Chapter Two

Forecasts

Defining demand that may reasonably be 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 potential aviation activity for at least a 20-year timeframe. Aviation demand forecasting for the Apple Valley Airport (APV) will primarily consider based aircraft, aircraft operations, and peak activity periods.

The Federal Aviation Administration (FAA) has oversight responsibility to review and approve aviation forecasts developed in conjunction with airport planning studies. The FAA will review individual airport forecasts and compare 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 has almost always been a disparity between the TAF and master planning forecasts. This is primarily because the TAF forecasts are the result of a top-down model that does not consider local conditions or recent trends. Because the TAF forecasts do not account for this important information, they are useful as a point of comparison for master plan forecasts but are not entirely reliable on their own. In addition to being a point of comparison, the TAF forecasts also serve other purposes, such as asset allocation by the FAA.

When reviewing a sponsor's forecast from the master plan, the FAA must ensure that the forecast is based on reasonable planning assumptions, uses current data, and is developed using appropriate forecast methods. As stated in FAA Order 5090.5, *Formulation of the National Plan of Integrated Airport Systems (NPIAS) and Airports Capital Improvement Plan (ACIP)*, 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 forecast process for an airport master plan consists of a series of basic steps that vary in complexity depending upon the issues to be addressed and the level of effort required. The steps include a review of previous forecasts, determination of data needs, identification of data sources, collection of data, selection of forecast methods, preparation of the forecasts, and evaluation and documentation of the results. FAA Advisory Circular (AC) 150/5070-6B, *Airport Master Plans*, outlines seven standard steps involved in the forecast process, including:

1) **Identify Aviation Activity Measures**: The level and type of aviation activities likely to impact facility needs. For general aviation, this typically includes based aircraft and operations.
2) **Review Previous Airport Forecasts**: May include the FAA *Terminal Area Forecast*, state or regional system plans, and previous master plans.
3) **Gather Data**: Determine what data is required to prepare the forecasts, identify data sources, and collect historical and forecast data.
4) **Select Forecast Methods**: There are several appropriate methodologies and techniques available, including regression analysis, trend analysis, market share or ratio analysis, exponential smoothing, econometric modeling, comparison with other airports, survey techniques, cohort analysis, choice and distribution models, range projections, and professional judgment.
5) **Apply Forecast Methods and Evaluate Results**: Prepare the actual forecasts and evaluate for reasonableness.
6) **Summarize and Document Results**: Provide supporting text and tables as necessary.
7) **Compare Forecast Results with the FAA's TAF**: For general aviation airports, such as Apple Valley Airport, forecasts for based aircraft and total operations are considered consistent with the TAF if they meet the following criteria:
    - Forecasts differ by less than 10 percent in the 5-year forecast period, and 15 percent in the 10-year forecast period, or
    - Forecasts do not affect the timing or scale of an airport project, or
    - Forecasts do not affect the role of the airport as defined in the current version of FAA Order 5090.5.

Aviation activity can be affected by many influences on the local, regional, and national levels, making it virtually impossible to predict year-to-year fluctuations of activity over 20 years with any certainty. Therefore, it is important to remember that forecasts are to serve only as guidelines, and planning must remain flexible enough to respond to a range of unforeseen developments.

> The forecast base year is 2022. The long-range forecast year is 2042.

The forecast analysis for Apple Valley Airport was produced following these basic guidelines. Existing forecasts are examined and compared against current and historic activity. The historical aviation activity is then examined, along with other factors and trends that can affect demand. The intent is to provide an updated set of aviation demand projections for the airport that will permit airport management to make planning adjustments as necessary to maintain a viable, efficient, and cost-effective facility.

The forecast for this master plan will utilize a base year of 2022 with a long-range forecast of 2042.

SOCIOECONOMIC TRENDS

The socioeconomic conditions provide an important baseline for preparing aviation demand forecasts. Local socioeconomic variables, such as population, employment, and income, are indicators for understanding the dynamics of the community and can relate to local trends in aviation activity. Analysis of the demographics of the airport service area will give a more comprehensive understanding of the socioeconomic situations affecting the region which supports the airport. The following is a summary of the historical demographic trends presented in Chapter One - Inventory, as well as forecasts of those socioeconomic characteristics.

Table 2A summarizes historical and forecast estimates for population, employment, and income for the primary airport service which includes the Town of Apple Valley, City of Victorville, City of Hesperia, and the City of Adelanto. Over the next 20 years, the population is projected to add approximately 176,100 people. This equates to an average annual growth rate of 2.07 percent. Employment is projected to grow at 1.62 percent annually, and income is projected to grow at 1.67 percent annually. Each of the socioeconomic indicators is projected to grow at a substantially higher rate than for the state. The area that the Airport primarily serves is a significant growth area in the state.

TABLE 2A | Area Socioeconomic Statistics

	SERVICE AREA[3]		
Year	**Population**	**Employment**	**Households**
2012[1]	312,000	64,000	91,100
2020[1]	332,800	82,100	104,700
2022[2]	346,800	85,600	108,600
CAGR 2012-2022	**1.18%**	**3.28%**	**1.97%**
2027[2]	384,300	95,000	119,100
2032[2]	425,800	105,400	130,600
2035[1]	452,900	112,200	138,000
2040[1]	484,200	116,400	147,400
2042[2]	522,900	118,100	151,300
CAGR 2022-2042	**2.07%**	**1.62%**	**1.67%**

[1]Southern California Association of Governments, Connect SoCal - Regional Transportation Plan 2016-2040
[2]Interpolated/Extrapolated
[3]Includes Town of Apple Valley, City of Victorville, City of Hesperia, and City of Adelanto
CAGR: Compound Annual Growth Rate

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 the 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 public. The current edition upon preparation of this ALP Update was *FAA Aerospace Forecast – Fiscal Years 2023-2043*, published in early 2023. 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 Forecast*.

Since its deregulation in 1978 and the great recession of 2007-09, the U.S. commercial air carrier industry experienced a series of 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. Since the end of the recession in 2009 through 2019, U.S. airlines revamped 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 three major mergers in five years. The results of these efforts were impressive: 2019 marked the eleventh consecutive year of profitability for the U.S. airline industry.

The outbreak of the COVID-19 pandemic in 2020, however, brought a rapid and cataclysmic end to those boom years. Airline activity and profitability tumbled almost overnight and without the financial and competitive strength built up during the boom, airlines would have faced even greater challenges. As it was, they were able to slash capacity and costs, and then, relying on their balance sheets, credit ratings and value inherent in their brands, to raise capital through borrowing and restructuring fleets allowing them to withstand the period of losses. Although several small regional carriers ceased operations in 2020, no mainline carriers did. Cargo activity was one of few bright spots as it surged, boosted by consumers purchasing goods to enhance time spent at home as necessitated by the pandemic, and by surface transportation disruptions caused by worker shortages due to COVID-19 illnesses.

Since 2020, conditions and the outlook have brightened considerably. As vaccines were introduced and local and international travel restrictions were lifted, leisure travel re-bounded. Initially concentrated in outdoor recreation spots, whether beach or mountain, the recovery in leisure demand spread first to domestic destinations in 2021 and then expanded to many traditional international vacation destinations and by the summer of 2022, most carriers were reporting lei-sure demand was exceeding pre-pandemic levels. A rebound in business travel, which had been severely curtailed with the onset of the pandemic, lagged that of leisure demand. However, by the end of 2022, U.S. airlines were reporting that business demand had recovered to 70-80% of pre-pandemic levels. Higher fares accompanied the strong rebound in leisure demand leading to positive financial results. For all of CY 2022, the top nine U.S. passenger carriers posted operating profits of $7.8 billion and net profits of $1.8 billion.

The general aviation (GA) sector was less affected by the COVID-19 crisis than the airlines and recovered faster. Private aviation became an attractive substitute for wealthier individuals who could afford to pay during the heaviest times of the pandemic. Even though there are recent indicators that with airlines increasing frequency of their scheduled flights, some reversal in this trend is expected, many have continued to fly privately. At the lower end of the industry, newcomers to private flying included students, private and commercial pilots, joining the existing GA pi-lot population. The long-term outlook for general aviation is promising, as growth at the higher-end offsets continuing retirements at the traditional low end, mostly piston-powered part of the sector. The active GA fleet is forecast to increase by 3.5 percent between 2023 and 2043, after declining slightly in 2022 from the year before. The turbine aircraft fleet, including rotorcraft, did not experience a decline between 2019 and 2021, and is estimated to have shown a small increase between 2021 and 2022. The total of piston fleet (single and multi-engine pistons, light-sport aircraft, and piston rotorcraft) declined by 2.0 percent between 2019 and 2021 and is estimated to have fallen by an additional 0.7 percent in 2022. 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 will continue to shrink over the forecast period, just to be offset by the growing turbine fleet. Despite the minimal growth of the active GA fleet between 2022 and 2042, the number of GA hours flown is projected to increase by 16.6 percent from 2022 to 2042 (an average of 0.7 percent per year), as growth in turbine, rotorcraft, and experimental hours more than offset a decline in fixed wing piston hours.

FAA GENERAL AVIATION FORECASTS

The FAA forecasts the fleet mix and hours flown for single and multi-engine piston aircraft, turboprops, business jets, piston and turbine helicopters, light sport, experimental, and other aircraft (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 stable to optimistic, as growth at the high-end offsets continuing retirement of aging aircraft at the traditional low-end of the segment. The active general aviation fleet is forecast to remain relatively stable between 2022 and 2042. The largest segment of the fleet – fixed-wing piston aircraft – is predicted to wane over the forecast period due to unfavorable pilot demographics, increasing cost of ownership, the availability of lower-cost alternatives for recreational uses, and new aircraft deliveries not keeping pace with the retirement of aging aircraft. Turbine aircraft, including helicopters, are projected to grow the most due to steady growth in both U.S. GDP and corporate profits. **Table 2B** shows the primary general aviation demand indicators as forecast by the FAA.

TABLE 2B | FAA General Aviation Forecast

Demand Indicator	2022	2042	CAGR
General Aviation Active Fleet Mix			
Total Fixed-Wing Piston	137,465	119,350	-0.70%
Total Fixed-Wing Turbine	26,145	38,980	2.02%
Total Helicopters	10,175	13,680	1.49%
Total Other (experimental, light sport, etc.)	35,355	43,380	1.03%
Total General Aviation Fleet	**209,140**	**215,390**	**0.15%**
General Aviation Operations			
Local General Aviation	14,029,412	16,562,635	0.83%
Itinerant General Aviation	14,634,811	16,660,141	0.65%
Total General Aviation Operations	**28,664,223**	**33,222,776**	**0.74%**
Total Air Taxi/Commuter Operations	**5,013,000**	**6,287,000**	**1.14%**

CAGR: compound annual growth rate (2022-2042)

Source: FAA Aerospace Forecast - Fiscal Years 2023-2043

General Aviation Fleet Mix

For 2022, the FAA estimates there are 137,465 piston-powered fixed-wing aircraft in the national fleet. This number is forecast to decline by 0.70 percent annually from 2022-2042, resulting in 119,350 by 2042. This includes a decline of 0.7 percent annually for single engine pistons and a decline of 0.2 percent for multi-engine pistons.

Total turbine aircraft are forecast to grow at an annual rate of 2.02 percent through 2042. The FAA estimates there are 26,145 fixed-wing turbine-powered aircraft currently in the national fleet. Turbine-powered aircraft include both turboprops – aircraft with propellers that are driven by a turbine engine – and jet aircraft. Annual growth rates for turboprops are 0.8 percent and 2.7 percent for business jets, resulting in a total of 38,980 turbine fixed wing aircraft by 2042.

The total number of helicopters, both piston- and turbine-powered, are forecast to grow at an annual growth rate of 1.49 percent through 2042. The FAA estimates there are 10,175 helicopters in 2022, which are predicted to grow to 13,680 by 2042. This includes annual growth rates of 0.5 percent for piston helicopters and 1.8 percent for turbine helicopters.

The FAA also forecasts changes in experimental, light sport, and other aircraft (including balloons and gliders). Combined, there is an estimated 35,355 of these aircraft in 2022 which is forecast to grow to 43,380 by 2042, a combined annual growth rate of 1.03 percent.

All combined, the total number of active aircraft in the national general aviation fleet in 2022 is 209,140. With a subtle annual growth rate of 0.15 percent, the national fleet is forecast to rise to 215,390 by 2042.

General Aviation Aircraft Shipments and Revenue

On an annual basis the General Aviation Manufacturers Association (GAMA) publishes an aviation industry outlook that documents past and current trends and provides an assessment of the future condition of the general aviation industry. **Table 2C** presents historical data related to general aviation aircraft shipments.

Worldwide shipments of general aviation airplanes increased in 2022, with a total of 2,818 units delivered around the globe, compared to 2,646 units in 2021. Worldwide general aviation billings also increased. In 2020, $20.0 billion in new general aviation aircraft were shipped, but in 2022, aircraft billings totaled just over $22.9 billion. Single engine pistons, turboprops, and business jet deliveries have increased year-over-year since 2020. Only multi-engine pistons realized a slight decline over the same period.

TABLE 2C | General Aviation Airplane Shipments and Billings						
Year	**Total**	**SEP**	**MEP**	**TP**	**J**	**Net Billings ($millions)**
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	24,129
2016	2,268	890	129	582	667	21,059
2017	2,324	936	149	563	676	20,201
2018	2,441	952	185	601	703	20,564
2019	2,658	1,111	213	525	809	23,515
2020	2,408	1,115	206	443	644	20,028
2021	2,646	1,209	200	527	710	21,600
2022	2,818	1,328	196	582	712	22,900
SEP - Single Engine Piston; MEP - Multi-Engine Piston; TP - Turboprop; J - Turbofan/Turbojet						

Source: General Aviation Manufacturers Association *2022 General Aviation Statistical Databook & Industry Outlook*

Business Jets: General aviation manufacturers' deliveries decreased in 2020 but rebounded in 2021 and 2022. The year 2022 marked the third consecutive year of increasing business jet deliveries. The North America market represents approximately 66 percent of the total business jet deliveries in 2022.

Turboprops: In 2020, 443 turboprop airplanes were delivered to customers around the world, a decrease from the 525 that were delivered in 2019. In 2021 and 2022, turboprop deliveries have increased to 527 and 528 in the respective years. Half of the total turboprop deliveries in 2022 went to customers in North America.

Pistons: Single-engine piston deliveries rose to 1,328 in 2022, continuing a six-year growth trend. Multi-engine piston deliveries declined slightly in 2022 but have been near or above 200 annually for four years in a row. North America accounted for 68 percent of all 1,1,524 piston units delivered in 2022.

General Aviation Operations

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. Air carrier operations are those conducted by scheduled commercial air carriers, such as United Airlines or Southwest. While these operations are vital to forecasting activity at airports with such activity, because CPT does not see scheduled air service, this part of the forecast is omitted. Military aircraft do use civilian airports across the country, but due to the inherent difficulty in predicting their operations, the FAA traditionally uses a zero-growth forecast for military operations.

General aviation (GA) is comprised of all non-commercial or military operations. Air taxi/commuter operations is another segment of commercial aviation that is conducted by aircraft with 59 seats or less that carry passengers or cargo for hire. Through 2042, total GA operations are forecast to grow 0.74 percent annually. This includes annual growth rates of 0.83 percent for local operations, 0.65 percent for itinerant operations, and 0.8 percent for air taxi/commuter operations. Local GA operations are expected to increase from 14.03 million in 2022 to 16.56 million in 2042, while itinerant GA operations are expected to grow from 14.63 million in 2022 to 16.66 million in 2042. Air taxi/commuter operations, which are always classified as itinerant, are projected to grow from 6.52 million in 2022 to 7.03 million in 2042.

Exhibit 2A presents the historical and FAA forecast of the U.S. active general aviation aircraft fleet and operations.

RISKS TO THE FORECAST

While the FAA is confident that its forecasts for aviation demand and activity can be reached, this is dependent on several factors, including the strength of the global economy, security (including the threat of international terrorism), and oil prices. Higher oil prices could lead to further shifts in consumer spending away from aviation, dampening a recovery in air transport demand.

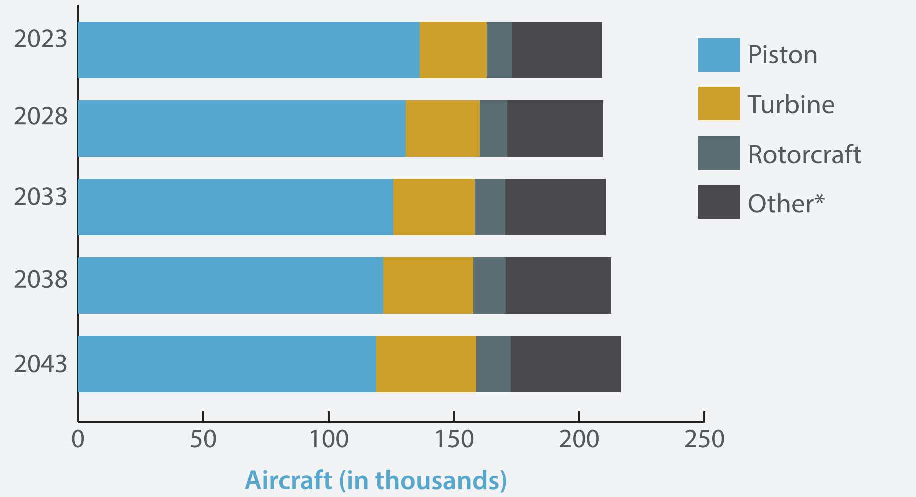
As stated previously, the rapid spread of COVID-19 that began within the United States in early 2020 now presents a new risk without clear historical precedent. It is not known at this point how the virus will continue to affect aviation. Impacts that were felt in 2020 have carried over into 2021. The long-term impact of COVID-19 on the aviation industry will not be understood until the full spread or intensity of the human consequences, as well as the breadth and depth of possible economic fallout, is known.

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 include trend line/time-series projections, correlation/regression analysis, and market share analysis. The forecast analyst may decide to employ one or all these methods to arrive at a reasonable single forecast. The following is a description of those methodologies utilized to develop the forecasts of aviation demand.

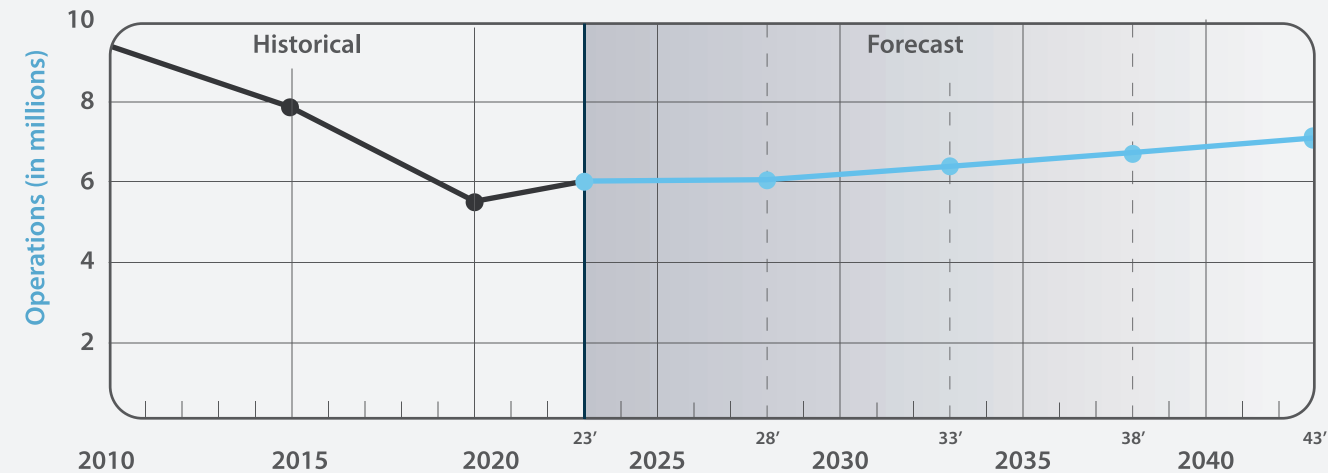
Trend Line/Time-Series Projections: Trend line/time-series projections are probably the simplest and most familiar of the forecasting techniques. By fitting growth curves to historical data, and then extending them into the future, a basic trend line projection is produced. An assumption of this technique 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.

U.S. Active General Aviation Aircraft

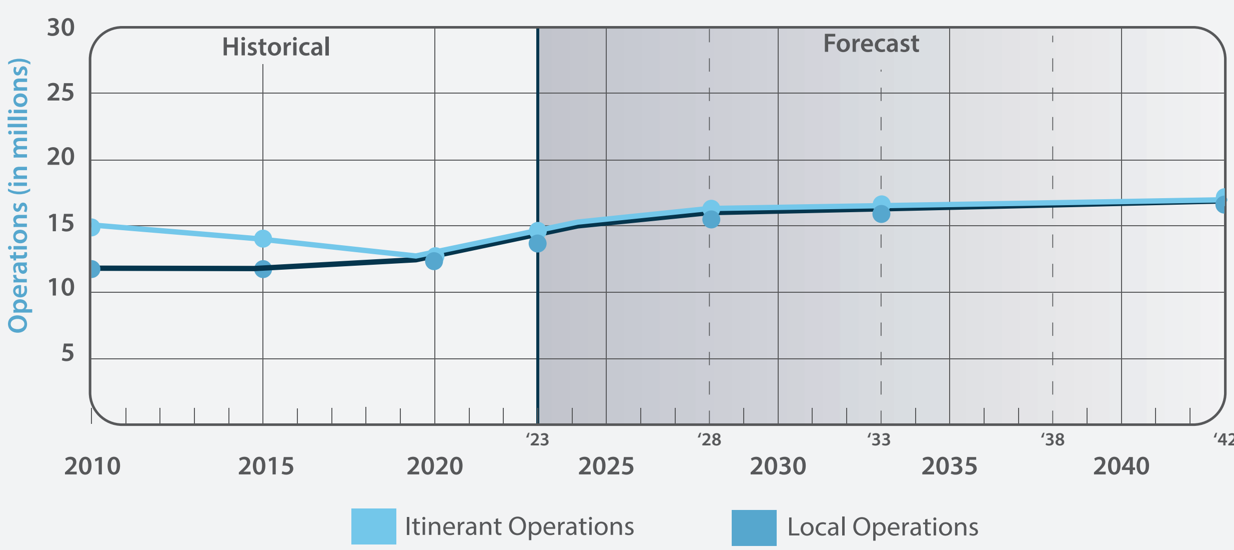


*Other includes Experimental and LSA aircraft

U.S. Air Taxi Operations



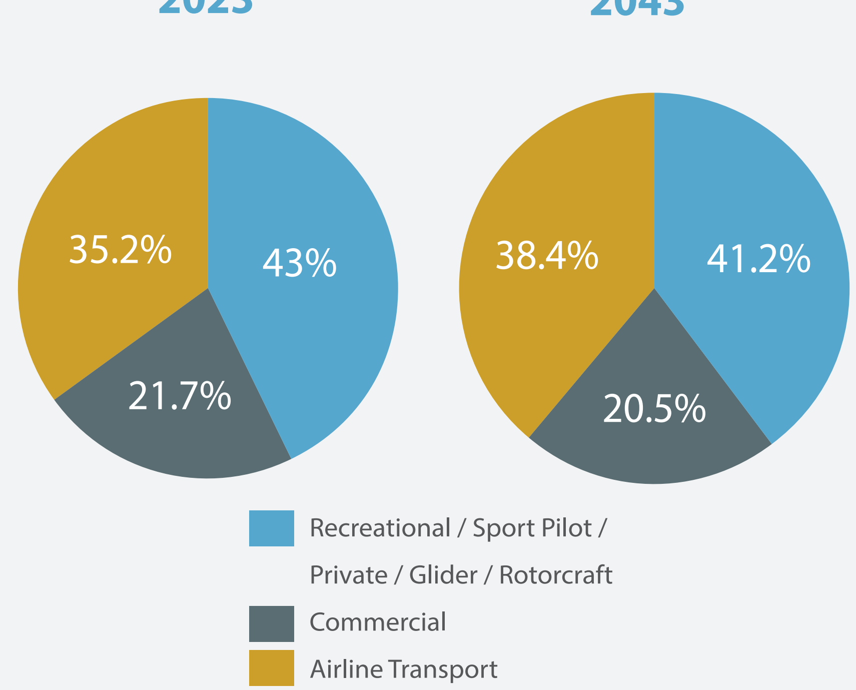
U.S. General Aviation Operations



Active Pilots By Certificate

Total Active Pilots: **482,025***

Total Active Pilots: **510,670**



Excludes Student Pilot Certificates

Source: FAA Aerospace Forecasts FY2023-2043

Ratio Projection: The ratio projection methodology examines the historical relationship between two variables as a ratio. A common example in aviation demand forecasting is to consider the number of based aircraft as a ratio of the service area population where there may be 1.8 aircraft per 1,000 people. This ratio can then be carried to future years in comparison to projections of population.

Market Share Analysis: Market share analysis involves a historical review of the airport 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 for 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.

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

Professional Judgement: Once one or more forecasting methodologies have been applied, the forecast analyst must select a single forecast for each aviation demand indicator (i.e., based aircraft, operations). The selected forecast can be one of the several developed or it can be a blended forecast. Any single forecast selected must be reasonable, logical, and defensible.

The FAA indicates that a 20-year forecast be developed for long-range airport planning. Facility and financial planning usually require at least a 10-year view because it often takes more than five years to complete a major facility development program. However, it is important to use forecasts that do not overestimate revenue-generating capabilities or understate demand for facilities required to meet public (user) needs.

A wide range of factors are known to influence the aviation industry and can have significant impacts on the extent and nature of aviation activity in both the local and national markets. Historically, the nature and trends of the national economy have had direct impacts on the level of aviation activity. Recessionary periods have been closely followed by declines in aviation activity. Nevertheless, over time, trends emerge and provide the basis for airport planning.

Future facility requirements, such as hangar and apron needs, are derived from projections of various aviation demand indicators. 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 aviation demand indicators:

- Based Aircraft
- Based Aircraft Fleet Mix
- General Aviation Operations
- Air Taxi and Military Operations
- Operational Peaks

This forecasting effort was completed in September 2023, with a base year of 2022. The negative impacts of the COVID-19 pandemic appear to have largely passed and were not as impactful to many general aviation airports, including APV.

EXISTING FORECASTS

During this forecasting effort, consideration has been given to any aviation demand forecasts for the airport that have been completed in the recent past.

FAA 2022 *TERMINAL AREA FORECAST (TAF published February 2023)*

On an annual basis, the FAA publishes the TAF for each airport included in the *National Plan of Integrated Airport Systems*. The TAF is a generalized forecast of airport activity used by the FAA for internal planning purposes. It is available to airports and consultants to use as a baseline projection and is an important point of comparison when developing local forecasts. The TAF is typically published early in the year and is based on the federal fiscal year (October-September).

Table 2D presents the 2022 TAF for Apple Valley Airport (published in February 2023). As can be seen, the TAF shows a zero-growth scenario for based aircraft and operations at the airport. The FAA does not do a detailed forecast for most general aviation airports and will frequently include a placeholder for operations and based aircraft. The FAA may choose to submit the forecasts developed for this Master Plan to headquarters to update the TAF.

TABLE 2D | 2022 FAA Terminal Area Forecast (TAF)

	2022	2027	2032	2042	CAGR 2022-2042
ANNUAL OPERATIONS					
Itinerant					
Air Taxi	0	0	0	0	-
General Aviation	12,500	12,500	12,500	12,500	0.00%
Military	0	0	0	0	-
Total Itinerant	*12,500*	*12,500*	*12,500*	*12,500*	*0.00%*
Local					
General Aviation	25,000	25,000	25,000	25,000	0.00%
Military	0	0	0	0	-
Total Local	*25,000*	*25,000*	*25,000*	*25,000*	*0.00%*
Total Operations	***37,500***	***37,500***	***37,500***	***37,500***	0.00%
BASED AIRCRAFT					
Total Based Aircraft	***124***	***124***	***124***	***124***	0.00%

Source: FAA Terminal Area Forecast (TAF), February 2023

2012 AIRPORT MASTER PLAN

A Master Plan for Apple Valley Airport was completed in 2012 and had a base forecast year of 2009. **Table 2E** summarizes the previous master plan forecasts. This forecast is somewhat dated; however, it does provide some insight to the environment at the time and the growth rates that were projected. At the time, it is estimated that there were 148 based aircraft, however FAA did not require airports to regularly document this. Today, FAA does require an updated based aircraft count which will be used in this forecast. The operations baseline in 2009 was derived from an FAA model that includes local variables such as population growth, regional based aircraft counts, and if there is a flight school. This model will be also used in this study with updated input variables as one of several forecasting methodologies to be considered.

TABLE 2E | 2012 Master Plan Forecasts

Year	Based Aircraft	OPERATIONS		
		Local General Aviation	Itinerant General Aviation	Total
2009	148	30,933	15,467	46,400
2015	155	32,200	16,000	48,200
2020	175	35,400	17,600	53,000
2030	225	43,000	21,400	64,400
CAGR	**2.12%**	**1.66%**	**1.64%**	**1.65%**

CAGR: Compound Annual Growth Rate

Source: 2012 Airport Master Plan - Coffman Associates

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 the airport, certain elements of this activity must be forecast. These indicators of general aviation demand include based aircraft, aircraft fleet mix, operations, and peak periods. Based aircraft are those active airplanes (i.e., they are flown at least one hour per year) that are stored at an airport for more than six months of the year. The fleet mix is the breakdown by aircraft type (i.e., piston, turboprop, jet, helicopter). Operations are classified as local and itinerant. A local operation is a takeoff 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 (i.e., training or practice activity). Itinerant operations are those performed by aircraft with a specific origin or destination away from an airport. Peak periods are an operational definition of busy hours, days, or months.

The number of based aircraft is the most basic indicator of general aviation demand. By first developing a forecast of based aircraft for the airport, other demand indicators 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. An initial forecast of service area registered aircraft has been developed and will be used as one data point to arriving at a based aircraft forecast for the airport.

BASED AIRCRAFT FORECAST

Forecasts of based aircraft may directly influence needed facilities and the applicable design standards. The needed facilities may include hangars, aprons, taxilanes, etc. The applicable design standards may include separation distances and object clearing surfaces. The size and type of based aircraft are also an important consideration. The addition of numerous small aircraft may have no effect on design standards, while the addition of a few larger business jets can have a substantial impact on applicable design standards.

Because of the numerous variables known to influence aviation demand, several separate forecasts of based aircraft are developed. Each of the forecasts is then examined for reasonableness, and any outliers are discarded or given less weight. The remaining forecasts collectively will create a planning envelope. A single planning forecast is then selected for use in developing facility needs for the airport. The selected forecast of based aircraft can be one of the several forecasts developed or based on the experience and judgment of the forecaster, it can be a blend of the forecasts.

Based Aircraft History

There are currently 117 validated based aircraft at the Apple Valley Airport.

Documentation of the historical number of based aircraft at Apple Valley Airport has been somewhat intermittent. For many years, the FAA did not require airports to report the number of based aircraft. It is only in recent years that the FAA has established a based aircraft inventory database in which it is possible to cross-reference based aircraft claimed by one airport with other airports. The FAA is now utilizing this based aircraft inventory as a baseline for determining how many and what type of aircraft are based at any individual airport. This database evolves daily as aircraft are added or removed, and it does not provide an annual history of based aircraft. It is the responsibility of the sponsor (owner) of each airport to input based aircraft information into the FAA database (www.basedaircraft.com).

As of August 2023, the database shows there to be 117 validated based aircraft. Of this total, 111 are single engine pistons, four are multi-engine pistons, and two are helicopters.

Table 2F shows the historical validated based aircraft at the airport since 2013. As can be seen, the airport has added 22 based aircraft in the last two years. According to airport staff, this rapid increase is due primarily to the fact that the airport was without an airport manager for those years so data input to the system was sporadic.

TABLE 2F | Historical Based Aircraft at APV

Forecast Year	APV Based Aircraft[1]
2013	130
2014	132
2015	131
2016	125
2017	123
2018	68
2019	100
2020	95
2021	112
2022	117

[1]*Source: basedaircraft.com.*

Exhibit 1P, presented previously, shows the location by address of the based aircraft in proximity to the airport. Approximately 80 percent of the based aircraft are registered to addresses within 25 miles of the Airport. Six percent are registered somewhere else in California including three law enforcement aircraft registered in Sacramento. Twenty aircraft are registered out of state.

Population Market Share Forecasts

The first based aircraft forecast presented takes into consideration the service area population as a ratio of based aircraft. In 2013, there were 0.4133 based aircraft per 1,000 people. This ratio declined year-over-year through 2020. In 2021, this ratio increased to 0.3297 and it increased again in 2022 to 0.3374. While the ratio has increased in the last two years, generally the trend is declining over time, and this is true for most airports where population typically outpaces growth in based aircraft. For this reason, a declining share ratio has been developed as a based aircraft forecast. Even when the ratio declines in future years, the associated number of projected based aircraft increases at an annual growth rate of 0.94 percent. This results in 141 based aircraft by 2042 as outlined in **Table 2G**.

TABLE 2G | Based Aircraft Market Share of Population

Year	Service Area Population[1]	Based Aircraft per 1,000 Population	Aircraft Based at APV[2]
2013	314,527	0.4133	130
2014	317,075	0.4163	132
2015	319,643	0.4098	131
2016	322,232	0.3879	125
2017	324,842	0.3786	123
2018	327,473	0.2077	68
2019	330,126	0.3029	100
2020	332,800	0.2855	95
2021	339,728	0.3297	112
2022	346,800	0.3374	117
Decreasing Share of Population (CAGR = 0.94%)			
2027	384,300	0.3300	127
2032	425,800	0.3100	132
2042	522,900	0.2700	141

[1]Southern California Association of Governments, Connect SoCal - Regional Transportation Plan 2016-2040 for the Town of Apple Valley, City of Victorville, City of Hesperia, and the City of Adelanto.
[2]Source: basedaircraft.com.

Households Market Share Forecast

The next based aircraft forecast considers the relationship between based aircraft and new households in the airport service area. Households often has a better correlation to based aircraft because it is an indicator of the economic health of the area which more directly translates to general aviation activity. In 2013, there was 1.4024 based aircraft at APV per 1,000 households. This ratio decreased slightly until

2020 when there were 0.9074 based aircraft per 1,000 households. Both 2021 and 2022 saw an increase in this ratio with 2022 having a ratio of 1.0773 based aircraft per 1,000 households. The 2022 ratio is close to the 10-year average so for this forecast the 2022 ratio of 1.0773 has been carried forward to the plan years as a constant. This results in 163 based aircraft by 2042 and an annual growth rate of 1.67 percent as outlined in **Table 2H**.

TABLE 2H | Based Aircraft Market Share of Households

Year	Service Area Households[1]	Based Aircraft per 1,000 Households	Aircraft Based at APV[2]
2013	92,698	1.4024	130
2014	94,325	1.3994	132
2015	95,980	1.3649	131
2016	97,664	1.2799	125
2017	99,377	1.2377	123
2018	101,121	0.6725	68
2019	102,895	0.9719	100
2020	104,700	0.9074	95
2021	106,632	1.0503	112
2022	108,600	1.0773	117
Constant Share of Households (CAGR = 1.67%)			
2027	119,100	1.0773	128
2032	130,600	1.0773	141
2042	151,300	1.0773	163

[1]Southern California Association of Governments, Connect SoCal - Regional Transportation Plan 2016-2040 for the Town of Apple Valley, City of Victorville, City of Hesperia, and the City of Adelanto.
[2]TAF history for 2013-2021; basedaircraft.com for 2022.

Statewide TAF Growth Rate Forecast

The FAA's Terminal Area Forecast can be examined on a statewide basis and a forecast developed by applying the statewide based aircraft growth rate to the subject airport. Combined all California NPIAS airports are projected to add more based aircraft at an annual rate of 0.84 percent. By applying this growth rate to the current number of based aircraft at APV, then carrying that forward, a forecast emerges. This forecast results in 138 based aircraft at APV by 2042 and is presented in **Table 2J**.

TABLE 2J | Statewide TAF Growth Rate Forecast

Forecast Year	APV Based Aircraft[1]
2013	130
2014	132
2015	131
2016	125
2017	123
2018	68
2019	100
2020	95
2021	112
2022	117
Statewide TAF Growth Rate Forecast (CAGR = 0.84%)	
2027	122
2032	127
2042	138

[1]TAF history for 2013-2021; basedaircraft.com for 2022.
CAGR = Compound Annual Growth Rate

Based Aircraft Summary

Three new forecasts of based aircraft have been presented. The first considers the relationship between projected growth in population and historical trends in relation to based aircraft. The next considers the same relationship to households. The last new forecast considers the application of the statewide TAF growth rate in based aircraft to APV.

Table 2K summarized the based aircraft forecasts for APV. The table also includes the current TAF flatline forecast for visual comparative purposes. The three new forecasts are considered reasonable and together form a fairly tight planning envelope. The next step is for the forecast analyst to select a single forecast for use throughout this master plan.

TABLE 2K | Based Aircraft Forecast Summary

Projection Sources	2027	2032	2042	CAGR 2022-2042
FAA Airport TAF	124	124	124	0.29%
Statewide TAF Based Aircraft Growth Rate	122	127	138	0.84%
Decreasing Market Share of Population	127	132	141	0.94%
Constant Market Share of Households	128	141	163	1.67%
SELECTED BASED AIRCRAFT FORECAST	**127**	**132**	**141**	**0.94%**

CAGR: Compound annual growth rate

Source: Coffman Associates analysis

The preferred and selected forecast is the one related to a decreasing ratio of population to based aircraft. This forecast follows the historical trends at the airport and it does not overly weigh the recent addition of 36 based aircraft over the last two years.

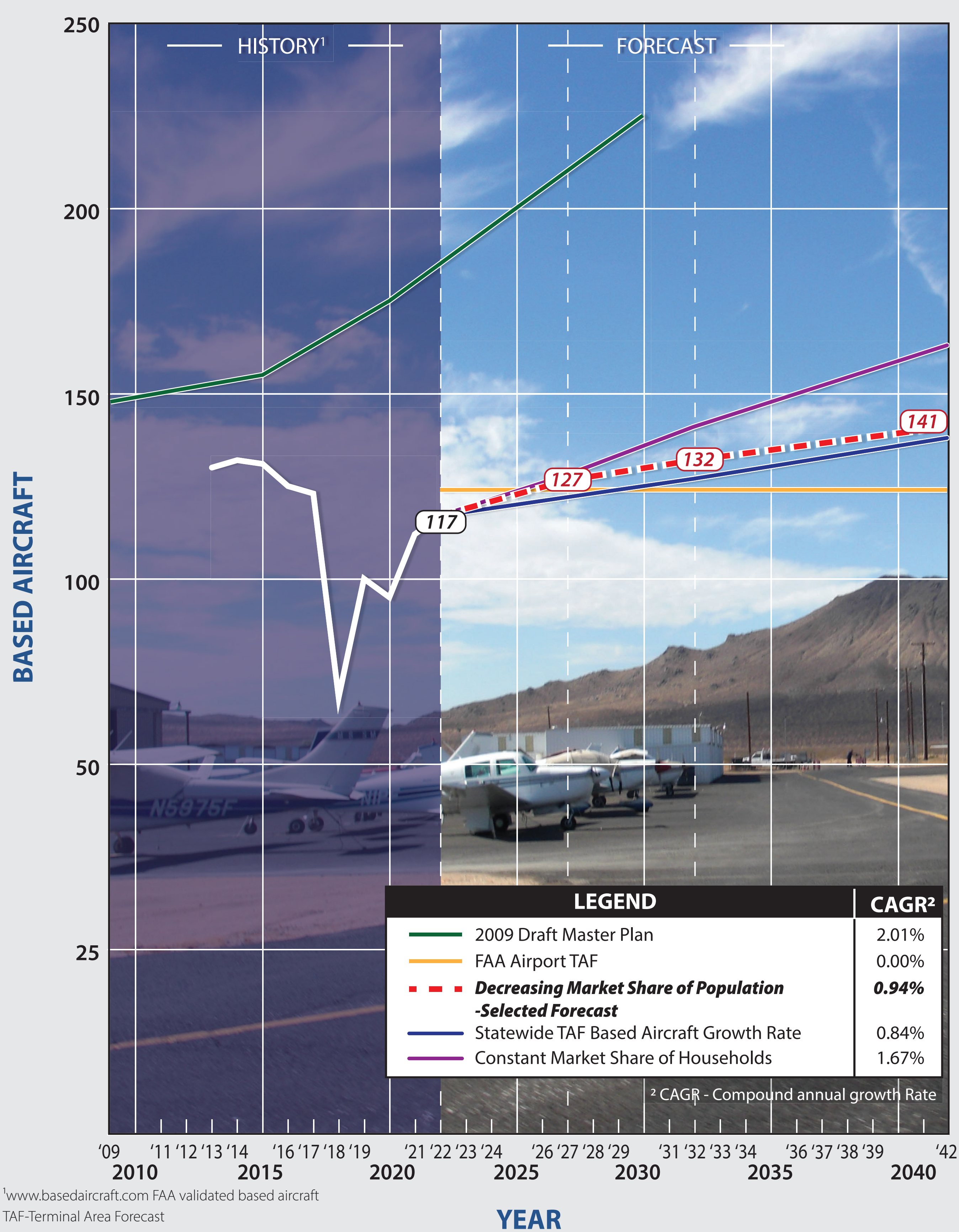
Therefore, the selected forecast is the constant market share of employment to based aircraft:

- 2027 – 127 based aircraft
- 2032 – 132 based aircraft
- 2042 – 141 based aircraft

Exhibit 2B graphically depicts the based aircraft forecasts and the selected forecast.

BASED AIRCRAFT FLEET MIX FORECAST

It is important to understand the current and projected based aircraft fleet mix at an airport to ensure proper facility planning. For example, the addition of one or several larger turboprop or business jet aircraft to the airfield can have a significant impact on the separation requirements and various obstacle clearing surfaces.



¹www.basedaircraft.com FAA validated based aircraft

TAF-Terminal Area Forecast

The current based aircraft fleet mix consists of 111 single-engine piston aircraft, four multi-engine piston aircraft, and two helicopters. The role of the airport is expected to remain as a general aviation facility; therefore, a significant departure from the current fleet mix is not anticipated. The future fleet mix is expected to continue to be dominated by single-engine piston aircraft with moderate increases in turboprops, jets, and helicopters. Multi-engine piston aircraft are projected to remain relatively flat. These forecast growth trends in the based aircraft mix are consistent with FAA projections of the national general aviation fleet mix.

Apple Valley Airport has been planned and developed to accommodate larger and more sophisticated turboprops and business jets. Trends at other airports in the region led to the conclusion that APV is likely to realize an increase in turboprops and business jet activity, therefore, the mix percentage of jets and turboprops is planned to increase at a higher rate than other aircraft categories. **Table 2L** presents the forecast fleet mix for based aircraft at Apple Valley Airport.

TABLE 2L | Based Aircraft Fleet Mix

Aircraft Type	2022	Percent	2027	Percent	2032	Percent	2042	Percent
Single Engine Piston	111	94.9%	117	92.1%	119	90.1%	121	85.8%
Multi-Engine Piston	4	3.4%	4	3.1%	4	3.1%	4	2.8%
Turboprop	0	0.0%	2	1.6%	3	2.3%	6	4.3%
Jet	0	0.0%	1	0.8%	2	1.5%	4	2.8%
Helicopters	2	1.7%	3	2.4%	4	3.1%	6	4.3%
Total	**117**	**100.0%**	**127**	**100.0%**	**132**	**100.0%**	**141**	**100.0%**

Source: Coffman Associates analysis of FAA Registered Aircraft Database

OPERATIONS FORECAST

General aviation operations include a wide range of activity from recreational use to business and corporate uses. Military operations include those operations conducted by various branches of the U.S. military. Air taxi operations are those conducted by aircraft operating under FAR Part 135, otherwise known as “for-hire” or “on-demand” activity. Air taxi operations typically include commuter, air cargo, air ambulance, and many fractional ownership operations.

Aircraft operations are further classified as local and itinerant. A local operation is a takeoff 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. Generally, local operations are characterized by training activity. Itinerant operations are those performed by aircraft with a specific origin or destination away from an airport. Typically, itinerant operations increase with business and commercial use since business aircraft are used primarily to transport passengers from one location to another.

The following sections present several new general aviation operations forecasts. Once a forecast of general aviation operations has been selected, they will be combined with air taxi and military operations to provide a total operations forecast for use in determining facility requirements for the airport. Several methods for determining general aviation operations have been employed to develop a reasonable planning envelope.

Total Operations Estimate and Forecast

Apple Valley Airport does not have an airport traffic control tower; therefore, an estimate of current activity levels must be made, then a forecast of future activity levels can be made. A common and generally reliable estimate of operations can be made using the FAA approved *Model for Estimating Operations at Non-Towered Airports.*

Model for Estimating Operations at Non-Towered Airports

The FAA provides a model specifically developed to estimate total operations at non-towered general aviation airports. The model is contained in the report entitled, *Model for Estimating General Aviation Operations at Non-Towered Airports Using Towered and Non-Towered Airport Data* (GRA, Inc. 2001). Independent variables used in the model include airport characteristics, demographics, and geographic features. The model was derived using a combined data set for towered and non-towered general aviation airports and incorporates a dummy variable to distinguish the two airport types. Specifically, the model utilizes the following variables for the baseline condition:

- Based aircraft (117, 127, 132, 141);
- Ratio of aircraft based at the subject airport to the total number of aircraft based at general aviation airports within 100 miles (5,250 aircraft are located within 100 miles; therefore, the ratio is 117/5,250 = 2.23%);
- Number of FAR 141 flight training schools at the airport (None currently; 1 in 2042);
- Population within 100 miles (18,793,979 based upon 2020 census);
- Ratio of population within 25 miles (470,638) to population within 100 miles (18,793,979), which equals 0.0250.

The model factors each of these variables so that both local and national factors are considered when estimating operations. The results of the model provide an annual operations estimate of 43,100, which equates to 368 operations per based aircraft in 2022. This is considered the current 2022 baseline operations figure.

The model can also be used to develop a forecast of total operations. To accomplish this a projection of each input variable must be considered. The based aircraft forecast has already been established. The projected growth in population has also been established and is simply projected to the 100-mile and 25-mile radius. For this projection, a future Part 141 certified flight school is considered in the long term. **Table 2M** presents the formula and input variables used for the calculations. Total operations using the model are projected to reach 61,400 by 2042 for an annual growth rate of 1.79 percent.

TABLE 2M | Estimated Annual Operations					
Function	Category	2022	2027	2032	2042
	775	775	775	775	775
+	241 (BA)	28,197	30.563	31.812	34.025
-	0.14 (BAsquared)	1,916	2.252	2.439	2.791
+	31478 (%100mi)	702	702	702	702
+	5577 (VITFSnum)	0	0	0	5,557
+	.001 (Pop100)	18,794	22,550	24,496	26,611
-	3736 (WACAORAK)	3,736	3,736	3,736	3,736
+	12121 (Pop25/100)	304	304	304	304
=	**Total (Round to 100)**	**43,100**	**48,900**	**51,900**	**61,400**
Operations Per Based Aircraft		**368**	**386**	**393**	**435**

Function Definitions:

- BA: Based Aircraft
- BAsquared: Based Aircraft Squared
- %100mi: % Based aircraft among based GA aircraft within 100 miles
- VITFSnum: # of FAR 141 flight schools on airport
- Pop100: Population within 100 miles
- WACAORAK: 1 if WA, CA, OR, AK; 0 otherwise
- Pop25/100: Ratio of Pop 25 to Pop 100 (proportion between 1 and 0)

Source: *Model for Estimating General Aviation Operations at Non-Towered Airports*, Equation #15, FAA Statistics and Forecast Branch (July 2001).

NPIAS Operations Estimate Formula

FAA Order 5090.5, *Formulation of the National Plan of Integrated Airport Systems* (NPIAS) *and the Airports Capital Improvement Plan (ACIP)*, provides general guidelines for estimating total operations at non-towered airports. The general guideline is approximately 250 operations per based aircraft for rural general aviation airports with little itinerant traffic, approximately 350 operations per based aircraft for busier general aviation airports with more itinerant traffic, and approximately 450+ operations per based aircraft for busy reliever airports. In unusual circumstances, such as a busy reliever airport with a high number of itinerant operations, the number of operations per based aircraft may be as high as 750 operations per based aircraft.

Apple Valley Airport should be considered in the middle category as a busier general aviation airport with more itinerant traffic. Supporting this designation is the fact that the airport provides a 6,500-foot-long runway and has been designed to accommodate turboprops and business jets. When applying 350 operations per based aircraft a forecast of annual operations emerges. as shown in **Table 2N**.

TABLE 2N | NPIAS Operations Estimate of 350 per Based Aircraft					
	2022	2027	2032	2042	CAGR 2022-2042
Based Aircraft Forecast	**117**	**127**	**132**	**141**	-
Operations per Based Aircraft	368	350	350	350	-
Operations Forecast	43,100	44,400	46,200	49,400	0.94%

CAGR = Compound annual growth rate

Source: FAA Order 5090.5, Formulation of the NPIAS and ACIP. Operations rounded to nearest 100.

Airport TAF Baseline with the Statewide TAF Growth Rate Applied

A third operations estimate has been developed that considers the statewide TAF growth rate for total operations which is 1.03 percent annually. By applying this growth rate to the baseline of 43,100 and extending that function to the plan years a forecast emerges. That forecast results in 45,400 operations in 2027, 47,800 in 2032, and 52,900 in 2042.

Total Operations Forecast Summary

Estimating operations is necessary as APV does not have a control tower. The FAA supports several methodologies for estimating operations. The first is the *Model for Estimating Operations at Non-Towered Airports*, and it is generally used to establish a current year baseline. The model was run for this study to establish the 2022 baseline operations estimate of 47,300 annual operations. The model was also used to develop a forecast, however, several assumptions are made to do this forecast such as future population levels, and if any Part 141 flight schools will base at the airport.

A second forecast following guidance in FAA Order 5090.5, *Formulation of the National Plan of Integrated Airport Systems* (NPIAS) *and the Airports Capital Improvement Plan (ACIP)*, was also presented. This methodology suggests multiplying 350 operations per based aircraft to arrive at an annual estimate for each of the plan years. The last forecast applied the statewide TAF growth rate of 1.03 percent for operations to the plan years. All three operations forecasts are summarized in **Table 2P** and graphically on **Exhibit 2C**.

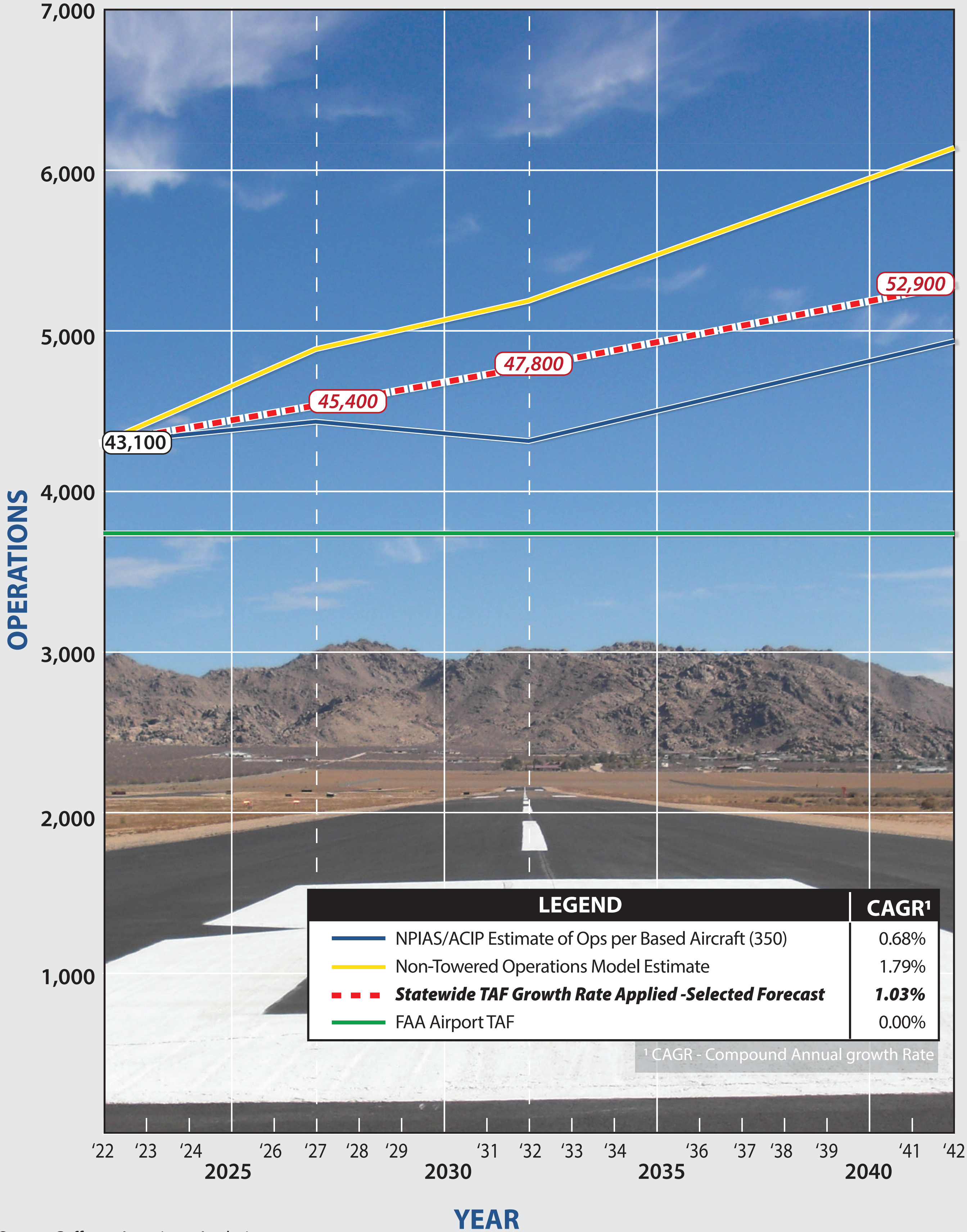
TABLE 2P | Operations Forecasts					
	2022	2027	2032	2042	CAGR 2022-2042
Non-Towered Operations Estimate	43,100	48,900	51,900	61,400	1.79%
NPIAS Ops per Based Aircraft (350)	43,100	44,400	46,200	49,400	0.68%
Statewide TAF Growth Rate Applied - SELECTED	**43,100**	**45,400**	**47,800**	**52,900**	**1.03%**
Note: Operations rounded to the nearest 100					

The three forecasts form a tight planning envelope. Any one of them could be the selected forecast. The model for non-towered airport estimate is used as the 2022 base line but it is not the selected forecast because the long-term operations estimate is on the high end and would require an active Part 141 flight school. The other two are so similar, the forecast analysis used their judgement to select the middle forecast, which is the application of the statewide TAF operations growth rate of 1.03 percent. The remaining forecast was not selected because the airport already has a ratio of based aircraft to operations that is above the 350 operations per based aircraft NPIAS estimate.

The total operations forecast results in the following:

- 2022 – 43,100 operations
- 2027 – 45,400 operations
- 2032 – 47,800 operations
- 2039 – 52,900 operations

The FAA TAF assumes that 66 percent of the operations are local in nature, and 34 percent are itinerant. For planning purposes, this ratio will be carried into the plan years.



Source: Coffman Associates Analysis

Air Taxi and Military Operations Forecast

The mix of operations by activity type is an important consideration as changes to the operating mix at the Airport can impact future design standards and facility requirements. Operations are classified as local general aviation, itinerant general aviation, itinerant air taxi, and local and itinerant military. Air taxi operations will be estimated first because there are sources of information available to quantify this activity.

Air Taxi Estimate

Air taxi operations are those with the authority to provide "on-demand" or "for-hire" transportation of persons or property via aircraft with fewer than 60 passenger seats. Air taxi includes a broad range of operations, including some smaller commercial service aircraft, some charter aircraft, air cargo aircraft, many fractional ownership aircraft, and air ambulance services. Currently, there is no commuter service or air cargo activity at the Airport, and none is anticipated. There is occasional air ambulance, charter, and fractional activity at the Airport, however, the activity levels are relatively low. In the future, each of these can be expected to increase as the region grows.

Table 2Q summarizes the projections of air taxi activity at the Airport over the plan years. Cargo is not expected to ever be established at the Airport because SCLA is better equipped to accommodate cargo operations. Air ambulance activity will increase as the region grows. Ultimately, the Airport could be a base for air ambulance operations. While not currently accounting for many operations, charter and fractional operations can be expected to increase substantially as business and industry increase in the areas immediately surrounding the airport. All air taxi operations are considered itinerant in nature.

TABLE 2Q | Air Taxi Operations Forecast	2022	2027	2032	2042
Cargo	0	0	0	0
Air Ambulance	20	100	300	600
Fractional/Charters	20	300	600	900
Total Air Taxi	**40**	**400**	**900**	**1,500**

Source: Coffman Associates analysis

Military Operations

Military aircraft can and do utilize civilian airports across the country. According to the TAF, there are no military operations at the airport currently and none projected in the future. Often military training flights will utilize an airport due to some specific feature such as the presence of an ILS instrument approach. Victorville (VCV) to the west of APV has an ILS, and the TAF for that airport indicated a high volume of military operations. It appears that military flights are attracted to that airport over APV. In accordance with the FAA TAF for APV, no future military operations are considered.

Total Operations Forecast Summary

Table 2R presents the classification of the selected operations forecast. The Airport primarily experiences general aviation activity and a small level of air taxi activity. In the future, as the region continues to grow and more business activity occurs, the Airport can expect increasing levels of air taxi operations.

TABLE 2R | Total Operations Forecast						
Year	LOCAL OPERATIONS		ITINERANT OPERATIONS			Grand Total
	General Aviation	Total	General Aviation	Air Taxi	Total	
2022	28,735	28,735	14,325	40	14,365	43,100
2027	30,268	30,268	14,732	400	15,132	45,400
2032	31,868	31,868	15,032	900	15,932	47,800
2042	35,268	35,268	16,132	1,500	17,632	52,900
					CAGR	1.03%
CAGR = Compound annual growth rate						

OPERATIONS BY FLEET MIX

Developing an understanding of the operational fleet mix, including the approximate volume of operations by aircraft type, is important because this information is utilized in airfield capacity analysis, fuel storage capacity analysis, pavement utilization determinations, and noise impact analysis.

Table 2S presents the fleet mix operations forecast for the Airport. Several operational assumptions have been made which were informed by interviews with tenants, Airport management, and operational averages by aircraft types at other general aviation airports with similar characteristics to APV. For example, at APV we know that the CHP helicopters are utilized on a near daily basis and often multiple times per day. We also know that there are relatively few turboprop and jet operations today, and none of them are considered local in nature.

Piston aircraft tend to have lower utilization rates as compared to turboprop and jet aircraft. Turboprop and jet aircraft tend to have high utilization rates. The helicopters at the APV have very high utilization rates because of the public safety nature of their mission. The fleet mix considers a substantial increase in turboprop and jet activity within the next five years with several turbine aircraft basing at the Airport. It should be noted that while the estimates are a function of the number of based aircraft, the estimates account for all activity by that type of aircraft at the Airport, not just those based at the Airport.

TABLE 2S | Fleet Mix Operations Forecast								
	2022	**%**	**2027**	**%**	**2032**	**%**	**2042**	**%**
LOCAL OPERATIONS								
Piston	28,635	99.7%	3118	99.5%	31,668	99.4%	34,968	99.1%
Helicopter	100	0.3%	150	0.5%	200	0.6%	300	0.9%
Total Local	***27,735***	***100.0%***	***32,268***	***100.0%***	***31,868***	***100.0%***	***35,268***	***100.0%***
ITINERANT OPERATIONS								
Single Piston	12,065	84.0%	11,732	77.5%	11,382	71.4%	10,532	59.7%
Multi-Piston	800	5.6%	800	5.3%	800	5.0%	800	4.5%
Turboprop	200	1.4%	500	3.3%	750	4.7%	1,500	8.5%
Jet	100	0.7%	300	2.0%	600	3.8%	1,200	6.8%
Helicopters	1,200	8.4%	1,800	11.9%	2,400	15.1%	3,600	20.4%
Total Itinerant	***14,365***	***100.0%***	***15,132***	***100.0%***	***15,932***	***100.0%***	***17,632***	***100.0%***
Total Operations	**43,100**		**45,400**		**47,800**		**52,900**	

Operational assumptions:
Multi-engine Piston: 200 per based aircraft
Turboprop: 250 per based aircraft
Jet: 300 per based aircraft
Helicopter: 400-600 per based aircraft

Source: Coffman Associates analysis

PEAKING CHARACTERISTICS

Many aspects of facility planning relate to levels of peaking activity – times when an airport is busiest. For example, the appropriate size of terminal facilities can be estimated by determining the number of people that could reasonably be expected to use the facility at a given time. The following planning definitions apply to the peak periods:

- **Peak Month** – The calendar month when peak aircraft operations occur.
- **Design Day** – The average day in the peak month.
- **Design Hour** – The peak hour within the design day.

The peak month is an absolute peak within a given year. All other peak periods will be exceeded at various times during the year. The peak period forecasts represent reasonable planning standards that can be applied without overbuilding or being too restrictive. Because there is not an ATCT, peak periods must be estimated based on the analyst's understanding of peak periods at towered general aviation airports. **Table 2T** summarizes the peak operations characteristics for the Airport.

TABLE 2T | Peaking Characteristics				
Peak Period	**2022**	**2027**	**2032**	**2042**
Annual Operations	**43,100**	**45,400**	**47,800**	**52,900**
Peak Month (12%)	5,172	5,448	5,736	6,348
Design Day (30)	172	182	191	212
Design Hour (11%)	19	20	21	23

Currently, the estimated design hour is 19 operations, which means facility planning that considers this variable, such as airfield capacity, should be designed to this level. By 2042, the design hour is projected to increase to 23 operations.

FORECAST SUMMARY

This chapter has outlined the various activity levels that might reasonably be anticipated over the planning period. **Exhibit 2D** presents a summary of the aviation forecasts prepared in this chapter. The base year for these forecasts is 2022 with a 20-year planning horizon to 2042. The primary aviation demand indicators are based aircraft and operations.

Based aircraft are forecast to increase from 117 in 2022 to 141 by 2042 for an annual growth rate of 0.94 percent. This growth scenario takes into consideration the current strong economic standing of the general aviation industry and the fact that the region in which the Airport is located is growing substantially. Total operations are forecast to increase from 43,100 in 2022 to 52,900 by 2042, which is an annual growth rate of 1.03 percent. Several forecasts for each aviation demand indicator were developed to create a range of reasonable forecasts, from which the final forecasts were selected.

FORECAST COMPARISON TO THE TAF

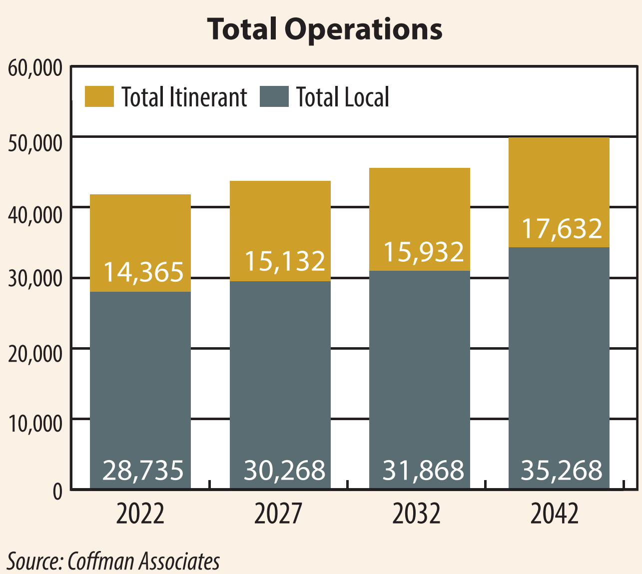
When reviewing airport master plan forecasts, FAA compares them to the TAF for consistency. To be consistent with the TAF, the master plan forecasts should differ by 10 percent or less in the first five years and 15 percent or less in the 10-year timeframe. In addition, the forecasts should not affect the timing of a project or the role of the airport. Where these criteria are not met, additional review with the local FAA office or FAA headquarters may be necessary.

As documented in Table 2D, the TAF forecast for both operations and based aircraft is flat, meaning the estimates for 2022 and every year after are the same. This is not a forecast, per se, and is instead a placeholder included by FAA headquarters to account for activity at the Airport. No analysis was done to establish the TAF forecasts. For based aircraft, the TAF has a value of 125 for every year, which does not take into consideration the validated based aircraft count (117) from the FAA's based aircraft inventory database. For total operations, the TAF does not present a forecast, instead using the same estimate of 37,500 for every year.

Table 2U presents a comparison of the Master Plan forecasts and the FAA TAF for based aircraft and total operations. The percentage difference is the absolute value of the difference between the two numbers divided by the average of the two numbers. For based aircraft, the Master Plan forecast is higher than the TAF because the TAF baseline of 125 is inconsistent with the FAA's based aircraft database (www.basedaircraft.com) which shows 117 validated base aircraft. For operations, the Master Plan forecast is higher than the TAF primarily because the TAF does not use any statistical analysis to establish an operations baseline. Conversely, the Master Plan forecasts establish the baseline operations count utilizing the FAA approved *Model for Estimating General Aviation Operations at Non-Towered Airports Using Towered and Non-Towered Airport Data*. FAA may use the forecasts developed for this Master Plan to update the TAF.

	Base Year	Forecast			
	2022	2027	2033	2042	CAGR* 2022-2042
BASED AIRCRAFT					
Single-engine piston	111	117	119	121	
Multi-engine piston	4	4	4	4	
Turboprop	0	2	3	6	
Jet	0	1	2	4	
Helicopter	2	3	4	6	
Total Based Aircraft	**117**	**127**	**132**	**141**	**0.94%**
ANNUAL OPERATIONS					
Air Taxi Itinerant	40	400	900	1,500	19.87%
General Aviation Itinerant	14,325	14,732	15,032	16,132	0.60%
General Aviation Local	28,735	30,268	31,868	35,268	1.03%
TOTAL OPERATIONS	**43,100**	**45,400**	**47,800**	**52,900**	**1.03%**
PEAKING CHARACTERISTICS					
Peak Month (12%)	5,172	5,448	5,736	6,348	1.03%
Design Day (30)	172	182	191	212	1.03%
Design Hour (11%)	19	20	21	23	1.03%

*CAGR: Compound annual growth rate



Source: Coffman Associates

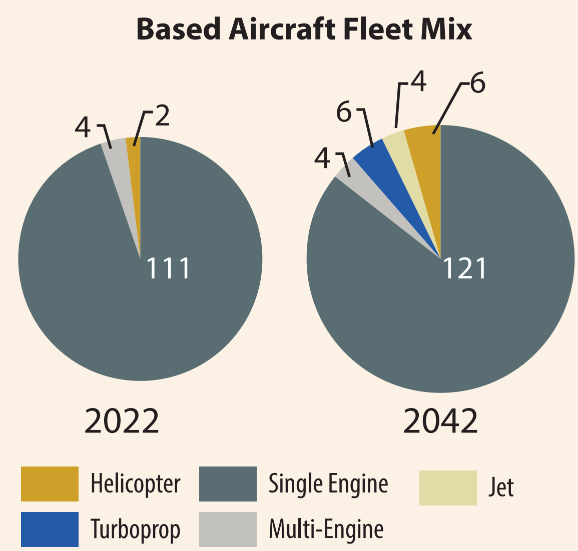


TABLE 2U | Forecast Comparison to the Terminal Area Forecast (TAF)					
	Base Year	FORECAST			CAGR
	2022	2027	2032	2042	2022-2042
TOTAL OPERATIONS					
Master Plan Forecast	43,100	45,400	47,800	52,900	1.03%
2022 FAA TAF[1]	37,500	37,500	37,500	37,500	0.00%
% Difference	13.9%	19.1%	24.2%	34.1%	
BASED AIRCRAFT					
Master Plan Forecast	117	127	132	141	0.94%
2022 FAA TAF[1]	125	125	125	125	0.00%
% Difference	-5.8%	2.4%	6.3%	12.8%	
CAGR: Average annual growth rate					

[1]*Source: Terminal Area Forecast (published February 2023)*

Projections of aviation demand will be influenced by unforeseen factors and events in the future. In the recent past, events such as terrorist attacks, economic recessions, and COVID-19, have impacted aviation demand. Therefore, it is not reasonable to assume that future demand will follow the exact projection line; however, over time, forecasts of aviation demand do tend to fall within the planning envelope. The forecasts developed for this master planning effort are considered reasonable for planning purposes. The need for additional facilities will be based upon these forecasts; however, if demand does not materialize as projected, implementation of facility construction can be slowed. Likewise, if demand exceeds these forecasts, implementation of facility construction can be accelerated.

AIRCRAFT/AIRPORT/RUNWAY CLASSIFICATION

The FAA has established several aircraft classification systems that group aircraft types based on their performance (approach speed in landing configuration) and 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 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 type or a composite aircraft representing a collection of aircraft with similar characteristics. The design aircraft is classified by three parameters: Aircraft Approach Category (AAC), Airplane Design Group (ADG), and Taxiway Design Group (TDG). FAA AC 150/5300-13B, *Airport Design*, describes the following airplane classification systems, the parameters of which are presented on **Exhibit 2E**.

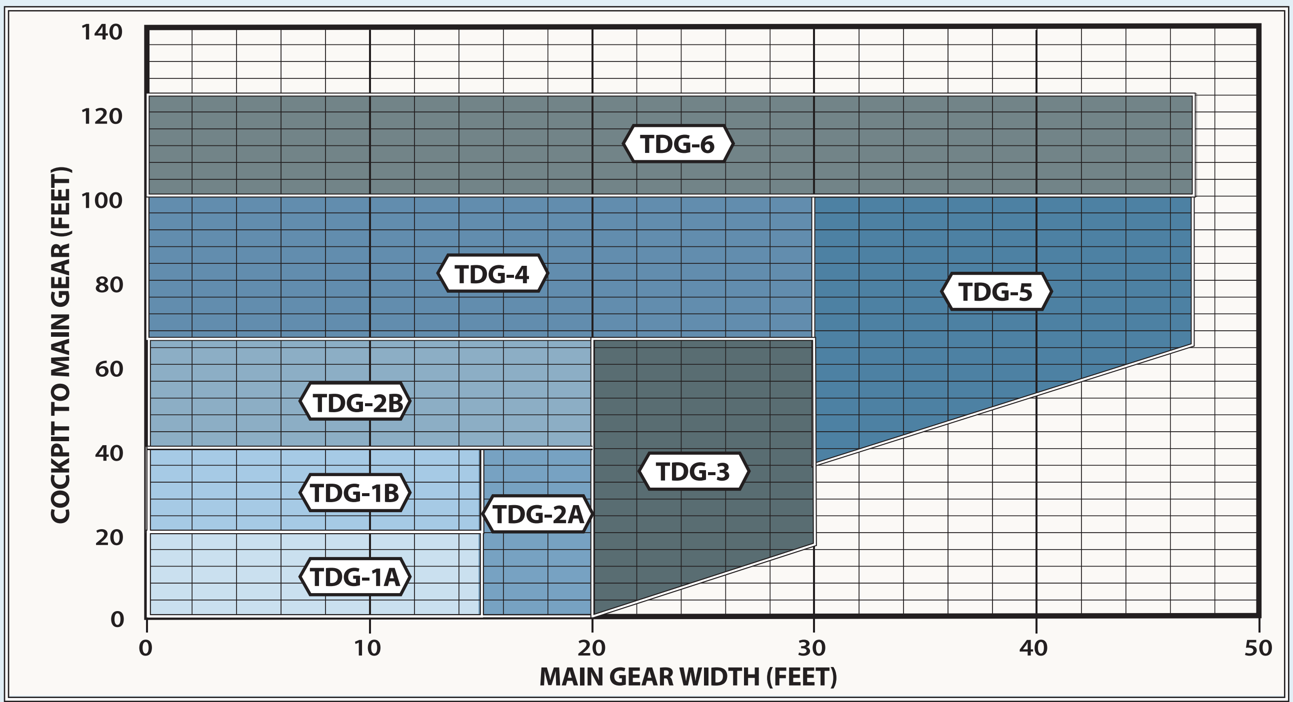
AIRCRAFT APPROACH CATEGORY (AAC)	
Category	**Approach Speed**
A	less than 91 knots
B	91 knots or more but less than 121 knots
C	121 knots or more but less than 141 knots
D	141 knots or more but less than 166 knots
E	166 knots or more

AIRPLANE DESIGN GROUP (ADG)		
Group #	**Tail Height (ft)**	**Wingspan (ft)**
I	<20	<49
II	20-<30	49-<79
III	30-<45	79-<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	Not lower than 1-mile
4,000	Lower than 1-mile but not lower than ¾-mile
2,400	Lower than ¾-mile but not lower than ½-mile
1,600	Lower than ½-mile but not lower than ¼-mile
1,200	Lower than ¼-mile

***RVR**: Runway Visual Range

TAXIWAY DESIGN GROUP (TDG)



Source: FAA AC 150/5300-13B, Airport Design

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 (operational characteristic). The higher the approach speed, the more restrictive the applicable design standards. The AAC, depicted by a letter A through E, relates to aircraft approach speed. 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 characteristics). 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 (TOFA), taxilane object free area, apron wingtip clearance, and various separation distances.

Taxiway Design Group (TDG): A classification of airplanes based on outer-to-outer Main Gear Width (MGW) and Cockpit to Main Gear (CMG) distance. The TDG relates to the undercarriage dimensions of the design aircraft. The TDG is classified by an alphanumeric system: 1A, 1B, 2A, 2B, 3, 4, 5, and 6. 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 taxiway safety area (TSA), taxiway/taxilane object free area (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 (ADG) 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 2F summarizes the classification of the most common aircraft in operation today. Generally, recreational and business piston and turboprop aircraft will fall in AAC A and B and ADG I and II. Business jets typically fall in ACC B and C, while larger commercial aircraft will fall in AAC C and D.

AIRPORT AND RUNWAY CLASSIFICATIONS

Airport and runway 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.

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

A-I

Aircraft	TDG
Beech Baron 55	1A
Beech Bonanza	**1A**
Cessna 150, 172	1A
Eclipse 500	1A
Piper Archer, Seneca	1A

B-I

Aircraft	TDG
Beech Baron 58	**1A**
Beech King Air 90	1A
Cessna 421	1A
Cessna Citation CJ1 (525)	1A
Cessna Citation 1(500)	2A
Embraer Phenom 100	1B

A/B-II 12,500 lbs. or less

Aircraft	TDG
Beech Super King Air 200	**2A**
Cessna 441 Conquest	1A
Cessna Citation CJ2 (525A)	2A
Pilatus PC-12	1A

B-II over 12,500 lbs.

Aircraft	TDG
Beech Super King Air 350	2A
Cessna Citation CJ3(525B), V (560)	2A
Cessna Citation Bravo (550)	1A
Cessna Citation CJ4 (525C)	**1B**
Cessna Citation Latitude/Longitude	1B
Embraer Phenom 300	1B
Falcon 10, 20, 50	1B
Falcon 900, 2000	2A
Hawker 800, 800XP, 850XP, 4000	1B
Pilatus PC-24	1B

A/B-III

Aircraft	TDG
Bombardier Dash 8	3
Bombardier Global 5000, 6000, 7000, 8000	**2B**
Falcon 6X, 7X, 8X	2B

C/D-I

Aircraft	TDG
Lear 25, 31, 45, 55, 60	**1B**
Learjet 35, 36 (D-I)	1B

C/D-II

Aircraft	TDG
Challenger 600/604/ 800/850	1B
Cessna Citation VII, X+	1B
Embraer Legacy 450/500	1B
Gulfstream IV, 350, 450 (D-II)	2A
Gulfstream G200/G280	1B
Lear 70, 75	1B

C/D-III less than 150,000 lbs.

Aircraft	TDG
Gulfstream V	2A
Gulfstream G500, 550, 600, 650 **(D-III)**	**2B**

C/D-III over 150,000 lbs.

Aircraft	TDG
Airbus A319-100, 200	3
Boeing 737 -800, 900, BBJ2 (D-III)	**3**
MD-83, 88 (D-III)	4

C/D-IV

Aircraft	TDG
Airbus A300-100, 200, 600	5
Boeing 757-200	4
Boeing 767-300, **400**	**5**
MD-11	6

D-V

Aircraft	TDG
Airbus A330-200, 300	5
Airbus A340-500, 600	6
Boeing 747-100 - 400	5
Boeing 777-300	6
Boeing 787-8, 9	5

Note: Aircraft pictured is identified in bold type.

Exhibit 2F
AIRCRAFT REFERENCE CODES

wingspan or tail height (physical characteristics), whichever is most restrictive. The third component relates to the available instrument approach 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 reads "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 take off 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.

***Airport Reference Code (ARC)*:** An airport designation that signifies the 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 at an airport. The current Airport Layout Plan (ALP) for the Airport, which will be updated as part of this master planning effort, identifies an ARC of C-II for Runway 18-36 and B-I for Runway 8-26 currently and in the future.

CRITICAL AIRCRAFT AND RUNWAY DESIGN CODE

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 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 as the most demanding aircraft type, or grouping of aircraft with similar characteristics, that make regular use of the airport. Regular use is 500 annual operations, excluding touch-and-go operations. 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 150/5300-13B, *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.

CURRENT CRITICAL AIRCRAFT

There are three elements for classifying the critical aircraft. The three elements are the AAC, ADG, and the TDG. The AAC and ADG are examined first, followed by the TDG. Typically, the primary source of operational data by aircraft type would be the FAA's Traffic Flow Management System Count (TFMSC) database, which captures an operation when a pilot files a flight plan and/or when flights are detected by the National Airspace System, usually via radar. Due to factors, such as incomplete flight plans, limited radar coverage, and VFR operations, TFMSC data does not account for all aircraft activity at an airport by a given aircraft type. The TFMSC does provide an accurate reflection of IFR activity, and operators of high-performance aircraft, such as turboprops and jets, tend to file flight plans at a high rate. However, nearly all operations at APV are conducted under visual flight rules so very few operations are captured in this database. As a result, it is necessary to estimate what the current critical aircraft may be based on the analyst's knowledge of activity at the Airport.

The current FAA approved Airport Layout Plan (ALP) classifies the Airport as C-II-1B with a Challenger 600 as a representative aircraft. This aircraft and others like it operate at the Airport infrequently (less than 500 operations per year), according to the TFMSC data. A more representative critical aircraft would be those in B-II-2A. A representative aircraft would be a King Air 300. **For planning purposes, the current critical aircraft is classified as B-II-2A.**

FUTURE CRITICAL AIRCRAFT

The current critical aircraft is B-II-2A, and the future critical aircraft is C-II-2A.

It is not unusual for an airport to transition from one critical aircraft to another. Apple Valley Airport is one such airport that is well positioned to experience a transition to a larger critical aircraft. The Victor Valley is rapidly growing, and the Airport is located within the North Apple Valley Industrial Specific Plan (NAVISP), which is a 6,600-acre area zoned for industrial uses. Numerous companies have already constructed large industrial and warehousing facilities in the NAVISP. Because of these factors, airport management should continue to plan and design the Airport to accommodate an increase in activity by larger business jets classified as C-II-2A. **Therefore, the future critical aircraft is classified as C-II-2A.** Since most C-II business jets have a relatively narrow wheelbase (TDG 1A and 1B), the TDG of the future critical aircraft is based on activity by turboprops with wider wheelbases such as the King Air 200. Therefore, a representative aircraft that captures the critical aircraft elements is a composite of a Cessna 680 (C-II) and a King Air 200 (TDG 2A).

RUNWAY DESIGN CODE

Each runway is assigned an RDC. The RDC relates to specific FAA design standards that should be met in relation to each runway. The RDC takes into consideration the AAC, ADG, and the RVR. In most cases, the critical design aircraft will also be the RDC for the primary runway.

Runway 18-36 is the primary runway and should be designed to accommodate the current and future critical design aircraft. This runway is 6,498 feet long and 150 feet wide and has an instrument approach to Runway 18 with visibility minimums as low as ⅞-mile. **Based on the current activity, the applicable RDC is B-II-4000**.

In the future, improvements to the instrument approach capability should be considered to the primary runway. The lowest visibility minimum generally available to general aviation airports is ½-mile. Often visibility minimums of ½-mile are associated with an instrument landing system (ILS), however, FAA's NextGen program is making significant progress on developing GPS based approaches with ½-mile minimums. A straight-in instrument approach with visibility minimums of ½-mile is planned for Runway 18. **Therefore, the future RDC of Runway 18 is C-II-2400.**

Runway 8-26 is the crosswind runway measuring 4,099 feet long and 60 feet wide. This is a visual approach runway. The current ALP for the Airport classifies this as a B-I runway. This is the appropriate designation for a crosswind runway at Apple Valley Airport because this runway is primarily intended for piston aircraft that would be susceptible to crosswinds to the primary runway. **The current and future RDC for Runway 8-26 is B-I-VIS.**

APPROACH AND DEPARTURE REFERENCE CODES

The approach and departure reference codes (APRC and DPRC) describe the current operational capabilities of each runway and the adjacent parallel taxiways, where no special operating procedures are necessary. Essentially, the APRC and DPRC describe the current conditions at an airport in runway classification terms when considering the separation distance to a parallel taxiway.

Taxiway A is 400 feet from Runway 18-36, and Taxiway B is 240 feet from the Runway 8-26, centerline to centerline. Runway 18 has non-precision instrument approaches with ⅞-mile visibility minimums. Ultimately, the Runway 18 is planned to have ½-mile visibility minimums. Runway 8-26 is planned to remain a visual approach runway. The current APRC for Runway 18-36 is D/IV/4000 and D/V/4000, and the future APRC for Runway 18-36 is D/V/2400. The current and future DPRC for Runway 18-36 is D-IV and D-V. The current and future APRC for Runway 8-26 is B/II/VIS, and the current and future DPRC for Runway 8-26 is B/II.

CRITICAL AIRCRAFT SUMMARY

Table 2V summarizes the airport and runway classification for the current and future condition. Currently the Airport should be classified as B-II. With a projected increase in activity by medium and large business jets, the Airport may transition to C-II. This change will require more restrictive design standards to be applied to the airfield (which will be discussed in detail in the Facility Requirements chapter). Fortunately, the Airport has long been planned and constructed to the more restrictive C-II design standards, so the Airport is well positioned to accommodate this anticipated growth segment.

TABLE 2V | Airport and Runway Classifications

	Current	Future
Airport Reference Code (ARC)	B-II	C-II
Airport Design Aircraft	B-II-2A	C-II-2A
Composite Aircraft	King Air 300	Cessna 680/King Air 200
Runway Design Code (RDC)		
Runway 18-36	B-II-4000	C-II-2400
Runway 8-26	B-I-VIS	Same
Approach Reference Code (APRC)		
Runway 18-36	D-IV-4000/ D-V-4000	D-IV-2400
Runway 8-26	B-II-VIS	Same
Departure Reference Code (DPRC)		
Runway 18-36	D-IV/D-V	Same
Runway 8-26	B-II	Same

Source: FAA AC 150/5300-13B, Airport Design

The RDC for Runway 18-36 is B-II-4000 because of the availability of an instrument approach with ⅞-mile visibility minimums. The future RDC considers an instrument approach with ½-mile visibility minimums, which equates to RDC C-II-2400. The RDC for Runway 8-26 is planned to be maintained as B-I-VIS.

FORECAST SUMMARY

This chapter has outlined the various activity levels that might reasonably be anticipated over the planning period, as well as the critical aircraft for the Airport. Based aircraft are forecast to grow from 117 in 2022 to 141 by 2042, for an annual compound growth rate of 0.94 percent. Operations are forecast to grow from 43,100 in 2022 to 52,900 by 2042, for an annual compound growth rate of 1.03 percent.

The critical aircraft for the Airport is currently classified as B-II-2A, which is best represented by a King Air 300 turboprop as well as others in this category. Planning in this Master Plan considers increasing activity levels by business jets which will lead to a transition to a critical aircraft of C-II-2A. Because consideration is given to improving the visibility minimums to Runway 18-36 from ⅞-mile to ½-mile, the RDC for Runway 18-36 will transition from B-II-4000 to C-II-2400. The RDC for crosswind Runway 8-26 is planned to remain B-I-VIS.

The next step in the planning process is to assess the capabilities of the existing facilities to determine what upgrades may be necessary to meet future demands. The range of forecasts developed here will be taken forward in the next chapter as planning horizon activity levels that will serve as milestones or activity benchmarks in evaluating facility requirements.