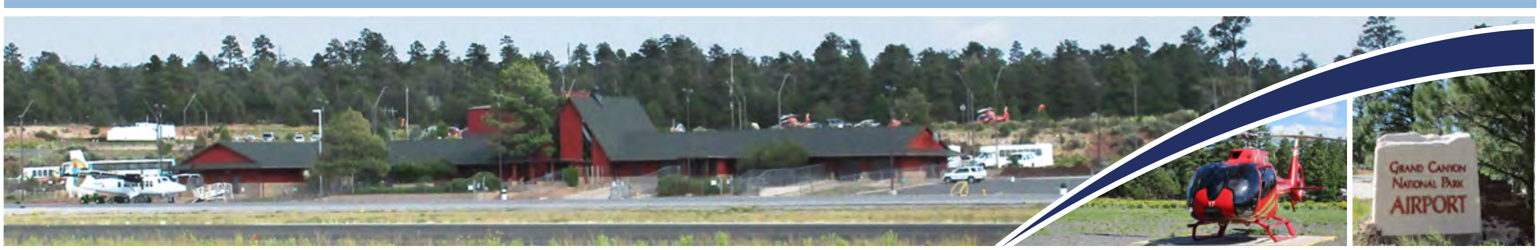
GRAND CANYON
NATIONAL PARK AIRPORT
ARIZONA

Chapter Two

FORECASTS



AIRPORT MASTER PLAN

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Chapter Two

FORECASTS

The definition of demand that may be reasonably expected to occur during the useful life of an airport's key components (e.g., runways, taxiways, terminal buildings, etc.) is an important factor in facility planning. In airport master planning, this involves projecting aviation activity for at least a 20-year timeframe. Aviation demand forecasting for the Grand Canyon National Park Airport (GCN or Airport) will consider commercial passenger enplanements (boardings), based aircraft, and aircraft operations.

The Federal Aviation Administration (FAA) has oversight responsibility to review and approve aviation forecasts developed in conjunction with airport planning studies. In addition, aviation activity forecasts may be an important input to future benefit-cost analyses associated with airport development, and the FAA reviews these analyses when federal funding requests are submitted.

The FAA will review individual airport forecasts with the objective of comparing them to its *Terminal Area Forecasts* (TAF) and the *National Plan of Integrated Airport Systems* (NPIAS). Even though the TAF is updated annually, in the past there was almost always a disparity between the TAF and master planning forecasts. This was primarily because the TAF forecasts did not consider local conditions or recent trends. In recent years, however, the FAA has improved its forecast model to be a demand-driven forecast for aviation services based upon local and national economic conditions, as well as conditions within the aviation industry.

The TAF projections of passenger enplanements and commercial operations at large, medium, and small hub airports are based on a bottom-up approach. The domestic enplanements are forecast by generating origin and destination (O&D) market demand forecasts using the Department of Transportation's (DOT) quarterly 10 percent sample data to model passenger flow on a quarterly basis.

The O&D passenger demand forecasts are based on regression analysis using fares, regional demographics, and regional economic factors as the independent variables. The O&D forecasts are then combined with DOT T-100 segment data to generate passenger forecasts by airport pair and segment pair. The segment pair passenger forecasts are assigned to aircraft equipment in order to produce segment pair operation forecasts. The quarterly segment pair forecasts are aggregated to produce annual airport forecasts.

Forecasts of itinerant general aviation operations and local civil operations at FAA facilities are based primarily on time series analysis. Because military operations forecasts have national security implications, the Department of Defense (DOD) provides only limited information on future aviation activity. Hence, the TAF projects military activity at its present level except when FAA has specific knowledge of a change. For instance, DOD may announce a base closing or may shift an Air Force wing from one base to another.

As stated in FAA Order 5090.3C, *Field Formulation of the National Plan of Integrated Airport Systems* (NPIAS), forecasts should be:

- Realistic;
- Based on the latest available data;
- Reflective of current conditions at the airport (as a baseline);
- Supported by information in the study; and
- Able to provide adequate justification for airport planning and development.

The FAA *Terminal Area Forecasts* published in January 2016 were utilized to supplement the Master Plan forecasting effort. A summary of those forecasts are presented in **Table 2A**. The following sections of this chapter will test the reasonableness of each forecast from the TAF as well as develop updated forecasts for use in this Master Plan.

TABLE 2A
2016 FAA Terminal Area Forecast
Grand Canyon National Park Airport

	2015	2020	2025	2030	2035	2040
ENPLANEMENTS						
Air Carrier	13,178	13,178	13,178	13,178	13,178	13,178
Commuter	103,555	99,052	99,052	99,052	99,052	99,052
Total Enplanements	**116,733**	**112,230**	**112,230**	**112,230**	**112,230**	**112,230**
ANNUAL OPERATIONS						
Itinerant						
Air Carrier	106	110	115	115	115	115
Air Taxi	102,063	107,237	112,689	118,419	124,443	130,773
General Aviation	2,874	2,688	2,728	2,768	2,808	2,848
Military	601	601	601	601	601	601
Total Itinerant	**105,644**	**110,636**	**116,133**	**121,903**	**127,967**	**134,337**
Local						
General Aviation	846	908	928	948	968	992
Military	562	562	562	562	562	562
Total Local	**1,408**	**1,470**	**1,490**	**1,510**	**1,530**	**1,554**
Total Operations	**107,052**	**112,106**	**117,623**	**123,413**	**129,497**	**135,891**
Based Aircraft	**38**	**40**	**41**	**41**	**41**	**41**

Source: FAA Terminal Area Forecast (Jan. 2016)

SOCIOECONOMIC TRENDS

Local and regional forecasts of key socioeconomic variables, such as population, employment, income, and gross regional product (GRP) provide an indication of the potential for growth in aviation activities at an airport. **Exhibit 2A** summarizes the socioeconomic history and projections for Coconino County and the state of Arizona. Population estimates and projections were gathered from the U.S. Census Bureau, Population Division; and the Arizona Department of Administration – Employment and Population Statistics. Data for employment, income, and GRP was taken from Woods & Poole Complete Economic and Demographic Data Source (CEDDS), 2016.

Population in Coconino County grew at a compound annual growth rate (CAGR) of 2.6 percent between 1970 and 2010. In the past five years, the CAGR has slowed to 1.0 percent. Population in the County is forecast to grow at a CAGR of 0.8 percent through 2035 to 164,844. This growth rate is behind what is projected for the entire state, which is forecast to grow at a CAGR of 1.5 percent through 2035.

Employment in the County grew at a 3.6 percent CAGR between 1970 and 2010. Similar to population, that rate slowed in the past five years to 1.3 percent. Employment in the County is forecast to grow at a CAGR of 1.7 percent through 2035, which matches the projected CAGR for employment in that state.

Per capita personal income (PCPI) inflation-adjusted to 2009 dollars dipped as a result of the recession years, but has grown each of the past three years. Inflation-adjusted PCPI is forecast to grow at a CAGR of 1.4 percent for the County and the state through 2035.

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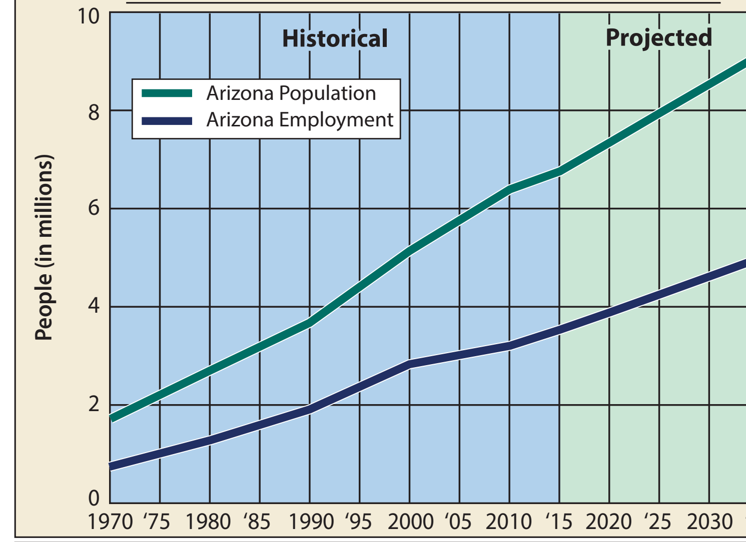
	Population		Employment		Income - PCPI ($2009)		Gross Regional Product ($millions)	
	Arizona	Coconino County	Arizona	Coconino County	Arizona	Coconino County	Arizona	Coconino County
YEAR								
1970	1,775,399	48,326	746,654	20,148	17,875	14,602	39,361	963
1980	2,718,425	75,008	1,282,615	35,163	21,905	17,953	71,736	1,778
1990	3,665,228	96,591	1,894,098	48,542	25,496	21,039	107,402	2,484
2000	5,130,632	116,320	2,808,568	70,053	31,923	29,003	199,448	3,929
2010	6,392,017	134,421	3,205,898	82,751	33,440	33,271	243,723	5,228
CAGR 1970-2010	**3.3%**	**2.6%**	**3.7%**	**3.6%**	**1.6%**	**2.1%**	**4.7%**	**4.3%**
2011	6,438,178	134,162	3,265,071	81,983	34,097	33,146	247,902	5,218
2012	6,498,569	134,313	3,320,848	82,723	34,531	32,941	255,985	5,290
2013	6,581,054	135,695	3,391,722	84,725	34,456	33,478	261,778	5,423
2014	6,667,241	139,372	3,461,988	86,500	35,054	34,052	269,909	5,553
2015	6,758,251	141,602	3,532,928	88,284	35,642	34,626	278,042	5,685
CAGR 2010-2015	**1.1%**	**1.0%**	**2.0%**	**1.3%**	**1.3%**	**0.8%**	**2.7%**	**1.7%**
2020	7,346,800	149,769	3,886,240	97,122	38,608	37,509	320,854	6,341
2025	7,944,800	156,363	4,250,546	106,137	41,787	40,577	368,353	7,021
2030	8,535,900	161,021	4,618,924	115,160	44,785	43,481	420,117	7,710
2035	9,128,900	164,844	4,988,431	124,096	47,432	46,102	476,348	8,401
CAGR 2015-2035	**1.5%**	**0.8%**	**1.7%**	**1.7%**	**1.4%**	**1.4%**	**2.7%**	**2.0%**

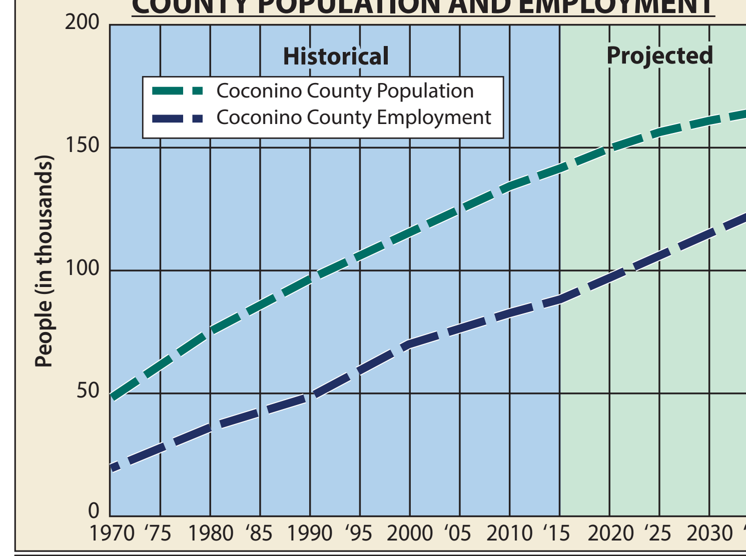
CAGR - Compound Annual Growth Rate
GRP - Gross Regional Product
PCPI - Per Capita Personal Income

Sources: Historical population (1970-2010) from the U.S. Census Bureau, Population Division
Historical population (2011-2015) and population projections from the Arizona Department of Administration - Employment and Population Statistics
Employment, Income, and Gross Regional Product from Woods & Poole Complete Economic and Demographic Data Source (CEDDS) 2016.

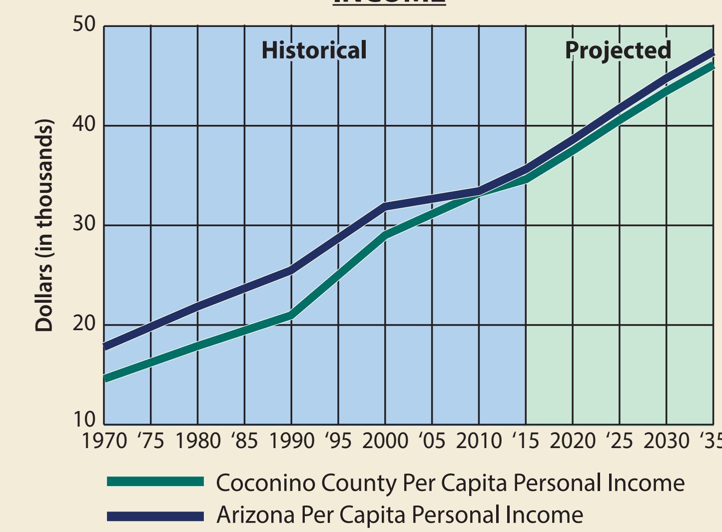
ARIZONA POPULATION AND EMPLOYMENT



COUNTY POPULATION AND EMPLOYMENT



INCOME



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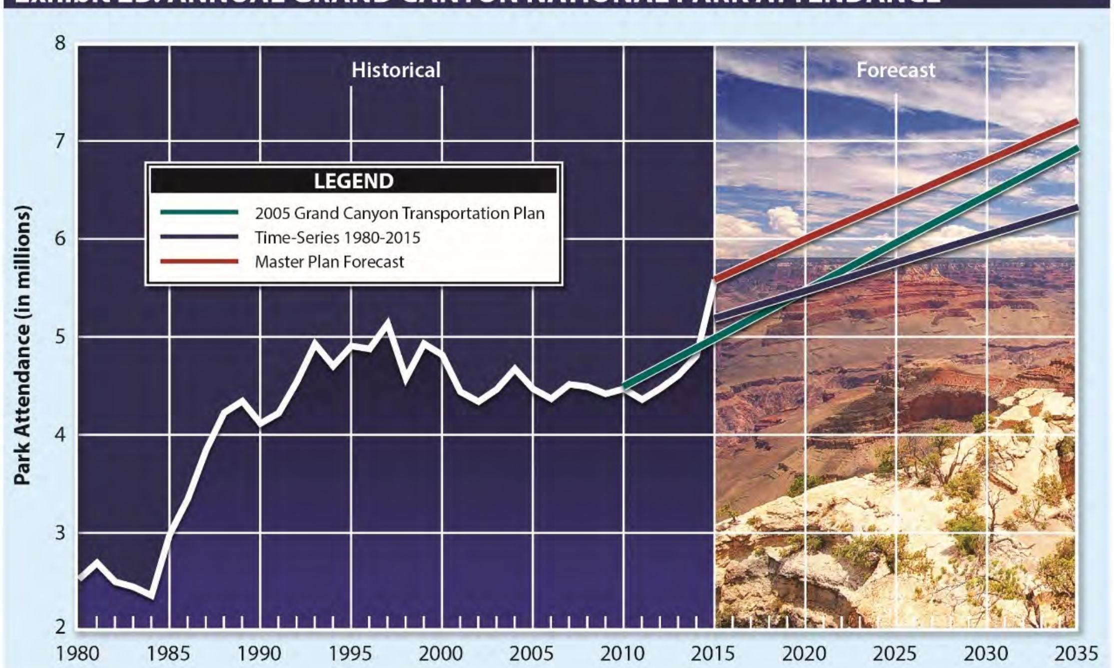
Gross regional product (GRP) is similar to gross domestic product, but on a regional rather than national level. It is also adjusted for inflation to 2009 dollars. GRP for the County dipped from 2010 to 2011 as a result of the recession, but has also recovered and shown growth for the past four years. GRP is forecast to grow at a CAGR of 2.0 percent for the County and 2.7 percent for the state through 2035.

PARK ATTENDANCE

Table 2B and **Exhibit 2B** present the annual attendance at Grand Canyon National Park as reported by the National Park Service (NPS). The totals include both recreational and non-recreational visitors, although recreational visitors typically make up 95 percent or more of the total. Between 1980 and 1997, attendance grew from 2.53 million visitors to 5.13 million, for an average annual growth rate of 4.3 percent. The 1997 mark served as GCNP's all-time high attendance until 2015 when attendance reached a record 5,583,612.

Exhibit 2B: ANNUAL GRAND CANYON NATIONAL PARK ATTENDANCE



In the 18 years between, park attendance slowed then flattened somewhat. After the events of 9-11, park attendance dipped to 4.34 million in 2002, the lowest level since 11 years earlier. Attendance began to grow slowly after that until the 2008 recession. By 2011, attendance was down to 4.36 million. In 2012, attendance began to recover, reaching 4.81 million in in 2014. In 2015, the Park experienced its greatest single year increase of over 776,000 visitors when attendance reached its new all-time high.

The last forecast of visitor attendance for GCNP was included in the *Environmental Assessment/Assessment of Effect* for the South Rim Visitor Transportation published in February 2008. The NPS forecast attendance to remain relatively flat around 4.5 million through 2010, then grow to 5.48 million by 2020, at an average projected growth rate of 98,000 visitors per year or 1.99 percent annually.

Through 2014, attendance was tracking slightly below the forecast, but in 2015, attendance increased to above the projected 2020 level. In addition, the first three months of 2016 were 6.9 percent above the same period in 2015.

A number of time-series regressions were tested, with the highest correlation being an r^2 of just 0.50 for the period from 1980 through 2015. The resulting projection is depicted on both **Table 2B** and **Exhibit 2B**. Interestingly, the 2020 projection matches that of the NPS 2008 forecast.

With the 2015 attendance already ahead of the 2020 projection, an adjustment to the forecast was considered. The Transportation Plan forecasts visitor growth of 96,000 per year, while the time-series projects visitor growth at 56,000 per year. While the growth cannot be expected to follow a straight line, an average rate between the two was felt to be most reasonable. The visitor forecast to be used by the Master Plan is also presented on **Table 2B** and **Exhibit 2B**.

TABLE 2B
Grand Canyon National Park Attendance
History and Forecast

Year	Park Attendance	Annual % Change	Year	Park Attendance	Annual % Change
1980	2,526,179	NA	2004	4,672,911	4.7%
1981	2,693,194	6.6%	2005	4,470,235	-4.3%
1982	2,499,800	-7.2%	2006	4,368,810	-2.3%
1983	2,448,539	-2.1%	2007	4,515,737	3.4%
1984	2,360,767	-3.6%	2008	4,491,145	-0.5%
1985	2,983,436	26.4%	2009	4,418,778	-1.6%
1986	3,347,872	12.2%	2010	4,470,267	1.2%
1987	3,843,639	14.8%	2011	4,360,443	-2.5%
1988	4,226,036	9.9%	2012	4,472,959	2.6%
1989	4,344,200	2.8%	2013	4,608,509	3.0%
1990	4,116,272	-5.2%	2014	4,807,138	4.3%
1991	4,222,397	2.6%	2015	5,583,612	16.2%
1992	4,542,883	7.6%	**2005 Grand Canyon Transportation Plan**		
1993	4,928,509	8.5%	2020	5,480,000	-0.4%
1994	4,702,989	-4.6%	2025	5,960,000	1.7%
1995	4,908,073	4.4%	2035	6,920,000	1.5%
1996	4,877,210	-0.6%	**Time-Series 1980-2015**		
1997	5,133,348	5.3%	2020	5,480,000	-0.4%
1998	4,578,089	-10.8%	2025	5,760,000	1.0%
1999	4,930,151	7.7%	2035	6,320,000	0.9%
2000	4,816,559	-2.3%	**Master Plan Forecast**		
2001	4,439,796	-7.8%	2020	6,000,000	1.4%
2002	4,339,139	-2.3%	2025	6,400,000	1.3%
2003	4,464,399	2.9%	2035	7,200,000	1.2%

NATIONAL AVIATION TRENDS

Each year, the FAA updates and publishes a national aviation forecast. Included in this publication are forecasts for the large air carriers, regional/commuter air carriers, general aviation, and FAA workload measures. The forecasts are prepared to meet budget and planning needs of the FAA and to provide information that can be used by state and local authorities, the aviation industry, and the general public. The current edition when this chapter was prepared was FAA *Aerospace Forecasts – Fiscal Years 2016-2036*, published in March 2016. The FAA primarily uses the economic performance of the United States as an indicator of future aviation industry growth. Similar economic analyses are applied to the outlook for aviation growth in international markets. The following discussion is summarized from the FAA Aerospace Forecasts.

Since its deregulation in 1978, the U.S. commercial air carrier industry has been characterized by boom-to-bust cycles. The volatility that was associated with these cycles was thought by many to be a structural feature of an industry that was capital intensive but cash poor. However, the great recession of 2007-09 marked a fundamental change in the operations and finances of U.S. airlines. Air carriers fine-tuned their business models to minimize losses by lowering operating costs, eliminating unprofitable routes, and grounding older, less fuel-efficient aircraft. To increase operating revenues, carriers initiated new services that customers were willing to purchase and started charging separately for services that were historically bundled in the price of a ticket. The industry experienced an unprecedented period of consolidation with four major mergers in five years. These changes along with capacity discipline exhibited by carriers have resulted in a fifth consecutive year of profitability for the industry in 2015. Looking ahead, there is optimism that the industry has been transformed from that of a boom-to-bust cycle to one of sustainable profits.

ECONOMIC ENVIRONMENT

According to the FAA forecast report, as the economy recovers from the most serious economic downturn and slow recovery since the Great Depression, aviation will continue to grow over the long run. Fundamentally, demand for aviation is driven by economic activity. As economic growth picks up, so will growth in aviation activity. The FAA forecast calls for passenger growth over the next 20 years to average 2.1 percent annually. The steep decline in the price of oil in 2015 was a catalyst for a short lived uptick in passenger growth; however, growth is anticipated to be somewhat muted, primarily due to the uncertainty that surrounds the U.S. and global economies.

Employee wages in 2015 continued to stagnate, household income growth was weak, the housing market's recovery was patchy across the country, and government spending at the federal and local levels remained stagnant and are projected to remain so for the next few years. Despite these dire statistics, the unemployment rate fell, consumer spending was up, and many urban housing markets have been revived strongly. U.S. economic performance in 2015 is estimated to have grown in real GDP to 16.3 trillion (inflation adjusted to 2009 dollars) and is forecast to grow at an average annual growth rate of

2.3 percent through 2036. Oil prices should remain below $50 per barrel through 2016, but are projected to grow at an annual average growth rate of 4.8 percent, reaching over $150 per barrel by 2036. Although the U.S. economy has managed to avoid a recession, a prolonged period of faster economic growth (e.g. > 3.0 percent) may not be forthcoming.

U.S. TRAVEL DEMAND

Mainline and regional carriers offer domestic and international passenger service between the U.S. and foreign destinations, although regional carrier international service is confined to the border markets in Canada, Mexico, and the Caribbean. Twenty-nine all-cargo carriers were providing domestic and/or international air cargo service at the end of 2015.

According to FAA, three distinct trends are shaping today's commercial air carrier industry: (1) continuing industry consolidation and restructuring; (2) continued capacity discipline in response to external shocks; and (3) the proliferation of ancillary revenues.

The restructuring and consolidation of the U.S. airline industry that began in the aftermath of the terror attacks of September 11, 2001 continued in 2015. American and US Airways combined their networks and reservations systems to form the world's largest airline with the last US Airways flight occurring in October 2015. Consequently, there are now only four dominant airlines in the U.S. – American, Delta, Southwest, and United – controlling approximately 76 percent of the domestic market. It is highly unlikely the U.S. Government will approve any further mergers among these four due to anti-trust regulations. In 2005, there were twelve major mainline airlines.

The mergers and increasing market presence of low cost carriers like Frontier, JetBlue, and Southwest have had clear implications on the fares, size of the aircraft being used, and the load factors.

One of the most striking outcomes of industry restructuring has been the unprecedented period of capacity discipline (achieving higher passenger loads through scheduled flight and fleet mix consolidation primarily), especially in domestic markets. Between 1978 and 2000, available seat miles (ASMs) in domestic markets increased at an average annual rate of four percent per year, recording only two years of decline. Even though domestic ASMs shrank by 6.9 percent in FY 2002, following the events of September 11, 2001, growth resumed and by FY 2007, domestic ASMs were 3.6 percent above the FY 2000 level. However, U.S. domestic ASMs are still down 1.2 percent when compared to 2007 as the industry responded first to the sharp rise in oil prices (up 155 percent between 2004 and 2008) and then the global recession that followed (2009 to the present). 2015 is the first year showing strong growth in ASMs (4.6 percent) since 2004.

The reduction in domestic capacity since 2007 has not been shared equally between the mainline carriers and their regional counterparts. To better match demand to capacity, the mainline carriers contracted out "thin" routes to their regional counterparts because they could provide lift at a lower cost, or simply removed the capacity altogether. In 2015, the mainline carrier group provided 0.9 percent less capacity than it did in 2007 (but carried 2.1 percent more passengers). Capacity flown by the regional group has shrunk by 3.0 percent over the same period (with passengers carried decreasing by 2.1 percent).

The regional market has continued to shrink as the regionals compete for even fewer contracts with the remaining dominant carriers; this has meant slow growth in enplanements and yields. The regionals have less leverage with the mainline carriers than they have had in the past and are facing large pilot shortages and tighter regulations regarding pilot training. Their capital costs have increased in the short-term as they continue to replace their 50-seat regional jets with more fuel efficient 70-seat jets. This move to the larger aircraft will prove beneficial in the future, however, since their unit costs are lower.

Another continuing trend is that of ancillary revenues. Carriers generate ancillary revenues by selling products and services beyond that of an airplane ticket to customers. This includes the un-bundling of services previously included in the ticket price, such as checked bags and on-board meals, and by adding new services, such as boarding priority. As a result of very low oil prices and ancillary revenue sources, U.S. passenger carriers posted net profits for the sixth consecutive year in 2015.

FORECASTING APPROACH

The development of aviation forecasts proceeds through both analytical and judgmental processes. A series of mathematical relationships is tested to establish statistical logic and rationale for projected growth. However, the judgment of the forecast analyst, based upon professional experience, knowledge of the aviation industry, and assessment of the local situation, is important in the final determination of the preferred forecast.

The most reliable approach to estimating aviation demand is through the utilization of more than one analytical technique. Methodologies frequently considered in the aviation industry include trend line projections, correlation/regression analysis, and market share analysis. By developing several projections for each aviation demand indicator, a reasonable planning envelope will emerge. The selected forecast may be one of the individual projections or a combination of several projections based on local conditions. The selected forecast will almost always fall within the planning envelope. Some combination of the following forecasting techniques is utilized to develop the planning envelope for each demand indicator.

Trend line projections are probably the simplest and most familiar of the forecasting techniques. By fitting growth curves to historical demand data, then extending them into the future, a basic trend line projection is produced. A basic assumption of this technique is that outside factors will continue to affect aviation demand in much the same manner as in the past. As broad as this assumption may be, the trend line projection does serve as a reliable benchmark for comparing other projections.

Correlation analysis provides a measure of the direct relationship between two separate sets of historic data. Should there be a reasonable correlation between the data, further evaluation using regression analysis may be employed.

Regression analysis measures the statistical relationship between dependent and independent variables, yielding a "correlation coefficient." The correlation coefficient (Pearson's "r") measures associations between the changes in a dependent variable and independent variable(s). If the r-squared (r^2) value (coefficient determination) is greater than 0.90, it indicates good predictive reliability. A value below 0.90 may be used with the understanding that the predictive reliability is lower.

Market share analysis involves a historical review of aviation activity as a percentage, or share, of a larger regional, state, or national aviation market. A historical market share trend is determined providing an expected market share for the future. These shares are then multiplied by the forecasts of the larger geographical area to produce a market share projection. This method has the same limitations as trend line projections, but can provide a useful check on the validity of other forecasting techniques.

It is important to note that forecasts will age, and the farther a forecast is from the base year, the less reliable it may become, particularly due to changing local and national conditions. Nonetheless, the FAA indicates that a Master Plan include a 20-year forecast for the airport. Facility and financial planning usually require at least a 10-year view, since it often takes more than five years to complete a major facility development program. However, it is important to use forecasts which do not overestimate revenue-generating capabilities or understate demand for facilities needed to meet public (user) needs.

A wide range of factors is known to influence the aviation industry and can have significant impacts on the extent and nature of air service provided in both the local and national markets. Technological advances in aviation have historically altered, and will continue to change, the growth rates in aviation demand over time. The most obvious example is the impact of jet aircraft on the aviation industry, which resulted in a growth rate that far exceeded expectations. Such changes are difficult, if not impossible, to predict, and there is simply no mathematical way to estimate their impacts.

Using a broad spectrum of local, regional, and national socioeconomic and aviation information and analyzing the most current aviation trends, forecasts are presented for the following demand indicators:

- COMMERCIAL PASSENGER SERVICE
  - Annual Enplaned Passengers
  - Operations and Fleet Mix
- MILITARY
  - Local and Itinerant Operations
- GENERAL AVIATION
  - Based Aircraft
  - Based Aircraft Fleet Mix
  - Local and Itinerant Operations
- PEAKING CHARACTERISTICS
  - Enplanement Peaks
  - Operations Peaks

COMMERCIAL PASSENGER SERVICE FORECASTS

To evaluate commercial service potential at GCN and the facilities necessary to properly accommodate present and future commercial activity, two basic elements must be forecast: annual enplaned passengers and annual commercial operations. Annual enplaned passengers serve as the most basic indicator of demand for commercial service activity. The annual number of enplanements is the figure utilized by the FAA to determine various entitlement funding levels for commercial service airports. The term "enplanement" refers to a passenger boarding a flight. In the case of GCN, enplanements refer to passengers on air tour flights offered by several on-site commercial operators. This analysis will also consider the potential for future scheduled airline service at GCN.

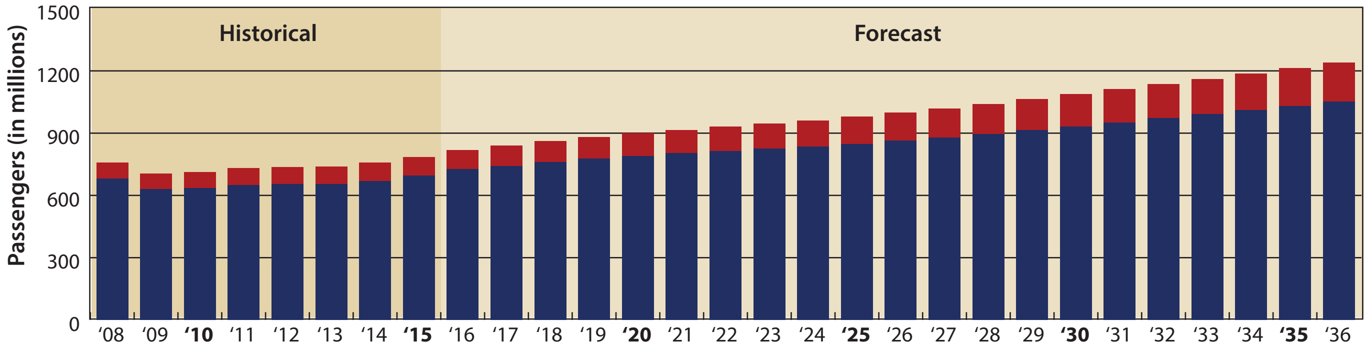
As indicated earlier, an important resource utilized in aviation demand forecasting is the annual FAA aviation forecasts. The most recent available version is the FAA Aerospace Forecasts – Fiscal Years 2016-2036, published in March 2016. The FAA forecasts a variety of aviation demand indicators on an annual basis. In the most current edition, fiscal year 2014 is presented as the baseline, with 2015 showing as an estimate and years 2016 through 2036 as projections. Many forecasting elements utilized in this analysis will consider the history and projections presented by the FAA in its annual forecast.

FAA COMMERCIAL AIR CARRIER FORECASTS

U.S. commercial air carriers' total number of domestic departures continued the downward trend that started in 2008, while ASMs, revenue passenger miles (RPMs) and enplanements all showed a rebound; these trends underlie the expanding size of aircraft and higher load factors. In 2015, the domestic load factor reached a historic high of 84.5 percent for commercial air carriers. In such an uncertain but slowly improving economic environment, industry capacity growth was somewhat restrained (up 3.9 percent in 2015), after only a 2.3 percent increase in 2014. U.S. mainline carrier capacity is projected to grow 3.8 percent in 2016, while capacity for regional carriers is forecast to remain static through 2016. Passenger demand growth is in line with capacity growth in 2016, with system (RPMs forecast to grow 3.8 percent. Supported by a growing U.S. and world economy, year over year RPM growth is forecast to be 2.7 percent on average over the period from 2015-2036. Over the same time period, system capacity growth averages 2.1 percent per year. System passengers are projected to increase an average of 2.0 percent a year, with mainline carriers growing at 2.0 percent a year, slightly higher than their regional counterparts (up 1.8 percent). By 2036, U.S. commercial air carriers are projected to fly 1.81 trillion ASMs and transport 1.24 billion enplaned passengers – a total of 1.53 trillion passenger miles.

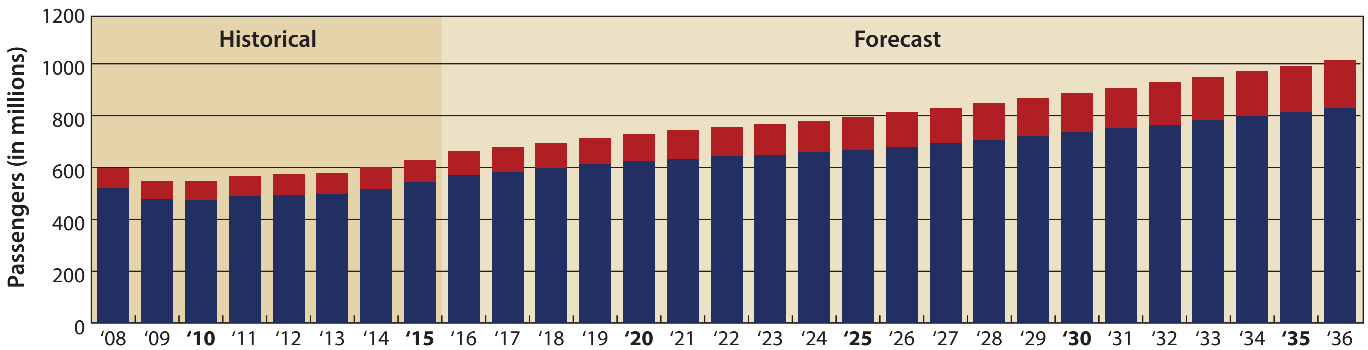
Planes will remain crowded, with load factors projected to grow moderately during the early years of the forecast period, then tapering during the mid to latter years to 84.7 percent in 2036 (up 1.3 points compared to the beginning of the forecast period in 2015). The FAA forecasts indicate that enplanements are anticipated to grow (up 4.2 percent) in 2016, following a 3.8 percent increase in 2015. Over the forecast period, domestic enplanements are projected to grow at an average annual rate of 2.0 percent, with mainline and regional carriers growing at the same rate. **Exhibit 2C** presents the annual historical and forecast enplanement totals for both large air carriers and commuter airlines in the U.S. as forecast by the FAA.

U.S. AIR CARRIER PASSENGER ENPLANEMENTS[1]



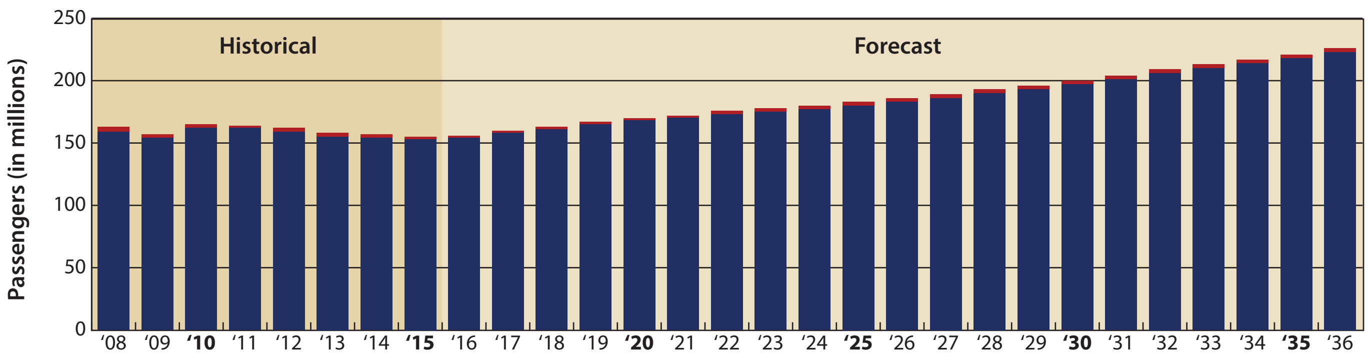
SOURCE	2015	2020	2025	2035	AAGR 2015-2036
Domestic Revenue Enplanements	696	790	848	1,031	2.0%
International Revenue Enplanements	89	109	131	182	3.6%
TOTAL	786	899	979	1,240	2.2%

U.S. MAINLINE AIR CARRIER PASSENGER ENPLANEMENTS



SOURCE	2015	2020	2025	2035	AAGR 2015-2036
Domestic Revenue Enplanements	543	623	668	829	2.0%
International Revenue Enplanements	87	107	152	185	3.6%
TOTAL	631	729	796	1,014	2.3%

U.S. REGIONAL AIR CARRIER PASSENGER ENPLANEMENTS



SOURCE	2015	2020	2025	2035	AAGR 2015-2036
Domestic Revenue Enplanements	153	168	180	223	1.8%
International Revenue Enplanements	2	2	3	3	1.8%
TOTAL	155	170	182	226	1.8%

Exhibit 2C
U.S. COMMERCIAL AIR CARRIER FORECASTS

Source: FAA Aerospace Forecast - Fiscal Years 2016-2036 Note: All figures measured in millions

FAA COMMERCIAL AIRCRAFT FLEET FORECAST

The commercial passenger carrier fleet is undergoing transformation. The mainline carriers are retiring older, less fuel-efficient aircraft (e.g., 737-300/400/500, 757/767, and MD-80) and replacing them with more technologically advanced A319/320 and 737-700/800/900 aircraft. The regional carriers are growing their fleet of 70-90 seat regional jet aircraft and reducing their fleet of 50-seat jet aircraft. Between 2015 and 2036, the number of jets in the U.S. mainline carrier fleet is forecast to grow from 3,946 to 5,339, an average of 66 aircraft a year. The regional carrier fleet is forecast to decline from 2,144 aircraft in 2015 to 1,961 in 2036 as the fleet shrinks by 21 percent (448 aircraft) between 2015 and 2022. **Exhibit 2D** presents the FAA commercial aircraft fleet forecast through 2036.

COMMERCIAL PASSENGERS

Historically, the vast majority of commercial service activity at Grand Canyon National Park Airport has been air tour/sightseeing traffic. While there has been scheduled service at the airport in the past, most non-tour commercial traffic has been relegated to charter flights since at least the turn of the century. The commercial service analysis is divided into two areas: 1) the demand for air tour-related flights, and 2) the potential for scheduled service that would serve non-tour or "destination" passengers.

Air Tour Sightseeing Passengers

Table 2C and **Exhibit 2E** present the history of passenger enplanements at GCN since 1980. Between 1986 and 1987, passenger traffic at the airport more than tripled from 136,000 to 450,000, even after a mid-air collision between

TABLE 2C
Air Tour Enplanement Forecasts
Grand Canyon National Park Airport

Year	Park Attendance	GCN Enplanements	Enpl. % of Visitors
1980	2,526,179	183,000	7.24%
1981	2,693,194	157,000	5.83%
1982	2,499,800	205,000	8.20%
1983	2,448,539	199,000	8.13%
1984	2,360,767	186,000	7.88%
1985	2,983,436	69,000	2.31%
1986	3,347,872	136,000	4.06%
1987	3,843,639	450,000	11.71%
1988	4,226,036	421,800	9.98%
1989	4,344,200	393,687	9.06%
1990	4,116,272	207,734	5.05%
1991	4,222,397	436,049	10.33%
1992	4,542,883	483,243	10.64%
1993	4,928,509	533,808	10.83%
1994	4,702,989	549,113	11.68%
1995	4,908,073	535,656	10.91%
1996	4,877,210	642,221	13.17%
1997	5,133,348	533,867	10.40%
1998	4,578,089	537,404	11.74%
1999	4,930,151	599,338	12.16%
2000	4,816,559	524,995	10.90%
2001	4,439,796	422,061	9.51%
2002	4,339,139	337,189	7.77%
2003	4,464,399	325,815	7.30%
2004	4,672,911	368,330	7.88%
2005	4,470,235	385,920	8.63%
2006	4,368,810	388,644	8.90%
2007	4,515,737	354,624	7.85%
2008	4,491,145	294,436	6.56%
2009	4,418,778	297,894	6.74%
2010	4,470,267	318,622	7.13%
2011	4,360,443	340,671	7.81%
2012	4,472,959	332,695	7.44%
2013	4,608,509	326,734	7.09%
2014	4,807,138	342,020	7.11%
2015	5,583,612	329,128	5.89%
2005 Master Plan Forecast			
2010	4,470,267	580,000	12.97%
2015	5,583,612	630,000	11.28%
2020	6,000,000	685,000	11.42%
FAA Terminal Area Forecast			
2020	6,000,000	112,230	1.87%
2025	6,400,000	112,230	1.75%
2035	7,200,000	112,230	1.56%
Master Plan Forecast			
2020	6,000,000	396,000	6.60%
2025	6,400,000	442,000	6.90%
2035	7,200,000	540,000	7.50%

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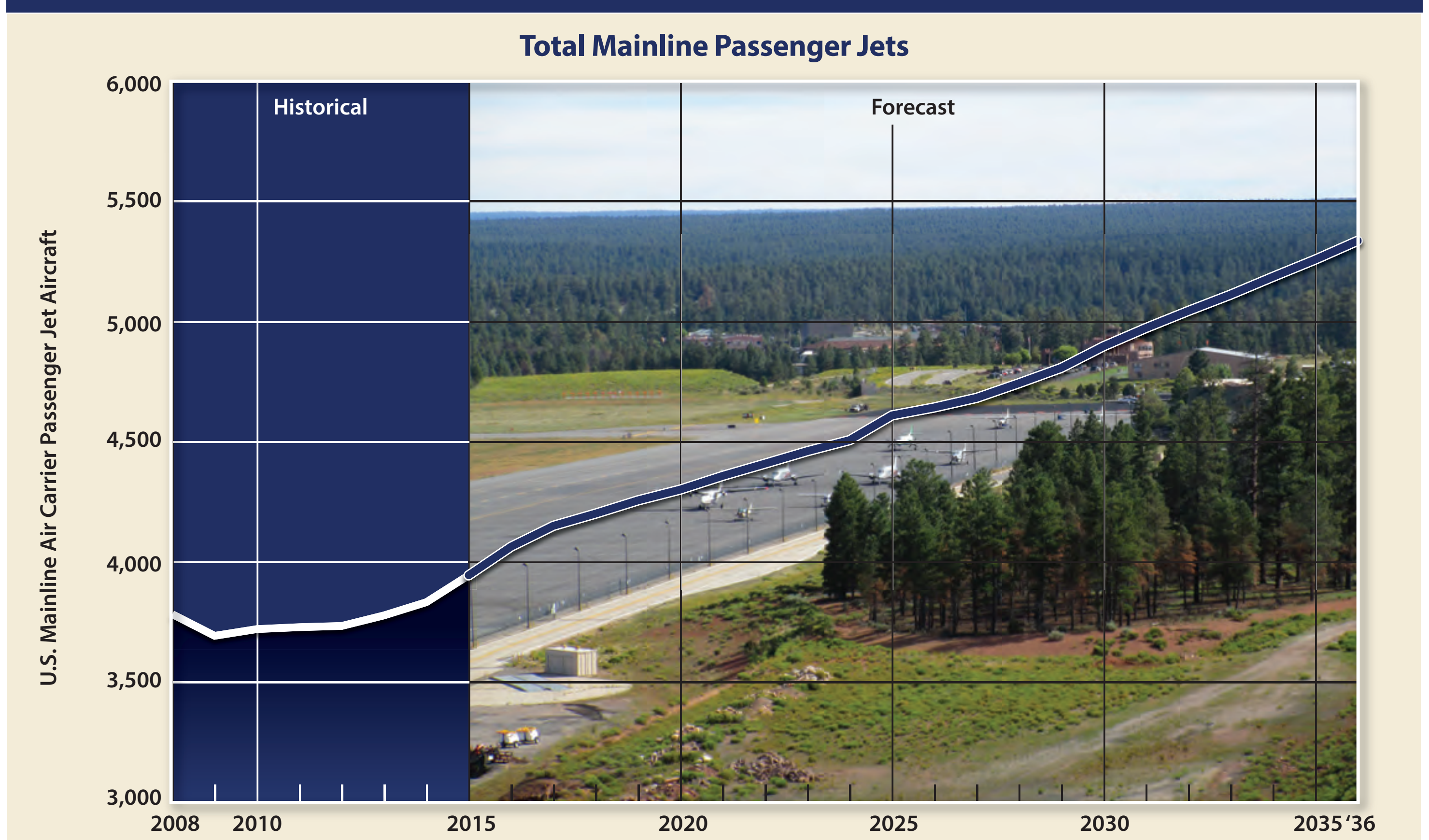
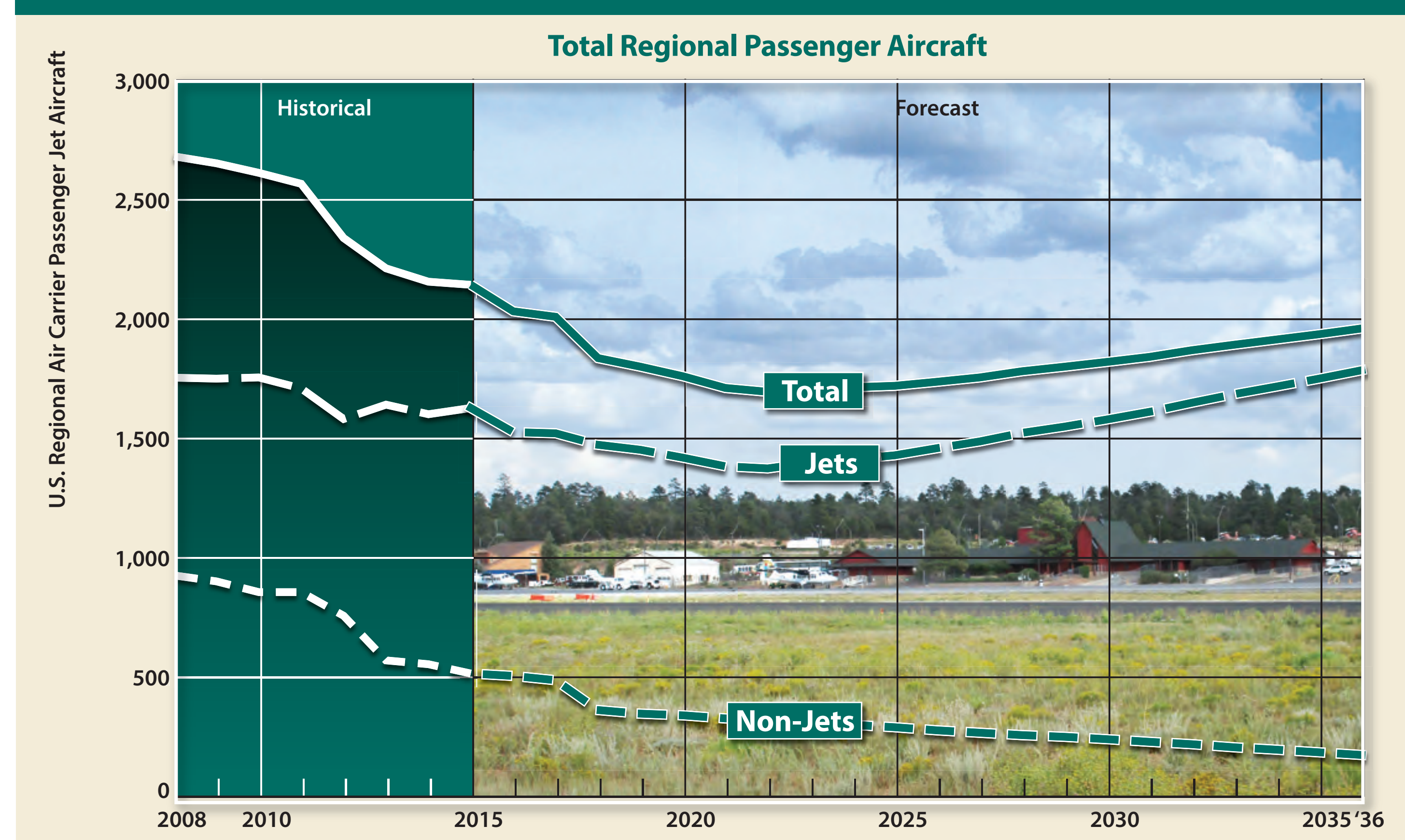
U.S. MAINLINE AIR CARRIER PASSENGER JET AIRCRAFT

	2015	2020	2025	2035	AAGR 2015-2036
Large Narrow Body					
2 Engine	3,322	3,568	3,512	4,016	1.16%
3/4 Engine	2	2	0	0	0.00%
Large Wide Body					
2 Engine	492	572	731	983	3.46%
3/4 Wide Body	31	0	0	0	0.00%
Total Large Jets	**3,847**	**4,142**	**4,243**	**4,999**	**1.47%**
Total Regional Jets	**99**	**161**	**97**	**113**	**0.93%**
Total Mainline Passenger Jets	**3,946**	**4,303**	**4,340**	**5,112**	**1.46%**

U.S. REGIONAL AIR CARRIER PASSENGER JET AIRCRAFT

	2015	2020	2025	2035	AAGR 2015-2036
Less than 30 Seats					
Turboprop	427	248	194	85	-21.6%
31-40 Seats					
Turboprop	32	26	21	9	-6.4%
Over 40 Seats					
Turboprop	57	67	76	92	2.4%
Jet	1,628	1,420	1,430	1,751	0.4%
Non-Jet Total	**516**	**341**	**291**	**186**	**-5.0%**
Jet Total	**1,628**	**1,420**	**1,430**	**1,751**	**0.4%**
Total Regional Passenger Aircraft	**2,144**	**1,761**	**1,721**	**1,937**	**-0.4%**





Source: FAA Aerospace Forecast - Fiscal Years 2016-2036

Exhibit 2D
NATIONAL U.S. COMMERCIAL FLEET FORECAST

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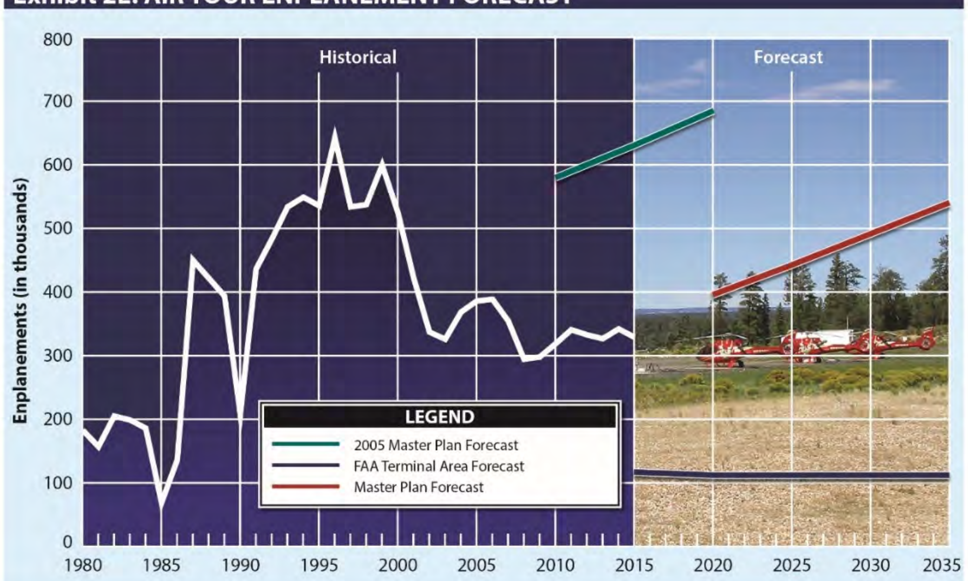
two air tour flights over the canyon during the summer of 1986. The collision led the enactment of the *National Overflights Act (*Public Law 100-91) in August 1987.

This increased popularity in aerial sightseeing tours brought about not only the concern for safety, but also for protecting the natural quiet of the area. In June of 1987, FAA issued Special Federal Aviation Regulation (SFAR) 50 to establish flight regulations in the vicinity of the park. Public Law 100-91 also required the analysis of the effects of overflights over National Parks, the success of SFAR in restoring the natural quiet, and the designation of free flight zones.

Exhibit 2E: AIR TOUR ENPLANEMENT FORECAST



This led to SFAR 50-2 in June of 1988, which revised flight procedures over Grand Canyon National Park, the establishment of free flight zones, and as well as established routes for commercial tour operators. By 1990, passenger traffic at GCN had declined by more than half of the 1987 enplanements. The next year, however, traffic began to grow once more, reaching an all-time high of 642,211 enplanements in 1996.

That year, in accordance with the *Overflights Act,* the DOT proposed regulations that would limit sight-seeing to immediately reduce aircraft noise and restore the natural quiet. Enplanements remained about half a million annually through the end of the decade. After the events of 9-11, however, passen-gers declined below 400,000, and have been under that level ever since.

Exhibit 2E depicts the air tour enplanement forecast from the 2005 Master Plan. With 2002 as the base year, the previous master plan projected a strong short term recovery, but over the long term it indicated that SFAR 50-2 would eventually limit the number of overflights as well as enplanement levels. The 2005 Master Plan estimated the maximum enplanement level at 711,900. From the FAA Terminal Area Fore-cast (TAF) presented earlier on **Table 2A**, it is apparent that the FAA projections do not fully account for the airport's passenger activity as a level 112,230 enplanements are projected through the planning period.

Since Park visitors make up most of the air tour enplanements at GCN, **Table 2C** looks at GCN enplanements in relation to park attendance. After regression analyses did not provide any meaningful correlations, the percentage of enplanements to visitors was examined. From 1991 through 2000, the enplanement percentage fluctuated around an average of 11.3 percent. After 9-11, however, the percentage declined to an average of 8.1 percent from 2001 through 2007. From the recession in 2008 through 2014, the enplanement percentage of visitors averaged 7.0 percent. Air tour passengers did not keep pace with the jump in visitors in 2015, as the percentage fell to 5.9 percent.

As visitor growth resumes a more normal growth trend, the percentage of air tour passengers can be expected to be recaptured and be more in line with the period since 2001. The Master Plan forecast presented on **Table 2C** and **Exhibit 2E** indicates the percentage to generally remain within the 7.0 to 7.5 percent range over the planning period.

Destination Passengers

As a destination for over 5.5 million annual visitors, Grand Canyon National Park is one of the most popular tourist destinations in the United States. Not only is it popular for tourists within in the U.S., it is also top destination for international visitors. Because of the area's scarce population, the Park's visitors create the only potential for destination passenger traffic at GCN.

As mentioned earlier, except for the occasional charter, nearly all the current passenger traffic at GCN is related to air tours. Although some may fly in from Las Vegas or Phoenix on a scenic tour flight, then take a charter vehicle for a ground tour, there is little traffic that could be considered as destination without the tie to an air tour.

The Arizona Hospitality Research Center of Northern Arizona University (NAU) prepared the *Grand Canyon National Park & Northern Arizona Tourism Study* in 2005. Prepared for the Arizona Department of Transportation in cooperation with the Federal Highway Administration, the study primarily looked at visitor's highway usage and transportation patterns. It did, however, study other travels modes such as commercial air service.

The study found that 16.4 percent of visitors utilized commercial airlines in their trip to Grand Canyon National Park. Of the 37 percent that cited the Grand Canyon as their primary destination, 18.8 percent used commercial airlines.

Arizona DOT commissioned an *Airline Market Study: Market Definition and Analysis* in 2014. Utilizing the results of the NAU study, the Market Study showed that the GCN visitors primarily used Phoenix Sky Harbor International (52 percent) and Las Vegas McCarren International (33 percent). The study estimated that 15.9 percent of the true air market for GCN was international traffic. The information from the aforementioned studies was utilized to estimate the full destination market potential based upon 2015 and forecast visitor levels. The results are presented in **Table 2D**.

Table 2D
Destination Passenger Forecast
Grand Canyon National Park Airport

	Actual	Forecast		
	2015	2020	2025	2035
Total Annual Park Visitors	5,583,612	6,000,000	6,400,000	7,200,000
Visitor Airline Use				
% using commercial airlines	16.4%	16.4%	16.4%	16.4%
Total using comm. Airlines	915,712	984,000	1,049,600	1,180,800
% using GCN	2.3%	2.3%	2.3%	2.3%
Total GCN enplanements	21,061	22,632	24,141	27,158
Park Destination Visitors				
% Grand Canyon Primary dest.	37.0%	37.0%	37.0%	37.0%
Primary destination total	2,065,936	2,220,000	2,368,000	2,664,000
% using commercial airlines	18.8%	18.8%	18.8%	18.8%
Total primary dest. using comm. airlines	388,396	417,360	445,184	500,832
Destination Enplanement Forecast	21,061	41,736	66,778	125,208
Current and Potential GCN Capture Rate	5.4%	10.0%	15.0%	25.0%

Source: Park Attendance - National Park Service Public Use Statistics Office Website;
Park Attendance Forecast - South Rim Visitor Transportation Plan Environmental Assessment, Feb. 2008
Grand Canyon National Park & Northern Arizona Tourism Study, Arizona Hospitality Research Center, Northern Arizona University, May 2005

Applying the percentages of the tourism study to 2015 visitors would suggest an overall airline market for the Grand Canyon National Park of 915,712 enplanements. The vast majority (85%), however, fly into Sky Harbor and McCarran, and then use other modes of transportation to access the park, as just 2.3 percent (21,000) indicate flying directly into GCN.

Vacation travelers to Arizona and the southwest typically have more than one planned destination on their itineraries. For example, the Grand Canyon may be a side trip from Las Vegas, or part of a tour of the many attractions in the southwest United States. The NAU study indicated that the Grand Canyon was the primary destination for 37 percent of its visitors. Of those, 18.8 percent indicated they used commercial airlines for part of their trip.

Table 2D applies these findings to the 2015 visitor census. The results indicate that destination passenger potential for Grand Canyon National Park Airport for that year to be 388,396. That further suggests that GCN is currently capturing no more than approximately 5.4 percent of its market potential.

While that would appear to be a strong passenger potential, the ability to capture market share is highly dependent upon the level of air service provided. This includes frequency of service, destinations available, aircraft type, and air fares. Based upon experience with other airports, small commuter turboprop service such as what is currently available to the east in Page is not likely to capture more than 10 to 15 percent of the market.

Attracting the next level of service, comparable to that available in Flagstaff where 50 to 70 seat turboprop and regional jet aircraft are used, could increase the capture rate into the 20 to 30 percent range. A high end capture rate of up to 60 percent would require multiple commercial jet flight options as well a competitive fares and non-stop flights beyond Phoenix and Las Vegas. In today's airline environment, this would be very difficult for a remote location such as GCN to accomplish.

Another example within the region is the Laughlin-Bullhead International Airport. Serving a gaming and recreation destination on the Arizona-Nevada border and along the Colorado River downstream from the airport, Laughlin-Bullhead attracts commercial jet charters such as Sun Country and Allegiant. In 2015, the charters enplaned over 66,000 passengers at Laughlin-Bullhead without regularly scheduled service.

Table 2D examines a destination passenger forecast based upon a reasonable ability to capture market share over time. Beginning with just a 10 percent capture rate in 2020, this assumes that service would be a combination of scheduled service by small turboprops as well as commercial jet charters with up to 160 seats. As service becomes established over time and park visitors continue to grow, regional jet service will likely replace turboprops. Supplemented by charter service, the capture rate could reach 25 percent or an annual total of 125,000 enplanements by 2035.

COMMERCIAL SERVICE OPERATIONS AND FLEET MIX

Commercial service operations forecasts are related not only to the number of passengers but also the aircraft fleet mix. The aircraft seating capacity and the boarding load factor desired by the airlines providing the service factor into this forecast as well.

Changes in equipment, airframes, and engines continue to have a significant impact on airlines and airport planning. Manufacturers continue to improve performance characteristics. Fuel efficiency is a primary factor for airlines. Noise and air emissions regulations also factor into changes. The commercial operations for Grand Canyon National Park Airport were developed by examining the fleet mix history as well as the aircraft likely to be used by the airlines at the airport in the future.

Air Tour Operations

Table 2E depicts the air tour fleet mix by seating capacity at GCN over the last five years (2011-2015). The fixed wing air tour mix has actually declined slightly from 19.5 seats per departure in 2008 and appears to have somewhat stabilized over the last five years. The flights above 19 and below eight seats have been on the decline with growth in the percentage of flights by aircraft in the eight to 19 seat range. Boarding load factors have continued to fluctuate around 75 percent. This resulted in average passengers per departure of 13.3.

TABLE 2E
Historic Air Tour Fleet Mix and Operations
Grand Canyon National Park Airport

Fixed Wing Fleet Mix Seating Capacity	2011	2012	2013	2014	2015
Air Tour Operators					
>79	0.0%	0.0%	0.0%	0.0%	0.0%
60-79	0.0%	0.0%	0.0%	0.0%	0.0%
40-59	0.0%	0.0%	0.0%	0.0%	0.0%
20-39	16.1%	19.7%	16.4%	9.6%	9.7%
12-19	65.2%	65.0%	65.6%	76.0%	74.1%
8-11	4.0%	6.9%	5.4%	6.5%	7.3%
5-7	14.7%	8.4%	12.6%	7.9%	8.9%
< 5	0.0%	0.0%	0.0%	0.0%	0.0%
Totals	100.0%	100.0%	100.0%	100.0%	100.0%
Seats/Departure	17.9	18.7	18.0	17.6	17.4
Boarding Load Factor	76.8%	72.2%	70.2%	79.6%	72.3%
Enplanements/Departure	13.7	13.5	12.6	14.0	12.6
Annual Enplanements	147,722	146,421	145,018	147,350	132,198
Annual Departures	10,764	10,822	11,501	10,503	10,491
Annual Operations	21,528	21,644	23,002	21,006	20,982
Avg Daily Flights	30	30	32	29	29
Helicopters					
Seats/Departure	6.5	6.5	6.5	6.5	6.5
Boarding Load Factor	86.2%	83.1%	84.9%	84.4%	85.9%
Enplanements/Departure	5.6	5.4	5.5	5.5	5.6
Annual Enplanements	192,949	186,274	181,716	194,670	196,930
Annual Departures	34,438	34,500	32,926	35,481	35,253
Annual Operations	68,876	69,000	65,852	70,962	70,506
Avg Daily Flights	96	96	91	99	98
Total Air Tour Activity					
Seats/Departure	9.2	9.4	9.5	9.0	9.0
Boarding Load Factor	81.9%	77.9%	77.7%	82.3%	79.9%
Enplanements/Departure	7.5	7.3	7.4	7.4	7.2
Total Tour Enplanements	340,671	332,695	326,734	342,020	329,128
Fixed Wing Enplaned Percentage	43.4%	44.0%	44.4%	43.1%	40.2%
Total Tour Departures	45,202	45,322	44,427	45,984	45,744
Fixed Wing Departure Percentage	23.8%	23.9%	25.9%	22.8%	22.9%

The fleet mix for helicopter air tours remains in the 6 to 7 seat range with load factors averaging 85 percent. This has resulted in an average of 5.5 passengers per departure.

A combined summary of air tour activity is provided at the bottom of the table. Fixed wing aircraft have carried an average of 43 percent of the air tour passengers on 23 percent of the flights. Prior to 2008, fixed wing tours carried over 50 percent of the passengers.

Table 2F shows the forecast for future fleet mix and operations by air tour operators. The ratio of fixed wing to helicopter air tour passengers is expected to remain relatively constant at 43 percent. The average seats per departure will remain relatively constant, and load factors can be expected to increase on fixed wing tours resulting in an increase in passengers per departure. Thus, operations will not increase at the same rate as passengers over the planning period.

TABLE 2F
Air Tour Fleet Mix and Operations Forecasts
Grand Canyon National Park Airport

Fixed Wing Fleet Mix Seating Capacity	2015	2020	2025	2035
Air Tour Operators				
>79	0.0%	0.0%	0.0%	0.0%
60-79	0.0%	0.0%	0.0%	0.0%
40-59	0.0%	0.0%	0.0%	0.0%
20-39	9.7%	8.0%	6.0%	10.0%
12-19	74.1%	75.0%	77.0%	72.0%
8-11	7.3%	8.0%	9.0%	12.0%
5-7	8.9%	9.0%	8.0%	6.0%
< 5	0.0%	0.0%	0.0%	0.0%
Totals	100.0%	100.0%	100.0%	100.0%
Seats/Departure	17.4	17.2	17.0	17.4
Boarding Load Factor	72.3%	80.0%	80.0%	80.0%
Enplanements/Departure	12.6	13.7	13.6	13.9
Annual Enplanements	132,198	170,280	190,060	232,200
Annual Departures	10,491	12,400	14,000	16,700
Annual Operations	20,982	24,800	28,000	33,400
Avg Daily Flights	29	34	38	46
Helicopters				
Seats/Departure	6.5	6.5	6.5	6.5
Boarding Load Factor	85.9%	86.0%	86.09%	86.0%
Enplanements/Departure	5.6	5.6	5.6	5.6
Annual Enplanements	196,930	225,720	251,940	307,800
Annual Departures	35,253	40,400	45,100	55,100
Annual Operations	70,506	80,800	90,200	110,200
Avg Daily Flights	98	112	125	153
Total Air Tour Activity				
Seats/Departure	9.0	9.0	9.0	9.0
Boarding Load Factor	79.9%	83.3%	83.3%	83.2%
Enplanements/Departure	7.2	7.5	7.5	7.5
Total Tour Enplanements	329,128	396,000	442,000	540,000
Fixed Wing Enplaned Percentage	40.2%	43.0%	43.0%	43.0%
Total Tour Departures	45,744	52,800	59,100	71,800
Fixed Wing Departure Percentage	22.9%	23.5%	23.7%	23.3%

Destination Airline Operations

America West Express served GCN in the later 1980s and early 1990s with 34-seat DeHavilland Dash 8 turboprops. After several acquisitions/mergers, that airline is a part of American Airlines with a hub still at Sky Harbor International Airport. SkyWest Airlines provides service to Flagstaff and Yuma under a codeshare agreement as American Eagle utilizing 50-seat Canadair Regional Jets. Other small commercial service airports in the state, located at Page and Prescott, are served by Great Lakes utilizing 19-seat turboprops.

A factor to be considered for the future is the declining use of 10 to 60 seat aircraft by the commercial airlines. Most of the turboprop aircraft being used are no longer being manufactured. The same is true of the 50-seat regional jet aircraft. In fact, many smaller airports are losing this level of service, and are left with independent small airlines using 9-seat aircraft. Many airports currently served by 50-seat regional jets will need to show a market for 70-seat and larger aircraft or risk losing service as well.

Also to be considered, as of August of 2013, FAA now requires that all airline pilots must have an Airline Transport Pilot (ATP) Certificate. While previously required by the major airlines, now it is required for regional/commuter airlines as well. The additional flight hours required (1,500 versus 250) has created a pilot shortage and leaves new commercial pilots searching for means to build flight time for an ATP Certificate that previously could be achieved flying for the commuters.

GCN also receives occasional charter flights from airlines such as Sun Country. Aircraft can range from Boeing 737-800s to regional jets. Some of these airlines provide service on less than a daily basis. Sun Country has provided twice a week service to Laughlin-Bullhead Airport from Minneapolis, and Allegiant Airlines operates hubs out of both Las Vegas and Phoenix-Mesa Gateway Airport to destinations around the country offering twice-a-week service.

TABLE 2G
Destination Airline Fleet Mix and Operations Forecast
Grand Canyon National Park Airport

Fleet Mix Seating Capacity	2020	2025	2035
Major Airlines			
>165	0.0%	0.0%	0.0%
135-164	5.0%	5.0%	5.0%
105-134	0.0%	0.0%	0.0%
80-104	0.0%	0.0%	35.0%
60-79	35.0%	65.0%	60.0%
40-59	0.0%	30.0%	0.0%
20-39	60.0%	0.0%	0.0%
< 20	0.0%	0.0%	0.0%
Totals	100.0%	100.0%	100.0%
Seats/Departure	50.0	68.0	81.0
Boarding Load Factor	75.0%	82.0%	86.0%
Enplanements/Departure	37.5	55.8	69.7
Annual Enplanements	42,000	67,000	125,000
Annual Departures	1,100	1,200	1,800
Annual Operations	2,200	2,400	3,600

Table 2G outlines a projected fleet mix based upon the destination passenger forecast for Grand Canyon National Park Airport. At lower enplanement levels, the turboprop and regional jets would be expected. Larger enplanement levels would potentially draw larger regional jets, particularly after the smaller jets are retired from service. In addition, larger charter aircraft are included in the mix, growing to up to two to three flights per week during the peak season.

GENERAL AVIATION FORECASTS

General aviation encompasses all portions of civil aviation except commercial service and military operations. To determine the types and sizes of facilities that should be planned to accommodate general aviation activity at GCN, certain elements of this activity must be forecast. These indicators of general aviation demand include based aircraft, aircraft fleet mix, and annual operations.

NATIONAL GENERAL AVIATION TRENDS

The FAA forecasts the fleet mix and hours flown for single engine piston aircraft, multi-engine piston aircraft, turboprops, business jets, piston and turbine helicopters, light sport, experimental, and others (gliders and balloons). The FAA forecasts "active aircraft," not total aircraft. An active aircraft is one that is flown at least one hour during the year. From 2010 through 2013, the FAA undertook an effort to have all aircraft owners re-register their aircraft. This effort resulted in a 10.5 percent decrease in the number of active general aviation aircraft, mostly in the piston category.

The long term outlook for general aviation is favorable, led by gains in turbine aircraft activity. The active general aviation fleet is forecast to increase 0.2 percent a year between 2015 and 2036, equating to an absolute increase in the fleet of about 7,000 units. While steady growth in both GDP and corporate profits results in continued growth of the turbine and rotorcraft fleets, the largest segment of the fleet – fixed wing piston aircraft - continues to shrink over the FAA's forecast.

In 2015, the general aviation industry experienced its first decline in aircraft deliveries since 2010. While the single engine piston aircraft deliveries by U.S. manufacturers continued to grow and business jet deliveries recorded a very modest increase compared to the previous year, turboprop deliveries declined by 10 percent, and the much smaller category of multi-engine piston deliveries declined 40 percent.

In 2015, the FAA estimated there were 138,135 piston-powered aircraft in the national fleet. The total number of piston-powered aircraft in the fleet is forecast to decline by 0.7 percent from 2015-2036, resulting in 118,855 by 2036. This includes -0.7 percent annually for single engine pistons and -0.5 percent for multi-engine pistons.

Total turbine aircraft are forecast to grow at an annual growth rate of 2.1 percent through 2036. The FAA estimates there were 29,040 turbine-powered aircraft in the national fleet in 2015, and there will be 44,655 by 2036. This includes annual growth rates of 1.3 percent for turboprops, 2.5 percent for business jets, and 2.3 percent for turbine helicopters.

While comprising a much smaller portion of the general aviation fleet, experimental aircraft, typically identified as home-built aircraft, are projected to grow annually by 0.9 percent through 2036. The FAA estimates there were 26,435 experimental aircraft in 2016, and these are projected to grow to 31,640 by 2036. Sport aircraft are forecast to grow 4.5 percent annually through the long term, growing from

2,410 in 2015 to 6,100 by 2036. **Exhibit 2F** presents the historical and forecast U.S. active general aviation aircraft.

The FAA also forecasts total operations based upon activity at control towers across the U.S. Operations are categorized as air carrier, air taxi/commuter, general aviation, and military.

General aviation operations, both local and itinerant, declined significantly as a result of the 2008-2009 recession and subsequent slow recovery. Through 2036, total general aviation operations are forecast to grow 0.3 percent annually. Air taxi/commuter operations are forecast to decline by 3.4 percent through 2025, and then increase slightly through the remainder of the forecast period. Overall, air taxi/commuter operations are forecast to decline by 1.1 percent annually from 2015 through 2036.

General Aviation Aircraft Shipments and Revenue

As previously discussed, the 2008-2009 economic recession has had a negative impact on general aviation aircraft production, and the industry has been slow to recover. Aircraft manufacturing declined for three straight years from 2008 through 2010. According to the General Aviation Manufacturers Association (GAMA), there is optimism that aircraft manufacturing will stabilize and return to growth, which has been evidenced since 2011. **Table 2H** presents historical data related to general aviation aircraft shipments.

Worldwide shipments of general aviation airplanes decreased in 2015 with a total of 2,331 units delivered around the globe compared to 2,454 units in 2014. Worldwide general aviation billings were also lower than the previous year. In 2015, $24 billion in new general aviation aircraft were shipped, but yearend results were mixed across the market segments. Results were impacted by economic uncertainty in key markets including Brazil, Europe, and China; however, the U.S. experienced stronger delivery numbers, which is cause for cautious optimism.

Business Jets: General aviation manufacturers delivered 718 business jets in 2015, as compared to 722 units in 2014. The industry's continued investment in new products helped maintain the delivery rate for business jets.

Turboprops: In 2015, 557 turboprop airplanes were delivered to customers around the world, a decline from the 603 delivered in 2014. Overall, the turboprop market is still significantly stronger over the past five years compared to years prior to 2011.

Pistons: Piston deliveries declined from 1,129 units during 2014 to 1,056 in 2015. Two-thirds of piston shipments were to North American customers, a significant increase from the 2014 North American market share of 55.1 percent.

TABLE 2H
Annual General Aviation Airplane Shipments
Manufactured Worldwide and Factory Net Billings

Year	Total	SEP	MEP	TP	J	Net Billings ($millions)
1994	1,132	544	77	233	278	3,749
1995	1,251	605	61	285	300	4,294
1996	1,437	731	70	320	316	4,936
1997	1,840	1043	80	279	438	7,170
1998	2,457	1508	98	336	515	8,604
1999	2,808	1689	112	340	667	11,560
2000	3,147	1,877	103	415	752	13,496
2001	2,998	1,645	147	422	784	13,868
2002	2,677	1,591	130	280	676	11,778
2003	2,686	1,825	71	272	518	9,998
2004	2,962	1,999	52	319	592	12,093
2005	3,590	2,326	139	375	750	15,156
2006	4,054	2,513	242	412	887	18,815
2007	4,277	2,417	258	465	1,137	21,837
2008	3,974	1,943	176	538	1,317	24,846
2009	2,283	893	70	446	874	19,474
2010	2,024	781	108	368	767	19,715
2011	2,120	761	137	526	696	19,042
2012	2,164	817	91	584	672	18,895
2013	2,353	908	122	645	678	23,450
2014	2,454	986	143	603	722	24,499
2015	2,331	946	110	557	718	24,120

SEP - Single Engine Piston; MEP - Multi-Engine Piston; TP - Turboprop; J - Turbofan/Turbojet

Source: General Aviation Manufacturers Association *2015 General Aviation Statistical Databook & 2016 Industry Outlook*

BASED AIRCRAFT FORECAST

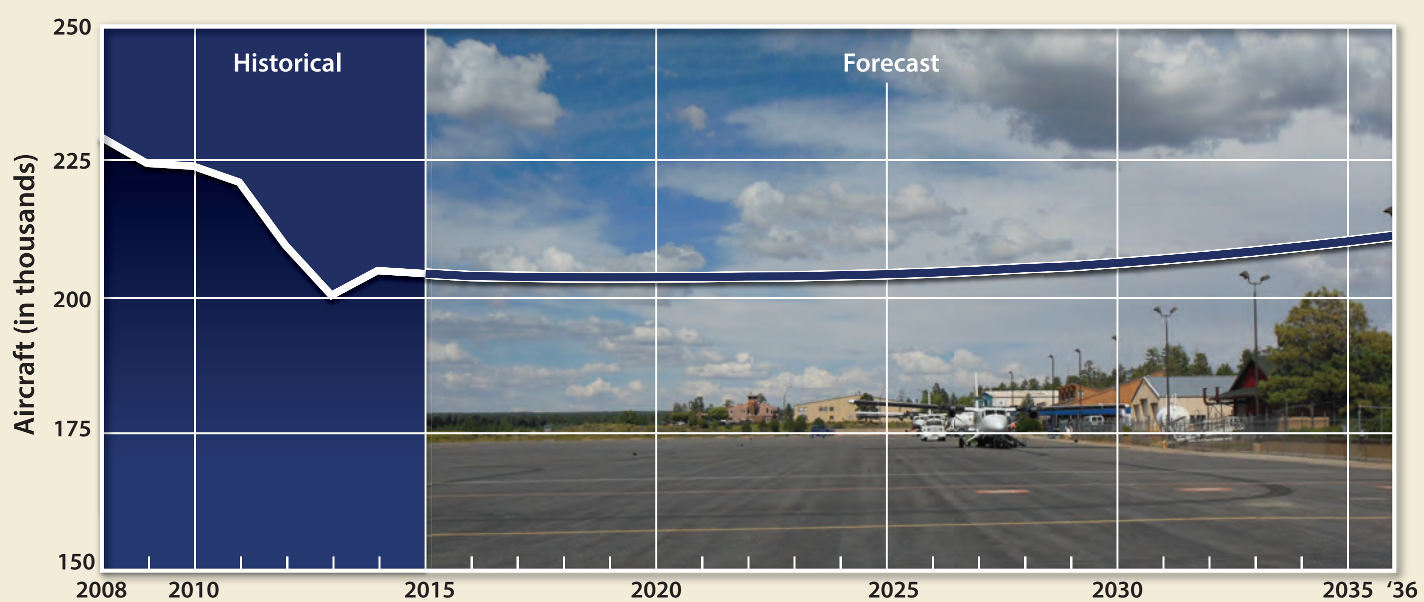
The number of based aircraft is the most basic indicator of general aviation demand. By first developing a forecast of based aircraft for GCN, other general aviation activities and demand can be projected. The process of developing forecasts of based aircraft begins with an analysis of aircraft ownership in the primary general aviation service area through a review of historical aircraft registrations.

Area Aircraft Ownership (Registered Aircraft)

Aircraft ownership trends in the primary service area typically dictate the based aircraft trends for an airport. The Airport's centralized location in Coconino County suggests that GCN's primary service area for based aircraft demand is within the County. As such, an analysis of Coconino County aircraft registrations was made.

U.S. ACTIVE GENERAL AVIATION AIRCRAFT

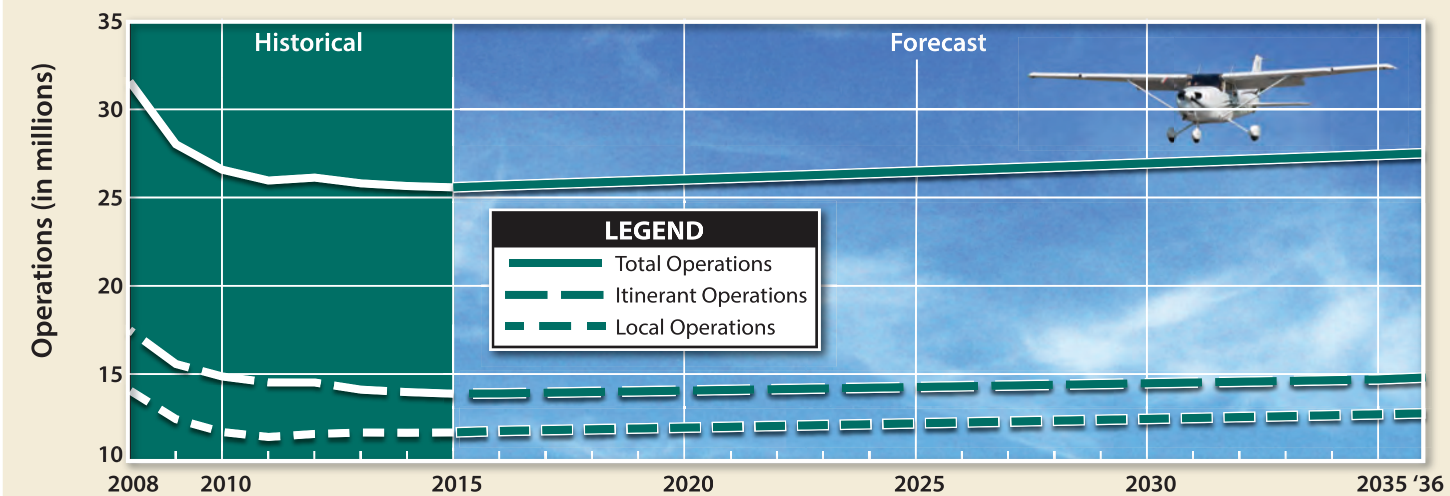
	2015	2020	2025	2035	AAGR 2015-2036
Fixed Wing					
Piston					
Single Engine	125,050	120,485	115,960	107,780	-0.7%
Multi-Engine	13,085	12,810	12,545	11,765	-0.5%
Turbine					
Turboprop	9,570	9,190	9,600	12,280	1.3%
Turbojet	12,475	13,680	15,340	12,280	2.5%
Rotorcraft					
Piston	3,245	3,690	4,090	4,915	2.1%
Turbine	6,995	8,020	8,990	11,020	2.3%
Experimental					
	26,435	27,485	28,500	31,365	0.9%
Sport Aircraft					
	2,410	3,310	4,230	5,940	4.5%
Other					
	4,615	4,525	4,490	4,445	-0.2%
Total Pistons	**141,380**	**136,985**	**132,595**	**124,460**	**-0.6%**
Total Turbines	**29,040**	**30,890**	**33,930**	**43,475**	**2.1%**
Total Fleet	**203,880**	**203,195**	**203,745**	**209,685**	**0.2%**



Notes: An active aircraft is one that has a current registration and was flown at least one hour during the calendar year.

U.S. GENERAL AVIATION OPERATIONS

	2015	2020	2025	2035	AAGR 2015-2036
Itinerant					
	13,886,867	14,062,324	14,267,238	14,697,64	0.3%
Local					
	11,691,349	11,963,428	12,205,656	12,718,674	0.4%
Total GA Operations	**25,578,216**	**26,025,752**	**26,472,894**	**27,416,314**	**0.3%**



U.S. GENERAL AVIATION AIR TAXI

	2015	2020	2025	2035	AAGR 2015-2036
Air Taxi/Commuter Operations					
Itinerant	7,895,017	6,640,509	5,579,158	6,137,321	-1.1%

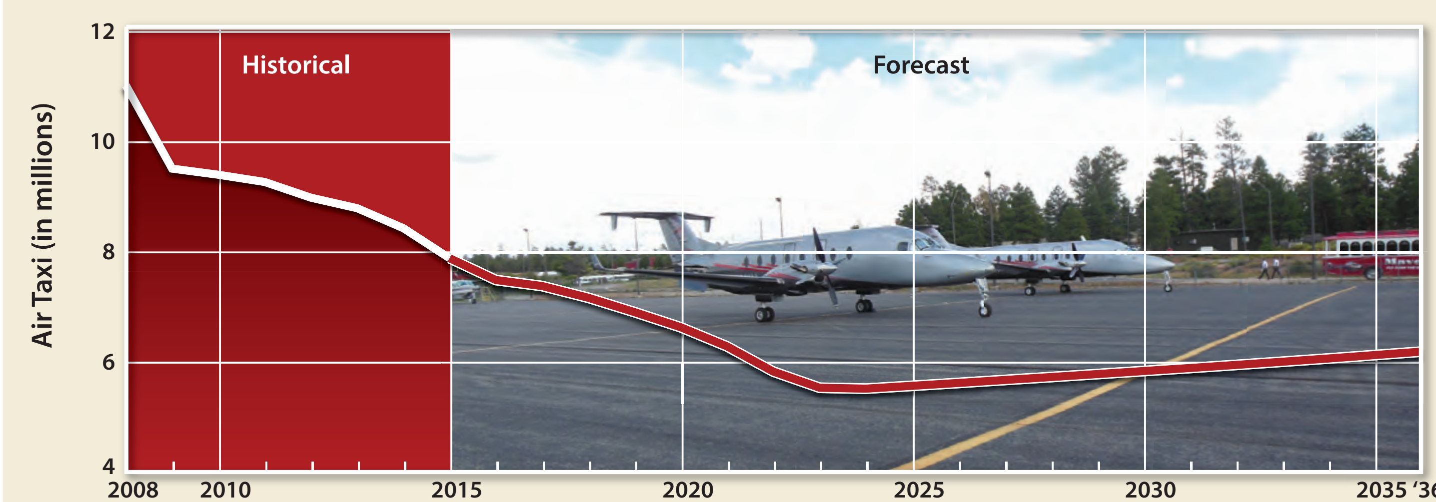


Exhibit 2F
NATIONAL GENERAL AVIATION/AIR TAXI FORECASTS

Source: FAA Aerospace Foreast - Fiscal Years 2016-2036

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Table 2J presents the history of registered aircraft in Coconino County from 2000 through 2015. These figures are derived from the FAA aircraft registration database that categorized registered aircraft by county based on the zip code of the registered aircraft. Although this information generally provides a correlation to based aircraft, it is not uncommon for some aircraft to be registered in the county, but based at an airport outside the county or vice versa.

TABLE 2J
Coconino County Registered Aircraft

Year	SEP	MEP	TP	J	H	Other[1]	Total
2000	236	23	13	0	20	39	331
2001	214	16	19	1	19	42	311
2002	212	15	18	2	19	42	308
2003	192	12	32	2	19	33	290
2004	194	14	33	1	19	33	294
2005	203	16	28	1	13	34	295
2006	218	20	8	0	16	36	298
2007	227	24	6	0	26	38	321
2008	219	20	15	1	14	38	307
2009	238	21	18	2	14	42	335
2010	212	22	15	1	14	45	309
2011	214	23	15	1	18	45	316
2012	199	21	11	0	17	44	292
2013	179	19	11	0	17	41	267
2014	182	16	9	1	17	43	268
2015	181	15	8	4	18	42	268
CAGR (2000-2015)	-1.8%	-2.8%	-3.2%	N/A	-0.7%	0.5%	-1.4%

[1] "Other" category consists of hot air balloons and ultralight aircraft.
SEP-Single engine piston; MEP-Multi-engine Piston, TP-Turboprop, J-Jet, H-Helicopter

Source: FAA Aircraft Registration Database

In 2015, there were 268 aircraft registered in the county, which is only one more than the 15-year low of 267 in 2013. The historic trend has shown minor growth spurts in an otherwise downward trend. One positive note for consideration is the growth in jets over the last year increasing by three aircraft. Now that the actual number of registered aircraft has been identified, several projections of future registered aircraft are considered for the 20-year planning horizon.

Registered aircraft projections are presented in **Table 2K**. These projections evaluate the potential growth of aircraft demand (registered aircraft) in Coconino County over the next 20 years.

Several regression and time-series analyses were conducted examining registered aircraft levels against historic population and active aircraft in the U.S. general aviation fleet. Unfortunately, the results did not produce reliable forecasts due to a lack of correlation between the variables. Therefore, several market share forecasts have been developed.

TABLE 2K
Registered Aircraft Projections
Coconino County

Year	County Registrations[1]	U.S. Active Aircraft[2]	Market Share	County Population[3]	Aircraft Per 1,000 Residents
2000	331	217,533	0.152%	116,320	2.85
2001	311	211,446	0.147%	122,255	2.54
2002	308	211,244	0.146%	124,509	2.47
2003	290	209,606	0.138%	126,876	2.29
2004	294	219,319	0.134%	128,211	2.29
2005	295	224,257	0.132%	128,907	2.29
2006	298	221,942	0.134%	130,269	2.29
2007	321	231,606	0.139%	132,512	2.42
2008	307	228,664	0.134%	132,864	2.31
2009	335	223,876	0.150%	133,626	2.51
2010	309	223,370	0.138%	134,421	2.30
2011	316	220,453	0.143%	134,162	2.36
2012	292	209,034	0.140%	134,313	2.17
2013	267	199,927	0.134%	135,695	1.97
2014	268	204,408	0.131%	139,372	1.92
2015	268	203,880	0.131%	141,602	1.89
CAGR (2000-2015)	-1.4%	-0.4%		1.3%	
Constant Market Share of U.S. Active Aircraft Projection					
2020	267	203,195	0.131%	149,769	2.75
2025	268	203,745	0.131%	156,363	2.52
2030	270	205,775	0.131%	161,021	2.35
2035	276	209,685	0.131%	164,844	2.22
CAGR (2015-2035)	0.1%	0.1%		0.8%	
Constant Ratio of Aircraft per 1,000 County Residents – Selected Forecast					
2020	283	203,195	0.140%	149,769	1.89
2025	296	203,745	0.145%	156,363	1.89
2030	305	205,775	0.148%	161,021	1.89
2035	312	209,685	0.149%	164,844	1.89
CAGR (2015-2035)	0.8%	0.1%		0.8%	

[1]*County Aircraft Registrations from FAA Aircraft Registration Database*
[2]*U.S. Active Aircraft from FAA Aerospace Forecasts – Fiscal Years 2016-2036*
[3]*Historical population from the US Census Bureau - Population division; Population projections*
CAGR – Compound Annual Growth Rate

The projections consider the county's market share of total active general aviation aircraft in the U.S. fleet as identified in the FAA's annual forecasts. The first projection considers the county maintaining its 2015 percent (0.131 percent) as a constant into the forecast years. This results in a long-term projection of 276 registered aircraft and a compound annual growth rate (CAGR) of 0.1 percent. The second projection considers maintaining the 2015 ratio of 1.89 aircraft per 1,000 people in the county. This results in a 2035 projection of 312 registered aircraft and an annual growth rate of 0.8 percent. This forecast has been selected as the most reasonable as it shows the potential for registered aircraft to rebound to levels experienced as recently as 2011. Should population and economic conditions continue to improve in the county, over time, it is reasonable that aircraft growth will return as well.

The registered aircraft projection is one data point to be used in the development of a based aircraft forecast. The following section will present several potential based aircraft forecasts as well as the selected based aircraft Master Plan forecast.

Based Aircraft Forecasts

Determining the number of based aircraft at an airport can be a challenging task. Aircraft storage can be somewhat transient in nature, meaning aircraft owners can and do move their aircraft. Some aircraft owners may store their aircraft at an airport for only part of the year. For many years, the FAA did not require based aircraft records; therefore, historical records are often incomplete or non-existent. For this study, GCN provided a current based aircraft count of 37 aircraft as of 2015.

The FAA TAF is an initial forecast source for based aircraft at airports. The 2016 TAF estimated that there were 38 based aircraft in 2015, which was forecast to grow to 41 by 2035 for a CAGR of 0.4 percent. **Table 2L** shows the FAA TAF history and forecasts of based aircraft. As can be seen, the 2015 TAF slightly overestimates the current number of based aircraft by a single aircraft.

TABLE 2L
Existing Based Aircraft Forecasts
Grand Canyon National Park Airport

	HISTORY			FORECAST		
	2000	**2010**	**2015**	**2020**	**2025**	**2035**
Actual Based Aircraft	52	34	37			
FAA TAF 2016	52	34	38	40	41	41

TAF - Terminal Area Forecast

Several new forecasts of based aircraft for GCN have been developed. As with forecasts of registered aircraft, the goal is to develop a planning envelope of reasonable forecasts, then select a 20-year planning forecast for use in this study. The new forecasts are summarized in **Table 2M**.

In 2009, a Terminal Area Plan (TAP) was prepared for GCN, which included a forecast analysis. The base year for the TAP was 2008 when there were 46 aircraft based at GCN. The TAP forecast based aircraft to grow to 62 by 2030 for a CAGR of 1.4 percent. Since the based aircraft level has since decreased, a new forecast was prepared by applying the TAP CAGR of 1.4 percent, which results in a based aircraft level of 49 by 2035.

TABLE 2M
Based Aircraft Forecast
Grand Canyon National Park Airport

Year	Coconino County Registered Aircraft	Based Aircraft	Market Share
2000	331	52	15.7%
2001	311	51	16.4%
2002	308	51	16.6%
2003	290	51	17.6%
2004	294	48	16.3%
2005	295	48	16.3%
2006	298	41	13.8%
2007	321	46	14.3%
2008	307	46	15.0%
2009	335	34	10.1%
2010	309	34	11.0%
2011	316	40	12.7%
2012	292	38	13.0%
2013	267	35	13.1%
2014	268	40	14.9%
2015	268	37	13.8%
CAGR (2000-2015)	-1.4%	-2.2%	
2009 Terminal Area Plan (TAP) Growth Rate Projection			
2020	283	40	14.1%
2025	296	42	14.2%
2035	312	49	15.7%
CAGR (2015-2035)	0.8%	1.4%	
Constant Share Projection			
2020	283	39	13.8%
2025	296	41	13.8%
2035	312	43	13.8%
CAGR (2015-2035)	0.8%	0.8%	
Increasing Share Projection – Selected Forecast			
2020	283	41	14.4%
2025	296	46	15.4%
2035	312	54	17.4%
CAGR (2015-2035)	0.8%	1.9%	
2016 TAF Growth Rate Projection			
2020	283	38	13.4%
2025	296	38	12.8%
2035	312	40	12.8%
CAGR (2015-2035)	0.8%	0.4%	

CAGR: Compound Annual Growth Rate

Several market share forecasts for based aircraft have been prepared utilizing the previously developed forecast of registered aircraft in the county. In 2015, GCN with 37 based aircraft, accounted for 13.8 percent of the registered aircraft in the county. By maintaining this percent as a constant, a long-term forecast of based aircraft emerges which results in 43 based aircraft by 2035. A second projection considers a modestly increasing market share of the county's registered aircraft, which would recapture share levels experienced in the early 2000s. This forecast results in 54 based aircraft by 2035. An additional projection shown utilizes the 2015 TAF projected annual growth rate of 0.4 percent which has a 2035 forecast of 40 based aircraft.

The increasing share projection was selected as the most reasonable forecast as it accounts for the growth potential of air tour activities. If Grand Canyon National Park (GCNP) visitors continue to grow as projected, it is reasonable this will result in an increase in air tour activities and thus drive a need for more based aircraft. The selected forecast projects based aircraft to grow by 17 aircraft over the next 20 years. **Exhibit 2G** illustrates both the registered and the based aircraft forecast.

BASED AIRCRAFT FLEET MIX

The fleet mix of based aircraft is oftentimes more important to airport planning and design than the total number of aircraft. For example, the presence of one or a few large business jets can impact design standards for the runway and taxiway system more than a large number of smaller single engine piston-powered aircraft.

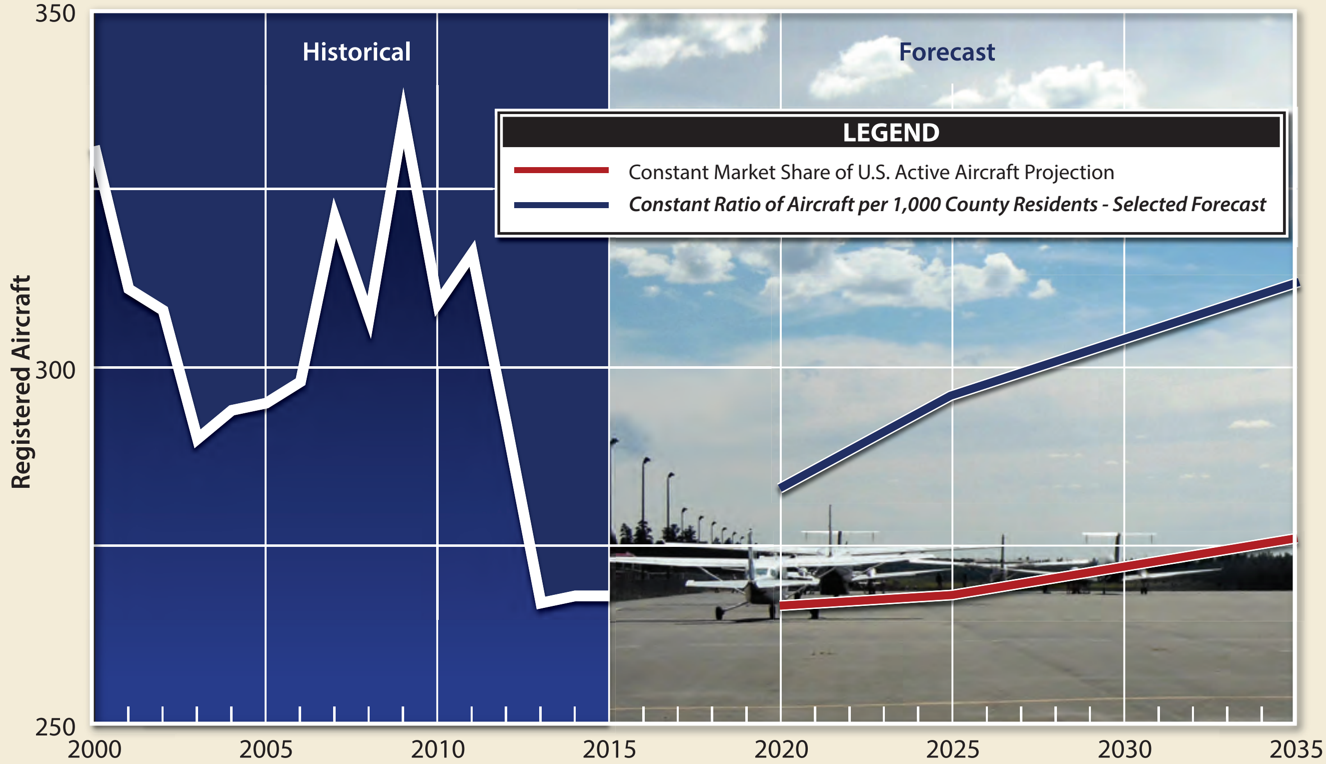
The based aircraft fleet mix forecast for GCN is presented in **Table 2N**. The majority of based aircraft (78.4 percent) are helicopters associated with the aerial tour operators. Forecasts of based aircraft fleet mix has been developed based upon anticipated growth of the air tour fleet, which is expected to be centered around helicopter and turboprop aircraft. The based aircraft fleet mix forecast also considers the potential for a jet aircraft to base at GCN in the future as they become more prevalent in the national fleet mix.

TABLE 2N
Based Aircraft Fleet Mix
Grand Canyon National Park Airport

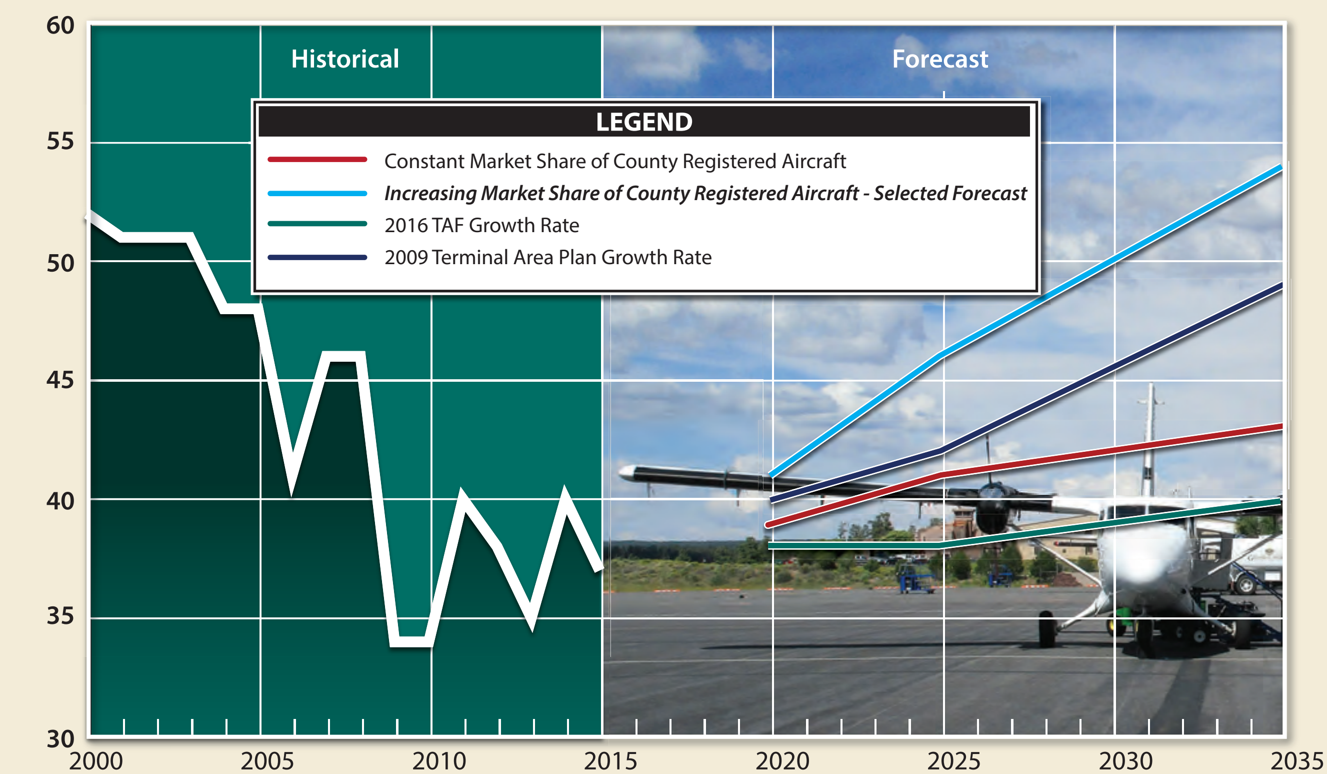
	EXISTING		FORECAST					
Aircraft Type	**2015**	**%**	**2020**	**%**	**2025**	**%**	**2035**	**%**
Single Engine	2	5.4%	2	4.9%	3	6.5%	5	9.3%
Multi-Engine	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Turboprop	6	16.2%	7	17.1%	8	17.4%	10	18.5%
Jet	0	0.0%	0	0.0%	1	2.2%	1	1.9%
Helicopter	29	78.4%	32	78.0%	34	73.9%	38	70.4%
Totals	**37**	**100.0%**	**41**	**100.0%**	**46**	**100.0%**	**54**	**100.0%**

Source: Airport Records; Coffman Associates Analysis

REGISTERED AIRCRAFT - COCONINO COUNTY



BASED AIRCRAFT



GENERAL AVIATION OPERATIONS

General aviation (GA) operations are classified by the airport traffic control tower (ATCT) as either local or itinerant. A local operation is a take-off or landing performed by an aircraft that operates within sight of an airport, or which executes simulated approaches or touch-and-go operations at an airport. Itinerant operations are those performed by aircraft with a specific origin or destination away from an airport. Generally, local operations are characterized by training operations. Typically, itinerant operations increase with business and commercial use, since business aircraft are operated on a higher frequency.

Itinerant Operations

Table 2P depicts general aviation itinerant operations at GCN from 2000 through 2015. General aviation itinerant operations have been on a gradual decline for the past several years, with 2015 reporting the lowest level in the past 15 years with 2,731 operations. National general aviation itinerant operations have been declining since at least 2000, but have taken a steeper decline since the beginning of the recession and have yet to recover. However, the FAA forecasts a reversal in 2016. Through 2036, the FAA forecasts an annual growth rate of 0.3 percent for itinerant general aviation operations.

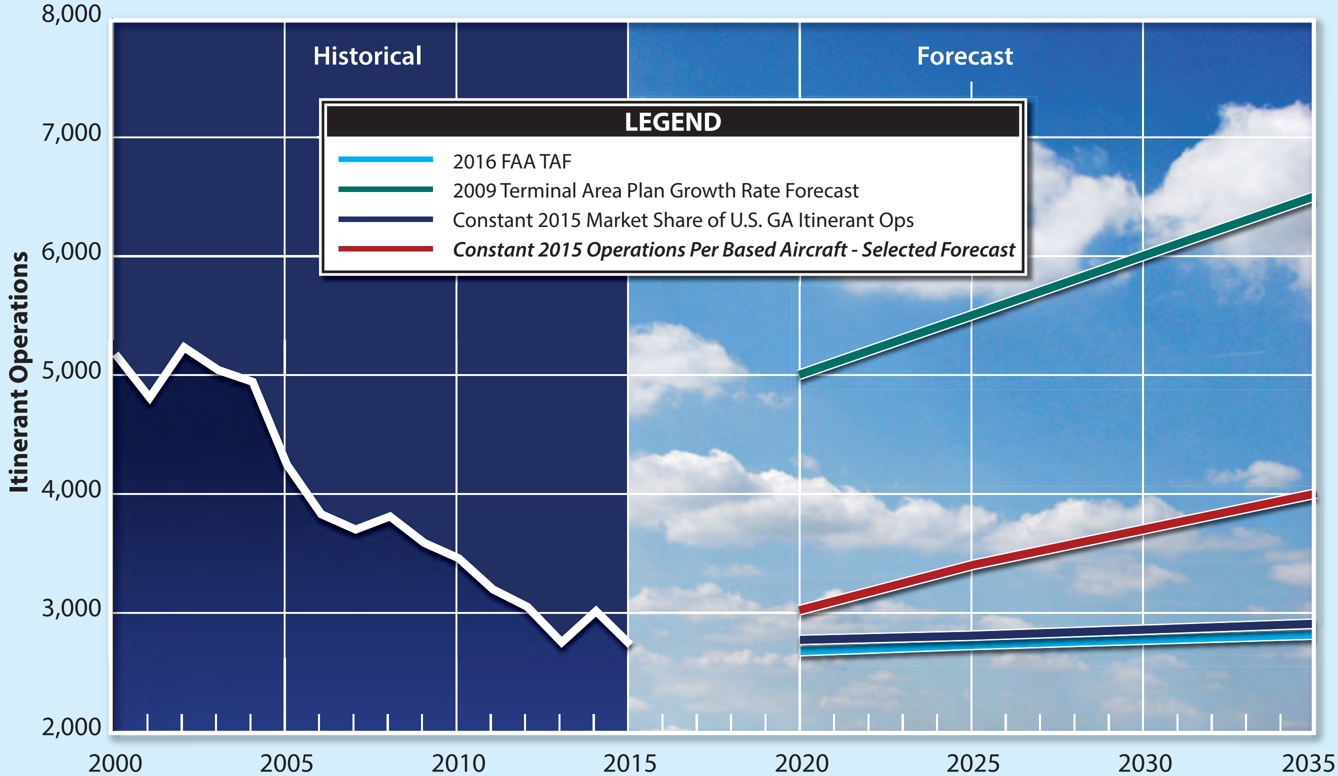
Three forecasts were prepared for future itinerant general aviation operations. The first forecast considers maintaining constant GCN's market share (0.0197 percent) of national itinerant general aviation operations as forecast by the FAA, which yields 2,900 operations by 2035.

The next projection considers the relationship between based aircraft and itinerant general aviation operations. In 2015, there were 74 itinerant general aviation operations per based aircraft. When maintaining this ratio, a forecast results in 4,000 itinerant general aviation operations by 2035. This represents an annual growth rate of 1.9 percent.

The 2016 FAA TAF also presents an itinerant general aviation operation forecast which is included in the table. The TAF forecasts a growth rate of 0.1 percent annually. This results in a 2035 itinerant general aviation operations projection of 2,808. The 2009 TAP forecast general aviation itinerant operations to grow at a CAGR of 4.4 percent, which was applied to the forecast years of this Master Plan Update, resulting in 6,500 itinerant general aviation operations by 2035.

The constant operations per based aircraft projection was selected as the most reasonable forecast as it correlates the potential for operational growth with the potential for based aircraft growth. In the next five years, itinerant general aviation operations are forecast to reach 3,030. In 10 years, 3,400 itinerant general aviation operations are forecast, and by 2035, 4,000 itinerant general aviation operations are projected. **Exhibit 2H** presents both the itinerant and local general aviation operations forecast.

GENERAL AVIATION ITINERANT OPERATIONS



GENERAL AVIATION LOCAL OPERATIONS

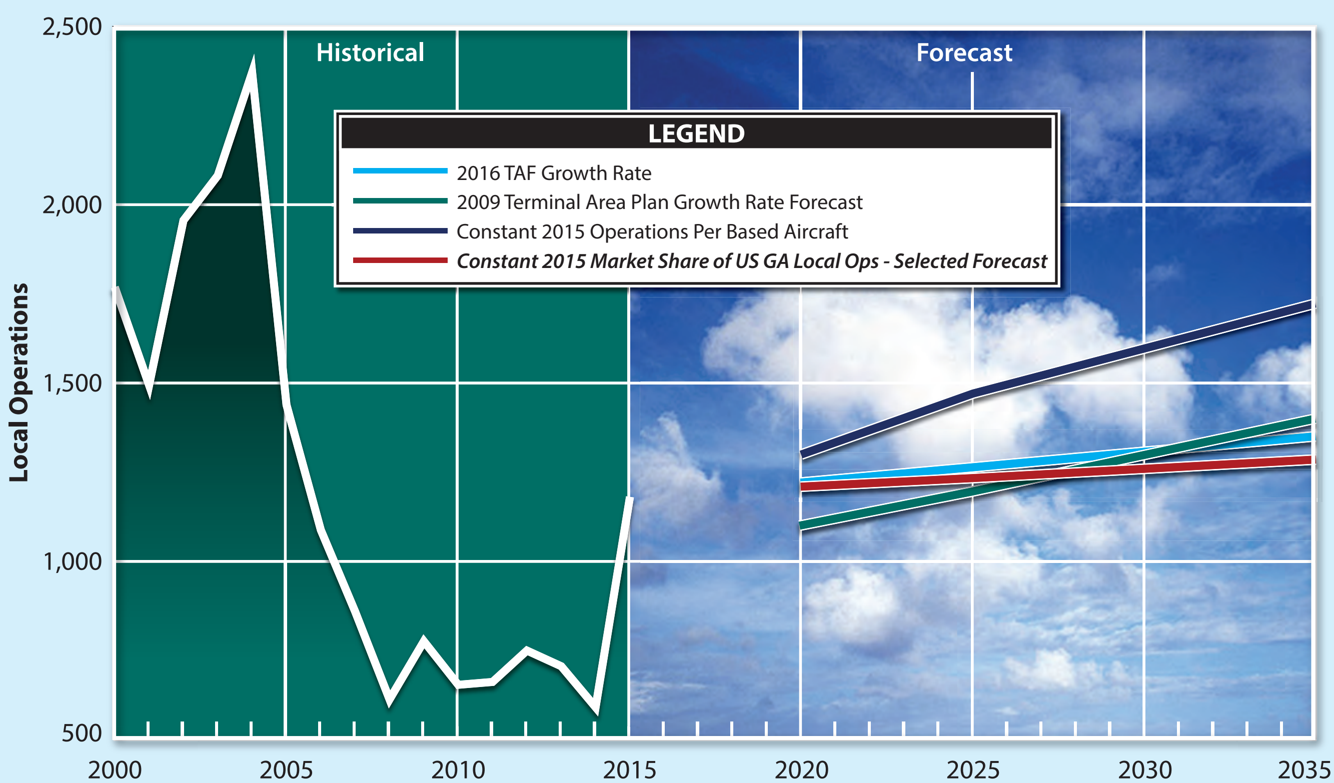


Exhibit 2H: LOCAL & ITINERANT GENERAL AVIATION OPERATIONS FORECAST

TABLE 2P
General Aviation Itinerant Operations Forecast
Grand Canyon National Park Airport

Year	GCN GA Itinerant Ops[1]	US GA Itinerant Ops[2] (millions)	Market Share Itinerant Ops	GCN Based Aircraft[3]	Itinerant Ops Per Based Aircraft
2000	5,177	22.84	0.0227%	52	100
2001	4,810	21.43	0.0224%	51	94
2002	5,234	21.45	0.0244%	51	103
2003	5,042	20.23	0.0249%	51	99
2004	4,943	20.01	0.0247%	48	103
2005	4,245	19.32	0.0220%	48	88
2006	3,829	18.74	0.0204%	41	93
2007	3,701	18.58	0.0199%	46	80
2008	3,811	17.49	0.0218%	46	83
2009	3,588	15.57	0.0230%	34	106
2010	3,459	14.86	0.0233%	34	102
2011	3,197	14.53	0.0220%	40	80
2012	3,051	14.52	0.0210%	38	80
2013	2,752	14.12	0.0195%	35	79
2014	3,015	13.98	0.0216%	40	75
2015	2,731	13.89	0.0197%	37	74
CAGR (2000-2015)	-4.2%	-3.3%		-2.2%	
Constant 2015 Market Share of U.S. GA Itinerant Ops					
2020	2,775	14.06	0.0197%	41	68
2025	2,815	14.27	0.0197%	46	61
2035	2,900	14.70	0.0197%	54	54
CAGR (2015-2035)	0.3%	0.3%		1.9%	
Constant 2015 Operations Per Based Aircraft – Selected Forecast					
2020	**3,030**	**14.06**	**0.0215%**	**41**	**74**
2025	**3,400**	**14.27**	**0.0238%**	**46**	**74**
2035	**4,000**	**14.70**	**0.0272%**	**54**	**74**
CAGR (2015-2035)	**1.9%**	**0.3%**		**1.9%**	
2016 FAA TAF Projections					
2020	2,688	14.06	0.0191%	41	66
2025	2,728	14.27	0.0191%	46	59
2035	2,808	14.70	0.0191%	54	52
CAGR (2015-2035)	0.1%	0.3%		1.9%	
2009 Terminal Area Plan Growth Rate Forecast					
2020	5,000	14.06	0.0356%	41	122
2025	5,500	14.27	0.0386%	46	120
2035	6,500	14.70	0.0442%	54	120
CAGR (2015-2035)	4.4%	0.3%		1.9%	

[1]Historical data from ATCT records as reported to FAA.
[2]FAA Forecasts Fiscal Years 2016-2036
[3]Airport records and FAA TAF
CAGR - Compound Annual Growth Rate
Source: Coffman Associates analysis

Local Operations

A similar methodology was utilized to forecast local general aviation operations. **Table 2Q** depicts the history of local operations at GCN and examines its historic market share of GA local operations at towered airports in the United States. Historical local operations range from a low of 591 in 2014 to a high of 2,371 in 2004. Similar to itinerant operations, local operations have also been on the decline; however, 2015 saw a significant increase in local operations growing by almost 100 percent over the previous year, reaching its highest level since 2005. Even with this growth in 2015, local operations still represent a very low percentage of total GCN operations.

As with national itinerant operations, local operations have been declining for some time. The FAA TAF and the national projections estimate a modest annual growth rate going forward of approximately 0.4 percent.

The first forecast of local general aviation operations consider GCN's market share of national local general aviation operations as counted by the FAA. This forecast maintains GCN's 2015 market share at 0.0101 percent, resulting in 968 local general aviation operations by 2035 with a CAGR of 0.4 percent. The second forecast applies a constant number of local general aviation operations per based aircraft. This forecast results in 1,725 local general aviation operations by 2035 and a CAGR of 1.9 percent.

The 2016 FAA TAF projection is also presented in the table. The FAA TAF uses a 2015 base count of 846 local general aviation operations, which is significantly lower than what was reported by tower counts for the year. Therefore, the growth rate utilized in the TAF of 0.7 percent was utilized to generate a new forecast. This TAF growth rate forecast results in 1,350 local general aviation operations by 2035. The 2009 TAP forecasted local general aviation operations growth rate of 0.9 percent was also utilized to generate a new forecast. Applying the CAGR of 0.9 percent results in 1,400 local general aviation operations by 2035.

Aside from this past year, trends have shown very limited local general aviation activity at GCN. For this reason, the constant market share projection is viewed as the most reasonable. This selected forecast accounts for potential limited growth consistent with national trends. At an airport that primarily serves aerial tour operators, including significant helicopter activity, local general aviation, and specifically flight training activities, are not viewed as a significant growth category. The planning forecast for local general aviation operations considers 1,210 by 2020, 1,235 by 2025, and 1,285 by 2035 at a CAGR of 0.4 percent.

TABLE 2Q
General Aviation Local Operations Forecast
Grand Canyon National Park Airport

Year	GCN GA Local Ops[1]	US GA Local Ops[2] (millions)	Market Share Local Ops	GCN Based Aircraft[3]	Local Ops Per Based Aircraft
2000	1,769	17.03	0.0104%	52	34
2001	1,494	16.19	0.0092%	51	29
2002	1,956	16.17	0.0121%	51	38
2003	2,082	15.29	0.0136%	51	41
2004	2,371	14.96	0.0158%	48	49
2005	1,439	14.85	0.0097%	48	30
2006	1,088	14.38	0.0076%	41	27
2007	859	14.56	0.0059%	46	19
2008	613	14.08	0.0044%	46	13
2009	776	12.45	0.0062%	34	23
2010	654	11.18	0.0059%	34	19
2011	662	11.44	0.0058%	40	17
2012	750	11.61	0.0065%	38	20
2013	706	11.69	0.0060%	35	20
2014	591	11.68	0.0051%	40	15
2015	1,181	11.69	0.0101%	37	32
CAGR (2000-2015)	-2.7%	-2.5%		-2.2%	
Constant 2015 Market Share of US GA Local Ops – Selected Forecast					
2020	1,210	11.96	0.0101%	41	30
2025	1,235	12.21	0.0101%	46	28
2035	1,285	12.72	0.0101%	54	25
CAGR (2015-2035)	0.4%	0.4%		1.9%	
Constant 2015 Operations Per Based Aircraft					
2020	1,300	11.96	0.0109%	41	32
2025	1,470	12.21	0.0120%	46	32
2035	1,725	12.72	0.0136%	54	32
CAGR (2015-2035)	1.9%	0.4%		1.9%	
2016 FAA TAF Growth Rate Projection					
2020	1,220	11.96	0.0102%	41	30
2025	1,260	12.21	0.0103%	46	27
2035	1,350	12.72	0.0106%	54	25
CAGR (2015-2035)	0.7%	0.4%		1.9%	
2009 Terminal Area Plan Growth Rate Forecast					
2020	1,100	11.96	0.0092%	41	27
2025	1,200	12.21	0.0098%	46	26
2035	1,400	12.72	0.0110%	54	26
CAGR (2015-2035)	0.9%	0.4%		1.9%	

[1]Historical data from ATCT records as reported to FAA.
[2]FAA Forecasts Fiscal Years 2016-2036
[3]Airport records and FAA TAF
CAGR - Compound Annual Growth Rate
Source: Coffman Associates analysis

OTHER AIR TAXI OPERATIONS

Air taxi operations as reported by the ATCT include air tour operations as well as for-hire general aviation operations. Some operations by aircraft operated under fractional ownership programs are also counted as air taxi operations. Since the air tour operations have been forecast, this section reviews the growth potential for the "other air taxi" operations. In 2015, there were a total of 9,402 other air taxi operations, which was 9.3 percent of all air tour operations. Maintaining that percentage through the planning period of the Master Plan results in 14,750 other air taxi operations by 2035 and a CAGR of 2.3 percent. The resulting forecast is presented in **Table 2R**.

TABLE 2R
Other Air Taxi Operations
Grand Canyon National Park Airport

Year	Other Air Taxi Operations
2015	9,402
Forecast	
2020	10,850
2025	12,150
2035	14,750

Source: Coffman Associates analysis.

MILITARY OPERATIONS FORECAST

Military operators routinely utilize GCN for various training operations and activities. **Table 2S** presents a summary of military operations, both local and itinerant, for the past 15 years. Tower records indicate a wide variety of military aircraft have utilized GCN in recent years, including turboprops such as the Lockheed C-130, Northrop Grumman E-2 Hawkeye, Lockheed P-3 Orion; and jet aircraft such as the C-17 Globemaster, K-135 Stratotanker, and occasionally, fighter aircraft such as the F-16.

TABLE 2S
Military Operations Forecasts
Grand Canyon National Park Airport

Year	Military (Local)	Military (Itinerant)	Total Military
2000	145	360	505
2001	174	234	408
2002	604	600	1,204
2003	398	464	862
2004	236	384	620
2005	332	440	772
2006	643	485	1,128
2007	631	555	1,186
2008	422	517	939
2009	262	501	763
2010	240	511	751
2011	450	570	1,020
2012	511	537	1,048
2013	311	493	804
2014	521	543	1,064
2015	553	604	1,157
Selected Forecast			
2020	550	600	1,150
2025	550	600	1,150
2035	550	600	1,150

Sources: Historical data from ATCT records as reported to FAA.
Forecast – Coffman Associates analysis.

Developing a reliable forecast of military activity is inherently difficult, primarily because the military mission can change rapidly. Therefore, this forecast assumes current levels will remain static at 1,150 annual operations (both local and itinerant) into the forecast years.

PEAKING CHARACTERISTICS

Many airport facility needs are related to the levels of activity during peak periods. The peaking periods that will be used in developing facility requirements for this study are as follows:

- **Peak Month** – The calendar month when peak aircraft operations occur.
- **Design Day** – The average day in the peak month. This indicator is derived by dividing the peak month operations by the number of days in a month.
- **Design Hour** – The peak hour within the design day.

It is important to note that only the peak month is an absolute peak within a given year. All other peak periods will be exceeded at various times during the year. However, they do represent reasonable planning standards that can be applied without overbuilding or being too restrictive. **Table 2T** outlines the peak baseline and forecast peaking characteristics for GCN.

TABLE 2T
Peaking Characteristics
Grand Canyon National Park Airport

	2015	2020	2025	2035
Fixed Wing Air Tour Activity				
Enplanements				
Annual	132,198	170,280	190,060	232,200
Peak Month	16,202	21,438	23,928	29,234
Design Day	540	705	787	962
Design Hour	71	97	108	133
Total Passengers				
Design Hour	142	194	216	266
Operations				
Annual	20,982	24,800	28,000	33,400
Peak Month	2,612	3,270	3,692	4,404
Design Day	87	109	123	147
Design Hour	11	14	16	19
Departures				
Design Day	44	55	62	74
Design Hour	6	7	8	10
Peak Helicopter Air Tour Activity				
Enplanements				
Annual	196,930	225,720	251,940	307,800
Peak Month	32,179	38,318	42,769	52,252
Design Day	1,038	1,260	1,407	1,719
Design Hour	134	162	179	218
Total Passengers				
Design Hour	268	324	358	436
Operations				
Annual	70,506	80,800	90,200	110,200
Peak Month	11,564	13,380	14,936	18,248
Design Day	373	440	491	600
Design Hour	48	57	64	78
Departures				
Design Day	187	220	246	300
Design Hour	24	29	32	39

TABLE 2T (Continued)
Peaking Characteristics
Grand Canyon National Park Airport

Peak Destinations Airline Activity				
Enplanements				
Annual	[redacted]	42,000	67,000	125,000
Peak Month	[redacted]	4,620	7,370	13,750
Design Day	[redacted]	165	263	491
Design Hour	[redacted]	75	112	139
Total Passengers				
Design Hour	[redacted]	150	223	279
Operations				
Annual	[redacted]	2,200	2,400	3,600
Peak Month	[redacted]	242	264	396
Design Day	[redacted]	9	9	14
Design Hour	[redacted]	3	3	4
Departures				
Design Day	[redacted]	4	5	7
Design Hour	[redacted]	2	2	2
Itinerant General Aviation Operations				
Annual	2,731	3,030	3,400	4,000
Peak Month	303	342	384	452
Design Day	10	11	13	15
Design Hour	2	2	3	3
Other Air Taxi Operations				
Annual	9,402	10,850	12,150	14,750
Peak Month	1,326	1,530	1,713	2,080
Design Day	43	50	56	68
Design Hour	9	10	11	14

Source: Coffman Associates analysis.

AIR TOUR PEAKING CHARACTERISTICS

Peak activity for air tour operations and passengers is divided into fixed wing and helicopter because their landside operations are essentially segregated on the airport. The fixed wing air tour operators utilize the aircraft apron along the runway as well as the terminal facilities adjacent to the aircraft apron. For the most part, the helicopter tour companies operate from their own facilities on the airport.

The peak month projections for fixed wing air tour operators were based upon the average peak month over the past five years, which was either the month of August or September. The average peak month for fixed wing air tours accounted for 12.6 percent of the enplanements and 13.2 percent of the operations. The design day is based upon the average day of the peak month, as activity during the peak month tends to be distributed relatively evenly through any given week.

Hourly activity is examined as a percentage of the daily activity. Air tour activity generally occurs over a 12-hour period each day. A peaking factor of 13 percent was applied to determine the design hour operations. Design hour enplanements were based upon the number of departures during the design hour times the average enplanements per departure (12.6 in 2015 growing to 13.9 by 2035).

The peak month projections for helicopter air tour operators were also based upon the average peak month over the past five years, which was usually August. The average peak month for helicopters accounted for 17.0 percent of the enplanements and 16.6 percent of the operations. The average day of the peak month was also used as the design day, and design hour operations were based upon 13 percent of the daily activity. Design hour helicopter enplanements were also based upon the number of departures during the design hour multiplied by the average passengers per departure (5.6 through all planning years).

PEAK DESTINATION AIRLINE ACTIVITY

GCN does not currently have scheduled airline activity; therefore, for the purposes of the Master Plan, peaking activity has been projected only for the forecast years. Peak month operations and enplanements were estimated to average 11.0 percent of annual totals. This is reflective of air service for a year-round tourism destination. Activity will peak in the summer months, more than at a typical airport, but less than the peak at a seasonal tourist destination.

Design day activity takes into account the potential for service on a less than daily basis. Many carriers today serving small markets provide service on a frequency of two to four times a week rather than the traditional five to seven days. This is the type of service potential anticipated for GCN. Design hour activity was based upon accommodating a portion of the design day operations. This percentage, which is projected to fluctuate between 30 and 25 percent, should decline over time as daily flights increase. Design hour enplanements were based upon the number of departures during the design hour times the average enplanements per operation (37.5 in 2020, growing to 69.7 by 2035).

ITINERANT GENERAL AVIATION/OTHER AIR TAXI PEAKING

The peak month for general aviation operations at GCN has averaged 11.3 percent of yearly general aviation operations since 2000. The most common peak month for general aviation operations at GCN over the past 15 years was May. The design day for general aviation operations are derived by dividing the peak month by the number of days in the month. Design hour general aviation operations are estimated as 20 percent of total operations for the design day.

The peak month for all air taxi operations since 2000 has averaged 14.1 percent of yearly operations. This percentage was applied to the peaking characteristics for other air taxi operations, which are those not associated with the air tour operators. Similar to itinerant general aviation operations, the design day was derived by dividing the peak month by the number of days in the month and design hour "other air taxi" operations are estimated as 20 percent of total operations for the design day.

FORECAST COMPARISON TO THE FAA TAF

The FAA will review the forecasts presented in this Master Plan for comparison to the *Terminal Area Forecast*. The local Airports District Office (ADO) of the FAA can approve the forecasts if they do not differ by more than 10 percent in the first five years and 15 percent for years 6-10. If the Master Planning forecasts exceed these parameters, then the forecasts must be forwarded to FAA headquarters in Washington, D.C. for further review. Any deviation from these thresholds will require specific local documentation. **Table 2U** presents the direct comparison of the Master Planning forecasts with the TAF published in January 2016. The reason the FAA allows this differential is because the TAF forecasts are not meant to replace forecasts developed locally (i.e., in this Master Plan). While the TAF can provide a point of reference or comparison, their purpose is much broader in defining FAA national workload measures.

TABLE 2U
Forecast Comparison to the 2016 FAA Terminal Area Forecast (TAF)
Grand Canyon National Park Airport

	2015	2020	2025	2035	CAGR 2015-2035
Enplanements					
Master Plan Forecast	329,128	438,000	509,000	665,000	3.6%
FAA TAF	116,733	112,230	112,230	112,230	-0.2%
% Difference	181.9%	290.3%	353.5%	492.5%	
Commercial Operations					
Master Plan Forecast[1]	100,890	118,650	132,750	161,950	2.4%
FAA TAF	102,169	107,347	112,804	124,558	1.0%
% Difference	-1.3%	10.5%	17.7%	30.0%	
Total Operations					
Master Plan Forecast	105,959	124,040	138,535	168,385	2.3%
FAA TAF	107,052	112,106	117,623	129,497	1.0%
% Difference	-1.0%	10.6%	17.8%	30.0%	
Based Aircraft					
Master Plan Forecast	37	41	46	54	1.9%
FAA TAF	38	40	41	41	0.4%
% Difference	-2.6%	2.5%	12.2%	31.7%	

[1]Includes air carrier and air taxi.
CAGR – Compound Annual Growth Rate
Source: Coffman Associates analysis

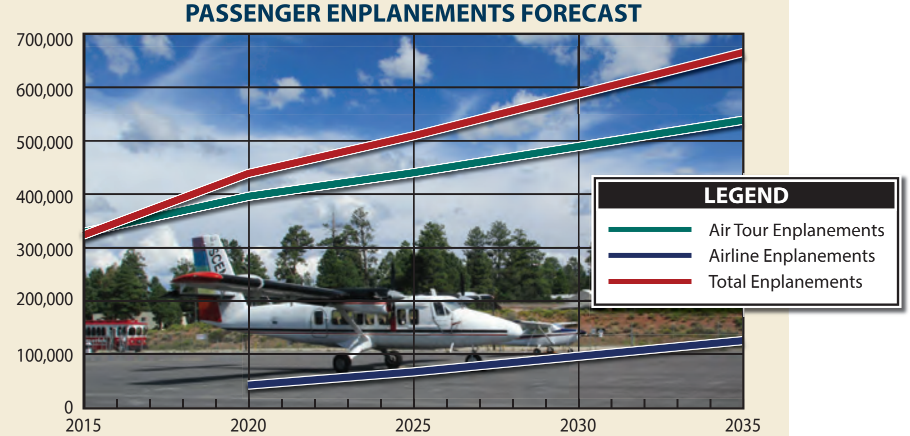
The comparison highlights that the FAA TAF is vastly underreporting enplanements at GCN in 2015 with actual reported enplanements 181.9 percent greater than TAF figures. This type of discrepancy puts the Master Plan forecast well outside local ADO approval range and will likely require approval from FAA headquarters. Commercial operations and total operations are slightly outside the five-year FAA tolerance in relation to the TAF at 10.5 and 10.6 percent respectively. In the 10-year horizon, commercial operations and total operations differ from the TAF by 17.7 percent and 17.8 percent respectively. Based aircraft remains within the five- and ten-year FAA tolerance.

FORECAST SUMMARY

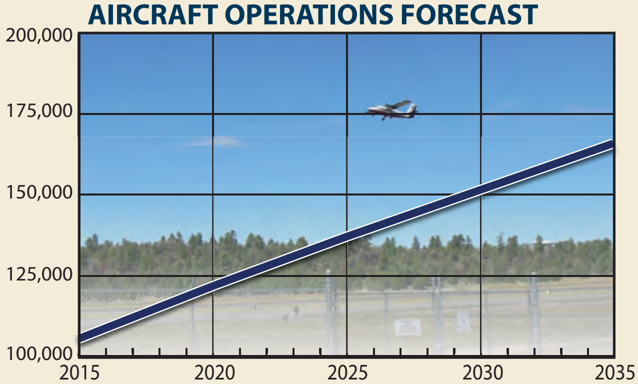
This chapter has outlined the various activity levels that might reasonably be anticipated over the planning period. **Exhibit 2J** is a summary of the aviation forecasts prepared in this chapter. Actual activity is

	2015	2020	2025	2035
ENPLANED PASSENGERS				
Fixed Wing Air Tour	132,198	170,280	190,060	232,200
Helicopter Air Tour	196,930	225,720	251,940	307,800
Airline/Air Charter	-	42,000	67,000	125,000
TOTAL ENPLANED PASSENGERS	**329,128**	**438,000**	**509,000**	**665,000**
BASED AIRCRAFT				
Single Engine	2	2	3	5
Multi-Engine	0	0	0	0
Turboprop	6	7	8	10
Jet	0	0	1	1
Helicopter	29	32	34	38
TOTAL BASED AIRCRAFT	**37**	**41**	**46**	**54**
ANNUAL OPERATIONS				
ITINERANT				
Airline/Air Charter	-	2,200	2,400	3,600
Fixed Wing Air Tour	20,982	24,800	28,000	33,400
Helicopter Air Tour	70,506	80,800	90,200	110,200
General Aviation	2,731	3,030	3,400	4,000
Air Taxi	9,402	10,850	12,150	14,750
Military	604	600	600	600
Total Itinerant	**104,225**	**122,280**	**136,750**	**166,550**
LOCAL				
General Aviation	1,181	1,210	1,235	1,285
Military	553	550	550	550
Total Local	**1,734**	**1,760**	**1,785**	**1,835**
TOTAL OPERATIONS	**105,959**	**124,040**	**138,535**	**168,385**

PASSENGER ENPLANEMENTS FORECAST



AIRCRAFT OPERATIONS FORECAST



BASED AIRCRAFT FORECAST

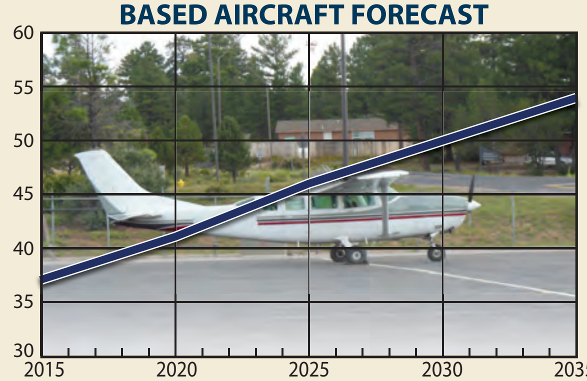


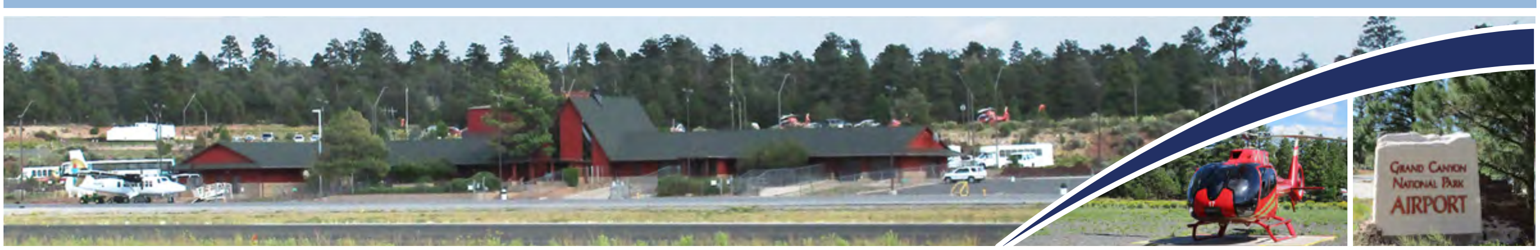
Exhibit 2J
FORECAST SUMMARY

included for 2015, which was the base year for these forecasts. In 2015, GCN had 329,128 passenger enplanements associated with the air tour operators. Enplanements are forecast to reach 665,000 within 20 years, which accounts for potential growth in air tour activities and accounting for the potential of scheduled airline activity to be introduced at GCN. Overall, GCN operations are forecast to continue to grow from 105,959 in 2015 to 164,785 by 2035. Based aircraft are forecast to grow from 37 in 2015 to 54 by 2035. Projections of aviation demand will be influenced by unforeseen factors and events in the future. Nonetheless, the forecasts developed for this Master Planning effort are considered reasonable for planning purposes. The FAA will review and, if acceptable, approve these forecasts for planning purposes.

GRAND CANYON
NATIONAL PARK AIRPORT
ARIZONA

Chapter Three

DEMAND/CAPACITY



AIRPORT MASTER PLAN

ADOT

Chapter Three

DEMAND/CAPACITY

To properly plan for the future of Grand Canyon National Park Airport (GCN or Airport), it is necessary to examine the capacities of the key airport systems. This chapter uses the results of the forecasts prepared in Chapter Two, as well as established planning criteria, to evaluate the airfield system, terminal facilities, and vehicle parking and access systems at the Airport. This analysis establishes capacities for each of these airport systems and compares those capacities to projected demand. Where deficiencies are identified, potential alternatives for reconciliation will be analyzed in the alternatives analysis of the Master Plan.

PLANNING HORIZONS

An updated set of aviation demand forecasts for the Airport has been established. The activity forecasts include enplanements, operations, based aircraft, fleet mix, and peaking characteristics. With this information, specific components of the airfield and landside systems are evaluated to determine their capacity to accommodate future demand.

Cost-effective, safe, efficient, and orderly development of an airport must rely more upon actual demand than a time-based forecast figure. In order to develop a Master Plan that is demand-based rather than time-based, a series of planning horizon milestones have been established that take into consideration the reasonable range of aviation demand projections.

It is important to consider that over time, the actual activity at the Airport may be higher or lower than what the annualized forecast portrays. By planning according to activity milestones, the resultant plan can accommodate unexpected shifts or changes in the area's aviation demand. It is important to plan for these milestones so that airport officials can respond to unexpected changes in a timely fashion. As a result, these milestones provide flexibility, while potentially extending this plan's useful life if aviation trends slow over the period.

The most important reason for utilizing milestones is to plan the development of facilities according to need generated by actual demand levels. The demand-based schedule provides flexibility in development, as the schedule can be slowed or expedited according to actual demand at any given time over the planning period. The resultant plan provides airport officials with a financially responsible and needs-based program. **Table 3A** presents the planning horizon milestones for each activity demand category.

TABLE 3A
Aviation Demand Planning Horizons
Grand Canyon National Park Airport

	Base Year (2015)	Short Term (1-5 Years)	Intermediate Term (6-10 Years)	Long Term (11-20 Years)
ENPLANED PASSENGERS				
Fixed Wing Air Tour	132,198	170,280	190,060	232,200
Helicopter Air Tour	196,930	225,720	251,940	307,800
Airline/Air Charter	-	42,000	67,000	125,000
TOTAL ENPLANED PASSENGERS	***329,128***	***438,000***	***509,000***	***665,000***
BASED AIRCRAFT				
Single Engine	2	2	3	5
Multi-Engine	0	0	0	0
Turboprop	6	7	8	10
Jet	0	0	1	1
Helicopter	29	32	34	38
TOTAL BASED AIRCRAFT	***37***	***41***	***46***	***54***
ANNUAL OPERATIONS				
Itinerant				
Airline/Air Charter	-	2,200	2,400	3,600
Fixed Wing Air Tour	20,982	24,800	28,000	33,400
Helicopter Air Tour	70,506	80,800	90,200	110,200
General Aviation	2,731	3,030	3,400	4,000
Air Taxi	9,402	10,850	12,150	14,750
Military	604	600	600	600
Total Itinerant	**104,225**	**122,280**	**136,750**	**166,550**
Local				
General Aviation	1,181	1,210	1,235	1,285
Military	553	550	550	550
Total Local	**1,734**	**1,760**	**1,785**	**1,835**
TOTAL OPERATIONS	***105,959***	***124,040***	***138,535***	***168,385***

AIRFIELD CAPACITY

An airfield's capacity is expressed in terms of its annual service volume (ASV). ASV is a reasonable estimate of the maximum level of aircraft operations that can be accommodated in a year without incurring significant delay factors. As aircraft operations near or surpass the ASV, delay factors increase exponentially. The Airport's ASV was examined utilizing the Federal Aviation Administration's (FAA) Advisory Circular (AC) 150/5060-5, *Airport Capacity and Delay*.

FACTORS AFFECTING ANNUAL SERVICE VOLUME

This analysis takes into account specific factors about the airfield in order to calculate GCN's ASV. These various factors are depicted in **Exhibit 3A**. The following describes the input factors as they relate to the Airport and include airfield layout, weather conditions, aircraft mix, and operations.

- **Runway Configuration –** The existing airfield configuration consists of a single runway supported by a full-length parallel taxiway on the east side of the runway. Runway 3-21 is 8,999 feet long and 150 feet wide.

- **Runway Use –** Runway use in capacity conditions will be controlled by wind and/or airspace conditions. For GCN, the direction of takeoffs and landings are generally determined by the speed and direction of the wind. It is generally safest for aircraft to takeoff and land into the wind, avoiding a crosswind (wind that is blowing perpendicular to the travel of the aircraft) or tailwind components during these operations.

  Based upon information received from airport traffic control tower (ATCT) personnel, Runway 21 is utilized most often, estimated at 70 percent of the time. The availability of instrument approaches is also considered. While both runway ends provide instrument approach capability (circling approaches), Runway 3 is primarily utilized in instrument weather conditions since it is afforded the only straight-in instrument approach procedures. It should be noted that the standard instrument departure procedures only allow for aircraft to takeoff on Runway 21.

- **Exit Taxiways -** Exit taxiways have a significant impact on airfield capacity since the number and location of exits directly determine the occupancy time of an aircraft on the runway. The airfield capacity analysis gives credit to taxiway exits located within the prescribed range from a runway's threshold. This range is based upon the mix index of the aircraft that use the runways. Based upon mix, only exit taxiways between 2,000 feet and 4,000 feet from the landing threshold count in the exit rating at GCN. The exits must be at least 750 feet apart to count as separate exit taxiways. Utilizing these standards, two exit taxiways are provided for aircraft landing on Runway 21 and one exit taxiway is considered for aircraft landing on Runway 3. It is preferred that two exit taxiways are provided for Runway 21 since it is the most utilized runway at the Airport.

AIRFIELD LAYOUT

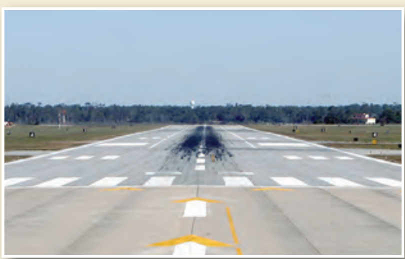
Runway Configuration

Runway Use

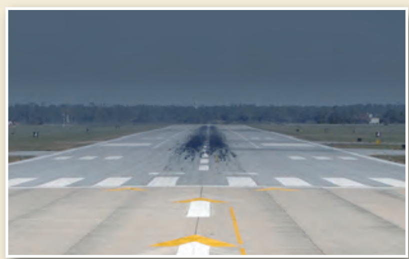
Number of Exits

WEATHER CONDITIONS

VMC
Visual Meteorological Conditions



IMC
Instrument Meteorological Conditions



PVC
Poor Visibility Conditions

AIRCRAFT MIX

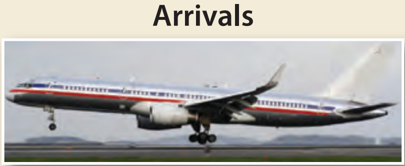
Category A & B Aircraft

Category C Aircraft

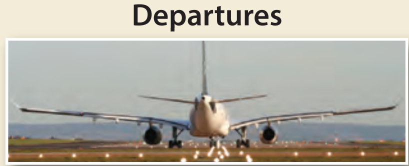
Category D Aircraft

OPERATIONS

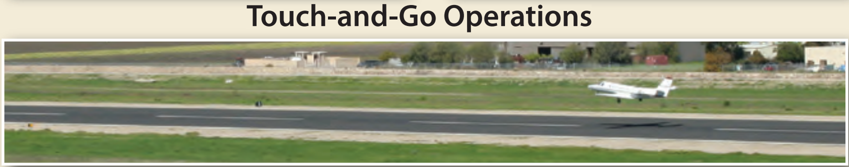
Arrivals



Departures



Touch-and-Go Operations



Total Annual Operations

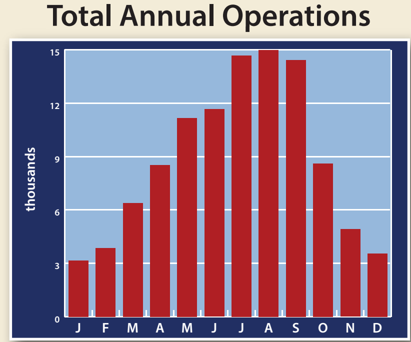


Exhibit 3A
AIRFIELD CAPACITY FACTORS

- **Weather Conditions –** Weather conditions can have a significant impact on airfield capacity. Airport capacity is usually highest in clear weather, when flight visibility is at its best. Airfield capacity is diminished as weather conditions deteriorate and cloud ceilings and visibility are reduced. As weather conditions deteriorate, the spacing of aircraft must increase to provide allowable margins of safety and air traffic vectoring. The increased distance between aircraft reduces the number of aircraft which can operate at the Airport during any given period, thus reducing overall airfield capacity.

  According to meteorological data collected from the on-airport automated surface observation system (ASOS), the Airport operates under visual meteorological conditions (VMC) approximately 88 percent of the time. VMC exist whenever the cloud ceiling is greater than 1,000 feet above ground level (AGL) and visibility is greater than three statute miles. Instrument meteorological conditions (IMC) are defined when cloud ceilings are between 500 and 1,000 feet AGL or visibility is between one and three miles. According to the weather observations, IMC prevailed approximately 6.3 percent of the time. Poor visibility conditions (PVC) apply for cloud ceilings below 500 feet and visibility minimums below one mile. PVC conditions occur approximately 5.7 percent of the year. **Table 3B** summarizes the weather conditions experienced at the Airport over a 10-year period of time.

TABLE 3B
Weather Conditions
Grand Canyon National Park Airport

Condition	Cloud Ceiling	Visibility	Percent of Total
VMC	> 1,000' AGL	> 3 statute miles	88.0 %
IMC	≥ 500' AGL and ≤ 1,000' AGL	1-3 statute miles	6.3 %
PVC	< 500' AGL	< 1 statute mile	5.7 %

VMC - Visual Meteorological Conditions
IMC - Instrument Meteorological Conditions
PVC - Poor Visibility Conditions
AGL - Above Ground Level

Source: National Oceanic and Atmospheric Administration (NOAA) - National Climatic Data Center. Airport observations from 2006 - 2015.

- **Aircraft Mix -** Aircraft mix for the capacity analysis is defined in terms of four fixed-wing aircraft classes. Classes A and B consist of small- and medium-sized propeller and some jet aircraft, all weighing 12,500 pounds or less. These aircraft are associated primarily with general aviation activity. A significant number of aircraft operations at GCN are those in Classes A and B. Class C consists of aircraft weighing between 12,500 pounds and 300,000 pounds. These aircraft include most business jets and large turboprop aircraft, as well as the larger charter aircraft that utilize the Airport semi-regularly. An array of aircraft that have historically utilized the Airport and belong in Class C include the King Air 200- and 300-series, Beech 1900, several business jet makes and models, and larger charter aircraft, such as the Boeing 737-series. Class D aircraft consists of large aircraft weighing more than 300,000 pounds. The Airport experiences very few operations by Class D aircraft that include the Boeing 767 and large military transport aircraft. In the future, aircraft in Class C will continue to constitute a substantial number of fixed-wing operations; however, Class D aircraft are not projected to contribute regular operational activity at GCN as part of the overall aircraft fleet mix at the Airport.

It should be noted that for purposes of determining airfield capacity, helicopter activity is not included in the aircraft mix classification. This is significant for GCN as a large percentage of overall operations at the Airport are historically attributed to helicopter activity.

- **Percent Arrivals –** The percentage of arrivals as they relate to total operations of the Airport is important in determining airfield capacity. Under most circumstances, the lower the percentage of arrivals, the higher the hourly capacity. The aircraft arrival-departure percentage split is typically 50/50, which is the case at GCN.

- **Touch-And-Go Activity –** A touch-and-go operation involves an aircraft making a landing and then an immediate takeoff without coming to a full stop or exiting the runway. A high percentage of touch-and-go traffic normally results in a higher operational capacity because one landing and one takeoff occurs within a shorter time period than individual operations. Touch-and-go operations at GCN have historically accounted for a small percentage of total annual operations, averaging approximately five percent over the past several years. This is due to the high percentage of itinerant aircraft and helicopter traffic associated with air tour operations. A similar ratio is expected in the future.

- **Peak Period Operations –** For the airfield capacity analysis, average daily operations and average peak hour operations during the peak month are utilized. Typical operations activity is important in the calculation of an airport's ASV as "peak demand" levels occur sporadically. The peak periods used in the capacity analysis are representative of normal operational activity and can be exceeded at various times throughout the year. For GCN, the peak periods typically occur during the summer months when tourism associated with the Grand Canyon National Park (GCNP) is at its highest.

AIRFIELD CAPACITY SUMMARY

Given the factors outlined above, the airfield's ASV will range between 200,000 and 230,000 annual operations. The ASV does not indicate a point of absolute gridlock for the airfield; however, it does represent the point at which operational delay for each aircraft operation will increase exponentially.

As previously detailed, during the past five years the Airport has averaged approximately 102,000 annual operations. This operational level for the Airport represents just over 50 percent of the airfield's ASV, if the ASV is considered at the low end of the typical range of 200,000 annual operations. By the end of the long term planning period, total annual operations are expected to represent 84 percent of the airfield's ASV.

It is important to note, however, that a large percentage of overall operations at the Airport consist of helicopter activity. According to ATCT personnel, helicopter activity constitutes approximately 80 percent of overall air taxi/tour operations at GCN. As such, over the past five years this accounts for approximately 78,000 of the 102,000 annual operations at the Airport. This is a significant statistic, in that fixed-wing aircraft drive the need for runway capacity as helicopters are capable of operating from areas other than the runway. This is the case at GCN, as helicopters associated with air tour operations operate directly to/from established landing areas on the northeast side of the airfield, avoiding the need to utilize the runway and taxiway system. Taking these operational factors into consideration, the airfield is actually operating well under 50 percent of its ASV. This has been confirmed by ATCT personnel as they have stated there are no capacity constraints realized on the airfield system given current operating procedures that are in place. When removing forecasted long term helicopter operations associated with the air tour operators, the airfield is projected to realize approximately 30 percent of its ASV.

FAA Order 5090.3B, *Field Formulation of the National Plan of Integrated Airport Systems* (NPIAS), indicates that improvements for airfield capacity purposes should begin to be considered once operations reach 60 to 75 percent of the annual service volume. This is an approximate level to begin the detailed planning of capacity improvements. At the 80 percent level, the planned improvements should be made. While no significant capacity improvements will be necessary, options to improve airfield efficiency will still be considered in the Master Plan.

DESTINATION PASSENGER TERMINAL CAPACITY

The purpose of the terminal building capacity analysis is to quantify and qualify the level of service the existing terminal building is capable of providing to a scheduled destination airline operator. A spreadsheet model was used in the demand capacity analysis. Since GCN is not currently served by a destination airline, this model was based on industry standards and calibrated for GCN based upon estimated activity levels. The model considers the level of service standards established by the International Air Transport Association (IATA). Level of service (LOS) defines the comfort and quality of the passenger experience. Some are related to crowding in queuing areas, while others define the amount of time a passenger must wait for processing. **Table 3C** outlines the basic level of service standards.

In general, LOS C is a typical design goal for most airports. LOS B would be a preferred goal if the budget allows, while LOS A is generally too expensive to achieve, and thus prohibitive to implement. For purposes of this analysis, an LOS C standards were applied where appropriate.

TABLE 3C
Level of Service Standards (IATA)
Grand Canyon National Park Airport

AREA PER OCCUPANT								
Level of Service Standards	**A** Ft^2	**B** Ft^2	**C+** Ft^2	**C** Ft^2	**C-** Ft^2	**D** Ft^2	**E** Ft^2	**F** Ft^2
Check-in Queue Area	19.4	17.2	16.1	15.1	14	12.9	10.8	-
Wait/Circulate	29.1	24.8	22.6	20.4	18.3	16.1	12.8	-
Holdroom	15.1	13.5	12.8	12	11.3	10.5	8	-
Bag Claim Area (excl. claim device)	21.5	19.4	18.3	17.2	16.1	15.1	12.9	-
Federal Inspection Services	15.1	12.9	11.8	10.8	9.7	8.6	6.5	-

A – Excellent levels of service; conditions of free flow; excellent level of comfort.
B – High level of service; condition of stable flow; very few delays; high level of comfort.
C – Good level of service; condition of stable flow; acceptable delay; good level of comfort.
D – Adequate level of comfort and service; condition of unstable flow; acceptable delays for short periods.
E – Inadequate level of service; condition of unstable flow; unacceptable delays; inadequate levels of comfort.
F – Unacceptable levels of comfort and service; conditions of cross flows, system breakdown and unacceptable delays; applies to areas below LOS E.

TABLE 3D
Destination Passenger Terminal Capacity Analysis
Grand Canyon National Park Airport

		Available	18,000 Enplanements
DEPARTURES PROCESSING			
Ticket Counters			
Utilization Factor	90%		
Agent Positions	#	10	2
Frontage	LF	86	12
Area	SF	513	120
Ticket Lobby			
Queuing Area	SF	443	130
TSA Baggage Check	SF	0	240
Outbound Baggage	SF	0	540
Airline Ticket Office	SF	1,034	240
Ticket Lobby Circulation	SF	636	140
Public Area			
Circulation	SF	1,074	930
Security Stations			
Number	#	0	1
Queuing Area	SF	0	90
Station Area	SF	0	360
TSA Administration/ Operations	SF	0	700
CONCOURSE FACILITIES			
Passenger Holdrooms			
Gates	#	5	2
Holdroom Area	SF	1,619	1,150
Airline Operations	SF	0	1,000
Concourse Circulation			
Circulation Area	SF	0	350
ARRIVALS PROCESSING			
Baggage Claim			
Passengers claiming bags	85%		
Claim Display Frontage	LF	0	20
Claim Device Floor Area	SF	0	100
Inbound Baggage	SF	0	320
Claim Lobby			
Area Excl. Device Area	SF	972	550
Circulation Area	SF		350
PUBLIC SPACES			
Restrooms	SF	668	270
Concessions/Retail	SF	1,114	0
Airport Administration	SF		0
FUNCTIONAL AREA TOTAL			
Total Programmed Functional Area	SF	8,073	7,580
BUILDING SYSTEMS/SUPPORT			
Mechanical/HVAC	SF	413	300
General Circulation/ Stairwells/Storage	SF		610
TOTAL TERMINAL			
Gross Building Area	**SF**	**8,486**	**8,490**

Based on the current footprint of the passenger terminal of 8,486 square feet (sf), the building is capable of accommodating approximately 18,000 annual scheduled passenger enplanements at LOS C standards. However, this does not suggest that the existing building configuration is capable of accommodating this type of activity. Currently, the building is configured to accommodate charter operations, which do not have the same security standards and LOS requirements that scheduled airline activities would impose.

Table 3D provides a breakdown of functional area spacing requirements to accommodate a theoretical annual enplanement level of 18,000 compared to the available functional areas of the terminal. This analysis shows that certain functional areas far exceed need, such as airline ticket office space, while many needed areas such as security stations and baggage claim are not currently available. In some instances, to accommodate functional area reconfigurations, some existing areas such as the concessions/retail and airport administration spaces may need to be removed entirely to allow for the addition of other more critical functional spaces such as TSA and baggage claim areas that are not currently available.

DESTINATION PASSENGER TERMINAL CAPACITY SUMMARY

The destination passenger terminal capacity analysis concluded that the current building has the capacity to accommodate approximately 18,000 annual enplanements by a scheduled airline operator. However, to accommodate a scheduled airline operator, the existing terminal building would likely require functional area reconfigurations to satisfy various requirements such as Transportation Security Administration (TSA) security requirements that would involve incorporating a security checkpoint and ensuring proper passenger hold room requirements are met. In addition, other building upgrades may be necessary to improve overall aesthetics to bring it up to standards of modern passenger terminal buildings as well as potential sustainable design considerations to improve the operational efficiency of the building and its systems. The passenger terminal building is often the first and last impression visitors have of the airport and the community. In the case of GCN, the terminal building is a gateway to the Grand Canyon National Park, visited by people from all over the world. Ensuring GCN has a convenient terminal facility equipped with modern passenger conveniences and an aesthetic that compliments the natural beauty of the region will only enhance the visitor experience and attract business development opportunities.

GRAND CANYON
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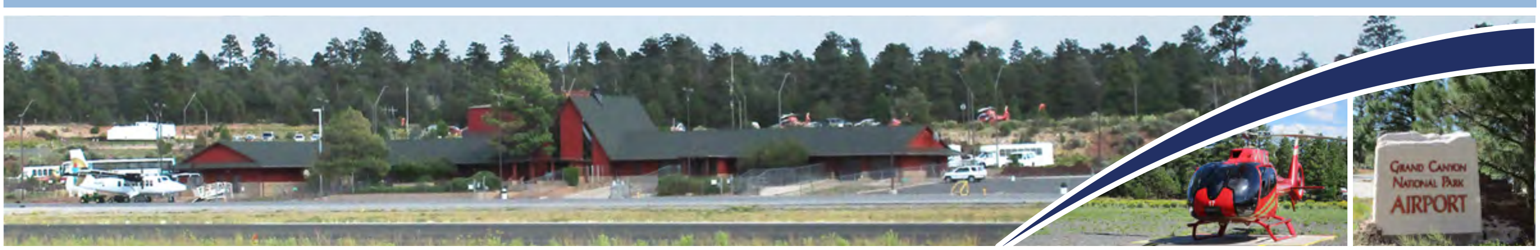
ARIZONA

Chapter Four

FACILITY REQUIREMENTS



AIRPORT MASTER PLAN

ADOT

Chapter Four

FACILITY REQUIREMENTS

Now that existing capacities and projected demands have been established, this data can be translated into the specific types and quantities of facilities that can adequately serve projected demand levels. This chapter determines airfield (i.e., runways, taxiways, navigational aids, marking and lighting, and support facilities) and landside (i.e., passenger terminal building, cargo buildings, general aviation terminal facilities, hangars, aircraft parking apron, support facilities) facility requirements based on the analysis done in Chapters Two and Three.

This chapter will evaluate the existing capacities of the Grand Canyon National Park Airport (GCN or Airport) and outline any new facilities needed to accommodate projected forecast levels. The existing capacity is compared to the forecast activity levels prepared in the previous chapters to determine where deficiencies currently exist or may be expected to materialize in the future. The chapter will cover:

- Airport Physical Planning Criteria
- Airside and Landside Facility Requirements

As indicated in Chapter One, airport facilities include both airside and landside components. Airside facilities include those that are related to the arrival, departure, and ground movement of aircraft. These components include:

- Runways
- Taxiways
- Navigational Approach Aids
- Airfield Lighting, Marking, and Signage

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Landside facilities are needed for the interface between air and ground transportation modes. At GCN, this includes components for commercial service, air taxi, and general aviation needs such as:

- Terminal Facilities
- Aircraft Hangars
- Aircraft Parking Aprons
- Automobile Parking
- Airport Support Facilities

The objective of this effort is to identify, in general terms, the adequacy of existing airport facilities, outline what new facilities may be needed, and when these may be needed to accommodate forecast demands. Having established these facility requirements, alternatives for providing these facilities will be evaluated in Chapter Five to determine the most practical, cost-effective, and efficient direction for future development.

AIRCRAFT/AIRPORT/RUNWAY CLASSIFICATION

The Federal Aviation Administration (FAA) has established several aircraft classification systems that group aircraft types based on their performance (approach speed in landing configuration) and on design characteristics (wingspan and landing gear configuration). These classification systems are used to determine the appropriate airport design standards for specific airport elements, such as runways, taxiways, taxilanes, and aprons.

AIRCRAFT CLASSIFICATION

The selection of appropriate FAA design standards for the development and location of airport facilities is based primarily on the characteristics of the aircraft which are currently using or are expected to use an airport. The critical design aircraft is used to define the design parameters for an airport. The design aircraft may be a single aircraft type or, more commonly, is a composite aircraft representing a collection of aircraft classified by three parameters: Aircraft Approach Category (AAC), Airplane Design Group (ADG), and Taxiway Design Group (TDG). FAA Advisory Circular (AC) 150/5300-13A, Change 1, *Airport Design*, describes the following airplane classification systems, the parameters of which are presented on **Exhibit 4A**.

Aircraft Approach Category (AAC): A grouping of aircraft based on a reference landing speed (V_{REF}), if specified, or if V_{REF} is not specified, 1.3 times stall speed (V_{SO}) at the maximum certificated landing weight. V_{REF}, V_{SO}, and the maximum certificated landing weight are those values as established for the aircraft by the certification authority of the country of registry.

The AAC generally refers to the approach speed of an aircraft in landing configuration. The higher the approach speed, the more restrictive the applicable design standards. The AAC, depicted by a letter A

AIRCRAFT APPROACH CATEGORY (AAC)

Category	Approach Speed
A	less than 91 knots
B	91 knots or more but less than 121 knots
C	121 knots or more but less than 141 knots
D	141 knots or more but less than 166 knots
E	166 knots or more

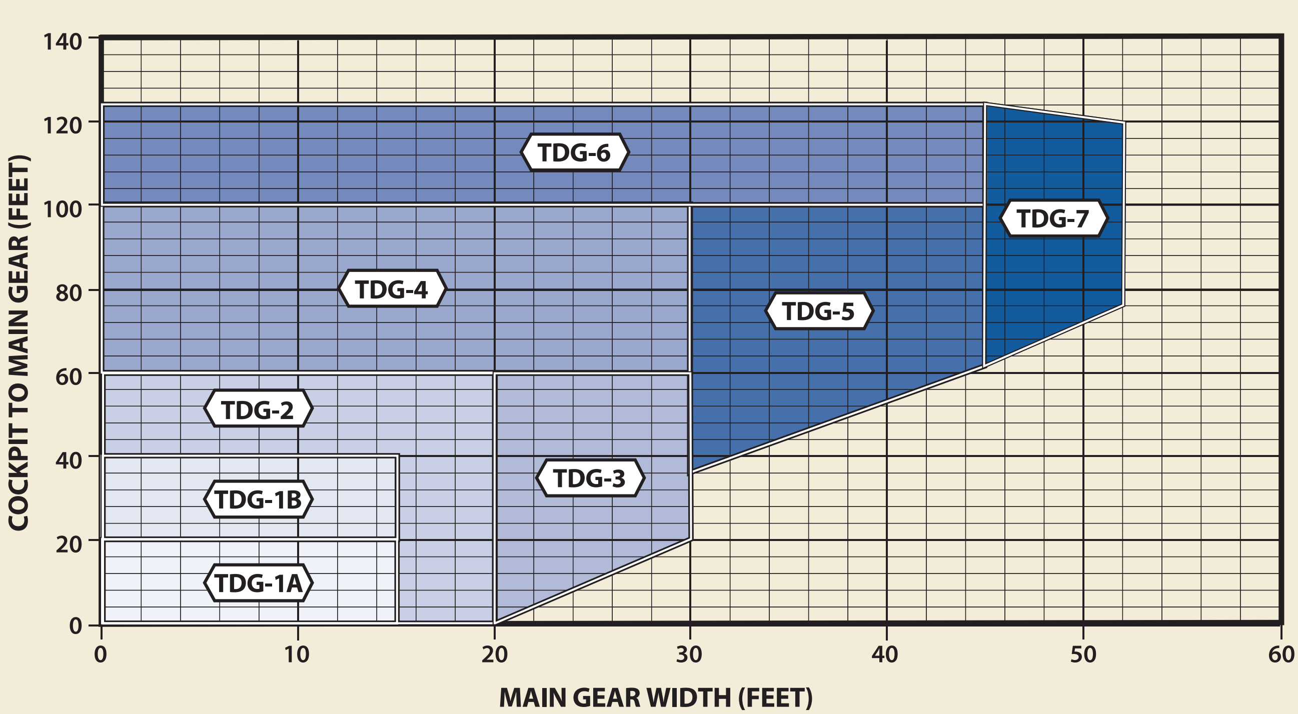
AIRPLANE DESIGN GROUP (ADG)

Group #	Tail Height (ft)	Wingspan (ft)
I	<20	<49
II	20-<30	49-<79
III	30-<45	70-<118
IV	45-<60	118-<171
V	60-<66	171-<214
VI	66-<80	214-<262

VISIBILITY MINIMUMS

RVR (ft)	Flight Visibility Category (statute miles)
VIS	3-mile or greater visibility minimums
5,000	Lower than 3 miles but not lower than 1-mile
4,000	Lower than 1-mile but not lower than ¾-mile (APV ≥ ¾ but < 1-mile)
2,400	Lower than ¾-mile but not lower than ½-mile (CAT-I PA)
1,600	Lower than ½-mile but not lower than ¼-mile (CAT-II PA)
1,200	Lower than ¼-mile (CAT-III PA)

TAXIWAY DESIGN GROUP (TDG)



KEY

APV: Approach Procedure with Vertical Guidance
PA: Precision Approach
RVR: Runway Visual Range
TDG: Taxiway Design Group

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

Exhibit 4A: AIRCRAFT CLASSIFICATION PARAMETERS through E, is the aircraft approach category and it relates to aircraft approach speed (operational characteristic). Aircraft in AAC A and B include pistons, turboprops, and small general aviation jets. Aircraft in AAC C, D, and E include medium-sized general aviation jets up to larger commercial jets. The AAC generally applies to runways and runway-related facilities, such as runway width, runway safety area (RSA), runway object free area (ROFA), runway protection zone (RPZ), and separation standards.

Airplane Design Group (ADG): The ADG, depicted by a Roman numeral I through VI, is a classification of aircraft which relates to aircraft wingspan or tail height (physical characteristic). When the aircraft wingspan and tail height fall in different groups, the higher group is used. The ADG influences design standards for taxiway safety area (TSA), taxiway object free area (TOFA), apron wingtip clearance, and various separation distances.

Taxiway Design Group (TDG): TDG is a classification of airplanes that is based on outer-to-outer Main Gear Width (MGW) and Cockpit to Main Gear (CMG) distances. The TDG relates to the undercarriage dimensions of the design aircraft, and the TDG standards are based on the MGW and CMG distances. The taxiway design elements determined by the application of the TDG include the taxiway width, taxiway edge safety margin, taxiway shoulder width, taxiway fillet dimensions, and, in some cases, the separation distance between parallel taxiways/taxilanes. Other taxiway elements, such as the TSA, TOFA, taxiway/taxilane separation to parallel taxiway/taxilanes or fixed or movable objects, and taxiway/taxilane wingtip clearances are determined solely based on the wingspan of the design aircraft utilizing those surfaces. It is appropriate for taxiways to be planned and built to different TDG standards based on expected use.

Exhibit 4B summarizes the aircraft classification of the most common aircraft in operation today. Generally, recreational and business piston and turboprop aircraft will fall in approach categories A and B and airplane design groups I and II. Business jets typically fall in approach categories B and C, while commercial aircraft will fall in approach categories C and D. It should be noted that given the unique operating characteristics of helicopters, they are not assigned an AAC or ADG. As such, they are not included in the airfield's critical design aircraft determination.

AIRPORT AND RUNWAY CLASSIFICATION

These classifications, along with the aircraft classifications defined previously, are used to determine the appropriate FAA design standards to which the airfield facilities are to be designed and built.

Airport Reference Code (ARC)**:** The ARC is a designation that signifies an airport's highest Runway Design Code (RDC), minus the third (visibility) component of the RDC. The ARC is used for planning and design only and does not limit the aircraft that may be able to operate safely on the Airport. The current Airport Layout Plan (ALP) for the Airport, which will be updated as part of this planning effort, identifies an ARC of C-III for the Airport. The ultimate ARC on the ALP is called out as ARC C-III.

A-I

- Beech Baron 55
- **Beech Bonanza**
- Cessna 150
- Cessna 172
- Cessna Citation Mustang
- Eclipse 500/550
- Piper Archer
- Piper Seneca

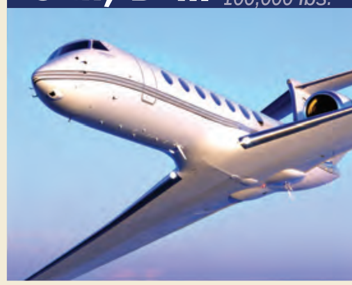
C-II, D-II

- Cessna Citation X (750)
- Gulfstream 100, 200,300
- Challenger 300/600
- **ERJ-135, 140, 145**
- CRJ-200/700
- Embraer Regional Jet
- Lockheed JetStar
- Hawker 800

B-I

- Beech Baron 58
- Beech King Air 100
- Cessna 402
- **Cessna 421**
- Piper Navajo
- Piper Cheyenne
- Swearingen Metroliner
- Cessna Citation I (525)

C-III, D-III *less than 100,000 lbs.*



- ERJ-170
- CRJ 705, 900
- Falcon 7X
- **Gulfstream 500**, 550, 650
- Global Express, Global 5000
- Q-400

B-II

- Super King Air 200
- Cessna 441
- DHC Twin Otter
- Super King Air 350
- Beech 1900
- Citation Excel (560), Sovereign (680)
- Falcon 50, 900, 2000
- **Citation Bravo (550)**
- Embraer 120

C-III, D-III *over 100,000 lbs.*

- ERJ-90
- Boeing Business Jet
- B-727
- **B-737**-300, **700**, 800
- MD-80, DC-9
- A319, A320

A-III, B-III

- DHC Dash 7
- **DHC Dash 8**
- DC-3
- Convair 580
- Fairchild F-27
- ATR 72
- ATP

C-IV, D-IV

- **B-757**
- B-767
- C-130 Hercules
- DC-8-70
- MD-11

C-I, D-I

- Beech 400
- **Lear** 31, **35**, 45, 60
- Israeli Westwind

D-V

- **B-747-400**
- B-777
- B-787
- A-330, A-340

Exhibit 4B
AIRCRAFT REFERENCE CODES

Note: Aircraft pictured is identified in bold type.

Runway Design Code (RDC): A code signifying the design standards to which the runway is to be built. The RDC is based upon planned development and has no operational component.

The AAC, ADG, and Runway Visual Range (RVR) are combined to form the RDC of a particular runway. The RDC provides the information needed to determine certain design standards that apply. The first component, depicted by a letter, is the AAC and relates to aircraft approach speed (operational characteristics). The second component, depicted by a Roman numeral, is the ADG and relates to either the aircraft wingspan or tail height (physical characteristics), whichever is most restrictive. The third component relates to the visibility minimums expressed by RVR values in feet of 1,200 (⅛-mile), 1,600 (¼-mile), 2,400 (½-mile), 4,000 (¾-mile), and 5,000 (1-mile). The RVR values approximate standard visibility minimums for instrument approaches to the runways. The third component should read "VIS" for runways designed for visual approach use only.

Approach Reference Code (APRC): A code signifying the current operational capabilities of a runway and associated parallel taxiway with regard to landing operations. Like the RDC, the APRC is composed of the same three components: the AAC, ADG, and RVR. The APRC describes the current operational capabilities of a runway under particular meteorological conditions where no special operating procedures are necessary, as opposed to the RDC which is based upon planned development with no operational component. The APRC for a runway is established based upon the minimum runway-to-taxiway centerline separation.

Departure Reference Code (DPRC): A code signifying the current operational capabilities of a runway and associated parallel taxiway with regard to takeoff operations. The DPRC represents those aircraft that can takeoff from a runway while any aircraft are present on adjacent taxiways, under particular meteorological conditions with no special operating conditions. The DPRC is similar to the APRC, but is composed of two components: ACC and ADG. A runway may have more than one DPRC depending on the parallel taxiway separation distance.

CRITICAL DESIGN AIRCRAFT

The selection of appropriate FAA design standards for the development and location of airport facilities is based primarily upon the characteristics of the aircraft which are currently using or are expected to use an airport. The critical design aircraft is used to define the design parameters for an airport. The design aircraft may be a single aircraft or a composite aircraft representing a collection of aircraft classified by the three parameters: AAC, ADG, and TDG. In the case of an airport with multiple runways, a design aircraft is selected for each runway.

The first consideration is the safe operation of aircraft likely to use an airport. Any operation of an aircraft that exceeds design criteria of an airport may result in either an unsafe operation or a lesser safety margin; however, it is not the usual practice to base the airport design on an aircraft that uses the airport infrequently.

The design aircraft is defined by the FAA as the most demanding category of aircraft, or family of aircraft, which conducts at least 500 operations (excluding touch-and-go's) per year at an airport. Planning for future aircraft use is of particular importance since the design standards are used to plan separation distances between facilities. These future standards must be considered now to ensure that short term development does not preclude the reasonable long range potential needs of the Airport.

According to FAA AC 150/5300-13A, Change 1, *Airport Design*, "airport designs based only on existing aircraft can severely limit the ability to expand the airport to meet future requirements for larger, more demanding aircraft. Airport designs that are based on large aircraft never likely to be served by the airport are not economical." Selection of the current and future critical design aircraft must be realistic in nature and supported by current data and realistic projections.

HISTORICAL AIRCRAFT ACTIVITY

The determination of the design aircraft (or family of aircraft) will first examine the types of based aircraft followed by an analysis of itinerant activity. The majority of based aircraft at GCN are helicopters, which are not included in the critical design aircraft determination. Fixed-wing aircraft based at the Airport include the Cessna 172, Cessna 206, Cessna 208 Caravan, and de Havilland DHC-6 Twin Otter. Of these aircraft, the DHC-6 Twin Otter and Cessna 208 Caravan are the most demanding in terms of critical design, categorized as A-II and B-II, respectively. These aircraft are also utilized regularly for air taxi/tour operations providing sightseeing tours over the Grand Canyon National Park (GCNP).

DHC-6 Twin Otter
Source: Coffman Associates

GCN is served by an airport traffic control tower (ATCT); however, the ATCT only logs aircraft operations by operational type (air carrier, air taxi, general aviation, and military), but not by specific aircraft make and model. The FAA maintains the *Traffic Flow Management System Counts* (TFMSC) database. The TFMSC database documents certain aircraft operations at certain airports. Information is added to the TFMSC database when pilots file flight plans and/or when flights are detected in the National Airspace System, usually via radar. It includes documentation of commercial traffic (air carrier and air taxi), general aviation, and military aircraft. Due to certain factors, such as incomplete flight plans and limited radar coverage, TFMSC data cannot account for all aircraft activity at an airport. Therefore, there are more operations at an airport than are captured by the TFMSC. Nonetheless, this information provides a reasonable estimate allowing for a greater extrapolation of all airport activity and serves as the primary source for turboprop and jet aircraft activity at the Airport.

Since turboprop and jet aircraft are larger and faster, they will typically have a greater impact on airport design standards than smaller aircraft. The following analysis will focus on itinerant activity by turbo-props and jets at GCN.

Exhibit 4C presents the TFMSC turboprop aircraft activity and **Exhibit 4D** presents jet aircraft activity at the Airport starting in 2006 through 2015. The Airport has experienced a wide variety of aircraft operations ranging from small turboprops and jets to large commercial transport aircraft. The exhibits also show the breakout of these aircraft by AAC and ADG.

Over the sample period, the greatest number of turboprop operations in any single design family combined was 16,272 in B-II. These accounted for approximately 67 percent of logged turboprop activity. Some of the more demanding representative aircraft in this design category include the Beech 1900, Dornier 328 Turboprop, Embraer 120, and several makes/models in the King Air family. The most demanding turboprops, in terms of overall design standards, to operate at the Airport during the time period are those in design categories A-III, B-III, C-III, and C-IV. The majority of operations in these categories were conducted by military aircraft, including the E-2 Hawkeye and C-130 Hercules.

Beech 1900
Source: Coffman Associates

Dornier 328 Turboprop
Source: Google Images

The Airport also experienced a significant amount of jet activity over the 10-year period. Similar to turboprop activity, the greatest number of operations in any single design family for jets was B-II, which constituted approximately 39 percent of total jet activity that was logged. The most common jet aircraft to utilize the Airport in this design category include several types of Cessna Citation jets. It should be noted that a significant number of jet aircraft in AAC C also utilized the Airport during the time period. These included several business jets such as the Challenger 300/600 and Gulfstream 550/650, as well as larger commercial transport aircraft including the Bombardier CRJ, Boeing 737-series, and MD-80-series.

Citation XLS
Source: Google Images

ARC	Aircraft Model	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A-I	Cessna 210 Turbine	2	0	0	0	0	0	0	0	0	0
	Piper Malibu/Meridian Turbine	0	0	14	30	14	8	22	14	10	18
	Total	*2*	*0*	*14*	*30*	*14*	*8*	*22*	*14*	*10*	*18*
A-II	Cessna 425	10	14	12	6	14	2	0	2	4	4
	DHC-6 Twin Otter	684	442	138	152	174	164	210	150	126	218
	Pilatus PC-12	0	0	16	30	32	24	32	42	24	30
	Total	*694*	*456*	*166*	*188*	*220*	*190*	*242*	*194*	*154*	*252*
A-III	De Haviland Dash 7/8-300	2	0	0	8	0	0	0	2	0	0
	Total	*2*	*0*	*0*	*8*	*0*	*0*	*0*	*2*	*0*	*0*
B-I	Aero Commander 690 A/B	0	4	0	2	0	0	0	0	0	0
	Fairchild Swearingen	2	14	12	6	4	8	16	6	56	108
	King Air 100	0	4	2	6	2	4	4	4	0	6
	Mitsubishi MU-2	2	2	6	2	2	6	2	8	2	2
	Piaggio P180 Avanti	22	16	12	16	14	10	14	2	2	2
	Piper Cheyenne	4	12	8	6	10	0	2	2	2	6
	Raytheon Texan II	4	6	4	0	6	28	26	18	30	34
	Swearingen Merlin 2/4	188	206	400	302	470	340	450	428	368	198
	TBM-7/850	4	4	6	12	10	20	14	8	16	32
	Total	*226*	*268*	*450*	*352*	*518*	*416*	*528*	*476*	*476*	*388*
B-II	Aero Commander 680/900/1000	10	14	8	12	16	22	6	8	16	6
	Beech 1900	316	2	152	880	880	622	748	1,930	2,130	2,186
	Cessna 441 Conquest	8	4	2	10	2	8	10	2	4	4
	Cessna Caravan	0	0	6	10	16	8	24	26	70	18
	Dornier 328 Turboprop	592	624	410	396	920	268	292	0	2	4
	Embraer 120	0	2	0	0	0	276	536	226	30	0
	Jetstream 31	36	0	0	0	0	0	0	0	0	0
	King Air 90/200/300/350	120	108	126	154	130	136	180	140	156	210
	Saab 340	0	0	0	0	2	0	0	0	0	0
	Total	*1,082*	*754*	*704*	*1,462*	*1,966*	*1,340*	*1,796*	*2,332*	*2,408*	*2,428*
B-III	E-2 Hawkeye	26	16	10	10	36	28	10	32	40	50
	Total	*26*	*16*	*10*	*10*	*36*	*28*	*10*	*32*	*40*	*50*
C-III	P-3 Orion	10	14	4	8	2	2	2	0	6	8
	Total	*10*	*14*	*4*	*8*	*2*	*2*	*2*	*0*	*6*	*8*
C-IV	C-130	50	66	46	46	30	72	70	80	86	96
	Total	*50*	*66*	*46*	*46*	*30*	*72*	*70*	*80*	*86*	*96*

TURBOPROP ARC CODE SUMMARY

ARC	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A-I	2	0	14	30	14	8	22	14	10	18
A-II	694	456	166	188	220	190	242	194	154	252
A-III	2	0	0	8	0	0	0	2	0	0
B-I	226	268	450	352	518	416	528	476	476	388
B-II	1,082	754	704	1,462	1,966	1,340	1,796	2,332	2,408	2,428
B-III	26	16	10	10	36	28	10	32	40	50
C-III	10	14	4	8	2	2	2	0	6	8
C-IV	50	66	46	46	30	72	70	80	86	96
Total	*2,092*	*1,574*	*1,394*	*2,104*	*2,786*	*2,056*	*2,670*	*3,130*	*3,180*	*3,240*

TURBOPROP APPROACH CATEGORY SUMMARY

AC	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A	698	456	180	226	234	198	264	210	164	270
B	1,334	1,038	1,164	1,824	2,520	1,784	2,334	2,840	2,924	2,866
C	60	80	50	54	32	74	72	80	92	104
Total	*2,092*	*1,574*	*1,394*	*2,104*	*2,786*	*2,056*	*2,670*	*3,130*	*3,180*	*3,240*

TURBOPROP DESIGN GROUP SUMMARY

DG	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
I	228	268	464	382	532	424	550	490	486	406
II	1,776	1,210	870	1,650	2,186	1,530	2,038	2,526	2,562	2,680
III	38	30	14	26	38	30	12	34	46	58
IV	50	66	46	46	30	72	70	80	86	96
Total	*2,092*	*1,574*	*1,394*	*2,104*	*2,786*	*2,056*	*2,670*	*3,130*	*3,180*	*3,240*

Exhibit 4C
TURBOPROP AIRCRAFT OPERATIONS BY REFERENCE CODE

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ARC	Aircraft Model	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A-I	Cessna Citation Mustang	0	6	4	12	4	14	10	14	14	12
	Eclipse 400/500	0	2	14	16	6	18	6	10	6	6
	Total	*0*	*8*	*18*	*28*	*10*	*32*	*16*	*24*	*20*	*18*
B-I	Beechjet 400	16	24	16	10	26	20	14	14	22	22
	Cessna Citation I/SP	14	14	18	6	12	8	2	0	2	2
	Cessna CJ1	18	22	24	14	6	12	14	16	20	18
	Dassault Falcon/Mystère 10	8	4	0	4	0	0	0	0	2	4
	Embraer Phenom 100	0	0	0	0	8	6	10	20	14	12
	Hawker 400/MU-300	0	0	2	2	0	2	0	0	0	0
	L-39 Albatross	0	0	0	0	0	0	0	0	0	2
	Rockwell Sabre 40/60	0	2	0	0	0	0	4	0	0	0
	Raytheon Premier I	6	0	2	4	6	14	2	6	0	6
	Total	*62*	*66*	*62*	*40*	*58*	*62*	*46*	*56*	*60*	*66*
B-II	Cessna Citation Bravo/SP	30	38	12	30	14	10	20	12	16	16
	Cessna Citation Excel/XLS	30	24	18	14	24	32	28	6	22	46
	Cessna Citation III/VI/VII	12	8	4	4	4	14	4	2	0	2
	Cessna Citation Sovereign	6	2	10	12	12	6	8	6	6	10
	Cessna Citation V/Encore/Ultra	100	46	56	38	42	24	34	12	20	48
	Cessna CJ2, CJ3, CJ4	8	6	14	14	26	16	16	14	26	24
	Dornier 328 Jet	0	44	472	4	2	68	0	0	164	4
	Dassault Falcon 20/50	12	12	24	8	4	4	4	4	4	10
	Dassault Falcon 2000	6	4	0	12	4	12	22	10	0	4
	Dassault Falcon 900	8	8	12	8	10	2	2	10	8	2
	Embraer Phenom 300	0	0	0	0	0	4	0	8	12	18
	Total	*212*	*192*	*622*	*144*	*142*	*192*	*138*	*84*	*278*	*184*
C-I	AV-8B Harrier	0	0	0	2	2	2	2	2	2	0
	BAE HS 125-1/2/3/125/400/600	18	28	32	14	18	16	22	20	12	10
	Bae Systems Hawk	0	4	0	2	6	12	10	0	12	14
	Fuji T-1	0	2	4	2	0	0	0	0	0	0
	IAI 1124/1125 Westwind	12	8	0	2	4	4	2	2	0	0
	Learjet 20 Series	2	0	0	2	4	0	0	2	4	0
	Learjet 30 Series	64	36	24	20	24	24	30	18	4	6
	Learjet 40/45/60	22	26	16	8	18	24	22	18	8	14
	Learjet 55	4	10	4	4	0	2	2	0	2	6
	T-45 Goshawk	0	0	0	0	0	2	4	0	0	0
	Total	*122*	*114*	*80*	*56*	*76*	*86*	*94*	*62*	*44*	*50*
C-II	A-6 Intruder	0	0	0	12	8	0	30	8	6	0
	Bombardier CRJ All Series	0	0	0	0	0	0	0	0	228	0
	Cessna Citation X	20	6	10	6	10	10	16	6	14	8
C-II	Challenger 300/600	22	22	30	12	12	14	20	14	24	12
	Embraer ERJ 135/140/145/Legacy	2	8	2	4	0	4	2	2	2	4
	Fairchild A-10	0	0	0	2	0	6	0	0	0	0
	Gulfstream 300	2	0	2	12	6	4	0	2	2	0
	Hawker 800/1000/4000	0	2	0	0	2	0	0	0	4	0
	IAI 1126 Galaxy	2	4	6	4	4	8	6	4	16	8
	Lockheed L-1329 Jetstar	0	0	2	0	0	0	0	0	0	0
	S-3 Viking	0	0	0	0	0	0	0	0	4	4
	Total	*48*	*42*	*52*	*52*	*42*	*46*	*74*	*36*	*300*	*36*
C-III	Airbus A319/320 Series	2	2	6	0	2	2	0	4	0	0
	Boeing 717/727/737 Series	32	40	16	22	4	110	2	80	94	18
	Bombardier Global 5000	2	10	6	2	10	4	2	4	4	2
	Dassault Falcon 7X	0	0	0	0	0	0	2	0	0	4
	Gulfstream G550/650	2	0	8	6	2	0	12	4	14	12
	DC-9/MD-80 series	18	8	0	2	6	18	28	14	4	4
	Total	*56*	*60*	*36*	*32*	*24*	*134*	*46*	*106*	*116*	*40*
C-IV	Boeing 707	2	2	0	2	4	0	0	2	0	0
	Boeing 757 200 Series	0	2	0	0	2	0	8	0	0	0
	Boeing 767 Series	0	0	0	2	4	0	0	0	0	4
	C-17 Globemaster	0	4	0	12	2	2	0	0	2	4
	KC-135 Stratotanker	0	4	0	0	0	4	0	2	0	2
	Total	*2*	*12*	*0*	*16*	*12*	*6*	*8*	*4*	*2*	*10*
D-I	F/A-18 Hornet	2	2	0	8	6	4	0	0	6	8
	F-15 Eagle	0	0	0	0	0	2	0	0	0	0
	F-22 Raptor	0	0	0	0	0	0	0	0	0	2
	T-38 Talon	2	2	0	0	0	0	0	2	0	4
	Total	*4*	*4*	*0*	*8*	*6*	*6*	*0*	*2*	*6*	*14*
D-II	Gulfstream 200	0	0	0	0	0	0	0	0	0	4
	Gulfstream 200/400	12	14	8	10	14	16	8	14	8	14
	Gulfstream G-150	0	0	0	0	0	0	2	8	0	0
	Total	*12*	*14*	*8*	*10*	*14*	*16*	*10*	*22*	*8*	*18*
D-III	Boeing 737-800/900	8	4	0	30	14	6	10	0	16	8
	Total	*8*	*4*	*0*	*30*	*14*	*6*	*10*	*0*	*16*	*8*
D-V	Boeing 747 Series	0	0	0	6	0	2	0	0	0	0
	Total	*0*	*0*	*0*	*6*	*0*	*2*	*0*	*0*	*0*	*0*
E-I	F-16	12	10	14	22	2	14	14	6	4	0
	Total	*12*	*10*	*14*	*22*	*2*	*14*	*14*	*6*	*4*	*0*

Source: FAA Air Traffic Airspace Lab

Exhibit 4D
JET AIRCRAFT OPERATIONS BY REFERENCE CODE

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JET ARC CODE SUMMARY

ARC	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A-I	0	8	18	28	10	32	16	24	20	18
B-I	62	66	62	40	58	62	46	56	60	66
B-II	212	192	622	144	142	192	138	84	278	184
C-I	122	114	80	56	76	86	94	62	44	50
C-II	48	42	52	52	42	46	74	36	300	36
C-III	56	60	36	32	24	134	46	106	116	40
C-IV	2	12	0	16	12	6	8	4	2	10
D-I	4	4	0	8	6	6	0	2	6	14
D-II	12	14	8	10	14	16	10	22	8	18
D-III	8	4	0	30	14	6	10	0	16	8
D-V	0	0	0	6	0	2	0	0	0	0
E-I	12	10	14	22	2	14	14	6	4	0
Total	***538***	***526***	***892***	***444***	***400***	***602***	***456***	***402***	***854***	***444***

JET APPROACH CATEGORY SUMMARY

AC	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A	0	8	18	28	10	32	16	24	20	18
B	274	258	684	184	200	254	184	140	338	250
C	228	228	168	156	154	272	222	208	462	136
D	24	22	8	54	34	30	20	24	30	40
E	12	10	14	22	2	14	14	6	4	0
Total	***538***	***526***	***892***	***444***	***400***	***602***	***456***	***402***	***854***	***444***

JET DESIGN GROUP SUMMARY

DG	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
I	200	202	174	154	152	200	170	150	134	148
II	272	248	682	206	198	254	222	142	586	238
III	64	64	36	62	38	140	56	106	132	48
IV	2	12	0	16	12	6	8	4	2	10
V	0	0	0	6	0	2	0	0	0	0
Total	***538***	***526***	***892***	***444***	***400***	***602***	***456***	***402***	***854***	***444***

Source: FAA Air Traffic Airspace Lab

Overall, the most demanding jets to utilize the Airport in terms of AAC were a mix of general aviation, commercial and military jets and include AACs D and E. The most demanding commercial jets in terms of ADG were the Boeing 757, Boeing 767, and Boeing 747 series, which fall in ADGs IV and V. Large military transport aircraft including the C-17 Globemaster and KC-135 Stratotanker represent the most demanding military ADG, belonging in ADG IV. These jet aircraft have operated at the Airport on a very limited basis in the past.

Table 4A presents the combined turboprop and jet activity at the Airport over the past 10 years and breaks out the operations by AAC and ADG. Over the sample period, the Airport has averaged nearly 3,000 operations annually by these aircraft. These operations have been conducted by a mix of aircraft representing business aviation as well as commercial service and air charter activity.

TABLE 4A
Total ARC Summary (Turboprop and Jet Aircraft)
Grand Canyon National Park Airport

AAC-ADG	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A-I	2	8	32	58	24	40	38	38	30	36
A-II	694	456	166	188	220	190	242	194	154	252
A-III	2	0	0	8	0	0	0	2	0	0
B-I	288	334	512	392	576	478	574	532	536	454
B-II	1,294	946	1,326	1,606	2,108	1,532	1,934	2,416	2,686	2,612
B-III	26	16	10	10	36	28	10	32	40	50
C-I	122	114	80	56	76	86	94	62	44	50
C-II	48	42	52	52	42	46	74	36	300	36
C-III	66	74	40	40	26	136	48	106	122	48
C-IV	52	78	46	62	42	78	78	84	88	106
D-I	4	4	0	8	6	6	0	2	6	14
D-II	12	14	8	10	14	16	10	22	8	18
D-III	8	4	0	30	14	6	10	0	16	8
D-V	0	0	0	6	0	2	0	0	0	0
E-I	12	10	14	22	2	14	14	6	4	0
Total	**2,630**	**2,100**	**2,286**	**2,548**	**3,186**	**2,658**	**3,126**	**3,532**	**4,034**	**3,684**

Source: FAA *Traffic Flow Management System Count* (2006 - 2015)

As previously discussed, critical aircraft design does not require one specific aircraft model to make up the 500 annual operations. Historically, approach category B has served as the most demanding AAC to exceed 500 annual operations. Likewise, design group II has constituted the most demanding ADG to exceed the 500 annual operations threshold the past several years. It is important to note; however, that in 2014, approach category C exceeded the 500 annual operations threshold, making it the most critical approach category to operate regularly at the Airport.

FUTURE DESIGN AIRCRAFT

As previously discussed, since 2006, total turboprop and jet activity at the Airport has averaged approximately 3,000 operations per year; however, the trend has been generally increasing over the period. Over the past four years, turboprop and jet operations at GCN have averaged 3,600 per year.

GCN has exhibited a long term trend of significant fixed-wing turboprop and jet aircraft activity. The aviation demand forecasts indicate the potential for continued growth in turboprop and jet activity at the Airport. This includes a forecast increase in based aircraft, commercial service, and air taxi/tour operations through the 20-year planning horizon. The type and size of turboprop and jet aircraft using the Airport regularly can impact the design standards to be applied to the airport system. Therefore, it is important to have an understanding of what type of aircraft may use the airport in the future. Factors such as population and employment growth in the airport service area, the proximity and level of service of other regional airports, and development at the airport can influence future activity.

The current ALP for the Airport defines Runway 3-21 as an existing and ultimate ARC C-III. (Note: The new AC would classify would classify Runway 3-21 as existing and ultimate RDC C-III based upon new terminology to define the runway system as previously detailed). According to the TFMSC data, operations by aircraft in approach category C exceeded the 500 operational threshold as recent as 2014. Over the past 10 years, operations in approach categories C, D, and E have averaged approximately 330 annually. It should be noted that more recently since 2011, approach categories C, D, and E have averaged closer to 400 operations annually.

In the event that larger business jets, such as the Gulfstream V or Global Express, utilize the Airport on a frequent basis, the design group could transition to ADG III. Furthermore, if the Airport experiences a significant enhancement in commercial passenger service in the future, larger turboprop and jet aircraft would be needed. Aircraft such as the Bombardier Q-400 turboprop, Bombardier CRJ-700 regional jet, or Boeing 737 could be options in the event this occurs. These aircraft all three fall in the C-III design category.

Bombardier Q-400
Source: Google Images

Boeing 737
Source: Google Images

Unless there is a discernable decrease in operations by aircraft in these categories, an airport should not be downgraded in its ability to meet airfield standards it has previously been designed to. In fact, the opposite is true for GCN as operations in the more demanding design categories to include C-III and higher have been on the increase in recent years. As previously noted, the critical threshold for approach category C exceeded 500 operations in 2014. Furthermore, it is important to note that the Airport is currently undergoing improvements to the runway and taxiway system to meet RDC C-III standards. Because the airport sponsor has the responsibility to provide for a safe airfield operating environment, it is prudent to continue to meet airfield design standards that consider the more demanding aircraft that utilize the airport.

Table 4B summarizes the design aircraft components to be applied to the Airport. The Master Plan will utilize an existing RDC of C-II for Runway 3-21 based upon historical aircraft activity as logged by the TFMSC. The future critical aircraft for Runway 3-21 is projected in RDC C-III. The ultimate RVR (visibility) components for Runway 3-21 may change based on analysis and recommendations regarding potential instrument approach capability. The APRC and DPRC are also noted for the runway system.

TABLE 4B
Design Aircraft Parameters
Grand Canyon National Park Airport

Runway Design Parameters	Runway Design Code (RDC)	Approach Reference Code (APRC)	Departure Reference Code (DPRC)
EXISTING			
Runway 3-21	C-II-4000	D/IV/4000	D/IV
(407' runway/taxiway separation)		D/V/4000	D/V
ULTIMATE			
Runway 3-21	C-III-4000	D/IV/4000	D/IV
(≥ 400' runway/taxiway separation)		D/V/4000	D/V

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

ARIZONA AIRPORT SYSTEM PLAN ROLE

As detailed earlier in the Master Plan, GCN is classified at the national level as a non-hub primary commercial service airport in the FAA's *National Plan of Integrated Airport Systems* (NPIAS). At the state level, the *Arizona State Airports System Plan* (SASP) classifies airports in the state by service level and role. The five roles are: Commercial Service, Reliever, General Aviation – Community, General Aviation – Rural, and General Aviation – Basic. The purpose of the SASP is to provide a framework for the integrated planning, operation, and development of Arizona's aviation assets. The SASP defines the specific role of each airport in the state's aviation system and establishes funding needs. The SASP provides policy guidelines that promote and maintain a safe aviation system in the state, assess the state's capital improvement needs, and identify resources and strategies to implement the plan.

Table 4C presents the functions of the airport roles. GCN is classified as a commercial service airport in the SASP.

TABLE 4C
Arizona Airports Functional Roles

Role	Typical Airport Reference Code	Function
Commercial Service	Consistent with Master Plan	Enplane 2,500 or more passengers annually and receive scheduled passenger service.
Reliever	Up to C/D-III	Relieve congestion at a commercial service airport.
General Aviation - Community	Up to B-II	Serve regional economies, connecting state and national economies, and serve all types of general aviation aircraft.
General Aviation - Rural	Up to B-I	Serve a supplemental role in local economies, primarily serving smaller business, recreational, and personal flying.
General Aviation - Basic	A-I	Serve a limited role in the local economy, primarily serving recreational and personal flying.

Source: *2008 Arizona State Airports System Plan*

The SASP presents minimum design criteria for each specific airport role. Each category level is recommended to meet a certain threshold of airside and landside criteria, with the commercial service category being the most demanding due to the expectation that this type of facility should be capable of accommodating the commercial service and general aviation activity up to and including large jets. **Table 4D** identifies the facility and service objectives for the commercial service role identified in the SASP.

TABLE 4D
Commercial Service Airports - Facility and Service Objectives

Airport Criteria	Minimum Objectives
ARC	Consistent with Master Plan (typically C-II or higher)
Runway Length	Consistent with Master Plan (typically C-II or higher)
Runway Width	To Meet ARC
Taxiway	Consistent with Master Plan (typically full parallel)
Surface	Asphalt/Paved
Approach Capability	Precision desired; Near Precision (minimum)
Visual Aids	Rotating Beacon; Lighted Wind Cone; Segmented Circle; REILs; VGSI
Lighting	HIRL/HITL desired; MIRL/MITL (minimum)
Approach Lighting System	ALS (MALS or MALSR)
Fencing	Perimeter Fencing and Controlled Access
Services	Full Service FBO/Maintenance/On-Site Rental Car/ Phone/Restrooms/24-7 Fuel (Jet A and 100LL)
Facilities	Consistent with Master Plan

ALS - Approach Lighting System
ARC - Airport Reference Code
FBO - Fixed Base Operator
HIRL/HITL - High Intensity Runway/Taxiway Lighting
MALS/MALSR - Medium Intensity Approach Lighting System (with Runway Alignment Indicator Lights)
MIRL/MITL - Medium Intensity Runway/Taxiway Lighting
REIL - Runway End Identification Lighting
VGSI - Visual Glide Slope Indicator

Source: 2008 *Arizona State Airports System Plan*

SAFETY AREA DESIGN STANDARDS

The FAA has established several imaginary surfaces to protect aircraft operational areas and keep them free from obstructions. These include the runway safety area (RSA), runway object free area (ROFA), runway obstacle free zone (ROFZ), and runway protection zone (RPZ).

The entire RSA, ROFA, and ROFZ must be under the direct ownership of the airport sponsor to ensure these areas remain free of obstacles and can be readily accessed by maintenance and emergency personnel. RPZs should also be under airport ownership. An alternative to outright ownership of the RPZ is the purchase of avigation easements (acquiring control of designated airspace within the RPZ) or having sufficient land use control measures in place which ensures the RPZ remains free of incompatible development. The various airport safety areas are presented on **Exhibit 4E**.

Dimensional standards for the various safety areas associated with the runway are a function of the type of aircraft using or expected to use the runway as well as the instrument approach capability. As previously identified, the current critical design aircraft is classified as C-II. The future airfield design should be planned to C-III; therefore, the design standards for both conditions are examined. **Table 4E** presents the FAA design standards as they apply to Runway 3-21 at GCN.

RUNWAY SAFETY AREA

The RSA is defined in FAA AC 150/5300-13A, *Airport Design,* as a "surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of undershoot, overshoot, or excursion from the runway." The RSA is centered on the runway and dimensioned in accordance to the approach speed of the critical design aircraft using the runway. The FAA requires the RSA to be cleared and graded, drained by grading or storm sewers, capable of accommodating the design aircraft and fire and rescue vehicles, and free of obstacles not fixed by navigational purpose such as runway edge lights or approach lights.

The FAA has placed a higher significance on maintaining adequate RSA at all airports. Under Order 5200.8, effective October 1, 1999, the FAA established the *Runway Safety Area Program.* The Order states, "The objective of the Runway Safety Area Program is that all RSAs at federally-obligated airports…shall conform to the standards contained in Advisory Circular 150/5300-13, *Airport Design*, to the extent practicable." Each Regional Airports Division of the FAA is obligated to collect and maintain data on the RSA for each runway at the airport and perform airport inspections.

For RDC C-II design, the FAA calls for the RSA to be 500 feet wide and extend 1,000 feet beyond the runway ends. Analysis in the previous section indicated that Runway 3-21 should be planned to accommodate aircraft in RDC C-III. The RSA for RDC C-III is also 500 feet wide and extends 1,000 feet beyond each runway end. It should be noted that only 600 feet of RSA is needed prior to the landing threshold on each runway end under RDC C-II and C-III standards.

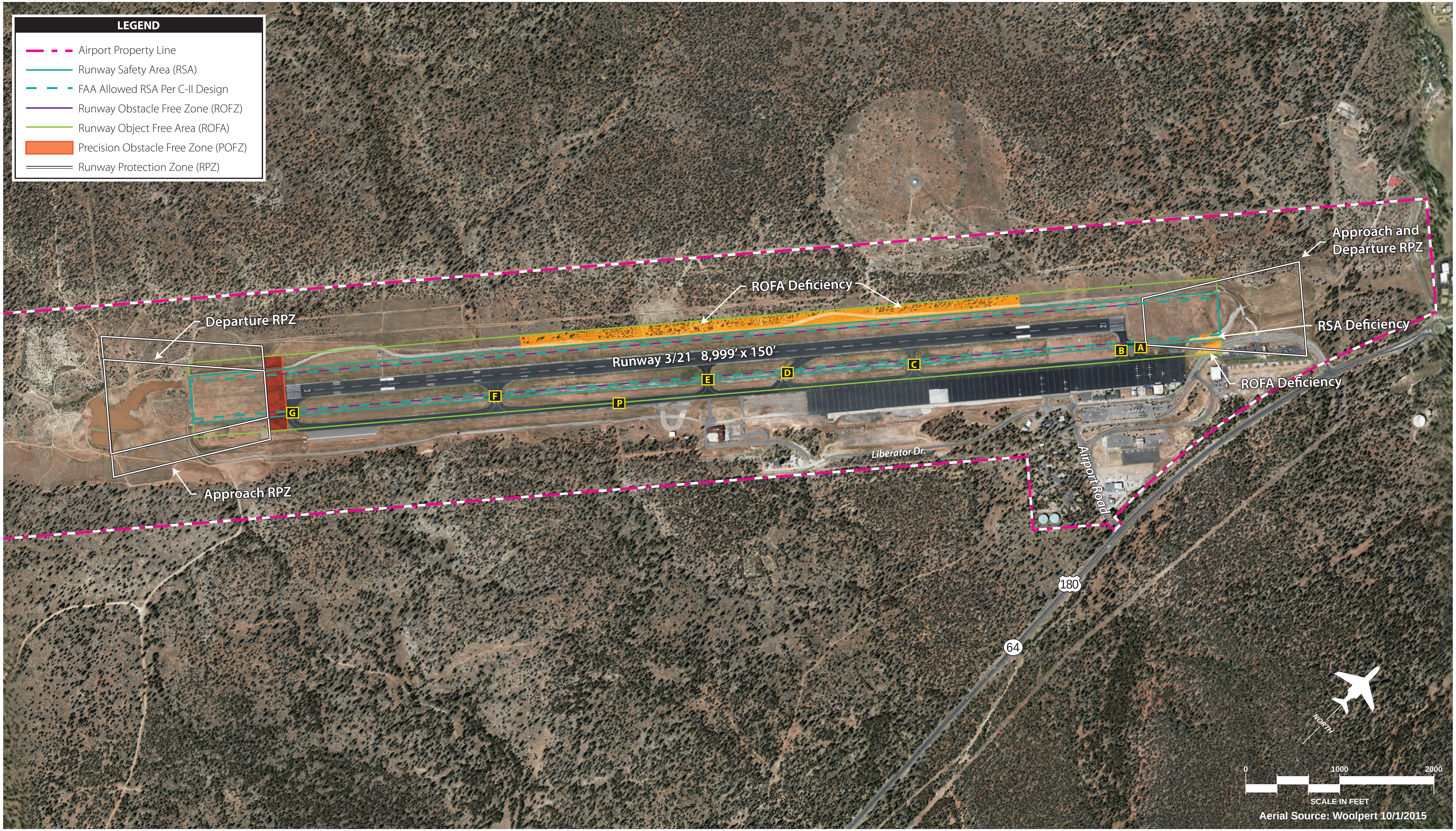

Exhibit 4E
AIRFIELD SAFETY AREAS

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TABLE 4E
Runway Design Standards
Grand Canyon National Park Airport

	Runway 3-21	
	Current	**Future**
RUNWAY CLASSIFICATION		
Runway Design Code	C-II	C-III
Visibility Minimums	¾-mile (3) / Visual (21)	¾-mile (3) / Visual (21)
RUNWAY DESIGN		
Runway Width	150	150[1]
Runway Shoulder Width	10	20
RUNWAY PROTECTION		
Runway Safety Area (RSA)		
Width	500[2]	500
Length Beyond Departure End	1,000	1,000
Length Prior to Threshold	600	600
Runway Object Free Area (ROFA)		
Width	800	800
Length Beyond Departure End	1,000	1,000
Length Prior to Threshold	600	600
Runway Obstacle Free Zone (ROFZ)		
Width	400	400
Length Beyond End	200	200
Precision Obstacle Free Zone (POFZ)		
Width	800	800
Length	200	200
Approach Runway Protection Zone (RPZ)		
Length	1,700/1,700	1,700/1,700
Inner Width	1,000/500	1,000/500
Outer Width	1,510/1,010	1,510/1,010
Departure Runway Protection Zone (RPZ)		
Length	1,700/1,700	1,700/1,700
Inner Width	500/500	500/500
Outer Width	1,010/1,010	1,010/1,010
RUNWAY SEPARATION		
Runway Centerline to:		
Hold Position	250	318[3]
Parallel Taxiway	300	400
Aircraft Parking Area	400	500

[1] For airplanes with maximum certificated takeoff weight of 150,000 pounds or less and approach visibility minimums of not less than ¾-mile, the standard runway width is 100 feet
[2] RSA width of 400 feet is permissible
[3] This distance is increased one foot for each 100 feet above sea level
Note: All dimensions in feet

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

As depicted on **Exhibit 4E**, there is an area on the airfield that does not conform to existing and/or ultimate RSA standards. A portion of the perimeter access road penetrates the northeastern-most portion of the RSA; however, the perimeter access road is restricted to authorized airport personnel and is not open to the public. In addition, certain portions of the infield area between the runway and parallel taxiway do not meet RSA standards. A series of culverts to aid in drainage on the airfield penetrate the RSA.

While the standard for RSA width is 500 feet for RDC C-II and C-III, AC 150/5300-13A, Change 1, *Airport Design*, allows for the application of a narrower RSA width of 400 feet for RDC C-II. As such, a 400-foot RSA is also presented on the exhibit. Under this scenario, the RSA still extends over a portion of the perimeter access road, but to a lesser extent. Potential solutions to meeting the full standards for RSA on the airfield will be evaluated in the alternatives analysis.

RUNWAY OBJECT FREE AREA

The ROFA is "a two-dimensional ground area, surrounding runways, taxiways, and taxilanes, which is clear of objects except for objects whose location is fixed by function (i.e., airfield lighting)." The ROFA does not have to be graded and level like the RSA; instead, the primary requirement for the ROFA is that no object in the ROFA penetrates the lateral elevation of the RSA. The ROFA is centered on the runway, extending out in accordance to the critical design aircraft utilizing the runway.

For RDC C-II and C-III design, the FAA calls for the ROFA to be 800 feet wide, extending 1,000 feet beyond each runway end. Similar to the RSA, only 600 feet is needed prior to the landing threshold. **Exhibit 4E** depicts two general areas on the airfield that do not meet ROFA standards. An area of trees and shrubs protrudes above the RSA elevation and serves as a ROFA deficiency along portions of the west side of the runway. On the north side of the runway, a retaining wall and associated fencing as well as a portion of Airport Road fall within the ROFA. Similar to the RSA, a detailed analysis of potential solutions to mitigating the ROFA deficiencies will be examined during the alternatives analysis.

Retaining Wall and Associated Fencing
Source: Coffman Associates

RUNWAY OBSTACLE FREE ZONE

The ROFZ is an imaginary volume of airspace which precludes object penetrations, including taxiing and parked aircraft. The only allowance for ROFZ obstructions is navigational aids mounted on frangible bases which are fixed in their location by function, such as airfield signs. The ROFZ is established to ensure the safety of aircraft operations. If the ROFZ is obstructed, an airport's approaches could be removed or approach minimums could be increased.

The FAA's criterion for runways utilized by aircraft weighing more than 12,500 pounds requires a clear ROFZ to extend 200 feet beyond the runway ends and 400 feet wide (200 feet on either side of the runway centerline). The ROFZ standards are met on Runway 3-21.

A POFZ is further defined for runway ends with a precision approach, such as the instrument landing system (ILS) approach to Runway 3. The POFZ is 800 feet wide, centered on the runway, and extends from the runway threshold to a distance of 200 feet. The POFZ is in effect when the following conditions are met:

a) The runway supports a vertically guided approach.
b) Reported ceiling is below 250 feet and/or visibility is less than ¾-mile.
c) An aircraft is on final approach within two miles of the runway threshold.

When the POFZ is in effect, a wing of an aircraft holding on a taxiway may penetrate the POFZ; however, neither the fuselage nor the tail may infringe on the POFZ. POFZ standards are met for Runway 3 at GCN.

RUNWAY PROTECTION ZONE

The RPZ is a trapezoidal area centered on the runway, typically beginning 200 feet beyond the runway end. The RPZ has been established by the FAA to provide an area clear of obstructions and incompatible land uses, in order to enhance the protection of people and property on the ground. The RPZ is comprised of the central portion of the RPZ and the controlled activity area. The central portion of the RPZ extends from the beginning to the end of the RPZ, is centered on the runway, and is the width of the ROFA. The controlled activity area is any remaining portions of the RPZ. The dimensions of the RPZ vary according to the visibility minimums serving the runway and the type of aircraft (design aircraft) operating on the runway.

While the RPZ is intended to be clear of incompatible objects or land uses, some uses are permitted with conditions and other land uses are prohibited. According to AC 150/5300-13A, the following land uses are permissible within the RPZ:

- Farming that meets the minimum buffer requirements,
- Irrigation channels as long as they do not attract birds,
- Airport service roads, as long as they are not public roads and are directly controlled by the airport operator,
- Underground facilities, as long as they meet other design criteria, such as RSA requirements, as applicable, and
- Unstaffed navigational aids (NAVAIDs) and facilities, such as required for airport facilities that are fixed by function in regard to the RPZ.

Any other land uses considered within RPZ land owned by the airport sponsor must be evaluated and approved by the FAA Office of Airports. The FAA has published *Interim Guidance on Land Uses within a*

Runway Protection Zone (9.27.2012), which identifies several potential land uses that must be evaluated and approved prior to implementation. The specific land uses requiring FAA evaluation and approval include:

- Buildings and structures (examples include, but are not limited to: residences, schools, churches, hospitals or other medical care facilities, commercial/industrial buildings, etc.)
- Recreational land use (examples include, but are not limited to: golf courses, sports fields, amusement parks, other places of public assembly, etc.)
- Transportation facilities. Examples include, but are not limited to:
  - Rail facilities - light or heavy, passenger or freight
  - Public roads/highways
  - Vehicular parking facilities
- Fuel storage facilities (above and below ground)
- Hazardous material storage (above and below ground)
- Wastewater treatment facilities
- Above-ground utility infrastructure (i.e., electrical substations), including any type of solar panel installations.

The *Interim Guidance on Land within a Runway Protection Zone* states, "RPZ land use compatibility also is often complicated by ownership considerations. Airport owner control over the RPZ land is emphasized to achieve the desired protection of people and property on the ground. Although the FAA recognizes that in certain situations the airport sponsor may not fully control land within the RPZ, the FAA expects airport sponsors to take all possible measures to protect against and remove or mitigate incompatible land uses."

Currently, the RPZ review standards are applicable to any new or modified RPZ. The following actions or events could alter the size of an RPZ, potentially introducing an incompatibility:

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

Since the interim guidance only addresses a new or modified RPZ, existing incompatibilities are essentially grandfathered under certain circumstances. While it is still necessary for the airport sponsor to take all reasonable actions to meet the RPZ design standard, FAA funding priority for certain actions, such as relocating existing roads in the RPZ, will be determined on a case by case basis.

RPZs have been further designated as approach and departure RPZs. The approach RPZ is a function of the AAC and approach visibility minimums associated with the approach runway end. The departure RPZ is a function of the AAC and departure procedures associated with the runway. For a particular runway end, the more stringent RPZ requirements (usually associated with the approach RPZ) will govern the property interests and clearing requirements that the airport sponsor should pursue.

As depicted on **Exhibit 4E**, the existing RPZ associated with the approach to Runway 21 has incompatibilities. Although under control of the Airport, a portion of the building and vehicle parking lot associated with Papillon Helicopters on the northeast side of the Airport is contained within the existing RPZ. In addition, a portion of Airport Road also traverses the RPZ. The approach RPZ serving Runway 3 is currently clear of any incompatibilities and also is controlled entirely on GCN property. The approach RPZ serving Runway 3 is larger than the one associated with Runway 21 due to the instrument approach procedure providing visibility minimums down to ¾-mile. Further examination of the RPZs associated with each end of Runway 3-21 will be undertaken later in this study.

RUNWAY/TAXIWAY SEPARATION

The design standard for the required separation between runways and parallel taxiways is a function of the critical design aircraft and the instrument approach visibility minimum. The separation standard for RDC C-II with not lower than ¾-mile visibility minimums is 300 feet from the runway centerline to the parallel taxiway centerline. For RDC C-III, the separation standard is 400 feet. Parallel Taxiway P is 407 feet from the runway (centerline to centerline); therefore, the location of the parallel taxiway exceeds the current design standard and meets the proposed design standards.

HOLD POSITION SEPARATION

Hold positions are markings on taxiways leading to runways. When instructed, pilots are to stop short of the hold line. For Runway 3-21, hold lines are situated 280 feet from the runway centerline, which at least meet the 250-foot separation for C-II design.

According to FAA AC 150/5300-13A, Change 1, *Airport Design*, the hold line location must be increased based on an airport's elevation and the RDC of the runway. For RDC C-III, the hold line position should be increased one foot for every 100 feet above sea level. With GCN's elevation at 6,609 feet above mean sea level (MSL), the hold lines for Runways 3-21 should be increased above 250 feet by 68 feet or at 318 feet from the runway centerline in order to meet RDC C-III standards.

AIRCRAFT PARKING APRON SEPARATION

For Runway 3-21, aircraft parking areas should be at least 400 feet from the runway centerline for RDC C-II. For RDC C-III, parking aprons should be located 500 feet from the runway centerline. The aircraft parking apron situated adjacent to the east side of parallel Taxiway P on the north half of the airfield currently begins approximately 480 feet from the runway centerline. This adheres to C-II design standards but falls slightly short of C-III design standards.

AIRFIELD SURFACE GRADIENTS

Work is currently being performed on the airfield to rehabilitate and enhance certain elements of the runway and taxiway system. During the design process, it has been realized that portions of parallel Taxiway A exceed the elevation of Runway 3-21. According to AC 150/5300-13A, Change 1, *Airport Design*, the crown of a taxiway should not be higher than the crown of the runway. Allowing the taxiway to be higher than the runway can create drainage issues between the runway and parallel taxiway system. Further analysis related to the runway versus taxiway elevation will be undertaken later in this study to determine potential ways to mitigate this design deficiency.

AIRSIDE FACILITIES

Airside facilities include those facilities related to the arrival, departure, and ground movement of aircraft. The adequacy of existing airfield facilities at GCN has been analyzed from a number of perspectives, including:

- Runways
- Taxiways
- Navigational and Approach Aids
- Airfield Lighting, Marking, and Signage

RUNWAYS

Runway conditions, such as orientation, length, width, and pavement strength, at GCN were analyzed. From this information, requirements for runway improvements were determined for the Airport.

Runway Orientation

For the operational safety and efficiency of an airport, it is desirable for the primary runway to be oriented as close as possible to the direction of the prevailing wind. This reduces the impact of wind components perpendicular to the direction of travel of an aircraft that is landing or taking off.

FAA AC 150/5300-13A, *Airport Design,* recommends that a crosswind runway be made available when the primary runway orientation provides for less than 95 percent wind coverage for specific crosswind components. The 95 percent wind coverage is computed on the basis of the crosswind component not exceeding 10.5 knots (12 mph) for RDC A-I and B-I, 13 knots (15 mph) for RDC A-II and B-II, and 16 knots (18 mph) for RDC A-III, B-III, C-I through C-III, and D-I through D-III.

Weather data specific to the Airport was obtained from the National Oceanic Atmospheric Administration (NOAA) National Climatic Data Center. This data was collected from the on-field Automated Surface

Observing System (ASOS) over a continuous time period from 2006 to 2015. A total of 93,956 observations of wind direction and other data points were made.

Exhibit 4F presents both the all-weather and instrument flight rules (IFR) wind rose for the Airport. IFR conditions exist when the visibility is below three miles and the cloud ceilings are below 1,000 feet. Based upon historical wind data, Runway 3-21 exceeds 95 percent for all crosswind components during all weather conditions. Under IFR conditions, the crosswind component coverages for the runway system are nearly identical to the all-weather conditions. Therefore, the runway is properly orientated to meet predominant winds and a crosswind runway is not needed.

Runway Length

AC 150/5325-4B, *Runway Length Requirements for Airport Design*, provides guidance for determining runway length needs. A draft revision to this AC is currently available (150/5325-4C) and the FAA is utilizing the draft revision in most cases when evaluating runway length needs for airports.

The determination of runway length requirements for GCN is based on five primary factors:

- Mean maximum temperature of the hottest month
- Airport elevation
- Runway gradient
- Critical aircraft type expected to use the runway
- Stage length of the longest nonstop destination (specific to larger aircraft)

Aircraft performance declines as elevations, temperature, and runway gradient factors increase. For GCN, the mean maximum daily temperature of the hottest month is 84 degrees Fahrenheit (F), which occurs in July. The Airport's elevation is 6,609 feet MSL. The runway elevation difference is 76 feet for Runway 3-21, which equates to a 0.8 percent gradient change. The gradient of the runway conforms to FAA design standards.

Airplanes operate on a wide variety of available runway lengths. Many factors will govern the suitability of those runway lengths for aircraft, such as elevation, temperature, wind, aircraft weight, wing flap settings, runway condition (wet or dry), runway gradient, vicinity airspace obstructions, and any special operating procedures. Airport operators can pursue policies that can maximize the suitability of the runway length. Policies, such as area zoning and height and hazard restrictions can protect an airport's runway length. Airport ownership (fee simple or easement) of land leading to the runway ends can reduce the possibility of natural growth or man-made obstructions. Planning of runways should include an evaluation of aircraft types expected to use the airport or a particular runway now and in the future. Future plans should be realistic and supported by the FAA approved forecasts and should be based on the critical design aircraft (or family of aircraft).

Commercial Service/Air Charter

Runway length needs for commercial service aircraft must factor the local airport conditions described above and the load carried. The aircraft load is dependent upon the payload of passengers and/or cargo, plus the amount of fuel it has on board. For departures, the amount of fuel varies depending upon the length of non-stop flights or trip length.

Currently, there is no scheduled air service to/from the Airport. An analysis of larger commercial service aircraft being utilized for unscheduled air charter activity at GCN has been evaluated. Over the past several years, representative markets, such as Las Vegas, the Los Angeles area, and Denver, are the most common to have reported air charter activity to the Airport. **Table 4F** shows these destinations served from GCN and their haul length. It should be noted that other destinations in the south-central and eastern portions of the United States have logged activity at the Airport, but on an infrequent basis. The majority of current haul lengths associated with air charter activity at GCN are less than 500 miles.

TABLE 4F
Non-Stop Trip Lengths
Grand Canyon National Park Airport

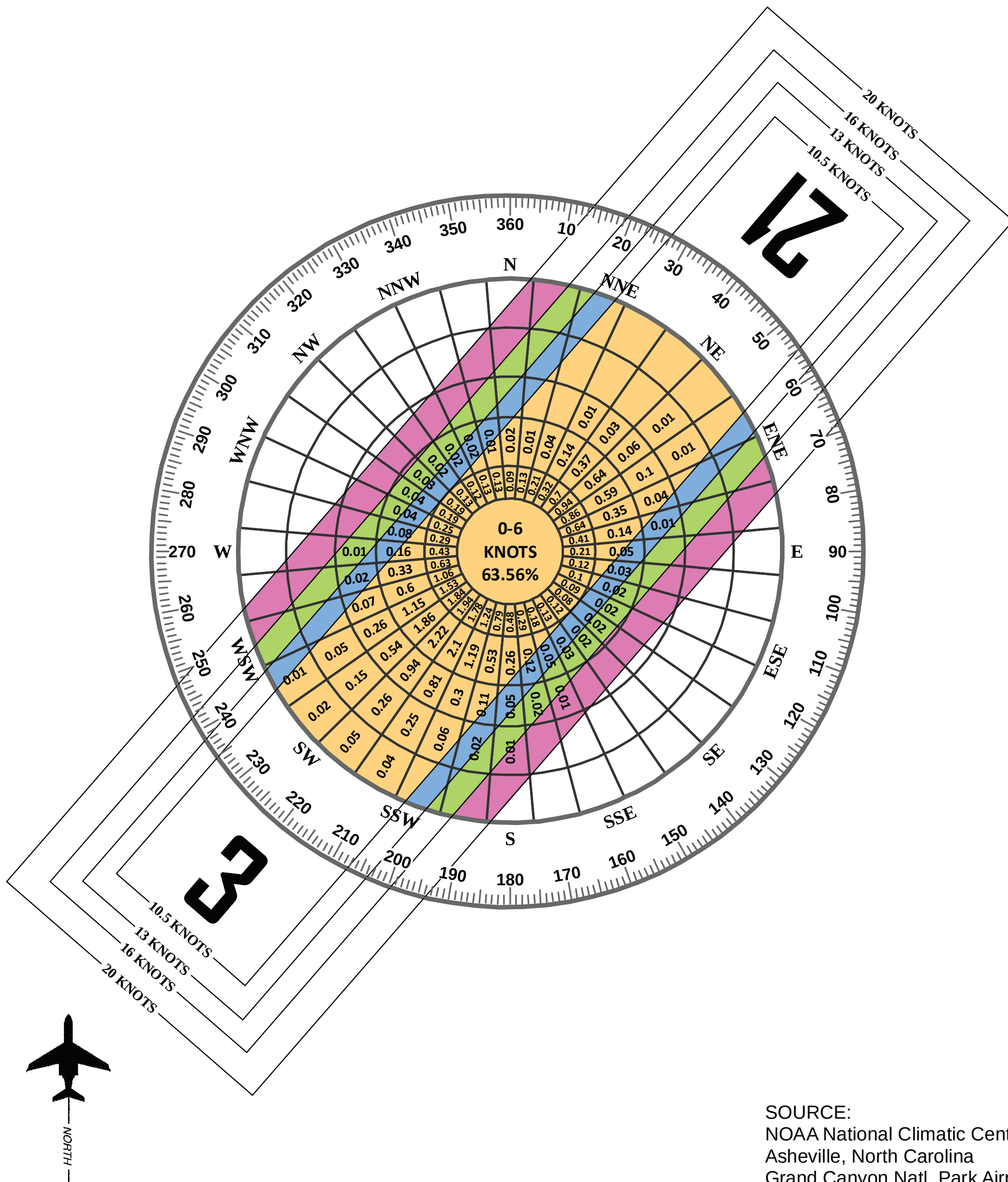
Historical Air Charter Destinations	Air Miles
Las Vegas	169
Los Angeles Area (several airports)	380
Denver	487

Source: http://www.landings.com

As previously detailed, the Airport has experienced an array of commercial service/air charter aircraft operations in the past, however, typically on an infrequent basis. These include a mix of turboprop and jet aircraft. Typically, the larger jet aircraft drive runway length needs for an airport. Forecasts anticipate the potential for continued operations by these types of aircraft in the future. It should be noted that the smaller 44-50 passenger seat regional jets (Embraer ERJ-140-series and CRJ-200 regional jets) are forecast to be retired from the operating fleet in the coming years. The projected replacement includes larger 70-90 passenger seat regional jets, including the Bombardier CRJ-700 and CRJ-900. **Table 4G** presents the takeoff weight limits for certain jets based upon operating conditions specific to GCN.

While the current length of 8,999 feet on Runway 3-21 is capable of handling existing operations by the more demanding commercial service/air charter jets, these aircraft are often weight-restricted, especially during times when warm temperatures and high density altitudes prevail at the Airport. While runway length needs in order to accommodate full payloads for these jets may be difficult to attain given the cost and environmental impacts involved, prudent planning should analyze potential runway extensions in order to better accommodate existing and future commercial service aircraft that operate at GCN.

ALL WEATHER WIND COVERAGE				
Runways	10.5 Knots	13 Knots	16 Knots	20 Knots
Runway 3-21	99.14%	99.70%	99.96%	100.00%

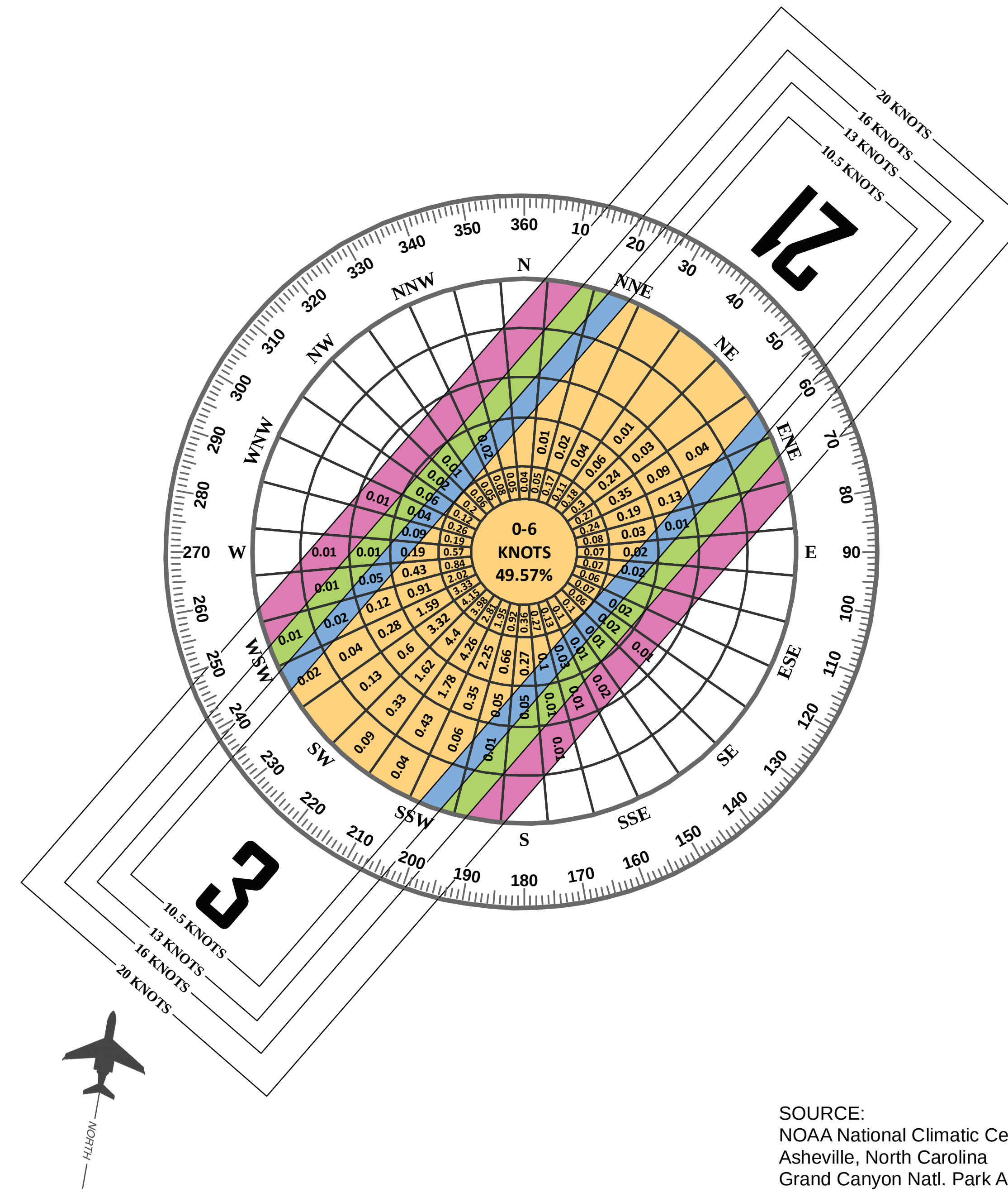


Magnetic Declination
10° 52' 00" East (May 2016)
Annual Rate of Change
00° 06' 00" West (May 2016)

SOURCE:
NOAA National Climatic Center
Asheville, North Carolina
Grand Canyon Natl. Park Airport
Grand Canyon, AZ

OBSERVATIONS:
93,956 All Weather Observations
Jan. 1, 2006 - Dec, 31 2015

IFR WIND COVERAGE				
Runways	10.5 Knots	13 Knots	16 Knots	20 Knots
Runway 3-21	99.20%	99.71%	99.93%	99.99%



Magnetic Declination
10° 52' 00" East (May 2016)
Annual Rate of Change
00° 06' 00" West (May 2016)

SOURCE:
NOAA National Climatic Center
Asheville, North Carolina
Grand Canyon Natl. Park Airport
Grand Canyon, AZ

OBSERVATIONS:
11,304 IFR Observations
Jan. 1, 2006 - Dec, 31 2015

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TABLE 4G
Takeoff Weight Limits
Grand Canyon National Park Airport

Aircraft	Maximum Takeoff Weight (pounds)	Runway Length (feet)	Maximum Allowable Takeoff Weight (pounds)
CRJ-700	72,750	8,999 9,500 10,000	66,000 66,800 67,500
CRJ-900	82,500	8,999 9,500 10,000	71,000 72,700 74,000
MD-80-series	160,000	8,999 9,500 10,000	130,000 133,000 137,000
Boeing 737-800	172,500	8,999 9,500 10,000	150,000 152,300 154,000

Current Runway 3-21 Length - 8,999 feet
Design Criteria: Elevation - 6,609 feet MSL; Temperature - 84 degrees F

Source: Aircraft Operating Manuals; Coffman Associates analysis

General Aviation Aircraft

A significant number of operations at GCN are conducted using smaller single engine piston-powered aircraft weighing less than 12,500 pounds. Following guidance from AC 150/5325-4B, to accommodate 100 percent of these small aircraft, a runway length of 8,000 feet is recommended.

The Airport is also utilized by aircraft weighing more than 12,500 pounds, including small to medium business jet aircraft. Runway length requirements for business jets weighing less than 60,000 pounds have also been calculated. These calculations take into consideration the runway gradient and landing length requirements for contaminated runways (wet). Business jets tend to need greater runway length when landing on a wet surface because of their increased approach speeds. AC 150/5325-4B stipulates that runway length determination for business jets consider a grouping of airplanes with similar operating characteristics. The AC provides two separate “family groupings of airplanes,” each based upon their representative percentage of aircraft in the national fleet. The first grouping is those business jets that make up 75 percent of the national fleet, and the second group is those making up 100 percent of the national fleet. **Table 4H** presents a partial list of common aircraft in each aircraft grouping. A third group considers business jets weighing more than 60,000 pounds. Runway length determination for these aircraft must be based on the performance characteristics of the individual aircraft.

TABLE 4H
Business Jet Categories for Runway Length Determination

75 percent of the national fleet	MTOW	75-100 percent of the national fleet	MTOW	Greater than 60,000 pounds	MTOW
Lear 35	20,350	Lear 55	21,500	Gulfstream II	65,500
Lear 45	20,500	Lear 60	23,500	Gulfstream IV	73,200
Cessna 550	14,100	Hawker 800XP	28,000	Gulfstream V	90,500
Cessna 560XL	20,000	Hawker 1000	31,000	Global Express	98,000
Cessna 650 (VII)	22,000	Cessna 650 (III/IV)	22,000		
IAI Westwind	23,500	Cessna 750 (X)	36,100		
Beechjet 400	15,800	Challenger 604	47,600		
Falcon 50	18,500	IAI Astra	23,500		

MTOW: Maximum Take Off Weight
Source: FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*

Table 4J presents the results of the runway length analysis for business jets developed following the guidance provided in AC 150/5325-4B. To accommodate 75 percent of the business jet fleet at 60 percent useful load, a runway length of 8,100 feet is recommended. This length is derived from a raw length of 7,300 feet that is adjusted, as recommended, for runway gradient and consideration of landing length needs on a contaminated runway (wet and slippery). To accommodate 100 percent of the business jet fleet at 60 percent useful load, a runway length of 11,800 feet is recommended.

TABLE 4J
Runway Length Requirements
Grand Canyon National Park Airport

Airport Elevation	6,609 feet above mean sea level
Average High Monthly Temp.	84 degrees (July)
Runway Gradient	76' Runway 3-21

Fleet Mix Category	Raw Runway Length from FAA AC	Runway Length With Gradient Adjustment (+760')	Wet Surface Landing Length for Jets (+15%)*	Final Runway Length
100% of small airplanes	8,000’	N/A	N/A	N/A
75% of fleet at 60% useful load	7,300’	8,060’	5,500'	8,100’
100% of fleet at 60% useful load	11,000’	11,760’	5,500’	11,800’
75% of fleet at 90% useful load	9,000’	9,760’	7,000’	9,800’
100% of fleet at 90% useful load	11,000’	11,760’	7,000'	11,800’

*Max 5,500' for 60% useful load and max 7,000' for 90% useful load in wet conditions
Source: FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*

Utilization of the 90 percent category for runway length determination is generally not considered by the FAA unless there is a demonstrated need at an airport. This could be documented activity by a business jet operator that flies out frequently with heavy loads. To accommodate 75 percent of the business jet fleet at 90 percent useful load, a runway length of 9,800 feet is recommended. To accommodate 100 percent of business jets at 90 percent useful load, a runway length of 11,800 feet is recommended.

Another method to determine runway length requirements for turboprop and jet aircraft at GCN is to examine aircraft flight planning manuals under conditions specific to the Airport. Several aircraft were analyzed for takeoff length required with a design temperature of 84 degrees F at a field elevation of 6,609 feet MSL.

The information presented on **Exhibit 4G** was obtained from Ultranav software which computes operational parameters for specific aircraft based on flight manual data. As presented, certain aircraft were evaluated for payload availability for the current runway length for dry and wet conditions. The analysis also presents takeoff length required by each aircraft departing under maximum takeoff weight. Nearly all the jet aircraft examined can operate from the existing runway length; however, several would be weight-restricted when using Runway 3-21. In fact, several aircraft were noted by the software program to be "climb restricted."

The table also presents the runway length required for landing under three operational categories: Title 14 Code of Federal Regulations (CFR) Part 25, CFR Part 135, and CFR Part 91k. CFR Part 25 operations are those conducted by individuals or companies which own their aircraft. CFR Part 135 applies to all for-hire charter operations, including most fractional ownership operations. CFR Part 91k includes operations in fractional ownership which utilize their owned aircraft under direction of pilots specifically assigned to said aircraft.

Runway Length Summary

Many factors are considered when determining appropriate runway length for safe and efficient operations of aircraft at GCN. The Airport should strive to accommodate commercial service/air charter aircraft and business jets to the greatest extent possible.

Runway 3-21 is 8,999 feet long. This runway can accommodate a large majority of business jets on the market under moderate loading conditions, especially with shorter trip lengths and during cool to warm temperatures. Likewise, it accommodates the irregular use of commercial service/ air charter turboprop and jet aircraft that utilize the airport; however, these aircraft are often weight-restricted when combining operational factors such as temperature and density altitude. Larger commercial service/air charter aircraft, such as the Boeing 737-series and MD-80-series, could support an even longer runway, but would be dependent upon the specific make and model that the FAA agrees to consider as the critical design aircraft in the event that these jets would operate on a regular basis at the Airport. The existing runway length presents loading limitations, as well as departure climb limitations. It is the hot days and longer trip lengths which will limit many jets at GCN.

The previous Master Plan and current ALP indicate a future runway length of 10,000 feet. The alternatives analysis in the next chapter will consider the possibility of lengthening Runway 3-21. This analysis will be subject to many factors, including economic, environmental, and safety design parameters, before a recommendation is made as a result of this Master Plan.

Runway Width

Runway width design standards are primarily based on the critical aircraft, but can also be influenced by the visibility minimums of published instrument approach procedures. For Runway 3-21, RDC C-II design criteria stipulate a runway width of 100 feet. Its current runway width of 150 feet exceeds this standard. RDC C-III design criteria calls for a width of 150 feet if the runway is served by an instrument approach with visibility minimums lower than ¾-mile. In addition, the runway is utilized occasionally by larger commercial/charter aircraft, and the 150 feet of width provides added safety enhancements for these operations. As such, the existing width of Runway 3-21 should be maintained in the future.

It should be noted that a recent survey of the runway system at GCN indicates that the current width of Runway 3-21 is approximately 148 feet wide versus the 150 feet that is published. Further evaluation of the runway system later in the Master Plan study will take into consideration the surveyed width of the runway and ultimate remedies to adhere to the 150-foot width standard as needed.

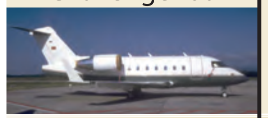
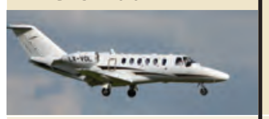
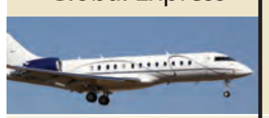
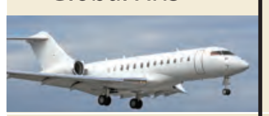
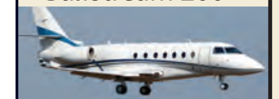
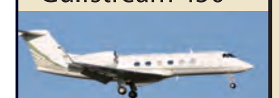
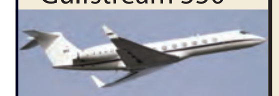
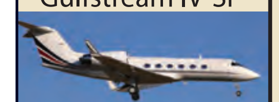
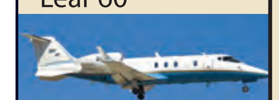
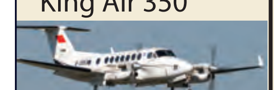
Runway Strength

An important feature of airfield pavement is its ability to withstand repeated use by aircraft. The FAA reports the pavement strength for Runway 3-21 at 88,000 pounds single wheel loading (SWL), 108,000 pounds dual wheel loading (DWL), and 160,000 pounds dual tandem wheel loading (DTWL). This strength rating refers to the configuration of the aircraft landing gear. For example, SWL indicates an aircraft with a single wheel on each landing gear.

The strength rating of a runway does not preclude aircraft weighing more than the published strength rating from using the runway. All federally obligated airports must remain open to the public, and it is typically up to the pilot of the aircraft to determine if a runway can support their aircraft safely. An airport sponsor cannot restrict an aircraft from using the runway simply because its weight exceeds the published strength rating. On the other hand, the airport sponsor has an obligation to properly maintain the runway and protect the useful life of the runway, typically for 20 years.

According to the FAA publication, *Airport/Facility Directory*, "Runway strength rating is not intended as a maximum allowable weight or as an operating limitation. Many airport pavements are capable of supporting limited operations with gross weights in excess of the published figures." The directory goes on to say that those aircraft exceeding the pavement strength should contact the airport sponsor for permission to operate at the airport.

The strength rating of a runway can change over time. Regular usage by heavier aircraft can decrease the strength rating, while periodic runway resurfacing can increase the strength rating. The current runway strength is adequate to accommodate a large majority of aircraft that currently operate at the Airport and are forecast to utilize the Airport in the future. The current ALP calls for an ultimate pavement design strength similar to what currently exists on the runway. As such, future consideration should be given to maintaining the pavement strength on Runway 3-21.

Aircraft Name	% Useful Load for 8,999' Runway		Take-off Length Required at Max Takeoff Weight		Landing Length Required for:					
					C.F.R. Part 25		C.F.R. Part 135		C.F.R. Part 91k	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
BUSINESS JETS										
Challenger 604 	66%	OL	11,367	12,162	3,387	5,466	5,645	9,110	4,234	6,833
CRJ 200 	72%	68%	9,754	10,263	3,908	4,494	6,513	7,490	4,885	5,618
Global 5000 	78%	78%	8,021*	8,109*	3,008	3,459	5,013	5,765	3,760	4,324
Global Express 	73%	73%	8,021*	8,109*	3,008	3,460	5,013	5,767	3,760	4,325
Global XRS 	69%	69%	8,021*	8,109*	3,008	3,459	5,013	5,765	3,760	4,324
Citation VII*** 	66%	66%	8,015*	8,015*	3,719	5,116	6,198	8,527	4,649	6,395
Citation X 	74%	67%	8,954*	9,659	4,762	6,933	7,937	11,555	5,953	8,666
Falcon 7X 	80%	80%	9,443	9,443	3,398	3,907	5,663	6,512	4,248	4,884
Falcon 900DX 	99%	100%	9,080	8,880	4,070	6,784	6,783	11,307	5,088	8,480
Falcon 2000EX 	74%	74%	9,442	9,565	3,990	4,589	6,650	7,648	4,988	5,736
Gulfstream 200 	62%	61%	9,676	9,829	3,923	4,511	6,538	7,518	4,904	5,639
Gulfstream 450 	71%	54%	11,867	13,000**	3,609	4,151	6,015	6,918	4,511	5,189
Gulfstream 550 	80%	70%	10,711	12,102	3,790	6,246	6,317	10,410	4,738	7,808
Gulfstream IV-SP 	70%	70%	11,933	11,665	3,219	5,476	5,365	9,127	4,024	6,845
Lear 45XR 	87%	87%	11,329	11,016	3,438	4,482	5,730	7,470	4,298	5,603
Lear 60 	56%	47%	12,038	13,000**	4,364	5,789	7,273	9,648	5,455	7,236
Hawker 800XP 	67%	67%	6,964*	8,602*	3,092	4,723	5,153	7,872	3,865	5,904
Hawker 4000 	81%	73%	9,713	10,674	3,717	4,275	6,195	7,125	4,646	5,344
TURBOPROP										
King Air 350 	89%	89%	6,567*	6,729*	1,820	2,094	3,033	3,490	2,275	2,618
Beech 1900D 	100%	100%	7,991	7,991	3,144	3,616	5,240	6,027	3,930	4,520

* Runway length required is less than existing, however climb restriction is in place due to temp. and elevation.
** Maximum takeoff weight is limited at maximum runway length listed in aircraft planning manual.
*** Calculation for maximum temp. (75.2ºF/24ºC) listed in aircraft planning manual.
O/L: Out of aircraft operational limits

Note: Part 135 is 60% Factored and Part 91k 80% Factored
Note: Field Elevation 6,609'; Mean Max Temp 84.2ºF(29ºC)
Source: Ultranav Flight Software based on aircraft operating manuals

Exhibit 4G
RUNWAY TAKE-OFF LENGTH

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TAXIWAYS

The design standards associated with taxiways are determined by the TDG or the ADG of the critical design aircraft. As determined previously, the applicable ADG for Runway 3-21 is currently ADG II. Ultimate planning should conform to ADG III for the runway. **Table 4K** presents the various taxiway design standards related to ADGs II and III.

TABLE 4K
Taxiway Dimensions and Standards
Grand Canyon National Park Airport

STANDARDS BASED ON WINGSPAN	***ADG II***	***ADG III***
Taxiway Protection		
Taxiway Safety Area width (feet)	79	118
Taxiway Object Free Area width (feet)	131	186
Taxilane Object Free Area width (feet)	115	162
Taxiway Separation		
Taxiway Centerline to:		
Fixed or Movable Object (feet)	65.5	93
Parallel Taxiway/Taxilane (feet)	105	152
Taxilane Centerline to:		
Fixed or Movable Object (feet)	57.5	81
Parallel Taxilane (feet)	97	140
Wingtip Clearance		
Taxiway Wingtip Clearance (feet)	26	34
Taxilane Wingtip Clearance (feet)	18	23
STANDARDS BASED ON TDG	***TDG 2***	***TDG 3***
Taxiway Width Standard (feet)	35	50
Taxiway Edge Safety Margin (feet)	7.5	10
Taxiway Shoulder Width (feet)	10	20

ADG: Airplane Design Group
TDG: Taxiway Design Group
Source: FAA AC 150/5300-13A, Change 1, *Airport Design*

The table also shows those taxiway design standards related to TDG. The TDG standards are based on the MGW and the CMG distance of the critical design aircraft expected to use those taxiways. Different taxiway and taxilane pavements can and should be planned to the most appropriate TDG design standards based on usage.

The current taxiway design for Runway 3-21 should be TDG 2. As such, the taxiways on the airfield should be at least 35 feet wide. Ultimate planning accounts for TDG 3. Thus, the taxiways associated with Runway 3-21 should be at least 50 feet to meet this standard.

The current taxiway system is composed of varying taxiway widths. Parallel Taxiway P and exit taxiways C, D, and E are 75 feet wide; entrance/exit Taxiways A and B are 84 feet and 82 feet wide, respectively;

and entrance/exit Taxiways F and G are 93 feet wide. While these widths exceed current and projected design needs on the taxiways, they could be maintained unless financial constraints dictate. As such, the width should remain until such time as rehabilitation is needed and financial resources to support such are not available. FAA grant availability can only be provided if the project meets eligibility thresholds as determined by the FAA.

It should be noted that certain taxiways on the airfield have recently been rehabilitated to their current respective widths. Through the design phase of this project, the FAA determined it was more reasonable to improve the taxiways at their current width versus reducing the width, which would have necessitated the need to relocate associated lighting. The decision for maintaining the future width of the taxiways should be made at the time of rehabilitation so as to reevaluate operational needs.

Taxiway Design Considerations

FAA AC 150/5300-13A, Change 1, *Airport Design*, provides guidance on recommended taxiway and taxilane layouts to enhance safety by avoiding runway incursions. A runway incursion is defined as "any occurrence at an airport involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and takeoff of aircraft."

The taxiway system at GCN generally provides for the efficient movement of aircraft; however, AC 150/5300-13A, Change 1, *Airport Design*, provides recommendations for taxiway design. The following is a list of the taxiway design guidelines and the basic rationale behind each recommendation:

1. **Taxi Method**: Taxiways are designed for "cockpit over centerline" taxiing with pavement being sufficiently wide to allow a certain amount of wander. On turns, sufficient pavement should be provided to maintain the edge safety margin from the landing gear. When constructing new taxiways, upgrading existing intersections should be undertaken to eliminate "judgmental oversteering," which is where the pilot must intentionally steer the cockpit outside the marked centerline in order to assure the aircraft remains on the taxiway pavement.

2. **Steering Angle**: Taxiways should be designed such that the nose gear steering angle is no more than 50 degrees, the generally accepted value to prevent excessive tire scrubbing.

3. **Three-Node Concept**: To maintain pilot situational awareness, taxiway intersections should provide a pilot a maximum of three choices of travel. Ideally, these are right and left angle turns and a continuation straight ahead.

4. **Intersection Angles**: Turns should be designed to 90 degrees wherever possible. For acute angle intersections, standard angles of 30, 45, 60, 120, 135, and 150 degrees are preferred.

5. **Runway Incursions**: Taxiways should be designed to reduce the probability of runway incursions.

- *Increase Pilot Situational Awareness*: A pilot who knows where he/she is on the airport is less likely to enter a runway improperly. Complexity leads to confusion. Keep taxiway systems simple using the "three node" concept.
- *Avoid Wide Expanses of Pavement*: Wide pavements require placement of signs far from a pilot's eye. This is especially critical at runway entrance points. Where a wide expanse of pavement is necessary, avoid direct access to a runway.
- *Limit Runway Crossings*: The taxiway layout can reduce the opportunity for human error. The benefits are twofold – through simple reduction in the number of occurrences, and through a reduction in air traffic controller workload.
- *Avoid "High Energy" Intersections*: These are intersections in the middle third of runways. By limiting runway crossings to the first and last thirds of the runway, the portion of the runway where a pilot can least maneuver to avoid a collision is kept clear.
- *Increase Visibility*: Right angle intersections, both between taxiways and runways, provide the best visibility. Acute angle runway exits provide for greater efficiency in runway usage, but should not be used as runway entrance or crossing points. A right angle turn at the end of a parallel taxiway is a clear indication of approaching a runway.
- *Avoid "Dual Purpose" Pavements*: Runways used as taxiways and taxiways used as runways can lead to confusion. A runway should always be clearly identified as a runway and only a runway.
- *Indirect Access*: Do not design taxiways to lead directly from an apron to a runway. Such configurations can lead to confusion when a pilot typically expects to encounter a parallel taxiway.
- *Hot Spots*: Confusing intersections near runways are more likely to contribute to runway incursions. These intersections must be redesigned when the associated runway is subject to reconstruction or rehabilitation. Other hot spots should be corrected as soon as practicable.

6. **Runway/Taxiway Intersections**:
   - *Right Angle*: Right-angle intersections are the standard for all runway/taxiway intersections, except where there is a need for a high-speed exit. Right-angle taxiways provide the best visual perspective to a pilot approaching an intersection with the runway to observe aircraft in both the left and right directions. They also provide optimal orientation of the runway holding position signs so they are visible to pilots.
   - *Acute Angle*: Acute angles should not be larger than 45 degrees from the runway centerline. A 30-degree taxiway layout should be reserved for high speed exits. The use of multiple intersecting taxiways with acute angles creates pilot confusion and improper positioning of taxiway signage.
   - *Large Expanses of Pavement*: Taxiways must never coincide with the intersection of two runways. Taxiway configurations with multiple taxiway and runway intersections in a single area create large expanses of pavement, making it difficult to provide proper signage, marking, and lighting.

7. **Taxiway/Runway/Apron Incursion Prevention**: Apron locations that allow direct access into a runway should be avoided. Increase pilot situational awareness by designing taxiways in such a manner that forces pilots to consciously make turns. Taxiways originating from aprons and forming a straight line across runways at mid-span should be avoided.

- *Wide Throat Taxiways*: Wide throat taxiway entrances should be avoided. Such large expanses of pavement may cause pilot confusion and makes lighting and marking more difficult.
- *Direct Access from Apron to a Runway*: Avoid taxiway connectors that cross over a parallel taxiway and directly onto a runway. Consider a staggered taxiway layout that forces pilots to make a conscious decision to turn.
- *Apron to Parallel Taxiway End*: Avoid direct connection from an apron to a parallel taxiway at the end of a runway.

FAA AC 150/5300-13A, Change 1, *Airport Design*, states that "existing taxiway geometry should be improved whenever feasible, with emphasis on designated "hot spots." To the extent practicable, the removal of existing pavement may be necessary to correct confusing layouts. The FAA has identified the following "hot spot" on the airfield as follows:

- Hot Spot 1: Pilots sometimes confuse Taxiway A and Taxiway B at the Runway 21 end because of the close proximity. Verify correct taxiway route.

Hot Spot 1 at Taxiways A and B
Source: Woolpert 10/1/2015

In the alternatives chapter, potential solutions to this Hot Spot will be presented. Analysis in the next chapter will also consider improvements which could be implemented on the airfield to minimize runway incursion potential, improve efficiency, and conform to FAA standards for taxiway design. Any future taxiways planned will also take into consideration the taxiway design standards.

Taxilane Design Considerations

Taxilanes are distinguished from taxiways in that they do not provide access to or from the runway system directly. Taxilanes typically provide access to hangar areas. As a result, taxilanes can be planned to varying design standards depending on the type of aircraft utilizing the taxilane. For example, a taxilane leading to a T-hangar area only needs to be designed to accommodate those aircraft typically accessing the T-hangar.

NAVIGATIONAL AND APPROACH AIDS

Navigational aids are devices that provide pilots with guidance and position information when utilizing the runway system. Electronic and visual guidance to arriving aircraft enhance the safety and capacity of the airfield. Such facilities are vital to the success of an airport and provide additional safety to passengers using the air transportation system. While instrument approach aids are especially helpful during poor weather, they are often used by pilots conducting flight training and operating larger aircraft when visibility is good. GCN employs the following navigational and approach aids.

Instrument Approach Aids

Instrument approaches are categorized as either precision or non-precision. Precision instrument approach aids provide an exact course alignment and vertical descent path for an aircraft on final approach to a runway, while non-precision instrument approach aids provide only course alignment information. In the past, most existing precision instrument approaches in the United States have been the ILS; however, with advances in global positioning system (GPS) technology, it can now be used to provide both vertical and lateral navigation for pilots under certain conditions.

GCN currently has straight-in instrument approach capability to Runway 3, including the ILS or localizer (LOC) with distance measuring equipment (DME) approach, area navigation (RNAV) GPS approach, and very high omnidirectional range (VOR) approach. The ILS approach provides for the lowest minimums with ¾-mile visibility and 200-foot cloud ceilings. A straight-in instrument approach procedure is not offered on Runway 21. It is unlikely that Runway 21 will be served by a straight-in instrument approach procedure due to the proximity and airspace associated with the GCNP to the north. It should be noted that the approaches serving Runway 3 also provide circling minimums to Runway 21.

Runway 3 is currently not served by an approach lighting system. In the past, Runway 3 was served by a medium intensity approach lighting system (MALS). The MALS, in conjunction with the localizer antenna and glide slope antenna, provided ideal approach minimums to Runway 3 down to 200-foot cloud ceilings and ¾-mile visibility minimums. This approach lighting system enhanced safety at the Airport, especially during inclement weather or nighttime activity. Although the MALS has been decommissioned, Runway 3 is still served by approach minimums providing for 200-foot cloud ceilings and ¾-mile visibility. It should be noted that a more sophisticated approach lighting system in the form of a medium intensity approach lighting system with runway alignment indicator lights (MALSR) would need to be implemented on a runway end in order to achieve visibility minimums lower than ¾-mile. Historically, an MALSR served Runway 3 at GCN and provided for approach visibility minimums down to ½-mile. The runway alignment indicator lights were decommissioned prior to the MALS being decommissioned. In doing so, the approach visibility minimums were increased to ¾-mile.

Visual Approach Aids

In most instances, the landing phase of any flight must be conducted in visual conditions. To provide pilots with visual guidance information during landings to the runway, electronic visual approach aids are commonly provided at airports. Currently, Runway 21 is served by a four-box visual approach slope indicator (VASI-4) system. In the event that the VASI-4 needs replaced, future planning should consider a four-box precision approach path indicator (PAPI-4). As detailed in Chapter One, the VASI system on Runway 21 has been replaced with a PAPI-4 system. In addition, a more current PAPI-4 should be implemented on Runway 3.

Runway end identification lights (REILs) are flashing lights located at the runway threshold end that facilitate rapid identification of the runway end at night and during poor visibility conditions. REILs provide pilots with the ability to identify the runway thresholds and distinguish the runway end lighting from other lighting on the airport and in the approach areas. The FAA indicates that REILs should be considered for all lighted runway ends not planned for a more sophisticated approach lighting system. A REIL system has been installed at the Runway 21 threshold.

Weather Reporting Aids

GCN has a lighted wind cone and segmented circle, as well as additional supplemental wind cones in various locations on the airfield. The wind cones provide information to pilots regarding wind speed and direction. The segmented circle consists of a system of visual indicators designed to provide traffic pattern information to pilots. These should be maintained throughout the planning period.

The Airport is equipped with an ASOS which provides weather observations 24 hours per day. The system updates weather observations every minute, continuously reporting significant weather changes as they occur. This information is then transmitted at regular intervals (usually once per hour) on the Airport's automated terminal information service (ATIS). Aircraft in the vicinity can receive this information if they have their radio tuned to the correct frequency (124.3 MHz). In addition, pilots and individuals can call a published telephone number and receive the information via an automated voice recording. This system should be maintained through the planning period.

Communication Facilities

GCN has an operational ATCT located on the east side of Runway 3-21. The ATCT is staffed with FAA personnel from 6:00 a.m. to 8:00 p.m. daily from June 1 through September 30 and from 7:00 a.m. to 7:00 p.m. from October 1 through May 31. The ATCT enhances safety at the Airport and should be maintained through the planning period.

AIRFIELD LIGHTING, MARKING, AND SIGNAGE

There are a number of lighting and pavement marking aids serving pilots using the Airport. These aids assist pilots in locating an airport and runway at night or in poor visibility conditions. They also assist in the ground movement of aircraft.

Airport Identification Lighting

The location of the airport at night is universally indicated by a rotating beacon. For civil airports, a rotating beacon projects two beams of light, one white and one green, 180 degrees apart. The existing beacon on top of the ATCT should be maintained through the planning period.

Runway and Taxiway Lighting

Runway lighting provides the pilot with positive identification of the runway and its alignment. Runway 3-21 is served by medium intensity runway lighting (MIRL). This system should be maintained through the planning period.

Medium intensity taxiway lighting (MITL) is provided on parallel Taxiway P and all associated entrance/exit taxiways serving Runway 3-21. This system is vital for safe and efficient ground movements and should be maintained in the future. Planning should consider MITL on future taxiways that support the runway system at GCN.

It should be noted that a project is currently underway to replace the incandescent runway and taxiway edge lighting systems and signage with light emitting diode (LED) technology. LEDs have many advantages, including lower energy consumption, longer lifetime, tougher construction, reduced size, greater reliability, and faster switching. While a substantial initial investment is required upfront, the energy savings and reduced maintenance costs will outweigh any additional costs in the long run.

Pavement Markings

Runway markings are typically designed to the type of instrument approach available on the runway. FAA AC 150/5340-1K, *Standards for Airport Markings*, provides guidance necessary to design airport markings.

Runway 3 is served by precision markings. This aids in accommodating the ILS approach to the runway end and provides enhanced identification for both ends of the primary runway at the Airport. Runway 21 currently has non-precision markings. All runway markings should be maintained through the long term planning period.

Airfield Signs

Airfield identification signs assist pilots in identifying their location on the airfield and directing them to their desired location. Lighted signs are installed on the runway and taxiway system on the airfield. The signage system includes runway and taxiway designations, holding positions, routing/directional, distance remaining, and runway exits. All of these signs should be maintained throughout the planning period.

A summary of the airside facilities previously discussed at GCN is presented on **Exhibit 4H**.

LANDSIDE FACILITIES

Landside facilities are those necessary for the handling of aircraft and passengers while on the ground. These facilities provide the essential interface between the air and ground transportation modes. The capacity of the various components of each element was examined in relation to projected demand to identify future landside facility needs. At GCN, this includes components for commercial service and general aviation needs such as:

- Passenger Terminal Facilities
- General Aviation Facilities
- Support Facilities

PASSENGER TERMINAL FACILITIES

Components of the passenger terminal complex include the terminal building, gate positions, and apron area. This section identifies the facilities required to meet the airport's needs through the planning period.

The review of the capacity and requirements for various terminal complex functional areas was performed with guidance from FAA AC 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities*. Terminal capacity and requirements were evaluated and developed for the following functional areas:

- Airline ticketing and operations
- Departure facilities
- Baggage claim
- Terminal services
- Public use areas and security
- Administration/Support
- Ground access

	AVAILABLE	SHORT TERM	LONG TERM
RUNWAY 3-21			
	RDC C-II-4000	RDC C-II-4000 - Improve RSA and ROFA	RDC C-III-4000
	8,999' x 150'*	Maintain	Examine potential to extend up to 10,000'
	88,000 lbs. SWL / 108,000 DWL / 160,000 DTWL	Maintain	Maintain
TAXIWAYS			
	All taxiways 75' - 93' wide	Re-evaluate width during future rehabilitation projects	Re-evaluate width during future rehabilitiation projects
	Runway/Parallel Taxiway Separation - 407'	Maintain at least 400' separation	Maintain at least 400' separation
	Hold apron serving Runway 3	Examine hold apron serving Runway 21	Maintain
	Hot Spot associated with Taxiways A and B	Mitigate Hot Spot	Maintain
		Examine taxiway system for safety, efficiency, and proper geometry	Examine taxiway system for safety, efficiency, and proper geometry
NAVIGATIONAL AND APPROACH AIDS			
	ILS or LOC/DME - Runway 3	Maintain	Maintain
	RNAV (GPS) - Runway 3	Maintain	Maintain
	VOR - Runway 3	Maintain	Maintain
	ASOS	Maintain	Maintain
	ATCT	Maintain	Maintain
	Lighted Windcones	Maintain	Maintain
	PAPI-4 - Runway 21	PAPI-4 - Runway 3	Maintain
	REILs - Runway 21	Maintain	Maintain
LIGHTING, MARKING, AND SIGNAGE			
	Rotating Beacon	Maintain	Maintain
	Non-Precision Markings - Runway 21	Maintain	Maintain
	Precision Markings - Runway 3	Maintain	Maintain
	MIRL with LED Technology	Maintain	Maintain
	MITL with LED Technology	Maintain	Maintain
	Hold lines 280' from runway centerline	Maintain	Hold lines 318' from runway centerline
	Lighted Airfield Signs	Maintain	Maintain

KEY:

RDC - Runway Design Code
RSA - Runway Safety Area
ROFA - Runway Object Free Area
SWL - Single Wheel Loading
DWL - Dual Wheel Loading
DTWL - Dual Tandem Wheel Loading
ILS - Instrument Landing System
LOC - Localizer
DME - Distance Measuring Equipment
RNAV - Area Navigation
GPS - Global Positioning System
VOR - Very High Frequency Omnidirectional Range
ASOS - Automated Surface Observing System
PAPI - Precision Approach Path Indicator
REIL - Runway End Identification Light
ATCT - Airport Traffic Control Tower
MIRL - Medium Intensity Runway Lighting
MITL - Medium Intensity Taxiway Lighting
LED - Light Emitting Diode

*Runway 3-21 surveyed width is 148'

Exhibit 4H
AIRSIDE FACILITIES SUMMARY

As previously discussed, GCN accommodates varying operational functionalities as it relates to passenger activity. Air tour activities associated with fixed-wing and helicopter operators carry different terminal requirements versus those needed for airline/air charter (destination airline) operators. As a result, this section separates the two types of operations and presents terminal facility needs for each. The first examines the fixed-wing air tour facility requirements and the second examines facility needs for destination airline activities forecast for this study. Depending on further evaluation to be made during the study process, the terminal facility needs could be served by one terminal facility or separate facilities.

It should be noted that since the helicopter air tour operators conduct activity from three private leaseholds on airport property, facility requirement needs associated with these operations were not included in this analysis. These needs are subject to their own planning and development with the private leaseholds.

Facility requirements were updated to reflect the short, intermediate, and long term planning horizons for enplanement milestones. For fixed-wing air tour operator facility requirements, this included the levels of 170,280, 190,060, and 232,200 annual enplaned passengers. For destination airline operator requirements, the forecast levels of 41,000, 67,000, and 125,000 annual enplanements were considered for the three planning horizons.

Fixed-Wing Air Tour Terminal Requirements

Currently fixed-wing air tour operations are conducted from the existing terminal building as well as the Grand Canyon Airlines' terminal facility located north of the passenger terminal building. In fact, approximately 70 percent of the current fixed-wing air tour enplanements are associated with Grand Canyon Airlines. As such, the majority of fixed-wing air tour passenger enplanements utilize the Grand Canyon Airlines facility.

The existing Airport terminal building provides for approximately 8,500 square feet of floor area. Grand Canyon Airlines operates out of a 5,473 square-foot facility which is used for a variety of functions to include passenger waiting lobbies, flight planning, restroom facilities, and other amenities. For purposes of this analysis, only the square footage offered in the Airport terminal building is considered. **Exhibit 4J** presents a functional breakdown of the current and future demand requirements for the terminal building.

When accounting for current activity levels, approximately 13,900 square feet of terminal space is needed in order to adequately accommodate fixed-wing air tour passenger enplanements. It is important to note that the functional space requirements for air tour operations do not include security screening as these flights typically do not operate under Title 14 CFR Part 139. The need for passengers to carry baggage is also minimal with these types of operations; therefore, baggage handling and claim functions are not factored into terminal facility needs for air tour operations.

		Current Need	Short 170,280	Intermediate 190,060	Long 232,200
DEPARTURES PROCESSING					
Ticket Counters					
Utilization Factor	100%	71	97	108	133
Agent Positions	#	6	7	7	9
Frontage	LF	36	42	42	54
Area	SF	380	440	440	570
Ticket Lobby					
Queuing Area	SF	380	520	580	710
Airline Ticket Office	SF	756	882	882	1,134
Ticket Lobby Circulation	SF	414	483	483	621
Public Area					
Waiting Lobby/Circulation	SF	1,243	1,698	1,890	2,328
CONCOURSE FACILITIES					
Passenger Holdrooms					
Gates	#	6	7	8	10
Holdroom Area	SF	2,565	3,205	3,620	4,370
Airline Operations	SF	3,300	4,200	4,800	5,700
Concourse Circulation					
Circulation Area	SF	770	962	1,086	1,311
PUBLIC SPACES					
Restrooms					
Area	SF	682	931	1,037	1,277
Concessions					
Food & Beverage	SF	430	553	618	755
Retail	SF	264	341	380	464
Support	SF	208	268	299	366
Rental Car					
Counter Frontage	LF	4	6	6	8
Counter and Office Area	SF	64	87	97	120
Counter Queuing Area	SF	34	47	52	64
Airport Administration					
Administration/Operations	SF	710	970	1,080	1,330
FUNCTIONAL AREA TOTAL					
Total Programmed Functional Area	SF	12,199	15,586	17,344	21,119
BUILDING SYSTEMS/SUPPORT					
Mechanical/HVAC	SF	488	623	694	845
General Circulation/ Stairwells/Storage	SF	1,220	1,559	1,734	2,112
TOTAL TERMINAL					
Gross Building Area	**SF**	**13,907**	**17,768**	**19,772**	**24,075**

Exhibit 4J: AIR TOUR TERMINAL FACILITY REQUIREMENTS

As passenger enplanements are forecast to increase through the long term planning period, the space requirements for terminal facilities is expected to increase. At the short term planning horizon, this could grow to 17,800 square feet, and by the long term, approximately 24,100 square feet of terminal area will be needed to support fixed-wing air tour activities. As previously discussed, the existence of the Grand Canyon Airlines facility does help to relieve space requirements. It will be important for GCN staff to coordinate with Grand Canyon Airlines in the future as it relates to meeting the needs of future fixed-wing air tour activities that could utilize either facility.

Airline/Air Charter (Destination Airline) Facility Requirements

The requirements for a terminal to serve destination airlines are more in line with a traditional commercial service passenger terminal. Since destination airline traffic at GCN is minimal at the present time of this analysis, base year data is not provided. The short term horizon would represent the minimum facility needs that should be planned for the first full year of a destination airline startup. **Exhibit 4K** summarizes the facility requirements for destination airline activities projected in the Master Plan.

The first destination for enplaning passengers in the terminal building is usually the airline ticket counter. The ticketing area consists of the ticket counters, queuing area for passengers in line at the counters, and the ticket lobby which provides circulation.

The ticket lobby should be arranged so that the enplaning passenger has immediate access and clear visibility to the individual airline ticket counters upon entering the building. Circulation patterns should allow the option of bypassing the counters with minimum interference. Provisions for seating should be minimal to avoid congestion and to encourage passengers to proceed to the gate area. Airline ticket counter frontage, counter area, counter queuing area, ticketing lobby, and airline office and operations area requirements for each potential enplanement level have been calculated. The amount of space needed in this area could be reduced with extensive curb and/or parking lot check-in options.

Ground level loading and unloading of passengers would be appropriate for GCN through at least the short term planning horizon. Achieving the forecast enplanement levels could lead to the utilization of loading bridges in the future, especially if jet aircraft with more than 70 or more passenger seats operate regularly at the Airport. Up to three departure gates could be needed through the long term planning horizon. Without an adequate number of gates, airline schedules may need to be coordinated to avoid overlapping arriving or departing aircraft.

The number of gates required to accommodate the combined peak hour activity and the aircraft seating capacities determine secure passenger hold room capacity requirements. Hold rooms should be sized to provide adequate space and area for the largest group of people that can use each gate. The entrance of larger commercial aircraft capable of seating more than 50 passengers could likely trigger the need for additional hold room area.

		Short 42,000	Intermediate 67,000	Long 125,000
DEPARTURES PROCESSING				
Ticket Counters				
Utilization Factor	90%	68	100	125
Agent Positions	#	4	5	5
Frontage	LF	24	30	30
Area	SF	260	330	330
Ticket Lobby				
Queuing Area	SF	380	570	710
TSA Baggage Check	SF	480	600	600
Outbound Baggage	SF	1,150	1,440	1,440
Airline Ticket Office	SF	500	630	630
Ticket Lobby Circulation	SF	280	350	350
Public Area				
Circulation	SF	4,200	6,250	7,800
Security Stations				
Number	#	1	1	2
Queuing Area	SF	240	360	450
Station Area	SF	360	360	720
TSA Administration/Operations	SF	700	700	1,400
CONCOURSE FACILITIES				
Passenger Holdrooms				
Gates	#	2	2	3
Holdroom Area	SF	1,930	2,480	3,450
Airline Operations	SF	1,500	1,500	2,000
Concourse Circulation				
Circulation Area	SF	580	740	1,040
ARRIVALS PROCESSING				
Baggage Claim				
Passengers claiming bags	85%	64	95	118
Claim Display Frontage	LF	50	80	100
Claim Device Floor Area	SF	250	400	500
Inbound Baggage	SF	800	1,280	1,600
Baggage Service Office	SF	100	160	200
Claim Lobby				
Area Excl. Device Area	SF	1,520	2,260	2,820
Circulation Area	SF	910	1,360	1,690
PUBLIC SPACES				
Restrooms				
Area	SF	720	1,070	1,340
Concessions				
Food & Beverage	SF	500	800	1,500
Retail	SF	210	340	630
Support	SF	140	230	430
Rental Car				
Counter Frontage	LF	15	22	28
Counter and Office Area	SF	230	330	420
Counter Queuing Area	SF	120	180	220
Airport Administration				
Administration/Operations	SF	1,200	1,800	2,200
FUNCTIONAL AREA TOTAL				
Total Programmed Functional Area	SF	19,260	26,520	34,470
BUILDING SYSTEMS/SUPPORT				
Mechanical/HVAC	SF	770	1,060	1,380
General Circulation/Stairwells/Storage	SF	1,930	2,650	3,450
TOTAL TERMINAL				
Gross Building Area	**SF**	**21,960**	**30,230**	**39,300**

Exhibit 4K: DESTINATION AIRLINE TERMINAL FACILITY REQUIREMENTS

The passenger arrival process consists primarily of those facilities and functions that reunite the arriving passengers with their checked baggage. The existing baggage claim area in the terminal building is limited and forecasts call for a significant increase in the size of the current baggage claim handling and lobby/pick-up area through the long term.

The public lobby is where passengers or visitors may comfortably relax while waiting for arrivals or departures. In today's environment, visitors must remain out of the secure departure areas, so a public lobby is important. At GCN, since most passengers will not be local, the amount of space needed for a public lobby area will be limited.

Unlike fixed-wing air tour operations, space for security passenger screening will be needed for destination airline activities. A single security screening station should be adequate through the intermediate term planning horizon; however, a second station could be needed in order to accommodate long term activity levels.

Public spaces include passenger and visitor-orientated amenities, concessions, restrooms, and rental car facilities. These space requirements in addition to other support needs such as airport administration and operations is outlined in **Exhibit 4K**. Given that GCN primarily caters to tourists, demands for rental cars and shuttle services could be higher than the typical airport that is forecast to have associated enplanement levels.

Building support facilities include all miscellaneous spaces at the airport, including mechanical, telephone, business centers, walls/structures, and general circulation. As other components of the airport increase in size, so will supporting spaces.

As indicated, a 22,000 square-foot terminal could accommodate the short term enplanement projection of 41,000. With a long term projection of 125,000 annual enplanements, planning should consider allowing for 39,300 square feet of terminal floor space. The alternatives analysis to be conducted later in this study will explore options for the Airport to meet potential destination airline demands.

Terminal Access Requirements

The passenger terminal building serves as the primary interface between air and ground transportation. Ground access to the terminal area is an important consideration as access and convenience can positively influence the development of an airport.

The capacity of the airport access and terminal area roadways is the maximum number of vehicles that can pass over a given section of a lane or roadway during a given time period. It is normally preferred that a roadway operate below capacity to provide reasonable flow and minimize delay to the vehicles using it. Access to/from the Airport, and more specifically to the terminal area, was detailed in Chapter One. Access to the terminal building is provided by Airport Road, which makes a loop road leading to the terminal building curb.

Curb Frontage

The curb element is the interface between the terminal building and the ground transportation system. The length of curb required for the loading and unloading of passengers and baggage is determined by the type and volume of ground vehicles anticipated in the peak period on the design day.

A typical problem for terminal curb capacity is the length of dwell time for vehicles utilizing the curb. At airports where the curb front has not been strictly patrolled, vehicles have been known to be parked at the curb while the driver and/or riders are inside the terminal checking in, greeting arriving passengers, or awaiting baggage pick-up. Since most curbs are not designed for vehicles to remain curbside for more than two to three minutes, capacity problems can ensue. Since the events of September 11, 2001, most airports police the curb front much more strictly for security reasons. This alone has reduced the curb front capacity problems at most airports.

The existing terminal building curb is approximately 315 feet in length. The mix at the curb during peaking periods can include buses, shuttles, and individual vehicles. The existing and projected terminal curb needs at GCN for fixed-wing air tour activities in presented in **Table 4L**. The current length is adequate through the intermediate term planning horizon, but additional curb front could be needed in the long term as passenger enplanements exceed 200,000. Approximately 370 feet of terminal curb is estimated for the long term planning horizon.

TABLE 4L
Fixed Wing Air Tour Terminal Curb and Parking Requirements
Grand Canyon National Park Airport

	Available	Current	Short Term	Intermediate Term	Long Term
Annual Enplanements		132,198	170,280	190,060	232,200
Terminal Curb Length (Ft)	315	200	260	290	370
Air Tour Parking (spaces)					
Auto Parking	186	89	122	136	168
Shuttle Parking	-	9	12	13	16
Bus Parking	34	14	18	20	24
Rental Car	-	16	21	24	29
Employee Parking	-	13	18	20	25
Total Vehicle Parking	186	141	191	212	262

Source: Coffman Associates analysis

Vehicle Parking

Vehicle parking in the passenger terminal area of the airport includes those spaces utilized by passengers, visitors, and employees of the terminal complex. Parking spaces can be classified as public, employee, and rental car.

Public parking is located in surface lots in the terminal area. This parking area currently contains approximately 186 spaces for individual vehicle parking and 34 marked spaces for buses and shuttle vans. It should be noted that the vehicle parking spaces associated with the helicopter tour operators are not factored into this analysis for similar reasons discussed in the terminal facility requirements.

As an airport located in a remote tourist location, most passengers utilizing GCN are visitors in the area. As a result, the ratio of public parking to enplaned passengers will be significantly lower than might be expected in typical airport settings.

Parking requirements associated with fixed-wing air tour operations were based upon a ratio to peak hour passengers. These would involve persons visiting the area that drive and park at the Airport to take part in an air tour. Bus parking is another component to consider in parking requirements as large groups of individuals often arrive at the Airport via a bus or shuttle in order to take an air tour. Space is currently provided in the terminal area to accommodate these buses or shuttles. The requirements for these operations are based upon a ratio of design day passengers that will utilize buses or shuttles. Since most individuals utilizing fixed-wing air tours already have other ground transportation on arrival, rental car requirements associated with this activity is limited.

The parking requirements for the fixed-wing air tour terminal area are presented in Table 4L. Additional parking could be needed through the long term planning horizon, mainly in the form of rental car and employee parking needs.

The destination airline terminal area parking requirements can be expected to have a much higher rental car requirement as many destination passengers will be looking for transportation in order to tour the area. In doing so, space for buses and shuttles is projected to be much less than those associated with the fixed-wing air tour activities. **Table 4M** presents the forecast destination airline curb and parking requirements for the short, intermediate, and long term planning horizons. Total parking requirements are projected at approximately 300 spaces in the long term, which are made up of several parking functions including individual, buses and shuttles, rental car, and employee. The alternatives phase of the Master Plan will further evaluate options to meet potential parking requirements outlined in this chapter based on the functional uses previously detailed.

TABLE 4M
Destination Airline Terminal Curb and Parking Requirements
Grand Canyon National Park Airport

	Short Term	Intermediate Term	Long Term
Annual Enplanements	42,000	67,000	125,000
Terminal Curb Length (ft)	150	230	290
Destination Parking (spaces)			
Auto Parking			
Short Term	23	33	42
Long Term	45	71	133
Total Auto Parking	68	104	175
Shuttle Parking	4	6	11
Bus Parking	1	1	2
Rental Car Ready/Return	26	42	79
Employee Parking	19	27	38
Total Vehicle Parking	118	180	305

Source: Coffman Associates analysis

GENERAL AVIATION FACILITIES

General aviation facilities are those necessary for handling general aviation aircraft, passengers, and cargo while on the ground. This section is devoted to identifying future general aviation facility needs during the planning period for the following types of facilities normally associated with general aviation terminal areas.

- General Aviation Terminal Services
- Hangars
- Aircraft Parking Aprons

General Aviation Terminal Services

The general aviation facilities at an airport are often the first impression of the community that corporate officials and other visitors will encounter. General aviation terminal facilities at an airport provide space for passenger waiting, pilots' lounge, pilot flight planning, concessions, management, storage, and various other needs. This space is not necessarily limited to a single, separate terminal building, but can include space offered by fixed base operators (FBOs) and other specialty operators for these functions and services. At GCN, general aviation terminal services are primarily provided by Grand Canyon Airlines. Grand Canyon Airlines currently operates out of a 5,473 square-foot facility on the north side of the Airport. This facility accommodates not only general aviation activities but also Grand Canyon Airlines' air tour operations.

The methodology used in estimating general aviation terminal facility needs was based upon the number of airport users expected to utilize general aviation facilities during the design hour. Space requirements for terminal facilities were based on providing 125 square feet per design hour itinerant passenger. A multiplier of 2.5 in the short term, increasing to 3.0 in the long term, was also applied to terminal facility needs in order to better determine the number of passengers associated with each itinerant aircraft operation. This increasing multiplier indicates an expected increase in operations through the long term. These operations often support larger turboprop and jet aircraft which accommodate an increasing passenger load factor.

Table 4N outlines the space requirements for general aviation terminal services at GCN through the long term planning period. As shown in the table, up to 1,100 square feet of space could be needed in the long term for general aviation passengers. The amount of space currently offered in the Grand Canyon Airlines' facility is 5,473 square feet; however, not all of this space is dedicated for general aviation activities. These spaces include designated areas for passenger waiting lobbies, flight planning, restroom facilities, and other amenities.

TABLE 4N
General Aviation Terminal Area Facilities
Grand Canyon National Park Airport

	Currently Available	Short Term Need	Intermediate Term	Long Term Need
General Aviation Services Facility Area (s.f.)	5,473*	600	900	1,100
Design Hour Passengers	5	5	8	9
Passenger Multiplier	2.3	2.5	2.7	3.0
Vehicle Parking Spaces	186**	6	8	11

* Includes approximate space offered by Grand Canyon Airlines
** Approximate number of marked vehicle parking spaces at the Airport that accommodate the terminal building and Grand Canyon Airlines
Source: Coffman Associates analysis

General aviation vehicular parking demands have also been determined for GCN. Space determinations for itinerant passengers were based on an evaluation of existing airport use, as well as standards set forth to help calculate projected terminal facility needs. Parking requirements for general aviation activity call for approximately six spaces in the short term, increasing to approximately 11 spaces in the long term planning horizon. It is estimated that there are 186 marked vehicle parking spaces at GCN currently serving various activities, including commercial passenger terminal services, Grand Canyon Airlines' FBO and air tour operations, and other aviation functions.

Hangars

The demand for aircraft hangars typically depends on local climate, security, and owner preferences. The trend in general aviation aircraft, whether single or multi-engine, is toward more sophisticated aircraft (and, consequently, more expensive aircraft); therefore, many aircraft owners prefer enclosed hangar space to outside tie-downs.

The demand for aircraft storage hangars is dependent upon the number and type of aircraft expected to be based at an airport in the future. For planning purposes, it is necessary to estimate hangar requirements based upon forecast operational activity. However, hangar development should be based upon actual demand trends and financial investment conditions.

Hangar types vary in size and function. T-hangars and linear box hangars are popular with aircraft owners having only one small aircraft. These hangars provide individual spaces within a larger structure. Aircraft owners are allowed privacy and individual access to their space. Executive hangars are open-space facilities with no interior supporting structure. These hangars can vary in size and typically house multi-engine, turboprop, or jet aircraft, in addition to helicopters. Conventional hangars are open space facilities with no supporting structure interference that can store several aircraft. Often, other airport services are offered from the conventional hangars, such as FBO activities.

As previously detailed, general aviation based aircraft at GCN is limited, with most of the based aircraft activity involved in air tour operations. The current based aircraft (fixed-wing and helicopters) are generally kept on the respective aircraft parking apron space and helicopter landing areas associated with each air tour operator; therefore, they are not factored into this analysis. There are two hangar facilities located at the Airport that are associated with general aviation activities. Grand Canyon Airlines utilizes a 10,000 square-foot hangar mainly for maintenance activities associated with its air tour operations; however, the facility can also be utilized to accommodate occasional general aviation needs. The National Park Service also operates out of a 3,600 square-foot hangar adjacent to the south side of the Aircraft Rescue and Firefighting Facility (ARFF).

Grand Canyon Airlines Hangar
Source: Coffman Associates

Future hangar requirements for the Airport are summarized in **Table 4P**. The analysis shows that future hangar requirements indicate that there is a potential need for 20,800 feet of hangar storage space to be offered through the long term planning period. This includes a mixture of hangar and maintenance areas. Since the hangar utilized by Grand Canyon Airlines is primarily dedicated to activities associated with its air tour operations, it is possible that additional hangar storage space would be needed to help satisfy potential general aviation demand through the long term planning period. Further evaluation during the alternatives phase of the Master Plan will explore the potential for additional hangars at the Airport.

TABLE 4P
General Aviation Aircraft Hangar Requirements
Grand Canyon National Park Airport

	Currently Available	Short Term Need	Intermediate Term Need	Long Term Need
Total Based Aircraft (non-air tour operator)	2	3	5	9
Hangar Area Requirements				
Executive/Conventional Hangar Area (s.f.)	13,600	6,000	10,500	19,000
Maintenance Area (s.f.)		600	1,000	1,800
Total Hangar Area (s.f.)	**13,600***	**6,600**	**11,500**	**20,800**

Note: * Includes total general aviation hangar and maintenance area currently at the Airport
Source: Coffman Associates analysis

It should be noted that hangar requirements are general in nature and based on the aviation demand forecasts. The actual need for hangar space will further depend on the actual usage within hangars. For example, some hangars may be utilized entirely for non-aircraft storage, such as maintenance; yet from a planning standpoint, they have an aircraft storage capacity. Therefore, the needs of an individual user may differ from the calculated space necessary.

Aircraft Parking Aprons

The aircraft parking apron is an expanse of paved area intended for aircraft parking and circulation. Typically, a main apron is centrally located near the airside entry point, such as the terminal building or FBO facilities. Ideally, the main apron is large enough to accommodate transient airport users, as well as a portion of locally based aircraft. Often, smaller aprons are available adjacent to FBO hangars and at other locations around the airport. The apron layout at GCN includes parking apron space adjacent to the FBO facility, as well as additional apron space for the parking and circulation of aircraft.

The total aircraft parking apron area dedicated for general aviation activities at GCN is approximately 8,500 square yards according to the Airport Certification Manual (ACM) and includes 17 marked fixed-wing aircraft tie-down spaces. This location is adjacent to Grand Canyon Airlines. A planning criterion of 800 square yards was used for single and multi-engine itinerant aircraft, while a planning criterion of 1,600 square yards was used to determine the area for transient turboprop and jet aircraft.

A parking apron should also provide space for the number of locally based aircraft that are not stored in hangars. Locally based tie-downs typically will be utilized by smaller single engine aircraft; thus, a planning standard of 360 square yards per position is utilized. For local tie-down needs, additional space is also identified for maintenance activities. Maintenance activities would include the movement of aircraft into and out of hangar facilities and temporary storage of aircraft on the apron.

The total apron parking requirements are presented in **Table 4Q**. As shown in the table, it appears that there are adequate marked tie-down positions available for general aviation activities through the intermediate planning period of this study. Future facility planning will consider the potential for additional parking apron space to accommodate the mix of general aviation activity that occurs at the Airport. It should be noted that the Airport provides a total of approximately 113,600 square yards of apron space that can be utilized for commercial/air charter and general aviation aircraft. While this existing space should be able to accommodate future aviation demand at the Airport, planning will consider re-designating certain portions of existing apron space to meet the long term demands of general aviation aircraft.

TABLE 4Q
General Aviation Aircraft Parking Apron Requirements
Grand Canyon National Park Airport

	Available	Short Term	Intermediate Term	Long Term
Transient Single, Multi-Engine Aircraft Positions		5	7	8
Apron Area (s.y.)		4,400	5,300	6,300
Transient Turboprop/Jet Positions		4	6	8
Apron Area (s.y.)		6,900	9,600	12,200
Locally-Based Aircraft Positions		3	4	5
Apron Area (s.y.)		1,100	1,400	1,800
Total Marked Positions	17	13	17	21
Total Apron Area (s.y.)	8,500	12,400	16,300	20,300

Source: Coffman Associates analysis

In addition to fixed-wing aircraft parking, areas should also be dedicated for transient and based helicopter parking that is not associated with the tour operators. Helicopters also operate on various apron areas shared by fixed-wing aircraft at GCN. Helicopter operations should be segregated to the extent practicable to increase safety and efficiency of aircraft parking aprons. Long term facility planning will consider dedicated transient and based helicopter activity areas on and adjacent to the expansive aircraft parking apron.

A summary of the general aviation landside facilities previously discussed at GCN is presented on **Exhibit 4L**.

SUPPORT FACILITIES

Various other landside facilities that play a supporting role in overall airport operations have also been identified. These support facilities include:

- Aircraft Rescue and Firefighting (ARFF)
- Aviation Fuel Storage
- Maintenance Facilities
- Perimeter Fencing and Gates
- Helicopter Parking
- Sky Diving Landing Operations
- Utilities

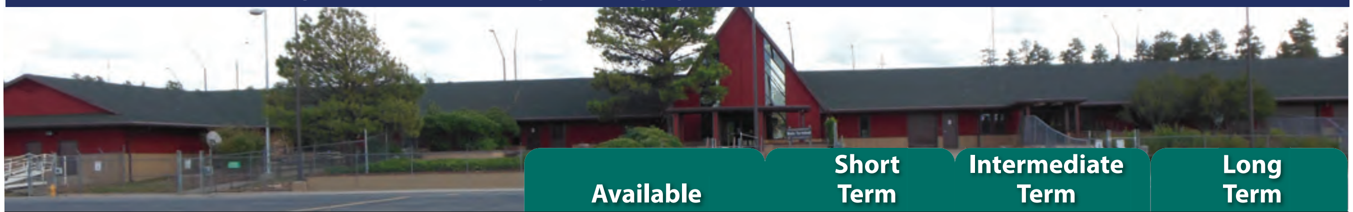
Aircraft Rescue and Firefighting

Requirements for aircraft rescue and firefighting (ARFF) services at an airport are established under Title 14 CFR Part 139, which applies to the certification and operation of airports served by any scheduled or unscheduled passenger operation of an air carrier using an aircraft with nine or more passenger seats. Paragraph 139.315 establishes ARFF Index ratings based on the length of the largest aircraft with an average of five or more daily departures.

The following indicates the requirements for each ARFF Index and the associated equipment requirements:

Index A - Includes aircraft less than 90 feet in length (Saab 340, Embraer ERJ-135).
Index B - Includes aircraft at least 90 feet but less than 126 feet in length (Embraer ERJ-145, Boeing 737).
Index C - Includes aircraft at least 126 feet but less than 159 feet in length (MD-83, Boeing 757).
Index D - Includes aircraft at least 159 feet but less than 200 feet in length (Boeing 767).
Index E - Includes aircraft at least 200 feet in length (Boeing 747).

GENERAL AVIATION TERMINAL SERVICES



	Available	Short Term	Intermediate Term	Long Term
General Aviation Services Facility Area (s.f.)	5,473*	600	900	1,100
Vehicle Parking Spaces	186**	6	8	11

AIRCRAFT STORAGE HANGAR REQUIREMENTS

	Available	Short Term	Intermediate Term	Long Term
Total Based Aircraft (non-air tour operator)	2	3	5	9
Executive/Conventional Hangar Area (s.f.)	13,600***	6,000	11,500	20,800
Maintenance Area (s.f.)		600	1,000	1,800
Total Hangar Area (s.f.)		**13,600**	**11,500**	**20,800**

AIRCRAFT PARKING APRON REQUIREMENTS

	Available	Short Term	Intermediate Term	Long Term
Transient Single and Multi-Engine Aircraft Positions		5	7	8
Apron Area (s.y.)		4,400	5,300	6,300
Transient Turboprop / Jet Positions		4	6	8
Apron Area (s.y.)		6,900	9,600	12,200
Locally-Based Aircraft Positions		3	4	5
Apron Area (s.y.)		1,100	14,000	1,800
Total Marked Positions	**17**	**13**	**17**	**21**
Total Apron Area (s.y.)	**8,500**	**12,400**	**16,300**	**20,300**

SUPPORT FACILITIES

	Available	Short Term	Intermediate Term	Long Term
Fuel Storage - 100LL	20,000 gallons	Based on Fixed Base Operator aircraft demand.		
Fuel Storage - JetA	20,000 gallons			
	ARFF - Index B	Maintain	Maintain	Maintain
	Security Fencing / Gates	Maintain	Maintain	Maintain
	Airport Maintenance Facilities	Consolidation of Airport Maintenance Facilities and Equipment		

*Includes approximate space offered by Grand Canyon Airlines
**Approximate number of marked vehicle parking spaces at the Airport that accommodate the terminal building and Grand Canyon Airlines
***Includes total general aviation hangar and maintenance area currently at the Airport

Exhibit 4L: GENERAL AVIATION LANDSIDE AND SUPPORT FACILITIES SUMMARY

The GCN ARFF facility must currently provide Index B for airline service according to the Airport Certification Manual. Based upon future forecasts of aviation demand, Index B should be applicable through the long term planning period. **Table 4R** presents the vehicle requirements and capacities for each index level. The existing ARFF facility is located south of the ATCT facility near midfield on the east side of the Airport. This location provides good access to the airfield system.

TABLE 4R
ARFF Index Requirements

Index	Aircraft Length	Requirements
Index A	<90'	1. One ARFF vehicle with 500 lbs. of sodium-based dry chemical or
		2. One vehicle with 450 lbs. of potassium-based dry chemical and 100 lbs. of water and AFFF for simultaneous water and foam application
Index B	90'-126'	1. One vehicle with 500 lbs. of sodium-based dry chemical and 1,500 gallons of water and AFFF or
		2. Two vehicles, one with the requirements for Index A and the other with enough water and AFFF for a total quantity of 1,500 gallons
Index C	126'-159'	1. Three vehicles, one having Index A, and two with enough water and AFFF for all three vehicles to combine for at least 3,000 gallons of agent or
		2. Two vehicles, one with Index B and one with enough water and AFFF for both vehicles to total 3,000 gallons
Index D	159'-200'	1. One vehicle carrying agents required for Index A and
		2. Two vehicles carrying enough water and AFFF for a total quantity by the three vehicles of at least 4,000 gallons
Index E	>200'	1. One vehicle with Index A and
		2. Two vehicles with enough water and AFFF for a total quantity of the three vehicles of 6,000 gallons

AFFF: Aqueous Film-Forming Foam
ARFF: Aircraft Rescue and Firefighting
Source: Title 14 Code of Federal Regulations Part 139

Aviation Fuel Facilities

As previously discussed in Chapter One, there are currently four fuel farms located on airport property that store aviation fuel. Three of these fuel farms are owned and operated by the helicopter tour operators (Grand Canyon Helicopters, Papillon Helicopters, and Maverick Helicopters) and utilized for the sole purpose of providing fuel to the company's helicopter operations and is not associated with the re-sale of fuel for commercial aviation activities.

Grand Canyon Airlines serves as a fixed base operator (FBO) at the Airport and is currently the only provider of fuel for commercial re-sale. It also conducts air tour operations utilizing fixed-wing aircraft and utilizes its fuel farm to provide fuel for the company's aircraft operations.

There is currently 40,000 gallons of fuel storage capacity on airport property utilized for the re-sale of fuel for commercial aviation activities. Of this capacity, 20,000 gallons is dedicated to Avgas (100LL) and 20,000 gallons is dedicated to Jet A fuel.

Fuel storage requirements are typically based upon keeping a two-week supply of fuel during an average month; however, more frequent deliveries can reduce the fuel storage capacity requirements. Generally, fuel tanks should be of adequate capacity to accept a full refueling tanker, which is approximately 8,000 gallons, while maintaining a reasonable level of fuel in the storage tank. Future fueling demand experienced by the FBO will determine the need for additional fuel storage capacity. It is important that GCN personnel work with the FBO to plan for adequate levels of fuel storage capacity through the long term planning period of this study.

In order to better accommodate future aviation demand, facility planning should consider enhancing fuel facilities at the Airport that could include the installation of a self-service fueling system. A self-service fueling system provides pilots the opportunity to access fuel at an airport 24 hours per day / seven days per week. A credit card reader is tied to the fueling system that activates the flow of fuel. This system is oftentimes beneficial for on-demand emergency aircraft that operate during irregular business hours. The alternatives analysis will further evaluate the potential for enhanced fueling capabilities at GCN and include such factors as location, land use issues, and the feasibility of upgrading existing systems and/or installing new systems.

Maintenance Facilities

The GCN maintenance facilities are located immediately south of the Tusayan Town Hall and Airport management office. There are four buildings in the maintenance complex totaling approximately 5,000 sf. These facilities are utilized for the storage of maintenance equipment and materials. The ARFF facility is also utilized for the storage of various maintenance equipment, including pavement sweepers and snow removal equipment (SRE). Future planning will consider the consolidation of airport maintenance facilities to provide for adequate staging and storing of airfield equipment and supplies.

Perimeter Fencing and Gates

Perimeter fencing is used at airports primarily to secure the aircraft operational area. The physical barrier of perimeter fencing provides the following functions:

- Gives notice of the legal boundary of the outermost limits of a facility or security-sensitive area.
- Assists in controlling and screening authorized entries into a secured area by deterring entry elsewhere along the boundary.
- Supports surveillance, detection, assessment, and other security functions by providing a zone for installing intrusion-detection equipment and closed-circuit television (CCTV).
- Deters casual intruders from penetrating a secured area by presenting a barrier that requires an overt action to enter.
- Demonstrates the intent of an intruder by their overt action of gaining entry.
- Causes a delay to obtain access to a facility, thereby increasing the possibility of detection.
- Creates a psychological deterrent.

- Optimizes the use of security personnel, while enhancing the capabilities for detection and apprehension of unauthorized individuals.
- Demonstrates a corporate concern for facilities.
- Limits inadvertent access to the aircraft operations area by wildlife.

GCN's airport operations area is enclosed with eight-foot tall chain-link fence topped by three-strand barbed-wire. Several controlled-access and manual gates associated with the fencing lead to different areas on the airfield.

Helicopter Parking

There are currently two marked helicopter landing areas adjacent to the north aircraft parking apron located approximately 600 feet from the Runway 21 landing threshold. These parking areas are associated with transient helicopter activity and not designed to accommodate the helicopter tour operations associated with Grand Canyon Helicopters, Papillon Helicopters, and Maverick Helicopters. It should be noted that the pavements associated with these landing areas are in poor condition. Furthermore, the existing locations of the landing areas are located within the ROFA associated with Runway 3-21.

Future planning will consider a dedicated location for a future helicopter landing area for transient use. Such a landing area could benefit specific needs associated with military training and on-demand medical emergency activities.

Sky Diving Landing Operations

Mentioned earlier in this study, an active sky diving landing zone is currently located on GCN and used in relation to operations conducted by Paragon Skydive based on the Airport. The sky diving landing zone is located toward the south end of the airfield to the east of Taxiway P.

According to the United States Parachute Association, an active civilian parachute landing area shall be unobstructed by hazards within a minimum radial distance of approximately 40 feet for experienced parachute holders and up to 330 feet for less experienced parachute holders and solo students. Hazards can be defined as telephone or power lines, towers, buildings, open bodies of water, highways, automobiles, and clusters of trees.

Consideration should be given to accommodating sky diving activities in the future should the Airport have available property to satisfy the safety requirements for a designated landing zone. In any event, it is desirable to keep these activities clear of the runway and taxiway system and their required safety areas, and properly separated from landside development.

Utilities

The availability and capacity of the utilities serving an airport are factors in determining the development potential of the Airport. Electrical, water, waste water, and telecommunication services are available at GCN. Utility extensions to potential development areas on the Airport may be needed through the planning period. In addition, the availability of water is a key factor in the future development potential of the Airport and surrounding region. A more detailed evaluation of existing and potential utility enhancements at the Airport will be undertaken later in this study.

REVENUE SUPPORT LAND USES

As part of this Master Plan, consideration will be given to portions of GCN property to be utilized for non-aviation purposes. As can be seen from the analysis of facility needs conducted so far, the majority of airport property is needed to help satisfy existing and projected aviation demand. Prudent planning, however, will evaluate various land uses that could be developed for non-aviation purposes that would be compatible with aviation-related activity in order to further support and enhance GCN's self-sufficiency.

It should be noted that the Airport does not have the approval to use undeveloped property for non-aviation purposes at this time. Specific approval from the FAA will be required to utilize undeveloped property for non-aviation uses. This planning document does not gain approval for non-aviation uses, even if these uses are ultimately shown in the Master Plan and on the ALP. A separate request justifying the use of airport property for non-aviation uses will be required. This study can be a source for developing that justification.

An environmental determination will also be required. While FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*, states that a release of an airport sponsor from federal obligations is normally categorically excluded and would not normally require an Environmental Assessment (EA), the issuance of a categorical exclusion is not automatic, and the FAA must determine that no extraordinary circumstances exist at the airport. Extraordinary circumstances would include a significant environmental impact to any of the environmental resources governed by federal law. An EA may be required if there are extraordinary circumstances. The generalized land use alternatives to follow outline areas on the Airport which could be planned and ultimately developed for non-aviation related uses.

ON-AIRPORT LAND USE OBLIGATIONS

The Airport has accepted grants for capital improvements from the FAA. As such, the Arizona Department of Transportation (ADOT), being the airport sponsor, has agreed to certain grant assurances. Grant assurances related to land use assure that airport property will be reserved for aeronautical purposes. If the airport sponsor wishes to sell (release) airport land or lease airport land for a non-aeronautical purpose (land use change), they must petition the FAA for approval. The ALP and the Airport Property Map must then be updated to reflect the sale or land use change of the identified property.

RELEASE OF AIRPORT PROPERTY

A release of airport property would entail the sale of land that is not needed for aeronautical purposes currently or into the future. The following documentation is required to be submitted to the FAA for consideration of a land release:

1. What is requested.
2. What agreement(s) with the United States are involved.
3. Why the release, modification, reformation, or amendment is requested.
4. What facts and circumstances justify the request.
5. What requirements of state or local law or ordinance should be provided for in the language of an FAA-issued document if the request is consented to or granted.
6. What property or facilities are involved.
7. How the property was acquired or obtained by the airport owner.
8. What is the present condition and what present use is made of any property or facilities involved.
9. What use or disposition will be made of the property or facilities.
10. What is the appraised fair market value of the property or facilities. Appraisals or other evidence required to establish fair market value.
11. What proceeds are expected from the use or disposition of the property and what will be done with any net revenues derived.
12. A comparison of the relative advantage or benefit to the airport from sale or other disposition as opposed to retention for rental income.

Each request should have a scaled drawing attached showing all airport property and facilities which are currently obligated for airport purposes by agreements with the United States. Other exhibits supporting or justifying the request, such as maps, photographs, plans, and appraisal reports, should be attached as appropriate. There are no areas of airport property currently planned for release from obligation and/or sale.

LAND USE CHANGE

A land use change permits land to be leased for non-aeronautical purposes. A land use change does not authorize the sale of airport land. Leasing airport land to produce revenue from non-aeronautical uses allows the land to earn revenue for the airport, as well as serve the interests of civil aviation by making the airport as self-sustaining as possible. Airport sponsors may petition for a land use change for the following purposes:

- So that land not needed for aeronautical purposes can be leased to earn revenue from non-aviation uses. This is land that is clearly surplus to the airport's aviation needs.

- So that land which cannot be used for aeronautical purposes can be leased to earn revenue from non-aviation uses. This is land that cannot be used by aircraft or where there are barriers or topography that prevents an aviation use.

- So that land not presently needed for aeronautical purposes can be rented on a temporary basis to earn revenue from non-aviation uses.

A land use change shall not be approved by the FAA if the land has a present or future airport or aviation purpose, meaning the land has a clear aeronautical use. If land is needed for aeronautical purposes, a land use change is not justified. Ordinarily, land on or in proximity to the flight line and airport operations area is needed for aeronautical purposes and should not be used or planned for non-aviation purposes.

The proceeds derived from the land use change must be used exclusively for the benefit of the airport. The proceeds derived from the land use change may not be used for a non-airport purpose. The proceeds cannot be diverted to the airport sponsor's general fund or for general economic development unrelated to the airport.

Generally, a land use change of airport property will be reviewed on a case-by-case basis at the time that the change is necessary. However, the airport land use drawing, which is included as part of the airport layout plan set, shows those areas likely eligible to be released from obligation.

Land use planning is a very common practice for communities across the country. The primary purpose of land use planning is to adequately plan for future needs in an organized, efficient, and beneficial manner. Airport planning also commonly considers land use planning concepts to ensure that development is orderly, efficient, safe, and maximizes available land inventories. The alternatives analysis in the next chapter will provide a breakdown of aviation and potential non-aviation uses on airport property and determine the viability of the Airport being able to support certain non-aviation uses.

SUMMARY

This chapter has outlined the safety design standards and facilities required to meet potential aviation demand projected at GCN for the next 20 years. In Chapter Five, potential improvements to the airside and landside systems will be examined through a series of airport development alternatives. Most of the alternatives discussion will focus on those capital improvements that would be eligible for federal and state grant funds. Other projects of local concern will also be presented. Ultimately, an overall airport development plan that presents a vision beyond the 20-year scope of this Master Plan will be developed.