Chapter 4 – Facility Requirements

Introduction

This chapter evaluates the existing airport facilities and identifies improvements needed to effectively meet the forecasted demand levels discussed in the Forecast Chapter in a manner that complies with FAA standards and best practices. Identification of a needed facility or infrastructure improvement does not necessarily constitute a "requirement" in terms of design standards, but an improvement "option" to accommodate future aviation activity levels. Market demand will ultimately drive facility development at Abilene Regional Airport (ABI) and the operational levels defined in the forecast chapter (e.g. enplanements, aircraft operations, based aircraft, etc.) should be used to help guide the timing and need for future developments/improvements.

Airport facilities can be divided into two areas: airside and terminal/landside. The airside/airspace facility components include runways, taxiways and their associated safety areas, navigational aids (NAVAIDs), airfield marking/signage, and lighting, while terminal/landside area components are comprised of hangars, terminal building, FBO facilities, aircraft parking apron, fuel storage and delivery, vehicular parking, and airport access.

Each of these facilities, including their current condition and forecasted demand, will be discussed in the remainder of this chapter. The results of this chapter will be utilized to drive the alternatives that are developed in Chapter 5.

Airside/Airspace Facilities

Runway Length

Runway length requirements for an airport can be evaluated utilizing a number of methodologies. To ensure a thorough and complete analysis regarding the sufficiency of ABI's current runway length, two evaluation methodologies were used for this analysis:

1. Runway Length Evaluation based on AC 150/5325-4B
2. Runway Length Evaluation Utilizing Forecasted Fleet Mix and Airport Planning Manuals (AMP) for Aircraft Expected to Frequently Use ABI

Runway Length Evaluation Based on AC 150/5325-4B

FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*, provides guidance to help determine the most appropriate recommended runway lengths for an airport. Runway length is typically predicated upon the category of aircraft using or forecasted to use the airport. By design, the primary runway at an airport is typically the longest runway, with the most favorable wind conditions, the highest pavement strength, and the lowest straight-in instrument approach minimums.

A significant factor to consider when analyzing the generalized runway length requirements for an airport is that aircraft takeoff performance is a function of an airport's elevation, temperature, and the slope of a runway as well as the aircraft's payload vs. fuel load, stage length, and general performance characteristics. As these factors change, the runway length requirements for an aircraft change accordingly. Thus, if a runway is designed to accommodate 75% of the fleet at 60% useful load, this does not prevent larger aircraft at certain times and during specific conditions from utilizing the runway. However, the amount of time such operations can safely occur is limited.

As **Table 4-1**, *Generalized Runway Length Requirements Based on AC 150/5325-4B,* indicates both Runway 17L/35R and Runway 17R/35L meet all the runway length requirements for small aircraft and the runway length requirements for large aircraft in 75% and 100% fleet categories at 60% of the useful load. Runway 4/22 does not meet any of the runway length requirements. The generalized runway length requirements shown in **Table 4-1** were derived from the nomographs contained in AC 150/5325-4B, *Runway Length Requirements for Airport Design*.

Table 4-1
Generalized Runway Length Requirements Based on AC 150/5325-4B

Aircraft Category	Runway Designation	Current Runway Length	Runway Length Requirement	Deficiency
Small Aircraft: 12,500 pounds or less:				
95% GA Fleet	17L/35R	7,198	**3,800**	3,398
	17R/35L	7,203		3,403
	4/22	3,679		-121
100% GA Fleet	17L/35R	7,198	**4,450**	2,748
	17R/35L	7,203		2,753
	4/22	3,679		-771
100% GA Fleet with 10 or more passenger seats	17L/35R	7,198	**4,650**	2,548
	17R/35L	7,203		2,553
	4/22	3,679		-971
Large Aircraft between 12,500 and 60,000 pounds:				
75% of fleet at 60% useful load	17L/35R	7,198	**5,199**	1,999
	17R/35L	7,203	**5,329**	1,874
	4/22	3,679	**5,157**	-1,478
75% of fleet at 90% useful load	17L/35R	7,198	**7,299**	-101
	17R/35L	7,203	**7,429**	-226
	4/22	3,679	**7,257**	-3,578
100% of fleet at 60% useful load	17L/35R	7,198	**6,349**	849
	17R/35L	7,203	**6,479**	724
	4/22	3,679	**6,307**	-2,628
100% of fleet at 90% useful load	17L/35R	7,198	**9,499**	-2,301
	17R/35L	7,203	**9,629**	-2,426
	4/22	3,679	**9,457**	-5,778

Source: AC 150/5325-4B Figures 2-1, 2-2, 3-1 and 3-2. Generalized length only. Actual lengths should be calculated based on the specific aircraft's operational nomographs. Useful load refers to all usable fuel, passengers, and cargo. Calculations based on 1,790.6' airport elevation, mean maximum daily temperature of 95˚F. The runway end elevation differences for ABI are as follows: RWY 17L/35R – 14.6 ft., RWY 17R/35L – 27.9 ft., RWY 4/22 – 10.7 ft. Figures are increased 10 ft. for each foot of elevation difference between high and low points of runway centerline.

Based on this analysis, Runway 4/22 is the only runway at ABI that is insufficient for the majority of the traffic using the airfield. However, since Runway 4/22 is a crosswind runway and it is expected that it will be decommissioned at some point during the forecast period to accommodate additional development, a runway extension does not need to be considered for Runway 4/22.

The majority of the large aircraft departing from ABI, are flying to locations within the continental United States and, consequently, are not required to depart ABI at the Maximum Takeoff Weight (MTOW) with a full load of fuel to reach their destination. This assumption is not expected to change significantly during the forecast period. Therefore, based on this analysis, the length of the existing runways at ABI are expected to be sufficient to meet the vast majority of the airport's existing and forecasted aircraft operations. This conclusion will be further analyzed in the following section that analyzes ABI's runway length requirements based on the operational characteristics of specific aircraft that are expected to operate at ABI during the forecast period.

Runway Length Evaluation Based on Aircraft Planning Manuals

The sufficiency of a runway's length can also be evaluated by reviewing the performance characteristics of aircraft that currently or are forecasted to operate from an airport. Information regarding aircraft performance can typically be obtained by reviewing the Airport Planning Manuals (APM) for the aircraft that are included in the study or by contacting aircraft manufacturers.

Table 4-2, *Published Aircraft Takeoff Distances*, shows some of the larger aircraft that operated out of ABI in 2016 and the published takeoff distances for each aircraft according to the aircraft manufacturer's website.

Table 4-2
Published Aircraft Takeoff Distances

Aircraft Type	Takeoff Distance	2016 Operations #
ERJ-145	7,448	2,939
ERJ-175	5,656	None
B-737-800	6,890	50
B-737-700	5,722	36
A-321-200	6,500	10

Source: Aircraft manufacturer websites.

All takeoff distances are based on the aircraft being loaded to its MTOW, International Standard Atmospheric (ISA) conditions being present, and Sea Level (SL) altitude. While no ERJ-175 operations occurred in 2016, it has been included in this analysis as it is anticipated that this will be the critical aircraft for ABI in the future.

The takeoff distances shown in **Table 4-2** do not take into account the stage length each of these aircraft would fly out of ABI, ABI's elevation, runway slope, and the higher temperatures that ABI experiences during the summer months.

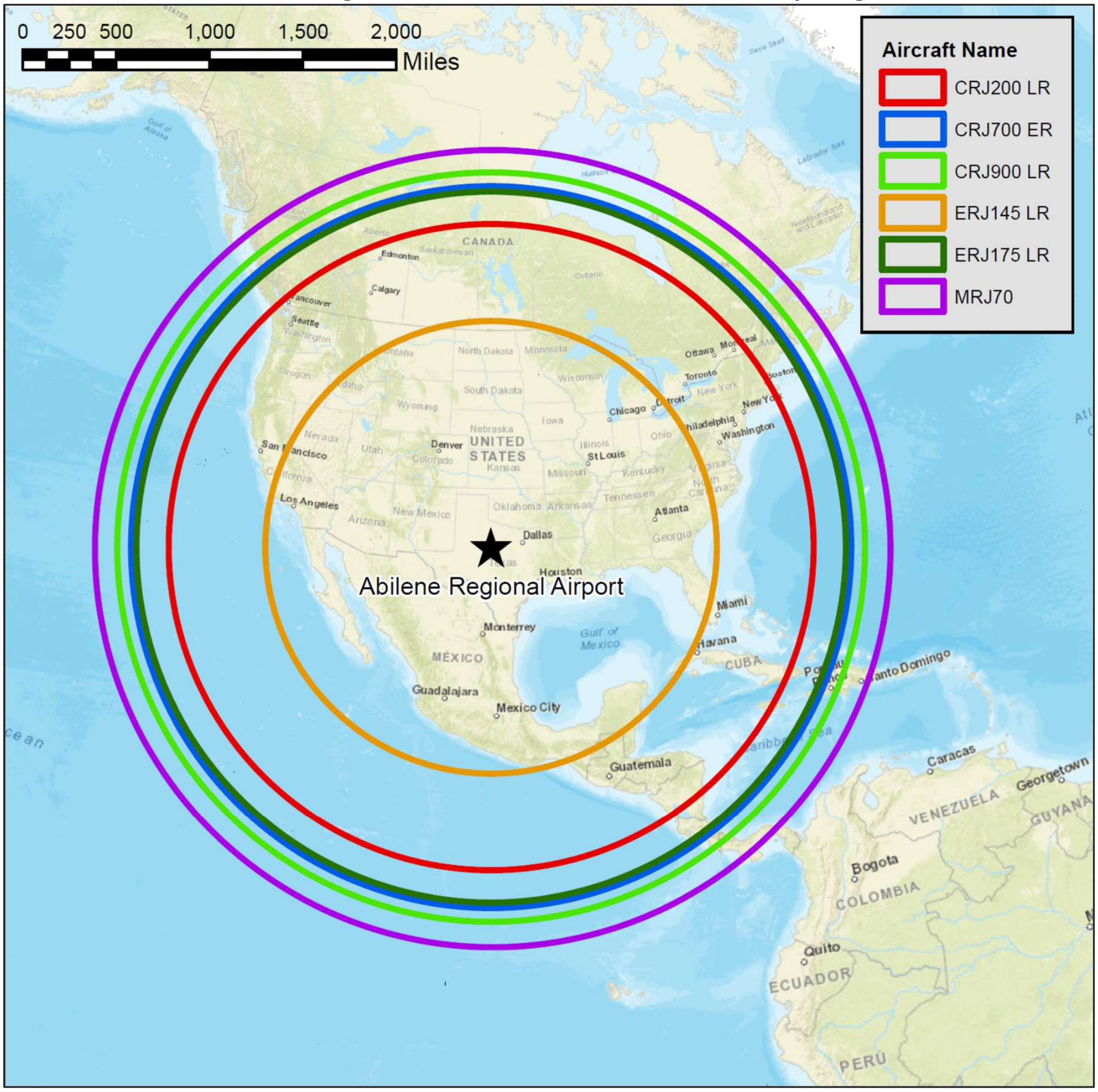
Consequently, to account for these factors, the following six aircraft makes/models were selected for an in-depth analysis to study the sufficiency of ABI's current runway length and the need for a future extension:

- Embraer Regional Jet 145 Long Range (ERJ-145 LR)
- Embraer Regional Jet 175 Long Range (ERJ-175 LR)
- Bombardier Canadair Regional Jet 200 Long Range (CRJ-200 LR)
- Bombardier Canadair Regional Jet 700 Extended Range (CRJ-700 ER)
- Bombardier Canadair Regional Jet 900 Long Range (CRJ-900 LR)
- Mitsubishi Regional Jet 70 Long Range (MRJ-70 LR)

The larger aircraft currently operating out of ABI (B-737, MD-80s) are usually diverted aircraft that fly to DFW (137 nautical miles away) when they depart ABI. Due to their limited stage length and frequency, these larger aircraft were excluded from this analysis.

Figure 4-1, *Aircraft Range Calculations Based on Current Runway Length*, shows the estimated maximum range that each of the six selected aircraft can achieve when departing ABI under International Standard Atmosphere (ISA) +15°C conditions at 85% of the aircraft's total usable payload. ISA +15°C conditions were selected for this analysis as compared to standard ISA conditions to help account for the hot summer temperatures that the Abilene area commonly receives. The range calculations for each of these aircraft were developed using the Airport Planning Manuals (APM) for the aircraft and the calculations were verified by the aircraft manufacturers.

Figure 4-1
Aircraft Range Calculations Based on Current Runway Length



Source: Aircraft Manufacturers – Airport Planning Manuals, Bombardier, Mitsubishi, Embraer

Of the six aircraft included in the evaluation, the MRJ-70 LR, CRJ-700 ER, CRJ-900 LR can all depart ABI at their established MTOW under ISA +15°C conditions at the existing runway lengths. This means that these aircraft can already achieve their maximum range from ABI utilizing the existing runway infrastructure. Consequently, a runway extension would not allow for a range increase for these aircraft when departing out from ABI.

The remaining three aircraft, the ERJ-145 LR, ERJ-175 LR, and CRJ-200 LR cannot depart ABI at their established MTOW under ISA +15°C conditions meaning that a runway extension would enable a range increase for these aircraft. Based on ABI's current runway length, the ERJ-145 LR could achieve a maximum range of 1,050 Nautical Miles (NM), the ERJ-175 LR could achieve a maximum range of 1,650 NM, and the CRJ200 LR could achieve a maximum range of 1,500 NM when departing ABI.

According to the APMs for these three aircraft and based on calculations run by Embraer and Bombardier, ABI's runway length would need to be extended to the following lengths for these aircraft to achieve their maximum range out of ABI under ISA +15°C conditions:

- 8,120 ft. in length for the ERJ-145 LR to depart ABI at its MTOW (assuming 85% payload) to achieve a maximum range of 1,520 NM
- 8,100 ft. in length for the ERJ-175 LR to depart ABI at its MTOW (assuming 85% payload) to achieve a maximum range of 1,950 NM
- 7,392 ft. in length for the CRJ 200 LR to depart ABI at its MTOW (assuming 85% payload) to achieve a maximum range of 1,590 NM

While these aircraft are not able to currently depart ABI at the established MTOW under ISA +15°C conditions, the CRJ-200 LR and ERJ-175 LR can still reach every major hub airport in the United States using the ABI's existing runway length. Also, the ERJ-145 LR can reach most major airline hubs in the United States with the exception of hubs in the northwestern and northeastern portions of the United States using ABI's existing runway length.

It should be noted that the ERJ-175, which is expected to become ABI's critical aircraft in the future, has a shorter Takeoff Field Length (TOFL) than the ERJ-145 that currently operates at the airport. Additionally, the majority of the newer regional jet aircraft that are currently being manufactured or are expected to be manufactured in the near future have airframes and engines that are more efficient than the existing ERJ-145 fleet. Consequently, it is not expected that the TOFL of newer regional jets will be longer than the TOLF for the ERJ-145 or ERJ-175.

Based on this analysis, it is expected that the existing runway length at ABI should be sufficient to accommodate future demand unless ABI's fleet mix and aircraft stage length requirements change.

Runway Length Analysis Conclusions

Based on the runway length analysis it is expected that the length of the existing runways at ABI should be sufficient to handle the anticipated aircraft traffic during the forecast period. However, a runway extension will be considered in the alternatives chapter to ensure sufficient space is reserved to expand the runways at ABI if the need should arise beyond the 20-year planning horizon or if industry/economic conditions dictate a significant change to ABI's future fleet mix.

Runway Strength

FAA AC 150/5320-6E, *Airport Pavement Design and Evaluation*, provides guidance on the structural design of airport pavements. The FAA requires the use of the pavement design program, FAARFIELD, to determine the pavement section that will support the various aircraft gear loadings. The design is be based on a 20-year life cycle. FAARFIELD analyzes the damage to the pavement done by each aircraft and determines the final pavement thickness/structure based on the total cumulative damage of all aircraft.

The published runway pavement strength for each of the runways at ABI is shown in **Table 4-3**, *Existing Runway Weight Bearing Capacity*.

Table 4-3
Existing Runway Weight Bearing Capacity

Gear Configurations	Runway 4/22	Runway 17L/35R	Runway 17R/35L
Single Wheel Gear (S)	30,000	85,000	85,000
Dual Wheel Gear (D)	60,000	160,000	160,000
Dual Tandem (2D)	N/A	160,000	160,000
PCN	5 /F/D/X/T	57 /F/C/X/T	61 /F/C/X/T

Source: ABI 5010

Table 4-4, *Existing Fleet Mix MTOW and Gear Configurations,* shows the landing gear configuration and MTOW of the larger aircraft currently operating at ABI.

Table 4-4
Existing Fleet Mix MTOW and Gear Configurations

Aircraft	Gear Configuration	MTOW (lbs.)
ERJ-145	Dual Wheel	48,502
ERJ-175	Dual Wheel	82,673
B-737-700	Dual Wheel	154,500
B-737-800	Dual Wheel	174,200
A321-200	Dual Wheel	171,961
C-130	Single Tandem	155,000

Source: Aircraft manufacturer websites.

The only aircraft currently operating at ABI on a regular basis that has a gear configuration and MTOW that exceeds the established weight bearing capacity of the air carrier runways (Runway 17R/35L and 17L/35R) is the B-737-800. The B-737-800 aircraft using ABI typically takeoff at a weight under their established MTOW. ABI does not have regular airline service with B-737-800 aircraft. The B-737-800 aircraft that do use ABI are typically diverted aircraft that stop at ABI temporarily until they can fly to DFW. Consequently, these aircraft typically depart ABI without a full load of fuel, resulting in a lower actual takeoff weight.

The frequency of larger aircraft traffic utilizing ABI that could exceed the established runway weight bearing capacity is expected to be primarily driven by aircraft diversion traffic and not aircraft using ABI as a point of origin or destination for scheduled airline service. It is not expected that any modifications to the existing runway pavement will be needed during the forecast period to improve the pavement's weight bearing capacity. However, if ABI attracts a large aircraft Maintenance, Repair, and Overhaul (MRO) operation or an aeronautical business that utilizes larger aircraft, the sufficiency of the current runway pavement strength will need to be revisited.

Runway Alignment

An evaluation of runway alignment is based on crosswind coverage and velocity and is based on the FAA guidance provided in FAA Advisory Circular 150-5300-13 (current series), *Airport Design*. In general, the FAA deems a runway to have sufficient wind coverage when the wind coverage is 95% or better for the runway's allowable crosswind component which is based on the runway's Runway Design Code (RDC).

As discussed in the Forecast Chapter, Chapter 3, the RDC for Runway 17L/35R and 17R/35L is C-III which has an allowable crosswind component of 16 knots. The RDC for Runway 4/22 is B-II which has an allowable crosswind component of 13 knots.

Table 4-5, *Runway Crosswind Coverage,* shows the crosswind coverage percentages for each runway at ABI and the combined runway wind coverage percentage.

Table 4-5
Runway Crosswind Coverage

	All Weather Wind Coverage %			IFR Wind Coverage %			VFR Wind Coverage %		
Runway	**10.5 Knots**	**13 Knots**	**16 Knots**	**10.5 Knots**	**13 Knots**	**16 Knots**	**10.5 Knots**	**13 Knots**	**16 Knots**
17L/35R & 17R/35L	94.53%	97.48%	99.16%	95.26%	97.35%	98.84%	94.38%	97.45%	99.17%
4/22	80.67%	89.29%	96.22%	80.67%	88.70%	95.03%	80.58%	89.26%	96.27%
Both	97.58%	98.99%	99.65%	97.28%	95.56%	99.27%	97.58%	99.02%	99.68%

Source: FAA Airports – GIS Wind Analysis Tool using ABI wind data as generated by the FAA's GIS tool. Completed 11/13/17.

As presented, Runways 17L/35R and 17R/35L meet the FAA wind coverage requirement (95% or more) for their RDC (C-III) crosswind component of 16 knots. A crosswind runway is not required per AC 150/5300-13 (current series). Runway 4/22 does not meet the FAA wind coverage requirement for its design category (B-II).

Instrument Approach Procedures

Instrument Approach Procedures (IAPs) are critical to ensuring the usability of a runway during poor weather conditions. IAPs provide guidance to pilots via land-based equipment or GPS satellites that aid them in executing an approach to land on a runway when a visual approach to the runway is not possible. The types of IAPs vary widely, however they can generally be segmented into three primary categories: precision, non-precision, and circling approaches. Precision instrument approaches are approaches where a pilot is provided with both vertical and horizontal guidance and the visibility minimums for the approach are below ¾ of a mile. Non-precision instrument are any straight-in instrument approaches with visibility minimums not lower than ¾ of a mile. Circling approaches are instrument approaches that do not provide an aircraft with a straight-in approach to a runway.

ABI currently has one precision instrument approach to Runway 35R, non-precision instrument approaches to Runway 17R, 17L, and 22, and one VOR-based circling approach. No instrument approach currently exists to Runway 35L. Since Runway 35R is the only runway with a precision instrument approach, ABI is subject to reduced operational capacity if Runway 17L/35R has to be closed. The feasibility of developing a precision approach with ½ visibility minimums to Runway 17R will be considered in the alternatives chapter to improve the operational capacity of ABI during poor weather conditions. However, based on historic weather data, weather below the existing Runway 17R LOC IAP minimums and winds favoring a Runway 17L/R flow only occur approximately 0.4% of the year.

The development of a GPS based non-precision approach to Runway 35L with 1 mile visibility minimums will be also considered to ensure instrument approach access to ABI when aircraft traffic is in a south flow pattern and Runway 35R is closed.

Magnetic Declination

As discussed in the inventory chapter, the current magnetic variation at ABI as shown on the FAA published airfield diagram is 5.3^{O} East with a 0.1^{O} West annual change. Currently, the established magnetic heading for each runway is shown below:

- Runway 17R/35L – 174.5 ^{O} and 354.5 ^{O}
- Runway 17L/35R– 174.5 ^{O} and 354.5 ^{O}
- Runway 4/22 – 47 ^{O} and 227 ^{O}

Based on the established annual rate of change, in approximately 5 years Runways 17R/35L and 17L/35R will have magnetic headings of 175 ^{O} and 355 ^{O} and will continue to move closer to magnetic headings that would be more in alignment with Runway 18/36 designations. Currently, Runway 4/22 should be more accurately labelled as Runway 5/23. The timing of the runway designation changes will be discussed in Capital Improvement Chapter of this Master Plan. Since Runway 4/22 is expected to be closed at some point during the forecast period the re-designation of Runway 4/22 may not be required.

Airport Design Considerations

Compliance with airport design standards is vitally important because compliance with these standards aids an airport in maintaining a minimum level of operational safety. The major airport design elements are established by FAA AC 150/5300-13 (current series). Ideally, airports should conform with all established FAA airport design standards without requiring a Modification to Standards (MOS). Frequently this is not possible as many airports have infrastructure that was designed before the current design standards were established. In these cases, airport operators are generally required to improve the facilities to the new design standards if they accept FAA grant funds to rehabilitate or improve that particular facility.

Table 4-6, *Runway Design,* provides an overview of the FAA Design Standards and the current runway facilities at ABI.

Table 4-6
Runway Design

Item	FAA Design Standard (C-III RWY)	Runway 17L/35R	Runway 17R/35L	FAA Design Standard (B-II-5,000 RWY)	Runway 4/22
Runway Design:					
Width (ft)	150	150	150	75	100
RSA Width (ft)	500	500	500	150	150
RSA Length beyond R/W end (ft)	1000	1000	1000	300	300
OFA Width (ft)	800	800	800	500	500
OFA Length beyond R/W end (ft)	1000	1000	1000	300	300
ROFZ Width (ft)	400	400	400	400	153-167
ROFZ Length beyond R/W end (ft)	200	200	200	200	200
Runway Setbacks -Runway Centerline to:					
Parallel Taxiway Centerline (ft)	400	400	500	240	250
Holdline (ft)	268	268	268	200	153-167
Aircraft Parking Area (ft)	500	650	None	250	300

Source: FAA AC 150/5300-13* deficiencies in red.

Currently, ABI has no deficiencies related to its runway width, Runway Safety Areas (RSA), Runway Object Free Areas (ROFA), runway to parallel taxiway separation, and aircraft parking area separation standards. There are some runway design issues with Runway 4/22 related to the runway's Runway Obstacle Free Zone (ROFZ) and the placement of the runway hold position markings for the runway.

Each of these aspects of runway design are discussed in more depth in the subsections below. An analysis of the Runway Protection Zones (RPZs) is also provided later in this chapter.

Runway Width

FAA AC 150/5300-13 (current series delineates the requirements for runway width. At present, both Runway 17R/35L and Runway 17L/35R are 150 ft. wide. This width meets the minimum runway width recommended in AC 150/5300-13 for runways with a C-III RDC which is 150 ft.

Runway 4/22 is 100 ft. wide which is 25 ft. wider than the required width of a runway with a B-II RDC (75 ft.). Runway 4/22 is primarily used by small aircraft when crosswinds for the parallel runways are strong. If Runway 4/22 is ever rehabilitated, reducing the width of Runway 4/22 should be considered.

ABI's critical aircraft is forecasted to remain in the C-III category throughout the forecast period. The existing runway width is expected be sufficient for the duration of the forecast period.

Runway Safety Area

The Runway Safety Area (RSA) is a two-dimensional area surrounding a runway that is centered along the runway centerline and extends beyond the edges of the useable runway pavement. RSA's are provided to reduce the risk of damage to airplanes in the event of undershoot, overshoot, or excursion from the runway pavement. RSAs must be free of objects, except those required for air navigation, and be graded to transverse and longitudinal standards to prevent water accumulation. Objects located in the RSA that are over 3 inches above grade must be constructed, to the extent practical, on frangible mounted structures with a frangible point no higher than 3 inches above grade. Under dry conditions, the RSA must support Aircraft Rescue and Fire Fighting (ARFF) equipment, snow removal equipment, and the occasional passage of aircraft without causing damage to the aircraft.

The FAA recommends airports own the entire RSA in "fee simple" title. Based on RDC C-III design standards, the RSAs for Runways 17L/35R and 17R/35L should extend beyond the end of the runway for 1,000 ft. and be 500 ft. wide (250 ft. each side of the runway centerline) with a grade not steeper than 3%. These standards are met on both of the parallel runways. Runway 4/22 is a B-II runway which requires an RSA that extends 300 ft. beyond the ends of the runway and that is 150 ft. wide (75 ft. each side of the runway centerline). This standard is met for Runway 4/22.

Since the Forecast Chapter, Chapter 3, identified that ABI is expected to remain in the C-III RDC during the 20-year planning horizon, no improvements to the RSAs at ABI are expected to be necessary during the forecast period.

Runway Object Free Area

The Runway Object Free Area (ROFA) is a two-dimensional area surrounding a runway that is centered along the runway centerline. The ROFA must be clear of objects except those used for air navigation or aircraft ground maneuvering purposes and clear of above-ground objects protruding higher than the elevation of the RSA at the closest adjacent point. An object is considered any terrain, structure, navigational aid, people, equipment, or parked aircraft. The FAA recommends that an airport own the entire ROFA in "fee simple" title.

Currently, FAA Airport Design criteria for a RDC C-III runway requires the ROFA to be 800 ft. wide (400 ft. each side of the runway centerline) and extend 1,000 ft. beyond each runway end. Runway 17R/35L and 17L/35R meet this requirement. FAA Airport Design criteria for a RDC-B-II runways requires the ROFA to be 500 ft. wide and extend 300 ft. beyond each runway end. Runway 4/22 meets these requirements.

Since the Forecast Chapter, Chapter 3, identified that ABI is expected to remain in the C-III RDC during the 20-year planning horizon, no improvements to the ROFAs at ABI are expected to be necessary.

Obstacle Free Zone

The Obstacle Free Zone (OFZ) is a volume of airspace above and centered along the runway centerline. The OFZ precludes taxiing and parked airplanes and object penetrations except for objects required to be located in the OFZ due to their function. OFZs can have a number of different components including a Runway Obstacle Free Zone (ROFZ), inner-transitional OFZ, inner approach OFZ, and a Precision Obstacle Free Zone (POFZ). The ROFZ applies to all the runways at ABI. Currently, the Inner-transitional OFZ, inner-approach OFZ, and POFZ only apply to Runway 35R because it is the only runway with a precision instrument approach and an approach lighting system. The status of all four OFZ surfaces are discussed below.

Runway Obstacle Free Zone (ROFZ)

The length of a ROFZ is fixed at 200 ft. beyond the associated runway end but the width is dependent upon the size of the aircraft using the runway (small – less than 12,500 lbs. or large – greater than 12,500 lbs.) and the visibility minimums for the lowest instrument approach to the runway. The ROFZ width for all three runways at ABI is 400 ft. wide (200 ft. each side of the runway centerline). The elevation of the ROFZ is equal to the closest point along the runway centerline.

Runways 17R/35L and 17L/35R meet the established ROFZ requirements. Runway 4/22 does not meet established ROFZ standards. As mentioned previously, all portions of the OFZ (including the ROFZ) preclude taxiing or parked aircraft. This includes aircraft stopped at a runway hold position markings associated with the runway. The runway hold position markings for Runway 4/22 vary between 153 ft. and 167 ft. from the Runway 4/22 centerline. For Runway 4/22, the runway hold position markings should be set 200 ft. back from the runway centerline to properly protect the ROFZ. Because these runway hold position markings are too close to the Runway 4/22 centerline it is possible for taxing aircraft to be penetrate the Runway 4/22 ROFZ while the runway is in use.

Figure 4-2, *Runway 4/22 ROFZ,* displays this issue. This issue will be considered during the development of alternatives.

Figure 4-2
Runway 4/22 ROFZ

Source: Garver, 2017

Inner Approach OFZ

Runway 35R has a MALSR approach lighting system. Consequently, an inner approach OFZ is applicable. The inner approach OFZ begins at the end of the ROFZ (200 ft. beyond the runway end) and extends to a point 200 ft. beyond the last lighting unit the MALSR system (2,600 ft. beyond the runway end). Consequently, the total inner approach OFZ is 2,400 ft. in length. Additionally, the inner approach OFZ rises at a 50:1 slope from the edge of the ROFZ and remains the same width as the ROFZ (400 ft.). The current inner-approach OFZ for Runway 35R meets the established FAA standards.

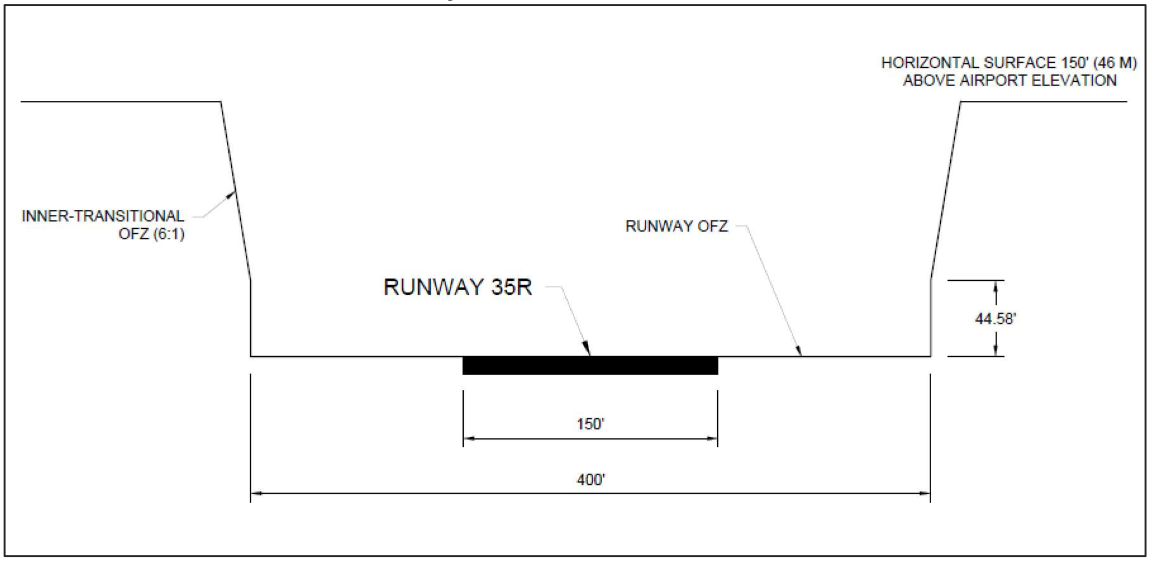
Inner Transitional OFZ

The inner transitional OFZ is a defined volume of airspace along the sides of the ROFZ and inner approach OFZ. It applies only to runways with lower than ¾ statue mile approach visibility minimums.

Runway 35R has an ILS approach with visibility minimums of ½ mile. Since these visibility minimums are below ¾ mile an inner-transitional OFZ is applicable.

Figure 4-3, *Runway 35R Inner Transitional OFZ,* displays the inner approach OFZ configuration for Runway 35R its relationship to the ROFZ and inner transitional OFZ.

Figure 4-3
Runway 35R Inner Transitional OFZ



Source: Garver, 2017

For category 1 ILS runways, the inner transitional OFZ begins at the edges of the ROFZ and inner-approach OFZ and then rises vertically to a height ("H") which is calculated using the following formula:

$$H = 61 - 0.094(S) - 0.003(E)$$

"S" is equal to the most demanding wingspan of the RDC of the runways which, for ABI, is 118 ft. "E" is equal to the runway threshold elevation above sea level which, for ABI, is 1,775.9 ft. MSL. Based on this formula, "H" equals 44.58 ft. for Runway 35R and 44.63 ft. for Runway 17R.

After rising to a height of "H", the inner transitional OFZ then slops outward at a 6:1 slope until reaching 150 ft. above the established airport elevation (1,790.6 ft. MSL).

The inner transitional OFZ for Runway 35R currently meets all established FAA standards.

Precision OFZ (POFZ)

The final OFZ surface that applies to Runway 35R is the Precision Obstacle Free Zone (POFZ). The POFZ is a defined volume of airspace above an area beginning at the threshold of the runway that extends to 200 ft. beyond the end of the runway and is 800 ft. wide, centered along the extended runway centerline. The volume of airspace begins at the threshold elevation for the applicable runway end. The wing of an aircraft may penetrate the POFZ but penetrations involving an aircraft fuselage or tail are not permitted. Runway 35R is the only runway at ABI that requires a POFZ. The POFZ for Runway 35R begins at the runway threshold elevation for

Runway 35R which is 1,775.9 ft. MSL. The POFZ for Runway 35R meets all established FAA standards.

Runway Hold Position Markings

The runway hold position markings (or holdlines) denote the entrance to the runway from a taxiway and the location where aircraft are supposed to stop when approaching the runway. Their location is prescribed by FAA AC 150/5300-13 (current edition). They are generally located across the centerline of a given taxiway within 10 ft. of an associated runway hold position sign. According to FAA standards, the holdlines for Runway 17R/35L and Runway 17L/35R should be located at least 268 ft. from the runway centerline on both runways. All of the runway hold position markings associated with Runway 17R/35L and Runway 17L/35R are located the proper distance from the runway centerline.

The holdlines for Runway 4/22 should be located 200 ft. from the runway centerline. As discussed in the OFZ section, the runway hold position markings for Runway 4/22 are located too close to the Runway 4/22 centerline allowing aircraft to potentially penetrate the ROFZ. Options to remedy this issue will be discussed in the Alternatives Chapter. If the runway hold position markings are relocated the associated runway hold position signage will have to be relocated as well.

Parallel Runway Separation Standards

AC 150/5300-13 (current edition) discusses parallel runway separation standards and the types of aeronautical operations that can be conducted based on the separation that exists between parallel runways. Runway 17R/35L and Runway 17L/35R currently have 3,100 ft. of separation (centerline to centerline). This separation is sufficient to allow simultaneous takeoffs or landings under Visual Flight Rules (VFR) rules. The ability to conduct simultaneous IFR approach to the runway would have to be studied further and coordinated with the FAA. With the provision of special radar and monitoring equipment, the FAA will allow simultaneous IFR approaches on parallel runways separated by as little as 3,000 ft. Based on the forecast it is not expected that the demand for instrument approaches will reach a level where the need for simultaneous instrument approaches will arise.

Runway to Parallel Taxiway Separation Standards

According for AC 150/5300-13 (current edition) the minimum necessary runway centerline to parallel taxiway centerline separation for a runway with an RDC of C-III is 400 ft. As previously mentioned, both Runway 17R/35L and 17L/35R are C-III runways. Currently, 500 ft. of separation exists between Runway 17L/35R and Taxiway Delta and 400 ft. of separation exists between Runway 17R/35L and Taxiway Charlie. Both runways meet the current minimum runway to parallel taxiway separation standards established by the FAA. It is not anticipated that the runway to parallel taxiway separation will need to be modified during the forecast period.

Building Restriction Line

According to AC 150/5300-13 (current series) the Building Restriction Line (BRL) represents the boundary where it is generally suitable or unsuitable to develop buildings such as hangars, terminals, or other facilities. The BRL is established based on an airport's FAR Part 77 imaginary surfaces, Runway Protection Zones (RPZs), Obstacle Free Zones (OFZ), Object Free Areas (OFA), runway visibility zones, NAVAID critical areas, and approach surfaces. Based on existing instrument approach procedures, the Runway 17L/35R primary surface is 1,000 ft. wide (500 ft. each side of the runway centerline) and extends 200 ft. beyond each runway end. The primary surface for Runway 17R/35L and Runway 4/22 is 500 ft. wide (250 ft. each side of the runway centerline) and extends 200 ft. beyond each runway end.

The transitional surface slopes up (7:1) from the primary surface to the horizontal surface which is 150 ft. above airport elevation (airport elevation is 1,790.6 ft. MSL). Buildings should not penetrate the transitional surface at any point. Based on the activity at the field, instrument approach procedures, and RDC, to avoid transitional surface penetrations, the 35.0 ft. BRL should be 745 ft. from the Runway 17L/35R centerline and 495 ft. from the Runway 17R/35L and Runway 4/22 centerline.

Currently, there are no buildings located with the existing BRLs surrounding Runway 17R/35L and Runway 17L/35R. Portions of the FedEx building and the AvFuel building are located within the 35 ft. BRL for Runway 4/22. At its closest point, the FedEx building is approximately 385 ft. from the Runway 4/22 centerline. At this point, the transitional surface is at a height of 19.29 ft. above the elevation of the Runway 4/22 centerline which is slightly above the height of the FedEx Building at this point. At its closest point the AvFuel building is 490 ft. from the Runway 4/22 centerline. However, its building height is well below 35 ft., so it does not penetrate the transitional surface for Runway 4/22.

All future developments should be located outside of the BRL. Placing buildings inside the BRL is possible if the height of a building is minimized. Locating buildings inside the BRL may hamper the options for expanding ABI in the future.

Runway Line-Of-Sight

To ensure the safety of aircraft operations at an airport it is imperative that proper lines of sight exist along a single runway and amongst intersecting runways. These lines of sight facilitate coordination amongst aircraft and vehicles operating on a runway(s) by allowing them to identify the position of other aircraft or vehicles operating on the same runway or on an intersecting runway.

On a single runway, an acceptable runway profile permits any two points, generally each runway end, 5 ft. above the runway centerline, to be mutually visible for the entire runway length. If the runway offers a full-length parallel taxiway, an unobstructed line of sight should exist from any point 5 ft. above the runway centerline to any other point 5 ft. above the runway centerline for one-half the runway length. There are no single runway line of sight issues for the runways at ABI.

On intersecting runways, an acceptable runway profile permits visibility between established points on each intersecting runway so aircraft operators and vehicle operators can see other aircraft or vehicles operating on the intersecting runway. ABI does not have any intersecting runways, so these standards are not applicable.

Runway Protection Zone

The purpose of the Runway Protection Zone (RPZ) is to enhance the protection of people and property on the ground, and to prevent developments that are incompatible with aircraft operations. The FAA recommends that airports own the entire RPZ in "fee simple" title and that the RPZ be clear of any non-aeronautical structure or object that would interfere with the arrival and departure of aircraft. If "fee simple" interest is unachievable, the next option is controlling the heights of objects through an avigation easement and keeping the area clear of any facilities that would support an incompatible activity (e.g., places of public assembly, etc.). An avigation easement is an agreement between the airport sponsor and a landowner that grants the airport sponsor various privileges related to the landowner's property and limit the potential impact to aircraft operations.

The RPZ is a two-dimensional trapezoidal area that normally begins 200 ft. beyond the paved runway end and extends along the runway centerline. When it begins somewhere other than 200 ft. from a runway end, there is a need for two RPZs, an approach RPZ and a departure RPZ. The approach RPZ begins 200 ft. from the runway threshold. A departure RPZ begins 200 ft. beyond the end of runway pavement or 200 ft. from the end of the Takeoff Runway Available (TORA), if established.

An FAA Interim Guidance Letter (IGL) (Sept 2012) addressed acceptable property uses within an RPZ. The IGL was released to specify and emphasize existing use standards and indicates that if any of the following parameters are met then the RPZ ownership must be reevaluated:

- An airfield project (e.g., a runway extension, runway shift)
- A change in the critical design aircraft that increases the RPZ size
- A new or revised instrument approach procedure that increases the RPZ dimensions
- A local development proposal in the RPZ (either new or reconfigured)

Land uses within an RPZ that require specific and direct coordination with the FAA include:

- Buildings and structures
- Recreational land uses
- Transportation facilities
- Rail facilities
- Public road/highways
- Vehicular parking facilities
- Fuel storage facilities
- Hazardous material storage
- Wastewater treatment facilities
- Above-ground utility infrastructure

RPZ dimensions are determined by the type/size of aircraft expected to operate at an airport and the type of approach, existing or planned, for each runway end (visual, precision, or non-precision). The recommended visibility minimums for the runway ends are determined with respect to published instrument approach procedures, the ultimate runway RDC, airfield design standards, instrument meteorological conditions, wind conditions, and physical constraints (approach slope clearance) along the extended runway centerline beyond the runway end. **Table 4-7**, *Runway Protection Zone Dimensions*, delineates the current RPZ requirements at ABI.

Table 4-7
Runway Protection Zone Dimensions

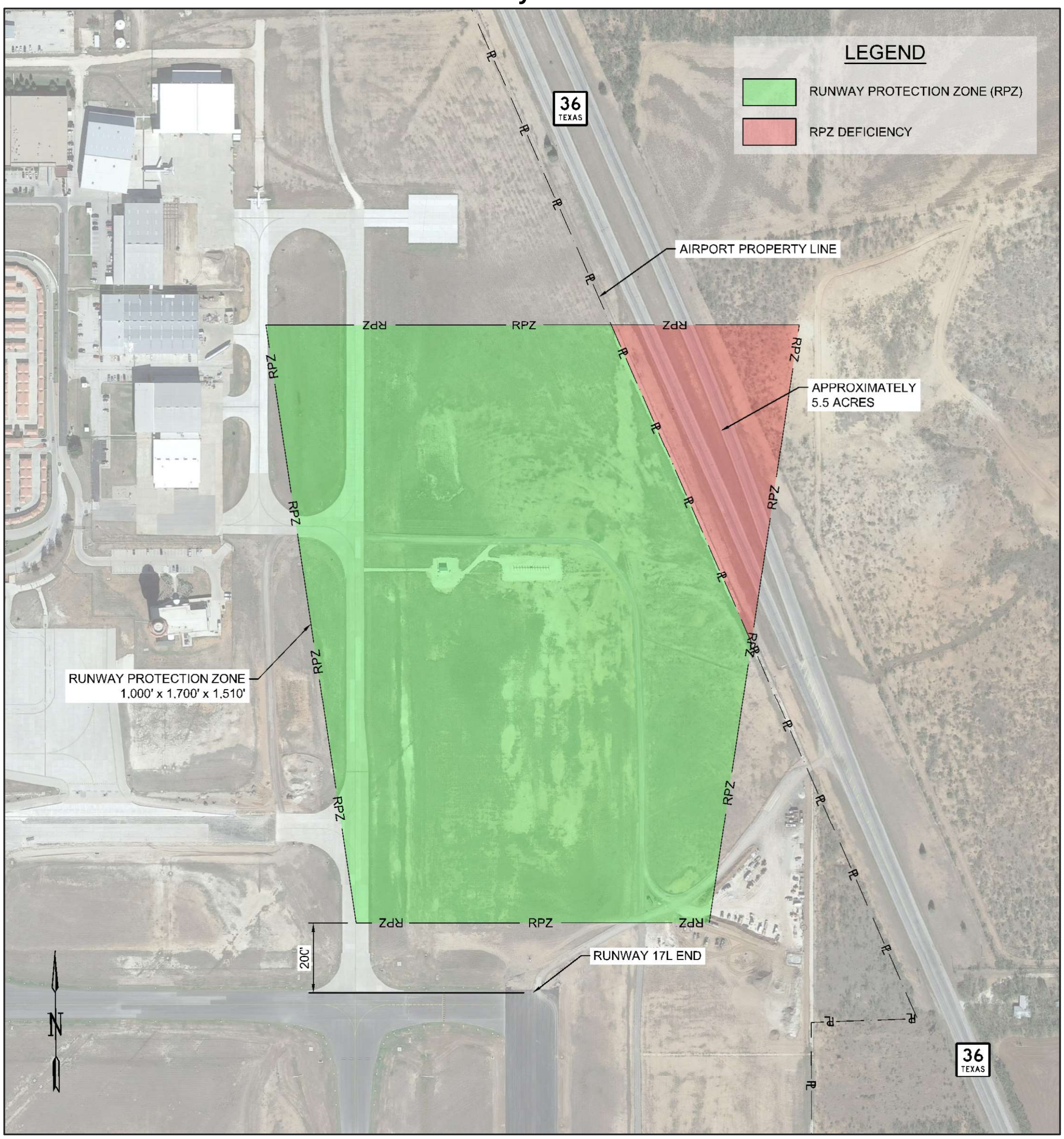
Runway End (s)	Approach Visibility Minimums	Facilities Expected to Serve (AAC - ADG)	Length (ft)	Inner Width (ft)	Outer Width (ft)	Acres
Runway 35R	Lower than 3/4 Mile	C-III	2,500	1000	1750	78.914
Runway 17L	Not Lower than ¾ Mile	C-III	1,700	1,000	1,510	48.978
Runway 35L	Visual	C-III	1,700	500	1,010	29.465
Runway 17R	Not Lower than 1 Mile	C-III	1,700	500	1,010	29.465
Runway 4	Visual	B-II	1000	500	700	13.77
Runway 22	Not Lower than 1 Mile	B-II	1000	500	700	13.77

Source: FAA Advisory Circular 150/5300-13 (current series).

Several of the RPZs at ABI extend outside of airport property. Currently, the RPZ's at the approach ends of Runway 17L, 17R, and 35R all extend outside of the ABI's established property line. Highway TX-36 runs through portions of the RPZ for Runways 17L and 17R. Based on the research performed as part of this master plan, it does not appear that any avigation easements exist on the properties where the RPZ extends outside of airport property. Consequently, where appropriate, property acquisition and avigation easements will be considered in the alternatives section of this master plan. Fortunately, with the exception of TX-36, the segments of the RPZ's outside of ABI's property line are generally undeveloped.

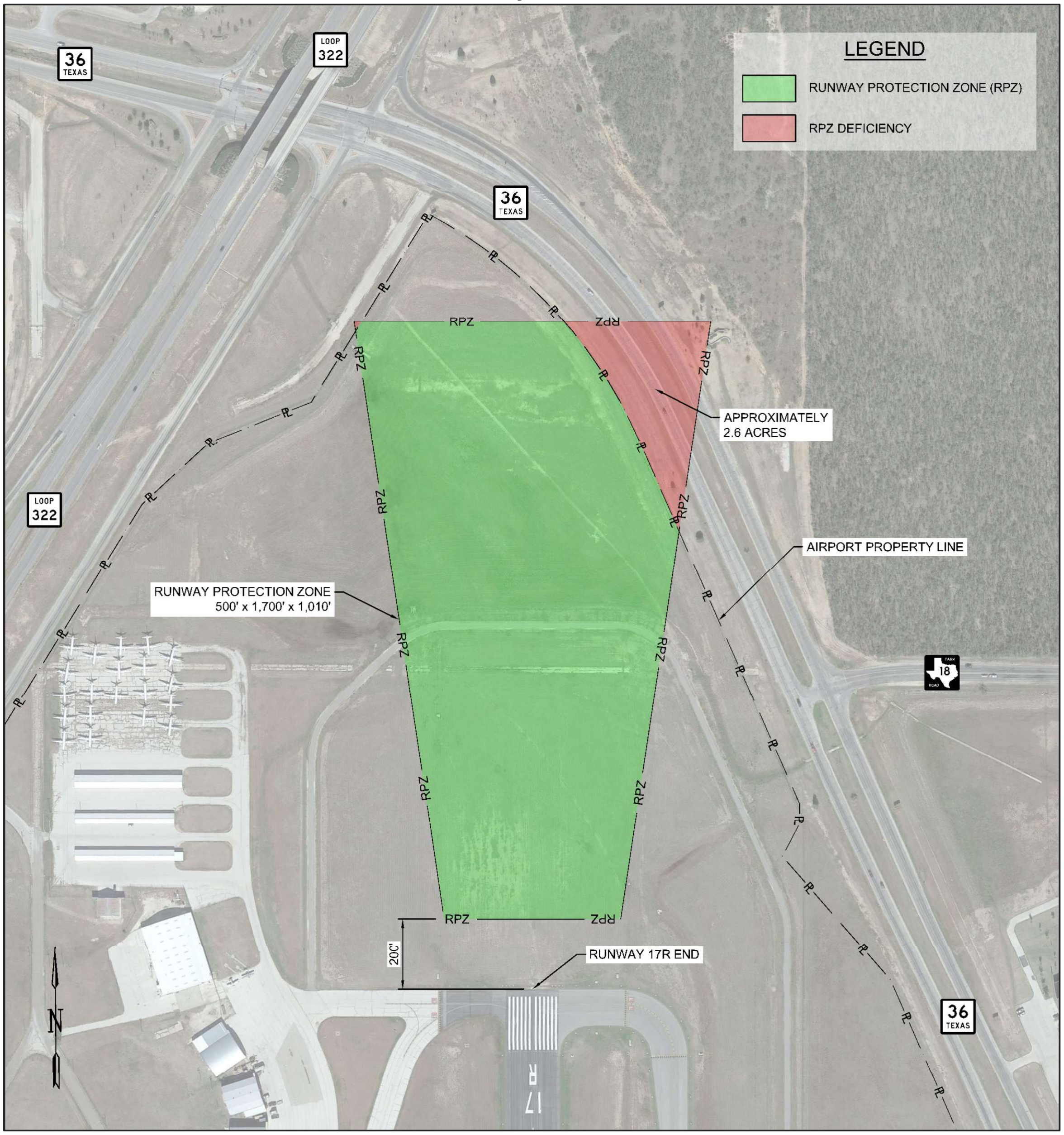
Figure 4-4, *Runway 17L RPZ*, **4-5**, *Runway 17R RPZ,* **and 4-6**, *Runway 35R RPZ,* depict the existing RPZs and highlights the portions outside of airport property.

Figure 4-4
Runway 17L RPZ



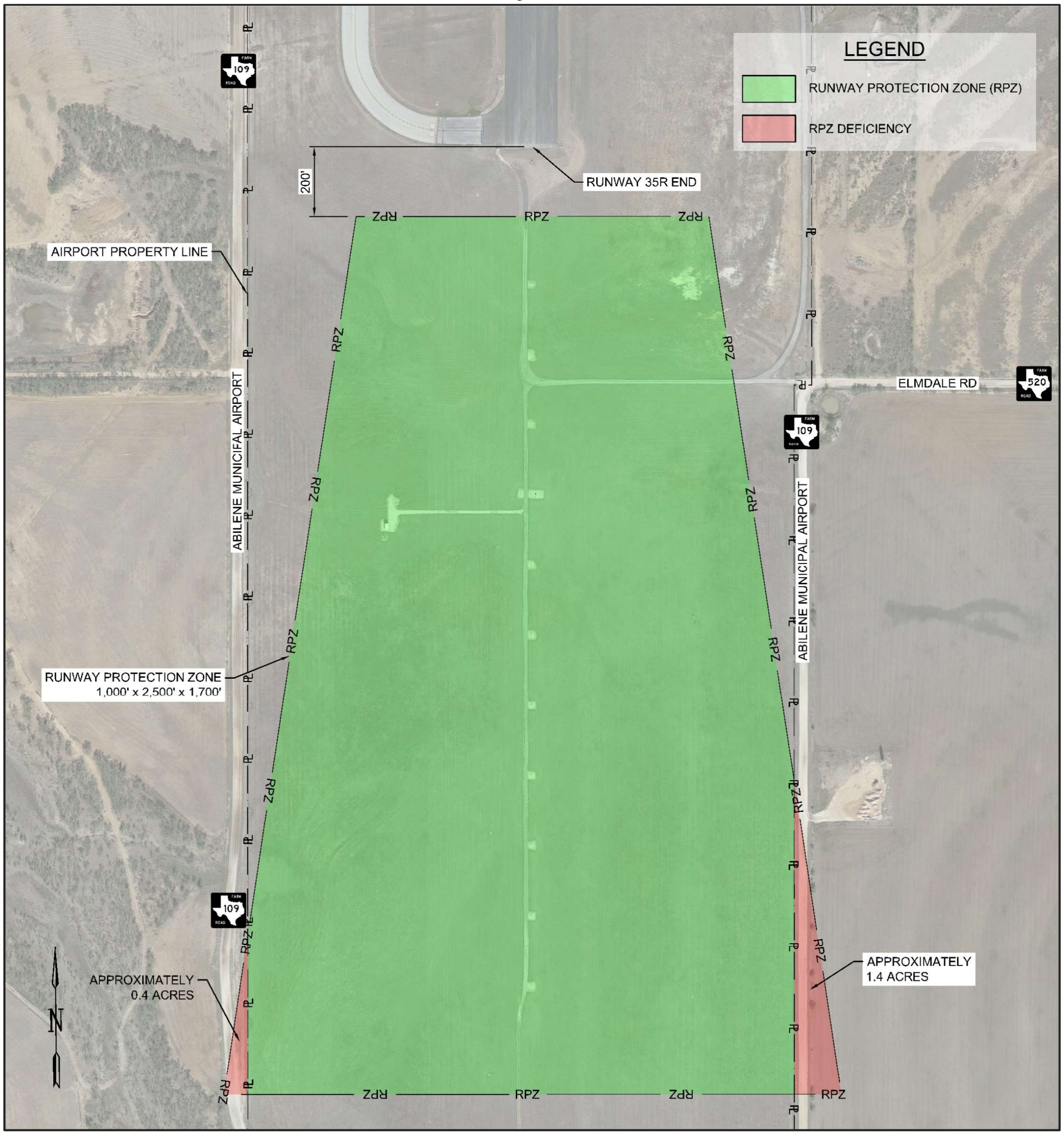
Source: Garver, 2017

Figure 4-5
Runway 17R RPZ



Source: Garver, 2017

Figure 4-6
Runway 35R RPZ



Source: Garver, 2017.

Considerations for ensuring the airport has sufficient control over the existing and ultimate RPZs will be considered in the Alternatives Chapter.

Taxiway Design Standards

In general, taxiway design can be segmented into two general categories:

1. Taxiway Pavement Design
2. Taxiway Layout Based on Aircraft Design Group (ADG)

Each of these design categories play a critical role in evaluating the sufficiency of taxiway pavements at an airport both now and in the future.

Taxiway Pavement Design

Taxiway pavement design is complex because it is largely based on landing gear configurations which vary widely amongst different aircraft types. The FAA has classified the numerous variations of land gear configurations into eight Taxiway Design Groups (TDG) that now guide taxiway pavement design.

Existing Taxiway Pavement Design

Taxiway pavement design standards have changed significantly over the past 10 years. Prior to 2012, taxiway pavement design was based on Aircraft Design Group (ADG), which categorizes aircraft based on wingspan and tail height. In 2012, when TDG standards came into effect, taxiway pavement design and fillet dimensions changed significantly. These standards went through another minor revision in 2014.

The most significant changes that occurred as a result of the transition from ADG to TDG based pavement design standards; the requirements for taxiway fillet dimensions increased and the general layout for pavement fillets changed. Consequently, at many airports, any taxiway pavements that were designed prior to 2012 do not meet the need TDG based standards. As a result, as these taxiway pavements are re-constructed they need to be re-designed to current TDG-based standards.

The taxiways at ABI are no different. The taxiways associated with Runway 4/22 and Runway 17L/35R are designed to older pavement design standards that were in effect prior to the new TDG standards being instituted. Consequently, the taxiway fillets in these areas do not follow the existing TDG standards and practices. Many of the taxiway's associated with the air carrier ramp, Runway 17R/35L, and Taxiways N, M, and P were redesigned in 2012 and 2013. Consequently, these taxiways more closely follow the existing TDG based design standards.

It should also be noted that most of the existing taxiway pavements at ABI were designed with a B-757 as the design aircraft. Most of the taxiway segments that were designed prior to 2012 were designed to the previous ADG IV pavement design standards.

Forecasted TDG

Table 4-8, *Existing Fleet Mix MTOW and Gear Configurations,* shows the TDG of some of the large aircraft that operated at ABI in 2016:

Table 4-8
Existing Fleet Mix MTOW and Gear Configurations

Aircraft	TDG	# of 2016 OPS
ERJ-145	2	2,939
ERJ-175	3	None
B-737-700	3	50
B-737-800	3	36
A-321-200	3	10
C-130	1B	92

Source: Aircraft manufacturer websites.

The majority of the large aircraft operations that occurred at ABI in 2016 fall into the TDG II and III categories.

Because ABI receives frequent diversions due to weather at DFW, larger aircraft with higher TDGs regularly use the airport. Consequently, TDG 4 standards should be used for pavement design at ABI during the forecast period. Aircraft in the TDG 4 category include the B-757, MD-82, and MD-83. **Table 4-9**, *TDG 4 Design Standards,* shows the FAA TDG 4 standards for Taxiway Design.

Table 4-9
TDG 4 Design Standards

Design Category	Dimensions (ft.)
Taxiway Width	50
Taxiway Edge Safety Margin	10
Taxiway Shoulder Width	20
Taxiway C/L Radius (90 degree turn)	95

Source: FAA AC 150/5300-13A

The width of most air carrier taxiways at ABI is 75 ft., which is more than the 50 ft. width required according to current TDG 4 standards. Many of the existing taxiway fillets at ABI do not meet the existing TDG 4 fillet design standards if the taxiways are narrowed to 50 ft. Therefore, it is recommended that the air carrier taxiways at ABI be maintained at 75 ft. in width to ensure TDG 4 aircraft have sufficient pavement to use cockpit-over-centerline turning procedures at taxiway/taxiway intersections.

The MTOW of the aircraft using ABI is not expected to change significantly during the forecast period no improvements to taxiway pavement strength are expected to be needed during the forecast period.

As previously mentioned, many of the taxiways at ABI were originally designed prior to the implementation of the new TDG based pavement design standards. As taxiway pavement reconstruction projects are initiated on the taxiways designed to the old ADG based standards, the taxiway fillets should be updated to the current TDG IV standards.

Taxiway Layout Design Standards Based on Aircraft Design Group (ADG)

While taxiway pavement design is based on TDG, Taxiway Safety Areas (TSA), Taxiway Object Free Areas (TOFAs), and separation standards are based on the Aircraft Design Group (ADG) of the critical aircraft for a given taxiway. Unlike a taxiway's TDG which is based on the critical aircraft's landing gear configuration, the ADG is based on aircraft wingspan and tail height.

The vast majority of the taxiways at ABI were originally designed and have been maintained to ADG IV standards (171 ft. wide TSAs and 259 ft. wide TOFA). Taxiways A, A2, A3, and T appear to have been originally designed to ADG III standards (118 ft. wide TSA and 186 ft. wide TOFA) as they are only 50 ft. wide while the other taxiways are 75 ft. or more wide.

Based on the Forecast Chapter, the critical aircraft at ABI is in the ADG III category. However, ABI regularly receives C-130's as well as diversions from DFW that are in the ADG IV category or larger. Due to their division traffic and because all of their air carrier taxiways have already been designed to ADG IV standards, ADG IV standards were applied to all the taxiways at ABI for this analysis.

Table 4-10, *Taxiway Standards Based on Aircraft Design Group*, below provides an overview of the ADG IV requirements applicable to ABI and the current TSA and TOFA dimensions.

Table 4-10
Taxiway Standards Based on Aircraft Design Group

Taxiway	Applicable Taxiway ADG	TSA (feet)			TOFA (feet)		
		Current	FAA Standard	Standard Met (Y/N)	Current	FAA Standard	Standard Met (Y/N)
A	III	118	118	Y	186	186	Y
A1	III	118	118	Y	186	186	Y
A2	III	118	118	Y	186	186	Y
A3	III	118	118	Y	186	186	Y
C	IV	150	171	Y	259	259	Y
C1	IV	150	171	Y	259	259	Y
C2	IV	150	171	Y	259	259	Y
C3	IV	150	171	Y	259	259	Y
C4	IV	150	171	Y	259	259	Y
D (south of TWY N)	IV	150	171	Y	259	259	Y
D1	IV	150	171	Y	259	259	Y
D2	IV	150	171	Y	259	259	Y
D3	IV	150	171	Y	259	259	Y
M	IV	150	171	Y	259	259	Y
N	IV	150	171	Y	259	259	Y
N1	IV	150	171	Y	259	259	Y
N2	IV	150	171	Y	259	259	Y
P	IV	150	171	Y	259	259	Y
Q	III	118	118	Y	186	186	Y
R	III	118	118	Y	186	186	Y
S	III	118	118	Y	186	186	Y
T	III	118	118	Y	186	186	Y

According to ABI's current FAA approved Airport Certification Manual (ACM), the air carrier taxiways are shown to have a Taxiway Safety Area (TSA) that is 150 ft. in width which is in-between the ADG III (118 ft.) and ADG IV (171 ft.) TSA standards. Based on this analysis it is recommended that ABI apply ADG IV standards to its air carrier taxiways. All the air carrier taxiways at ABI currently meet ADG IV TSA and TOFA standards so no improvements are required to meet the existing standards.

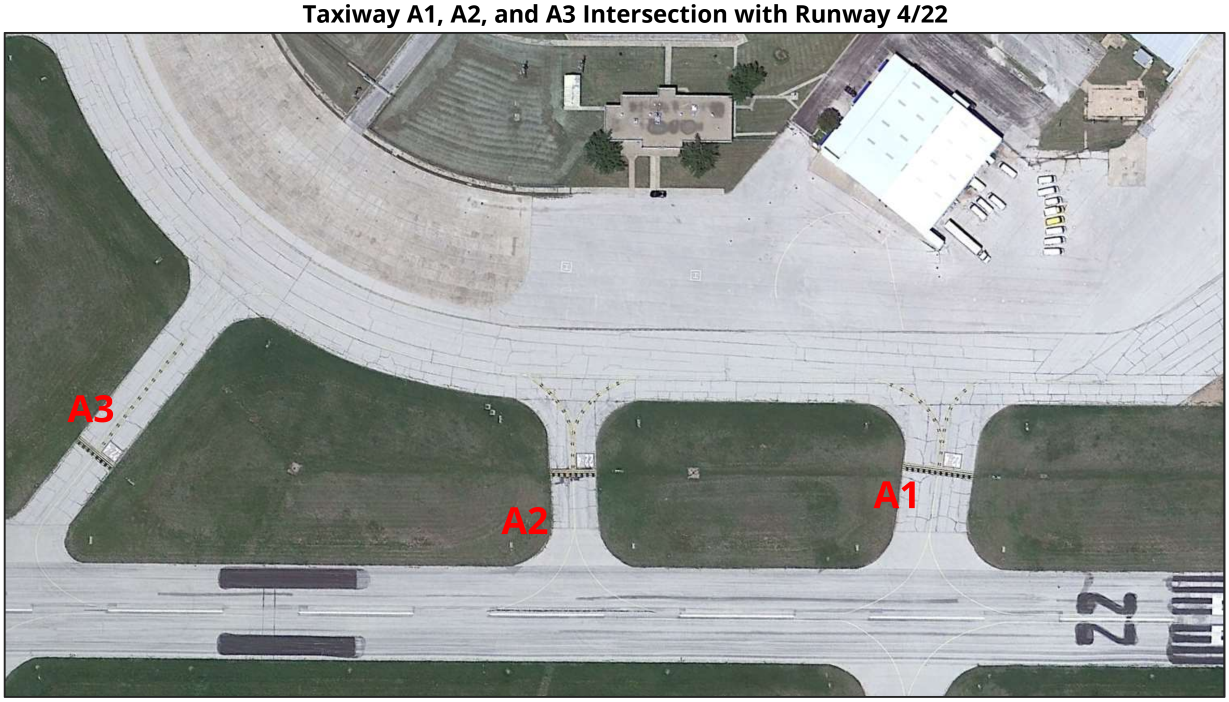
Taxiway Configuration Issues

Based on research, FAA has identified a number of taxiway layout/configuration issues that have been shown to cause pilot confusion, which can lead to safety issues such as runway incursions. ABI has six existing taxiway configurations that are currently not recommended by the FAA. Each of the six taxiway configurations at ABI allow direct access from a ramp area to a runway without requiring a turn which has been shown to contribute to runway incursions. This issue occurs at the following locations on the airfield:

- Runway 4/22
  - Taxiway A1 intersection with Runway 4/22 (Northwest GA Ramp)
  - Taxiway A2 intersection with Runway 4/22 (Northwest GA Ramp)
  - Taxiway A3 intersection with Runway 4/22 (Northwest GA Ramp)
- Runway 17R/35L
  - Taxiway R intersection with Runway 17R/35L (Northwest GA Ramp)
  - Taxiway C3 Intersection with Runway 17R/35L (Abilene Aero Hangar)
  - Taxiway C1 intersection with Runway 17R/35L (Air Carrier Ramp)

None of these locations are considered “Hot Spots” and there is no history of runway incursions at these locations. Each of these intersections are shown in **Figures 4–7 through 4-10**.

Figure 4-7
Taxiway A1, A2, and A3 Intersection with Runway 4/22



Source: Garver, 2017

Figure 4-8
Taxiway R Intersection with Runway 17R/35L

Source: Garver, 2017

Figure 4-9
Taxiway C3 Intersection with Runway 17R/35L

Source: Garver, 2017

Figure 4-10
Taxiway C1 Intersection with Runway 17R/35L

Source: Garver, 2017

These issues will be addressed in the alternatives section of the document. No other prohibited/not-recommended taxiway configurations exist at ABI.

Airfield Lighting, Marking, and Signage Requirements

Sufficient and accurate airfield marking, lighting and signage is essential to maintaining a high level of safety in an airport's daily operation. In this section the existing airfield lighting, marking, and signage will be reviewed in light of the established activity forecast to determine where improvements need to be made.

Runway Lighting, Marking, and Signage

Runway marking and lighting requirements vary based on the utilization characteristics of a runway including each runway's critical aircraft and instrument approaches.

Runway 17R/35L and Runway 17L/35R

Currently, Runway 17R/35L and Runway 17L/35R are equipped with high intensity runway edge lights (HIRL) that are controlled by the ATCT. The HIRLs are in good condition and were recently rehabilitated (2007 for Runway 17L/35R and 2009 for Runway 17R/35L). It is not expected that the HIRL system will need to be upgraded or replaced during the forecast period.

Runway Centerline Lightings and Touchdown Zone Lights (TDZ) are required on runways with Category (CAT) II or III Instrument Landing System (ILS) operations or any CAT I ILS runways with operations below 2,400 ft. visibility. The lowest IAP minimum at ABI is currently 2,400 ft. visibility for the CAT I ILS approach to Runway 35R. Based on the forecast it is not anticipated that lower IAP minimums will be needed during the forecast period. It is not anticipated that ABI will need to add runway centerline lights or touchdown zone lights during the forecast period.

Runway 17L/35R has precision instrument runway markings that are in good condition. Runway 17R/35L has non-precision instrument runway markings that are in good condition. If a precision instrument approach is added to Runway 17R/35L the runway markings will need to be upgraded (centerline increased to 36 inches in width, touchdown zone markings added, and side strip markings added).

Runway 17L/35R and Runway 17R/35L have appropriate and sufficient signage. There are no known issues that require modifications to the existing signage system for the runways at this time. As runways and taxiways are modified, changes to the signage system will need to be assessed.

Runway 4/22

Currently, Runway 4/22 is equipped with Medium Intensity Runway Edge Lights (MIRL). However, the circuit is out of service indefinitely. Since the Runway 4/22 area is being considered as a potential aeronautical development site, no improvements to the MIRL system are needed.

Runway 4/22 is also equipped with non-precision instrument runway markings. The markings are in poor condition. It is not expected that any additional instrument approaches will be developed for Runway 4/22. It is not expected that the markings for the runway will need to be changed. If Runway 4/22 is re-designated based on magnetic declination the runway designation markings will need to be changed to correspond to the new runway designation.

The signage for Runway 4/22 is also sufficient. No signage improvements are necessary.

Taxiway Lighting, Marking, and Signage

Lighting

Taxiways C, C1, C2, C3, C4, D, D1, D2, D3, R, M, N, N1, N2, and P are the taxiways available for air carrier use and each of these taxiways is illuminated by medium intensity taxiway edge lights. These taxiway edge light circuits are in good condition. Since ABI does not conduct air carrier operations below 1,200 RVR and there are no reported issues related to aircraft missing taxiways turns, taxiway centerline lights are not required. Additionally, since there are no reported runway incursion issues at ABI, there is no need to install runway guard lights (elevated or in-pavement) at any of the runway/taxiway intersections at this time.

Taxiways A, A1, A2, A3, Q, S, and T are not available for air carrier use. Each of these taxiways are unlit but they do have taxiway centerline reflectors. Since most of these taxiways are associated with Runway 4/22 and the area is being considered as a potential site for an aeronautical development, no lighting improvements are needed.

Markings

All paved taxiways should be painted with standard taxiway markings as prescribed in FAA Advisory Circular 150/5340-1 (current series), *Standards for Airport Markings*. All taxiways at ABI have taxiway centerline markings and enhanced taxiway centerline markings where required. These markings all appear to be in good condition.

Surface painted runway hold position signs and runway hold position markings are painted on all runway/taxiway intersections. These markings are in good condition with the exception of the surface painted signs along Runway 4/22 which are faded and in fair condition.

No major marking modifications are expected to be needed during the forecast period.

Signage

ABI has an airfield signage system that provides guidance to aircraft operators regarding their location on the airfield and the location of significant facilities. ABI has an FAA-approved Airfield Signage and Marking Diagram that is part of their Airport Certification Manual (ACM). The airfield signage at ABI is in good condition. ABI staff have not received any inquiries from pilots stating that a portion of the existing signage system is confusing or misleading. There have been no reported runway incursions were airfield signage was listed as a contributing factor. No major signage changes should be needed during the forecast period.

Approach Lighting Systems

An Approach Lighting System (ALS) provides the basic means to transition from instrument flight to visual flight for landing. ALS are a configuration of signal lights starting at the landing threshold and extending into the approach area a distance of 2400-3000 ft. for precision instrument runways and 1400-1500 ft. for non-precision instrument runways. Some systems include sequenced flashing lights that appear to the pilot as a ball of light traveling towards the runway at high speed blinking twice per second.

Operational requirements dictate the sophistication and configuration of the ALS for a particular runway. Depending on the type of approach, certain ALS are required to aide pilots in the identification of the airport environment during instrument meteorological conditions.

These requirements are found in FAA AC 150/5300-13 (current edition). It should be noted that ALS systems are required for runways with precision instrument approaches.

ABI currently has a 1,400 ft. Medium Intensity Approach Light System with Runway Alignment Indicator Lights (MALSR) for the ILS approach for Runway 35R. The Runway Alignment Indicator Lights for the MALSR extend an additional 1,000 ft. making the total length of the MALSR system 2,400 ft.

Future consideration for a new ALS will be predicated on user needs, instrument approach minimum requirements, and the restrictions of surrounding property and land use. The MALSR for Runway 35R should be sufficient during the forecast period. However, if a precision instrument approach is added to Runway 17R, an ALS for that runway will need to be added. This will be considered in the alternatives chapter.

Runway End Identifier Lights

Runway End Identifier Lights (REILs) provide rapid and positive identification of the approach end of a runway. The system consists of a pair of synchronized flashing white strobes located laterally along the runway threshold. REILs are typically installed along with threshold lights at each runway end. REILs are not commonly needed unless an airport is situated in an area of heavy light pollution where identifying the approach end of the runway may be difficult.

Currently, ABI has a set of REILs at the approach end of Runway 35L. Runway 35L is currently the only air carrier runway at ABI without a straight-in instrument approach. Currently, only a circling instrument approach to the runway can be conducted. REILs can aid pilots in identifying a runway end during circling approaches. It is expected that the REILs to Runway 35L should remain until a straight-in instrument approach is established for the runway.

Wind Cone/Segmented Circle/Airport Beacon

The center-field windsock and segmented circle at ABI are located approximately 200 ft. south of the Intersection of Taxiway M and P, adjacent to the ARFF station. The wind cone apparatus and the segmented circle are in good condition.

There are supplemental lighted windsocks at the approach ends of Runway 35R and 17R (close to the intersection with Runway 4/22) that are in good condition. Additionally, there is an unlighted windsock at the approach end of Runway 35L. As part of the alternatives chapter, the feasibility of adding a lighted windsock to the approach ends of Runway 35L and 17L will be considered.

The airport beacon at ABI is located north of the Terminal Ramp and west of the existing terminal building. The rotating beacon is in good condition and it is not expected that it will need to be replaced during the forecast period.

Airfield Lighting Vault

As stated in the Inventory Chapter, ABI currently has two airfield lighting vaults. The main vault is located adjacent to the terminal building and it houses the regulators for all the airfield lighting circuits except Runway 4/22. The main airfield lighting vault is in good condition, and it is not expected that it will need to be substantially modified during the forecast period.

The regulator for Runway 4/22 is located adjacent to the AvFuel office building on the Northwest GA apron and it is inoperative. Since it is expected that Runway 4/22 will be closed at some point during the forecast period, no improvements or modifications to the existing facility for Runway 4/22 will be considered in the alternatives chapter.

NAVAIDs

Airport Navigation Aids (NAVAIDs) are installed on or near an airport to increase the airport's reliability during night and inclement weather conditions and to provide electronic guidance and visual references for executing an approach to the airport or runway.

FAA Order 7031.2C, *Airport Planning Standard Number One - Terminal Air Navigation Facilities and Air Traffic Control Services*, specifies minimum activity levels to qualify for instrument approach equipment and approach procedures. As forecast in the previous chapter, approximately 11,314 instrument operations (approaches and takeoffs) will be conducted annually under IFR flight rules by the end of the 20-year planning period. The following describes the status of existing and new NAVAIDs used at general aviation airports.

Visual Guidance Slope Indicators

Typical visual guidance slope indicators (VGSI) provide a system of sequenced colored light beams providing continuous visual descent guidance information along the desired final approach descent path (normally at 3 degrees for 3 nautical miles during daytime, and up to 5 nautical miles at night to the runway touchdown point). The system normally consists of two Precision Approach Path Indicator lamp housings (PAPI-2) or four (PAPI-4) lamp housing units installed 600 to 800 ft. from the runway threshold and offset 50 ft. to the left of the runway edge.

Runways 17L, 17R, and 35L are equipped with 4-light PAPI systems. Each of the units are in good condition. Consideration will be given in the alternatives chapter regarding adding a PAPI to Runway 35R.

Very High Frequency Omni-Directional Radio Range

The Very High Frequency Omni-Directional Radio Range (VOR/VORTAC) system emits a very high frequency radio signal utilized for both enroute navigation and non-precision approaches.

It provides the instrument rated pilot with 360 degrees of azimuth information oriented to magnetic north. Due to the recent development of more precise navigational systems it is planned to be phased-out by the FAA.

ABI is served by the Abilene VORTAC, located 9.3 nautical miles northwest of ABI, and the Tuscola VOR/SME, located 13 nautical miles southwest of ABI. The Abilene VORTAC is utilized for the VOR-A approach, the ILS approach for Runway 35, and the LOC approach for Runway 17R. The Tuscola VOR/DME is utilized for the ILS approach for Runway 35R and the LOC approach for Runway 17R. A VOR approach to Runway 14 exists but the minimums for that approach are higher than the established GPS approach. With the FAA's migration toward GPS based approaches and enroute navigation, it is not expected that any additional VOR will be needed in the area.

Global Positioning System

Global positioning system (GPS) is a highly accurate worldwide satellite navigational system that is unaffected by weather and provides point-to-point navigation by encoding transmissions from multiple satellites and ground-based data-link stations using an airborne receiver. GPS is presently FAA-certified for enroute and instrument approaches into numerous airports. The current program provides for GPS stand-alone and overlay approaches where GPS fixes are overlaid on top of an existing approach (typically NDB or VOR approaches). Recently, the selective availability segment of the channel was decommissioned, thereby enhancing the accuracy of the GPS signal. The Wide Area Augmentation System (WAAS) is being installed at or near airports to provide a signal correction enabling GPS precision approaches (commonly called GPS approaches with LPV minimums).

A straight-in area navigation instrument approach is available to Runways 17L, 22, and 35R utilizing GPS signals and on-aircraft receivers to guide aircraft to a safe landing at ABI. No GPS approaches currently exist to Runway 4, 17R, or 35L. GPS based approaches for Runway 17R and 35L will be considered in the alternatives chapter.

Weather Observing System

Automated Weather Observation Systems (AWOS) and Automated Surface Observation Systems (ASOS) consist of various types of sensors, a processor, a computer-generated voice subsystem, and a transmitter to broadcast minute-by-minute weather data from a fixed location directly to the pilot. The information is transmitted over the voice portion of a local NAVAID (VOR or DME), or a discrete VHF radio frequency. The transmission is broadcast in 20-30 second messages in standard format and can be received within 25-nautical miles of the automated weather site.

At airports with instrument procedures, an AWOS/ASOS weather report eliminates the remote altimeter setting penalty, thereby permitting lower minimum descent altitudes (lower approach minimums). These systems should be sited within 500 to 1,000 ft. of the primary runway centerline. FAA Order 6560.20B, *Siting Criteria for Automated Weather Observing Systems*, assists in the site planning for AWOS/ASOS systems.

ABI is equipped with an ASOS that is owned and operated by the National Weather Service. The ASOS is in good condition and is not expected to need to be modified/improved during the forecast period.

Instrument Landing System (ILS)

Instrument Landing Systems (ILS) are a ground-based navigation system, composed of a localizer and glideslope that provide vertical and horizontal guidance to pilots when conducting an instrument approach to a runway during inclement weather. Today, ILS systems are still the primary instrument approach system utilized at commercial service airports across the United States. However, with the FAA's migration to GPS based approaches and enroute navigation the need for ILS systems is expected to decrease in the future.

Currently, ABI has an instrument landing system for Runway 35R. The system is in good condition. Due to the FAA's migration to GPS based instrument approach procedures, it is not expected that an additional ILS system will be needed at ABI.

Localizer System (LOC)

Localizer systems (LOC) are similar to ILS systems but the glide slope, which provides vertical guidance to pilots when conducting an ILS approach, is not present. Consequently, when conducting a localizer approach a pilot is only provided with horizontal guidance that tells them whether they are properly aligned with the runway centerline. Currently, ABI has a localizer approach to Runway 17R and the system is in good condition.

As previously discussed in this chapter, Runway 17R should be evaluated for a GPS based precision instrument approach. The existing localizer system should remain in place to support instrument approaches for aircraft that are not equipment with the proper GPS equipment to be able to execute a GPS based approach.

Airspace

The term "airspace" is frequently used when discussing the areas surrounding an airport. There are a number of different categories/types of airspace that must be considered as part of the airport master planning process. These include:

- Airspace Classification for Aeronautical Operators (e.g. Class B, C, D, etc.)
- FAR Part 77 – Imaginary Surfaces

Airspace Classification for Aeronautical Operators

The current airspace surrounding ABI is classified as Class C airspace. As the aeronautical operations levels are not expected to change significantly during the forecast period it is not expected that the current airspace classification will need to be changed during the 20-year planning horizon.

FAR Part 77 – Imaginary Surfaces

The 14 CFR Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace*, provides standards and procedures to protect the continued safe and efficient use of airspace. 14 CFR Part 77.19, *Civil Airport Imaginary Surfaces*, defines the five civil imaginary surfaces related to airports. To ensure the continued safe and efficient use of the airspace surrounding an airport, it is important that the five civil airport imaginary surfaces remain clear of any obstructions that could pose a hazard to air navigation. It should be noted that some objects may be located within an airport's imaginary surfaces as long as they have been properly marked/lighted and an airspace review has been completed and determined that the object will not adversely affect the safe and efficient use of the local airspace.

The five civil airport imaginary surfaces described in 14 CFR Part 77 are defined below:

- Primary Surface - A surface longitudinally centered on a runway. When the runway has a specially prepared hard surface, the primary surface extends 200 ft. beyond each end of that runway; but when the runway has no specially prepared hard surface, the primary surface ends at each end of that runway. The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline.
- Approach Surface - A surface longitudinally centered on the extended runway centerline and extending outward and upward from each end of the primary surface. An approach surface is applied to each end of each runway based upon the type of approach available or planned for that runway end.
- Horizontal Surface - A horizontal plane 150 ft. above the established airport elevation, the perimeter of which is constructed by swinging arcs of a specified radii from the center of each end of the primary surface of each runway of the airport and connecting the adjacent arcs by lines tangent to those arcs.
- Conical Surface - A surface extending outward and upward from the periphery of the horizontal surface at a slope of 20 to 1 for a horizontal distance of 4,000 ft.
- Transitional Surface - These surfaces extend outward and upward at right angles to the runway centerline and the runway centerline extended at a slope of 7 to 1 from the sides of the primary surface and from the sides of the approach surfaces. Transitional surfaces for those portions of the precision approach surface which project through and beyond the limits of the conical surface, extend a distance of 5,000 ft. measured horizontally from the edge of the approach surface and at right angles to the runway centerline.

Based on the criteria described in 14 CFR Part 77, the five civil imaginary surfaces for ABI are described below:

- Runway 17L/35R
  - Primary Surface – 1,000 ft. wide x 200 ft. past each runway end
  - Approach Surface Runway 35R – 50:1 slope for first 10,000 ft. and a 40:1 slop for an additional 40,000 ft. Inner width of the approach surface is 1,000 ft. wide and expands to 16,000 ft. wide.
  - Approach Surface Runway 17L – 34:1 slope for 10,000 ft. Inner width of the approach surface is 1,000 ft. wide and expands to 4,000 ft. wide.
- Runway 17R/35L
  - Primary Surface – 500 ft. wide x 200 ft. past each runway end
  - Approach Surface Runway 17R – 34:1 slope for 10,000 ft. Inner width of the approach surface is 500 ft. wide and expands to 4,000 ft. wide.
  - Approach Surface Runway 35L – 20:1 slope for both runway ends for 5,000 ft. Inner width of the approach surface is 500 ft. wide and expands to 1,500 ft.
- Runway 4/22
  - Primary Surface – 500 ft. wide x 200 ft. past each runway end
  - Approach Surface Runway 22 – 34:1 slope for 10,000 ft. Inner width of the approach surface is 500 ft. wide and expands to 4,000 ft. wide.
  - Approach Surface Runway 4 – 20:1 slope for both runway ends for 5,000 ft. Inner width of the approach surface is 500 ft. wide and expands to 1,500 ft.
- Non-Runway Specific Surfaces
  - Horizontal Surface – Flat surface established at an elevation 1,940.6 ft. (150 ft. above field elevation). Perimeter is based on 10,000 ft. arcs swung from the ends of Runway 17L, 17R, and 35R and a 5,000 ft. arc swung from the end of Runway 35L.
  - Conical Surface – Extends from the edges of the Horizontal surface for a horizontal distance of 4,000 ft. at a 20:1 slope.
  - Transitional Surface – Extends from the edges of the primary surface until it reaches the horizontal surface and from the edges of the approach surfaces until it reaches the horizontal surface or for a horizontal distance of 5,000 ft.

These surfaces are depicted in the Airspace Drawing that is included as part of the Airport Layout Plan. ABI has no existing FAR Part 77 surface penetrations that need to be considered in the alternatives chapter.

Airfield Capacity and Delay Analysis

The FAA's standard method for determining airport capacity and delay for long-range planning purposes can be found in Advisory Circular (AC) 150/5060-5 (current edition), *Airport Capacity and Delay*. For this portion of the analysis, generalized airfield capacity was calculated in terms of:

1) Hourly capacity of runways
2) Annual Service Volume (ASV)

This approach utilizes the projections of annual operations by the proposed fleet mix as projected in the Forecast Chapter, Chapter 3, while considering a variety of other factors that are described below.

Airport Characteristics

In addition to the aviation activity forecasts, a number of an airport's characteristics and operational considerations are required in order to properly conduct an FAA capacity and delay analysis.

These elements include:

- Runway Configuration
- Taxiway Configuration
- Aircraft Mix Index
- Operational Characteristics
- Meteorological Conditions

When analyzed collectively, the above elements provide the basis for establishing the generalized operational capacity of an airport as expressed by Annual Service Volume. The following sections evaluate each of these characteristics with respect to Abilene Regional Airport.

Runway Configuration

The runway configuration is one of the primary factors that determine airfield capacity. The capacity of a two or more-runway system is substantially higher than an airport with a single runway. If runways intersect, the capacity is generally not as great as in a parallel runway layout because operations on the second runway are not possible until the aircraft on the first runway has cleared the intersection point.

As previously mentioned, ABI has two offset parallel runways (Runway 17L/35R and 17R/35L) that are available for air carrier use and a shorter crosswind runway (Runway 4/22) that is primarily used by smaller aircraft when needed due to wind conditions. Since it is expected that Runway 4/22 will be closed at some point during the 20-year planning horizon and is not currently used on a daily basis, it has been excluded from this analysis to focus on the capacity and delay inherent with the utilization of the parallel runway system.

Taxiway Configuration

The distance an aircraft has to travel to an exit taxiway after landing also sets limits on the airfield capacity. Larger aircraft require more distance to slow to a safe speed before exiting the runway. Thus, they require greater runway occupancy times. If taxiways are placed at the approximate location where the aircraft would reach safe taxiing speed, the aircraft can exit and clear the runway for another user. However, if the taxiway is spaced either too close or too far from the touchdown zone, the aircraft will likely spend more time on the runway than if the taxiway had been in the optimal location. Based on ABI's current and forecasted fleet mix, the optimal location for exit taxiways is in a range from 3,000 ft. to 5,500 ft. from the landing threshold with each exit separated by at least 750 ft. Based on the FAA criteria, the exit factor within the formula is maximized when a runway has four exit taxiways within the optimal range.

ABI currently has one exit taxiway within this range for Runway 17L, 17R, and 35L. Runway 35R has two exits available within this range.

Aircraft Mix Index

The operational fleet at an airport influences an airfield's capacity based upon differing aircraft requirements. Various operational separations are set by the FAA for a number of safety reasons. An airfield's capacity is the time needed for the aircraft to clear the runway either on arrival or departure. As aircraft size and weight increases, so does the time needed for it to slow to a safe taxing speed or to achieve the needed speed for takeoff. Thus, a larger aircraft generally requires more runway occupancy time than a smaller aircraft. As additional larger aircraft enter an airport's operating fleet, the lower the capacity will likely be for that Airport.

There are four categories of aircraft used for capacity determinations under the FAA criteria. These classifications are based upon the maximum certificated takeoff weight, the number of engines, and wake turbulence classifications. The aircraft indexes and characteristics are shown in the following table, **Table 4-11,** *Aircraft Classifications*, and the following figure, **Figure 4-11**, *Cross Section of Aircraft Classifications*.

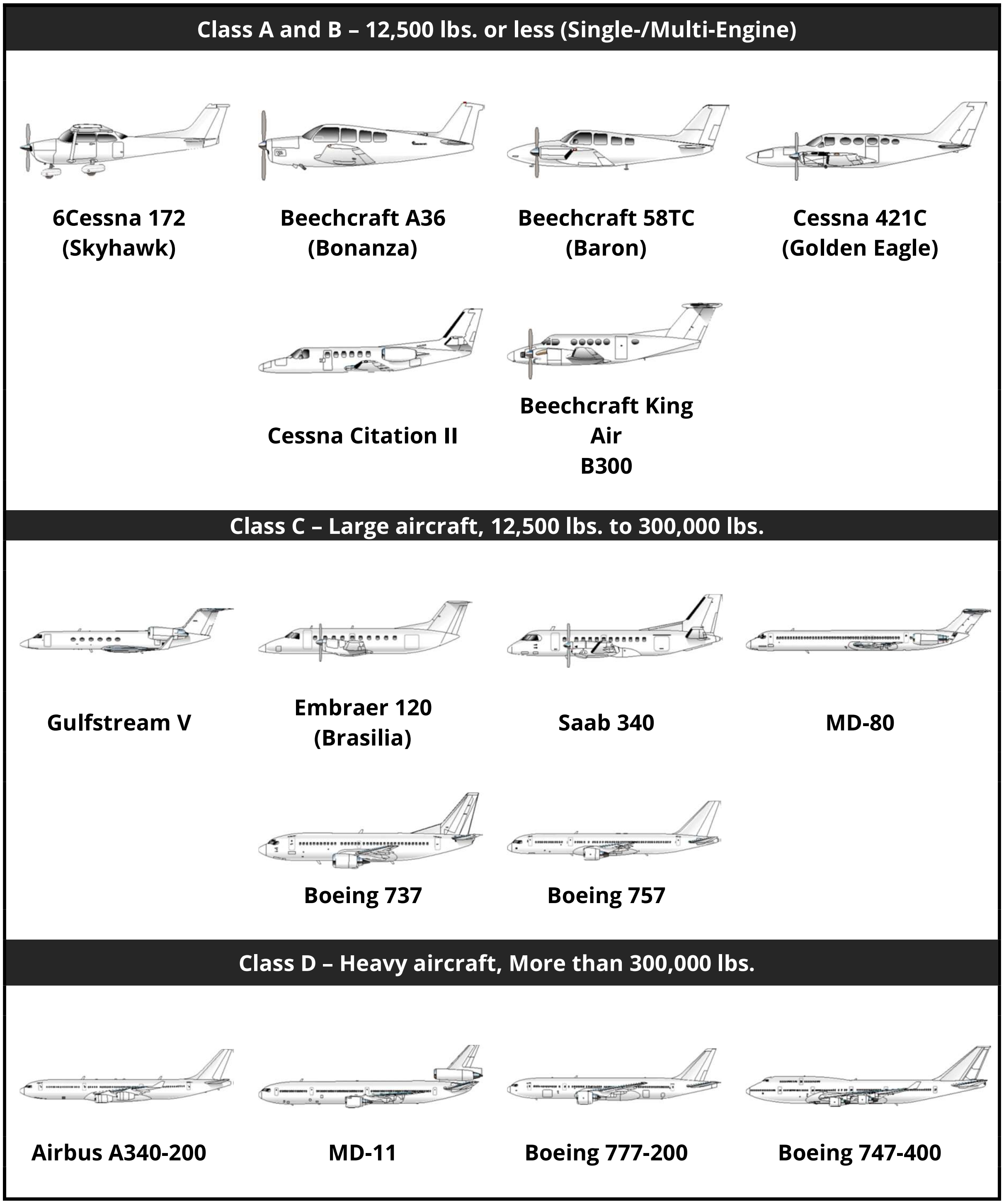
Table 4-11
Aircraft Classifications

Aircraft Class	Maximum Certificated Takeoff Weight (lbs)	Number of Engines	Wake Turbulence Classification [1]
A and B	Under 12,500	Single-/Multi-	Small
C	12,500 – 300,000	Multi-	Large
D	Over 300,000	Multi-	Heavy

Source: FAA Advisory Circular 150/5360-5, Change 2, *Airport Capacity and Delay*.
[1] Wake turbulence classifications as defined by the FAA, Small – Aircraft of 41,000 lbs. maximum certificated takeoff; Large – Aircraft more than 41,000 lbs certificated takeoff weight, up to 255,000 lbs: Heavy – Aircraft capable of takeoff weights of more than 255,000 lbs whether or not they are operating at this weight during a particular phase of flight.

These classifications are used to determine the mix index, which is required to calculate the theoretical capacity of an airfield. The mix index is defined as the percent of Class C aircraft plus three (3) times the percent of Class D aircraft, reflected as a percentage (C+3D). The percent of A and B class aircraft do not count towards the calculation of mix index due to the quick dissipation of turbulence produced by this category. Using the FAA formula, the aircraft mix for ABI is expected to be approximately 35 during the planning horizon.

Figure 4-11
Cross Section of Aircraft Classifications



Source: Dr. Antonio Trani, Department of Civil Engineering, Virginia Tech University.

Airfield Operational Characteristics

Operational characteristics that can affect an airfield's overall capacity include the percent of aircraft arrivals and the percent of touch-and-go operations.

Percent of Aircraft Arrivals

The percent of aircraft arrivals is the ratio of landing operations to the total operations for the airport. This percent is considered due to the fact that aircraft approaching an airport for landing require more runway occupancy time than an aircraft departing the airfield. The FAA methodology used provides for computing airfield capacity with a 40%, 50%, or 60% of arrivals. For the purposes of capacity and delay calculations, the 50% arrivals factor was used.

Percent of Touch-and-Go Operations

The percent of touch-and-go operations plays a critical role in the determination of airport capacity. Touch-and-go operations are defined as an aircraft touching down on the runway and immediately taking off again without stopping. Touch-and-go operations are typically associated with flight training activity. It is estimated that the total number of touch-and-go operations at ABI is less than 10% of total operations.

Meteorological Conditions

Aircraft operating parameters are dependent upon the weather conditions, such as cloud ceiling height and visibility range. As weather conditions deteriorate, pilots must rely on instruments to define their position both vertically and horizontally. Capacity is lowered during such conditions because the FAA requires aircraft separation increases for safety reasons. Additionally, some airports may have limitations with regards to their instrument approach capability which also impacts capacity during inclement weather. The FAA defines three (3) general weather categories, based upon the ceiling height of clouds above ground level and visibility.

- Visual Flight Rules (VFR): Cloud ceiling is greater than 1,000 ft. above ground level (AGL) and the visibility is at least 3 statute miles
- Instrument Flight Rules (IFR): Cloud ceiling is at least 500 ft. AGL but less than 1,000 ft. AGL and/or the visibility is at least 1 statute mile but less than 3statute miles
- Poor Visibility and Ceiling (PVC): Cloud ceiling is less than 500 ft. AGL and/or the visibility is less than 1 statute mile

According to 2016 ASOS data, ADS observes VFR conditions approximately 91% of the time, IFR conditions approximately 6% of the time, and PVC conditions approximately 3% of the time.

Hourly Capacity of Runways

Hourly capacity of a runway system measures the maximum number of aircraft operations that can be accommodated by an airport's runway configuration in one hour. This capacity is calculated by analyzing the appropriate series of graphs and tables for VFR and IFR conditions within FAA (AC) 150/5060-5. From these figures, the hourly capacity is calculated by multiplying the hourly capacity base, the touch-and-go factor, and the exit factor together. The equation for this formula is:

$$\text{Hourly Capacity} = C^* \times T \times E$$

where: C^* = hourly capacity base
T = touch-and-go factor
E = exit factor

The airport's calculated hourly capacity can be seen in the following table, **Table 4-12**, *Hourly Capacity*.

Table 4-12
Hourly Capacity

Year	VFR Operations	IFR Operations	Weighted Hourly Capacity (Cw)
2017	135	75	113.95
2022	135	75	113.95
2027	135	75	113.95
2032	135	75	113.95
2037	135	75	113.95

Source: FAA Advisory Circular 150/5360-5, Change 2, Airport Capacity and Delay.

Annual Service Volume

Under the FAA methodology, the most important value that must be computed to evaluate the capacity at an airport is the annual service volume (ASV). ASV represents a measure of the approximate number of total operations that an airport can support annually. Using the FAA's methodology to estimate ASV, the ratio of annual operations to average daily operations, during the peak month, must first be calculated along with the ratio of average daily operations to average peak hour operations, during the peak month. These values are then multiplied together resulting in a product to be multiplied by the weighted hourly capacity.

The equation used to calculate ASV is:

$$\text{Annual Service Volume} = C_w \times D \times H$$

where: C_w = weighted hourly capacity

D = ratio of annual operations to average daily operations during the peak month

H = ratio of average daily operations to average peak hour operations during the peak month

The Airport's ASV, as calculated based on the method above, can be seen in the following table, **Table 4-13**, *Annual Service Volume (ASV).*

Table 4-13
Annual Service Volume (ASV)

Year	Forecasted Annual Operations	Forecasted Peak Hour Operations	Computed ASV	Forecasted Operations % of ASV (% Capacity)
2017	46,223	16	331,887	13.9%
2022	45,982	16	331,887	13.8%
2027	46,448	16	331,887	14%
2032	46,717	16	331,887	14.1%
2037	47,143	16	331,887	14.2%

Source: FAA Advisory Circular 150/5360-5, Change 2, Airport Capacity and Delay.

Aircraft Delay

ABI currently has excess capacity and is forecasted to continue to have excess capacity during the forecast period. Consequently, the average delay per aircraft is estimated to be less than 1 minute. The total annual delay is also estimated to be negligible. Based on this analysis it is estimated that most aircraft delays will be due to circumstances outside the design capacity of ABI's airfield.

Delay and Capacity Analysis Summary

Based on the results of this analysis it is not expected that airfield delay and capacity will be an alternative consideration during the forecast period.

Airfield/Airspace Facility Requirements Summary

Based on airfield/airspace facility requirements defined previously in this document, the following airfield/airspace development objectives have been created to guide the alternatives development process:

Runways:

- Evaluate the feasibility of extending Runway 17R/35L or 17L/35R to at least 8,500 ft. to accommodate future traffic.
- Evaluate the feasibility of adding a GPS based precision instrument approach to Runway 17R and a GPS based non precision instrument approach to Runway 35L.
- Evaluate the feasibility of adding an approach lighting system to Runway 17R to complement the proposed precision instrument approach for that runway.
- Gain sufficient control over the land outside of airport property but within the RPZ for Runway 17L, 17R, and 35R.
- Address the deficiency of the runway hold position markings for Runway 4/22.
- Add a four light PAPI system to Runway 35R.

Taxiways

- Update all taxiway fillets that were designed to the older ADG based taxiway design standards as part of upcoming pavement rehabilitation projects.
- Resolve the prohibited taxiway configuration issues. Currently, there are six taxiways that allow direct access from a ramp area to a runway without requiring an aircraft to make a turn.

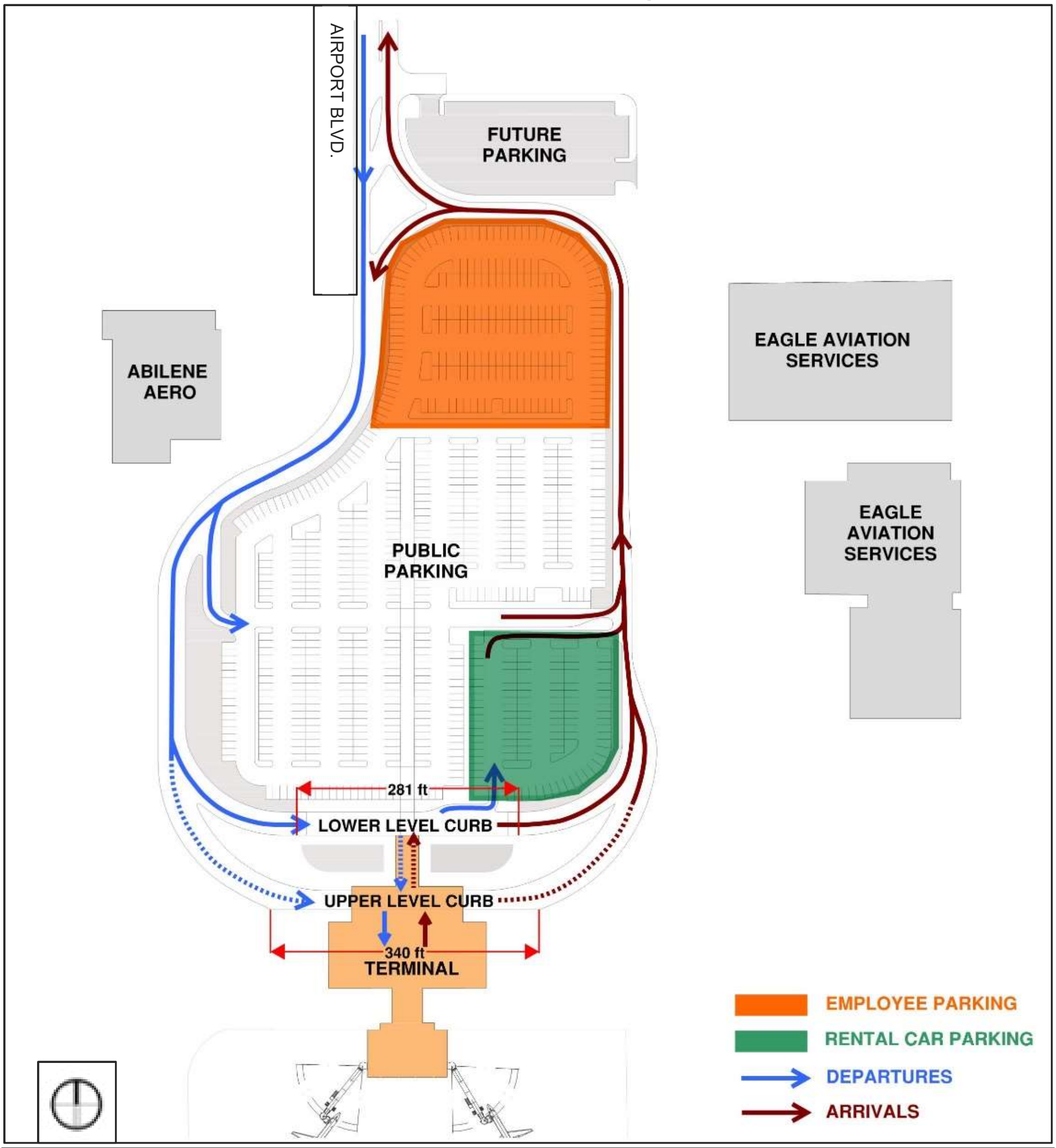
Landside/Roadway Facility Requirements

Landside facilities include the airport access roads, curbside areas and parking facilities that accommodate passenger movement, vehicle parking and ground transportation services such as car rental, shuttle, cab and/or Transportation Network Companies (TNCs). Landside facilities at ABI are displayed in **Figure 4-12**, *Landside Facilities Map.*

TNCs are defined as companies that provide prearranged transportation services using an online-enabled application or platform to connect passengers with drivers using their personal, non-commercial, vehicles. Two of the biggest TNC companies in operation today are Uber and Lyft.

For this analysis, it was assumed that there will not be a significant change in the relative availability, convenience, or price of the various landside modes or facilities over the planning period.

Figure 4-12
Landside Facilities Map



Source: Corgan, 2018

Automobile Access/Circulation and Parking

Ground Transportation Trends

Emerging trends in ground transportation include the increase in popularity of TNCs and the development of autonomous vehicles.

TNCs are already commonplace today and their popularity is expected to continue to rise. Based on a Goldman Sachs study, it was estimated that 15 million TNC trips occurred world-wide on a daily basis in 2017. By 2030, that number is expected to increase to 97 million trips per day.

Autonomous vehicles, while still a new and emerging technology, are expected to become more commonplace during the forecast period. An autonomous vehicle is defined as a vehicle with features that allow it to accelerate, brake, and steer with limited or no driver interaction. A report published by *Forbes* magazine states that it is expected that 10 million autonomous vehicles will hit the road by the year 2020 and that 25% of vehicles on the road will be autonomous by the year 2030. A report published by *Fortune* estimates that by 2040, 95% of new vehicles sold will be autonomous vehicles.

These trends will have an impact on the utilization of landside facilities at airports as more people begin to use them. In general, it is expected that the proliferation of TNCs and autonomous vehicles will result in an increase in demand for curbside space and a decrease in demand for parking facilities.

<u>Airport Roadways Signage</u>

The access and circulation roads at ABI are asphalt roads in good condition and are devoid of potholes. However, the curvilinear geometry of the roads creates a limited sight distance for vehicles circulating within the landside area. Portions of the ABI roadway are shown in **Figure 4-13**, *Upper & Lower Level Access Roads*, and **Figure 4-14**, *Upper Level Curb*.

On-airport wayfinding signage is provided at several locations along airport roadways to guide vehicle traffic to a variety of destinations. Proceeding south towards the terminal on Airport Boulevard and further onto Airport Parking Circle, multiple signs with plain arrows (as shown in **Figure 4-15**, *Access Road Signage,* and **Figure 4-16**, *Exit Signage)* provide guidance to airport patrons on where to access and exit the terminal area, parking area, rental car return, and Abilene Aero. These signs are not consistent in terms of color, size and overall visual style. Additionally, the location of each sign (driver's side or passenger's side of the roadway) varies. In an effort to improve an airport patron's ability to find their intended destination, it is recommended that the existing roadway signage be replaced with new signage that has a consistent color, size, style and location.

Figure 4-13
Upper & Lower Level Access Roads

Source*:* Corgan, 2018

Figure 4-14
Upper Level Curb

Source: Corgan, 2018

Figure 4-15
Access Road Signage

Source: Corgan, 2018

Figure 4-16
Exit Signage

Source: Corgan, 2018

Off-Airport Roadways Signage

Approaching Airport Boulevard from TX-36, two signs indicate a turn for merging onto Airport Boulevard, one for vehicles coming from the north and one from the south. There is a marquee airport entrance sign located at the intersection of TX-36 and Airport Boulevard. However, the entrance sign is not easily visible when travelling northbound on TX-36 making the airport entrance easy to miss. Modifications to the actual sign or the location of the sign are recommended to improve visibility of the sign for traffic flowing in both directions on TX-36, but particularly for northbound vehicles.

Additionally, there is limited signage on Loop 322 for the airport. This issue should be reviewed and discussed with TxDOT to identify opportunities to improve directional signage to the airport along Loop 322.

Departure Curb Capacity

Facility requirements, capacity and performance of an airport's roadways are evaluated based on Level of Service (LOS) standards discussed in Airport Cooperative Research Program (ACRP) Report #25, *Airport Passenger Terminal Planning and Design*.

A roadways LOS is determined based on the congestion and delay vehicles experience when utilizing the roadways. Based on the congestion and delay experienced a roadways LOS category (A-F) can be estimated. LOS Category A roads have little to no congestion/delay while LOS Category F roads common have severe congestion/delay.

Using these standards and terminal curbside field observations, curb and roadway requirements can be calculated. The factors that can affect a roadway's given Level of Service (LOS) include the number of lanes, the length of the curbs, and how the curb roadways are allocated and managed. Table **4-14.**

Table 4-14, *Departure Curbside Length Requirements Analysis,* summarizes the departure curb requirements for all scenarios as well as the existing curb conditions at ABI. The existing terminal has an upper level departures curb that measures 340 linear ft. and a lower level arrivals curb that measures 281 linear ft. Combined, the two curbs provide the existing terminal with a curbside total of 621 linear ft.

Passengers being dropped off at ABI throughout the planning horizon are likely to be dropped off by private vehicle, TNCs, or autonomous vehicles. As mentioned previously, autonomous vehicles are expected to be more common by 2030 but they will not completely replace driver operated vehicles. They are expected to be adopted in major metropolitan areas first and then permeate to smaller communities. To account for the potential pace that the new technology will be adopted in and around Abilene, it was assumed that approximately 30% of passengers departing ABI will be dropped off by one of these 3 transportation modes with the remaining 70% of departing passengers driving to the airport and parking their vehicles in public parking spaces or returning rental cars. This represents a Modal Split (the percentage of travelers using a particular type of transportation) of 30%. Through field observations at airports throughout the country, the typical dwell time for passengers being dropped off by the 3 transportation modes is 60-90 seconds depending on whether a vehicle was dropping off or picking-up passengers, ease of circulation and congestion on the curb roadways.

For the purpose of this analysis, a dwell time of 60 seconds was used for vehicles dropping off departing passengers as this was consistent with curbside operations observed at ABI and other regional airports of similar size. Contributing factors to departure curbside dwell time include low congestion on the roadway meaning that vehicles do not often find themselves boxed in between other vehicles operating on the curbside preventing them from being able to move off the curb after dropping off a passenger.

In scenario 1, there are 71 Peak Hour Departing Passengers (PHDP). Based the aforementioned modal split of 30%, during the peak hour, 21 passengers would be dropped off by TNCs, autonomous vehicles, or traditional vehicles (30%) and 50 passengers would park vehicles in the ABI parking lot or return a rental car (70%). A 30-minute peaking factor was assumed where 60% of the PHDP passengers would be dropped off in a 30-minute period. Assuming the same 30% modal split, 13 passengers would be dropped off at the airport by TNCs, autonomous vehicles, or traditional vehicles and 29 passengers would be parking in the ABI parking lot or return a rental car. This assumption is in line with expert expectations for the utilization of the modes of transportation previously mentioned. A 15-minute peaking factor was also established. The 15-minute peaking period assumes that 50% of the 30-minute peaking period passengers would arrive during the same 15-minute period. Consequently, the 15-minute peaking period establishes that 6 passengers would be dropped off by TNCs, autonomous vehicles or traditional vehicles. Using a vehicle length of 25 ft. which is representative of a Large SUV, it was determined that 53 linear ft. of curbside will be required to accommodate departing passengers dropped off during a 5-minute peak period.

For scenario 4 where the PHDP is 86, the 30-minute peaking period equals 15, meaning that approximately 15 passengers will arrive within a 30-minute period. This leads to 8 passengers arriving during a 15-minute peaking period which coupled with a 25-foot vehicle length leads to a required curbside length of 65 linear ft. to accommodate passengers dropped off during a 5-minute peaking period.

Based on this analysis, the existing departure curbside is sufficient to accommodate all four future scenarios as shown in **Table 4-14.**

Table 4-14
Departure Curbside Length Requirements Analysis

	PHDP	Mode Split	30 MIN Peaking at 60%	15 MIN Peaking at 50%	Vehicle Length (Feet)	Peak 5 MIN Curb Requirement (Feet)
Scenario 1	71	21	13	6	25	53
Scenario 2	77	23	14	7	25	58
Scenario 3	81	24	15	7	25	61
Scenario 4	86	26	15	8	25	65

Source: Corgan, 2018

Arrivals Curb Capacity

Vehicles operating on the arrivals curb that pick up arriving passengers were observed to have a longer dwell time through field observations. The longer dwell time is due to the time it takes for a passenger to approach the vehicle picking them up, greet the driver, organize and stow away their belongings and then get in the car to leave the curb. Due to these factors, the 90 second dwell time was used for vehicles operating on the arrivals curb. It was assumed that arriving passengers would use the same modal split as that used by departing passengers, meaning that 30% of passengers arriving at ABI will be picked up by TNC, autonomous vehicle or private vehicle. The other 70% of arriving passengers will be going to their cars in the parking facility or renting a vehicle. The same methodology used to determine departure curb requirements was used to determine requirements for the arrival curb. **Table 4-15**, *Arrivals Curbside Length Requirements Analysis*, summarizes the arrivals curb requirements for all scenarios.

The scenario 1 forecast shows a demand for 71 Peak Hour Terminating Passengers (PHTP). A 30-minute peaking factor was assumed where 100% of passengers being picked up occupy the curb in a 30-minute period. This means that 21 passengers would be picked up by one of the three transportation modes, all of which would be picked up during the 30-minute peak period. A 15-minute peaking factor is also assumed, where 50% of the 21 passengers are picked up during a 15-minute period. The 15-minute peaking period equals 11 passengers. Using a vehicle length of 25 ft. that is representative of a Large SUV, it was determined that 89 linear ft. of curbside will be required to accommodate departing passengers getting picked up during a 5-minute peak period.

For scenario 4 where the PHTP is 86, where the modal split equals 26 passengers being picked up at the airport curb, the 30-minute peaking for the arrivals curb was 26 passengers. This leads to a 15-minute peaking period during which 13 passengers are picked up. Factoring a 25-foot vehicle length leads to a required curbside length of 108 linear ft. to accommodate passengers getting picked up during a 5-minute peaking period.

Based on this analysis, the existing arrivals curbside of 281 linear ft. is sufficient to accommodate all four future scenarios.

Table 4-15
Arrivals Curbside Length Requirements Analysis

	PHTP	Mode Split	30 MIN Peaking at 100%	15 MIN Peaking at 50%	Vehicle Length (Feet)	Peak 5 MIN Curb Requirement (Feet)
Scenario 1	71	21	21	11	25	89
Scenario 2	77	23	23	12	25	96
Scenario 3	81	24	24	12	25	101
Scenario 4	86	26	26	13	25	108

Source: Corgan, 2018

Public Parking

The existing landside facility includes a covered parking area with 732 spaces. Out of these 732 spaces, 103 are dedicated for rental car services and approximately 200 are utilized by employees (e.g. EASI, terminal, etc.). This leaves approximately 429 parking spaces for public use. An expansion of public parking would be required should utilization of the parking facility reach a rate of 90% utilization during a peak period.

The methodology for this analysis was to determine vehicle parking space utilization during the highest 3-month (90 days) parking revenue period that was reported over a five-year period from 2012 through 2016. The highest 3-month parking revenue period was identified to be September – November of 2016, which had a total revenue of $198,899. The total revenue was divided by the 429 available public parking spaces to find a revenue of $463.63 per space over this 3-month period. The revenue per space was then divided by the parking rate of $9 per day to find a parking space occupancy of 51.51 days out of the 3-month period, which equals a utilization rate of 56%.

Taking the total revenue for the 3-month period and applying it to the approved forecast for annual passengers with a CAGR of 0.82%, the total revenue for the 3-month period during scenario 4 equals $234,189. Following the same method, this equals a $545.90 revenue per space which equals a space occupancy of 60.66 days out of the 3-month period which equals a utilization rate of 66%.

This would stand true assuming that modal splits that passengers use to get to and from ABI would remain the same as they are today. With the emergence of autonomous vehicles and the increase in use of TNCs, it was considered that the same modal split of 70% private vehicles and 30% drop-off, TNC and autonomous vehicles, which was applied to the terminal curbside analysis would actually reduce the utilization rate for public parking to 53%.

The analysis means that an expansion of the airport's parking facilities is not required over the four scenarios of the planning horizon. **Table 4-16**, *Public Parking Busiest Quarter Analysis*, summarizes the results of the public parking utilization analysis.

Table 4-16
Public Parking Busiest Quarter Analysis

	Spaces	Rev. / Space	Days Occupied	Utilization %
Existing	429	$463.63	51.51	0.56
Scenario 4 Constant Mode Split	429	$545.90	60.66	0.66
Scenario 4 w/TNC & Autonomous	429	$436.72	48.52	0.53

Source: Corgan, 2018

Employee Parking

While there is dedicated parking for employees of Abilene Aero, the Air Traffic Control Tower (ATCT) and some for Eagle Aviation Services Inc. (EASI), approximately 200 out of the 629 spaces in the main parking area are utilized by airport, terminal, and EASI employees.

Based on the public parking analysis, the assumption is that the 200 employee parking spaces would not be needed for public parking over the four scenarios. The operations of major airport tenants, such as EASI, could potentially drive an increase in the need for additional employee parking should EASI or other tenants decide to hire more staff. If this growth occurs the need for additional parking spots could occur.

An increase in public parking spaces could drive the need to provide additional employee parking if a number of the current employee spaces are used for public parking. This scenario is not expected.

Rental Car Ready/Return

Rental car requirements were determined based on aggregate for all providers. There are currently 103 rental car parking positions located on-site at ABI.

Rental car revenue data was compiled for the 2014, 2015 and 2016 Fiscal Years as well as partial data for Fiscal Year 2017, which made for a small sample of data to analyze. The data from the 3 full years (FY2014, FY2015 and FY2016) shows that annual rental car revenue was reported in the low to mid $50,000s each year

The data shows that over the three-year period, revenue from rental car commissions remained relatively consistent so the assumption was made that the same will occur over the planning horizon. Applying the anticipated technology advancements in TNCs and autonomous vehicles, the existing rental car facilities have been deemed to be sufficient for all future scenarios. Rental car companies have expressed the need for a quick turn-around facility where they can clean and service vehicles to improve the efficiency of their operations. A separate area along the main airport roadway would be recommended to accommodate this facility.

Landside Facilities Requirements Summary

The Landside Facility Requirements Analysis shows that the existing roadways, terminal curb areas, public, employee and rental car parking facilities are sufficient to accommodate future facility requirements. Modifications to the roadway layout are recommended to improve line of sight to the terminal building along the roadways. Additional facilities may be required such as a quick turn-around facility for the rental car companies.

It is recommended that existing roadway signage be modified to provide consistency in terms of sign color, size, overall visual style and the location of these signs with regards to the road (i.e., on the left or right side of the road).

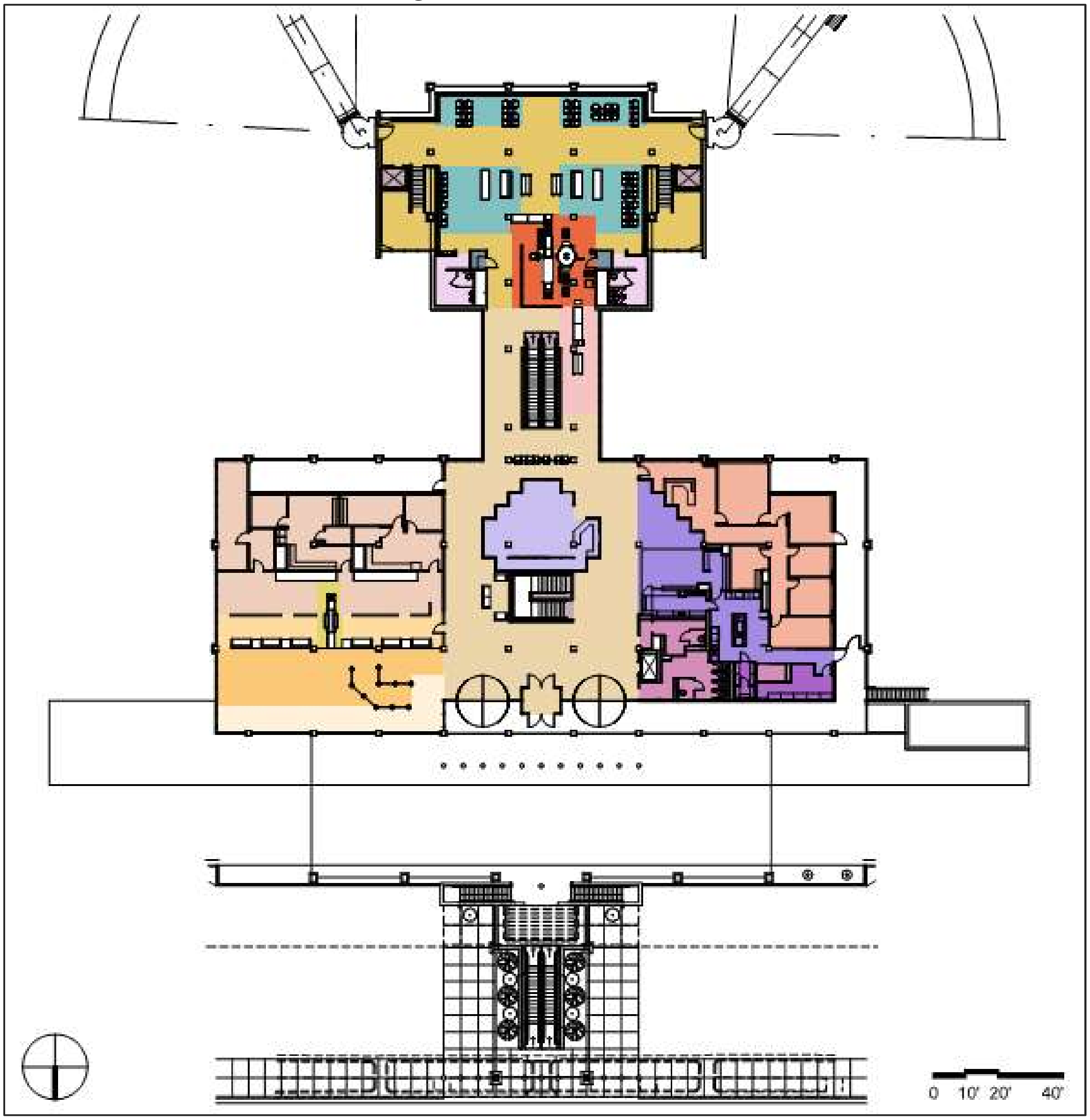
Existing off-property signage requires improvement to provide more signage indicating the airport's location on nearby roads such as TX-36 and TX-322. Improvements are recommended to the airport's entrance sign to improve visibility for vehicles travelling northbound on TX-36.

Terminal Facility Requirements

Passenger Terminal Facilities

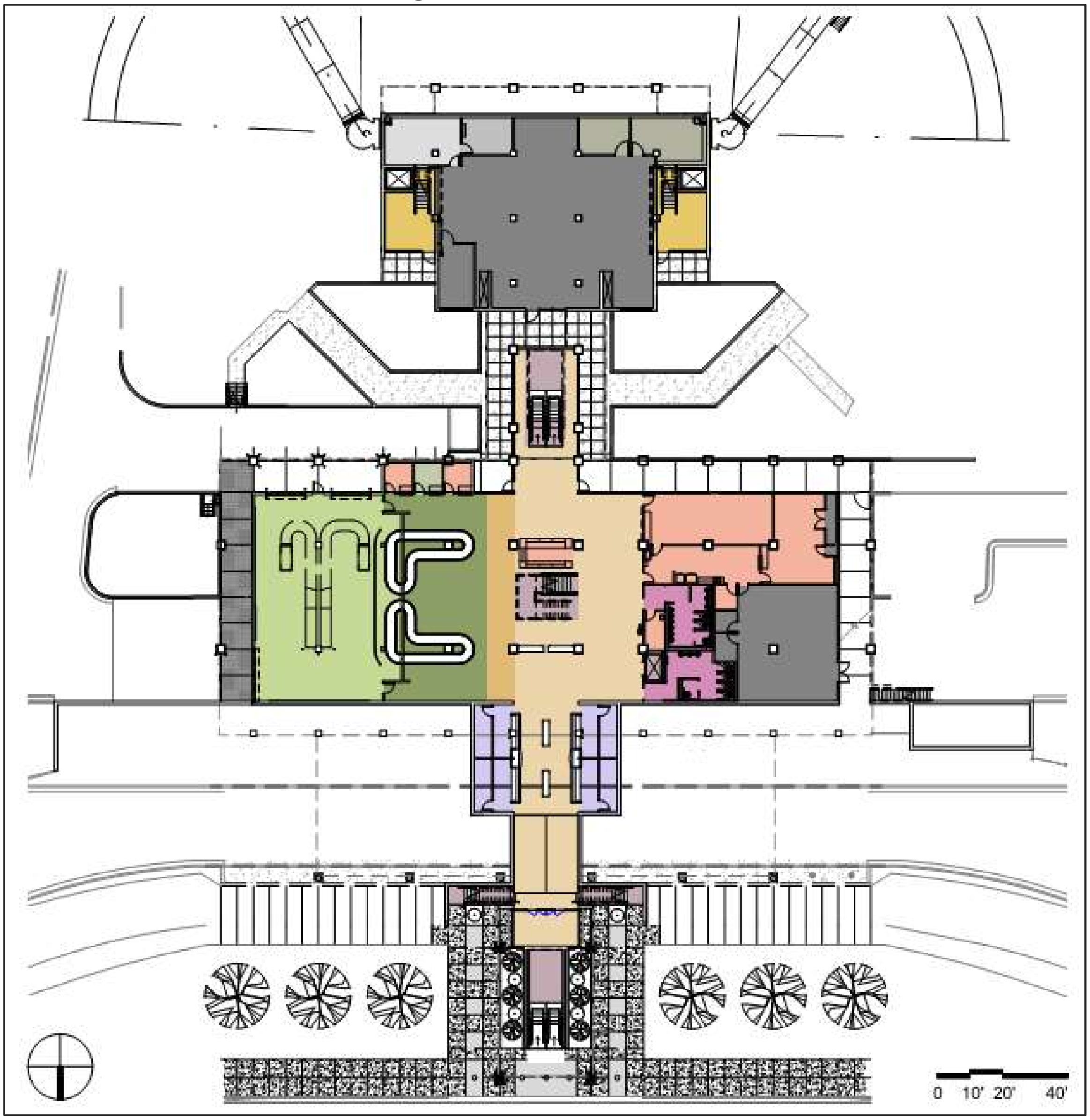
The existing terminal at ABI consists of a 2-level building with a large vertical core located in the center of the non-secure area. Inside the terminal, passengers experience exposed aggregate material and flare columns that frame a pan-formed ceiling. **Figure 4-17**, *Existing Terminal Floor Plan – Level 2*, and **Figure 4-18**, *Existing Terminal Floor Plan – Level 1*, show color block floor plans for level 2 and level 1 respectively.

Figure 4-17
Existing Terminal Floor Plan – Level 2



Source: Corgan, 2018

Figure 4-18
Existing Terminal Floor Plan – Level 1



Source: Corgan, 2018

Terminal space requirements for ABI were determined by applying planning factors to future passenger activity levels, based on Level of Service (LOS) Optimum standards set by the International Air Transportation Association (IATA) Airport Development Reference Manual (ADRM) 10th edition, the Transportation Security Administration (TSA), Corgan experience and various industry best practices for terminal planning. **Table 4-17**, *Forecast Commercial Passenger Enplanements*, displays peak hour passenger demand data from the Forecast Chapter, Chapter 3, which was used to size terminal facilities and determine facility requirements for Scenarios 1, 2, 3 and 4.

Table 4-17
Forecast Commercial Passenger Enplanements

Description	Base Year 2017	Scenario 1 2022	Scenario 2 2027	Scenario 3 2032	Scenario 4 2037
Annual (ANNEP)	90,399	90,045	98,885	103,108	110,367
Peak Month	8,814	8,464	9,295	9,692	10,374
Peak Month Average Day (PMAD)	294	282	310	323	346
Peak Hour Departing Passengers (PHDP)	59	71	77	81	86
Peak Hour Passengers	118	142	154	162	172

Source: Corgan, 2018

Passenger Processing

The terminal provides passenger processing functions such as ticketing, checked baggage screening, passenger security screening, and baggage claim.

Ticketing

The ticketing area includes check-in counters and queue area in front of the counters. The offices behind the counters serve as airline office/operations areas. There are six check-in counters with a total of seven check-in positions totaling an area of 626 sq. ft. Facility requirements for the ticketing area were determined using IATA ADRM-10th edition. The ticket counter area is defined using a planning factor of 3.9 sq. ft. per PHDP as shown in **Table 4-18**, *Ticketing Area Facility Requirements*, below. The current check-in counter area exceeds current area requirements and requirements for all four future scenarios.

To determine facility requirements for the ticket counter queuing area a planning factor of 5.8 sq. ft. per PHDP is applied. In the existing terminal, the queueing area in front of the check-in measures 1,166 sq. ft. **Table 4-18** shows the existing area exceeds current requirements and requirements for all four future scenarios.

However, there is the occasional charter flight that operates out of ABI with a narrow-body aircraft. On the occasion these charter flights operate simultaneously or at similar times to a scheduled air carrier flight, there are congestion issues in the ticketing area due to passengers for both flights checking in. Since charter flights are not a daily occurrence, expanding the ticketing area based on facility requirements for simultaneous charter and air carrier operations is not recommended. Implementing non-capital solutions such as, reallocation of existing ticketing area, temporary stanchions or active line management should be considered to manage departing passenger demand during charter operations.

In the existing terminal, Airline Operations/Airline Ticket Offices area measure 2,476 sq. ft. Facility requirements for these offices are determined by applying a planning factor of 0.023 sq. ft. per Annual Enplanements (ANNEP). This is an industry best practice for regional airports that Corgan has utilized when programing and designing regional terminal buildings similar in size and scope to ABI. Applying this methodology, it was determined that the existing airline office space exceeds current requirements as well as scenarios 1, 2 and 3. For scenario 4, requirements show that the offices need to be expanded 62 sq. ft. to meet the scenario 4 requirement of 2,538 sq. ft. as shown in **Table 4-18**.

Table 4-18
Ticketing Area Facility Requirements

Description	Existing Terminal	Scenario 1 2022	Scenario 2 2027	Scenario 3 2032	Scenario 4 2037
Ticket Counter Area	626	277	300	316	335
Ticket Counter Length (7 Positions)	*52*	*28.4*	*30.8*	*32.4*	*34*
Ticket Counter Queuing	1,166	412	447	470	499
Curbside Baggage Check	-	60	65	68	72
Airline Operations / Airline Ticket Office	2,476	2,071	2,274	2,371	2,538

Source: Corgan, 2018

Baggage Screening

The baggage screening requirements are based on TSA's 2016 count of checked bags screened at ABI. This includes bags scanned through the Explosive Detection System (EDS) machines and hand searched bags (trace detection). The TSA currently uses one CT-80 EDS machine with a manufacturer's hourly throughput of 226 bags. The CT-80 EDS is located on the departures level between the two central check-in counters. **Table 4-19** shows EDS requirements for Scenario 4 based on passenger arrival distribution. The analysis assumes 1.5 bags per passenger. It identifies that one EDS machine is adequate to meet requirements for all future scenarios.

Table 4-19
EDS Requirements Analysis

Passenger Arrival Distribution %			
Time Before Departure (minutes)	**90 min Check-in Distribution**	**Total Bags**	**Required EDS in Scenario 4**
90 - 100			
80 - 90	20.00%	25.8	0.7
70 - 80	20.00%	25.8	0.7
60 - 70	25.00%	32.3	0.9
50 - 60	20.00%	25.8	0.7
40 - 50	12.50%	16.1	0.4
30 - 40	2.50%	3.2	0.1
Total	**100.00%**	**129.00**	

Source: Corgan, 2018

However, a second EDS machine is recommended to provide redundancy and prevent TSA staff from having to resort to hand inspection for checked baggage should the single machine malfunction.

Instead of being placed in between the check-in counters, an in-line baggage screening system is recommended. The area required for an in-line EDS system includes the space needed for the EDS machine itself, an input and output baggage belt, a side table to perform manual bag searches by hand and space for personnel to circulate. Space requirements for a typical in-line layout is approximately 1,250 sq. ft. per machine. If two EDS machines were installed at ABI a total area of 2,500 sq. ft. would be needed as shown in **Table 4-20**, *Baggage Screening Facility Requirements*.

Table 4-20
Baggage Screening Facility Requirements

Description	Existing Terminal	Scenario 1 2022	Scenario 2 2027	Scenario 3 2032	Scenario 4 2037
Bag Screen Room	164	2,500	2,500	2,500	2,500

Source: Corgan, 2018

Outbound Baggage

The outbound baggage area is on the first floor of the terminal behind the baggage claim area. There are two parallel bag belts that carry bags down from behind the bag screening area. Once here, bags are manually lifted off the bag belts by airline employees and loaded onto baggage carts to be sent out to the aircraft. The existing terminal has 1,868 sq. ft. of outbound baggage area. Facility requirements for the outbound baggage area are determined by multiplying the PHDP by a planning factor of 25 sq. ft. per PHDP. **Table 4-21**, *Baggage Processing Facility Requirements*, shows that the existing outbound baggage area is sufficient to meet demand for scenario 1. However, the area would need to be expanded to meet total area demand for outbound baggage in scenarios 2, 3 and 4, which are 1,925 sq. ft., 2,025 sq. ft. and 2,150 sq. ft. respectively.

Baggage Claim

The baggage claim area consists of non-secure public space used by passengers to collect their checked bags. This area includes the space around the claim carousels.

The existing terminal has two L-shaped flat-plate baggage claim devices, providing a total linear frontage of 116 ft. Facility requirements for the baggage claim linear frontage is determined by multiplying the Peak Hour Terminating Passenger (PHTP) by a planning factor of 1.4 linear ft. per PHTP. The existing frontage exceeds requirements for scenarios 1, 2 and 3 but falls just short of the scenario 4 demand of 120 ft. as shown in **Table 4-21**. Instead of expanding the linear frontage by 4 ft. to meet scenario 4 demand, it is recommended that the airport should monitor congestion levels in scenarios 3 and 4. There is currently 0 ft. of linear frontage for oversized baggage claim, which falls short of the demand of 8 ft. for all four scenarios.

Facility requirements for the baggage claim area are determined by multiplying the PHTP value by a planning factor of 20 sq. ft. per PHTP. The existing baggage claim area is 1,716 sq. ft. which is sufficient to meet current requirements and requirements of all four scenarios. **Table 4-21** shows baggage claim area requirement to be 1,420 sq. ft., 1,540 sq. ft., 1,620 sq. ft. and 1,720 sq. ft. for scenarios 1, 2, 3 and 4 respectively.

Inbound Baggage

The existing inbound baggage area is located behind the baggage claim carousel. Bags coming off an aircraft enter this area on via a baggage cart and are then loaded onto the baggage claim carousel by airline employees. Facility requirements for the inbound baggage area are determined by multiplying the PHTP value by a planning factor of 11.8 sq. ft. per PHTP. The inbound baggage area in the existing terminal is 935 sq. ft. which exceeds demand for scenarios 1 and 2. The inbound baggage area would need to be expanded to meet total area demand for inbound baggage in scenarios 3 and 4, which are 956 sq. ft. and 1,015 sq. ft. respectively as shown by **Table 4-21**.

Baggage Service Office

Baggage service offices, managed by the airlines, generally provide assistance for delayed, damaged, or lost baggage. In the existing terminal, there are three baggage service offices each measuring 79 sq. ft. However, two of these offices are utilized by the airport administration, meaning that the total area for baggage service offices in the existing terminal is 79 sq. ft. Facility requirements for the baggage service offices are determined by multiplying the PHTP value by a planning factor of 2.87 sq. ft. per PHTP. **Table 4-21** shows that the baggage service office would need to be increased to meet the total area demand for scenarios 1, 2, 3 and 4 which are 204 sq. ft., 221 sq. ft., 232 sq. ft. and 247 sq. ft. respectively.

Table 4-21
Baggage Processing Facility Requirements

Description	Existing Terminal	Scenario 1 2022	Scenario 2 2027	Scenario 3 2032	Scenario 4 2037
Baggage Claim Area / Oddsize Area	1,716	1,420	1,540	1,620	1,720
Baggage Claim Frontage	*116*	*99.4*	*107.8*	*113.4*	*120*
Oversized Bag Claim	*0*	*8*	*8*	*8*	*8*
Baggage Service Office	79	204	221	232	247
Outbound Baggage	1,868	1,775	1,925	2,025	2,150
Inbound Baggage	935	838	909	956	1,015

Source: Corgan, 2018

Concessions

Concessions requirements were projected in terms of four categories of use for the terminal. Currently, all concession areas are located landside and accessible to the public. Vending machines are the only concessions on the secure side of the terminal. The methodology to determine demand concession requirements is based on a Corgan best practice planning factor that considers an area requirement of 9 sq. ft. per 1,000 enplanements. Forecast enplanements are divided by 1,000 and then multiplied by 9 sq. ft. or determine total concessions requirements. The total concession requirement is then divided into subset concession categories for food & beverage and retail concessions. The percentage for each subset category is determined in accordance with IATA guidelines and is discussed in the following sections.

Food and Beverage

This area includes food and beverage restaurants, kiosks, and quick serve locations. The existing terminal has one restaurant on the non-secure side. On the secure side of the terminal, vending machines are provided. The existing terminal has a total of 1,244 sq. ft. of space allocated for food and beverage concessions. IATA recommends that 60% of the total food and beverage and retail concessions area be dedicated to food and beverage, which leads to the facility requirements shown below in **Table 4-22**, *Concessions Facility Requirements*. Existing food and beverage concessions space exceeds future requirements for all scenarios.

News, Gifts, and Sundry (Retail)

This area includes bookstores, newsstands, small gift shops, specialty shops, and other retail. In the existing terminal, a gift shop is located south of the terminal entrance and measures 768 sq. ft. IATA recommends that 40% of the total food and beverage and retail concessions area be dedicated to retail which means he existing area exceeds requirements for all scenarios as shown in **Table 4-22**.

Concession Storage

Concession storage constitutes the storage and support space separate from the individual concession locations. This can be dry storage, freezers, and coolers. The existing terminal has 253 sq. ft. of storage available for concessionaires. Based on experience, Corgan believes it is a best practice for concession storage space to be approximately 20% of the total food and beverage and retail concessions space. This leads to the conclusion that existing storage for concessions areas meets requirements for all four scenarios as shown in **Table 4-22.**

Ground Transportation

The ground transportation area is comprised of the area used by ground transportation companies other than rental cars to book services for passengers. An example of a ground transportation company using this area would be a shuttle bus company. Since there are no ground transportation services at ABI, there is not a ground transportation area within the existing terminal. Should ground transportation services operate out of ABI in the future, facility requirements for the space required inside the terminal building using a planning factor of 0.004 sq. ft. multiplied by the total number of annual enplaned passenger. This method and planning factor is an industry best practice used for regional airports of similar size to ABI. Ground transportation requirements for all scenarios are shown in **Table 4-22** below.

Information

The existing terminal has a 144-sq. ft. informational booth where visitors can obtain information on the airport, flights or the surrounding community. Information booths are not commonplace in regional terminals and are subject to the value that each individual airport and local community place on the information booth. As such, an industry standard planning factor does not exist for information booths. There is no expansion requirement for this area and the existing information booth could be retained or reduced in size.

Rental Car Counters

Three rental car companies at ABI currently operate out of a 755 sq. ft. area located on the lower level of the terminal near the baggage claim area along the circulation path to the Level 1 Entrance/Exit. The rental car area consists of four counters, circulation and queuing space in front of the counters. Congestion occurs in this area as it is too narrow to accommodate multiple rental counter queues and circulation of passengers exiting or entering the building through this area. Facility requirements for this area are determined with an industry best practice that is applied to regional airports of similar size to ABI. The industry best practice applies a planning factor of 0.015 sq. ft. is required per the annual enplanement volume, meaning that the annual enplanement volume value is multiplied by 0.015 to obtain requirements. **Table 4-22** shows that the rental car counter area would have to be increased to 1,351 sq. ft., 1,483 sq. ft., 1,547 sq. ft. and 1,656 sq. ft. for scenarios 1, 2, 3 and 4 respectively.

Table 4-22
Concessions Facility Requirements

Description	Existing Terminal	Scenario 1 2022	Scenario 2 2027	Scenario 3 2032	Scenario 4 2037
Concessions (Food / Beverage)	1,244	486	534	557	596
Concessions (News / Gifts / Sundry)	768	324	356	371	397
Concessions (Concession Storage)	253	162	178	186	199
Ground Transportation	-	360	396	412	441
Information	144	-	-	-	-
Rental Car Counters	755	1,351	1,483	1,547	1,656
Subtotal Concessions	**3,164**	**2,683**	**2,947**	**3,073**	**3,289**

Source: Corgan, 2018

Secure Public Area

The secure public area within the terminal building includes security screening check point, holdrooms, restrooms, and airline operations space.

Transportation Security Administration (TSA) Security Screening Checkpoints

The existing Security Screening Check Point (SSCP) consists of single screening lane with an hourly passenger processing capacity of 150 passengers under TSA protocols and covers an area of 734 sq. ft. **Table 4-23** shows SSCP requirements analysis for Scenario 4 based on passenger arrival distribution and a processing rate of 150 passengers per hour.

The analysis was conducted on a 90-minute passenger distribution where the checkpoint is expected to open one and half hour before scheduled departure and under a 60-minute passenger distribution where the checkpoint is expected to open an hour before scheduled departure. In both cases, it was found that the existing single lane is sufficient to meet demand for all future scenarios. However, a second lane is recommended for the purpose of redundancy should the existing equipment malfunction. Facility requirements for the SSCP and SSCP Queuing space are TSA standards that cover the area required for all equipment and space necessary for personnel and passengers. Adding a second SSCP lane would require an expansion of 1,666 sq. ft. to meet the required area of 2,400 sq. ft. for scenario 1. Further expansion would not be required after scenario 1.

Table 4-23
SSCP Requirements Analysis

Passenger Arrival Distribution %						
Time Before Departure (minutes)	**90 min Distribution**	**Total Passengers**	**Required SSCP in Scenario 4**	**60 min Distribution**	**Total Passengers**	**Required SSCP in Scenario 4**
90 - 100	5.00%	4.30	0.2			
80 - 90	10.00%	8.60	0.3			
70 - 80	10.00%	8.60	0.3			
60 - 70	15.00%	12.90	0.5			
50 - 60	25.00%	21.50	0.9	10.00%	8.60	0.3
40 - 50	25.00%	21.50	0.9	15.00%	12.90	0.5
30 - 40	10.00%	8.60	0.3	20.00%	17.20	0.7
20 - 30	5.00%	4.30	0.2	27.50%	23.65	0.9
20 -	10.00%	8.60	0.3	27.50%	23.65	0.9
Total	100.00%	**86.00**		**100.00%**	**86.00**	

Source: Corgan, 2018

The existing terminal has 392 sq. ft. of SSCP Queuing space. Since the second SSCP lane is recommended for redundancy purposes, facility requirements for queuing area are equal to a single checkpoint lane. TSA standards state a requirement of 400 sq. ft. of queuing space per checkpoint. Facility requirements for the SSCP and the SSCP Queuing area are shown below in **Table 4-24.**

TSA Administration

In addition to the passenger screening area that TSA operates, TSA needs space for administrative functions, including breaks, restrooms and training areas. Facility requirements for these areas are driven by industry best practices. A planning factor of 1.4 sq. ft. per PHDP is applied to determine size requirements for TSA offices. A planning factor of 2.94 sq. ft. per PHDP is applied to determine size requirements for TSA break areas. The TSA office and breakroom in the existing terminal are located on the lower level below the holdroom area. The office measures 175 sq. ft. and the breakroom measures 338 sq. ft., both of which exceed demand for all scenarios as shown in **Table 4-24.**

Table 4-24
TSA Area Facility Requirements

Description	Existing Terminal	Scenario 1 2022	Scenario 2 2027	Scenario 3 2032	Scenario 4 2037
SSCP	734	2,400	2,400	2,400	2,400
SSCP Queuing	392	400	400	400	400
TSA Offices / Training / Restrooms	175	99	108	113	120
TSA Break	338	209	226	238	253

Source: Corgan, 2018

Passenger Holdrooms

ABI has two airline gates in the terminal building for arriving and departing passengers. Holdroom seating is dependent on peak hour operations, design aircraft, assumed load factor and the resulting peak hour departing passenger. For this analysis, a space allocation per passenger was used in accordance to IATA Level of Service (LOS) Optimum guidance. This guidance recommends allocating 18.2 sq. ft. per seated passenger and 12.9 sq. ft. per standing passenger. IATA LOS Optimum provides for 80% of Peak Hour Departing Passengers (PHDP) seated and 20% standing.

The forecast identified a requirement of 86 PHDP for scenario 4 based on scheduled air carrier service. Charter flights are occasionally operated out of ABI on a narrow body aircraft. For the purpose of the holdroom sizing analysis, the peak hour was assumed to consist of passengers to depart on a regularly scheduled air carrier flight on a regional jet and passengers to depart on a Charter flight to occupy the holdroom simultaneously.

The existing holdroom measures 1,530 sq. ft. The requirements analysis in **Table 4-26** shows that an expansion would be required to meet the demand of 4,192 sq. ft. for scenario 1. After scenario 1, no further expansion would be required.

Table 4-25 shows how the demand requirement of 4,192 sq. ft. was calculated in accordance to IATA Optimum Level of Service standards.

Table 4-25
IATA Optimum Level of Service Holdroom Calculations

Aircraft	Seats	Load Factor	% PAX Seated	% PAX Standing	SF/seated PAX	SF/Standing PAX	Ticket Lift Area	Total Holdroom Area
Regional Jet	76	90%	70%	20%	18.2	12.9	310	1,357
Narrow-body	170	90%	70%	20%	18.2	12.9	490	2,835
							Total	**4,192**

Source: Corgan, 2018

Restrooms

Restrooms on the secure side of the existing terminal measure 351 sq. ft. Facility requirements for secure side restrooms are driven by the number of Peak Hour Passengers (PHP) with an industry best practice planning factor of 3.5 sq. ft. applied per PHP. Requirements for secure side restrooms are larger than non-secure side due to secure side restrooms being utilized more during peak times. Peak times for secure side restrooms would be right after a flight has arrived, due to a high percentage of arriving passengers coming off the flight deciding to use the restrooms in the secure side of the terminal instead of using the restrooms available on the aircraft. Projected requirements in **Table 4-26** show that the restrooms would need to be expanded to 497 sq. ft., 539 sq. ft., 567 sq. ft. and 602 sq. ft. to meet demand for scenarios 1, 2, 3 and 4 respectively.

Circulation

Secure side circulation refers to areas of the terminal building, on level 2 after the SSCP, that does not serve a specific function such as SSCP, holdroom seating, restrooms or airline functional areas. These areas allow passengers on the secure side of the terminal to walk freely and without obstruction between the secure side functional areas. The area for secure-side circulation in the existing terminal is 2,653 sq. ft. Facility requirements for secure side circulation are determined by applying an industry best practice used at airports of similar size to ABI. The planning factor used requires 750 sq. ft. of circulation space for each airline gate. Since there are two gates served out of the secure side, circulation space requirements equals 1,500 sq. ft. as seen in **Table 4-26**.

Table 4-26
Secure Public Area Facility Requirements

Description	Existing Terminal	Scenario 1 2022	Scenario 2 2027	Scenario 3 2032	Scenario 4 2037
Departure Lounges (Holdrooms)	1,530	4,192	4,192	4,192	4,192
Restrooms	351	497	539	567	602
Circulation	2,653	1,500	1,500	1,500	1,500

Source: Corgan, 2018

Non-Secure Public Area

Non-secure public area entails facilities and spaces available to passengers on the non-secure side of the terminal. These spaces include non-secure circulation and areas for non-secure restrooms and other support functions.

Non-Secure Restrooms

Non-secure restrooms in the existing terminal are located to the West of the airport entrance on both levels. Non-secure restrooms in the existing terminal measure a total of 1,133 sq. ft., which exceeds requirements for all scenarios. Facility requirements for non-secure restrooms are driven by the number of Peak Hour Passengers (PHP) and an industry best practice planning factor of 3 sq. ft. per PHP. The facility requirement calculation involves taking the 3 sq. ft. planning factor and multiplying it by the PHP. Non-secure restroom requirements are 426 sq. ft., 462 sq. ft., 486 sq. ft. and 516 sq. ft. respectively as shown in **Table 4-27**, *Non-Secure Public Area Facility Requirements*. Recommendation is to retain existing restrooms in order to maintain the same level of service that exists today.

Non-Secure Circulation

Non-secure circulation space is comprised of circulation for ticketing and baggage claim as well as general circulation. Non-secure circulation allows passengers on the non-secure side of the terminal, prior to going through SSCP, to walk freely and without obstruction between the secure side functional areas. Facility requirements for all non-secure circulation categories are implemented from industry best practices that have been applied at airports of similar size to ABI.

The existing terminal has 647 sq. ft. of circulation for ticketing which satisfies requirements for scenario 1. A planning factor of 8.7 sq. ft. per Peak Hour Departing Passenger (PHDP) is multiplied by the PHDP value to determine ticketing circulation area requirements. The ticketing circulation area would need to be expanded to meet facility requirements of 670 sq. ft., 705 sq. ft. and 748 sq. ft. for scenarios 2, 3 and 4 respectively as shown below in **Table 4-27**.

The existing terminal has 516 sq. ft. of circulation for baggage claim. A planning factor of 10 sq. ft. per Peak Hour Terminating Passenger (PHTP) is multiplied by the PHTP value to determine baggage claim circulation area requirements. The baggage claim circulation area would need to be expanded to meet area requirements for baggage claim circulation are 710 sq. ft., 770 sq. ft., 810 sq. ft. and 860 sq. ft. for scenarios 1, 2, 3 and 4 respectively as shown below in **Table 4-27**.

The existing terminal has 8,526 sq. ft. of general non-secure circulation space, which exceeds current and future demand. As seen in **Figure 4-17** showing the floor plan for level 2 of the existing terminal building, general circulation consists of the area in between the main entrance, the ticketing area to the left, restrooms and restaurant to the right and down towards the security checkpoint. The retail concessions and vertical circulation area to the south of the entrance are not included as general circulation space.

As seen in **Figure 4-18** showing the floor plan for level 1 of the existing terminal building, general circulation space consists of the area connecting the main entrance to the escalators going around the west side of the central staircase and information booth. A planning factor of 0.02 sq. ft. per Annual Enplanements is multiplied by the ANNEP value to determine general non-secure circulation area requirements. General non-secure circulation space requirements are 1,801 sq. ft., 1,978 sq. ft., 2,062 sq. ft. and 2,207 sq. ft. for scenarios 1, 2, 3 and 4 respectively.

Table 4-27
Non-Secure Public Area Facility Requirements

Description	Existing Terminal	Scenario 1 2022	Scenario 2 2027	Scenario 3 2032	Scenario 4 2037
Circulation–Ticketing	647	618	670	705	748
Circulation-Baggage Claim	516	710	770	810	860
Circulation-General	8,526	1,801	1,978	2,062	2,207
Restrooms	1,133	426	462	486	516
Other	-	126	138	144	155

Source: Corgan 2018

Non-Public Areas

Non-public areas were assessed as a whole for the terminal. These areas include mechanical, communications rooms and electrical spaces, loading docks, general storage for custodial and Airport, and restrooms not accessible to the public.

Airport Administration

The existing terminal has 3,781 sq. ft. of airport administration space located on both levels of the terminal's non-secure side. The airport administration space includes four offices, conference room, reception area, kitchen, break room, press/meeting room and communications room. The airport administration has expressed the desire to provide additional office space for staff to be hired in the future. With this in mind, the recommendation was made for three additional 150-sq. ft. offices to be added for a total expansion of 450 sq. ft. It is assumed that two offices, for a total of 300 sq. ft., would be added in scenario 1 and the final 150 sq. ft. of office space would be added in scenario 4. **Table** 4-2**8** shows Airport Administration space requirements.

Table 4-28
Airport Administration Facility Requirements

Description	Existing Terminal	Scenario 1 2022	Scenario 2 2027	Scenario 3 2032	Scenario 4 2037
Airport Administration	3,781	4,081	4,081	4,081	4,231

Source: Corgan 2018

Loading Docks

The existing terminal has 0 sq. ft. of loading dock area; concessionaires currently bring supplies through the airport's main door. Adding a loading dock would eliminate the need for concessioner deliveries to be brought through the main terminal lobby. Loading dock area requirements are determined by an industry best practice applied at airports of similar size where loading dock area represents 0.3% of the building's total sq. footage. Loading dock area requirements are 88 sq. ft., 92 sq. ft., 94 sq. ft. and 98 sq. ft. for scenarios 1, 2, 3 and 4 respectively as shown in **Table 4-29**. The main goal of a loading dock at ABI would be to eliminate the need for concessionaires to bring in goods into the airport through the main door. An alternative solution could be considered to avoid the need to build a loading dock.

Storage

Storage space are dedicated areas used by custodial or the airport administration to store supplies and other items. The existing terminal has 50 sq. ft. of storage space. An expansion of total storage space would be required to meet the demands for scenarios 1, 2, 3 and 4 which are 293 sq. ft., 306 sq. ft., 313 sq. ft. and 325 sq. ft. respectively as shown in **Table 4-29**. Space requirements for these areas are driven by the building's total sq. footage where these areas represent 1% of total square footage. Therefore, if the terminal building is expanded these areas may also need to be increased accordingly.

Maintenance

Maintenance areas include janitor closets and closets to store custodial supplies. The existing terminal has 486 sq. ft. of maintenance space which exceeds requirements for all scenarios. Total maintenance space requirements are 293 sq. ft., 306 sq. ft., 313 sq. ft. and 325 sq. ft. for scenarios 1, 2, 3 and 4 respectively as shown in **Table 4-29**. Space requirements for these areas are driven by the building's total square footage where these areas represent 1% of total square footage. Therefore, if the terminal building is expanded these areas may also need to be increased accordingly.

Mechanical/Electrical/Building Systems

Mechanical, Electrical and Building Systems areas include the interior rooms in the Airport that house air handling units, electrical panels, and communications systems. Space requirement for these facilities is based on a percentage of the total building square footage. The existing terminal has 4,522 sq. ft. of mechanical, electrical, building systems areas which exceeds requirements for all scenarios as shown by **Table 4-29***.* Space requirements for these areas are driven by the building's total square footage where these areas represent 12% of total square footage. Therefore, if the terminal building is expanded these areas may also need to be increased accordingly.

Table 4-29
Non-Public Area Facility Requirements

Description	Existing Terminal	Scenario 1 2022	Scenario 2 2027	Scenario 3 2032	Scenario 4 2037
Loading Dock	-	88	92	94	98
Storage	50	293	306	313	325
Maintenance	486	293	306	313	325
Mech. / Elec. / Bldg. Systems	4,522	3,516	3,671	3,760	3,906
Subtotal Non-Public Area	**5,058**	**4,190**	**4,375**	**4,480**	**4,655**

Source: Corgan, 2018

Wayfinding

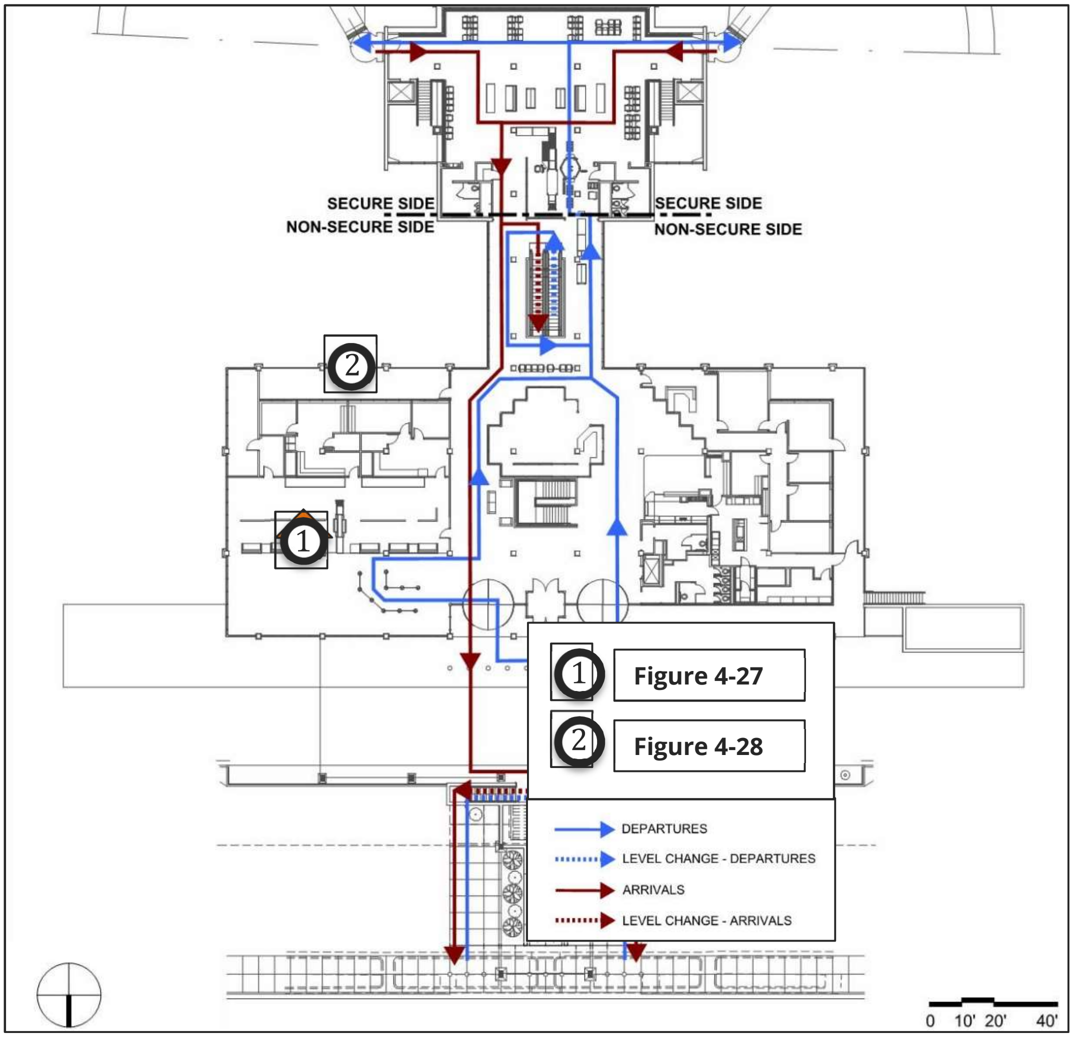
Wayfinding plays a very large role in passengers' journey while navigating through the airport. When passengers perform wayfinding tasks needed to reach their destinations, they are not relying on signage alone as wayfinding is primarily spatial problem solving (Arthur and Passini, 1992). Consequently, architectural design is crucial to successful wayfinding strategies.

Environmental Level & Passenger Perspective

This section refers to elements in the space or environment around a person that define that space and in turn define a person's perception of these spaces. The first objective is to create a unique personality and identity for each destination along the path. Clear wayfinding between destinations should then be articulated through architectural design, landmarks, signage and user-friendly technology. Placing proper hierarchy of these elements with strategic use of colors, patterns and lighting can further ensure the success of the passenger's journey. For example, orienting ticket counters in such a way as to be part of the edge defining the path to the security screening checkpoint or inserting a bold piece of art in an area that can be associated with only that location would give passengers a memorable element for guidance. Art may also be used as an identifying branding element for the airport in general. ABI does a good job of using art to aid with wayfinding with the display of a vintage model airplane in the central lobby area of the departures level.

Clear and consistent naming of functions, areas, and levels of the building will take the guesswork out of how a passenger identifies their location. Applying individual colors or visual themes for different functions is a way for passengers to not only know where they are, but also mentally connect with their location and understand when they move from one section of the terminal building to another. This can be achieved inside the terminal building by subtle changes in flooring colors and materials, ceiling patterns and ceiling heights that help identify a specific functional area inside the building and separate it from other functional areas. **Figure 4-19** identifies locations on the upper level where environmental level wayfinding is observed. As shown in **Figure 4-20**, *Terminal Environmental Level Wayfinding – Entrance Lobby Ceiling*, and **Figure 4-21**, *Terminal Environmental Level Wayfinding – Ceiling Change at SSCP*, the ABI terminal achieves this objective with changes in ceiling color and "honeycomb size and depth" shape as the passenger moves from the non-secure side of the terminal building through the SSCP and into the holdrooms. Having a unique art piece like the vintage aircraft model ABI has in the central lobby of the upper level is also an effective manner to uniquely identify an area of the building. The vintage aircraft model provides a consistent wayfinding landmark, sense of place, and convenient meeting place for passengers.

Figure 4-19
Terminal Environmental Level Wayfinding – Upper Level



Source: Corgan, 2018

Figure 4-20
Landmark in Entrance Lobby

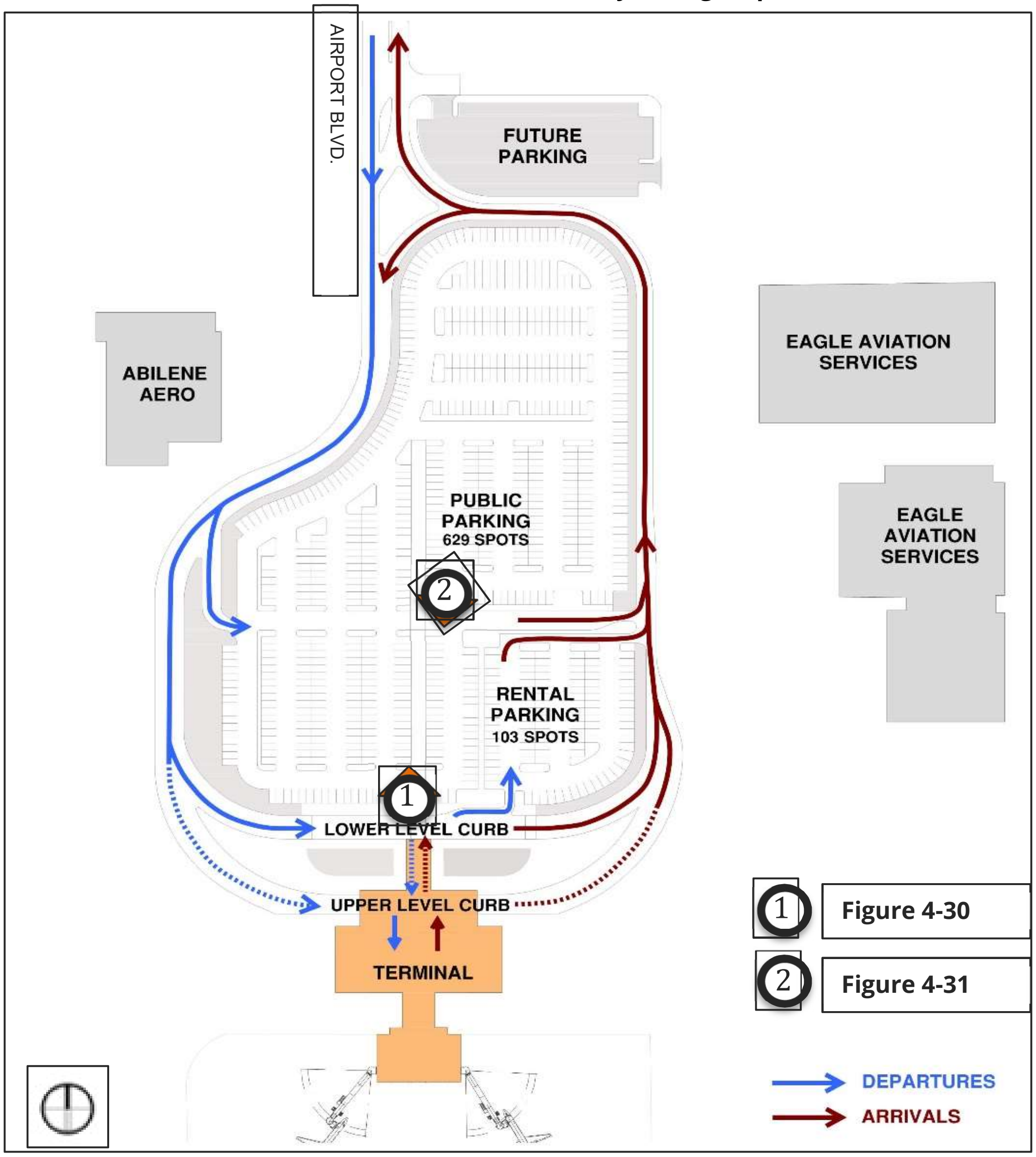
Source: Corgan, 2018

Figure 4-21
Ceiling Change at SSCP

Source: Corgan, 2018

These principles can be applied in the terminal building as well as the parking area. Providing unique colors or themes for specific zones of the parking facility can help passengers to remember where they are parked. Changes in pavement material types and colors in the parking area is also an effective wayfinding method for parking areas. **Figure 4-22**, *Landside Environmental Level Wayfinding Map*, shows locations where wayfinding examples were found within the landside facilities at ABI. An example of this would be the red concrete pavers ABI employs to delineate passenger walkways and corridors through the parking lot as shown in **Figure 4-23.** **Figure 4-24** depicts an example of existing signage that is insufficient because it is not prominent enough.

Figure 4-22
Landside Environmental Level Wayfinding Map

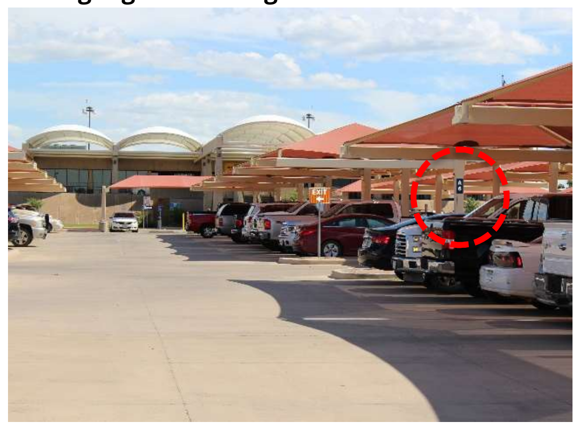


Source: Corgan, 2018

Figure 4-23
Red Concrete Pavers Marking Path Towards Parking

Source: Corgan, 2018

Figure 4-24
Signage In Parking Lot Not Prominent



Source: Corgan, 2018

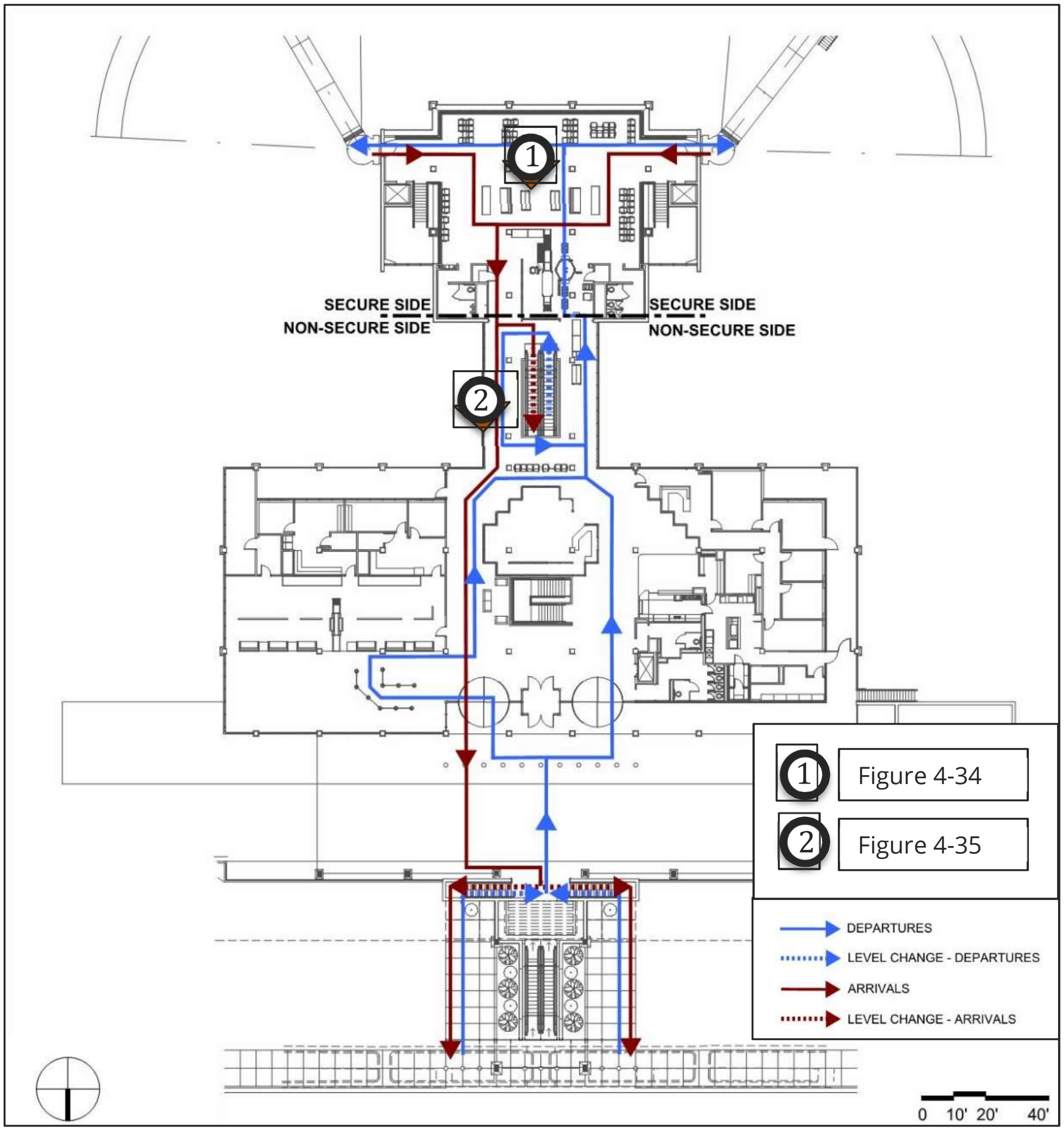
Location Level

On a very basic level, a person arriving at an airport terminal for a flight is coming from a vehicular curb and going to a gate. Being able to visually associate to those two points allows them to quickly orient themselves within the building. They know the ultimate beginning and end to their path and want to continually travel in a direction that leads them there. Being able to see the curb or parking area, as well as the airfield, subconsciously leads a passenger in the right direction.

Within a public parking area, passengers need to know where they are leaving their vehicle, where they need to go to continue their journey, and how they can get back to their vehicle later. Each section or zone of the parking area should have unique identifiers to provide a sense of place. ABI does provide signage that helps passengers identify what specific section or zone of the parking facility they are in by giving zones an alpha-numeric denomination. There are signs, consisting of white text on blue background, on the canopy poles to uniquely identify parking sections. However, these signs are small in size and are not easily noticeable.

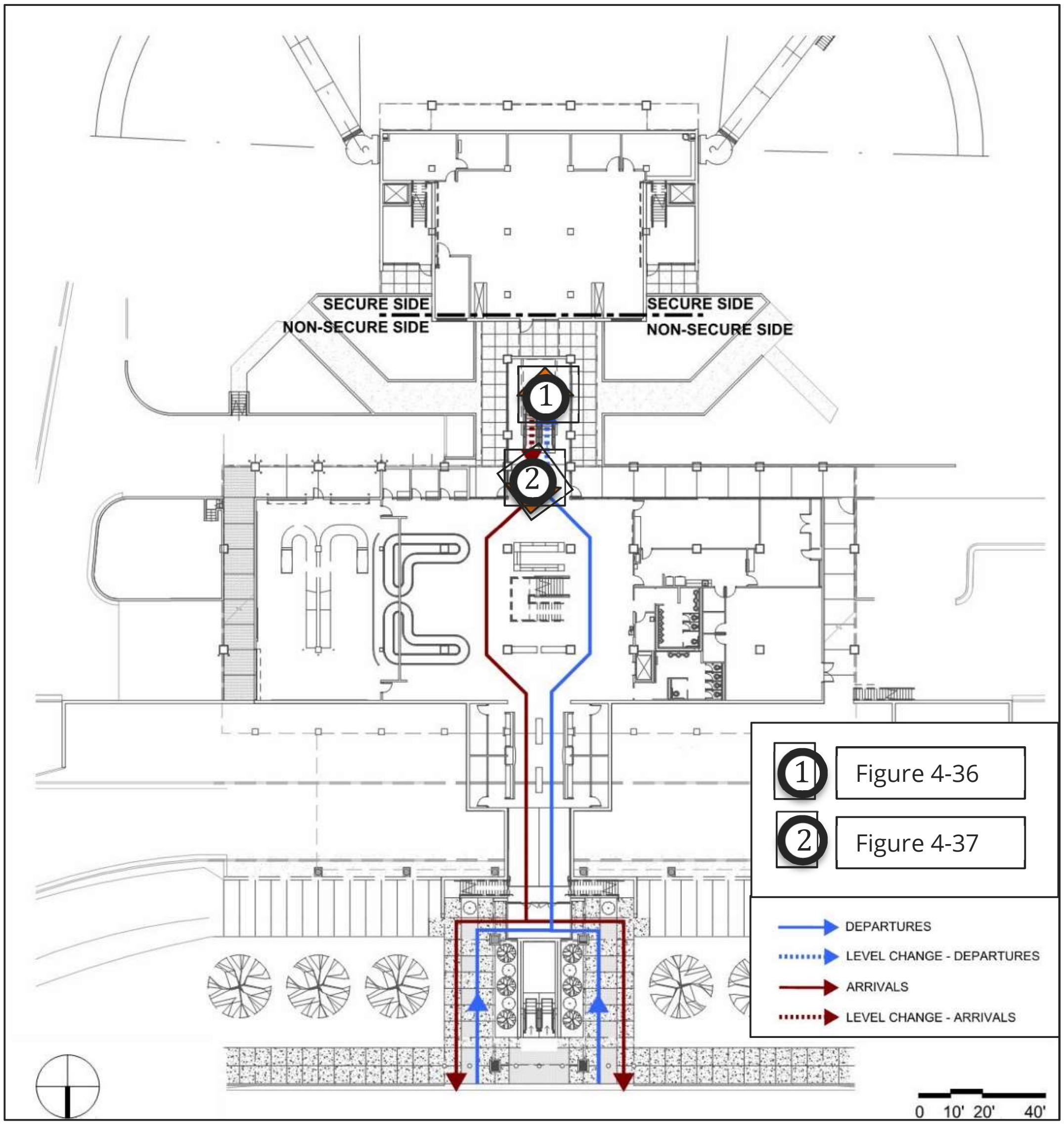
There should be clear lines of sight and safe pedestrian paths to terminal entrances that guide them to check-in locations. Visual cues within the terminal should also easily lead the passenger back to the correct section or zone of the parking area so that the frustration of finding their vehicle at the end of their trip is diminished. Signage within ABI's existing terminal should be updated to provide clear direction of where passengers are located within the terminal in relation to the passenger path and ultimate destinations such as check-in, ticketing, SSCP, departures gates or bag claim. **Figure 4-25,** *Terminal Location Level Wayfinding – Upper Level* and **Figure 4-26**, *Terminal Location Level Wayfinding – Lower Level* depict areas of the terminal where wayfinding issues were found. Specific examples at ABI of where passenger paths are not intuitive and reliance on signage is critical include but are not limited arrival passengers exiting the holdroom (**Figure 4-27**), outside the holdroom where arriving passengers will miss the start of the escalator(**Figure 4-28).** The top of the escalators where departing passengers are trying to get to the SSCP (**Figure 4-29**), and at the bottom of the escalators where there is a lack of signage on the lower level to direct passengers to baggage claim and landside functions (**Figure 4-30**).

Figure 4-25
Terminal Location Level Wayfinding – Upper Level



Source: Corgan, 2018

Figure 4-26
Terminal Location Level Wayfinding – Lower Level



Source: Corgan, 2018

Figure 4-27
Cluttered Signage for Arriving Passengers

Source: Corgan, 2018

Figure 4-28
Signage on Arriving From SSCP Exit Lane

Source: Corgan, 2018

Figure 4-29
Top of Escalator

Source: Corgan, 2018

Figure 4-30
Bottom End of Escalator

Source: Corgan, 2018

Building Level

Once inside the building, having direct paths between typical destinations with few choices for deviation make navigation easier. Straight paths with fewer turns and corners are most intuitive. Using the building elements to control sight lines along the path allows for less distractions and easier decision making, which maintains lower anxiety levels for the passenger. Finish materials can also be used to indicate a path in a very literal way to remove any question about the direction one should take.

Passengers should always have a perception of where the ultimate destination is located. Not knowing how far away that point is causes unneeded anxiety. Primary circulation paths should focus lines of sight between points by using major building elements and/or landmark icons. Intermediate destinations should be visible from primary paths at decision point nodes. These nodes should be sized to allow time and space for those decisions to be made, allowing passengers to orient themselves before moving on. Paths should be kept as short as possible between decision points and destinations. Passengers need to know how far they are going and how long it will take them to get there.

At ABI there are some areas where there is limited visibility between a passenger's current location and destination. An example of this would be when passengers enter the building at the departures level. From the building entrance and from the ticketing area there is not a direct line of sight to the security checkpoint and passengers find themselves having to walk on an indirect path to go around the vertical circulation core and retail concessions area in the central lobby as shown in **Figure 4-31**, *Exiting Ticketing Lobby*. On the lower level, the central stairway blocks line of sight from the entrance rental car counters to the escalators as shown in **Figure 4-32**, *Central Stairs Block Line of Sight Towards Escalator.*

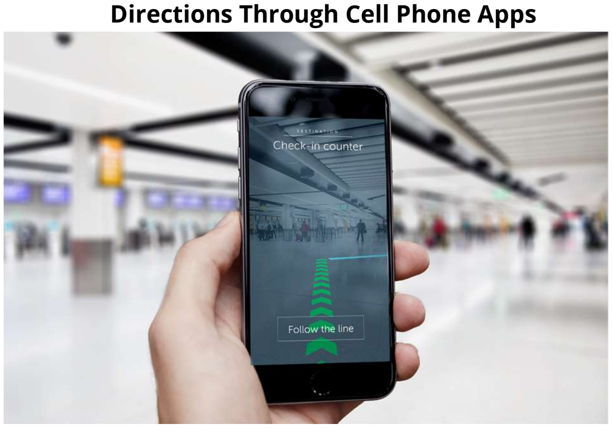
Figure 4-31
Exiting Ticketing Lobby

Source: Corgan, 2018

Figure 4-32
Central Stairs Block Line of Sight Towards Escalator

Source: Corgan, 2018

Figure 4-33
Directions Through Cell Phone Apps



Source: Corgan 2018

Beyond visual perception of the length of a path, the use of technology to convey this information can be used in many ways. Electronic signage that indicates travel time between two functional areas can be displayed throughout the terminal building to allow passengers to estimate their allowable dwell time in these areas. In addition to supplementing visual perception, this technology is useful when visual line of sight is not feasible to provide that visual perception.

The recent development of beacon technology has provided a convenient way to address peoples' needs to offer help and services based on their current location. Beacons are one-way transmitters that are used to mark important places and objects. Typically, a beacon is visible to a user's device from a range of a few meters, allowing for highly context-sensitive use cases.

This allows for a temporal, context and location driven communication with passengers through their cell phones' Bluetooth feature. Smart phone apps can display path guidance as well as calculate travel time as shown in **Figure 4-33**, *Directions Through Cell Phone Apps*. Such solutions utilizing the smart phone platform could be implemented at ABI to assist passengers in wayfinding. The more personalized this information can be to the individual passenger, the more relaxed they will feel which will improve their airport experience.

Each key area within the facility should have a unique identity to aide in wayfinding. So that this does not become more overwhelming than it should, centralized areas that provide time and space for decision-making should tie these key destinations together. A place to gather, meet up with other travelers in their party, eat a meal, or visit the retail shops in the area help to relax passengers. Large volumes and broad vistas allow the passenger to get a sense of the entire space, taking in destination points, paths available, and vertical circulation methods to get there. The lobby area on the second level of ABI's existing terminal could be an ideal location for an open centralized area with concessions, circulation and other functional areas located around it.

Intuitive Wayfinding

Intuitive wayfinding is defined as finding your way, based on quick perception and direct interpretation, without consciously thinking about it.

To understand how we can find our way without even thinking about it, we have to look at psychology. This field of science teaches us that there are two processes of reasoning, called System 1 and System 2. System 1 is characterized by unconscious reasoning. This way of reasoning is implicit. It is also fast and automatic, and influenced by emotions. This way of reasoning is very difficult to change or manipulate. System 2 is characterized by conscious reasoning. This way of reasoning is explicit. It is also slow and volatile, and influenced by conscious judgement. The advantage of this is that we can easily expand or change this way of reasoning when we encounter new or unexpected situations.

Intuitive wayfinding makes use of our System 1 way of reasoning. It is therefore mostly based on experience. People learn how to navigate when driving through a country, walking in a city, or moving through a building. Intuitive wayfinding in these cases is based on common sense knowledge, learned through experience. It is therefore important to stick to well established conventions when routing passengers through an airport. Using intuitive wayfinding it is possible to:

- Reinforce main routes/entrances within the terminal
- Improve the atmosphere of specific functional areas like SSCP (safe, warm, welcome)

- Attract passengers (in a direction, up the stairs, etc.)
- Influence speed of moving through the terminal
- Influence perceived waiting time
- Improve passenger experience (fun!)

Figure 4-34
Intuitive Wayfinding

Source: Corgan, 2018

Intuitive wayfinding is not useful to communicating complex routes or processes. It is also hard to implement when the building or environment is not intuitive. The role of intuitive wayfinding in an airport environment will therefore typically be limited to reinforcing paths and directions. While airports should provide sufficient signage to help passengers find the way, the goal of intuitive wayfinding would be to make the terminal facility easy enough to navigate that a passenger does not have to be constantly looking for signage to find their way through the terminal building.

Intuitive wayfinding can be implemented within ABI's terminal building with the use of distinctive finishes that trace a path for passengers to follow as seen in the **Figure 4-34**, *Intuitive Wayfinding*. Specific areas within the building can be renovated or expanded in such a manner that passengers moving through the spaces can intuitively find their way towards destination. For instance, on entering the ABI terminal at lower level, the natural path for departing passengers to go up to the upper level for security or ticketing is obstructed as the corridor between the rental car counters is narrow and the location and orientation of central staircase obstructs the view towards the escalator going up to the upper level. Similarly, the natural path for arriving passengers who wish to exit the terminal from the upper level is obstructed when arriving through the exit lane due to the central position of the gift shop in the middle of Level 2.

Landmarks and Visual Focus Points

Landmarks and visual focus points are memorable locations that help the passenger to orient himself. **Figure 4-35** shows an example landmark.

Figure 4-35
Example of a Prominent Landmark

Landmarks are features that stand out in the environment, and that are distinct enough to function as identification for an entire area. Additional landmarks could be added to identify specific zones of ABI's parking facility which would make it easier for passengers to identify where they are parked or where their pick-up is located.

The following represent important criteria for landmarks:

- Each landmark should be unique and not share any characteristics with other landmarks (no 'family' or 'series')
- A user must be able to easily describe a landmark
- A landmark should stand out from the architecture and regular signage
- A landmark should articulate a location not a function

The existing terminal at ABI has a prominent landmark on the second floor in the form of the vintage aircraft model hanging from the ceiling. This is a good example of a location within the terminal where a person knows exactly where they are and that is easy to find as a meeting place.

Visual focus points are an identifiable structure or element that stands out from its background. Visual focus points are conspicuous and unique enough to identify routes of places ('I have been here before'), but not to identify entire areas or spaces.

Terminal Facility Requirements Summary

A summary of the terminal building facility requirements discussed above are shown in **Table 4-30**, *Terminal Facilities Requirements Summary*, below where areas that currently do not meet requirements are shown in red. From the table, the following significant areas of the terminal building do not meet Scenario 1 requirements.

- Departure Lounges - Expansion required to meet 4,192 sq. ft. of holdroom space required in future scenarios to accommodate peak hour departing passengers.
- Security Checkpoint Expansion required to meet 2,400 sq. ft. of SSCP space required in future scenarios in accordance with TSA standards. Expansion required due to the recommended addition of a second SSCP processing lane for redundancy purposes.
- Baggage Screening Expansion required to meet 2,500 sq. ft. requirement for baggage screening space. Expansion is driven by the recommendation to establish a standard in-line baggage screening layout and the addition of a second EDS machine for redundancy purposes.

Table 4-30
Terminal Facilities Requirements Summary

Description	Existing Terminal	Scenario 1 2022	Scenario 2 2027	Scenario 3 2032	Scenario 4 2037
Airline Functions					
Ticket Counter Area	626	277	300	316	335
Ticket Counter Length (7 Positions)	*52*	*28.4*	*30.8*	*32.4*	*34*
Ticket Counter Queuing	1,166	412	447	470	499
Curbside Baggage Check	-	60	65	68	72
Baggage Claim Area / Oddsize Area	1,716	1,420	1,540	1,620	1,720
Baggage Claim Frontage	*116*	*99.4*	*107.8*	*113.4*	*120*
Oversized Bag Claim	*0*	*8*	*8*	*8*	*8*
Baggage Service Office	79	*204*	221	232	247
Outbound Baggage	1,868	1,775	1,925	2,025	2,150
Inbound Baggage	935	838	909	956	1,015
Airline Operations / Airline Ticket Office	2,476	2,071	2,274	2,371	2,538
Departures Lounges (Holdrooms)	1,530	4,192	4,192	4,192	4,192
Jet Gates	*2*	*2*	*2*	*2*	*2*
Subtotal Airline Functions	**10,396**	**11,248**	**11,873**	**12,250**	**12,769**
Concessions					
Concessions (Food / Beverage)	1,244	486	534	557	596
Concessions (News / Gifts / Sundry)	768	324	356	371	397
Concessions (Concession Storage)	253	162	178	186	199
Ground Transportation	-	360	396	412	441
Information	144	-	-	-	-
Rental Car Counters	755	1,351	1,483	1,547	1,656
Subtotal Concessions	**3,164**	**2,683**	**2,947**	**3,073**	**3,289**
Secure Public Area					
SSCP	734	2,400	2,400	2,400	2,400

	SSCP Queuing	392	400	400	400	400
	Circulation	2,653	1,500	1,500	1,500	1,500
	Restrooms	351	497	539	567	602
	Bag Screen Room	164	2,500	2,500	2,500	2,500
	TSA Offices / Training / Restrooms	175	99	108	113	120
	TSA Break	338	209	226	238	253
	Airport Administration / Training	3,781	4,081	4,081	4,081	4,231
	Other	-	-	-	-	-
	Subtotal Secure Public Area	**8,588**	**11,686**	**11,754**	**11,800**	**12,006**
	Non-Secure Public Area					
	Circulation - Ticketing	647	618	670	705	748
	Circulation - Baggage Claim	516	710	770	810	860
	Circulation - General	8,526	1,801	1,978	2,062	2,207
	Restrooms	1,133	426	462	486	516
	Other	-	126	138	144	155
	Subtotal Non-Secure Public Area	**10,822**	**3,681**	**4,018**	**4,207**	**4,486**
						-
	Non-Public Area					-
	Loading Dock	-	88	92	94	98
	Storage	50	293	306	313	325
	Maintenance	486	293	306	313	325
	Mech. / Elec. / Bldg. Systems	4,522	3,516	3,671	3,760	3,906
	Subtotal Non-Public Area	**5,058**	**4,190**	**4,375**	**4,480**	**4,655**
	Grand Total	**38,028**	**33,488**	**34,966**	**35,810**	**37,204**

Source: Corgan 2018

General Aviation and Aircraft Maintenance Facilities

General Aviation facilities are an important component of an airport. Consequently, as part of the master planning process it is important to analyze the existing general aviation facilities in light of the established forecast to identify where improvements are necessary.

For this analysis, the Abilene Aero Ramp and the Northwest GA ramp and their associated hangars are considered general aviation facilities. ABI has a large aircraft Maintenance, Repair, and Overhaul (MRO) operation on the airfield – Eagle Aviation Services, Inc. The development needs of this facility will also be discussed in this section.

General Aviation Terminal/FBO Facilities

General aviation terminal/Fixed Based Operator (FBO) facilities and vehicle parking facilities play an important role in an airport's efforts to serve the general aviation and air taxi community.

General Aviation Terminal/FBO Building

Sufficient general aviation terminal/FBO facilities are vital to support the propagation of general aviation activity at an airport. Currently, ABI has one FBO - Abilene Aero. Abilene Aero is a full-service FBO that offers a wide array of amenities and services including aircraft fueling, aircraft maintenance, aircraft sales, charters, meeting rooms, pilot lounges, flight planning facilities, crew cars, catering, etc.

In establishing future plans for the development of general aviation terminal/FBO facilities some key considerations are:

- Planned development should allow for incremental linear expansion of facilities and services in a modular fashion along an established flightline.
- Major design considerations involve minimizing earthwork/grading, avoiding flood-prone areas and integrating existing paved areas to reduce pavement (taxilane) costs.
- Future terminal expansion should allow sufficient maneuverability and accessibility for appropriate types (mix) of general aviation aircraft within secured access areas.
- Future terminal area development should enhance safety, visibility, and be aesthetically pleasing.

The GA terminal at ABI is operated by Abilene Aero. The facility is approximately 8,000 sq. ft., was recently remodeled, and is in good condition. The facility currently provides a sufficient level of service to airport users and receives high ratings of general aviation centric websites such as Airnav.com.

The formula contained in the Airport Cooperative Research Program (ACRP) *Report 113: Guidebook on General Aviation Facility Planning*, was used to evaluate whether the existing terminal facility will be sufficient to meet forecasted demand. The formula states that the demand for general aviation terminal space is a function of an airport's forecasted peak hour air taxi, general aviation, and military operations multiplied by a per square footage allotment per person and the average number of pilots/passengers per aircraft. According to ACRP Report 113 the average number of pilots/passengers per aircraft is typically 2.5. However, because of the number of larger aircraft using ABI this number was increased to 3.5. For the square footage allotment per person, ACRP Report 113 recommends between 100 sq. ft. and 150 sq. ft. For these calculations 150 sq. ft. was used to provide maximum comfort/support space.

The results of these calculations are shown in **Table 4-31**, *GA/FBO Terminal Building Facility Requirements*.

Table 4-31
GA/FBO Terminal Building Facility Requirements

Facility	2017	2022	2027	2032	2037
Formula Factors					
- Peak Hour Operations (AT, GA, Military)	14	14	14	14	14
- Peak Hour Multiplier	3.5	3.5	3.5	3.5	3.5
- Sq. Ft. Per Person	150	150	150	150	150
Total Terminal Sq. Ft. Requirement	7,350	7,350	7,350	7,350	7,350
Current Terminal Sq. Ft.	8,000	8,000	8,000	8,000	8,000
Surplus/Deficiency (Sq. Ft.)	**650**	**650**	**650**	**650**	**650**

Source: Garver, 2017

Based on these calculations, it is estimated that the size of the existing GA/FBO Terminal Building will be sufficient to accommodate future general aviation, air taxi, and military demand.

General Aviation Terminal/FBO Vehicle Parking

Vehicle parking space requirements are based on the number of pilots/passengers using general aviation facilities and the number of employees working at those facilities.

Vehicle parking space requirements were completed utilizing the formula contained in ACRP Report 113 for calculating the number of parking spaces needed for FBO terminal/hangar facility. The formula states that vehicle parking space requirements are a function of passenger/pilot activity and employee parking space requirements.

To calculate the vehicle parking space needs for passenger/pilots the number of peak hour general aviation, air taxi, and military operations were multiplied by the average number of pilots/passengers per aircraft. According to ACRP Report 113 the average number of pilots/passengers per aircraft is typically 2.5. However, because of the number of larger jet aircraft using ABI this number was increased to 3.5.

The amount of vehicle space required for employees is primarily a function of office space at a particular location. ACRP Report 113 recommends that on average one vehicle parking space is needed per 200 sq. ft. of office space. Abilene Aero's employees park their vehicles inside the

Air Operations Area (AOA) behind Abilene Aero's terminal/hangar building and not in the public parking lot. Consequently, employee parking has been excluded from the analysis below. It is not expected that additional parking spaces beyond what is already available will be needed for employee parking during the forecast period.

Table 4-32, *GA/FBO Terminal Vehicle Parking Facility Requirements,* provides an estimate of the terminal space requirements during the forecast period based on these factors.

Table 4-32
GA/FBO Terminal Vehicle Parking Facility Requirements

Facility	2017	2022	2027	2032	2037
Passenger/Pilot Parking Needs					
- Peak Hour Operations (AT, GA, and Military)	14	14	14	14	14
- Peak Hour Multiplier	3.5	3.5	3.5	3.5	3.5
- Parking Space Need for Passenger/Pilot	49	49	49	49	49
Total # of Spaces Currently	66	66	66	66	66
Total Deficiency/Surplus	**17**	**17**	**17**	**17**	**17**

Source: Garver, 2017

Based on these calculations, it is estimated that the size of the existing GA/FBO parking lot will be sufficient to accommodate future general aviation, air taxi, and military demand.

General Aviation Hangar Facilities

Future hangar areas should achieve a balance between maintaining an unobstructed expansion area, minimizing pavement development, and allowing convenient airside and landside access. For planning purposes, hangars should accommodate at least 95 percent of all based general aviation aircraft. Typically, single-engine piston aircraft demand 1,200 sq. ft., twin-propeller aircraft require 1,200 to 3,000 sq. ft., business turboprop/jet aircraft require approximately 3,000 to 5,000 sq. ft., and helicopters typically require approximately 1,500 sq. ft. General hangar design considerations include the following:

- Construction of aircraft hangars should be beyond an established building restriction line (BRL) surrounding the runway and taxiway areas, the runway OFZ, runway and taxiway OFAs, and remain clear of the FAR Part 77 Surfaces and Threshold Siting Surfaces.
- Maintaining the minimum recommended clearance between T-hangars of 79 ft. for one-way traffic, and 143 ft. for two-way traffic is required. Taxilanes supporting T-hangars should be no less than 25 ft. wide. Individual paved approaches to each hangar stall are typically less costly, but not preferred to paving the entire T-hangar access/ramp area.

- Construction of additional hangar space if required to accommodate 95% of the current based aircraft, hangar waiting list, and forecast need.
- Adequate drainage with minimal slope differential between the hangar door and taxilane. A hard-surfaced hangar floor is recommended, with less than 1% downward slope to the taxilane/ramp.
- Segregate hangar development based on the hangar type and function. From a planning standpoint, hangars should be centralized in terms of auto access, and located along the established flight line to minimize costs associated with access, drainage, utilities and auto parking expansion.

Currently, on the Abilene Aero and Northwest GA Ramp, ABI has 143,500 sq. ft. of T-hangar space and approximately 188,000 sq. ft. of corporate/executive/box hangar space. As of July 2017, multiple T-hangars were vacant and approximately 36,000 sq. ft. of box hangar space was still available.

There are currently 105 based aircraft (79 single engine, 17, multi-engine, 8 jets, 1 helicopter) on the airport. Based on the forecast for based aircraft and the based aircraft fleet mix changes, it is presumed that hangar space will need to change as described in **Table 4-33**, *Hangar Facility Requirements,* to accommodate future demand.

Table 4-33
Hangar Facility Requirements

Facility	2017	2022	2027	2032	2037
Based Aircraft - Single Engine Piston/Light Sport Aircraft	79	77	76	75	74
Estimated Hangar Space per Aircraft	1,250	1,250	1,250	1,250	1,250
T-Hangar Space Required (sq. ft.)	98,750	96,250	95,000	93,750	92,500
Based Aircraft - Multi-Engine/Turboprop	17	17	17	17	17
Estimated Hangar Space per Aircraft	3,000	3,000	3,000	3,000	3,000
Box Hangar Space Required (sq. ft.)	51,000	51,000	51,000	51,000	51,000
Based Aircraft - Helicopters	1	2	2	3	3
Estimated Hangar Space per Aircraft	1,500	1,500	1,500	1,500	1,500
Box Hangar Space Required (sq. ft.)	1,500	3,000	3,000	4,500	4,500
Based Aircraft - Jet	8	10	11	12	13
Estimated Hangar Space per Aircraft	5,000	5,100	5,200	5,300	5,400
Box Hangar Space Required (sq. ft.)	40,000	51,000	57,200	63,600	70,200
Annual Itinerant Aircraft Operations - Airline OPS	25,224	25,736	26,013	26,366	26,673
Maintenance/Transient Hangar Area Demand (ft^2)	12,612	12,868	13,007	13,183	13,337
Total T-Hangar Space Required (sq. ft.)	98,750	96,250	95,000	93,750	92,500
Current T-Hangar Space (sq. ft.)	143,500	143,500	143,500	143,500	143,500
Surplus/Deficiency (sq. ft.)	**44,750**	**47,250**	**48,500**	**49,750**	**51,000**
Total Box Hangar Space Required (sq. ft.)	105,112	117,868	124,207	132,283	139,037
Box Hangar Space Lost to Exclusive Use/Office Space (estimated at 30%) (sq. ft.)	31,534	35,360	37,262	39,685	41,711
Total Box Hangar Space Required + Space Lost to Exclusive Use/Office Space (sq. ft.)	136,646	153,228	161,468	171,968	180,747
Current Box Hangar Space (sq. ft.)	188,000	188,000	188,000	188,000	188,000
Surplus/Deficiency (sq. ft.)	**51,354**	**34,772**	**26,532**	**16,032**	**7,253**

Source: Garver, 2017

Table Notes:

1. An average of 1,250 sq. ft. per aircraft was utilized for single-engine/light sport aircraft as it is the average size of an individual T-hangar.
2. An average of 3,000 sq. ft. per aircraft was utilized for the size of turboprop/multi-engine aircraft (this is approximately the size of a King Air 350).
3. An average of 1,500 sq. ft. per helicopter was utilized for based helicopter hangar demand calculations.
4. An average of 5,000 sq. ft. per aircraft was utilized for the size of jet aircraft (this is approximately the size of a Citation X). An escalation factor of 100 additional sq. ft. per 5-year increment was added to the jet aircraft category to account for the general trend toward larger jet aircraft.

5. A factor of .5 per operation was utilized for the calculations related to itinerant/maintenance hangar area demand.
6. To account for lost box hangar space due to a tenant's exclusive use of a facility/building in office space, an exclusive use/office space factor of 30% has been added to hangar space demand.

Based on these calculations, it is estimated that ABI will have sufficient T-hangar and box hangar space to accommodate demand during the forecast period. Additionally, ABI should consider reducing the current number of T-hangars present on the field and explore the possibility of redeveloping some of those sites into other facilities. Even though the existing box hangar infrastructure should be theoretically sufficient to accommodate forecasted demand, the location of additional box hangar sites will be considered in the alternatives chapter in case a new hangar needs to be constructed.

General Aviation Ramp/Apron Facilities

Aircraft ramp/apron areas are provided for aircraft maneuvering and parking. Typically, aprons are utilized for aircraft parking have a blend of based aircraft utilizing the apron as a permanent parking location and itinerant aircraft that are using the apron as a temporary parking location. However, Abilene Aero only has three Cessna Caravans that use the ramp as a regular tie down location. Consequently, the ramp is almost exclusively used by aircraft for temporary parking on the ramp. This assumption has been taken into consideration in the calculations contained in this section related to the required aircraft apron area. This assumption is not expected to change during the forecast period.

Additionally, only the Abilene Aero and Northwest GA ramps were utilized for these calculations as those are the ramps primarily used by GA aircraft. The terminal area ramp is primarily used by airline aircraft and consequently has been included in the evaluation of the terminal ramp. The need to expand the EASI ramp is expected to be driven by the growth of the EASI facility. The facility requirements of the EASI ramp will be considered in a different section.

To begin the analysis, a weighted average of the apron square footage needed to park an aircraft was calculated. This weighted average was calculated based on the forecasted aircraft operations fleet mix at ABI. The weighted average also accounts for all required wingtip/nose/tail clearances on all sides of the aircraft and equivalent taxilane in front of the aircraft to allow aircraft of a similar size to pass by.

Table 4-34, *Aircraft Apron Space – Weighted Average Requirement – 2017*, shows the weighted average apron space requirement per aircraft calculation for 2017. The fleet mix at ABI is expected to shift slightly during the forecast period. Consequently, the weighted averages 2017, 2022, 2027, 2032, and 2037 are shown in **Table 4-35**, *Aircraft Apron Space – Weighted Average Requirement*.

Table 4-34
Aircraft Apron Space – Weighted Average Requirements - 2017

ADG	Average Length (ft)	Average Wingspan (ft)	Additional Clearance (ft)	TOFA Clearance (ft)	Average Parking Area Required (ft^2)	Fleet Mix	Weighted Average Parking Area (ft^2)
I	26	35	7.50	79	6,000	60.40%	3,624
II	55	60	9.00	115	14,664	38.35%	5,624
III	100	100	11.00	162	34,648	0.68%	236
IV	155	140	13.5	225	67,969	0.22%	153
Helicopter	35	30	12.00	0	3,186	0.34%	11
					Weighted Average:		**9,648**

Source: Garver, 2017
Notes: These calculations take into account the TOFA required for another aircraft to pass by the parked aircraft. The average parking area required was calculated by multiplying the average aircraft length plus 2 times the additional clearance margin by the average aircraft wingspan plus 2 times the additional clearance margin and then adding that number to the TOFA plus the aircraft's average wingspan plus 2 times the additional clearance margin.

Table 4-35
Aircraft Apron Space – Weighted Average Requirement

Year	Weighted Average Parking Area (ft^2) Per Aircraft
2017	9,648
2022	9,815
2027	9,816
2032	9,836
2037	9,846

Source: Garver, 2017

Based on these calculations and the ABI peaking characteristics described in the Forecast Chapter, Chapter 3, **Table 4-36**, *Aircraft Apron Space – Facility Requirement Calculations*, shows the estimated amount of apron space that will be required at ABI during the forecast period.

Table 4-36
Aircraft Apron Space – Facility Requirement Calculations

Year	Peak Month Average Day (PMAD) (GA/AT/ MILITARY ONLY)	Forecasted % of Itinerant Operations	Estimated Percentage of Itinerant Ops on Apron at Same Time	Weighted Average Aircraft Parking Area (ft^2)	Estimated Parking Apron Required	Aircraft Circulation Factor	Total Apron Area Required (ft^2)	Current Apron Area (ft^2)	Surplus/ Deficiency Based on Current Apron Size (ft^2)
2017	141	66.00%	70.00%	9,648	628,490	314,245	942,735	1,432,098	**489,363**
2022	142	66.00%	70.00%	9,815	643,903	321,952	965,855	1,432,098	**466,243**
2027	144	66.00%	70.00%	9,816	653,039	326,519	979,558	1,432,098	**452,540**
2032	145	66.00%	70.00%	9,836	658,914	329,457	988,370	1,432,098	**443,728**
2037	147	66.00%	70.00%	9,846	668,681	334,341	1,003,022	1,432,098	**429,076**

Source: Garver, 2017
Notes: An assumption was made that no more than 70% of the total number of estimated itinerant operations during the PMAD would be on the ramp at the same time. The estimated parking apron required was calculated by multiplying the PMAD by the forecasted % of itinerant operations, then multiplying that result by the estimated percentage of itinerant OPS on the apron at the same time, and then multiplying that result by the weighted average aircraft parking area. A factor of .5 was added to the apron space calculation to account for general aircraft circulation and aircraft movement.

Based on these calculations, ABI should have sufficient ramp space to be able to accommodate the forecasted general aviation, air taxi, and military traffic throughout the forecast period. As part of the Alternatives Chapter, various alternatives will be considered for expanding the GA ramp areas in case the need arises during the forecast period.

EASI Ramp and Hangar Facilities

As discussed previously, Eagle Aviation Services, Inc. (EASI) is an aircraft maintenance base for Envoy Air who provides airline flights at ABI under the American Eagle brand. Currently, EASI handles the maintenance for the majority of the ERJ-145 and ERJ-140 fleet for the entire Envoy Air. Due to the growth of Envoy's fleet, increasing demands have been placed on EASI's facilities in the past 5 years. As a result of that demand, EASI has had to build new hangars to support the growing maintenance demands of the Envoy fleet.

Envoy continues to add new aircraft to their existing fleet. They have added new ERJ-175 aircraft and have started bringing older ERJ-140 aircraft out of storage for use. Consequently, it is expected that the need to expand the EASI facilities (hangars and aprons) could occur during the forecast period. As a result, options for the continued development of EASI's facilities will be considered in the Alternatives Chapter.

General Aviation Fuel Storage Facilities

Fuel storage requirements are based on the forecast of annual operations, aircraft utilization, average fuel consumption rates, and the forecast mix of aircraft anticipated at ABI. On average, the typical single-engine airplane consumes 12.0 gallons of fuel per hour and flies approximately 100 nautical miles (1.0 to 1.5 hours) per flight. Turbine aircraft generally will fly greater distances averaging 300 nautical miles and approximately 1.5 – 2.0 hours. Market conditions will determine the ultimate need for fuel tanks and their size. The following guidelines should be implemented when planning future airport fuel facilities:

- Aircraft fueling facilities should remain open continually (24-hour access), remain visible and be within close proximity to the terminal building or FBO to enhance security and convenience.
- Fuel storage capacity should be sufficient for average peak-hour activity.
- Fueling systems should permit adequate wing-tip clearance to other structures, designated aircraft parking areas (tie-downs), maneuvering areas, and OFAs associated with taxilane and taxiway centerlines.
- Fuel facilities should be located beyond the RSA and BRL.
- Fuels storage tanks should be equipped with monitors to meet current state and federal environmental regulations and be sited in accordance with local fire codes.
- Have a dedicated fuel truck for Jet-A delivery to minimize the liability associated with towing and maneuvering expensive aircraft up to and in the vicinity of fueling facilities.
- Maintaining adequate truck transport access to the fuel storage tanks for fuel delivery.

As reported in the Inventory chapter, Chapter 2, ABI is equipped, through Abilene Aero, with four Jet-A tanks totaling 47,000 gallons of storage capacity and two 100LL tanks totaling 20,000 gallons of storage capacity. Additionally, Abilene Aero recently installed a 500-gallon 100LL self-service tank. Based on discussions with the FBO it is believed that these tanks will provide sufficient storage capacity for the duration of the forecast period unless aircraft operations and fleet mix change significantly. The development of a larger fuel farm facility will not be a development objective in the Alternatives Chapter.

Air Cargo/Unmanned Aircraft System (UAS) Facilities

FedEx currently has a facility on the Northwest GA ramp. The building includes a distribution facility that sorts shipments for delivery and truck transfer. FedEx currently operates a small number of Cessna Caravans out of ABI for air cargo purposes.

As discussed in the Forecast Chapter, Chapter 3, air cargo demand is forecasted to grow at a slow rate at ABI during the forecast period. This is expected to be primarily driven by the incremental growth of the Abilene region’s economy and the continued growth of direct-to-consumer shipping that is a result of more online purchasing. As part of the master planning process, FedEx was contacted to gather their input/insight on how cargo operations at ABI could change in the future. However, no actionable information was obtained. Consequently, it is difficult to establish how this growth will translate into future facility requirements for ABI.

An additional factor that adds complexity to establishing cargo related facility requirements at ABI is the growth and continued evolution of UAS. The utilization of drones and drone technology have evolved at a rapid pace over the past 5 years and this trend is expected to continue. There are now companies developing UAS for cargo transport (both package delivery and mass transport). While the technology is evolving quickly, it is expected that the FAA will be cautious and diligent in studying the use of UAS and determining how, and if, UAS should be integrated into the regular use of airports and the National Air Space System. However, if UAS integration at airports does occur, it is expected that the commercial use of drones for cargo operations will probably occur before the utilization of UAS for passenger carriage.

Since it is unclear exactly how the use of UAS may be integrated into the daily use of an airport, it is important that flexibility is maintained when planning for potential on-airport drone facilities for UAS -based cargo operations and other commercial purposes.

In the Alternatives Chapter, various sites at ABI will be reviewed and considered for traditional air cargo, UAS -based cargo, and other commercial UAS operations. In general, it is believed that these facilities should be located on-airport but as far away as practical from the primary runways to ensure maximum flexibility if the FAA decides not to allow UAS to utilize the runways used by piloted aircraft.

Support Facilities

ABI has a number of support facilities that need to be considered in the facility requirements analysis. These facilities include the ARFF Station, utilities, the airport maintenance facility, and the rental car service center.

ARFF Station

The existing Aircraft Rescue and Fire Fighting (ARFF) facility is located south of the intersection of Taxiway M and P close to the terminal ramp. The facility is occupied 24 hours per day, 7 days a week, 365 days a year. The facility currently houses two 1,500-gallon ARFF trucks. ABI is currently an ARFF Index B airport and is expected to remain an ARFF Index B airport during the forecast period. The ERJ-175 which is forecasted to become the primary air carrier aircraft at ABI during the forecast period is 104 ft. in length which is within the Index B aircraft length parameters (90 ft. to 126 ft.).

An expansion is currently planned for the existing ARFF station. The expansion will extend the existing facility an additional 20+ ft. to the north to allow it to accommodate newer ARFF trucks which are typically longer than older ARFF trucks. Based on the forecast, no additional expansions should be required unless a new regulatory requirement is placed on ARFF facilities that require an expansion.

Utilities

As discussed in the Inventory Chapter, Chapter 2, ABI currently has sufficient utility infrastructure to meet its needs. Due to the slight growth expected during the forecast period, it is not expected that significant utility improvement will be needed during the forecast period. The exception is the storm water drainage infrastructure. As discussed in the Inventory Chapter a drainage issue exists along Lance Drive close to the EASI facility. This issue needs to be addressed with storm water infrastructure improvements.

Airport Maintenance Facility

The ABI maintenance facility is located on Bonanza Drive, close to the intersection of Bonanza Drive and Airport Blvd. The facility consists of a single small building (approximately 2,000 sq. ft.) and a laydown yard (approximately 28,000 sq. ft.). ABI would like to expand the facility to provide covered parking for vehicles/equipment and a larger enclosed storage/maintenance area. Development alternatives for the airport maintenance facility will be included in the Alternatives Chapter.

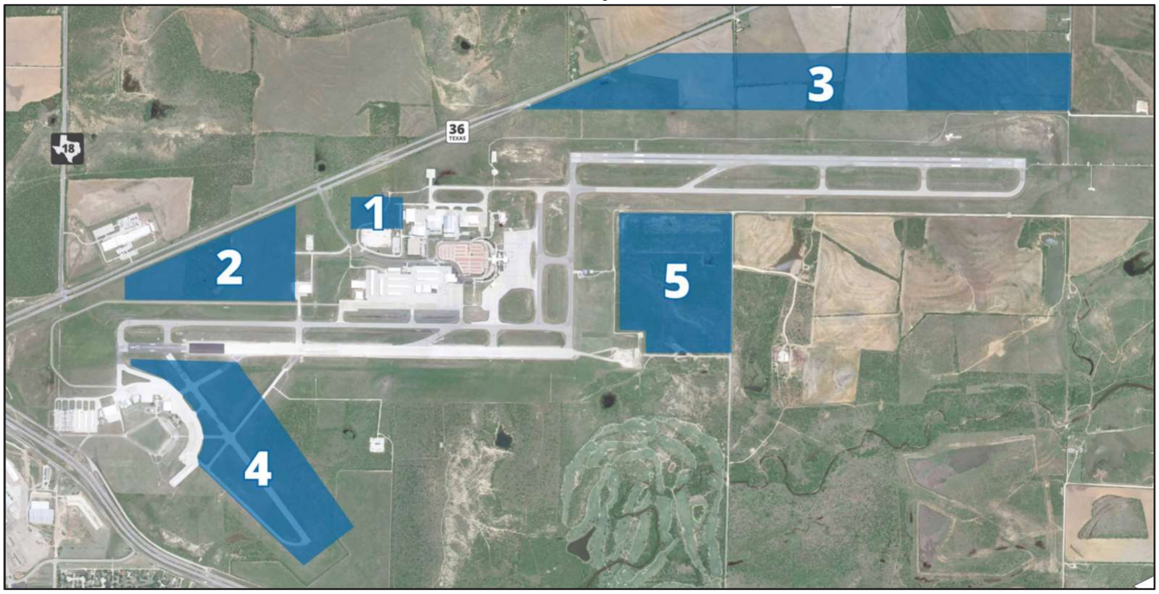
Rental Car Service Center

ABI is currently collecting a Customer Facility Charge (CFC) to fund the development of a consolidated rental car service facility. This facility will provide rental car storage and maintenance facilities. Additionally, this facility could also serve as a rental car return facility. Potential locations for this facility will be considered during the Alternatives Chapter.

Future Aeronautical/Non-Aeronautical Development

Future new aeronautical and non-aeronautical developments at ABI will play a major role in the growth and development of ABI during the forecast period. As discussed in the Inventory Chapter, ABI has a number of areas that are undeveloped or well-suited for redevelopment. These areas are shown below in **Figure 4-36**, *Potential Development Areas,* and **Table 4-37**, *Potential Development Areas*.

Figure 4-36
Potential Development Areas



Source: Garver, 2017

Table 4-37
Potential Development Areas

Development Area	Acreage	Potential Use	Owned by ABI (Y/N)	Location Description
#1	21	Aeronautical	Yes	North of existing EASI Facility and South of Airport Blvd.
#2	66	Aeronautical and Non-aeronautical	Yes	Area north of Airport Blvd and west of HWY 36
#3	100	Aeronautical	No	Area east of Runway 17L/35R
#4	87	Aeronautical	Yes	Runway 4/22 Area
#5	85	Non-aeronautical	No	Area south of ARFF Station

Source: Garver, 2017

The type(s) of development(s) that should be considered in each of these areas will be discussed in the Alternatives Chapter.

Facility Requirements Summary

Based on the analysis described in this chapter, the following development objectives have been developed for ABI to guide the alternatives development process:

Runways:

- Evaluate the feasibility of extending Runway 17R/35L or 17L/35R to at least 8,500 ft. to accommodate future traffic.

- Evaluate the feasibility of adding a GPS based precision instrument approach to Runway 17R and a GPS based non precision instrument approach to Runway 35L.
- Evaluate the feasibility of adding an approach lighting system to Runway 17R to complement the proposed precision instrument approach for that runway.
- Gain sufficient control over the land outside of airport property but within the RPZ for Runway 17L, 17R, and 35R.
- Address the deficiency of the runway hold position markings for Runway 4/22.
- Add a four light PAPI system to Runway 35R.

Taxiways

- Update all taxiway fillets that were designed to the older ADG based taxiway design standards as part of upcoming pavement rehabilitation projects.
- Resolve the prohibited taxiway configuration issues. Currently, there are six taxiways that allow direct access from a ramp area to a runway without requiring an aircraft to make a turn.

Landside/Roadway:

- Improve roadway signage on airport.
- Improve roadway signage off airport and the visibility of the airport's marquee sign.

Terminal:

- Evaluate the need to reduce space allocated for areas that are larger than needed over the forecast period.
- Expand the areas where additional space is required (e.g. departure lounges, outbound baggage, rental car, SSCP, baggage screening, airport offices, etc.)

General Aviation and Aircraft Maintenance Facilities:

- Identify site for potential box hangar development. Consider potentially re-developing some T-hangar sites for this.
- Identify site for potential ramp expansion.
- Establish an expansion plan for EASI facility.

Other Facilities and Future Development:

- Establish land-use plan for potential aeronautical/non-aeronautical development sites.
- Evaluate potential locations for rental car service center.
- Evaluate options for expanding the existing airport maintenance facility.
- Storm water drainage improvements along Lance Drive by EASI facility.
- Evaluate potential air cargo and drone development/expansion sites.