San Antonio International Airport
Strategic Development Plan

2021 AIRPORT MASTER PLAN

CHAPTER 4 – DEMAND/CAPACITY AND FACILITY REQUIREMENTS

JUNE 2021

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4 DEMAND/CAPACITY ANALYSIS AND FACILITY REQUIREMENTS

The demand/capacity analysis assesses the capacity of Airport facilities, and defines what additional facilities are necessary to accommodate the projected demand through the planning horizon, based on the inventory of existing facilities and the approved FAA aviation forecasts. The functional areas analyzed in this chapter include:

- Airfield (runway and taxiway design requirements, runway capacity, runway length);
- Passenger terminal, including aircraft gates and apron, public parking and rental car facilities
- Air cargo
- General aviation
- Aviation support
- Landside

4.1 AIRFIELD FACILITIES

This section outlines future airfield requirements to meet the long-term aviation demand defined in Chapter 4, *Aviation Activity Forecasts*. In addition to meeting the growing demand, the airfield should accommodate aircraft types expected to operate at the airport through the planning horizon. The main drivers of the analysis are the following factors:

- Capacity and safety of existing facilities
- Climate (wind coverage and temperature)
- Future activity and profile of aviation demand
- Projected fleet mix (and aircraft characteristics)

4.1.1 RUNWAYS ORIENTATION AND NUMBER

RUNWAY ORIENTATION

An analysis of wind coverage allows to determine the most advantageous orientation of runways required at an airport, by calculating the percentage of time certain crosswind values (10.5, 13, 16 and 20 knots) are not exceeded for each runway orientation. The desirable wind coverage for an airport is 95 percent. Two runways may be required to achieve the desired 95 percent wind coverage for the critical aircraft. A wind coverage analysis was conducted and considers weather observations for the most recent ten years (2008 through 2017 at the time of this analysis). **Appendix 4A** provides a memorandum summarizing the results of the wind coverage analysis.

At SAT, both Runways 13L-31R/13R-31L and 4-22 individually provide 95 percent or greater wind coverage for ADG III, IV and V aircraft, as shown in **Table 4.1-1**. However, neither runway alone provides sufficient wind coverage for smaller aircraft (A-I, B-I), and Runway 4-22 also does not provide sufficient wind coverage for A-II and B-II aircraft, as illustrated in red text in Table 4.1-1. Combined, however, the two SAT runway orientations provide 95 percent or greater wind coverage for all aircraft.

If an airport needs more than one runway to provide the required wind coverage, the additional runway (Runway 4-22 at SAT) is considered a "crosswind runway", with the purpose of providing the required wind coverage for smaller aircraft (A-I and B-I at SAT).

Table 4.1-1: Annualized Runway Wind Coverage by Runway (All Weather)

CROSSWIND COMPONENT	AIRPLANE DESIGN GROUP (ADG)	WIND COVERAGE		
		Runways 13-31	**Runway 4-22**	**Combined**
10.5 knots	A-I, B-I	94.2%	84.5%	98.8%
13 knots	A-II, B-II	97.5%	91.4%	99.8%
16 knots	A-III, B-III C-I through C-III D-I through D-III	99.5%	97.6%	99.9%
20 knots	All others	99.9%	99.5%	100.0%

Sources: Federal Aviation Administration, Advisory Circular 150/5300-13A, Change 1, *Airport Design*, February 2014; National Climatic Data Center, Weather Station 722530, San Antonio International Airport, 2008-2017; WSP USA, 2018.

To address stakeholder concerns about strong northerly winds in the winter months, a seasonal wind analysis was also conducted, with results shown in **Table 4.1-2**.

Table 4.1-2: Runways 13-31 Seasonal Wind Coverage (All Weather)

YEAR	MONTH	CROSSWIND			
		10.5 knots (A-I, B-I)	**13 knots (A-II, B-II)**	**16 knots (A/B-III, C/D-I through III)**	**20 knots (All others)**
2017	January	88.7%	94.1%	98.5%	99.9%
2017	November	89.4%	94.8%	98.9%	99.7%
2017	December	89.5%	94.1%	98.2%	99.7%
2017	November, December, January	89.4%	94.4%	98.5%	99.8%
2014	November, December, January	85.5%	92.3%	98.0%	99.7%
2011	November, December, January	90.5%	95.5%	99.2%	99.9%
2008	November, December, January	87.3%	92.5%	97.3%	99.4%
2008-2017	12 months	94.2%	97.5%	99.5%	99.9%

Sources: National Climatic Data Center, Weather Station 722530, San Antonio International Airport, 2008-2017; WSP USA, 2018.

In addition to the findings of the annualized wind coverage analysis, the seasonal analysis revealed that Runways 13-31s also do not provide 95 percent or higher wind coverage for A-II and B-II aircraft during the months of November through January (illustrated in red text).

Although a crosswind runway is only required for A-I and B-I aircraft based on annual wind coverage, the seasonal analysis of wind coverage shows that a crosswind runway accommodating A-II and B-II aircraft is also required during the winter months.

RUNWAY FUNDING ELIGIBILITY

The FAA determines the funding eligibility of runway projects based on runway definitions: primary, crosswind and secondary runways are eligible for funding, while additional runways are not. At SAT, per the FAA definitions of funding eligibility, Runway 13R-31L is a primary runway, Runway 4-22 is a crosswind runway for small aircraft up to A-II and B-II, and Runway 13L-31R is an additional runway.

As a result, when Runway 4-22 requires reconstruction, it is not eligible for reconstruction as a C/ D-III/IV runway. It might be eligible for FAA funding for reconstruction up to B-II airfield design standards, assuming the results of the seasonal wind coverage are applied; this will be assessed further in the *Alternatives Development Evaluation* chapter. When existing Runway 13L-31R requires reconstruction, it would not be eligible for FAA funding in its current role, as it does not meet requirements of a secondary runway.

4.1.2 AIRFIELD GEOMETRY

In addition to a significant evolution in aircraft characteristics, many airports were designed long before current geometry standards came into effect and, as a result, may not meet the latest standards set forth in FAA AC 150/5300-13A, *Airport Design*, Change 1. Airfield geometry is typically tailored to the projected critical aircraft.

CRITICAL AIRCRAFT

FAA AC 150/5000-17 on *Critical Aircraft and Regular Use Determination* defines the critical aircraft as the most demanding aircraft type, or grouping of aircraft with similar characteristics, operating at the airport with a minimum of 500 annual operations. Based on the FAA-approved forecast for SAT, the following aircraft were identified as the critical aircraft:

- Existing: Airbus 300-600F (C-IV)
- Future:
  - Passenger: Boeing 787-9 (D-V)
  - Cargo: Boeing 747-8F (D-VI)

Although the Boeing 747-8F is ADG VI, the entire airfield does not need to be designed for ADG VI requirements. Indeed, this aircraft type is associated with air cargo carrier UPS only, and is only anticipated to operate on Runways 13R-31L and 4-22 and associated taxiways. As such, airfield upgrades should be selective and cost-effective for accommodating the specific aircraft that use each portion of the infrastructure, specifically towards the UPS facility.

Beyond the FAA planning horizon (2038) toward 2068, it is projected that larger passenger aircraft, such as the Airbus A350-1000 and Boeing 777-8/-9 and 787-10 may operate at SAT. Requirements for these aircraft types will not drive the 20-year needs for SAT, but will be considered to inform the future alternatives, so as to not preclude the use of these aircraft through the 2068 planning horizon.

AIRPORT REFERENCE CODE

The Airport Reference Code (ARC) is composed of the Aircraft Approach Category (AAC) and the ADG. The ARC provides design standards based on operational and physical characteristics of aircraft expected to use the airport. AAC represents the aircraft approach speed and ADG is a combination of wingspan and tail height.

As shown in **Table 4.1-3**, the existing ARC for SAT is D-IV, and is anticipated to become D-V through the planning horizon based on passenger aircraft. Should the Boeing 747-8F cargo aircraft start operating at SAT, the ARC would become D-VI.

Table 4.1-3: Proposed Airport Reference Code

TIMEFRAME	CRITICAL AIRCRAFT	AIRPORT REFERENCE CODE
Existing	MD-11 (D-IV)	D-IV
Future	Passenger: Boeing 787-9/-10 (D-V) Cargo: Boeing 747-8F (D-VI)	Passenger: D-V Cargo: D-VI

Source: San Antonio International Airport Master Plan, *Approved Aviation Activity Forecasts*, 2018.

RUNWAY DESIGN CODE

The RDC provides information on runway design standards (dimensions, separations, etc.). The RDC, similar to the ARC, is based on the critical aircraft and is composed of the AAC, the ADG, and approach visibility minimums. Approach visibility relates to the approach visibility minimums for a specific runway.

Based on the FAA-approved forecast, SAT runways should be able to accommodate D-V aircraft on a regular basis. However, it would be prudent to plan for at least one D-VI runway, should regular activity by cargo aircraft such as the Boeing 747-8F materialize.

AIRFIELD DESIGN STANDARDS

The existing runway dimensions and airfield design standards for ADGs III, IV, V and VI are summarized in **Table 4.1-4**. Red text indicates that existing conditions do not meet standards.

Table 4.1-4: Airfield Design Standards

	RUNWAY 13L-31R		RUNWAY 4-22		RUNWAY 13R-31L			
Design Standard	Existing (B-III)	B-III Standards	Existing (D-IV)	D- IV Standards	Existing (D-IV)	D- IV Standards	D-V Standards	D-VI Standards
Runway Width	100’	100’	150’	150’	150’	150’	150’	150’
Shoulder Width	0’	20’	25’	25’	0’	25’	35’	40’
Blast Pad Width	100’ / 0’	140’	200’/ 220’	200’	150’/200’	200’	220’	280’
Blast Pad Length	150’ / 0’	200’	200’/ 400’	200’	200’	200’	400’	400’
Runway Safety Area								
Length Beyond	600’	600’	1,000’	1,000’	1,000’	1,000’	1,000’	1,000’
Length Prior To	600’	600’	600’	600’	600’	600’	600’	600’
Width	300’	300’	500’	500’	500’	500’	500’	500’
Runway Object Free Area								
Length Beyond	600’	600’	1,000’	1,000’	1,000’	1,000’	1,000’	1,000’
Length Prior To	600’	600’	600’	600’	600’	600’	600’	600’
Width	800’	800’	800’	800’	800’	800’	800’	800’
Runway Obstacle Free Zone								
Length Beyond	200’	200’	200’	200’	200’	200’	200’	200’
Width	400’	400’	400’	400’	400’	400’	400’	400’
Precision Obstacle Free Zone								
Length	N/A	N/A	200’	200’	200’	200’	200’	200’
Width	N/A	N/A	800’	800’	800’	800’	800’	800’
Approach Runway Protection Zone [1/]								
Length	1,000’	1,000’	1,700’	1,700’	2,500’	1,700’	2,500’	2,500’
Inner Width	500’	500’	1,000’	1,000’	1,000’	1,000’	1,000’	1,000’
Outer Width	700’	700’	1,510’	1,510’	1,750’	1,510’	1,750’	1,750’
Departure Runway Protection Zone								
Length	1,000’	1,000’	1,700’	1,700’	1,700’	1,700’	1,700’	1,700’
Inner Width	500’	500’	500’	500’	500’	500’	500’	500’
Outer Width	700’	700’	1,010’	1,010’	1,010’	1,010’	1,010’	1,010’
Runway-Parallel Taxiway Separation	410’	300’	400’	400’	400’	400’	400’/ 500’ [2/]	500’/550’ [2/]

Notes:

Red text indicates existing conditions do not meet design standards.

SM = statute mile

1/ Approach Runway Protection Zone Visibility Minimums:

Runway 13L-31R: > 1 statute mile

Runway 4-22: visual for B-II, > ¾ statute mile for C-IV

Runway 13R-31L: < ¾ statute mile

2/ Visibility Minimum < ½ statute mile

Sources: Federal Aviation Administration, Advisory Circular 150/5300-13A Change 1, *Airport Design*, 2014; San Antonio International Airport, *Airport Layout Plan,* June 2017.

RUNWAY DESIGN

Runways 13R-31L and 4-22 are designed for ADG IV aircraft, and Runway 13L-31R for ADG III aircraft. Should Runway 13R-31L remain, the critical aircraft is anticipated to become ADG V and possibly ADG VI within the planning period, requiring improvements to meet ADG V and ADG VI standards. Runway 4-22 is not required as a D-IV runway, and would not be eligible for FAA funding at D-IV design standards when the time comes to reconstruct it. It is anticipated that if Runway 4-22 were to remain, it would be downgraded to a B-II visual runway upon reconstruction. Runway 13L-31R is not required from a capacity or wind coverage perspective, and as such, would not be eligible for FAA funding when the time comes to reconstruct it.

RUNWAY INTERSECTIONS/HOT SPOTS

Intersecting runways are undesirable and often create "hot spots". Eliminating existing runway intersections or avoiding future intersections increases margins of safety, and is therefore recommended by the FAA. There are two hot spots at SAT, one where Runway 13R-31L intersects with Taxiway N, and one where Runways 13R-31L and 4-22 intersect. Additionally, intersecting runways, such as Runways 13R-31L and 4-22, cannot be used independently of each other, and therefore, either add no or very little airfield capacity.

RUNWAY WIDTH

All runways meet the design standard for their respective existing and potential future RDCs.

RUNWAY SHOULDERS

Paved shoulders are required for runways accommodating ADG IV aircraft and larger, and are recommended for runways accommodating ADG III aircraft. Runways 13R-31L and 13L-31R do not have paved shoulders. Twenty-foot wide shoulders are recommended to be added to Runway 13L-31R, and 40-foot wide shoulders are required on Runway 13R-31L to accommodate ADG VI aircraft. Runway 4-22 has 25-foot-wide paved shoulders that meet the ADG IV standards.

BLAST PADS

The Runway 4-22 blast pads are ADG IV-compliant. The Runway 13R-31L blast pads would need to be widened to either 220 feet or 280 feet, to meet ADG V or ADG VI standards, respectively. The Runways 13L-31R blast pads do not meet ADG III standards, and should be widened to 140 feet and lengthened to 200 feet.

RUNWAY/PARALLEL TAXIWAY SEPARATION DISTANCES

Separation distances between runways and parallel taxiways at SAT meet current FAA standards as reported in the 2017 SAT ALP. Should the Runway 13R-31L RDC increase to D-V or D-IV, the separation with Taxiway G would need to increase to either 500 feet or 550 feet respectively, based on approach visibility minimums less than ½ statute mile.

RUNWAY LENGTH REQUIREMENTS

The purpose of this section is to determine the runway length required to accommodate the forecast fleet mix through the planning horizon, for both takeoff and landing.

The main sources of information on aircraft performance for runway planning and design are the aircraft/airport compatibility manuals provided by the aircraft manufacturers – also known as Aircraft

Characteristics for Airport Planning (ACAP) and Airport Planning Manual (APM). These documents feature charts for different aircraft configurations (weight, flaps, etc.) and weather conditions (temperature, elevation, etc.). The operating weight of the aircraft has a considerable influence on the takeoff and landing performances. Runway length requirements were calculated for the Maximum Gross Takeoff Weight (MGTOW) and Maximum Landing Weight (MLW). Additionally, lower fuel (Boeing 747-8F on SAT-SDF route) and payload (Boeing 787-9 to Europe at 75% and 90% load factors) were also considered.

This approach may differ from the analysis individual airlines perform as part of the decision-making process, when considering new air service or a change of aircraft type – where market considerations and aircraft performance are balanced. Also, airlines are subjected to different standards than airports, and the runway length is not the only factor to be considered. Aircraft operators' specific criteria, such as the One Engine Inoperative (OEI) surface for ensuring the safety of large aircraft commercial flights performing takeoff with an engine failure, can prevent an airline from utilizing all the runway length available to clear objects. Therefore, this analysis assumes "unconstrained" runway length available – i.e. without obstacle limitations.

Methodology and Assumptions

The runway length requirements were determined in accordance with the guidance provided by FAA AC 150/5325-4B, *Runway Length Requirements for Airport,* for aircraft over 60,000 pounds. The following factors were taken into consideration:

- Local climate: Mean Daily Maximum Temperature (MDMT) of 97.6°F in August
- Airport elevation: 809.1 feet Above Mean Sea Level (AMSL)
- Runway characteristics:
  - Maximum difference in runway centerline elevations: effective runway gradient for Runway 13R-31L of 0.33 percent
  - Runway surface conditions
- Critical aircraft: MTOW, MLW and preferred flap settings (when available)

The FAA recommends computing the runway length requirements by grouping aircraft types with similar performance characteristics that "result in the longest recommended runway length".[1] The aircraft chosen for the runway length requirements are the Airbus A330-900neo, the Airbus A350-900, the Boeing 787-9, and the Boeing 747-8F. Also, the needs of the Boeing 777 family were evaluated for the period beyond the 2038 horizon.

<u>Typical Destinations for Heavy Aircraft:</u>

The forecast projects an increase in long-haul international service. The Boeing 787-9 could start operations to Europe by 2028, with daily flights in 2038. Furthermore, UPS expressed the desire to operate the Boeing

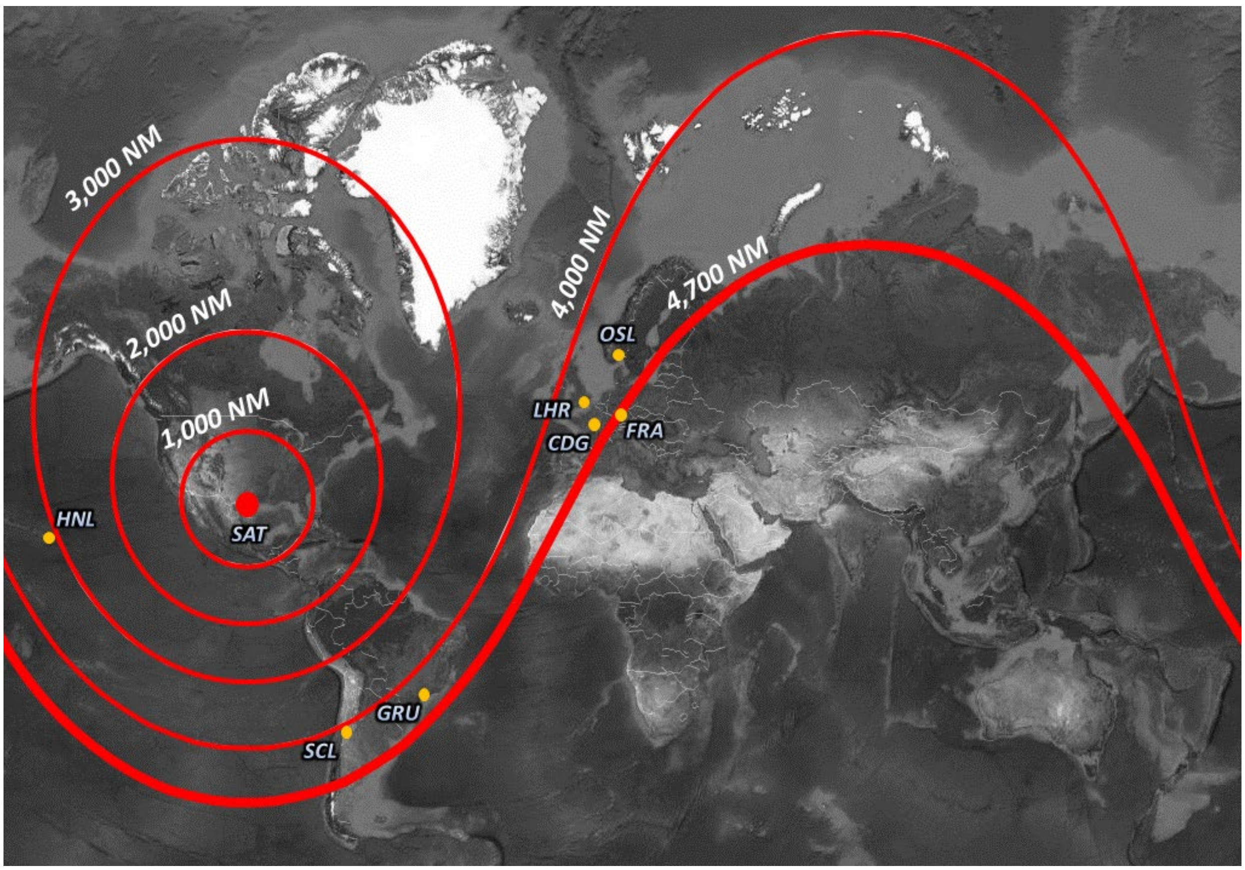
[1] FAA AC 150/5325-4B, Runway Length Requirements for Airport Design, Section 102.a.2, p. 1, 2005.

747-8F to its Louisville Muhammad Ali International Airport (SDF) hub from SAT as soon as possible. Therefore, the runway length requirements analysis was performed for various payloads and ranges:

- 4,700 nautical miles (NM), as a representative range to the large European hub airports, such as Amsterdam (AMS), London (LHR and LGW), Paris (CDG), Frankfurt (FRA) and Oslo (OSL). Today, the Boeing 757-200 and 767-300/400ER can fly to Europe from SAT's existing runways, but with reduced payload only.
- 800 NM to SDF, the U.S. hub for UPS

Figure 4.1-1 depicts range rings from SAT relevant to this analysis.

Figure 4.1-1: Range Rings from San Antonio



Source: WSP USA, 2018.

Landing and Take-Off Length Requirements

Take-off and landing runway length requirements were evaluated separately. Landing length requirements were assessed using the MLW, while take-off length requirements were assessed using the MGTOW or the Maximum Allowable Take-off Weight (MATOW). MATOW is the maximum weight an aircraft can take off at, based on local conditions (runway length, airport elevation). Additionally, take-off length requirements were assessed for load factors of 75 percent and 90 percent.

The landing and take-off runway length requirements for the current and future critical aircraft are summarized in **Table 4.1-5** and depicted on **Figure 4.1-2.**

Findings for the 20-year planning period:

- The Boeing 747-8F can operate on the existing 8,500-foot-long runways: UPS expressed the desire to operate the Boeing 747-8F to its SDF hub from SAT as soon as possible. The departure runway length requirement for this aircraft to this relatively close destination is 7,900 feet. However, this aircraft type currently cannot operate at SAT because its tail would penetrate the Part 77 Transitional Surface when parked on the UPS apron.
- Direct flights to certain western Europeans destinations are possible with the existing runway length (8,500 feet), but for the 20-year planning horizon, serving all European destinations with an extensive fleet mix would require a runway extension, depending on the aircraft. The runway length requirements to Europe for the critical aircraft, the Boeing 787-9, are:
  - MATOW: 13,200 feet (the longest length of several similar aircraft types)
  - 90% load factor: 12,500 feet
  - 75% load factor: 10,700 feet (more realistic load factor)

  Other suitable aircraft have requirements between 9,450 feet (Airbus A350-900) to 12,200 feet (Boeing 777-300ER).

Based on the Boeing 787-9 at a 75% load factor, the recommended runway length through the 20-year planning horizon is 10,700 feet. The actual runway length that can be achieved will be studied in *Chapter 5 - Alternatives Development and Evaluation*.

Considerations for runway length requirements beyond the planning period:

Potential new routes beyond Europe could require more length than 10,700 feet, up to 12,000 feet.

Table 4.1-5: Runway Length Requirements

AIRCRAFT	TYPICAL SEAT CAPACITY	ASSUMPTIONS	WEIGHT (LBS.)	LANDING LENGTH REQUIREMENT (FEET)	TAKE-OFF LENGTH REQUIREMENT (FEET)
A330-900neo[1,2]	287-303	MLW	421,000	TBD	N/A
		MTOW	554,000	N/A	TBD
		To 4,700 NM (Europe)	TBD	N/A	TBD
A350-900[1]	315-325	MLW	457,00	6,600	N/A
		MTOW	618,000	N/A	10,400
		To 4,700 NM (Europe)	580,000	N/A	9,450
		90% of Load Factor	568,000	N/A	8,800
		75% of Load Factor	550,000	N/A	8,250
767-200ER	174-245	MLW	300,000	6,300	N/A
		MTOW	395,000	N/A	11,540
		To 4,700 NM (Europe)	388,000	N/A	10,500
		90% of Load Factor	380,000	N/A	9,400
		75% of Load Factor	369,000	N/A	8,500
787-8	242-359	MLW	380,000	6,500	N/A
		MTOW	502,500	N/A	15,400[3]
		To 4,700 NM (Europe)	481,000	N/A	14,600
		90% of Load Factor	472,000	N/A	13,250
		75% of Load Factor	458,500	N/A	12,800
787-9[1,3]	290-406	MLW	425,000	7,200	N/A
		MTOW	560,000	N/A	14,050[3]
		To 4,700 NM (Europe)	544,000	N/A	13,200
		90% of Load Factor	532,000	N/A	12,500
		75% of Load Factor	514,500	N/A	10,700
747-8F[1]	N/A	MLW	763,000	9,000	N/A
		MTOW	987,000	N/A	13,350
		To 800 NM (SDF)	777,000	N/A	7,900

Notes:

MGTOW – Maximum Gross Takeoff Weight

MLW – Maximum Landing Weight

NM – Nautical Miles

SDF – Louisville International Airport

The Boeing 757-200 and 767-300/400ER can fly to Europe from SAT's existing runways with reduced payload only.

1 – Design aircraft per FAA approved forecasts.

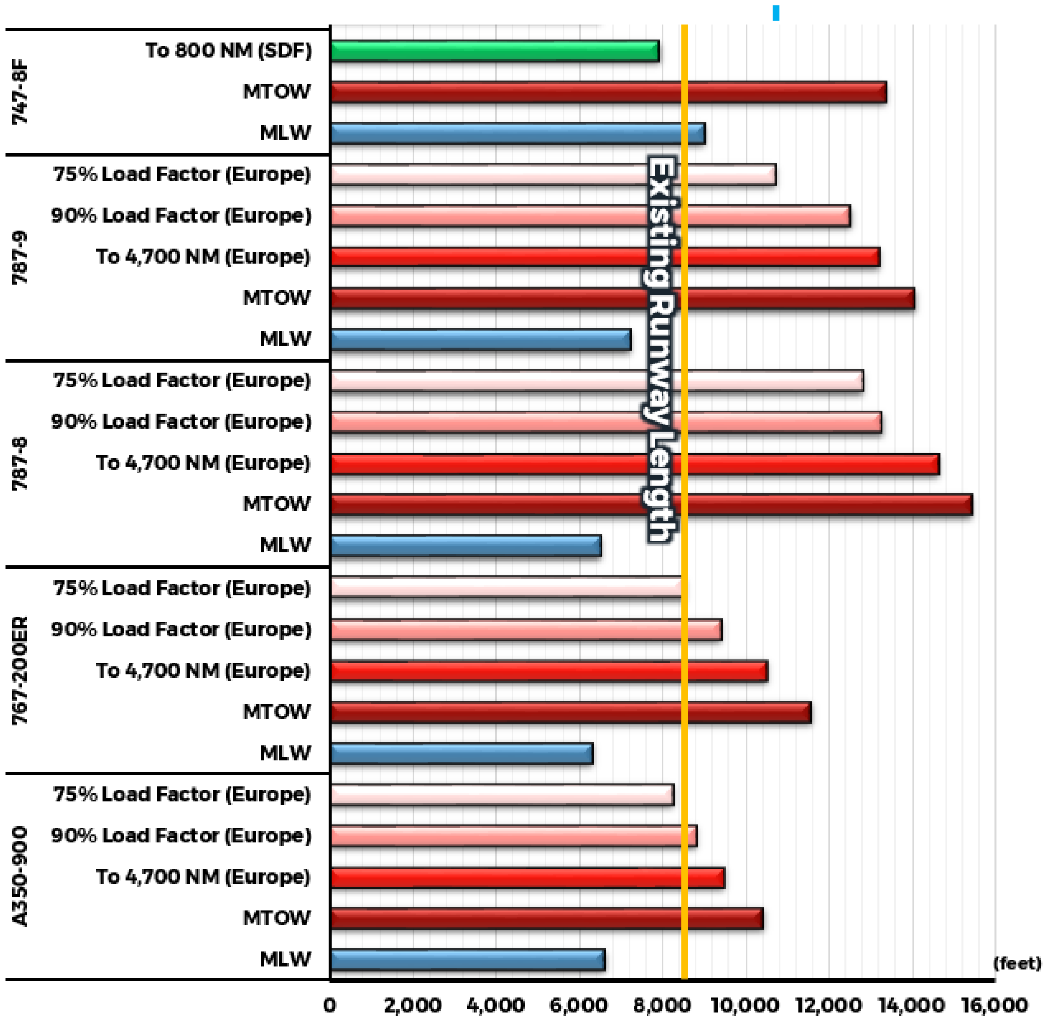
2 – Airbus has not yet released the takeoff performances of the A330-900neo.

3 – At SAT elevation, 787-8 cannot takeoff at MGTOW. The maximum weight allowed at SAT elevation is 494,000 lbs.

4 – At SAT elevation, 787-9 cannot takeoff at MGTOW. The maximum weight allowed at SAT elevation is 548,000 lbs.

Source: WSP USA, 2018.

Figure 4.1-2: Runway Length Requirements vs Existing Runway Length



Notes:

MLW – Maximum Landing Weight

MTOW – Maximum Takeoff Weight

NM – Nautical Miles

SDF – Louisville International Airport

Source: WSP USA, 2018.

Long-Term Climate Change Impacts

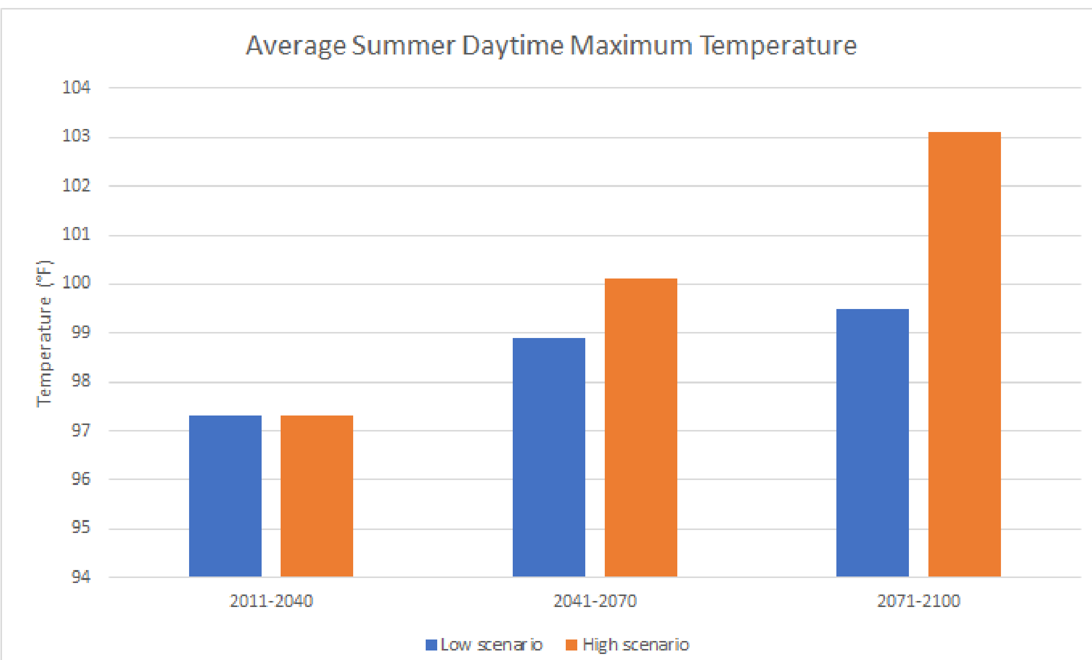
Per NOAA and the recently completed report of the City of San Antonio, *San Antonio Climate Ready Plan* of June 2018, San Antonio is likely to continue to warm up over the 21th century. The report has generated 21 global climate models proposed by the Coupled Model Inter-Comparison Project 5 (CMIP5). CMIP is a project developed by the World Climate Research Program (WCRP) that aims to realize climate simulations in coordinated ways between the different research groups, allowing a better estimation and understanding of the differences between the climate models.

For the *SA Climate Ready Plan*, two projections were explored: a scenario of the Climate Change of Lower Representative Concentration Pathway (RCP) 4.5, and a scenario of the higher RCP 8.5. These two scenarios encompass the uncertainty of human activities and emission of heat trapping gas. Each projection was averaged over 30-year periods, a typical interval used to estimate climatic norms.

The temperature projections for the City of San Antonio are depicted in **Figure 4.1-3** and summarized in **Table 4.1-6.**

The changes were computed for the Summer Daytime Maximum Temperature averaged over 30-year periods, which is a different concept than the Mean Daytime Maximum Temperature (MDMT) used in aviation planning. The MDMT assessment considers only the temperatures of the hottest month, whereas the Summer Daytime Maximum Temperature focuses on three whole months. However, the hottest month of the year in San Antonio is August and therefore, the same temperature increase was assumed for the MDMT.

Figure 4.1-3: Average Summer Daytime Maximum Temperature in San Antonio



Source: SA Climate Ready, Climate Projections for the City of San Antonio, June 2018.

Table 4.1-6: Forecasted Temperature for San Antonio

TEMPERATURE SCENARIO	2011-2040	2041-2070	2071-2100
Temperatures			
Low Scenario	97.3 °F	98.9 °F	99.5 °F
High Scenario	97.3 °F	100.1 °F	103.1 °F
Temperature Increase			
Low Scenario	97.3 °F	+1.6 °F	+2.2 °F
High Scenario	97.3 °F	+2.8 °F	+5.8 °F

Source: SA Climate Ready, Climate Projections for the City of San Antonio, June 2018.

There is a differential of 0.3°F between the MDMT computed and the average summer daytime maximum temperatures for the current 30-year period (2011-2040). For the following period, the analyses published in the *SA Climate Ready Plan* led to an increase by 1.6° F for the low scenario and by 2.8° F for the high scenario. Using these climate assumptions, the runway length required for the Boeing 787-9 flying to Europe has a sensitivity of an additional 125 feet per 1° F increase.

The runway lengths for the Boeing 787-9 operating for a 4,700-NM range are projected to need an additional 200 feet for a low climate change scenario, and an additional 350 feet for a high scenario, as shown in **Table 4.1-7**.

Table 4.1-7: 787 Runway Length Requirement Considering Long-Term Climate Change

TEMPERATURE	IMPACT ON TAKE-OFF LENGTH REQUIREMENT (FEET)
$MDMT_{2018}$[1]	Reference
$MDMT_{2018}$ + 1.6 °F	+200’
$MDMT_{2018}$ + 2.8 °F	+350’

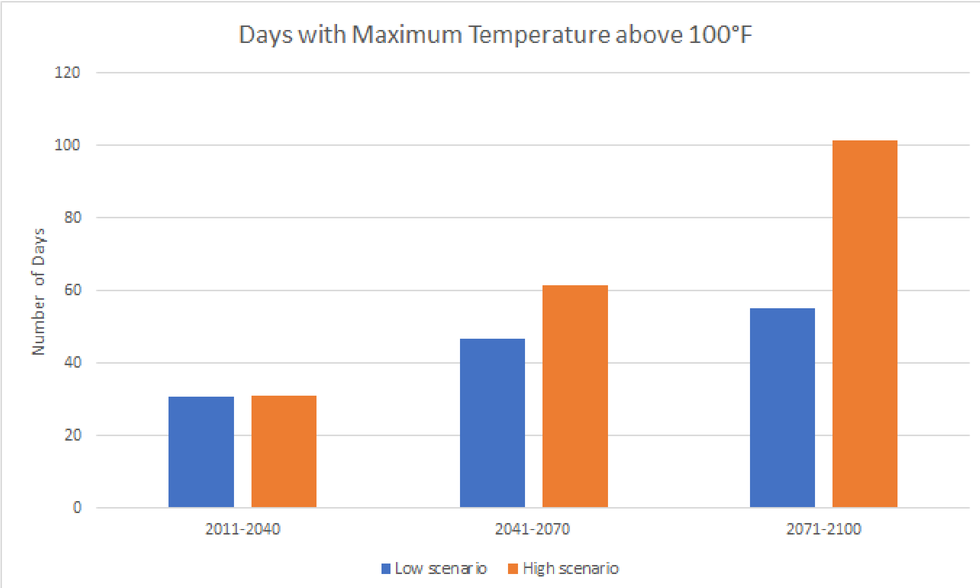
Notes:

MDMT – Mean Daytime Maximum Temperature

Source: WSP USA, 2018.

In addition, the *SA Climate Ready Plan* studied the annual number of hot days, defined as days with temperature over 100 °F (approximately but not identical as the MDMT), as shown in **Figure 4.1-4** and **Table 4.1-8**.

Figure 4.1-4: Annual Number of Days with the Maximum Temperature above 100°F



Source: SA Climate Ready, Climate Projections for the City of San Antonio, June 2018.

Table 4.1-8: Annual Number of Days with the Maximum Temperature above 100°F

SCENARIO	2011-2040	2041-2070	2071-2100
Annual Number of Days with Maximum Temperature above 100°F			
Low Scenario	31	47	55
High Scenario	31	61	101
Annual Number of Days Increase			
Low Scenario	31	+16	+24
High Scenario	31	+30	+70

Source: SA Climate Ready, Climate Projections for the City of San Antonio, June 2018.

During these hot days, based on a runway designed for the current MDMT per FAA standards, long-haul flights may experience operational restrictions as they will not be able to takeoff at their MGTOW. As runway planning advances, climate effects will need to be considered further.

RUNWAY AREAS

The FAA's design standards for the various runway areas at SAT are presented in this section. The following is a list of the airfield safety areas that were evaluated for the Airport:

- Runway Safety Areas
- Runway Object Free Areas
- Runway Obstacle Free Zones
- Runway Protection Zones

The existing ALP was used to determine the locations of objects that may affect navigation. The existing runway area deficiencies are described in more detail in this section.

RUNWAY SAFETY AREA

The RSA is a surface located at ground level and centered on the runway centerline. The RSA surrounds the runway and is designed to reduce the risk of damage to aircraft in the event of an undershoot, overshoot, or excursion from the runway. The surface shall be clear of objects except those required for air and ground navigation. RSA standard dimensions assume containing about 90 percent of aircraft that overrun and veer-off the runway within the RSA. RSA grades shall meet specific requirements: the longitudinal grade should be from 0 to -3 percent for the first 200 feet from the end of the runway, and to -5 percent for the last 300 feet. Transverse grades should be -1.5 to -3 percent away from the runway shoulder edge.

Per the 2010 SAT Master Plan and the 2017 SAT ALP, the existing RSAs meet design standards for aircraft anticipated to operate at SAT through 2038. Table 4.1-4 summarizes the standards for ADG IV, V and ADG VI RSAs.

RUNWAY OBJECT FREE AREA

The Runway Object Free Area (ROFA) is a surface located at ground level and centered on the runway centerline. The ROFA surrounds the runway and aims to enhance the safety of aircraft operations by clearing the area of objects, to avoid any collisions between aircraft and objects. The surface shall be clear of objects, except those required for air and ground navigation. The ROFA design standards for ADG VI are provided in Table 4.1-4, which shows different transverse grade standards for ADG IV and ADG V-VI. The maximum allowable slope between the edge of the RSA and the edge of the ROFA is 10:1 for ADG IV aircraft, and 16:1 for ADG V and ADG VI aircraft.

SAT's existing ROFAs are meeting FAA standards for ADG IV, V and VI, based on the 2017 SAT ALP.

OBSTACLE FREE ZONE

The Obstacle Free Zone (OFZ) shall be clear of objects, except for frangible navigational aids fixed by function. The OFZ is composed of a Runway Object Free Zone (ROFZ), an Inner-approach OFZ, and an Inner-transitional OFZ, as applicable.

The ROFZ is a volume of airspace centered above the runway centerline, with an elevation at any point that is the same as the elevation of the nearest point on the runway centerline. It extends 200 feet beyond the end of each runway and has a width of 400 feet for runway accommodating large aircraft (maximum takeoff weight greater than 41,000 pounds).

The Inner-approach OFZ is a volume of airspace centered on the approach area that applies only to runways equipped with an Approach Lighting System (ALS). This surface is 400 feet wide, begins 200 feet from the runway threshold at the same elevation as the runway threshold, and extends 200 feet beyond the last light unit in the ALS. The Inner-approach OFZ has a slope of 50:1.

The Inner-transitional OFZ is a volume of airspace along the sides of the ROFZ and Inner-approach OFZ, and applies to runways with lower than ¾ statute mile approach visibility minimums. It begins at the edge of the ROFZ and the Inner-approach OFZ, and then rises at a slope of 6:1 to a height of 150 feet above airport elevation for instrument approach category I (CAT I) runways. The Inner-approach OFZ cannot be penetrated by an aircraft tail.

The Precision Obstacle Free Zone (POFZ) applies to runways with precision instrument approaches. It is defined as a volume of airspace above an area beginning at the runway's landing threshold and centered on runway centerline. It extends 200 feet from the runway threshold, has a width of 800 feet and has the same elevation as the runway threshold elevation. The Precision OFZ can be penetrated by the wing of an aircraft holding on a taxiway waiting, but not by the fuselage or the tail of an aircraft.

At SAT, all runways have a ROFZ. Only Runways 13R-31L and 4-22 have an Inner-approach OFZ, Inner-transitional OFZ and a Precision OFZ. The 2017 ALP states that all OFZs meet FAA standards, i.e. there are no penetrations to the OFZs. Table 4.1-4 summarizes the dimensional standards for OFZs.

RUNWAY PROTECTION ZONE

The RPZ is a two-dimensional surface with the purpose to enhance the protection of people and property on the ground through specific land-use limitations designed to keep an area clear of incompatible uses, such as residences and public assembly buildings. The shape of this area is a trapezoid centered on the extended runway centerline. There are two types of RPZs: approach and departure. The dimensions of these areas are depending of the type of aircraft and the approach visibility minimums. FAA AC 150/5300-13A recommends that the airport have control of the RPZs and have it "clear of all above-ground objects". When it is not practical to have complete control of the entire RPZ, the airport should at a minimum obtain avigation easements to keep the RPZ clear of incompatible objects and activities.

Table 4.1-4 provides the standard RPZ dimensions. **Table 4.1-9** summarizes the portions of the existing RPZs that are not within airport property, and that have incompatible land uses. These include the RPZs for Runway 4, Runway 22, Runway 13L and Runway 31L. FAA policies recommend mitigation such as land acquisition, avigation easements and removal of incompatible land uses inside the RPZ[2].

Table 4.1-9: Existing Runway Protection Zones Off Airport Property

OFF-AIRPORT RUNWAY PROTECTION ZONE LAND USE	RUNWAY 4-22		RUNWAY 13L-31R		RUNWAY 13R-31L	
	4 End	22 End	13L End	31R End	13R End	31L End
Incompatible Land Use						
Buildings (acres)	3.2	0.0	1.0	6.1	0.0	0.0
Public Roadways (acres)	3.2	0.0	16.7	1.8	0.0	0.0
Compatible Land Use (acres)	0.0	1.4	0.0	0.0	0.0	0.0
TOTAL PER RUNWAY (acres)	7.8		25.6		0.0	
TOTAL (acres)	33.4					

Source: San Antonio International Airport, *Airport Layout Plan,* June 2017.

[2] Federal Aviation Administration, Interim Guidance on Land Uses Within a Runway Protection Zone, September 2012.

TAXIWAY DESIGN

Taxiway upgrades should be selective and cost-effective for accommodating the specific aircraft that use each portion of the infrastructure.

TAXIWAY WIDTH

Table 4.1-10 compares the existing and standard width of the SAT taxiway network, based on the existing TDG. Red text indicates deficiencies. Future width requirements were not evaluated, as the proposed airfield layout will be determined in Chapter 6 – *Alternatives Development and Evaluation*.

Figure 4.1-5 depicts the three taxiways that do not meet existing width standards:

- Taxiway E
- The northern part of Taxiway J
- Taxiway P

Taxiway E has a width of 40 feet. This portion of Taxiway E provides access to the east GA apron, where the FBOs occasionally serve large charter aircraft, and have expressed the desire for a wider taxiway. In addition, the south end of this apron is served by a TDG 6 taxiway. The two other taxiways are both TDG 3 and only have a width of 40 feet, instead of 50 feet. Therefore, enhancements are recommended for these taxiways to meet existing design standards.

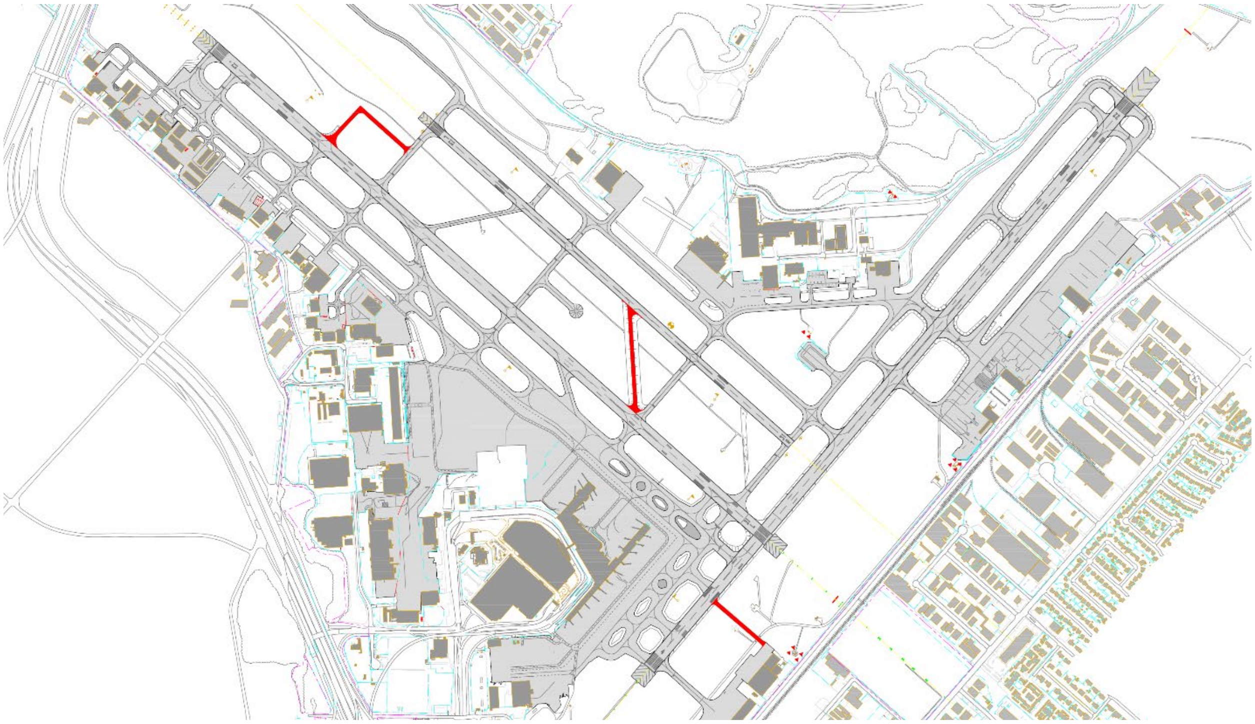
Table 4.1-10: Existing and Standard Taxiway Widths

TAXIWAY	EXISTING TAXIWAY DESIGN GROUP	STANDARD TAXIWAY WIDTH (IN FEET)	EXISTING TAXIWAY WIDTH (IN FEET)
A	6	75	75
B	5	75	75
D (West of Taxiway N)	6	75	75
D (East of Taxiway N)	6	75	130
E (East of Taxiway N)	6	75	40
F	4	50	75
G	6	75	75
G1	4	50	130
G2	4	50	135
G3	4	50	135
H	6	75	75
J (North of Runway 13R-31L)	3	50	40
J (South of Runway 13R-31L)	6	75	75
K	6	75	90
L	6	75	75
M	3	50	50
N	6	75	75
N1	6	75	100
N2	6	75	132
N3	6	75	102
N6	6	75	130
N7	6	75	100
N8	6	75	100
P	3	50	40
Q	6	75	75
Q1	6	75	100
R	6	75	75
S	6	75	75
T	5	75	75
V	6	75	82
W	6	75	110
Y	6	75	80
Z	6	75	150
RC	2	35	50

Note: Red text indicates deficiencies in meeting design standards.

Sources: San Antonio International Airport, *Airport Layout Plan,* June 2017; Source: Federal Aviation Administration, Advisory Circular AC 150/5300-13A Change 1, *Airport Design*, 2014.

Figure 4.1-5: Taxiways with Non-Compliant Widths



Source: San Antonio International Airport Layout Plan, 2017; WSP USA, 2018.

TAXIWAY SHOULDERS AND FILLETS

Paved shoulders are required for taxiways, taxilanes and aprons accommodating ADG IV and higher aircraft, and are recommended for taxiways, taxilanes and aprons accommodating ADG III aircraft. **Table 4.1-11** summarizes taxiway fillets and shoulder standards.

Table 4.1-11: Taxiway Shoulder and Fillets Standards

DESIGN STANDARDS	TAXIWAY DESIGN GROUPS 3 AND 4	TAXIWAY DESIGN GROUPS 5 AND 6
Taxiway Edge Safety Margin	10’	15’
Taxiway Shoulder Width	20’	30’

Source: Federal Aviation Administration, Advisory Circular AC 150/5300-13A Change 1, *Airport Design*, 2014.

Most of SAT’s taxiways do not have paved shoulders; shoulders should be added to taxiways that accommodate ADG IV aircraft or larger as part of these taxiways’ next pavement rehabilitation project.

Since 2013, taxiway fillets were improved on Taxiways D, G, J, N, Q and W. A taxiway fillet analysis is recommended as part of a subsequent study to assess taxiway turning movements with insufficient taxiway edge safety margins (TESM).

TAXIWAY PROTECTION AREAS

The terminal apron and a service road penetrate the existing ADG IV Taxiway H object free area, north of Terminals A and B, and the Purple Lot. The available OFA is only 100 feet wide on this side of the Taxiway

H centerline, for a requirement of 129.5 feet. The southern edge of the service road/terminal apron is 125 feet from the Taxiway H centerline; as such, approximately 4 feet of apron are inside the taxiway OFA.

Additionally, ADG V and VI taxiway protection standards will be considered in Chapter 6 - *Alternatives Development and Evaluation*, where appropriate.

PARALLEL TAXIWAY

A full length parallel taxiway is required for instrument approach procedures with visibility minimums below one SM, and recommended for all other conditions.

Runways 13R-31L and 4-22 both have instrument approaches with visibility minimums below one SM, and both have a full-length parallel taxiway, Taxiway G and Taxiway N, respectively, and two partial-length parallel taxiways, Taxiway H and Taxiway Q, respectively.

Additionally, Runway 13L-31R has a full-length ADG IV parallel taxiway, Taxiway R.

RUNWAY ENTRANCE AND EXIT TAXIWAYS

Runway entrance and exit taxiways connect runways to the taxiway network. An entrance taxiway may also be used as an exit taxiway. The FAA recommends two types of runway entrance/exit taxiways: right-angled exit taxiways and high-speed exit taxiways. A right-angled taxiway forms a 90-degree angle with the runway centerline, which provides the pilot with the best visual perspective and thus increases safety. A high-speed exit taxiway typically forms a 30-degree angle with the runway. It is designed to allow an aircraft to exit a runway without decelerating to typical taxi speed, thus reducing the Runway Occupancy Time (ROT) and increasing runway capacity if located properly.

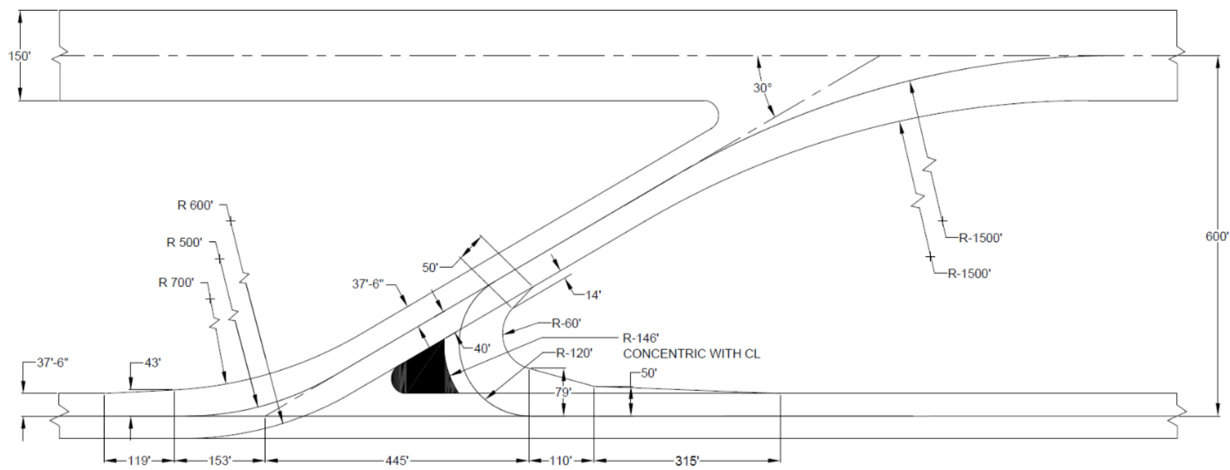
Geometry

Runways 13R, 13L, and 31R ends have four angled exit taxiways: Taxiways B, L, M and P. The geometry of these exit taxiways does not meet the FAA design standards (see **Figure 4.1-6**) for high-speed exit taxiways, as their initial radius is too short.

Additionally, high-speed runway exits should not connect directly to another runway (such as Taxiways M and P), nor should connect to the outer of two parallel taxiways (such as Taxiway B to Taxiway H). As such, Taxiways B, L, M and P are not considered to be high-speed exit taxiways.

However, these taxiways still allow aircraft to exit Runway 13R-31L through Taxiways B, L, M and P at a design speed of 35 knots, 20 knots, 11 knots and 11 knots, respectively, instead of approximately 50 knots per high-speed exit standards, as shown in **Table 4.1-12**. To avoid confusions and allow aircraft to vacate the runway at 50 knots, their geometry could be corrected and their initial radius from the runway to the taxiway should be increased to 1,500 feet.

Figure 4.1-6: Taxiway Design Group-5 High-Speed Exit Taxiway Standard Geometry



Source: Federal Aviation Administration, Advisory Circular 150/5300-13A, Change 1, *Airport Design*, February 2014.

Table 4.1-12: Characteristics of Existing Angled Taxiways

DESIGNATION	RUNWAY	INITIAL TURN RADIUS	DESIGN SPEED	LANDING DISTANCE AVAILABLE	THEORETICAL CUMULATIVE UTILIZATION PERCENTAGE
B	31L	890’	35 knots	2,830’	30% - T 99% - S
M	31L	85’	11 knots	3,026’	40% - T 100% - S
L	31L	290’	20 knots	5,239’	75% - H 80% - L 100% - T 100% - S
P	13L	80’	11 knots	3,000’	40% - T 100% - S

Notes:

S - Small, single engine aircraft: 12,500 lbs. or less;

T - Small, twin engine aircraft: 12,500 lbs. or less;

L - Large aircraft: 12,500 lbs. to 300,000 lbs.;

H - Heavy aircraft: > 300,000 lbs.

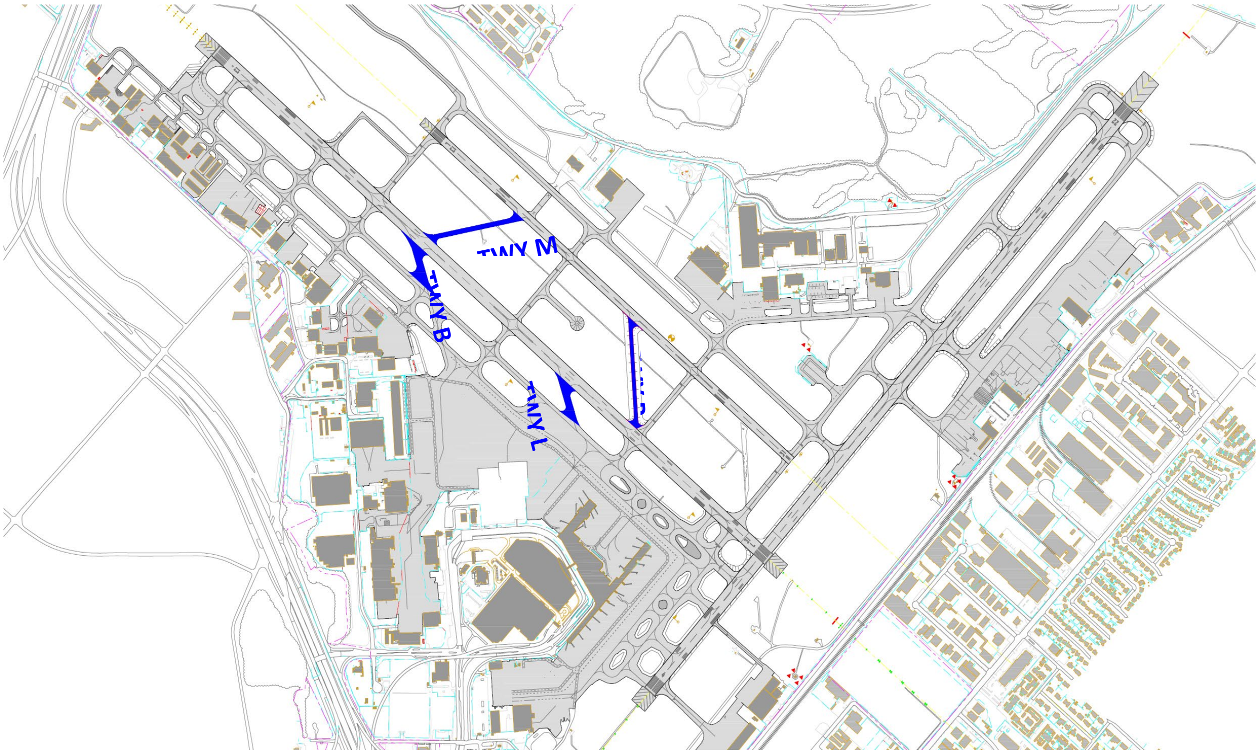
Source: Federal Aviation Administration, Advisory Circular 150/5300-13A, Change 1, *Airport Design*, February 2014.

Location

ATCT personnel mentioned that the existing angled runway exit taxiways are not in optimal locations. Taxiways B, M and P are located at approximately 3,000 feet from the runway threshold, as shown on **Figure 4.1-7,** and intercept a significant part of the general aviation traffic landing on Runway 13L and 13R. Taxiway L is strategically located for utilization by most of the fleet landing on Runway 13R. There is no angled exit taxiway on Runway 4-22.

Should the airfield capacity analysis warrant it, additional angled or high-speed exit taxiways could be considered to capture future critical aircraft with longer landing distances (e.g., Airbus A350, Boeing 747-8, Boeing 787).

Figure 4.1-7: Angled Exit Taxiways



Source: San Antonio International Airport, *Airport Layout Plan,* June 2017.

TAXIWAY GEOMETRY

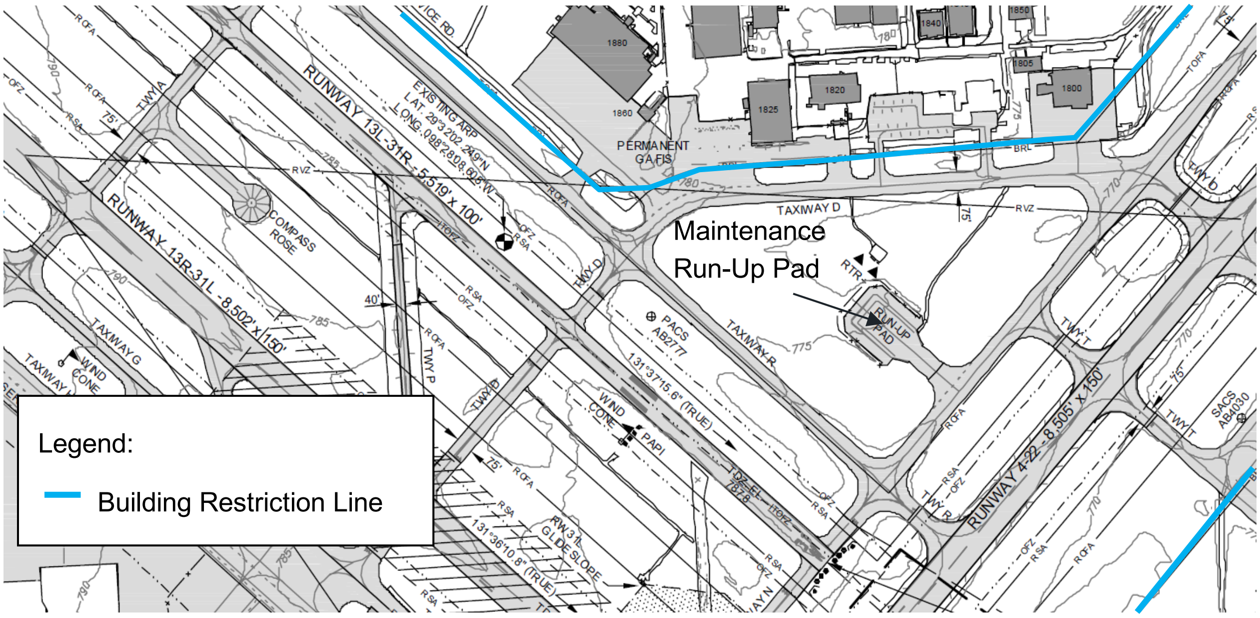
The main areas of taxiway geometry concern are Hot Spots 1 and 2, where two runways and a runway and taxiway intersect, respectively. The airfield alternatives analysis will consider eliminating runway intersections, and propose a future airfield layout that is compliant with the latest taxiway geometry guidance.

BUILDING RESTRICTION LINE

FAA AC 150/5300-13A defines the Building Restriction Line (BRL) as a "line that identifies suitable and unsuitable locations for buildings on airports". A BRL delimitates adapted building areas that are beyond the RPZ, the OFA, the ROFZ, the FAA Terminal Instrument Procedures (TERPS) surfaces and the Runway Visibility Zone (RVZ). A modification to this standard may be approved by the FAA if an acceptable level of safety is maintained, such as the airport having a 24-hour control tower with a clear line-of-sight (LOS). The existing BRL is offset 750 feet from the Runway 4-22 and Runway 13R-31L centerlines. On the north part of Runway 13L-31R, the separation reaches 540 feet. The only existing BRL issue is the engine maintenance run-up pad located within the RVZ, as depicted in **Figure 4.1-8**. The *1998 SAT Master Plan* states that the ATCT LOS has been designed to be compliant with ADG V aircraft, providing an adequate level of safety for the engine maintenance run-up pad.

The future BRL should be evaluated as part of the *Alternatives Development and Evaluation* in Chapter 6.

Figure 4.1-8: Building Restriction Line Between Runways 13R-31L and 4-22



Source: San Antonio International Airport, *Airport Layout Plan,* June 2017.

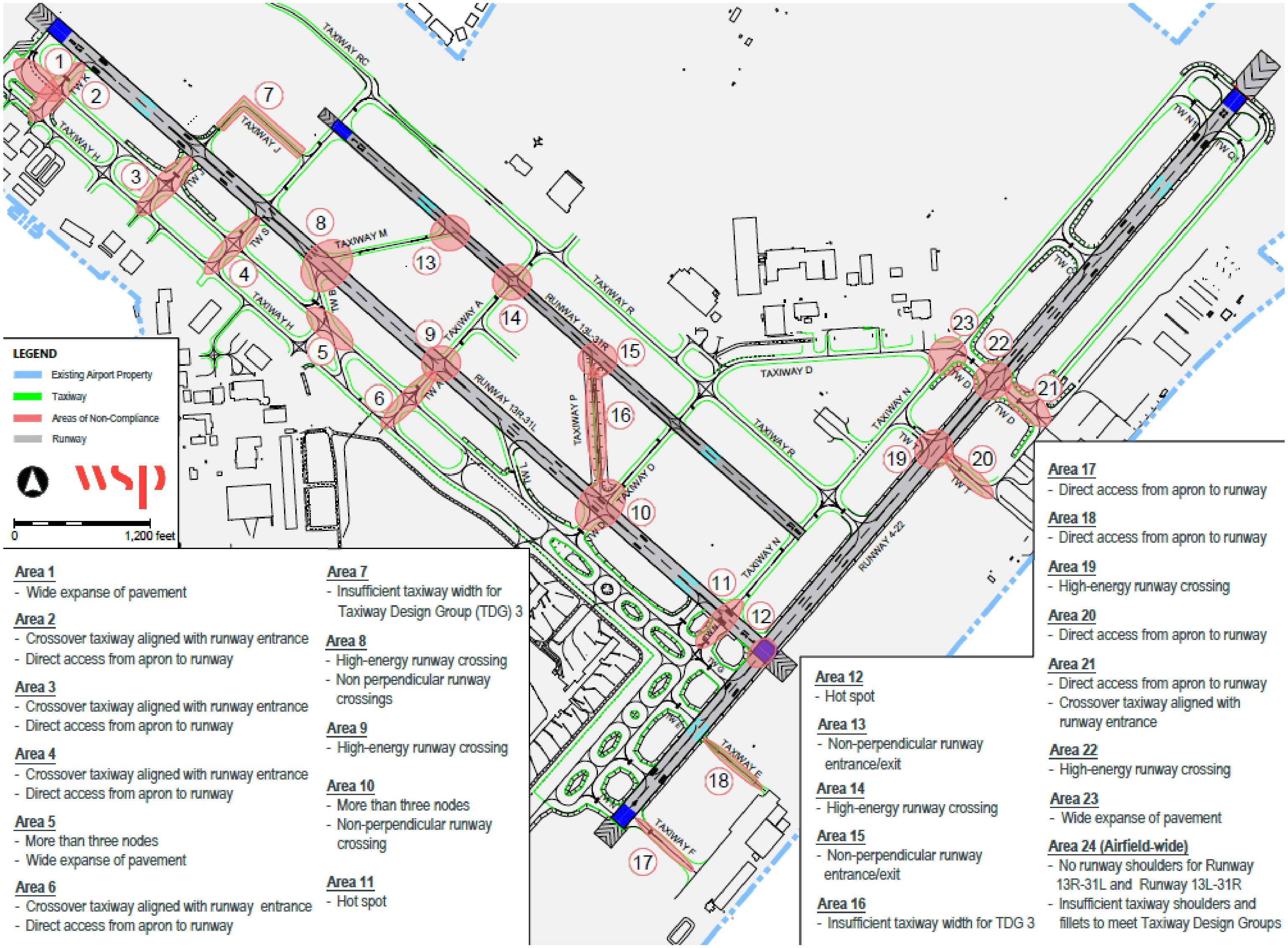
4.1.3 AIRFIELD GEOMETRY AREAS OF NONCOMPLIANCE

An assessment of airfield geometry principles and dimension standards at SAT was conducted to assess compliance with the airfield geometry guidance set forth in the FAA AC 150-5300-13A, Airport Design (Change 1). A total of 24 areas of noncompliance were identified and are highlighted in **Figure 4.1-9.**

Areas 1 through 6 are specific areas located at the southern part of Runway 13R-31L. Areas 7 through 16 are specific areas on or between Runway 13R-31L and Runway 13L-31R with Areas 11 and 12 being hotspots. Areas 17 through 23 are specific areas situated along Runway 4-22. Area 24 is airfield-wide.

- **Area 1** - Between Taxiway Z and Taxiway K east of Taxiway H:
  - Wide expanse of pavement.
- **Area 2** - Taxiway K between Runway 13R-31L and hangar apron:
  - Crossover taxiway aligned with Runway 13R-31L entrance
  - Direct access from apron to runway.
- **Area 3** - Taxiway J between Runway 13R-31L and hangar apron:
  - Crossover taxiway aligned with Runway 13R-31L entrance.
  - Direct access from apron to runway.

Figure 4.1-9: Airfield Geometry Areas of Noncompliance



Source: San Antonio International Airport, *Airport Layout Plan,* June 2017; WSP USA, 2020 (analysis).

- **Area 4** - Taxiway S between Runway 13R-31L and hangar apron:
  - Direct access from apron to runway.
  - Crossover taxiway aligned with Runway 13R-31L entrance
- **Area 5** - Taxiway A, between Runway 13R-31L and hangar apron:
  - More than three nodes.
  - Wide expanse of pavement
- **Area 6** - Taxiway A, between Runway 13R-31L and Hangar Apron:
  - Crossover taxiway aligned with Runway 13R-31L entrance.
  - Direct access from Apron to Runway.
- **Area 7** - Taxiway J North of Runway 13R-31L:
  - Insufficient taxiway width (40 ft.) Taxiway Design Group (TDG) 3 taxiways (50 ft.).
- **Area 8** - Taxiway M/B Intersection with Runway 13R-31L:
  - High-energy runway crossing.
  - Non-perpendicular runway crossings.

  The Airfield Capital Improvement includes a project for the removal of existing Taxiway M to resolve the issue of runway crossing.
- **Area 9** - Taxiway A and Runway 13R-31L intersection:
  - High-energy runway crossing.
- **Area 10 –** Taxiway P and Runway 13R-31L intersection:
  - More than three nodes.
  - Non-perpendicular runway crossing.

  The Airfield Capital Improvement includes a project for the removal of existing Taxiway P to resolve the issue.
- **Area 11** - Intersection of Taxiway N and Runway 13R-31L:
  - Hot Spot.
- **Area 12** - Intersection of Runway 13R-31L and Runway 4-22:
  - Hot Spot.
- **Area 13** - Taxiway M Intersection with Runway 13L-31R:
  - Non-perpendicular runway entrance/exit.

  The Airfield Capital Improvement includes a project for the removal of existing Taxiway M to resolve the issue.
- **Area 14** - Taxiway A and Runway 13L-31R intersection:

  - High-energy runway crossing.
- **Area 15** - Taxiway P and Runway 13L-31R intersection:
  - Non-perpendicular runway entrance/exit.
- **Area 16** - Taxiway P between Runway 13R-31L and Runway 13L-31R:
  - Insufficient taxiway width (40 ft.) Taxiway Design Group (TDG) 3 taxiways (50 ft.).
- **Area 17** - Taxiway F between Runway 4-22 and Hangar Apron:
  - Direct access from apron to runway.
- **Area 18** - Taxiway E between Runway 4-22 and Hangar Apron:
  - Direct access from apron to runway.
- **Area 19** - Taxiway T and Runway 4-22 intersection:
  - High-energy runway crossing.
- **Area 20** - Taxiway F between Runway 4-22 and Hangar Apron:
  - Direct access from apron to runway.
- **Area 21** – Taxiway D between Runway 4-22 and Hangar Apron:
  - Direct access from apron to runway.
  - Crossover taxiway aligned with Runway 4-22 entrance.
- **Area 22** – Taxiway T and Runway 4-22 intersection:
  - High-energy runway crossing.
- **Area 23** – Intersection of Taxiway D and Taxiway N:
  - Wide Expanse of Pavement.
- **Area 24** – Airfield-wide:
  - Runways: No runway shoulders for Runway 13R-31L to meet the standard for Runway Design Code (RDC) D-IV (25ft.) and Runway 13L-31R for RDC C-II (20 ft.).
  - Taxiways: Insufficient taxiway shoulders and fillets to meet the respective Taxiway Design Group.

4.1.4 AIRFIELD DEMAND/CAPACITY ANALYSIS

Airfield capacity is defined by the FAA as a measure of the airfield's ability to accommodate the maximum number of aircraft operations. The purpose of calculating airfield capacity is to compare the existing capacity and the forecast demand to determine whether the airfield is capable to handle the operations without significant delay.

The capacity of the airfield is not constant over time, there are several factors that could affect the capacity including:

- Efficiency and safety of existing airfield and airspace
- Wind coverage and runway orientations
- Weather conditions and runway use
- Future level of demand
- Future fleet mix
- Taxiway exit locations

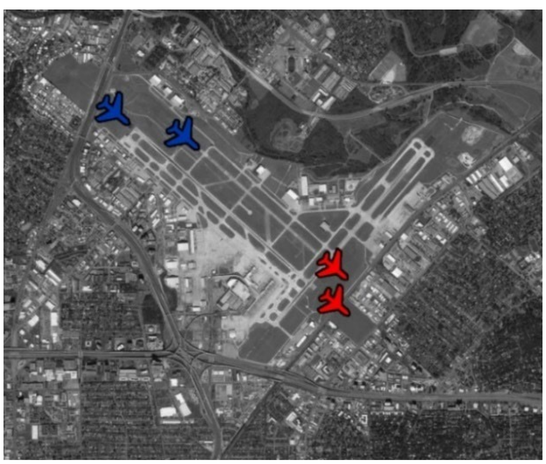
FAA AC 150/5060-5 on *Airport Capacity and Delay* provides guidance to estimate Hourly Airport Capacity, Aircraft Delay, and Annual Service Volume (ASV):

- The Hourly Airport Capacity is defined as "a measure of the maximum number of aircraft operations which can be accommodated on the airport in an hour"
- Aircraft Delay is defined as "the difference between constrained and unconstrained operating time"
- ASV is defined as "a reasonable estimate of an airport's annual capacity. It accounts for differences in runway use, aircraft fleet mix, weather conditions, etc. that would be encountered over a one-year timeframe

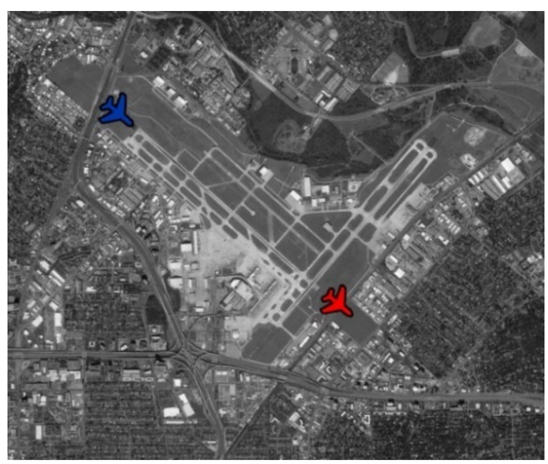
CURRENT RUNWAY CONFIGURATION

SAT's airfield is comprised of three runways: two parallel and one crosswind. Runway 13R-31L, the primary runway, is 150 feet wide and 8,505 foot-long. Runway 4-22 crosses the Runway 31 threshold 2,000 feet from the Runway 4 threshold. Runway 4-22 is 8,504 feet long and 150 feet wide. Runway 13L-31R is a GA runway with a RDC of B-III. The two parallel runways, Runway 13R-31L and Runway 13L-31R, are separated by 990 feet. The runway configurations used to assess airfield capacity are assumed to be the same as the ones in the *2010 SAT Master Plan*. They are depicted in **Figure 4.1-10, Figure 4.1-11** and **Figure 4.1-12**.

Figure 4.1-10: Eastbound Runway Configuration



VFR (51.8%)



IFR (5.4%)

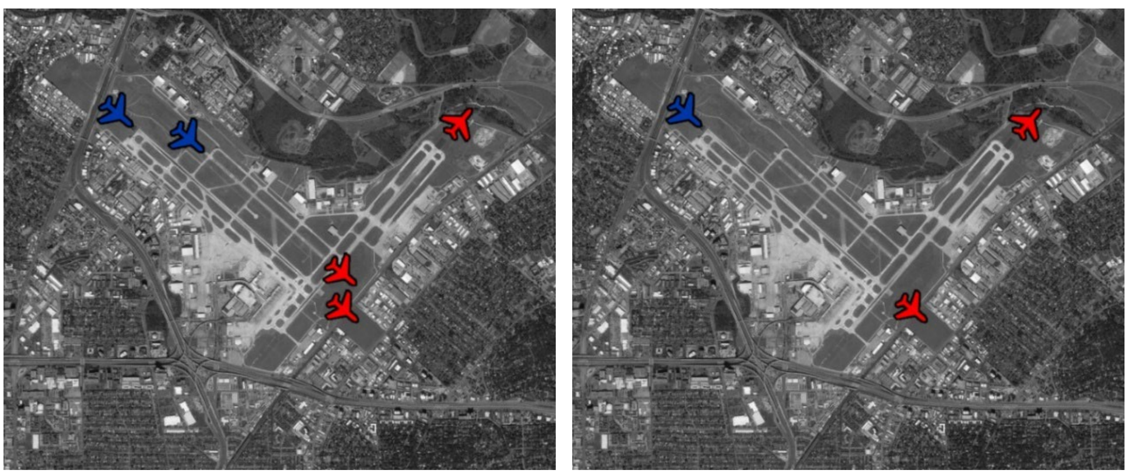
Sources: San Antonio International Airport, *Airport Master Plan*, 2010.

Figure 4.1-11: Westbound Runway Configuration

VFR (22.0%) **IFR (2.8%)**

Sources: San Antonio International Airport, *Airport Master Plan*, 2010.

Figure 4.1-12: Northbound Runway Configuration



VFR (15.8%) **IFR (2.2%)**

Sources: San Antonio International Airport, *Airport Master Plan*, 2010.

AIRCRAFT FLEET MIX

The aircraft fleet mix is the main factor affecting airport capacity. During arrival operations, the separation between aircraft will differ depending on the type and size of aircraft, to avoid wake turbulence. This separation will impact the number of operations per hour, and thus airport capacity. The mix index is based on the different aircraft classes, defined in the FAA AC 150/5060-5, *Airport Capacity and Delay*. Each aircraft class categorizes aircraft based on MTOW and the number of engines. However, recently, the threshold of each category has changed and AC 150/5060-5 does not consider the wake recategorization (RECAT) aircraft separations in force at SAT TRACON/ATCT. For this study, the aircraft classification was modified to reconcile, as far as practicable, these separations with the methodology of the AC, as shown in **Table 4.1-13.**

Table 4.1-13: Aircraft Classification

<table>
<tr><th>*MAXIMUM TAKEOFF WEIGHT*</th><th colspan="2">FAA AC 150/5060-5 (1983)</th><th colspan="2">ASSUMED CLASSIFICATION FOR THE 2018 SAT SDP</th><th colspan="3">RECAT
FAA JO 7110.689C (2014)</th></tr>
<tr><td>**Up to 12,500 lbs.**</td><td>A: Single Engine</td><td>B: Multiple Engines</td><td rowspan="2">A: Single Engine</td><td rowspan="2">B: Multiple Engines</td><td colspan="2" rowspan="2">F:
125’ > wingspan</td><td rowspan="5">C & D:
175‘ > w > 125‘</td></tr>
<tr><td>**Up to 41,000 lbs.**</td><td colspan="2" rowspan="3">C</td></tr>
<tr><td>**Up to 225,000 lbs.**</td><td colspan="2" rowspan="2">C</td><td colspan="2" rowspan="2">E:
90’ > wingspan > 65’</td></tr>
<tr><td>**Up to 300,000 lbs.**</td></tr>
<tr><td>**Over 300,000 lbs.**</td><td colspan="2">D</td><td colspan="2">D</td><td>A:
w > 245’</td><td>B:
245’ > w > 125’</td></tr>
</table>

Notes:

FAA AC – Federal Aviation Administration Advisory Circular

FAA JO - Federal Aviation Administration Order

lbs. - pounds

RECAT – Recategorization

SAT SDP – San Antonio International Airport Strategic Development Plan

Source: Miscellaneous sources.

The aircraft fleet mix used to estimate Hourly Airport Capacity, Aircraft Delay and ASV is based on the forecast. The fleet mix was separated between commercial operations and GA operations. **Table 4.1-14** presents the fleet mix for each planning year, based on the Table 4.1-13 aircraft classification and two forecast scenarios (FAA-approved forecast and high growth forecast).

Table 4.1-14: Fleet Mix

AIRCRAFT CLASS	2018 (%)	2025 (%)	2030 (%)	2040 (%)	2070 (%)
High Growth Forecast Scenario					
A	26	24	23	20	14
B	6	6	6	5	4
C	65	67	69	72	80
D	3	3	3	3	3
FAA Forecast Scenario					
A	26	25	23	22	18
B	6	6	6	5	5
C	65	66	68	70	74
D	3	3	3	3	3

Source: WSP USA, 2018.

FAA AC 150/5060-5, *Airport Capacity and Delay*, defines the mix index as the sum of the percentage of Class C aircraft and three times the percentage of Class D aircraft (%C+3*%D). **Table 4.1-15** provides the resulting mix index for each planning year and two forecast scenarios (FAA forecast and high growth forecast).

Table 4.1-15: Forecast Mix Index

	2018	2025	2030	2040	2070
Mix Index (High Growth)	73	76	78	81	87
Mix Index (FAA Forecast)	73	76	77	78	83

Source: WSP USA, 2018.

ANNUAL SERVICE VOLUME AND HOURLY CAPACITY

Several assumptions were considered during the capacity calculations, and are listed below:

- 50 percent arrivals, which is a common assumption.
- No or minimal touch-and-go operations, since SAT is mostly operated by commercial aircraft.
- 89 percent of operations are under VMC, based on the runway configuration.
- 10 percent of operations are under IMC, based on the runway configuration.

ANNUAL SERVICE VOLUME

ASV accounts for variations in runway use, aircraft mix and weather conditions. The current ASV can be estimated with FAA AC 150/5060-5.[3] However, the estimated ASV from the FAA AC does not reflect recent changes in aircraft separations and technology, or potential airfield geometry or procedures improvements that could increase ASV.

The following is a description of how the airfield capacities used in this analysis were derived.

Existing Airfield Capacity:

- Assessed capacity of existing runway system based on FAA capacity tables for long-range planning in FAA AC 150/5060-5 = 205,000 annual operations
- Adjusted airfield capacity to reflect modified aircraft classifications, per wake turbulence recategorization (see Table 4.1-13) = 207,000 annual operations

Optimized Airfield Capacity:

- Assessed how can optimize existing capacity:
  - Reduce the use of the Northbound Runway configuration (both Runways 13RL and 4 used simultaneously)

[3] Federal Aviation Administration, Advisory Circular 150/5060-5, *Airport Capacity and Delay*, 1983.

- Add/optimize Runway 13R-31L exits

- Quantified gains in hourly capacity of each improvement:
  - Assessed results of airfield capacity enhancements at other airports
  - Used professional judgement:
    - Optimization of runway exits = +2 aircraft operations/hour
    - Enhanced pilot/ATC coordination in NextGen context = +2 aircraft operations/hour
    - High intensity runway operations[4] = +2 aircraft operations/hour
    - Total = +6 aircraft operations/hour
- Translated hourly capacity gains into annual capacity gains:
  - Assumed hourly gains could be achieved only 12 hours each day, 365 days a year
  - 6 x 12 x 365 = approximately 25,000 annual operations
- Existing capacity + optimized airfield gains = 207,000 + 25,000 = approximately 230,000 annual operations

Maximized Airfield Capacity:

- Started with optimized airfield capacity of 230,000 annual operations
- Assumed small GA aircraft operators would relocate their facilities to the north side of the airfield (this would need to be considered in the *Alternatives Development and Evaluation* chapter). Today, GA operators are mostly based on the south side of the airfield. As a result, they either use Runway 13R-31L and take “slots” that could be used by commercial traffic, or they use the shorter GA runway (Runway 13L-31R) and have to cross Runway 13L-31R, possibly interfering with Runway 13R-31L operations.
- Quantified impacts of relocating small GA aircraft operations to the north side of the airfield:
  - Small GA aircraft use Runway 13L-31R = no more Runway 13R-31L crossings
  - There are approximately 48,000 GA operations/year at SAT = average of 132 GA operations/day
  - Assumed a third of Runway 13R-31L crossings by GA aircraft currently occur during peak hours
  - 132 daily GA operations / 3 = 44 less operations/days in Runway 13R-31L queue

[4] High intensity runway operations are enhanced pilot procedures for challenging runway occupancy times and runway vacating efficiency, to increase overall operational efficiency and thus airfield capacity. They are informal procedures and best practices tailored to individual airports, considering inefficient conditions, such as pilots not discussing the location of the high-speed exit taxiways when starting the approach, pilots taxiing at very low speed on high-speed exit taxiways, mismanagement of approach speed, performing checklists when at the runway holding position, etc.

- 44 operations * 365 days = approximately 15,000 operations/year available for commercial service aircraft on Runway 13R-31L

- Estimated increase in capacity of approximately 15,000 annual operations
- Optimized airfield + GA relocation = 230,000 + 15,000 = 245,000 annual operations

HOURLY CAPACITY

The computation of hourly capacity considers the percentage of arrival operations, the percentage of touch and goes, as well as the number and location of runway exits. Unlike ASV, FAA AC 150/5060-5 provides charts for runway restricted to small A and B aircraft. Per the AC, hourly capacity can be computed for VMC and IMC.

FINDINGS

The existing runway capacity is approximately 207,000 annual operations, based on the current runway operational dependencies, location of existing runway exits and the aircraft traffic mix on each runway. This finding is in line with the fact that a dependent two-runway airfield has an ASV of slightly more than a single runway.

Maximum capacity of the existing airfield is projected to be reached in:

- 2031 (high-growth forecast)
- 2036 (FAA-approved/baseline forecast)

The more desirable 80% target level of capacity, which reflects a more desirable level of delay and congestion for planning purposes, was reached in 2018 (FAA-approved/baseline and high-growth forecast).

The optimized capacity of the existing airfield could yield an ASV of up to approximately 230,000 annual operations if all three runways were used at their optimal efficiency, as described below:

- **Reduced Runway Occupancy Time**: the time spent on the runway by a landing aircraft is called Runway Occupancy Time (ROT) and is affected by the location and number of exit taxiways. Over time, aircraft types and performance have changed, and the exits at SAT are no longer ideal for today's fleet, causing some landed and decelerated aircraft to stay on the runway longer, as they miss one exit and taxi on the runway to the next one. In addition to the number and location of taxiway exits, another capacity and operational optimization is the availability of a high-speed exit taxiway (as opposed to one at a right angle to the runway), which can allow aircraft to safely exit the runway sooner at a higher speed (benefit of about 2-5 ops/hour to a runway system).
- **Reduced use of Runway 4-22**: the crosswind runway provides SAT with several benefits. However, because of its dependency with the other two runways, it does not add capacity, and rather slightly reduces it. Additionally, departures on Runway 4 and arrivals on Runway 22 are dependent on military operations at Randolph AFB. Benefits of the runway include convenient Runway 4 departures for northbound flights, convenient location relative to Terminal A and the cargo facilities, and serving as a back-up runway when Runway 13R-31L is temporarily closed. However, wind analysis shows that Runway 4-22 is only required for small GA aircraft (including small jets such as the HondaJet of Runway Design Code B-I), for less than 3 percent of the time

on an annual basis. Reduced use of Runway 4-22 during the peak periods would slightly benefit efficiency, and therefore capacity.

- **Air traffic technology improvements**: beyond the Next Generation Air Transportation System (NextGen) system improvements discussed in Section 4.1.5, the FAA also continues to develop and improve technology and approach procedures that may help certain airports. These technologies primarily serve to maintain airport capacity during poor weather conditions, rather than to add capacity. For instance, advanced features on runway safety and traffic flow management at hub airports like ORD and SFO optimize the use of their intersecting runways. Such air traffic management improvements could be a benefit to SAT by minimizing delays during poor weather, but would not materially increase ASV.

The optimized SAT airfield would reach maximum capacity in:

- 2038 (high-growth forecast)
- 2048 (FAA-approved/baseline forecast)

The more desirable 80% target level of capacity, which reflects a more desirable level of delay and congestion for planning purposes, is anticipated to be reached in 2024 for both the high-growth and FAA-approved/baseline forecast scenarios.

Further capacity increases of the existing airfield (Maximized Capacity) could be achievable with relocation of smaller based GA aircraft facilities to the other side of Runway 13L-31R. This would make Runway 13L-31R available to these users without requiring a runway crossing, and would eliminate queueing with larger aircraft for Runway 13R-31L. Whether this is feasible will need to be assessed in the alternatives analysis, but this would represent the maximum-use scenario of the SAT airfield. This could increase capacity to approximately 245,000 annual operations ("maximum capacity" of existing runway configuration).

Additional runway(s) can increase capacity beyond this "maximized capacity". The *Alternatives Development and Evaluation* chapter will determine the best long-term capacity solutions for SAT. However, in general terms, the following incremental capacity benefit would be realized by additional runway(s):

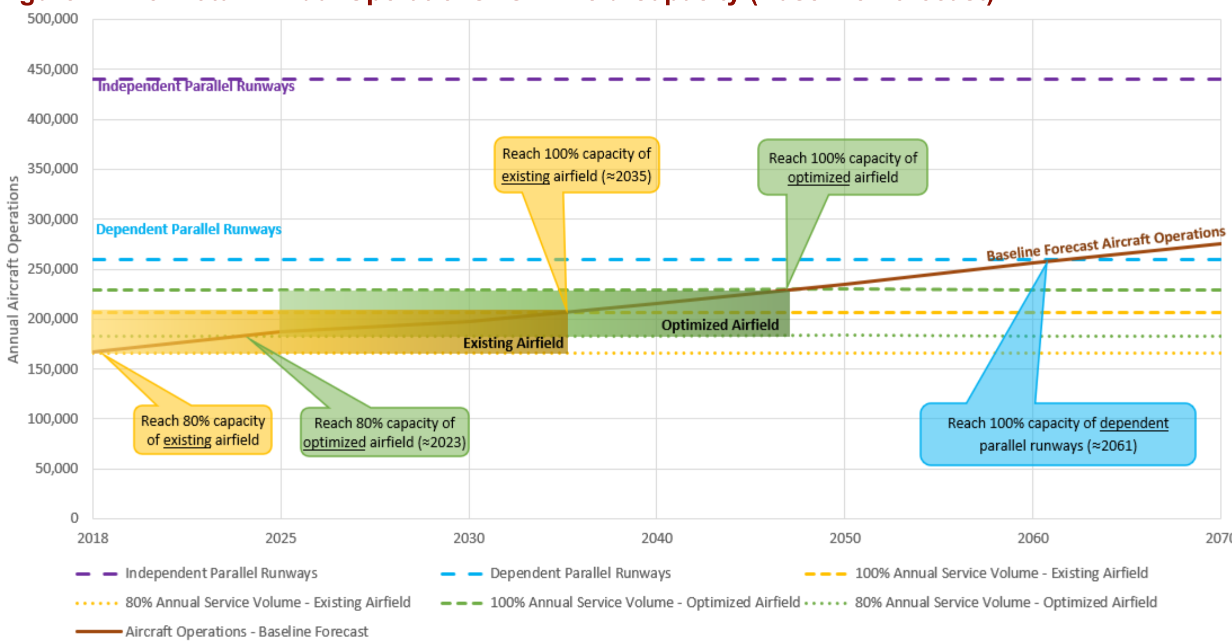
- **A dependent parallel runway** with a 700 to 2,500-foot separation from Runway 13R-31L would be an air carrier-capable runway. This could be an extended and upgraded version of Runway 13L-31R, as was studied in a previous master plan, or a new runway. Such a runway would increase the ASV from an optimized 230,000 to around 260,000 annual operations.
  - Maximum capacity of dependent parallel runways is projected to be reached in:
    - 2048 (high-growth forecast)
    - 2062 (FAA-approved/baseline forecast)
  - 80% capacity of dependent parallel runways is projected to be reached in:
    - 2031 (high-growth forecast)
    - 2036 (FAA-approved/baseline forecast)

- ***An independent parallel runway*** with a separation from Runway 13R-31L centerline of at least 3,000 feet[5] would allow simultaneous independent approaches (assuming certain air traffic management improvements would be implemented). Such a runway would increase SAT's ASV to 440,000 operations. This would meet airfield demand beyond 2070 for both the FAA-approved and high-growth scenario forecasts.

Figures 4.1-13 and **4.1-14** depict the timeframes for reaching 80 percent and 100 percent capacity of various airfield layouts with the baseline and high-growth forecast scenarios, respectively.

It is not known if a parallel runway will be needed by the end of the planning horizon (2040), or if enhancing existing Runway 13R-31L would provide adequate airfield capacity. However, even if enhancing the existing runway will provide adequate capacity through 2040, a new runway will eventually be needed, and it is prudent to plan for it, and reflect it on the Airport Layout Plan to provide airspace and land use protection.

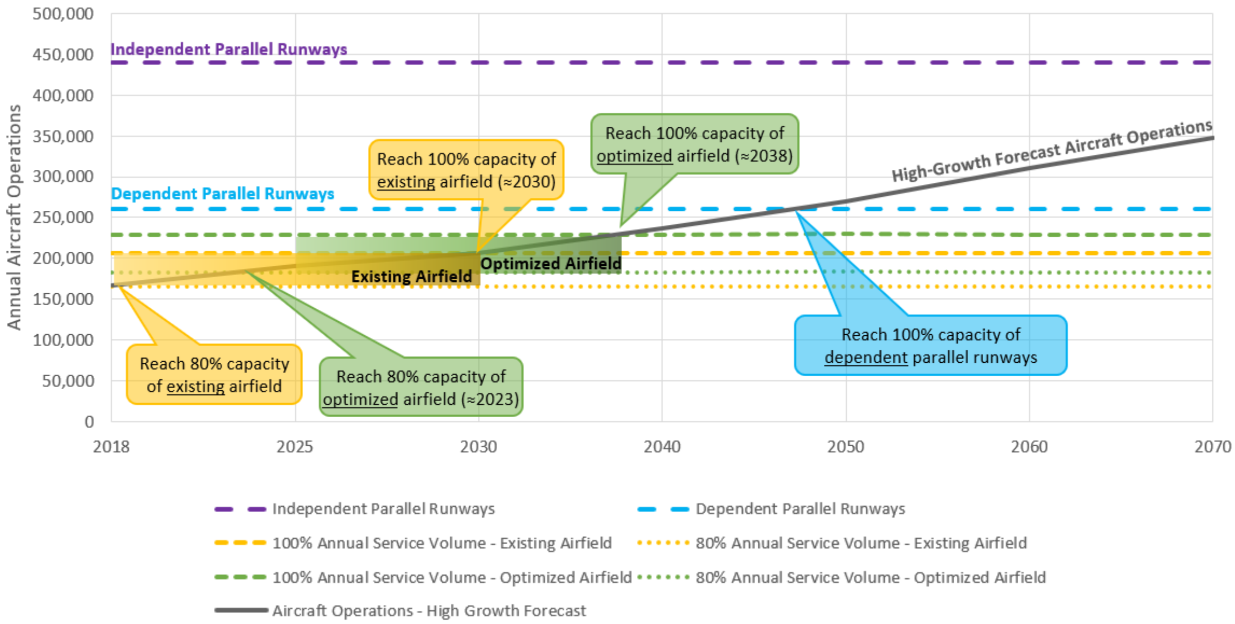
Figure 4.1-13: Total Annual Operations vs Airfield Capacity (Baseline Forecast)



Source: WSP USA, 2019.

[5] Dual simultaneous precision instrument approaches are normally approved on parallel runway centerline separation of 4,300 feet. On a case-by-case basis, the FAA can consider proposals utilizing separations down to a minimum of 3,000 feet where a 4,300-foot separation is impractical. When feasible, this reduction of separation requires special high update radar, monitoring equipment, etc.

Figure 4.1-14: Total Annual Operations vs Airfield Capacity (High-Growth Forecast)



Source: WSP USA, 2019.

Based on FAA Advisory Circular 150/5060-5, the capacity of the airfield is 91 aircraft operations per hour with good weather conditions (VMC) and 56 operations per hour with reduced visibility and cloud ceiling (IMC). As shown in **Table 4.1-16**, the existing airfield will not be saturated during the peak hours through the next fifty years, for both forecast scenarios.

Table 4.1-16: Peak Hour Operations and Calculated Hourly Capacity (Existing Airfield)

OPERATIONS	2018	2025	2030	2040	2070
Peak Hour Operations – High Growth	36	40	43	49	74
Peak Hour Operations – FAA Forecast	36	39	41	44	NA
Visual Meteorological Conditions Hourly Capacity	91	89	90	88	85
Instrument Meteorological Conditions Hourly Capacity	55	55	55	55	55

Source: WSP USA, 2019.

4.1.5 NAVIGATIONAL AIDS AND APPROACH PROCEDURES

Runway approach procedures are discussed in the Inventory of Existing Conditions (Chapter 2). Precision approaches are available to Runways 4, 13R and 31L. These three runways have ILS CAT I equipment, and only Runway 13R is ILS CAT II capable. Runway 22 is a non-precision runway and Runways 13L and 31R are visual only runways. The control tower manager indicated that the current equipment and procedures are adequate during low visibility conditions. A potential new runway might be equipped with ILS CAT I or CAT II, based on a cost-benefit analysis considering preferred use (arrival/departure) and precision procedures available in the future. The need for new ground-based infrastructure (ILS localizer and glide slope antennas) will be evaluated with the availability of satellite-based precision approach procedures.

NextGen is the FAA's plan to modernize the NAS through 2025. The primary goal of NextGen is to address the effects of air traffic growth by increasing airspace capacity and efficiency while simultaneously improving safety, sustainability, and accessibility. As part of NextGen implementation, Area Navigation (RNAV) procedures have been set up at SAT. Runways 4, 22, 13R and 31L have RNAV GPS (Global Positioning System) and Required Navigation Performance (RNP) procedures. RNP procedures require onboard equipment providing the air crew with monitoring and alerting capabilities to fly a specific path with a higher accuracy.

Performance-Based Navigation (PBN) is a framework for defining navigation performance requirements. PBN includes both RNAV and RNP specifications. It represents an evolution toward satellite-based navigation, making flying independent from ground-based infrastructure. Work on PBN evolutions of RNP procedures at SAT is in progress by the FAA. Although RNP approach procedures have visibility minima close to ILS CAT I minima (200 feet and ½ SM), they are officially non-precision approaches at this time. With the progress of technology, the improvement of satellite-based vertical guidance and the evolution of regulations, it is expected RNP procedures can achieve precision approach requirements in the future.

4.1.6 AIRSPACE INTERACTIONS

Randolph Air Force Base (RND) is located 12 miles east of SAT. Its parallel runways extended centerlines intersect with the SAT Runway 4-22 extended centerline. While ATCT personnel at both airports coordinate and manage the occasional interference in traffic, use of SAT's Runway 4-22 tends to stop when RND is active. As a result, although today's occasional use of SAT's Runway 4-22 is manageable, increased or regular use of Runway 4-22 (or another runway in a similar alignment) would increase dependency on RND. As such, it is not recommended to consider primary runways (arrival or departures) that would interfere with RND operations (ie, in the Runway 4-22 alignment).

4.1.7 SUMMARY OF AIRFIELD REQUIREMENTS

- Runway 13L-31R remains B-III:
  - Install 20-foot wide shoulders (recommendation only)
  - Widen and lengthen blast pads to 140 x 200 feet
- Runway 13R-31L:
  - Install shoulders (25-, 35- or 40-foot wide for ADG IV, V and ADG VI respectively)
  - Widen blast pads (200, 220 or 280 feet wide for ADG IV, V or ADG VI respectively)
  - Increase separation with Taxiway G (500 or 550 feet for ADG V or ADG VI respectively)
- Provide up to 10,700-foot long departure runway
- Runway areas:
  - Mitigate incompatible land uses in Runways 4, 22, 13L and 31L Protection Zones
- Taxiway design:
  - Address airfield non-standard geometry

  - Install high-speed exit taxiways as needed
- Consider airfield capacity improvements to accommodate high-growth forecast scenario

4.2 PASSENGER TERMINAL FACILITIES

A major element of the SDP is the passenger terminal building. The Airport has a single terminal complex consisting of two terminals/concourses that are connected at both departures and arrivals levels and share a common curb:

- Terminal A was opened in 1984. It is acknowledged that Terminal A has numerous functional deficiencies and that many of its building systems are at or past the end of their useful lives.
- Terminal B was opened in 2010. As it is much newer than Terminal A, it was built to more currently accepted standards.

Developing a terminal facilities program begins with examining the adequacy of each existing component (baseline) to serve current activity. Forecast changes in activity are applied to the baseline to develop recommendations for future planning horizons. These recommendations use actual activity and facilities at SAT as a baseline, and are the subject of quantitative, as well as qualitative, analyses. Although some "industry standard" criteria are used, the recommendations for future facilities are based on local conditions and circumstances.

4.2.1 DESIGN LEVEL ACTIVITY

Airport terminal facilities are sized to accommodate the peak hour passenger volumes of a design day. Annual enplanements are typically an indicator of overall airport size; however, peak hour volumes more accurately determine the demand for airport facilities based on the specific user patterns of a given airport. Peak hour passengers are typically defined as Peak Hour-Average Day-Peak Month (PHADPM) passengers, and are also often referred to as Design Hour passengers. The Design Hour measures the number of enplaned and deplaned passengers departing or arriving on aircraft in an elapsed hour of a typically busy (design) day. The Design Hour typically does not correspond exactly to a "clock hour," such as 7:00-7:59, but usually overlaps two "clock hours", for example 7:20-8:19 reflecting airline scheduling patterns.

The Design Hour is typically not the absolute peak level of activity, nor is it equal to the number of persons occupying the terminal at a given time. It is, however, a level of activity that the industry has traditionally used to size many terminal facilities. The number of persons in the terminal during peak periods, including visitors and employees, is also typically related to Design Hour passengers.

Each airport has its own distinct peaking characteristics, because of differences in airline schedules, business or leisure travel, long or short haul flights, and the mix of mainline jets and regional aircraft. These peaking characteristics determine the size and type of terminal facilities. Thus, two airports with similar numbers of annual passengers may have different terminal requirements, even if the Design Hour passenger volumes are approximately the same.

EXISTING ACTIVITY

Since the Airline Deregulation Act took effect in 1978, most major airlines have developed "hub and spoke" route systems, such as American Airlines' hubs in Chicago and Dallas/Ft. Worth, Delta Airlines' hubs in Atlanta and Detroit, United Airlines' hubs in Chicago and Denver, etc. At these hubs, “banks” of flights occur when most passengers change planes to reach their destination. These banks of connecting flights form a series of peaks during the day - typically 7 to 10 peaks per day. A few carriers, such as Southwest Airlines or JetBlue Airways, have ‘focus cities’ with 9 to 10 daily departures per gate, but operations are not as concentrated for formal connection scheduling.

The destination cities served from the airline hubs are referred to as "spokes". Individual airline schedules at the spoke cities are generally tied to the connecting banks at the hub. Most airlines have similar scheduling patterns, and these tend to reinforce each other at the spoke airports resulting in, for example, a large number of departures between 6:00 a.m. and 6:30 a.m. at SAT. As passenger volumes on specific routes increase, the number of flights also tends to increase, which can fill in the ‘valleys’ during the day.

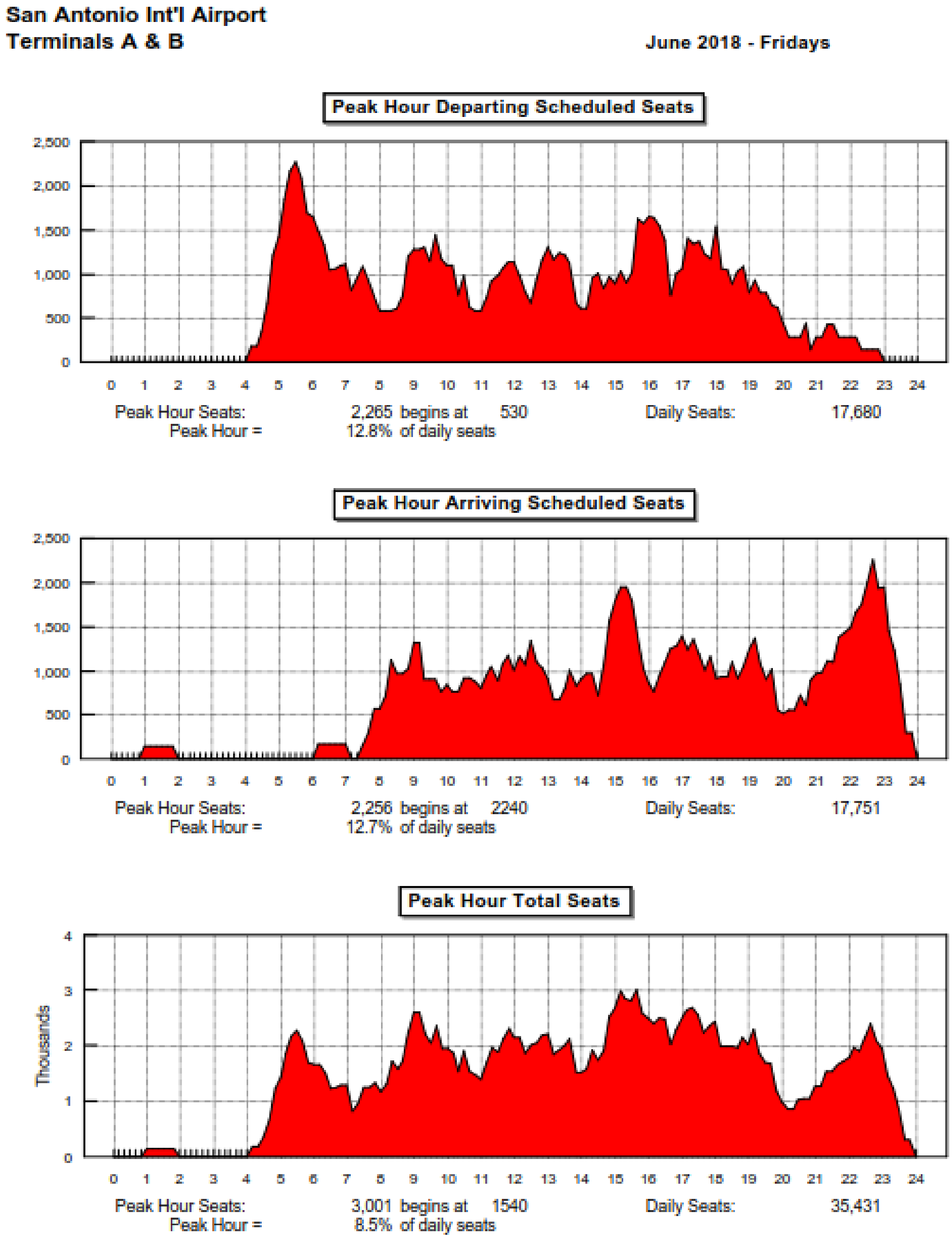
The four major carriers at SAT, American Airlines, Delta Air Lines, Southwest Airlines and United Airlines, as well as Alaska Airlines, Allegiant Air, and Frontier Airlines, serve domestic destinations. An additional four international carriers provide service to Mexico and Canada – Aero Mexico, Air Canada, Interjet and Volaris.

The daily pattern of flight activity and passenger peaking at SAT is typical of spoke activity at a medium sized airport (medium hub in FAA terminology). Morning departures have flights to all the major hub destinations served from SAT and other selected markets. In the evening, there are corresponding arrivals, which serve to position equipment for the next day's departure peak. There are also several mid-day secondary peaks for both arrivals and departures. **Figure 4.2-1** shows typical weekday activity in June 2018.

PROJECTED DESIGN HOUR ACTIVITY

The forecast chapter outlined a range of forecast scenarios in addition to the FAA's TAF. The base Master Plan 20-year forecasts through 2038 are the primary basis for facilities planning. However, the Airport wishes to evaluate the capability of the terminal and other facilities to support both the High Growth forecasts for 2038 and a very long-term forecast for up to 50 years (2068). All these forecast levels have been considered to test the question of “Will it fit?”.

Figure 4.2-1: Terminal A and B Peak Hour Scheduled Seats



Source: Hirsh Associates, 2018.

PEAK MONTH PASSENGER

The peak month averaged 9.5 percent of annual enplanements over the past five years and occurred in July most years. This was assumed to continue in the future.

DESIGN HOUR PASSENGERS

An estimate of the existing design hour passenger volume as a percentage of daily activity was made based on analyses of scheduled seats and assumptions as to flight load factors on busy days. This applies to combined domestic and international passengers.

As shown in Figure 4.2-1, the weekday morning enplaning peak hour has 2,265 seats, accounting for 12.8 percent of the daily departing seats. Based on observations and discussions with the airlines, it is assumed that the peak hour has a 90 percent average load factor in the peak month, or approximately 2,040 passengers. Airline annual system-wide load factors have been growing from historic levels and are now approximately 85 percent. Applying this average load factor to daily departing seats (17,680) would be an estimated 15,030 busy day enplaning passengers. Thus, the enplaning design hour represents 13.6 percent of daily enplaning passengers, as compared to 12.8 percent of departing seats. Similar calculations were made for design hour deplaned and total passengers and are presented in **Table 4.2-1**.

In the near term (2025), it is assumed that airlines will continue to reinforce the current peaks, either with additional flights or larger aircraft. As additional service (either frequency or destinations) is added, some would be expected to occur off-peak, or in secondary peaks, which would reduce the design hour factor. For the medium to long term (2030 and 2040), the design hour factor was reduced by 5 percent. For the 2040 High Growth scenario, the design hour factor was reduced an additional 5 percent. For the 2070 High Growth scenario (very long-term), design hour factors were reduced a further 10 percent.

Although some airlines report a limited number of connecting passengers at SAT, for planning purposes, all passengers are assumed to be O&D.

International design hour activity varies seasonally and by day of the week. While there are currently multiple arrivals from Mexico City and Monterey (both in Mexico) at mid-day, the largest peaks occur on the weekends with overlapping arrivals from Cancun (Mexico), using larger aircraft. The Cancun peak, with a 90 percent load factor, is assumed to represent the design hour for international arrivals. The design hour is assumed to grow proportionately with annual international passengers, but may shift in time if widebody services are introduced.

Table 4.2-1: Forecast Design Hour Passengers

FORECAST ACTIVITY LEVEL						
	2018 (est.)	2025	2030	2040	2040 High	2070 High
Annual Enplanements	4,873,000	5,731,000	6,283,000	7,234,000	8,349,000	16,118,000
Peak Month Enplanements						
% of Annual Enplanements	9.6%	9.5%	9.5%	9.5%	9.5%	9.5%
Peak Month Enplanements	466,620	544,400	596,900	687,200	793,200	1,531,200
Average Day/Peak Month (31 days)						
Enplaned Passengers	15,050	17,560	19,250	22,170	25,590	49,390
Design Hour Passengers						
Percentage of daily activity in the design hour 1/						
Enplaned	13.6%	13.6%	12.9%	12.9%	12.3%	11.0%
Deplaned 2/	13.5%	13.5%	12.8%	12.8%	12.2%	11.0%
Total 2/	18.0%	18.0%	17.1%	17.1%	16.2%	14.6%
Design Hour Passengers						
Enplaned	2,050	2,390	2,490	2,860	3,140	5,460
Deplaned	2,030	2,370	2,470	2,840	3,120	5,420
Total	2,710	3,160	3,290	3,790	4,160	7,220

Notes:
Est. = estimated
High = high growth forecast scenario
1/ Based on June 2018 weekday scheduled seats.
Assume ratios remain constant through 2023; with 5% reduction by 2028.
Remain constant for Base forecast in 2038, but reduce additional 5% in High Growth.
Reduce additional 10% for 2068.
2/ Based on daily enplaned passengers.

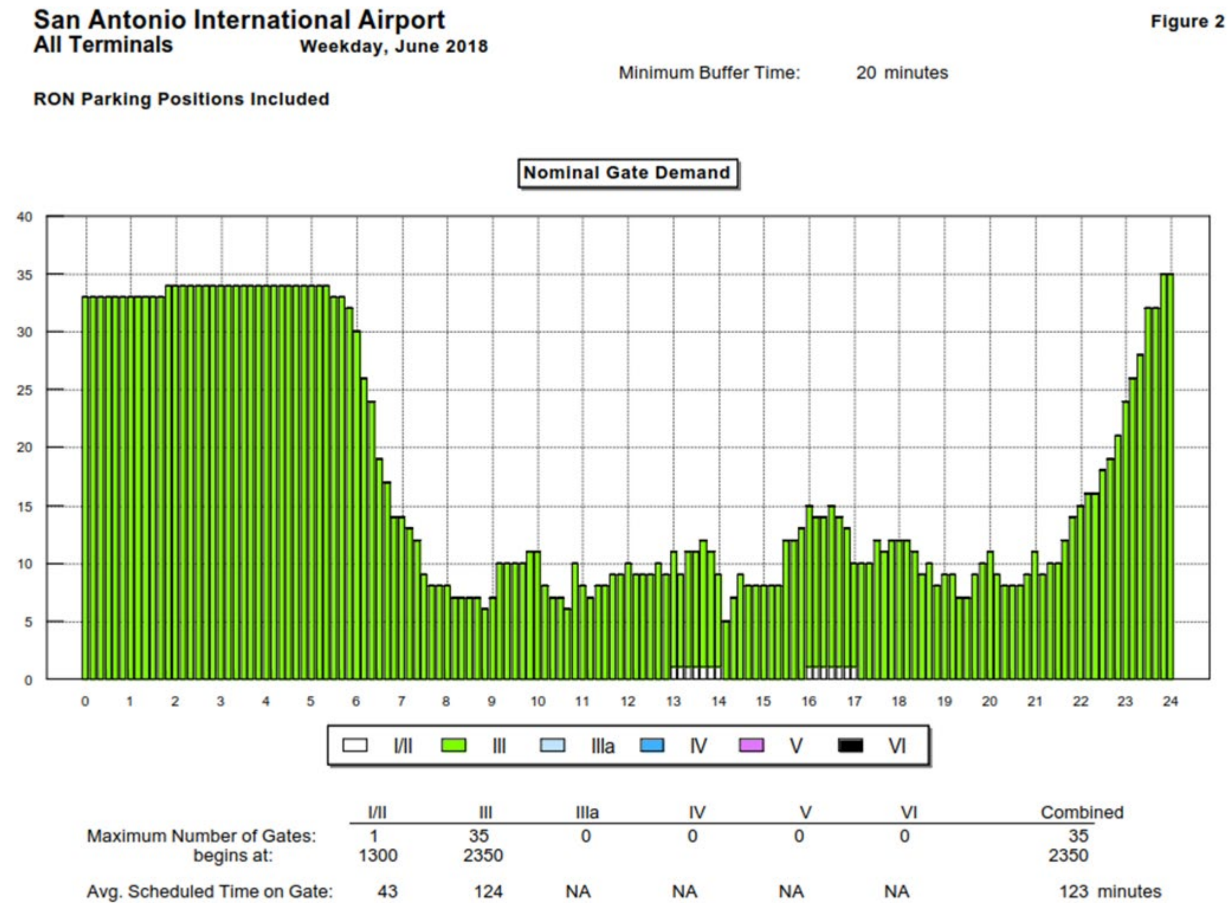
Source: Hirsh Associates, 2018.

4.2.2 AIRCRAFT GATES

The number of gates needed to support forecast activity is a critical element in determining the overall size and configuration of the terminal complex. A "gate" is defined as an aircraft parking position near the terminal, which is used daily for actively loading and unloading passengers. A gate may have a passenger loading bridge or be ground loaded.

The SAT terminal complex has notionally 25 gates. However, Gate A1 is not used because of its proximity to an airfield access gate and lack of holdroom space. Gate A16 exists only as a holdroom and has no passenger boarding bridge (PBB). Thus, there are effectively 23 gates.The June 2018 schedule was analyzed to determine gate utilization. **Figure 4.2-2** illustrates the number of aircraft parking positions, including RON, required to support the 2018 summer day schedule. A 20-minute buffer time between a scheduled departure and the next arrival is assumed. This shows that the maximum number of aircraft on the ground was 35 during the overnight period. All the aircraft were larger regional jets or mainline narrowbody aircraft falling within ADG III.

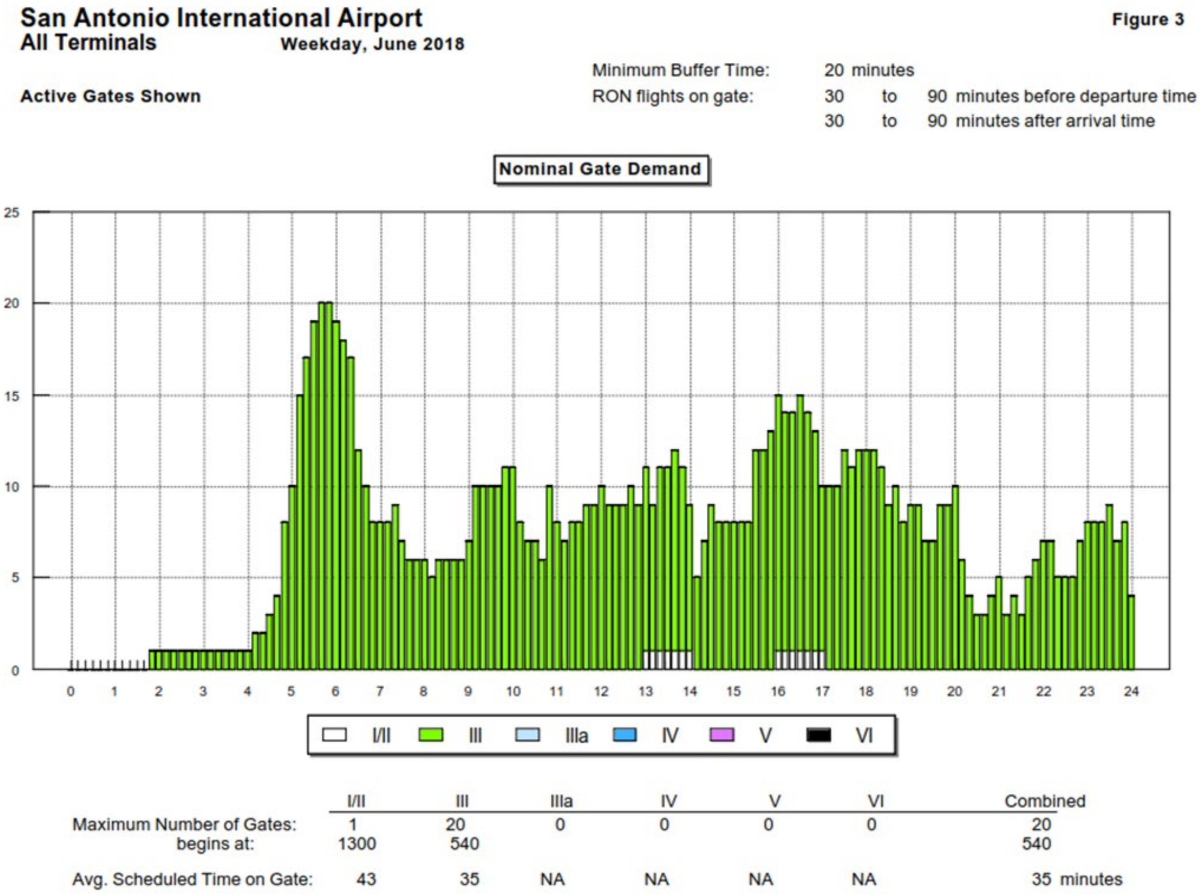
Figure 4.2-2: Aircraft Parking Positions Requirements



Source: Hirsh Associates, 2018.

Figure 4.2-3 illustrates the same schedule, but only for active gates. The assumptions in this analysis are that a remote/RON aircraft requires a gate from 50 minutes before departure time or 30 minutes after arrival. These would be the parameters by which an aircraft may be towed to or from a remote remote/RON parking pad. The peak active gate demand is between 5 a.m. and 6 a.m. for 20 gates. Thus, the 23 active gates are considered well-utilized for the morning peak, with only a few gates potentially occupied by remote/RONs after the main morning departures bank.

Figure 4.2-3: Active Gate Aircraft Parking Positions Requirements



Source: Hirsh Associates, 2018.

Gate demands have been estimated for each of the forecast planning activity levels. Methodologies used to project future gate demand include ratios of annual passengers per gate, daily flights per gate, and design day flight schedules projections. Since design day flight schedules were not developed for the forecast years, this approach was not used.

ANNUAL PASSENGERS PER GATE APPROACH

The first approach (**Table 4.2-2**) uses the current ratio of annual passengers per gate, adjusted for forecast changes in fleet mix and annual load factors at each forecast level. This methodology assumes that the pattern of gate utilization will remain relatively stable. The increase in passengers per gate would be the result of increases in enplanements per departure (because of fleet seating capacity and/or passenger load factors), as opposed to increasing numbers of departures per gate.

Table 4.2-2: Projected Aircraft Gate Demand – Annual Passengers per Gate Approach

	ENPLANED PASSENGERS	DEPARTURES	ENPLANED PASSENGERS/ DEPARTURE	ENPLANED PASSENGERS/ GATE	GATES AVAILABLE	GATES NEEDED
2017	4,431,532	42,090	105	192,700	23	23
2018 (est.)	4,873,000	43,700	111	211,900	23	23
2025	5,731,000	49,100	117	221,800		26
2030	6,283,000	52,900	119	225,800		28
2040	7,234,000	60,100	120	228,800		32
2040 High	8,349,000	69,000	121	229,900		37
2070 High	16,118,000	118,400	136	258,600		63

Notes:
Est. = estimated
High = high growth forecast scenario

Source: Hirsh Associates, 2018.

The baseline for the existing enplanements per gate factor is the number of gates in use. All 23 usable gates were considered active. The ratio of passengers/gate for each forecast year was calculated by multiplying the current (2018) factor by the percentage increase in passengers/operation. For example, the factor would increase from 211,900 enplanements/gate (2018 data) to 221,800 for 2025, based on enplanements per departure increasing from 111.5 to 117 in the near term. This would increase further to 229,900 enplanements/gate by 2040 (High Growth forecast, or HG) without any further increase in the number of daily departures per gate.

Future gate requirements were then estimated by dividing annual forecast passengers by the estimated passengers per gate factor for that forecast period. For example, in the 2040 HG scenario, 8.349 million enplanements divided by 229,900 enplanements/gate results in a demand for 37 gates.

DEPARTURES PER GATE APPROACH

The first methodology assumes that the pattern of service at SAT is stable. While this may be true at many airports and for some airlines at SAT, it is likely that gate utilization will experience variations for other airlines, as was observed when additional service was added. The average number of daily departures per gate (turns per gate) increased from 5.2 in 2017 to an estimated 5.4 in 2018. Further increase in turns per gate can be assumed. While Southwest Airlines routinely schedules 8 or 9 turns per gate, this is not typical of other airlines. Increased gate utilization was assumed over time, but was capped at an average of 6.0 turns per gate by 2040, representative of the activity of a typical medium-sized airport.

For the Departures per Gate approach (**Table 4.2-3**), the ratio of annual departures/gate for each forecast year was calculated by multiplying the current (2018) factor by the percentage change in assumed daily departures/gate. For example, the factor would increase from 1,900 departures/gate (2018) to 1,960 for 2025, as average daily departures per gate increased from 5.4 to an estimated 5.6.

Table 4.2-3: Projected Aircraft Gate Demand – Departures per Gate Approach

	ENPLANED PASSENGERS	DEPARTURES	DAILY DEPARTURES/ GATE	ANNUAL DEPARTURES/ GATE	GATES
2017	4,431,532	42,090	5.2	1,830	23
2018 (est.)	4,873,000	43,700	5.4	1,900	23
2025	5,731,000	49,100	5.6	1,960	25
2030	6,283,000	52,900	5.8	2,030	26
2040	7,234,000	60,100	6.0	2,100	29
2040 High	8,349,000	69,000	6.0	2,100	33
2070 High	16,118,000	118,400	6.0	2,100	57

Notes:
Est. = estimated
High = high growth forecast scenario

Source: Hirsh Associates, 2018.

Future gate requirements were then projected by dividing annual forecast departures by the estimated departures per gate factor for that forecast period. For example, in the 2040 HG scenario, 69,000 departures divided by 2,100 departures/gate results in a demand for 33 gates.

RECOMMENDED AIRCRAFT GATES REQUIREMENTS

The results of the two gate methodologies are summarized in **Table 4.2-4**. Airlines would require fewer gates under the Departures per Gate approach.

Table 4.2-4: Projected Aircraft Gate Demand

	NUMBER OF GATES		
2018	25		
	Passengers/Gate Method	**Departures/Gate Method**	**Recommended**
2025	26	25	26
2030	28	26	27
2040	32	29	31
2040 High	37	33	35
2070 High	63	57	63

Note:
High = high growth forecast scenario

Source: Hirsh Associates, 2018.

Typically, from a Master Plan perspective, the higher number of gates from the Passengers per Gate approach should be used to preserve a land envelope for terminal development. For financial feasibility, a lower gate demand is typically seen as more conservative. It is recommended that an average of the two approaches be used. The exception is for the very long-term 2070 forecast, where the higher gate number is recommended to test the ability of the Airport to accommodate this potential level of activity.

4.2.3 HARDSTAND/REMAIN OVERNIGHT PARKING POSITIONS

The 2040 high growth forecast indicates the need for 10 hardstand/RON aircraft parking positions (off-gate), in addition to the 37 proposed at-gate positions (for a total of 47 aircraft parking positions).

Based on SAAS input considering MRO and airline hardstand needs, a minimum of 18 off-gate parking positions will be provided in 2040, for a total of 55 aircraft parking positions.

4.2.4 PASSENGER TERMINAL

Terminal facility requirements for an airport (the terminal program) are a function of the specific and unique characteristics of that airport. These include the design levels of passenger and aircraft activity, the number and type of airlines serving the airport, the operating requirements of the airlines, and local factors, such as the proportions of leisure vs. business travelers, locally originating passengers, etc.

TERMINAL CAPACITY METRICS

Unlike airfield facilities, the capacity of each element of a terminal facility can vary, depending on the level of crowding and/or processing/waiting times considered acceptable. In many cases, the degree of acceptability may also vary depending on the configuration of the terminal space and the level of amenity provided. Thus, the 'capacity' of a terminal can vary significantly.

LEVEL OF SERVICE

The term “World Class” has been used to describe some airports around the world and by many other airports as an aspirational goal. What “World Class” actually means is subject to debate.

- In the 9th Edition of the International Air Transport Association (IATA)’s *Airport Development Reference Manual (ADRM),* published in 2004, the term is defined as “top-rated airports from worldwide passenger surveys”. These airports “usually have airport layouts that allow for efficient airline operations and passenger terminal designs that are passenger friendly”. The ADRM lists 20 key characteristics from the passenger and airline perspectives.
- The ADRM then lists a series of standards, including maximum queuing times for major processes, minimum area per passengers for passenger queues and seating areas, percentages of passengers seated in various areas, and several airline operational metrics such as wheel stop to last bag delivery, and minimum connecting times.
- For terminal functional areas, such as queues or seating areas, the “World Class” standards generally correspond to LOS ‘C’. LOS ‘C’ was recommended as the design objective as it provides good service and comfort with acceptable delays at a reasonable cost. This applies to the design hour levels of activity. The same basic criteria are recommended in the Airport Cooperative Research Program (ACRP) Report 25, *Airport Passenger Terminal Planning and Design*.
- In the ADRM 10th Edition (2016), the term “World Class” does not appear. The various LOS metrics - from A (excellent) to F (unacceptable) - were revised to “Over-Design”, “Optimum” and “Sub-

Optimum". In most cases, the Optimum range corresponds to the former LOS 'C' areas. Maximum waiting times in some cases are shorter than the 9th Edition "World Class" (a higher LOS) and in other cases are longer (a lower LOS). The ADRM 9th Edition LOS metric will be used in this analysis.

It should be noted that most time-based levels of service are outside the Airport's control, in that U.S. Airlines, TSA, CBP and others ultimately determine staffing levels and processes that affect a passenger's waiting time and experience, regardless of the number and size of facilities provided by the airport.

The approach taken in developing terminal facilities requirements for SAT was to review the plans and areas of the terminal, make observations of passenger activity, and discuss with airport and airline staff how well the present facilities are functioning. These observations, coupled with calculations of area per passenger, per gate, or other determinant of demand, were compared to generally accepted industry planning factors (LOS 'C'). From these comparisons, a planning factor for each terminal component was determined and used to project facility requirements.

As noted previously, Design Hour passengers were used for passenger processing to which LOS 'C' criteria were applied. Much of the design day (as well as most of the year) has less activity than the Design Hour, as depicted in **Figure 4.2-4**.

Thus, the effective LOS of a terminal designed for LOS 'C' will be at LOS 'B' or 'A' most of the time. Figure 4.2-4 illustrates this using ratios of area previously published in the ADRM 9th Edition. If LOS 'C' areas are used for the peak hour, over 90 percent of the day passenger activity would result in areas/passenger of LOS 'B' or 'A'.

The program areas developed were based on the utilization of existing facilities and on projected trends. **Table 4.2-5** presents the program data in seven columns:

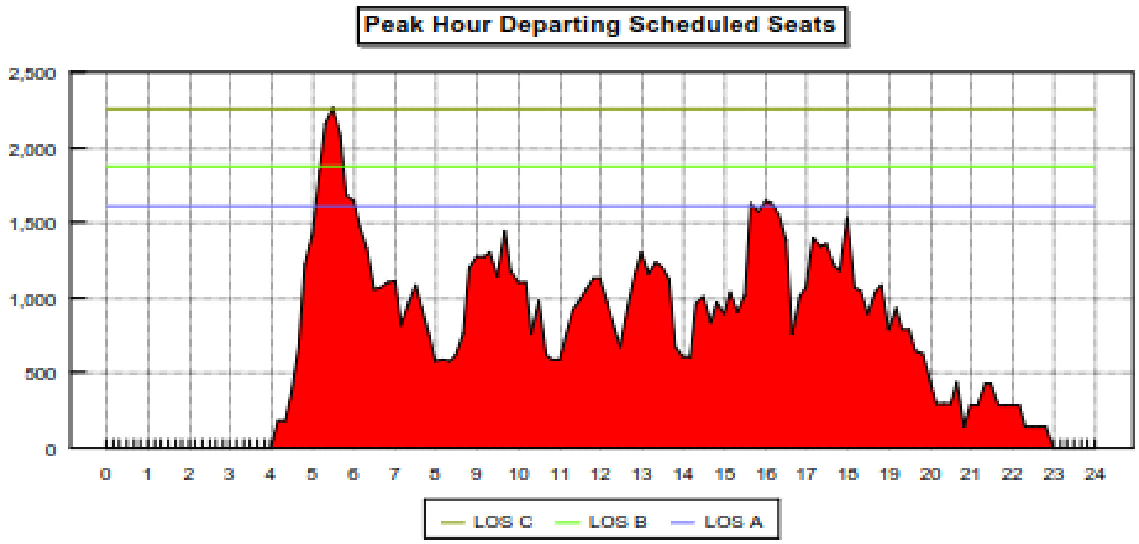
- Column 1 - Existing Facilities: These are the areas measured from architectural plans of the terminal, and the current functions as observed.
- Column 2 - Base Year 2018 Activity: These areas represent the facilities that would be needed to support levels of passenger activity for the base planning year. These values may differ from existing conditions and either highlight deficiencies in existing facilities, or facilities with excess capacity. These differences help establish whether existing ratios of space per unit of demand are appropriate to use for planning.
- Columns 3 through 7 - Recommended Facilities (2025-2070): These are the areas recommended to support each level of design hour passengers and the associated annual enplanements for each forecast level. The timing of the needed improvements would be based on the actual passenger growth rates.

It should be noted that the terminal space program represents a starting point for terminal planning. It is generally considered a minimum program supporting the design hour levels of passenger activity. As such, it does not refer to any specific terminal concept or gate configuration. When a final terminal concept is chosen, the gross terminal area may differ from the total square footage presented in the tables. For example, the amount of secure and non-secure circulation may vary from the program as a result of terminal configuration and location of the security checkpoint, whereas the amount of airline space should be relatively independent of the concept selected.

Figure 4.2-4: Terminal Level of Service if Facilities are Sized for Level of Service 'C'

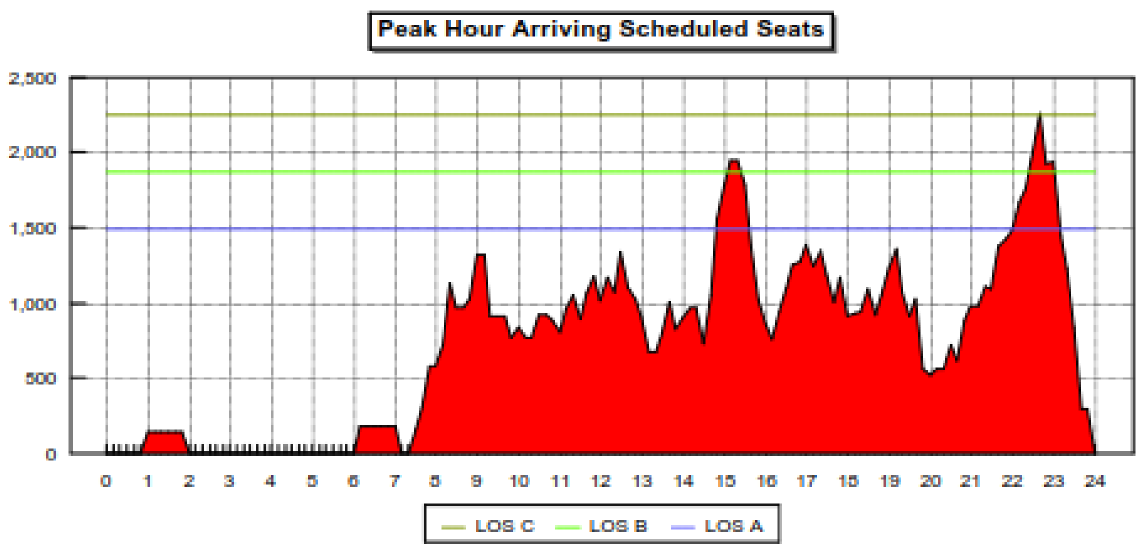
San Antonio Int'l Airport
Terminals A & B **June 2018 - Fridays**

LOS Levels If Facilities Are Sized To LOS C For Peak Hour



If facilities are sized at LOS C for the peak hour:

Percentage of time at LOS C	3%		
Percentage of time at LOS B	5%	LOS area/pax =	1.2 x LOS C *
Percentage of time at LOS A	92%	LOS area/pax =	1.4 x LOS C *



If facilities are sized at LOS C for the peak hour:

Percentage of time at LOS C	5%		
Percentage of time at LOS B	4%	LOS area/pax =	1.2 x LOS C *
Percentage of time at LOS A	91%	LOS area/pax =	1.5 x LOS C *

Source: Hirsh Associates, 2018.

Table 4.2-5: Terminal Facilities Requirements

	Existing Facilities	Recommended Facilities: Base Year 2018	Forecast Year 2025	Forecast Year 2030	Forecast Year 2040	Forecast Year 2040 High	Forecast Year 2070 High	
Annual Enplanements								
Domestic		4,650,000	5,410,000	5,931,000	6,829,000	7,882,000	14,703,000	
International		223,000	352,000	352,000	404,000	467,000	1,415,000	
Combined		4,873,000	5,731,000	6,283,000	7,234,000	8,349,000	16,118,000	
Design Hour Passengers								
Enplaned Domestic + International		2,050	2,390	2,490	2,860	3,140	5,460	
Enplaned International		320	510	510	580	670	2,030	
Deplaned Domestic		2,030	2,370	2,470	2,840	3,120	5,420	
Deplaned International		320	510	510	580	670	2,030	
Total Combined		2,710	3,160	3,290	3,790	4,160	7,220	
Meeter/Greeters per O&D Passenger		0.2	0.2	0.2	0.2	0.2	0.2	
GATES & HOLDROOMS								
Total Gates (Domestic & International):								
Small RJ/Medium Commuter (Group II)								gates
Narrowbody/Large RJ (Group III)	16	23	24	25	29	32	59	gates
B757 (Group IIIa)	6							gates
Widebody (Group IV)								gates
B777/A350 (Group V)	1		2	2	2	3	4	gates
Total Gates	23	23	26	27	31	35	63	gates
Narrowbody Equivalent Gates (NBEG)	24.4	23.0	27.6	28.6	32.6	37.4	66.2	NBEG
Equivalent Aircraft (EQA)	26.6	23.0	29.6	30.6	34.6	40.4	70.2	EQA
International Arrivals Gates:								
Narrowbody/Large RJ (Group III)	3	4	2	2	3	2	2	gates
B757 (Group IIIa)	1							gates
Widebody (Group IV)								gates
B777/A350 (Group V)			2	2	2	3	4	gates
Total Gates	4	4	4	4	5	5	6	gates
Narrowbody Equivalent Gates (NBEG)	4.1	4.0	5.6	5.6	6.6	7.4	9.2	NBEG
Equivalent Aircraft (EQA)	4.3	4.0	7.6	7.6	8.6	10.4	13.2	EQA
Additional RON positions	9	12	14	12	12	12	13	positions
Holdrooms:								
Regional Aircraft (Groups II & III)		0	0	0	0	0	0	SF
Narrowbody (Group III)		49,500	51,600	53,800	62,400	68,800	126,900	SF
B757 (Group IIIa)		0	0	0	0	0	0	SF
Widebody (Group IV)		0	0	0	0	0	0	SF
B777/A350 (Group V)		0	6,200	6,200	6,200	9,300	12,400	SF
Total Holdroom Area	49,310	49,500	57,800	60,000	68,600	78,100	139,300	SF
CBP Outbound Gate Interview Rooms		200	200	200	300	300	300	SF
Subtotal	49,310	49,700	58,000	60,200	68,900	78,400	139,600	SF

	Existing Facilities	Recommended Facilities						
		Base Year	Forecast Year					
		2018	2025	2030	2040	2040 High	2070 High	
AIRLINE SPACE								
Ticketing/Check-in Positions:								
Total Equivalent Check-in Positions	124	108	126	132	151	166	288	pos
Percentage Using Staffed Positions		47%	45%	40%	40%	40%	25%	
Conventional Staffed Positions	67	51	57	53	60	66	72	pos
Percentage Using Kiosks		53%	55%	60%	60%	60%	75%	
Self Service Kiosks & Bag Drops	57	57	69	79	91	100	216	kiosks
Linear Positions	83	67	76	75	86	94	133	pos
Ticket/Check-in Counter - length	447	370	420	410	470	520	730	LF
Ticket/Check-in Counter - area	4,833	4,100	4,600	4,500	5,200	5,700	8,000	SF
ATO and Other Airline Offices	18,906	20,400	23,100	22,600	25,900	28,600	40,200	SF
Airline Operations	35,948	41,400	53,300	55,100	62,300	72,700	126,400	SF
Airline Clubs & 1st/Bus. Class Lounges	2,436	12,000	15,000	15,000	18,000	18,000	24,000	SF
Baggage Service Offices	2,268	3,300	3,600	3,700	4,200	4,800	8,400	SF
Baggage Handling:								
Estimated make-up capacity	85	80	100	110	120	140	250	carts
Baggage Make-up area	38,992	48,000	60,000	66,000	72,000	84,000	150,000	SF
Checked Baggage Screening - EDS units	5	5	6	6	7	7	14	units
Checked Baggage Screening - area	16,051	16,000	19,200	19,200	22,400	22,400	44,800	SF
Baggage Claim Off-load - domestic	14,029	12,000	14,000	16,000	18,000	20,000	32,000	SF
Baggage Claim Off-load - international	0	8,000	10,000	10,000	10,000	12,000	34,000	SF
Baggage Tug/cart Circulation	17,928	18,000	12,600	13,800	15,000	17,400	32,400	SF
Ramp Control Tower	0	0	500	500	500	500	500	SF
Airline Systems	inc ops.	2,100	2,700	2,800	3,100	3,600	6,300	SF
Subtotal	151,391	185,300	218,600	229,200	256,600	289,700	507,000	SF
DOMESTIC BAGGAGE CLAIM								
Claim Frontage Required	-	900	1,050	1,090	1,250	1,380	2,390	LF
Claim Units	6	6	7	8	9	10	16	units
Claim Frontage Programmed	765	900	1,050	1,200	1,350	1,500	2,400	LF
Baggage Claim Area	18,400	31,500	36,800	42,000	47,300	52,500	84,000	SF
Oversized Baggage	90	1,600	1,800	2,100	2,400	2,600	4,200	SF
Subtotal	18,490	33,100	38,600	44,100	49,700	55,100	88,200	SF
CONCESSIONS								
Ground Services/Information Counter	2,259	800	800	1,200	1,200	1,200	2,000	SF
Food/Beverage; Secure	18,941	26,300	30,900	33,900	39,100	45,100	87,000	SF
News/Gift/Retail; Secure	11,007	16,200	19,100	20,900	24,100	27,800	53,700	SF
Subtotal; Secure Concessions	29,948	42,500	50,000	54,800	63,200	72,900	140,700	SF
Food/Beverage; Non-Secure	0	2,900	3,400	3,800	4,300	5,000	9,700	SF
News/Gift/Retail; Non-Secure	3,497	1,800	2,100	2,300	2,700	3,100	6,000	SF
Subtotal; Non-Secure Concessions	3,497	4,700	5,500	6,100	7,000	8,100	15,700	SF
Duty Free	1,082	1,000	1,700	1,700	1,900	2,200	6,700	SF
Other Services	450	500	600	700	800	900	1,800	SF
USO	2,280	4,500	5,200	5,500	6,300	6,900	12,000	SF
Concession Support Area	10,029	12,200	14,500	15,800	18,200	21,000	41,200	SF
Subtotal	49,545	66,200	78,300	85,800	98,600	113,200	220,100	SF
PUBLIC SPACE & CIRCULATION								
Ticket Lobby	21,870	23,100	26,300	25,600	29,400	32,500	45,600	SF
Security Screening (SSCP) Lanes	10	13	15	15	18	19	33	lanes
Checkpoint/Queue/Search Area	15,616	25,200	29,100	29,100	34,900	36,900	64,000	SF
Secure Circulation Corridor Width	16' - 26'	30	45	45	45	45	45	ft
Secure Circulation	47,500	58,000	104,500	108,300	123,400	141,600	250,600	SF
Sterile (Int'l Arrivals) Circulation	13,506	8,600	12,000	12,000	14,200	15,900	19,700	SF
Public Seating/Waiting/Domestic M/G Area	7,699	12,200	14,200	14,800	17,100	18,700	32,500	SF
International Meeter/Greeter Lobby	0	1,700	2,500	2,500	2,700	3,100	10,300	SF
Restrooms - Non-Secure Departures Level	2,645	3,200	3,700	3,900	4,500	4,900	8,500	SF
Restrooms - Non-Secure Arrivals Level	2,691	2,700	3,100	3,300	3,700	4,100	7,200	SF
Restrooms - Secure Locations	9,416	6,600	8,800	8,800	11,000	13,200	19,800	SF
Other Public Circulation	104,280	88,000	114,900	120,300	138,600	155,700	269,100	SF
Subtotal	225,223	206,200	292,800	303,000	350,100	394,100	681,700	SF

	Existing Facilities	Recommended Facilities						
		Base Year	Forecast Year					
		2018	2025	2030	2040	2040 High	2070 High	
FEDERAL INSPECTION SERVICES								
Primary Inspection:								
Global Entry Kiosks	8	3	4	4	4	5	14	kiosks
APC Kiosks	6	7	12	12	15	18	57	kiosks
CBP Officers for APC Verification & Triage								
Global Entry Officers		1	1	1	1	1	3	officers
APC Verification & Triage Officers		3	5	5	6	7	22	officers
Non-APC Inspection Officers		3	4	4	3	3	9	officers
Double Inspector Counters	4	4	5	5	5	6	17	counters
Counters, Kiosks, Queues and Exit Area	9,370	3,070	4,550	4,550	5,250	6,130	18,900	SF
CBP Command & Control Center (CCC)	225	225	225	225	225	225	250	SF
Public Restrooms	1,680	2,200	2,200	2,200	4,400	4,400	4,400	SF
Baggage Claim:								
Claim Frontage Required	-	195	355	355	470	540	1,770	LF
Average Claim Unit Size	125	100	165	165	185	185	225	
Claim Units	2	2	2	2	3	3	8	units
Claim Frontage Provided	250	200	330	330	555	555	1,800	LF
Claim Area	6,460	9,000	14,900	14,900	25,000	25,000	81,000	SF
Bag Trolley Area	inc above	700	1,200	1,200	1,300	1,500	5,100	SF
Exit Podium	inc above	180	180	180	180	180	315	SF
Exit Control Queue	inc above	1,100	1,800	1,800	2,000	2,400	7,700	SF
Unified Secondary Processing & Inspection	5,560	5,000	5,400	5,400	5,800	5,800	14,000	SF
CBP Secondary Operations & Support	inc above	1,800	1,800	1,800	1,800	1,800	2,600	SF
CBP Administration & Staff Offices	8,460	1,200	1,500	1,500	3,000	3,100	6,400	SF
CBP Support Spaces	inc above	3,400	3,500	3,500	4,300	4,300	8,400	SF
Transfer Baggage Re-check:								
Assisted Check-in Positions	0	1	2	2	2	2	6	pos
Counter Length	0	5	10	10	10	10	30	LF
Counter & Queuing Area	0	300	500	500	500	500	1,500	SF
FIS Circulation	5,775	2,000	3,000	3,000	4,400	4,600	13,700	SF
Subtotal	37,530	33,200	45,300	45,300	63,400	66,100	183,300	SF
OTHER AREAS								
Airport Administration/Operations	27,493	30,000	30,000	30,000	30,000	30,000	30,000	SF
TSA Offices & Support	6,810	9,000	10,500	10,500	12,500	13,000	23,500	SF
Loading Docks & Receiving	0	5,000	5,000	5,000	10,000	10,000	15,000	SF
Non-Public Circulation	10,739	18,000	20,900	21,300	24,400	26,900	42,500	SF
Subtotal	45,042	62,000	66,400	66,800	76,900	79,900	111,000	SF
Total Functional Area	576,531	635,700	798,000	834,400	964,200	1,076,500	1,930,900	SF
Mechanical/Electrical/Utilities	65,475	76,300	95,800	100,100	115,700	129,200	231,700	SF
Janitorial/Storage/Shops	8,605	9,500	12,000	12,500	14,500	16,100	29,000	SF
Structure/non-net areas	inc above	21,600	27,200	28,400	32,800	36,700	65,700	SF
TOTAL TERMINAL GROSS AREA	**650,611**	**743,100**	**933,000**	**975,400**	**1,127,200**	**1,258,500**	**2,257,300**	**SF**
Gross Terminal Area per gate:	26,700	32,300	33,800	34,100	34,600	33,600	34,100	SF/NBEG

Notes:

High = high growth forecast scenario

LF = linear feet

NBEG = narrwobody equivalent gate

Pos = positions

SF = square feet

Source: Hirsh Associates, November 2019.

GATE METRICS

Comparisons between airports, or between alternative concepts, are frequently made based on passengers per gate, or terminal area per gate. But these lack a consistent definition of the term "gate". To standardize the definition of "gate" when evaluating aircraft utilization and requirements, a statistic referred to as a Narrow-Body Equivalent Gate (NBEG) index, is used, as shown in **Table 4.2-6**. This statistic allows normalizing the apron frontage demand and capacity to that of a typical narrowbody aircraft gate. The amount of space each aircraft requires is based on the *maximum* wingspan of aircraft in its respective aircraft group. FAA ADG used to define runway/taxiway dimensional criteria were used to classify the aircraft. ADG IIIa was added to more accurately reflect the Boeing 757 aircraft, which has a wider wingspan than ADG III, but is substantially less than a typical ADG IV aircraft.

Table 4.2-6: Narrow-Body Equivalent Gate Index

AIRPLANE DESIGN GROUP	MAXIMUM WINGSPAN	TYPICAL AIRCRAFT	NBEG INDEX
I - Small Regional	<49'	Metro	0.4
II - Medium Regional	<79'	SF340, CRJ	0.7
III - Narrowbody/Large Regional	<118'	A320, B737, DHC8, E175	1.0
IIIa - B757 (winglets)	<135'	B757	1.1
IV - Widebody	<171'	B767, MD11	1.4
V - Jumbo	<214'	B777, B787, A330, A350	1.8

Notes:

NBEG - Narrow-Body Equivalent Gate

Source: Hirsh Associates, 2018.

In developing terminal facilities requirements, the apron frontage of the terminal, as expressed by the NBEG index, is a good determinant for some facilities, such as secure circulation. Different terminal concepts can also be more easily compared by normalizing different gate mixes.

The concept of Equivalent Aircraft (EQA) is similar to that of NBEG; it is a way to look at the capacity of a gate. EQA, however, normalizes each gate based on the seating capacity of the aircraft that can be accommodated, as summarized in **Table 4.2-7**.

To have a relationship with the physical parameters associated with the NBEG, the basis of EQA is also a ADG III narrowbody jet. Most aircraft in this class typically have 140-150 seats. This establishes a basis of 1.0 EQA = 145 seats. Recently, larger ADG III aircraft with 170-180 seats have become more common, but the original seat basis was retained to maintain consistency with historic data and trends. As with the concept of NBEG, smaller aircraft may use a gate, but the EQA capacity is based on the aircraft seating configuration typically in use.

While most terminal facility requirements are a function of design hour passenger volumes, some airline facilities are more closely related to the capacity of the aircraft. Thus, the EQA capacity of the terminal can represent a better indicator of demand for these facilities.

Table 4.2-7: Equivalent Aircraft Index

AIRPLANE DESIGN GROUP	TYPICAL SEATS	TYPICAL AIRCRAFT	EQA INDEX
I - Small Regional	25	Metro	0.2
II - Medium Regional	50	Saab 340, Bombardier CRJ 200	0.4
III - Large Regional	90	Bombardier CRJ 900, Embraer ERJ 175	0.6
III - Narrowbody	145	Airbus A320, Boeing 737, McDonnell-Douglas MD80	1.0
IIIa - B757 (winglets)	185	Boeing 757	1.3
IV - Widebody	280	Boeing 767, McDonnell-Douglas MD11	1.9
V - Jumbo	400	Boeing 777, Boeing 787, Airbus A330, Airbus A350	2.8

Note: EQA - Equivalent Aircraft

Source: Hirsh Associates, 2018.

In the following program analysis, design hour passengers, NBEG and EQA are used to estimate the demand for terminal facilities.

AIRCRAFT GATES AND HOLDROOMS

The total number of gates needed to support forecast activity is a critical element in determining the overall size and configuration of the terminal complex, based on the methodology used for total gates described previously.

GATE MIX

All the usable gates at SAT have PBBs. As noted previously, the current demand is for ADG III gates only, either for mainline narrowbody aircraft or larger regional jets. The airport has a number of larger capacity (Boeing 757) gates in Terminal A and one widebody-capable (ADG V) gate in Terminal B. These are occasionally needed for diverted flights from Dallas-Fort Worth International Airport (DFW) or William P. Hobby International Airport (HOU), but are not needed to support regular activity. Based on the annual aircraft mix forecasts, all domestic gates are expected to remain ADG III in the future.

International arrival gates, however, will need to accommodate widebody aircraft in the near term, if the airport's air service development objectives are met. Based on aircraft design trends, these gates should be capable of handling ADG V aircraft. It is recommended that at least two widebody (ADG V) gates be available to provide redundancy, but that they be configured with dual PBBs, so that each could serve two ADG III aircraft most of the time. The required number of future international aircraft gates would be highly schedule-dependent, but it is recommended that terminal development plans provide flexibility to add ADG V gates in a similar 2:1 ratio as needed.

REMOTE/REMAIN OVERNIGHT AIRCRAFT PARKING

As described in the Inventory of Existing Conditions chapter, there are nine designated remote/RON parking positions near the terminals. Current remote/RON demand exceeds that number, requiring aircraft in need for remote/RON positions (when contact gates are occupied) to be parked on cargo aprons and other locations. It is expected that remote/RON parking position demand will increase in the near term, even as the number of contact gates increases, because of the scheduling patterns of most airlines. Longer term, the number of remote/RON parking position needs are expected to stabilize, although this is highly dependent on individual airline schedules.

HOLDROOMS

Holdrooms, or gate lounges, requirements are based on the mix of gates and the average seating capacity of each class of aircraft. The holdroom area consists of the passenger seating/lounge area, the airline's ticket lift podium and circulation. The amount of seating/lounge area is dependent on the LOS the Airport wishes to provide. The LOS is based on the aircraft load factor, the percentage of passengers seated vs. standing, and the average area per seated or standing passenger.

The current holdrooms vary in size and configuration by terminal. In Terminal A, the holdrooms are approximately 30 feet deep, while in Terminal B, they are approximately 37 feet deep. These are both considered adequate depths to allow different types of boarding queues. It is noted, however, that the four international swing gates in Terminal A (Gates A6 - A9) have internal ramps to the PBB door, which force all boarding into the concourse corridor, at times blocking passenger flows.

Typically, holdrooms are planned for 80 percent aircraft load factors, with 50 to 80 percent of passengers seated and the balance standing. This was considered LOS C to B, and typically assumes a large amount of secure concessions area where many passengers may wait. For SAT, 80 percent of passengers seated is recommended. This net of 64 percent of aircraft capacity compares favorably to the more recent IATA ADRM 10th Edition recommendation of 50 to 70 percent of holdroom occupants seated. It should also be noted, however, that both airline systemwide and peak hour load factors are exceeding 80 percent in the U.S., and airport planners are considering using higher aircraft load factors. Offsetting this to some extent is the availability of seating in nearby concessions. With 80 percent of design passengers seated, the remaining 20 percent are assumed to be either standing or elsewhere in the terminal, until the boarding process begins. When holdrooms are paired, which is the case at SAT, the amount of seating and standing area is typically reduced by 10 percent.

A 240 square-foot (8-foot wide) boarding/deplaning corridor was added to the requirements (assumes an average 30-foot deep holdroom). The corridor effectively acts as an extension of the loading bridge door. Each ticket lift podium position is allocated 5 feet for width, although many airlines use 3-4-foot wide positions. The depth of the podium and back wall is typically 8 feet, and a 15-foot deep queuing area is provided.

The average assumed aircraft seating capacity vs. holdroom size are shown in **Table 4.2-8.**

The narrowbody aircraft size represents a mix of the aircraft sizes serving SAT. The widebody size represents a smaller long range aircraft (Boeing 787/Airbus A330), which might serve the destinations being considered as part of ongoing air service development efforts.

Table 4.2-8: Average Seating Capacity and Holdroom Size

AIRCRAFT	SEATS	AREA (SF)
Narrowbody	160	2,150
Widebody	250	3,090

Source: Hirsh Associates, 2018.

The existing holdroom areas available meet the requirements for 23 active gates. This includes the A16 holdroom, which is available to serve nearby gates but cannot be used as a separate gate.

Holdroom areas should also include space for CBP Outbound Interview rooms of 100 SF per two international gates.

AIRLINE SPACE

Airline space includes both exclusive leased areas (e.g. offices and operations), and joint use space (e.g. baggage claims). The amount of exclusive leased areas is generally proportional to the amount done in-house. As such, the air carriers serving SAT were contacted to determine how well their facilities met requirements for current levels of activity. The larger air carriers provide almost all their customer and aircraft services ('below the wing') in-house. Other carriers use third-party ground handlers or personnel from the larger air carriers for some or all these services.

Each airline area is configured differently, and functions such as airline offices and operations are not easily distinguished in some cases. Recommended facilities for each function have been developed separately.

AIRLINE TICKETING AND CHECK-IN (ATO COUNTER)

The ATO counter traditionally has consisted of staffed agent positions. As airlines provide more self-service kiosks, the definition and configuration of check-in function has, and will continue to, change. To estimate future ATO requirements, staffed positions and kiosks were combined as Total Equivalent Check-in Positions (ECP).

Ticketing/check-in positions are typically based on the number of design hour enplaning passengers; the number of design hour departing flights; the number of airlines; the time distribution of passengers arriving at the terminal; and the percentage of passengers checking in at the ticket counter vs. curbside check-in, using a self-service kiosk or electronically. Most of this information was not directly available for all airlines. A planning factor was developed, which reflects these characteristics to the extent known, current ATO counter and kiosk utilization (not necessarily leased positions), and understood excesses and shortfalls.

At present, all ATO counters and kiosks are exclusive use, although Aeromexico is handled by their alliance partner Delta. There is a total of 124 ECPs, categorized as follows:

- 51 staffed counters in use
- 4 dedicated bag drop counters
- 12 multifunction kiosks in-line with the ATO counter
- 37 multifunction kiosks located within the check-in queue
- 4 kiosks for boarding pass printing only
- 16 vacant counter positions

Some of the airlines are providing bag tag printers at the kiosks to allow self-tagging. This trend, along with increased use of kiosks and other check-in options, is expected to continue.

From the number of kiosks in use and airline discussions, it is assumed that a little more than 50 percent of the passengers currently use kiosks or other self-service check-in options. Based on industry trends, the percentage of kiosk use is expected to increase in the medium-term future to between 55 and 60 percent.

The smaller international and domestic carriers do not have kiosks. These airlines are not expected to have kiosks at SAT unless common use kiosks are provided in the future and the airlines opt into the common use system.

The number of forecast ECPs was converted to conventional linear positions to establish the length of the ATO counter. Locations for kiosks are a combination of airline preference and the physical constraints of the ticket lobby. For SAT, it was assumed that future kiosks and bag drop positions would be located in-line with the staffed counters, at a similar ratio as today.

Most domestic carriers can use a 6-foot double counter plus a shared 30-inch bag well for an average of 4.25 feet per agent. There are also breaks in the ATO counter to allow personnel access to individual ATO office areas and end counters typically without bag wells. This increases the average ATO counter length for planning to typically 5.5 linear feet (LF) per position, which is similar to existing conditions.

The ATO counter depth is typically 10 feet from face of counter to back wall for domestic terminals to provide space for the counter, agent work space and a baggage conveyor parallel to the counter. The existing counter depths average approximately 11 feet, because of differences in counter module designs. This slightly higher ratio has been assumed for programming.

AIRLINE OFFICES

Airline offices include the ATO offices and other airline administrative spaces. At SAT, like most airports, the ATO offices are located immediately behind or adjacent to the ATO counters, to provide support functions for the customer service agents. Typically, these are 30-35 feet deep along the length of the counter. At SAT, these vary from 42 feet deep (Terminal A) to 40 feet deep (Terminal B, plus a circulation corridor). Other offices may include functions such as housing the airline station manager. The amount and location of these offices (ATO, operations area, office location on a terminal upper level, etc.) is dependent on individual airline requirements and preferences, as well as space availability.

Discussions indicate that offices in the ATO area are undersized for many carriers, but there are also non-airline functions located within these areas. For planning, the existing ratio of offices per linear foot of ATO counter has been increased slightly.

AIRLINE OPERATIONS

Airline operations include all the support spaces for aircraft servicing and aircraft crews. The demand for airline operations areas is a function of the size and types of aircraft being operated and individual airline operating policies. Because many airlines do not identify their specific space requirements at this stage of planning, and future airlines cannot be identified, a program for airline operations areas is typically based on the number/size of gates (expressed as EQA) and airlines at an airport. There are also third party ground handlers providing ‘below the wing’ services for smaller carriers. These ground handlers may have consolidated support facilities outside of the terminal.

Discussions indicate that airline operations spaces are undersized for many carriers, and that at a minimum, many of these areas need to be reconfigured for better functionality. For planning purposes, the current ratio of operations spaces per EQA has been increased to a more typical value for a spoke airport.

AIRLINE CLUBS AND LOUNGES

Airlines typically provide membership clubs based on their level of activity at an airport, the number of club members living in or regularly traveling to the airport area and other marketing considerations. Only United Airlines has a club at SAT (United Club). The club is considered small (53 seats and a maximum fire code capacity of 84), and does not have all the facilities and amenities normally provided. Both United Airlines and American Airlines station managers noted that many frequent American Airlines passengers living in San Antonio have joined the United Club since it is accessible to American Airlines gates.

Based on these discussions, it has been assumed that United Airlines would want to expand to approximately 4,000 SF and that American Airlines would want a similarly sized club. A third 4,000-sq. ft. club might be viable, and supported by Delta Air Lines or as a third-party club open to all passengers. In the future, the total amount of airline club space is expected to increase.

BAGGAGE SERVICE OFFICES

Baggage service offices (BSOs) are typically required by airlines with sufficient activity to warrant staffing; the four larger carriers at SAT (American Airlines, Delta Air Lines, United Airlines and Southwest Airlines) have BSOs. Other airlines' late bags are presently stored in the ATO offices, which is inconvenient. A new BSO for Frontier Airlines, and a common baggage lock-up area for smaller carriers are being constructed in the former rental car counter area of Terminal A. There is not enough BSO space to accommodate new entrant airlines at SAT.

BAGGAGE MAKE-UP

Baggage make-up includes the make-up units or conveyors, the cart loading areas and baggage tug/cart (baggage train) maneuvering. The checked baggage inspection and outbound baggage systems are operated and maintained by an airline consortium. While the system is common-use, each airline has its own make-up units. There are seven sloped bed and flat plate make-up units of various sizes and configurations. The capacities range from 8 to approximately 20 staged carts, for a total of approximately 85 carts. All the make-up units allow for bag carts to be staged parallel to the make-up units. Some are separated far enough to allow bag trains to bypass the units, whereas others must operate on a 'first-in, first-out' basis.

Baggage cart staging demand is a function of aircraft size (seat capacity) and the number of hours a flight is in the make-up process (typically 2 hours for a domestic flight). This has usually resulted in a demand for one cart per 50 aircraft seats, or 3-4 carts for a narrowbody flight. Not all carts are staged simultaneously, with filled carts being moved to a holding area or the gate area while empty carts are staged. With the increased baggage fees and lower percentages of passengers with checked bags, the total number of bag carts has been declining for many airlines. Based on modeling of the make-up process at other domestic airports, a planning factor of 3.5 staged carts per EQA has been assumed.

CHECKED BAGGAGE SCREENING

Because of the Aviation and Transportation Security Act, all checked baggage is subject to screening for explosives. The Airport has a fully automated, in-line Checked Baggage Inspection System (CBIS) for screening and sorting outbound bags. The screening matrix includes five L3 6600 EDS units. These are arranged so that three units primarily service bags coming from Terminal A and two units from Terminal B.

However, there are numerous conveyor cross-overs to allow bag loads to be balanced between the EDS units when necessary.

Bags that alarm in the EDS units (Level 1) are subject to on-screen resolution (Level 2) while within the baggage system. If a TSA screener cannot determine if the bag can be cleared, the bag is diverted to the Checked Bag Resolution Area (CBRA), where screeners using images from the EDS open the bag and check its contents with Explosives Trace Detection (ETD) (Level 3). There are eight CBRA inspection tables. Cleared bags are then re-inducted into the baggage system toward the make-up units. Oversized bags (either manually identified or measured by the CBIS as too long for the EDS units) are sent directly to the CBRA for manual inspection.

Based on discussions with the airlines, the baggage system consortium operator and TSA, an average of 0.7 checked bags per passenger is estimated during the peak months. Each EDS unit has a rated processing capacity of 500 bags/hour. In the preferred operating configuration of 3 units (2 active plus 1 spare) for Terminal A and 2 units (1 active plus a spare) for Terminal B, the CBIS should have a design capacity of approximately 1,500 bags/hour. However, it is reported that when volumes exceed approximately 1,200 bags/hour, conveyor back-ups begin and the system throughput is reduced. Modifications to the system controls are planned, and although an increase in sustained capacity is expected, it has not yet been quantified.

For planning purposes, a lower EDS throughput rate (400 bags/hour) was assumed, which recognizes the split nature of the current system. Longer term, more advanced EDS units are anticipated to be installed, requiring fewer EDS units; however, the area required per advanced EDS unit typically increases. As such, the program area is considered reasonable for Master Planning-level programming.

BAGGAGE CLAIM OFFLOAD

Baggage offload includes: the portion of a flat plate, direct feed claim unit upon which the bags are placed or the input conveyor for a sloped bed claim unit, the adjacent baggage train lane and work area, and a by-pass lane for baggage trains. A 75-foot long off-load zone is assumed to allow a four-cart baggage train to be unloaded.

Plans for the expanded FIS (see Section 2.6) do not indicate an enclosed offload area similar to existing conditions; the offload area is assumed to be a non-enclosed canopy over the input conveyor.

BAGGAGE TRAIN CIRCULATION

A percentage of baggage handling space for baggage train circulation around and between the bag make-up and off-load areas is included for planning. Ten percent of baggage handling space is a typical factor, but for SAT, 15 percent was used, because of a large amount of baggage train circulation within the existing terminal complex. This assumes that future terminal concepts will require relatively less circulation than at present. However, the final configuration of the terminal may require more space or less space.

RAMP CONTROL TOWER

There is no Ramp Control Tower at SAT. All aircraft pushbacks are either handled by ATCT staff if into a movement area (taxiway), or coordinated between airline ground staff, such as between Terminals A & B. An allowance is included for a small Ramp Control Tower to coordinate pushbacks among airlines and between the concourses. The final size and location(s) will be determined when the concept is finalized.

AIRLINE SYSTEMS

An allowance of 5 percent of airline operations area was included in the Program to accommodate airline systems that may not be considered in the terminal's mechanical/electrical area estimates. These systems typically include computer and communications rooms, which have increased in size and complexity as more airline functions are automated. The allowance is not intended to cover large, centralized ground power motor/generators or centralized pre-conditioned air systems.

DOMESTIC BAGGAGE CLAIM

There are six flat plate baggage claim units – three in each terminal:

- The three "W"-shaped claims in Terminal A have approximately 135 LF of claim frontage (i.e. where passengers can access the bags). The separation between the 'arms' of the claim units is 25 feet, which is less than recommended, but the relatively shallow arms of the claim units offset this shortfall to some extent.
- Terminal B has two "T"-shaped claim units, each with 125 LF of claim frontage, and one "L"-unit with 110 LF of claim frontage. The separation between the units is approximately 44 feet, and although there are intermediate columns, the distance between the columns and claim units (±20 feet) is adequate.

Baggage claim requirements are based primarily on design hour deplaned passengers, the concentration of these arriving passengers within a 20-minute period and to a lesser extent, checked bag per passenger ratios. Observations at most U.S. airports indicate that many domestic passengers arrive at the baggage claim area before their bags are unloaded onto the claim units. At an airport such as SAT, virtually 100 percent of the passengers are waiting prior to first bag delivery. The result is that the claim unit should be sized for the estimated number of passengers waiting for baggage, because most bags are claimed on the first revolution of the claim unit.

Based on current schedules, the peak 20 minutes represents 50 percent of the design hour activity. This is a typical arrival concentration at spoke airports. The percentage of passengers who have checked baggage is estimated at 60 percent during the peak hours.

The existing bag claim sizes are considered adequate for smaller and medium sized narrowbody aircraft, especially with fewer passengers checking bags. For the longer term, larger claim units (150 LF) are recommended, to provide more flexibility for larger aircraft or multiple smaller flights. The baggage claim area is recommended to be 35 SF per foot of frontage to provide adequate queuing and circulation space with flat plate claim units. A 30-foot separation between adjacent claim units is recommended.

An allowance for oversized baggage delivery was included. This would be for oversized baggage slides of adequate size for skis and other large checked items. There is no dedicated area to deliver oversized baggage in Terminal A, and only a 7-foot-wide slide in Terminal B.

CONCESSIONS

Terminal concessions include all the commercial revenue-producing functions serving the traveling public, as well as some services that may not directly produce revenue. Concessions programming at this level of planning are based on factors of square feet per 1,000 annual enplanements. Planning factors reflect the characteristics of the passengers, but may also be heavily influenced by the types of concessions, and especially their location.

The current facility restricts the revenue potential at SAT. The amount of space dedicated to the types of concessions, the infrastructure to support those concessions, and the circulation space in Terminal A significantly restricts where concessions offerings can be located due to queue conflicts with passenger traffic flows in the terminal. In both terminals, approximately 90 percent of the food/beverage and retail concessions are currently located inside security, which is desirable by most passengers. **Appendix 4B** provides the *Terminal Concessions Analysis*.

GROUND SERVICES/INFORMATION COUNTERS

There are information counters on the departures and arrivals levels of both terminals, staffed by volunteer "Airport Ambassadors". Future terminal processors are assumed to have similar counters.

Rental car counters have been relocated to the Consolidated Rental Car Center across from the terminals, and are not considered part of the terminal program. The space formerly occupied by the rental car counters and offices (included as existing space) is anticipated to be converted to baggage service offices and other uses. There are no counters for other ground transportation modes. Super Shuttle has a kiosk near the exit door from the Terminal A bag claim.

FOOD AND BEVERAGE SERVICES

There is not sufficient space to add a ghost kitchen to support both terminals. A ghost kitchen would allow the Airport to decrease spaces used on the terminal levels for kitchens and maximize the revenue production of those spaces. This would also allow flexibility in offerings to test new concepts out without significant investment in facilities.

The planning ratio (in terms of square feet per 1,000 annual enplanements) was increased approximately 10 percent over the existing ratio.

NEWS/GIFT/SPECIALTY

This category includes news, gift, retail and specialty shops. The planning ratio was increased to provide a larger retail space in the secure area, and accommodate a potential small non-secure news stand operation, possibly in association with the non-secure food/beverage operation or a vending operation.

OTHER SERVICES

This category usually includes ATMs, vending, arcades and other services. The terminal has one small vending/arcade area near the baggage claim. A similar planning ratio was assumed for these services in the future.

UNITED SERVICE ORGANIZATIONS (USO)

The USO operates a lounge in the arrivals area between Terminal A and Terminal B, and provides hospitality for traveling service members and their families. Because of the large military presence in the San Antonio area, especially for training, there are large numbers of service members traveling weekly.

The 2,300 sq.ft. facility has seating for 30 people and an effective capacity of approximately 40 people. On busy days, demand exceeds this capacity. USO staff have witnessed service members look in and turn away because of overcrowding. Support spaces within the lounge (baggage storage, food storage, etc.)

are also undersized. Discussions with staff indicate that approximately 4,500 sq.ft. would be needed to serve current levels of activity. This area is projected to increase in proportion to design hour enplaned passengers.

CONCESSION SUPPORT

Concession support consists of storage areas, preparation kitchens, employee lockers and administrative offices. The food/beverage support is primarily the adjacent kitchen and preparation areas. A small storage room for the food/beverage is located within the ATO#2 office/operations area. There is no remote storage for the news/gift shop.

Existing concession support space is limited, and all concessionaires have shortages of on-site storage. This is especially acute because of the need for screening deliveries prior to being moved into secure areas of the terminal. For Programming, 25 percent of the customer-serving areas was assumed for concession support.

PUBLIC SPACES

Public spaces include most of the non-revenue producing areas of the terminal, such as queuing areas, seating and waiting areas, restrooms and circulation. Some of the public space elements are directly related to design hour passenger volumes, whereas others are functions of other facility requirements.

TICKET LOBBY

The ticket lobby includes ATO counter queuing area, self-service kiosks and cross circulation:

- In Terminal A, there is approximately 45 feet from the ATO counter to the escalators and store fronts. Of this, 25 feet re designated for passenger queuing and the location of most self-service kiosks. The remaining 20 feet for cross circulation are often partially occupied by check-in queue overflows from some airlines. During the peak hours, the overflow from the SSCP can also extend through the ticket lobby and block circulation.
- In Terminal B, there is approximately 47 feet from the ATO counter to the main column line, with additional circulation beyond to the window wall. Passenger queuing and kiosk depth varies from 25 feet to 30 feet. Cross circulation is effectively limited to passengers accessing the escalators to the Rental Car Center bridge at the end of the United Airlines ATO counter. Passenger overflow from the SSCP uses the area adjacent to the ATO counters and does not directly block circulation in the same way as in Terminal A.

The minimum dimension from the face of the ticket counter to any obstruction to cross circulation should be 45 feet to 50 feet, for airports with traffic similar to SAT. Existing dimensions in Terminal B are adequate. Terminal A has some constraints, but some of this is due to inadequate capacity and queuing of the SSCP. Although the trend toward increased self-service check-in has led some in the industry to predict the extinction of ticket lobbies, thus far, airlines are using ticket lobbies for different configurations of kiosks and baggage drop counters. A 50-foot deep ticket lobby is recommended for future development.

SECURITY SCREENING CHECKPOINT

With the changes in security inspection procedures and equipment, processing rates have changed at most airports. The TSA also continues to mandate new security SSCP configurations.

- Terminal A has six SSCP lanes. The carry-on baggage X-rays have varying configurations in terms of the length of divest tables and composure (pick-up) conveyors/rollers. Lanes with shorter composure rollers can cause delays for the X-ray if bags and bins are not cleared out by passengers. The four lanes for regular passenger screening have Advanced Imaging Technology (AIT) body scanners, which are slower than Walk-Through Metal Detectors (WTMDs), but often the limiting factor for processing rates is the baggage X-ray. TSA Pre-Check and Clear passengers have two lanes available.
- Terminal B has four SSCP lanes: three regular lanes and one Pre-Check lane. All lanes have the same configuration. Two AIT scanners can serve all four lanes, but are not used for Pre-Check passengers.

Both checkpoints have multiple entrances and queues:

- Regular passengers
- Premium passengers screened at regular lanes
- TSA Pre-Check passengers
- Clear members, using Pre-Check lanes
- Wheelchair and employee entrance
- Known crewmembers bypass the screening lanes and enter through the passenger exit lanes

Activity surveys carried out by the consulting team on Friday, June 8, 2018 (referred to as “Freak Week”) and Monday, June 11, 2018, included SSCP process times and queue lengths during the early morning and late afternoon departures peaks. Queue lengths are illustrated in **Figure 4.2-5** and **Figure 4.2-6**. The following observations were made:

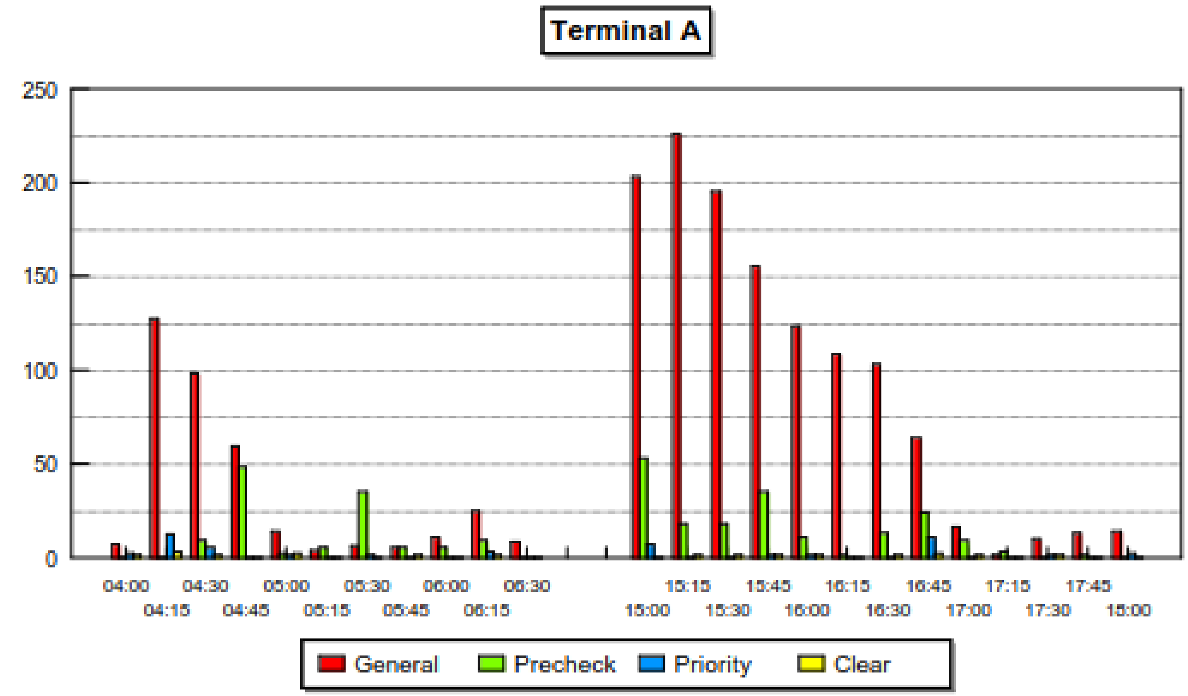
- Both terminals have similar numbers of departing seats in the early morning peak hour: 1,340 for Terminal A and 1,240 for Terminal B. However, as shown in the figures, the lower SSCP capacity of Terminal B leads to longer queues.
- In the afternoon, Terminal A has multiple secondary peaks between 16:00 and 19:00, whereas Terminal B has less than half that amount of activity. It was noted that not all Terminal A lanes were staffed for the full busy period, which may partially explain the long queues. These queues overflowed the available SSCP queuing area and extended into the ticket lobby.

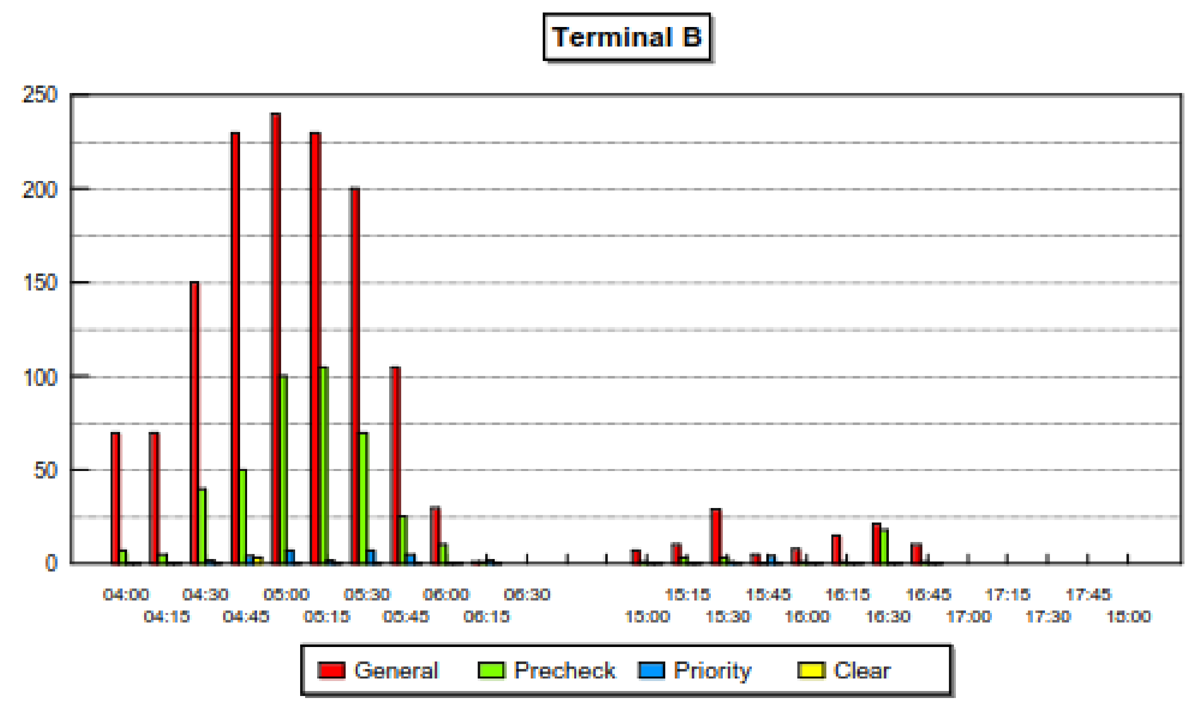
Observed throughput rates (measured when queues were present) were also variable, both by day, morning vs afternoon, and by terminal. In Terminal A, throughput rates were higher in the morning than afternoon on both days, and 20 to 25 percent greater than Terminal B on comparable days and times. Variations in processing rates by lane are often observed, but a consistent difference between checkpoints is unusual. An average of both checkpoints’ regular lanes throughputs was in the range of 150 passengers/hour/lane. Discussions with TSA confirmed that this is a reasonable planning value given current procedures. Throughput rates for Pre-Check lanes were significantly higher, but the number of Pre-Check users is highly variable by time of day and flight.

For terminal planning, all lanes have been assumed to have the capacity of regular screening lanes. During design hours, a 10-minute wait time was assumed, but the queue area has been sized to accommodate a

20-minute queue. Because the current terminals have separate SSCPs, an 'inefficiency' factor of 20 percent has been added to increase the total number of lanes as compared to a single SSCP location.

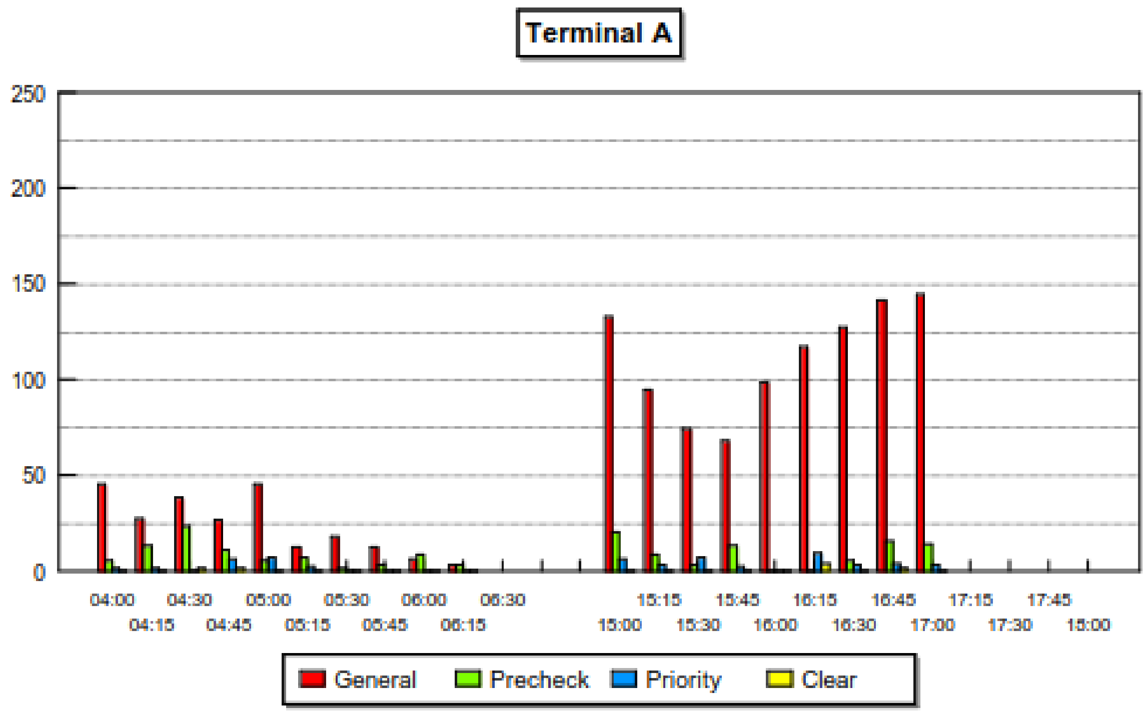
Figure 4.2-5: Checkpoint Queue Lengths Friday, June 8, 2018

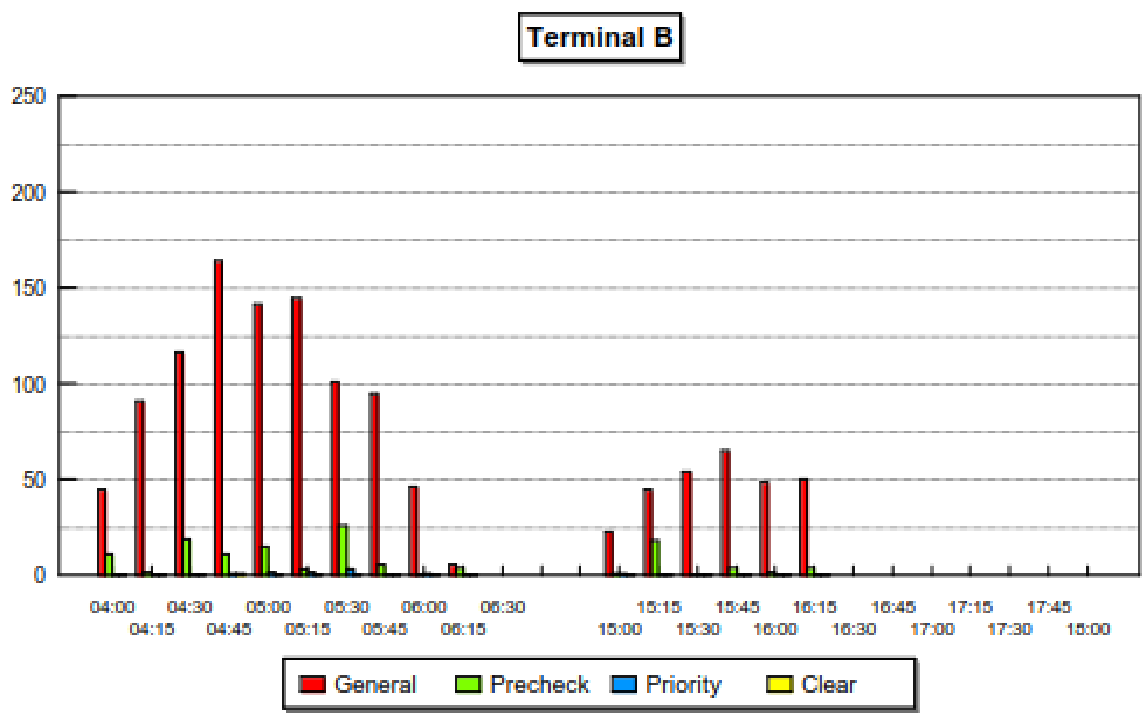




Source: Hirsh Associates, 2018.

Figure 4.2-6: Checkpoint Queue Lengths Monday, June 11, 2018





Source: Hirsh Associates, 2018.

For current activity, this results in a demand for 13 lanes, which is consistent with observations, discussions and planned expansion of the Terminal A SSCP (removal of Dunkin Donuts to add an additional security lane).

The program area includes the actual SSCP equipment, divesting/bag repacking areas and TSA support space that is required at the checkpoint. This can vary by equipment configuration. Current TSA configurations require up to 60 feet by 30 feet wide (per pair of lanes) for the equipment, plus additional space for document checking, trace detection and passengers to re-pack their carry-ons. The program has assumed an 85-foot deep zone to accommodate all these functions. Additional area for TSA support at the SSCP (5 percent) has been included.

SECURE CIRCULATION

Secure circulation typically consists of the central corridor of the concourses and adjacent egress stairs. Existing corridor widths differ by terminal:

- Terminal A's corridor width varies. In the single-loaded gate area from gate A1 - A7, the corridor is 19 feet wide, including the columns, for a clear width of approximately 16 feet. In the double-loaded gate area from A8 - A16, the holdrooms extend to the centerline of the columns, reducing the available width to approximately 17 feet, with the same clear width of 16 feet.
- The corridor varies in width in the central concessions area, narrowing to as little as 12 feet opposite the SSCP where the recomposing seats are located.
- Terminal B's corridor is 26 feet wide between holdrooms, widening to 30 feet in the central concessions zone. Columns are located within the holdrooms, so the full width is available.

Terminal planning practice would recommend a 30-foot wide clear corridor for double-loaded concourses without moving walkways, and between 20 feet to 25 feet for a single-loaded corridor, depending on whether there are significant uses across from the holdrooms and the number of gates. Corridors with moving walkways would be 45' wide for double-loaded concourses and 35-40' wide for single loaded concourses. Ancillary uses would be located outside of these corridors. Thus, Terminal A is extremely undersized as noted during peak periods. Terminal B is closer to recommended dimensions and generally functions adequately.

The program area is based on an area per equivalent concourse length determined by gates expressed as NBEG. The actual amount of secure circulation required will depend on the terminal configuration. For programming, it has been assumed that a mix of single-loaded and double-loaded concourses would be used. Future terminals are assumed to have moving walkways.

STERILE INTERNATIONAL ARRIVALS CIRCULATION

Arriving international passengers must be kept separate from other passengers, visitors or unauthorized airline employees until they have cleared all FIS inspections. This requires a separate corridor system from the aircraft gate to primary inspection. Terminal A has four international arrivals gates (A6 - A9), which access a 10-foot wide sterile corridor. It is located on a mezzanine level between the arrival and departure levels. Some internal ramping in the holdrooms and exterior ramps allow separation of arriving international and departing passengers.

Unusually, the sterile corridor ramps down to continue all the way to gate A1, but no other gates can access the corridor at present. It is understood that international GA arrivals used gate A1 at times prior to the construction of the separate GA FIS across the airfield. This unused extended corridor overstates the existing effective sterile corridor area by approximately 4,000 SF.

Sterile corridors should be sized for single direction passenger flow - typically 10 to 15 feet wide, depending on whether a moving walkway is required. Because departing passengers can use the same gates as international arrivals, control doors and monitoring of the corridor system is required to prevent mixing of arriving and departing passengers.

At this point in the planning process, it is assumed that international gates would be single-loaded, or on one side of a double-loaded concourse. The program area allowance assumes that the gates and FIS will be in reasonable proximity with each other and that moving walkways would not be required.

PUBLIC SEATING

Public seating areas include general waiting areas near the ticket lobby, domestic baggage claim areas and concessions. These are typically in non-secure areas of the terminal. The bulk of the seating/waiting area would be located to provide an area for domestic meeters/greeters outside of security or near the baggage claim.

Airports typically provide seating for a portion of the design hour total passengers and their visitors. Because of security restrictions, the number of well-wishers at most airports have declined dramatically and these ratios are estimated to be low. For terminal programming, it is assumed that non-secure seating would be provided for 10 percent of design hour total passengers, the well-wishers for the enplaning passengers and the meeters/greeters of deplaning domestic design hour passengers.

A separate estimate was made for the international meeters/greeters lobby, which is located at the exit from the FIS, and was sized for all the meeters/greeters of the design hour terminating international passengers.

RESTROOMS

Restrooms should have at least as many toilets for women as toilets and/or urinals (fixtures) for men. Newer building codes in some cities require 25 percent to 50 percent more fixtures for women than for men in buildings such as terminals. This is consistent with methodologies presented in ACRP publications (see ACRP Report 130) when a 50/50 male/female gender split is assumed.

None of the restroom locations at SAT meet the recommended fixture ratios. A few locations have equal numbers of men and women fixtures or more women fixtures (two Terminal A concourse locations and the departure and arrival restrooms in Terminal B). All the other locations have more fixtures for men than women.

The program area has been divided between the main terminal locations (departure and arrival levels) and the secure concourse area. The terminal factor is based on design hour passengers and their estimated visitors. The minimum number of toilets and/or urinals is recommended to be 10 for men and 12 for women in the secure locations. Because the main demand on secure restrooms is for arriving passengers, it is recommended that these be located conveniently for passengers proceeding from gate to baggage claim. The planning factor is based on a restroom with 12 men and 16 women fixtures for every eight EQA.

In addition to handicapped access toilets, sinks and urinals, it is recommended in transportation facilities such as airports that companion care restrooms be provided. These unisex restrooms allow an elderly or disabled person to be accompanied into a restroom by another person who assists the disabled person. All the SAT restroom locations have a companion care restroom. The program restroom area includes a companion care restroom for each restroom module.

GENERAL PUBLIC CIRCULATION

Other public circulation includes the corridors, vertical circulation elements and other architectural spaces, which tie the public functional elements of the terminal together. The existing terminals have a relatively high percentage of public circulation.

The program area is based on a percentage (30 percent) of these functional areas: ticket lobby, domestic baggage claim, baggage service offices, holdrooms, concessions (excluding concession support area), airline clubs and other public areas. The percentage is a first approximation and will also vary with the terminal configuration. The split between secure and non-secure (public) circulation is also a function of the terminal concept, however in the table, the public circulation allowance was included as non-secure circulation.

FEDERAL INSPECTION SERVICES

Federal Inspection Services (FIS) facilities are required at all airports with international flights. The exception are most flights from Canada and a limited number of other airports with U.S. pre-clearance facilities. These passengers are treated the same as domestic arrivals. In Terminal A, Air Canada’s flights are pre-cleared and do not use the FIS.

The CBP inspection process flow has changed and continues to evolve since the last formal facilities standards (Airport Technical Design Standards, or ATDS) were published in June 2012. Tables for support facilities (November 2017) also do not fully reflect the current primary inspection flow. Thus, one challenge for FIS planning is to accommodate the current process flow while maintaining flexibility for future changes.

CBP procedures require that all passengers be processed through the primary inspection counters. Self-service kiosks (where available) can be used by US citizens, permanent legal residents and some others depending on visas. Secondary passenger and baggage inspection is based on more selective procedures using computer-based lists of passengers, roving agents, designations of 'high-risk' and 'low-risk' flights and other selection techniques. A ‘unified secondary inspection area’, which incorporates both secondary passenger and baggage inspection, is typically located after baggage claim.

The SAT FIS is unusual in that baggage claim is located prior to Primary Inspection. Modifications and expansion of the FIS are in process and are expected to be completed during 2019. The renovated FIS will retain the ‘bags first’ flow and will introduce self-service kiosks. The “Existing Facilities” column in Table 4.2-5 reflects conditions when the modifications are complete. It should be noted that the following facilities requirements reflect a more conventional passenger flow with baggage claim between primary and secondary inspection areas.

INTERNATIONAL BAGGAGE CLAIM

Prior to Primary Inspection, passengers collect their checked bags from the bag claim devices. The expanded FIS will have two sloped bed claim units with 125 LF of claim frontage. These are suitable for smaller narrowbody aircraft and/or a lower percentage of passengers with checked bags as is experienced at SAT. In the near to mid term, larger claim units are recommended to accommodate wide-body aircraft.

PRIMARY INSPECTION

The current Primary Inspection process flow relies more heavily on different types of automation to accommodate higher passenger volumes with fewer CBP officers. The basic Primary process is as follows:

US Citizens, Legal Permanent Residents and Canadian Citizens can use automated processes:

- Global Entry (GE) kiosks: after using the kiosks, passengers pass by an officer for verification of their receipt.
- Mobile Passport Control (MPC): passengers use an app on a mobile phone to enter data prior to arriving at the FIS, then proceed to a CBP officer.
- Automated Passport Control (APC) kiosks: passengers use a kiosk to enter data and have their photo taken for the receipt. Visitors to the U.S. with some types of passports (Canadian citizens, B1/B2/Visa Waiver Program) can also use the APC kiosks. Most APC users can go to an officer for verification of their electronic or printed receipt. The remaining passengers are directed to a 'triage' officer to take care of issues that the automated systems flag.

SAT has GE kiosks whose usage varies significantly by flight. There are currently no APC kiosks, although APC kiosks are planned for the expanded FIS. Because there is no data on APC/MPC usage, assumptions were made based on other airports with small FISs. A maximum wait time of 10 minutes was assumed for APC kiosks, with zero wait time for GE.

SECONDARY INSPECTION

After Primary Inspection, passengers enter a queue for Exit Control. Based on notations on their primary inspection receipt, passengers either exit the FIS or are directed to Secondary Inspection. At some airports, CBP has been testing a system where there is no Exit Control, but passengers are escorted from Primary Inspection to Secondary. This is not yet widespread, so an Exit Control queue has been included in the program.

CBP uses a Unified Secondary where all passport and baggage inspection occurs. Secondary Inspection has:

- A waiting area and interview rooms for passport related issues.
- Agriculture inspection X-ray and counter for bags from originations that may contain food and other prohibited plant or animal products.
- Customs inspection counter, X-ray and search rooms for inspection of bags for other items.

Passengers connecting to domestic flights re-check their bags after exiting the FIS at a counter outside the FIS. Connecting passenger volumes are extremely low at present. The recent code share announcement between Frontier and Volaris has the potential for some connecting traffic. Longer term, potential flights to Europe and/or South America also have some connecting potential.

CUSTOMS AND BORDER PROTECTION ADMINISTRATIVE AND SUPPORT AREAS

The total amount of space, as specified in the CBP Technical Design Standards, is based on the rated capacity of the FIS. The CBP administrative and support spaces should be located within the sterile perimeter, and be accessible from the primary and secondary processing areas.

Other government agencies may have offices within the FIS. These include Public Health Services/Centers for Disease Control (PHS/CDC), U.S. Fish & Wildlife Service (FWS), and Immigration & Customs Enforcement (ICE). None of these currently have offices at SAT. Discussions with CBP do not indicate that such offices are expected soon and have not been included for programming.

FEDRAL INSPECTION SERVICES CIRCULATION

FIS circulation is based on 10 percent of the inspection and baggage claim areas. Circulation within the administrative and support areas is included in those sub-totals. The actual amount of circulation would depend on the configuration of the FIS.

As noted above, CBP processes and procedures are continually evolving, and official facilities guidance lags what is observed in the field. Estimating future FIS facilities requirements is thus more subject to variability than other passenger processes. The gross area of the FIS in the program table should be considered a general area for master planning with less focus on the specifics (other than baggage claim) than on other portions of the terminal program.

OTHER AREAS

AIRPORT ADMINISTRATION/OPERATIONS OFFICES

Airport administrative offices are located on the upper mezzanine of Terminal A and in a portion of the Terminal A ATO office block. Terminal operations offices are in other locations scattered throughout the apron level of both terminals. Many other administrative and operations functions for the Airport are located outside of the terminal.

An Administration Space Study is underway, and will include a detailed assessment of the Airport's office needs and locations. This will be included in the Support Facilities section. Until that is completed, it has been assumed that the same amount of office and operations space will remain in the terminal complex.

TRANSPORTATION SECURITY ADMINISTRATION OFFICES

In addition to the passenger and baggage screening equipment and adjacent search areas, the TSA requires space for supervisors' offices, training, agent break rooms and storage. These are presently located in Terminal B next to the United Airlines ATO counter, in the Terminal A ATO office block, and in three locations on the apron level of Terminal A. TSA's main offices and administrative support is located off-airport and these are expected to remain in that location.

The terminal program for TSA space is limited to that needed to support the SSCP and checked baggage screening operations, and is based on the number of SSCP lanes and EDS units.

LOADING DOCKS AND RECEIVING

A terminal should have a loading dock and receiving area to allow deliveries from the public roadway system, as well as removal of trash generated by terminal users. The TSA requires screening of deliveries for secure side concessions before these are moved into or through secure areas.

A single receiving area was assumed for the existing terminal complex, with additional receiving areas as the terminal complex expands. The actual area would be dependent on terminal configurations.

NON-PUBLIC CIRCULATION

Non-public circulation provides access to airline operations, airport administration areas, concession support, and other areas typically not used by the traveling public, as well as restrooms used by airport tenants and screening checkpoints for employees.

Non-public circulation also includes elevators for concessions servicing. These should be sized and rated for freight of the type required by the various concessions. Non-public circulation should be located as to provide delivery and trash removal to as many concessions as possible without requiring passage through public spaces. The program area is based on 12 percent of non-public functional areas, and includes an area for employee restrooms.

MECHANICAL/ELECTRICAL/UTILITY

At the planning and programming stage, utility areas are typically estimated as a percentage of the enclosed functional areas of a terminal. This will vary with the provision of central plant functions either within the terminal or remotely; and, in some cases, architectural design considerations, which may limit the use of roof-top equipment, etc. Most newer terminals are in the range of 10 to 12 percent of functional areas when there is a separate heating/cooling plant, such as at SAT.

The existing terminal mechanical/electrical systems equal to approximately 11.4 percent of the functional area of the terminal. For planning purposes, a factor of 12 percent of functional areas was used.

JANITORIAL/STORAGE/SHOPS

Janitorial, storage and shop space include the building maintenance functions that are required to be inside the terminal building. In addition to typical janitorial functions, space must be provided to store any specialized maintenance equipment for the terminal, such as lifts for high ceiling areas.

Maintenance and storage areas are in multiple locations in the terminal and occupy space that may have been intended for airline operations. The existing overall ratio of these spaces to the functional areas (1.5 percent) was used for planning (within typical ranges).

STRUCTURE/NON-NET AREAS

Non-net areas are added to the recommended facility requirements to provide a better estimate of the total gross building footprint. Although the program areas are in terms of gross space, allowances must be made for exterior walls. It is also expected that buildings will have areas that are unusable or occupied by special structures. For planning, a 3 percent factor was used, which is typical of terminals with conventional designs.

4.2.5 TERMINAL CURBS

Terminal curbs provide the interface between non-parked vehicles and the terminal. The curb consists of both pedestrian facilities (sidewalk) and vehicle facilities (pick-up/drop-off lanes and through-traffic lanes).

EXISTING CURB CONFIGURATIONS

VEHICLE LANES

At SAT, continuous curbs serving both Terminal A and Terminal B are configured as follows:

- The upper level departures curb consists of four lanes. All types of vehicles, private and commercial, drop off departing passengers at this curb. A four-lane curb is typically recommended where the public is allowed to double-park.
- The lower level inner arrivals curb also consists of four lanes. It is primarily reserved for private vehicle pick-ups. Hotel shuttles have an assigned pick-up area on the inner curb located beyond the end of Terminal B.
- The lower level outer arrivals curb is reserved for commercial vehicles. There are zones designated for taxis, ridesharing (TNCs), parking shuttles and buses. The curb has three lanes, which is suitable for these types of vehicle use when double-parking is discouraged.

Although the curbs run the full length of the terminal building, the frontages are not fully usable because of a combination of roadway geometry and design of the terminal/curb interface:

- The first door into Terminal A is located approximately 75 feet from the curve where the two-lane approach road transitions into the four-lane roadway. Although this initial section of curb is marked for no stopping, vehicles for Terminal A tend to want to stop at the first door, causing bunching and double-parking. It was also observed that the outermost (4^{th}) lane was seldom used by Terminal B vehicles to bypass Terminal A. A similar situation occurs on the inner arrivals level.
- On the upper and lower levels, the two-lane approach roads do not widen to four lanes until after the curve. Drivers do not appear to want to use the outer lanes to get to the second or third doors of Terminal A or to Terminal B.
- There are four crosswalks on the inner arrivals level curb to reach the outer commercial curb. This reduces the effective curb length by approximately 80 feet.

CURB SIDEWALKS

The sidewalk along the terminal building facade should be a minimum of 12 feet wide to allow two pedestrians with luggage to pass each other comfortably. Obstructions such as columns, signs, benches or curbside check-in counters need to be considered when evaluating the sidewalk width.

The sidewalks of the two terminals differ in configuration, but are the same at both upper and lower levels:

- The curb in front of Terminal A is at an angle to the building grid, and the terminal facade is in the form of a ‘saw tooth’. This results in varying separations along the sidewalk between the building and curb lanes. There is also a row of columns set approximately 4 feet from the curb lanes. This is enough separation to allow car doors to open without damage and passengers to unload, but not enough for lateral movement along the curb.
- At the terminal entrance doors, the distance to the curb lanes varies from 18 feet to 25 feet at each vestibule. However, between the vestibules, the distance between the building and the columns can be as little as 9 feet, which is less than recommended. This combination of varying/limited

clearance and the columns tends to concentrate vehicles at the terminal entrances even more than would typically occur.

- The facade of Terminal B was built parallel to the curb, so the sidewalk is a uniform width. There is approximately 20 feet of separation between the vestibule doors and vehicle lanes.
- In one location, curbside check-in counters reduce the sidewalk width to approximately 12 feet. This area is also used for queuing for the curbside check-in, which can impede lateral pedestrian movement.

CURB ACTIVITY CHARACTERISTICS

The planning team undertook a series of curb activity and traffic surveys on Friday, June 8, 2018 and Monday, June 11, 2018. The Friday date was selected by the Airport to coincide with “Freak Week”, when activity is very high and considered representative of the Design Day. Additional data was collected on Monday to examine variations as compared to a more typical business day. The purpose of the surveys was to determine characteristics such as modal splits at the curb, vehicle dwell times, average passenger occupancies and vehicle volumes on airport and surrounding roads.

Data was collected on the departures curb from 04:00 am to 06:30 am, and from 3:00 pm - 5:00 pm. This covered the early morning peak and the late afternoon secondary peak. The departure curb was surveyed on both Friday and Monday.

The arrivals curbs were surveyed from 3:00 pm - 7:00 pm, and from 10:30 pm - 12:00 am on Friday. This covered the late-night peak and the late afternoon/early evening secondary peak.

CURB MODAL SPLITS

The curb modal splits are based the observed numbers of vehicles stopping at the curbs and do not include passengers parking in airport garages or using rental cars. The modal splits are shown in **Table 4.2-9.** It should be noted that it is often difficult to distinguish TNCs from other private vehicles from a distance. Thus, for the departures curb, it is likely that some private vehicles were TNCs.

Table 4.2-9: Curb Modal Splits

	DEPARTURES CURB	ARRIVALS CURB
Private Vehicles	81%	63%
Transportation Network Companies	4%	11%
Shuttles (hotel, parking, etc.)	7%	4%
Taxis	7%	18%
Buses	1%	3%
Other	<1%	1%
Total	100%	100%

Source: Hirsh Associates, 2018.

VEHICLE DWELL TIMES

Dwell times were measured for a sample of vehicles using the curbs. Times were measured from when the vehicle pulled to the curb (or stopped in a double-parked lane) until it pulled away. Timing was stopped after six minutes and averages with, and without, these long-duration vehicles were calculated separately.

Dwell times varied by time of day and between Friday and Monday. The times shown in **Table 4.2-10** (in minutes) were considered the most representative for use in calculating peak curb demands.

Table 4.2-10: Peak Curb Demand Times

	DEPARTURES CURB	ARRIVALS CURB
Private Vehicles	2.1 minutes	1.8 minutes
Transportation Network Companies	1.0 minute	2.1 minutes
Shuttles (hotel, parking, etc.)	1.5 minutes	1.6 minutes
Taxis	2.2 minutes	2.1 minutes
Buses	3.8 minutes	3.8 minutes
Other	6.0 minutes	6.0 minutes

Source: Hirsh Associates, 2018.

AVERAGE PASSENGERS PER VEHICLE

When the dwell times were measured, the number of people (assumed to be passengers) getting in or out of the vehicle were counted. As with dwell times, there were variations by time of day, but no consistent pattern was established. The ratios shown in **Table 4.2-11** were considered the most representative.

Table 4.2-11: Peak Curb Demand Ratios

	DEPARTURES CURB	ARRIVALS CURB
Private Vehicles	1.7 passenger/vehicle	1.4 passenger/vehicle
Transportation Network Companies	1.3 passenger/vehicle	1.4 passenger/vehicle
Shuttles (hotel, parking, etc.)	3.8 passenger/vehicle	6.3 passenger/vehicle
Taxis	1.8 passenger/vehicle	1.3 passenger/vehicle
Buses	8.0 passenger/vehicle	-
Other	-	-

Source: Hirsh Associates, 2018.

CURB LENGTH PLANNING FACTORS

The existing curb activity was evaluated to determine the current LOS and to develop planning factors related to Design Hour Passengers. These LOS calculations are based on the available curb length, and do not consider geometry or terminal entrance issues that could affect vehicle flows.

The curb analysis is based on vehicle volumes measured by traffic tube counters on Friday, June 8, 2018 (see appendices for the full traffic analysis). The traffic counters provided data in 15-minute increments and measured the total vehicle flows separately for the drop-off and pick-up lanes. As shown in **Table 4.2-12**, the traffic flow during peak periods was relatively uniform with the peak 15 minutes representing 28 percent of a rolling peak hour for both drop-off and pick-up lanes. Table 4.2-12 summarizes calculations for:

- The existing curb demands based on curb modal splits, vehicle dwell times and vehicle length
- A curb demand/capacity ratio and how this translates into LOS
- The curb lengths based on the range of curb lengths needed to achieve LOS ‘C’
- A curb length planning factor using the high end of the LOS ‘C’ range and the estimated peak hour passengers from June 8, 2018

The LOS criteria for curbs, as developed in ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*, is expressed as the maximum demand for curbside parking divided by the effective curbside length, and is summarized in **Table 4.2-13.**

Table 4.2-12: Existing Terminal Curb Conditions

Departures

Existing Conditions - Early Morning Friday 6/8/18

Peak hour vehicles:	713	vehicles
15 min peak vehicles:	198	vehicles
= 15 minutes as % of hour	28%	
Peak hour seats:	2,265	seats
Est. peak hour passengers		
90% load factor:	2,040	pax

Vehicle Type	Curb Survey Modal Splits Vehicles	Peak 15 Minutes	Vehicle Dwell Time (min.)	Peak 15 Min. Demand in Minutes	Vehicle Length (ft)	Peak 15 Min. Demand (ft)
Private Vehicles	81%	160	2.1	336	25	550
TNCs	4%	8	1.0	8	25	25
Shuttles	7%	14	1.5	21	40	40
Taxis	7%	14	2.2	31	25	50
Buses	1%	2	3.8	8	50	50
Other	0%	0	6.0	0	35	0
Total	100%	198				715

Existing Curbfront Length:	735	ft	Existing Capacity Ratio:	0.97		
			Existing Level of Service:	**B**	dbl park allowed [1]	
			Required LOS 'C' Curbfront	from:	550	ft
				to:	650	ft

Departures Curb Planning Factor:

Design Hour Pax	2,040	enplaned pax
LOS 'C' curbfront	650	LF
=>	0.32	LF/design hour enplaned pax

Arrivals

Existing Conditions - Early evening Friday 6/8/18

Peak hour vehicles:	1,088	vehicles
15 min peak vehicles:	301	vehicles
= 15 minutes as % of hour	28%	
Peak hour seats:	2,256	seats
Est. peak hour passengers		
90% load factor:	2,030	pax

Public Curb

Vehicle Type	Curb Survey Modal Splits Vehicles	Peak 15 Minutes	Vehicle Dwell Time (min.)	Peak 15 Min. Demand in Minutes	Vehicle Length (ft)	Peak 15 Min. Demand (ft)
Private Vehicles	63%	190	1.8	342	25	575
TNCs	na	0	2.1	0	25	0
Shuttles	na	0	1.6	0	40	0
Taxis [2]	na	0	2.1	0	25	0
Buses	na	0	3.8	0	50	0
Other	na	0	6.0	0	35	0
Total		190				575

Existing Curbfront Length:	660 ft [2]	Existing Capacity Ratio:	0.87		
		Existing Level of Service:	**A**	dbl park allowed [1]	
		Required LOS 'C' Curbfront	from:	440	ft
			to:	520	ft

Public Arrivals Curb Planning Factor:

Design Hour Pax	2,030	deplaned pax
LOS 'C' curbfront	520	LF
+ allowance for crosswalks	80	LF
=>	0.30	LF/design hour deplaned pax

Commercial Curb

Vehicle Type	Curb Survey Modal Splits Vehicles	Peak 15 Minutes	Vehicle Dwell Time (min.)	Peak 15 Min. Demand in Minutes	Vehicle Length (ft)	Peak 15 Min. Demand (ft)
Private Vehicles	na	0	1.8	0	25	0
TNCs	11%	33	2.1	69	25	125
Shuttles	4%	12	1.6	19	40	40
Taxis	18%	54	1.8	97	25	150
Buses	3%	9	3.8	34	50	100
Other	1%	3	6.0	18	35	35
Total	37%	111				450

Existing Curbfront Length:	905 ft	Existing Capacity Ratio:	0.50		
		Existing Level of Service:	**A**	single parking allowed [3]	
		Required LOS 'C' Curbfront	from:	450	ft
			to:	530	ft

Commercial Arrivals Curb Planning Factor:

Design Hour Pax	2,030	deplaned pax
LOS 'C' curbfront	530	LF
=>	0.26	LF/design hour deplaned pax

Notes -
[1] - Assumes a 4 lane curbside roadway where double parking is allowed - ACRP 40.
[2] - Public curb effective length excludes 4 crosswalks (80 LF).
[3] - Assumes a 3 lane roadway with a single parking curb - ACRP 40.
Source: Hirsh Associates, 2018.

For example, for the departures curb:

- During the morning departures peak hour, there were 713 drop-off vehicles counted, with 198 in a peak 15-minute period.
- Based on the modal splits for departures, average dwell times by vehicle class and the typical vehicle length required for curb operations, the calculated demand was for 715 LF of curbside length.
- The effective curb front length of the combined Terminal A and Terminal B curbs is 735 LF, resulting in a demand/capacity ratio of 0.97. This is equivalent to an overall LOS B. However, as noted in Section 4.2.5, the geometry of the roadway and Terminal A sidewalks causes more double-parking at the beginning of the curb than the overall LOS would indicate.
- If the future curb is planned for LOS 'C', the required curb length for 715 LF of demand is between 550 LF and 650 LF. This assumes that the available curb length is equally usable over its full length.
- This results in a deplaning curb planning factor of 650 LF / 2,040 passengers = 0.32 LF / design hour enplaned passengers.

Table 4.2-13: Curb Level of Service Criteria

	RATIO OF MAXIMUM DEMAND FOR CURBSIDE PARKING / EFFECTIVE CURBSIDE LENGTH	
Level of Service	Double-Parking Allowed	Double-Parking Prohibited
A	0.90	0.70
B	1.10	0.85
C	1.30	1.00
D	1.70	1.20
E	2.00	1.35
F	>2.00	>1.35

Source: Airport Cooperative Research Program, Report 40, *Airport Curbside and Terminal Area Roadway Operations*, Table 5-2, 2010.

Table 4.2-14 summarizes the forecast curb recommendations.

Table 4.2-14: Terminal Curb Facility Requirements

	EXISTING FACILITIES	RECOMMENDED FACILITIES						
		BASE YEAR	FORECAST YEAR					
		2018	2023	2028	2038	2038 High	2068	
Design Hour Passengers								
Enplaned Domestic + International		2,050	2,390	2,490	2,860	3,140	5,460	
Deplaned Domestic		2,030	2,370	2,470	2,840	3,120	5,420	
Terminal Curbs								
Departing Curb	735	660	760	800	920	1,000	1,750	LF
Arriving Public Curb	660	610	710	740	850	940	1,630	LF
Arriving Commercial Curb	905	530	620	640	740	810	1,410	LF

Note:
LF – linear feet

Source: Hirsh Associates, 2018.

4.2.6 TECHNOLOGICAL INNOVATIONS IN PASSENGER TERMINALS

INSIDE THE TERMINAL

Information technology and systems in the passenger journey through the airport will impact flows and waiting time. Some airports and air carriers have already deployed facial recognition to simplify the passenger journey. For instance, Delta Air Lines uses facial recognition devices at Hartsfield-Jackson Atlanta International Airport (ATL) to verify the identity at the gate when boarding international flights, instead of scanning boarding pass and checking passports by hand. This expedites the process and minimizes the boarding time. Biometrics will be available in the very near future for other steps of the passenger journey from curbside to gate.

Over the past few years, equipment manufacturers have developed suites of solutions for check-in, bag drop-off and boarding, using the same biometric passenger database. In the medium term, these solutions will reduce waiting times and increase the automation of control and identification processes from the curbside to the gate, along with other technologies such as the self-service bag drop-off kiosks. Crossing a border without having passports checked by a border agent is a reality. The Global Entry program offers a similar service at 75 international airports. For passengers who did not subscribe to Global Entry, Mobile Passport Control (MPC) allows to perform the operations preceding the physical control of passports by a CBP agent, from a smartphone. The TSA is working with the industry on developing the next generation of checkpoints with expedited processes for the most trusted passengers.

Some of these systems and technologies are still emerging or being defined; as a result, their impact on future facility requirements is still uncertain. However, they will ease congestion and help enhance passenger flows and airport resources.

OUTSIDE THE TERMINAL

Airport buses and GSE are turning electric (referred to as eGSE). eGSE is reducing air pollution, carbon emissions and noise at a growing number of airports. Many of these electrification projects are eligible for federal grants through the FAA's Voluntary Airport Low Emissions Program (VALE). Impact on airports include a higher demand on electrical power and space availability for charging stations. Cost-efficient retrofit of existing facilities is possible. For instance, charging stations for eGSE at existing terminals use the same source of power than jet bridges.

4.2.7 SUMMARY OF TERMINAL REQUIREMENTS

- Aircraft gates (23 existing):
  - 2040: build 6-10 gates (for a total of 32-37 gates)
  - 2070: build an additional 18-22 gates (for a total of 63 gates)
  - Include 2 ADG V gates (for international flights)
  - Build additional remote/RON positions
- Passenger terminal requirements based on industry standards
- Curbside:
  - Additional departing and arriving public curb space starting in 2025
  - Additional arriving commercial curb space starting in 2070

4.3 AIR CARGO FACILITIES

Two segments of air freight operate at SAT:

- Integrator cargo, carried by FedEx, and UPS, and;
- Belly cargo, carried as payload of passenger aircraft.

Integrator cargo carriers operate on the East Cargo Ramp, whereas belly cargo operations are conducted in the West Cargo facilities.

WFS provides ground handling for UPS, and is located in the Lynx Building, between the FedEx and UPS facilities on the East Cargo Ramp. Future requirements were assessed based on surveys and interviews of the air cargo operators (station managers), and the model provided by ACRP Report 143 on Air Cargo Facility Planning and Development. Aircraft operations forecasts were input into the ACRP model. Each functional area analysis is described below:

- Cargo building space: warehouse space used to store and sort air cargo and where the offices are located.
- Apron area: paved airside areas used for aircraft parking during loading and unloading operations. This area also provides parking for ground support equipment (GSE).
- Landside area: vehicle access to the cargo buildings and parking.

The needs expressed by the cargo carriers and the requirements estimated with the ACRP model were considered based on existing operations at SAT.

4.3.1 INTEGRATOR CARGO FACILITIES

Integrator cargo is handled on the East Cargo Ramp by FedEx, UPS and WFS. **Table 4.3-1** summarizes existing and required integrator cargo facilities in 2040, based on tenant interviews and calculated requirements (using ACRP Report 143) for buildings (warehouse and offices), apron (aircraft parking, equipment statging) and landside (roadway access, truck and auto parking).

As shown in Table 4.3-1, tenants' expected requirements are lower than the requirements calculated with ACRP Report 143 for building space, but significantly higher for apron space. This difference can be attributed to the organization of integrator cargo operations at SAT, where a portion of cargo sorting is performed on the apron (e.g., UPS). Landside expected and calculated requirements are similar. The tenants' consolidated expected needs (building, apron and landside) are higher than the output of the ACRP model. *Therefore, for planning purposes, the needs expressed by the tenants were used to determined required integrator cargo space.*

At the direction of SAAS, the integrator cargo requirements were increased to account for:

- a potential new entrant (10 acres)
- a multi-tenant cargo facility (3 acres)

These two additional items are also reflected in Table 4.3-1. As a result, total integrator cargo site requirements in 2040 are 89 acres.

Table 4.3-1: Integrated Express Facility Requirements (in Acres)

TYPE OF FACILITY		EXISTING	REQUIREMENTS	
		2018	2020	2040
Building	Tenant Input	2	3	4
	Calculated (ACRP Report 143)	-	8	11
Apron	Tenant Input	31	38	49
	Calculated (ACRP Report 143)	-	13	17
Landside	Tenant Input	6	9	13
	Calculated (ACRP Report 143)	-	10	13
TOTAL REQUIRED SPACE FOR EXISTING TENANTS		**39**	**50**	**76**
Vacant Cargo Facilities (west of FedEx)		**8**		
Additional Space for New Entrant		-	-	10
Additional Space for Multi-Tenant Facility		-	-	3
TOTAL INTEGRATOR CARGO SPACE		**47**	**50**	**89**

Note:
ACRP = Airport Cooperative Research Program
Source: WSP USA, 2021.

4.3.2 BELLY CARGO (PASSENGER AIRLINES)

Table 4.3-2 summarizes belly cargo requirements through 2040, based on calculations using the ACRP Report 143 model.

Existing space occupied by belly cargo functions was derived from interviews with airport staff, and totals approximately 1.1 acres, which is slightly more than calculated with the ACRP Report 143 model (0.8 acres required in 2020). Based on the ACRP Report 143 model, a 1.3-acre site is required in 2040 for belly cargo operations.

Table 4.3-2: Belly Cargo Facility Requirements

TYPE OF FACILITY	EXISTING	REQUIREMENTS (ACRES) [1/]	
	2018	2020	2040
Building	0.3	0.2	0.3
Apron	0.3	0.3	0.5
Landside	0.5	0.3	0.5
TOTAL REQUIRED SPACE	1.1	0.8	1.3

Notes:
1/ Total space requirements based on ACRP Report 143.
ACRP = Airport Cooperative Research Program
Source: WSP USA, 2018.

4.3.3 SUMMARY OF AIR CARGO REQUIREMENTS

- Integrator cargo: need additional 42 acres (total of 89 acres)
- Belly cargo: need additional 0.2 acres (total of 1.3 acres)

4.4 GENERAL AVIATION FACILITIES

General aviation facility demand is based on space needed for both based aircraft and itinerant aircraft. This section will assess the existing and future needs for FBO facilities and general aviation aircraft storage facilities (terminal/office, hangar, apron, auto parking).

4.4.1 FIXED-BASE OPERATOR FACILITIES

Future FBO needs are summarized in **Table 4.4-1**. The existing FBOs provided desired growth plans through 2040 (additional hangar facilities). Industry planning factors were applied to determine the corresponding overall FBO campus size. Also, the *SAT FBO Feasibility Study* concluded that the SAT market cannot support a new FBO entrant; as such, no allocation for new FBO entrant was included.

Long-term requirements (2040) correspond to 1.6 times the existing footprint, for a total of approximately 56 acres.

Table 4.4-1: Fixed Base Operators Facility Requirements (in Acres)

	EXISTING	REQUIRED	
	2018	2020	2040
Existing Fixed Base Operators	34	43	56
New Fixed Base Operators Entrants		0	0
Total Fixed Base Operators Sites	**34**	**43**	**56**
Ratio of Total / 2018 Footprint	1.0	1.3	1.6

Source: WSP USA, 2021.

4.4.2 CORPORATE GENERAL AVIATION FACILITIES

Corporate aviation facilities at SAT consist of business aviation hangars and buildings owned by individual corporate entities (e.g., H-E-B, Lewis Energy Group, Valero Energy Corp.), as well as small business aircraft operators.

Future corporate GA needs are summarized in **Table 4.4-2**. The existing corporate tenants provided immediate needs and desired growth plans through 2040 (additional hangar facilities). Industry planning factors were applied to determine the corresponding overall site size. An additional 2 acres are required by existing tenants.

Additionally, based on discussions with SAAS, allocations for new entrants were included (assumed 5 individual hangars, for a total area of 5 acres).

Table 4.4-2: Corporate Aviation Facilities Requirements (in Acres)

	EXISTING	REQUIRED	
	2018	2020	2040
Existing Corporate Aviation	55	55	57
New Corporate Aviation Entrants			5
Total Corporate Aviation Sites	**55**	**55**	**62**
Ratio of Total / 2018 Footprint	1.0	1.0	1.1

Source: WSP USA, 2021.

4.4.3 SMALL GENERAL AVIATION FACILITIES

Small GA aircraft storage facilities represent small aviation hangars (such as T-hangars, or small box hangars); small GA hangars at SAT are located on the Security Airpark campus, on the northwest side of the airfield. It is estimated that the small GA portion of the campus represents approximately 4 acres. Based on the SAT development vision and priorities, no additional development space for small GA aircraft will be included through 2040.

4.4.4 TECHNOLOGICAL INNOVATIONS IN GENERAL AVIATION

This section discusses requirements for emerging aviation users such as sUAS and Urban Air Mobility (UAM).

SMALL UNMANNED AERIAL SYSTEM FOR AIRPORT OPERATIONS

The use of sUAS by airport operators is growing. sUAS can provide a wide variety of services, from perimeter surveillance to jet bridge inspection. Based on current investigations of sUAS uses, specific facility requirements are not necessary for sUAS. Services are typically provided by external providers on demand. In the future, airport operators might acquire UAS for their own needs. However, neither should require specific accommodation from an airport long-term planning standpoint, giving the size and concept of operations of these aircraft.

URBAN AIR MOBILITY

UAM encompasses the operation of sUAS for delivery and new electrical "air taxis" in dense, urban environments. In the United States, both are still in a research and development stage.

Based on the FAA's UAM Concept of Operations (ConOps)[6], initial UAM "air taxi" operations, which may start to operate in the 2025-2030 timeframe, will use eVTOL aircraft that are certified to fly within the current regulatory and operational environment with an onboard pilot. As the tempo of UAM operations increases, the FAA will establish performance-based airspace structures with defined dimensions, called UAM corridors. Aircraft operating within the corridors will still have pilots onboard, but will also be equipped to exchange information with other users of the corridor in order to deconflict traffic without relying on ATC. Eventually, the FAA anticipates the system evolving to the point where UAM corridors form a complex, high-volume network through which UAM aircraft will fly autonomously.

Provisions for a vertiport will be explored in the *Alternatives Development and Evaluation* chapter.

ELECTRIC AIRCRAFT

There is an increased interest in electric aircraft by industry and stakeholders. While the electrification of larger commercial service aircraft seems today beyond the planning horizons of the SAT SDP, e-aircraft (new models or variant and retrofit of existing types) might be available in the short-term in the general aviation and commuter market segments. Prototypes are already flying and ongoing research projects are paving the way for this technology and its integration in the airport environment. They will most likely require high-power charging stations to recharge their batteries, similar to a 400Hz Ground Power Unit (GPU), which could be made available at the gate or on RON/hardstand parking positions.

SUMMARY OF EMERGING AVIATION USERS REQUIREMENTS

- UAM: future vertiport capability

[6] Federal Aviation Administration, Urban Air Mobility (UAM) Concept of Operations (ConOps), Version 1.0, June 2020.

4.4.5 SUMMARY OF GENERAL AVIATION REQUIREMENTS

- FBO requirements: additional 22 acres (for a total of 56 acres in 2040)
- Corporate GA: additional 16 acres (for a total of 71 acres in 2040)
- Small GA: no additional footprint (existing 4 acres remain in 2040)
- Vertiport capability

4.5 AVIATION SUPPORT FACILITIES

Aviation support facilities include buildings and other structures that serve secondary roles in the operation of the Airport. They are usually located on or adjacent to the AOA. The purpose of aviation support facilities ranges from administration to storage to health and safety.

4.5.1 AIRPORT ADMINISTRATION/POLICE FACILITIES

Airport administration facilities are anticipated to be relocated to an off-Airport facility, most likely as an office space lease. This section presents the facility requirements for the Aviation Department through 2040, which is the end of the SDP planning period.

METHODOLOGY

The process for determining the amount of office space started with conducting interviews with Aviation Department staff, then identifying the inventory of administration/office space currently available on the Airport campus. From there, WSP conducted research to determine the amount of office space needed per employee, based on national and industry averages. The amount of space needed was then compared to the current and projected number of employees to determine gaps for current and future conditions.

Details about the interview process, the inventory of existing office space used by Aviation Department staff, the parameters used to determine current and projected administration/office spaces needs, as well as recommendations are provided in **Appendix 4C**.

ASSUMPTIONS

In general, the weighted average high-end of the administration/office space permitted by City of San Antonio policy and adding 60% for circulation/other space (144 square feet per employee) is at the low end of what is considered average space density (150 square feet to 250 square feet) per employee by national standards.

This analysis uses a factor of 175 square feet per employee. This amount reflects an upward adjustment to the existing baseline of 144 square feet per employee to account for the inadequacies in the existing facilities identified during the interview process, specifically having additional and more flexible conference room/meeting areas.

The determination of the number of employees used to develop the facilities requirements for administration/office space takes into account other SDP analysis in planning for airport support facilities that will house a portion of the Aviation's Department's staff at various locations around the Airport campus as part of the SDP. These facilities include the following:

- ARFF Building: This building serves a definitive purpose and cannot be co-located with other Aviation Department administrative functions. It is also subject other FAA criteria when determining its location.
- AICC: this building has been in the Aviation Department's plan for several years and a location is currently being determined for this facility.
- Operations, airside maintenance, facilities maintenance, and terminal services: the SDP plan includes a facility that combines these functions in one location that will include facilities for all the functions undertaken by these divisions, including their administration/office space needs.
- Terminal Services: the SDP plan includes an amount of terminal space that will be adequate to accommodate a portion of this division that is needed on site at the terminal, as well as an area for storage for items that are often needed to perform the division's functions.

Table 4.5-1 below presents current and projected employees adjusted for the department exclusions described above.

Table 4.5-1: Aviation Department Staff Adjustment

YEAR	PROJECTED EMPLOYEES	EXCLUDED EMPLOYEES	NET EMPLOYEES
2020	493	188	305
2025	583	213	370
2030	635	232	403
2040	726	265	461

Sources: Airport Employee Interviews, 2020; WSP USA, 2021 (analysis).

Table 4.5-2 illustrates the office space requirements over time in relation to space in square feet.

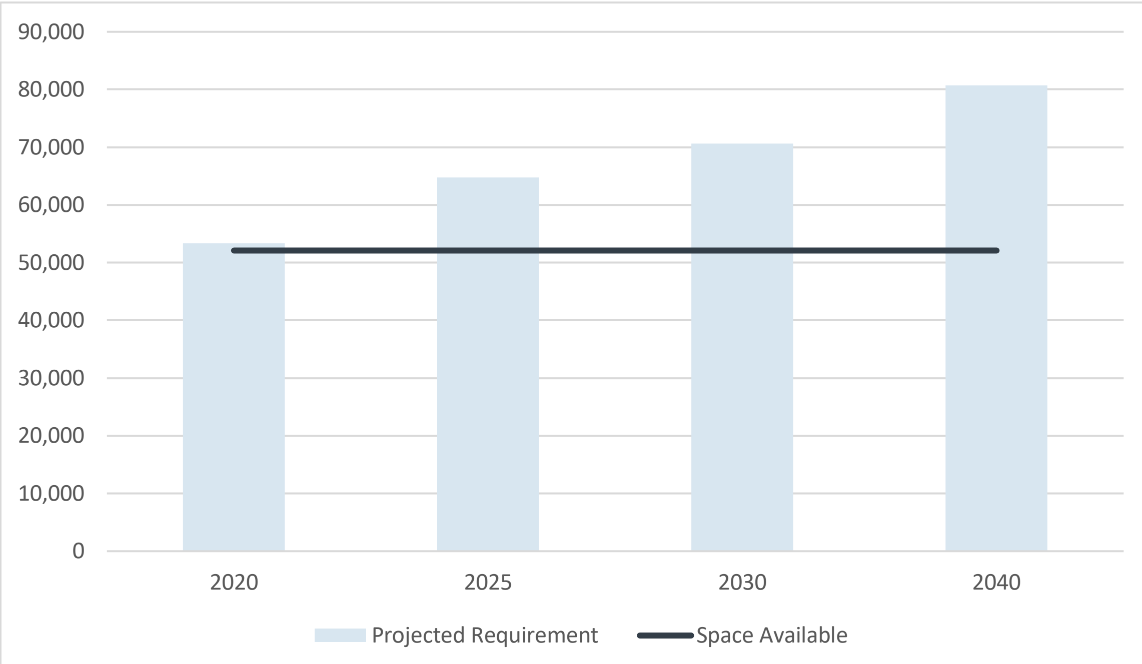
Table 4.5-2: Projected Space Requirements

YEAR	EMPLOYEES	SPACE REQUIREMENT (SF)
2020	305	53,375
2025	370	64,750
2030	403	70,565
2040	461	80,656

Note:
SF – Square feet
Source: WSP USA, 2021 (analysis).

The amount of space required for administration/office functions was then compared to the amount of space available on the Airport's campus today, reduced for the departments that have been excluded from the analysis as described previously, which results an office space amount of approximately 34,000 square feet and a total space of approximately 52,100 square feet. **Figure 4.5-1** compares the space currently available to the projected space needed over time.

Figure 4.5-1: Comparison of Administration/Office Space Requirement to Available Space (Square Feet)



Source: WSP USA, 2021 (analysis).

As shown in Figure 4.5-1, the required amount of space is slightly more in 2020 than what is available currently. As early as 2025, it is approximately 14,000 square feet over the currently available space. The most efficient way for the Aviation Department to accommodate the future need for administration/office space and also provide better efficiency would be to co-locate many of the functions that are housed in the Terminal Mezzanine, other terminal areas, and Building 1039. Other divisions that could be included in this space would be Security (Badge and ID) and some of the existing Police Department functions. However, it may be easiest to relocate those functions to vacated facilities in the terminal building once other employees are moved to the leased space. Given the need for additional and more functional administration/office space and the lack of on-airport availability of parcels for a new building, the Aviation Department could benefit from leasing space to accommodate its administrative/office space needs to allow for a quicker relocation of employees such that efficiencies and synergies from being co-located much sooner than if a new facility was constructed.

SUMMARY OF ADMINISTRATION FACILITIES REQUIREMENTS

- 2020: 53,000 square feet of office space would be needed to consolidate current Aviation Department administrative staff that are not included in the planning for other facilities identified as part of the SDP's support facilities plan.
- 2025: An additional 11,375 square feet will be needed as the staff is projected to grow by 65 employees.
- 2040: 80,700 square feet

4.5.2 AIRPORT MAINTENANCE AND OPERATIONS FACILITIES

Airport Maintenance facilities are comprised of two departments: Airfield Maintenance and Facilities Maintenance. The main location for Airport Maintenance is the Maintenance Yard, on West Cargo Rd. Satellite locations for Facilities Maintenance and Terminal Services are in the terminal. Equipment is also stored in the West Cargo Building, Hangar 4 and on the Wright Flyers apron, by the north airfield MROs.

Per SAAS leadership, Airfield and Facilities Maintenance should be collocated with Airfield Operations. A satellite facility for Facilities Maintenance would be provided in the terminal. Additionally, airfield access is needed: an airfield gate is acceptable in the short term, however, in the long term, direct access is desired.

Per SAAS leadership, a site approximately 8 acres, with a two-story building for office and auto shop, was deemed adequate to house all Airfield and Facilities Maintenance functions, as well as Airfield Operations. Covered outdoor equipment storage would also be provided on the new site.

A new Airport Integrated Control Center is planned on a 1.4-acre site adjacent and west of the ARFF station.

4.5.3 AIRCRAFT RESCUE AND FIREFIGHTING FACILITIES

The site of the existing ARFF station is approximately 4.3 acres. Several factors will help determine whether a new or expanded ARFF station is required, in the existing or a different location.

INDEX

Per 14 CFR Part 139 on Certification and Operations, for airports serving certain air carriers, the ARFF Index is based on the longest passenger aircraft that operates an average of five daily departures or over at least 1,825 annual operations:

- Index A: for aircraft less than 90 feet in length.
- Index B: for aircraft at least 90 feet in length, but less than 126 feet in length.
- Index C: for aircraft at least 126 feet in length, but less than 159 feet in length.
- Index D: for aircraft at least 159 feet in length, but less than 200 feet in length.
- Index E: for aircraft at least 200 feet in length.

SAT's ARFF station is currently Index C. Index C includes most ADG III aircraft and the Boeing 757-200. Based on the forecasted fleet mix, presented in **Table 4.5-3**, the ARFF Index in 2038 would remain Index C.

RESPONSE VEHICLES

Airports with ARFF Index C are required to operates with a minimum of three vehicles, per FAA *AC 150/5220-10E, Guide Specification for Aircraft Rescue and Fire Fighting (ARFF) Vehicles*. Currently, SAT's ARFF station has four vehicles with a minimum of three operational at any time. Vehicles requirements are listed in **Table 4.5-4**.

Table 4.5-3: Aircraft Rescue and Firefighting Index Determination

AIRCRAFT TYPE	AIRCRAFT LENGTH (FEET)	ARFF INDEX	2018 AIRCRAFT OPERATIONS	2038 AIRCRAFT OPERATIONS
Airbus A319 **Airbus A320** **Airbus A321**	111 123 146	C	19,354	31,604
McDonnell Douglas MD-80 **McDonnell Douglas MD-88** **McDonnell Douglas MD-90**	148 148 153	C	6,010	0
Boeing 737-700	110	B	29,435	40,002
Boeing 737-800 **Boeing 737 MAX 8** **Boeing 737-900**	130 130 138	C	13,974	23,403
Boeing 757-200	155	C	1,158	2,336
Boeing 757-300	179	D	229	0
Boeing 767-300ER (cargo)	180	D	402	1,126
Airbus A300 (cargo)	177	D	2,428	2,844
Airbus A330-900	209	E	0	500
Airbus A350-900	198	E		
Boeing 787-9	206	E		
Boeing 747-8F (cargo)	250	E	0	500
Required ARFF Index			C	C

Note: cargo aircraft (grey text) are not included in the detemination of the ARFF index.

Source: WSP USA, 2018.

Table 4.5-4: Vehicle Class Requirements

VEHICLE	CAPACITY	EXISTING/ INDEX C
Class 1	100-gallon Water/AFFF, and Dry Chemical (500 lbs. sodium- or 450 potassium-based), or Halogenated Agent (460 lbs.).	1
Class 2	300-gallon Water/AFFF, and Dry Chemical (500 lbs. sodium- or 450 potassium-based), or Halogenated Agent (460 lbs.).	1 instead of Class 1
Class 3	500-gallon Water/AFFF, and Dry Chemical (500 lbs. sodium- or 450 potassium-based), or Halogenated Agent (460 lbs.).	1 instead of Class 1 or 2
Class 4	1,500-gallon Water/AFFF.	2
Class 5	3,000-4,500-gallon Water/AFFF.	0

Source: WSP USA, 2018.

RESPONSE TIME

14 CFR Part 139 specifies that "within three minutes from the time of the alarm, at least one required aircraft rescue and firefighting vehicle must reach the midpoint of the farthest runway serving air carrier aircraft

from its assigned post or reach any other specified point of comparable distance on the movement area that is available to air carriers, and begin application of extinguishing agent". Per the SAT ARFF chief, the current ARFF station location allows emergency vehicles to meet the mandated response times. Response times will be evaluated for proposed airfield layouts, to identify the need for additional ARFF stations.

STRUCTURAL RESPONSE

ARFF personnel at SAT also provide structural response to emergencies occurring in/around buildings on Airport property, such as building fires, injuries, illnesses, … There are no requirements pertaining to structural response on airport. However, options will be discussed in the *Alternatives Development and Evaluation* chapter to provide adequate structural response.

SUMMARY OF ARFF REQUIREMENTS

The existing ARFF station size and functions are adequate through the planning horizon. However, a new ARFF station may be needed by 2040 to address the condition of the existing station.

4.5.4 FUEL STORAGE FACILITIES

In 2018, Allied Aviation provided commercial fueling services at SAT, supplying Jet A fuel for passenger and all-cargo airlines. The Airport fuel farm has two 420,000-gallon above ground Jet A tanks. FBOs and corporate tenants have their own fuel farms and handle GA fueling.

Fuel storage requirements were projected based on an analysis of current fuel consumption and aircraft operations data, presented in **Table 4.5-5**.

As presented in the aviation demand forecasts, aircraft departures accounted for 268 operations during the peak month average day. During this average day, around 300,000 gallons of fuel are consumed for an average of 2,241 gallons of jet fuel dispensed per departure, as depicted in **Figure 4.5-2**. The net usable storage capacity of the tank is 360,000 gallons, which represents 86 percent of the total tank capacity. Therefore, the jet fuel reserve requirements for a 1-day, 2-day, and 3-day supply were estimated by applying the average jet fuel dispensed per aircraft departure to the forecast average daily demand.

For future planning, the number of tanks required were translated into land area to accommodate future demand for storage capacity. Currently, the fuel farm occupies 8.5 acres with 1.3 acres for the fuel tanks. To estimate the future required fuel tank needs, an area of 0.6 acre per tank was assumed.

An additional 420,000-gallon tank is recommended at the end of the 20-year planning period (resulting in three tanks total), and three more in 50 years (six tanks total). This would provide the Airport with sufficient fuel reserves for two days, which is the current reserve and was deemed appropriate during stakeholder interviews.

Hydrant fueling facilities are recommended to be installed under the terminal apron, to optimize fueling operations and reduce fuel truck traffic.

Table 4.5-5: Fuel Storage Requirements

		2018	2025	2030	2040
OPERATION FORECASTS - HIGH GROWTH SCENARIO					
Annual Operations - Total		96,600	110,800	123,800	149,200
Peak Month (8.6% of CY Total)		8,300	9,500	10,600	12,800
Peak Month Average Day		268	306	342	413
FUEL CONSUMPTION					
Average Daily Demand (gallons)		300,000	343,379	383,139	462,658
Average Jet Fuel Dispensed per Departure (gallons)		2,241	2,241	2,241	2,241
GROSS JET FUEL STORAGE					
1-day supply	Volume (gallon)	348,837	399,278	445,510	537,974
	Required 420,000-gal. tanks	1	2	2	2
	Tanks footprint area (acre)	0.6	1.3	1.3	1.3
2-day supply	Volume (gallon)	697,674	798,556	891,020	1,075,949
	Required 420,000-gal. tanks	2	3	3	3
	Tanks footprint area (acre)	1.3	1.9	1.9	1.9
3-day supply	Volume (gallon)	1,046,512	1,197,834	1,336,530	1,613,923
	Required 420,000-gal. tanks	3	4	4	5
	Tanks footprint area (acre)	1.9	2.6	2.6	3.2

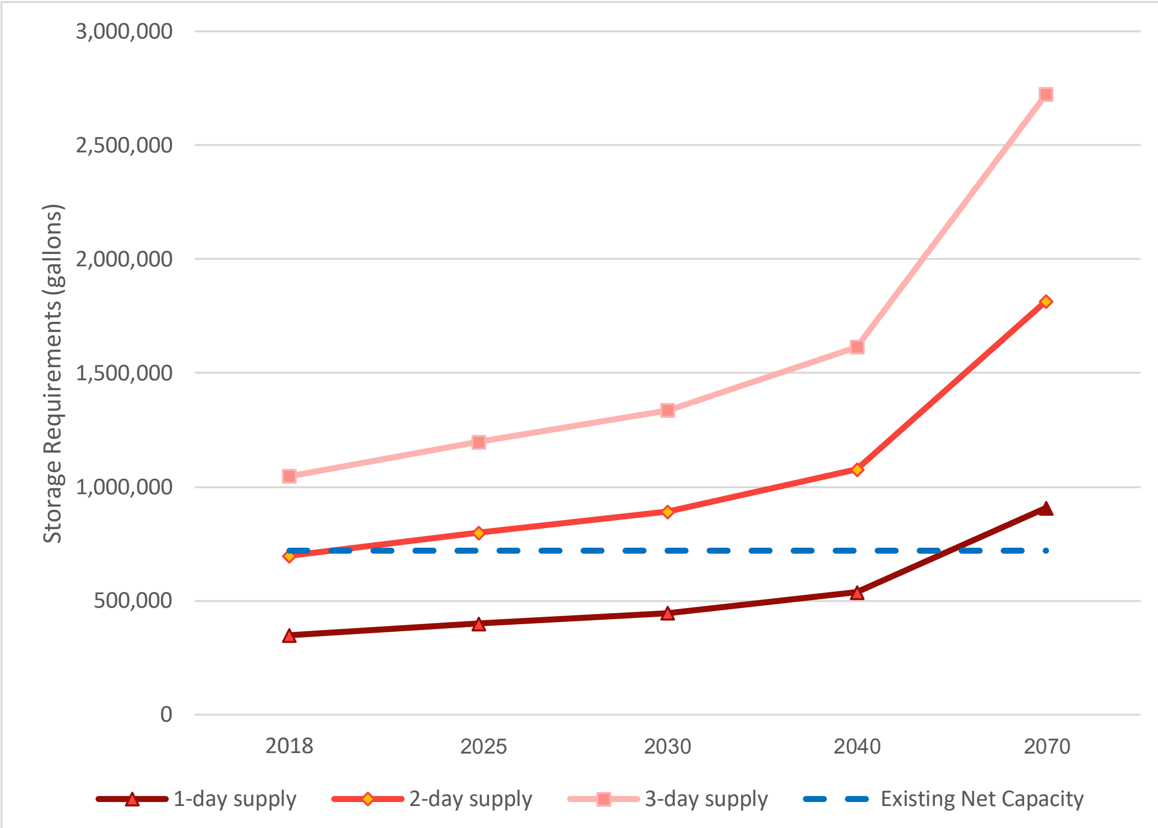
Notes:

CY = civil year

Gal. = gallons

Source: WSP USA, 2018.

Figure 4.5-2: Jet Fuel-Day Supply Requirements



Source: WSP USA, 2018.

4.5.5 AIRCRAFT MAINTENANCE, REPAIR AND OVERHAUL FACILITIES

SAT's MRO service providers include GA MROs (Cutter and Textron), large aircraft MROs (VT SAA, M7 Aerospace, Aerosky), and aeroframes/structures (M7 Aerospace). These activities have different needs that were documented through interviews with and questionnaires to these tenants, and are summarized in **Table 4.5-6**.

Table 4.5-6: Maintenance, Repair and Overhaul Facility Requirements (in acres)

	EXISTING	REQUIRED	
	2018	**2020**	**2040**
Existing Tenants	**69**	**78**	**112**
Large Aircraft MRO	62	65	89
Small Aircraft MRO	7	13	23
New Entrants	**-**	**-**	**15**
TOTAL	**69**	**78**	**127**
RATIO OF TOTAL / 2018 FOOTPRINT	1	1.1	1.8

Source: WSP USA, 2021.

The additional 58-acre requirement includes 43 acres for existing MRO tenants, and 15 acres for potential new MRO entrants.

4.5.6 FEDERAL AVIATION ADMINISTRATION FACILITIES

AIR TRAFFIC CONTROL TOWER FACILITIES

FAA personnel at the SAT ATCT and TRACON stated that their existing facilities would be adequate through the planning horizon (2040). The existing ATCT/TRACON site is approximately 2.4 acres.

Should the ATCT/TRACON need to be relocated to accommodate other airport developments, a 4-acre site is recommended for the new ATCT/TRACON.

NAVIGATIONAL AIDS

No navigational aids are anticipated to be required or replaced within the planning horizon.

4.5.7 RAMP TOWER

It is anticipated that a ramp tower will be needed in the future, to alleviate ramp operations congestion. A ramp tower will be included in the passenger terminal program.

4.5.8 AIRLINE CATERING FACILITIES

Gate Gourmet has food preparation facilities providing catering services to the SAT airlines. These facilities are located off-airport, on Isom Road. Based on discussions with SAAS, catering facilities will remain off-airport.

4.5.9 GROUND SUPPORT EQUIPMENT STAGING AND STORAGE

Existing ground support equipment (GSE) staging and storage occurs on the terminal apron and on the apron level of the passenger terminal facilities. These functions are expected to grow with the terminal facilities; as such, their requirements are included in the passenger terminal program.

4.5.10 GROUND SUPPORT EQUIPMENT AND AIRCRAFT LINE MAINTENANCE FACILITIES

Existing GSE and aircraft line maintenance facilities are located in the West Cargo Building, where they occupy approximately 20 bays. Requirements for GSE/line maintenance include building space, equipment staging and auto parking, and are based on tenant and SAAS input. Requirements are summarized in **Table 4.5-7**.

Table 4.5-7: Ground Support Equipment and Aircraft Line Maintenance Requirements (in acres)

	EXISTING	REQUIRED	
	2018	2020	2040
Site Requirements	**3**	**5**	**8**
RATIO OF TOTAL / 2018 FOOTPRINT	1	1.5	2.5

Source: WSP USA, 2021.

4.5.11 CENTRAL RECEIVING/DISTRIBUTION FACILITY

Concessions are currently delivered through an airfield gate, then to various terminal locations. Options for a centralized receiving/distribution facility (CRDF) will be explored in the *Alternatives Development and Evaluation* chapter.

A CRDF is a warehouse with raised platforms and loading docks, to facilitate the movement of goods. The warehouse would have a non-secure delivery area, a security screening area, dry/cold/freezer storage, and a secure loading dock. The warehouse would also include offices and areas to accommodate future security screening facilities and requirements. A 1.5-acre site would be adequate.

4.5.12 REMOTE OVERNIGHT/HARDSTAND PARKING APRONS

Requirements for RON/hardstand parking positions are based on the forecast and SAAS input. The forecast recommended 10 off-gate parking positions, in additional to the proposed 37 terminal gate positions, which could accommodate a total of 47 aircraft. SAAS input resulted in the addition of 8 off-gate aircraft positions, for a total of 18 off-gate positions and 55 aircraft parking positions overall.

A combined 12 acres is anticipated to be required for RON/hardstand parking, which can accomodate approximately 18 narrowbody aircraft parking positions.

4.5.13 DEICING FACILITIES

Typically, SAT only experiences condensation frost. Airlines are able to find areas on the south and west RONs to deice aircraft away from stormwater drains. The water evaporates and the glycol decomposes. Deicing facilities are anticipated to be collocated with the RON/hardstand parking aprons.

4.5.14 AIRLINE WASHRACK

There is no airline washrack at SAT. An airline washrack facility is assumed to be collocated with the proposed RON/hardstand parking aprons.

4.5.15 GROUND RUNUP ENCLOSURE

The existing ground runup enclosure can accommodate up to the Boeing 777-300 aircraft. During the planning horizon, there may be a need to upgrade the GRE to accommodate the Bowing 747-8 aircraft. Such a facility would have a minimum footprint of approximately 310 feet by 290 feet.

4.5.16 ISOLATION PAD

The existing isolation pad is located on Taxiway N, between Taxiways N6 and N7. Optimal sites will be assessed in the *Alternatives Development and Evaluation* chapter.

4.5.17 WASTE DISPOSAL

Additional waste disposal facilities (triturator and trash compactor) are anticipated to be required with additional terminal expansion.

4.5.18 COMPASS ROSE

The FAA does not provide a standard radius for the compass rose that "varies depending on requirements of user aircraft"[7]. However, the SAT rose is compliant with the Army and Air Force criteria[8]. A facility of such size is usually suitable for small general aviation aircraft. Compatibility with aircraft depends on the procedure used for operating compass calibration (e.g., aircraft towed, etc.). Options for maintaining this facility will be explored in the *Alternatives Development and Evaluation* chapter.

Should the compass rose need to be relocated to accommodate other airport developments, a similarly-sized site is recommended for the new compass rose.

4.5.19 SUMMARY OF AVIATION SUPPORT FACILITIES REQUIREMENTS

- Airport Administration/Police facilities: 80,700 square feet
- Airport Maintenance and Operations facilities: 7 acres
- Catering facilities: none, remains off-airport
- Ground support equipment staging/storage: within/around terminal
- Ground support equipment/aircraft line maintenance: 8 acres
- Central receiving and distribution facility: 1.5 acres
- FAA facilities: none
- ARFF: new facility as condition requires
- Fuel storage facilities: need one extra tank

[7] Federal Aviation Administration, Advisory Circular 150/5300-13A, *Airport Design*, Chg. 1, Appendix 6 – Compass Calibration Pad, 2014.

[8] Department of Defense, Unified Facilities Criteria 3-260-01, *Airfield and Heliport Planning and Design*, Section 6-11.5, pp. 166-167, November 2008.

- Engine maintenance run-up pad: upgrade to accommodate the Boeing 747-8.
- Compass rose: maintain a compass rose when develop new airfield layouts
- MRO facilities:
  - Existing: 69 acres
  - 2040 needed: additional 58 acres (for a total of 127 acres)

4.6 LANDSIDE FACILITIES

This section documents the landside facility requirements developed as part of the SDP. Requirements were developed for the following landside elements:

- Airport Roadways
- Airport Access Gates
- Proposed Transit Connections to Regional Transit
- Automobile Parking
- Rental Car Facilities

4.6.1 AIRPORT ROADWAY ACCESS

For the most part, the roadway network providing access to/from SAT is planned to remain primarily the same as it is today with a few exceptions according to TxDOT and the City of San Antonio. TxDOT has identified future improvements to US Highway 281, Loop 410, IH 10, and Loop 1604. While these improvements are not nearby the Airport, they serve traffic that travels to and from the Airport. More relevant improvements are currently being developed as part of a planning project for the US Highway 281/North Loop 410 interchange. Since this interchange is immediately adjacent to the Airport and provides access to a significant portion of Airport traffic, any improvements will help improve travel to and from the Airport in the future. A review of the TxDOT improvement plans indicate that what is proposed will most likely lead to increased capacity, as well as improved access. Additional details regarding the planned improvements are covered in subsequent sections.

This chapter focuses on traffic conditions along the roadways identified in the *Inventory of Existing Conditions*. The expected traffic conditions of the study area intersections during the Years 2028 and 2038 is described in the following sections.

METHODOLOGY

Understanding the future traffic growth within the study area, as well as within the region, plays an important role in assessing traffic conditions. For purposes of the SDP, growth rates along roadways within the study area were derived from two sources. The first source was the AAMPO travel demand model. The travel demand model (TDM) includes key roadways within the entire San Antonio region along with future land use and population growth for the Year 2040. Key transportation improvements that are categorized as funded are also included within the TDM. Growth rates along roadways within the study area ranged from –10% to +5% per year based on the TDM. The second source included a review of the expected growth in enplanements at SAT. As discussed in Chapter 3, *Aviation Activity Forecasts*, the anticipated growth rates (based on adjusted TAF) within the next 20 years will range from 1.6% to 1.9% per year.

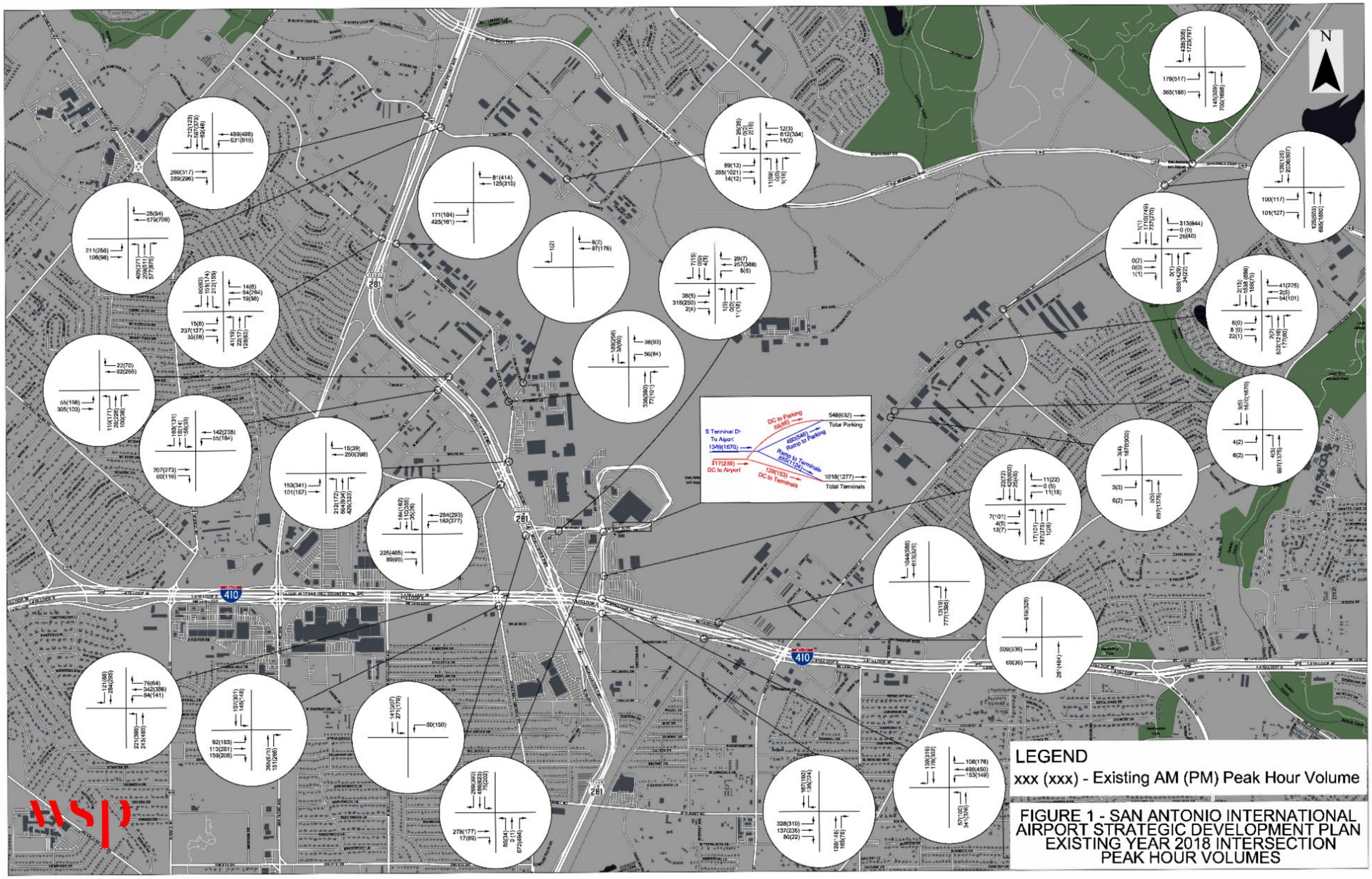
Future traffic flow conditions within the study area were analyzed based upon the intersections highlighted in the *Inventory of Existing Conditions*, as well as upon the volume/capacity (V/C ratio) for roadways within the study area. Both analyses require traffic volume as a key input. The next section highlights the development of future traffic volumes.

DEVELOPMENT OF TRAFFIC VOLUMES

Two types of traffic volumes were used for purposes of assessing traffic flow. The first was average daily traffic (ADT) volumes, while the second is morning/afternoon (AM/PM) peak hour traffic volumes. Average Daily Traffic volumes were derived directly from the Year 2040 travel demand model and were used in calculating the future V/C ratios along roadways within the study area.

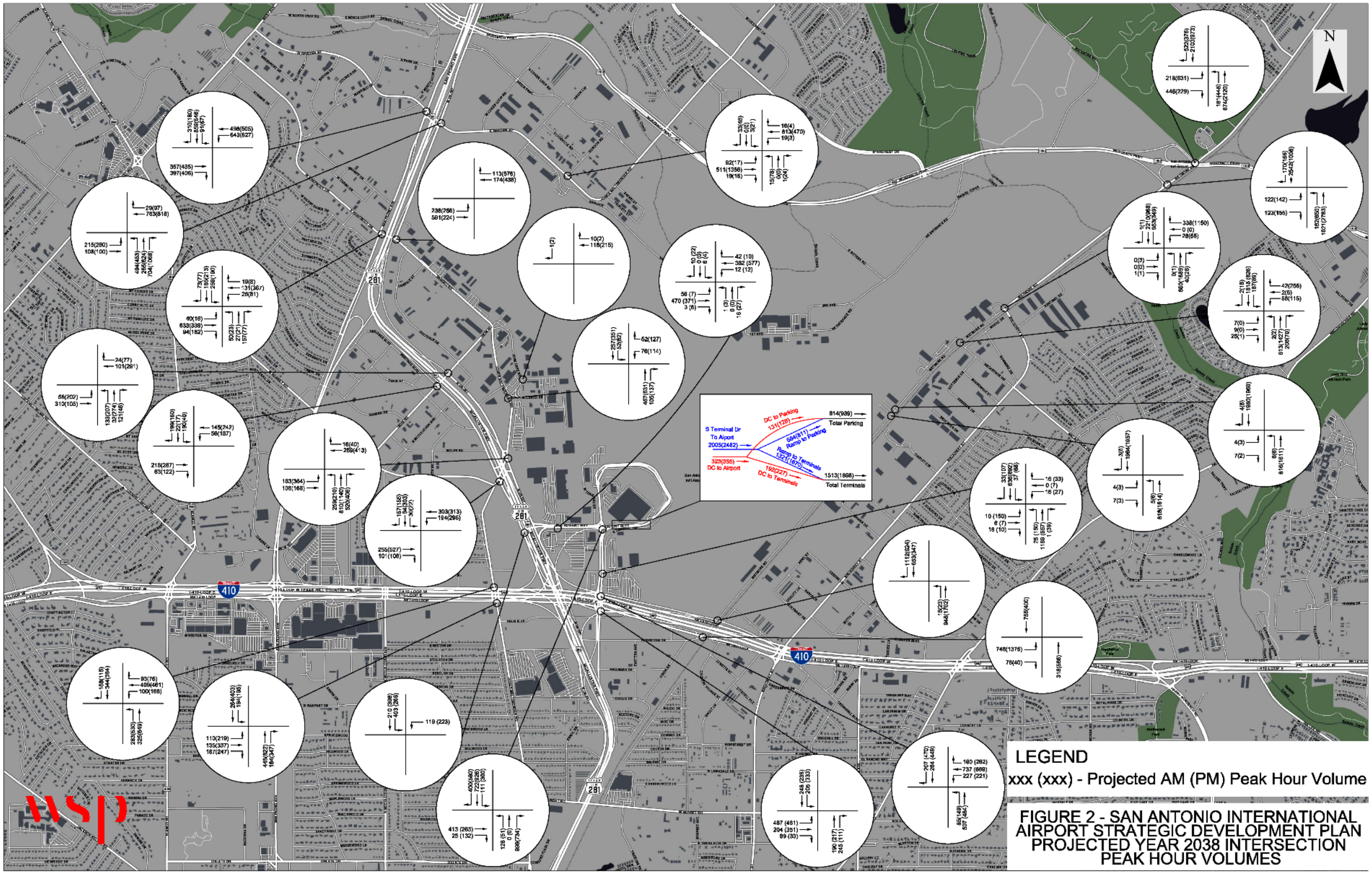
The development of AM/PM peak hour volumes were necessary for the Year 2028 and 2038 intersection analysis. For intersections located outside of the main SAT ring road, the development of future peak hour volumes was based on the growth rates derived from the TDM. It should be noted that a minimum growth rate of 1% per year was used for intersections with derived growth rates below zero. A minimum growth rate of 2% per year was used for study area intersections along Dee Howard Way and Airport Boulevard. **Figure 4.6-1** depicts the Year 2028 AM/PM peak hour volumes, while **Figure 4.6-2** depicts the Year 2038 AM/PM peak hour volumes.

Figure 4.6-1: Year of 2028 Morning/Afternoon Peak Hour Volumes



Source: WSP USA, 2018.

Figure 4.6-2: Year of 2038 Morning/Afternoon Peak Hour Volumes



Source: WSP USA, 2018.

OPERATIONAL ASSESSMENT

A future operational assessment of the study area intersections and roadways was also conducted and is summarized within this section. For purposes of this analysis, it was assumed that future passenger growth would occur at the existing terminal buildings. Future traffic to/from SAT would therefore primarily use the same roadways and travel through the same key study intersections.

INTERSECTION ASSESSMENT

The study area intersections were analyzed for Years 2028 and 2038. For the base case, no improvements were included in the Synchro 9 traffic models that were developed for both the AM and PM peak hours for each planning year.

Table 4.6-1 includes a summary of the signalized intersection delay/LOS, while **Table 4.6-2** includes a summary of the unsignalized intersection delay/LOS.

Figures 4.6-3 and **4.6-4** depict a map of the LOS results at each of the study intersections. During the Year 2028, it is expected that only two signalized intersections degrade to a LOS E during either the AM or PM peak hour. During the year 2038, however, two signalized intersections degraded to LOS E, while four signalized intersections had increases in delay and thus are expected to operate at LOS F. Three of the five unsignalized intersections degraded to LOS E or F during both Years 2028 and 2038 . Additional details regarding these intersections are included in the next section.

It should be noted that the delay values included in Table 4.6-1 do not include excessive queuing that is expected along the terminal roadways due to increases in the number of passenger pick-ups and drop-offs. The queueing is expected during peak times due to increases in traffic and cut-through traffic, due to the expected congestion.

Table 4.6-1: Signalized Intersection Delay and Level of Service

CONTROL DELAY (SECONDS/VEHICLE)/LEVEL OF SERVICE						
	Existing – Year 2018		Year 2028		Year 2038	
IntersectIntersectionion	Morning Peak Hour	Afternoon Peak Hour	Morning Peak Hour	Afternoon Peak Hour	Morning Peak Hour	Afternoon Peak Hour
U.S. 281 NB Frontage Road at Nakoma Drive*	41.9/D	40.9/D	53.5/D	65.9/E	65.2/E	108.5/F
U.S. 281 SB Frontage Road at Nakoma Drive*	18.3/B	18.6/B	21.0/C	20.9/C	28.5/C	26.8/C
U.S. 281 SB Frontage Road at Rhapsody Drive	17.9/B	14.7/B	92.1/F	17.5/B	388.1/F	39.7/D
U.S. 281 NB Frontage Road at Isom Road*	15.1/B	36.3/D	15.6/B	40.6/D	16.1/B	46.0/D
U.S. 281 SB Frontage Road at Isom Road*	23.2/C	22.8/C	23.6/C	23.5/C	24.0/C	24.4/C
U.S. 281 NB Frontage Road at Jones Maltsberger Road*	20.1/C	49.9/D	21.4/C	71.5/E	21.7/C	88.6/F
U.S. 281 SB Frontage Road at Jones Maltsberger Road*	19.8/B	35.5/D	21.6/C	36.9/D	21.0/C	35.4/D
U.S. 281 SB Frontage Road at Dee Howard Way	0.3/A	0.3/A	0.4/C	0.4/A	0.4/C	0.4/A
Loop 410 EB Frontage Road at Jones Maltsberger Road*	19.5/B	33.9/C	19.8/B	38.5/D	20.2/C	48.7/D
Loop 410 WB Frontage Road at Jones Maltsberger Road*	17.6/B	17.2/B	17.7/B	18.5/B	17.8/B	19.9/B
Loop 410 EB Frontage Road at Airport Boulevard*	34.0/C	27.2/C	33.3/C	27.8/C	32.9/C	28.5/C
Loop 410 WB Frontage Road at Airport Boulevard*	25.0/C	32.4/C	24.7/C	28.9/C	24.9/C	40.3/D
Wurzbach Parkway EB at Wetmore Road	3.5/A	21.1/C	4.8/A	23.3/C	18.2/B	36.2/D
Wurzbach Parkway WB at Wetmore Road	21.6/C	41.8/D	27.3/C	92.3/F	38.6/D	115.9/F
Wetmore Road at Bitters Road*	25.9/C	16.5/B	54.3/D	18.3/B	92.1/F	21.9/C
Wetmore Road at Broadway Street*	26.3/C	41.8/D	35.8/D	70.4/D	55.5/E	128.3/F
Nakoma Drive at Skyplace Boulevard*	8.1/A	11.4/B	8.4/A	12.8/B	8.6/A	13.5/B
Jones Maltsberger Road at Paul Wilkins Street	11.0/B	7.3/A	10.8/B	7.6/A	10.5/B	8.1/A
Dee Howard Way at John Saunders Road*	8.2/A	5.2/A	8.4/A	4.5/A	8.5/A	4.4/A
Airport Boulevardat Northern Boulevard*	9.5/A	16.5/B	10.8/B	18.8/B	12.7/B	22.5/C
Airport Boulevard at Dee Howard Way/Terminal Boulevard*	15.0/B	12.2/B	16.5/B	13.5/B	19.5/B	24.5/C

Notes:

EB – eastbound

NB – northbound

SB - southbound

WB – westbound

Delay and Level of Service determined by *Highway Capacity Manual 2010* methodology.

*Delay and Level of Service determined by *Highway Capacity Manual* 2000 methodology

Source: WSP USA, 2018.

Table 4.6-2: Summary of Unsignalized Intersection Delay and Level of Service

CONTROL DELAY (SECONDS/VEHICLE)/LEVEL OF SERVICE							
		Existing – Year 2018		Year 2028		Year 2038	
Intersection	Control Type	Morning Peak Hour	Afternoon Peak Hour	Morning Peak Hour	Afternoon Peak Hour	Morning Peak Hour	Afternoon Peak Hour
Loop 410 EBFR at Wetmore Road	AWSC	23.1/C	108.2/F	42.6/E	185.2/F	63.4/F	269.4/F
Wetmore Road at DHL Driveway	TWSC (EB)	47.6/E	36.9/E	54.5/F	194.4/F	96.5/F	264.4/F
Wetmore Road at FedEx Driveway	TWSC (EB)	54.7/F	109.0/F	72.8/F	157.6/F	92.3/F	309.7/F
Paul Wilkins Street at John Cape Road	TWSC (SB)	10.6/B	12.4/B	10.9/B	13.0/B	11.1/B	13.6/B
U.S. 281 NBFR at Dee Howard Way*	TWSC (WB)	10.6/B	13.4/B	10.6/B	13.4/B	10.6/B	13.4/B
U.S. 281 SBFR at Loop 410 WBFR*	TWSC (SB)	36.2/E	111.6/F	81.1/F	312.5/F	241.1/F	649.8/F

Notes:

AWSC – All-Way STOP-Controlled

TWSC – Two-Way STOP-Controlled

EB – eastbound

FR – frontage road

NB – northbound

SB - southbound

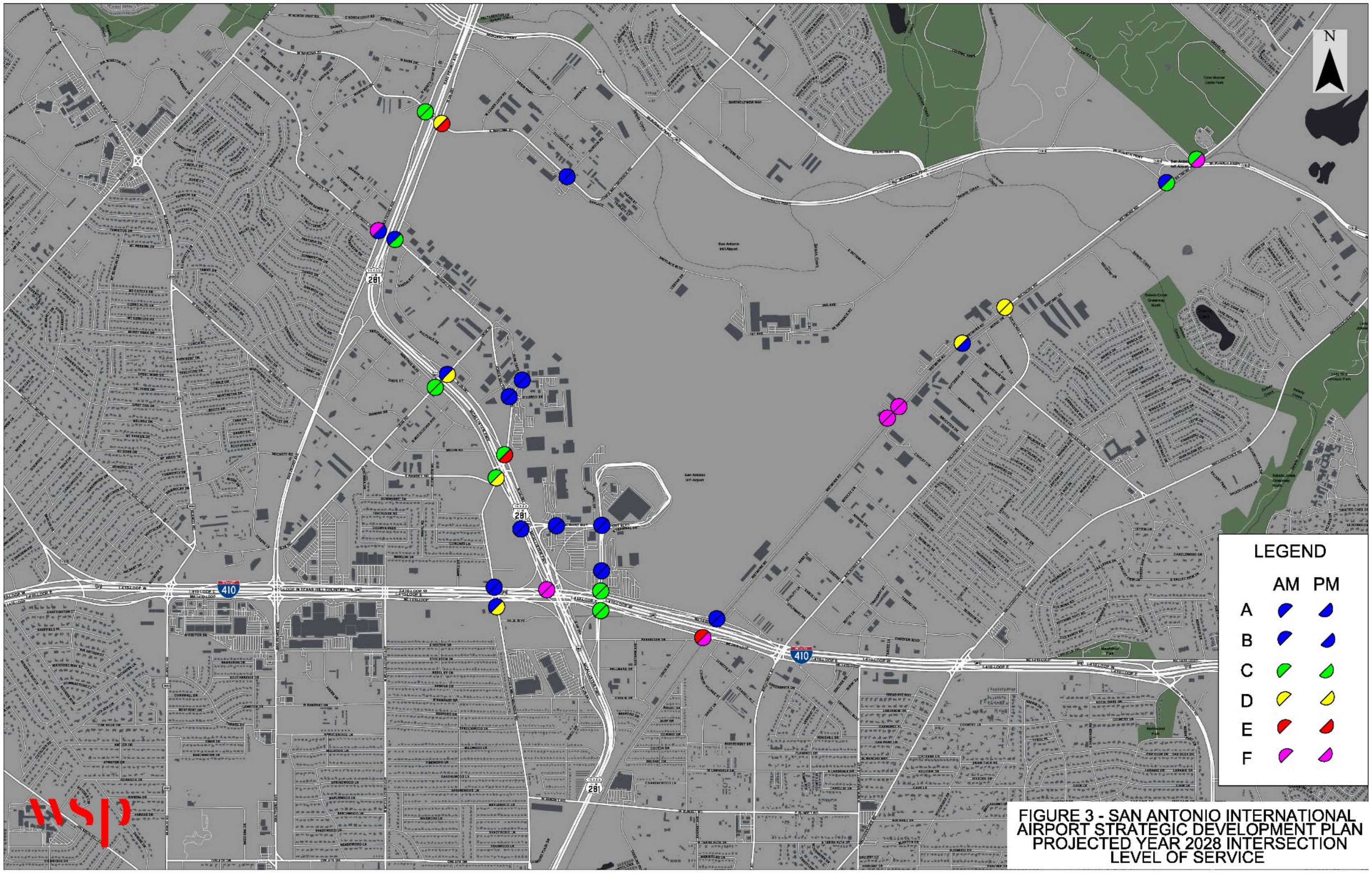
WB – westbound

Delay and LOS determined by *Highway Capacity Manual 2010* methodology.

*Delay and LOS determined by *Highway Capacity Manual 2000* methodology

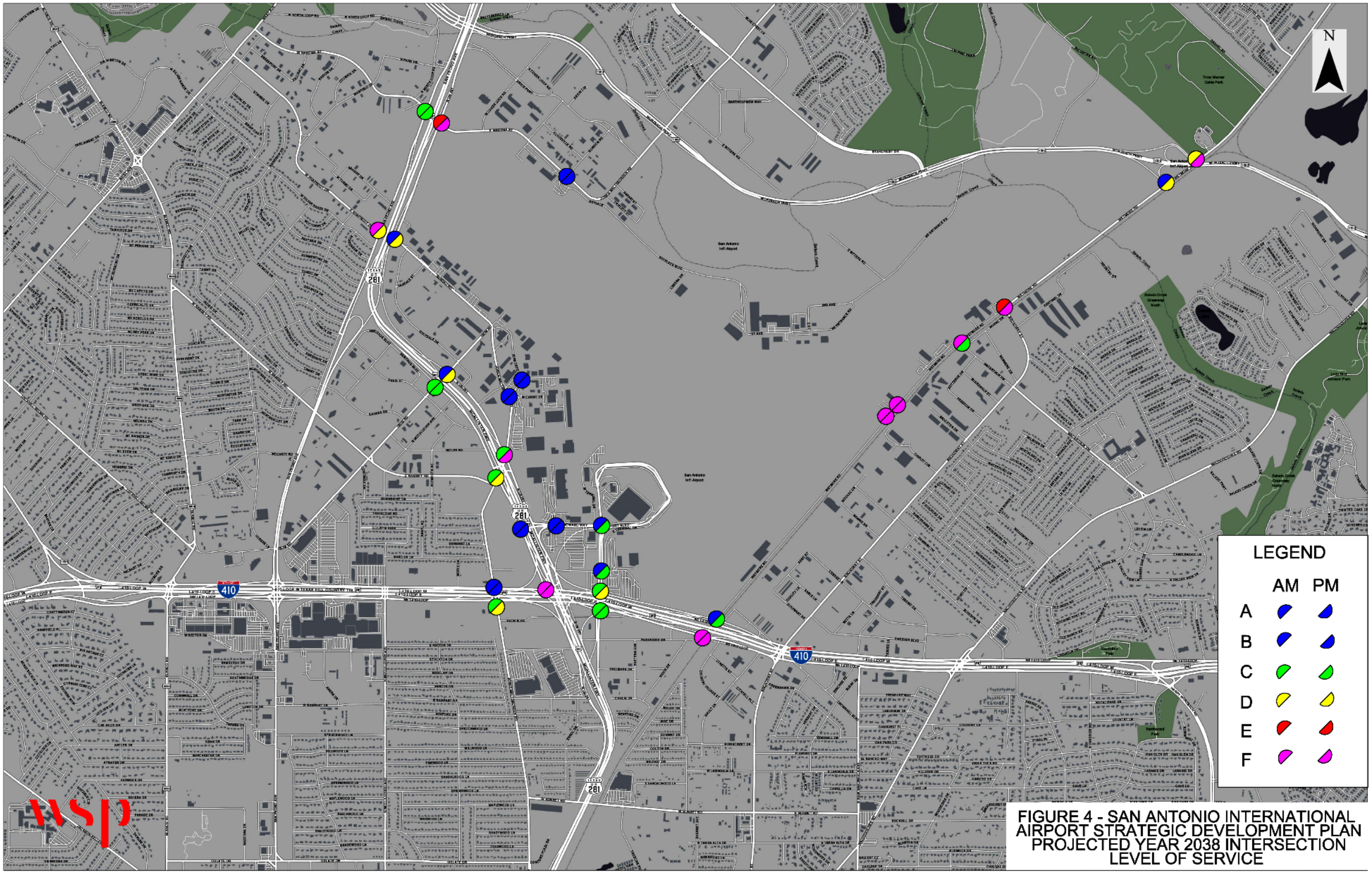
Source: WSP USA, 2018.

Figure 4.6-3: Year 2028 Morning/Afternoon Intersection Level of Service



Source: WSP USA, 2018.

Figure 4.6-4: Year 2038 Morning/Afternoon Intersection Level of Service



Source: WSP USA, 2018.

AIRPORT ACCESS ROADWAYS

The future Year 2040 Volume to Capacity (V/C) ratios were also calculated based on the forecasted daily traffic volume derived from the AAMPO TDM. There were a few key locations where updates to the forecasted traffic volumes were required due to the future airport enplanement forecasts. The roadways included were along Dee Howard Way, Airport Boulevard, and the terminal roadways. It is expected that these roadways will reach capacity by early 2030's if the expected growth rates occur. The Year 2040 revised V/C ratios related to these roadways are included below:

- Dee Howard Way – As Dee Howard Way approaches Airport Boulevard, the V/C ratios are at capacity, ranging from 0.85 to 1.0.
- Airport Boulevard – V/C ratios are at capacity ranging from 0.85 to 1.0 between I-410 and Dee Howard Way.
- Terminal Roadways – V/C ratios are over capacity ranging from 1.0 to great than 1.0 between I-410 and Dee Howard Way.

Traffic flow along these roadways will be critical during peak times and thus adding capacity will be vital as growth in passenger enplanements at the terminal increases. Development of a new dedicated "entrance" to the airport will improve access, and may alleviate some of congestion due to the current constraints along these roadways. This will be examined in Phase 2.

CUT-THROUGH TRAFFIC

For purposes of this section, there are two types of traffic traveling along Airport Boulevard/Dee Howard Way that are critical to traffic flow and circulation on the airport site. The first type of vehicle traffic are passengers and airport tenant employees and the second type is the cut-through traffic related to general non-airport trips that begin or end in the vicinity of the airport site. Non-airport cut-through traffic is primarily a result of increased traffic volumes and congestion levels along US 281 and I-410 as well as nearby local streets. Both of these types of traffic exist today and are projected to increase in the future, resulting in more congestion and longer queues at critical intersections along airport roadways. With increases in peak hour non-airport cut-through traffic percentages (currently 10.4% to 33.2%) in addition to the expected increases in peak hour passenger pickup and drop-off, excessive queuing beyond the Airport Boulevard/Dee Howard Way intersection is likely, possibly resulting in spillback to adjacent freeway interchanges on US 281 and I-410. Traffic using Skyplace Boulevard as a cut-through route between Jones Maltsberger Road and Wurzbach Parkway east of US 281 was determined to be 2.3% to 11.5% of total traffic. However, the traffic volumes on Skyplace Boulevard are currently very low. While there is an anticipated increase in regional traffic using these routes, the current volumes are low enough that the increase in cut-through traffic will likely not adversely impact operations of that roadway, nor degrade operations at the intersections of Skyplace Boulevard with Nakoma Drive and Wurzbach Parkway.

REGIONAL ROADWAYS

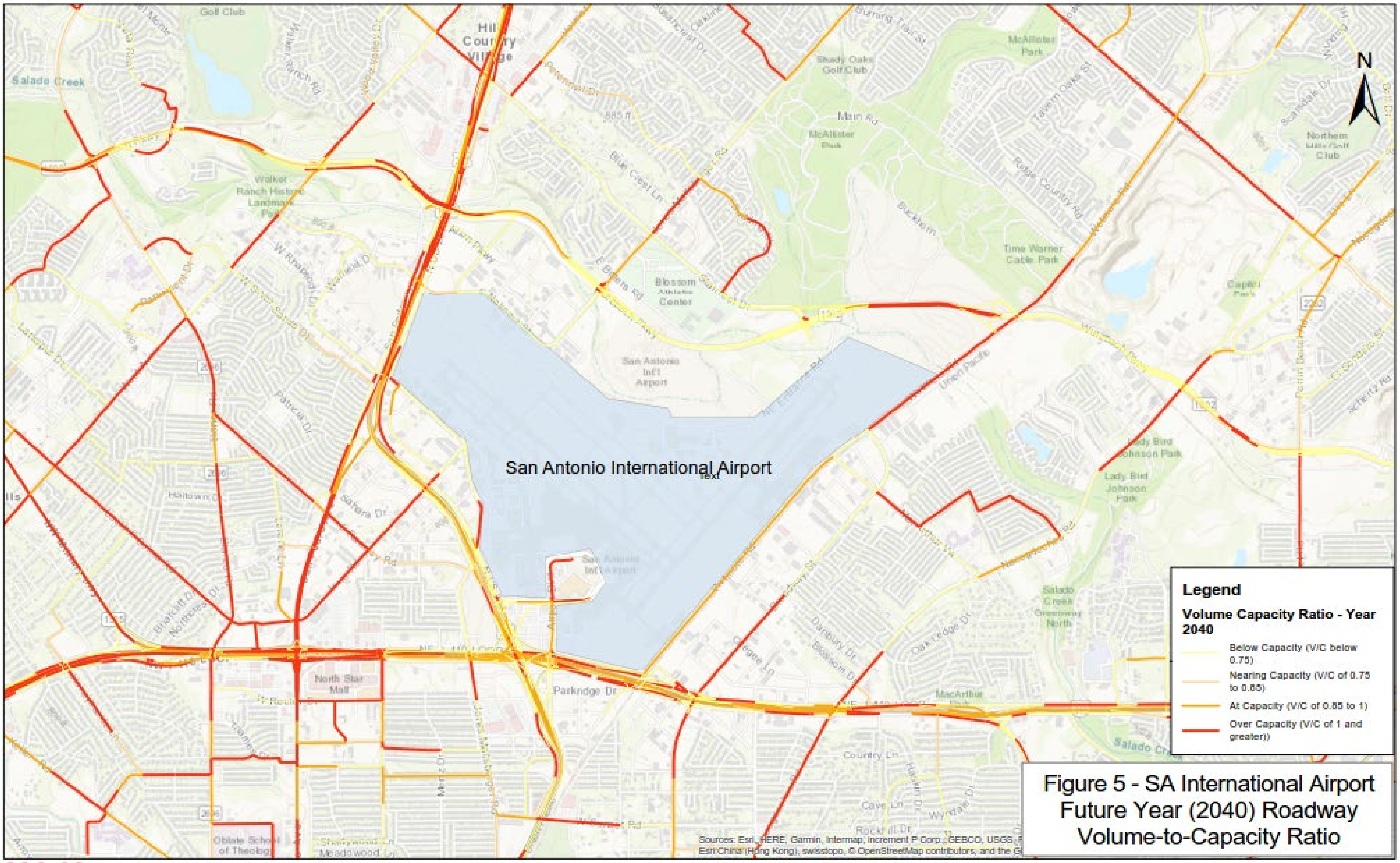
As discussed earlier, improvements to the US Highway 281/North Loop 410 interchange are in the planning stages and will provide increased capacity for airport patrons. **It is important to note that these improvements are expected to be completed within the next ten years and are still preliminary and subject to change.** Improvements related to additional lane capacity were included in the calculation of V/C ratios. The key improvements consist of the following:

- Dee Howard Way at US Hwy 281 northbound Frontage Road – install concrete median separating through lanes from turning lanes.
- Loop 410 eastbound Frontage Road at Jones Maltsberger Road – widen eastbound approach to install a right turn lane, two through lanes and left turn lane.
- US Hwy 281 northbound Frontage Road at Jones Maltsberger Road – remove northbound entrance ramp to US Hwy 281. Construct extension of 2-lane direct connector ramp from Loop 410.
- US Hwy 281 northbound Frontage Road at Isom Road – reconfigure northbound lanes to allow for two shared through lanes.
- US Hwy 281 southbound Mainlanes at Nakoma – construct Collector-Distributor ramp (CD) for the Nakoma entrance ramp and the San Pedro Exit ramp.
- US Hwy 281 Frontage Roads at Nakoma – reconfigure eastbound lanes at northbound Frontage Road.
- Loop 410, McCullough to West Avenue – selected ramp reversals
- Loop 410 westbound Frontage Road at Blanco Road – reconfigure lanes on westbound approach.
- Loop 410 at San Pedro Interchange – Widen southbound lanes on San Pedro, lane reconfiguration on the westbound approach, implement triple left-turn on the eastbound approach.
- Loop 410 at McCullough Interchange – close McCullough to northbound and southbound through movements.

Figure 4.6-5 depicts the Year 2040 V/C ratios for all key roadways near the airport. Even with the improvements highlighted above, several roadways will be nearing or over capacity. It is important to note that additional capacity will be necessary to provide airport patrons a positive (LOS C or D) experience and to ensure the reliability needed in the transportation system.

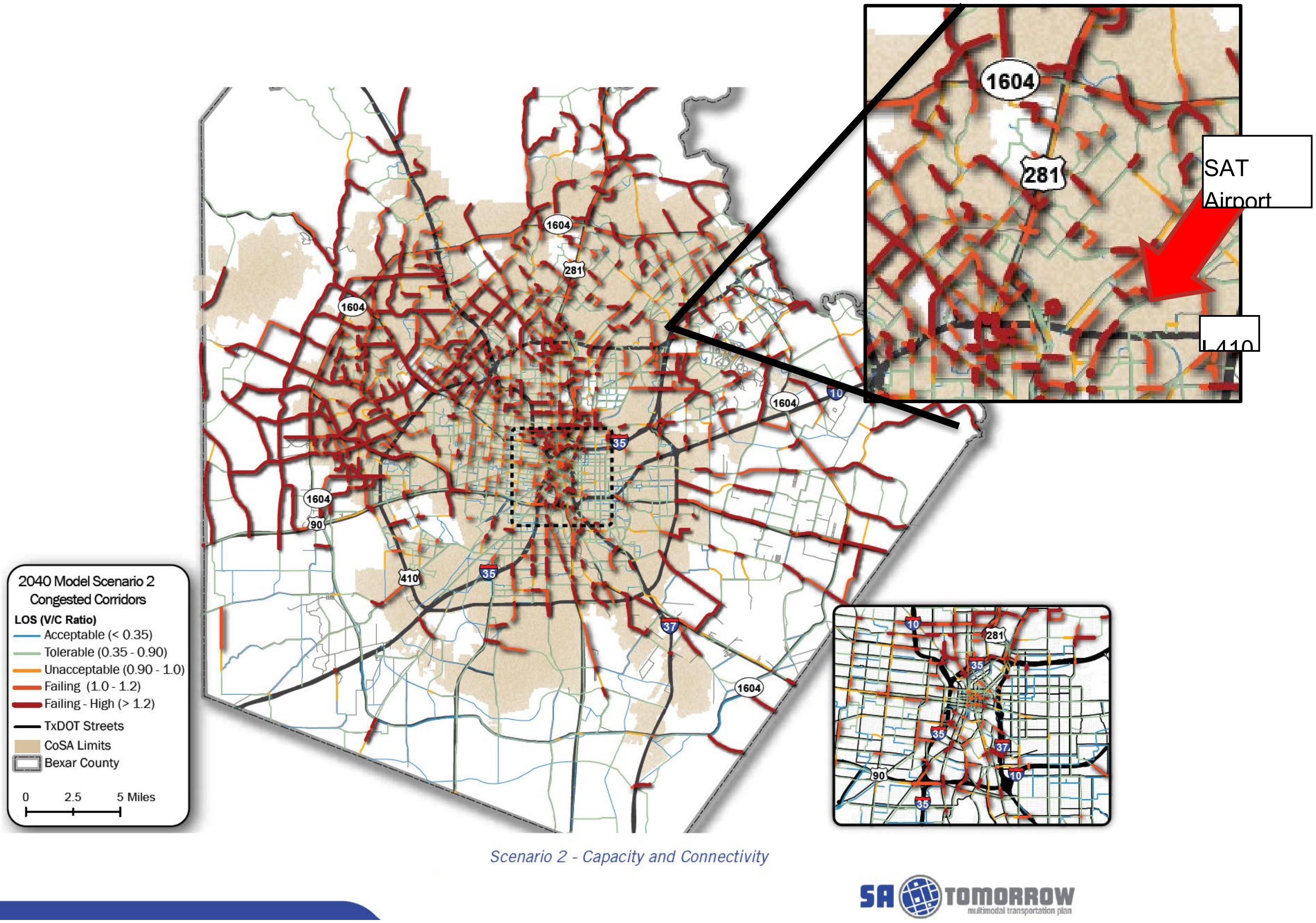
The SA Tomorrow Multimodal Transportation Plan included future needs based on scenario planning using the AAMPO 2040 travel demand model. The Capacity and Connectivity Scenario considered all programed improvements included in the AAMPO 2040 plan along with a full build-out of the City of San Antonio Major Thoroughfare Plan. This included roadways that were not built to the full number of lanes as well as those that were not yet constructed. The results, as reported in the SA Tomorrow Multimodal Transportation Plan, showed congestion levels were still present even after adding approximately $3B in capacity from the Major Thoroughfare Plan. **Figure 4.6-6** shows the congested corridors/segments around the airport that would remain over or near capacity after this investment.

Figure 4.6-5: Year of 2040 V/C Ratios with Preliminary Proposed US 281/I-410 Interchange Improvements



Source: WSP USA, 2018.

Figure 4.6-6: SA Tomorrow Multimodal Transportation Plan: Scenario 2 Connectivity and Capacity 2040 Modeling Results



Source: WSP USA, 2018.

FACILITY REQUIREMENTS

This section focuses on potential improvements to both airport-related intersections and roadways based on no major changes to the overall roadway network. The improvements primarily include capacity enhancements to increase capacity rather than roadway realignments. The next sections briefly highlight short term improvements that are expected to improve traffic flow.

AIRPORT INTERSECTIONS

Although there were no intersections along Dee Howard Way or Airport Boulevard that were expected to operate at LOS E or F during the 2028 or 2038 horizon years, there are short-term improvements that should be considered to reduce delay and further improve traffic flow and safety. The first consists of conducting a traffic signal timing study based on current traffic volumes to improve both cycle lengths and split times to minimize delay during peak conditions. The second is focused on modifications to the Dee Howard Way/Airport Boulevard intersection. As volumes continue to increase at this intersection, an additional northbound right turn lane may be needed and thus may need to be controlled as part of the existing traffic signal due to the traffic volume destined for the garages and terminal curb front. The actual modifications will vary depending on the future proposed terminal building layouts.

It should be noted that the congestion expected along the terminal roadways could lead to excessive queuing at the Airport Boulevard/Dee Howard Way intersection, thus leading to LOS F during peak times. Additional review of the terminal roadways is necessary in Phase 2 of the SDP, to consider future terminal buildings.

AIRPORT ACCESS ROADWAYS

Based on the V/C ratios that are expected along Dee Howard Way, Airport Boulevard, and Terminal Roadways, they are likely to require additional lanes along with the intersection improvements described above. The actual roadway enhancements will vary depending on other facility improvements considered by SAT. Creating a new dedicated entrance to the airport to improve overall access to the terminals and parking garages should be a key consideration in Phase 2.

REGIONAL ROADWAY NETWORK

There are several intersections along the regional roadway network within the next 20-year horizon that will need modifications to achieve LOS D or better. Several roadways will also need capacity improvements to reduce the V/C ratios within acceptable ranges. The following includes a summary of the key locations.

- I-410 eastbound Frontage Road/Wetmore Road – Construct a traffic signal.
- US 281/Nakoma Drive – New interchange to increase capacity due to high turning volumes.
- Wurzbach Parkway/Wetmore Road – Additional turn lanes.
- Wetmore Rd/Broadway Street – Additional turn lanes.
- U.S. 281 southbound Frontage Road/Loop 410 westbound Frontage Road- Construct a traffic signal.
- Each of the study area unsignalized intersections along Wetmore need improvements, which should consist of additional turn or through lanes.

- Each of the key roadway segments along US 281, I-410, Wetmore Road, and a few segments along Wurzbach Parkway need additional capacity. Additional through lanes and or interchange improvements will be necessary to reduce the V/C ratios.

It should be noted that there are several Planned Roadway Improvements over the next 20 years within the San Antonio Region will improve access to/from SAT. These improvements range from minor improvements to large roadway reconstruction projects. Although there are no major roadway improvements within the immediate airport study area, with the exception of the US 281/I-410 interchange, the regional roadway network will benefit from the planned improvements. **Figure 4.6-7** depicts a map of the Planned Improvements identified by AAMPO.

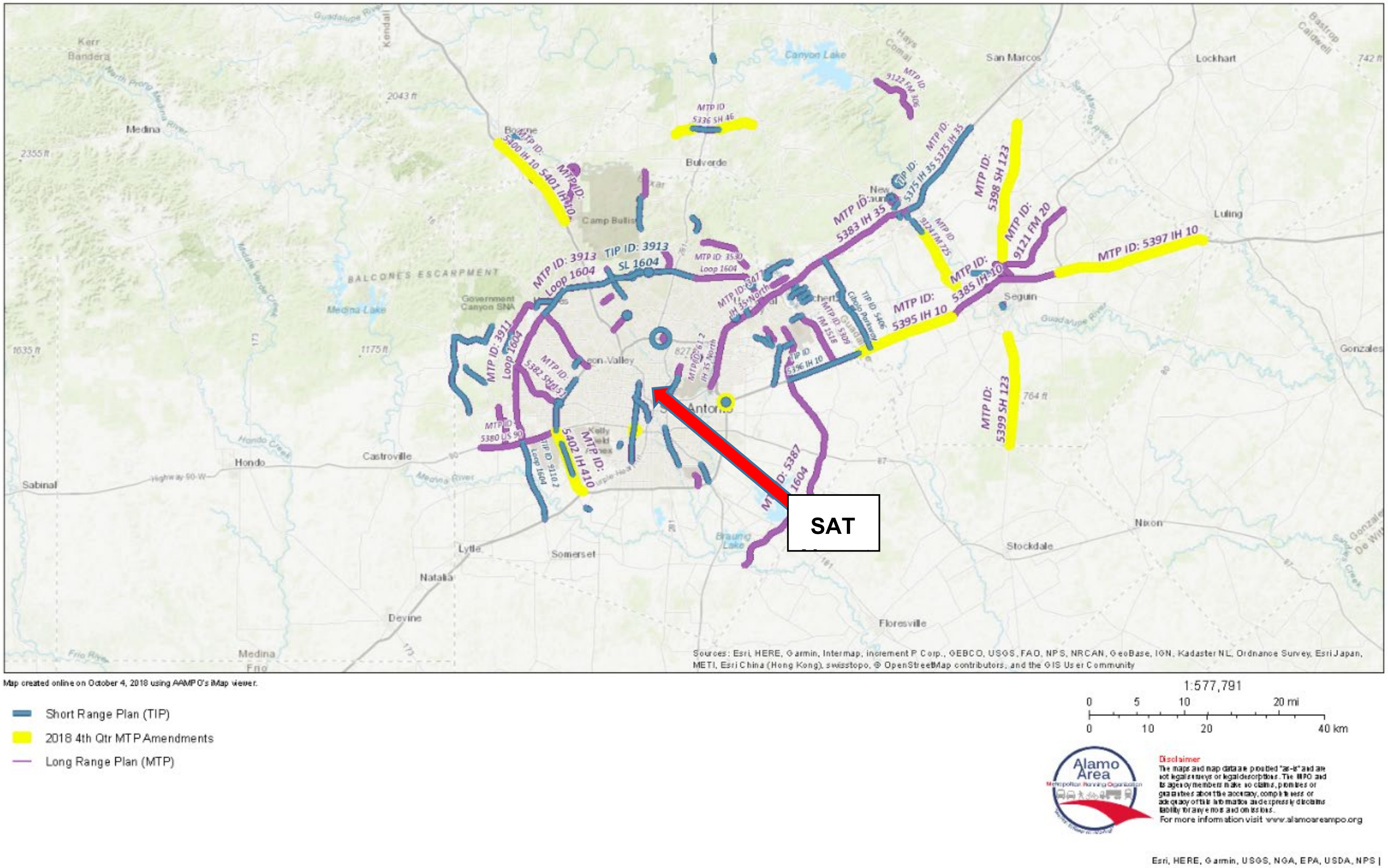
TRANSIT INTEGRATION

VIA Metropolitan Transit (VIA) has identified corridors that will serve future rapid transit in the Vision 2040 Plan as shown in **Figure 4.6-8**. The North-Central corridor includes a connection to the airport and to downtown San Antonio. Rapid transit can consist of several different modes. While VIA has not yet identified which mode would be proposed for the North-Central corridor, emphasis has focused on dedicated right-of-way.

On April 10, 2018, Mayor Ron Nirenberg announced the formation of a non-profit, ConnectSA, with Bexar County Judge Nelson Wolff. ConnectSA is tasked with working with VIA to implement a multimodal transit plan that would be put before voters by the end of 2019. Members of ConnectSA come from the leaders in both the public and private sectors. ConnectSA will use much of the work done for VIA's Vision 2040 long-term plan and SA Tomorrow's Multimodal Transportation Plan, to develop a complete system plan to bring before voters. More recently, ConnectSA was directed to provide a report in December 2018 addressing route recommendations for corridors, "trackless transit" options, funding sources and adaptive technology. Trackless transit uses driverless vehicles resembling light rail cars, in dedicated right-of-way. The success of a connected transit system will require a transit hub located on or adjacent to the airport. The transit hub will provide connections to downtown directly or via shuttle service to the downtown link.

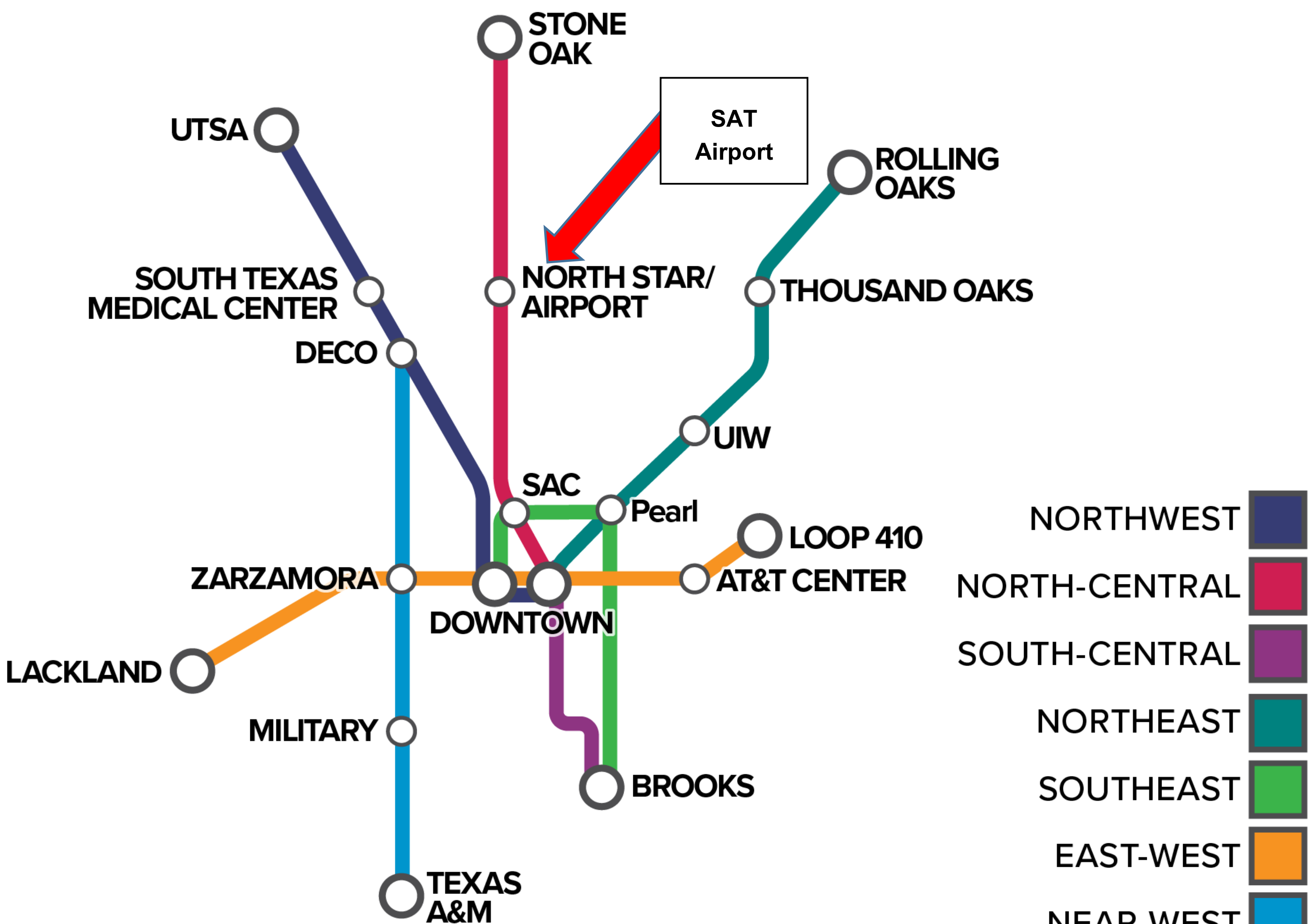
VIA recently completed construction on a Park-N-Ride facility in Stone Oak that provides express service to downtown. Direct access to an HOV lane on the main lanes of US Highway 281 is being constructed by TxDOT as part of the US 281/I-410 interchange improvement project. While the HOV lane is currently planned only to travel a short distance, it could be the first leg in a dedicated transit lane to downtown.

Figure 4.6-7: Alamo Area Metropolitan Planning Organization Planned Improvements



Source: WSP USA, 2018.

Figure 4.6-8: VIA Vision 2040 Plan – Rapid Transit Corridors



Source: WSP USA, 2018.

ACCOMMODATING FUTURE CHANGES TO MODE CHOICE AND TECHNOLOGY

The advances in automated vehicle/connected vehicle technology may influence vehicle ownership, and ridesharing significantly in the future and, as a result, increase capacity and reduce congestion. Opinions vary greatly regarding how much these changes will result in substantial reductions to vehicle ownership and when this will occur. Also, the advancement of driverless technology may actually increase trips by providing access to those who are currently unable to drive. The increase in trips may absorb or even exceed the additional capacity created from the technology.

It is anticipated that driverless vehicles will be deployed in fleets and operated similar to existing TNCs at a lower cost to the current TNC pricing structure due to the elimination of the cost of the driver. The industry indicates that initial deployments in small operating areas within smaller cities will proceed in 2019. However, arriving at the point of serving airports implies operating a full regional network of driverless TNCs on highways in many varying conditions. This type of network is not imminent and future projections cannot determine when such a network will be in place.

4.6.2 AUTOMOBILE PARKING

As passenger travel increases at SAT, the demand for short-term and long-term parking is anticipated to also increase. Estimating future parking demand provides a basis for planning additional parking supply and dedicating the needed funding to construct the parking infrastructure.

There are three categories of parking supply at SAT: on-site public parking facilities, off-site privately operated public parking facilities, and employee parking facilities. In addition to passenger and employee parking, SAT provides parking for the pick-up, drop-off, and storage of vehicles to facilitate rental car operations at the CONRAC facility. The following sections provide a description of each category and provide the assumptions used to derive future parking demand.

General automobile parking concerns are:

- Excessive changes in levels when going from parking garage to terminal
- Garage is full during peak summer months

SUMMARY OF PARKING SUPPLY AND OCCUPANCY

SAT provides publicly accessible passenger parking facilities in the form of one short-term parking garage, a long-term parking garage, and surface economy lots. In addition to SAT-operated passenger parking facilities, several privately-operated parking facilities exist near the Airport. These lots provide shuttle service to the Airport terminals. These privately-operated surface lots provide parking supply for airport passengers and, as such, have a role in meeting existing and future parking demand at SAT. Lastly, parking facilities for employees and TNC/rideshare/taxi services are also provided. The available capacity of each of the passenger parking lots was measured in June of 2018, along with the peak occupancy, and is summarized in **Table 4.6-3**. The long-term parking garage experienced the highest utilization at almost 92 percent. As parking facilities near 90 to 95 percent utilization, they are considered “at-capacity”, since drivers must circulate for long periods searching for available parking spaces.

Table 4.6-3: Total 2018 Parking Supply and Peak Occupancy

PARKING FACILITY TYPE	PARKING SUPPLY	2018 PEAK OCCUPANCY	% UTILIZATION
Short-term Garage	1,221	920	75.3%
Long-term Garage	5,596	5,124	91.6%
Economy Surface Lots	1,797	1,227	68.3%
Private Surface Lots	1,951	1,351	69.2%
Employee Parking	934	805	86.2%
Taxi/Rideshare/Cell Phone Staging	530	242	45.7%
Consolidated Rental Car Staging	1,959	N/A	N/A

Notes:

Peak parking occupancy was determined for each facility and represents the peak parking demand that occurred during the week of June 8-14, 2018. During that week, peak parking demand occurred on various weekdays depending on the lot. Passenger parking facilities experienced peaks during the afternoon hours.

Source: WSP USA, 2018.

FUTURE PARKING DEMAND PROJECTION METHODOLOGY

Generally, parking demand for any airport facility is correlated to airport passenger load. However, other factors should be considered, such as pricing structure of parking facilities, availability of transit, taxi, TNC services and ease of access, and proximity to terminal facilities. It should be noted that parking demand is highly elastic, meaning that increases in prices for the parking facilities can lead to a corresponding reduction in parking demand, and vice versa.

For the purposes of this analysis, parking demand is based on the growth in passenger load and assumes that relative pricing structure does not change for future years. Competition from other modes may result in changes in pricing structure for airport parking, which would result in significant changes to parking demand.

Future parking demand for this study was derived from the existing parking generation rates observed during the week of June 8 through June 14, 2018. This calculation yields the parking demand for each facility per 100 daily passengers enplaned during the peak month of 2018. The rates of parking generation that were used to determine future parking demand projections are shown in **Table 4.6-4**. These parking generation rates were then multiplied by the future passenger volume forecasts, as shown in **Table 4.6-5**.

Existing (2018) passenger load was estimated from observed travel patterns utilizing SAT data on annual and peak monthly enplanements. Passenger growth for the forecast years were developed as described in previous sections, and were developed based on regional demographic growth projections and the ability of regional airport facilities to meet the growth in demand. Forecasted rate of passenger growth is presented in 5-, 10-, 20-, and 50-year increments. The 5-, 10-, and 20-year projections are required by FAA guidelines. For the 20- and 50-year projections, additional “high growth” scenarios were evaluated, which assumed an accelerated rate of passenger growth.

The information presented in Table 4.6-4 reflects parking generation rates per 100 daily passengers, as observed at SAT during the peak passenger travel period in June 2018. The Institute of Transportation Engineers' (ITE) *Parking Generation, 4th Edition*, also provides data recorded at over 16 airport sites across North America. ITE derived an average total parking generation rate of 21 to 78 parked vehicles per daily 100 passengers enplaned. The 85th percentile rate was determined to be 61 parked vehicles per daily 100 passengers emplaned, while the SAT-observed parking generation rate for total passenger parking in June 2018 was about 57 parked vehicles per 100 daily passengers emplaned (see Table 4.6-4). The ITE *Parking Generation* manual states that while parking demand was stable for a majority of the year, the peak travel days during the year (cited as Christmas, Thanksgiving, Spring Break, and the end of school year) represented a significant increase in parking demand over the average parking demand that was observed throughout the rest of the year.

Table 4.6-4: Parking Generation per Passenger by Facility Type

PARKING FACILITY TYPE	2018 PEAK PARKING DEMAND	2018 AVERAGE DAILY PASSENGERS (PEAK MONTH)	PARKING GENERATION RATE (# OF PARKED VEHICLES PER 100 DAILY PASSENGERS)
Short-term Garage	920	15,050	6.11
Long-term Garage	5,124		34.05
Economy Surface Lots	1,227		8.15
Private Surface Lots	1,351		8.98
Total Passenger Parking	8,622		57.29
Employee Parking	805		5.35
Taxi/Rideshare/Cell Phone Staging	242		1.61

Source: WSP USA, 2018.

Table 4.6-5: Forecast Peak Hour Passengers for San Antonio International Airport

	STANDARD PASSENGER GROWTH RATE SCENARIO				HIGH PASSENGER GROWTH RATE SCENARIO	
	2018	**2025**	**2030**	**2040**	**2040**	**2070**
2018 Average Daily Passengers (peak month)	15,050	17,560	19,250	22,170	25,580	44,570
% Growth over 2018	---	16.7%	27.9%	47.3%	70.0%	196.1%

Source: WSP USA, 2018.

Using the forecasts for passenger load, the parking generation for future year scenarios were calculated by facility type and are presented in **Table 4.6-6**. Because rideshare and taxi services also correlate highly with passenger load, the same parking generation methodology (as a function of passenger volume) was used to project demand in rideshare and taxi staging.

Table 4.6-6: Peak Parking Demand Forecasts by Parking Facility

LOCATION	PARKING SUPPLY (# OF SPACES)	PEAK DEMAND (# OF SPACES)					
		STANDARD PASSENGER GROWTH RATE SCENARIO				HIGH PASSENGER GROWTH RATE SCENARIO	
		2018	2025	2030	2040	2040	2070
Short Term Garage	1,221	920	1,074	1,177	1,355	1,564	2,724
Long Term Garage	5,596	5,124	5,979	6,555	7,546	8,709	15,173
Green/Red Lot	2,347	1,277	1,490	1,634	1,881	2,170	3,781
Total SAT Passenger Parking Supply	9,164	7,321	8,543	9,366	10,782	12,443	21,678
Purple Lot (Employee)	934	805	939	1,030	1,186	1,368	2,384
Orange Lot - Taxicab Staging*	297	118	138	151	174	201	349
TNC (rideshare) Staging*	83	72	84	92	106	122	213
Cell Phone Lot 1 (closed July, 2018)	83	52	---	---	---	---	---
Cell Phone Lot 2**	150	---	61	67	77	88	154
Total SAT Parking	10,711	8,368	9,764	10,704	12,327	14,222	24,782
Airport Security (North)*	835	793	793	793	793	793	793
Airport Security (South)*	854	427	1288	1334	1412	1505	2018
Budget Long Term Parking*	262	131	153	168	193	223	388
Total Private Passenger Parking*	1,951	1,351	2,234	2,295	2,398	2,521	3,199
GRAND TOTAL	12,662	9,719	11,998	12,998	14,725	16,743	27,981

Notes:

*Rideshare staging and private parking lot supply and 2018 measurements of Peak Demand were estimated from on-site observation (May, 2018) and aerial imagery (January, 2018).

**Red Lot and Cell Phone Lot 2 were not open during the June, 2018 data collection period. Cell Phone parking was moved to the Cell Phone Lot 2 location after data collection, in August, 2018.

Source: WSP USA, 2018.

A similar methodology was utilized to determine employee parking requirements, based on the anticipated passenger growth for future years. As passenger growth occurs, a similar growth will be expected in the number of people the airport employs, from security to gate attendants and so on. Because many of these positions are dependent on the number of passengers the Airport is serving, passenger growth was assumed to be the basis by which employee parking demand was projected. To determine employee parking generation, a parking generation rate was calculated as a function of employees per passenger served by the Airport. Employee parking demand will therefore grow proportionally to passenger growth. Using these assumptions, a forecast for future year parking demand was developed. Table 4.6-6 demonstrates the increase in parking demand by number of spaces that will be needed for each analysis year. If the assumption that passenger growth corresponds to parking demand at a similar rate, SAT will need over 20,000 parking spaces to meet peak demand in year 2068.

A similar breakdown of the parking demand as a percentage of parking supply or percent utilization is presented in **Table 4.6-7**. While SAT currently provides 9,164 parking spaces that are about 80 percent utilized during peak periods, the increase in passenger load will drive the parking demand to exceed parking supply by 2025 within a 5-year time period, unless additional supply is provided or demand is reduced. Similarly, employee parking demand is projected to exceed supply within a 5-year period. The forecast for Taxi staging indicates that facility will have sufficient capacity through the year 2068. However, TNC parking demand will exceed its supply prior to 2025.

Table 4.6-7: Peak Parking Utilization Forecast by Parking Facility

LOCATION	PARKING SUPPLY (# OF SPACES)	PEAK DEMAND (AS % OF SUPPLY)					
		STANDARD PASSENGER GROWTH RATE SCENARIO				HIGH PASSENGER GROWTH RATE SCENARIO	
		2018	2025	2030	2040	2040	2070
Short Term Garage	1,221	75.3%	88.0%	96.4%	111.0%	128.1%	223.1%
Long Term Garage	5,596	91.6%	106.8%	117.1%	134.8%	155.6%	271.1%
Green/Red Lot	2,347	71.1%	82.9%	90.9%	104.7%	120.8%	210.4%
Total SAT Passenger Parking Supply	9,164	79.9%	93.2%	102.2%	117.7%	135.8%	236.6%
Purple Lot (Employee)	934	86.2%	100.5%	110.3%	127.0%	146.5%	255.2%
Orange Lot - Taxicab Staging*	297	39.7%	46.5%	50.8%	58.6%	67.7%	117.5%
TNC (rideshare) Staging*	83	86.7%	101.2%	110.8%	127.7%	147.0%	256.6%
Cell Phone Lot 1 (closed July, 2018)	83	62.7%	---	---	---	---	---
Cell Phone Lot 2**	150	---	40.7%	44.7%	51.3%	58.7%	102.7%
Total SAT Parking	10,711	78.1%	91.2%	99.9%	115.1%	132.8%	231.4%
Airport Security (North)*	835	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%
Airport Security (South)*	854	50.0%	150.8%	156.2%	165.3%	176.2%	236.3%
Budget Long Term Parking*	262	50.0%	58.4%	64.1%	73.7%	85.1%	148.1%
Total Private Passenger Parking*	1,951	69.2%	114.5%	117.6%	122.9%	129.2%	164.0%
GRAND TOTAL	12,662	76.8%	94.8%	102.7%	116.3%	132.2%	221.0%

Notes:

*Rideshare staging and private parking lot supply and 2018 measurements of Peak Demand were estimated from on-site observation (May, 2018) and aerial imagery (January, 2018).

**Red Lot and Cell Phone Lot 2 were not open during the June, 2018 data collection period. Cell Phone parking was moved to the Cell Phone Lot 2 location after data collection, in August, 2018.

Source: WSP USA, 2018.

Since some parking facilities will exceed capacity sooner than others, it may be necessary to continue to evaluate peak utilization and manage parking demand by shifting parking supply from one facility to another to accommodate the growth in the most efficient manner possible. Other methods of managing parking demand include introducing or increasing the frequency of transit service.

An additional calculation was derived to illustrate the amount of acreage currently used for parking facilities to serve both on- and off-site Airport traffic. Existing acreage was calculated from the approximate footprint of each garage or surface lot. By dividing the number of parking spaces provided by the acreage for each facility, the density of spaces per acre for each facility type was determined. To calculate the acreage needed to meet the projected future parking demand (as shown in Table 4.6-7), the facility density was multiplied by the forecasted number of spaces required for each future year scenario. **Table 4.6-8** demonstrates the forecasted acreage for future year scenarios based on facility type. For this analysis, it was assumed that the current parking densities will continue for future conditions (for example, short-term parking will continue to be served by a parking garage).

Table 4.6-8 demonstrates that to accommodate the forecasted parking demand for future scenarios, an additional 21 acres of land will be needed for the 2038 baseline scenario, with an additional 134 acres needed to accommodate the 2068 high-growth scenario. The acreage can be supplied by either garage facilities or surface lots. It is noted, again, that parking demand is highly contingent on a number of factors including pricing structures, vehicle ownership, future mode shifts away from the existing "park on-site" model, as presented in the following section.

Table 4.6-8: Approximate Forecasted Acreage Needed for Parking Supply by Facility

LOCATION	# OF LEVELS	EXISTING ACREAGE PROVIDED	PARKING FACILITY DENSITY (SPACES/ ACRE)*	NEEDED ACREAGE TO MEET PARKING DEMAND AT CURRENT DENSITY**					
				STANDARD PASSENGER GROWTH RATE SCENARIO				HIGH PASSENGER GROWTH RATE SCENARIO	
				2018	2025	2030	2040	2040	2070
Short Term Garage	2 Levels	11 (5.5 acres/level)	111	8.3	9.7	10.6	12.2 (+1 level)	14.1 (+1 level)	24.5 (+3 levels)
Long Term Garage	5 Levels	44 (8.8 acres/level)	127	40.3	47.0 (+1 level)	51.5 (+1 level)	59.3 (+2 levels)	68.5 (+3 levels)	119.3 (+9 levels)
Green/Red Lot	Surface	15.1	155	10.7	12.5	13.7	15.8 (+0.7 acres)	18.2 (+3.1 acres)	31.8 (+16.7 acres)
Total SAT Passenger Parking Acreage		70		59	69	76	87	101	176
Purple Lot (Employee)	Surface	9.5	98	8.2	9.6 (+0.1 acres)	10.5 (+1.0 acres)	12.1 (+2.6 acres)	13.9 (+4.4 acres)	24.2 (+14.7 acres)
Orange Lot - Taxicab Staging	Surface	2.5	119	1.0	1.2	1.3	1.5	1.7	2.9 (+0.4 acres)
TNC (rideshare) Staging	Surface	2.5	33	2.2	2.5	2.8 (+0.3 acres)	3.2 (+0.7 acres)	3.7 (+1.2 acres)	6.4 (+3.9 acres)
Cell Phone Lot 1 (closed July, 2018)	Surface	0.8	104	0.5	---	---	---	---	---
Cell Phone Lot 2	Surface	1.4	107	---	0.6	0.6	0.7	0.8	1.4
Total SAT Parking Acreage		87		71	83	91	105	121	211
Airport Security (North)***	Surface	7.5	111	7.1	7.1	7.1	7.1	7.1	7.1

Airport Security (South)* **	Surface	7.2	119	3.6	10.9	11.2	11.9	12.7	17.0
Budget Long Term Parking* **	Surface	2.1	125	1.1	1.2	1.3	1.5	1.8	3.1
Total Private Passenger Parking* **		17		12	19	20	21	22	27
GRAND TOTAL		104		83	102	111	125	143	238

Notes:

*Parking spaces per acre was calculated by dividing the total existing facility acreage by the existing parking supply (number of spaces) provided by that facility.

**Needed acreage assumes that there are no changes in the Parking Density by Facility. If, for future parking demand, additional parking acreage is needed, the quantity of additional space is denoted within parentheses.

***For private parking facilities, the additional parking acreage needed (if any) was not calculated.

Source: WSP USA, 2018.

4.6.3 RENTAL CAR

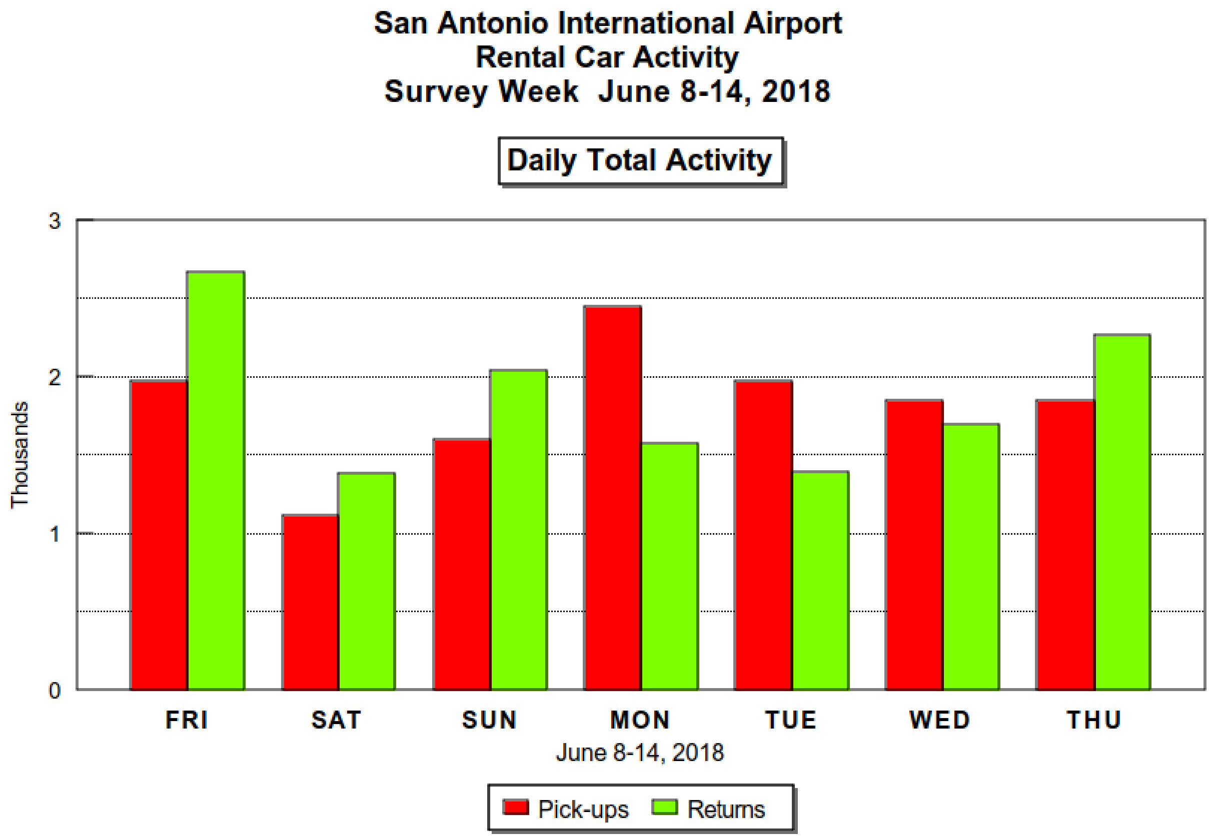
Rental cars are used overwhelmingly by visitors to the region. In December 2017, all rental car (RAC) operations were moved to a ConRAC located across from the terminals. The ConRAC is connected by a pedestrian bridge located between Terminal A and Terminal B, which has eliminated RAC shuttles from the terminal curbs.

Counters for the 13 rental car companies are located at the bridge level with 1,960 combined ready/return and RAC storage spaces on three parking levels. There are three levels of quick-turn facilities (QTF) adjacent to the ConRAC parking, which provide fueling, washing and light maintenance. This minimizes the movements of RAC vehicles as they are returned and prepared for another rental. Short-term public parking occupies 1,220 spaces within the structure on Levels 1 and 2. The public parking facility has separate entrances and Exit Control from the rental cars facilities.

Hourly RAC pick-up and return counts were requested from all the on-airport RACs for the week of Friday, June 8 through Thursday June 14, 2018. Findings are listed below:

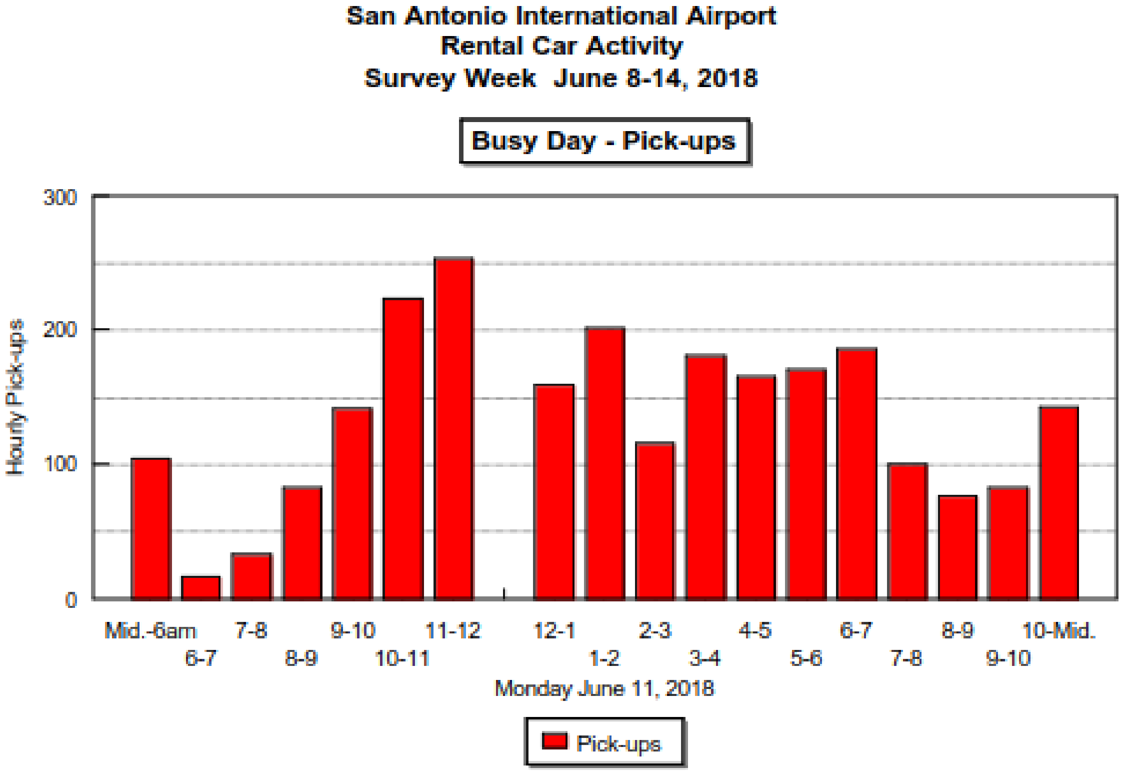
- Daily totals are illustrated in **Figure 4.6-9,** and show a typical RAC activity pattern for a mixed business/leisure destination airport. Pick-ups are strongest on Mondays and fall off during the middle of the week, with another uptick for the weekend.
- Returns are strongest on Thursday and Friday (business related), and Sunday (leisure related).
- Hourly activity is illustrated in **Figure 4.6-10** for the busiest days of the survey week. Pick-ups are typically strongest after the first waves of flight arrivals in mid- to late morning and again late afternoon, but did not coincide with the peak flight arrivals late at night, which typically represent residents returning home.
- Returns occurring during the overnight hours corresponded to the early morning departures peak. There were also high numbers of returns in early to mid-afternoon, corresponding to the mid- to late afternoon secondary departures peaks.

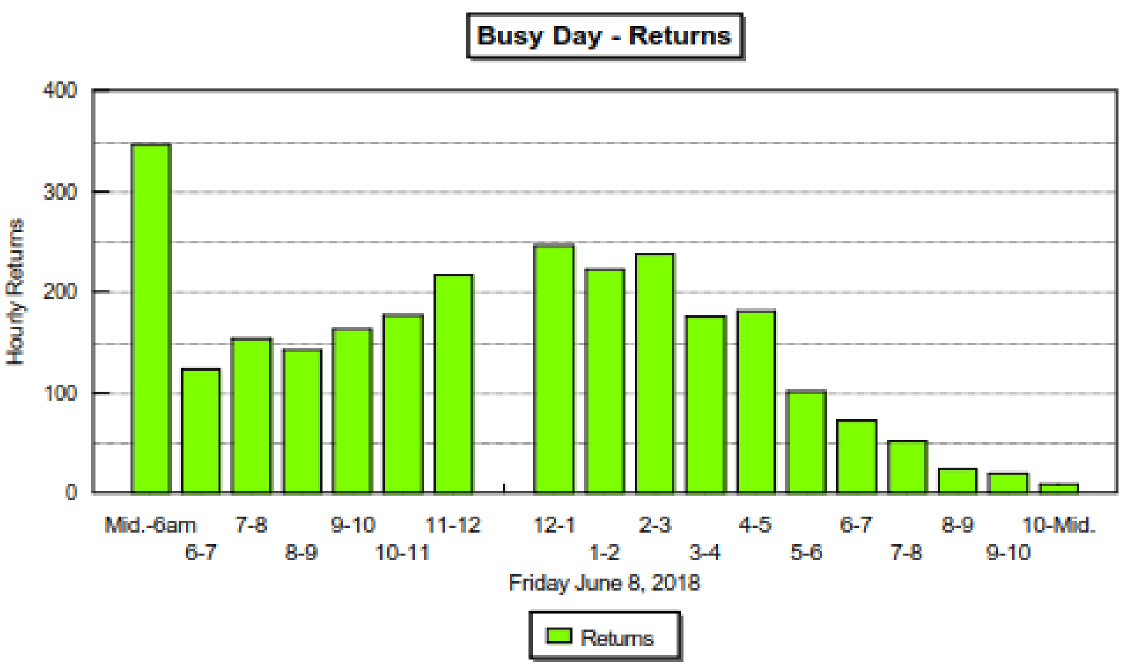
Figure 4.6-9: Rental Car Activity Daily Totals



Source: WSP USA, 2018.

Figure 4.6-10: Rental Car Activity Pickups and Returns





Source: WSP USA, 2018.

For terminal area planning, RAC facilities to be considered are typically the RAC customer service counters and the ready/return (R/R) spaces. Other RAC vehicle storage and service centers are typically located outside the immediate terminal area. However, the location of the ConRAC adjacent to the terminals allows to combine all RAC functions. It is assumed that if the terminal complex remains within walking distance of the ConRAC, the ConRAC will continue to provide customer service counters, R/R spaces and QTF. If the demand for R/R spaces grows, additional vehicle parking would be relocated to another portion of the Airport. The following planning factors were assumed for SAT:

- Customer service counters are both a function of passenger volume, the number of RACs and degree of pre-booking/automation. The ConRAC's large counter and queuing/waiting area is assumed to have sufficient flexibility to accommodate changes in future operations.
- Typically, return spaces are provided for 1 to 1.5 hours of peak activity. This depends on the 'peakiness' of the return volumes, the proximity to a QTF and available personnel. Both the busiest 1.5 hours during mid-day Friday and the overnight returns had approximately 350 returned vehicles. Comparing this to the estimated 2,040 peak hour enplanements results in a ratio of 0.17 spaces per design hour enplanement. However, since the R/R spaces are divided into three floors and further segregated by company, the planning factor was increased by 30 percent to 0.22 return spaces per design hour enplanement.
- Typically, ready car spaces (pick-ups) are provided for up to two hours of peak activity. The controlling factors are like those of return spaces, except that RACs usually need to have a wider selection of vehicles types to meet customer demands. The busiest two hours on the peak day of the week accounted for approximately 480 vehicles. Comparing this to the estimated 2,030 peak hour deplanements results in a ratio of 0.23 spaces per design hour deplanement. A 30 percent multiple company factor was also applied, resulting in a planning factor of 0.30 ready spaces per design hour deplanement.

Table 4.6-9 summarizes the estimated R/R spaces requirements. As shown, the existing facilties are anticipated to accommodate the 2040 high growth forecast R/R spaces needed, and no additional facilities are required.

Table 4.6-9: Rental Car Facility Requirements (Number of Spaces)

		RECOMMENDED FACILITIES					
	EXISTING FACILITIES	BASE YEAR	FORECAST YEAR				
		2018	2025	2030	2040	2040 HIGH	2070
Rental Car Ready/Return Spaces							
Return Car Spaces	incl below	450	530	550	630	690	1,200
Ready Car Spaces	incl below	610	710	740	850	940	1,630
Combined R/R Spaces (separate lots)	1,960 /1	1,060	1,240	1,290	1,480	1,630	2,830

Notes:

1/ Existing ConRAC spaces include vehicle storage

R/R – Ready/Return

Source: WSP USA, 2018.

4.6.4 AIRPORT ACCESS GATE

Airside access from the landside occurs through an airside gate south of Terminal A, as shown on **Figure 4.6-11**. The vehicle queue at this location occasionally backs up onto the road. Options for redesigning this airside access gate will be explored in the *Alternatives Development and Evaluation* chapter.

Figure 4.6-11: Vehicle Airside Access Gate

Sources: Google Earth Pro, 2019; SP USA, 2018.

4.6.5 TECHNOLOGICAL INNOVATIONS IN AIRPORT LANDSIDE FACILITIES

The advances in automated vehicle/connected vehicle (AV/CV) technology may influence vehicle ownership, ridesharing, and parking demand significantly in the future. Opinions vary greatly regarding how much these changes will reduce the need for parking and result in substantial reductions to vehicle ownership and when this will occur. With the increase in pace of development in technologies that drive demand for certain modes of transportation, it is likely that the forecasted parking demand will shift in future years, requiring further analysis.

Strongly correlated to airport parking demand is the recent proliferation of Transportation Network Company (TNC) pickups and drop offs from airport terminals. As with taxi operations, passengers choose this mode to avoid parking or car rental at airport facilities. TNCs such as Uber and Lyft provide additional convenience and availability over traditional taxicab service, resulting in cheaper fares and decreased usage of parking facilities provided by SAT and other private lots.

It is anticipated that driverless vehicles will be deployed in fleets and operated similar to existing TNCs at a lower cost to the current TNC pricing structure due to the elimination of the cost of the driver. If this advancement comes to pass in future scenarios, it will likely further degrade demand for parking at airport facilities. The industry indicates that initial deployments in small operating areas within smaller cities will proceed in 2019. However, arriving at the point of serving airports implies operating a full regional network of driverless TNCs on highways in many varying conditions. This type of network is not imminent and future projections cannot determine when such a network will be in place. Similarly, future scenarios may also need to accommodate the possibility of the deployment of automated passenger aerial drones (also known as Urban Air Mobility or UAM), potentially operated by TNCs, at airport drop off and pick up locations, which could impact passenger, rideshare, and taxi parking demand. Ultimately, decisions regarding installation of new parking facilities should be made based on time-to-return measures. For example, if a 50-year bond is required to pay down a parking structure, it would be a riskier situation than a 20-year bond.

Similarly, airports can proactively develop parking structures for the potential of repurposing them in a few different ways:

- **Pick-up/Drop-off Facilities**: If there is much higher pick-up/drop-off demand (because parking demand has dropped off in this scenario), portions of existing parking facilities could be repurposed for staging pick-up/drop-off operations, with a possible ability to place a surcharge on those operations, depending on market conditions.
- **Automated Vehicle (AV) Fleet Staging and Storage:** Regional AV fleets will have to operate out of somewhere. Whoever is operating these fleets will need places to stage these fleets, including charging electric vehicles, washing, repairing, etc. By designing the supporting infrastructure for that (water leads, conduit, etc.), the assets could be potentially repurposed to support these fleets. Airports may be particularly attractive for this, as they have large parking facilities that are not (typically) in central cities, and they have good freeway access, etc.
- **Automated Passenger Aerial Drone Staging and Storage:** In the event that TNCs operate aerial drones for pick-up and drop-off, those operations will need a clear area on the top of some structure, within walking distance of passenger terminals, similar to today's helicopter operations. Depending on future utilization of parking facilities, parking garage structures or surface facilities could be repurposed to provide the needed surface area for these operations (see Section 4.6.2).

Airports such as Austin-Bergstrom International Airport (AUS) are testing electric autonomous vehicles. The AUS shuttle, with seating for six and room for other passengers to stand, has a pre-programmed route between the passenger terminal and the rental car/ground transportation sites.

Finally, as public transportation becomes more available, convenient and frequent, the need for parking at airport facilities will also decrease. Incorporation of a transit hub with service to/from downtown will further reduce parking demand, and adjustments to the parking forecasts presented in this report will need to be made to account for that reduced demand.

The short-term evidence points to a significant amount of traffic being diverted from traditional taxi or park-and-fly modes to the Rideshare mode or to public transportation. Unfortunately, it is nearly impossible to derive long-term trends from short-term data, considering the uncertainty on the future of the urban mobility market. It is the recommendation of this report, therefore, that these trends continue to be evaluated every 5 years, or in the event that a decision must be made on future airport parking facilities.

4.6.6 SUMMARY OF LANDSIDE REQUIREMENTS

- Airport roadways:
- Airport intersections:
  - Intersections along Dee Howard Way and Airport Boulevard: improvements to reduce delay and improve traffic flow and safety
  - Dee Howard Way/Airport Boulevard intersection: additional northbound right turn lane as traffic volumes continue to increase
- Airport access:
  - Additional lanes on Dee Howard Way, Airport Boulevard, and terminal roadways
- Regional roadways:
  - I-410 eastbound Frontage Road/Wetmore Road: construct a traffic signal
  - US 281/Nakoma Drive: new interchange
  - Wurzbach Parkway/Wetmore Road: additional turn lanes
  - Wetmore Rd/Broadway Street: additional turn lanes
  - U.S. 281 southbound Frontage Road/Loop 410 westbound Frontage Road: construct a traffic signal.
  - Study area unsignalized intersections along Wetmore need improvements, which should consist of additional turn or through lanes.
  - Key roadway segments along US 281, I-410, Wetmore Road, and a few segments along Wurzbach Parkway: additional through lanes and/or interchange improvements
- Transit integration:
  - Transit hub on or adjacent to the Airport
- Automobile parking:

  - 2038 baseline: additional 21 acres
  - 2068 high-growth: additional 134 acres
- Rental car: existing facilities can accommodate demand through the planning horizon

4.7 OTHER AERONAUTICAL FACILITIES

The FlightSafety Learning Center provides aviation training for Textron products. It is located on Airport property, at the intersection of Airport Boulevard and Dee Howard Way. FlightSafety did not express the need for additional facilities.

San Antonio Airport System Strategic Development Plan

2021 AIRPORT MASTER PLAN

MASTER PLAN UPDATE
CHAPTER 4 – DEMAND/CAPACITY AND FACILITY REQUIREMENTS
APPENDIX 4A – WIND COVERAGE

MEMO

TO: Susan St. Cyr, P.E., San Antonio Airport System

FROM: John van Woensel, Brittany Hause

SUBJECT: San Antonio International Airport Strategic Development Plan
Crosswind Runway 4-22 Future Eligibility - Wind and Operational Analysis

DATE: October 22, 2019 (Revised February 20, 2020)

The **purpose of this memo** is to report the findings of additional seasonal wind analysis and the implications on the future Federal Aviation Administration (FAA) funding eligibility of Runway 4-22, as a crosswind runway at San Antonio International Airport (SAT). A crosswind runway is typically needed when wind conditions do not allow for arrivals or departures on a primary runway.

The October 2, 2019 discussion with the FAA Airports District Office program manager led to the additional seasonal analysis, to establish whether Runway 4-22 might be eligible for future FAA participation at a reduced runway design code (RDC) for smaller aircraft. It was established and reported in Phase 1 of the SAT Strategic Development Plan (SDP), that due to the very high wind coverage of Runway 13R-31L (the primary runway at SAT), crosswind Runway 4-22 is not required, per FAA airport planning and design standards. Therefore, it is ineligible for FAA funding participation as a full commercial service runway with an RDC of D-IV. Once Runway 4-22 exceeds its useful life, it will require replacement, decommissioning, or shortening/downgrading. Because of the runway's current good pavement condition, this is not estimated to occur until the end of the SDP's 2038 planning horizon or later.

Based on the information presented below and discussions with San Antonio Airport System (SAAS) staff and the FAA, the SDP is considering reduced RDC options for a shortened Runway 4-22 in the 20-year alternatives evaluation, rather than completely eliminating the runway. An RDC B-I runway would be narrower and shorter than an RDC D-IV runway.

Wind Analysis:

The **applicable FAA guidance** in Order 5100.38D, *Airport Improvement Program (AIP) Handbook,* states that for a crosswind runway (Runway 4-22) to be eligible for FAA funding participation, the wind coverage on the primary runway (Runway 13R-31L) must be 95% or less for the future RDC D-VI (documented in the forecast approved by the FAA in October 2018). In other words, the need for a crosswind runway (due to excessive crosswinds) would need to occur more than 5% of the time for a crosswind runway to be required and eligible for FAA funding participation. This criterion is also contained in FAA Advisory Circular 150/5300-13A, *Airport Design*.

Overall SAT wind conditions: The wind coverage analysis for the recent 10-year period (2008-2017) for All-Weather, Instrument Flight Rules (IFR), and Visual Flight Rules (VFR) conditions is shown in **Table 1**.

The analysis shows that the wind coverage of Runway 13R-31L was a very high 99.94% for All Weather conditions and that therefore, no crosswind runway is required for the current design aircraft (RDC D-IV, e.g. Boeing 767-300). This means that when the runway comes due for reconstruction, it will not be eligible for FAA funding participation as a D-IV runway. We first reported this finding during the SDP's Phase 1, in 2018 presentations to the SDP advisory groups, the community, and City Council and its Transportation and Mobility Committee. SAAS could theoretically fund the entire cost of an air carrier runway reconstruction project without FAA funding participation, but given the high cost of major airfield projects, this is unlikely (also, a long-term elimination of the Runways 13R-31L and 4-22 intersection is required by the FAA, to improve airfield safety).

Because SAT accommodates significant non-commercial service aircraft activity, both by propeller and jet aircraft, the impact of high crosswinds on smaller aircraft was considered. The analysis shows that the primary runway (Runway 13R-31L) also exceeds the 95% wind coverage requirement for the 13- and 16-knot crosswind components for smaller aircraft (the crosswind component is the highest value of a direct crosswind in which a pilot can land the aircraft safely), which correspond to aircraft such as the King Air 200 (13 knots) or Boeing 737 (16 knots). The only aircraft categories for which the primary runway does not meet the FAA 95% wind coverage requirement are those of the smallest users, A-I and B-I aircraft (e.g., Cirrus SR22, King Air 90). These aircraft can only operate with a crosswind component up to 10.5 knots.

Table 1: Wind Coverage for SAT's Runways 13-31

Crosswind (knots)	Wind Coverage (%)		
	All Weather	Instrument Flight Rules (IFR)	Visual Flight Rules (VFR)
10.5	**94.19**	96.87	93.87
13	97.47	98.53	97.35
16	99.53	99.65	99.51
20	**99.94**	**99.89**	**99.94**

Sources: National Oceanic and Atmospheric Administration, San Antonio International Airport Weather Observations, 2008-2017; WSP USA, 2019.

Table 2 summarizes **seasonal wind coverage** for Runway 13R-31L. The months of November through January were identified for the seasonal wind analysis, as they bring occasional strong northerly winds that result in excessive crosswind components on the primary runway, Runway 13R-31L, requiring the use of the crosswind runway, Runway 4-22. Seasonally, the primary runway still exceeds the FAA wind coverage requirement for the design aircraft (20-knot crosswind component), as well as for smaller or slower aircraft capable of a 16-knot crosswind component. However, the seasonal analysis found that the primary runway does not provide seasonal 95% wind coverage for aircraft with a 13-knot or 10.5-knot crosswind component, which includes A-II, B-II and smaller or slower aircraft.

Table 2: Seasonal Wind Coverage for Runways 13-31 for All Weather Conditions

		Crosswind Component (knots)			
Year	**Month**	10.5	13	16	20
2017	January	88.69	94.07	98.54	99.92
2017	November	89.41	94.79	98.86	99.67
2017	December	89.53	94.06	98.17	99.66
2017	Nov, Dec, Jan	89.44	94.42	98.54	99.75
2014	Nov, Dec, Jan	85.52	92.28	97.96	99.65
2011	Nov, Dec, Jan	90.47	95.53	99.2	99.85
2008	Nov, Dec, Jan	87.31	92.53	97.28	99.37
2008-2017	Nov, Dec, Jan	**89.90**	**94.75**	98.56	99.73
2008-2017	12 months	**94.19**	97.47	99.53	99.94

Sources: National Oceanic and Atmospheric Administration, San Antonio International Airport Weather Observations, 2008-2017; WSP USA, 2019.

Operational Analysis:

SAT is an air carrier airport with an Airport Reference Code (ARC) of D-IV (existing) and D-VI (future) (the ARC is the highest RDC of all runways at the airport). However, SAT also serves a significant share of non-commercial operations. To help quantify the number of aircraft that could be affected (either inconvenienced or unable to operate due to crosswind runway unavailability during high crosswind conditions) if Runway 4-22 were to be eliminated, aircraft operations recorded by the SAT Airport Noise and Operations Monitoring System (ANOMS) between September 2018 and August 2019 were analyzed. **Appendix A** summarizes the most common aircraft types and operations recorded by the SAT ANOMS during this time period.

Table 3 shows total aircraft operations at SAT from September 2018 to August 2019, by runway. Approximately 36% of SAT's aircraft operations occurred on Runway 4-22 during the sample period.

Table 3: Total Operations by Runway

Runway	Operations	Percent of Operations
13R-31L	87,151	59%
13L-31R	7,078	5%
4-22	54,310	36%
Total*	**148,539**	100%

Sources: San Antonio International Airport, *Airport Noise and Operations Monitoring Systems*, September 2018-August 2019; WSP USA, 2019.
*ANOMS captures most aircraft operations, but actual total airport operations were slightly higher

Table 4 summarizes Runway 4-22 aircraft operations by RDC, for small aircraft. During the analysis timeframe, 54,310 operations occurred on Runway 4-22. Of those operations, over 6,600 operations were conducted by A-I and B-I aircraft. Based on the wind data, only an estimated 462 aircraft operations (0.3% of all SAT aircraft operations) were required to take place on Runway 4-22 because the crosswind component exceeded 10.5 knots on the primary runway. Additionally, there were over 8,000 aircraft operations by A-II and B-II aircraft (e.g., Cessna Caravan, Beechcraft 1900), with only an estimated 164 (0.1% of total SAT aircraft operations) required to operate on Runway 4-22 because the crosswind component exceeded 13 knots on the primary runway. Of the 54,310 aircraft operations on Runway 4-22 during the analysis timeframe, only 626 (1.2%) A-I through B-II aircraft were required to operate on Runway 4-22 due to the crosswinds being beyond aircraft limits. The remaining 98.8% of the aircraft that operated on Runway 4-22 did so out of convenience (proximity to apron, takeoff aligned with route of flight, etc.).

Table 4: Runway 4-22 Small Aircraft Operations

Aircraft	FAA Crosswind Component Limit (knots)	Runway 4-22 Aircraft Operations	
		Total Aircraft Operations	Wind-Dictated Operations
A-I	10.5	2,582	194
B-I	10.5	4,033	268
A-II	13	1,564	17
B-II	13	6,513	147

Sources: San Antonio International Airport, *Airport Noise and Operations Monitoring Systems*, September 2018-August 2019; WSP USA, 2019.

APPENDIX A

Table A-1: San Antonio International Airport - Top 40 Aircraft by Operations (Sep 2018-Aug 2019)

Aircraft			Runway						Total
			13R	31L	4	22	13L	31R	
Boeing 737	B737	C-III	12,690	2,626	11,219	392	3	4	26,934
Boeing 737-800	B738	D-III	8,175	1,700	4,954	204	4	5	15,042
Airbus A319	A319	C-III	5,134	982	2,655	123	3	1	8,898
Airbus A320	A320	C-III	4,164	778	3,525	140	3	0	8,610
Embraer 175	E75L	C-III	3,840	776	1,953	90	2	0	6,661
Airbus A321	A321	C-III	2,619	562	1,510	74	1	3	4,769
Bombardier CRJ-900	CRJ9	C-III	1,883	328	1,483	51	1	0	3,746
Boeing 737-900	B739	D-III	1,727	313	889	25	1	0	2,955
McDonnell Douglas MD-83	MD83	D-III	1,560	298	760	135	0	0	2,753
McDonnell Douglas MD-90	MD90	C-III	1,223	248	1,111	53	1	0	2,636
Boeing 757-200	B752	C-IV	963	202	793	433	1	1	2,393
Cessna 208 Caravan	C208	A-II	111	42	477	495	682	288	2,095
Embraer 170	E170	C-III	1,102	309	557	54	0	1	2,023
Beechcraft King Air 90	BE9L	B-II	885	212	725	50	43	24	1,939
Cessna Citation CJ1	C525	B-I	887	192	539	47	171	29	1,865
Beechcraft King Air 200	BE20	B-II	901	189	567	41	89	41	1,828
Pilatus PC-12	PC12	A-II	596	108	565	24	308	81	1,682
Cessna Citation Excel	C56X	B-II	873	183	463	17	76	16	1,628
Bombardier CRJ-700	CRJ7	C-II	875	190	438	27	0	0	1,530
Cessna Citation Sovereign	C680	B-II	697	143	360	15	170	56	1,441
Beechcraft 1900	B190	B-II	66	18	397	406	335	210	1,432
Beechcraft Hawker 800	H25B	C-II	742	157	404	19	59	11	1,392
McDonnell Douglas MD-11	MD11	D-IV	600	103	473	199	2	0	1,377
Bombardier Challenger 300	CL30	C-II	822	153	250	17	27	17	1,286
Embraer Phenom 300	E55P	B-II	685	134	350	39	26	8	1,242
Embraer Phenom 100	E50P	B-I	573	83	500	29	31	8	1,224
Cirrus SR22	SR22	A-I	450	89	347	21	203	65	1,175
Cessna Citation Encore	C560	B-II	580	111	358	23	50	24	1,146
Cessna Citation CJ4	C25C	B-II	378	87	409	24	165	29	1,092
Cessna Citation II	C550	B-II	455	84	396	27	69	18	1,049

Aircraft			Runway						Total
			13R	31L	4	22	13L	31R	
Cessna Citation X	C750	B-II	580	106	258	26	19	3	992
Gulfstream V	GLF5	D-III	513	114	236	17	23	14	917
Beechcraft Beechjet 400	BE40	B-I	477	103	301	23	8	4	916
Raytheon/Beech Beechjet 400/T-1	BE40	B-I	477	103	301	23	8	4	916
Beechcraft King Air 350	B350	B-II	394	93	312	21	68	22	910
Fairchild Merlin 3	SW3	B-I	322	74	417	13	23	13	862
Gulfstream IV	GLF4	D-II	512	95	197	17	4	1	826
Bombardier Learjet 45	LJ45	C-I	415	76	303	12	13	3	822
Embraer 190	E190	C-III	389	85	297	15	1	0	787
Boeing 727-200	B712	C-III	350	64	346	4	0	0	764
Other			11693	2460	7410	1040	2575	806	25,984
Total Aircraft Operations*			**72,378**	**14,773**	**49,805**	**4,505**	**5,268**	**1,810**	**148,539**

Sources: San Antonio International Airport, *Airport Noise and Operations Monitoring Systems*, September 2018-August 2019; WSP USA, 2019.

*ANOMS captures the majority of aircraft operations, but actual total airport operations are slightly higher

San Antonio Airport System
Strategic Development Plan

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2.13 TERMINAL CONCESSION ANALYSIS

As part of the inventory phase of the City of San Antonio Aviation Department's (City or Aviation Department) Strategic Development Plan (SDP) for the San Antonio International Airport (SAT), a comprehensive terminal concessions analysis was conducted. The primary objectives of this analysis include the following:

- Identifying the existing terminal concession revenue sources
- Comparing SAT to similar airports
- Identifying shortfalls in the existing concessions program
- Developing projections of future space needed to maintain and increase terminal concessions revenue in the future

2.13.1 CONCESSIONS PROGRAM OVERVIEW

SITUATIONAL ANALYSIS

This section is intended to provide a comprehensive review of SAT's current concession program. This is an important first step to understanding of SAT's current conditions and assessing potential for future concession opportunities.

Additionally, through examination of the types of products and locations of facilities, we are better able to identify opportunities for expanding and/or enhancing service and revenue productivity. To accomplish this objective, existing concession program was analyzed through a review of current concession gross sales and rent revenue, airline activity data, and traffic projections on the relevant planning horizon.

PERFORMANCE MEASURES

Gross Sales for each major concession category are examined. Gross Sales are reviewed in terms of total sales per category, sales per square foot per category (SPSF), and sales per enplaned passenger (SEP) for calendar years (CY) 2014 through 2018[1].

In addition, the amount of concession space relative to enplanements was reviewed. SEP, SPSF, and relative concession space (described below as the Space Utilization Factor or SUF) are some of the ratios that are important to the quantitative evaluation of concession performance, and should be used in conjunction with each other. Used alone, these ratios cannot provide an accurate assessment of a concessions program and, in fact, may at times be misleading when used independently.

SEP reflects the extent to which passengers choose to take advantage of concession opportunities. A high level of SEP is a positive indicator of concession performance. However, SEP must be analyzed in

[1] Except where otherwise noted, all years presented in this section are in calendar year versus fiscal year, which ends on September 30th each year.

conjunction with relative concession space to properly assess the performance and efficiency of concessions.

The Space Utilization Factor (SUF) represents the amount of concession square footage that is allocated for every one thousand annual enplaned passengers. A high SUF indicates that concessions are well-sized relative to the number of enplanements. However, when a high SUF is accompanied by a low SEP statistic, concessions are not operating effectively and may be oversized relative to enplanement levels. When the SUF is low and SEP is high, the opposite is generally true; concessions are undersized. A robust concession program should ideally have a balanced SEP and SUF ratio, which indicates an effective or an optimized operation.

SPSF is a measure of the productivity that a concession program generates through its concession space. In general, a high level of SPSF is desirable, indicating an efficient use of space. However, a SPSF significantly greater than comparable locations may indicate that a facility is undersized.

Additional concession space may be necessary to reduce congestion, serve more customers, and ultimately increase sales, rental revenues, and customer satisfaction. Conversely, low SPSF may indicate several deficiencies, including problems related to facility design, merchandise mix, customer service, visibility, size, and/or location.

The following discussion reviews these statistics, specifically within the context of each terminal area which has distinct passenger volumes. Therefore, when calculating SEP, it would be inaccurate to use enplanement figures for the entire airport when only those passengers exposed to the terminal facilities will have an opportunity to make purchases.

Total enplanements at SAT grew at a compound annual growth rate (CAGR) of 3.7 percent from 2014 to 2018 (Table 1). In 2018, enplanements reached over 5.0 million passengers. The two largest airlines operating at SAT (based on passenger volume) are Southwest, who operates exclusively in Terminal A and American Airlines, who operates from both Terminal A and B.

Table 1 | Summary of Enplanements by Terminal (Calendar Year)

Enplanements	2014	2015	2016	2017	2018
Terminal A[1]	2,828,558	2,787,314	2,950,293	3,036,589	3,570,437
Terminal B[1]	1,359,095	1,466,853	1,355,847	1,485,022	1,458,348
Total Airport[2]	**4,187,653**	**4,254,167**	**4,306,140**	**4,521,611**	**5,028,785**
International[1]	174,683	194,413	174,729	185,692	208,263

Source: SAAS; Compiled by Unison

[1] Full calendar-year terminal-level enplanement allocations for 2017 based on January - November 2017 enplanement allocation provided in RFP 18-014.
[2] Full calendar-year terminal-level enplanement allocations for 2018 based on percentage allocations provided Department staff.

OVERVIEW OF CONCESSIONS

The City of San Antonio, Department of Aviation (City) currently utilizes a hybrid management approach for terminal concessions. Lease agreements are in effect with both prime operators and individual concessionaires. In 2018, the City had nearly 30 separate terminal concessions lease agreements: the two largest agreements are held by HMS Host, which operates the majority of food and beverage concessions and World Duty Free, which operates several retail shops.

Last year, the City issued a request for proposals (RFP) to develop and operate approximately 10,000 square feet (SF) of concessions in Terminal A. The selected respondent, Paradies Lagardère, will bring a variety of new concepts to the program including The Luxury from local chef Andrew Weissman, Smoke Shack BBQ and Southern Kitchen, Boss Wood Fired Bagels and Coffee, Sip Brew Bar and Market, and Local Coffee, as well as retail outlets such as the Spurs Store, Adina's Market, and an iStore.

The current concession program includes nearly 37,000 SF, which is comprised of support space and approximately 50 individual concession facilities. Food and beverage concessions comprise the majority of concessions space (54 percent) with 20 individual food offerings such as: casual dining restaurants, quick service restaurants, coffee, and walk away snacks (Figure 1). News and gift stores comprise 19 percent of concessions space with six locations. Additionally, there are 11 specialty shops, which occupy 21 percent of the total concessions space. There is one duty free store that occupies 3 percent of total space. Services account for the remaining 3 percent of concession revenue-generating space.

Figure 1 | Breakdown of Concession Space

As illustrated in Table 2, total concession Gross Sales at SAT in 2018 were approximately $48.2 million and Rent Revenues ("rent paid") were $7.4 million, representing an effective rental rate of 15.4 percent of gross sales. Gross Sales from food and beverage concessions increased from $21.2 million in 2014 to

$28.8 million in 2018 (Table 2). Gross Sales from retail (news and specialty) shops increased from $15.7 million in 2014 to nearly $17.3 million in 2018. Services generated almost $0.5 million in concession revenue.

Table 2 | Summary of Gross Sales and Rent Revenues

Category	2014	2015	2016	2017	2018	Rent Paid 2018	Effective Rent
Food & Beverage	$21,196,065	$22,069,311	$24,259,897	$25,786,712	$28,845,204	$3,949,271	13.7%
Specialty Retail	$8,482,530	$8,164,520	$7,715,158	$8,405,870	$9,011,786	$1,357,702	15.1%
News & Gifts	$7,224,195	$6,994,177	$7,052,820	$7,467,169	$8,271,198	$1,584,794	19.2%
Total Retail	$15,706,725	$15,158,697	$14,767,978	$15,873,039	$17,282,985	$2,942,496	17.0%
Duty Free	$2,170,211	$2,341,117	$1,696,410	$1,621,312	$1,610,584	$500,000	31.0%
Services	$577,723	$569,050	$511,764	$488,368	$448,579	$43,661	9.7%
Grand Total	**$39,650,724**	**$40,138,175**	**$41,236,049**	**$43,769,431**	**$48,187,351**	**$7,435,428**	**15.4%**

Source: Department Records; Compiled by Unison.

SUMMARY OF FINDINGS

Overall, concessions Gross Sales at SAT have grown consistently since 2014, rising at a CAGR of 4.0 percent. However, on a per enplanement basis sales have been flat: SEP increased at a CAGR of 0.2 percent from $9.47 in 2014 to $9.58 in 2018. In 2018, Rent Revenues (rent paid) per enplanement was $1.48. Table 3 presents a summary of gross concession sales by terminal and category and Table 4 presents historical estimated concessions gross sales per enplanement.

With respect to concessions by terminal, Gross Sales for Terminal A's concessions mirrored the overall airport growth rate: Gross Sales were almost $33 million in 2018, growing at a CAGR of 4.0 percent since 2014. However, SEP growth was generally flat, declining at a annual rate of 0.7 percent. Duty free sales on Terminal A decreased at a annual rate of nearly 6 percent or by 9 percent on a per international enplanement basis. With new locations and concepts being developed on Terminal A, concessions Gross Sales in this terminal are expected to increase at a higher rate. However, it is important to note with only one duty free store at the airport and international enplanements projected to grow substantially in the near term, additional concessions may need to be considered to accommodate demand.

Gross Sales for Terminal B's concessions also mirrored the overall airport growth rate: Gross Sales were over $14 million in 2018, growing at a CAGR of 4.3 percent since 2014. SEP growth for Terminal B has been steady during this time, rising at a CAGR of 2.8 percent. Food and beverage SEP increased by 4.6 percent, while retail SEP grew slightly at a CAGR of 0.6 percent.

Table 3 | Summary of Gross Sales by Terminal

Terminal/Category	2014	2015	2016	2017	2018	CAGR
Terminal A						
Food & Beverage	$14,951,109	$15,348,708	$17,336,200	$17,885,146	$20,464,489	6.5%
Specialty Retail	$5,756,797	$5,424,278	$5,262,021	$5,625,148	$5,956,851	0.7%
News & Gifts	$4,087,378	$3,942,866	$4,155,523	$4,272,120	$4,876,629	3.6%
Duty Free	$2,170,211	$2,341,117	$1,696,410	$1,621,312	$1,610,584	-5.8%
Total Terminal A	**$26,965,495**	**$27,056,970**	**$28,450,154**	**$29,403,727**	**$32,908,552**	**4.1%**
Terminal B						
Food & Beverage	$6,244,956	$6,720,603	$6,923,696	$7,901,566	$8,380,716	6.1%
Specialty Retail	$2,282,227	$2,367,553	$2,115,712	$2,392,346	$2,601,968	2.7%
News & Gifts	$3,136,817	$3,051,311	$2,897,297	$3,195,049	$3,394,570	1.6%
Total Terminal B	**$11,644,000**	**$12,139,467**	**$11,936,705**	**$13,488,962**	**$14,377,254**	**4.3%**
Specialty Vending	$443,506	$372,688	$337,426	$388,375	$452,967	0.4%
Services	$577,723	$569,050	$511,764	$488,368	$448,579	-4.9%

Source: Department Records; Compiled by Unison.

Table 4 | Historical Estimated Generated Aviation Enplanements

Terminal/Category	2014	2015	2016	2017	2018	CAGR
Terminal A						
Food & Beverage	$5.29	$5.51	$5.88	$5.89	$5.73	1.6%
Specialty Retail	$2.04	$1.95	$1.78	$1.85	$1.67	-3.9%
News & Gifts	$1.45	$1.41	$1.41	$1.41	$1.37	-1.1%
Duty Free	$12.42	$12.04	$9.71	$8.73	$7.73	-9.0%
Total Terminal A	**$9.53**	**$9.71**	**$9.64**	**$9.68**	**$9.22**	**-0.7%**
Terminal B						
Food & Beverage	$4.59	$4.58	$5.11	$5.32	$5.75	4.6%
Specialty Retail	$1.68	$1.61	$1.56	$1.61	$1.78	1.2%
News & Gifts	$2.31	$2.08	$2.14	$2.15	$2.33	0.2%
Total Terminal B	**$8.58**	**$8.28**	**$8.80**	**$9.08**	**$9.86**	**2.8%**
Specialty Vending	$0.11	$0.09	$0.08	$0.09	$0.09	-3.2%
Services	$0.14	$0.13	$0.12	$0.11	$0.09	-8.4%
All Concessions	**$9.47**	**$9.44**	**$9.58**	**$9.68**	**$9.58**	**0.2%**

Source: Department Records; Compiled by Unison.

At approximately 35,000 SF (not including storage/support space), the overall size of SAT’s concession program measured as a SUF of 6.96 SF per 1,000 enplaned passengers in 2018 (Table 5Table 1). As will be shown in the Comparative Airport Analysis subsection, this figure is below the average concessions area for SAT’s peer airport group and below the generally accepted industry “rule of thumb” minimum space requirements of 8.0 SF per 1,000 passengers.

On a category level, SAT's Food & Beverage program area measured as a SUF of 3.77, while the Total Retail program (Specialty Retail and News & Gift) measured as a SUF of 2.97.

Table 5 | Summary of Concessions Space by Category

Concessions Category	Current SF/1,000 Eps (SUF)	Current Program
Food & Beverage		
Terminal A	3.45	12,307
Terminal B	4.55	6,634
Total Food & Beverage	**3.77**	**18,941**
Retail		
Terminal A	2.73	9,744
Terminal B	3.57	5,210
Total Retail	**2.97**	**14,954**
Duty Free	5.20	1,082
Total Concessions Program	**6.96**	**34,977**

Source: Department Records; Compiled by Unison.

Gross Sales, SPSF at SAT have also grown at a steady rate since 2014, increasing by a CAGR of 4.5 percent (slightly outpacing pure sales growth during this time due to the unoccupied Blimpie's space in 2018). Program-wide SPSF reached $1,360 in 2018 (Table 6).

At a terminal level, SPSF for Terminal A (excluding Services and Automated Retail) reached $1,472 in 2018 and have grown at a CAGR of 5.0 percent since 2014. Food & Beverage SPSF grew at a CAGR of 8.3 percent, while as shown above in the Gross Sales reporting, the retail categories grew at lower rates, even contracting in the case of Duty Free.

SPSF for Terminal B (excluding Services and Automated Retail) reached $1,214 in 2018. The program has remained consistent in unit size and concepts since 2014, SPSF growth rates across all categories mirror the Gross Sales growth rates for this terminal, combining for a CAGR of 4.5 percent over the five-year span. Upon initial review, it may appear that the steady growth in SPSF is ideal. However, when combined with the lack of growth in SEP and a below average SUF, these statistics indicate an opportunity for additional concessions revenue growth.

Table 6 | Summary of Sales Per Square Foot by Terminal

Terminal/Category	2014	2015	2016	2017	2018	CAGR
Terminal A						
Food & Beverage	$1,251	$1,284	$1,451	$1,497	$1,864	8.3%
Specialty Retail	$990	$932	$905	$967	$1,024	0.7%
News & Gifts	$1,057	$1,020	$1,075	$1,105	$1,261	3.6%
Duty Free	$1,286	$1,387	$1,005	$960	$954	-5.8%
Total Terminal A	**$1,156**	**$1,160**	**$1,220**	**$1,261**	**$1,472**	**5.0%**
Terminal B						
Food & Beverage	$941	$1,013	$1,044	$1,191	$1,263	6.1%
Specialty Retail	$1,035	$1,073	$959	$1,084	$1,179	2.7%
News & Gifts	$1,044	$1,016	$964	$1,064	$1,130	1.6%

Total Terminal B	**$985**	**$1,025**	**$1,008**	**$1,139**	**$1,214**	**4.3%**
Specialty Vending	$3,759	$3,158	$2,860	$3,291	$3,839	0.4%
Services	$517	$509	$458	$437	$401	-4.9%
All Concessions	**$1,089**	**$1,103**	**$1,133**	**$1,202**	**$1,360**	**4.5%**

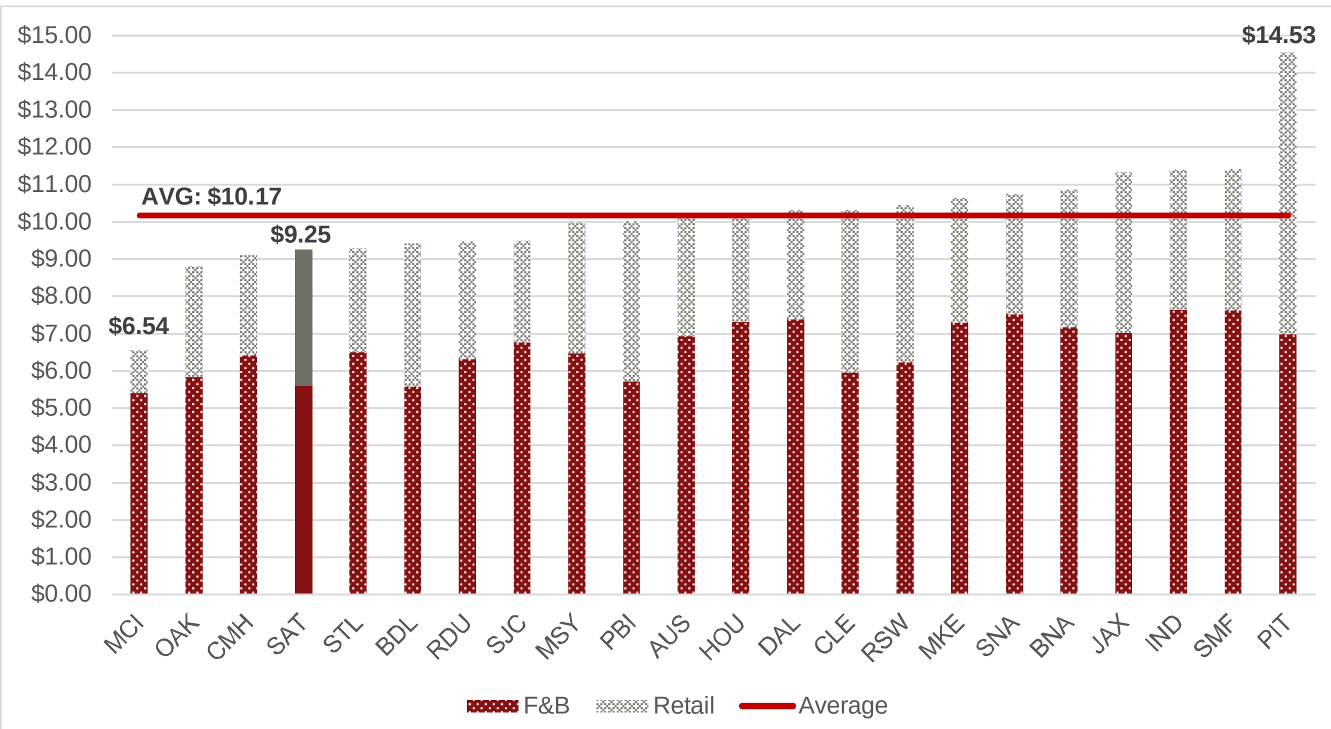
Source: Department Records; Compiled by Unison.

COMPARATIVE AIRPORT ANALYSIS

To benchmark SAT's concessions program to other airports, concession programs at 21 medium hub airports with similar characteristics to SAT were reviewed. Calendar year 2017 statistics at comparative airports, which represent the most current available information, were compared to 2017 statistics for SAT.

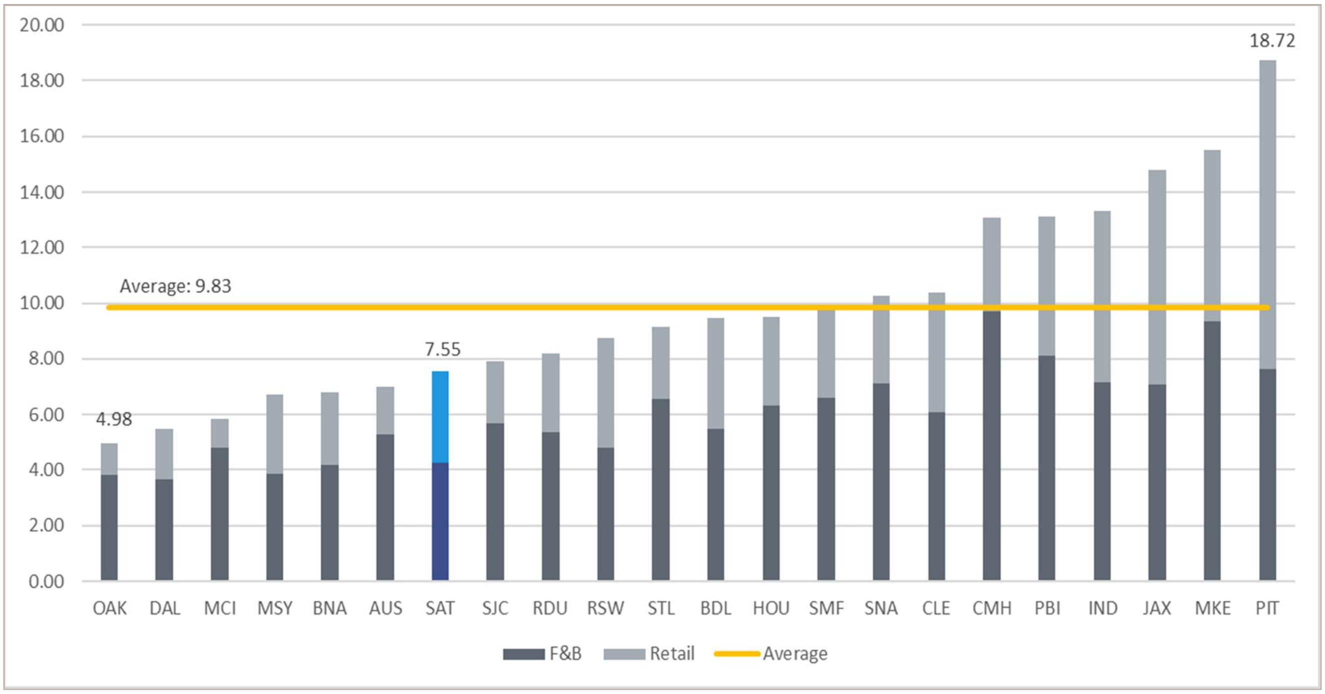
Total concessions sales range from $6.54 per enplaned passenger at Kansas City International Airport (MCI) to $14.53 at Pittsburgh International Airport (PIT). In comparison to these airports, SAT's concession program is operating below the average of $10.17 per enplaned passenger. 2017 SEP at SAT were $9.25, which is on the lower end of the range and below the average of comparative airports.

Figure 2 | 2017 Sales Per Enplanement Comparison



The analysis reviewed and compared 2017 SUF data of concession space for comparable airport groups. PIT has the largest relative concessions program, allocating approximately 18.72 SF for every 1,000 enplanement passengers (Figure 3) in 2017. In contrast, Oakland International (OAK) has the smallest program at 4.98 SF for every 1,000 enplaned passengers. SAT's program allocated 7.55 SF per 1,000 enplaned passengers in 2017, well below the average of comparative airports (9.83).

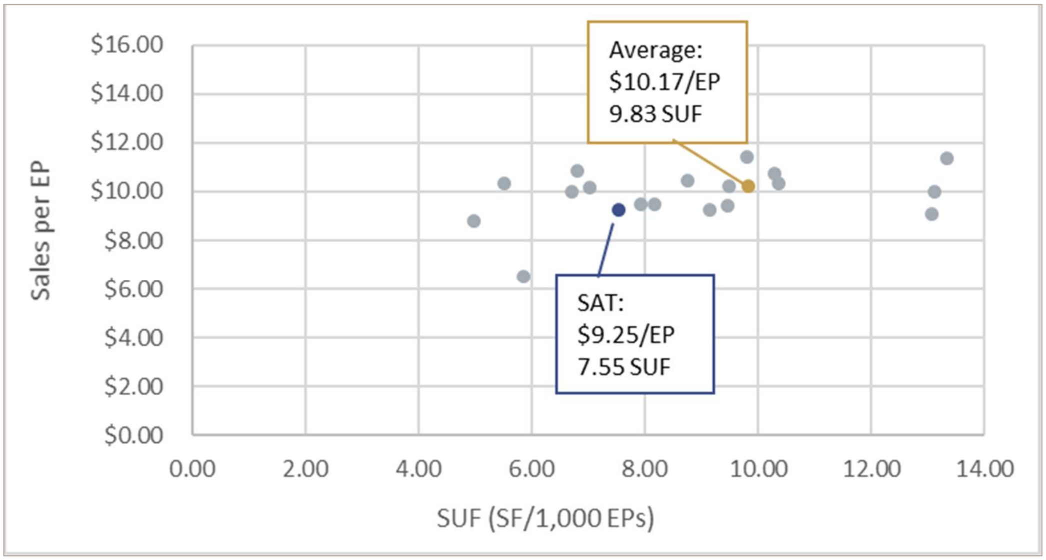
Figure 3 | 2017 Relative Program Size Comparison



2017 AIRPORT CONCESSIONS STATISTICS

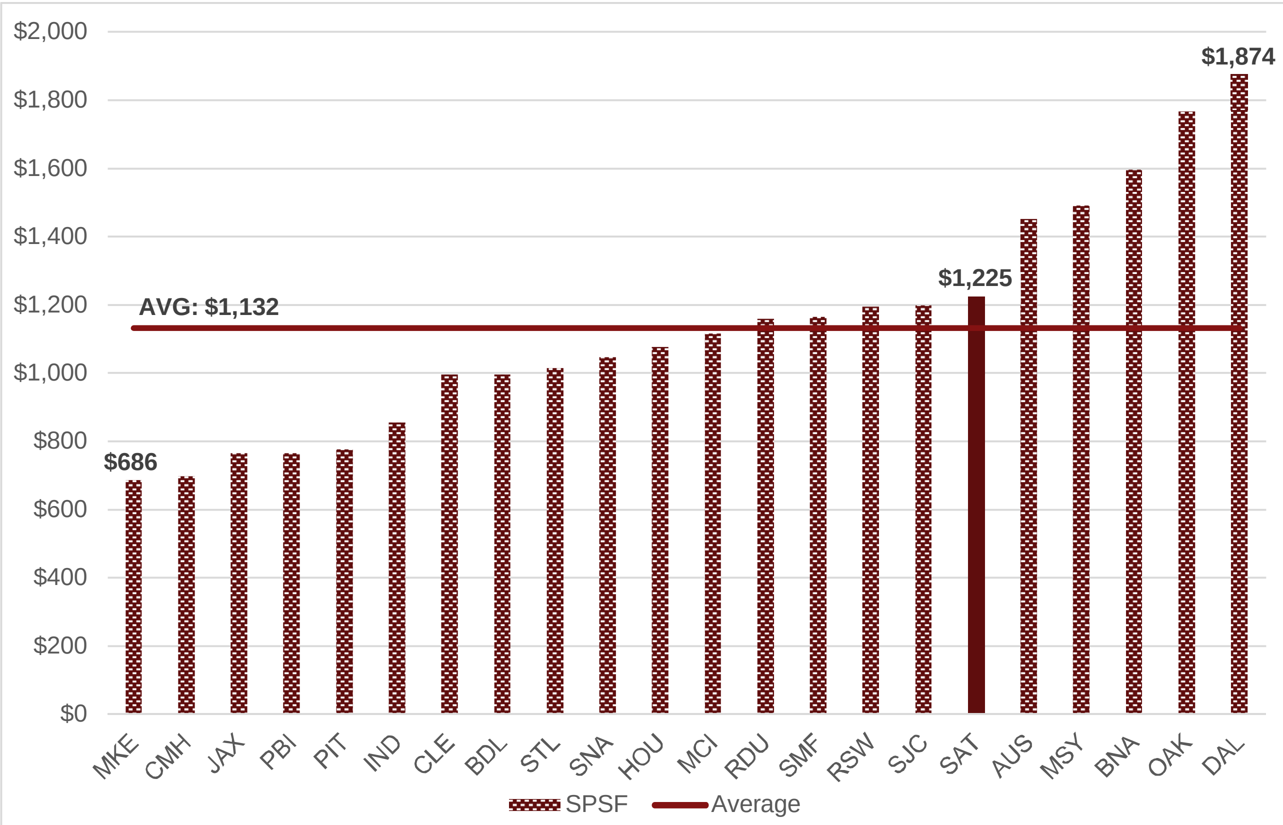
SEP compared to SUF ratio is a key statistic in assessing the effectiveness of concessions programs. As shown on Figure 4, SAT's current concessions program is not operating at an effective level –the SEP is lower than the average of comparative airports and the SUF is also below the average of other airports. This ratio indicates the concessions program is under-sized relative to enplanements and that enhancements are required to the overall program

Figure 4 | 2017 Sales Per Enplanement to Area Ratio Comparison



To further compare the productivity of SAT's concessions space relative to its peer airport group, the 2017 SPSF data were reviewed and compared for the respective airport set (Figure 5). Based on 2017 sales and square footage statistics, SAT's combined food and beverage and total retail SPSF of $1,225 is above the group average of $1,132. As mentioned previously, a high SPSF is not necessarily ideal when SEP and the SUF is below the average of comparative airports

Figure 5 | 2017 Sales Per Square Foot Comparison



SUMMARY OF FINDINGS

The program overview and comparative airport analysis reveal that the SAT concession program, as a whole, is underperforming and could improve in both sales and revenue generation performance. SAT's SEP is below the average of comparable airports, and the program is also undersized relative to enplanement levels. Following are some additional notes and observations generated from the analyzed data and via in-terminal visits:

- SEP statistics reveal that the Terminal B program has been performing at a higher level than Terminal A. While overcrowding of locations due to Terminal A's higher volume of passengers and shortage of concessions space plays a significant role in this underperformance, further analysis (addressed in Section 3) indicates that the Terminal B passenger profile likely presents a greater concessions-spending opportunity compared to the Terminal A passenger.
- An additional factor of the more efficient performance of the Terminal B concessions program is the amount of concessions area available to passengers. Terminal B's 2018 SUF measured at 8.12 SF per 1,000 enplanements, which on a terminal basis places the size of the program within suitable levels per generally accepted industry standards. Terminal A's 2018
- SUF measured 6.48, well below the same generally accepted minimum industry standard of 8.0 SF per 1,000 enplanements.

- It is important to note that the concessions in Terminal A awarded to Paradies includes 1,000 additional SF of space, which should improve Terminal A's SEP performance due to new concepts and additional spending opportunities for passengers.
- SAT's SPSF statistics show that the airport's concessions space productivity is on the high end (particularly as compared to the peer airport group), but combined with a below average SEP and low SUF these statistics indicate the program is undersized and can generate further sales productivity from its space.
- As enplanement traffic increases, it is important to re-assess the needs of the traveling market to ensure that current concepts, particularly with respect to specialty retail concessions, meet passenger needs

2.13.2 TERMINAL CONCESSION PROGRAM REQUIREMENTS

REVIEW OF TERMINAL PLANS AND DESIGNS

To develop the baseline programming requirements for the concession program, the existing terminal design was reviewed to understand how the current layout may impact sales and revenue productivity. This analysis included a review of SAT's current passenger traffic conditions and flows in the terminal area – the volume and type of passengers and where they congregate. This is an important exercise to help identify how current concession locations meet passenger demands.

SAT is comprised of two terminals: Terminal A and B. Terminal A has 16 gates and is comprised of five sections: North Concourse, South Concourse, Central, Pre-Security, and Baggage Claim. Terminal B has eight gates, and as a smaller concourse, only includes one post-security area along with Pre-Security and Baggage Claim areas. As outlined in the previous section, the overall concessions program at SAT is undersized relative to its comparison airport set, which on a holistic level is impacting Gross Sales and Rent Revenue performance (as the program's SEP is also below that of its peer airport group). The following section will offer a review and analysis of the existing program design on a terminal level in order to determine more specific details regarding how the current layout is impacting Gross Sales and Rent Revenue productivity.

However, prior to the terminal-level analysis, the following brief section offers overarching industry design and layout principles that generally guide our concessions program layout and design planning recommendations.

CONCESSION PLANNING OBJECTIVES

The allocation and configuration of concessions space is based largely on several key retail space planning objectives. These goals are designed to maximize a passenger's exposure to concessions and are achieved by locating shops and restaurants in optimal areas of the terminal. To create a premier concessions program, enhance customer satisfaction, and optimize revenues for both the operators and Airport, Unison uses the following guidelines to program space within terminal complexes:

- Concessions space should be in areas of the terminal that provide optimum exposure - visibility and accessibility – to the maximum number of passengers, well-wishers, and greeters.
- Concessions space should be clustered together and double-loaded where possible (located on both sides of the terminal across from one another) in specific areas of the Airport which are accessible and visible by the greatest majority of passengers.
- The total size, location and variety of concessions categories (e.g. food & beverage, specialty retail, and news & gifts) should form a critical mass, which attracts passengers to the area and communicates a sense of place.
- The location of retail areas (including remote storage) should allow tenants to operate efficiently and easily access delivery and storage areas.
- Passengers generally prefer concessions located airside (after security screening) over those located landside (before security screening). Research has shown that passengers spend less time at landside concessions than airside concessions. This pattern is attributed to greater passenger anxiety concerning the time it will take to pass through security and locate the proper gate. Once passengers complete ticketing, baggage checking and security, they tend to be more relaxed and are more willing to browse, eat and shop.

These objectives help establish distinct retail zones within the Airport and promote buying. The clustering of concessions to create a critical mass communicates to passengers that this is a prime retail area in which to shop and dine. When concessions are spread out, passengers will tend to speculate about where the next shopping or dining choice will be and continue walking. When distinct concessions zones are created, a passenger can be confident that their needs will be fulfilled within this zone, dwell time in the zone increases, and impulse buying is facilitated.

CONCESSIONS PROGRAM DESIGN RATING MATRIX

In order to provide a concise review and analysis of the design of SAT's concessions program, Unison created a matrix of categories and ratings based on the concessions design planning objectives discussed above (Table 7). Both Terminal A and Terminal B were rated individually in seven different categories. The scores for each terminal are then averaged to create an overall rating for each terminal's program.

Based on several data-driven and observed elements of the concession program's layout and design, Terminal A received a score of 2.3 (on a 1 to 5 rating scale where 1 equals "Poor" and 5 equals "Ideal"), rating the program nearest to "Inadequate" on the scale. Terminal B received a score of 4.0, rating as "Good" regarding program layout and design.

Following Table 1Table 7 are some notes and observations to support the rankings presented therein.

Table 7 | Concessions Program Design Rating Matrix

Category/Characteristic	Terminal A	Terminal B
Majority of space is airside with basic services landside	5	5
Visibility is ideal - in main walking path of passengers	3	4
Concessions are clustered and centralized in blocks of space, exposed to majority of passenger	2	4
Double loaded space - concessions are found on both sides of concourse	1	4
Total size, placement and variety of program creates a critical mass of shopping opportunity	2	3
Revenue generating space is sufficient for passenger demand	1	4
Adequate amount of support space for efficient operation*		
Terminal Average Score	**2.3**	**4**

* Existing support space is unknown. Ideally, support space totals should represent 15 percent of revenue generating space.

Legend:
1 Poor
2 Inadequate
3 Adequate
4 Good
5 Ideal

TERMINAL A

- As noted in earlier, with a SUF of 6.48, the Terminal A concessions program is significantly short of the concessions space needed to ideally meet passenger demand, making the creation of robust concessions zones difficult.
- While 61 percent of Terminal A’s concessions space is located in the “Central Zone” of the terminal and theoretically exposed to the optimal number of passengers, congestion and visual impediments create challenges in regard to the ability to create the ideal critical mass.
- Due to the narrow concourse design structure, the terminal is not conducive to double-loading of concession space, further compromising the ability to cluster concessions into distinctive retail zones.

TERMINAL B

- With an SUF of 8.12, Terminal B has adequate levels of concessions space to meet passenger demand. This is reflected in the SEP performance of the program, which has increased at a CAGR of 2.8 percent since 2014.
- The singular traffic flow of passengers to the right after the security checkpoint creates optimal exposure for the vast majority of concession units in the Terminal.

- The concessions node in the center of Terminal B's concourse is double-loaded and offers multiple categories of merchandise, creating a specific zone of critical concessions mass for passengers.

2.13.3 PASSENGER SURVEY RESULTS

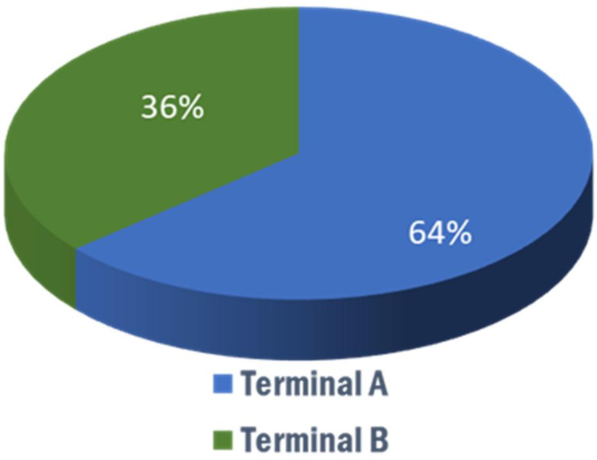
To develop a concessions plan that is specifically tailored to the needs and preferences of SAT's consumer market, a thorough understanding of the passenger profile is critical. This section provides a summary of the key findings from the SAT passenger survey, which answers the following key questions:

- Who are our passengers?
- What are their needs?
- What are their opinions about our concession program?
- What additional choices do our passengers prefer?

SAMPLE METHODOLOGY

In December 2018, 851 passenger surveys were collected at SAT (**Error! Reference source not found.**). The objective was to target at least 400 passengers per terminal to help ensure data can be analyzed with a high level of statistical validity by terminal. Each terminal-level sample produced a margin of error of no greater than ±5 percent at a 95 percent confidence level, which is in line with industry standards. To obtain a representative sample, a stratified random sampling approach was employed that was based on the actual distribution of passengers. Specific targets were established with respect to the proportional breakdown of the sample by terminal and major airline. Using Official Airline Guide (OAG) schedule data, Unison reviewed the number of scheduled seats and departure times for each airline for the selected survey days. To help capture a wide range of passengers, surveys were conducted using a staggered schedule that included early morning and evening flights.

Figure 6 | Survey Sample by Terminal

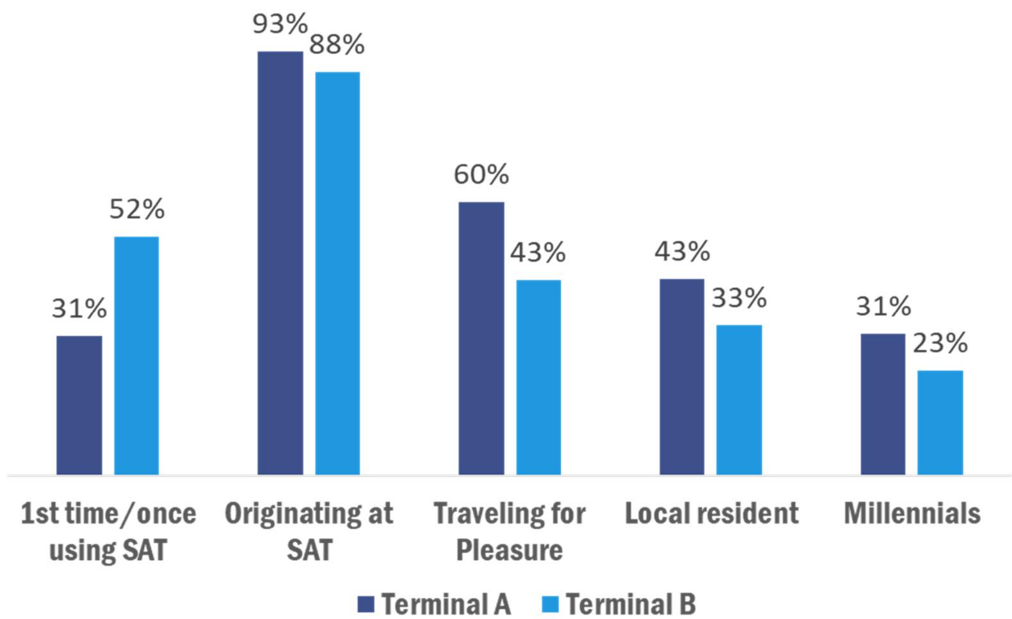


PASSENGER PROFILE

Identification of passenger composition is important because demographic characteristics generally influence passenger behavior and needs at the airport. Some notable findings are detailed below.

- The largest subgroup of passengers are residents, from San Antonio or the surrounding area. As shown in **Error! Reference source not found.** the proportion of residents is greater on Terminal A (43 percent) than on Terminal B (33 percent).
- Twenty-eight percent of all passengers are millennials (aged between 18 to 25). Fewer millennials travel from Terminal B (23 percent) as compared to Terminal A (31 percent).
- The overwhelming majority of passengers are originating at SAT (91 percent of all passengers). There are slightly more originating passengers on Terminal A (93 percent) compared to Terminal B (88 percent).
- Fifty-four percent of passengers are traveling for pleasure/personal reasons and the proportion of these travelers are higher on Terminal A (60 percent) versus (43 percent) on Terminal B.
- The majority of originating passengers on Terminal A have dwell times between one to two hours, while (43 percent) of passengers on Terminal B had dwell times between one to two hours and another (43 percent) had dwell times between two to three hours.
- Layover times were shorter among Terminal A connecting passengers. Thirty percent of connecting passengers on Terminal A had layover times of less than an hour and (38 percent) had layover times of two to three hours. Meanwhile, nearly half of Terminal B passengers had layover times between two to three hours.

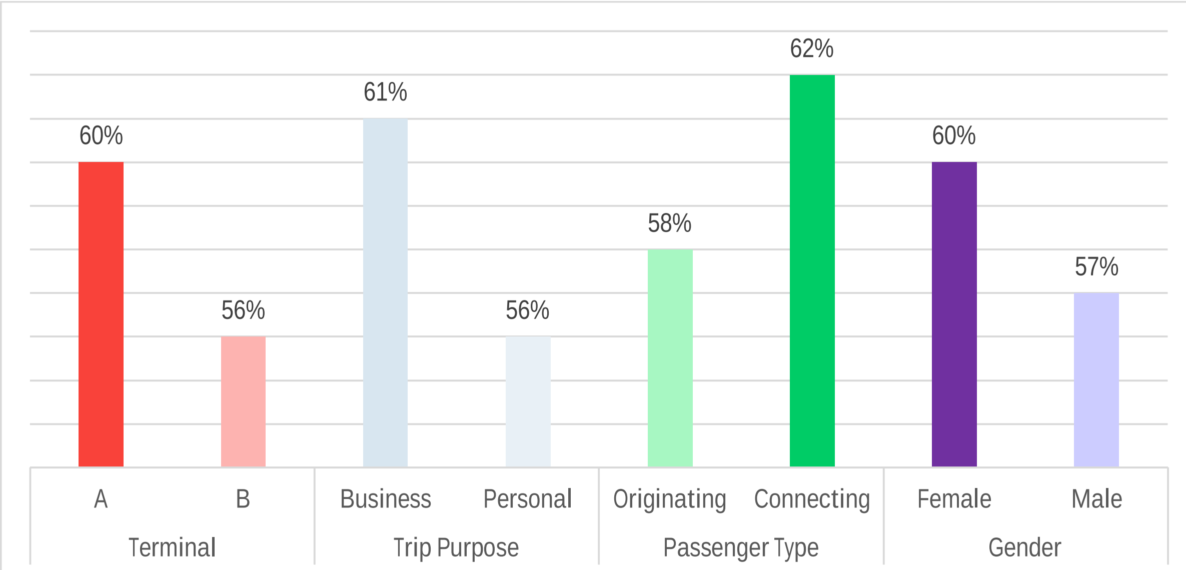
Figure 7 | Summary of Passenger Characteristics



Shopping Behavior

The majority of passengers made a food and beverage purchase (58 percent). Cross tabulation analysis reveals differences in food and beverage purchases among passenger groups: slightly more passengers on Terminal A made a purchase compared to Terminal B passengers. Connecting passengers, business travelers, and female passengers were more likely to make purchases than their counterparts (Figure 8). For passengers who did not make a purchase, 70 percent of passengers said they did not need or want anything as the top reason for not making a purchase.

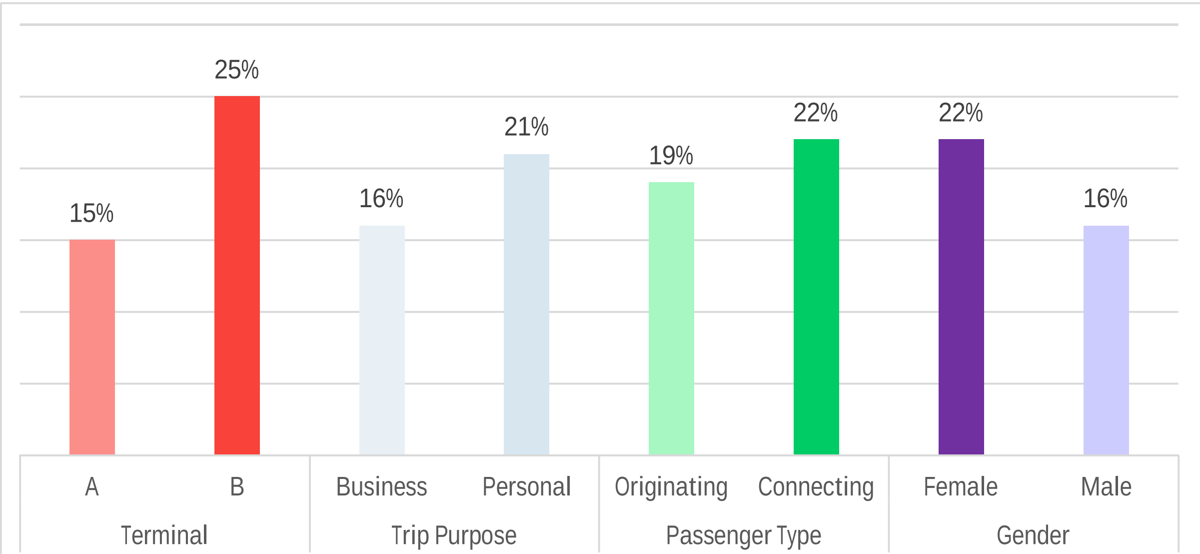
Figure 8 | Food & Beverage Purchases Summary



Significantly fewer passengers made a retail purchase (19 percent). A larger proportion of Terminal B passengers made a purchase (25 percent) compared to Terminal A passengers (15 percent).

Contrary to our findings with food & beverage purchasing behavior, business passengers were less likely than pleasure/personal travelers to purchase retail concessions. However, connecting passengers and female passengers were also more likely to purchase retail concessions compared to their counterparts (Figure 9).

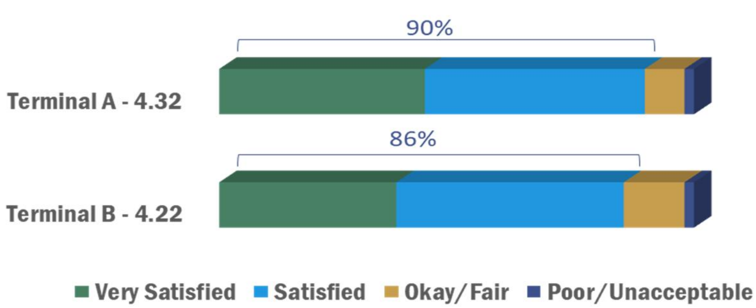
Figure 9 | Retail Purchases by Category



SATISFACTION RATINGS

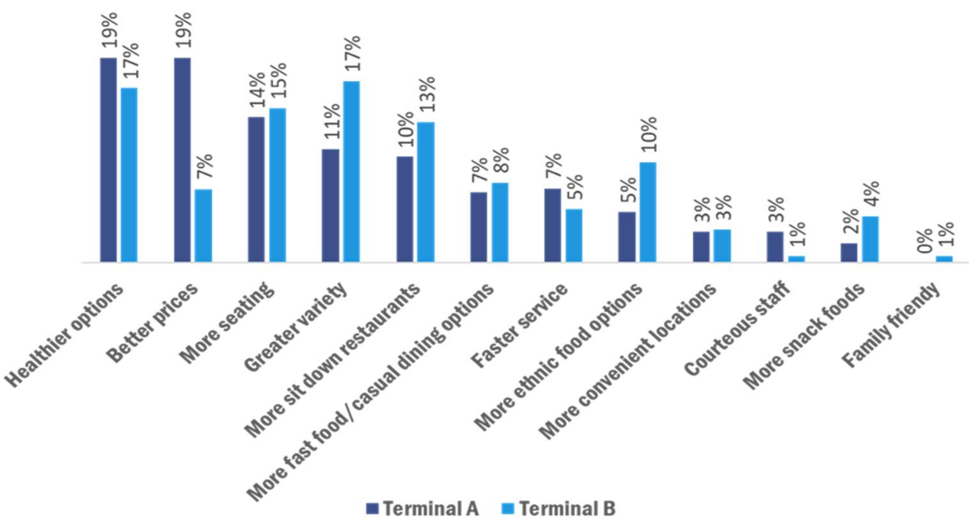
Passengers were asked to rate their overall experience with food and beverage concessions on a scale of 1 (poor) to 5 (very satisfied). Of passengers who made a purchase, 89 percent of passengers are satisfied with food and beverage concessions, giving their experience an average satisfaction rating of 4.29 (out of 5.00). Passengers on Terminal A gave their experience with food and beverage concessions more favorable ratings (4.32) compared to Terminal B passengers who gave their experience a rating of 4.22 (Figure 10).

Figure 10 | Satisfaction with Food & Beverage Concessions



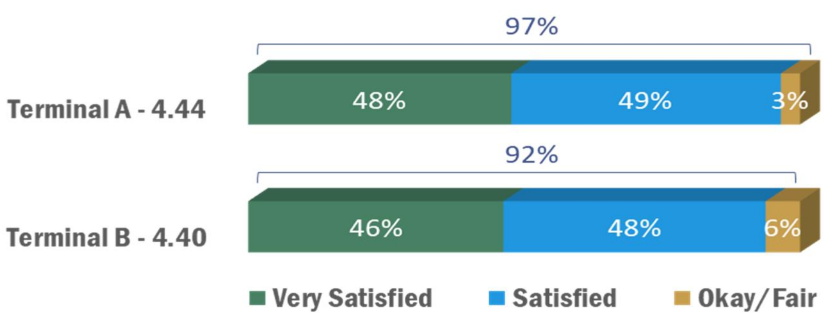
Passengers were also asked to provide responses related to opportunities for SAT to enhance the food and beverage program. Responses varied among terminal passengers: the largest subgroup of Terminal A passengers said better prices is an area of opportunity while Terminal B passengers want greater variety. However, Terminal A and Terminal B passengers both agree healthier options are important (Figure 11).

Figure 11 | Opportunities to Enhance Food & Beverage Experience



The overall satisfaction rating for retail concessions received a high average satisfaction rating of 4.42, with more than 90 percent of passengers who stated they were satisfied or very satisfied with their experience. However, when reviewing cross tabulation data such as satisfaction by terminal (Figure 12), it is important use caution when interpreting the results since the samples are small (n=80 to 86 passengers).

Figure 12 | Satisfaction with Retail Concessions



PASSENGER PREFERENCES

Passengers were asked, “based on your situation today, from where would you most likely make a purchase at the airport?” Fast food/casual dining restaurants are preferred by SAT passengers with more than one-third of these passengers interested in these choices (Figure 13). Within this category the top food choices include sandwiches/deli, chicken, fresh salads, Tex-Mex, and Mexican food (Figure 14). Because pizza and hamburgers are consistently top preferences, as evidenced in other concession surveys and industry studies, these two choices were intentionally excluded from the list of food preferences presented to passengers in the survey. Also notable is Terminal A passengers showed a greater preference for fast food/quick service compared to Terminal B passengers (40 percent versus 28 percent).

Figure 13 | Most Likely to Make a Food & Beverage Purchase

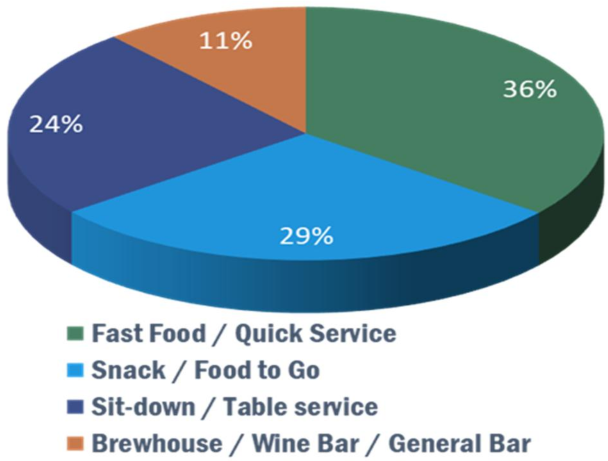
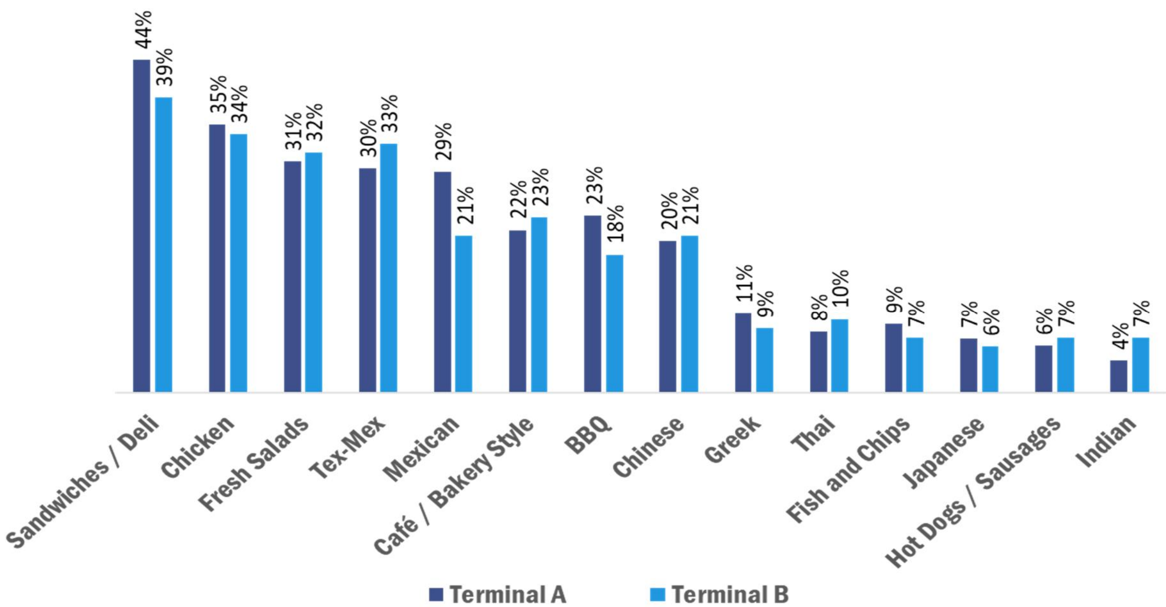
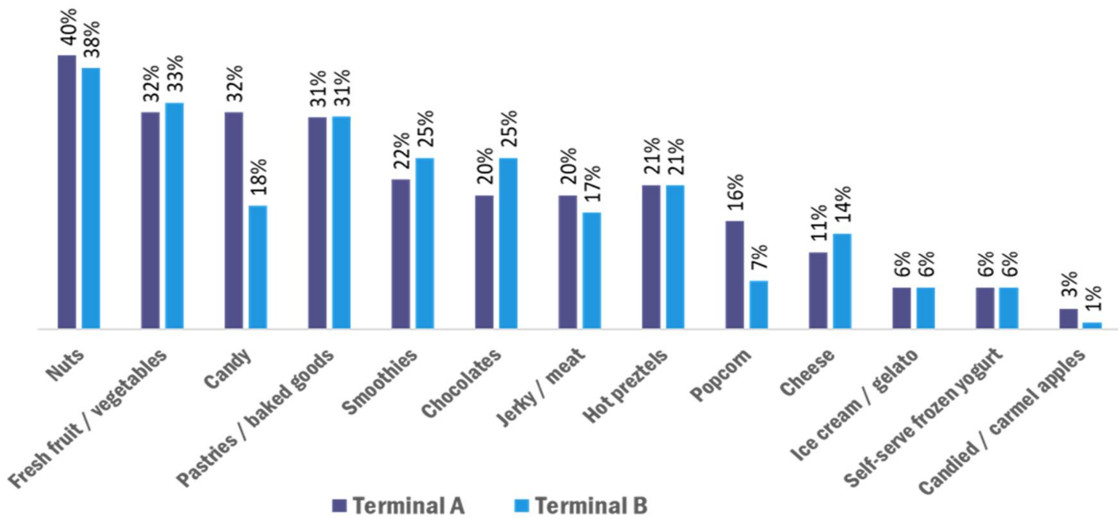


Figure 14 | Top Three Preferences for Fast Food/QSR2



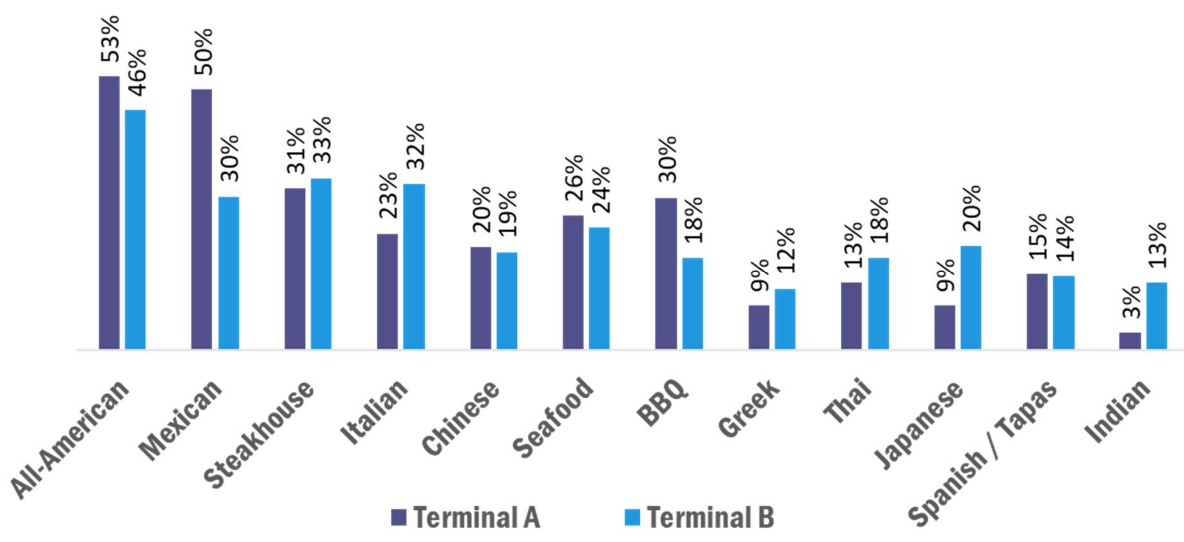
Twenty-nine percent of all passengers prefer snack or food-to-go with nuts, fresh fruit/vegetables, pastries/baked goods, candy, and smoothies as the top choices (Figure 15). Terminal A passengers showed a stronger preference for candy and popcorn and Terminal B passengers had a greater preference for chocolates and cheese. Notably, a larger percent of Terminal B passengers state snack/food to go as their top choice compared to of Terminal A passengers (35 percent versus 25 percent).

Figure 15 | Top Three Snack Choices



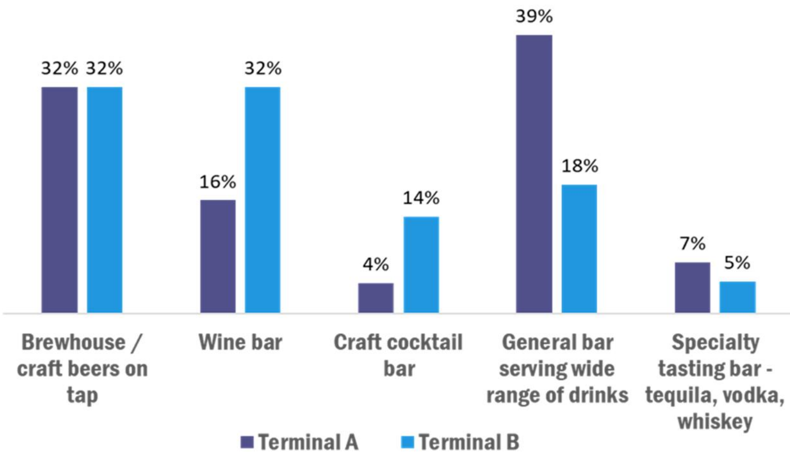
Sit-down / table service restaurants are preferred by 24 percent of all SAT passengers. All American, Mexican, Steakhouse, Italian, and Seafood are top food choices in the sit-down / table service restaurant category. Terminal A passengers showed a strong preference toward All-American, Mexican, Seafood, and BBQ (Figure 16). Meanwhile Terminal B passengers showed a stronger preference for Italian, Greek, Thai, Japanese, and Indian food.

Figure 16 | Top Three Sit Down/Table Service Dining Choices



Eleven percent of passengers selected brew house/wine bar/general bar as their preferred food concession. Almost the same percentage (32-34 percent) of passengers prefer a general bar that serves a wide range of drinks or a brew house with craft beers on tap as their preferred choice in this category. Also notable is passengers on Terminal B have a stronger preference for a wine bar and Terminal A passengers have a stronger preference towards a general bar (Figure 17).

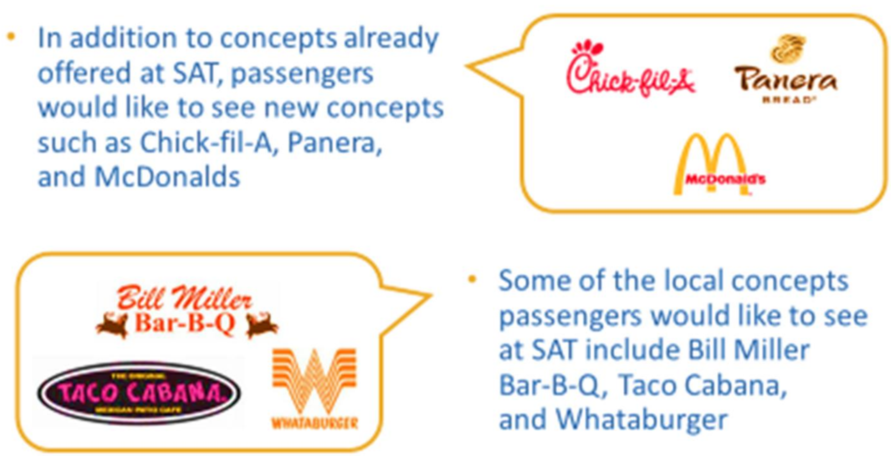
Figure 17 | Preferred Type of Bar



When asked about their preference regarding restaurant concept / brand origin, local / independent restaurants, specifically those unique to San Antonio, received the most responses (39 percent). Thirty-seven percent of passengers did not have a preference or were unsure, and (22 percent) prefer a chain / brand restaurant. Findings among Terminal A and Terminal B passengers were similar.

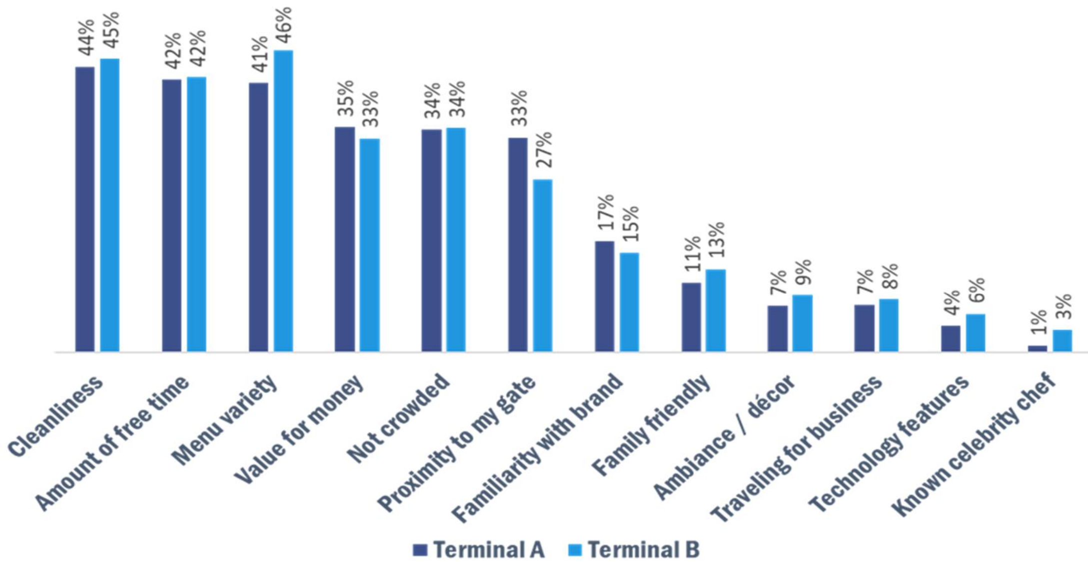
Passengers who preferred local / independent restaurants were asked to indicate what San Antonio eatery they would like to see at the airport. Top choices named by passengers for each category are shown in Figure 18.

Figure 18 | Most Desired Local and National Restaurant Brands



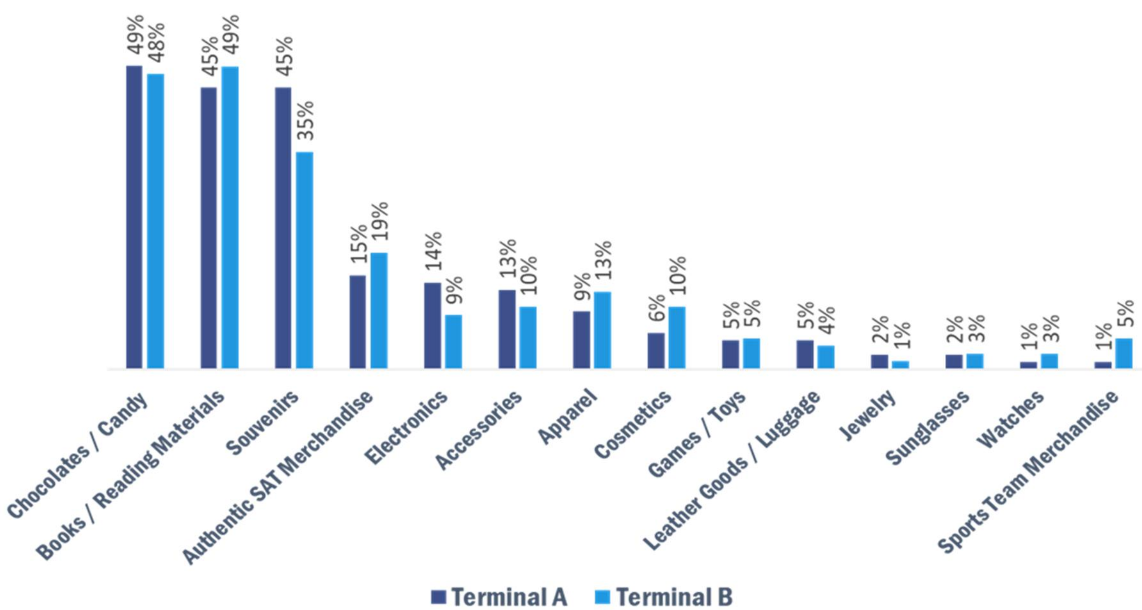
Passengers were asked to indicate the top three considerations when choosing a place to eat at the airport, given the 12 choices provided. Cleanliness, menu variety, and amount of free time were the top responses among all passengers. Passengers on Terminal B preferred menu variety and having a family friendly atmosphere when choosing a place to eat compared to Terminal A passengers (Figure 19). Meanwhile, a larger proportion of Terminal A passengers indicate proximity to gate as being a greater consideration when choosing a place to eat than Terminal B passengers.

Figure 19 | Top Considerations When Choosing a Place to Eat at the Airport



In terms of retail preferences, the top three merchandise preferences include chocolates and candy, books / reading materials, and souvenirs. Notably, Terminal A passengers had a greater preference for souvenirs (45 percent) compared to (35 percent) of Terminal B passengers (Figure 20). Terminal B passengers had a greater preference for books / reading materials, and authentic San Antonio merchandise than Terminal B passengers.

Figure 20 | Retail Merchandise Preferences



2.13.4 MARKET ANALYSIS

RESEARCH LOCAL AND MARKET TRENDS

This section provides a brief review and analysis of the San Antonio marketplace and its impact on SAT's concession program, integral common attributes of successful airport and off-airport retail environments, and retail/dining industry trends and their applicability to the evolution of the SAT concessions program.

Understanding and incorporating local market preferences and retail practices, and adopting best practices within the leisure/entertainment, retail, and service industries will lead to greater conversion of passengers into shoppers, ultimately enhancing passenger satisfaction, concessionaire success, and airport revenues. Presented below are some key highlights regarding the local and market trends.

Local Market Analysis

Per a May 2019 U.S. Census Bureau report, San Antonio was the second fastest growing city in the country from 2017 to 2018 for cities with at least 50,000 residents. This surge in population growth mirrors and is likely a catalyst of the high rate of enplanement growth that SAT continues to experience with enplanements up by nearly 11 percent in calendar year 2018.

The evolving vibrancy of the cultural and social landscape in San Antonio led by population growth and the tourism industry has spawned a transformation of the city into a destination for food enthusiasts.

The appeal of San Antonio's thriving retail, dining and entertainment tourism is reflected in SAT's passenger demographics. Per the 2018 Airport Experience News (AXN) Fact Book, 60 percent of SAT passengers are traveling for leisure purposes. Most passengers are visitors to the San Antonio area (57 percent of Terminal A passengers and 67 percent of Terminal B passengers, per Unison Consulting's 2018 Passenger Survey), and as a predominately origination and destination (O&D) airport (92 percent O&D per the 2018 AXN Fact Book), travelers flying through SAT are staying in the area and able to partake in the rich dining and retail environments found in the city.

MARKET TRENDS

SENSE OF PLACE

Conveying a "sense of place" via local and regional themes at SAT – specifically within the design, materials, concepts and brands, ambiance and product offerings – is an essential component of any successful airport concession program. In fact, using and reflecting local design influence, locally sourced materials in construction, local hand-crafted merchandise and/or locally sourced food products has become the new normal as consumer tastes and preferences have shifted toward unique and authentic experiences of a local culture.

EXPERIENTAL RETAIL

Providing retail experiences that are engaging and experiential have evolved from a trend to an essential element in crafting successful retail environments. Because of technology-driven methods like “Augmented Reality” experiences using mobile apps and the physical blurring of retail and food categories, retailers are devising approaches to combat the ever-present options of content and entertainment available to passengers via their mobile devices, and increase foot traffic and engagement within their shops.

FLEXIBLE/DYNAMIC CONCEPTS

The integration of pop-up retail and dining concepts featuring frequently rotating product assortments has graduated from a trend to a vital component of retail success. Millennial and Generation Z shoppers being fed a perpetual stream of new products and creative content have ushered in an era where foot traffic and engagement are tied to the fresh concepts and continual change that a retail marketplace can offer. Airports have caught up with the off-airport marketplace regarding inventive pop-up concepts featuring local brands and artisans, and some concessions RFPs explicitly solicit for operators to implement pop-up programs.

CONVENIENCE

As consumer attention spans shorten and time constraints on the day increases, successful retail marketplaces have adjusted to offer multiple modes of shopping options that attempt to address these continued pressures. Off-airport shopping centers and retailers have embraced programs including click and collect (buy online and pick up in store) and local delivery that provide added convenience for harried customers. Restaurants have focused on creating pick-up experiences that are seamless, and are increasingly signing on with third-party delivery services to cater to the dining habits of millennials.

In the food & beverage category, airports are offering multiple shopping modes including the adoption of gate delivery services like Grab and Airport Sherpa, tablet-based ordering at dining venues, and kiosk/touchscreen experiences at grab-and-go venues. Conversely, the retail category in airports has not seen the same level of experimentation and implementation with multiple shopping modes.

2.13.5 CONCESSIONS SPACE PLANNING CONSIDERATIONS

CONCESSIONS SPACE REQUIREMENTS

To determine the amount of concessions space that is needed to meet estimated future consumer demand, Unison conducted a quantitative assessment of space requirements. Considerations include various space demand factors that represent passenger, facility, and concession characteristics of the airport as well as enplanement projections. This section describes Unison’s methodology to help determine concessions facility requirements for the 5-, 10-, and 20-year planning horizons.

CONCESSIONS PLANNING CRITERIA

One of the more important elements in the evaluation and planning of an airport concessions program is determining the appropriate amount of space to be allocated for food and beverage and news, gift, and specialty concessions. Space requirements are developed through an iterative process, beginning with a preliminary quantitative analysis of space requirements, which is then refined as other elements of the concession program are incorporated.

The quantitative measures used in this section provide an objective starting point from which to estimate future space demands, as well as evaluate the adequacy of current concession space. The calculated maximum space requirements represent the ideal case, ignoring any physical or financial constraints. If there were no other considerations or limitations, passenger traffic could support the amount of space described below. The recommended size and configuration of concession space is continually refined and ultimately determined by a combination of factors, including the location and configuration of concessions, passenger flow, passenger demographics, and the amount of space available given the physical constraints of the facility. A Space Utilization Factor ("SUF") is developed for each concession category (food & beverage and news, gift & specialty). The methodology used to develop these factors is discussed in this section.

SPACE UTILIZATION FACTOR ANALYSIS

The SUF methodology evaluates the amount of concession space required by category type at an airport to meet current and future passenger demand. The SUF represents the number of SF of concession space required per thousand annual enplaned passengers. The SUF factor is comprised of several components representing passenger, facility and retail operating characteristics that serve as space "drivers" – those characteristics that influence the amount of concessions space that is needed to optimize customer satisfaction, concessionaire financial viability and revenues to the airport. A ranking is applied to each component of the major characteristics according to its contribution in allocating an airport's concession space. Each characteristic is ranked from 0.1 (requiring less space) to 0.6 (requiring more space) for both the food and beverage and retail categories.

Passenger Characteristics focus on factors descriptive of the passenger base, including leisure versus business travelers, origination & destination passengers versus connecting passengers, the degree of passenger peaking, and area residents versus visitors. These characteristics have a significant impact on buying behavior and consequently on the amount of concession space required.

Facility Characteristics focus on the physical characteristics of SAT, such as whether concession locations are scattered throughout terminals or centrally located, if they are highly visible and accessible to dense passenger traffic, if they are located pre- or post-security, and if the concession locations are close to boarding gates. These characteristics affect program sizing because when concession locations are clustered in highly visible and accessible locations, they are more likely to serve a greater number of customers and thus require additional space. Those locations that are out of passenger sight or access will naturally attract less traffic.

Concession Characteristics include those factors that are specific to each concession category. For example, for food and beverage concessions, if the program includes a full-service restaurant, more space will be required than if it includes only snack bars scattered throughout the terminals. This is because restaurants require more space for seating and kitchens. All of these characteristics are discussed in detail below.

Once each characteristic is ranked, individual rankings are totaled for each concession category. An additional adjustment factor is applied to the calculated SUF for retail concessions to take into account generally overall lower consumer demand for retail merchandise, higher passenger exposure requirements for specialty retail in order to maintain financial viability, and no need for seating. Unison used a Retail Adjustment Factor of 39 percent, which is determined based on calculating the percentage difference between the average F&B and Retail SUFs among SAT's comparable airport group.

The SUF represents the amount of retail space required in a particular category per thousand enplaned passengers. The higher the SUF, the greater the amount of space required. In order to arrive at an estimate of space requirements, the SUF is multiplied by the total number of enplaned passengers and divided by one thousand. It should be noted that although the SUF analysis is an extremely important factor in determining space requirements, it is a starting point in space planning for a concessions program. Additional factors such as merchandise mix, design concepts, space requirements of individual concepts and facility constraints are also considered in developing and finalizing the overall program space.

RATIONALE FOR SUF CHARACTERISTIC RANKINGS

The SUF analysis includes the ranking of characteristics grouped into the following categories: Passenger Characteristics, Facility Characteristics, Food & Beverage Characteristics and Retail Characteristics. The rationale for our rankings of each characteristic are discussed below. These rankings are specific to the characteristics of SAT and its passenger market, and to the concessions program, as evidenced by passenger survey results, terminal layout plans, and traffic information

SUF ANALYSIS – PASSENGER CHARACTERISTICS

Passenger characteristics have a significant impact on buying behavior and consequently on the amount of retail space required. The key characteristics considered in the estimation of space requirements are described below.

- Connecting / O&D: Passengers who begin or end their trip at an airport (O&D passengers) typically have longer dwell times than connecting passengers, and thus a greater need for concessions space. According to the passenger survey conducted at SAT last year, 93 percent of Terminal A passengers and 88 percent of Terminal B passengers are O&D.
- Travel Purpose: Leisure travelers tend to arrive earlier at the airport, purchase more on impulse, and spend more money on gifts and souvenirs, thus requiring more space. Per the survey results passengers traveling for pleasure or personal reasons (60 percent in Terminal A, 43 percent in Terminal B) are more likely to purchase retail merchandise, while business travelers are more likely to purchase food and beverages.
- Resident versus Visitor: Visitors are more likely than residents to spend money on souvenirs and gifts, as well as arrive earlier due to unfamiliarity with the Airport.

  Passenger Peaking: Passenger peaking refers to periods during which a greater than average number of departures are scheduled within a short period. A high level of passenger peaking generally necessitates more concession space to accommodate the higher volume of passengers using retail space during these periods.

SUF ANALYSIS – FACILITY CHARACTERISTICS

The physical characteristics of SAT have a considerable impact on the number of passengers exposed to concessions and consequently on the amount of space required for concessions to satisfy passenger demand. Pertinent facility characteristics and the corresponding SUF rankings are discussed below:

- Accessibility and Visibility: Those concession spaces that are the most accessible and visible require the most space. This is because highly visible spaces are more likely to attract passengers, whereas concession spaces that are hidden or in low-traffic areas will need less floor space. An undersized concession space will lead to long lines and frustrated passengers.
- Clustered or Scattered Location: Concession location is critical to attract passengers and promote spending. Concessions that are clustered in central areas attract more passengers than do scattered facilities. Clustered concessions that provide a critical mass of retail area create distinct and inviting concession environments. Clustering increases the passenger's propensity to shop because there is a higher likelihood of finding a necessity or impulse item to purchase from the variety of options available.
- Pre / Post Security Screening: Passengers generally prefer concessions located airside (after security screening) over those located landside (before security screening). Research has shown that passengers spend less time at landside concessions than airside concessions. This pattern is attributed to greater passenger anxiety concerning the time it will take to pass through security and locate the proper gate. Once passengers complete ticketing, baggage checking and security, they tend to be more relaxed and are more willing to browse, eat and shop.
- Terminal Configuration: The layout of the terminal has an impact on the amount of exposure that passengers have to concession facilities. Terminal configurations that require longer walking distances generally require more scattered retail space than terminal configurations with shorter walking distances.

In addition to passenger and facility characteristics, there are characteristics specific to each concession category – food & beverage and retail (news, gift, and specialty).

SUF ANALYSIS – FOOD & BEVERAGE CHARACTERISTICS

- Style of Food Service: The style of food service at airports typically ranges from on-the-go (or "walk-away") food concepts to sit down table service restaurants. Sit-down restaurants generally require more space to accommodate kitchen/prep areas, seating areas and longer dwell times at these types of venues.
- Degree of National / Regional Brand Recognition: National or regional brands attract passengers based on their familiarity with a particular concept and instill confidence that they can expect consistent quality and value, thus increasing the need for larger concession space.

SUF ANALYSIS – RETAIL CHARACTERISTICS

- Merchandise & Store Concepts: Retail programs with a variety of specialty retail shops generate greater customer satisfaction and sales performance than those programs with only combined news and gift shops.
- Degree of National/ Regional Brand Recognition: Brand name recognition of national retailers provides passengers with confidence and assurance that they are purchasing quality products at reasonable prices. However, not all airports have the passenger base to financially support a wide variety of national branded stores.

CONCESSION SUF

The SUF analysis for SAT indicates a basic space requirement for food & beverage space (excluding "back of house" support and storage) of 5.8 SF for Terminal A and 6.0 SF for Terminal B per 1,000 enplaning passengers. For retail concessions, the utilization factor is 3.5 for Terminal A and 3.7 for Terminal B SF per 1,000 enplanements. The individual SUF rankings are based on passenger, terminal, and concessions characteristics for each terminal and concessions category as shown in Table 8 and Table 9.

Table 8 | Utilization Factor Analysis: Food and Beverage

Lower Range of Values *Requires Less Space* 0.1 – 0.2 – 0.3		Upper Range of Values *Requires More Space* 0.4 – 0.5 – 0.6	Food & Beverage Terminal A	Food & Beverage Terminal B
Passenger Characteristics				
Connecting Passengers	⟷	Originating Passengers	0.5	0.5
Business Traveler	⟷	Leisure Traveler	0.4	0.3
Local Resident	⟷	Visitor	0.4	0.5
Short Dwell Time	⟷	Long Dwell Time	0.4	0.4
Low Degree of Passenger Peaking	⟷	High Degree of Passenger Peaking	0.5	0.5
Household Incomes <$100,000	⟷	Household Incomes >$100,000	0.4	0.4
Facility Characteristics				
Difficult Access to Facilites	⟷	Easy Access to Facilities	0.6	0.6
Poor Visibility	⟷	Facilities are Highly Visible	0.5	0.5
Limited or No Clustering/Central Zone	⟷	Facilities are Clustered	0.4	0.4
Landside Locations	⟷	Concessions is Located Airside	0.6	0.6
Linear or Single Terminal Configuration	⟷	Multiple Concourses or Terminals	0.3	0.3
Food Service Characteristics				
Fast Food Service	⟷	Sit-Down Food & Beverage Service	0.3	0.5
Non-Brand Name Eateries	⟷	Nat'l/Regional Brand Recognition	0.5	0.5
Total Space Requirement (per 1,000 Enplanements)			**5.8**	**6.0**

Source: Developed Space Requirements estimated by Unison Consulting based on data from Unison's 2018 Concessions Preference Survey, SAT's Semi-Annual Passenger Survey (Wave 8), ACI-ASQ Survey Data, 2018 ARN Fact Book and OAG data, as well as characteristics of current and expected SAT concessions programs and comparable airports.

Table 9 | Space Utilization Factor Analysis: Retail Concessions

Lower Range of Values *Requires Less Space*		Upper Range of Values *Requires More Space*	Retail Concessions Terminal A	Retail Concessions Terminal B
0.1 0.2 0.3		0.4 0.5 0.6		
Passenger Characteristics				
Connecting Passenger	↔	Originating Passenger	**0.6**	**0.5**
Business Traveler		Leisure Traveler	**0.4**	**0.3**
Local Resident		Visitor	**0.4**	**0.5**
Short Dwell Time		Long Dwell Time	**0.4**	**0.5**
Low Degree of Passenger Peaking		High Degree of Passenger Peaking	**0.5**	**0.5**
Household Incomes <$100,000		Household Incomes >$100,000	**0.4**	**0.4**
Facility Characteristics				
Difficult Access to Facilites	↔	Easy Access to Facilities	**0.6**	**0.6**
Poor Visibility		Facilities are Highly Visible	**0.5**	**0.5**
Limited or No Clustering/Central Zone		Facilities are Clustered	**0.4**	**0.4**
Landside Locations		Concessions is Located Airside	**0.6**	**0.6**
Linear or Single Terminal Configuration		Multiple Concourses or Terminals	**0.3**	**0.3**
Retail Characteristics				
Traditional Airport Products/Services	↔	Specialty Shops/Services	**0.3**	**0.4**
Non-Brand Name Shops/Merchandise		Nat'l/Regional Brand Recognition	**0.4**	**0.5**
Subtotal			**5.8**	**6.0**
Retail Adjustment Factor			-39.0%	-39.0%
Total Space Requirement (per 1,000 Enplanements)			**3.5**	**3.7**

Source: Developed Space Requirements estimated by Unison Consulting based on data from Unison's 2018 Concessions Preference Survey, SAT's Semi-Annual Passenger Survey (Wave 8), ACI-ASQ Survey Data, 2018 ARN Fact Book and OAG data, as well as characteristics of current and expected SAT concessions programs and comparable airports.

Notes:

1) Retail Adjustment Factor determined based on calculation of the percentage difference between the average F&B and Retail SUFs among SAT's comparable airport group (data sourced from the 2018 ARN Fact Book (2017 data)).

SPACE REQUIREMENTS

To ensure that the concession program is adequately sized to serve future passenger demand, Unison examined space requirements in consideration of projected enplanement levels for planning years 2023, 2028, 2033, and 2038. For this analysis, Unison used enplanement projections developed by the WSP project team.

Total concession space requirements for planning year 2023 are approximately 55,600 SF of food and beverage, retail, and duty-free concessions. As enplanements increase so does the need for additional concessions space. In year 2028, concession space requirements are approximately 61,000 SF, indicating the need for approximately 26,100 SF of additional concession space to meet the forecasted passenger demand. By year 2038, SAT will need approximately 70,000 SF of concession space - double of what is available today. Table 10provides a summary of space requirements for Terminals A and B by category. It is important to note the space requirements by terminal are based on the current market share allocation. Should airlines move from one terminal to another, the amount of required concessions space by terminal will also change.

Additionally, it is important to note that several assumptions are made in developing space needs, particularly with respect to the location of concession space within the terminal. We assumed that the principal concession spaces will continue to be airside, highly visible, easily accessible, and within the direct flow of passenger traffic. By doing so, the most optimal concessions program may be developed. If the concession program is relegated to secondary space within the terminal, where visibility and access may be hampered, the amount of required space will likely be reduced, the variety of the program will be diminished and the overall success of the program will be severely hampered.

The need to place concessions airside is particularly important. Historically, passengers have tended to get through security prior to visiting concessions. Further, with the restriction of carrying liquids through the security checkpoint, passengers are more likely to wait until they are airside to purchase their beverages. Finally, as noted above, the SUF analysis serves as a guideline for space planning recommendations. Other factors that are considered include the availability of space in the terminal, minimum and/or maximum sizes for individual concepts and locations, the number of individual concession locations, availability of support/storage space, and overall business potential. In some cases, these considerations may lead to deviations from the findings of the SUF analysis.

Table 10 | Concession Space Requirements by Category

Concessions Category	Current Program	Expansion Needed[4]	2023	2028	2033	2038
Food and Beverage						
Terminal A	12,307	13,800	23,800	26,100	28,100	30,000
Terminal B	6,634	4,100	9,800	10,700	11,600	12,400
Total Food & Beverage[1]	**18,941**	**17,900**	**33,600**	**36,800**	**39,700**	**42,400**
Retail						
Terminal A	9,744	6,200	14,500	15,900	17,100	18,300
Terminal B	5,210	1,400	6,000	6,600	7,100	7,500
Total Retail[1]	**14,954**	**7,600**	**20,500**	**22,500**	**24,200**	**25,800**
Duty Free[5]	**1,082**	**600**	**1,500**	**1,700**	**1,800**	**1,900**
Total Concession Space Requirement[2]	**34,977**	**26,100**	**55,600**	**61,000**	**65,700**	**70,100**
Projected Enplanements (000)[3]			**5,731**	**6,283**	**6,768**	**7,234**
Terminal A			4,098	4,493	4,839	5,171
Terminal B			1,633	1,791	1,929	2,062
Projected International Enplanements (000)[3]			**339**	**372**	**401**	**429**

Notes:
1. Space Requirement equals Developed SUF multiplied by total projected enplanements in thousands.
2. Total Concession Space Requirement is for selling space only. Excludes storage and support space.
3. Projected enplanements source: WSP Project Team.
4. Expansion Needed represents amount of space to be added to achieve 2028's space requirements.
5. Duty Free Space Requirement equals Duty Free Developed SUF multiplied by total projected international enplanements in thousands.

San Antonio Airport System Strategic Development Plan

2021 AIRPORT MASTER PLAN

MASTER PLAN UPDATE
CHAPTER 4 – DEMAND/CAPACITY AND FACILITY REQUIREMENTS
APPENDIX 4C – ADMINISTRATIVE SPACE ANALYSIS

SAN ANTONIO INTERNATIONAL AIRPORT

STRATEGIC DEVELOPMENT PLAN—ADMINISTRATION/OFFICE SPACE ANALYSIS

INTRODUCTION

BACKGROUND

The City of San Antonio's Aviation Department (Aviation Department) employs approximately 450 people at the San Antonio International Airport (Airport)[1]. These employees are in various locations over its 2,600-acre campus. The Aviation Department's administration/office space has been historically allocated based on immediate need and available resources and facilities. In some instances, locations have been selected based upon facility availability rather than being in an ideal location or offering the most suitable layout. This has resulted in some employees being located in areas that are far away from their primary function or away from the locations of divisions with synergies. In other cases, divisions have been co-located with other departments that have no similar form or functional association. Over time, this has resulted in inefficiencies in daily functions or delays due to travel time between facilities.

PURPOSE

As part of the Airport's Strategic Development Plan (SDP), WSP undertook analyses aimed at determining future support facilities needs for the Airport through 2040-the end of the planning period. Understanding the administration/office space needs for the Aviation Department is critical to managing the available inventory and identifying what needs remain to be filled. By appropriately locating divisions in proximity to their function, efficiencies can be realized. By combining divisions with similar functions or synergies, limited resources can be shared to maximize the potential benefits for a greater number of employees. Additionally, the Aviation Department aims to provide a pleasant work environment and experience for all its employees.

PROCESS OVERVIEW

The process for determining the amount of office space started with conducting interviews with Aviation Department staff, then identifying the inventory of administration/office space currently available on the Airport campus. From there, WSP conducted research to determine the amount of office space needed per. The amount of space needed was then compared to the current and projected number of employees to determine gaps for current and future conditions.

Details about the interview process, the inventory of existing office space used by Aviation Department staff, the parameters used to determine current and projected administration/office spaces needs, as well as recommendations are provided in the sections below.

INTERVIEWS

WSP began the process of determining the administration/office space requirements by conducting interviews with Aviation Department Division Managers. These interviews were conducted in 2018 and again in 2020 to better understand the nature and facilities needs for each department as well as identify the existing efficiencies or inefficiencies that exist. Throughout this process, there was also an effort to identify other considerations that could affect space needs.

[1] The Aviation Department also runs Stinson Municipal Airport, a general aviation facility. The employees whose sole function is to support activity at Stinson are excluded from this study; however, the employees who provide support to both facilities and are housed on the Airport's campus are included.

During the divisional interviews, information about the number of employees, the number of employees who require a desk (either in an office or a cubicle), and the functions the division oversees was collected. In addition, specialty space requirements were also assessed. This included items such as breakrooms, locker rooms, training and conference space, and equipment and supply storage.

Further, the Division Managers were asked to provide information related to how they thought their division might expand over the next five years to determine the number of future Aviation Department employees. During the 2020 interviews, data regarding the long-term impact of COVID-19 on both the number of staff and the amount of office space was also collected.

CURRENT EMPLOYEES

A tally of current employees was conducted during the interview process along with a projection for the next five years. **Table 1** below presents the results. Note that analysis only includes those employed by the Aviation Department Airline and tenant employees are not included since their space is leased from the Airport and included in the terminal space requirements.

Table 1: Aviation Department Employees by Division 2020 & 2025

DIVISION	EMPLOYEES 2020	EMPLOYEES 2025
Aviation Director	15	17
Deputy Aviation Director	8	8
Operations*	162	189
Development*	29	40
Administration	49	56
Customer Experience	17	27
Strategy & Innovation	5	7
AICC	20	26
ARFF	46	47
Airside Operations & Maintenance	26	40
Facilities Maintenance	76	84
Terminal Services	40	42
TOTAL	**493**	**583**

* Includes all divisions except ARFF, AICC, and Airside Operations and Maintenance
** Includes all divisions except Facilities Maintenance and Terminal Services

Source: WSP Interviews with SAAS, 2020; Compiled by WSP

STAFFING PROJECTIONS

An analysis of current and future staffing needs is required to determine if the existing office spaces are adequate for growth. Projections for employee growth in the near-term (2020 & 2025) were based on interviews with specific division managers and airport executives. The medium- to long-term employee growth projects were developed by applying the same growth rate as enplanements from the forecast that was prepared for the SDP. **Table 2** below presents the projected employees during the planning period.

Table 2: Projected Aviation Department Employees through 2040

YEAR	EMPLOYEES
2020	493
2025	583
2030	635
2040	726

Source: WSP Analysis

EXISTING SPACE INADEQUACIES/INEFFICIENCIES

During the course of the interview process other items were consistently identified by division managers that were inadequacies or inefficiencies, as well as special requirements for Aviation Department staff space. The following provides a summary of these items:

- Because travel times between locations can take as much as an hour round trip, colocation of certain departments would provide better efficiency
- There is a lack of flexible conference room space – larger conference rooms, no meeting space to have a small meeting (fewer than 5), unless there is an office available
- Some divisions require locker rooms for their staff (facilities and airside maintenance, police)
- For most divisions, warehousing and storage space was adequate but located in areas that were not efficient
- Additional locker room space would be nice
- Some departments that should be co-located that currently are not

COVID-19 PANDEMIC IMPACTS

The effects of the COVID-19 pandemic were certainly profound in the short-term, forcing staff to telecommute per the City's policies, when possible. With social distancing practices implemented, in general, the common spaces (such as break rooms and locker rooms) utilized by employees were deemed to be inadequate. From a long-term perspective, there do not appear to be any substantial impacts of the COVID-19 pandemic that require the need for additional office space.

ADMINSTRATION/OFFICE SPACE INVENTORY

An inventory of the Aviation Department's current administration/office space located on the Airport's campus was developed for this analysis. As previously mentioned, the office space located around the airport is scattered. **Exhibit 1** below presents a map of the locations of the office spaces inventoried for this analysis.

Exhibit 1: Administration/Office Space Locations

Source: WSP

Table 3 below presents an overview of the amount of office space by location available at the Airport. As shown, approximately 42,000 SF of office space is located in approximately 88,000 SF of building area on the Airport's campus. As also shown, the total building area is approximately 160% of the office space area on average for the Aviation Department's facilities. That additional space includes circulation, restrooms, mechanical, electrical and communications rooms, janitorial closets, storage, breakrooms and lockers. This is an important factor to understand how much gross space will be needed per employee versus the amount of space that is strictly office space.

Table 3: Administration Space by Location

LOCATION	DIVISIONS/FUNCTIONS	OFFICE AREA (SF)	BUILDING AREA (SF)	BUILDING AREA/ OFFICE AREA
Terminal Mezzanine	Executives, Air Service Customer Experience, HR, Strategy & Innovation, Legal, Compliance	11,160	15,046	135%
Other Terminal*	Terminal Services, AICC/Communication Center, IT, Safety, Customer Experience, Concessions & Properties Wildlife, Security, Police	13,022	13,022	100%
Building 1039	Planning & Development, Design & Construction, Airfield Operations, Environmental Stewardship Fiscal	4,604	11,000	239%
Building 1154	Airside & Facilities Maintenance	1,888	3,950	209%
Maintenance Trailer	Airside & Facilities Maintenance	1,936	4,984	257%
Building 1362	Parking & Ground Transportation	1,800	5,230	291%
Building 1320	Airport Police	1,742	5,283	303%
Hangar 4 **	Airport Police	5,304	5,304	100%
Building 1322	Security	712	2,795	393%
Trailer Near CUP	Security	469	1,138	243%
Building 1920 **	ARFF	989	989	100%
Total		**43,626**	**68,741**	**160%**

* This office space is scattered throughout the terminal; therefore, the footprint of the offices is the footprint of the total area.
**These areas provide areas for specialty functions such as the K-9 Unit and emergency services and firefighting. As a result, these areas are outliers and the comparison between building area and office area is not analogous to the remaining areas.

Source: Aviation Department Records; Compiled by WSP

ADMINISTRATION/OFFICE SPACE NEEDS

To determine and project the administration/office space requirements, WSP conducted research to review office space trends at the national level from prominent corporate real estate companies and architectural firms, in various metropolitan areas of Texas, and reviewed the City of San Antonio Administrative Directive related to the amount of office space per employee. The following sections outline this research.

NATIONAL TRENDS

WSP conducted research to determine the national trends related to office space. Nationwide office space (SF) per employee (or office density) has consistently decreased since the Great Recession. According to Cushman and Wakefield, a nationally known commercial real estate firm, between 2009 and 2017 the nationwide average office density decreased from 211 SF to 194 SF, or roughly 8%. This trend is driven by commercial strategies to maximize office space utilization through initiatives such as: continued shift away from paper, telecommuting, flexible work schedules, shared/agile workspaces, utilizing temporary office space, etc. Office space per employee is expected to continue to decrease in the future, but at a slower rate, as employers will continue to maximize office space utilization but eventually be limited by employee productivity and comfort requirements.

The bullets below provide general guidelines for the ranges of office space density.

— High Density (80 – 150 square feet per employee): Majority open seating with rows of small desks. May have a few private offices. Often seen in companies that house many different teams within the same space, as well as for sales, engineering, technology, coworking or customer support offices.
— Average Density (150 – 250 square feet per employee): Mix of open cube or desk space and private offices. Traditional office layout.
— Spacious (250 – 500 square feet per employee): Majority of the space consisting of large private offices. Historically seen in law firms.

At the market level, more expensive markets typically have lower office density; however, the growth of new office supply in relation to job growth since the Great Recession will typically determine a given market's rate of densification. For example, markets that have seen significant job growth since the recession without the requisite increase in available office space will observe a decrease in the average office space per employee to make more efficient use of the office space that is available.

According to the 2012 *Workplace Standards Benchmarking* study published by Gensler, a nationally recognized architectural firm, the following ranges were identified for office space based on the function of the space.

— Call center: 50 to 175 USF
— Technology: 115 to 155 USF
— Finance: 110 to 245 USF
— Engineering: 150 to 185 USF
— Law enforcement: 100 to 240 USF
— Social services: 175 to 235 USF
— Biotech and science: 125 to 410 USF
— Legal: 245 to 525 USF

As shown in the bullets above, the average of the above space densities (high and low) is approximately 135 to 250 SF, with a median of approximately 200 SF per employee.

TEXAS BENCHMARKS

The San Antonio market and other major Texas markets have observed notable job growth since 2009, **Table 4** below demonstrates how limited available office inventory is contributing to decreased office space per employee in many Texas markets. The average office density for the San Antonio market was 110 SF per employee in 2017, roughly 2% lower than 2009, which is likely a result of job growth slightly outpacing the growth of available office space. The Austin and Houston markets demonstrate that if job growth significantly outpaces the supply of available office space, the rate of office densification will be more extreme (Houston is also home to many energy companies, which tend to provide more space per employee). The Dallas/Fort Worth market shows that if the supply of available office space grows faster than the job market, office space per employee is likely to increase.

Table 4: Texas Market Office Space Comparison

		% CHANGE (2009-2017)		
MARKET	SF PER EMPLOYEE	SF PER EMPLOYEE	OCCUPIED OFFICE SPACE	NUMBER OF JOBS
San Antonio	110	-2%	29%	31%
Austin	177	-9%	33%	46%
Dallas/Fort Worth	191	4%	6%	24%
Houston	218	-15%	6%	24%
United States	194	-8%	11%	20%

Sources: Cushman and Wakefield, Bureau of Labor and Statics, Moody's; Compiled by WSP

CITY OF SAN ANTONIO ADMINISTRATIVE DIRECTIVE

The City of San Antonio Administrative Directive 1.10 (AD 1.10) outlines the standards for office space, furniture, and equipment for all City personnel. Some of the purposes of this directive are to "realize efficiencies in space, purchasing, and inventory tracking, promote equity among City departments, and allow for more efficient reorganization." AD 1.10 provides standards for space allocated to employee based on an employee's classification. **Table 5** provides an overview of these standards and then applies it to the number of employees in each classification at the Airport to develop a weighted average for space per employee of the Aviation Department. As shown in the table the weighted average based on AD 1.10 results in range of 88 SF to 90 SF when accounting for a factor of an additional 30% for circulation and common areas.

Table 5: Administrative Directive 1.10 Summary

CLASSIFICATION	EMPLOYEES *	LOW SF	HIGH SF	LOW SF TOTAL	HIGH SF TOTAL
Executive	10	200	250	20,000	25,000
Management	60	120	150	7,200	9,000
Professional	170	64	84	10,880	14,280
Support	200	48	64	9,600	13,000
TOTAL SPACE REQUIREMENT				29,680	38,780
Weighted Average				67	90
With Circulation SF (60%)				91	117

* The total number of employees in this table differs from the total presented earlier, as some staff the for which the Aviation Department is required to provide space are shared services with the City of San Antonio and are not included in the classifications identified in this table. These departments include ARFF, Police, Fiscal, and Procurement.

Source: City of San Antonio AD 1.10 and Aviation Department Equal Employment Opportunity Commission Report; compiled by WSP

FACILITY REQUIREMENTS

This section presents the facility requirements for the Aviation Department through 2040, which is the end of the SDP planning period. First the assumptions for determining the administration/office space requirements are discussed, which is followed by an overview of the administration/office space facility requirements during the planning period.

PLANNING ASSUMPTIONS

The information presented above presents varying ranges for administration/office space that could be used as a basis for the planning assumptions to determine the future needs for these facilities. In general, based on using AD 1.10 as a guideline, the weighted average high-end of the administration/office space permitted by City of San Antonio policy and adding 60% for circulation/other space (144 SF per employee) is at the low end of what is considered average space density (150 SF to 250 SF) per employee by national standards. This amount is also within the ranges for call centers, technology, finance, engineering, and law enforcement, all of which are functions of the activities undertaken by the Aviation Department.

This analysis uses a factor of 175 SF per employee. This amount reflects an upward adjustment to the existing baseline of 144 SF per employee outlined in the previous section to account for the inadequacies in the existing facilities identified during the interview process, specifically having additional and more flexible conference room/meeting areas.

The determination of the number of employees used to develop the facilities requirements for administration/office space takes into account other SDP analysis in planning for airport support facilities that will house a portion of the Aviation's Department's staff at various locations around the Airport campus as part of the SDP. These facilities include the following:

— ARFF Building: This building serves a definitive purpose and cannot be co-located with other Aviation Department administrative functions. It is also subject other FAA criteria when determining its location.

- AICC: this building has been in the Aviation Department's plan for several years and a location is currently being determined for this facility.
- Operations, airside maintenance, facilities maintenance, and terminal services: the SDP plan includes a facility that combines these functions in one location that will include facilities for all the functions undertaken by these divisions, including their administration/office space needs.
- Terminal Services: the SDP plan includes an amount of terminal space that will be adequate to accommodate a portion of this division that is needed on site at the terminal, as well as an area for storage for items that are often needed to perform the division's functions.

Table 6 below presents current and projected employees adjusted for the department exclusions described above.

Table 6: Aviation Department Staff Adjustment

YEAR	PROJECTED EMPLOYEES	EXCLUDED EMPLOYEES	NET EMPLOYEES
2020	493	188	305
2025	583	213	370
2030	635	232	403
2040	726	265	461

Source: WSP Analysis

Table 7 below illustrates the office space requirements over time in relation to space in square feet.

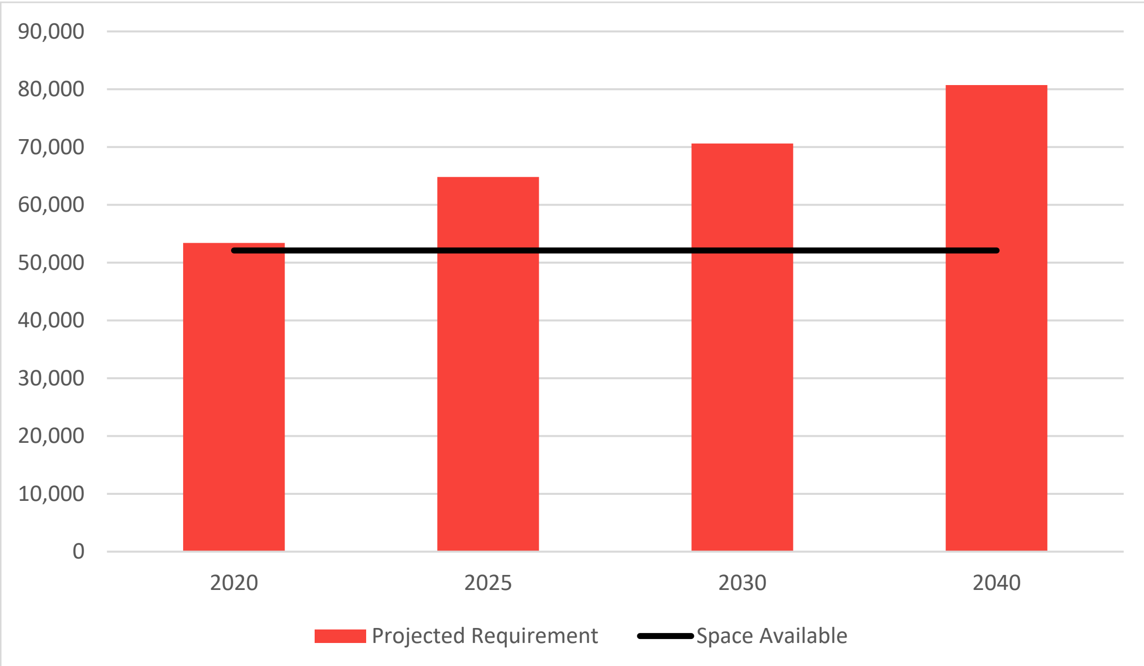
Table 7: Projected Space Requirements

YEAR	EMPLOYEES	SPACE REQUIREMENT (SF)
2020	305	53,375
2025	370	64,750
2030	403	70,565
2040	461	80,656

Source: WSP Analysis

The amount of space required for administration/office functions was then compared to the amount of space available on the Airport's campus today, reduced for the departments that have been excluded from the analysis as described previously, which results an office space amount of approximately 34,000 SF and a total space of approximately 52,100. **Exhibit 2** below compares the space currently available to the projected space need over time.

Exhibit 2: Comparison of Administration/Office Space Requirement to Available Space (SF)



As shown in the chart above, the required amount of space is slightly more in 2020 than what is available currently and as early as 2025 is approximately 14,000 over the currently available space. The most efficient way for the Aviation Department to accommodate the future need for administration/office space and also provide better efficiency would be to co-locate many of the functions that are housed in the Terminal Mezzanine, other terminal, and Building 1039. Other divisions that could be included in this space would be Security (Badge and ID) and some of the existing Police Department functions. However, it may be easiest to relocate those functions to vacated facilities in the terminal building once other employees are moved to the leased space. Given the need for additional and more functional administration/office space and the lack of on-airport availability of parcels for a new building, the Aviation Department could benefit from leasing space to accommodate its administrative/office space needs to allow for a quicker relocation of employees such that efficiencies and synergies from being co-located much sooner than if a new facility was constructed.

CONCLUSIONS

Approximately 53,000 square feet of office space would be needed to consolidate current Aviation Department administrative staff that are not included in the planning for other facilities identified as part of the SDP's support facilities plan. An additional 11,375 square feet will be needed by 2025 as the staff is projected to grow by 65 employees. Long-term, office needs are projected to be approximately 80,700 square feet to meet the projected number of employees who will need to be housed in the Aviation Department's administration/office space. In addition to this space, some functions currently located outside of the terminals could be relocated in office space vacated when new administrative space is leased. The space allocation is consistent with City of San Antonio Administrative Directive 1.10, as well as allowing for additional small conference rooms to meet operational needs of the Aviation Department.