputs from the simulation model were then used to determine the traffic at each roadway link during the analysis peak hour and to determine the level of service provided by each roadway link.

Roadway level of service is a qualitative measure that describes traffic operating conditions on a roadway (e.g., delay, queue lengths, congestion). Roadway LOSs range from A (excellent conditions with little or no vehicle delay) to F (excessive vehicle delays and queue lengths). Roadway LOS definitions are presented in **Table 4-62**.

Table 4-62: Roadway Level of Service Definitions

LEVEL OF SERVICE	DEFINITION
A	EXCELLENT: Free flow conditions with no delay or backups.
B	VERY GOOD: Relatively free flow conditions with negligible delays.
C	GOOD: Occasionally, drivers may experience very little delay.
D	FAIR: Delays may be substantial during portions of the rush hours, but enough lower volume periods occur to permit clearing of developing queues, preventing excessive backups.
E	POOR: Represents the most vehicles a roadway link can accommodate; substantial delays are experienced by drivers.
F	FAILURE: Tremendous delays with continuously increasing queue lengths leading to gridlock conditions

SOURCE: Transportation Research Board, Transportation Research Circular No. 212, *Interim Materials on Highway Capacity*, January 1980.
PREPARED BY: Ricondo & Associates, Inc., April 2013.

To analyze the operating conditions along the Airport roadway system, the simulated traffic on each roadway link (i.e., number of vehicles) was compared to the capacity of the roadway at that particular location. The capacities of the roadway links were determined based on the characteristics of the roadway link, the number of travel lanes, and the effects of curbside congestion. Based on the *Highway Capacity Manual, Special Report 209*, prepared by the Transportation Research Board, the theoretical capacity of a roadway is the maximum hourly flow rate per lane under ideal conditions, consisting of: (a) uninterrupted flow, (b) all passenger vehicles driven by people who are frequent users of the roadway, (c) 12-foot minimum lane width, (d) relatively flat grades with minor curvature, and (e) optimal lateral clearance between the edge of lane and nearby obstacles and walls. For Airport roadways, however, capacities are substantially lower, as many of the ideal conditions listed above cannot be achieved. For example, drivers are often unfamiliar with the roadway system. Also, increased interaction and impedances between vehicles usually result in drivers slowing to change lanes or maneuver in response to signage describing multiple on-airport destinations occurring over relatively short distances. Therefore, capacity values typically used for city roads, as set forth in the *Highway Capacity Manual,* cannot be directly used in an analysis of airport roadways. ACRP Report 40[4] provides guidelines for determining terminal area roadway capacity and these roadways are classified based on speed-flow rate tables, as summarized in **Table 4-63**. The speed limits on Airport roadways range from 15 mph on curbside approach roads and ramps to 50 mph at entry/exit roadways.

4 Transportation Research Board, Airport Cooperative Research Program Report 40, *Airport Curbside and Terminal Area Roadway Operations,* December 2, 2010, and Federal Aviation Administration Advisory Circular 150/5360-13, *Planning and Design Guidelines*, January 19, 1994.

Table 4-63: Capacity and Level of Service Ranges for Terminal Area Roadways

TYPICAL ROADWAY CLASSIFICATION 2/	MAXIMUM FREE FLOW SPEED (MILES PER HOUR) 2/	MAXIMUM FLOW RATE (VEHICLES/HOUR/LANE) AT LEVEL OF SERVICE 1/ A	B	C	D	E
Airport Access Highway	60	630	1,030	1,460	1,880	2,090
	55	520	850	1,220	1,580	1,800
Entry/Exit Roadway	50	450	730	1,050	1,390	1,620
	45	400	660	950	1,260	1,530
Terminal Loop Roadway	40	370	600	860	1,130	1,410
	35	340	540	790	1,030	1,290
Terminal Access Roadway	30	310	480	700	930	1,170
	25	250	400	600	800	1,010
Ramps (25 miles per hour or less)	15	250	400	600	800	1,010

NOTES:

1/ Flow rates were adjusted to account for heavy vehicles and the effects of unfamiliar drivers.

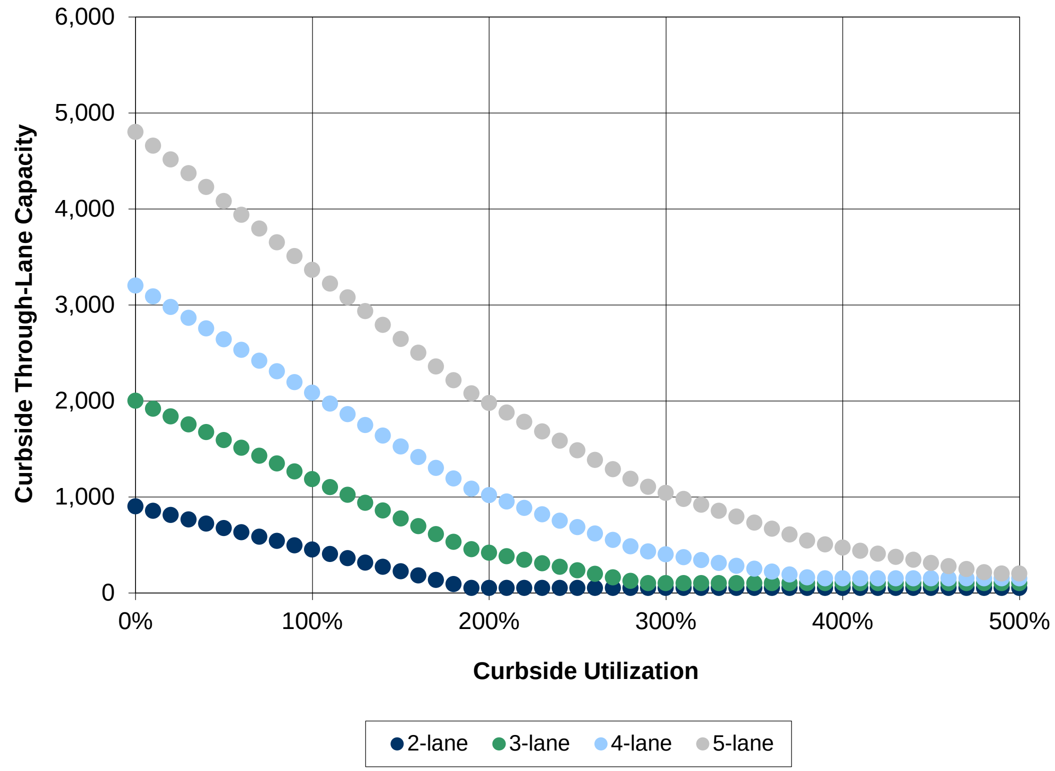
2/ The roadway classifications and associated speeds represent a typical range that varies by airport.

SOURCES: Ricondo & Associates, Inc., based on information presented in (a) Transportation Research Board, National Research Council, *Highway Capacity Manual*, December 2000, Exhibit 21-2; and (b) Airport Cooperative Research Program, Revised Preliminary Draft, *Guide for Analysis of Airport Curbside and Terminal-Area Roadway Operations*, June 4, 2009.

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

As airport curbsides accommodate relatively intense activity in a relatively compact area, throughput capacities of curbside roadway are much lower than those provided by non-airport roadway systems. The throughput capacity of roadways adjacent to a curbside is a function of the number of lanes, effects of friction from stopped and maneuvering vehicles, pedestrian crossing activity, and other characteristics. Consequently, curbside roadway throughput capacity decreases as curbside utilization increases (i.e., double and triple parking increases, which slows vehicles trying to pass.) Therefore, the throughput capacity of each lane is related to the level of congestion at the adjacent curbside. **Exhibit 4-38** illustrates curbside roadway throughput capacity as a function of curbside utilization.

Exhibit 4-38: Curbside Roadway Through-Lane Capacity



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

Analysis

A micro simulation model was developed using VISSIM, a commercially available simulation modeling tool. The roadway links were coded into VISSIM and the numbers of vehicles were then input into the model. The travel path of the vehicles (routing) was made consistent with the traffic assignment/distribution discussed in Section 4.4.2.1. The routing was developed based on observed traffic volumes for each vehicle mode. Various other simulation modeling elements, such as reduced-speed areas and traffic control devices, were also modeled to reflect the actual conditions on the roadway network. For off-Airport intersections, traffic signal timings were obtained from Gunda Corporation, LLC and these timings reflect current signal timing patterns.

The model was calibrated by comparing recorded vehicle traffic with modeled vehicle traffic. The modeling error was less than 1.0 percent at each link. Once the model was calibrated, the roadway network was changed to reflect the reconfigured roadway alignment. All other simulation elements were adjusted to synchronize them with the reconfigured roadway network.

Future vehicle traffic was generated using the calibrated trip generation model, as discussed in Section 4.4.2. The model estimates roadway traffic by mode on the basis of the numbers of passengers to numbers of vehicles relationship. The mode choice and occupancy rates together with future numbers of passengers were used to calculate the numbers of vehicles on the network by mode. The following assumptions were made in calculating future numbers of vehicles.

- **Mode Choice** - The mode choice pattern will not change between existing conditions and future conditions.
- **Vehicle Occupancy** - The occupancy rates for private vehicles will remain the same between existing conditions and future conditions. However, for commercial vehicles, the occupancy rate was increased based on an assumed maximum capacity of the vehicles. As a result, additional commercial vehicle trips would be generated only if the assumed maximum occupancy of the vehicle were achieved. For example, for hotel/motel shuttles, trips were calibrated using an occupancy of 1.55 passengers per vehicle, resulting in 11 hotel/motel shuttle trips per hour for the existing year, which was the same as the observed number of vehicles on the roadway network. However, the maximum occupancy of the vehicle was conservatively assumed to be 5 passengers. Therefore, the trip generation model did not generate additional hotel/motel shuttle trips unless the calculated occupancy was greater than 5 passengers. For this example, in 2030, the calculated occupancy was 4.89 passengers per hotel/motel shuttle trip; therefore, additional hotel/motel shuttle trips (compared with existing trips) were not generated in the model for that year.
- **Recirculation** - The percentage of recirculating vehicles was assumed to be the same as existing conditions. It is anticipated that the percentage of recirculating vehicles will be lower in the future following construction of a new cell phone lot on Airport property. However, for a conservative analysis, it was assumed that the recirculation percentage will remain the same.
- **Parking Demand** - Parking facility entries and exits were considered to increase in proportion to the growth in numbers of peak hour passengers. The overall number of parking trips was also increased in proportion to the growth in numbers of peak hour passengers.
- **Regional Distribution** - The regional distribution of trips entering and exiting the Airport was assumed to remain the same as existing conditions.
- **Background Traffic** – Non-Airport-related background traffic on the off-Airport roadways was increased at an annual rate of 1.5 percent.

Simulation Results

Future-year vehicle traffic numbers were coded into the simulation model with roadway parameters, such as geometry, lane configurations, speed limits, etc. The forecast numbers of vehicles (i.e., demand) obtained as output from the simulation model are presented in **Table 4-64**.

The analysis indicated that the roadways would perform without significant congestion. The reconfigured roadway alignment and lane configuration were determined to be adequate. However, the simulation was designed to measure any capacity-related constraints, and other constraints, such as sight distance requirements, turning radius, and other design considerations, were not analyzed in detail. During the design phase of the project, the roadway realignment may be refined to consider these potential constraints.

The outer and middle lanes of the Arrivals Curbside, and the Departures Curbside were determined to operate without significant congestion. However, on the inner lanes of the Arrivals Curbside, moderate congestion was observed for existing conditions as well as for 2015 conditions. In 2020 and 2030, this congestion would become more severe.

Table 4-64: Terminal Area Roadway Demand

		NUMBER OF VEHICLES		
LINK ID	**DESCRIPTION**	**2015**	**2020**	**2030**
1	Entry Ramp from Westbound Airport Boulevard	502	599	702
2	Entry Ramp from Broadway Street	280	331	386
3	Exit Ramp to Broadway Street and Westbound Airport Boulevard	518	622	717
4	Exit Ramp to Eastbound Airport Boulevard	438	530	620
5	Recirculation Ramp	162	194	220
6	Entry Ramp from Eastbound Airport Boulevard	265	319	348
A	Hobby Airport Loop Road North of Rental Car Road Exit	1,519	1,786	2,017
8	Exit to Rental Car Road	109	124	148
B	Hobby Airport Loop Road South of Exit to Rental Car Road	1,410	1,665	1,876
9	Ramp to Departures Curbside (upper level)	466	575	677
C	Hobby Airport Loop Road to Lower Level and Parking Garage	942	1,087	1,204
10	Entry from Rental Car Road	96	106	117
11	Entry into Parking Garage	258	316	371
D	Hobby Airport Loop Road to Lower Level before Parking Garage Entry	680	773	839
E	Hobby Airport Loop Road Entering Arrivals Curbside (lower level)	681	773	838
G	Exit from inner lanes of the Arrivals Curbside (lower level)	545	622	680
17	Recirculation Ramp from Arrivals Curbside (lower level)	132	148	162
H	Exit from Departures Curbside (upper level)	377	486	582
I	Exit Loop Roadway	1,119	1,345	1,554
J	Return to Airport Recirculation Road	231	252	260
18	Exit from Departures Curbside (upper level)	475	587	679
16	Parking Exits	199	237	291
14	Lower Level Outer Curbside	82	83	78
15	Lower Level Middle Curbside	529	609	673
F	Lower Level Inner Curbside	73	57	84
9 Curbside	Departures Curbside (upper level)	466	575	677

SOURCES: Ricondo & Associates, Inc., April 2013.
PREPARED BY: Ricondo & Associates, Inc., April 2013.

As shown in **Table 4-65**, it is estimated that all roadways links will operate at LOS C or better in 2015. It is estimated that all roadway links will operate at LOS C or better in 2020, except for the inner lanes of the Arrivals Curbside, which is estimated to operate at LOS E. This level of service results from curbside congestion and, as discussed in the previous section, this curbside congestion will directly affect roadway throughput capacity. It is estimated that 7 of the 26 roadway links analyzed will operate at LOS C in 2030, with the inner lanes of the Arrivals Curbside experiencing severe congestion. All other roadway links are estimated to operate under nearly free-flow conditions.

Based on this analysis, it was determined that the on-Airport terminal area roadways have adequate capacity to accommodate demand throughout the planning period. The inner lanes of the Arrivals Curbside are estimated to experience congestion and it is suggested that taxicabs be metered adequately to prevent curbside congestion.

4.4.3 OFF-AIRPORT ROADWAY INTERSECTIONS ANALYSIS AND REQUIREMENTS

As part of the Airport Master Plan Update, the effects of the proposed growth on the intersections surrounding the Airport were analyzed.

4.4.3.1 Study Area Existing Conditions

As shown on Exhibit 4-30, the study area for the intersection analysis in the immediate vicinity of the Airport included intersections on the north side of the Airport. Intersections analyzed included the following:

- Airport Boulevard and Broadway Street
- Airport Boulevard and Telephone Road
- Airport Boulevard and Monroe Road
- Airport Boulevard and Glencrest Street

Additional off-Airport intersections were evaluated along the main access roads. Results are presented in **Appendix F**.

Airport Boulevard and Broadway Street

The intersection of Airport Boulevard and Broadway Street is a signalized intersection with the Airport entrance on the south side and Broadway Street on the north side intersecting east-west Airport Boulevard. Airport Boulevard consists of three lanes in each direction separated by a raised median. Broadway Street consists of two lanes in each direction on the north side of the intersection. The Airport entrance on the southern approach to the intersection consists of a channelized right turn lane, one left turn lane, and two through lanes. On the western approach to the intersection, the three-lane Airport Boulevard widens to a channelized right turn bay, an auxiliary left turn lane, and two through lanes. Southbound Broadway Street on the northern approach to the intersection consists of two left turn lanes and one right turn lane. The eastern approach to the intersection consists of the three westbound Airport Boulevard lanes, which become two through lanes and a shared through right lane. This intersection serves as the primary access and egress to the Airport, with Airport traffic exiting the Airport from the south side of the intersection. Traffic from the north and east uses an above-grade flyover to access the Airport, while traffic from the west accesses the Airport via a right turn lane at the western leg of the intersection.

Table 4-65 (1 of 2): Roadway Demand/Capacity Analysis Results

			FUTURE NETWORK											
			2015				2020				2030			
LINK ID	DESCRIPTION	NUMBER OF LANES	NUMBER OF VEHICLES	CAPACITY (NUMBER OF VEHICLES)	V/C	LOS	NUMBER OF VEHICLES	CAPACITY (NUMBER OF VEHICLES)	V/C	LOS	NUMBER OF VEHICLES	CAPACITY (NUMBER OF VEHICLES)	V/C	LOS
1	Entry Ramp from Westbound Airport Boulevard	1	502	1,530	0.33	B	599	1,530	0.39	B	702	1,530	0.46	C
2	Entry Ramp from Broadway Street	1	280	1,530	0.18	A	331	1,530	0.22	A	386	1,530	0.25	A
3	Exit Ramp to Broadway Street and Westbound Airport Boulevard	1	518	1,530	0.34	B	622	1,530	0.41	B	717	1,530	0.47	C
4	Exit Ramp to Eastbound Airport Boulevard	3	438	4,590	0.10	A	530	4,590	0.12	A	620	4,590	0.14	A
5	Recirculation Ramp	1	162	1,530	0.11	A	194	1,530	0.13	A	220	1,530	0.14	A
6	Entry Ramp from Eastbound Airport Boulevard	1	265	1,530	0.17	A	319	1,530	0.21	A	348	1,530	0.23	A
A	Hobby Airport Loop Road South of Rental Car Road Entry	3	1,519	4,590	0.33	B	1,786	4,590	0.39	B	2,017	4,590	0.44	C
8	Exit to Rental Car Road	1	109	1,290	0.08	A	124	1,290	0.10	A	148	1,290	0.11	A
B	Hobby Airport Loop Road North of Exit to Rental Car Road	4	1,410	6,120	0.23	A	1,665	6,120	0.27	B	1,876	6,120	0.31	B
9	Ramp to Departures Curbside (upper level)	2	466	2,580	0.18	A	575	2,580	0.22	A	677	2,580	0.26	A
C	Hobby Airport Loop Road to Lower Level and Parking Garage	2	942	2,580	0.37	B	1,087	2,580	0.42	C	1,204	2,580	0.47	C
10	Entry from Rental Car Road	1	96	1,290	0.07	A	106	1,290	0.08	A	117	1,290	0.09	A
11	Entry into Parking Garage	2	258	2,340	0.11	A	316	2,340	0.14	A	371	2,340	0.16	A
D	Hobby Airport Loop Road to Lower Level before Parking Garage Entry	2	680	2,580	0.26	B	773	2,580	0.30	B	839	2,580	0.33	B

Table 4-65 (2 of 2): Roadway Demand/Capacity Analysis Results

			FUTURE NETWORK											
			2015				2020				2030			
LINK ID	DESCRIPTION	NUMBER OF LANES	NUMBER OF VEHICLES	CAPACITY (NUMBER OF VEHICLES)	V/C	LOS	NUMBER OF VEHICLES	CAPACITY (NUMBER OF VEHICLES)	V/C	LOS	NUMBER OF VEHICLES	CAPACITY (NUMBER OF VEHICLES)	V/C	LOS
E	Hobby Airport Loop Road Entering Arrivals Curbside (lower level)	2	681	2,580	0.26	B	773	2,580	0.30	B	838	2,580	0.32	B
G	Exit from Arrivals Curbside (lower level)	1	545	1,290	0.42	C	622	1,290	0.48	C	680	1,290	0.53	C
17	Recirculation Ramp from Arrivals Curbside (lower level)	1	132	1,290	0.10	A	148	1,290	0.11	A	162	1,290	0.13	A
H	Exit from Departures Curbside (upper level)	1	377	1,290	0.29	B	486	1,290	0.38	B	582	1,290	0.45	C
I	Exit Loop Roadway	4	1,119	5,160	0.22	A	1,345	5,160	0.26	A	1,554	5,160	0.30	B
J	Return to Airport Recirculation Road	1	231	1,290	0.18	A	252	1,290	0.20	A	260	1,290	0.20	A
18	Exit from Upper Level Curbsides	1	475	1,290	0.37	B	587	1,290	0.46	C	679	1,290	0.53	C
16	Parking Exits	2	199	2,340	0.09	A	237	2,340	0.10	A	291	2,340	0.12	A
14	Lower Level Outer Curbside	2	82	495	0.17	A	83	495	0.17	A	78	495	0.16	A
15	Lower Level Middle Curbside	3	529	675	0.78	C	609	630	0.97	E	673	630	1.07	F
F	Lower Level Inner Curbside	4	73	405	0.18	A	57	405	0.14	A	84	405	0.21	A
9 Curbside	Departures Curbside (upper level)	4	466	2,307	0.20	A	575	2,195	0.26	A	677	1,860	0.36	A

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

Airport Boulevard and Telephone Road

The intersection of Airport Boulevard and Telephone Road is a signalized intersection located west of the Airport. Airport Boulevard is an east-west roadway with three lane in each direction on the east side of the intersection and two lanes in each direction on the west side of the intersection. Telephone Road is a north-south roadway with three lanes in each direction. The northern and southern approaches to this intersection consist of one shared through/right lane, two through lanes, and one auxiliary left turn lane. The eastern and western approaches to this intersection consist of a separate right turn lane, two through lanes, and an auxiliary left turn lane.

Airport Boulevard and Monroe Road

The intersection of Airport Boulevard and Monroe Road is a signalized intersection located east of the Airport. Airport Boulevard is an east-west roadway with three lanes in each direction separated by a raised median and Monroe Road is a north-south roadway with two lanes in each direction. The southern approach to the intersection consists of one shared through/right lane, two through lanes, and one auxiliary left turn lane. The northern approach consists of a separated right turn lane with two through lanes and an auxiliary left turn lane. The east and west approaches to the intersection consist of one shared through/right lane, two through lanes, and an auxiliary left turn lane.

Airport Boulevard and Glencrest Street

The intersection of Airport Boulevard and Glencrest Street currently has three approaches, with three through lanes in the eastbound and westbound directions, and an auxiliary eastbound left turn lane. The northern approach has one wide shared lane serving left and right turn movements. This intersection is immediately east of the Airport entrance. With the proposed expansion of Ecopark – Lot 2, a southern approach to the intersection is anticipated to be constructed in the future.

4.4.3.2 Analysis Methodology

Analysis Approach

The turning movement volumes collected by CH2M Hill and discussed in its *2011 William P. Hobby Airport Peak Week Survey* report were used as the baseline traffic volumes in this analysis. As part of the peak weak survey data collection, CH2M Hill collected roadway counts 24 hours per day for 7 days at various strategic locations on the Airport as well as in the vicinity of the Airport. Intersection turning movement counts were also collected in the midday as well as the p.m. commuter peak hour for the adjacent roadway by Gunda Corporation, LLC in 2011. The data provided in the CH2M Hill report represented the most complete data set available at the time of this analysis. The total vehicle movement counts were then split into Airport traffic and non-Airport-related background traffic using the roadway counts into and out of the Airport as well as trip generation estimates using the Airport trip generation and parking model developed as part of the on-Airport roadway requirements analysis.

The a.m. commuter peak hour data were unavailable. It was assessed that the p.m. commuter peak hour was more critical based on the local experience of the project team. Therefore, all analysis was conducted using the p.m. commuter peak hour data with the exception of the analysis for the intersection of Airport Boulevard and Glencrest Street to account for the employee shift change. As the data were collected during peak season, any seasonal variance was not applied.

To determine if intersection performance degraded as a result of ambient background growth or if any degradation was a result of Airport growth, the analysis was conducted for the following two scenarios.

- **Scenario 1:** Future intersection performance with non-Airport-related background traffic growth and Airport traffic held constant at 2012 levels.
- **Scenario 2**: Future intersection performance with non-Airport-related background traffic growth and Airport traffic growing based on passenger growth at the Airport.

If the intersection performance was the same under both scenarios, then it was concluded that any capacity constraints at the intersections resulted from growth in non-Airport- related background traffic. However, if the intersection performance degraded under Scenario 2 compared with Scenario 1, it was concluded that Airport-related traffic caused the capacity constraints at the study intersections.

Intersection Analysis Planning Years

The analysis was conducted for three future years—2015, 2020, and 2030—in addition to a baseline year of 2012. In addition to the baseline, 2015 was selected to correspond to the anticipated opening of the FIS facilities and the initiation of international flights at HOU by Southwest Airlines. The years 2020 and 2030 were selected to determine the long-term effects of growth in non-Airport-related background traffic as well as Airport-related traffic.

Analysis Peak Hour

The intersections were analyzed during the commuter peak hour between 5:00 p.m. and 6:00 p.m. for all intersections with the exception of Airport Boulevard and Glencrest Street. For this analysis, it was assumed that the a.m. commuter peak hour would have traffic flows in the opposite direction from the p.m. commuter peak hour. Therefore, the intersection improvements recommended as a result of the p.m. commuter peak hour analysis was mirrored to account for increased demand in the opposite direction.

The intersection of Airport Boulevard and Glencrest Street is expected to serve an expanded surface public parking lot, as well as an expanded employee parking lot, located on the south side of the intersection. The critical maximum traffic at this intersection is expected to occur during employee shift changes. Based on data collected by Gunda Corporation, LLC, the employee shift change peak traffic occurs between 1:30 p.m. and 2:30 p.m. Traffic data at this intersection were unavailable for this time period; therefore, the parking lot entrance and exit volumes for the proposed southern approach to this intersection generated during the peak period between 1:30 p.m. and 2:30 p.m. were used in combination with traffic volumes during the midday peak hour of 12:00 p.m. to 1:00 p.m. for all other approaches to provide a conservative analysis of the intersection.

4.4.3.3 Traffic Forecasting and Trip Generation

Trip Generation for New Surface Parking Lot

The proposed surface parking lot on the east side of the Airport is expected to be connected to the roadway network at the intersection of Airport Boulevard and Glencrest Street by means of a new roadway connecting with the south side of the intersection. This parking lot is expected to provide approximately 1,060 public parking spaces and 800 employee parking spaces. The public parking spaces would generate trips based on parking lot use, which will depend on airline schedules and general parking behavior of the patrons, which is unique to each airport. The employee spaces would typically generate traffic only during a shift change.

Public Parking Trips: Public parking trips were generated using a parking model previously developed by Ricondo & Associates, Inc., as part of the parking requirements study conducted for the Airport. The per space turnover rate was obtained using this model and applied to the proposed 1,060 spaces to estimate the trips that would be generated by the public parking portion of the new surface lot. Public parking trips represent the peak hourly demand at an intersection (by turning movement and by classification). They are not tied to any landside peak hour flows, but rather the "peak hour" projected at the terminal. Thus, the numbers should be interpreted as "the peak load". It was determined from the analysis that the peak hour turnover rate per space was 9.5 percent for short-term parking. **Table 4-66** shows the public parking trips expected to be generated.

Table 4-66: Public Parking Trips at Airport Boulevard and Glencrest Street

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND		
	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT
2012	53	0	47	0	0	0	0	0	24	21	0	0
2015	58	0	51	0	0	0	0	0	26	23	0	0
2020	66	0	59	0	0	0	0	0	30	26	0	0
2030	76	0	67	0	0	0	0	0	34	30	0	0

SOURCE: Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

Parking trip growth rates were estimated on the basis of annual growth rather than peak hour growth. To determine traffic volumes between 2012 and 2015, a 2.1 percent per year growth rate was used. Traffic volumes between 2015 and 2020 were grown at a rate of 2.7 percent per year growth and between 2020 and 2030, a 1.4 percent per year growth rate was used. These growth rates were determined by comparing the growth in numbers of passengers forecast between baseline year 2012 and the future planning years from the design day flight schedules as well as on the basis of Airport operations growth forecast between baseline year 2012 and each of the future planning years.

Employee Parking Trips: Existing employee parking lot entry and exit counts were used to generate numbers of employee trips. The trips generated for the employee portion of the parking lot (800 spaces) was then grown using the Airport operations growth rates for each planning year. To determine traffic growth between 2012 and 2015, a 2.1 percent per year growth rate was used. To determine traffic growth between

2015 and 2020, a 2.7 percent per year growth rate was used, and to determine growth between 2020 and 2030, a 1.4 percent per year growth rate was used. Growth rates were determined by comparing the growth in Airport operations forecast between baseline year 2012 and each of the future planning years.

It is anticipated that the intersection of Airport Boulevard and Glencrest Street will experience higher turning volumes during the employee shift change between 1:30 p.m. and 2:30 p.m. As a result, this intersection was analyzed using midday peak hour volumes supplemented with peak employee trips to provide a conservative analysis.

Table 4-67 shows the employee trips in and out of the new parking lot proposed to be located at the intersection of Airport Boulevard and Glencrest Street.

Table 4-67: Employee Parking Trips at Airport Boulevard and Glencrest Street

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND		
	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT
2012	81	0	72	0	0	0	0	0	76	70	0	0
2015	88	0	78	0	0	0	0	0	83	76	0	0
2020	101	0	90	0	0	0	0	0	95	87	0	0
2030	116	0	103	0	0	0	0	0	109	100	0	0

SOURCE: Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

Total Intersection Trips: The new parking lot entry and exit traffic volumes were generated using the traffic counts at the existing employee parking lot and then combined with the traffic volumes derived from the trip generation of public parking spaces. Background traffic was then added to the count and the total intersection turning volumes were determined. **Table 4-68** shows the total trips generated at the intersection of Airport Boulevard and Glencrest Street.

Table 4-68: Total Trips at Airport Boulevard and Glencrest Street

	NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND		
	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT
2012	134	0	119	50	0	50	50	1,124	100	91	961	50
2015	146	0	130	53	0	53	53	1,193	109	99	1,020	53
2020	167	0	148	57	0	57	57	1,285	125	113	1,099	57
2030	192	0	170	66	0	66	66	1,491	143	130	1,275	66

SOURCE: Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

Traffic Forecast at Other Intersections

Traffic at the intersections of Airport Boulevard and Monroe Road, Airport Boulevard and Telephone Road, and Airport Boulevard and Broadway Street was forecast based on passenger growth factors for each planning year.

Growth Factors: Non-Airport-related background traffic was increased 1.5 percent per year from 2012 to 2030. Based on the design day flight schedules developed by Ricondo & Associates, Inc., for each planning year, passenger numbers at the Airport during the p.m. peak hour (5:00 p.m. to 6:00 p.m.) were determined. Table 4-69 presents the growth rates derived from the design day schedules. These growth rates are different from those used to increase employee and public parking trips because these growth rates are based on numbers of passengers during the p.m. peak hour, while parking growth is based on design day growth in aircraft operations.

Table 4-69: Airport-related Traffic Growth Rates

	2012	2015	2020	2030
Numbers of Passengers in the p.m. Commuter Peak Hour	1,409.3	1,578.6	1,850.3	2,505.0
Growth from 2012		12%	31%	78%

SOURCE: Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

Analysis Scenarios: The intersections were analyzed for capacity constraints using Synchro, a commercially available traffic analysis software. The analysis was conducted for the following two scenarios:

- **Scenario 1**: Future intersection performance with background traffic increasing 1.5 percent per year to each planning year and Airport-related traffic at 2012 levels.
- **Scenario 2**: Future intersection performance with background traffic increasing 1.5 percent per year to each planning year and Airport-related traffic increasing based on passenger growth shown in Table 5-13.

The results of the analysis of the two scenarios were compared to determine if the increase in Airport-related traffic resulting from Airport growth would significantly affect the intersections.

Traffic Volumes: Table 4-70 shows the traffic volumes for the three intersections analyzed under each scenario. The intersection of Airport Boulevard and Glencrest Street was not analyzed because the improvements needed would be triggered as a result of facility expansions.

However, in the case of other intersections, the Airport contribution to the degradation of intersection level of service needed to be measured and, therefore, these intersections were analyzed under both scenarios.

4.4.3.4 Roadway Intersection Analysis

The intersections were analyzed under both scenarios using Synchro software. The traffic signals were optimized for future year scenarios.

Table 4-70: Intersection Volumes

		NORTHBOUND			SOUTHBOUND			EASTBOUND			WESTBOUND		
		LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT
Airport Boulevard at Telephone Road													
Baseline	2012	53	603	332	200	1,018	124	175	444	110	315	310	68
	2015	56	640	348	210	1,080	132	186	466	117	328	323	71
Scenario 1	2020	61	689	370	223	1,164	142	200	495	126	346	340	75
	2030	70	800	419	253	1,351	165	232	561	146	385	379	83
	2015	56	640	356	215	1,080	132	186	476	117	340	335	73
Scenario 2	2020	61	689	391	235	1,164	142	200	522	126	377	371	81
	2030	70	800	470	283	1,351	165	232	628	146	463	456	100
Airport Boulevard at Monroe Road													
Baseline	2012	158	567	56	59	647	99	252	880	223	123	617	57
	2015	164	602	59	63	687	103	262	916	232	131	639	61
Scenario 1	2020	171	648	64	68	740	107	276	963	244	141	668	65
	2030	188	752	74	78	859	118	306	1,069	271	163	734	76
	2015	172	602	59	63	687	108	273	952	241	131	670	61
Scenario 2	2020	192	648	64	68	740	120	303	1,057	268	141	749	65
	2030	239	752	74	78	859	150	373	1,303	330	163	935	76
Airport Boulevard at Broadway Street													
Baseline	2012	221	215	466	176	0	201	186	783	191	0	611	136
	2015	221	215	466	187	0	213	197	831	191	0	648	144
Scenario 1	2020	221	215	466	201	0	230	213	895	191	0	699	156
	2030	221	215	466	234	0	267	247	1039	191	0	811	180
	2015	248	241	522	187	0	213	197	831	214	0	648	144
Scenario 2	2020	290	282	612	201	0	230	213	895	251	0	699	156
	2030	393	382	828	234	0	267	247	1,039	340	0	811	180

SOURCE: Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

Level of Service Criteria

Intersection level-of-service analysis is used to quantitatively determine the efficiency of the signalized intersections. Intersection level of service is a function of delay contributed by the presence of a traffic control device, either a traffic signal or a stop sign, and is expressed in seconds per vehicle based on the criteria listed in **Table 4-71**.

Table 4-71: Level of Service Criteria for Signalized Intersections

LOS	CONTROL DELAY (SECONDS PER VEHICLE)	CONDITIONS
A	<= 10	EXCELLENT: No vehicle waits longer than one red light and no approach phase is fully used.
B	10-20	VERY GOOD: An occasional approach phase is fully used; many drivers begin to feel somewhat restricted within groups of vehicles.
C	20-35	GOOD: Occasionally, drivers may have to wait through more than one red light; backups may develop behind turning vehicles.
D	35-55	FAIR: Delays may be substantial during portions of the rush hours, but enough lower volume periods occur to permit clearing of developing lines, preventing excessive backups.
E	55-80	POOR: Represents the most vehicles that intersection approaches can accommodate; may be long lines of waiting vehicles through several signal cycles.
F	Greater than 40	FAILURE: Backups from nearby intersections or on cross streets may restrict or prevent movement of vehicles out of the intersection approaches. Tremendous delays with continuously increasing queue lengths.

SOURCE: Transportation Research Board, National Research Council, *Highway Capacity Manual,* 2000.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

Analysis Results

The analysis of intersection delays and level of service is summarized in **Table 4-72** for each planning year under both scenarios.

Airport Boulevard and Telephone Road: This intersection performed at LOS D under baseline conditions (2012). Under Scenario 1 (no Airport growth) in 2015, the intersection was determined to perform at LOS D and in 2020 and 2030, the intersection was determined to operate at LOS E. Under Scenario 2, (with Airport growth), the intersection was determined to perform at LOS E in 2015 and 2020 under both scenarios; however, the delays increased under Scenario 2. The intersection was determined to operate at LOS F with severe traffic delays in 2030 under Scenario 2.

Airport Boulevard and Monroe Road: This intersection was determined to perform at LOS D under baseline conditions (2012). Under Scenario 1 (no Airport growth), the intersection was determined to perform at LOS D in 2015 and at LOS E in 2020 and 2030. Under Scenario 2 (with Airport growth), the intersection was determined to perform at LOS E in 2015 and 2020; however, the delays increased under Scenario 2. The intersection was determined to operate at LOS F, with severe traffic delays, in 2030 under Scenario 2.

Airport Boulevard and Broadway Street: This intersection was determined to perform at LOS C in all planning years under both scenarios, with delays slightly higher under Scenario 2.

Table 4-72: Intersection Levels of Service

	2012			2015						2020						2030					
	BASELINE			SCENARIO 1			SCENARIO 2			SCENARIO 1			SCENARIO 2			SCENARIO 1			SCENARIO 2		
INTERSECTION	LOS	DELAY 1/	V/C	LOS	DELAY 1/	V/C	LOS	DELAY 1/	V/C	LOS	DELAY 1/	V/C	LOS	DELAY 1/	V/C	LOS	DELAY 1/	V/C	LOS	DELAY 1/	V/C
Airport Boulevard at Telephone Road	D	49.6	0.95	D	53.7	1.01	E	55.8	1.04	E	59.7	1.09	E	65.1	1.15	E	77.8	1.23	F	96.2	1.29
Airport Boulevard at Broadway Street	C	21.9	0.56	C	22.1	0.60	C	22.3	0.60	C	22.5	0.65	C	22.8	0.65	C	23.3	0.75	C	24.2	0.79
Airport Boulevard at Monroe Road	D	51.1	0.91	D	53.8	0.92	E	55.2	0.95	E	58.2	0.96	E	62.8	1.05	E	73.0	1.09	F	94.8	1.29

NOTES:

LOS = Level of Service

V/C = Volume to Capacity Ratio

1/ Delay is presented in seconds per vehicle.

SOURCE: Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

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4.5 Public Parking Facility Requirements

This section summarizes the space requirements for all public parking facilities serving the Airport. The parking requirements were derived from existing (2011) conditions at the Airport. Future requirements were determined by applying the forecast growth rate for originating passengers at the Airport.

4.5.1 STUDY AREA CONDITIONS

At the time of the analysis, a total of 4,360 public parking spaces were provided at the Airport in the terminal area and economy parking facilities. **Table 4-73** summarizes the 2011 on-Airport public parking facilities. The existing parking garage accounted for approximately 79 percent of total Airport public parking spaces. Economy parking was provided in two remote parking lots: Ecopark - Lot 1 and Ecopark - Lot 2.

The maximum daily rate for parking in the existing parking garage is $17, while the daily rates for economy parking are $10 in Ecopark - Lot 1 and $6 in Ecopark - Lot 2. Based on the current parking rate schedule, the maximum daily rate for parking in the existing parking garage is reached in 5 hours, whereas the maximum daily rate in the economy lots is reached in 3 hours.

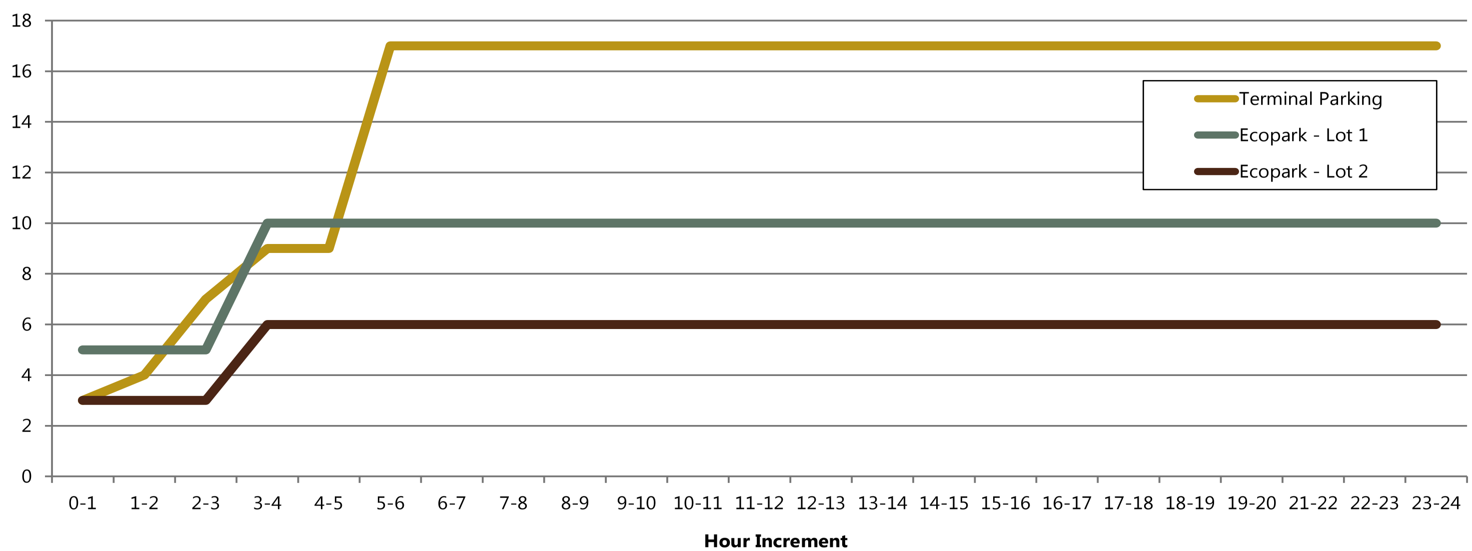
Further descriptions of the on-Airport public parking facilities existing at the time of the analysis are provided below:

- The **existing parking garage** is located immediately north of the Terminal. The four-story structure provides 3,438 parking spaces. The garage has historically been the Airport's most popular public parking option. Planning of a West Parking Garage was underway at the time of the analysis; however, no sizing information was available yet; as such, the West Parking Garage capacity was not included in the analysis. Construction of the West Parking Garage started in Spring 2014. As described in Appendix B, the West Parking Garage was planned for approximately 3,100 spaces, which would result in 2,500 net new spaces.
- **Ecopark - Lot 1** is the middle-priced on-Airport public parking option. The 566-space lot is located west of the garage, within walking distance of the Terminal. Ecopark – Lot 1 was decommissioned in Spring 2014 for the construction of the West Parking Garage.
- **Ecopark - Lot 2** is the least expensive on-Airport public parking option. The 356-space lot is located northeast of the garage. Ecopark - Lot 2 is farthest from the Terminal, although still within walking distance. Ecopark – Lot 2 was expanded in November 2013 to 1,022 spaces.

Since the public parking requirements analysis was completed, a new Valet Parking service was introduced at the Airport.

Table 4-73: Current (2011) on-Airport Public Parking Products and Rates

PARKING PRODUCT	NUMBER OF SPACES	MAXIMUM DAILY RATE	HOURLY RATE PROGRESSION						HOURS TO REACH DAILY MAXIMUM
			0 - 1 HOUR	1 - 2 HOUR	2 - 3 HOUR	3 - 4 HOUR	4 - 5 HOUR	5 - 24 HOUR	
Existing Parking Garage	3,438	$17.00	$3.00	$4.00	$7.00	$9.00	$9.00	$17.00	5
Ecopark - Lot 1	566	$10.00	$5.00	$5.00	$5.00	$10.00	$10.00	$10.00	3
Ecopark - Lot 2	356	$6.00	$3.00	$3.00	$3.00	$6.00	$6.00	$6.00	3
Total	**4,360**								



SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-74 provides an overview of the parking facilities provided by off-Airport parking operators at the time of the analysis (2011). Five dedicated off-Airport parking operators serve the Airport and directly compete with the on-Airport parking products. The off-Airport parking operators offer a total of 5,701 spaces, accounting for 86 percent of remote parking capacity, while the remaining 14 percent of remote parking capacity is provided in Ecopark products on the Airport. When taxes are included, the average maximum daily rate for off-Airport parking ($7.70) is between that for Ecopark - Lot 2 ($6) and Ecopark - Lot 1 ($10).

Table 4-75 provides annual numbers of parking transactions for 2006 through 2011.[5] The total number of annual parking transactions decreased from 1,021,348 in 2006 to 824,339 in 2010, representing a compound annual decrease of 5.2 percent during this period. During this same period, the number of originating passengers at the Airport increased from 3,329,885 to 3,546,227, representing a compound annual increase of 1.6 percent. This suggests a possible diversion of customers to off-Airport parking operators or a change in mode split to an increased number of curbside pickups and dropoffs, with a decrease in the number of passengers opting to park at the Airport. Between 2006 and 2010, the existing parking garage accounted for approximately 91 percent of all on-Airport public parking transactions. Based on data through October 2011, the total number of parking transactions is estimated to have increased 6.7 percent in 2011 compared with the number in 2010.

Table 4-76 shows the distribution of parking transactions and revenues by parking facility and incremental duration for July 2011, the peak month for parking transactions at the Airport. Given the available data, parking transactions at the two economy lots were aggregated. As shown, 58.0 percent of all Airport parking durations during July 2011 were for less than 3 hours. These short-term parkers were primarily meeters/greeters and well-wishers transporting airline passengers to/from the Airport. Given the location of the existing parking garage relative to the Terminal, short-stay parkers (0 – 3 hours) account for the majority of garage transactions (63.2 percent) at the Airport. In comparison, 74.2 percent of all transactions at the economy lots represent durations longer than 24 hours.

Table 4-77 presents monthly parking transactions by month for 2007 through 2010. The peak month for total on-Airport public parking transactions has historically been July. For purposes of this analysis, the peak month of July 2011 was used to forecast future parking demand. It should be noted that each parking facility experiences different demand trends throughout the year. Demand is consistently high in most facilities throughout the year, with July being the overall peak month.

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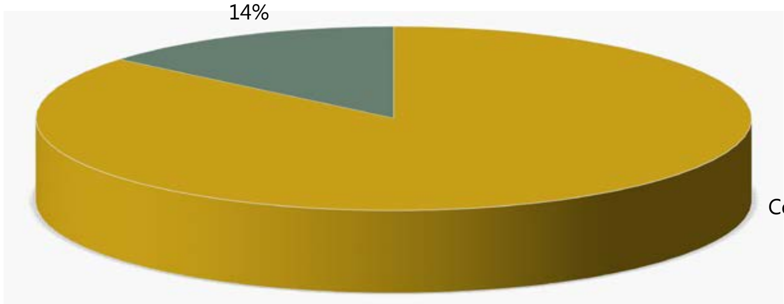
5 Parking transactions for 2011 were estimated based on data for January through October 2011.

Table 4-74: Summary of Long-Term Parking Facilities

OFF-AIRPORT COMMERCIAL PARKING FACILITY	NUMBER OF SPACES		COVERED OR UNCOVERED	ADVERTISED MAXIMUM DAILY RATE 1/	DISTANCE TO/FROM TERMINAL (MILES)
Ace Park & Ride	323		Covered	$8.08	0.4
	709		Uncovered	$6.92	
FastTrack Airport Parking (The Parking Spot)	-		Covered	N/A	0.8
	1,470		Uncovered	$6.92	
PreFlight Airport Parking	1,226		Covered	$9.00	0.8
	307		Uncovered	$6.50	
Super Park	287		Covered	$7.00	0.6
	-		Uncovered	N/A	
The Parking Spot	706		Covered	$9.24	2.0
	673		Uncovered	$6.92	
Total Off-Airport Commercial Parking	**5,701**	**86%**		**$7.70 2/**	
On-Airport Long-term (Ecopark)	922	14%	Uncovered	$6 / $10 3/	
Total Long-term Parking Capacity	**6,623**				



NOTES:

1/ Represents advertised maximum daily rate (including 16.25 percent tax) from Internet search on November 21, 2011. Discounts may be available with Internet coupons. Rates do not include per stay service fee.

2/ Includes all fees and taxes.

3/ Weighted average parking rate (weighted by the number of spaces).

4/ The Ecopark remote parking product at HOU shows different rates for Lot 1 ($7) and Lot 2 ($5). The Airport's advertised rates include all taxes and fees.

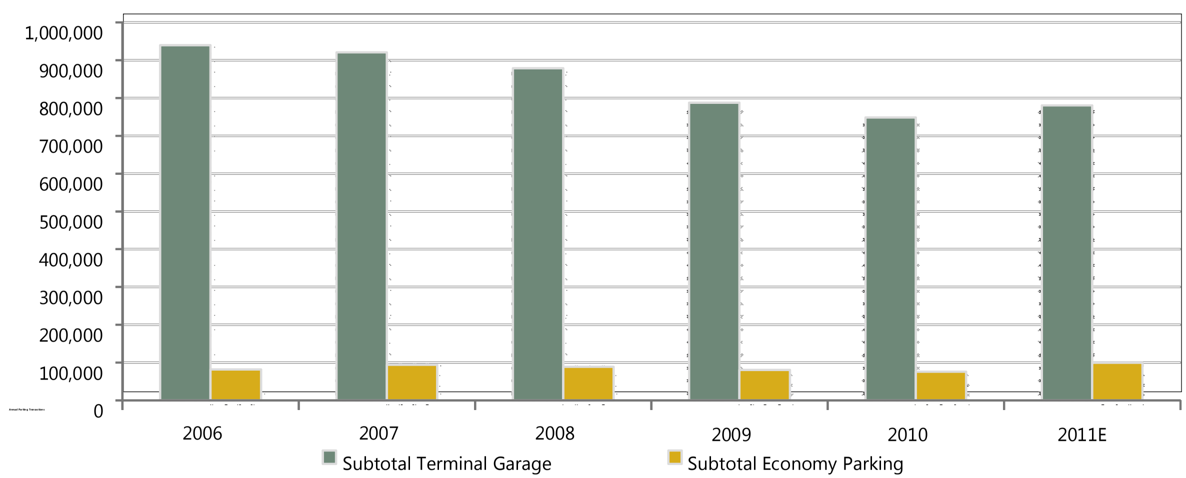
SOURCE: Official websites for different parking facilities, accessed November 21, 2011.

PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-75: Historical Transactions by Parking Product (2006 - 2011E)

		ANNUAL PARKING TRANSACTIONS						COMPOUND ANNUAL GROWTH RATE	
PARKING PRODUCT		2006	2007	2008	2009	2010	2011E [1/]	2006 - 2010	2010 - 2011
Existing Parking Garage	Short-term	551,238	341,490	-	-	-	-		
	Long-term	388,651	579,327	878,603	787,324	748,609	780,300		
Subtotal Terminal Parking		**939,889**	**920,817**	**878,603**	**787,324**	**748,609**	**780,300**	**-5.5%**	**4.2%**
Economy Parking	Ecopark - Lot 1	81,459	93,861	88,500	80,410	75,383	73,600		
	Ecopark - Lot 2 [2/]	-	-	-	-	347	25,800		
Subtotal Economy Parking		**81,459**	**93,861**	**88,500**	**80,410**	**75,730**	**99,400**	**-1.8%**	**31.3%**
Annual Parking Transactions		**1,021,348**	**1,014,678**	**967,103**	**867,734**	**824,339**	**879,700**	**-5.2%**	**6.7%**

Historical Parking Transactions (2006 to 2011E)



NOTES:

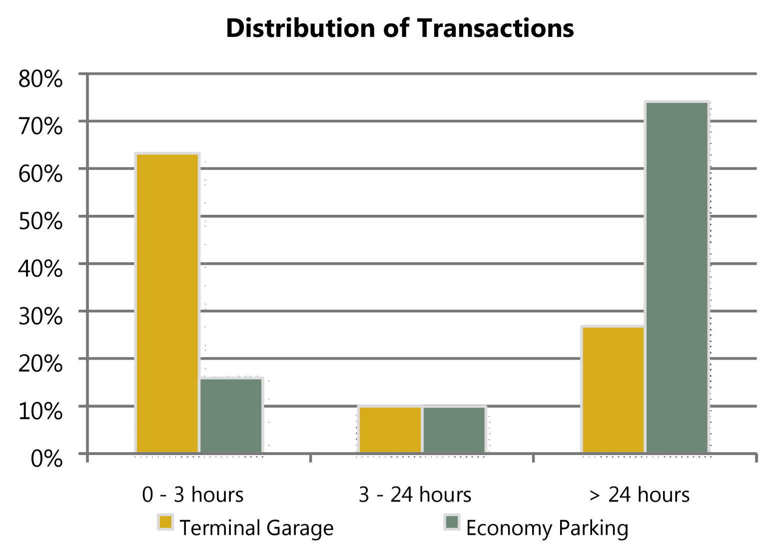
1/ Parking transactions for 2011 were estimated based on data for January through October 2011.

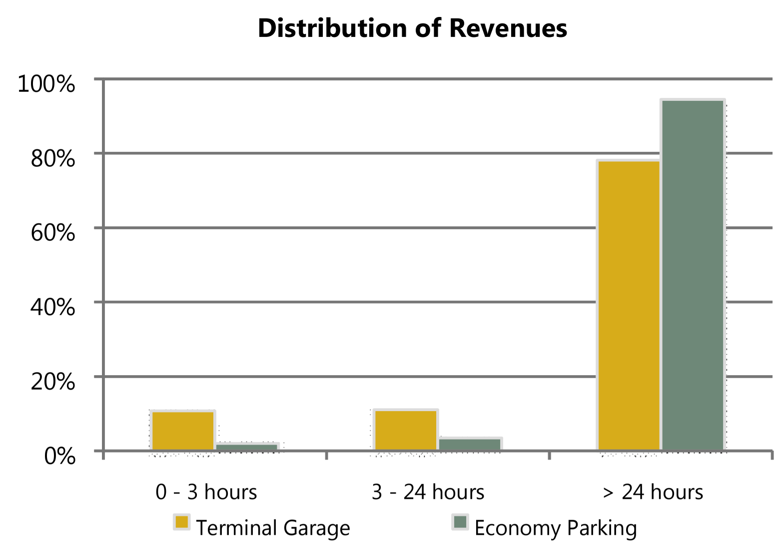
2/ Ecopark - Lot 2 opened in December 2010.

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-76: Distribution of Parking Transactions by Duration Category (July 2011)

	DISTRIBUTION OF TRANSACTIONS BY DURATION CATEGORY			DISTRIBUTION OF REVENUES BY DURATION CATEGORY		
DURATION INCREMENT	EXISTING PARKING GARAGE	ECONOMY PARKING	OVERALL	EXISTING PARKING GARAGE	ECONOMY PARKING	OVERALL
0 - 3 hours	63.2%	15.9%	58.0%	10.8%	2.1%	9.5%
3 - 24 hours	9.9%	9.9%	10.0%	11.1%	3.5%	9.9%
> 24 hours	26.9%	74.2%	32.0%	78.1%	94.4%	80.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**



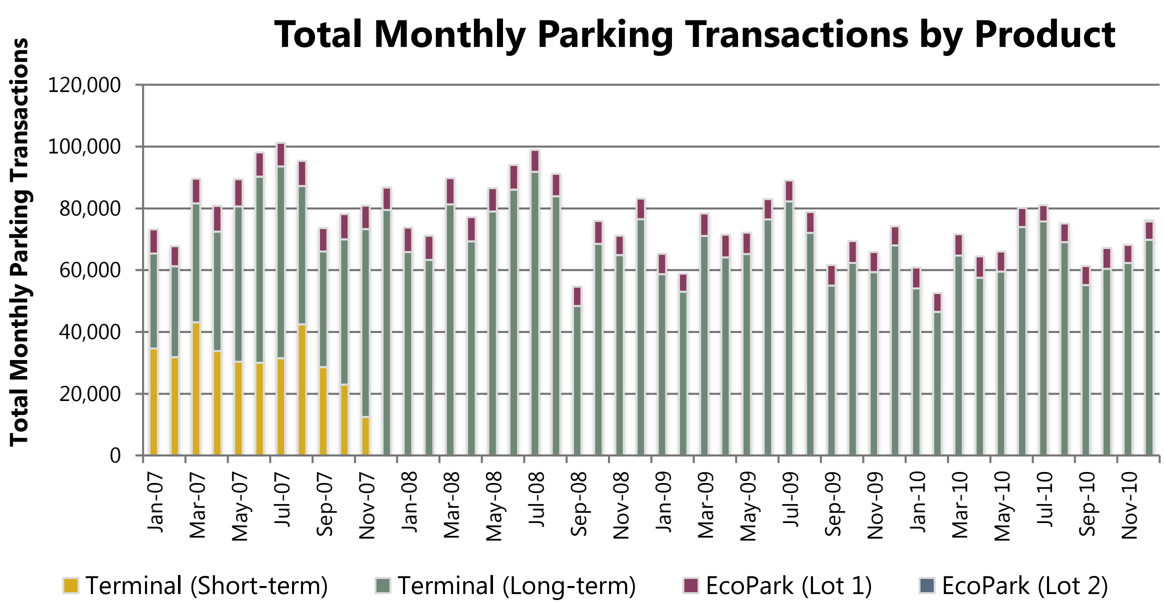


NOTE: Based on distribution estimated for July 2011.

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-77: Historical Monthly Parking Transactions

	TOTAL MONTHLY PARKING TRANSACTIONS			
MONTH	**2007**	**2008**	**2009**	**2010**
January	73,198	73,743	65,248	60,832
February	67,732	71,116	58,819	52,590
March	89,572	89,725	78,325	71,604
April	80,740	77,155	71,432	64,416
May	89,447	86,514	72,135	65,981
June	98,114	94,040	82,956	80,097
July	101,234	98,863	88,980	81,049
August	95,340	91,164	78,763	75,045
September	73,615	54,651	61,684	61,298
October	78,134	75,868	69,410	67,155
November	80,847	71,133	65,838	68,187
December	86,705	83,131	74,144	76,085
Annual Total	**1,014,678**	**967,103**	**867,734**	**824,339**
Peak Month (July)	101,234	98,863	88,980	81,049



SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

The daily distribution of peak period parking occupancy, collected at 4:00 p.m., in the existing parking garage, Ecopark - Lot 1 and Ecopark - Lot 2, and total on-Airport parking facilities is shown on **Exhibit 4-39** through **Exhibit 4-41**, respectively. The data are sorted in decreasing order of occupied spaces, which represents peak daily parking demand. Noted on the individual exhibits are the design day occupancies, which are represented by the 95th percentile daily peak occupancy.

- As shown on Exhibit 4-39, on the 95th percentile design day (July 26, 2011), a total of 3,410 vehicles were parked in the existing parking garage. Comparing the design day demand with the capacity in the existing parking garage (3,438 spaces) produces an occupancy rate of 99.2 percent.
- As shown on Exhibit 4-40, on the 95th percentile design day (December 25, 2011), a total of 920 vehicles were parked in the economy lots. Comparing the design day demand with the capacity of the economy lots (922 spaces) produces an occupancy rate of 99.8 percent.
- As shown on Exhibit 4-41, on the 95th percentile design day (September 22, 2011), a total of 4,297 vehicles were parked at on-Airport public parking facilities. Comparing the design day demand with the capacity of the on-Airport public parking facilities (4,360 total spaces) produces an occupancy rate of 98.6 percent.

The data depicted on the exhibits indicate a constrained condition in which the on-Airport parking facilities are operating at or near their effective capacity for much of the year. This level of constraint may indicate that the actual demand for on-Airport public parking is not being met and that customers wishing to park on-Airport are opting to park at off-Airport privately operated facilities or diverting to other modes of transportation to access the Airport.

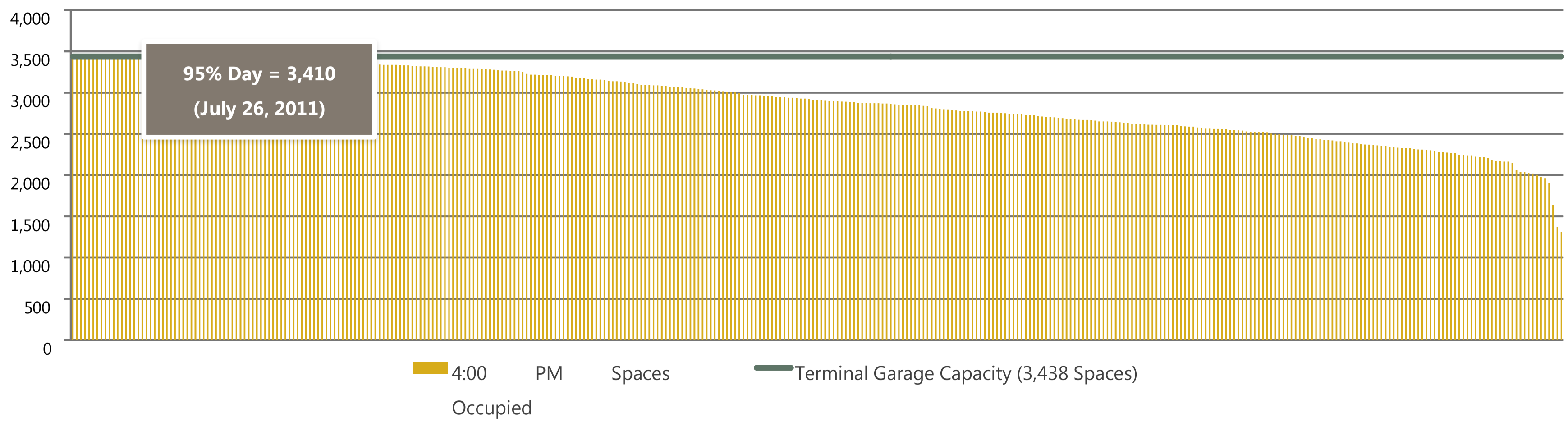
4.5.2 EXISTING (2011) PUBLIC PARKING DEMAND

Detailed parking data by on-Airport parking facilities were collected and analyzed. The data included monthly vehicle exit transactions and revenues, daily occupancy counts, and transactions by duration. Using these data, a parking demand model was calibrated for use in this analysis. The model parameters were, on average, calibrated within 5 percent of actual.

The model was calibrated on a facility-by-facility basis using the following data provided by the parking operator at the Airport:

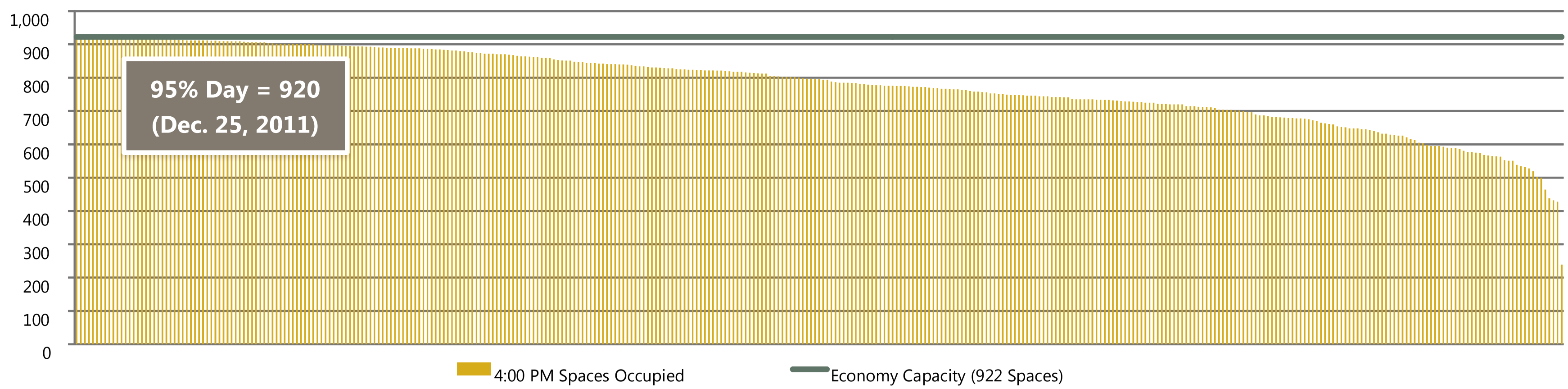
- **Monthly Transactions** - Total monthly transactions, January 2000 through June 2011.
- **Daily Occupancy Counts** - Daily parking inventory counts collected at 10:00 am and 4:00 pm at the existing parking garage, Ecopark - Lot 1 and Ecopark - Lot 2.
- **Overnight Counts** - Daily overnight counts collected at the existing parking garage, Ecopark - Lot 1 and Ecopark - Lot 2.
- **Duration Reports** - Monthly transactions by facility and duration for July 2011.

Exhibit 4-39: 2011 Daily Occupancy (Existing Parking Garage)



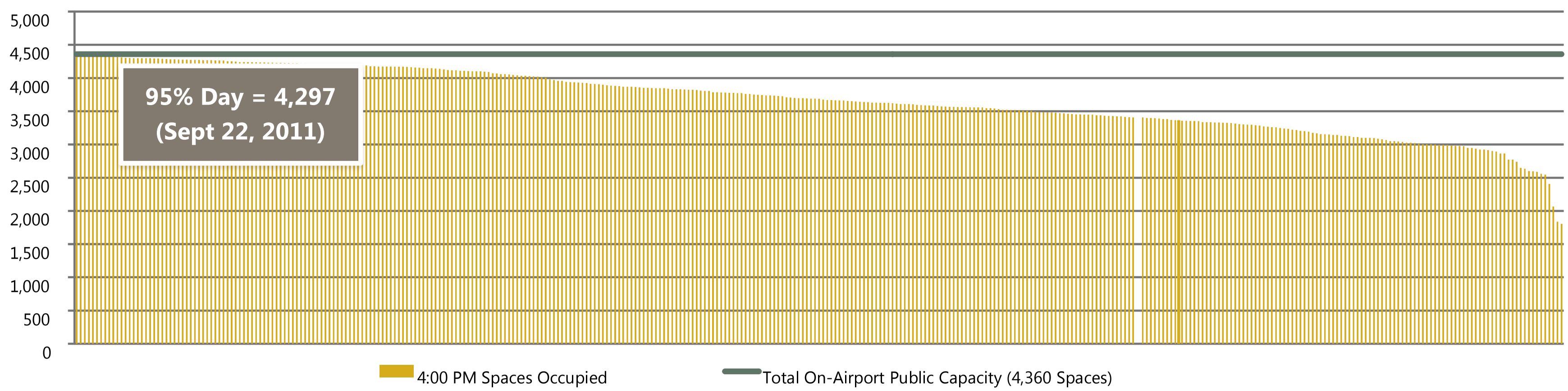
SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Exhibit 4-40: 2011 Daily Occupancy (Ecopark - Lot 1 and Ecopark - Lot 2)



SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Exhibit 4-41: 2011 Daily Occupancy (Total Parking System)



SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Existing public parking demand was computed using transaction data for the peak month (July 2011) and the correlation between average turnover per space and daily peaking characteristics. The demand for spaces equals the daily number of transactions divided by the turnover rate.

Table 4-78 summarizes the calculated 2011 design day on-Airport public parking demand by facility and the results of the model calibration. Total existing design day demand was estimated to be 3,810 parking spaces. This design day demand accounts for approximately 87.4 percent of current capacity. As also shown, the calibrated peak occupancy is within 2.0 percent of actual occupancy, which is a sufficient correlation for purposes of this analysis.

4.5.3 FUTURE PARKING REQUIREMENTS

Parking garages are typically planned to accommodate design day parking demand. The design day was selected based on the goal of accommodating approximately 95 percent of demand on the peak parking days throughout the year, which, in this case, represents the 18th busiest day of the year. Transaction information provided by Airport staff confirms that the design day represents a typical busy day in July. Adequate overflow facilities should be provided to accommodate the peak day demand that typically occurs during holiday periods. Parking demand is converted to design day requirements by applying a factor to help ensure an adequate buffer of additional spaces to allow customers to find a parking space without undue search time. This factor consists of a buffer of 5.0 percent applied to long-term (economy) spaces that have low turnover rates. A larger buffer of 10.0 percent was applied to the demand for short-term parking spaces in facilities, such as the existing parking garage, that typically accommodate a higher number of transactions and resulting space turnover.

Future requirements were projected based on the assumption that parking activity will increase in proportion to forecast growth in numbers of originating passengers. A variety of passenger growth scenarios and parking demand scenarios were used to develop a range of future parking requirements calculated on a design day basis.

4.5.3.1 Passenger and Parking Growth Scenarios

Parking requirements through 2030 were developed based on three originating passenger growth scenarios: Baseline, Low Growth, and High Growth, as described in Section 3, and for three parking demand scenarios: Baseline, Scenario 1 (Medium Growth), and Scenario 2 (High Growth). The originating passenger growth scenarios were developed based on input from stakeholders and represent conservative, average, and aggressive originating passenger growth. **Table 4-79** presents the range of passenger growth forecasts used in this analysis. As shown in the table, annual growth rates vary from year to year, with a surge factor applied for the anticipated initiation of airline flights to international destinations.

Table 4-78: 2011 Design Day On-Airport Public Parking Demand Summary

		ECOPARK			
	EXISTING PARKING GARAGE	LOT 1	LOT 2	TOTAL	TOTAL PUBLIC PARKING
Existing (2011) Demand Summary:					
Design Day Demand (spaces)	2,910	570	330	900	3,810
Current Capacity (spaces)	3,438	566	356	922	4,360
Demand as Percent of Current Capacity	84.6%	100.7%	92.7%	97.6%	87.4%
Calibration Results:					
Occupancy					
Estimated Percent Occupied:	79.8%	100.2%	92.9%		
Actual Percent Occupied:	80.9%	100.0%	92.7%		
Percent Difference	-1.1%	0.2%	0.2%		
Length of Stay					
Estimated Average Length of Stay (hours)	21.6	77.5	77.5		
Actual Average Length of Stay (hours)	28.8	75.1	75.4		
Percent Difference	-25.0%	3.2%	2.8%		

SOURCE: Ricondo & Associates, Inc., June 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-79: Passenger Growth Scenarios

	BASELINE		LOW GROWTH		HIGH GROWTH	
YEAR	AMBIENT GROWTH	INTERNATIONAL OPERATIONS	AMBIENT GROWTH	INTERNATIONAL OPERATIONS	AMBIENT GROWTH	INTERNATIONAL OPERATIONS
2012	1.8%	-	1.8%	-	1.8%	-
2013	2.1%	-	1.4%	-	2.1%	-
2014	2.7%	-	1.4%	-	2.7%	-
2015	2.7%	7.7%	1.4%	2.1%	2.7%	8.4%
2016	2.8%	-	2.5%	-	3.5%	-
2017	2.8%	-	2.5%	-	3.5%	-
2018	2.8%	-	2.5%	-	3.5%	-
2019	2.8%	-	2.5%	-	3.5%	-
2020	2.8%	-	1.4%	-	1.9%	-
2021	2.0%	-	2.1%	-	2.8%	-
2022	2.0%	-	2.1%	-	2.8%	-
2023	2.0%	-	2.1%	-	2.8%	-
2024	2.0%	-	2.1%	-	2.8%	-
2025	2.0%	-	2.1%	-	2.8%	-
2026	2.0%	-	2.1%	-	2.8%	-
2027	2.0%	-	2.1%	-	2.8%	-
2028	2.0%	-	2.1%	-	2.8%	-
2029	2.0%	-	2.1%	-	2.8%	-
2030	2.0%	-	2.0%	-	2.4%	-

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

The parking demand scenarios account for a variety of parking characteristics that could be observed at the Airport in future years. The three parking demand scenarios considered in this analysis are as follows:

- **Baseline Parking Demand Scenario** - Existing parking characteristics remain unchanged, and parking demand increases in proportion to the baseline growth forecast for passengers.
- **Parking Demand Scenario 1 (Medium Growth)** – The average parking duration increases when international operations begin in 2015. Of the total increase in parking demand resulting from international activity, 80 percent of parking patrons were assumed to park for longer than one day, while the remaining 20 percent were assumed to park for less than 3 hours.

- **Parking Demand Scenario 2 (High Growth)** – In addition to all aspects of Parking Demand Scenario 1, 10 percent of off-Airport parking demand would shift to on-Airport parking if additional capacity were available.

The passenger growth rates and parking demand scenarios were combined to develop nine parking requirement scenarios for on-Airport and off-Airport parking.

4.5.3.2 Off-Airport Parking Requirements

Off-Airport parking requirements were calculated by assuming that these facilities would be operated similarly to the on-Airport economy lots. Specifically, it was assumed that patrons of the off-Airport parking operations have similar parking duration distributions and average occupancy rates. Given the location and pricing of on- and off-Airport parking products, these assumptions are considered reasonable for purposes of this analysis.

4.5.3.3 Total Airport Parking Requirements

The extent to which public parking capacity at the Airport will need to be increased to accommodate future demand is dependent on the extent to which off-Airport facilities continue to expand to meet demand, the cost for parking both on-Airport and off-Airport, and amenities provided by each, among other factors.

If off-Airport parking operators do not expand to meet demand, at least some of that demand will shift to on-Airport parking facilities. Changes in parking pricing would also affect the distribution of demand among the various parking facilities.

4.5.3.4 Parking Requirements Summary

Table 4-80 through **Table 4-88** summarize the requirements for on-Airport public parking, off-Airport parking, and total parking by facility for 2011 through 2030 for the nine parking requirement scenarios. As shown in the tables, deficits in on-Airport public parking capacity begin to develop as early as 2014, with deficits in 2030 ranging from 1,853 spaces (in the Low Passenger Growth Forecast with Baseline Parking Demand) to 4,924 spaces (in the High Passenger Growth Forecast with Parking Demand Scenario 2 [High Growth]). Deficits in off-Airport parking capacity begin to develop in 2023, with deficits in 2030 as high as 1,370 spaces (in the High Passenger Growth Forecast with Parking Demand Scenario 1 [Medium Growth]). Deficits in total Airport parking capacity begin to develop as early as 2015, with deficits through 2030 ranging from 1,853 spaces (in the Low Passenger Growth Forecast with Baseline Parking Demand) to 5,584 spaces (in the High Passenger Growth Forecast with Parking Demand Scenario 2 [High Growth]).

Table 4-80: Baseline Passenger Growth Forecast – Baseline Parking Demand Scenario

	EXISTING (2011) CAPACITY				BASELINE PARKING FORECAST (ON-AIRPORT)					BASELINE PARKING FORECAST (OFF-AIRPORT)			TOTAL PARKING		
YEAR	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)
2011	3,438	566	356	4,360	3,201	602	351	4,154	206	5,700	3,820	1,880	10,060	7,974	2,086
2012	3,438	566	356	4,360	3,256	609	357	4,222	138	5,700	3,890	1,810	10,060	8,112	1,948
2013	3,438	566	356	4,360	3,333	630	368	4,331	29	5,700	3,970	1,730	10,060	8,301	1,759
2014	3,438	566	356	4,360	3,421	641	378	4,440	(80)	5,700	4,070	1,630	10,060	8,510	1,550
2015	3,438	566	356	4,360	3,773	714	410	4,897	(537)	5,700	4,500	1,200	10,060	9,397	663
2016	3,438	566	356	4,360	3,883	725	420	5,028	(668)	5,700	4,620	1,080	10,060	9,648	412
2017	3,438	566	356	4,360	3,993	746	441	5,180	(820)	5,700	4,750	950	10,060	9,930	130
2018	3,438	566	356	4,360	4,103	767	452	5,322	(962)	5,700	4,890	810	10,060	10,211	(151)
2019	3,438	566	356	4,360	4,213	788	462	5,463	(1,103)	5,700	5,030	670	10,060	10,493	(433)
2020	3,438	566	356	4,360	4,334	819	473	5,626	(1,266)	5,700	5,170	530	10,060	10,796	(736)
2021	3,438	566	356	4,360	4,422	830	483	5,735	(1,375)	5,700	5,270	430	10,060	11,005	(945)
2022	3,438	566	356	4,360	4,510	851	494	5,855	(1,495)	5,700	5,370	330	10,060	11,224	(1,164)
2023	3,438	566	356	4,360	4,598	861	504	5,963	(1,603)	5,700	5,480	220	10,060	11,443	(1,383)
2024	3,438	566	356	4,360	4,686	882	515	6,083	(1,723)	5,700	5,590	110	10,060	11,673	(1,613)
2025	3,438	566	356	4,360	4,785	903	525	6,213	(1,853)	5,700	5,700	-	10,060	11,913	(1,853)
2026	3,438	566	356	4,360	4,873	914	536	6,323	(1,963)	5,700	5,810	(110)	10,060	12,132	(2,072)
2027	3,438	566	356	4,360	4,972	935	546	6,453	(2,093)	5,700	5,930	(230)	10,060	12,383	(2,323)
2028	3,438	566	356	4,360	5,071	956	557	6,584	(2,224)	5,700	6,050	(350)	10,060	12,633	(2,573)
2029	3,438	566	356	4,360	5,170	977	567	6,714	(2,354)	5,700	6,170	(470)	10,060	12,884	(2,824)
2030	3,438	566	356	4,360	5,280	987	578	6,845	(2,485)	5,700	6,290	(590)	10,060	13,135	(3,075)

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-81: Baseline Passenger Growth Forecast – Parking Demand Scenario 1 (Medium Growth)

	EXISTING (2011) CAPACITY				SCENARIO 1: MEDIUM PARKING GROWTH FORECAST - INCREASED LENGTH OF STAY (ON-AIRPORT)					SCENARIO 1: MEDIUM PARKING GROWTH FORECAST (OFF-AIRPORT)			TOTAL PARKING		
YEAR	GARAGE	ECOPARK LOT 1	ECOPAR K LOT 2	TOTAL	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)
2011	3,438	566	356	4,360	3,201	602	351	4,154	206	5,700	3,820	1,880	10,060	7,974	2,086
2012	3,438	566	356	4,360	3,256	609	357	4,222	138	5,700	3,890	1,810	10,060	8,112	1,948
2013	3,438	566	356	4,360	3,333	630	368	4,331	29	5,700	3,970	1,730	10,060	8,301	1,759
2014	3,438	566	356	4,360	3,421	641	378	4,440	(80)	5,700	4,070	1,630	10,060	8,510	1,550
2015	3,438	566	356	4,360	4,301	725	420	5,446	(1,086)	5,700	4,600	1,100	10,060	10,046	14
2016	3,438	566	356	4,360	4,422	746	431	5,599	(1,239)	5,700	4,730	970	10,060	10,328	(268)
2017	3,438	566	356	4,360	4,543	767	452	5,762	(1,402)	5,700	4,860	840	10,060	10,621	(561)
2018	3,438	566	356	4,360	4,675	788	462	5,925	(1,565)	5,700	5,000	700	10,060	10,925	(865)
2019	3,438	566	356	4,360	4,807	809	473	6,089	(1,729)	5,700	5,140	560	10,060	11,228	(1,168)
2020	3,438	566	356	4,360	4,939	830	483	6,252	(1,892)	5,700	5,290	410	10,060	11,542	(1,482)
2021	3,438	566	356	4,360	5,038	851	494	6,383	(2,023)	5,700	5,390	310	10,060	11,772	(1,712)
2022	3,438	566	356	4,360	5,137	861	504	6,502	(2,142)	5,700	5,500	200	10,060	12,002	(1,942)
2023	3,438	566	356	4,360	5,236	882	515	6,633	(2,273)	5,700	5,610	90	10,060	12,243	(2,183)
2024	3,438	566	356	4,360	5,346	903	525	6,774	(2,414)	5,700	5,720	(20)	10,060	12,494	(2,434)
2025	3,438	566	356	4,360	5,445	914	536	6,895	(2,535)	5,700	5,830	(130)	10,060	12,724	(2,664)
2026	3,438	566	356	4,360	5,555	935	546	7,036	(2,676)	5,700	5,950	(250)	10,060	12,986	(2,926)
2027	3,438	566	356	4,360	5,665	956	557	7,178	(2,818)	5,700	6,070	(370)	10,060	13,247	(3,187)
2028	3,438	566	356	4,360	5,775	977	567	7,319	(2,959)	5,700	6,190	(490)	10,060	13,509	(3,449)
2029	3,438	566	356	4,360	5,896	998	578	7,472	(3,112)	5,700	6,310	(610)	10,060	13,781	(3,721)
2030	3,438	566	356	4,360	6,006	1,019	588	7,613	(3,253)	5,700	6,430	(730)	10,060	14,043	(3,983)

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-82: Baseline Passenger Growth Forecast – Parking Demand Scenario 2 (High Growth)

	EXISTING (2011) CAPACITY				SCENARIO 2: HIGH PARKING GROWTH FORECAST - INCREASED LENGTH OF STAY + OFF AIRPORT DEMAND SHIFT (ON-AIRPORT)					SCENARIO 2: HIGH PARKING GROWTH FORECAST (OFF-AIRPORT)			TOTAL PARKING		
YEAR	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)
2011	3,438	566	356	4,360	3,201	602	351	4,154	206	5,700	3,820	1,880	10,060	7,974	2,086
2012	3,438	566	356	4,360	3,256	609	357	4,222	138	5,700	3,890	1,810	10,060	8,112	1,948
2013	3,438	566	356	4,360	3,333	630	368	4,331	29	5,700	3,970	1,730	10,060	8,301	1,759
2014	3,438	566	356	4,360	3,421	641	378	4,440	(80)	5,700	4,070	1,630	10,060	8,510	1,550
2015	3,438	566	356	4,360	4,840	756	441	6,037	(1,677)	5,700	4,140	1,560	10,060	10,177	(117)
2016	3,438	566	356	4,360	4,972	777	452	6,201	(1,841)	5,700	4,260	1,440	10,060	10,461	(401)
2017	3,438	566	356	4,360	5,115	798	473	6,386	(2,026)	5,700	4,380	1,320	10,060	10,766	(706)
2018	3,438	566	356	4,360	5,258	830	483	6,571	(2,211)	5,700	4,500	1,200	10,060	11,071	(1,011)
2019	3,438	566	356	4,360	5,412	851	494	6,757	(2,397)	5,700	4,630	1,070	10,060	11,386	(1,326)
2020	3,438	566	356	4,360	5,555	872	504	6,931	(2,571)	5,700	4,760	940	10,060	11,691	(1,631)
2021	3,438	566	356	4,360	5,665	893	515	7,073	(2,713)	5,700	4,850	850	10,060	11,922	(1,862)
2022	3,438	566	356	4,360	5,786	903	525	7,214	(2,854)	5,700	4,950	750	10,060	12,164	(2,104)
2023	3,438	566	356	4,360	5,896	924	536	7,356	(2,996)	5,700	5,050	650	10,060	12,406	(2,346)
2024	3,438	566	356	4,360	6,017	945	546	7,508	(3,148)	5,700	5,150	550	10,060	12,658	(2,598)
2025	3,438	566	356	4,360	6,138	966	557	7,661	(3,301)	5,700	5,250	450	10,060	12,911	(2,851)
2026	3,438	566	356	4,360	6,259	977	567	7,803	(3,443)	5,700	5,350	350	10,060	13,153	(3,093)
2027	3,438	566	356	4,360	6,380	998	588	7,966	(3,606)	5,700	5,460	240	10,060	13,426	(3,366)
2028	3,438	566	356	4,360	6,501	1,019	599	8,119	(3,759)	5,700	5,570	130	10,060	13,688	(3,628)
2029	3,438	566	356	4,360	6,633	1,040	609	8,282	(3,922)	5,700	5,680	20	10,060	13,962	(3,902)
2030	3,438	566	356	4,360	6,765	1,061	620	8,446	(4,086)	5,700	5,790	(90)	10,060	14,235	(4,175)

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-83: Low Passenger Growth Forecast – Baseline Parking Demand Scenario

	EXISTING (2011) CAPACITY				BASELINE PARKING FORECAST (ON-AIRPORT)					BASELINE PARKING FORECAST (OFF-AIRPORT)			TOTAL PARKING		
YEAR	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)
2011	3,438	566	356	4,360	3,201	602	351	4,154	206	5,700	3,820	1,880	10,060	7,974	2,086
2012	3,438	566	356	4,360	3,256	609	357	4,222	138	5,700	3,890	1,810	10,060	8,112	1,948
2013	3,438	566	356	4,360	3,311	620	357	4,288	72	5,700	3,940	1,760	10,060	8,228	1,832
2014	3,438	566	356	4,360	3,355	630	368	4,353	7	5,700	4,000	1,700	10,060	8,353	1,707
2015	3,438	566	356	4,360	3,465	651	378	4,494	(134)	5,700	4,130	1,570	10,060	8,624	1,436
2016	3,438	566	356	4,360	3,553	672	389	4,614	(254)	5,700	4,240	1,460	10,060	8,854	1,206
2017	3,438	566	356	4,360	3,641	683	399	4,723	(363)	5,700	4,350	1,350	10,060	9,073	987
2018	3,438	566	356	4,360	3,740	704	410	4,854	(494)	5,700	4,460	1,240	10,060	9,313	747
2019	3,438	566	356	4,360	3,828	725	420	4,973	(613)	5,700	4,570	1,130	10,060	9,543	517
2020	3,438	566	356	4,360	3,883	735	431	5,049	(689)	5,700	4,630	1,070	10,060	9,679	381
2021	3,438	566	356	4,360	3,971	746	431	5,148	(788)	5,700	4,730	970	10,060	9,877	183
2022	3,438	566	356	4,360	4,048	756	441	5,245	(885)	5,700	4,830	870	10,060	10,075	(15)
2023	3,438	566	356	4,360	4,136	777	452	5,365	(1,005)	5,700	4,930	770	10,060	10,295	(235)
2024	3,438	566	356	4,360	4,224	798	462	5,484	(1,124)	5,700	5,040	660	10,060	10,524	(464)
2025	3,438	566	356	4,360	4,312	809	473	5,594	(1,234)	5,700	5,140	560	10,060	10,733	(673)
2026	3,438	566	356	4,360	4,400	830	483	5,713	(1,353)	5,700	5,250	450	10,060	10,963	(903)
2027	3,438	566	356	4,360	4,499	840	494	5,833	(1,473)	5,700	5,360	340	10,060	11,193	(1,133)
2028	3,438	566	356	4,360	4,587	861	504	5,952	(1,592)	5,700	5,470	230	10,060	11,422	(1,362)
2029	3,438	566	356	4,360	4,686	882	515	6,083	(1,723)	5,700	5,590	110	10,060	11,673	(1,613)
2030	3,438	566	356	4,360	4,785	903	525	6,213	(1,853)	5,700	5,700	-	10,060	11,913	(1,853)

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-84: Low Passenger Growth Forecast – Parking Demand Scenario 1 (Medium Growth)

	EXISTING (2011) CAPACITY				SCENARIO 1: MEDIUM PARKING GROWTH FORECAST - INCREASED LENGTH OF STAY (ON-AIRPORT)					SCENARIO 1: MEDIUM PARKING GROWTH FORECAST (OFF-AIRPORT)			TOTAL PARKING		
YEAR	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)
2011	3,438	566	356	4,360	3,201	602	351	4,154	206	5,700	3,820	1,880	10,060	7,974	2,086
2012	3,438	566	356	4,360	3,256	609	357	4,222	138	5,700	3,890	1,810	10,060	8,112	1,948
2013	3,438	566	356	4,360	3,311	620	357	4,288	72	5,700	3,940	1,760	10,060	8,228	1,832
2014	3,438	566	356	4,360	3,355	630	368	4,353	7	5,700	4,000	1,700	10,060	8,353	1,707
2015	3,438	566	356	4,360	4,169	704	410	5,283	(923)	5,700	4,460	1,240	10,060	9,742	318
2016	3,438	566	356	4,360	4,279	725	420	5,424	(1,064)	5,700	4,570	1,130	10,060	9,994	66
2017	3,438	566	356	4,360	4,389	735	431	5,555	(1,195)	5,700	4,690	1,010	10,060	10,245	(185)
2018	3,438	566	356	4,360	4,499	756	441	5,696	(1,336)	5,700	4,810	890	10,060	10,506	(446)
2019	3,438	566	356	4,360	4,609	777	452	5,838	(1,478)	5,700	4,930	770	10,060	10,768	(708)
2020	3,438	566	356	4,360	4,675	788	462	5,925	(1,565)	5,700	5,000	700	10,060	10,925	(865)
2021	3,438	566	356	4,360	4,774	809	473	6,056	(1,696)	5,700	5,100	600	10,060	11,155	(1,095)
2022	3,438	566	356	4,360	4,873	819	483	6,175	(1,815)	5,700	5,210	490	10,060	11,385	(1,325)
2023	3,438	566	356	4,360	4,972	840	494	6,306	(1,946)	5,700	5,320	380	10,060	11,626	(1,566)
2024	3,438	566	356	4,360	5,082	861	504	6,447	(2,087)	5,700	5,430	270	10,060	11,877	(1,817)
2025	3,438	566	356	4,360	5,192	872	515	6,579	(2,219)	5,700	5,550	150	10,060	12,128	(2,068)
2026	3,438	566	356	4,360	5,291	893	525	6,709	(2,349)	5,700	5,670	30	10,060	12,379	(2,319)
2027	3,438	566	356	4,360	5,412	914	536	6,862	(2,502)	5,700	5,790	(90)	10,060	12,651	(2,591)
2028	3,438	566	356	4,360	5,522	935	546	7,003	(2,643)	5,700	5,910	(210)	10,060	12,913	(2,853)
2029	3,438	566	356	4,360	5,643	945	557	7,145	(2,785)	5,700	6,030	(330)	10,060	13,175	(3,115)
2030	3,438	566	356	4,360	5,753	966	567	7,286	(2,926)	5,700	6,150	(450)	10,060	13,436	(3,376)

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-85: Low Passenger Growth Forecast – Parking Demand Scenario 2 (High Growth)

	EXISTING (2011) CAPACITY				SCENARIO 2: HIGH PARKING GROWTH FORECAST - INCREASED LENGTH OF STAY + OFF AIRPORT DEMAND SHIFT (ON-AIRPORT)					SCENARIO 2: HIGH PARKING GROWTH FORECAST (OFF-AIRPORT)			TOTAL PARKING		
YEAR	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)
2011	3,438	566	356	4,360	3,201	602	351	4,154	206	5,700	3,820	1,880	10,060	7,974	2,086
2012	3,438	566	356	4,360	3,256	609	357	4,222	138	5,700	3,890	1,810	10,060	8,112	1,948
2013	3,438	566	356	4,360	3,311	620	357	4,288	72	5,700	3,940	1,760	10,060	8,228	1,832
2014	3,438	566	356	4,360	3,355	630	368	4,353	7	5,700	4,000	1,700	10,060	8,353	1,707
2015	3,438	566	356	4,360	4,697	735	431	5,863	(1,503)	5,700	4,020	1,680	10,060	9,883	177
2016	3,438	566	356	4,360	4,818	756	441	6,015	(1,655)	5,700	4,120	1,580	10,060	10,135	(75)
2017	3,438	566	356	4,360	4,939	777	452	6,168	(1,808)	5,700	4,220	1,480	10,060	10,388	(328)
2018	3,438	566	356	4,360	5,060	788	462	6,310	(1,950)	5,700	4,330	1,370	10,060	10,640	(580)
2019	3,438	566	356	4,360	5,192	809	473	6,474	(2,114)	5,700	4,440	1,260	10,060	10,913	(853)
2020	3,438	566	356	4,360	5,258	819	483	6,560	(2,200)	5,700	4,500	1,200	10,060	11,060	(1,000)
2021	3,438	566	356	4,360	5,368	840	494	6,702	(2,342)	5,700	4,590	1,110	10,060	11,292	(1,232)
2022	3,438	566	356	4,360	5,489	861	504	6,854	(2,494)	5,700	4,690	1,010	10,060	11,544	(1,484)
2023	3,438	566	356	4,360	5,599	882	515	6,996	(2,636)	5,700	4,790	910	10,060	11,786	(1,726)
2024	3,438	566	356	4,360	5,720	893	525	7,138	(2,778)	5,700	4,890	810	10,060	12,028	(1,968)
2025	3,438	566	356	4,360	5,841	914	536	7,291	(2,931)	5,700	4,990	710	10,060	12,280	(2,220)
2026	3,438	566	356	4,360	5,962	935	546	7,443	(3,083)	5,700	5,100	600	10,060	12,543	(2,483)
2027	3,438	566	356	4,360	6,094	956	557	7,607	(3,247)	5,700	5,210	490	10,060	12,816	(2,756)
2028	3,438	566	356	4,360	6,215	977	567	7,759	(3,399)	5,700	5,320	380	10,060	13,079	(3,019)
2029	3,438	566	356	4,360	6,347	998	578	7,923	(3,563)	5,700	5,430	270	10,060	13,352	(3,292)
2030	3,438	566	356	4,360	6,468	1,019	588	8,075	(3,715)	5,700	5,540	160	10,060	13,615	(3,555)

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-86: High Passenger Growth Forecast – Baseline Parking Demand Scenario

	EXISTING (2011) CAPACITY				BASELINE PARKING FORECAST (ON-AIRPORT)					BASELINE PARKING FORECAST (OFF-AIRPORT)			TOTAL PARKING		
YEAR	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)
2011	3,438	566	356	4,360	3,201	602	351	4,154	206	5,700	3,820	1,880	10,060	7,974	2,086
2012	3,438	566	356	4,360	3,256	609	357	4,222	138	5,700	3,890	1,810	10,060	8,112	1,948
2013	3,438	566	356	4,360	3,333	630	368	4,331	29	5,700	3,970	1,730	10,060	8,301	1,759
2014	3,438	566	356	4,360	3,421	641	378	4,440	(80)	5,700	4,080	1,620	10,060	8,520	1,540
2015	3,438	566	356	4,360	3,806	714	420	4,940	(580)	5,700	4,530	1,170	10,060	9,470	590
2016	3,438	566	356	4,360	3,938	735	431	5,104	(744)	5,700	4,690	1,010	10,060	9,794	266
2017	3,438	566	356	4,360	4,070	767	452	5,289	(929)	5,700	4,860	840	10,060	10,148	(88)
2018	3,438	566	356	4,360	4,213	788	462	5,463	(1,103)	5,700	5,030	670	10,060	10,493	(433)
2019	3,438	566	356	4,360	4,367	819	483	5,669	(1,309)	5,700	5,200	500	10,060	10,869	(809)
2020	3,438	566	356	4,360	4,444	840	483	5,767	(1,407)	5,700	5,300	400	10,060	11,067	(1,007)
2021	3,438	566	356	4,360	4,576	861	504	5,941	(1,581)	5,700	5,450	250	10,060	11,391	(1,331)
2022	3,438	566	356	4,360	4,697	882	515	6,094	(1,734)	5,700	5,600	100	10,060	11,694	(1,634)
2023	3,438	566	356	4,360	4,829	903	525	6,257	(1,897)	5,700	5,760	(60)	10,060	12,017	(1,957)
2024	3,438	566	356	4,360	4,961	935	546	6,442	(2,082)	5,700	5,920	(220)	10,060	12,362	(2,302)
2025	3,438	566	356	4,360	5,104	956	557	6,617	(2,257)	5,700	6,080	(380)	10,060	12,696	(2,636)
2026	3,438	566	356	4,360	5,247	987	578	6,812	(2,452)	5,700	6,250	(550)	10,060	13,062	(3,002)
2027	3,438	566	356	4,360	5,390	1,008	588	6,986	(2,626)	5,700	6,430	(730)	10,060	13,416	(3,356)
2028	3,438	566	356	4,360	5,544	1,040	609	7,193	(2,833)	5,700	6,610	(910)	10,060	13,803	(3,743)
2029	3,438	566	356	4,360	5,698	1,071	620	7,389	(3,029)	5,700	6,790	(1,090)	10,060	14,179	(4,119)
2030	3,438	566	356	4,360	5,830	1,092	641	7,563	(3,203)	5,700	6,960	(1,260)	10,060	14,523	(4,463)

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Table 4-87: High Passenger Growth Forecast – Parking Demand Scenario 1 (Medium Growth)

	EXISTING (2011) CAPACITY				SCENARIO 1: MEDIUM PARKING GROWTH FORECAST - INCREASED LENGTH OF STAY (ON-AIRPORT)					SCENARIO 1: MEDIUM PARKING GROWTH FORECAST (OFF-AIRPORT)			TOTAL PARKING		
YEAR	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)
2011	3,438	566	356	4,360	3,201	602	351	4,154	206	5,700	3,820	1,880	10,060	7,974	2,086
2012	3,438	566	356	4,360	3,256	609	357	4,222	138	5,700	3,890	1,810	10,060	8,112	1,948
2013	3,438	566	356	4,360	3,333	630	368	4,331	29	5,700	3,970	1,730	10,060	8,301	1,759
2014	3,438	566	356	4,360	3,421	641	378	4,440	(80)	5,700	4,080	1,620	10,060	8,520	1,540
2015	3,438	566	356	4,360	4,301	725	420	5,446	(1,086)	5,700	4,610	1,090	10,060	10,056	4
2016	3,438	566	356	4,360	4,455	756	441	5,652	(1,292)	5,700	4,770	930	10,060	10,422	(362)
2017	3,438	566	356	4,360	4,609	777	452	5,838	(1,478)	5,700	4,940	760	10,060	10,778	(718)
2018	3,438	566	356	4,360	4,774	809	473	6,056	(1,696)	5,700	5,110	590	10,060	11,165	(1,105)
2019	3,438	566	356	4,360	4,939	830	483	6,252	(1,892)	5,700	5,290	410	10,060	11,542	(1,482)
2020	3,438	566	356	4,360	5,038	851	494	6,383	(2,023)	5,700	5,390	310	10,060	11,772	(1,712)
2021	3,438	566	356	4,360	5,170	872	504	6,546	(2,186)	5,700	5,540	160	10,060	12,086	(2,026)
2022	3,438	566	356	4,360	5,313	893	525	6,731	(2,371)	5,700	5,690	10	10,060	12,421	(2,361)
2023	3,438	566	356	4,360	5,467	924	536	6,927	(2,567)	5,700	5,850	(150)	10,060	12,777	(2,717)
2024	3,438	566	356	4,360	5,621	945	557	7,123	(2,763)	5,700	6,020	(320)	10,060	13,143	(3,083)
2025	3,438	566	356	4,360	5,775	977	567	7,319	(2,959)	5,700	6,180	(480)	10,060	13,499	(3,439)
2026	3,438	566	356	4,360	5,940	998	588	7,526	(3,166)	5,700	6,360	(660)	10,060	13,886	(3,826)
2027	3,438	566	356	4,360	6,105	1,029	599	7,733	(3,373)	5,700	6,530	(830)	10,060	14,263	(4,203)
2028	3,438	566	356	4,360	6,270	1,061	620	7,951	(3,591)	5,700	6,720	(1,020)	10,060	14,670	(4,610)
2029	3,438	566	356	4,360	6,446	1,092	630	8,168	(3,808)	5,700	6,900	(1,200)	10,060	15,068	(5,008)
2030	3,438	566	356	4,360	6,600	1,113	651	8,364	(4,004)	5,700	7,070	(1,370)	10,060	15,434	(5,374)

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

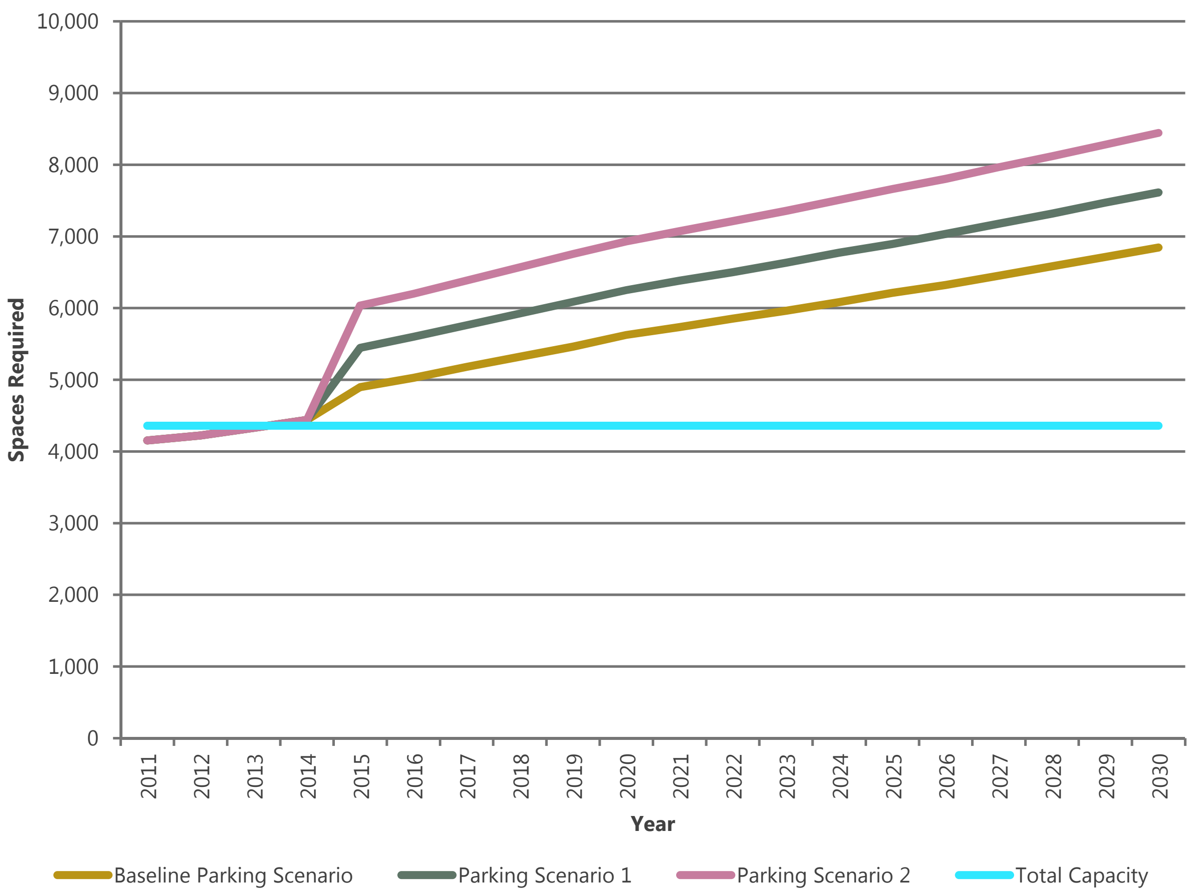
Table 4-88: High Passenger Growth Forecast – Parking Demand Scenario 2 (High Growth)

	EXISTING (2011) CAPACITY				SCENARIO 2: HIGH PARKING GROWTH FORECAST - INCREASED LENGTH OF STAY + OFF AIRPORT DEMAND SHIFT (ON-AIRPORT)					SCENARIO 2: HIGH PARKING GROWTH FORECAST (OFF-AIRPORT)			TOTAL PARKING		
YEAR	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	GARAGE	ECOPARK LOT 1	ECOPARK LOT 2	TOTAL	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)	CAPACITY	DEMAND	SURPLUS/ (DEFICIT)
2011	3,438	566	356	4,360	3,201	602	351	4,154	206	5,700	3,820	1,880	10,060	7,974	2,086
2012	3,438	566	356	4,360	3,256	609	357	4,222	138	5,700	3,890	1,810	10,060	8,112	1,948
2013	3,438	566	356	4,360	3,333	630	368	4,331	29	5,700	3,970	1,730	10,060	8,301	1,759
2014	3,438	566	356	4,360	3,421	641	378	4,440	(80)	5,700	4,080	1,620	10,060	8,520	1,540
2015	3,438	566	356	4,360	4,840	756	441	6,037	(1,677)	5,700	4,150	1,550	10,060	10,187	(127)
2016	3,438	566	356	4,360	5,016	788	462	6,266	(1,906)	5,700	4,290	1,410	10,060	10,556	(496)
2017	3,438	566	356	4,360	5,192	809	473	6,474	(2,114)	5,700	4,440	1,260	10,060	10,913	(853)
2018	3,438	566	356	4,360	5,379	840	494	6,713	(2,353)	5,700	4,600	1,100	10,060	11,313	(1,253)
2019	3,438	566	356	4,360	5,566	872	504	6,942	(2,582)	5,700	4,760	940	10,060	11,702	(1,642)
2020	3,438	566	356	4,360	5,665	893	515	7,073	(2,713)	5,700	4,850	850	10,060	11,922	(1,862)
2021	3,438	566	356	4,360	5,830	914	536	7,280	(2,920)	5,700	4,990	710	10,060	12,269	(2,209)
2022	3,438	566	356	4,360	5,984	935	546	7,465	(3,105)	5,700	5,120	580	10,060	12,585	(2,525)
2023	3,438	566	356	4,360	6,160	966	567	7,693	(3,333)	5,700	5,270	430	10,060	12,963	(2,903)
2024	3,438	566	356	4,360	6,325	987	578	7,890	(3,530)	5,700	5,410	290	10,060	13,300	(3,240)
2025	3,438	566	356	4,360	6,501	1,019	599	8,119	(3,759)	5,700	5,570	130	10,060	13,688	(3,628)
2026	3,438	566	356	4,360	6,688	1,050	609	8,347	(3,987)	5,700	5,720	(20)	10,060	14,067	(4,007)
2027	3,438	566	356	4,360	6,875	1,082	630	8,587	(4,227)	5,700	5,880	(180)	10,060	14,467	(4,407)
2028	3,438	566	356	4,360	7,062	1,103	641	8,806	(4,446)	5,700	6,040	(340)	10,060	14,845	(4,785)
2029	3,438	566	356	4,360	7,260	1,134	662	9,056	(4,696)	5,700	6,210	(510)	10,060	15,266	(5,206)
2030	3,438	566	356	4,360	7,436	1,166	683	9,285	(4,925)	5,700	6,360	(660)	10,060	15,644	(5,584)

SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Exhibit 4-42 depicts the on-Airport parking requirements for the three parking demand scenarios relative to the Baseline Passenger Growth Forecast. As shown, a deficit would begin to develop for each parking demand scenario in 2014.

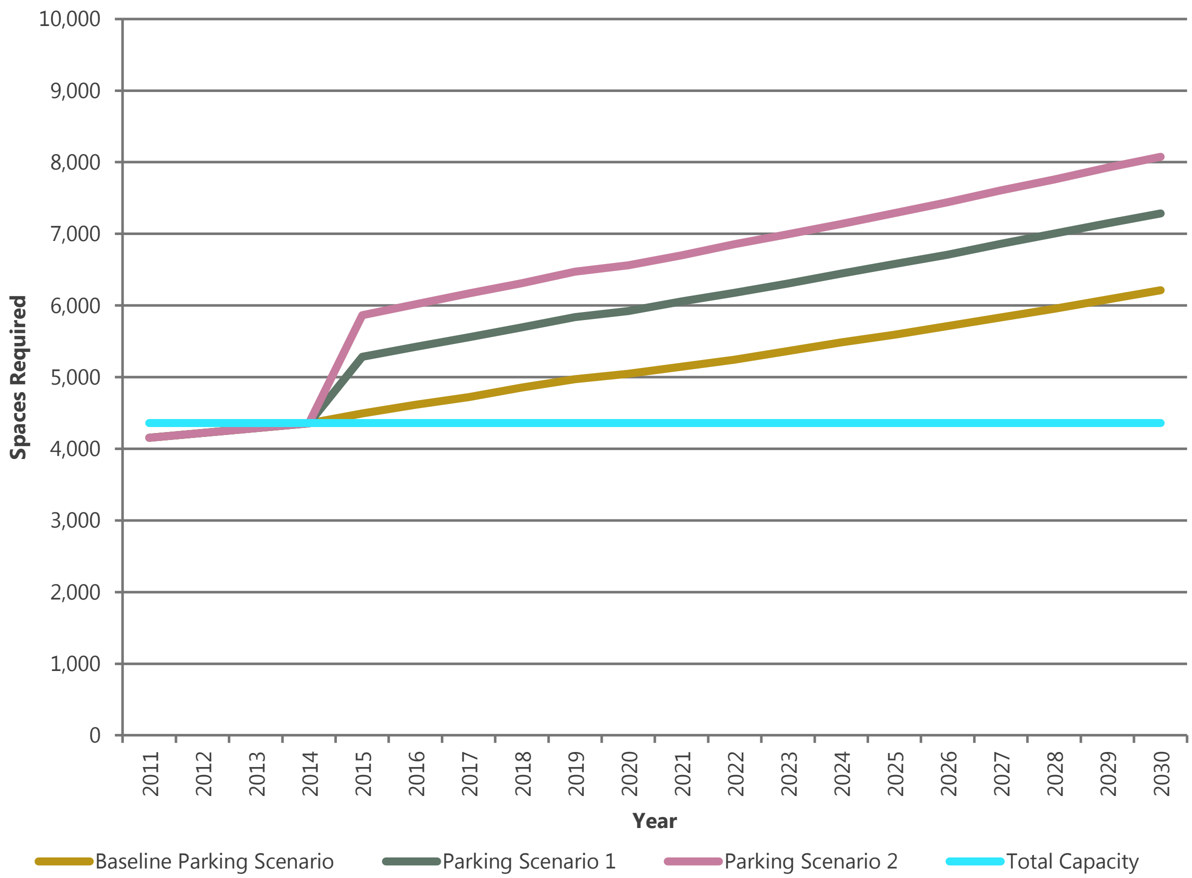
Exhibit 4-42: On-Airport Parking Scenario Requirements for the Baseline Passenger Growth Forecast



SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., November 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Exhibit 4-43 depicts the on-Airport parking requirements for the three parking demand scenarios relative to the Low Passenger Growth Forecast. As shown, a deficit would begin to develop for the Baseline Parking Demand Scenario and Parking Demand Scenario 2 in 2014, and for Parking Demand Scenario 1 in 2015.

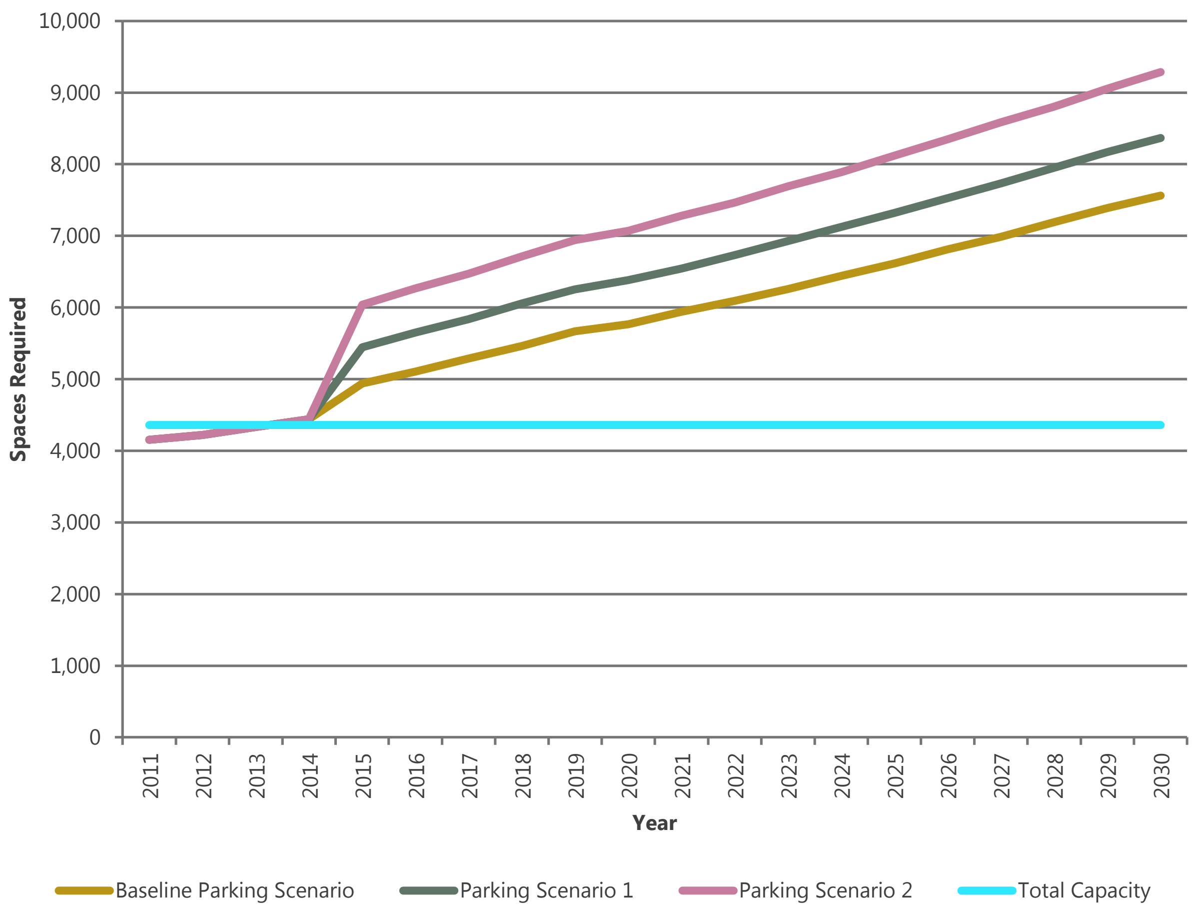
Exhibit 4-43: On-Airport Parking Scenario Requirements for the Low Passenger Growth Forecast



SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., November 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

Exhibit 4-44 depicts the on-Airport parking requirements for the three parking demand scenarios relative to the High Passenger Growth Forecast. As shown, a deficit would begin to develop for the Baseline Parking Demand Scenario and Parking Demand Scenario 2 in 2014 and for Parking Demand Scenario 1 in 2015.

Exhibit 4-44: On-Airport Parking Scenario Requirements for the High Passenger Growth Forecast



SOURCES: Houston Airport System, December 2011; Ricondo & Associates, Inc., November 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

In the scenarios analyzed, total on-Airport parking deficits are expected to occur as early as 2014 and continue through 2030. Based on available parking facility occupancy and parking transaction data provided by Airport staff, it is estimated that the existing capacity of the parking facilities will be constrained, possibly forcing patrons to off-Airport parking facilities, or originating passengers could decide to be picked up or dropped off by friends or family, bypassing the parking facilities entirely.

4.6 Rental Car Facilities Requirements

Specific requirements for each of the following rental car facility components are discussed in this section

- Customer service area
- Ready/return and onsite vehicle storage area
- Quick turnaround area
  - fueling positions
  - wash bays
  - vehicle stacking/staging spaces
  - vehicle light maintenance bays and employee requirements

4.6.1 METHODOLOGY

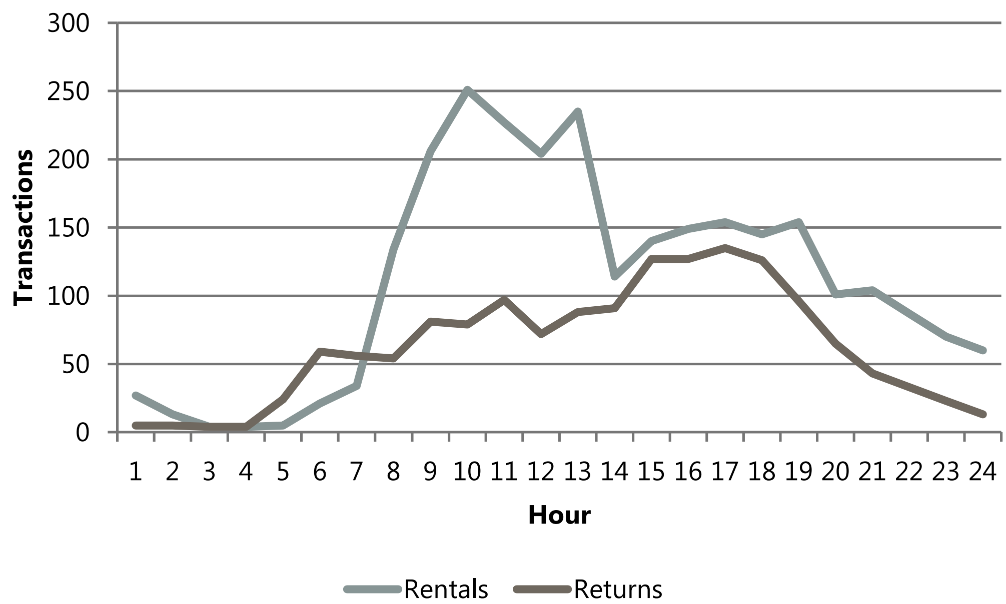
The rental car facility requirements were developed using Airport-specific facility utilization rates based on hourly rental transactions during a peak rental day. The peak rental day was selected as the design day because ready vehicles occupy more space than the same number of return vehicles and, therefore, account for the maximum space required during a peak period. A questionnaire requesting hourly transaction information, as well as the size, configuration, and use of their existing facilities, was sent by Ricondo & Associates, Inc. to each on-Airport rental car company in April 2012. All eight of the on-Airport companies returned a completed questionnaire.

Exhibit 4-45 depicts hourly rentals and returns during the peak rental day, which was determined to be a Monday. It was assumed that rental car activity would increase at the same rate as the number of originating passengers. Therefore, the existing requirements were increased based on the passenger forecasts presented in Section 3.

The utilization factor used to determine customer service counter requirements was the highest 5-hour average number of rentals at the counter on the peak rental day. A 5-hour average number of rentals was used to normalize any hourly spikes in activity, as sizing the facility based on a single peak hour of activity could result in facility oversizing.

At the time this Master Plan Update was being prepared for final production (and in response to heightened interest from rental car companies after the third public meeting about the future site of a consolidated rental car facility), HAS invited the rental car companies to revise and resubmit surveys that were originally provided in 2013 and 2014 for the analyses provided below. Rental car companies believed that the original surveys they submitted were under-representing their future needs in light of projected international traffic. Once the revised surveys were submitted, future facility requirements were re-evaluated. The revised requirements were presented to HAS and the rental car companies during a workshop in October 2014. The workshop presentation materials are included in Appendix B. The facility requirements presented in this section may, therefore, under-represent the current assessment of future rental car companies' needs.

Exhibit 4-45: Peak Rental Day Rentals and Returns by Hour



SOURCE: Ricondo & Associates, Inc., *William P. Hobby Airport Rental Car Industry Questionnaire*, April 2012.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.6.2 CUSTOMER SERVICE AREA

The customer service area is used to process arriving rental car customers. The number of counter positions required is the primary factor that determines the size of the customer service area.

During the peak rental day, the 5-hour average number of rental car transactions was 226. According to the questionnaire results, 140 were regular counter transactions and 86 were preferred area transactions, in which the customer is able to bypass the counter areas and proceed directly to the vehicle area. Based on Ricondo & Associates, Inc. experience at similar airports with rental car customer business/leisure splits similar to the Airport market, it was assumed that a typical rental car counter transaction takes approximately 10 minutes (which translates to six transactions per hour). **Table 4-89** depicts the customer service counter facility requirements for existing (2012) and each planning year demand.

Table 4-89: Customer Service Counter Facility Requirements

COMPONENT	EXISTING 2012	2015	2020	2030
Customer Service Counter Facility Requirements				
Regular Customer Service Positions	30	33	37	45
Existing Customer Service Counters				
Regular Customer Service Positions	50	50	50	50
Surplus/(Deficit)				
Regular Customer Service Positions	20	17	13	5

SOURCE: Ricondo & Associates, Inc., *William P. Hobby Airport Rental Car Industry Questionnaire*, April 2012.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.6.3 READY/RETURN AND ONSITE VEHICLE STORAGE AREA

Customers pick up and return rental cars in the rental car companies' ready/return areas. Ready vehicles are parked in a 90-degree configuration, 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 account for the maximum space required during a peak period.

The key utilization rate used to determine ready and return space requirements was the highest 5-hour average numbers of rentals and returns and the number of hours of peak period activity the spaces can accommodate during the peak rental day.

Rental car companies prefer to maintain a sufficient supply of ready spaces and cars 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, such as delayed flights, occur. 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, providing more than one hour of capacity.

Typically, the rental car companies prefer to have 2 to 3 hours of capacity for both rental car ready and return spaces. According to responses regarding the number of existing spaces and transaction information collected from the questionnaire, the rental car companies at the Airport provide approximately 2.4 hours of rental car ready space capacity and 1.8 hours of return space capacity during peak periods. Based on this information, averages of 2.5 hours of ready car capacity and 2.0 hours of return capacity were used to develop the rental car facility requirements.

The onsite vehicle storage requirement during a peak week is also included in the vehicle space requirement. This requirement represents the number of spaces the rental car companies need to store vehicles that are not being rented or parked in a rental or return space. The number is calculated using the total vehicle deficit on the peak rental day. The effective numbers of ready and return stalls were calculated. Twelve return vehicles parked at a 90 degree angle could be accommodated in a 60-foot-by-60-foot planning grid. Eighteen return vehicles could be accommodated in the same 60-foot-by-60-foot grid by parking the vehicles nose to tail.

Table 4-90 depicts the ready/return and facility requirements for existing (2012) and each planning year demand.

Table 4-90: Rental Car Ready/Return Facility Requirements

COMPONENT	EXISTING (2012)	2015	2020	2030
Rental Car Ready/Return Facility Requirements				
Effective Ready Spaces	565	610	686	839
Effective Return Spaces	171	185	208	254
TOTAL	**736**	**795**	**894**	**1,093**
Existing Rental Car Ready/Return				
Ready/Return Spaces	1,058	1,058	1,058	1,058
Surplus/(Deficit)				
Ready/Return Spaces	322	263	164	(35)

SOURCE: Ricondo & Associates, Inc., *William P. Hobby Airport Rental Car Industry Questionnaire*, April 2012.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

Table 4-91 depicts the onsite vehicle storage facility requirements for existing (2012) and each planning year demand.

Table 4-91: Rental Car Onsite Vehicle Storage Facility Requirements

COMPONENT	EXISTING (2012)	2015	2020	2030
Rental Car Onsite Vehicle Storage Facility Requirements				
Storage Spaces	1,136	1,228	1,381	1,688
Existing On-Site Vehicle Storage				
Storage Spaces	1,090	1,090	1,090	1,090
Surplus/(Deficit)				
Storage Spaces	(46)	(138)	(291)	(598)

SOURCE: Ricondo & Associates, Inc., *William P. Hobby Airport Rental Car Industry Questionnaire*, April 2012.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.6.4 QUICK TURNAROUND AREA

The quick turnaround area (QTA) is designed to accommodate vehicle support functions, such as fueling, vacuuming, washing, and maintenance. After being processed through the QTA, vehicles are parked either in stacking spaces located in the QTA, or in a rental space for the next customer. The QTA is configured similar to a gas station, with three double fuel dispensers (totaling six fuel nozzles) installed on a raised concrete island. Each island is equipped so that vehicles can be vacuumed and fluids checked while fueling is in process. Once the service is completed, vehicles are driven forward through an automated vehicle wash bay and drying tunnel. 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 or staged in lanes after fueling while waiting for washing, or staged after washing, waiting for an available rental space.

4.6.4.1 Fueling Positions

The number of fueling nozzles required to accommodate future demand is based on the number of vehicles that can be fueled within the peak hour. The utilization rate, or number of vehicles that can be processed per hour per nozzle, was calculated by dividing the number of return transactions in the peak hour by the number of fuel nozzles available.

The utilization rate used for this analysis was five vehicles per hour, or 12 minutes per vehicle, based on Ricondo & Associates, Inc. experience and understanding of similar airport CRCF. This utilization rate results in a requirement of 36 fuel nozzles in 2030. **Table 4-92** presents the fueling facility requirements for existing (2012) and each planning year demand.

Table 4-92: Fueling Position Requirements

COMPONENT	EXISTING (2012)	2015	2020	2030
Required Fueling Positions	24	26	30	36
Existing Fueling Positions	22	22	22	22
Fueling Position Surplus/(Deficit)	(2)	(4)	(8)	(14)

SOURCE: Ricondo & Associates, Inc., *William P. Hobby Airport Rental Car Industry Questionnaire*, April 2012.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.6.4.2 Wash Bays

The number of wash bays required to accommodate future demand was based on the number of vehicles that can be washed within the peak hour.

The utilization rate, or number of vehicles that can be processed per hour per wash bay, was calculated by dividing the number of return transactions in the peak hour by the number of wash bays available.

The utilization rate determined was 30 vehicles per hour, or 2 minutes per vehicle, based on professional experience and understanding of similar facilities. This utilization rate results in a requirement of six wash bays in 2030. **Table 4-93** depicts the wash bay requirements for existing (2012) and each planning year demand.

Table 4-93: Wash Bay Requirements

COMPONENT	EXISTING (2012)	2015	2020	2030
Required Wash Bays	4	4	5	6
Existing Wash Bays	7	7	7	7
Wash Bay Surplus/(Deficiency)	3	3	2	1

SOURCE: Ricondo & Associates, Inc., *William P. Hobby Airport Rental Car Industry Questionnaire*, April 2012.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.6.4.3 Vehicle Stacking/Staging Spaces

Parking areas near the service facilities are provided for the staging of clean vehicles and the stacking of dirty vehicles. The utilization rate used to size the areas is based on the number of required fuel nozzles. Returned vehicles are positioned in the stacking areas prior to the fueling positions before being serviced. In some cases, clean vehicles can be stored in this area prior to being placed back in a rental space. It was assumed that each nozzle would accommodate six vehicle stacking spaces. Depending on the number of fuel nozzles on each island, it was determined that two, four, or six spaces would be provided at each island to stack clean or dirty vehicles based on R&A experience and understanding of similar airport CRCF. **Table 4-94** depicts the requirements for vehicle stacking/staging spaces for existing (2012) and each planning year demand.

Table 4-94: Vehicle Stacking/Staging Space Requirements

COMPONENT	EXISTING (2012)	2016	2021	2031
Required Vehicle Stacking/Staging Spaces	144	156	180	216
Existing Vehicle Stacking/Staging Spaces	175	175	175	175
Stacking/Staging Space Surplus/(Deficiency)	31	19	(5)	(41)

SOURCE: Ricondo & Associates, Inc., *William P. Hobby Airport Rental Car Industry Questionnaire*, April 2012.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.6.4.4 Vehicle Light Maintenance Bays and Employee Requirements

Requirements for vehicle maintenance facilities, including vehicle lifts, parts storage, tool lockers, and vehicle records storage, were developed. The 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 area and employee parking were also developed. Requirements for these three components were developed by taking the existing quantity and increasing it by the same rate as the O&D passenger forecasts. **Table 4-95** depicts the requirements for light maintenance bays, employee administrative area, and employee parking spaces.

Table 4-95: Light Maintenance Bay Facility Requirements

COMPONENT	EXISTING (2012)	2015	2020	2030
Light Maintenance Bay Requirements	9	10	11	13
Employee Administrative Area (square feet)	9,200	9,945	11,187	13,671
Employee Parking Spaces	182	197	221	270

SOURCE: Ricondo & Associates, Inc., *William P. Hobby Airport Rental Car Industry Questionnaire*, April 2012.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

4.6.5 FACILITY REQUIREMENTS SUMMARY

Requirements for each rental car facility component described above are presented in **Table 4-96** for 2012 (existing demand) and for the future planning years selected for the Master Plan Update analyses.

4.7 Employee Parking, Taxicab Staging, and Cell Phone Waiting Lot Requirements

Existing and future employee parking, taxicab staging, and cell phone waiting lot demand and requirements are discussed in this section. Information, including a June 2012 data collection effort at the Airport by Gunda Corporation, LLC, as well as forecast enplaned passengers and aircraft operations, were used to estimate these future demand for 2015, 2020, and 2030.

4.7.1 STUDY AREA CONDITIONS

As of 2012, employee parking is accommodated in two parking lots, one east of the terminal area and one west of the terminal area. These two lots provide a total of 625 spaces. During the June 2012 data collection period, Gunda Corporation estimated that these lots were operating at approximately 40 percent capacity, or 250 vehicles.

Taxicab staging is currently located south of Airport Boulevard, between Fuel Farm Road and Rental Car Road, on the northwest side of the Airport. This area accommodates approximately 108 taxicabs at full capacity; however, Gunda Corporation estimated that this lot was operating at approximately 50 percent capacity during the weekdays and at 20 percent capacity on the weekend, for an initial occupancy of 54 and 22 taxicabs, respectively.

Table 4-96 (1 of 2): Rental Car Facility Requirements

	2012 SPACE PROGRAM			2015 SPACE PROGRAM			2020 SPACE PROGRAM			2030 SPACE PROGRAM		
	QUANTITY	SF	TOTAL SF	QUANTITY	SF	TOTAL SF	QUANTITY	SF	TOTAL SF	QUANTITY	SF	TOTAL SF
CUSTOMER SERVICE AREAS												
Counter Positions	30	300	9,100	33	300	9,800	37	300	11,000	45	300	13,500
Circulation	25% of total area		2,300	25% of total are		2,500	25% of total area		2,800	25% of total area		3,400
Subtotal			11,400			12,300			13,800			16,900
READY/RETURN/STORAGE AREAS												
Ready Spaces	565	300	169,400	610	300	183,100	686	300	205,900	839	300	251,700
Return Spaces	171	200	34,200	185	200	36,900	208	200	41,500	254	200	50,800
Storage Spaces	1,136	170	193,100	1,228	170	208,800	1,381	170	234,800	1,688	170	287,000
Total Spaces	1,871			2,023			2,276			2,781		
Exit Booths	8	20	200	8	20	200	9	20	200	11	20	200
Circulation	20%		79,400	20%		85,800	20%		96,500	20%		117,900
Subtotal			476,300			514,800			578,900			707,600
QTA/SERVICE SITE												
Fueling Positions	24	300	7,300	26	300	7,900	30	300	8,900	36	300	10,900
Wash Bays	4	2,00	8,100	4	2,00	8,800	5	2,00	9,900	6	2,00	12,100
Stacking and Staging	144	200	28,800	156	200	31,200	180	200	36,000	216	200	43,200
Maintenance Bays	9	810	7,300	10	810	7,900	11	810	8,900	13	810	10,800
Administrative Area	9,200		9,200	9,945		9,945	11,187		11,187	13,671		13,671
Employee Parking	182	250	45,500	197	250	49,200	221	250	55,300	270	250	67,600
Circulation	20% of total area		21,200	20% of total area		23,000	20% of total area		26,000	20% of total area		31,700
Subtotal			127,400			137,945			156,187			189,971

Table 4-96 (2 of 2): Rental Car Facility Requirements

	2012 SPACE PROGRAM			2015 SPACE PROGRAM			2020 SPACE PROGRAM			2030 SPACE PROGRAM		
	QUANTITY	**SF**	**TOTAL SF**	**QUANTITY**	**SF**	**TOTAL SF**	**QUANTITY**	**SF**	**TOTAL SF**	**QUANTITY**	**SF**	**TOTAL SF**
Small Market Entrant			12,300	2% of total area		13,300	2% of total area		15,000	2% of total area		18,300
Total Facility			627,400			678,300			763,900			932,800
Landscaping/circulation (15% of total facility area)			**94,100**			101,700			114,600			139,900
Total Requirement - Square Feet			**721,500**			**780,000**			**878,500**			**1,072,700**
Total Requirement - Acres			**17**			**18**			**20**			**25**

SF = Square Feet

SOURCE: Ricondo & Associates, Inc., *William P. Hobby Airport Rental Car Industry Questionnaire*, April 2012.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

The cell phone waiting lot, where private vehicles wait for airline passengers to arrive at the curb, is located in the southwest quadrant of the intersection formed by Airport Boulevard and Fauna Street and provides space for approximately 50 vehicles. During the observation period, Gunda Corporation observed very little activity in this lot, with only a few vehicles occupying the lot at once. For this analysis, an initial count of two vehicles was used for both weekday and weekend conditions.

4.7.2 DATA COLLECTION RESULTS

In June 2012, Gunda Corporation conducted traffic counts at the employee parking lots, taxicab staging area, and cell phone waiting lot. Employee parking lot counts were based on employee shift change periods, which were determined to occur between 6:00 a.m. and 6:30 a.m., and 2:00 p.m. to 2:30 p.m. To account for all employee vehicles expected to arrive at and depart from the employee parking lot, and based on these shift change periods, the employee parking lot counts were collected from 5:30 a.m. to 7:30 a.m. and from 1:30 p.m. to 3:30 p.m. The a.m. and p.m. traffic counts at the employee parking lots are summarized in **Table 4-97**.

Table 4-97: Employee Parking Lot Vehicle Counts

TIME INTERVAL	ENTER	EXIT	NET TOTAL 1/
5:30 a.m. – 5:45 a.m.	12	2	260
5:45 a.m. – 6:00 a.m.	14	4	270
6:00 a.m. – 6:15 a.m.	21	5	286
6:15 a.m. – 6:30 a.m.	24	2	308
6:30 a.m. – 6:45 a.m.	22	8	322
6:45 a.m. – 7:00 a.m.	33	12	343
7:00 a.m. – 7:15 a.m.	13	21	335
7:15 a.m. – 7:30 a.m.	17	17	335
1:30 p.m. – 1:45 p.m.	39	51	238
1:45 p.m. – 2:00 p.m.	41	36	243
2:00 p.m. – 2:15 p.m.	24	33	234
2:15 p.m. – 2:30 p.m.	30	33	231
2:30 p.m. – 2:45 p.m.	16	47	200
2:45 p.m. – 3:00 p.m.	8	14	194
3:00 p.m. – 3:15 p.m.	9	19	184
3:15 p.m. – 3:30 p.m.	8	19	173

NOTE:

1/ The initial vehicle count based on Gunda Corporation observation was 250 vehicles.

SOURCE: Gunda Corporation, LLC, *William P. Hobby Airport Master Plan Update Existing Conditions Traffic Analysis,* July 24, 2012, Tables 1-A and 1-B.
PREPARED BY: Ricondo & Associates, Inc., September 2013.

Data collection times for the taxicab staging area were based on peak flight activity for the commercial airlines serving the Airport. The existing (2012) flight schedule indicated that the a.m. peak period for deplaned passengers during the week is from 11:00 a.m. to 1:00 p.m., and the p.m. peak period is from 6:30 p.m. to 8:30

p.m. To account for the time taken by deplaning passengers to travel from the aircraft to the curbside, the data were collected from 11:30 a.m. to 1:30 p.m. and from 7:00 p.m. to 9:00 p.m. The data collection period was the same for both weekday and weekend counts. The taxicab staging area counts are summarized in **Table 4-98**.

Table 4-98: Taxicab Staging Area Vehicle Counts

	WEEKDAY			WEEKEND		
TIME INTERVAL	ENTER	EXIT	NET TOTAL 1/	ENTER	EXIT	NET TOTAL 1/
11:30 a.m. – 11:45 a.m.	0	0	54	0	2	20
11:45 a.m. – 12:00 p.m.	0	0	54	1	4	17
12:00 p.m. – 12:15 p.m.	0	0	54	5	0	22
12:15 p.m. – 12:30 p.m.	4	1	57	1	2	21
12:30 p.m. – 12:45 p.m.	13	18	52	3	1	23
12:45 p.m. – 1:00 p.m.	14	18	48	4	0	27
1:00 p.m. – 1:15 p.m.	3	9	42	5	4	28
1:15 p.m. – 1:30 p.m.	6	10	38	5	3	30
7:00 p.m. – 7:15 p.m.	8	5	57	4	9	17
7:15 p.m. – 7:30 p.m.	9	10	56	4	0	21
7:30 p.m. – 7:45 p.m.	4	17	43	5	9	17
7:45 p.m. – 8:00 p.m.	7	6	44	7	0	24
8:00 p.m. – 8:15 p.m.	6	18	32	4	12	16
8:15 p.m. – 8:30 p.m.	2	4	30	6	5	17
8:30 p.m. – 8:45 p.m.	5	19	16	1	1	17
8:45 p.m. – 9:00 p.m.	3	12	7	8	7	18

NOTE:

1/ The initial vehicle count based on Gunda Corporation observation; the weekday initial count was 54 vehicles, the weekend initial count was 22 vehicles.

SOURCE: Gunda Corporation, LLC, *William P. Hobby Airport Master Plan Update Existing Conditions Traffic Analysis,* July 24, 2012, Tables 1-C and 1-D.
PREPARED BY: Ricondo & Associates, Inc., September 2013.

Cell phone waiting lot counts were conducted during the same period as the taxicab staging area counts, which were based on the existing airline flight schedules. The cell phone waiting lot counts are summarized in **Table 4-99**.

Table 4-99: Cell Phone Waiting Lot Vehicle Counts

	WEEKDAY			WEEKEND		
TIME INTERVAL	**ENTER**	**EXIT**	**NET TOTAL 1/**	**ENTER**	**EXIT**	**NET TOTAL 1/**
11:30 a.m. – 11:45 a.m.	2	2	2	2	1	3
11:45 a.m. – 12:00 p.m.	3	2	3	1	0	4
12:00 p.m. – 12:15 p.m.	0	2	1	1	2	3
12:15 p.m. – 12:30 p.m.	0	0	1	0	2	1
12:30 p.m. – 12:45 p.m.	0	0	1	1	0	2
12:45 p.m. – 1:00 p.m.	1	1	1	1	0	3
1:00 p.m. – 1:15 p.m.	0	0	1	4	2	5
1:15 p.m. – 1:30 p.m.	0	0	1	2	2	5
7:00 p.m. – 7:15 p.m.	1	1	2	4	1	5
7:15 p.m. – 7:30 p.m.	2	1	3	2	3	4
7:30 p.m. – 7:45 p.m.	1	1	3	3	1	6
7:45 p.m. – 8:00 p.m.	0	1	2	0	5	1
8:00 p.m. – 8:15 p.m.	1	1	2	5	1	5
8:15 p.m. – 8:30 p.m.	1	1	2	0	4	1
8:30 p.m. – 8:45 p.m.	1	2	1	0	0	1
8:45 p.m. – 9:00 p.m.	0	1	0	1	1	1

NOTE:

1/ The initial vehicle count based on Gunda Corporation observation was two vehicles for both weekday and weekend scenarios.

SOURCE: Gunda Corporation, LLC, *William P. Hobby Airport Master Plan Update Existing Conditions Traffic Analysis,* July 24, 2012, Tables 1-E and 1-F.
PREPARED BY: Ricondo & Associates, Inc., September 2013.

4.7.3 EXISTING (JUNE 2012) DEMAND

Combining the initial vehicle counts provided in the tables above with the 15-minute traffic counts collected by Gunda Corporation, existing demand for employee parking, taxicab staging, and cell phone waiting lot was determined. As shown in Tables 4-97 through 4-99, peak existing demand for each mode was determined to be as follows:

- Employee Parking – 343 vehicles (occurring between 6:45 a.m. and 7:00 a.m.)
- Taxicab Staging Area – 57 vehicles (occurring on the weekday between 12:15 p.m. and 12:30 p.m. and between 7:00 p.m. and 7:15 p.m.)
- Cell Phone Waiting Lot – 6 vehicles (occurring on the weekend between 7:30 p.m. and 7:45 p.m.)

4.7.4 GROWTH RATES

Three growth rates were used to determine existing and future demand for employee parking, the taxicab staging area, and the cell phone waiting lot. The first growth rate used was to convert the June 2012 demand (obtained from the Gunda Corporation counts) to peak month 2012 demand. The other two growth rates were used to estimate future demand for each mode and were based on forecast passengers and airline aircraft operations. The growth rates and their application are discussed below.

4.7.4.1 Peak Month (May 2012) Growth Rate

According to historical data provided by Airport staff, overall airline aircraft operations in June 2012 (16,438 total operations) were lower than during the peak airline aircraft operations month of May 2012 (18,779 total operations). As a conservative approach, the June 2012 employee parking, taxicab staging area, and cell phone waiting lot demand was increased by 14.24 percent to adjust for peak month activity. The resulting calculated demand for each mode is as follows:

- Employee Parking – 392 vehicles
- Taxicab Staging Area – 65 vehicles
- Cell Phone Waiting Lot – 7 vehicles

4.7.4.2 Originating Passengers/Aircraft Operations Growth Rates

Originating passengers and aircraft operations are forecast to increase in future years, at rates presented in **Table 4-100** and **Table 4-101** respectively.

Table 4-100: Forecast Originating Passenger Growth Rates

	HISTORICAL		FORECAST	
	2012	2015	2020	2030
Passengers	3,534,900	4,260,500	5,068,100	6,031,900
Growth Rate	---	20.5%	43.4%	70.6%

SOURCES: Houston Airport System (Historical); InterVISTAS Consulting (Forecasts); Ricondo & Associates, Inc. (Forecasts), March 2012.
PREPARED BY: Ricondo & Associates, Inc., September 2013.

Table 4-101: Airline Aircraft Operations Growth Rates

	HISTORICAL		FORECAST	
	2012	2015	2020	2030
Aircraft Operations	202,670	218,560	242,120	269,540
Growth Rate	---	7.8%	19.5%	33.0%

SOURCES: FAA Air Traffic Activity Data System (Historical); InterVISTAS Consulting (Forecast); Ricondo & Associates, Inc. (Forecast), March 2012.
PREPARED BY: Ricondo & Associates, Inc., September 2013.

4.7.4.3 Blended Growth Rate

A blended growth rate for originating passengers and airline aircraft operations was calculated for use in determining future employee parking demand. It was assumed that the number of Airport employees would not increase at the same rate as the number of originating passengers. As passenger numbers increase, airline load factors will also increase, or the airlines will transition to larger aircraft. Therefore, there is not a linear relationship between employees and originating passengers. The same is true for the relationship between employees and aircraft operations. **Table 4-102** presents the blended growth rates used to calculate future employee parking demand.

Table 4-102: Blended Growth Rate

	2015	2020	2030
Originating Passengers Growth Rate	20.5%	43.4%	70.6%
Aircraft Operations Growth Rate	7.8%	19.5%	33.0%
Blended Growth Rate	14.2%	31.4%	51.8%

SOURCES: InterVISTAS Consulting; Ricondo & Associates, Inc., March 2012.
PREPARED BY: Ricondo & Associates, Inc., September 2013.

4.7.5 FUTURE DEMAND

June 2012 demand, increased to reflect the peak operations month of May 2012, was scaled based on the growth rates described above. Employee parking demand was scaled using the blended growth rates set forth in Table 4-102 above, while the taxicab staging area and cell phone waiting lot demand was scaled using the passenger growth rate. Future demand for each area is presented in **Table 4-103**.

Table 4-103: Future Demand Summary (number of spaces)

	HISTORICAL		FORECAST	
	2012	2015	2020	2030
Capacity [A]				
Employee Parking	625	625	625	625
Taxicab Staging Area	108	108	108	108
Cell Phone Waiting Lot	50	50	50	50
Demand [B]				
Employee Parking	392	447	515	595
Taxicab Staging Area	65	78	93	111
Cell Phone Waiting Lot	7	8	10	12
Surplus/(Deficit) [A] – [B]				
Employee Parking	233	178	110	30
Taxicab Staging Area	43	30	15	(3)
Cell Phone Waiting Lot	43	42	40	38

SOURCES: Gunda Corporation, LLC, July 2012; Ricondo & Associates, Inc., September 2013.
PREPARED BY: Ricondo & Associates, Inc., September 2013.

4.7.6 SUMMARY

As shown in Table 4-103, it is estimated that the current capacity of 625 employee parking spaces will be sufficient to meet demand through 2030, with a surplus of 30 spaces.

The taxicab staging area, however, was estimated to operate at a slight deficit (three spaces) in 2030.

It appears that the cell phone waiting lot is not considered a primary option for Airport users waiting to pick up passengers. The existing configuration, which provides approximately 50 spaces, is expected to be sufficient through 2030.

4.8 General Aviation and Support Facilities Requirements

This section presents the requirements for general aviation, airline support, HAS, and other support facilities at HOU. For purposes of this analysis, these facilities are classified as follows:

- **General aviation** facilities include those dedicated to FBOs, corporate leased hangars, avionics and repair centers, and helicopter facilities. Currently, five FBOs operate at the Airport, including Atlantic Aviation, Jet Aviation, Million Air, Signature Flight Support, and Wilson Air Center. In addition, nine individually leased corporate hangars and two helicopter facilities are located at the Airport.
- **Airline support** facilities consist of airline aircraft maintenance, air cargo/provisioning, and aircraft fuel farm facilities. Aircraft maintenance facilities at the Airport are currently operated by Southwest Airlines and United Airlines. The air cargo/provisioning facility and fuel farm are also primarily operated by Southwest Airlines.
- **HAS** facilities include Airport administration, Airport maintenance and ARFF facilities.
- **Other support** facilities encompass facilities not dedicated to serving the needs of aircraft operators. These facilities are leased to the Houston Aeronautical Heritage Society, the Houston Police Department's K-9 unit, and ESC Polytech Consultants, Inc.

The facilities included in this analysis are limited to those located within the contiguous Airport property boundary. Noncontiguous parcels, such as the various commercial and retail properties located north of Airport Boulevard and south of Braniff Avenue, are not considered part of this analysis.

Table 4-104 presents a summary of the overall land areas dedicated to each of the four classifications of general aviation and support facilities. The land areas currently developed with tenant facilities are differentiated, and vacant areas are identified for future facility expansion/development. As shown, approximately 211 acres of land are dedicated to general aviation and support facilities. In addition, approximately 19 acres were identified for future facility development by various tenants and include:

- Atlantic Aviation (6.1 acres)
- Jet Aviation (2.8 acres)

- Signature Flight Support (6.6 acres)
- Wilson Air Center (1.2 acres)
- HAS Maintenance Facility (0.5 acre)
- Houston Aeronautical Heritage Society (Option Tract) (1.4 acres)

Table 4-104: Baseline General Aviation and Support Facilities

	CURRENT LAND USE AREAS (ACRES)		
LAND USE CLASSIFICATION	**DEVELOPED**	**PLANNED**	**TOTAL**
General Aviation:			
Fixed Base Operator	114.6	16.6	131.3
Corporate Aviation	32.6	-	32.6
Helicopter Facilities	4.3	-	4.3
Subtotal (GA Facilities)	**151.6**	**16.6**	**168.2**
Airline Support:			
Airline Maintenance	24.9	-	24.9
Air Cargo/Provisioning	3.2	-	3.2
Airline Fuel Farm	2.8	-	2.8
Subtotal (Airline Support Facilities)	**30.8**	**-**	**30.8**
Houston Airport System:			
Administration	2.1	-	2.1
Aircraft Rescue and Fire Fighting	1.4	-	1.4
Airport Maintenance	1.0	0.5	1.5
Subtotal (HAS Facilities)	**4.4**	**0.5**	**5.0**
Other Facilities	**24.4**	**1.4**	**25.9**
Grand Total	**211.2**	**18.55**	**229.8**

NOTE: Columns may not add to totals shown because of rounding.

SOURCES: Houston Airport System Geographic Information System, *Existing Airport Leaseholds*, July 15, 2013; Ricondo & Associates, William P. Hobby Airport Master Plan Update Forecast, December 2012; Ricondo & Associates, Inc., HOU Tenant Interviews, January 2013.

PREPARED BY: Ricondo & Associates, Inc. July 15, 2013.

For purposes of this analysis, the total area dedicated to existing and planned facility development set forth in Table 4-104 served as a baseline for establishing future facility requirements. Future facility requirements were projected on an aggregate basis in terms of gross acres, reflective of the demand for 2015, 2020 and 2030 under the Master Plan Update forecast (see Section 3). The specific methodologies and conclusions for each of the four classifications are discussed below.

4.8.1 GENERAL AVIATION FACILITIES

All tenant facilities that serve general aviation aircraft either based at the Airport or transient aircraft that require temporary aircraft storage or flight support services at the Airport were considered in this analysis. These facilities include aircraft storage/maintenance hangars, aircraft parking aprons, administrative offices/FBO terminal buildings, and automobile parking facilities. Fueling services offered by these tenants were evaluated and are presented separately (see Section 4.8.2.3).

For the purposes of this analysis, these tenants are classified as FBOs, corporate tenants, or helicopter tenants. FBOs typically provide a wide range of services for the owners of both based and transient aircraft. These services may include aircraft fueling, storage, maintenance, and flight planning, as well as arranging local transportation and hotel accommodations for flight crews and passengers. In comparison, corporate aviation facilities are leased directly to aircraft owners for their exclusive use. These facilities primarily serve private owners of aircraft based at the Airport. Corporate tenants may operate a variety of jet, multi-engine, and single-engine aircraft. Similar to corporate tenants, helicopter tenants lease facilities directly from HAS for their exclusive use. However, these tenants operate helicopters in lieu of fixed-wing aircraft.

Because of their unique facility needs, operational characteristics, and demand levels, each of these three tenant classifications were analyzed separately. As FBOs serve both based and transient aircraft owners, their facility needs are typically predicated on the demand associated with aircraft based at the FBO facilities on the Airport and itinerant aircraft. Corporate and helicopter tenant facility needs can be correlated with based aircraft and helicopter demand, respectively. However, corporate aircraft and helicopters located in space subleased from the FBOs are considered part of the FBO's based aircraft. Therefore, the actual and forecast numbers of based aircraft formed the basis for establishing the requirements for corporate and helicopter tenant facilities.

Table 4-105 presents a summary of the demand contained in the general aviation forecasts that formed the basis for establishing general aviation facility requirements. Demand was associated with itinerant operations and based jets and helicopters. Single-engine and multi-engine based aircraft were excluded, as the Master Plan Update forecasts show a modest decrease in the number of these based aircraft at the Airport throughout the planning period. Although the reduction in single-engine and multi-engine aircraft would reduce facility requirements, this reduction would be offset by the growth in larger jet aircraft based at the Airport.

Table 4-105: General Aviation Forecast Summary

YEAR	ITINERANT OPERATIONS	BASED AIRCRAFT JET	BASED AIRCRAFT HELICOPTER
2011	57,786	178	26
2015	58,450	182	27
2020	59,300	188	27
2030	61,100	200	29
COMPOUND ANNUAL GROWTH RATE (2011-2030)	**0.3%**	**0.6%**	**0.6%**

SOURCE: Ricondo & Associates, *William P. Hobby Airport Master Plan Update Forecast*, December 2012.
PREPARED BY: Ricondo & Associates, Inc., July, 2013.

For long-range planning purposes, the establishment of future GA facility requirements corresponds with an average annual growth rate of 0.6 percent. This growth rate reflects the growth forecast for both the based jets and helicopters under the Master Plan Update forecast. In addition, these future facility requirements were based on the assumption that the current market share of demand for each FBO, as well as the corporate aviation and helicopter facilities, would remain constant throughout the planning period.

4.8.1.1 FBO Requirements

FBO tenant interviews were conducted in January 2013. During the interviews, each FBO at the Airport indicated that its existing facilities were currently at capacity during peak demand periods. All five FBOs have plans to either expand or reconfigure their current facilities to meet their customers' needs. Once these improvements are completed, three of the five FBOs will have surplus capacity, while the other two expect that their facilities will still be constrained.

Table 4-106 presents the resulting acreage anticipated upon completion of each of the FBO's planned expansion programs. It also presents a growth factor, which indicates the amount of additional demand that each FBO's facilities could accommodate. In consideration of this information and the annual growth rates in the Master Plan Update forecasts, the gross facility requirements through 2030 are summarized in **Table 4-107**. The resulting facility requirements indicate that the gross acreage would increase from 131.3 acres to 141.6 acres, a net increase of 10.3 acres.

Table 4-106: Fixed Base Operator Expansion and Growth Factors

	CURRENT LEASEHOLD AREA (ACRES)1/			
FBO TENANT	**EXISTING**	**PLANNED**	**TOTAL**	**GROWTH FACTOR**
Atlantic Aviation	11.4	6.1	17.5	10.0%
Jet Aviation	21.6	2.8	24.4	30.0%
Million Air	28.0	-	28.0	0.0%
Signature Flight Support	25.3	6.6	31.9	3.6%
Wilson Air	28.4	1.2	29.6	0.0%
Total/Weighted Average	**114.6**	**16.6**	**131.3**	**7.8%**

NOTES:

1/ Columns may not add due to totals shown because of rounding

2/ Growth factors are predicated on 2012 operational demand

SOURCES: Houston Airport System Geographic Information System, *Existing Airport Leaseholds*, July 15, 2013; Ricondo & Associates, William P. Hobby Airport Master Plan Update Forecast, December 2012; Ricondo & Associates, Inc., HOU Tenant Interviews, January 2013.
PREPARED BY: Ricondo & Associates, Inc. July 15, 2013.

Table 4-107: Gross Fixed Base Operator Facility Requirements 1/

		FACILITY REQUIREMENTS (ACRES) 3/		
FBO TENANT	**BASELINE FACILITIES 2/**	**2015**	**2020**	**2030**
Atlantic Aviation	17.5	17.5	17.5	17.9
Jet Aviation	24.4	24.4	24.4	24.4
Million Air	28.0	28.6	29.6	31.4
Signature Flight Support	31.9	31.9	32.5	44.7
Wilson Air	29.6	30.2	31.2	33.2
Total	**131.3**	**132.6**	**135.1**	**141.6**

NOTES:

1/ Columns may not add to totals shown because of rounding. A constant market share was assumed throughout the planning period among FBOs.

2/ Baseline facilities include both existing facilities and planned development/redevelopment by FBOs, as identified during the interviews.

3/ Growth factors are predicated on 2012 operational demand.

SOURCES: Houston Airport System Geographic Information System, *Existing Airport Leaseholds*, July 15, 2013; Ricondo & Associates, William P. Hobby Airport Master Plan Update Forecast, December 2012; Ricondo & Associates, Inc., HOU Tenant Interviews, January 2013.
PREPARED BY: Ricondo & Associates, Inc. July 15, 2013.

4.8.1.2 Corporate Aviation and Helicopter Facility Requirements

The facility requirements for corporate aviation and helicopter facilities in future years are presented in **Table 4-108.** For comparative purposes, the gross FBO requirements are also presented. As shown, the gross facility requirements are projected to increase from 168.2 acres currently to 183.6 acres in 2030, a net increase of 15.4 acres.

Table 4-108: Gross General Aviation Facility Requirements

		FACILITY REQUIREMENTS (ACRES) 2/		
USE	BASELINE FACILITIES 1/	2015	2020	2030
Fixed Base Operator	131.3	132.6	135.1	141.6
Corporate Aviation	32.6	34.6	34.6	36.7
Helicopter Facilities	4.3	4.3	5.3	5.3
Total	**168.2**	**171.5**	**175.0**	**183.6**
Net Increase	**NA**	**3.2**	**6.8**	**15.4**

NOTE:

1/ Baseline facilities include both existing facilities and planned development/redevelopment by FBOs, as identified during the interviews.

2/ Growth factors are predicated on 2012 operational demand.

SOURCES: Houston Airport System Geographic Information System, *Existing Airport Leaseholds*, July 15, 2013; Ricondo & Associates, William P. Hobby Airport Master Plan Update Forecast, December 2012; Ricondo & Associates, Inc., HOU Tenant Interviews, January 2013.

PREPARED BY: Ricondo & Associates, Inc. July 15, 2013.

It should be noted that the current leasehold areas for corporate aviation facilities range from 2 acres to 8 acres. Similarly, the leasehold areas for helicopter facilities range from 1 acre to 3 acres. Therefore, the net increase in facility requirements for both corporate aviation and helicopter facilities was established in 2 acre and 1 acre increments, respectively. However, the actual incremental increase in these facilities will depend on each tenant's specific needs and opportunities.

4.8.2 AIRLINE AND AIRPORT SUPPORT FACILITIES

Gross facility requirements for airline support facilities are presented in **Table 4-109.** Based on conversations with current airline representatives and HAS staff, no additional airline maintenance or air cargo provisioning facilities are anticipated to be required through 2030. The aircraft fuel farm, however, would need to be expanded to adequately serve projected fuel demand. This expansion would result in approximately 1.5 acres of additional property dedicated to fuel farm facilities.

Table 4-109: Gross Airline Support Facility Requirements 1/

USE	BASELINE FACILITIES 2/	FACILITY REQUIREMENTS (ACRES) 3/ 2015	2020	2030
Airline Maintenance	24.9	24.9	24.9	24.9
Air Cargo / Provisioning	3.2	3.2	3.2	3.2
Aircraft Fuel Farm	2.8	3.2	3.7	4.2
Total	**30.8**	**31.2**	**31.8**	**32.3**
Net Increase	**NA**	**0.4**	**0.9**	**1.5**

NOTES:

1/ Columns may not add to totals shown because of rounding.

2/ Baseline facilities include both existing facilities and planned development/redevelopment by FBOs, as identified during the interviews.

3/ Growth factors are predicated on 2012 operational demand.

SOURCES: Houston Airport System Geographic Information System, *Existing Airport Leaseholds*, July 15, 2013; Ricondo & Associates, William P. Hobby Airport Master Plan Update Forecast, December 2012; Ricondo & Associates, Inc., HOU Tenant Interviews, January 2013.
PREPARED BY: Ricondo & Associates, Inc. July 15, 2013.

4.8.2.1 Aircraft Maintenance

The need for aircraft maintenance facilities cannot necessarily be correlated with operational demand at the Airport. Many airports, including commercial service airports, do not have dedicated aircraft maintenance facilities on site. Other airports may have large maintenance facilities dedicated to air carrier aircraft although the airport has little or no commercial airline service.

Southwest Airlines currently provides regularly scheduled service and conducts aircraft maintenance at the Airport. Interviews with airline representatives revealed that Southwest Airlines does not foresee any expansion of its aircraft maintenance operations at HOU throughout the planning period.

United Airlines is the only other airline that conducts aircraft maintenance at the Airport, although it does not serve HOU. Its facilities are not ideally suited for the aircraft types maintained at the Airport. Expansion of United Airlines' aircraft maintenance facilities at the Airport is not anticipated throughout the planning period.

4.8.2.2 Air Cargo and Provisioning Facilities

Although the existing cargo facility also serves as a provisioning warehouse for Southwest Airlines, this function was not analyzed separately. Air cargo warehouse, apron, and loading dock areas directly correlate with the annual tonnage of enplaned belly cargo. These needs are typically identified according to the gross area of the cargo warehouse.

When interviewed, the airlines that offer belly cargo stated that no additional facilities would be needed throughout the planning period. However, HAS envisions significant growth of belly cargo upon initiation of international air service by Southwest Airlines, requiring the relocation of the Air Cargo facilities by 2020.

4.8.2.3 Aircraft Fueling Facilities

The demand/capacity of aircraft fueling facilities serving air carrier/regional and general aviation aircraft was analyzed separately because the fuel storage capacities and demand characteristics associated with these facilities are different. In addition, the fueling services provided for general aviation aircraft must include both avgas and Jet A fuel, whereas air carrier/regional aircraft require Jet A fuel exclusively.

The demand/capacity analysis of the aircraft fueling facilities was based on the number of days that the fuel storage tanks could sustain operation if the supply of fuel to the Airport were disrupted. The daily fuel demand was estimated by each type of user: air carrier aircraft, GA jets, and GA piston-driven aircraft. Historical fuel demand was obtained from the various fuel providers and formed the basis for establishing an average fuel demand per aircraft operation. This demand was multiplied by the average number of daily operations to estimate the daily fuel demand associated with each type of user. The number of days' supply was calculated by dividing total storage by peak month, average day demand for each planning year. Southwest Airlines aims to provide a 10-day supply of aviation fuel at its HOU station.

Table 4-110 summarizes the current fuel storage capabilities of the two fuel farm facilities currently owned and operated by Southwest Airlines. These facilities include the primary fuel farm located immediately west of the passenger terminal, and a second fuel farm located along the eastern Airport boundary, previously owned by NuStar Energy L.P. This second fuel farm is now referred to as the Southwest Airlines East Side Fuel Facility and provides an additional Jet A fuel storage capacity of 4,422,600 gallons.

The estimated annual fuel demand associated with Southwest Airlines' two fuel farm facilities is also shown in the table. This demand includes both the estimated fuel demand for air carrier aircraft operations and select FBOs that have fueling agreements with Southwest Airlines. Currently, Wilson Air Center, Atlantic Aviation, and Jet Aviation purchase Jet A fuel from Southwest Airlines, while the other FBOs have their fuel shipped via tanker trucks. Based on information provided by Southwest Airlines, the airline estimated that its fuel demand averages 244,000 gallons of Jet A per day. An analysis of the fuel storage capacities of the air carrier aircraft fleet that operated during the peak month at HOU was conducted to estimate the fuel demand associated with the other airlines operating at the Airport. It was determined that the Jet A fuel demand from the other airlines is approximately 44,000 gallons per day.

Table 4-110: Airline Fueling Facilities Summary

FACILITY	FUEL TYPE	FUEL TANKS	CAPACITY PER TANK (GALLONS)	TOTAL CAPACITY (GALLONS)	ANNUAL FUEL USE (GALLONS) 1/
Southwest Airlines Fuel Farm	Jet A	3	230,000	690,000	114,068,000 2/
Southwest Airlines East Side Fuel Facility	Jet A	4	2,541,000; 1,428,000; 2 x 226,800	4,422,642	NA
				5,112,642	**114,068,000**

NOTES:

1/ Air carrier aircraft fuel use was based on average daily fuel consumption of 288,000 gallons and an additional 7.2 million gallons from the FBOs. FBO fuel use was based on HAS fuel records from May 2011 through April 2012.

2/ Atlantic Aviation, Wilson Air Center and Jet Aviation obtain Jet A fuel directly from the Southwest Airlines fuel storage facilities.

SOURCES:Tenant Interviews, January 2013; Ricondo & Associates, Inc., Houston Airport System, July 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

Table 4-111 summarizes the current fuel storage capabilities of each general aviation tenant that either provides fueling services for based and transient aircraft or operates its own fuel storage tanks within its current leasehold. These tenants include all of the FBOs at the Airport and the Houston Police Department. The annual fuel demand shown represents FBO fuel demand between May 2011 and April 2012, the most recent complete year fueling records available at the time of this analysis. Based on discussions with the Houston Police Department, an average of 60,000 gallons of Jet A fuel and 8,000 gallons of AvGas were also considered.

Table 4-112 presents the results of the demand/capacity analysis for the fuel storage facilities operated by the general aviation tenants at the Airport. The table presents the calculation of the average fuel demand per operation, the average daily fuel demand for the peak month, average day (PMAD) in 2011 and 2030, and the number of days that the fuel supply could serve PMAD operational demand. As some FBOs at the Airport do not operate fuel farm facilities, the storage capacities of the fuel trucks were also considered. The Jet A fuel storage capacity for 2030 is projected to be approximately 3.3 days, while the avgas storage capacity is projected to be approximately 97.8 days. For general planning purposes, a minimum of 3.0 days of fuel supply is recommended for general aviation facilities.

It should be noted that this demand/capacity analysis included consideration of the overall fuel storage capacities for the entire Airport. Ultimately, the desire or need to develop new fueling facilities may be identified by individual Airport tenants. During the interviews with the FBOs, none reported any plans to construct new fueling facilities in the near future. However, several indicated that they may consider new fueling facilities sometime in the future.

Table 4-111: General Aviation Fueling Facilities Summary

FACILITY	FUEL TANKS (GALLONS)	FUEL TRUCKS (GALLONS)	TOTAL CAPACITY (GALLONS)	ANNUAL FUEL USE (GALLONS) [1/]
JET A:				
Atlantic Aviation	- [2/]	13,000	13,000	2,907,656
Jet Aviation	- [2/]	20,000	20,000	2,434,183
Million Air	50,000	18,000	68,000	2,974,836
Wilson Air Center	12,000	18,000	30,000	1,853,793
Signature Flight Support	60,000	-	60,000	2,614,358
Houston Police Department	12,000	-	12,000	60,000 (est.)
	134,000	**69,000**	**203,000**	**12,844,826**
AVGAS:				
Atlantic Aviation [3/]	- [3/]	750	750	-
Jet Aviation [3/]	- [3/]	-	-	-
Million Air	12,000	2,000	14,000	48,702
Wilson Air Center	12,000	1,000	13,000	63,077
Signature Flight Support	30,000	-	30,000	43,034
Houston Police Department	8,000	-	8,000	8,000
	62,000	**3,750**	**65,750**	**162,813**

NOTES:

1/ FBO fuel use based on HAS fuel records between May 2011 and April 2012.

2/ Atlantic Aviation and Jet Aviation obtain Jet A fuel directly from the Southwest Airlines fuel storage facilities.

3/ Atlantic Aviation and Jet Aviation currently do not provide avgas.

4/ During the FBO interviews, Million Air indicated that it had a total fuel truck capacity of 20,000 gallons, the capacity distribution between Jet A fuel and avgas fuel was not provided. Therefore, for the purpose of this analysis, it was assumed that Million Air operated one avgas fuel truck with an estimated capacity of 2,000 gallons, with the remaining trucks representing 18,000 gallon capacity for Jet A fuel.

SOURCES: Tenant Interviews, January 2013; Ricondo & Associates, Inc.; January 2013; Houston Airport System, July 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

Table 4-112: General Aviation Fuel Storage Demand/Capacity

	JET A	AVGAS
2011 Aircraft Operations	72,105	24,035
2011 Fuel Demand (gallons)	12.8 million	162,813
2012 Average Fuel Demand per Operation (gallons/operation)	**178**	**7.0**
2011 PMAD Operations	293	98
2011 PMAD Fuel Demand (gallons)	52,154	686
2030 PMAD Operations	345	96
2030 PMAD Fuel Demand (gallons)	61,054	672
Existing Fuel Capacity (gallons)	203,000	65,750
2011 Fuel Supply (days)	3.9	95.8
2030 Fuel Supply (days)	3.3	97.8
Recommended Fuel Supply (days)	**3 days**	**3 days**

PMAD = Peak month, average day.

SOURCES: Tenant Interviews, January 2013, Ricondo & Associates, Inc.; January 2013; Houston Airport System, HOU Fuel Record, July 2013.
PREPARED BY: Ricondo & Associates, Inc., August 2013.

Table 4-113 presents the results of the demand/capacity analysis of the aircraft fueling facilities operated by Southwest Airlines at the Airport. The table also presents the calculation of the average fuel demand per operation, the average daily fuel demand on the PMAD for each planning year, and the number of days that the fuel supply could serve PMAD operational demand.

As shown, the Jet A fuel storage capacity for 2030 is projected to be approximately 8.5 days, which would not meet Southwest Airlines' goal of maintaining a 10-day fuel supply.

If Southwest Airlines were to discontinue providing fueling services to the FBOs, a shortage in its minimum storage capacity would still result (9 days). It has been determined that the 10-day minimum fuel supply would be achieved when forecast operational demand for 2021 is achieved at HOU.

Table 4-113: Southwest Airlines' Fueling Facility Demand/Capacity

	AIRLINES	FBO 1/	TOTAL/AVERAGE
2011 Aircraft Operations	103,780	42,000	145,780
2011 Fuel Demand (gallons)	106.9 million	7.4 million	114.3 million
2012 Average Fuel Demand per Operation (gallons/operation)	**1,030**	**178**	**785**
2011 PMAD Operations	352	172	524
2011 PMAD Fuel Demand (gallons)	362,560	30,438	392,998
2030 PMAD Operations	549	201	750
2030 PMAD Fuel Demand (gallons)	565,470	35,778	601,248
Existing Fuel Capacity (gallons)	5.1 million	5.1 million	5.1 million
2011 Fuel Supply (days)	14.1	NA	13.0
2030 Fuel Supply (days)	9.0	NA	8.5
Recommended Fuel Supply (days)	**10**	**10**	**10**

NOTES:

1/ FBO fuel use was based on 2012 use. The share of general aviation aircraft using Jet A and avgas was based on the 2011/2012 Airport Noise and Operations Monitoring System data split of jet and multi-engine aircraft. Jet aircraft represented 75 percent of the total general aviation fleet; the remaining 25 percent are piston-powered aircraft.

SOURCES: Tenant Interviews, January 2013, Ricondo & Associates, Inc.; HOU Fuel Records, HAS, July 2013.

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

If Southwest Airlines were to discontinue providing fueling services to all other Airport tenants, the 10-day minimum fuel supply would be achieved when forecast operational demand for 2025 is achieved.

4.8.2.4 HAS Facilities

The gross HAS facility requirements are presented in **Table 4-114**. Based on conversations with HAS staff, no additional facilities are anticipated to be required beyond the planned construction of a new Airport maintenance facility and upgrades to the existing ARFF station.

Table 4-114: Gross HAS Facility Requirements

USE	BASELINE FACILITIES 1/	FACILITY REQUIREMENTS (ACRES) 2/ 2015	2020	2030
Administration	2.1	2.1	2.1	2.1
Airport Maintenance	1.5	1.5	1.5	1.5
ARFF	1.4	1.4	1.4	1.4
Total	**5.0**	**5.0**	**5.0**	**5.0**
Net Increase	**NA**	**0.0**	**0.0**	**0.0**

NOTES:

1/ Baseline facilities include both existing facilities and planned development/redevelopment by FBOs that were identified during the interviews.

2/ Growth factors are predicated on 2012 operational demand.

SOURCES: Houston Airport System Geographic Information System, *Existing Airport Leaseholds*, July 15, 2013; Ricondo & Associates, William P. Hobby Airport Master Plan Update Forecast, December 2012; Ricondo & Associates, Inc., HOU Tenant Interviews, January 2013.

PREPARED BY: Ricondo & Associates, Inc., July 15, 2013.

Airport Maintenance Complex

HAS is in the process of designing a consolidated Airport Maintenance Complex, which would include existing maintenance facilities in the south quadrant of the Airport. The consolidation would add approximately 0.5 acre to the existing 1.0-acre maintenance facilities located on the site. No additional expansion is anticipated throughout the planning period.

Airport Administration Facilities

HAS Administration facilities are temporarily located in the HOU FAA/U.S. Customs Building (S-262), in the south quadrant of the Airport, which encompasses approximately 2.1 acres. Upon completion of the Hobby International Terminal, the HAS Administration facilities are anticipated to return inside the passenger terminal building. No additional expansion is anticipated to be required throughout the planning period.

Airport Operations offices (terminal and airside) are also temporarily located in the HOU FAA/U.S. Customs Building. Upon completion of the Hobby International Terminal, these offices are planned to be relocated to the east end of the Lower Level temporary baggage claim area. No additional expansion is anticipated throughout the planning period.

Aircraft Rescue and Fire Fighting Facilities

Each airport with daily scheduled airline service is required to provide ARFF services.

Facility Conditions

Based on interviews with HAS, the existing facilities need to be upgraded to provide dedicated quarters for female staff members. Additionally, the introduction of larger ARFF trucks will require widening the truck bays and doors.

Fire Extinguishing Agents and Equipment

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 ADG), and the number of average daily departures by the most demanding ADG that serves the Airport. Air carrier aircraft are grouped as follows into ARFF indices:

- Index A: Aircraft less than 90 feet long (Beech 1900D and CRJ200)
- Index B: Aircraft at least 90 feet long, but less than 126 feet long (ERJ145 and Boeing 737-300)
- Index C: Aircraft at least 126 feet long, but less than 159 feet long (Boeing 757-200 and MD-88)
- Index D: Aircraft at least 159 feet long , but less than 200 feet long (Boeing 757-300 and A330-200)
- Index E: Aircraft at least 200 feet long (A340-600 and Boeing 747-200)

Aircraft length is representative of the number of passengers that could be involved in an incident, and thus dictates the required number of firefighting vehicles and amounts of extinguishing agents. The largest ADG with an average of five or more daily departures is the ARFF Index required for the airport. At HOU, Index C encompasses the ADG with five or more daily scheduled departures. The majority of the Boeing 737s operated by Southwest Airlines range from approximately 100 feet to 120 feet long. The Boeing-800 is 129.8 feet long, and the MD-80 is also an Index C aircraft. The Airport is currently rated and meets the requirements of ARFF Index C. The fleet mix projected to operate at the Airport throughout the planning period does not warrant an increase in the ARFF rating beyond Index C. Therefore, HAS does not need to add any ARFF equipment or staff under existing criteria.

Response Time Requirements

The ARFF station is located on the airfield so that ARFF personnel can achieve a response time of 3.0 minutes to the midpoint of all air carrier runways under normal conditions. With the current airfield configuration, a 3-minute response time is attainable for all runways.

4.8.2.5 Other Facilities

Currently, approximately 24.5 acres of Airport property are dedicated to other support facilities at the Airport. With the exception of an additional 1.4 acres available for future development by the Houston Aeronautical Heritage Society, no additional other facilities are currently planned. In lieu of speculating on potential development of other facilities at the Airport, the Master Plan Update identifies surplus Airport property that may be available for HAS to consider for future development of other facilities. Therefore, no increases in facility requirements are projected at this time.

4.8.3 SUMMARY OF FINDINGS

Table 4-115 summarizes the gross facility requirements projected for all general aviation and support facilities in 2030. As shown, the overall land area dedicated to these facilities is projected to increase from approximately 230 acres to 247 acres; a net increase of approximately 17 acres. This increase is in addition to the approximately 19 acres of planned tenant facility expansion identified by the various tenants.

Table 4-115: Gross General Aviation and Support Facility Requirements 1/

		2030 REQUIREMEMTS (ACRES)	
LAND USE CLASSIFICATION	**BASELINE FACILITIES (ACRES)**	**TOTAL**	**NET INCREASE**
General Aviation:			
Fixed Base Operator	131.3	141.6	10.3
Corporate Aviation	32.6	36.7	4.0
Helicopter Facilities	4.3	5.3	0.5
Subtotal (GA Facilities)	**168.2**	**183.6**	**15.4**
Airline Support:			
Airline Maintenance	24.9	24.9	-
Air Cargo/Provisioning	3.2	3.2	-
Airline Fuel Farm Facilities	2.8	4.2	1.5
Subtotal (Airline Support Facilities)	**30.8**	**32.3**	**1.5**
Houston Airport System:			
Administration	2.1	2.1	-
Aircraft Rescue and Fire Fighting	1.4	1.4	-
Airport Maintenance	1.5	1.5	-
Subtotal (HAS Facilities)	**5.0**	**5.0**	**-**
Other Facilities	25.9	25.9	-
Grand Total	**229.8**	**246.8**	**16.9**

NOTES:

1/ Columns may not add to totals shown because of rounding. A constant market share was assumed throughout the planning period among FBOs.

2/ Baseline facilities include both existing facilities and planned development/redevelopment by FBOs, as identified during the interviews.

3/ Growth factors are predicated on 2012 operational demand.

SOURCES: Houston Airport System Geographic Information System, *Existing Airport Leaseholds*, July 15, 2013; Ricondo & Associates, William P. Hobby Airport Master Plan Update Forecast, December 2012; Ricondo & Associates, Inc., HOU Tenant Interviews, January 2013.
PREPARED BY: Ricondo & Associates, Inc., July 15, 2013.

5. Alternatives Development

A key objective of the master planning process is to identify the best solutions for addressing future development needs at the Airport. To accomplish this objective, it is necessary to identify and evaluate a range of alternatives that would satisfy the requirements identified in Section 4, and ultimately to provide a planning framework on which to base future Airport development decisions. This Master Plan Update builds on parallel studies and the 2003 Master Plan, and is intended to be used as a consolidated reference for implementing future Airport improvements to meet the region's needs. Many of the alternatives discussed in this section will continue to be modified and refined prior to final design and construction.

5.1 Requirements Overview

Development requirements for planning future facilities are based on future activity, as discussed in Section 4. These facility requirements are summarized as follows by category:

- Airfield
  - Additional runway capacity by 2025
  - Air carrier runway redundancy
  - Increased safety of runway/taxiway interface
- Aviation Support: Additional FBO/corporate business operator space to accommodate general aviation growth
- Terminal Area: Upon the opening of the Hobby International Terminal (HIT), also referred to as the West Concourse in this report, currently under construction, the following facilities will be operational:
  - New parking garage
  - Realigned Hobby Airport Loop
  - Relocated long-term parking facilities
  - The Satellite Utility Plant to support the new West Concourse and supplement the aging existing CUP
- Passenger Terminal Facilities: Upon the opening of the HIT, which is currently under construction, five additional aircraft gates will be available. It is anticipated that seven additional gates will be required

by 2020, and up to nine additional gates before the end of the master planning horizon (2030). These gates could be provided at an extension to the HIT, an East Concourse with contact aircraft parking positions, or as remote parking positions on the apron east of the existing terminal facilities depending on the nature of the passenger operations that would be driving the need for additional gates. Additional passenger processing facilities are also anticipated to be required, and would be accommodated in an expansion of the terminal on the east end.

- Rental Car Facilities: A consolidated rental car facility is anticipated to be required to accommodate growth and improve the customer experience.
- Taxicab Staging Areas: The taxicab staging area will need to be relocated and expanded to accommodate anticipated growth.
- Cell Phone Waiting Lot: the cell phone waiting lot will need to be relocated to accommodate the CRCF.
- Roadways: Roadway intersection improvements will be required to accommodate the forecast increase in enplaned passengers at HOU. Also, roadway access improvements to the long-term surface parking lot are recommended.

5.2 Constraints and Opportunities

Development of the Airport is constrained by roadways, a combination of residential and industrial development that surrounds the Airport, and other developed areas outside the Airport boundary, as well as by existing facilities on the Airport (such as the ATCT, the terminal complex, the airfield, and other navaids). **Exhibit 5-1** shows existing land uses on and in the vicinity of the Airport. Areas to the northwest, north, and south of the Airport are mostly residential, with commercial parcels adjacent to Airport property. Areas to the east and west of the Airport are mostly industrial or vacant/undeveloped. Vacant areas on- and off-Airport are also shown.

5.3 Airfield Layout

The identification of future airfield facility requirements at HOU was focused on airfield capacity enhancements, runway length requirements, and compatibility with FAA design standards (including the desire to increase safety). Airfield capacity enhancements typically include additional runway development, but may also include other infrastructure improvements to operational efficiency, such as runway exits or instrument approach/departure procedures. Similarly, adding runway length or improving airfield geometry to satisfy the FAA design standards could enable the Airport to better serve larger aircraft with higher aircraft performance characteristics.

LEGEND

Runway Pavement	Public Parking	Vacant/Undeveloped Land	Agricultural	Residential
Taxiway Pavement	Employee Parking	Federal	Commercial	Transportation/Utility
Airfield	Rental Car Facility	City of Houston	Industrial	Building
Airline Support	HAS Maintenance and Support	Houston Police Department	Park/Open Space	Planned Construction
General Aviation	Terminal	Nonaviation	Public/Institutional	Airport Property Line

SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, November 2013; Houston Airport System, Geographic Information System Data, Jacobs Engineering, February 2013; Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

EXHIBIT 5-1

NORTH

0 1,800 ft.

Land Uses on and in the Vicinity of the Airport

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\Existing Land Use\Exhibit_5-1_On_&_Off_Airport_Land_Use-With_LU_STNDs.dwg_Layout: 8.5x11P_2100xp_Dec 26, 2014, 1:21pm

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The following conclusions were reached from the airfield requirements analysis (Section 4):

- The existing longest runway length of 7,602 feet can accommodate the anticipated aircraft fleet mix and destinations expected to be served through the planning period.
- The existing runway configuration is adequate to serve current (2011-2012) operational demand.
- As demand increases throughout the planning period, airfield capacity will be exceeded during peak demand periods.

These capacity exceedances will create aircraft delays during peak hours and increase operating costs. Existing average aircraft delay is estimated to be 1.5 minutes. This delay is expected to increase to nearly 6 minutes per aircraft operation in 2030. At medium-hub airports such as HOU, an average aircraft delay of 4 minutes is typically considered the threshold of unacceptable delay. (These delays are analytical estimates and only include delays incurred while operating on the airfield; they do not include delays that may be incurred on approach to the Airport. Detailed simulation analyses that are beyond the scope of this master plan update would be required to accurately project the total delays that may be incurred by aircraft throughout the planning horizon.)

Therefore, the exploration of airfield capacity enhancement opportunities is warranted. Future airfield capacity requirements vary depending on the anticipated growth and demand characteristics of aviation activity. Capacity enhancements should be recommended so that sufficient lead-time is available to add capacity before the lack of needed capacity becomes critical. According to the *National Plan of Integrated Airport Systems*[1] (NPIAS), capacity enhancements should be recommended when demand exceeds 60 percent of the ASV of the specific facility. These values are approximate thresholds for beginning to plan for enhancements. The airfield demand capacity analysis discussed in Section 4 showed that the airfield currently operates at 83 percent of its calculated ASV and is expected to operate at 105 percent of the ASV in 2030. For the purposes of this Master Plan Update, it is desirable to identify an airfield development alternative that will be able to accommodate forecast 2030 operational demand.

5.3.1 2003 MASTER PLAN PREFERRED ALTERNATIVE

The existing and proposed airfield configurations depicted on HOU's current ALP reflects the recommended airfield improvements set forth in the previous HOU Master Plan prepared in 2003. As the result of a variety of factors, primarily the land constraints at HOU, the following airfield capacity enhancements were adopted in the 2003 Master Plan and are reflected on the current ALP:

- **Shift and extend Runway 17-35:** This enhancement would eliminate the intersection of Runway 17-35 and Runway 12R-30L, thereby allowing independent operations under certain airfield operating configurations.

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

- **Redevelop Runway 12L-30R:** This enhancement includes widening and extending the runway pavement, as well as other modifications necessary to comply with RDC C-IV standards. The alignment of the runway would also be shifted to achieve a lateral separation of 913 feet from existing Runway 12R-30L so that the runways would function as a closely spaced parallel runway system.
- **Construct a future Runway 4R-22L:** With a lateral separation of 1,055 feet from existing Runway 4-22, this proposed RDC C-IV runway would serve as a closely spaced parallel runway.

Rather than reiterate the comprehensive airfield alternatives analysis that was conducted as part of the 2003 HOU Master Plan, it was determined that the airfield capacity enhancements recommended in the 2003 Master Plan would be reviewed and validated. To the extent possible, the preferred airfield layout alternative selected as a result of the 2003 Master Plan analyses was carried through to this Master Plan Update. A summary of the process for selecting the 2003 Master Plan preferred alternative is provided in the subsections below. This alternative was re-evaluated and refined to reflect the latest priorities and requirements, as discussed in Section 5.3.2.

5.3.1.1 Initial Airfield Development Alternatives (2003 Master Plan)

Using an unconstrained approach, 13 initial airfield development alternatives were identified in the 2003 Master Plan. However, variations of many of the alternatives were also developed (such as varying the separation between runways), increasing the total number of alternatives to 43. Some of the alternatives were conservative in nature and would only require augmenting the existing airfield. Other alternatives were more aggressive, consisting of the partial or total replacement of the existing airfield. In general, the airfield alternatives considered can be grouped into six airfield development strategies:

- No build – 1 alternative
- South flow open-V runway configurations – 4 alternatives
- North flow open-V runway configurations – 6 alternatives
- North and south flow open-V runway configurations – 5 alternatives
- Dual parallel (to existing) runway configurations – 21 alternatives
- Miscellaneous parallel runway configurations – 6 alternatives

An initial screening of the 43 airfield development alternatives was conducted to establish which alternatives should be further refined and evaluated in greater detail. Screening criteria were developed to provide a preliminary assessment of the overall merits of each alternative in relation to each other. The initial screening was the first step in a two-step process for selecting the preferred facility development strategy. The screening criteria included:

- Operational efficiency/effectiveness
- Constructability and physical characteristics
- Relative development costs
- Environmental and community impacts

Based on the initial screening, seven alternatives were short-listed for refinement and further evaluation.

5.3.1.2 Refinement of Short-listed Airfield Alternatives (2003 Master Plan)

The short-listed alternatives were refined to better define the physical characteristics of each alternative and to facilitate the quantitative evaluation process used to select the preferred alternative. To derive a short list of alternatives, the required airfield geometry was evaluated. The geometric characteristics included runway length requirements, runway and taxiway geometry, and vertical, horizontal, and approach clearances for ADG IV aircraft, as defined in FAA AC 150/5300-13, *Airport Design* (which has since been cancelled and replaced by AC 150/5300-13A). Estimated land acquisition requirements were identified based on the apparent configurations of the parcels of land that would be acquired.

5.3.1.3 Evaluation of Short-listed Airfield Alternatives (2003 Master Plan)

The short-listed alternatives were evaluated to provide a secondary assessment of the future airfield and facility development patterns identified for the Airport. However, unlike the initial screening, in which the various development alternatives were evaluated using a qualitative approach, the strengths and weaknesses of the short-listed alternatives were qualitatively evaluated using measurable criteria.

The measurable evaluation criteria included the following:

- Operational Impacts – The initial screening process established each alternative's ability to accommodate the aircraft operational demand forecast through the planning horizon. The operational impacts associated with each development alternative were evaluated, including consideration of the impacts on airfield circulation, such as runway crossings during taxiing operations and operational dependencies associated with runway operations.
- Relative Capital Investment – The relative capital investment required for each alternative was compared using a weighted scoring model. A rough order-of-magnitude estimate was developed for each major cost item, such as land acquisition, airfield pavement requirements, fill/excavation requirements, roadway realignments, and facility relocations. Based on these estimates, cost items associated with the alternatives were given ratings of 1 through 6, with 1 representing the lowest cost and 6 representing the highest cost. A factor was then applied to each cost item to represent its relevance to the overall development cost to establish a weighted score for each alternative. The alternatives with the highest scores would have the highest development costs while the alternatives with the lowest scores would have the lowest development costs. The alternative with the lowest development cost was considered to be the most preferable alternative.
- Long-Term Flexibility and Expandability – The ability of each alternative to accommodate future facility demand beyond the planning horizon was assessed. ASV was calculated for each alternative and compared to demand at the end of the planning horizon.
- Indirect Facility Impacts – The level of disruption to landside or airside facilities caused by increased demand for specific facilities was also evaluated. The displacement of existing Airport facilities was evaluated based on the magnitude and generalized impacts of the disruption. While the screening process generally identified affected facilities, the evaluation process included a quantification of such

indirect impacts to ascertain the desirability of each development alternative. For instance, an alternative that required a significant amount of capital to re-establish/relocate existing facilities affected by the new facilities was considered to be less attractive than one that allowed for construction of the new facilities with minimum impacts on existing facilities.

None of the seven short-listed alternatives was determined to be adequate to accommodate the aircraft operational demand at the end of the planning horizon. Therefore, individual airfield development alternatives were combined into hybrid concepts that would increase capacity.

A combination of Alternatives 3C and 7A-2 was selected as the preferred airfield development alternative to be implemented as a near- to mid-term (5-10 years) project. Although this hybrid alternative would improve the ASV of the airfield, the annual demand at the end of the planning horizon would still exceed the airfield's ASV. Therefore, construction of Runway 4R-22L under Alternative 5A was recommended as the long-term (15-20 years) airfield development alternative. Construction of this runway would not only ensure that the ASV exceeds annual demand beyond the planning horizon, but it would delay the displacement of the existing Southwest Airlines maintenance hangar and East Ramp tenant facilities.

5.3.1.4 Refinement of the Preferred Airfield Alternative (2003 Master Plan)

Refinement of the preferred airfield alternative in the 2003 Master Plan included defining geometric characteristics for the future airfield, as well as the vertical, horizontal, and approach clearances associated with the approach capability of each runway. Refinements included:

- Reducing the proposed extension of Runway 17-35 to the south to preserve Almeda-Genoa Road. The usable runway length would not be less than the current length of 6,000 feet, and is shown at approximately 6,500 feet. The runway length to be decommissioned on the north end was also reduced to maximize the departure length available on Runway 17. However, to eliminate dependencies with Runway 12R-30L, the Runway 17 threshold would be displaced, requiring the use of declared distances on Runway 17-35.
- Redeveloping Runway 12L-30R to an ultimate length of approximately 7,600 feet, consistent with that of existing Runway 12R-30L. It is anticipated that the redeveloped runway would primarily serve aircraft departures; therefore, no angled taxiway exits would be provided. A holding bay was added to serve as a staging area for aircraft queuing to depart on Runway 30R.
- Reducing the overall length proposed for future Runway 4R-22L to approximately 7,315 feet to eliminate dependencies with Runway 17-35. Although it is anticipated that Runway 4R-22L would primarily serve aircraft arrivals during VFR conditions, the use of Runway 22L (west flow) would be limited. Therefore, angled runway exits were only proposed for landings on Runway 4R. In addition, the separation between the new runway and its parallel taxiways would not be configured to allow for the installation of a glide slope antenna. This is acceptable, as existing Runway 4L-22R would remain the primary landing runway during IFR weather conditions, as it is currently planned to be served by a CAT II/III ILS.

5.3.2 CURRENT MASTER PLAN UPDATE ALTERNATIVES

The 2003 Master Plan preferred airfield alternative was refined into three layouts that also address recent Airport safety priorities, as well as community concerns.

5.3.2.1 Alternative 1 (Refinement of Preferred Airfield Alternative from 2003 Master Plan)

The preferred airfield development alternative identified in the 2003 Master Plan was reviewed to determine if it is still viable. The Airport's existing property envelope, anticipated development impacts, airfield safety issues, and facility requirements were considered.

It was concluded from the review that the planned extension of Runway 17-35 was no longer necessary, as the overall development costs had increased substantially since 2003. In addition, because Runway 17-35 intersects both Runways 12R-30L and 4-22 and thereby creates hot spots for runway incursions, the FAA and HAS concur that eliminating these safety issues is a priority. Shortening Runway 17-35 on both the north and south ends to eliminate these hot spots would reduce the available runway length considerably. In addition, the closure of Runway 17-35 would reduce Airport maintenance expenses and make some additional land available for potential future development. On these bases, and despite a loss of runway capacity, all parties are in favor of decommissioning Runway 17-35 as part of the airfield development plan. The planned upgrade of existing Runway 12L-30R and construction of a new parallel Runway 4R-22L were determined to remain the most viable opportunities for enhancing the airfield throughput capacity. Because of the potential closure of both Runways 12R-30L and 4-22 during maintenance activities at the intersection of these two runways, the planned upgrade of Runway 12L-30R must occur prior to the decommissioning of Runway 17-35. As such, the proposed airfield improvements associated with the Alternative 1 consists of two distinct development phases:

- *Phase 1,* which consists of:
  - Upgrading Runway 12L-30R to accommodate the commercial airlines by shifting the runway centerline approximately 113 feet to the northeast, staggering the Runway 12L threshold approximately 789 feet, widening the runway to 150 feet, and lengthening the runway to 8,002 feet.
  - Upon completion of the Runway 12L-30R upgrade, decommission Runway 17-35.
- *Phase 2*, which consists of constructing a parallel Runway 4R-22L equal in width and length to existing Runway 4-22.

Phase 1 should be implemented by 2025 as discussed in Section 4, and Phase 2 would be the preferred alternative if the need for additional airfield capacity materializes at the end of the planning horizon (2030). It was determined that HAS will not pursue Phase 2 development at this time for the following reasons:

- The high cost implications associated with relocating Airport tenants and Airport neighbors (residences, hotels, gas stations, etc.) and roadways
- The fact that the Airport may gain additional airfield capacity prior to the end of the planning period as a result of the implementation of the next generation air transportation system (NextGen)

- The potential for challenging airspace constraints associated with the runway (further analysis is required to determine if the local and regional airspace around HOU can accommodate the number of aircraft operations that would result from the Phase 2 airfield layout)

Details of the proposed Phase 1 and 2 airfield layouts are described below.

Phase 1 Airfield Layout

Exhibit 5-2 illustrates a conceptual layout of the airfield upon completion of Phase 1. The proposed improvements are based on a combination of the *Environmental Impact Statement* (EIS)[2], the runway length analysis discussed in Section 4, and discussions with HAS. The proposed Phase 1 airfield layout includes an upgrade to Runway 12L-20R to accommodate air carrier aircraft, by shifting the runway centerline approximately 113 feet to the northeast, resulting in a runway centerline-to-centerline separation with Runway 12R-30L of 913 feet. Although the minimum runway centerline separation required by the FAA is 700 feet, the additional separation would allow for a parallel taxiway between the runways, which would reduce ROTs, in turn increasing runway capacity. A separation of 800 feet would be sufficient to provide for a parallel taxiway, but would require relocation of the existing parallel Taxiway M from its current offset of 513 feet to 400 feet from Runway 12R-30L. The Runway 12L threshold would be staggered to the northwest by approximately 789 feet. Other improvements to Runway 12L-30R would include widening the runway to 150 feet and lengthening it to 8,002 feet, providing similar physical characteristics and functionality as those of Runway 12R-30L. HOU ATC personnel would favor operating the inboard runway (Runway 12L-30R) as the primary arrival runway in South Flow, while the outboard runway (Runway 12R-30L) would be the primary departures runway. This operating configuration would require departing aircraft to cross Runway 12L en route to the Runway 12R threshold. To expedite these runway crossings, HOU ATC personnel requested staggering the runway thresholds to allow departing aircraft to cross in front of the future Runway 12L glide slope antenna so as not to interfere with arrival operations. Further evaluation of the threshold stagger is required to identify potential airspace impacts.

Preliminary siting of the proposed runway ends was based on the following assumptions:

- Provide a 600-foot arrival RSA for landing aircraft on Runways 12L and 30R (the existing service road and ditch around the Runway 12L end were assumed to remain in their existing locations; as a result, the ditch would be the limiting object for the RSA on the northwest end).
- Provide an accelerate-stop distance available (ASDA) of 7,602 feet for aircraft taking off on Runway 30R.
- Minimize the impacts to residential areas northwest of the Airport (upgrading Runway 12L-30R from an RDC of B-II to an RDC of C-IV would result in larger arrival and departure RPZs).
- Minimize the impacts to areas southeast of the Airport by limiting the extent of the RSA and ROFA to the edge of the proposed taxiway object free area.

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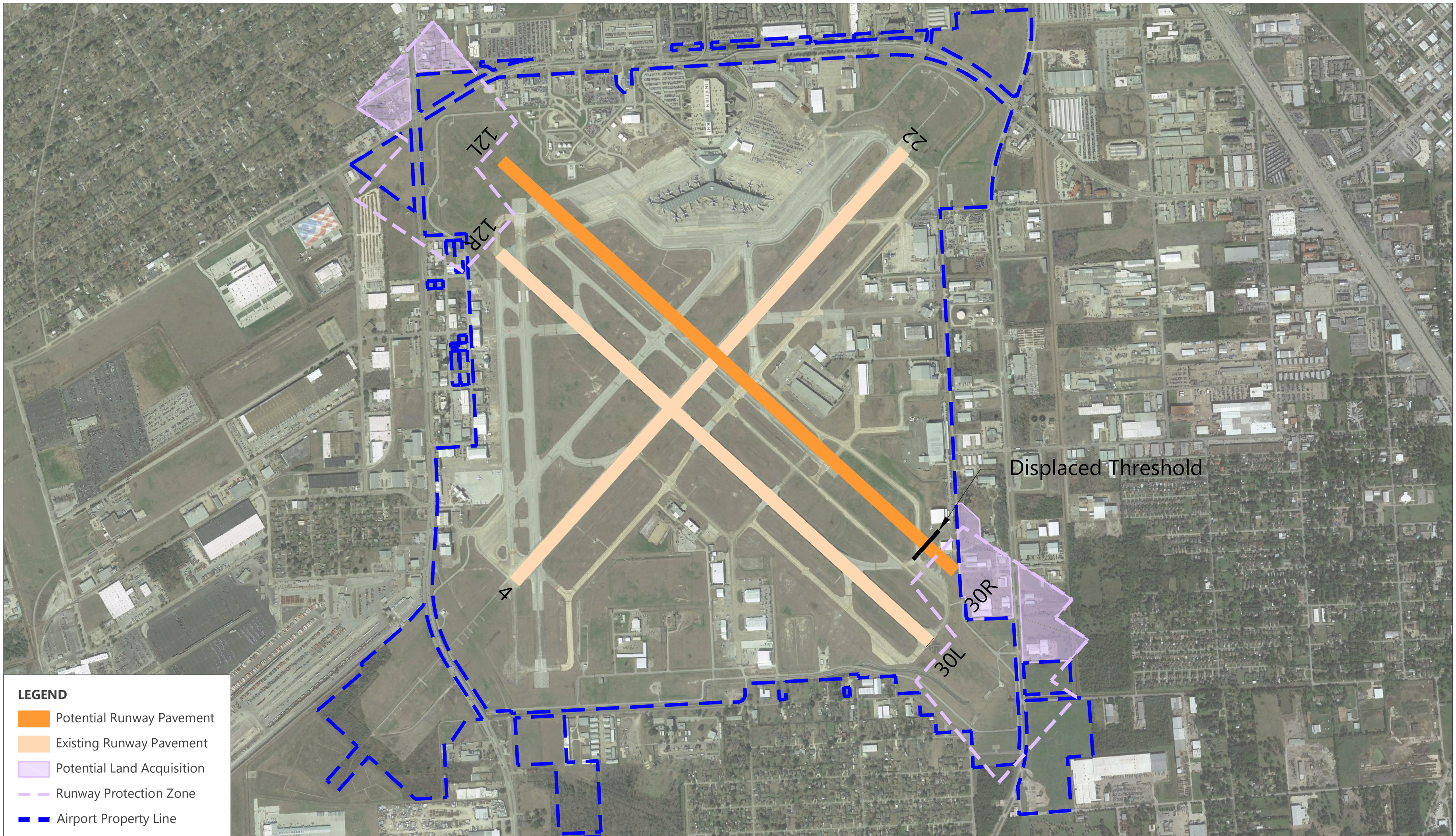
[2] CH2M Hill, *Phase 1 Documentation - William P. Hobby Airport Environmental Impact Statement (EIS)*, March 2008.



SOURCE: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, June 2014; Google Earth Pro 2014; Terra Metrics, February 14, 2014 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

EXHIBIT 5-2

NORTH 0 2,000 ft.

Alternative 1
Phase 1 Airfield Layout

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Rwy 12L Upgrade Layout Alternatives\CAD\5-2_Alternative 1-Phase 1 Airfield Layout.dwg Layout: 5-2 - Rwy 12L Upgrade Layout - Alt. 1 - Stagger Plotted: Dec 26, 2014, 01:28PM

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The resulting Runway 12L-30R declared distances upon implementation of the Phase 1 airfield layout are depicted on **Exhibit 5-3**, and listed below:

- Runway 12L landing distance available (LDA): 7,094 feet
- Runway 12L ASDA: 7,094 feet
- Runway 12L takeoff run available (TORA): 8,002 feet
- Runway 12L takeoff distance available (TODA): 8,002 feet
- Runway 30R LDA: 7,094 feet
- Runway 30R ASDA: 7,602 feet
- Runway 30R TORA: 8,002 feet
- Runway 30R TODA: 8,002 feet

A partial parallel taxiway that can accommodate ADG III aircraft, north and east of Runway 12L-30R, would provide access to the extended Runway 30R end. Upon completion of the Runway 12L-30R upgrade, Runway 17-35 would be decommissioned. The decommissioning of Runway 17-35 would provide the following benefits:

- Removal of runway incursion hot spots, one of the Airport's safety priorities
- Reduced airfield complexity for Airport users (pilots, controllers, drivers)
- Reduced overall Airport maintenance costs
- No need for land acquisition on the south side of the Airport to lengthen Runway 17-35 upon decoupling from Runway 12R-30L (as recommended in the 2003 Master Plan)
- Closure of a runway with use restrictions (ARC B-II aircraft and smaller) caused by:
  - Proximity to Taxiway G to the west
  - Limited RSA available on the south end of the runway

Impacts resulting from the implementation of the Phase 1 airfield layout would remain to be evaluated; a preliminary high-level analysis shows that the following would be required:

- Land acquisition beyond the northwest and southeast ends of the Airport property. At a minimum for new runways, land acquisition should include ROFAs and RPZs. To the extent practicable, land acquisition should include adequate areas surrounding the runway to protect the runway approach and departure surfaces identified in FAA AC 150/5300-13A, paragraph 303. Parcels anticipated to be impacted by land acquisition are depicted on **Exhibit 5-4**.
- Realignment/closure of portions of West Monroe Road
- Demolition of several Signature Flight Support and Jet Aviation facilities

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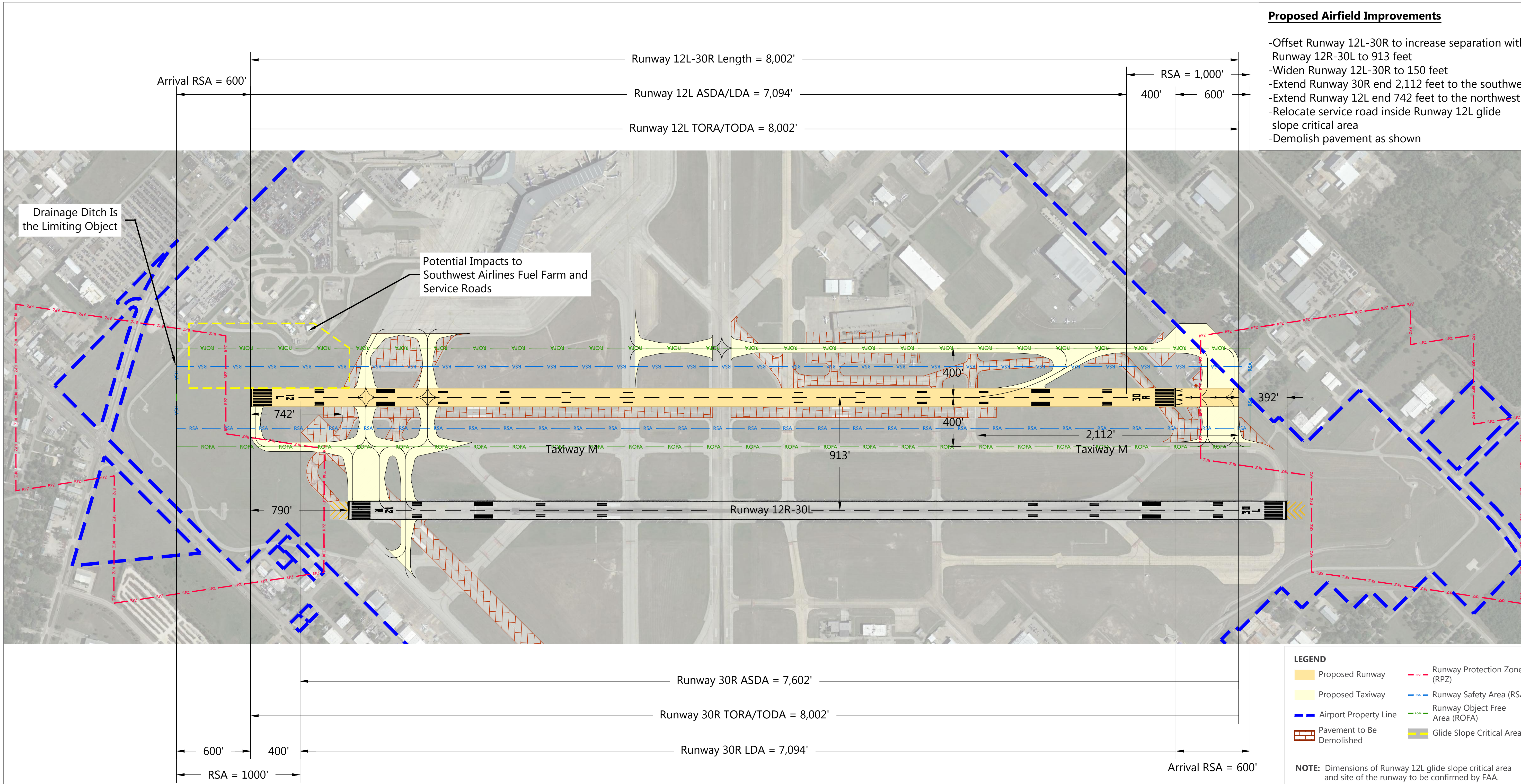

SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, October 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., October 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 5-3

Acronyms

ASDA - Accelerate Stop Distance Available
LDA - Landing Distance Available
MOS - Modification of Standards
TODA - Takeoff Distance Available
TORA - Takeoff Run Available

NORTH 0 800 ft.

Alternative 1
Phase 1 Airfield Runway 12L-30R Declared Distances

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Exh 5-3_Declared DistancesPhase 1-Rwy 12L Upgrade-Refinement 1.dwg_Layout: 11x17L_Dec 26, 2014, 1:34pm

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SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, June 2014; Houston Airport System, Geographic Information System Data, Jacobs Engineering, May 2013, Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

EXHIBIT 5-4

NORTH 0 400 ft.

Alternative 1
Parcels Anticipated to Be Impacted by Land Acquisition

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Rwy 12L Upgrade Layout Alternatives\CAD\5-4_Alternative 1-Parcels Impacted.dwg Layout: 5-4 -Parcels Impacted_Stagger Plotted: Dec 26, 2014, 01:39PM

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- Relocation of the deicing pad
- Relocation of a portion of the Southwest Airlines Fuel Farm
- Realignment of the service road south of the Southwest Airlines Fuel Farm
- Coordination with the FAA on impacts of proposed RPZs on various roadways in the vicinity of the Airport

Phase 2 Airfield Layout

A conceptual layout of the airfield upon completion of Alternative 1 - Phase 2 is illustrated on **Exhibit 5-5**. The proposed improvements would include constructing a parallel Runway 4R-22L, which would be 7,602 feet long and 150 feet wide, similar to Runway 4-22 (proposed Runway 4L-22R). Although the minimum runway centerline-to-centerline separation required by the FAA is 700 feet, a wider separation of 1,055 feet would allow existing parallel Taxiway K to be preserved between the runways, which would reduce ROTs, in turn increasing runway capacity. A separation of 800 feet would be sufficient to provide for a parallel taxiway, but would require the relocation of existing parallel Taxiway K from its current offset from existing Runway 4-22 of 655 feet to 400 feet. Another parallel taxiway would also be proposed east of proposed Runway 4R-22L to provide access to the runway ends. Future Runway 4L-22R would remain the main arrival runway and as such, no instrument approach procedures or lighting systems are anticipated for proposed Runway 4R-22L.

Construction of Runway 4R-22L and its associated parallel taxiway would require the relocation of existing facilities on the east side of the Airport.

5.3.2.2 Alternative 2

As a result of public comments obtained during community outreach, further coordination occurred between Hobby ATCT personnel, the FAA and HAS to evaluate the feasibility of a “No-Stagger” alternative for the upgraded Runway 12L-30R that would minimize land acquisition on the Northwest side of the Airport. This alternative is referred to as Alternative 2. **Exhibit 5-6** depicts a conceptual layout of Alternative 2.

The following anticipated preliminary impacts were identified:

- Land acquisition beyond the southeast ends of the Airport property. At a minimum for new runways, land acquisition should include ROFAs and RPZs. To the extent practicable, land acquisition should include adequate areas surrounding the runway to protect the runway approach and departure surfaces identified in FAA AC 150/5300-13A, paragraph 303. . Parcels anticipated to be impacted by land acquisition are depicted on **Exhibit 5-7**.
- Realignment/closure of portions of West Monroe Road
- Demolition of several Signature Flight Support and Jet Aviation facilities

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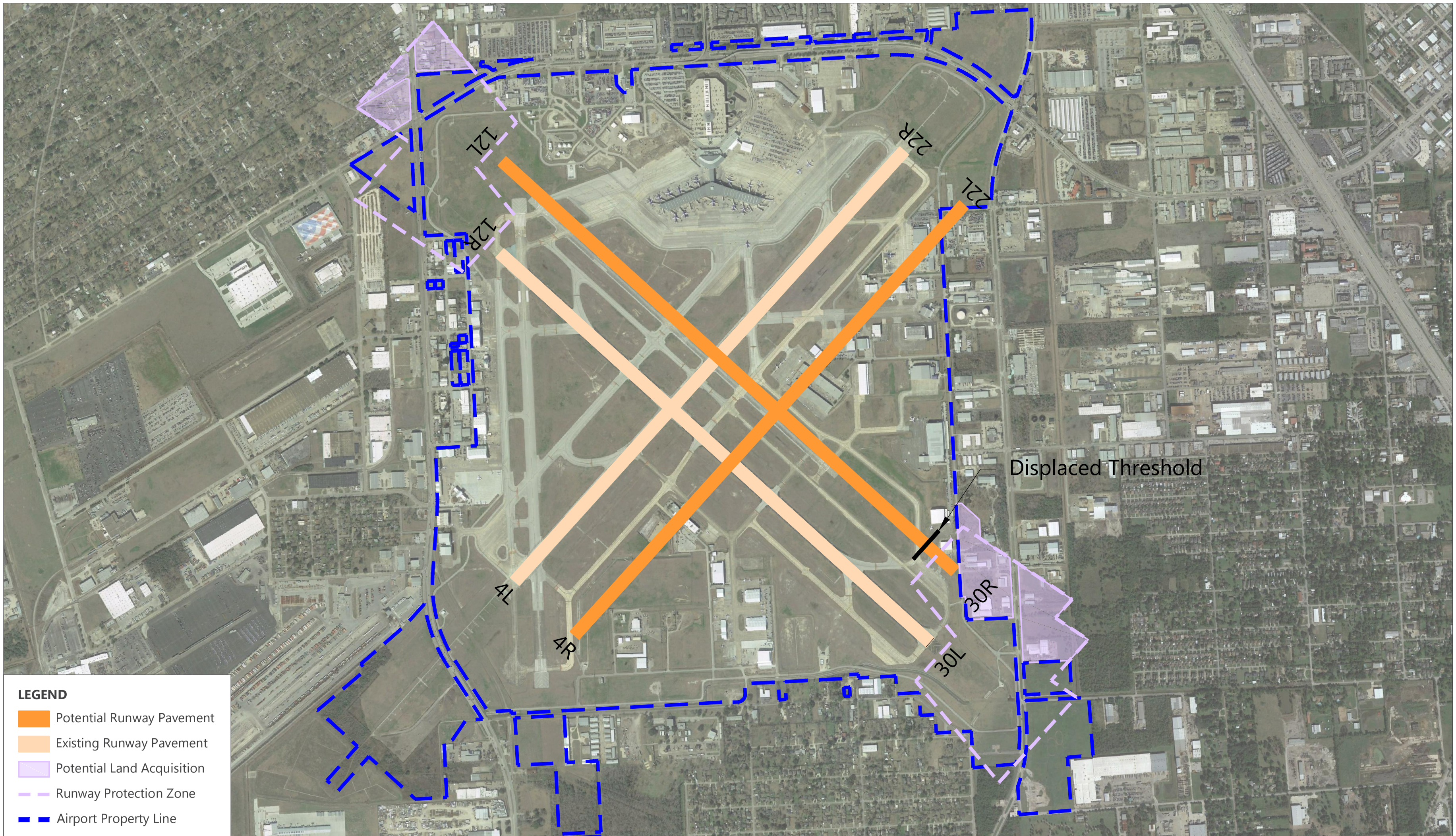

SOURCE: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, June 2014; Google Earth Pro 2014; Terra Metrics, February 14, 2014 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

EXHIBIT 5-5

NORTH 0 2,000 ft.

Alternative 1
Phase 2 Airfield Layout

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Rwy 12L Upgrade Layout Alternatives\CAD\5-5_Alternative 1-Phase 2 Airfield Layout.dwg Layout: 5-5 - Alternative 1 - Phase 2 Airfield Layout Plotted: Dec 26, 2014, 01:41PM

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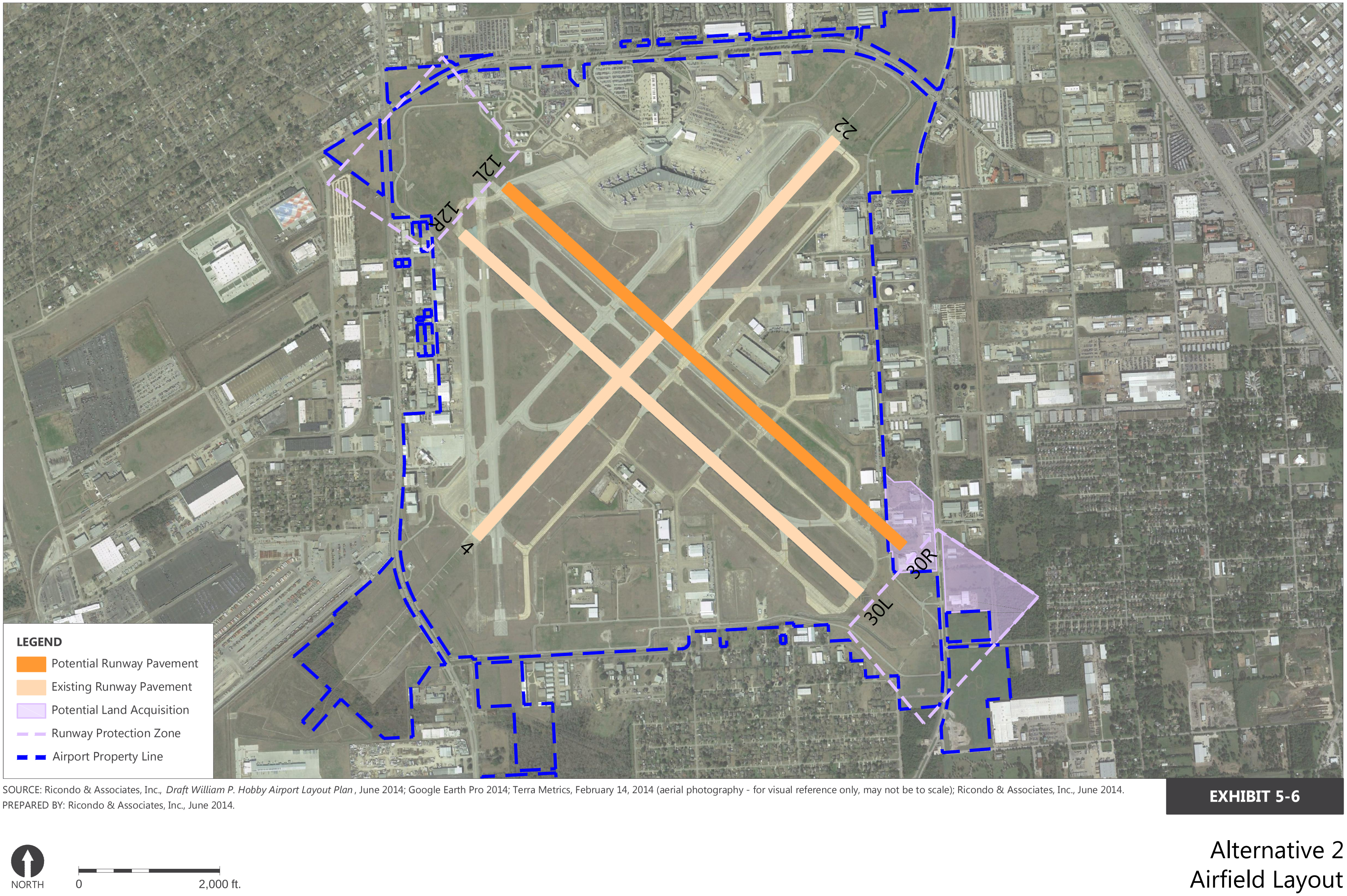

SOURCE: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, June 2014; Google Earth Pro 2014; Terra Metrics, February 14, 2014 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

EXHIBIT 5-6

Alternative 2 Airfield Layout

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Rwy 12L Upgrade Layout Alternatives\CAD\5-6_Alternative 2-Airfield Layout.dwg Layout: 5-6 - Rwy 12L Upgrade Layout - Alt. 2 - No Stagger Plotted: Dec 26, 2014, 01:44PM

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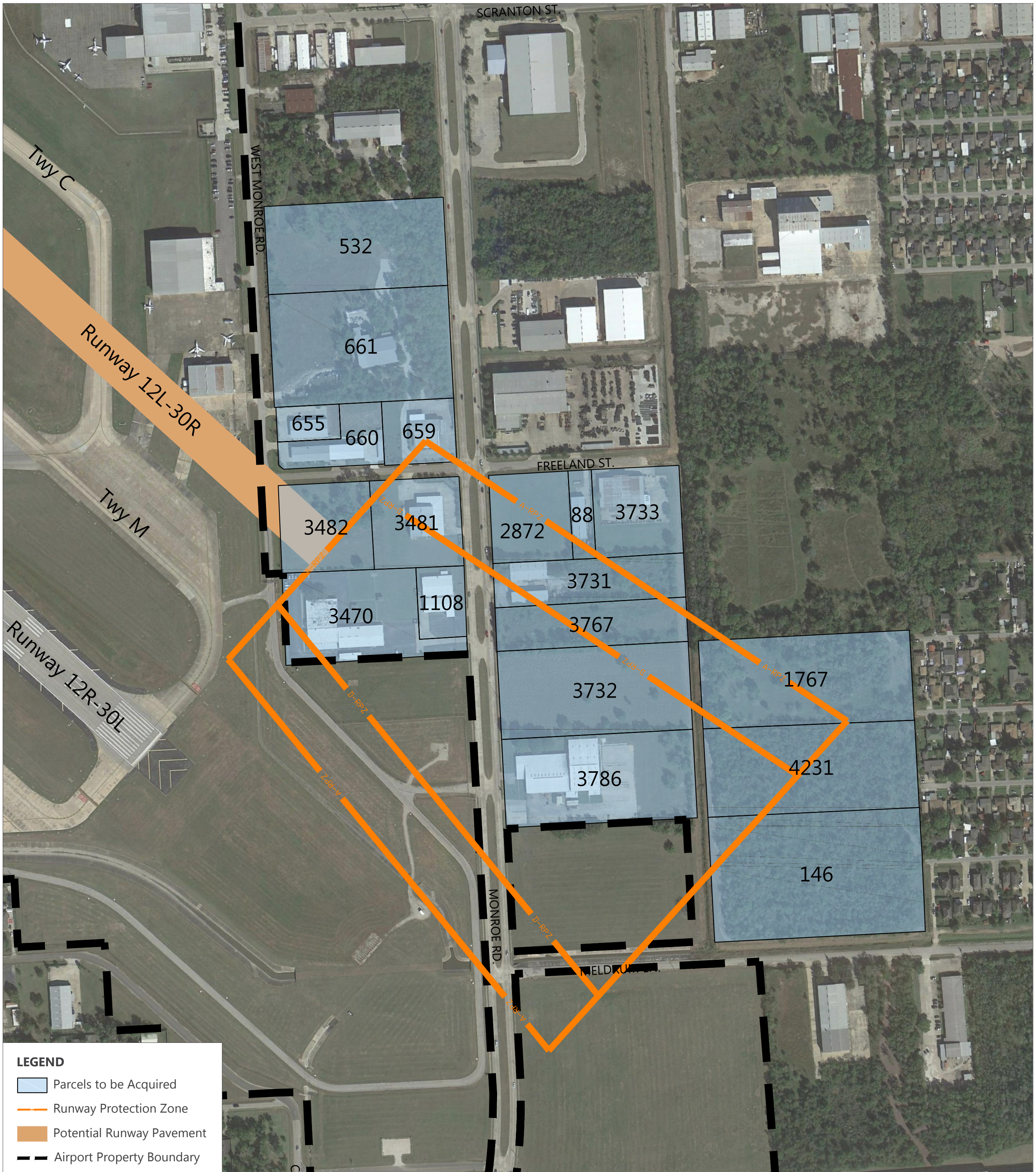

SOURCE: Ricondo & Associates, Inc., *Draft William P. Hobby Layout Plan*, June 2014; Houston Airport System, Geographic Information Data, Jacobs Engineering, May 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

EXHIBIT 5-7

NORTH 0 500 ft.

Alternative 2
Parcels Anticipated to Be Impacted by Land Acquisition

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Rwy 12L Upgrade Layout Alternatives\CAD\5-7_Alternative 2-Parcels Impacted.dwg Layout: Exhibit 5-7 Plotted: Dec 26, 2014, 01:47PM

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- Relocation of the deicing pad
- Relocation of a portion of the Southwest Airlines Fuel Farm
- Realignment of the service road south of the Southwest Airlines Fuel Farm
- Coordination with the FAA on impacts of proposed RPZs on various roadways in the vicinity of the Airport

After considering the operational impacts of Alternative 2, Hobby ATCT personnel proposed to make Taxiway H the crossing point for all departures on Runway 12R, in order to allow arrivals on Runway 12L, which is the Hobby ATCT personnel's preference.

As depicted on **Exhibit 5-8**, there would be no declared distances on Runway 12L-30R with Alternative 2. Usable runway length for all operations would be 7,602 feet.

Similar to Alternative 1, a partial parallel taxiway that can accommodate ADG III aircraft would be proposed north and east of Runway 12L-30R to provide access to the extended Runway 30R end. Upon completion of the Runway 12L-30R upgrade, Runway 17-35 would be decommissioned.

5.3.3 SHORTLISTED ALTERNATIVE

Alternatives 1 and 2 were evaluated based on the following criteria:

- Noise impacts
- Pavement length
- Cost
- Residential impacts
- Commercial impacts
- Roadway impacts
- Operational impacts

Table 5-1 represents an evaluation matrix that provides qualitative evaluation of Alternatives 1 and 2.

In order to minimize impacts on residential areas located northwest of the Airport, Alternative 2 was shortlisted for further refinement.

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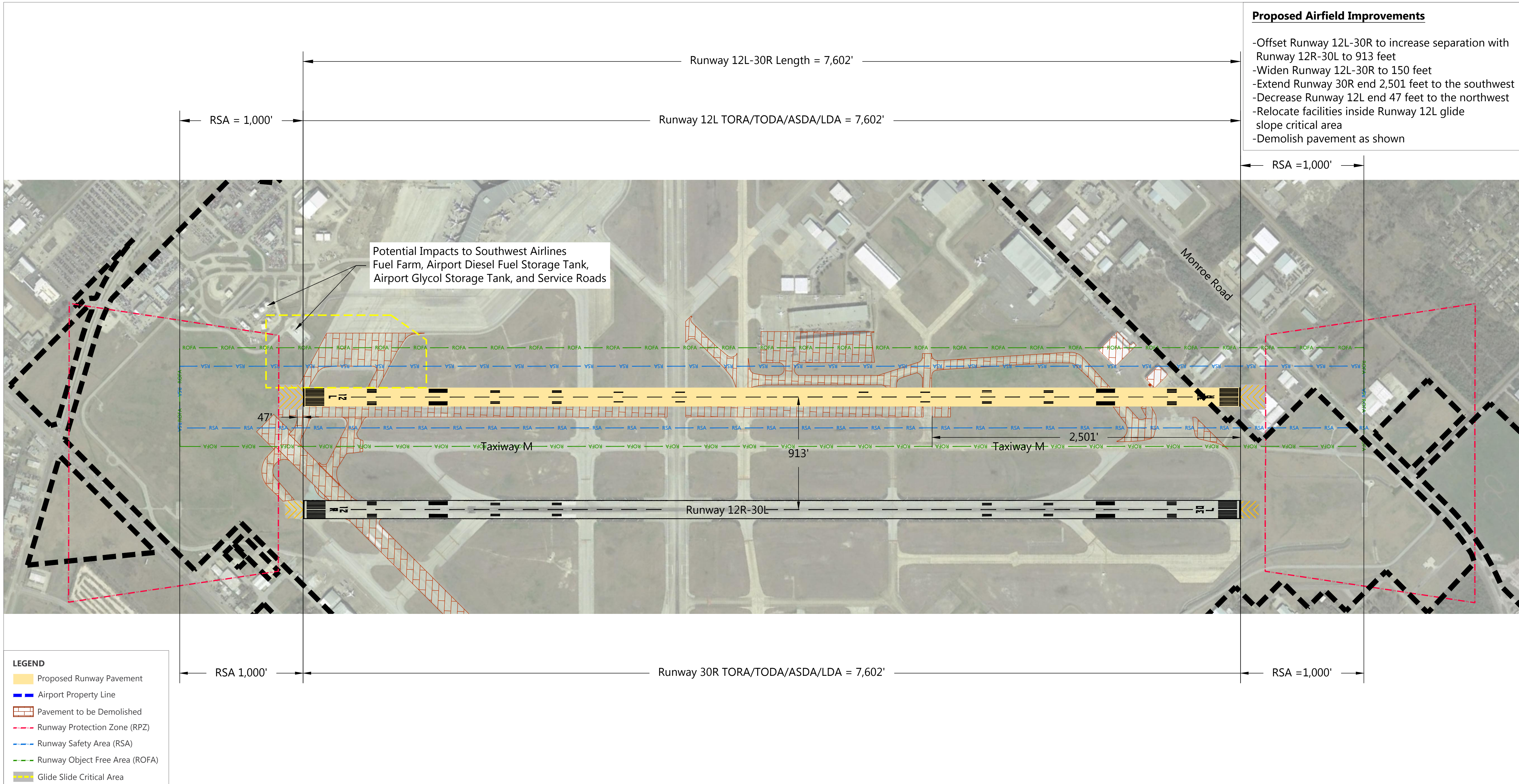

SOURCE: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, June 2014; Google Earth Pro 2014; Terra Metrics, February 14, 2014 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

EXHIBIT 5-8

Acronyms

ASDA - Accelerate Stop Distance Available
LDA - Landing Distance Available
TODA - Takeoff Distance Available
TORA - Takeoff Run Available

Alternative 2
Runway Declared Distances

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Rwy 12L Upgrade Layout Alternatives\CAD\5-8_Alt.2 Rwy 12L-30R-Declared Distances.dwg Layout: 5-8 - Rwy 12L-30R-Alt.2-Declared Distances Plotted: Dec 26, 2014, 01:49PM

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Table 5-1: Runway 12L-30R Upgrade Alternatives Evaluation Matrix

CRITERIA	ALTERNATIVE 1	ALTERNATIVE 2
Noise	Contours slightly further to northwest	Slightly less impact on Garden Villas
Runway Pavement Length	8,002'	7,602'
Cost	"Middle" runway cost alt, no roadway costs	Lowest rwy cost alt, but may have very high roadway costs
Residential Areas	6 parcels, including parcels in Garden Villas	0 parcels
Commercial Areas	29 parcels	11 parcels
Roadways	None	Monroe Road realignment
Aircraft Operations	None	None

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

5.3.4 ALTERNATIVE REFINEMENT

In order to meet aircraft operational requirements, answer community concerns and control project costs, Alternative 2 was refined into Alternative 3. Alternative 3 proposes the use of displaced thresholds to minimize impacts to Monroe Road, while still providing departure and landing runway lengths equivalent to existing Runway 12R-30L. Total runway length would be approximately 8,206 feet. No impacts are anticipated to the residential parcels northwest of the Airport, and 11 commercial parcels southeast of the Airport property line may be subject to land acquisition. More importantly, the use of displaced thresholds would eliminate impacts to Monroe Road. Although the resulting RPZ will overlay Monroe Road, additional guidance is required from the FAA on how to address the issue of public roads inside the RPZ. **Exhibit 5-9** depicts a conceptual layout for Alternative 3.

The following anticipated preliminary impacts were identified:

- Land acquisition beyond the southeast ends of the Airport property. At a minimum for new runways, land acquisition should include ROFAs and RPZs. To the extent practicable, land acquisition should include adequate areas surrounding the runway to protect the runway approach and departure surfaces identified in FAA AC 150/5300-13A, paragraph 303. Parcels anticipated to be impacted by land acquisition are depicted on **Exhibit 5-10**.

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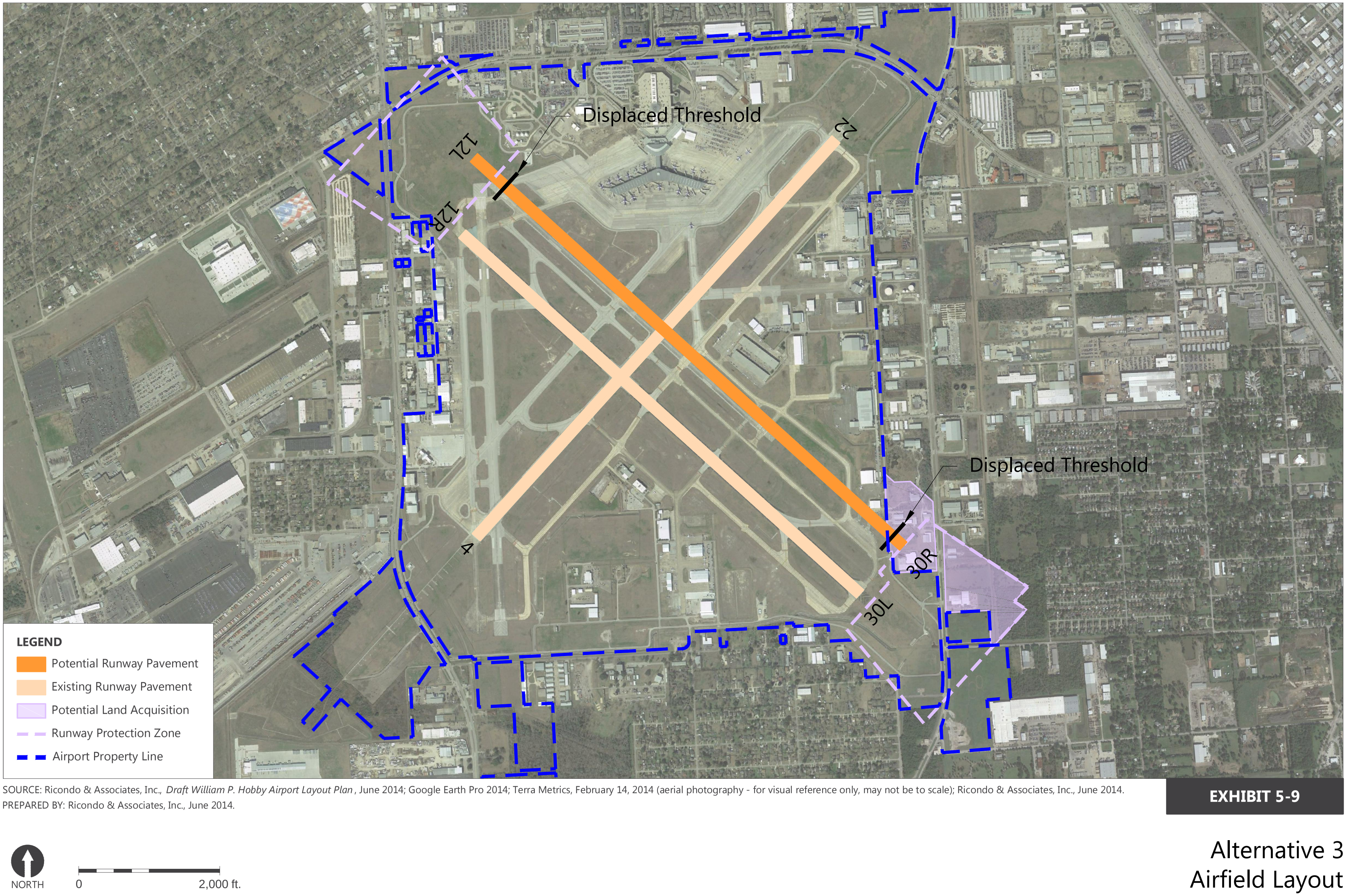

SOURCE: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, June 2014; Google Earth Pro 2014; Terra Metrics, February 14, 2014 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

EXHIBIT 5-9

Alternative 3
Airfield Layout

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Rwy 12L Upgrade Layout Alternatives\CAD\5-9_Alternative 3-Airfield Layout.dwg Layout: 5-9 - Rwy 12L Upgrade Layout - Alt. 3 - Stagger Plotted: Dec 26, 2014, 01:53PM

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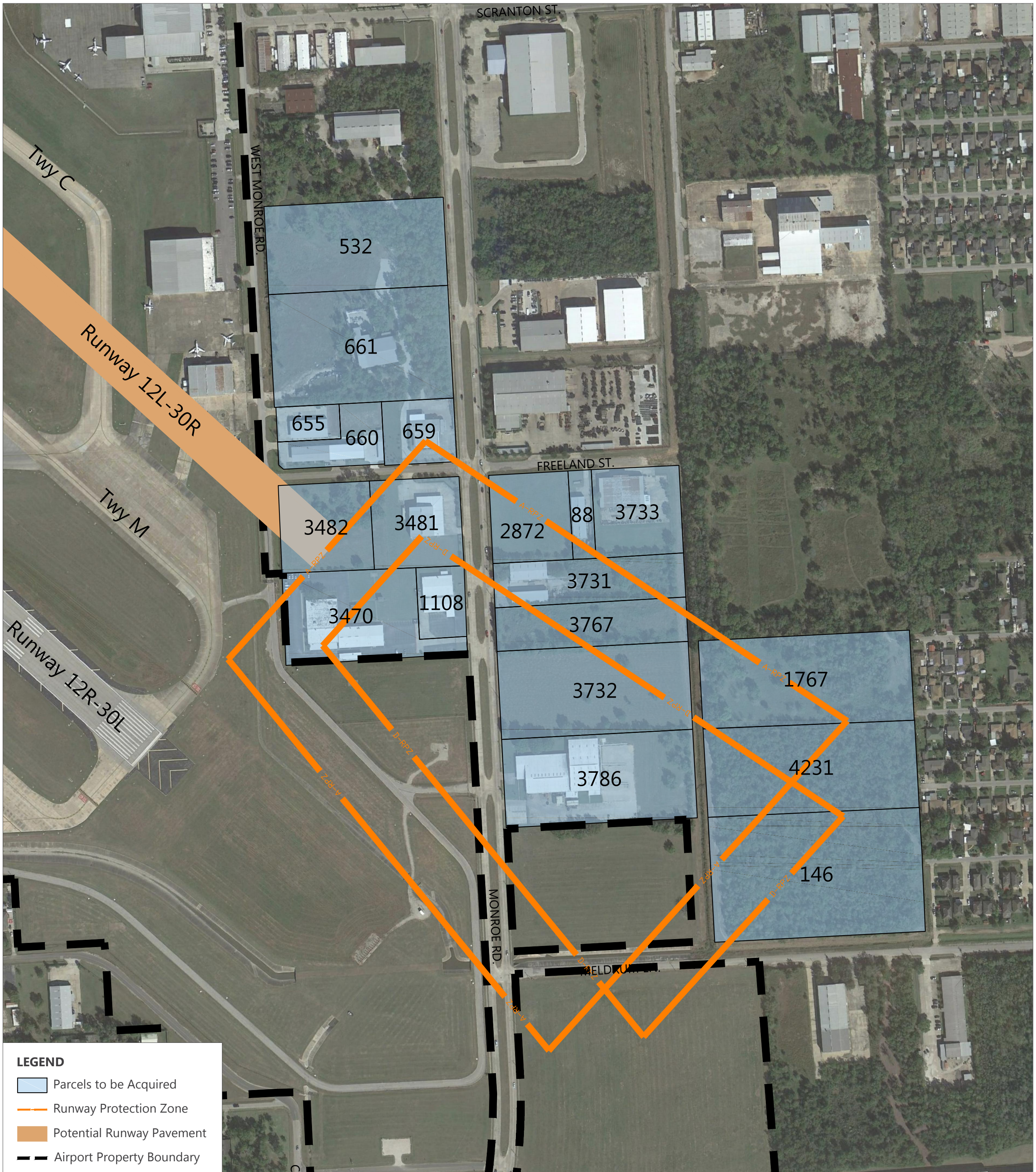

SOURCE: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, June 2014; Houston Airport System Data, Jacobs Engineering, May 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

EXHIBIT 5-10

NORTH 0 500 ft.

Alternative 3
Parcels Anticipated to Be Impacted by Land Acquisition

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Rwy 12L Upgrade Layout Alternatives\CAD\5-10_ALternative 3-Parcels Impacted.dwg Layout: Exhibit 5-10 Plotted: Dec 26, 2014, 01:55PM

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- Realignment/closure of portions of West Monroe Road
- Demolition of several Signature Flight Support and Jet Aviation facilities
- Relocation of the deicing pad
- Relocation of a portion of the Southwest Airlines Fuel Farm
- Realignment of the service road south of the Southwest Airlines Fuel Farm
- Coordination with the FAA on impacts of proposed RPZs on various roadways in the vicinity of the Airport

The resulting Alternative 3 Runway 12L-30R declared distances are depicted on **Exhibit 5-11**, and listed below:

- Runway 12L LDA: 6,999 feet
- Runway 12L ASDA: 7,602 feet
- Runway 12L TORA/TODA: 8,206 feet
- Runway 30R LDA: 7,399 feet
- Runway 30R ASDA/TORA/TODA: 7,602 feet

Similar to Alternatives 1 and 2, a partial parallel taxiway that can accommodate ADG III aircraft is proposed north and east of Runway 12L-30R to provide access to the extended Runway 30R end. Upon completion of the Runway 12L-30R upgrade, Runway 17-35 would be decommissioned.

5.3.5 PREFERRED ALTERNATIVE

Upon review of Alternative 3, HAS and Airport stakeholders agreed that Alternative 3 was the preferred runway development alternative recommended for the Master Plan Update. A more detailed depiction of the Alternative 3 airfield layout, although still preliminary, is shown on the Future ALP sheet, in Appendix D. Further evaluation and refinement of the airfield layout will be required in subsequent studies.

5.3.6 HOURLY AIRFIELD CAPACITY ANALYSIS

An airfield capacity analysis was conducted to validate that the selected layouts could accommodate forecast demand through the planning period (2030) and to identify when each development phase should be implemented. The proposed airfield operating configurations in Phases 1 and 2 are described below.

5.3.6.1 Phase 1

Upon completion of Phase 1, the airfield would have a pair of parallel runways, Runways 12L-30R and 12R-30L, and one intersecting runway, Runway 4-22. These runways could be operated in four primary runway use configurations during both VMC and IMC, with two alternative noise abatement flows (Sunday AM Flow and Mid Flow) used when weather permits. The SMGCS Flow configuration would also be available when weather conditions are below standard minimums for the ILS.

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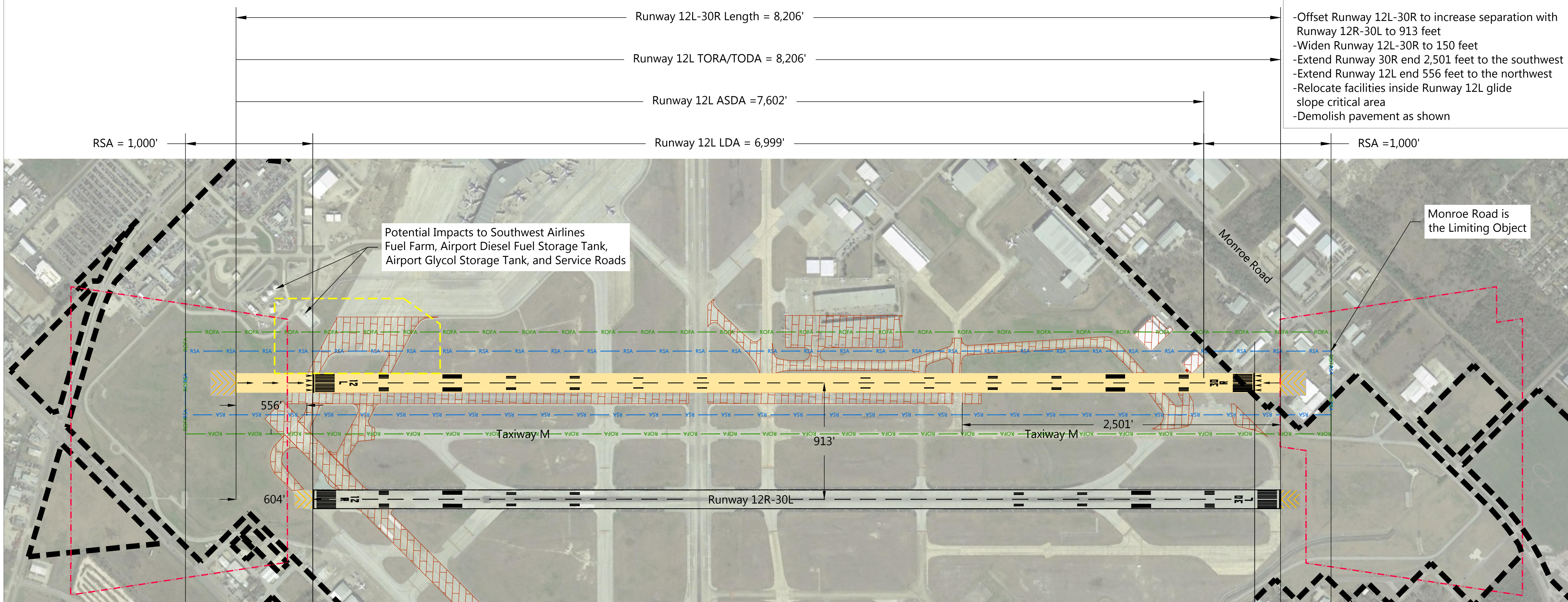

Proposed Airfield Improvements

- Offset Runway 12L-30R to increase separation with Runway 12R-30L to 913 feet
- Widen Runway 12L-30R to 150 feet
- Extend Runway 30R end 2,501 feet to the southwest
- Extend Runway 12L end 556 feet to the northwest
- Relocate facilities inside Runway 12L glide slope critical area
- Demolish pavement as shown

LEGEND

- Proposed Runway Pavement
- Airport Property Line
- Pavement to be Demolished
- Runway Protection Zone (RPZ)
- Runway Safety Area (RSA)
- Runway Object Free Area (ROFA)
- Glide Slide Critical Area

SOURCE: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, June 2014; Google Earth Pro 2014; Terra Metrics, February 14, 2014 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

Acronyms

ASDA - Accelerate Stop Distance Available
LDA - Landing Distance Available
TODA - Takeoff Distance Available
TORA - Takeoff Run Available

EXHIBIT 5-11

Alternative 3
Runway Declared Distances

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Rwy 12L Upgrade Layout Alternatives\CAD\5-11_Alt.3 Rwy 12L-30R-Declared Distances.dwg Layout: 5-11 - Rwy 12L-30R Refinement- Declared Distances Plotted: Dec 26, 2014, 02:09PM

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Exhibits 5-12 and **5-13** show the percentage of time that each runway operating configuration is anticipated to be in use at the Airport during VMC and IMC. The exhibits also show the prevailing wind direction under which each airfield operating configuration is anticipated to be used. The occurrence rate (percentage of time) that each operating configuration is likely to be used is based on hourly weather observations for the 10-year period between January 1, 2000, and December 31, 2009.[3] For the IMC operating configurations, the lowest cloud ceiling and visibility minimums for published instrument approach procedures associated with the arrival runway are also presented.

As illustrated on Exhibits 5-5 and 5-6, six operating configurations are anticipated to be used during both VMC and IMC, and a seventh operating configuration would only apply during IMC. These operating configurations are described in the following paragraphs.

- **South Flow:** South Flow would remain the preferred operating condition during both VMC and IMC, as it would result in the highest airfield capacity considering airspace interactions with operations at IAH. During VMC, Runways 12L and 12R would provide simultaneous arrivals capability, with Runway 12L being the primary arrival runway. Runways 12R and 22 would be used for aircraft departures during South Flow operations. However, because of the close lateral separation between the runways, simultaneous aircraft operations on Runways 12L and 12R would be prohibited when wake turbulence hazards exist.

  During IMC, use of the South Flow operating configuration would be similar to its use during VMC. The lateral separation between Runways 12L and 12R would not allow for simultaneous operations on the runways. As a result, operations would be restricted to either of these two runways, with Runway 12L being the preferred runway because of its close proximity to the terminal area. Runway 22 would continue to be used for aircraft departures only, considering its operational dependencies with Runway 12L or 12R.

  The South Flow operating configuration in both VMC and IMC would be used when prevailing winds are reported from a heading of 120 degrees through 220 degrees. As it would yield the greatest capacity with the least impacts on IAH operations, this configuration would also be preferred during calm wind conditions. It should be noted, however, that aircraft arrivals on Runways 12R and 12L during South Flow operations would require ATC coordination with controllers at IAH regarding aircraft departures from Runways 15R and 15L at IAH. Similarly, aircraft departures on Runway 12R at HOU would require ATC coordination with controllers at Ellington Airport.

- **North Flow:** During VMC, Runways 30L and 30R would provide simultaneous arrivals capability in the North Flow configuration, with Runway 30R being the primary arrival runway. Runways 30L and 4 would be used for aircraft departures during North Flow operations. However, because of the close lateral separation between the runways, simultaneous aircraft operations on Runways 30L and 30R would be prohibited when wake turbulence hazards exist.

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3 National Climatic Data Center, "TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009; 6 a.m. to midnight)," May 3, 2012.

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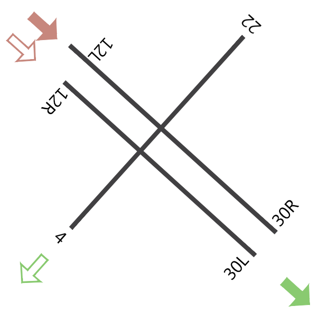
South Flow

Prevailing Winds: Calms (=<7 kts), 120° - 220°

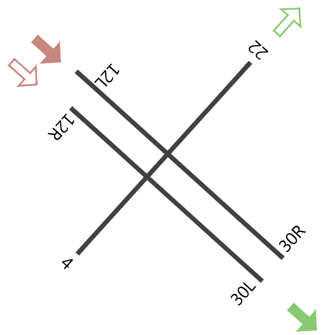
Occurrence: 71.1 %



East Flow

Prevailing Winds: 040° - 120°

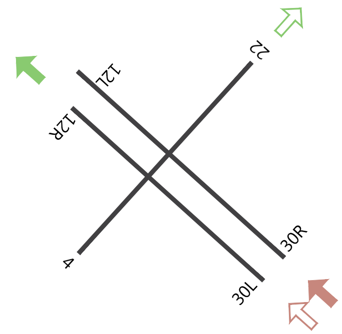
Occurrence: 8.3 %



North Flow

Prevailing Winds: 300° - 040°

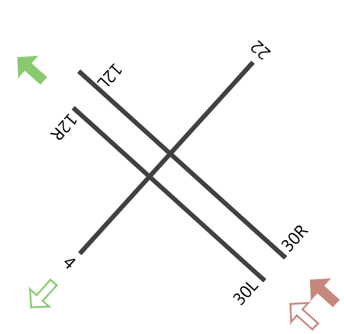
Occurrence: 11.5 %



West Flow

Prevailing Winds: 220° - 300°

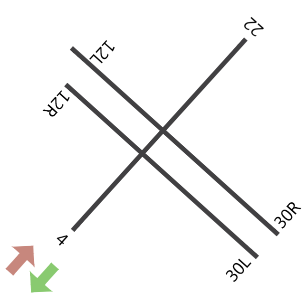
Occurrence: 2.9 %



MID Flow (12 a.m. - 6 a.m.)

Prevailing Winds: Calms

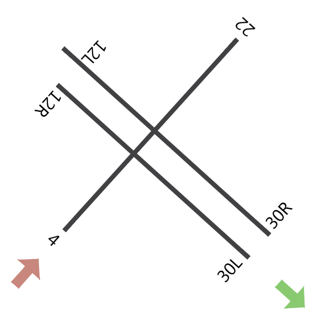
Occurrence: N/A



Sunday AM Flow

Prevailing Winds: Calms, 030° - 130°

Occurrence: N/A



LEGEND
- Primary Arrivals
- Secondary Arrivals
- Primary Departures
- Secondary Departures

NOTE :
The reported wind direction is based on prevailing winds during which each Airport operating configuration could be used without experiencing tailwind conditions. Additional consideration was given for preferential configurations, as identified by Air Traffic Control staff.

EXHIBIT 5-12

SOURCES: National Climatic Data Center, TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009, 6 a.m. to midnight), May 3, 2021; William P. Hobby Airport Air Traffic Control, *HOU ATCT 7110.1W*, August 15, 2011; Ricondo & Associates, Inc., June 2012.
PREPARED BY: Ricondo & Associates, Inc., June 2012.

NORTH 0 Not to Scale

Runway Use Configurations - Visual Meteorological Conditions Phase 1 Airfield

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Runway Use Configurations\CAD\Exh 5-12 & 5-13_HOU-Runway Configurations_Phase 1_20140903.dwg_Layout: 5-12_VMC Revised_Dec 26, 2014, 2:18pm

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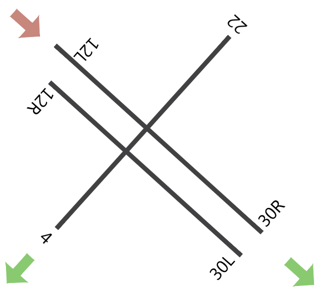
South Flow

Prevailing Winds: Calms (=<7 kts), 120° - 220°

Occurrence: 2.9 %

Ceiling/Visibility Minimums: 250' - $\frac{3}{4}$ SM

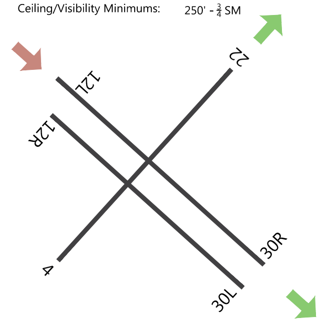


East Flow

Prevailing Winds: 040° - 120°

Occurrence: 0.8 %

Ceiling/Visibility Minimums: 250' - $\frac{3}{4}$ SM

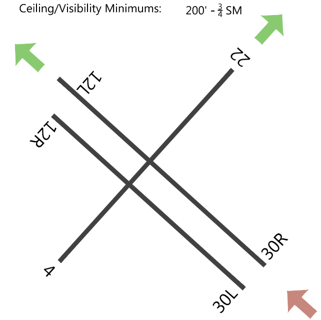


North Flow

Prevailing Winds: 300° - 040°

Occurrence: 1.3 %

Ceiling/Visibility Minimums: 200' - $\frac{3}{4}$ SM

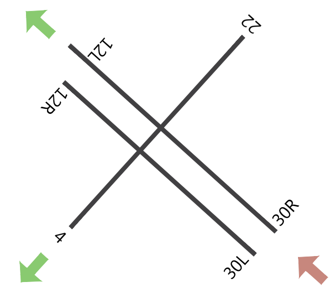


West Flow

Prevailing Winds: 220° - 300°

Occurrence: 0.1 %

Ceiling/Visibility Minimums: 200' - $\frac{3}{4}$ SM

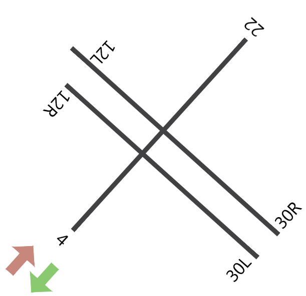


MID Flow (12 a.m. - 6 a.m.)

Prevailing Winds: Calms

Occurrence: N/A

Ceiling/Visibility Minimums: 0' - 0 SM (CAT IIIC)

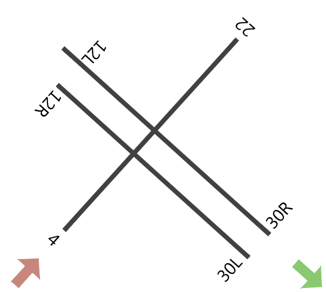


Sunday AM Flow

Prevailing Winds: Calms, 030° - 130°

Occurrence: N/A

Ceiling/Visibility Minimums: 0' - 0 SM (CAT IIIC)

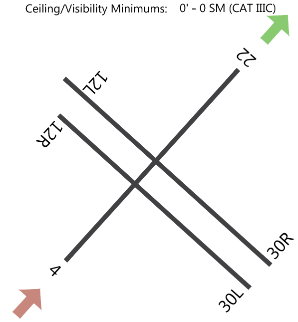


SMGCS Flow (600 =< RVR =< 1,200)

Prevailing Winds: N/A

Occurrence: 0.1 %

Ceiling/Visibility Minimums: 0' - 0 SM (CAT IIIC)



NOTES:

1. The reported wind direction is based on prevailing winds during which each airport operating configuration could be operated without experiencing tailwind conditions. Additional consideration was given for preferential configurations, as identified by Air Traffic Control staff.

2. Ceiling and minimum visibility are based on the lowest approach minimums prescribed for the arrivals runway.

LEGEND

Primary Arrivals

Primary Departures

EXHIBIT 5-13

SOURCES: National Climatic Data Center, TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009, 6 a.m. to midnight), May 3, 2021; William P. Hobby Airport Air Traffic Control, *HOU ATCT 7110.1W*, August 15, 2011; Ricondo & Associates, Inc., June 2012.

PREPARED BY: Ricondo & Associates, Inc., June 2012.

NORTH

0 Not to Scale

Runway Use Configurations - Instrument Meteorological Conditions Phase 1 Airfield

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Runway Use Configurations\CAD\Exh 5-12 & 5-13_HOU-Runway Configurations_Phase 1_20140903.dwg_Layout: 5-13_IMC_Dec 26, 2014, 2:19pm

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During IMC, use of the North Flow operating configuration would be similar to its use during VMC. Only Runway 30R would be used for both arrivals and departures during North Flow IMC, while Runway 4 would continue to be used for aircraft departures only. The North Flow operating configuration in both VMC and IMC would be used when prevailing winds are reported from a heading of 300 degrees through 040 degrees.

- **East Flow:** During VMC, Runways 12L and 12R would provide simultaneous arrivals capability in the East Flow configuration, with Runway 12L being the primary arrival runway. Runways 12R and 4 would be used for aircraft departures. However, because of the close lateral separation between the runways, simultaneous aircraft operations on Runways 12L and 12R would be prohibited when wake turbulence hazards exist.

  During IMC, use of the East Flow configuration would be very similar to its use during VMC. The lateral separation between Runways 12L and 12R would not allow for simultaneous operations. As a result, operations would be restricted to either of these two runways, with Runway 12L being the preferred runway because of its close proximity to the terminal area. Runway 4 would continue to be used for aircraft departures only, considering its operational dependencies with Runway 12L or 12R.

  The East Flow operating configuration in both VMC and IMC would be used when prevailing winds are reported from a heading of 040 degrees through 120 degrees. It should be noted, however, that aircraft arrivals on Runways 12R and 12L during East Flow operations would require ATC coordination with controllers at IAH regarding aircraft departures from Runways 15R and 15L at IAH. Similarly, aircraft departures on Runway 12R would require ATC coordination with controllers at Ellington Airport.

- **West Flow:** During VMC, Runways 30L and 30R would provide simultaneous arrivals capability in the West Flow configuration, with Runway 30R being the primary arrival runway. Runways 30L and 22 would be used for aircraft departures. However, because of the close lateral separation between the runways, simultaneous aircraft operations on Runways 30L and 30R could be prohibited when wake turbulence hazards exist.

  During IMC, use of the West Flow configuration is similar to its use during VMC. Only Runway 30R would be used for both arrivals and departures during West Flow IMC, while Runway 22 would continue to be used for aircraft departures only. The West Flow operating configuration in both VMC and IMC would be used when prevailing winds are reported from a heading of 220 degrees through 300 degrees.

- **Sunday AM Flow:** Between the hours of 10 a.m. and noon on Sunday mornings, ATC would continue to use the Sunday AM Flow operating configuration, traffic and weather conditions permitting. This operating configuration is used in an attempt to minimize aircraft flights over residential areas and other noise-sensitive land uses immediately north of the Airport. In this operating configuration, Runway 4 is used exclusively for arrivals and Runway 12R is used exclusively for departures in both VMC and IMC. The Sunday AM Flow operating configuration can be used only if prevailing winds are from a heading between 040 degrees and 120 degrees, or during calm wind conditions. The Sunday AM Flow capacity was not evaluated because of its low rate of occurrence.

- **MID Flow:** MID Flow would remain the preferred operating configuration between the hours of 12 a.m. and 6 a.m. In this configuration, Runway 4 would be used for arrivals and Runway 22 would be used for departures only when prevailing winds are calm. During IMC, the ILS serving Runway 4 can be operated with reported visibility as low as 600 feet. The MID Flow operating configuration was not evaluated, as it is only used at night, when there are no capacity issues. Additionally, wind occurrence calculations are based on data from 6 a.m. to midnight only.
- **SMGCS Flow**: SMGCS Flow would be the preferred operating configuration when weather conditions are below the CAT I approach minimums (0.5 mile visibility and/or cloud ceiling below 200 feet above ground level), requiring the use of the Runway 4 CAT II/III ILS. In this configuration, Runway 4 is used for arrivals and departures.

Consistent with information shown on Exhibits 5-5 and 5-6, **Table 5-2** provides anticipated occurrence rates of each runway use configuration during Phase 1 based on historical weather data. As indicated, VMC and IMC had occurrence rates of 93.8 percent and 5.2 percent, respectively. The remaining 0.9 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.

Table 5-2: Anticipated Runway Use Configuration Occurrence Rates – Phase 1

RUNWAY USE CONFIGURATIONS	VMC	IMC	CLOSED
South Flow	71.1%	2.9%	-
North Flow	11.5%	1.3%	-
East Flow	8.3%	0.8%	-
West Flow	2.9%	0.1%	-
SMGCS Flow	-	0.1%	-
Airport Closed	-	-	0.9%
Total	93.8%	5.2%	0.9%
		Total Observations:	99.9%

SOURCES: National Climatic Data Center, "TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009)," May 3, 2012; Ricondo & Associates, Inc., June 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

5.3.6.2 Phase 2

In Phase 2, the airfield would have two sets of intersecting parallel runways, Runways 12L-30R and 12R-30L and Runways 4L-22R and 4R-22L.

Exhibit 5-14 and **Exhibit 5-15** illustrate the percentage of time that each runway operating configuration is anticipated to be in use at the Airport during VMC and IMC. The exhibits also present the prevailing wind direction during which each airfield operating configuration is anticipated to be used. The occurrence rate (percentage of time) that each operating configuration is likely to be used is based on hourly weather observations for the 10-year period between January 1, 2000, and December 31, 2009.[4]

As illustrated on Exhibits 5-7 and 5-8, five operating configurations are anticipated to be used during both VMC and IMC, and a sixth operating configuration would apply during IMC. These operating configurations are described in the following paragraphs.

- **East Flow:** In Phase 2, East Flow would become the preferred operating configuration, and would be similar to the Sunday AM Flow used with the existing airfield and Phase 1 layouts. During VMC, Runways 4L and 4R would provide simultaneous arrivals capability in the East Flow configuration, while Runways 12L and 12R would be used for aircraft departures. Runway 4R could also be used as a secondary departure runway. However, because of the close lateral separation between the runways, aircraft operations on either set of parallel runways would be prohibited when wake turbulence hazards exist.

  During IMC, use of the East Flow configuration would be similar to its use during VMC. The lateral separation between Runways 4L and 4R would not allow for simultaneous operations. As a result, operations would be restricted to either of these two runways, with Runway 4L being the preferred runway because of its close proximity to the terminal area. Runway 12L would be used for aircraft departures.

  The East Flow operating configuration in both VMC and IMC would be used when prevailing winds are reported from a heading of 030 degrees through 130 degrees, and when the winds are reported as “calm.” It should be noted that aircraft departures on Runways 12L and 12R would require ATC coordination with controllers at Ellington Airport.

- **South Flow:** During VMC, Runways 12L and 12R would provide simultaneous arrivals capability, while Runways 22L and 22R would be used for simultaneous aircraft departures. Runway 12R would also be used as a secondary departure runway. However, because of the close lateral separation of the parallel runways, simultaneous aircraft operations on either pair of parallel runways would be prohibited when wake turbulence hazards exist.

  During IMC, use of the South Flow configuration would be very similar to its use during VMC. The lateral separation between Runways 12L and 12R would not allow for simultaneous operations. As a result, operations would be restricted to either of these two runways, with Runway 12L being the preferred runway because of its close proximity to the terminal area. Runway 22R would be used for aircraft departures.

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4 National Climatic Data Center, “TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009; 6 a.m. to midnight),” May 3, 2012.

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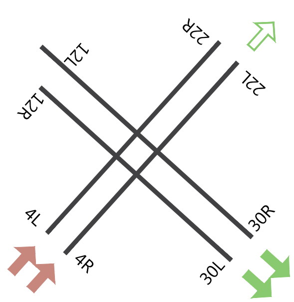
East Flow (old Sunday AM Flow)

Prevailing Winds: Calms (=<7 kts), 030°- 130°

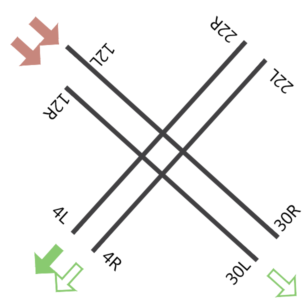
Occurrence: 62.0 %



South Flow

Prevailing Winds: 140°-210°

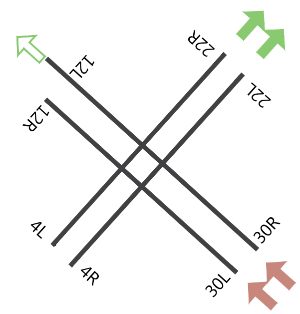
Occurrence: 18.6 %



North Flow

Prevailing Winds: 320°-020°

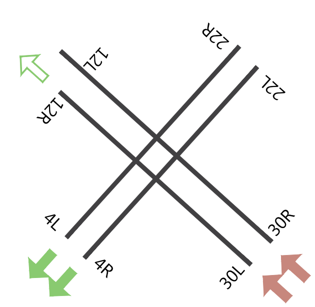
Occurrence: 8.2 %



West Flow

Prevailing Winds: 220°-310°

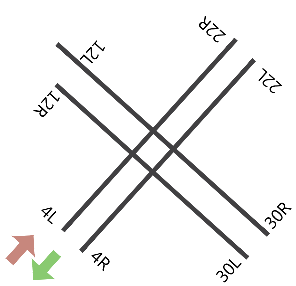
Occurrence: 5.0 %



MID Flow (12 a.m. - 6 a.m.)

Prevailing Winds: Calms

Occurrence: N/A



LEGEND

- Primary Arrivals
- Secondary Arrivals
- Primary Departures
- Secondary Departures

NOTE :
The reported wind direction is based on prevailing winds during which each Airport operating configuration could be used without experiencing tailwind conditions. Additional consideration was given for preferential configurations, as identified by Air Traffic Control staff.

SOURCES: National Climatic Data Center, TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009, 6 a.m. to midnight), May 3, 2021; William P. Hobby Airport Air Traffic Control, *HOU ATCT 7110.1W*, August 15, 2011; Ricondo & Associates, Inc., June 2012.
PREPARED BY: Ricondo & Associates, Inc., June 2012.

EXHIBIT 5-14

NORTH

0 Not to Scale

Runway Use Configurations - Visual Meteorological Conditions Phase 2 Airfield

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Runway Use Configurations\CAD\Exh 5-14 & 5-15_HOU-Runway Configurations_Phase 2-revised_20130218.dwg_Layout: 5-14_VMC_Dec 26, 2014, 2:22pm

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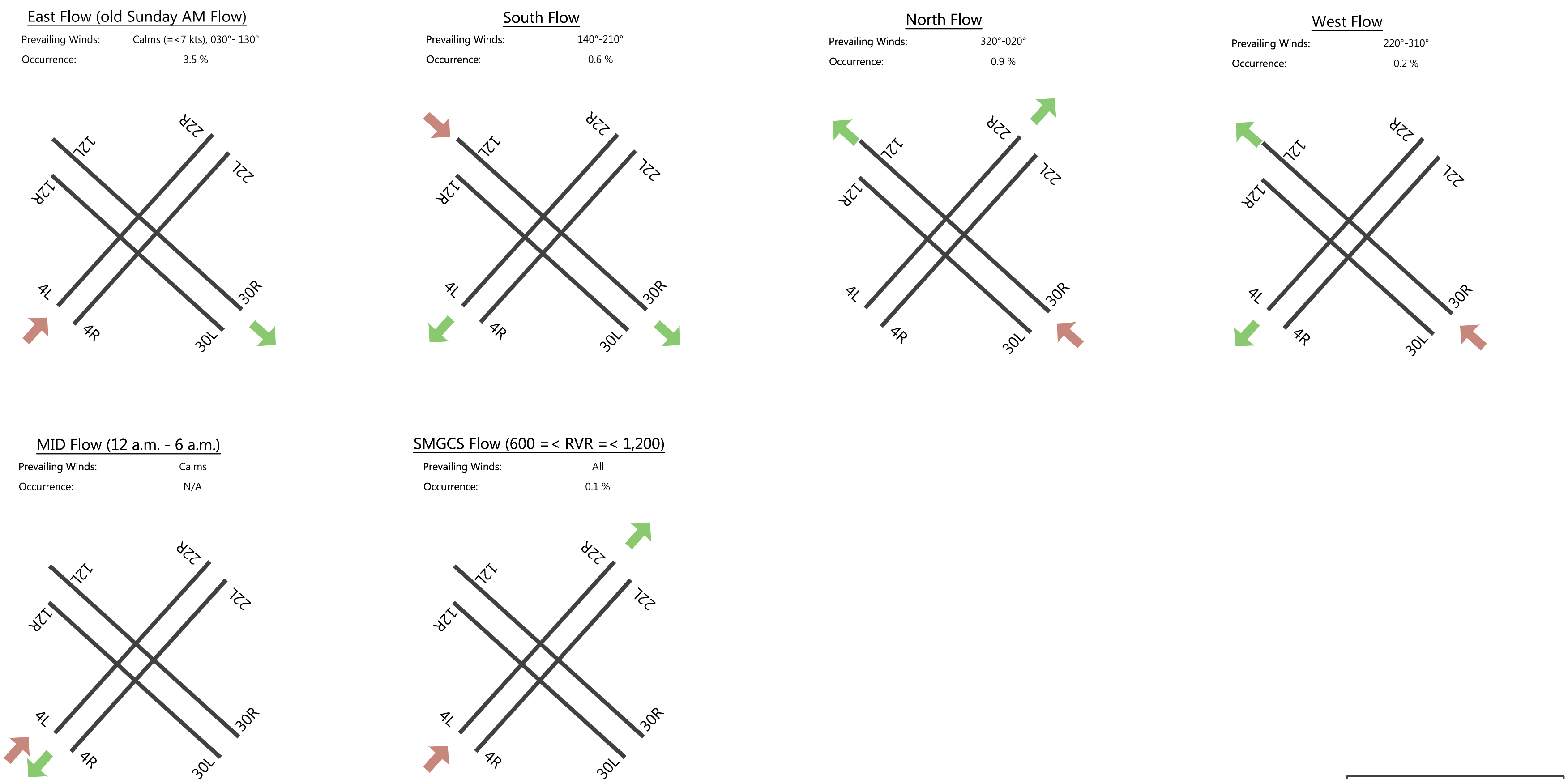

NOTES:
1. The reported wind direction is based on prevailing winds during which each airport operating configuration could be operated without experiencing tailwind conditions. Additional consideration was given for preferential configurations, as identified by Air Traffic Control staff.
2. Ceiling and minimum visibility are based on the lowest approach minimums prescribed for the arrivals runway.

LEGEND
- Primary Arrivals
- Primary Departures

EXHIBIT 5-15

SOURCES: National Climatic Data Center, TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009, 6 a.m. to midnight), May 3, 2021; William P. Hobby Airport Air Traffic Control, *HOU ATCT 7110.1W*, August 15, 2011; Ricondo & Associates, Inc., June 2012.
PREPARED BY: Ricondo & Associates, Inc., June 2012.

NORTH

0 Not to Scale

Runway Use Configurations - Instrument Meteorological Conditions Phase 2 Airfield

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\1-Airfield Layout Alternatives\Runway Use Configurations\CAD\Exh 5-14 & 5-15_HOU-Runway Configurations_Phase 2-revised_20130218.dwg_Layout: 5-15_IMC_Dec 26, 2014, 2:23pm

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The South Flow operating configuration in both VMC and IMC would be used when prevailing winds are reported from a heading of 140 degrees through 210 degrees. It should be noted, however, that aircraft arrivals on Runways 12R and 12L during South Flow operations would require ATC coordination with controllers at IAH regarding aircraft departures from Runways 15R and 15L at IAH. Similarly, aircraft departures on Runways 12L and 12R at HOU would require ATC coordination with controllers at Ellington Airport.

- **North Flow:** During VMC, Runways 30L and 30R would provide simultaneous arrivals capability, while Runways 4R and 4L would be used for aircraft departures. Runway 30R could also be used as a secondary departure runway. However, because of the close lateral separation between the parallel runways, simultaneous aircraft operations on either pair of parallel runways would be prohibited when wake turbulence hazards exist.

  During IMC, use of the North Flow configuration would be similar to its use during VMC. Runway 30R would be used for both arrivals and departures during North Flow IMC, while Runway 4L would be used for aircraft departures. The North Flow operating configuration in both VMC and IMC would be used when prevailing winds are reported from a heading of 320 degrees through 020 degrees.

- **West Flow:** During VMC, Runways 30L and 30R would provide simultaneous arrivals capability, while Runways 22R and 22L would be used for aircraft departures. Runway 30L would also be used as a secondary departure runway. However, because of the close lateral separation between the parallel runways, simultaneous aircraft operations on either set of parallel runways would be prohibited when wake turbulence hazards exist.

  During IMC, use of the West Flow configuration would be similar to its use during VMC. Only Runway 30R would be used for both arrivals and departures during West Flow IMC, while Runway 22R would be used for aircraft departures. The West Flow operating configuration in both VMC and IMC would be used when prevailing winds are reported from a heading of 220 degrees through 310 degrees.

- **MID Flow:** The MID Flow operating configuration would remain the preferred operating configuration between the hours of midnight and 6 a.m. In this configuration, Runway 4L would be used for arrivals and Runway 22R would be used for departures. The MID Flow configuration would be used only when prevailing winds are calm. During IMC, the ILS serving Runway 4L can be operated when the reported visibility is as low as 600 feet. The percentage of occurrence of the MID Flow configuration was not evaluated, as it is only used at night when there are no capacity issues. Additionally, wind occurrence calculations are based on data from 6 a.m. to midnight.

- **SMGCS Flow**: The SMGCS Flow would be the preferred operating configuration when weather conditions are below the CAT I approach minimums (0.5 mile visibility and/or the cloud ceiling is below 200 feet above ground level), requiring use of the Runway 4 CAT II/III ILS. In this configuration, Runway 4L is used for arrivals and departures.

Consistent with the information presented on Exhibits 5-7 and 5-8, **Table 5-3** provides the anticipated occurrence rates of each runway use configuration during Phase 2 based on historical weather data. As indicated, VMC and IMC had occurrence rates of 93.8 percent and 5.3 percent, respectively. The remaining 0.9

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.

Table 5-3: Anticipated Runway Use Configuration Occurrence Rates – Phase 2

RUNWAY USE CONFIGURATIONS	VMC	IMC	CLOSED
East Flow	62.0%	3.5%	-
South Flow	18.6%	0.6%	-
North Flow	8.2%	0.9%	-
West Flow	5.0%	0.2%	-
SMGCS Flow	-	0.1%	-
Airport Closed	-	-	0.9%
Total:	93.8%	5.3%	0.9%
		Total Observations:	100.0%

SOURCES: National Climatic Data Center, "TD3280 HOU Surface Hourly Weather Observations (January 1, 2000 – December 31, 2009)," May 3, 2012; Ricondo & Associates, Inc., June 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

5.3.6.3 Hourly Capacity Estimates

Table 5-4 presents the VMC and IMC hourly capacity estimates anticipated to be achieved with the operating configurations considered (Phase 1 and Phase 2 airfield layout during South Flow, East Flow, North Flow, West Flow, and SMGCS Flow). For the purposes of evaluating airfield capacity, the demand/capacity assessment was focused on the hourly capacity estimates for 50 percent arrivals and 50 percent departures. Because the mix indexes for VMC and IMC are nearly identical for all planning years, the hourly capacity estimates were assumed to be the same for 2011-2012, 2015, 2020, and 2030.

Assuming a 50 percent arrivals mix, the VMC hourly capacity with the Phase 1 airfield layout would be 76 aircraft operations in all operating configurations. In Phase 2, the VMC hourly airfield capacity would range from 101 aircraft operations in West Flow to 127 aircraft operations in North Flow.

The IMC hourly capacity would be lower than the VMC capacity for a variety of reasons, including (1) an increase in the mix index, (2) increased separation requirements between successive aircraft operations, and (3) the inability to conduct simultaneous arrivals and simultaneous departures on parallel runways. Assuming a 50 percent arrival mix, the IMC hourly capacity estimates range from 47 operations during SMGCS Flow to 57 and 58 operations in the other operating configurations, for both Phases 1 and 2.

Table 5-4: Proposed Hourly Airfield Capacity with Specific Runway Use Configurations

	VMC CAPACITY (NUMBER OF OPERATIONS) (50% ARRIVALS)		IMC CAPACITY (NUMBER OF OPERATIONS) (50% ARRIVALS)	
	PHASE 1 AIRFIELD LAYOUT	PHASE 2 AIRFIELD LAYOUT	PHASE 1 AIRFIELD LAYOUT	PHASE 2 AIRFIELD LAYOUT
South Flow	76	107	58	58
East Flow	76	126	58	57
North Flow	76	127	58	58
West Flow	76	101	58	58
SMGCS Flow	N/A	N/A	47	47

SOURCES: Federal Aviation Administration, Advisory Circular 150/5060-5, *Airport Capacity and Delay*, 1995; Ricondo & Associates, Inc., October 2012.
PREPARED BY: Ricondo & Associates, Inc., October 2012.

Exhibit 5-16 shows the relationships between the ASV and demand, as well as the corresponding average delay per aircraft operation. This exhibit shows when each development phase would need to be implemented. Demand would equal the existing airfield ASV around 2025, when average runway delay per aircraft operation is expected to reach 4 minutes. As a result, it is recommended to implement Phase 1 before or by 2025. By 2030, demand would equal the Phase 1 ASV, thus indicating that Phase 2 should be operational before the end of the planning period, if the goal is to minimize operating delays at the Airport.

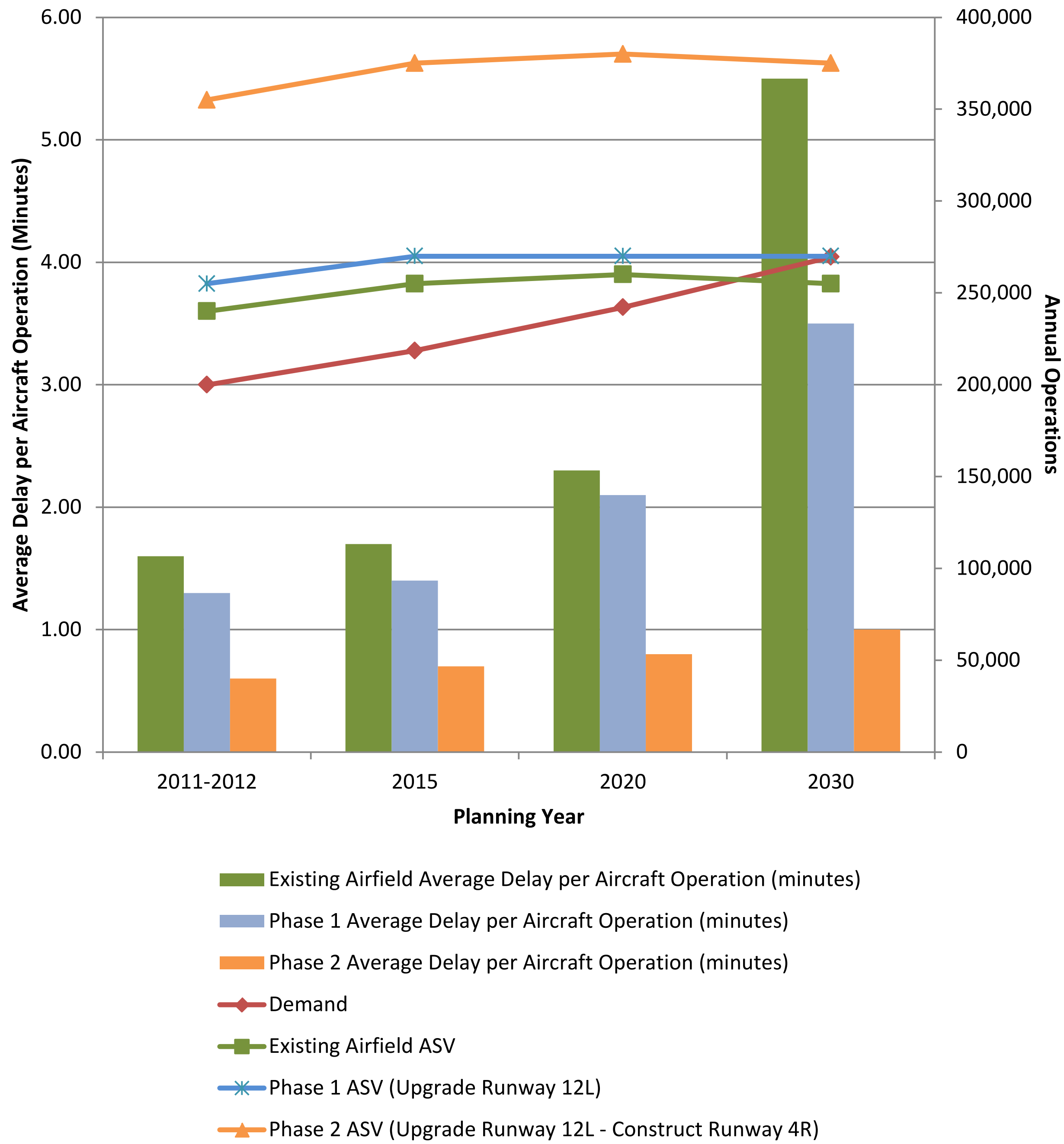
Exhibit 5-17 illustrates forecast annual operations demand compared with the ASV (i.e., the capacity) of the airfield based on the proposed projects that would provide additional airfield capacity. Planned implementation of these projects is also shown, based on the number of annual aircraft operations. Capacity development projects should be initiated when demand exceeds 60 percent of airfield capacity. Exhibit 5-10 also shows the 60 percent capacity mark for each airfield configuration (existing, Phase 1, and Phase 2). Existing demand is well beyond 60 percent of the existing and Phase 1 capacity and, as such, is it appropriate to be in the planning phase for the Runway 12L-30R upgrade and Runway 4R-22L construction.

5.4 Aviation Support Facilities

Gross facility requirements were derived for each aviation support facility component considered in the demand/capacity assessment. Total requirements were assessed to determine if adequate area would be available to accommodate tenant needs throughout the planning period.

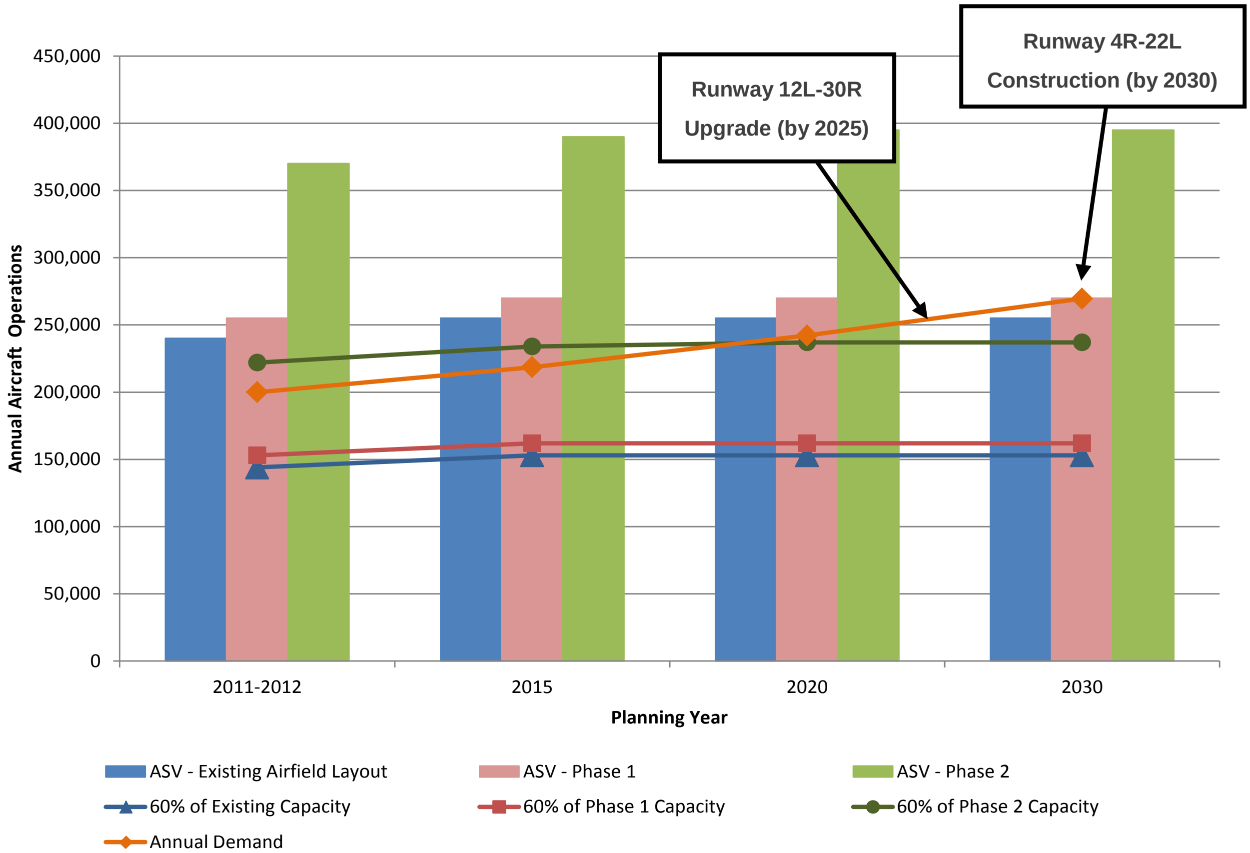
In the demand/capacity assessment for the existing aviation support facilities, it was determined that the existing FBO facilities at the Airport are adequate to serve current (2012) demand. The facility requirements for general aviation tenant facilities are based on the number of based aircraft at the Airport throughout the planning period.

Exhibit 5-16: Annual Service Volume, Demand, and Delay Comparison



SOURCES: Federal Aviation Administration, Advisory Circular 150/5060-5, *Airport Capacity and Delay*, 1995; Ricondo & Associates, Inc., September 2012.
PREPARED BY: Ricondo & Associates, Inc., February 2013.

Exhibit 5-17: Airfield Development Timing



SOURCES: Federal Aviation Administration, Advisory Circular 150/5060-5, *Airport Capacity and Delay,* 1995; Ricondo & Associates, Inc., August 2012.
PREPARED BY: Ricondo & Associates, Inc., September 2012.

5.4.1 FIXED BASE OPERATORS AND CORPORATE AVIATION

Consistent with the demand/capacity assessment, separate facility requirements are presented for the FBO, corporate, and helicopter tenants at the Airport. This approach allows for the distinction between the facility development requirements for based and transient aircraft at the Airport, as well as those associated with helicopters. **Table 5-5** summarizes the facility requirements established for the FBO, corporate, and helicopter tenants. The table includes the gross area that would be required to accommodate these facilities. For comparison, the estimated gross area of the existing (baseline) facilities are also presented.

Table 5-5: Gross General Aviation Facility Area Requirements (Acres)

		FACILITY AREA REQUIREMENTS [1/]			
USE	BASELINE FACILITIES [2/]	2015	2020	2025	2030
Fixed Base Operator	131.3	132.6	135.1	138.1	141.6
Corporate Aviation	32.6	34.6	34.6	36.7	36.7
Helicopter Facilities	4.3	4.3	5.3	5.3	5.3
Total	**168.2**	**171.5**	**175.0**	**180.1**	**183.6**
Net Increase from Baseline	--	**3.3**	**6.8**	**11.9**	**15.4**

NOTES:

1/ Growth factors are based on 2012 operational demand.

2/ Baseline facilities include both existing facilities and planned development/redevelopment by FBOs that was identified during the interviews.

SOURCES: Houston Airport System Geographic Information System, *Existing Airport Leaseholds*, July 15, 2013; Ricondo & Associates, *William P. Hobby Airport Master Plan Update Forecast*, December 2012; Ricondo & Associates, Inc., *HOU Tenant Interviews*, January 2013.

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

Various sites that could accommodate the development requirements listed in Table 5-5 were identified in the south and west quadrants of the Airport, as shown on **Exhibit 5-18.**

5.4.2 AIR CARGO AND PROVISIONING FACILITY

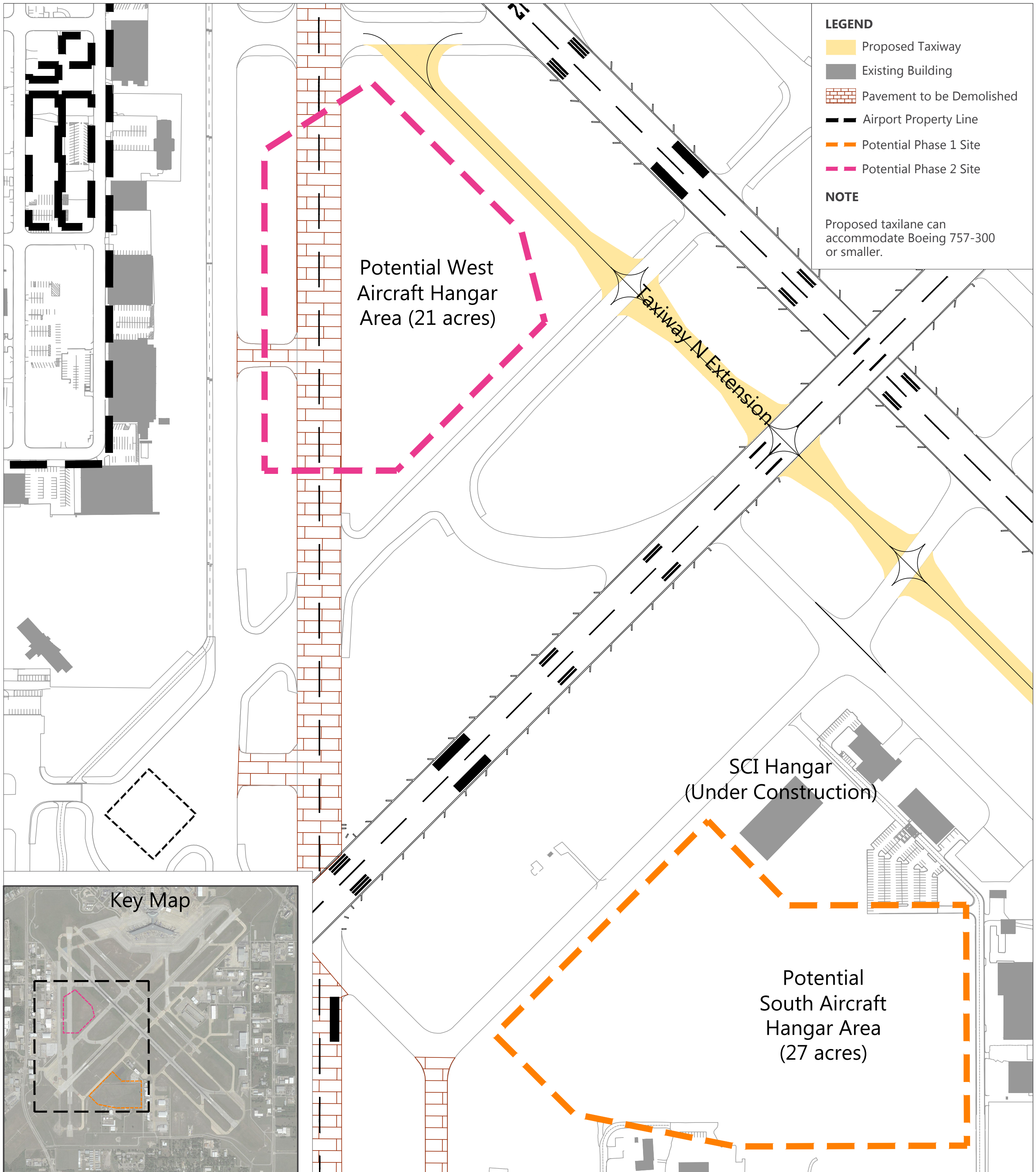
A replacement site for the air cargo and provisioning facility was identified in the east quadrant of the Airport if the anticipated growth of belly cargo materializes, or if the space at its current location is needed to accommodate additional long-term terminal area or employee parking. The proposed site, located northeast of the Southwest Airlines Maintenance Base and east of Taxiway K, is shown on **Exhibit 5-19**. The site provides airside access to Taxiway K and landside access to Monroe Road. The site is adjacent to a service road that provides direct access to the terminal area.

5.4.3 AIRCRAFT DEICING PAD

The proposed upgrade of Runway 12L-30R will impact the main deicing pad (West Pad), and the 30L Alternate Pad. New sites were evaluated for both pads.

5.4.3.1 West Pad

The West Pad is the only deicing pad at HOU with underground infrastructure to collect deicing fluids. However, based on discussions with stakeholders, it was agreed that a hold pad with underground storage tanks was not necessary for the infrequent deicing events at HOU. As such, it was recommended that a simple hold pad be built, where deicing operations could be conducted in a similar fashion to the existing alternate pads. Such a hold pad could also be used for aircraft staging during inclement weather.



SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, November 2013; Houston Airport System, Geographic Information System Data, Jacobs Engineering, February 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., November 2013.

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

EXHIBIT 5-18

NORTH 0 1,200 ft.

Future Aircraft Hangar Areas

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\7-Aircraft Hangar Areas\South Corporate Hangar Area\Exh 5-18_South Coropate Hangar Area-20141226.dwg_Layout: 01-Zoomed_No Aerial_Dec 29, 2014, 2:32pm

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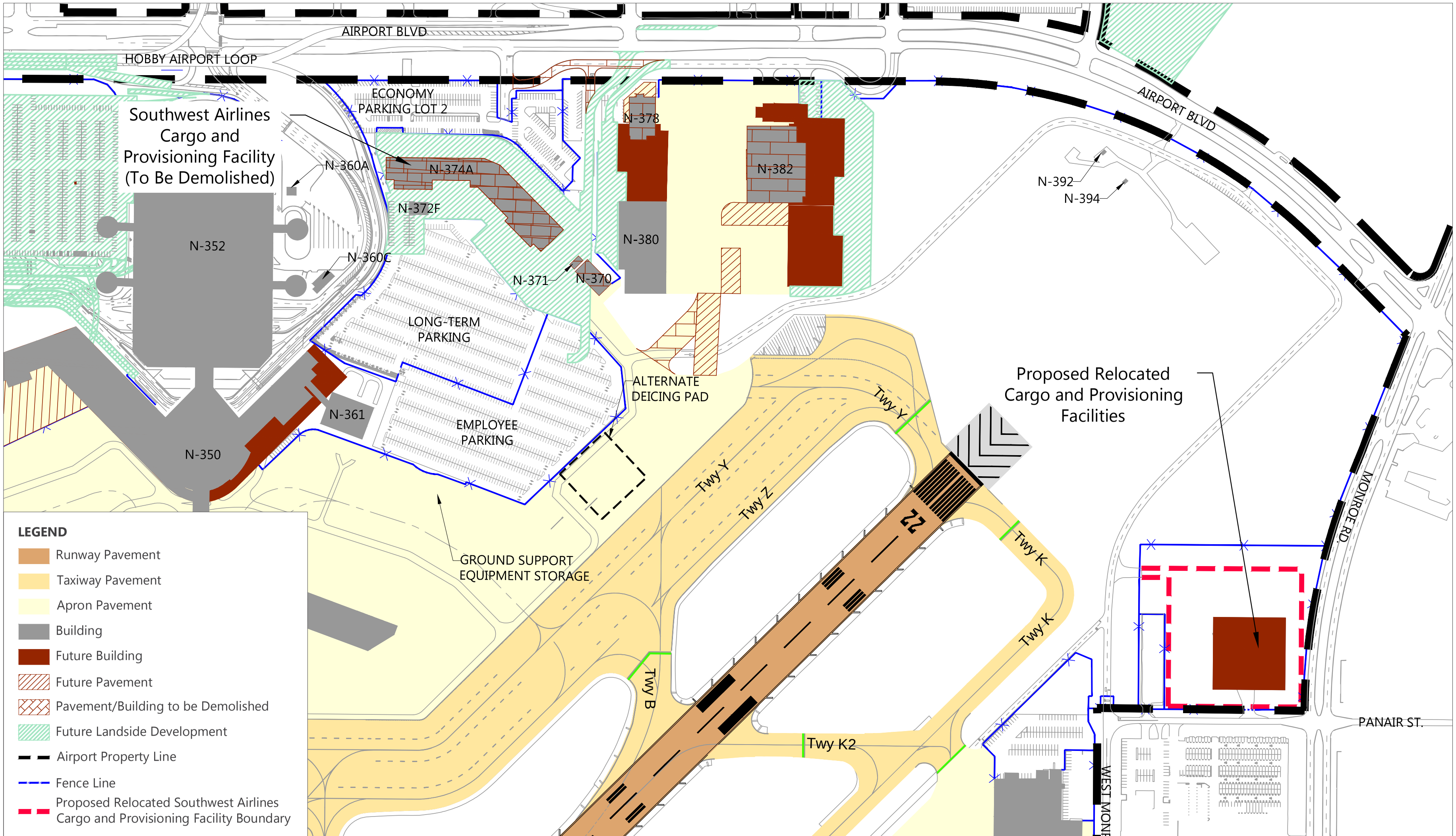

SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, October 2013; Ricondo & Associates, Inc., October 2013.
PREPARED BY: Ricondo & Associates, Inc., October 2013.

EXHIBIT 5-19

Proposed Site
Relocated Cargo and Provisioning Facilities

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\2-Airport Support\Cargo-Provisioning Building\Exh 5-19_Proposed Cargo Provisioning Building.dwg_Layout: 5-19_Proposed Relocated SW Cargo and Provisioning_Dec 29, 2014, 2:35pm

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The West Pad needs to accommodate two Boeing 737-900W aircraft parking positions and supporting deicing equipment. Based on proposed runway use configurations (departures on Runway 12R), the optimum location identified for the relocation of the West Pad is along Taxiways H and Z. Aircraft would get deiced, then cross Runway 12L at Taxiway H, and join the Runway 12R departure queue on Taxiway M. This location would also provide two additional aircraft staging positions in the vicinity of the passenger terminal. **Exhibit 5-20** depicts the existing and proposed sites for the west deicing pad.

5.4.3.2 30L Alternate Pad

The 30L Alternate Pad, which is currently located on the east side of Taxiway M, is proposed to be relocated to the west side of Taxiway N, on the Runway 30L west hold pad. **Exhibit 5-21** depicts the existing and proposed sites for the Runway 30L deicing pad.

5.5 Passenger Terminal Facilities

Shortly after this Master Plan Update was initiated, Southwest Airlines announced the intent to initiate international service to/from HOU. A study separate from this Master Plan Update was conducted to (1) identify the optimal site for the international gates and associated FIS facility, and (2) assess how adjacent facilities (terminal curbsides, roadways, utilities, etc.) would be affected. Ultimately, the purpose of the study was to prepare an advanced planning document that would guide space programming of the new international gate expansion. This element of the study is presented in the *William P. Hobby Airport International Expansion PDM*. A secondary outcome of this study was a series of recommendations about the land use in the terminal area, which are summarized in this section.

5.5.1 INTERNATIONAL TERMINAL PLANNING STUDY OVERVIEW

The conclusions presented in the *William P. Hobby Airport International Expansion Project Definition Manual* (PDM), prepared by Ricondo & Associates, Inc., in March 2013 are summarized in this section. The PDM defines program requirements for facilities needed to accommodate the introduction of international airline service at the Airport. The PDM includes drawings, diagrams, and narrative text describing the layout and details for construction of the facilities. Several goals were set for the PDM in conjunction with HAS, including:

- Provide a facility to accommodate five gates connected by passenger loading bridges plus one additional ground-loaded parking position for GA operations. All parking positions must be connected to an international arrivals facility, with a sterile corridor system, able to accommodate independent departures and international and domestic arrivals.
- Expansion must remain consistent with long-term master plan needs.
- Preserve the ability for the capacity of the ultimate terminal buildout to be in balance with the ultimate airfield capacity.

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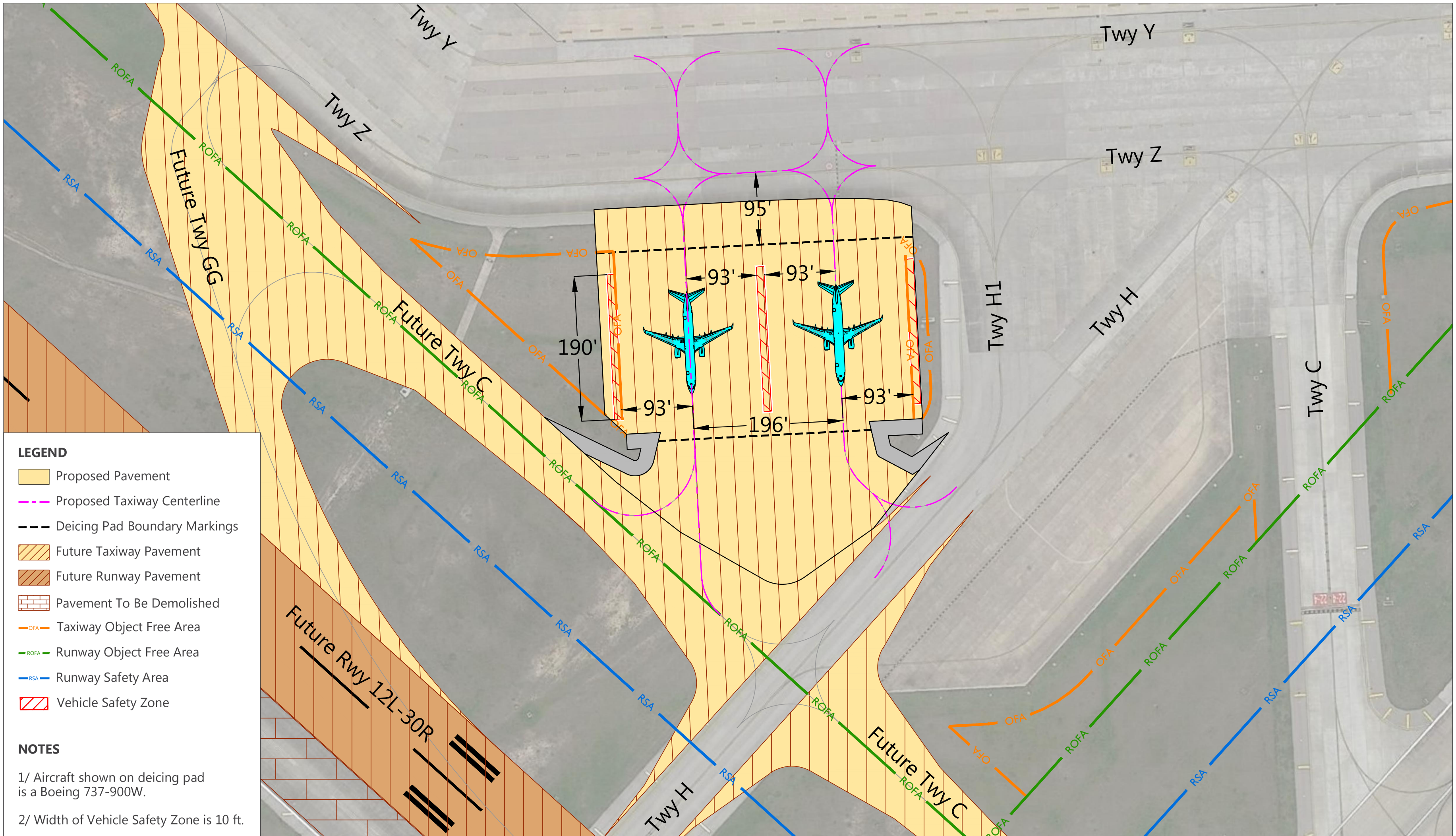

LEGEND

- Proposed Pavement
- Proposed Taxiway Centerline
- Deicing Pad Boundary Markings
- Future Taxiway Pavement
- Future Runway Pavement
- Pavement To Be Demolished
- Taxiway Object Free Area
- Runway Object Free Area
- Runway Safety Area
- Vehicle Safety Zone

NOTES

1/ Aircraft shown on deicing pad is a Boeing 737-900W.

2/ Width of Vehicle Safety Zone is 10 ft.

SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, August 2014, Google Earth Pro 2014, April 8, 2014 (aerial photography - for visual reference only, may not be to scale); Federal Aviation Administration, *Advisory Circular 150/5300-14C, Design of Aircraft Deicing Facilities*, August 7, 2013; Ricondo & Associates, Inc., August 2014.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

EXHIBIT 5-20

NORTH 0 200 ft.

Proposed West Deicing Pad Site

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\2-Airport Support\Deicing Pad\CAD\5-20 -Proposed West Deicing Pad.dwg Layout: 5-20 - Proposed West Deicing Pad Site Plotted: Dec 29, 2014, 03:04PM

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SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, September 2014, Google Earth Pro 2014, April 8, 2014 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., September 2014.
PREPARED BY: Ricondo & Associates, Inc., September 2014.

EXHIBIT 5-21

NORTH 0 200 ft.

Proposed Runway 30L Deicing Pad

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\2-Airport Support\Deicing Pad\CAD\5-21 -Proposed Runway 30L Deicing Pad.dwg Layout: 5-21 - Proposed Runway 30L Deicing Pad Plotted: Dec 29, 2014, 03:04PM

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- Provide an international arrivals processing capacity of 550 passengers per hour upon commissioning and 850 passengers per hour in future phases.
- Enhance the security screening capacity and queuing and resolve operational deficiencies.
- Improve the operation and performance of the terminal curbside.
- Provide for a secure connection between the Central Concourse and the new five-gate concourse.
- Provide the ability to complete construction and occupy and operate the new concourse by 2015.
- Preserve the ability to expand the new concourse without major interruption to active airline operations.
- Continue to promote a high level of customer service and a positive customer experience.
- Minimize passenger walking distances.
- Enhance the openness of the terminal lobby.

5.5.1.1 Forecast Demand

Passengers and aircraft operations forecasts that were prepared for this Master Plan Update were also used as the basis for planning the facilities for international service at the Airport. These forecasts are presented in Section 3 of this document. The major component of the terminal and concourse expansion is the new FIS facility, which will accommodate the processing of passengers arriving on international flights. In association with Southwest Airlines' Air Service Development staff, international service at HOU was forecast for 2015, 2020, and 2030. Based on this input, the peak period number of international passengers was anticipated to be approximately 800 passengers per hour, which was assumed to be the design day activity level for the FIS facility.

Table 5-6 summarizes the peak period arriving passengers and aircraft seats associated with the base 2011 schedule and design day flight schedules for 2015, 2020, and 2030. It was determined early in the project that the FIS facilities and the new concourse would be designed to accommodate 2020 demand, requiring a total of five international gates.

5.5.1.2 Project Area

The passenger terminal complex and associated facilities (e.g., terminal roadways, public and employee parking facilities, and rental car facilities) are located in the Airport's north quadrant. **Exhibit 5-22** provides an overview of the facilities located in the north quadrant, at the inception of this study, in 2012.

Terminal Building

The passenger terminal complex consists of a terminal building and a concourse, designated as the Central Concourse. They are connected by a walkway referred to as the Central Concourse Connector. More information on the existing terminal facilities is provided in Section 2, "Inventory of Existing Conditions".

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Table 5-6: Peak Period Passengers and Aircraft Seats - Arrivals

	2011				2015				2020				2030			
ARRIVALS	AIRCRAFT SEATS	TOTAL ARRIVING PASSENGERS	DEPARTING PASSENGERS	AIRCRAFT OPERATIONS	AIRCRAFT SEATS	TOTAL ARRIVING PASSENGERS	DEPARTING PASSENGERS	AIRCRAFT OPERATIONS	AIRCRAFT SEATS	TOTAL ARRIVING PASSENGERS	DEPARTING PASSENGERS	AIRCRAFT OPERATIONS	AIRCRAFT SEATS	TOTAL ARRIVING PASSENGERS	DEPARTING PASSENGERS	AIRCRAFT OPERATIONS
Domestic Service Overall																
Peak 10 Minutes	1,066	765	491	8	1,123	828	529	8	1,144	917	583	8	1,183	988	684	8
Peak Hour	1,888	1,493	1,034	14	2,047	1,722	1,078	15	2,497	2,151	1,339	18	3,007	2,513	1,604	20
International Service Overall																
Peak 10 Minutes	-	-	-	-	286	221	136	2	286	220	146	2	318	271	170	2
Peak Hour	-	-	-	-	572	400	246	4	858	512	314	6	922	631	387	6
Southwest Airlines Domestic Service																
Peak 10 Minutes	1,066	765	491	8	1,123	828	529	8	1,144	917	583	8	1,065	905	556	7
Peak Hour	1,888	1,433	1,004	14	1,981	1,551	1,078	14	2,288	1,981	1,214	16	2,798	2,342	1,435	18
Southwest Airlines International Service																
Peak 10 Minutes	-	-	-	-	286	221	136	2	286	220	135	2	318	271	166	2
Peak Hour	-	-	-	-	572	400	246	4	858	512	314	6	922	631	387	6
Other Airlines Domestic Service																
Peak 10 Minutes	275	253	253	2	293	252	225	2	293	250	226	2	325	271	243	2
Peak Hour	393	333	333	4	435	339	315	4	435	367	340	4	467	393	342	4
Other Airlines International Service																
Peak 10 Minutes	-	-	-	-	144	113	113	1	285	146	146	2	285	170	170	2
Peak Hour	-	-	-	-		144		1	285	188	188	2	285	219	219	2

NOTE: O&D = Origin and Destination

SOURCES: Official Airline Guides, Inc. (2011); U.S. Department of Transportation T-100 Database (2011); InterVISTAS Consulting (2015-2030); Ricondo & Associates, Inc. (2015-2030), March 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2012.

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SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

Acronyms

HAS - Houston Airport System
TSA - Transportation Security Administration

EXHIBIT 5-22

North Quadrant Overview (2012)

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\3-Terminal Area\CAD\5-22_North Quadrant Overview (2012).dwg_Layout: Ex-05-22_Dec 29, 2014, 3:06pm

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Landside Facilities

Landside access to the terminal complex is provided via an entrance at the intersection of Airport Boulevard and Broadway Street, with flyover ramps from southbound Broadway Street and westbound Airport Boulevard. A secondary entrance is available for rental car facilities located west of the terminal complex. At the entrance to Airport property, the terminal roadway diverges. Lanes to the right lead to the Departures Curbside (i.e., Upper Level Roadway) on the terminal Ticketing Level (first floor). Both private and commercial vehicles use this curb for departing passengers. The lanes to the left lead to the Arrivals Curbside (i.e., Lower Level Roadway) on Baggage Claim Level (ground floor) of the terminal. Private vehicles use the innermost curbside, while commercial vehicles use the two outer curbs located within the parking structure.

Public parking is provided in the parking garage located directly north of the terminal complex and in two surface lots, Ecopark - Lot 1 and Ecopark – Lot 2. Employee parking is provided adjacent to the west side of the terminal building. Additional employee parking is provided east of the terminal. Two rental car facilities are located west of the terminal complex, and other rental car facilities are located on the east side of the Airport. Taxicab queuing is accommodated west of the terminal complex.

More information on the existing landside facilities is provided in Section 2, "Inventory of Existing Conditions."

Airfield

The terminal complex is located north of the runways, and the Central Concourse is bordered on the south by Taxiways Y and Z, which are movement areas controlled by Airport Traffic Control Tower staff. A single taxilane sized to accommodate up to ADG III aircraft is provided on the northwest and northeast sides of the Central Concourse. A dedicated taxilane provides access to the SCI Management hangar from the taxilane on the northwest side of the Central Concourse.

Support Facilities

Several support facilities are located near the terminal complex.

5.5.1.3 Program Requirements

The PDM sets forth a list of requirements that were used as the basis for formulating the alternative development concepts from which the preferred development concept was selected. These requirements are discussed below.

Airside

Adequate separation between the existing and future concourses is required to accommodate dual taxilanes for the operation of ADG III aircraft. **Exhibit 5-23** illustrates the recommended configuration of the dual taxilanes and the adjacent end-of-stand vehicle service road. **Exhibit 5-24** illustrates a general parking template that can accommodate Boeing 737-900W aircraft, as assumed for the West Concourse. Minimum apron depth is defined by the aircraft fuselage length plus space between the nose of the aircraft and the face of the terminal or concourse building to provide clearance for tow tractors and other apron equipment. A wingtip-to-wingtip separation of 25 feet was assumed and NFPA standards were also considered in aircraft hydrant fueling placement.

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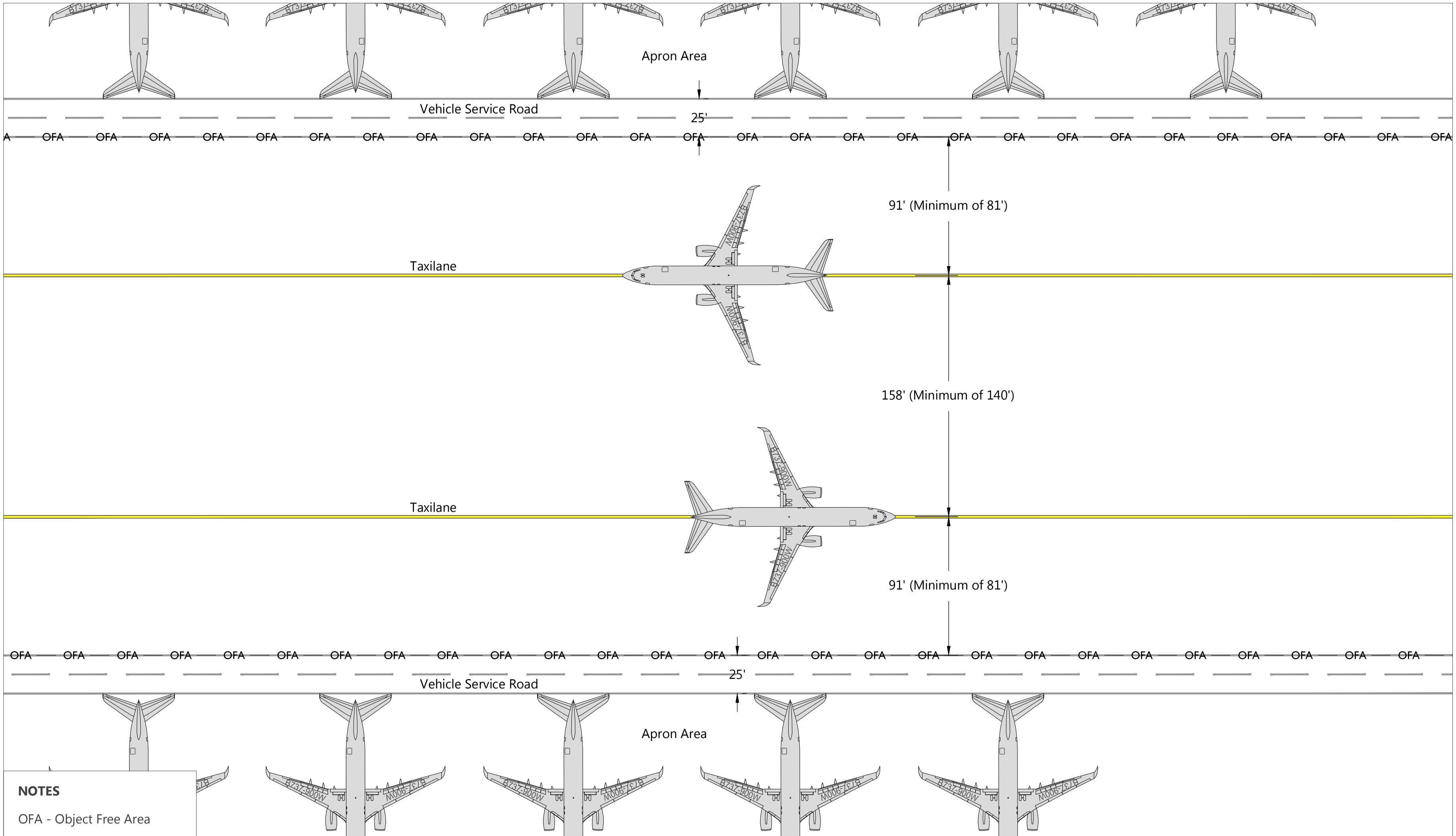

NOTES

OFA - Object Free Area

SOURCE: Federal Aviation Administration, Advisory Circular 150/5300-13A, *Airport Design,* September 28, 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

EXHIBIT 5-23

NORTH 0 100 ft.

Recommended Apron Configuration

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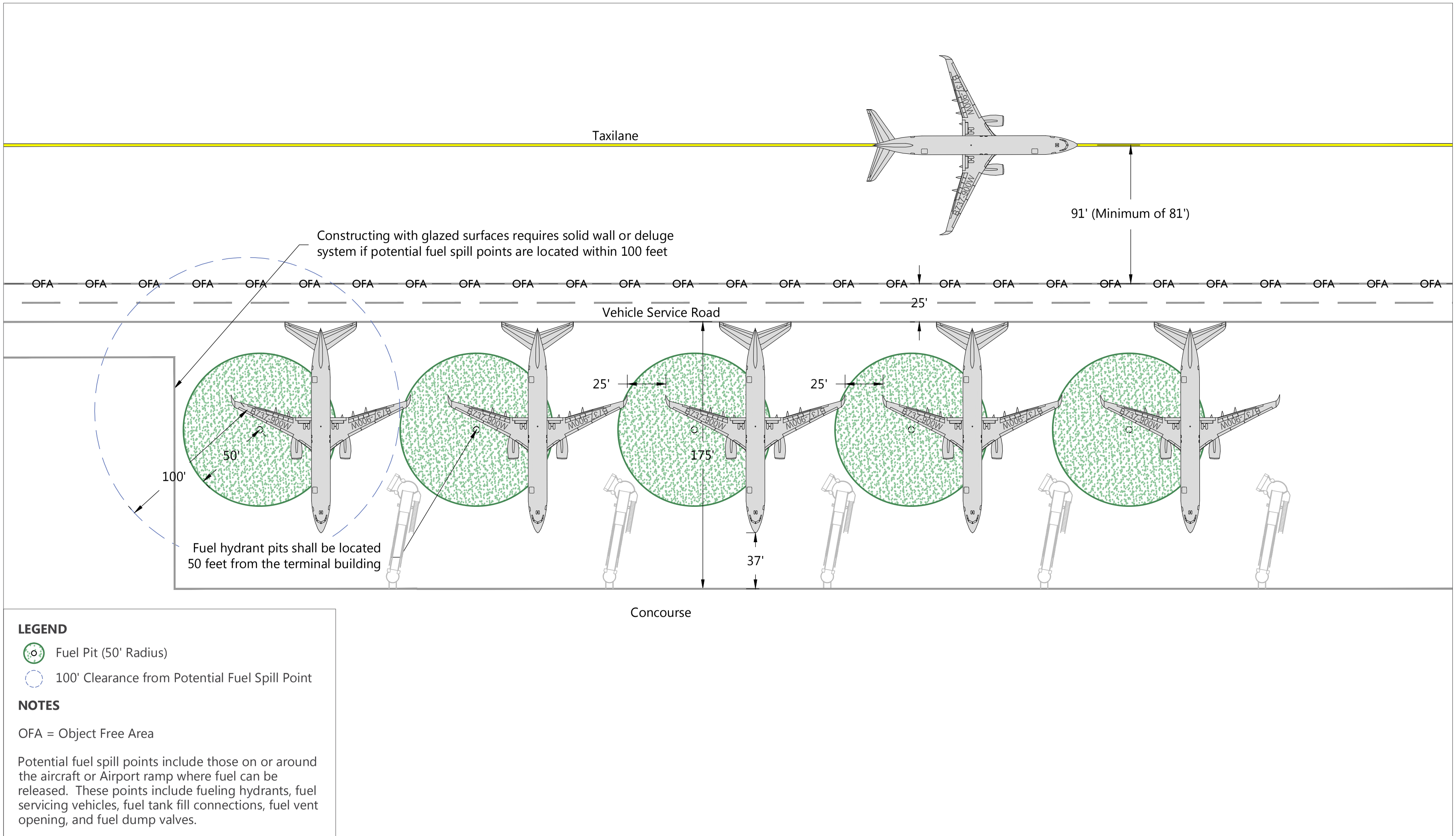

SOURCES: National Fire Protection Association, *NFPA 415, Standard on Airport Terminal Buildings, Fueling Ramp, Drainage, and Walkways*, June 18, 2012; Ricondo & Associates, Inc., December 2012
PREPARED BY: Ricondo & Associates, Inc., December 2012.

EXHIBIT 5-24

Boeing 737-900W Aircraft Parking Template

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\3-Terminal Area\CAD\5-23,24-Recommended Apron Configuration.dwg_Layout: Ex-05-24_Dec 29, 2014, 3:07pm

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Terminal

Passenger terminal facility requirements for HOU were developed to accommodate forecast peak hour enplaned and deplaned passengers. The 2020 forecast was used as the design level with the 2030 forecast shown for future-growth planning purposes. Facility requirements were developed to accommodate demand forecast to occur during a peak 10-minute period of the peak hour of the average weekday of the peak month. Computer simulations were used to derive demand loads and performance data pertaining to numbers of passengers waiting for processing and related wait times, which were correlated to the IATA-prescribed LOS framework. Desirable wait times and space requirements for passengers were simulated to achieve LOS C, which equates to a good level of service, condition of stable flow, acceptable delays, and the provision of a good level of comfort.

Several passenger attributes were considered for facility planning. These included, but were not limited to, the time passengers show up at the terminal to check in for their flights, the mode of ground transportation used to access and exit the Airport (which determines the level and portal used to enter the terminals), and the percentage of passengers checking baggage.

International Arrivals Facilities

FIS facility requirements were derived from *Airport Technical Design Standards*, published in June 2012 by U.S. Customs and Border Protection. Requirements for the number of baggage claim facilities and the area for the West Concourse were developed based on the anticipated demand inherent in the design day flight schedules. The FIS facilities are generally sized to initially process up to 400 passengers per hour, with expansion capability planned to process 800 passengers per hour. The major components of the FIS facilities are:

- Primary Screening – Where passports and immigration status are checked
- International Baggage Claim – Where passengers retrieve their baggage
- Secondary Screening – Where passengers go through additional Customs and passport screening, if required
- Exit Control – The final process before passengers exit the FIS facilities and enter the United States

CBP administration space, including offices, break rooms, locker rooms, holding facilities, information technology (IT) equipment rooms, conference rooms, and other spaces pertinent to the mission of an FIS facility were also planned. A recheck and meeters and greeters lobby area was considered outside of the FIS facilities, where connecting passengers can recheck baggage and access airline customer service counters or meet non-travelers. Final CBP administration space and known traveler requirements would be defined during the design phase.

Concourse

The planned five gates were assumed to be used for both domestic and international departures and arrivals. As such, arriving aircraft originating from international locations would not need to be towed to the Central Concourse for departure, enabling increased gate utilization during peak period domestic operations when few international arrivals occur, or during irregular operations when domestic passengers need to be deplaned because of delays The concourse will consist of three categories of space: gate areas, passenger amenities, and circulation. The gate areas include holdrooms for passengers to wait, ticket lift areas where boarding passes are read before passengers enter the aircraft, gate counters for airline agents, and distinct aisles to allow for aircraft enplaning and deplaning.

Terminal

The preferred development concept includes a westerly expansion of the terminal, which affects the existing Southwest Airlines ticket counters and the TSA security checkpoint. The existing security checkpoint will be reconfigured and expanded to address capacity constraints.

Table 5-7 summarizes the space requirements for design level 2020 and future demand level 2030.

Table 5-7: Summary of Functional Space Requirements (in square feet)

	SPACE REQUIREMENT 2020 DESIGN LEVEL (SQUARE FEET)	SPACE REQUIREMENT 2030 DESIGN LEVEL (SQUARE FEET)
INTERNATIONAL FACILITIES		
CBP Primary Screening	11,040	11,040
International Baggage Claim	23,616	23,616
CBP Secondary Screening and Support	15,000	15,000
CONCOURSE FACILITIES		
Holdroom Area (per gate)	2,752	2,752
Total Holdroom Area	13,760	13,760
Concessions Area	9,200	11,200
TERMINAL AREAS	4	
Check-in	2,752	15,138
Security Screening Checkpoint	13,760	29,770

SOURCE: Ricondo & Associates, Inc., November 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

5.5.1.4 Alternatives

Several alternatives were developed to accommodate future gate expansion, as well as incremental phases to accommodate the five gates associated with 2020 demand. The alternatives generally remained consistent with the 2003 Master Plan, which defined both an East and West Concourse north of the existing Central Concourse (either parallel to each wing of the Central Concourse or parallel to the primary road alignment in front of the main Terminal entrance), providing a total of approximately 25 to 30 additional gates.

Opportunities for incorporating additional parking facilities in the terminal area and expansion of the terminal curb were also explored and incorporated into the alternatives.

Exhibit 5-25 illustrates the two alternatives considered for future gate expansion: angled concourse alternatives and East/West Concourse alternatives. Numerous alternatives were considered during the coordination meetings with HAS and Southwest Airlines. The alternatives illustrated on Exhibit 5-25 are, therefore, to be considered illustrative in nature. The first alternative consists of a set of angled concourses constructed parallel to the existing taxilanes north of the existing Central Concourse. This alternative would provide dual ADG III taxilanes on both sides of the concourse. It would allow for approximately 16 ADG III gates on the West Concourse and 18 ADG III gates on the East Concourse at full buildout. The existing Baggage Screening and Sortation Facility could remain in operation, although it would reduce the number of gates available on the East Concourse.

The second alternative consists of the construction of a set of concourses in an east-west orientation aligned with Airport Boulevard and the parking garage. This alternative would also allow for dual ADG III taxilanes and would provide approximately 16 ADG III gates on the West Concourse and 17 ADG III gates on the East Concourse at full buildout. Construction of the East Concourse would require demolition and replacement of the existing Baggage Screening and Sortation Facility.

Exhibit 5-26 illustrates the two concourse alternatives with new parking garages located on both the east and west sides of the existing parking garage. Incorporation of the parking garage on the west side would require realignment of the terminal roadways and would reduce by two the number of available gates on the West Concourse in each alternative. The terminal roadway realignment shown in the angled concourse alternatives would facilitate an extension of the curb in front of the expanded terminal. The east/west-oriented concourse alternatives would also accommodate an extended curb in front of a portion of the expanded terminal building. The remainder of the curb could be accessed by an extension of the sidewalk or corridor connecting to the new West Garage. The east curb could also be extended with a similar extension of the sidewalk or corridor leading to the East Garage. **Exhibit 5-27** depicts the incremental construction that would be required to accommodate five gates for each concourse alternative.

The potential to create a sterile corridor connecting five of the existing gates on the Central Concourse to an FIS facility located in an easterly or westerly expansion of the terminal was also explored. The presence of a baggage system and vehicle cut-through on the Apron Level (ground floor) would require the secure corridor to be located above the Ticketing Level (first floor) along the face of the existing concourse, as shown on **Exhibit 5-28**. It was determined early in the planning process that, although this alternative would initially allow for the greatest number of gates connected to an FIS facility, the relocation of mechanical utilities above the Ticketing Level (first floor) of the center core of the Central Concourse would be cost prohibitive.

A qualitative evaluation of the four five-gate concourse and terminal expansion alternatives was completed, as summarized in **Table 5-8**.

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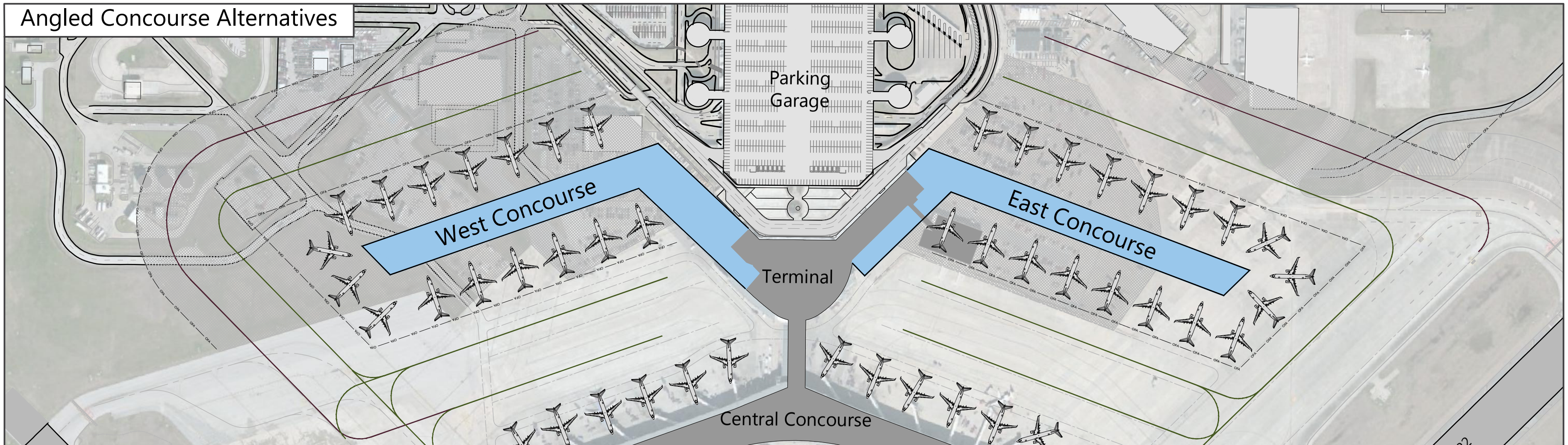

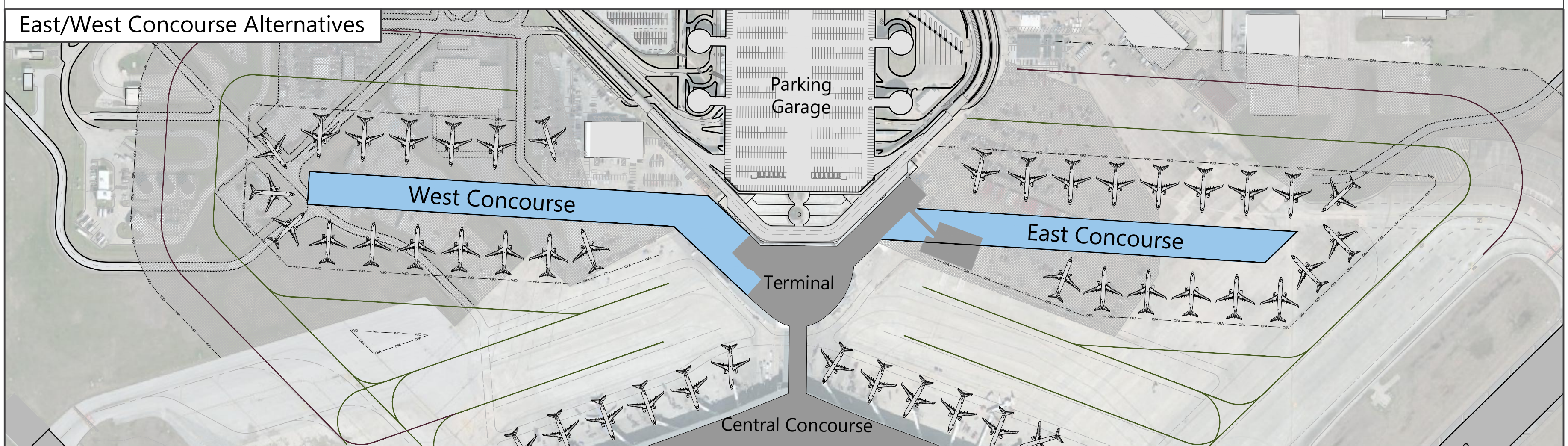

SOURCE: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

EXHIBIT 5-25

NORTH

0 500 ft.

Gate Expansion Alternatives

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\3-Terminal Area\CAD\5-25,5-26_Family of Concepts.dwg_Layout: Ex-05-25_Dec 29, 2014, 3:00pm

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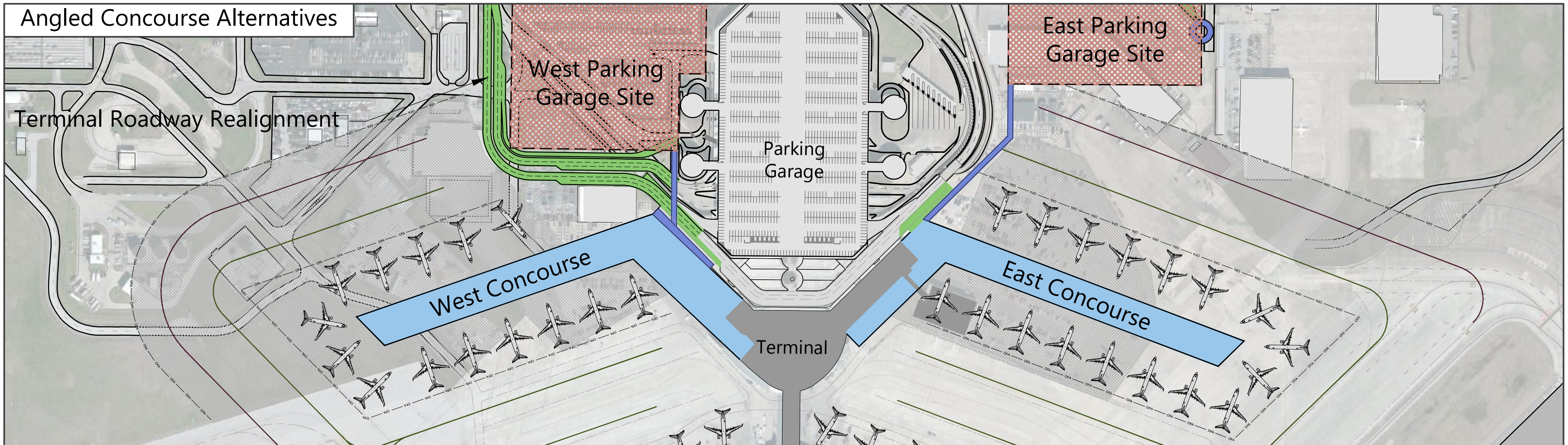

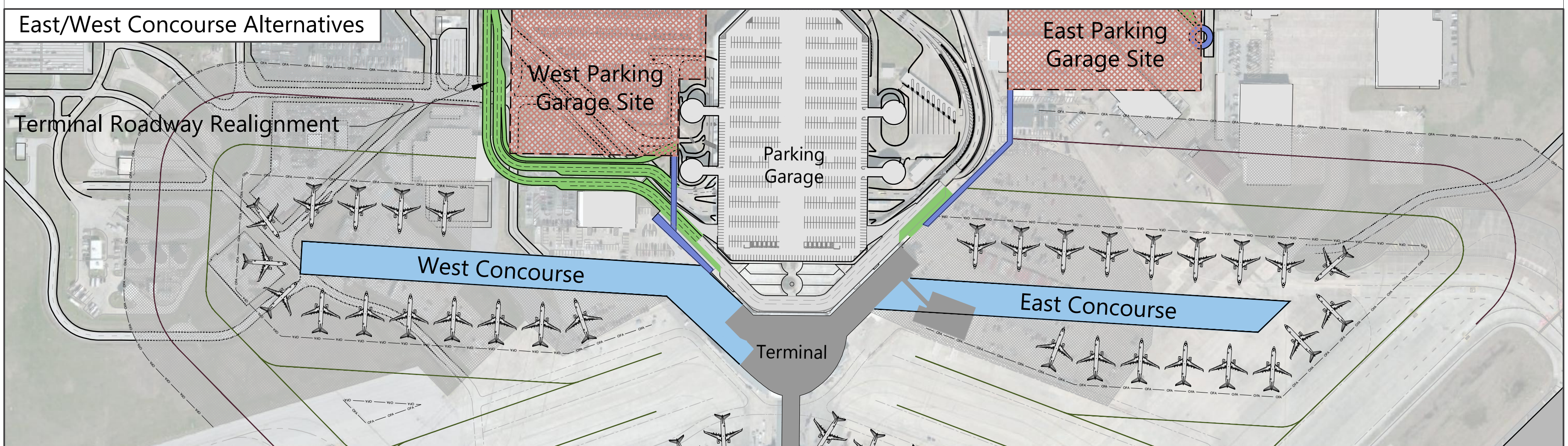

SOURCE: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

EXHIBIT 5-26

NORTH 0 500 ft.

Parking Garage Alternatives

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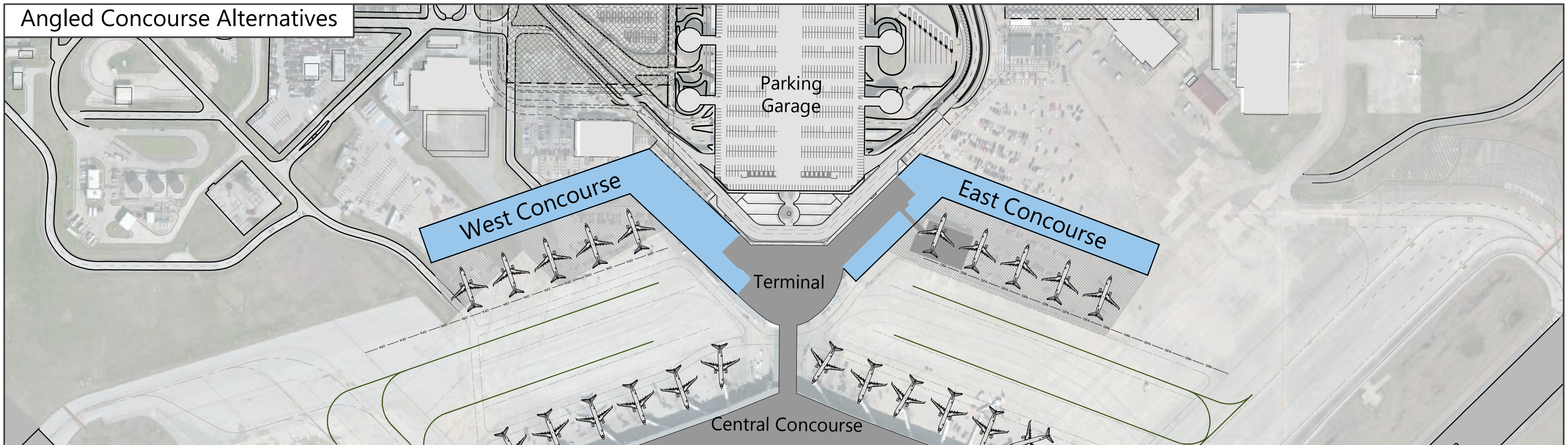

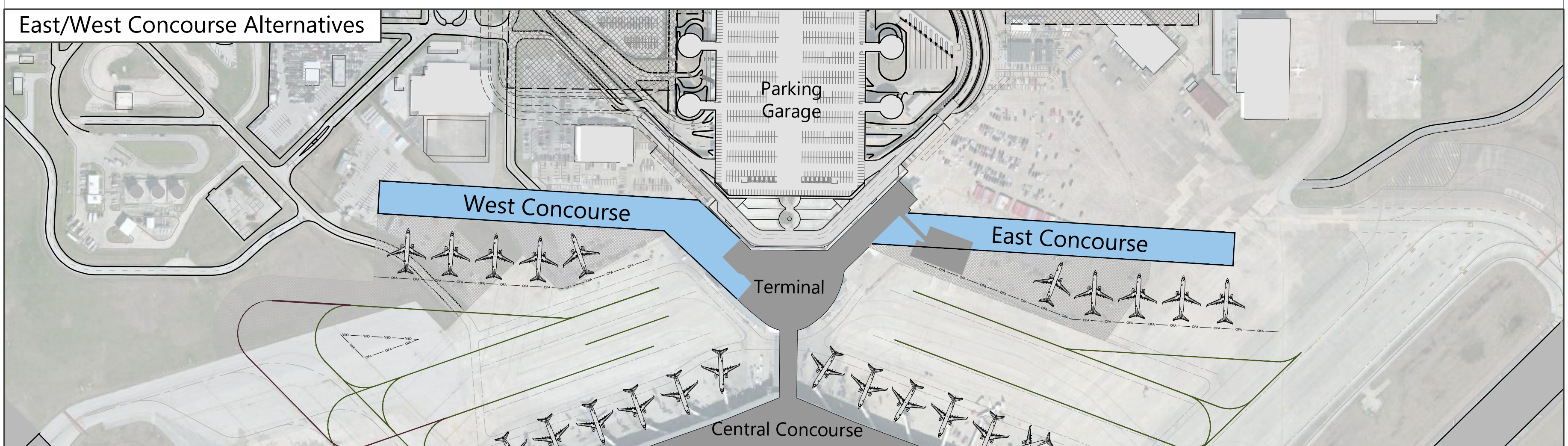

SOURCE: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

EXHIBIT 5-27

NORTH 0 500 ft.

Alternatives Incremental Construction

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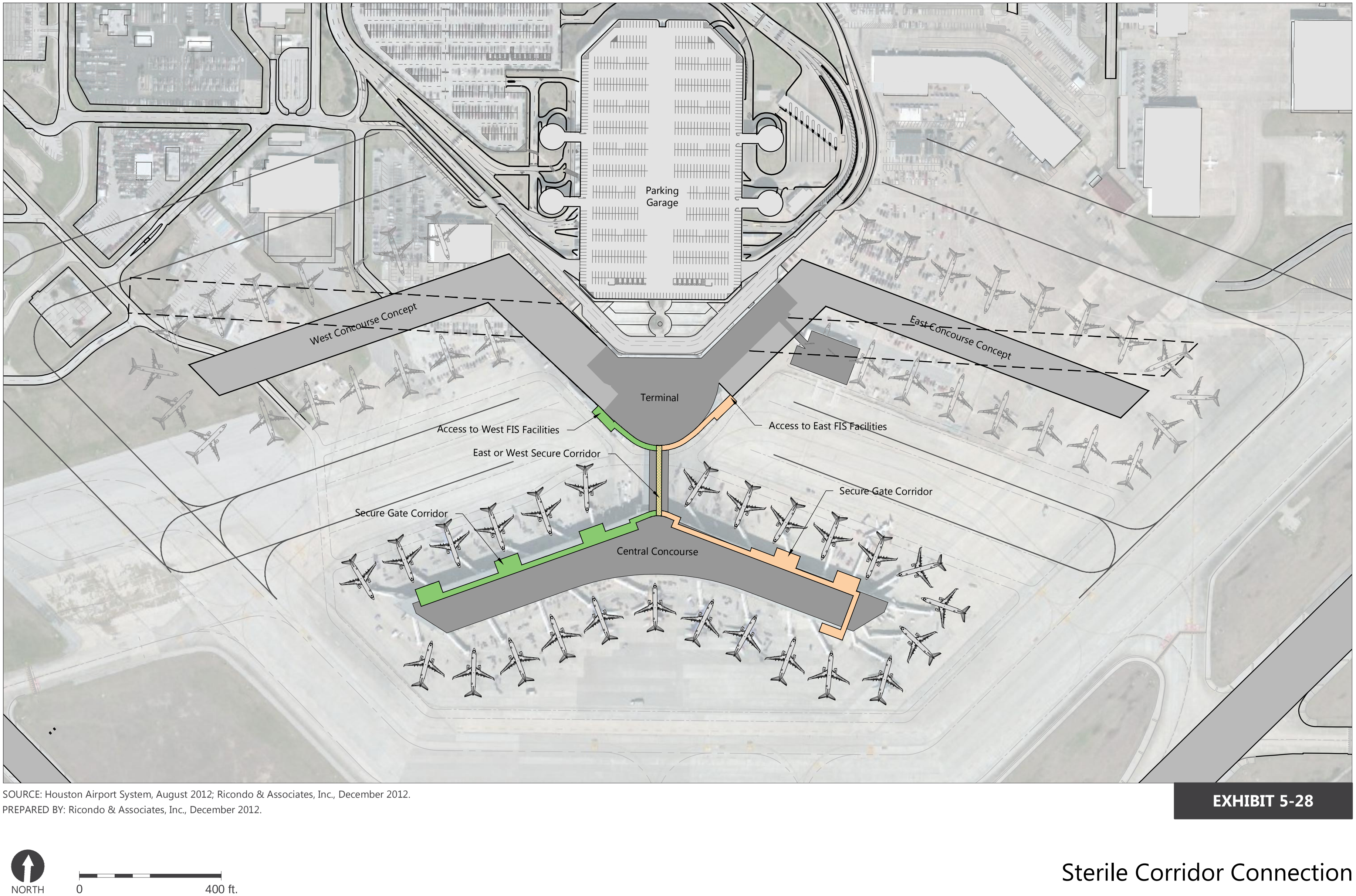

SOURCE: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

EXHIBIT 5-28

Sterile Corridor Connection

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Table 5-8: Evaluation of Concourse Alternatives

CATEGORY	ANGLED ALIGNMENT WEST SIDE	EAST/WEST ALIGNMENT WEST SIDE	ANGLED ALIGNMENT EAST SIDE	EAST/WEST ALIGNMENT EAST SIDE
Enabling Projects				
For five gates, parking and roadway (if applicable)	Emergency generator Utilities Employee parking Houston Airport System badging/TSA building Airport Operations Center Administration	Emergency generator Utilities Employee parking Houston Airport System badging/TSA building Airport Operations Center Administration	Other airlines baggage building Other airlines ticketing Utilities Houston Airport System badging/TSA building Employee parking	Other airlines baggage building Other airlines ticketing Utilities Houston Airport System badging/TSA building Employee parking
Additional for full extension of concourse	SCI Management hangar	Budget Rent A Car facility SCI Management hangar	Portion of Southwest Airlines cargo building Portion of Atlantic Aviation hangar	Portion of Southwest Airlines cargo building Portion of Atlantic Aviation hangar
Constructability				
Construction cost		Larger concourse building to reach initial gates	Potential cost savings in reuse of existing east side terminal structure. Would require removal of existing Baggage Screening and Sortation Facility.	Larger concourse building to reach initial gates. Potential cost savings in reuse of existing east side terminal structure. Would require removal of existing Baggage Screening and Sortation Facility.
Operational Efficiency				
Terminal - Efficiency of flow	With relocation of Southwest Airlines ticketing to the west, allows for efficient passenger flow from curb to security.	With relocation of Southwest Airlines ticketing to the west, allows for efficient passenger flow from curb to security.	Southwest Airlines on East Concourse would create some passenger cross flows.	Southwest Airlines on East Concourse would create some passenger cross flows.
Terminal - Security	Supplemental or expanded security checkpoint; secure corridor recommended between concourses for long-term expansion and flexibility.	Supplemental or expanded security checkpoint; secure corridor recommended between concourses for long-term expansion and flexibility.	Supplemental or expanded security checkpoint; secure corridor recommended between concourses for long-term expansion and flexibility.	Supplemental or expanded security checkpoint; secure corridor recommended between concourses for long-term expansion and flexibility.
Terminal - Bag handling	Other Airlines baggage systems remain; allows for international recheck connectivity to Southwest Airlines system.	Other Airlines baggage systems remain; allows for international recheck connectivity to Southwest Airlines system.	Other Airlines baggage system would be replaced; international recheck connectivity to Southwest Airlines may be challenging.	Other Airlines baggage system is replaced; international recheck connectivity to Southwest Airlines may be challenging.
Airside (aircraft movements)	Dual-taxilane access to all gates.	Dual-taxilane access to all gates.	Dual-taxilane access to all gates; longer taxiing distance to Runways 12L/12R; potential interaction with Atlantic Aviation traffic; potential Airport Traffic Control Tower line-of-sight limitations.	Dual-taxilane access to all gates; longer taxiing distance to Runways 12L/12R; potential interaction with Atlantic Aviation traffic; potential Airport Traffic Control Tower line-of-sight limitations.
Landside (curbside capacity, access efficiency, wayfinding, parking availability)	Would create additional curb and large area for parking garage.	Would create additional curb and large area for parking garage.	Would create less additional curb.	Would create less additional curb.
Ability to resolve current security deficiencies	Ability to expand central security checkpoint by relocating Southwest Airlines ticketing to west expansion.	Ability to expand central security checkpoint by relocating Southwest Airlines ticketing to west expansion.	Ability to expand central security checkpoint by relocating Southwest Airlines ticketing to east expansion may be challenging; expanding security checkpoint to the east would require filling in of oval area.	Ability to expand central security checkpoint by relocating Southwest Airlines ticketing to east expansion may be challenging; expanding security checkpoint to the east would require filling in of oval area.
Program Requirements and Phasing				
Ultimate concourse buildout capacity	Combined with East Concourse, would accommodate approximately 50 to 55 gates.	Combined with East Concourse, would accommodate approximately 50 to 55 gates.	Combined with West Concourse, would accommodate approximately 50 to 55 gates.	Combined with West Concourse, would accommodate approximately 50 to 55 gates.
Compatibility with ultimate terminal area development (consolidated rental car facility, employee parking, other)	Able to accommodate loop roadway and ground transportation facilities in terminal area.	Able to accommodate loop roadway and ground transportation facilities in terminal area.	Able to accommodate loop roadway and ground transportation facilities in terminal area.	Able to accommodate loop roadway and ground transportation facilities in terminal area.
Consistency and flexibility with future long-term Airport development	Able to accommodate east-west terminal roadway.	Able to accommodate east-west terminal roadway.	Able to accommodate east-west terminal roadway.	Able to accommodate east-west terminal roadway.
Summary				
Summary of each concept, with the following characteristics common to all concepts: Ultimate expansion provides balanced airfield Required terminal process improvements would not be significantly limited by any concept except curb and roadway All parking capacity expansions would meet (or nearly meet) demand through 2030 All concepts would be compatible with ultimate terminal area expansion.	Relatively few enabling projects required to provide construction zone with little effect on terminal operations. Somewhat higher construction cost expected because of roadway expansion. Excellent airfield access for new gates. Excellent parking/terminal adjacencies. Greatly improved terminal roadway level of service.	Relatively few enabling projects required to provide construction zone with little effect on terminal operations. Somewhat higher construction cost expected because of roadway expansion. Excellent airfield access for new gates. Excellent parking/terminal adjacencies. Greatly improved terminal roadway level of service. Cross flow of Southwest Airlines passengers and baggage.	Concourse construction would require relocating other airlines baggage building (or less efficient aircraft parking) and reconfiguration of east terminal; ultimate concourse expansion would impinge on cargo and fixed base operator facilities. New gates would not be in best location in relation to primary runway.	Concourse construction would require relocating other airlines baggage building (or less efficient aircraft parking) and reconfiguration of east terminal; ultimate concourse expansion would impinge on cargo and fixed base operator facilities. New gates would not be in best location in relation to primary runway. Cross flow of Southwest Airlines passenger and baggage.

SOURCE: Ricondo & Associates, Inc., November 2012.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

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An angled five-gate concourse on the west side of the terminal building and expansion of the terminal was selected as the preferred development alternative by the PDM team, HAS, and Southwest Airlines representatives. Concourse expansion to the west was preferred over expansion to the east for the following reasons:

- Expansion to the west would allow for the relocation and expansion of Southwest Airlines ticket counters and create a large space for expansion of the security screening checkpoint.
- By expanding the security checkpoint to the west, modifications to the oval area and disruptions to passenger flows to the baggage claim area can be avoided.
- Connecting a West Concourse to the Southwest Airlines baggage screening and sortation facilities in the Central Concourse would be simpler than connecting an East Concourse.
- Construction on the west side would also avoid affecting the other airlines ticketing counters, located on the east side of the terminal.
- Shifting the Southwest Airlines ticket counters to the west, combined with extension of the curb, would help distribute traffic more evenly along the curb rather than the congestion that occurs at the central portion of the curb with the existing configuration.

5.5.1.5 Preferred Development Alternative

The preferred development alternative consists of a new West Concourse, westerly expansion of the existing terminal, and associated enabling projects, as shown on **Exhibit 5-29**. A new parking garage west of the existing parking garage and realignment of the terminal roadway, the Hobby Airport Loop, are also included in the preferred development alternative. The PDM sets forth the space program for the terminal expansion and West Concourse, as summarized in **Table 5-9**.

Apron Level / Ground Floor

In the conceptual interior layout, shown on **Exhibit 5-30,** the elevation of the Apron Level (ground floor) is approximately equivalent to the elevation of the apron. The ground floor would primarily contain the FIS facilities and sterile corridor system leading to the FIS facilities. Inbound baggage unloading areas would also be accommodated on the Apron Level (ground floor), as would MEP systems and IT-related functions. It was assumed that the FIS area would be approximately 3 feet lower than the elevation of the apron, but further analysis and investigation by the selected architect/engineer may yield options that do not require the depressed slab. The depressed FIS area is intended to provide additional clearance between the Apron Level (ground floor) and Concourse Level (first floor) to allow for overhead baggage conveyors from the baggage makeup area to the international baggage claim devices. Where the existing terminal and expansion area meet, a meeter/greeter area would be provided, along with nonsecure public circulation.

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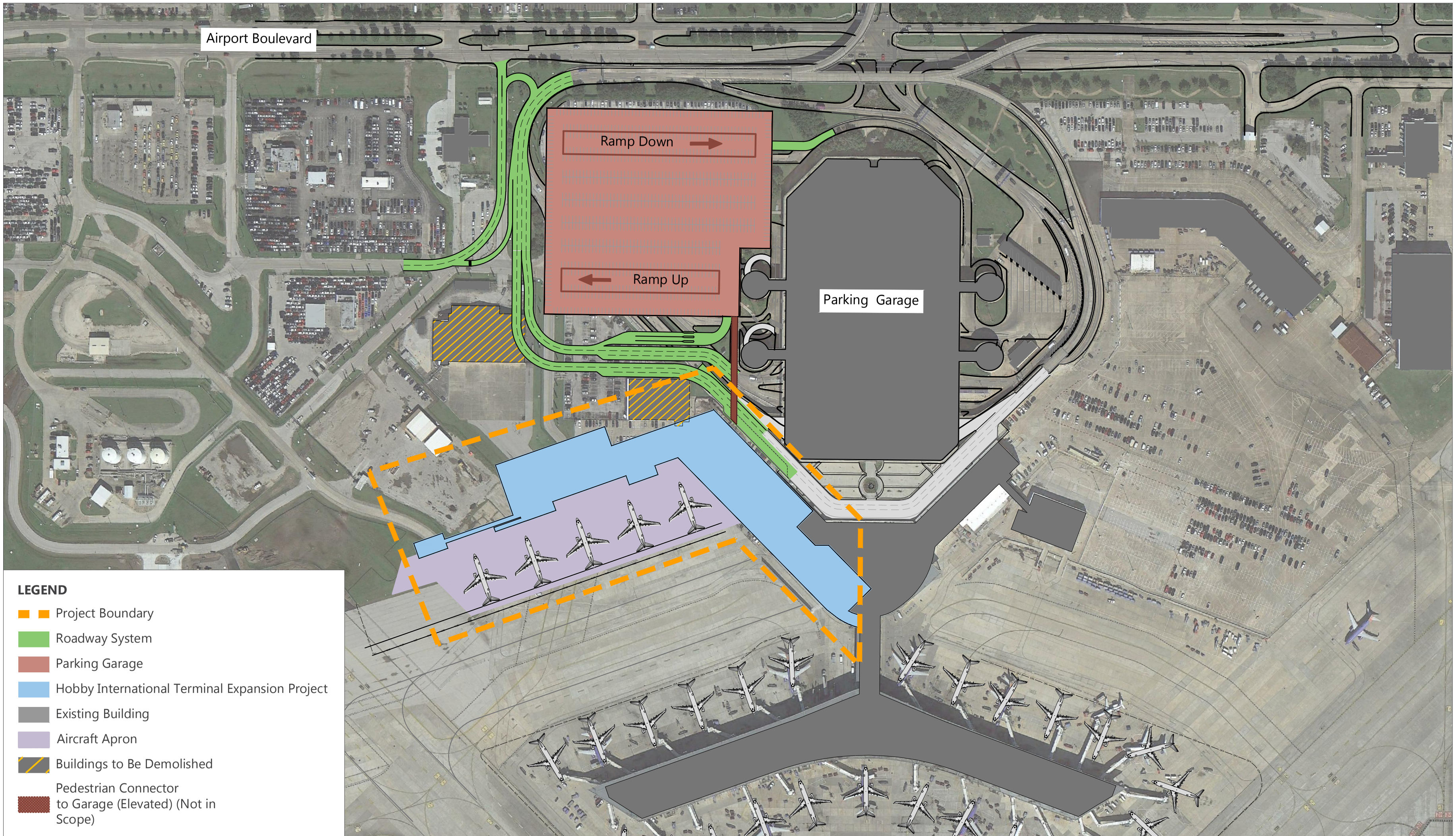

SOURCES: Houston Airport System, August 2012; Google Earth Pro 2014; Terra Metrics, October 31, 2013; Ricondo & Associates, Inc., September 2012.
PREPARED BY: Ricondo & Associates, Inc., September 2012.

EXHIBIT 5-29

Preferred Development Alternative

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Table 5-9: Preferred Development Alternative Space Program

	FUNCTION	FUNCTIONAL SPACE (SQUARE FEET)
International Arrivals Facility	Sterile Corridor	18,254
	CBP Primary Processing	13,450
	International Baggage Claim	28,180
	CBP Secondary Processing and Support	19,705 1/
	Recheck	2,244
	Inbound Baggage Area	9,747 2/
Concourse Areas	Holdrooms	18,894
	Leasable Area	10,970
Terminal Areas	Check-in	5,627 3/
	Airline Ticketing Offices	4,481
	Security Screening Checkpoint	26,611 4/
Other Spaces	Restrooms	5,779
	Houston Airport System	16,233 5/
	Mechanical, Electrical, Plumbing	14,258
Circulation	Secure	40,010
	Non-Secure	38,191
	Vertical	3,926
	Total Program Area	**276,560**

NOTES:

CBP = Customs and Border Protection

1/ Program does not include locker rooms and other variable spaces.

2/ Includes baggage tug drive area.

3/ Program includes curbside check-in location not included in concept.

4/ Concept has limited revesting area.

5/ Replacement of affected areas.

SOURCE: Ricondo & Associates, Inc., March 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

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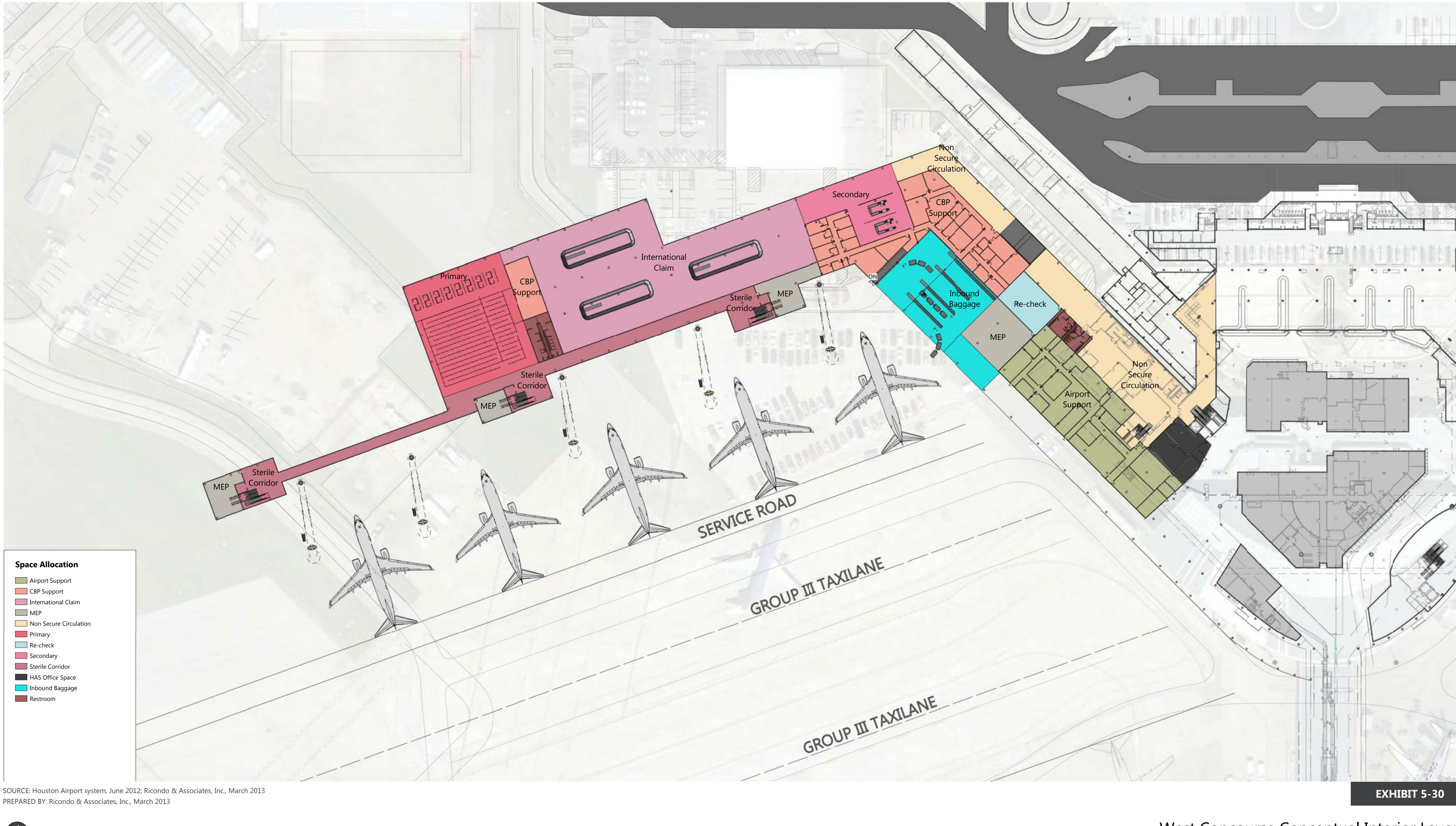

SOURCE: Houston Airport system, June 2012; Ricondo & Associates, Inc., March 2013
PREPARED BY: Ricondo & Associates, Inc., March 2013

EXHIBIT 5-30

West Concourse Conceptual Interior Layout
Apron Level/ Ground Floor

N:\Houston Airport System (HAS)\01 Master Plan 2011 - 2012\04 Hobby (HOU)\Terminal\ACAD and 3d\02_Revit\Hobby_PDM.rvt

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Ticketing Level / First Floor

The Ticketing Level (first floor) would provide a floor-to-floor clearance of approximately 15.5 feet within the FIS area. In other areas, the floor-to-floor clearance would be approximately 12.5 feet. Further analysis and investigation by the selected architect/engineer may yield options that do not require the depressed slab resulting in different floor-to-floor clearances. The Ticketing Level (first floor) would primarily contain gate holdrooms on the concourse portion of the development. Passenger amenities, such as concessions and restrooms, as well as general secure public circulation, would be provided along the concourse. The terminal portion of the expansion would include reconfiguration and expansion of the Southwest Airlines ticket counters, as well as reconfiguration and expansion of the security screening checkpoint. The conceptual interior layout of the first floor is shown on **Exhibit 5-31**.

Impacts on Existing/Enabling Projects

Exhibit 5-32 identifies impacts of the planned development on existing facilities. **Exhibit 5-33** through **Exhibit 5-35** identify the impacts on facilities within the existing terminal building.

5.5.1.6 Aircraft Apron Improvements

The aircraft parking position layout for the preferred development alternative is shown on **Exhibit 5-36** and is based on accommodating up to six ADG III aircraft (e.g., Boeing 737 models, Airbus A318 through A321, Embraer E170 through E195) on the West Concourse apron. Five of the six aircraft parking positions would be served by passenger loading bridges. Dual taxilanes would be provided on the apron between the West and Central Concourses. Both taxilanes are planned to accommodate independent Boeing 737-900W aircraft operations.

5.5.2 LONG-TERM DEVELOPMENT ALTERNATIVES

Passenger terminal facility alternatives were developed to accommodate the demand forecast for HOU. The alternatives included concepts for expansion of the terminal building and concourse to the west, as well as to the east. No alternatives were considered that expanded the Airport property line. These alternatives address the primary need for an international arrivals facility to accommodate forecast demand. The alternatives are described in this section.

5.5.2.1 Alternatives

The alternatives developed for HOU to accommodate forecast demand through the planning period (2030) focused on development of terminal and concourse expansion on the east side or the west side of the existing facility. Ultimately, terminal and concourse expansion would be required on both sides, but the location of new FIS facilities for international arriving flights was a key component in the initial phases. Additionally, the configuration of roads and parking facilities will affect the orientation and expansion of the terminal facility.

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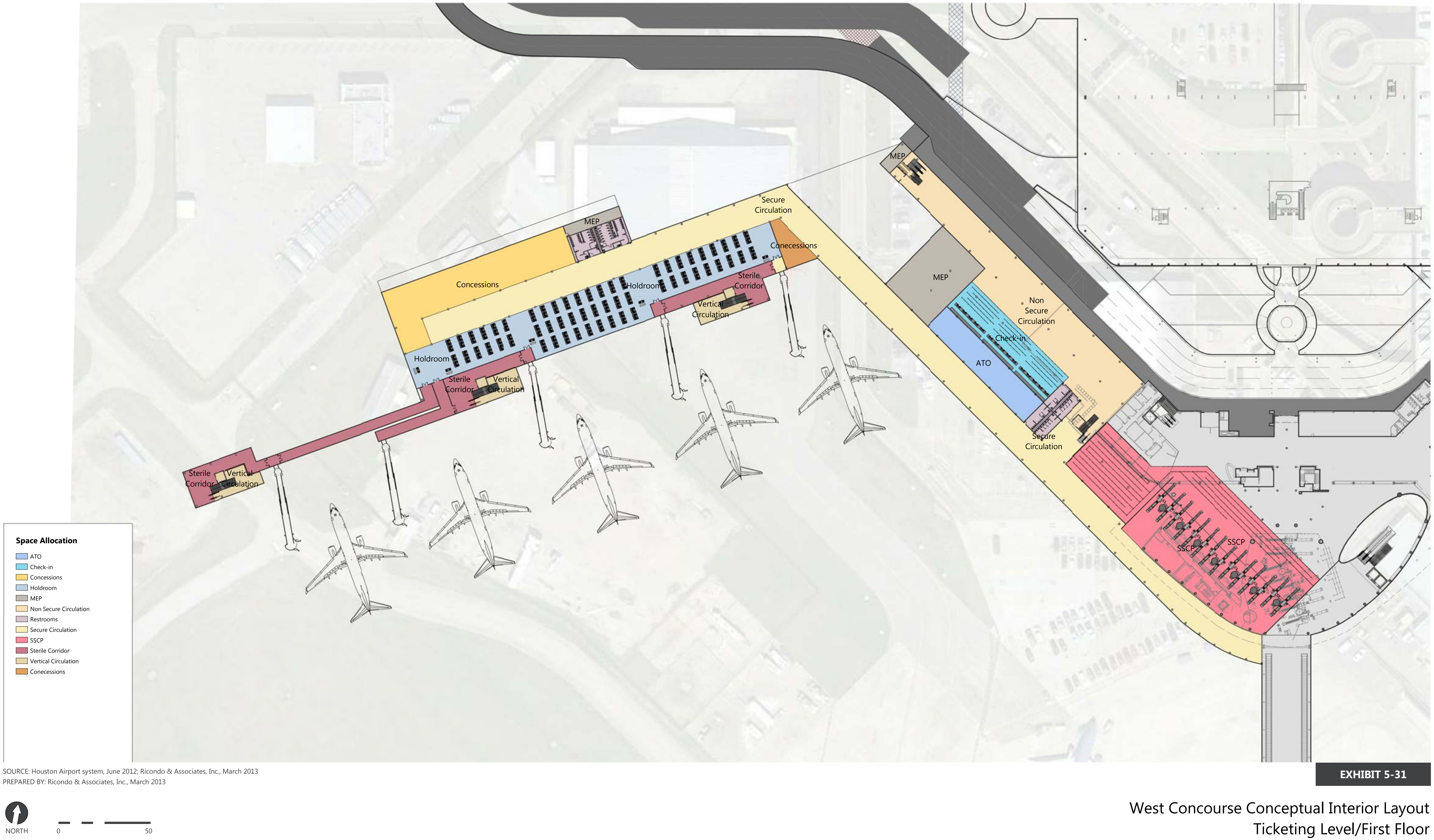

SOURCE: Houston Airport system, June 2012; Ricondo & Associates, Inc., March 2013
PREPARED BY: Ricondo & Associates, Inc., March 2013

EXHIBIT 5-31

West Concourse Conceptual Interior Layout
Ticketing Level/First Floor

N:\Houston Airport System (HAS)\01 Master Plan 2011 - 2012\04 Hobby (HOU)\Terminal\ACAD and 3d\02_Revit\Hobby_PDM.rvt

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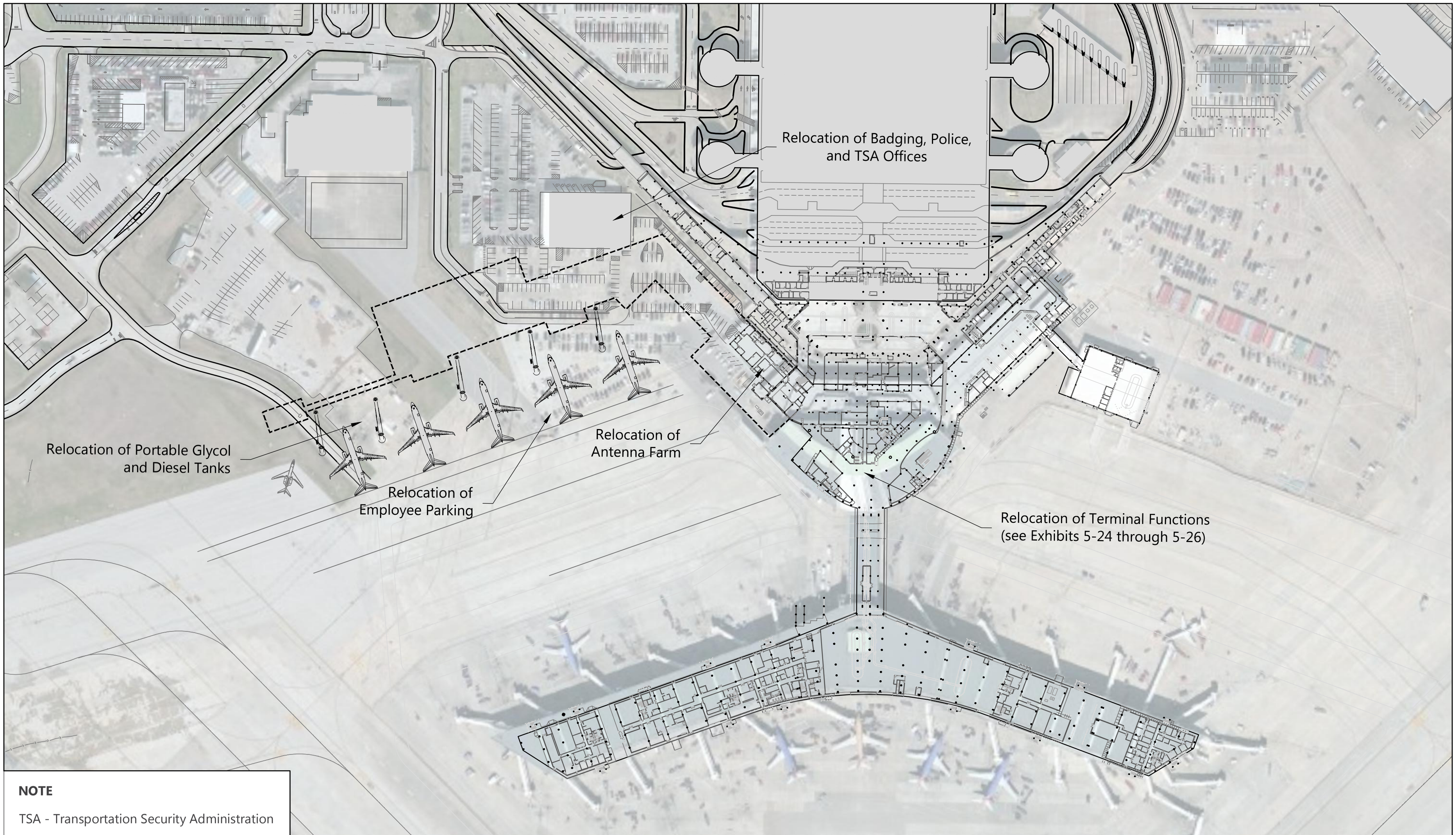

NOTE

TSA - Transportation Security Administration

SOURCE: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012
PREPARED BY: Ricondo & Associates, Inc., December 2012..

EXHIBIT 5-32

Impacts of the Preferred Development Alternative to Existing Facilities

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\3-Terminal Area\CAD\5-32-Impacts to Existing Facilities.dwg_Layout: Ex-05-32_Dec 29, 2014, 3:13pm

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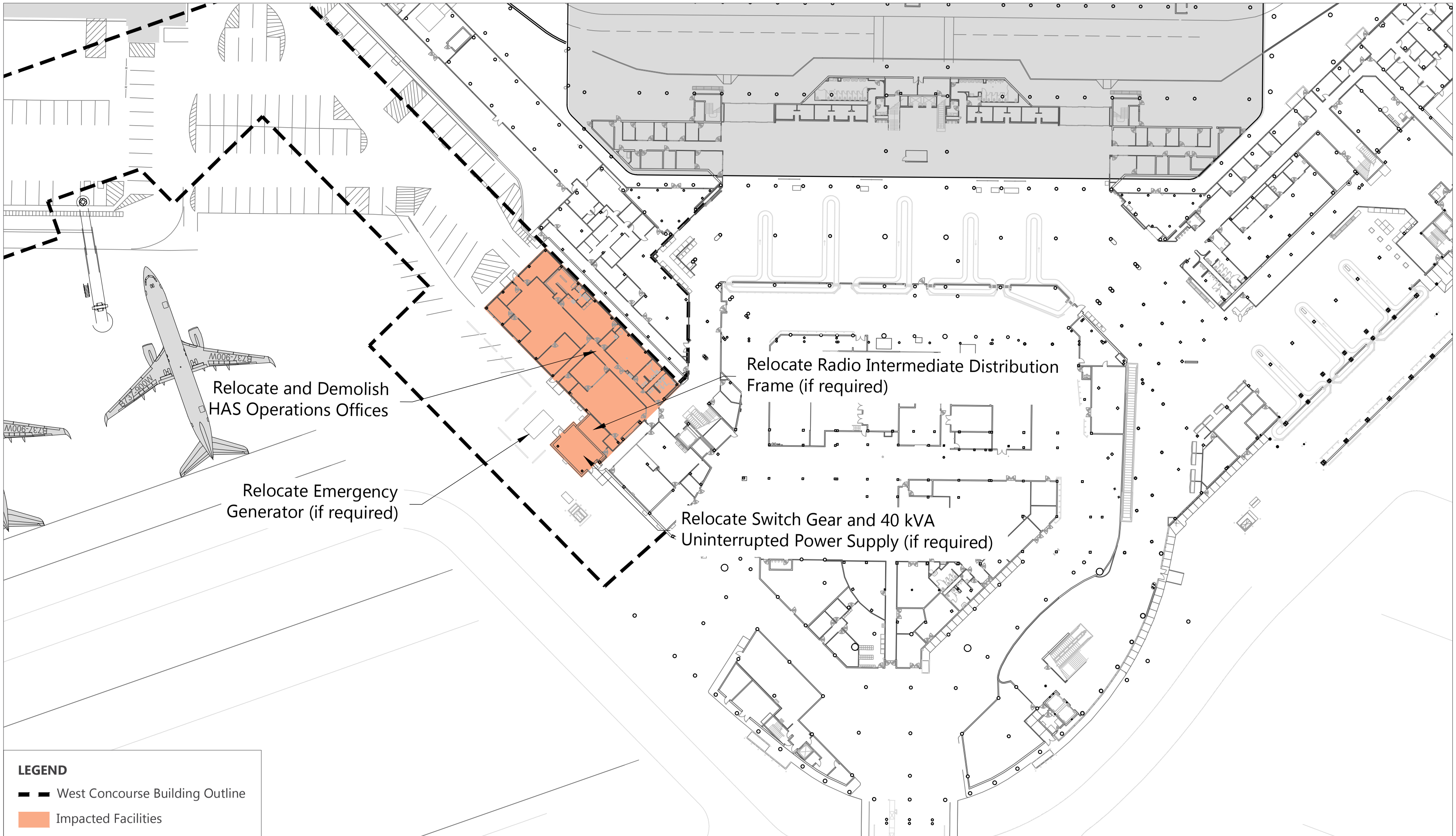

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

EXHIBIT 5-33

Impacts of the Preferred Development Alternative to the Terminal Building Baggage Claim Level / Ground Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\3-Terminal Area\CAD\5-33-Impacts to Existing Facilities-Lev01.dwg_Layout: Ex-05-33_Dec 29, 2014, 3:14pm

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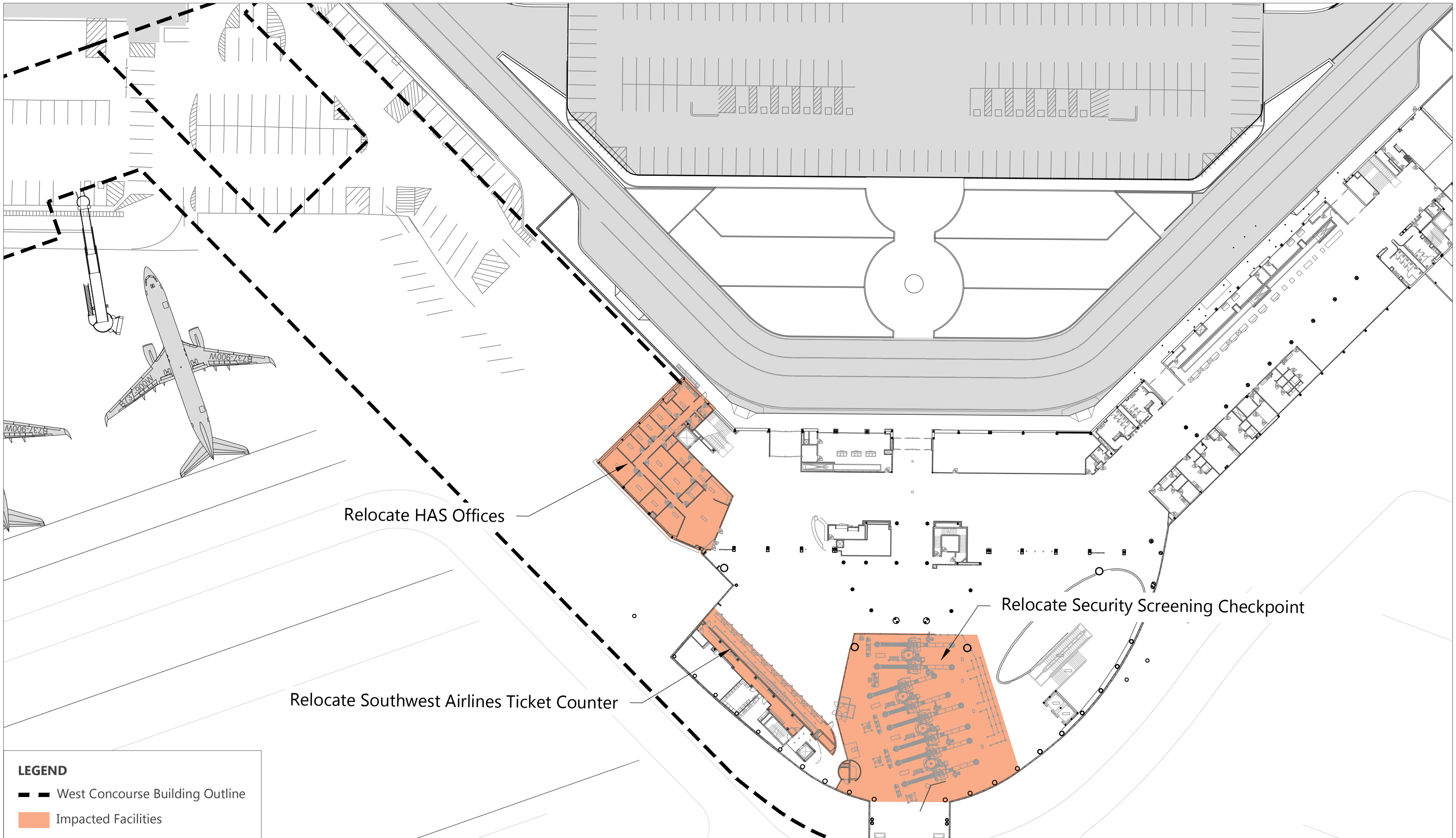

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

EXHIBIT 5-34

Impacts of the Preferred Development Alternative to the Terminal Building
Ticketing Level / First Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\3-Terminal Area\CAD\5-34-Impacts to Existing Facilities-Lev02.dwg_Layout: Ex-05-34_Dec 29, 2014, 3:15pm

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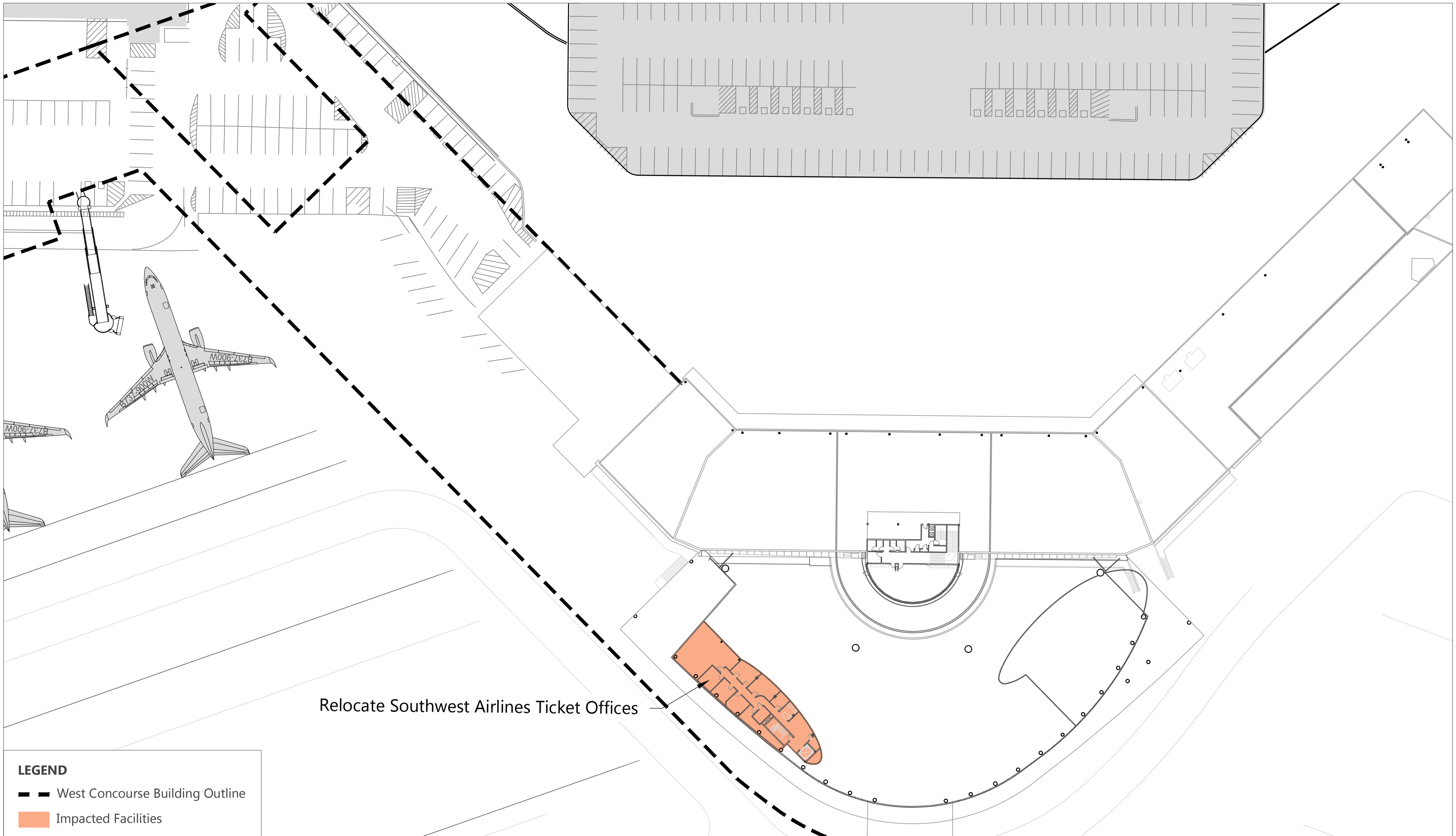

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

EXHIBIT 5-35

Impacts of the Preferred Development Alternative to the Terminal Building
Mezzanine Level / Second Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\3-Terminal Area\CAD\5-35-Impacts to Existing Facilities-Lev03.dwg_Layout: Ex-05-35_Dec 29, 2014, 3:16pm

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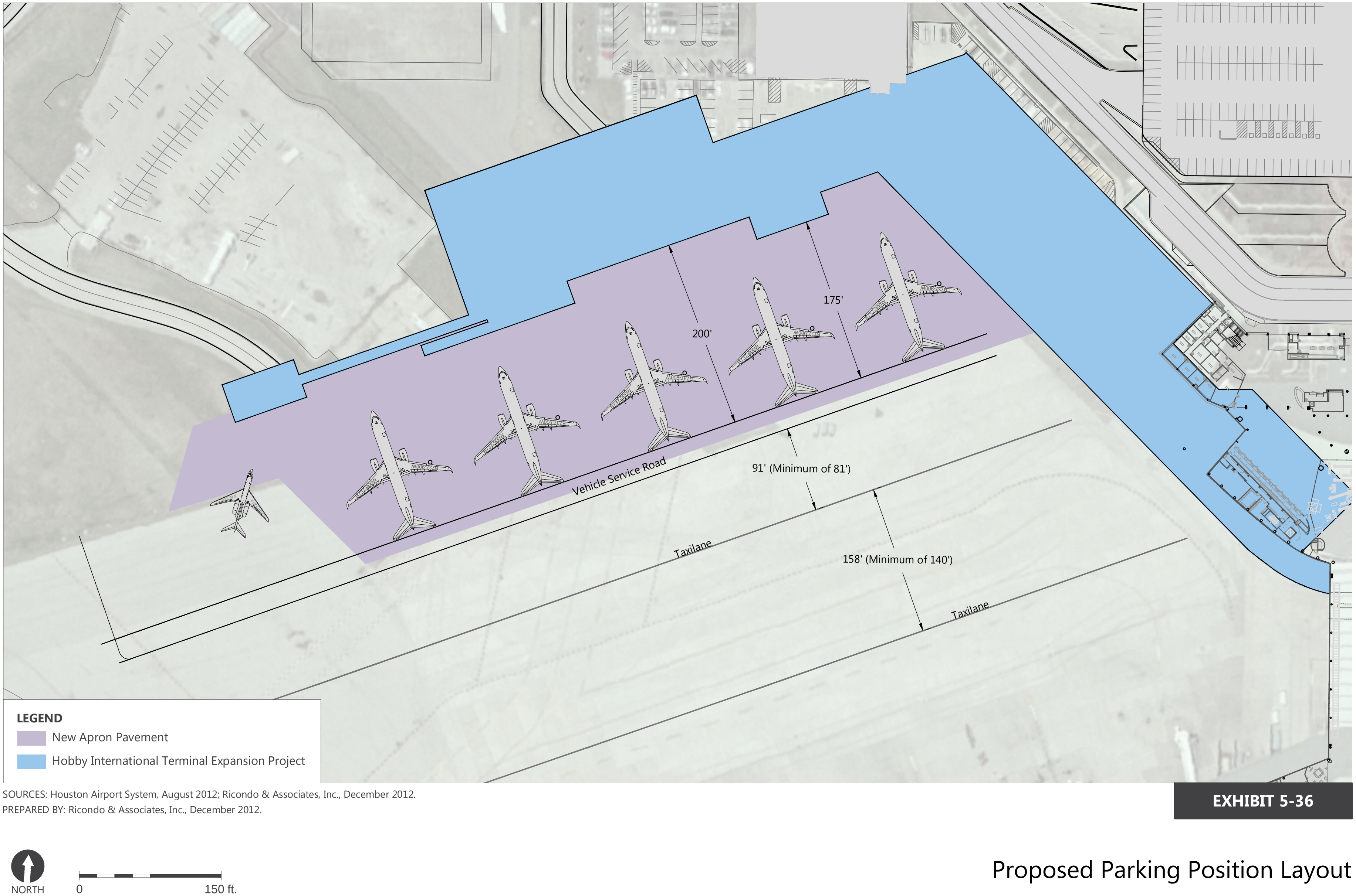

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., December 2012.
PREPARED BY: Ricondo & Associates, Inc., December 2012.

EXHIBIT 5-36

Proposed Parking Position Layout

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\3-Terminal Area\CAD\5-36-Aircraft Parking Positions Layout.dwg_Layout: Ex-05-36_Dec 29, 2014, 3:18pm

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As shown on **Exhibit 5-37**, the long-term terminal development plan for HOU includes concourse development adjacent to the terminal building on the east and west sides of the building. **Exhibit 5-38** shows the refinements of the west expansion concept. Each concourse concept shown would accommodate 9 to 12 new narrowbody aircraft parking positions upon full development. In the western expansion alternative, no significant development would be anticipated for the Central Concourse. Additionally, to accommodate future demand, expansion of the terminal facilities as shown on Exhibits 5-28 and 5-29 would provide more ticketing, baggage claim, and baggage makeup functional space. The major distinguishing feature among the concept alternatives is the location of the FIS facilities.

5.5.2.2 Development Triggers

During the master planning process, the need for FIS facilities was determined to accommodate international arriving flights by Southwest Airlines/AirTran Airways. The FIS facilities were planned to be adjacent to the terminal facility to enable direct access to the curb, as well as to the security screening checkpoint in the terminal for passengers connecting from an international arriving flight to a domestic departing flight. The location of the FIS facilities was a major determining factor in the initial development concepts for expansion of the terminal and concourse facilities; however, other triggers influenced the alternative development concepts through the planning period.

The triggers described in this section are directly related to the phases identified in the exhibits. The main reason to refer to triggers is the need to maintain flexibility for the Airport and HAS to adjust the overall plan as necessary. As conditions change and evolve at HOU, evaluation would be needed to determine which trigger is more closely achieved to aid in the decisions process for terminal development.

The first trigger was the need for remain-over-night (RON) positions under existing conditions. Phase 1 consists of using several RON positions of the east side of the Central Concourse. By increasing gate utilization, the need to expand gate facilities can be delayed for a number of years, postponing significant capital investment. However, to accommodate the aircraft arrival and departure profiles for HOU and accommodate each arrival and each departure at a concourse gate, RON positions would be needed. RON positions would be used to accommodate aircraft that arrive at HOU typically during the afternoon or late evening and do not depart until the next morning. Passengers would deplane at a gate, but the aircraft does not need to occupy the gate until departing the next day or even until later the same day. Therefore, the aircraft would be towed to a parking position, sometimes referred to as a “hardstand” position, where it would remain until being towed back to a gate later the same day or the next day for departure.

Hardstand positions are typically concrete pads that are appropriately designed to accommodate aircraft loads. Some airports provide amenities at the hardstand positions, such as aircraft ground power units (i.e., 400 Hertz power converters), potable water, and, in some cases, accommodations for preconditioned air to heat and cool the aircraft interior. RON aircraft parking would address a number of situations for the Airport and the airlines, but would primarily provide for the needed aircraft equipment at HOU for the morning departures peak and provide the airlines a means for positioning aircraft for the next day operation of that specific aircraft. As shown on **Exhibit 5-39**, RON positions could be accommodated on the east side of the terminal complex.

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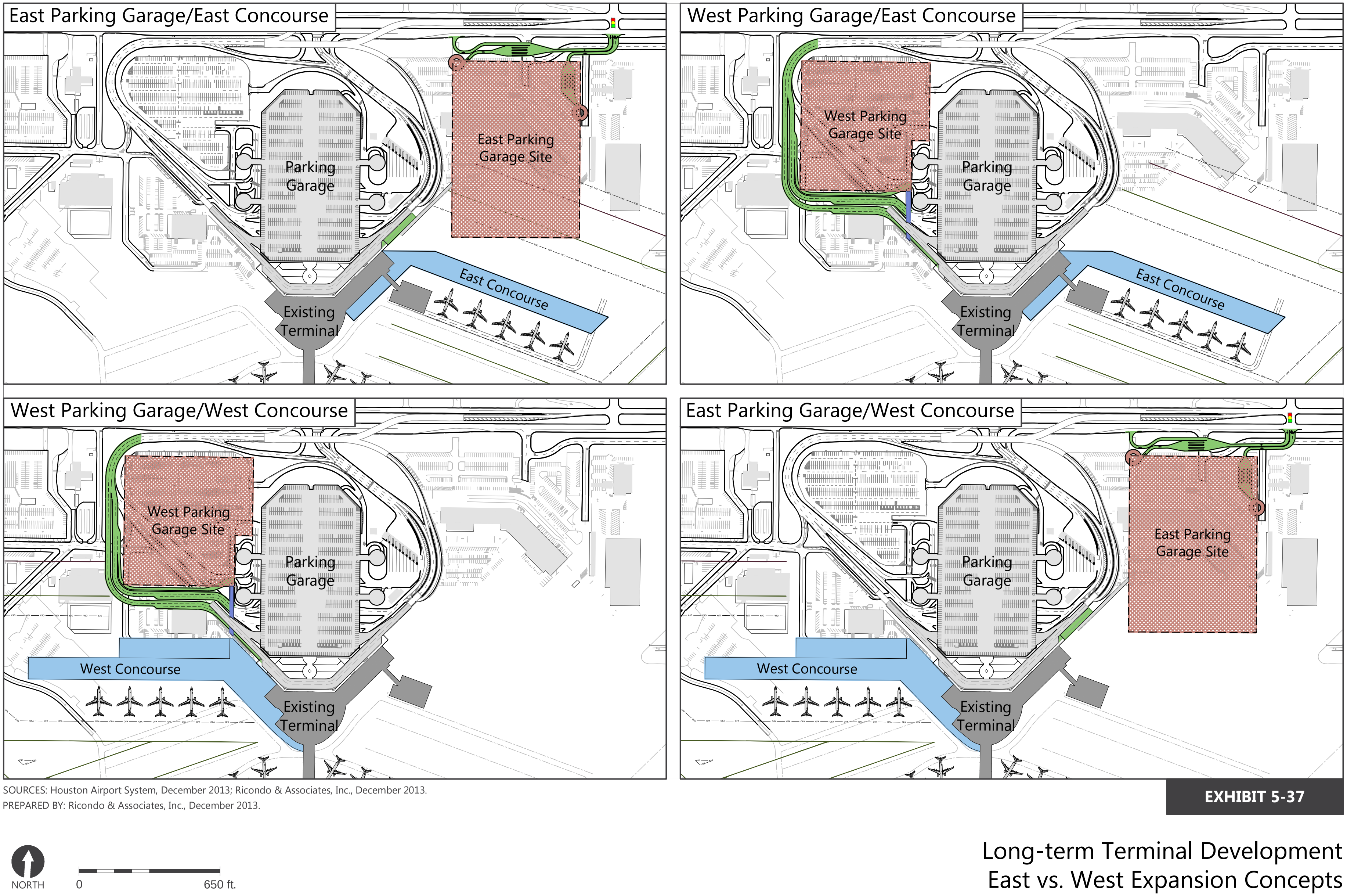

SOURCES: Houston Airport System, December 2013; Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-37

Long-term Terminal Development
East vs. West Expansion Concepts

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Ex-6-01-Family of Concepts1\5-37,5-38_Long Term Terminal Development.dwg_Layout: Ex-5-37_Dec 29, 2014, 3:24pm

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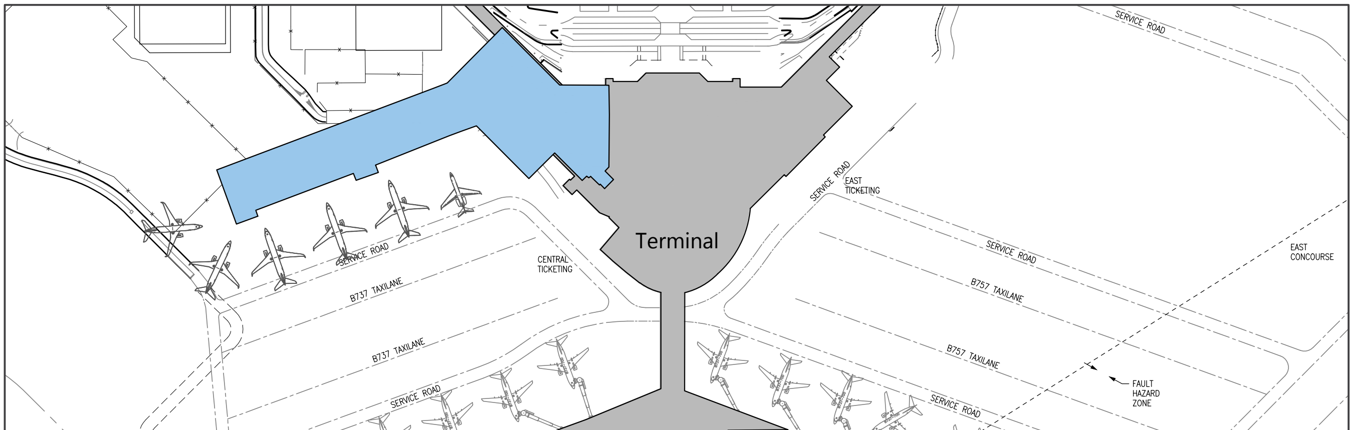
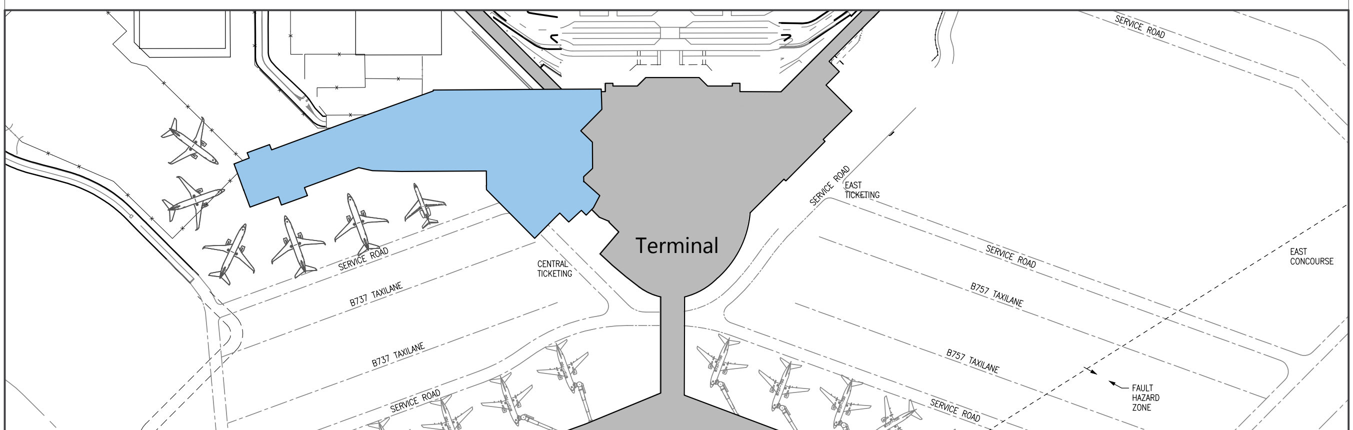
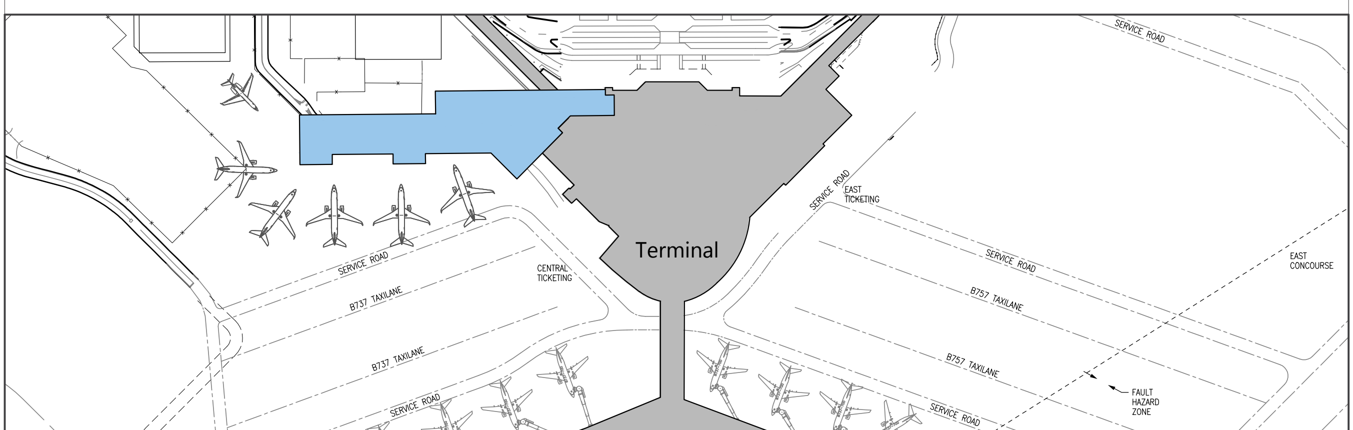


CONCEPT A



CONCEPT B



CONCEPT C

SOURCES: Houston Airport System, December 2013; Ricondo & Associates, Inc., December 2013
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-38

Long-term Terminal Development
West Concourse Expansion Concepts

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Ex-6-01-Family of Concepts1\5-37,5-38_Long Term Terminal Development.dwg_Layout: Ex-5-38_Dec 29, 2014, 3:26pm

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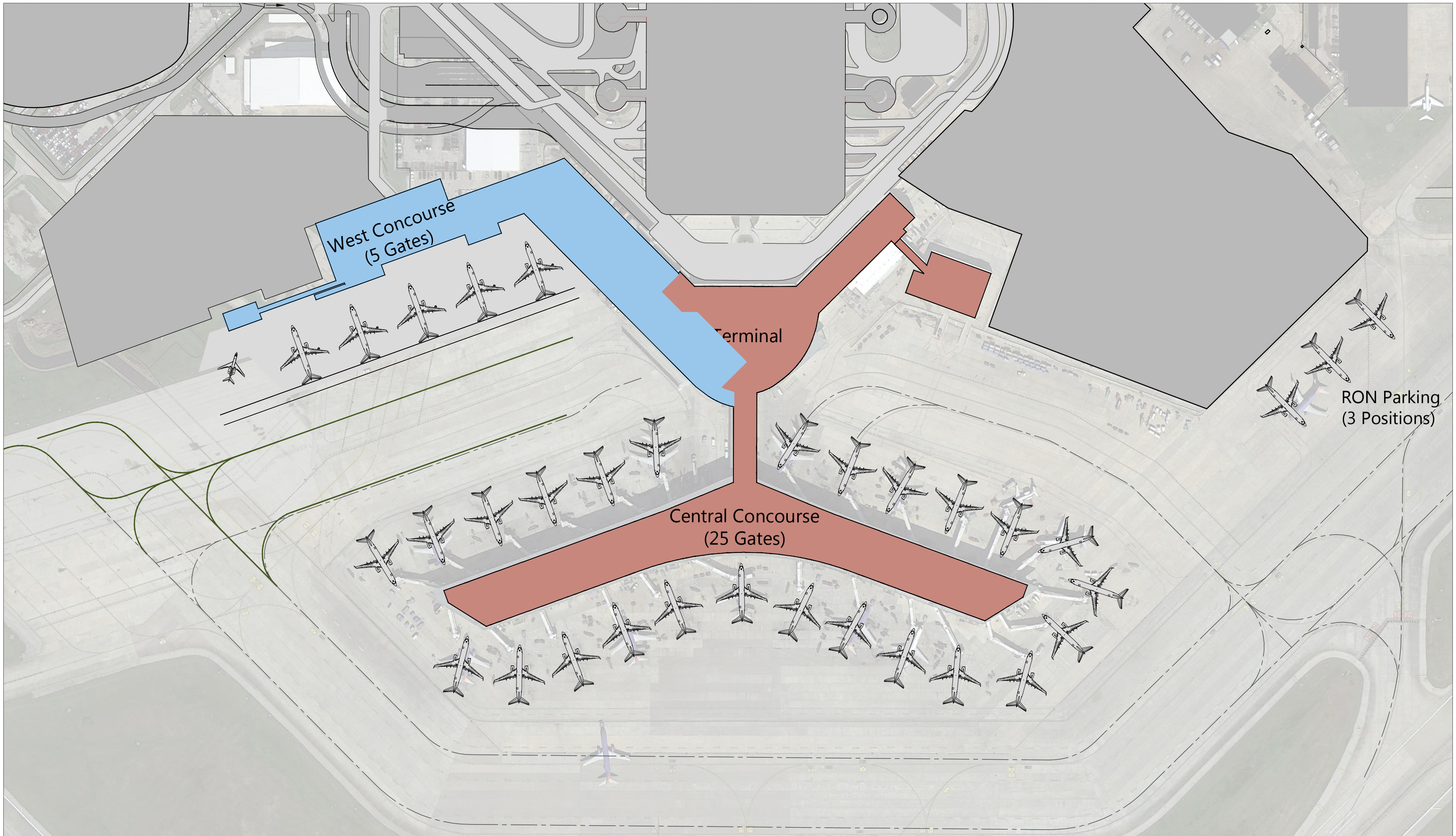

SOURCES: Houston Airport System, December 2013; Google Earth Pro 2014; Terra Metrics, October 31, 2013 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-39

NORTH 0 350 ft.

Remain Overnight Aircraft Parking Positions East of the Terminal
Phase 1 Overview

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Future Gate Capacity (2020) 250\Exh 5-39, 40, 41, 42_Future Gate Capacity (2020) 250.dwg_Layout: 5-39_Dec 29, 2014, 3:28pm

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As aircraft activity at HOU increases (and subsequently as each gate is used more frequently throughout the day) additional concourse gates will be needed, even with the use of RON positions. Gate use is characterized as "turns-per-gate" or aircraft turns. Increased activity at HOU will increase the turns per gate to levels that indicate a need for additional concourse gates to accommodate the activity; the second trigger is when turns per gate number 10 or greater, indicating a need for additional gates during peak periods. Based on forecast activity, it is anticipated that approximately five to seven additional concourse gates will be required. Phase 2 consists in a seven-gate expansion of the West Concourse. In planning for the West Concourse, future expansion to provide additional gates was assumed, as shown on **Exhibit 5-40**. The expansion would occur to the west and create a double-loaded concourse to provide the needed gates.

The third trigger addresses the need for additional facilities to accommodate non-Southwest Airlines activity beyond existing surplus capacity. The airlines that need to be considered in this analysis include other (non-Southwest Airlines) domestic airlines and new international airline entrants into the HOU market. Phase 3 would accommodate this non-Southwest Airlines growth, and activity initially will require expanded terminal functions, such as ticketing, outbound baggage makeup, inbound baggage claim and makeup, and checked baggage inspection systems (CBIS). As Southwest Airlines fully occupies the west side of the terminal, the planned expansion to accommodate this need could occur on the east side of the terminal, as shown on **Exhibit 5-41**.

The fourth and final development trigger for the planning period addresses the fact that HOU is essentially gate-constrained beyond the West Concourse expansion. As activity increases for all airlines, additional concourse gates will be required. Phase 4 would consist in constructing a new East Concourse to address the gate demand with up to nine concourse gates. As shown on **Exhibit 5-42**, the concourse would extend to the east and would initially be a single-loaded facility with aircraft gates on the south side. Implementation of Phase 4 is not planned within the planning horizon.

5.5.2.3 Interior Development Alternatives

As stated previously, the development triggers for HOU provide direction for determining the facilities that would be needed to accommodate demand. The various triggers suggest facility changes or operational changes or both. Facility requirements by development trigger or phase are discussed in Section 4.

The first trigger (Phase 1 - Additional RON Positions) would not require any new terminal or concourse facilities, but does indicate a potential need to add concrete to support aircraft loads, as shown on Exhibit 5-30. Additionally, with the first trigger, the need to better use existing gates is indicated with operational changes that would increase the number of aircraft turns per gate. No interior development would be required in Phase 1.

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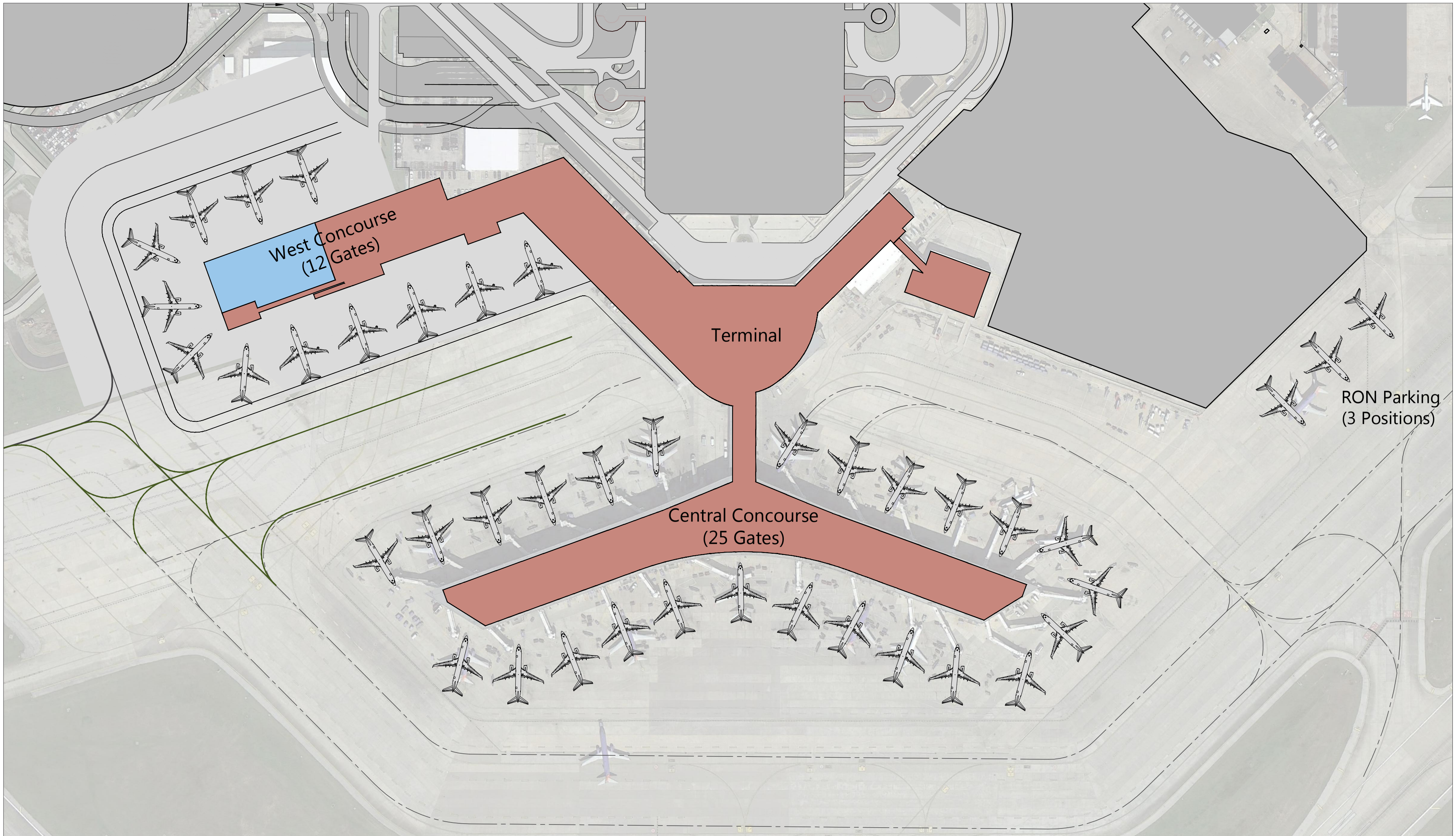

SOURCES: Houston Airport System, December 2013; Google Earth Pro 2014; Terra Metrics, October 31, 2013 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-40

NORTH 0 350 ft.

Phase 2 Overview
West Concourse Expansion

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Future Gate Capacity (2020) 250\Exh 5-39, 40, 41, 42_Future Gate Capacity (2020) 250.dwg_Layout: 5-40_Dec 29, 2014, 3:28pm

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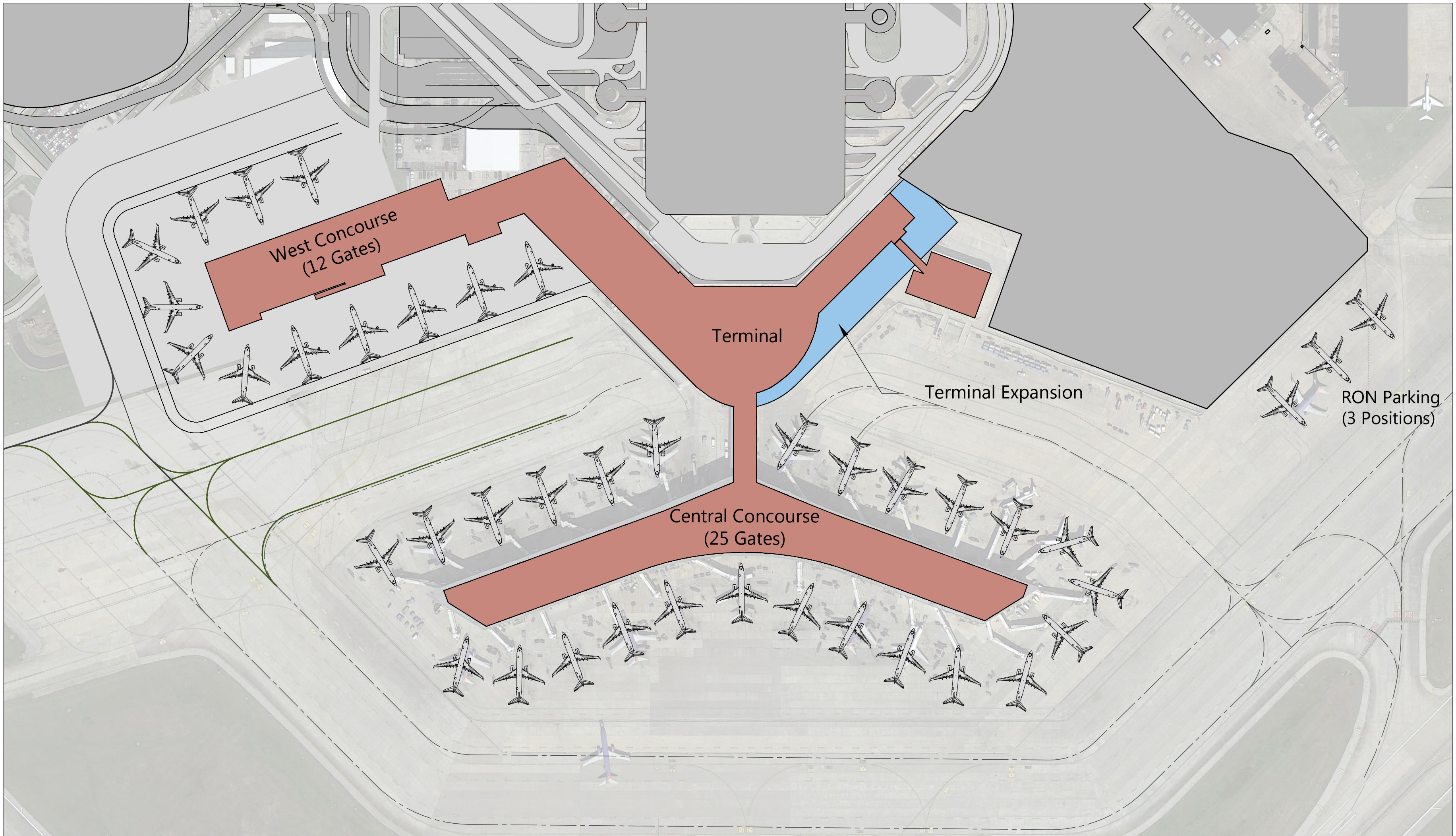

SOURCES: Houston Airport System, December 2013; Google Earth Pro 2014; Terra Metrics, October 31, 2013 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-41

NORTH 0 350 ft.

Phase 3 Overview
Terminal Expansion (East Side)

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Future Gate Capacity (2020) 250\Exh 5-39, 40, 41, 42_Future Gate Capacity (2020) 250.dwg_Layout: 5-41_Dec 29, 2014, 3:29pm

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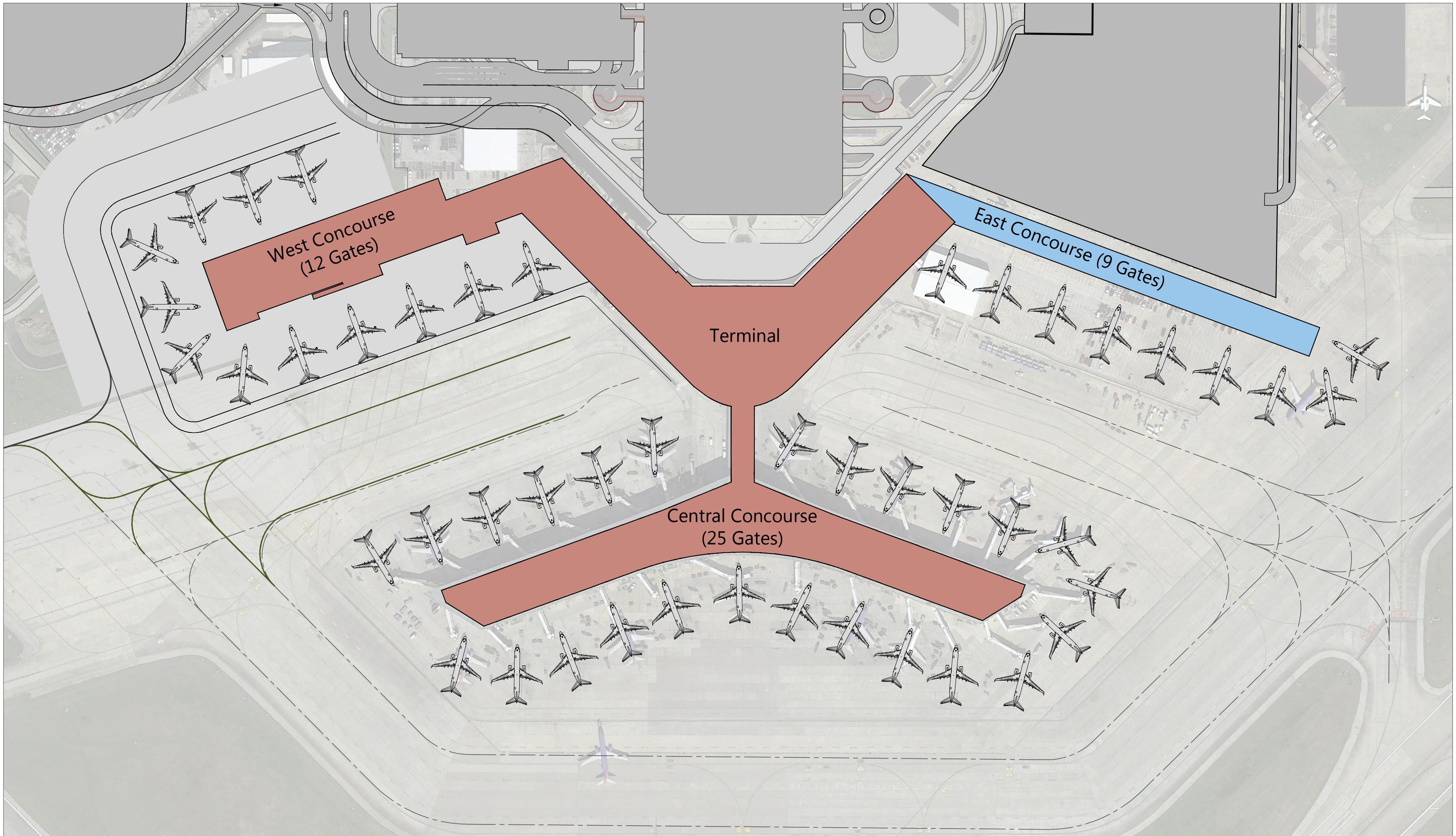

SOURCES: Houston Airport System, December 2013; Google Earth Pro 2014; Terra Metrics, October 31, 2013 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-42

Phase 4 Overview
East Concourse Construction

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Future Gate Capacity (2020) 250\Exh 5-39, 40, 41, 42_Future Gate Capacity (2020) 250.dwg_Layout: 5-42_Dec 29, 2014, 3:29pm

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Expansion of the West Concourse would essentially address the second trigger (or Phase 2) for development. As shown on **Exhibit 5-43**, West Concourse expansion would consist of the addition of seven gates to create a 12-gate West Concourse. Exhibit 5-34 also depicts the conceptual interior layout on the Apron Level, where space would be provided for airline and Airport operations, as well as the building's mechanical systems. **Exhibit 5-44** depicts the conceptual interior layout of the West Concourse Upper Level, where the existing facilities secure circulation corridor and other passenger amenities would be extended. All 12 gates would be connected to the international arrivals facility which is part of the international terminal.

Development to address the third trigger or Phase 3 is shown on **Exhibit 5-45** and **Exhibit 5-46**. The Baggage Claim Level (ground floor) and Ticketing Level (first floor) of the expanded terminal facility needed to address anticipated growth of non-Southwest Airlines activity and new entrant international airlines are shown on the exhibits. As shown on Exhibit 5-36, the major areas of the Baggage Claim Level (ground floor) include a new outbound baggage makeup area; a new CBIS would be installed to screen baggage for airlines operating on the east side of the terminal. At the Ticketing Level (first floor), shown on Exhibit 5-37, ticket counter functional space would be provided for non-Southwest Airlines domestic airlines and new entrant foreign-flag airlines.

The fourth trigger or Phase 4 of terminal and concourse development is shown on **Exhibit 5-47** and **Exhibit 5-48**. This phase of development would add gates by developing a new two-level concourse east of the terminal. The Apron Level (ground floor), as shown on Exhibit 5-38, would primarily accommodate airline and Airport operational space. Additionally, mechanical rooms needed to support the building systems would be accommodated on the Apron Level (ground floor). The concourse expansion, presented on Exhibit 5-39, shows nine added concourse gates and associated holdroom areas. The new East Concourse would be single-loaded with the gates positioned on the south side of the building. Concession space and other passenger amenities would be provided to create a fully functional East Concourse. The East Concourse is not anticipated to be required within the planning horizon.

5.6 On-Airport Landside Improvements

The ground transportation system (including roadways, parking, and associated elements) were not discussed in detail in the PDM. Final design of the concourse and expanded terminal will preserve the ability to construct the new parking garage and realign the terminal roadway system.

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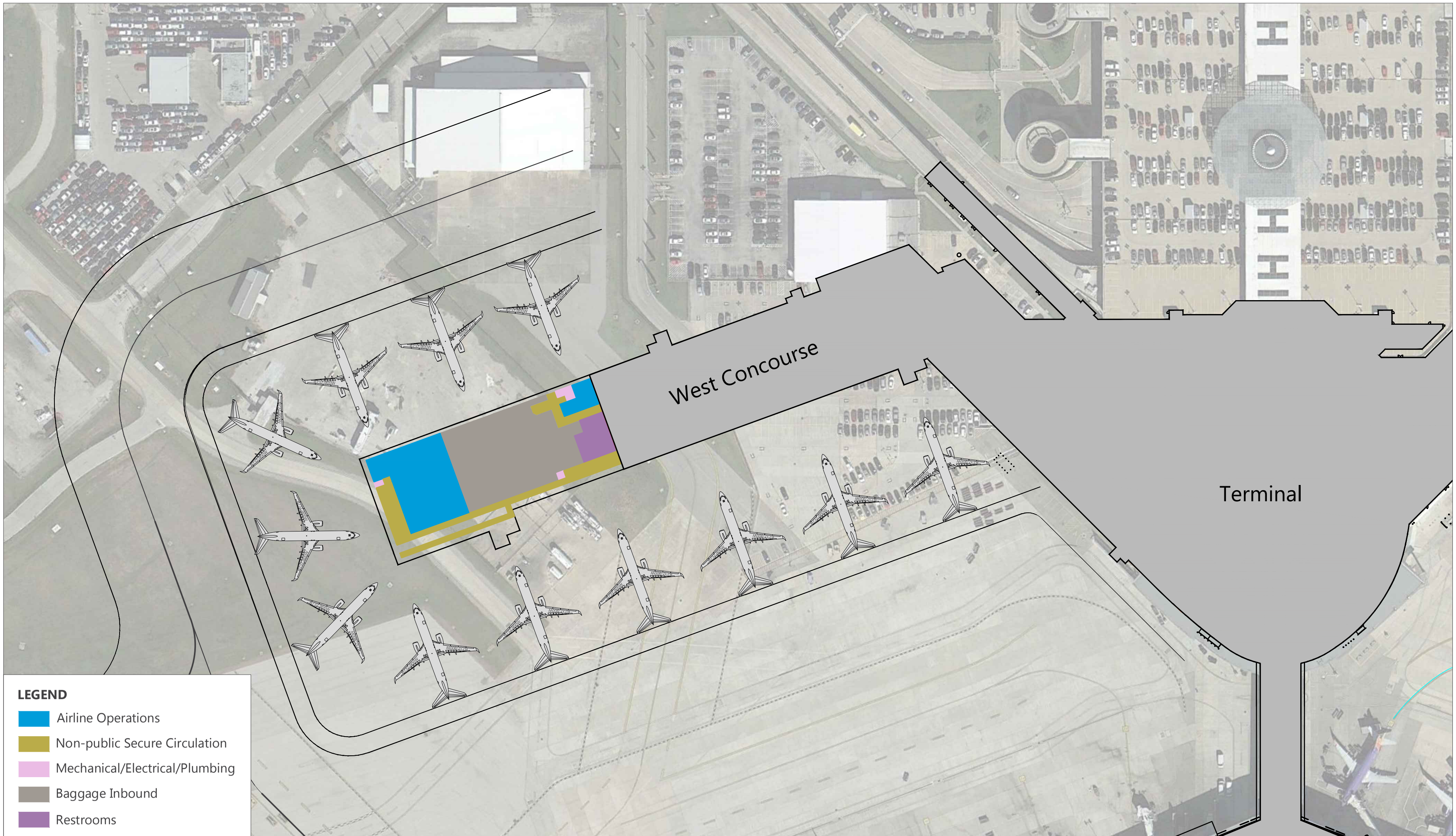

SOURCES: Houston Airport System, December 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-43

NORTH 0 200 ft.

Phase 2 Interior Layout
West Concourse Expansion - Apron Level/Ground Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Main&West Terminal- Standard\Exh 5-43 & 44_Main&West Terminal Ph2_20140114.dwg_Layout: 5-43_Dec 29, 2014, 3:32pm

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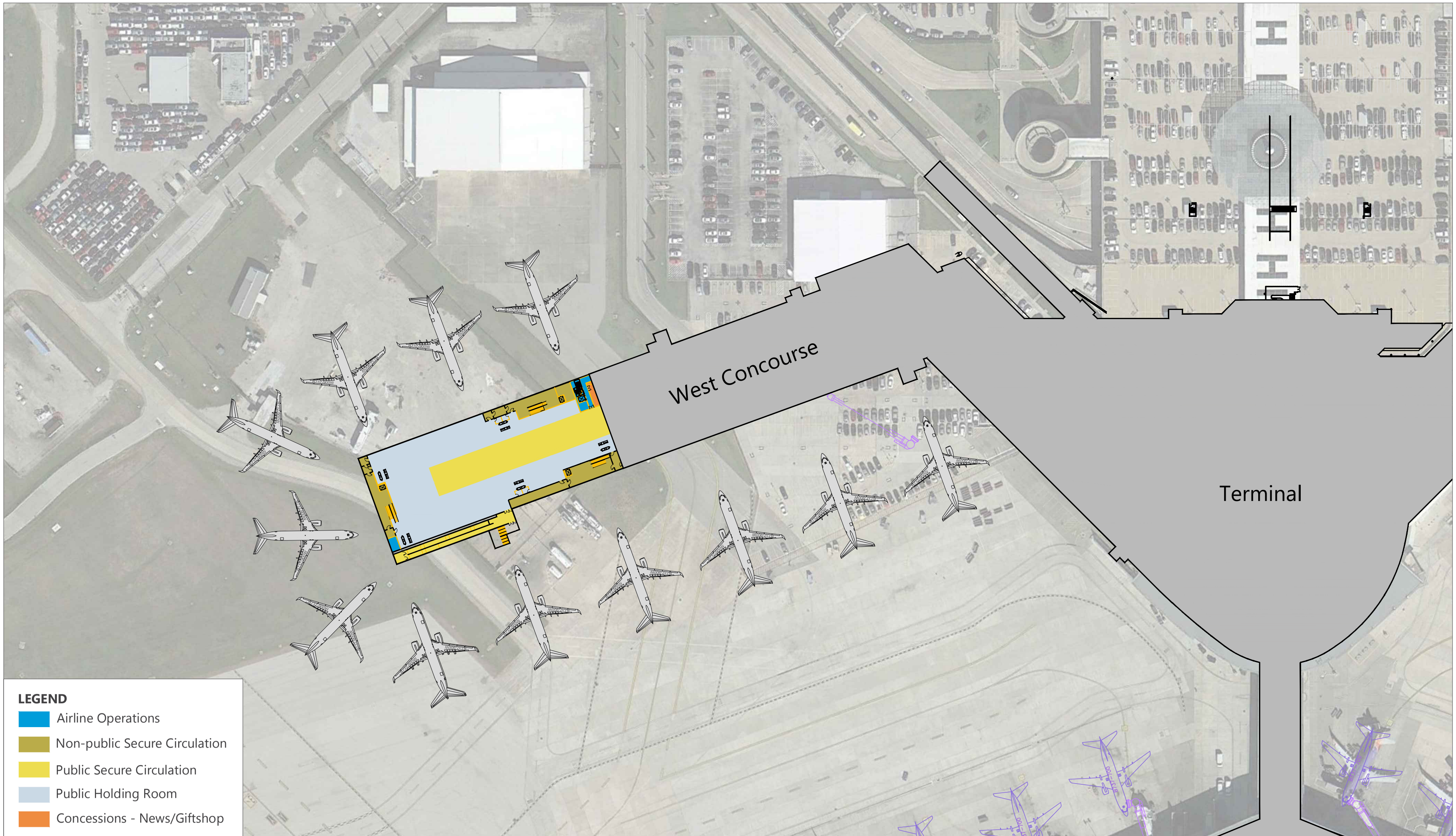

SOURCES: Houston Airport System, December 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-44

NORTH 0 200 ft.

Phase 2 Interior Layout
West Concourse Expansion - Upper Level/First Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Main&West Terminal- Standard\Exh 5-43 & 44_Main&West Terminal Ph2_20140114.dwg_Layout: 5-44_Dec 29, 2014, 3:32pm

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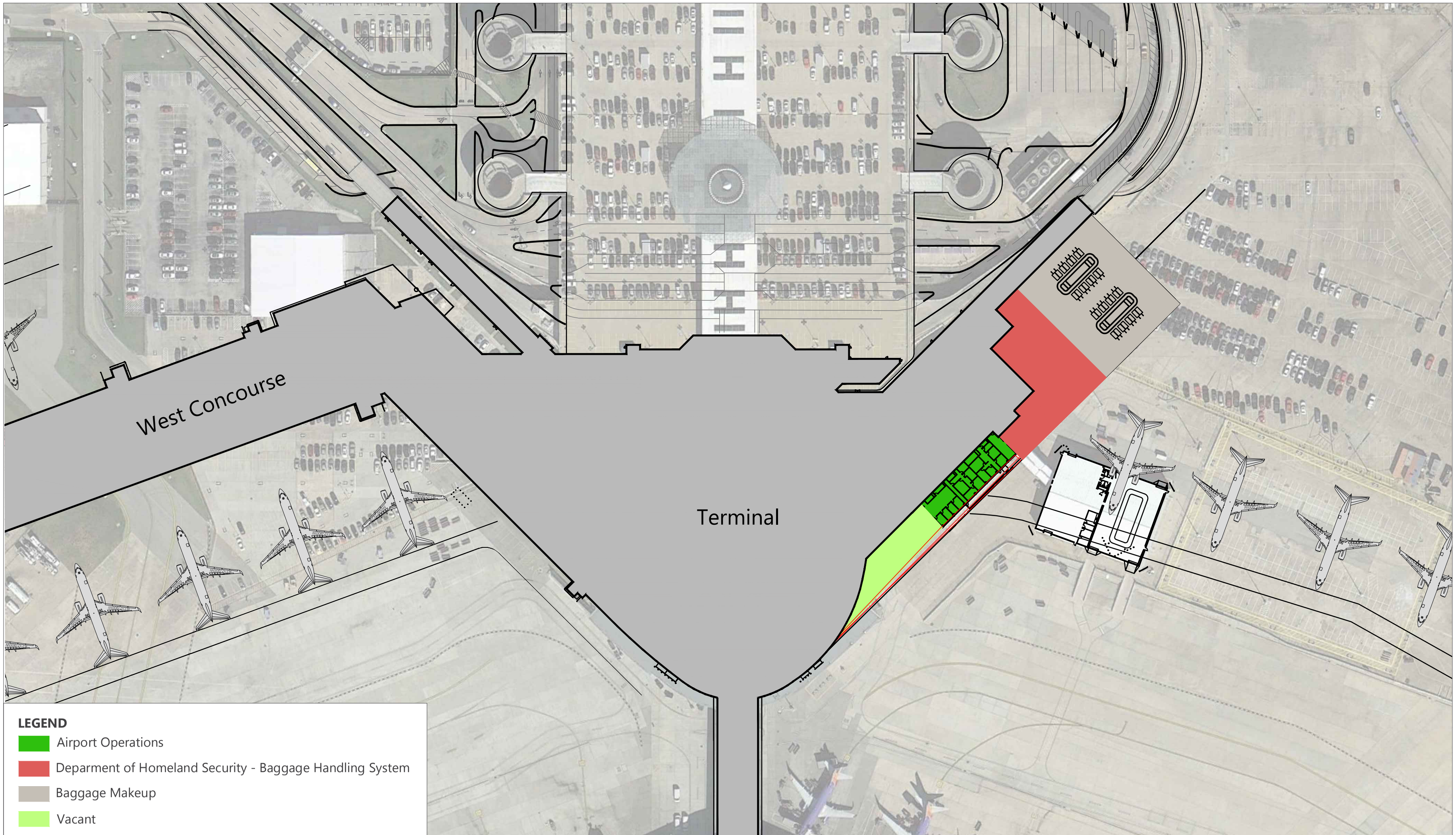

SOURCES: Houston Airport System, December 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-45

NORTH 0 200 ft.

Phase 3 Interior Layout
Terminal Expansion - Baggage Claim Level/Ground Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Main&West Terminal- Standard\Exh 5-45 & 46_Main&West Terminal Ph3_20140114.dwg_Layout: 5-45_Dec 29, 2014, 3:33pm

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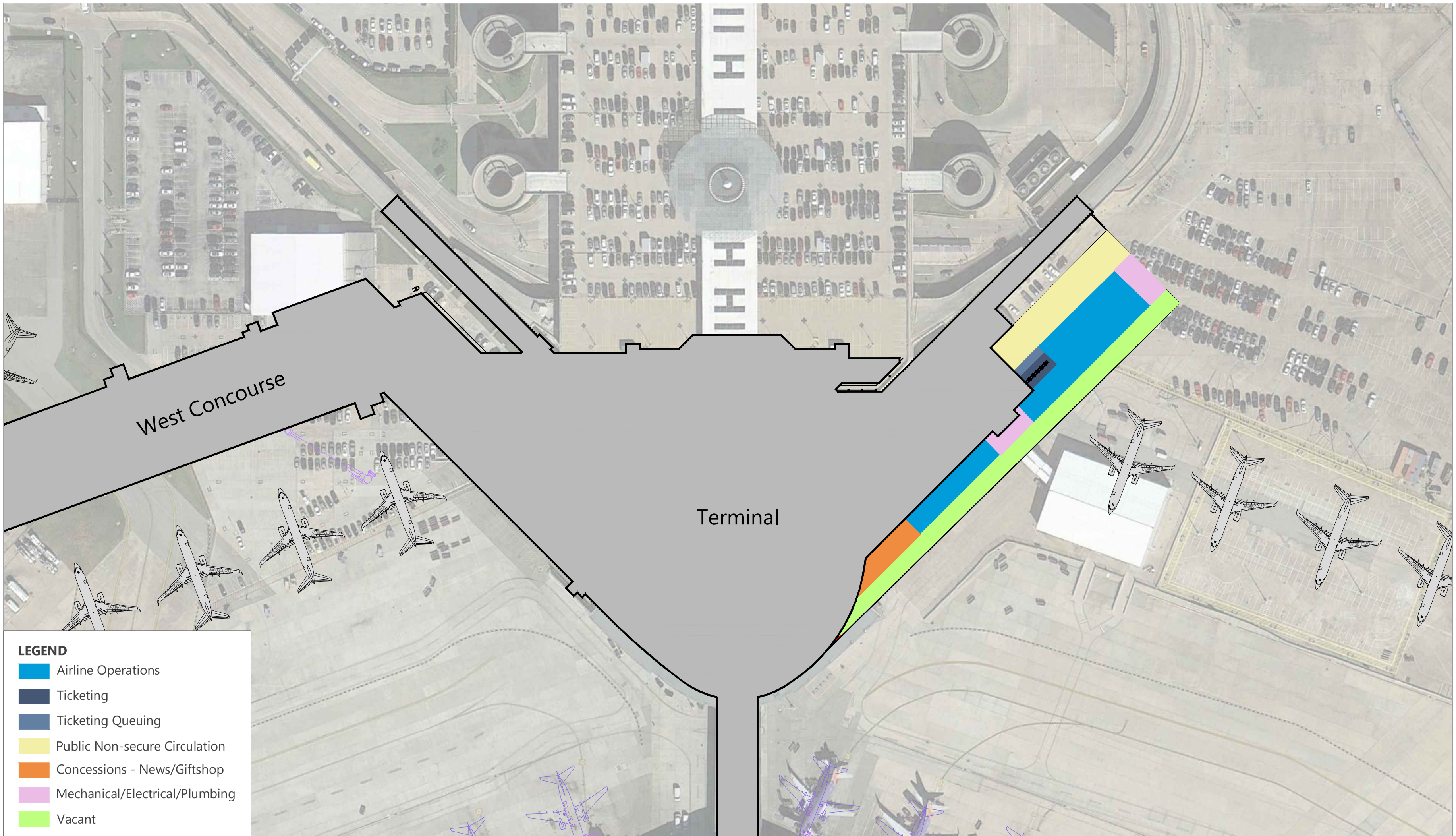

SOURCES: Houston Airport System, December 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-46

NORTH 0 200 ft.

Phase 3 Interior Layout
Terminal Expansion - Ticketing Level/First Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Main&West Terminal- Standard\Exh 5-45 & 46_Main&West Terminal Ph3_20140114.dwg_Layout: 5-46_Dec 29, 2014, 3:33pm

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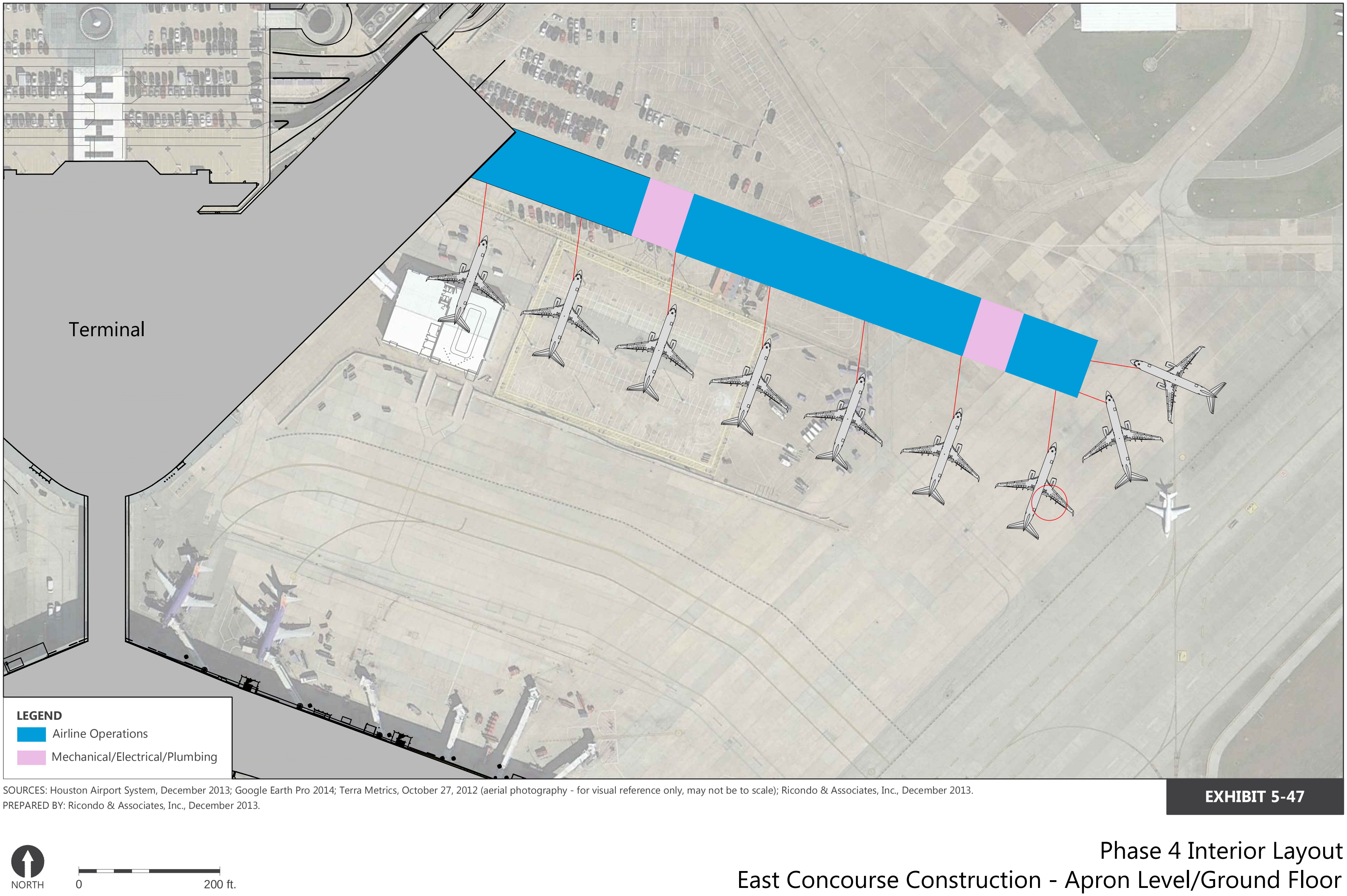

SOURCES: Houston Airport System, December 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-47

Phase 4 Interior Layout
East Concourse Construction - Apron Level/Ground Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Main&West Terminal- Standard\Exh 5-47 & 48_Main&West Terminal Ph4_20140114.dwg_Layout: 5-47_Dec 29, 2014, 3:34pm

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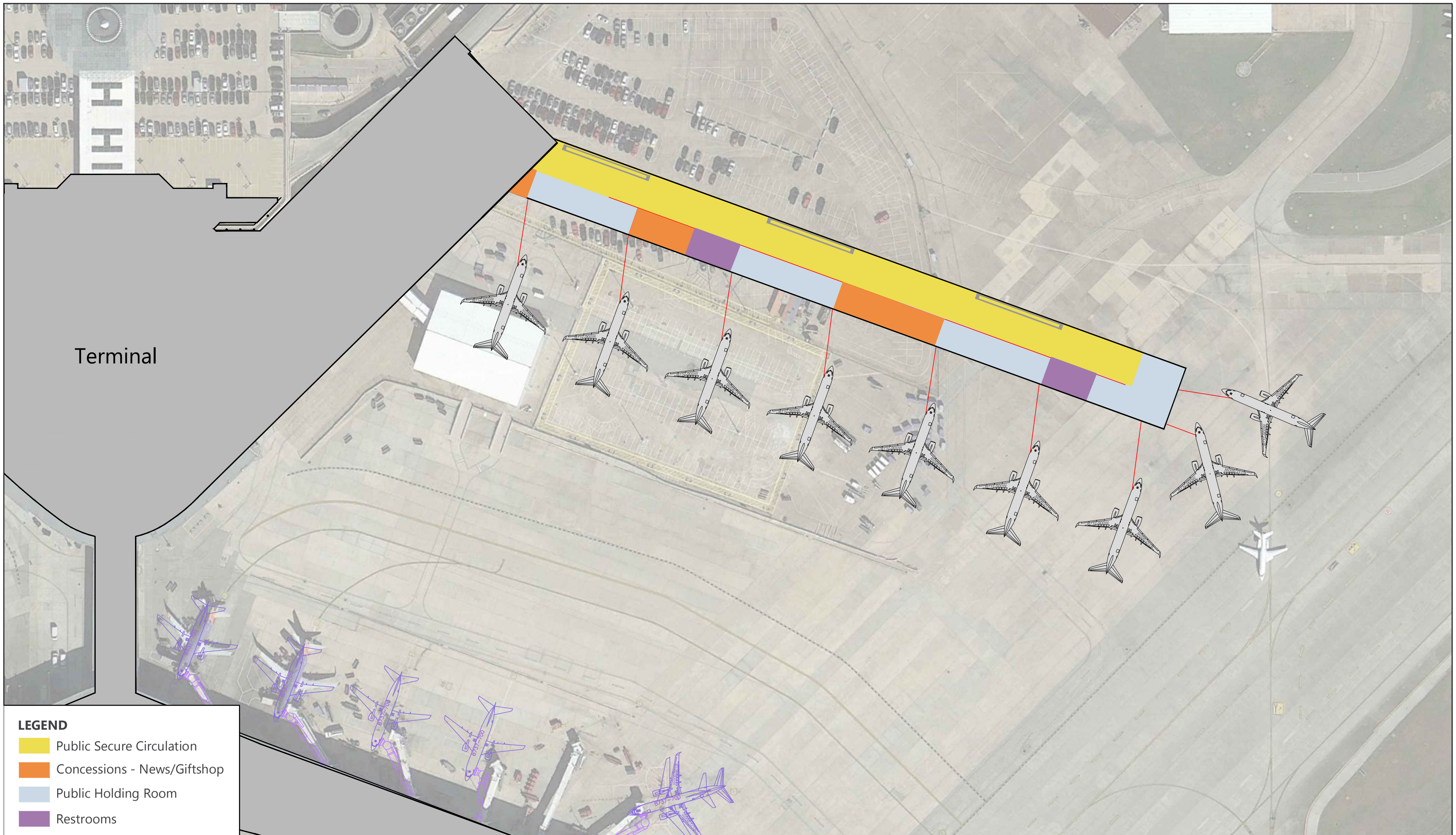

SOURCES: Houston Airport System, December 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-48

NORTH 0 200 ft.

Phase 4 Interior Layout
East Concourse Construction - Upper Level/First Floor

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\4-Terminal\CAD\Main&West Terminal- Standard\Exh 5-47 & 48_Main&West Terminal Ph4_20140114.dwg_Layout: 5-48_Dec 29, 2014, 3:35pm

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5.6.1 ROADWAYS

Based on the proposed layout for the West Concourse, the majority of the Hobby Airport Loop could remain, with modifications to the west side of the loop to allow additional space for the new parking garage and to provide access to on-Airport rental car facilities and commercial ground transportation vehicles. **Exhibit 5-49** depicts the original layout for the terminal area roadways, where the Hobby Airport Loop west of the main terminal entrance would be extended to the south to provide access for the new West Parking Garage and an expanded Departures Curbside. In addition, a single lane from the Hobby Airport Loop would be created to provide access to the areas west of the terminal, where on-Airport rental car companies and commercial vehicle staging areas are currently located. The redesigned roadway system would also include a single lane from the west to the Hobby Airport Loop to provide access to the terminal area from the rental car and commercial vehicle storage areas. Because of the fast-track nature of the West Concourse project, the conceptual plan for the redesigned Hobby Airport Loop was forwarded to Reynolds, Smith and Hills, Inc., for design prior to completion of this Master Plan Update.

The refined terminal area roadways layout is illustrated on **Exhibit 5-50**. It reflects the changes to the roadway system that resulted from the design phase of the West Concourse, such as the addition of lanes on the western portion of the roadway network, revised access to on-Airport rental car company locations and the proposed west parking garage, and an updated access point to the Arrivals Curbside. This revised roadway layout was evaluated to ensure that it would meet level-of-service goals discussed in Section 4 of this document. These roadways are anticipated to meet LOS requirements throughout the planning period.

5.6.2 PASSENGER AND EMPLOYEE PARKING

Based on the analysis described in Section 4.5 (Public Parking Facility Requirements), it is anticipated that HOU will have a parking deficit of approximately 4,000 spaces by the end of the planning period. To complement construction of the West Concourse and to accommodate anticipated parking demand, a new parking garage west of the existing parking garage was selected as the preferred alternative. A portion of the site for the new West Parking Garage is currently occupied by the 566-surface parking spaces in Ecopark - Lot 1. Based on the facility layout depicted on Exhibit 5-41, it was anticipated that each level of the garage would accommodate approximately 1,000 spaces. The 566 parking spaces in Ecopark – Lot 1 would need to be relocated to Ecopark – Lot 2 located east of the Hobby Airport Loop. Similar to the roadway network plans, the conceptual plans for the new parking garage were forwarded to the design team prior to completion of this Master Plan Update. As a result of changes during the design phase, the anticipated garage capacity was reduced to approximately 3,000 spaces. Because of this capacity reduction, the additional spaces will need to be accommodated within the expanded Ecopark – Lot 2 footprint. Expansion of the Ecopark – Lot 2 in November 2013 increased the number of parking spaces to approximately 1,054. Upon the relocation of the Southwest Airlines Cargo and Provisioning Facility, the Ecopark – Lot 2 will provide approximately 2,000 surface parking spaces. No improvements are planned through the planning horizon for the employee parking lot, located south of the expanded Ecopark – Lot 2, and which counts 800 parking spaces.

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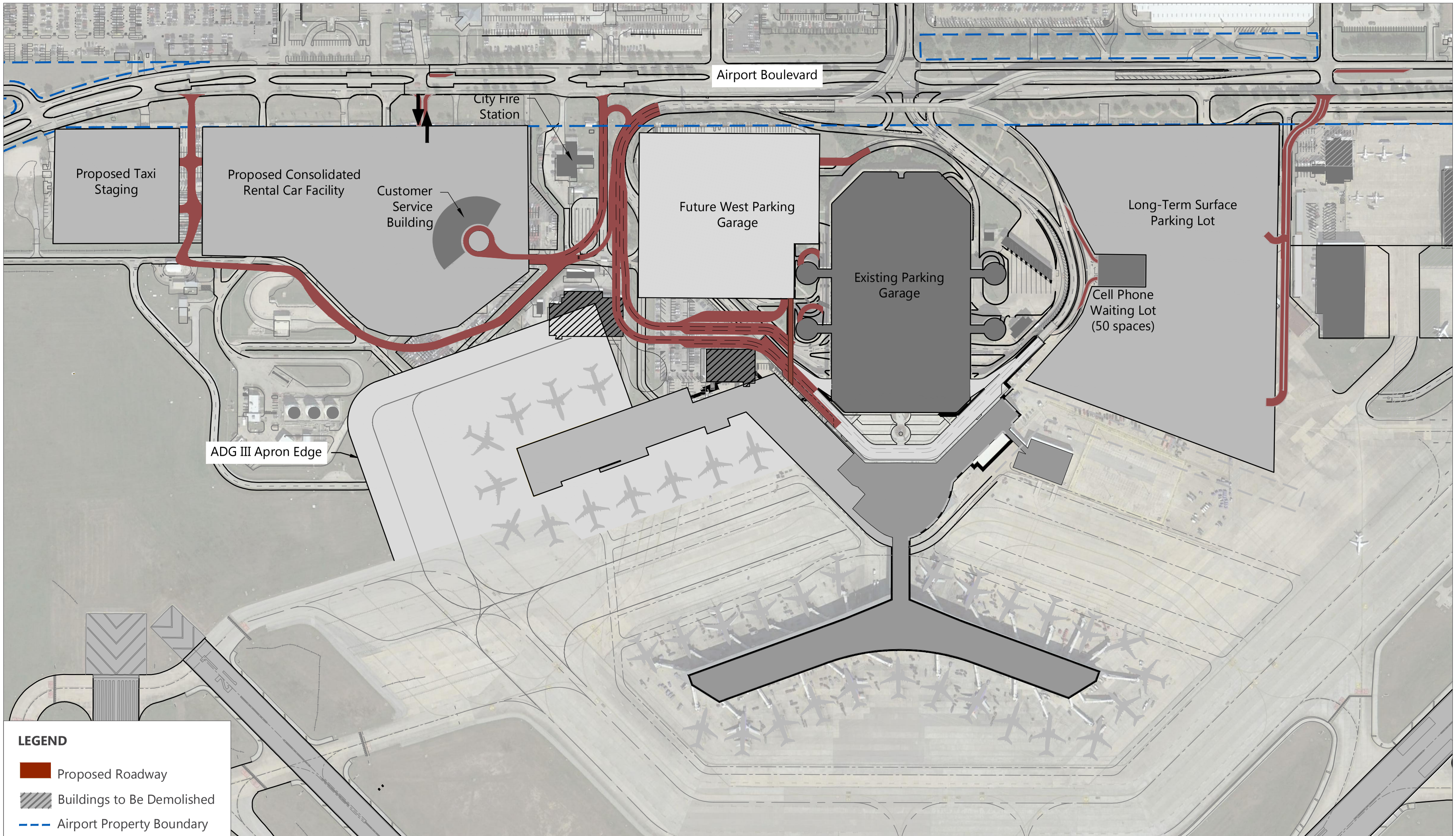

SOURCES: Houston Airport System, December 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-49

NORTH 0 500 ft.

Proposed Terminal Area Roadways Initial Layout

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\5-Roadways\CAD\5-49 & 5-50_Proposed Terminal Area Roadways\5-49_Proposed Terminal Area Roadways_Initial Layout.dwg_Layout: Exhibit 5-49_Dec 29, 2014, 3:37pm

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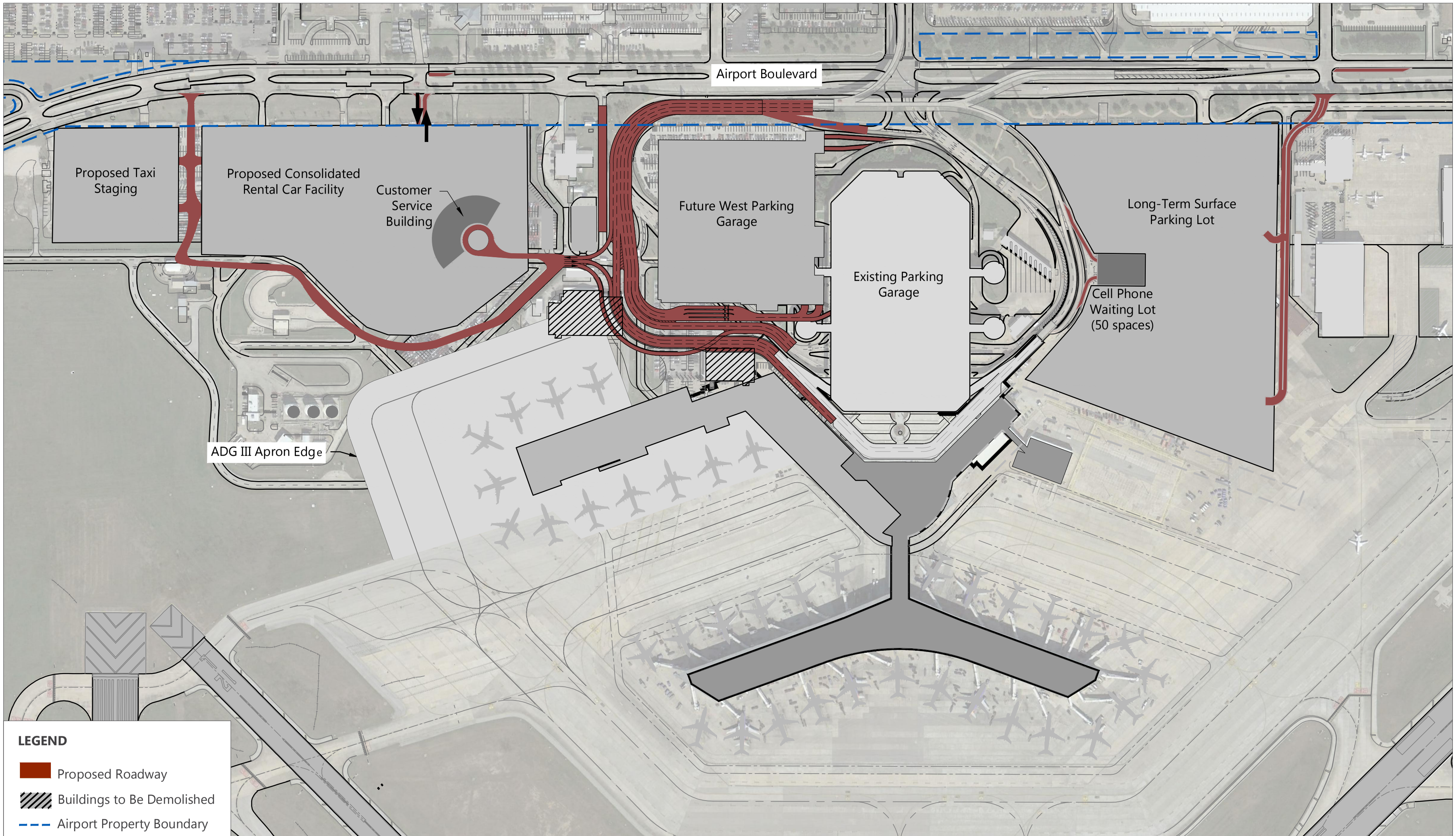

SOURCES: Houston Airport System, August 2012; RS&H Inc., December 2013; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

EXHIBIT 5-50

Proposed Terminal Area Roadways Refined Layout

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\5-Roadways\CAD\5-49 & 5-50_Proposed Terminal Area Roadways\5-50_Proposed Terminal Area Roadways_Refined Layout.dwg_Layout: Exhibit 5-50_Dec 29, 2014, 3:38pm

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Expansion of Ecopark - Lot 2 will require improved road access to the lot. It is anticipated that the intersection of Glencrest Street and Airport Boulevard would serve as the access point, thus requiring intersection improvements. To accomplish this, it will be necessary to use a portion of the northwest corner of the Atlantic Aviation leasehold to facilitate access to the improved intersection. These parking lot and intersection improvements, as well as the impacts on the Atlantic Aviation FBO leasehold, are depicted on **Exhibit 5-51**. Phase 1 of the access improvements would create the new intersection at Glencrest Street, realign the access road to the Atlantic FBO facilities to make room for the new access road to the Ecopark – Lot 2, and close a portion of the existing Ecopark – Lot 2 access road. Upon relocation of the Southwest Airlines Cargo and Provisioning Facility, Phase 2 improvements would be implemented; they consist in extending the new access road to the Ecopark – Lot 2 further south to provide an additional access point to the lot.

5.6.3 RENTAL CAR FACILITIES

Rental car facility siting alternatives were developed based on the requirements discussed in Section 4.6.

5.6.3.1 Desired Facility Attributes

Prior to developing alternatives, the desired attributes for rental car facilities were identified, as follows:

- Optimized use of existing terminal and landside infrastructure
- Minimum demolition and/or relocation of existing facilities
- Ease of wayfinding for passengers
- Ability to expand without disrupting ongoing operations
- Flexibility to address implications of various demand scenarios
- High level of service for users of all facilities
- Ability to expand incrementally and beyond 2030

Development of a CRCF campus was also preferred over individual rental car company facilities.

5.6.3.2 Potential Sites

Two sites were identified to accommodate a future CRCF: the existing cargo/long-term parking area east of the existing parking garage and south of Airport Boulevard (Site 1) and the existing rental car area west of the terminal area and south of Airport Boulevard (Site 2). Sites 1 and 2 are illustrated on **Exhibit 5-52** and **Exhibit 5-53,** respectively.

5.6.3.3 Site Evaluations

Both potential CRCF sites have common planning components:

- The customer service building would be centrally located in the ready/return area to minimize the walking distance from the customer service building to the ready/return cars.
- The QTA would be separated from the ready/return area and a common roadway would be provided for rental cars to be shuttled from storage to the ready/return area.

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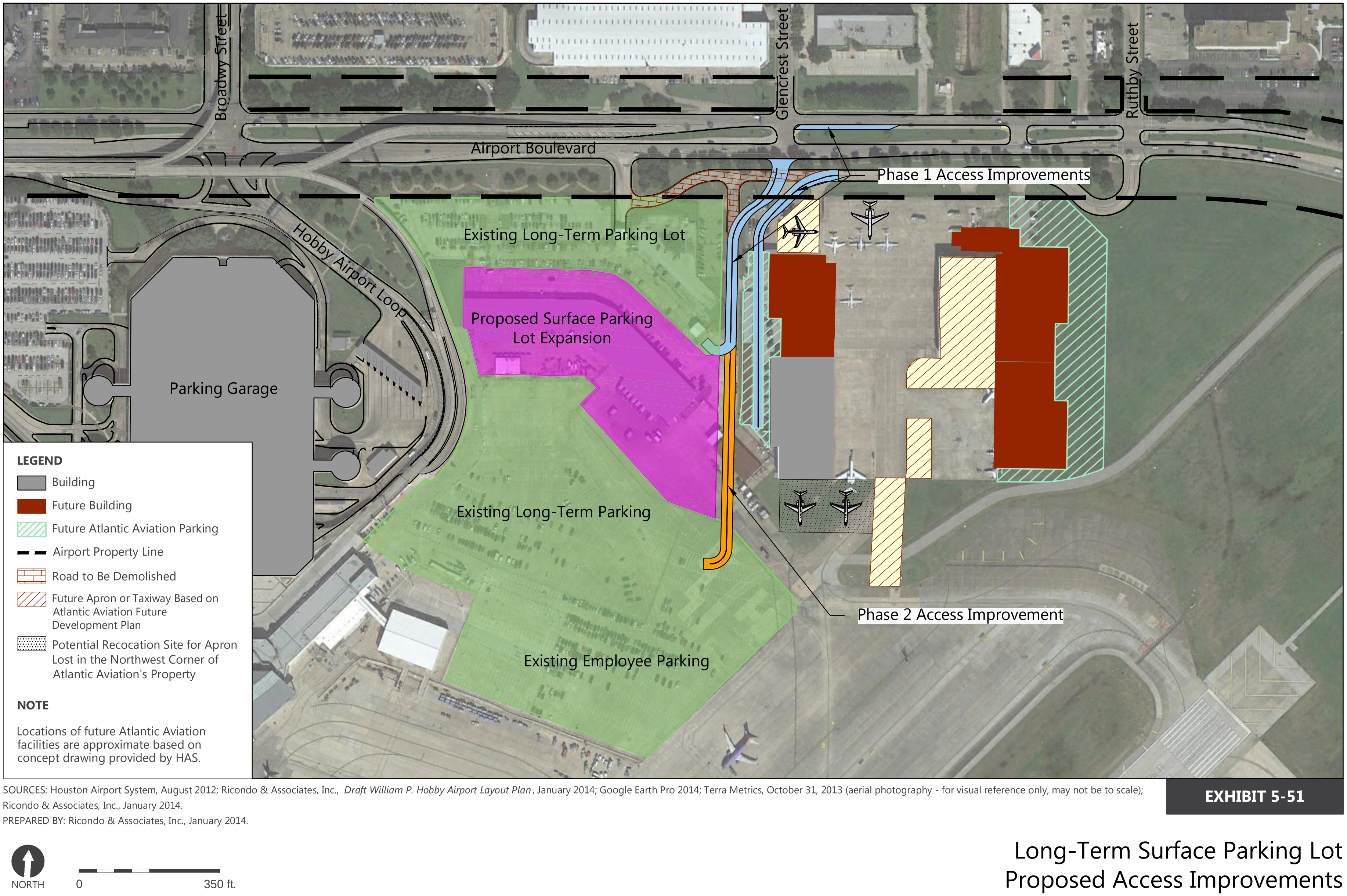

SOURCES: Houston Airport System, August 2012; Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, January 2014; Google Earth Pro 2014; Terra Metrics, October 31, 2013 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., January 2014.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

EXHIBIT 5-51

Long-Term Surface Parking Lot Proposed Access Improvements

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\5-Roadways\CAD\5-51_Surface Parking Lot Access Improvements\5-51_Long-Term Surface Parking Lot_Proposed Access Improvements.dwg_Layout: Exhibit 5-51_Dec 29, 2014, 3:39pm

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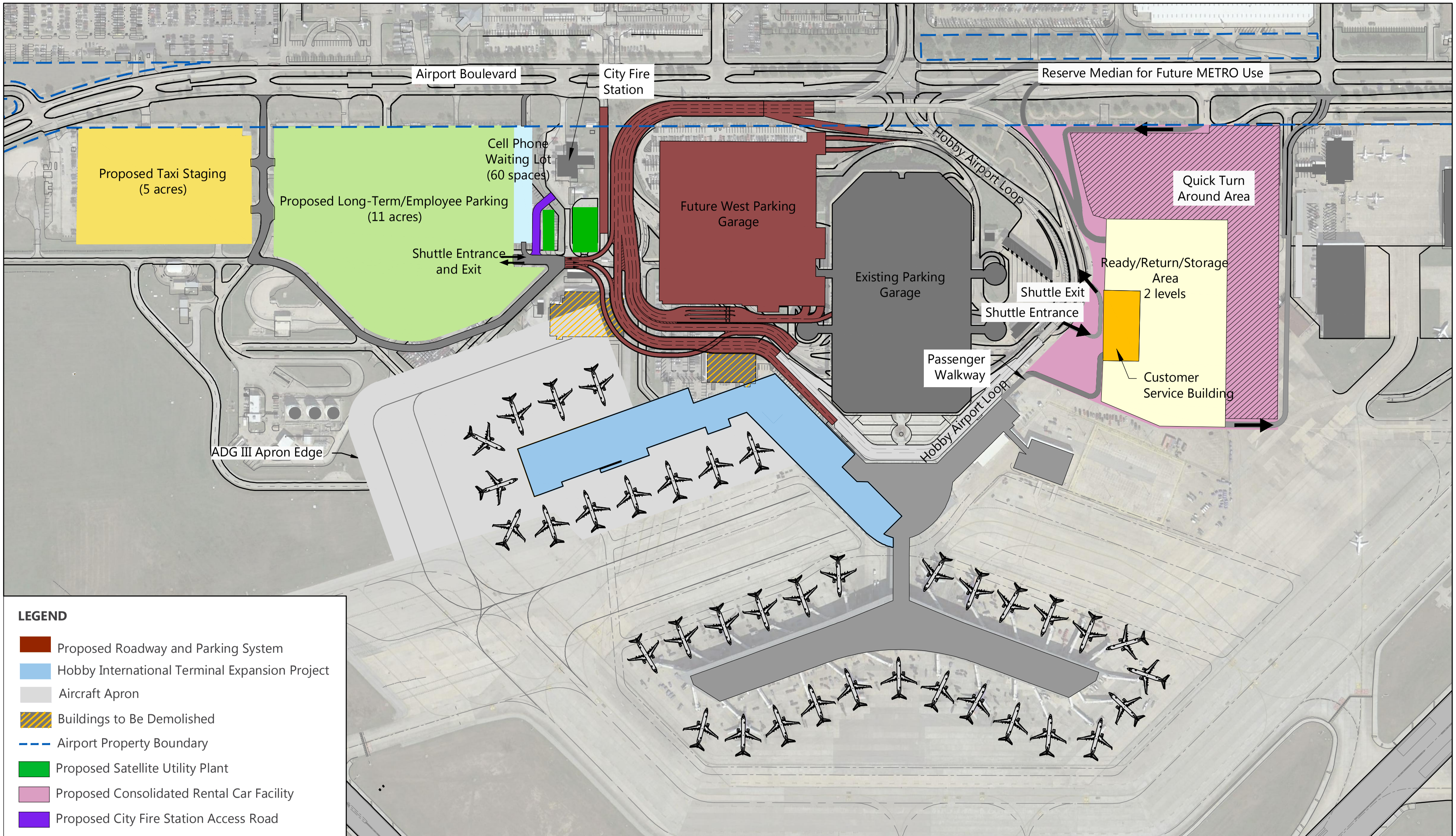
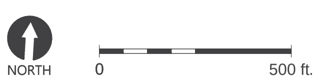


SOURCES: Houston Airport System, August 2012; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., September 2012.
PREPARED BY: Ricondo & Associates, Inc., September 2012.

EXHIBIT 5-52



Consolidated Rental Car Facility
Site 1 - East of the Terminal Area

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\6-RAC\CAD\5-52,5-53,5-55_2030 Future Terminal Area Land Use Concepts_July11.dwg_Layout: Exhibit-5-52_Dec 29, 2014, 3:41pm

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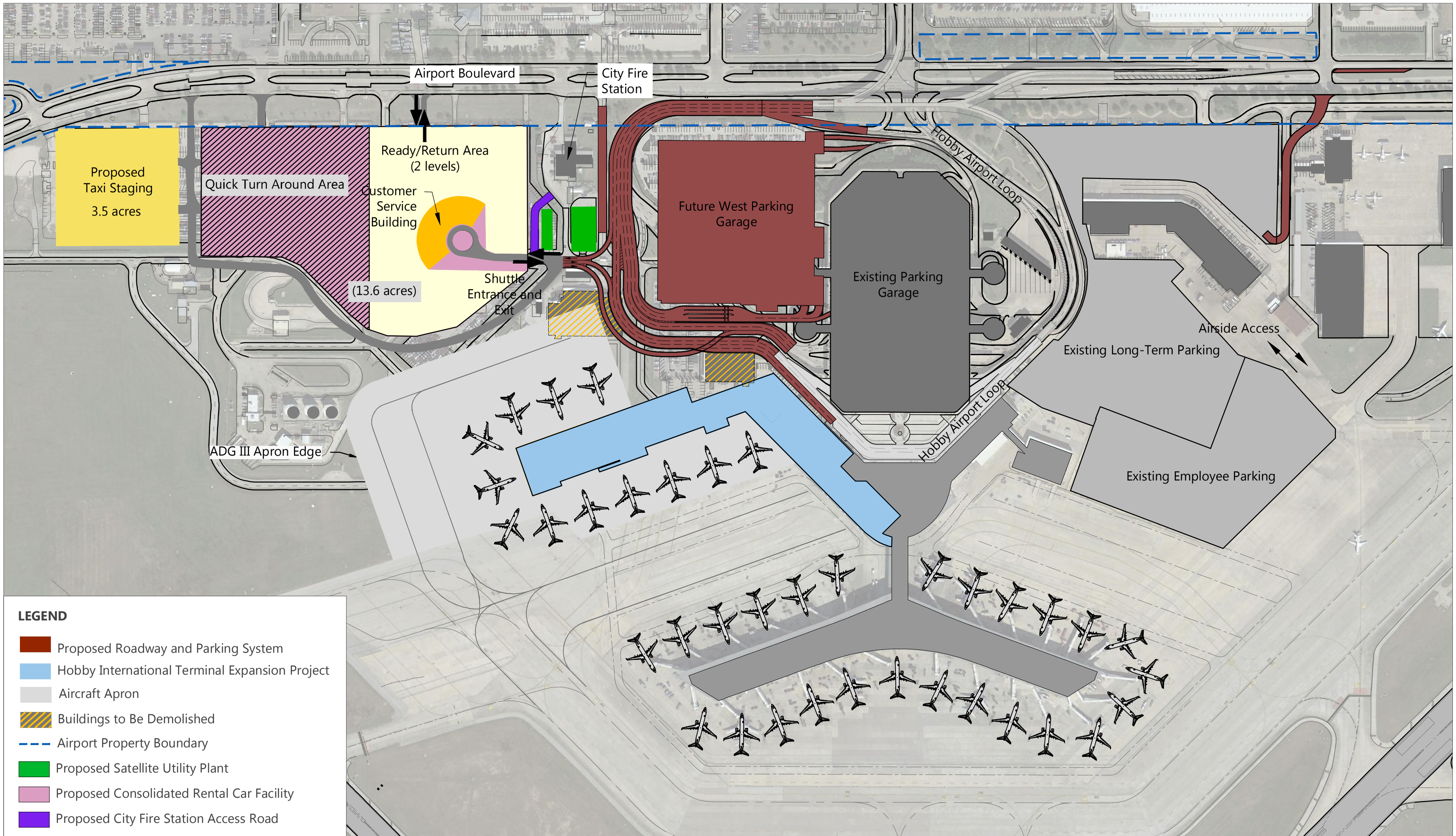

SOURCES: Houston Airport System, August 2012; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., September 2012.
PREPARED BY: Ricondo & Associates, Inc., September 2012.

EXHIBIT 5-53

Consolidated Rental Car Facility
Site 2 - West of the Terminal Area

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\6-RAC\CAD\5-52,5-53,5-55_2030 Future Terminal Area Land Use Concepts_July11.dwg_Layout: Exhibit-5-53_Dec 29, 2014, 3:42pm

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- The ready/return area would be sized to meet 20-year requirements to avoid reconstruction of roadway and other improvements serving the ready/return area.
- Service facilities within the QTA would be located so that the lots can be easily reallocated.
- Public access to and from the CRCF would be provided from Airport Boulevard.
- Each site would accommodate eight rental car brands.

The sites differ in how they would accommodate facility location, access, and facility organization. Site 1 would accommodate rental car facilities east of the existing parking garage, on the site currently occupied by the Southwest Airlines Cargo and Provisioning Facility. Both rental and return vehicles would use Airport Boulevard to access and exit the site; roadway access from the Airport Boulevard westbound lanes would require construction of a flyover ramp. Shuttle buses would enter and exit the site via the Hobby Airport Loop. The facility would be within walking distance of the exiting terminal building. All parking would be provided in a two-level parking structure. However, siting of the CRCF on the east side of the existing parking garage would restrict space available for a potential East Concourse, limiting it to only a single-loaded design.

Site 2 would accommodate rental car facilities west of the future west parking garage, on the site currently occupied by the rental car companies. Both rental and return vehicles would use Airport Boulevard to access and exit the site. Shuttle buses would enter and exit the site via the redesigned Hobby Airport Loop. All parking would be provided in a two-level parking structure.

5.6.3.4 Preferred Site

Site 2, west of the terminal area, was selected as the preferred CRCF site for the following reasons:

- HAS would like to maintain revenue-generating activities (such as parking) within walking distance of the existing and potential East Concourse. Therefore, the area east of the existing parking garage should remain available for potential development of a third parking garage.
- The roadway improvements to facilitate access to Site 2 would be minor compared to the flyover ramp that would be required for Site 1.
- Site 2 would not affect the Southwest Airlines Cargo and Provisioning Facility.
- Site 2 would not preclude the development of a double-loaded East Concourse.

5.6.3.5 Temporary Relocation of Facilities during CRCF Construction

The preferred site of the proposed CRCF is currently occupied by two rental car companies (Avis and Budget), as well as the taxi staging area. Construction of the CRCF would require the temporary relocation of these facilities. **Exhibit 5-54** depicts one of the potential temporary relocation sites for these facilities. The Avis and Budget facilities may be temporarily relocated to vacant non-HAS land on the west side of the Airport, while the taxi staging area may be able to be temporarily relocated in the west corner of the North Quadrant. Another alternative is to first relocate the Southwest Airlines Cargo and Provisioning Facility, and then relocate the Avis and Budget facilities to that site during construction of the CRCF. The implementation plan described in this report (Section 8) assumes the use of the non-HAS vacant land west of the Airport. Should the site of the existing Southwest Airlines Cargo and Provisioning Facility be selected instead, there would be impacts to the timing of other projects.

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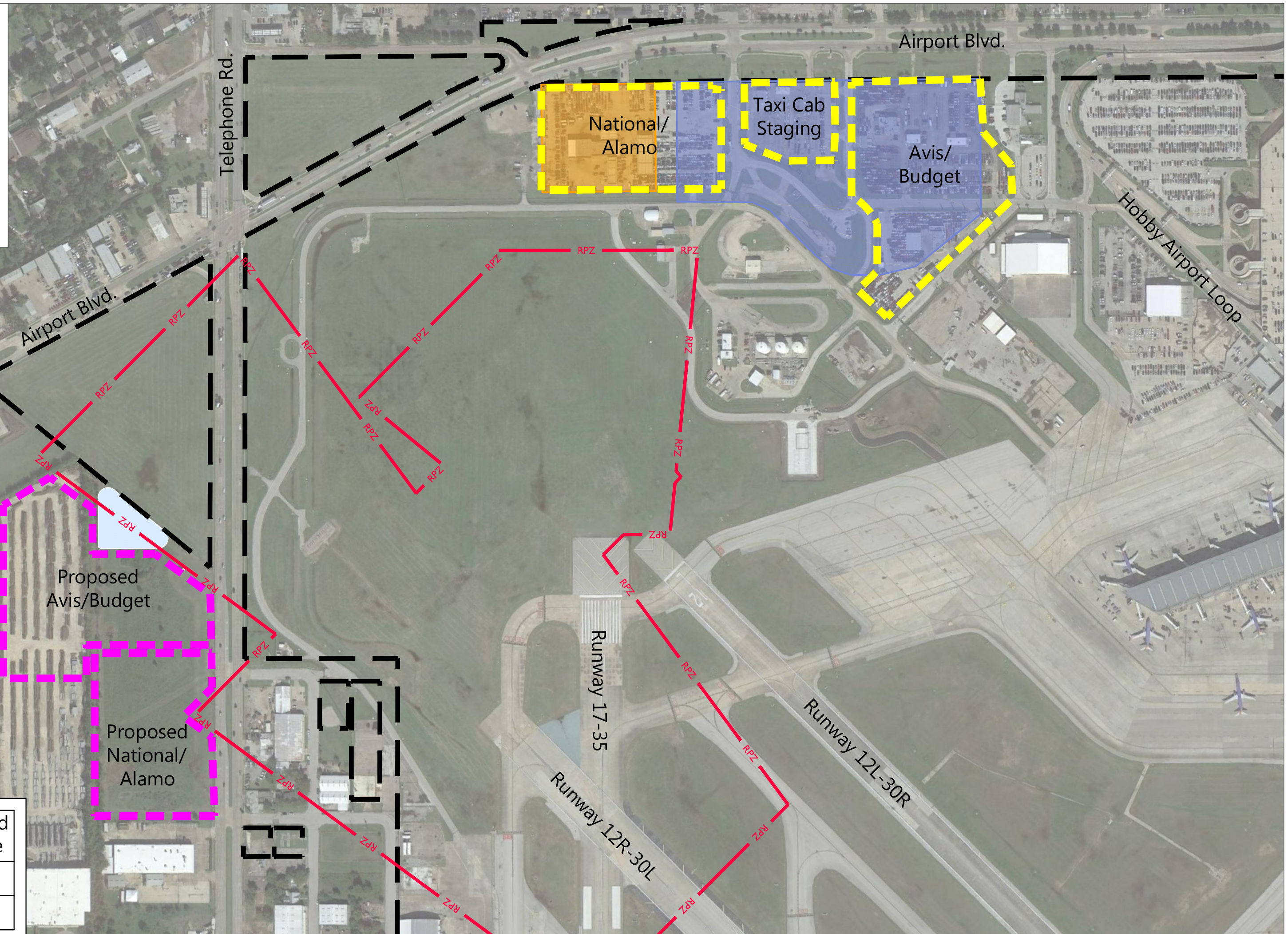
LEGEND
- Airport Property Line
- Runway Protection Zone
- Existing Facilities
- Proposed Temporary Facilities
- Proposed Consolidated Rental Car Facility
- Proposed Taxi Cab Staging
- Detention Basin



Tenant	Existing Acreage	Proposed Acreage
Avis/Budget	7.40	7.40
National/Alamo	5.25	5.25

SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, February 2014; Google Earth Pro 2014; Terra Metrics, October 31, 2013 (aerial photography - for visual reference only, may not be to scale)
Ricondo & Associates, Inc., February 2014.
PREPARED BY: Ricondo & Associates, Inc., February 2014.

NORTH 0 600 ft.

EXHIBIT 5-54

Potential Temporary Rental Car Facilities Relocation Site During Construction of the Consolidated Rental Car Facility

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\6-RAC\CAD\5-54 RAC Temporary Relocation_Implementation_Options-2007.dwg_Layout: Ex. 5-54_Dec 30, 2014, 10:14am

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5.6.4 TAXICAB STAGING AREA

As part of terminal area development, the optimal location for the taxicab staging area was proposed to be west of the proposed CRCF, and south of Airport Boulevard. The proposed location is anticipated to meet requirements through the planning period, and is depicted on Exhibit 5-53.

5.6.5 CELL PHONE WAITING LOT

Current use of the cell phone waiting lot is limited because of its remote distance from the Arrivals Curbsides. Two alternative sites were evaluated to improve the proximity of this lot to the Arrivals Curbsides.

Site 1 would be west of the proposed Hobby Airport Loop and west of the City fire station, as shown on Exhibit 5-52. This location would provide approximately 60 spaces and would be accessed via Airport Boulevard or the future Hobby Airport Loop. Site 2 would be east of the existing Hobby Airport Loop and south of the existing Southwest Airlines Cargo and Provisioning Facility. Access to this site would be via the Lower Level Roadway to the Hobby Airport Loop.

Siting of the cell phone waiting lot is tied to the location of the CRCF. As such, as part of terminal area development, the optimal location for the cell phone waiting lot was determined to be Site 2, inside the long-term surface parking lot, east of the existing parking garage and the Hobby Airport Loop, and south of Airport Boulevard. This location also offers proximity to the Arrivals Curbsides, ease of wayfinding for vehicles dwelling at the Arrivals Curbsides, and ease of recirculation to the Arrivals Curbsides. The preferred location is anticipated to accommodate demand through the planning period.

5.6.6 UTILITY PLANT

A new utility plant is required to meet the current and future utility needs of the Airport, including the West Concourse under construction. The new plant has been referred to as the Satellite Utility Plant (SUP); site selection for the new SUP should also allow for future expansion of the SUP as needed.

Several sites for the SUP were evaluated based on the following criteria: maximum allowable distance between the SUP and the terminal building, and location outside of future development areas. The preferred site for the SUP is south of the City Fire Station, where the existing taxicab staging area and the eastern portion of the Avis Rent A Car lot are located. The existing taxicab staging area has to be relocated to accommodate growing demand, which would leave this area available for development.

One alternative that was evaluated consisted of preserving the access road serving the City Fire Station from South Rental Car Road. In this alternative, the SUP would be located on the site of the existing taxicab staging area (which would be relocated) and the cooling towers would be located in the area currently occupied by Avis. A second alternative evaluated consisted of shifting the City Fire Station access road to the west and developing the SUP on one parcel of land. This second alternative was selected as the preferred alternative, and is depicted on **Exhibit 5-55**.

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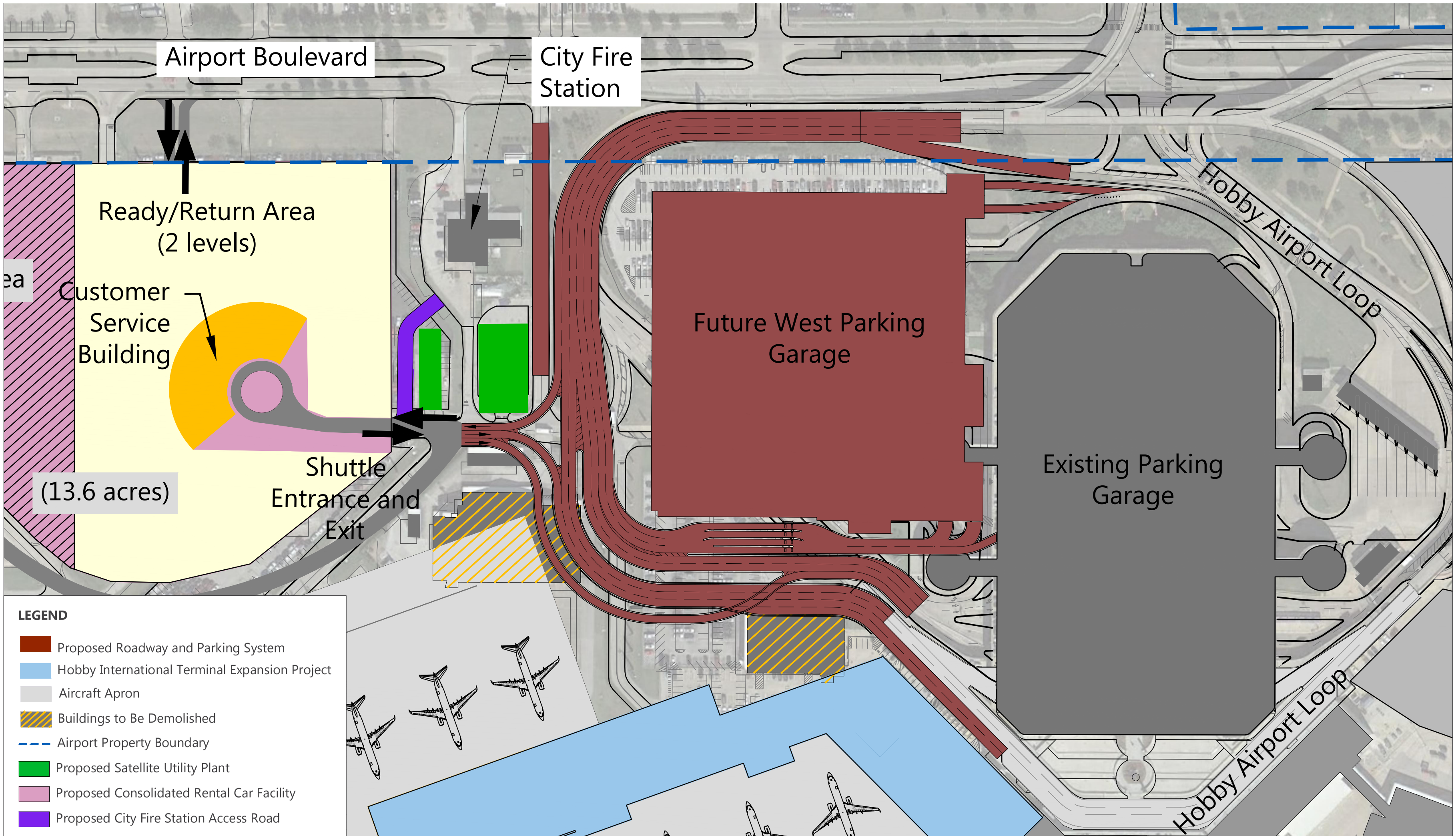

SOURCES: Houston Airport System, August 2012; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., September 2012.
PREPARED BY: Ricondo & Associates, Inc., September 2012.

EXHIBIT 5-55

Satellite Utility Plant
Preferred Site

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\6-RAC\CAD\5-52,5-53,5-55_2030 Future Terminal Area Land Use Concepts_July11.dwg_Layout: Exhibit-5-55_Dec 29, 2014, 3:42pm

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5.7 Off-Airport Roadway Intersections

As part of the Airport Master Plan Update, the impacts of the proposed growth on the roadway intersections surrounding the Airport were analyzed and the improvements needed to minimize traffic congestion at these intersections were identified. In addition to the overall levels of service and delays, individual movement levels of service were analyzed, and the following improvements are recommended for each of the study area intersections, except at the intersection of Airport Boulevard and Broadway Street, where no improvements are recommended based on the analysis. **Table 5-10** presents the intersection levels of service following implementation of the recommended improvements.

Exhibit 5-56 shows the recommended improvements at the intersection of Telephone Road and Airport Boulevard as follows:

1. Provide an additional 200-foot left turn bay on the eastbound approach on Airport Boulevard.
2. Provide an additional 200-foot left turn bay on the westbound approach on Airport Boulevard.
3. Provide an additional 265-foot left turn bay on the southbound approach on Telephone Road.

Exhibit 5-57 shows the recommended improvements at the intersection of Monroe Road and Airport Boulevard as follows:

1. Provide an additional 300-foot left turn bay on the eastbound approach on Airport Boulevard.
2. Provide a 200-foot exclusive right turn bay at the eastbound approach on Airport Boulevard.
3. Provide an additional 175-foot left turn bay on the westbound approach on Airport Boulevard.
4. Provide a 200-foot exclusive right turn bay on the southbound approach on Monroe Road.
5. Provide an additional 150-foot left turn bay on the northbound approach on Monroe Road.

Exhibit 5-58 shows the recommended improvements at the intersection of Airport Boulevard and Glencrest Street as follows.

1. Retain the existing left turn bay on the eastbound approach on Airport Boulevard.
2. Provide a 200-foot left turn bay on the westbound approach on Airport Boulevard.
3. For the new south leg of the intersection, provide an exclusive left turn lane and through/right shared lane in the northbound direction and one lane in the southbound direction.

Table 5-10: Intersection Level of Service after Implementation of Recommended Improvements

	BASELINE			2015			2020			2030		
INTERSECTION	**LOS**	**DELAY[1/]**	**V/C**	**LOS**	**DELAY[1/]**	**V/C**	**LOS**	**DELAY[1/]**	**V/C**	**LOS**	**DELAY[1/]**	**V/C**
Airport Boulevard at Telephone Road	D	45.9	0.92	D	39.2	0.71	D	40.6	0.78	D	48.7	0.93
Airport Boulevard at Broadway Street	C	21.9	0.56	C	22.3	0.6	C	22.8	0.65	C	24.2	0.79
Airport Boulevard at Monroe Road	D	41.3	0.88	C	36.2	0.76	D	37.3	0.82	D	47.1	0.98
Airport Boulevard at Glencrest Street	C	14.4	0.68	B	13.2	0.69	B	14	0.72	B	17.6	0.77

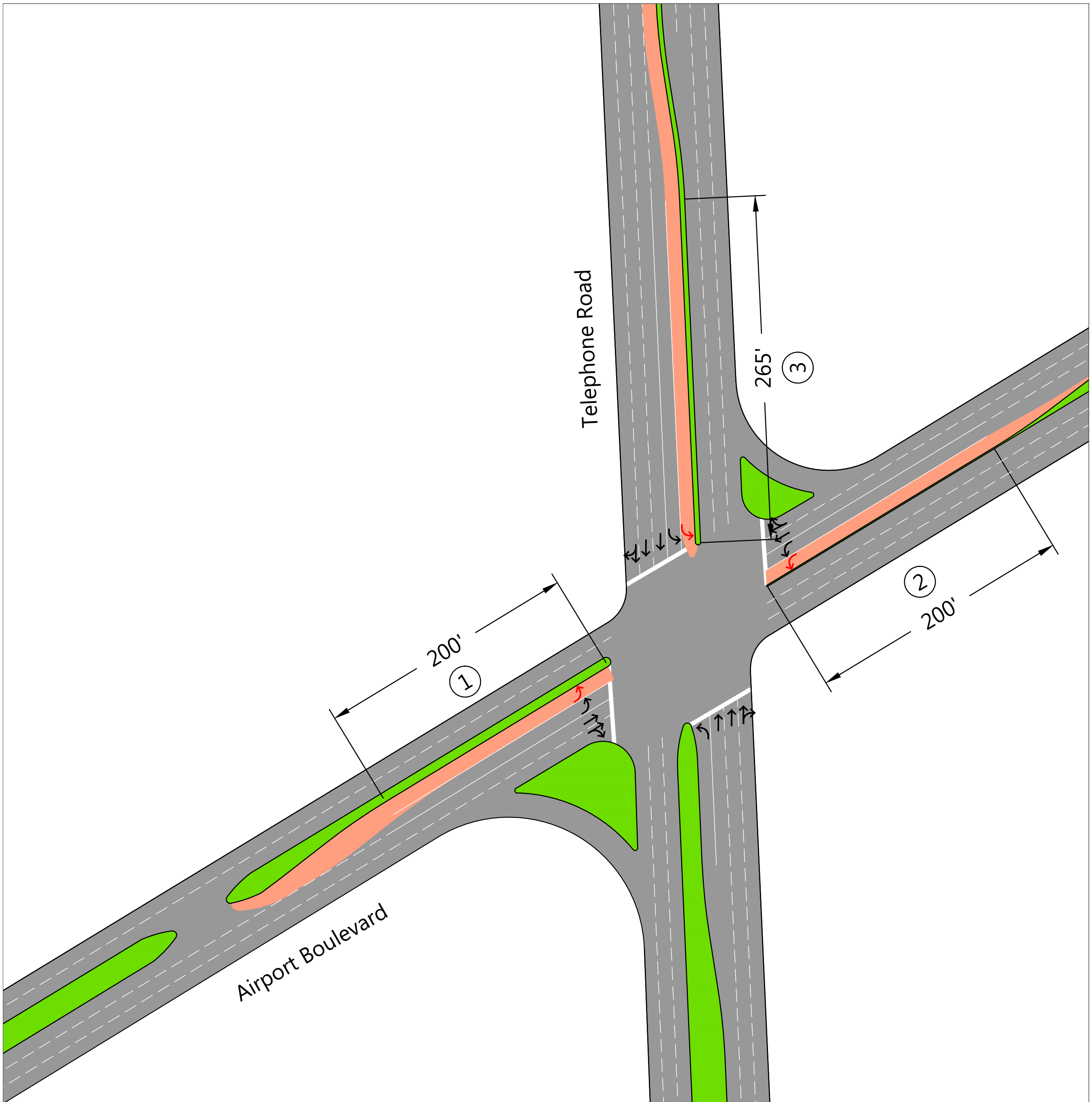
NOTES:

LOS = Level of Service

V/C = Volume to Capacity Ratio

1/ Delay is presented in seconds per vehicle.

SOURCE: Ricondo & Associates, Inc., November 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.



LEGEND

Existing

Proposed Improvment

1. Provide additional 200-foot left turn bay on eastbound approach to Telephone Road.
2. Provide additional 200-foot left turn bay on westbound approach to Telephone Road.
3. Provide additional 265-foot left turn bay on southbound approach to Airport Boulevard.

SOURCE: Gunda Corportation, LLC., September 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

EXHIBIT 5-56

NORTH 0 120 ft.

Recommended Lane Configuration Telephone Road at Airport Boulevard

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\5-Roadways\CAD\Exhibits 5-56, 5-57, 5-58_Intersection Improvments.dwg_Layout: Exhibit 5-56_Dec 29, 2014, 3:46pm

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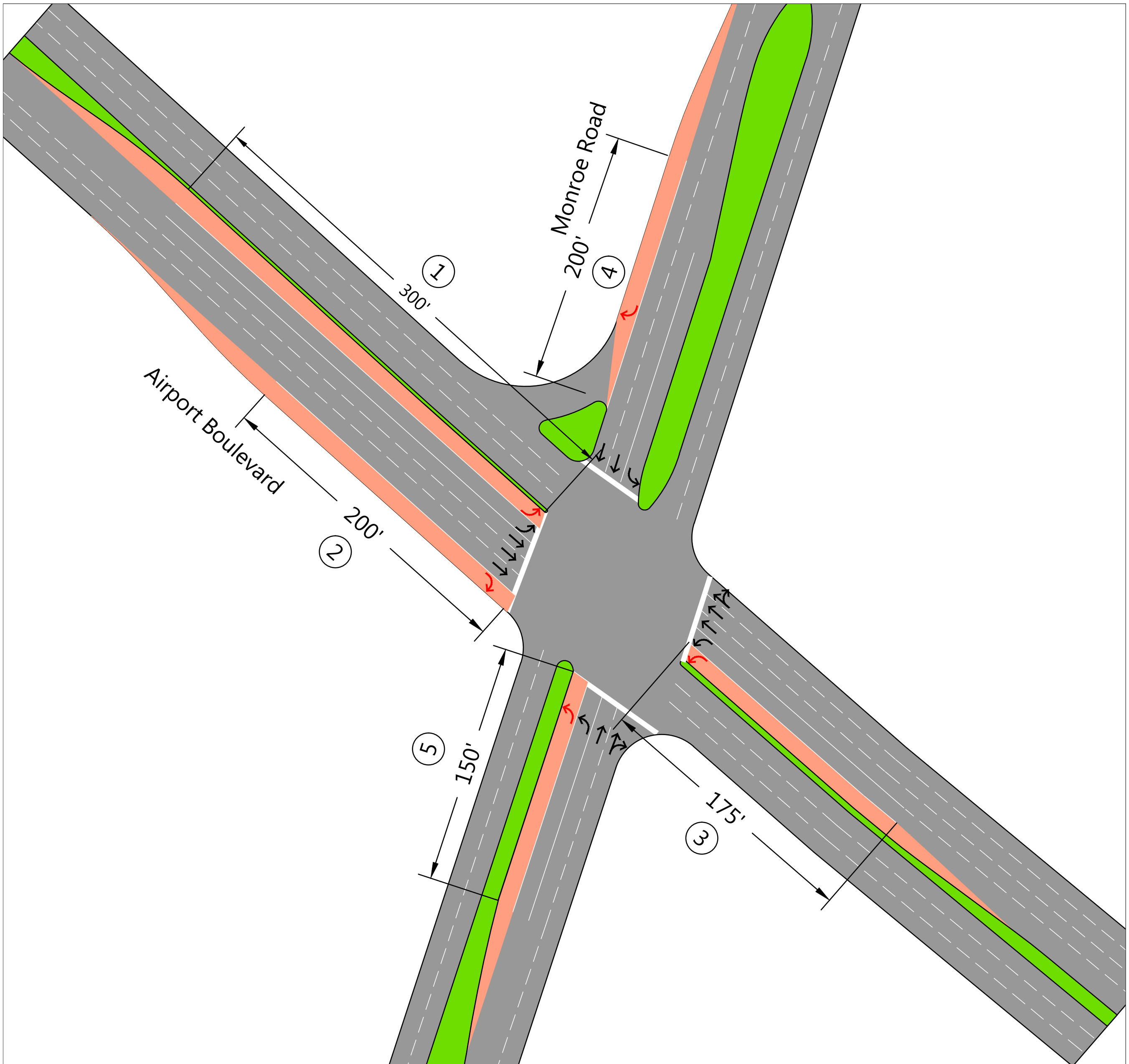

1. Provide additional 300-foot left turn bay on eastbound approach to Monroe Road.
2. Provide additional 200-foot exclusive right turn bay at eastbound approach to Monroe Road.
3. Provide additional 175-foot left turn bay on westbound approach to Monroe Road.
4. Provide additional 200-foot exclusive right turn bay on southbound approach to Airport Boulevard.
5. Provide additional 150-foot left turn bay on northbound approach to Airport Boulevard.

LEGEND

- Existing
- Proposed Improvment

SOURCE: Gunda Corportation, LLC., September 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

EXHIBIT 5-57

NORTH 0 100 ft.

Recommended Lane Configuration
Monroe Road at Airport Boulevard

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\5-Roadways\CAD\Exhibits 5-56, 5-57, 5-58_Intersection Improvments.dwg_Layout: Exhibit 5-57_Dec 29, 2014, 3:47pm

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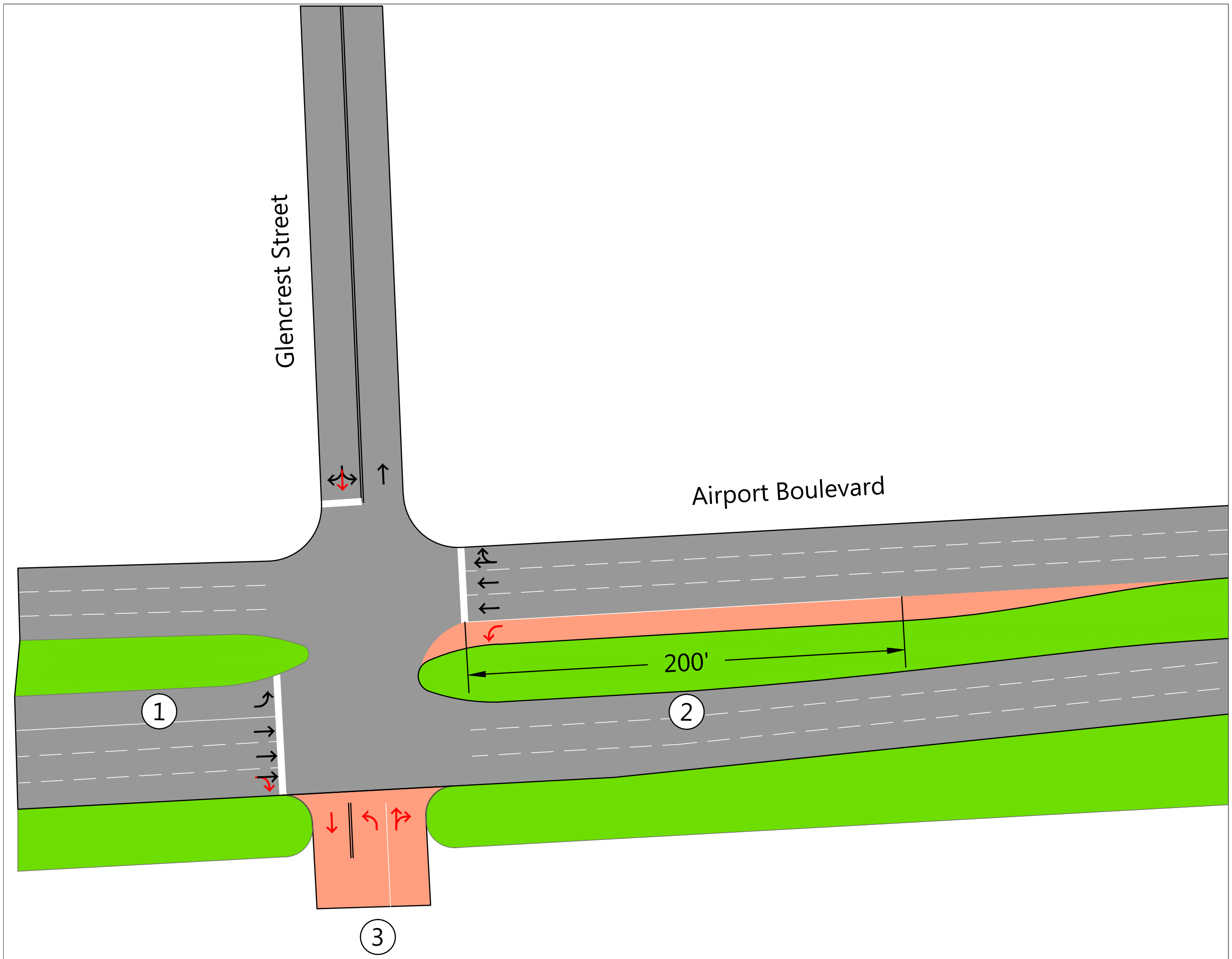

LEGEND

Existing

Proposed Improvment

1 Retain existing left turn bay on eastbound approach to Glencrest Street.

2 Provide 200-foot left turn bay on westbound approach to Glencrest Street.

3 For the new south leg of the intersection, provide an exclusive left turn lane and through/right shared lane in northbound direction and one lane in southbound direction.

SOURCE: Gunda Corportation, LLC., September 2013.
PREPARED BY: Ricondo & Associates, Inc., November 2013.

EXHIBIT 5-58

NORTH 0 80 ft.

Recommended Lane Configuration Glencrest Street at Airport Boulevard

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\05_Chapter 5_Alternatives\5-Roadways\CAD\Exhibits 5-56, 5-57, 5-58_Intersection Improvments.dwg_Layout: Exhibit 5-58_Dec 29, 2014, 3:47pm

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6. Airport Environs Development Framework Plan

6.1 Existing Conditions

This section discusses the appropriate development for the areas surrounding HOU. Houston Airport System staff and City Planning and Development Department staff continually work to minimize the public's exposure to excessive noise and safety hazards, and to ensure that aircraft approaches to HAS airports are kept clear of structures and other impediments that could pose a hazard to air navigation. At the same time, the role of HOU is expanding to include international operations, which will lead to numerous changes on- and off-Airport. Land uses near HOU consist of a mixture of agricultural, single-family residential, multifamily residential, industrial, and commercial uses, as well as schools, churches, and vacant/under-developed land. There is a strong consensus among Airport operators, tenants, and users that there is a poignant need to revitalize the land uses along the major thoroughfares that lead to HOU in order to attract the caliber of off-Airport development desired to improve the image of HOU and that is suitable for the new HOU FIS facilities.

The existing land uses around the Airport are described in the remainder of this section, as well as key facilities and supporting infrastructure that support the Airport's domestic (and soon to be international) transportation role.

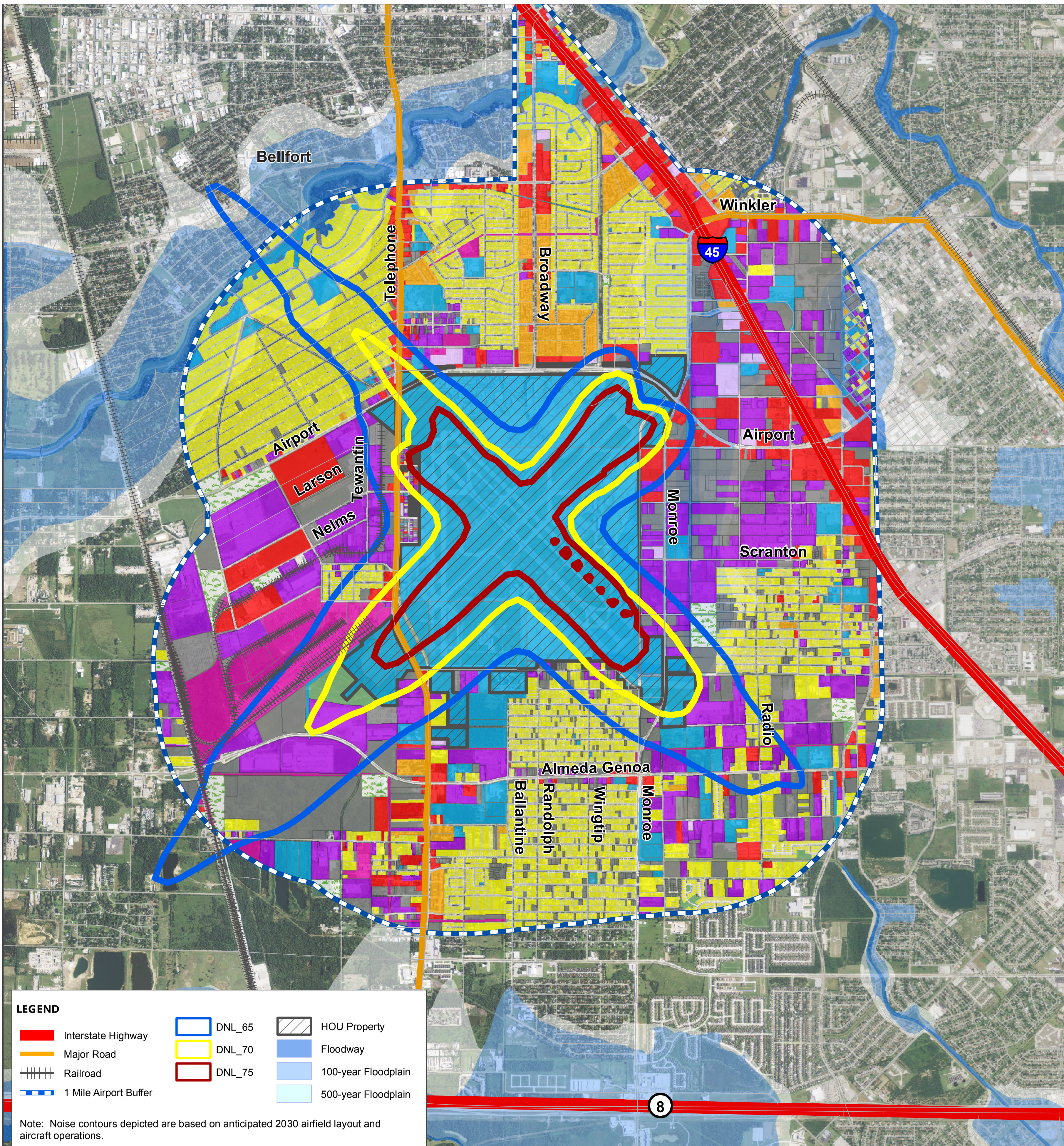
6.1.1 EXISTING LAND USE WITHIN THE AREA OF INFLUENCE

The broad categories of off-Airport land use and specific development proposals within the Airport's Area of Influence (AOI) are summarized below. Generally speaking, the land use analysis was based on a factual and graphic depiction of how the land and structures are currently used for particular purposes. The acreage devoted to specific land uses was calculated and the issues associated with those land uses were analyzed, including conflicting or inefficient uses as well as the impediments related to the physical environment and community infrastructure on the evolving land use of the City and Harris County. The highest and best land use capabilities of vacant, open, and under-developed land were also evaluated. These areas present the greatest opportunities for accommodating anticipated growth and for using economic tools to guide the compatible revitalization of the land uses along the major thoroughfares serving HOU. The ability to incentivize redevelopment that is compatible with HOU is a powerful tool to achieve the goals of the Master

Plan, since the City of Houston does not have a zoning ordinance. More importantly, the tools should also be used to guide the renaissance of the Airport's surrounding environs. Land use maps are the most common way of presenting land-based data. They show land-uses by rendering them in different colors. The AOI consists of a mixture of land uses that can be grouped into the following categories:

- Residential (Single-family and Multifamily)
- Commercial
- Industrial
- Office
- Agricultural (Agricultural Exempt Land)
- Public/Institutional (City/County/State/Federal Owned Land, Schools, Places of Worship)
- Vacant/underdeveloped
- Parks/Open Space (Parks, Homeowners Association Parks, Detention/Retention Ponds, Cemeteries)
- Transportation/Utilities (Pipelines, Railways, Utility Easements, Private Streets)

Exhibit 6-1 shows the 2012 land use categories within the AOI and the 2030 noise contours for HOU. Overlaying the 2030 noise contours allows determining if there will be any non-compatible land uses in the future, should HOU grow as planned, and to ensure that no new non-compatible land uses will be built within those future noise contours. The AOI is densely developed to the north and less densely developed to the east and west. There are over 1,200 acres of vacant/undeveloped land. A majority of the vacant/underdeveloped land is located on the northeast, east and southwest of the AOI. A majority of the single-family residential parcels are located to the north, southeast and northwest of HOU. Multifamily residents cluster along Broadway Street north of HOU. There are several parks and recreation areas surrounding HOU, including Dow Park, Glenbrook Golf Course, Reveille Park, Garden Villas Park, Robert C. Stuart Park, Center Park, Blackhawk Park and Beverly Hills Park. Industrial land use clusters to the east and west of HOU, while commercial land use boarders I-45, Telephone Road and Bellfort Street.



Landuse	Number of Parcels	Dwelling/Units	% of Total Dwellings	Sq Miles	Acres	Avg Property Value	Total Market value
Single Family Residential	6,387	6387	44.60%	3.22	2,059	$93,825 / dwelling	$599,260,085
Multi-family Residential	469	7934	55.40%	0.40	256	$19,296 / unit	$153,093,467
	Total	14321	100%	0.00			
Commercial	457			2.00	1,283	$5.40/ sq ft	$301,816,885
Industrial	518			2.18	1,394	$5.77/ sq ft	$350,330,093
Office	34			0.09	58	$14.73/ sq ft	$37,206,702
Agricultural	30			0.31	199	$29,003/ per acre	$5,779,736
Public/Institutional	281			2.98	1,907	$1.53/ sq ft	$126,866,326
Vacant/underdeveloped	1,368			1.83	1,171	$1.16/ sq ft	$59,213,350
Parks/Open Space	28			0.09	58	$11,250/ per acre	$655,959
Transportation/Utilities	56			0.62	399	$0.31/ sq ft	$5,365,823
No Data/Public Right of Way	14			1.15	737		$0
			Totals	**14.88**	**9,522**		**$1,639,588,426**

SOURCE: HAS, 2013; HCAD, 2012; Railroad Commission of Texas, 2013; Quadrant Consultants, Inc., August 2014 (2030 Noise Contours).
PREPARED BY: Knudson, LP, August 2014.

EXHIBIT 6-1

NORTH 0 3,200 ft.

2012 Land Use in the Vicinity of the Airport

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Table 6-1 presents the 2012 land use breakdown within the study area boundary around HOU. Future land use requirements are summarized following the discussion of existing land use characteristics and the potential use capabilities of vacant, open, and underdeveloped properties. Both qualitative and quantitative requirements are described. As shown in Table 6-1, single-family residential is the land use that accounts for the largest land area with 22.3 percent (2,059 acres) of the total AOI. Of the total single-family residential land use, 145 acres (309 dwelling units) are within the area exposed to day-night average sound level (DNL) 65, expressed in A-weighted decibels. The average real property valuation of the single-family dwelling units within the DNL 65 noise exposure contour is $97,737, slightly higher than the AOI average.

Public/institutional land uses represent properties that are typically not on the tax rolls and owned by tax exempt entities. This land use category represents the second largest land area, with 20.2 percent (1,876 acres) of the total AOI. HOU encompasses 644 acres of the public/institutional land use. Publicly owned real estate is easier to control for land use purposes, with the exception of schools and places of worship. There are nine public, private and early education schools within the AOI. Those include Bellfort Elementary School, Developing Minds Learning Center, Marque High School Diploma GED, Electrical Training Center, Ortiz Middle School, Luv N Care Learning Center Too, Jessup Elementary School, Rick Schneider Middle School, Houston Can Academy Hobby and Bellfort Street Kinder Care.

There are 14,321 total residential dwelling units within the HOU AOI; 6,387 of those are single-family residences, 7,934 are multifamily residences and 880 residential parcels are categorized as vacant per the Harris County Appraisal District (HCAD). The average value of the single-family dwelling units is $93,825 and the average value of the multifamily dwelling units is $19,296. This level of value for single-family as well as multifamily home values is considered Community Development Block Grant (CDBG)-eligible and is significantly below average property value for both single-family and multifamily dwelling units in the immediate environs of HOU. The continued decline in off-Airport property values has also negatively impacted the visual aesthetics of all thoroughfares serving HOU. Property values increased overall between 2005 and 2012 due to real property value appreciation; they were not the result of any significant revitalization of off-Airport properties.

There are 869 acres of vacant/undeveloped parcels inside the AOI. This land use category provides a great opportunity for redevelopment strategies that are in alignment with the future HOU land use plan and could be incentivized for the revitalization of off-Airport properties along the major thoroughfares accessing HOU. In addition, 199 acres are classified as agricultural land uses. The majority of the 256 acres of multifamily land use is a candidate for redevelopment, based on the age of those land uses. These properties may also be eligible for compatible revitalization in support of potential transit-oriented development opportunities along proposed light rail lines on Telephone Road and Airport Boulevard, as well as on Broadway Street and Monroe Road. A focused City-approved initiative will be required to drive that revitalization through the use of developer incentives targeted to compatible off-airport land uses. Unless a City initiative is approved, there are no assurances that the previous development trends will be reversed.

Table 6-1: 2012 AOI Land Use Breakdown

LAND USE CATEGORY	NUMBER OF PARCELS / UNITS	TOTAL MARKET VALUE	AVERAGE PROPERTY VALUE	TOTAL AREA (ACRES)	PERCENT OF TOTAL LAND AREA
Agricultural	30	$ 5,779,736	$ 29,003/acre	199	2.1%
Commercial	457	$ 301,816,885	$ 5.40/SF	1,283	13.8%
Industrial	518	$ 350,330,093	$ 5.77/SF	1,907	20.6%
Multifamily Residential	7,934	$ 153,093,467	$ 19,926/unit	256	2.8%
Office	34	$ 37,206,702	$ 14.73/SF	58	0.6%
Parks/Open Space	28	$ 655,959	$ 11,250/acre	58	0.6%
Public/ Institutional	281	$ 126,866,326	$ 1.53/SF	1,876	20.2%
Residential Vacant	880	$ 18,525,905	$ 21,052/lot	302	3.3%
Single-family Residential	6,387	$ 599,260,085	$ 93,825/unit	2,059	22.3%
Transportation/ Utilities	56	$ 5,365,823	$ 0.31/SF	399	4.3%
Vacant/Underdeveloped/No Data	1,606	$ 40,687,445	$ 1.07/SF	869	9.4%
Total	**16,605**	**$ 1,639,588,426**		**9,266**	**100.0%**

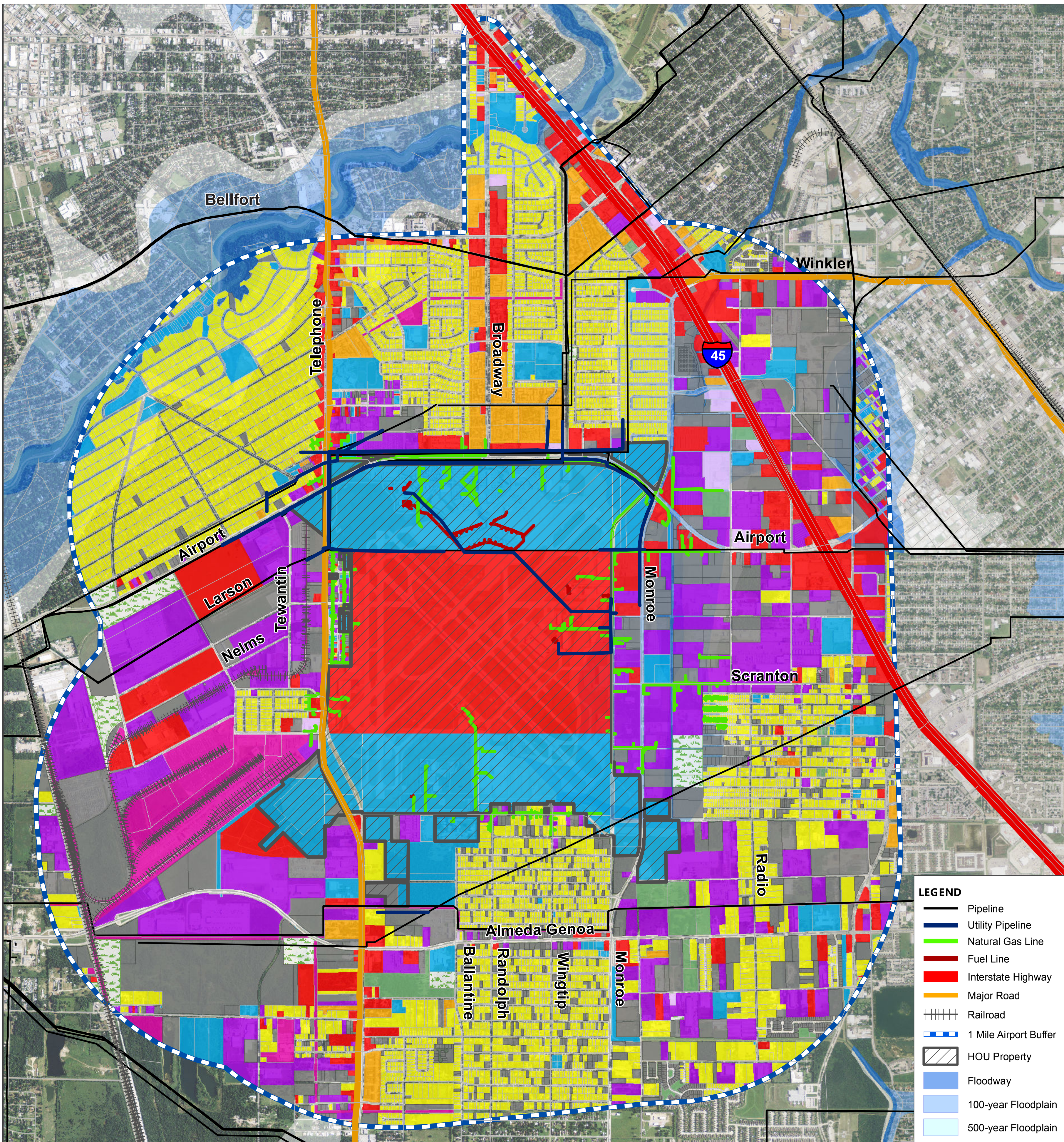
SF = Square Foot

SOURCE: Harris County Appraisal District, July 2012.

PREPARED BY: UrbanCore Collaborative, Inc., and Knudson, LP, September 2013.

Exhibit 6-2 shows land uses in 2005 within the AOI. The AOI was densely developed to the north and less densely developed to the east and west. The majority of vacant/underdeveloped land was located on the northeast, east and southwest of the AOI. The majority of single-family residential parcels was located to the north, southeast and northwest of HOU. Multifamily residents clustered along Broadway Street, north of HOU. The majority of commercial land use bordered I-45, Telephone Road and Bellfort Street.

Table 6-2 presents information on the land uses surrounding HOU in 2005, including the number of parcels or units, the total market value, the average property value, the total acreage and the percent of land each land use has within the AOI. Single-family residential was the predominant land use by total land area, followed by public/institutional in 2005.



Landuse	Number of Parcels	Dwelling/Units	% of Total Dwellings	Sq Miles	Acres	Avg Property Value	Total Market value
Single Family Residential	6,098	1212	13.86%	3.20	2,046	$98,849 / dwelling	$602,781,168
Multi-family Residential	460	7531	86.14%	0.39	249	$14,128 / unit	$106,396,917
	Total	8743	100%	0.00			
Commercial	413			0.82	525	$8.36/ sq ft	$191,264,485
Industrial	471			1.73	1,110	$3.41/ sq ft	$164,824,735
Office	34			0.06	39	$14.45/ sq ft	$24,333,581
Agricultural	31			0.25	157	$19,879/ per acre	$3,125,170
Public/Institutional	262			2.52	1,610	$0/ sq ft	$0
Vacant/underdeveloped	1,749			1.87	1,195	$0.94/ sq ft	$48,916,587
Parks/Open Space	46			0.10	62	$48,035/ per acre	$2,979,966
Transportation/Utilities	49			0.53	337	$0.23/ sq ft	$3,311,386
No Data/Public Right of Way	10			1.06	678		$0
			Totals	12.51	8,008		$1,147,933,995

SOURCE: HAS, 2013: HCAD, 2012; Railroad Commission of Texas, 2013.
PREPARED BY: Knudson, LP, August 2014..

EXHIBIT 6-2

NORTH 0 2,700 ft.

2005 Land Use in the Vicinity of the Airport

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Table 6-2: 2005 AOI Land Use Breakdown

LAND USE CATEGORY	NUMBER OF PARCELS/ UNITS	TOTAL MARKET VALUE	AVERAGE PROPERTY VALUE	TOTAL AREA (ACRES)	PERCENT OF TOTAL LAND AREA
Agricultural	31	$ 3,125,170	$ 19,879/acre	157	2.0%
Commercial	413	$ 191,264,485	$ 8.36/SF	525	6.6%
Industrial	471	$ 164,824,735	$ 3.41/SF	1,110	13.9%
Multifamily Residential	7,531	$ 106,396,917	$ 14,128/unit	249	3.1%
Office	34	$ 24,333,581	$ 14.45/SF	39	0.5%
Parks / Open Space	46	$ 2,979,966	$ 48,035/acre	62	0.8%
Public/ Institutional	262	$ 0	$ 0.00/SF	1,610	20.1%
Residential Vacant	1,212	$ 15,644,326	$ 12,908/lot	359	4.5%
Single-family Residential	6,098	$ 602,781,168	$ 98,849/unit	2,046	25.4%
Transportation/ Utilities	49	$ 2,979,966	$ 0.23/SF	337	4.2%
Vacant/Underdeveloped/No Data	537	$ 33,603,681	$ 0.51/SF	1,514	18.9%
Total	**16,684**	**$1,147,933,995**		**8,008**	100.0%

SF = Square Feet

SOURCE: Harris County Appraisal District, July 2012.

PREPARED BY: UrbanCore Collaborative, Inc., and Knudson, LP, October 2013.

Table 6-3 shows the property value and total land area comparisons between 2005 and 2012 per HCAD and further illustrates the redevelopment opportunities (per the level of vacant land and low real property valuations). These are solid indicators that a successful and robust revitalization strategy could be implemented as the on-Airport terminal area improvements are made and as passenger demand increases. The targeted approach of City incentives and CIP improvement would be instrumental in driving a revitalization effort for the off-Airport properties. Commercial and industrial land uses increased in total land area in the study area in 2012 from 2005. Table 6-3 shows that the average property value for single-family residential units decreased $5,024 per unit between 2005 and 2012. The average property value for commercial land use decreased $2.96 per square foot over those seven years. Between 2005 and 2012, the amount of vacant land available in various land use categories decreased from approximately 1,514 acres to 869 acres. This suggests a growing development pattern within the study area boundary. All other land use categories have not changed significantly since 2005. The change in land use between 2005 and 2012 was not large enough to suggest a particular trend in future development within the study area. Real property redevelopment or revitalization is not occurring in a meaningful focused manner; therefore, land use patterns are scattered and, absent a City of Houston economic development strategy to influence land use patterns, it can be assumed that the land uses characteristics present in 2005 and 2012 will remain in 2020. Using economic tools to strategically realize a vision for off-Airport land uses and influence land use patterns could yield significant results in five to ten years.

Table 6-3: Change from 2005 to 2012 Land Use Comparisons

LAND USE CATEGORY	CHANGE FROM 2005 TO 2012 IN TOTAL MARKET VALUE	CHANGE FROM 2005 TO 2012 IN AVERAGE PROPERTY VALUE PER UNIT	CHANGE FROM 2005 TO 2012 IN TOTAL AREA (ACRES)	CHANGE FROM 2005 TO 2012 IN PERCENT OF TOTAL LAND AREA
Agricultural	$ 2,654,566	$ 9,124/acre	42	0.1%
Commercial	$ 110,552,400	($ 2.96/SF)	758	7.2%
Industrial	$ 185,550,358	$ 2.36/SF	284	6.7%
Multifamily Residential	$ 46,696,550	$ 5,168/unit	7	(0.3%)
Office	$ 12,873,121	$ 0.28/SF	19	0.1%
Parks/Open Space	($ 2,324,007)	($ 36,785/acre)	(4)	(0.2%)
Public/Institutional	$ 126,866,326	$ 1.53/SF	297	0.1%
Residential Vacant	$ 2,881,579	$ 8,144/lot	(57)	(1.2%)
Single-family Residential	($ 3,521,083)	($ 5,024/unit)	13	(3.1%)
Transportation/ Utilities	$ 2,054,437	$ 0.08/SF	62	0.1%
Vacant/Underdeveloped/No Data	$ 7,083,764	$ 0.56/SF	(645)	(9.5%)
Total	**$ 491,654,431**			

SF = Square Feet

SOURCE: Harris County Appraisal District, July 2012.

PREPARED BY: UrbanCore Collaborative, Inc., and Knudson, LP, October 2013.

6.1.2 LAND USE ANALYSIS

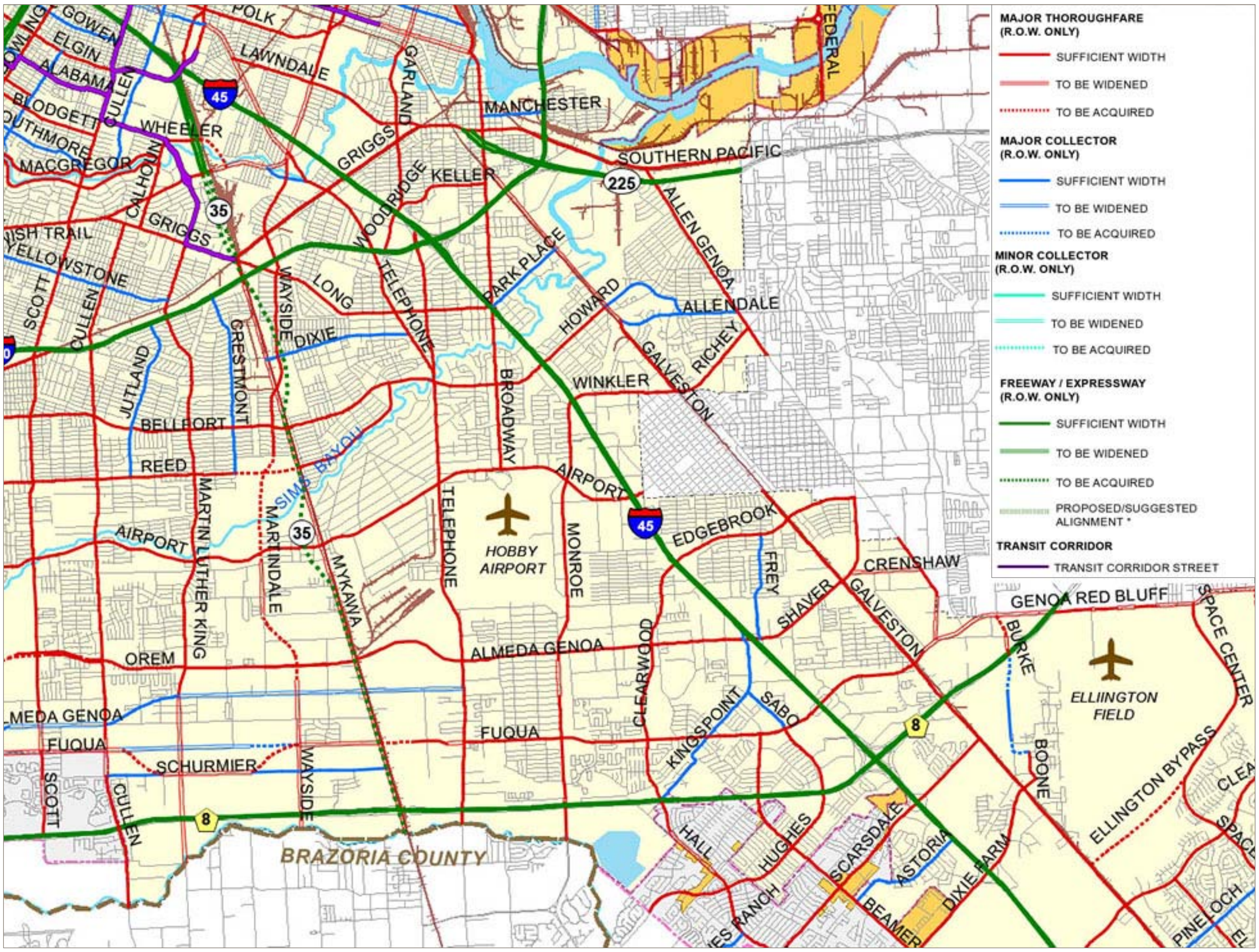
HOU is accessible by five major thoroughfare corridors. All roadways within the AOI are maintained by the City of Houston with the exception of Telephone Road, which is maintained by the Texas Department of Transportation. Understanding the existing land use pattern surrounding each corridor will help HAS prepare for redevelopment strategies unique to the areas surrounding the particular corridor. The creation of new arrival gateways from each major thoroughfare to HOU will require multiple property owners to participate in an area-wide economic development initiative along each corridor to facilitate the renaissance of the area. Unfortunately, there are too many small properties and too many multiple-property owners for a revitalization strategy to succeed with a “one property at a time” approach. Seeking public-to-public partnerships across political jurisdictions is equally as important as public-to-private partnerships for off-Airport redevelopment, and is critical to the success of such redevelopment.

Exhibit 6-3 is taken from the 2013 Major Thoroughfare and Freeway Plan (MTFP) for the City of Houston and shows the types of streets and connectivity surrounding HOU; these are described below.

- Major thoroughfares roads are designed for fast, heavy traffic, and are intended to serve as traffic arteries of considerable length and continuity throughout the community. The location of these streets is based on a grid system covering the area within the City's jurisdiction, which provides a theoretical spacing of major thoroughfares at one mile intervals. Major thoroughfares are divided into two classifications; principal thoroughfare and thoroughfare.
- Principal thoroughfares are public streets that collect traffic from collector streets and other major thoroughfares for primary distribution to the freeway system. They may be a highway and typically provide a high degree of mobility for long distance trips. Principal thoroughfares generally serve high-volume travel corridors that connect major generators of traffic such as: the central business district, other large employment centers, suburban commercial centers, large industrial centers, major residential communities, and other major activity centers within the urban area.
- Thoroughfares are public streets that accumulate traffic from collector streets and local streets for distribution through the thoroughfare and freeway system. These streets distribute medium to high volume traffic and provide access to commercial, mixed use and residential areas.
- Transit corridor streets are a rights-of-way or easements that METRO has proposed as a route for a guided rapid transit or fixed guideway transit system and that is included on the City's MTFP.
- Collector streets are public streets that accumulate traffic from local streets for distribution to the major thoroughfare streets. A collector street may be a minor collector or a major collector. Collectors streets are designed to provide a greater balance between mobility and land access within residential, commercial, and industrial areas.
- Major collectors are public streets that accumulate traffic from local streets and minor collectors for distribution to the major thoroughfare. A major collector street may have commercial, residential or have mixed uses abutting.
- Minor collectors are public streets that accumulate traffic from local streets for distribution into a major thoroughfare or a major collector. A minor collector typically has residential uses, however it may also serve commercial or mixed uses.
- Local street are public streets that provide access to individual single-family residential lots, provide entry and exit to the neighborhood, and provide connectivity to collectors and thoroughfares. In short, all other streets not previously listed are considered local streets that function to provide access from individual properties to the thoroughfare network.

Broadway Street, Telephone Road, and Airport Boulevard are classified as Principal Thoroughfares, Monroe Road is classified as a Major Thoroughfare and Almeda-Genoa Road is classified as a major collector.[1]

Exhibit 6-3: 2013 City of Houston Major Thoroughfare and Freeway Plan



SOURCE: City of Houston, 2013.

PREPARED BY: City of Houston 2013.

1 City of Houston, *2013 Major Thoroughfare & Freeway Plan*, http://www.houstontx.gov/planning/mobility/MTFP.html (accessed July 2014).

6.1.2.1 Broadway Street Corridor

Broadway Street is one of the primary corridors used to access HOU. The reconstruction of Broadway Street is a City of Houston CIP project designed to replace and widen the current four-lane paving section in 2014. Broadway Street is lined with deteriorating multifamily housing constructed in the 1970s and aging neighborhood retail development south of Sims Bayou. Property values along Broadway Street have declined since the 2003 Master Plan update was prepared. Aging multifamily land uses and retail are also impacting the adjacent single-family residential neighborhoods as evidenced by the 2013 HCAD property values. The changing demographics of the multifamily housing units along Broadway Street are changing neighborhood needs, such as the need for new schools. This corridor provides one of the best opportunities for revitalization with hotels, new multifamily housing in appropriate areas and revitalization of retail and office buildings. Broadway Street is approximately 1.85 miles long from Airport Boulevard to I-45. Neighborhood retail development is limited and few parks and recreational opportunities are evident. The *Airport Environs Image Plan,* prepared in 2003 as part of the 2004 HOU Airport Master Plan, recommends more commercial development and beautification of the corridors. Those recommendations are still relevant today and should be funded for 2014-2020 implementations. **Appendix G** shows a summary of the *2003 Airport Environs Image Plan*.

6.1.2.2 Airport Boulevard Corridor

The major land uses along Airport Boulevard are industrial and commercial, along with vacant land. Most of the commercial properties along Airport Boulevard are hotels/motels, surface parking lots, parking garages, and retail shopping centers. Most of the industrial properties are developed as warehouse/office space. Airport Boulevard is unique in that it is the proposed light rail transit corridor off Telephone Road for expansion of the METRORail to HOU, as shown on **Exhibit 6-4**. Land use incentives should be formalized now to incentivize redevelopment of the area. Airport Boulevard is a natural gateway to HOU for transit access as well as vehicular traffic from the I-45 corridor. Airport Boulevard has a good mix of hotels and restaurants, but also presents many redevelopment challenges. Airport Boulevard links Monroe Road and Telephone Road and provides a front door for HOU, yet the land use patterns are not necessarily conducive to a compatible economic development strategy for HOU. There are only three viable vacant parcels between two and three acres that may be suitable for midsize hotel development. The current market value of these vacant parcels ranges from $1.00 per square foot to $3.00 per square foot according to the HCAD, which is an extremely low property value for this location.

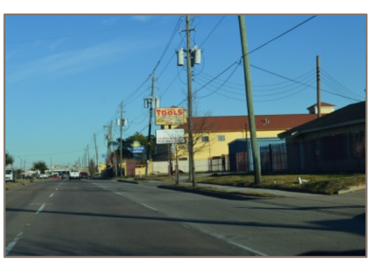
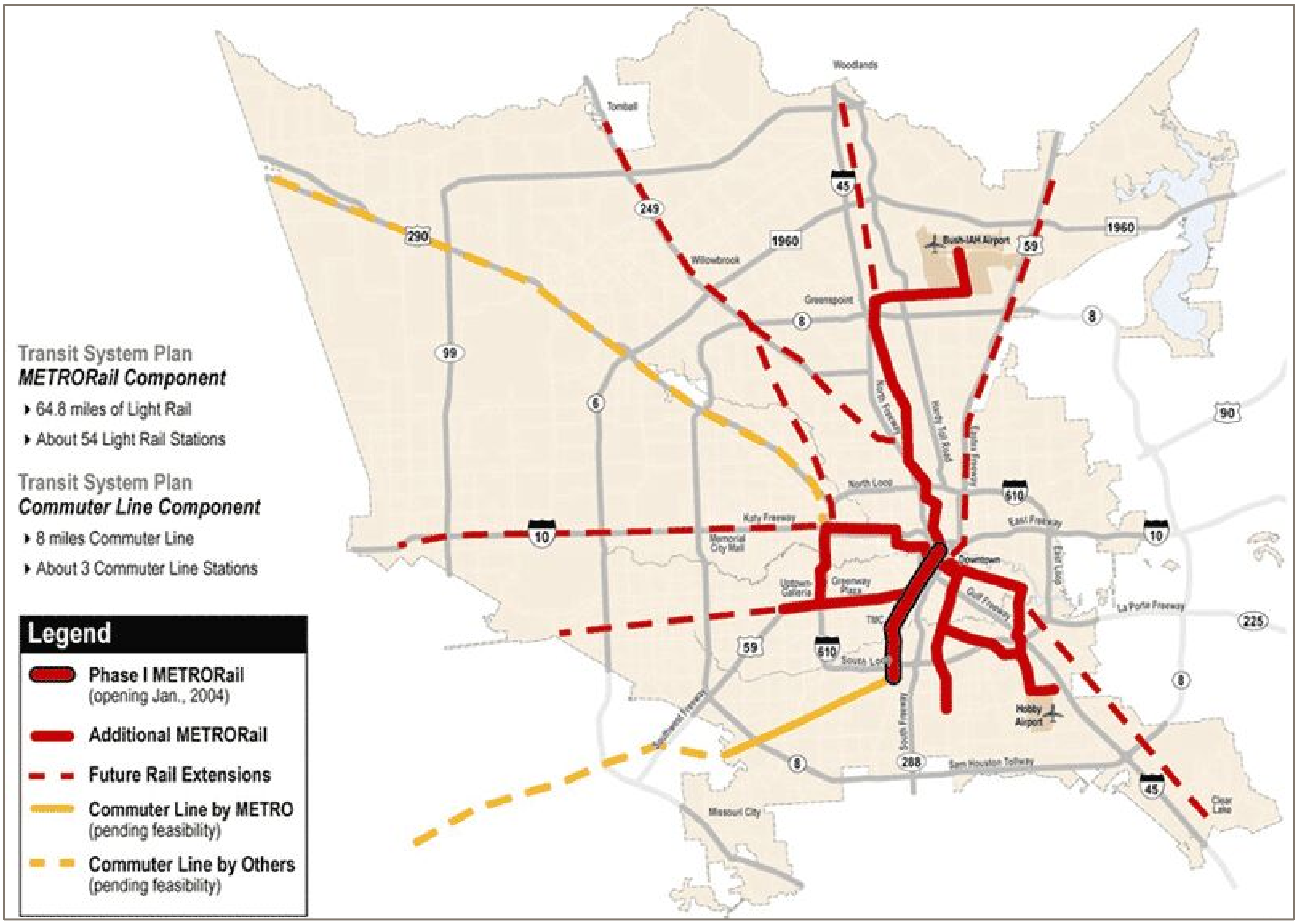


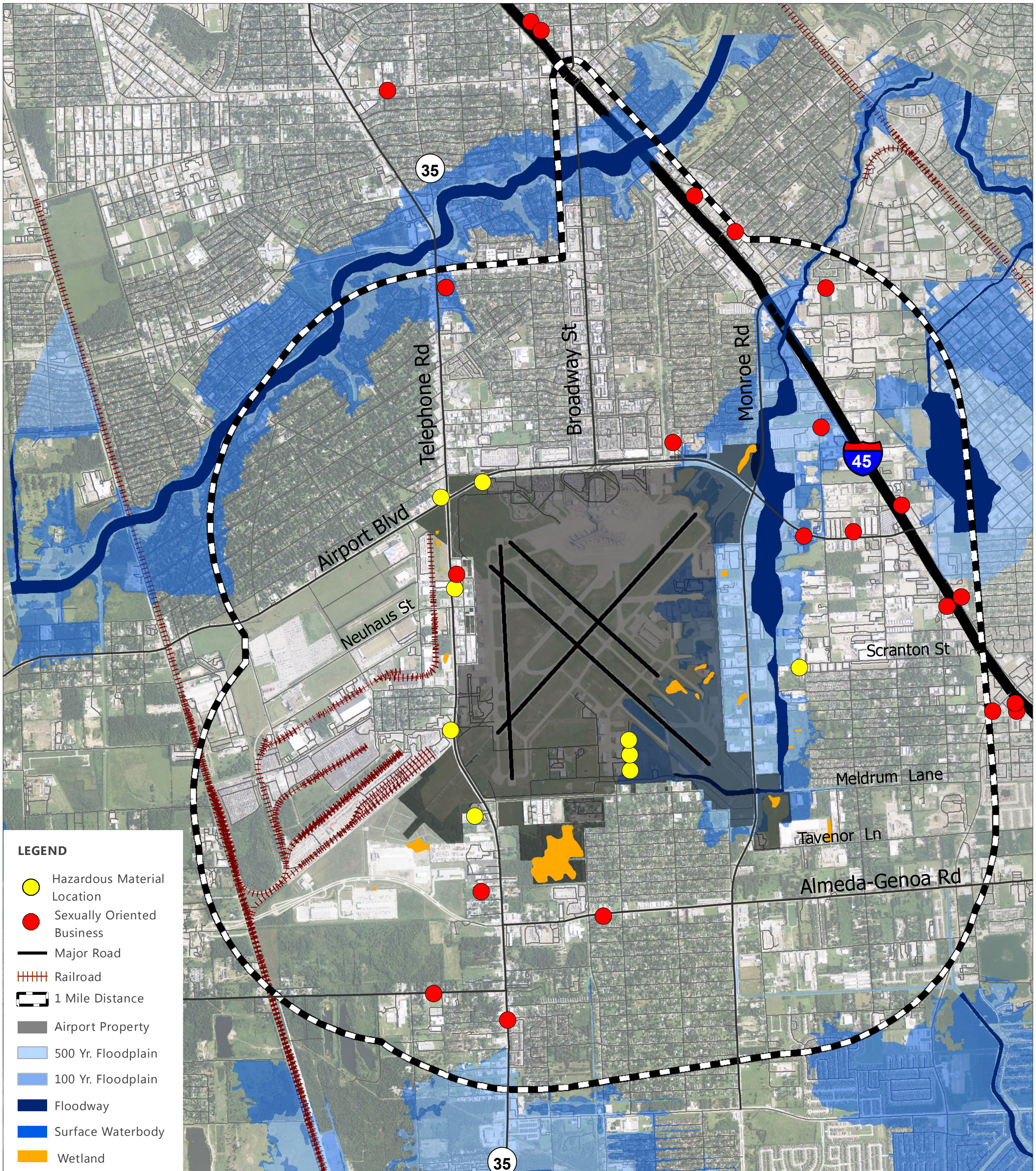
Exhibit 6-4: Rail Transit



SOURCE: LightRailNow!, *As Houston's Light Rail Project Nears Finish, Major Vote Looms Nov. 4th*, October 2003. http://www.lightrailnow.org/news/n_hou003.htm.

PREPARED BY: Metropolitan Transit Authority of Harris County, Houston, Texas, October 2003.

Airport Boulevard is home to many sexually oriented businesses, shown in red on **Exhibit 6-5,** which do not contribute to the quality of the environment necessary to create a development renaissance around HOU. The City has no planned CIP improvements along this corridor at this time.



SOURCES: H-GAC, HAS (OASIS), Harris County Appraisal District (HCAD) 2013.
PREPARED BY: UrbanCore Collaborative, Inc., May 2013.

EXHIBIT 6-5

NORTH 0 3,800 ft.

Land Use Development Challenges

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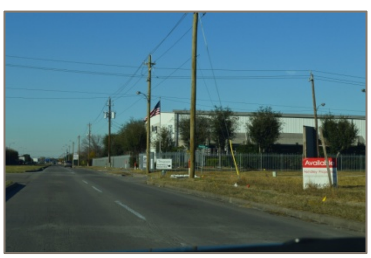
6.1.2.3 Telephone Road Corridor

The land uses surrounding this corridor are primarily commercial and industrial. The commercial properties are gas stations, automobile service garages, neighborhood strip centers, and a grocery chain store (large Fiesta). The industrial properties are mostly warehouses and automobile salvage yards throughout the length of the corridor. The City has no planned CIP improvements along this corridor at this time. Houston METRO is the transit agency for the Houston and Harris County. The METRORail Transit System Plan was adopted in the early 2000's: the plan includes nearly 73 miles of rail transit, shown in Exhibit 6-4, which, together with the 50 percent expansion of bus services, represents METRO's effort to deal with the projected two million new residents who will be in the Houston area by 2025 (the target year of full build out of the plan). Houston METRO operates both the bus and rail system for the region. Exhibit 6-4 shows the Phase 1 of the plan as adopted by METRO. Approximately 36 miles of the METRORail expansion is set to open by the end of 2014. However, the extension to HOU is not currently funded.

6.1.2.4 Monroe Road Corridor

Major properties along Monroe Road consist of industrial warehouses and retail commercial properties. A sizable vacant commercial parcel, available for sale at a fairly low property value ($322,044), provides an opportunity for redevelopment. The existing commercial properties are developed as gas stations with attached single-occupant retail stores. Many established industrial warehouses and manufacturing plants are located along this corridor. Multiple vacant commercial parcels are also available along Monroe Road, with parcel size ranging from two-acre to seven-acre tracts. Monroe Road provides a viable alternative as a gateway to HOU from the southeast. The vacant lots, along with a few surface parking lots at the intersection with Airport Boulevard, provide an excellent opportunity to develop a mid-sized hotel or a cluster of restaurants and bars. No CIP projects are planned along this corridor that would help with the City's infrastructure upgrade. This corridor will require substantial private development efforts to result in the needed changes that would add value to HOU.



6.1.2.5 Almeda-Genoa Road Corridor

The Almeda-Genoa Road corridor runs east-west, south of HOU. The primary land uses along this corridor are a row of public/institutional parcels, a few retail strip centers and industrial businesses with single-family residential units behind these land uses. Almeda-Genoa Road is a four-lane divided roadway. The area west of Telephone Road is mostly undeveloped. A significant amount of vacant land is located on the south side of HOU between Telephone Road and Monroe Road. The vacant land extends east to I-45, with the majority of vacant land north of Almeda-Genoa Road. This major thoroughfare corridor should be included in a defined revitalization strategy for the HOU area.

6.1.2.6 Planned Improvements of On-Airport and Major Streets within the Area of Influence

Most Capital Improvement Plans are short-range plans (four to ten years) that identify capital projects and equipment purchases, provide a planning schedule and identify options for financing the plan. Essentially, the plan provides a link between: (1) a municipality, school district, parks and recreation department and/or other local government entity, and (2) a comprehensive and strategic plan and the entity's annual budget. The City of Houston conducts public meetings on the City's Annual CIP in each council district. Since 1984, the City has held public meetings to obtain citizen input before preparation of the CIP. These meetings provide citizens the opportunity to participate in the CIP process by contributing comments and suggestions about needed services and improvements. The public meeting schedule is usually posted in early February of each year. The District information posted is updated annually after the last CIP Public Meeting held in the calendar year. The Capital Budget is a five-year plan updated annually, addressing the infrastructure needs for the City of Houston. The City of Houston CIP improvements within the study area and on HOU property are shown in **Appendix F.**[2]

6.2 Opportunities and Constraints

The development of land uses that are not compatible with airports and aircraft noise is a growing concern across the country. In addition to aircraft noise, there are other issues, such as safety and other environmental impacts to land uses around airports that need to be considered when addressing the overall issue of land use compatibility. Although several federal programs include noise standards or guidelines as part of their funding eligibility and performance criteria, the primary responsibility for integrating airport considerations into the local land use planning process rests with local governments. The objectives of compatible land use planning are to encourage land uses that are generally considered to be incompatible with airports (such as residential, schools, and churches) to locate away from airports and to encourage land uses that are more compatible (such as industrial and commercial uses) to locate around airports. The FAA has been actively supporting programs to minimize noise impacts.

Federal Aviation Regulations Part 150, Airport Noise Compatibility Planning, is the primary federal regulation guiding and controlling planning for aviation noise compatibility on and around airports. Part 150 establishes procedures, standards, and methodologies to be used by airport operators for the preparation of Noise Exposure Maps (NEM) and Airport Noise Compatibility Programs (NCP), which they may submit to the FAA under Part 150 and the Aviation Safety and Noise Abatement (ASNA) Act of 1979.

Part 150 provides for the following:

- Establishes standard noise methodologies and units;

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2 City of Houston, *Capital Improvement Plan*, www.houstontx.gov/cip (accessed July 2014.)

- Establishes the Integrated Noise Model (INM) as the standard noise modeling methodology;
- Identifies the land uses that normally are compatible or non-compatible with various levels of airport noise;
- Provides for voluntary development of NEM's and NCP's by airport operators;
- Provides for review of NEM's to insure compliance with the Part 150 regulations;
- Provides for review and approval or disapproval of Part 150 NCP's submitted to the FAA by airport operators, and;
- Establishes procedures and criteria for making projects eligible for funding as noise projects through the Airport Improvement Program (AIP).

DNL (Day-Night Average Sound Level) is the standard federal metric for determining cumulative exposure of individuals to noise. DNL is based on sound levels measured in relative intensity of sound, or decibels (dB), on the "A"-weighted scale (dBA). In 1981, the FAA formally adopted DNL as its primary metric to evaluate cumulative noise impacts on people due to aviation activities. This scale most closely approximates the response characteristics of the human ear to sound. The higher the number on the scale, the louder the sound. DNL represents noise exposure events over a 24-hour period. To account for human sensitivity to noise between the hours of 10:00 p.m. and 7:00 a.m., noise events occurring during these hours receive a "penalty" when the DNL is calculated. Each nighttime event is measured as if ten daytime events occurred.

Noise contours of specific DNL levels are developed using the FAA's Integrated Noise Model (INM). Airport-specific data used in the INM model to develop the contours results in the depiction of noise exposure in the vicinity of an airport. Airport-specific data used in the INM include: average daily operations, aircraft fleet mix, runway use, flight corridors and usage, departure destinations and day/night use.

Noise contours are a series of lines superimposed on a map of the airport's environs. These lines represent various DNL levels (typically 65, 70, and 75 dBA). DNL noise contours are used for several purposes:

- Noise contours highlight existing or potential areas of significant aircraft noise exposure (as defined by the FAA).
- Noise contours are used to assess the relative aircraft noise exposure levels of different runway and/or flight corridor alternatives.
- Noise contours provide guidance to political jurisdictions in the development of land use control measures. These measures include zoning ordinances, subdivision regulations, building codes, and airport overlay zones. 3

[3] Federal Aviation Administration, Part 150 Land Use Compatibility, http://www.faa.gov/airports/environmental/airport_noise (Accessed August 2014).

The FAA considers areas within the 65, 70, and 75 DNL noise contours to be the most impacted by aircraft-generated noise. Under the 65 DNL noise contour, noise is most noticeable in areas below established flight corridors.

To implement effective land use planning and control measures around airports, it is necessary to identify specific planning boundaries. These boundaries will define the airport environs for land-use planning purposes. It is essential that airport owners, elected officials, land-use planners and developers understand the components of an effective compatible airport land-use plan. A land use plan incorporates federal and state airport design criteria, safety of flight requirements, land use provisions, and economic development strategies unique to the community. Safety zones, standard traffic patterns, over flight areas, noise contours and FAR Part 77 height restriction criteria should be considered as "building blocks" by land-use planners when developing zoning ordinances, airport overlay districts, comprehensive land use plans or economic development strategies for their community. A land use plan for airport-compatible land uses should include an area large enough to consider all these factors.

Besides the effects of noise on land use compatibility, the FAA also assesses the compatibility of land uses in the vicinity of an airport to ensure these uses do not adversely affect safe aircraft operations. The City of Houston's City Council passed Chapter 9 of the Code of Ordinances, Houston, Texas, "Airport Hazard Area Regulations Ordinance" on December 16, 2009, and made effective March 1, 2010. This ordinance made it unlawful to create or maintain any electronic emission, visual effect or other object or activity in an airport hazard area that adversely affects the operation of aircraft. It also made it unlawful to plant or permit to grow any object of natural growth whose typical height at maturity will penetrate any airport hazard notification surface.

The 2030 noise contours for HOU will result in redevelopment constraints northwest of HOU. If the 2030 land use were to stay the same as it is today, there would be 498 occupied single-family residential parcels, 53 vacant residential parcels and two places of worship within the updated 2030 65 DNL. Within the updated 2030 70 DNL, there would be 48 occupied single-family residential parcels, seven vacant residential parcels and one place of worship. There would be one occupied single-family residential parcel within the updated 2030 75 DNL. **Table 6-4** provides a number of current non-compatible land uses within the updated 2030 noise contours of 65, 70, and 75 DNL. When redevelopment occurs, it will be important to verify the compatibility of land uses, especially northwest of HOU and within the updated 2030 noise contours, due to the proposed upgrade of Runway 12L-30R and the proposed decommissioning of Runway 17-35.

Table 6-4: Sensitive Land Uses within the 2030 Noise Contours

NOISE CONTOUR	SINGLE FAMILY RESIDENTIAL OCCUPIED/VACANT	MULTI-FAMILY UNITS	SCHOOLS	CHURCHES
Between 65 DNL and 70 DNL	551	363	1	2
Between 70 DNL and 75 DNL	55	13	0	1
Within 75 DNL	1	0	0	0

SOURCES: Harris County Appraisal District, Houston-Galveston Area Council, August 2012.
PREPARED BY: Knudson, LP, September 2014.

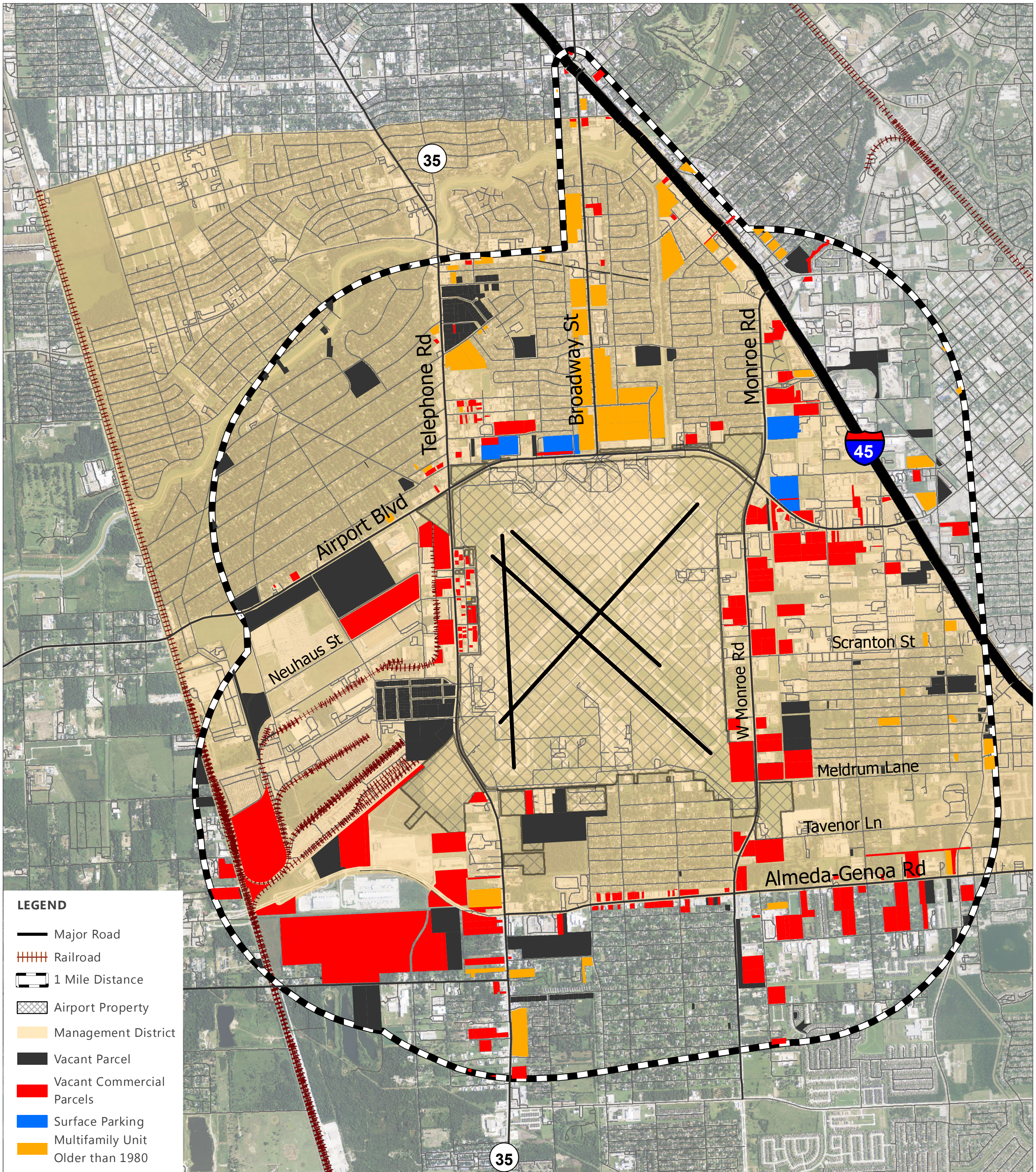
The off-Airport private properties in the vicinity of the Airport are very attractive candidate sites for redevelopment. The study area includes the five major thoroughfares serving Hobby Airport with primary vehicular access. It has the potential to be redeveloped over time and may be provided with light rail access along Telephone Road to Airport Boulevard. In addition, a major image plan is needed for these corridors to improve their visual aesthetics. Currently, the land uses in the study area are mixed, providing a variety of services and everyday shopping needs. Opportunities to improve the current land uses over the next five to ten years are clear, but the thoroughfare corridors cannot be redeveloped without an area-wide City initiative of incentives that trigger revitalization and, in turn, add value to the Airport environment. **Table 6-5** provides a list of opportunities for and constraints to redevelopment around the Airport boundary. **Exhibit 6-6** identifies current vacant tracts in red with no improvements, ready for development of hotels and/or retail centers in the AOI. A majority of the raw land is along Almeda-Genoa Road, Monroe Road and Airport Boulevard. Surface parking lots are shown in blue and identify areas of opportunity for a higher and better use of those lots or areas in which a higher density of parking is recommended, such as vertical parking structures. Existing multifamily residential tracts are shown in orange. These multifamily units were built in the 1970s and the property values have been declining over the last ten years, which make these tracts good candidates for redevelopment; new housing products are a better investment than upgrading the existing apartments. Land located within the 100-year flood plain, as shown in Exhibit 6-5, could be purchased by Harris County Flood Control, the Hobby Area Management District and/or the City to create park and open space area for the AOI.

Table 6-5: Development Opportunities and Constraints around the Airport

OPPORTUNITIES	CONSTRAINTS
Market	
Strong projected population and employment growth in short term	Requires area wide city economic development incentives Economic market subject to state and national economy. Forecast for oil and gas in Texas slowing in 2015 according to Greater Houston Partnership
Increased market for commercial, retail, and residential uses to support new International Terminal	Requires robust economic development incentives to jumpstart initiative; Lack of CIP funding for public project implementation
Land Use	
Predominance of older multifamily units (more than 30 years old) along Broadway Street corridor good are candidates for redevelopment	Sexually oriented businesses along Airport Boulevard and Telephone Road
Large vacant commercial and industrial lots on the west side of the Airport along the Telephone Road and Monroe Road corridors	Automobile-oriented land uses
Surface parking lots along Airport Boulevard	Rundown condition of commercial development along Telephone Road and Broadway Street corridors
Mid-size sites along Broadway Street, Monroe Road, and Airport Boulevard for hotel development	Lack of connectivity between different uses
Airport Management district created to provide security for off airport property owners	Management District has not secure petitions necessary to tax property owners within the Management District to implement safety and security objectives of the Management District.
Transportation	
Good freeway access with pending rail line extension planned by METRO	Gateways along major thoroughfares are not attractive and land uses detract from redevelopment. No CIP funding for gateway improvements.
Future light rail transit stations along Telephone Road and Airport Boulevard connecting HOU to 33 miles of Houston Rail lines	Timeframe for extension is not funded.
Good regional bus service to be improved via Imagineering METRO study a new program being launched in 2014 which will identify local bus service improvements. by	Program recommendations should include access to HAS facilities and be timed for implementation as a priority.

SOURCE: UrbanCore Collaborative, Inc., September 2013.

PREPARED BY: UrbanCore Collaborative, Inc., September 2013.



SOURCES: H-GAC, HAS (OASIS), Harris County Appraisal District (HCAD) 2013.
PREPARED BY: UrbanCore Collaborative, Inc., May 2013.

EXHIBIT 6-6

NORTH 0 3,800 ft.

Land Use Opportunities and Constraints in the Vicinity of the Airport

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6.2.1 BUSINESS CATEGORIES THAT FAVOR THE AIRPORT ENVIRONS

A 2012 study indicates that the new international terminal and resulting competition to near-international destinations will generate more than 10,000 jobs across the Greater Houston metropolitan area and will provide an economic impact of $1.6 billion. The study estimates that the terminal will bring an additional 1.6 million passengers annually to HOU.[4]

Business categories that would be encouraged with the new international terminal would include hotels and new retail and restaurants catering to Latin American travelers.

6.2.2 PROPERTY OWNERSHIP PATTERNS THAT MAY IMPEDE OR ENHANCE POTENTIAL REDEVELOPMENT

An estimated 2,000 acres of vacant or underdeveloped commercial, industrial, aging multifamily apartments, and retail land uses, as well as surface parking lots, are available for redevelopment and could be used for a focused revitalization effort by the City to incentivize land uses compatible with the AOI. However, there is a total of 16 sexually-oriented businesses that operate in the study area, seven of which are located on the main corridors approaching the terminal area. New development along Monroe Road between Airport Boulevard and Almeda-Genoa Road should be avoided, because the area is within the 100-year floodplain. Building in floodplain areas requires many mitigation measures that are not only costly, but also create impediments to the building permit process.

The primary corridors, based on physical location for terminal approach and available development or redevelopment opportunities, are Broadway Street, Monroe Road (northern section from I-45 to Airport Boulevard), and Airport Boulevard (I-45 to Telephone Road).

One complex issue that must be resolved is the conversion of previously approved multifamily apartments into condominiums located at 8200 Broadway Street. These conversions did not follow local or state requirements, but nonetheless occurred over the last ten years, thus complicating revitalization of two large multifamily residential projects. Other economic development tools may be needed to assist in the redevelopment of those converted apartment buildings, which primarily were purchased by immigrants relocating to Houston. Designation of a Neighborhood Empowerment Zone (NEZ) may be a better tool to implement in working with the homeowners, as well as partner with the Houston Housing Authority, to provide financing for the building improvements.

The 2004 William P. Hobby Airport Master Plan Update identified the need for creation of an Image Plan (Appendix G) that could be implemented within the public right-of-way to improve and enhance the visual corridors serving HOU. This plan is even more important today with development of the new Hobby International Terminal to revitalize the AOI. The Rebuild Houston website indicates that the surrounding area requires additional improvements for stormwater and flood abatement. The visual appearance of all gateway

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[4] Houston Airport System, *What to Expect at Hobby Airport*, www.fly2houston.com/HOUPlan (accessed July 2014).

major thoroughfare corridors should be enhanced with trees, wider sidewalks, wayfinding, and decorative lighting announcing the arrival to HOU.

6.2.3 OPPORTUNITIES FOR ENHANCEMENT AND IMPROVED PUBLIC RIGHT-OF-WAY

Streetscape refers to urban roadway design and conditions as they impact street users and nearby residents. Streetscaping recognizes that streets are places where people engage in various activities including, but not limited to, motor vehicle travel. Streetscapes are an important component of the public realm (public spaces where people interact), which help define a community's aesthetic quality, identity, economic activity, health, social cohesion and opportunity, not just its mobility. Streetscaping can include changes to the road cross section, traffic management, sidewalk conditions, landscaping (particularly tree cover), street furniture (utility poles, benches, garbage cans, etc.), building fronts, and materials specifications. It also involves improving signage for all users of the roadway. Streetscapes can have a significant effect on how people perceive and interact with their community. If streetscapes are safe and inviting to pedestrians, people are more likely to walk, which can help reduce automobile traffic, improve public health, stimulate local economic activity, and attract residents and visitors to a community. To be considered a gateway to HOU, the rundown condition of the properties along the Broadway Street corridor require significant upgrades in terms of street infrastructure, redefinition of curb-cuts, drainage and lighting for safety, improved streetscape and landscaping or other beautification treatments. Improved streetscape and the addition of public art along Broadway Street, Monroe Road and Airport Boulevard will enhance the AOI. All thoroughfares within the AOI are at sufficient width per the 2013 MTFP.[5]

6.2.4 GROUND TRANSPORTATION ACCESS TO THE AREA

Ground transportation access to the area includes private vehicles (owned/hired/rented), METRO buses, and taxicabs. METRO buses serve the Hobby Transit Center, located at Curbzone 13, outside of the baggage claim area at the lower level. This location has no parking area. Routes 50 Harrisburg / Heights, 73 Bellfort Crosstown and 88 Hobby Airport operate through the Hobby Transit Center.[6]

Approximately 500,000 additional passengers are anticipated at HOU in the first year of international airline service. Many of these passengers will originate from (or be destined to) the City of Houston, and therefore will travel through the AOI as part of their journey. By 2020, the forecast growth is projected to be 900,000 passengers annually. To improve the image of the Airport and to improve the travel experience of passengers going through the AOI, land uses and services immediately adjacent to the major corridors serving HOU should be transformed into higher real estate property values to support the services needed by the Airport. Land uses such as hotels, restaurants, and commercial businesses would all be compatible with the Airport and would support travelers. Economic development strategies should be area-based and be focused on

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5 Victoria Transport Policy Institute, *Streetscape Improvements*, http://www.vtpi.org/tdm/tdm122.htm (accessed July 2014).

6 Metropolitan Transit Authority of Harris County. *Hobby Transit Center*, http://www.ridemetro.org/SchedulesMaps/TransitCenter/Hobby.aspx (accessed July 2014).

promoting compatible Airport-related land uses that will drive redevelopment of the area in support of the new international operations.

6.2.5 ECONOMIC DEVELOPMENT INCENTIVES

A number of economic development incentives are available under state or local law to encourage development and redevelopment around the AOI.

The neighborhoods (Golfcrest/Bellfort/Reveille), located north of Airport Boulevard, west of I-45, south of I-610, and east of Mykawa Road, are in an area eligible for a CDBG. Houston is an entitlement city and receives CDBG funds annually. The CDBG-funded projects are selected through development of a funding program initiated by the City and approved annually by City Council. Proposed CDBG-funded projects must be consistent with broad national priorities for CDBGs: activities that benefit low- and moderate-income people, such as the prevention or elimination of slums, blight, or other community development activities to address an urgent threat to community health or safety. CDBG funds may be used for community development activities (such as the acquisition, relocation, demolition, or rehabilitation of housing and commercial buildings), construction of public facilities and improvements (such as water, sewer, and other utilities, street paving, and sidewalks), construction and maintenance of neighborhood centers, redevelopment of school buildings or other public facilities suitable for reuse, public services, and economic development and job creation/retention activities. CDBG funds can also be used for preservation and restoration of historic properties in low-income neighborhoods. CDBG funds could be leveraged for a component of the redevelopment of the area for off-airport properties.

Nationally, CDBG funds were allocated to the following purposes in 2011:

- Public infrastructure (32.7 percent)
- Housing (24.8 percent)
- Administration and planning (15.1 percent)
- Public services (11.4 percent)
- Economic development (7.3 percent)
- Property acquisition (4.9 percent)
- Other (3.8 percent)

Most of the area around HOU is located in a CDBG Target Area, and coordination of proposed improvements is recommended to meet both City and HAS community goals. Funds from various federal sources can also be leveraged with Congestion Mitigation Air Quality (CMAQ) funds from the Houston-Galveston Area Council, as well as other programs.

6.2.5.1 Chapter 380/381 Texas Local Government Code

Chapter 380 agreements refer to an economic development tool for cities allowed under Chapter 380 of the Texas Local Government Code. Chapter 381 agreements are similar, but extend the same powers to counties under Chapter 381 of the Texas Local Government Code. Houston has extensively used Chapter 380 agreements over the last four years. Harris County has also initiated a Chapter 381 program. These two sections of the state law grant authority to allow cities and counties to provide contractual economic incentives, consisting of loans and public grant funds, to use for development and redevelopment of facilities and services. Developers receive cash reimbursement or other considerations based on the newly created increment, generated by sales or real property values.

Under Mayor Annise Parker, the City has pioneered the use of Chapter 380 agreements to incentivize over $2 billion in new real property values since 2010, generating over $13 million annually in new City tax revenue. These agreements can be used for public or private improvements, but the City has elected to only allow Chapter 380 agreements for public improvements. The City has used Chapter 380 agreements for asbestos abatement and demolition, which will be needed for the multifamily dwelling units constructed in this immediate area in the 1970s. These agreements can be used for remediation, water, sewer, drainage, paving, parks, and streetscapes in support of private development. These agreements also can be established for 10- to 40-year terms or longer, as determined by the City Council. The term of the agreements is typically driven by the City Council-approved agreements that outline the eligible projects and total value of the proposed projects outlined in the developer agreement. These agreements are very flexible and would be ideal for redevelopment along the major thoroughfare corridors to support the revitalization of off-Airport land uses. These City-approved agreements can be used to incentivize hotel/convention facilities, housing, and commercial, retail, and industrial properties around the Airport. In October 2013, the City created its first area Chapter 380 Program to mitigate blight in the Westchase District from declining multifamily developments and aging retail establishments. The Houston City Council adopts ordinances creating the Chapter 380 agreements, which can be adopted for an area or a single property or development.

The City Council determines terms and levels of funding up to 100 percent of the funds available. The City can use this incentive to drive the vision for off-Airport development that would complement the new International Terminal at HOU.

6.2.5.2 Municipal Management Districts

Municipal Management Districts (MMD) are created by the Texas State legislature by special legislation (Texas Local Government Code Section 375.001). A MMD is a geographic area defined at the time the District is created. The documents creating the districts outline the project plan, the eligible project improvements, and the proposed tax or assessment, as applicable. The MMD provides for an overlapping tax or assessment on the commercial real property located within the MMD. This overlapping tax/assessment is used to finance facilities, infrastructure, and services beyond those already provided by the county or municipality. The improvements may be paid for by a combination of self-imposed property taxes, special assessments and impact fees, or by other charges against property owners within the MMD. The Hobby Management District was created in 2007 by special legislation. At the time of preparing this master plan update, the district has not secured the necessary petitions to implement their plan.

6.2.5.3 Neighborhood Empowerment Zones

Texas Local Government Code Section 378.002 - Neighborhood Empowerment Zone (NEZ) — allows creation of an NEZ as a designated area where municipalities can offer economic incentives that promote investment and redevelopment. According to Chapter 378 of the Texas Local Government Code, an NEZ must be created for at least one of the following purposes: the creation and rehabilitation of affordable housing (including manufactured housing), economic development opportunities, or an increase in the quality of social services, education, or public safety.

An NEZ is beneficial in revitalizing areas within a municipality that are in need of physical, economic, and social rehabilitation. An NEZ has greater flexibility and power to remove unwanted elements from the area and promote new housing, business, and social services than a local government has in and of itself.

Specifically, within an NEZ, a municipality may:

- Waive or adopt fees for construction of new buildings, including inspection and impact fees;
- Enter into agreements, not to exceed 10 years, for refunds of municipal sales tax for sales made within the zone;
- Abate municipal property taxes, subject to a time limit, and;
- Set performance standards to encourage the use of alternative building materials that will benefit the environment through reduced maintenance needs and/or energy consumption.

To form an NEZ within Texas, a municipality must adopt a resolution stating the proposed purpose of the NEZ, a description of its boundaries, and a finding by the governing city that the NEZ will benefit the public health, safety, and welfare of the community.

Any tax abatements in an NEZ must conform to the guidelines of Title 2, Subtitle B, Chapter 312 of the Texas Tax Code, the Property Redevelopment and Tax Abatement Act. Individual municipalities may have additional eligibility requirements to establish NEZs or additional requirements for NEZs to qualify for particular incentives. This incentive should be explored for the areas around HOU, specifically those with declining surrounding property values and opportunities for compatible single-family housing revitalization.

Through the NEZ program, building permit fee waivers, release of city liens, municipal property tax abatements, and sales tax refunds can be granted to homeowners, investor-owners, and developers proposing new construction projects or rehabilitation projects within the NEZ.

6.2.5.4 Public Improvement Districts

Establishment of a Public Improvement District (PID) – Texas Local Government Code Section 372.001 – provides for the cost of improvements benefiting a commercial area to be spread equally among all properties. City Council action is required to establish a PID. Upon the development of a PID Plan that outlines eligible project costs and estimated assessments, the City may levy a special assessment on property owners within the PID boundaries. The assessment is based on property tax values and the level of improvements proposed. The findings at establishment of the PID must include the benefits from the proposed improvements and the corresponding assessments. These assessments may be used to pay the debt service on bonds or they may be used to pay for services directly if no bonds are issued. PID funds may be used to purchase real property in connection with improvements. Improvements include enhancements to water and wastewater facilities, streets, drainage, parking, landscaping, and the like. The terms of a PID can be for a defined period of time or terminated early upon satisfactorily paying off any obligations, including debt service or direct pay to a developer. The PID Plan can be amended as deemed necessary by the City Council.

6.2.5.5 Tax Abatements

A project may be eligible for tax abatement – Texas Tax Code Section 312.002 – if it relates to a business or manufacturing facility, research facility, distribution center, regional service facility, basic industry, or other facility "deemed essential to the City's growth." A project may be eligible for the abatement of up to 100 percent of taxes and for as long as ten years, depending upon the amount of expenditure and/or the number of employees affected. Reinvestment in an existing project or expansion of existing facilities may also be eligible for tax abatement.

6.2.5.6 Tax Increment Reinvestment Zones

A Tax Increment Reinvestment Zone (TIRZ) is allowed under Section 311.002 of the Texas Tax Code. The City of Houston has created 25 TIRZs over the last 20 years. A TIRZ is ideal for geographically large economic development districts with multiple property owners. The TIRZ is created by the City Council and enables the City to offer incentives to redevelop an area in a manner that is conducive to the vision of the City improving the overall area, creating higher property values, and increasing sales tax collection. A TIRZ can be used for onsite and offsite public improvements and the term of the TIRZ can be as long as the City deems reasonable to revitalize a geographic area. These zones have been highly successful in transforming certain neighborhoods and communities in the Houston region. The newly created tax increment from the TIRZ is used to reimburse the developer. The developer advances all funds and reimbursement is based on performance. The eligible costs of the improvements within the TIRZ are repaid by the contributions of future tax revenues of the participating entities that levy taxes on affected properties. Once the City initiates tax increment financing, counties and junior colleges may also participate in the tax increment financing program. The TIRZ is not a tool for providing incentives for private development improvements, but can be leveraged with the Chapter 380/381 programs, which can provide incentives for private improvements.

6.2.5.7 Texas Emerging Technology Fund

The Texas Emerging Technology Fund (TETF) is a technology investment fund created by legislation in 2005 at the urging of Governor Rick Perry to provide Texas with an unparalleled advantage in the research, development, and commercialization of emerging technologies. The enabling legislation (Texas HB1188 of the 79th Legislature) launched the ETF with $200 million to help create jobs and develop the economy of Texas. The fund works through partnerships among the State, institutions of higher education, and private industry and is dedicated to three areas: Regional Centers of Innovation and Commercialization; matching grant funds for research and development projects that accelerate commercialization and that have demonstrated an ability to receive or have received federal grants or non-State grants; and assisting Texas public universities in attracting renowned research teams from universities and institutions in other states.[7]

6.2.5.8 Texas Enterprise Zone Program

The Texas Enterprise Zone Program (TEZ) – Texas Local Government Code Section 2303.002 – is an economic development tool for local communities to partner with the State of Texas to promote job creation and capital investment in economically distressed areas of the state. Companies may qualify for refunds of State sales tax paid on eligible items used at the qualified business site. The total amount of any refund is predicated on the investment amount and the number of jobs created/retained at the qualified business site. To qualify, companies must commit that at least 25 percent of their new employees will meet economically disadvantaged or enterprise zone residence requirements if the company is locating or expanding into one of the State's enterprise zones. If the company is not locating in one of the State’s enterprise zones, then it must commit that at least 35 percent of its new employees will meet economically disadvantaged or enterprise zone residence requirements.[8]

6.2.5.9 Texas Product Development/Small Business Fund

This fund provides financing to aid in the development, production, and commercialization of new or improved products within the State, and provides financing to foster and stimulate the development of small and medium-sized businesses in Texas. Special funding preference is given to emerging technologies, including semiconductors, nanotechnology, biotechnology and biomedicine, renewable energy, and aerospace. Additional preference is given to applicants who have acquired other sources of financing, have formed companies in Texas, and who are receiving assistance from designated State small business development centers or through the Small Business Innovation Research program. Products appropriate for the fund are inventions, devices, techniques, or processes that have advanced beyond the theoretical stage and are ready for immediate commercial application. Preference for funding is given to the State's defined industry clusters within emerging technology fields, including semiconductors, nanotechnology, biotechnology and biomedicine, renewable energy, agriculture, and aerospace. The fund is self-supporting,

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7 State of Texas, *Texas Emerging Technology Fund*, http://governor.state.tx.us/ecodev/etf (accessed July 2014).

8 Texas Ahead, *Texas Enterprise Zone Program*, http://www.texasahead.org/reports/incentives/tezp.php (accessed July 2014).

paid for by the program loan participant's repayments. Thus, the loan repayments are to be structured to fully pay the costs of issuance and program administration. Pursuant to Government Code 489.213 (c), loan participants must provide appropriate security or collateral, equity interest, and the rights and remedies of the board and bank in the event of a default on the loan.[9]

6.2.6 POTENTIAL INFLUENCE OF PLANNED ON- AND OFF-AIRPORT DEVELOPMENT OPPORTUNITIES

The development of international air service at HOU has created the sense of urgency that is necessary to focus on off-Airport revitalization strategies that could improve access to the Airport via any of the five major thoroughfare corridors. The revitalization strategies should include public-to-public, as well as public-to-private, programs. The amount of vacant land and opportunities for redevelopment of aging multi-family land uses should be leveraged to improve the corridors that act as a gateway to HOU, but also provide revitalization for the property owners in the area.

The amount of vacant land surrounding HOU presents an opportunity to target development that is compatible to HOU and an asset to the new international traveler, as well as the adjacent neighborhoods. The *2003 Airport Environs Image Plan* should be used as a guide for public works plans, as well as public/private economic initiatives for the area. The result of concerted economic development strategy would be an increase in real property values, and a subsequent increase in Sales and Hotel Occupancy Tax collection.

6.3 Framework Plan (Area Concept Plan)

The Area Concept Plan is intended to provide an overview of the layout and design features of development expected to take place in the Airport area. The concept plan, shown on **Exhibit 6-7**, provides a visual interpretation of the potential development patterns for the Airport area.

HOU is a gateway to the Houston region and should create a good first impression on travelers arriving at HOU, and provide a positive image of the City as a whole. The exterior spaces and building faces along major corridors such as Telephone Road, Airport Boulevard, Broadway Street, and Monroe Road, are critical in forming an identity for the area. Landscape and building materials should reflect HOU's local and regional setting and should introduce travelers to regional amenities, such as access to the Texas Gulf Coast, the cruise industry at the Port of Houston and Port of Galveston, NASA facilities, the oil and gas hub, and the bayous and native sanctuaries in the area. The HOU gateway to the new international airport should include implementation of the *2003 Airport Environs Image Plan*, as shown in Appendix G, by providing wayfinding, streetscape and public art located at each major intersection, as shown in Exhibit 6-7.

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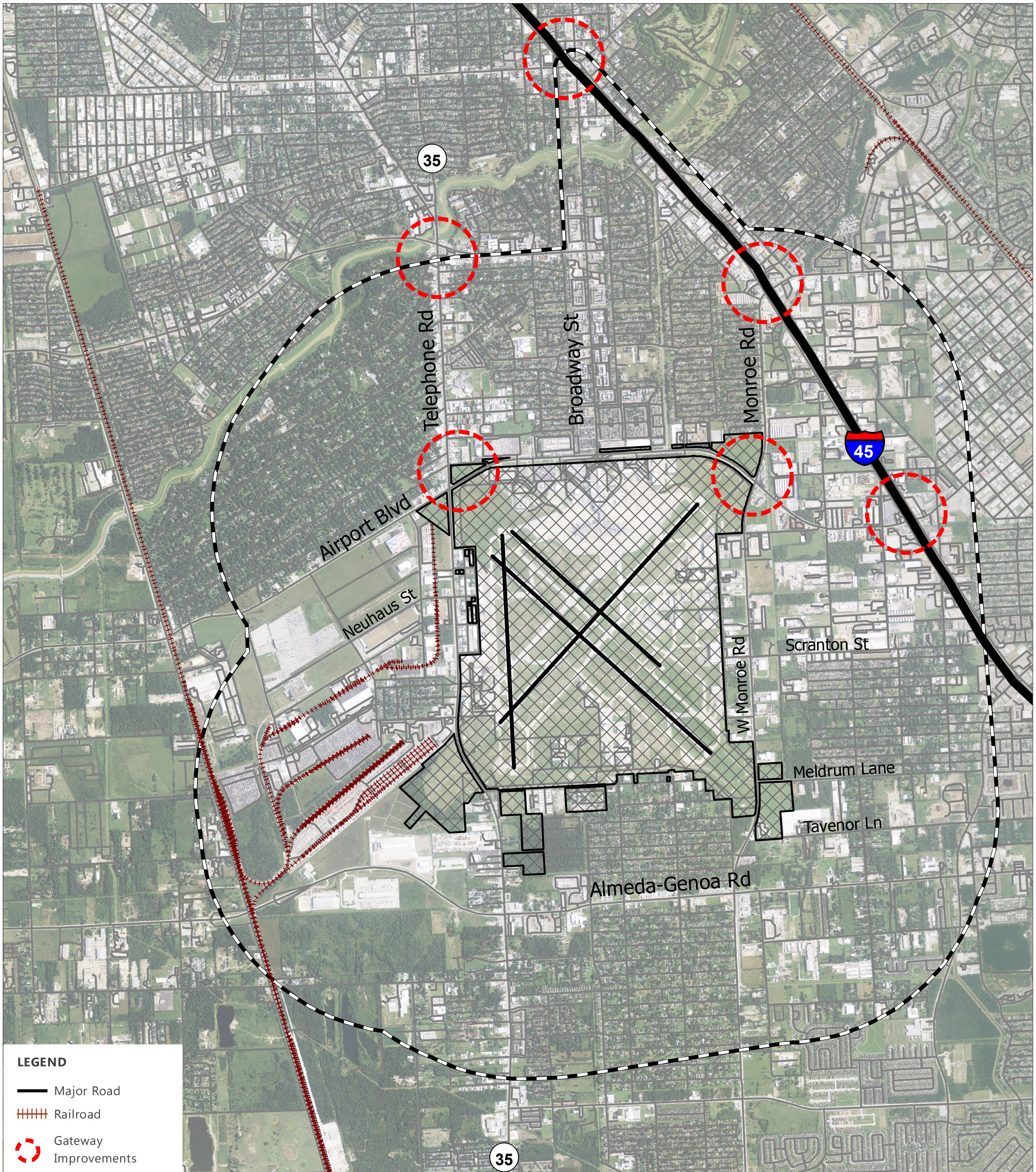
[9] State of Texas, *Texas Product / Business Fund*, http://www.texaswideopenforbusiness.com/incentives-financing/financing/product-fund.php (accessed July 2014).



SOURCES: H-GAC, HAS (OASIS), Harris County Appraisal District (HCAD) 2012.
PREPARED BY: UrbanCore Collaborative, Inc., September 2013.

EXHIBIT 6-7

NORTH 0 3,800 ft.

Area Concept Plan

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Major Airport signage and area-wide designed landscape monumentation features should be created at each major thoroughfare corridor announcing the arrival to Hobby. This family of landscape architecture monumentation could be in the form of signage and public art. The dual design opportunity would be conducive to the nearby residential community. Residential neighborhoods surrounding the HOU should also be incorporated in the overall Area Concept Plan to promote the compatible residential development characteristics of streets entering the adjacent neighborhoods, and to promote the sustainable protection of those areas.

The economic development strategies should include onsite and offsite beautification elements as a component of the public-private partnerships between the private sector and the City. If a developer is offered incentives, the incentives should include extending improvements beyond the project site boundaries. Infrastructure should be required offsite and onsite to ensure that the City's overall vision can be implemented strategically, providing catalytic revitalization opportunities for other projects in Houston.

6.3.1 POTENTIAL NONAERONAUTICAL ACTIVITIES

This section identifies potential nonaeronautical activities that could be attracted to the Airport in support of the new Federal Inspection Services facility. With the addition of international flights at HOU, the Airport area will attract many new retail, commercial, office, and industrial developments on and off the Airport. The areas immediately adjacent to HOU may attract:

- Services directly supporting operation of the Airport (additional flight kitchens, aircraft maintenance services)
- Services for airline employees and passengers (additional hotels, restaurants, and additional rental car facilities)
- Additional Airport-related freight services (shipping, freight forwarding, Customs, and foreign trade zone)

In addition, business activities within 15 minutes of the Airport are referred to as "spin-off industries." These industries include gas stations, lodging and housing for airport workers, and retail shops serving these industries. These activities typically trend with airport activity levels. These businesses do not rely directly on the airport for their operation, but value location near an airport because of its prestige, air services, and accessibility of location for visiting customers and employees traveling by air. Other types of businesses that may be attracted to the airport area are warehouses, printing and publishing services, automotive services, building services, travel agent offices, and commercial office spaces.

6.3.2 NEEDED IMPROVEMENTS TO PUBLIC FACILITIES AND INFRASTRUCTURE

The City's 5-year CIP is updated annually to include new projects, reflect changes in priorities and circumstances, and to extend the capital improvement program on a rolling 5-year basis as projects are approved for each additional year. The CIP is based on the City's Fiscal Year, which runs from July 1 through June 30. The CIP is adjusted throughout the year as needs dictate or when changes are made to existing approved projects. The CIP reflects the City priorities of rehabilitation and replacement of the City's existing public facilities. It is imperative for the area revitalization that projects in the study area are included in the CIP annually to further the revitalization of the major thoroughfares that serve HOU.

Other possible infrastructure improvements could be completed through the Hobby Area Management District/Harris County Improvement District (HCID) #9 approved in 2007 by the Texas Legislature. This special district provides a plan for security and beautification to be funded by an overlapping tax on real property owners within the boundaries. This other funding tool should be leveraged and coordinated with the City CIP. HCID #9 operates at the consent from the City, and pursuant to the authority granted by Chapter 375, Texas Local Government Code, as amended, and Chapter 3859, Special District Local Laws Code. Its boundaries are depicted on **Exhibit 6-8**.

Exhibit 6-8: Hobby Area Management District/Harris County Improvement District #9 Boundaries

SOURCE: Harris County Improvement District #9 (Hobby Area)

PREPARED BY: Harris County Improvement District #9 (Hobby Area)

The vision outlined in the HCID #9 Plan is to strengthen HCID #9's local economy, enhance property values, and improve the quality of life for both the business and residential communities using urban development techniques that have been implemented in other management districts in Harris County. The intent of HCID #9 is to promote a sense of place, a concept of identity that calls attention to the area's unique attributes and their special value to the Greater Houston metropolitan region. By emphasizing these attributes, HCID #9 serves as a powerful advocate on matters regarding transportation, public safety, environmental planning, and business development. HOU is included within HCID #9's boundary. Based on the *Service and Improvement Plan and Assessment Plan (Fiscal Years 2008-2017)*, created by the consultants for the District, nearly $8 million worth of funds are dedicated to projects such as proposed security, public safety, business development, transportation planning, and visual improvements within the management district boundaries. These projects include promoting City Parks Department esplanade and median adoptions, art in public areas, and funds for regular landscape maintenance; enhancing the public parks and trail system; addressing water, wastewater, and drainage requirements; implementing pedestrian improvements; and promoting Broadway Street as a major ceremonial corridor to HOU. The Plan also identifies that additional coordination with the Texas Department of Transportation will be necessary during construction around I-45; the need for a possible parking plan for the area were also mentioned in the Service and Improvement Plan and Assessment Plan. HCID #9 contemplates an assessment on the land and related improvements of commercial property owners within the District's boundaries to provide funding for the projects within the boundaries of the Plan. The assessment for each year of the Service and Improvement Plan is proposed to be set at $0.15 for each $100 of value based on the taxable property value as certified by HCAD with respect to that calendar year. The assessment has not been fulfilled until necessary petitions are secured.

A separate initiative related to transportation services to HOU continues in early 2014 and includes a City review and modifications to the current taxicab and limousine ordinance to potentially offer additional services, such as Uber for the City. The Administrative & Regulatory Affairs (ARA) department presented the proposed changes to Chapter 46 of the Code of Ordinances relating to vehicles for hire to a Joint Special Called Public Safety and TTI committee April 22, 2014. General and housekeeping changes applying to all vehicles for hire were addressed as well as changes to address new entrants into the Houston vehicle for hire industry. At this time, there is no set date to bring this item to City Council for consideration.[10]

An additional consideration for new parking garages is the inclusion of electrical charging stations for the existing and new garages at HOU, to accommodate changes in transportation options.[11]

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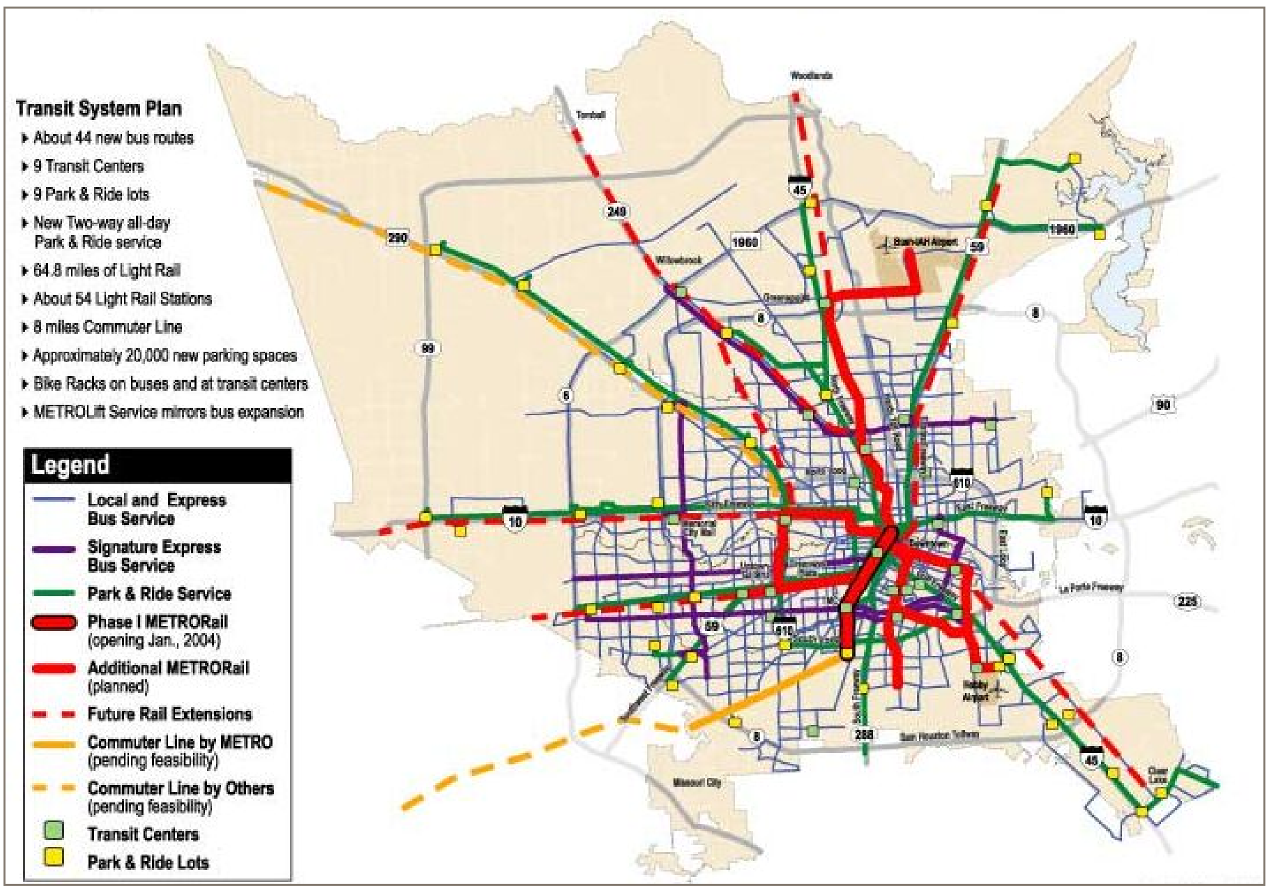
10 City of Houston, Department of Administration & Regulatory Affairs, *Substitute Ordinance Provisions Related to Chapter 46 of the Code of Ordinances Related to Vehicles-for-Hire*, http://www.houstontx.gov/ordinancefeedback/chapter46-presentation-20140728.pdf (accessed August 2014).

11 Hobby Area Management District, www.hadistrict.org (accessed February 2014).

6.3.3 POTENTIAL LINKAGES TO THE METRORAIL SYSTEM

METRO serves the HOU area through regular bus services connecting downtown and many other parts of the City. Current bus service to HOU provides the level of service expected by METRO in serving the expected demand in the region. Demand for METRO is not sufficient to significantly increase or change the service currently offered to HOU. METRO has engaged in *Re-Imagine METRO* for bus transit services, which includes evaluating bus equipment and bus routes; this study should be concluded in 2014. METRO will evaluate the types of services to be added or modified. HAS should be an integral part of that planning decision. METRO has a long-term plan to extend the Southeast Light Rail Transit Line to HOU; however, funding is not currently available. An aggressive economic development program focused on raising real property values and sales tax revenues could be a critical funding component to extending the Southeast Line to HOU in the long term. The Southeast Light Rail Transit Line to HOU will require additional funding sources to be implemented. It is proposed to be extended at grade to the south on Telephone Road and to the east on Airport Boulevard, terminating just east of Airport Boulevard and Broadway Street, as shown on **Exhibit 6-9**.

Exhibit 6-9: METRO Solutions Transit System Plan Including Bus and Rail



SOURCE: LightRailNow!, *As Houston's Light Rail Project Nears Finish, Major Vote Looms Nov. 4th*, October 2003. http://www.lightrailnow.org/news/n_hou003.htm.

PREPARED BY: Metropolitan Transit Authority of Harris County, Houston, Texas, October 2003.

METRO Solutions, the agency's rail transit plan, includes over 72 miles of rail extension and a 50% expansion of bus services, at a total cost of $7.5 billion. However, METRO Solutions is much more than a transit plan. The bus system component of the plan provides for a massive, 50 percent expansion and upgrade of METRO's bus services, with about 44 new bus routes to provide transit access to currently underserved portions of METRO's service area, nine additional Transit Centers, nine additional park and ride (P&R) lots, totally new two-way, all-day P&R service, and introduction of a de facto Quality Bus ("BRT"-like) service. In addition, MetroLift service for the mobility-impaired would be significantly expanded.[12]

6.3.4 IMPROVEMENT OF THE APPEARANCE AND IMAGE OF THE AREA

There are key areas in the airport environs that may merit special urban design treatments to improve the appearance and image of the area. The recommendations made in the *2003 Airport Environs Image Plan* (Appendix G) are still valid and should be implemented with the updated 2014 Master Plan.

6.4 Recommendations

This report presents a variety of opportunities and constraints that affect the development of HOU and its immediate environs. It is apparent that a number of constraints exist, including road and water infrastructure capacity, location in the 100-year floodplain, the presence of sexually oriented businesses, lack of connectivity between land uses, rundown property conditions, and the perceived lack of public safety.

However, the opportunities presented by this area outweigh the constraints. The AOI has excellent transportation connectivity essential for commercial, retail, and other light industrial businesses. The topography is flat, which translates into low site development costs. On balance, the north section of Monroe Road, Broadway Street, and Airport Boulevard offer opportunities for near-term redevelopment as a result of:

- the presence of several significant redevelopment parcels, surface parking lots, and older multifamily residential units;
- the availability of vacant commercial and industrial parcels, and;
- the proximity to a developing employment base.

The location has one of the most accessible visible industrial areas in the City and has the potential to become a gateway to the communities around HOU. Given the opportunities and constraints discussed in this section, an overall land use plan is essential to stimulate and encourage development within the AOI. To formulate a consistent strategy, an Area Concept Plan is recommended.

[12] LightRailNow!, *As Houston's Light Rail Project Nears Finish, Major Vote Looms Nov. 4th*, October 2003. http://www.lightrailnow.org/news/n_hou003.htm (accessed July 2014).

After a review of current conditions at HOU and the opportunities that present itself for international travel, it is clear that specific redevelopment strategies should be pursued to facilitate and guide off-Airport revitalization strategies. The new Hobby International Terminal and international service at HOU will increase passenger miles traveled, making off-Airport enhancements and redevelopment strategies a priority for the City and HAS.

The proposed strategy includes an area-wide approach to creating sustainable development that supports the new Hobby International Terminal and also benefits the surrounding community. The impacts of HAS and Airport facilities cross municipal and county boundaries, and coordination among all jurisdictions is recommended, including the newly created Hobby Area Management District. The use of special incentives, such as a TIRZ or an area Chapter 380 creation should be reviewed to facilitate revitalization of the corridors providing access to HOU, as well as provide buffering and beautification for the existing neighborhoods.

The proposed objectives are recommended to create a sustainable Airport-related development strategy using the most recent environmental technologies and to establish an international identity for HOU and the surrounding areas. The program for revitalization of the area should include the following:

- Coordinate CIP improvements to enhance public infrastructure to serve 10 million HOU passengers annually, including intersection improvements, flood abatement, beautification, and wayfinding;
- Develop a multijurisdictional strategy with Harris County as well as private developers to leverage public and private economic development participation to accelerate redevelopment on off-airport properties;
- Establish incentives to encourage the development of hotels and other airport-compatible commercial development along all thoroughfares serving HOU in an aggressive manner;
- Provide developer incentives and economic development tools such as a TIRZ, area Chapter 380 Agreement, NEZ, or other tools to promote and preserve compatible development in the areas surrounding HOU;
- Preserve the ability to provide light rail transit access to the Airport as part of METRO expansion and encourage mixed-use development and infill development to serve international service.

Economic development is not just a real estate marketing activity to entice businesses to relocate into a community or to HOU. Today, economic development is truly about enhancing quality of life. Such enhancements include increasing per capita wages, training a workforce, and enhancing infrastructure that, in turn, protects and enhances the area's natural resources. Economic development encompasses not only business expansion and retention, but also addresses tourism, community development, quality of life, workforce development, and environmental protection. Off-airport compatible land uses include hotels, offices, retail, and restaurants. The estimated increases in passenger miles traveled and growth of the international terminal will generate the need for additional services such as hotels, restaurants and other related airport compatible land uses.

Measuring success is critical and should be done annually. Creating a scoreboard that measures the success of the City's programs, including measuring property value increases, the benefits of sales tax growth, and increased occupancy for area hotels, results in a mechanism that enables the City to quantify success and demonstrate that public policies have been effective or enables the City to create modifications to the incentives to create a more lucrative program. Some incentives are better than others, depending on the proposals received, and many incentives can be used in combination. They should be designed to help achieve the vision for redevelopment of the corridors accessing HOU and should be implemented efficiently. The private sector can be a true partner in both off-airport and on-airport improvements. Some City incentives relate to private improvements, such as gap financing for a hotel or building. This type of incentive has not typically been used in the City of Houston, but is allowed under State law.

Redevelopment should be focused specifically along the major corridors, specifically, Airport Boulevard, Broadway Street, and Telephone Road. Airport Boulevard and Broadway Street have the most potential for redevelopment. Broadway Street is the main connector from the Airport to central and northern Houston. Airport Boulevard is the main connector from the Airport to the Clear Lake and Galveston area.

The AOI could be designated a special district and multiple economic incentives could directly assist private developers in creating compatible and desirable land uses in support of the new Hobby International Terminal. A special district could also be used to preserve and protect the residential communities, improving the safety of the area for over 500,000 passengers on international trips.

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7. Airport Development Plan

The Airport Development Plan (ADP) is a composite of the preferred alternatives described in Section 5, pertaining to airfield, terminal, ground access, and tenant/land use development. In the process of consolidating the preferred alternatives for inclusion in the Master Plan Update, many of the recommended development projects were refined to ensure that they form a compatible development plan, and maximize land use efficiency while preserving flexible expansion opportunities.

7.1 Overview

The ADP consists of a summary of Airport development projects recommended for implementation during the planning period and the benefits these projects will generate for the Airport and its tenants and users. The projects include capacity enhancements for the terminal, airfield, access roadways and tenant facilities.

Airfield improvements will ensure that adequate capacity enhancements to accommodate forecast activity and growth will be in place in the long term, in addition to several projects that will increase safety and operational efficiency of the airfield in the short term. These improvements include an upgrade to general aviation Runway 12L-30R to air carrier status and reconfiguration of certain areas of the airfield to enhance safety and efficiency. Land acquisition north and south of the runway will accommodate the runway upgrade and protect the area in the RPZs.

For the terminal area, the ADP includes expansion of the West Concourse (the West Concourse is currently under construction and is scheduled to open in 2015) and the surrounding apron areas, as well as expansion of the terminal building to accommodate additional passenger processing facilities. Realignment of the Hobby Airport Loop not only provides space for a West Parking Garage, but also increases terminal curb length to accommodate passenger dropoff in front of the West Concourse. Parking capacity at the terminal complex will substantially increase with construction of the West Parking Garage.

A number of ground access improvements are recommended throughout the planning period, including realignment of the Hobby Airport Loop. Capacity enhancing projects, such as the addition of turn lanes at the intersections of Airport Boulevard with Monroe and Telephone Roads and Broadway and Glencrest Streets, are also incorporated in the ADP.

The tenant and land use section of the ADP sets forth a variety of projects that support tenant development in conjunction with anticipated Airport growth. Where space is available, general aviation and FBO facilities will be expanded in areas adjacent to existing facilities. A new development area was identified in the south quadrant of the Airport for new general aviation facilities.

7.2 Airport Development Plan Projects

The ADP incorporates a number of major development initiatives. Each initiative includes a variety of specific projects that must be carefully coordinated and planned to ensure that operational impacts are minimized throughout implementation. The development plan for the Airport is divided into four categories: airfield, terminal area, ground access, and tenant/land use development. The major initiatives were grouped into the corresponding categories, as listed below, generally, in chronological order with a description of each initiative. In addition, a land acquisition program would be needed to support all of the individual facility development initiatives, as described in Section 7.5. The following subsections list and describe the projects recommended as a result of the analyses conducted in this Master Plan Update.

7.2.1 AIRFIELD

The following airfield projects are recommended as part of this Master Plan Update:

- Runway 12L-30R upgrade will increase the width of the existing runway to 150 feet, lengthen the runway to 8,002 feet, and increase the centerline-to-centerline separation from existing Runway 12R-30L to accommodate air carrier aircraft operations on the upgraded Runway 12L-30R. Generally, project elements include:
  - Relocate/redevelop tenant facilities within development footprint
  - Close a portion of West Monroe Road and Freeland Street
  - Remove existing Runway 12L-30R pavement and construct a new Runway 12L-30R and partial parallel taxiway. The centerline-to-centerline separation of the new runway and Runway 12R-30L will be approximately 913 feet
  - Install proper lighting and markings on the new runway and taxiway
- Construction of a partial parallel taxiway to the upgraded Runway 12L-30R between the new Runway 30R end and Taxiway H will provide direct access between the terminal and the new Runway 30R end. This project will require removal of several tenant buildings.
- Installation of navigational aids associated with the upgrade of Runway 12L-30R. This project would include:
  - Install ILS on Runway 12L, which will allow Runway 12L to be used as the primary arrival runway in South Flow
  - Install approach lighting system on Runway 12L
  - Install a PAPI to both ends of Runway 12L-30R
  - Install windsocks

- The northwest airfield reconfiguration will result in a less confusing and safer taxiway layout between and alongside the Runway 12L and 12R thresholds. Removal of pavement and reconfiguration of the taxiways will help reduce the possibility of runway incursions in that area while easing ATC coordination and workload. This project is predicated on the decommissioning of Runway 17-35.
- Decommissioning of Runway 17-35 will eliminate runway intersections, thereby increasing safety by reducing pilot confusion and controller workload. Because of its proximity to the West Ramp service road, Taxiway G will still be limited to use by ADG II aircraft. It should be emphasized that the decommissioning of Runway 17-35 should not be pursued until after the upgrade of Runway 12L-30R to an air carrier runway has been completed.
- Upon decommissioning of Runway 17-35, Runway 12R-30L obstruction clearing and threshold relocation should take place to increase the operational length of the runway. Buildings and utility poles currently identified as obstructions will be removed. As a result of the relocation, the Runway 12R arrival RPZ will be shifted and the Million Air fuel farm will no longer be located within the RPZ.
- Extension of Taxiway N between Taxiways G and H will improve airfield safety and enhance the efficiency of airfield operations. The extended taxiway will provide access to the departure end of Runway 12R (which will then be the primary departure runway in South Flow) and will minimize the traffic queue of departing aircraft on Taxiway G. The extended taxiway will provide access to Runway 12R for aircraft taxiing from the south quadrant that cannot use Taxiway G.
- Realignment of the perimeter road and fence in the north and east quadrants of the Airport will provide continuous access to the interior perimeter of the airfield for ARFF, Airport Operations, and other vehicles.

Prior to the upgrade of Runway 12L-30R, an EA of the potential effect of all near-term projects should be conducted.

7.2.2 PASSENGER TERMINAL BUILDING

The following passenger terminal projects are recommended as part of this Master Plan Update:

- Expansion of the West Concourse and associated apron could add up to seven gates to accommodate forecast international demand at the Airport. RON parking will be available to provide scheduling flexibility for the airlines.
- Terminal Expansion to the east will add ticketing space for new entrant airlines serving the Airport.

7.2.3 GROUND ACCESS

The following ground access projects are recommended as part of this Master Plan Update:

7.2.3.1 Roadway Intersection Improvements

A variety of ground access improvements will be implemented to ease vehicular congestion, particularly along Airport Boulevard where significant congestion exists from mixing Airport-related traffic with local pass-through traffic. Improvements to public streets would require a joint effort between HAS, the City of Houston, and possibly TxDOT. Potential improvements include roadway intersection improvements, such as longer turn bays or additional lanes to improve the level of service at each of the following intersections:

- Intersection improvements at Telephone Road and Airport Boulevard
- Intersection improvements at Monroe Road and Airport Boulevard
- New intersection at Airport Boulevard and Glencrest Street

7.2.3.2 Long-Term Parking Lot Access Road Improvements

The expansion of the long-term parking lot located east of the terminal, Ecopark – Lot 2, will require improvements to the roadway access, to accommodate additional traffic. These improvements include building a new roadway intersection at Airport Boulevard and Glencrest Street, which would become the main access point to Ecopark – Lot 2. The realignment of the Atlantic Aviation FBO access road would be required.

7.2.3.3 West Terminal Area Roadways

In order to accommodate the proposed improvements on the west side of the terminal area (CRCF, SUP, relocated taxi staging area), a new roadway network is required to provide adequate access to these facilities.

7.2.3.4 Road Closures

Prior to completion of the upgrade to Runway 12L-30R, portions of West Monroe Road and Freeland Street would be closed. West Monroe Road would be closed south of Scranton Street and Freeland Street would be closed west of Monroe Road to provide for the upgrade of Runway 12L-30R and the parallel taxiway. Roadway pavement and utilities would be demolished in conjunction with runway and taxiway construction.

7.2.4 AIRPORT SUPPORT

The following airport support projects are recommended as part of this Master Plan Update:

- Relocation of the West (main) Deicing Pad and 30L Deicing Pad to accommodate upgrade of Runway 12L-30R. New apron pavement will be built for the new West Pad, while the 30L Pad will be relocated onto existing apron pavement.
- Demolition of the Southwest Airlines Cargo and Provisioning Facility and construction of the Hobby Cargo Building on a site in the east quadrant of the Airport.
- Expansion of the long-term surface parking lot (Ecopark – Lot 2) on the site of the existing Southwest Airlines Cargo and Provisioning Facility.
- Relocation of the cell phone waiting lot inside the long-term parking lot to accommodate redevelopment of the west terminal area.
- Relocation of the taxi staging area west of its existing location to accommodate construction of the CRCF.
- Temporary relocation of Avis and Budget Rent A Car facilities during construction of a CRCF.

- Consolidation of all rental car operations in a Consolidated Rental Car Facility will improve customer service while eliminating the need for numerous individual rental car shuttle buses on the roads and at the curbfront. This facility will improve rental car customer service and air quality. It is planned to be located in the north quadrant, on the site of the existing Avis and Budget Rent A Car facilities and taxi staging area.
- Realignment of the Southwest Airlines Fuel Farm boundary and the adjacent service road is required to provide for a clear Runway 12L glide slope critical area. Adjacent land may be available for a replacement in kind of the affected area.
- General aviation and corporate business operator aircraft hangars will be developed in the south quadrant of the Airport. An area of approximately 24 acres is available for development. Hangars could be located along Taxiway K and along a taxilane that would penetrate the south quadrant from Taxiway K. This development would accommodate up to ADG III aircraft.

7.2.5 TENANT/LAND USE

- Demolition of two Signature Flight Support buildings and two Jet Aviation buildings prior to the upgrade of Runway 12L-30R (Buildings E-160, E-170, E-390 and E-392).

7.2.6 OFF-AIRPORT

7.2.6.1 Obstruction Removal

Removal of obstructions to the upgraded Runway 12L-30R ground and airspace surfaces will be required before the runway becomes operational. Existing structures may require demolition and poles that presently obstruct the approach surfaces to both ends of existing Runway 12L-30R may require removal.

7.2.6.2 Land Acquisition

Parcels anticipated to be impacted by airport development projects encompass an area totaling approximately 56 acres southeast of the Airport. **Exhibit 7-1** shows these parcels, by parcel number. In some instances, the entire parcel may not be required to be acquired, and only the portion required for airport development is needed. Only approximately 41 acres are within the RPZ, ROFA or taxiway object free area, and are needed to support the ADP. As such, it was estimated that the overall land acquisition area associated with this Master Plan Update is between approximately 41 acres and 56 acres.

In some instances, after the property is acquired, existing structures will have to be demolished to clear obstructions or to make the land available for additional airfield or tenant development. On property with compatible land uses, current owners could be allowed to lease the facilities back from HAS and continue operating until the property is required for Airport development. These operational continuance periods could vary from 6 months to a number of years, depending on the location of the property, the speed of acquisition, and the schedule for Airport expansion.

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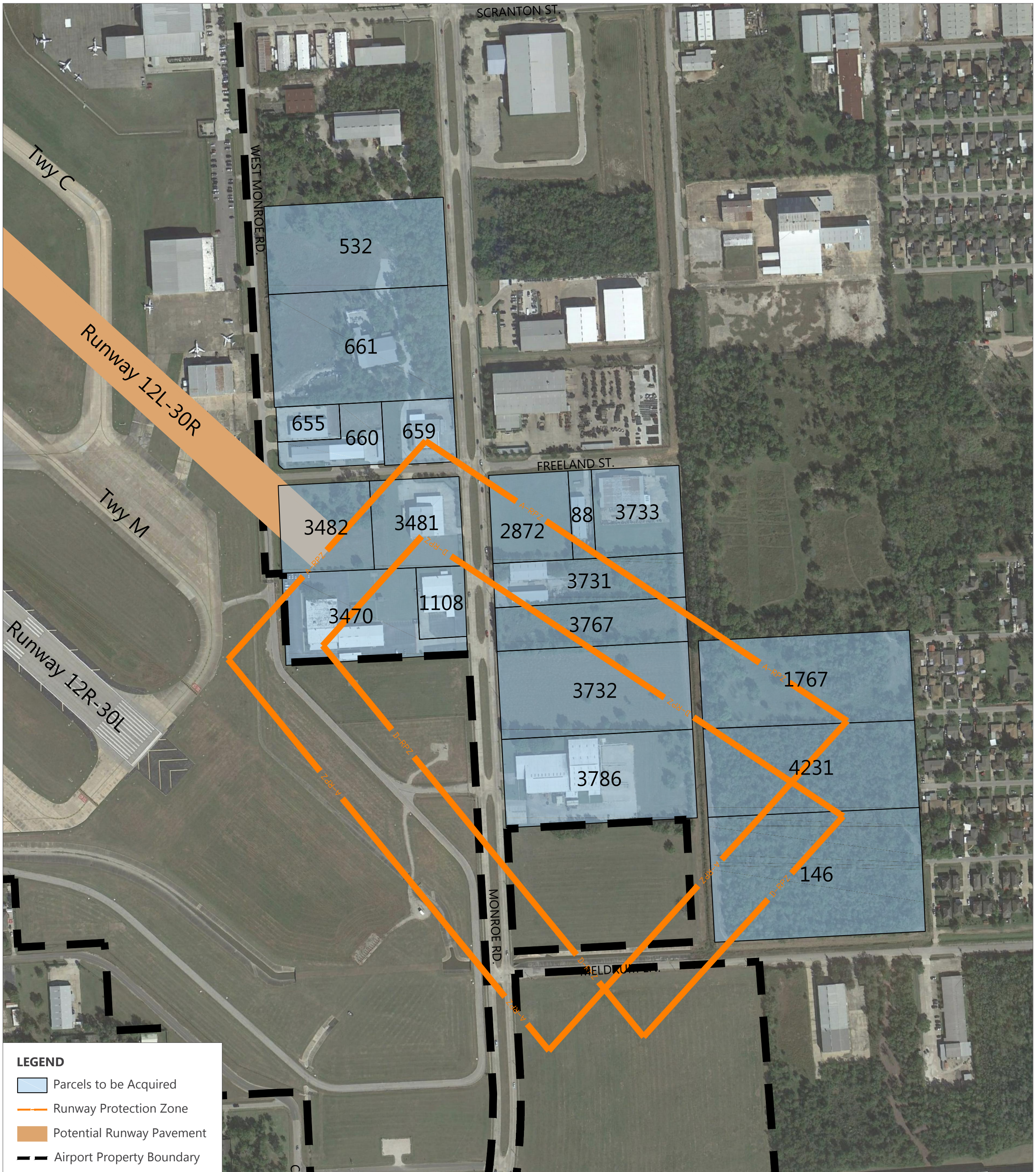

SOURCE: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, June 2014; Google Earth Pro 2014; Terra Metrics, October 27, 2012 (aerial photography - for visual reference only, may not be to scale); Ricondo & Associates, Inc., June 2014.
PREPARED BY: Ricondo & Associates, Inc., June 2014.

EXHIBIT 7-1

NORTH 0 500 ft.

Parcels in the Vicinity of the Airport Impacted by Proposed Airport Development

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\13_Chapter 7_ADP\CAD\7-1_Parcels Impacted.dwg Layout: 7-1 - Parcels Affected by Airport Development Plotted: Dec 29, 2014, 03:55PM

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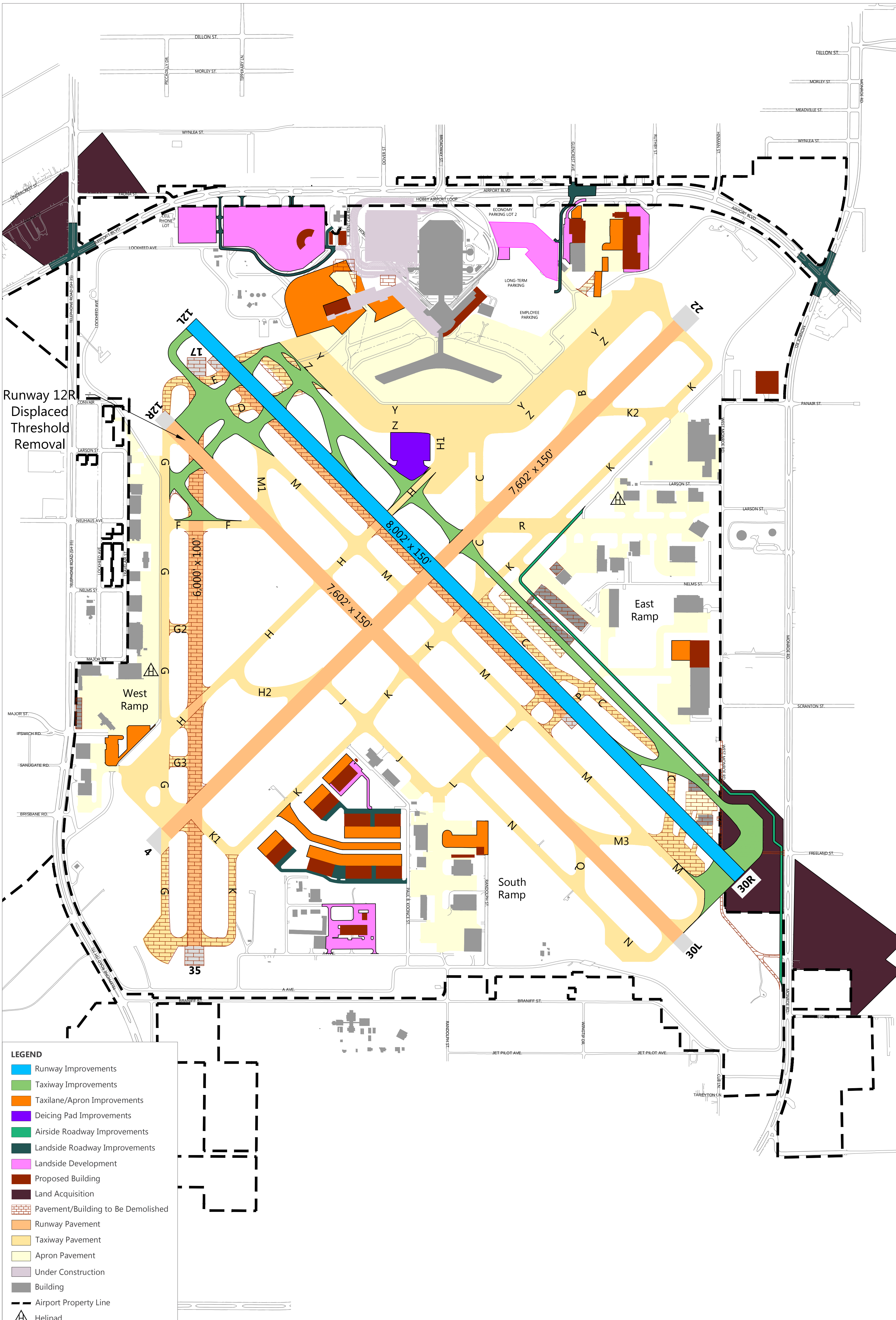
Preliminary recommendations are provided by parcel based on the implementation timing presented in this Master Plan Update:

- Parcel 3482, located on the southeast corner of West Monroe Road and Freeland Street, should be acquired to protect the RPZ for extended Runway 30R. This parcel is currently undeveloped and should remain that way.
- Parcel 3470, located east of West Monroe Road and south of Freeland Street, should be acquired to protect the RPZ for extended Runway 30R. This land should be cleared after acquisition.
- Parcel 1108, located west of Monroe Road and south of Freeland Street, should be acquired to protect the RPZ for extended Runway 30R. This land should be cleared after acquisition.
- Parcel 3481, located on the southwest corner of Monroe Road and Freeland Street, should be acquired to protect the RPZ for extended Runway 30R. This land should be cleared after acquisition.
- Parcel 2872, located on the southeast corner of Monroe Road and Freeland Street, should be acquired to protect the RPZ for extended Runway 30R. This land is currently undeveloped and should remain that way.
- Parcel 88, located south side of Freeland Street east of the Freeland Street and Monroe Road intersection, should be acquired to protect the RPZ for extended Runway 30R. This parcel should be cleared after acquisition.
- Parcel 3733 is located on the south side of Freeland Street east of the Freeland Street and Monroe Road intersection. A portion of the southwest corner (approximately 0.3 acre) of this parcel should be acquired to protect the RPZ for extended Runway 30R. This portion of the parcel should be cleared after acquisition.
- Parcel 3731, located on the east side of Monroe Road between Freeland Street to the north and Meldrum Lane to the south, should be acquired to protect the RPZ for extended Runway 30R. This land should be cleared after acquisition.
- Parcel 3767, located east side of Monroe Road between Freeland Street to the north and Meldrum Lane to the south, should be acquired to protect the RPZ for extended Runway 30R. This land is currently undeveloped and should remain so.
- Parcel 3732, located east side of Monroe Road between Freeland Street to the north and Meldrum Lane to the south, should be acquired to protect the RPZ for extended Runway 30R. This land is currently undeveloped and should remain that way.
- Parcel 3786, located east side of Monroe Road between just north of Meldrum Lane, should be acquired to protect the RPZ for extended Runway 30R. This land should be cleared after acquisition.
- Parcel 1767 is located west of Monroe Road and north of Meldrum Lane. A portion of the southwest corner of this parcel (approximately 0.1 acre) should be acquired to protect the RPZ for extended Runway 30R. This land should be cleared after acquisition.

- Parcel 4231 is located west of Monroe Road and north of Meldrum Lane. A portion of the northwest corner of this parcel (approximately 0.5 acre) should be acquired to protect the RPZ for extended Runway 30R. This land is currently undeveloped and should remain that way.
- Parcel 146 is located west of Monroe Road and north of Meldrum Lane. A portion of the northwest corner of this parcel should be acquired to protect the RPZ for extended Runway 30R. This land is currently undeveloped and should remain that way..
- Parcel 659, located on the northwest corner of Freeland Street and Monroe Road, should be acquired to protect the RPZ for extended Runway 30R. This land should be cleared after acquisition.
- Parcel 660, located on the northeast corner of West Monroe Road and Freeland Street, should be acquired to protect the RPZ for extended Runway 30R and construction of the realigned perimeter airfield road. This land should be cleared after acquisition in preparation for construction of the realigned perimeter airfield road.
- Parcel 655, located between West Monroe Road and Monroe Road just north of Freeland Street, should be acquired to protect the RPZ for extended Runway 30R, construction of the realigned perimeter airfield road, and construction of the new taxiway connector to extended Runway 30R. This land should be cleared after acquisition in preparation for construction of the realigned airfield perimeter road and new taxiway connector.
- Parcel 661 is located between West Monroe Road and Monroe Road and north of Freeland Street. The western half of this parcel (approximately 2.8 acres) should be acquired to protect the RPZ associated with extended Runway 30R, construction of the realigned perimeter airfield road, and construction of the new taxiway connector to Runway 35L. This portion of land should be cleared after acquisition in preparation for construction of the realigned airfield perimeter road and new taxiway connector.
- Parcel 532 is located between West Monroe Road and Monroe Road and north of Freeland Street. The southwest corner of this parcel (approximately 1.0 acre) should be acquired to protect the RPZ for extended Runway 35L, construction of the realigned airfield perimeter road, and construction of the new taxiway connector at the end of Runway 30R. This portion of land is currently undeveloped and should remain that way.

Exhibit 7-2 presents a composite view of the Airport after completion of the projects included in the ADP.



SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, August 2014; Ricondo & Associates, Inc., August 2014.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

EXHIBIT 7-2

Airport Development Plan
2014-2030

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8. Implementation Plan

An implementation plan sets forth a possible development sequence and schedule based on the character and rates of growth anticipated through the planning period (2030). The development initiatives shown on the ALP and described in the previous sections were categorized into distinct projects with budgeted costs and durations, which are the basis for the implementation plan. The development sequence is assessed in this section. The funding plan is provided in Section 9.

The timing of project implementation is based on demand. As actual growth will probably vary from forecast growth, the Implementation Plan includes an overview of factors that are anticipated to prompt a development action. This approach offers HAS the ability to assess actual demand and the flexibility to respond effectively. Through regular monitoring and data analysis and an understanding of the impacts of various trends, HAS can respond strategically to meet tenant and user needs by developing demand-driven facilities in a timely manner.

This section addresses the following:

- Factors Affecting Implementation and Development Phasing – These factors include general criteria upon which decisions regarding facility development should be based and identifies specific implementation indicators.
- Phased Implementation Plan – The plan includes phased project development, identifies individual projects in the ADP, and illustrates the logical progression of those projects from existing conditions at the Airport to future development, as dictated by demand.
- Annual Activity Monitoring – Key data items required to provide a more thorough understanding of the character of Airport growth serve as a guide for the annual update of the HAS CIP for HOU. A flow chart of the processes that should be followed throughout the year to monitor activity at the Airport is discussed.
- Additional Development Initiative – The development of a Ground Transportation Center would affect the Airport in some way but would not be intended for the sole benefit of the Airport or its tenants and users.
- Implementation Conclusion – Summarizes the implementation plan.

8.1 Factors Affecting Implementation and Development Phasing

Implementation of the ADP should be phased so that development corresponds with the anticipated demand discussed in Section 3, "Aviation Demand Forecasts." Preferably, projects should be implemented in sufficient time to accommodate growing demand, but not so early that facilities are underutilized. The ability to phase implementation correctly requires an understanding of the factors that prompt development, and ongoing data monitoring and analysis to identify when actions should be taken. It is anticipated that Airport development projects recommended as part of the Master Plan Update will be constructed as demand growth materializes, but it must also be recognized that HAS will continually need to replace or modernize older facilities.

8.1.1 VOLUME AND CHARACTER OF ACTIVITY GROWTH

The volume and character of activity (factors addressed in detail in Section 3) determine when development should occur throughout the planning period. Recognizing that activity may not increase as forecast, it is crucial to continuously monitor overall activity and assess the individual characteristics of that activity. For example, an increase in the number of operations by Boeing 737-type aircraft may not require the same improvements as the same increase in the number of Boeing 757 aircraft operations. The use patterns and facility needs to accommodate the type of demand placed on individual Airport facilities may be more important than overall activity statistics.

Factors that could influence the volume and character of activity growth at the Airport are changes in the fleet mix, the introduction of service by other low cost or regional airlines, use of the Airport as a mid-continent connecting point for Southwest Airlines, significant fluctuation in O&D traffic versus connecting traffic, and fluctuations in the type and amount of general aviation operations.

Currently, the commercial aircraft fleet serving the Airport consists mainly of Boeing 737-series aircraft, with the Boeing 737-700 being the most common. It is projected that, throughout the planning period, additional aircraft types will be introduced into the commercial fleet. An increase in the use of longer-range Boeing 737-800 aircraft is also projected.

Significant changes in general aviation activity could greatly affect the airfield. For example, an increase in general aviation aircraft operations could decrease the airfield capacity at the Airport. The in-trail separation between certain general aviation and commercial aircraft is greater than the separation required between commercial aircraft because of the impacts of wake turbulence. As the in-trail separation requirements increase, the amount of time between aircraft operations increases, which reduces airfield capacity. However, a reduction in general aviation activity could increase the ASV of the airfield by decreasing the in-trail separation requirements between aircraft and reducing the amount of time between aircraft operations.

The Airport Development Plan and the Implementation Plan were developed based on the forecasts presented in Section 3 and the demand/capacity analysis discussed in Section 4, which describes how these factors affect aviation activity. Changes in the commercial fleet should be monitored to assess whether they correspond to the fleet mix projections. If the commercial fleet changes significantly from what was set forth in Section 3, elements of the ADP may need to be re-addressed. For example, the addition of more international flights than anticipated could create a need for additional FIS facilities. Similarly, a shift from passenger jets with 100 or more seats to smaller regional jets would also affect both demand and financial considerations for development.

Historically, the Airport has been a connecting point for passengers traveling from east to west or vice versa, with a consistent number of O&D passengers. As indicated in Section 3, forecast growth at the Airport is based on the addition of flights to Central America and a greater number of connecting passengers than O&D passengers. These forecasts are based on historical data and the expectation that Southwest Airlines will continue to use the Airport as a connecting point and introduce international service.

Throughout the planning period, the growth and type of operations conducted by Southwest Airlines and other major airlines should be carefully observed. In the event that the market shifts from connecting passengers to O&D passengers, recommended terminal facility layouts should be re-evaluated. A greater number of O&D passengers would create higher demand for additional ticket counter space, passenger and baggage screening devices, and additional area at the curbsides for arriving and departing passengers.

As the Airport and aviation services offered continue to grow and expand, the ADP and Implementation Plan should be periodically reviewed to ensure that actual trends are similar to the forecast.

8.1.2 RELOCATION AND REPLACEMENT OF DISPLACED FACILITIES

Expansion of terminal and airfield facilities to meet growing demand will affect existing Airport tenants or other Airport facilities. Facility replacement and the need to minimize the disruption of tenant activities will be a factor in determining project phasing. Therefore, detailed planning, design, financing, and construction of replacement facilities must occur prior to expansion that affects existing facilities. Likewise, the HAS Airport Property Management & Commercial Development Division should review the ADP in consultation with the HAS Planning Division prior to initiating lease negotiations with tenants to ensure that new facilities are not constructed in areas that will be needed for expansion, and that lease renewals are negotiated to include requirements for planned expansion.

8.1.3 GENERAL CRITERIA FOR IMPLEMENTATION

The primary criteria used to phase the ADP include:

- Initiate detailed project planning and design so that improvements can be in place when needed. For runways and airfield expansion, environmental analyses and preliminary design should precede design and construction. These steps may take several years before the improvement can be in place and operational.

- Minimize operational impacts on the airfield, terminal, and ground access routes – This includes minimizing closures of runways and taxiways to minimize interim capacity reductions on the airfield, minimizing pilot and passenger inconvenience and confusion, and maintaining the access roadways and parking facilities accessible to passenger vehicles.
- Maintain a logical sequence of development, building individual projects toward the ultimate Airport Development Plan – Near-term development projects should be phased to support long-term development and protect future options. Project sequence must also be based on airfield access and utility infrastructure considerations.
- Meet HAS goals and objectives – HAS plans and goals were considered during development of the ADP. Optimum development strategies and tenant impacts were with the HAS Planning Department.

8.1.4 IMPLEMENTATION INDICATORS

Two types of indicators or activity levels that will trigger development were identified as useful to activity monitoring and implementation: primary and secondary. Primary indicators are considered “triggers” for implementation when a specific level of activity is reached. Secondary indicators do not trigger implementation actions, but provide more insight into the type of demand that is occurring. Secondary indicators may provide another way to measure activity or guide how the element is implemented once the trigger is reached.

Indicators for each area of Airport development are discussed below. These indicators are intended to identify an impending need for additional facilities given existing demand/capacity relationships. Once these triggers are reached, in depth analyses should be undertaken to confirm the continued validity of the triggers and the facility concepts.

8.1.4.1 Airfield Indicators

As previously discussed, the planning for additional airfield capacity should begin when demand exceeds 60 percent of the ASV. By initiating planning at that point, additional capacity could be expected to become operational as demand begins to exceed 100 percent of the ASV. The current airfield demand at the Airport is approximately 85 percent of the ASV. Therefore, it is recommended that airfield capacity-enhancing projects remain a priority to implement the Phase 1 airfield layout before the airfield reaches capacity, which is anticipated to occur in 2025. The upgrade of Runway 12L-30R will increase airfield capacity, and the decommissioning of Runway 17-35 will eliminate two runway incursion hot spots.

8.1.4.2 Terminal/Gate Indicators

The timing of terminal/gate expansion or development is typically based on airline demand for additional facilities, the need to replace old or insufficient facilities, or the need to enhance passenger service. These needs may or may not be specifically linked to demand. As such, the following triggers were identified for terminal gate development, in chronological order:

- Need for RON gates under existing conditions
- Turns per gate equal 10 or more
- Need for additional facilities to accommodate non-Southwest Airlines activity beyond existing surplus capacity
- Need for additional concourse gates

8.1.4.3 Access and Curbside Indicators

Peak hour curbside operations should be observed to determine whether congestion is affecting operations. Typically, this occurs when the LOS reaches LOS E. Planning should be initiated when PMAD Peak hour operations reach LOS D. Additionally, operational modifications should be considered to improve curbside use prior to implementing improvements.

8.1.4.4 Parking Indicators

A primary indicator for public parking facility development is parking lot occupancy during the peak month. Planning should be initiated when average peak month occupancy reaches 80 percent to 85 percent of total capacity so that improvements can be in place when occupancy reaches approximately 90 percent to 95 percent of capacity. Typically, 90 to 95 percent occupancy represents the effective capacity of parking facilities. In addition to parking occupancy, secondary indicators such as the split of parking facility occupancies among the hourly, daily, and remote lots, and the total parkers by month and type of lot should be monitored to for demand shifts that may indicate shortfalls in capacity.

8.1.4.5 General Aviation Indicators

Two principal types of general aviation tenants have facilities at the Airport: corporate tenants and FBOs. The development of new or improved general aviation facilities is typically driven by tenant initiatives rather than by an Airport owner (i.e., HAS). However, activity indicators may provide insight into overall general aviation demand. With a multiple-airport system, HAS has the flexibility to offer development options at another airport (such as Ellington Airport). The based aircraft fleet and the annual number of general aviation operations indicate the overall demand for general aviation facilities and services at the Airport. Growth in the based aircraft fleet by tenant (corporate or FBO) can indicate a demand for hangar, terminal, or apron expansion.

8.2 Phased Implementation Plan

8.2.1 EXISTING CONDITIONS

For purposes of the Implementation Plan, existing conditions for the terminal area were assumed to consist of the recommended layout of this area in December 2015, when the Hobby International Terminal is scheduled to open. Enabling projects for the Hobby International Terminal are not included in the Implementation Plan, and are labeled on the phasing exhibits included in this section as "2015 Existing Conditions."

ADP phasing is based on specific demand levels that will trigger the need for implementation of the individual projects and a logical progression of development that will allow critical projects to be in place to meet that demand. **Table 8-1** presents the relationship between the phases and total annual aircraft operations and enplaned passengers. Although the demand will dictate when development should occur at the Airport rather than a particular date or timeframe, for purposes of the implementation and funding plans, a timeline was applied.

Table 8-1: Correlation Between Phases and Activity

PHASE	YEARS	AIRCRAFT OPERATIONS AT END OF PHASE	ENPLANED PASSENGERS AT END OF PHASE
1	2014-2016	221,210	6,270,300
2	2017-2019	239,430	7,237,300
3	2020-2023	250,220	7,890,800
4	2024-2030	269,540	9,070,600

NOTE: 2025 aircraft operations and enplaned passenger numbers are averages between 2020 and 2030.

SOURCE: Ricondo & Associates, Inc., December 2013.
PREPARED BY: Ricondo & Associates, Inc., December 2013.

Exhibit 8-1 presents a simple bar chart schedule for the recommended implementation of each Master Plan project listed in Phases 1 through 4 of the Implementation Plan.

8.2.2 PHASE 1 PROJECTS (2014 – 2016)

8.2.2.1 On-Airport Projects

Phase 1 consists of the near-term development of general aviation facilities and roadway access improvements. **Exhibit 8-2** graphically depicts the Phase 1 project areas:

- An Environmental Assessment for Phase 1 projects should be completed before any construction is initiated.
- General aviation and corporate business operator aircraft hangars in the south quadrant include aircraft hangars along Taxiway K and along a taxilane that would penetrate the south quadrant from Taxiway K. The first phase of development would cover an area approximately 13 acres.
- Roadway access improvements to the long-term surface parking lot (Ecopark – Lot 2).
- An Environmental Assessment for Phase 2 projects should be initiated in Phase 1.

Exhibit 8-1: Recommended Implementation Schedule

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Phase 1 (2014-2016)																		
Phase 1 Master Plan Projects - Environmental Study	2014	🟩																
Roadway Intersection Improvements - Airport/Telephone	2015		▨🟩															
Roadway Intersection Improvements - Airport/Monroe	2015		▨🟩															
Roadway Intersection Improvements - Airport/Glencrest	2015		▨🟩															
Long-Term Surface Parking Lot Access Road Improvements	2015		▨🟩															
GA/CBO Development in South Quadrant	2015		▨🟩															
CRCF Enabling - West Terminal Area Roadways	2016			▨🟩														
Rwy 12L Upgrade - Land Acquisition	2016			🟩														
Phase 2 Master Plan Projects - Environmental Study	2015/2016		🟩	🟩														
Phase 2 (2017-2019)																		
CRCF Enabling - Temporary Relocation of Rental Car Facilities	2018					▨🟩												
CRCF Enabling - Relocation of Taxi Staging Area	2018					▨🟩												
Consolidated Rental Car Facility (CRCF) Construction	2018/2019					▨	🟩											
West Concourse Expansion (7 gates, apron)	2018/2019					▨	🟩											
Phase 3 Master Plan Projects - Environmental Study	2019						🟩											
Phase 3 (2020-2023)																		
Hobby Cargo Building	2020/2021							▨	🟩									
Rwy 12L Upgrade - Relocation of Main Deicing Pad	2021								▨🟩									
Rwy 12L Upgrade - Signature Buildings Demolition	2021								🟩									
Rwy 12L Upgrade - Jet Aviation South Hangars Demolition	2021								🟩									
Rwy 12L Upgrade - Taxiway Construction	2021/2023								▨	🟩	🟩							
Rwy 12L Upgrade - Runway Construction	2021/2023								▨	🟩	🟩							
SWA Cargo & Provisioning Facility Demo & Expansion of Long-Term Surface Parking Lot	2022									🟩								
Relocation of West Cell Phone Waiting Lot to Long-Term Parking Lot	2022									🟩								
Rwy 12L Upgrade - Perimeter Road/Fence Realignment	2022									🟩								
Rwy 12L Upgrade - Closure of a portion of West Monroe Road and Freeland Street	2022									🟩								
Rwy 12L Upgrade - SWA Fuel Farm Boundary Changes	2022									🟩								
Rwy 12L Upgrade - Obstruction Removal	2023										🟩							
Rwy 12L Upgrade - Navaids Installation (ALS, LOC, PAPI, GS)	2023										🟩							
Decommissioning of Rwy 17-35	2023										🟩							
Rwy 12R Displaced Threshold Removal	2023										▨🟩							
Phase 4 Master Plan Projects - Environmental Study	2023										🟩							
Phase 4 (2024-2030)																		
Terminal Expansion (East Side)	2028/2030															▨	🟩	🟩

LEGEND:
▨ Design Phase
🟩 Construction Phase

SOURCES: Houston Airport System, 2014; Ricondo & Associates, Inc., 2014.
PREPARED BY: Ricondo & Associates, Inc., December 2014.

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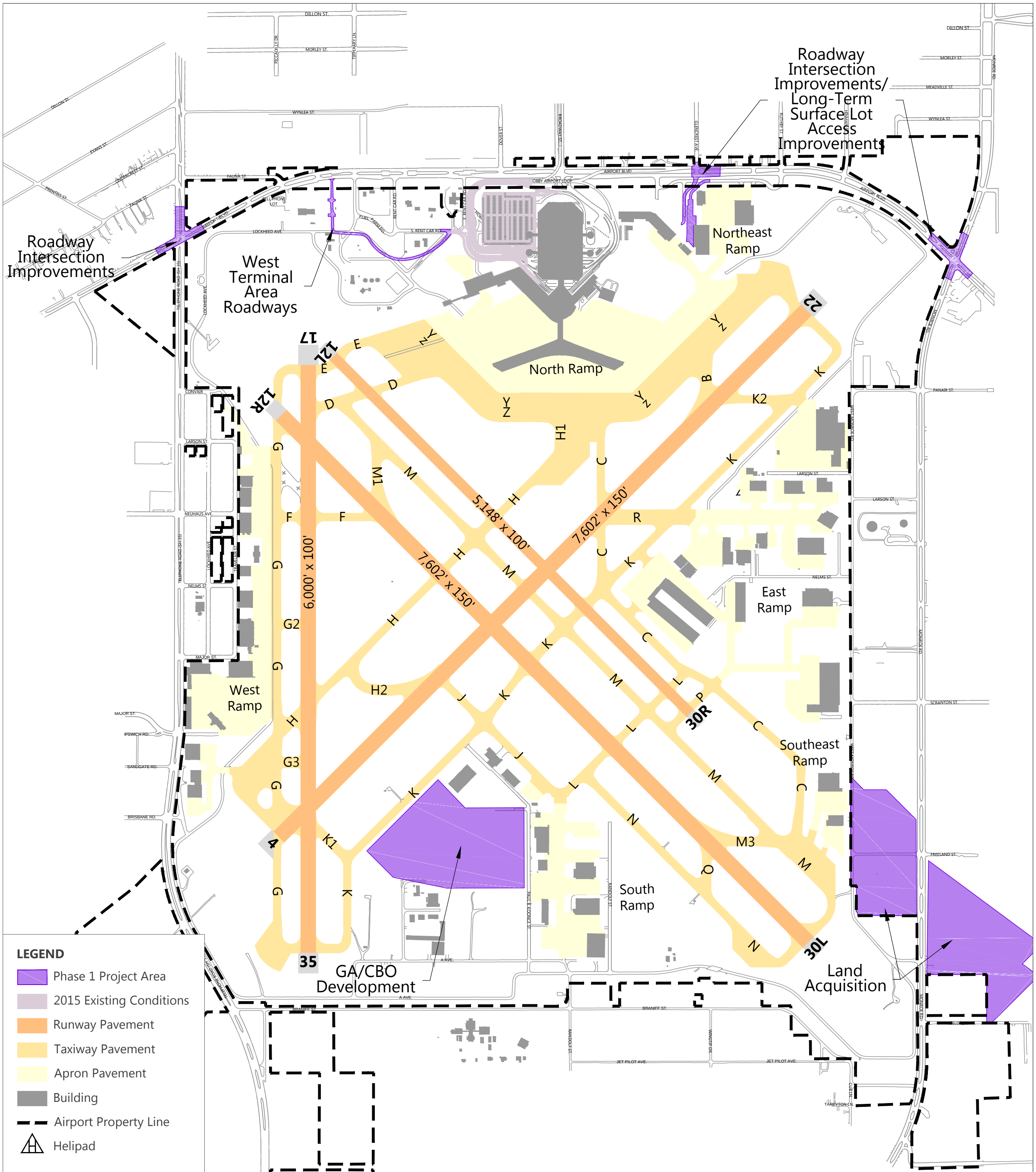

SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, August 2014; Ricondo & Associates, Inc., August 2014.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

EXHIBIT 8-2

NORTH 0 1,500 ft.

Project Areas
Phase 1 (2014-2016)

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\14_Chapter 8_Implementation Plan\CAD\Exh 8-2 to 5_Airfield_Implementation_Plan.dwg Layout: Ex 8-2 - Phase 1 Plotted: Jan 12, 2015, 12:06PM

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8.2.2.2 Off-Airport Projects

- Ground access improvements are recommended for the following roadway intersections:
  - Telephone Road and Airport Boulevard
  - Monroe Road and Airport Boulevard
  - Airport Boulevard and Glencrest Street
- Land acquisition in preparation of the upgrade of Runway 12L-30R includes parcels located northwest and southeast of the Airport boundary.

8.2.3 PHASE 2 PROJECTS (2017 – 2019)

Phase 2 includes Airport facilities and infrastructure to be developed between 2017 and 2019. **Exhibit 8-3** depicts the Phase 2 project areas:

- Temporary relocation of the rental car facilities located in the west terminal area during construction of the CRCF.
- Construction of a road network in the west terminal area to accommodate proposed developments.
- Relocation of the taxi staging area west of the proposed consolidated rental car facility.
- Construction of a consolidated rental car facility west of the terminal area.
- Expansion of the West Concourse, which would provide seven additional gates for international flights.
- An environmental assessment for Phase 3 projects should be initiated in Phase 2 and be completed prior to the upgrade of Runway 12L-30R and land acquisition.

8.2.4 PHASE 3 PROJECTS (2020 – 2023)

Phase 3 consists of the upgrade of Runway 12L-30R and its enabling projects, to be completed between 2020 and 2023. **Exhibit 8-4** depicts the Phase 3 project areas, which include:

- Relocation and expansion of the Southwest Airlines Cargo and Provisioning Facility to the east quadrant (Hobby Cargo Building).
- Demolition of two Signature Flight Support buildings (E-160 and E-170) within the footprint of the proposed Runway 12L-30R parallel taxiway object free area.
- Demolition of two Jet Aviation buildings (E-390 and E-392) within the footprint of the proposed Runway 12L-30R improvements.
- North airfield taxiway network improvements.
- Upgrade of Runway 12L-30R.

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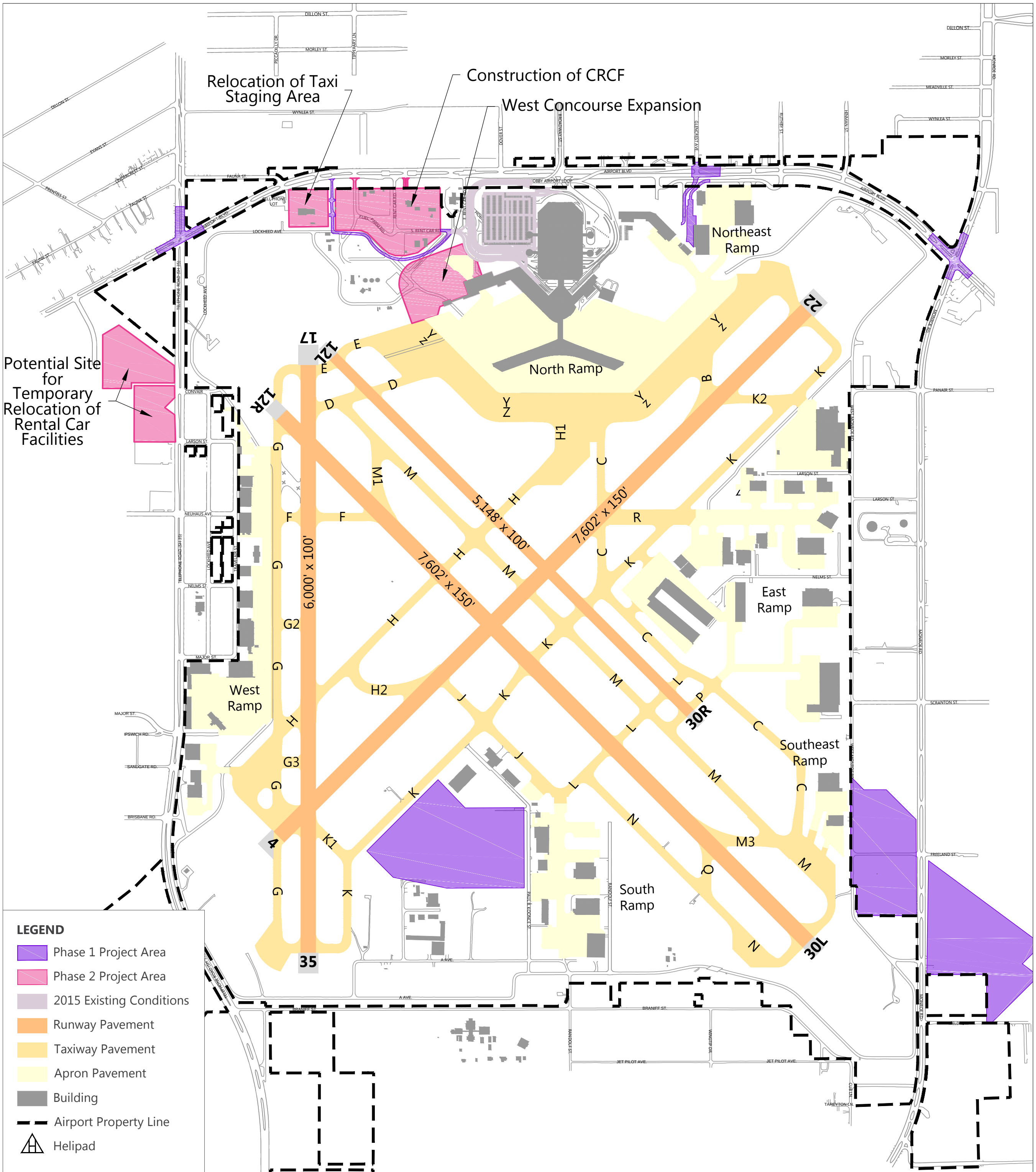

SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, August 2014; Ricondo & Associates, Inc., August 2014.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

EXHIBIT 8-3

NORTH 0 1,500 ft.

Project Areas
Phase 2 (2017-2019)

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\14_Chapter 8_Implementation Plan\CAD\Airfield_Implementation_Plan.dwg Layout: Ex 8-3 - Phase 2 Plotted: Dec 30, 2014, 10:52AM

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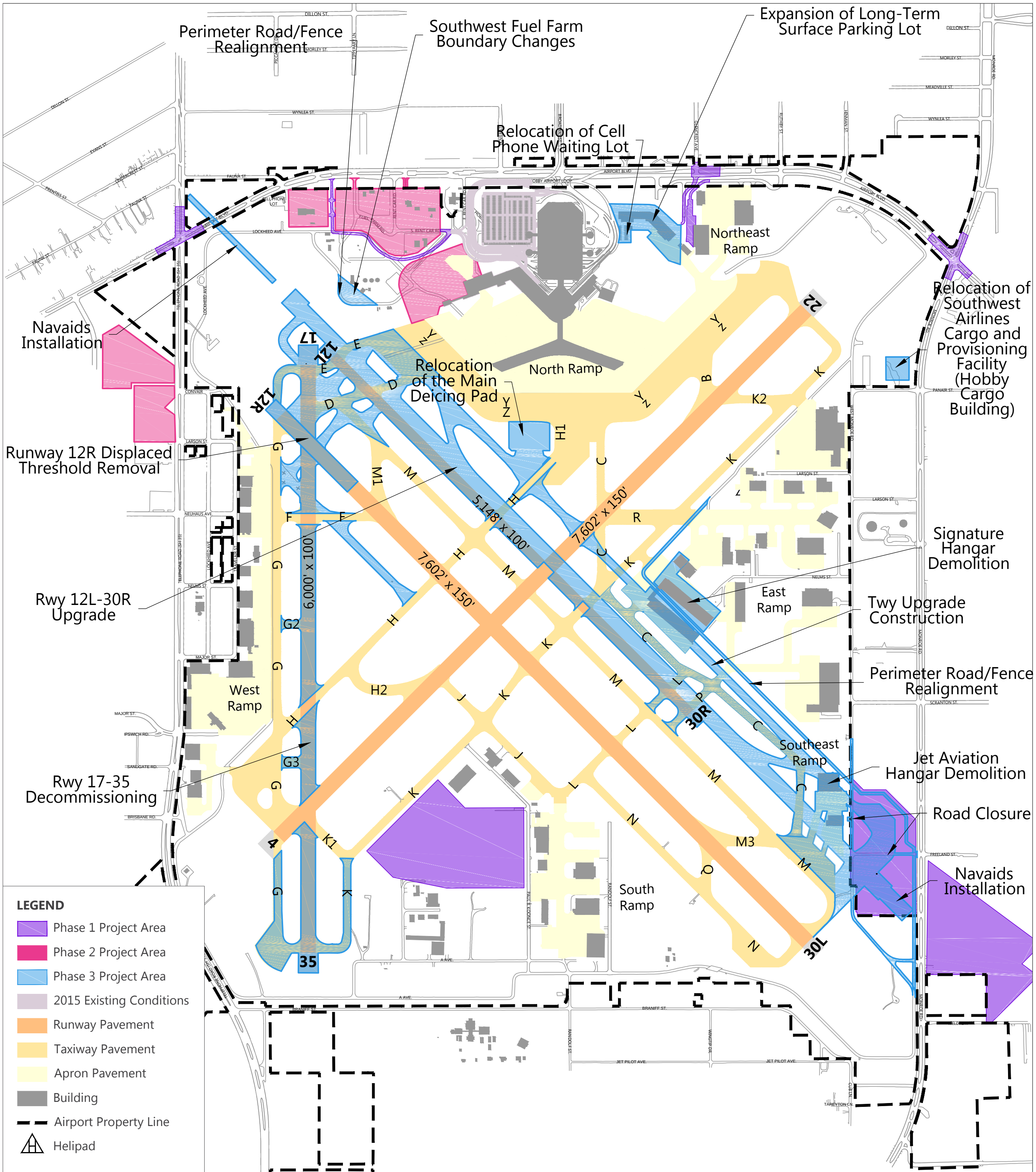

SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, August 2014; Ricondo & Associates, Inc., August 2014.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

EXHIBIT 8-4

NORTH 0 1,500 ft.

Project Areas
Phase 3 (2020-2023)

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\14_Chapter 8_Implementation Plan\CAD\Airfield_Implementation_Plan.dwg Layout: Ex 8-4 - Phase 3 Plotted: Dec 30, 2014, 10:52AM

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- Expansion of the long-term parking lot (Ecopark – Lot 2) on site of old Southwest Airlines Cargo and Provisioning Facility.
- Relocation of the cell phone waiting lot from the northwest corner of the Airport property to the long-term parking lot.
- Realignment of the perimeter road and fence along the proposed Runway 12L-30R ends.
- Closure of a portion of West Monroe Road and Freeland Street.
- Realignment of the Southwest Airlines fuel farm boundary to remain clear of the Runway 12L glide slope critical area.
- Removal of obstructions for Runway 12L-30R.
- Relocation/installation of navigational aids associated with the upgrade of Runway 12L-30R.
- Decommissioning of Runway 17-35 upon the opening of upgraded Runway 12L-30R.
- Removal of the Runway 12R Displaced Threshold upon decommissioning of Runway 17-35.
- An environmental assessment of Phase 4 projects.

8.2.4 PHASE 4 PROJECTS (2024 – 2030)

Phase 4 consists of the expansion of the passenger terminal, to be completed between 2024 and 2030. **Exhibit 8-5** graphically depicts the Phase 4 project area, which includes:

- Expansion of the Passenger Terminal on the east side to provide for additional terminal functions, such as ticketing, outbound baggage makeup, inbound baggage claim and makeup, and checked baggage inspections systems.

8.3 Annual Activity Monitoring

HAS currently monitors passenger, aircraft operations, and cargo data to assess growth. To help ensure that the monitoring process provides a deeper understanding of activity at the Airport and a deeper understanding of the rate of growth, it is recommended that additional activity statistics be monitored as well. This will enhance HAS' ability to determine if the schedule for future projects needs to be adjusted and, therefore, if the CIP should also be adjusted. Statistics that may be useful to HAS in the process of monitoring activity are listed below.

- Aircraft operations –Total, cargo, air carrier, air taxi, military, general aviation, based and itinerant, and overflights
- Annual average delay per aircraft
- Commercial aircraft fleet mix

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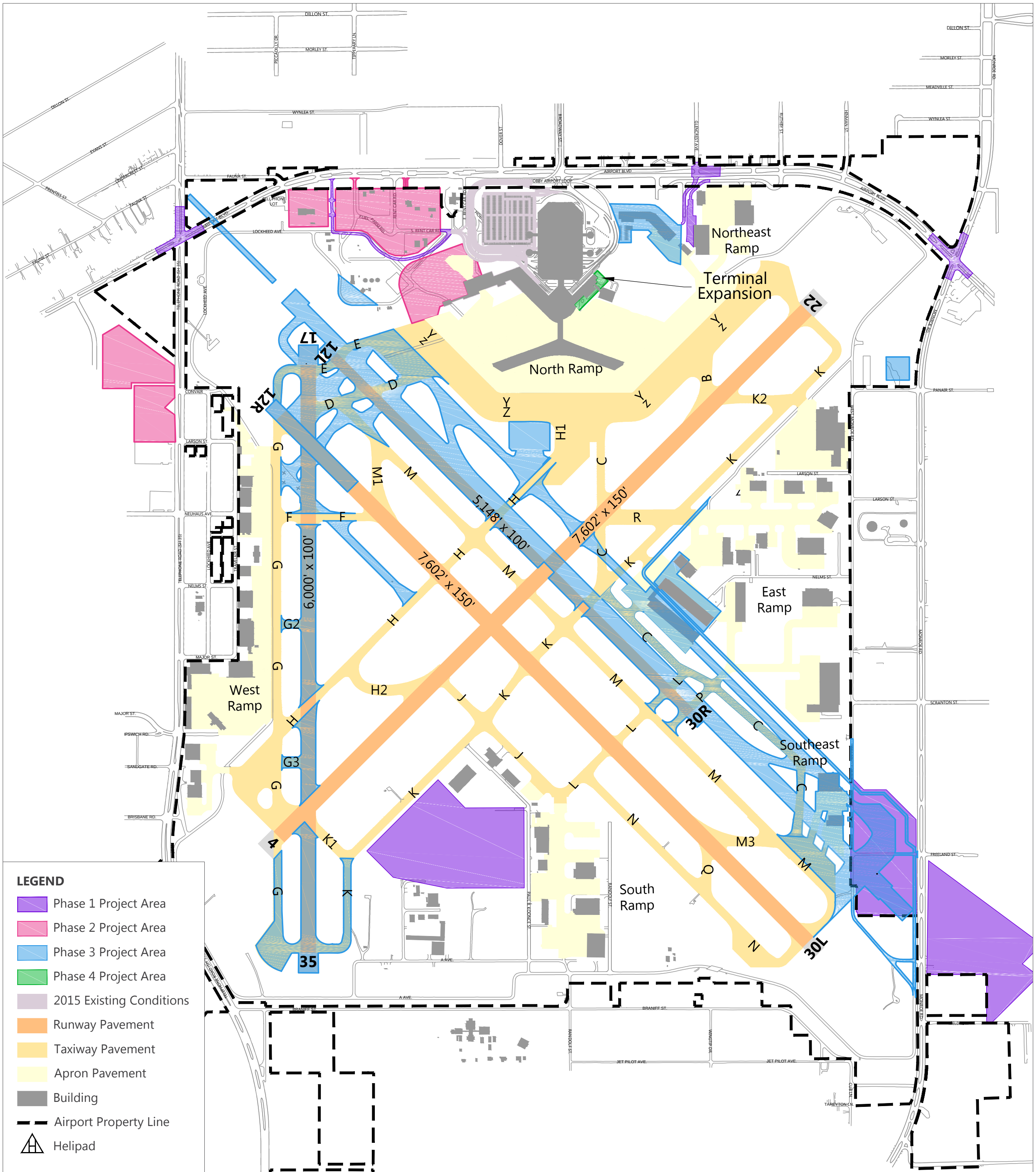

SOURCES: Ricondo & Associates, Inc., *Draft William P. Hobby Airport Layout Plan*, August 2014; Ricondo & Associates, Inc., August 2014.
PREPARED BY: Ricondo & Associates, Inc., August 2014.

EXHIBIT 8-5

NORTH 0 1,500 ft.

Project Areas
Phase 4 (2024-2030)

Drawing: Z:\Houston\2-HOU\Hobby Master Plan 2012\14_Chapter 8_Implementation Plan\CAD\Airfield_Implementation_Plan.dwg Layout: Ex 8-5 - Phase 4 Plotted: Dec 30, 2014, 10:52AM

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- Hourly distribution of activity on the PMAD
- Observations of peak hour passenger flow at security checkpoints, within the terminal, at baggage claim, and at the curb
- Enplaned passengers per gate – Overall commuter, by airline, by terminal
- O&D passengers as a percentage of total passengers
- Number of flights per gate and number of departing seats, overall and by airline
- Cargo tonnage – Enplaned and deplaned, domestic and international
- Number of based aircraft
- Number of vehicles using parking facilities, and entry and exit data for designated periods
- Tenant improvements
- Other CIP and maintenance projects

As the data is collected and analyzed, they should be compared to the forecasts for the corresponding functional area of the Airport. This comparison will help HAS determine what phase of planning is necessary given present conditions. Analyzing data to assess facility use, and comparing the data to PALs or demand thresholds set forth in this Master Plan Update can provide HAS early indications of the need for implementation. By reviewing activity levels in conjunction with implementation triggers, HAS will be prepared to initiate implementation of the ADP as justified by demand.

HAS should begin monitoring activity and the progress of the Master Plan Update implementation. Actual activity should be compared with forecast activity to determine if demand is exceeding the capacity of Airport facilities. For other areas of consideration, such as tenant growth, a review of existing facilities should be completed to assess growth (i.e., the need for additional hangars or ramp space for an FBO) compared with the previous year, to assess conditions at the Airport, and to determine if actual growth is similar to the forecasts presented in Section 3. **Table 8-2** shows the planning factors for the various activities, which will enable HAS to decide if projects need to be initiated or postponed.

If actual operations lag the forecasts, then the next phase of projects may not need to be implemented as presented herein, and if the triggers occur in advance of the forecasts, projects could be implemented more quickly. Furthermore, by reviewing operations and Airport growth in the summer, HAS would have sufficient opportunity to include projects in the following year's CIP and funding cycles, which occur around the first of the year.

In addition to Airport activity statistics, other capital improvements and general maintenance projects separate from those identified in the Master Plan Update should also be monitored. These projects could increase the costs or delay implementation of CIP projects. Therefore, prior to implementation of other capital improvements and maintenance projects, the potential impacts on CIP projects should be considered and a strategy developed to minimize these impacts.

Table 8-2: Planning Factors

ACTIVITY STATISTICS	INDICATES	ACTIVITY TRIGGERS	ACTION REQUIRED
Aircraft Operations: total, air carrier, cargo, military, GA/Air taxi, peak hour operations	Traffic segments in which growth is occurring	Master Plan Aviation Demand Forecasts, Table 3-22	Monitor for long term trends and compare with operations forecasts
Aircraft Delay	Airfield capacity	Demand is > 60% of ASV	Monitor for increase in delay as indication that additional airfield capacity may be required.
Commercial Aircraft Fleet Mix	Type of aircraft utilizing the airfield and terminal facilities	No trigger	Monitor to determine if fleet is increasing and the nature of increase.
Hourly Distribution of Activity in Peak Month, Average Day (PMAD)	Peaking factor, impacts annual service volume (ASV)	4 minutes average annual runway delay per aircraft	Monitor for long-term trends. Assess changes in seasonal distribution of activity.
Observe Peak Hour Passenger Flows at security checkpoints, within the terminal, at baggage claim and on the curbfront	Utilization of specific functional areas of the terminal	Master Plan Demand/Capacity Analysis, Tables in Section 4-2; Curbside: PMAD Peak hour operations reach LOS D	Monitor the demand for each functional area. May indicate the need for additional area for the specific function.
Commercial Enplanements/Gate: overall, commuter, by airline, by terminal	Passenger demand at terminal gates	See Section 8.1.4.2.	Monitor for indication of overall demand at gates.
Number of departing seats per gate: overall, by terminal, and by carrier	Seating availability in departure lounge(s)	< 70% of passengers waiting to board flight are seated	Monitor for long term trends by terminal and carrier to develop understanding of typical utilization, assess changes in number of scheduled seats. May indicate the need for additional seating and/or larger departure lounges.
Cargo: Enplaned/Deplaned	Amount of enplaned and deplaned cargo	N/A	Monitor for growth in cargo volume. An increase in cargo volume may indicate the need for additional facilities.
Based Aircraft: general aviation itinerant and based operations	General Aviation activity levels	Master Plan Demand/Capacity Analysis, Table 4-105	Monitor to assess whether activity is increasing.
Parking: total parkers by month and type of lot, entry and exit data from lots and toll plaza	Utilization of individual lots	80-85% occupancy for on-Airport parking:	Monitor demand for each facility to determine averages and track shifts in demand of various lots. May be used to assess effectiveness of rate changes on lot utilization.
Tenant Improvements (new hangars, ramp, fuel storage and maintenance facilities)	Utilization of tenant facilities	No trigger	Monitor tenant activity/improvements with respect to Master Plan recommendations.
Other CIP and Maintenance	Additional considerations for CIP costs, scope, and timing	No trigger	Coordinate with PDC managers and HAS Program Managers to identify ongoing or planned activities in vicinity of proposed CIP projects.

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

8.4 Additional Development Initiative

In recent years, METRO has indicated interest in developing a Ground Transportation Center at the northwest corner of the intersection of Airport Boulevard and Broadway Street to accommodate a METRO bus transfer and rail station. (This project was illustrated in the 2003 Master Plan for HOU). If this project is pursued by METRO in the future, consideration should be given to designing the project in such a way that the passenger terminal and employee-screening checkpoint at HOU could be accessed via an elevated walkway that crosses Airport Boulevard. The walkway should be an interior walkway and climate controlled, with moving walkways. This initiative would benefit the Airport environs and the residents and communities around the Airport, as well as its users and employees. However, planning and implementation of such a facility is largely outside HAS's control. The timing of this facility is yet to be determined, and may even be jeopardized by the recent purchase of land on this corner by a private developer.

Additionally, if METRO is able to extend rail service to HOU in the future, they have indicated that the plan would call for the rail line to be located in the median of Airport Boulevard. If this rail extension reaches the planning/design phase, HAS should coordinate closely with METRO to seek a design that allows for vertical circulation from the rail stop and an elevated walkway that connects to the passenger terminal, similar to what was described above. This would ensure that passengers would have safe access to the terminal without having to cross lanes of Airport Boulevard. An at-grade crossing would also cause a reduction in the vehicle capacity of Airport Boulevard.

8.5 Implementation Conclusions

The ADP will be implemented in phases so that development corresponds with the demand discussed in Section 3, "Aviation Demand Forecasts." Detailed planning, design, and construction information is important in the phasing process to minimize impacts on the airfield, terminal, and ground access routes. The ability to effectively phase implementation requires an understanding of the factors that prompt development and the various characteristics of Airport growth. Implementation indicators are specific activity levels that trigger the initiation of development. In the event that actual demand varies significantly from that forecast, the Master Plan Update should be updated to reflect the differences between forecast and actual demand. These potential differences may also change the ADP and the implementation of projects listed in the ADP. Therefore, it is recommended that the ADP and Implementation Plan be reviewed annually through activity monitoring and comparative analysis for comparison to actual activity levels prior to the initiation of development.

Additionally, HAS should continue to work collaboratively with the Texas Department of Transportation, METRO, and other agencies to help influence and encourage appropriate development within the Airport environs, as defined in this Master Plan Update. Just as on-Airport elements of the Implementation Plan will be incorporated into the HAS CIP for HOU, off-Airport projects should be incorporated into the development plans of other agencies. Through active coordination with these agencies, HAS can help ensure that critical off-Airport projects are implemented in a manner and on a schedule consistent with plans for the Airport. The specific means for this coordination should be determined by HAS and other agencies.

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9. Funding Plan

This section provides a funding plan for implementing the recommended Master Plan Update Capital Improvement Program for HOU. The actual implementation schedule for the capital projects identified in the CIP will be defined by development triggers and demand growth rather than by specific years. For purposes of these analyses, however, a specific implementation schedule is presented for illustrative purposes only. The actual funding strategies to be used will be determined at the time of implementation, reflecting HAS' philosophy and expansion strategies for development, HAS' financial health, and overall economic conditions nationwide.

This section, which provides a Funding Plan for the Master Plan CIP for Phase 1 (2014-2016), Phase 2 (2017-2019), Phase 3 (2020-2023), and Phase 4 (2024-2030), is organized as follows:

- HAS Financial Structure
- Master Plan CIP Capital Costs
- Funding Sources
- Other Airport Capital Improvements
- Summary

It should be noted that the financial analysis presented in this section differs from the typical master plan financial analysis. With a one-airport system, a typical financial analysis includes the recommended capital program, funding sources for the capital program, operating expenses and revenue projections, future debt service requirements, airline rates and charges, and overall cash flow. The financial feasibility of undertaking the recommended capital program for a single airport is typically measured by: (1) the reasonableness of airline rates and charges (as determined by airline cost per enplaned passenger) and (2) whether or not airport net revenues are adequate to meet debt service coverage requirements of the issuer's bond enabling legislation.

HAS, however, consists of three airports. Thus, in its financial decision-making, HAS must consider the needs of the overall Airport System rather than one airport. Therefore, it was not feasible to separate funding decisions regarding the HOU Master Plan CIP without considering the effects on the other airports in the Houston Airport System. As recommended by HAS, this section focuses only on the HOU Master Plan CIP and potential funding sources.

9.1 HAS Financial Structure

HAS manages and operates the Airport System Fund (the Fund), as an enterprise fund of the City. The Fund is used to account for services provided to the general public using the Airport System, and its costs are recovered primarily through user rentals, fees, and charges (e.g., landing fees, building and ground rentals, parking fees, concession fees).

HAS accounts for Airport System operating revenues and expenses using five—soon to be seven—direct (revenue-producing) cost centers and six indirect (allocated) cost centers, as follows:

- Direct Cost Centers
  - Airfield
  - Central Concourse Apron
  - Terminal Building
  - Parking and Ground Transportation
  - Other
  - International Concourse (once it opens in 2015)
  - International Apron (once it opens in 2015)
- Indirect Cost Centers
  - Roads
  - Systems and Utilities
  - Airport Management/HAS Allocation
  - Police Protection
  - Fire Protection
  - Drainage Fee

The rate-setting methodology for the HOU terminal, concourse, and apron rentals is cost center compensatory. Cost-center-specific operating expenses, allocated indirect operating expenses, allocated Renewal and Replacement Fund replenishment, and amortized capital improvements are combined in the Airline Requirement. This requirement is divided by cost-center-specific usable square footage to determine the average rental rate per square foot. The HOU landing fee methodology is also cost center compensatory, but with a reconciliation. It combines Airfield-specific expenses listed above, less credits for fuel flowage fees (paid by general aviation aircraft in lieu of landing fees). This net Airline Requirement is divided by airline landed weight (of passenger and all-cargo aircraft) to determine the landing fee rate per 1,000-pound units of landed weight.

9.2 Master Plan CIP Capital Costs

Table 9-1 presents a summary of phased capital costs for the Master Plan CIP. Construction costs were either provided by HAS or estimated by Connico, Inc., with the exception of a few minor projects whose costs were estimated by Ricondo & Associates, Inc. HAS-provided costs covered construction and (when applicable) design, art, and Construction Management at Risk (CMAR). Vertical structures must have an allowance for an art element, and CMAR is a soft cost quantified for already-committed projects. For projects with Connico-provided construction costs, a 10 percent design premium was assumed. For all projects, a 20 percent soft cost premium was assumed (in addition to CMAR). Construction, design, art, CMAR, and soft costs compose project costs.

For this analysis, estimated project costs were inflated at an annual compounded growth rate of 2.4 percent, which is the 10-year inflation rate for the Houston-Galveston-Brazoria metropolitan statistical area (as measured by the U.S. Department of Labor, Bureau of Labor Statistics, in its Consumer Price Index). The cost of each project was inflated to the midpoint of its planned construction period.

As shown, the Master Plan CIP for HOU is estimated to cost approximately $656.6 million in 2014 dollars ($734.0 million in inflated dollars) through the end of the fourth and final planning phase in 2030. For ease of presentation, the costs discussed in the remainder of this section are presented in inflated dollars.

Table 9-2 presents individual project costs on an annual basis in conjunction with the implementation plan presented in Section 8.

9.3 Funding Sources

Based on the recommended Master Plan CIP, its associated costs, and available funding sources, a recommended Funding Plan was developed to maximize the use of external resources and minimize the amount of funding to be derived from local sources. The sources of funds available to implement the Master Plan CIP at HOU and the recommended funding sources are discussed below.

9.3.1 FEDERAL AIRPORT IMPROVEMENT PROGRAM GRANTS

Projects were reviewed to determine their eligibility for federal Airport Improvement Program (AIP) grant funding. As a general rule, only those projects that do not generate revenues are eligible for federal funding. (A typical example is an airfield construction project.) Federal grant eligibility is generally assumed to be 75 percent for airfield, ramp, and roadway projects. Federal funds are either in the form of entitlement grants based on numbers of enplaned passengers or discretionary grants distributed by the FAA on the basis of availability and the priority of projects at airports nationwide. In determining eligibility for federal grant funding from the AIP, it was assumed that the AIP would continue to be in effect throughout the planning period, without any major changes.

Table 9-1 (1 of 2): Master Plan Capital Improvement Program

PROJECT	PURPOSE	COST IN 2014 $	COST IN INFLATED $
Phase 1 (2014-2016)			
Phase 1 Master Plan Projects - Environmental Study	Planning	$92,000	$92,000
New Parking Garage at Hobby	Expansion	77,660,000	77,660,000
Hobby Roadway Relocation	Maintenance/replacement	13,801,000	13,801,000
Houston International Facility - Lease Agreement	Expansion	20,470,000	21,411,000
Pavement Replacement at HOU (R&R) - Phase I	Maintenance/replacement	676,000	676,000
Satellite Utilities Plant (SUP)	Expansion	16,257,000	16,257,000
Rwy 12L Upgrade – Land Acquisition	Safety/security	1,412,000	1,477,000
Design and Install Canopy at Passenger Drop-Off Area	Expansion	10,133,000	10,133,000
HOU TSA EDS/CBRA Recapitalization	Expansion	13,518,000	13,525,000
Consolidated Maintenance Facility	Expansion	11,013,000	11,013,000
Remodel of West Cell Lot & Construction of East Cell Lot	Expansion	737,000	737,000
Roadway Intersection Improvements - Airport/Telephone	Maintenance/replacement	1,650,000	1,689,000
Roadway Intersection Improvements - Airport/Monroe	Maintenance/replacement	2,310,000	2,364,000
Roadway Intersection Improvements - Airport/Glencrest	Maintenance/replacement	990,000	1,013,000
Long-Term Surface Parking Lot Access Road Improvements	Maintenance/replacement	1,980,000	2,027,000
GA/CBO Development in South Quadrant	Expansion	33,660,000	34,451,000
Parking Technology for HOU	Maintenance/replacement	3,685,000	3,769,000
Rehabilitate & Expand ARFF Station 81	Maintenance/replacement	1,335,000	1,365,000
Phase 2 Master Plan Projects - Environmental Study	Planning	184,000	193,000
CRCF enabling – West Terminal Area Roadways	Expansion	3,300,000	3,455,000
Phase 1 Total		**$214,863,000**	**$217,101,000**
Phase 2 (2017-2019)			
West Concourse Expansion (7 gates, apron)	Expansion	$99,155,000	$110,811,000
CRCF enabling - Temporary Relocation of Rental Car Facilities	Expansion	5,544,000	6,065,000
CRCF enabling - Relocation of Taxi Staging Area	Maintenance/replacement	2,640,000	2,888,000
Hobby Drainage - Roadway Flooding - Planning	Planning	430,000	469,000
Pavement Replacement at HOU (R&R) - Phase II	Maintenance/replacement	676,000	738,000
Perimeter Security Intrusion Detection System (PIDS)	Safety/security	614,000	671,000
Reconstruct Rwy 12R-30L (Asphalt to Concrete)	Maintenance/replacement	8,106,000	8,851,000
Consolidated Rental Car Facility	Expansion	101,072,000	112,954,000
Pavement Replacement at HOU (R&R) - Phase III	Maintenance/replacement	676,000	753,000
Phase 3 Master Plan Projects - Environmental Study	Planning	307,000	342,000
Install 12-4-7 Back-Up Generators	Maintenance/replacement	9,212,000	10,270,000
Phase 2 Total		**$228,432,000**	**$254,812,000**

Table 9-1 (2 of 2): Master Plan Capital Improvement Program

PROJECT	PURPOSE	COST IN 2014 $	COST IN INFLATED $
Phase 3 (2020-2023)			
Hobby Cargo Building	Expansion	$7,524,000	$8,585,000
Rwy 12L Upgrade – Relocation of Main Deicing Pad	Maintenance/replacement	6,864,000	7,994,000
Rwy 12R Displaced Threshold Removal	Safety/security	891,000	1,080,000
Reconstruct Rwy 4-22 – Phase I	Planning	7,369,000	8,893,000
Relocation of West Cell Lot to Long-Term Parking Lot	Maintenance/replacement	660,000	784,000
Rwy 12L Upgrade - Signature Buildings Demolition	Asset removal	3,828,000	4,458,000
Rwy 12L Upgrade - Jet Aviation South Hangars Demolition	Asset removal	1,848,000	2,152,000
SWA Cargo Facility Demolition and Parking Lot Expansion	Expansion	3,300,000	3,921,000
Rwy 12L Upgrade - Taxiway Construction	Maintenance/replacement	40,524,000	49,099,000
Rwy 12L Upgrade - Runway Construction	Maintenance/replacement	42,636,000	51,658,000
Rwy 12L Upgrade - Perimeter Road/Fence Realignment	Maintenance/replacement	1,452,000	1,725,000
Rwy 12L Upgrade - Partial Closure of W Monroe Rd and Freeland St	Maintenance/replacement	1,056,000	1,255,000
Rwy 12L Upgrade - SWA Fuel Farm Boundary Changes	Maintenance/replacement	1,003,000	1,192,000
Remove Phone/Utility Poles - Re-Run Power Lines	Maintenance/replacement	843,000	998,000
Hobby Drainage - Roadway Flooding - Mitigation	Safety/security	3,869,000	4,669,000
Rwy 12L Upgrade - Obstruction Removal	Maintenance/replacement	660,000	800,000
Rwy 12L Upgrade - Navaids Relocation (ALS, LOC, PAPI, GS)	Maintenance/replacement	6,864,000	8,316,000
Decommissioning of Rwy 17-35	Asset removal	1,228,000	1,482,000
Phase 4 Master Plan Projects - Environmental Study	Planning	92,000	111,000
Phase 3 Total		**$132,511,000**	**$159,172,000**
Phase 4 (2024-2030)			
Shortening of Rwy 17-35 (Discretionary)	Asset removal	$1,228,000	$1,510,000
Reconstruct Rwy 4-22 – Phase II	Maintenance/replacement	39,303,000	48,331,000
Twys M3, H2 H & G (Discretionary)	Maintenance/replacement	7,369,000	9,401,000
Terminal Expansion (on east side)	Expansion	32,868,000	43,687,000
Phase 4 Total		**$80,768,000**	**$102,929,000**
MASTER PLAN CIP TOTAL COSTS		**$656,574,000**	**$734,014,000**

SOURCES: Houston Airport System, January 2014; Connico, Inc., and Ricondo & Associates, Inc., September 2014.
PREPARED BY: Ricondo & Associates, Inc., September 2014.

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Table 9-2 (1 of 2): Individual Project Costs (Thousands of Dollars, Inflated)

PHASE	PROJECT	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1	Phase 1 Master Plan Projects - Environmental Study	$92	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	New Parking Garage at Hobby	$77,660	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Hobby Roadway Relocation	$13,801	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Houston International Facility - Lease Agreement	$0	$0	$21,411	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Pavement Replacement at HOU (R&R) - Phase I	$676	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Satellite Utilities Plant (SUP)	$16,257	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Rwy 12L Upgrade – Land Acquisition	$0	$0	$1,477	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Design and Install Canopy at Passenger Drop-Off Area	$10,133	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	HOU TSA EDS/CBRA Recapitalization	$13,518	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Consolidated Maintenance Facility	$11,013	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Remodel of West Cell Lot & Construction of East Cell Lot	$737	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Roadway Intersection Improvements - Airport/Telephone	$0	$1,689	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Roadway Intersection Improvements - Airport/Monroe	$0	$2,364	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Roadway Intersection Improvements - Airport/Glencrest	$0	$1,013	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Long-Term Surface Parking Lot Access Road Improvements	$0	$2,027	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	GA/CBO Development in South Quadrant	$3,132	$31,319	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Parking Technology for HOU	$0	$3,769	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Rehabilitate & Expand ARFF Station 81	$0	$751	$614	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	Phase 2 Master Plan Projects - Environmental Study	$0	$64	$128	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	CRCF enabling – West Terminal Area Roadways	$0	$314	$3,141	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	Rwy 12R Displaced Threshold Removal	$0	$0	$0	$0	$10,074	$100,738	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	CRCF enabling - Temporary Relocation of Rental Car Facilities	$0	$0	$0	$551	$5,514	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	CRCF enabling - Relocation of Taxi Staging Area	$0	$0	$0	$263	$2,626	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	Hobby Drainage - Roadway Flooding - Planning	$0	$0	$0	$0	$469	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	Pavement Replacement at HOU (R&R) - Phase II	$0	$0	$0	$0	$738	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	Perimeter Security Intrusion Detection System (PIDS)	$0	$0	$0	$268	$402	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	Reconstruct Rwy 12r-30L (Asphalt to Concrete)	$0	$0	$402	$3,084	$5,364	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	Consolidated Rental Car Facility	$0	$0	$0	$0	$10,269	$102,685	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	Pavement Replacement at HOU (R&R) - Phase III	$0	$0	$0	$0	$0	$753	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	Phase 3 Master Plan Projects - Environmental Study	$0	$0	$0	$0	$0	$342	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	Install 12-4-7 Back-Up Generators	$0	$0	$0	$0	$0	$10,270	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Table 9-2 (2 of 2): Individual Project Costs (Thousands of Dollars, Inflated)

PHASE	PROJECT	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
3	Hobby Cargo Building	$0	$0	$0	$0	$0	$0	$4,683	$3,902	$0	$0	$0	$0	$0	$0	$0	$0	$0
3	Rwy 12L Upgrade – Relocation of Main Deicing Pad	$0	$0	$0	$0	$0	$0	$727	$7,267	$0	$0	$0	$0	$0	$0	$0	$0	$0
3	Rwy 12R Displaced Threshold Removal	$0	$0	$0	$0	$0	$0	$0	$0	$98	$981	$0	$0	$0	$0	$0	$0	$0
3	Reconstruct Rwy 4-22 – Phase I	$0	$0	$0	$0	$0	$0	$0	$0	$0	$8,893	$0	$0	$0	$0	$0	$0	$0
3	Relocation of West Cell Lot to Long-Term Parking Lot	$0	$0	$0	$0	$0	$0	$0	$0	$784	$0	$0	$0	$0	$0	$0	$0	$0
3	Rwy 12L Upgrade - Signature Buildings Demolition	$0	$0	$0	$0	$0	$0	$0	$4,458	$0	$0	$0	$0	$0	$0	$0	$0	$0
3	Rwy 12L Upgrade - Jet Aviation South Hangars Demolition	$0	$0	$0	$0	$0	$0	$0	$2,152	$0	$0	$0	$0	$0	$0	$0	$0	$0
3	Reconstruct Rwy 12R-30L (Asphalt to Concrete)	$0	$0	$0	$0	$0	$0	$0	$0	$3,921	$0	$0	$0	$0	$0	$0	$0	$0
3	Rwy 12L Upgrade - Taxiway Construction	$0	$0	$0	$0	$0	$0	$4,464	$14,879	$14,879	$14,879	$0	$0	$0	$0	$0	$0	$0
3	Rwy 12L Upgrade - Runway Construction	$0	$0	$0	$0	$0	$0	$4,696	$15,564	$15,564	$15,564	$0	$0	$0	$0	$0	$0	$0
3	Rwy 12L Upgrade - Perimeter Road/Fence Realignment	$0	$0	$0	$0	$0	$0	$0	$0	$1,725	$0	$0	$0	$0	$0	$0	$0	$0
3	Rwy 12L Upgrade - Partial Closure of W Monroe Rd and Freeland St	$0	$0	$0	$0	$0	$0	$0	$0	$1,255	$0	$0	$0	$0	$0	$0	$0	$0
3	Rwy 12L Upgrade - SWA Fuel Farm Boundary Changes	$0	$0	$0	$0	$0	$0	$0	$0	$1,192	$0	$0	$0	$0	$0	$0	$0	$0
3	Remove Phone/Utility Poles - Re-Run Power Lines	$0	$0	$0	$0	$0	$0	$0	$0	$998	$0	$0	$0	$0	$0	$0	$0	$0
3	Hobby Drainage - Roadway Flooding - Mitigation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,669	$0	$0	$0	$0	$0	$0	$0
3	Rwy 12L Upgrade - Obstruction Removal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$800	$0	$0	$0	$0	$0	$0	$0
3	Rwy 12L Upgrade - Navaids Relocation (ALS, LOC, PAPI, GS)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$8,316	$0	$0	$0	$0	$0	$0	$0
3	Decommissioning of Rwy 17-35	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,482	$0	$0	$0	$0	$0	$0	$0
3	Phase 4 Master Plan Projects - Environmental Study	$0	$0	$0	$0	$0	$0	$0	$0	$0	$111	$0	$0	$0	$0	$0	$0	$0
4	Shortening of Rwy 17-35 (Discretionary)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$151	$1,359	$0	$0	$0	$0	$0	$0
4	Reconstruct Rwy 4-11 – Phase II	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$48,331	$0	$0	$0	$0	$0	$0
4	Twys M3, H2 H & G (Discretionary)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$940	$4,230	$4,230	$0	$0	$0	$0
4	Terminal Expansion (on east side)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,972	$39,715	$0	$0
	Total Annual Costs (inflated)	**$147,019**	**$43,310**	**$27,173**	**$4,166**	**$35,456**	**$214,788**	**$14,570**	**$48,312**	**$40,506**	**$55,936**	**$50,630**	**$4,230**	**$4,230**	**$3,792**	**$39,715**	**$0**	**$0**

SOURCES: Houston Airport System, January 2014; Connico, Inc., and Ricondo & Associates, Inc., September 2014.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

For purposes of this analysis, it was not assumed that HAS will receive the maximum federal grants for all eligible Master Plan CIP projects. **Table 9-3** presents projections of annual AIP entitlement grants to be applied to the HOU Master Plan CIP. The projections were based on the following assumptions:

- Entitlement grants were projected based on the current FAA formula using the enplaned passenger data included in Section 3 of this Master Plan Update:
  - $7.80 per enplaned passenger for the first 50,000 enplaned passengers
  - $5.20 per enplaned passenger for the next 50,000 enplaned passengers
  - $2.60 per enplaned passenger for the next 400,000 enplaned passengers
  - $0.65 per enplaned passenger for the next 500,000 enplaned passengers
  - $0.50 per enplaned passenger beyond 1,000,000 enplaned passengers

  Because a passenger facility charge (PFC) of $3.00 per eligible enplaned passenger is levied at the Airport, these totals were adjusted by subtracting 50 percent of PFC revenues projected to be collected in a fiscal year, until reaching 50 percent of entitlement grants, as calculated by the formula set forth above.
- HAS can legally distribute federal grants as it deems appropriate among its three airports, depending on need and available funds. For this analysis, it was assumed that HAS would distribute the AIP entitlement grants to HOU as shown in Table 9-3.
- It was assumed that the Runway 12L-30R improvements (and associated projects in Phase 3) would be implemented if they were determined to be necessary by demand and would be FAA-funded. Therefore, two projects—the upgrade of Runway 12L-30R and the associated taxiway improvements—are likely candidates for discretionary grant funding from the FAA.

Table 9-4 presents potential sources of funds for the Master Plan CIP, including federal grants, other funds, and HAS (local) funds. Other funds are comprised of CFC revenues (for the Consolidated Rental Car Facility), TxDOT funds (for certain roadway intersection improvements), TSA grants and tenant contributions. As shown, and discussed above, the maximum federal share of eligible projects is 75 percent; however, the federal share for the West Concourse Expansion in Phase 2 was reduced to 25 percent to account for revenue-producing portions of the project that would not be eligible for AIP funding. As also shown, eligible projects could receive maximum federal grants totaling approximately $191.5 million (26.1 percent of the total cost of the Master Plan CIP).

As shown in Table 9-3, approximately $45.1 million in federal AIP entitlement grants is projected for the Master Plan CIP, or 6.1 percent of the total cost. These AIP entitlement grants were assigned to eligible projects based on the priority system recommended by HAS.

Table 9-3: Projection of AIP Entitlement Grants to Hobby

YEAR	ENTITLEMENTS
Phase 1	
2014	$2,084,000
2015	2,290,000
2016	2,351,000
Phase 1 Total	**$6,725,000**
Phase 2	
2017	$2,412,000
2018	2,475,000
2019	2,540,000
Phase 2 Total	**$7,427,000**
Phase 3	
2020	$2,608,000
2021	2,656,000
2022	2,694,000
2023	2,733,000
Phase 3 Total	**$10,691,000**
Phase 4	
2024	$2,772,000
2025	2,812,000
2026	2,853,000
2027	2,895,000
2028	2,938,000
2029	2,982,000
2030	3,025,000
Phase 4 Total	**$20,277,000**
TOTAL	**$45,120,000**

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

Table 9-4 (1 of 3): Potential Sources of Funds for the Hobby Master Plan Capital Improvement Program

PROJECT	TOTAL COSTS (INFLATED)	MAXIMUM ELIGIBLE AIP SHARE	MAXIMUM ELIGIBLE AIP GRANTS	SOURCES OF FUNDS		
				EXPECTED AIP GRANTS	OTHER FUNDS	HAS SHARE
Phase 1 (2014-2016)						
Phase 1 Master Plan Projects - Environmental Study	$92,000	0%	$0	$0	$0	$92,000
New Parking Garage at Hobby	77,660,000	0%	-	-	-	77,660,000
Hobby Roadway Relocation	13,801,000	0%	-	-	-	13,801,000
Houston International Facility - Lease Agreement	21,411,000	0%	-	-	-	21,411,000
Pavement Replacement at HOU (R&R) - Phase I	676,000	0%	-	-	-	676,000
Satellite Utilities Plant (SUP)	16,267,000	0%	-	-	-	16,257,000
Rwy 12L Upgrade – Land Acquisition	1,477,000	75%	1,108,000	1,108,000	-	369,000
Design and Install Canopy at Passenger Drop-Off Area	10,133,000	75%	7,600,000	3,800,000	-	6,333,000
HOU TSA EDS/CBRA Recapitalization	13,518,000	0%	-	-	13,518,000	-
Consolidated Maintenance Facility	11,013,000	0%	-	-	-	11,013,000
Remodel of West Cell Lot & Construction of East Cell Lot	737,000	0%	-	-	-	737,000
Roadway Intersection Improvements - Airport/Telephone	1,689,000	0%	-	-	1,689,000	-
Roadway Intersection Improvements - Airport/Monroe	2,364,000	0%	-	-	2,364,000	-
Roadway Intersection Improvements - Airport/Glencrest	1,013,000	0%	-	-	1,013,000	-
Long-Term Surface Parking Lot Access Road Improvements	2,027,000	0%	-	-	-	2,027,000
GA/CBO Development in South Quadrant	34,451,000	0%	-	-	17,225,500	17,225,500
Parking Technology for HOU	3,769,000	0%	-	-	-	3,769,000
Rehabilitate & Expand ARFF Station 81	1,365,000	0%	-	-	-	1,365,000
Phase 2 Master Plan Projects - Environmental Study	193,000	0%	-	-	-	193,000
CRCF enabling – West Terminal Area Roadways	3,455,000	75%	2,591,000	1,296,000	0	2,159,000
Phase 1 Total	**$217,101,000**		**$11,299,000**	**$6,204,000**	**$35,809,500**	**$175,087,500**

Table 9-4 (2 of 3): Potential Sources of Funds for the Hobby Master Plan Capital Improvement Program

PROJECT	TOTAL COSTS (INFLATED)	MAXIMUM ELIGIBLE AIP SHARE	MAXIMUM ELIGIBLE AIP GRANTS	SOURCES OF FUNDS: EXPECTED AIP GRANTS	SOURCES OF FUNDS: OTHER FUNDS	SOURCES OF FUNDS: HAS SHARE
Phase 2 (2017-2019)						
West Concourse Expansion (7 gates, apron)	$110,811,000	25%	$27,703,000	$0	$0	$110,811,000
CRCF enabling - Temporary Relocation of Rental Car Facilities	6,065,000	0%	-	-	-	6,065,000
CRCF enabling - Relocation of Taxi Staging Area	2,888,000	0%	-	-	-	2,888,000
Hobby Drainage - Roadway Flooding - Planning	469,000	75%	352,000	352,000	-	117,000
Pavement Replacement at HOU (R&R) - Phase II	738,000	0%	-	-	-	738,000
Perimeter Security Intrusion Detection System (PIDS)	671,000	75%	503,000	503,000	-	168,000
Reconstruct Rwy 12R-30L (Asphalt to Concrete)	8,851,000	0%	-	-	-	8,851,000
Consolidated Rental Car Facility	112,954,000	0%	-	-	112,954,000	-
Pavement Replacement at HOU (R&R) - Phase III	753,000	0%	-	-	-	753,000
Phase 3 Master Plan Projects - Environmental Study	342,000	0%	-	-	-	342,000
Install 12-4-7 Back-Up Generators	10,270,000	0%	-	-	-	10,270,000
Phase 2 Total	**$254,812,000**		**$28,558,000**	**$855,000**	**$112,954,000**	**$141,003,000**
Phase 3 (2020-2023)						
Hobby Cargo Building	$8,585,000	0%	$0	$0	$8,585,000	$0
Rwy 12L Upgrade – Relocation of Main Deicing Pad	7,994,000	75%	5,996,000	5,996,000	-	1,998,000
Rwy 12R Displaced Threshold Removal	1,080,000	75%	810,000	810,000	-	270,000
Reconstruct Rwy 4-22 – Phase I	8,893,000	75%	6,670,000	6,670,000	-	2,223,000
Relocation of West Cell Lot to Long-Term Parking Lot	784,000	0%	-	-	-	784,000
Rwy 12L Upgrade - Signature Buildings Demolition	4,458,000	75%	3,344,000	3,344,000	-	1,114,000
Rwy 12L Upgrade - Jet Aviation South Hangars Demolition	2,152,000	75%	1,614,000	1,614,000	-	538,000
SWA Cargo Facility Demolition and Parking Lot Expansion	3,921,000	0%	-	-	-	3,921,000

Table 9-4 (3 of 3): Potential Sources of Funds for the Hobby Master Plan Capital Improvement Program

				SOURCES OF FUNDS		
PROJECT	**TOTAL COSTS (INFLATED)**	**MAXIMUM ELIGIBLE AIP SHARE**	**MAXIMUM ELIGIBLE AIP GRANTS**	**EXPECTED AIP GRANTS**	**OTHER FUNDS**	**HAS SHARE**
Rwy 12L Upgrade - Taxiway Construction	49,099,000	75%	36,824,000	36,824,000	-	12,275,000
Rwy 12L Upgrade - Runway Construction	51,658,000	75%	38,744,000	38,744,000	-	12,914,000
Rwy 12L Upgrade - Perimeter Road/Fence Realignment	1,725,000	75%	1,294,000	1,294,000	-	431,000
Rwy 12L Upgrade - Partial Closure of W Monroe Rd and Freeland St	1,255,000	75%	941,000	941,000	-	314,000
Rwy 12L Upgrade - SWA Fuel Farm Boundary Changes	1,192,000	75%	894,000	894,000	-	298,000
Remove Phone/Utility Poles - Re-Run Power Lines	998,000	75%	749,000	749,000	-	249,000
Hobby Drainage - Roadway Flooding - Mitigation	4,669,000	75%	3,502,000	-	-	4,669,000
Rwy 12L Upgrade - Obstruction Removal	800,000	75%	600,000	600,000	-	200,000
Rwy 12L Upgrade - Navaids Relocation (ALS, LOC, PAPI, GS)	8,316,000	75%	6,237,000	6,237,000	-	2,079,000
Decommissioning of Rwy 17-35	1,482,000	0%	-	-	-	1,482,000
Phase 4 Master Plan Projects - Environmental Study	111,000	75%	83,000	83,000	-	69,000
Phase 3 Total	**$159,172,000**		**$108,302,000**	**$104,759,000**	**$8,585,000**	**$45,828,000**
Phase 4 (2024-2030)						
Shortening of Rwy 17-35 (Discretionary)	$1,510,000	0%	$0	$0	$0	$1,510,000
Reconstruct Rwy 4-22 – Phase II	48,331,000	75%	36,248,000	36,248,000	-	12,083,000
Twys M3, H2 H & G (Discretionary)	9,401,000	75%	7,051,000	3,526,000	-	5,875,000
Terminal Expansion (on east side)	43,687,000	0%	-	-	-	43,687,000
Phase 4 Total	**$102,929,000**		**$43,299,000**	**$39,774,000**	**$0**	**$63,155,000**
TOTAL	**$734,014,000**		**$191,458,000**	**$151,592,000**	**$157,348,500**	**$425,073,500**

SOURCES: Houston Airport System; Connico, Inc.; Ricondo & Associates, Inc., January 2014.
PREPARED BY: Ricondo & Associates, Inc., January 2014.

9.3.2 PASSENGER FACILITY CHARGES

In May 1991, the FAA issued 14 CFR Part 158, allowing public agencies controlling commercial service airports to impose a PFC per eligible enplaned passenger. In 2006, HAS successfully applied to impose a PFC of $3.00 per eligible enplaned passenger at HOU. For this analysis, it is not expected that HAS will submit an application to the FAA during the planning period to use PFC revenues to help fund Master Plan CIP projects. Also, it is not expected that HAS will amend its existing application to increase the PFC level imposed at HOU. However, if the incremental PFC revenue generated at HOU were used solely for eligible Master Plan CIP projects from 2014 through 2030, PFC revenues at a $4.50 PFC level could provide an increment of nearly $200 million, while also reducing entitlement grants by 50 percent (-$22.5 million).

9.3.3 OTHER FUNDING

Other funding sources for certain Master Plan CIP projects include general aviation/corporate business operator developments and construction of a cargo building. These projects are estimated to cost approximately $157.3 million, or 21.4 percent of the total cost of the CIP. These projects are best suited for third-party funding based on the following rationale:

- Tenant/developer funding was previously used for belly freight facilities at IAH. It was assumed that similar funding arrangements would be used for these projects at HOU.
- Tenant/developer funding was previously used for general aviation facilities at HOU. It was assumed that similar funding arrangements would be used.
- Improvements to certain roadway intersections outside Airport property fall under the purview of TxDOT, not HAS. As such, TxDOT funding is assumed to cover project costs.
- The Consolidated Rental Car Facility would be funded by bonds, the debt service on which would be paid by rental car customer facility charges.

9.3.4 LOCAL FUNDING

The remaining $425.1 million (57.9 percent) of project costs would be funded through HAS. As shown in Table 9-4, the plurality of local funding would be required in Phase 2 (2017-2019), with $141.0 million required, chiefly for the West Concourse Expansion. Major projects in other phases requiring local funding include the upgrade of Runway 12L-30R and terminal expansion on the east side. These projects are demand-driven and would not be constructed until demand warrants.

Project costs not funded with federal grants or third-party funding would most likely be funded through some combination of Airports Improvement Fund moneys and the sale of general airport revenue bonds. Project costs that are airfield- or terminal/apron-related would be amortized over a 15-, 20-, or 25-year period and included in the airline rate base. (Equipment would be amortized over a 15-year period, renovations over a 20-year period, and new projects over a 25-year period.) Airfield project costs would be recovered entirely through landing fees and terminal/apron project costs would be recovered based on the airlines' share of the total square footage in that particular cost center.

9.4 Other Airport Capital Improvements

In addition to the Master Plan CIP, HAS maintains an ongoing 6-year CIP. The current Airport CIP differs from the Master Plan CIP in that the phasing and implementation of projects are in finer detail than that required for the Master Plan CIP. Whereas projects in the Master Plan CIP are grouped into broad categories, in HAS's current Airport CIP, these projects are phased over many years. **Table 9-5** presents the current HAS CIP for HOU from FY 2014 through FY 2019.

9.5 Summary

A broad, aggregate approach was used in developing the Master Plan CIP, as projects will be refined before implementation. As discussed earlier, the financial analysis presented in this section differs from the typical master plan financial analysis. Given the dynamics of the three airports included in the Houston Airport System, neither a financial feasibility analysis nor a detailed financial analysis could be conducted without isolating HOU from the other airports in the system. This isolation is inconsistent with the financial decision-making conducted by HAS for the three facilities. As a result, HAS recommended that this section be limited to the Master Plan CIP and potential funding levels from various sources to implement the Master Plan CIP.

Table 9-5 (1 of 3): Airport Capital Improvement Program

CIP #	PN	PHASE	CATEGORY	DESCRIPTION	FY14	FY15	FY16	FY17	FY18	FY19	TOTAL
A-0310.13	597A	D	Rev Generator	New Parking Garage at Hobby	$1,120	$0	$0	$0	$0	$0	$1,120
A-0422.04	597A	D	Rev Generator	Art - New Parking Garage at Hobby (Design)	15	-	-	-	-	-	15
A-0422.104	597A	C	Rev Generator	Art - New Parking Garage at Hobby (Const)	914	-	-	-	-	-	914
A-0422.80	597A	C	-	Art - CMAR Pre-construction Phase Services	11	-	-	-	-	-	11
A-0310.03	597A	C	Rev Generator	New Parking Garage at Hobby - Construction	61,336	-	-	-	-	-	61,336
A-0310.09	597A	-	-	CMAR Pre-construction Phase Services	159	-	-	-	-	-	159
A-0592.02	685	C	HOU	Hobby Roadway Relocation	11,237	-	-	-	-	-	11,237
A-0592.03	685	C	-	CMAR Pre-construction Phase Services	447	-	-	-	-	-	447
A-0601.01	720	C	HOUFIS	HOU International Facility - Reimbursable Projects - Approved by Council - 2/13/13 Ordinances No. O2013-0129	-	20,000	-	-	-	-	20,000
A-0513.10	460B	C	Critical Infra	Pavement Replacement at HOUR(R&R)	550	-	-	-	-	-	550
A-0614.02	692	C	Critical Infra	Satellite Central Utilities Plant (sup) at Hobby	13,036	-	-	-	-	-	13,036
A-0614.01	692	C	-	CMAR Pre-construction Phase Services	447	-	-	-	-	-	447
A-0614.03	692	C	-	Satellite Utilities Plant (sup)at Hobby (Equipment)	889	-	-	-	-	-	889
A-0422.03	692	C	Critical Infra	Art - Satellite Utilities Plant (sup) at Hobby	225	-	-	-	-	-	225
A-0422.92	692	C	-	Art - Satellite Utilities Plant (sup) at Hobby	16	-	-	-	-	-	16
A-0613.01	695	D	Critical Infra	Security Enhancements of Airport Operations Area - Perimeter Fence Line	100	-	-	-	-	-	100
A-0613.02	695	C	Critical Infra	Security Enhancements of Airport Operations Area - Perimeter Fence Line	-	900	-	-	-	-	900

Table 9-5 (2 of 3): Airport Capital Improvement Program

CIP #	PN	PHASE	CATEGORY	DESCRIPTION	FY14	FY15	FY16	FY17	FY18	FY19	TOTAL
A-0519.01	703	D	Customer Svc	Design & Install Canopy at Passenger Drop Off Area	750	-	-	-	-	-	750
A-0519.02	703	C	Customer Svc	Design & Install Canopy at Passenger Drop Off Area	-	7,500	-	-	-	-	7,500
A-0594.02	597C	O	Rev Generator	Parking Technology for Hobby Airport	-	3,000	-	-	-	-	3,000
A-0362.03	545D	D	Infrastructure	Design - Airport Services Complex Upgrade Enabling Project - PFC Eligible.	350	-	-	-	-	-	350
A-0422.89	545D	D	Infrastructure	Art - Airfield & Ground Expansion	14	-	-	-	-	-	14
A-0362.04	545D	D	Infrastructure	New Maintenance Facility and New Fleet Shop	450	-	-	-	-	-	450
A-0362.09	545B	C	Infrastructure	Inclined Driveway for Sweeper at Airfield and Grounds	52	-	-	-	-	-	52
A-0362.10	545B	C	Infrastructure	Vehicle Wash Expansion	145	-	-	-	-	-	145
A-0362.11	545B	C	Infrastructure	New Airfield & Grounds Building	2,677	-	-	-	-	-	2,677
A-0422.41	545B	C	Infrastructure	Art - Airfield & Grounds Expansion	126	-	-	-	-	-	126
A-0362.05	545B	C	Infrastructure	New Maintenance Facility and New Fleet Shop	4,500	-	-	-	-	-	4,500
A-0513.13	460C	C	Infrastructure	Pavement Replacement at HOU (R&R)	-	-	-	-	550	-	550
A-0513.05	460D	C	Infrastructure	Pavement Replacement at HOU (R&R)	-	-	-	-	-	550	550
A-0580.01	672	D	Drainage	Hobby Drainage - Roadway Flooding	-	-	-	-	350	-	350
A-0576.01	653	D	Infrastructure	Modify North Electrical Vault & Misc. Elect. Upgrades - This Project Will Go Away	-	-	-	-	1,175	-	1,175
A-0576.02	653	C	Infrastructure	Modify North Electrical Vault & Misc. Elect. Upgrades - This Project Will Go Away	-	-	-	-	10,575	-	10,575
A-0590.03	669	D	Infrastructure	Rehabilitate & Expand ARFF Station 81 Move to FY15	-	100	-	-	-	-	100

Table 9-5 (3 of 3): Airport Capital Improvement Program

CIP #	PN	PHASE	CATEGORY	DESCRIPTION	FY14	FY15	FY16	FY17	FY18	FY19	TOTAL
A-0590.04	669	C	Infrastructure	Rehabilitate & Expand ARFF Station 81 Move to FY16	-	-	900	-	-	-	900
A-0604.02	690B	C	Other/Product	HOU TSA EDS/CBRA Recapitalization	11,006	-	-	-	-	-	11,006
A-0418.01	710	D	Other/Product	Hobby Cargo Building FY17	-	-	590	-	-	-	590
A-0422.75	710	D	Other/Product	Art - Hobby Cargo Building (design) FY17	-	-	11	-	-	-	11
A-0418.02	710	C	Other/Product	Hobby Cargo Building FY18	-	-	-	5,310	-	-	5,310
A-0422.76	710	C	Other/Product	Art - Hobby Cargo Building (Const) FY18	-	-	-	93	-	-	93
A-0573.01	650	D	Other/Product	Perimeter Security Intrusion Detection System (Pids)	-	-	-	50	-	-	50
A-0573.02	650	C	Other/Product	Perimeter Security Intrusion Detection System (Pids)	-	-	-	-	450	-	450
A-0520.01	704	D	Other/Product	Install 12-4-7 Back-up Generators	-	-	-	-	-	950	950
A-0520.02	704	C	Other/Product	Install 12-4-7 Back-up Generators	-	-	-	-	-	6,550	6,550
					$110,572	**$31,500**	**$1,501**	**$5,453**	**$13,100**	**$8,050**	**$170,176**

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

10. Environmental Overview

This Master Plan Update includes recommendations for major projects at the Airport through 2030. These projects include expanded runways and taxiways, roadway improvements, a new cargo building, a new consolidated rental car facility and terminal expansion, all of which will require environmental analyses and land acquisition. This environmental overview presents the potential environmental issues related to the Master Plan Update recommendations for future environmental assessment. It addresses the environmental resource categories in FAA Orders 1050.1E and 5050.4B to inform decision makers of the potential environmental impacts that could result from implementation of these projects.

This environmental overview does not fulfill requirements under the National Environmental Policy Act of 1969 (NEPA); environmental issues are identified but not assessed in detail, nor are alternative actions other than the projects recommended in this Master Plan Update considered. As specific projects recommended in this Master Plan Update are developed, they will be evaluated for NEPA compliance and, if appropriate, Environmental Impact Statements (EIS) or Environmental Assessments (EA) will be prepared to identify and disclose the environmental impacts of the specific projects, along with alternative actions and no action.

10.1 Aircraft Noise

Most aircraft noise is generated from the engines of the aircraft (the airframe also produces some aircraft noise). The large fleet of jet aircraft operated by commercial airlines is the primary source of noise related to Airport operations. Relatively less noise is produced from the smaller fleet of propeller-driven aircraft used in general aviation, but the noise has a different frequency distribution.

Loudness, measured in decibels (dB), is the most commonly used metric to define the level of noise. A-weighted decibels (dBA) are used to measure aircraft noise because this measure closely imitates the sensitivity of the human ear to the entire spectrum of sound frequencies.

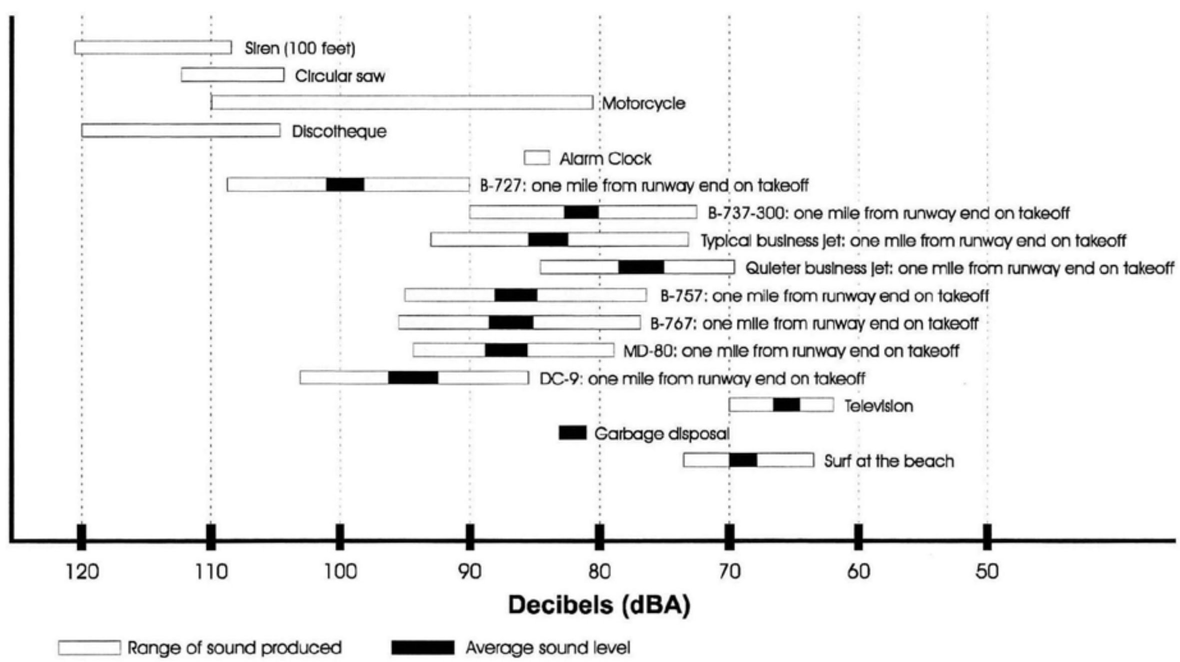
Table 10-1 lists common sounds and their typical sound levels. The decibel scale is geometric in terms of human perception, but logarithmic in terms of sound pressure energy. As shown, for each 10-dBA increase in sound level, most people perceive the relative loudness to double, while the physical sound energy increases by a factor of 10. **Exhibit 10-1** illustrates the range of sound produced and the average sound level of several aircraft types compared with other sounds, such as sirens, motorcycles, and garbage disposals. Most listeners cannot perceive differences in sounds of two dBA or less.

Table 10-1: Common Sound Levels in Decibels, Loudness and Sound Energy

SOUND	SOUND LEVEL (dBA)	PERCEIVED LOUDNESS RELATIVE TO 60 dBA	SOUND PRESSURE ENERGY RELATIVE TO 60 dBA
Amplified rock music	120	64	1,000,000
Thunder, snowmobile (operator)	110	32	100,000
Boiler shop, power mower	100	16	10,000
Orchestra fortissimo at 25 feet, noisy kitchen	90	8	1,000
Busy street	80	4	100
Interior of department store	70	2	10
Ordinary conversation at 3 feet	60	1	1
Quiet automobile interior at low speed	50	1/2	0.1
Average office	40	1/4	0.01
City residence	30	1/8	0.001
Quiet country residence	20	1/16	0.0001
Rustle of leaves	10	1/32	0.00001
Threshold of hearing	0	1/64	0.000001

SOURCE: U.S. Department of Housing and Urban Development, *Aircraft Noise Impact: Planning Guidelines for Local Agencies*, 1972.
PREPARED BY: Quadrant Consultants Inc., 2013.

Exhibit 10-1: Typical Sound Levels



SOURCE: Brown-Buntin Associates, Inc., 2001.
PREPARED BY: Brown-Buntin Associates, Inc., 2001.

A noise event produced by a jet aircraft flyover is usually characterized by a buildup to a peak noise level as the aircraft approaches, followed by a decrease in the noise level through a series of lesser peaks or pulses after the aircraft passes and the noise recedes.

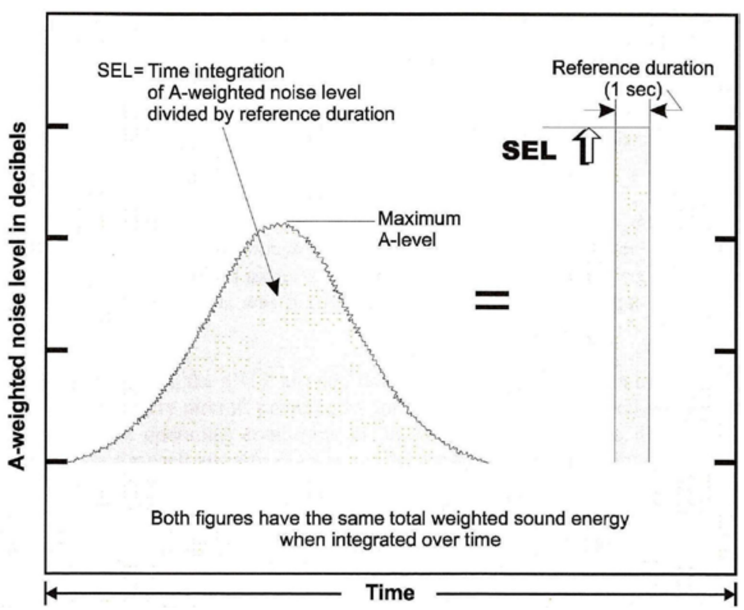
10.1.1 METHODS

There are several descriptors used to assess noise for aircraft noise analyses, as described below.

- **Maximum Noise Level (L_{max})**: L_{max} is the maximum sound level during a noise event, corresponding to the noise level at the peak of the noise exposure curve over time. L_{max} accounts for the instantaneous peak intensity of the sound, but neither the duration nor the total sound energy of the event.

- **Sound Exposure Level (SEL)**: SEL is the sound energy of a single noise event, integrated over the entire duration of the event, generally during the time the sound level exceeds a threshold (typically, 65 dBA). The SEL for a specific noise event varies by the location and type of aircraft and the type of operation (landing, takeoff or overflight). As shown on **Exhibit 10-2**, SEL accounts for both the magnitude and the duration of the sound, but only for single events.
- **Equivalent Sound Level (L_{eq}):** L_{eq} is the sound energy of all the noise events over a specific period, often one hour. L_{eq} accounts for the magnitude and duration of the sound and integrates noise exposure over meaningful periods. Because it integrates all sound events into a single number (measured in decibels), it is a good indicator of total noise exposure by receptors.

Exhibit 10-2: Sound Exposure Level



SOURCE: Brown-Buntin Associates, Inc., 2001.
PREPARED BY: Brown-Buntin Associates, Inc. 2001.

- **Day-Night Average Sound Level (DNL)**: DNL, like L_{eq}, is the sound energy at a location over a specified period, but with sound levels between 10:00 p.m. and 7:00 a.m. weighted by a 10-dB penalty. This weighting penalty accounts for the more intrusive perception of noise during nighttime hours and is equivalent to a tenfold increase in aircraft operations.

The FAA mandates that DNL be used to measure cumulative noise exposure near airports to determine potential noise impacts and land use compatibility. To calculate DNL, all of the SELs for aircraft landings, takeoffs and overflights are measured over a time period, the levels are adjusted to reflect the duration of the operation (and the nighttime penalty, if applicable), and the levels are added logarithmically to determine the total aircraft noise exposure.

Because noise exposure increases on a logarithmic rather than a linear scale, the noise level resulting from combining a relatively quiet event with a relatively noisy event will be the level of the noisy event itself. For example, a 60 dBA noise occurring along with a 70 dBA noise results in a total noise level of 70 dBA because the quieter event has only one-tenth of the sound energy of the noisier event and the quieter noise event is overwhelmed by the noisier one.

To determine future noise impacts from aircraft operations at an airport, a computer model is used to calculate future noise levels resulting from expected changes in the frequency or direction of aircraft operations, changes in runway layout, or new receptor locations. The Integrated Noise Model (INM) was developed for the FAA to predict aircraft noise exposure near airports. Version 7.0d, the most recent release of the INM at the time this Master Plan Update was prepared, was used for this aircraft noise analysis.

The INM database includes aircraft noise data for most commercial, general aviation, and military aircraft, whether powered by turbojet, turbofan or propeller engines. The data reflect average aircraft operating conditions at an average airport, and data can be customized for temperature and elevation differences. The database contains, for each aircraft, a set of departure profiles for several trip stage lengths, a set of approach parameters, and SEL-distance curves for several thrust settings. INM also includes runway layout geometry for most major airports in the United States. When provided with numbers of aircraft, by type and stage length (distance traveled), flight tracks for takeoffs and landings on typical days, and other conditions specific to an airport, the model produces noise exposure contours enclosing areas that would experience airport noise levels of DNL 65, 70 and 75. Noise exposure contours are lines on a map that connect points of equal DNL values. In this analysis, INM was used to calculate areas exposed to DNL 65, 70 and 75 for existing (2011) conditions and expected conditions in 2020 and 2030. The noise exposure contours, overlaid on a geographic information system (GIS) map that combines U.S. Census data and field observations were used to estimate the number of residents exposed to noise between DNL 65 and 70, between DNL 70 and 75, and DNL 75 or greater. These data are presented in Section 10.2 below, "Compatible Land Use."

10.1.2 DATA, ASSUMPTIONS, AND RESULTS

The following data for 2011, 2020 and 2030 were used in this INM analysis:

- Average daily aircraft operations by time of day, aircraft type and stage length (nonstop departure distance).
- Locations of representative flight tracks (aerial paths used by aircraft around the Airport). No actual radar tracks were available; as a result, flight track assumptions were based on published arrival and departure procedures, and typical aircraft performance.
- Annual percentage of operations on each runway, by aircraft type, for each general wind direction (North or South Flow) and assigned flight track.
- Departure profiles and current noise abatement procedures.

To calculate current and future aircraft noise, aircraft operations for an annual average day were input into the INM. The numbers of aircraft operations, by time of day and aircraft type, for an average day in 2011, 2020 and 2030 are listed in **Table 10-2**, **Table 10-3** and **Table 10-4**, respectively. Aircraft operations in 2011 were based on the ANOMS database, which lists all aircraft operations at the Airport from April 2011 through March 2012. This same consecutive 12-month period was used to develop forecasts of aviation operations. Forecast aircraft operations in 2020 and 2030 are set forth in Section 3, "Aviation Demand Forecasts," and were allocated to runways, aircraft types, and flight tracks in the INM based on current patterns and forecast trends.

The INM aircraft database includes information for most, but not all, aircraft types that operate at the Airport. For those aircraft operating at the Airport that are not in the INM database, other aircraft with similar engine types, numbers of engines, weights, and performance characteristics that are in the INM database were substituted in accordance with the FAA's list of approved aircraft substitutes. The types of INM aircraft listed in Table 10-2, Table 10-3 and Table 10-4 are most of the aircraft types that currently operate at the Airport or that are expected to operate at the Airport through 2030.

Departure stage length is the distance an aircraft travels from the Airport. At the Airport, departing aircraft can be categorized as Stage 1 (less than 500 nautical miles), Stage 2 (500 to 1,000 nautical miles), or Stage 3 (1,000 to 1,500 nautical miles). An aircraft's stage is determined by its fuel load and, therefore, its average gross takeoff weight, which is used in the INM to set an appropriate departure profile. Aircraft noise on takeoff varies by the takeoff weight of the aircraft and the weather conditions. For example, a fully loaded aircraft departing on a long flight will weigh more than the same type of fully loaded aircraft departing on a shorter flight because the longer flight requires more fuel. The heavier aircraft will take longer to gain altitude than the lighter aircraft, especially on hot days. Therefore, more land area will be exposed to higher levels of aircraft noise for the heavier aircraft, as the aircraft is closer to the ground for a greater distance from the airport. This information represents the stage length profile. Stage length profiles for aircraft operating at the Airport in 2011 and projected to operate at the Airport in 2020 and 2030 were based on destination data provided in the ANOMS database of flight operations.

Table 10-2 (1 of 2): 2011 Aircraft Operations at the Airport

	ARRIVALS			DEPARTURES						
				STAGE 1		STAGE 2		STAGE 3		
AIRCRAFT TYPE	DAY	NIGHT	TOTAL	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	TOTAL
Air Carrier	**43,981**	**4,510**	**48,491**	**15,833**	**1,623**	**11,435**	**1,173**	**16,713**	**1,714**	**48,491**
Airbus A318	16	2	18	6	1	4	0	6	1	18
Airbus A319	757	78	835	273	28	197	20	288	30	835
Airbus A320	300	31	331	108	11	78	8	114	12	331
Boeing 717	1,388	142	1,530	500	51	361	37	527	54	1,530
Boeing 737-300	15,619	1,602	17,221	5,623	577	4,061	416	5,935	609	17,221
Boeing 737-400	81	8	89	29	3	21	2	31	3	89
Boeing 737-500	3,514	360	3,874	1,265	130	914	94	1,335	137	3,874
Boeing 737-700	21,907	2,246	24,153	7,886	809	5,696	584	8,325	854	24,153
Boeing 737-800	54	6	60	20	2	14	1	21	2	60
Boeing DC9	218	22	240	78	8	57	6	83	8	240
Boeing MD80	127	13	140	46	5	33	3	48	5	140
Regional/Commuter	**4,701**	**482**	**5,183**	**4,701**	**482**	**0**	**0**	**0**	**0**	**5,183**
Bombardier CR7	107	11	118	107	11	0	0	0	0	118
Bombardier CR9	1,860	191	2,051	1,860	191	0	0	0	0	2,051
Embraer E70/E75	90	9	99	90	9	0	0	0	0	99
Embraer E90	449	46	495	449	46	0	0	0	0	495
Embraer ERJ	531	54	585	531	54	0	0	0	0	585
Embraer ER4	1,664	171	1,835	1,664	171	0	0	0	0	1,835
GA Business Jet/Air Taxi	**14,573**	**1,393**	**15,966**	**14,573**	**1,393**	**0**	**0**	**0**	**0**	**15,966**
Learjet 45	1,153	110	1,263	1,153	110	0	0	0	0	1,263
Cessna 560XL	904	86	991	904	86	0	0	0	0	991
Cessna 560	692	66	759	692	66	0	0	0	0	759
Cessna 550	663	63	726	663	63	0	0	0	0	726
Cessna 650	656	63	719	656	63	0	0	0	0	719
Gulfstream G150	550	53	603	550	53	0	0	0	0	603
Gulfstream G-IV	489	47	536	489	47	0	0	0	0	536
Cessna 750	465	45	510	465	45	0	0	0	0	510
Other GA business jet	9,000	860	9,861	9,000	860	0	0	0	0	9,861

Table 10-2 (2 of 2): 2011 Aircraft Operations at the Airport

	ARRIVALS			DEPARTURES						
				STAGE 1		STAGE 2		STAGE 3		
AIRCRAFT TYPE	**DAY**	**NIGHT**	**TOTAL**	**DAY**	**NIGHT**	**DAY**	**NIGHT**	**DAY**	**NIGHT**	**TOTAL**
General Aviation	**26,383**	**2,523**	**28,906**	**25,761**	**3,144**	**0**	**0**	**0**	**0**	**28,906**
MD Helicopter 369E	124	37	161	124	37	0	0	0	0	161
Bell 407	82	24	106	82	24	0	0	0	0	106
Eurocopter AS350B2	12	4	16	12	4	0	0	0	0	16
Schweizer 269C	9	3	12	9	3	0	0	0	0	12
Berry B-8M	9	3	12	9	3	0	0	0	0	12
Sikorsky S-92A	3	1	5	3	1	0	0	0	0	5
Other helicopter	3,116	931	4,047	3,116	931	0	0	0	0	4,047
Beech 58	149	14	163	149	14	0	0	0	0	163
Cessna 421C	115	11	127	115	11	0	0	0	0	127
Piper PA-31-200T	70	7	77	70	7	0	0	0	0	77
Cessna 421B	54	5	59	54	5	0	0	0	0	59
Cessna 414A	50	5	55	50	5	0	0	0	0	55
Piper PA-34-200T	50	5	55	50	5	0	0	0	0	55
Cessna 402B	41	4	45	41	4	0	0	0	0	45
Other multi-engine	9,236	883	10,119	9,236	883	0	0	0	0	10,119
Cirrus Design SR22	183	17	201	183	17	0	0	0	0	201
Beech A36	168	16	185	168	16	0	0	0	0	185
Cirrus Design SR20	32	3	35	32	3	0	0	0	0	35
Beech G36	31	3	35	31	3	0	0	0	0	35
Piper PA46-350P	30	3	33	30	3	0	0	0	0	33
Other single-engine	12,198	1,166	13,365	12,198	1,166	0	0	0	0	13,365
Military	**1,291**	**123**	**1,414**	**1,282**	**132**	**0**	**0**	**0**	**0**	**1,414**
T-38 Trainer	1,291	123	1,414	1,282	132	0	0	0	0	1,414
Total Operations	**90,929**	**9,031**	**99,960**	**62,151**	**6,775**	**11,435**	**1,173**	**16,713**	**1,714**	**99,960**

NOTE: Columns and rows may not add to totals shown because of rounding.

SOURCES: Airport Noise and Operations Monitoring System Database, Houston Airport System, April 2012.

PREPARED BY: Quadrant Consultants Inc., 2013.

Table 10-3 (1 of 2): 2020 Aircraft Operations at the Airport

	ARRIVALS			DEPARTURES						
				STAGE 1		STAGE 2		STAGE 3		
AIRCRAFT TYPE	DAY	NIGHT	TOTAL	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	TOTAL
Air Carrier	**60,352**	**6,188**	**66,540**	**21,727**	**2,228**	**15,691**	**1,609**	**22,934**	**2,352**	**66,540**
Airbus A319	2,617	268	2885	942	97	680	70	994	102	2885
Airbus A320	654	67	721	235	24	170	17	248	25	721
Boeing B737-300	17,010	1,744	18,754	6,124	628	4,423	453	6,464	663	18,754
Boeing B737-500	3,272	335	3,607	1,178	121	851	87	1,243	127	3,607
Boeing B737-700	32,711	3,354	36,065	11,776	1,207	8,505	872	12,430	1,275	36,065
Boeing B737-800	3,925	403	4328	1,413	145	1,021	105	1,492	153	4328
Boeing MD80	163	17	180	59	6	42	4	62	6	180
Regional/Commuter	**5,070**	**520**	**5,590**	**1,825**	**187**	**1,318**	**135**	**1,927**	**198**	**5,590**
Bombardier CR7	654	67	721	235	24	170	17	248	25	721
Bombardier CR9	2,453	252	2705	883	91	638	65	932	96	2705
Embraer E70/E75	327	34	361	118	12	85	9	124	13	361
Embraer E90	654	67	721	235	24	170	17	248	25	721
Embraer ERJ	327	34	361	118	12	85	9	124	13	361
Embraer ER4	654	67	721	235	24	170	17	248	25	721
GA Business Jet/Air Taxi	**16,306**	**1,559**	**17,865**	**12,229**	**1,169**	**3,261**	**312**	**815**	**78**	**17,865**
Learjet 45	1,153	110	1,263	865	83	231	22	58	6	1,263
Cessna 560XL	904	86	991	678	65	181	17	45	4	991
Cessna 560	692	66	759	519	50	138	13	35	3	759
Cessna 550	663	63	726	497	48	133	13	33	3	726
Cessna 650	656	63	719	492	47	131	13	33	3	719
Gulfstream G150	550	53	603	413	39	110	11	28	3	603
Gulfstream G-IV	489	47	536	367	35	98	9	24	2	536
Cessna 750	465	45	510	349	33	93	9	23	2	510
Other GA Business Jet	10,733	1,026	11,760	8,050	770	2,147	205	537	51	11,760

Table 10-3 (2 of 2): 2020 Aircraft Operations at the Airport

	ARRIVALS			DEPARTURES						
				STAGE 1		STAGE 2		STAGE 3		
AIRCRAFT TYPE	**DAY**	**NIGHT**	**TOTAL**	**DAY**	**NIGHT**	**DAY**	**NIGHT**	**DAY**	**NIGHT**	**TOTAL**
General Aviation	**27,063**	**2,587**	**29,650**	**22,831**	**6,820**	**0**	**0**	**0**	**0**	**29,650**
MD Helicopter 369E	127	38	165	127	38	0	0	0	0	165
Bell Helicopter 407	84	25	109	84	25	0	0	0	0	109
Eurocopter AS 350 B2	12	4	16	12	4	0	0	0	0	16
Schweizer Helicopter 269C	9	3	12	9	3	0	0	0	0	12
Berry Helicopter B-8M	9	3	12	9	3	0	0	0	0	12
Sikorsky S-92A	4	1	5	4	1	0	0	0	0	5
Other Helicopter	3,196	955	4,151	3,196	955	0	0	0	0	4,151
Beech 58	153	15	167	129	38	0	0	0	0	167
Cessna 421C	118	11	130	100	30	0	0	0	0	130
Piper PA-31-200T	72	7	78	60	18	0	0	0	0	78
Cessna 421B	55	5	61	47	14	0	0	0	0	61
Cessna 414A	51	5	56	43	13	0	0	0	0	56
Piper PA-34-200T	51	5	56	43	13	0	0	0	0	56
Cessna 402B	42	4	46	35	10	0	0	0	0	46
Other Multi-Engine	9,474	906	10,379	7,992	2,387	0	0	0	0	10,379
Cirrus Design SR22	188	18	206	158	47	0	0	0	0	206
Beech A36	173	17	189	146	44	0	0	0	0	189
Cirrus Design SR20	33	3	36	28	8	0	0	0	0	36
Beech G36	32	3	35	27	8	0	0	0	0	35
Piper PA 46-350P	30	3	33	26	8	0	0	0	0	33
Other Single-Engine	12,512	1,196	13,708	10,556	3,153	0	0	0	0	13,708
Military	**1,292**	**123**	**1,415**	**1,282**	**132**	**0**	**0**	**0**	**0**	**1,415**
T-38 Trainer	1,292	123	1,415	1,282	132	0	0	0	0	1,415
Total Operations	**110,082**	**10,978**	**121,060**	**59,894**	**10,535**	**20,271**	**2,056**	**25,676**	**2,627**	**121,060**

NOTE: Columns and rows may not add to totals shown because of rounding.

SOURCES: Airport Noise and Operations Monitoring System Database, Houston Airport System, April 2012.
PREPARED BY: Quadrant Consultants Inc., 2013.

Table 10-4 (1 of 2): 2030 Aircraft Operations at the Airport

	ARRIVALS			DEPARTURES						
				STAGE 1		STAGE 2		STAGE 3		
AIRCRAFT TYPE	DAY	NIGHT	TOTAL	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	TOTAL
Air Carrier	**68,739**	**7,048**	**75,787**	**24,746**	**2,537**	**17,872**	**1,833**	**26,121**	**2,678**	**75,787**
Airbus A319	2,247	230	2,477	809	83	584	60	854	88	2,477
Airbus A320	749	77	826	270	28	195	20	285	29	826
Airbus A321	375	38	413	135	14	97	10	142	15	413
Boeing 737-300	13,103	1,344	14,447	4,717	484	3,407	349	4,979	511	14,447
Boeing 737-700	43,429	4,453	47,882	15,634	1,603	11,292	1,158	16,503	1,692	47,882
Boeing 737-800	7,488	768	8,256	2,696	276	1,947	200	2,846	292	8,256
Boeing 737-900	1,348	138	1,486	485	50	350	36	512	53	1,486
Regional/Commuter	**6,139**	**629**	**6,768**	**2,210**	**227**	**1,596**	**164**	**2,333**	**239**	**6,768**
Bombardier CR7	1,123	115	1,238	404	41	292	30	427	44	1,238
Bombardier CR9	2,995	307	3,302	1,078	111	778	80	1,138	117	3,302
Bombardier CS300	375	38	413	135	14	97	10	142	15	413
Embraer E70/E75	824	84	908	296	30	214	22	313	32	908
Embraer E90	824	84	908	296	30	214	22	313	32	908
GA Business Jet/Air Taxi	**18,483**	**1,767**	**20,250**	**18,483**	**1,767**	**0**	**0**	**0**	**0**	**20,250**
Learjet 45	1,462	140	1,602	1,462	140	0	0	0	0	1,602
Cessna 560XL	1,147	110	1,256	1,147	110	0	0	0	0	1,256
Cessna 560	878	84	962	878	84	0	0	0	0	962
Cessna 550	840	80	921	840	80	0	0	0	0	921
Cessna 650	832	80	912	832	80	0	0	0	0	912
Gulfstream G150	698	67	765	698	67	0	0	0	0	765
Gulfstream G-IV	620	59	679	620	59	0	0	0	0	679
Cessna 750	590	56	647	590	56	0	0	0	0	647
Other GA business jet	11,415	1,091	12,506	11,415	1,091	0	0	0	0	12,506
General Aviation	**27,884**	**2,666**	**30,550**	**25,137**	**5,413**	**0**	**0**	**0**	**0**	**30,550**
MD Helicopter 369E	155	15	170	131	39	0	0	0	0	170
Bell 407	102	10	112	86	26	0	0	0	0	112
Eurocopter AS 350 B2	15	1	16	13	4	0	0	0	0	16
Schweizer 269C	11	1	12	9	3	0	0	0	0	12

Table 10-4 (2 of 2): 2030 Aircraft Operations at the Airport

				DEPARTURES						
	ARRIVALS			STAGE 1		STAGE 2		STAGE 3		
AIRCRAFT TYPE	DAY	NIGHT	TOTAL	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	TOTAL
Berry B-8M	11	1	12	9	3	0	0	0	0	12
Sikorsky S-92A	4	0	5	4	1	0	0	0	0	5
Other helicopter	3,903	373	4,277	3,293	984	0	0	0	0	4,277
Beech 58	157	15	172	157	15	0	0	0	0	172
Cessna 421C	122	12	134	122	12	0	0	0	0	134
Piper PA-31-200T	74	7	81	74	7	0	0	0	0	81
Cessna 421B	57	5	62	57	5	0	0	0	0	62
Cessna 414A	53	5	58	53	5	0	0	0	0	58
Piper PA-34-200T	53	5	58	53	5	0	0	0	0	58
Cessna 402B	43	4	47	43	4	0	0	0	0	47
Other multi-engine	9,761	933	10,695	9,761	933	0	0	0	0	10,695
Cirrus Design SR22	193	18	212	163	49	0	0	0	0	212
Beech A36	178	17	195	150	45	0	0	0	0	195
Cirrus Design SR20	34	3	37	28	9	0	0	0	0	37
Beech G36	33	3	36	28	8	0	0	0	0	36
Piper PA 46-350P	31	3	34	26	8	0	0	0	0	34
Other single-engine	12,892	1,233	14,125	10,876	3,249	0	0	0	0	14,125
Military	**1,292**	**123**	**1,415**	**1,283**	**132**	**0**	**0**	**0**	**0**	**1,415**
T-38 Trainer	1,292	123	1,415	1,283	132	0	0	0	0	1,415
Total Operations	**122,536**	**12,234**	**134,770**	**71,859**	**10,075**	**19,468**	**1,996**	**28,453**	**2,917**	**134,770**

NOTE: Columns and rows may not add to totals shown because of rounding.

SOURCES: Airport Noise and Operations Monitoring System Database, Houston Airport System, April 2012.
PREPARED BY: Quadrant Consultants Inc., 2013.

Nighttime aircraft operations were quantified using the ANOMS database of all aircraft operations at the Airport from April 2011 through March 2012. The percentage of nighttime operations is not expected to change through 2030. As mentioned previously, nighttime noise is more intrusive to receptors, and, the DNL noise measure weights aircraft operations between 10:00 p.m. and 7:00 a.m. with a 10-decibel penalty. INM reports noise levels as DNL.

The categories of aircraft used in this analysis are commercial air carrier, regional/commuter, general aviation business jet, general aviation other than business jet (including multi-engine propeller, single-engine propeller and helicopter) and military.

Runway use at an airport depends on wind and weather conditions, the lengths and widths of the runways, the availability of navigation systems on runways, any current closures of runways or taxiways, and interactions with operations at nearby airports. To a lesser extent, runway use is also influenced by the direction the aircraft arrives from or is destined to, and the location of the aircraft parking position at the airport. **Table 10-5** shows the allocation of aircraft on the Airport's four runways in 2011 and 2020 and on the future runway layout in 2030, by operation type (arrival or departure) and by aircraft category. The current runway use distribution was derived from the ANOMS database. Future runway use is projected from current runway use data and recommended locations of future facilities at the Airport. Flight tracks are an important input to INM because they determine the areas exposed to aircraft noise. All aircraft operations in INM are assigned a flight track. Fixed-wing aircraft use flight tracks based on the locations of runways, while helicopters use different flight tracks based on the locations of helipads at the Airport.

Table 10-5: Runway Use Allocation at the Airport

	RUNWAY							
YEAR/OPERATION	**12L**	**12R**	**30L**	**30R**	**4**	**22**	**17**	**35**
2011								
Arrivals: Daytime	5.5%	56.1%	7.6%	0.6%	22.5%	4.3%	2.4%	1.0%
Arrivals: Nighttime	2.1%	53.9%	3.5%	-	34.2%	3.2%	2.3%	0.8%
Departures: Daytime	0.8%	41.1%	6.0%	1.7%	5.5%	41.2%	2.0%	1.7%
Departures: Nighttime	0.3%	44.6%	4.6%	1.3%	9.0%	38.9%	0.6%	0.7%
2020								
Arrivals: Daytime	4.9%	57.0%	7.7%	0.5%	22.8%	4.2%	2.1%	0.8%
Arrivals: Nighttime	1.9%	54.7%	3.5%	-	34.2%	3.0%	2.0%	0.7%
Departures: Daytime	1.0%	39.7%	5.8%	2.2%	5.5%	41.6%	2.3%	1.9%
Departures: Nighttime	0.5%	37.5%	5.3%	2.5%	10.9%	41.1%	1.0%	1.2%
2030								
Arrivals: Daytime	78.6%	3.9%	0.8%	15.6%	1.1%	-	-	-
Arrivals: Nighttime	28.9%	1.4%	0.4%	9.6%	59.7%	-	-	-
Departures: Daytime	0.5%	44.8%	12.5%	-	2.6%	39.6%	-	-
Departures: Nighttime	-	16.3%	7.9%	-	2.1%	73.7%	-	-

NOTE: Runway 17-35 is proposed to close by 2023.

SOURCES: Airport Noise and Operations Monitoring System Database, Houston Airport System, April 2012.

PREPARED BY: Quadrant Consultants Inc., 2013.

Generalized aircraft flight tracks were estimated from standard FAA flight procedures for the Airport. Actual flight tracks vary because of weather conditions, pilot decisions, air traffic control procedures and aircraft weight. However, as long as actual flight tracks are within a mile of their assigned generalized flight tracks, the differences in noise generation calculated in the INM are small. Generalized flight tracks were developed from official FAA flight procedures for the Airport and its environs dated October 12, 2012, and percentages of aircraft operations were assigned to flight tracks based on the ANOMS database of aircraft destinations. Future (2020 and 2030) flight tracks were assumed similar to those in 2011, with modifications resulting from recommended changes to the runways.

In addition to runway use and flight tracks, in developing the noise exposure contours for the Airport, it was assumed that the mean temperature at the Airport is 70 degrees Fahrenheit based on historical weather data; noise, thrust and altitude information for each aircraft was not modified from the INM aircraft database.

The results of the INM runs for the Airport are shown on **Exhibits 10-3**, **10-4** and **10-5**. Noise contours for DNL 65, 70 and 75 in 2011, 2020 and 2030, respectively, were overlaid onto a 2011 aerial base map of the Airport area. **Table 10-6** lists the acreage exposed to each DNL contour cited above.

Table 10-6: Off-Airport Area Affected by Aircraft Noise (acres)

YEAR	DNL 65 TO 70	DNL 70 TO 75	GREATER THAN DNL 75	TOTAL DNL 65 AND OVER
2011	784	54	4	842
2020	1,020	89	4	1,115
2030	1,219	158	4	1,383

SOURCE: Quadrant Consultants Inc., 2014.
PREPARED BY: Quadrant Consultants Inc., 2014.

10.2 Compatible Land Use

The FAA has issued guidelines for the compatibility of various land uses exposed to varying levels of aircraft noise. The guidelines are published in 14 CFR Part 150. Land uses include residential, institutional, commercial, industrial and recreational. As shown in **Table 10-7**, all land uses are generally compatible with noise exposure below DNL 65, and most land uses are incompatible with noise exposure above DNL 75; more sensitive land uses require noise mitigation measures or are incompatible with noise exposure between DNL 65 and DNL 75.

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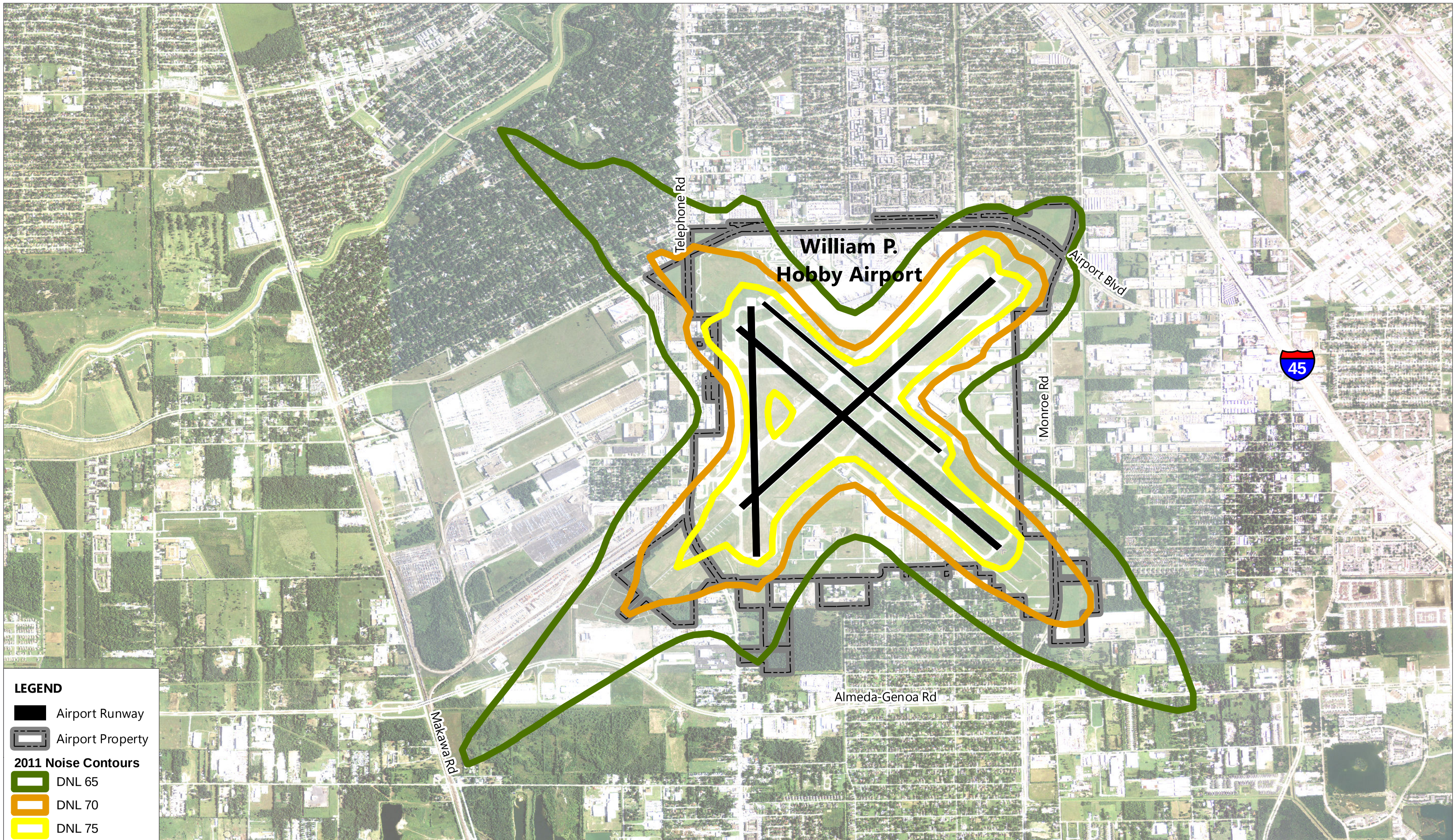

SOURCE: Quadrant Consultants Inc., August 2014.
PREPARED BY: Quadrant Consultants Inc., August 2014.

EXHIBIT 10-3

2011 Noise Contours

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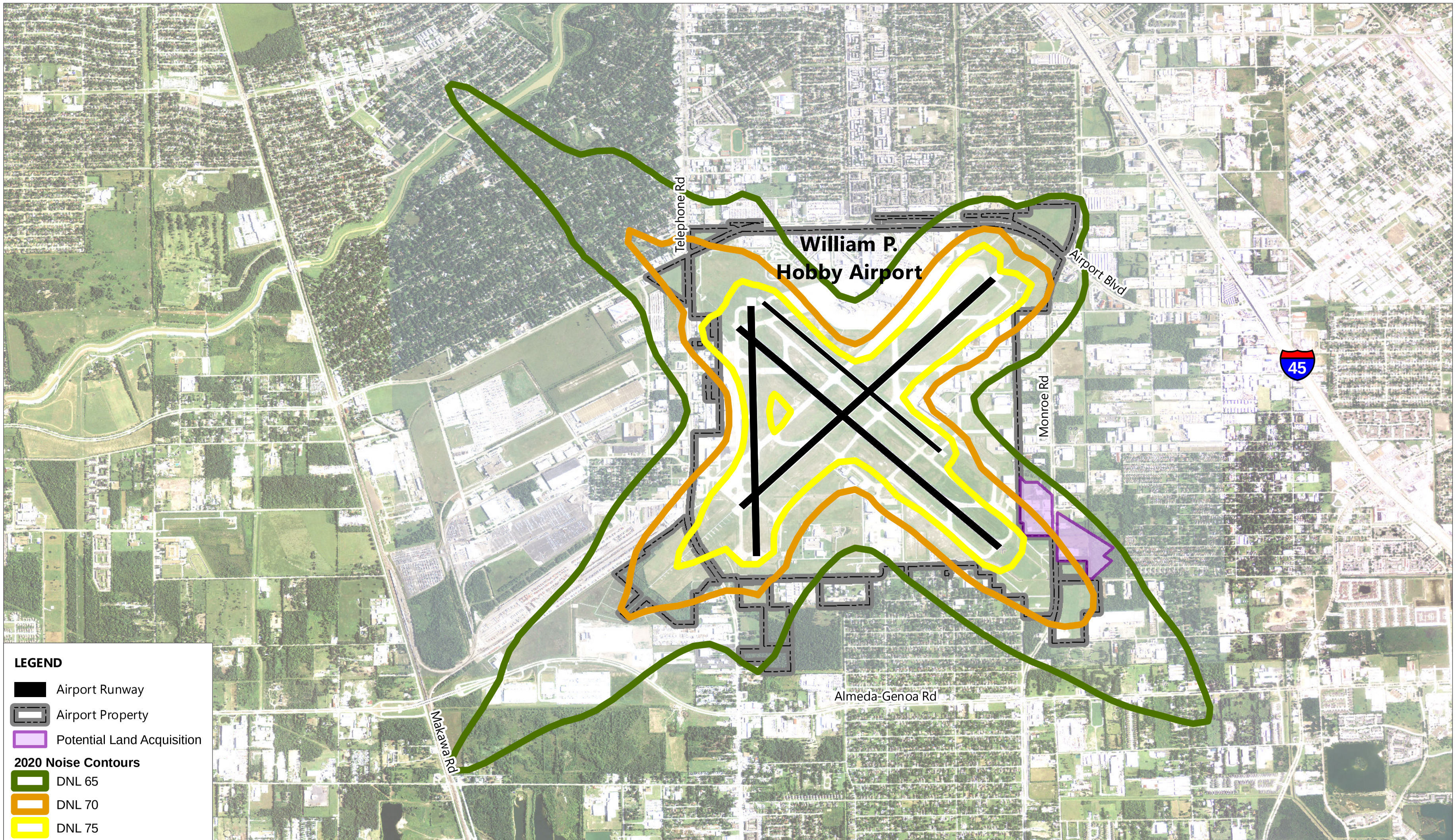

SOURCE: Quadrant Consultants Inc., August 2014.
PREPARED BY: Quadrant Consultants Inc., August 2014.

EXHIBIT 10-4

NORTH 0 4,000 ft.

2020 Noise Contours

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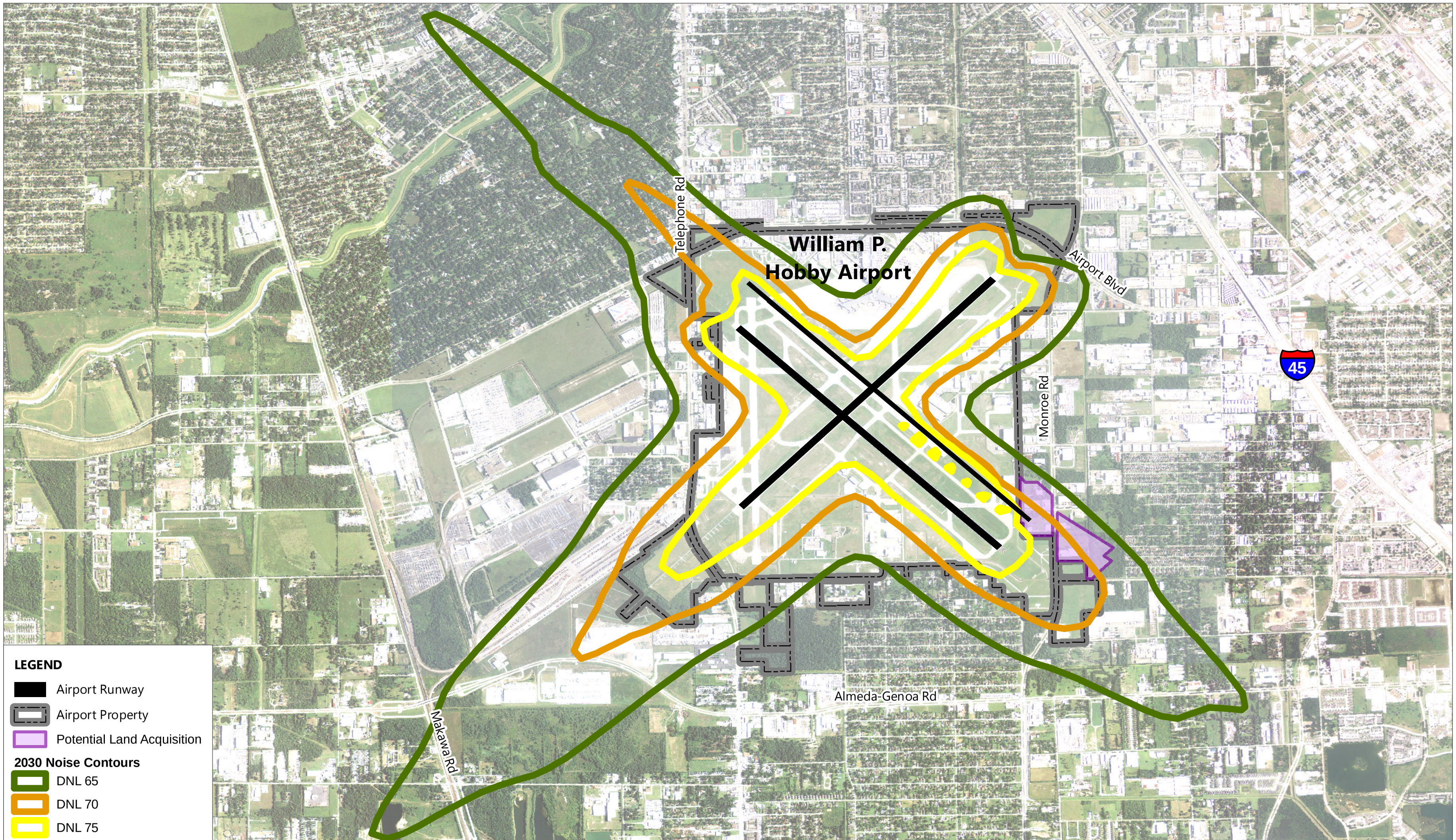

SOURCE: Quadrant Consultants Inc., August 2014.
PREPARED BY: Quadrant Consultants Inc., August 2014.

EXHIBIT 10-5

NORTH 0 4,000 ft.

2030 Noise Contours

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Table 10-7: Land Use Compatibility Guidelines

	LAND USE	DNL 65 TO 70	DNL 70 TO 75	GREATER THAN DNL 75
Residential	Residential other than mobile homes and transient lodgings	NLR required	NLR required	Incompatible
	Mobile homes	Incompatible	Incompatible	Incompatible
	Transient lodgings (hotels and motels)	NLR required	NLR required	Incompatible
Public	Schools, hospitals and nursing homes	NLR required	NLR required	Incompatible
	Churches, auditoriums and concert halls	NLR required	NLR required	Incompatible
	Governmental services	Compatible	NLR required	NLR required
	Transportation	Compatible	Compatible	Compatible
	Parking	Compatible	Compatible	Compatible
Commercial	Offices, business and professional	NLR required	NLR required	NLR required
	Wholesale and retail-building materials, hardware, and farm equipment	Compatible	Compatible	Compatible
	Retail trade (general)	NLR required	NLR required	NLR required
	Utilities	Compatible	Compatible	Compatible
	Communication	NLR required	NLR required	NLR required
Manufacturing and Production	Manufacturing (general)	Compatible	Compatible	Compatible
	Photographic and optical	Compatible	NLR required	NLR required
	Agriculture (except livestock) and forestry	Compatible	Compatible	Compatible
	Livestock farming and breeding	Compatible	Compatible	Incompatible
	Mining and fishing resources production and extraction	Compatible	Compatible	Compatible
Recreational	Outdoor sports arenas and spectator sports	Compatible	Compatible	Incompatible
	Outdoor music shells, amphitheaters	Incompatible	Incompatible	Incompatible
	Nature exhibits and zoos	Compatible	Compatible	Incompatible
	Amusements, parks, resorts and camps	Compatible	Compatible	Incompatible
	Golf courses, riding stables and water recreation	Compatible	Compatible	Incompatible

NOTES:

1. DNL = Day-night average sound level, in A-weighted decibels.
2. Compatible = No special noise attenuating materials are required to achieve an interior noise level of DNL 45 in habitable spaces, or the activity (whether indoors or outdoors) would not be subject to a significant adverse effect because of the outdoor noise level.
3. Incompatible = The land use, whether in a structure or an outdoor activity, is incompatible with the outdoor noise level even if special attenuating materials were used in construction of the building.
4. NLR = Noise Level Reduction. NLR is used to denote the total amount of noise transmission loss, in decibels, required to reduce an exterior noise level in habitable interior spaces to DNL 45. In most places, typical building construction automatically provides an NLR of 20 decibels. Therefore, if a structure were located in an area exposed to aircraft noise of DNL 65, the interior noise level would be about DNL 45. If the structure were located in an area exposed to aircraft noise of DNL 70, the interior noise level would be about DNL 50, so an additional NLR of 5 decibels would be required if not afforded by typical construction. This NLR can be achieved with noise attenuating materials in construction of the building.
5. Residential land use is generally incompatible with aircraft noise and should only be permitted in areas of infill in existing neighborhoods, or where the community determines that the use must be allowed.
6. NLR is only required in offices or other areas with noise-sensitive activities.
7. Outdoor sports arenas are compatible with noise levels up to DNL 75, if special sound reinforcement systems are installed.

SOURCE: U.S. Department of Transportation, Federal Aviation Administration, Federal Aviation Regulations Part 150, *Airport Noise Compatibility Planning*, Code of Federal Regulations, Title 14, Chapter I, Subchapter I, Part 150, Table 1, January 18, 1985, as amended.
PREPARED BY: Quadrant Consultants Inc., 2013.

Table 10-7 presents the land use types that are compatible and incompatible with the relevant noise levels, or that would be compatible with noise mitigation measures. For example, residential land uses are incompatible with the highest noise levels and are only compatible with lower noise levels (above DNL 65) with noise mitigation measures, while manufacturing land uses are compatible with all noise levels.

10.2.1 CURRENT LAND USE

Land uses near the Airport can be categorized as follows:

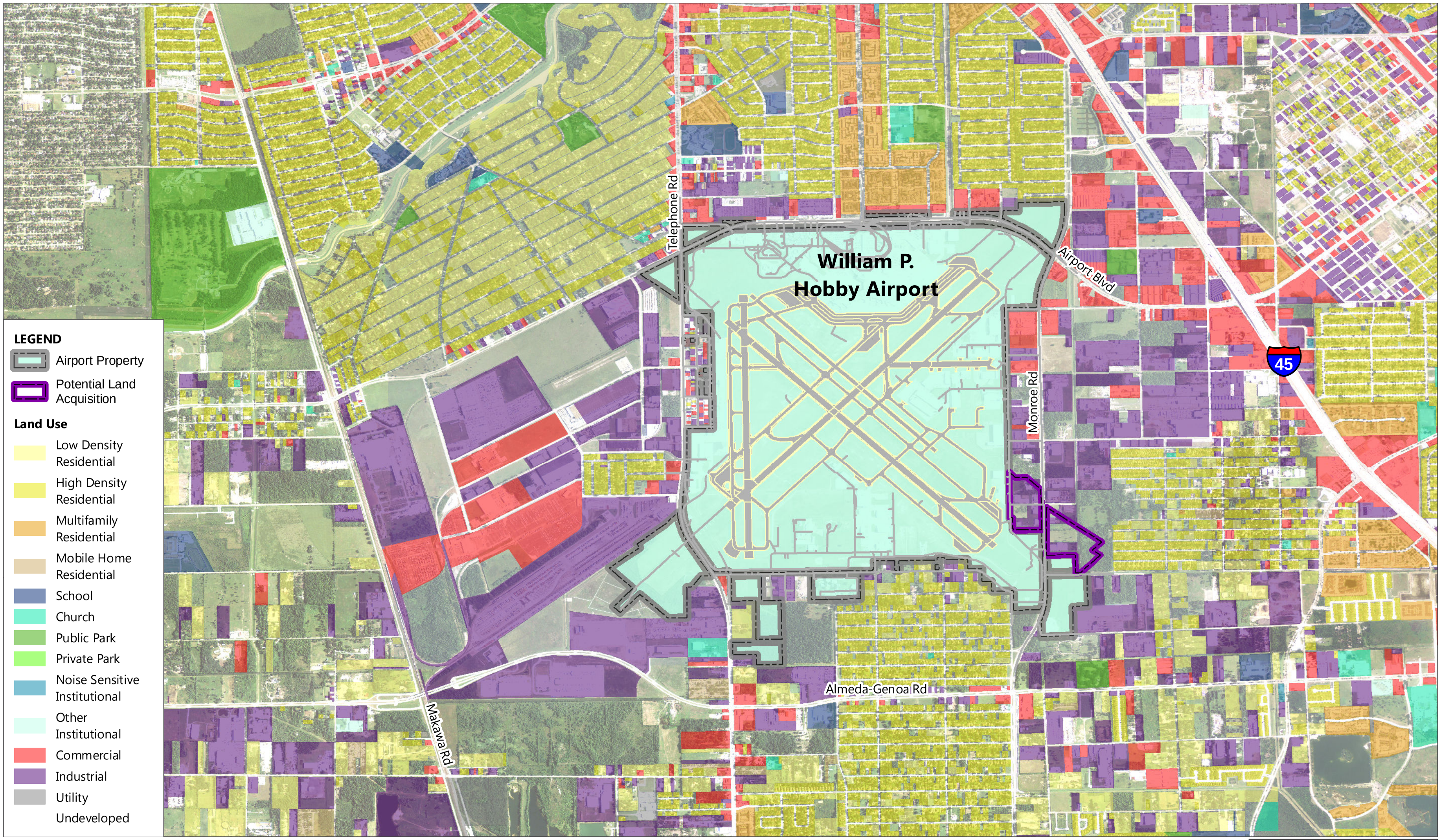
- Residential (single-family, multifamily, mobile homes)
- Public, including public parks, institutional sites (schools, churches, public places of assembly) and transportation rights-of-way
- Commercial, including business and professional offices, retail and utility rights-of-way
- Manufacturing and Production, including industrial sites and warehouses
- Recreational, including private golf courses and outdoor arenas
- Undeveloped (vacant land)

Exhibit 10-6 shows land uses near the Airport in 2011. In general, areas northwest, north, northeast, east, and southeast of the Airport are densely developed in mostly residential use and areas south, southwest, and west of the Airport are less densely developed in mostly industrial and commercial land uses, with some residential land uses. Most multifamily residential land uses are along major roadways; a large cluster of multifamily residences is located just north of the Airport, along Broadway Street. Two recreational use areas (Glenbrook Golf Course and Law Park) are located north and west of the Airport, respectively.

Exhibit 10-7 presents the same land use map as shown on Exhibit 10-6, but with the 2011 noise exposure contours shown on Exhibit 10-3 overlaid onto the map.

Table 10-8 summarizes the population and land uses exposed to aircraft noise from operations at the Airport in 2011 (existing) and projected years of 2020 and 2030.

In all, 373 residences are currently exposed to DNL 65 and greater. If these residences are representative of the demographic characteristics of the 2010 U.S. Census blocks in which they are located, about 83 percent of their residents are racial or ethnic minorities and about 10 percent of their families are low-income families. Seven of these affected residences are exposed to DNL 70 to 75; none is exposed to noise greater than DNL 75. In addition, two churches are exposed to DNL 65 to 70.



SOURCE: Houston-Galveston Area Council and Quadrant Consultants Inc., August 2014.
PREPARED BY: Quadrant Consultants Inc., August 2014.

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EXHIBIT 10-6

Existing Land Use

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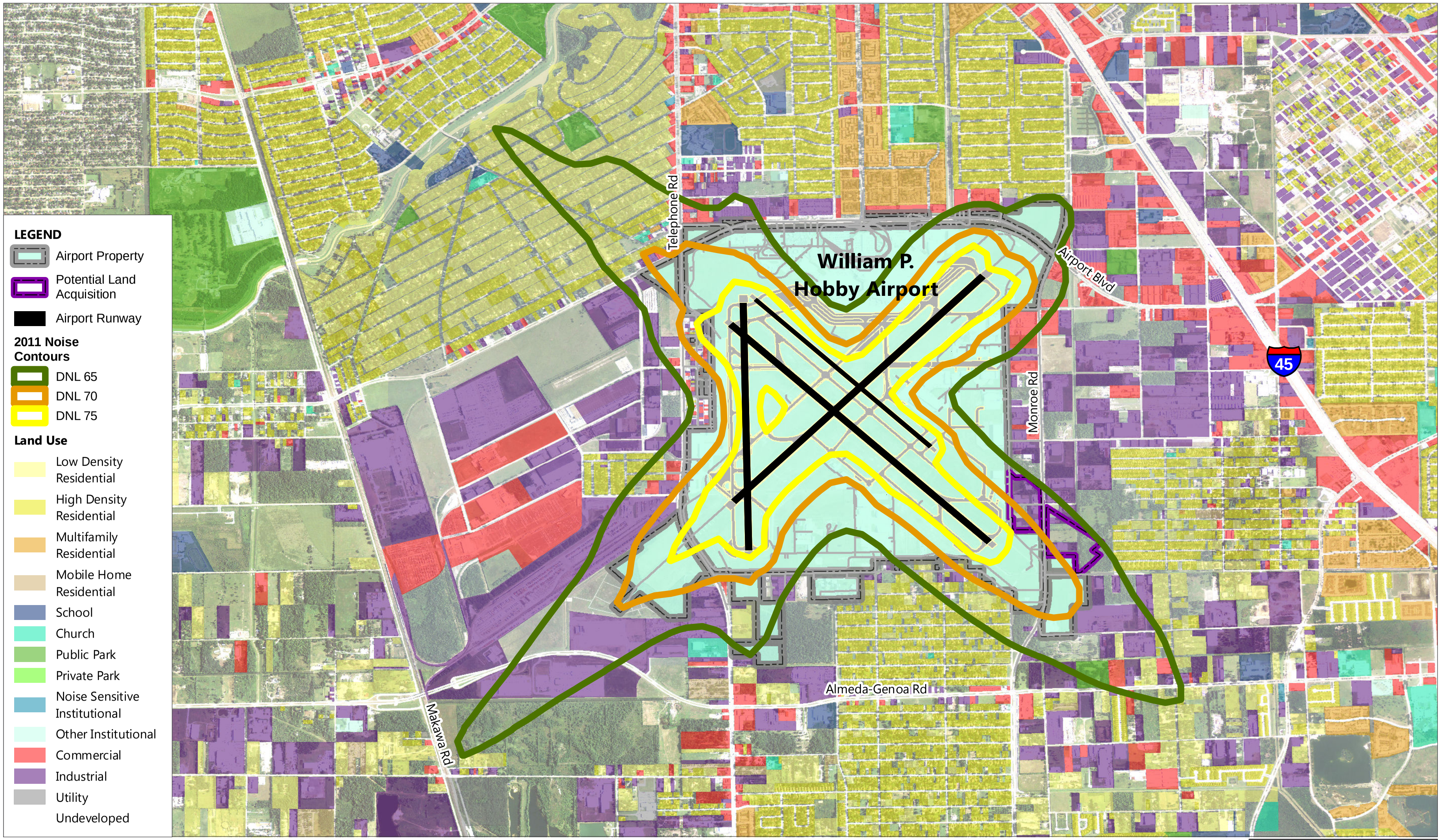

SOURCE: Houston-Galveston Area Council and Quadrant Consultants Inc., August 2014.
PREPARED BY: Quadrant Consultants Inc., August 2014.

EXHIBIT 10-7

2011 Noise Exposure Areas and Land Uses near the Airport

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Table 10-8: Population and Land Use Exposed to Aircraft Noise

	DNL 65–70	DNL 70–75	OVER DNL 75	OVER DNL 65
2011				
Total population	933	18	0	1,051
Racial and ethnic minorities	818	15	0	833
Total families	360	7	0	367
Low-income families	42	7	0	49
Noise-exposed residential single family units	320	7	0	327
Noise-exposed residential multi-family units	46	0	0	46
Schools	0	0	0	0
Churches	2	0	0	2
Hospitals	0	0	0	0
Nursing homes	0	0	0	0
Day care centers	0	0	0	0
2020				
Total population	1,501	57	0	1,558
Racial and ethnic minorities	1,263	45	0	1,308
Total families	435	25	0	460
Low-income families	57	9	0	66
Noise-exposed residential single family units	454	27	0	481
Noise-exposed residential multi-family units	46	0	0	46
Schools	0	0	0	0
Churches	3	1	0	4
Hospitals	0	0	0	0
Nursing homes	0	0	0	0
Day care centers	0	0	0	0
2030				
Total population	2,075	135	0	2,210
Racial and ethnic minorities	1,744	116	0	1,860
Total families	565	44	0	609
Low-income families	80	11	0	91
Noise-exposed residential single family units	560	41	0	601
Noise-exposed residential multi-family units	63	10	0	73
Schools	0	0	0	0
Churches	3	1	0	4
Hospitals	0	0	0	0
Nursing homes	0	0	0	0
Day care centers	0	0	0	0

SOURCES: U.S. Census Bureau, 2010 Census and 2007-2011 American Community Survey; Quadrant Consultants Inc., August 2014.
PREPARED BY: Quadrant Consultants Inc., August 2014.

10.2.2 FUTURE LAND USE

In 2020, increasing numbers of aircraft operations at the Airport are expected to expand the area affected by aircraft noise. **Exhibit 10-8** presents the projected noise exposure areas in 2020 (as shown on Exhibit 10-4) overlaid onto the current land use map.

Table 10-8 lists the numbers of noise-sensitive land uses likely to be affected by future aircraft noise at the Airport, based on 2010 U.S. Census data, assuming that current population distribution remains the same through 2020. As shown in Table 10-8, 527 residences would be exposed to aircraft noise of DNL 65 and higher in 2020, 41 percent more than in 2011. Twenty-seven of these residences would be exposed to DNL 70 to 75. These residences are projected to have about the same racial and economic characteristics as in 2011. In addition, three churches would be exposed to aircraft noise between DNL 65 and DNL 70 and one church between DNL 70 and DNL 75.

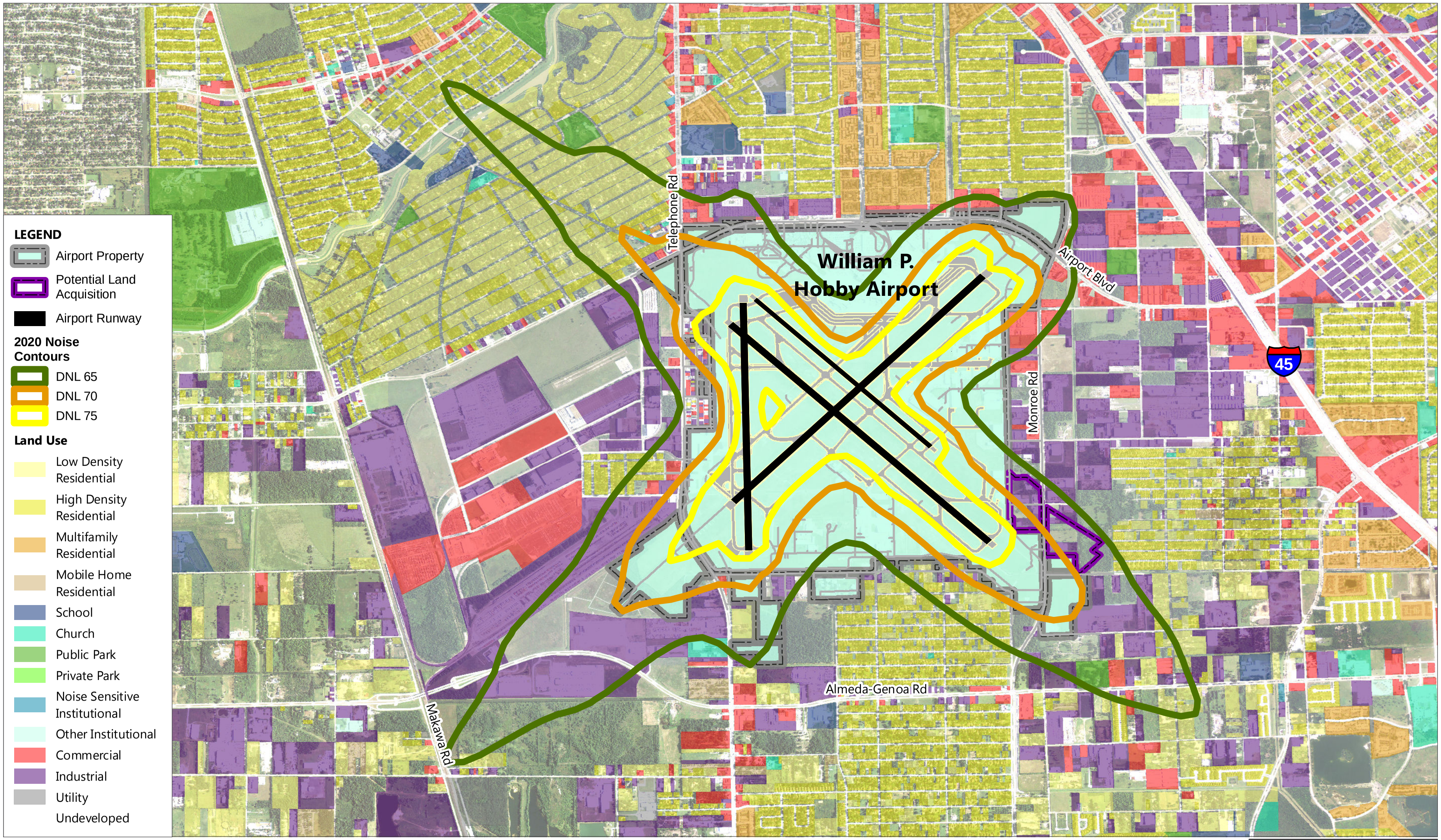
By 2030, changes in Airport runway layout and aircraft use would change and further increase the area exposed to aircraft noise, especially in the residential area northwest of the Airport. The result is that areas affected by airport noise would increase toward the northwest, southwest and southeast. **Exhibit 10-9** presents the noise exposure areas projected for 2030 (Exhibit 10-5) overlaid onto the current land use map.

Table 10-8 also presents the population and noise-sensitive land uses that would be affected by aircraft noise in 2030 based on 2010 U.S. Census data. This analysis assumes that the proposed ADP is implemented and that current population distribution remains the same through 2030. About 674 residences would be exposed to DNL 65 and greater in 2030, a 28 percent increase from 2020. Of these residences, 51 would be exposed to aircraft noise between DNL 70 and DNL 75. Three churches would also be exposed to aircraft noise between DNL 65 to DNL 70 and one church between DNL 70 and DNL 75 in 2030.

As shown in Table 10-8, the population that would be exposed to aircraft noise of DNL 65 and greater is projected to increase between 2011 and 2020 and increase again between 2020 and 2030. FAA Order 5050.1B defines a “significant noise impact” as “causing noise sensitive areas in the DNL 65 dB contour to experience at least a DNL 1.5 dB noise increase when compared to the no action alternative for the same time frame.” Therefore, implementation of the ADP would result in continued aircraft noise exposure in the Airport vicinity, and noise mitigation measures may be appropriate.

10.3 Socioeconomic Impacts and Environmental Justice

In addition to aircraft noise exposure, airport development can affect the human environment by displacing homes and businesses or by changing access, traffic patterns and aesthetics. Potential social and economic impacts that may result from Airport development are discussed below.



SOURCE: Houston-Galveston Area Council and Quadrant Consultants Inc., August 2014.
PREPARED BY: Quadrant Consultants Inc., August 2014.

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EXHIBIT 10-8

2020 Noise Exposure Areas and Land Uses near the Airport

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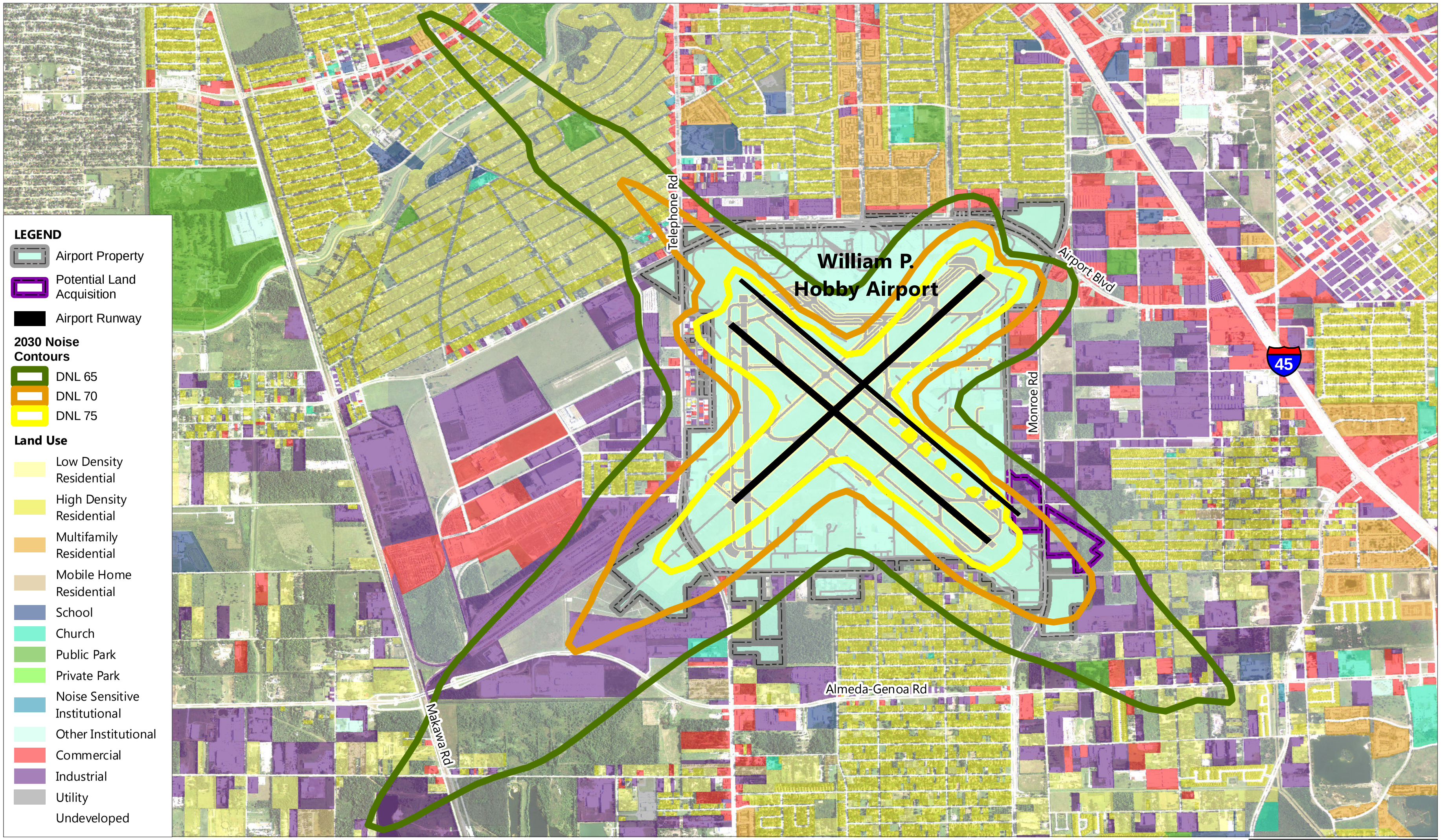

SOURCE: Houston-Galveston Area Council and Quadrant Consultants Inc., August 2014.
PREPARED BY: Quadrant Consultants Inc., August 2014.

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EXHIBIT 10-9

2030 Noise Exposure Areas and Land Uses near the Airport

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10.3.1 RELOCATIONS OF RESIDENCES AND BUSINESSES

The proposed Airport development projects are discussed in Section 7. This development would include acquiring land adjacent to the Airport for runway and taxiway extensions. **Exhibit 10-10** shows the proposed land acquisition areas on an aerial photograph of the Airport vicinity. The 40.6 acres proposed to be acquired include industrial and undeveloped land uses.

Table 10-9 lists the numbers of residences and businesses that would be affected by the proposed land acquisition. In all, nine industrial businesses are proposed for acquisition, requiring the relocation of affected businesses.

Table 10-9: Residences and Businesses Affected by Proposed Land Acquisition

LAND USE	NUMBER	ACRES
Residential units	0	0
Commercial businesses	0	0
Industrial businesses	9	5.4
Institutional (Church)	0	0
Undeveloped	8	35.2

SOURCE: Quadrant Consultants Inc., August 2014.
PREPARED BY: Quadrant Consultants Inc., August 2014.

As shown on Exhibit 10-6, much undeveloped land is located within three miles of the Airport, especially to the west and south. As undeveloped land is available near the Airport, the businesses proposed for acquisition should be able to relocate near the Airport (if desired) without jeopardizing their business. Furthermore, rental car companies with facilities along Airport Boulevard or Monroe Road would be provided space in the proposed consolidated rental car facility on the Airport, freeing more space for the relocation of businesses.

All relocations would be performed in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970. This Act ensures the fair and equitable treatment of people whose real property is acquired or who are displaced because of a federal or federally assisted project. Government agencies acquiring real property are required to conduct fair appraisals, pay fair market value and provide adequate notice to owners, among other services. The act also provides for relocation payments and advisory assistance for residents and businesses.

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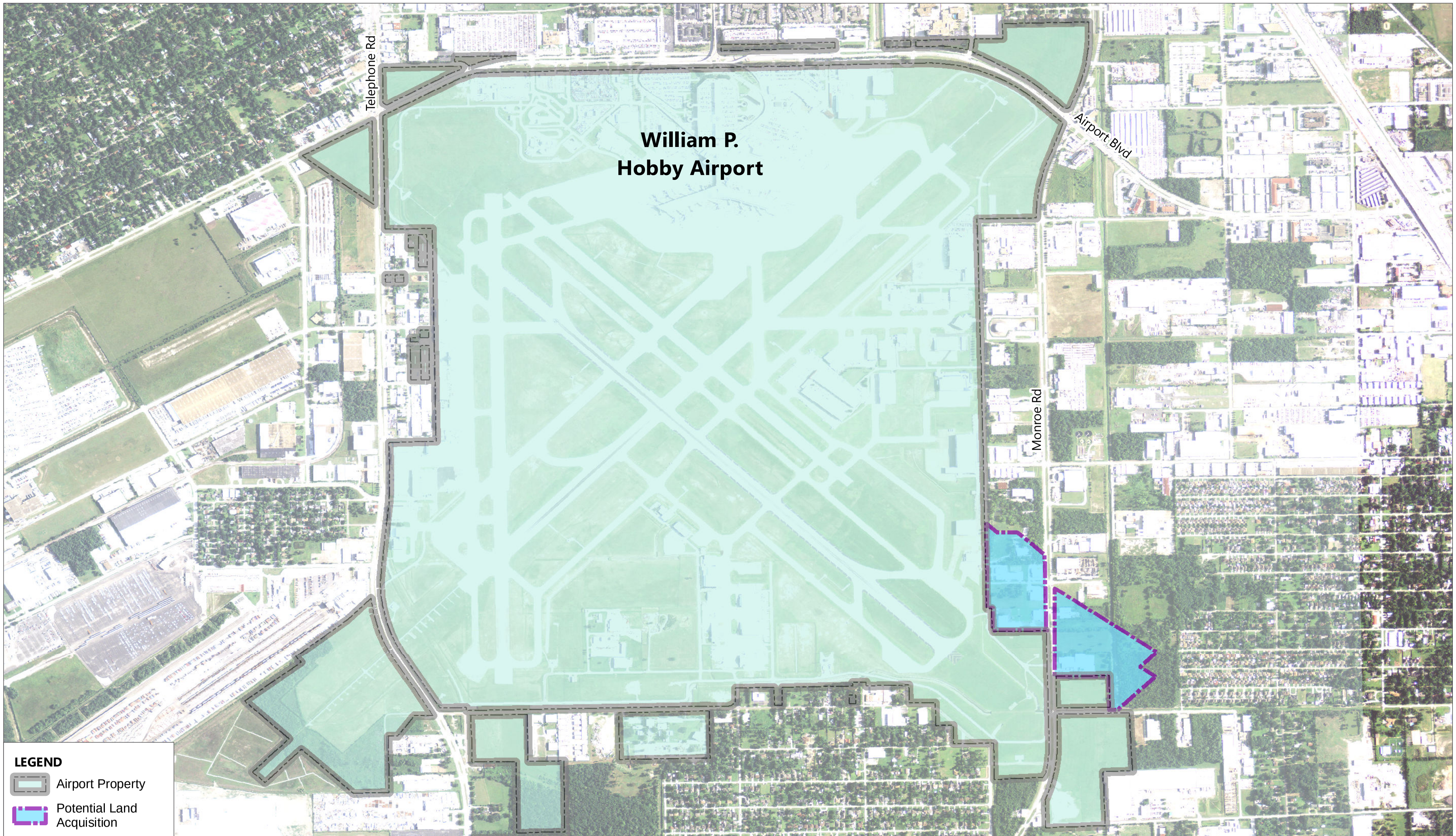

SOURCE: Ricondo & Associates, Inc., August 2013.
PREPARED BY: Quadrant Consultants Inc., August 2014.

EXHIBIT 10-10

Potential Land Acquisitions

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10.3.2 SOCIOECONOMIC CHARACTERISTICS OF ADJACENT POPULATIONS

Exhibit 10-11 shows the populations of census block groups near the Airport from the 2007-2011 American Community Survey conducted by the U.S. Department of Commerce, Bureau of the Census. This exhibit shows red circles in census block groups within census tracts with diameters proportional to the population of the census blocks in which they are located. A relatively large population base is concentrated north of the Airport in the apartment complex at the comer of Airport Boulevard and Broadway Street. Areas to the northwest, north, northeast, east, southeast, and south of the Airport are moderately populated, while areas to the west and southwest are less populous.

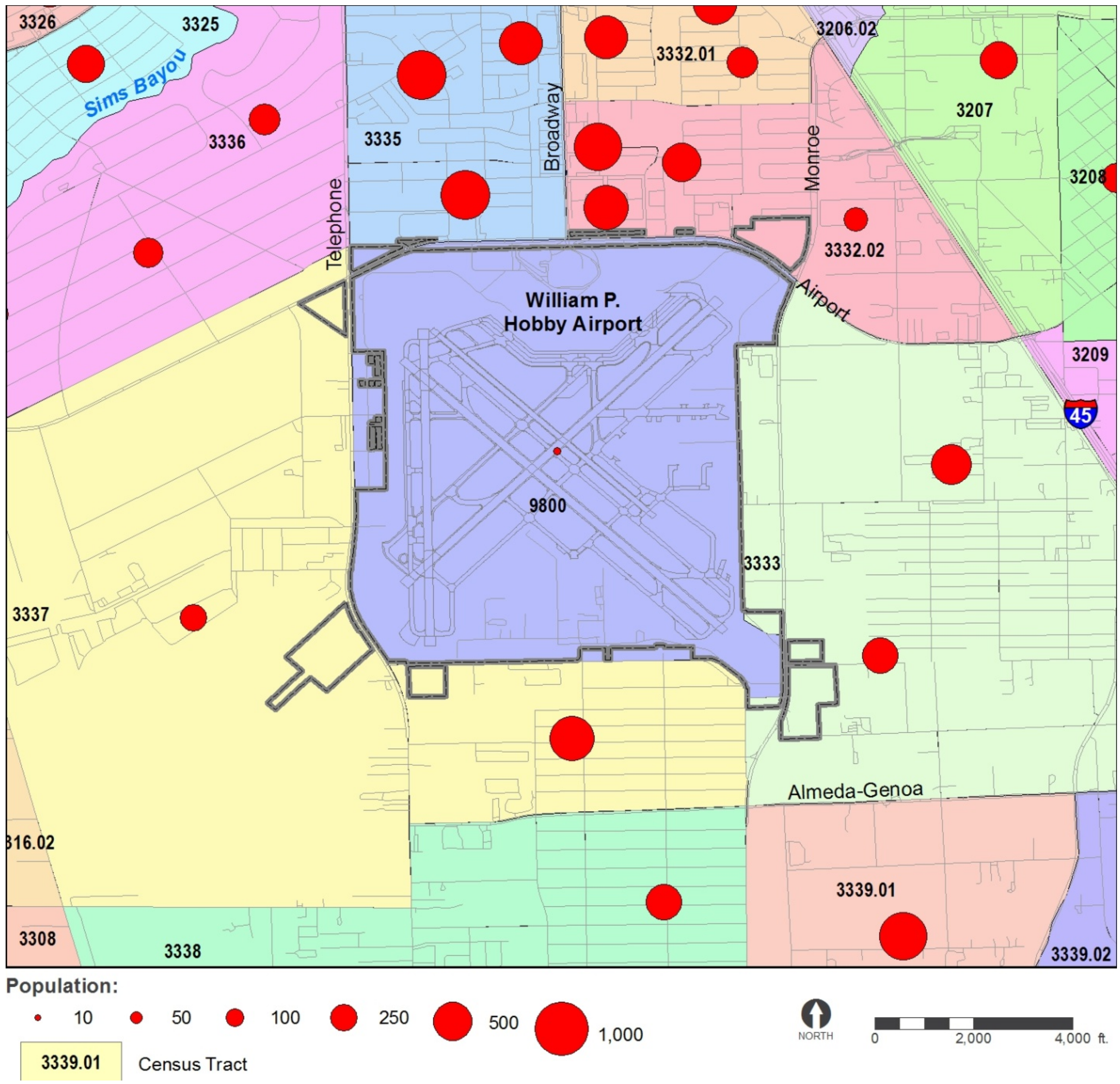
Exhibit 10-12 shows low-income populations near the Airport. The map presents pie charts inside census block groups within census tracts (shaded areas) that show the proportions of families with household income below the poverty level (as defined by the U.S. Department of Health & Human Services). As shown on the exhibit, much of the area around the Airport has some population that is low-income, and many of the populations in the area directly north of the Airport range from 33 percent to 50 percent below the poverty level. Large proportions of low-income residents are also located northwest, east and south of the Airport. For comparison, the proportion of Houston families below the poverty level in the same survey was determined to be 18 percent.

Exhibit 10-13 shows the proportions of racial minorities (black, American Indian, Asian, other, and more than one race) in populations near the Airport. The exhibit shows pie charts inside census block groups within census tracts (shaded areas) that present the proportions of residents who categorize themselves into at least one of the racial populations listed above. The exhibit shows that the populations northwest and north of the Airport are mostly racial minorities, and that racial minorities account for about half of the population in most of the area near the Airport.

Exhibit 10-14 shows the proportions of residents in census block groups near the Airport who identified themselves as Hispanic in the American Community Surveys from 2007 to 2011. This exhibit shows that Hispanic populations are established in most of the area around the Airport, especially areas to the north, northeast and east.

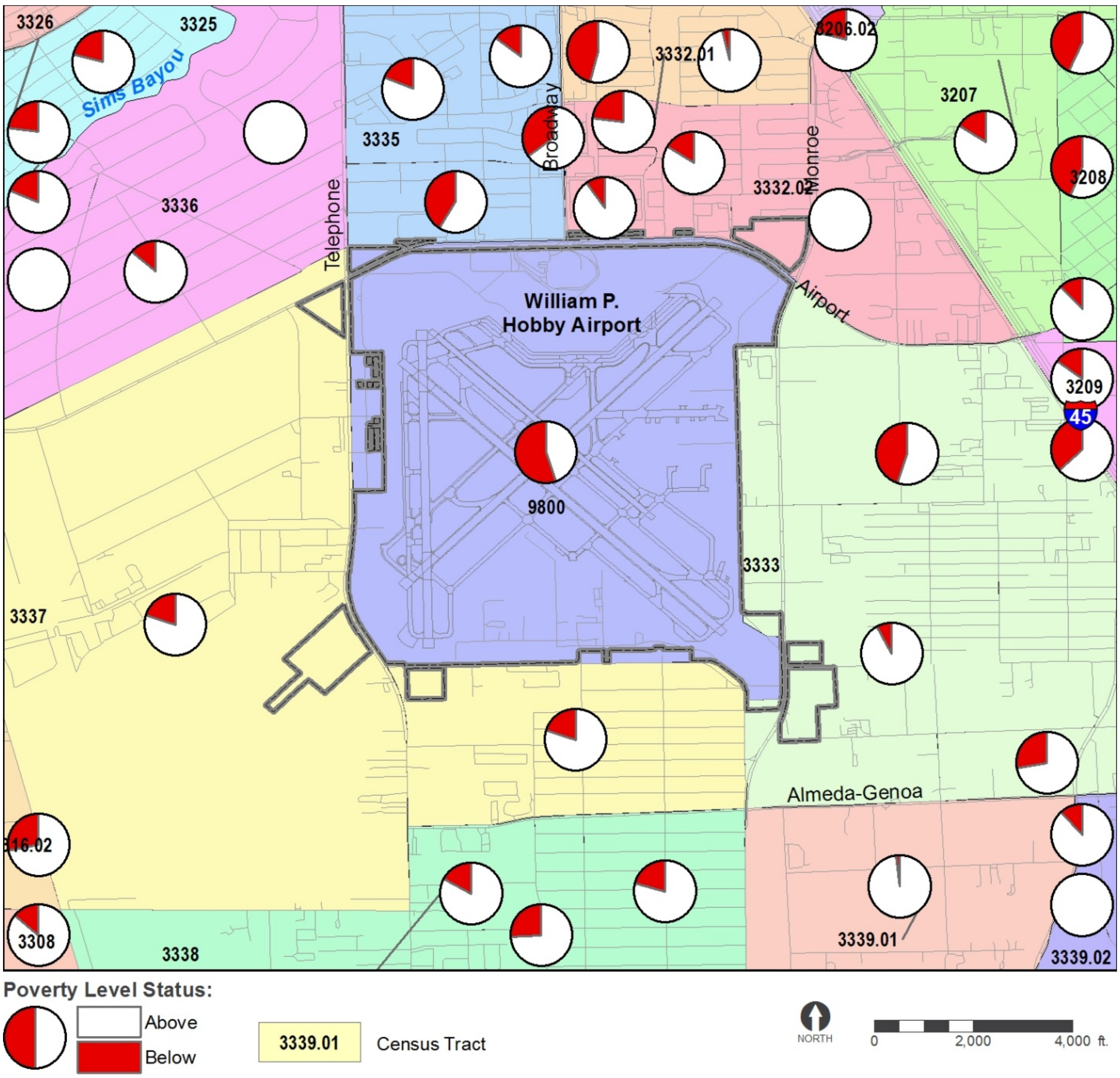
A comparison of Exhibit 10-12, Exhibit 10-13, and Exhibit 10-14 indicates that the population within three miles of the Airport consists mostly of racial and ethnic minorities that are disproportionately below the poverty level (when compared to the greater Houston metropolitan area). Consequently, actions that affect populations near the Airport (such as property acquisition and changes in noise exposure) could affect minority or low-income populations disproportionately, and an environmental justice assessment will be required during the planning process for specific Airport projects in the ADP.

Exhibit 10-11: Population of Census Block Groups near the Airport



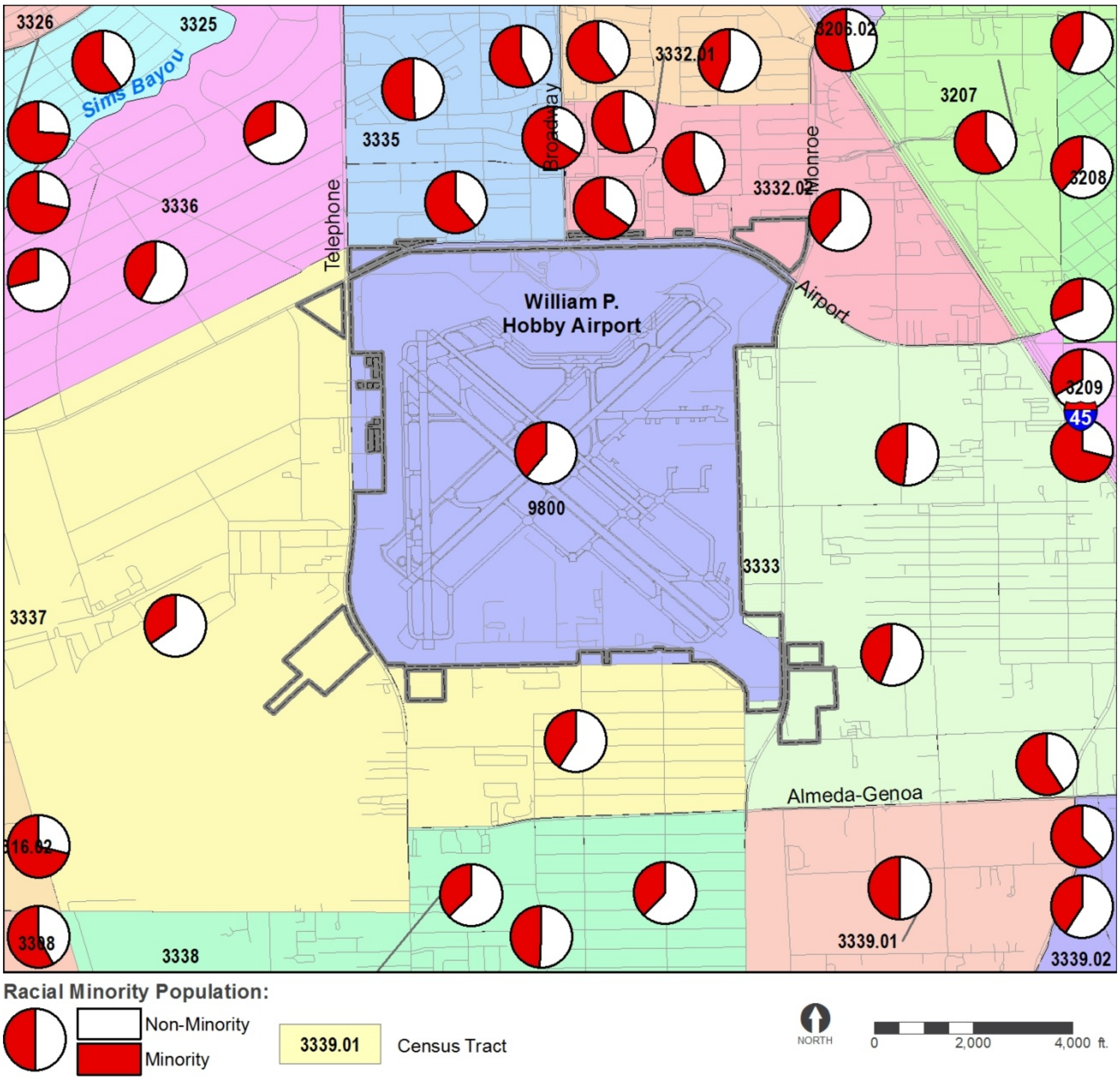
SOURCE: U.S. Department of Commerce, Bureau of the Census, *American Community Survey 2007-2011*, December 2012.
PREPARED BY: Quadrant Consultants Inc., 2014.

Exhibit 10-12: Low-Income Proportions in Census Block Groups near the Airport



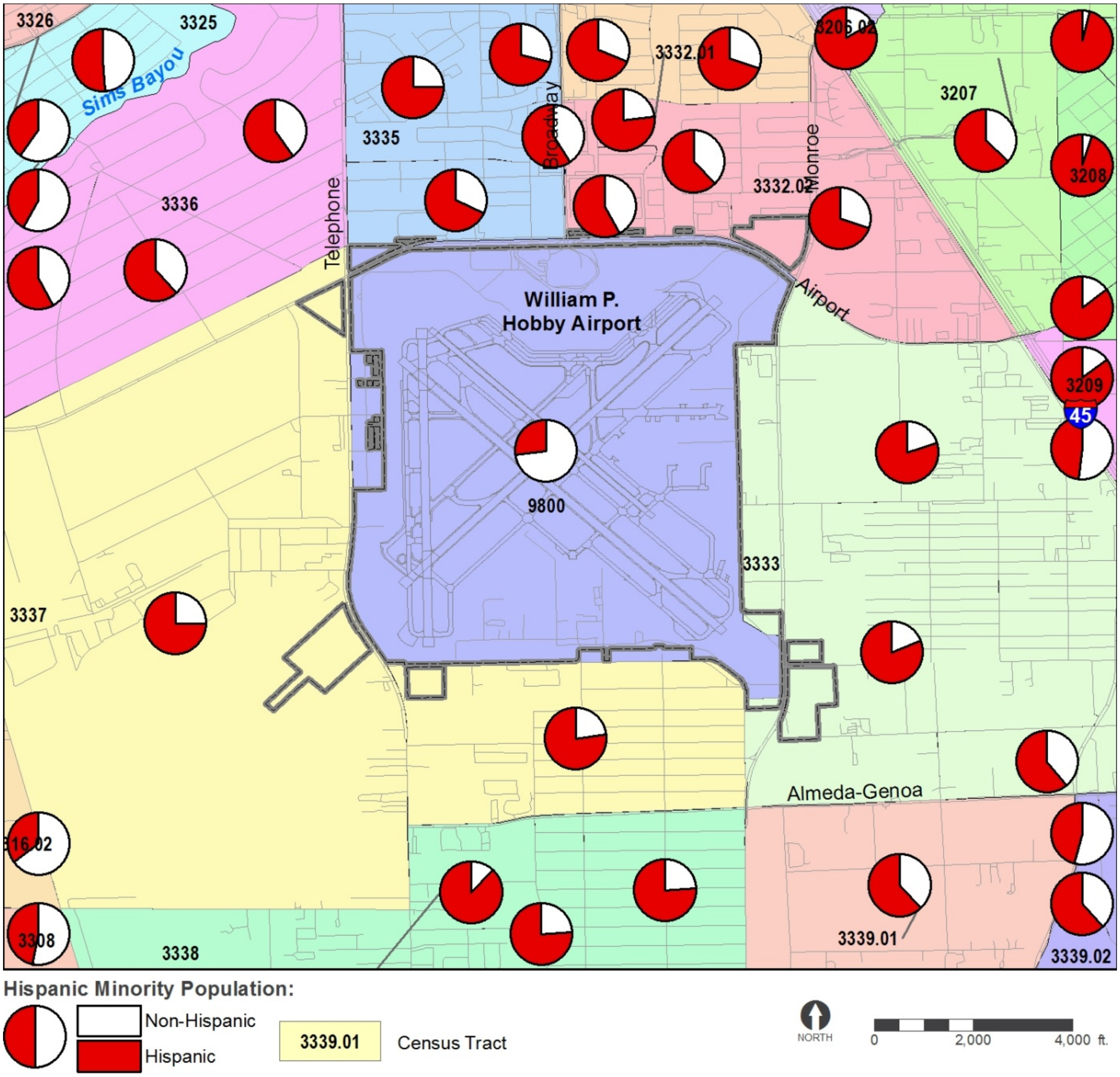
SOURCE: U.S. Department of Commerce, Bureau of the Census, *American Community Survey 2007-2011*, December 2012.
PREPARED BY: Quadrant Consultants Inc., 2014.

Exhibit 10-13: Racial Minority Proportions in Census Block Groups near the Airport



SOURCE: U.S. Department of Commerce, Bureau of the Census, *American Community Survey 2007-2011*, December 2012.
PREPARED BY: Quadrant Consultants Inc., 2014.

Exhibit 10-14: Hispanic Proportions in Census Block Groups near the Airport



SOURCE: U.S. Department of Commerce, Bureau of the Census, *American Community Survey 2007-2011*, December 2012.
Prepared by: Quadrant Consultants Inc., 2014.

10.3.3 ESTABLISHED COMMUNITIES

Implementation of the ADP would not disrupt any residential neighborhood near the Airport.

10.3.4 ORDERLY DEVELOPMENT

The ADP maintains compatible land uses and responds to increased ground access demand because of increased Airport use. Although the ADP would not affect current or planned development, it would change noise exposure in the community. Therefore, the ADP should be accompanied by an amendment to the City of Houston's land use control ordinance for land use around the Airport. This ordinance protects the Airport from height hazards and protects surrounding land from incompatible land uses. As the Airport runways are expanded, the locations of incompatible land uses will change and, therefore, the areas designated for land use control tiers should also change. Timely amendment to the land use control ordinance would ensure the orderly development of compatible land uses near the Airport.

10.3.5 EMPLOYMENT

The ADP would not displace many businesses. The owners of displaced businesses would most likely be able to relocate near the Airport or elsewhere, continue their operations, and maintain their staff. In addition, expansion of the Airport would provide jobs during construction, and new and expanded facilities at the Airport would provide permanent employment opportunities.

10.3.6 ROADWAY TRAFFIC NOISE

Increased automobile and truck traffic on Broadway Street, Airport Boulevard, Telephone Road, and Monroe Road as the result of increased activity at the Airport would also increase traffic noise. Apartments on Broadway Street and some residences adjacent to Telephone Road would be affected. However, most residential land is at sufficient distance from the major thoroughfares that they would not be significantly affected by increased roadway traffic noise.

10.4 Secondary Impacts

Secondary impacts (also called induced or indirect impacts) occur when a project enables additional development, which in turn causes additional environmental impacts. For an airport expansion project, an example of secondary impacts could be demand for additional warehouse and light industry resulting from the additional aviation capacity, which causes additional land development and consequent loss of habitat and water pollution.

The planned Airport development projects recommended in this Master Plan Update would increase the capacity of the Airport to accommodate projected increases in passenger and cargo traffic at the Airport over the planning period (through 2030). New businesses will also likely be created on and around the Airport to handle the increased Airport activity. Such development could cause additional environmental impacts through the release of hazardous materials and air and water pollutants and the loss of natural habitat. However, most of the available land around the Airport has already been altered; destruction of natural habitats would not likely occur. Furthermore, any new development would be subject to federal, State of Texas, and local laws requiring the management of hazardous materials and the reduction or elimination of air and water pollution. Therefore, any secondary environmental impacts from implementation of the ADP are likely to be minor.

Public service demands are anticipated to increase because of the operation of new Airport facilities; however, preliminary investigation has determined that local utility infrastructure is sufficient to accommodate the public service demands of the new facilities.

10.5 Air Quality

Procedures to analyze and evaluate air quality at airports are described in the FAA report, *Air Quality Procedures for Civilian Airports and Air Force Bases*. The types of air quality analyses that might be required for projects in the ADP are summarized in this section.

10.5.1 REGULATORY REQUIREMENTS

The Clean Air Act of 1970 requires states to identify areas where national ambient air quality standards are not met for six criteria pollutants. The U.S. Environmental Protection Agency (EPA) designates such areas as nonattainment areas. A state with a nonattainment area must prepare a State Implementation Plan (SIP) that details the programs and requirements that the state will implement to meet the air quality standards by specified deadlines.

The Clean Air Act Amendments of 1990 require federal agencies to ensure that their actions not only conform to SIPs, but also reduce the severity and number of violations of air quality standards to achieve expeditious attainment of the standards. Actions or projects funded and approved by the FAA are subject to the General Conformity regulations of the Clean Air Act Amendments (40 CFR Part 93, Subpart B).

To comply with the General Conformity regulations, two criteria must be met:

- Total direct and indirect pollutant emissions from a project in a nonattainment area must be included in a SIP budget, or must be below *de minimis* (insignificant) emissions levels for the nonattainment area; and
- Pollutant emissions from the project must not be "regionally significant"; *i.e.*, the project must contribute less than 10 percent of the region's total emissions for a criteria pollutant.

If total annual pollutant emissions from a project (including indirect effects) would be below *de minimis* levels and would not be regionally significant, the project is presumed to conform to the SIP and no further air quality analysis is required. If a project's total annual emissions would exceed the *de minimis* levels, a conformity determination and pollution assessment, including dispersion analysis, would be required.

Many airport projects are too small to require a detailed pollution assessment; only a few projects in nonattainment areas have been broad enough in scope to require determination of air quality conformity through an emissions inventory and dispersion analysis. However, the number of airport projects that have required a conformity determination in the past decade has increased.

10.5.2 CURRENT AIR QUALITY

The Airport is in the Houston-Galveston-Brazoria air quality control region, which is currently designated as marginal non-attainment for ozone (O_3). Ozone is not emitted directly, but is the product of the atmospheric chemical reaction of the ozone precursors nitrogen oxides (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. The *de minimis* emissions levels for NO_x and VOC are 25 tons per year each.

Each project recommended in this Master Plan Update, as it undergoes preliminary design, would be evaluated for its potential effects on air quality under NEPA during the preparation of a NEPA assessment.

Table 10-10 lists the major Master Plan Update projects, and indicates which types of air quality assessments may be required before each project receives FAA approval.

Table 10-10: Air Quality Analyses Required for Master Plan Update Projects

PROJECT	OPERATIONS EMISSIONS INVENTORY	CONSTRUCTION EMISSIONS INVENTORY	CARBON MONOXIDE ASSESSMENT	GENERAL POLLUTION ASSESSMENT
Phase 1 (2014-2016)				
Roadway improvements	✓	✓	✓	
General Aviation development	✓	✓		
Land acquisition				
Phase 2 (2017-2019)				
Concourse expansion	✓	✓		
Consolidated rental car facility		✓	✓	
Phase 3 (2020-2023)				
New cargo building	✓	✓		
Taxiway extension		✓		✓
Runway 12L-30R upgrade	✓	✓		✓
Runway 17-35 decommissioning				
Phase 4 (2024-2030)				
Terminal improvements	✓	✓	✓	

SOURCE: Ricondo & Associates, Inc., September 2014.
PREPARED BY: Quadrant Consultants Inc., September 2014.

10.5.3 OPERATIONS EMISSIONS INVENTORY

An operations emissions inventory is prepared to assess the quantities of pollutant emissions resulting from changing airport activity levels. If, because of an airport project, a change is expected in the number, type, or operating patterns of mobile sources, such as aircraft, ground support equipment vehicles, or passenger vehicles, or if the numbers or emissions rates of point sources, such as boilers and fuel tanks, change, then an operations emissions inventory is warranted. If project-related emissions (direct and indirect) are not expected to exceed *de minimis* thresholds over the planning period, then no further air quality analysis is required. If project-related emissions are expected to exceed the *de minimis* thresholds over the planning period, a general pollution assessment is required. The FAA requires use of the Emissions and Dispersion Modeling System (EDMS) as the model to be used to estimate emissions and pollutant concentrations at airports. FAA is scheduled to replace EDMS with the Airport Environmental Design Tool (AEDT) in the near future.

10.5.4 CONSTRUCTION EMISSIONS INVENTORY

A construction emissions inventory is prepared to assess the emissions caused by temporary construction and demolition activities during project development. Typical sources of construction-related emissions are off-road equipment (backhoes, drilling rigs, mixers), on-road equipment (dump trucks, concrete trucks), and passenger vehicles used by construction employees. Several projects in the ADP will require construction or demolition of landside or airside facilities and may require a construction emissions inventory.

Construction emissions are not modeled. Emissions from construction equipment are calculated from emissions factors presented in Report AP-42, *Compilation of Air Pollutant Emissions Factors,* Volume 11: "Mobile Sources," Fourth Edition, prepared by the U.S. EPA. Similar to the operations emissions inventory, the construction emissions inventory triggers a pollution assessment if the direct and indirect emissions from the project will exceed *de minimis* thresholds. Construction-related emissions for most airport projects are below *de minimis* thresholds, but emissions caused by on-road construction vehicle trips may require a carbon monoxide assessment and a general pollution assessment (described below).

10.5.5 CARBON MONOXIDE ASSESSMENT

If a project would substantially increase traffic at roadway intersections on or near the Airport, it has the potential to cause harmful levels of carbon monoxide (CO) near the intersections. CO is a poisonous gas byproduct of incomplete fuel combustion. The purpose of conducting a carbon monoxide assessment is to determine if project-related emissions of CO caused by motor vehicles would cause the national ambient air quality standard to be exceeded in the area. Intersections predicted to have high traffic volumes and low levels of service are modeled using the MOBILE 6 emissions model and the CAL3QHC dispersion model.

10.5.6 GENERAL POLLUTION ASSESSMENT

If total pollutant emissions from an airport project (including indirect causes) are determined to exceed *de minimis* thresholds in a nonattainment area, and pollutant concentrations are likely to exceed national ambient air quality standards for any of the six criteria pollutants, a general pollution assessment is required. Future project emissions are estimated for no action and each project alternative. The dispersion of future emissions is then modeled using EDMS to project pollutant concentrations, which are then added to background concentrations and compared to the standard. If expected pollutant concentrations would not exceed the standard, the project can obtain an air quality certificate from the TCEQ and the general pollution assessment is complete. If expected pollutant concentrations would exceed the standard, emissions must be mitigated or offset, or the project must be redesigned to reduce emissions.

10.6 Water Quality

The U.S. Geological Survey 7½-minute topographic map (**Exhibit 10-15**) for Park Place, Texas, shows two streams near the Airport: Sims Bayou to the north and Berry Creek to the northwest. Berry Creek flows into Berry Bayou, which flows into Sims Bayou, which then flows into Buffalo Bayou (Houston Ship Channel) and ultimately to Galveston Bay. Neither Sims Bayou nor Berry Creek are navigable waters of the United States (as defined by the U.S. Army Corps of Engineers).

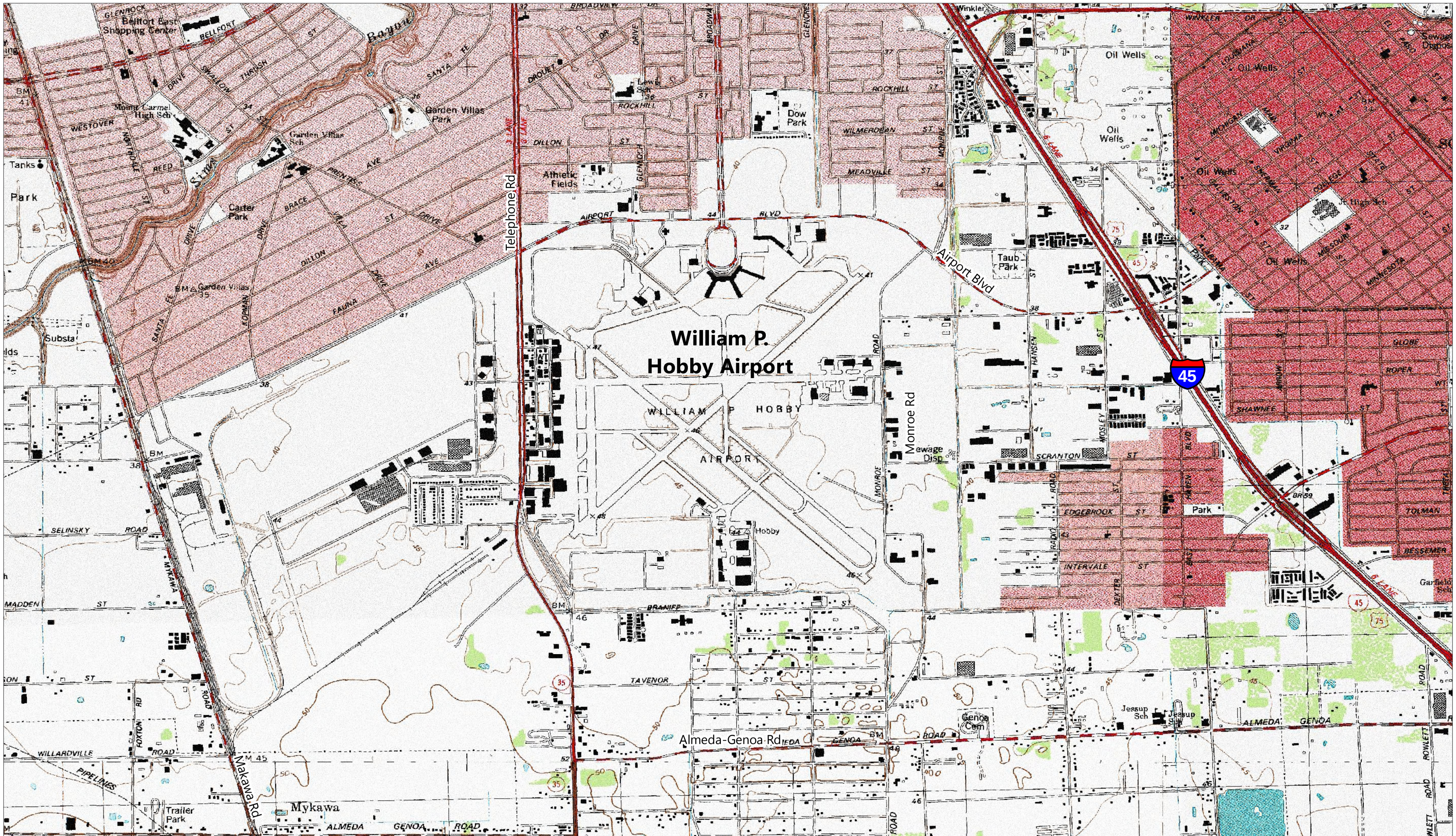
Two ditches are located on or near the Airport. Most of the Airport area drains to a ditch that begins at Airport Boulevard between Broadway Street and Monroe Road and flows north to Sims Bayou. The south end of the Airport drains to another ditch that flows east across the entire southern boundary of the Airport, crossing Monroe Road and turning northward about 1,500 feet east of the Airport, eventually flowing to Berry Creek north of Airport Boulevard. Neither ditch appears to be a water of the United States. In addition, a small area on the far northwest end of the Airport drains to Telephone Road storm sewers and then to Sims Bayou.

The quality of Sims Bayou and Berry Creek water is poor, commonly having low concentrations of dissolved oxygen, high concentrations of suspended solids, and high levels of fecal bacteria, indicating potential contamination with fecal material. Both Sims Bayou above the tidal limit (Segment 1007D) and Berry Bayou above the tidal limit (Segment 1007F) are listed in the 2010 *Texas Integrated Report on Water Quality*[1] as impaired streams because of the high fecal coliform bacteria counts.

A *Storm Water Master Plan*[2] was prepared for the Airport in 2008. The plan indicates that the Airport's storm sewer system is sized for a 2-year storm, and that larger storms can surcharge the system, causing backups and possibly damage to the system. Furthermore, the east side of the Airport is in the 100-year floodplain (based on FEMA maps updated in 2007 to reflect data acquired during Tropical Storm Allison). The Storm Water Master Plan recommends measures to relieve the storm water system and add capacity to the drainage ditch that drains to Berry Creek to convey larger quantities of floodwaters and reduce the floodplain area. New storm water detention facilities are also recommended to mitigate additional runoff caused by new development, particularly on the east side of the Airport.

1 Texas Commission on Environmental Quality, *Texas Integrated Report on Water Quality,* 2010. Submitted to the US Environmental Protection Agency on September 17, 2010, and approved on November 18, 2011. http://www.tceq.texas.gov/assets/public/compliance/monops/water/10twqi/2010_303d.pdf.

2 CivilTech, *William P. Hobby Airport Storm Water Master Plan,* 2008. Houston Airport System, Houston, Texas.



SOURCE: U.S. Geological Survey, 7½-minute topographic map for Park Place, Texas, 1994.
PREPARED BY: Quadrant Consultants Inc., August 2014.

EXHIBIT 10-15

Topographic Map

NORTH 0 2,000 ft.

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The Airport was also the subject of a *Storm Water Quality Master Plan*[3] in 2008. This plan indicates that the Airport is permitted under the Multi-Sector General Permit and the Construction General Permit (for construction activities) in the Texas Pollutant Discharge Elimination System. In accordance with best management practices, the Airport uses two oil-water separators and a deicing storage tank to prevent pollutants from reaching streams for best management practices, in addition to vegetated buffer areas along the ditch on the south side of the Airport. As a condition of these permits, a Storm Water Pollution Prevention Plan[4] is in place for the Airport, which indicates the specific sources of storm water pollution, the best management practices to be used, as well as where and how they are to be used, and monitoring and reporting requirements.

As specific projects from this Master Plan Update enter the planning phase, HAS will prepare a Storm Water Pollution Prevention Plan under the Texas General Permit for Construction to control pollution and erosion. Since much of the area surrounding the Airport is already developed, drainage systems are in place to accommodate storm water runoff. Under the general Airport Storm Water Pollution Prevention Plan, Airport staff monitors runoff quarterly at outfalls from the Airport during first-flush rain events, and any obvious pollution that occurs is reported and remedied.

10.7 DOT Section 4(f) Lands

Section 4(f) of the Department of Transportation Act of 1966 specifies that transportation projects cannot take land from public parks, historic sites, or wildlife refuges without a determination that there is no reasonable and prudent alternative. Takings can include physical acquisition of lands or significant environmental effects to such lands caused by noise, pollution, etc., that make the lands unsuitable for the desired use.

Exhibit 10-16 shows and **Table 10-11** lists the public parks within three miles of the Airport.

Table 10-11 also lists schools within the 3-mile radius that have playgrounds that have been designated as SPARK Parks. The SPARK School Park Program is a cooperative arrangement between the Houston Independent School District and the City of Houston Department of Parks and Recreation, by which schools open their playgrounds during off-school hours for public use.

No public park is recommended for acquisition under this Master Plan Update, but Jessup Elementary School is within the area projected to be exposed to aircraft noise of DNL 65. However, Jessup Elementary School is not part of the SPARK Park program and, therefore, does not meet the definition of a public park for purposes of Section 4(f) of the DOT Act.

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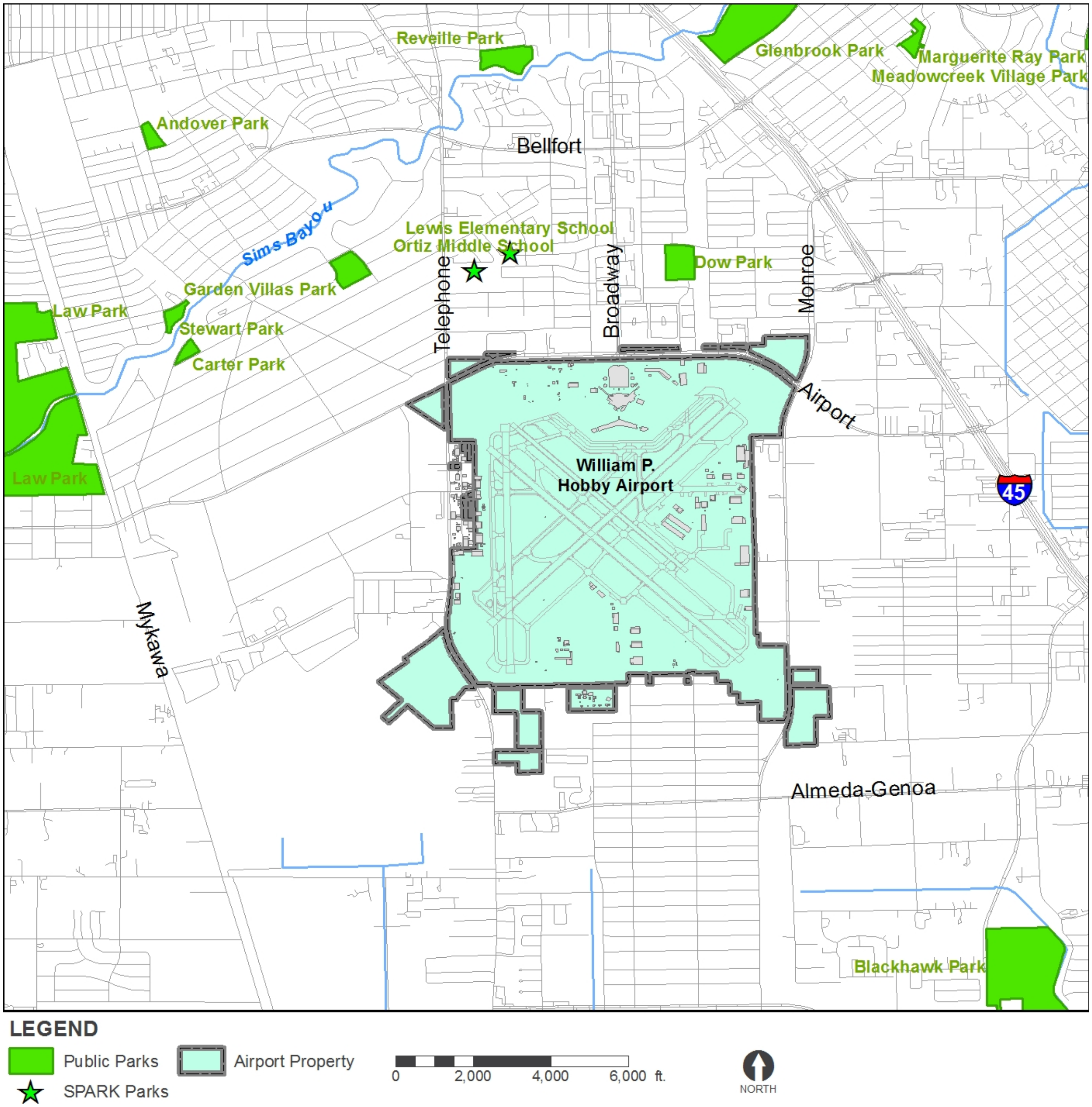
3 CivilTech, *William P. Hobby Airport Storm Water Quality Master Plan,* 2008. Houston Airport System, Houston, Texas.

4 Camp Dresser & McKee, *Storm Water Pollution Prevention Plan for William P. Hobby Airport*. Houston Airport System, Houston, Texas. August 2006.

Exhibit 10-16: Public Parks and SPARK Parks within Three Miles of the Airport



SOURCE: Houston-Galveston Area Council, 2013.
PREPARED BY: Quadrant Consultants Inc., 2014.

Table 10-11: Public Parks and SPARK Parks within Three Miles of the Airport

LAND TYPE	NAME	ADDRESS	DISTANCE FROM THE AIRPORT (MILES)	LOCATION IN RELATION TO THE AIRPORT
Public Park	Allendale Spaceway	9300 Howard Drive	3	Northeast
Public Park	Andover Park	6301 Nunn Street	2	Northwest
Public Park	Beverly Hills Park	10201 Kingspoint Road	2.5	Southeast
Public Park	Blackhawk Park	9401 Fuqua Street	2.25	Southeast
Public Park	Carter Park	7000 Santa Fe	1.25	West
Public Park	Charlton Park	8200 Park Place	3	North
Public Park	City Park	515 Avenue A	3	Northeast
Public Park	Cullinan Park	6700 Long Drive	3	Northwest
Public Park	Dow Park	7942 Rockhill Street	0.5	North
Public Park	Edgewood Park	5803 Bellfort Avenue	3	Northwest
Public Park	El Franco Lee Park & Hall Road Reserve	9400 Hall Road	3	South
Public Park	Freeway Manor Park	2241 Bronson Street	3	East
Public Park	Garden Villas Park	6720 South Haywood Drive	1	Northwest
Public Park	Glenbrook Park	8201 North Bayou Drive	1.25	North
Public Park	Jerry Sharp Park	3234 Chaffin Street	3	Northwest
Public Park	Kingspoint Dog Park	9100 Kingspoint Road	2.75	Southeast
Public Park	Law Park	8400 Mykawa Road	2	Northwest
Public Park	Marguerite Ray Park	8401 Elrod Street	2	Northeast
Public Park	Meadowcreek Village Park	5333 Berry Creek Drive	2	Northeast
Public Park	Oak Meadow Park	500 Ahrens Street	3	Northeast
Public Park	Reveille Park	7700 Oak Vista Street	1.5	North
Public Park	South Houston City Park	600 Georgia Street	2	East
Public Park	Stewart Park	6700 Reed Road	1.5	West
Public Park	Walter Jones Park	8000 Coastway Lane	1.75	South
Public Park	Wilson Memorial Park	100 Gilpin Lane	2	East
School	Alcott Elementary School	5859 Bellfort Avenue	2.5	Northwest
School	Freeman Elementary School	2323 Theta Street	2	East
School	Lewis Elementary School	7649 Rockhill Street	0.25	North
School	Matthys Elementary School	900 College Avenue	1.5	East
School	Patterson Elementary School	5302 Allendale Road	2.5	Northeast
School	Park Place Elementary School	8235 Park Place	2	North
School	Ortiz Middle School	6767 Telephone Road	0.25	North
School	Stevenson Middle School	9595 Winkler Drive	1.75	Northeast
School	Chavez High School	8501 Howard Drive	2	North

SOURCE: City of Houston, 2013.
PREPARED BY: Quadrant Consultants Inc., 2014.

10.8 Historic, Architectural, Archaeological and Cultural Resources

Potential impacts on historic, architectural, archaeological and cultural resources are discussed in this section. Two federal laws apply:

- The National Historic Preservation Act of 1966 established the Advisory Council on Historic Preservation to advise the President and Congress on historic preservation matters, recommend measures to coordinate federal historic preservation activities, and comment on federal actions affecting properties on (or eligible for) the National Register of Historic Places.
- The Archaeological and Historic Preservation Act of 1974 provides for the survey, recovery and preservation of significant scientific, prehistoric, historical, archaeological or paleontological data when such data may be destroyed or irreparably lost because of a federal, federally funded or federally licensed project.

As projects are developed from this Master Plan Update, further surveys and assessments of historic, architectural, archaeological and cultural resources that may be affected will be performed.

The original passenger terminal (which was also the original U.S. Customs building) is the most recognized structure on the Airport with historical and architectural significance. This structure is listed as a historic site by the Texas Historical Commission, but is not currently listed on the National Register of Historic Places. The two-story, open floor plan building was constructed in 1937 as the primary facility for processing departing and arriving passengers. The Houston Aeronautical Heritage Society has been renovating the building, and the 1940 Air Terminal Museum was opened in early 2004. The museum is being restored to the style of its original era. Eventually, the building will include a restaurant. The building is on Airport property, within the area exposed to DNL 65, but because it is aviation-related, it is compatible with aircraft noise.

A second building with potential historical and architectural interest is the Continental Airlines Aircraft Parts Hangar. This building is also not on the National Register of Historic Places. The hangar is located on the west side of the Airport property, parallel to and at the midpoint of Runway 17-35. This hangar, constructed in 1937, appears to be in good condition. It is currently used as an aircraft parts hangar. There are no plans to change its use.

10.9 Biotic Communities

The Airport is in an urban environment. Highly managed biotic communities typical of urban areas can be found on and around the Airport. These include mowed turf grasses consisting of St. Augustine grass (*Stenotaphrum secundatum*) and Bermuda grass (*Cynodon dactylon*), with ornamental shrubs and trees. In undeveloped lands off Airport property, scattered woodlots are dominated by sugarberry (*Celtis laevigata*) and Chinese tallow (*Sapium sebiferum*) trees, with water oak (*Quercus nigra*) and pecan trees (*Carya illinoinensis*) present; old fields are dominated by brownseed paspalum (*Paspalum plicatulum*), Bermuda grass, and herbaceous plants, such as goldenrod (*Solidago canadensis*) and ragweed (*Ambrosia trifida*).

Wildlife seen on the Airport and in the surrounding areas include rock doves (*Columba livia*), common grackles (*Quiscalus quiscula*), house sparrows (*Passer domesticus*), and laughing gulls (*Larus atricilla*) from the Gulf of Mexico and Galveston Bay.

As projects are developed from this Master Plan Update, further surveys and assessments of biotic communities that may be affected will be performed. Runway expansion projects and roadway relocation projects would have greater potential to affect biotic resources than apron expansion or building re-development.

10.10 Endangered and Threatened Species of Flora and Fauna

Endangered species are species of plants or animals that are in danger of extinction throughout all or much of their ranges. Threatened species are likely to become endangered soon. The U.S. Fish & Wildlife Service (FWS) is responsible for determining which species are endangered and providing for their continued survival. The FWS also lists candidate species, which are proposed for listing as endangered or threatened, but have not yet been so confirmed. The Texas Parks and Wildlife Department (TPWD) also lists endangered and threatened species in Texas, along with species and habitats of concern (which have no protection status), and works to preserve them.

Table 10-12 lists endangered and threatened species and candidate species on the federal list, and endangered and threatened species and species and habitats of concern on the Texas list that may be found in Harris County. The FWS and the TPWD were contacted to provide comments on the Airport Master Plan Update regarding these listed species and habitats. The FWS indicated that the projects recommended in the Master Plan Update would have no effect on endangered, threatened, or candidate species. The TPWD indicated that the projects recommended in the Master Plan Update would not affect endangered or threatened species, species of concern, or habitats of concern.

A field reconnaissance was conducted on August 7, 2013, to observe areas subject to land acquisition and Airport property expansion. These areas consist primarily of vacant grass lots of the prairie and woodlot types, as well as industrial buildings or properties. Therefore, it is not anticipated that these types of biotic communities present in the undeveloped lots are rare or endangered or that these areas are habitats to rare or endangered species.

Further analysis and coordination with the FWS and the TPWD would be conducted in future environmental assessments to determine potential impacts of specific projects on endangered species.

Table 10-12 (1 of 4): Endangered and Threatened Species and Species of Concern in Harris County

COMMON NAME	SCIENTIFIC NAME	STATE STATUS	FEDERAL STATUS	HABITAT DESCRIPTION	HABITAT PRESENT?
Amphibians					
Houston toad	*Bufo houstonensis*	E	E†	Sandy soil, breeds in ephemeral pools	No
Birds					
American peregrine falcon	*Falco peregrinus anatum*	T	DM†	Potential migrant, nests in west Texas	No
Arctic peregrine falcon	*Falco peregrinus tundrius*	SOC	DM†	Potential migrant	No
Bald eagle	*Haliaeetus leucocephalus*	T	DM	Near water areas, in tall trees	No
Black rail	*Laterallus jamaicensis*	SOC		Freshwater marshes and grassy swamps	No
Brown pelican	*Pelecanus occidentalis*	E	DM†	Island near coastal areas	No
Henslow's sparrow (wintering)	*Ammodramus henslowii*	SOC	-	Weedy fields, fields with bunch grass, vines, and brambles, needs bare ground	No
Mountain plover	*Charadrius montanus*	SOC	-	Short grass plains and bare dirt (plowed fields)	No
Snowy plover	*Charadrius alexandrinus*	SOC	-	Coastal winter migrant	No
Southeastern snowy plover	*Charadrius alexandrinus tenuirostris*	SOC	-	Winter migrant on Texas coast beaches, bayside mud, or salt flats	No
Red-cockaded woodpecker	*Picoides borealis*	E	E†	Nests in 60+ year pine, forages in 30+ pine	No
White-faced ibis	*Plegadis chihi*	T	†	Freshwater marshes, but some brackish or salt marshes	No
White-tailed hawk	*Buteo albicaudatus*	T	*	Coastal prairies	No
Whooping crane	*Grus americana*	E	E†	Winters in Aransas National Wildlife Refuge	No
Wood stork	*Mycteria americana*	T	E†	Prairie ponds and flooded pastures	No
Fish					
American eel	*Anguilla rostrata*	SOC	-	Coastal waterways below reservoirs to Gulf	No
Creek chubsucker	*Erimyzon oblongus*	T	*	Variety of small rivers and creeks, prefers headwaters	No

Table 10-12 (2 of 4): Endangered and Threatened Species and Species of Concern in Harris County

COMMON NAME	SCIENTIFIC NAME	STATE STATUS	FEDERAL STATUS	HABITAT DESCRIPTION	HABITAT PRESENT?
Fish					
Smalltooth sawfish	*Pristis pectinata*	E	E†	Various water depths	No
Mammals					
Louisiana black bear	*Ursus americanus luteolus*	T	T†	Bottomland hardwoods; large, undisturbed forest areas	No
Plains spotted skunk	*Spilogale putorius interrupta*	SOC	†	Wooded, brushy areas and tall-grass prairie	No
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	T	†	Cavity trees in hardwood forest, concrete culverts, abandoned buildings	No
Red wolf	*Canis rufus*	E	E†	Extirpated, brushy, forested areas, coastal prairies	No
Southeastern myotis bat	*Myotis austroriparius*	SOC	-	Cavity trees in hardwood forest, concrete culverts, abandoned buildings	No
Mollusks					
Little spectacle-case	*Villosa lienosa*	SOC	-	Creeks, rivers, and reservoirs, sandy substrates, slight to moderate currents, along banks in slower currents	No
Louisiana pigtoe	*Pleurobema riddellii*	T	-	Streams and moderate-sized rivers, mud, sand and gravel	No
Pistol-grip	*Tritogonia verrucosa*	SOC	-	Rock, hard mud, silt, and soft bottoms, often buried deeply	No
Rock pocketbook	*Arcidens confragosus*	SOC	-	Mud, sand and gravel substrates in standing or slow flowing water	No
Sandbank pocketbook	*Lampsilis satura*	T	-	Rivers with moderate to swift flows, gravel-sand and sand	No

Table 10-12 (3 of 4): Endangered and Threatened Species and Species of Concern in Harris County

COMMON NAME	SCIENTIFIC NAME	STATE STATUS	FEDERAL STATUS	HABITAT DESCRIPTION	HABITAT PRESENT?
Mollusks					
Texas pigtoe	*Fusconaia askewi*	T	-	Rivers with mixed mud, sand, and fine gravel in protected areas	No
Wabash pigtoe	*Fusconaia flava*	SOC	-	Creeks to rivers, mud, sand, and gravel, moderate to swift currents	No
Reptiles					
Alligator snapping turtle	*Macrochelys temminckii*	T	*	Deep water of rivers and canals	No
Green sea turtle	*Chelonia mydas*	T	T†	Gulf and bay system	No
Gulf salt marsh snake	*Nerodia clarkii*	SOC	-	Saline flats, coastal bays, and brackish river mouths	No
Kemp's Ridley sea turtle	*Lepidochelys kempii*	E	E†	Gulf and bay system	No
Leatherback sea turtle	*Dermochelys coriacea*	E	E†	Gulf and bay system	No
Loggerhead sea turtle	*Caretta caretta*	T	T†	Gulf and bay system	No
Smooth green snake	*Liochlorophis vernalis*	T	*	Gulf coastal prairies, prefers dense vegetation	No
Texas horned lizard	*Phrynosoma cornutum*	T	†	Open, semi-arid regions with bunch grass	No
Timber or canebrake rattlesnake	*Crotalus horridus*	T	*	Swamps and floodplains of hardwood and upland pine	No
Plants					
Coastal gay-feather	*Liatris bracteata*	SOC	-	Coastal prairie grasslands	No
Giant sharpstem umbrella-sedge	*Cyperus cephalanthus*	SOC	-	Deep prairie depressions on saturated, fine sandy loam soils or on heavy black clay	No
Houston daisy	*Rayjacksonia aurea*	SOC	-	Barren, sparsely vegetated saline slicks, pimple mounds, on sandy to sandy loam	No
Texas meadow-rue	*Thalictrum texanum*	SOC	-	Woodland margins on sandy loam, on pimple mounds, clay pan savannahs	No

Table 10-12 (4 of 4): Endangered and Threatened Species and Species of Concern in Harris County

COMMON NAME	SCIENTIFIC NAME	STATE STATUS	FEDERAL STATUS	HABITAT DESCRIPTION	HABITAT PRESENT?
Plants					
Texas prairie dawn	*Hymenoxys texana*	E	E	Poorly drained areas in open grasslands; pimple mounds	No
Texas windmill-grass	*Chloris texensis*	SOC	-	Sandy to sandy loam soils in bare areas	No
Threeflower broomweed	*Thurovia triflora*	SOC	-	Low vegetation, on light colored silt or fine sand over saline clay	No

NOTES:

E = Endangered; T = Threatened; SOC = Species of Concern; DM = Delisted Taxon, Recovered, Being Monitored First 5 Years.

* These species are included on the Texas list of endangered or threatened species, but they are not listed at this time by the U.S. Fish and Wildlife Service.

† These species are listed by the U.S. Fish and Wildlife Service, but they are not listed to occur in Harris County by the Clear Lake (Texas) office of the U.S. Fish and Wildlife Service.

SOURCES: U.S. Fish and Wildlife Service; Texas Parks and Wildlife Department, 2013.
PREPARED BY: Quadrant Consultants Inc., 2013.

10.11 Wetlands

Wetlands are habitats that are frequently inundated or saturated with water, have soils that show the effects of saturation, and support species of plants that are suitable for wet conditions. Wetlands provide a variety of ecological services that are valuable to society, including water quality improvement, wildlife habitat, storm water detention, and ground water recharge.

Executive Order 11990, *Protection of Wetlands*, directs federal agencies to minimize the destruction, loss or degradation of wetlands on federal property or on projects with federal funding. Wetlands that are adjacent to waters of the United States, or have a significant physical, chemical or biological nexus with them, are also considered waters of the United States. Jurisdictional wetlands are protected under the Clean Water Act of 1972; a permit from the U.S. Army Corps of Engineers is required before they may be filled.

The potential presence of wetlands was assessed by offsite methods for the proposed acquisitions and the future Airport boundary. Color infrared aerial photographs and soil surveys were reviewed for this assessment. The photograph presented on **Exhibit 10-17** shows that the vicinity of the project area is mostly developed with impermeable surfaces. Three potential wetlands were found from the inspection of aerial photographs and observations of public rights-of-way. However, field verification would be required to determine whether these potential wetlands are actually wetlands.

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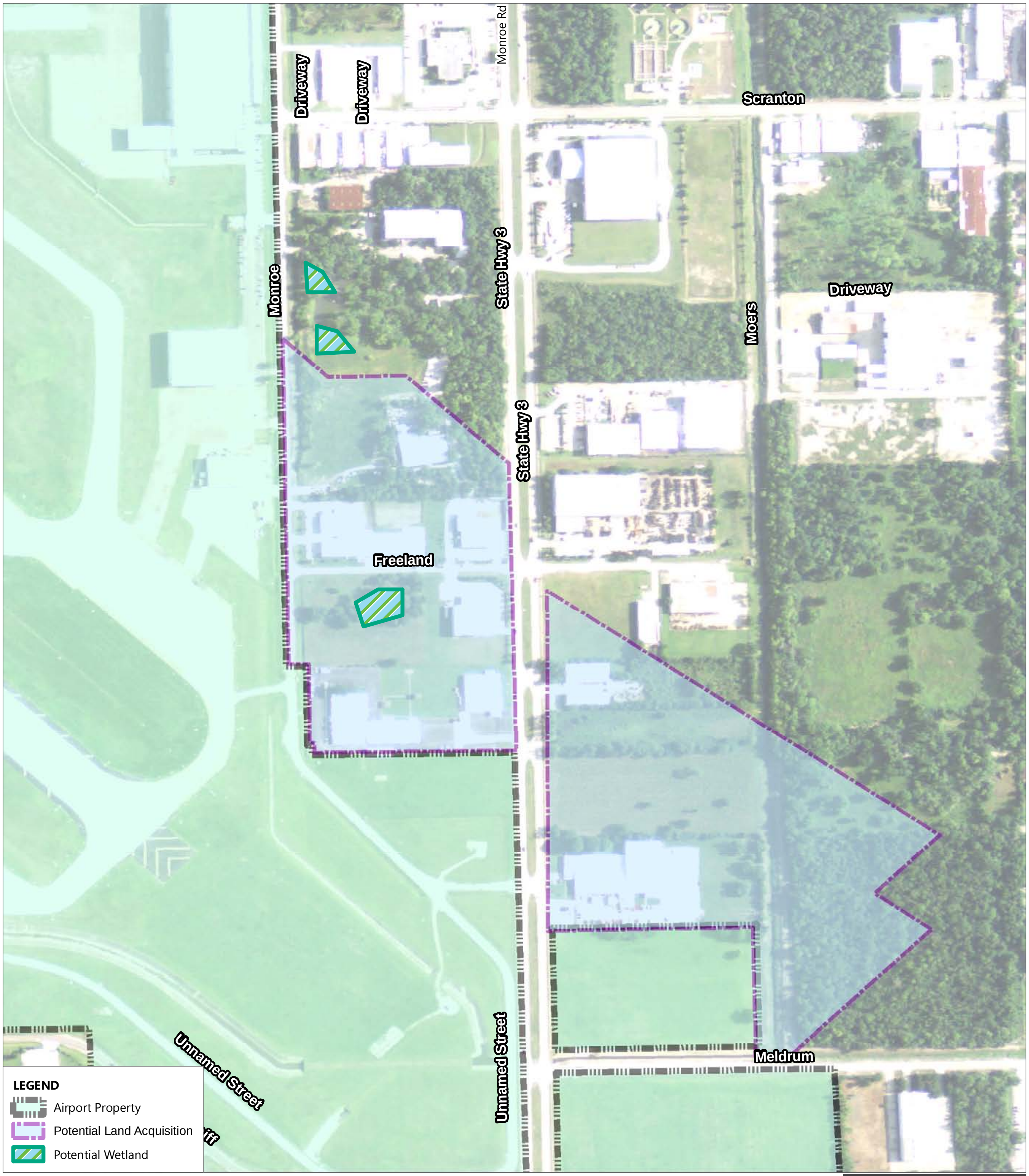

SOURCE: Quadrant Consultants Inc., August 2014.
PREPARED BY: Quadrant Consultants Inc., August 2014.

EXHIBIT 10-17

NORTH 0 1,000 ft.

Potential Wetlands on Lands to be Acquired

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As projects are developed from this Master Plan Update, fieldwork and coordination with the U.S. Army Corps of Engineers would be required to determine whether wetlands are present, delineate their boundaries and determine whether they are jurisdictional under Section 404 of the Clean Water Act. Wetlands would be delineated according to the Corps' 2009 *Regional Supplement to the 1987 Corps of Engineers Wetland Delineation Manual for the Atlantic and Gulf Coastal Region* to confirm hydrologic, vegetation, and soil indicators, as well as connections to waters of the United States. Based on current guidelines and regulations, it is anticipated that any effects on wetlands in this area would be eligible for permitting under Nationwide Permit 14 (Linear Transportation Crossings) or Nationwide Permit 25 (Structural Discharges).

10.12 Floodplains

The 100-year floodplain is an area that has a 1-percent chance of flooding in a year. Executive Order 11988, *Floodplain Management*, requires federal agencies to avoid or minimize activities that directly or indirectly result in developing floodplain areas. The City of Houston is a participant in the National Flood Insurance Program.

The Flood Insurance Rate Map[5] (**Exhibit 10-18**) prepared by FEMA shows that much of the eastern side of the Airport is in the 100-year floodplain; 199 acres of Airport property are within the 100-year floodplain. Acquisition of land for Master Plan Update projects would add 30 acres of land in the 100-year floodplain, resulting in 229 total acres of Airport property in the 100-year floodplain by 2030.

For projects developed from this Master Plan Update, HAS would be required to perform an analysis demonstrating that impacts to floodplains have been avoided or minimized as much as possible. For remaining impacts to floodplains, HAS would be required to provide flood mitigation for any buildings constructed in the floodplain by creating additional floodable volume in the floodplain equaling the volume of buildings constructed within the floodplain and below the flood elevation. Before development may be initiated within a floodplain, a floodplain effect study must be completed for the area. If the development would cause an increase in the 100-year flood elevation after mitigation, a Letter of Map Revision, based on the floodplain effect study, would be prepared showing the new floodplain lines. FEMA and the Harris County Flood Control District must approve the letter before development could continue.

In addition, a plat of the development approved by the District is required for each development within Harris County. The purpose of the approval process is to ensure compliance with design criteria, rules and regulations for the area to be developed. The City of Houston must also review and approve the drainage plans for new development within the City limits.

5 Federal Emergency Management Agency. *Flood Insurance Rate Map,* No. 48201 C 0895L, revised June 18, 2007.

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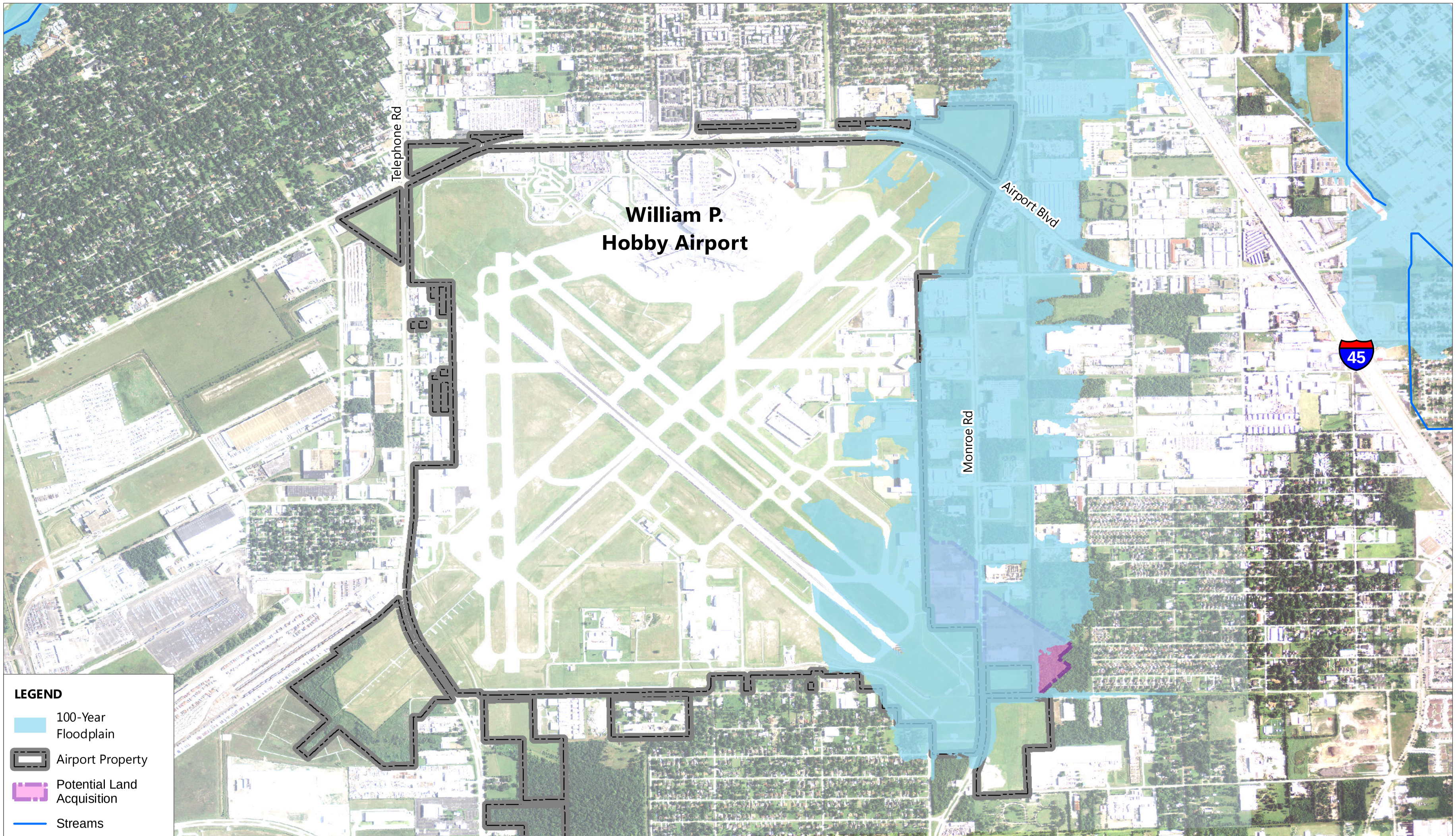

SOURCE: Federal Emergency Management Agency, Flood Insurance Rate Map, No. 48201 C 0895L, revised June, 2007.
PREPARED BY: Quadrant Consultants Inc., August 2014.

EXHIBIT 10-18

100-Year Floodplains

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For development areas larger than 10 acres, onsite or offsite detention ponds would be required to mitigate the storm water runoff. For development areas that are 10 acres or less, a fee must be paid to the Harris County Flood Control District to compensate for the increased water runoff. The District is responsible for providing the necessary drainage infrastructure improvements to accommodate the increase in water runoff from the development areas that are less than 10 acres.

10.13 Coastal Management Program

The Texas Coastal Management Plan, administered by the Texas General Land Office, governs the management of coastal resources along the Texas Gulf Coast. Projects for which State support is sought must be consistent with the Coastal Management Plan. The Airport is not within the area covered under the Coastal Management Plan and, therefore, Airport expansion will not affect the coastal management program.

10.14 Coastal Barriers

Coastal barriers are narrow islands or margins along the Texas Gulf Coast with active dunes (or structures built to replace them). In Texas, these barriers are managed to prevent beach erosion. The Airport is not on a coastal barrier. Therefore, the ADP will not affect coastal barriers.

10.15 Wild and Scenic Rivers

Wild and scenic rivers are designated by the U.S. Department of the Interior to protect the most beautiful and unspoiled rivers in the nation under the Wild and Scenic River Act. These rivers have exceptional beauty, historic and natural sources, aquatic and wildlife habitats and geological values. Only one river in Texas, the Rio Grande at Big Bend, is currently designated a wild and scenic river. The Airport is not near this river. Therefore, Airport expansion will not affect a wild and scenic river.

10.16 Farmland

The preservation of prime farmland is a priority goal for the U.S. Department of Agriculture, and the effects of projects with federal support on prime farmland must be assessed. The Airport is in an urban area. No farmland is on or adjacent to the Airport, and no farmland would be lost because of the proposed Airport Master Plan Update projects.

10.17 Energy Supply and Natural Resources

The projects recommended in this Master Plan Update would add facilities within the current Airport boundary and on 40.6 acres of developed land proposed to be acquired adjacent to the southeast corner of the Airport. Because of these activities, certain natural resources, such as forests, wetlands and wildlife habitat, would be lost.

Projects associated with the Master Plan Update would increase the capacity of the Airport to meet forecast demand. The Airport and aircraft operating at the Airport would consume more energy in the future because of the increased demand for aviation services. Most of the energy would be consumed in the form of electricity (to power airfield and landside lighting, air conditioning and heating inside terminals and other buildings, and many other functions) and fuel for aircraft and ground-based equipment, specifically jet fuel (Jet A), propeller aircraft fuel (100LL), gasoline, and diesel fuel. The Airport is not a major consumer of regional fresh water supplies.

It was estimated during the master planning process that fuel consumption at the Airport may increase by about 35 percent between 2011 and 2030. Fuel suppliers are projected to have adequate fuel to supply the Airport throughout the planning period.

It is estimated that electricity consumption would increase less than 10 percent of current consumption, with increasing power-using facilities partly offset by energy conservation measures. Currently, Reliant Energy provides electric power to the Airport. Reliant has 22,000 megawatts of power generation capacity in the United States, and is among the largest power marketers in North America. Reliant Energy and other Texas energy suppliers are expected to meet demand through 2030, including the energy requirements for the Airport.

10.18 Light Emissions and Visual Impacts

Emissions from navigational aids and illumination on the airfield and terminal, and from parking areas can annoy residents near the Airport if their homes are on a line of sight with Airport light sources. Light sources are located throughout the airfield and beyond the ends of the runways, and around the terminal building.

The consolidated rental car facility would be lit at night, but these areas are already illuminated at night and the new facilities would not introduce lighting to formerly unlit areas.

Light emissions would also occur during construction. Airfield construction operations would likely occur at night, and construction lighting would be local and shielded to reduce interference with ongoing aircraft operations. These areas are far from residential areas, so light emissions should not affect them. It is not anticipated that nighttime construction would occur for the consolidated rental car facility.

10.19 Hazardous Material, Pollution Prevention, and Solid Waste

10.19.1 MUNICIPAL SOLID WASTE LANDFILL SITES

The Airport currently generates about 6,530 tons of solid waste per year. To prevent water pollution and contamination of surrounding areas, solid waste must be disposed of at secure and regulated disposal sites, which are located increasingly farther from urban areas as development occurs. The operator of a large generator of solid waste such as the Airport must also ensure that appropriate disposal facilities will continue to be available to handle the expected future waste stream.

Landfills near airports attract birds and can lead to bird strikes on aircraft. About 10,000 bird and other wildlife strikes on civil aircraft were reported in the United States in 2011. Over the past 25 years, bird and other wildlife strikes have cost over $700 million and caused 10 human deaths per year on average.[6] The FAA recognizes the hazard that wildlife attracted to airports represent, and has issued appropriate regulations. FAA Advisory Circular 150/5200-33B, *Hazardous Wildlife Attractants on or near Airports,*[7] and FAA Advisory Circular 150/5200-34A, *Construction or Establishment of Landfills near Public Airports,*[8] direct local governments to prohibit new landfills from being constructed within six miles of an airport. These regulations also discourage airport operators from increasing airport capacity if an existing landfill that handles putrescible wastes is closer than six miles from an airport.

One active landfill (Greenbelt Landfill) is located 4.5 miles from the Airport. This landfill accepts only nonhazardous construction and demolition waste, including concrete and building materials; it does not accept domestic waste or other putrescible wastes. In addition, five active landfills are farther than 10 miles from the Airport. As shown on **Exhibit 10-19,** three closed landfills are within 6 miles of the Airport, but these are completely sealed and do not attract wildlife.

The Airport's solid waste is accumulated in four 30-yard compactors and three 30-yard open-top disposal units. The refuse is collected on call or at scheduled times for each compactor. The refuse is disposed of by McCarty Road Landfill of Texas, LP, at the McCarty Road Landfill in northeast Houston. This landfill is more than 14 miles from the Airport.

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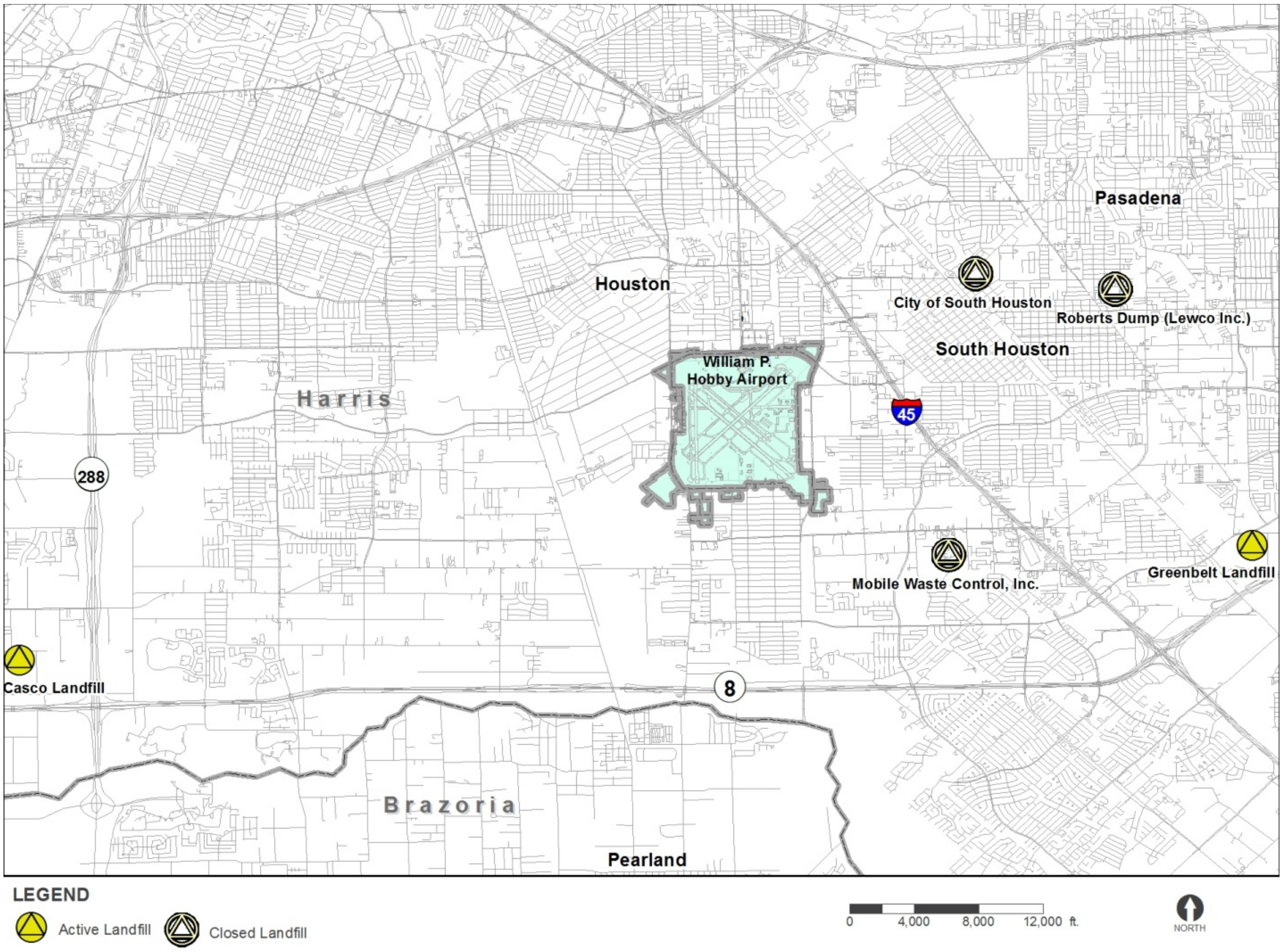
6 Bird Strike Committee USA. *Understanding and reducing bird and other wildlife hazards to aircraft*, 2013. www.birdstrike.org.

7 Federal Aviation Administration. Advisory Circular 150/5200-33B, *Hazardous Wildlife Attractants on or near Airports.* August 28, 2007, http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/22820.

8 Federal Aviation Administration. Advisory Circular 150/5200-34A, *Construction or Establishment of Landfills near Public Airports,* January 26, 2006, http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/ go/document.information/documentID/22095.

Exhibit 10-19: Landfills near the Airport



SOURCE: Houston-Galveston Area Council, 2013.
PREPARED BY: Quadrant Consultants Inc., 2013.

The Airport produces an average of 545 tons of refuse a month, of which 75 percent is compacted by one of four compactors used by HAS or Airport tenants. The McCarty Road Landfill can handle refuse collection beyond 2022. Adequate storage capacity is available in area landfills to handle solid waste from the Airport during the planning period.

10.19.2 HAZARDOUS MATERIALS

Databases maintained by the U.S. EPA and the TCEQ were searched on April 26, 2013, for sites on or near the Airport with soil or groundwater that may have been contaminated by hazardous substances. **Table 10-13** shows the results of this search, in which 331 records of sites with potential for contamination were found, 77 of which are on Airport property and one is on land proposed to be acquired for projects recommended in this Master Plan Update.

Table 10-13: Potential Hazardous Materials Sites On or Near the Airport

DATABASE SEARCHED	AGENCY	SITES ON AIRPORT PROPERTY	SITES ON LAND TO BE ACQUIRED	VICINITY SEARCH RADIUS	SITES IN SEARCH RADIUS
National Priority List (Superfund) Sites	U.S. EPA	0	0	1 mile	1
State-listed Superfund Sites	TCEQ	0	0	1 mile	1
Delisted National Priority List Sites	U.S. EPA	0	0	0.5 mile	0
CERCLIS Contaminated Sites	U.S. EPA	0	0	0.5 mile	2
State-listed Contaminated Sites	TCEQ	0	0	0.5 mile	0
CERCLIS Sites, No Further Remedial Action Planned	U.S. EPA	0	0	0.5 mile	3
RCRA Waste Generator Corrective Action Sites	U.S. EPA	0	0	1 mile	0
State-listed Disposal or Landfill Sites	TCEQ	0	0	0.5 mile	1
RCRA Waste Treatment, Storage, and Disposal Sites	U.S. EPA	1	0	0.5 mile	4
RCRA Hazardous Waste Generators	U.S. EPA	3	0	0.25 mile	13
State-listed Hazardous Waste Generators	TCEQ	9	1	0.25 mile	77
State-listed Hazardous Materials Sites	TCEQ	9	0	0.25 mile	53
Federal Brownfield Sites	U.S. EPA	0	0	0.5 mile	0
State Brownfield Sites	TCEQ	0	0	0.5 mile	0
Federal Institutional Control Sites	U.S. EPA	0	0	0.5 mile	0
State-listed Institutional Control Sites	TCEQ	0	0	0.25 mile	3
Federal Engineering Control Sites	U.S. EPA	0	0	0.5 mile	0
State-listed Engineering Control Sites	TCEQ	0	0	0.5 mile	0
Voluntary Cleanup Sites	TCEQ	0	0	0.5 mile	8
Emergency Response Notification System Sites	U.S. EPA	0	0	0.25 mile	22
Leaking Petroleum Storage Tank Sites	TCEQ	20	1	0.5 mile	52
Registered Petroleum Storage Tank Sites	TCEQ	33	3	0.25 mile	90
Dry Cleaners	TCEQ	0	0	0.25 mile	1

NOTES:

CERCLIS = Comprehensive Environmental Response, Compensation and Liability Information System

EPA = Environmental Protection Agency

RCRA = Resource Conservation and Recovery Act

TCEQ = Texas Commission on Environmental Quality.

SOURCE: Banks Environmental Data, *Regulatory Database Report*, April 26, 2013.
PREPARED BY: Quadrant Consultants Inc., 2013.

10.19.2.1 National Priority List ("Superfund")

The National Priority List is a federal list maintained by the U.S. EPA of sites with the worst contamination and with little likelihood of remediation without government intervention. The TCEQ maintains a similar list. One site located about a mile northeast of the Airport is on the National Priority List: Geneva Industries (now Fuhrmann Energy), 9334 Caniff Road, Houston 77017 (EPA No. TXD980748453). The site was used for petroleum exploration and production until 1978, when it was abandoned. The site is also on the Texas Superfund list. The TCEQ reports: "As of 1981, the site and adjoining property to the south contained processing tanks and piping, a large wastewater lagoon, two smaller lagoons, a closed lagoon holding solid PCB-containing wastes, a tank area, several drum storage areas, a landfill, and a possible land farm. As a result of past operating practices, extensive soil and shallow groundwater contamination existed at the site." (Banks Environmental Data, 2013). The U.S. EPA removed most of the contamination during 1983 and 1984 and began treating contaminated groundwater, which is ongoing. In 2008, the EPA determined that the site remediation measures protect human health. The site is down-gradient from the Airport and could not have affected soil or groundwater at the Airport or at the land proposed for acquisition.

10.19.2.2 CERCLIS Contaminated Sites

Two sites within 0.5 mile of the Airport are in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) database of contaminated sites. Urban Machine, located at 8236 Travelair Street just west of the Airport, was contaminated by radium, but all contamination has been removed. Condor Services, located at 8102 Braniff Street, just south of the Airport, was a repair station for aircraft until the late 1980s, when it closed. Contamination on the site was determined to be minor and remedial action is not required.

10.19.2.3 RCRA Treatment, Storage, and Disposal Facilities

In accordance with the Resource Conservation and Recovery Act (RCRA), one site on Airport property is registered as a Treatment, Storage and Disposal facility for hazardous materials. The Simmons American Company is known to have handled ignitable wastes, but little else is known. The site has incurred no violation from the TCEQ.

10.19.2.4 Leaking Underground Petroleum Storage Tanks

The TCEQ has records of 20 sites on Airport property with 126 leaking underground storage tanks. Of these 126 leaking tanks, 118 have been removed from the ground and eight have been filled in place. All have had contamination removed and none poses a threat to soil or groundwater today.

One site on the land proposed for acquisition has a record of leaking underground storage tanks. The Chevron fuel station at 7050 Telephone Road has had five leaking underground petroleum storage tanks; all have been removed from the ground along with contaminated soil and groundwater.

10.19.2.5 RCRA Hazardous Waste Generators

Nine industrial businesses on the Airport and one industrial business that is on land proposed for acquisition generate hazardous wastes and could be sources of hazardous contamination. One of these sites (the United

Airlines maintenance shop adjacent to the Airport at 8451 Travelair Street) generates waste solvents and metal solutions. In 2004, the TCEQ issued a final compliance order to United to comply with RCRA hazardous waste laws, the resolution of which is still pending. The other sites are operating without violation.

10.19.2.6 Voluntary Cleanup Sites

Two sites on Airport property controlled by fixed base operators have been contaminated by hazardous materials, and their tenants have agreed to clean them up voluntarily. The two sites are Enterprise Air Center, located at 8850 West Monroe Road, and Wilson Air Center, located at 9000 Randolph Street. The first site has been completely remediated and the second site is still under investigation.

10.20 Construction Impacts

Construction activities can affect the construction site and the surrounding area. These effects are generally temporary, subsiding once construction is completed. The affected environmental categories include air quality, noise, water quality, light emissions, solid and hazardous waste, and traffic.

10.20.1 AIR QUALITY

Construction activities can affect air quality around the Airport through emissions of pollutants from construction equipment and through the generation of fugitive dust from demolition, construction, and material and waste hauling. A general conformity analysis may be necessary for each construction project.

An operations emissions inventory is prepared to assess the quantities of pollutant emissions resulting from changing airport activity levels. If, because of an airport project, a change is expected in the number, type, or operating patterns of mobile sources, such as aircraft, ground support equipment vehicles, or passenger vehicles, or if the numbers or emissions rates of point sources, such as boilers and fuel tanks, change, then an operations emissions inventory is warranted. If project-related emissions (direct and indirect) are not expected to exceed *de minimis* thresholds over the planning period, then no further air quality analysis is required. If project-related emissions are expected to exceed the *de minimis* thresholds over the planning period, a general pollution assessment is required. The FAA requires use of the Emissions and Dispersion Modeling System (EDMS) as the model to be used to estimate emissions and pollutant concentrations at airports. FAA is scheduled to replace EDMS with the Airport Environmental Design Tool (AEDT) in the near future.

Table 10-10 indicates which of the Master Plan Update projects will require an air quality analysis for construction.

Construction of the Master Plan Update projects would generate fugitive dust when dry bare soil is exposed to wind erosion, especially during clearing and earth-moving operations. The effect of fugitive dust generation during construction would be to increase dust fall downwind of the area of active construction, generally within the construction area. Construction contracts will include provisions to water bare soil to minimize wind erosion and fugitive dust generation.

10.20.2 NOISE

Noise would be generated during construction by onsite equipment and heavy vehicles entering and leaving construction sites. Most vehicles delivering items to the construction sites would be expected to be active only during daylight hours. As discussed in Sections 10.1 and 10.2, all construction would be on Airport property, at sufficient distance from residential areas and other noise-sensitive land uses to not cause significant noise impacts.

10.20.3 WATER QUALITY

Construction activities for the Master Plan Update projects can cause erosion or siltation mainly resulting from storm water runoff. A National Pollutant Discharge Elimination System (NPDES) construction permit application, which is required for all construction areas of 5 acres or more, must be filed with U.S. EPA Region 6 for all construction activities related to the proposed projects. As part of the NPDES permit application, a construction Storm Water Pollution Prevention Plan will also be prepared. This plan will require erosion and siltation control measures, such as silt fences, hay bales and retention basins, to protect water quality during construction.

10.20.4 SOLID AND HAZARDOUS WASTE

Construction would generate solid waste from demolitions and excavations. This construction material would be removed from Airport property and disposed of in an appropriate landfill. Construction of proposed projects would not be expected to generate hazardous materials, but further analysis will be required to confirm this, as stated in Section 10.19. Any hazardous waste would be disposed of according to applicable local, State of Texas and federal regulations.

10.20.5 TRAFFIC

Construction vehicles would access the Airport via major thoroughfares wherever possible and not via residential streets. The temporary disruption of traffic flow is possible during construction, but, where possible, such disruption would occur during off-peak hours.

Appendix A

List of Acronyms

Appendix A List of Acronyms

AAC: Aircraft Approach Category

AC: Advisory Circular

ACRP: Airport Cooperative Research Program

ADG: Airplane Design Group

ADP: Airport Development Plan

ADT: Average Daily Traffic

AGL: Above Ground Level

AIP: Airport Improvement Program

AIT: Advanced Imaging Technology

ALP: Airport Layout Plan

ALSF-II: Approach Lighting System with Sequenced Flashing Lights

ANOMS: Airport Noise and Operations Monitoring System

AOA: Air Operations Area

AOI: Area of Influence

ARC: Airport Reference Code

ARFF: Aircraft Rescue and Fire Fighting

ARTCC: Air Route Traffic Control Center

ASDA: Accelerate-Stop Distance Available

ASDE-X: Airport Surface Detection Equipment – Model X

ASNA: Aviation Safety and Noise Abatement

ASOS: Automated Surface Observing System

ASV: Annual Service Volume

ATC: Air Traffic Control

ATCT: Airport Traffic Control Tower

ATO: Airline Ticket Offices

BHS: Baggage Handling System

BRL: Building Restriction Line

BSO: Baggage Service Offices

CAGR: Compound Annual Growth Rate

CAT: Category

CBD: Central Business District

CBIS: Checked Baggage Inspection System

CBP: Customs and Border Protection

CCTV: Closed-Circuit Television

CDBG: Community Development Block Grant

CERCLIS: Comprehensive Environmental Response, Compensation and Liability Information System

CFR: Code of Federal Regulations

CIP: Capital Improvement Program

CMAQ: Congestion Mitigation Air Quality

CMAR: Construction Management at Risk

CMSA: Consolidated Metropolitan Statistical Area

CRCF: Consolidated Rental Car Facility

CUP: Central Utility Plant

DAL: Dallas Love Field

dB: Decibel

dBA: Sound level in decibel, on A-weighted scale

DDFS: Design Day Flight Schedule

DHS: Department of Homeland Security

DME: Distance Measuring Equipment

DMP: Drainage Master Plan

DNL: Day-Night Average Sound Level

DOT: Department of Transportation

EA: Environmental Assessment

EDMS: Emissions and Dispersion Modeling System

EDS: Explosives Detection System

EFD: Ellington Airport

EIS: Environmental Impact Statement

EPA: Environmental Protection Agency

FAA: Federal Administration Agency

FBO: Fixed Base Operator

FEMA: Federal Emergency Management Agency

FIRM: Flood Insurance Rate Map

FIS: Federal Inspection Services

FWS: Fish & Wildlife Service

GA: General Aviation

GDP: Gross Domestic Product

GIS: Geographic Information System

GPS: Global Positioning System

GSE: Ground Support Equipment

HAS: Houston Airport System

HCAD: Harris County Appraisal District

HCDD: Housing and Community Development Department

HCID: Harris County Improvement District

HIRL: High Intensity Runway Lights

HIT: Hobby International Terminal

HOU: William P. Hobby Airport

HPD: Houston Police Department

HVAC: Heating, Ventilation and Air Conditioning

IAH: George Bush Intercontinental Airport/Houston

IATA: International Air Transport Association

IFR: Instrument Flight Rules

ILS: Instrument Landing System

IMC: Instrument Meteorological Conditions

INM: Integrated Noise Model

IT: Information Technology

LAHSO: Land and Hold Short Operations

LDA: Landing Distance Available

LIRL: Low Intensity Runway Lights

LLWAS: Low Level Windshear Alert System

Leq: Equivalent Sound Level

Lmax: Maximum Noise Level

LOS: Level of Service

MALS: Medium Intensity Approach Lighting System

MALSR: Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights

MAP: Million Annual Passengers

MEP: Mechanical, Electrical and Plumbing

MIRL: Medium Intensity Runway Lights

MITL: Medium Intensity Taxiway Lights

MMD: Municipal Management District

mph: miles per hour

MSL: Mean Sea Level

NASA: National Aeronautics and Space Administration

NCDC: National Climatic Data Center

NCP: Airport Noise Compatibility Programs

NEM: Exposure Maps

NEPA: National Environmental Policy Act

NextGen: Next Generation Air Transportation System

NEZ: Neighborhood Empowerment Zone

NFPA: National Fire Protection Association

NPIAS: National Plan of Integrated Airport Systems

NM : nautical mile

NPDES: National Pollutant Discharge Elimination System

O&D : Origin and Destination

OFZ: Obstacle Free Zone

PAL: Planning Activity Level

PAPI: Precision Approach Path Indicator

PDM: Project Definition Manual

PFC: Passenger Facility Charge

PID: Public Improvement District

PMAD: Peak Month Average Day

QTA: Quick Turnaround Area

RCRA: Resource Conservation and Recovery Act

RDC: Runway Design Code

REIL: Runway End Identifier Lights

RNAV : Area Navigation

ROFA : Runway Object Free Area

RON : Remain Over Night

ROT : Runway Occupancy Time

RPZ : Runway Protection Zone

RSA : Runway Safety Area

RTM: Revenue-Ton-Miles

RVR: Runway Visual Range

RVZ: Runway Visibility Zone

SCI: Service Corporation International

SEL: Sound Exposure Level

SIDA : Security Identification Display Area

SIP: State Implementation Plan

SMGCS: Surface Movement Guidance and Control System

SSCP: Security Screening Checkpoint

SUP: Satellite Utility Plant

TAF: Terminal Area Forecast

TCEQ: Texas Commission on Environmental Quality

TDG: Taxiway Design Group

TDZL: Touchdown Zone Light

TESM: Taxiway Edge Safety Margin

TIRZ: Tax Increment Reinvestment Zone

TODA: Take-Off Distance Available

TORA: Take-Off Run Available

TPWD: Texas Parks and Wildlife Department

TRACON: Terminal Radar Approach Control

TSA: Transportation Security Administration

USO: United Service Organizations

VASI: Visual Approach Slope Indicator

VFR: Visual Flight Rules

VMC: Visual Meteorological Conditions

VOR: Very-High Frequency Omnirange

VORTAC: Very-High Frequency Omnirange with Tactical Air Navigation System

WTMD: Walk-Through Metal Detectors

Appendix B

Stakeholder Workshop Presentation Materials

Hobby Airport Master Plan Update

Worskshop #1

February 27, 2013

William P. Hobby Airport
Ellington Airport

PHOTOS COURTESY OF HOUSTON AIRPORT SYSTEM

Airport Master Plan Updates
Workshop #1

February 27, 2013

Agenda

- Introduction
- Overview and status of the HOU and EFD Master Plan Updates
- William P. Hobby Airport (HOU):
  - Overview and status of Master Plan Update
  - Forecast highlights
  - Preliminary observations of demand/capacity analyses:
    - Airfield capacity
    - Terminal and gate requirements
    - Airfield facilities (including FBOs, tenants and ancillary facilities)
    - On-airport and off-airport parking
    - Access roadways
    - Rental car
  - Current development initiatives
- Ellington Airport (EFD):
  - Overview and status of Master Plan Update
  - Forecast highlights
  - Key planning issues
  - Current projects
- Next steps

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William P. Hobby Airport

MASTER PLAN UPDATE OVERVIEW AND STATUS

R&A Team
Team Member Firms and Role in Master Plan Updates

- M/W/DBE firms:
  - Knudson and Associates, Inc. (WDBE) – GIS, land use planning and development
  - Jacobsen Daniels and Associates (DBE) – Airfield planning support
  - Quadrant Consultants, Inc.(MDBE) – Environmental overview and METRO coordination
  - USA Shelco (MDBE) – MEP and utility infrastructure
  - *Connico, Inc. (WDBE) – Cost estimating
  - *XArc (MDBE) – Spaceport business planning
  - *UrbanCore Collaborative (MDBE) – GIS support
  - *B&E Reprographics, Inc. (MDBE) – Production and reprographics
- Other firms:
  - *RS&H – Spaceport certification and facility planning
- Programmed for 32% MWDBE participation (20% currently committed via purchase orders)

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HOU Master Plan Update

Elements and Status

Phase 1 Tasks (Project 677)	Phase 2 Tasks (Project 688C)	Percent Complete
1. Master plan update oversight (including workshops)		--
2. Data collection and inventory of existing conditions		90 %
3. Aviation activity forecasts		99 %
4. Facility development strategies		
4.1 Airfield		95 %
4.2 Terminal		85 %
4.4 Parking access and design support		95 %
	4.5 Airport access and curbside planning	10 %
	4.6 Other facilities and land use planning	20 %
	5. Master plan update	
	5.1 Airport development plan	0 %
	5.2 Implementation and CIP planning	0 %
	5.3 Overview of environmental issues	0 %
	6. Airport layout drawings (existing and future only)	25 %
	7. Final documentation	0 %

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William P. Hobby Airport

FORECAST HIGHLIGHTS

HOU Annual Airport Activity Forecasts Results

- Baseline forecast for total enplaned passengers:
  - 4.9 million in 2011 (5.3 million in 2012)
  - 6.1 million in 2015
  - 7.4 million in 2020
  - 9.1 million in 2030
- Low-growth and high-growth scenarios were also prepared
- Comparisons with other forecasts:

– HOU Master Plan Update baseline CAGR	3.2 %
• Without new international passengers	2.3 %
– 2011 FAA TAF	1.5 - 1.6 %
– 2012 FAA TAF	2.0 – 2.1 %
– Market share FAA aerospace forecast (2010-2030)	2.4 %

- 2011 – 2012 passenger enplanement increase of 6.0%; operations decrease by 5.7%

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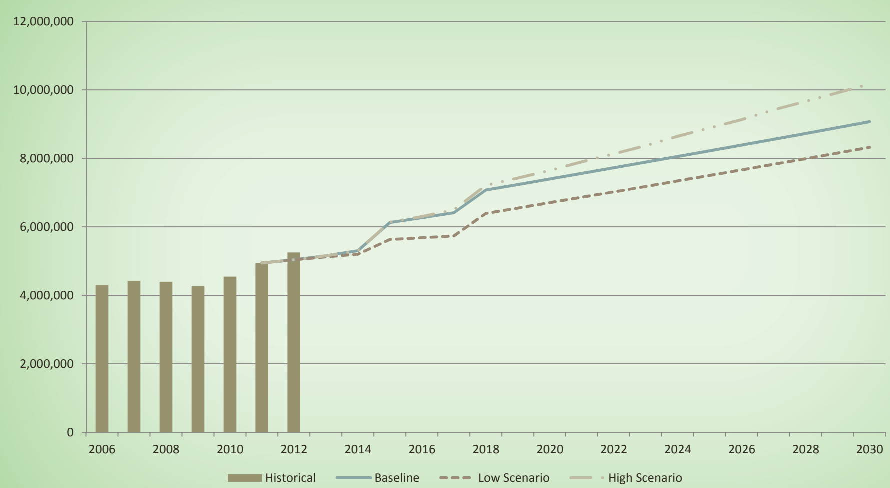
Annual Enplaned Passengers
Comparison of Low-Baseline-High Growth Scenarios



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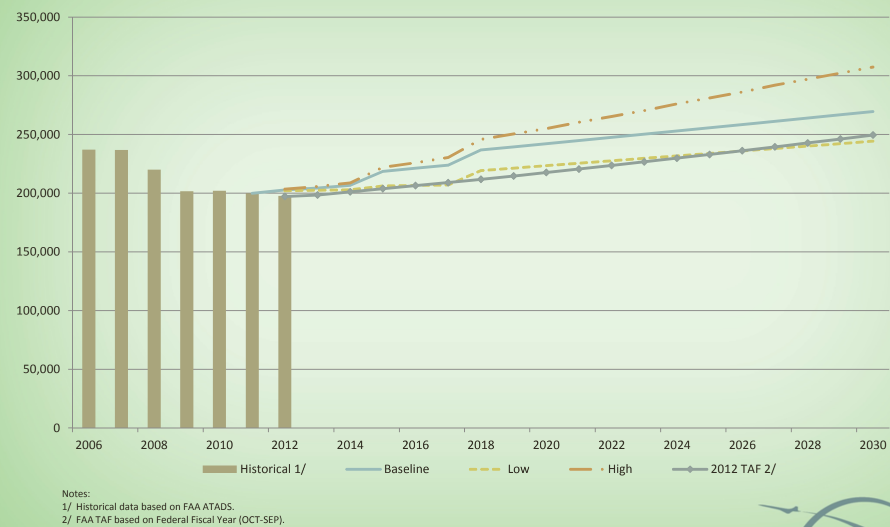
Annual Airport Operations
Comparison of Forecast Scenarios to 2012 FAA TAF



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William P. Hobby Airport

AIRFIELD CAPACITY ANALYSIS HIGHLIGHTS

Previous and Current Airfield Studies

- 2004 Airport Master Plan:
  - Airfield alternatives combined increase in capacity and airfield safety improvements
- 2008 Environmental Impact Statement:
  - No capacity improvements needed in the near future
  - Airfield alternatives focused on safety improvements
- 2013 Airport Master Plan Update:
  - Airfield capacity issues anticipated by 2025 if no action
  - Recommended airfield development plan will call for decommissioning Runway 17-35:
    - Rwy 17-35 is currently a B-II runway due to RSA issues on the south end of the runway. Costly land acquisition and roadway realignments would be required to correct the issue so Rwy 17-35 could accommodate Group III aircraft. (Group III aircraft includes all B-737 aircraft.)
    - The north end of Rwy 17-35 should be relocated to remove the intersection with Rwy 12R-30L for safety reasons. Unless Rwy 17-35 would then be lengthened to the south, it would not be of sufficient length to accommodate commercial operations and many GA operations.
    - Rwy 17-35 provides no significant increase in airfield capacity. It’s primary benefit is that of convenience for west-ramp tenants.

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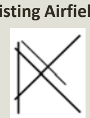
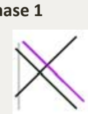
Airfield Capacity Summary

Airfield Configuration		2030 Weighted Hourly Operations	2030 Annual Service Volume
Existing Airfield 		61	255,000
Phase 1 	Runway 12L-30R upgrade; Runway 17-35 closure • Increase capacity • Reduce runway incursion potential • Reduce significance of “iron cross” • Increase GA development potential on west side	65	270,000
Phase 2 	Runway 12L-30R upgrade, Runway 17-35 closure, • New Runway 4R-22L • Increase in airfield capacity	95	395,000

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Airfield Expansion Based on Forecast Scenarios

Year	Annual Forecast Total Operations (Airline + GA)			Annual Service Volume (Airfield Capacity)	Proposed Airfield Layout
	Low Scenario	Baseline	High Scenario		
2012	204,288	204,288 (80% ASV)	204,288	255,000	Existing
2020	223,410	242,120 (90% ASV)	254,990	270,000	Phase 1 Extend and shift, 12L-30R Close 17-35
2030	244,260	269,540	307,420	395,000	Phase 2 Extend and shift, 12L-30R Close 17-35 New 4R-22L

- FAA recommends planning for additional capacity when current activity reaches 60% of ASV.
- FAA recommends constructing additional capacity when current activity reaches 80% of ASV.

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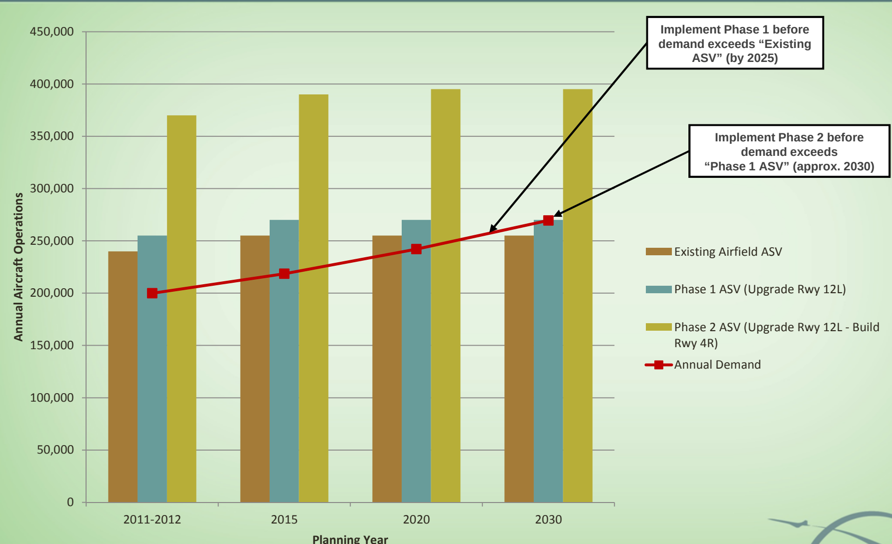
Proposed Airfield Development Timing



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William P. Hobby Airport

TERMINAL GATES REQUIREMENTS

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Gate Requirements Based on Forecast Scenarios

	Annual Enplaned Passengers	Annual Airline Departures	Daily Airline Departures	Required Number of Gates		
				Turns per Gate		
				6.6	7.3	8.0
2011	4,944,576	53,674	164	25	22	21
2012	5,252,139	55,746	161	25	22	21
Low Scenario						
2015	5,634,000	56,815	174	26	24	22
2020	6,706,800	65,420	200	30	27	25
2030	8,324,200	75,845	232	35	32	29
Baseline						
2015	6,129,700	61,805	188	**28**	**26**	**24**
2020	7,399,900	72,130	219	**33**	**30**	**27**
2030	9,070,600	82,555	251	**38**	**34**	**31**
High Scenario						
2015	6,175,000	62,170	187	28	26	23
2020	7,711,500	75,175	230	35	31	29
2030	10,225,300	93,710	287	43	39	36

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Balanced Airfield and Terminal Gates
Based on Expanded Airfield

Airfield Layout	Annual Service Volume	Daily Airport Operations at ASV	Daily Airline Departures at ASV	Turns per Gate		
				6.6	7.3	8.0
				Gates Required		
Existing	255,000	728	237	36	32	30
Phase 1 (2025) Extend and relocate 12L-30R Close 17-35	270,000	771	251	38	34	31
Phase 2 (2030) Extend and relocate 12L-30R Close 17-35 New 4R-22L	395,000	1,128	367	56	50	46

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Proposed Conceptual Terminal Area Buildout

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William P. Hobby Airport

AIRFIELD FACILITIES REQUIREMENTS

Existing Land Uses

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Airside Land Use
Requirements/Issues

- On-Airport Development:
  - Limited room for tenant facilities expansion / new tenants
- Evaluate removal of Runway 12R displaced threshold in short-term
- Upgraded Runway 12L-30R (Phase 1):
  - Proposed Runway 12L would be the main arrival runway: ATC suggested stagger to the north so aircraft departing from Runway 12R do not penetrate the Runway 12L glide slope critical area when taxiing to 12R. The stagger will be evaluated.
- Impacts of new RPZ guidance:
  - Current FAA *Airport Design AC* does not list public roads as permissible inside the RPZ
  - Until RPZ guidance is finalized, any new airfield project resulting in a public road inside the RPZ requires FAA approval
- Land Acquisition:
  - Airport property expansion required to accommodate Phase 1 and Phase 2 layouts
  - Should land be reserved for a potential Runway 4R-22L?

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Runway Protection Zones
Existing

Previous FAA guidance allowed public roads inside the RPZ

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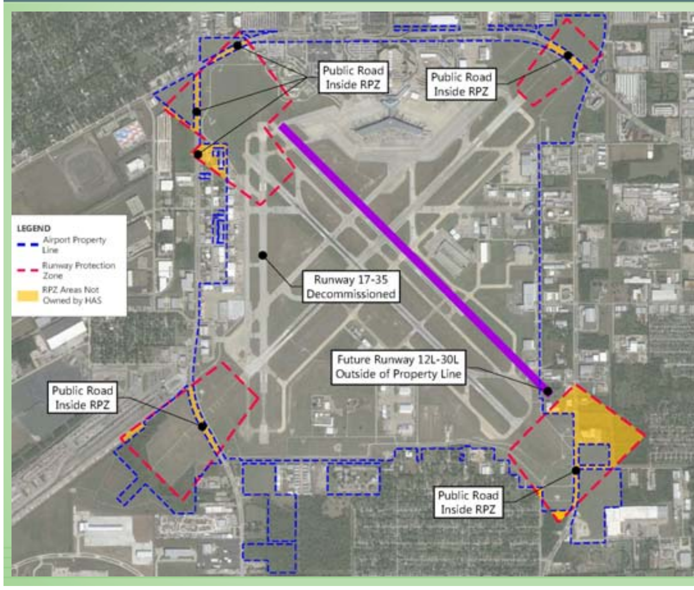
Proposed Runway Protection Zones
Phase 1



New FAA guidance <u>does not allow</u> public roads inside the RPZ

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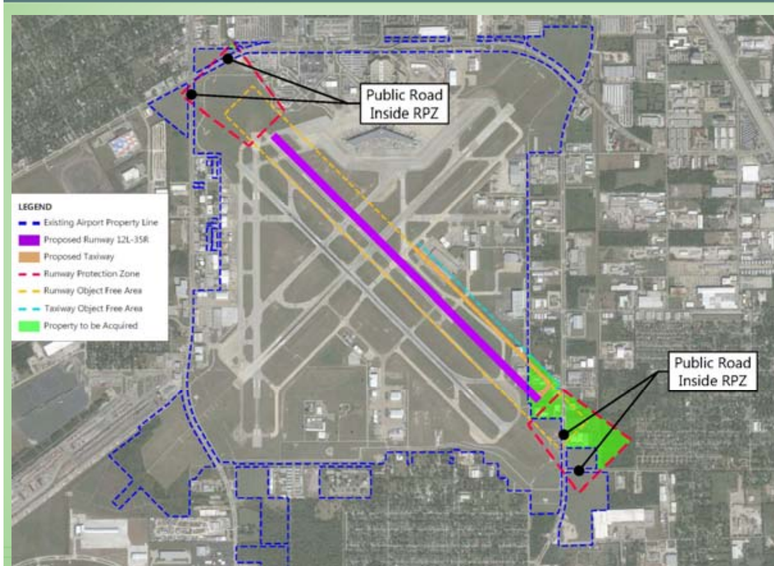
Required Land Acquisition
Phase 1



Land acquisition in southeast corner of the Airport

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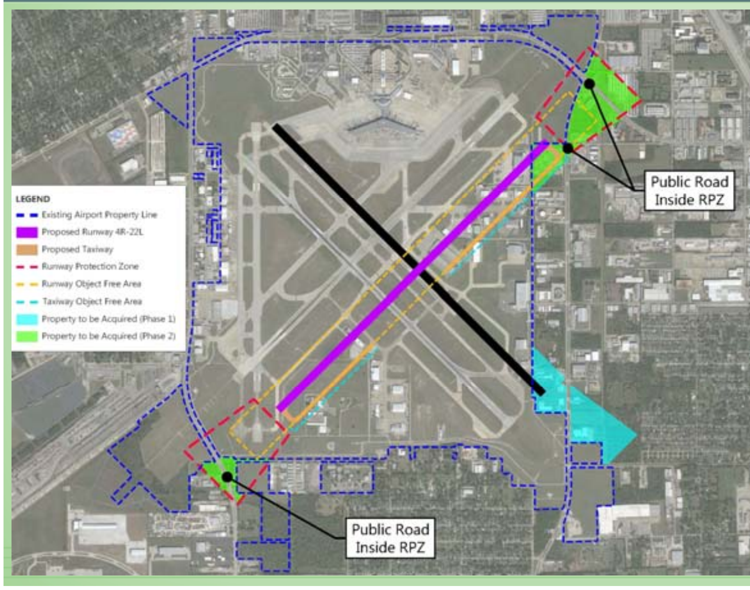
Required Land Acquisition
Phase 2



Land acquisition in southwest, southeast, and northeast corners of the Airport

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Tenant Facilities
Requirements/Issues

- Plans for expansion of Airport maintenance complex
- Aircraft Maintenance:
  - Expansion plans for SWA?
  - Uncertain future of United Airlines Maintenance
- All FBO's are wanting to expand (hangars/terminals/apron/fuel storage, etc):
  - Limited room for growth in existing facilities
  - Some FBOs face space constraints inside/around their leasehold:
    - Expand leasehold where available
    - Create additional property available for expansion?
  - Image and quality of landside access for FBOs on south and west sides
  - Impacts on east side FBO facilities with Runway 12L-30R upgrade
- Suspension of fuel farm supply via pipeline 2/28/2013
- Houston Police Department Air Support facility improvement/expansion

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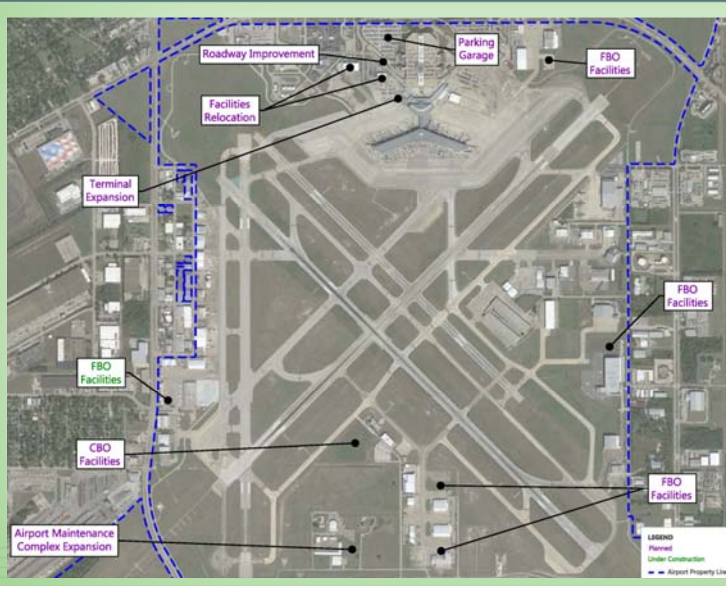
Current Projects Status



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William P. Hobby Airport

AUTOMOBILE PARKING REQUIREMENTS

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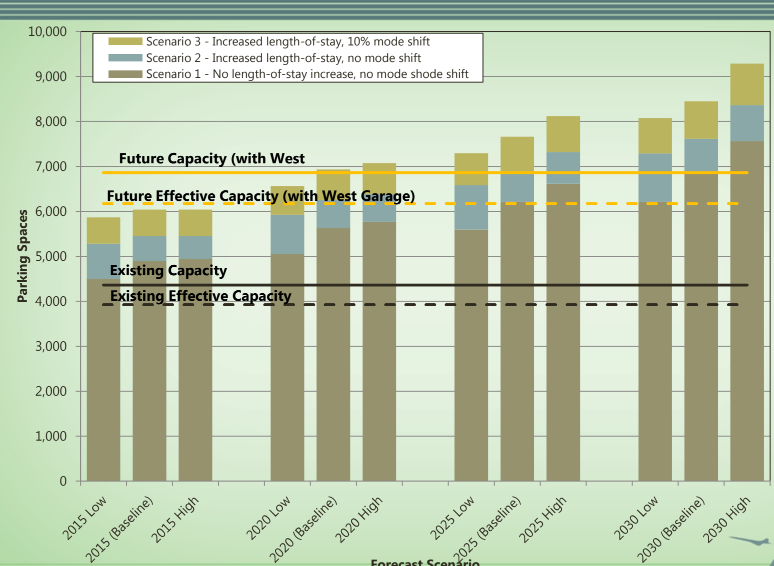
Parking Requirements

- On-airport parking is at capacity; Off-airport parking can reach capacity
  - On-Airport Spaces (existing) = 4,360
    - 3,438 in garage; 566 in Ecopark 1; 356 in Ecopark 2
  - Off-Airport Spaces (existing) = 5,700

	2030 PARKING REQUIREMENT (NET NEW SPACES)		
Forecast Description	Scenario 1 No length-of-stay increase No mode shift	Scenario 2 Increased length-of-stay No mode shift	Scenario 3 Increased length-of-stay 10% mode shift
Low Growth Forecast	1,853	2,485	3,203
Baseline Forecast	2,926	3,253	4,004
High Growth Forecast	3,715	4,085	4,924

- Proposed West Garage Planned for approximately 3,100 spaces (2,500 net new)

Parking Capacity and Requirements



William P. Hobby Airport

RENTAL CAR REQUIREMENTS

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Preliminary Space Program Methodology

- Requirements were developed using Airport-specific 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.
- Planning hour activity was defined as the highest 5-hour average number of rentals and returns
- Standard industry planning factors were used to define other facility requirements (which can be adjusted as appropriate)
- 2012, 2015, 2020, 2030 planning horizon demand was based on growth in originating passengers

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Questionnaire Results

COMPONENT	HAVE (2012)	NEED (2012)	2015	2020	2030
Customer Service Area					
Regular Customer Service Positions	50	52	55	59	63
Kiosk Positions	0	2	4	4	4
Administrative Area - In terminal	0	1,600	1,800	1,800	1,800
Administrative Area - Service Facility	9,200	11,600	12,600	12,600	12,600
Ready/Return Area					
Regular Ready Spaces	427	580	640	810	955
Premium Ready Spaces	361	490	500	525	550
Total Ready	**788**	**1,070**	**1,140**	**1,335**	**1,505**
Return Spaces	270	660	755	920	965
Total Ready/Return	**1,058**	**1,730**	**1,895**	**2,255**	**2,470**
Service Area					
Vehicle fueling positions (nozzles)	22	36	42	48	50
Car wash bays	7	11	11	13	13
Vehicle light maintenance bays	9	17	17	19	19
Overflow vehicle storage spaces	1,090	1,400	1,500	1,600	1,750
Employee Parking Spaces	182	262	272	282	292

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Customer Service Area Counter Analysis

- Utilization rate: number of customers that can be processed per hour, per counter
  - 10 minutes per transaction or 6 transactions per hour per position
- Existing 2012 requirements calculation:
  - 62% of transactions were processed at a counter = 140 counter transactions
  - 140/6 = 23 positions + 30% surge factor = 30 positions

Component	EXISTING 2012	2015	2020	2030
Counter Facility Requirements	30	33	37	45
Existing Customer Service Counters	50	50	50	50
Surplus/(Deficiency)	20	17	13	5

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Ready/Return Space Analysis

- Utilization rate: hours of available parking capacity
  - Rental vehicle spaces = 2.5 hours of capacity X peak hour rentals
  - Return vehicle spaces = 2.0 hours of capacity X peak hour returns
- Existing 2012 requirements calculation:
  - 226 peak hour rentals X 2.5 hours of capacity = (x1.0) 565 effective spaces
  - 122 peak hour returns X 2.0 hours of capacity = (x0.7) 171 effective spaces

Component	EXISTING 2012	2015	2020	2030
Effective Ready Spaces	565	610	686	839
Effective Return Spaces	171	185	208	254
Total	736	795	894	1,093
Existing Ready/Return Spaces	1,058	1,058	1,058	1,058
Surplus/(Deficiency)	322	263	164	(35)

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Vehicle Storage Space Analysis

- Utilization rate: total peak rental day deficit minus total ready/return requirement
- Existing 2012 requirements calculation:
  - 1,136 peak day vehicle deficit – ready/return requirement 736 (x0.6) = 240 effective spaces
  - Storage could also be accommodated in surplus ready/return spaces

Component	EXISTING 2012	2015	2020	2030
Vehicle Storage Space Requirements	240	260	292	357
Existing Vehicle Storage Spaces	1,090	1,090	1,090	1,090
Surplus/(Deficiency)	850	830	798	733

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Fueling Position Analysis

- Utilization rate: number of vehicles that can be processed per hour, per position = 5
- Existing 2012 requirements calculation:
  - 122 peak hour returns / 5 vehicles processed per hour, per position = 24 positions

Component	EXISTING 2012	2015	2020	2030
Fueling Positions Requirements	24	26	30	36
Existing Fueling Positions	22	22	22	22
Surplus/(Deficiency)	(2)	(4)	(8)	(14)

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Wash Bay Analysis

- Utilization rate: number of vehicles that can be processed per hour, per bay = 30
- Existing 2012 requirements calculation:
  - 122 peak hour returns / 30 vehicles processed per hour, per bay = 24 bays

Component	Existing 2012	2016	2021	2031
Wash Bay Requirements	4	4	5	6
Existing Wash Bays	7	7	7	7
Surplus/(Deficiency)	3	3	2	1

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Vehicle Stacking/Staging Space Analysis

- Utilization rate: number of stacking/staging spaces per fuel nozzle required = 6
- Existing 2012 requirements calculation:
  - 24 positions X 6 stacking/staging spaces = 144 spaces

Component	Existing 2012	2015	2020	2030
Stacking/Staging Spaces Requirements	144	156	180	216
Existing Stacking/Staging Spaces	175	175	175	175
Surplus/(Deficiency)	31	19	(5)	(41)

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Vehicle Light Maintenance Bay and Employee Requirements

- Utilization rate: Existing quantity
  - Quantities grown based on planning forecast

Component	Existing 2012	2015	2020	2030
Light Maintenance Bays	9	10	11	13
Administrative Area (square feet)	9,200	9,945	11,187	13,671
Employee parking spaces	182	197	221	270

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Requirement Summary
Surplus/(Deficiency)

Component	Existing 2012	2015	2020	2030
Regular Customer Service Positions	20	17	13	5
Ready/Return and Onsite Vehicle Storage Area				
Total Ready/Return Spaces	322	263	164	(35)
Storage Spaces	850	830	798	733
Quick Turnaround Area				
Fueling Positions	(2)	(4)	(8)	(14)
Wash Bays	3	3	2	1
Stacking/Staging Spaces	30	19	(5)	(41)

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Requirement Summary
Total Area Required

	2012 SPACE PROGRAM			2015 SPACE PROGRAM			2020 SPACE PROGRAM			2030 SPACE PROGRAM		
	Quantity	SF	Total SF	Quantity	SF	Total SF	Quantity	SF	Total SF	Quantity	SF	Total SF
Customer Service Areas												
Counter Positions	30	300	9,100	33	300	9,800	37	300	11,000	45	300	13,500
Circulation	25%		2,300	25%		2,500	25%		2,800	25%		3,400
Subtotal			**11,400**			**12,300**			**13,800**			**16,900**
Ready/Return/Storage Areas												
Ready Spaces	565	300	169,400	610	300	183,100	686	300	205,900	839	300	251,700
Return Spaces	171	200	34,200	185	200	36,900	208	200	41,500	254	200	50,800
Storage Spaces	240	170	40,900	260	170	44,200	292	170	49,700	357	170	60,700
Total Spaces	976			1,055			1,186			1,450		
Exit Booths	8	20	200	8	20	200	9	20	200	11	20	200
Circulation	20%		48,900	20%		52,900	20%		59,500	20%		72,700
Subtotal			**293,600**			**317,300**			**356,800**			**436,100**
QTA/Service Site												
Fueling Positions	24	300	7,300	26	300	7,900	30	300	8,900	36	300	10,900
Wash Bays	4	2,000	8,100	4	2,000	8,800	5	2,000	9,900	6	2,000	12,100
Stacking and Staging Spaces	144	200	28,800	156	200	31,200	180	200	36,000	216	200	43,200
Maintenance Bays	9	810	7,300	10	810	7,900	11	810	8,900	13	810	10,800
Administrative Area	9,200		9,200	9,945		9,945	11,187		11,187	13,671		13,671
Employee Parking	182	250	45,500	197	250	49,200	221	250	55,300	270	250	67,600
Circulation	20%		21,200	20%		23,000	20%		26,000	20%		31,700
Subtotal			**127,400**			**137,945**			**156,187**			**189,971**
Small Market Entrant			8,600	2% of total area		9,400	2% of total area		10,500	2% of total area		12,900
Total Facility			441,000			476,900			537,300			655,900
Landscaping/circulation (15% of total facility area)			66,200			71,500			80,600			98,400
TOTAL REQUIREMENT - SQUARE FEET			**507,200**			**548,400**			**617,900**			**754,300**
TOTAL REQUIREMENT - ACRES			**12**			**13**			**14**			**17**

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William P. Hobby Airport

LANDSIDE ACCESS REQUIREMENTS

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Roadways/Landside Access
Requirements / Issues

- Primary access routes are currently being evaluated to assess the existing and future Levels of Service (LOS)
  - Broadway St, Telephone Rd, Airport Blvd, Monroe Rd
- Intersection LOS is currently being evaluated, leading to long-term recommendations
  - Telephone/Airport, Airport/Broadway, Airport/Monroe
- Curbside LOS is currently being evaluated (via simulation), under current conditions as well as with the international facility and new parking garage

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Hobby Airport Master Plan Update

Airfield Worskshop

April 29, 2013

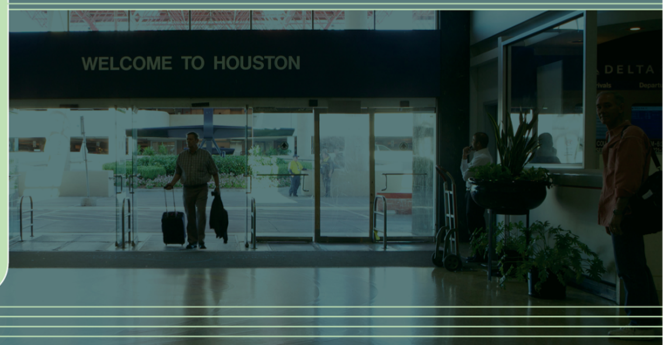
Airfield Planning Workshop

Discussion Materials

April 29, 2013

William P. Hobby Airport

PHOTOS COURTESY OF HOUSTON AIRPORT SYSTEM



Introduction & Overview

- Workshop Objective: Discuss/document key planning considerations for implementing the Master Plan's recommended airfield development option:
  - Operational Assumptions
    - Runway Use
    - Declared Distances
  - Off-airport Impacts
    - Airspace Constraints
    - FAA Airfield Design Standards
  - On-airport Impacts
    - NAVAID Siting

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Agenda

- Introduction/Overview
- HOU Master Plan – Airfield Analyses Review
- Master Plan Recommended Airfield Alternative
- Prior HOU Airfield Development Initiatives
- Runway 12L-30R Redevelopment: Planning Considerations
- Meeting Adjourned

3

HOU Master Plan
Airfield Analyses Review

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HOU Master Plan: Airfield Facility Requirements

- Airfield Capacity Needs (2030 projected)
  - 270,000 Annual Operations
  - 61 Hourly Operations
- Runway Length Requirements (B737-800)
  - Landing Distance = 6,600 feet
  - Take-off Distance = 7,600 feet
- Airport Design Standards
  - Design Aircraft B757-300 & B737-800/900
  - Airport Reference Code D-IV (B757 specific)
- Instrument Landing System on Primary Landing Runways

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HOU Master Plan: Proposed Airfield Modifications

- Phase 1:
  - Shift/extend Runway 12L-30R
  - Decommission Runway 17-35
- Phase 2:
  - Construct new Runway 4R-22L

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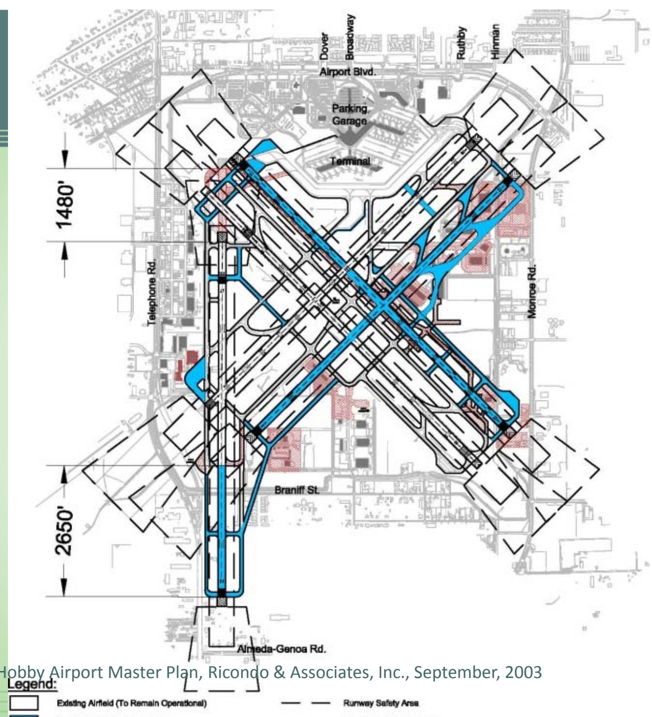
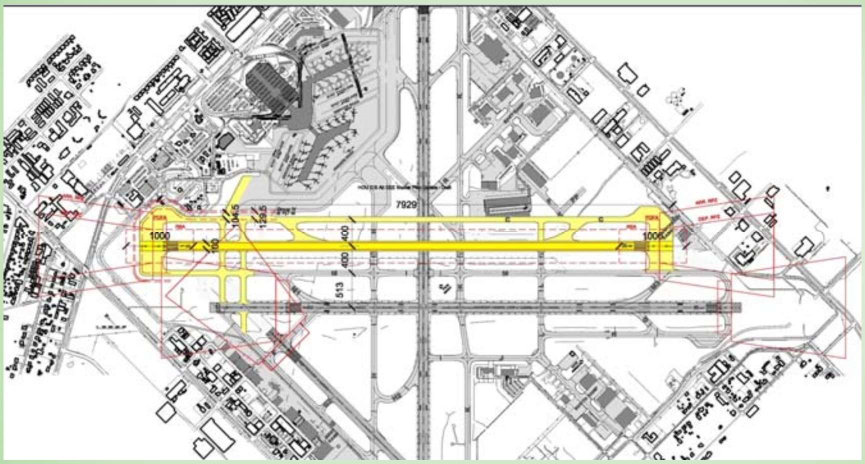
Prior HOU Airfield Development Initiatives



Source: Hobby Airport Master Plan, Ricondo & Associates, Inc., September, 2003

2008 Environmental Impact Statement



Source: Environmental Impact Statement, Phase 1, Jacobs Consultancy, February, 2008.

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HOU Master Plan
Runway 12L-30R Placement Options

Option 1 – Non-staggered Runway Ends

Option 2 – Staggered Runway Ends

Source: Hobby Airport Master Plan, Ricondo & Associates, Inc., April, 2013

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Runway 12L-30R Redevelopment: Planning Considerations

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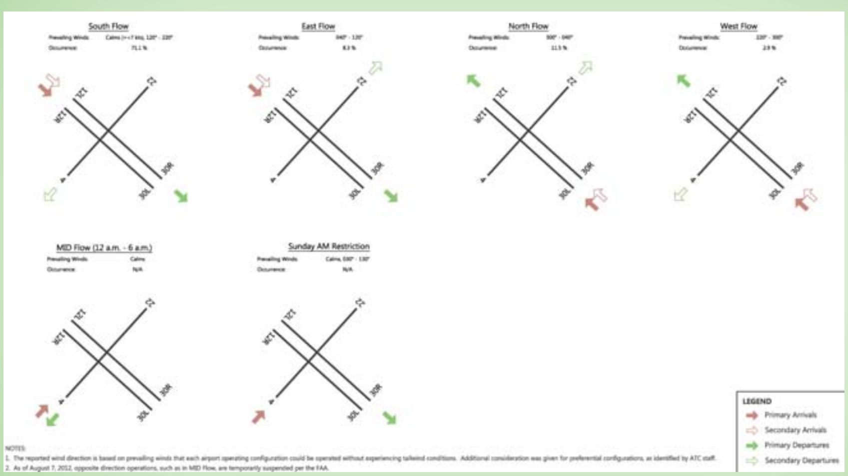
Phase 1 Runway Use Configurations
Visual Meteorological Conditions



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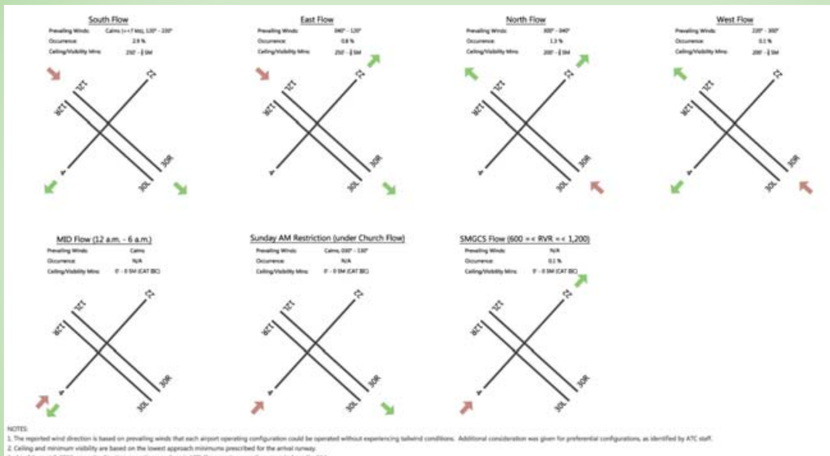
Phase 1 Airfield Configurations
IMC



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Threshold Siting Considerations: Runway 12L-30R Upgrade

- Airfield Capacity Implications
- Off-Airport Impacts:
  - Airspace/Obstruction
  - RPZ Impacts
  - Environmental Impacts (Noise)
- NAVAID Siting Constraints
- Aircraft Taxi Routes

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Staggered Runway Capacity Impacts

- Staggered Runways = Airfield Capacity Reduction
  - Additional time to cross intersection with Runway 4-22
    - South & East Flow (> 80% occurrence)
  - After Phase 2 is implemented:
    - Difficult to synchronize arrivals and departures
    - Approximate reduction of 30 operations/hour (During South & East Flow)

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Off-Airport Impacts - Airspace

- TERPS
  - FAA Order 8260.3B
  - FAA Order 8260.54A (RNAV)
- CFR Part 77
- Threshold Siting Surface (TSS)
  - FAA Advisory Circular 150/5300-13A, *Airport Design*
- One-engine Inoperative (OEI) surface

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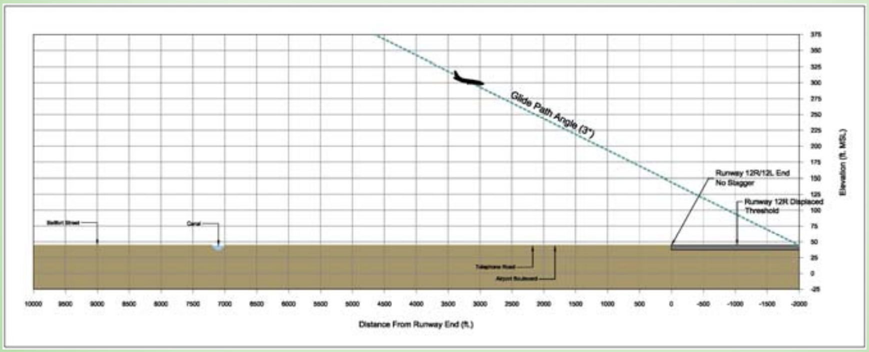
Current Airspace Constraints: Runway 12R



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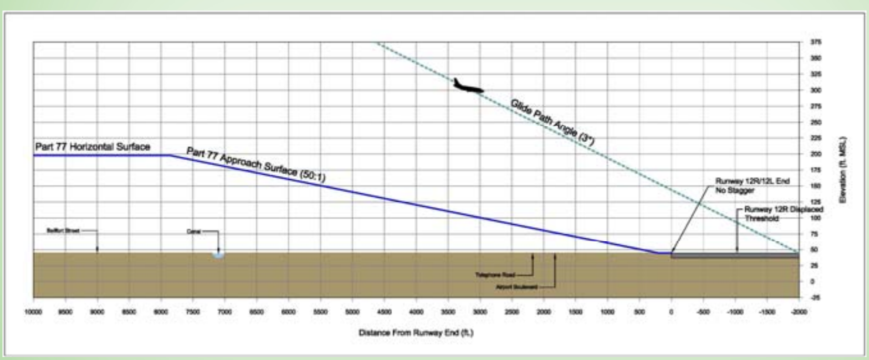
Current Airspace Constraints: Runway 12R



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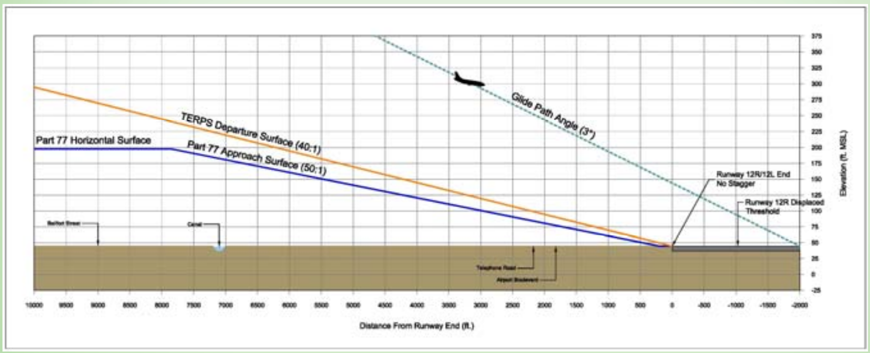
Current Airspace Constraints: Runway 12R



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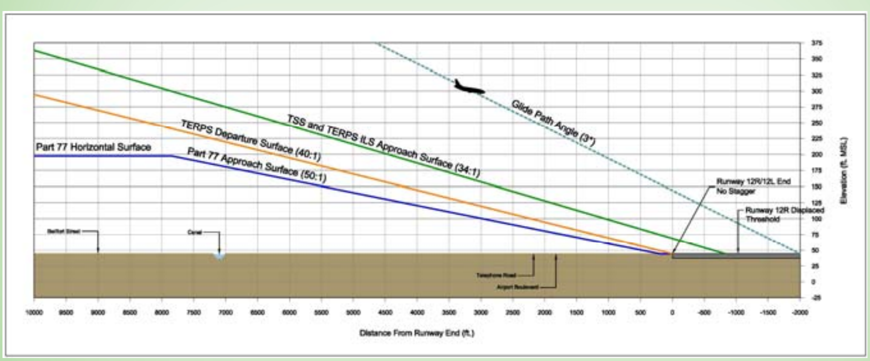
Current Airspace Constraints: Runway 12R



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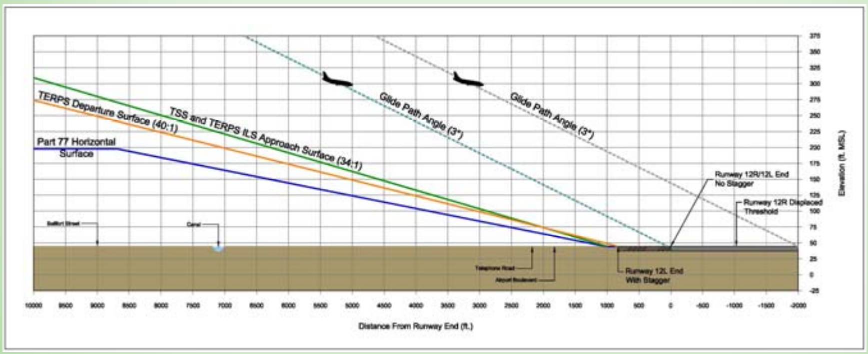
Off-Airport Airspace Impacts: Staggered Runway Ends



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Off-Airport Impacts: Runway Protection Zones (RPZ)

- FAA Advisory Circular 150/5300-13A states:
  - "it is desirable to clear all objects from the RPZ"
  - "Airport control over RPZ is preferably exercised through acquisition of sufficient property interests and clearing RPZ areas of incompatible objects and activities"
  - HAS currently owns most property within the existing RPZs at Hobby

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Off-Airport Impacts - RPZ

- Land uses within the RPZ that considered non-compatible and therefore, would require coordination with APP-400 include:
  - Buildings and structures
  - Transportation facilities (including roads, railways, etc.)
  - Fuel storage facilities
  - Hazardous material storage
  - Wastewater treatment facilities
  - Above ground utility infrastructure
  - Recreational land uses

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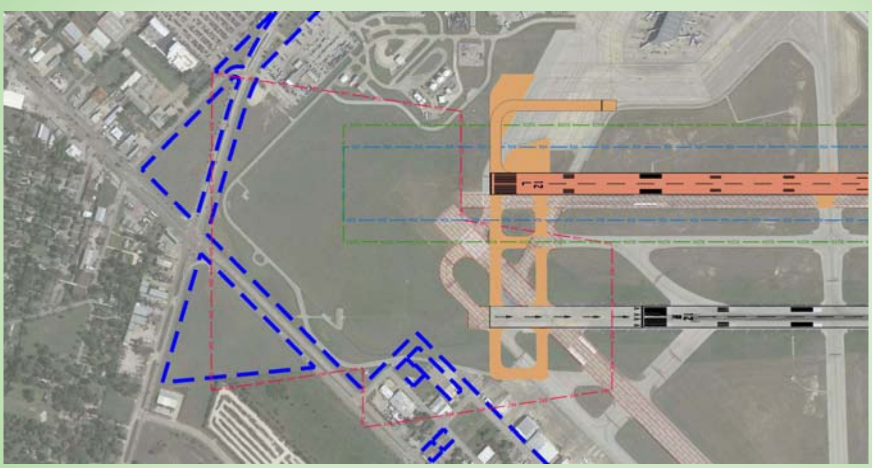
Off-Airport Impacts
Non-staggered Runway 12L RPZ



Source: Hobby Airport Master Plan, Ricondo & Associates, Inc., April, 2013

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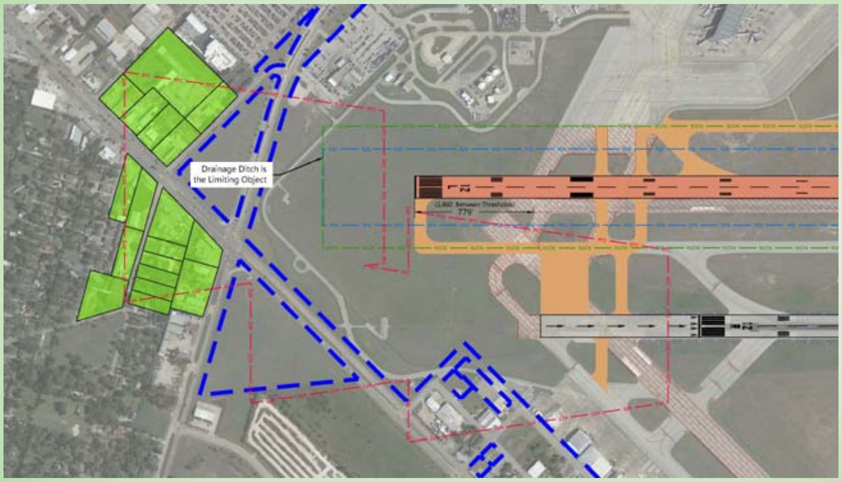
Off-Airport Impacts
Staggered Runway 12L RPZ



Source: Hobby Airport Master Plan, Ricondo & Associates, Inc., April, 2013

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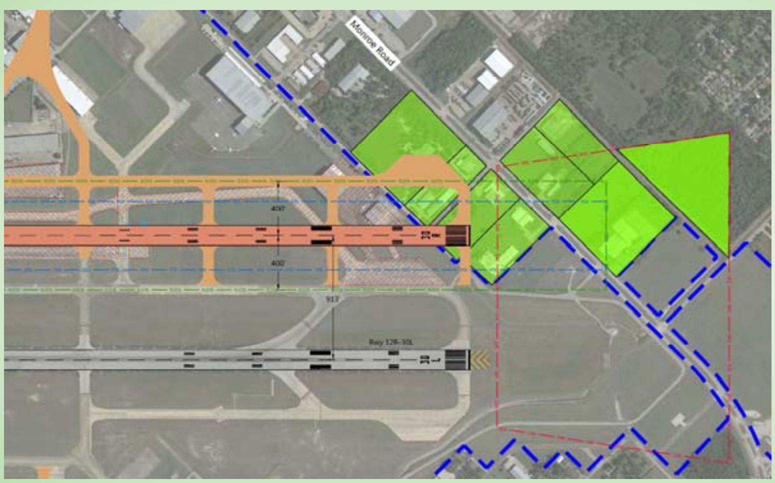
Off-Airport Impacts
Non-staggered Runway 30R RPZ



Source: Hobby Airport Master Plan, Ricondo & Associates, Inc., April, 2013

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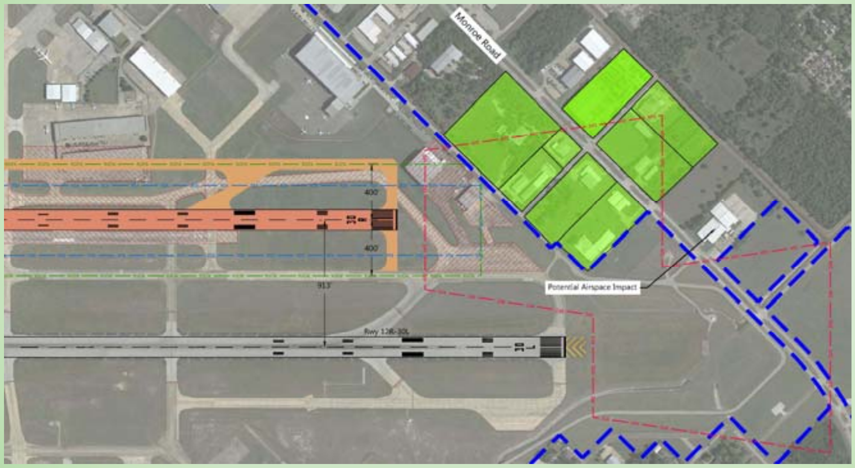
Off-Airport Impacts
Staggered Runway 30R RPZ



Source: Hobby Airport Master Plan, Ricondo & Associates, Inc., April, 2013

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Off-Airport Impacts
Runway 12L-30R RPZs

Option 1 – Non-staggered Runway Ends

Option 2 – Staggered Runway Ends

Source: Hobby Airport Master Plan, Ricondo & Associates, Inc., April, 2013

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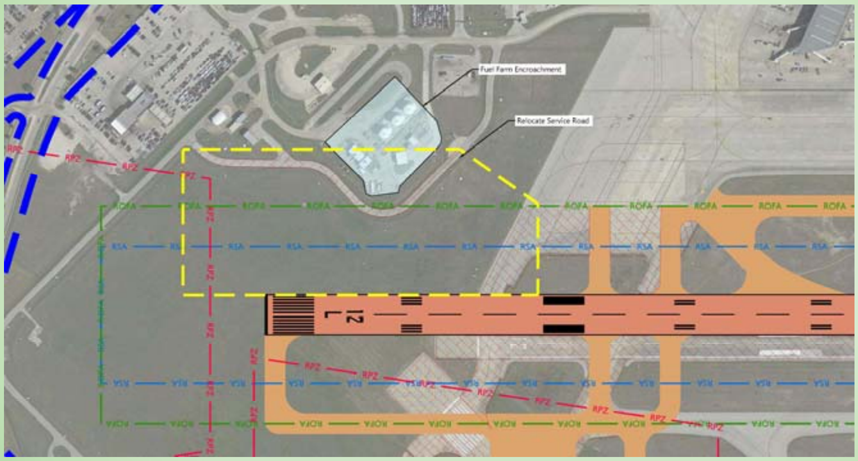
NAVAIDs Siting Implications: Staggered Runway 12L Glide Slope



Source: Hobby Airport Master Plan, Ricondo & Associates, Inc., April, 2013

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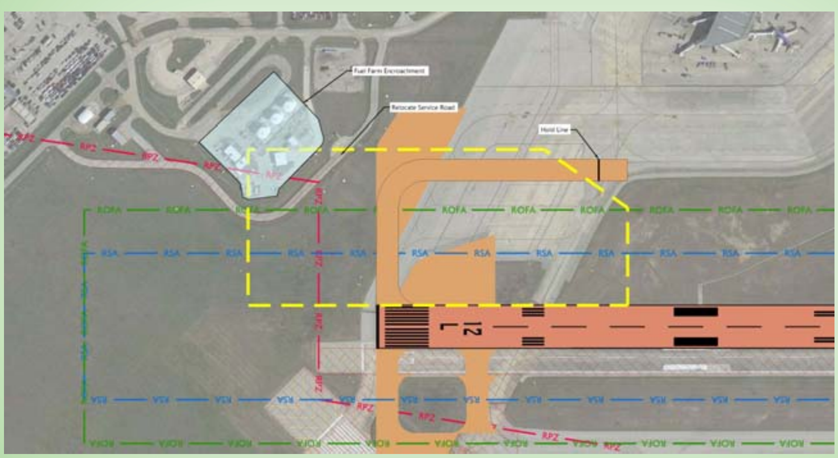
NAVAIDs Siting Implications: Non-staggered Runway 12L Glide Slope



Source: Hobby Airport Master Plan, Ricondo & Associates, Inc., April, 2013

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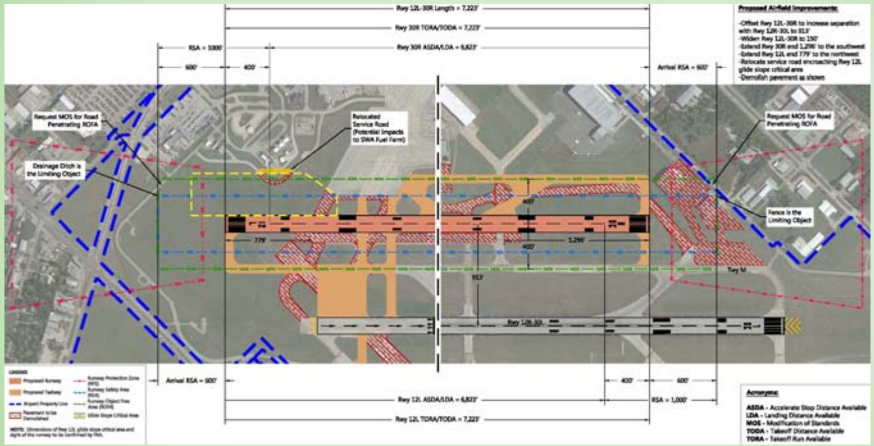
Runway 12L-30R Declared Distances: Option 2 – Staggered Runways



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Other Planning Considerations

- Runway Incursions:
  - Avoid wide expanses of pavement
  - Limit Runway crossings
  - Avoid runway/taxiway intersections within the middle third of the runway
  - Runway exit taxiway geometry
  - Avoid direct access from aprons and runway exits associated with closely spaced parallel runway
- Aircraft Holding bays
- Taxiway Geometric Constraints
- Environmental Constraints:
  - Aircraft noise
- Implementation (operations during construction)

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Hobby Airport Master Plan Update

Worskshop #2

July 16, 2013

William P. Hobby Airport
Ellington Airport

PHOTOS COURTESY OF HOUSTON AIRPORT SYSTEM

Airport Master Plan Updates
Workshop #2

July 17, 2013

Workshop #2
Agenda

- William P. Hobby Airport
  - Recap of Aviation Activity Forecast
  - Demand/Capacity, Requirements, and Alternatives
    - Airside
    - Terminal
    - Landside
    - Support Facilities and General Aviation
    - Off-Airport Land Use and Development
- Ellington Airport
  - Spaceport Economic and Business Plan Update
  - Master Plan Considerations
  - Off-Airport Land Use and Development
- Current Status of Master Plan Updates and Next Steps

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William P. Hobby Airport

RECAP OF AVIATION ACTIVITY FORECAST

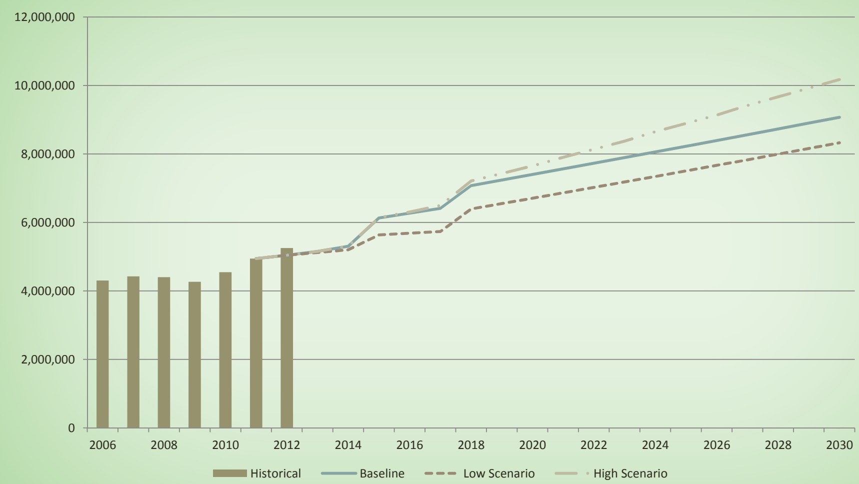
Aviation Activity Forecast Summary

	2012	2015	2020	2030
ENPLANED PASSENGERS				
Domestic Passengers	5,252,139	5,639,300	6,480,500	7,956,900
International Passengers	-	490,400	919,400	1,113,700
TOTAL ENPLANED	**5,252,139**	**6,129,700**	**7,399,900**	**9,070,600**
AIRCRAFT OPERATIONS				
Domestic Airlines	111,492	120,690	137,690	158,540
Foreign Flag Airlines	-	2,920	6,570	6,570
General Aviation/Other	92,796	94,950	97,860	104,430
TOTAL OPERATIONS	**204,288**	**218,560**	**242,120**	**269,540**

- Aviation Activity Forecasts have been approved by the FAA

Recap of Aviation Activity Forecast

Annual Enplaned Passengers



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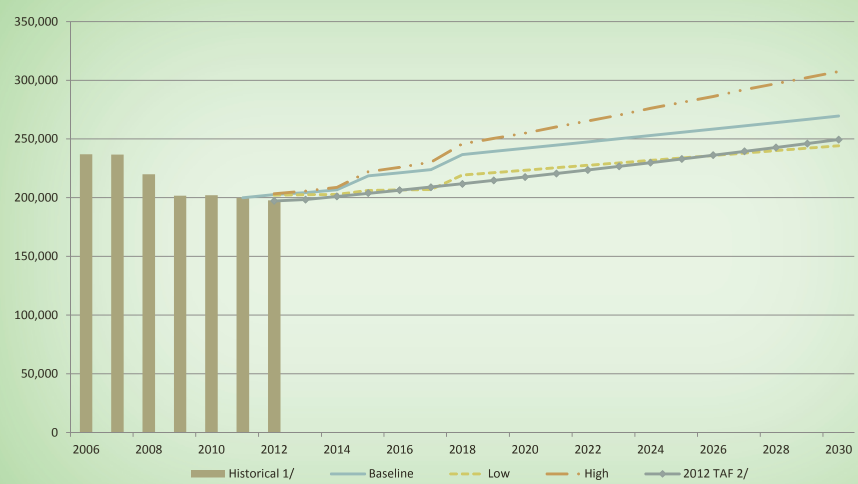
Recap of Aviation Activity Forecast

Annual Airport Operations



Notes:
1/ Historical data based on FAA ATADS.
2/ FAA TAF based on Federal Fiscal Year (OCT-SEP).

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William P. Hobby Airport

DEMAND/CAPACITY, REQUIREMENTS, AND ALTERNATIVES

Airside Terminal Landside FBO/Tenant

William P. Hobby Airport

Demand/Capacity, Requirements, and Alternatives - Airside

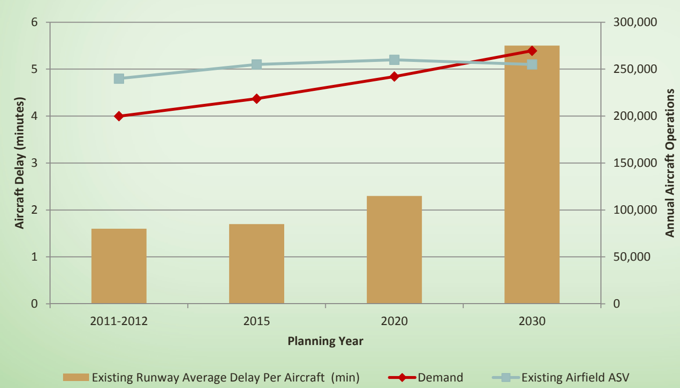
Airfield Demand/Capacity/Delay Analysis Metrics

- Peak Hour Capacity calculations take into account:
  - Specific runway use configurations
  - Occurrence and operational impacts of Visual Meteorological Conditions (VMC) and Instrument Meteorological Conditions (IMC)
- Annual Service Volume (ASV) is a capacity metric which provides an “overall” quantification of the capacity of the airfield:
  - Adjusted to account for daily and seasonal variations, fleet mix, and other
  - Predicated on hourly capacities for each runway use configuration
- Average Annual Aircraft Delay is an estimate of average delay per aircraft.
  - Average delay per aircraft operation increases exponentially as demand approaches the ASV.

Demand/Capacity/Delay Relationships for Current Airfield Configuration

Typically, planning for a new runway will begin when runway capacity reaches between 60 and 75 percent of the ASV.

- As of 2011, the HOU runway system had reached approximately 80% of its capacity.
- Planning to implementation of a new runway can take up to 10 years.



Demand/Capacity, Requirements, and Alternatives - Airside

Airfield Facility Requirements

- Airfield Annual Service Volume:
  - Existing airfield ASV is approximately 250,000 operations (61 operations weighted hourly capacity)
  - 2030 airfield layout yields approximately 270,000 operations (65 operations weighted hourly capacity)
- Baseline forecast of aircraft operations (2030):
  - 270,000 annual operations
  - 65 hourly operations
- Additional airfield capacity will be needed in the long-term to accommodate demand without incurring significant aircraft delays.

- Runway Length Requirements for B737-800:
  - Landing Distance = 6,600 feet
  - Take-off Distance = 7,600 feet (current length of Runway 12R-30L is 7,602 feet)

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Demand/Capacity, Requirements, and Alternatives - Airside

Phase 1 Airfield Improvements

- Major Improvements:
  - Shift/extend Runway 12L-30R
    - Parallel taxiway
  - Decommission Runway 17-35

- Additional Analyses Required:
  - Assess runway stagger
  - Obstruction analysis
  - Finalize land acquisition requirements
  - Siting of navigational aids
  - Taxiway fillet evaluation

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Demand/Capacity, Requirements, and Alternatives - Airside

Land Acquisition Considerations
Runway 12L-30R RPZs

Option 1 – Non-staggered Runway Ends

Option 2 – Staggered Runway Ends

Source: Hobby Airport Master Plan, Ricondo & Associates, Inc., April, 2013

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William P. Hobby Airport

Demand/Capacity, Requirements, and Alternatives - Terminal

Validation of Gate Requirements

- Design Day Flight Schedules were used to further assess future gate requirements
  - Minimum of 20 minutes between a departure and an arrival
  - Central Concourse used only for domestic flights; West Concourse used for international or domestic flights
  - Aircraft towed out 30 minutes after arrival time; towed in 45 minutes before departure time
  - Airline has exclusive use if more than 5 flights on the gate

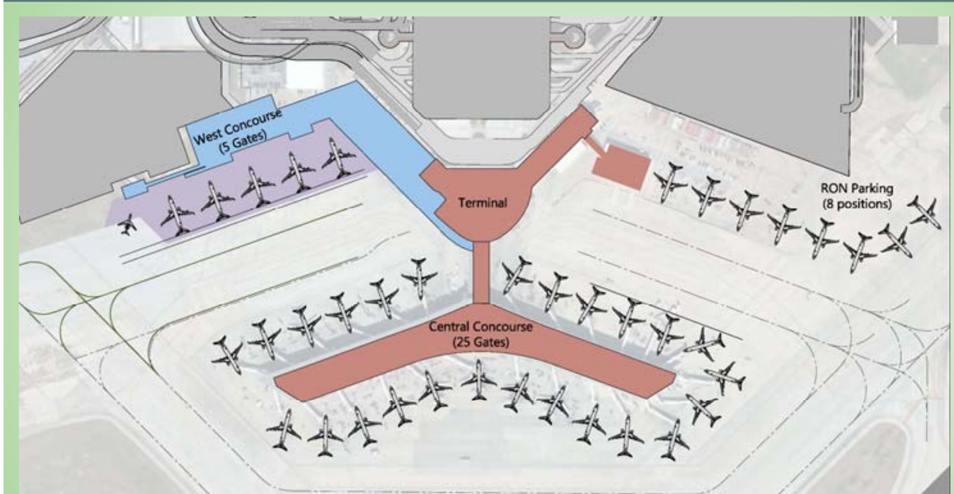
	SCHEDULE	GATE REQUIREMENTS			
Year	Number of Daily Flights	International gates required	Total gates required	Number of RON or maintenance positions needed	Average turns per gate (all airlines)
2011 (with 5 remote positions)	164	0	20	5	6.7
2011 (with no remote position)	164	0	25	0	5.8
2015	188	5	30	7	6.2
2020	219	10	37	7	5.9
2030	251	12	37	10	6.8

Terminal Requirements (Preliminary)

	Existing (No FIS)	2015 6.1 MAP	2030 9.0 MAP
Airline	**254,000**	**290,800**	**362,400**
Check-In	*13,900*	*8,600*	*13,300*
Baggage Handling	*91,200*	*94,300*	*114,200*
Boarding Areas	*66,000*	*86,600*	*106,800*
Airline Support	*83,300*	*101,300*	*128,200*
Transportation Security Administration (TSA)	**30,000**	**44,800**	**49,400**
Passenger Checkpoint	*12,500*	*27,300*	*31,900*
Baggage Screening	*17,500*	*17,500*	*17,500*
Customs and Border Protection (CBP)		**84,300**	**84,300**
Retail. Food & Beverage , Specialties	**46,500**	**57,930**	**85,500**
Ground Transportation	**1,300**	**1,300**	**1,300**
Houston Airport System	**49,500**	**51,000**	**86,200**
Circulation	**141,500**	**167,200**	**222,000**
Non-Secure	*82,700*	*97,800*	*129,800*
Secure	*58,800*	*69,500*	*92,200*
Restrooms	**16,700**	**24,700**	**40,000**
Building Systems	**54,400**	**64,200**	**85,200**
TOTAL PROGRAM (GROSS AREA)	**621,000**	**725,000**	**963,000**

Demand/Capacity, Requirements, and Alternatives - Terminal

Phase 1 Expansion (2015)



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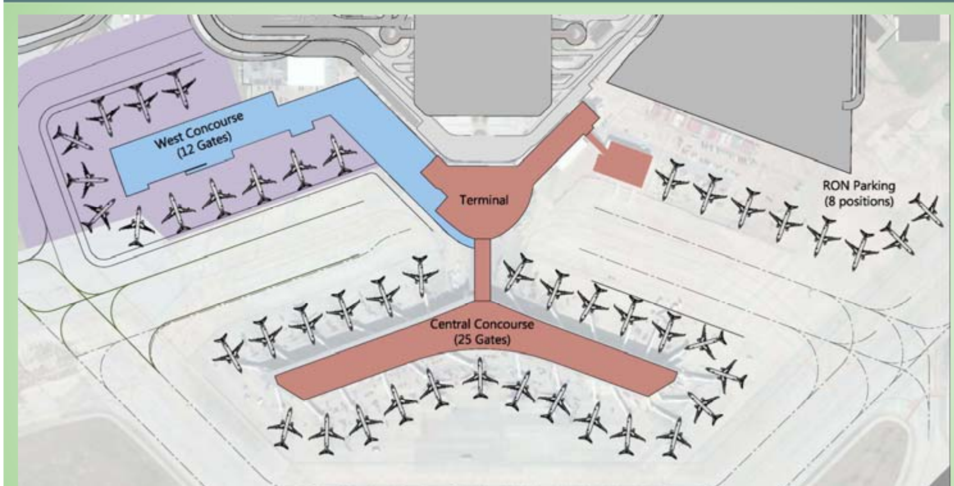
Demand/Capacity, Requirements, and Alternatives - Terminal

Phase 2 Expansion



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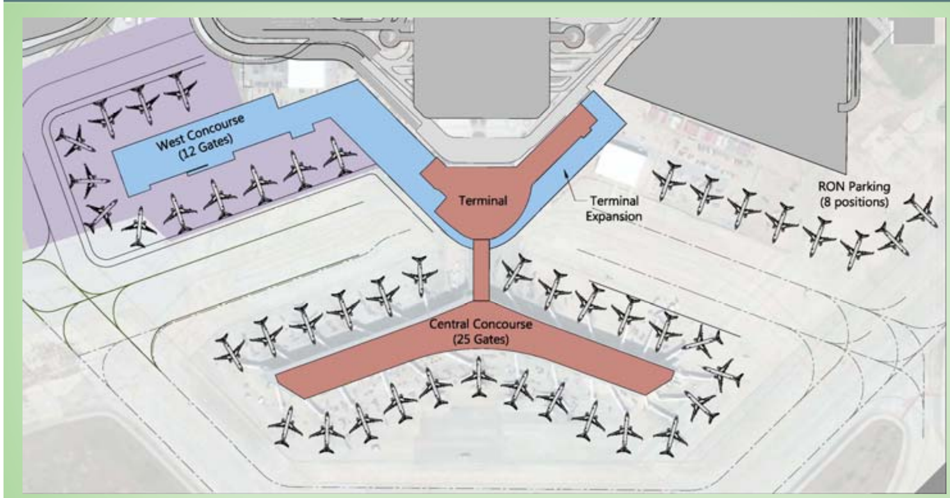
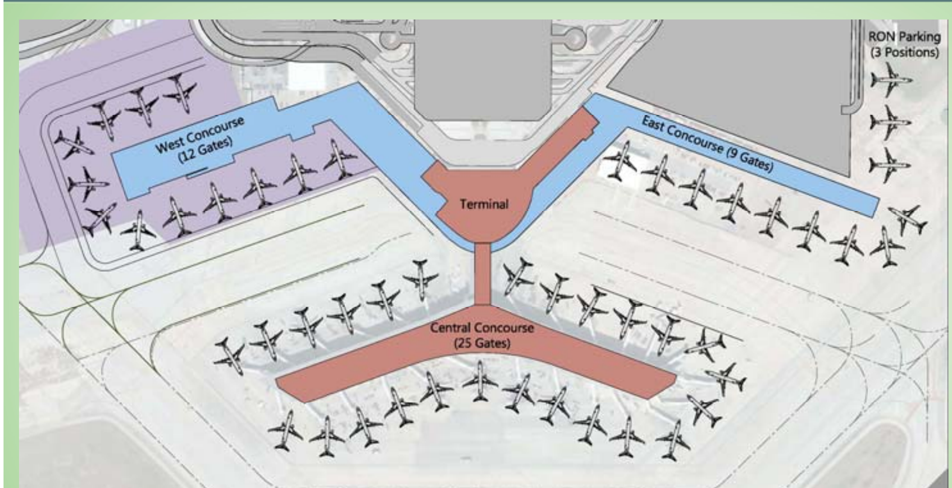
Phase 3 Expansion (RON Alternative)



Phase 3 Expansion (Concourse Alternative)



William P. Hobby Airport

Demand/Capacity, Requirements, and Alternatives - Landside

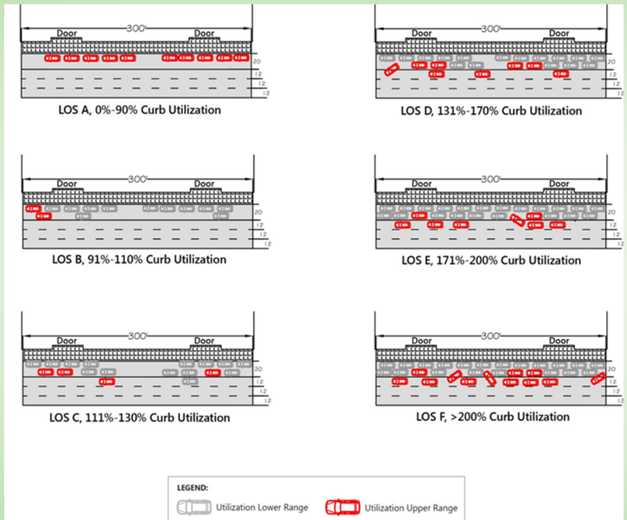
Parking Requirements

- On-airport parking is at capacity; Off-airport parking can reach capacity
  - On-Airport Spaces (existing) = 4,360
    - 3,438 in garage; 566 in Ecopark 1; 356 in Ecopark 2
  - Off-Airport Spaces (existing) = 5,700
- Proposed West Garage Planned for approximately 3,100 spaces (2,500 net new)

	PARKING REQUIREMENT			
	2015	2020	2025	2030
Without New Garage	(1,677)	(2,571)	(3,301)	(4,085)
With New Garage	823	(71)	(801)	(1,585)

Demand/Capacity, Requirements, and Alternatives - Landside

Curbside Level of Service Ranges



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Demand/Capacity, Requirements, and Alternatives - Landside

2015 Curbside Requirements (Departures Level)

	AVAILABLE LENGTH	UTILIZED LENGTH	UTILIZATION	LOS	OPTIMAL LOS C LENGTH	SURPLUS / (DEFICIT) FOR LOS C
	[A]	[B]	[B]/[A]		[D]	[D]-[A]
Departures Level (Existing Conditions)						
West Section	160	605	378%	F	465	(305)
Central Section	235	400	170%	D	308	(73)
East Section	290	180	62%	A	138	152
Departures Level (Commercial Vehicles on East Section)						
West Section	160	275	172%	E	212	(52)
Central Section	235	400	170%	D	308	(73)
East Section	290	380	131%	D	292	(2)

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2030 Curbside Requirements (Departures Level)

	AVAILABLE LENGTH	UTILIZED LENGTH	UTILIZATION	LOS	OPTIMAL LOS C LENGTH	SURPLUS / (DEFICIT) FOR LOS C
	[A]	[B]	[B]/[A]		[D]	[D]-[A]
Departures Level (Existing Conditions)						
West Section	160	730	456%	F	562	(402)
Central Section	235	535	228%	F	412	(177)
East Section	290	205	71%	A	158	132
Departures Level (Commercial Vehicles on East Section)						
West Section	160	375	234%	F	288	(128)
Central Section	235	535	228%	F	412	(177)
East Section	290	500	172%	E	385	(95)

2015 Curbside Requirements (Arrivals Level)

	AVAILABLE LENGTH	UTILIZED LENGTH	UTILIZATION	LOS	OPTIMAL LOS C LENGTH	SURPLUS / (DEFICIT) FOR LOS C
	[A]	[B]	[B]/[A]		[D]	[D]-[A]
Arrivals Level (Inner Roadway)						
Rental Car Shuttles	300	315	105%	D	315	(15)
Taxicabs	355	100	28%	A	100	255
Arrivals Level (Center Roadway)						
Private Vehicles	500	275	55%	A	275	225
Arrivals Level (Outer Roadway)						
Parking Shuttles	130	210	162%	F	210	(80)
Hotel Shuttles	75	70	93%	C	70	5
METRO Bus	50	50	100%	C	50	0
Shared Ride/Economy	200	35	18%	A	35	165

2030 Curbside Requirements (Arrivals Level)

	AVAILABLE LENGTH	UTILIZED LENGTH	UTILIZATION	LOS	OPTIMAL LOS C LENGTH	SURPLUS / (DEFICIT) FOR LOS C
	[A]	[B]	[B]/[A]		[D]	[D]-[A]
Arrivals Level (Inner Roadway)						
Rental Car Shuttles	300	350	117%	E	350	(50)
Taxicabs	355	125	35%	A	125	230
Arrivals Level (Center Roadway)						
Private Vehicles	500	400	80%	B	400	100
Arrivals Level (Outer Roadway)						
Parking Shuttles	130	210	162%	F	210	(80)
Hotel Shuttles	75	70	93%	C	70	5
METRO Bus	50	50	100%	C	50	0
Shared Ride/Economy	200	35	18%	A	35	165

Other Landside Requirements

- Employee parking
  - Currently being finalized based on existing parking allotment plus growth percentage
- Cell phone parking lot
  - 50-60 spaces (preliminary)
- Taxi staging
  - Refining future requirement and evaluating alternatives
    - Taxi pool and taxi puddle separate (current operation)
    - Combine taxi pool and taxi puddle
    - Finalize location (west side of terminal)

Demand/Capacity, Requirements, and Alternatives - Landside

Rental Car Requirements
Surplus/(Deficiency)

Component	Existing	2015	2020	2030
Regular Customer Service Positions	20	17	13	5
Ready/Return and Onsite Vehicle Storage Area				
Total Ready/Return Spaces	322	263	164	(35)
Storage Spaces	850	830	798	733
Quick Turnaround Area				
Fueling Positions	(2)	(4)	(8)	(14)
Wash Bays	3	3	2	1
Stacking/Staging Spaces	30	19	(5)	(41)

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Demand/Capacity, Requirements, and Alternatives - Landside

Rental Car Requirements
Total Area Required

	2012 SPACE PROGRAM		2015 SPACE PROGRAM		2030 SPACE PROGRAM	
	Quantity	Total SF	Quantity	Total SF	Quantity	Total SF
Customer Service Areas						
Counter Positions	30	9,100	33	9,800	45	13,500
Circulation	25%	2,300	25%	2,500	25%	3,400
Subtotal		**11,400**		**12,300**		**16,900**
Ready/Return/Storage Areas						
Ready Spaces	565	169,400	610	183,100	839	251,700
Return Spaces	171	34,200	185	36,900	254	50,800
Storage Spaces	240	40,900	260	44,200	357	60,700
Total Spaces	976		1,055		1,450	
Exit Booths	8	200	8	200	11	200
Circulation	20%	48,900	20%	52,900	20%	72,700
Subtotal		**293,600**		**317,300**		**436,100**
QTA/Service Site						
Fueling Positions	24	7,300	26	7,900	36	10,900
Wash Bays	4	8,100	4	8,800	6	12,100
Stacking and Staging Spaces	144	28,800	156	31,200	216	43,200
Maintenance Bays	9	7,300	10	7,900	13	10,800
Administrative Area	9,200	9,200	9,945	9,945	13,671	13,671
Employee Parking	182	45,500	197	49,200	270	67,600
Circulation	20%	21,200	20%	23,000	20%	31,700
Subtotal		**127,400**		**137,945**		**189,971**
Small Market Entrant		8,600	2% of total area	9,400	2% of total area	12,900
Total Facility		441,000		476,900		655,900
Landscaping/circulation (15% of total facility area)		66,200		71,500		98,400
TOTAL REQUIREMENT - SQUARE FEET		**507,200**		**548,400**		**754,300**
TOTAL REQUIREMENT - ACRES		**12**		**13**		**17**

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Demand/Capacity, Requirements, and Alternatives - Landside

Terminal Area Plan – 2015
"Existing Condition"

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Demand/Capacity, Requirements, and Alternatives - Landside

Future (2030) Terminal Area Plan
Alternative 1A

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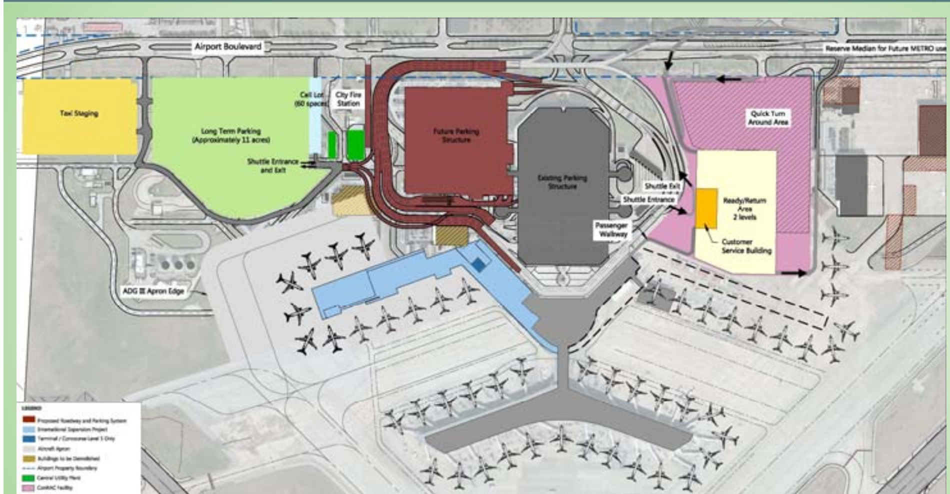
Demand/Capacity, Requirements, and Alternatives - Landside

Future (2030) Terminal Area Plan
Alternative 1B



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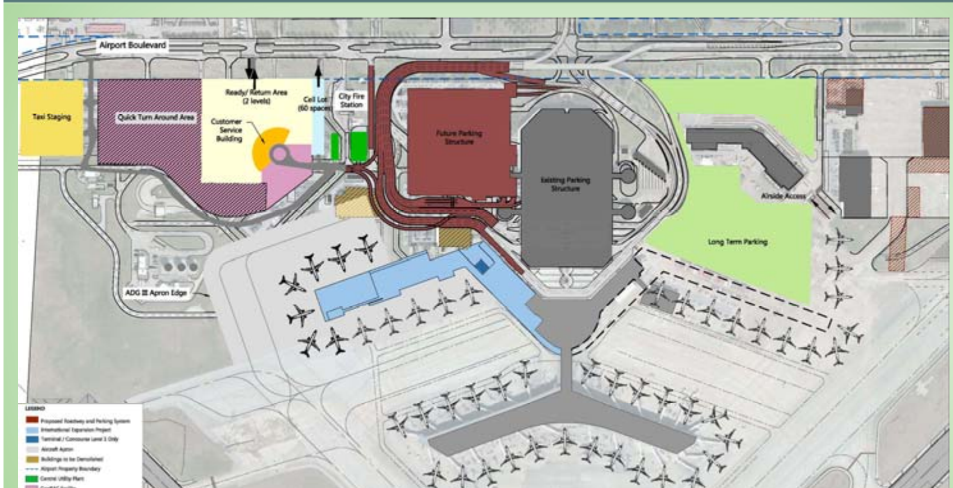
Demand/Capacity, Requirements, and Alternatives - Landside

Future (2030) Terminal Area Plan
Alternative 2



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Demand/Capacity, Requirements, and Alternatives - Landside

Future (2030) Terminal Area Plan
Alternative 3

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William P. Hobby Airport

Demand/Capacity, Requirements, and Alternatives - Support Facilities and General Aviation

Support Facilities Requirements Analysis

- Support facilities include:
  - General aviation (GA)
  - Airline support
  - HAS/Airport support
- Assumptions:
  - GA facilities requirements based on number of based aircraft.
  - No growth anticipated for:
    - Airline maintenance facilities
    - Air cargo/provisioning facilities
  - Planned HAS Administration and Airport Maintenance facilities will be adequate through the planning horizon.

Support Facilities Requirements Analysis

		Current Land Use Areas (Acres)				2030 Requirements	
Land Use Classification:		Developed	Planned	Total		Total	Net Increase
General Aviation (GA):							
	Fixed Base Operator	114.6	16.6	131.3		141.6	10.3
	Corporate Aviation	32.6	0.0	32.6		36.7	4.0
	Helicopter Facilities	4.3	0.0	4.3		4.8	0.5
	Sub-total (GA Facilities)	151.6	16.6	168.2		183.0	14.8
Airline Support:							
	Airline Maintenance	24.9	0.0	24.9		24.9	0.0
	Air Cargo/Provisioning	3.2	0.0	3.2		3.2	0.0
	Airline Fuel Farm Facilities	2.8	0.0	2.8		4.2	1.5
	Subtotal (Airline Support)	30.8	0.0	30.8		32.3	1.5
Houston Airport System (HAS):							
	Administration	2.1	0.0	2.1		2.1	0.0
	Aircraft Rescue & Fire Fighting	1.4	0.0	1.4		1.4	0.0
	Airport Maintenance & Support	1.0	0.6	1.5		1.5	0.0
	Sub-total (GA Facilities)	4.4	0.6	5.0		5.0	0.0
Other Support Facilities		24.4	2.4	26.9		26.9	0.0
Grand Total		**211.2**	**19.6**	**230.8**		**247.2**	**16.3**

- Only significant requirements are for GA facilities.
- SWA acquired 6-acre NUSTAR fuel farm along the east Airport boundary.

Demand/Capacity, Requirements, and Alternatives - Support Facilities and General Aviation

Available Development Areas

- Available Areas:
  - East quadrant:
    - 5 acres now
  - South quadrant:
    - 20 acres available now
    - Additional 16 acres after closure of Runway 17-35
  - West quadrant:
    - 34 acres after closure of Runway 17-35
- Space available exceeds requirements
  - Potential for other non-aeronautical developments

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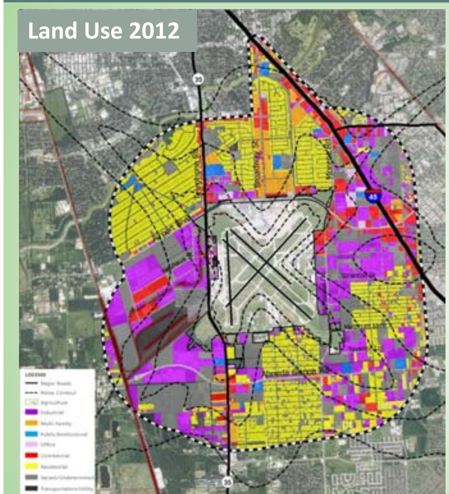
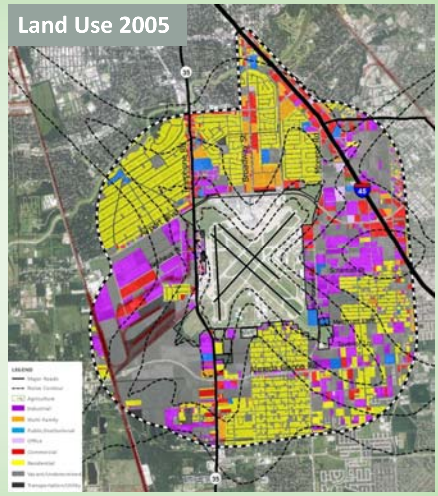
William P. Hobby Airport

HOU Off-Airport Land Use and Development

HOU Off-Airport Land Use and Development

Hobby Land Use Analysis (2005-2012)





Source: HCAD 2012, HAS, H-GAC

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HOU Off-Airport Land Use and Development

Land Use Comparison (2005-2012)

Land Use	Acres (2005)	Acres (2012)	Land Value (2005)	Land Value (2012)	Improved Value (2005)	Improved Value (2012)
Agricultural	-	1	$ -	$100	$ -	$ -
Commercial	532	671	$50,205,275	$69,012,207	$126,206,260	$162,005,101
Commercial Vacant	789	979	$29,907,262	$41,214,339	$762,023	$57,652
Industrial	1,193	1,548	$45,281,363	$73,722,470	$114,959,845	$167,227,187
Industrial Vacant	51	47	$343,373	$204,943	$ -	$ -
Multi-Family	2,136	2,146	$23,604,515	$37,360,054	$82,850,404	$113,679,272
Office	37	58	$4,489,046	$7,461,461	$19,390,276	$29,554,443
Public/Institutional	113	116	$519,393	$9,490,197	$2,030,607	$2,421,711
Residential Vacant	431	354	$14,552,246	$18,897,424	$124,629	$2,133,877
Single Family	2,054	2,001	$135,699,512	$170,767,059	$464,235,617	$391,346,926
Transportation/Utility	226	282	$1,083,297	$3,178,500	$1,653,741	$ -
Vacant	1,435	610	$6,114,172	$4,209,110	$17,617	$ 17,205,251
Transportation Vacant	117	0	$489,884	$ -	$ -	$ -
Parks – Open Spaces	5	0	$895,834	$ -	$558,316	$ -
Unknown	22,469	25,505				
Total	**31,599**	**34,317**	**$313,185,172**	**$435,517,864**	**$812,789,335**	**$885,6331,420**

Source: HCAD 2012
Footnote: The total area (acres) in 2005 and 2012 does not match due to insufficient data available.

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Land Use Comparison (2005-2012) Along Major Corridors

Land Use	Broadway MV (2005)	Broadway MV (2012)	Monroe MV (2005)	Monroe MV (2012)	Telephone MV (2005)	Telephone MV (2012)	Airport Blvd MV (2005)	Airport Blvd MV (2012)
Commercial	$ 17,470,747	$ 28,869,516	$ 15,669,346	$ 20,317,579	$ 15,979,659	$ 23,029,150	$ 37,884,853	$ 54,218,486
Industrial	$ 571,670	$ -	$11,578,620	$ 17,547,747	$ 9,085,372	$ 12,417,859	$ 30,696,718	$ 7,830,296
Single Family Residential	$ 2,418,830	$ 2,790,758	$ 4,287,412	$ 3,709,178	$ 1,282,173	$ 1,226,56	$ 1,366,079	$ 946,846
Vacant	$ -	$ -	$ -	$ -	$ 710,791	$ 8,450,207	$ 2,980,753	$ 424,537

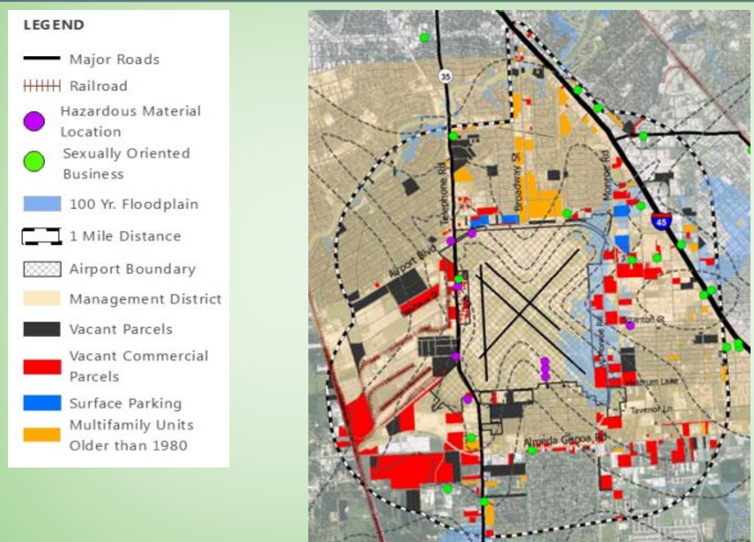
Source: HCAD 2012

Land Use Observations (2005-2012)

- Increase in Commercial, Industrial and Single Family Residential market value along Broadway, Monroe and Telephone Road corridors
- Along Airport Blvd, 43% increase in Commercial market value but 74% loss in of market value for Industrial, 30% loss in Single Family Residential - 85% loss in value for Vacant land use – (2005) 2, 275 acres versus 1,636 acres in 2012
- 1088% increase in market value for Vacant land along Telephone Road
- Based on loss in market value, Airport Blvd ranks 1st among the four major corridors
- Overall 39% increase in land value in the study area, but minor increase in the improvement value (i.e., there has not been much improvement in the study area)
- Between 2005 and 2012, the study area saw 57% loss of available Vacant land area that in turn saw an increase of 26% increase in commercial, and 29% increase in Industrial parcels. The study area did not see much gain or loss in office, public/institutional or single family residential land use.

HOU Off-Airport Land Use and Development

Development Opportunities - Challenges



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HOU Off-Airport Land Use and Development

Hobby Area Management District #9

- Graffiti abatement and prevention –enhanced beautification through landscaping
- Increase and maintain consistent street lighting in public areas.
- Improve safety and reduce crime through:
  – a series of partnerships with law enforcement agencies and programs such as HPD's Positive Interaction Program (PIP).
  – advocacy for regional security needs with county, city, state, and federal law enforcement agencies
  – build positive relationships between property owners and public safety agencies to improve safety awareness activities
- Coordinate with the city to provide traffic control devices where necessary.

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Economic Development Tools

- Area 380 Designation for all major thoroughfares that lead to Hobby
  - Promote revitalization of compatible land uses to serve new FIS
    - Hotels-Retail -Office
    - Revitalize existing multi-family
    - Airport related uses needed to expand operational benefits to Hobby and HAS
    - Incentivize relocation of incompatible uses
  - Criteria for 380 participation to meet CoH/HAS design goals and quality for the projects
    - Enhanced landscaping & beautification
    - Low Impact Design/LEED
  - Incentivize developers to provide off-site improvements
  - Coordinate 380 improvements with traffic, safety and beautification initiatives
  - Increase funding partnerships through coordination Harris County, State and Federal programs

Hobby Airport Master Plan Update

Worskshop #3

October 25, 2013

Agenda

- Key topics covered:
  - Aviation Activity Forecast
  - Recommended Master Plan Developments
    - Airside
    - Terminal
    - Landside
  - Noise Impacts
  - Other
    - Preliminary Implementation/CIP
    - METRO Coordination
    - Off-Airport land-use analysis
- Overall project status
  - Technical work 90% complete
  - Draft documentation will be completed by end of calendar year. (Will use 2015 terminal, roadway, garage, CUP and enabling project layouts as "existing conditions" for completion of master plan.)

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William P. Hobby Airport

AVIATION ACTIVITY FORECAST

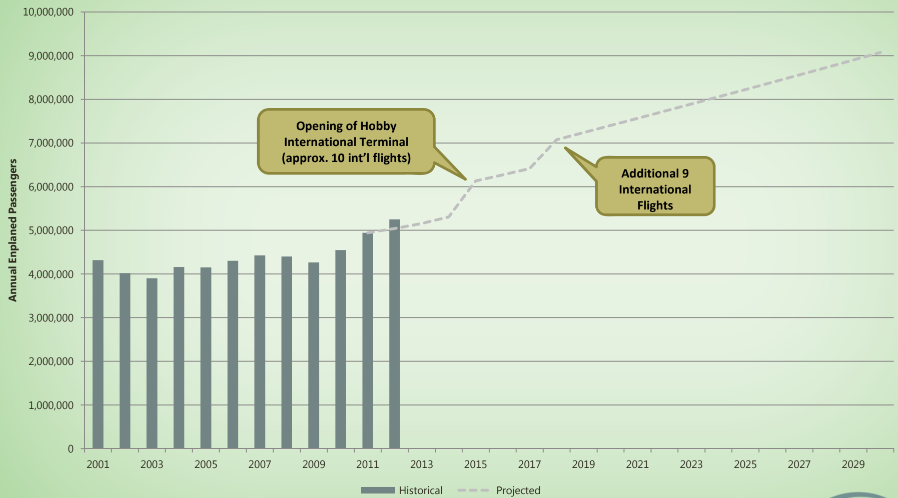
Aviation Activity Forecast Summary

- Forecasts developed in light of GRA market assessments prepared in 2011-2012 and input from Southwest Airlines. Forecasts have been approved by HAS and the FAA.
- Forecast summary
  - Domestic enplanements increase approx 50% (to almost 8 million enplanements)
  - More than 1 million international enplanements by the year 2030
  - Connecting passenger percentage increases from 30% to almost 35%
  - Total operations increase from 202,000 to almost 270,000 operations (GA activity experiences incremental growth)

	2012	2015	2020	2030
ENPLANED PASSENGERS				
Domestic Passengers	5,252,139	5,639,300	6,480,500	7,956,900
International Passengers	-	490,400	919,400	1,113,700
TOTAL ENPLANED	**5,252,139**	**6,129,700**	**7,399,900**	**9,070,600**
AIRCRAFT OPERATIONS	**202,670**	**218,560**	**242,120**	**269,540**

Aviation Activity Forecast

Annual Enplaned Passengers



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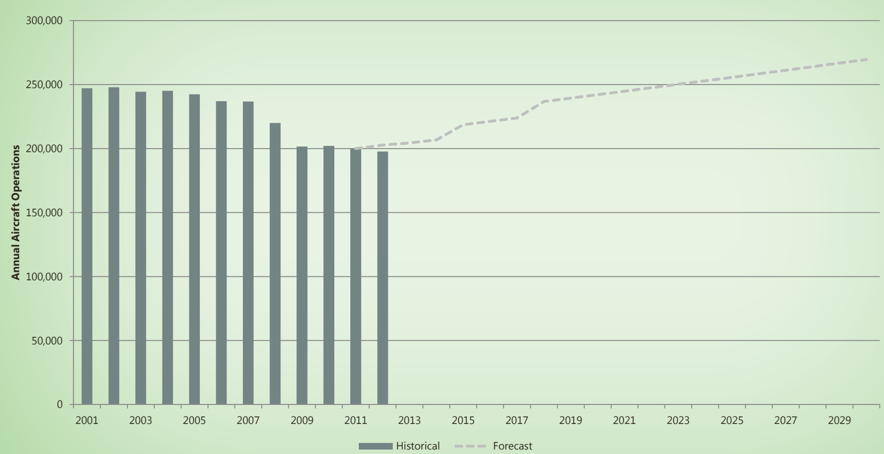
Aviation Activity Forecast

Annual Aircraft Operations



Note: Historical data based on FAA ATADS.

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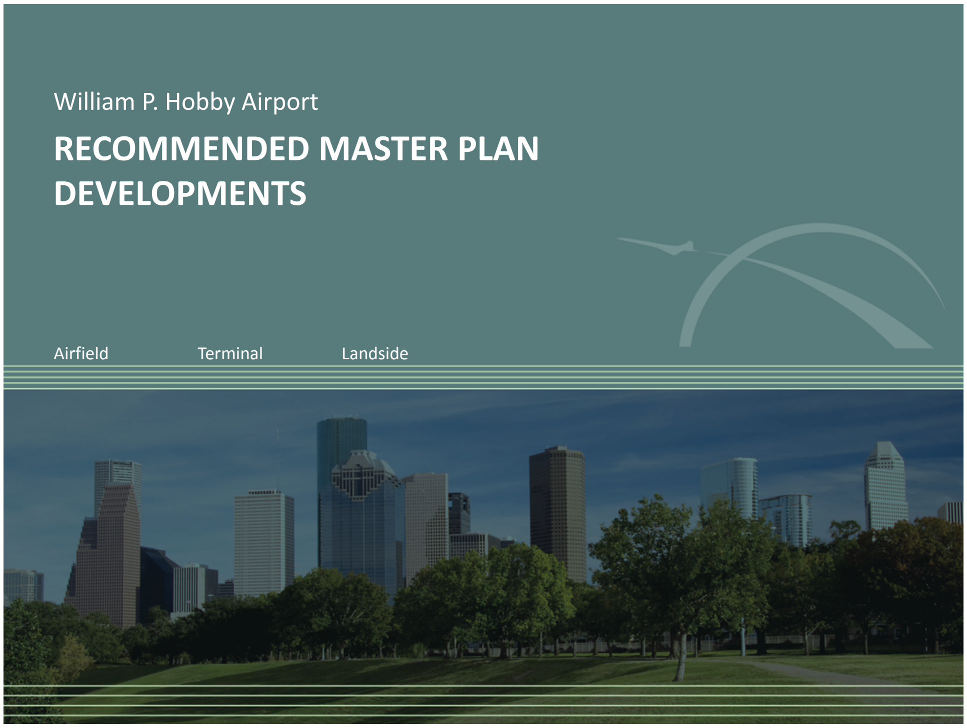
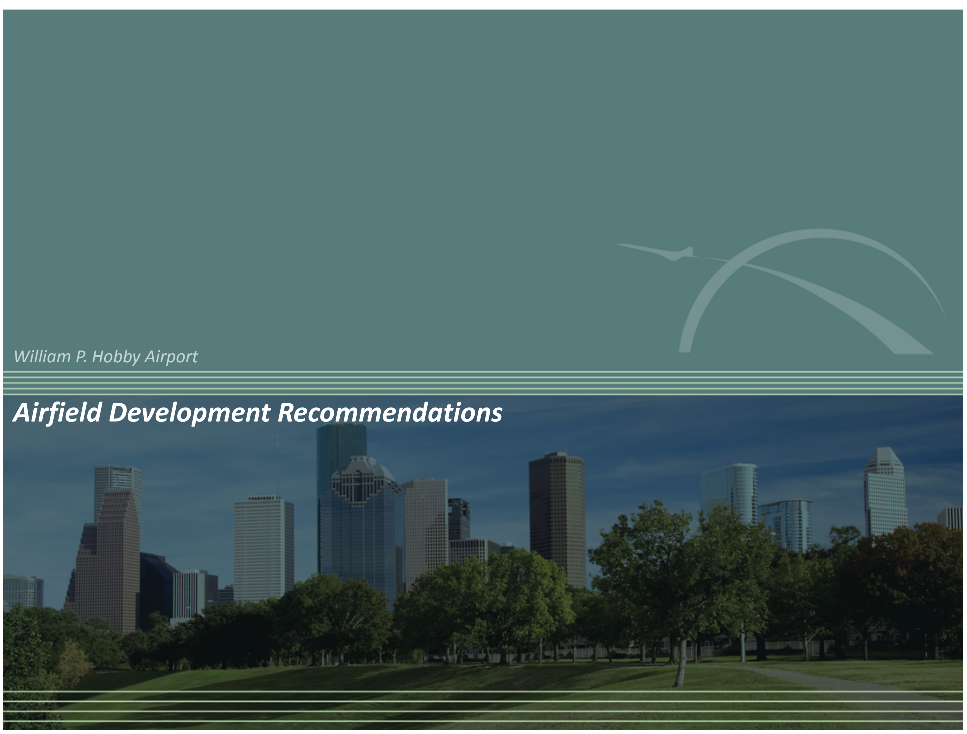

William P. Hobby Airport
RECOMMENDED MASTER PLAN DEVELOPMENTS
Airfield
Terminal
Landside


William P. Hobby Airport
Airfield Development Recommendations

Key Considerations Affecting Airfield Operations and Development

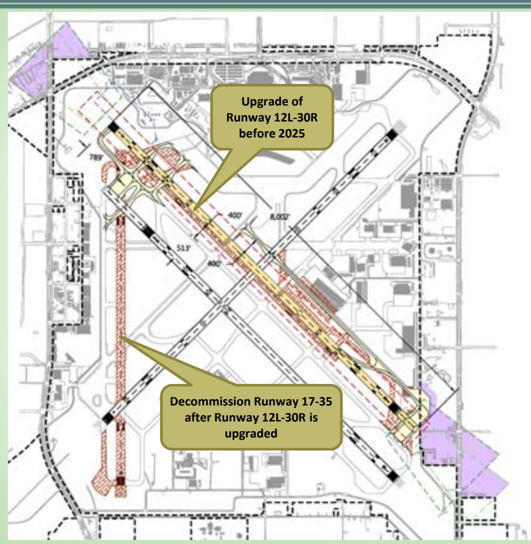
- Regulatory compliance
  - Runway 17-35 does not meet FAA planning criteria for Group III aircraft (which includes B737-series aircraft). Note: when the *iron-cross* needs maintenance, Runways 17-35 and 12L-30R are the only runways "available" for Group III aircraft operations.
- Operational safety
  - Hot spots in northwest and southwest corners of the airfield
- Airfield capacity
  - Existing airfield capacity expected to become a constraint by 2025
- Operational flexibility
  - Air carrier runway closures (during periods of maintenance or airfield incidents)
- New regulations regarding runway geometry
- Runway length (in comparison to anticipated future markets being served)

Recommended Airfield Development Projects

- Upgrade Runway 12L-30R to an air carrier runway
  - Consensus (ATCT and Southwest Airlines) for inboard arrivals and outboard departures during south flow operations
  - Staggered runway ends
    - Preliminary location of runway ends based on previous studies
    - Glide slope critical area may encroach on fuel farm facilities
  - Increases airfield capacity, particularly in the dominant "south flow"
  - Upgrade will impact FBO facilities (Signature, Jet Aviation)
- Close Runway 17-35
  - Removes numerous airfield "hot spots" and geometry compliance issues
  - Should not be closed until Runway 12L-30R is upgraded
  - Slight decrease in overall airfield capacity
  - Allows for expansion of ramp area or increase of developable land
  - Reduce maintenance costs
- Taxiway improvements associated with runway development strategy

Airfield Development Recommendations

Primary Airfield Development Projects



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Airfield Development Recommendations

Land Acquisition Considerations Runway 12L-30R RPZs

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Land Acquisition Considerations

- Future studies will need to finalize threshold location
- Potential timeline:
  - Planning: current-2017
  - Design: 2018
  - Build: 2019-2020
- Preliminary land acquisition impacts:

	NUMBER OF PARCELS	ACREAGE
RESIDENTIAL	9	4
COMMERCIAL/ INDUSTRIAL	29	42
AGRICULTURAL/ UNDEVELOPED	15	25
TOTAL	53	71

Long-Range Airfield Development

- Long-term, if additional airfield capacity is required, the next recommended airfield improvement is construction of a parallel runway to Runway 4-22
  - Will not be required during forecast period
  - Would provide significant increase in airfield capacity (assuming regional airspace capacity can accommodate the additional runway and operations)
  - Would require major capital investment:
    - Complete realignment of Monroe Road
    - Purchase of hotel(s)
    - Complete displacement of numerous airport tenants and airport neighbors
- This airfield development project will not be included in the Airport Layout Plans which will be submitted to the FAA

Airfield Development Recommendations

Range of B737-800 and Existing Runway Lengths

- Expected destinations to Central America and portions of South America
- Max range of B737-800 is approximately 2,600 nautical miles
  - Maximum Allowable Take-Off Weight
  - Standard temperature (59 deg F) and standard+27 (86 deg F)

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William P. Hobby Airport

Terminal Recommendations

Terminal Recommendations

Key Considerations Affecting Terminal Development

- Hobby currently has 25 gates, all of which can only accommodate domestic flights.
- In 2012, Southwest Airlines announced plans for the inauguration of international service from Hobby starting in 2015
- New terminal required to process international arrivals (immigration/customs)
  - The new international terminal will originally have 5 gates, with the ability to expand to 12 gates in the future
  - New international terminal scheduled to open in December 2015 (currently in design)

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Terminal Recommendations

Terminal Requirements

- Future terminal and gate requirements are calculated based on forecasts of aviation activity and estimated flight schedules
  - Increase of domestic passenger enplanements from 5.2 million to 8 million
  - Anticipate growth of international passenger enplanements to 1.1 million

	SCHEDULE	GATE REQUIREMENTS			
YEAR	NUMBER OF DAILY FLIGHTS	INTERNATIONAL GATES	DOMESTIC GATES	REMOTE PARKING POSITIONS	TOTAL GATES
2011	164	0	25		25
2015	188	5	25	7	30
2020	219	10	27	7	37
2030	251	12*	25*	10	37+

* International gates may be used for domestic flights.

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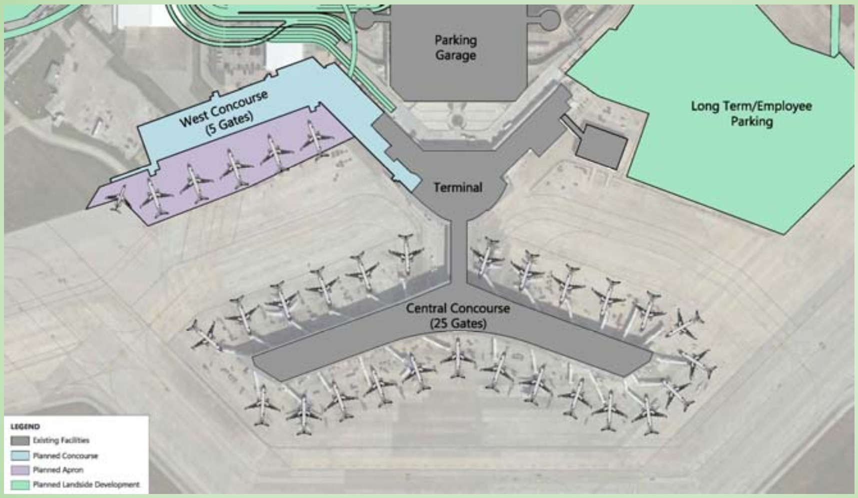
Terminal Recommendations

Phase 1 Expansion (2015)



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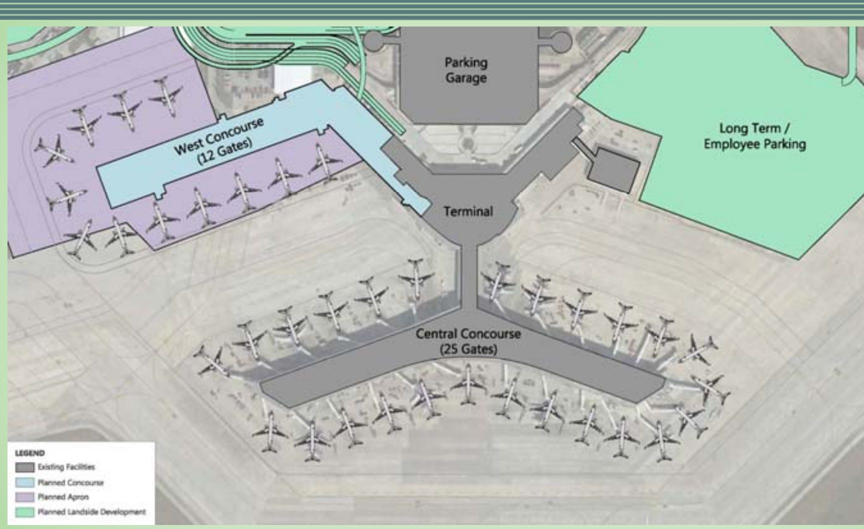
Terminal Recommendations

Phase 2 Expansion



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Terminal Recommendations

Hobby International Terminal Rendering

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Terminal Recommendations

Hobby International Terminal Rendering

22

William P. Hobby Airport

Landside Recommendations

Key Considerations Affecting Landside Operations and Development

- Curbside congestion at the terminal
  - Departures Level - West and central sections, in front of Southwest Airlines' ticket counters
  - Arrivals Level – Curb sections served by rental car and parking shuttles
- Parking shortage
  - In peak seasons, all on-Airport and off-Airport parking spaces can be filled
  - Additional aviation growth cannot be accommodated without increasing parking capacity
- Intersections near the airport can become congested
- Rental car facilities are constrained

Parking Facilities Requirements

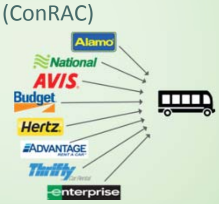
- On-airport parking is at capacity; off-airport parking can reach capacity
  - On-Airport Spaces (existing) = 4,360
    - 3,438 in garage
    - 566 in Ecopark 1
    - 356 in Ecopark 2
  - Off-Airport Spaces (existing) = 5,700
- Proposed West Parking Garage planned for approximately 3,000 spaces (2,400 net new)

	PARKING REQUIREMENTS SURPLUS / (DEFICIENCY)			
	2015	2020	2025	2030
Existing Conditions	(1,677)	(2,671)	(3,401)	(4,185)
With New Garage	823	(171)	(901)	(1,685)

West Parking Garage Rendering

Rental Car Facilities Requirements

- Rental car companies are currently dispersed on- and off-airport, with limited shared facilities
- Facility requirements include:
  – Vehicle storage (deficient approx 50 spaces now, which will increase to almost 600)
  – Additional fueling stations are needed, short-term and long-term (14)
  – Stacking/staging spaces will become deficient by 2025
- Recommend development of a consolidated rental car facility (ConRAC)
  – Reduce number of shuttle trips
    - Multiple busing operations would be reduced to one
    - Environmental benefits (air quality)
    - Reduced curbside congestion
  – Reduce driving time between terminal and ConRAC
  – Improve customer level of service (access, and newer facilities)
  – Funded by facility users (not Airport)



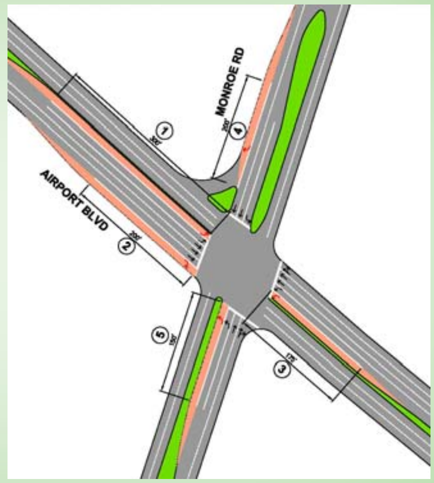
Intersection Analysis

- Intersection analysis completed for four intersections along Airport Boulevard
  – Monroe
  – Broadway
  – Telephone
  – Proposed intersection for east surface and employee parking
- Traffic data compiled and compared from multiple sources
  – Trip Generation Model used to generate airport traffic volumes (R&A)
  – Intersection turning movement counts (Gunda Corporation)
  – HOU Peak Week tube count data (CH2MHill)
- Background traffic growth assumed to be 1.5 percent per year
- Airport traffic increases based on forecasted (originating) passenger growth
- LOS values based on P.M. commuter peak hour volumes

Landside Recommendations

Monroe Rd. and Airport Blvd.

- Recommended improvements
  - (1) Provide additional 300’ left turn bay on eastbound approach of Airport Blvd
  - (2) Provide 200’ exclusive right turn bay at eastbound approach of Airport Blvd
  - (3) Provide additional 175’ left turn bay on westbound approach of Airport Blvd
  - (4) Provide a 200’ exclusive right turn bay on southbound approach of Monroe
  - (5) Provide additional 150’ left turn bay on northbound approach to Monroe Rd
- Estimated Levels of Service
  - Baseline - LOS D (No Improvements)
  - 2015 LOS C
  - 2020 LOS D
  - 2030 LOS D



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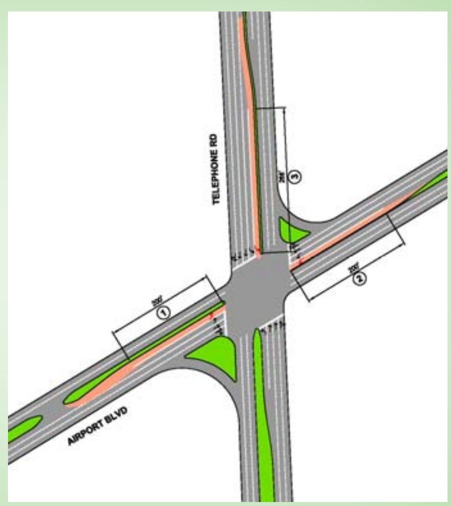
Landside Recommendations

Telephone Rd. And Airport Blvd.

- Recommended improvements
  - (1) Provide additional 200’ left turn bay on eastbound approach of Airport Blvd.
  - (2) Provide additional 200’ left turn bay on west bound approach of Airport Blvd.
  - (3) Provide additional 265’ left turn bay on southbound approach of Telephone Road.
- Estimated Levels of Service
  - Baseline LOS D
  - 2015 LOS D
  - 2020 LOS D
  - 2030 LOS D



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Landside Recommendations

Broadway St. And Airport Blvd.

- Recommended improvements
  - None Anticipated
- Estimated Levels of Service
  - Baseline LOS C
  - 2015 LOS C
  - 2020 LOS C
  - 2030 LOS C

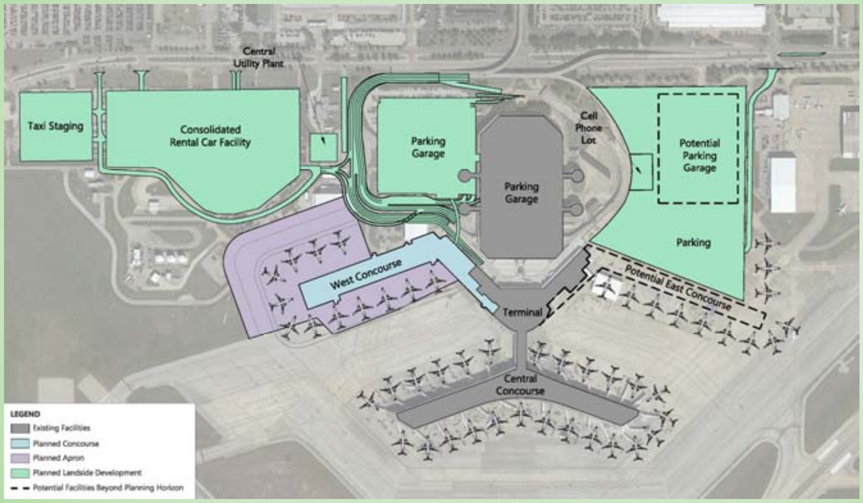
Landside Recommendations

Proposed East Parking And Airport Blvd.

- Recommended improvements
  - (1) Retain existing left turn bay on eastbound approach of Airport Blvd.
  - (2) Provide 200' left turn bay on westbound approach of Airport Blvd.
  - (3) Provide a exclusive left turn lane and thru-right for the new south leg of the intersection
  - Install traffic signals
- Estimated Levels of Service
  - Baseline LOS C (No Improvements)
  - 2015 LOS B
  - 2020 LOS B
  - 2030 LOS B

Landside Recommendations

Ultimate Terminal Area Plan



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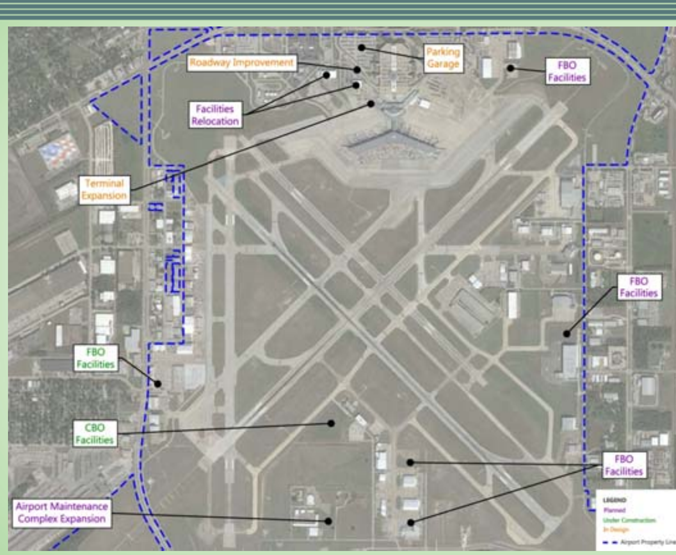
Landside Recommendations

Current Projects Status



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Landside Recommendations

Available Development Areas

- Available Areas:
  - East quadrant:
    - 5 acres now
  - South quadrant:
    - 20 acres available now
    - Additional 16 acres after closure of Runway 17-35
  - West quadrant:
    - 34 acres after closure of Runway 17-35
- Space available exceeds requirements
  - Potential for other non-aeronautical developments

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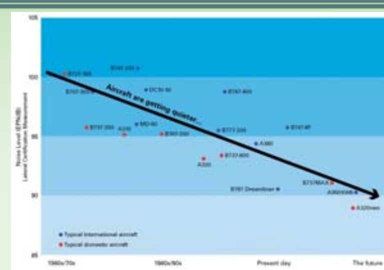
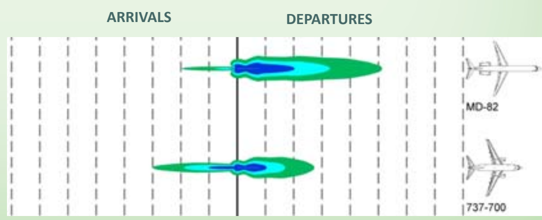
William P. Hobby Airport

Noise Impacts

Noise Analysis

“Background” Noise Images

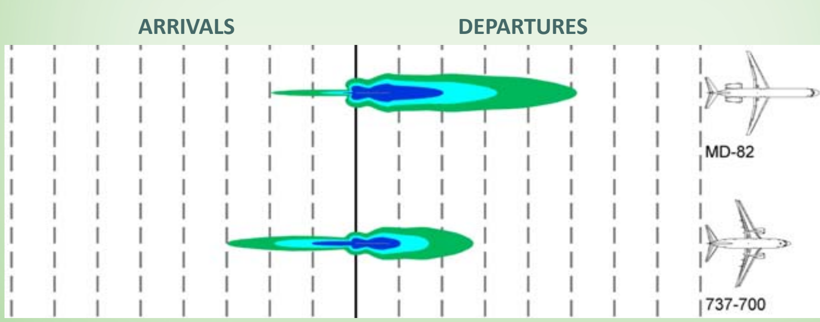




Noise Analysis

Noise Contours

- Reasons for differences:
  - Quieter aircraft
  - Fleet mix changes (more airline/business aircraft vs small propeller aircraft)
  - Closure of Runway 17-35



Noise Analysis

2000 Noise Contours
(75 DNL through 65 DNL)

Source: 2003 Master Plan

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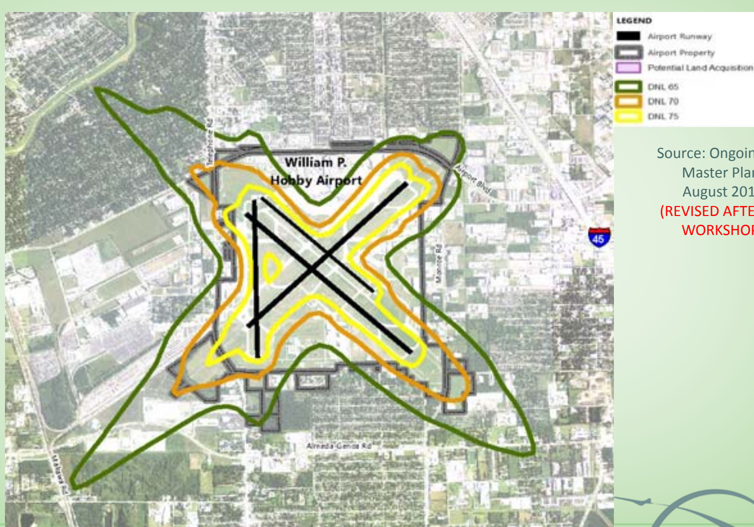
2011 Noise Contours
(75 DNL through 65 DNL)



Source: Ongoing Master Plan, August 2014 (REVISED AFTER WORKSHOP)

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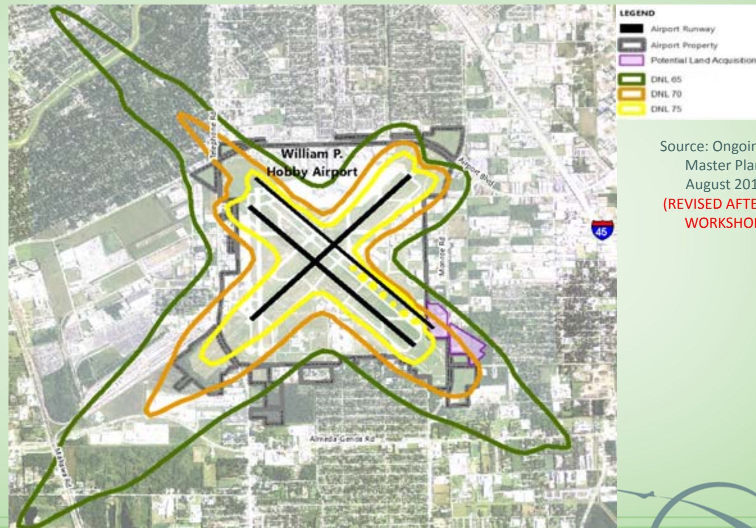
2030 Noise Contours
(75 DNL through 65 DNL)



Source: Ongoing Master Plan, August 2014
(REVISED AFTER WORKSHOP)

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Hobby Airport Master Plan Update

Consolidated Rental Car Facility Worskshop

October 22, 2014

William P. Hobby Airport



PHOTOS COURTESY OF HOUSTON AIRPORT SYSTEM

Rental Car Facility Planning and Site Assessment Workshop

October 22, 2014

Workshop Agenda

- Welcome and introductions
- Overview of terminal area land use planning meetings
- Rental car facility requirements
  - Aggregated survey results
  - Analytical assessment of facility requirements
- Site identification and evaluation
  - Implementation complexity
  - Vehicular access
  - Passenger access and level-of-service (LOS)
  - Site Suitability
  - Consistency with long-term airport strategies

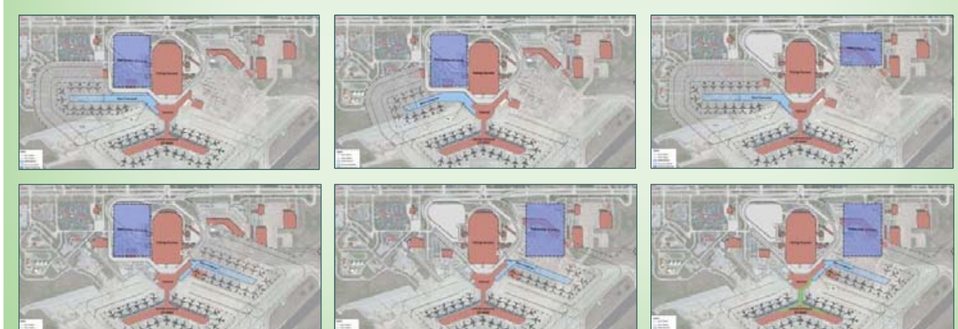
2

William P. Hobby Airport

TERMINAL AREA LAND USE PLANNING

Example Terminal Area Site Plan Concepts

- Preliminary terminal area land use planning conducted Aug-Dec, 2012
- Purpose – to determine the location of the new garage and the concourse expansion in the context of the master plan update, while ensuring airfield and terminal capacity remains balanced



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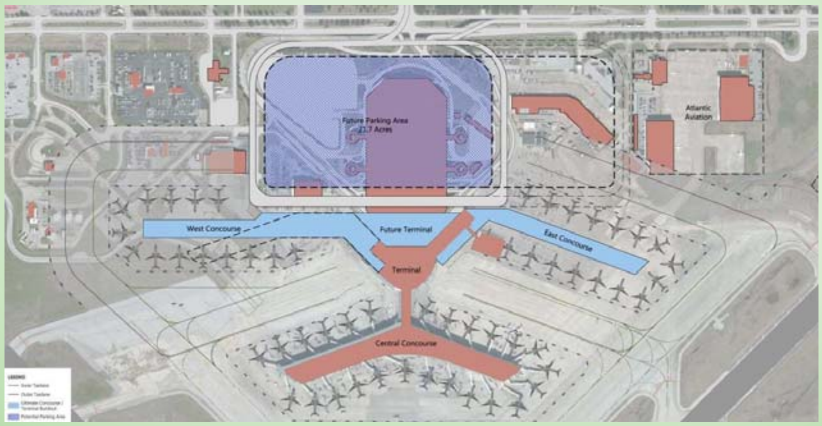
Terminal Area Land Use Considerations and Constraints

- Preliminary concept, prepared in 2012 to broadly define long-term land uses and development potential



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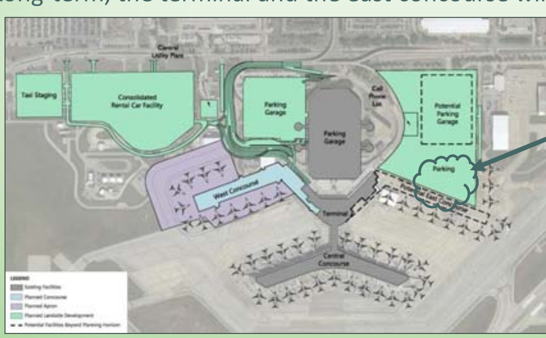
Summary of Terminal Area Land Use Planning

- New parking garage to the west of existing garage
  - Closer to ticketing and baggage claim areas of terminal
  - New garage to be integrated with existing garage
- 5 international gates (expandable to 12 gates) on a new west concourse
- Roadway realignment (road and curb capacity increases)
- Long-term, the terminal and the east concourse will need to be expanded



Preferred master plan concepts avoided vertical structures in this area to allow for potential of future ramp/concourse development

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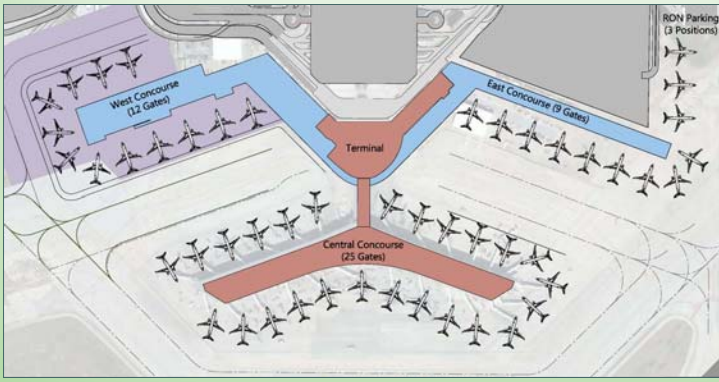
Long-Term (2030) Terminal Area Development Concept

- Gate requirements will depend on airline operating strategies (utilization of hard-stand positions, and scheduled turns per day)
  - Future req't of 37 total gates with up to 10 hard stand positions, or 47+ gates
- Projected gate req'ts are balanced with the capacity of future airfield



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RENTAL CAR DEMAND/CAPACITY ANALYSIS

Questionnaire Responses

- A questionnaire requesting hourly transaction information--as well as the size, configuration, and use of existing facilities--was sent to all on-Airport rental car companies in April 2012. 8 brands returned a completed questionnaire.
- Questionnaires were re-distributed in 2014 per RAC agency requests, to update the 2012 responses
  - Questionnaire also received from Advantage (9th brand) and incorporated into the analysis
- Specific requirements were established for:
  - Customer service area
  - Ready/return and onsite vehicle storage area
  - Quick turnaround area
    - Fueling positions
    - Wash bays
    - Vehicle stacking spaces
    - Vehicle light maintenance bays

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Summary of Space Program Methodology

- Requirements were developed using HOU-specific 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.
- Planning hour activity was defined as the highest 5-hour average number of rentals and returns
- Standard industry planning factors were used to define other facility requirements (which can be adjusted as appropriate)
- 2015, 2020, 2030 (master plan update planning horizon), and 2040 rental car demand was based on projected growth of originating passengers at HOU (as compared to 2013 actuals):
  - 2015 = 18% increase (4.3M from 3.6M)
  - 2020 = 41% increase (5.1M from 3.6M)
  - 2030 = 67% increase (6.0M from 3.6M)
  - 2040 = 99% increase (7.2M from 3.6M)

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Recent Rental Car Transaction Increases

- **Transaction Increase**
  - From 2011 to 2013 there was a 20% increase in annual transactions
  - Note: Annual transaction data for 2014 unavailable as the year is not complete
- **Peak Day Transaction Increase (2012 to 2014)**
  - Peak day rentals = 9% growth over two year period
  - Peak day returns = 6% growth over two year period

Peak hour activity has increased at a lower rate than overall (annual) transactions

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Peak Rental Day Activity

MONDAY - PEAK RENTAL DAY					
	Counter Rentals	Kiosk Rentals	Premium Rentals	Returns	NET
12:00 AM	-12	0	-5	4	-13
1:00 AM	-5	-1	-1	5	-15
2:00 AM	-4	0	0	5	-14
3:00 AM	-4	0	0	5	-13
4:00 AM	-5	0	-1	32	12
5:00 AM	-14	0	-3	68	62
6:00 AM	-15	-1	-10	56	92
7:00 AM	-48	-1	-55	58	45
8:00 AM	-87	0	-112	79	-75
9:00 AM	-105	0	-147	86	-240
10:00 AM	-109	0	-112	100	-361
11:00 AM	-123	-6	-109	77	-521
12:00 PM	-125	-1	-146	99	-695
1:00 PM	-76	-1	-70	93	-749
2:00 PM	-79	-4	-99	128	-803
3:00 PM	-82	-3	-57	117	-826
4:00 PM	-85	-4	-93	146	-862
5:00 PM	-90	-1	-98	133	-919
6:00 PM	-95	-3	-103	97	-1,023
7:00 PM	-74	-4	-54	73	-1,082
8:00 PM	-53	-3	-49	48	-1,139
9:00 PM	-36	-3	-38	36	-1,180
10:00 PM	-41	0	-51	30	-1,243
11:00 PM	-28	-1	-18	15	-1,275
Sub-Total	-1,396	-40	-1,431	1,591	-1,275
Total			**-2,866**		
Running Total			**-2,866**	**1,591**	**-1,275**

5 HOUR PEAK AVERAGE					
2013	110	3	125		
	238			124	114

Peak day rentals
2,866

Planning hour rentals
238 (5 hour average)

Peak day returns
1,591

Planning hour returns
124 (5 hour average)

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Aggregated Summary of 2014 Questionnaires [1/]

Functional Component	Existing (2014)	Stated Need (2014)	2015	2020	2030
Customer Service Area					
Regular Customer Service Positions	49	53	57	60	60
Kiosk Positions	1	2	5	5	5
Administrative Area - In terminal	0	1,300	1,500	1,650	1,800
Administrative Area - Service Facility	18,250	19,600	20,100	21,600	24,100
Ready/Return Area					
Regular Ready Spaces	549	665	800	945	1,070
Premium Ready Spaces	326	582	620	665	710
Total Ready	**875**	**1,247**	**1,420**	**1,610**	**1,780**
Return Spaces	380	775	925	1,045	1,105
Total Ready/Return	**1,255**	**2,022**	**2,345**	**2,655**	**2,885**
Service Area					
Vehicle fueling positions (nozzles)	27	42	50	56	58
Car wash bays	8	12	12	14	14
Vehicle light maintenance bays	11	19	19	21	21
Overflow vehicle storage spaces	1,020	1,550	1,700	1,825	1,925
Employee Parking Spaces	211	290	307	377	409

[1/] Every brand did not answer every question on the questionnaire

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Functional Components Assessed




- Customer service area counters (CSB)
- Ready/return/storage spaces
- Service area functions (QTA)
  - Fueling
  - Vehicle washing
  - Vehicle stacking/staging
  - Light maintenance
  - Administrative area
  - Employee parking

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Requirement Summary
Surplus/(Deficiency)

Component	Existing 2014	2015	2020	2030	2040
Regular Customer Service Positions	25	21	16	9	2
Ready/Return and Onsite Vehicle Storage Area					
Total Ready/Return Spaces	411	258	69	(157)	(426)
Storage Spaces	(255)	(487)	(773)	(1,113)	(1,520)
Quick Turnaround Area					
Fueling Positions	2	(2)	(8)	(15)	(23)
Wash Bays	4	3	2	1	0
Stacking/Staging Spaces	25	(1)	(35)	(75)	(122)

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Requirement Program
Total Area Required

	2015 Space Program Quantity	2015 Stated Needs Quantity	2020 Space Program Quantity	2020 Stated Needs Quantity	2030 Space Program Quantity	2030 Stated Needs Quantity	2040 Space Program Quantity[1/]
Customer Service Areas							
Counter Positions	28	57	33	60	40	60	47
Subtotal Area + 25% Circulation (SF)	10,500	21,400	12,500	22,500	14,900	22,500	17,800
Ready/Return/Storage Areas		`					
Ready/Return Spaces	909	2,345	1,081	2,655	1,287	2,885	1,532
Storage Spaces	1,507	1,700	1,793	1,825	2,133	1,925	2,540
Subtotal Ready/Return & Storage Area (SF)	508,300	900,000	604,600	1,002,300	719,700	1,082,300	856,800
Exit Booths	9	9	11	11	13	13	16
Subtotal Area + 20% Circulation (SF)	610,200	1,080,200	725,800	1,203,000	864,000	1,299,100	1,028,500
QTA/Service Site							
Fueling Positions	29	50	35	56	42	58	50
Wash Bays	5	12	6	14	7	14	8
Stacking and Staging Spaces	176	176	210	210	250	250	297
Maintenance Bays	13	19	15	21	18	21	22
Administrative Area (SF)	21,573	20,100	25,663	21,600	30,543	24,100	36,364
Employee Parking	249	307	297	377	353	409	420
Subtotal area + 20% Circulation (SF)	178,073	223,900	211,863	263,600	252,043	286,400	300,064
Small Market Entrant (2% of total area)	16,000	26,500	19,000	29,800	22,600	32,200	26,900
Total Facility Area (SF)	**814,800**	**1,352,000**	**969,200**	**1,518,900**	**1,153,500**	**1,640,200**	**1,373,300**
Landscaping/Circulation [15% of Total Facility Area](SF)	122,200	202,800	145,400	227,800	173,000	246,000	206,000
TOTAL REQUIREMENT - SQUARE FEET	***937,000***	***1,554,800***	***1,114,600***	***1,746,700***	***1,326,500***	***1,886,200***	***1,579,300***
TOTAL REQUIREMENT - ACRES	***22***	***36***	***26***	***40***	***30***	***43***	***36***

[1/] 2040 needs were not requested in the questionnaires that were distributed to each brand

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Goals of ConRAC Site Selection and Terminal Area Land Use

- Maximize the use of available land to the east and west of the parking garage complex
  - Protect for long-term development interests in the terminal area
  - Ensure that long-term master plan recommendations can be achieved
- Focus on accommodating facility requirements through 2040 planning year
- Prefer vehicular access to the selected site via multiple routes
- Desire to minimize impact on Airport Boulevard traffic and existing tenants
- Minimize shuttle bus operations (consolidated shuttle) or eliminate shuttles altogether for passenger transfer between the terminal and the ConRAC
  - Minimize the walking distance between the terminals and the ConRAC

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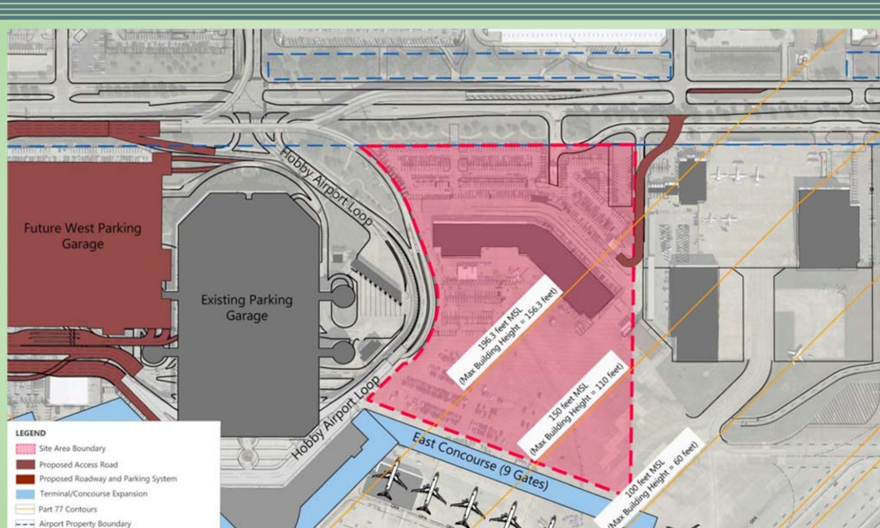
Height Implications of Potential Sites



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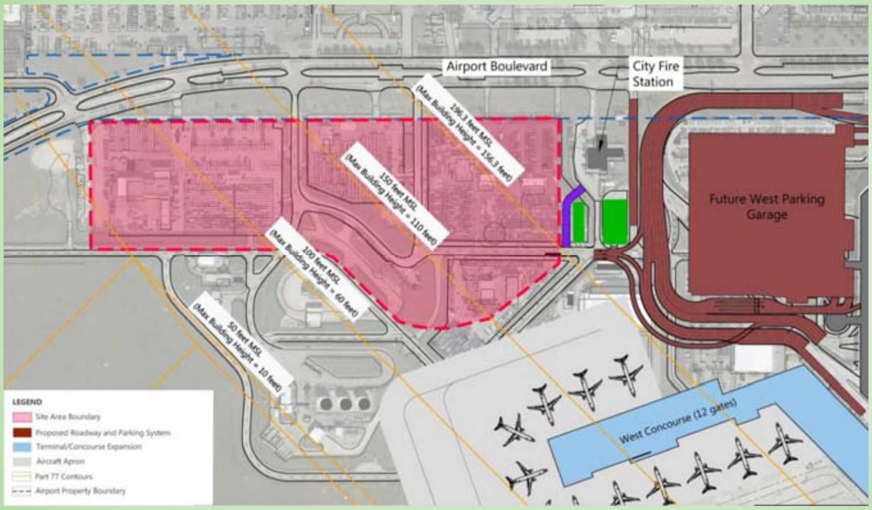
Height Implications of Potential Sites



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ConRAC Site Alternatives

- Three on-Airport sites are large enough to accommodate ConRAC facility requirements
  - Alternative 1 – East of the parking garages
  - Alternative 2 – West of the parking garages
  - Alternative 3 – South quadrant of Airport. (This site was not evaluated due to accessibility and low level of service (LOS) for the customer.)
- Evaluation criteria includes:
  - “Implement-ability” of the site
  - Vehicular access (way finding, ingress/egress, tenant impacts)
  - Passenger access and LOS (transfer between terminal and ConRAC)
  - Site suitability (acreage available, expandability, operational efficiency)
  - Consistency with long-term airport strategies

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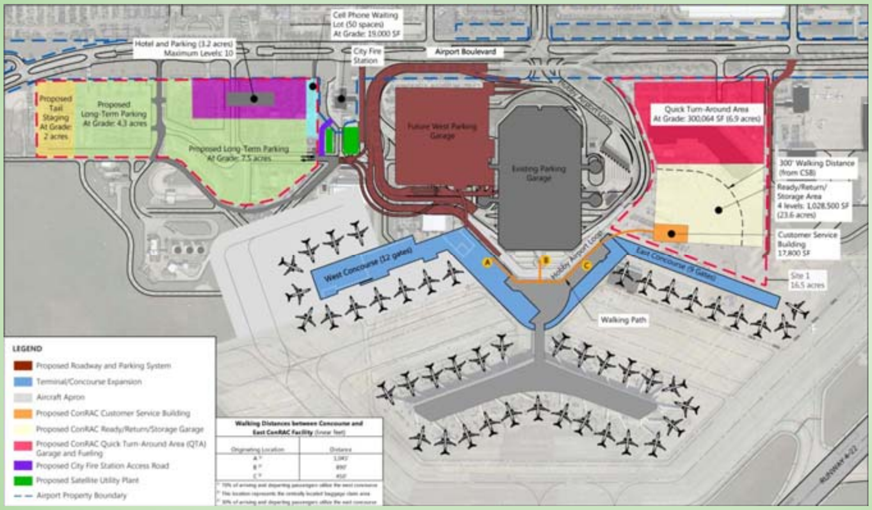
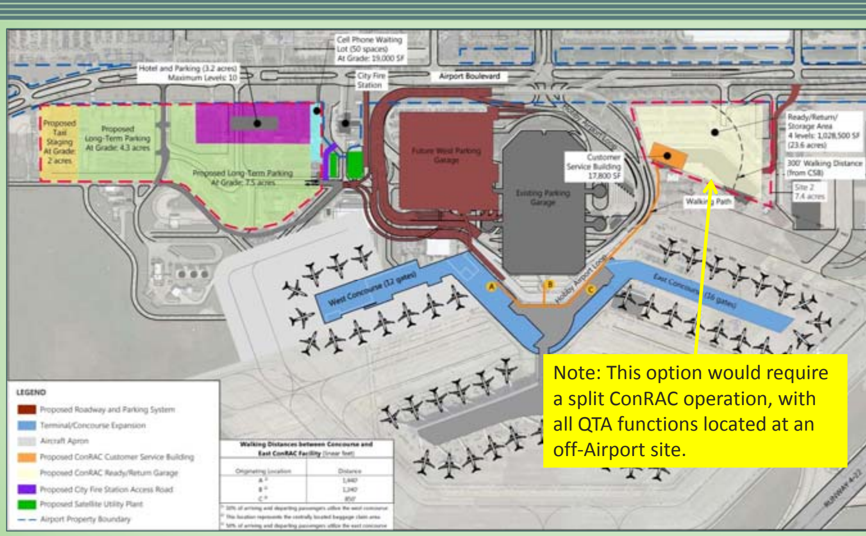
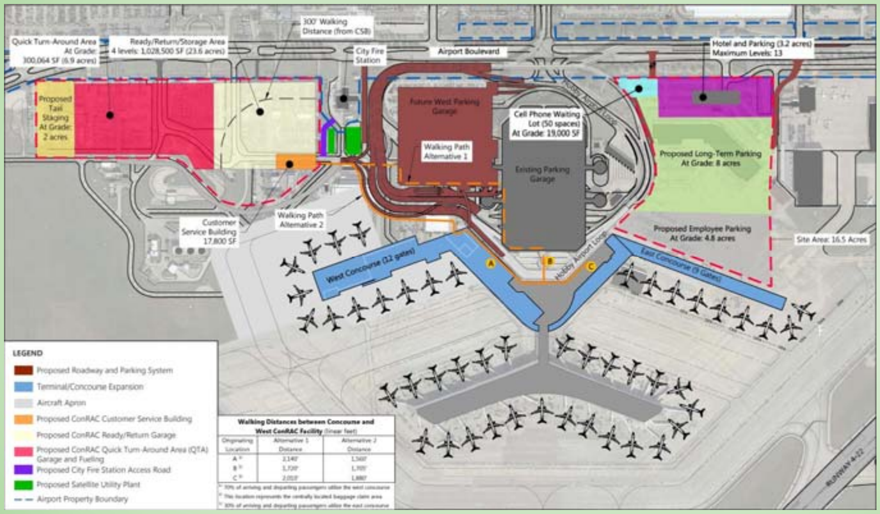
Alternative 1 (East ConRAC) with Single-Loaded Concourse



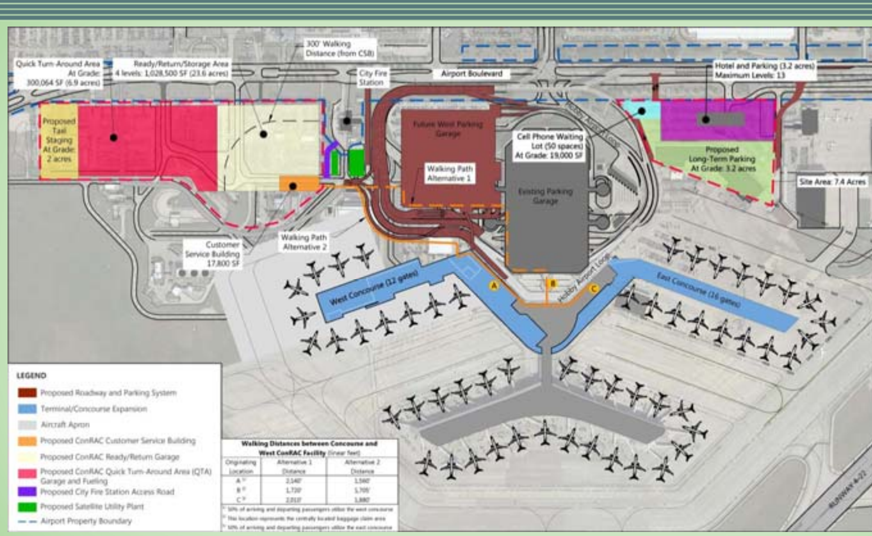
Alternative 1 (East ConRAC) with Double-Loaded Concourse



Alternative 2 (West ConRAC) with Single-Loaded Concourse



Alternative 2 (West ConRAC) with Double-Loaded Concourse



Implementation Strategy for Alternative 2 (West ConRAC)

- Prior to construction, the "cargo and provisioning" facilities would need to be relocated
- During construction, all west-side rental car operations would need to be temporarily relocated to the east side, displacing existing long-term and employee parking spaces (after new garage is opened in 2015)

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Pedestrian Distances for Alternative Sites

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Appendix C

Public Meeting Presentation Materials

Hobby Airport Master Plan Update

Public Meeting #1

March 6, 2014

William P. Hobby Airport

PHOTOS COURTESY OF HOUSTON AIRPORT SYSTEM

Airport Master Plan Update (2012-2030) **Public Meeting**

March 6, 2014

Agenda

- Introductions
- Master Planning Process:
  - FAA regulations and guidelines
  - New developments shortly after initiation of this master plan
  - Community involvement
- Master Plan Overview:
  - On-airport developments
  - Off-airport developments
- Q&A

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The Role of Houston Airport System

- George Bush Intercontinental (IAH)
  - The City's largest airport and global gateway; 40 million passengers
- William P. Hobby (HOU)
  - Future introduction of international flights; 11 million passengers
- Ellington Airport (EFD)
  - A commerce and aviation center; potential spaceport site



"We exist to connect the people, the businesses, the cultures and the economies of the world to Houston."

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Economic Impact of Hobby on the City of Houston (2010)

Total Economic Impact	Jobs Created	Earnings Generated
$4.4 Billion	52,000 Jobs	$1.7 Billion
"The total economic impact of Hobby is over $4.4 billion for the Houston Regional Economy."	**"Hobby is responsible for over 52,000 full time equivalent jobs."**	**"Hobby generates $1.7 billion in employee & proprietor earnings."**

GRA, Incorporated; Economic Impact Study June 30, 2011

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- $156 million investment for the construction of the international terminal
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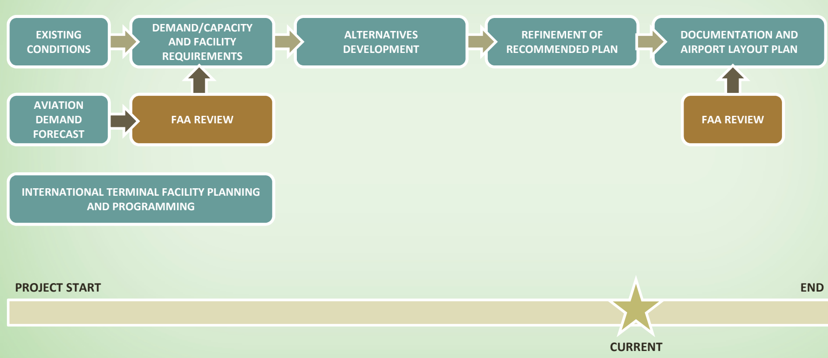
Master Plan Process and Status

- The HOU Master Plan Update focusses on development recommendations through the year 2030



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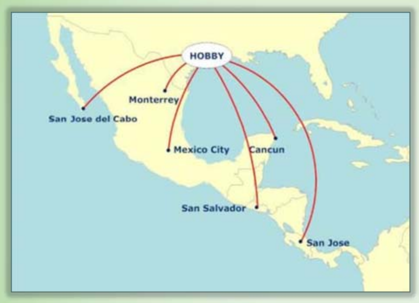
William P. Hobby Airport

AVIATION ACTIVITY FORECAST SUMMARY

International Destinations Potentially Served from Hobby Airport

Potential Destinations – Initial Phase



Potential Destinations – Developed Phase

Prepared by GRA, Inc. and InterVISTAS Consulting LLC and presented in:
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Range Limitation of Modern Boeing 737 Aircraft

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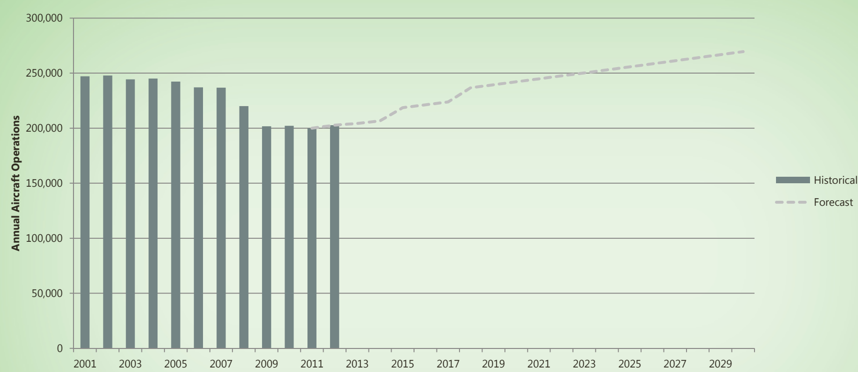

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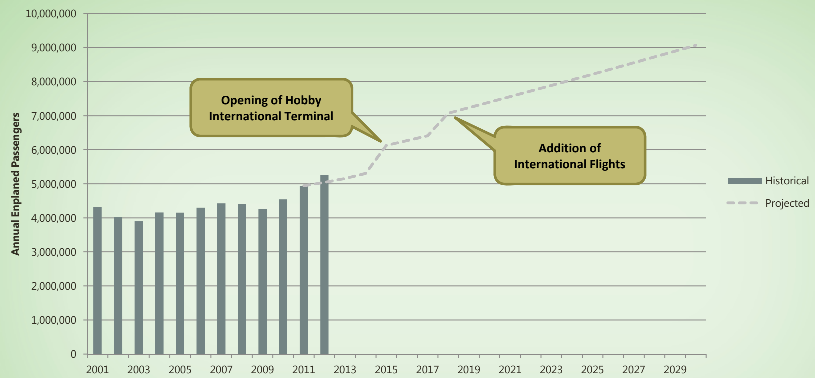

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Recommended Airport Development : Airfield

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- Associated taxiway network
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Parcels Anticipated to be Impacted by Runway 12L-30R Upgrade

Source: Ongoing Master Plan

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Potential Land Acquisition for Runway 12L-30R Improvements

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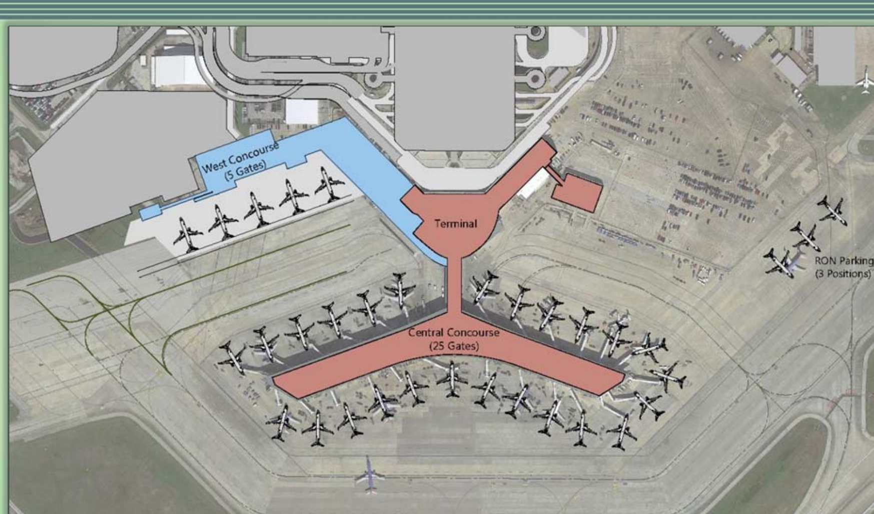
Phase 1 Terminal Expansion
30 Total Gates (2015)



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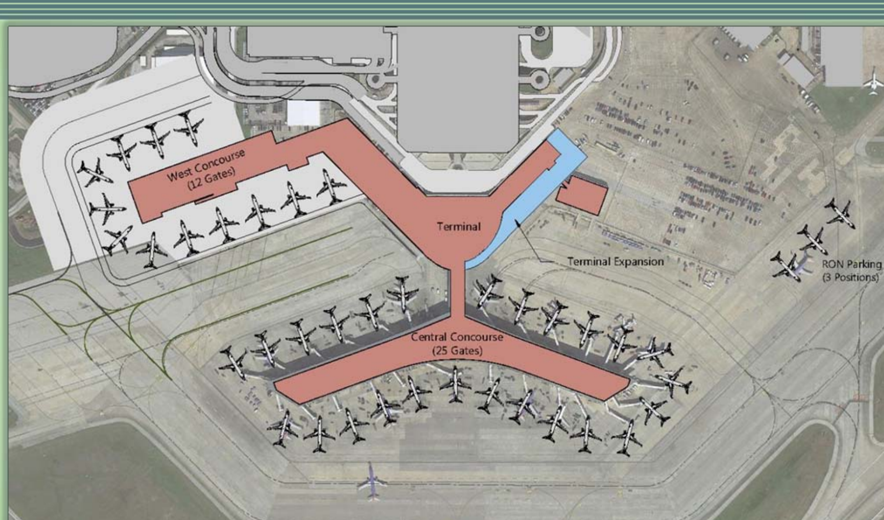

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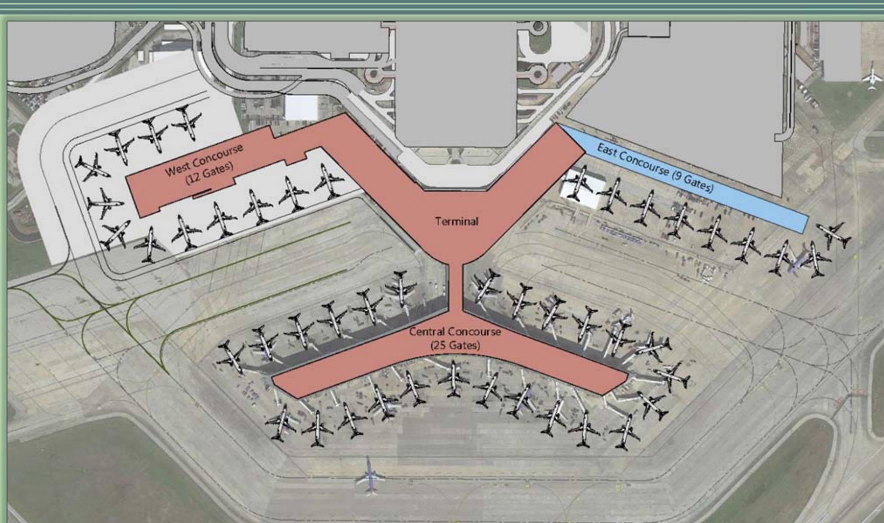

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Hobby International Terminal Rendering

Rendering prepared by *Corgan Associates*

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Hobby International Terminal Rendering
Check-In Hall

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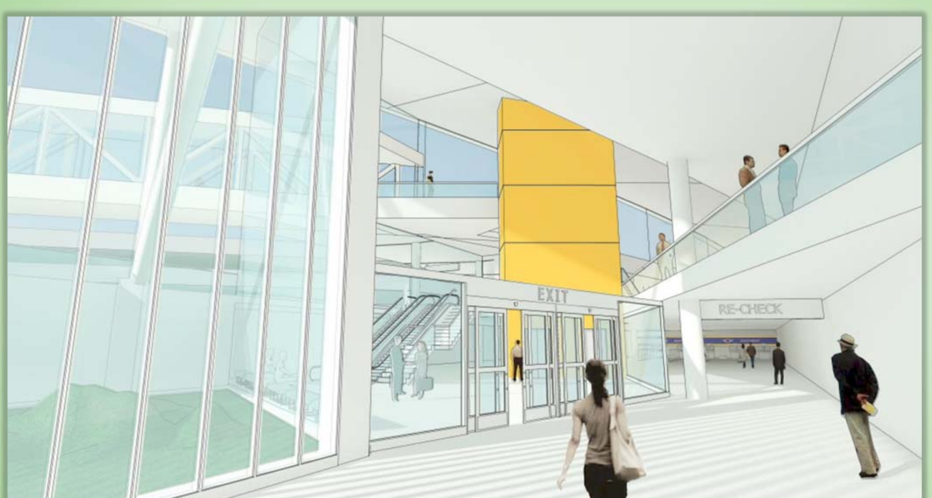
International Arrivals Exit



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Hobby International Terminal Rendering

Upper-Level (Departures) Roadway

Rendering prepared by *Corgan Associates*

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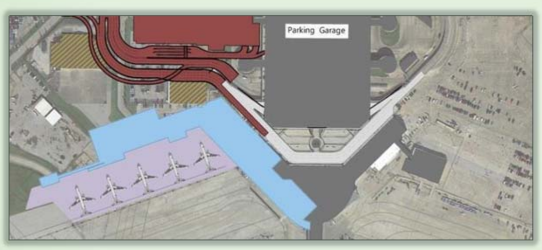
William P. Hobby Airport

Recommended Airport Development : Landside

Terminal Curbside

- Curbside congestion during peak-hour operations
  - Upper level (departures level) - in front of Southwest Airlines' ticket counters
  - Lower level (arrivals level) – Rental car and parking shuttles



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On-Airport Parking

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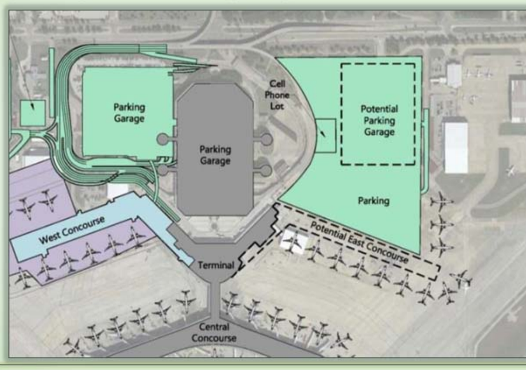

Expanded Ecopark 2 provides 100 new public parking spaces during construction. New parking garage will provide additional 2,500 parking spaces.

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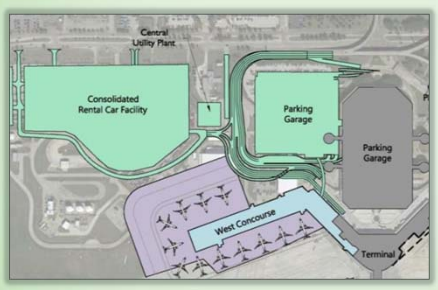
Rental Car Facilities

- Multiple rental car shuttles operate simultaneously, creating curbside congestion (lower level)
- Vehicle storage constraints at some rental car company facilities



Consolidated facility will reduce curbside congestion, increase vehicle storage, and enhance customer service.

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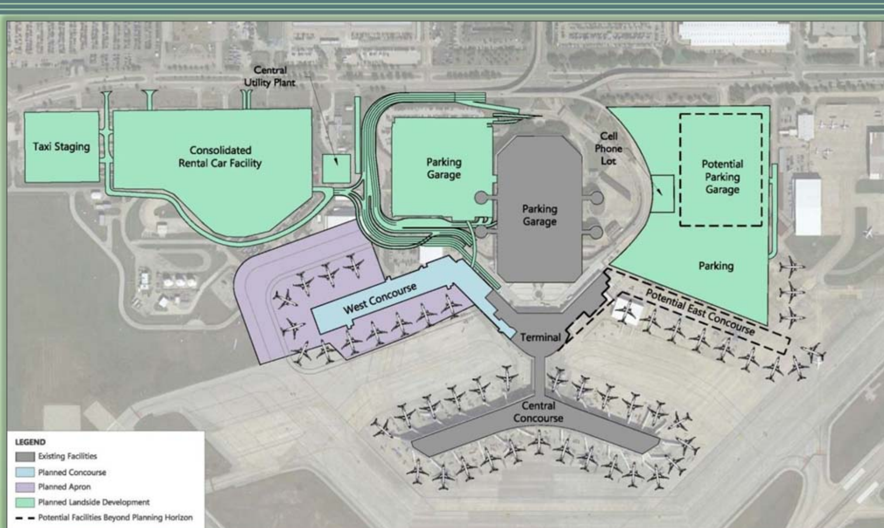
Terminal Area Plan (Ultimate)



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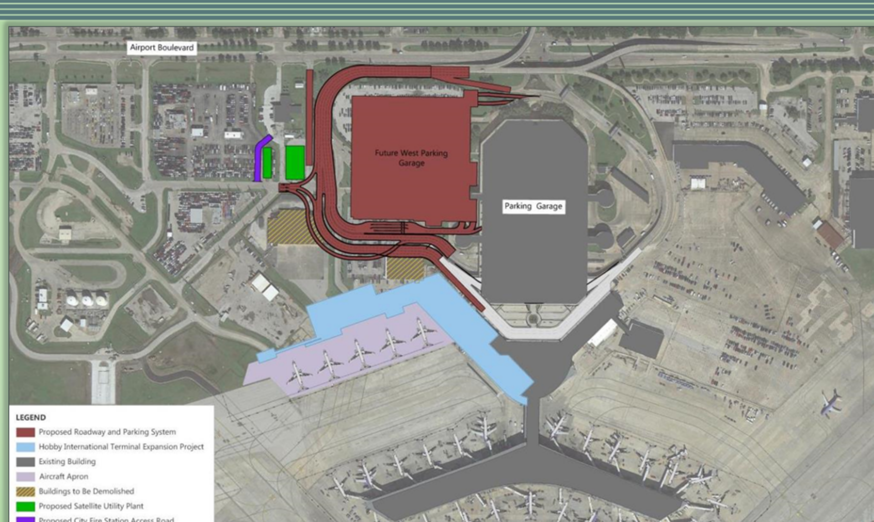
Terminal Area Plan
What You Will See in 2015



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West Parking Garage Rendering

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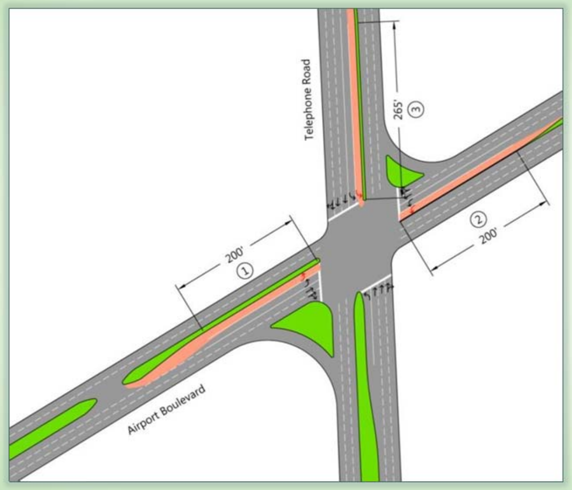
Recommended Roadway Intersection Improvements

Study Area:

34

Recommended Roadway Intersection Improvements
Airport Boulevard & Telephone Road



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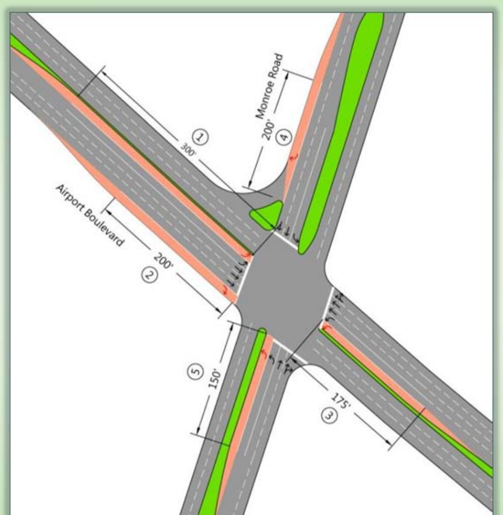
Recommended Roadway Intersection Improvements
Airport Boulevard & Monroe Road



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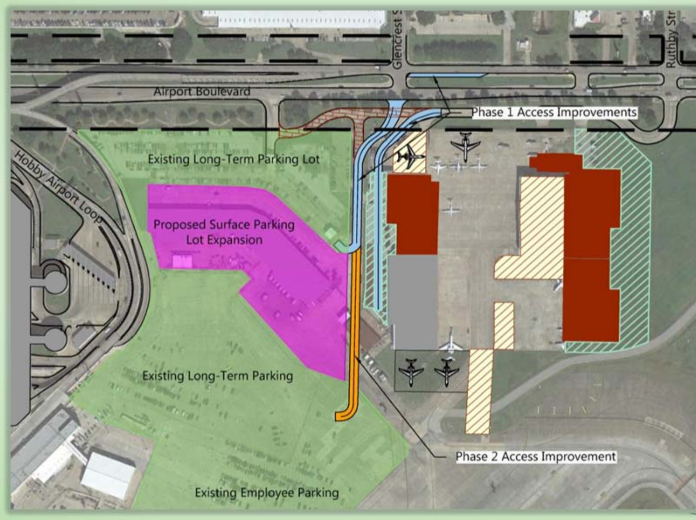
Recommended Long-Term Parking Lot Access Improvements



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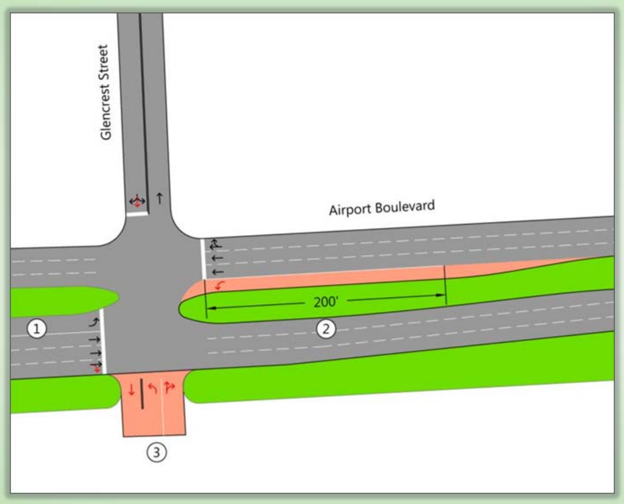
Recommended Roadway Intersection Improvements Airport Boulevard & Glencrest Street



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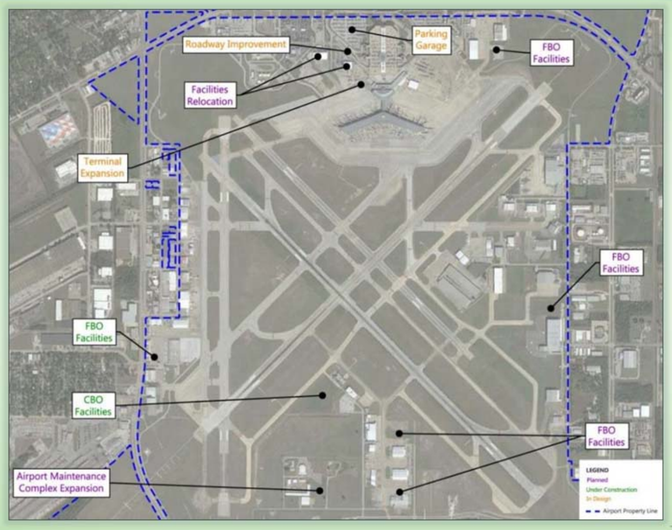
Hobby Airport – Development Projects



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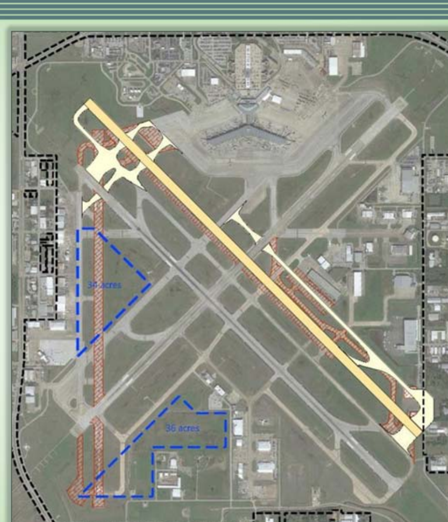
Available On-Airport Development Areas

- Available Areas:
  - South quadrant:
    - 20 acres available now
    - Additional 16 acres after closure of Runway 17-35
  - West quadrant:
    - 34 acres after closure of Runway 17-35
- Space available exceeds requirements
  - Potential for other non-aeronautical developments



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Recommended On-Airport Development Plan (2014-2030)

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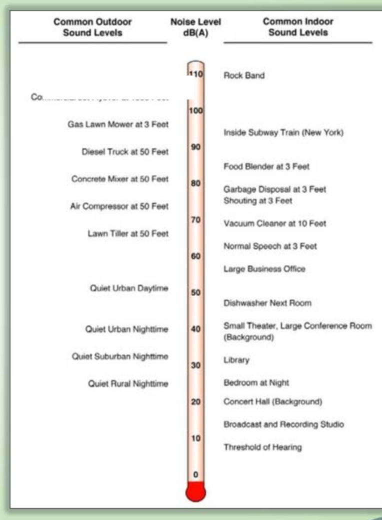
William P. Hobby Airport

Noise and Off-Airport Developments

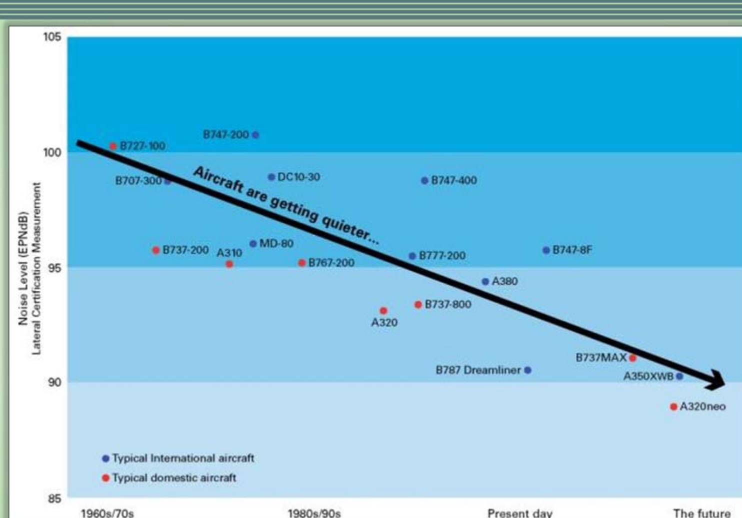
Relative Noise Levels

- Airport noise levels between 65 DNL and 75 DNL are typically evaluated during a master plan
  - DNL is the weighted average sound level over a 24-hour period, measured in decibels.



43

Aircraft Are Getting Quieter



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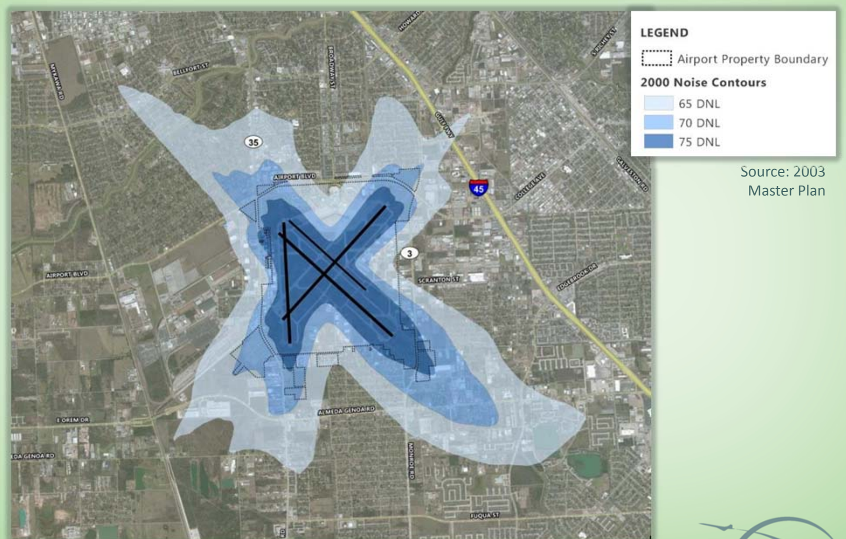
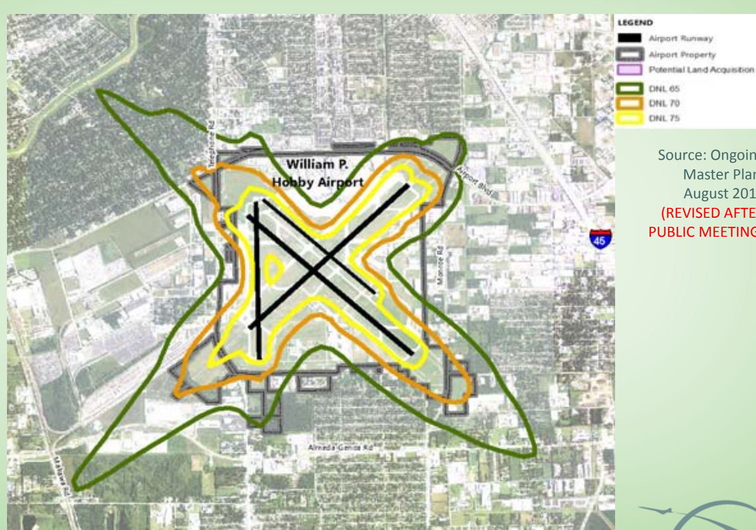
2000 Noise Contours
(75 DNL through 65 DNL)



Source: 2003 Master Plan

45

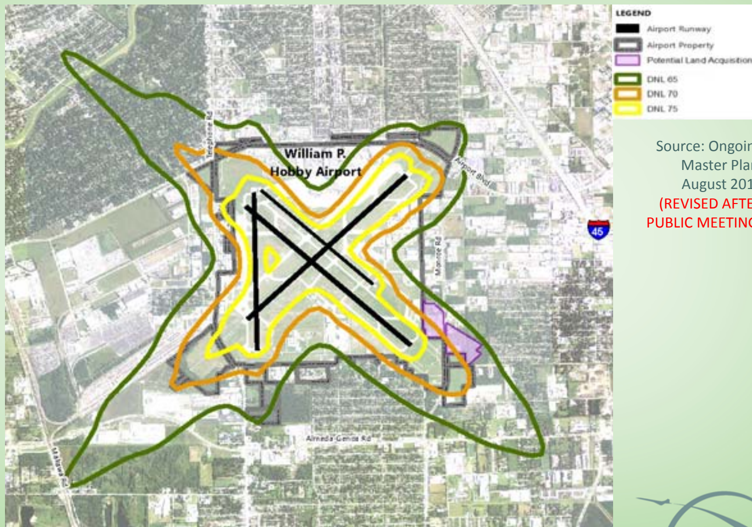
2011 Noise Contours
(75 DNL through 65 DNL)



Source: Ongoing Master Plan, August 2014 (REVISED AFTER PUBLIC MEETING)

46

2020 Noise Contours
(75 DNL through 65 DNL)



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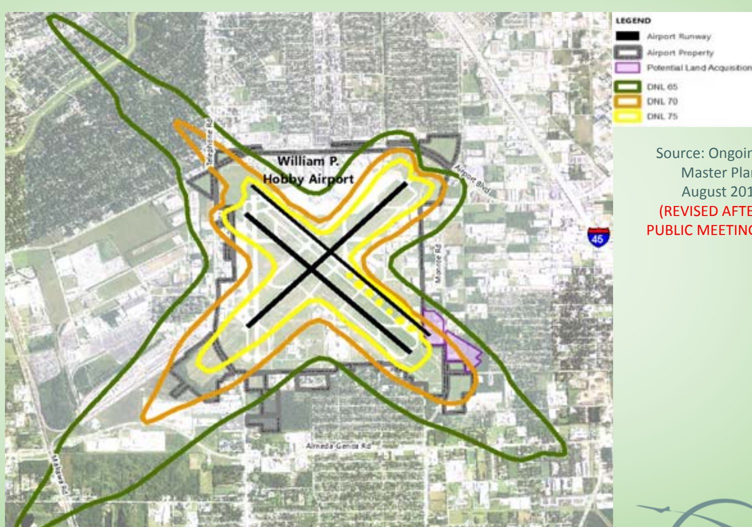
2030 Noise Contours
(75 DNL through 65 DNL)



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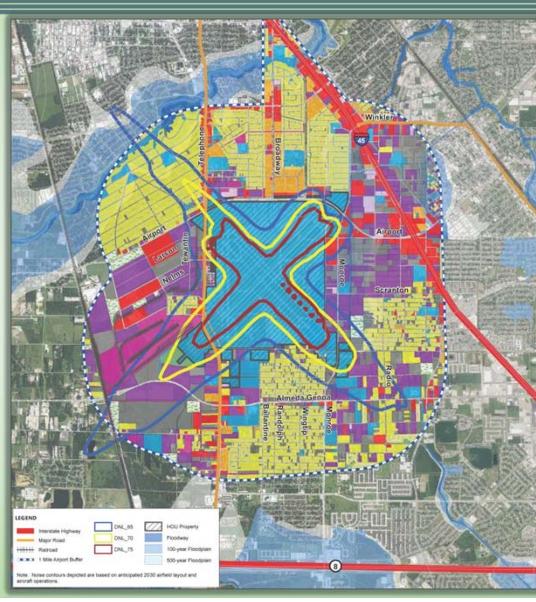
2012 Land Use with 2030 Noise Contours



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(NOISE CONTOURS REVISED AFTER PUBLIC MEETING)

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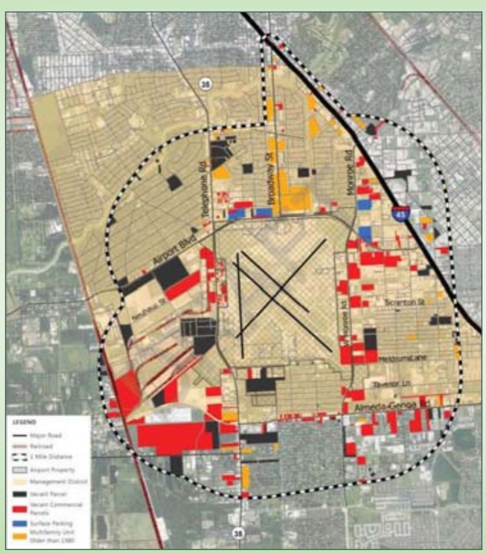
Land Use Opportunities and Constraints



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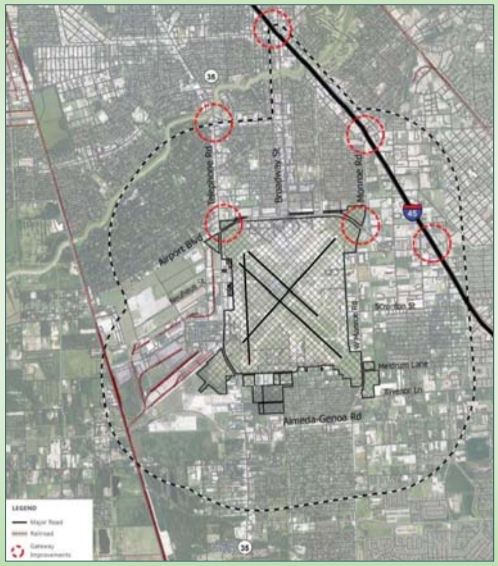
Area Concept Plan



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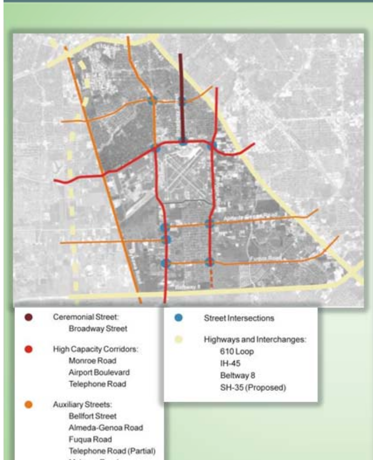
Streetscape Concepts from HOU Image Plan

Llewelyn-Davies Sahni, Inc. (2003)



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Proposed Landscaping Plan for Airport Boulevard

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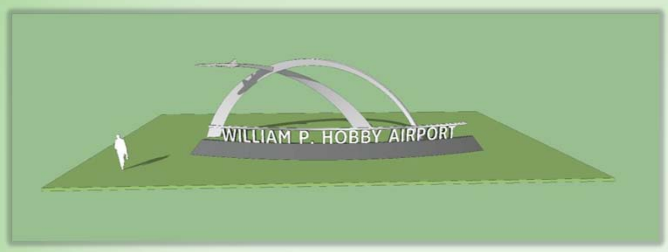
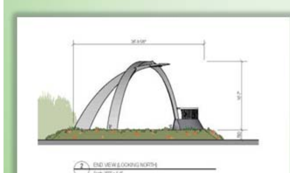
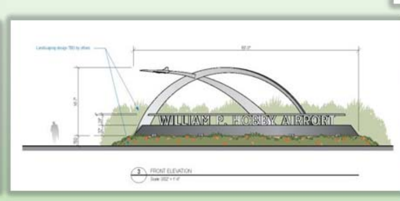
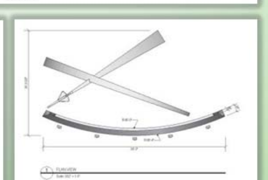
Roadway Entry Monument Design for HOU

Labozan Associates (2014)









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Roadway Entry Monument Design for HOU
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Roadway Entry Monument Sign at IAH

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Questions and Answers

Hobby Airport Master Plan Update

Public Meeting #2

April 9, 2014

William P. Hobby Airport

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Airport Master Plan Update (2012-2030) **Public Meeting**

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- Overview of Current Master Plan Recommendations
- Upcoming Projects
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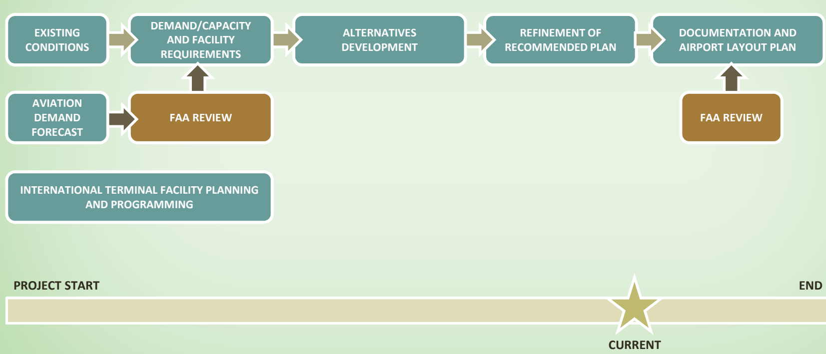

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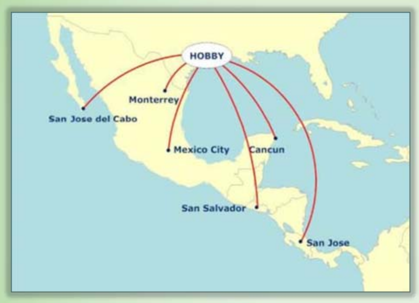

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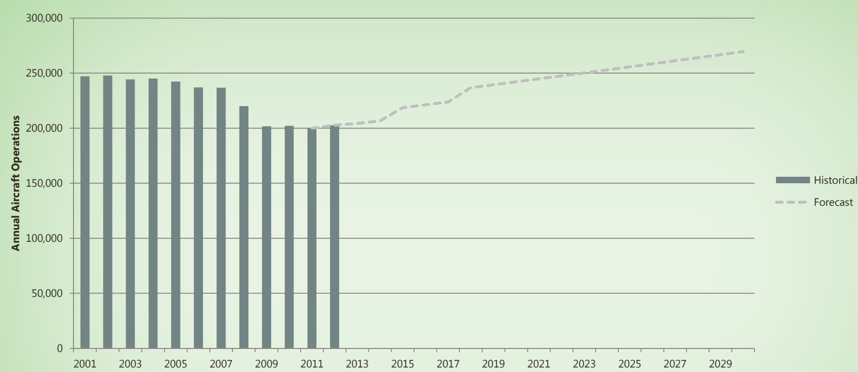

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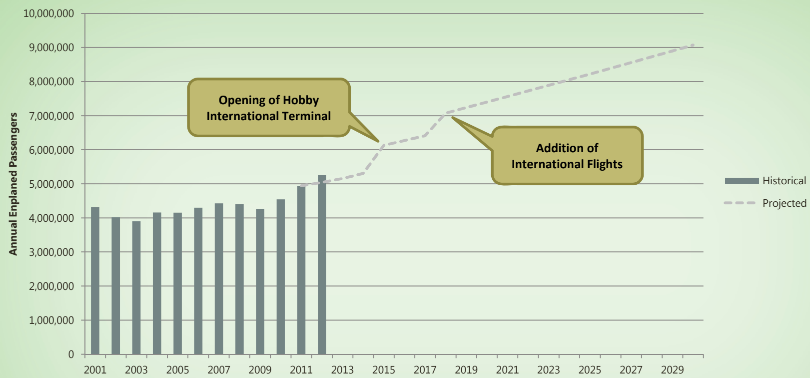

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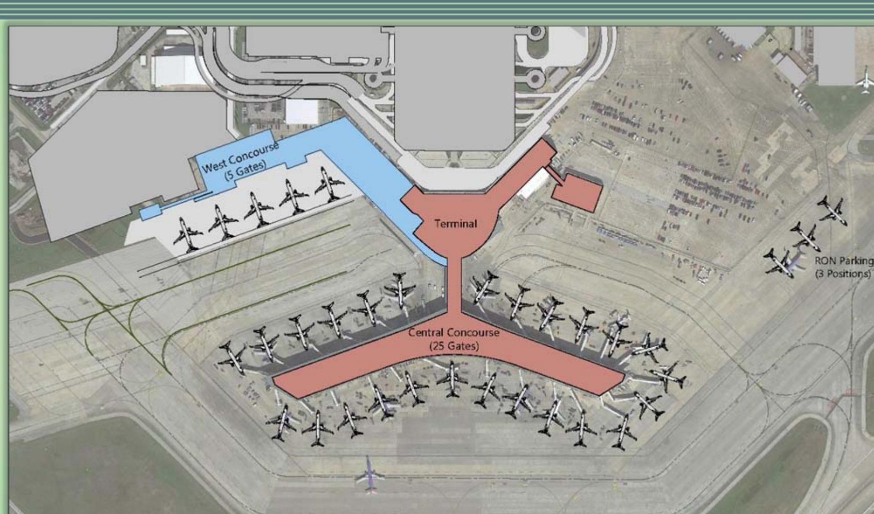

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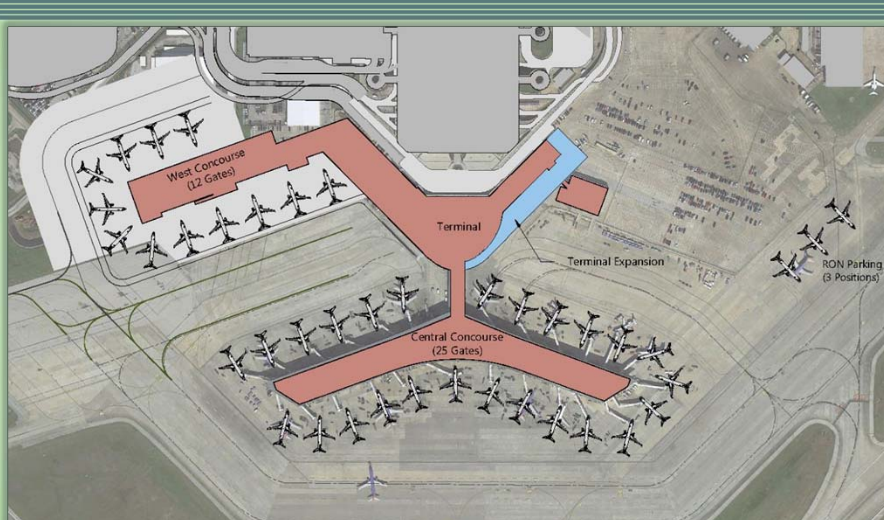

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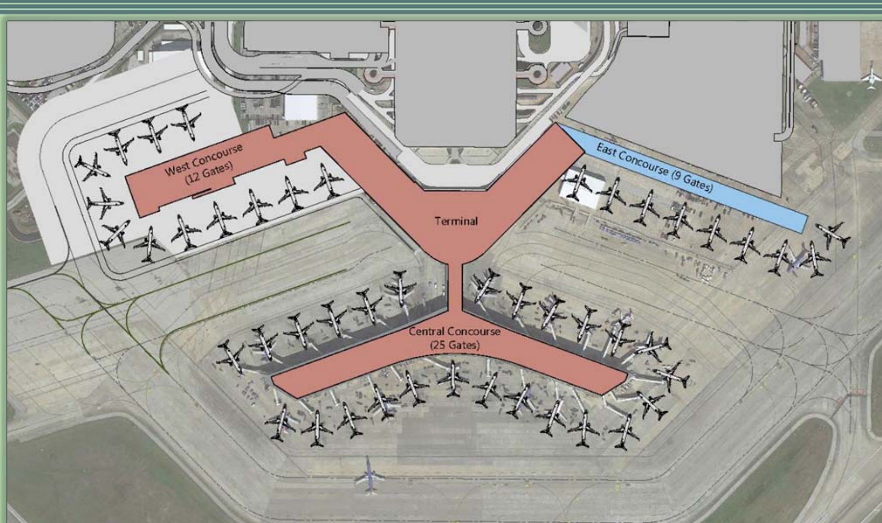

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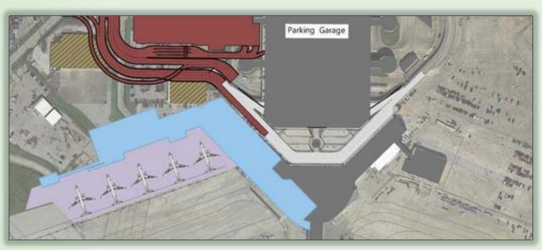

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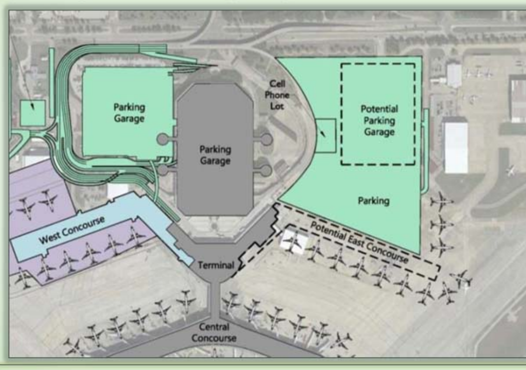
- Off-Airport parking can reach capacity

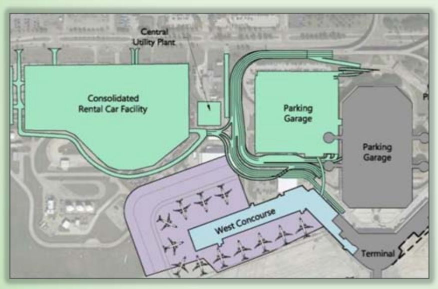


Expanded Ecopark 2 provides 100 new public parking spaces during construction. New parking garage will provide additional 2,500 parking spaces.

29

Rental Car Facilities

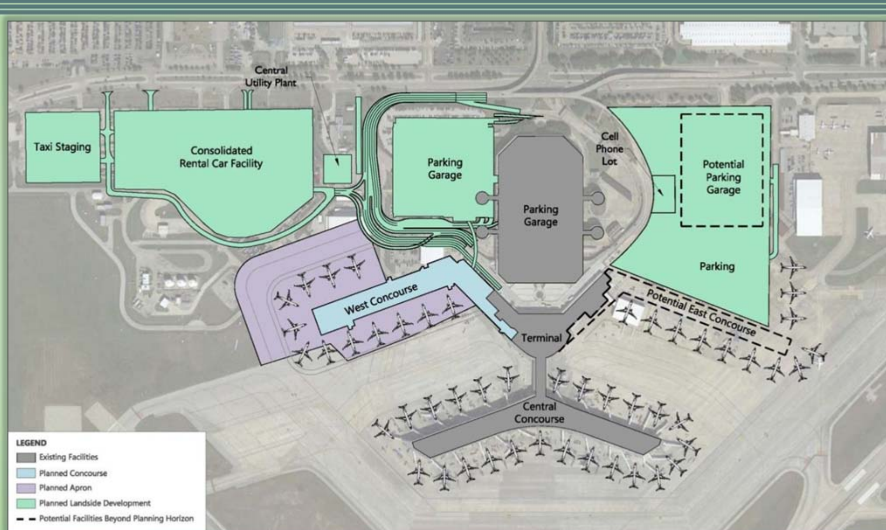
- Multiple rental car shuttles operate simultaneously, creating curbside congestion (lower level)
- Vehicle storage constraints at some rental car company facilities



Consolidated facility will reduce curbside congestion, increase vehicle storage, and enhance customer service.

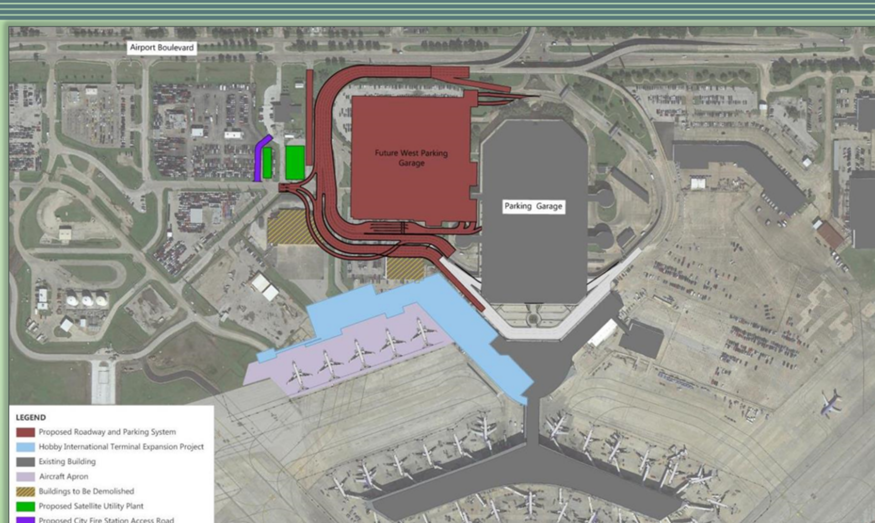
30

Terminal Area Plan (Ultimate)



31

Terminal Area Plan
What You Will See in 2015



32

West Parking Garage Rendering

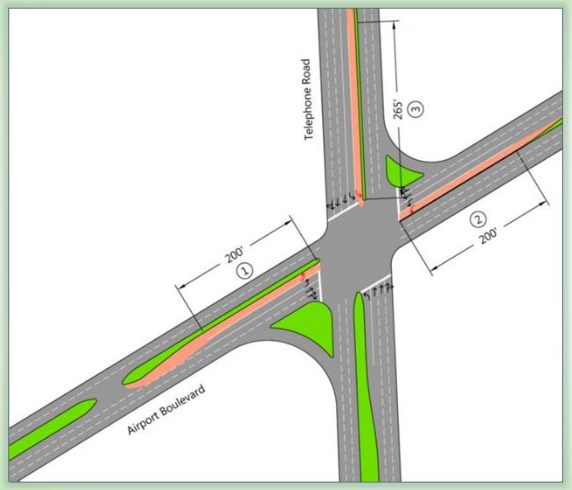
33

Recommended Roadway Intersection Improvements

Study Area:

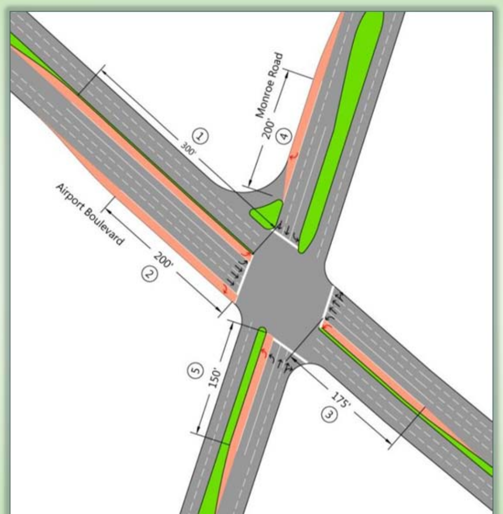
34

Recommended Roadway Intersection Improvements
Airport Boulevard & Telephone Road



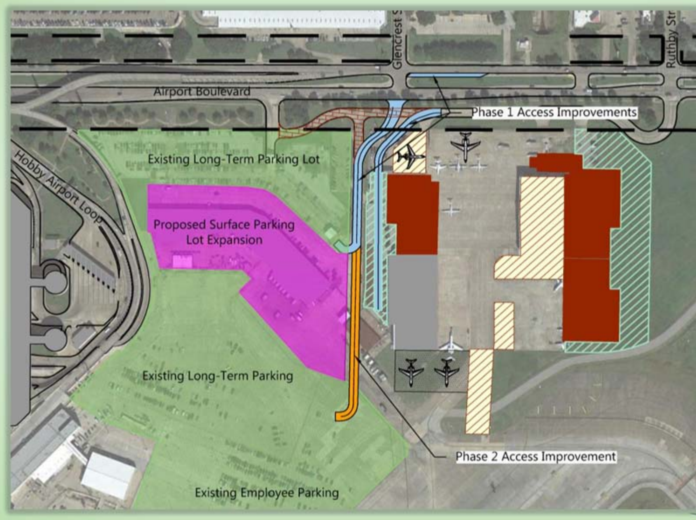
35

Recommended Roadway Intersection Improvements
Airport Boulevard & Monroe Road



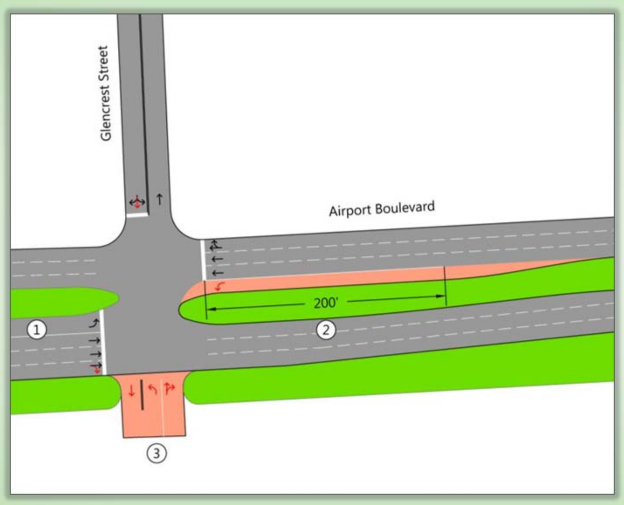
36

Recommended Long-Term Parking Lot Access Improvements



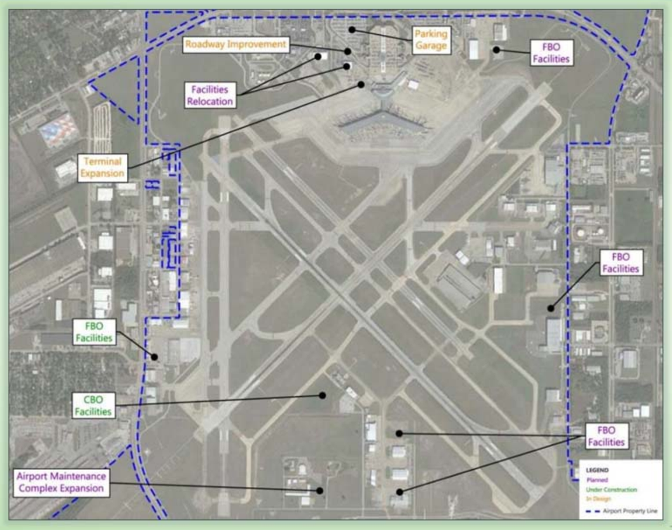
37

Recommended Roadway Intersection Improvements Airport Boulevard & Glencrest Street



38

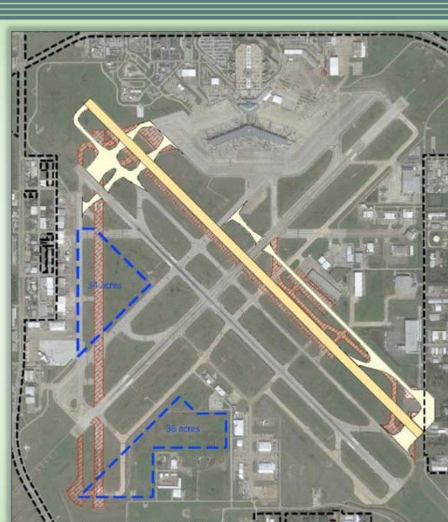
Hobby Airport – Development Projects



39

Available On-Airport Development Areas

- Available Areas:
  - South quadrant:
    - 20 acres available now
    - Additional 16 acres after closure of Runway 17-35
  - West quadrant:
    - 34 acres after closure of Runway 17-35
- Space available exceeds requirements
  - Potential for other non-aeronautical developments



40

Recommended On-Airport Development Plan (2014-2030)

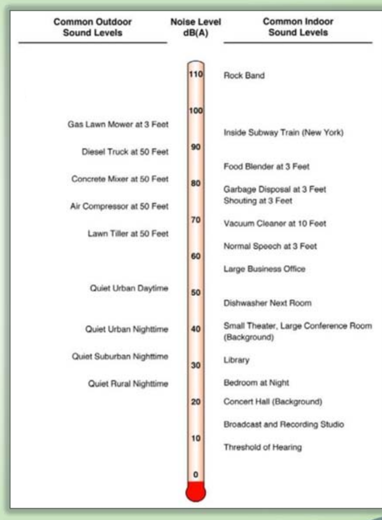
41

William P. Hobby Airport

Noise and Off-Airport Developments

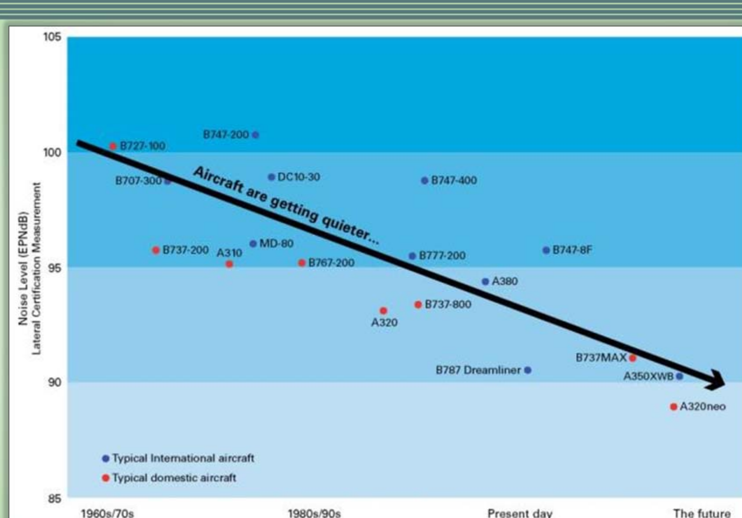
Relative Noise Levels

- Airport noise levels between 65 DNL and 75 DNL are typically evaluated during a master plan
  - DNL is the weighted average sound level over a 24-hour period, measured in decibels.



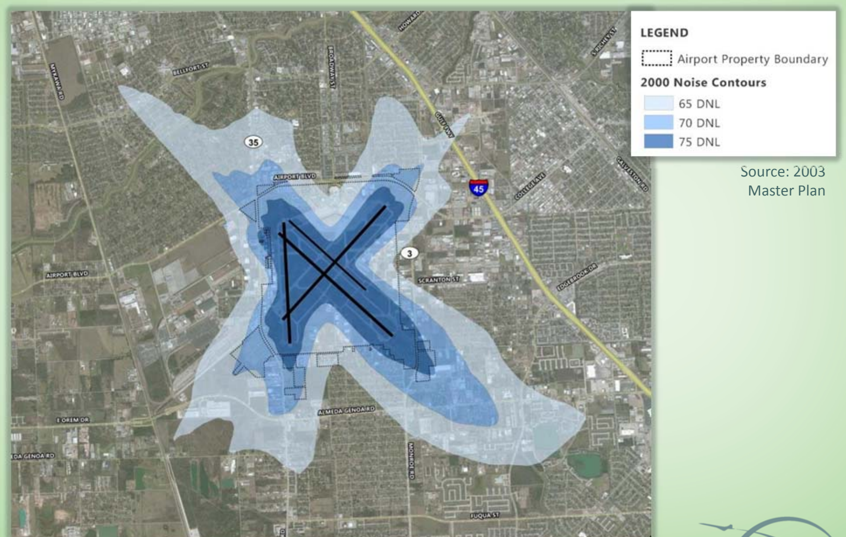
43

Aircraft Are Getting Quieter



44

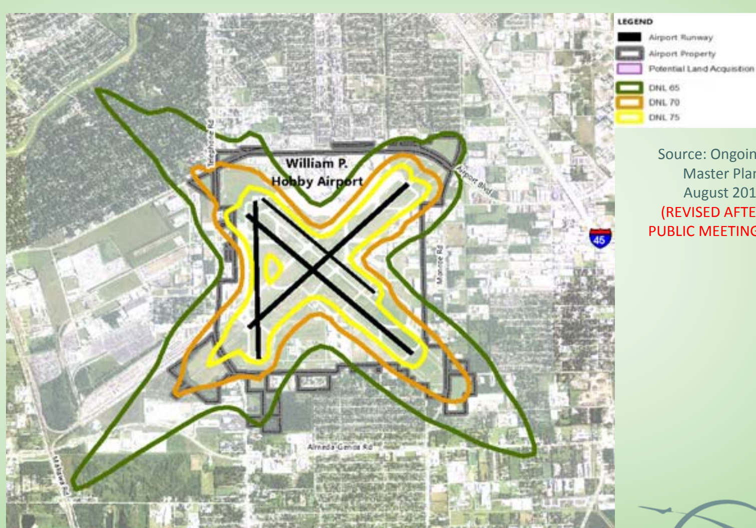
2000 Noise Contours
(75 DNL through 65 DNL)



Source: 2003 Master Plan

45

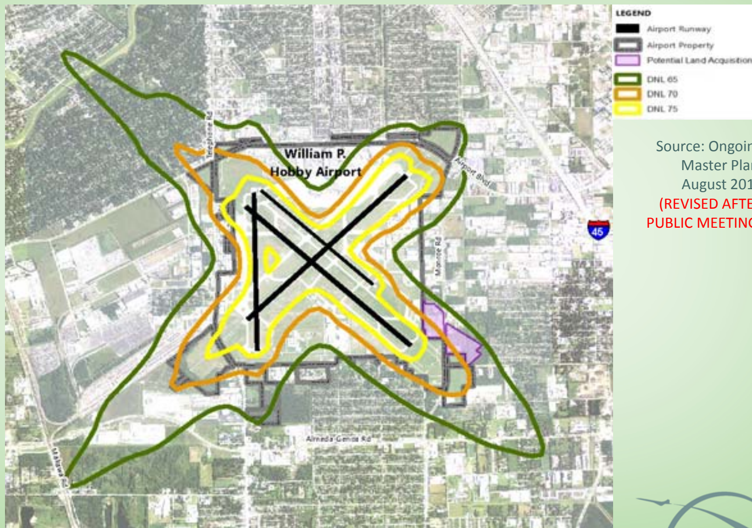
2011 Noise Contours
(75 DNL through 65 DNL)



Source: Ongoing Master Plan, August 2014 (REVISED AFTER PUBLIC MEETING)

46

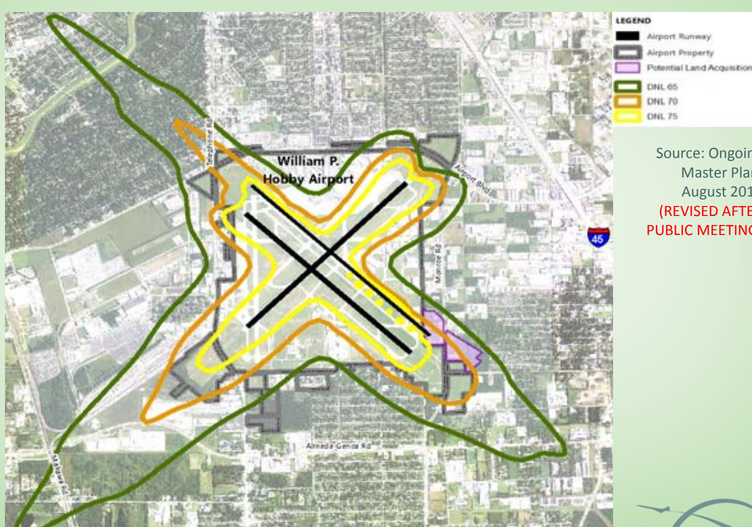
2020 Noise Contours
(75 DNL through 65 DNL)



Source: Ongoing Master Plan, August 2014
(REVISED AFTER PUBLIC MEETING)

47

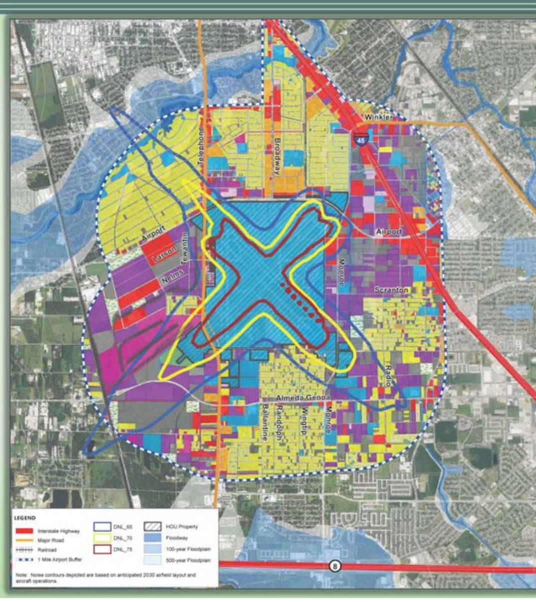
2030 Noise Contours
(75 DNL through 65 DNL)



Source: Ongoing Master Plan, August 2014
(REVISED AFTER PUBLIC MEETING)

48

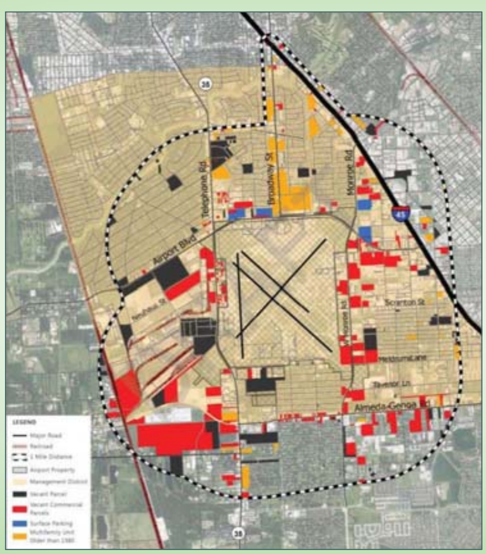
2012 Land Use with 2030 Noise Contours



Source: Ongoing Master Plan, August 2014
(NOISE CONTOURS REVISED AFTER PUBLIC MEETING)

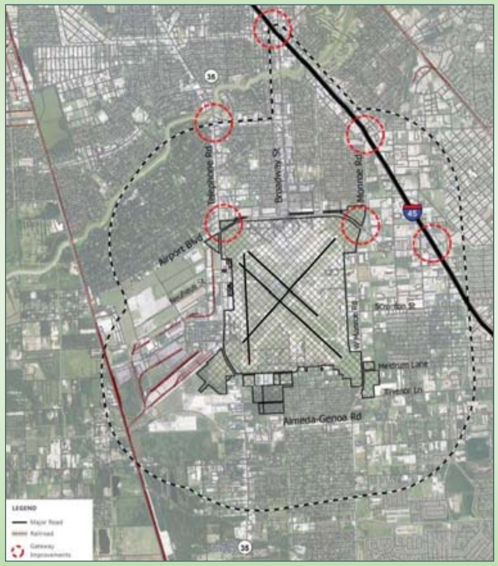
49

Land Use Opportunities and Constraints



50

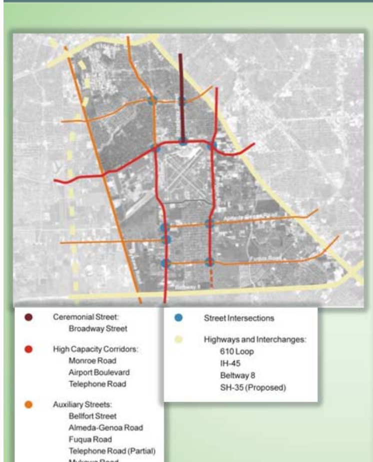
Area Concept Plan

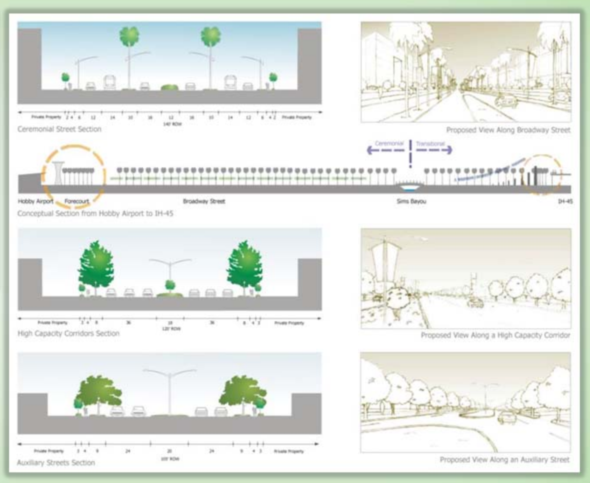


51

Streetscape Concepts from HOU Image Plan

Llewelyn-Davies Sahni, Inc. (2003)





52

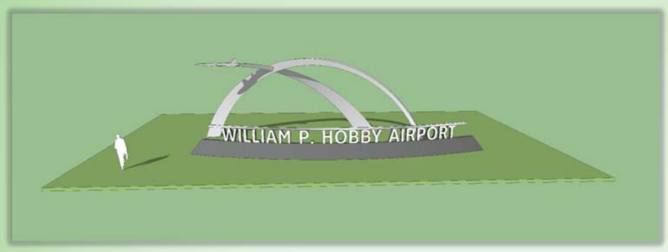
Proposed Landscaping Plan for Airport Boulevard

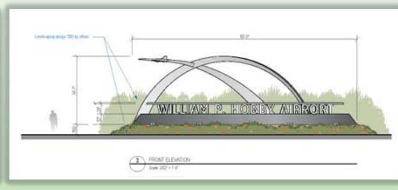
53

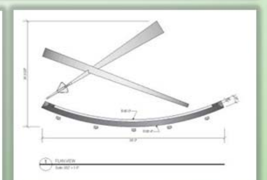
Example of Landscape Improvements on Airport Boulevard

54

Roadway Entry Monument Design for HOU
Labozan Associates (2014)







55

Roadway Entry Monument Design for HOU
Labozan Associates (2014)

56

Roadway Entry Monument Sign at IAH

57

Select Comments Received Since Previous Public Meeting

- More detailed analysis of primary arterial roadways is needed
- Request more detailed information about alternatives considered (e.,g.CONRAC locations)
- Airport Master Plan Update did not include stormwater/drainage projects

58

Questions and Answers

59 April 9, 2014

Hobby Airport Master Plan Update

Public Meeting #3

June 25, 2014

William P. Hobby Airport

PHOTOS COURTESY OF HOUSTON AIRPORT SYSTEM

Airport Master Plan Update (2012-2030) **Public Meeting**

June 25, 2014

Agenda

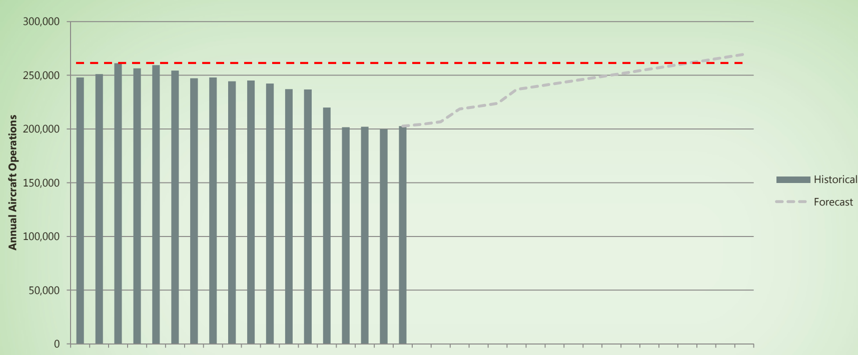
- Introductions (Perry Miller – HAS)
- Recap of Current Master Plan Recommendations (Max Kiesling – Ricondo)
- Updates on Key Master Plan Issues
  - Runway 12L-30R Upgrade (Max Kiesling – Ricondo)
  - Off-Airport Traffic Analysis (Ramesh Gunda - Gunda Corporation)
  - Property Development in Garden Villas (Carlos Ortiz - HAS)
  - City/County Drainage Improvements (HCFC and COH PWE)
  - Off-Airport Beautification Initiatives (Jason Miller – Clark Condon))
- Questions/Answers
- Closing (Perry Miller – HAS)

2

William P. Hobby Airport

RECAP OF CURRENT MASTER PLAN RECOMMENDATIONS

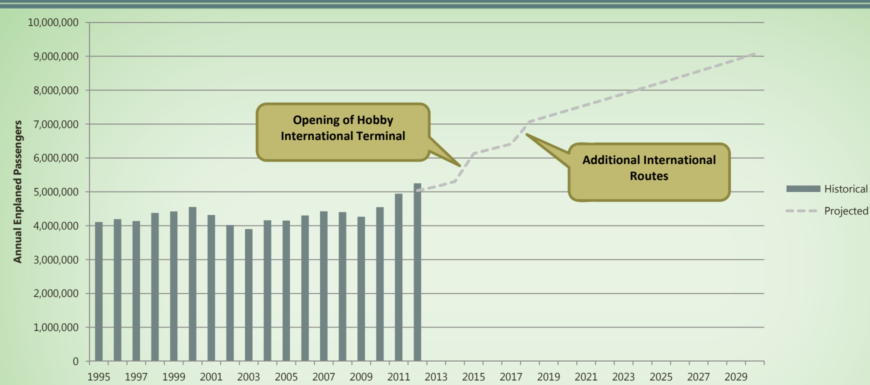
Annual Aircraft Operations



	2012	2015	2020	2030
Domestic Airlines	109,540	120,690	137,690	158,540
Foreign Flag Airlines	-	2,920	6,570	6,570
General Aviation/Other	92,874	94,950	97,860	104,430
TOTAL OPERATIONS	**202,670**	**218,560**	**242,120**	**269,540**

4

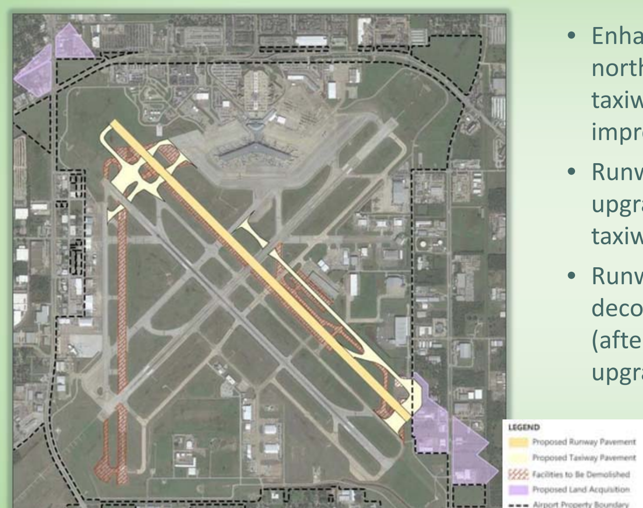
Annual Enplaned Passengers



	2012	2015	2020	2030
Domestic Airlines	5,252,139	5,639,300	6,480,500	7,956,900
Foreign Flag Airlines	-	490,400	919,400	1,113,700
TOTAL ENPLANEMENTS	**5,252,139**	**6,129,700**	**7,399,900**	**9,070,600**

5

Recommended Airfield Improvements



- Enhance safety on northwest side with taxiway layout improvements
- Runway 12L-30R upgrade and associated taxiway network
- Runway 17-35 decommissioning (after Runway 12L-30R upgrade)

6

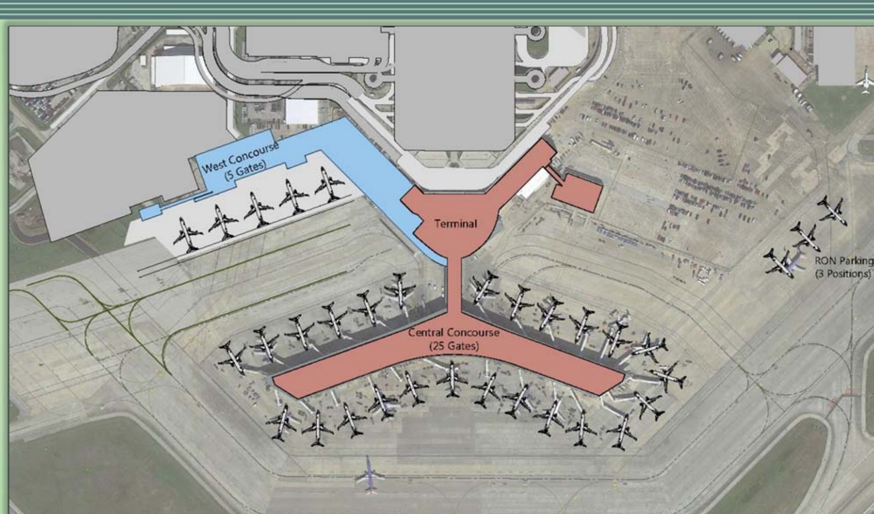
Terminal Gate Requirements

	SCHEDULE	GATE REQUIREMENTS		
YEAR	DAILY FLIGHTS	INTERNATIONAL GATES	DOMESTIC GATES	TOTAL GATES
2011	164	0	25	25
2015	188	5	25	30
2020	219	10	27	37
2030	251	12*	25*	37

* International gates may be used for domestic flights.

7

Phase 1 Terminal Expansion
30 Total Gates (2015)

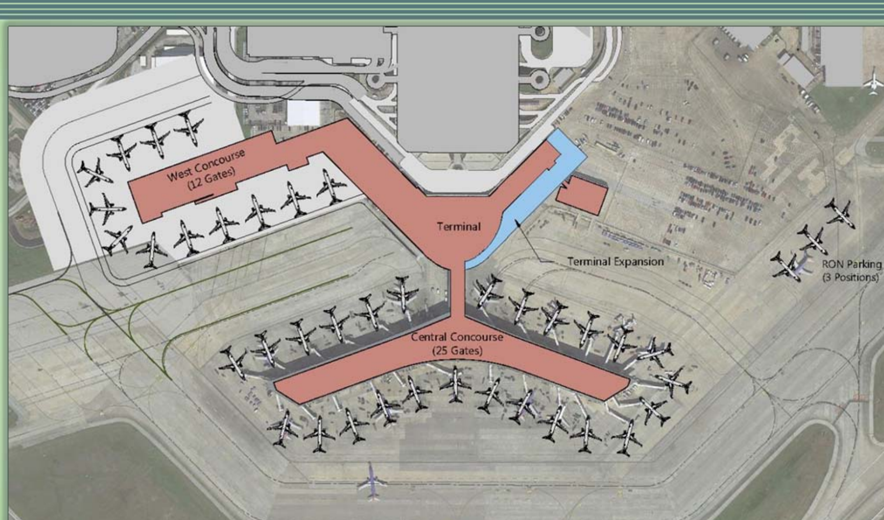


8

Phase 2 Terminal Expansion
37 Total Gates (2020-2021)

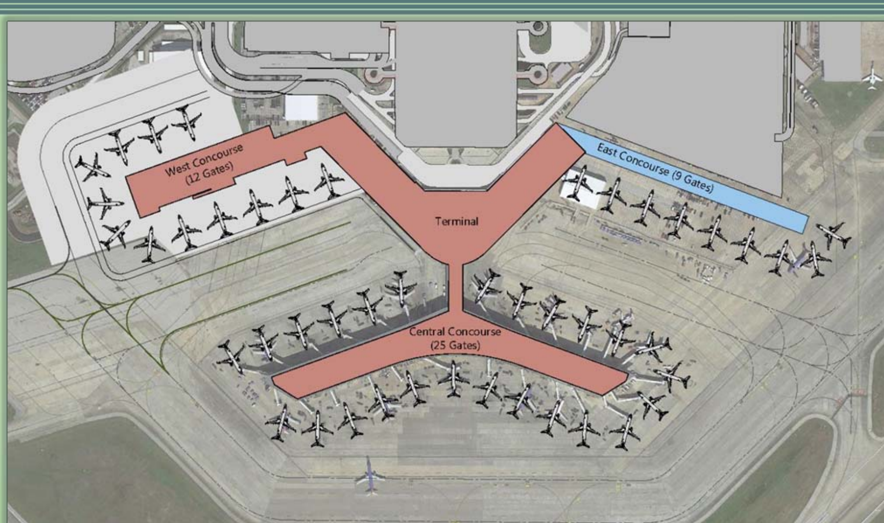
9

Phase 3 Expansion
(Demand-driven Based on Carrier Needs)



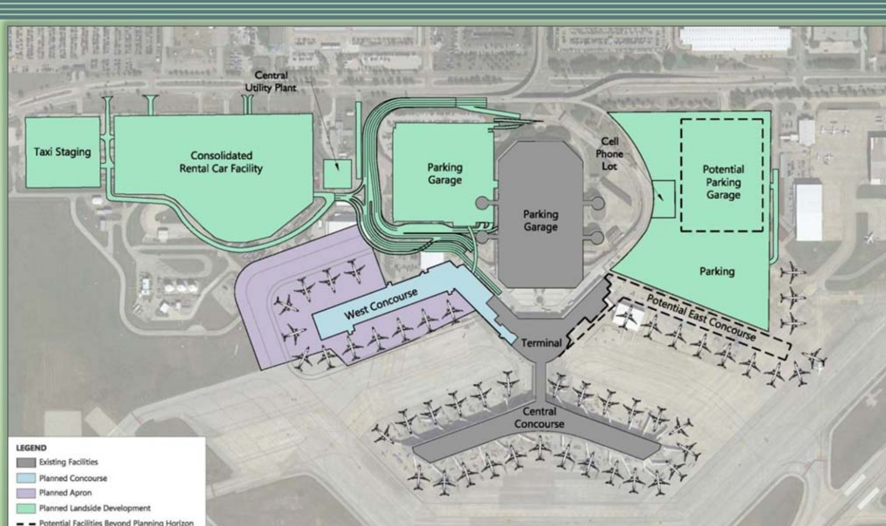
10

Ultimate Terminal Concept (Beyond Master Plan Horizon)



11

Terminal Area Plan (Ultimate)



12

Terminal Area Plan
What You Will See in 2015

13

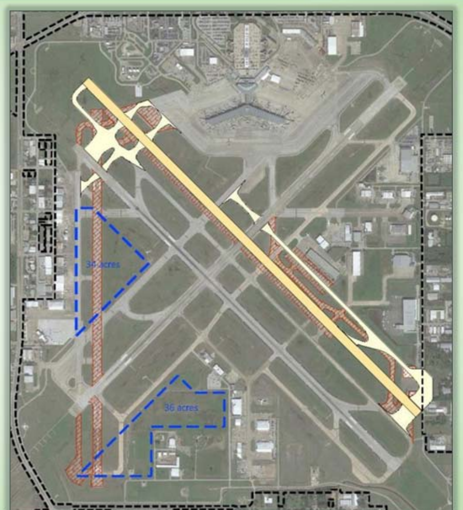
Recommended Roadway Intersection Improvements

Study Area:

14

Available On-Airport Development Areas

- Available Areas:
  - South quadrant:
    - 20 acres available now
    - Additional 16 acres after closure of Runway 17-35
  - West quadrant:
    - 34 acres after closure of Runway 17-35
- Space available exceeds requirements
  - Potential for other non-aeronautical developments



15

Recommended On-Airport Development Plan (2014-2030)

16

RUNWAY 12L-30R UPGRADE

Runway 12L-30R Upgrade Alternatives

- **Alternative 1, Staggered Runways**
  - Source: Environmental Impact Statement (2008)
  - Currently the recommended master plan alternative

> *Community expressed interest in Public Meeting #2 for consideration of concepts that did not impact Garden Villas in terms of potential property acquisition*

- **Alternative 2, Non-staggered (Abeam) Runways**
- **Alternative 3, Non-staggered Runways with Displaced Thresholds**

18

Alternative 1 – Staggered Runways

- Runway 30R displaced arrival threshold to prevent realignment of Monroe Road
- Staggered Runway 12L impacts Garden Villas property
- Requires property acquisition to southeast and northwest

19

Parcels Anticipated to be Impacted with Alternative 1 (Stagger)

Source: Ongoing Master Plan

20

Alternative 2 – Non-Staggered (Abeam) Runways

- Runway 12L arrival threshold abeam to end of Runway 12R pavement
- However, Monroe Rd must be realigned OR the 12L dep length and 30R arrival length must be reduced below what is currently available on 12R-30L
- No property acquisition in Garden Villas

21

Parcels Anticipated to be Impacted with Alternative 2 (Abeam)

Source: Ongoing Master Plan

22

Alternative 3 – Non-Staggered Runways with Displaced Thresholds

- Displaced arrival threshold on 12L (to be abeam with 12R pavement end)
- Displaced arrival threshold on 30R (to prevent Monroe Rd realignment)
- Full length 12L pavement for departure (8,206')
- No impacts to Monroe Rd
- Property acquisition only on southeast side
- Longer physical runway

23

Parcels Anticipated to be Impacted with Alternative 3 (Abeam with Displaced Thresholds)

Source: Ongoing Master Plan

24

Potential Land Acquisition for Runway 12L-30R Alternatives

	ALT 1 - STAGGER		ALT 2 - ABEAM		ALT 3 – ABEAM WITH DISPLACED THRESHOLDS	
	PARCELS	ACREAGE	PARCELS	ACREAGE	PARCELS	ACREAGE
RESIDENTIAL	6	2	0	0	0	0
COMMERCIAL / INDUSTRIAL	29	42	11	24	11	24
AGRICULTURAL / UNDEVELOPED	15	25	8	29	8	29
PUBLIC / INSTITUTIONAL	2	2	0	0	0	0
TOTAL	**52**	**72**	**19***	**53***	**19**	**53**

* Additional parcels may be required to allow for realignment of Monroe Road, if Alternative 2 pursued

25

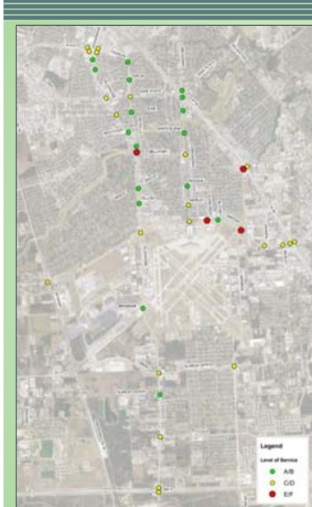
OFF-AIRPORT TRAFFIC ANALYSIS

Study Area

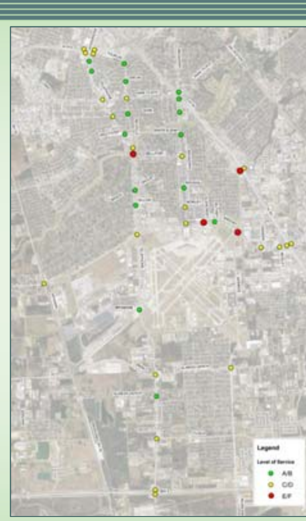
- Study Area:
  - Airport Boulevard: IH 45 to Mykawa Road
  - Telephone Road : IH 610 to Sam Houston Tollway
  - Broadway Street: IH 45 to Airport Boulevard
  - Monroe Road: IH 45 to Almeda Genoa Road
- Intersections
  - 45 Signalized Intersections
  - 3 Unsignalized Intersections

27

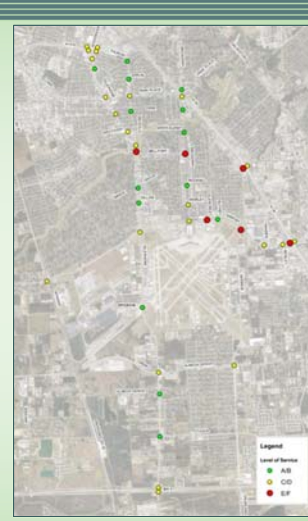
Level of Service - AM Peak Hour



Existing



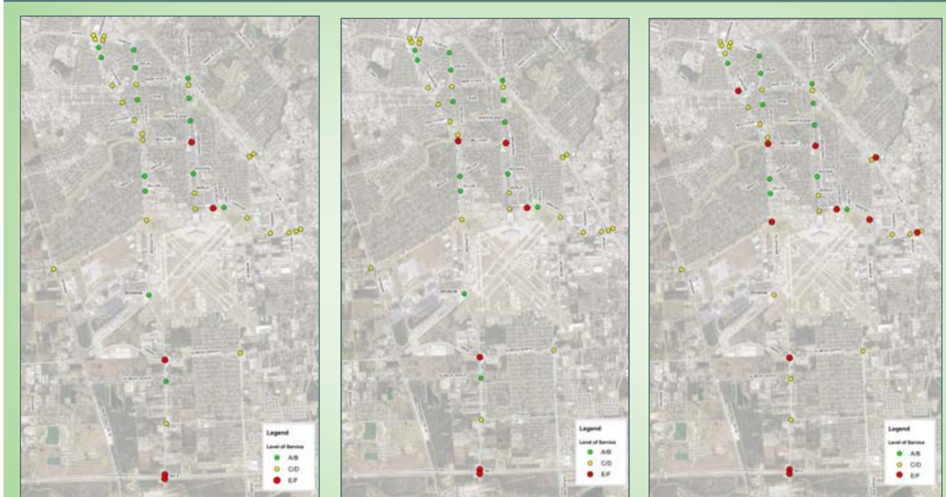
2015



2030

28

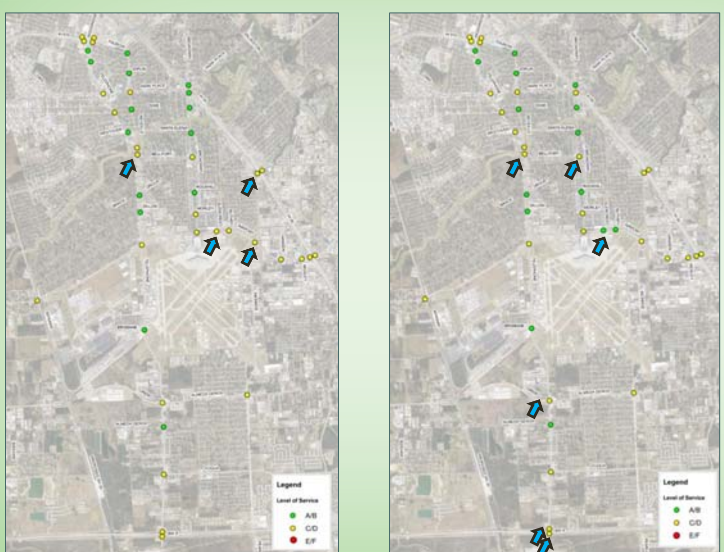
Level of Service - PM Peak Hour



Existing 2015 2030

29

Level of Service
Year 2015 Conditions:
AM & PM Peak Hour Mitigated Project Condition



30

Level of Service
Year 2030 Conditions:
AM & PM Peak Hour Mitigated Project Condition

31

Planned Improvements

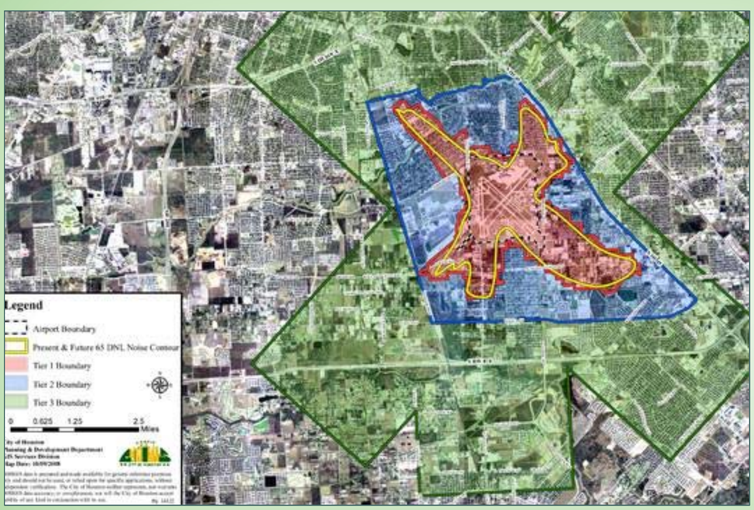
- TxDOT
  - SH 35 Improvements
  - Project Schedule not available
  - Anticipated to be completed by 2030
  - Trips oriented towards Brazoria County would use New SH 35 Facility
  - Local traffic will stay on Telephone Road
- Other
  - Common shuttle for all rental car companies in Consolidated Rental Car Facility
  - Improved way finding signage for Parking Facilities
  - Improved access to off-airport Parking Facilities along Airport Blvd.

32

PROPERTY DEVELOPMENT IN GARDEN VILLAS

33

Height Hazard Zoning Ordinance Tiers



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Land Use Compatibility Matrix, per Height Hazard Zoning Ordinance

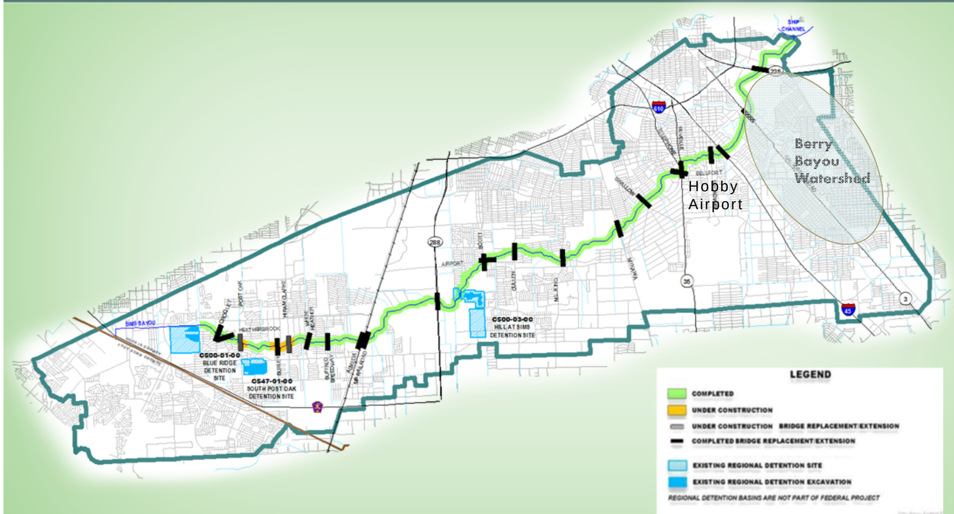
Land Use Compatibility Matrix **FINAL - 03/09/11**

Land Uses	Tier 1[1]	Tier 2[1]	Tier 3[1]
Residential Dwellings (Single Family or Multi-Family)			
A: Enlargement of existing single family structures	CONDITIONAL[2]	YES	YES
B: Renovation of existing single family structures	YES	YES	YES
C: Replacement of existing single family structures after casualty[3]	CONDITIONAL[2]	YES	YES
D: Enlargement, renovation or replacement of existing multi-family structures	CONDITIONAL[2]	CONDITIONAL[2]	YES
E: New Multi-family development	NO	CONDITIONAL[2]	YES
F: New mobile home parks or subdivisions	NO	NO	YES
G: New single family construction, including demolition, in existing developed residential areas	CONDITIONAL[2]	CONDITIONAL[2]	YES
H: New construction in undeveloped or non-residential areas	NO	CONDITIONAL[2]	YES
Sensitive and Public Assembly Uses (e.g. Hospitals, Nursing Homes, Assisted Living Centers, K-12 Schools, Higher Educational Institutions, Day Care Centers, Places of Worship, Movie Theaters, Amphitheaters)			
A: Enlargement or renovation of existing structures	CONDITIONAL[2]	CONDITIONAL[2]	YES
B: New construction	CONDITIONAL[2]	CONDITIONAL[2]	YES
Lodging			
A: Enlargement or renovation of existing structures	CONDITIONAL[2]	CONDITIONAL[2]	YES
B: New construction	CONDITIONAL[2]	CONDITIONAL[2]	YES
Commercial and Employment Uses (Retail, Restaurants, Offices, Warehouses, Industrial Uses)			
A: Enlargement or renovation of existing structures	YES	YES	YES
B: New construction	YES	YES	YES

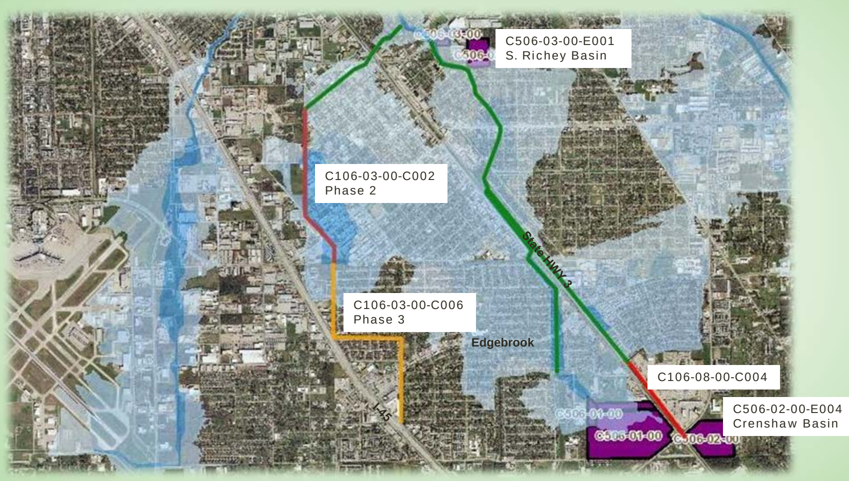
35

CITY/COUNTY DRAINAGE IMPROVEMENTS

Sims Bayou Federal
Flood Damage Reduction Project

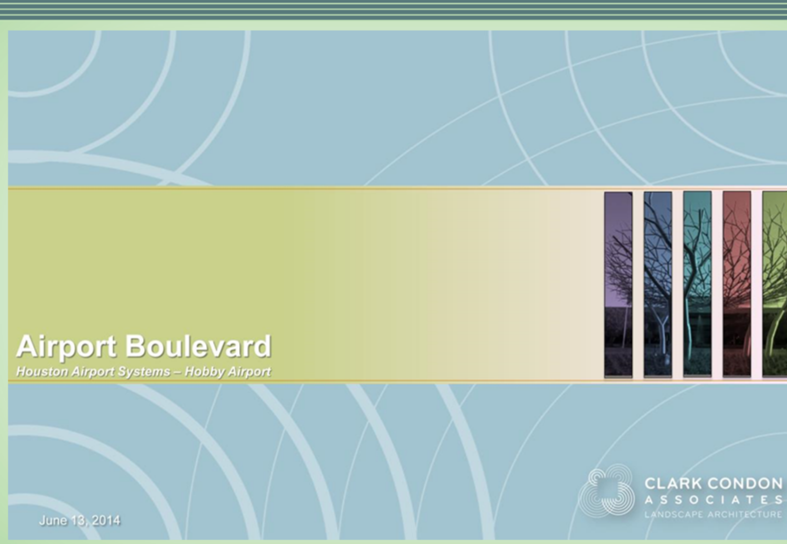


Berry Bayou Watershed
Berry Bayou Projects



OFF-AIRPORT BEAUTIFICATION INITIATIVES

Status of Beautification Initiative

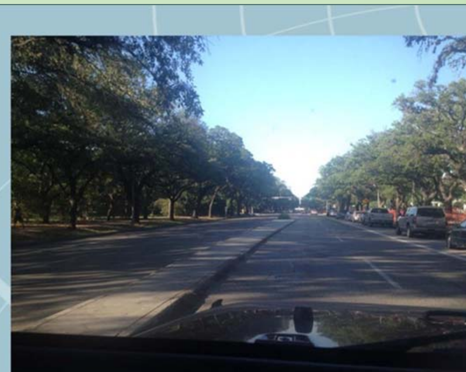


40

Scheme 1 – Classic Houston

41

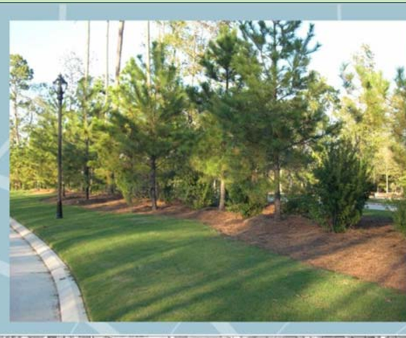
Scheme 1 – Precedent Images



The Classic Houston look is a shady street lined with live oaks

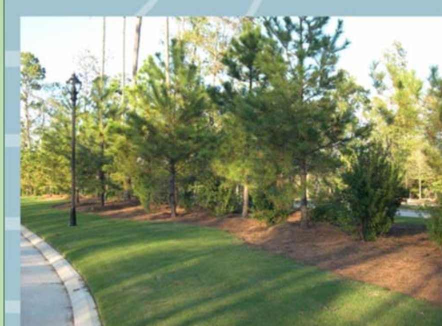
42

Scheme 2 - Reforestation



43

Scheme 2 – Precedent Images



44

Scheme 3 – Making Connections

45

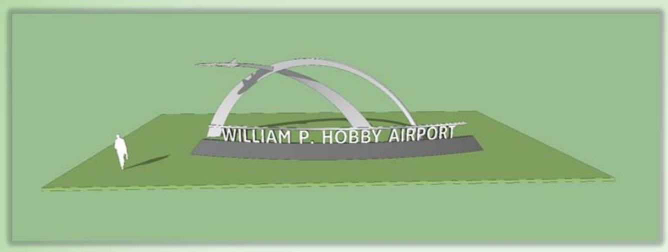
Scheme 3 – Precedent Images

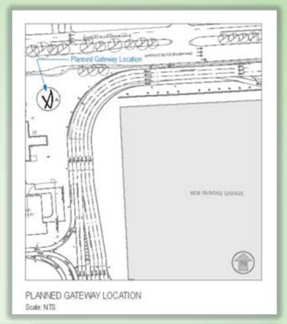
Painting and lighting the underpass will retro fit existing infrastructure adding visual interest and beautify the existing overpass entrances.

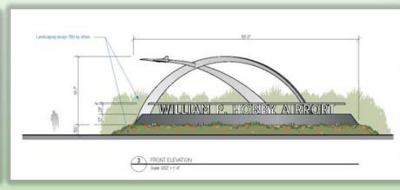
46

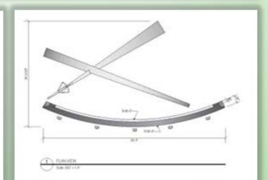
Roadway Entry Monument Design for HOU

Labozan Associates (2014)









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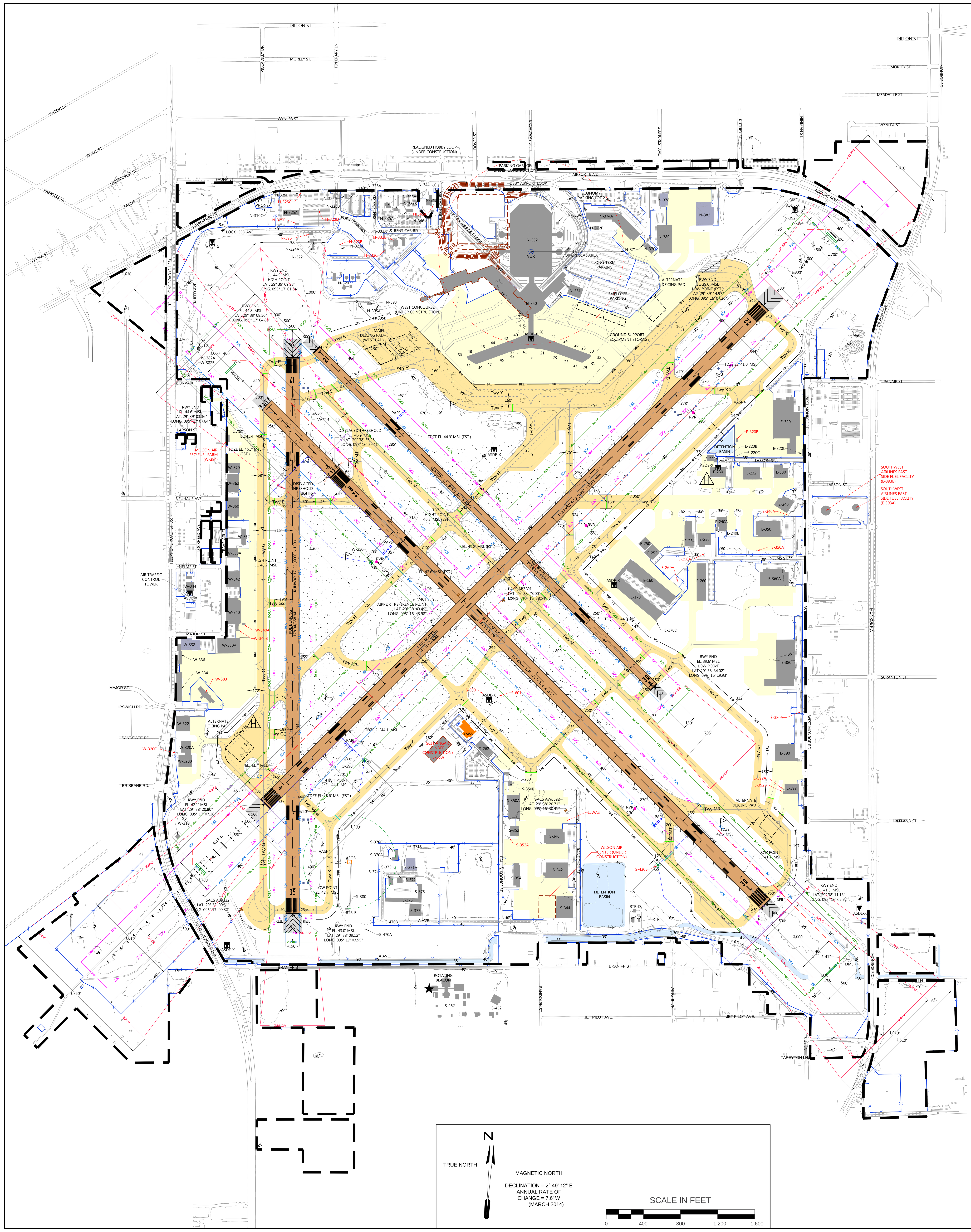
Questions and Answers

48 June 25, 2014

Appendix D

Draft Existing & Future Airport Layout Drawings



AIRPORT BUILDING DATA TABLE

NEW NO.	OLD NO.	DESCRIPTION	ROOF ELEV.
E-160	ER-3	HAWKER BEECHCRAFT MAINTENANCE FACILITY	66.7'
E-170	ER-2	SIGNATURE FLIGHT SUPPORT FBO AIRCRAFT HANGAR	65.4'
E-170D	NONE	SIGNATURE FLIGHT SUPPORT FBO STORAGE	44.6'
E-220A	NONE	HOUSTON POLICE DEPARTMENT AIR SUPPORT HANGAR	60.2'
E-220B	NONE	HOUSTON POLICE DEPARTMENT AIR SUPPORT STORAGE	46.2'
E-220C	ER-14	HOUSTON POLICE DEPARTMENT AIR SUPPORT STORAGE	50.1'
E-230	ER-13	HOUSTON POLICE DEPARTMENT AIR SUPPORT HANGAR/OFFICE	63.2'
E-232	ER-12	WING AVIATION AIRCRAFT CHARTER HANGAR/OFFICE	84.3'
E-240A	ER-8	ABCO HANGAR	69.0'
E-240B	NONE	ABCO STORAGE	68.9'
E-250	ER-4	SIGNATURE FLIGHT SUPPORT FBO HANGAR	61.4'
E-252	ER-5	SIGNATURE FLIGHT SUPPORT FBO HANGAR/OFFICE	61.4'
E-254	ER-6	SIGNATURE FLIGHT SUPPORT FBO HANGAR	60.7'
E-256	ER-7	STARFLITE HANGAR/OFFICE	74.6'
E-256A	NONE	STARFLITE STORAGE	41.4
E-260	ER-1	SIGNATURE FLIGHT SUPPORT FBO HANGAR	73.2
E-262	NONE	SIGNATURE FLIGHT SUPPORT FBO FUEL FACILITY	43.8'
E-320	ER-15	SOUTHWEST AIRLINES AIRCRAFT MAINTENANCE HANGAR	93.4'
E-320B	NONE	SOUTHWEST AIRLINES AIRCRAFT MAINTENANCE STORAGE	46.4
E-320C	ER-15	SOUTHWEST AIRLINES AIRCRAFT MAINTENANCE STORAGE	45.5'
E-330	ER-11	STARFLITE HANGAR/OFFICE	76.4'
E-340	ER-10	F2000 HANGAR/OFFICE	73.7'
E-340A	NONE	F2000 STORAGE	49.2'
E-350	ER-9	SPECTRA ENERGY SERVICES HANGAR/OFFICE	79.0'
E-350A	NONE	SPECTRA ENERGY SERVICES FUEL FACILITY	40.5'
E-360A	NONE	FREDKIN AVIATION HANGAR/OFFICE	80.8'
E-380	NONE	JET AVIATION FBO HANGAR/OFFICE	87.8'
E-380A	NONE	JET AVIATION FBO GUARD POST	45.0'
E-390	SER-2	JET AVIATION FBO HANGAR	80.8'
E-392	SER-1	JET AVIATION FBO HANGAR	63.3'
E-392A	SER-1	JET AVIATION FBO STORAGE	51.1'
E-392B	SER-1	JET AVIATION FBO STORAGE	49.5'
E-393A	ER-16	SOUTHWEST AIRLINES EAST SIDE FUEL FACILITY	77.7'
E-393B	ER-17	SOUTHWEST AIRLINES EAST SIDE FUEL FACILITY	75.7'
N-310C	NONE	HAS ALERT RESPONSE POINT	51.5'
N-320	NR-14	SOUTHWEST AIRLINES FUEL FARM	60.6'
N-322	NR-4	NORTH ELECTRICAL VAULT	57.7'
N-323A	NONE	HUDSON FUEL COMPANY FUEL PUMP	50.8'
N-323B	NONE	HUDSON FUEL COMPANY FUEL PUMP-ELECTRICAL VAULT	52.8'
N-324A	NR-3	TRASH COMPACTOR	61.8'
N-325A	NONE	NATIONAL RENTAL MAINTENANCE FACILITY	63.1'
N-325B	NONE	NATIONAL RENTAL BOOTH	55.0'
N-325C	NONE	NATIONAL RENTAL BOOTH	54.2'
N-325D	NONE	NATIONAL RENTAL BOOTH	53.8'
N-325E	NONE	NATIONAL RENTAL MAINTENANCE FACILITY	57.5'
N-326A	NONE	TAXI CAB BREAK ROOM	57.1'
N-326B	NONE	TAXI CAB FUELING STATION	52.8'
N-332A	NONE	BUDGET RENTAL CAR SERVICE FACILITY	61.8'
N-332B	NONE	BUDGET RENTAL CAR SERVICE FACILITY	61.6'
N-332C	NONE	BUDGET RENTAL CAR PICK UP CANOPY	54.8'
N-333A	NONE	AVIS RENTAL CAR ADMINISTRATION FACILITY	61.3'
N-333B	NONE	AVIS RENTAL CAR SERVICE FACILITY	59.4'
N-335A	NONE	AVIS RENTAL CAR SERVICE FACILITY	56.8'
N-335B	NONE	AVIS RENTAL CAR SERVICE FACILITY	53.7'
N-336A	NONE	TAXI CAB STAGING AREA OFFICE	50.5'
N-342	NONE	CITY OF HOUSTON FIRE STATION NO. 36	60.1'
N-342A	NONE	CITY OF HOUSTON FIRE STATION NO. 36	52.4'
N-344	NONE	ELECTRICAL SERVICE ENTRY BUILDING	57.0'
N-346	NONE	COMMUNICATION BUILDING FOR ADJACENT CELL TOWER	52.2'
N-350	NR-8	TERMINAL BUILDING	88.0'
N-352	NONE	PARKING GARAGE	88.8'
N-360A	NONE	PARKING TOLL BOOTH	52.9'
N-360C	NONE	COOLING TOWERS	66.1'
N-361	NONE	BAGGAGE SORTATION FACILITY	65.6'
N-370	NR-10	AIRPORT STORAGE FACILITY (TO BE DEMO)	56.0'
N-371	NONE	TRASH COMPACTOR	59.4'
N-372F	NONE	AIRLINE CARGO & SOUTHWEST AIRLINES PROVISIONING FACILITY	53.4'

NEW NO.	OLD NO.	DESCRIPTION	ROOF ELEV.
N-374A	NR-9	AIRLINE CARGO & SOUTHWEST AIRLINES PROVISIONING FACILITY	56.5'
N-378	NR-12	ATLANTIC AVIATION FBO TERMINAL (TO BE DEMO)	62.3'
N-380	NR-11	ATLANTIC AVIATION FBO HANGAR/OFFICE	78.3'
N-382	NR-13	ATLANTIC AVIATION FBO HANGAR/OFFICE (TO BE DEMO)	72.7'
N-392	NONE	DISTANCE MEASURING EQUIPMENT SHELTER	43.9'
N-393	NONE	INSPECTION STATION	?
N-394	NONE	RUNWAY 4 LOCALIZER SHELTER	43.4'
N-395A	NONE	AIRPORT DIESEL FUEL STORAGE TANK	?
N-395B	NONE	AIRPORT GLYCOL STORAGE TANK	?
N-396	NONE	AIRPORT WASHRACK	?
S-250	SR-3	SOUTH ELECTRICAL VAULT	51.9'
S-260	SR-1	AIRPORT RESCUE & FIREFIGHTING STATION 81	62.0'
S-262	SR-2	FAA/PDC-CONSTRUCTION/US CUSTOMS & HAS ADMIN FACILITIES	67.5'
S-290	NONE	RUNWAY 4 GLIDE SLOPE SHELTER	50.9'
S-340	SR-10	WILSON AIR CENTER FBO HANGAR/OFFICE	85.6'
S-342	SR-9	WILSON AIR CENTER FBO HANGAR/OFFICE	85.1'
S-344	SR-8	WILSON AIR CENTER FBO HANGAR/OFFICE	?
S-350A	NONE	HCC SERVICES HANGAR/OFFICE	82.6'
S-350B	NONE	HCC SERVICES STORAGE	53.3'
S-352	SR-5	CENTRAL HELICOPTER SERVICES HANGAR/OFFICE	52.5'
S-352A	NONE	CENTRAL HELICOPTER SERVICES STORAGE	51.5'
S-354	SR-6	WILSON AIR CENTER FBO HANGAR/OFFICE	78.0'
S-370A	SR-13	HOUSTON POLICE DEPARTMENT DOG KENNEL & NARCOTICS	54.4'
S-370C	NONE	HOUSTON POLICE DEPARTMENT DOG KENNEL STORAGE	56.7'
S-371A	SR-14	AIRFIELD & GROUNDS OFFICE (TO BE DEMO)	60.1'
S-371B	NONE	AIRFIELD & GROUNDS STORAGE (TO BE DEMO)	58.6'
S-372	SR-17	AIRFIELD & GROUNDS REPAIR SHOP	62.7'
S-373	SR-16	AIRFIELD & GROUNDS TOOLS	59.8'
S-374	SR-15	AIRFIELD & GROUNDS WAREHOUSE	60.1'
S-375	SR-20	AIRFIELD & GROUNDS PAINT SHOP	58.7'
S-376	SR-21	AIRFIELD & GROUNDS COVERED PARKING	59.1'
S-377	SR-22	ELECTRICAL BUILDING-AVIATION	64.5'
S-380	SR-18	FAA REMOTE TRANSMITTER/RECEIVER B SHELTER	53.0'
S-412	NONE	RUNWAY 12R LOCALIZER & DME SHELTER	48.4'
S-430	SR-19	FAA REMOTE TRANSMITTER/RECEIVER D SHELTER	61.6'
S-430B	SR-19	RUNWAY 30L GLIDE SLOPE SHELTER	49.1'
S-452	NONE	HOUSTON FIRE DEPARTMENT VAL JAHNKE TRAINING FACILITY	70.6'
S-462	NONE	HOUSTON FIRE DEPARTMENT VAL JAHNKE TRAINING FACILITY	119.8'
S-470A	SR-23	AIRPORT VEHICLE FUELING STATION	58.7'
S-470B	NONE	FIBER OPTIC BUILDING	49.0'
S-500	NONE	SCI HANGAR (UNDER CONSTRUCTION)	?
S-600	NONE	FAA CENTERFIELD WIND MASS ANTENNA (NOT USED)	?
S-601	NONE	FAA AIR MAST ANTENNA (NOT USED)	?
W-250	NONE	RUNWAY 12R GLIDE SLOPE SHELTER	53.5'
W-310	NONE	RUNWAY 4 ALS & RUNWAY 22 LOCALIZER SHELTER	58.3'
W-320A	WR-23	MILLION AIR FBO HANGAR	81.0'
W-320B	WR-24	MILLION AIR FBO HANGAR	81.0'
W-320C	NONE	MILLION AIR FBO GUARD POST	51.3'
W-322	WR-22	MILLION AIR FBO HANGAR/OFFICE	84.4'
W-330A	WR-13	MILLION AIR FBO HANGAR/OFFICE	86.8'
W-334	WR-16	MILLION AIR FBO HANGAR/OFFICE	67.1'
W-336	WR-15	MILLION AIR FBO HANGAR/OFFICE	87.8'
W-338	WR-14	MILLION AIR FBO HANGAR/OFFICE (TO BE DEMO)	75.3'
W-340	WR-12	UNITED AIRLINES MAINTENANCE HANGAR 6	93.4'
W-340A	WR-12	UNITED AIRLINES MAINTENANCE HANGAR 6 STORAGE	78.5'
W-340B	WR-12	UNITED AIRLINES MAINTENANCE HANGAR 6 STORAGE	78.5'
W-342	WR-11	UNITED AIRLINES MAINTENANCE HANGAR 7	85.1'
W-344	WR-7	AIR TRAFFIC CONTROL TOWER COMPLEX	187.9'
W-350A	WR-10	UNITED AIRLINES STORAGE	57.3'
W-352	WR-9	HOUSTON AERONAUTICAL HERITAGE SOCIETY(AIRPORT MUSEUM)	121.3'
W-360	WR-6	SUMMIT SEAFOOD	82.2'
W-362	WR-5	MILLION AIR FBO HANGAR	72.9'
W-370	WR-4	HOUSTON AERONAUTICAL HERITAGE SOCIETY HANGAR	63.4'
W-382A	NONE	RUNWAY 30L LOCALIZER SHELTER	51.7'
W-382B	NONE	RUNWAY 12R ALS SHELTER	49.1'
W-383	NONE	MILLION AIR FBO FACILITY	?
W-384	NONE	MILLION AIR FBO FUEL FARM (N OF W-370)	?

LEGEND

- RUNWAY PAVEMENT
- TAXIWAY PAVEMENT
- APRON PAVEMENT
- BUILDING
- AIRCRAFT RESCUE & FIRE FIGHTING (ARFF)
- DETENTION BASIN/DRAINAGE DITCH
- FACILITY TO BE DEMOLISHED
- FACILITY UNDER CONSTRUCTION
- EXISTING AIRPORT PROPERTY LINE
- FENCE (8' AGL)
- A-RPZ APPROACH RUNWAY PROTECTION ZONE
- D-RPZ DEPARTURE RUNWAY PROTECTION ZONE
- RSA RUNWAY SAFETY AREA (RSA)
- OFZ RUNWAY OBSTACLE FREE ZONE (OFZ)
- POFZ PRECISION RUNWAY OBSTACLE FREE ZONE (POFZ)
- ROFA RUNWAY OBJECT FREE AREA (ROFA)
- BRL BUILDING RESTRICTION LINE (BRL)
- LOCALIZER CRITICAL AREA
- GLIDESLOPE CRITICAL AREA
- ASOS CRITICAL AREA
- HOLD BAR
- ILS CRITICAL AREA HOLD BAR
- RUNWAY VISIBILITY ZONE (RVZ)
- 40 CONTOUR ELEVATION (FEET)
- WIND CONE
- HELIPAD
- ROTATING BEACON
- ASDE-X ANTENNA

Notes:
1. All coordinates reference the North American Datum 1983 (NAD 83).
2. All elevations reference the North American Vertical Datum 1988 (NAVD 88).

RICONDO® & ASSOCIATES

NO.	DATE	BY	DESCRIPTION	APP'D	NO.

REVISIONS

WILLIAM P. HOBBY AIRPORT
Houston, Texas

EXISTING AIRPORT LAYOUT PLAN

HOUSTON AIRPORTS

APPROVED BY: City of Houston
Department of Aviation

Director of Aviation — Date

APPROVED BY: City of Houston
Department of Aviation

Planning Manager — Date

APPROVED BY:

DRAFT

FAA — Date

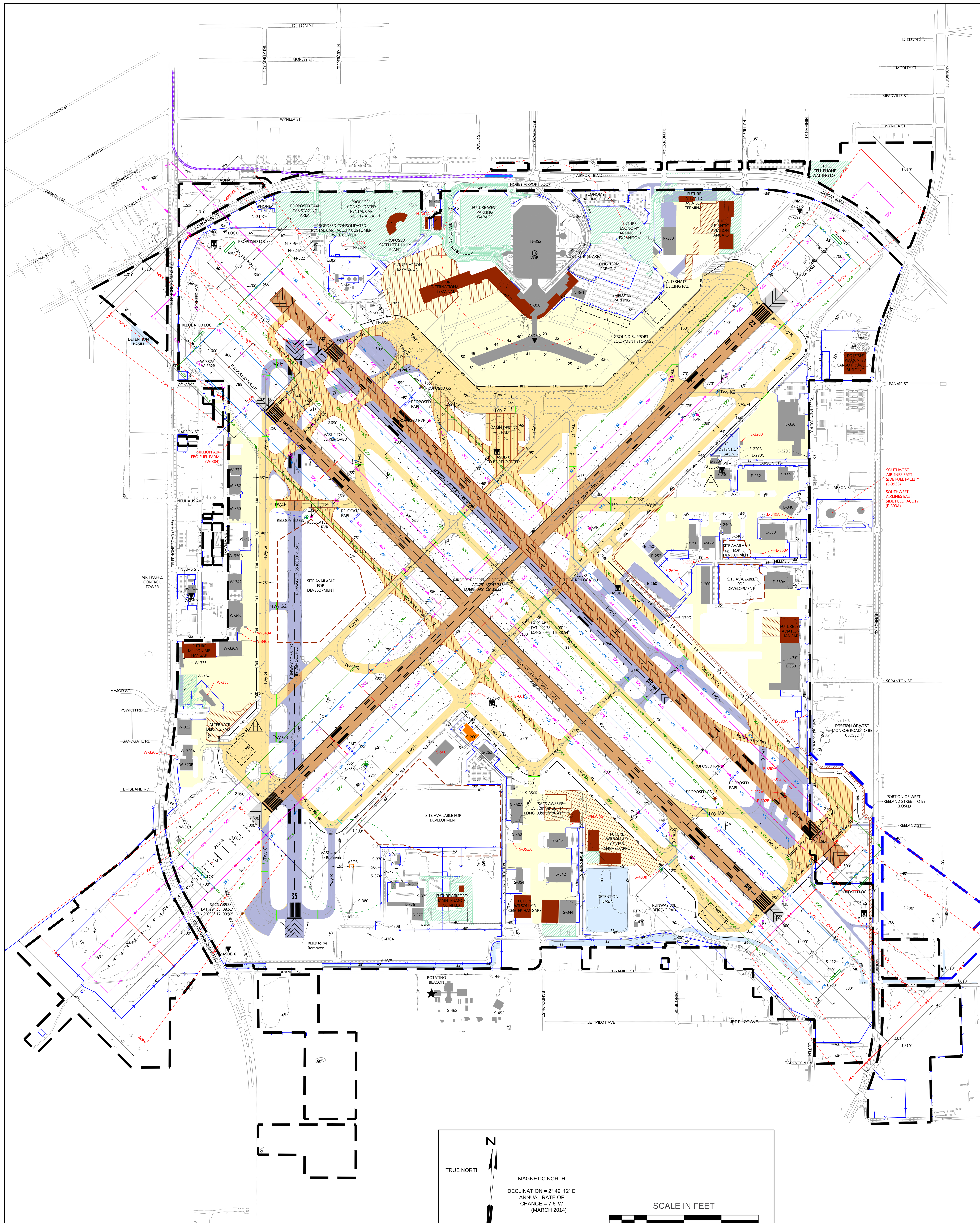
DRAWN BY: AFB

CHECKED BY: EMG

PREPARED BY:
Ricondo & Associates, Inc.

DATE: September 2014

Sheet 2 of 29



AIRPORT BUILDING DATA TABLE

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E-160	ER-3	HAWKER BEECHCRAFT MAINTENANCE FACILITY	66.7'
E-170	ER-2	SIGNATURE FLIGHT SUPPORT FBO AIRCRAFT HANGAR (TO BE DEMO)	65.4'
E-170D	NONE	SIGNATURE FLIGHT SUPPORT FBO STORAGE (TO BE DEMO)	44.6'
E-220A	NONE	HOUSTON POLICE DEPARTMENT AIR SUPPORT HANGAR	60.2'
E-220B	NONE	HOUSTON POLICE DEPARTMENT AIR SUPPORT STORAGE	46.2'
E-220C	ER-14	HOUSTON POLICE DEPARTMENT AIR SUPPORT STORAGE	50.1'
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E-340A	NONE	F2000 STORAGE	49.2'
E-350	ER-9	SPECTRA ENERGY SERVICES HANGAR/OFFICE	79.0'
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E-360A	NONE	FRIEDKIN AVIATION HANGAR/OFFICE	80.8'
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N-352	NONE	PARKING GARAGE	88.8'
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N-394	NONE	RUNWAY 4 LOCALIZER SHELTER	43.4'
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S-344	SR-8	WILSON AIR CENTER FBO HANGAR/OFFICE	?
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W-250	NONE	RUNWAY 12R GLIDE SLOPE SHELTER	53.5'
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W-383	NONE	MILLION AIR FBO FACILITY	?
W-384	NONE	MILLION AIR FBO FUEL FARM (N OF W-370)	?

LEGEND

- RUNWAY PAVEMENT
- TAXIWAY PAVEMENT
- APRON PAVEMENT
- BUILDING
- AIRCRAFT RESCUE & FIRE FIGHTING (ARFF)
- DETENTION BASIN/DRAINAGE DITCH
- PROPOSED RUNWAY PAVEMENT
- PROPOSED TAXIWAY PAVEMENT
- PROPOSED APRON PAVEMENT
- PROPOSED BUILDING
- PREFERRED FUTURE METRO RAIL STATION SITE
- PROPOSED METRO RAIL ALIGNMENT
- PROPOSED LANDSIDE DEVELOPMENT
- PROPOSED AIRSIDE SERVICE ROAD
- FACILITY TO BE DEMOLISHED
- EXISTING AIRPORT PROPERTY LINE
- PROPOSED AIRPORT PROPERTY LINE
- FENCE (8' AGL)
- A-RPZ — APPROACH RUNWAY PROTECTION ZONE
- D-RPZ — DEPARTURE RUNWAY PROTECTION ZONE
- RSA — RUNWAY SAFETY AREA (RSA)
- OFZ — RUNWAY OBSTACLE FREE ZONE (OFZ)
- POFZ — PRECISION RUNWAY OBSTACLE FREE ZONE (POFZ)
- ROFA — RUNWAY OBJECT FREE AREA (ROFA)
- BRL — BUILDING RESTRICTION LINE (BRL)
- LOCALIZER CRITICAL AREA
- GLIDESLOPE CRITICAL AREA
- ASOS CRITICAL AREA
- HOLD BAR
- ILS CRITICAL AREA HOLD BAR
- RUNWAY VISIBILITY ZONE (RVZ)
- CONTOUR ELEVATION (FEET)
- WIND CONE
- HELIPAD
- ROTATING BEACON
- ASDE-X ANTENNA

Notes:
1. All coordinates reference the North American Datum 1983 (NAD 83).
2. All elevations reference the North American Vertical Datum 1988 (NAVD 88).

RICONDO® & ASSOCIATES

NO.	DATE	BY	REVISIONS DESCRIPTION	APP'D

WILLIAM P. HOBBY AIRPORT
Houston, Texas

FUTURE AIRPORT LAYOUT PLAN

HOUSTON AIRPORTS

APPROVED BY: City of Houston Department of Aviation

Director of Aviation — Date

APPROVED BY: City of Houston Department of Aviation

Planning Manager — Date

APPROVED BY:

DRAFT

FAA — Date

DRAWN BY: AFB

CHECKED BY: EMG

PREPARED BY: Ricondo & Associates, Inc.

DATE: December 2014

Appendix E

Runway Length Requirements Analysis

jacobsen**daniels** associates, llc
planning and implementation consultants

+Memorandum

Date: February 20, 2013

To: Ricondo & Associates, Inc.; Houston Airport System

From: Marc Hepburn (JDA)

Subject: Houston Hobby - Runway Length Analysis

The following represents JDA's deliverable for the Runway Length Analysis for Houston Hobby Airport. This technical analysis includes a runway length analysis for three scenarios focusing on three specific design aircraft. The scenarios provide an understanding of the manufacturer specified capabilities of the design aircraft and their ability to reach existing and potential new Latin American destinations.

William P. Hobby Airport (HOU) has four operational runways. The Airport has two 7,600-foot runways (Runway 4-22 and Rwy 12R-30L) and a 6,000-foot runway (Runway 17-35) that are utilized by commercial service airline traffic. The existing lengths of these runways were examined to determine what limitations, if any, they portrayed on the target design aircraft in question (737-800, 737-900, 757-300). This memorandum describes the methodology, assumptions, and results of the runway length analysis for three different scenarios.

This technical analysis assumes the Federal Aviation Administration accepted standard atmospheric temperature of 59 degrees Fahrenheit and uses 92 degrees for a typical 'hot' day evaluation at HOU. The range analysis incorporates both the temperature assumptions and that the existing runway length at HOU of 7,600 feet will remain constant for the mid and long term planning periods as defined in the current Airport Master Plan.

The aircraft design criteria used in this analysis are the accepted performance standards presented by the manufacturer to the FAA when applying for Airworthiness Certification for the specific model aircraft. The three models in this analysis (737,-800, 737-900, and 757-300) all have the same manufacturer, The Boeing Company. These aircraft are assumed to not be equipped with winglets to provide a more conservative estimate of the range capabilities under the conditions specified in each scenario.

Runways	4/22	12R/30L	17/35	12L/30R
Length	7,602'	7,602'	6,000'	5,148'
Air Carrier Runway	Yes	Yes	Yes	No
Displacement	None	1,034' (12R end)	None	None
Surface	Concrete	Asphalt	Asphalt / Concrete	Concrete

Scenario One

The first scenario considered provides a base level analysis of the standard aircraft configuration for each sample aircraft under FAA normal operating conditions including the manufacturer defined range, and associated weight limitations for each aircraft in order to reach their furthest destinations given the existing HOU runway lengths. Based on the standard weight and balance and ideal weather conditions, Scenario One illustrates that the design aircraft can reach all domestic destinations in the contiguous United States and foreign destinations that are approximately 1,700 nautical miles or less.

The performance characteristics of the designated design aircraft are included in the following paragraphs. All three aircraft represent aircraft that either currently in use at HOU or that are anticipated to use the airfield within the mid and long term planning period of 10 to 20 years. The existing condition section reflects the approximate maximum weight and range each aircraft can achieve from HOU today. The range calculation assumes that the aircraft are at their maximum takeoff weight based on the existing runway length, the temperature factors as defined by FAR Part 150, and the airport's elevation based on the most recent FAA 5010 survey. There are two ranges provided for each aircraft based on the temperature. One temperature is based on the federally accepted standard atmospheric temperature of 59 degrees Fahrenheit and the other is based on an adjusted hot day temperature value (varies by aircraft performance manual).

Aircraft Manufacturer Design Standards

Aircraft	B737-800	737-900	757-300	757-300
Engine Type	CFM-7B26	CFM-7B26	PW2040	RB211-535E4B
MTOW	174,200 lbs.	174,200 lbs.	270,000 lbs.	270,000 lbs.
Runway Length Required for Max Range (Standard Day)	7,800'	9,800'	9,900'	7,900'
Runway Length Required for Max Range (Standard Day + 45°F)	10,100'	15,000'	10,400' (STD + 28°F)	8,200' (STD + 28°F)
Range with Existing Runway Length (4/22) (At standard day temp)	2,800 NM	3,100 NM	3,600 NM	3,200 NM
Range with Existing Runway Length (12R/30L) (At standard day temp)	2,800 NM	3,100 NM	3,600 NM	3,200 NM

Boeing 737-800

The 737-800 model used in this analysis has a maximum operating range of approximately 3,500 nautical miles and utilizes the CFM56-7B26 engines. This aircraft was selected due to its extensive use by aircraft operators at the HOU airport today. The runway length is sufficient to accommodate this aircraft at its maximum landing weight. There are no runway length deficiencies that would hinder accommodations for this aircraft model landing at HOU.

Aircraft (Engine type)	Temperature (degrees F)	TOW [1] (lbs.)	Range[4] (NM)	Aircraft MTOW[3] (lbs.)	Weight Hit/Limit[2] (lbs.)
737-800 (CFM-7B26)	STD	172,000	2,800	174,200	2,200
	STD + 27	169,000	2,750	174,200	5,200

1. Max takeoff weight achievable given 7,600' runway and respective temperature.
2. Weight limit that the aircraft is restricted to due to runway length and temperature.
3. Maximum takeoff weight of aircraft.
4. Range of aircraft given the runway length/temperature available.
5. The associated aircraft range maps do not represent the absolute distance the aircraft can fly as the aircraft must consume fuel during the descent and approach. In addition the aircraft must have fuel on board to reach an alternate airport. As a result the aircraft range maps are shown with a 100 to 200 nautical mile safety buffer.

Below is a map of the 2,600 nautical mile range from Houston Hobby Airport achievable by the Boeing 737-800 with the CFM56-7B26 engines.

Boeing 737-900

The 737-900 model used in this analysis utilizes the CFM-7B26 engines. Current users of the Airport are expected to utilize this aircraft model in the future as the fleet mix is updated to rotate out aging aircraft. The runway length is sufficient to accommodate this aircraft at its maximum landing weight. There are no runway length deficiencies to accommodate this aircraft landing.

Aircraft (Engine type)	Temperature (degrees F)	TOW [1] (lbs.)	Range[4] (NM)	Aircraft MTOW[3] (lbs.)	Weight Hit/Limit[2] (lbs.)
737-900 (CFM-7B26)	STD	158,000	3,100	174,200	16,200
	STD + 27	157,000	3,150	174,200	17,200

1. Max takeoff weight achievable given 7,600' runway and respective temperature.
2. Weight limit that the aircraft is restricted to due to runway length and temperature.
3. Maximum takeoff weight of aircraft.
4. Range of aircraft given the runway length/temperature available.
5. The associated aircraft range maps do not represent the absolute distance the aircraft can fly as the aircraft must consume fuel during the descent and approach. In addition the aircraft must have fuel on board to reach an alternate airport. As a result the aircraft range maps are shown with a 100 to 200 nautical mile safety buffer.

Below is a map of the 3,200 nautical mile range achievable by the Boeing 737-900 with the CFM 7B26.

Boeing 757-300

There are four engine types of the 757-300 model analyzed below. This aircraft is not commonly utilized at HOU at this time; however as the demand for services grows and aging fleet mixes are updated there will be potential demand for a larger design aircraft at HOU. The runway length is sufficient to accommodate this aircraft at its maximum landing weight. There are no runway length deficiencies to accommodate this aircraft landing.

Aircraft (Engine type)	Temperature (degrees F)	TOW [1] (lbs.)	Range[4] (NM)	Aircraft MTOW[3] (lbs.)	Weight Hit/Limit[2] (lbs.)
757-300 (PW2043)	STD	261,000	3,500	270,000	9,000
	STD + 28	256,000	3,600	270,000	14,000
757-300 (PW2040)	STD	254,000	3,600	270,000	16,000
	STD + 28	250,000	3,700	270,000	20,000
757-300 (RB211-535E4B)	STD	264,000	3,200	270,000	6,000
	STD + 25	260,000	3,300	270,000	10,000
757-300 (RB211-535E4)	STD	255,000	3,300	270,000	15,000
	STD + 25	251,000	3,400	270,000	19,000

1. Max takeoff weight achievable given 7,600' runway and respective temperature.
2. Weight limit that the aircraft is restricted to due to runway length and temperature.
3. Maximum takeoff weight of aircraft.
4. Range of aircraft given the runway length/temperature available.
5. The associated aircraft range maps do not represent the absolute distance the aircraft can fly as the aircraft must consume fuel during the descent and approach. In addition the aircraft must have fuel on board to reach an alternate airport. As a result the aircraft range maps are shown with a 100 to 200 nautical mile safety buffer.

Below is a map of the 3,200 nautical mile range achievable from Houston Hobby Airport by the Boeing 757-300 with RB211-535E4B engines as this version of the 757 has the most restrictive range.

Scenario Two

There are approximately 14 destinations throughout Latin America that could potentially become regular destinations from Houston Hobby Airport based on several factors including but not limited to: air carrier fleet mixes currently serving HOU and the common destinations of these carriers to specific countries of interest and historical service to these markets. These destinations were also chosen based on the Official Airline Guide (OAG) documenting the use of other non-HAS departing airport locations, including Phoenix, AZ (PHX), Dallas, TX (DFW), Albuquerque, NM (ABQ) and New Orleans, (MSY) for service to these specific destinations by air carriers currently using HOU. The second scenario addresses whether or not the design aircraft has the range ability to reach these anticipated future destinations. The following Potential Latin American destinations are within the manufacturer design aircraft range ability for standard atmospheric conditions. They include:

- Bogota, Colombia (2,000 NM)
- Liberia, Costa Rica (1,300 NM)
- San Jose, Costa Rica (1,300 NM)
- San Salvador, El Salvador (1,100 NM)
- Cancun, Mexico (700 NM)
- Guadalajara, Mexico (700 NM)
- Los Cabos, Mexico (900 NM)
- Monterrey, Mexico (360 NM)
- Mexico City, Mexico (650 NM)
- Puerto Vallarta, Mexico (770 NM)
- Caracas. Venezuela (1,970 NM)
- Belize City, Belize (900 NM)
- San Luis Potosi, Mexico (537 NM)
- Tegucigalpa, Honduras (1,034 NM)

There has been an expressed interest and strong likelihood of these destinations becoming standard international destinations from Houston Hobby Airport. These destinations are between 1,000 and 2,000 nautical miles from HOU. As shown above in Scenario Two, the design aircraft are capable of reaching all 14 of the destinations under the conservative maximum conditions defined by the manufacturer for fuel use consumption, the standard cruising altitude and Victor Airways routes serving these destinations.

Scenario Three

In this Scenario we specifically examine major Latin American destinations that are located more than 3,000 nautical miles away from Houston Hobby Airport and have a population greater than 5 Million people. These destinations were chosen because they represent major hub cities in South America that are considered potential long term international aircraft destinations with strong economic vitality in both their domestic gross national product and for international commerce. The cities are also located in countries that have significant levels of oil and natural resource production in South America. The five destinations that make up the third Scenario include:

City	Country	Distance from HOU (Nautical Miles)	Population
Lima	Peru	2,700	7,603,500
Buenos Aires	Argentina	4,400	11,655,100
Santiago	Chili	4,000	5,034,500
Sao Paulo	Brazil	4,200	10,057,700
Rio de Janeiro	Brazil	4,300	6,029,300

Source: Great Circle Mapper (www.gcmap.com)

Lima, Peru is the only city destination that is located within the range of one of the design aircraft. It is estimated that the 757-300 is capable of reaching a destination of 3,200 nautical miles. The destinations represented in Scenario three are located beyond the aircraft range capabilities of the three design aircraft using conservative fuel consumption conditions as specified by the manufacturer.

Runway Length Analysis

The Airport has two 7,600 foot runways and a 6,000 foot long runway utilized by commercial service airline traffic. The existing lengths of these runways were examined to determine what limitations, if any, they portrayed on the target aircraft in question (737-800, 737-900, 757-300).

The table below shows the stage lengths each aircraft is capable of achieving, assuming that the aircraft has a high takeoff weight. The runway length analysis also addresses the weight limit restrictions the design aircraft will experience given the existing 7,600 foot runway. All four design aircraft considered would not be able to depart HOU at the manufacturer specified maximum full Take-off Weight with the existing runway length remaining 7,600 feet long. With the designated runway length of 7,600 feet a range analysis was completed based on current destinations of air carriers currently utilizing HOU.

As previously noted, the table below illustrates the effects of temperature when trying to maximize the range and weight of the design aircraft. It is important to note that the 737-900 aircraft is not capable of obtaining a range that is longer than 3,400 nautical miles from HOU at or above standard temperature with the current runway length of 7,600 feet. It is also important to note that as shown in the Boeing aircraft characteristics manual and as demonstrated in the table below, this aircraft has a very similar maximum range capability when the aircraft weighs 135,000 pounds(operating at standard temperature plus 63 degrees) as it does when it weighs 157,000 pounds (operating at standard temperature plus 27 degrees). However, the payload that is able to be accommodated by the aircraft with warmer atmospheric temperatures is reduced significantly at the lower air temperatures and varies depending upon how the carrier chooses to accommodate the changes in weight and balance that must occur to reach the designated range for specific flight operations. If the carrier chooses to reduce fuel capacity of the aircraft to accommodate the weight and balance changes needed due to the limited runway length of the airfield, this will in turn reduce the range capability of the specified aircraft. This can also be seen on the table as the weight limit or hit that the aircraft takes on its ability to carry more weight based on the conditions at the airfield.

Aircraft (Engine type)	Temperature (degrees F)	TOW [1] (lbs.)	Range[4] (NM)	Aircraft MTOW[3] (lbs.)	Weight Hit/Limit[2] (lbs.)
737-800 (CFM-7B26)	STD	172,000	2,800	174,200	2,200
	STD + 27	169,000	2,750	174,200	5,200
	STD + 45	157,000	3,200	174,200	17,200
	STD + 63	145,000	3,500	174,200	29,200
737-900 (CFM-7B26)	STD	158,000	3,100	174,200	16,200
	STD + 27	157,000	3,150	174,200	17,200
	STD + 45	145,000	3,400	174,200	29,200
	STD + 63	135,000	3,200	174,200	39,200
737-900ER (CFM-7B26) (46,063 lb fuel capacity model)	STD	172,000	2,700	187,700	15,700
	STD + 27	168,000	2,800	187,700	19,700
	STD + 45	158,000	3,200	187,700	29,700
	STD + 63	148,000	3,300	187,700	39,700
757-300 (PW2043)	STD	261,000	3,500	270,000	9,000
	STD + 28	256,000	3,600	270,000	14,000

Red is greater than mean max temperature.
1. Max takeoff weight achievable given 7,600' runway and respective temperature.
2. Weight limit that the aircraft is restricted to due to runway length and temperature.
3. Maximum takeoff weight of aircraft.
4. Range of aircraft given the runway length/temperature available.

Assumptions used in the process included:

- All the standard day & hot day temperature performance
- 737-900ER assumes 46,063 lb. fuel capacity tank

Conclusion

Based on review of the Airport Master Plan near and long term FAA approved forecast, the design aircraft currently in use at HOU, the current runway length of 7,600 feet would be sufficient to meet the majority of destinations utilized by the air carriers currently operating at HOU in the near, 5 year and mid,10 year planning period.

The design aircraft currently using HOU cannot operate at full Maximum Take Off Weight as defined by the manufacturer due to the runway length limitation of 7,600 feet. Carriers must adjust their maximum takeoff weight to accommodate the current runway length. When adding in warmer atmospheric conditions the weight restrictions are even greater however the maximum range ability of these aircraft is reduced by low amounts.

The changes in range distance coverage areas due to the higher than normal atmospheric temperatures are generally more than 100 – 300 nautical miles. This varies slightly depending upon the engine model used and the specific density altitude at the time of departure. This same distance on average is less than the range between the next major internationally recognized ICAO destination city therefore having minor impact on the maximum range distance obtainable by each specific aircraft.

A runway extension would be needed to accommodate longer distance destinations greater than 3,500 Nautical Miles from HOU if desired by the airport or airport tenants. As aircraft operators update their fleet mix for new modern aircraft and as demand for passenger services to these Latin American destinations increases a runway extension should be considered for the next Airport Master Plan update to ensure the economic vitality of HOU in these up and coming market destinations.

Methodology

1. Look up aircraft performance characteristics for HOU.
2. Make assumptions based on operating conditions at the airport and the airlines.
    a. Airport assumptions
        i. Hot day – Use 92 degrees F to determine the operating conditions of aircraft at the airport.
        ii. Operations will take place only on air carrier runways by the designated "critical aircraft types."
        iii. Air carrier runways used in the analysis include: Runway 4-22 (7,602 feet) & Runway 12R-30L (7,602 feet). Runway 12R has a displaced threshold and only has 6,568 feet available for landing. All other runways have 7,602 feet available for takeoff and landing.
        iv. Both runways (Runway 4-22 and 12R-30L) are 7,602 feet but the analysis rounded the length to 7,600 feet for ease of calculations and to take a more conservative approach to the calculations.
        v. The future runway length is to remain the same as the existing runway length for all runways.
    b. Aircraft assumptions
        i. Use following aircraft models: 737-700, 737-900, 757-300.
        ii. Aircraft are assumed not to have winglets. (The aircraft performance manuals do not include winglet model estimate. Most 737 aircraft operating at Hobby currently have winglets in real life; a non-winglet estimate is more conservative.)
    c. Destination Assumptions
        i. Domestic
            1. Domestic destinations assumed the continental United States.
            2. International destinations assumed key Latin American cities. The cities in question include the following. The reason these destinations were chosen are also attached behind each destination.
                a. Cancun, Mexico (700 NM) nearby popular vacation destination from the U.S.
                b. Rio de Janeiro, Brazil (4,300 NM) 2014 World Cup/2016 Olympics
                c. Lima, Peru (3,200 NM) ICAO hub destination
                d. Buenos Aries, Argentina (4,400 NM) ICAO hub destination, Capital City
                e. Santiago, Chili (4,000 NM) ICAO hub destination, Capital City
                f. Bogota, Columbia (2,000 NM) ICAO hub destination, Capital City
3. Results

   The critical aircraft can all make it to destinations throughout the continental United States on a hot day with the current runway lengths but not to Hawaii or all Alaska destinations.

Appendix F

Off-Airport Roadway Intersections Traffic Analysis

WILLIAM P. HOBBY AIRPORT MASTER PLAN UPDATE
TRAFFIC ANALYSIS REPORT

Prepared for:

RICONDO & ASSOCIATES

Prepared by

GUNDA CORPORATION
Engineers, Planners & Managers

October 2014

WILLIAM P. HOBBY AIRPORT MASTER PLAN UPDATE
TRAFFIC ANALYSIS REPORT

Prepared by

GUNDA CORPORATION
TBPE Firm Registration No. F-3531
6161, Savoy Street, Suite 550
Houston, Texas, 77036
Telephone: (713) 541-3530
Fax: (713) 541-0032

October 7, 2014

WILLIAM P. HOBBY AIRPORT MASTER PLAN UPDATE

TRAFFIC ANALYSIS REPORT

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CONTENTS

APPENDICES

LIST OF TABLES(Appendix A)

LIST OF FIGURES

Introduction

This report summarizes the data collection procedures, analysis, and results of a traffic study conducted by Gunda Corporation, LLC (GUNDA) in connection with the William P. Hobby Airport (HOU) Master Plan Update.

Background

Houston Airport System (HAS) requested the consultant team to evaluate the traffic operations on the major roadways in the vicinity of the Airport as part of the HOU Master Plan Update. This request was made in response to concerns expressed by the community during the public meetings for the master plan that the local roads and intersections would not adequately accommodate the forecasted increase in passenger activity at the airport. One of the goals of the project is for the Master Plan Update to accommodate future aviation activity while balancing the capacity of the airfield, the passenger terminal, the ground transportation system, and support facilities at the airport. In order to achieve this goal, an evaluation of 45 intersections along four major roadways providing access to HOU was conducted for existing conditions, opening day, and design year. It is recommended that the plan emerging from this study be coordinated with related City and Regional development projects.

Existing Conditions

The land use in the study area is a combination of commercial, residential, and industrial, with single-family residences located predominately on the north and south and commercial/industrial establishments located predominately on the east and west of the airport. The location of the study area is illustrated in **Exhibit 1-1 Vicinity Map** and an overview of the study area presented in **Exhibit 1-2 Study Corridors Map**.

Regional access to the project site is provided by IH 45 on the east, IH 610 on the north, and Sam Houston Tollway on the south. Telephone Road, Broadway Street, and Monroe Road are the major thoroughfares to the north and south which provide access to the airport. Airport Boulevard, an east-west major thoroughfare, provides direct access to the airport. Direct access to the airport is also provided by Broadway Street via a direct connector. Currently, the primary access to the airport terminal and parking facilities is through the intersection of Airport Boulevard and Broadway Street.

Study Area Roadways

The characteristics of the major roadways serving the study area are described below.

Airport Boulevard

Airport Boulevard is an east-west directional roadway which commences at Almeda Road in the west and ends at Interstate Highway 45. Airport Boulevard is a four to six lane divided street in the study area. The posted speed limit on Airport Boulevard is 40 MPH. The average daily traffic on Airport Boulevard in the study area is approximately 34,095 vehicles.

Monroe Road

Monroe Road is a north-south roadway which commences at Interstate Highway 45 in the north and ends at South Sam Houston Parkway in the south. Monroe Road is a four lane divided street with a posted speed limit of 45 MPH south of Airport Boulevard and 40 MPH north of Airport Boulevard in the study area. The average daily traffic on Monroe Road in the study area is approximately 17,973 vehicles.

Broadway Street

Broadway Street is a north-south roadway which commences at Hockley Street in the north and ends at Hobby Airport. Broadway Street is a four lane divided street with a posted speed limit of 35 MPH in the study area. The average daily traffic on Broadway Street in the study area is approximately 25,948 vehicles.

Telephone Road

Telephone Road is a north-south roadway which commences at Lockwood Drive in the north and ends at South Sam Houston Parkway in the south. Telephone Road is a six lane divided street with a posted speed limit of 45 MPH south of Airport Boulevard and 35 MPH north of Airport Boulevard in the study area. According to the Houston District Traffic Map (Year 2009) prepared by Texas Department of Transportation (TxDOT), the average daily traffic on Telephone Road in the study area is approximately 27,000 vehicles.

The list of analysis intersections located in the vicinity of the Airport are listed in **Table 1 - List of Study Area Intersections** in Appendix A.

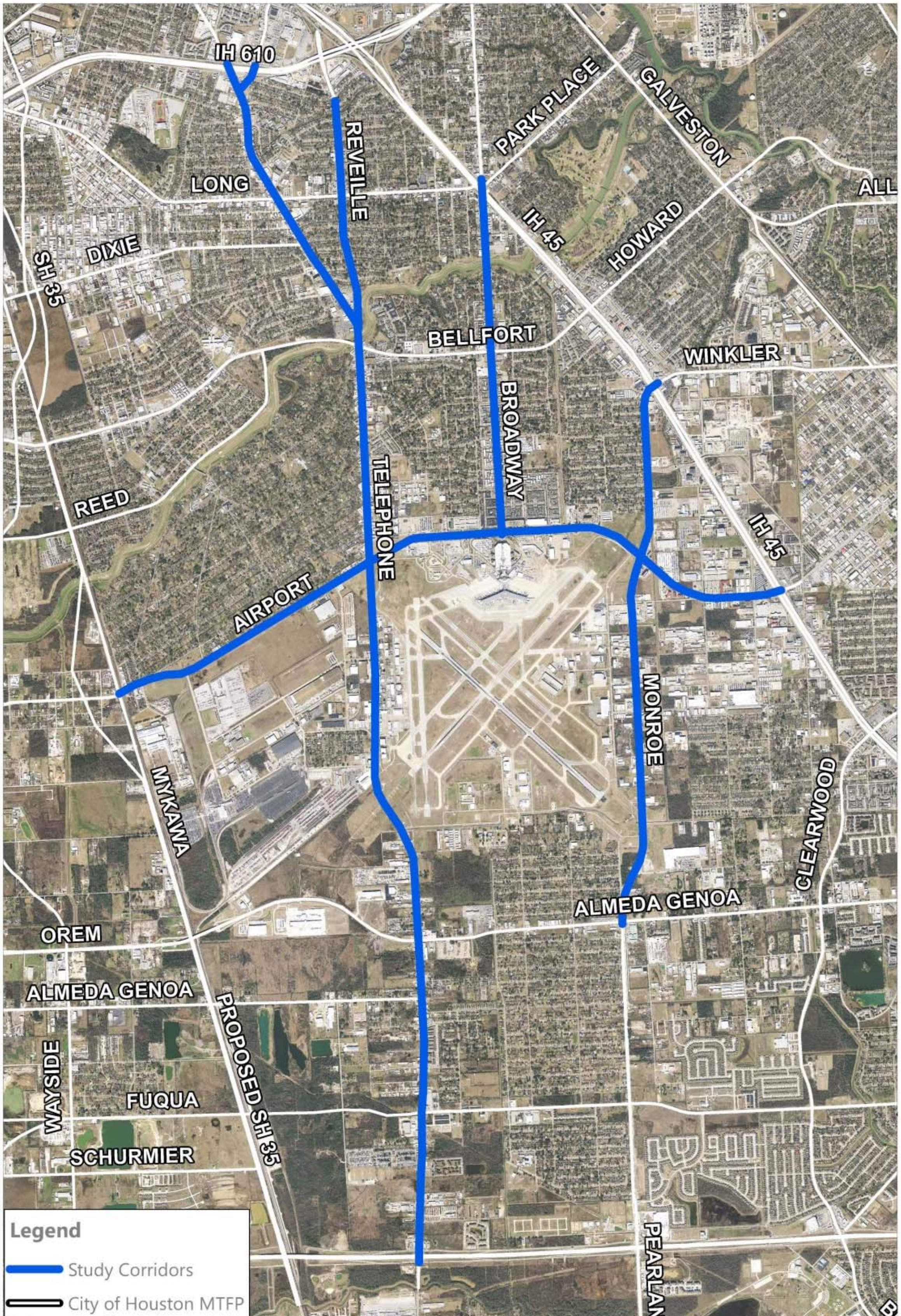
SOURCE: City of Houston Planning and Development Department (COHGIS), 2014 Major Thoroughfare Plan.
PREPARED BY: Gunda Corporation, October 2014.

EXHIBIT 1-1

NORTH

5,250 2,625 0 5,250 Feet

HOUSTON AIRPORT SYSTEMS
VICINITY MAP



SOURCE: City of Houston Planning and Development Department (COHGIS), 2014 Major Thoroughfare Plan.
PREPARED BY: Gunda Corporation, October 2014.

EXHIBIT 1-2

NORTH

4,000 2,000 0 4,000 Feet

HOUSTON AIRPORT SYSTEMS
STUDY AREA MAP

Programmed and Planned Roadway Improvements

The 2013 Major Thoroughfare and Freeway Plan (MTFP) amendment requests published by the planning and development division of City of Houston were reviewed to identify any major changes to roadways in the vicinity of Hobby Airport. The planning commission has reclassified Broadway Street from IH-45 to Galveston Road from a 6 lane Major Thoroughfare with 120' Right-of-Way (T-6-120) to a Principal Thoroughfare (P-6-120). No changes were made to other major roadways in the vicinity of the Airport.

As part of the improvements proposed for the airport, a new surface parking lot will be constructed on the east side of the airport, across Hobby Airport Loop. The access to this parking facility will be provided via signalized intersection of Airport Boulevard at Ruthby Street.

In 2012, Southwest Airlines announced its intention to initiate international service from the airport beginning in 2015. As a result, a major construction project is underway at the Airport. This includes a new five-gate international concourse, terminal expansion, utility modifications, a new central utility plant, terminal area roadway realignment, and new parking facilities.

There are currently several City of Houston Active Capital Improvement Program projects in the study area. **Table 2-CIP Improvements** lists the project name, project type, and construction dates.

Data Collection

Gunda Corporation collected peak period turning movement counts for the study intersections during the month of May 2014.

The traffic data collection effort included the following items:

- 24-Hour traffic volumes;
- Intersection turning movement counts;
- Existing roadway geometry and traffic control information; and
- Signal timing data requested from the City of Houston.

Bi-directional 24-hour traffic volumes on the roadways in the study area were collected in May 2014. The 24-hour traffic counts are summarized in **Table 3 24-Hour Bi-Directional Traffic Volumes**, found in Appendix A.

Turning Movement Counts were collected during the AM/Mid-Day/Airport peak period (11:00 to 1:00 PM) and PM peak period (4:00 to 6:00 PM) on typical weekdays (Tuesday-Thursday). The pedestrian volumes at the study intersections were also collected during the same peak periods.

Traffic volumes for all study intersections were compared to determine the study area peak hours within the peak periods. The overall peak hours determined from these counts are as follows:

AM Airport Peak Hour – 12:00 AM to 1:00 PM

PM Airport Peak Hour – 4:45 PM to 5:45 PM

The existing AM and PM peak hour intersection traffic data are summarized in **Table 4 AM Peak Hour Turning Movement Counts** and **Table 5 PM Peak Hour Turning Movement Counts**, respectively.

Project area field reconnaissance was conducted to gather information such as roadway geometry, lade widths, turning lane lengths, intersection traffic control, and general traffic conditions in the study area.

The existing traffic signal timing for the signalized intersections were obtained by contacting City of Houston - Traffic Operations Division.

Traffic Analysis

The purpose of this traffic analysis is to analyze traffic operations at the intersections along the primary roadways providing access to Houston William P. Hobby Airport in existing conditions, opening day (Year 2015), and design year (Year 2030). Present roadway conditions and traffic operations were assessed in order to determine the existing conditions. In order to accommodate the expected increase in vehicular traffic, the existing roadway was analyzed with projected traffic volumes. From this, any locations which require additional capacity or improvements were identified.

Analysis Methodology

Intersection Level of Service (LOS) analyses were performed in accordance with the procedures set forth and recommended by the Highway Capacity Manual (HCM) Level of Service methodologies for evaluation of signalized and unsignalized intersections. The traffic analysis software SYNCHRO was used to evaluate the operations of the study intersections. The LOS criteria for signalized and unsignalized intersections are listed in **Table 6 Level of Service Criteria**. The LOS is based on delay per vehicle.

LOS is a quantitative stratification of a performance measure or measures that represent quality of service. The Highway Capacity Manual defines six levels of service, ranging from A to F based on a quantitative value of performance measures. LOS 'A' is considered as best, free-flow conditions and LOS 'F' is considered failing conditions. A change of LOS indicates that roadway performance has transitioned from one given range of traveler-perceivable conditions to another range. LOS 'D' is considered acceptable during peak hours to the City of Houston.

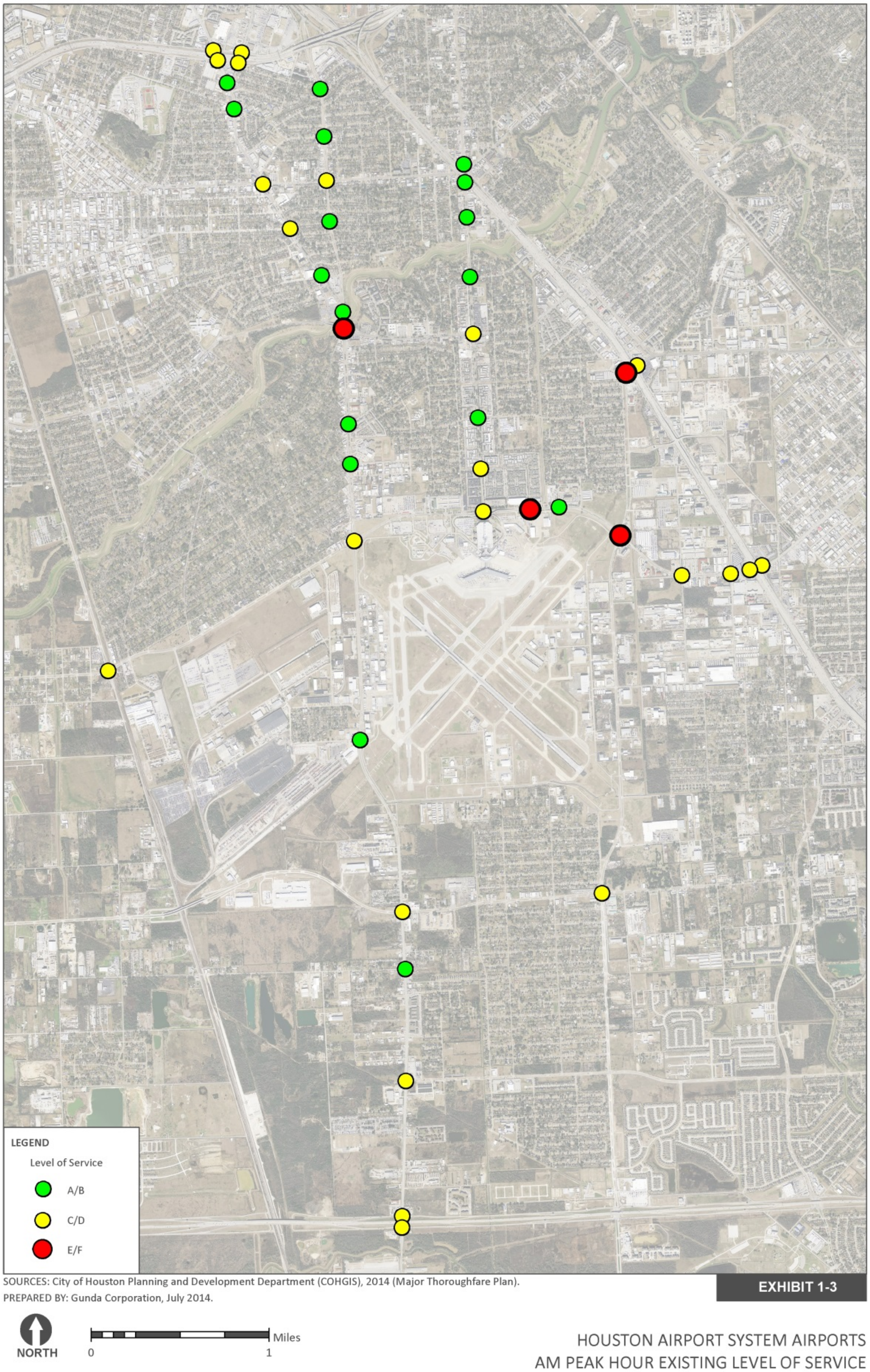
Delay is defined as additional travel time experienced by a driver beyond that required to travel at the desired speed, and is measured in seconds.

Volume to Capacity Ratio (v/c Ratio) is defined as the ratio of flow rate to capacity for a roadway segment.

Existing Conditions

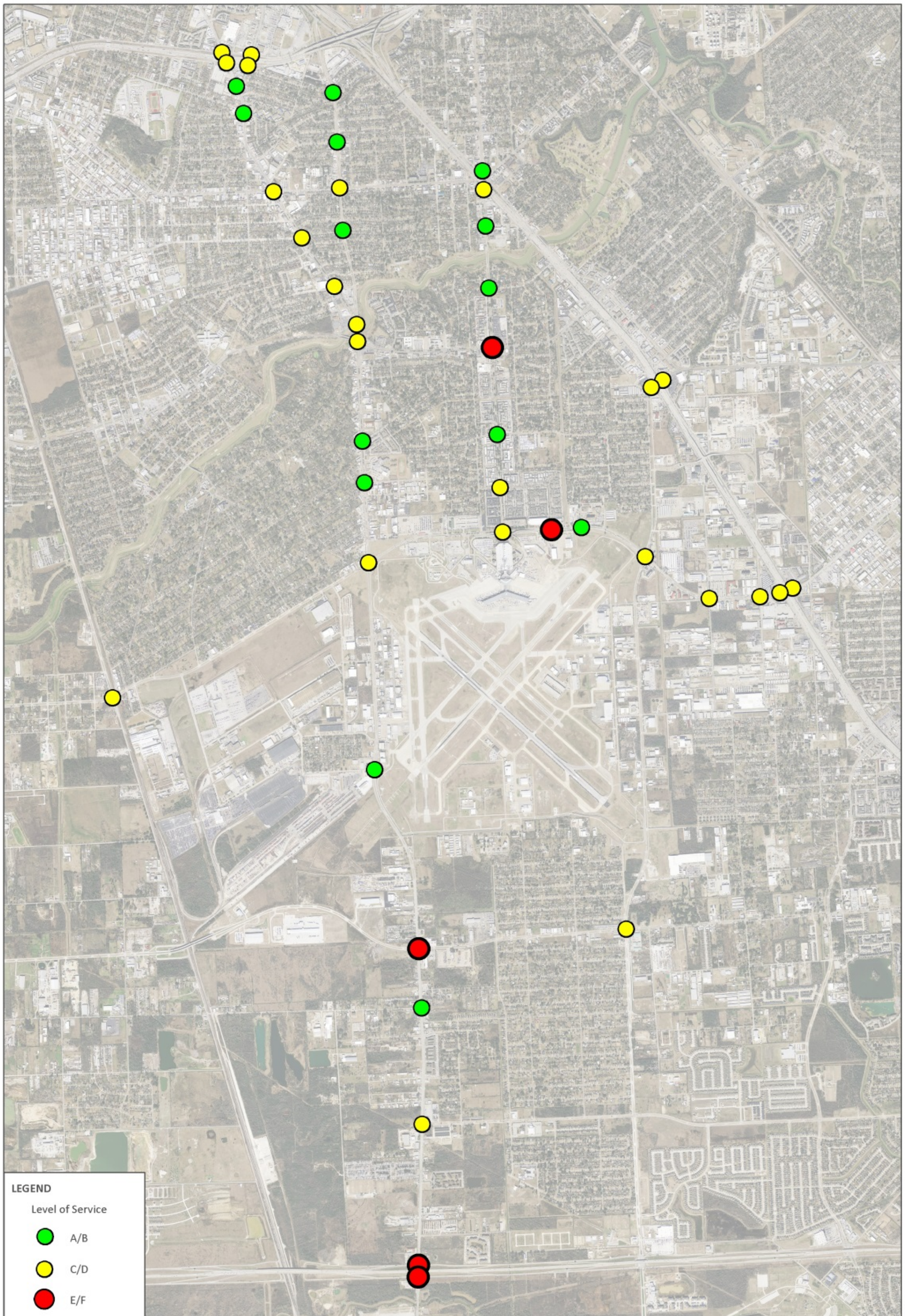
The base SYNCHRO model network was developed using the field collected data, which includes lane configuration, traffic control at the intersections, and speed limits on streets in the study area. The peak hour traffic volumes, pedestrian volumes, and peak hour factors were entered as input. The model was then calibrated based on observations made during the field visit in order to represent the field conditions of study intersections.

The existing AM and PM peak hour levels of service of the analysis intersections are summarized in **Table 7 Existing, Background, and Project Conditions Levels-of-Service**, while detailed level of service analyses are found in Appendix B of this report. As presented in Table 1.7, some of the study intersections are presently operating at levels of service D or better; however, some intersections are operating at level of service E or F. **Exhibit 1-3 AM Peak Hour Existing Condition Level of Service** and **Exhibit 1-4 PM Peak Hour Existing Condition Level of Service** graphically represent the intersection LOS for existing conditions.



SOURCES: City of Houston Planning and Development Department (COHGIS), 2014 (Major Thoroughfare Plan).
PREPARED BY: Gunda Corporation, July 2014.

HOUSTON AIRPORT SYSTEM AIRPORTS
AM PEAK HOUR EXISTING LEVEL OF SERVICE



SOURCES: City of Houston Planning and Development Department (COHGIS), 2014 (Major Thoroughfare Plan).
PREPARED BY: Gunda Corporation, July 2014.

EXHIBIT 1-4

NORTH

0 1 Miles

HOUSTON AIRPORT SYSTEM AIRPORTS
PM PEAK HOUR EXISTING LEVEL OF SERVICE

Background Conditions (Without Airport Growth)

The annual traffic growth rate was estimated taking into consideration the location of the airport, as well as the horizon year (2030). Ricondo and Associates have estimated that the traffic along the major roadways in the vicinity of the Airport will grow at a compound annual growth rate of 1.5% through the ear 2030. The same growth rate was applied to project the traffic at the study area intersections, which are being analyzed as part of the study, to Year 2015 and Year 2030.

Utilizing the projected traffic data for the study intersections, the background AM and PM peak hour levels of service for the study intersections were calculated. The background AM and PM peak hour levels of service of the analysis intersections are summarized in Table 1.7, while detailed level of service analyses are included in Appendix B of this report. As presented in Table 1.7, there are several intersection that will operate at level of service E or F by 2015.

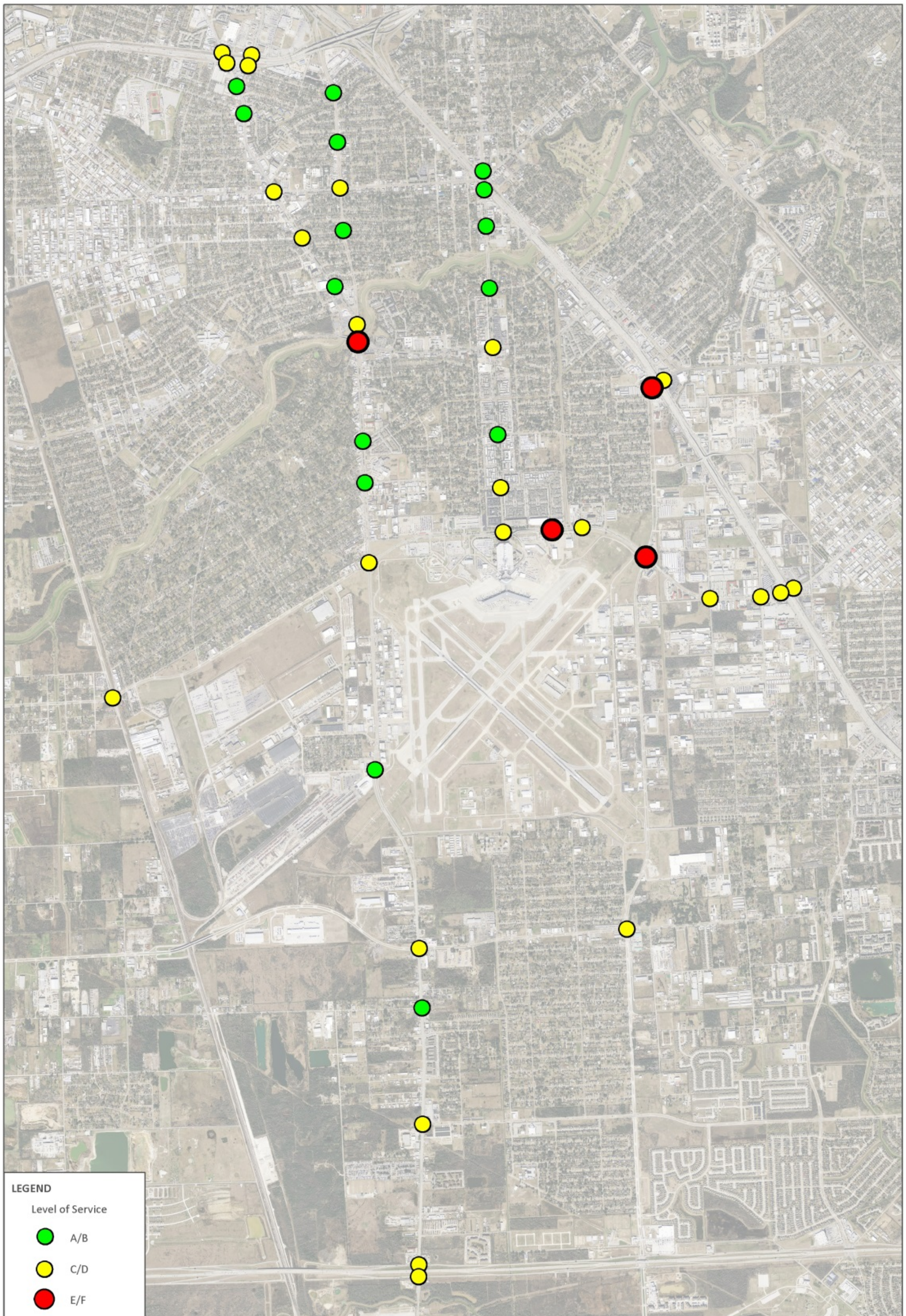
Project Conditions (With Airport Growth)

Based on the Historical and Projected Emplaned Passengers data presented in the technical memorandum summarizing the aviation activity forecast for Houston Hobby Airport, Ricondo and Associates determined the increase in traffic volumes which are anticipated as a result of the Airport improvement. It was determined the compound annual growth rate of enplaned passengers between 2011 and 2015 is 3.0% and between 2011 and 2030 is 4.0%. Based on this growth rate, the number of additional trips generated has been estimated.

As seen in the exhibits presenting proposed developments, the proposed surface parking lot on the east side of the airport will provide long-term parking to passengers travelling via Hobby Airport. The ingress and egress to this parking lot will be provided via the signalized intersection of Airport Boulevard at Ruthby Street and the roadway running parallel to Airport Boulevard. The traffic volumes exiting the parking facility through this intersection were estimated based on the new parking lot capacity and anticipated activity.

The estimate of an approach/departure routing distribution for site traffic, and the assignment of site traffic to the adjacent roadways are essential in determining the traffic impacts of a proposed development. Based on the observed traffic patterns in the vicinity of the site, the new trips generated by the airport were distributed through the study area road network.

Utilizing the traffic volumes developed for the project conditions, the AM and PM peak hour levels of service for the study intersections were calculated for Year 2015 Project Conditions and Year 2030 Project Conditions, summarized in Table 7. Detailed levels of service analyses are included in Appendix B. As presented in Table 7, there are ten intersections operating at LOS E or F in 2015 and fourteen intersections operating at LOS E or F in 2030. **Exhibits 1-5 through 1-8** graphically represent the intersection LOS for Year 2015 and Year 2030 Project Conditions.



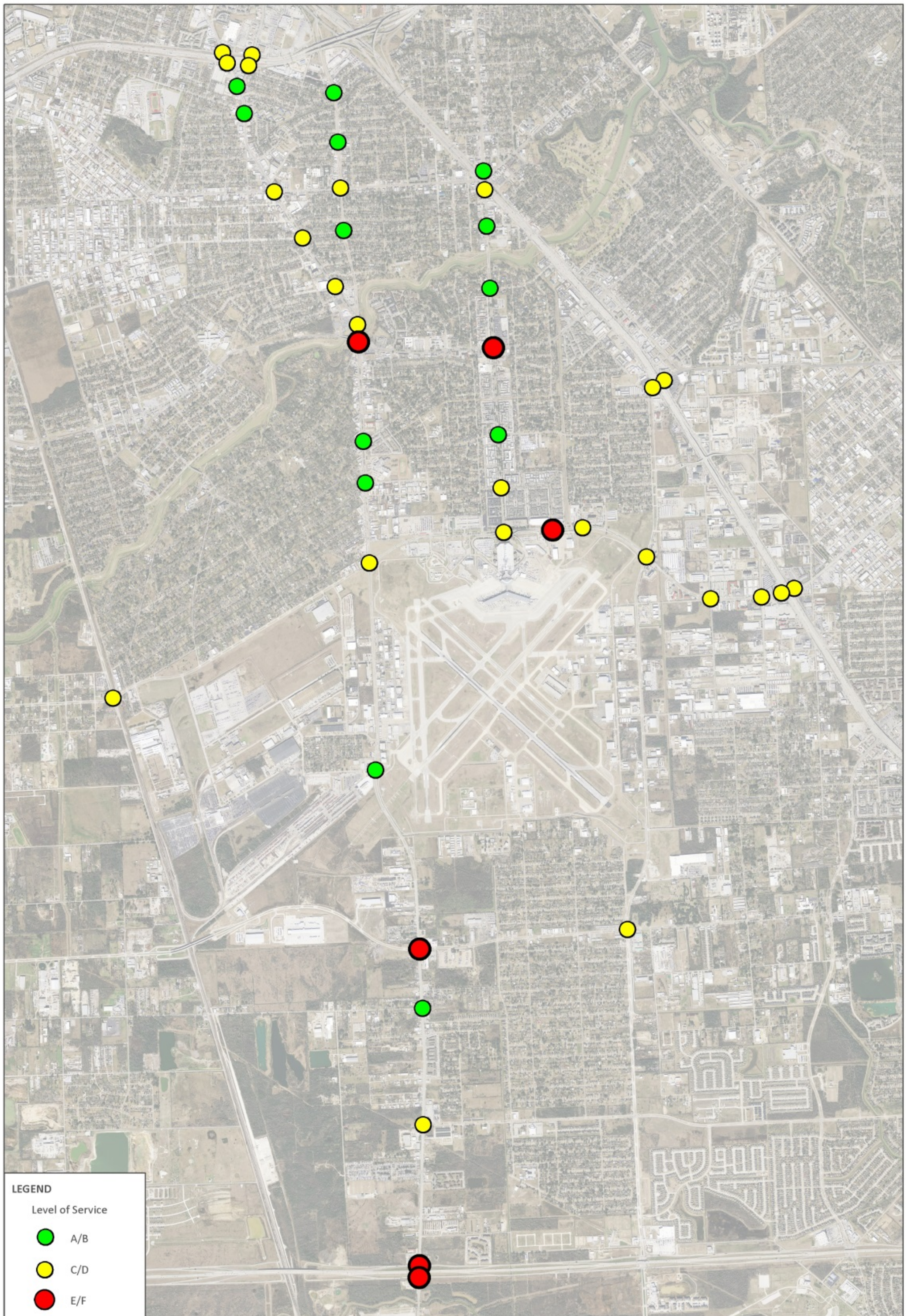
SOURCES: City of Houston Planning and Development Department (COHGIS), 2014 (Major Thoroughfare Plan).
PREPARED BY: Gunda Corporation, July 2014.

EXHIBIT 1-5

NORTH

0 1 Miles

HOUSTON AIRPORT SYSTEM AIRPORTS
AM PEAK HOUR 2015 BACKGROUND LEVEL OF SERVICE



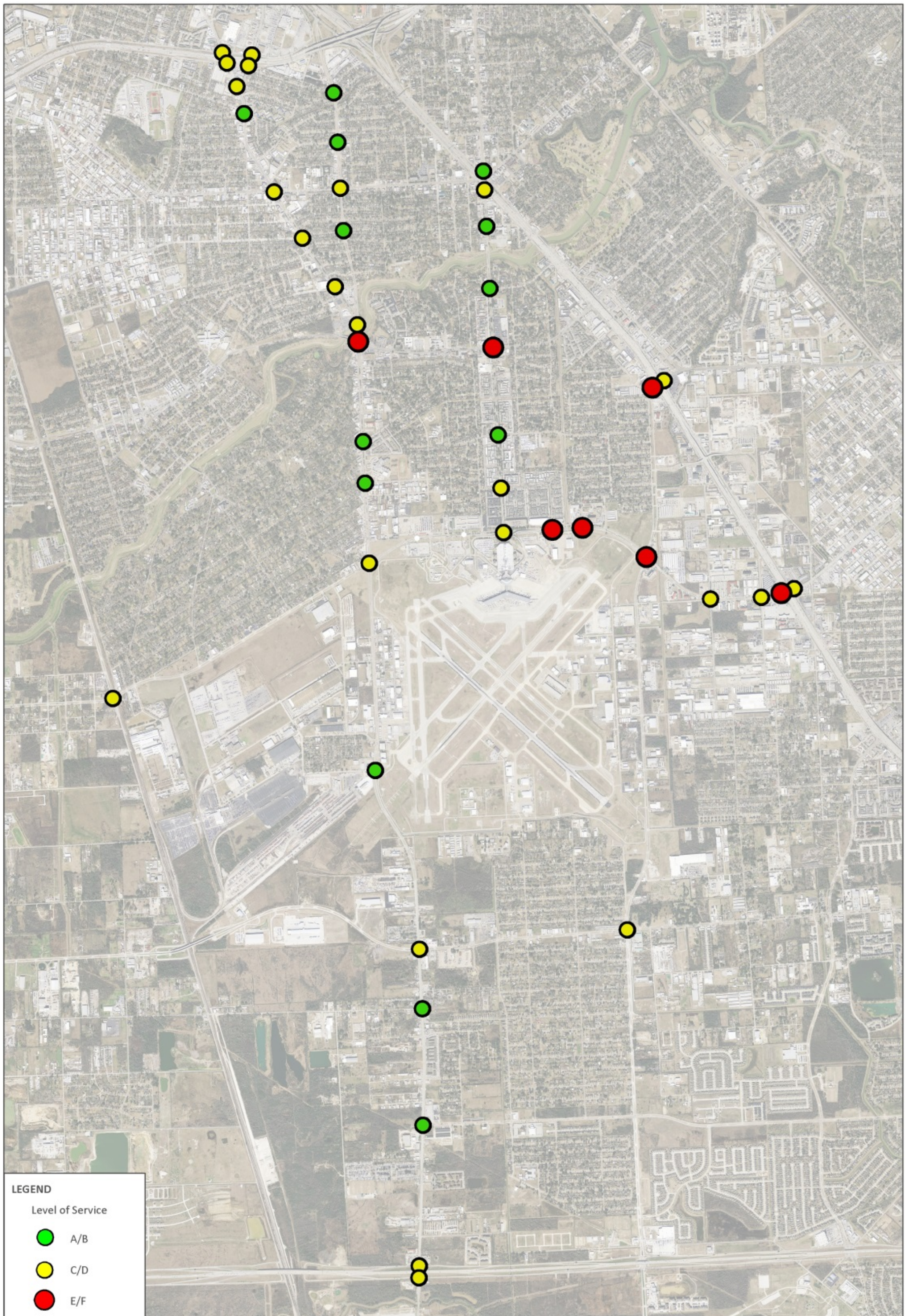
SOURCES: City of Houston Planning and Development Department (COHGIS), 2014 (Major Thoroughfare Plan).
PREPARED BY: Gunda Corporation, July 2014.

EXHIBIT 1-6

NORTH

0 1 Miles

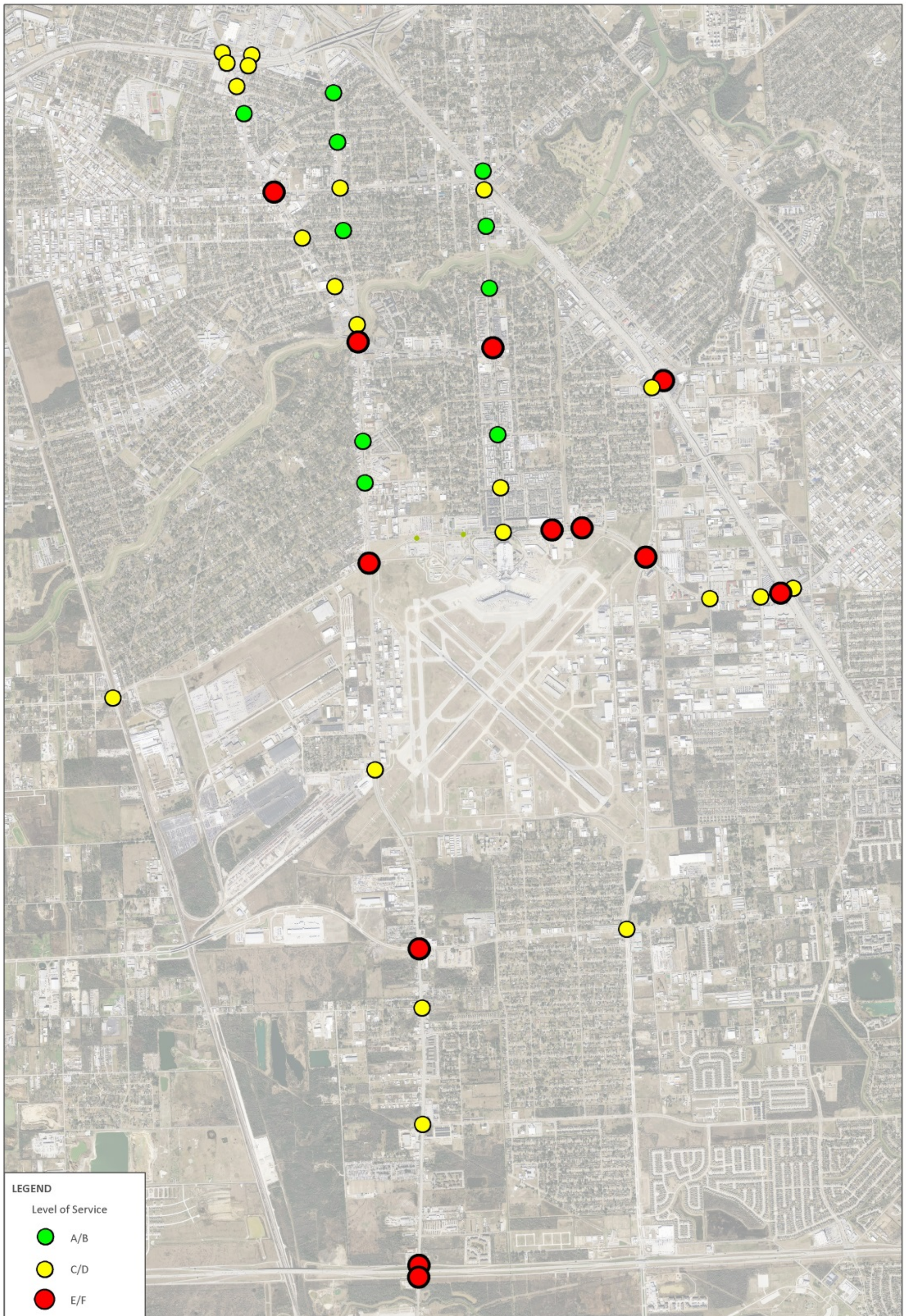
HOUSTON AIRPORT SYSTEM AIRPORTS
PM PEAK HOUR 2015 BACKGROUND LEVEL OF SERVICE



SOURCES: City of Houston Planning and Development Department (COHGIS), 2014 (Major Thoroughfare Plan).
PREPARED BY: Gunda Corporation, July 2014.

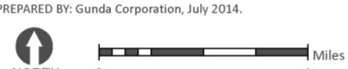
EXHIBIT 1-7

HOUSTON AIRPORT SYSTEM AIRPORTS
AM PEAK HOUR 2030 BACKGROUND LEVEL OF SERVICE



SOURCES: City of Houston Planning and Development Department (COHGIS), 2014 (Major Thoroughfare Plan).
PREPARED BY: Gunda Corporation, July 2014.

EXHIBIT 1-8



HOUSTON AIRPORT SYSTEM AIRPORTS
PM PEAK HOUR 2030 BACKGROUND LEVEL OF SERVICE

Recommended Roadway Improvements

This section presents the roadway improvements which are recommended to be implemented in order to facilitate efficient traffic operations along the roadways providing access to the airport. The following roadway improvements are recommended to improve the traffic operations at the study intersections along Airport Boulevard in the vicinity of the airport:

Year 2015 Improvements

- Airport Boulevard at Ruthby Street
    - Restripe existing pavement markings on the northbound approach of Ruthby Street at Airport Boulevard to provide and exclusive right turn lane and one left/through shared lane

Year 2030 Improvements

- Airport Boulevard at Monroe Road (Estimated Cost: $2,000,000)
    - Provide an additional 300-ft eastbound left turn bay on Airport Boulevard
    - Provide an additional 200-ft eastbound right turn bay on Airport Boulevard
    - Provide an additional 175-ft westbound left turn bay on Airport Boulevard
    - Provide an additional 200-ft southbound right turn bay on Monroe Road
    - Provide an additional 150-ft northbound left turn bay on Monroe Road

- Telephone Road at Airport Boulevard (Estimated Cost: $1,500,000)
    - Provide an additional 200-ft eastbound left turn bay on Airport Boulevard
    - Provide an additional 200-ft westbound left turn bay on Airport Boulevard
    - Provide an additional 265-ft southbound left turn bay on Telephone Road

In addition to the intersection improvements listed for Airport Boulevard, the following improvements are suggested to improve traffic flow in the study area:

Year 2015 Improvements

- Telephone Road at Beltway 8 westbound frontage road
    - Provide a 250-ft exclusive south bound right turn lane on Telephone Road at Beltway 8 westbound frontage road
    - Further co-ordination with TxDOT and HCTRA will be required

Year 2030 Improvements

- Telephone Road at Beltway 8 westbound frontage road
    - Provide a 250-ft westbound right turn bay on Beltway 8 westbound frontage road

- Telephone Road at Beltway 8 westbound frontage road
    - Provide a 250-ft northbound right turn bay on Telephone Road
    - Modify westbound lane configuration to two lefts, one thru, and one thru/right shared lane by eliminating exclusive U-turn lane
    - Restripe northbound lane configuration to have two thru lanes, one thru/left shared lane and one left only lane

- Airport Boulevard at IH 45 Southbound Frontage Road
    - Provide a southbound acceleration lane along IH-45 southbound frontage road (TxDOT coordination required)

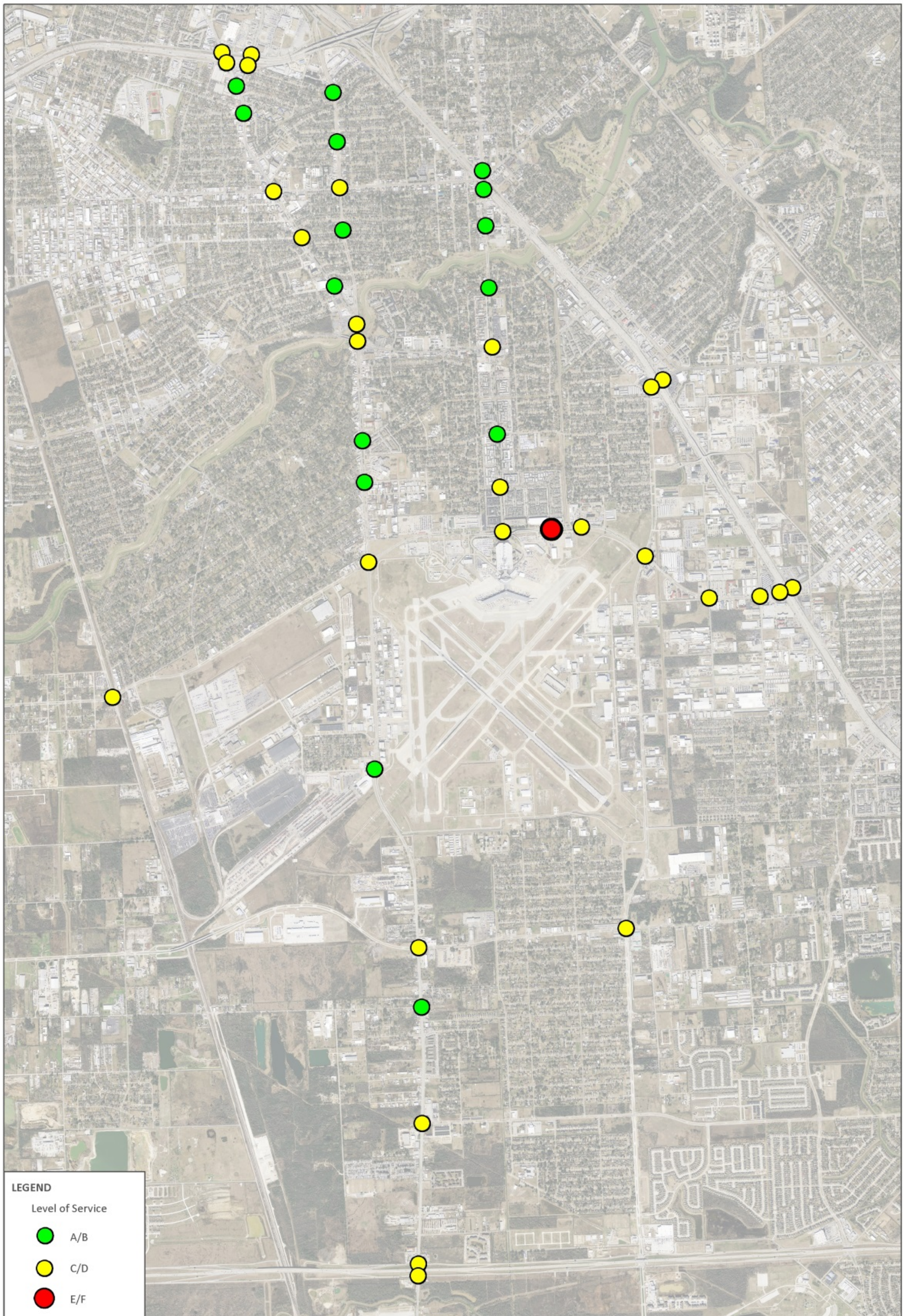
- Telephone Road at Almeda Genoa Road/E. Orem Street
    - Provide a 200-ft southbound right turn bay on Telephone Road
    - Provide an additional 200-ft southbound left turn bay on Telephone Road
    - Provide a 200-ft westbound right turn bay on E. Orem Street
    - Provide an additional 200-ft westbound left turn bay on E. Orem Street
    - Provide a 200-ft northbound right turn bay on Telephone Road
    - Provide a 200-ft northbound left turn bay on Telephone Road
    - Provide a 200-ft eastbound right turn bay on Almeda Genoa Road
    - Provide a 200-ft eastbound left turn bay on Almeda Genoa Road

- Telephone Road at Bellfort Avenue
    - Provide a 200-ft westbound right turn bay on Bellfort Avenue
    - Provide a 200-ft northbound right turn bay on Telephone Road
    - Provide an additional 200-ft westbound left turn bay on Bellfort Avenue

- Broadway Street at Bellfort Avenue
    - Provide a 200-ft eastbound right turn bay on Bellfort Avenue (Development on southwest corner is very close to ROW)

Following the implementation of recommended improvements, the study intersections appeared to be operating at LOS D or better. **Table 8 Project and Mitigated Project Conditions Level of Service** summarizes the mitigated conditions level of service for AM and PM peak periods. The intersections of the Ace Parking Driveway and The Parking Spot Driveway are LOS E and F due to the high volume of Airport Boulevard; however, traffic volumes coming from these driveways do not warrant a signal.

Exhibits 1-9 through 1-12 graphically represent the intersection LOS for Year 2015 and Year 2030 following the implementation of recommended improvements.



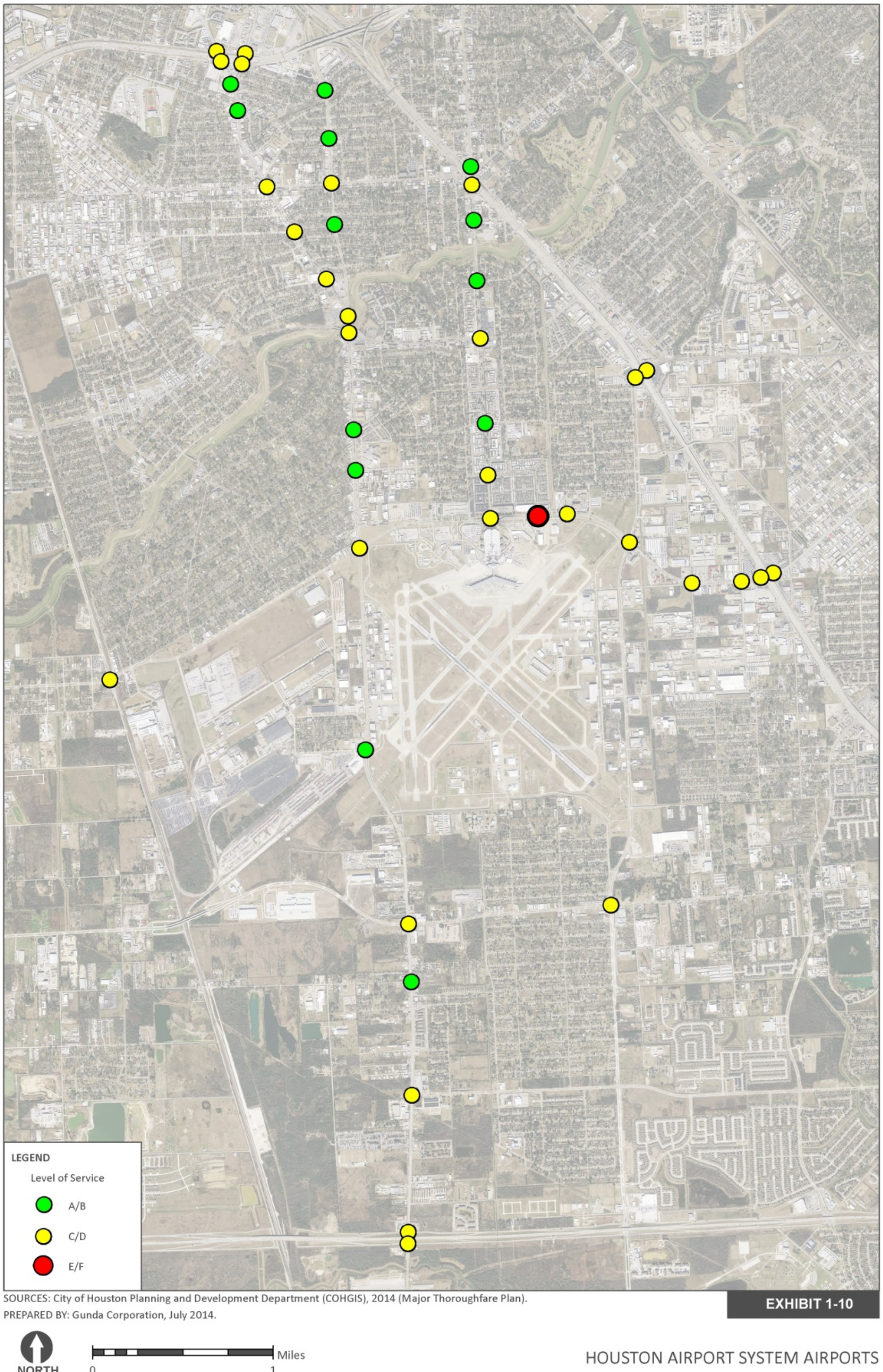
SOURCES: City of Houston Planning and Development Department (COHGIS), 2014 (Major Thoroughfare Plan).
PREPARED BY: Gunda Corporation, July 2014.

EXHIBIT 1-9

NORTH

0 1 Miles

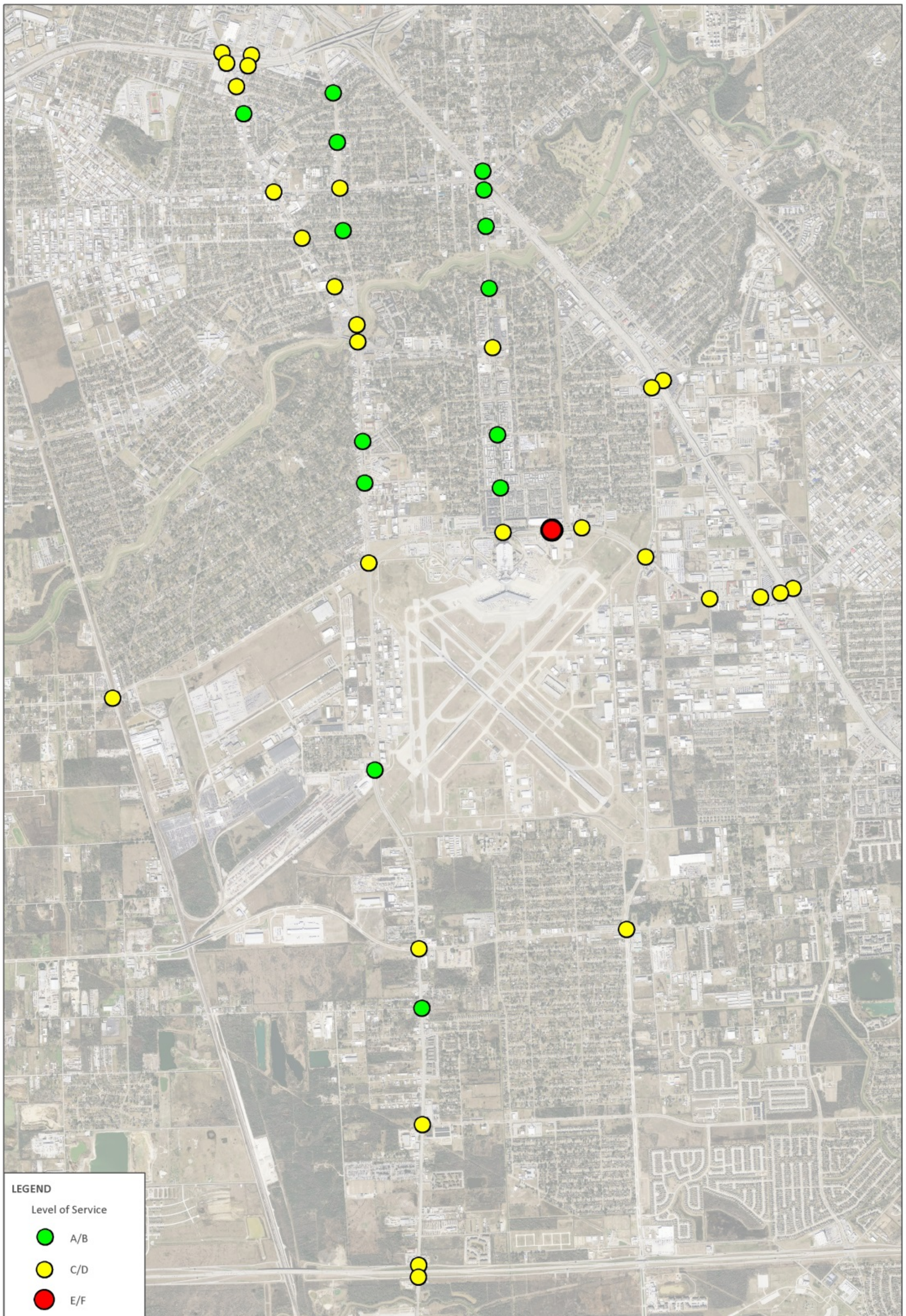
HOUSTON AIRPORT SYSTEM AIRPORTS
AM PEAK HOUR 2015 MITIGATED LEVEL OF SERVICE



SOURCES: City of Houston Planning and Development Department (COHGIS), 2014 (Major Thoroughfare Plan).
PREPARED BY: Gunda Corporation, July 2014.

EXHIBIT 1-10

HOUSTON AIRPORT SYSTEM AIRPORTS
PM PEAK HOUR 2015 MITIGATED LEVEL OF SERVICE



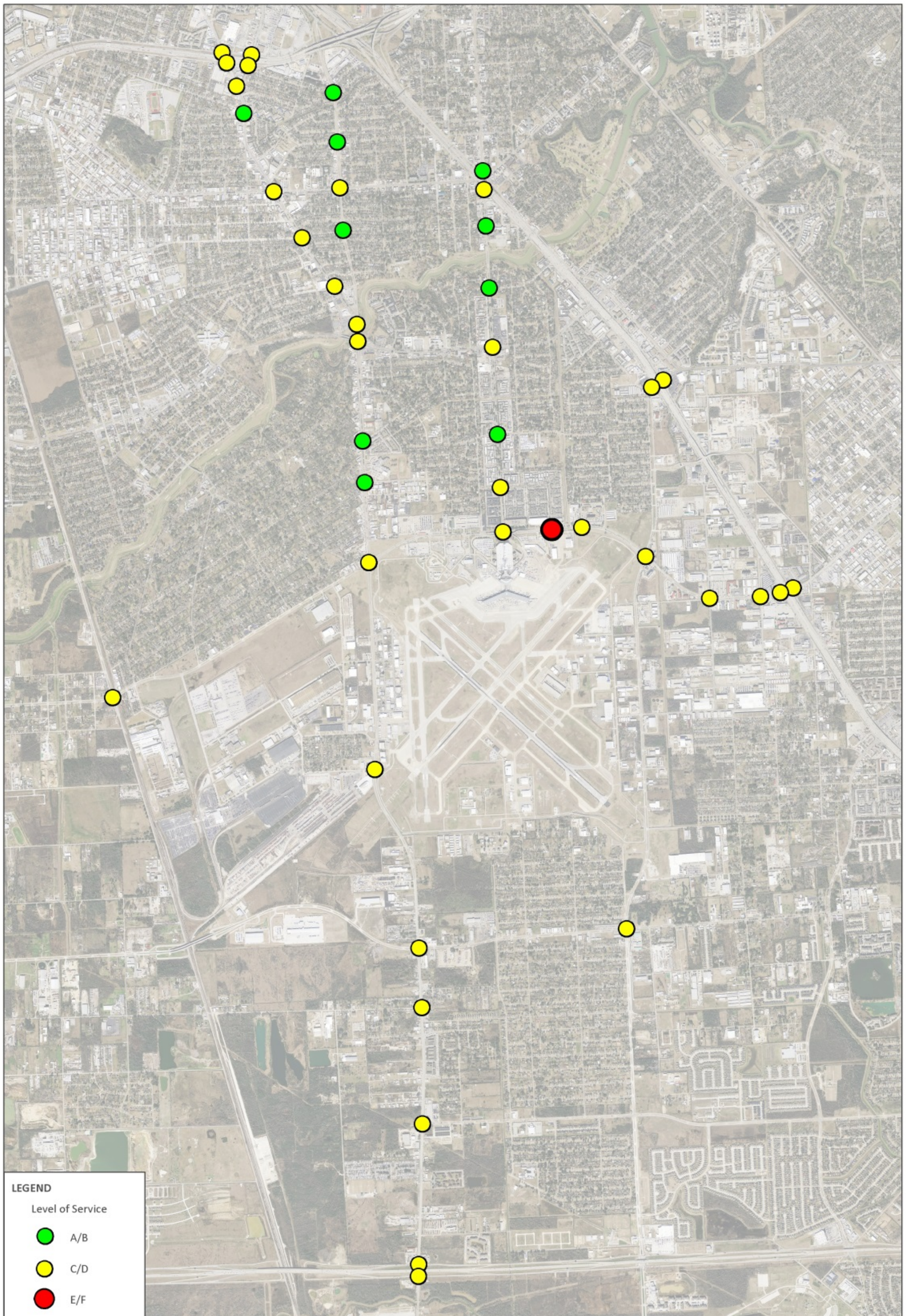
SOURCES: City of Houston Planning and Development Department (COHGIS), 2014 (Major Thoroughfare Plan).
PREPARED BY: Gunda Corporation, July 2014.

EXHIBIT 1-11

NORTH

0 1 Miles

HOUSTON AIRPORT SYSTEM AIRPORTS
AM PEAK HOUR 2030 MITIGATED LEVEL OF SERVICE



SOURCES: City of Houston Planning and Development Department (COHGIS), 2014 (Major Thoroughfare Plan).
PREPARED BY: Gunda Corporation, July 2014.

EXHIBIT 1-12

NORTH

0 Miles 1

HOUSTON AIRPORT SYSTEM AIRPORTS
PM PEAK HOUR 2030 MITIGATED LEVEL OF SERVICE

Findings and Conclusion

Based on the results of the traffic analysis conducted to evaluate the traffic operations along the major roadways providing access to William P Hobby Airport, and the intersections in the vicinity of the project site, the following observations have been made:

- Under existing conditions, the following study area intersections are operating at level of service E or F, during AM and/or PM peak hours:
    - Airport Boulevard at Monroe Road
    - Airport Boulevard at Glencrest Drive/Future Driveway
    - Airport Boulevard at Ace Parking Driveway
    - Airport Boulevard at Parking Spot Driveway
    - Telephone Road at Bellfort Avenue
    - Telephone Road at E. Orem Drive/Almeda Genoa Road
    - Telephone Road at Sam Houston Tollway Westbound Service Road
    - Telephone Road at Sam Houston Tollway Eastbound Service Road
    - Broadway Street at Bellfort Avenue
    - Monroe Street at IH-45 Southbound Service Road

- Under Year 2015 Background Conditions, as well as Project Conditions, the abovementioned study area intersections continue to operate at level of service E or F during AM and/or PM peak hours.

- The intersection of Airport Boulevard at Ruthby Street, which operates at level of service B in existing conditions, would deteriorate to level of service D. This intersection will serve as the ingress/egress point for the proposed east surface parking lot to be developed as part of the master plan.

- Under Year 2030 conditions, the following study area intersections operate at level of service E or F under Background Conditions as well as Project Conditions, during AM and/or PM peak hours:
    - Airport Boulevard at IH-45 Northbound Service Road
    - Airport Boulevard at Monroe Road
    - Airport Boulevard at Glencrest Drive/Future Driveway
    - Airport Boulevard at Ace Parking Driveway
    - Airport Boulevard at Parking Spot Driveway
    - Airport Boulevard at Telephone Road
    - Telephone Road at Long Drive/Park Place Boulevard
    - Telephone Road at Bellfort Avenue
    - Telephone Road at E. Orem Drive/Almeda Genoa Road

- Telephone Road at Sam Houston Tollway Westbound Service Road
- Telephone Road at Sam Houston Tollway Eastbound Service Road
- Broadway Street at Bellfort Avenue
- Monroe Street at IH-45 Northbound Service Road
- Monroe Street at IH-45 Southbound Service Road

The study concludes that the public roadway system, following the implementation of above mentioned improvements, can accommodate the anticipated traffic volumes generated by the proposed developments at William P. Hobby Airport during the opening year and design year.

APPENDIX A

TABLES

Table 1
William P. Hobby Airport Master Plan Update
List of Study Area Intersections

1	Airport Boulevard at IH 45 NB Service Road
2	Airport Boulevard at IH 45 SB Service Road
3	Airport Boulevard at Mosley Road
4	Airport Boulevard at Hansen Road
5	Airport Boulevard at Monroe Road
6	Airport Boulevard at Ruthby Road
7	Airport Boulevard at Glencrest Drive
8	Airport Boulevard at Broadway Street
9	Airport Boulevard at Ace Parking Driveway
10	Airport Boulevard at Parking Spot Driveway
11	Airport Boulevard at Telephone Road
12	Airport Boulevard at Mykawa Road
13	Reveille Street at Thurow Street
14	Reveille Street at Joplin Street
15	Reveille Street at Park Place Boulevard
16	Reveille Street at Dixie Road
17	Telephone Road at Reveille Street
18	Woodridge Drive at IH 610 WB Service Road
19	Woodridge Drive at IH 610 EB Service Road
20	Telephone Road at IH 610 WB Service Road
21	Telephone Road at IH 610 EB Service Road
22	Telephone Road at Woodridge Drive
23	Telephone Road at Fairway Drive
24	Telephone Road at Long Drive/Park Place Boulevard
25	Telephone Road at Dixie Drive
26	Telephone Road at Westover Street
27	Telephone Road at Bellfort Avenue
28	Telephone Road at Drouet Street/Brace Street
29	Telephone Road at Dillon Street
30	Telephone Road at Brisbane Street
31	Telephone Road at E. Orem Drive/Almeda Genoa Road
32	Telephone Road at Almeda Genoa Road
33	Telephone Road at Fuqua Street
34	Telephone Road at Sam Houston Tollway WBSR
35	Telephone Road at Sam Houston Tollway EBSR
36	Broadway Street at IH 45 NB Service Road
37	Broadway Street at IH 45 SB Service Road
38	Broadway Street at Dixie Drive
39	Broadway Street at Santa Elena Street
40	Broadway Street at Bellfort Avenue
41	Broadway Street at Rockhill Street
42	Broadway Street at Morley Street
43	Monroe Street at IH 45 NB Service Road
44	Monroe Street at IH 45 SB Service Road
45	Monroe Street at Almeda Genoa Road

Table 2
William P. Hobby Airport Master Plan Update
City of Houston Capital Improvement Projects - Active Projects in HOU Study Area

Project Description	Layer Name	Primary Project	Associate Project	Project Type	Project Phase	Construction Start	Construction End	Council District
Skyscraper Shadows Area (Local Drainage Program)	Benefit Drainage Area	M-000126-0076	M-000126-0076	MLD	Design	6/10/2014		D
Skyscraper Shadows Area (Local Drainage Program)	Storm water	M-000126-0076	M-000126-0076	MLD	Design	6/10/2014		D
Broadway: IH-45 To Airport Blvd	Street and Traffic	N-000573-0001	N-000573-0001	NMT	Design	1/5/2014	10/15/2016	I
Broadway: IH-45 To Airport Blvd	Wastewater	N-000573-0001	R-000500-0166	R500	Design	1/5/2014	10/15/2016	I
Broadway: IH-45 To Airport Blvd	Water	N-000573-0001	S-000500-0166	S500	Design	1/5/2014	10/15/2016	I
Bellfort: MLK To I-45	Asphalt	N-001037-0063	N-001037-0063	ASPH	Under Construction	2/4/2013	9/2/2013	I,D
Almeda Genoa: Telephone To Clearwood	Concrete Panel	N-321038-0000	N-321038-0000	CONP	Pending Construction	4/1/2014	6/30/2015	D
Santa Rosa & Park Place Proj Area: Neighborhood Sewer System Improvements	Wastewater	R-002011-0054	R-002011-0054	RWLI	Under Construction	8/19/2013	6/12/2014	I
Prv Pkg# 6: Pressure Reducing Valve Station Improvements	Water	S-000701-0012	S-000701-0012	SWV	Design	4/13/2014	9/30/2015	I
Moers Road And Almeda-Genoa From Proposed Moers Row To Monroe: 66-Inch Waterline	Water	S-000900-0103	S-000900-0103	Design	8/17/2014	12/5/2015	6/10/2014	D
Monroe From Almeda Genoa To Airport Blvd: 66-Inch Waterline	Water	S-000900-0104	S-000900-0104	SWLR	Under Construction	9/3/2013	9/12/2014	I,D
Monroe And Rockhill From Airport To Glen Valley: 60-Inch Water Line	Water	S-000900-0129	S-000900-0129	SWLE	Design	8/2/2015	3/25/2017	I
Glen Valley, Bellfort, Colgate And Dover From Rockhill To Dixie: 60-Inch Water Line	Water	S-000900-0130	S-000900-0130	Design	8/23/2015	5/24/2017	6/10/2014	I
Telephone And Almeda Genoa From Mykawa To Moers : 36-Inch Water Line	Water	S-000900-0137	S-000900-0137	SWLE	Design	3/6/2016	8/30/2017	D

Table 3
William P. Hobby Airport Master Plan Update
24-Hour Volumes

Location	Direction	24-Hour Volume	
		Directional	Bi-Directional
Reveille at Park Place	Northbound	13,972	28182
	Southbound	14,210	
Park Place at Reveille	Eastbound	8,015	14414
	Westbound	6,399	
Telephone at Bellfort	Northbound	24,326	57837
	Southbound	33,511	
Bellfort at Telephone	Eastbound	8,914	20,416
	Westbound	11,502	
Bellfort at Broadway	Eastbound	11,995	22,604
	Westbound	10,609	
Broadway at Bellfort	Northbound	6,962	18,371
	Southbound	11,409	
Monroe at Almeda Genoa	Northbound	8,081	15,097
	Southbound	7,016	
Almeda Genoa at Monroe	Eastbound	8,478	15,976
	Westbound	7,498	
Orem at Telephone	Eastbound	6,948	14,586
	Westbound	7,638	
Telephone at Almeda Genoa	Northbound	16,424	31,330
	Southbound	14,906	
Monroe at Braniff	North bound	N/A	-
	Southbound	12,402	
Braniff at Monroe	Eastbound	140	-
	Westbound	N/A	

Table 4
William P. Hobby Airport Master Plan Update
AM Peak Hour Turning Movement Counts

INTERSECTIONS	Southbound				Westbound				Northbound				Eastbound			
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U
Airport Blvd. at IH 45 NB Service Road	-	-	-	-	-	599	424	-	502	233	132	222	450	666	-	-
Airport Blvd. at IH 45 SB Service Road	397	282	87	233	334	744	-	-	-	-	-	-	-	727	520	1
Airport Blvd. at Mosley Road	27	48	151	-	54	769	25	-	40	3	125	-	16	1059	24	2
Airport Blvd. at Hansen Road	55	34	83	-	85	705	108	8	34	26	108	-	55	858	30	0
Airport Blvd. at Monroe St.	59	333	146	-	129	656	55	5	209	372	64	-	212	781	178	-
Airport Blvd. at Ruthby Road	54	6	33	-	72	859	57	2	27	6	80	-	45	1005	4	3
Airport Blvd. at Glencrest Dr. /Future Dwy.	55	-	23	-	-	1043	46	3	-	-	-	-	31	1143	-	77
Airport Blvd. at Broadway St.	120	-	155	2	-	591	121	3	130	169	439	-	159	615	179	2
Airport Blvd. at Ace Parking Driveway	5	-	2	-	-	971	18	15	1	-	1	-	1	1090	2	4
Airport Blvd. at The Parking Spot Driveway	22	-	23	-	-	758	33	10	8	-	27	-	18	916	2	4
Airport Blvd. at Telephone Rd.	122	405	174	3	245	299	55	-	56	437	269	0	235	355	66	-
Airport Blvd. at Mykawa Road	104	206	36	-	65	187	101	-	5	182	80	-	29	173	10	0
Reveille St. at Thurow St.	9	529	15	13	9	2	6	-	28	496	7	5	14	5	41	-
Reveille St. at Joplin St.	4	529	11	4	6	5	7	-	14	458	2	12	12	8	14	-
Reveille St. at Park Place Blvd.	50	483	55	5	96	288	65	-	43	290	78	5	72	261	26	-
Reveille St. at Dixie Road	7	534	18	0	15	16	11	-	1	390	12	1	18	40	5	-
Telephone Rd. at Reville St.	-	567	-	-	-	-	-	-	714	424	-	-	-	-	703	-
Woodridge Dr. at IH 610 WB Service Road	-	392	311	-	157	387	262	102	34	639	-	-	-	-	-	-
Woodridge Dr. at IH 610 EB Service Road	171	367	-	2	-	-	-	-	-	269	139	-	352	177	11	-
Telephone Rd. at IH 610 WB Service Road	-	342	168	-	62	563	123	-	249	514	-	1	-	-	-	37
Telephone Rd. at IH 610 EB Service Road	79	286	-	3	-	-	-	-	-	531	73	-	239	428	212	-
Telephone Rd. at Woodridge Dr.	2	491	11	-	285	42	13	-	5	584	357	-	1	12	9	-
Telephone Rd. at Fairway Dr.	6	710	30	-	28	9	32	-	20	821	17	-	40	9	15	-
Telephone Rd. at Long Dr./Park Place Blvd.	92	466	23	3	88	202	119	-	76	637	83	3	106	149	120	0
Telephone Rd. at Dixie Dr.	10	626	62	3	3	26	9	-	80	662	13	1	70	33	102	-
Telephone Rd. at Westover St.	19	597	86	-	9	57	27	-	38	653	30	1	51	18	16	-
Telephone Rd. at Bellfort Avenue	263	677	82	0	131	256	271	3	127	724	120	0	71	292	106	2
Telephone Rd. at Drouet St./Brace St.	29	844	12	18	12	3	41	-	10	899	17	23	16	2	14	-
Telephone Rd. at Dillon Street	4	896	8	22	5	-	11	-	4	930	9	1	2	0	4	-
Telephone Rd. at Brisbane St.	0	650	103	1	-	-	-	-	41	663	1	0	116	-	74	-
Telephone Rd. at E. Orem Dr./Almeda Genoa	100	529	43	-	135	170	104	0	103	554	144	-	60	168	113	4
Telephone Rd. at Almeda Genoa Rd.	-	692	47	-	-	-	-	-	55	708	-	-	67	-	90	0
Telephone Rd. at Fuqua St.	100	634	6	-	74	3	109	0	1	580	69	-	5	1	3	0
Telephone Rd. at Sam Houston Tollway WBSR	-	399	229	-	183	304	151	11	179	472	-	-	-	-	-	17
Telephone Rd. at Sam Houston Tollway EBSR	157	444	-	-	-	-	0	13	-	420	171	1	216	292	260	17
Broadway St. at IH 45 NB Service Road	-	-	-	193	-	392	98	-	4	677	309	474	-	-	-	-
Broadway St. at IH 45 SB Service Road	313	580	689	-	178	-	-	-	-	-	-	-	560	39	-	-
Broadway St. at Dixie Dr.	18	703	23	22	4	10	18	-	22	581	12	2	12	40	35	-
Broadway St. at Santa Elena St.	2	679	14	4	1	0	19	-	2	565	12	1	12	0	1	-
Broadway St. at Bellfort Avenue	48	559	92	2	110	360	47	-	155	458	103	2	113	389	155	1
Broadway St. at Rockhill St.	32	703	36	3	13	28	52	-	21	568	17	5	38	33	17	-
Broadway St. at Morley Street	87	569	27	3	15	32	92	-	9	423	13	27	31	34	22	-
Monroe St. at IH 45 NB Service Road	-	-	-	162	-	530	341	-	127	545	122	191	593	540	-	-
Monroe St. at IH 45 SB Service Road	397	673	483	156	346	291	-	-	-	-	-	293	-	656	98	-
Monroe St. at Almeda Genoa Rd.	8	282	60	-	2	280	61	-	53	254	88	1	96	300	50	1

Table 5
William P. Hobby Airport Master Plan Update
PM Peak Hour Turning Movement Counts

INTERSECTIONS	Southbound				Westbound				Northbound				Eastbound			
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U
Airport Blvd. at IH 45 NB Service Road	-	-	-	-	-	757	401	-	447	179	142	181	423	961	-	-
Airport Blvd. at IH 45 SB Service Road	508	333	50	281	486	715	-	-	-	-	-	-	-	899	672	1
Airport Blvd. at Mosley Road	21	66	102	-	47	717	25	-	31	3	220	-	21	1314	16	3
Airport Blvd. at Hansen Road	61	21	80	-	50	749	30	6	37	2	151	-	24	1054	22	3
Airport Blvd. at Monroe St.	59	647	99	-	123	617	57	12	158	567	56	-	252	880	223	-
Airport Blvd. at Ruthby Road	41	0	37	-	20	962	29	1	21	3	76	-	49	1485	2	6
Airport Blvd. at Glencrest Dr. /Future Dwy.	68	-	53	-	-	1176	70	12	-	-	-	-	45	1262	-	77
Airport Blvd. at Broadway St.	176	-	201	1	-	611	136	4	221	215	466	-	186	783	191	2
Airport Blvd. at Ace Parking Driveway	3	-	5	-	-	1137	14	22	1	-	1	-	9	1406	0	4
Airport Blvd. at The Parking Spot Driveway	12	-	24	-	-	997	25	14	11	-	12	-	21	1325	3	4
Airport Blvd. at Telephone Rd.	200	1018	124	2	315	310	68	-	53	603	332	1	175	444	110	-
Airport Blvd. at Mykawa Road	202	903	35	-	136	297	194	-	12	311	93	-	48	274	46	2
Reveille St. at Thurow St.	21	1088	10	10	23	7	6	-	29	632	11	4	11	11	46	-
Reveille St. at Joplin St.	16	1078	12	2	6	11	8	-	25	610	8	7	14	10	18	-
Reveille St. at Park Place Blvd.	99	938	52	3	168	281	112	-	65	493	102	1	69	596	37	-
Reveille St. at Dixie Road	19	1017	31	1	16	21	15	-	4	585	19	3	31	109	2	-
Telephone Rd. at Reville St.	-	796	-	-	-	-	-	-	691	498	-	-	-	-	1280	-
Woodridge Dr. at IH 610 WB Service Road	-	353	318	-	250	422	284	49	26	650	-	-	-	-	-	-
Woodridge Dr. at IH 610 EB Service Road	109	487	-	0	-	-	-	-	-	303	182	-	380	209	20	-
Telephone Rd. at IH 610 WB Service Road	-	630	242	-	49	658	117	-	289	514	-	0	-	-	-	76
Telephone Rd. at IH 610 EB Service Road	80	599	-	1	-	-	-	-	-	602	53	-	211	488	333	-
Telephone Rd. at Woodridge Dr.	8	898	14	-	379	56	17	-	4	657	422	-	3	21	10	-
Telephone Rd. at Fairway Dr.	26	1169	37	-	34	21	35	-	19	909	23	-	46	26	44	-
Telephone Rd. at Long Dr./Park Place Blvd.	150	830	26	1	89	168	152	-	92	650	80	3	119	417	243	1
Telephone Rd. at Dixie Dr.	20	1088	67	2	2	39	13	-	65	731	20	2	72	90	162	-
Telephone Rd. at Westover St.	15	1145	75	-	7	55	20	-	20	687	27	2	62	41	30	-
Telephone Rd. at Bellfort Avenue	411	1596	81	2	146	357	211	0	142	926	134	4	88	427	178	1
Telephone Rd. at Drouet St./Brace St.	91	1613	25	18	24	16	53	-	29	980	40	23	27	5	17	-
Telephone Rd. at Dillon Street	14	1594	20	31	28	-	33	-	4	1115	10	6	10	3	1	-
Telephone Rd. at Brisbane St.	0	1711	99	0	-	-	-	-	38	921	0	1	120	-	137	-
Telephone Rd. at E. Orem Dr./Almeda Genoa	175	1655	115	-	191	266	106	2	136	678	177	-	100	352	225	2
Telephone Rd. at Almeda Genoa Rd.	177	1488	85	-	175	250	94	0	105	616	180	-	80	309	196	2
Telephone Rd. at Fuqua St.	234	1693	12	-	187	7	180	8	6	731	189	-	8	6	12	0
Telephone Rd. at Sam Houston Tollway WBSR	-	1126	482	-	214	478	163	21	223	655	-	-	-	-	-	23
Telephone Rd. at Sam Houston Tollway EBSR	461	882	-	-	-	-	1	22	-	548	228	0	342	664	250	23
Broadway St. at IH 45 NB Service Road	-	-	-	187	-	678	96	-	15	754	453	442	-	-	-	-
Broadway St. at IH 45 SB Service Road	311	1203	573	-	165	-	-	-	-	-	-	-	720	32	-	-
Broadway St. at Dixie Dr.	23	670	22	29	4	17	9	-	28	698	21	3	29	129	83	-
Broadway St. at Santa Elena St.	5	761	33	1	1	3	13	-	4	657	12	0	15	6	9	-
Broadway St. at Bellfort Avenue	90	583	113	0	145	396	41	-	179	495	116	2	115	535	210	0
Broadway St. at Rockhill St.	51	804	56	1	28	55	66	-	17	683	40	3	64	41	41	-
Broadway St. at Morley Street	130	588	44	0	25	39	115	-	8	531	31	71	54	67	31	-
Monroe St. at IH 45 NB Service Road	-	-	-	78	-	657	338	-	145	552	150	0	560	576	-	-
Monroe St. at IH 45 SB Service Road	365	728	487	-	424	392	-	-	-	-	-	203	-	794	81	-
Monroe St. at Almeda Genoa Rd.	11	364	26	-	4	437	58	-	57	328	93	0	96	527	126	3

Table 6

William P. Hobby Airport Master Plan Update

Level of Service (LOS) Criteria for Intersections

LOS	Signalized Intersection	Unsignalized Intersection
	Delay (sec/veh)	Delay (sec/veh)
A	0-10	0-10
B	>10-20	>10-15
C	>20-35	>15-25
D	>35-55	>25-35
E	>55-80	>35-50
F	>80	>50

Table 7
William P. Hobby Airport Master Plan Update
Existing, Opening Day(Year 2015) and Design Year (Year 2030) - AM and PM Peak Hour Level of Service (LOS)

INTERSECTIONS	Existing Conditions				2015 Background				2015 Project Conditions				2030 Background				2030 Project Conditions			
	AM		PM		AM		PM		AM		PM		AM		PM		AM		PM	
	LOS	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**
Airport Blvd. at IH 45 NB Service Road	C	25.6	C	26.9	C	25	C	26.4	C	25	C	27.5	C	34.9	D	40.9	D	35.5	D	42.6
Airport Blvd. at IH 45 SB Service Road	C	30.1	D	47	C	30.7	D	47.7	C	33.1	D	50.1	E	56.9	F	83.6	E	65.9	F	92.9
Airport Blvd. at Mosley Road	C	21	C	21	C	21.6	C	21.6	C	21.6	C	21.7	D	36.6	D	37.7	D	35.7	D	40.6
Airport Blvd. at Hansen Road	C	23.6	C	20.7	C	24.4	C	21.6	C	24.2	C	21.5	D	41.5	D	40.6	D	39.6	D	40
Airport Blvd. at Monroe Road	E	56.6	D	51.7	E	58.5	D	54.2	E	57.2	E	60.3	E	72.9	F	83.1	E	77.1	F	108.9
Airport Blvd. at Ruthby Road	B	17.6	A	8.7	B	17.5	A	8.6	D	50.3	D	53.5	C	23.2	B	12.8	F	129.8	F	140.2
Airport Blvd. at Glencrest Dr. /Future Dwy.*	F	56.7	F	202.6	F	59.1	F	237.5	E	44.2	F	213.6	F	297.8	F	1015.9	F	450.6	F	958.7
Airport Blvd. at Broadway St.	C	26.1	C	28	C	26.8	C	28.7	C	23.5	C	29.5	C	28.8	C	32.3	C	26.8	C	30
Airport Blvd. at Ace Parking Driveway*	C	23.7	E	44.6	C	23.6	E	45.7	D	26	E	47	D	33.7	F	99.8	E	40.8	F	104.4
Airport Blvd. at Parking Spot Driveway*	D	25.2	F	82	D	26.3	F	91.3	D	26.8	F	95.4	F	54.5	F	449.4	F	59	F	503.2
Airport Blvd. at Telephone Rd.	D	40.3	D	40.9	D	42.1	D	43.6	D	41.5	D	44.2	D	52.4	E	70.2	D	52.9	F	80.2
Airport Blvd. at Mykawa Road	D	36.9	D	44.4	D	37	D	45.2	D	37.2	D	45.5	D	39.4	D	41.1	D	41	D	41.8
Reveille St. at Thurow St.	A	8.9	A	9.1	A	8.9	A	9.2	A	8.9	A	9.2	B	10.4	B	11	B	10.4	B	11
Reveille St. at Joplin St.	A	7.8	A	9	A	7.9	A	9.1	A	7.9	A	9.1	A	9.2	B	10.7	A	9.3	B	11
Reveille St. at Park Place Blvd.	D	38.1	D	48.5	D	38.2	D	48.9	D	38.2	D	48.9	D	39.4	D	53.1	D	39.3	D	53
Reveille St. at Dixie Road	A	8.4	B	10.9	A	8.7	B	11.1	A	8.7	B	11.1	B	10.3	B	14.9	B	10.2	B	15.3
Telephone Rd. at Reveille St.	B	20	C	24.8	C	23.2	C	25.1	C	23.2	C	25.1	C	24.5	C	28.7	C	24.5	C	28.8
Woodridge Dr. at IH 610 WB Service Road	C	25.9	C	27.2	C	26.3	C	27.6	C	26.3	C	27.6	C	31	D	36.4	C	31	D	36.6
Woodridge Dr. at IH 610 EB Service Road	D	36.2	C	32.7	D	36.3	C	33.4	D	36.3	C	33.4	D	38.9	D	47.6	D	38.9	D	47.8
Telephone Rd. at IH 610 WB Service Road	C	22.9	C	26.2	C	23.2	C	26.5	C	23.2	C	26.5	C	27.4	C	32.3	C	27.3	C	32.4
Telephone Rd. at IH 610 EB Service Road	C	27.2	C	28.6	C	27.3	C	28.7	C	27.3	C	28.7	D	35.9	D	42.8	D	36.3	D	43
Telephone Rd. at Woodridge Dr.	B	16	B	18.5	B	16.3	B	19.4	B	16.3	B	19.4	C	25.1	C	26.6	C	25.1	C	26.7
Telephone Rd. at Fairway Dr.	B	12.9	B	12.2	B	13.1	B	11.9	B	13.1	B	11.9	B	15.8	B	14.8	B	15.8	B	14.6
Telephone Rd. at Long Dr./Park Place Blvd.	D	38.8	D	46.9	D	39.3	D	47.4	D	39.3	D	47.4	D	46.3	E	56.7	D	46.4	E	57.3
Telephone Rd. at Dixie Dr.	C	21.7	C	29.1	C	22.5	C	29.5	C	22.5	C	29.5	C	24.3	C	32.8	C	24.3	C	32.9
Telephone Rd. at Westover St.	B	18.2	C	20.1	B	18.3	C	20.4	B	18.3	C	20.4	C	21.1	C	27.4	C	21.1	C	27.3
Telephone Rd. at Bellfort Avenue	E	67.1	D	54.6	E	73.7	E	55.8	E	73.7	E	55.8	F	132.2	F	90.2	F	131.4	F	92.6
Telephone Rd. at Drouet St./Brace St.	B	15	B	17.2	B	12.8	B	17.3	B	12.8	B	17.3	B	16.6	B	19.4	B	16.4	B	19.2
Telephone Rd. at Dillon St.	A	4	A	6.4	A	3.8	A	6.4	A	3.8	A	6.4	A	4.9	A	7.3	A	4.5	A	7.3
Telephone Rd. at Brisbane St.	B	14.7	B	19.3	B	14.9	B	19.8	B	14.9	B	19.8	B	17.5	C	29.1	B	17.3	C	29.9
Telephone Rd. at E. Orem Dr./Almeda Genoa	D	35.9	F	88	D	36.2	F	93.8	D	36.1	F	94.6	D	40.1	F	153.9	D	40	F	159
Telephone Rd. at Almeda Genoa Rd.	B	12.7	B	17.5	B	12.8	B	17.6	B	12.8	B	16.9	B	13.8	C	22.3	B	13.9	C	22.7
Telephone Rd. at Fuqua St.	C	20.8	C	27.9	C	21.2	C	28.6	C	21.3	C	26.1	B	17.8	C	29.5	B	17.9	C	30.4
Telephone Rd. at Sam Houston Tollway WBSR	C	29	E	76.1	C	29.8	F	82.3	C	29.8	F	68.3	D	35.2	F	168.4	D	37.1	F	172.9
Telephone Rd. at Sam Houston Tollway EBSR	C	28.9	F	89.7	C	26.6	E	77.4	C	26.9	F	92	D	45.8	F	174.8	D	37.9	F	129.8
Broadway St. at IH 45 NB Service Road	A	0	A	0	A	0	A	0	A	0	A	0	A	0.4	A	0.4	A	0	A	0
Broadway St. at IH 45 SB Service Road	B	13.4	D	44.3	B	13.8	D	49.3	B	14	D	49.1	C	25.1	D	36.3	C	30	D	40.8
Broadway St. at Dixie Dr.	A	5.4	A	8.6	A	5.3	A	8.6	A	5.2	A	8.5	A	5.7	A	9.8	A	5.8	B	10.1
Broadway St. at Santa Elena St.	A	5.8	A	6	A	5.8	A	6.1	A	5.8	A	6.1	A	7.5	A	7.5	A	7.5	A	7.8
Broadway St. at Bellfort Avenue	D	46.1	E	58.8	D	46.5	E	59.5	D	46.6	E	60.3	E	56.8	E	79.4	E	62.9	F	94.3
Broadway St. at Rockhill St.	B	12.8	B	12	B	11.3	B	12.1	B	11	B	11.9	B	13.7	B	13.8	B	12.6	B	13.3
Broadway St. at Morley Street	C	20.2	C	24.2	D	51.4	C	24.5	D	49.7	C	24.2	C	21.4	C	28.8	C	20.9	C	28.4
Monroe St. at IH 45 NB Service Road	C	21	C	30	C	21.4	C	25.1	C	21.4	C	31.6	C	29.1	E	56	C	29.4	E	55.5
Monroe St. at IH 45 SB Service Road	E	63.8	C	22.4	E	67.4	C	22.7	E	67.4	C	23	F	122.8	D	36.4	F	122	D	37
Monroe St. at Almeda Genoa Rd.	C	33.7	D	39.8	C	33.7	D	40	C	33.9	D	40.1	C	35	D	44.3	D	35.6	D	48.2

Table 8
William P. Hobby Airport Master Plan Update
Opening Day(Year 2015) and Design Year (Year 2030) - AM and PM Peak Hour Level of Service (LOS)

INTERSECTIONS	2015 Project Conditions				2015 Mitigated Project Conditions				2030 Project Conditions				2030 Mitigated Project Conditions			
	AM		PM		AM		PM		AM		PM		AM		PM	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Airport Blvd. at IH 45 NB Service Road	C	25	C	27.5	C	24.9	C	28.6	D	35.5	D	42.6	D	43.7	D	38.7
Airport Blvd. at IH 45 SB Service Road	C	33.1	D	50.1	C	32	D	40.6	E	65.9	F	92.9	D	44.5	D	45.4
Airport Blvd. at Mosley Road	C	21.6	C	21.7	C	21.6	C	21.2	D	35.7	D	40.6	C	34.6	D	41.5
Airport Blvd. at Hansen Road	C	24.2	C	21.5	C	24.2	C	21.5	D	39.6	D	40	D	39.6	D	40
Airport Blvd. at Monroe Road	E	57.2	E	60.3	E	55.4	E	56.7	E	77.1	F	108.9	D	45.3	D	41
Airport Blvd. at Ruthby Road	D	50.3	D	53.5	C	32.4	C	28.1	F	129.8	F	140.2	D	54.1	D	54.3
Airport Blvd. at Glencrest Dr. /Future Dwy.*	E	44.2	F	213.6	C	20.6	B	13.1	F	450.6	F	958.7	D	39.4	D	28.7
Airport Blvd. at Broadway St.	C	23.5	C	29.5	C	24.4	C	30	C	26.8	C	30	C	27.8	C	34.1
Airport Blvd. at Ace Parking Driveway*	D	26	E	47	D	26	E	47	E	40.8	F	104.4	E	36.9	F	104.4
Airport Blvd. at Parking Spot Driveway*	D	26.8	F	95.4	D	26.8	F	95.4	F	59	F	503.2	F	59	F	503.2
Airport Blvd. at Telephone Rd.	D	41.5	D	44.2	D	39	D	44.2	D	52.9	F	80.2	C	28.4	D	38.5
Airport Blvd. at Mykawa Road	D	37.2	D	45.5	D	35.8	D	45.5	D	41	D	41.8	D	36.8	D	43.2
Reveille St. at Thurow St.	A	8.9	A	9.2	A	8.9	A	9.2	B	10.4	B	11	B	10.4	B	10.9
Reveille St. at Joplin St.	A	7.9	A	9.1	A	7.9	A	9.1	A	9.3	B	11	A	9.3	B	10.9
Reveille St. at Park Place Blvd.	D	38.2	D	48.9	D	38.2	D	48.9	D	39.3	D	53	D	39	D	52.9
Reveille St. at Dixie Road	A	8.7	B	11.1	A	8.6	B	11.1	B	10.2	B	15.3	A	10	B	15.2
Telephone Rd. at Reveille St.	C	23.2	C	25.1	C	22.3	C	24.7	C	24.5	C	28.8	C	25	C	28.4
Woodridge Dr. at IH 610 WB Service Road	C	26.3	C	27.6	C	26.3	C	27.6	C	31	D	36.6	C	31	D	36.6
Woodridge Dr. at IH 610 EB Service Road	D	36.3	C	33.4	D	36.3	C	33.4	D	38.9	D	47.8	D	38.6	D	47.5
Telephone Rd. at IH 610 WB Service Road	C	23.2	C	26.5	C	23.2	C	26.5	C	27.3	C	32.4	C	27.3	C	32.4
Telephone Rd. at IH 610 EB Service Road	C	27.3	C	28.7	C	27.3	C	28.7	D	36.3	D	43	D	35.7	D	43.9
Telephone Rd. at Woodridge Dr.	B	16.3	B	19.4	B	16.3	B	19.4	C	25.1	C	26.7	C	25.1	C	25.6
Telephone Rd. at Fairway Dr.	B	13.1	B	11.9	B	13.1	B	11.9	B	15.8	B	14.6	B	14.9	B	14.3
Telephone Rd. at Long Dr./Park Place Blvd.	D	39.3	D	47.4	D	39.3	D	47.4	D	46.4	E	57.3	C	32.8	D	41.6
Telephone Rd. at Dixie Dr.	C	22.5	C	29.5	C	22.5	C	29.5	C	24.3	C	32.9	C	25.3	C	31.4
Telephone Rd. at Westover St.	B	18.3	C	20.4	B	18.5	C	20.3	C	21.1	C	27.3	C	22.3	C	26.6
Telephone Rd. at Bellfort Avenue	E	73.7	E	55.8	D	47.9	D	52.3	F	131.4	F	92.6	D	41.1	D	49.4
Telephone Rd. at Drouet St./Brace St.	B	12.8	B	17.3	B	12.8	B	17.4	B	16.4	B	19.2	B	15.4	B	19.4
Telephone Rd. at Dillon St.	A	3.8	A	6.4	A	4	A	6.3	A	4.5	A	7.3	A	2.7	A	6.4
Telephone Rd. at Brisbane St.	B	14.9	B	19.8	B	14.9	B	19.8	B	17.3	C	29.9	B	17.3	C	29.9
Telephone Rd. at E. Orem Dr./Almeda Genoa	D	36.1	F	94.6	C	27.3	D	50.7	D	40	F	159	C	24.1	D	54.8
Telephone Rd. at Almeda Genoa Rd.	B	12.8	B	16.9	B	12.9	B	17.8	B	13.9	C	22.7	B	15.8	C	32.2
Telephone Rd. at Fuqua St.	C	21.3	C	26.1	C	21.2	C	28.1	B	17.9	C	30.4	C	21.9	C	29
Telephone Rd. at Sam Houston Tollway WBSR	C	29.8	F	68.3	C	29.7	D	51.2	D	37.1	F	172.9	C	22.1	D	52.1
Telephone Rd. at Sam Houston Tollway EBSR	C	26.9	F	92	C	26.7	D	50.7	D	37.9	F	129.8	C	25.4	D	54.5
Broadway St. at IH 45 NB Service Road	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0
Broadway St. at IH 45 SB Service Road	B	14	D	49.1	B	13.7	D	49.1	C	30	D	40.8	B	17	D	40.9
Broadway St. at Dixie Dr.	A	5.2	A	8.5	A	5.2	A	8.5	A	5.8	B	10.1	A	7.5	B	10.6
Broadway St. at Santa Elena St.	A	5.8	A	6.1	A	5.8	A	6.1	A	7.5	A	7.8	B	11.4	A	8.2
Broadway St. at Bellfort Avenue	D	46.6	E	60.3	D	46.6	D	51.9	E	62.9	F	94.3	D	39	D	50.7
Broadway St. at Rockhill St.	B	11	B	11.9	B	11.1	B	12.8	B	12.6	B	13.3	B	13.9	B	17.6
Broadway St. at Morley Street	D	49.7	C	24.2	D	50	C	24.1	C	20.9	C	28.4	B	18.1	C	27.7
Monroe St. at IH 45 NB Service Road	C	21.4	C	31.6	C	20.6	C	31.6	C	29.4	E	55.5	D	38.6	C	30.7
Monroe St. at IH 45 SB Service Road	E	67.4	C	23	D	46.9	C	23	F	122	D	37	C	33.3	D	38.8
Monroe St. at Almeda Genoa Rd.	C	33.9	D	40.1	C	33.8	D	40.5	D	35.6	D	48.2	C	33.5	D	41.4

Appendix G

Airport Capital Improvement Program

(Prepared by Houston Airport System, January 10, 2014)

HAS CIP FY 2014 - 2019

	Project in Planning for FY2014
	Active Projects for FY2014

Updated as of 1/10/14

Changes via MOD

Changes done on spreadsheet not entered in PMIS

CIP #	Loc	PN	Phase	Description	Council Date	Sponsor	FY14	FY15	FY16	FY17	FY18	FY19	FY14-19 Total Amount X $1000
CIP Meeting on 11/13/2013													
				Committed Projects									
A-0310.13	HOU	597A	D	NEW PARKING GARAGE AT HOBBY	12/1/2013	Ian Wadsworth	1,120						1,120
A-0422.04	HOU	597A	D	ART - NEW PARKING GARAGE AT HOBBY (Design)	12/1/2013	Ian Wadsworth	15						15
A-0422.104	HOU	597A	C	ART - NEW PARKING GARAGE AT HOBBY (CONST)	12/1/2013	Ian Wadsworth	914						914
A-0422.80	HOU	597A	C	ART - CMAR PRE-CONSTRUCTION PHASE SERVICES	12/1/2013	Ian Wadsworth	11						11
A-0310.03	HOU	597A	C	NEW PARKING GARAGE AT HOBBY - CONSTRUCTION	12/1/2013	Ian Wadsworth	61,336						61,336
A-0310.09	HOU	597A		CMAR PRE-CONSTRUCTION PHASE SERVICES	12/1/2013	Ian Wadsworth	159						159
A-0592.02	HOU	685	C	HOBBY ROADWAY RELOCATION	3/1/2014	Perry Miller	11,237						11,237
A-0592.03	HOU	685	C	CMAR PRE-CONSTRUCTION PHASE SERVICES	12/1/2013	Perry Miller	447						447
A-0601.01	HOU	720	C	**HOU INTERNATIONAL FACILITY - Reimbursable Projects -** Approved by Council - 2/13/13 Ordinance No. O2013-0129	2/1/2014			20,000					20,000
				Project Total			75,239	20,000	0	0	0	0	95,239
				Accumulative Total			**75,239**	**20,000**	**0**	**0**	**0**	**0**	**95,239**
				Mandatory									
A-0513.10	HOU	460B	C	PAVEMENT REPLACEMENT AT HOU (R&R)	12/1/2013	Perry Miller	550						550
A-0513.11	EFD	460B	C	PAVEMENT REPLACEMENT AT EFD (R&R)	12/1/2013	Brian Rinehart	350						350
A-0441.01	EFD	628	D	EXTEND CHALLENGER TO BRANTLEY	N/A	Brian Rinehart	0						0
A-0441.02	EFD	628	C	EXTEND CHALLENGER TO BRANTLEY	12/1/2013	Brian Rinehart	2,700						2,700
A-0564.01	EFD	629	C	REPLACE THE AIR TRAFFIC TOWER - $1.5 million from FAA	8/1/2014	Brian Rinehart		6,400					6,400
A-0422.82	EFD	629	C	ART - AIR TRAFFIC CONTROL TOWER	8/1/2014	Brian Rinehart		101					101
A-0564.05	EFD	633	C	OVERHEAD POWER LINES AT EFD	4/1/2014	Brian Rinehart	750						750
A-0555.02	EFD	632	C	REHAB SCHOLL ST. BETWEEN AEROSPACE & BRANTLEY AVE.	10/1/2013	Brian Rinehart	360						360
A-0614.02	HOU	692	C	SATELLITE ~~CENTRAL~~ UTILITIES PLANT (SUP) AT HOBBY	3/1/2014	Perry Miller	13,036						13,036
A-0614.01	HOU	692	C	CMAR PRE-CONSTRUCTION PHASE SERVICES	12/11/2013	Perry Miller	447	A					447
A-0614.03	HOU	692	C	SATELLITE UTILITIES PLANT (SUP)AT HOBBY(EQUIPMENT)	1/1/2014	Perry Miller	889						889
A-0422.03	HOU	692	C	ART - SATELLITE UTILITIES PLANT (SUP) AT HOBBY	3/1/2014	Perry Miller	225						225
A-0422.92	HOU	692	C	ART - SATELLITE UTILITIES PLANT (SUP) AT HOBBY	1/1/2014	Perry Miller	16						16

HAS CIP FY 2014 - 2019

Project in Planning for FY2014

Active Projects for FY2014

Updated as of 1/10/14

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CIP #	Loc	PN	Phase	Description	Council Date	Sponsor	FY14	FY15	FY16	FY17	FY18	FY19	FY14-19 Total Amount X $1000
CIP Meeting on 12/2/2013													
A-0613.01		695	D	SECURITY ENHANCEMENTS OF AIRPORT OPERATIONS AREA - PERIMETER FENCE LINE	6/14/2013	Perry Miller	100						100
A-0613.02	HOU	695	C	SECURITY ENHANCEMENTS OF AIRPORT OPERATIONS AREA - PERIMETER FENCE LINE	1/1/2015	Perry Miller		900					900
				Project Total			19,423	7,401	0	0	0	0	26,824
				Accumulative Total			**94,662**	**27,401**	**0**	**0**	**0**	**0**	**122,063**
				Critical Support									
A-0446.04	HAS	715A	D	PROFESSIONAL ON CALL DESIGN SERVICES	12/1/2013		2,200	RCA					2,200
A-0446.05	HAS	715B	D	PROFESSIONAL ON CALL DESIGN SERVICES	12/1/2013		2,200	RCA					2,200
A-0446.06	HAS	715C	D	PROFESSIONAL ON CALL DESIGN SERVICES	12/1/2013		2,200	RCA					2,200
A-0368.18	HAS	688	O	ON CALL PLANNING - FY15	8/14/2013	Samar Mukhopadh	4,500	Actual					4,500
A-0348.02	HAS	516D	C	JOB ORDER CONTRACTING FY14	10/1/2014	Samar Mukhopadhyay		1,500					1,500
A-0348.12	HAS	516E	C	JOB ORDER CONTRACTING FY14	10/1/2014	Samar Mukhopadhyay		1,500					1,500
A-0423.14	HAS	693	O	ENVIRONMENTAL CONSULTING SERVICES (PN 625D)	3/1/2014	Carlos Ortiz	1,400						1,400
A-0547.04	HAS	697	O	PROGRAM MANAGEMENT SERVICES	7/1/2014	Samar Mukhopadhyay		18,000					18,000
				Project Total			12,500	21,000	0	0	0	0	33,500
				Accumulative Total			**107,162**	**48,401**	**0**	**0**	**0**	**0**	**155,563**
				Customer Service									
A-0519.01	HOU	703	D	DESIGN & INSTALL CANOPY AT PASSENGER DROP OFF AREA	6/1/2014	Perry Miller	750						750
A-0519.02	HOU	703	C	DESIGN & INSTALL CANOPY AT PASSENGER DROP OFF AREA	3/1/2015	Perry Miller		7,500					7,500
				Project Total			750	7,500	0	0	0	0	8,250
				Accumulative Total			**107,912**	**55,901**	**0**	**0**	**0**	**0**	**163,813**
				Revenue Generator									
A-0594.02	HOU	597C	O	PARKING TECHNOLOGY FOR HOBBY AIRPORT	12/1/2014	Ian Wadsworth		3,000					3,000
A-0530.01	EFD	708	D	FIS & GENERAL AVIATION CENTER	9/1/2014	Brian Rinehart		900					900
				Project Total			0	3,900	0	0	0	0	3,900
				Accumulative Total			**107,912**	**59,801**	**0**	**0**	**0**	**0**	**167,713**
				Infrastructure									
A-0362.03	HOU	545D	D	DESIGN - AIRPORT SERVICES COMPLEX UPGRADE Enabling project - PFC Eligible.	12/1/2013	Perry Miller	350						350
A-0422.89	HOU	545D	D	ART - AIRFIELD & GROUND EXPANSION	12/1/2013	Perry Miller	14						14
A-0362.04	HOU	545D	D	NEW MAINTENANCE FACILITY AND NEW FLEET SHOP	12/1/2013	Perry Miller	450						450
A-0362.09	HOU	545B	C	INCLINED DRIVEWAY FOR SWEEPER AT AIRFIELD AND GROUN	5/1/2014	Perry Miller	52						52

HAS CIP FY 2014 - 2019

Project in Planning for FY2014

Active Projects for FY2014

Updated as of 1/10/14

Changes via MOD

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CIP #	Loc	PN	Phase	Description	Council Date	Sponsor	FY14	FY15	FY16	FY17	FY18	FY19	FY14-19 Total Amount X $1000
A-0362.10	HOU	545B	C	VEHICLE WASH EXPANSION	5/1/2014	Perry Miller	145						145
A-0362.11	HOU	545B	C	NEW AIRFIELD & GROUNDS BUILDING	5/1/2014	Perry Miller	2,677						2,677
A-0422.41	HOU	545B	C	ART - AIRFIELD & GROUNDS EXPANSION	5/1/2014	Perry Miller	126						126
A-0362.05	HOU	545B	C	NEW MAINTENANCE FACILITY AND NEW FLEET SHOP	5/1/2014	Perry Miller	4,500						4,500
CIP Meeting on 12/11/2013													
A-0513.13	HOU	460C	C	PAVEMENT REPLACEMENT AT HOU (R&R)	7/1/2017	Samar Mukhopadhyay					550		550
A-0513.14	EFD	460C	C	PAVEMENT REPLACEMENT AT EFD (R&R)	7/1/2017	Samar Mukhopadhyay					250		250
A-0513.05	HOU	460D	C	PAVEMENT REPLACEMENT AT HOU (R&R)	7/1/2018	Samar Mukhopadhyay						550	550
A-0513.08	EFD	460D	C	PAVEMENT REPLACEMENT AT EFD (R&R)	7/1/2018	Samar Mukhopadhyay						250	250
A-0580.01	HOU	672	D	HOBBY DRAINAGE - ROADWAY FLOODING	7/1/2017	Perry Miller					350		350
A-0580.02	HOU	672	C	HOBBY DRAINAGE - ROADWAY FLOODING	7/1/2022	Perry Miller							0
A-0526.01	HOU	534	O	RELOCATION OF TENTANTS - 12L - 30R FY21	7/1/2020	Perry Miller							0
A-0526.02	HOU	534	D	MASTER PLAN RUNWAY 12L-30R IMPLEMENTATION FY21	7/1/2020	Perry Miller							0
A-0526.03	HOU	534	C	MASTER PLAN RUNWAY 12L-30R IMPLEMENTATION - $160,000 FY22	5/1/2022	Perry Miller							0
A-0576.01	HOU	653	D	MODIFY NORTH ELECTRICAL VAULT & MISC. ELECT. UPGRADES - this project will go away	7/1/2017	Perry Miller					1,175		1,175
A-0576.02	HOU	653	C	MODIFY NORTH ELECTRICAL VAULT & MISC. ELECT. UPGRADES - this project will go away	7/1/2017	Perry Miller					10,575		10,575
A-0590.03	HOU	669	D	REHABILITATE & EXPAND ARFF STATION 81 move to FY15	6/1/2015	Perry Miller		100					100
A-0590.04	HOU	669	C	REHABILITATE & EXPAND ARFF STATION 81 move to FY16	6/1/2016	Perry Miller			900				900
A-0582.01	HOU	680	D	TAXIWAYS M3, H2 H AND G (DISCRETIONARY)	7/1/2024	Perry Miller							0

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CIP #	Loc	PN	Phase	Description	Council Date	Sponsor	FY14	FY15	FY16	FY17	FY18	FY19	FY14-19 Total Amount X $1000
A-0582.02	HOU	680	C	TAXIWAYS M3, H2 H AND G (DISCRETIONARY)	7/1/2025	Perry Miller							0
A-0581.01	HOU	681	D	SHORTENING RUNWAY 17 (DISCRETIONARY)	7/1/2023	Perry Miller							0
A-0581.02	HOU	681	C	SHORTENING RUNWAY 17 (DISCRETIONARY)	7/1/2023	Perry Miller							0
A-0591.01	HOU	FUT	D	Reconstruct Runway 12R-30L (Asphalt to Concrete) Move to FY21 - $6 million	7/1/2020	Perry Miller							0
A-0542.01	HOU	FUT	D	RUNWAY 4-22 RECONSTRUCTION (DISCRETIONARY)	7/1/2019	Perry Miller							0
A-0542.02	HOU	FUT	C	RUNWAY 4-22 RECONSTRUCTION (DISCRETIONARY) $32,000	7/1/2020	Perry Miller							0
A-0577.01	EFD	654	D	NEW ELECTRICAL VAULT AT AOA	7/1/2017	Brian Rinehart					275		275
A-0577.02	EFD	654	C	NEW ELECTRICAL VAULT AT AOA	7/1/2017	Brian Rinehart					2,475		2,475
~~A-0575.01~~	~~EFD~~	~~682~~	~~D~~	~~TAXIWAY G EXTENSION TO C (DISCRETIONARY) `~~	~~7/1/2017~~	~~Brian Rinehart~~					~~200~~		~~200~~
~~A-0575.02~~	~~EFD~~	~~682~~	~~C~~	~~TAXIWAY G EXTENSION TO C (DISCRETIONARY)~~	~~7/1/2017~~	~~Brian Rinehart~~					~~1,800~~		~~1,800~~
A-0523.03	EFD	707	D	NEW TAXIWAY ON SOUTHEAST SIDE OF R/W 4-22	7/1/2021	Brian Rinehart							0
A-0523.04	EFD	707	C	NEW TAXIWAY ON SOUTHEAST SIDE OF R/W 4-22	7/1/2021	Brian Rinehart							0
A-0564.04	EFD	629A	O	FAA Engineering Agreement	8/1/2014	PDC		105					105
A-0138.29	HAS	615T	D	Misc Geo Tech Engineering Services	4/1/2014	PDC	400						400
~~A-0138.30~~	~~HAS~~	~~615T~~	~~D~~	~~Misc Geo Tech Engineering Services~~	~~12/1/2013~~	~~PDC~~	0						0
CIP Meeting on 1/8/2014													
A-0615.01	EFD	728	D	CARGO RAMP AND TAXI LANE	9/1/2014	Brian Rinehart		900					900
A-0615.02	EFD	728	C	CARGO RAMP AND TAXI LANE	9/1/2015	Brian Rinehart			8,380				8,380
A-0616.01	EFD	729	D	INSTALL CATEGORY IIIA ILS	9/1/2015	Brian Rinehart			645				645
A-0616.02	EFD	729	C	INSTALL CATEGORY IIIA ILS	9/1/2016	Brian Rinehart				5,805			5,805
A-0617.01	EFD	730	D	EXTEND RUNWAY 17R-35L	9/1/2018	Brian Rinehart						545	545
A-0617.02	EFD	730	C	EXTEND RUNWAY 17R-35L FY21	9/1/2020	Brian Rinehart							0
A-0618.01	EFD	731	D	RUNWAY 17R-35L IMPROVEMENT- ASPHALT SHOULDERS FY2	9/1/2018	Brian Rinehart						1,745	1,745
A-0618.02	EFD	731	C	RUNWAY 17R-35L IMPROVEMENT - ASPHALT SHOULDERS	9/1/2020	Brian Rinehart							0
A-0619.01	EFD	732	C	REHABILITATION OF AIRFIELD SERVICE ROAD	9/1/2015	Brian Rinehart			547				547
A-0620.01	EFD	733	D	T-HANGER RAMP AND TAXIWAY D PAVEMENT REHAB	9/1/2014	Brian Rinehart		96					96
A-0620.02	EFD	733	C	T-HANGER RAMP AND TAXIWAY D PAVEMENT REHAB	9/1/2015	Brian Rinehart			859				859
				Project Total			8,714	1,201	11,331	5,805	17,650	3,090	47,791
				Accumulative Total			**116,626**	**61,002**	**11,331**	**5,805**	**17,650**	**3,090**	**215,504**

HAS CIP FY 2014 - 2019

Project in Planning for FY2014

Active Projects for FY2014

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CIP #	Loc	PN	Phase	Description	Council Date	Sponsor	FY14	FY15	FY16	FY17	FY18	FY19	FY14-19 Total Amount X $1000
				OTHER/PRODUCT									
A-0559.05	IAH	636B	C	GATE A-28 PASSENGER LOADING BRIDGE FY15	7/1/2014	Carl Newman		250					250
A-0058.11	IAH	FUT	O	DITCH G MAINTENANCE	7/1/2022	Pete Ferguson							0
A-0604.02	HOU	690B	C	HOU TSA EDS/CBRA Recapitalization	5/1/2014	Perry Miller	11,006						11,006
A-0418.01	HOU	710	D	HOBBY CARGO BUILDING FY17	12/1/2016	Perry Miller			590				590
A-0422.75	HOU	710	D	ART - HOBBY CARGO BUILDING (DESIGN) FY17	12/1/2016	Perry Miller			11				11
A-0418.02	HOU	710	C	HOBBY CARGO BUILDING FY18	12/1/2017	Perry Miller				5,310			5,310
A-0422.76	HOU	710	C	ART - HOBBY CARGO BUILDING (CONST) FY18	12/1/2017	Perry Miller				93			93
A-0554.01	HOU	631	D	REMOVE PHONE/UTILITY POLES RE-RUN POWER LINES	8/1/2021	Perry Miller							0
A-0554.02	HOU	631	C	REMOVE PHONE/UTILITY POLES RE-RUN POWER LINES	8/1/2021	Perry Miller							0
A-0573.01	HOU	650	D	PERIMETER SECURITY INTRUSION DETECTION SYSTEM (PIDS	7/1/2016	Perry Miller				50			50
A-0573.02	HOU	650	C	PERIMETER SECURITY INTRUSION DETECTION SYSTEM (PIDS	7/1/2017	Perry Miller					450		450
A-0520.01	HOU	704	D	INSTALL 12-4-7 BACK UP GENERATORS	7/1/2018	Perry Miller						950	950
A-0520.02	HOU	704	C	INSTALL 12-4-7 BACKUP GENERATORS	7/1/2018	Perry Miller						6,550	6,550
~~A-0521.01~~	~~HOU~~	~~705~~	~~DB~~	~~DESIGN & INSTALL ELEVATOR FOR ACCESS TO CLOUD ROOM~~	~~7/1/2020~~	~~Perry Miller~~							~~0~~
A-0528.03	HOU	999	LA	LAND ACQUISITION FOR HOBBY EXPANSION	7/1/2020	Perry Miller							0
A-0528.08	HOU	999	LA	LAND ACQUISITION FOR HOBBY	7/1/2021	Perry Miller							0
A-0368.11	EFD	734	O	SPACEPORT PLANNING & LICENSING AT EFD	7/17/2013	Ian Wadsworth	720	A					720
A-0532.01	EFD	529	D	Construction of Ellington Field Bypass	7/1/2018							900	900
A-0532.02	EFD	529	C	Construction of Ellington Field Bypass	7/1/2019								0
A-0579.01	EFD	656	D	GRASS ISLAND PAVING - NORTH SIDE 2 (~~BUSINESS DEAL~~)	7/1/2015	Brian Rinehart			150				150
A-0579.02	EFD	656	C	GRASS ISLAND PAVING - NORTH SIDE 2 (~~BUSINESS DEAL~~)	7/1/2023	Brian Rinehart							0
A-0389.01	EFD	667	D	RUNWAY 17L/35R REHAB	7/1/2017	Brian Rinehart					109		109
A-0389.02	EFD	667	C	RUNWAY 17L/35R REHAB	7/1/2017	Brian Rinehart					1,210		1,210
A-0593.02	EFD	671	C	HORSEPEN BAYOU DRAINAGE IMPROVEMENT	7/1/2020	Brian Rinehart							0
A-0523.01	EFD	706	D	REHAB OUTER PANELS ON RUNWAY 4-22	7/1/2020	Brian Rinehart							0
A-0523.02	EFD	706	C	REHAB OUTER PANELS ON RUNWAY 4-22	7/1/2020	Brian Rinehart							0
A-0533.01	EFD	709	D	RAMP PAVEMENT RECONSTRUCTION ADJACENT TO SW AIRP(	7/1/2017	Brian Rinehart					200		200
A-0533.02	EFD	709	C	RAMP PAVEMENT RECONSTRUCTION ADJACENT TO SW AIRP(	7/1/2020	Brian Rinehart							0
					Actuals for FY2013								28,549
							11,726	250	751	5,453	1,969	8,400	
						Proposed CIP	**128,352**	**61,252**	**12,082**	**11,258**	**19,619**	**11,490**	**244,053**

Appendix H

Airport Environs Image Plan (2003)

William P. Hobby Airport

AIRPORT ENVIRONS

2003 Master Plan

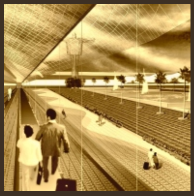
IMAGE

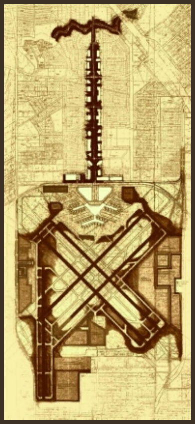
Houston Airport System

PLAN

City of Houston

Executive Summary







1 INTRODUCTION

The Hobby Airport Environs Image Plan, a 6-month endeavor undertaken by Llewelyn-Davies Sahni in the winter of 2002, was developed as an appendage to the 2022 Hobby Airport Master Plan, which will be completed in mid-2003 by the Ricondo & Associates consultant team.

The resultant image plan is an integral component to the airport master planning process, thus resulting in concurrent accommodation of physical and functional needs.

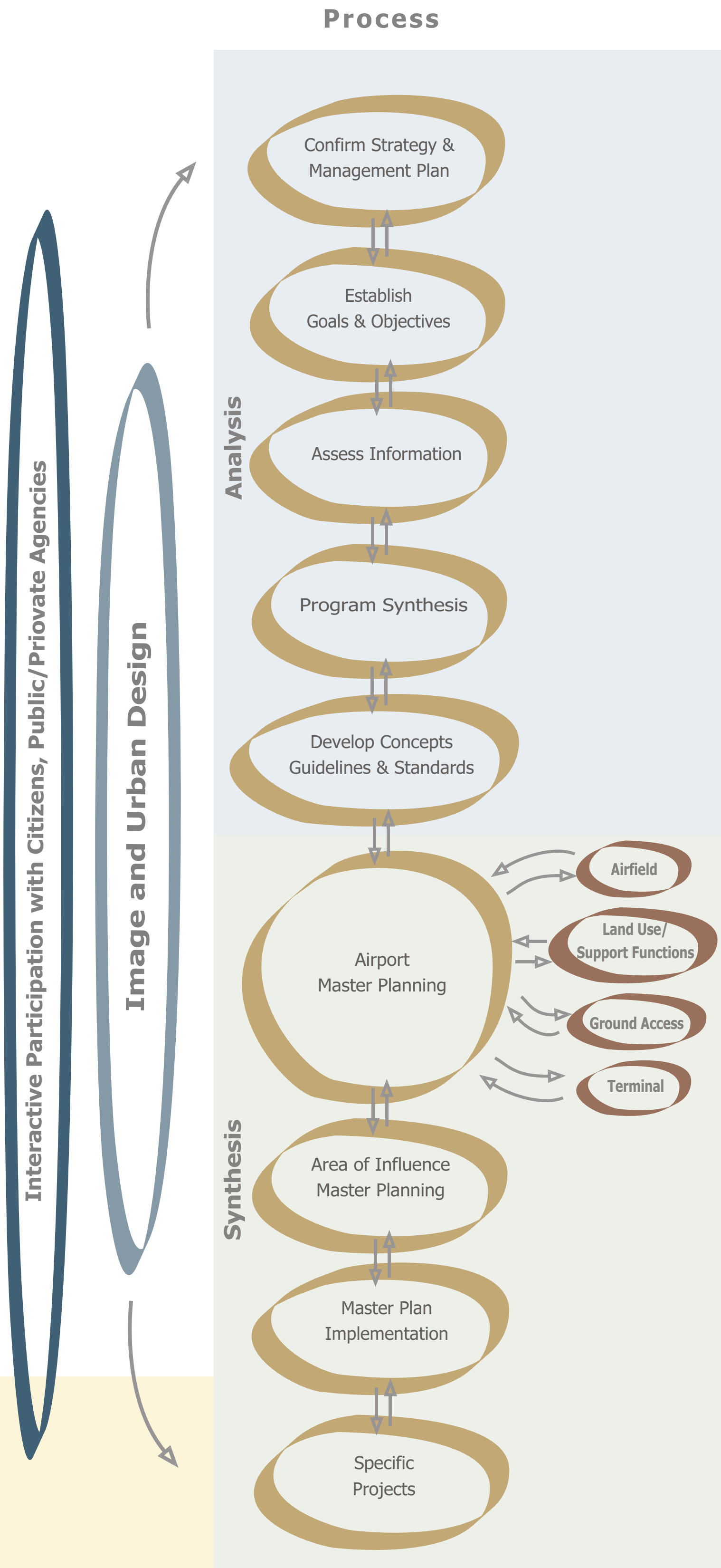
The main objective of the Image Plan was to create a cohesive identity for Hobby Airport and its surrounding areas in order to improve the passenger's travel experience and to celebrate Houston's rich history and cultural vitality. Through the use of ground plane treatment, architecture, lighting, and graphics, a common theme was created that could influence land use development and the creation of jobs, potentially improving the quality of life in the area.

For the purpose of the image study, the Hobby Airport "Area of Influence", or the AOI, is bounded on the North by the 610 Loop, on the South by Beltway 8, on the East by IH-45, and on the West by Mykawa Road.

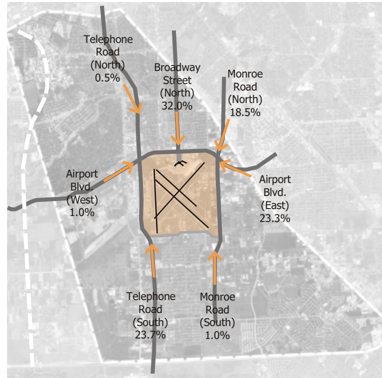
Within this AOI, the Image Plan documented existing physical conditions, assessed opportunities and constraints, and identified a framework plan that delineated five concepts to optimize the opportunities of the area, while mitigating the constraints.

The Image Plan also listed design elements that are vital to create a sense of place, outlined mandatory and discretionary guidelines, and presented implementation process flowcharts.

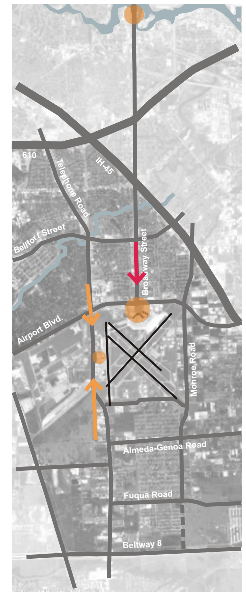
For a detailed understanding of the plan, interested parties are encouraged to refer to the Hobby Airport Master Plan and Airport Environs Image Plan.



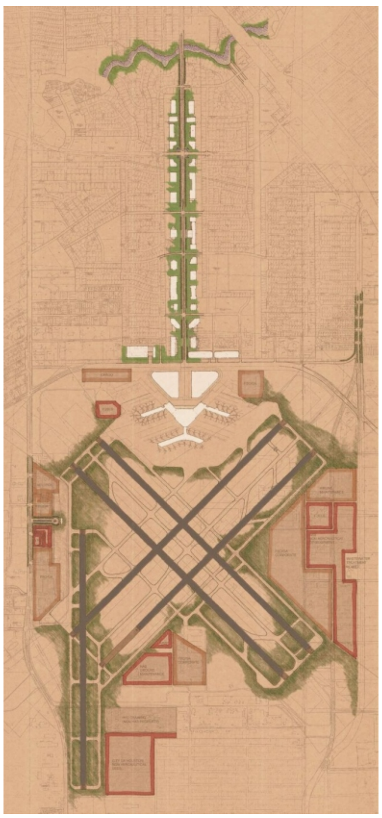
Open Space and Parks



Percentage of Street Use to Access Airport



Historical Visual Access Between Navigation Tower and Hobby Airport



Hobby Airport, Broadway Street, and Sims Bayou

Hobby Airport Area of Influence

Section of Hobby Airport Terminal, Looking West

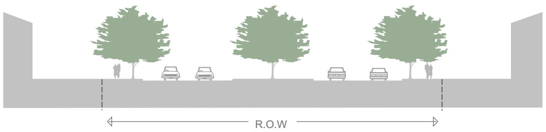
3 FACTS

Documenting existing conditions within the AOI included the analysis of facts such as land use, open space, street right-of-ways, traffic lights, landscape and vegetation, and ground-plane conditions.

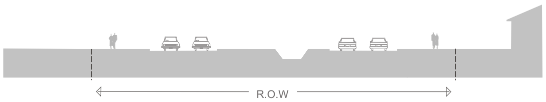
At the present time, the area around the Airport offers a negative image. A substantial amount of land is vacant and cluttered with weeds and garbage. The landscape maintenance is irregular, and sidewalks and streets are in serious disrepair. There is no common design theme, nor is there adequate way-finding signage that directs passengers to the Airport.

As a consequence of these conditions, the area does not attract new investments, causing the value of existing improvements to decline and hindering the development of businesses and the creation of jobs. Meanwhile, the area's economic growth potential revenues remain untapped.

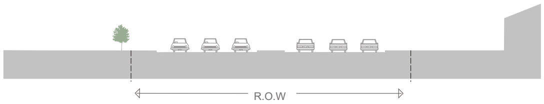
Based on these facts, opportunities and constraints for capital and image-related improvements were assembled and evaluated.



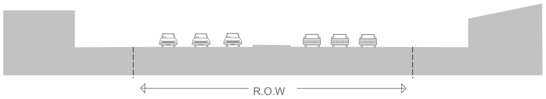
Broadway Street



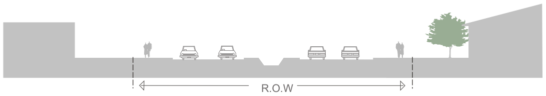
Monroe Road



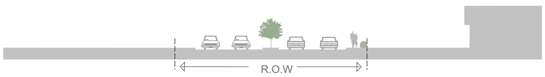
Airport Boulevard after completion of TxDOT project

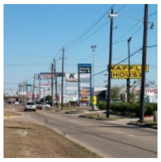


Telephone Road, from Park Place Blvd. to Beltway 8

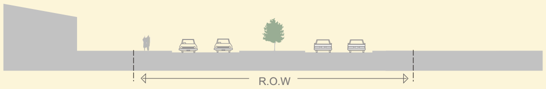


Bellfort Street

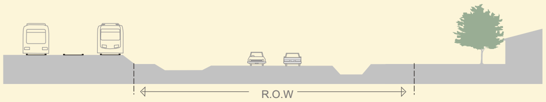




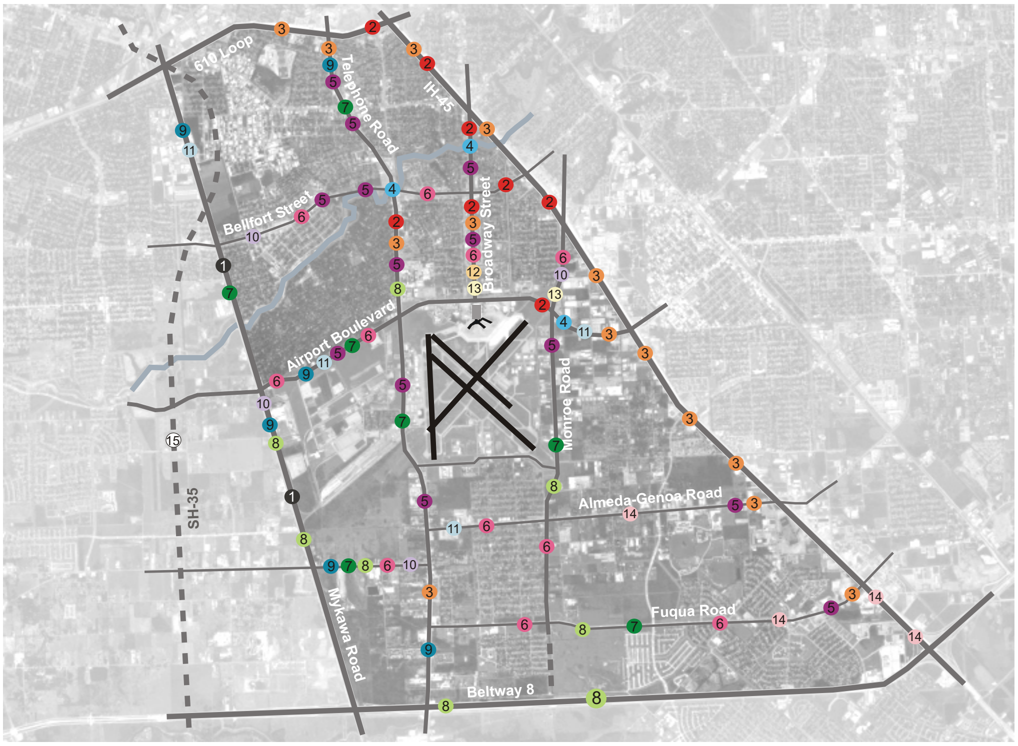
Almeda-Genoa Road



Fuqua Road



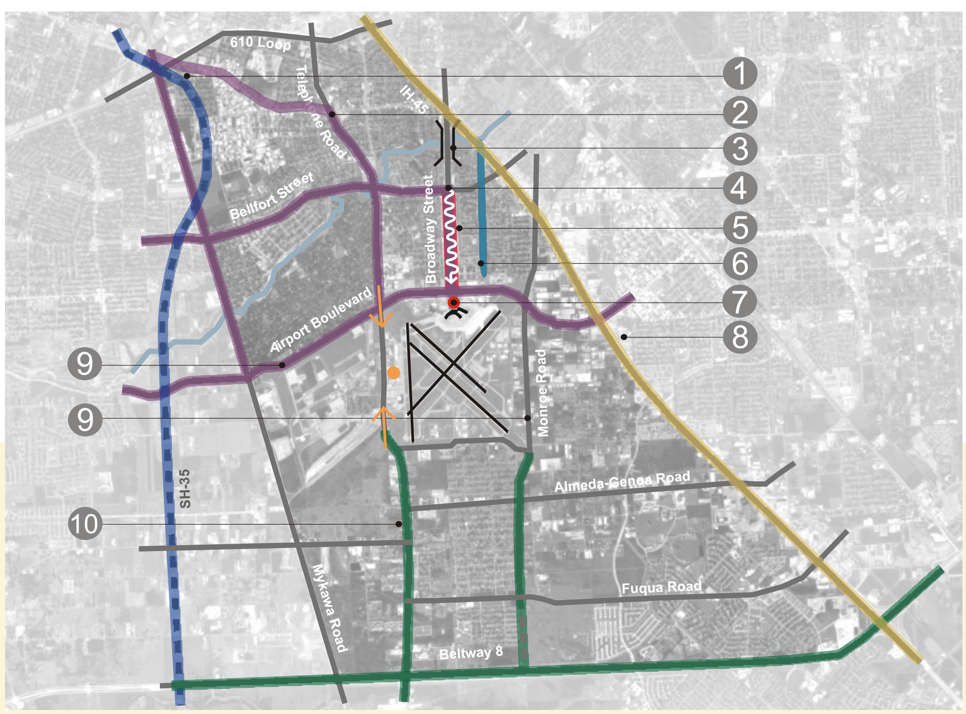
Mykawa Road



1 Train Tracks
2 Inconsistent Airport Signs
3 Visually Distracting Billboards
4 Unappealing Bridge
5 Dilapidated Commercial Property
6 Neglected Residential Area
7 Inconsistent Landscape
8 Vacant Lots and Empty Fields
9 No Sidewalks/Inconsistent Sidewalks
10 Large Drainage Ditch Along Road
11 Industrial Property
12 Deep Property Setbacks
13 Wide Median
14 Formal Landscaping Treatment
15 Planned New SH-35 ROW

Summary of AOI Existing Conditions

1. The ground plane treatment of planned SH-35 could complement AOI design elements
2. The METRO MOBILITY 2025 plan could increase accessibility to the airport
3. The bridge over Sims Bayou could act as a visual link with the airport
4. A direct and dramatic view of the terminal and airport forecourt could be achieved
5. Broadway Street could be redeveloped to improve the overall image of the area
6. The existing drainage channel east of Broadway Street could accommodate increased airport area drainage needs
7. The form of the VHF Omnidirectional Radio Range (VOR) could become a visual symbol for the airport
8. User experience along the highways could be improved through signage and landscaping
9. Monroe Road and Airport Blvd. could become high speed access roads
10. Monroe Road, Telephone Road and Beltway 8 could be influenced by airport area design standards
11. The 1940's terminal tower could act as a visual terminus for travelers on Telephone Road



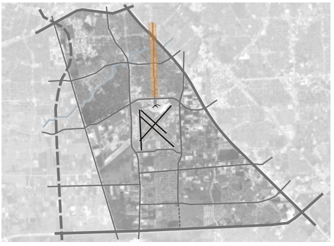
AOI Opportunities

5 FRAMEWORK PLAN

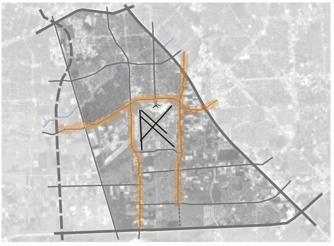
The Image Plan identified five separate but integrated concepts that attempted to enhance the existing area opportunities and minimize the effects of the constraints.

- **Ceremonial Street** - Broadway Street was identified as the ceremonial gateway to Hobby Airport and an overall revitalization plan was prescribed. This area has the potential to create a major urban statement that would celebrate the rich diversity of the area and attract new public and private investments.
- **High-Capacity Corridors** - Monroe Road, Airport Boulevard and Telephone Road were designed to accommodate sufficient traffic capacity to meet the 2022 needs of the Airport. Design elements were prescribed to address specific conditions along these streets.
- **Auxiliary Streets -** Bellfort Street, Almeda-Genoa Road and Fuqua Road were designed to accommodate local traffic, functionally supporting the High-Capacity Corridors. The treatment responded to the scale and level of anticipated activity.
- **Street Intersections** - Distinctively designed intersections within the immediate vicinity of Hobby Airport would enhance the traveler's sense of place.
- **Freeways and Interchanges** - Sensitively designed ground plane treatment along the freeways would achieve a pleasant and desirable experience for motorists traveling to and from the Airport.

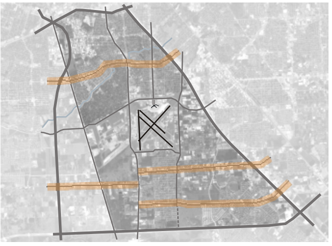
Ceremonial Street



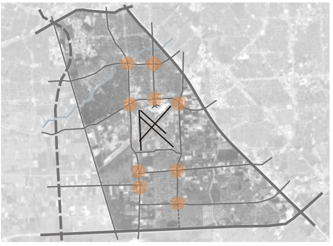
High Capacity Corridors



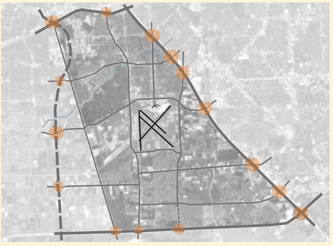
Auxiliary Streets

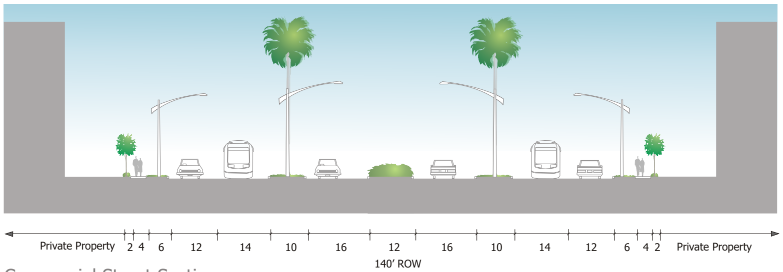


Intersections



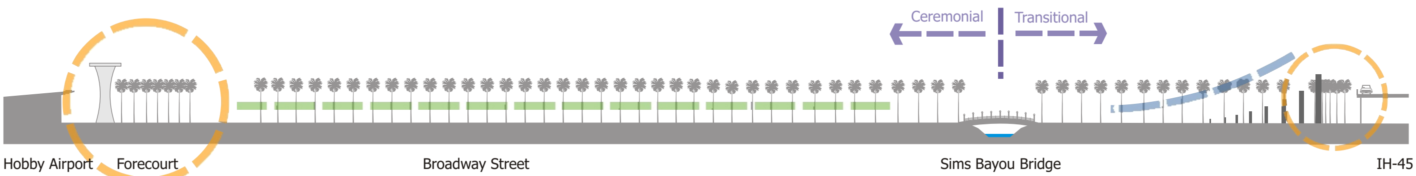
Freeways and Interchanges



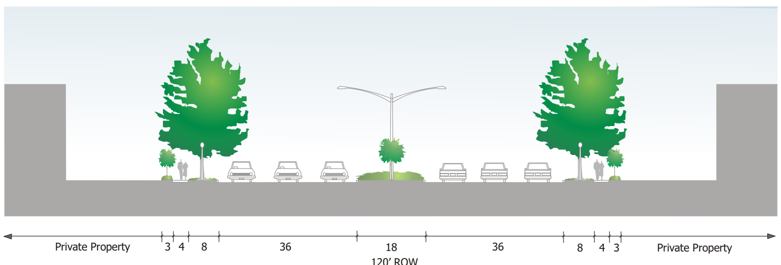


Ceremonial Street Section

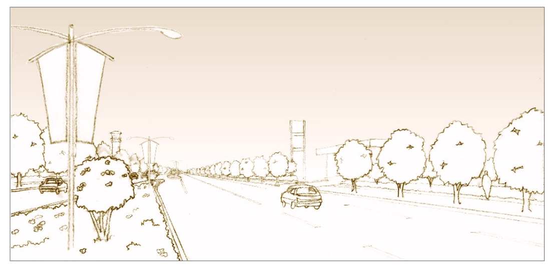
Proposed View Along Broadway Street



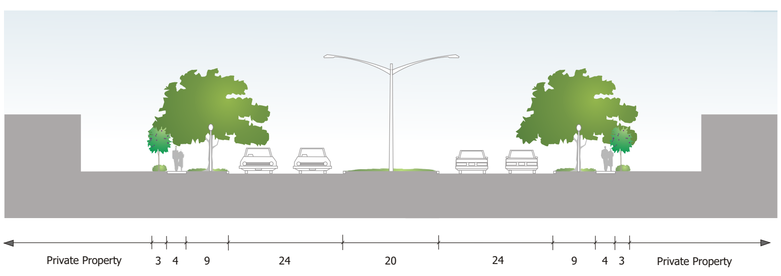
Conceptual Section from Hobby Airport to IH-45



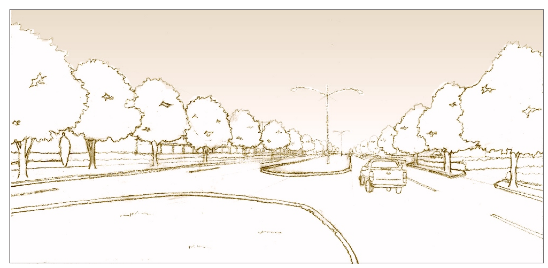
High Capacity Corridors Section



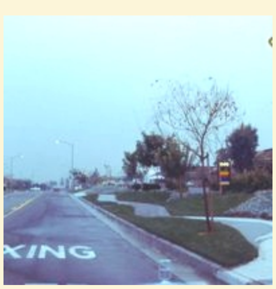
Proposed View Along a High Capacity Corridor



Auxiliary Streets Section

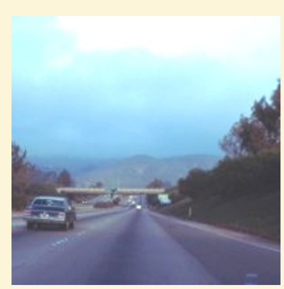


Proposed View Along an Auxiliary Street



Transparent Freeway Edge

Translucent Freeway Edge



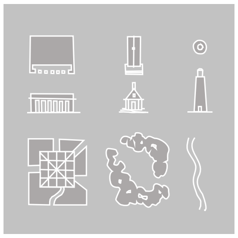
Opaque Freeway Edge

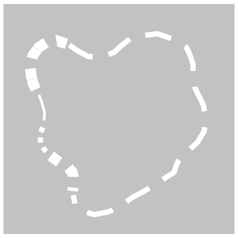
7 DESIGN ELEMENTS

The framework plan identified five distinct categories by which various design elements could be integrated to create unique area characteristics. The following list addresses both physical and intangible elements:

- Streetscape
    - Ground plane treatment
    - Lighting
    - Utility elements
    - Traffic signals
    - Street furniture
        - Transit stops/vending machines
        - Information kiosks
        - Seating
    - Waste receptacles
    - Signage
    - Public art
    - Billboards
    - Intersections/crosswalks
    - Temporary furniture
- Buildings
    - Façade
    - Set backs
    - Heights
    - Servicing
- Form-Giving Elements
    - Space
        - Public/private
    - Form
    - Movement
    - Edge
- Maintenance


Axes and Views - New York City

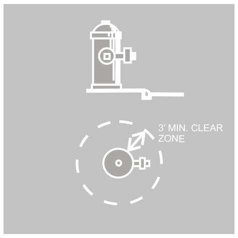

Form


Edge

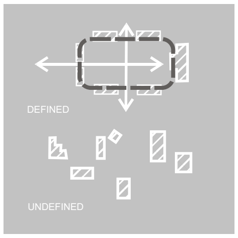
Signage - Yukon, Canada


Landscape


Public Art - Goteborg, Sweden



Utility Elements



Space

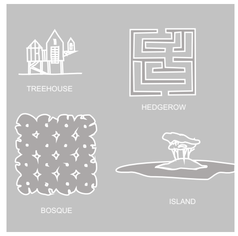

Lighting - Vancouver, Canada

Landscape - Zaragosa, Spain

Temporary Furniture

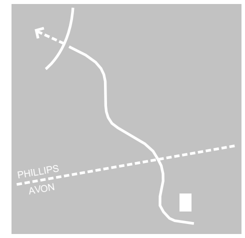

Street Furniture


Public Art - Barcelona, Spain



Fantasy


Public Art - Madrid, Spain

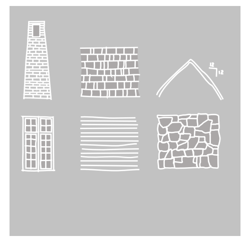


Movement


Axes and Views - Siena, Italy


Lighting - Helsinki, Finland

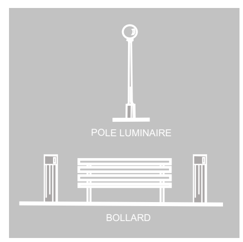

Billboards


Materials


Plazas - Westbury Square, Texas

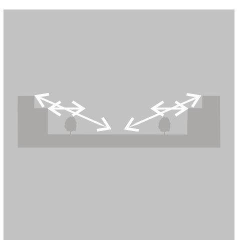

Public Art

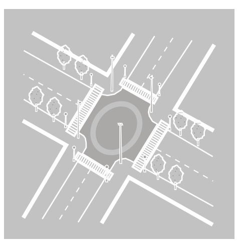

Axes and Views - Paris, France

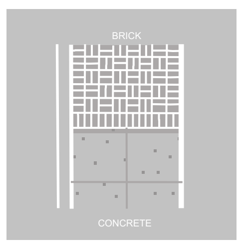


Lighting


Maintenance

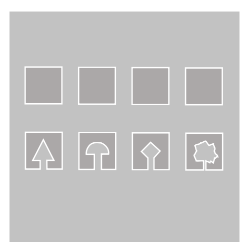

Building Controls


Intersections



Ground Plane Treatment


Open Space - Rome, Italy


Legibility


Signage


Hegenberger Road at Oakland Airport


San Francisco International Airport


Salt Lake City International Airport


TF Green Airport


Norfolk Virginia Airport

9 IMPLEMENTATION

Due consideration should be given to the following issues before the Image Plan is implemented:

- Distracting Billboards
- Revitalization & Redevelopment
- Scenic Districts
- Dilapidated Property
- Insufficient ROW
- Federal/State/City/Public Programs
- Level of Control
- Meeting the Market Place
- Level of Quality
- Impermanent Elements
- Capital Improvements

An outline of the implementation process was developed for effectuation of the Image Plan over the coming decade and the following actions were suggested:

ACTION 1: Detailed Design Framework

- **Creating a Framework**
  Allowing for overall project development, including initiation, understanding of context, relationships to urban structure, detailed design, and on-going implementation and management

ACTION 2: Acceptance of Plan of Action

- **Formation of a Legal Body for Management & Implementation**
  Identifying a body of representatives of all interested parties, public and private investors and developers to focus on area rejuvenation

- **Community Buy-In & Public Outreach**
  Developing a thorough, on-going and inclusive community participation process that allows for project authorship and endorsement

- **City/County/TxDOT/Private Sector Cooperation**
  Coordinating capital improvements scheduled for implementation that are in harmony with the framework of the Image Plan

- **Inter-Jurisdiction Agreement**
  Gaining agreement and consensus from the City of Houston, Harris County, METRO, the Houston-Galveston Area Council, TxDOT, Hobby Airport representatives, (the Hobby Airport Hotel Coalition), and other civic and private groups and stakeholders for clear definition of responsibilities

ACTION 3: Attainment of Grants & Community Development Funds

- **Preparation of Applications**
  Applying to public and private bodies for grants to fund any and all improvement projects

- **Allocation of Monies Received for Program**
  Utilizing monies on projects that are vital to the goal of the Image Plan framework, making it attractive to private investors

ACTION 4: Land Assembly

- **Identification of Public/Private Funds to Assemble Key Parcels of Land**
  Working within the legal framework to assemble, prepare and resell parcels to developers for appropriate uses essential for the success of the Image Plan

- **Creation of Development Corporation with Borrowing Power**
  Identifying entities that work within the legal framework to act as developers with borrowing power needed for proposed projects

- **Redevelopment of Land**
  Redeveloping land that will serve airport functions and improve the overall image of the area, using focal or background architecture and selected design elements

ACTION	STEP 1	STEP 2	STEP 3	STEP 4
1. Detailed Design Framework (Physical)				
2. Acceptance of Plan of Action (Political)	Formation of Legal Body for Management & Implementation	Community Buy-In & Public Participation	City / County / TxDOT Private Sector Cooperation	Inter-Jurisdiction Agreement
3. Attainment of Grants & Community Development Funds (Funding)	Preparation of Applications	Allocation of Monies Received for Program		
4. Land Assembly (Asset Collection)	Identification of Public / Private Funds to Assemble Key	Creation of Development Corporation with Power to Sell Debt Instruments	Redevelopment of Land	

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DRAFT

William P. Hobby Airport

AIRPORT ENVIRONS

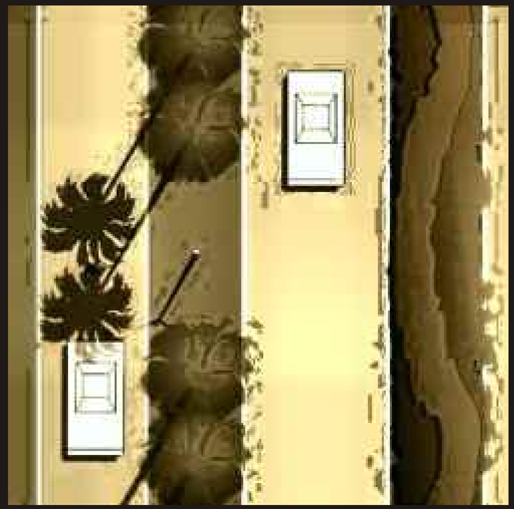
2003 Master Plan

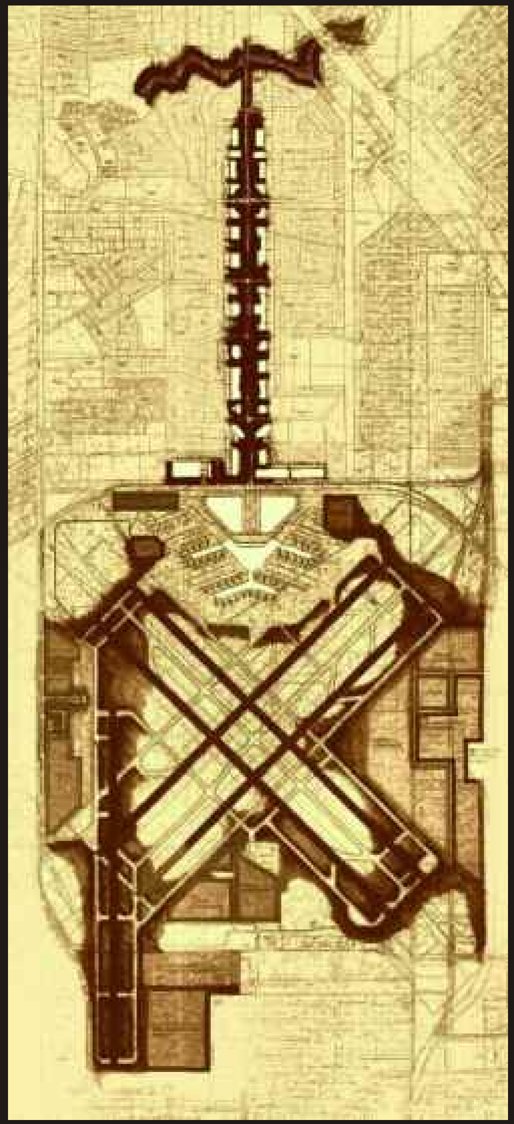
IMAGE

Houston Airport System

PLAN

City of Houston





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William P. Hobby Airport

MASTER PLAN

2003 Master Plan

IMAGE

Houston Airport System

PLAN

City of Houston

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Figure 1
Proposed View on Broadway Street

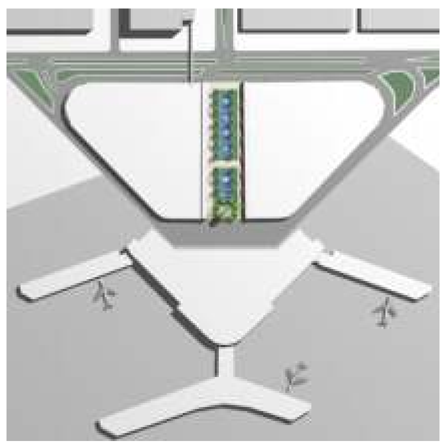

Figure 2
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Introduction

This document contains the William P. Hobby Airport Environs IMAGE PLAN and was developed as a component of the Airport Master Plan, completed in 2003. The IMAGE PLAN was a 6-month endeavor, completed in early 2003.

The Plan delineates the Hobby Airport Area of Influence (AOI) and documents existing physical conditions, as well as the opportunities and constraints offered by these conditions, for capital and image-related improvements. In addition, this report provides a framework for further planning, urban design, agency cooperation, economic development, and implementation.

The Plan consists of physical and operational concepts to achieve a higher quality of urban environment. It is accompanied by a framework for development implementation and suggested physical character of urban functions. The Plan outlines mandatory and discretionary guidelines as a means to communicate the intent of the plan to public as well as private agencies responsible for capital improvements within and around the AOI.

The Plan also contains a listing of key design elements and related issues that should be addressed through the urban design implementation process. The last chapter, Background Research, contains photographed examples of different urban settings.

The objective of the Hobby Airport Image Plan is to create a cohesive identity for the area around the Airport. Through the use of a common theme that influences land use, redevelopment, ground plane treatment, architecture, lighting, and graphics, this Image Plan could transform Hobby Airport and its surrounding Area of Influence into an engaging, economically viable and inviting gateway to Houston that celebrates the rich vitality of the city.

At the present time, the area around the Airport offers a negative impression of the region. A substantial amount of land is vacant and cluttered with weeds and garbage. The landscape maintenance is irregular, and sidewalks and streets are in a state of disrepair. There is no common design theme, nor is there adequate way-finding signage that directs passengers to the Airport. Consequently, the area is not able to attract investments, and hinders the development of businesses and jobs, while the area's economic growth potential revenues remain untapped.

Controlled use of key design elements produces a sense of place by creating a new ambiance, enriching existing qualities and visually screening undesirable zones. However, it is important to keep in mind that while applied streetscape and lighting enhancements will improve the general image of the area, they must be prescribed within a larger structural redevelopment framework in order to achieve an overall identity for the airport. It is this unique identity that will promote Houston's extraordinary character and provide the pleasant and memorable airport experience that will encourage people to use Hobby Airport for their travel needs in the future.

With careful planning and a commitment to quality, the area surrounding Hobby Airport can be revitalized to offer a distinguished, memorable image of Hobby Airport, the surrounding community, and the City of Houston.

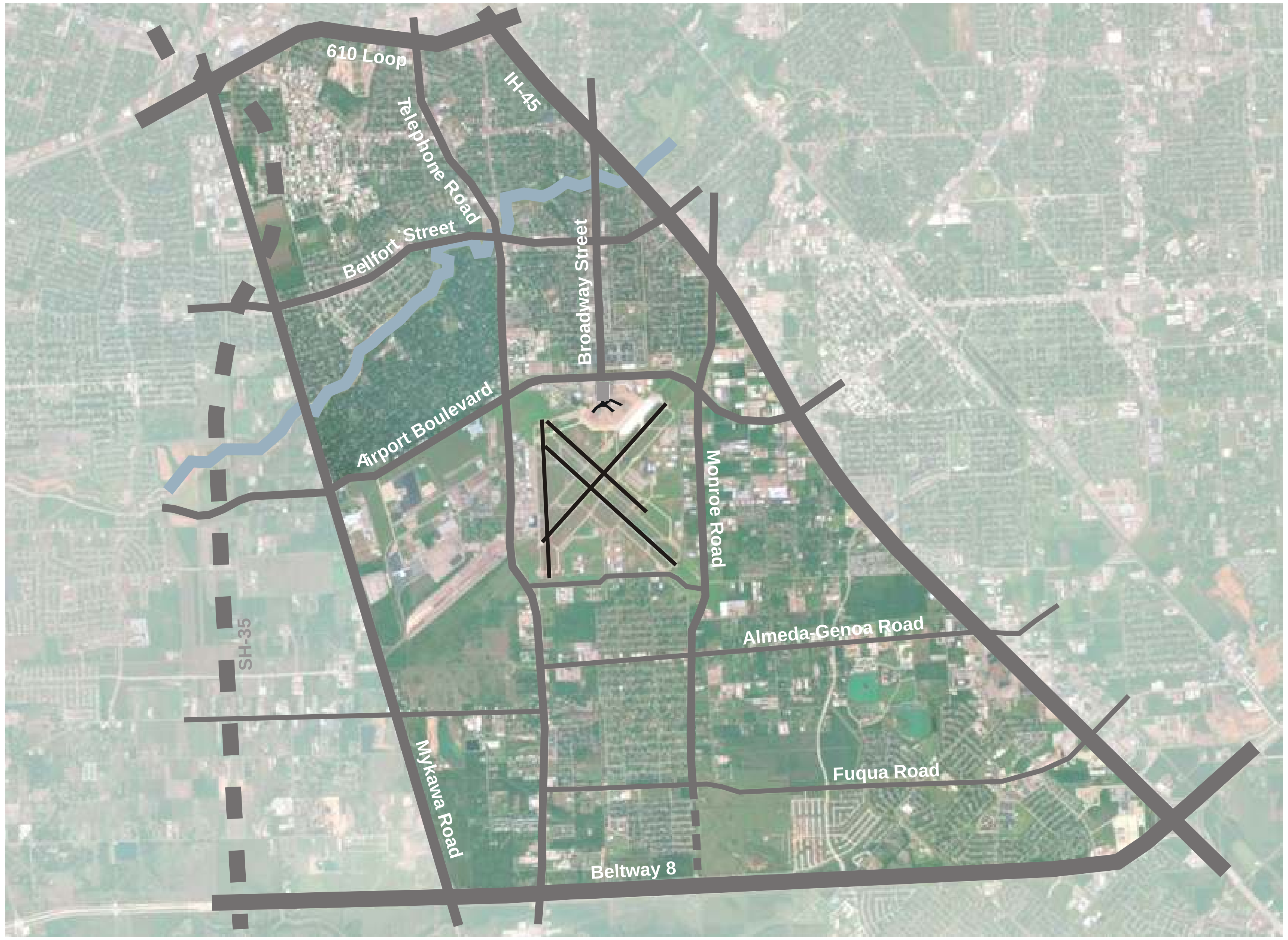

Figure 7
Hobby Airport Area of Influence

Every urban node has a surrounding area that is affected by the level and quality of activities in that node. Texas Medical Center, Uptown-Galleria, and Greenspoint Greenway Plaza are examples of Houston urban nodes that were developed over the last 50 years.

Opened in 1937, Hobby Airport, is older and while its area of influence was once larger, over the years infrastructure developments such as the highway system have since confined it.

The geographical scope of the project is bounded on the North by the 610 Loop, on the South by Beltway 8, on the West by the planned SH-35, and on the East by IH-45. For the purposes of the image study, the area including and contained by the three existing freeways and by the train tracks on Mykawa Road, was referred to as the "Area of Influence", or the AOI. The AOI presents a number of unique geographical distinctions, including a portion of Sims Bayou, various sizes of open spaces and parks, Broadway Street, the newly constructed Beltway 8, and a wide range of land uses.

This variety offers the opportunity for growth and change especially in a city that chooses not to impose land use controls or its attributes. These opportunities could undoubtedly promote a new public policy to enhance public investment in capital projects, which in turn could attract new private investment. This investment has the potential to encourage significant redevelopment on a wide scale, similar to the growth experienced in the late 1990's and early 2001 in Mid-Town and CBD Houston.

The following goals give direction and state the outcomes to be achieved. They are a collection of objectives relating to the needs of Hobby Airport, the Area of Influence, and interested public and private agencies.

These goals were developed during work sessions with public agency representatives, and area property/business owners.

Goals

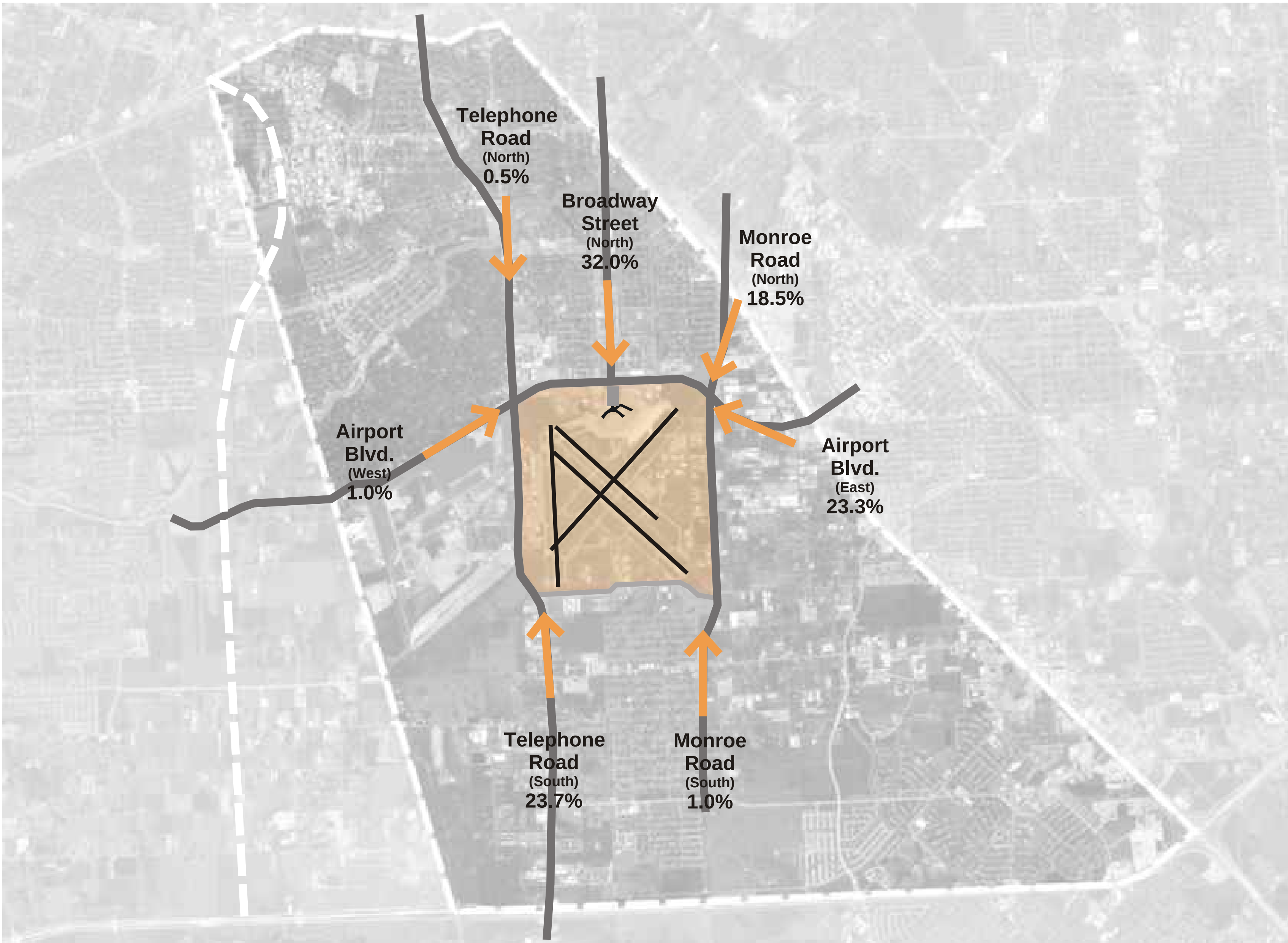

Figure 8
Percentage of Street Use to Access Airport

0 1.15 mi. North

The following goals were established at the outset of the development of the Image Plan:

- To improve patron **experience** when visiting or leaving the airport, including terminal parking and the urban fabric in the AOI
- To create a unique experience or **"sense of place"** within the AOI
- To establish a **"framework plan"** that will provide a design guide for economic and physical redevelopment, including thoroughfares, open space and land use within the AOI
- To use the framework plan as a basis for **inter-local agreements** to coordinate design and implement street and other infrastructure improvements
- To attract **private development** within the AOI that complements the recommendations of the Master Plan
- To communicate the Image Plan to interested parties in a **simple and systematic** way

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Regional Location

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Figure 19
Storm Sewer System

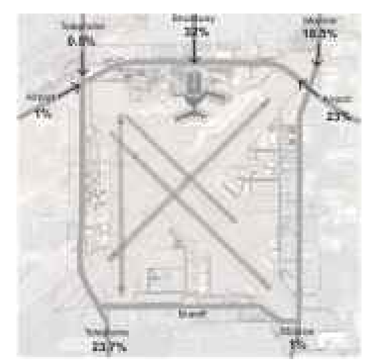


Figure 20
Percentage of Street Use
to Access Airport

Reviewing information about the airport and its environs provides a thorough understanding of the context within which the Image Plan is developed and helps identify issues that need to be addressed. The process results in quantitative information about the physical, aesthetic, and geographical nature of the Area of Influence, in relation to the established goals.

This section complements Volume 1 of the Master Plan document and relies on that report for communication of additional relevant contextual information.

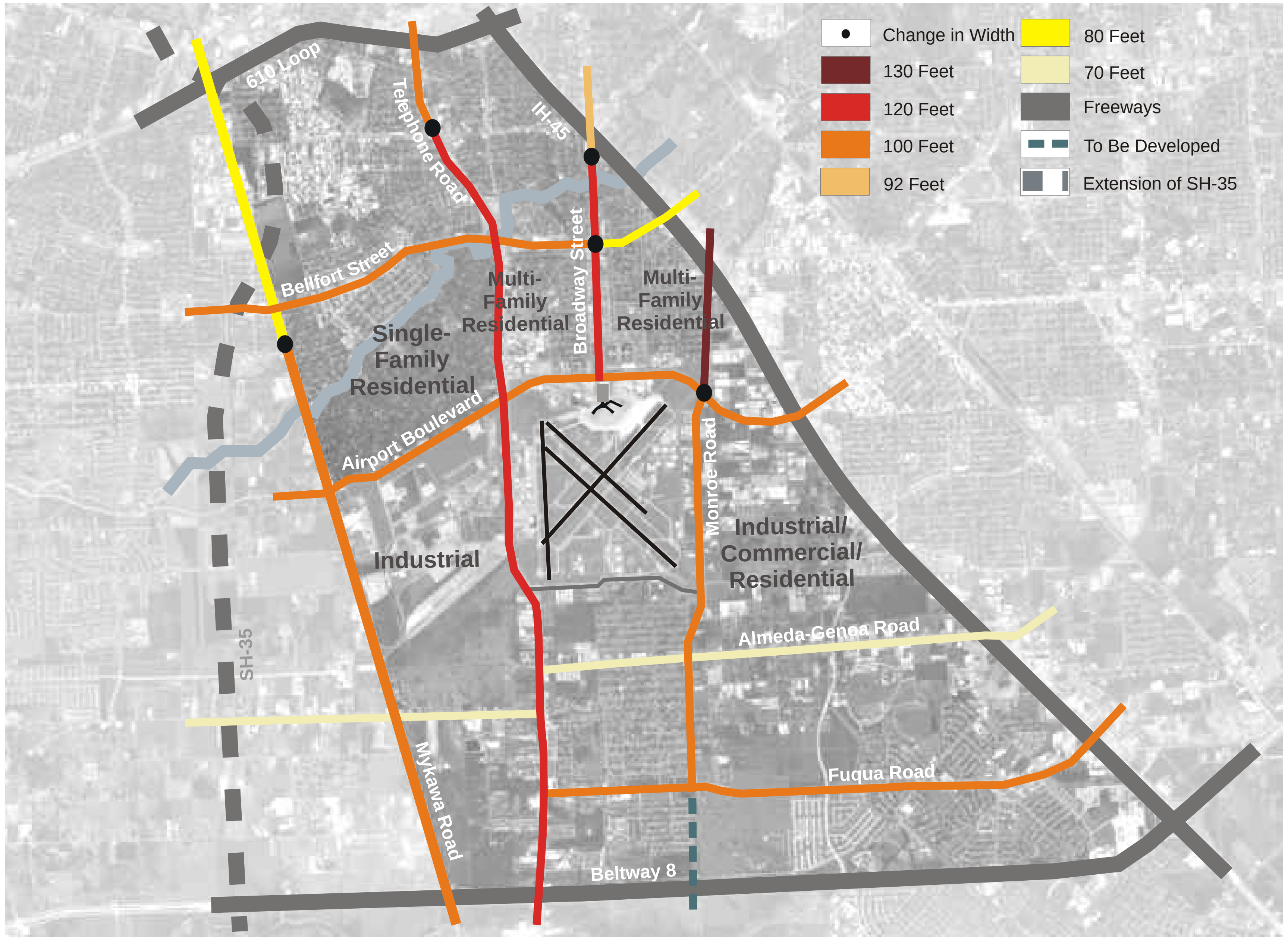


Figure 21
Area of Influence ROW, Planned Arteries and Land Use

Houston, a city that evolved through private initiative has a unique urban setting. Over the years, Houston has grown through annexation, thus its ROWs are not uniform and result in uneven street capacity. Although dedicated ROW width must have been considered adequate to accommodate anticipated land uses, present-day dedicated street right-of-ways change in width without clear purpose.

This exhibit shows the inconsistencies in the ROW width within the Area of Influence.

1. Mykawa Road, forming the existing western boundary of the AOI, has an 80' ROW from the 610 Loop to Bellfort Street, and 100' ROW from Bellfort to Beltway 8.
2. Telephone Road, presently designated as SH-35, and running north-south, has a100' ROW from the 610 Loop to Park Place and 120' ROW from Park Place to Beltway 8.
3. Broadway Street, a main Airport access artery from IH-45, runs north-south, terminating at Airport Boulevard, and has a 92' ROW north of Park Place, that changes to 120' ROW from Park Place to Airport Boulevard.
4. Also running north-south, Monroe Road has a 130' ROW from IH-45 to Airport Boulevard and contains a central drainage ditch. From Airport Boulevard to Fuqua Road, the ROW changes to 100 feet.
5. Bellfort Street runs east-west and has a 100' ROW from Mykawa Road to Broadway Street, and 80' ROW from Broadway to IH-45.

0 1.15 mi. North

Facts

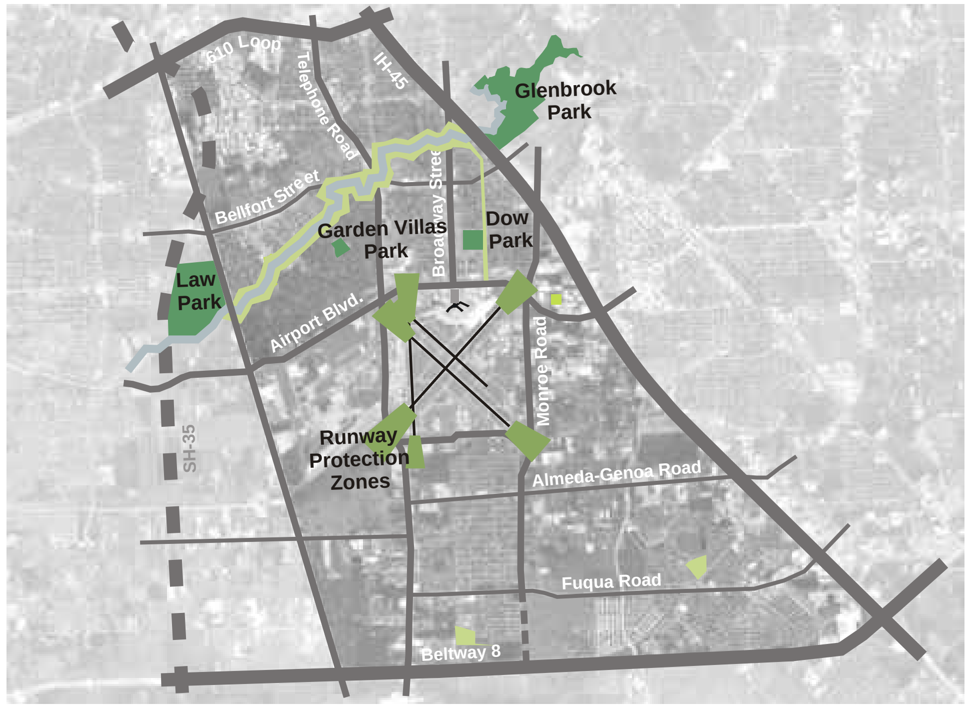


Figure 22
Open Space

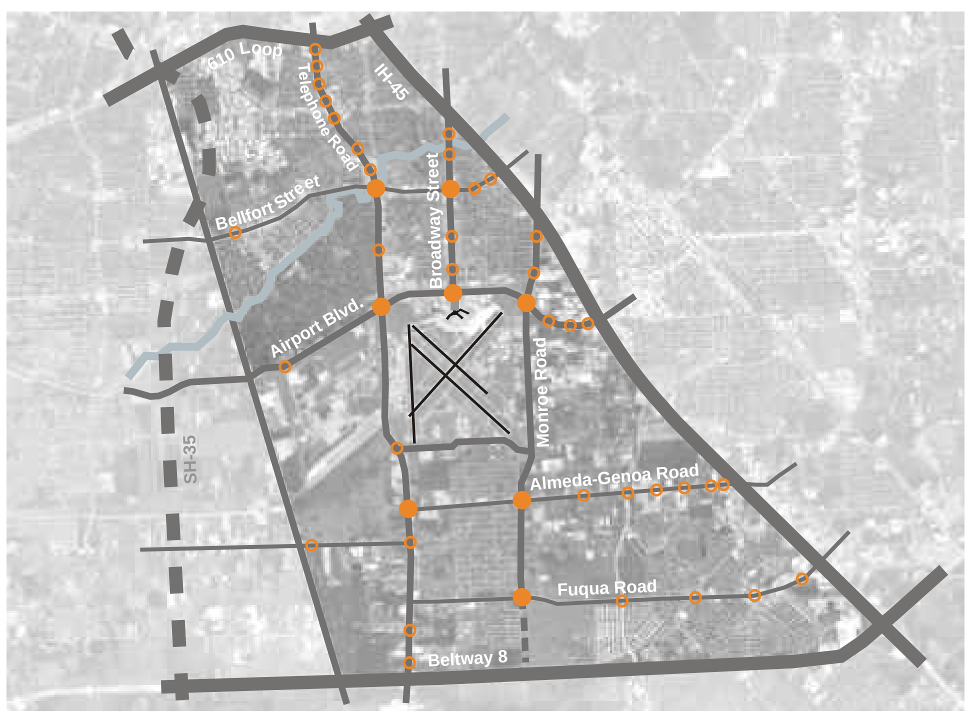


Figure 23
Traffic Controls

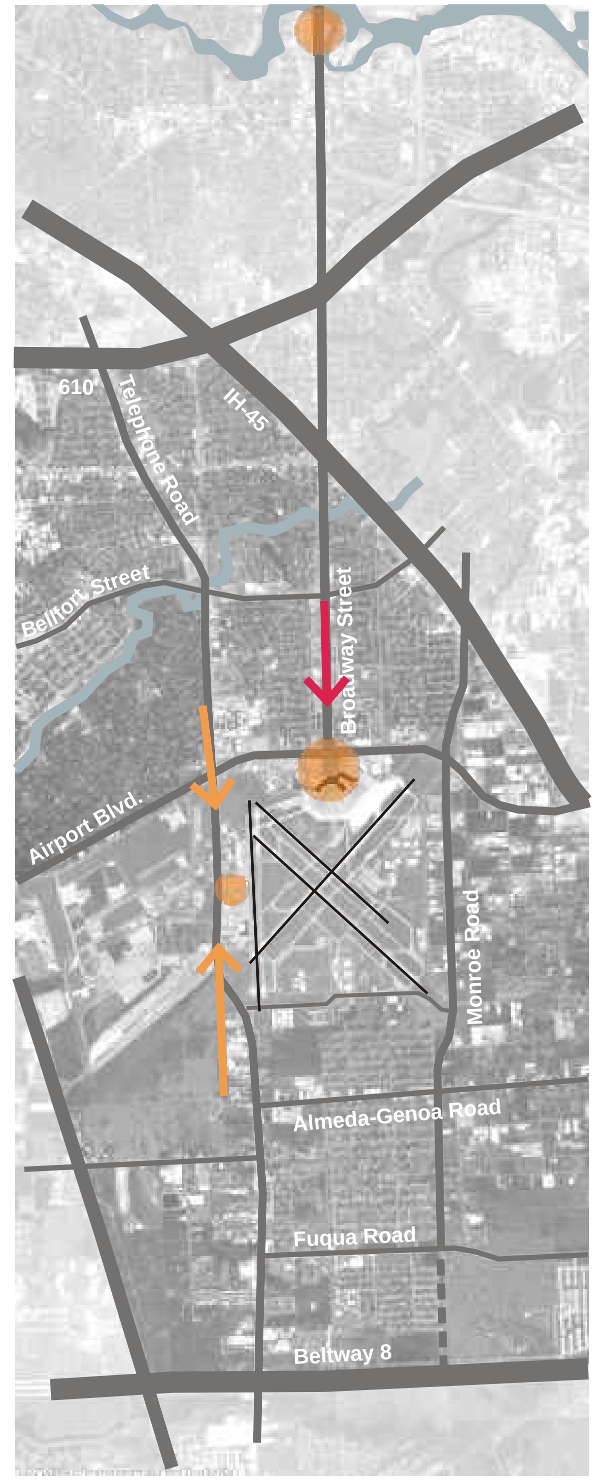


Figure 24
Significant Views and Landmarks

Figure 25
View on Telephone Road-Looking North at Old Tower

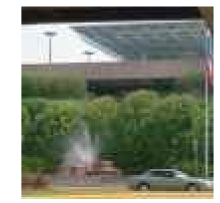


Figure 26
View on Broadway Street-Looking South at Airport Parking Garage

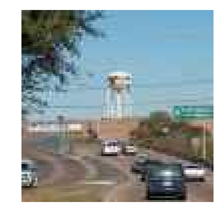


Figure 27
View on Broadway Street-Looking North at Shipping Channel Tower

0 2.2 mi. North

Open Space

The AOI has a natural open space system along Sims Bayou that moves west to east, crossing Broadway Street a quarter of a mile south of IH-45. Structured open space in the form of parks, drainage easements, and runway protection zones (RPZ's), are scattered throughout the AOI.

Traffic Arteries and Controls

There are 16 traffic lights on Telephone Road from the 610 Loop to Beltway 8. Broadway Street has a total of 6 traffic lights, from IH-45 to Airport Boulevard. Monroe Road has only 5 lights from IH-45 to Fuqua Road. Also within the AOI, Bellfort Street has 5 lights, Airport Boulevard has 6, Almeda-Genoa Road has 8, and there are 6 traffic lights on Fuqua Road.

Significant Views and Landmarks

Broadway Street is anchored by two landmarks that have the potential to provide views to motorists moving north or south. The north terminus is the Navigation Tower on the southern edge of the ship channel. A direct view of the airport was possible at one time as traffic moved south along Broadway, but it is currently obstructed by the 610 Loop and IH-45, as well as by large untrimmed Live Oaks along the street ROW and within the central median.

The southern visual terminus of Broadway Street is the airport itself; however this view is obscured by the Airport Parking Garage and various ramps and flyovers across Airport Boulevard.

Moving north or south along Telephone Road, which forms the western boundary of the airport, the old control tower is visible from the road and announces the presence of the airport in an otherwise non-descript area.

Figure 28
1. Inconspicuous Hobby
Airport Signage from IH-45

Figure 29
2. Existing Bridge Over Sims
Bayou-Looking North

Figure 30
3. Existing Bridge Over Sims
Bayou-Looking Northeast

Figure 31
4. Existing Bridge Over Sims
Bayou-Looking North

Figure 32
5. Wide Median With Large Live Oaks
and Shurbs

Figure 33
6. Small Flowering Trees and Pruned

Figure 271
7. Multi-Family Residences

Figure 272
8. Apartment Homes

Travelers approaching Broadway Street exit along IH-45 are confronted with an assortment of signage, including small green signs announcing exits for Hobby Airport. The Broadway Street exit is comprised of a number of streets that cross each other at obtuse angles, causing visitors to be confused and disoriented. Once on Broadway, moving south, the 92' ROW becomes obvious and this narrow scale marginalizes Broadway's role as a major ceremonial corridor to the airport.

Moving south towards Airport Boulevard, the ROW increases to 120'; however the impact of this change of scale is interrupted by large Live Oaks along the sidewalks and within the median. These trees also obscure the vista to the airport.

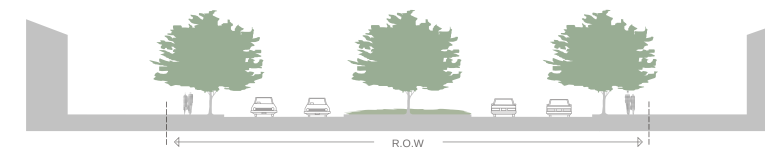


Figure 34
Broadway Street - Existing Section A

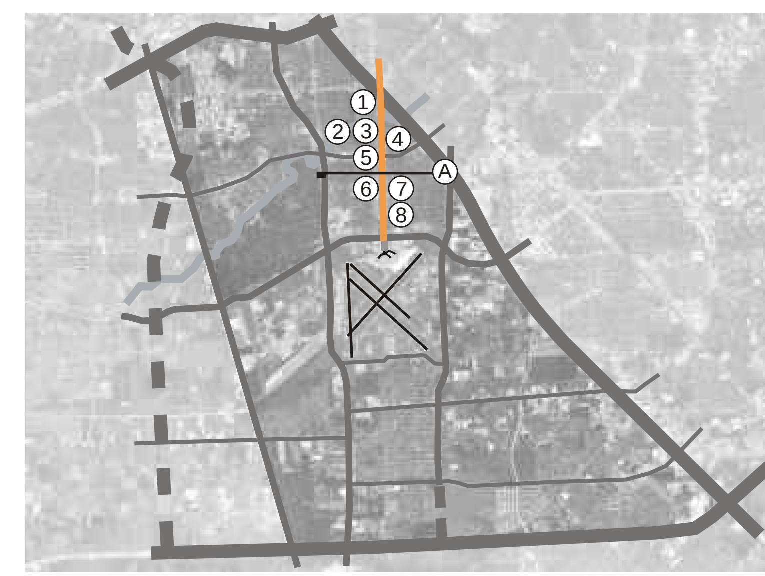


Figure 35
Broadway Street - Key Plan

Figure 36
9. Existing Hobby Airport Signage, Approaching Airport Boulevard

Figure 37
10. Deep Setbacks - Looking East at Intersection with Airport Boulevard

Figure 38
11. View of Airport Parking Structure- Looking South

Frontage property consists of a rundown mixture of multi-family residences and a few commercial establishments. In addition, there are numerous billboards that have different messages when moving south or north.

The bridge over Sims Bayou lacks character and Hobby Airport signage is inconsistent and easy to miss, resulting in a cluttered, unrewarding experience when moving through the "Ceremonial Gateway."

Figure 39
Intersection B - Airport Boulevard and Broadway Street

Figure 40
Broadway Street -Key Plan

Figure 41
1. Underdeveloped, Vacant Land without Sidewalks

Figure 42
2. Open Drainage Ditch in Median and Residential Property Beyond

Figure 43
3. Open Drainage Ditch in Median

Figure 273
4. Hertz Rental Car Near Intersection With Airport Blvd.

Figure 274
5. Small Businesses Near Intersection With Airport Blvd.

Figure 44
6. Overhead Power Lines with Some Tree Screening

Figure 45
7. Overgrown Vegetation/Foliage

Figure 46
8. Wide Existing Median without Trees

When exiting onto Monroe Road from IH-45 and driving south to Airport Boulevard, the wide ditch in the center median along Monroe Road presents the traveler with a “rural” experience. In addition, the residential property along the west side of the Monroe ROW represents a 1950’s rundown neighborhood and the road is flanked on the East by open, overgrown land. From Airport Boulevard to Almeda-Genoa Road, various commercial and airport-related businesses are dispersed throughout empty frontage land. The southern portion of Monroe Road, past Almeda-Genoa, is also bordered by vacant, underdeveloped land and lacks planned landscaping treatment.

The Harris County CIP program has funds allocated for the extension of Monroe Road in the South, from Almeda-Genoa Road to Beltway 8 between 2003 - 2007.

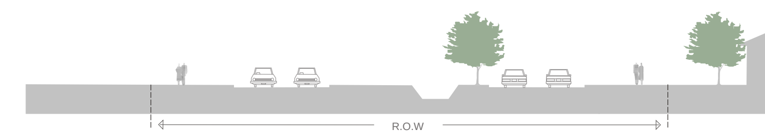


Figure 47
Monroe Road - Existing Section A

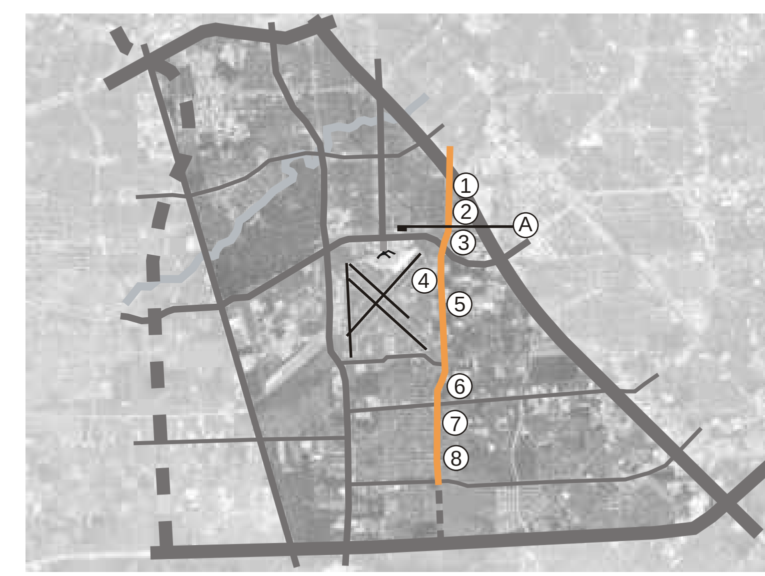


Figure 48
Monroe Road Key Plan

Figure 49
1. Inconspicuous Airport Signs and

Figure 50
2. Inconsistent Airport Signage at

Figure 51
3. Median Without Trees and Airport Hotel Beyond

Figure 52
4. Broadway Street Overpass With Multi-Family Housing Beyond

Figure 53
5. No Sidewalk, Neglected Land and Industrial Property Beyond

Figure 54
6. Unattractive Frontage Property Without Tree Screening

Figure 55
7. Small Businesses Along North Side of Airport Blvd.

Figure 275
8. Housing Along North Side of Airport Blvd.

Figure 276
9. Housing Along North Side of Airport Blvd.

Figure 277
10. Housing Along Mykawa Road Train Tracks

Figure 278
11. Train Tracks at Intersection with Mykawa Road

Accessing Airport Boulevard from the West, travelers must first move across the railroad tracks along Mykawa Road. The north side of Airport Boulevard is flanked by lower income houses, some of which have been converted into small businesses. The south side of Airport Boulevard is lined with some industrial developments until Telephone Road. After passing the airport, the character of Airport Boulevard from Monroe Road to IH-45 offers a mixed visual experience. ROW improvements such as sidewalks and street lights are in poor repair and private developments lack design and maintenance.

The character of Airport Boulevard is changing as TxDOT is implementing its plans to expand the street to six lanes. The portion of Airport Boulevard along airport property has been improved with landscaping and median cuts to accommodate traffic movement needs.

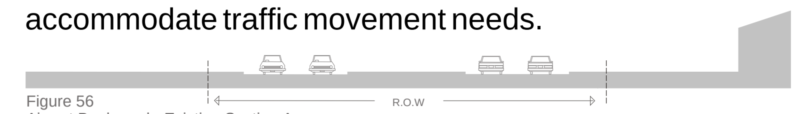


Figure 56
Airport Boulevard - Existing Section A

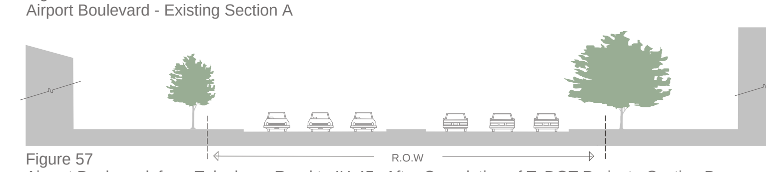


Figure 57
Airport Boulevard, from Telephone Road to IH-45 -After Completion of TxDOT Project - Section B

Figure 58
Airport Boulevard - Key Plan

Figure 59
1. No Sidewalks from the 610 Loop to Park Place

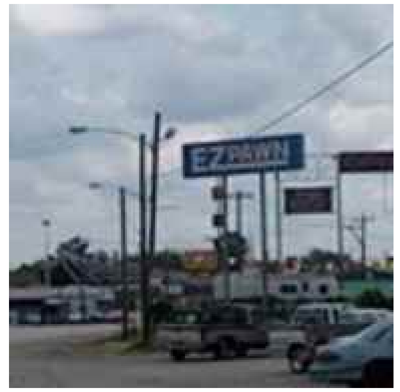


Figure 60
2. Dilapidated Street Frontage

Figure 61
3. Bridge Over Sims Bayou

Figure 62
4. Inconspicuous Street Signs and Distracting Commercial Signage

Figure 63
5. Power Lines at Airport Boulevard

Figure 64
6. Median with Small Trees

Figure 65
7. Entrance to Braniff Street

Figure 66
8. Empty Lots and Overhead Power

Figure 67
9. Rundown Commericial Property

Figure 68
10. Multi-Family Residential

Figure 69
Intersection B - Telephone Road and Airport Boulevard Looking South, Towards the Old Airport Control Tower

Source: Llewelyn-Davies Sahni, Inc.
Prepared by: Llewelyn-Davies Sahni, Inc., November 2002

Although it is a major artery to and from the airport, Telephone Road provides a poor overall visual experience. From the 610 Loop to Park Place Boulevard, Telephone Road is without basic pedestrian amenities such as sidewalks. The visitor experiences low-end, rundown businesses, and is not aware of the proximity of the airport. Neglected frontage property and distracting billboards create an unpleasant visual impact. However, improvements such as tree planting have been undertaken south of Bellfort Street, to Airport Boulevard.

From Airport Blvd. to Braniff Street, Telephone Road is lined with industrial development on the West and airport-related businesses on the East. South of Braniff street, the visual experience changes to a typical lower-end commercial development all the way to Beltway 8.

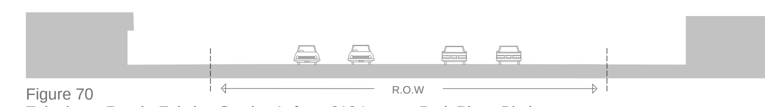


Figure 70
Telephone Road - Existing Section A, from 610 Loop to Park Place Blvd.

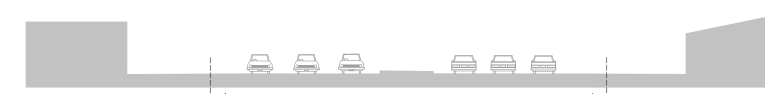


Figure 71
Telephone Road - Existing Section C, from Park Place Blvd. to Beltway 8

Figure 72
Telephone Road - Key Plan

Facts

Figure 73
1. Inconsistent Hobby Airport Sign and Distracting Commercial Signage

Figure 74
2. Residential Property

Figure 75
3. Inconspicuous Airport Signage and Power Lines

Figure 76
4. Dilapidated Commercial Frontage Property

Figure 77
5. Shallow Property Setback

Figure 78
6. Dilapidated Frontage Property without

Figure 79
7. Overgrown Vegetation and Rundown

Figure 80
5. Intersection with Telephone Road and

Figure 81
9. Empty Lots and Billboards

Figure 82
10. Central Ditch and Residential Area Beyond

Figure 83
11. Residential Area

When traveling east on Bellfort Street, from Mykawa Road to IH-45 the experience is unsightly, generally consisting of run-down multi-family and single-family residences and unappealing commercial property.

A central ditch along the western portion of the street, distracting billboards, inconsistent airport signage and overgrown vegetation present a distinct lack of development, quality and civic pride.

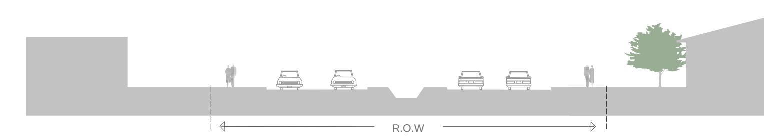


Figure 84
Bellfort Street - Existing Section A

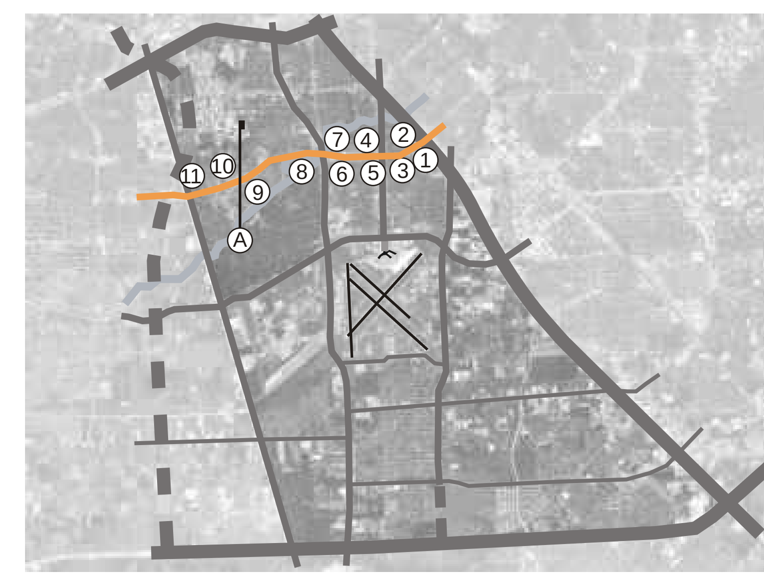


Figure 85
Bellfort Street - Key Plan


Figure 86
1. Commercial Property With Distracting Billboards


Figure 87
2. Small Trees in Median


Figure 88
3. Commercial Property


Figure 89
4. Institutional Architecture


Figure 90
5. Residential Frontage Property


Figure 91
6. Intersection with Monroe Road


Figure 279
7. Commercial Property


Figure 280
8. Rundown Curb and Sidewalks, Overgrown Landscape


Figure 281
9. Dilapidated Service Property at Intersection With Telephone Road


Figure 282
10. Residential Area With Drainage Ditch

Almeda-Genoa Road is a secondary access road that runs east-west. This street experience is one of overgrown and inconsistent vegetation, non-descript, residential areas, and unappealing commercial property.

The eastern portion of the road near IH-45 is mainly low-end commercial, lined with distracting billboards and signage. Moving from Monroe Road to Telephone Road, the street is sparsely occupied with gas stations at intersections, run-down commercial property, a few multi-family residences, and some institutional architecture. The western portion, from Telephone Road to Mykawa Road, is low-end residential in quality, flanked by a drainage ditch and overgrown foliage.

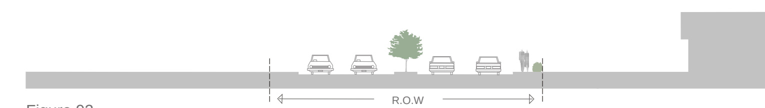


Figure 92
Almeda-Genoa Road - Existing Section A

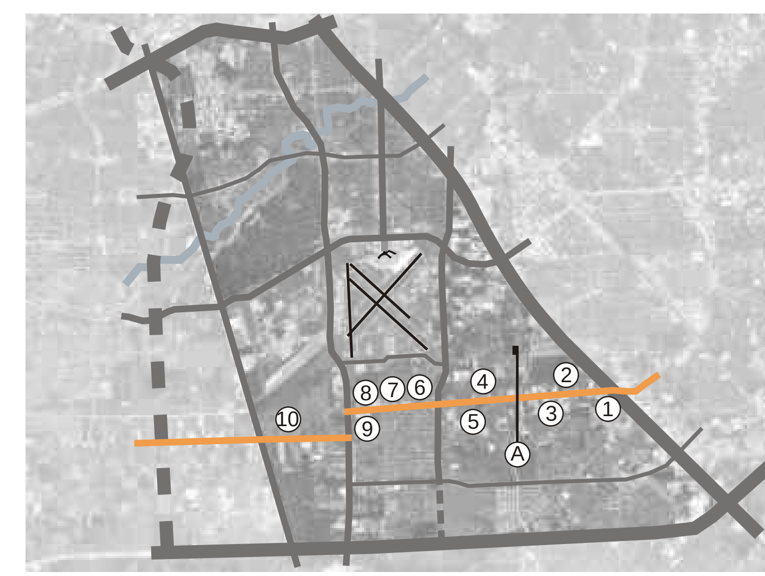


Figure 93
Almeda-Genoa Road - Key Plan

Fuqua Road, another secondary airport access road that extends from Mykawa Road to IH-45, is lined with vacant, neglected land. The ROW serves single-family and multi-family residential and some commercial development. The overall character of the road is overgrown rural with little or no maintenance.

Figure 94
1. Small Flowering Trees in Median and Planting Strip With Multi-Family Residences Beyond

Figure 95
2. Vacant Land and Street Lights-Looking West at Intersection with Monroe Road

Figure 96
3. Large, Neglected Trees Along Road

Figure 97
4. Large, Neglected Trees Along Road

Figure 98
5. Neglected Vegetation/Foliage

Figure 99
6. Light Poles and Vacant Land

Figure 283
7. Residential Area

Figure 284
8. Overgrown, Inconsistent Landscape

Figure 285
9. Residential Property

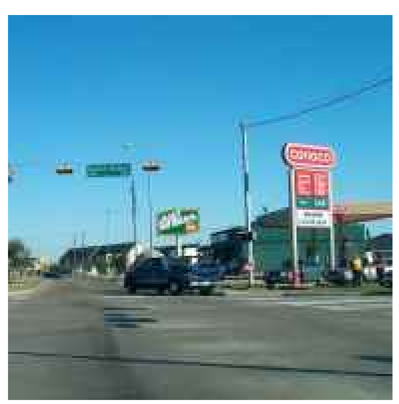


Figure 286
10. Intersection With Seaford / Beamer, Near IH-45

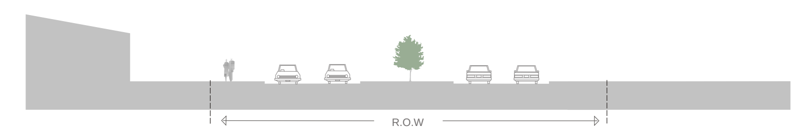


Figure 100
Fuqua Road - Existing Section A

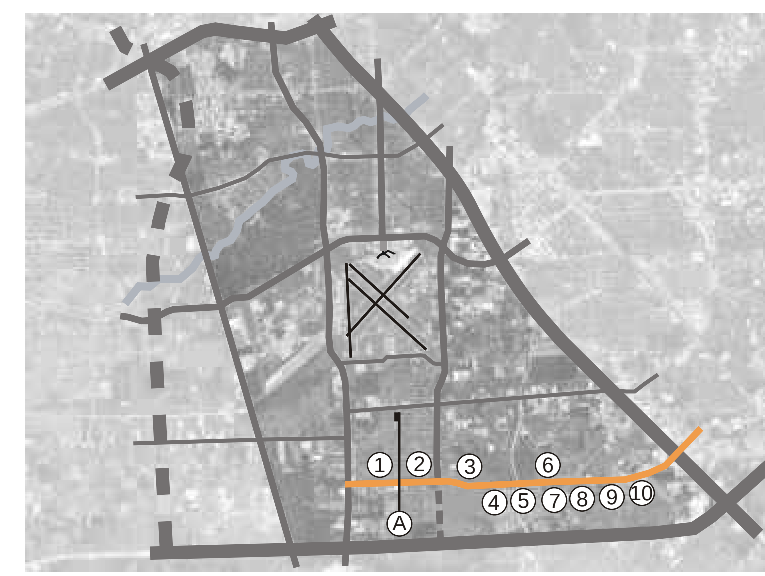


Figure 10
Fuqua Road - Key Plan

Figure 102
1. Unattractive Entrance to 610 Loop

Figure 103
2. Power Lines, Unattractive Signage

Figure 104
3. Railroad Crossing

Figure 105
4. Empty Fields, No Sidewalk

Figure 106
5. Residential Area without

Figure 107
6. Residential Area

Figure 108
7. Overgrown Vegetation and Empty

Figure 109
8. Residential Property and Roadside

Mykawa Road is a typical industrial artery serving a mixture of land uses including housing, industrial, institutional and open farm land. It runs parallel to the railroad tracks, without any ROW treatment or sidewalks in most places. A drainage ditch running on either side of the road and overgrown vegetation display a low level of maintenance.

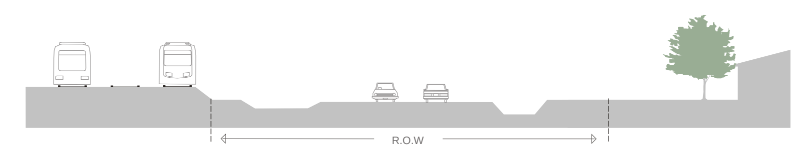


Figure 110
Mykawa Road - Existing Section A

Figure 111
Mykawa Road - Key Plan

Facts

Figure 112
1. 610 Loop - Freeway Condition

Figure 113
2. Entrance to IH-45 from 610 Loop

Figure 114
3. Inconspicuous Hobby Airport Signage

Figure 115
4. Exit for Broadway Street from IH-45

Figure 116
5. Exit for Airport Boulevard from IH-45

Figure 117
6. Distracting Signage Along IH-45

Figure 118
7. Exit for Almeda-Genoa from IH-45

Figure 119
8. Entrance to Beltway 8 from IH-45

Figure 120
9. Exit Telephone Road from Beltway 8

Figure 217
10. Exit for Telephone Road

Figure 218
11. Underdeveloped Frontage Land

The IH-45 and 610 Loop interchange offers convenient transition from one highway to the other, although it is difficult for the traveler to exit at Broadway to get to Hobby Airport. Auto dealerships, distracting signs, overgrown vegetation and rundown property offer a confusing visual experience for the traveler from Beltway 8 to the 610 Loop, along IH-45.

Most of the land along Beltway 8 is yet underdeveloped, offering an opportunity to complement the airport AOI developmental characteristics. The design character of the proposed SH-35 can also be influenced, as it was under design at the time this report was written.

In 2002, TxDOT initiated landscaping improvements along IH-45 from downtown to the Beltway 8 interchange. An understanding of the planned design and its implementation process could complement the recommendations of the Image Plan.

Figure 121
Freeways - Key Plan

Facts

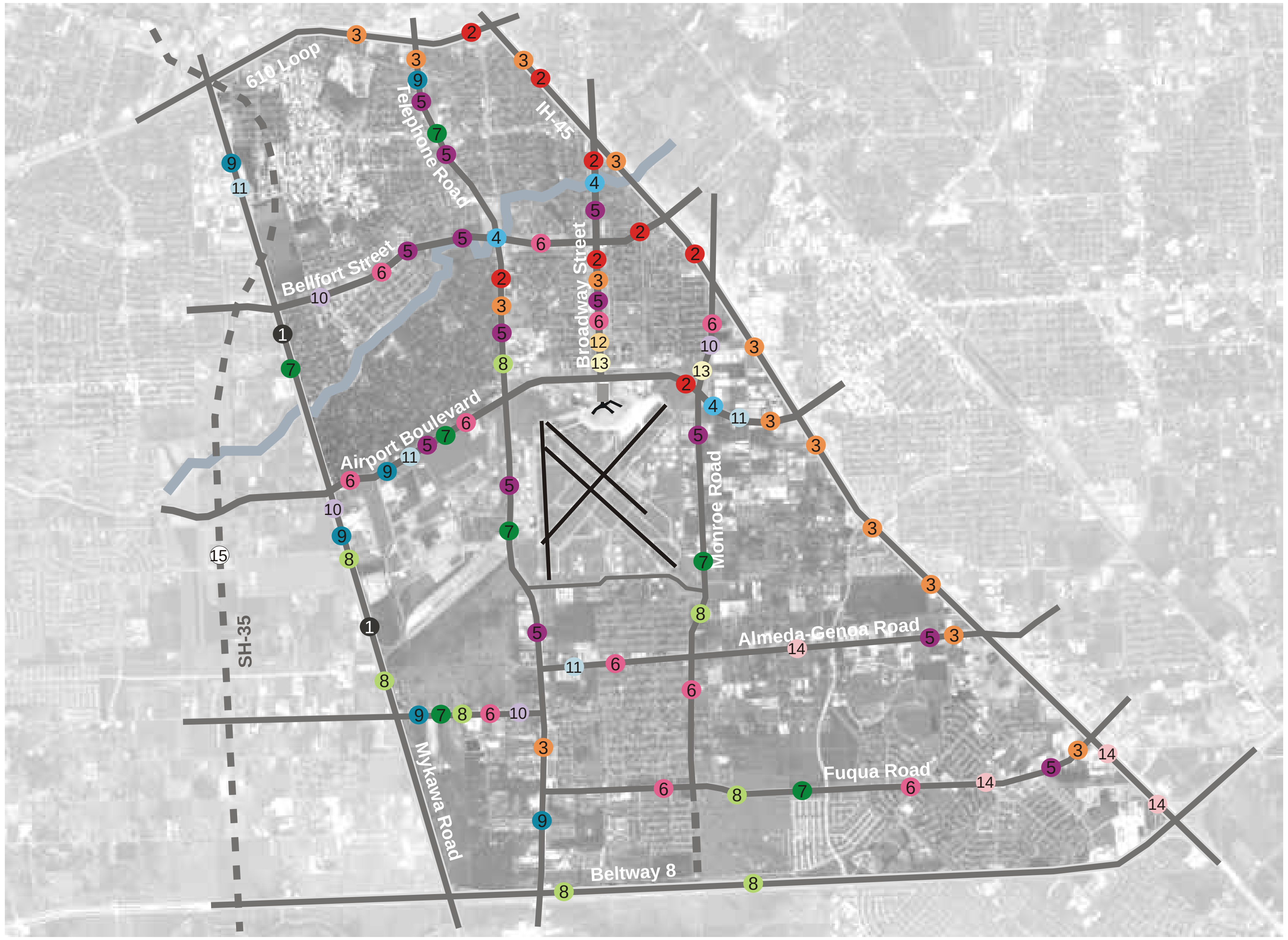


Figure 122
Summary of Existing Conditions

Listed below is a summary of existing conditions by their general location:

1. Train Tracks
2. Inconsistent, Inconspicuous Hobby Airport Signs
3. Visually Distracting Billboards
4. Unappealing Bridge
5. Dilapidated Commercial Property
6. Neglected Residential Area
7. Inconsistent Landscape/Overgrown Vegetation
8. Vacant Lots and Empty Fields
9. No Sidewalks/Inconsistent Sidewalks
10. Large Drainage Ditch Along Road
11. Industrial Property
12. Deep Property Setbacks
13. Wide Median
14. Formal Landscaping Treatment
15. Planned New SH-35 ROW

The opportunities and constraints are a synthesis of facts related to the existing conditions within the Hobby Airport Area of Influence. This synthesis guides the subsequent planning and design process by identifying issues that should be addressed.

Planned capital improvements should strive to enhance the identified opportunities, while mitigating the constraints.

Opportunities & Constraints

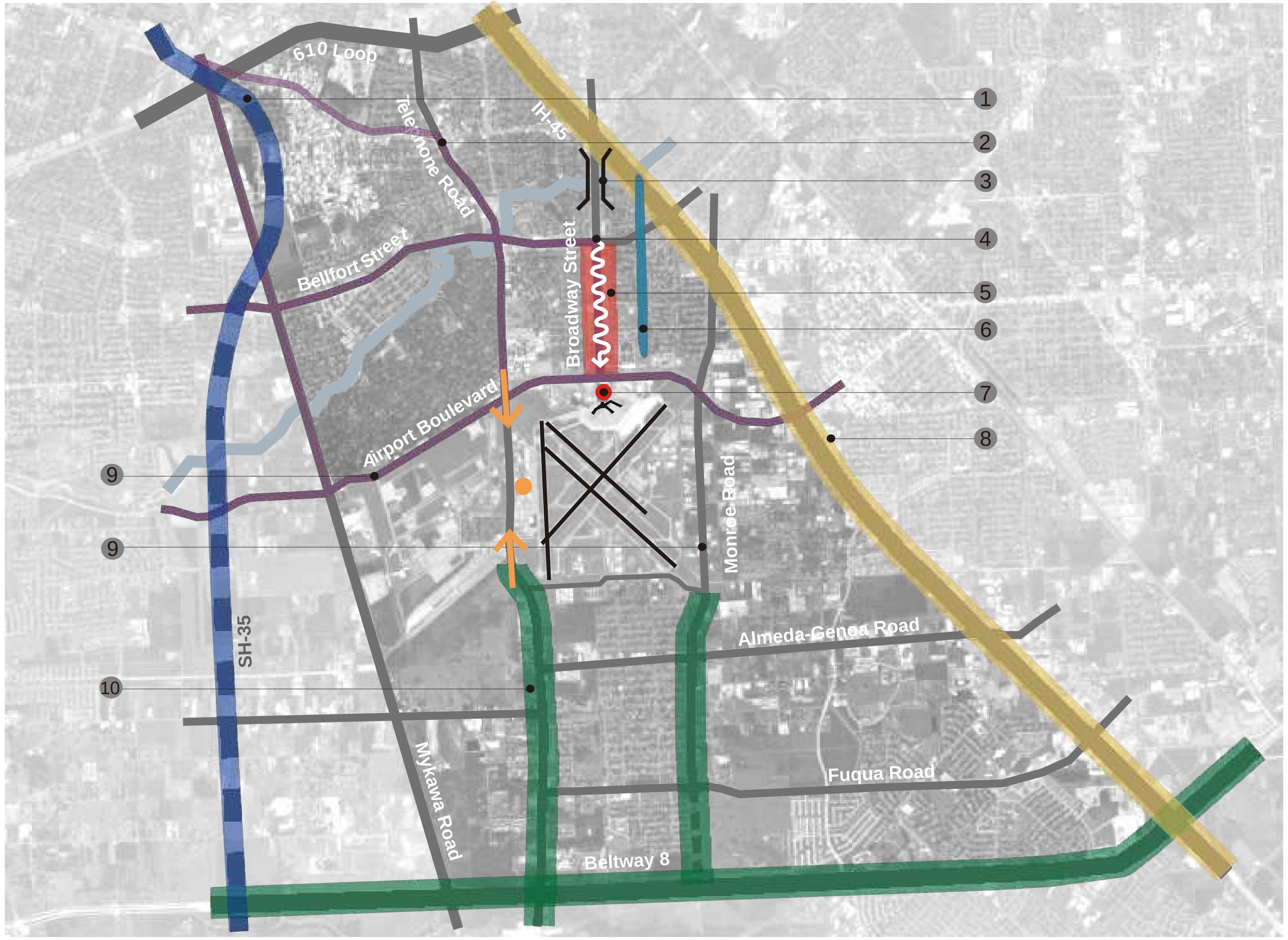
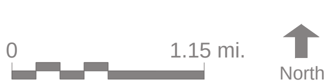


Figure 123
Area of Influence Opportunities

The following 11 opportunities have the potential to help achieve the goals of the Image Plan:

1. The planned SH-35 could provide another route for high speed traffic traveling to and from the airport. Its ground plane treatment could complement the AOI design elements.
2. The METRO MOBILITY 2025 plan could include a mass transit line to Hobby Airport and has the potential to increase accessibility to the airport.
3. The bridge over Sims Bayou has the potential to evoke a memorable impression of Broadway Street and act as a visual link with the airport.
4. A direct and dramatic vista of the terminal and airport forecourt, seen from as far north as the Sims Bayou bridge, could be achieved.
5. Using existing and new economic development programs, Broadway Street's frontage properties could be redeveloped between Sims Bayou and Airport Blvd. to increase jobs and improve the overall image of the area.
6. The existing drainage channel east of Broadway Street, running north-south could accommodate increased airport area drainage needs.
7. The form of the VHF Omnidirectional Radio Range (VOR) has the potential to become a visual symbol for the airport once the parking garage is removed.
8. User experience along the highways can be enhanced by improved signage and landscape screening treatment along the frontage road and at key intersections.
9. Monroe Road and Airport Blvd. have the ROW and thus the potential to become high speed access roads.
10. The treatment character of Monroe Road, Telephone Road and Beltway 8 should be influenced by airport area design standards.
11. The dominant form of the 1940's terminal tower could act as a visual terminus for travelers on Telephone Road.



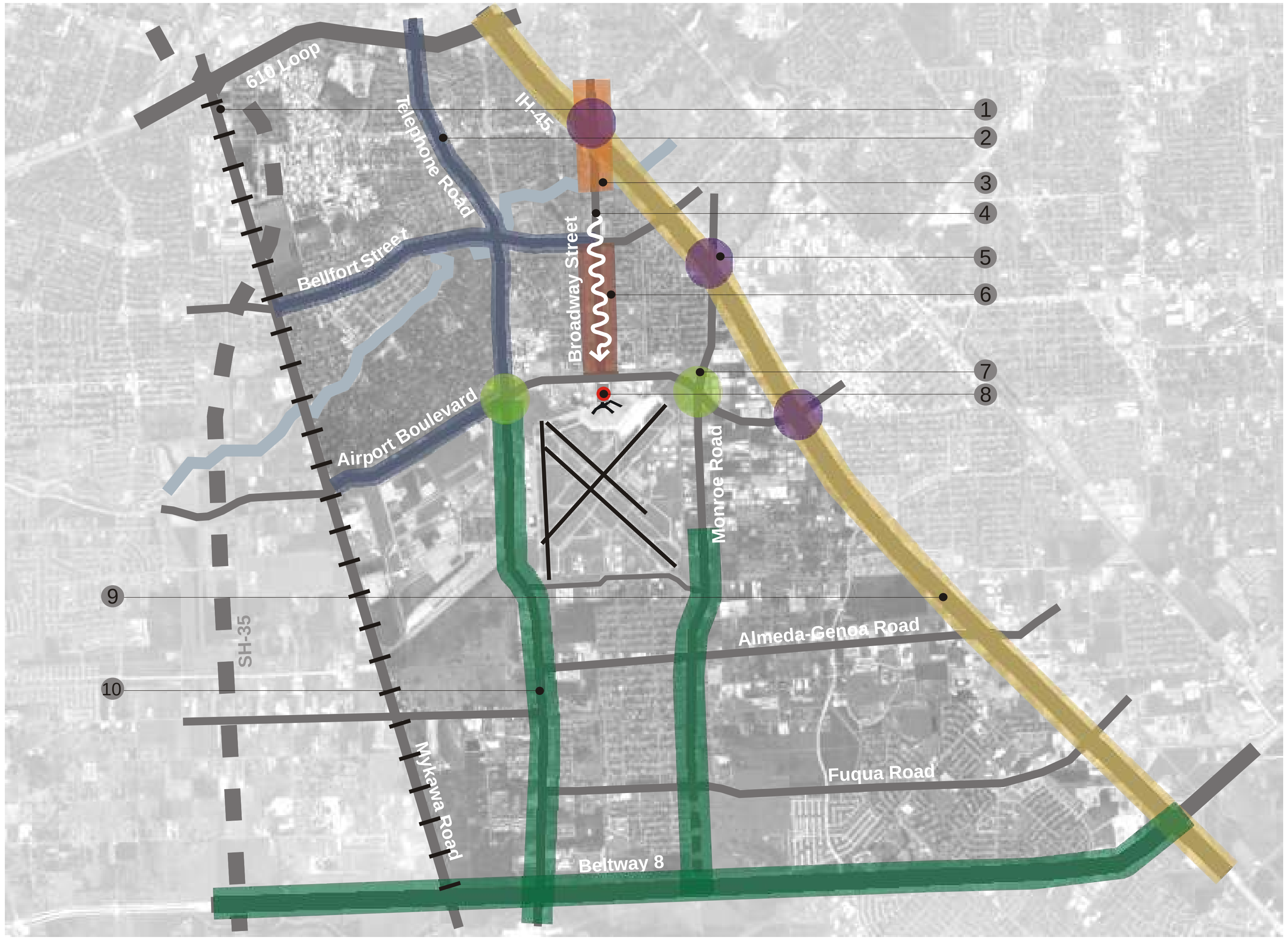
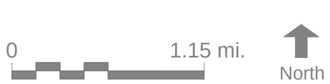


Figure 124
Area of Influence Constraints

The following 11 constraints should be addressed in order to achieve the goals of the Image Plan:

1. Train tracks along Mykawa Road hinder accessibility and offer an undesirable image for traffic coming from the West.
2. Street frontage and improvements along Telephone Road and Bellfort Street are dilapidated and in disrepair.
3. Broadway Street's ROW is inconsistent, with 92' north of Park Place and 120' south of Park Place.
4. The view looking south on Broadway Street is currently blocked by the airport parking garage, ramps directly in front of the terminal, and foliage along the street.
5. The interchanges along IH-45 do not allow for smooth movement of traffic, thus resulting in poor legibility.
6. Broadway Street's current frontage property, consisting of run-down multi-family housing and small commercial property, conveys a poor image of the City of Houston, the 4th largest U.S. city.
7. Intersections on Telephone Road and Monroe Road, at Airport Blvd., perform at a low level of service, impeding traffic.
8. The VOR should remain intact and unharmed at its present location throughout the redevelopment process.
9. IH-45 lacks appropriate Airport signage and is cluttered with distracting billboards that do not convey a positive/coherent image.
10. Land along Monroe Road and Beltway 8 is undeveloped, overgrown, and may present a rural image.
11. There is a distinct lack of design treatment throughout the AOI.



Based on an understanding of the existing opportunities and constraints within the AOI, the team explored the functional and ceremonial hierarchy of airport access streets. The Framework Plan consists of six different treatments and responds to the opportunities offered by the area, while mitigating the existing constraints.

This plan addresses the identified goals, taking into consideration various factors such as existing land-use, planned capital improvements, private ownership of land, and its development potential within the context of future growth.

Framework Plan

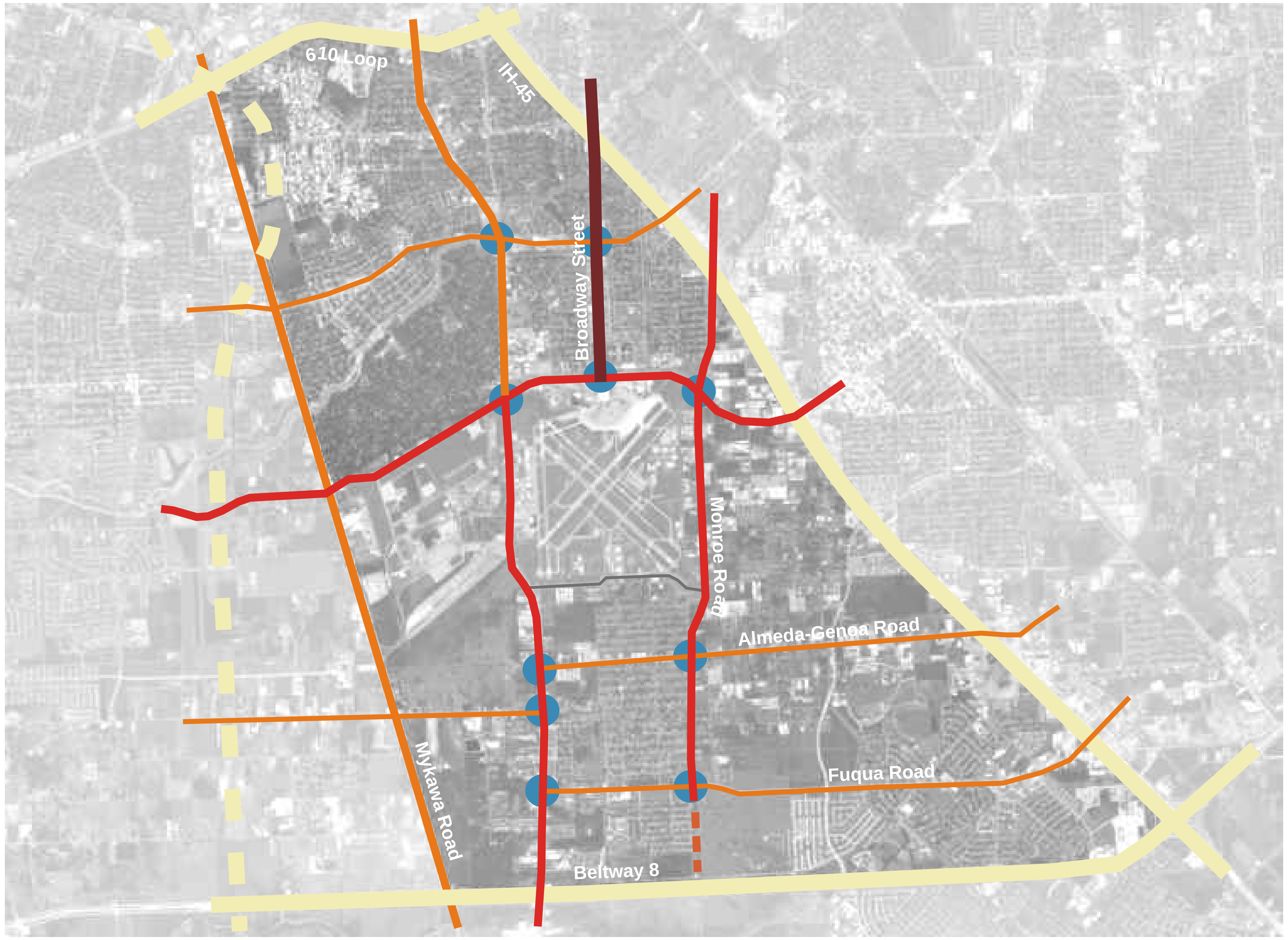


Figure 125
Framework Plan Hierarchy

0 1.15 mi.
North

Based on their function and location, traffic arteries within the AOI have been categorized to create an Image Plan hierarchy. The primary goal of this hierarchy is to achieve levels of distinction for various arteries. Each artery type can achieves its own unique character, yet they should all be consistent with the overall treatment of the AOI. Concepts related to each artery, including actual street plans and sections, are described in greater detail on the following pages.

The figure to the left documents the different street categories.

- Ceremonial Street:
  - Broadway Street
- High Capacity Corridors:
  - Monroe Road
  - Airport Boulevard
  - Telephone Road
- Auxiliary Streets:
  - Bellfort Street
  - Almeda-Genoa Road
  - Fuqua Road
  - Telephone Road (Partial)
  - Mykawa Road
- Street Intersections
- Highways and Interchanges:
  - 610 Loop
  - IH-45
  - Beltway 8
  - SH-35 (Proposed)

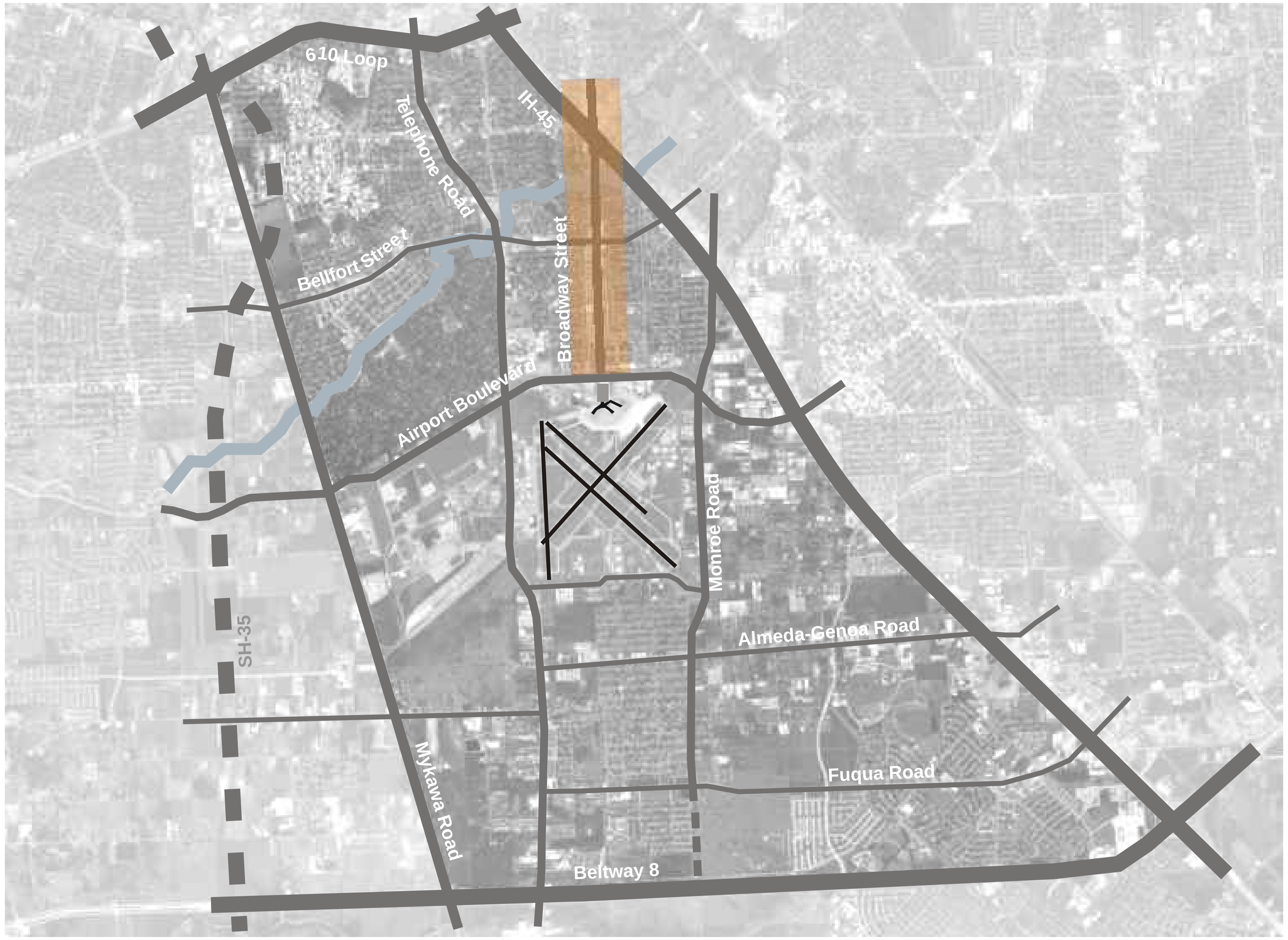


Figure 126
Ceremonial Street

0 1.15 mi. North

Ceremonial Street

When people travel south towards the airport, Broadway Street provides a direct line of sight to the terminal facility, which is a potential vista. Broadway is also the most direct access route to the airport from downtown and its existing ROW provides an opportunity for the development of a special experience when moving through the corridor.

These characteristics support the idea that Broadway has the potential to be transformed into a distinguished Ceremonial Street.

Aside from lighting, ground plane treatment, and graphic improvements, the overall image of Broadway could be enhanced with changes in land use and building facades.

By attracting airport-related service facilities such as hotels, offices and other commercial activities to Broadway, this street can potentially regain its historic role of a premier commercial avenue terminating at the airport.

The pictures below show similar developed examples from other parts of the world.

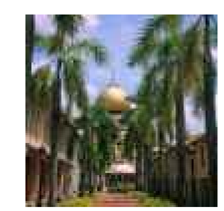


Figure 127
Singapore

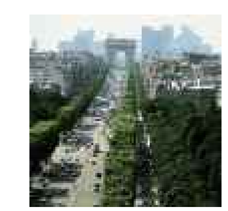


Figure 128
Paris, France

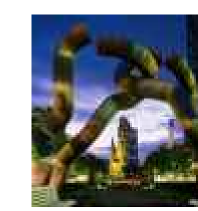


Figure 129
Berlin, Germany

Figure 130
New York City

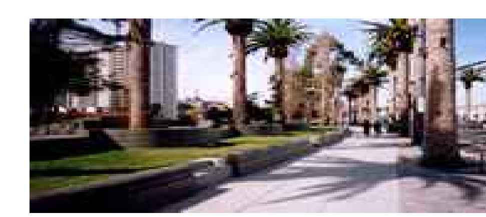


Figure 131
San Francisco, California

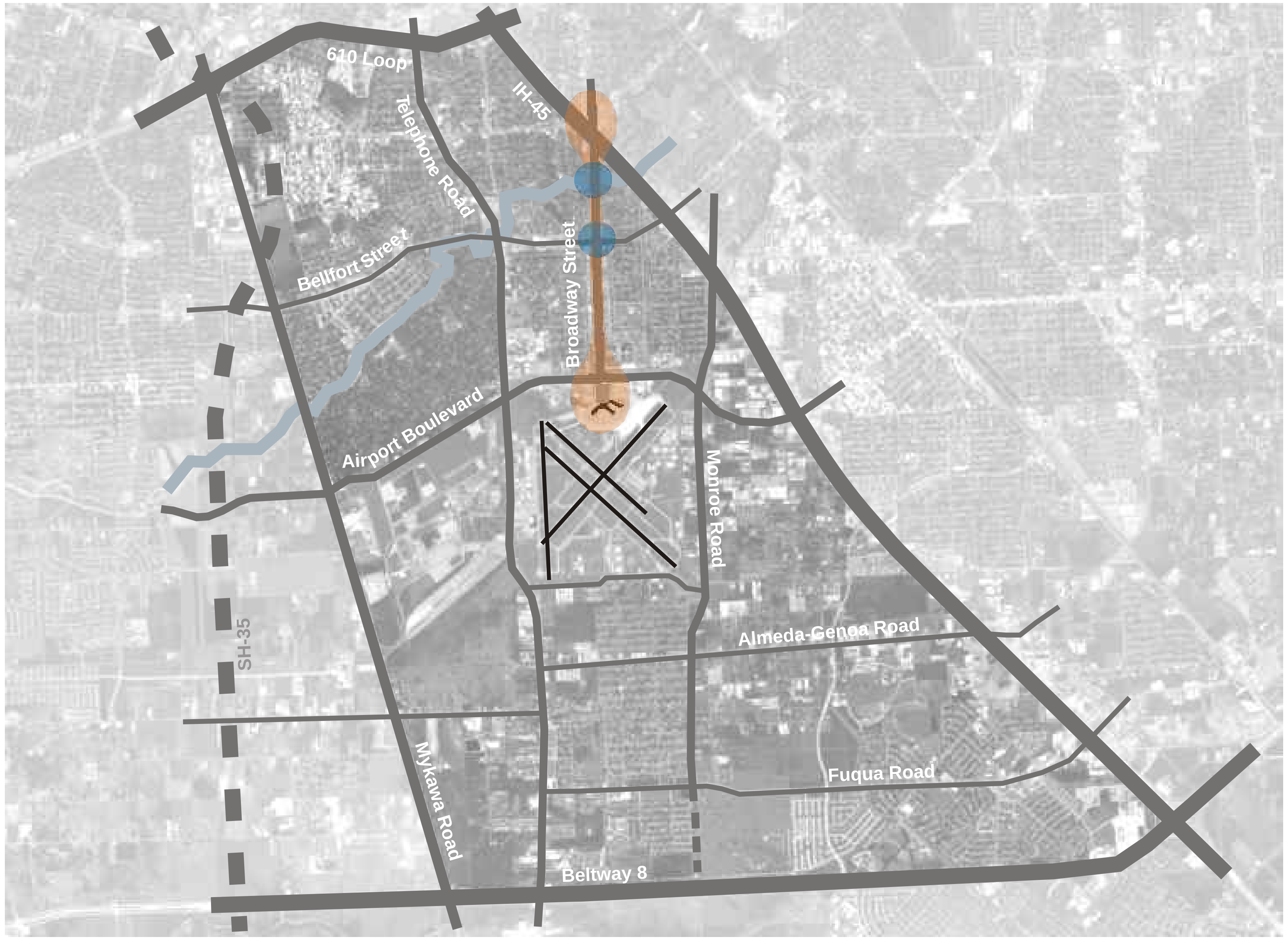


Figure 132
Broadway Street Concept

When traveling from IH-45 to the airport, the opportunity exists to create a transition of different, yet complimentary experiences along Broadway Street, at these key zones:

1. IH-45 exit toBroadway Street
2. Broadway Street exit to Sims Bayou Bridge
3. Sims Bayou Bridge to the Hobby Airport Terminal

Figures 137-139 on the following page describe improvements that could enhance the experience of moving along Broadway Street, towards or away from Hobby Airport.

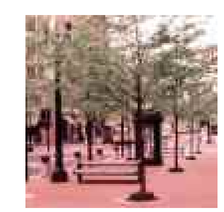


Figure 133
Portland, Oregon

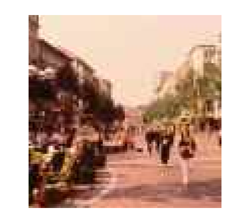


Figure 134
Frankfurt, Germany


Figure 135
Munich, Germany

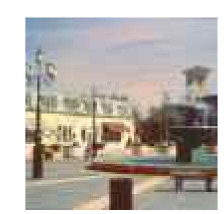


Figure 136
Westbury Square, Texas

0 1.15 mi. North

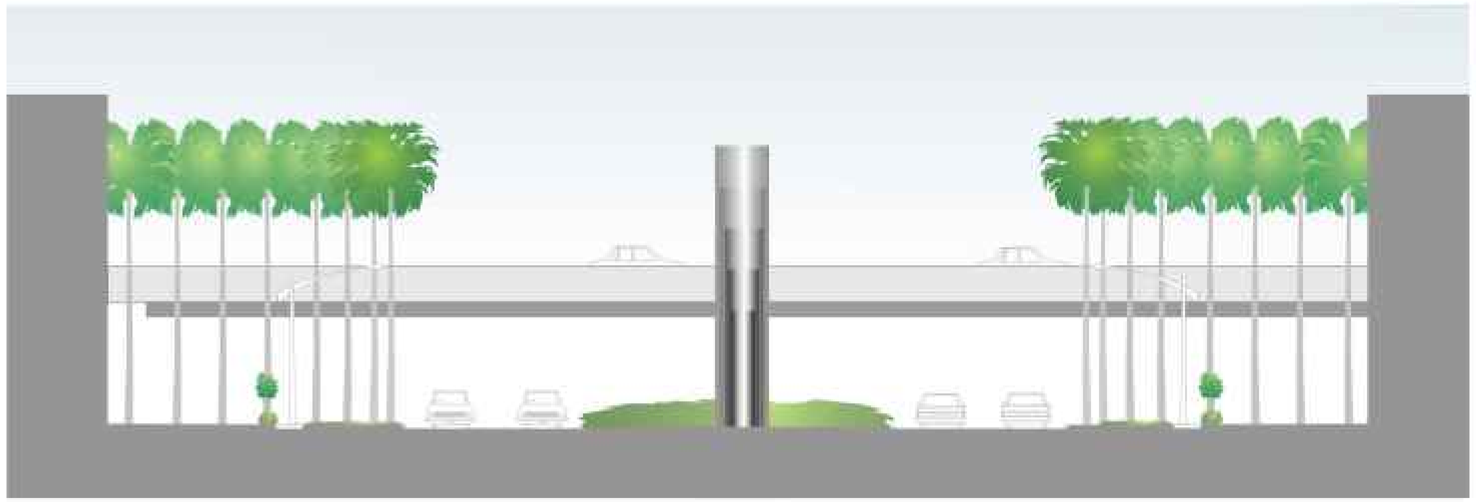


Figure 137
Section of Broadway Street and IH-45 Looking North

Figure 138
Plan of Broadway Street Exit, from IH-45

Broadway's median from IH-45 to the Sims Bayou could contain a procession of large sculptural elements, as shown in figure 137. Diminishing in size as they continue farther away from IH-45, these art objects would softly fade into the background, experienced by passengers as they approach the Sims Bayou Bridge.

A new, well designed bridge would be lit to glow dramatically at night. To call attention to the open space and water, the lighting would fan out from the bridge, moving east and west along the Bayou – announcing the "Bayou City". After passing the bridge the passengers would begin to see the Hobby Airport Terminal building, the forecourt and its VOR in the distance. Broadway property, when redeveloped, could contain this view with focal architecture.

All interchanges around the AOI could be accentuated by the use of tall trees, possibly palm trees, lit at night to create a glow experienced by the driver at a distance from the exit. Trees planted in a geometric pattern, dramatically lit at night, would serve as beacons for all airport exits, as presented in figure 138.

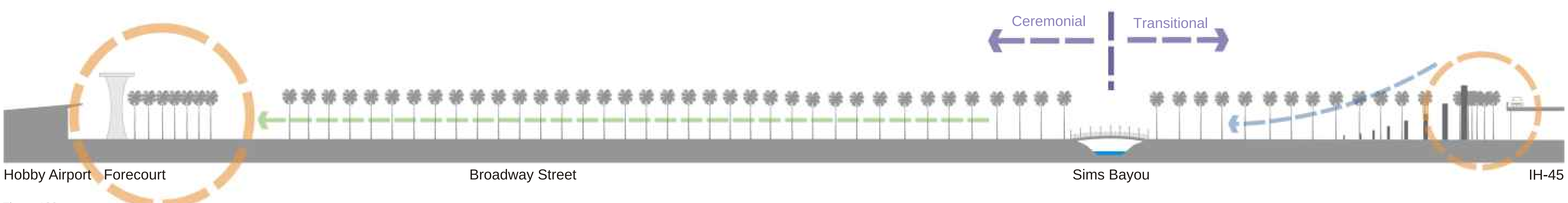


Figure 139
Section from Hobby Airport to IH-45 Interchange, Looking West

Figure 140
Broadway Street - Key Plan

Figure 141
Existing Broadway Street, Looking South

Figure 142
Sketch of Proposed Broadway Street, Looking South

Four different treatments of the ceremonial gateway function are documented in the following pages:

1. A 140' ROW that allows for METRO to run on both sides of the center median and separates through-traffic lanes from local traffic
2. A 128' ROW that accommodates METRO light rail and includes separation of through-traffic from local traffic
3. A 120' ROW that does not include light rail, but provides for separation of through-traffic and local traffic
4. A 120' ROW that does not include light rail and does not separate through-traffic from local traffic

The first three schemes separate through-traffic from local traffic for quick and smooth movement to and from the airport. All four alternatives include redevelopment of the land fronting Broadway Street to revitalize the community, create higher density land use, and increase jobs and civic pride.

The design elements shown in figure 142 include pairs of palm trees that would offer the traveler a distinct sense of place, while also guiding and containing the view to the airport terminal. Shrubs and smaller trees such as crepe myrtles would line the frontage property to provide some mild screening and increased seasonal vibrance. Sculptural street lighting would also be placed along the secondary medians to enhance the unique identity of the area.

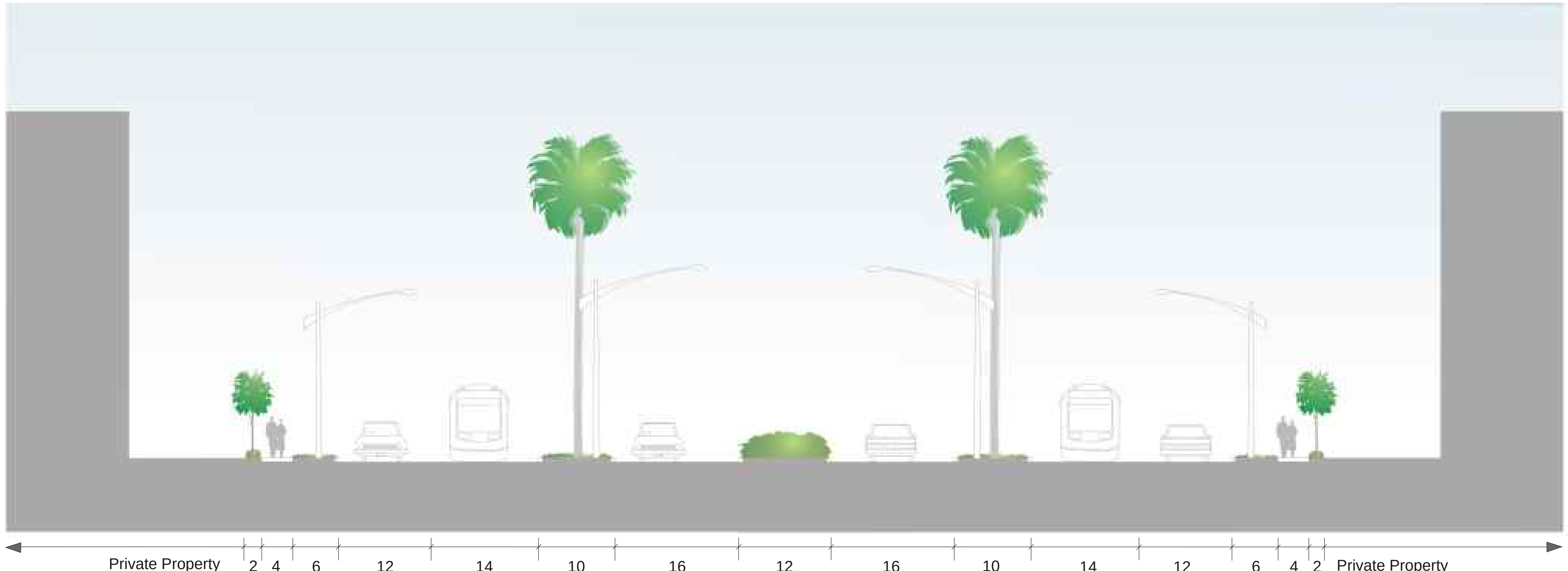


Figure 143
Alternative 1 - Section -140' ROW

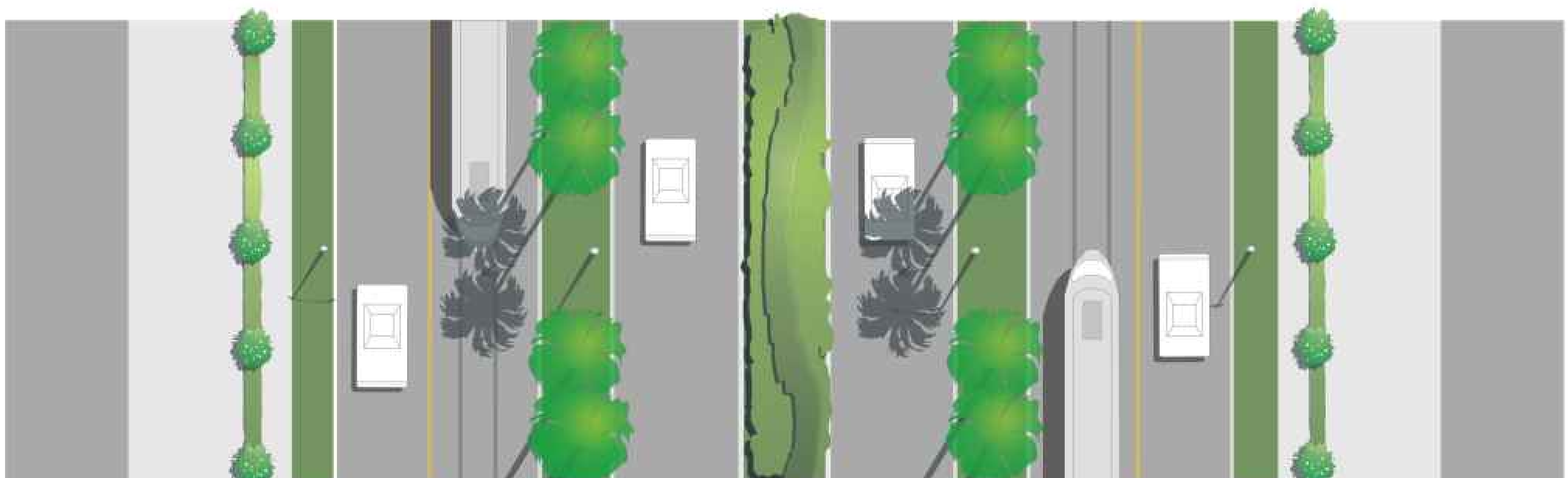


Figure 144
Alternative 1 - Plan -140' ROW

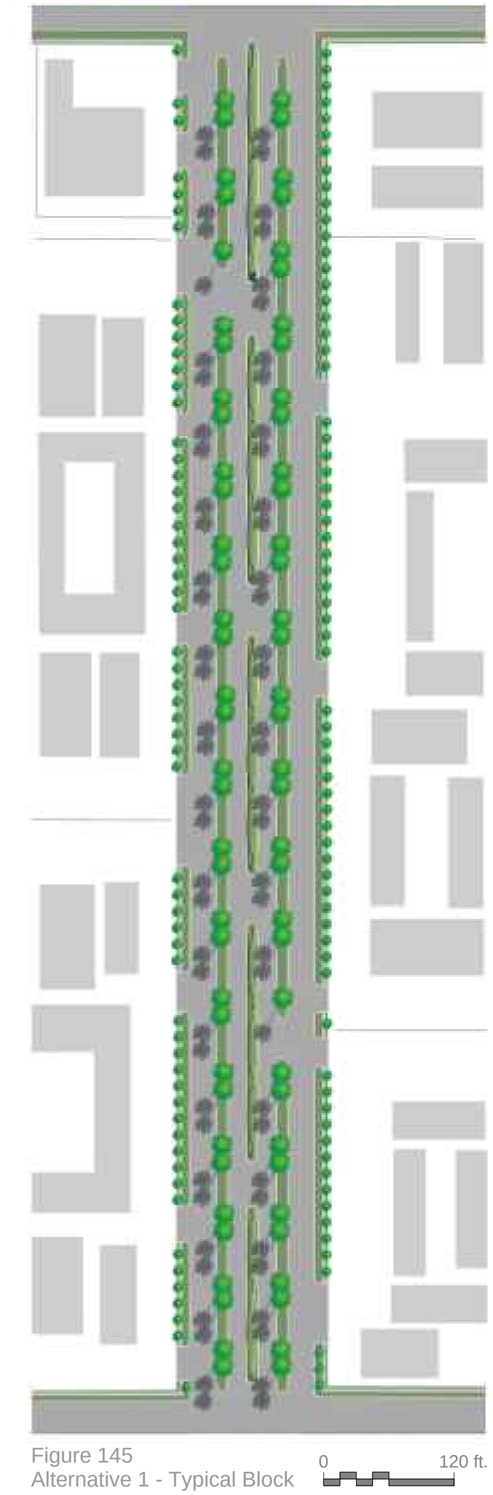


Figure 145
Alternative 1 - Typical Block

0 16 ft. North

Framework Plan

Figure 146
Alternative 2 - Section -128' ROW

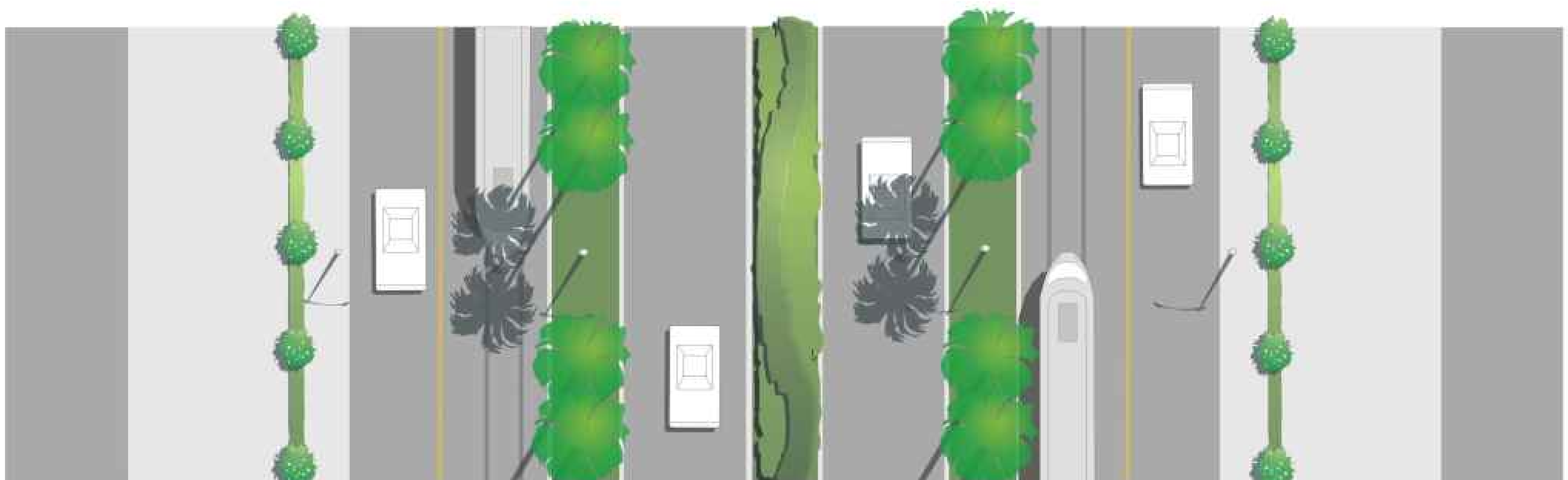


Figure 147
Alternative 2 - Plan -128' ROW

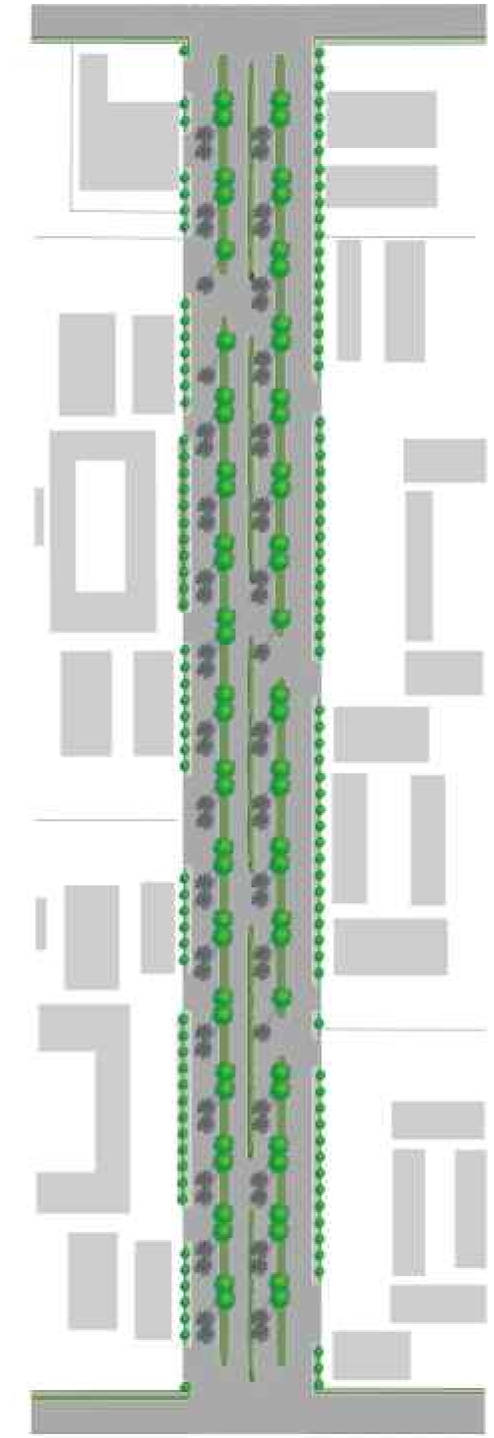


Figure 148
Alternative 2 - Typical Block

0 120 ft.

0 16 ft. North

Framework Plan

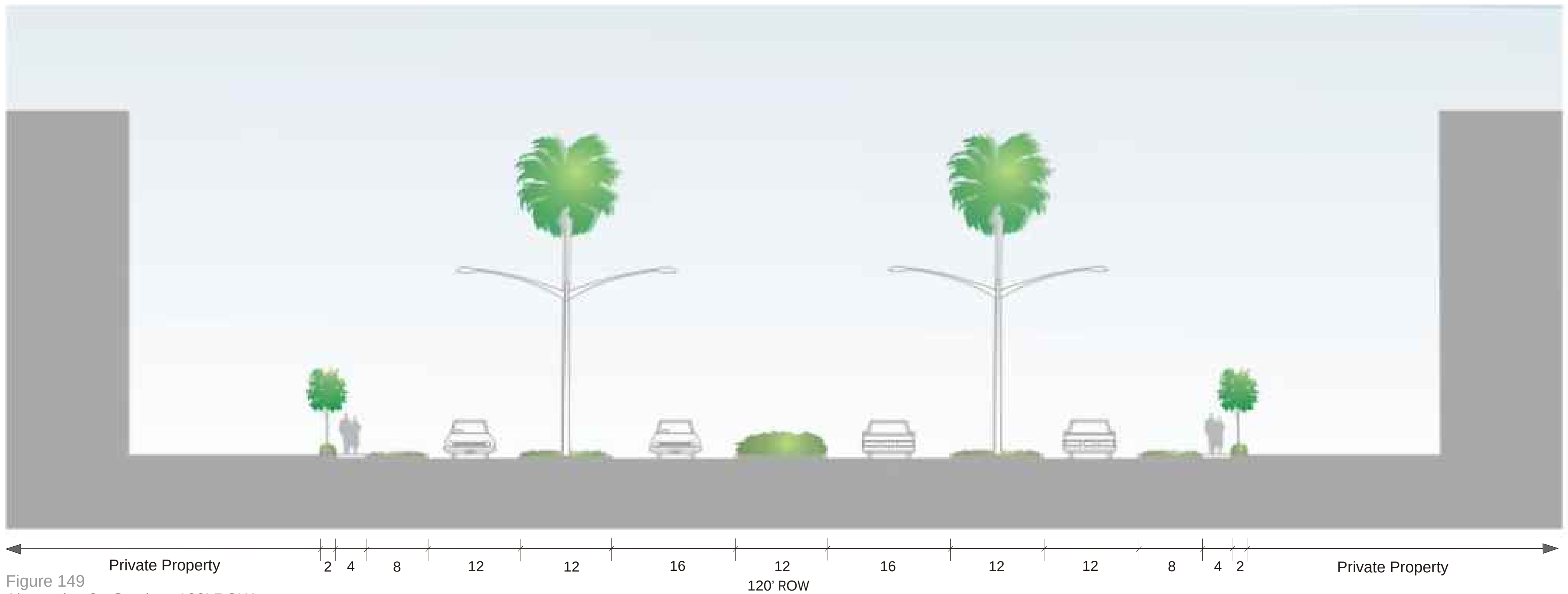


Figure 149
Alternative 3 - Section -120' ROW

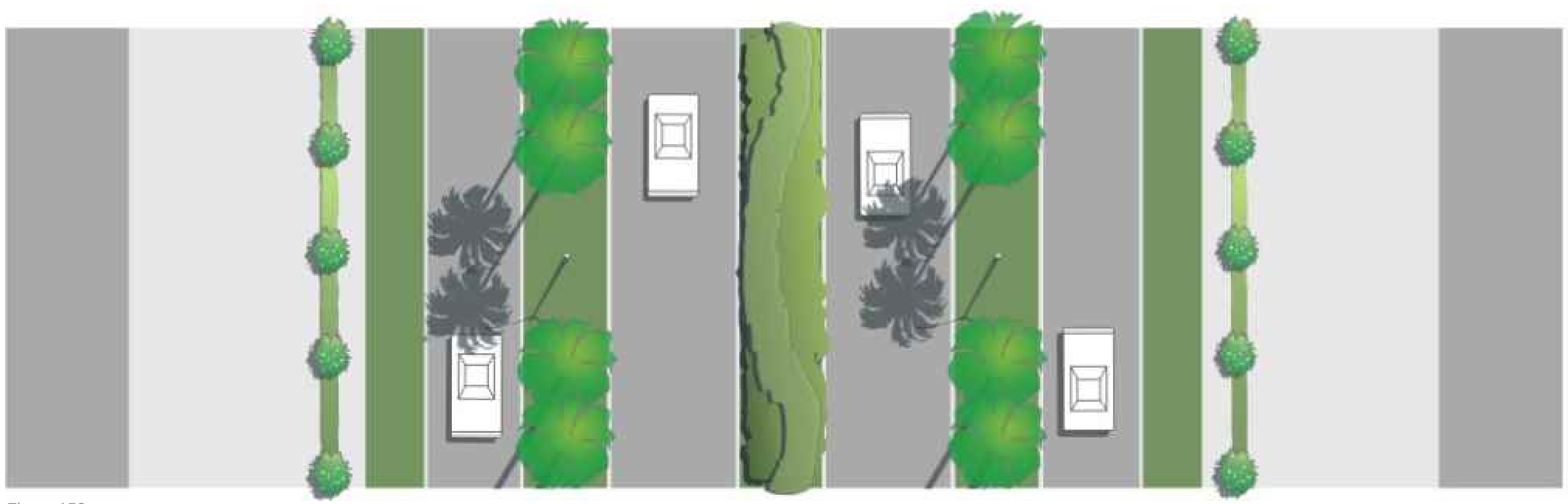


Figure 150
Alternative 3 - Plan -120' ROW

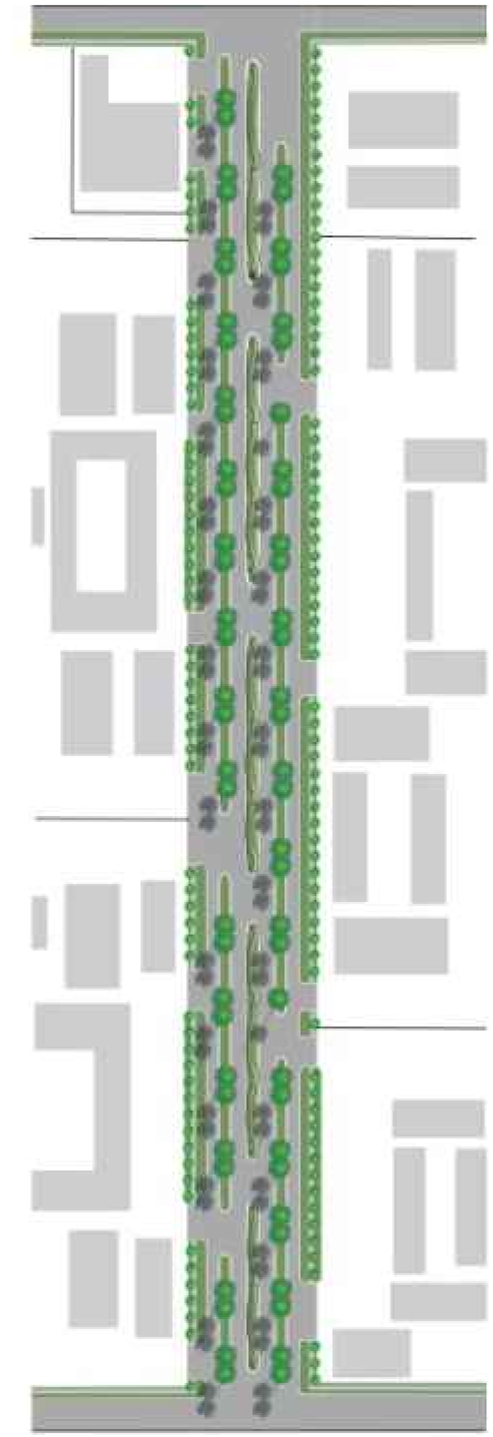


Figure 151
Alternative 3 - Typical Block

0 120 ft.

0 16 ft. North

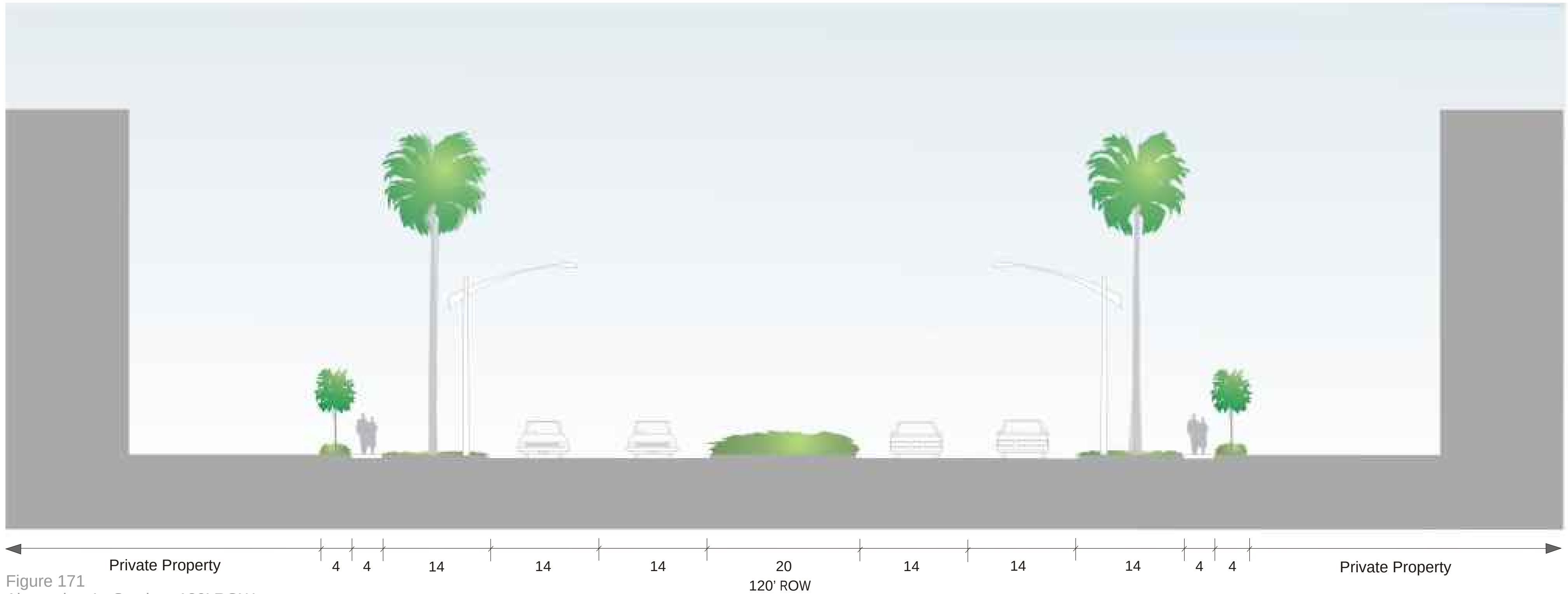


Figure 171
Alternative 4 - Section -120' ROW

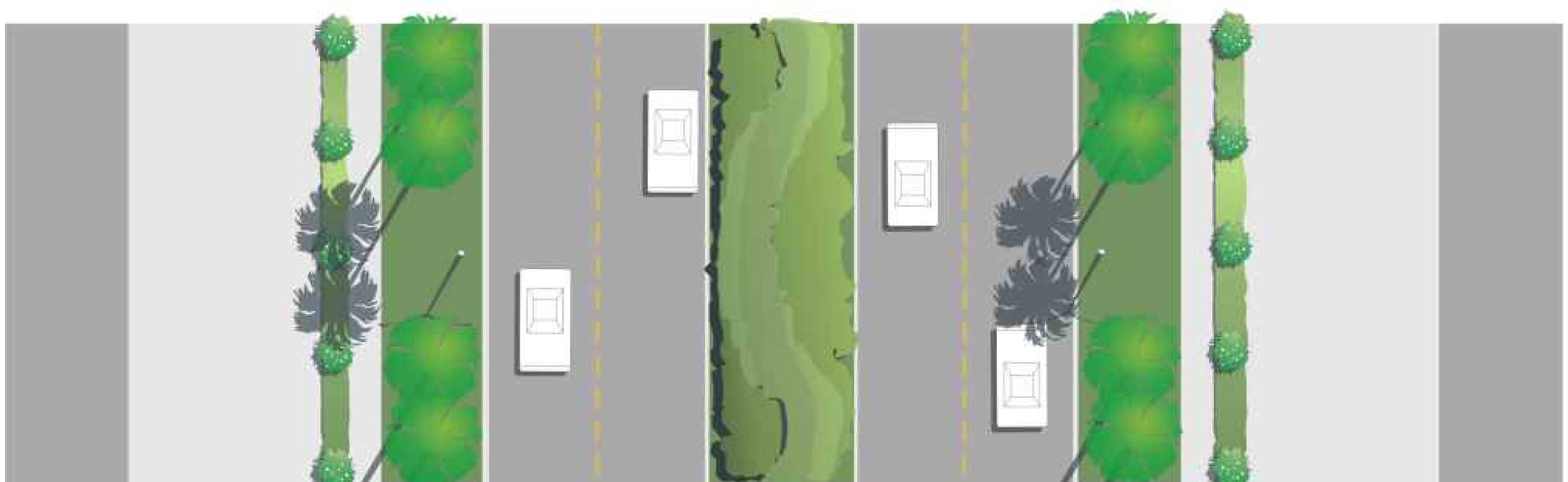


Figure 172
Alternative 4 - Plan -120' ROW

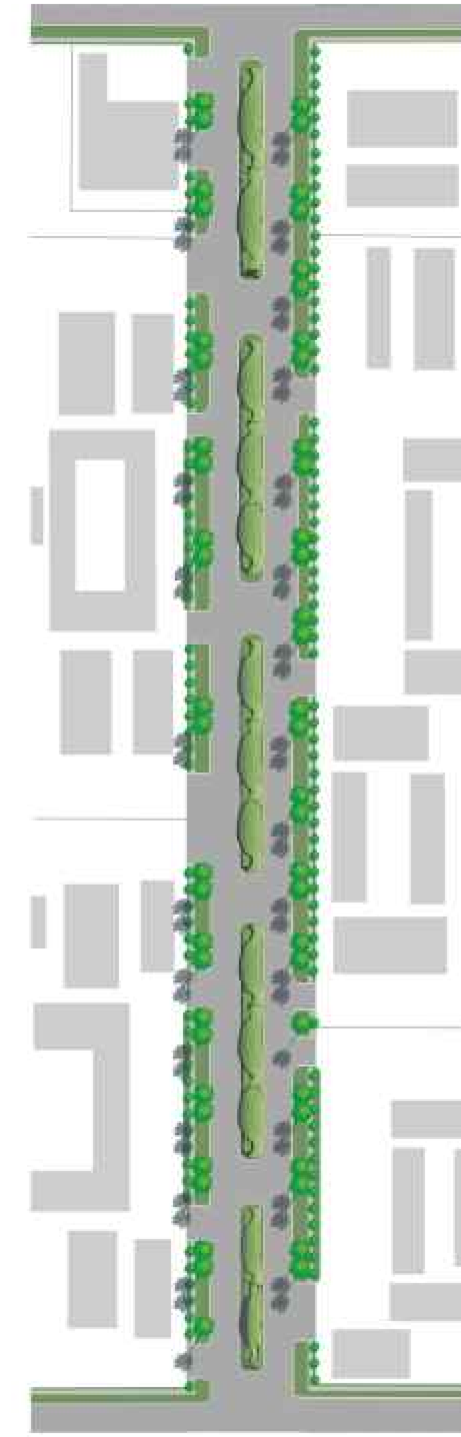


Figure 173
Alternative 4 - Typical Block

0 120 ft.

0 16 ft.
North

Framework Plan

Ceremonial Street
Alternative 4 - 120' ROW

Figure 152
High Capacity Corridors

High Capacity Corridors

In the 2022 Hobby Airport Master Plan, the designated role of Monroe Road, Airport Boulevard and Telephone Road is to move a significant volume of traffic to and from the airport. Monroe Road will connect IH-45 with Airport Blvd. to the North and Beltway 8 from the South, allowing the Airport east ramp support functions, (including general aviation), to be served by this high capacity corridor.

After completion of SH-35, Airport Boulevard will also serve as a high capacity link from the West.

Telephone Road, when improved, will provide the airport with necessary high capacity access to west and south ramps. This access will serve general aviation and chartered jet traffic.

Landscaping design along these streets could produce a combination of transparent, translucent and opaque edge conditions. This layering concept has worked very successfully along high capacity routes in California, shown below, in figures 153-155.

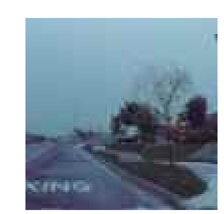


Figure 153
Transparent Edge

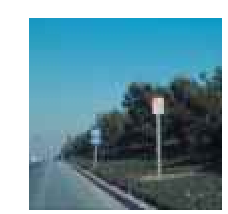


Figure 154
Translucent Edge

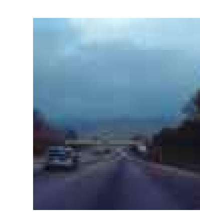


Figure 155
Opaque Edge

0 1.15 mi.

North

Figure 156
Telephone Road - Key Plan

Figure 157
Existing Telephone Road, Looking South

Figure 158
Sketch of Proposed Telephone Road, Looking South

These corridors will accommodate sufficient traffic capacity to meet the 2022 needs of the airport. In addition, various ground plane treatment is suggested, along with design elements described briefly in the following section.

Because there is a need for more property screening along these streets, tall, round trees such as Shumard Oaks are suggested. Like the treatment on Broadway Street, shrubs and crepe myrtles would line the frontage to provide more screening, and a similar combination of crepe myrtles and flowers could be planted in the central median.

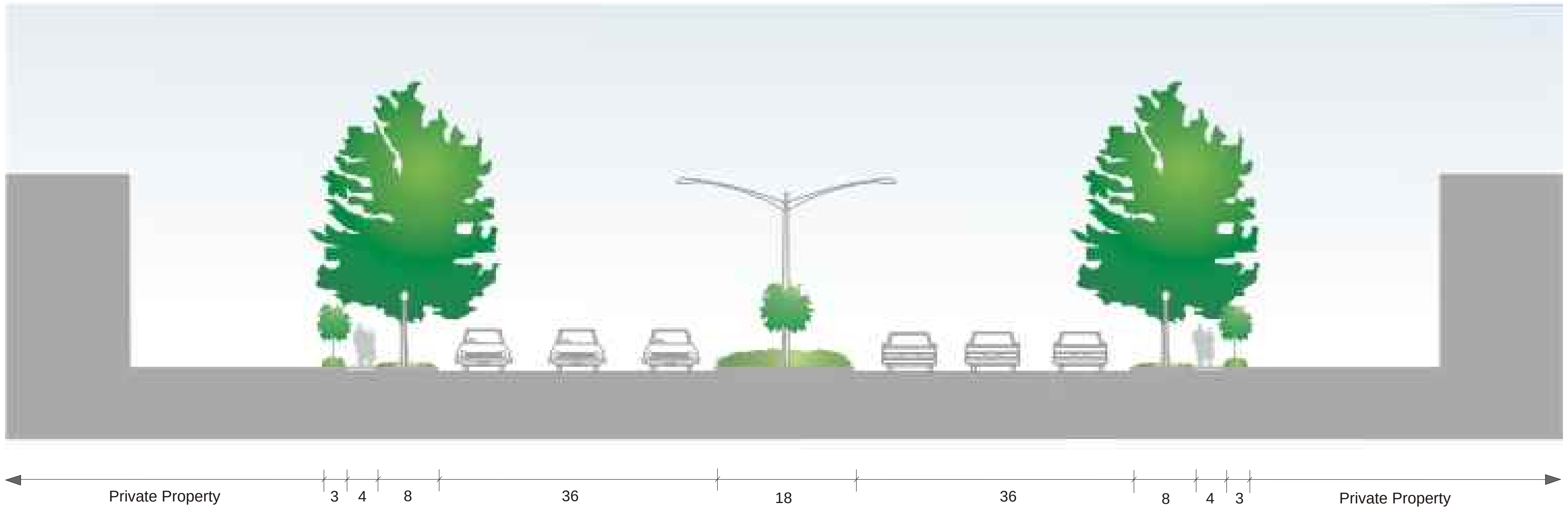


Figure 159
High Capacity Corridors - Section -120' ROW

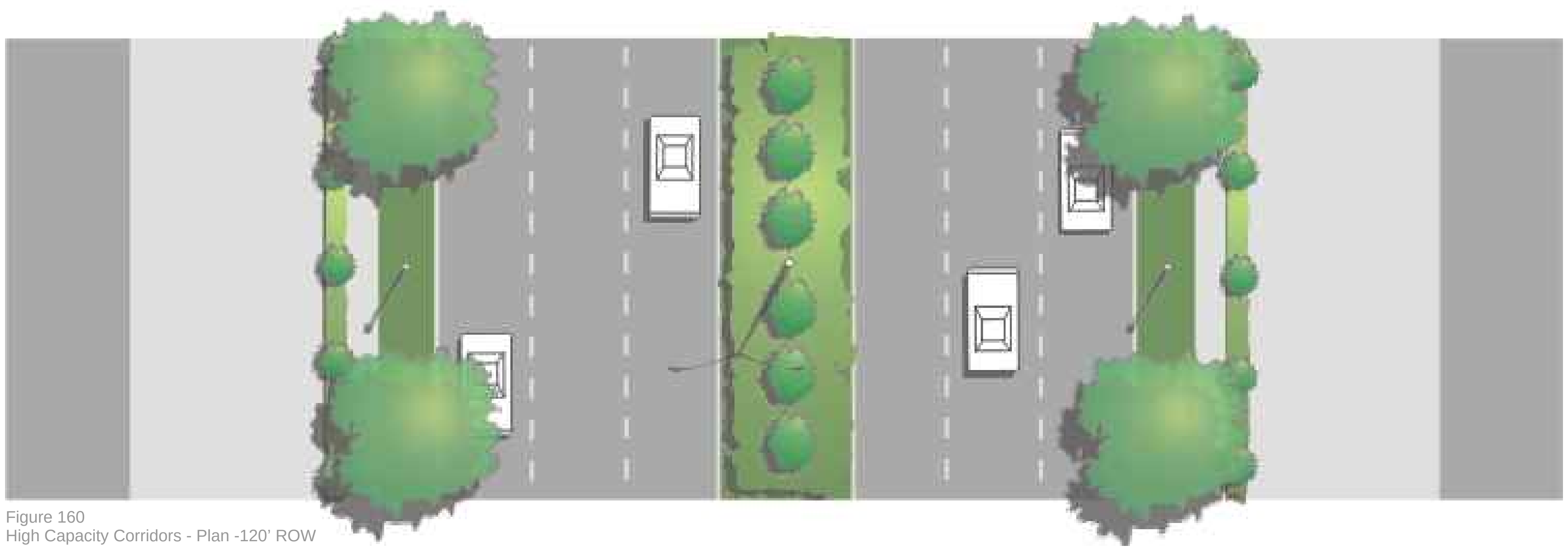


Figure 160
High Capacity Corridors - Plan -120' ROW

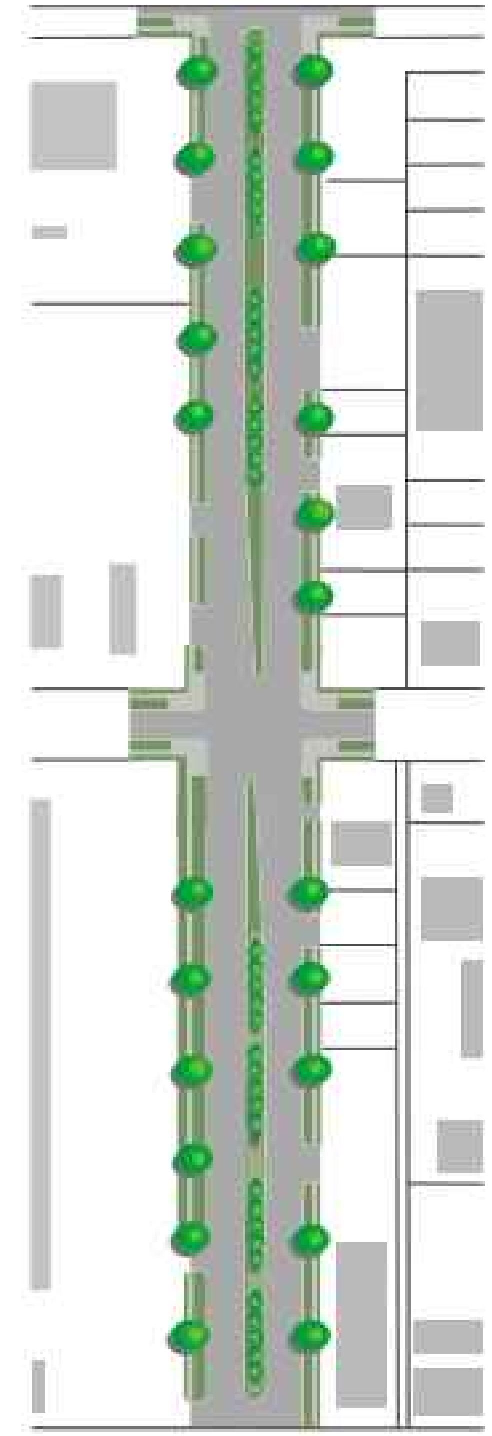


Figure 161
High Capacity Corridors - Typical Block

0 120 ft.

0 16 ft. North

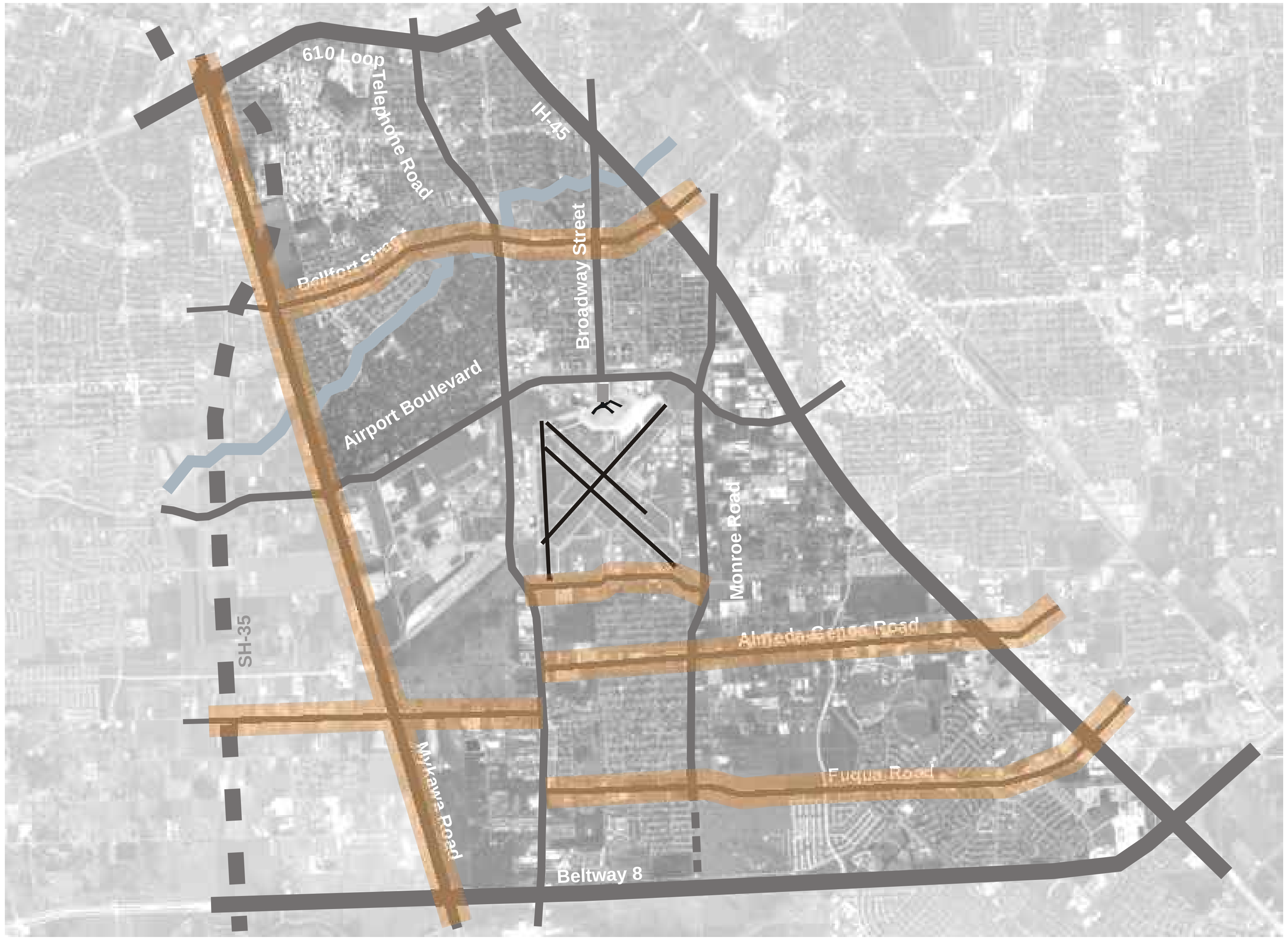


Figure 162
Auxiliary Streets

Auxiliary Streets

Auxiliary streets will functionally support and act as feeders to functional corridors.

Designed to accommodate local traffic, these streets will have treatment similar to that of the high capacity corridors. This treatment should respond to the scale and level of anticipated activity.

0 1.15 mi. North

Figure 163
Almeda-Genoa Road - Key Plan

Figure 164
Existing Almeda-Genoa Road, Looking East

Similar to the High Capacity Corridors, large and small trees will line the street in order to screen the frontage property. Because these streets need maximum screening, wider, lower trees like the Cedar Elm are suggested. No median treatment is necessary for these streets.

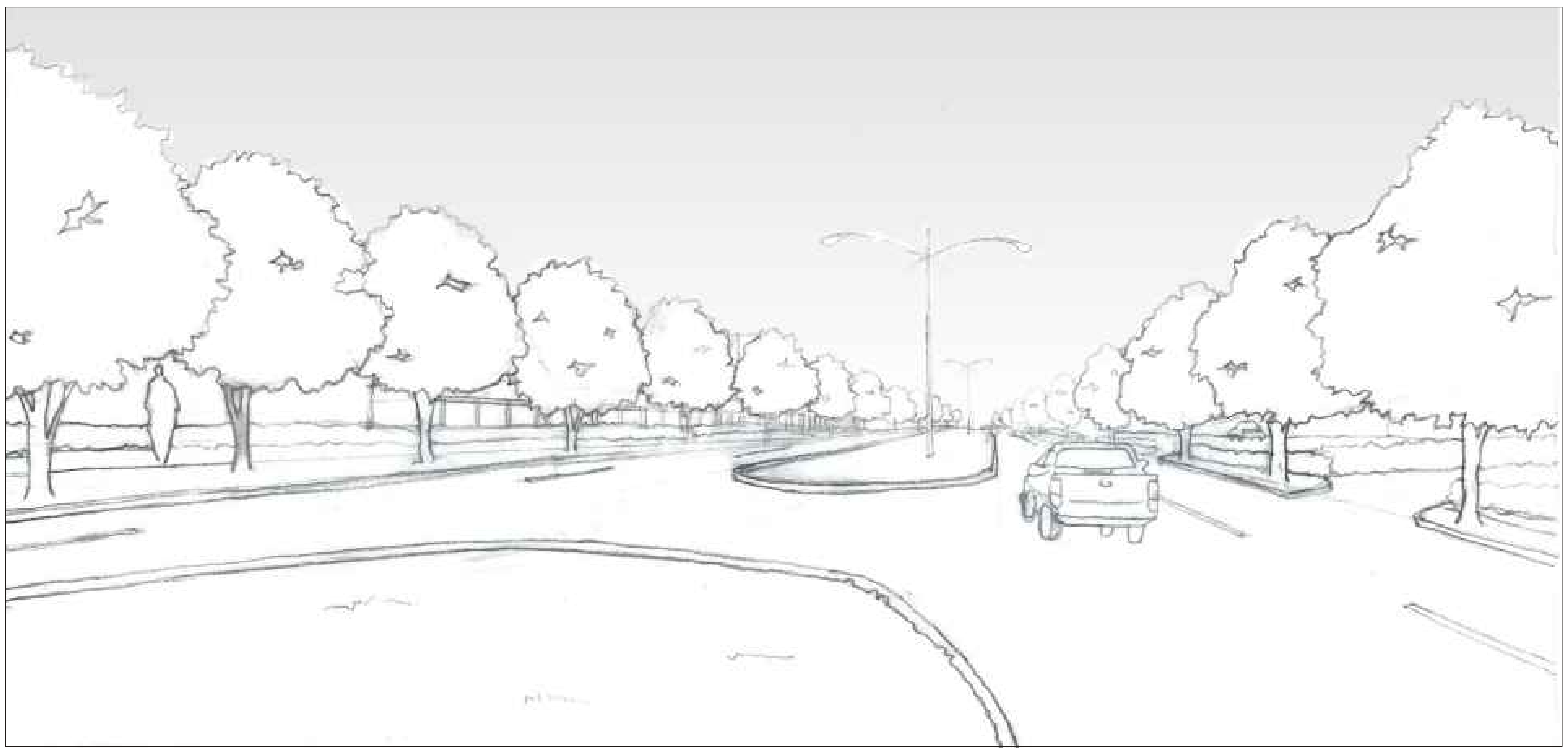


Figure 165
Sketch of Proposed Almeda-Genoa Road, Looking East

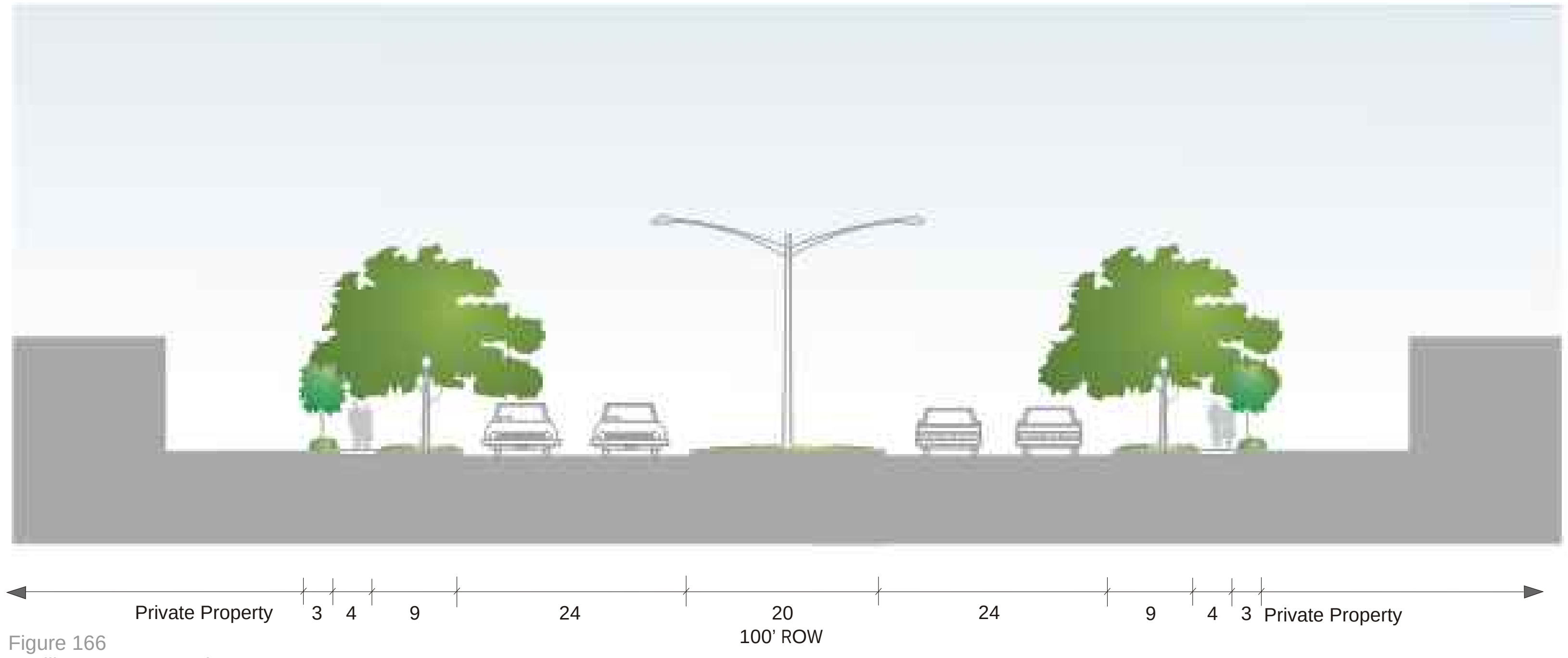


Figure 166
Auxiliary Street - Section -100' ROW

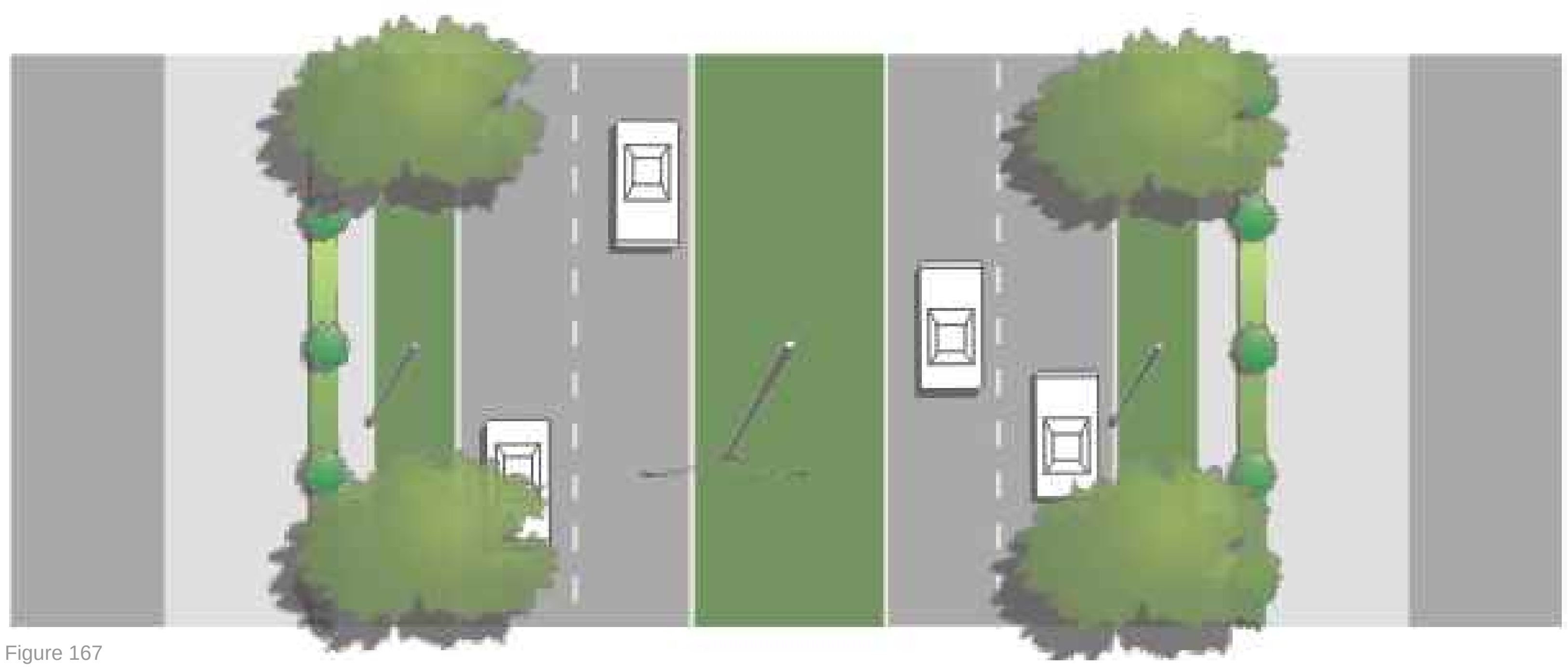


Figure 167
Auxiliary Street - Plan -100' ROW

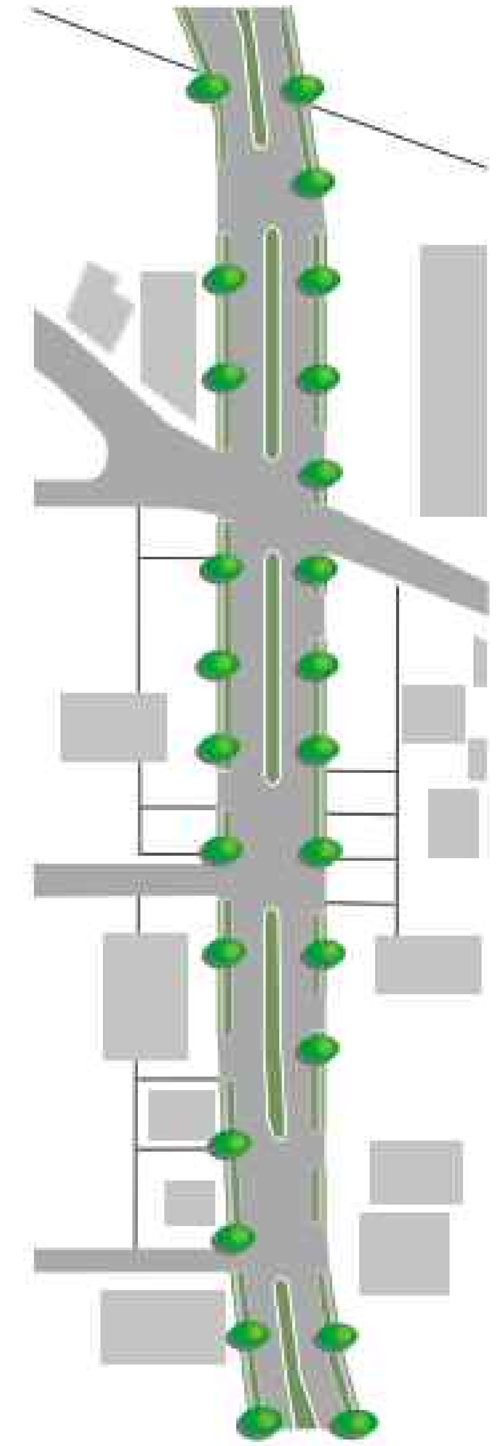


Figure 168
Auxiliary Street - Typical Block

0 120 ft.

0 16 ft. North

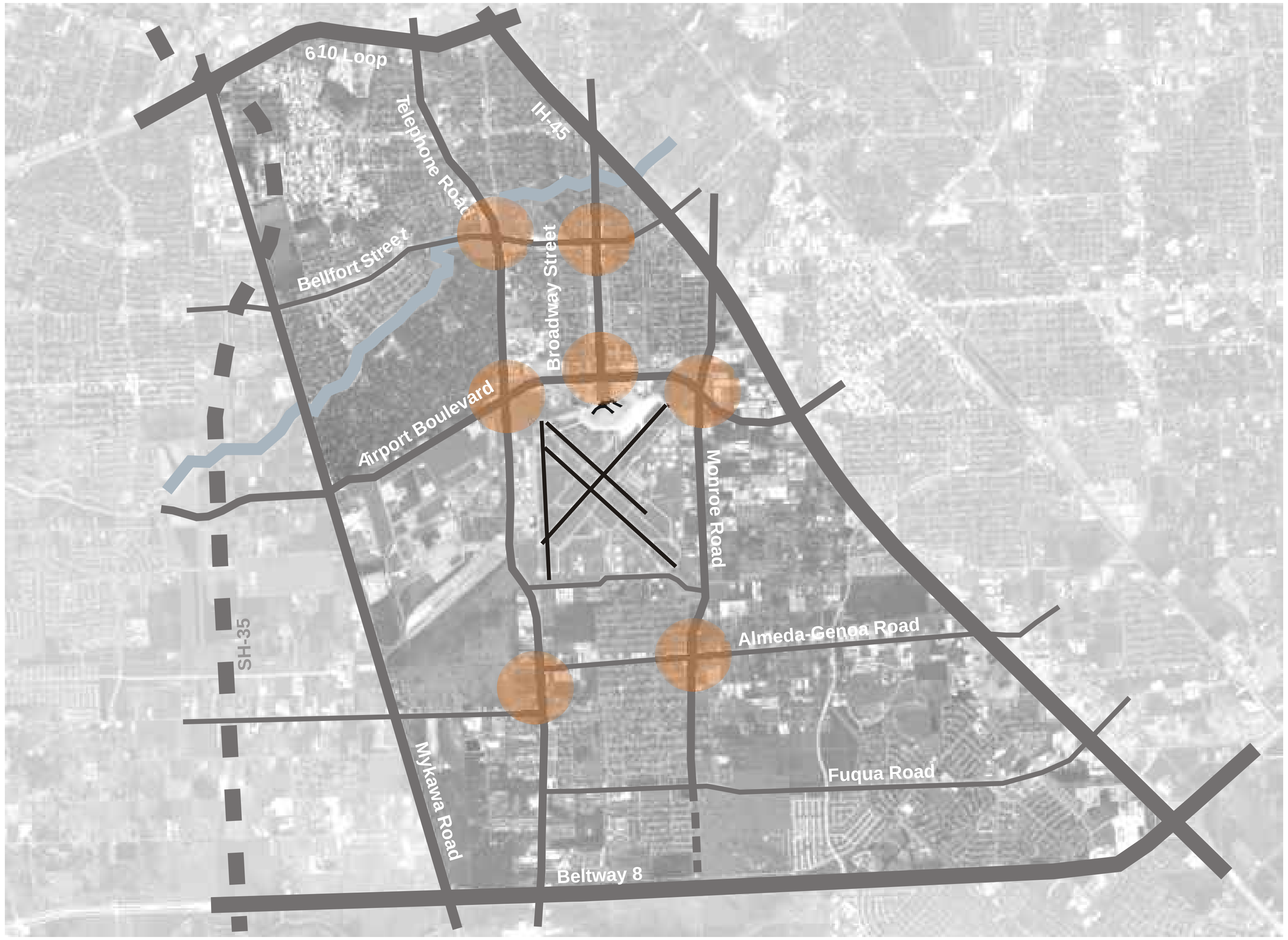


Figure 169
Street Intersections

0 1.15 mi. North

Street Intersections

Distinctive intersection design within immediate proximity of Hobby Airport could create visual and physical links between the airport and its surroundings. Focal design elements, special lighting, unique ground treatment, material changes, and wider building setbacks at intersections will announce the airport's presence.

Figures 170-172 present examples of paved intersections in Portland, Oregon.

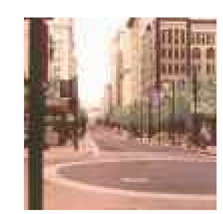


Figure 170
Portland, Oregon

Figure 171
Portland, Oregon

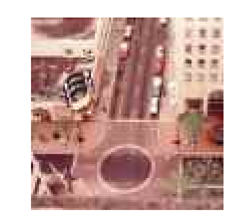


Figure 172
Portland, Oregon

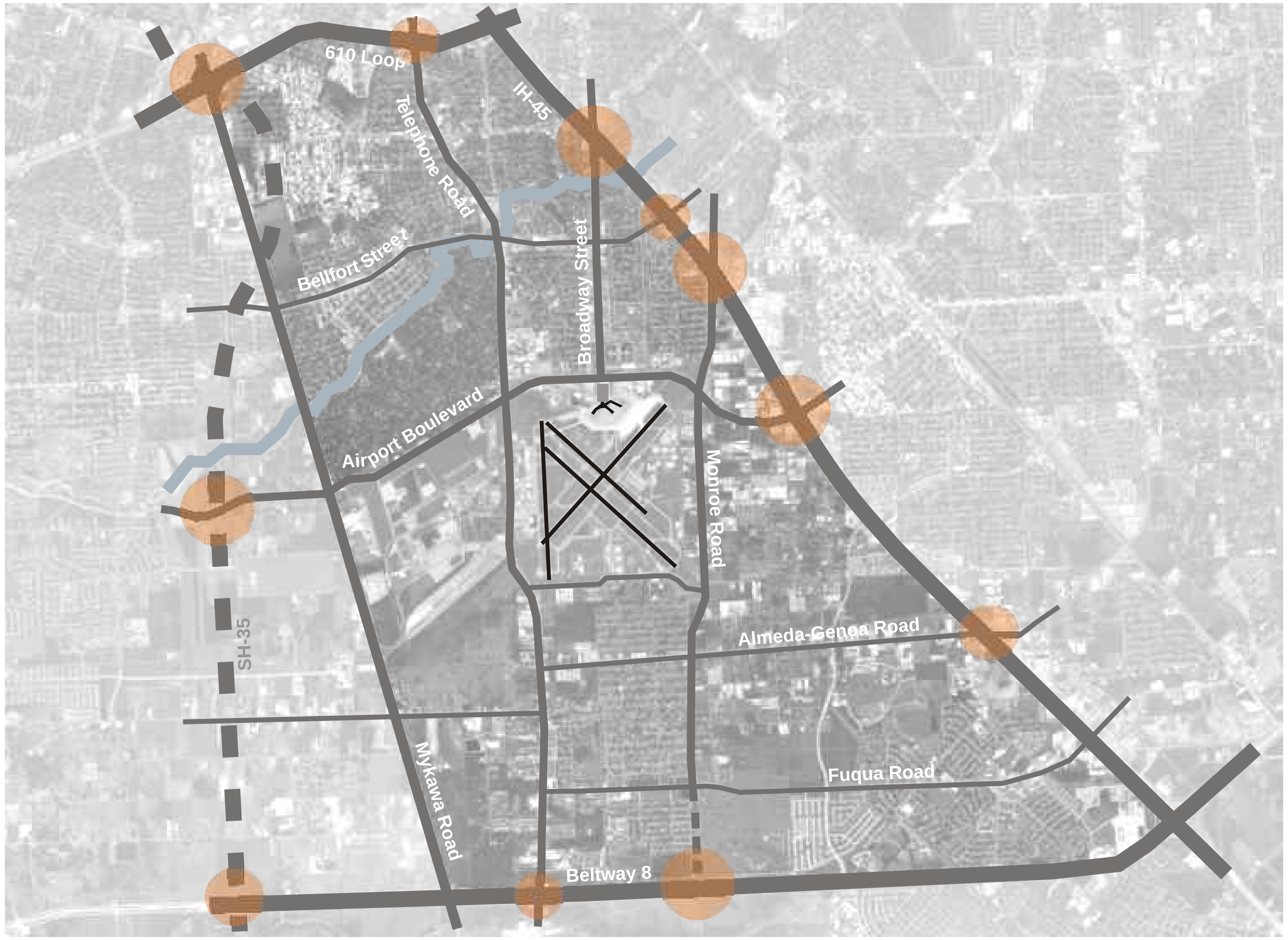


Figure 173
Highways and Interchanges

Highways and Interchanges

The planned SH-35 extension in the West, in addition to the 610 Loop, IH-45 and Beltway 8, present unique opportunities of creating multiple access corridors and gateways to Hobby Airport. However, these multiple entrances can only work to the airport's advantage if the exits at the freeways are designed to announce and celebrate the presence of a major activity hub–Hobby Airport.

Opportunities exist to enhance the freeway experience during the day through landscape elements, and at night, through lighting design. In addition to the use of design elements, a removal program for the distracting billboards that line the exits and frontage property should be implemented.

As documented on page 3.3.10 of the Facts section, TxDOT is in the process of completing a landscaping theme that utilizes palm trees along the junction of IH-45 and Beltway 8. This concept could possibly be extended northward, to accentuate the interchanges along IH-45.

A detailed urban design plan must address every element within the public right-of-way, in order to achieve a sense of continuity.

Elements described in this section include tangible objects such as trees and lighting, as well as form-giving and thought-provoking elements such as ground plane treatment, formal and informal space, and legibility.

This section is intended to provide a range of possibilities, as and when the framework plan is implemented over time.

Design Elements

This general list of design elements should be given consideration to create a distinctive **sense of identity** within the AOI.

It is intended to provoke thought to substantiate the framework plan described in the previous section.

1 Streetscape

- Ground plane treatment
- Lighting
- Utility elements
- Traffic signals
- Street furniture
    - Transit stops / vending machines
    - Information kiosks
    - Seating
    - Waste receptacles
- Signage
- Public art
- Billboards
- Intersections / crosswalks
- Temporary furniture

2 Buildings

- Façade
- Set backs
- Heights
- Servicing

3 Other Elements

- Space
    - Public / private
- Form
- Movement
- Edge

4 Maintenance

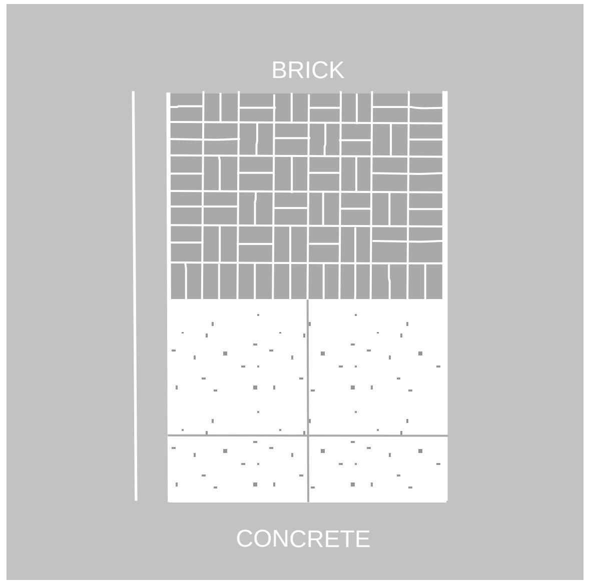


Figure 174
Ground Plane Treatment

Figure 175
Ground Plane Treatment - Trees to Separate Zones

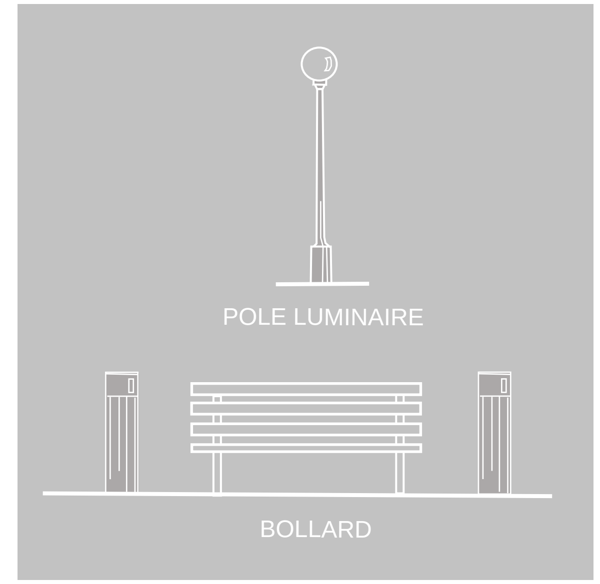


Figure 176
Lighting

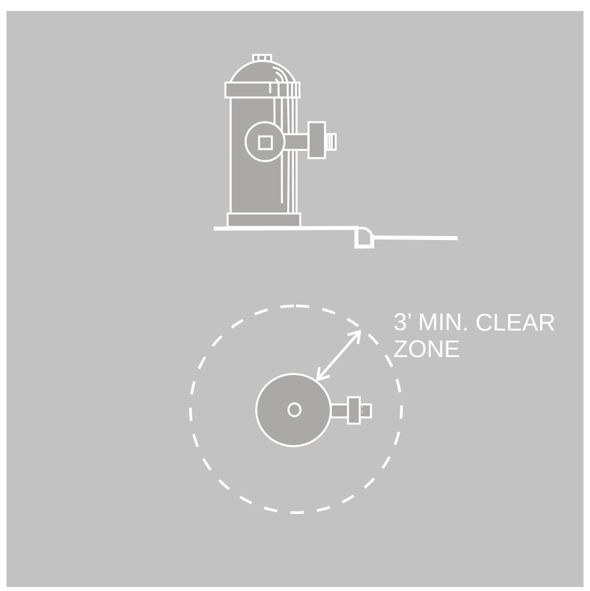


Figure 177
Utility Elements

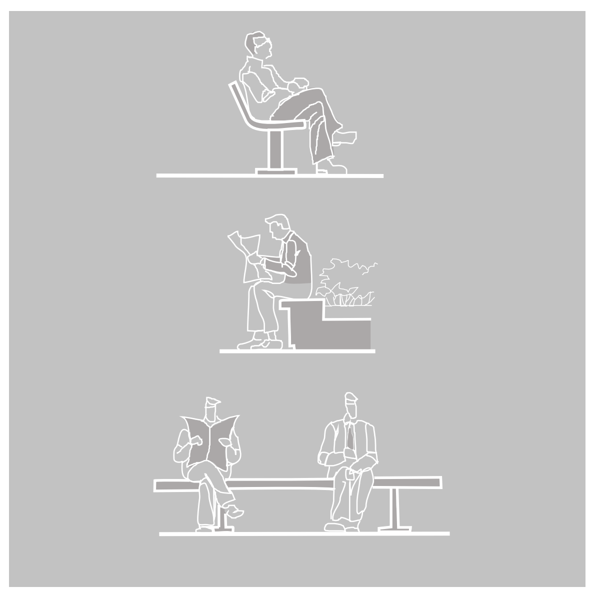


Figure 178
Street Furniture

Figure 179
Signage

Streetscape is comprised of a family of elements that implement a unified theme and contribute to the street scene. These elements are briefly described below:

Ground Plane Treatment should provide visual richness and color/contrast, spatial definition, and scale to the hard urban environment. Trees should provide shade from the hot summer sun, reduce glare, act as wind breakers, reduce pollution, screen undesirable views, and separate pedestrian movement from vehicular flow.

Lighting should provide safe conditions for vehicles and pedestrians, supporting a perception of safety and security while facilitating traffic flow. It should be used to emphasize intersections and open space, and to punctuate areas or objects of interest.

Utility Elements such as signal boxes, high-tension wire poles, and directional signage should be designed to minimize the disruption of pedestrian movement and visual access. The design and location of these elements should be in sympathy with their surroundings.

Traffic Signal standard design should be compatible with the character of the street, streetscape, and sidewalk elements.

Street Furniture character will vary from location to location within the Area of Influence. Designs should address transit stops, vending machine and information kiosks, seating, waste receptacles, and bollards.

Signage includes the design of all levels of information systems and should be coordinated, efficient, orderly, flexible, and expandable. The signs should also encourage a specific theme that characterizes the AOI and complements the interior design theme of Hobby Airport.

Source: Llewelyn-Davies Sahni, Inc.
Prepared by: Llewelyn-Davies Sahni, Inc., January 2003

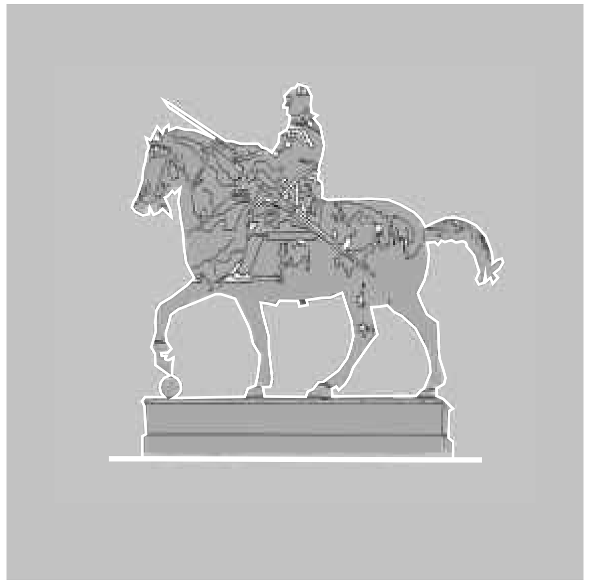


Figure 180
Public Art

Figure 181
Billboards

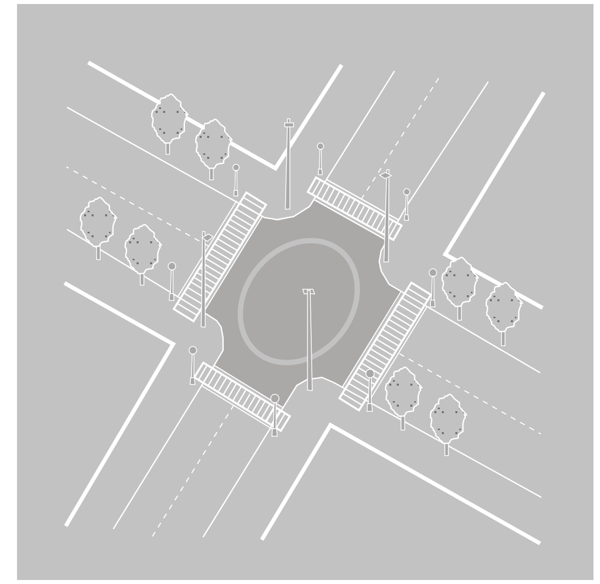


Figure 182
Intersections and Crosswalks

Figure 183
Temporary Furniture

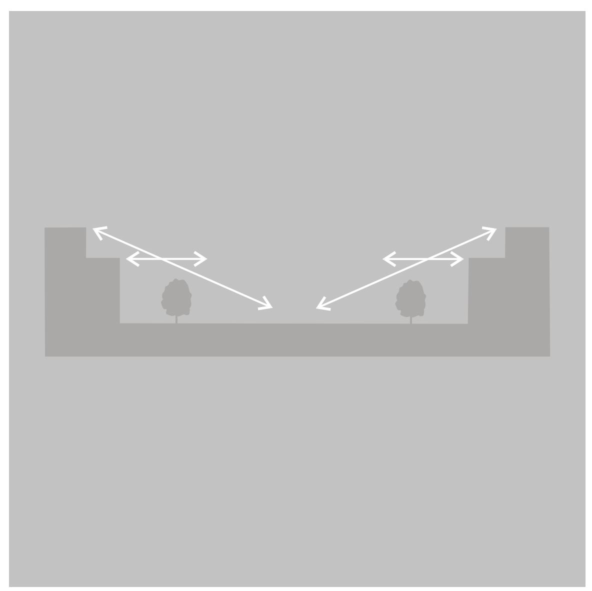


Figure 184
Building Controls

Public Art encompasses permanent as well as temporary work, and should be encouraged to enrich the character of the Area of Influence. It should not hinder pedestrian movement and keep visual corridors open for vehicular safety.

Billboards, wherever possible, should be disallowed within a certain distance of the street right-of-way. Billboard messages should be controlled, and billboard sizes and shapes should be subservient to the theme of the area.

Intersections and Crosswalks should provide visual caution to pedestrians and motorists, related to their conflicts in movement. The design should reflect a pedestrian scale.

Temporary Furniture such as traffic barricades, are actually permanent except for their location, and should be designed specifically for the AOI. Rather than the standard TxDOT appearance, the furniture should have a deliberate, unified style and contain the same thematic design approach as other objects or signage within the area. In addition to traffic barricades, temporary furniture includes roadblocks, barriers, orange barrels, caution lights, and various other advisory or deterrent devices.

Building Controls regulate façades, building heights, and setbacks. Buildings developed on the ceremonial street should have focal architecture façades and intersections and vistas should be emphasized by use of special façade treatment. Building heights and setbacks should also complement the character of the street.

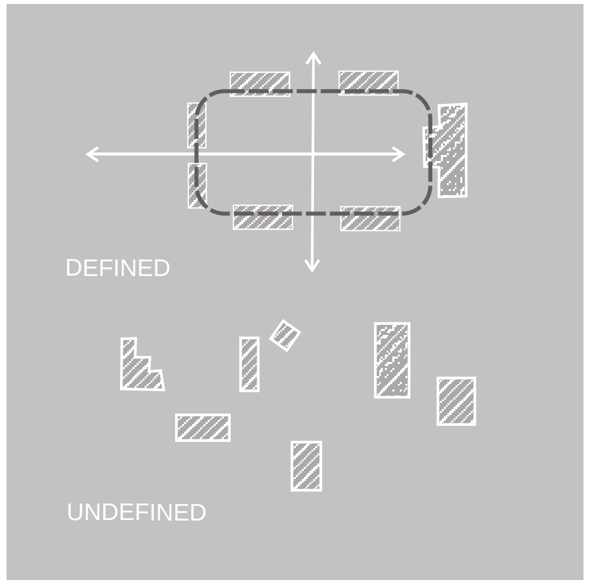


Figure 185
Space

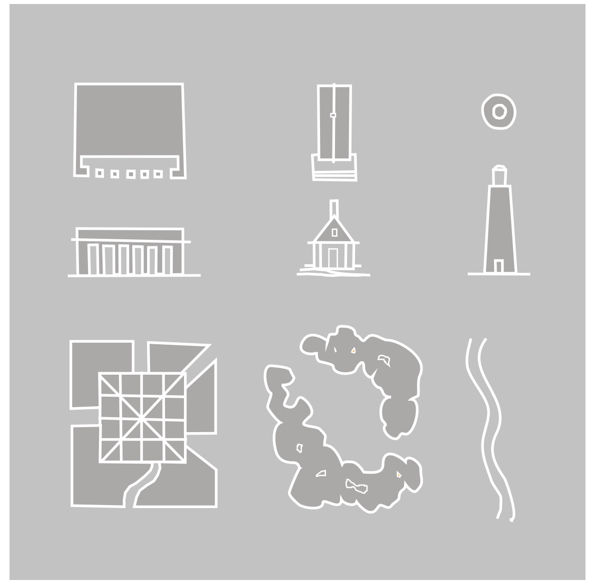


Figure 186
Form

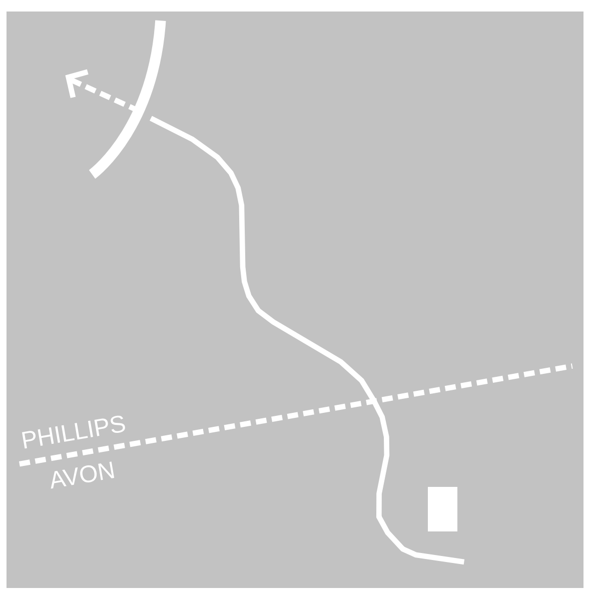


Figure 187
Movement

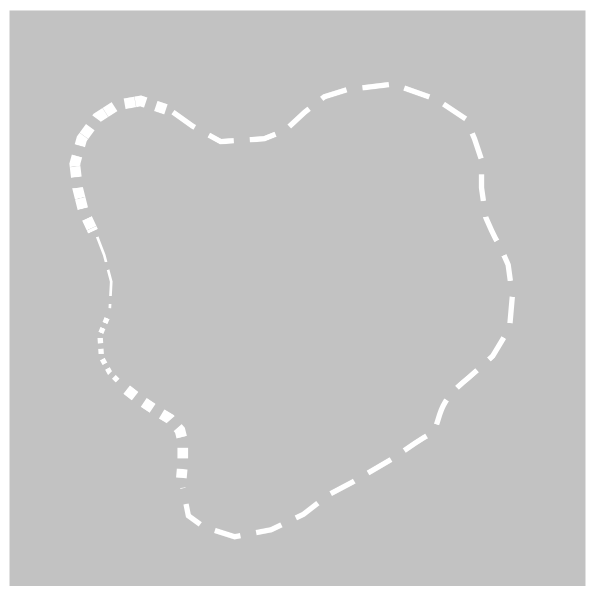


Figure 188
Edge

Space is the medium through which our senses are awakened, where the quality of light and scale depend on our perception of the spatial boundaries defined by elements of form. Where possible, (public / private) space should be designed in response to traffic movements .

Form is not only three-dimensional mass or volume, but a principle that gives unity to the whole. Through form and shape, a space can be captured and molded into an experience that will remain in the memory long after the visit, inspiring the visitor to repeat the experience.

Movement determines the particular way in which a place is experienced. Whether strolling down a winding garden path or glimpsing a courtyard beyond a row of buildings, the transitions from one space to another and the order in which the experience occurs, these transitions are all governed by elements that influence movement.

Edges are boundaries that define zones and nodes of interest, guiding the user through a space and revealing new experiences as the edge shifts and changes.

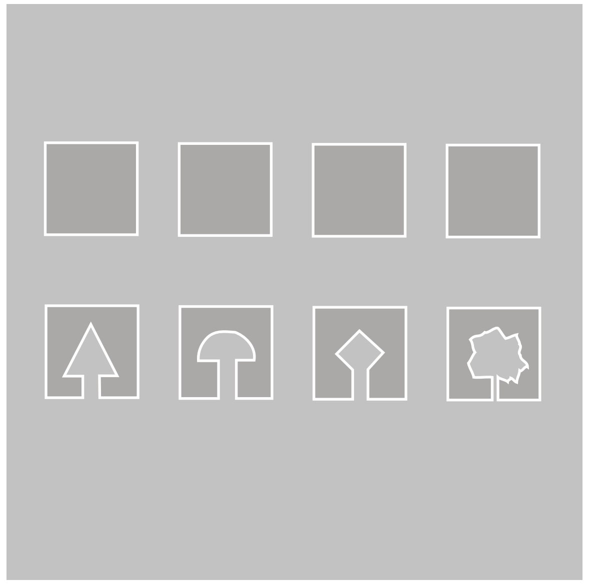


Figure 189
Legibility

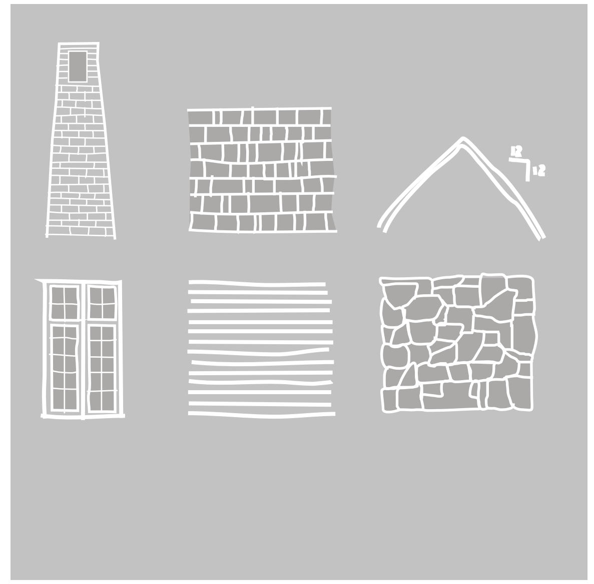


Figure 190
Materials

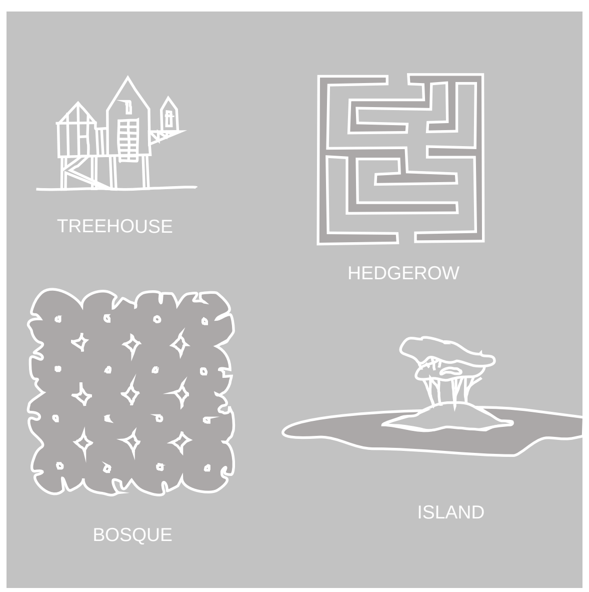


Figure 191
Fantasy

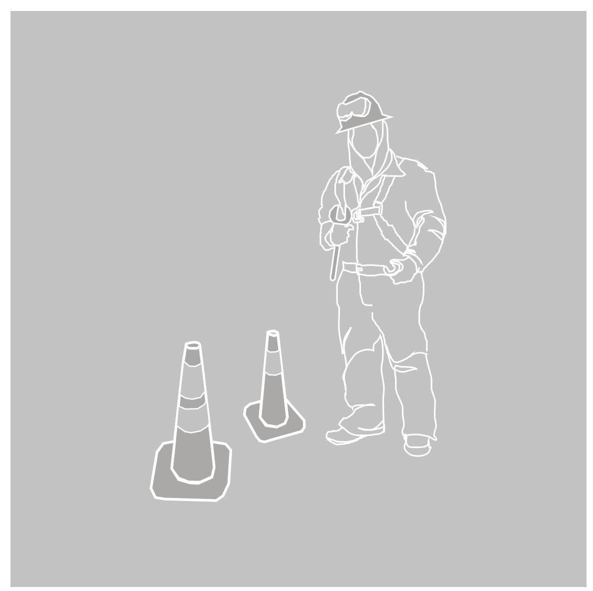


Figure 192
Maintenance

Legibility provides a sense of comfort and recognition as the user moves through spaces. While well-defined, consistent signage is the essential basis to legibility, other characteristics such as unique landscape elements and a refined palette of **materials** enables the observer to distinguish and recognize distinct surroundings.

Fantasy is the playful, imaginative ingredient that makes a place unique and memorable. The element of fantasy transports the observer to a different world, speaking to the child within the individual and infusing the space with compelling allure. It is this unusual appeal that creates an entire personality for a place, allowing the user to immediately recognize and relate to it.

Identity is the distinctive character that is produced by coordinating and arranging all of the elements listed above. And upon recognizing this identity, users feel a great **sense of presence**, complete and timeless.

Maintenance is a vital component to the survival of any place and must be continued with the utmost respect and commitment to quality in order to preserve the exceptional place that has been conceived and realized through these design elements.

Figure 193
Black Cherry

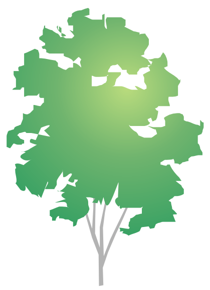


Figure 194
Live Oak

Figure 195
Shumard Oak

Figure 196
Cedar Elm

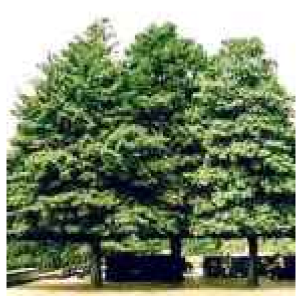


Figure 197
American Holly

Figure 198
Crape Myrtle

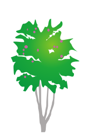
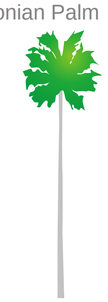


Figure 199
Washingtonian Palm



The chart below presents a list of trees that can be used in downtown Houston. To the left, a pallette of trees was chosen to be used within the AOI in order to provide a pleasant variety of color, shape, and scale. Other considerations were practical application to the area, ability to provide shade, and relatively low maintenance requirements.

		Sun	Partial Sun	Shade	Wet	Medium Wet	Dry	Fast Growth	Med. Growth	Slow Growth
Street Trees										
Cedar Elm	Ulmus Crassifolia	●					●			●
Live Oak	Quercus Virginiana	●	●			●				●
Shumard Oak	Quercus Shumardii	●	●			●			●	
Small Trees										
Crape Myrtle	Lagerstroemia Indica	●				●		●		
Mexican Plum	Prunus Mexicana	●				●				●
Texas Redbud	Cercis Canadensis 'Texana'			●		●			●	
Shrubs										
Dwarf Crape Mrytle	Lagerstroemia Indica 'Dwarf'	●				●		●		
Dwarf Nandina	Nandina Domestica 'Dwarf'		●			●		●		
Glossy Abelia	Abelia Grandiflora		●			●		●		
Indian Hawthorn	Rapholepsis Indica		●			●			●	
Rosemary	Rosemarinus 'Prostrate'	●					●		●	
Texas Mountain Laurel	Kalnia Latifolia	●	●	●		●	●			●
Texas Sage	Cenezia Spp.	●					●		●	
Yaupon	Ilex Vomitora	●				●			●	
Ground Covers										
Asian Jasmine	Trachelospermum Asiaticum	●	●	●	●				●	
Liriope	Liriope Muscari			●		●		●		
Monkey Grass	Ophiopogon Spp.			●		●		●		
Vines										
Boston Ivy	Parthenocissus Pricuspidata		●			●		●		
Carolina Jessamine	Gelsemium Sempervirens	●				●		●		
Fig Vine	Ficus Pumila			●		●				●
Annuals										
Begonia	Begonia Semperflorens Spp.	●	●		●			●		
Pansy	Viola Spp.	●			●			●		
Sand Verbena	Verbena Tenera	●					●	●		
Perennials										
Autumn Sage	Salvia Greggii	●				●			●	
Frikarti Aster	Aster 'Frikarti'	●	●			●		●		
Lantana	Lantana Spp.	●				●	●	●		

Detailed guidelines ensure that the original intent and quality standards of the Hobby Airport Master Plan and Image Plan will be conveyed to the individual design teams working within the 20-year period.

Mandatory guidelines have a geographical coverage of the total Area of Influence and include issues such as size, location, materials and performance.

Discretionary guidelines are devised for specific areas and include issues such as theme, form, emphasis and character.

Outline of Mandatory/Discretionary Guidelines

Mandatory Guidelines comprise the minimum criteria for physical elements, as well as minimum performance standards required for the range of streetscape improvements suggested for the project.

Discretionary Guidelines comprise the design criteria, including the range of materials and performance standards suggested for specific areas. These guidelines exemplify the appropriate direction for final design decisions and will be devised for the following specific areas:

- **Thematic Areas** have sufficiently homogeneous physical or functional characteristics for designers to consider concepts which promote a unifying theme.
- **Cohesive Sub Areas** encompass parts of street intersections or public spaces and may have a combination of physical and spatial qualities, giving them a cohesive character which might inform design decisions.
- **Compatibility Zones** comprise the interface of separate design packages, where potential conflict is anticipated. These issues can be minimized by placing due importance on the relationships between spaces with different characteristics, as well as setting up a review system to settle any potential conflicts.

This section identifies controls and design principles that should be defined at a detailed level before implementation of the Image Plan takes place. Also included is a flowchart that outlines the basic steps of the Image Plan implementation strategy, in addition to a detailed outline of the framework development process.

Implementation: Ways & Means

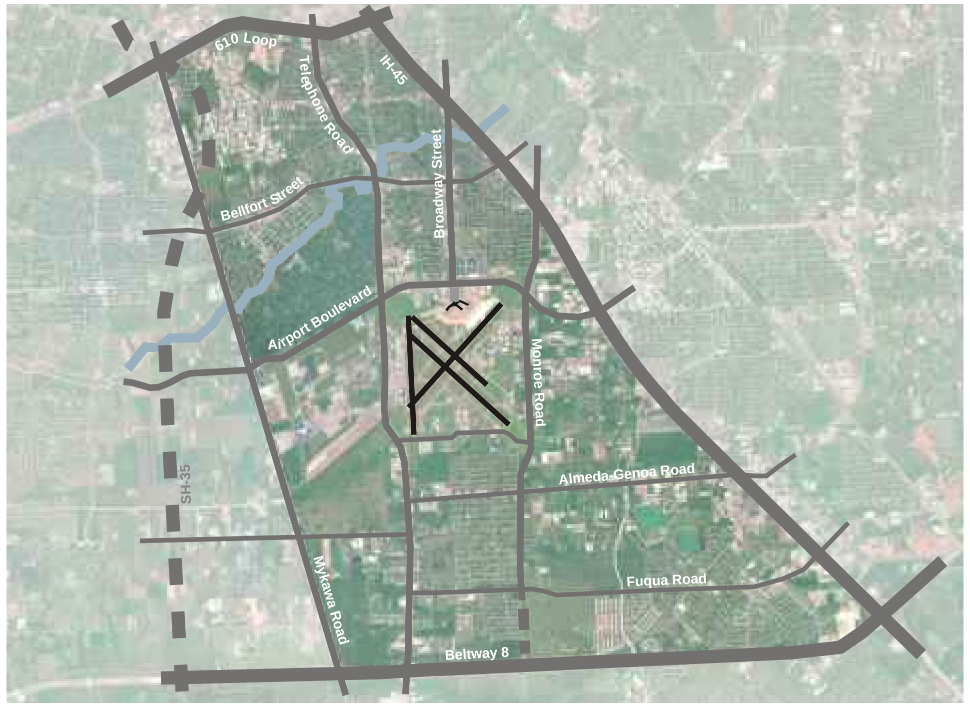


Figure 200
Area of Influence

Due consideration should be given to the following issues when before the Image Plan is implemented:

- **Distracting Billboards**-
  To achieve a change in character of the AOI, a policy related to billboards needs to be established. The policy should address:
  - Size
  - Content
  - Location
- **Revitalization & Redevelopment**-
  To achieve desired development that compliments airport related activities, public policy that encourages and provides financial incentives will have to be adopted by an authority such as "Special District" or the Tax Increment Reinvestment Zone.
- **Scenic Districts**
  This tool can be used to implement an established theme for the Area of Influence, similar to Harris County Improvement District #1 (HCID#1). This district has successfully changed the face of the Galleria / UPTOWN area over the last 10 years.
- **Dilapidated Property**
  Certain City of Houston laws provide for the condemnation of property. Strict enforcement of these laws is suggested. In order to avoid hardship on property owners, low-interest loans should be made available to owners that are willing to improve the quality of their property.
- **Insufficient ROW**
  Where absolutely necessary, in order to meet traffic capacity needs and the goals of the Image Plan, additional ROW should be acquired.
- **Federal/State/City/Public Programs**
  A number of programs allow various agencies to provide resources for improving public infrastructures as well as private property.
- **Level of Control**
  Control over development should be exercised with a high level of discretion. The private marketplace should be enticed to exercise control to experience economic gain.
- **Meeting the Market Place**
  Anticipated changes in the marketplace should be addressed in the implementation of the Image Plan.
- **Level of Quality**
  The Image Plan should aspire to achieve the highest level of quality permitting Hobby Airport to compete with any domestic or international airport.
- **Impermanent Elements**
  Temporary improvements and signage should project an image of completeness.
- **Capital Improvements**
  Coordination by a special body, such as an Airport Commission, has the potential for earning the best return for every public dollar available for the Area of Influence.

The purpose of the following diagrams is to establish a general procedural framework to implement the plan and its components.

0 1.7 mi. North

Source: Llewelyn-Davies Sahni, Inc.
Prepared by: Llewelyn-Davies Sahni, Inc., January 2003

SEE ATTACHED CHART

ACTIONS	STEP 1	STEP 2	STEP 3	STEP 4
Detailed Design Framework (Physical)				
Acceptance of Plan of Action (Political)	Formation of Gateway Commission	Community Buy-In of Designated Gateway	City / County / TxDOT Private Sector Corporation	Inter-Jurisdiction Agreement
Grants / Community Development Funds (Funding)	Prepare Applications	Allocate Monies Received for Program		
Land Assembly (Asset Collection)	Identify Public / Private Funds to Assemble Key Parcels of Land	Create Development Corporation with Power to Sell Debt Instruments	Acquire Land	Redevelop Land

Figure 201
Implementation Flowchart

PROJECT KICK-OFF

- Assemble steering group and core client team
- Identify project manager
- Set project objectives
- Outline a strategy and its resource requirements

- Form a multidisciplinary project team
- Define the project in terms of program, responsibilities and authority delegations
- Establish overall objectives, scope of work and deliverables
- Define budgets and funding sources
- Estimate team inputs and prepare a program
- Decide lines of communication
- Encourage active community participation
- Establish review process for monitoring and control

- Project Program
- Project Development Plan
- Initial Project Proposals

(Deliverables)

CONTEXT

- Collate existing data and information
- Undertake site analysis and context appraisals
- Community Appraisal / Input
- Planning policy analysis / need changes
- Character appraisal
- Environment and landscape appraisal
- Movement analysis
- Market supply and demand assessment (market studies)
- Engineering feasibility
- Meet with stakeholders and seek local opinions
- Interact with agencies providing services
- Review of information

- Prepare analysis
- Undertake "Planning for Real" or design charette workshop as necessary
- Set design principles and objectives
- Agree the overall "vision" and initial concept ideas

- Project Appreciation and Definition Report
- Design Principles, Objectives, Vision and initial concept ideas

(Deliverables)

URBAN STRUCTURE

- Define assessment criteria
- Confirm base case
- Generate options (if necessary)
- Evaluate options
- Establish preferred approach
- Present deign rationale to client team / community forum (depending on project scope)

- Outline proposed development form, content and mix
- Elaborate the plan
- Undertake environmental, community and traffic impact assessment and financial appraisals
- Prepare urban design guidelines
- Define delivery mechanisms
- Review project (internal and community)

- Draft Master Plan
- Possible outline planning application / development agreement / impact assessments (environment, community, traffic, etc.), financial appraisal

(Deliverables)

DETAILING THE PLACE

- Identify priorities (short/long term)
- Prepare Action Plan and program
- Focus detailed design development and feasibility on priority projects

- Progress detailed Master Plan:
  - Area plans
  - Three-dimensional imagery
  - Site-specific and thematic urban design program
- Detail delivery mechanisms and program

- Detailed Master Plan
- Design guides or codes
- Development program
- Action plan

(Deliverables)

FOLLOWING UP

- Confirm implementation and management arrangements
- Formally adopt Master Plan / program
- Promote / market proposals
- Sustain community involvement
- Create media interest

- Formalize design review mechanism
- Monitor project implementation against design principles, objectives and Master Plan intentions
- Agree on updating procedures

- Implementation strategy
- Individual project proposals
- Implementation reports

(Deliverables)

Figure 202
Design Framework Flowchart

This background research was collected at the outset of the Image Plan study and was used as a tool throughout the design process. The information was used to compare and contrast how different domestic and international cities utilize design elements to improve function, circulation, and overall experience. These design elements reinforce a city's identity and many serve as an abstract chronicle of the city's history and culture.

Background Research

Figure 203
1. Midway Airport - Chicago, Illinois

Figure 204
2. Salt Lake City International Airport - Salt Lake City, Utah

Figure 205
3. TF Green Airport - Providence, Rhode Island

Figure 206
4. TF Green Airport - Providence, Rhode Island

Figure 207
5. San Francisco International Airport - San Francisco, California

Figure 208
6. Norfolk Virginia Airport - Norfolk, Virginia

Figure 209
7. Las Ramblas - Barcelona, Spain

Figure 210
8. Champs-Elysees - Paris, France

Figure 211
9. Chicago, Illinois

Figure 212
10. New York City, New York

Figure 213
11. La Pantiero - Cannes, France

Figure 214
12. Portland, Oregon

Other Airports

More and more airports across the United States are making a concerted effort to revitalize and enhance their images through the use of architecture, landscaping, lighting, signage, and artwork.

Primary Access Arteries

Streets are more than public utilities and linear physical spaces that allow people to move from here to there. They moderate the form, function, comfort and identity of the urban community and serve as the communication links that unify the three key urban elements: people, architecture, and transportation. They can focus people's attention on points of interest, define edges and boundaries, and give an entire city its unique identity. Some of the ingredients to great streets are as follows:

- Automobile and Transit-Supportive
- Generous Spaces for Pedestrians-Spacious Sidewalks, Setbacks
- Elements for Physical Comfort: Shade or Sunlight, Street Furniture
- Qualities that Engage the Eyes: Movement of Trees and People
- Transparency: Trees, Windows
- Maintenance
- Quality of Construction and Design

Source: Great Streets, by Allan Jacobs, Dinodia.com, getmarketingright.com, Figures 203-206 Courtesy of HNTB Corporation and Hedrich-Blessing Photography
Prepared by: Llewelyn-Davies Sahni, Inc., January 2003

Figure 215
1. Champs-Elysees - Paris, France

Figure 216
2. Las Ramblas - Barcelona, Spain

Figure 217
3. San Francisco, California

Figure 218
4. Galveston, Texas

Figure 218
5. Houston, Texas

Figure 219
6. Dallas, Texas

Figure 220
7. Westbury Square, Texas

Figure 221
8. Las Ramblas - Barcelona, Spain

Figure 222
9. Frankfurt, Germany

Figure 223
10. Chicago, Illinois

Figure 224
11. St. Peter's Square - Rome, Italy

Pedestrian Paths of Circulation

Pedestrians are the essential ingredient to any street's character. They are the energy, the movement, the vitality of the space. In order to be inviting and lively, pedestrian circulation routes must have a quality and level of detail that compliments the human scale. Paving patterns and types are especially important to define spaces and create boundaries and layers for pedestrians. In addition to paving, signage, landscaping, street furniture, artwork and lighting must all be combined in order to create good pedestrian paths.

Open Space and Plazas

Open spaces facilitate interaction between people, provide people with places to congregate, and create opportunities for public art, and unique lighting and landscaping. They are the activity nodes and energy hubs of any distinctive place and they are create a focal point that serves either as a point of departure or as a terminus.

Source: Llewelyn-Davies Sahni, Inc., Dinodia.com, getmarketingright.com, Figure 215 Courtesy of Project for Public Spaces, Inc., www.pps.org
Prepared by: Llewelyn-Davies Sahni, Inc., January 2003

Figure 225
1. Nathan Road - Kowloon, Hong Kong

Figure 226
2. Dempster Highway - Yukon, Canada

Figure 227
3. Athens, Greece

Figure 228
4. Norfolk Virginia Airport

Figure 229
5. Haparanda, Sweden

Figure 230
6. Beale Street -Memphis, Tennessee

Figure 231
7. Ronda de Dalt - Madrid, Spain

Figure 232
8. Paris, France

Signage

Oftentimes, signage is over-used and under-designed. People are so overwhelmed by the varying, distracting signage, that they loose focus and can not prioritize the information presented.

A cohesive signage strategy defines a place by establishing a consistent standard for the way information is presented and by avoiding visual clutter and confusion. Once this standard is in place, a hierarchy can be created that will emphasize and organize appropriate landmarks, circulation routes and points of interest for better way-finding.

Source: Llewelyn-Davies Sahni, Inc., Great Streets, by Allan Jacobs, Dinodia.com
Prepared by: Llewelyn-Davies Sahni, Inc., January 2003


Figure 233
1. Maremagnum - Barcelona, Spain


Figure 234
2. Portland, Oregon


Figure 235
3. Berlin, Germany


Figure 236
4. Frankfurt, Germany


Figure 237
5. KIO Towers - Madrid, Spain


Figure 238
6. Statue of Poseidon -Goteborg, Sweden


Figure 239
7. Portland, Oregon


Figure 240
8. Chicago, Illinois


Figure 241
9. Plaza Mayor - Madrid, Spain


Figure 242
10. Merlion - Singapore


Figure 243
11. Eiffel Tower - Paris, France

Public Art

Public art and sculpture have always brought definition, character and vitality to a space. The more colorful, tasteful and dramatic the artwork, the more engaging and lively the place becomes. In addition, the artwork can be functional, as well as aesthetic, such as street furniture, light poles, and signage. Public Arts Projects have been undertaken for many major airports in the Unites States, including Miami International Airport, Los Angeles International Airport, Washington National Airport, Pittsburgh International Airport, San Francisco International Airport, Denver International Airport, San Digo International Airport and Seattle International Airport.

Landscaping

Trees can transform a street more easily than any other physical improvement. Trees provide shade for comfort, oxygen, and modulated light. An appropriate rhythm of trees also offers a transparent, but distinctive edge to the street, while screening possible unwanted views and frontages. Furthermore, trees are an effective layer that separates and protects pedestrians from automobiles. According to Allan Jacobs, author of Great Streets, the most effective expenditure of funds to improve a street would be on trees.

Small flowering trees and shrubs are also important to provide color and vibrance to a street. The organization of these elements should be strategically placed at intersections, entrances and focal points in order to enhance the aesthetic quality of the street.

Figure 244
1. Office Tower - Vancouver, Canada

Figure 245
2. Champs-Elysees - Paris, France

Figure 246
3. Hillcrest Area - San Diego, California

Figure 247
4. Kinkaku-Ji - Kyoto, Japan

Figure 248
5. Norfolk Virginia Airport

Figure 249
6. Westin Regina Hotel - Baja California, Mexico

Figure 252
8. Stock Exchange - Mexico City, Mexico

Figure 253
9. Church of Santa Maria - Zaragosa, Spain

Figure 250
7. Tremoureax House - California

Figure 251
8. Tofuku-Ji Temple - Kyoto, Japan

Source: Llewelyn-Davies Sahni, Inc., Great Streets, by Allan Jacobs, Dinodia.com
Prepared by: Llewelyn-Davies Sahni, Inc., January 2003

Lighting

Like trees, street lights form lines through the rhythmic regularity of their placement along a street. The best streetlights are well-designed to be distinctive and unique, offering a sense of comfort and safety, as well as character and identity to the street. At night, spaces can be transformed into exciting, dramatic scenes and backdrops through deliberate lighting enhancements, drawing attention to focal points.

Figure 254
1. Arch of Santa Catalina - Guatemala

Figure 255
2. Big Ben - London, England

Figure 256
3. Eiffel Tower - Paris, France

Figure 257
4. Senate Square - Helsinki, Finland

Figure 258
5. Gran Via - Madrid, Spain

Figure 259
6. NASDAQ Building - New York City, New York

Figure 260
7. Opera House - Sydney, Australia

Figure 261
8. Norfolk Virginia Airport - Norfolk, Virginia

Figure 262
9. Golden Gate Bridge - San Francisco, California

Figure 263
10. AlHambra - Granada, Spain

Figure 264
1. Sultan's Palace - Singapore

Figure 265
2. New York City, New York

Figure 266
3. Riena Maria Cristina Avenue
Barcelona, Spain

Figure 267
4. Arc de Triomphe - Paris, France

Views and Axes

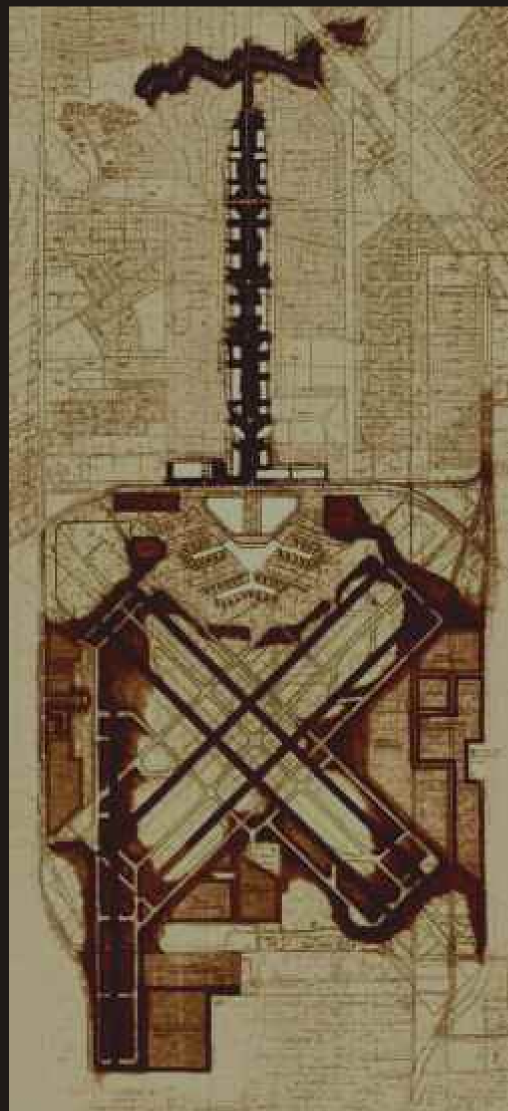
Most great streets have notable points of origination and termination, whether it be a distinct sculpture, grand monument, or celebrated open space or plaza. These ending and beginning nodes give aesthetic character and definition to the street, while also improving the function of the street by providing a sense of direction and destination, a bearing point from which people may gauge their location, as well as a focal point to engage the eye of people moving towards it.

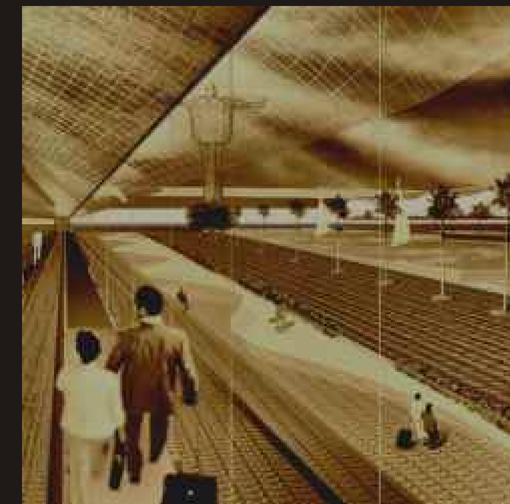
Figure 268
5. Mangia Tower - Siena, Italy

Figure 269
6. Naples, Italy

Figure 270
7. St. Peter's Basilica - Rome, Italy

Source: Llewelyn-Davies Sahni, Inc., Great Streets, by Allan Jacobs, Dinodia.com
Prepared by: Llewelyn-Davies Sahni, Inc., January 2003





Acknowledgements

City of Houston

Harris County Parks Department

METRO

Texas Department of Transportation

Trees for Houston

Scenic Houston

The Park People

Port of Oakland

Freedman Tung & Bottomley

Ted Tokio Tanaka Architects

Studio of Richard Jeter

Appendix I

Master Plan Projects Cost Estimates

William P. Hobby Airport
Houston, Texas

Master Plan - Airport Development Plan Phasing

Preliminary Rough Order of Magnitude Estimates

September 12, 2014

Prepared by:

Connico Incorporated
2594 N. Mount Juliet Road
Mount Juliet, TN 37122

Prepared for:

Ricondo & Associates, Inc.
909 Lake Carolyn Parkway, Suite 850
Irving, TX 75039

Nashville • Cincinnati

September 12, 2014

Dr. Max Kiesling, Director
Ricondo & Associates, Inc.
909 Lake Carolyn Parkway, Suite 850
Irving, TX 75039

Ms. Eliane Grayer, Managing Consultant
Ricondo & Associates, Inc.
20 North Clark Street, Suite 1500
Chicago, IL 60602

RE: Airport Development Plan Phasing
William P. Hobby Airport
Houston, Texas
Preliminary Rough Order of Magnitude Estimates

Dear Max/Eliane:

We are pleased to present the Preliminary Rough Order of Magnitude Estimate for the referenced projects. The Preliminary Rough Order of Magnitude Estimates have been drawn from information as noted in Exhibit A. Included within the report are our Estimate Notes, which outlines the criteria that were used to produce the estimate.

We appreciate the opportunity of working with you on this project. Should you have any questions or need additional information, please contact us at your convenience.

Sincerely,
CONNICO INCORPORATED

Derek L. Brown, CCP, CPE, LEED AP BD+C
dlbrown@connico.com
Vice-President, Senior Cost Estimator

Attachment
File No. 3537.13 HOU Master Plan ADP Phasing – ROM Cost Estimate Report 2014.09.12

TABLE OF CONTENTS

EXECUTIVE SUMMARY

TASK OUTLINE

- Ricondo & Associates, Inc. retained Connico Incorporated as cost consultants to provide an opinion of probable cost for the Airport Development Plan Phasing at the William P. Hobby Airport in Houston, Texas. The estimate was based on the information noted in Exhibit A of this report.

- In providing opinions of probable construction cost (cost estimates), the Client understands that the Consultant has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that the Consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, express or implied; that the bids or the negotiated cost of the Work will not vary from the Consultant's opinion of probable construction cost.

- The Opinion of Probable Cost has been prepared based on information prepared/provided by others. Connico has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions that may be incorporated as a result of erroneous information provided by others.

PROJECT DESCRIPTION

- This preliminary rough order of magnitude planning estimates include the following project components:

PHASE 1 (2014-2016)

- GA/CBO Development in South Quadrant
- Roadway / Intersection Improvements – Airport / Telephone
- Roadway / Intersection Improvements – Airport / Monroe
- Roadway / Intersection Improvements – Airport / Glencrest
- Long-Term Parking Access Road Improvements
- CRCF Enabling - West Terminal Area Roadways

PHASE 2 (2017-2019)

- CRCF Enabling - Temporary Relocation of Rental Car Facilities (during ConRAC construction)
- CRCF Enabling - Relocation of Taxi Staging Area
- Consolidated Rental Car Facility
- West Concourse Expansion (7 gates, apron)

PHASE 3 (2020-2023)

- Construction of Hobby Cargo Building
- RWY 12L Upgrade - Signature Buildings Demo
- RWY 12L Upgrade - Jet Aviation South Hangars Demo
- RWY 12L Upgrade - Taxiway Construction
- RWY 12L Upgrade – Relocation of Main Deicing Pad
- RWY 12L Upgrade - Runway Construction
- RWY 12L Upgrade - Perimeter Road/Fence Realignment
- RWY 12L Upgrade – Partial Closure of W Monroe Rd and Freeland Street
- RWY 12L Upgrade - SWA Fuel Farm Boundary Changes
- Relocation of West Cell Phone Lot
- SWA Cargo & Provisioning Facility Demo and Parking Lot Expansion
- RWY 12L Upgrade - Obstruction Removal
- RWY 12L Upgrade - Navaids Installation (ALS, LOC, PAPI, GS)
- RWY 12R Displaced Threshold Removal

PHASE 4 (2024-2030)

- Terminal Expansion (on east side)

ESTIMATE NOTES

GENERAL

- Connico did not perform a site observation to assist in the preparation of this estimate.
- The Rough Order of Magnitude cost estimates have been developed using "cost per square foot" models based on other similar projects.
- The Rough Order of Magnitude Estimated Costs represent raw construction costs only. It is understood that markups and soft costs will be added to these raw construction cost by Ricondo.
- The estimate is costed on the understanding that there will be free and open competition at all levels of contracting, that there will not be a restricted bidders list either for general or trade contractors, that there will be at minimum three general contract bidders and at minimum three sub bids will be available for each trade involved. The Owner can facilitate these conditions by ensuring that the project is publicly advertised for bids in general circulation as well as trade publications where advertisements for bid are regularly posted, that prequalification requirements, if prequalification of either general or sub bidders is contemplated, are not unduly restrictive, and by maintaining good industry relations.
- The Opinion of Probable Cost is based on 3rd quarter 2014 dollars with no adjustment for escalation.
- Allowances included within the Opinion of Probable Cost are amounts the owner should expect to spend.
- The Opinion of Probable Cost does not include any allowance for fees normally attributed to the Owner such as Real Estate fees, Impact fees, Tap fees, etc.
- Temporary site storage, parking for contractor is assumed to be within the vicinity of the site.
- All impact fees to be paid by Owner.
- LEED requirements are not included.

ESTIMATE SUMMARY

TOTAL CONSTRUCTION COST SUMMARY

	DESCRIPTION	CONSTRUCTION YEAR		CONSTRUCTION COST
Phase 1 (2014-2016)	GA/CBO Development in South Quadrant	2015	$	25,500,000
	Roadway Intersection Improvements - Airport / Telephone	2015	$	1,250,000
	Roadway Intersection Improvements - Airport / Monroe	2015	$	1,750,000
	Roadway Intersection Improvements - Airport / Glencrest	2015	$	750,000
	Long-Term Parking Access Road Improvements	2015	$	1,500,000
	CRCF Enabling - West Terminal Area Roadways	2016	$	2,500,000
	PHASE 1 TOTAL - CONSTRUCTION COST		***$***	***33,250,000***
Phase 2 (2017-2019)	CRCF Enabling - Temporary Relocation of Rental Car Facilities	2018	$	4,200,000
	CRCF Enabling - Relocation of Taxi Staging Area	2018	$	2,000,000
	Consolidated Rental Car Facility	2019	$	76,570,000
	West Concourse Expansion (7 gates, apron)	2019	$	75,117,371
	PHASE 2 TOTAL - CONSTRUCTION COST		***$***	***157,887,371***
Phase 3 (2020-2023)	Construction of Hobby Cargo Building	2020	$	5,700,000
	Runway 12L Upgrade, Signature Buildings Demo	2021	$	2,900,000
	Runway 12L Upgrade - Jet Aviation South Hangars Demo	2021	$	1,400,000
	Runway 12L Upgrade - Taxiway Construction	2021-2023	$	30,700,000
	Runway 12L Upgrade - Relocation of Main Deicing Pad	2021	$	5,200,000
	Runway 12L Upgade - Runway Construction	2021-2023	$	32,300,000
	Runway 12L Upgrade - Perimeter Road/Fence Realignment	2022	$	1,100,000
	Runway 12L Upgrade - Partial Closure of W Monroe Rd and Freeland Street	2022	$	800,000
	Runway 12L Upgrade - SWA Fuel Farm Boundary Changes	2022	$	760,000
	Relocation of West Cell Phone Waiting Lot to Long-Term Parking Lot Expansion	2022	$	500,000
	SWA Cargo & Provisioning Facility Demo and Parking Lot Expansion	2022	$	2,500,000
	Runway 12L Upgrade - Obstruction Removal	2023	$	500,000
	Runway 12L Upgrade - Navaids Installation (ALS, LOC, PAPI, GS)	2023	$	5,200,000
	Runway 12R Displaced Threshold Removal	2023	$	675,000
	PHASE 3 TOTAL - CONSTRUCTION COST		***$***	***90,235,000***
Phase 4 (2024-2030)	Terminal Expansion (on east side)	2028	$	24,900,000
	PHASE 3 TOTAL - CONSTRUCTION COST		***$***	***24,900,000***
	MASTER PLAN PROJECTS - CONSTRUCTION TOTAL		***$***	***306,000,000***

CONNICO INCORPORATED

ESTIMATE DETAIL

Phase 1

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stag	Concept		
Project No.		**Revision**	3
Original Date	18-Nov-13	**Revision Date**	12-Sep-14
Assumed Bid Opening Date		**CI Project No.**	3537.13
Manager	DLB	**Checked by**	DLB

Runway 12L Upgrade - GA/CBO Development in South Quadrant

		DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
	CBO Hangar 1			35,000 sf	
	CBO Hangar 2			35,000 sf	
	CBO Hangar 3			35,000 sf	
	CBO Hangar 4			35,000 sf	
	CBO Hangar 5			35,000 sf	
	Apron			210,000 sf	
	Roadways			210,000 sf	
A	***SUBSTRUCTURE***				
	A10	Foundations			
		CBO Hangar 1	35,000 sf	$ 3.50	$ 122,500
		CBO Hangar 2	35,000 sf	$ 3.50	$ 122,500
		CBO Hangar 3	35,000 sf	$ 3.50	$ 122,500
		CBO Hangar 4	35,000 sf	$ 3.50	$ 122,500
		CBO Hangar 5	35,000 sf	$ 3.50	$ 122,500
	A20	Slabs on Grade			
		CBO Hangar 1	35,000 sf	$ 5.50	$ 192,500
		CBO Hangar 2	35,000 sf	$ 5.50	$ 192,500
		CBO Hangar 3	35,000 sf	$ 5.50	$ 192,500
		CBO Hangar 4	35,000 sf	$ 5.50	$ 192,500
		CBO Hangar 5	35,000 sf	$ 5.50	$ 192,500
	Subtotal Substructure				***$ 1,575,000***
B	***SHELL***				
	A10	Pre-engineered Structure, including façade and roof			
		CBO Hangar 1	35,000 sf	$ 35.00	$ 1,225,000
		CBO Hangar 2	35,000 sf	$ 35.00	$ 1,225,000
		CBO Hangar 3	35,000 sf	$ 35.00	$ 1,225,000
		CBO Hangar 4	35,000 sf	$ 35.00	$ 1,225,000
		CBO Hangar 5	35,000 sf	$ 35.00	$ 1,225,000
	Subtotal Shell				***$ 6,125,000***
C	***INTERIORS***				
	C10	Interior Finishes			
		CBO Hangar 1	35,000 sf	$ 20.00	$ 700,000
		CBO Hangar 2	35,000 sf	$ 20.00	$ 700,000
		CBO Hangar 3	35,000 sf	$ 20.00	$ 700,000
		CBO Hangar 4	35,000 sf	$ 20.00	$ 700,000
		CBO Hangar 5	35,000 sf	$ 20.00	$ 700,000
	Subtotal Interiors				***$ 3,500,000***

Runway 12L Upgrade - GA/CBO Development in South Quadrant

DESCRIPTION			QUANTITY	UNIT COST	TOTAL COST
C	***SERVICES***				
	C20	Fire Protection			
		CBO Hangar 1	35,000 sf	$ 3.50	$ 122,500
		CBO Hangar 2	35,000 sf	$ 3.50	$ 122,500
		CBO Hangar 3	35,000 sf	$ 3.50	$ 122,500
		CBO Hangar 4	35,000 sf	$ 3.50	$ 122,500
		CBO Hangar 5	35,000 sf	$ 3.50	$ 122,500
	C30	Plumbing			
		CBO Hangar 1	35,000 sf	$ 5.00	$ 175,000
		CBO Hangar 2	35,000 sf	$ 5.00	$ 175,000
		CBO Hangar 3	35,000 sf	$ 5.00	$ 175,000
		CBO Hangar 4	35,000 sf	$ 5.00	$ 175,000
		CBO Hangar 5	35,000 sf	$ 5.00	$ 175,000
	C40	HVAC			
		CBO Hangar 1	35,000 sf	$ 15.00	$ 525,000
		CBO Hangar 2	35,000 sf	$ 15.00	$ 525,000
		CBO Hangar 3	35,000 sf	$ 15.00	$ 525,000
		CBO Hangar 4	35,000 sf	$ 15.00	$ 525,000
		CBO Hangar 5	35,000 sf	$ 15.00	$ 525,000
	C50	Electrical			
		CBO Hangar 1	35,000 sf	$ 10.00	$ 350,000
		CBO Hangar 2	35,000 sf	$ 10.00	$ 350,000
		CBO Hangar 3	35,000 sf	$ 10.00	$ 350,000
		CBO Hangar 4	35,000 sf	$ 10.00	$ 350,000
		CBO Hangar 5	35,000 sf	$ 10.00	$ 350,000
	Subtotal Services				***$ 5,162,500***
E	***EQUIPMENT & FURNISHINGS***				
F	***SPECIAL CONSTRUCTION & DEMOLITION***				
G	***BUILDING SITEWORK***				
	G20	**Site Improvements**			
		G2010 Apron area	210,000 sf	$ 20.00	$ 4,200,000
		G2011 Roadway Areas	210,000 sf	$ 15.00	$ 3,150,000
		G2012 Taxilane Area	900 lf	$ 2,000.00	$ 1,800,000
Subtotal Building Sitework					***$ 9,150,000***
Subtotal Opinion of Probable RAW Construction Cost					***$ 25,512,500***
				TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST	***$ 25,500,000***

CONNICO INCORPORATED

fly2houston
William P. Hobby Airport

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	2
Original Date	18-Nov-13	**Revision Date**	9-Sep-14
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

Roadway Intersection Improvements - Airport / Telephone

	DESCRIPTION	QUANTITY		UNIT COST		TOTAL COST
A	***SUBSTRUCTURE***					
B	***SHELL***					
C	***INTERIORS***					
C	***SERVICES***					
E	***EQUIPMENT & FURNISHINGS***					
G	***SITEWORK***					
G20	**Site Improvements**					
G2010	Tempoary Construction Measures	1	ls	$ 125,000.00	$	125,000
G2020	Left Turn bay on eastbound approach of Airport Blvd	200	lf	$ 500.00	$	100,000
G2020	Left Turn bay on westbound approach of Airport Blvd	200	lf	$ 500.00	$	100,000
G2030	Left Turn bay on southbound approach of Airport Blvd	200	lf	$ 500.00	$	100,000
G2040	Signalization	3	ea	$ 275,000	$	825,000
	Subtotal Sitework				***$***	***1,250,000***
	TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST				***$***	***1,250,000***

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Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	2
Original Date	18-Nov-13	**Revision Date**	9-Sep-14
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

Roadway Intersection Improvements - Airport / Monroe

	DESCRIPTION	QUANTITY		UNIT COST		TOTAL COST
A	*SUBSTRUCTURE*					
B	*SHELL*					
C	*INTERIORS*					
C	*SERVICES*					
E	*EQUIPMENT & FURNISHINGS*					
G	*SITEWORK*					
G20	**Site Improvements**					
G2010	Temporary Construction Measures	1 ls	$	200,000	$	200,000
G2020	Left turn bay on eastbound approach to Airport Blvd	300 lf	$	500.00	$	150,000
G2020	Exclusive right turn bay on eastbound approach to Airport	200 lf	$	500.00	$	100,000
G2030	Additional left turn bay on westbound approach to Airport	175 lf	$	600.00	$	105,000
G2030	Exclusive right turn bay on southbound approach to Monroe	200 lf	$	500.00	$	100,000
G2030	Additional left turn bay on northbound approach to Monroe	150 lf	$	600.00	$	90,000
G2040	Signalization	4 ea	$	250,000	$	1,000,000
	Subtotal Sitework				***$***	***1,745,000***
	TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST				***$***	***1,750,000***

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	2
Original Date	18-Nov-13	**Revision Date**	9-Sep-14
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

Roadway Intersection Improvements - Airport / Glencrest

	DESCRIPTION	QUANTITY		UNIT COST	TOTAL COST
A	***SUBSTRUCTURE***				
B	***SHELL***				
C	***INTERIORS***				
C	***SERVICES***				
E	***EQUIPMENT & FURNISHINGS***				
G	***SITEWORK***				
G20	**Site Improvements**				
G2010	Temporary Construction Measures	1	ls	$ 50,000	$ 50,000
G2020	Left turn bay on westbound approach to Airport Blvd	200	lf	$ 500.00	$ 100,000
G2020	New south leg of intersection	1	ls	$ 100,000.00	$ 100,000
G2040	Signalization	2	ea	$ 250,000	$ 500,000
	Subtotal Sitework				***$ 750,000***
	TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST				***$ 750,000***

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Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	2
Original Date	18-Nov-13	**Revision Date**	9-Sep-14
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

Long-Term Parking Access Road Improvements

	DESCRIPTION	QUANTITY		UNIT COST	TOTAL COST
A	***SUBSTRUCTURE***				
B	***SHELL***				
C	***INTERIORS***				
C	***SERVICES***				
E	***EQUIPMENT & FURNISHINGS***				
G	***SITEWORK***				
	G20 Site Improvements				
	G2010 Temporary Construction Measures	1	ls	$ 150,000	$ 150,000
	G2020 Roadways	11,500	sy	$ 95.00	$ 1,092,500
	G2040 Signalization	1	ea	$ 250,000	$ 250,000
	Subtotal Sitework				***$ 1,492,500***
	TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST				***$ 1,500,000***

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Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stag	Concept		
Project No.		Revision	3
Original Date	18-Nov-13	Revision Date	12-Sep-14
Opening Date		CI Project No.	3537.13
Project	DLB	Checked by	DLB

CRCF Enabling - West Terminal Area Roadways

		DESCRIPTION		QUANTITY		UNIT COST	TOTAL COST
A	*SUBSTRUCTURE*						
B	*SHELL*						
C	*INTERIORS*						
C	*SERVICES*						
E	*EQUIPMENT & FURNISHINGS*						
G	*SITEWORK*						
	G20	*Site Improvements*					
		G2010	Temporary Construction Measures	1	ls	$ 200,000.00	$ 200,000
		G2020	Roadways	15,000	sy	$ 100.00	$ 1,500,000
		G2040	Landscaping & Signage	1	ea	$ 750,000.00	$ 750,000
		G2040	Signalization	0	ea	$ 250,000.00	$ -

Subtotal Sitework ***$ 2,450,000***

TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST $ 2,500,000

ESTIMATE DETAIL

Phase 2

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		Revision	1
Original Date	9-Sep-14	Revision Date	12-Sep-14
Assumed Bid Opening Date	TBD	CI Project No.	3537.13
Project Manager	DLB	Checked by	DLB

CRCF Enabling - Temporary Relocation of Rental Car Facilities

	DESCRIPTION				QUANTITY		UNIT COST	TOTAL COST
A	*SUBSTRUCTURE*							
B	*SHELL*							
C	*INTERIORS*							
C	*SERVICES*							
E	*EQUIPMENT & FURNISHINGS*							
F	*SPECIAL CONSTRUCTION & DEMOLITION*							
		F20	**Demolition**					
			F2010	Miscellaneous Site Demolition	70,000	sy	$ 10.00	$ 700,000
	Subtotal Special Construction & Demolition							*$ 700,000*
G	*BUILDING SITEWORK*							
		G20	**Site Improvements**					
			G2010	Pavement for temporary relocation	70,000	sy	$ 35.00	$ 2,450,000
			G2020	Utilities for Temp Relocation	1	ls	$ 250,000	$ 250,000
			G2020	Equipment relocation for temp RAC relocation	1	ls	$ 500,000	$ 500,000
			G2030	Fence at perimeter of temporary RAC area	3200	lf	$ 50.00	$ 160,000
			G2040	Misc. signage	1	ls	$ 100,000	$ 100,000
	Subtotal Building Sitework							*$ 3,460,000*
	Subtotal Opinion of Probable Construction Cost							***$ 4,160,000***
							TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST	***$ 4,200,000***

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	2
Original Date	18-Nov-13	**Revision Date**	9-Sep-14
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

CRCF Enabling - Relocation of Taxi Staging Area

	DESCRIPTION				QUANTITY		UNIT COST	TOTAL COST
A	*SUBSTRUCTURE*							
B	*SHELL*							
C	*INTERIORS*							
C	*SERVICES*							
E	*EQUIPMENT & FURNISHINGS*							
G	*SITEWORK*							
		G20	**Site Improvements**					
			G2010	Temporary Construction Measures	1	ls	$ 200,000.00	$ 200,000
			G2020	Parking Area	18500	sy	$ 90.00	$ 1,665,000
			G2040	Signage	1	ea	$ 150,000.00	$ 150,000
	Subtotal Sitework							$ 2,015,000
							TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST	*$ 2,000,000*

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		Revision	2
Original Date	18-Nov-13	Revision Date	9-Sep-14
Assumed Bid Opening Date		CI Project No.	3537.13
Project Manager	DLB	Checked by	DLB

Consolidated Rental Car Facility

	DESCRIPTION	QUANTITY		UNIT COST		TOTAL COST
	Level 1 (Ground Level)			232,500 sf		
	Level 2 (Elevated)			232,500 sf		
	Level 3 (Elevated)			232,500 sf		
	Level 4 (Elevated)			232,500 sf		
				930,000 sf		
A	***SUBSTRUCTURE***					
	A10 Foundations	232,500 sf	$	5.00	$	1,162,500
	A20 Slabs on Grade	232,500 sf	$	7.00	$	1,627,500
	Subtotal Substructure				***$***	***2,790,000***
B	***SHELL***					
	A10 Elevated Concrete Slabs	525,000 sf	$	25.00	$	13,125,000
	A20 Ramps	175,000 sf	$	25.00	$	4,375,000
	A30 Perimeter façade	125,000 sf	$	35.00	$	4,375,000
	A40 Canopy at Top level	232,500 sf	$	50.00	$	11,625,000
	Subtotal Shell				***$***	***33,500,000***
C	***INTERIORS***					
	C10 Allowance for interior core of CONRAC	100,000 sf	$	75.00	$	7,500,000
	C20 Vertical circulation cores (equipment included below)	25,000 sf	$	50.00	$	1,250,000
	Subtotal Interiors				***$***	***8,750,000***
C	***SERVICES***					
	C10 Vertical Circulation					
	C1010 Elevators	16 stops	$	75,000	$	1,200,000
	C1020 Escalators	12 ea	$	150,000	$	1,800,000
	C20 Fire Protection	920,000 sf	$	4.00	$	3,680,000
	C30 Plumbing	920,000 sf	$	5.00	$	4,600,000
	C40 HVAC - Interiors Only	125,000 sf	$	30.00	$	3,750,000
	C50 Electrical	920,000 sf	$	12.50	$	11,500,000
	Subtotal Services				***$***	***26,530,000***
E	***EQUIPMENT & FURNISHINGS***					
	E10 RAC equipment	1 ls	$	2,500,000	$	2,500,000
	Subtotal Equipment & Furnishings				***$***	***2,500,000***
F	***SPECIAL CONSTRUCTION & DEMOLITION***					

Consolidated Rental Car Facility

	DESCRIPTION	QUANTITY		UNIT COST		TOTAL COST
G	***BUILDING SITEWORK***					
G20	**Site Improvements**					
	G2010 Misc. Site Improvements	1 ls	$	1,500,000	$	1,500,000
	G2020 Misc Site Utilities	1 ls	$	1,000,000	$	1,000,000
	Subtotal Building Sitework				***$***	***2,500,000***
				TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST	***$***	***76,570,000***

CONNICO INCORPORATED

Project Title	Hobby International Expansion Project		
Location	William P. Hobby Airport		
Submittal Stage	Conceptual Programming		
Project No.		**Revision**	6
Original Date	19-Oct-12	**Revision Date**	05-Nov-13
Assumed Bid Opening Date		**CI Project No.**	3302.12
Project Manager	DLB	**Checked by**	DLB

HOBBY INTERNATIONAL - 7 GATE EXPANSION TO WEST CONCOURSE

DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
New Terminal Construction			
Level 1			
Sterile Corridor System		*5,000 SF*	
Primary Screening		*2,500 SF*	
Restrooms - FIS		*2,500 SF*	
International Bag Claim		*10,000 SF*	
Secondary Screening		*- SF*	
US CBP Admin		*- SF*	
Baggage Re-check		*- SF*	
Public Circulation		*5,000 SF*	
Replacement Administration		*- SF*	
Unassigned		*- SF*	
Baggage Input		*15,000 SF*	
Level 2			
Sterile Corridor System		*5,000 SF*	
Holdroom		*20,000 SF*	
Concessions (Shell Space)		*2,500 SF*	
Restrooms - Secure		*2,500 SF*	
Restrooms - Public		*- SF*	
Public Circulation		*5,000 SF*	
Replacement Administration		*- SF*	
Ticketing - Queue		*- SF*	
Ticketing - Counter		*- SF*	
Ticketing - Office		*- SF*	
Security Checkpoint - Queue		*- SF*	
Security Checkpoint		*- SF*	
Secure Corridor - Hallway		*5,000 SF*	
Shell Space for HOU Management Ops		*- SF*	
Total Area		***80,000 SF***	
A SUBSTRUCTURE			
A10 Foundations			
A1010 Standard Foundations			
A1011 Column Foundations & Pile Caps	40,000 sf	$ 5.00	$ 200,000
A1012 Grade Beams / Wall Footings	40,000 sf	$ 4.00	$ 160,000
A1013 Perimeter Drainage & Insulation	1,000 lf	$ 15.00	$ 15,000
A1020 Special Foundations			
A1021 Pile Foundations and Column Footings	40,000 sf	$ 6.00	$ 240,000
A1022 Jetway Foundations	7 ea	$ 25,000	$ 175,000
A1023 Dewatering	40,000 sf	$ 1.00	$ 40,000
A1030 Slab on Grade			
A1031 Slab on Grade	40,000 sf	$ 5.00	$ 200,000
A1032 Trenches, Pits & Bases	74 cy	$ 500.00	$ 37,037

HOBBY INTERNATIONAL - 7 GATE EXPANSION TO WEST CONCOURSE

DESCRIPTION				QUANTITY			UNIT COST		TOTAL COST
		A1033	Elevator/Escalator Pits	2	ea	$	10,000.00	$	20,000
		A1034	Under-slab Drainage & Insulation	40,000	sf	$	1.00	$	40,000
Subtotal Substructure								***$***	***1,127,037***
B	***SHELL***								
B10	**Superstructure**								
	B1010	Floor Construction							
		B1011	Steel Floor Structure	240	tns	$	3,750.00	$	900,000
		B1012	Steel Floor Deck	40,000	sf	$	3.50	$	140,000
		B1013	Concrete Fill to Steel Floor Deck	40,000	sf	$	4.00	$	160,000
		B1014	Misc. Steel (5%)	12	tns	$	3,750.00	$	45,000
		B1015	Elevated Floor Slab Fireproofing (columns only)	40,000	sf	$	2.50	$	100,000
	B1020	Roof Construction							
		B1021	Steel Roof Structure	200	tns	$	3,750.00	$	750,000
		B1023	Steel Roof Deck	40,000	sf	$	2.25	$	90,000
		B1024	Misc. Steel (5%)	10	tns	$	3,750.00	$	37,500
		B1025	Flat Roof Fireproofing (columns + deck)	40,000	sf	$	3.50	$	140,000
B20	**Exterior Enclosures**								
	B2010	Exterior Walls							
		B2011	Exterior Wall Construction - Apron Level	7,500	sf	$	35.00	$	262,500
		B2012	Exterior Wall Construction - Concourse Level	6,000	sf	$	35.00	$	210,000
		B2014	Exterior Soffits (Framing and Finish)	-	sf	$	15.00	$	-
	B2020	Exterior Windows							
		B2022	Curtain Walls - Concourse Level	1,500	sf	$	110.00	$	165,000
	B2030	Exterior Doors							
		B2031	Solid Exterior Doors - in C3010 Below			$	-	$	-
B30	**Roofing**								
	B3010	Roof Coverings							
		B3011	Roof Finishes	40,000	sf	$	15.00	$	600,000
	B3020	Roof Openings							
		B2021	Roof Hatches	1	ea	$	5,500.00	$	5,500
Subtotal Shell								***$***	***3,605,500***
C	***INTERIORS***								
C10	**Interior Construction**								
	C1010	Partitions							
		C1011	Fixed Partitions - In C3010 below			$	-	$	-
		C1012	Rough Carpentry and Blocking	80,000	sf	$	1.00	$	80,000
		C1013	Caulking and Sealants	80,000	sf	$	1.00	$	80,000
	C1020	Interior Doors							
		C1021	Interior Doors, Frames, Hardware - in C3010			$	-	$	-
C20	**Stairs**								
	C2010	Stair Construction							
		C2011	Regular Stairs	4	flts	$	17,000.00	$	68,000
		C2012	Stair Handrails and Balustrades	4	flts	$	5,000.00	$	20,000

HOBBY INTERNATIONAL - 7 GATE EXPANSION TO WEST CONCOURSE

DESCRIPTION			QUANTITY			UNIT COST		TOTAL COST
	C2020	Stair Finishes						
	C2021	Stair, Tread, and Landing Finishes	4	flts	$	7,500.00	$	30,000
	C2022	Stair Handrail & Balustrade Finishes	4	flts	$	2,500.00	$	10,000
C30	Interior Finishes							
	C3010	Interior Finishes						
		New Terminal Construction						
		Level 1						
		Sterile Corridor System	5,000	sf	$	45.00	$	225,000
		Primary Screening	2,500	sf	$	45.00	$	112,500
		Restrooms - FIS	2,500	sf	$	65.00	$	162,500
		International Bag Claim	10,000	sf	$	45.00	$	450,000
		Secondary Screening	-	sf	$	45.00	$	-
		US CBP Admin	-	sf	$	45.00	$	-
		Baggage Re-check	-	sf	$	45.00	$	-
		Public Circulation	5,000	sf	$	45.00	$	225,000
		Replacement Administration	-	sf	$	45.00	$	-
		Unassigned	-	sf	$	-	$	-
		Baggage Input	15,000	sf	$	10.00	$	150,000
		Level 2						
		Sterile Corridor System	5,000	sf	$	45.00	$	225,000
		Holdroom	20,000	sf	$	45.00	$	900,000
		Concessions (Shell Space)	2,500	sf	$	10.00	$	25,000
		Restrooms - Secure	2,500	sf	$	65.00	$	162,500
		Restrooms - Public	-	sf	$	65.00	$	-
		Public Circulation	5,000	sf	$	45.00	$	225,000
		Replacement Administration	-	sf	$	45.00	$	-
		Ticketing - Queue	-	sf	$	45.00	$	-
		Ticketing - Counter	-	sf	$	45.00	$	-
		Ticketing - Office	-	sf	$	45.00	$	-
		Security Checkpoint - Queue	-	sf	$	45.00	$	-
		Security Checkpoint	-	sf	$	45.00	$	-
		Secure Corridor - Hallway	5,000	sf	$	45.00	$	225,000
		Shell Space for HOU Management Ops	-	sf	$	20.00	$	-
	F2011	Temporary office space	-	sf	$	45.00	$	-
Subtotal Interiors							***$***	***3,375,500***
C	***SERVICES***							
D10	Conveying System							
	D1010	Elevators & Lifts						
	D1011	Freight Elevators	1	ea	$	75,000.00	$	75,000
	D1012	Passenger Elevators	1	ea	$	65,000.00	$	65,000
	D1013	Escalators	-	ea	$	150,000.00	$	-
	D1014	Power Walks	-	lf	$	3,000.00	$	-
D20	Plumbing							
	D2010	Plumbing Systems						
		New Terminal Construction						
		Level 1						
		Sterile Corridor System	5,000	sf	$	10.00	$	50,000
		Primary Screening	2,500	sf	$	10.00	$	25,000
		Restrooms - FIS	2,500	sf	$	75.00	$	187,500
		International Bag Claim	10,000	sf	$	10.00	$	100,000
		Secondary Screening	-	sf	$	10.00	$	-
		US CBP Admin	-	sf	$	10.00	$	-
		Baggage Re-check	-	sf	$	10.00	$	-

HOBBY INTERNATIONAL - 7 GATE EXPANSION TO WEST CONCOURSE

DESCRIPTION		QUANTITY			UNIT COST		TOTAL COST
	Public Circulation	5,000	sf	$	10.00	$	50,000
	Replacement Administration	-	sf	$	10.00	$	-
	Unassigned	-	sf	$	-	$	-
	Baggage Input	15,000	sf	$	5.00	$	75,000
	Level 2						
	Sterile Corridor System	5,000	sf	$	10.00	$	50,000
	Holdroom	20,000	sf	$	10.00	$	200,000
	Concessions (Shell Space)	2,500	sf	$	20.00	$	50,000
	Restrooms - Secure	2,500	sf	$	75.00	$	187,500
	Restrooms - Public	-	sf	$	75.00	$	-
	Public Circulation	5,000	sf	$	10.00	$	50,000
	Replacement Administration	-	sf	$	10.00	$	-
	Ticketing - Queue	-	sf	$	10.00	$	-
	Ticketing - Counter	-	sf	$	10.00	$	-
	Ticketing - Office	-	sf	$	10.00	$	-
	Security Checkpoint - Queue	-	sf	$	10.00	$	-
	Security Checkpoint	-	sf	$	10.00	$	-
	Secure Corridor - Hallway	5,000	sf	$	10.00	$	50,000
	Shell Space for HOU Management Ops	-	sf	$	10.00	$	-
D30	**HVAC**						
D3010	HVAC Systems						
	New Terminal Construction						
	Level 1						
	Sterile Corridor System	5,000	sf	$	30.00	$	150,000
	Primary Screening	2,500	sf	$	30.00	$	75,000
	Restrooms - FIS	2,500	sf	$	30.00	$	75,000
	International Bag Claim	10,000	sf	$	30.00	$	300,000
	Secondary Screening	-	sf	$	30.00	$	-
	US CBP Admin	-	sf	$	30.00	$	-
	Baggage Re-check	-	sf	$	30.00	$	-
	Public Circulation	5,000	sf	$	30.00	$	150,000
	Replacement Administration	-	sf	$	30.00	$	-
	Unassigned	-	sf	$	-	$	-
	Baggage Input	15,000	sf	$	5.00	$	75,000
	Level 2						
	Sterile Corridor System	5,000	sf	$	30.00	$	150,000
	Holdroom	20,000	sf	$	30.00	$	600,000
	Concessions (Shell Space)	2,500	sf	$	15.00	$	37,500
	Restrooms - Secure	2,500	sf	$	30.00	$	75,000
	Restrooms - Public	-	sf	$	30.00	$	-
	Public Circulation	5,000	sf	$	30.00	$	150,000
	Replacement Administration	-	sf	$	30.00	$	-
	Ticketing - Queue	-	sf	$	30.00	$	-
	Ticketing - Counter	-	sf	$	30.00	$	-
	Ticketing - Office	-	sf	$	30.00	$	-
	Security Checkpoint - Queue	-	sf	$	30.00	$	-
	Security Checkpoint	-	sf	$	30.00	$	-
	Secure Corridor - Hallway	5,000	sf	$	30.00	$	150,000
	Shell Space for HOU Management Ops	-	sf	$	15.00	$	-
D3060	Controls and Instrumentation						
	New Terminal Construction						
	D3061 Building Automation Systems	80,000	sf	$	2.50	$	200,000
D3070	Systems Testing & Balancing						
	New Terminal Construction						
	D3071 Air Systems Testing & Balancing	80,000	sf	$	1.00	$	80,000

HOBBY INTERNATIONAL - 7 GATE EXPANSION TO WEST CONCOURSE

DESCRIPTION		QUANTITY		UNIT COST		TOTAL COST
G3091 Central Plant Allowance		1 al	$	2,500,000.00	$	2,500,000
D40 Fire Protection						
D4010	Sprinklers					
	New Terminal Construction					
	Level 1					
	Sterile Corridor System	5,000 sf	$	3.50	$	17,500
	Primary Screening	2,500 sf	$	3.50	$	8,750
	Restrooms - FIS	2,500 sf	$	3.50	$	8,750
	International Bag Claim	10,000 sf	$	3.50	$	35,000
	Secondary Screening	- sf	$	3.50	$	-
	US CBP Admin	- sf	$	3.50	$	-
	Baggage Re-check	- sf	$	3.50	$	-
	Public Circulation	5,000 sf	$	3.50	$	17,500
	Replacement Administration	- sf	$	3.50	$	-
	Unassigned	- sf	$	-	$	-
	Baggage Input	15,000 sf	$	5.00	$	75,000
	Level 2					
	Sterile Corridor System	5,000 sf	$	3.50	$	17,500
	Holdroom	20,000 sf	$	3.50	$	70,000
	Concessions (Shell Space)	2,500 sf	$	3.50	$	8,750
	Restrooms - Secure	2,500 sf	$	3.50	$	8,750
	Restrooms - Public	- sf	$	3.50	$	-
	Public Circulation	5,000 sf	$	3.50	$	17,500
	Replacement Administration	- sf	$	3.50	$	-
	Ticketing - Queue	- sf	$	3.50	$	-
	Ticketing - Counter	- sf	$	3.50	$	-
	Ticketing - Office	- sf	$	3.50	$	-
	Security Checkpoint - Queue	- sf	$	3.50	$	-
	Security Checkpoint	- sf	$	3.50	$	-
	Secure Corridor - Hallway	5,000 sf	$	3.50	$	17,500
	Shell Space for HOU Management Ops	- sf	$	3.50	$	-
D4030	Fire Protection Specialties					
	D4031 Fire Extinguishers	10 ea	$	300.00	$	3,000
D50 Electrical						
D5010	Electrical Systems					
	New Terminal Construction					
	Level 1					
	Sterile Corridor System	5,000 sf	$	25.00	$	125,000
	Primary Screening	2,500 sf	$	25.00	$	62,500
	Restrooms - FIS	2,500 sf	$	25.00	$	62,500
	International Bag Claim	10,000 sf	$	25.00	$	250,000
	Secondary Screening	- sf	$	25.00	$	-
	US CBP Admin	- sf	$	25.00	$	-
	Baggage Re-check	- sf	$	25.00	$	-
	Public Circulation	5,000 sf	$	25.00	$	125,000
	Replacement Administration	- sf	$	25.00	$	-
	Unassigned	- sf	$	-	$	-
	Baggage Input	15,000 sf	$	5.00	$	75,000
	Level 2					
	Sterile Corridor System	5,000 sf	$	25.00	$	125,000
	Holdroom	20,000 sf	$	25.00	$	500,000
	Concessions (Shell Space)	2,500 sf	$	25.00	$	62,500
	Restrooms - Secure	2,500 sf	$	25.00	$	62,500
	Restrooms - Public	- sf	$	25.00	$	-
	Public Circulation	5,000 sf	$	25.00	$	125,000
	Replacement Administration	- sf	$	25.00	$	-

HOBBY INTERNATIONAL - 7 GATE EXPANSION TO WEST CONCOURSE

		DESCRIPTION		QUANTITY		UNIT COST		TOTAL COST
			Ticketing - Queue	- sf	$	25.00	$	-
			Ticketing - Counter	- sf	$	25.00	$	-
			Ticketing - Office	- sf	$	25.00	$	-
			Security Checkpoint - Queue	- sf	$	25.00	$	-
			Security Checkpoint	- sf	$	25.00	$	-
			Secure Corridor - Hallway	5,000 sf	$	25.00	$	125,000
			Shell Space for HOU Management Ops	- sf	$	15.00	$	-
		D5020	Communications & Security					
			New Terminal Construction					
			G5021 Data/Communications	80,000 sf	$	4.00	$	320,000
			G5022 Security / Access Control	80,000 sf	$	5.50	$	440,000
			G5023 CCTV	80,000 sf	$	18.00	$	1,440,000
	Subtotal Services						***$***	***10,188,000***
E	***EQUIPMENT & FURNISHINGS***							
	E10	**Equipment**						
		E1090	Other Equipment					
			E1091 FF&E Allowance	80,000 sf	$	5.00	$	400,000
			E1092 Security Screening Station Tables	2 ea	$	20,000.00	$	40,000
			E1093 FIDS, BIDS, MUFIDS	1 ls	$	100,000.00	$	100,000
			E1094 Framing for Displays/Branding at Ticket Counters	1 ls	$	15,000.00	$	15,000
			E1096 New Passenger Boarding Bridges	7 ea	$	750,000.00	$	5,250,000
			E1097 Technology Kiosks	2 ea	$	25,000.00	$	50,000
		D1090	Baggage Handling Equipment					
			Temporary Measures					
			D1091 Allowance for Temporary Baggage Measures	- ls	$	-	$	-
			Permanent Measures					
			D1092 Standard Conveyor	100 lf	$	1,300.00	$	130,000
			D1093 90 Degree Turn	3 ea	$	15,000.00	$	45,000
			D1094 45 Degree Turn	3 ea	$	15,000.00	$	45,000
			D1095 Flat Plate Claim Device - Bag Claim	150 lf	$	2,000.00	$	300,000
			D1096 Catwalks / Controls / Testing	1 ls	$	50,000.00	$	50,000
	E20	**Furnishings**						
		E2010	Fixed Furnishings					
			E2011 Fixed Casework					
			E2012 Gate Podiums and Backscreens	7 ea	$	25,000	$	175,000
			E2013 Ticket Counters	20 lf	$	1,500	$	30,000
			E2014 Check-in Kiosks	2 ea	$	5,000	$	10,000
			E2015 Misc. Casework Allowance	1 ls	$	25,000	$	25,000
			E2016 Holdroom Seating	875 ea	$	250.00	$	218,750
			E2017 Misc. Seating etc.	1 ls	$	25,000	$	25,000
	Subtotal Equipment & Furnishings						***$***	***6,908,750***
F	***SPECIAL CONSTRUCTION & DEMOLITION***							
	F20	**Selective Building Demolition**						
		F2010	Building Elements Demolition					
			F2012 Temporary Walls & Partitions	5,000 sf	$	8.00	$	40,000

HOBBY INTERNATIONAL - 7 GATE EXPANSION TO WEST CONCOURSE

	DESCRIPTION			QUANTITY		UNIT COST		TOTAL COST
		F2013	Building Exterior Wall Demolition - Level 1	7,500 sf	$	5.00	$	37,500
		F2014	Building Exterior Wall Demolition - Level 2	7,500 sf	$	5.00	$	37,500
	Subtotal Special Construction & Demolition						***$***	***115,000***
G	***BUILDING SITEWORK***							
	G10 **Site Preparation**							
	G1010	Site Demolition						
		G1011	Demolition of Site Components	100,000 sf	$	5.00	$	500,000
		G1012	Demolition of Existing Apron	50,000 sy	$	15.00	$	750,000
	G1020	Site Earthwork						
		G1021	Excavation for New Slab on Grade Elevations	3,300 cy	$	15.00	$	49,500
		G1022	Site Dewatering	1 ls	$	15,000	$	15,000
		G1023	Erosion Control	1 ls	$	10,000	$	10,000
	G20 **Site Improvements**							
	G2010	Pavement						
		G2011	New Apron	52,000 sy	$	125.00	$	6,500,000
		G2012	Patch & Repair Existing Apron	5,000 sy	$	25.00	$	125,000
		G2013	New Pavement Markings at Apron	1 ls	$	100,000	$	100,000
		G2014	Unclassified Excavation for Pavement	52,000 sy	$	15.00	$	780,000
	G2020	Site Development						
		G2021	Signage	1 ls	$	50,000.00	$	50,000
	G30 **Site Mechanical Utilities**							
	G3010	Site Mechanical						
		G3012	Fuel Hydrant System Allowance	7 ea	$	150,000.00	$	1,050,000
		G3013	Fuel Hydrant System	1,750 lf				included in G3012
		G3014	Fuel Hydrant Pits	7 ea				included in G3012
		G3015	Isolation Valve Pits	2 ea				included in G3012
	G40 **Electrical Utilities**							
	G4020	Site Lighting						
		G4021	Ramp Light Fixtures	4 ea	$	25,000.00	$	100,000
	Subtotal Building Sitework						***$***	***10,029,500***

HOBBY INTERNATIONAL - 7 GATE EXPANSION TO WEST CONCOURSE

	DESCRIPTION	QUANTITY	UNIT COST		TOTAL COST
	Subtotal Opinion of Probable Construction Cost (Building and Site)			***$***	***35,349,287***
10.00%	General Conditions			$	3,534,929
2.00%	Payment & Performance Bonds			$	777,684
1.50%	Insurance			$	594,929
12.00%	Architectural / Engineering Design			$	4,830,819
1.00%	Materials Testing			$	450,876
5.00%	Escalation			$	2,276,926
30.00%	Bidding and Construction Reserves			$	14,344,635
5.00%	Preconstruction Costs			$	3,108,004
5.00%	Program Management Team			$	3,263,405
1.00%	DOA Liaison			$	685,315
0.25%	Legal Services			$	173,042
0.50%	Airport Operations Readiness			$	346,949
0.25%	Owner Insurance			$	174,342
1.75%	Artwork			$	1,223,445
1.00%	Commissioning			$	711,346
4.50%	Contractor's Fee			$	3,233,000
	Total Opinion of Probable Construction Cost		***$938.97***	***$***	***75,117,371***
	TOTAL OPINION OF ROM ESTIMATED PROJECT COST		***$938.75***	**$**	**75,100,000**

ESTIMATE DETAIL

Phase 3

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	
Original Date	18-Nov-13	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

Construction of Hobby Cargo Building

	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
	Hobby Cargo Building		55,691 sf	
A	***SUBSTRUCTURE***			
	A10 Foundations			
	Hobby Cargo Building	55,691 sf	$ 3.50	$ 194,919
	A20 Slabs on Grade			
	Hobby Cargo Building	55,691 sf	$ 5.50	$ 306,301
	Subtotal Substructure			***$ 501,219***
B	***SHELL***			
	A10 Pre-engineered Structure, including façade and roof			
	Hobby Cargo Building	55,691 sf	$ 35.00	$ 1,949,185
	Subtotal Shell			***$ 1,949,185***
C	***INTERIORS***			
	C10 Interior Finishes			
	Hobby Cargo Building	55,691 sf	$ 20.00	$ 1,113,820
	Subtotal Interiors			***$ 1,113,820***
C	***SERVICES***			
	C20 Fire Protection			
	Hobby Cargo Building	55,691 sf	$ 3.50	$ 194,919
	C30 Plumbing			
	Hobby Cargo Building	55,691 sf	$ 5.00	$ 278,455
	C40 HVAC			
	Hobby Cargo Building	55,691 sf	$ 15.00	$ 835,365
	C50 Electrical			
	Hobby Cargo Building	55,691 sf	$ 10.00	$ 556,910
	Subtotal Services			***$ 1,865,649***
E	***EQUIPMENT & FURNISHINGS***			
F	***SPECIAL CONSTRUCTION & DEMOLITION***			
	F20 Demolition			
	F2010 Site demolition of existing parking area	55,691 sy	$ 5.00	$ 278,455
	Subtotal Services			***$ 278,455***
G	***BUILDING SITEWORK***			
	Subtotal Building Sitework			***$ -***

TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST $ 5,700,000

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	
Original Date	18-Nov-13	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

Runway 12L Upgrade - Signature Buildings Demo

	DESCRIPTION	QUANTITY		UNIT COST		TOTAL COST
	Building E-250			10,700 sf		
	Building E-170			67,200 sf		
	Building E-160			80,400 sf		
	Apron area			268,900 sf		
F	***SPECIAL CONSTRUCTION & DEMOLITION***					
F20	**Demolition**					
	F2010 Demo existing buildings	158,300 sf	$	5.00	$	791,500
	F2010 Demo existing apron	268,900 sf	$	3.00	$	806,700
	Subtotal Special Construction & Demolition				***$***	***1,598,200***
G	***BUILDING SITEWORK***					
G20	**Site Improvements**					
	G2010 Apron area	268,900 sf	$	5.00	$	1,344,500
	Subtotal Building Sitework				***$***	***1,344,500***
	TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST				***$***	***2,900,000***

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		Revision	
Original Date	18-Nov-13	Revision Date	
Assumed Bid Opening Date		CI Project No.	3537.13
Project Manager	DLB	Checked by	DLB

Runway 12L Upgrade - Jet Aviation South Hangars Demo

	DESCRIPTION			QUANTITY		UNIT COST		TOTAL COST
	Building E-390					40,400 sf		
	Building E-392					15,900 sf		
	Apron area					139,300 sf		
F	***SPECIAL CONSTRUCTION & DEMOLITION***							
	F20	**Demolition**						
		F2010	Demo existing buildings	56,300	sf	$ 5.00	$	281,500
		F2010	Demo existing apron	139,300	sf	$ 3.00	$	417,900
	Subtotal Special Construction & Demolition						***$***	***699,400***
G	***BUILDING SITEWORK***							
	G20	**Site Improvements**						
		G2010	Apron area	139,300	sf	$ 5.00	$	696,500
	Subtotal Building Sitework						***$***	***696,500***

TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST $ 1,400,000

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	
Original Date	18-Nov-13	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

Runway 12L Upgrade - Taxiway Construction

	DESCRIPTION	QUANTITY		UNIT COST		TOTAL COST
	Taxiway Pavement			1,023,000	sf	
	Taxiway Shoulder			455,000	sf	
A	SUBSTRUCTURE					
B	SHELL					
C	INTERIORS					
C	SERVICES					
E	EQUIPMENT & FURNISHINGS					
F	SPECIAL CONSTRUCTION & DEMOLITION					
G	BUILDING SITEWORK					
	G20 Site Improvements					
	G2010 Taxiway Pavement Construction, including painting, lights, etc.	113,667 sy	$	210.00	$	23,870,000
	G2011 Taxiway Shoulder	50,556 sy	$	135.00	$	6,825,000
	Subtotal Building Sitework				*$*	*30,695,000*
				TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST	***$***	***30,700,000***

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	
Original Date	9-Sep-14	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

Runway 12L Upgrade - Relocation of Main Deicing Pad

	DESCRIPTION	QUANTITY		UNIT COST		TOTAL COST
	Taxiway Pavement			23,000 sy		
	Taxiway Shoulder			1,500 sy		
A	***SUBSTRUCTURE***					
B	***SHELL***					
C	***INTERIORS***					
C	***SERVICES***					
E	***EQUIPMENT & FURNISHINGS***					
F	***SPECIAL CONSTRUCTION & DEMOLITION***					
G	***BUILDING SITEWORK***					
	G20 Site Improvements					
	G2010 Pavement Construction, including painting, lights, etc.	23,000 sy	$	200.00	$	4,600,000
	G2011 Shoulder Pavement	1,500 sy	$	135.00	$	202,500
	G2011 Underground Deicing Fluid Storage Tanks	1 ls	$	500,000	$	500,000
	G2011 Deicing Piping Allowance	1 ls	$	250,000	$	250,000
	G2011 Relocate ASDE-X Antenna	1 ls	$	100,000	$	100,000
	Subtotal Building Sitework				***$***	***5,652,500***
				TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST	***$***	***5,700,000***

9/9/2014

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	
Original Date	18-Nov-13	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

Runway 12L Upgrade - Runway Construction

	DESCRIPTION	QUANTITY			UNIT COST		TOTAL COST
	Runway Pavement				1,200,000	sf	
	Runway Shoulder				400,000	sf	
	Blast Pads				80,000	sf	
A	***SUBSTRUCTURE***						
B	***SHELL***						
C	***INTERIORS***						
C	***SERVICES***						
E	***EQUIPMENT & FURNISHINGS***						
F	***SPECIAL CONSTRUCTION & DEMOLITION***						
G	***BUILDING SITEWORK***						
	G20 Site Improvements						
	G2010 Runway Pavement	133,333	lf	$	185.00	$	24,666,667
	G2011 Runway Shoulder	44,444	sy	$	145.00	$	6,444,444
	G2011 Blast Pads	8,889	sy	$	135.00	$	1,200,000
	Subtotal Building Sitework					***$***	***32,311,111***
					TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST	***$***	***32,300,000***

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	
Original Date	18-Nov-13	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

Runway 12L Upgrade - Perimeter Road/Fence Realignment

	DESCRIPTION	QUANTITY		UNIT COST	TOTAL COST
	Perimeter Road			5,300 lf	
	Perimeter Fence			1,600 lf	
A	***SUBSTRUCTURE***				
B	***SHELL***				
C	***INTERIORS***				
C	***SERVICES***				
E	***EQUIPMENT & FURNISHINGS***				
F	***SPECIAL CONSTRUCTION & DEMOLITION***				
	F10 Site Demolition				
	F1010 Site demolition allowance	125,000	sf	$ 1.00	$ 125,000
	Subtotal Demolition				***$ 125,000***
G	***BUILDING SITEWORK***				
	G20 Site Improvements				
	G2010 Roadway pavement, including curbs, lighting, etc.	2,100	lf	$ 300.00	$ 630,000
	G2011 Perimeter fence	1,600	lf	$ 50.00	$ 80,000
	G2011 Landscaping	1	ls	$ 100,000	$ 100,000
	G2011 Drainage	1	ls	$ 200,000	$ 200,000
	Subtotal Building Sitework				***$ 1,010,000***
				TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST	***$ 1,100,000***

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	
Original Date	18-Nov-13	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

Runway 12L Upgrade - Partial Closure of W Monroe Rd and Freeland Street

DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
Perimeter Road		5,300 lf	
Perimeter Fence		1,600 lf	
A SUBSTRUCTURE			
B SHELL			
C INTERIORS			
C SERVICES			
E EQUIPMENT & FURNISHINGS			
F SPECIAL CONSTRUCTION & DEMOLITION			
G BUILDING SITEWORK			
G20 Site Improvements			
G2010 Demo portion of W Monroe and Freeland Streets	1,500 lf	$ 55.00	$ 82,500
G2011 Rerouting of Streets	1,200 lf	$ 300.00	$ 360,000
G2011 Landscaping	1 ls	$ 100,000	$ 100,000
G2011 Drainage	1 ls	$ 250,000	$ 250,000
Subtotal Building Sitework			***$ 792,500***
TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST			***$ 800,000***

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		Revision	
Original Date	18-Nov-13	Revision Date	
Assumed Bid Opening Date		CI Project No.	3537.13
Project Manager	DLB	Checked by	DLB

Runway 12L Upgrade - SWA Fuel Farm Boundary Changes

	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
	Building 1		1,700 sf	
	Building 2		3,000 sf	
	Roadways		1,000 lf	
A	***SUBSTRUCTURE***			
	A10 Foundations			
	Building 1	1,700 sf	$ 3.50	$ 5,950
	Building 2	3,000 sf	$ 3.50	$ 10,500
	A20 Slabs on Grade			
	Building 1	1,700 sf	$ 5.50	$ 9,350
	Building 2	3,000 sf	$ 5.50	$ 16,500
	Subtotal Substructure			***$ 42,300***
B	***SHELL***			
	A10 Pre-engineered Structure, including façade and roof			
	Building 1	1,700 sf	$ 35.00	$ 59,500
	Building 2	3,000 sf	$ 35.00	$ 105,000
	Subtotal Shell			***$ 164,500***
C	***INTERIORS***			
	C10 Interior Finishes			
	Building 1	1,700 sf	$ 20.00	$ 34,000
	Building 2	3,000 sf	$ 20.00	$ 60,000
	Subtotal Interiors			***$ 94,000***
C	***SERVICES***			
	C20 Fire Protection			
	Building 1	1,700 sf	$ 3.50	$ 5,950
	Building 2	3,000 sf	$ 3.50	$ 10,500
	C30 Plumbing			
	Building 1	1,700 sf	$ 5.00	$ 8,500
	Building 2	3,000 sf	$ 5.00	$ 15,000
	C40 HVAC			
	Building 1	1,700 sf	$ 15.00	$ 25,500
	Building 2	3,000 sf	$ 15.00	$ 45,000
	C50 Electrical			
	Building 1	1,700 sf	$ 10.00	$ 17,000
	Building 2	3,000 sf	$ 10.00	$ 30,000
	Subtotal Services			***$ 157,450***

Runway 12L Upgrade - SWA Fuel Farm Boundary Changes

DESCRIPTION		QUANTITY	UNIT COST	TOTAL COST
E	*EQUIPMENT & FURNISHINGS*			
F	*SPECIAL CONSTRUCTION & DEMOLITION*			
G	*BUILDING SITEWORK*			
G20	**Site Improvements**			
	G2011 Roadway Areas	1,000 lf	$ 300.00	$ 300,000
	Subtotal Building Sitework			***$ 300,000***
			TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST	***$ 760,000***

CONNICO INCORPORATED

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		Revision	2
Original Date	18-Nov-13	Revision Date	9-Sep-14
Assumed Bid Opening Date		CI Project No.	3537.13
Project Manager	DLB	Checked by	DLB

Relocation of West Cell Phone Waiting Lot to Long-Term Parking Lot Expansion

DESCRIPTION		QUANTITY		UNIT COST		TOTAL COST	
A	***SUBSTRUCTURE***						
B	***SHELL***						
C	***INTERIORS***						
C	***SERVICES***						
E	***EQUIPMENT & FURNISHINGS***						
G	***SITEWORK***						
G20	**Site Improvements**						
G2010	Temporary Construction Measures	1	ls	$	50,000	$	50,000
G2020	Parking Area	5,000	sy	$	85.00	$	425,000
G2040	Signage	1	ea	$	25,000	$	25,000
Subtotal Sitework						***$***	***500,000***
TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST						***$***	***500,000***

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		**Revision**	9/10/2014
Original Date	18-Nov-13	**Revision Date**	
Opening Date		**CI Project No.**	3537.13
Project Manager	DLB	**Checked by**	DLB

SWA Cargo & Provisioning Facility Demo and Parking Lot Expansion

DESCRIPTION			QUANTITY		UNIT COST	TOTAL COST
Parking Area					225,000 sf	
A SUBSTRUCTURE						
B SHELL						
C INTERIORS						
C SERVICES						
E EQUIPMENT & FURNISHINGS						
F SPECIAL CONSTRUCTION & DEMOLITION						
F20	**Demolition**					
	F2010	Site demolition of existing parking area	25,000	sy	$ 5.00	$ 125,000
Subtotal Services						***$ 125,000***
G BUILDING SITEWORK						
G20	**Site Improvements**					
	F2010	Parking area, including curb, striping, landscaping, lighting, etc.	25,000	sf	$ 95.00	$ 2,375,000
Subtotal Services						***$ 2,375,000***
		TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST				***$ 2,500,000***

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		Revision	2
Original Date	18-Nov-13	Revision Date	9-Sep-14
Assumed Bid Opening Date		CI Project No.	3537.13
Project Manager	DLB	Checked by	DLB

Runway 12L Upgrade - Obstruction Removal

DESCRIPTION		QUANTITY		UNIT COST		TOTAL COST
A	***SUBSTRUCTURE***					
B	***SHELL***					
C	***INTERIORS***					
C	***SERVICES***					
E	***EQUIPMENT & FURNISHINGS***					
G	***SITEWORK***					
G20	**Site Improvements**					
G2010	Temporary Construction Measures	1	ls	$ 100,000	$	100,000
G2020	Site Demolition Allowance	1	ls	$ 350,000	$	350,000
Subtotal	***Sitework***				***$***	***450,000***
	TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST				***$***	***500,000***

CONNICO INCORPORATED

Project Title	Airport Development Plan Phasing		
cation	Houston Hobby International Airport, Houston, TX		
bmittal Stage	Concept		
oject No.		Revision	
Original Date	18-Nov-13	Revision Date	
Assumed Bid Opening Date		CI Project No.	3537.13
Project Manager	DLB	Checked by	DLB

Runway 12L Upgrade - Navaids Installation (ALS, LOC, PAPI, GS)

	DESCRIPTION	QUANTITY		UNIT COST		TOTAL COST
A	***SUBSTRUCTURE***					
B	***SHELL***					
C	***INTERIORS***					
C	***SERVICES***					
E	***EQUIPMENT & FURNISHINGS***					
G	***BUILDING SITEWORK***					
	G20 Site Improvements					
	G2020 Runway 12L					
	MALSR	1 ls	$	500,000.00	$	500,000
	ILS	1 ls	$	2,000,000.00	$	2,000,000
	Touchdown Zone Lights	1 ls	$	150,000.00	$	150,000
	PAPI	1 ls	$	75,000.00	$	75,000
	RVR	1 ls	$	100,000.00	$	100,000
	G2030 Runway 30R					
	ILS	1 ls	$	2,000,000.00	$	2,000,000
	Touchdown Zone Lights	1 ls	$	150,000.00	$	150,000
	PAPI	1 ls	$	75,000.00	$	75,000
	RVR	1 ls	$	100,000.00	$	100,000
	Subtotal Building Sitework				***$***	***5,150,000***
	TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST				***$***	***5,200,000***

CONNICO INCORPORATED

Project Title	Airport Development Plan Phasing		
Location	Houston Hobby International Airport, Houston, TX		
Submittal Stage	Concept		
Project No.		Revision	
Original Date	18-Nov-13	Revision Date	
Assumed Bid Opening Date		CI Project No.	3537.13
Project Manager	DLB	Checked by	DLB

Runway 12R Displaced Threshold Removal

	DESCRIPTION	QUANTITY		UNIT COST		TOTAL COST
A	SUBSTRUCTURE					
B	SHELL					
C	INTERIORS					
C	SERVICES					
E	EQUIPMENT & FURNISHINGS					
F	SPECIAL CONSTRUCTION & DEMOLITION					
	F20 Demolition					
	F2010 Miscellaneous Site Demolition / Pavement Marking Removal	1 ls	$	100,000.00	$	100,000
	Subtotal Special Construction & Demolition				$	100,000
G	BUILDING SITEWORK					
	G20 Site Improvements					
	G2010 New runway paint markings	1 ls	$	50,000.00	$	50,000
	G2020 Relocation of runway lighting	1 ls	$	250,000.00	$	250,000
	G2030 Relocation of PAPI	1 ls	$	100,000.00	$	100,000
	G2040 Relocation of airfield signage	1 ls	$	75,000.00	$	75,000
	Subtotal Building Sitework				$	475,000
	TOTAL OPINION OF PROBABLE RAW CONSTRUCTION COST				$	575,000

ESTIMATE DETAIL

Phase 4

Project Title	Airport Development Plan Phasing			
Location	Houston Hobby International Airport, Houston, TX			
Submittal Stage	Concept			
Project No.		**Revision**	1	
Original Date	9-Sep-14	**Revision Date**	12-Sep-14	
Assumed Bid Opening Date		**CI Project No.**	3537.13	
Project Manager	DLB	**Checked by**	DLB	

EAST TERMINAL EXPANSION

		DESCRIPTION	QUANTITY		UNIT COST	TOTAL COST
		New Terminal Construction				
		Ground Floor				
		Airport Operations			*6,000 SF*	
		Dept of Homeland Security Baggage Handling			*15,000 SF*	
		Baggage Makeup			*23,000 SF*	
		Vacant			*6,000 SF*	
		First Floor				
		Airline Operations			*16,000 SF*	
		Concessions (Shell only)			*3,500 SF*	
		Back of House / MEP			*4,000 SF*	
		Public Non-secure Circulation			*10,000 SF*	
		Ticket Queuing			*500 SF*	
		Ticketing			*1,000 SF*	
		Vacant			*15,000 SF*	
		Total Area			***100,000 SF***	
A		***SUBSTRUCTURE***				
	A10	**Foundations**				
	A1010	Standard Foundations				
	A1011	Column Foundations & Pile Caps	100,000	sf	$ 5.00	$ 500,000
	A1012	Grade Beams / Wall Footings	100,000	sf	$ 4.00	$ 400,000
	A1013	Perimeter Drainage & Insulation	1,500	lf	$ 15.00	$ 22,500
	A1020	Special Foundations				
	A1021	Pile Foundations and Column Footings	100,000	sf	$ 6.00	$ 600,000
	A1023	Dewatering	100,000	sf	$ 1.00	$ 100,000
	A1030	Slab on Grade				
	A1031	Slab on Grade	75,000	sf	$ 5.00	$ 375,000
	A1032	Trenches, Pits & Bases	200	cy	$ 500.00	$ 100,000
	A1034	Under-slab Drainage & Insulation	75,000	sf	$ 1.00	$ 75,000
		Subtotal Substructure				***$ 2,172,500***
B		***SHELL***				
	B10	**Superstructure**				
	B1010	Floor Construction				
	B1011	Steel Floor Structure	375	tns	$ 3,750.00	$ 1,406,250
	B1012	Steel Floor Deck	50,000	sf	$ 3.50	$ 175,000
	B1013	Concrete Fill to Steel Floor Deck	50,000	sf	$ 4.00	$ 200,000
	B1014	Misc. Steel (5%)	19	tns	$ 3,750.00	$ 70,313
	B1015	Elevated Floor Slab Fireproofing (columns only)	50,000	sf	$ 2.50	$ 125,000

		B1020	Roof Construction						
			B1021 Steel Roof Structure	250	tns	$	3,750.00	$	937,500
			B1023 Steel Roof Deck	50,000	sf	$	2.25	$	112,500
			B1024 Misc. Steel (5%)	13	tns	$	3,750.00	$	46,875
			B1025 Flat Roof Fireproofing (columns + deck)	50,000	sf	$	3.50	$	175,000
	B20	**Exterior Enclosures**							
		B2010	Exterior Walls						
			B2011 Exterior Wall Construction - Apron Level	10,800	sf	$	35.00	$	378,000
			B2012 Exterior Wall Construction - Concourse Level	6,000	sf	$	35.00	$	210,000
		B2020	Exterior Windows						
			B2021 Storefront Glazing / Windows - Apron Level	1,200	sf	$	50.00	$	60,000
			B2022 Curtain Walls - Concourse Level	6,000	sf	$	110.00	$	660,000
		B2030	Exterior Doors						
			B2031 Solid Exterior Doors - in C3010 Below			$	-	$	-
	B30	**Roofing**							
		B3010	Roof Coverings						
			B3011 Roof Finishes	50,000	sf	$	15.00	$	750,000
		B3020	Roof Openings						
			B2021 Roof Hatches	1	ea	$	5,500.00	$	5,500
Subtotal Shell								***$***	***5,311,938***
C	***INTERIORS***								
	C10	**Interior Construction**							
		C1010	Partitions						
			C1011 Fixed Partitions - In C3010 below			$	-	$	-
			C1012 Rough Carpentry and Blocking	100,000	sf	$	1.00	$	100,000
			C1013 Caulking and Sealants	100,000	sf	$	1.00	$	100,000
		C1020	Interior Doors						
			C1021 Interior Doors, Frames, Hardware - in C3010			$	-	$	-
	C20	**Stairs**							
		C2010	Stair Construction						
			C2011 Regular Stairs	3	flts	$	17,000.00	$	51,000
			C2012 Stair Handrails and Balustrades	3	flts	$	5,000.00	$	15,000
		C2020	Stair Finishes						
			C2021 Stair, Tread, and Landing Finishes	3	flts	$	7,500.00	$	22,500
			C2022 Stair Handrail & Balustrade Finishes	3	flts	$	2,500.00	$	7,500
	C30	**Interior Finishes**							
		C3010	Interior Finishes						
			New Terminal Construction						
			Ground Floor						
			Airport Operations	6,000	sf	$	40.00	$	240,000
			Dept of Homeland Security Baggage Handling	15,000	sf	$	30.00	$	450,000
			Baggage Makeup	23,000	sf	$	15.00	$	345,000
			Vacant	6,000	sf	$	10.00	$	60,000
			First Floor						
			Airline Operations	16,000	sf	$	40.00	$	640,000
			Concessions (Shell only)	3,500	sf	$	10.00	$	35,000
			Back of House / MEP	4,000	sf	$	10.00	$	40,000
			Public Non-secure Circulation	10,000	sf	$	55.00	$	550,000
			Ticket Queuing	500	sf	$	55.00	$	27,500
			Ticketing	1,000	sf	$	55.00	$	55,000
			Vacant	15,000	sf	$	10.00	$	150,000
Subtotal Interiors								***$***	***2,888,500***

C	***SERVICES***							
D10	**Conveying System**							
	D1010	Elevators & Lifts						
		D1012 Passenger Elevators	1	ea	$	75,000.00	$	75,000
D20	**Plumbing**							
	D2010	Plumbing Systems						
		New Terminal Construction						
		Airport Operations	6,000	sf	$	10.00	$	60,000
		Dept of Homeland Security Baggage Handling	15,000	sf	$	5.00	$	75,000
		Baggage Makeup	23,000	sf	$	5.00	$	115,000
		Vacant	6,000	sf	$	5.00	$	30,000
		First Floor						
		Airline Operations	16,000	sf	$	10.00	$	160,000
		Concessions (Shell only)	3,500	sf	$	10.00	$	35,000
		Back of House / MEP	4,000	sf	$	5.00	$	20,000
		Public Non-secure Circulation	10,000	sf	$	10.00	$	100,000
		Ticket Queuing	500	sf	$	10.00	$	5,000
		Ticketing	1,000	sf	$	10.00	$	10,000
		Vacant	15,000	sf	$	5.00	$	75,000
D30	**HVAC**							
	D3010	HVAC Systems						
		New Terminal Construction						
		Airport Operations	6,000	sf	$	30.00	$	180,000
		Dept of Homeland Security Baggage Handling	15,000	sf	$	15.00	$	225,000
		Baggage Makeup	23,000	sf	$	15.00	$	345,000
		Vacant	6,000	sf	$	5.00	$	30,000
		First Floor						
		Airline Operations	16,000	sf	$	30.00	$	480,000
		Concessions (Shell only)	3,500	sf	$	15.00	$	52,500
		Back of House / MEP	4,000	sf	$	15.00	$	60,000
		Public Non-secure Circulation	10,000	sf	$	30.00	$	300,000
		Ticket Queuing	500	sf	$	30.00	$	15,000
		Ticketing	1,000	sf	$	30.00	$	30,000
		Vacant	15,000	sf	$	10.00	$	150,000
	D3060	Controls and Instrumentation						
		New Terminal Construction						
		D3061 Building Automation Systems	100,000	sf	$	2.50	$	250,000
	D3070	Systems Testing & Balancing						
		New Terminal Construction						
		D3071 Air Systems Testing & Balancing	100,000	sf	$	1.00	$	100,000
D40	**Fire Protection**							
	D4010	Sprinklers						
		New Terminal Construction						
		Airport Operations	6,000	sf	$	3.50	$	21,000
		Dept of Homeland Security Baggage Handling	15,000	sf	$	5.00	$	75,000
		Baggage Makeup	23,000	sf	$	3.50	$	80,500
		Vacant	6,000	sf	$	5.00	$	30,000
		First Floor						
		Airline Operations	16,000	sf	$	3.50	$	56,000
		Concessions (Shell only)	3,500	sf	$	3.50	$	12,250
		Back of House / MEP	4,000	sf	$	3.50	$	14,000
		Public Non-secure Circulation	10,000	sf	$	3.50	$	35,000
		Ticket Queuing	500	sf	$	3.50	$	1,750
		Ticketing	1,000	sf	$	3.50	$	3,500
		Vacant	15,000	sf	$	3.50	$	52,500

		D4030	Fire Protection Specialties						
			D4031 Fire Extinguishers	10	ea	$	300.00	$	3,000
	D50	**Electrical**							
		D5010	Electrical Systems						
			New Terminal Construction						
			Airport Operations	6,000	sf	$	25.00	$	150,000
			Dept of Homeland Security Baggage Handling	15,000	sf	$	15.00	$	225,000
			Baggage Makeup	23,000	sf	$	15.00	$	345,000
			Vacant	6,000	sf	$	10.00	$	60,000
			First Floor						
			Airline Operations	16,000	sf	$	25.00	$	400,000
			Concessions (Shell only)	3,500	sf	$	10.00	$	35,000
			Back of House / MEP	4,000	sf	$	10.00	$	40,000
			Public Non-secure Circulation	10,000	sf	$	25.00	$	250,000
			Ticket Queuing	500	sf	$	25.00	$	12,500
			Ticketing	1,000	sf	$	25.00	$	25,000
			Vacant	15,000	sf	$	25.00	$	375,000
		D5020	Communications & Security						
			New Terminal Construction						
			G5021 Data/Communications	100,000	sf	$	4.00	$	400,000
			G5022 Security / Access Control	100,000	sf	$	5.50	$	550,000
			G5023 CCTV	100,000	sf	$	18.00	$	1,800,000
	Subtotal Services							***$***	***8,029,500***
E	***EQUIPMENT & FURNISHINGS***								
	E10	**Equipment**							
		E1090	Other Equipment						
			E1091 FF&E Allowance	22,000	sf	$	12.50	$	275,000
			E1094 Framing for Displays/Branding at Ticket Counters	1	ls	$	20,000.00	$	20,000
			E1097 Technology Kiosks	10	ea	$	25,000.00	$	250,000
			E1097 Technology Kiosks	10	ea	$	25,000.00	$	250,000
		D1090	Baggage Handling Equipment						
			Permanent Measures						
			D1092 Standard Conveyor	1,200	lf	$	1,300.00	$	1,560,000
			D1093 90 Degree Turn	10	ea	$	15,000.00	$	150,000
			D1094 45 Degree Turn	3	ea	$	15,000.00	$	45,000
			D1095 Claim Device - Makeup	600	lf	$	2,000.00	$	1,200,000
			D1096 Catwalks / Controls / Testing	1	ls	$	150,000.00	$	150,000
	E20	**Furnishings**							
		E2010	Fixed Furnishings						
			E2011 Fixed Casework						
			E2013 Ticket Counters	150	lf	$	1,500.00	$	225,000
			E2014 Check-in Kiosks	6	ea	$	5,000.00	$	30,000
			E2015 Misc. Casework Allowance	1	ls	$	100,000.00	$	100,000
			E2017 Misc. Seating etc.	1	ls	$	10,000.00	$	10,000
	Subtotal Equipment & Furnishings							***$***	***4,265,000***

F	***SPECIAL CONSTRUCTION & DEMOLITION***								
	F20	**Selective Building Demolition**							
		F2010	Building Elements Demolition						
			F2011	Interior Demolition - Renovation	20,000 sf	$	10.00	$	200,000
	Subtotal Special Construction & Demolition							***$***	***200,000***
G	***BUILDING SITEWORK***								
	G10	**Site Preparation**							
		G1010	Site Demolition						
			G1011	Demolition of Site Components	100,000 sf	$	5.00	$	500,000
			G1012	Demolition of Existing Apron	5,000 sy	$	15.00	$	75,000
		G1020	Site Earthwork						
			G1021	Excavation for New Slab on Grade Elevations	6,200 cy	$	15.00	$	93,000
			G1022	Site Dewatering	1 ls	$	20,000.00	$	20,000
			G1023	Erosion Control	1 ls	$	3,000.00	$	3,000
	G20	**Site Improvements**							
		G2010	Pavement						
			G2011	New Apron	5,000 sy	$	110.00	$	550,000
			G2012	Patch & Repair Existing Apron	5,000 sy	$	25.00	$	125,000
			G2013	New Pavement Markings at Apron	1 ls	$	20,000.00	$	20,000
			G2014	Unclassified Excavation for Pavement	5,000 sy	$	15.00	$	75,000
		G2020	Site Development						
			G2021	Signage	1 ls	$	20,000.00	$	20,000
	G30	**Site Mechanical Utilities**							
		G3010	Site Mechanical						
			G3011	Site Mechanical Allowance	1 ls	$	500,000.00	$	500,000
	G40	**Electrical Utilities**							
		G4010	Electrical Utilities						
		G4020	Site Lighting						
			G4021	Ramp Light Fixtures	4 ea	$	25,000.00	$	100,000
	Subtotal Building Sitework							***$***	***2,081,000***
	Subtotal Opinion of Probable Construction Cost (Building and Site)							***$***	***24,900,000***

EXHIBITS

Exhibit A
Document List

EXHIBIT A – DOCUMENT LIST

- The estimate reflects the documents listed herein (attached for reference).

  Description

  - Future Airport Layout Plan
  - Airport Development Plan Phasing

RICONDO®
& ASSOCIATES

HEADQUARTERS

CHICAGO
20 NORTH CLARK STREET
SUITE 1500
CHICAGO, ILLINOIS 60602
T 312.606.0611 F 312.606.0706

DALLAS/FORT WORTH AREA
909 LAKE CAROLYN PARKWAY
SUITE 850
IRVING, TEXAS 75039
T 214.989.4800 F 972.506.8678

PLEASE VISIT OUR WEBSITE AT:
WWW.RICONDO.COM